San Lorenzo Valley and North Coast Watersheds Sanitary Survey

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Prepared for

City of Santa Cruz
715 Graham Hill Rd.
Santa Cruz, CA 95060
In association with
San Lorenzo Valley Water District and
Lompico County Water District

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# Table of Contents

List of Tables ................................................................................................................ ix
List of Figures .................................................................................................................. x
List of Appendices .......................................................................................................... x
Executive Summary ...................................................................................................... I

## SECTION 1: INTRODUCTION ............................................................................. 1-1

1.1 Study Area ............................................................................................. 1-1
1.2 Watershed Sanitary Survey Requirements ......................................... 1-1
1.3 Objectives ............................................................................................... 1-3
1.4 Participating Drinking Water Utilities ................................................... 1-3
1.5 Report Organization ............................................................................. 1-3

## SECTION 2: WATERSHEDS AND WATER SUPPLY SYSTEMS ....................... 2-1

2.1 Watershed Description ........................................................................ 2-1
  2.1.1 Regional Hydrologic Setting ..................................................... 2-1
  2.1.2 Prior Studies .......................................................................... 2-2
  2.1.3 Significance of Storms, Droughts, Geology, and Baseflow .......... 2-3
  2.2 Land Use and Water Quality ................................................................. 2-4
    2.2.1 Land Use ........................................................................... 2-4
    2.2.2 Residential ......................................................................... 2-7
    2.2.3 Agricultural Uses and Animal Grazing .................................. 2-8
    2.2.4 Timber Harvests ................................................................. 2-8
    2.2.5 Mining ............................................................................. 2-11
    2.2.6 Recreation ......................................................................... 2-11
    2.2.7 Reservoir Sedimentation .................................................... 2-13
  2.3 Natural Conditions and Water Quality ................................................. 2-13
    2.3.1 Soils and Geology ................................................................ 2-14
    2.3.2 Faults and Seismic Activity ................................................. 2-16
    2.3.3 Volcanic Activity ................................................................. 2-16
    2.3.4 Vegetation ......................................................................... 2-18
    2.3.5 Wildlife ............................................................................ 2-18
  2.4 Water Supply Systems Background ....................................................... 2-19
    2.4.1 History ............................................................................... 2-19
    2.4.2 Santa Cruz Water Department (SCWD) ................................. 2-21
    2.4.3 San Lorenzo Valley Water District (SLVWD) ....................... 2-22
    2.4.4 Lompico County Water District (LCWD). ............................ 2-22
  2.5 Water Sources ..................................................................................... 2-23
    2.5.1 Santa Cruz Water Department ............................................. 2-23
Section 3: POTENTIAL CONTAMINANT SOURCES IN THE WATERSHEDS

3.1 Survey Methods ......................................................... 3-1
3.2 Wastewater ............................................................... 3-4
  3.2.1 Contaminants of Concern .................................. 3-6
  3.2.2 Existing Conditions ............................................. 3-7
    3.2.2.1 San Lorenzo River Watershed .................... 3-7
    3.2.2.2 Bacteria ................................................... 3-11
    3.2.2.3 Nitrate ..................................................... 3-11
    3.2.2.4 Loch Lomond Reservoir Subwatershed .......... 3-12
    3.2.2.5 North Coast Watersheds ............................ 3-12
  3.2.3 Significance ......................................................... 3-13
3.3 Urban Runoff ............................................................ 3-13
  3.3.1 Contaminants of Concern ................................. 3-13
  3.3.2 Existing Conditions ............................................ 3-14
    3.3.2.1 San Lorenzo River Watershed .................... 3-15
Table of Contents (cont’d)

3.3.2.2 Loch Lomond Reservoir and the Upper Newell Creek Watershed ........................................ 3-17
3.3.2.3 North Coast Watersheds .............................................. 3-17
3.3.2.4 SLVWD ....................................................................... 3-17
3.3.2.5 LCWD ...................................................................... 3-17
3.3.3 Significance ............................................................................ 3-17

3.4 Agricultural Land Use ........................................................................ 3-18
3.4.1 Contaminants of Concern ...................................................... 3-18
3.4.2 Existing Conditions ................................................................. 3-18
3.4.2.1 San Lorenzo River Watershed ........................................ 3-18
3.4.2.2 Loch Lomond Reservoir Subwatershed ....................... 3-19
3.4.2.3 North Coast Watersheds ............................................... 3-19
3.4.2.4 SLVWD .................................................................... 3-20
3.4.2.5 LCWD ...................................................................... 3-20
3.4.3 Significance ............................................................................ 3-20

3.5 Grazing Livestock .............................................................................. 3-20
3.5.1 Contaminants of Concern ...................................................... 3-20
3.5.2 San Lorenzo Valley .............................................................. 3-21
3.5.3 Loch Lomond Reservoir and upper Newell Creek watershed .................................................. 3-21
3.5.4 North Coast Watersheds ....................................................... 3-21
3.5.5 SLVWD .......................................................................... 3-21
3.5.6 LCWD ........................................................................... 3-21
3.5.7 Significance ............................................................................ 3-22

3.6 Concentrated Animal Facilities .......................................................... 3-22
3.6.1 Contaminants of Concern ...................................................... 3-24
3.6.2 San Lorenzo Watershed ....................................................... 3-25
3.6.3 Loch Lomond Reservoir Subwatershed ............................... 3-25
3.6.4 North Coast Watersheds ....................................................... 3-25
3.6.5 SLVWD .......................................................................... 3-25
3.6.6 LCWD ........................................................................... 3-25
3.6.7 Significance ............................................................................ 3-25

3.7 Pesticide and Herbicide Use .................................................................. 3-26
3.7.1 Contaminants of Concern ...................................................... 3-26
3.7.2 Existing Conditions ................................................................. 3-27
3.7.2.1 San Lorenzo River Watershed ........................................ 3-27
3.7.2.2 Loch Lomond Reservoir and upper Newell Creek watershed .................................................. 3-27
3.7.2.3 North Coast Watersheds ............................................... 3-28
3.7.2.4 SLVWD .................................................................... 3-29
3.7.2.5 LCWD ...................................................................... 3-29
3.7.3 Significance ............................................................................ 3-29

3.8 Wildlife ............................................................................................... 3-30
3.8.1 Contaminants of Concern ...................................................... 3-30
Table of Contents

3.8.2 San Lorenzo Valley, North Coast Watersheds, SLVWD, and LCWD ......................................................... 3-30
3.8.3 Significance ........................................................................................................................................... 3-30
3.9 Quarries/Mine Runoff ................................................................................................................................. 3-30
3.9.1 Contaminants of Concern ................................................................. 3-31
3.9.2 Existing Conditions ................................................................................................................................. 3-31
  3.9.2.1 San Lorenzo River Watershed ......................................................... 3-31
  3.9.2.2 Loch Lomond Reservoir and the upper Newell Creek watershed ............................................. 3-33
  3.9.2.3 North Coast Watersheds ................................................................. 3-33
  3.9.2.4 SLVWD .......................................................................................... 3-34
  3.9.2.5 SLVWD .......................................................................................... 3-34
3.9.3 Significance ........................................................................................................................................... 3-34
3.10 Solid and Hazardous Waste Disposal Facilities .......................................................................................... 3-35
3.10.1 Contaminants of Concern ................................................................. 3-35
3.10.2 Existing Conditions ................................................................................................................................. 3-35
  3.10.2.1 San Lorenzo River Watershed ......................................................... 3-35
  3.10.2.2 North Coast Watersheds and the Loch Lomond Reservoir .................................................. 3-36
3.10.3 Significance ........................................................................................................................................... 3-37
3.11 Timber Harvests/Logging ......................................................................................................................... 3-37
3.11.1 Contaminants of Concern ................................................................. 3-37
3.11.2 Existing Conditions ................................................................................................................................. 3-39
  3.11.2.1 SLVWD .......................................................................................... 3-41
  3.11.2.2 LCWD .......................................................................................... 3-41
3.11.3 Significance ........................................................................................................................................... 3-41
3.12 Recreation ................................................................................................................................................ 3-43
3.12.1 Contaminants of Concern ................................................................. 3-43
3.12.2 Existing Conditions ................................................................................................................................. 3-43
  3.12.2.1 San Lorenzo River Watershed ......................................................... 3-43
  3.12.2.2 Loch Lomond Reservoir and the upper Newell Creek watershed ............................................. 3-44
  3.12.2.3 North Coast Watersheds ................................................................. 3-44
  3.12.2.4 SLVWD .......................................................................................... 3-45
  3.12.2.5 LCWD .......................................................................................... 3-45
3.12.3 Significance ........................................................................................................................................... 3-45
3.13 Unauthorized Activity ............................................................................................................................... 3-46
3.13.1 Contaminants of Concern ................................................................. 3-46
3.13.2 San Lorenzo River Watershed ................................................................. 3-46
3.13.3 Loch Lomond Reservoir Subwatershed ................................................................. 3-47
3.13.4 North Coast Watersheds ................................................................. 3-47
3.13.5 SLVWD .......................................................................................... 3-47
3.13.6 LCWD .......................................................................................... 3-48
3.13.7 Significance ........................................................................................................................................... 3-48
3.14 Vehicle Upsets and Spills ......................................................................................................................... 3-48
3.14.1 San Lorenzo River Watershed ................................................................. 3-49
  3.14.1.1 Valeteria Dry Cleaners (6539 Highway 9) ......................................... 3-49
<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.14.1.2</td>
<td>Chevron Underground Storage Tank Leak (6325 Highway 9)</td>
</tr>
<tr>
<td>3.14.1.3</td>
<td>Sturdy Oil (former Exxon Station) Storage Tank Leak(s) (6225 Graham Hill Road)</td>
</tr>
<tr>
<td>3.14.1.4</td>
<td>Other Sites with Potential Plumes</td>
</tr>
<tr>
<td>3.14.2</td>
<td>Other Watersheds</td>
</tr>
<tr>
<td>3.14.3</td>
<td>Significance</td>
</tr>
<tr>
<td>3.15</td>
<td>Geologic Hazards</td>
</tr>
<tr>
<td>3.15.1</td>
<td>Seismic Events</td>
</tr>
<tr>
<td>3.15.2</td>
<td>Significance</td>
</tr>
<tr>
<td>3.15.3</td>
<td>Landslides and Other Major Slope Instabilities</td>
</tr>
<tr>
<td>3.15.4</td>
<td>Weather-related Events</td>
</tr>
<tr>
<td>3.15.5</td>
<td>Significance</td>
</tr>
<tr>
<td>3.16</td>
<td>Fires</td>
</tr>
<tr>
<td>3.16.1</td>
<td>San Lorenzo River Watershed</td>
</tr>
<tr>
<td>3.16.2</td>
<td>Loch Lomond Reservoir and the upper Newell Creek watershed</td>
</tr>
<tr>
<td>3.16.3</td>
<td>North Coast Watersheds</td>
</tr>
<tr>
<td>3.16.4</td>
<td>SLVWD</td>
</tr>
<tr>
<td>3.16.5</td>
<td>LCWD</td>
</tr>
<tr>
<td>3.16.6</td>
<td>Significance</td>
</tr>
</tbody>
</table>

**SECTION 4: WATERSHED MANAGEMENT AND CONTROL PRACTICES**

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>Introduction</td>
</tr>
<tr>
<td>4.2</td>
<td>Water Utility Management Practices</td>
</tr>
<tr>
<td>4.2.1</td>
<td>Jurisdiction</td>
</tr>
<tr>
<td>4.2.2</td>
<td>Watershed and Reservoir Management Practices</td>
</tr>
<tr>
<td>4.2.2.1</td>
<td>City of Santa Cruz Water Department</td>
</tr>
<tr>
<td>4.2.2.2</td>
<td>San Lorenzo Valley Water District</td>
</tr>
<tr>
<td>4.2.2.3</td>
<td>Lompico County Water District</td>
</tr>
<tr>
<td>4.2.3</td>
<td>Watershed Lands Acquisition</td>
</tr>
<tr>
<td>4.3</td>
<td>Inspection and Surveillance of the Watersheds</td>
</tr>
<tr>
<td>4.4</td>
<td>Key County Watershed Management Activities</td>
</tr>
<tr>
<td>4.5</td>
<td>Watershed Control Authority</td>
</tr>
<tr>
<td>4.5.1</td>
<td>The County General Plan and the Local Coastal Program (LCP)</td>
</tr>
<tr>
<td>4.5.2</td>
<td>Wastewater Discharge</td>
</tr>
<tr>
<td>4.5.3</td>
<td>Stormwater Regulations</td>
</tr>
<tr>
<td>4.5.4</td>
<td>Mines and Quarries</td>
</tr>
<tr>
<td>4.5.5</td>
<td>Animal Keeping Regulations in Santa Cruz County</td>
</tr>
<tr>
<td>4.5.6</td>
<td>Recreational Activities and Policies</td>
</tr>
<tr>
<td>4.6</td>
<td>Open Space Policies</td>
</tr>
<tr>
<td>4.7</td>
<td>Erosion Control/Soil Management Policies</td>
</tr>
<tr>
<td>4.7.1</td>
<td>Roads</td>
</tr>
</tbody>
</table>
4.8 Fire Management ................................................................. 4-14
4.9 Other Local, State and Federal Regulations ....................... 4-14
  4.9.1 Local Regulations .......................................................... 4-14
    4.9.1.1 Santa Cruz County Water Quality Control Ordinance [1974] 4-14
    4.9.1.2 Santa Cruz County Riparian Corridor and Wetlands Protection Ordinance 4-15
    4.9.1.3 Santa Cruz County Sensitive Habitat Protection Ordinance 4-15
  4.9.2 California State Regulations ........................................... 4-17
    4.9.2.1 California Porter-Cologne Water Quality Act [1969] ........ 4-17
    4.9.2.2 California Environmental Quality Act (CEQA) [1970] ....... 4-25
    4.9.2.3 California Department of Fish and Game .................... 4-25
    4.9.2.4 Statewide On-Site Wastewater Treatment Policy Assembly Bill (AB) 885 4-25
    4.9.2.5 Other State Legislation ........................................ 4-26
  4.9.3 Federal Regulation ........................................................ 4-26
    4.9.3.1 Clean Water Act – NPDES and TMDL ....................... 4-26
    4.9.3.2 Section 404 Wetland Filling and/or Dredging Permit Program .......... 4-27

SECTION 5: WATER QUALITY REGULATIONS AND EVALUATION ....... 5-1

  5.1 Water Quality Regulations .............................................. 5-1
    5.1.1 Surface Water Treatment Rule (SWTR) ....................... 5-1
    5.1.2 Interim Enhanced Surface Water Treatment Rule (IESWTR) .......... 5-2
    5.1.3 Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) 5-3
    5.1.4 Stage 1 and Stage 2 Disinfectants/Disinfection Byproducts/Rule .... 5-3
  5.2 Water Quality Constituents of Concern .............................. 5-4
    5.2.1 Cryptosporidium and Giardia ..................................... 5-4
    5.2.2 Turbidity ................................................................. 5-4
    5.2.3 Disinfection and Disinfection Byproducts ....................... 5-5
    5.2.4 Total Organic Carbon (TOC) ...................................... 5-5
    5.2.5 Perchlorate ............................................................ 5-5
    5.2.6 Arsenic Rule .......................................................... 5-6
  5.3 Groundwater Regulations .................................................. 5-6
    5.3.1 Radionuclides Rule .................................................. 5-6
    5.3.2 Groundwater Rule .................................................. 5-6
  5.4 Water Quality Evaluation .................................................. 5-6
    5.4.1 Coliform Bacteria .................................................... 5-7
    5.4.2 Santa Cruz Water Department ..................................... 5-8
    5.4.3 SLVWD .................................................................. 5-9
    5.4.4 LCWD .................................................................. 5-9
  5.5 Turbidity ................................................................. 5-13
Table of Contents (cont’d)

5.5.1 Santa Cruz Water Department .......................................................... 5-15
5.5.2 SLVWD .................................................................................. 5-15
5.5.3 LCWD ..................................................................................... 5-15
5.6 Nitrate ................................................................................................ 5-20
5.6.1 Santa Cruz Water Department .......................................................... 5-20
5.6.2 SLVWD .................................................................................. 5-21
5.6.3 LCWD ..................................................................................... 5-21
5.7 Odors ............................................................................................. 5-25
5.8 Organic Contaminants ....................................................................... 5-25
5.9 Other Water Quality Parameters ....................................................... 5-28

SECTION 6: CONCLUSIONS AND RECOMMENDATIONS............................... 6-1
6.1 SWTR Disinfection Compliance Requirements ........................................ 6-1
6.2 Significant Contaminant Sources ....................................................... 6-1
6.2.1 Significance of Contaminants .......................................................... 6-2
6.2.1.1 Conclusions ........................................................................ 6-2
6.2.1.2 Water Utilities Influenced ................................................... 6-9
6.2.1.3 Wastewater Discharge Recommendations ............................ 6-9
6.2.1.4 Urban Runoff Recommendations .......................................... 6-10
6.2.2 Confined Animal Facilities ............................................................. 6-11
6.2.2.1 Conclusions ........................................................................ 6-11
6.2.2.2 Water Utilities influenced ................................................... 6-11
6.2.2.3 Confined Animal Facilities Recommendations .................. 6-11
6.2.3 Unauthorized Activity ..................................................................... 6-12
6.2.3.1 Conclusions ........................................................................ 6-12
6.2.3.2 Water Utilities Influenced ................................................... 6-12
6.2.3.3 Unauthorized Activities Recommendations ....................... 6-12
6.2.4 Roads .......................................................................................... 6-12
6.2.4.1 Conclusions ........................................................................ 6-12
6.2.4.2 Water Utilities Influenced ................................................... 6-13
6.2.4.3 Roadway Maintenance Recommendations ......................... 6-13
6.2.4.4 Timber Harvests Roadway Recommendations ...................... 6-14
6.2.5 Mining/Quarry Activities ............................................................... 6-14
6.2.5.1 Conclusions ........................................................................ 6-14
6.2.5.2 Utilities influenced ............................................................... 6-15
6.2.5.3 Quarries and Mines Recommendations .................................. 6-15
6.2.6 Geologic Hazards and Fires ............................................................ 6-16
6.2.6.1 Conclusions ........................................................................ 6-16
6.2.6.2 Utilities influenced ............................................................... 6-16
6.2.6.3 Recommendations ............................................................... 6-16
6.2.7 Chemical Spills ............................................................................ 6-17
6.2.7.1 Conclusions ........................................................................ 6-17
6.2.7.2 Utilities influenced ............................................................... 6-17
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.2.7.3 Recommendations</td>
<td>6-17</td>
</tr>
<tr>
<td>6.2.8 Pesticides and Herbicides</td>
<td>6-17</td>
</tr>
<tr>
<td>6.2.8.1 Conclusions</td>
<td>6-17</td>
</tr>
<tr>
<td>6.2.8.2 Utilities influenced</td>
<td>6-17</td>
</tr>
<tr>
<td>6.2.8.3 Recommendations</td>
<td>6-18</td>
</tr>
<tr>
<td>6.3 Potential Contaminant Sources That Are Not Significant</td>
<td>6-18</td>
</tr>
<tr>
<td>6.3.1 Agricultural Land Use</td>
<td>6-18</td>
</tr>
<tr>
<td>6.3.2 Wildlife</td>
<td>6-20</td>
</tr>
<tr>
<td>6.3.3 Grazing Animals and Livestock</td>
<td>6-20</td>
</tr>
<tr>
<td>6.3.4 Solid or Hazardous Waste Facilities</td>
<td>6-20</td>
</tr>
<tr>
<td>6.3.5 Recreational Uses</td>
<td>6-20</td>
</tr>
<tr>
<td>6.3.6 NPDES Point Sources</td>
<td>6-20</td>
</tr>
<tr>
<td>6.4 Other Conclusions and Recommendations</td>
<td>6-21</td>
</tr>
<tr>
<td>6.4.1 Water-Quality Monitoring</td>
<td>6-21</td>
</tr>
<tr>
<td>6.4.1.1 Conclusions Regarding Water Quality Monitoring Programs</td>
<td>6-21</td>
</tr>
<tr>
<td>6.4.1.2 Recommendations Regarding Water Quality Monitoring Programs</td>
<td>6-21</td>
</tr>
<tr>
<td>6.4.2 Watershed Management Practices</td>
<td>6-22</td>
</tr>
<tr>
<td>6.4.2.1 Conclusions Regarding Watershed Management Practices</td>
<td>6-22</td>
</tr>
<tr>
<td>6.4.2.2 Recommendations for Water Utilities</td>
<td>6-22</td>
</tr>
<tr>
<td>6.4.2.3 Recommendations for Watershed Managers</td>
<td>6-23</td>
</tr>
<tr>
<td>6.4.3 Emergency Plans</td>
<td>6-24</td>
</tr>
<tr>
<td>6.5 Implementation</td>
<td>6-24</td>
</tr>
</tbody>
</table>

References
List of Tables

Table 2-1: Watershed Areas and Drinking Water Purveyors Served
Table 2-2: Summary of Drinking Water Purveyors Serving Surface Water With More Than 200 Service Connections in the Study Area
Table 2-3: Summary of Small and Non-Participating Drinking Water Purveyors in the San Lorenzo River Watershed
Table 2-4: Summary of SCWD Water Rights
Table 2-5: Summary of Surface Water Rights for Utilities With More Than 200 Service Connections
Table 2-6: Summary of Water Sources Available for Utilities With More Than 200 Service Connections
Table 2-7: Summary of Conveyance/Intake Facilities for Utilities With More Than 200 Service Connections
Table 2-8: Summary of Surface Water Treatment Facilities for Utilities With More Than 200 Service Connections
Table 2-9: Summary of Distribution Systems for Utilities With More Than 200 Service Connections
Table 2-10: Summary of Distribution System Storage Reservoirs for Utilities With More Than 200 Service Connections
Table 3-1: Santa Cruz Watershed Sanitary Survey Contacts
Table 4-2: Surface Water Quality Regulations Relevant to Drinking Water Compliance
Table 5-1: Regulatory Schedule
Table 5-2: Lompico Creek Total Coliform (MPN/100 ml)
Table 5-3: Turbidity Results for SLVWD
Table 5-4: Summary of Nitrate Data Evaluated
Table 5-5: Total Hardness Summary of Available Data (mg/L as CaCO₃)
Table 5-6: Calcium Summary of Available Data (mg/L)
Table 5-7: Magnesium Summary of Available Data (mg/L)
Table 5-8: Sodium Summary of Available Data (mg/L)
Table 5-9: Potassium Summary of Available Data (mg/L)
Table 5-10: Alkalinity Summary of Available Data (mg/L as CaCO₃)
Table 5-11: Sulfate Summary of Available Data (mg/L)
Table 5-12: Chloride Summary of Available Data (mg/L)
Table 5-13: Fluoride Summary of Available Data (mg/L)
Table 5-14: Water pH Summary of Available Data (units)
Table 5-15: Total Dissolved Solids Summary of Available Data (mg/L)
Table 5-16: Conductivity Summary of Available Data (µhos/cm)
Table 5-17: Apparent Color Summary of Available Data (units)
Table 5-18: MBAS Summary of Available Data (mg/L)
Table 5-19: E.Coli, Cryptosporidium, Giardia
List of Figures

Figure 1-1: San Lorenzo Valley and North Coast Watersheds
Figure 2-1: Land Use
Figure 2-2: San Lorenzo Watershed Historic Timber Harvests
Figure 2-3: Quarries
Figure 2-4: Sandy Soil
Figure 2-5: Regional Geology
Figure 2-6: Process Layout of the Graham Hill Water Treatment Plant
Figure 3-1: Communities Wastewater Facilities
Figure 3-2: Commercial Stables Locations
Figure 3-3: Timber Resources
Figure 3-4: Fire Hazard Areas
Figure 5-1: Annual Geometric Mean of Total Coliform in the SCWD’s San Lorenzo River Sources, 2002-2011
Figure 5-2: Annual Geometric Mean of Total Coliform in the SCWD’s North Coast Sources, 2002-2011
Figure 5-3: Annual Geometric Mean of Total Coliform from Detectable Results for SLVWD, 2009-2013
Figure 5-4: Turbidity in SCWD’s San Lorenzo River Sources, 2001-2011
Figure 5-5: Turbidity in SCWD’s North Coast Sources, 2001-2011
Figure 5-6: Turbidity in SCWD’s San Lorenzo River Sources, 2006-2011 (10 point running average shown for clarity.) Data taken at varying intervals
Figure 5-7: Turbidity in SCWD’s North Coast Sources, 2006-2011 (10 point running average shown for clarity.) Data taken at varying intervals
Figure 5-8: Nitrate Concentrations in the SCWD’s San Lorenzo River Sources, 2001-2011
Figure 5-9: Nitrate Concentrations in the SCWD’s San Lorenzo River Sources, 1967-2011
Figure 5-10: Nitrate Concentrations in the SCWD’s North Coast Sources, 2001-2011
Figure 5-11: TON Measured in SCWD’s San Lorenzo River Sources, 2001-2011
Figure 5-12: TON Measured in SCWD’s North Coast Sources, 2001-2011

List of Appendices

A Draft Report: Graham Hill WTP Operations Permit Assistance Study
B Primary and Secondary Maximum Contaminant Limits
Executive Summary

The narrative below is a high-level summary of the major Watershed Sanitary Survey topics discussed in detail in this Watershed Sanitary Survey Update for the City of Santa Cruz Water Department (SCWD), the San Lorenzo Valley Water District (SLVWD), and the Lompico County Water District (LCWD).

Watersheds and Water Supply Systems: - The City of Santa Cruz (City) owns 3,640 acres, and San Lorenzo Valley Water District (SLVWD) owns 2,197 acres, and the Lompico County Water District is in the process of obtaining guardianship of almost 500 acres of the estimated 76,400 total acres within the San Lorenzo River upstream of the Tait Street diversion and are able to influence water quality management activities within the lands under their control including prohibitions on timber harvest.  In addition, there are other entities including Santa Cruz County, State of California Parks (Parks), and non-profit organizations such as Sempervirens Fund that can own, regulate and/or protect watershed lands for water quality benefit. Almost one –quarter of the lands in the San Lorenzo River are under ownership by entities that retain them as preserves.

The 7,600 acres of the North Coast watershed sources are mostly under private ownership. However, in 2011, the CEMEX properties were acquired by a group of organizations which results in the protection of an additional 8,532 acres of land with likely water quality benefit. Included in this acquisition is the quarry in the Liddell Springs watershed which is one of the City’s North Coast sources  The land is owned by the Sempervirens Fund and Peninsula Open Space Trust (POST) with funding support from Save the Redwoods League, the Nature Conservancy the Santa Cruz County Land Trust, and a number of foundations.  Future management of these lands is currently under development.

Potential Contaminant Sources: As discussed in Section 3, Section 6.2 and summarized in Table 6-2, there are a number of contaminant sources that can contribute sediments, pathogens, and chemicals that are potentially significant to drinking water quality which include:

- Wastewater and Urban Runoff
- Confined Animal Facilities
- Unauthorized Activity
- Roads including Timber Harvest Roads
- Mining/Quarry Activities
- Geologic Hazards and Fires
- Chemical Spills
- Pesticides and Herbicides

Watershed Management Activities: As discussed in Section 4, watershed management jurisdiction in the San Lorenzo and North Coast watersheds is distributed; the majority of the watershed is governed by Santa Cruz County and/or regulated by Federal and state agencies such as National Oceanic and Atmospheric Administration (NOAA) Fisheries, US Army Corps of Engineers, California Regional Water Quality Control Board (RWQCB), Parks, California Department of Forestry and Fire Protection (CalFire or CDF), and California Department of Fish
and Game (DFG) with the water purveyors jurisdiction limited mostly to those areas that they have land ownership as summarized earlier. In addition, local non-governmental organizations can play a role in watershed protection and water quality improvement as partners as well as individually.

Watershed management includes regulatory activities and management/planning activities which are detailed in Section 4. Regulatory activities include the County’s ordinances on wastewater management, water quality, riparian and sensitive habitats; State regulations on beneficial use and permitting of stormwater, urban runoff, riparian zone construction, and timber harvest by the California Regional Water Quality Control Board (RWQCB); and federal water quality regulations for waste discharge and wetland filling. Specific discussion regarding the non-drinking water quality regulatory activities is discussed further below.

Management and planning activities also occur at the local, state and federal levels and include the City’s watershed management plan that can include patrol of riparian areas; the County’s General Plan, San Lorenzo River Watershed, Wastewater, and Nitrate Management Plans as well as County road maintenance manuals; the activities of local non-governmental organizations to educate and work with landowners on horse stable management, fire protection, and water quality improvement; and State fire and fuel management plans within the State Parks as well as on other lands. Collectively, these regulations and watershed management plans generally provide a high level of oversight of activities that impact and improve water quality which is supported by the water quality data. However, coordination between the entities and their activities can be improved upon.

In addition, City staff has been creative in implementing measures that have the potential to directly improve water quality. Measures include funding patrols especially in riparian areas as well as establishing conservation easements on private lands that allow City staff to work near drinking water diversions to restore and improve the waterway especially as related to unauthorized activities such as homeless encampments. On a broader San Lorenzo River watershed basis, the City has partnered with non-governmental organizations (NGOs) such as the Resource Conservation District of Santa Cruz County (RCD) to educate watershed users by installing watershed identification signs and signs at creek signings; these projects have been submitted to the Santa Cruz Integrated Regional Water Management (IRWM) for future funding. Other water quality improvement activities of NGOs include Santa Cruz RCD’s partnership with Ecology Action to assist citizens to improve horse stable facilities as well as Sempervirens Fund and POST’s efforts to acquire and protect watershed lands; both of which provide significant benefit to drinking water quality.

Non-Drinking Water Regulatory Challenges: Regulatory challenges such as water quality Total Maximum Daily Loads (TMDLs) administered by the RWQCB and fisheries-related Habitat Conservation Plans (HCP) administered by DFG continue to challenge the City. For example, implementation of TMDLs for pathogens and nutrients will ultimately benefit water quality but the City must rely on many other individuals to remove these constituents. In addition, implementation of the instream flow targets for HCPs, described in greater detail in Section 2.3.5, may limit the City’s use of their high quality North Coast water sources which will increase reliance on other sources with higher total organic carbon and resulting disinfection challenges.

Water Quality Data Summary: Water quality data for the period from 2006 -2011/2012 found in Figures and Tables in Section 5 indicate no unexpected changes in total coliform, turbidity, or
nitrate concentrations in the City’s North Coast or the San Lorenzo River watershed sources for the City, SLVWD, or LCWD; expected seasonal and dry/wet year variations have occurred. The North Coast sources, in particular Liddell Spring, have continued to have lower total coliform levels when compared to the San Lorenzo River sources.

Conclusions and Recommendations: The San Lorenzo and North Coast watersheds are generally providing a high water quality, with some expected variability during the wet season. The agencies closely manage the high turbidity events by bypassing stormflows, using stored water and/or alternative sources, that, when combined with the water treatment processes at the WTPs, are delivering a consistently safe drinking water to the residents. However, some of the future regulatory challenges faced particularly by the City, described above, may make it more difficult to continue to meet the drinking water regulations. The City has evaluated the water quality data in greater detail and has identified some potential changes, for discussion with DPH staff, which can be implemented to ensure continuing to meet drinking water regulations in the future.

More specific conclusions and recommendations are discussed in Section 6 and summarized in Table 6-2 and include activities such as continuing:

- Coordination acquisition and review of water quality monitoring data
- Implementation of County wastewater management and other management plans, road maintenance manual, and ordinances as well as coordinating with County agencies such as Emergency Response for toxic spills
- Review of developments in the watersheds, especially near diversions
- Support of local non-governmental organizations in public education and implementation of best management practices for roads and confined animals as well as land acquisition for preserves
- Improving collaboration with state regulatory agencies with regard to timber harvests, forest fuel management, illegal marijuana cultivation, and fisheries improvement
SECTION 1: INTRODUCTION

Sanitary surveys are required by the California Department of Public Health (DPH) to be completed for each watershed that is a drinking water source. Updates are required every five years per the State of California Surface Water Treatment regulations (Chapter 17, Title 22). These requirements incorporate the Surface Water Treatment Rule (SWTR) mandated by the United States Environmental Protection Agency (EPA) and enforced by DPH as a primacy agency for federal regulations.

This sanitary survey includes the San Lorenzo Valley and North Coast watersheds, all within Santa Cruz County, California (Figure 1-1). The first sanitary survey for this area was completed in 1996 by Camp Dresser & McKee, was updated in 2001 by the City of Santa Cruz Water Department (SCWD or City), and subsequently updated in 2006. This sanitary survey update is based on numerous discussions with utility and regulatory staff, review of various reports, an evaluation of historic and recent water quality monitoring results, and analyses of the ongoing management practices within the watershed area.

1.1 Study Area

Figure 1-1 illustrates the approximate watershed boundaries of the San Lorenzo Valley and North Coast watersheds, all within Santa Cruz County. The San Lorenzo Valley is the watershed for numerous water purveyors including SCWD, SLVWD, and LCWD. The North Coast watersheds included in this study provide water only to the SCWD. There are several large surface water intakes located throughout the study area.

1.2 Watershed Sanitary Survey Requirements

A watershed sanitary survey is a detailed evaluation of surface water sources and their vulnerability to contamination. It is more comprehensive than a Source Water Assessment (SWA) and can be used in place of a SWA to fulfill the requirements of California’s 1996 Drinking Water Source Assessment and Protection (DWSAP) Program. Whereas a SWA ranks and inventories possible contaminating activities (PCAs) located within the source area, a sanitary survey provides more background, descriptive information, and review of all relevant monitoring data. A SWA has been completed for each individual SCWD water source (Johnson 2002, 2003, 2005).

Specific sanitary survey requirements are:

- Conduct a sanitary survey of the watershed(s) at least every five years.
- Describe the hydrological conditions of the watershed, summarize source water quality data, describe activities and possible contamination sources, and identify any significant changes since a previous survey was conducted.
- Describe watershed control and management practices.
• Evaluate compliance with the SWTR with a focus on disinfection requirements.
• Recommend corrective actions to maintain or improve water quality.

1.3  Objectives

The objectives of this project are to:

• Prepare a stand-alone document that complies with the DPH requirements to update the 2006 watershed sanitary survey.
• Identify potential sources where chemical and microbiological contaminants may enter the water supply.
• Establish the baseline information needed for a watershed management program.
• Recommend actions to enhance water quality protection and watershed management.

The drinking water purveyors involved in this project should use this report to compare existing water quality conditions with future monitoring data, implement improvements to improve water quality, and reduce the risk of source water contamination.

1.4  Participating Drinking Water Utilities

A number of drinking water utilities are participating in this project because they receive surface water from the San Lorenzo Valley watershed area. The water purveyors that participated in this update include:

City of Santa Cruz Water Department
San Lorenzo Valley Water District
Lompico County Water District

1.5  Report Organization

This report follows the format in the Watershed Sanitary Survey Guidance Manual as required by DPH so that it conforms with reports developed by other suppliers for their watershed areas. Specific sections are:

Section 1: Introduction
Section 2: Watershed and Water Supply System
Section 3: Potential Contaminant Sources in the Watersheds
Section 4: Watershed Management and Control Practices
Section 5: Water Quality Regulations and Evaluation
Section 6: Conclusions and Recommendations

Figure 1-1, located at the front of this report, illustrates the approximate watershed boundaries, key subwatersheds, location of the large raw water intakes, primary roadways, and streams within the study area. This other watershed figures will be referred to throughout the report.
SECTION 2: WATERSHEDS AND WATER SUPPLY SYSTEMS

2.1 Watershed Description

The San Lorenzo Valley and North Coast watersheds and water purveyors which use surface water are described in this section. This description includes the San Lorenzo Valley and North Coast watersheds. The latter sources are used only by the SCWD. The watershed area, subwatersheds within the San Lorenzo Valley, and approximate land areas are listed in Table 2-1.

Table 2-1: Watershed Areas and Drinking Water Purveyors Served

<table>
<thead>
<tr>
<th>Watershed Area</th>
<th>Utilities Served</th>
<th>Watershed Area</th>
<th>Square Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Lorenzo River Valley (upstream of the SCWD Tait Street Diversion)</td>
<td>SCWD, SLVWD</td>
<td>74,000</td>
<td>115</td>
</tr>
<tr>
<td>Subwatersheds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loch Lomond Reservoir</td>
<td>SCWD and SLVWD</td>
<td>5,300</td>
<td>8.3</td>
</tr>
<tr>
<td>Fall Creek, Bennett and Bull Springs</td>
<td>SLVWD</td>
<td>2,600</td>
<td>4.1</td>
</tr>
<tr>
<td>Sweetwater Creek</td>
<td>SLVWD</td>
<td>180</td>
<td>0.3</td>
</tr>
<tr>
<td>Clear Creek</td>
<td>SLVWD</td>
<td>460</td>
<td>0.7</td>
</tr>
<tr>
<td>Foreman Creek</td>
<td>SLVWD</td>
<td>500</td>
<td>0.8</td>
</tr>
<tr>
<td>Silver Creek</td>
<td>SLVWD</td>
<td>20</td>
<td>0.03</td>
</tr>
<tr>
<td>Peavine Creek</td>
<td>SLVWD</td>
<td>230</td>
<td>0.4</td>
</tr>
<tr>
<td>Lompico Creek</td>
<td>LCWD</td>
<td>1,470</td>
<td>2.29</td>
</tr>
<tr>
<td>North Coast Watersheds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liddell Spring</td>
<td>SCWD</td>
<td>1,200</td>
<td>1.9</td>
</tr>
<tr>
<td>Laguna Creek/Reggiardo Creek</td>
<td>SCWD</td>
<td>3,300</td>
<td>5.2</td>
</tr>
<tr>
<td>Majors Creek</td>
<td>SCWD</td>
<td>2,500</td>
<td>3.9</td>
</tr>
</tbody>
</table>

(1) Figure 1-1 shows the study area primary watersheds and subwatersheds within the San Lorenzo River valley, the North Coast watersheds, and the general locations for each utility.

(2) Numerous other drinking water purveyors with less than 200 service connections use surface water from this watershed.

(3) The surface watershed at Liddell Spring is 1,200 acres, the total drainage area including subsurface karst is approximately 2,000 acres (P.E. LaMoreaux & Associates, 2005a).

2.1.1 Regional Hydrologic Setting

The project area includes the San Lorenzo River and the North Coast watersheds which include Majors Creek, Laguna Creek, and Liddell Spring watersheds in north central Santa Cruz County. The City diverts water from Reggiardo Creek, which provides a minimal amount of flow, into Laguna Creek where a larger diversion exists. The San Lorenzo River watershed is the largest contiguous watershed area in the area with an overall area of about 76,400 acres or 115 square miles. The smaller North Coast watersheds are west of the City of Santa Cruz and drain the coastal side of Ben Lomond Mountain. The North Coast watersheds have a total area

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1 Because Ben Lomond Mountain is so asymmetrical, with a steep eastern face, it is likely that subsurface flows from near its crest drains eastward into the San Lorenzo Valley (see Hecht, 1978; Johnson, 1999). Hence, headwardmost portions of the Laguna and Majors topographic watersheds may be recharge areas to San Lorenzo Valley sources.
of about 5,600 acres, or approximately 9 square miles. The SCWD maintains one large reservoir, Loch Lomond, on Newell Creek, a tributary to the San Lorenzo River.

### 2.1.2 Prior Studies

The City and County of Santa Cruz, as well as the area water purveyors, have conducted evaluations of watershed management, water supply, and water quality protection. Key existing information sources include hydrologic and water quality studies conducted by the County of Santa Cruz, U.S. Geological Survey, U.S. Army Corps of Engineers, Central Coast Regional Water Quality Control Board (Regional Board), California Department of Water Resources, local water purveyors, and consulting specialists. Much of this work is considered and cited in several summary reports (Ricker, 1994; Hecht and others, 1991; Camp Dresser & McKee, 1994; Swanson, 2001; and the San Lorenzo River Watershed Plan Update, 2001). Pertinent findings of the prior investigations are incorporated into this report.

Streamflow in the area has been measured by several resource agencies throughout the last several decades. On the San Lorenzo River, the U.S. Geological Survey (USGS) operates long-term stream gages at Big Trees (at the Henry Cowell State Park entrance road) and at Santa Cruz (at Tait Street near the City’s Graham Hill Water Treatment Plant (WTP)) in cooperation with the City Water Department as shown on Figure 1-1.

In the past, USGS operated gages for multi-year periods at: San Lorenzo River near Boulder Creek, Boulder and Bear Creeks near Boulder Creek, Newell Creek (prior to the construction of Loch Lomond Reservoir), Zayante Creek at Zayante, Bean and Carbonera Creeks in Scotts Valley, and Branciforte Creek. In the North Coast watersheds, the USGS operated gages for multi-year periods at: Majors Creek, Laguna Creek, and San Vincente Creek, an adjoining watershed of similar size immediately to the west of Laguna Creek.

From 2000 to the present, the City of Santa Cruz established ten gaging stations within the study area to help manage the water resource and in-stream habitat, some of which occupy former USGS gaging stations. Two gages are located within the San Lorenzo Valley: on Newell Creek, above and below Loch Lomond. Eight gages are located in the North Coast watersheds: three gages are on Laguna Creek, upstream and downstream of the diversion dam, and downstream at Highway 1; three gages are located on Majors Creek, upstream and downstream of the diversion dam, and downstream at Highway 1; and two gages are located on Liddell Creek, immediately downstream of the spring box and at Highway 1. Some of these stations are equipped with specific conductance and temperature sensors or have had such measurements made routinely over the past several years. In 2011, Scotts Valley Water District established two gaging stations on Bean Creek near Scotts Valley: one at Mount Hermon Camp, and the other upstream at Mount Hermon Road (former USGS site).²

Water quality stations were operated for several years at the San Lorenzo Valley gages by the USGS or the California Department of Water Resources (DWR).² Water quality and instantaneous flow were monitored intermittently in Kings, Two Bar, Love, Fall, and Lompico Creeks, and on lower Zayante Creek below Bean Creek, although no daily records were developed. Much of the USGS water-quality information has been summarized in a report by Sylvester and Covay (1978). Santa Cruz County has routinely sampled an array of other stations in the San Lorenzo Valley. The City of Santa Cruz regularly samples water quality from

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² Bean Creek at Mount Hermon is a continuous turbidity monitoring station, while upstream Bean Creek at Mount Hermon Road is a continuous specific conductance monitoring station.

² DWR also sampled the coastal streams for water quality on a monthly, and then on an intermittent basis, during the 1960s and 1970s.
San Lorenzo River sources (Loch Lomond, the Felton Diversion, and Tait Street intakes) and from North Coast sources (Liddell Spring, Laguna Creek, and Majors Creek). The City also operates continuous turbidity monitoring stations at Upper Newell Creek, Tait Street, Liddell Spring, Upper Laguna Creek, and Upper Majors Creek. The San Lorenzo Valley Water District regularly samples water quality at each point of diversion: Clear Creek, Peavine Creek, Sweetwater Creek and Foreman Creek but does not collect creek flow data. SLVWD has also recently completed Parts I- Existing Conditions and II- Goals, Objectives, and Policies of the Watershed Management Plan for the SLVWD watersheds.

LCWD staff sample at the Lompico Creek intake structure to conform to regulatory requirements. These data are recorded and kept on-site, and are also submitted to the California DPH.

While streamflow gaging has diminished in the San Lorenzo Valley over the past 25 years, the number of stations at which water-quality sampling is conducted has gradually increased, as have the frequency of sampling and the number of constituents tested.

2.1.3 Significance of Storms, Droughts, Geology, and Baseflow

Streamflow in the Santa Cruz Mountains varies seasonally. About 85 percent of annual rainfall occurs in the six months from December through May. Winter precipitation generally does not increase streamflow until after soil saturation occurs, following the initial rains of the season, with the highest flows typically occurring from late December through March. Streamflow declines sharply after the winter rains cease. Snows are relatively rare in the Santa Cruz Mountains and do not create a snowmelt-runoff season.

The longest continuous period of record in the area is the USGS gage on the San Lorenzo at Big Trees located just south of Felton (USGS Station No. 11160500). This gage has operated since 1937 and measures discharge from about 85 percent of the watershed upstream of the Tait Street Diversion. The maximum recorded discharge was 30,400 cfs (19,600 million gallons per day or ‘mgd’) on December 23, 1955. The minimum instantaneous daily discharge was 5.6 cfs (3.6 mgd) on July 27 and 28, 1977, during a hard two-year drought. The annual mean runoff for the period of water year 1937 to water year 2010 is 132 cfs (86 mgd).

Surface water quality in the San Lorenzo River basin fluctuates seasonally in relation to streamflow. During periods of high runoff, sediment and organic debris, urban runoff, animal wastes and wastewater from septic systems enter the surface water system. During dry periods and droughts, ground water sustains baseflow to the area streams. The ground-water quality varies widely because of both geologic and human influences. As ground water contributes to streamflow, it may carry dissolved constituents from the bedrock formations, discharges from septic systems, and other constituents that have percolated into the aquifer.

In general, water quality in the San Lorenzo Valley is primarily influenced by the three geologic subareas bounded by the Zayante and Ben Lomond faults (c.f., Battleson, 1966; Ricker and others, 1977; Sylvester and Covay, 1978). North of the Zayante fault, streams draining the older sedimentary formations contain relatively high concentrations of dissolved solids (c.f., Philips and Rojstaczer, 2001). The upper watersheds of the San Lorenzo River, and Kings, Two Bar, Bear, Zayante and Newell Creeks are all underlain mainly by erosive sedimentary formations, principally the Butano sandstone, Two Bar shale, Rices mudstone, Vaqueros sandstone, and Lambert shale.

South of the Zayante Fault and east of the Ben Lomond fault, streams originate in the younger sedimentary formations and contain water of intermediate quality. Rainfall runoff tends occur
more slowly because of the higher permeability soils that have developed on parts of the Santa Margarita sandstone, Lompico sandstone and Purissima formation (most commonly a water-bearing sandy shale, but locally quite sandy). These geologic formations are shown on Figure 2-5 and discussed further in Section 2.3. Less permeable geologic formations in these eastside streams include the Monterey formation and the Santa Cruz mudstone. The high rates of recharge and relatively large available volumes within the Santa Margarita sandstone have resulted in extensive development of its water resources. Use of wells has lowered ground-water levels and diminished streamflow, altered the direction of ground-water flow, and helped to induce increases in the dissolved solids (‘salts’) and nitrate levels in this aquifer, originating (respectively) from ground-water inflow from deeper aquifers and from partial recharge from leach fields or other sources that contribute human or livestock wastes. The larger streams that in summer flow largely from these formations include Bean, Zayante, Lompico, and Love Creeks.

West of the Ben Lomond fault, San Lorenzo tributary streams drain the crystalline rocks, have relatively lower concentrations of dissolved solids and tend to provide high quality water at reasonably constant rates. The weathered upper zone of the crystalline rocks (principally granodiorite, quartz diorite, schist, and marble) exposed on Ben Lomond Mountain serves to recharge precipitation and provide dry-season baseflow to the streams that drain the east side of Ben Lomond Mountain. These include Jamison, Peavine, Foreman, Malosky, Clear, Fall, and Shingle Mill Creeks, and Hubbard and Gold Gulches, as well as Bennett and Corvin Springs. Flows in Boulder Creek during dry seasons or drought years are also sustained primarily by flows emanating from these crystalline rocks. Hare Creek and upper Boulder Creek drain similar watersheds from Ben Lomond Mountain, but are underlain by sedimentary rocks generally yielding much lower rates of summer baseflow (Hecht, 1977).

In the North Coast watersheds, surface water in the streams are also influenced by the same crystalline rocks of Ben Lomond Mountain. In addition, the Lompico sandstone, Monterey formation, and Santa Margarita sandstone overlay the crystalline rocks of Ben Lomond Mountain and provide ground-water storage and baseflow to the streams. Sinkholes and cavernous fractures occur in several parts of the Laguna and Majors Creek watersheds and at Liddell Spring, which serves as the most distant and reliable North Coast source of water for the SCWD. Upstream of the City’s diversion, Majors Creek has been generally and actively incising into the underlying alluvium and weathered sedimentary rocks since at least the 1960s (Hecht and others, 1968; Hecht, 1978), contributing waters that are typically more turbid than in Laguna Creek or at Liddell Spring (Camp Dresser McKee, 1996).

2.2 Land Use and Water Quality

This subsection describes land use and aspects of the natural setting that may affect potential contaminant sources. In general, there have been limited changes to land uses in the watershed since the 2006 sanitary survey.

2.2.1 Land Use

Almost one-quarter of the San Lorenzo River watershed lands are in public or private ownership for natural resource conservation. There are a variety of land uses in the watershed including: timber production, quarrying, agriculture, ranching, rural residential and unincorporated communities with urban densities as found on Figure 2-1. In the 1960's and 1970's, Santa Cruz County experienced rapid growth in both population and development. The San Lorenzo Valley entered a period of transition from primarily seasonal vacation homes to full-time residences.
which are nearly complete today. The subsequent pressure on existing infrastructure and natural systems has led to several water quality issues worthy of note.

During the period of rapid growth, year-round residential occupancy increased which resulted in adding more on-site disposal systems in the San Lorenzo River watershed. More recently the rate of new septic system addition has decreased to about 15 systems per year in 2007 and 4 systems per year in 2009. Another water quality issue associated with new development in steep and remote areas of the watersheds is increased runoff and erosion, which led to increases in sedimentation and persistent turbidity in water supply streams. This can be attributed both to decisions made at the level of individual lots with respect to grading and land clearing as well as cumulative impacts of widespread development. Resolution of grading violations can take a long time to resolve based on the property owners’ willingness and ability to comply. Furthermore, continuous use of unpaved roads to access residences, especially in wet periods, contributes both sediment and turbidity to receiving waters. Partially offsetting these trends is growing acreage of lands no longer open to logging, most significantly in the headwaters of the San Lorenzo River and on lands of the San Lorenzo Valley Water District and the City of Santa Cruz Water Department.

Many of the same dynamics have affected land use in the North Coast watersheds, although the initial proportion of seasonal homes was much lower. Residential growth has been steady through the past 40 years but has flattened in recent years. As in the San Lorenzo Valley, virtually all wastewater disposal is through leachfields, so the volume and areas of watershed affected are growing. Some areas with sandy soils critical for recharge of local aquifers sustaining baseflow have been protected by establishment of the Bonny Doon Ecological Preserve and by inclusion of the Grey Whale Ranch within Wilder Ranch State Park.

Figure 2-1 shows the general developed areas within the watersheds as well as the protected public park lands within the San Lorenzo River watershed.
Figure 2-1

Agriculture
Existing Parks & Recreation
Urban Open Space
Community Commercial
Neighborhood Commercial
Service Commercial
High Density Residential
Suburban Residential
Urban High Residential
Urban Medium Residential
Urban Low Residential
Urban Very Low Residential
Rural Residential
Mountain Residential
Lakes/Reservoirs/Lagoons
Office
Public Facility
R-UL
Resource Conservation
Visitor Accommodations
Visitor Accommodations
Parks

Land Use

Santa Cruz Water Department
WSS Update

GIS Data Source: Santa Cruz County

Path: \pao-vm\project\11\1188024.00_CityofSantaCruz_DrinkingWtrSanSurvey\final_report\KJ_GIS_Files\Events\20121211_Figures\F 2-1 Land Use.mxd
2.2.2 Residential

Within the survey area, the majority of the population is concentrated along Highway 9 on the floor of the San Lorenzo Valley. Steep slopes and rugged terrain have long been a significant constraint to commercial and residential development in all areas of Santa Cruz County. As a result, the county is rural in character, heavily forested, and visually dominated by open space.

The 2010 census indicated a population of 41,538 people in the San Lorenzo Valley (Census Tracts 1203 through 1209), which is six percent less than the population reported in the 2000 census. The 2010 census gave a population for the North Coast (Census Tract 1202) of 4,283, an increase of just two percent compared with the 2000 census. The actual population in the North Coast water supply watersheds is significantly less than the census tract value because the latter includes residents of Davenport, Swanton, and dispersed residences along Highway 1 which lie outside of the small watersheds above the SCWD intake structures.

Within the San Lorenzo Valley, the majority of the population lives in unincorporated communities located along the San Lorenzo River. Felton, Ben Lomond, Brookdale, and Boulder Creek stretch out along State Highway 9. Other communities have developed along major tributaries to the San Lorenzo, including the areas along Zayante Creek and Lompico Creek. Several closely-packed residential communities which originated as summer ‘encampments’ also exist in the area. These include the Paradise Park, Forest Lakes, Mount Hermon, Riverside Grove and San Lorenzo Park subdivisions. Conventional 1960s and 1970s subdivision communities established throughout the Valley include: the Boulder Creek Golf and Country Club, Galleon Heights, Bear Creek Estates, Quail Hollow and Glen Arbor, and the portions of Rollingwood and Pasatiempo which lie within the San Lorenzo watershed. There are, in fact, relatively few valleys without a few clusters of homes, now typically occupied year-round. More recently, stand-alone mountain residences have been arrayed along most ridgelines.

The population in the North Coast drainages is far less than that of the San Lorenzo Valley. The largest area in the North Coast drainage with a concentrated population is known as Bonny Doon. Most of the population lives in rural and mountainous areas, mainly along the major roads: Empire Grade, Smith Grade, and Bonny Doon and Martin Roads.

Scotts Valley (2010 pop. 11,580) is an incorporated city within the San Lorenzo watershed but most of the city lies beyond the eastern edge of the sanitary survey area, within the Carbonera Creek and Branciforte Creek subwatersheds. These two creeks flow into the San Lorenzo River within the city limits of Santa Cruz but below the Tait Street Diversion. However, key commercial and industrial centers of Scotts Valley drain to Bean Creek, which is within the study area.

The County of Santa Cruz Health Services Agency estimates that just under 13,500 parcels in the San Lorenzo River watershed are served by individual on-site wastewater disposal systems, most of which meet current standards (John Ricker, personal communication, 2011). Residences in the North Coast watersheds are also served by septic systems. However, there are relatively few community or institutional wastewater treatment and disposal systems within the survey area due to the remote nature and dispersed population of the watershed. Community on-site disposal systems serve: Bear Creek Estates, Boulder Creek Golf and Country Club (County Service Area (CSA) 7), the Mt. Hermon Association, and Big Basin State Park. Institutional disposal systems are in service at: the San Lorenzo Valley Unified School District, Camp Harmon, Camp Campbell and at several other camps or conference centers in

San Lorenzo Valley and North Coast Watersheds Sanitary Survey for SCWD, SLVWD, LCWD  Page 2-7
Watersheds and Water Supply Systems

p:\111188034.00_citiesantacruz_drinkingwtrsanwersurvey\final_report\report2012jan_2013_final\jan_2013_wss_update_report_final.doc
the San Lorenzo Valley. More recently Rollingwood (CSA 10), has been connected to the City of Santa Cruz wastewater collection, treatment, and ocean disposal system.

Zoning and land development standards for the unincorporated portions of the county reflect an area-wide awareness of the potential adverse effects of wastewater disposal and other development-related impacts on water supply. Within the area, mountain residential is the lowest density range, where minimal services are available. These areas include various open space and natural resource conservation areas unsuitable for more intense development. Rural residential areas are the next highest density range, requiring access from roads maintained to rural road standards. Suburban residential areas require service from a public water system to develop at the highest allowed density. The most densely populated areas along Highway 9 — Felton, Paradise Park, and Boulder Creek — have been developed at density levels typical of many urban areas despite their rural surroundings. County policies designate that these communities be limited to urban low density development unless community disposal systems are available. Santa Cruz County established CSA 12 in 1989 to promote better septic system management and maintenance and imposes an annual fee to fund the on-site wastewater management program.

New development and road construction, frequent landslides, and rainy season use of dirt roads by residents have been major sources of erosion to area streams. As the population has increased, there are now heavier traffic loads during all seasons on all area roads.

### 2.2.3 Agricultural Uses and Animal Grazing

Agricultural acreage in the San Lorenzo River and North Coast watersheds is limited because of the steep topography and limited tillable land. Following the widespread initial logging of the late 1800’s and early 1900’s, apples and other orchard fruits were, however, planted on the flatter newly opened slopes throughout the subject watersheds. Much of this acreage has been abandoned and now supports chaparral, second growth redwood forests, and residential development. Vineyards and Christmas tree farms occupy the largest amount of agricultural acreage. Majors Creek has the most significant agricultural land use of the tributary watersheds as shown on Figure 2-1. The lowest coastal terraces, downstream of the SCWD supply intakes in the North Coast watersheds, are used for pasture or are cultivated for brussel sprouts and other row crops. Agricultural activity along the coast does not extend into the watersheds of the supply intakes. Agricultural or animal grazing is limited to that associated with residential uses in the SLVWD and LCWD subwatersheds.

Limited cattle grazing occurs in the North Coast drainages. Grazing leases are held on private lands and vary from year to year. Horses, on the other hand, are commonly kept by rural residents, and by several commercial stables. Confined animals are considered to be a potential source of nitrogen and pathogens (cf., Hecht and others, 1991; White and Hecht, 1993, Ricker 1995, Ivanetich, 2006) and can also contribute to persistent turbidity in the area’s streams.

### 2.2.4 Timber Harveses

Timber resources historically formed the foundation of the major industry in the Santa Cruz Mountains as shown on Figure 2-2. Timber harvests continue in many parts of the watersheds, and the average timber harvest size in the San Lorenzo River watershed from 2006 to 2008 was about 400 acres. A history of timber harvests is shown graphically on Figure 2-3 based on information provided by Sempervirens Fund.
Both the San Lorenzo Valley Water District and the City of Santa Cruz have stopped timber harvesting, instead managing their watersheds for the yield of water and for open-space uses. SLVWD ceased timber harvesting since the 1970s and adopted a prohibition on timber harvesting in 1986. Concurrently, SLVWD and Lompico Water District have been cooperating in several different ways with Sempervirens Fund and other conservation groups to limit harvesting in their water-supply watersheds. Major cessations of harvesting have occurred or are in the process of occurring through this cooperative set of efforts in the SLVWD watershed lands on the east slope of Ben Lomond Mountain, in the upper San Lorenzo watershed, and in the upper Lompico watersheds.
2.2.5 Mining

Sand mining is the major mineral extraction activity in the survey area, although a number of operations have been closed over the past decade, most recently the CEMEX Bonny Doon marble (locally called ‘limestone’) and shale mine. There are several active sand operations in the vicinity of Scotts Valley as shown on Figure 2-3. Decomposed or weathering granitic rock is mined at Felton Quarry. Sand is still mined at the Quail Hollow Quarry. However, mining activities have been discontinued since 2004 at the Olympia and Hanson (‘Kaiser’) Quarries although reclamation and monitoring activities continue. There are no commercial or informal instream gravel mining operations in the subject watersheds.

Exploratory drilling for oil and gas has been conducted throughout the survey area, principally during the 1950s and 1960s. No current or shut-in (potentially re-activatable) production is reported. The principal water-effects of drilling have been unquantified increases in the salinity of the local stream system associated with deep, highly saline waters emanating from several abandoned boreholes (c.f., Hecht, 1975). Naturally-occurring asphaltum or bituminous sandstone outcrops at the edges of the Majors Creek watershed, where it was mined about 100 years ago. No effects on waters of Majors Creek have been reported.

2.2.6 Recreation

Santa Cruz and its surroundings have served as a center of recreation for more than 150 years. In the San Lorenzo Valley, much of the recreation is focused on summer use of the streams and riparian corridors. Use of the San Lorenzo River and its tributaries includes swimming in natural pools, canoeing, fishing, hiking, and equestrian activities. Visitor use – especially the traditional river-based water-contact recreation – is both a motivation for cleaner streams as well as a secondary contributor to bacteria, nitrate, and possibly turbidity levels.

The California Department of Parks and Recreation manages about 15 percent of the watershed, including Henry Cowell (including Fall Creek), Castle Rock and portion of Big Basin Redwood State Parks. See Figure 2-1 for locations of parks and open space within the Santa Cruz City Water Supply Watersheds. Managers continue to pursue restoration projects, when funds allow, and recently completed removal of a leaking earthen dam and series of culverts on Tin Can Creek. Since there was no spillway for the 45-foot dam, there had been gullying and consistent erosion around the structure. Managers also continue to use controlled burns to maintain open grasslands (Portia Halbert, personal communication, 2012), and typically burn areas every other year, mostly in the Waddell and Wilder Creek watersheds (Tim Hyland, personal communication, 2012). City-operated recreation facilities at Loch Lomond will continue to emphasize boating, picnicking, and trail uses.

Recreational use of the Majors and Laguna Creek watersheds covered by the survey are diffuse and typical of rural residential areas, concentrated along the roads and trails. Significant portions of the southeastern side of the Majors Creek watershed are within the sectors of the
Grey Whale Ranch and Wilder Ranch State Park that will likely remain closed to visitor use during the coming five years, according to Mr. Hyland. Public access and recreation are limited in the SLVWD and LCWD watersheds except for the Fall Creek, Bennett and Bull Springs portion of the SLVWD watershed which are largely within the Fall Creek State Park which has hiking and equestrian trails. Additional discussion regarding the potential water quality threats from recreation occurs in Section 3.1.2.

Off road vehicles and mountain-bike use can be locally common. Trail (bike, horse, and hiker) and off-road vehicle use can be sources of erosion adding to background levels.

2.2.7 Reservoir Sedimentation

Sedimentation rates in Loch Lomond are small relative to its capacity, perhaps because the watershed of the reservoir is maintained primarily in open space, and are not expected to constrain the water supply functions of the reservoir for many years to come. The City has commissioned four separate sedimentation surveys of Loch Lomond by USGS, beginning in 1971 (Brown, 1973), followed by a 1982 survey by Fogelman and Johnson (1986), and then a 1998 survey by McPherson and Harmon (2000).

The most recent 2009 sedimentation survey by McPherson and others (2011) used a new, state-of-the-art method combining bathymetric scanning with multibeam-sidescan sonar, and topographic surveying with laser scanning (LiDAR) to obtain information about temporal changes in the upper reach of the reservoir where the water is shallow or the reservoir may be dry, as well as to obtain information about shoreline changes throughout the reservoir. Results indicate that this method accurately captures the features of the wetted reservoir surface and along the shoreline that affect the storage capacity calculations. Comparison of the 2009 reservoir-bed surface with the surface defined in 1998 indicates that sedimentation is occurring throughout the reservoir. About 320 acre-feet of sedimentation has occurred since 1998, as determined by comparing the revised 1998 reservoir-bed surface, with an associated maximum reservoir storage capacity of 8,965 acre-feet, to the 2009 reservoir bed surface, with an associated maximum capacity of 8,646 acre-feet. This sedimentation is more than 3 percent of the total storage capacity that was calculated on the basis of the results of the 1998 bathymetric investigation.

2.3 Natural Conditions and Water Quality

The San Lorenzo River watershed and the North Coast water supply drainages are located in north central Santa Cruz County, California. These watersheds drain runoff from the Santa Cruz Mountains into the Pacific Ocean at or near the north end of Monterey Bay (see Figure 1-1).

The Santa Cruz Mountains extend south to southwest for about 100 miles from San Francisco to the Pajaro River. The ridge of the Santa Cruz Mountains rises between San Francisco Bay and the Santa Clara Valley on the east and the Pacific Ocean on the west. The topography of the area is moderately rugged, with elevations ranging from sea level to over 2,600 feet along the crest of Ben Lomond Mountain, and over 3,300 feet at several locations along the northeastern edge of the watershed. Steep slopes of over 30 percent are common, and most of the streams discussed in this report flow through deep canyons cut into bedrock. This is particularly true in the San Lorenzo River watershed, whose many streams are deeply shaded by a dense growth of redwood and Douglas fir trees.
The region has a Mediterranean climate with cool, dry summers and moderate-to-heavy rainfall in the winter months from November through March. Average annual rainfall ranges from about 25 inches along the coast to about 60 inches along the ridge of Ben Lomond Mountain. Coastal fog is common during the summer months and tends to spread inland at night.

The crest of Ben Lomond Mountain forms the topographic divide between the San Lorenzo River watershed to the east and the North Coast watersheds (Majors and Laguna Creeks) to the west.

Coastal terraces, in the North Coast drainages, are a mosaic of grasslands, oak woodlands, steep forested canyons, and chaparral

### 2.3.1 Soils and Geology

The area is underlain by a complex mosaic of alluvial and terrace deposits of Quaternary age; mudstone, shales, and sandstones of tertiary age; and fractured granitic rocks, schists, and metamorphosed limestones. Soils are highly variable, with a dense mosaic, depending on the underlying parent materials, and other factors such as climate, aspect, vegetation cover, and local relief. Alluvial and terrace soils of varying ages have formed on the alluvial and terrace deposits along nearly all of the major streams. Some of these soils have well-developed clay subsoils, inhibiting use of leachfields.

In the most general terms, soils underlain by permeable sandstones, as well as igneous and metamorphic rocks, are deep and well-drained. These loamy and sandy loam soils are found throughout the heavily forested reaches of the survey area. Soils formed from the Santa Margarita and several other sandstone formations are also sandy, deep, and well drained as shown on Figure 2-4. In the sandy soils, organic-matter content and cation exchange capacities are often about 15 to 25 percent of those found in many forest soils in coastal California. Santa Cruz County has been developing approaches and technologies to control erosion in these soils, and to improve nitrogen and pathogen removal in discharges from septic systems. Soils formed from mudstones and shales also tend to be deep, yet somewhat less well-drained. Overall, soil depth is often limited by shallow bedrock, steep slopes and the gradual loss of topsoil to erosion.

In the alluvial areas of the San Lorenzo and North Coast watersheds, soils are also deep and well drained, although soil depth may be limited by low-permeability layers of fines. In the marine terraces of the North Coast, soils are characterized as deep to very deep and range from well-drained to somewhat poorly drained where claypans have developed in the old and illuviated soils. As in the San Lorenzo Valley, depths vary with slope and aspect.
Santa Cruz Water Department
WSS Update

Figure 2-4

GIS Data Source: Balance Hydrologies

- Sandy Soils
  - Hyper Sandy > 6"/hr
  - Very Sandy > 2"/hr
  - Sandy > 0.6"/hr
  - Sandy, shallow Limited Recharge

Santa Cruz City Water Supply Watersheds

- Area Locations
- Lakes
- Streams
- Sub-Watershed

Scale: Feet

Area Locations:
- Redwood Grove
- Boulder Creek
- Loch Lomond Reservoir
- Ben Lomond
- Zayante
- Olympia
- Scotts Valley
- Boulder Creek
- Henry Cowell
- Redwoods State Park
Naturally-occurring cadmium occurs in portions of the Monterey shale and (to a much lesser extent) Santa Cruz mudstone geologic units. Because cadmium is tightly bound to minerals and clays in the local soils, elevated levels of cadmium are seldom if ever encountered in the water diverted from either the San Lorenzo River or North Coast watersheds. Higher levels are found in stream sediments and vegetation, and cadmium can be bioconcentrated by organisms living in the sediments and soils. The geochemistry of cadmium enrichment is described in Majmundar (1980). The distribution of cadmium in western Santa Cruz County is explained in Golling (1983). Zinc and other trace elements often co-occurring with cadmium are not reported to be elevated in the local soils and sediment derived from the Monterey formation. The same formations tend to be rich in phosphorus, which is widespread in the streams of all surveyed watersheds. With organic carbon also abundant, the ecosystems of these streams are nearly always nitrogen-limited (Aston and Ricker, 1976; Butler, 1978).

### 2.3.2 Faults and Seismic Activity

Faulting and seismicity pose a potential geologic hazard in the Santa Cruz Mountains. The San Andreas fault parallels the northern boundary of the project area approximately two miles to the north. Numerous faults cross the project area. In the San Lorenzo Valley, the most notable faults include: the Zayante fault, which runs primarily east-west, crossing Loch Lomond; Ben Lomond fault, with a trace roughly paralleling the San Lorenzo River from Santa Cruz to the Boulder Creek area; and the Butano fault, which crosses the northern, highest portions of the San Lorenzo watershed. No recent movement has been recorded on any of the three faults but these faults, as shown on Figure 2-5 control groundwater flow and quality in the region.

The principal fault in the North Coast area is the San Gregorio fault zone, which trends north-northwestward several miles offshore from the mouths of Laguna and Majors Creeks. It is active and has sustained recurrent activity for several million years.

Santa Cruz County experiences low-level seismic activity on a regular basis. The most significant recent event was the 1989 Loma Prieta earthquake. Significant damage to structures, roadways, and utilities occurred, including damage to water systems occurred following the magnitude 7.1 Loma Prieta earthquake. Landslides, debris flows, and the reconstruction of residences and infrastructure contributed to persistent turbidity in area streams and surface waters for a period thereafter. Future seismic activity should be anticipated and this expectation should be a major factor in public policy and management of local water supplies.

### 2.3.3 Volcanic Activity

While known for their seismic activity, the Santa Cruz Mountains are highly unlikely to experience any volcanic activity in the foreseeable future.


2.3.4 Vegetation

The watershed lands evaluated in this survey area are dominated by dense forests consisting of a mix of deciduous and evergreen trees and hardy shrubs. Second growth coast redwood is the dominant forest species in the steep canyons, particularly where coastal fog can supply summer moisture. Several species of oak, as well as Douglas fir, tanoak, and madrone form mixed stands on drier slopes and aspects. Some ridges are covered by dense chaparral, composed mainly of manzanita and chamise. Ponderosa pine, a forest species not generally found in the Coast Range, forms a distinct community in the locations where the coarse sands of the Santa Margarita formation are exposed.

While scattered grasslands can still be seen in the San Lorenzo River watershed, most have been converted to residential uses or have reverted to chaparral and second growth forests. The coastal terraces support larger grasslands, but are also subject to the same sorts of residential development pressures and conversion to chaparral and coastal scrub. Within the area grasslands, few native bunchgrasses are found, having long ago been replaced by the exotic annual grasses introduced by early European settlers.

Riparian plant communities are established along all streams in the surveyed watersheds, although human activity or debris from unstable slopes often encroaches in these areas. Several species of willow and alder, as well as big leaf maple, box elder, sycamore, and cottonwood are the most common tree species. California blackberry, poison oak, stinging nettle, in addition to numerous species of sedge and rush, make up much of the understory streambank vegetation. In disturbed riparian areas, non-native vegetation such as French broom, English or cape ivy, poison hemlock, periwinkle, and acacia have become established and compete with native species. These riparian zones are thought to play vital roles in protecting and maintaining water quality in most of the water supply watersheds.

2.3.5 Wildlife

Numerous wildlife species inhabit the California Coastal Ranges. The steep topography, extensive open space, and vegetation communities that range from aquatic and riparian to woodland and chaparral, provide a wide range of habitats for terrestrial and avian species. The area supports such mammalian species as: black-tail deer, mountain lion, bobcat, gray fox, California ground squirrel and a variety of other small terrestrial mammals. A number of non-native species have become established in the Santa Cruz Mountains, including bullfrogs, New Zealand mudsnail, wild pig, Norway rat, common opossum, and feral domestic dogs and cats.

The number of bird species found in the Santa Cruz Mountains reflects the variety of habitats and the location along the Pacific Coast migratory route of waterfowl and songbirds. The riparian habitats fringing the San Lorenzo River and the smaller streams of the region have the highest breeding bird density of all habitat types in the area. Several species of wading birds live in the area, including great blue heron, green heron, and black crested night heron. Belted kingfishers, Stellar’s jays, and wood ducks are also residents. Raptors are common throughout the area and include red-shouldered hawks, red-tailed hawks, and Coopers hawks, while occasionally golden eagles can also be encountered in the watershed. Reptile and amphibians are also abundant in local riparian habitats. Notable species in the County include the western pond turtle, California red-legged frog, legless lizard, and several species of salamander although specific presence in the watersheds varies.

The San Lorenzo River supports many species of fish. Steelhead trout and coho salmon are considered native to the coastal streams in Santa Cruz County and the San Lorenzo River
supports the region’s largest steelhead run. Once a hotbed for anglers, the San Lorenzo fisheries have suffered a decline, widely thought to result from sedimentation and other land-use effects. In 1964 the estimated run consisted of 20,000 steelhead (Ricker, 1979). Runs of 500 to 1,500 adult steelheads are more typical of current conditions. Coho salmon, with a historically smaller run, have also declined. Since 1981, coho have been intermittently observed in the San Lorenzo River, though local populations are on the verge of extirpation. Both steelhead and coho are federally listed as threatened under the Endangered Species Act, while coho are listed by the State under the more-critical ‘endangered’ designation. The primary threats to these species include: loss of high quality rearing and spawning habitats due to flow reductions and excessive fine sediment loads; and barriers to migration due to dams, culverts, and flow-depleted critical riffles (Alley and others, 2004).

In August 2011, the SCWD issued a draft Habitat Conservation Plan: Conservation Strategy for Steelhead and Coho Salmon (HCP) in order to be able to operate and maintain their water facilities while considering the needs of these endangered species. The streamflow restoration elements of the HCP, especially in the San Lorenzo River at Tait Street and Laguna Creek, are intended to maximize instream habitat using the City’s existing infrastructure. To accommodate, natural flow variations, flow targets vary monthly by hydrologic year type (wet to critically dry) as well as by naturally occurring seasonal variations. These minimum instream flow targets have been developed to maintain all life history stages (spawning, incubation, rearing, and migration) of steelhead and coho salmon. It is expected that these minimum instream flow targets will decrease availability of the North Coast sources, including Laguna Creek, and increase dependence on San Lorenzo River water stored in Loch Lomond which has higher organic carbon resulting in higher potential for formation of disinfection by products.

2.4 Water Supply Systems Background

2.4.1 History

The San Lorenzo Valley and North Coast Watersheds provide drinking water for numerous communities in the Santa Cruz area. Table 2-2 lists the water supply sources and general treatment processes used by the three purveyors participating in this sanitary survey update (SCWD, SLVWD, and LCWD). These purveyors use surface water and have over 200 total service connections. Table 2-3 lists the same information for non-participating purveyors many of which have less than 200 service connections. All the purveyors listed in Tables 2-2 and 2-3 use surface water in the San Lorenzo Valley Watershed. The following sections focus on the larger utilities, listed in Table 2-2, which include SCWD and SLVWD. The watershed areas for each participating utility are shown on Figure 1-1.
### Table 2-2: Summary of Drinking Water Purveyors Serving Surface Water With More Than 200 Service Connections in the Study Area

<table>
<thead>
<tr>
<th>Utility Name and Number of Service Connections</th>
<th>Surface Water Sources</th>
<th>Treatment Process</th>
<th>Average Flow</th>
<th>Primary Disinfectant</th>
<th>Last DPH Inspection Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>Santa Cruz Water Department (City of Santa Cruz)</td>
<td>San Lorenzo River/Loch Lomond Reservoir and North Coast Springs &amp; Creeks</td>
<td>Conventional Filtration at the Graham Hill WTP</td>
<td>7.95 mgd (2010 flow from 2011 UWMP)</td>
<td>Chlorine</td>
<td>June 2010</td>
</tr>
<tr>
<td>24,351 Service Connections</td>
<td></td>
<td>Microfiltration at Loch Lomond WTP</td>
<td>7 gpm/15 gpm maximum</td>
<td>Chlorine</td>
<td>June 2010</td>
</tr>
<tr>
<td>San Lorenzo Valley Water District</td>
<td>Clear Creek, Foreman Creek, Peavine Creek, Silver Creek, and Sweetwater Creek</td>
<td>Lyons WTP - Package WTP (Trident Microfloc) 1 mgd WTP w/Conventional Treatment Equivalency (2000 - 2008 Average Production)</td>
<td>1.92 mgd (includes use of groundwater sources)</td>
<td>Chlorine</td>
<td>Feb-2012</td>
</tr>
<tr>
<td>6,000 Service Connections</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>San Lorenzo Valley Water District - Felton</td>
<td>Fall Creek, Bull Springs and Bennett Spring</td>
<td>Kirby WTP - CPC Microfloc-Trimite TM-350</td>
<td>1.0 mgd capacity</td>
<td>Chlorine</td>
<td>May 2012</td>
</tr>
<tr>
<td>1,300 Service Connections</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lompico County Water District</td>
<td>Lompico Creek below Mill Creek</td>
<td>497</td>
<td>Microfiltration</td>
<td>Chlorine</td>
<td>-Sept 2011</td>
</tr>
<tr>
<td>497 Service Connections</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note to Reviewers: Big Basin MWC participated in the 1996 sanitary survey and is included in Table 2-3.*
Table 2-3: Summary of Small and Non-Participating Drinking Water Purveyors in the San Lorenzo River Watershed

<table>
<thead>
<tr>
<th>Name</th>
<th>Watershed Location</th>
<th>Number of Connections</th>
<th>Filtration System/Type</th>
<th>Disinfection Strategy</th>
<th>Other Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big Basin Water Company</td>
<td>Four surface sources; Jamison Springs (No. 1 and 2), Corvin Springs, Well No. 5 (horizontal under the influence of surface water)</td>
<td>551</td>
<td>Jamison WTP; Conventional Processes with Capacity to Treat 150 gpm (Neptune Microfloc/ Trimite)</td>
<td>Chlorine</td>
<td>--</td>
</tr>
<tr>
<td>Brackenbrae Mutual Water Company(1)</td>
<td>North of Boulder Creek</td>
<td>27</td>
<td>Package WTP (3M bag filter)</td>
<td>Chlorine</td>
<td>Protected streams and spring</td>
</tr>
<tr>
<td>Forest Springs Mutual Water Company(1)</td>
<td>North of Boulder Creek</td>
<td>130</td>
<td>Sedimentation only</td>
<td>Chlorine</td>
<td>Spring source</td>
</tr>
<tr>
<td>Bonnymede Mutual Water Company(1)</td>
<td>On Reggiardo Creek</td>
<td>10</td>
<td>--</td>
<td>Ozone</td>
<td>--</td>
</tr>
<tr>
<td>Olympia Mutual Water Company(1)</td>
<td>n/a</td>
<td>n/a (&lt;200)</td>
<td>Filtration</td>
<td>Chlorine</td>
<td>Annexation with SLVWD in progress</td>
</tr>
<tr>
<td>Quaker Center</td>
<td>Near Ben Lomond</td>
<td>Non-Community System (&lt;200)</td>
<td>Package WTP (3M bag filter)</td>
<td>Chlorine</td>
<td>--</td>
</tr>
<tr>
<td>River Grove Water System(1)</td>
<td>Near Felton</td>
<td>23</td>
<td>Slow sand filtration</td>
<td>Chlorine</td>
<td>--</td>
</tr>
</tbody>
</table>

Data source: 1996 Sanitary Survey
n/a = Information is not applicable for this project.
(1) Small water companies represented by Santa Cruz County

2.4.2 Santa Cruz Water Department (SCWD)

As described in greater detail in Section 2.6, generally, the City of Santa Cruz began establishing water rights to area streams and underflow in the late 1800s. The riparian rights to the North Coast sources were purchased from downstream landowners. The City also has appropriative rights to San Lorenzo River water via licenses. These licenses allow the withdrawal of water at the Tait Street diversion for delivery to the Graham Hill water treatment plant and the Felton diversion for storage at Loch Lomond Reservoir. In 1960, Newell Creek
Dam was constructed to create Loch Lomond Reservoir, with a then-reported capacity of 8,500 acre-feet\(^3\). Jointly, these three surface water sources are the primary supply for the City.

Source water development and the supply history of the Santa Cruz Water Department through 1986 were described in detail in the 1996 sanitary survey. During that year, the City upgraded the Graham Hill Water Treatment Plant (WTP) to improve treatment performance. Improvements consisted of replacing the filter media; modifying the chemical feed systems, flocculators, monitoring and control system, and sludge collectors; and installing tube settlers in the sedimentation basins. There have been no major changes in the SCWD water supply and treatment system that have occurred since the 2006 sanitary survey update.

### 2.4.3 San Lorenzo Valley Water District (SLVWD)

The SLVWD, originally the San Lorenzo Valley County Water District, was formed by a special election of the residents of Santa Cruz County on April 3, 1941. At that time the boundaries were established to include 58 square miles of the San Lorenzo Valley in the Santa Cruz Mountains. During the late 1940's, the SLVWD purchased large areas of land with an initial intent of potential reservoir development; as philosophies changed these lands were later preserved for watershed protection in the early 1980s. In 1958, the SLVWD sold 2,500 acres of land to the City of Santa Cruz for the placement of Loch Lomond Reservoir.

Major events in the development of the current SLVWD water supply system are described in detail in the 1996 sanitary survey. The District has not used springs as water sources since 1993 when the Lyons surface water treatment plant was constructed. More recent developments include the annexation of the Manana Woods Mutual Water Company and the acquisition of protected lands in the Malosky Creek watershed both of which occurred in 2006 and are described in the 2006 watershed sanitary survey.

In 2008, SLVWD acquired the Felton Water System from California-American Water Company. Felton is supplied water from two (2) spring sources and one (1) surface water diversion. The spring sources are Bennett Spring and Bull Spring. The surface water source is Fall Creek. Supply water from the combined springs is routed through a raw water transmission line to the Kirby Street Water Treatment Plant. Supply water from Fall Creek is also routed through separate raw water transmission line to the Kirby Water Treatment Plant (Kirby WTP). The Kirby Street Water Treatment Plant was brought on line in January 1997 to meet the requirements of the Surface Water Treatment Rule. The nominal capacity of the Kirby Street Water Treatment Plan is 1.0 mgd using two (2) 350 gpm rated, two stage filtration constant adsorption clarification/tri-media filtration units (CPC Microfloc-Trimite TM-350). Disinfection is provided at the Kirby Street Water Treatment Plant by contact mixing with sodium hypochlorite prior to introduction into the treated water distribution system.

### 2.4.4 Lompico County Water District (LCWD)

The Lompico County Water District was first issued a permit to supply drinking water in 1966. LCWD obtained the water system from the Lompico Cooperative Water Association at that time. LCWD has approximately 500 service connections (which has not changed as of 1996) within its service area, which generally surrounds the Lompico area. Lompico is shown just east of the Loch Lomond Reservoir in Figure 1-1.

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\(^3\) Recent re-surveys indicate a current capacity of about 8,600 acre-feet above the spillway elevation (McPherson, 2011)
Activities to develop safe water sources for LCWD, have included the purchase of the 425-acre Lompico headwaters property, which supplies water to the community of Lompico. As of May 2010, Sempervirens Fund had purchased these lands, and is in the process of transferring guardianship of the purchased land to LCWD.

2.5 Water Sources

2.5.1 Santa Cruz Water Department

The existing SCWD water supply system is described in detail in planning reports and studies such as the 2003 City of Santa Cruz Integrated Water Plan and the 2000 and 2002 Water Supply Alternatives Studies. The SCWD supply system is comprised of four main production elements: (1) the North Coast streams and Liddell Spring; (2) the San Lorenzo River (Tait Street Diversion and Wells and Felton Diversion); (3) Loch Lomond on Newell Creek; and (4) the Live Oak wells. All but the Live Oak wells system, which are not included in this surface water sanitary survey, are described in the following paragraphs. The main water supply facilities are shown on Figure 1-1.

2.5.2 North Coast

The North Coast water supply system consists of surface diversions from three coastal streams and one natural spring located approximately six to eight miles northwest of downtown Santa Cruz. These sources are Liddell Spring, Laguna Creek, its tributary Reggiardo Creek, and Majors Creek. A few changes to the facilities described in the 1996 sanitary survey have been made including repairs at the Majors Dam following a failure and sediment transport improvements including new drain valves and operational improvements required by DFG at Laguna and Majors Creeks. A brief summary follows, for reference. More detailed descriptions are found in the 1996 sanitary survey.

Liddell Spring — Liddell Spring, developed in 1913, is a natural spring used for water supply. The spring box/diversion is located at elevation 584 feet. Water from the spring is directed through a 10-inch steel pipeline into the Coast Pipeline for transmission to the SCWD service area.

Laguna and Reggiardo Creeks — Flows from Reggiardo Creek, which are quite limited, are captured at a diversion dam located at elevation 630 feet. Diversions from Reggiardo Creek are diverted through about 850 feet of pipeline to Laguna Creek and are not monitored separately from Laguna Creek. Combined flows from Laguna Creek and diversions from Reggiardo Creek are captured at a concrete and limestone dam located at elevation 623 feet on Laguna Creek. The original dam constructed in 1890 is still in use today. These diversions are sent through 12,400 linear feet of 14-inch steel pipeline to the junction with the transmission pipeline from Liddell Spring. The junction is known as the Laguna-Liddell “Y”.

Majors Creek — Flow from Majors Creek is diverted from a concrete dam located at elevation 352 feet, which was built in the late 1800’s. As noted earlier, a dam failure in the winter of 2011, was repaired to restore the original diversion in the summer of 2011. Diversions from Majors Creek are conveyed through 11,300 linear feet of pipeline varying between 10 and 16 inches in diameter before joining the main Coast Pipeline along Highway 1. Because the Majors Creek diversion is located at a much lower elevation than the other North Coast sources, use of the Majors Creek Diversion is limited by the hydraulic loading from the other North Coast sources...
(i.e. the Majors Creek flows can enter the Coast Pipeline only when the head from the other sources is low).

Water from the North Coast diversions flows by gravity to the SCWD system via the Coast Pipeline, which varies from 16 inches in diameter between the Laguna-Liddell "Y" and Majors Creek up to 24 inches in diameter near Bay Street Reservoir. Several thousand feet of temporary aboveground pipeline has been installed to replace badly deteriorated sections of the Coast Pipeline.

Water from the Coast Pipeline is boosted at the 5-mgd Coast Pump Station to the Graham Hill WTP for treatment.

2.5.3 San Lorenzo River - Tait Street Diversion and Wells

San Lorenzo River flows are diverted at the Tait Street Diversion just north of Highway 1. Water is diverted at a concrete check dam into a screened intake sump where three vertical turbine pumps with a total capacity of 7.8 mgd are used to pump the water to the Graham Hill WTP. One of the pumps has been converted to a variable frequency drive (VFD) to better match pump output to demand and available flow. These pumps are located in the same building as the pumps for the North Coast diversions.

The Tait Street Diversion also includes two wells, located on the east side of the river. Tait Well No. 1 is 92 feet deep and Tait Well No. 4 is 79 feet deep. Each of these wells can produce 0.6 mgd and both are tied to the City's appropriative rights for San Lorenzo River flows. The Tait wells are believed to be hydraulically connected to the river. The DPH classifies water from the Tait wells as GWUDI (Ground Water Under Direct Influence of Surface Water).

Water produced by the Tait wells is also delivered to the San Lorenzo River intake sump. The ground water is then pumped into a common transmission pipeline used to convey water from both the North Coast and San Lorenzo River sources to the Graham Hill WTP for treatment.

2.5.4 San Lorenzo River - Felton Diversion

There have been no major changes or modifications to this system in the last five years. The Felton Diversion is located on the San Lorenzo River just downstream of the Zayante Creek confluence, which is approximately five river miles north of the Tait Street Diversion. The diversion structure consists of an inflatable rubber dam to divert flows into a screened intake sump. Flows are then pumped through the Felton Booster Station into Loch Lomond for storage via the Newell Creek Pipeline. The desired diversion rate is regulated by using different combinations of the three pumps at the Felton Diversion and the six pumps at the Felton Booster Station.

2.5.5 Loch Lomond on Newell Creek

The Loch Lomond Reservoir was created by the construction of Newell Creek Dam, located about ten miles north of Santa Cruz and northeast of the town of Ben Lomond. The reservoir was constructed in 1960, and currently has a maximum storage capacity of about 8,600 acre feet. Loch Lomond is the only major reservoir in the San Lorenzo River watershed. There have been no major changes in this system in the last five years.

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4 Per a 2009 survey discussed in Section 2.2.7.
Newell Creek Dam is an earthfill dam, 190 feet high and 750 feet long at the crest. The spillway crest is at elevation 577 feet. Releases from the reservoir are made through outlet works on the upstream face of the dam. The lowest outlet is at elevation 470 feet. At maximum capacity, Loch Lomond covers an area of about 180 acres.

Water released from Loch Lomond for use by SCWD is conveyed to the Graham Hill WTP through the Newell Creek Pipeline. The water flows by gravity from the reservoir to the Felton Booster Station, approximately 4.3 miles downstream of the dam. The water is then pumped at Felton Booster Station to clear a ridge in Henry Cowell State Park at an elevation of about 580 feet. To meet fluctuating head and flow conditions, six pumps and alternative valving configurations are available at the Felton Booster Station.

2.5.6 SLVWD

Clear Creek, Foreman Creek, Peavine Creek, Silver Creek, and Sweetwater Creek are the primary surface water sources for the Lyons WTP which serves the northern portion of SLVWD’s service area. The current average stream diversion yearly total is about 900 acre-feet from these sources. SLVWD has appropriative rights to these creeks. These sources are perennial creeks and are located west of Highway 9 along the Ben Lomond Mountain. The watersheds of the creeks are contiguous and rugged with extremely steep slopes. The watersheds above the creek intakes are largely uninhabited. In addition, the SLVWD’s Felton system is served by Fall Creek and Bennett and Bull Springs. The approximate location of each creek intake and watershed area is illustrated in Figure 1-1.

2.5.7 LCWD

The surface water source for LCWD is Lompico Creek, downstream of the Mill Creek confluence which has a watershed area of about 1,470 acres. LCWD has an appropriative water rights for Lompico Creek dating to the mid-1940’s. The estimated population for the service area is about 1,500 people. The average drinking water use is about 0.10 mgd, which is supplied by both surface and ground-water sources. In 1996, LCWD constructed a new water treatment plant, a microfiltration unit, to comply with SWTR requirements. The Lompico Community Center sponsors a community creek clean-up event annually.

2.6 Water Rights

2.6.1 SCWD

Table 2-4 lists the SCWD water rights, which were found in the 2005 Urban Water Management Plan. There have been no changes in the SCWD water rights since the preparation of the 1996 sanitary survey although SCWD is developing and submitting filings for a change to the water rights that would allow direct diversion at Felton for delivery to the Graham Hill WTP as discussed in the SCWD 2011 Urban Water Management Plan. The HCP that is under preparation, as discussed earlier, may limit diversions from some of SCWD’s most important water sources.
Table 2-4: Summary of SCWD Water Rights

<table>
<thead>
<tr>
<th>Source</th>
<th>Period</th>
<th>Maximum Diversion Rate (cfs)</th>
<th>Fish Flow Requirement (cfs)</th>
<th>Annual Diversion Limit (mg/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Coast (1)</td>
<td>Year-round</td>
<td>No limit</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Liddell Spring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laguna/Reggiardo Creeks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Majors Creek</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>San Lorenzo River</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tait Street Diversion and Wells</td>
<td>Year-round</td>
<td>12.2</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Felton Diversion to Loch Lomond Reservoir</td>
<td>September</td>
<td>7.8</td>
<td>10</td>
<td>977</td>
</tr>
<tr>
<td></td>
<td>October</td>
<td>20</td>
<td>25</td>
<td>977</td>
</tr>
<tr>
<td></td>
<td>November-May</td>
<td>20</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>June-August</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>Loch Lomond Reservoir on Newell Creek</td>
<td>Collection</td>
<td>No limit</td>
<td>---</td>
<td>1,825</td>
</tr>
<tr>
<td></td>
<td>Withdrawal</td>
<td>---</td>
<td>1</td>
<td>1,042</td>
</tr>
</tbody>
</table>

(1) Water rights for the North Coast Sources are pre-1914 rights containing all downstream rights. Therefore, the SCWD may divert up to the full natural flow of each stream. SCWD owns all downstream riparian water rights on the North Coast sources.

2.6.2 Other Utilities

Table 2-5 summarizes the water rights for the larger utilities in the watershed area in the San Lorenzo Valley watershed. The large utilities, such as SLVWD and LCWD, have more than 200 service connections. The smaller utilities have less than 200 service connections and are monitored by the County Health Services Agency. This table also lists the limiting flow rates or diverted flow rates from the different surface waters, if applicable.
Table 2-5: Summary of Surface Water Rights for Utilities With More Than 200 Service Connections

<table>
<thead>
<tr>
<th>Utility</th>
<th>Source(s)</th>
<th>Rights</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Santa Cruz Water Department (SCWD)</td>
<td>Tait Street Diversion and Wells</td>
<td>Year-round use; There are no fish flow requirements or annual flow limitations based on water rights but limitations are proposed under the minimum instream flow targets under the HCP (see Section 2.3.5)</td>
<td>12.2 cfs (7.9 mgd) maximum withdrawals per day.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Felton Diversion</td>
<td>Can divert 20 cfs (12.9 mgd) from October through May to Loch Lomond</td>
<td>Must provide at least 25 cfs in October and 20 cfs from November through May for fish flows. Maximum allowable diversion is 977 per year.</td>
<td></td>
</tr>
<tr>
<td>Loch Lomond Reservoir</td>
<td>Can withdraw year-round</td>
<td>Nominal fish flow into Newell Creek (1 cfs)</td>
<td></td>
</tr>
<tr>
<td>Coast sources including Liddell Spring, Laguna/Reggiardo Creeks, and Majors Creek</td>
<td>Fully appropriated rights</td>
<td>There are no fish flow requirements or annual flow limitations based on water rights but limitations are proposed under the minimum instream flow targets under the HCP (see Section 2.3.5)</td>
<td>None</td>
</tr>
<tr>
<td>San Lorenzo Valley Water District (SLVWD)</td>
<td>Clear Creek, Foreman Creek, Peavine Creek, Sweetwater Creek, Fall Creek, Bennett and Bull Springs</td>
<td>Fully appropriated rights</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fully appropriated rights</td>
<td>Required minimum bypass flows vary from 0.05 – 1.5 cfs, depending on the cumulative monthly runoff of the San Lorenzo River, as measured at the Big Trees gage</td>
</tr>
<tr>
<td>Lompico County Water District</td>
<td>Lompico Creek</td>
<td>Appropriate Rights</td>
<td>Diversion of up to 24,000 gallons per day of surface water and must have 0.1 cfs bypass</td>
</tr>
</tbody>
</table>

Source: DPH Annual Inspection Reports and State Water Resources Control Board Water Rights Database

*Note to Reviewers:* Info for Big Basin MWC is not included in this table but was included in the 1996 survey.

### 2.6.2.1 SLVWD

SLVWD has pre-1914 appropriative water rights to divert from the northern tributaries to the San Lorenzo River and appropriative water rights transferred during SLVWD’s acquisition of the Felton System for Fall Creek and Bennett and Bull Springs.
2.6.2.2 LCWD

LCWD currently holds an appropriative water right to divert up to 24,000 gallons of surface water at the Lompico Creek intake structure. Based on conversations with staff at the LCWD, the District has not exceeded their allowable diversion since the last Water Sanitary Survey in 2007.

2.6.3 Water Quantity

Table 2-6 summarizes the water sources and the quantity of water available for each large utility. This table lists the surface water sources for each utility, the approximate average surface water supply capacity for the source, the total supply capacity (including ground water), and the total average day use. Each of the large utilities has a limited supply of water for drinking water purposes. For example, SCWD has about 11.4 to 15.7 mgd of combined ground and surface water available for drinking water purposes, of which about 75 percent comes from flowing surface diversions, about 5 percent from groundwater and the remaining 20 percent from water stored in Loch Lomond at the present time. The average day use from 2007 to 2010 was about 8.5 mgd, with a potential average demand in 2030 of up to 12.4 mgd (2011 UWMP: Tables 4-2 and 4-10). Although average water demand appears to be met with the available supply, during periods of drought, flows in the San Lorenzo River and coast sources run low and cannot support average dry-season demands. This situation can stress the system, especially given the unpredictable nature of climate conditions. The 2004 study SCWD Adequacy of Municipal Water Supplies to Support Future Development in the City of Santa Cruz Service Area identified system limitations. SCWD will be challenged to consistently provide and achieve the desired supply capacity, especially during extended drought periods, under the minimum instream flow targets for the HCP, and in the future with the current supply sources.

Although efforts are made to maximize the volume of water available from surface water sources, especially the San Lorenzo River, after a storm event, the City operates under a maximum turbidity level for withdrawal from the San Lorenzo River of 10 NTU at the coast pump station. During first flush storm events in the early season, turn outs are bypassed as soon as it starts raining.
### Table 2-6: Summary of Water Sources Available for Utilities With More Than 200 Service Connections

<table>
<thead>
<tr>
<th>Utility</th>
<th>Source(s)</th>
<th>Maximum Surface Water Supply Capacity (mgd)</th>
<th>Maximum Groundwater Supply Capacity (mgd)</th>
<th>Total Supply Capacity (mgd)</th>
<th>Total Average Day Use (mgd)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>City of Santa Cruz Water Dept.</td>
<td>Tait Street Division</td>
<td>5.5 to 7.88</td>
<td>N/A</td>
<td></td>
<td>8.5 (2007 - 2010 Average Annual)</td>
<td>Total supply capacity depends on annual rainfall</td>
</tr>
<tr>
<td></td>
<td>Tait Street Wells&lt;sup&gt;(1)&lt;/sup&gt;</td>
<td>1.2</td>
<td>N/A</td>
<td>11.4 to 17.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Loch Lomond Reservoir</td>
<td>1.1</td>
<td>N/A</td>
<td>11.4 to 17.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coast Sources including Liddell Spring, Laguna/Reggiardo Creeks, and Majors Creek</td>
<td>2.7 to 5.5</td>
<td></td>
<td>11.4 to 17.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Beltz Wells&lt;sup&gt;(2)&lt;/sup&gt;</td>
<td>N/A</td>
<td>1.94</td>
<td>11.4 to 17.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>San Lorenzo Valley Water District</td>
<td>Clear Creek, Foreman Creek, Silver Creek, Peavine Creek, Sweetwater Creek</td>
<td>1.2</td>
<td>N/A</td>
<td>11.4 to 17.5</td>
<td></td>
<td>Most of the demand is in surface water service area (about 70 percent)</td>
</tr>
<tr>
<td></td>
<td>Quail Hollow Wells, Olympia Wells, Pasatiempo Wells</td>
<td>N/A</td>
<td>3.3</td>
<td>11.4 to 17.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fall Creek, Bennett and Bull Springs</td>
<td>0.5</td>
<td>N/A</td>
<td>11.4 to 17.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lompico County Water District</td>
<td>Lompico Creek</td>
<td>0.06</td>
<td>N/A</td>
<td>11.4 to 17.5</td>
<td>0.12</td>
<td>0.082</td>
</tr>
<tr>
<td></td>
<td>Well Sources (3 wells)</td>
<td>N/A</td>
<td>0.06</td>
<td>11.4 to 17.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: 1996 Watershed Sanitary Survey  
N/A - Not applicable  
<sup>(1)</sup> Tait Street wells are considered a surface water because they are hydraulically influenced by the San Lorenzo River flow.

### 2.6.4 Source Management

Each of the utilities in the area manages their sources in an attempt to satisfy the water demands for their specific systems. All utilities are dependent upon the surface flows from the various creeks, streams, and springs that make up their drinking water source. Factors such as highly turbid water caused by stormwater runoff make the water more difficult to treat, requiring diversion of the source to be discontinued until the water quality returns to acceptable levels. For example, SCWD does not use water from the Tait Street Diversion during storm events when the turbidity exceeds about 10 NTU. When flows are diminishing towards the end of a storm and/or on the receding limb of the hydrograph, turbidity of about 25 NTU is diverted. Also, SLVWD does not use highly turbid water at their Lyon and Kirby WTPs during high-turbidity periods.
One of the major issues that continues to face SCWD is the proposed in-stream flow requirements for Endangered Species Act (ESA) requirements under the HCP will be established on some of the North Coast streams, potentially reducing the volume of flow available from these sources. As discussed in Section 2.3.5, the consequence of reduced North Coast flows would be higher reliance on water from Loch Lomond Reservoir, which has a higher total organic carbon (TOC) concentration, and hence a higher potential for formation of disinfection byproducts (DBP).

City staff has continued to discuss, at a conceptual level, the implications of ESA in-stream flow requirements, which could include modifying the treatment process and/or constructing horizontal wells at the San Lorenzo River diversion -- both of which are activities that will require many years to plan and implement. In addition, Graham Hill WTP improvements to meet LT2 and Stage 2 rule requirements were evaluated in 2010. These improvements include alternatives that could be implemented to meet more stringent D/DBPR requirements and reduce the higher levels of DBP that are associated with elevated TOC concentrations. However, the estimated costs for these treatment improvements and/or horizontal well construction ranged from $20 to $40 million dollars (T. Tompkins, personal communication, 2012). The City lacks the financial resources to pursue this scale of improvement and is evaluating alternative means of meeting the suite of water quality regulations.

Water utilities must therefore balance the need to satisfy their customer demand with the requirement to comply with drinking water regulations. Most utilities, large and small, experience difficulty in treating highly-turbid water, and therefore prepare and adjust for such operations before, during, and after storms events as do SLVWD and LCWD.

### 2.7 Facilities

#### 2.7.1 Raw Water Reservoirs

With the exception of small diversions in creeks and streams, the only large raw water reservoir in this study area is Loch Lomond, which is managed by SCWD. This roughly 8,600 acre-foot capacity reservoir, located on Newell Creek northeast of Felton and east of Ben Lomond, also stores San Lorenzo River water diverted at the Felton Diversion structure. The SLVWD is entitled to 313 AFY of the capacity of this reservoir through its agreement with SCWD.

#### 2.7.2 Intakes/Conveyance Systems

The locations of major water intakes are shown in Figure 1-1. Table 2-7 describes the intake and conveyance systems for the large utilities. Note that the San Lorenzo Valley and North Coast watersheds have extensive intake and conveyance systems needed to efficiently use the readily available supply of water in this area. Many of the intake structures have been constructed to prevent contamination from outside sources. Some of the key intake and conveyance systems are discussed below.
Table 2-7: Summary of Conveyance/Intake Facilities for Utilities With More Than 200 Service Connections

<table>
<thead>
<tr>
<th>Utility</th>
<th>Source</th>
<th>Intake Details</th>
<th>Pipeline Dimensions</th>
<th>Pump Station Capacity</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>City of Santa Cruz Water Department</td>
<td>San Lorenzo River - Tait Street diversion</td>
<td>Combination concrete check dam and screened intake sump with vertical turbine pumps on wells</td>
<td>Varies</td>
<td>7.8 mgd</td>
<td></td>
</tr>
<tr>
<td>San Lorenzo River - Felton diversion</td>
<td>Inflatable rubber dam, screened intake pump</td>
<td>N/A</td>
<td>Diversion P.S. at 2,850 gpm</td>
<td></td>
<td>Diverts water to Loch Lomond</td>
</tr>
<tr>
<td>Loch Lomond Reservoir</td>
<td>Large earthen dam with multi-stage outlet tower</td>
<td>44,000 ft pipeline; 18 to 27 inches diameter</td>
<td>Gravity flow to Felton Pump Station at 13.5 MGD</td>
<td>Used in specific months to augment supply or when other sources have high turbidity that is difficult to treat</td>
<td></td>
</tr>
<tr>
<td>Coast sources</td>
<td>These sources have small diversion structures or a protected spring box</td>
<td>Diameter varies - total pipelines</td>
<td>Gravity flow</td>
<td></td>
<td>Gravity flow to the Coast pump station then; pumped to GHWT</td>
</tr>
<tr>
<td>Majors</td>
<td>Concrete full-span dam with wire screened intake</td>
<td>10'</td>
<td>Gravity flow</td>
<td></td>
<td>Gravity flow to the Coast pump station then; pumped to GHWT</td>
</tr>
<tr>
<td>Laguna</td>
<td>Concrete/stone full span dam with wire screened intake</td>
<td>14’</td>
<td>Gravity flow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reggiardo</td>
<td>Concrete/stone full span dam with wire screened intake</td>
<td>8’</td>
<td>Gravity flow</td>
<td></td>
<td>Gravity fed to Laguna impoundment</td>
</tr>
<tr>
<td>Liddell</td>
<td>Concrete/Corrugated Aluminum springbox with wire screened intake</td>
<td>16’</td>
<td>Gravity flow</td>
<td></td>
<td>Gravity flow to the Coast pump station then; pumped to GHWT</td>
</tr>
<tr>
<td>San Lorenzo Valley Water District</td>
<td>Clear Creek</td>
<td>Protected spring box at elev 1250 ft, 8-inch pipe to Foreman Creek</td>
<td>N/A</td>
<td>Gravity flow to Lyon WTP</td>
<td></td>
</tr>
<tr>
<td>Sweetwater Creek</td>
<td>Protected spring box at elev. 1230 ft.</td>
<td>N/A</td>
<td>Gravity flow</td>
<td></td>
<td>Gravity flow to Lyon WTP</td>
</tr>
<tr>
<td>Peavine Creek</td>
<td>Small diversion structure at elev 1264 ft.</td>
<td>8 in. pipeline to Foreman Creek</td>
<td>Gravity flow</td>
<td></td>
<td>Gravity flow to Lyon WTP, Christmas tree farm in watershed</td>
</tr>
<tr>
<td>Foreman Creek</td>
<td>Small diversion structure at elev 927 ft.</td>
<td>8 in. pipeline to WTP</td>
<td>Gravity flow</td>
<td></td>
<td>Gravity flow to Lyon WTP, small subdivision in headwaters</td>
</tr>
<tr>
<td>Fall Creek</td>
<td>Small wire screen structures</td>
<td>8-inch</td>
<td>500 gpm</td>
<td></td>
<td>Gravity flow to Kirby WTP, Fall Creek St Park</td>
</tr>
<tr>
<td>Bennett Spring</td>
<td>Protected spring box</td>
<td>4-inch</td>
<td>N/A</td>
<td>Gravity flow to Kirby WTP</td>
<td></td>
</tr>
<tr>
<td>Bull Spring</td>
<td>Protected spring box for #1 and #2</td>
<td>4-inch</td>
<td>N/A</td>
<td>Gravity flow to Kirby WTP</td>
<td></td>
</tr>
<tr>
<td>Lompico County Water District</td>
<td>Lompico Creek</td>
<td>Secured, screened structure adjacent to creek impoundment dam with concrete deep well and 1 HP pump</td>
<td>2” PVC Raw water line to holding tank 260-ft away</td>
<td>30 gpm Pump</td>
<td></td>
</tr>
</tbody>
</table>

N/A Not applicable or available.

Note to Reviewers: Info for Big Basin MWC is not included in this table but were included in 1996.

2.7.2.1 SCWD

Figure 1-1 shows approximate intake locations for the SCWD system. These include pipelines from the North Coast watershed and the San Lorenzo Valley. The details of these intakes and conveyance systems have been previously described in the 1996 sanitary survey.
2.7.2.2 SLVWD

Figure 1-1 shows the locations of the surface water sources used by the SLVWD. The Sweetwater Creek and Clear Creek intakes have been relocated further upstream on each creek to minimize the impact from human activity. However, this relocation has also moved the intakes closer to Empire Grade Road and reduced the runoff area. The impact of this relocation should be beneficial unless there is a significant chemical spill upstream of one or both intakes.

2.7.2.3 LCWD

LCWD has an intake on Lompico Creek below the Mill Creek confluence. About 15-20 houses are located upstream of these intake structures. The LCWD obtains about 25% of its water from the Lompico Creek surface intake. The other approximately 75% is obtained from groundwater wells. LCWD’s long-term plan includes relocating the creek intake structure upstream of existing houses.

2.7.3 Treatment Plants/Processes

The water treatment plant facilities for the large utilities in the watershed study areas are summarized in Table 2-8 and are described in more detail below.

Table 2-8: Summary of Surface Water Treatment Facilities for Utilities With More Than 200 Service Connections

<table>
<thead>
<tr>
<th>Utility/Treatment Plant (Capacity)</th>
<th>Subject Watershed Source(s)</th>
<th>Pretreatment Process</th>
<th>Coagulant/ Flocculation Process</th>
<th>Sedimentation</th>
<th>Filtration (Rate)</th>
<th>Disinfection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Santa Cruz Water Dept. Graham Hill WTP (24 mgd)</td>
<td>San Lorenzo River, Loch Lomond, and North Coast sources</td>
<td>Potassium permanganate or chlorine for oxidation, powdered activated carbon and potassium permanganate for taste and odor removal</td>
<td>Alum and cationic polymer Horizontal paddle mixers</td>
<td>Conventional - enhanced using tube settlers</td>
<td>Dual media (4 gpm/ft2)</td>
<td>Sodium Hypochlorite with liquid chlorine back-up</td>
</tr>
<tr>
<td>San Lorenzo Valley Water District - Lyon WTP (1.0 mgd)</td>
<td>Clear Creek, Foreman Creek, Peavine Creek, Sweetwater Creek</td>
<td>Chlorine for oxidation</td>
<td>Adsorption clarification/ filtration (Neptune Trident Microfloc)</td>
<td>Adsorption onto floating media which is equivalent to sedimentation</td>
<td>3 Multi-media filters at 350 gpm rating each (6gpm/ft2)</td>
<td>Sodium Hypochlorite</td>
</tr>
<tr>
<td>San Lorenzo Valley Water District - Kirby WTP (0.5 mgd)</td>
<td>Fall Creek, Bennett and Bull Springs</td>
<td>Sodium Hypochlorite</td>
<td>Adsorption clarification/ filtration (Neptune Trident Microfloc)</td>
<td>Adsorption onto floating media which is equivalent to sedimentation</td>
<td>2 – filters at 350 gpm rating</td>
<td>Sodium Hypochlorite</td>
</tr>
<tr>
<td>Lompico County Water District – Mill Creek WTP</td>
<td>Lompico Creeks</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>Microfiltration membrane 0.5 gpm/m2 of membrane area</td>
<td>Chlorine Post-treatment</td>
</tr>
</tbody>
</table>

Source: DPH Annual Inspection Reports
N/A = Not applicable
(1) Beltz WTP is not included because it is a groundwater source and Loch Lomond Recreation Area WTP is not included because it is a transient non-community water system.

Note to Reviewers: Info for Big Basin MWC is not included in this table but was included in 1996.
2.7.3.1 SCWD

Figure 2-6 illustrates the water treatment processes used by SCWD at the Graham Hill WTP. The Graham Hill WTP is a conventional treatment plant with key processes such as preoxidation, coagulation, carbon/potassium permanganate contactors (for taste and odor control), flocculation, sedimentation, filtration, and disinfection. These processes are fully described in the June 2010 Inspection Report by DPH.

The Loch Lomond Reservoir Recreational Area (LLRRA) water system uses a microfiltration system to provide water for park users and the caretakers of the reservoir watershed. This system produces about 15 gallons per minute (gpm) of reservoir water through a microfiltration unit, equivalent to about 20,000 gallons per day. The microfiltration membranes were last replaced in 2010.

SCWD also operates the Live Oak (previously Beltz) Wells Filtration Plant, which is an oxidation and pressure filtration process to remove ambient iron and manganese from a ground water source. The Live Oak well plant has dual-media filtration consisting of sand and anthracite coal on a gravel support layer and it operates at a rate of about 3 gallons per minute per square foot (gpm/ft²).

2.7.3.2 SLVWD

SLVWD constructed the Lyon WTP in 1994, a two-stage package filtration plant which uses floating media to remove floc particles followed by a granular media filtration. DPH accepted this process as equivalent to conventional treatment. The system consists of three prefabricated adsorption, clarification, and filtration units each rated at 420 gpm. Due to piping system constraints, however, the maximum treated water production rate is 1,150 gpm.

In addition SLVWD operates the Kirby WTP in Felton which is described in Section 2.4.3

2.7.3.3 LCWD

LCWD constructed a new pressure filtration system with microfiltration facilities for the Mill Creek WTP in 1996. This treats surface water from Lompico Creek using a sand trap for pre-treatment, followed by a cartridge filter, then to a 400-gallon equalization tank that provides a constant flow rate to the microfiltration membranes. Following membrane filtration, the water passes through granular activated carbon for taste and odor control and disinfected with sodium hypochlorite before entering the disinfection system.
Figure 2-6  Process Layout of the Graham Hill Water Treatment Plant, Santa Cruz Water Department.
2.7.4 Pipeline Data, Capacity

Table 2-9 summarizes the pipeline data for each of the large utilities. Table 2-10 lists the distribution system reservoirs for each of the large utilities. The distribution system storage capacity for these utilities appears sufficient to account for short-duration periods when the lower quality water is diverted and water treatment facilities are not used. The maximum storage capacity for these utilities is about two to ten times more than the average daily use. Therefore, each utility has enough storage to allow a short-term period when water treatment facilities are not operational.

Table 2-9: Summary of Distribution Systems for Utilities With More Than 200 Service Connections

<table>
<thead>
<tr>
<th>Utility</th>
<th>Number of Service Connections</th>
<th>Total Pipeline Length</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>City of Santa Cruz Water Department</td>
<td>24,351 in 11 pressure zones 300 miles (4 in. to 18 in.)</td>
<td>Satellite disinfection available at 3 locations</td>
<td></td>
</tr>
<tr>
<td>San Lorenzo Valley Water District</td>
<td>6,000 in 23 pressure zones 1,300 in 6 pressure zones for Felton System 155 miles (SLVWD 125 miles and Felton 30 miles) (2 in. to 16 in.)</td>
<td>Satellite disinfection available at 2 locations</td>
<td></td>
</tr>
<tr>
<td>Lompico County Water District</td>
<td>484 in 3 pressure zones 32 miles</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note to Reviewers:* Info for Big Basin MWC is not included in this table but was included in 1996.
Table 2-10: Summary of Distribution System Storage Reservoirs for Utilities with more than 200 Service Connections

<table>
<thead>
<tr>
<th>Utility</th>
<th>Reservoir Name</th>
<th>Capacity (Gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>City of Santa Cruz Water Department (16 reservoirs total)</td>
<td>Carbonera 1,000,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>University #5 2,000,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>University #4 400,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>University #2 1,000,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bay St. (4 tanks) 6,000,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DeLaveaga 1 1,000,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DeLaveaga 2 1,000,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>S.C Gardens 1 250,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>S.C Gardens 2 250,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rollingwoods 270,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pasatiempo 1 750,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pasatiempo 2 300,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Finished Water Tank @ GHWTP 1,000,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Echo 1,000,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reader 150,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brookdale 750,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Big Steel 1,400,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lyon 3,000,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Little Lyon 250,000</td>
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</tr>
<tr>
<td></td>
<td>Blue Ridge 40,000</td>
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</tr>
<tr>
<td></td>
<td>Huckleberry 125,000</td>
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</tr>
<tr>
<td></td>
<td>Bear Creek Estates 75,000</td>
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</tr>
<tr>
<td></td>
<td>Ralston 10,000</td>
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</tr>
<tr>
<td></td>
<td>Eckley 4,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Blackstone 1 11,000</td>
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<td></td>
<td>Blackstone 2 11,000</td>
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<tr>
<td></td>
<td>Highland 60,000</td>
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<tr>
<td></td>
<td>Nina 1 64,500</td>
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<td></td>
<td>Nina 2 64,500</td>
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<tr>
<td></td>
<td>South 1 9,000</td>
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<td>South 2 9,000</td>
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<td>South 3 9,000</td>
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<td>South 4 9,000</td>
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<tr>
<td></td>
<td>Spring 65,000</td>
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<tr>
<td></td>
<td>Swim 1 10,000</td>
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<td></td>
<td>Swim 2 10,000</td>
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<tr>
<td></td>
<td>Quail 1 211,000</td>
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<td>Quail 2 240,000</td>
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<td></td>
<td>University 51,000</td>
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<tr>
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<td>Reagon 500</td>
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<td></td>
<td>Probation 100,000</td>
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<tr>
<td></td>
<td>Lower Pasatiempo 100,000</td>
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<tr>
<td></td>
<td>Upper Pasatiempo 100,000</td>
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</tr>
<tr>
<td></td>
<td>Blue Tank 65,000</td>
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</tr>
<tr>
<td></td>
<td>Charlie Tank 45,000</td>
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</tr>
<tr>
<td></td>
<td>Felton – Kirby 250,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Felton - Blair 255,000</td>
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</tr>
<tr>
<td></td>
<td>Felton - El Solyo 20,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Felton – McCloud 284,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Felton Acres 100,000</td>
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</tr>
<tr>
<td>San Lorenzo Valley Water District (37 reservoirs total)</td>
<td>Clear well 48,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tank 1 65,000</td>
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<td></td>
<td>Tank 2 100,000</td>
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<td></td>
<td>Tank 3 100,000</td>
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<tr>
<td></td>
<td>Tank 4 100,000</td>
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<tr>
<td></td>
<td>Tank 5 100,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tank 6 100,000</td>
<td></td>
</tr>
<tr>
<td>Lompico County Water District</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.7.5 Satellite treatment facilities

Besides small chlorination systems for numerous wells used throughout the area, the main satellite treatment facilities are chlorination facilities used by SCWD at the University Reservoir. Satellite chlorination equipment is housed in a separate room from the source. SCADA systems are used to control and monitor these facilities. The targeted chlorine residual leaving these facilities to the appropriate pressure zones is about 0.5 mg/l of free chlorine. SLVWD has a similar facility at one of its reservoirs.

2.8 Emergency Plans

Most utilities experience periodic emergencies that disrupt water treatment or water supply. The SWTR requires utilities to develop standard and emergency response plans for specific types of emergency episodes. These include chemical spills, fires, equipment failure, serious power failure, and deliberate water fouling. Some emergency plans may include responses to seismic episodes, floods, and droughts. In addition, the Bioterrorism Act, established after the attacks of September 11, 2001 (9-11), requires that drinking water systems serving a population greater than 3,300 (or 1,000 service connections) complete a vulnerability assessment in regard to terrorist activity and modify their emergency plans to reduce the risk posed by terrorist attacks. Most of the utilities in the study area have developed emergency response plans as part of the Operations Plans for each WTP. Also, the County uses the emergency response dispatch, NETCOMM, to notify drinking water utilities of chemical spills, fires, and other emergencies in the watershed. The Emergency Plan includes a response when episodes are notified via the 911 emergency telephone number. However, SCWD staff has indicated that notifications are not always made; therefore a recommendation to have an annual discussion with emergency response dispatchers has been made. Specific emergency plans for each utility are discussed below.

2.8.1 SCWD

The SCWD issued a revised Emergency Operations Plan in 2011, which addresses natural and man-made disasters such as earthquakes, tidal waves, flood, fire, vandal-caused disasters, and chemical spills. This Emergency Operations Plan would be used in the event of contamination of the water supply by acts of terrorism or vandalism. The response to equipment failures and serious power failures at the WTP is included in the December 2005 Plant Operations Manual.

SCWD has conducted a seismic risk evaluation called the Earthquake Response Procedures for the Newell Creek Dam and Other Critical Structures. This information is available in the 2005 General Emergency Plan and is likely to be contained in the Section/Unit Operations Plans that are “under construction” in the 2011 Emergency Operations Plan. SCWD also has a Water Shortage Contingency Plan which was adopted by resolution of the Santa Cruz City Council in March 2009 and an Ordinance (Santa Cruz Municipal Code Chapter 16.01) that implements water shortage regulations and restrictions. Both of these documents are included as appendices to the 2011 Urban Water Management Plan and call for an aggressive conservation effort and public relations program to reduce the drinking water demand of the customers during emergencies.

The broader 2005 Santa Cruz County Operational Area Emergency Management Plan addresses the consequences of any emergency or disaster which may occur within the County. The plan also provides a means by which State and Federal assistance is requested if

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5 The Santa Cruz Operational Area consists of the County and all political subdivisions within the County.
necessary. Depending on the size and complexity of the incident, an emergency operations center (EOC) may be activated under the direction of the Santa Cruz County Office of Emergency Services. The Santa Cruz Operational Area transitioned to a Standardized Emergency Management System (SEMS) in 2007 that is compliant with the National Incident Management System (NIMS). NIMS was developed by the Department of Homeland Security to improve national readiness to respond to not only terrorist events but all types of disasters (Santa Cruz County Office of Emergency Services, 2005).

2.8.2 SLVWD

SLVWD lists most of their emergency response plans in the Lyon WTP Operations Plan. This plan includes a response to most natural disasters and chemical spills in the watershed. For other emergencies, SLVWD can rely on the County EOC infrastructure.

2.8.3 LCWD

LCWD responds to emergency plans such as natural, accidental, and vandal-caused disasters as documented in the LCWD Emergency Response Plan. This includes the specific responses, disinfection, and notification for these types of disasters. Generally, the LCWD will shut off the water supply that has been possibly contaminated and use the alternative supply if necessary.

For chemical spills, Zayante Fire Protection District personnel are required to notify LCWD through established County communications for any incident that occurs upstream of the Lompico Creek intake structure. For fires, the LCWD has established fire breaks around all treated water reservoir sites.

For equipment failures or extended power outages, the LCWD stocks a surplus of spare pipe fittings, pipe, replacement motors, belts, and chemicals to keep the system operational. The LCWD also has a trailer-mounted emergency generator that will provide 30 kilowatts power. The WTP and booster stations are outfitted with quick-disconnect emergency-hookup switches. The LCWD also has smaller generators to provide power for office and radio operations.

To plan for earthquakes in the area, five of the six water storage tanks have been rehabilitated with restraint hold-downs and flexible fittings to minimize any lateral movement. All LCWD structures have been evaluated for seismic risk.

Finally, the LCWD has a Drought Contingency Plan, which calls for public education to conserve water and a tiered rate structure for the drinking water.
Section 3: POTENTIAL CONTAMINANT SOURCES IN THE WATERSHEDS

3.1 Survey Methods

The survey consisted of a combination of discussions and meetings with several County staff and Water Department staff, update calls to selected agencies, and a review of several agency files. Contacts are listed in Table 3.1. Field measurements made during stream gaging, watershed surveys, and sediment sampling by Balance staff have also been drawn upon for this analysis. The survey work was also supplemented with additional data and report review and discussions with various agency staff. This section discusses the specific potential contaminant sources.

Table 3-1: Santa Cruz Watershed Sanitary Survey Contacts

<table>
<thead>
<tr>
<th>Category</th>
<th>Contact</th>
<th>Agency</th>
<th>Phone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Drinking Water Regulations/Treatment</em></td>
<td>Jan Sweigert</td>
<td>CA DHS (Monterey)</td>
<td>(831) 655-6944</td>
</tr>
<tr>
<td><em>Processes/Quality Control</em></td>
<td>Querube Moltrip</td>
<td>CA DHS (Monterey)</td>
<td>(831) 655-6936</td>
</tr>
<tr>
<td><em>General Watershed Information</em></td>
<td>Chris Berry</td>
<td>SCWD</td>
<td>(831) 420-5483</td>
</tr>
<tr>
<td></td>
<td>John Ricker</td>
<td>SCCo Environmental Health Services</td>
<td>(831) 454-2750</td>
</tr>
<tr>
<td></td>
<td>Jim Mueller</td>
<td>SLVWD</td>
<td>(831) 430-4625</td>
</tr>
<tr>
<td></td>
<td>Chris Spohrer</td>
<td>CA Parks and Recreation</td>
<td>(831) 359-7420</td>
</tr>
<tr>
<td></td>
<td>Matt Johnston</td>
<td>Santa Cruz County Planning</td>
<td>(831) 454-3114</td>
</tr>
<tr>
<td><em>Drinking Water Production/Treatment</em></td>
<td>Terry Tompkins</td>
<td>SCWD</td>
<td>(831) 420-5454</td>
</tr>
<tr>
<td></td>
<td>Jim Mueller</td>
<td>SLVWD</td>
<td>(831) 338-2153</td>
</tr>
<tr>
<td></td>
<td>Troy Boone</td>
<td>SCCo Environmental Health Services</td>
<td>(831) 454-3069</td>
</tr>
<tr>
<td></td>
<td>Bill O'Brien</td>
<td>Scotts Valley Water District*</td>
<td>(831) 438-2363</td>
</tr>
<tr>
<td></td>
<td>Scott Harmon</td>
<td>Lompico Water District</td>
<td>(831) 335-5200</td>
</tr>
<tr>
<td></td>
<td>Bob Scholle</td>
<td>Big Redwood Park MWC*</td>
<td>(831) 353-1088</td>
</tr>
<tr>
<td></td>
<td>Michael Stus</td>
<td>Sequoia Seminar*</td>
<td>(831) 336-5060</td>
</tr>
<tr>
<td></td>
<td>David Forbes</td>
<td>Quaker Center*</td>
<td>(831) 336-8333</td>
</tr>
<tr>
<td></td>
<td>Tom Rafaeli</td>
<td>CalAm*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dale Pollock</td>
<td>Mt. Hermon*</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>* = non-participants in this Sanitary Survey</td>
<td></td>
</tr>
<tr>
<td>Urban Runoff</td>
<td>Rachael Fatoohi</td>
<td>SCCo</td>
<td>(831) 454-3160</td>
</tr>
<tr>
<td></td>
<td>Bridget Hoover</td>
<td>Monterey Bay National Marine Sanctuary</td>
<td>(831) 647-4217</td>
</tr>
<tr>
<td>Category</td>
<td>Contact</td>
<td>Agency</td>
<td>Phone Number</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>--------------------------</td>
<td>-------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Land Use (Agricultural, etc.)</td>
<td>Matt Johnston</td>
<td>SCCo Planning Department</td>
<td>(831) 454-3114</td>
</tr>
<tr>
<td></td>
<td>John Ricker</td>
<td>SCCo Environmental Health Services</td>
<td>(831) 454-2750</td>
</tr>
<tr>
<td></td>
<td>Lisa LeCoump</td>
<td>SCCo Agricultural Commissioner</td>
<td>(831) 454-2620</td>
</tr>
<tr>
<td></td>
<td>Betsy Herbert</td>
<td>SLVWD</td>
<td>(831) 430-4627</td>
</tr>
<tr>
<td></td>
<td>Richard Casale</td>
<td>USDA NRCS</td>
<td>(831) 475 1967</td>
</tr>
<tr>
<td>Concentrated Animal Facilities</td>
<td>John Ricker</td>
<td>SCCo Environmental Health Services</td>
<td>(831) 454-2750</td>
</tr>
<tr>
<td></td>
<td>Chris Berry</td>
<td>SCWD</td>
<td>(831) 420-5483</td>
</tr>
<tr>
<td></td>
<td>Betsy Herbert</td>
<td>SLVWD</td>
<td>(831) 430-4627</td>
</tr>
<tr>
<td></td>
<td>Angela Stuart</td>
<td>SCCo RCD</td>
<td>(831) 464-2950</td>
</tr>
<tr>
<td></td>
<td>Jennifer Harrison</td>
<td>Ecology Action</td>
<td>(831) 425-1404</td>
</tr>
<tr>
<td></td>
<td>Howard Kolb</td>
<td>RWQCB</td>
<td>(831) 549-3332</td>
</tr>
<tr>
<td>Pesticide and Herbicide Use</td>
<td>Kris Griffin</td>
<td>CalTrans - Landscape Specialist</td>
<td>(805) 549-3124</td>
</tr>
<tr>
<td></td>
<td>Tom Barnett</td>
<td>CalTrans - Santa Cruz Area Supt</td>
<td>(831) 476-1351</td>
</tr>
<tr>
<td></td>
<td>Steve Tjosvold</td>
<td>UC Cooperative Extension</td>
<td>(831) 763-8040</td>
</tr>
<tr>
<td></td>
<td>Dawn Harman</td>
<td>SCCo Road Maintenance</td>
<td>(831) 477-3999</td>
</tr>
<tr>
<td></td>
<td>Chris Berry</td>
<td>SCWD</td>
<td>(831) 420-5483</td>
</tr>
<tr>
<td></td>
<td>Scott Lang</td>
<td>SCWD, Loch Lomond</td>
<td>(831) 335-2586</td>
</tr>
<tr>
<td></td>
<td>Mary Lou</td>
<td>SCCo Agricultural Commissioner</td>
<td>(831) 454-2590</td>
</tr>
<tr>
<td></td>
<td>Nicoletti</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bill Keller</td>
<td>Boulder Cr. Golf and Country Club</td>
<td>(831) 338-3717</td>
</tr>
<tr>
<td>Wild Animals</td>
<td>Chris Spohrer</td>
<td>CA DPR</td>
<td>(831) 359-7420</td>
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<tr>
<td></td>
<td>Betsy Herbert</td>
<td>SLVWD</td>
<td>(831) 430-4627</td>
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<td>Scott Lang</td>
<td>SCWD, Loch Lomond</td>
<td>(831) 335-2586</td>
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<td></td>
<td>Chris Berry</td>
<td>SCWD</td>
<td>(831) 420-5483</td>
</tr>
<tr>
<td></td>
<td>Don Kelly</td>
<td>DFG Warden</td>
<td>(831) 649-2942</td>
</tr>
<tr>
<td></td>
<td>Paul Houghtaling</td>
<td>UCSC</td>
<td>(650) 208-5766</td>
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<tr>
<td>Quarries</td>
<td>Chris Berry</td>
<td>SCWD</td>
<td>(831) 420-5483</td>
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<td>David Carlson</td>
<td>SCCo Planning Department</td>
<td>(831) 454-3173</td>
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<td></td>
<td>Terry Tompkins</td>
<td>SCWD</td>
<td>(831) 420-5454</td>
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<td></td>
<td>Barry Hecht</td>
<td>Balance Hydrologics</td>
<td>(510) 704-1000</td>
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<td>Solid and Hazardous Waste</td>
<td>Scott Carson</td>
<td>SCCo Environmental Health Services</td>
<td>(831) 454-2758</td>
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<td>Disposal Facilities</td>
<td>Jose DeAnda</td>
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<td>(831) 454-2759</td>
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<td>Tim Fillmore</td>
<td>SCCo Environmental Health Services</td>
<td>(831) 454-2761</td>
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<td></td>
<td>Tom Sayles</td>
<td>RWQCB</td>
<td>(805) 542-4640</td>
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<td></td>
<td>Thea Tryon</td>
<td>RWQCB</td>
<td>(805) 542-4776</td>
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<td></td>
<td>Patrick Mathews</td>
<td>SCCo Public Works Department</td>
<td>(831) 454-2160</td>
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Table 3-1. Santa Cruz Watershed Sanitary Survey Contacts (cont’d)

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<tr>
<th>Category</th>
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<tr>
<td><strong>Timber Harvesting</strong></td>
<td>Donna Bradford</td>
<td>SCCo Environmental Health Services</td>
<td>(831) 454-7580</td>
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<td></td>
<td>Betsy Herbert</td>
<td>SLVWD</td>
<td>(831) 430-4627</td>
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<td></td>
<td>Chris Berry</td>
<td>SCWD</td>
<td>(831) 420-5483</td>
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<td></td>
<td>Rich Sampson</td>
<td>CDF</td>
<td>(831) 335-6742</td>
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<td></td>
<td>Terris Kastner</td>
<td>DFG</td>
<td>(408) 365-1066</td>
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<td></td>
<td>Mike Higgins</td>
<td>RWQCB</td>
<td>(805) 542-4649</td>
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<td><strong>Recreation</strong></td>
<td>Gretchen Illif</td>
<td>SC Co Parks</td>
<td>831-454-7908</td>
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<td></td>
<td>Chris Spohrer</td>
<td>CA Parks and Recreation</td>
<td>359-7420</td>
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<td>Betsy Herbert</td>
<td>SLVWD</td>
<td>(831) 430-4627</td>
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<td>Chris Berry</td>
<td>SCWD</td>
<td>(831) 420-5483</td>
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<td></td>
<td>Mauro Garcia</td>
<td>City of Santa Cruz Parks and Recreation</td>
<td>(831) 420-5366</td>
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<td><strong>Unauthorized Activity</strong></td>
<td>Chris Berry</td>
<td>SCWD</td>
<td>(831) 420-5483</td>
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<td>Scott Lang</td>
<td>SCWD</td>
<td>(831) 335-2586</td>
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<td></td>
<td>Betsy Herbert</td>
<td>SLVWD</td>
<td>(831) 430-4627</td>
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<td></td>
<td>Matt Johnston</td>
<td>Santa Cruz County Planning</td>
<td>(831) 454-3114</td>
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<td>Jose DeAnda</td>
<td>SCCo Environmental Health Services</td>
<td>(831) 454-2022</td>
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<td>John Buchanon</td>
<td>CDF</td>
<td>(831) 423-0528</td>
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<td>Rich Sampson</td>
<td>CDF</td>
<td>(831) 335-6742</td>
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<tr>
<td><strong>Traffic Accidents and Spills</strong></td>
<td>Scott Carson</td>
<td>SCCo Environmental Health Services</td>
<td>(831) 454-2758</td>
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<td>Jose DeAnda</td>
<td>SCCo Environmental Health Services</td>
<td>(831) 454-2022</td>
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<td>SCCo Environmental Health Services</td>
<td>(831) 454-2022</td>
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<tr>
<td><strong>Geologic Hazards</strong></td>
<td>Rob Walker</td>
<td>CEMEX</td>
<td>831-458-5711</td>
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<tr>
<td></td>
<td>Joe Hanna</td>
<td>SCCo Planning Department</td>
<td>(454) 454-3175</td>
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<td><strong>Fire</strong></td>
<td>Tim Hyland</td>
<td>CA Parks and Recreation</td>
<td>(831) 335-6384</td>
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<tr>
<td></td>
<td>Scott Lang</td>
<td>SCWD, Loch Lomond</td>
<td>(831) 335-2586</td>
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<td></td>
<td>Chris Berry</td>
<td>SCWD</td>
<td>(831) 420-5483</td>
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<td>Chris Spohrer</td>
<td>CA Parks and Recreation</td>
<td>(831) 359-7420</td>
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<td></td>
<td>Jim Rust</td>
<td>CDF</td>
<td>(831) 335-6723</td>
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<td>Mike Gagarin</td>
<td>CDF</td>
<td>(831) 427-2430</td>
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<td></td>
<td>Betsy Herbert</td>
<td>SLVWD</td>
<td>(831) 430-4627</td>
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<td></td>
<td>Chief John Stipes</td>
<td>Zayante Fire Dept.</td>
<td>(831) 335-5100</td>
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<tr>
<td><strong>Wastewater</strong></td>
<td>Rachel Lather</td>
<td>SCCo Public Works</td>
<td>(831) 420-5160</td>
</tr>
<tr>
<td></td>
<td>Scott Hamby</td>
<td>City of Scott's Valley</td>
<td>(831) 438-0732</td>
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<td></td>
<td>Rick Rogers</td>
<td>SLVWD</td>
<td>(831) 430-4624</td>
</tr>
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<td></td>
<td>Dale Pollock</td>
<td>Mt Hermon</td>
<td>(831) 335-4466</td>
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<td>Big Basin Water Co.</td>
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<td></td>
<td>Mike Higgins</td>
<td>RWQCB</td>
<td>(805) 542-4649</td>
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<td></td>
<td>John Ricker</td>
<td>SCCo Environmental Health Services</td>
<td>(831) 454-2750</td>
</tr>
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<td></td>
<td>Cheryl Wong</td>
<td>SCCo Environmental Health Services</td>
<td>(831) 454-3219</td>
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3.2 Wastewater

A number of communities and organizations are served by package wastewater treatment systems that discharge to common leachfields as shown on Figure 3-1. These entities include: County Service Area No. 7 in the vicinity of the Boulder Creek Golf and Country Club, Bear Creek Estates, the Mt. Hermon Association, the San Lorenzo Valley Unified School District, Camp Harmon, Camp Campbell and several other camps and conference centers. Recently, County Service Area No. 10 - Rollingwood Estates was connected to the City of Santa Cruz wastewater treatment plant which discharges the wastewater through the City of Santa Cruz ocean outfall.

However, the great majority of the residences and businesses in the San Lorenzo River watershed are on individual or community (e.g., trailer parks) septic systems. As the San Lorenzo Valley has shifted from a primarily second-home area to a year-round residential community, homes have been remodeled and expanded but improvements to the old sub-standard septic systems often lagged far behind improvements to the homes. The dispersed rural population in the North Coast watersheds is served by individual septic tank and leachfield systems. There are no direct discharges of municipal wastewater to surface waters in the San Lorenzo Valley or North Coast watersheds.\(^6\)

As shown on Figure 2-1, the majority of the SLVWD watershed areas are either in a state park or is protected land designated as Resource Conservation Land Use. The state park has hiking trails but no wastewater facilities as the nearby park entrance station, outside of the drainage, has visitor facilities. Only a small portion of the SLVWD watershed lands are designated rural residential with associated septic systems; these lands are near the upper watershed, quite a distance from the diversion locations.

Septic systems have the potential to contaminate surface water either by percolation of wastewater through the soil into ground water which recharges surface water, or by direct surface runoff. If septic systems are improperly designed or installed in highly-permeable soils, wastewater constituents can leach into ground water and from there seep into nearby surface waters. Surface water contamination from septic systems can also occur by system ‘failure’, or insufficient percolation rates leading to ponding and surfacing of effluent. A ‘failing’ septic system can allow large amounts of nutrients, viruses and bacteria to contaminate nearby surface waters. The portions of the San Lorenzo Valley that overlie high permeability soils has a higher probability of nitrates entering groundwater from the individual septic systems through excessively rapid percolation to ground water rather than by system failures as a result of the sandy soils discussed in Section 2.3.1. It is estimated that 11% of septic systems are located in high permeability soils.

There are about 15 homes upstream of the LCWD intake one of which was documented as failing in the 1996 sanitary survey. LCWD staff performs monthly drive-by inspections of these upstream homes for visible evidence of septic failure which would be reported to the County Health Department as necessary for follow-up.

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\(^6\) The Watkins Johnson site in Scotts Valley, has had declining levels of TCE and PCE that have been treated and released. The site owners are currently negotiating with the USEPA to formally close the site.
Surface water contamination by nutrients and coliform bacteria from septic systems in the San Lorenzo Valley has been intensively studied. The 1979 Watershed Management Plan identified improperly functioning septic systems as one of the major pollutants sources to the San Lorenzo River. In 1995, the County Board of Supervisors and the Regional Board adopted the Wastewater Management Plan for the San Lorenzo River Watershed which has been considered a model for the on-site septic wastewater management standards in the State under AB 885 as discussed in Section 4.9.

The Wastewater Management Plan contains management practices to prevent further degradation of water quality from septic systems and corrective measures to improve existing systems and reduce the loading of pollutants to the San Lorenzo River. The County implements a series of activities including septic tank pumping reporting to manage on-site wastewater systems as discussed in Section 5. Many of these measures were emplaced after extended field trials at sites throughout the valley under a range of soil and slope conditions. The 1999-2001 program status report indicates a total of at least 3,000 systems were upgraded between 1986 and 2001; wet season septic failure rates of 5 to 14% have subsequently declined to 1 to 3% (Santa Cruz County, 2003).

More recent estimates indicate that failures rates are less than 0.5%. About 50 complaints/year regarding septic systems have been recorded in the San Lorenzo River Watershed, which is significantly less than the 130-160 failures per year recorded in the 1990s. Of those 50 complaints, about 50 percent had documented failures requiring improvements. Furthermore, the rate of new septic system addition has also reduced from about 15 systems per year down to 4 systems per year which further reduces the risk of water quality contamination from septic systems. An updated program status report is anticipated during 2012. (J. Ricker, Personal Communication, 2012)

3.2.1 Contaminants of Concern

Contaminants in wastewater can be divided into those that present an acute health risk and those that may pose a chronic, or long-term health risk. An acute health risk is posed by the presence of pathogenic microorganisms. A chronic health risk is posed by excessive concentrations of compounds present in the source water or formed in the water treatment process.

Wastewater contains a number of pathogenic microorganisms responsible for causing diseases, such as hepatitis, typhoid, cholera, dysentery, salmonella, giardiasis, and cryptosporidiosis. In a properly functioning septic system, the effluent is treated by the soil and the microorganisms are removed. If the system is not functioning properly, incompletely treated effluent may enter streams, or reach ground water.

Wastewater also contains high concentrations of nutrients and organic carbon. Most nitrogen in wastewater is converted to the nitrate form, which is highly soluble and readily transmitted through the soil to ground or surface waters. Nutrients can stimulate biological productivity in surface waters leading to high concentrations of organic carbon at downstream water intakes. Organic carbon combined with disinfectants used at water treatment plants produces trihalomethanes (THMs), five haloacetic acids (HAA5) and other disinfection byproducts (DBP) which can have long-term health implications. Excessive algal growth, promoted by introducing
additional nitrate into a natural system in which phosphorus is widely available, also causes taste and odor problems in drinking water systems.

Blooms of blue-green algae (cyanobacteria), which form in nutrient-rich, non-turbulent waters, could cause more serious problems as some of these organisms produce harmful toxins. In September 2009, the EPA finalized its Drinking Water Contaminant Candidate List to include cyanobacteria which prioritizes this issue for further investigation. Usually, management practices to control taste and odor help to reduce the likelihood of toxic blue-green algal blooms; however, prevention is the preferred method because some types of treatment can rupture the cells and release the toxins.

Greywater consists of wastewater not originating from the toilet. A greywater system collects and disposes of wastewater from systems such as the washing machine, shower, and bathroom sink. Greywater sumps are used by some homeowners to reduce loadings on a septic system with inadequate leaching capacity and to be able to reuse greywater for landscape irrigation. Although greywater contains fewer pathogens, solids, and nutrients than toilet wastes, it can still present a significant health hazard. According to the County Health Services Agency, bacterial concentrations in greywater from shower or bath water can reach 400,000 fecal coliforms/100 milliliter (ml) and 3 million total coliforms/100 ml. Washing machine wastewater can range from 2,000 to 10 million fecal coliforms/100 ml. In addition, there are roughly 200 enteric virus/Liter (L) of undisinfected greywater from showers and baths and 3,000 viruses/L from washing machines. County policy requires permitting of greywater sumps and includes connection of all greywater to an adequately sized septic system for the winter time when irrigation demands are low. The County permits the installation of at least 25 to 50 greywater sumps each year under appropriate conditions (Ricker, 1995).

SB 1258 passed in 2008 directs the California Department of Housing and Community Development to develop a more wide-ranging set of greywater standards for both indoor and outdoor uses than current law allows. These standards are expected to be incorporated in California Plumbing Code updates. Proposed standards include consideration of source water protection through containment on the site where generated and disposed of, prohibition on ponding and runoff, and prohibition of the use of greywater containing infectious (e.g. diapers) or hazardous contaminants.

### 3.2.2 Existing Conditions

#### 3.2.2.1 San Lorenzo River Watershed

The Regional Water Quality Control Board is responsible for permitting and management of wastewater systems that discharge greater than 20,000 gallons per day (gpd). As part of County Service Area No. 7, the County-operated Boulder Creek Wastewater Treatment Plant serves the neighboring country club, 18-hole golf course, tennis facilities, restaurant and pro shop, as well as about 200 townhouses and residences built along the fairways. The collection system includes 24 miles of 6- and 8-inch gravity mains, a 4-inch PVC force main, and five lift stations. The plant was upgraded to tertiary treatment in 1996 and has a capacity of 104,000 gpd. The treated effluent is pumped to a leachfield, where it is disposed of by subsurface discharge. In the past, tertiary treated water has also been delivered to the Boulder Creek Golf and Country Club, blended with raw water and used for irrigation. In recent years, process improvements to
reduce the nitrate concentration, improved distribution of effluent to the leachfield, as well as force main upgrades to reduce spills between the treatment plant and leachfield have been implemented. (J. Ricker, Personal Communication, 2012). The force main improvements have particularly reduced spills to Boulder Creek. It has not been confirmed that back-up generators for the collection system and effluent pump stations have been installed.

The Bear Creek Estates Wastewater Treatment Plant, which is owned and operated by the SLVWD, serves units 3, 4, and 5 of Bear Creek Estates. SLVWD has a waste discharge permit to treat up to 12,000 gallons per day of wastewater, then discharge it to a community leachfield. In 2005, SLVWD installed improvements for nitrogen removal pursuant to the Regional Water Quality Control Board’s minimum discharge requirement of 50 percent nitrogen removal, prior to subsurface disposal.

The Mt. Hermon Association is another significant community wastewater disposal system in the watershed. The Mt. Hermon Association is served by a sequential batch reactor package plant that treats wastewater from a hotel, cabins and homes. The plant has a permitted capacity of 63,000 gpd but is currently operating at about 45,000 gpd (Mike Higgins, Regional Board, personal communication). Treated effluent is pumped uphill and discharged to a community leachfield above the plant. More recently, the Rollingwood subdivision of about 30 homes, near Scotts Valley has been connected to the City of Santa Cruz wastewater treatment plant as discussed earlier.

Significant institutional wastewater disposal systems in the San Lorenzo Valley include those serving Camp Harmon, Camp Campbell and other organized camps, as well as the San Lorenzo Valley Unified School District (high school, junior high school, elementary school) facility in Felton. The latter system is unique in that treated effluent is further polished in a constructed wetland prior to being discharged to a leachfield.

There are also approximately 13,500 individual septic systems in the San Lorenzo watershed, of which about 11,950 occur above the SCWD Tait Street diversion. The density of systems is higher than that of any other comparable area in California watershed. Overall, the density of development in the creek bottoms, both along the river itself and on the river’s tributaries, is quite high. Many residences were originally used as summer homes and are now occupied year-round. Some homes were built with part of the building supported by stilts, over the floodplain. In many areas the density is akin to urban areas in California which are served by municipal sewer systems.

There are a number of limitations to on-site disposal systems in the San Lorenzo Valley watershed, as described in the 1995 Wastewater Management Plan:

- Approximately 55 percent of the developed parcels are less than 15,000 square feet and 11 percent are less than 6,000 square feet. This significantly limits the size of leachfields and the opportunity to install back-up/replacement leachfields.

- Two-thirds of the systems are substandard in size and did not meet the repair standards of 1995. Significant improvements have been made to at least 3,000 systems since 1986.
- About 40 percent of the systems were constructed before 1975 and have not experienced significant additions (i.e. remodels/expansions/subdivisions) or do not have second leachfields.

- About 14 percent of the systems are located less than 100 feet from a stream.

- Winter ground-water levels are less than 10 feet from the surface in 30 to 50 percent of the systems and less than 3 feet from the surface in 3 to 6 percent of the systems.

The County has conducted numerous surveys and evaluations of the septic systems in the watershed since 1986. The County has continued to have a low frequency of septic-system surveys since the late 1990s, as relatively few changes were reported and the value of continuing the surveys does not compete effectively with enforcement or other County Environmental Health Service priorities (John Ricker, personal communication, 2012). Because there is real value to neighborhood- or community-scale discussion, the community-scale results from the 1996 sanitary survey are included and updated as appropriate.

**Kings Creek** - The greater Kings Creek area includes 800 developed parcels in the neighborhoods of Wildwood, Redwood Grove, River Rights, Lower Kings Creek, Sunbeam Woods, Blue Ridge, Madrona and Sequoia Drives, Lower Two Bar Creek, and Juanita Woods. This area has soils with significant clay content, high winter ground-water levels, small lots, and steep slopes. Despite potential significant constraints to septic systems, over 80 percent of the systems were found to be performing without any signs of failure during the wet winter of 1986. During the wet winter of 1993, the overall failure rate was below 2 percent. Most of the failing systems could be adequately upgraded using conventional systems. The Wastewater Management Plan concludes that a community system is not feasible because it lacks a disposal site.

**Boulder Creek** - The Boulder Creek area includes the developed areas centered around downtown Boulder Creek and extending a short distance up the valleys along Bear Creek, Boulder Creek, and the San Lorenzo River. This area has relatively permeable alluvial soils with some localized areas of clay soils. Winter ground-water levels are less than 10 feet below the surface in most of the area. Ground-water underlying Boulder Creek probably contributes nitrate to the San Lorenzo River. There have been repeated instances of septic system failure, with discharge of untreated effluent to roadside areas and eventually to the San Lorenzo River. During the early period of the County’s wastewater management program, the river downstream from Boulder Creek had the highest incidence of contamination by sewage of any area in the watershed. Conditions have improved significantly during recent years. During the winters of 1987 and 1988, 85 percent of the parcels surveyed were performing adequately and 4 percent were found to have surfacing sewage. In 1991, re-inspection of systems repaired as a result of the survey found that 90 percent were performing satisfactorily, and 95% of the systems were performing adequately in 1999 and 2001 (John Ricker, personnel communication, 2007). A feasibility study was conducted for a community sewage disposal system for the downtown area.

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7 Balance staff also reviewed the long-term data provided by the County and City for indications that the 1989 Loma Prieta earthquake or the storms of 1995 and 1998 may have damaged sufficient systems to make a difference in bacterial or nitrate loadings. Neither constituent appears to have been affected by the three events queried.
but it was found to be too costly. A community service district provides a regular pumpout service for the downtown area, with disposal outside of the watersheds.

**Ben Lomond** - The Ben Lomond area includes 780 developed parcels. There are no constraints to septic system performance in most of the Ben Lomond area. Historically the water quality in Ben Lomond has been the best of any developed area in the watershed. The survey conducted from 1989 through 1991 showed a 1 percent failure rate. In 1993, the failure rate was down to 0.5 percent. A community sewage disposal system is not warranted because of the cost and the low incidence of problems in this area.

**Glen Arbor** - The Glen Arbor area includes 500 parcels south of Ben Lomond. The area consists of three distinct zones; an upland area underlain by the Santa Margarita sandstone, an area of relatively steep slopes, and a lower area on well drained soils of the river terrace. Although the upland systems perform well, the effluent discharged to the highly permeable sandy soils contributes to elevated nitrate levels in the river. The lower portions of Glen Arbor have contributed to bacterial contamination of the river caused by high ground water and some pockets of clay soil. In recent years, a number of systems have been repaired. During the 1990 through 1993 surveys, a failure rate of 2 percent was found. A community disposal system was judged to be infeasible because of high cost and potential impacts on the Quail Hollow groundwater basin. Most homes in the Glen Arbor area were constructed during the late 1960s through late 1980s. Relatively few changes in the number of homes or of waste disposal systems since the early 1990s (White and Hecht, 1993) suggests that little if any change in effects on downstream community water supplies would be expected.

**Felton** - The Felton area includes 820 developed parcels. This area was surveyed in 1989 and 1991. Much of the Felton area is on a broad alluvial flat, with high ground water and small lot sizes being the main constraints to proper septic system functioning. Failure rates in 1993 were 0.6 percent. El Solyo Heights is a separate neighborhood of 80 developed parcels at the north end of Felton. Failure rates in this area were 13 percent in 1989. Constraints to proper septic tank functioning include high ground water, clay soils, shallow depth to bedrock, moderate slopes, and presence of cuts and fills. Alternative systems are being required on a case by case basis. A community disposal system feasibility study concluded that there was not an adequate disposal site and that the project would be too costly to justify.

**Brook Lomond** - The Brook Lomond area consists of 120 developed parcels between Ben Lomond and Brookdale. This area has permeable alluvial soils with high ground water and some areas of clay soil. In the 1987 survey, 6 percent of the parcels were found to have failing septic systems. The County recommends improved onsite disposal rather than a community disposal system.

**Forest Lakes** - The Forest Lakes area includes 970 developed parcels immediately south of Felton. This area has small lots, and localized pockets of high ground water and dense clay soils. The 1990 and 1991 survey found a failure rate of 2 percent. There has been no indication of wastewater contamination in Gold Gulch, the stream that drains most of the area. Because of the scattered occurrence of problem parcels, community collection and disposal is not a feasible alternative to onsite treatment.

The two most significant potential impacts of wastewater disposal on the drinking water supplies in the San Lorenzo watershed are the release of pathogenic organisms and excessive nutrients. However, close focus to wastewater management by the County as well as connection of some
on-site systems to community wastewater treatment with off-site disposal has reduced the risk of contamination by wastewater.

Wastewater facilities in the SVLWD, are limited to residential septic systems, none of which are located near the diversion locations.

3.2.2.2 Bacteria

A number of studies have been conducted to evaluate the proportion of the bacterial contributions resulting from wastewater discharge versus the proportion resulting from other sources, including waterfowl, livestock, pet waste, failing septic systems, sewer system leaks, encampments, and urban runoff. Ground-water monitoring conducted in Boulder Creek and as part of the County’s ongoing monitoring program has shown that fecal coliform levels decrease to background levels more than 25 feet from septic systems. Beginning in 1981 (Johnson and others, 1982), the County has assessed fecal coliform concentration in shallow ground water underlying developed areas. The absence of fecal coliforms indicates that incidents of bacterial contamination of surface waters do not result from cumulative contamination of ground water, but result from failures and discharges to the ground surface from individual systems.

Rapid detection of failing septic systems under the Wastewater Management Program, especially through the 1990s and the resulting system repairs and/or upgrades have substantially improved dry-season bacteria levels in the San Lorenzo River upstream from Santa Cruz (Santa Cruz County, 2003). As discussed below in Section 3.3 (urban runoff), results of recent microbiological source tracking indicate that birds are by far the major source of microbial contamination in the river, although human waste is a significant contributor, particularly during the wet season and downstream from suburban areas, such as Felton, and within the City of Santa Cruz (Ricker and Peters, 2006). As noted earlier, high bacterial levels in Lompico Creek, most likely the result of failing septic systems, have resulted in a more stringent treatment requirement of Log 4 / 5 removal for LCWD.

Blue-green algae (cyanobacteria), which are closer to bacteria than algae, have been reported in Loch Lomond during warm summer conditions (Chris Berry, personal communication, 2007).

3.2.2.3 Nitrate

Although nitrate concentrations in the San Lorenzo River had increased five to seven times over background levels (Ricker, 1995), as discussed in Section 5. It was estimated that 50 to 80 percent of this increase is attributable to nitrate from wastewater (Ricker, 1989). Approximately two thirds of the nitrate load in the river comes from the area of the watershed underlain by the highly permeable Santa Margarita sandstone. Unlike bacteria, there has been a significant cumulative release of nitrate from septic systems in the watershed, particularly in areas underlain by sandy soils.

A Nitrate Management Plan was first implemented in 1995 and was subsequently formalized as a total maximum daily load (TMDL) for nitrate in 2000 as a result of the rising nitrate levels and is discussed in Section 4.9.1. The extensive effort in improving wastewater management since 1995 has also resulted in reduced nitrate levels. More recently, nitrate levels in the San Lorenzo River are not apparently increasing and County staff has indicated that further reductions to nitrate concentrations will be challenging (J. Ricker, Personal Communication,
Since San Lorenzo River water is pumped to Loch Lomond reservoir, the linkage between nitrate, algae production and the resulting odors and disinfection-by-product precursors will continue to be a challenge, especially for the SCWD as well as for SLVWD.

### 3.2.2.4 Loch Lomond Reservoir Subwatershed

Most of the watershed is owned by the City of Santa Cruz and the only structure under the City’s jurisdiction is the ranger’s residence. There are a handful of homes on parcels not held by the City and two wineries that drain to Newell Creek; all of which are served by septic systems. County staff has noted road development in these headwater areas (see Section 3.15.3). Loch Lomond stores wastewater from its recreational areas in vaults, which are pumped periodically and transported to the Santa Cruz Wastewater Treatment Plant.

### 3.2.2.5 North Coast Watersheds

Most septic systems in the North Coast watersheds are not anticipated to be a significant source of contamination because of: (a) very low residential densities, (b) a highly-dispersed pattern of residential settlement, and (c) soils and underlying geologic units which are generally loamy or crystalline and favorable for the use of conventional on-site systems. Scattered areas in these watersheds have substrates with limited percolation rates, principally in some of the older soils along Empire Grade (including the Pineridge subdivision), some shallow soils along Ice Cream Grade, and small areas underlain by shales in the upper Majors watershed. Karst, which is associated with subsurface connectivity through the limestone, can occur in portions of the watersheds including the upper portions of the Liddell Spring and Laguna Creek drainages. These areas are sparsely populated and it is not known if wastewater sources directly overlie karst areas. The largest community in the area, Bonny Doon, does not drain to the watersheds of Laguna or Majors creeks.

The water quality data presented in Figure 5-2 in Section 5 indicate that the annual geometric mean of the total coliform bacteria concentrations in the Laguna and Majors Creek watersheds have varied from 177 MPN/100 ml up to 936 MPN/100 ml over the past 10 years. Liddell Spring’s total coliform data are consistently lower with a geometric mean of less than 10 MPN/100ml. The County’s 2006 microbiological source tracking effort (Ricker and Peters, 2006) did not collect data for North Coast streams but instead focused on the San Lorenzo River watershed, where development is concentrated and is the subject of a pathogen TMDL. The County has also focused bacteriological testing on County beaches at the River mouth and to the south, which receive the greatest number of visitors. Failing septic systems are a potential source of increased coliforms in these streams, as are wildlife, waterfowl and livestock.

The nitrate data presented in Section 5 shows an increasing trend in annual median nitrate concentrations in Liddell Spring and Majors Creek over the past 30 years, with no long-term trend distinguishable in Laguna Creek. However, data from the past five years (2001-2006) shows a slight increasing trend in Laguna Creek, while median nitrate concentrations in Liddell Spring and Majors Creek appear to be declining.

The hydrogeologic report on the Bonny Doon quarry (Watkins-Johnson, 1992) indicated that nitrate concentrations were high (over 6 mg/l as nitrogen) in monitoring wells upgradient of the quarry. Because very little development exists upstream of this facility, the report suggested without elaboration that septic systems or a former poultry operation along Smith Grade as the
sources of this nitrate. Among other potential sources are explosives in use at the quarry. The likely sources of nitrate in the Laguna Creek and Majors Creek watersheds are the same as for microbial contamination.

### 3.2.3 Significance

After many years of study, the County and the Regional Board have concluded that the large majority of existing septic systems do not consistently contribute significantly to dry-season microbial concentrations measured in surface waters. Occasionally, failing septic systems are responsible for significant localized degradation of bacterial quality in surface waters during summer months. However, bacterial contributions from septic systems are probably greater during or following wet periods when runoff can convey surface sewage from failing systems to the River. Efforts made since 1995 to improve septic system performance have reduced the septic failure rate and therefore the water quality degradation related to septic systems. As noted earlier, the elevated bacteria levels in Lompico Creek are indicative of septic system pollution and have resulted in higher treatment levels.

The San Lorenzo Nitrate Management Plan (Ricker, 1995) concluded that an estimated 84 percent of the nitrate load in the River resulted from human activities in the watershed. Two-thirds of the nitrate was attributed to wastewater discharges, particularly from septic systems in the highly-permeable Santa Margarita sandstone.

### 3.3 Urban Runoff

Urban runoff is that portion of stream flow originating from urban or densely-suburbanized areas. Most urban runoff occurs during storms; however, inter-storm period nuisance flows from urbanized areas can account for significant components to flow during those times. Urban runoff flows and contaminant concentrations are highly variable. Some factors affecting this variability include duration and intensity of rain events, specific urban land use (residential, commercial, industrial), and the length of the preceding dry period during which pollutants build up on the land surface. In addition to specific land uses, the atmosphere and automobiles are significant contributors to the contaminant load in urban runoff.

#### 3.3.1 Contaminants of Concern

The urban runoff contaminants of most concern to drinking water are microbial organisms and suspended sediments. Sources of microbes in urban runoff include: animal wastes from pets, birds and rodents; human waste from sewer system leaks and encampments; diffuse (nonpoint source) runoff, and decaying organic material in storm drains. Suspended sediment levels are often high in urban runoff because of the ease of mobilization and transport of small particles on impervious surfaces. In addition, suspended sediments are higher in runoff from erosion from newly-developed areas prior to establishment of vegetation. Suspended sediments in urban runoff contribute to high turbidities in the stream system during wet weather and also are significant because contaminants may be adsorbed to the sediment particles and transported

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8 The former poultry farm, in a highly karstic area locally known as the ‘sinkhole plain’, was discontinued at least 30 years ago, and should no longer seriously be considered as a discernible source of nitrogen in this sanitary survey.
into the streams. Note that construction of new impervious surfaces in urban areas can result in higher peak flows which, without mitigation, can lead to increased in-stream erosion and turbidity.

Other common contaminants of concern in urban runoff include: metals (notably copper, lead, and zinc), hydrocarbons, and pesticides. These contaminants can be significant to aquatic life in the receiving stream but at the levels found in the Santa Lorenzo River, have not been shown to be of exceptional significance to the drinking water quality.

### 3.3.2 Existing Conditions

The urbanized population in the San Lorenzo River watershed centers around the communities of Boulder Creek, Ben Lomond, Brookdale and Felton. There are also pockets of development in the Boulder Creek Golf and Country Club area, along Newell Creek (Rancho Rio), lower Bear Creek, Zayante Creek, Lompico Creek, and Paradise Park, and in numerous small valleys confluent with the San Lorenzo River. Rural residential areas along Bean Creek Road at the fringes of Scotts Valley are also experiencing growth. The rest of the watershed, as noted above, is sparsely populated.

Many houses and residential areas were built during several speculative vacation housing booms in the 1890s, 1900s and from 1920 to 1940. A large percentage of existing homes were built before 1960. More recent housing has been primarily for year-round residences. Many of the older vacation homes were built very close to the creeks. Further development within the riparian corridors is currently limited, requiring County exemptions. Riparian corridors now extend out to the edge of the riparian woodland if the woodland is extensive enough to have been mapped on County vegetation maps. Otherwise, they are defined to be 50 feet from the high water mark for a perennial stream, less for an intermittent stream, and more in the coastal zone area. As discussed in Section 3.13.2, violations of County riparian corridor disturbance ordinances occurs but limited enforcement resources are available to limit potential damage. Most new housing has been infills or on rural acreage, with few if any major subdivisions within County jurisdiction. Future residential growth is expected to be mostly accommodated with minor land divisions.

In October 1990, the EPA issued final regulations requiring NPDES Municipal Stormwater permits for urban runoff from cities with a population of 100,000 or greater, from certain types of industries, and from construction sites which involve a land disturbance of greater than 5 acres (Phase I). Although there are no cities this large in Santa Cruz County, the Central Coast office of the Regional Board, which administers the NPDES stormwater permit program, worked with County and municipal staff in anticipation of future regulations. In 1999, EPA expanded the NPDES Municipal Stormwater permit program to require permits for urban runoff discharges from cities with a population of less than 100,000 and from industries or construction sites which result in a land disturbance of from 1 to 5 acres (Phase II). The City and County subsequently developed comprehensive Storm Water Management Plans (SWMPs) describing compliance with the new regulations. The plans were submitted and approved by the Regional Board with applications for coverage under the Phase II permit. The County of Santa Cruz also joined the Central Coast Regional effort to develop hydromodification criteria by October 2012. Additional details about urban runoff regulations are included in Section 5 of this sanitary survey.
Watersheds in the study area are relatively unindustrialized, so there are few facilities which must comply with the state’s NPDES General Industrial Stormwater permit program. The state permit requires industrial facilities to implement pollution prevention measures and to collect monitoring data during rainfall events. Each industrial facility files a Notice of Intent (NOI) which certifies that it will comply with these permit requirements. There is currently little oversight and enforcement of the industrial stormwater permit program because most of the state’s effort has been channeled into simply identifying facilities which should be under permit. Types of industrial facilities which must file a NOI to comply with the state permit include: manufacturers (food, textiles, lumber, paper, chemicals, petroleum, rubber, plastic, metals, stone, clay, glass, machinery, electric, electronic, equipment, instruments, cement, phosphate, asphalt, fertilizer); confined animal facilities with over 700 animals; printing operations; recyclers; landfills; mining operations; transportation businesses (such as bus and trucking companies and airports); petroleum bulk plants; all NPDES wastewater dischargers with a design flow greater than 1.0 million gallons per day; Superfund sites; and steam electric power generator facilities.

A list of active industrial stormwater permittees in Santa Cruz County was downloaded from the SWRCB database in January 2012. Only 77 facilities county-wide have filed a NOI with the SWRCB. Most of these are located in Watsonville (28) and the City of Santa Cruz (24), outside of the sanitary survey study area. In Scotts Valley, both a computer technology manufacturer and a construction site in the Bean Creek watershed have filed for a NOI. In Felton, five companies have filed for a NOI within the San Lorenzo watershed: Granite Construction Company (for work in the Felton Quarry), Granite Rock Company (for an industrial site), Santa Cruz County (for improvements on Graham Hill Road), Hillcrest Vineyard, and Chevron Environmental Management (for the construction of automotive service shop). Lastly, in Ben Lomond, the San Lorenzo Valley School District also filed for a NOI (for their bus transportation yard). Quarries in the Scotts Valley and Bonny Doon area are not in the SWRCB database. The historic airport in Scotts Valley is inactive, while the one in Bonny Doon may receive occasional use by small private aircraft.

Since 2009, any construction activities greater than 1 acre will require permitting under the revised statewide Construction General Permit (CA 2009-0009-DWQ.) The local jurisdictions (City and County) have construction best management practices that are required for smaller projects to control erosion and sediments that could negatively impact water quality.

3.3.2.1 San Lorenzo River Watershed

The San Lorenzo River watershed is in Zone 8 of the Santa Cruz Flood Control District. Drainage in the towns along Highway 9 consists of a combination of sheet flow, roadside swales and ditches, and some inlets and piping in low spots. In smaller population centers, the engineered drainage system consists mostly of cross culverts to move stormwater across roads. There is an urban runoff control structural feature, a detention basin, and several check dams downstream of the Rancho Rio subdivision. These facilities were installed by the County Planning Department after construction of the subdivision to minimize the considerable erosion resulting from disturbance of this sandy area.

The County’s Water Resources Program has been sampling the San Lorenzo River since 1968 for chemical and microbial constituents. The program currently includes collection and analysis of weekly samples from 15 regular sites throughout the County as well as at an additional 30 locations weekly for trend evaluation and source tracking. Heavy metals (e.g., zinc, copper,
cadmium, and lead) and toxic organic compounds, such as pesticides and PCBs, have often been detected at low levels in ambient receiving waters of the San Lorenzo River watershed and occasionally at higher levels in storm drain discharges. Because these constituents can bioconcentrate in tissues, the County conducted a study focused on sampling sites in the lower River, including analysis of tissues from freshwater clams (Ricker and others, 2001). The results were generally consistent with previous monitoring studies in the watershed, the region, and the State (c.f. EPA Nationwide Urban Runoff Program): low levels of pesticides and PCBs (at 2 to 7 percent of hazardous thresholds), elevated concentrations of cadmium and zinc (both of geologic origin); and elevated levels of lead (potentially from prior use in gasoline or from the prior use of lead shot at a gun range near Castle Rock State Park). In all cases, concentrations were below levels of biotic or regulatory concern.

Bacteria levels in the San Lorenzo River have often exceeded County water quality objectives and on May 8, 2009, the San Lorenzo River Watershed Pathogen TMDL was approved by RWQCB Central Coast Region. However, bacteria levels in the upper watershed are typically much lower than those at the mouth of the river, and recent monitoring data show considerable improvement in dry-season bacteria levels, which in summer months, now generally meet standards for safe swimming at locations upstream from Santa Cruz (John Ricker, personal communication, 2012). Bacteria concentrations during storm events remain high, and are more elevated at downstream stations (i.e. at Felton vs upstream Sycamore Grove station), reflecting proportionally greater contributions from suburban and urban areas than from more rural areas. Despite progress in reducing bacteria levels, the Regional Board recently decided to combine the TMDL for the Branciforte Creek/San Lorenzo River Estuary with the TMDL for the Lompico Creek/upper San Lorenzo River watershed, based on elevated bacteria levels at two locations on the River during summer 2006, and higher-than-expected bacteria levels in 2005-2006 sampling.

Funded by a Proposition 13 grant from the SWRCB, the County analyzed over 2,000 water samples collected from 2002-2004 in storm drains, stream reaches, and beaches in an effort to identify the source and causes of elevated bacteria levels (Ricker and Peters, 2006). Ribotyping, a method of microbiological source tracking that differentiates human *E. coli* from other types of *E. coli*, was employed to discriminate between fecal coliform sources. Overall, birds were found to account for over 50 percent of bacterial contamination in samples from the San Lorenzo River, and 64 percent of summer bacteria samples in the upper watershed. In contrast, human waste was identified in approximately 11 percent of all samples, and in none of the dry-season samples from the upper watershed. Human contributions in the River were found to increase significantly between Sycamore Grove and the mouth, due to inflows from urban areas, and were higher in wet weather when runoff scours storm drains and mobilizes waste from developed areas, encampments and the occasional failing septic system. Decomposing organic materials and sediments in storm drains were found to provide a good environment for bacteria to thrive and multiply.

Work in coastal San Mateo County (Ivanetich and others, 2006) was also able to distinguish fecal bacteria originating from dog, deer, horse, seagull and human sources. It is notable that the Santa Cruz County microbial source assessment study found that dogs alone accounted for about 7 percent of the dry-season bacteria in the upper watershed, and about 12 percent of wet-weather bacteria at Felton (Ricker and Peters, 2006). Waste from domestic animals such as cats, dogs and chickens probably contribute greatly to the high fecal coliform counts in the first
flush of stormwater through urbanized areas. The County has not conducted further ribotyping work since the 2006 watershed sanitary survey. Further inquiries into sources and travel pathways of pathogens in the San Lorenzo Valley watershed, in particular, would be worthwhile, with special attention to streams reaches downstream of densely-urban communities and in areas receiving summer baseflow from sandy aquifers.

### 3.3.2.2 Loch Lomond Reservoir and the Upper Newell Creek Watershed

Urban runoff into Loch Lomond is effectively limited to contributions from Bear Creek Road, which are minor in magnitude. However, urban runoff constituents from the water pumped from the San Lorenzo River to Loch Lomond may be present in Loch Lomond.

### 3.3.2.3 North Coast Watersheds

There are no major towns in the North Coast watersheds. The Bonny Doon Airport is a small landing strip for private planes.

### 3.3.2.4 SLVWD

Based on conversations with staff from the SLVWD, there is no urban runoff that influences surface water in their watersheds. Most of the roads within the watershed of the SLVWD are district owned and maintained or are private access roads. Only the staff of the SLVWD has access to District roads.

### 3.3.2.5 LCWD

There are only approximately 20 residences located above the Lompico Creek surface water intake, and based on conversations with the LCWD staff, urban runoff is not highly likely.

### 3.3.3 Significance

Overall, urban runoff directly contributes a significant part of the total microbial load in the river system during summer and winter, it enriches summer baseflows with added nutrients, and it contributes some part of the sediment load entering the River during rain events.

Most ‘urban' development in the San Lorenzo Valley is residential. Many of the residents seek a rural residential lifestyle, and the contributed contaminants (microbes from both domestic and wild animals, nutrients, sediment) may best be seen in that light. There are homes in the four main communities that are very close to and positioned well above the stream system, such that contaminants can move rapidly from neighborhood areas in the main communities into the channels. In these areas, source control to reduce runoff as well as redirecting runoff to areas for infiltration has particular value as a way of reducing contaminants. In particular, the results of the microbial source tracking study show that efforts to minimize or prevent dry-season runoff from landscape irrigation and other human activities would reduce transport of bacteria and other contaminants to storm drains and the River during the summer months when dilution is minimal and recreational use is at its peak.

Elsewhere, homes overlying sandy soils contribute a disproportionate volume of nutrients which enter the streams through the sandy aquifers. As discussed further in Sections 5 and 6 later,
nutrient concentrations are elevated during summer months in the streams with appreciable sandy soil areas in their watersheds, offering different source-control opportunities in the sandy areas away from the streams. Because sandy soil areas occur in both the North Coast and San Lorenzo watersheds, efforts to address the particular issues of sandy soils can be especially effective over a period of decades. There are few industrial facilities or large expanses of paved areas.

3.4 Agricultural Land Use

Santa Cruz is a strongly agricultural county. However, the majority of the existing row-crop acreage is located along the coast, in the Pajaro Valley in South County and on the marine terraces of the North Coast, neither of which extend into the watersheds of this survey. Commercial cropping with the study area watersheds is presently limited to small areas of vineyards and Christmas tree farms. Both watershed areas once supported widespread cultivation of apples and other orchard fruits wherever suitable sites with deep soils and southern exposures were found, but most such areas had already gone out of commercial production before the onset of extensive pesticide use in orchards began during the early 1960s. In scattered locations throughout the study area row crops are grown on a commercial or horticultural basis but these operations are on limited acreage and typically use organic practices.

3.4.1 Contaminants of Concern

The primary contaminant of concern from these types of agricultural uses is sediment from erosion of fallow or improperly tilled land and from eroding drainages downstream from cultivated areas. Other potential contaminants include nutrients, pesticides, herbicides, and organic matter in stormwater runoff from the fields and vineyards.

3.4.2 Existing Conditions

3.4.2.1 San Lorenzo River Watershed

In the San Lorenzo Valley, vineyards and Christmas tree farms occupy the largest agricultural acreage. Several established vineyards exist in the area; in Felton (Hallcrest Vineyard and the Organic Wine Works), next to Bear Creek Road on the ridge above Loch Lomond (Byington, David Bruce, and Bear Creek Vineyards), and in side valleys near Boulder Creek (P & M Staiger and Equinox), along Bean Creek in Scotts Valley (Roudon Smith Vineyard), up Highway 9 near Waterman Gap (Ahlgren) and along the top of the watershed divide at Skyline Boulevard (Zayante Vineyard). Small personal vineyards are commonly seen on larger residential parcels with adequate sunlight. Land clearing for vineyards has the potential to be problematic, if not done correctly, e.g., poor drainage design, improper grading, and inadequate erosion control. Santa Cruz County regulates agricultural grading in an effort to protect water quality but has limited enforcement resources to monitor grading in general.

Unlike vineyards, Christmas tree farms are operated with little cultivation or disturbance to the soil surface. Field visits to several of these operations throughout the watershed showed that annual grasses, forbs and bracken serve as a cover crop between rows of spruce and fir. The
roads in the tree farms are intermittently used, with the greatest use generally during the two months prior to Christmas.

To a lesser extent, apples and other tree fruits are still grown in the old and declining orchards in the sunnier aspects of the Santa Cruz Mountains. According to County Agricultural Commission staff, little to no new commercial acreage has been developed during the last two decades. The existing orchards tend to be managed organically or with few applications of chemical pesticides or fertilizers, and minimal tillage.

Small commercial greenhouse operations and flower farms exist along Bean Creek and in the San Lorenzo Valley. Rhododendrons are no longer grown in the Bean Creek subwatershed, nor elsewhere in the San Lorenzo Valley (Roberta Haver, former owner, personal communication, 2006). Pesticide use is minor. University of California Agricultural Extension staff indicated that the primary potential contaminant in these container greenhouses is nitrogen, which is flushed through the containers by proper irrigation, and which exceeds crop needs typically by 20 percent during each watering. These operations are located on the extremely permeable Santa Margarita sandstones, which provides the excellent drainage needed for these uses, but which may permit the greenhouses to become a source of nitrogen to both Bean Creek and the Santa Margarita aquifer.

As discussed in Section 3.7.1, the San Lorenzo River has been Clean Water Act (CWA) Section 303d listed for chlorpyrifos which may be associated with agriculture.

### 3.4.2.2 Loch Lomond Reservoir Subwatershed

Other than the vineyards described above, there is no conventional agriculture in the Loch Lomond watershed. In the past, small-scale diversions associated with covert marijuana plantations have been reported on tributaries that drain into Newell Creek and Loch Lomond.

### 3.4.2.3 North Coast Watersheds

The coastal terraces of northern Santa Cruz County are one of the classic agricultural areas of California, supporting far more cultivated acreage than the San Lorenzo Valley. The crops are grown mainly on the lowest two terraces along Hwy 1, below the diversion points on the North Coast streams. These areas are farmed primarily for brussel sprouts and (less frequently) artichokes. Both crops require the unique climate dominated by marine fog found on these lower terraces. Other crops include lettuce, strawberries, broccoli, and flowers.

Four vineyards operate in the North Coast, the Bonny Doon and McHenry Vineyards, and recently the Rancho Madera Roja in the upper Liddell Creek watershed and Redwood Meadows Ranch Winery in the upper Majors Creek watershed. Cattle are occasionally grazed on the mosaic of grasslands, oak/madrone woodland, and mixed evergreen forests which separate the belt of row crops along the coast from the residential areas and orchards of the Empire Grade portion of the Bonny Doon area. A small portion of this area drains to Majors Creek upstream of the intake. Some Christmas tree farms are also located in Bonny Doon, near the northern end of Empire Grade.

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9 The lack of erosion control in the winter of 2008 resulted in a violation, but the issue has since been resolved (Chris Berry, personal communication, 2012).
3.4.2.4 SLVWD

The only known commercial agriculture known to be present is a Christmas Tree farm along Upper Empire Grade Road within the Foreman Creek watershed. There has been no contamination observed due to this farm’s operations.

3.4.2.5 LCWD

There are no known commercial agricultural land uses within the Lompico Creek watersheds.

3.4.3 Significance

As a minor land use in the water supply watersheds, agricultural production does not appear to be a major source of concern at present and in the foreseeable future. The two most visible crops in the watersheds, Christmas trees and grapes, tend to be grown at higher elevations, along ridges and in areas above the fog line, away from the major streams. Past observations at Christmas tree farms in the survey area suggest that these are unlikely to be major sources of contamination, or erosion. Vineyards, on the other hand, are typically located on slopes with loose, sandy soils, and controlling weeds by harrowing between rows leaves soils exposed to rainfall and rill erosion. Marginal to poor drainage design and inadequate erosion control can result in vineyards being a source of sediment and persistent turbidity. Some vineyards use organic practices; others employ pesticides to a light or a moderate degree.

Cultivation of other crops is less likely to affect the quality of water supplies, because of the minimal acreage of land under cultivation and the generally low level use of pesticides.

3.5 Grazing Livestock

Watersheds in the study area are primarily forested or vegetated brushlands of various types, so the extent of grazed areas is also limited, particularly in the San Lorenzo watershed. The North Coast watersheds are better suited for livestock and have had several cattle and dairy operations working in the subject water supply drainages. Throughout the watersheds, impacts from grazing cattle are less than those of confined horses, except in areas where cattle are watered from streams. This section includes discussion of cattle and individual or small horse groupings; the main discussion of horses as they affect water quality is within Section 3.6.

3.5.1 Contaminants of Concern

Erosion and waste products are of primary concern. Where unfenced, destruction of streambanks and wetland vegetation by grazing animals causes an increase in erosion, indirect loss of channel stability (eventually generating pulses of sediment entering directly into the creeks), and persistent turbidity. Manure, urine, and pathogens may be introduced directly into streamflow year round, with elevated rates of transport into waterways during wet periods.
3.5.2 San Lorenzo Valley

Residential development of the valley bottoms, stream terraces, and sunny ridgelines in the survey area puts a premium on "buildable" land. This trend, combined with the gradual succession from grassland to chaparral, in the absence of wildfire, has gradually reduced cattle and sheep operations in the San Lorenzo Valley.

No active commercial cattle operations are known in the San Lorenzo watershed, other than occasional use of small acreages in the Bean Creek subwatershed. Equestrian use is widespread in the watershed and horses are kept on residential parcels and at commercial or boarding stables. The latter facilities typically have more horses but also have larger pastures for grazing (and dispersal of animal wastes). As a result of the low numbers, grazing animals pose a minor threat to the water quality of the San Lorenzo watershed. Concentrated animals such as horse stables upstream of water intakes pose a greater threat and are discussed in Section 3.6.2.

3.5.3 Loch Lomond Reservoir and upper Newell Creek watershed

No grazing animals were encountered in the Loch Lomond area during prior visits to the lake and upper watershed. The City does not allow riding animals in the watershed area.

3.5.4 North Coast Watersheds

As discussed above, a limited amount of rangeland drains to Majors Creek upstream of the City’s diversion structure, including the northern parts of Grey Whale Ranch. These areas seem to be grazed intermittently, principally by individual horses or small groups of horses, with occasional cattle grazing (apparently) under lease arrangements. Most of these grasslands are located along ridgelines or on slopes distant from the streams, reducing but not eliminating the potential for contributing nutrients, pathogens, and sediment to the streams. Further downstream on Liddell Creek, beyond the boundaries of the survey area, issues of livestock management are being addressed by the County. Trails, and roads used as trails, do come close to the main stem and east fork of Majors Creek; these could prove to be a small, but perhaps growing, source of sediment and pathogens.

3.5.5 SLVWD

There is no commercial grazing livestock present within the SLVWD. Based on conversations with staff from the district, indicated that there may be a limited number of residences that may have goats and chickens, but these would be unlikely to impact the watershed.

3.5.6 LCWD

As in the SLVWD, there is no known commercial grazing livestock present within the LCWD. Horses are known to be present at one residence within the watershed. Staff from the LCWD indicated that it would be highly unlikely for any runoff from this residence to reach Lompico Creek. Other residents within the LCWD are also known to keep some chickens and goats, however these are not likely to impact the water quality within the watershed.
3.5.7 Significance

The San Lorenzo River Pathogen and Nitrate TMDL list livestock as sources of the respective constituents. Pathogenic microorganisms are the major source of concern when contact between grazing animals and water supplies occurs. Hecht and others (1991) identified horses as a significant contributor to the San Lorenzo Valley nitrate budget and the County has taken measures to assess and control equine nitrate contributions to both surface and ground waters (c.f., the 1995 Wastewater Management Plan and the 2001 Watershed Management Plan Update) to reduce costs of treatment for taste and odor problems. Where access to water is limited only to streams, degradation of habitat and bank stability is evident (see also Section 3.6). Development of improved water sources for grazing animals has played a significant part in limiting erosion impacts on water quality. Fencing, which is associated with water source improvements also reduce the impacts of manure and urine by creating buffer zones between grazing animals and waterways. That said, percolation of urine, especially in areas overlying sandy soils may be a source of nutrients from grazing livestock. Since 2005, the Santa Cruz County Resource Conservation District has partnered with a local non-governmental organization to provide resources in a Livestock and Land program, described in greater detail in Section 3.6.1 to assist homeowners in proper management measures to reduce water quality impacts of livestock and small agricultural activities.

3.6 Concentrated Animal Facilities

While traveling through the watershed it is apparent that although there are a number of commercial stables which house larger numbers of horses as found on Figure 3-2, there are also many residences that support one or two horses, despite small lot sizes and/or limited acreage suitable for pasturing horses or applying manure. While many of these small residential facilities are well-managed, it is also common to observe corral areas that are bare or partially denuded of vegetation from overgrazing, and manure management is often limited to stockpiling on site. Conditions contrast with the commercial facilities, which tend to have greater capacity to manage drainage and manure accumulations responsibly, in part because of their greater visibility and liability.
Figure 3-2 Commercial Stables Locations
3.6.1 Contaminants of Concern

Horses are considered a major source of pathogens and nitrogen and can also contribute to persistent turbidity in the water supply watersheds. While horses were a relatively newly-recognized concern during the 1996 sanitary survey, some important actions were taken to protect water quality and improve care of the animals.

One key step was publication of *Horsekeeping: A Guide to Land Management for Clean Water*, in 2001 (CABRCD, 2001). This manual for horse owners, developed by the Council of Bay Area Resource Conservation Districts and the USDA NRCS, explains water quality concerns, provides technical assistance with design and implementation of structural control measures, and includes a directory of conservation-related resources for further exploration. Based on use of this manual, and with funding from the SWRCB through Propositions 13 and 50 (Manure and Erosion Prevention), the Santa Cruz County Resource Conservation District (RCD) and Ecology Action developed a Livestock and Land Program to educate owners about best management practices to improve manure management. Working with both commercial and residential facilities, and coordinating with the Santa Cruz County Horsemen’s Association, the Program has provided technical assistance and cost-sharing to install filter strips, energy dissipaters, and other practices at a number of demonstration sites. The RCD reports that these measures have also been widely-installed at residential sites following owner attendance at technical trainings and workshops sponsored by the Program, and through outreach via a Peer Leader Program (Angela Stuart, personal communication, 2007).

Ecology Action estimated that raw manure loads were reduced by 328,500 pounds per year in 2007 as a result of the nutrient management practices implemented at horse facilities, such as manure bunkers, regraded pastures and/or paddocks to re-direct runoff to a filter area, exclusionary fencing, retention/sediment basins, and reduction in numbers of animals living in properties (Rose, 2011). Load reductions have increased since 2009 as the program reaches more owners (Nick Sudano, personal communication, 2012). From 2006 to 2009, eleven individual horse facility improvement projects were implemented in the San Lorenzo Watershed. Manure management plans are required for new development with greater than four horses and complaints.

It is estimated that the equine population in the survey area has not changed over the last five years based on permitting of facilities (John Ricker, personal communication, 2012). While many more horses are now boarded in private paddocks or boarding facilities with control measures in place than was the case at the time of the 1996 sanitary survey, City and County staff still report problems, particularly with new ownership (Chris Berry, personal communication, 2012). Throughout the subject watersheds, stables or paddocks are sometimes located on the edges of properties, often in swales and along waterways. This bare ground can be a source of sediment, and offers minimal breakdown of manure and nitrogen uptake by plants. The net result is often a rapid transport of these pollutants into surface and shallow ground waters during periods of rain.
3.6.2 San Lorenzo Watershed

The County does not maintain a comprehensive inventory of stables but staff estimate that there may be more than 300 horses in large stables within the San Lorenzo River watershed, and an equal number in smaller residential stables (John Ricker, personal communication, 2012). While numbers of animals at commercial stables vary from year to year, some of the largest stables are Covered Bridge, formerly Chaparral Stables (70 to 100 horses) in Felton, Eddy Ranch (40 to 50 horses) on Bear Creek, Zayante Equestrian Center, formerly Horse Haven (20 to 40 horses) on Zayante Creek, Glenwood Equestrian Center (20 to 25 horses) on Bean Creek, and Lichen Oaks (15 horses) in Quail Hollow. Additionally, the Santa Cruz County Horsemens’s Association operates a regular calendar of events at the Graham Hill Showgrounds, including overnight and short-term stays for multiple animals.

3.6.3 Loch Lomond Reservoir Subwatershed

No confined animal facilities are reported or were noted in this watershed.

3.6.4 North Coast Watersheds

The numbers of animals kept in the North Coast watersheds are not available. Some homes are on one to five acre parcels, often with one or two horses, several chickens, and other domestic animals. Areas of bare soil are sometimes seen in the paddocks and associated areas. The Vigne Farms is a commercial stable located in Bonny Doon which is not in the surface drainage to Liddell Spring. However, the underlying karst in the area may provide a subsurface conduit to Liddell Spring. The County regulates the facility which has covered, concrete floored manure storage and surface water monitoring as a condition of approval. Continued attention by regulatory and NGOs to manure management at confined animal facilities, especially those near surface waters upstream of diversions is an important element of pathogen and nitrate control.

3.6.5 SLVWD

There are no known concentrated animal facilities within the SLVWD.

3.6.6 LCWD

There are no known concentrated animal facilities within the LCWD.

3.6.7 Significance

The San Lorenzo River Pathogen and Nitrate TMDLs list domestic animals/stables as sources of the respective constituents. Wastes from horses have been estimated to contribute significantly to the pathogen and nitrogen load in the region's upper watersheds. One systematic study (Hecht and others, 1991) estimated that horses in the San Lorenzo Valley contributed nitrogen equal to one fifth or more of the amount released from septic systems. The San Lorenzo Nitrate Management Plan estimated that livestock and stables contributed about 6 percent of the nitrate load in the River (Ricker, 1995). The microbial source assessment found
that horses were responsible for 10 percent of the wet weather *E. coli* samples at the Felton station but less than 2 percent of the wet weather *E. coli* load downstream (Ricker and Peters, 2006). No bacteria contributions from horses were noted in dry season samples. Other types of confined animal facilities do not appear to be a major concern in the subject area.

Both commercial stables and backyard paddocks can be found in almost all sub-watersheds of the San Lorenzo and North Coast water supply drainages, and animal wastes receive less treatment than human wastes and are more easily mobilized into streams. These facts suggest that effective manure management at all times of the year, but especially during winter and spring months, is critically important in reducing nitrogen and pathogen transport to ground and surface waters. Nitrate data, described in Section 5, indicate that nitrate concentrations have declined and stabilized in recent years suggesting that livestock management, as well as other management measures, has been successful in improving water quality.

### 3.7 Pesticide and Herbicide Use

Pesticides and herbicides are chemical compounds specifically formulated for their lethal effects on animal and plant life. Pesticides and herbicides are used in: (1) agriculture, (2) rights-of-way along roadsides, (3) landscaped areas such as parks and golf courses, (4) for structural pest control, and (5) by individuals. Volumes of specific chemicals used annually for the first four uses are represented in the reported use information collected by the County Agricultural Commissioner and reported to the State Department of Pesticide Regulation (DPR). The fifth use, by individuals in the home and garden, is unreported. Thus, a complete accounting of the chemicals used or the amounts applied is unavailable. The toxicity of compounds available to individuals – and generally to licensed professional applicators as well – has decreased markedly since the late 1980s.

All pesticides and herbicides used by licensed applicators (such as crop dusters, landscape maintenance professionals, and structural control businesses) are reported and sales of “restricted” chemicals are also reported by distributors. The Department of Pesticide Registration determines whether a pesticide/herbicide is classed as restricted based on its potential hazard to humans, animals, crops, or the environment in general. The County Agricultural Commissioner enforces related laws and regulations within the county, issues Restricted Materials Permits, and collects the use data which is then reported to the DPR. In addition, the City’s Integrated Pest Management (IPM) policy guides pesticide and herbicide use on City-managed lands. Using a limited data set, the RWQCB has listed the San Lorenzo River under CWA Section 303d for a suite of pesticides as discussed in Section 3.7.3.

#### 3.7.1 Contaminants of Concern

While all pesticides and herbicides can be considered undesirable in a drinking water source, the legacy pesticide, chlordane, and the organophosphate pesticide, chlorpyrifos, are of greatest concern as shown by the 303d listing and TMDL development planned for 2021 is for these constituents recently established by the Regional Board. Other specific chemicals of concern are the synthetic organic chemicals (SOC) regulated under the Phase II/V Rules (see Section 5). The Phase II/V pesticides and herbicides are those which EPA has established requirements for drinking water (see Section 5).
3.7.2 Existing Conditions

Comprehensive information on the specific types and locations of pesticide and herbicide use throughout the North Coast and San Lorenzo River watersheds was not developed for the original 1996 sanitary survey or any subsequent updates. Logically, such use will be a tiny fraction of the applications throughout Santa Cruz County. Most pesticides for which regional records are kept are used for agricultural activities in the Watsonville area and in the marine terrace agriculture downstream of the North Coast watersheds, rather than within the North Coast and San Lorenzo watersheds. Similarly, most of the reported structural pest control use will be from the urban and industrial areas which are mostly outside the survey watersheds; i.e. the Cities of Santa Cruz, Watsonville, and Scotts Valley. However, the San Lorenzo River has been 303d listed for the organophosphate insecticide, chlorpyrifos (source unknown), indicating that residues from commercial and/or residential applications are regularly reaching the river.

Use along rights-of-way and for landscape maintenance is primarily of concern in the San Lorenzo River watershed and are discussed under that subsection. Although there are no reported data for individual home and garden use, such usage is likely to be relatively small in these watersheds. There is a pervasive sensitivity to chemical use and a general public sentiment opposed to such use which will continue to limit applications at the watershed scale. Additional data collection to support development and implementation of the TMDLs for chlorpyrifos and chlordane (a legacy pesticide not currently permitted for use) will reinforce these attitudes through outreach and education activities.

3.7.2.1 San Lorenzo River Watershed

The most sensitive right-of-way in the watersheds, because of its proximity to the San Lorenzo River is State Highway 9, which is maintained by the California Department of Transportation (Caltrans). Caltrans staff report that herbicide use along Highway 9 has been reduced 50 percent or more since the early 1990s under the agency’s NPDES permit for roadside vegetation maintenance (Kris Griffin, personal communication, 2012). Targeted applications of less-toxic materials at low rates immediately adjacent to fixed safety hardware (e.g., signposts, guardrails, reflectors), maintaining a minimum 20-foot buffer between the spray zone and the edge of live streams or the River. Caltrans staff currently applies two herbicides annually, both in late fall/early winter: a systemic pre-emergent, Goaltender 2 (oxyfluorfen), and a more typical pre-emergent, Oust (sulfometuron methyl), that also has some post-emergent properties. Oxyfluorfen disperses readily in water, is slightly mobile and is acutely toxic to aquatic organisms but practically non-toxic to terrestrial biota and birds. Sulfometuron methyl is also readily dispersible in water and moderately mobile, but practically non-toxic to both aquatic and terrestrial biota. Both materials are moderately persistent.

Caltrans uses spot treatments as needed with the broad spectrum (non-selective) systemic herbicide Roundup (glyphosate), and the selective (broadleaf) systemic herbicide Garlon 4 (triclopyr) for brush control in the highway right-of-way, to remove woody vegetation such as blackberries, poison oak and tree seedlings before they interfere with visibility or impinge on the roadway. Roundup has been considered to be one of the more benign herbicides from a drinking water point-of-view, because the active ingredient, glyphosate, is practically non-toxic to aquatic and terrestrial biota and effectively immobile, being strongly adsorbed to soil. However, recent research suggests that at least one of the inert ingredients in Roundup has
higher toxicity. Triclopyr is slightly soluble in water, moderately persistent, potentially mobile, and slightly toxic to mammals but highly toxic to aquatic biota.

Vegetation maintenance along County roads in the San Lorenzo River watershed has relied on targeted mowing since the Board of Supervisors passed a moratorium on roadside herbicide spraying in May 2005 (Dawn Harman, personal communication, 2012).

Because mowing is far more labor intensive than spraying, mowing efforts concentrate on maintaining safe sight distance at critical intersections, road curves and other areas. While roadside maintenance in riparian areas involves herbicides for flood control purposes, the County is exploring alternatives, such as organic pesticides, to reduce the environmental impact of conventional spraying.

The four State parks in this watershed are: Big Basin Redwoods State Park, Castle Rock State Park, Fall Creek State Park\textsuperscript{10} and the Henry Cowell State Park. These parks use very little pesticides and herbicides as they are mostly preserved natural environments with very little landscaped area.

The four County parks in this watershed are: Felton Covered Bridge, Highlands Park, Ben Lomond Mill Street Park, and Quail Hollow Ranch. The County uses essentially no pesticides and herbicides – only one application of Roundup was used along fence lines and on baseball fields at Pinto Lake and Polo Grounds Parks last year and both these parks are outside of the survey area (Gretchen Illif, personal communication, 2012).

The golf course at the Boulder Creek Golf and Country Club is managed based on IPM principles and use of least toxic materials at the lowest rates feasible. The course employs two licensed pesticide applicators and primarily uses broadleaf weed control herbicides and fungicides (Bill Keller, personal communication, 2007). Confront (Triclopyr and Clopyralid), a post-emergent selective (broadleaf) herbicide is applied to fairways annually. Greens are treated approximately monthly from April to October with fungicides, rotating products regularly to inhibit build-up of resistance. The fungicides currently used comprise the contact fungicide Daconil Weatherstik (Chlorothalonil), which is mixed with one of several systemic fungicides: Banner Maxx (Propiconazole), Signature (Fosetyl-Aluminum) or Heritage (Azoxystrobin). The active ingredient in each of these products has low to very low mammalian toxicity. Triclopyr, clopyralid, propiconazole and fosetyl-aluminum are slightly toxic to practically non-toxic to aquatic species, while azoxystrobin and chlorothalonil are extremely toxic to fish and aquatic invertebrates.

\textbf{3.7.2.2 Loch Lomond Reservoir and upper Newell Creek watershed}

The Loch Lomond Recreation Area is mostly non-landscaped and uses mechanical weed control for road right-of-way and other park maintenance. Although no pesticides, herbicides, or fertilizers are applied in these areas, consistent with the City of Santa Cruz policy, City policy will allow applications of Roundup on the firebreaks/ridgetops if necessary to reduce fuel loads; the City has recently applied Roundup as part of its fire preparation program.

\textsuperscript{10} More correctly, the Fall Creek unit of Henry Cowell State Park. Popular nomenclature used here.
Over the past five years, the City has attempted several methods to control algae (primarily blue-green algae or cyanobacteria) in the reservoir. Historically, pesticides containing copper as the active ingredient were successfully used. In an effort to reduce copper use, the City installed a mechanical mixing system (Solarbee® Reservoir Circulators) on a trial basis from May 2003 through September 2005. The Solarbees® were expected to remove the potentially harmful blue-green algae by creating conditions more favorable to its competitors (diatoms and green algae). Unfortunately this method did not work in Loch Lomond. The City also considered ultrasonic devices (SonicSolutions™) but found them both ineffective and logistically impractical.

At present, the City uses a combination of sodium bicarbonate and hydrogen peroxide (PAK 27). When algal blooms do occur or are predicted to occur, chemical algaecide applications are made to the Newell Creek Reservoir to protect against degradation of beneficial uses (e.g., objectionable taste and odor, production of disinfection by-product precursors and cyanotoxins, and oxygen depletion and subsequent fish kills). These algaecide applications are regulated by an NPDES permit and implementation is described in the City’s Aquatic Pesticide Application Plan (Chris Berry, personal communication, 2012).

### 3.7.2.3 North Coast Watersheds

Use of pesticides and herbicides in these watersheds is likely to be very small as agriculture and landscaped areas are a very minor land use, and there are no large urban areas or major thoroughfares. Pesticides are not being used within the 240 acres of watershed lands, consistent with City policies favoring mechanical and other IPM control methods.

### 3.7.2.4 SLVWD

SLVWD’s watershed management plan, restricts, and where feasible, excludes the use of pesticide or herbicide within SLVWD lands. SLVWD also supports the minimal and restricted use of herbicides and pesticides in the District’ service area as well as contributing to the control of herbicide and pesticide use in the greater San Lorenzo River watershed.

### 3.7.2.5 LCWD

There is no known use of pesticides and herbicide use in the LCWD. Staff routinely inspect residences and areas within the watershed and have not documented excessive herbicide or pesticide use.

### 3.7.3 Significance

The RWQCB’s recent decision to place the San Lorenzo River on the 303d list for chlordane and chlorpyrifos suggest pesticides and herbicides as well as chemicals are becoming a contaminant source of concern. However, SCWD has provided written input to the RWQCB that the dataset on which the 303d list is limited since pesticides or herbicides have not been detected in the raw water for the SCWD at their diversions.
3.8 Wildlife

3.8.1 Contaminants of Concern

Wildlife may pose a threat of contamination to public water supplies under certain conditions. The likeliest condition is the contact between water supply sources and animal or waterfowl waste. The potential for transmission of waterborne pathogens such as Giardia cysts and Cryptosporidium oocysts varies with fluctuations in wildlife populations. While considered a potential problem, the relative importance is lessened when compared with the impacts of domestic and confined animals.

3.8.2 San Lorenzo Valley, North Coast Watersheds, SLVWD, and LCWD

The wild animals that have the greatest potential impact in the San Lorenzo Valley and the North Coast watershed are wild pig, black tailed deer, California ground squirrel, and other local terrestrial mammals. NRCS District Conservationist Rich Casale stated that he has seen evidence of pig populations in every part of Santa Cruz County. Where there has been a noticeable increase in wild pig populations, there can be erosion problems caused by the foraging and wallowing habits of this species. In the 2006 watershed sanitary survey, SLVWD reported high levels of activity in the vicinity of their newly constructed intakes, especially the Foreman intake. SLVWD staff indicate that pigs no longer appear to be as rampant a problem. Past activity may be associated with residential development encroaching on the wildlands, thereby reducing hunting, or wetter-than-normal conditions prevalent during the decade prior to the previous update contributing to growing populations. LCWD staff indicated that wildlife, while resident in the watershed, do not appear to be causing any discernible water quality concerns.

California ground squirrels are a minor potential source of sediment and fecal coliform bacteria. Ground squirrels are a source of bank instability in grassland areas and along levees and earthen dam structures. This instability often necessitates eradication efforts that when done by rodenticides may be a source of chemical contamination to adjacent water sources. In small spring systems, it was noted that occasionally other rodents, like the dusky footed woodrat and deer mice, as well as a variety of lizards may foul water supplies when they die and decompose in water sources. This issue illustrates the need for vigilance on the part of the small-scale water suppliers and spring owners.

3.8.3 Significance

Pigs and other wild animal populations do not appear to have a great potential for contamination of surface waters at this time.

3.9 Quarries/Mine Runoff

There are four quarries in the San Lorenzo River watershed and one quarry in the Liddell Spring watershed that could impact the quality of public drinking water supplies. Mineral extraction in the San Lorenzo River watershed consists of rock, gravel, and sand for the construction and glass industries. The Felton and Quail Hollow Quarries are still active while the Hanson and Olympia Quarries are no longer active. Mining at the Hanson Quarry ceased in 2004 and
reclamation is presently underway, while mining at the Olympia Quarry ceased in 2002 and reclamation is stalled due to endangered species issues. The CEMEX Bonny Doon Quarry in the Liddell Springs watershed was a limestone quarry, but is now closed and reclamation is underway on portions of the site while an application is in progress to address changes required to adequately reclaim other portions of the site (David Carlson, personal communication, 2012).

The quarries are regulated under California’s Surface Mining and Reclamation Act (SMARA) and by the County’s Mining Ordinance. The County Mining Ordinance requires that the application package be submitted to the water purveyor in the drainage area of the quarry. The County inspects the quarries four times each year and the state inspects annually. The County conducts an extensive review each five years. At that time, the County Planning Commission can impose conditions on the quarry as part of the Certificate of Compliance. The Regional Board issues NPDES permits that set limits on contaminants that can be discharged to surface waters from quarries.

3.9.1 Contaminants of Concern

Sediment, nitrate, dissolved metals and minerals are all contaminants of concern related to quarry operations. The Felton Quarry has historically been a source of dissolved minerals, sulfate, iron, and manganese in moderately elevated concentrations while the Bonny Doon Quarry for limestone, which recently closed, was associated with high sulfate, turbidity, sediment and nitrate. The other quarries in the watersheds are closed but may be a source of sediment if not properly maintained. Each quarry is discussed further in Section 3.9.2.

3.9.2 Existing Conditions

3.9.2.1 San Lorenzo River Watershed

This section presents existing conditions of the four quarries in the San Lorenzo River watershed. Again, two quarries are still active (Felton and Quail Hollow) and two are presently inactive (Hanson and Olympia).

Felton Quarry - Felton Quarry, mined by Granite Construction Company, is a 262-acre granite quarry rising in elevation from 550 feet at the eastern edge to 1,550 feet at the northwest corner. The Felton Quarry mineral deposit, a spatially-limited unit of fractured and stained granitic rock (mapped as adamellite, also known as alaskite), is located on the southeastern side of Ben Lomond Mountain. The quarry consists of an active open pit, an asphalt plant, a washwater recirculation system, a polymer clarifier system, and settling ponds. It produces both decomposed granite used in construction and a stained aggregate marketed as a high-value landscaping rock under the ‘California Gold’ trademark.11

Mining occurs on approximately 85 acres of the site (Carlson, 2005). The quarry has been active since the early 1970s, and has been operated under the present permit for 31 years with an additional 19 years of feasible mining projected. Limestone Brook drains through the center of the site in a southerly direction forming the headwaters of Gold Gulch, which flows east to the

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11 See Hecht, 1978 for a discussion of the hydrogeologic and weathering conditions which have led to deep weathering and the lightly-stained rock mined at the site.
San Lorenzo River. Washwater is recirculated and stored in three detention ponds. It is not discharged except during major storm events. Stormwater runoff from the site is also stored in the three on-site detention ponds. Prior to major storm events, water is pumped from the ponds and discharged to Gold Gulch to increase pond capacity for stormwater runoff. The ponds are designed to handle a 2-hour, 100-year storm, providing a median detention time of at least 20 to 40 minutes. During extreme storm events the capacity of the detention ponds is exceeded and stormwater flows out of the ponds to downstream receiving waters. Discharges to surface waters are regulated under an NPDES permit issued by the Regional Board. The quarry submits quarterly discharge reports to the Regional Board.

Granite monitors groundwater and surface-water quality twice each year at a number of monitoring locations. Ground-water levels are measured in nine wells and samples are collected for pH and conductivity. Surface water samples are collected at 16 locations including the settling ponds, springs, Gold Gulch, and Limestone Brook. All samples are analyzed for pH and specific conductance. Selected samples are analyzed for general water quality parameters such as total dissolved solids, calcium, and sulfate. In April 1995, a sample was collected from the effluent of the clarifier and analyzed for the 13 priority pollutant metals. Most of the metals were not detected. Lead and nickel were detected at concentrations well below drinking water standards. High concentrations of sulfate, calcium, iron, and manganese have been detected in the ground-water basins of Limestone Brook and Gold Gulch. County requirements call for developing a set of protective measures should water quality change by more than 20 percent. The Felton Quarry has controlled erosion at the site by revegetation with native plants.

Historically there was concern that the quarry’s operations might affect the water supply of the Forest Lakes Mutual Water Company, as the quarry’s product of partly-weathered rock is part of the source aquifer for the Company’s wells. A hydrogeologic assessment study (Hecht, 1978) showed that there was no impact on ground-water levels; however, the operator drilled a new well for Forest Lakes MWC that provides 18 acre-feet of water to the water district each year. Conditions of approval for the quarry require that if the water supply were to diminish, Granite would be required to provide a new water supply to this purveyor.

**Quail Hollow** - The Quail Hollow Quarry encompasses 240 acres and is located on Quail Hollow Road near the community of Ben Lomond (Carlson, 2005). Mining is estimated to continue for decades from the present. The Santa Margarita Sandstone is mined for sand which is used in the construction industry; however the Quail Hollow quarry is locally unique in that it also contains fine, industrial grade sand used by the glass industry (Carlson, 2005). The quarry consists of an open pit, a washwater recirculation system, and detention ponds. In 1998, the Planning Commission certified an EIR for the project and approved the Mining Approval and Certificate of Compliance. In 2007, the first permit review since the 1998 approval was conducted and staff concluded that the quarry was in substantial compliance with the Conditions of Approval (Carlson, 2007). Additional best management practices were installed to better manage stormwater runoff. In 2008, Graniterock finalized the Long Term Management and Maintenance Plans (LTMP), which was a stipulation of their 1998 Mining Approval and Certificate of Compliance. The purpose of the Plan is to implement the conservation goals of the Habitat Conservation Plan by describing the management and maintenance actions that will

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12 There are actually two Approvals for the Quail Hollow Quarry and two corresponding sets of conditions of approval. The approval for the “Current Mining Area” was in 1994, and that for the “Future Mining Area” was in 1998.
be undertaken to preserve conservation and reclaimed areas of the mine in perpetuity (Carlson, 2008). The LTMMP calls for a more comprehensive monitoring program to include, invasive species mapping, vegetation community mapping and plan plant species mapping, as well as an adaptive and research-oriented approach that will allow management to be refined and improved as new information is obtained.

Hanson Quarry - The Hanson Quarry is a 275-acre quarry in the Bean Creek watershed mining the Santa Margarita sandstone. The quarry consists of an open pit, a washwater recirculation system, a polymer clarifier system, and four settling ponds. Operations at this facility ceased in 2004, and since then, a number of reclamation activities have occurred at the site (Carlson, 2010). The processing plant, and fuel and oil storage tanks have been removed. The quarry floor was graded and large-scale plantings have been completed. A major repair of storm damage to Conference Drive at the quarry entrance was completed in 2006, and this included installation of major drainage improvements to handle runoff that had been handled by the former processing plant water recycling system. Studies have been conducted to assess the feasibility of using the former quarry pit as a recharge facility in association with a larger conjunctive use ground-water program for the lower San Lorenzo River. There is no specific project, or funding for a project, at this time. In addition, the Hanson Quarry contains some preserved sandhills habitat and undisturbed areas around the east, south, and west rim of the quarry pit are covered by conservation easement (David Carlson, personal communication, 2012).

Olympia Quarry - Olympia Quarry occupies 210 acres. The quarry consists of an open pit, wash water recirculation system, sand loading facilities, and a detention pond. Operations were discontinued at this facility in 2002. Reclamation and revegetation of the site remains stalled due to difficulty aligning reclamation plans with United States Fish and Wildlife Service requirements to protect two on-site endangered species – the Mt. Hermon June beetle and the Zayante band-winged grasshopper (David Carlson, personal communication, 2012).

3.9.2.2 Loch Lomond Reservoir and the upper Newell Creek watershed

There are no quarries in this watershed.

3.9.2.3 North Coast Watersheds

Bonny Doon Quarry - The Bonny Doon Quarry, purchased by CEMEX, is located immediately upslope and up-watershed of the SCWD Liddell Spring intake. Quarry operations started in August 1970 and, in January 2010, CEMEX officially decided to cease operations and the property was purchased by a group of local non-governmental organizations for preservation. Although a reclamation plan has been prepared, it has not yet been accepted by the Board of Supervisors. In addition, the reclamation phase will likely involve earth-moving and therefore could be a continued source of some water quality impacts.

Prior to this closure, CEMEX was operating under a Certificate of Compliance and Reclamation Plan approved in 1997 and was pursuing expansion of quarrying activities through a Mining Plan Amendment to the County of Santa Cruz, which triggered a project Environmental Impact Report. The quarry operation included an open pit, shop, office building, crusher, and a conveyor belt. Approximately 97 acres was mined for limestone to the 750 foot elevation. Approximately 150 tons of rock was mined each year using ammonium nitrate as a blasting agent. There were 86 blasts in water year 2006, 63 blasts in water year 2007, 51 blasts in
water year 2008, 1 blast in water year 2009, and 0 blasts in water year 2010. Increased turbidity and nitrate concentrations at Liddell Spring have been attributed to quarry operations by SCWD. Balance Hydrologics has shown that quarry blasting can generate turbidity signals at Liddell Spring regardless of season (i.e. turbidity signals due to quarry blasting have been recorded in the winter, wet season and the summer, dry season).\textsuperscript{13} (c.f. Strudley and others, 2009).\textsuperscript{14}

Nitrate sources have been previously reported upgradient of the quarry (Watkins-Johnson, 1992). The same study also reports that the quarry area ground-water was affected by nitrate before the commencement of quarry operations. Time-series data dating back to the 1970’s indicates a slight upward trend in background nitrate concentrations of Liddell Spring discharge. The source(s) of nitrate which reaches Liddell Spring, if it is indeed increasing, has however not yet been identified.

3.9.2.4 SLVWD

No quarries exist within the SLVWD so contaminants associated with active quarries are not a concern for the relative watersheds.

3.9.2.5 SLVWD

No quarries exist within the LCWD, therefore the Lompico and Mills Creek watershed are not influenced by any potential contaminants associated with quarries.

3.9.3 Significance

Within the four quarries in the San Lorenzo watershed, occasional heavy sedimentation can occur because of exceedance of settling pond capacities during major storms. This condition is not likely to change in the foreseeable future. The potential water quality impact is more significant with the operational quarries at Felton and Quail Hollow. With the closure of the Bonny Doon quarry, Liddell Spring water quality will no longer be negatively impacted by blasting events. The Peninsula Open Space Trust and Sempervirens Fund with other organizations acquired the Davenport Forest from CEMEX in the winter of 2011, and with its partners, are seeking to design a conservation plan for the 8,500-acre property which includes the Bonny Doon quarry site.

\textsuperscript{13} Turbidity responses triggered by blasting in the absence of rainfall are characterized as having a very short lag from blast to peak turbidity (2 hours) and an abrupt rise, followed by a clear recession following the peak to pre-event turbidity levels (~0.40-0.50 NTU). It is more difficult to discern turbidity responses from blasting occurring within 24 or 48 hours of daily rainfall exceeding 0.10 inches, though it seems likely that blasting increased turbidity levels or prolonged the duration of turbidity exceeding 10 NTU.

\textsuperscript{14} From blasts conducted in August and September 2006, it has also become evident that blasting at locations near to a locally mapped fracture or fault line trace within the active quarry floor (Pacific Geotechnical Engineering and Balance Hydrologics, 2002) and believed to be hydrologically connected to Liddell Spring can result in turbidity signals at Liddell Spring which exceed the SCWD treatment capacity. This suggests that blast-related turbidity impacts are somewhat dependent on blasting location, and demonstrates the connection between quarrying activities and Liddell Spring.
3.10 Solid and Hazardous Waste Disposal Facilities

In California, there are three main categories of waste disposal facilities: (1) solid waste disposal facilities, (2) hazardous waste treatment, storage, and disposal (TSD) facilities, and (3) illegal dump sites. Solid waste facilities are regulated by the California Department of Resources, Recycling and Recovery (CDRRR, formerly the State Integrated Waste Management Board), although pollution problems are handled by the Regional Boards. Hazardous waste facilities are overseen by the State Department of Toxic Substances Control (DTSC). The County removes trash and abandoned articles from illegal dump sites.

There is one closed solid waste facility in the San Lorenzo River watershed, discussed below. A review of the DTSC database of TSD facilities showed there are no TSD facilities in any of the watersheds.

3.10.1 Contaminants of Concern

Leachate from waste disposal facilities is a liquid formed as infiltrating rainwater seeps through the landfilled material mobilizing a variety of contaminants. Leachate is typically a highly mineralized liquid containing heavy metals, dissolved solids, nutrients, and organic chemicals. The composition of leachate from any particular landfill will depend on the nature of the decomposing landfilled materials. Although regulations aim to minimize or eliminate leachate from contaminating the underlying groundwater and nearby surface waters, complete leachate control is difficult to achieve.

3.10.2 Existing Conditions

3.10.2.1 San Lorenzo River Watershed

There are no active solid waste disposal facilities in the watershed. The County provides trash pick-up service in all the watersheds and transports the material to one of the two operating landfills, both of which are outside the watershed areas for this study.

There is one closed County landfill, the former Ben Lomond Landfill. This facility was in operation since the early 1950s and was classified first as a Class II Landfill, then later as a Class III Landfill. The landfill ceased acceptance of waste in July 1991 and it is now used as a transfer station and recycling center and is known as the Ben Lomond Transfer Station. It is located on the north side of Newell Creek, downstream of Loch Lomond, in the highly permeable Santa Margarita sandstone which is underlain in this area by the south-southeast dipping Monterey shale.

Requirements for management of active landfills, closure of landfills, and air and water quality testing are described under Subchapter 15 of the California Code of Regulations. The CDRRR implements source reduction and recycling requirements, waste handling and landfill design, and waste disposal standards. Landfills are to be designed and closed to permit no off-site movement of leachate. Both active and inactive solid waste disposal sites are required to conduct monitoring specifically to identify the content of any leachate leaving the site and whether there are water quality problems posed by the site. The monitoring results are reported to the Regional Board in Solid Waste Assessment Test (SWAT) reports.
In 1976, the County monitored Newell Creek upstream and downstream of the landfill as well as monitoring a seep into Newell Creek which was downgradient of the landfill and would be expected to intercept any leachate movement. The samples were analyzed for conventional parameters and nutrients. No significant differences between the three surface water sites were seen and leachate contamination was not judged to be significant (Santa Cruz County, 1977).

Water quality problems were later recognized, not from the leachate, but from exposure of the Monterey shale to the atmosphere as a result of landfill excavating activities. Runoff from the wetted Monterey shale contained high levels of naturally occurring cadmium. At one point, lime was spread on the exposed shale in an effort to reduce the cadmium concentrations. This was not sufficiently successful, however, and a clay cover was installed in 1982-83 on the landfill areas which had reached capacity. Thereafter, clay was used as intermediate cover on active areas until the landfill, having reached capacity, was closed (Santa Cruz County Planning Department, July 1981).

The entire Ben Lomond Landfill is now under a clay cover. Regional Board staff report this cover has been effective in reducing the cadmium levels. Closure measures include gas extraction, installation of a sedimentation basin, and installation of a drainage system. The County submitted a closure plan to the Regional Board in 1996.

Monitoring wells were first installed around the perimeter of the landfill in late 1987. Groundwater samples collected from these monitoring wells showed the presence of elevated levels (i.e. over background) of organic and inorganic compounds. Most constituents were detected at low levels. Three volatile organic compounds (VOCs) were detected at levels which exceeded their respective MCLs. These were benzene; cis-1,2 dichloroethene; and 1,4-dichlorobenzene (Emcon Associates, October 1989).

Additional monitoring wells were installed and a quarterly monitoring program was begun. Analyses are conducted for total dissolved solids, sodium, chloride, nitrates, iron, phenols, chemical oxygen demand, and VOCs. VOCs have not been detected in the downgradient monitoring wells installed close to Newell Creek, between the landfill and the creek. In addition, monthly monitoring of Newell Creek upstream and downstream of the landfill has been conducted since mid-1988. Surface water samples are analyzed for cadmium, pH, turbidity, color, iron, chloride, and sodium (Santa Cruz County Department of Public Works, 1995).

In summary, there is a ground-water plume beneath the Ben Lomond Landfill but concentrations of most monitored constituents are at low levels. A few VOCs are detected above MCLs in three of the wells close to the landfill perimeter. Downgradient groundwater monitoring wells, however, show no evidence of VOC contamination. Monitoring of Newell Creek shows some increases in mean constituent concentrations from upstream to downstream of the landfill, including an apparent increase in turbidity. Leachate inflow into Newell Creek would be unlikely to cause the turbidity increase; this apparent increase may have some other source, possibly erosion within the Rancho Rio subdivision on the opposite creek bank.

3.10.2.2 North Coast Watersheds and the Loch Lomond Reservoir

There are no identified and no permitted waste disposal facilities in any of the other watershed areas.
3.10.3 Significance

Waste disposal facilities most likely are not a significant threat to the water quality of the San Lorenzo River or the creeks in the North Coast watershed. There are no hazardous waste disposal facilities in any of the watersheds. The closed Ben Lomond Landfill in the Newell Creek watershed appears to have created a low-concentration groundwater plume with a few elevated VOCs but the plume does not appear to be migrating into the creek. There is an apparent turbidity increase in the creek from upstream to downstream of the landfill. The landfill leachate, however, is unlikely to be the source of this turbidity increase.

3.11 Timber Harvests/Logging

Logging is part of the land-use mosaic and tradition in Santa Cruz Mountains. Most old-growth redwood had been cut by 1915. Douglas fir and hardwoods have also been extensively logged. Timber harvests continue as an integral part of the local economy.

Timber harvests occur throughout the surveyed watersheds, but primarily in the San Lorenzo Valley. Virtually all portions of this watershed are affected as timber resources as designated by the County are in a large portion of the watershed (Figure 3-3). Using the GIS data displayed on Figure 2-3, a compilation of historic permitted timber harvests in the San Lorenzo Valley developed by Sempervirens Fund shows that 893 acres of the 71,900 acres in the watershed -- or about 1.2 percent -- were likely harvested commercially during 2007 and 2008 after which Sempervirens’ data are not available. This can be compared to the average annual timber harvest of about 280 acres per year for the period from 2001 – 2006 to about 447 acres per year for 2007 and 2008. When a five-year running average of timber harvest acreages is calculated, the number of acres that have been harvested appear to be declining since a peak acreage of timber harvest in the early 1990s.

3.11.1 Contaminants of Concern

Timber harvesting is responsible primarily for the contribution of additional sediment through erosion from logging roads. With the sediment, nutrients and bacteria are also introduced into the streams. The relationship between timber harvesting and sediment yield is poorly defined and related to specific site conditions including geology, slope, and stream proximity as well as specific timber harvesting practices. Limited local studies have been conducted to measure effects of erosion from timber harvesting roads.\(^\text{15}\) One field-based study in the Zayante, Newell, and Love Creek watersheds (Swanson and Dvorsky, 2001) suggests that roads related to timber entry (past and present) are sources for perhaps 30 to 50 percent of sediment delivered to the creek system, with values differing substantially by (a) subwatershed, (b) sandy vs. non-sandy soils, and (c) inner gorge versus hillslope location.\(^\text{16}\) Similarly, no local data are available addressing the relationship of timber harvests and road construction in general (as well as other

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\(^\text{15}\) The County Planning Department once applied for and was awarded a 205j grant to study this issue, but could not find a landowner willing to cooperate in field monitoring,. The grant funds were returned to the state.

\(^\text{16}\) Values are approximate, as the study area considered in this report is not truly representative of the two surveyed watershed, but these findings are both important and applicable; table ES-1 from the report provides additional information.
Potential Containment Sources in the Watershed

3.11.2 Existing Conditions

Logging is a major land-use activity in all the watersheds. Nearly half the County is zoned for timber production. Logging is done of both hardwoods (mostly for firewood) and redwoods and Douglas fir (for lumber). Virtually all logging in the watershed study area is on privately owned lands. The City of Santa Cruz has discontinued timber harvesting within its watershed lands. The San Lorenzo Valley Water District has sold much of its timberlands to Sempervirens Fund and has policies against harvesting on remaining watershed lands. No known timber harvests have occurred in the Lompico County Water District watershed. Much of the Timber Production Zone (TPZ) land, which is land designated as suitable for commercial logging, is owned by individuals with relatively small acreages. Only a few private companies and the SCWD own TPZ lands in areas greater than 2,500 acres. Thus, the location of logging changes every year, depending on the decisions of many individual land owners and the price of timber. Some TPZ lands are retired from timber harvesting, particular those in public ownership. Conservation groups (e.g., Save the Redwoods) continue to purchase forested acreage, retiring it from timber production. Some smaller water purveyors continue to sell timber; logging is not allowed in the State or County parks.

On private lands, the California Department of Forestry and Fire Protection (Cal Fire or CDF) is responsible for regulating timber harvesting by enforcing the regulations of the 1973 California Forest Practice Act, contained in Title 14 of the California Code of Regulations. The logging season is generally April 15 through October 15, but tree-cutting may continue all year long, and CDF may approve winter operations. Prior to 1983, counties could regulate timber harvesting within their county area. Then, SB856 prohibited local regulation and reserved jurisdiction to the state under the CDF. At that time, special County rules were incorporated into the Forest Practice Act.

The basic structure of the CDF requirements are:

1. A Sustained Yield Plan is required for TPZ lands greater than 2,500 acres, describing the attributes of the timber and how the land will be managed to sustain the land as a productive timber area producing a certain number of board feet per year. The SCWD has developed a timber management plan which is similar to a sustained yield plan for its TPZ lands in the Loch Lomond, Laguna Creek, and Zayante Creek watersheds, but has discontinued harvests. This plan is discussed further in Section 4.

2. A Timber Harvest Plan (THP) is required for each specific project on all parcels if the product is to be sold. The plan submitter must retain a registered professional forester (RPF) to prepare the THP. The skill of the RPF directly affects the water-quality effects of each cut. Actual logging is usually put out for bid to logging companies. THPs are discussed in some detail below.

3. Certain exemptions from the THP process are allowed. Parcels less than 3 acres do not require a THP but must abide by cutting standards and other requirements for the CDF district. Exemptions from the THP requirement are also allowed for Christmas tree cutting, and removal of dead or diseased trees, removal of trees within 150 feet of

surface-disrupting activities) on dissolved organic carbon, a constituent of concern in water treatment.
a residence for fire control. Clear cutting for conversion to other land uses (such as orchards or vineyards) can be done. However, this practice now requires a report from a registered professional forester and CDF now inspects to verify conversion.

The THP process is the functional equivalent of preparing an EIR under CEQA. The THP, once filed and approved, is good for 3 years. Two one-year extractions may be granted by the director of the CDF.

Once the plan submitter files the THP, CDF staff at the region office review the THP for completeness. If it is found to be complete, it is sent to the district CDF office. The THP is then reviewed in the field during the Pre-Harvest Inspection (PHI). The entire Review Team has the opportunity to attend the PHI. The potential members of this multi-disciplinary review team consists of: a CDF staff forester, a representative of the Regional Board, a representative of the County, a representative from the Department of Fish and Game (DFG), a representative from the regional Coastal Commission office (for a THP in the coastal zone), a representative from the California Department of Parks and Recreation (SDP) when THPs which could affect values related to State Parks.

The local water purveyor holding an interest in the watershed of a THP acts as advisor to the Review Team. However, additional water purveyor notification of the PHI and THP by CDF or the Regional Board and/or a more formal role for water purveyors is encouraged because of the potential negative water quality impacts. The California Geological Survey, or CGS, (formerly California Division of Mines and Geology, CDMG) also acts as advisor to the Review Team upon request by CDF; as implied by the advisory role, the extent to which technical advice from purveyors or CGS practitioners is discretionary. The Director may also request other State, Federal, or County agencies to act as advisors to the Review Team.

The findings of the PHI are finalized at the final Review Team Meeting (RTM). Any changes resulting from the PHI or from public input are made part of the THP.

The public is notified by both the plan submitter and CDF of relevant information and dates, through direct mailing to neighbors (within one thousand feet of the property) and publishing in the local newspaper. The properties are also posted. Public hearings are held by CDF, and responses are generated to all issues received through the public hearing or written correspondence. A new administrative process of non-industrial timber management plans (NTMPs) has been established allowing recurrent entry to smaller private holding on a sustain-yield basis without public notice or review, but subject to continuing CDF oversight.

The County Board of Supervisors has the authority to challenge the approval of a THP by appealing the issue to the State Board of Forestry. The Board of Forestry has the authority to overturn the approval of a timber harvest plan.

CDF Southern SubDistrict requirements, which the THPs must show they meet, include conformance with cutting standards, return cycle cutting, slash treatment, road construction and design, and post-logging erosion-control measures. The San Lorenzo River and North Coast watersheds are in CDF’s Southern Subdistrict of the Coast Forest District. Cutting standards for this District allow only selective harvesting. The registered professional forester determines the level of cut within District standards and marks individual trees. Portions of the North Coast
watersheds are in Coastal Commission special treatment areas and must comply with additional rules. A specific area may be logged no more than once every 10 years. All slash must be cut to rest a maximum of 18 inches off the forest floor.

Permanent, seasonal, and temporary roads are the three categories of roads recognized by CDF. Permanent roads are asphalted or otherwise surfaced. Seasonal roads are dirt roads on which erosion control features must be installed by October 15. Temporary roads are physically destroyed or blocked after the logging. Most road construction in the watersheds for timber harvesting is of seasonal roads. Road building plans must be discussed in detail in the THP including use of soil generated during the road building. The THP must identify the installation of erosion control features for roads, such as water bars. Water bars are a swale/berm combination that cut across roads to act as a cross drains. Additional erosion control features include construction of out-facing slopes (outsloping) on roads, avoiding inside slope drainage, and “armoring” susceptible areas to dissipate energy from storm flow.

Post-disturbance erosion control is site specific. The application of straw, wood chips, hydromulch, slush, or fabrics to a skid road or other feature is dependent on such factors as slope, proximity to a watercourse, rating of the watercourse as to sensitivity, and professional judgment. Since the early 1990s, stream crossings have received particular attention and care, with respect to not only inhibiting sediment delivery during washouts but also protecting adult passage of salmonids.

CDF requires that erosion-control features be maintained for an additional 1 to 3 years after completion of the first winter after harvest. CDF staff inspect a logging operation a minimum of three times: before, during, and after the harvest. However, they can and do inspect more frequently if appropriate. After the harvest is closed, CDF inspects the roads during the extended maintenance period. Beyond this period CDF cannot control any subsequent destruction or non-maintenance of the roads.

3.11.2.1 SLVWD

There is no known timber harvesting that occurs within the SLVWD other than a Christmas Tree farm that exists on the Upper Empire Grade within the Foreman Creek watershed. This operation does not compare to the size and scale of a timber harvesting operation, and it is unlikely to impact the watershed to the extent of a commercial timber harvesting operation. If there were to be any timber harvest within any of the SLVWD watershed lands, the District would be notified and proper planning and inspection would be assessed. SLVWD has a prohibition on commercial timber harvest on District lands.

3.11.2.2 LCWD

There are no timber harvests within the LCWD watershed boundaries, 500 acres of which is now under ownership by Sempervirens Fund.

3.11.3 Significance

The cumulative impact of timber harvests, both at individual sites and cumulatively on downstream channels, must be considered significant, although the reduction in acreage of
timber harvest in recent years has somewhat reduced the potential water quality impact. The primary potential problem arises with erosion resulting from the roads constructed to access the logging area, particularly after CDF oversight ceases and erosion control measures may not be maintained. CDF requirements do not limit road density within a watershed. NOAA fisheries uses road density (measured as the ratio of miles of road per square mile (mi./sq. mi.) of watershed) as an indicator of watershed conditions in salmonid habitat assessments. NOAA fisheries has found that road densities greater than 3 mi./sq. mi. may indicate impaired ecosystem function (NMFS, 1996). In addition, Swanson (2001) found that legacy and current logging roads are the source of 30 to 50 percent of sediment delivered to the Zayante Creek. If extended throughout the sanitary survey study areas, as is reasonable based on underlying soils and geology, Swanson’s study compels attention.

The relative significance of these old logging roads depends not just on original road design and construction but also on the maintenance of erosion control features and the slope and type of underlying soils and geologic conditions. The watersheds contain many geologic formations and unconsolidated colluvial and slope deposits which differ markedly in the degree of erodibility. ‘Colluvial wedge’ failures (slipouts of the soils filling steep draws or swales) and small landslides which displace a segment of logging road are endemic to the Santa Cruz Mountains. These are of particular concern for protecting water supplies (and spawning habitat) because the toes of the failure often are deposited directly into a stream or its riparian zone, where they continue to contribute sediment and turbidity for long after the streams would otherwise run clear. These slope failures are recurrently repaired for temporary entry, and tend to fail again during the next severe winter, resulting in a cycle that cumulatively results in persistence of turbidity following individual storms or over several years which affects divertibility and the quality of water diverted.

Additional attention to road failures, and their underlying geologic or geotechnical causes, could help alleviate both the magnitude and persistence of turbidity in the San Lorenzo watershed. Another major regional challenge especially specific to the San Lorenzo watershed (and adjoining catchments to the northwest and southeast) is to reduce sediment delivery from erosion of road treads. Deep, multi-branched gully systems tend to develop on roads cut into weathered slopes within (especially) the Vaqueros and Butano sandstones. The gullies are left to continue growing, or are temporarily filled during re-opening of harvest areas only to re-erode with the next wet season. While not limited to the Santa Cruz Mountains, this set of issues is particularly manifested in the local setting. Means of controlling such erosion in this ‘sugar sand’ setting have yet to be specified or enforced. This could be usefully addressed in a rigorous control-measure focused study of intermittently-open roads in such watersheds as Logan Creek (and upper Kings Creek generally), Newell Creek, or Hare Creek where weathered Vaqueros sandstone is widespread. An appropriate set of practices for Southern District lands underlain by such geology may serve to measurably diminish sediment delivery and turbidity, and including sedimentation of Loch Lomond – one of the subwatersheds with the largest acreage of land managed for timber.17 It should be noted that CDF issued 2012 Forest Practice Rules that includes topics specific to the Southern District and the Regional Board has issued

\[\text{17 This would be a logical extension of prior grants obtained by the County to further implement the County manual for road maintenance practices to reduce erosion and sedimentation using the inventory of potential sediment sources along County roads in the San Lorenzo Watershed that has been completed.}\]
Order no. R3-2012-0008 which is a General Conditional Waiver of Waste Discharge Requirements Timber Harvest Activities in the Central Coast Region. These documents should be reviewed to evaluate whether they are sufficient to address the specific geologic concerns.

### 3.12 Recreation

Principal recreational activities in the watersheds include swimming, fishing, hiking, and horseback riding. Along with hiking and horseback riding, mountain biking also occurs on trails in the watersheds. Water contact recreation (swimming) occurs primarily during fair weather and relatively warm temperature conditions, conditions typical of May through October. The peak water-contact recreation season is traditionally from the Memorial Day through the Labor Day weekend and is limited to natural swimming holes as temporary rubber dams are limited by DFG; however, a summer dam on Zayante Creek has been observed. In addition, weekend use is generally more intensive than weekday use. Swimming and wading has been listed as the most popular recreational activity in the watersheds. Hiking, mountain biking, and horseback riding are more year-round activities (County General Plan).

#### 3.12.1 Contaminants of Concern

Water-contact recreation is a potential source of viruses, pathogens, and bacteria, principally from the introduction of human fecal matter (most likely from infants and children) directly into the stream. Hiking, mountain biking, and particularly horseback riding, can contribute to erosion and increased turbidity, especially where conducted off established trails and at stream crossings. Fishing activity is limited to catch-and-release steelhead, except at Loch Lomond, and is unlikely to be a source of contaminants.

#### 3.12.2 Existing Conditions

##### 3.12.2.1 San Lorenzo River Watershed

There are three state parks, four county parks, one City recreation area, one private country club, and several public and private swimming holes within the watersheds. Water contact recreation is prohibited in the City recreation area but is widespread elsewhere in the creek system. The state parks include Castle Rock State Park, the Henry Cowell State Park, and a small portion of the Big Basin Redwoods State Park. The state parks are essentially open spaces. Big Basin Redwoods State Park has more than 18,000 acres with many miles of trails for hiking, biking, and horseback riding, 147 developed campsites, 6 trail camps, and 36 tent cabins. Castle Rock State Park has more than 5,000 acres and 32 miles of trails for hikers and equestrians. Camping is for backpackers only. Henry Cowell State Park consists of two units; a main park area of about 1,800 acres and the Fall Creek Unit which has about 2,500 acres and has about 20 miles of trails. Some trail sections are designated for horses, leashed dogs, or bicycles but most trails are for hiking. There is also a 112-unit campground. Illicit recreational uses in Henry Cowell State Park and adjacent lands have recently increased, particularly mountain biking off the designated trails; reduced state funding and closure for state parks will further reduce enforcement of park regulations. The City has been working with the State Parks staff to set up stake outs to improve enforcement of regulations. (C. Berry, 2012. Personal Communication,)
The County parks include the Felton Covered Bridge County Park (playground, covered bridge, horse trail access, volleyball); Highlands County Park (senior center, swimming pool, picnicking, playing fields, nature trail); Ben Lomond Mill Street Park (picnicking, small playing field); and Quail Hollow Ranch County Park (equestrian facility).

The Boulder Creek Golf and Country Club is a private facility which provides an 18-hole golf course as well as other recreational facilities, such as tennis courts and a swimming pool.

Historically, there were several small dams constructed across creeks to afford summer swimming holes at locations that included, San Lorenzo Woods, Bear Creek Scout Camp, Gold Gulch in Forest Lakes, and Zayante Creek in Mt. Hermon. Swimming holes are now limited to natural swimming holes which are located in less accessible portions of the watershed although illegal dams constructed of cobbles and plastic are occasionally constructed. The County Health Services Agency continues to monitor coliform bacteria along the creek system and uses the data to issue health advisories against swimming, when coliform counts are high. The coliform data can indicate sewage contamination from failing septic systems, urban runoff, domestic animal wastes, wildlife, birds, and/or water contact recreation itself.

A historic examination of the geographical distribution of the County fecal coliform data shows that the urbanized portions of the river system, generally between Boulder Creek and Felton, have fairly similar average and median values. There is an apparent trend of decreasing coliform counts through reaches that pass through the State Parks, which are mostly open space. SCWD total coliform data also suggest the mitigating effects of Henry Cowell State Park, as well as the City’s reservoir at Loch Lomond. That is, total coliform counts at Loch Lomond and the Tait Street diversion are lower than the counts at the Felton Diversion as shown in Section 5. The County’s wastewater management program evaluation found no significant increases of fecal coliform bacteria in the swimming areas of the San Lorenzo River system, indicating that water contact recreation at parks and designated recreation areas is not a significant source of the bacterial load in the river (John Ricker, personal communication, 2007).

3.12.2.2 Loch Lomond Reservoir and the upper Newell Creek watershed

Loch Lomond Recreation Area occupies the east side of the reservoir and is owned and operated by the SCWD. Recreational use averages around 55,000 visitors per year. There is day use only, with picnicking, fishing, and boating as the primary activities. Only electric powered boats and manually paddled boats such as rowboats are allowed. There is no water contact recreation allowed.

Wastewater is trucked out of the recreation area and virtually no pesticides or herbicides are used in the area. The park is open from March 1 to September 15 from 6 AM roughly to sunset (varying times). In private lands of the upper Newell Creek watershed, there are a few septic systems on to serve homes and wineries.

3.12.2.3 North Coast Watersheds

There are no designated recreation areas or regional parks in the North Coast watersheds. There are informally established horse trails in the watersheds.
3.12.2.4 SLVWD

The Fall Creek State Park is available for day use, and is located just upstream of the Fall Creek intake. Since this area is only available for day use, there is a limited chance of contamination occurring. Recreation activities consist mainly of family picnics and hiking. The road along fall creek is gated just past the campground, so vehicles other than SLVWD vehicles, do not have access beyond Fall Creek State Park. Recreation use is minimal within other areas of the SLVWD and are limited to hikers and the possibility of some mountain biking.

3.12.2.5 LCWD

LCWD has limited recreation activities within its watershed. According to LCWD staff, there is a small pool below the Lompico Creek intake that local children swim in during warmer months, however, this has not had any effect on the water at the intake facility. Other activities that may exist in the watershed are limited to hiking and possibly some mountain biking.

3.12.3 Significance

Many recreational activities are relatively benign and non-polluting. Large recreational areas, especially those which are mostly open space like Henry Cowell State Park, or are managed specifically for water quality such as the Loch Lomond Recreation Area, appear to enhance water quality. As discussed above, bacterial water quality appears to improve as the water passes through large open space parks (Henry Cowell State Park) or resides in a reservoir for extended periods (Loch Lomond Reservoir).

Recreational activities generally considered of most significance involve water contact recreation. However, an evaluation of the County fecal coliform bacteria data conducted during prior watershed sanitary surveys, conducted by the County Health Services Agency, found no significant increase in bacteria in the swimming areas of the San Lorenzo River system. The introduction of fecal matter from horses may be significant, especially at stream crossings, as discussed previously.

The potential for erosion from hiking, horseback riding, and mountain biking may also be significant. Illegal trespass and damage caused by recreational activity, particularly unauthorized equestrian and off-road vehicle use, was an issue in the Olympia Wellfield of the San Lorenzo Valley Water District, but additional patrol, fencing, and blocking of access with appropriate horse crossings has improved protection of biotic and water resources of the property (SLVWD, 2010). Downhill biking has also become increasingly popular since the last watershed sanitary survey and biking-induced damage (including the building of illegal jumps) has stirred controversy in the San Lorenzo River Watershed (Betsy Herbert, personal communication, 2012). There are few signs to alert bikers coming from legal trails on UCSC’s upper campus that they are entering closed trails under state park control, and law enforcement has begun issuing tickets to riders exiting Henry Cowell State Park onto Highway 9. Allegedly, the only legal trails in the county that satisfy downhill bikers are in the Soquel Demonstration Forest, and given this limited amount of legal space, there have been preliminary conversations

18 SLVWD does not actively manage much of its land for recreational purposes; however, in 2011, SLVWD approved limited recreational use (equestrian, walking, and dog walking) on the Olympia watershed property.
between officials and bikers over building a park on federal land maintained by the Bureau of Land Management near Davenport.

### 3.13 Unauthorized Activity

Unauthorized activities are found at varying levels throughout the San Lorenzo Valley and North Coast watersheds and include unpermitted grading, illegal timber harvests, and unauthorized dumping of solid and liquid wastes. Area resource managers find that land clearing (including that associated with marijuana plots), road construction, and maintenance by individual landowners are the primary sources of avoidable erosion. Many of the more problematic roads and stream crossings have been constructed informally, without the benefit of County or DFG review.

Homeless encampments can also be a source of human waste and are the subject of targeted enforcement.

#### 3.13.1 Contaminants of Concern

Generally, sediment caused by eroding land is the primary contaminant of concern, though illegal human waste discharges also contribute pathogens, particularly to the San Lorenzo River and illegal marijuana plots can also contribute chemicals and fuels. In 2011, CalFire has opened 22 cases of unpermitted timber harvest against illegal marijuana cultivation in the Santa Cruz Mountains; it is not known how many of these cases are in the San Lorenzo or North Coast watersheds. By contrast, CalFire opened 3 cases of unpermitted timber harvest in 2010. In addition to the fire and erosion risk, chemical spills including pesticides, herbicides, and fuels pose additional water quality threats.

#### 3.13.2 San Lorenzo River Watershed

The transition from summer to year-round occupancy in the San Lorenzo Valley resulted in heavier traffic loads on unimproved roads during the winter months. The use of both newly constructed and older dirt roads in periods of winter rains is the most consistent source of sedimentation and turbidity.

Numerous violations of the Santa Cruz County Erosion Control Ordinance can be seen throughout the subject watersheds, primarily in connection with roads. County Planning Department staff estimate that in the project area, there are scores of "active" violations of the County Grading and Erosion Control, the Riparian Habitat Protection, and the Sensitive Habitats Protection Ordinances. In addition, several large illegal roads in the Bear Creek and King Creek watersheds remain open and are a significant source of sediment and persistent turbidity. County enforcement staff do their best to obtain compliance for these situations, however with limited resources, violations are prioritized based upon severity and overall threat to life and safety. For larger land clearing or grading violations it may take years to ultimately resolve the violation due to many factors including the magnitude of the violation as well as the property owner’s willingness and financial ability to comply.
Besides grading and brush clearing by individual landowners, unpermitted timber harvests for firewood occasionally occur in the watersheds. Illegal timber harvests are seen by resource managers as causing more aesthetic damage than water supply damage.

Other unauthorized activities that may have an adverse impact on water quality are associated with homeless encampments in and around the San Lorenzo River from the Highway 1 bridge to Paradise Park. The upper portion of this corridor is upstream of the Tait Street intake, the downstream limit of the survey area. The wooded riparian area just upstream of the Tait Street Diversion has historically been used as an informal settlement with efforts made by the City to resolve homeless issues with multiple approaches including providing social services. Because there is a lack of sanitary facilities in the vicinity of the encampments, these sites may be a source of human waste. The City has increased patrols in the area, and has been actively negotiating with riparian landowners upstream of the Tait Street intake for the right to conduct maintenance and restoration along the river (Chris Berry, personal communication, 2012). Homelessness is a complex issue, and while cleaning up one site does not solve the underlying problem, it is significant that the City has been working to keep riparian areas clean. Encampments in the Pogonip remain an issue and have been addressed with increased patrols; they likely have less of an adverse impact on San Lorenzo River water quality than those along the river because of the greater distance.

3.13.3 Loch Lomond Reservoir Subwatershed

While the upper Newell Creek watershed is sparsely populated, a number of rural residential parcels have been developed. Formerly almost inaccessible, this area was cited by County resource planners as an area to watch. Old roads have been regraded to provide better access for the few households that have developed. Because of this new increased intensity of use, including year-round use, City staff has seen increased damage from vehicles to roadways in the last several years.

3.13.4 North Coast Watersheds

County enforcement staff indicated that numerous violations of the grading and erosion control ordinances, sensitive habitat protection ordinance, and timber harvest plans have occurred in the North Coast area. Sedimentation of Majors Creek has been cited as evidence of a general trend towards erosion and illegal grading and a potential TMDL is discussed further in Table 4-2. Although the general consensus was that violations are widespread throughout the subject watersheds and will continue, legacy logging roads are still considered the primary sediment source.

3.13.5 SLVWD

There has been no sign of unauthorized activity within the SLVWD. There are no regular or recurring inspections of the entire SLVWD lands because much of the watersheds are inaccessible to SLVWD staff, however, the staff do make visits to diversions sights and intakes approximately once per week when intakes are in service and prior to placing an out of service intake into service. Signs are posted throughout the watersheds that notify the public that the streams and surrounding areas are used for public water supply. Signs of vandalism have been rare, and most intakes are accessed by roads that are gated to control access by the public.
With the exception of the Fall Creek intake, intakes are not fenced but are behind gated roads. A few intakes are only accessed by roads that cross private lands, for which the District has easements in order to cross. Per conversations with SLVWD staff, no signs of dumping or illegal activity have been witnessed by the staff or have been reported to the district.

3.13.6 LCWD

Per conversations with LCWD staff, they conduct routine (almost weekly) inspections of the Lompico Creek watershed. They inspect the creeks and residences along the creeks to identify if any unauthorized activity has taken place. LCWD has not observed any illegal activity, and they do investigate if there have been any reports. Reports are usually forwarded to Santa Cruz County so that they may look into potential unauthorized activity.

There was a report from a resident that a commercial carpet cleaner may have illegally dumped products into Lompico Creek. Both the LCWD and Santa Cruz County looked into the claim and did not find any evidence that a spill or illegal release had occurred.

3.13.7 Significance

Unauthorized activities are significant sources of sediment from eroding property in the watersheds. Small-scale grading and timber harvest frequently use poor practices which lead to barren, unprotected roads, yards, etc. Illegal marijuana plots can contribute chemicals and fuels in addition to sediments. Finally, homeless encampments can increase the concentration of microbial and particulate contaminants in streams, and are identified as a source contributing to water quality objective violations in the San Lorenzo River Pathogen TMDL.

3.14 Vehicle Upsets and Spills

Vehicle upsets are potential sources of contamination of hazardous materials into surface waters through the spilling or rupturing and subsequent discharge of the materials being transported. In addition to spilling of any cargo being carried, collisions can release petroleum products from the vehicles themselves. Factors that affect the level of risk for vehicle spills include overall traffic volume, amount of hazardous materials being transported, highway characteristics, and road conditions. There are no prohibitions on the transport of hazardous materials within the study area watershed.

There are two major transportation routes suited for heavy vehicles, both in the San Lorenzo River watershed. State Highway 9 is the major traffic route through the San Lorenzo Valley, while State Highway 17 skirts the eastern edge of the San Lorenzo watershed (see Figure 1-1). There are no major transportation routes in the North Coast watersheds. Empire Grade Road skirts the east boundary – and the west boundary of the San Lorenzo River watershed -- but is not as heavily traveled as Highways 9 and 17. The risk for spills is generally present, and several spills were noted by City staff including an event that resulted in a fish kill in Brookdale, near the Clear Creek and the San Lorenzo River, cars that had entered the creek near Lompico, and the application of fire-fighting foam some of which entered the creek during the wildfires described in Section 3.16.
The Santa Cruz County Hazardous Materials Area Plan was updated in January 2012, which summarizes how local agencies have planned, prepared, and will respond to such an event in Santa Cruz County. The document is an annex to the County Operational Area Plan describing how county resources will be utilized to deal with many different kinds of emergencies affecting the county. Any public safety official on scene can declare a hazardous materials incident, and should immediately call 911. The dispatchers at 911/NetCom (Santa Cruz Consolidated Emergency Communications Center) will route the call to the appropriate local agency. Depending on its size and significance, the incident could be handled by local fire departments, by specialized hazmat teams, or coordinated by an operational area Emergency Operations Center. County staff then preliminarily assess the nature of the contamination, how far it has gone, and whether it has entered a waterway. County staff will then request assistance from the CDFG if a waterway is affected and will directly notify the downstream water user if appropriate. City staff report that timely notification from the County is an ongoing area of concern and is not consistently performed in a functional manner (Chris Berry, personal communication, 2012).

3.14.1 San Lorenzo River Watershed

Within the town of Felton, there are three known ground-water contamination plumes which are seeping into the San Lorenzo River. These are the only sites known to be impacting stream water quality. They are under the jurisdiction of the Regional Board.

3.14.1.1 Valeteria Dry Cleaners (6539 Highway 9)

This site was identified when perchloroethylene (PCE) was detected in the San Lorenzo River in 1985 (0.5 µg/L). Further monitoring tracked the PCE, in 1988, to a spring near this dry cleaner shop. The source was determined to be contamination of soils in the dry cleaner’s septic system and leachfield originating during the 1960s. The owner conducted a remediation which included removal of sludge within the on-site waste disposal system, steam-cleaning the redwood septic tank, and backfilling with sand. The remediation proved insufficient, and the site was re-excavated in 2002 (U.S. EPA, 2002). The leachfield was then relocated and contaminated soil was exported. Groundwater monitoring results continue to show elevated PCE and TCE concentrations at a location approximately 20 feet upgradient of the San Lorenzo River, and downstream San Lorenzo River monitoring results also show low PCE concentrations. This suggests that the wastes released at the site have migrated, and may continue migrating downgradient. The responsible party is now required to submit a Corrective Action Plan to evaluate and select remedial alternatives for controlling groundwater contamination plume from further migration and impacting the river and for complete cleanup of the groundwater contaminations (Briggs, 2011). The Felton Diversion, which is about 1 mile downstream of the dry cleaner’s, has detected PCE as high as 1.7 µg/L on November 1, 2011 relative to an at-the-tap maximum contaminant level of 5.0 µg/L.

3.14.1.2 Chevron Underground Storage Tank Leak (6325 Highway 9)

A ground-water plume beneath this site caused by a leaking underground storage tank is contaminating a nearby seep to the river. Chevron has installed an interception sump which collects the seepage. In the seep, recent levels of total purgeable hydrocarbons have been measured at 67 to 7,400 µg/L and benzene has been measured at 2 to 1,700 µg/L, which were...
consistent with historical concentrations (Stantec Consulting Corporation, 2011). During dry weather, this system appears to be effective in intercepting much of the gasoline-contaminated ground water. During long wet periods, however, the effectiveness is limited. Monitoring occurs quarterly. Currently, Chevron is doing bi-weekly free product pump outs and high-vacuum groundwater extractions on a regular basis and is in the process of getting a commingled plume agreement with the Cornerstone property at 6320 Hwy 9, Felton. Until this is completed, Chevron will continue the groundwater monitoring (Tom Sayles, personal communication, 2012).

3.14.1.3 Sturdy Oil (former Exxon Station) Storage Tank Leak(s) (6225 Graham Hill Road)

The former Exxon Station near the Covered Bridge in Felton reported leaking conditions in 2000. A ground-water cleanup program was initiated, and, following a brief uptick in gasoline and MTBE concentrations in early 2005, this site is now deemed currently in compliance, with ongoing quarterly monitoring. The on site concentrations of MTBE has dissipated over time, due to the high solubility of MTBE in water, to non-detect concentrations. Residual MTBE concentrations have moved down-gradient and appear to be centered around an off-site monitoring well (Hydro Analysis, 2011). Cleanup will continue indefinitely, with quarterly monitoring. The site continues to be in compliance, and there is no indication of contamination within the stream network.

3.14.1.4 Other Sites with Potential Plumes

Watkins-Johnson operates an extraction and remediation program at its manufacturing facility next to Bean Creek in western Scotts Valley. Watkins-Johnson used a variety of chemicals in the manufacture of industrial furnaces and electronic parts. Past operations resulted in contamination of the underlying Santa Margarita sandstone with methylene chloride, chloroform, and TCE. The plume contributed TCE to Bean Creek. The site is overseen by the EPA and has an ongoing remediation system which consists of several pumping wells and treatment by granular activated carbon adsorption. The treated water is considered contaminant-free and is either recharged to the aquifer through a leach field, re-used on-site as non-process cooling water, or discharged to Bean Creek. In addition to monitoring the treated discharge, Bean Creek is monitored at one upstream and two downstream sites. Contaminants are now non-detectable in Bean Creek.

3.14.2 Other Watersheds

No ground-water contamination plumes are known in the other watersheds.

3.14.3 Significance

The existing County system is used to report and clean-up traffic accident and other surface spills. Notification of the downstream water user is part of the response process although it is inconsistent and City staff have made efforts to improve notification. Remediation actions have occurred at all four ground-water contamination sites and resulted in a lessening of the contaminant levels seeped to the river at three sites, and possibly at the fourth.
3.15 Geologic Hazards

The two main geologic hazards affecting the quality of drinking water in the study area are earthquakes and landslides. These, along with other infrequent or less challenging geologic hazards, are discussed in this section.

3.15.1 Seismic Events

Few areas of the state are as familiar with the effects of an earthquake on public water supply systems as Santa Cruz County. Santa Cruz County purveyors had to repair a substantial number of emergency main breaks and re-sanitize their distribution systems in the days immediately following the 1989 Loma Prieta event. Observed or potential effects on water supply sources include:

Significant changes in the flow of springs — The yield of Liddell Spring reportedly increased to about 8 to 10 mgd for two months following the October 17, 1989 earthquake and returned to normal, less than 2 mgd, in March 1990. The yield of the nearby quarry spring is reported to have doubled. Many other streams and springs in the region reported similar responses.

Source water quality may change — The mineral quality of most of the northern San Lorenzo tributaries changed noticeably following the 1989 event, and seem to be gradually returning to pre-event conditions. The bacterial pathogen levels of any of the surface sources can potentially change as surface soils and debris are dislodged and enter the stream system. This is particularly a risk with the sources emanating from karstic watersheds. Also, soils and surficial debris can be dislodged by seiches (waves in lakes generated by earthquakes or landslides), and enter Loch Lomond.

Constituent release from reservoir-bottom sediments — While not reported after the 1989 earthquake, other earthquakes could potentially cause the release of gases, pathogens, and oily substances, all of which were observed in Searsville Lake near Palo Alto following the 1906 earthquake (Lawson and others, 1908).

3.15.2 Significance

Seismic events are a significant potential source of contamination and structural damage to existing water supply systems throughout the project area. The ability of treatment plants to anticipate and respond to damage to their own facilities, while also responding to fluctuating water quality and quantity, is a critical factor in the overall management of drinking water in the project area.

3.15.3 Landslides and Other Major Slope Instabilities

Landslides are prevalent throughout the Santa Cruz Mountains, and particularly in the San Lorenzo Valley. Nonetheless, the SCWD and other purveyors have been quite successful in maintaining continuity of service and in avoiding the elevated turbidity and other water quality problems associated with landslides upstream of water intakes. This record reflects, in part, an awareness of the chronic landslide hazard which prevails throughout the subject watershed, and the judgment of senior staff of the purveyors in avoiding water sources which are especially prone to landslides. Large slope instabilities, including landslides, do occur periodically within...
the subject watersheds, and are expected to keep recurring. Specifically, a landslide was reported in the Loch Lomond watershed in 2006.

Landslides constrain local water systems well beyond concerns over turbidity. Sediment entering the channels limits habitat values, that can result in regulatory burdens including need for greater in-stream flow, change in release timing, and other water agency action that can limit water availability in the long-term. For example, the sandy material which has been entering Bean Creek for the past 20 years from the Mount Hermon slide does not appear to elevate turbidities either at the Felton Diversion or at Tait Street at low flows, although the sandy sediment does complicate and add to the cost of diversions and causes other critical environmental damage in addition to the related bed sedimentation and loss of aquatic habitat value. Hence, landslides might be seen as constraining water supplies both when (and just after) they occur as well as during the subsequent period when habitat is impaired downstream - generally the following spring(s) and summer(s), when water may not be divertible because it is needed to sustain sufficient habitat.

During the past several decades, there have been a number of very large landslides along nearby streams in settings similar to those which prevail near certain intakes. In addition to the Mount Hermon slide, and Bean Creek slides in general, two examples are:

**Baldwin Creek** — A very large rock fall completely dammed and impounded Baldwin Creek. Based on observations made by project staff in 1968, the rockfall may have occurred during the prior 10 or 20 years. The setting in which this rockfall occurred is very similar geologically to those found near the Majors Creek intake and along Laguna Creek downstream of the intake.

**Love Creek Landslide** — In January 1982, a landslide occurred in moderately dipping fractured Monterey shales, such as occur upstream of a number of other areas west of Highway 9 between San Lorenzo Valley High School and Boulder Creek.

No known landslides or slope instabilities have been reported by SLVWD or LCWD staff.

### 3.15.4 Weather-related Events

Occasional major wind storms or snow falls can introduce a very large amount of organic debris to the watersheds upstream of the intakes. For example, a snowstorm during the first week of January 1974 broke off an astounding number of branches, mainly of oaks and other hardwoods, many of which fell directly into the stream system and decomposed in place. Access to intakes was greatly inhibited for a period of several days to a week or longer.

### 3.15.5 Significance

Landslide and slope failures are common occurrences in the Santa Cruz Mountains. The greatest potential impact is at points of diversion and immediately upstream. Major landslides may occur as a result of seismic activity and/or rainfall throughout the subject watersheds and it can be difficult to differentiate weather related impacts from landslides as they often occur in similar time periods. Damage to intakes and stream channels in their vicinities may render such facilities inoperable from a period of days to several weeks. In the case of several smaller purveyors, such an occurrence could prevent the delivery of treated surface water to their service areas.
3.16 Fires

Wildfire has long been both a natural occurrence and land management tool along the coast and in the Santa Cruz Mountains since the earliest inhabitants arrived between 30,000 to 10,000 years ago. Native inhabitants used fire to burn off scrub and grasslands to facilitate acorn gathering and to foster the growth of seed-bearing annuals. Logging operations in the late 1800's to the early 1900's also relied heavily on fire to reduce slash piles and to clear acreage for conversion to grazing and homesites. Evidence of this can be seen throughout the subject watersheds as fire scars on old growth redwood stumps. See Figure 3-4 for locations of potential fire hazard area within the San Lorenzo Valley and North Coast Watersheds.

The California Department of Forestry and Fire Protection (CalFire or CDF) is responsible for fire suppression and management in State Responsibility Areas (SRAs) and the Santa Cruz County Fire jurisdiction. Outside of SRAs, local governments typically have jurisdiction, e.g., fire districts in Boulder Creek, Felton, Ben Lomond, Zayante, and Scotts Valley. Since the last watershed survey, there have been five major wildfires in Santa Cruz County:

Summit Fire — The Summit Fire burned approximately 4,270 acres of the upper watersheds of Corralitos, Browns, Soquel, and Uvas Creeks on May 22-27, 2008.19

Martin Fire — The Martin Fire burned approximately 520 acres in the Laguna Creek and San Vicente Creek Watersheds, mostly within the Bonny Doon Ecological Reserve, on June 11-16, 2008. Post fire monitoring by the City indicated the expected increased sediment load but no other impacts. It should be noted that there may be subsurface connectivity through the karst from the Martin fire location into the Liddell watershed.


Lockheed Fire — The Lockheed Fire burned approximately 7,900 acres of the upper watersheds of Scotts and San Vicente Creeks on August 12-23, 2009.

Loma Fire — The Loma Fire burned approximately 485 acres near Maymens Flat on October 25-27, 2009 which is south of the watersheds area.

19 Strudley and others (2010) monitored post-Summit Fire bed conditions and found very little discernible change throughout the Corralitos-Browns Creeks watershed. Our data suggest that while the Corralitos-Browns Creeks watersheds have not yet responded in an appreciable way to any increase in sediment availability and mobilization that the fire may have engendered, some modest changes have occurred in the upper Soquel Creek watershed. The lack of geomorphic response at most of the monitoring sites in these streams is largely attributable to the following: (1) The Water Year 2009 winter was relatively gentle, with minimal rainfall that fell late in the season and storm intensities not often exceeding thresholds capable of causing heavy rilling and transporting sediment in the channel systems. Although WY 2010 was much wetter than WY 2009, the conditions in 2009 set the stage for early and rapid “healing” of the upper, burned watershed areas. The lack of significant and protracted rainfall events during the WY 2009 winter made sediment mobilization and delivery less efficient, with the storage of fire-borne sediment likely retained in-situ, in unchanneled valleys above the headwaters, or in the uppermost reaches of the channel networks. Only during the most intense events of WY 2010 were the mobilization of this material into our uppermost monitoring site on East Fork Soquel Creek detected.
Following the 2008 fires, the CalFire San Mateo-Santa Cruz Unit, RCD for San Mateo County, and Santa Cruz County developed the Community Wildlife Protection Plan (CWPP), a strategic plan identifying risks and hazards associated with wildland fires in the wildland urban interface (WUI) based on input from local stakeholders and the general public and adopted by the Board of Supervisors for both counties (CALFIRE and others, 2010). The plan identifies some critical resources such as Lexington Reservoir but omits Loch Lomond and makes recommendations aimed at preventing and reducing both infrastructure and ecosystem damage associated with wildland fires. Fuel reduction projects identified in the CWPP receive priority for federal funds. The funding is made available primarily through the California Fire Safe Council’s grant clearinghouse. The Fire Safe Council (FSC) provides resources for local communities to form their own FSC. Since 2008, the Soquel, South Skyline, and Bonny Doon FSCs have formed, each of which has submitted roadside and neighborhood shaded fuel breaks project proposals to the CWPP. Fire management in the region is primarily done on a small-scale, working with FSCs and landowners on projects to reduce fuels and create defensible space.

The City has taken several steps to address fire hazards within Loch Lomond and other watersheds that may fill gaps in the CWPP. The City has a draft fire plan for watershed properties and routinely meets with fire chiefs to review maps, keys, gates and field conditions, ensuring access to City watershed property for fire suppression and minimizing wildfire hazards. Additionally the City installed a weather station at Loch Lomond to aid in decisions of how to prepare for potential fire.
3.16.1 San Lorenzo River Watershed

The San Lorenzo watershed contains substantial areas of fire-adapted vegetation, reported to burn at historical intervals of typically 40 to 80 years (Hecht and Kittleson, 1998). Several fires occurred in the 1930's and 1940's, with a large fire known as the Sawmill Fire in the 1950's. One other fire of note was the Love Creek fire in 1970. Numerous small fires occur every year, yet in total, they have not had much impact on reducing total fuel load. The potential for a large-scale fire with multi-year consequences for water supply remains.

3.16.2 Loch Lomond Reservoir and the upper Newell Creek watershed

No significant fires were noted in the Loch Lomond watershed since 1959, which burned about 1,000 acres on both sides of the lake. Evidence of this fire can be seen on the east side of the lake, where numerous snags have been left to tower above the regrowth.

3.16.3 North Coast Watersheds

Brushfires in the North Coast watersheds have occurred periodically, both by human sources (i.e., arson, prescribed burns) and lightning fires. The Martin Fire was predominantly fuel-driven, and March through June rainfall amounts were the lowest ever recorded for the area, about eight percent of normal (Gordon and Ferreira, 2009).

3.16.4 SLVWD

There have been no recent fires within the SLVWD subwatershed lands.

3.16.5 LCWD

There have been no recent fires within the LCWD watershed lands.

3.16.6 Significance

There are three issues related to fire in the subject watershed.

First and foremost, the absence of wildfire increases the chance of a major event which could seriously alter surface hydrology and sedimentation in any or all subject water supply streams. Elevated levels of turbidity are likely to persist from several months to several years following an extensive fire. Only part of this time will levels remain elevated above 10 to 25 NTUs, a rule-of-thumb threshold range above which reliable water treatment becomes more challenging. Because turbidities persist much longer in reservoirs than in springs or run-of-the-stream

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20 Following the fire, CDF master sawyers have felled hazard trees killed by the Western Pine Beetle, and Ben Lomond Camp (BLC) crews have restored and re-marked the trails, and uprooted acres of invasive, fire-prone, nonnative broom. Contractors have also been working on redoing the Reggiardo Creek crossing, and BLC crews and local volunteers are maintaining the shaded fuel breaks that enabled firefighters to battle the fire (http://www.bonnydoon.got.net/11-11_hlndr.html).
diversions, post-fire turbidity persistence may prove to be more challenging for the SCWD, which draws heavily upon Loch Lomond Reservoir during the summer. Experience with major floods or fires has shown that reservoirs of similar size can remain turbid throughout the summer (or two) following an extensive burn or other disruptive event. Soulajule Reservoir, in Marin County, sustained turbidities in excess of 50 NTU for the entire summer following the January 1982 storm. Data collected following the October 1961 fire in the Uvas Creek headwaters indicate much-increased sediment yields. Uvas was high in sediment following the fire and was not available for use as a municipal water supply for several months following the fire.

Second, fire suppression activities include creation of temporary roads and firebreaks that can be a source of persistent sedimentation and turbidity if not properly abandoned following fire events. Recent philosophies with post fire restoration has avoided traditional reseeding of burned slopes and mulching exposed soils because of changes to the vegetation community that result in reduced biodiversity and potential for a more fire prone landscape in the future. Therefore, the use of erosion control techniques are balanced against the potential for significant erosion to occur following a wildfire.

Third, fire retardants may also have adverse effects on water quality. Historically, retardants used by CDF have included borate salts and bentonite clay in water. Borate salts are long lasting, but they are also phytotoxic and soil sterilants. Bentonite clay is less persistent. Use then shifted to ammonium-based fire retardants, which as a group accounted for nearly all chemical retardants used to control wildland fires. The retardant now used by CalFire is Phos-Chek, which is a dry powder made of diammonium sulfate and ammonium phosphate that gets mixed with non-potable water at the air attack base (Hollister, San Andreas, or Sonoma) and then dropped by fixed-wing airplanes along ridgelines or other control points to retard the fire from spreading (Angela Bernheisel, personal communication, 2012). If the retardant is applied directly to stream surfaces, it may cause fish mortalities (Buhl and Hamilton, 1998) and alter aquatic conditions by elevating nitrogen and causing eutrophication downstream (Camp and others, 1996). However, CalFire avoids drops along water courses (Angela Bernheisel, personal communication, 2012).

Fire suppressant foams applied by fire trucks and helicopters may have adverse impacts on water quality, and are more toxic to aquatic biota than the ammonium-based fire retardants (Gaikowski and others, 1996). Application requires leaving a buffer between the spray zone and live streams. Studies by the US Forest Service have shown that the water quality impacts of these materials vary with three elements: the characteristics of the application (i.e., how much dropped and where), the characteristics of the site (steepness, vegetation types, extent of riparian stream cover), and the characteristics of streamflow (higher, turbulent flows result in better mixing, dilution, and reduced toxicity to aquatic life). In general, it can be said that adverse water quality impacts decrease as the distance of application from a stream increases.

The inevitability of a major wildfire has been echoed by state, county and local natural resource managers. When a major fire does occur, water resources may suffer immediately and significantly as homes, roads and infrastructure are rebuilt. In subsequent years, the water utilities will likely see a decrease in turbidity and sedimentation, as vegetation becomes re-established and reconstruction activity decreases. Hulda McLean, a former County supervisor and owner of Rancho Los Osos in lower Waddell Creek, emphasized the importance of turbidity persistence after the 1948 Pine Mountain fire by noting that it took five years before Waddell...
Creek ran clear at any time during the winter months – a lesson on the effects of a watershed-scale fire. (Hecht and others, 2011)
SECTION 4: WATERSHED MANAGEMENT AND CONTROL PRACTICES

4.1 Introduction

This section summarizes existing policies and control measures of the various entities which manage, control or influence land and resource use in the San Lorenzo and North Coast watersheds. The control measures discussed in this section are those watershed management practices that may impact water quality of the San Lorenzo River and its tributaries, as well as the SCWD’s water supply on the North Coast.

The following sub-sections, which in large part follow the structure of the AWWA Watershed Sanitary Survey Guidance Manual, are included in Section 4:

- Water Utility Management Practices
- Jurisdiction and Population
- Watershed and Reservoir Management Practices
- Watershed Lands Acquisition
- Inspection and Surveillance of the Watersheds
- Key County Watershed Management Activities
- Watershed Control Authority
- The County General Plan and Local Coastal Program (LCP)
- Wastewater Discharge
- Stormwater Regulations
- Mines and Quarries
- Animal Keeping Regulations in Santa Cruz County
- Recreation Activities and Policies
- Open Space Policies
- Erosion Control/Soil Management Policies
- Roads
- Fire Management
Some of these sub-sections have changed since completion of the 1996 sanitary survey and the 2001 and 2006 updates (Watershed and Reservoir Management Practices, Watershed Lands Acquisition, Key County Watershed Management Activities, and Animal Keeping Regulations). The details of the remaining sub-sections have not changed since those reports and are thus only summarized in the present sanitary survey. Table 4-1 lists the general policies and practices that impact water quality in the project study area and summarizes their effectiveness. Generally, there appears to be a comprehensive group of regulations, policies, and practices in place that can be used to effectively manage watershed activities. Figure 1-1 shows the primary watershed and subwatershed boundaries, as well as the locations of the drinking water utilities. The County GIS system has numerous layers which can be used to identify the locations of specific uses within the approximate boundaries shown in Figure 1-1 (e.g., open spaces, water district boundaries).
### Table 4-1: Updated Summary of Policies and Practices which Impact Water Quality

<table>
<thead>
<tr>
<th>Agency/Utility</th>
<th>Primary Watershed Objective</th>
<th>Policies or Controls which Impact Water Quality</th>
<th>Effectiveness of Policies and Practices</th>
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</table>
| Water Utilities – notably City of Santa Cruz Water Department and San Lorenzo Water District | • Protect drinking water supply.  
• Protect water quality of drinking water sources and manage to minimize quality change.  
• Manage to avoid microbiological and chemical contamination.  
• Manage drinking water source areas for environmental quality.                                                                                                                                                                                                                                                                               | • Control or disallow public access to watershed lands.  
• Manage secure intake structures.  
• Implementation and growth of the Watershed Protection Program.  
• Advocacy and environmental review of proposed projects in watershed lands.  
• Conservation easements on private lands.                                                                                                                                                                                                                                                                                              | • Watershed Resources Management Program is resulting in the collection of valuable data which are used to plan for more effective lands management.  
• Continued success in working with other agencies/groups on projects which enhance water quality protection measures.  
• Increased patrolling of source facilities is helping to minimize impacts associated with trespassing and illicit land use.                                                                                                                                                                                                 |
| Santa Cruz County (e.g., Parks, Health Services Agency, Planning Department)    | • General Plan established a regulatory approach to plan future development.  
• Regulate septic systems.  
• Protect riparian and wetland systems.  
• Regulate erosion control practices.  
• Regulate small water systems.  
• Provides for open space access.                                                                                                                                                                                                                                                                                                                    | • County General Plan.  
• Ordinances for Erosion control, water quality control, riparian corridor/wetlands protection, sensitive habitat  
• Surveillance of parks.  
• Control illegal or mis-implemented grading, development and dumping.  
• Reduce nitrates, pathogens and sediment in streams.  
• San Lorenzo River Watershed management plan.  
• County Forest Practice Rules.  
• Wastewater/Nitrate management plan.                                                                                                                                                                                                                                                                                                      | • Grading/erosion control ordinance can be too cumbersome to small homeowners or small projects.  
• Exceptions to ordinances often granted.  
• San Lorenzo Watershed management plan is well thought out and presents tangible recommendations for betterment of water quality.  
• Turbidity, nitrate and pathogen monitoring in support of the 303(d) impairment listing is providing needed data to track trends and responses to implemented projects.  
• Insufficient staffing has been exacerbated by budget cuts.                                                                                                                                                                                                                                                                               |
| California Dept. of Forestry and Fire Protection (Cal Fire, formerly CDF)       | • Suppress wildland fires (fire protection division).  
• Control logging (resource management division).                                                                                                                                                                                                                                                                                                               | • Prescribed burning to minimize impact of larger fires.  
• Require Timber Harvest Plans for logging of more than 3 acres.  
• Monitor and enforce forest practice rules.  
• Coordinate fire fighting efforts.                                                                                                                                                                                                                                                                                                        | • Several wildfires have occurred in the area in 2008 and 2009 as discussed in Section 3.16.  
• Excessive fuel levels and substantial urban/rural interface area could result in severe wildfire.  
• Harvest Plans are comprehensive, though follow through, especially in critical years after the harvest is often not sufficient.  
• Some harvests cause roadway erosion.  
• Timber harvest plan rules should provide water quality protection.                                                                                                                                                                                                                                                                  |
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</table>
| California State Water Resources Control Board and the Regional Water Quality Control Board - Central Coast Region (SWRCB and RWQCB) | • Adopt area-wide water quality control plans (Basin Plans).  
• Control/coordinate water quality issues.  
• Control quality and quantity of discharges from wastewater treatment facilities and construction activities. | • Enforcement power to issue permits with specific water quality requirements.  
• Enforcement power of State Water Code.  
• Issue NPDES permits to specific entities for waters-of-the-state discharges.  
• Establish water quality objectives.  
• Impaired Water Body listings and Pathogen, Nitrate and Sediment TMDL for San Lorenzo River.  
• Provide some funding for septic tank system improvements.  
• Administering Phase II NPDES and Construction Stormwater regulations. | • Regional Board is coordinating with County’s efforts to reduce nitrates. Approved nitrate TMDL and Sediment TMDL in 2000 and 2003, respectively.  
• Pathogen TMDL approved in 2009.  
• Implementing programs to emphasize watershed protection from both point and non-point discharges.  
• Regional Board was more active in the review of Timber Harvest Plans and attendance pre harvest inspections from a water quality perspective in the years prior to 2007 but activity appears to have declined in recent years.  
• Implementation of Stormwater Management Plan for county and cities under Phase II NPDES permit |
| California Department of Fish and Game (DFG)                                   | • Protect fish and wildlife.  
• Permit diversions from waterways. | • Enforcement power of state code.  
• Limit diversions from waterways.  
• 1600 permits now require CEQA review.  
• Fisheries Restoration Grants Program is viable mechanism for drinking water source protection. | • DFG has specific regulations to control water quality.  
• DFG is not well organized or setup to enforce applicable water quality regulations because game wardens are police rather than scientists.  
• Staff turnover may limit effectiveness. |
4.2 Water Utility Management Practices

The SCWD, the SLVWD, and the California Department of State Parks are the largest watershed property managers in the project area; however, several of the smaller water purveyors own and/or manage land adjacent to their wells, springs and surface water intakes. Watershed management practices vary for each utility agency. The SCWD, for example, manages its lands to maintain optimal water quality and to limit recreation at the Loch Lomond Reservoir. SLVWD also manages its watershed lands, through administration of their Watershed Protection Plan, to maintain optimal water quality, limit access, and minimize potential land disturbances.

4.2.1 Jurisdiction

The jurisdictional area of this sanitary survey is within Santa Cruz County. Within the sanitary survey watersheds, the City of Santa Cruz serves the Pasatiempo and Sycamore Grove areas. The other water utilities participating in the Sanitary Survey are located in the San Lorenzo River watershed and are in unincorporated portions of Santa Cruz County, except for a portion of the middle Bean Creek watershed within the City of Scotts Valley. Most of the City of Scotts Valley drains to the San Lorenzo River via Carbonera Creek and Branciforte Creek, which flow

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</table>
| Cal-Trans and County Public Works | • Construct and maintain primary and secondary roadways.  
   • Respond to accidents and landslides.  
   • Design of drainage systems and in-stream habitat improvements | • Minimize herbicide use.  
   • Avoid dumping debris into streams from roads projects.  
   • Quick response to chemical spills. | • Storage, sidecast, and transfer of roadway debris can lead to increased sediment in streams.  
   • Endangered Species Act requirements may improve road practices.  
   • Implementing projects which improve in-stream salmonid habitat and riparian habitat in conjunction with roads projects. |
| National Marine Fisheries Services (NMFS or NOAA Fisheries) | • Protection-restoration of special status species (Coho Salmon and Steelhead Trout) in the San Lorenzo and North Coast watersheds. | • Implement and enforce the Endangered Species Act (ESA). | City of Santa Cruz issued a draft Habitat Conservation Plan for steelhead and coho to address ESA related issues related to operations of the City’s water facilities.  
   • Sediment reduction will improve turbidity.  
   • Potential source loss from the north coast surface sources through ESA compliance will result in a degradation of the City’s raw water supply quality. |
| United States Fish and Wildlife Service (USFWS) | • Protection-restoration of special status species (Red-legged Frog, etc.) in the San Lorenzo and North Coast watersheds. | • Implement and enforce the Endangered Species Act. | City of Santa Cruz is presently engaged in ESA related negotiations as a part of the City’s draft Habitat Conservation Plan.  
   • Sediment reduction will reduce turbidity.  
   • Potential source loss from the North Coast surface sources through ESA compliance may result in a degradation of ambient City water supply quality. |

Table 4.1
Updated Summary of Policies and Practices which Impact Water Quality
into the San Lorenzo River below the SCWD Tait Street Diversion. This portion of Scotts Valley shares most watershed management issues with the San Lorenzo Valley but was not part of the 2012 watershed sanitary survey.

4.2.2 Watershed and Reservoir Management Practices

4.2.2.1 City of Santa Cruz Water Department

The SCWD owns watershed land in the Newell Creek (2,880 acres), Zayante Creek (880 acres), and Laguna Creek (240 acres) watersheds. The SCWD has developed a comprehensive watershed management program, in part, to manage City-owned lands for water-quality protection. The primary objective of the water resources management program is to focus on environmental compliance on the part of the City with applicable State and Federal regulations. In addition to the primary charge of the program, some effort is spent reviewing and commenting on plans which if implemented may impact City water resources, and assisting the Santa Cruz County Resource Conservation District with public outreach and education. The SCWD now employs five staff (three full-time and two part-time/temporary) to implement this program. In addition, the Recreation and Water Resources sections have merged into a Watershed section to better coordinate the activities at Loch Lomond with resource protection. One of the activities in process is a recreation area study at Loch Lomond. The SCWD has conducted a watershed lands assessment of natural resources in order to make more informed decisions regarding management of watershed lands for water quality and quantity protection and protection of special status species and their habitats. In addition, the SCWD partnered with the Santa Cruz RCD in a program for watershed identification and signage at creek crossings and have educational outreach programs to the San Lorenzo Valley schools.

The Loch Lomond Recreation Area (LLRA) is managed for water quality as well as recreational benefits. One of the most significant reservoir management changes since the 2001 sanitary survey update is management of blue-green algae (cyanobacteria) blooms at Loch Lomond through the use of PAK 27™ – a non-copper-based algaecide. PAK 27™ is characterized as an environmentally safe algaecide/algaestat which produces oxygen and hydrogen peroxide by-products, neither of which are reported to be harmful to aquatic species, such as fish, or other forms of algae, such as green algae or diatoms. However, it is also important to consider that a recent ruling by the State Water Resources Control Board grants the City of Santa Cruz an exception for the use of copper-based algaecides, if the need arises (General Permit No. CAG990005). In addition to blue-green algae management, wastewater is trucked out of the recreation area, human body contact recreation is not allowed at the reservoir, and no cattle or horses are permitted in the watershed.

4.2.2.2 San Lorenzo Valley Water District

The SLVWD service boundaries encompass 37,120 acres in the San Lorenzo Valley watershed, including a small portion of the Pescadero drainage which is northwest of the San Lorenzo River watershed. Watershed lands owned by the SLVWD include approximately 1,000 acres in one continuous piece on Ben Lomond Mountain, around the tributaries of the San Lorenzo River that supply the SLVWD’s surface water (Clear Creek, Sweetwater Creek, Peavine Creek, Foreman Creek, and Silver Creek), and in the Malosky Creek and Harmon Creek drainages. The SLVWD also owns approximately 126 acres in the recharge area of its Olympia wellfield.
Marked trails on these watershed areas are used by horse riders. In early 2012, SLVWD initiated a formal agreement with the Santa Cruz Land Trust to provide patrol service. The primary concerns continue to focus on trespassers and off-road vehicles. Public access is limited.

Timber harvesting continues to not be permitted on SLVWD watershed lands. No pesticide/herbicide use is permitted on SLVWD lands.

### 4.2.2.3 Lompico County Water District

Although LCWD does not own lands within the Lompico Creek watershed, about 500 acres is now under the ownership of Sempervirens Fund which seeks to transfer guardianship of the lands to LCWD. In addition, LCWD has been deeded some riparian lands from nearby private landowners as the lands are not developable.

### 4.2.3 Watershed Lands Acquisition

The SLVWD purchased the 188-acre Malosky Creek property from Sempervirens Fund in 2006. This property had been on the District’s list of most wanted watershed acquisitions for years. The District’s 5-mile long pipeline crosses the property. As part of the transaction, the SLVWD agreed to retire the timber rights on the property. The SLVWD has had a no-commercial logging policy on its watershed lands since the 1980s.

SLVWD acquired the Felton Water System from California-American Water Company in 2008 which also included about 252 acres in the Fall Creek watershed that supply the Felton water system.

In addition, as discussed in the Executive Summary, the acquisition of the 8,532 acres of CEMEX lands on the North Coast watersheds by a number of land preservation organization has resulted in protection of water quality, particularly for the community of Davenport.

### 4.3 Inspection and Surveillance of the Watersheds

Inspection and surveillance of watershed lands in the project area are performed by numerous agencies, depending on ownership and type of use. For example, State Parks regulations are enforced by Parks staff. County Parks, like Quail Hollow County Park (about 300 acres), are managed by County Parks personnel. Surveillance of the purveyor-owned watershed lands is conducted by the water purveyors themselves. In addition, the City has recently increased funding for patrols in the Pogonip Preserve open space area upstream of the Tait Street diversion as well as acquiring conservation easements which have expanded the ability to monitor and control activities. The remainder of the project area is under the jurisdiction of Santa Cruz County.

Within the Loch Lomond watershed, the City has instituted a comprehensive security program that includes installing cameras, fences, and gates on the City’s portion of the watershed and increased patrols. The City has also installed a weather station at Loch Lomond to improve preparation for fire.
The County of Santa Cruz’s Planning Department, Health Services Agency, and Department of Public Works develop and enforce water-quality related county ordinances and provide review and permitting of development plans, timber harvest plans, erosion control plans, quarry plans, and maintenance of county roads. The Santa Cruz County Fire Department and the Office of Emergency Services participate in the development of fire-related development standards and post-fire restorations efforts, in addition to the review and updating of the countywide Disaster Contingency Plan and Critical Fire Hazard Maps.

4.4 Key County Watershed Management Activities

As previously mentioned, Santa Cruz County developed a comprehensive management plan for the San Lorenzo River watershed in 1979. The San Lorenzo River Watershed Management Plan was updated in 2001 through a collaborative process with the Regional Board, a citizen and landowner group, and other agencies. The ongoing efforts by the County and the completed update to the watershed management plan underscore the continued efforts of the County to implement practices, programs and ordinances which aim to improve water quality in the San Lorenzo River watershed. Pertinent efforts and data from those efforts will be used for the purposes of this report to summarize water quality and watershed management activities in the San Lorenzo River watershed.

4.5 Watershed Control Authority

Policies and control measures adopted by the governmental agencies are described in this subsection. All the watersheds in this area are located in Santa Cruz County, and are therefore subject to the policies adopted by the County General Plan. Key goals and policies outlined in the General Plan are described below.

4.5.1 The County General Plan and the Local Coastal Program (LCP)

The 1994 Santa Cruz County General Plan and the Local Coastal Program (LCP) is a combined planning document that serves two primary purposes and have not been updated since the 2006 watershed sanitary survey. First, it establishes a regulatory framework against which all proposed development is measured. Second, it serves as a vision statement for the desired future of the county. The General Plan was prepared to meet the requirements of both the State Planning Laws and the Coastal Act.

The General Plan sets up numerous goals, objectives, policies, and programs related to the protection of water resources and sensitive habitats. The County adopted an ecosystem approach while drafting ordinances pertinent to water quality concerns. In other words, there is a clear understanding that by preserving and enhancing the natural systems of the county, a secure and safe drinking water supply will most likely be obtained. General Plan elements that contain goals most pertinent to the protection of water resources are as follows: Chapter 5 - Conservation and Open Space, Chapter 6 - Public Safety and Noise, and Chapter 7 - Parks Recreation and Public Facilities. The General Plan Conservation and Open Space, Public Safety and Noise, and Parks and Recreation and Public Facilities elements have not been updated since 1994.
4.5.2 Wastewater Discharge

Wastewater discharge requirements for point source discharges from wastewater treatment plants or from industrial facility plants directly to receiving streams are established through National Pollutant Discharge Elimination System (NPDES) permits administered by the Regional Board under the federal Clean Water Act. These NPDES permits control the discharge by establishing numerical effluent limitations for specific constituents and parameters which the treatment plant or industrial facility must meet. The constituents for which effluent limitations are established are specific to the type of discharge. Suspended solids and coliform bacteria may be regulated, depending on the type of plant or facility. Each NPDES permittee collects data which it reports to the Regional Board on a regular basis. This self-monitoring data demonstrates compliance status with the specific effluent limitations.

Wastewater discharges to septic systems are regulated by the County within guidelines established by the Regional Board. Although no changes have been made to the County Sewage Disposal Ordinance, policies have been adopted to provide for tighter oversight and maintenance of alternative technology systems. In addition, a State-revolving fund was historically used to promote the use of such systems through a low-interest loan program. However, this loan program is no longer available. The County's comprehensive Wastewater Management Program have served as a model for draft statewide wastewater management scheduled for adoption by the State Water Resources Control Board in 2012.

The SWRCB's proposed state-wide septic regulations under AB 885, detailed in Section 4.9.2.4, will provide some strengthening of local septic regulations, particularly within the area 2,500 ft upstream from a surface water intake.

4.5.3 Stormwater Regulations

Municipalities with populations greater than 100,000 and certain classes of industries (including construction sites which involve a land disturbance of more than 1 acre) are regulated under the NPDES Phase I permit program administered by the Regional Board. Municipal permits are specific and individual to the municipality in question, but all contain provisions for management of specific activities (e.g., construction, new development planning, industries, illicit discharges, public agency activities such as street sweeping and public education) and for monitoring. Certain classes of industries are required to file a Notice of Intent (NOI) to comply with the provisions of the State General Industrial Stormwater NPDES Phase I Permit. The industry makes this notification to the SWRCB and, thereafter, is expected to comply with the general permit provisions which focus on pollution prevention and good housekeeping measures. Construction sites with a land disturbance greater than 1 acre must file a NOI with the SWRCB to comply with provisions of the state General Construction Activities Stormwater NPDES (Order No. 2009-0009 DWQ). This permit focuses on sediment control and waste management. The SWRCB maintains a database of industries and construction sites which have filed NOIs.

The County of Santa Cruz and the City of Santa Cruz have each completed and submitted a complete Phase II NPDES application to the Regional Board, and the Regional Board approved their submitted Storm Water Management Plans in 2009. The County and City both require construction phase and post-construction phase erosion control plans for construction projects.
encompassing an area of less than 1 acre and for which grading is part of the construction plan. The plans typically must include best management practices (BMPs) which protect against illegal discharge of pollutants to the creeks and streams in the project area. The Phase II regulations provide support for existing County and City ordinances which establish the criteria for protection of water quality and natural resources.

In addition, in April 2012, the County adopted a Stormwater Ordinance (Chapter 7.79) that will prohibit any non-stormwater discharges or discharge of any material that could cause pollution,

4.5.4 Mines and Quarries

Surface discharges from both active and inactive mines to receiving streams are regulated by the Regional Board under the Waste Discharge Requirement permit program. Permit conditions for discharges from active mines usually allow only inert or non-hazardous waste releases. Mines typically meet these requirements by implementing various best management practices.

Regulation of mine and quarry operations in the watershed study area is covered under the County Mining ordinance. Mineral Resource Areas are designated by the State Geologist and State Mining and Geology Board. The County classifies these areas as within the County Mineral Zone Extraction District (M-3) and requires environmentally sound quarry operations and reclamation practices in accordance with the state Surface Mining and Reclamation Act (SMARA), which emphasizes the primacy of post-reclamation uses and the need to plan and limit mining to be compatible with such uses. Development on M-3 lands is restricted to mining and other compatible uses. Compliance with the California Environmental Quality Act (CEQA) for mining operations is required. Mining operations adjacent to riparian corridors must be conducted in accordance with the Riparian Corridor and Wetlands Protection ordinance. Quarry operations are overseen by the County Planning Department Quarry Coordinator. There have been no changes made to the County Mining Ordinance since completion of the 1996 sanitary survey, the 2001 update, or the 2006 update however a karst protection zone ordinance is under consideration.

The Santa Cruz County Water Advisory Commission is currently working on development of specific development standards for areas of the county where such activity would be especially threatening to water resources and associated biotic values due to the unique complexity of karst systems. These standards would be especially relevant for the municipal water source at Liddell Spring which has historically suffered impacts associated with mining of limestone adjacent to the spring. Proposed development standards include but are not limited to mining separation from groundwater, distance limits on placement of onsite wastewater disposal systems and related standards.

4.5.5 Animal Keeping Regulations in Santa Cruz County

The County of Santa Cruz does not currently have a specific ordinance regulating domestic and confined animals in residential and rural areas. General animal keeping and breeding regulations, however, are outlined in the County Code under Chapter 13.10, Part VI, Article IV (animal regulations). The Article provides regulations for animal enclosures (stables and paddocks), care of animals (animal hospitals and kennels), animal keeping (horses, cows,
sheep, etc.) different types of animal raising (family raising, poultry, bird, turkeys, etc.) and biomedical animal operations.

At the time of the 2001 sanitary survey update, the County of Santa Cruz made efforts to outline new recommendations for the management of horses and farm animals with the intent to minimize nitrogen, sediment and contaminant concentrations in effluent discharged from stable and paddock areas. These recommendations were formally outlined in the 2001 San Lorenzo River Management Plan update. After meeting with stakeholders, however, it was agreed that the County would not formally enact these recommendations through development of a County ordinance, but would instead pursue an approach of education, technical assistance and voluntary compliance with horse and animal keepers. In implementing the proactive approach, the Santa Cruz County Resource Conservation District received a Clean Water Act Section 319(h) grant in 2001 to work with the Santa Cruz County Horsemen’s Association to improve stable and paddock management techniques for the betterment of creek, stream and groundwater water quality. One hope of the voluntary approach is that landowners will maintain manure piles and paddock areas at least 50 to 100 feet away from streams or smaller drainages, and minimize surface flow connectivity from manure piles and paddock areas to streams or smaller drainages. Additional information regarding more recent activities of these voluntary programs is described in Section 3.6.

4.5.6 Recreational Activities and Policies

Agencies which administer the recreational and open space areas in the watershed study area include the County Parks Department, the Boulder Creek Recreation and Park Department, the State Department of Parks and Recreation, and the SCWD. Management policies in the SCWD’s Loch Lomond Recreation Area were previously described in Section 4.2.2. Overall, recreational policies and open space policies in the watershed are described in the County’s General Plan. Since the General Plan has not been updated since 1994, recreational policies and open space policies have not changed since completion of the 1996 sanitary survey and the 2001 and 2006 updates.

The County Health Services Agency continues to routinely monitor creek and river swimming areas in the San Lorenzo Valley for fecal coliform bacteria. This monitoring is conducted to obtain information on when to issue advisories avoiding swimming areas, and is part of larger County-wide program. The State parks in the watershed study area are essentially open spaces. The County General Plan promotes cooperation with state activities and specifically encourages expansion of state ownership at the Fall Creek and Henry Cowell park units.

4.6 Open Space Policies

The Santa Cruz County General Plan goals for open space protection are as follows: “To retain the scenic wooded, open space and rural character of Santa Cruz County; to provide a natural buffer between communities; to prevent development in naturally hazardous areas; and to protect wildlife habitat and other resources.”

Within the project watersheds, the majority of the population is concentrated along Highway 9 on the floor of the San Lorenzo Valley. Steep slopes and rugged terrain have long been a significant constraint to commercial and residential development in all areas of Santa Cruz.
County. As a result, the area is rural in general character, heavily forested, and visually dominated by open and undeveloped space.

Henry Cowell Redwoods State Park, the Fall Creek unit of Henry Cowell, Castle Rock State Park, and Big Basin Redwood State Park are all managed as public open space. The water purveyors' watershed lands are managed for water resource protection, and to a limited extent, for timber and recreation. Several land trusts, including the Santa Cruz County Land Trust, the Sempervirens Fund, and the Cowell Foundation own and/or manage open spaces in the project area. A portion of the University of California Santa Cruz - Upper Campus and the Pogonip Preserve are adjacent to Henry Cowell Redwoods State Park in the San Lorenzo Valley. Portions of the UCSC campus draining to Gold Gulch or the San Lorenzo River above Tait Street are presently managed as open space. Several summer camps, conference centers, and retreats operate small water systems and own watershed lands. Private owners hold the remainder of lands in the project area.

4.7 Erosion Control/Soil Management Policies

The County has an Erosion Control Ordinance with the purpose of eliminating and preventing conditions of accelerated erosion that may lead to degradation of water quality, loss of fish habitat, damage to property, loss of topsoil and vegetative cover, disruption of water supply, and increased danger from flooding. The policies in the ordinance that are intended to protect water supply are as follows:

- Streams or drainage courses shall not be obstructed or disturbed except for approved road crossings, unless disturbance of a drainage course will improve overall site design and be consistent with the purpose of the ordinance.
- Erosion control measures specified in, or pursuant to, this ordinance, shall be in place and maintained at all times between October 15 and April 15.
- Runoff from activities subject to a building permit, land division permit, or development permit shall be properly controlled to prevent erosion and adequate for runoff from a ten-year storm.
- Land clearing shall be kept to a minimum and vegetation removal shall be limited to that amount necessary for building, access, and construction.

When no land development permit has been issued, the following types of land clearing require an erosion control plan:

- Any amount of clearing in a sensitive habitat.
- One-quarter acre or more of clearing in the Coastal Zone if also in a least disturbed watershed, a water supply watershed, or an area of high erosion hazard.
- One acre or more of clearing in all areas not included in the above items.
When a land development permit has been issued, land clearing may be done in accordance with the approved development plan; however, approval of land clearing requires that “all disturbed surfaces shall be prepared and maintained to control erosion and to establish native or naturalized vegetative growth compatible with the area.”

Despite the fact that the Erosion Control Ordinance has not changed since the 2006 sanitary survey update, new stormwater discharge regulations under Phase II of the NPDES permitting system administered by the Regional Board are followed by both the City and the County through administration of various permits, including most notably construction permits. Both entities require erosion control plans covering the construction and post-construction phases of projects as small as less than one acre in size. The erosion control plans are developed to protect against illegal discharge of sediment and other contaminants to creeks, streams and other water bodies.

4.7.1 Roads

As mentioned in Section 3, Timber Harvest Plans and logging activities are required to construct and maintain roads to minimize erosion. A significant portion of the sediment and debris that washes into streams, however, originates from other public and private roadways (c.f., Swanson, 2001).

Caltrans and the County Department of Public Works are responsible for roadway maintenance on specific corridors. Both agencies have policies to truck roadway debris to designated dump sites. For example, they should not “broad-cast” or “side-cast” debris to the side of any road, especially roads near streams. Also, some county roads are owned jointly and shared among residents in rural areas. The County has established numerous roadway associations to tax residents and fund maintenance, culvert design and construction for these roads. This keeps the County in control of the maintenance activities and proper techniques are typically followed to mitigate erosion. The County’s Road Maintenance Manual links directly to the FishNet 4C Roads Manual: Guidelines for Protecting Aquatic Habitat and Salmon Fisheries for County Road Maintenance published by the Fishery Network of the Central California Coastal Counties which indicates the sensitivity to proper road maintenance activities to minimize water quality impacts.

In addition, the Santa Cruz County Resource Conservation District (SCCRCD) has undertaken a private roads rehabilitation program aimed at identifying those private road segments (after being approached by private landowners or roads associations) which contribute sediment to creeks and streams and further identifying repair schemes for the sediment contributing road segments. As a partner in this effort, the Coastal Watershed Council has developed a Rural Roads Sediment Inventory Manual which Council and Conservation District staff can use while conducting roads inventory work. In addition, the SCCRCD applied for and obtained funding that allowed rural road erosion control projects through 2008 some of which are also described in Section 5.5.
4.8 Fire Management

The General Plan fire management objective is “to protect the public from the hazards of fire through citizen awareness, mitigating the risks of fire, responsible fire protection planning, and built-in systems for fire protection and suppression.”

The San Lorenzo Valley and North Coast watersheds are within the jurisdiction of the California Department of Forestry and Fire Protection (CDF or CalFire), locally headquartered on Highway 9 in Felton. CDF is equipped to suppress wildland fires throughout the project area. Local fire districts take primary responsibility for fighting domestic and commercial fires in their specific areas of jurisdiction. At the county level, the Santa Cruz County Fire Marshall is responsible for the coordination between neighboring fire districts, particularly during first alarm response. The Santa Cruz County Office of Emergency Services provides communication and warning services to area residents and fire districts.

Prescribed burning by the California Department of Parks and Recreation at the perimeters of Henry Cowell Redwoods State Park and Big Basin State Park was conducted in 2011 to minimize the potential spread of a major conflagration either into or out of the parks. Prescribed burns are also used to promote fire-tolerant native vegetation threatened by invasive non-natives.

In addition, the City has prepared a draft Fire Plan for watershed properties to improve fire management planning on City properties. The City has also focused on maintaining fuel breaks and roads in their watershed. Maintenance has included the use of herbicides at the ridge top firebreaks as part of an integrated pest management (IPM) approach to fire preparedness.

4.9 Other Local, State and Federal Regulations

In addition to the topic-specific watershed management practices, activities, and controls described in Sections 4.1 through 4.9, other surface water quality environmental regulations exist that pose a challenge for the Santa Cruz Water Department in meeting drinking water quality regulations (especially the Disinfection By-Products Rule discussed in Section 5). The regulations are summarized in Table 4-2 and more detailed individual discussions follow.

4.9.1 Local Regulations

4.9.1.1 Santa Cruz County Water Quality Control Ordinance [1974]

Santa Cruz County developed a water quality ordinance in 1974 to manage the turbidity level of natural waters in relation to projects which may impact these turbidity levels. Numerical criteria were established in relation to the impact on natural water turbidity levels from the implementation of any project. If the criteria are exceeded due to activity of any permitted project, then the project is deemed to be in violation of the permit. The County criteria are valid unless more stringent permit criteria are established by the California Department of Fish and Game or the Regional Water Quality Control Board.
4.9.1.2 Santa Cruz County Riparian Corridor and Wetlands Protection Ordinance

The purpose of this ordinance is to eliminate or minimize encroachment into the riparian corridors of Santa Cruz County to preserve, protect, and restore riparian corridors. No development activities are allowed within the riparian corridor other than those allowed through the following key exemptions and exceptions:

Exemptions

- The continuance of any pre-existing nonagricultural use, provided such use has not lapsed for a period of one year or more. This includes changes of uses which do not significantly increase the degree of encroachment into or impact on the riparian corridor as determined by the Planning Director.
- The continuance of any pre-existing agricultural use, provided such use has been exercised within the last five years.
- Control or eradication of a pest as defined in Section 5006, Food and Agriculture Code, as required or authorized by the County Agricultural Commissioner.
- Drainage, erosion control, or habitat restoration measure required as a condition of County approval of a permitted project.

Exceptions are granted on a case by case basis after a filing with the County and based on findings by the Zoning Administrator that include that there are special circumstances affecting the property; that the exception will not be detrimental to the public or injurious to other downstream properties and is in accordance with ordinance. Conditions may be imposed that include maintenance of a protective vegetated strip between the activity and the water body; installation and maintenance of water breaks, sediment and erosion control including reseeding and other surface treatments and sediment catch basins.

The ordinance has not been updated changed since the 2006 sanitary survey but the County Fish and Game Advisory Commission is currently considering changes to recommend to the County Board of Supervisors. The Santa Cruz County Fish and Game Commission and the National Marine Fisheries Service (NMFS) have recently recommended to the Board of Supervisors that the County code regarding protection of riparian corridors be strengthened with new standards for streamside development and with targeted implementation and enforcement in water supply and coho salmon recovery watersheds. The Santa Cruz County Planning Department has agreed to consider these matters during the third quarter of fiscal year 2013 in partnership.

In addition, since 2003, a Stream Care Guide has been available by Santa Cruz County Planning Department (http://www.dpw.co.santa-cruz.ca.us/Streamcare_Guide.pdf) that provides information for homeowners on maintaining and improving the riparian corridors.

4.9.1.3 Santa Cruz County Sensitive Habitat Protection Ordinance

The purpose of the Sensitive Habitat Protection Ordinance is to minimize the disturbance of biotic communities which are rare or especially valuable because of their special nature or role
in an ecosystem. Lakes, wetlands, estuaries, lagoons, streams, rivers, and riparian corridors are among the habitats considered sensitive. Some of the sensitive-habitat policies have changed since completion of the 2001 sanitary survey update. These changes include:

- A more comprehensive list of permitted or discretionary land uses within different types of sensitive habitats, for example kelp beds and cliff nesting areas;
- A comprehensive list of permitted or discretionary land uses adjacent to the essential habitats of rare and endangered species; and
- A comprehensive list of permitted or discretionary land uses for lands of locally unique species.

In addition to these changes, sensitive habitat policies of interest include:

- No toxic chemical substance shall be used in such a way as to have deleterious effects on the habitat unless an emergency has been declared, or such use has been deemed necessary by the California Department of Fish and Game to eliminate or reduce a threat to the habitat itself, or a substantial risk to public health will exist if the toxic chemical substance is not used.
- The Agricultural Commissioner, when reviewing an application to use a restricted material, shall consider the potential effects of the material on a sensitive habitat, and mitigation measures shall be required as necessary to protect the habitat. No approval shall be issued if adverse impacts cannot be mitigated.
- A biotic assessment shall be required for all development activities and applications in areas of biotic concern.
- No development activity shall commence until approved, unless such activity has been reviewed concurrently with the review of a development or land division permit.

Any development within any sensitive habitat area shall be subject to the following conditions:

- All development shall mitigate significant environmental impacts.
- Dedication of an open space, conservation easement, or equivalent measure shall be required as necessary to protect the portion of a sensitive habitat which is undisturbed by the proposed activity or to protect a sensitive habitat on an adjacent parcel.
- Restoration of any area which is a degraded sensitive habitat or has caused or is causing the degradation of a sensitive habitat shall be required, provided that any restoration required shall be commensurate with the scale of the proposed development.

No new development shall be allowed adjacent to marshes, streams, and bodies of water if such development would cause adverse impacts on water quality which cannot be mitigated or
will not be fully mitigated by the project proponent. Development that has received a riparian exception according to the provision of the Riparian Corridor and Wetlands Protection Ordinance may be exempted from the provisions of this ordinance if the Planning Director has determined that the activity has received a review that is equivalent to the review required by the Sensitive Habitat Protection Ordinance.

Finally, the City and County are in the process of developing a Karst Protection Zone Policy. Karst is known to occur in several areas of Santa Cruz County, primarily in Bonny Doon, Felton, and the southeastern end of Ben Lomond Mountain in the vicinity of Pogonip and UCSC, and since karst aquifers have unique recharge properties, current regulations designed for non-karst aquifers having fairly regular porosity, transmissivity, and hydraulic conductivity provide inadequate protection (Chris Berry, 2012, Personal Communication).

4.9.2 California State Regulations

4.9.2.1 California Porter-Cologne Water Quality Act [1969]

The California State Water Resources Control Board (State Board) and the nine California Regional Water Quality Control Boards (Regional Board or RWQCB) have the authority in California to protect and enhance water quality, both through their designation as the lead agencies in implementing the Section 319 nonpoint source program of the federal Clean Water Act (CWA), and from the state’s primary water-pollution control legislation, the Porter-Cologne Water Quality Control Act. CWA Section 303 and the Porter-Cologne Water Quality Control Act establish water quality objectives for all waters in the State. These objectives are implemented locally through Water Quality Control Plans, the National Pollutant Discharge Elimination System (NPDES) permits for discharges to receiving waters, and waste discharge requirements (WDRs) for discharges to land. Santa Cruz County is within the Central Coast Region, which includes San Luis Obispo, Monterey, Santa Barbara and San Benito Counties, along with small portions of Santa Clara, San Mateo, Kern and Ventura Counties.

In addition to obtaining WDRs for wastewater treatment plant discharges, individual or NPDES permits must be obtained for stormwater discharges. The NPDES Municipal Stormwater Permit program is divided into Phase 1 regional permits for municipal separate storm sewer systems (MS4’s)’ servicing populations greater than 100,000, and a statewide Phase 2 (Small MS4) program covering populations less than 100,000. Industrial dischargers in specific industries are required to obtain coverage under site-specific NPDES Industrial Stormwater Permits. Construction sites where disturbance to more than 1 acre is proposed must obtain coverage under the NPDES Construction General Permit.

The Porter-Cologne Water Quality Act is the state law governing nonpoint-source water quality regulation. The State Water Resources Control Board (SWRCB) has responsibility for the State’s water quality and water rights programs. State policies set forth by the SWRCB are administered by nine Regional Water Quality Control Boards. The Porter-Cologne Act refers to the Regional Boards as “principal state agencies with the primary responsibility for the coordination and control of water quality” (Section 13001). The Regional Boards are also directed to adopt water quality control plans (Basin Plans) for all regions within the State. Santa Cruz County is within the Central Coast Region, which includes San Luis Obispo, Monterey,
Santa Barbara and San Benito Counties, along with small portions of Santa Clara, San Mateo, Kern and Ventura Counties.

Water quality standards for individual projects are established by the Regional Board as part of the NPDES Phase I and Phase II permitting procedure under the *Federal Clean Water Act*. The NPDES program applies to all point-, and nonpoint-source discharges to all surface waters including wetlands. Municipalities must obtain an individual or regional NPDES stormwater permit for the entire stormwater drainage system. This applies to both municipal separate storm sewer systems (MS4’s) which service populations in excess of 100,000 and industrial/construction sites with coverage greater than 5 acres (Phase I) as well as smaller MS4’s which service populations less than 100,000 and industrial/construction sites which cover an area of 1 to 5 acres.

Land management activities (such as timber harvests and agriculture) that have the potential to affect water quality and are not covered under the NPDES program are regulated by the Regional Boards under the authority of the Porter-Cologne Act. In 1999, the California legislature passed Bill 390, which clarified the role of the Regional Boards in actively regulating these activities. Specifically, this Bill required a re-evaluation of all waivers of waste discharge requirements (WDRs). In response, the Central Coast Regional Board determined that the long-standing categorical waiver for timber harvest activities should not be renewed. Instead, in 2005, the Regional Board issued a general conditional waiver of WDRs for timber harvest activities that are not subject to individual conditional waivers or WDRs. The conditional waiver was renewed in 2012 under Order No. R3-2012-2007. The general conditional waiver boosts the role of the Regional Board in review of THPs during the CDF approval process and requires notification by timber harvesters once the THP has been approved. In addition, the waiver’s Monitoring and Reporting Program results in post-harvest inspections by Regional Board staff.
<table>
<thead>
<tr>
<th>Regulation</th>
<th>Regulatory Agency</th>
<th>Status of Regulation</th>
<th>Relation to Drinking Water Compliance</th>
<th>Impact/Benefit to Water Treatment</th>
<th>Regional Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safe Drinking Water Act: Log 4/5 Giardia and Virus Removal</td>
<td>CDPH</td>
<td>SCWD currently has a 4-log Giardia and 5-log virus reduction treatment requirement.</td>
<td>To comply with the log 4/5 removal requirement, increased chlorine contact time is the most economical solution; however, this increases the risk of DBP formation.</td>
<td>Compliance with DBP limits would require SCWD to upgrade their the Graham Hill WTP at an estimated cost of $25-40 M.</td>
<td>Implementation of the TMDL requires the County, City of Santa Cruz and City of Scotts Valley to potentially invest additional resources in management of: wastewater (especially for on-site systems), stormwater, and riparian-area homeless encampments.</td>
</tr>
<tr>
<td>San Lorenzo River Pathogen TMDL</td>
<td>Central Coast Regional Board</td>
<td>A pathogen TMDL was approved for the San Lorenzo River in May 2009 due to impairment of water contact recreation beneficial use.</td>
<td>Implementation of the TMDL will improve SCWD's source water quality.</td>
<td>Improved water quality potentially reduces water treatment costs.</td>
<td>Implementation of the TMDL requires the County, City of Santa Cruz and City of Scotts Valley to potentially invest additional resources in stormwater management improvements especially as they relate to upstream sediment discharge and hydromodification.</td>
</tr>
<tr>
<td>San Lorenzo River Sediment TMDL</td>
<td>Central Coast Regional Board</td>
<td>A sediment TMDL was approved for the San Lorenzo River in May 2003 due to impairment of fish and wildlife beneficial use. RWQCB staff recommend revision of the existing numeric targets to sediment and biological indicators.</td>
<td>Implementation of the TMDL will improve TSS and turbidity, which will improve SCWD's source water quality.</td>
<td>Improved water quality potentially reduces water treatment costs.</td>
<td>Implementation of the TMDL requires the County, City of Santa Cruz and City of Scotts Valley to potentially invest additional resources in stormwater management improvements especially as they relate to upstream sediment discharge and hydromodification.</td>
</tr>
<tr>
<td>Regulation</td>
<td>Regulatory Agency</td>
<td>Status of Regulation</td>
<td>Relation to Drinking Water</td>
<td>Impact/Benefit to Water Treatment</td>
<td>Regional Implications</td>
</tr>
<tr>
<td>------------</td>
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<tr>
<td>San Lorenzo River Nitrate TMDL</td>
<td>Central Coast Regional Board</td>
<td>A nitrate TMDL was approved for the San Lorenzo River in September 2000 due to potential to adversely affect municipal and domestic water supply beneficial use and water contact and non-contact water recreation beneficial uses.</td>
<td>While nitrate is not violating the drinking water standard for nitrate, implementation of the TMDL will improve SCWD’s source water quality. Nitrate can create taste and odor problems through the promotion of biological growth. Biological growth is also a concern as it can lead to higher TOC concentrations and higher potential for DBP formation as well as increased growth downstream that results in a higher upstream regulatory burden for the City with respect to threatened and endangered species.</td>
<td>When taste and odor were a problem, SCWD had to spend $60,000/year on treatment of the problem. Additional studies would be necessary to assess the connection between nitrate/biological growth and water treatment.</td>
<td>There are likely secondary impacts (i.e. biological growth formation at the Lagoon) from nitrate concentrations; therefore, the river is still considered impaired for nitrate. Nitrate levels continue to vary year to year. To decrease nitrate levels will require additional investment in nitrate reduction measures.</td>
</tr>
<tr>
<td>Proposed Majors Creek Sediment TMDL</td>
<td>Central Coast RWQCB</td>
<td>The City of Santa Cruz submitted data in support of listing Majors Creek (North Coast water source) as a sediment impaired waterbody during the last TMDL listing period in the hopes that listing would bring resources to improve beneficial uses in this</td>
<td>Implementation of a sediment TMDL will improve TSS and turbidity, which will improve SCWD’s source water quality, but at the same time, the improvements will also enhance habitat, which could increase allowable</td>
<td>Implementation of a Majors sediment TMDL has benefits such as allowing operational flexibility among the City’s water sources – thereby enabling projects such as the</td>
<td>Reduced availability of Majors Creek water may hinder regional water transfer currently being investigated with Soquel and Scotts Valley.</td>
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<tr>
<td>Regulation</td>
<td>Regulatory Agency</td>
<td>Status of Regulation</td>
<td>Relation to Drinking Water</td>
<td>Impact/Benefit to Water Treatment</td>
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<td>water supply watershed. City water operations have been hampered by the relatively huge volume of suspended and bedload sediment which moves during storm events in this creek, as well as by the persistent turbidity which is related to that sediment load. Historic clearcuts overlain on top of naturally highly erosive soils – particularly in the east branch of Majors Creek – have resulted in sediment loads which are among the highest in the County. Improvement of this condition would reduce maintenance and treatment costs and allow increased use of Majors Creek in the winter when this creek is becoming increasingly important due the reduced availability of Laguna and Liddell Creeks (due to ESA-related restrictions). Also, the City would benefit indirectly from improved habitat associated with smaller sediment loads, as the overall impacts on special status fisheries in the creek</td>
<td>water diversions. If water diversion from Majors Creek are limited, SCWD will have higher reliance on water from Loch Lomond Reservoir which has higher TOC concentration and higher potential for DBP formation.</td>
<td>regional recharge project currently being investigated. Additionally, greater availability of coastal sources such as Majors Creek has the benefit of reducing the probability of DPB compliance issues associated with Loch Lomond and San Lorenzo River water - which thereby limits the need for SCWD to upgrade the Graham Hill WTP at an estimated cost of $25-40 M.</td>
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<tr>
<td>Regulation</td>
<td>Regulatory Agency</td>
<td>Status of Regulation</td>
<td>Relation to Drinking Water</td>
<td>Impact/Benefit to Water Treatment</td>
<td>Regional Implications</td>
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<tr>
<td>AB 885 - Statewide On-Site Wastewater Treatment Policy</td>
<td>Regional Board</td>
<td>The State Water Board proposes to adopt an OWTS Policy and a statewide conditional waiver that establish minimum requirements for the permitting and operation of OWTS.</td>
<td>Prior to issuing a permit to install an OWTS the permitting agency (Santa Cruz County) shall determine if the OWTS is within 1,200 feet of an intake for a surface water treatment plant for drinking water and is in the drainage catchment in which the intake is located. If so, the permit application shall be provided to the CDPH Drinking Water Program and the public water system owner, who shall have 5 days from receipt of the permit application to provide recommendations and comments to the permitting agency.</td>
<td>SCWD's Felton Diversion is downstream of OWTS. Regulations of OWTS would provide additional protection of SCWD's source water quality; however, the regulations require SCWD to review permit applications which allows SCWD to identify potential water quality threats.</td>
<td>The County's wastewater discharge policies may need to be modified based on the final recommendations of AB 885.</td>
</tr>
<tr>
<td>Regulation</td>
<td>Regulatory Agency</td>
<td>Status of Regulation</td>
<td>Relation to Drinking Water Treatment</td>
<td>Impact/Benefit to Water Treatment</td>
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<tr>
<td>Endangered Species Act</td>
<td>CDFG/NOAA</td>
<td>In-stream flow requirements may impose restrictions on water diversions from streams from which the SCWD diverts.</td>
<td>If North Coast water diversions are limited, SCWD will have higher reliance on water from Loch Lomond Reservoir which has higher TOC concentration and higher potential for DBP formation.</td>
<td>Compliance with DBP limits may require SCWD to upgrade their the Graham Hill WTP at an estimated cost of $25-40 M.</td>
<td>Reduced availability of North Coast water may hinder regional water transfer currently being investigated with Soquel and Scotts Valley.</td>
</tr>
</tbody>
</table>
4.9.2.2 California Environmental Quality Act (CEQA) [1970]

CEQA was modeled after the National Environmental Policy Act (NEPA) and establishes the state's basic framework for the environmental review of new development projects. CEQA provides the effected agencies and the public with a role in the review of proposed development and sets forth standards of significance when evaluating the potential effects of projects. CEQA requires that potential adverse impacts be identified and mitigated; mitigations, however, are difficult to implement and enforce.

4.9.2.3 California Department of Fish and Game

The California Department of Fish and Game is responsible for the regulation of impacts to wetlands, rivers, and lakes through the mandate of Sections 1601-1603 of State Fish and Game Code. The department is required to review projects with the potential to divert or obstruct natural flows of waters in streambeds and wetlands. Alteration of wetlands, rivers, streams and lakes must be done with the permission of the Department of Fish and Game, which places conditions of approval on the proposed action to mitigate any adverse effects to the habitat to be altered.

The Department of Fish and Game also regulates the hunting and trapping of wild and feral pigs on public and private lands. In 2006 it had been reported that feral pigs had become established near one of SLVWD’s intake structures. Similar conditions in lands owned by the City of San Francisco’s Water Department (SFWD) and the East Bay Regional Park District (EBRPD) led to the development of a wild pig-removal program. The Department of Fish and Game developed a Memorandum of Understanding to control the pig population. The memorandum includes requirements for disposal of pig carcasses, reporting program results, and maintenance of specific records. SLVWD staff indicated that feral pigs no longer appear to be causing erosion problems near the intake structure.

The Department of Fish and Game in coordination with NOAA Fisheries regulates impacts to fisheries habitat in accordance with the Endangered Species Act. SCWD has prepared a draft HCP described in Section 3.5.1 for maintenance activities on diversions and other stream facilities that could impact fisheries. Watershed management decisions made to support fisheries habitat can impact the availability of water supplies from the North Coast watersheds, which are the highest water quality source for the region. If diversions from those watersheds are restricted, SCWD will have higher reliance on water from Loch Lomond Reservoir. The reservoir has higher TOC concentrations, which has a higher potential for DBP formation and could result in significant water treatment changes as indicated in Table 4-2.

4.9.2.4 Statewide On-Site Wastewater Treatment Policy Assembly Bill (AB) 885

In 2000, the California Legislature passed AB 885, which requires the State Water Quality Control Board to adopt regulations for the operation of on-site wastewater treatment systems (OWTS). The policy which is currently in draft form was released in September 2011 for public comment. Designed to ensure that surface waters and groundwater are not contaminated by septic systems, the draft policy provides minimum OWTS standards for local agency OWTS management programs and proposes that permits for OWTS within 1,200 feet of surface water intake be reviewed by the public water system owner as described in Table 4-2. Santa Cruz...
County has developed and has been implementing many of the actions required under the draft OWTS policy under its Wastewater Management Plan prepared in 1995 and it is believed that some of these OWTS standards are already in place.

### 4.9.2.5 Other State Legislation

Several other key state acts affect the management of pollutants and the potential impacts to water quality that may result from their use:

- Pesticide Contamination Act [1967]
- Forest Practice Act [1973]
- Subdivision Map Act [1974]
- Hazardous Waste Control Act [1982]
- Safe Drinking Water and Toxic Enforcement Act [1986]
- Integrated Waste Management Act [1989]

### 4.9.3 Federal Regulation

Federal provisions pertinent to the sanitary survey are described below.

#### 4.9.3.1 Clean Water Act – NPDES and TMDL

The Federal Water Pollution Control Act of 1972, also known as the Clean Water Act (CWA), was enacted to "restore and maintain the chemical, physical, and biological integrity of the Nation's water." The CWA established the NPDES permit program described above under California regulations. The CWA also includes Section 303(d), which specifically requires states to identify those water bodies not meeting established water quality goals relative to a pollutant or a suite of pollutants. Once a water body is found to not meet applicable water quality goals, it must be added to the 303(d) list as an impaired water body and a TMDL must be developed for the specified pollutants. 303(d) listing recommendations are made by the Regional Board and approved by the State Board. The San Lorenzo River is 303(d) listed for nutrients (1996), pathogens (1998), sediment (1998), chlordane (2010), chlorpyrifos (2010) and PCBs (2010), and the Lower Newell Creek is listed for pH (2010). Based on the 303(d) listing for nutrients, pathogens and sediment in the San Lorenzo River, TMDLs have been adopted for nitrate (2000), pathogens (2009) and sediment (2003). The sources contributing chlordane, chlorpyrifos and PCBs to the San Lorenzo River and sources contributing pH to Lower Newell Creek have not been identified and adoption of TMDLs for these constituents is not anticipated until 2021. Although not 303(d) listed, SCWD proposed a sediment TMDL for Majors Creek to the Regional Board, which is pending approval.

Significant progress has been made locally towards the TMDLs for nitrate, pathogens and sediment in the San Lorenzo River. With respect to nitrate, the County has continued
implementation of the San Lorenzo Wastewater Management Program and Nitrate Management Plan, which has resulted in significant declines in on-site wastewater system failure rates and stopped the rise of nitrate in the watershed that is believed to contribute to excessive algae growth, especially in the San Lorenzo River lagoon near the discharge to the Pacific Ocean. The San Lorenzo River is still considered by the Regional Board to be impaired for nitrate although levels are particularly low in the upper watershed. With respect to pathogens significant progress has been made locally to address the various contributing sources. The San Lorenzo Wastewater Management Program addresses pathogens from wastewater systems. The City’s stormwater ordinance and the County, City of Santa Cruz and City of Scotts Valley’s stormwater management plan address pathogens from urban runoff.

Local outreach programs like Ecology Action’s Livestock and Land program address pathogens from livestock and stables. Increased patrols by the County and City of Santa Cruz address pathogens from unauthorized homeless encampments next to waterways. With respect to sediment, the County and City of Santa Cruz have implemented infrastructure improvements that reduce sediment loading and the County has a riparian ordinance that addresses unauthorized grading activities.

While intended to protect water quality for beneficial uses including municipal beneficial use, 303(d) listing and associated TMDL implementation requirement can result in unintentional consequences to water supply agencies and at times may be unresponsive to the beneficial use of municipal supply. Implementation of TMDLs are constrained not only by watershed management agencies’ financial resources due to the additional investments required locally to meet TMDL targets. Where TMDL targets are aligned with municipal beneficial use levels, this additional expenditure may be offset by reduced water treatment costs by water agencies. However, when TMDL targets are more stringent than the levels that protect municipal beneficial use, the cost of TMDL implementation can reduce the availability of local funding for water treatment. On the other hand, sometimes data used by the Regional Board in 303(d) listing decisions does not capture impacts to municipal beneficial use. The interplay between TMDL regulations and water treatment decisions is also discussed in Table 4-2.

**4.9.3.2 Section 404 Wetland Filling and/or Dredging Permit Program**

Section 404 of the CWA regulates the discharge of dredged and fill material into wetlands and water of the United States, and establishes a permit program to ensure that such discharge complies with environmental requirements. The 404 permit process is administered by the U.S. Army Corps of Engineers (ACOE) and the U.S. Environmental Protection Agency (EPA).

The activities regulated by Section 404 include channel construction and maintenance, filling wetlands to create development sites, transportation improvements, and water resource projects. Some activities that may adversely impact wetlands and rivers, such as drainage or ground-water pumping, are often conducted without discharging dredged or fill material and are not regulated under Section 404. The exemptions to Section 404 that are pertinent to the sanitary survey study area include: normal farming, ranching and silvicultural practices; maintenance and emergency repair of levees and bridges; construction or maintenance of farm or stock ponds; construction of temporary sedimentation basins; and construction or maintenance of farm and forest roads, if best management practices are followed.
SECTION 5: WATER QUALITY REGULATIONS AND EVALUATION

5.1 Water Quality Regulations

The U.S. Environmental Protection Agency (EPA) and/or state agencies regulate the water quality of drinking water systems. EPA delegates primary enforcement responsibility for drinking water program implementation and enforcement to the State. In California, the Department of Public Health (DPH) is the primacy agency for drinking water regulations. To maintain primacy, the authority to enforce drinking water regulations, under the Safe Drinking Water Act (SDWA), DPH must adopt drinking water regulations at least as stringent as the Federal regulations and meet other relevant criteria. State drinking water regulations may be more stringent than the Federal regulations, but not less stringent.

The City of Santa Cruz 1996 Watershed Sanitary Survey provides a detailed account of the development of water quality regulations in the United States. Subsequent updates to the 1996 sanitary survey in 2001 and 2006 describe a number of regulations that were the most current at the time those documents were written. These regulations still apply. New regulations since the 2006 report are the state adoption of the Interim Enhanced Surface Water Treatment Rule (IESWTR) and development of the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR). The paragraphs below provide a brief summary of the main surface water quality regulations.

Table 5-1: Regulatory Schedule

<table>
<thead>
<tr>
<th>Rules</th>
<th>Promulgation Date</th>
<th>Compliance Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal IESWTR &amp; Stage 1 D/DBPR</td>
<td>December 1998</td>
<td>January 2002</td>
</tr>
<tr>
<td>California IESWTR</td>
<td>Anticipated in 2007</td>
<td>Anticipated in 2010</td>
</tr>
<tr>
<td>California Stage 1 D/DBPR</td>
<td>June 2006</td>
<td>2009</td>
</tr>
<tr>
<td>Federal Long-term 2 &amp; Stage 2 D/DBPR (1)</td>
<td>January 2006</td>
<td>October 2012 (for &lt; 100,000 population)</td>
</tr>
</tbody>
</table>

(1) Each of these two rules include data collection tasks with “early compliance dates” six months after the publication date for sampling plans, and 24 months after rule promulgation for both data collection and report submission.

5.1.1 Surface Water Treatment Rule (SWTR)

The Surface Water Treatment Rule (SWTR) was implemented to provide protection against Giardia cysts and pathogenic enteric viruses. The federal SWTR requires that the water treatment process achieve a minimum of 99.9 percent (3-log) removal and/or inactivation of...
Giardia cysts and 99.99 percent (4-log) removal and/or inactivation of enteric viruses. This must be accomplished through a combination of physical removal and disinfection. The DPH generally requires that the water treatment process provide the minimum removal and/or inactivation requirements for Giardia and viruses in the federal SWTR (99.9 percent (3-log) for Giardia cysts and 99.99 percent (4-log) for viruses).

The DPH published a guidance document, “Surface Water Treatment Staff Guidance Manual” in May 1991 that summarizes the treatment requirements in the SWTR as adopted by the State in the California Code of Regulations (CCR). Appendix B of the DPH guidance manual establishes guidelines for determining when source waters will require more than the minimum levels of 3-log Giardia and 4-log virus removal. The guidance indicates that treatment can be based on total coliform levels and that for water sources with significant sewage, recreation or agricultural hazards where median monthly total coliform concentration exceeds 1,000 MPN/100 ml, treatment must provide 4-log Giardia removal and 5-log virus removal.

Based on sampling performed during August 1996 through March 1998, DPH concluded that SCWD should be required to meet the higher level of treatment of 4-log Giardia removal and 5-log virus removal as described in the July 13, 1998 letter to SCWD. This requirement would be in effect at GHWTP until a watershed sanitary survey or continued monitoring could demonstrate that lesser levels of treatment should be required. Based on a draft report documenting additional analysis conducted for the SCWD found in Appendix A, it is believed that the 4-log Giardia removal can be reduced to 3.0-log removal through a combination of reducing the inactivation requirement and increasing the removal credits. The 5-log virus removal is not proposed to be changed. High raw water pathogen levels at LCWD have also resulted in 4-log Giardia and 5-log virus removal.

In addition to further protect public health, significant effort has been made in identifying and managing pathogen sources. As indicated in previous sections, a pathogen TMDL was been established for the San Lorenzo River in 2009 and significant progress has in reduced pathogen levels. However, SCWD recognizes that median monthly total coliform levels still exceed 1,000 MPN/100 ml at time. SCWD is in the process of reviewing source water quality data to evaluate how often the median monthly total coliform level is consistently less than 1,000 MPN/100 ml; this information will enhance SCWD’s Source Selection Procedure as another level of protection. The goal of the Source Selection Procedure is to guide when each of the source waters would be suitable for treatment to ensure that the total coliform MPN would be less than 1,000 MPN/100 ml (for each of the source waters and hence also for the blend). This should enable the City to reliably select source water that only require 3-log Giardia and 5-log virus reduction as requested in Appendix A.

5.1.2 Interim Enhanced Surface Water Treatment Rule (IESWTR)

The final Federal Interim Enhanced Surface Water Treatment Rule (IESWTR) was published in the Federal Register on December 16, 1998 and became effective in January 2002. California adopted the IESWTR in January 2008. The California IESWTR includes several additional monitoring requirements that create a more stringent filtered water performance standard. The IESWTR includes a 2-log Cryptosporidium oocyst removal requirement which can be achieved by maintaining filtered water turbidity less than or equal to 0.3 NTU in at least 95 percent of the filtered water samples collected during each month. As discussed in the draft analysis.
conducted in Appendix A, 95th percentile filter turbidity data are consistently less than 0.3 NTU which meets the IESWTR requirements.

5.1.3 Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR)

The LT2ESWTR was published in the Federal Register on January 5, 2006. The draft State LT2ESWTR was last revised on February 8, 2012. Until State adoption of the LT2ESWTR, DPH will be responsible for monitoring water suppliers for compliance with the rule, but the EPA will be responsible for enforcement of the rule.

The LT2ESWTR requires that all water supplies collect source water data on Cryptosporidium, and it sets new treatment requirements that include treatment plant performance standards for each water supply based on the relative risk due to presence of Cryptosporidium in the source water.

5.1.4 Stage 1 and Stage 2 Disinfectants/Disinfection Byproducts/Rule

In conjunction with the federal IESWTR, the USEPA promulgated another new drinking water regulation on December 16, 1998: the Stage 1 Disinfectants/Disinfection Byproducts Rule (Stage 1 D/DBPR). The State of California adopted the Stage 1 D/DBPR in June 2006. The Stage 1 D/DBPR focuses on controlling production of DBPs, while also meeting disinfection requirements. It revised the THM MCL, created a new MCL for HAA5, and also included MCLs for bromate and chlorite as part of the new regulations. The Total THM (TTHM) MCL was reduced from 0.1 mg/l (100 µg/l) to 0.080 mg/l (80 µg/l). The HAA5 MCL was set at 0.060 mg/l (60 µg/l). The bromate MCL was set at 0.010 mg/l (10 µg/l) and the chlorite MCL was set at 1.0 mg/l. In addition, the Stage 1 DBPR included maximum residual disinfectant levels (MRDLs) for chlorine at 4.0 mg/L (as Cl₂), chloramine at 4.0 mg/L (as Cl₂), and chlorine dioxide at 0.80 mg/L (as ClO₂). For SCWD, D/DBPR1 requires that the system-wide running annual average (RAA) concentration based on the quarterly samples for TTHM be less than 80 µg/L and for HAA5 be less than 60 µg/L.

The Stage 2 Disinfectants and Disinfection Byproducts Rule (Stage 2 D/DBPR) was published in the Federal Register on January 4, 2006. The THM and HAA5 MCLs remain at 80 µg/l and 60 µg/l, respectively, but the new Stage 2 D/DBP Rule differs from the Stage 1 Rule by requiring that each of the locations monitored meet the TTHM and HAA5 concentration limits based on its individual locational RAA. This approach, referred to as the locational running annual average (LRAA), differs from current requirements, which determine compliance by calculating the running annual average of samples from all monitoring locations across the system. Given SCWD’s more stringent Giardia and virus reduction requirements, which are discussed in Section 5.1.1, it may be difficult to meet the LRAA DBP requirements in the Stage 2 D/DBPR. Moreover, the Stage 2 D/DBPR may be even more difficult to meet in the future if the City has to use a source water that is higher in DBP precursors because the other North Coast water sources are not available for environmental reasons; other regulatory forces that affect treatment are summarized in Table 4-2.
The State of California adopted the D/DBPR1 four and one-half years after the rule’s compliance date (January 1, 2002), and 9 years after the rule was published in the Federal Register. During this four and one-half year period, the DPH was responsible for monitoring water suppliers for compliance with this rule, and the EPA was responsible for enforcement of the rule. It should be noted that if the State of California requires as much time to adopt the D/DBPR2 as it needed to adopt the D/DBPR1, EPA, and not DPH, will be responsible for enforcement of the rule, including granting of additional compliance time.

5.2 Water Quality Constituents of Concern

EPA, as well as DPH, has developed Maximum Contaminant Limits (MCLs) for over 100 organic and inorganic compounds, some occurring naturally in water supplies but many occurring as a result of contamination. Major sources of contamination include discharges from manufacturing processes, leaks from storage or disposal containers, and runoff from areas treated with pesticides. Treatment techniques are available for removing these contaminants from water supplies. Protecting source waters from contamination, however, is often more effective than treatment at eliminating contaminants. A list of MCLs for compounds regulated by EPA and DPH is included in Appendix B.

MCLs are developed based upon a number of factors including health risk, analytical detection limits, effectiveness of the best available treatment, and economic considerations. Maximum contaminant level goals (MCLG) are set at the level in which no adverse health effects are seen; in many cases, this is zero.

5.2.1 Cryptosporidium and Giardia

There have been no significant regulatory changes associated with Giardia since 2006. However, SCWD is currently required to meet a more stringent, 4-log Giardia reduction than the minimum SWTR standard 3-log reduction. SCWD is evaluating modifications of the higher regulatory mandate discussed earlier and documented in Appendix A.

Cryptosporidium is specifically addressed in the IESWTR adopted by California in 2008 and in the LT2ESWTR published by EPA in 2006. The IESWTR includes a Maximum Contaminant Level Goal (MCLG) for Cryptosporidium set at zero, and the treatment technique standard will require systems that use conventional filtration treatment to achieve at least a 2.5-log removal of Cryptosporidium oocysts up to a total of 5.5 log depending on the bin classification. Additionally, the LT2 ESWTR required facilities to undergo a two-year Cryptosporidium monitoring plan to determine if source water quality requires additional treatment for removal/inactivation which was completed in March 2009 by SCWD.

5.2.2 Turbidity

The IESWTR strengthened previous turbidity performance regulatory requirements. The following are current regulatory standards for turbidity, which serve to demonstrate compliance with pathogen log removal requirements.

Individual Filter Effluent (IFE): Facilities are required to conduct continuous turbidity monitoring for each individual filter and submit an exceptions report to DPH if:
• IFE has a turbidity level greater than 1.0 NTU based on two consecutive measurements taken 15 minutes apart

• IFE turbidity is greater than 0.5 NTU at the end of the first 4 hours of filter operation, based on two consecutive measurements taken 15 minutes apart.

• Combined Filter Effluent (CFE): The turbidity level of the filtered water is required to be less than or equal to 0.3 NTU in at least 95 percent of the measurements taken each month and not to exceed 1.0 NTU at any time. Compliance is based on measurements taken at four-hour intervals.

5.2.3 Disinfection and Disinfection Byproducts

The current Stage 1 Disinfectants and Disinfection Byproducts Rule (D/DBPR) for total trihalomethanes (TTHMs) and the five haloacetic acids (HAA5) MCLs are 80 μg/L and 60 μg/L, respectively. The Stage 1 D/DBPR compliance is based on a system-wide running annual average (RAA). The Stage 2 D/DBPR includes more stringent regulatory requirements for TTHM and HAA5. The Stage 2 D/DBPR requires that each water purveyor perform an Initial Distribution System Evaluation (IDSE) to identify locations in their distribution system that are most vulnerable to DBP formation. The RAA MCLs will remain in effect and an additional limit of 80 μg/L of TTHMs and 60 μg/L of HAA5, based on a locational running annual average (LRAA) at sites identified in the IDSE, will be instituted. The IDSE plan prepared by SCWD was submitted by April 1, 2007 and identified monitoring and other actions necessary to comply with the Stage 2 D/DBPR; the monitoring was completed and the report submitted in July 2009.

The Stage 1 D/DBPR set MCLs for bromate (10 μg/L), and chlorite (1.0 mg/L). The Stage 2 D/DBPR does not change the existing MCLs for these DBPs. Since the water purveyors do not use ozone or chlorine dioxide at their WTPs, these two MCLs should not impact treatment operations. DBPs are of concern primarily in the distribution system but DBP precursors, discussed below, are related to source water quality.

5.2.4 Total Organic Carbon (TOC)

The Stage 1 D/DBPR requires applicable systems that use conventional filtration treatment to remove a certain target level of TOC (DBP precursor) by enhanced coagulation. The required removal level is based on Source Water alkalinity and TOC concentration.

There has been no further significant regulatory change associated with this constituent since 2006. While there have been no water treatment regulatory changes, surface water quality regulations summarized in Table 4-2 have the potential to restrict SCWD to source water with higher concentrations of TOC, which may require changes to SCWD operations.

5.2.5 Perchlorate

Previously regulated through the establishment of a public health goal (PHG) and a notification level of 6 μg/l, perchlorate is now a contaminant of concern with a respective, enforceable, MCL
in the state of California. As of October 2007, water systems in the state are required to produce water at or below this concentration.

5.2.6 Arsenic Rule

The final Federal Arsenic Rule, published by EPA on January 22, 2001, established the MCL for this constituent at 0.010 mg/L (10 μg/L). The Rule was to become effective on March 23, 2001, 60 days after publication. The rule established that the revised MCL for arsenic is 0.010 mg/l (10 ug/l) and became enforceable on January 23, 2006.

The State of California completed drafting the Revised Drinking Water Standard for Arsenic, which became effective on November 28, 2008 and officially adopted an MCL equivalent to the EPA standard of 0.010 mg/l.

5.3 Groundwater Regulations

Although these regulations do not apply to the surface water sources directly within the City’s control, they may be applicable to well sources within the Santa Cruz system (e.g. Beltz wells) and SLVWD’s Manana Woods wells and are thus included here for completeness.

5.3.1 Radionuclides Rule

The Federal Radionuclides Rule was promulgated in December 7, 2000 and the MCLs published therein became effective in December 2003. Additionally, by the end of 2007, four quarters of initial monitoring are required for each entry point to the distribution system of agencies treating groundwater. The state Radionuclide Drinking Water Regulations became effective June 11, 2006.

5.3.2 Groundwater Rule

On August 9, 2000 EPA proposed a rule specifying the appropriate use of disinfection in groundwater and addresses other components of ground water systems to assure the protection of public health. The Ground Water Rule (GWR) establishes multiple barriers to protect against bacteria and viruses in drinking water obtained groundwater sources and will establish a targeted strategy to identify groundwater systems at high risk for fecal contamination. The GWR provides four elements that target risks to the system. The rule requires regular sanitary surveys, source water monitoring when a positive sample occurs its TCR monitoring, corrective actions upon evidence of fecal contamination, and compliance monitoring.

The California Groundwater Rule became effective on August 18, 2011.

5.4 Water Quality Evaluation

The following subsections summarize the key water quality concerns in the San Lorenzo Valley and North Coast watersheds based on review of data available from SCWD databases. Generally, the discussion focuses on microbiological parameters, turbidity and sediment, and
nitrates. Other parameters discussed are odors, organic contamination and general mineral and metals content.

A major reason for emphasizing total coliform, turbidity, and nitrates is because of the findings from previous studies and field surveys and because the River is listed as impaired for each of these parameters, with TMDLs already being implemented (pathogens, sediment, and nitrate). Coliform bacteria are the primary microbial group measured to determine the health of a drinking water supply. Total coliform bacteria is considered a good general indicator of contamination but does not indicate specific contamination sources. The turbidity parameter is used commonly in drinking water treatment to quantify water quality, primarily because it is easily measured and provides virtually instantaneous results. Also, high turbidity has been correlated with high protozoa (and bacteria) concentrations in some waters. Nitrate has been a targeted parameter in the subject watersheds, mostly because of the predominance of septic tanks as the domestic wastewater treatment technique, especially from systems located on or near highly permeable soils. Elevated nitrate levels promote algal growth which, upon decay, produces taste and odor compounds that increase water treatment costs. Nitrate-rich water also favors growth of cyanobacteria, some of which produce harmful toxins.

5.4.1 **Coliform Bacteria**

Coliform bacteria data are evaluated in this subsection. SCWD analyzes sources water weekly, with each source sampled 2 to 3 times per month. SLVWD and LCWD also sample raw water bi-weekly and weekly respectively. Each sample is analyzed for total coliform and *E. coli* data but SCWD does not measure fecal coliform, a subset of total coliform bacteria, also known as thermotolerant coliforms. The County has measured, among other microbiological parameters, total and fecal coliform bacteria, but recently discontinued fecal coliform in favor of *E. coli*.

Drinking water and sanitary microbiological experience has established the presence or absence of coliform bacteria as an indicator of the sanitary quality of drinking water supplies. The significance of coliform tests and the interpretation of results are well authenticated and have been used as a basis for standards of bacteriological quality of water supplies (Standard Methods for the Examination of Water and Wastewater, 21st Edition).

Most drinking water purveyors determine the most probable concentration (MPN) of total coliform and *E. coli* bacteria present in the drinking water sources of supply. All purveyors are also required to determine the presence or absence of total coliform and fecal coliform bacteria in the distribution system. Total coliform bacteria are a relatively broad group, which includes species that can live for extended periods outside a host body. These sometimes-termed “environmental” coliform bacteria are present in waters exposed to urban development and wildlife activities. Drinking water utilities are required to resample the distribution system in areas where detectable total coliforms are found and eliminate any fecal coliform in the distribution system, as described in the water quality regulation portion of this section. The presence of fecal coliform in the distribution systems can indicate contamination or an improper disinfection process at the treatment works.

Thermotolerant (formerly fecal) coliform bacteria can be present in the gut and feces of warm blooded animals, soil, and organically enriched waters and are detected in the laboratory by the
characteristic of fermenting lactore to produce gas at 44.5°C. This differentiation yields valuable information concerning the possible source of pollution in water sources.

The fecal coliform to fecal streptococci (FC:FS) ratio has been used to determine if the contamination source originated from human wastes. A ratio greater than 4 was considered indicative of human contamination. Conversely, a ratio less than 0.7 suggested the contamination was non-human related. This tool has been questioned of late because of variable survival rates among the fecal streptococcus species, and some researchers do not recommend the use of the FC:FS ratio to evaluate bacteria origin.

Current efforts to differentiate sources of bacterial contamination focus on use of QCPR (quantitative polymerase chain reaction) analysis. The County of Santa Cruz previously used ribotyping, a method of microbiological source tracking that differentiates human *E. coli* from other types of *E. coli* to assess the source and causes of elevated bacteria levels at local beaches (Ricker and Peters, 2006). Overall, of 1200 bacterial isolates tested between 2002 and 2004, only 15 percent could not be attributed to a particular source. Study results relevant to this sanitary survey update include findings that: contamination by birds was a dominant source of bacteria in both upstream and urban (lower River) locations; cracks in storm drains and sewer pipes, as observed by videography, could facilitate cross-contamination; storm drains and sumps appear to promote incubation and multiplication of bacteria; bacteria loadings from human, pet and livestock wastes, while significant, are much lower than avian loadings; and human contributions in the River were much higher in wet weather, when runoff scours storm drains and mobilizes waste from developed areas, encampments and the occasional failing septic system as well as exacerbating high groundwater levels that can come into septic leachlines.

### 5.4.1.1 Santa Cruz Water Department

As discussed in Section 4 earlier, on May 8, 2009, the San Lorenzo River Watershed Pathogen TMDL was approved by RWQCB Central Coast Region, where fecal coliform concentration, based on a minimum of not less than five samples for any 30-day period, shall not exceed a log mean of 200 MPN per 100 mL, nor shall more than 10 percent of samples collected during any 30-day period exceed 400 MPN per 100 mL (for the San Lorenzo River and Estuary, Branciforte Creek, Camp Evers Creek, Carbonera Creek and Lompico Creek). The City does not measure fecal coliform.

The results of an analysis of total coliform data for SCWD’s San Lorenzo River and North Coast sources are presented in Figures 5-1 and 5-2. Figure 5-1 shows the annual geometric mean of total coliform since water year 2002 for SCWD’s San Lorenzo River sources (Loch Lomond, Felton Diversion, and Tait Street).\(^{21}\) Values along the San Lorenzo River are greater than 1,000 MPN/100 ml, and vary slightly over time. Values from Loch Lomond are less than 1,000 MPN/100 ml, and increase in 2008 and 2009, and then decrease in 2010 to 2006 levels. This suggests that the type of water year can influence total coliform in Loch Lomond, where drier years have higher values and wetter years have lower values.

\(^{21}\) A geometric mean, unlike an arithmetic mean, tends to dampen the effect of very high or low values, which is helpful since levels may vary anywhere from 10 to 10,000 over a given period.
Figure 5-2 shows the annual geometric mean of total coliform since water year 2002 for SCWD’s North Coast sources (Liddell Spring, Laguna Creek, and Majors Creek). Values are almost a magnitude lower than the Felton Diversion or Tait Street sources, and particularly low at Liddell Spring. These values have remained relatively unchanged since 2006. The City prefers the use of the North Coast sources, when available, because of the lower coliform levels and therefore higher source water quality. However, as discussed earlier, other environmental surface water regulations related to fisheries recovery may restrict the availability of the North Coast water sources in the future.

5.4.1.2 SLVWD

The Annual Geometric Mean of Total Coliform for sources from the SLVWD is graphically represented on Figure 5-3. The data presented is from 2009 to 2013. Results seem to be rather consistent from year to year, however the 2013 water year results are slightly elevated due to the fact that only two results have been made available thus far. The annual geometric mean was calculated from bi-weekly data collected over the separate water years. Periods where data were unavailable or simply labeled as “Present” or “Absent” were left out of the geometric mean calculations. The following raw water sources were included in the graph: Bennett Springs, Bull Springs-1, Bull Springs-2, Clear Creek, Fall Creek, Foreman Creek, Peavine Creek, and Sweetwater Creek.

5.4.1.3 LCWD

LCWD currently samples weekly and submits Total Coliform data to the California DPH. The Total Coliform data for Lompico Creek is represented on Table 5-2 for the period from 2007 to 2012.

<table>
<thead>
<tr>
<th>Water Year</th>
<th>Geometric Mean</th>
<th>Max</th>
<th>Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>1255</td>
<td>19200</td>
<td>145</td>
</tr>
<tr>
<td>2009</td>
<td>1264</td>
<td>15880</td>
<td>210</td>
</tr>
<tr>
<td>2010</td>
<td>853</td>
<td>3790</td>
<td>178</td>
</tr>
<tr>
<td>2011</td>
<td>782</td>
<td>4550</td>
<td>0</td>
</tr>
<tr>
<td>2012</td>
<td>804</td>
<td>6830</td>
<td>206</td>
</tr>
<tr>
<td>2013</td>
<td>913</td>
<td>2640</td>
<td>201</td>
</tr>
</tbody>
</table>

As noted earlier, coliform levels are consistently high with a geometric mean of over 800 MPN/100 ml in the last several years and historic maximum values over 15,000 MPN/100 ml. The annual geometric mean was calculated from weekly data collected over the separate water years. These high coliform levels are likely associated with septic systems and have resulted in higher treatment requirements for this source water.
Figure 5-1. Annual geometric mean of total coliform in the SCWD's San Lorenzo River Sources, 2002-2011 (through June/July 2011). Common maximum thresholds for data analysis were 23, 230, 2400, and 24000 MPN/100ml. Common minimum thresholds for data analysis were 1, 1.1, and 4.5 MPN/100ml. SCWD uses the San Lorenzo River at Big Trees as an index of water supply conditions. According to its classification system, WYs 2002 - 2004 were normal, 2005 - 2006 were wet, 2007 was critically dry, 2008 was normal, 2009 was dry, 2010 was normal, and 2011 was wet.
Figure 5-2. Annual geometric mean of total coliform in the SCWD’s North Coast Sources, 2001-2011 (through June/July 2011). Common maximum thresholds for data analysis were 23, 230, 2400, and 24000 MPN/100ml. Common minimum thresholds for data analysis were 1, 1.1, and 4.5 MPN/100ml. SCWD uses the San Lorenzo River at Big Trees as an index of water supply conditions. According to its classification system, WYs 2002 - 2004 were normal, 2005 - 2006 were wet, 2007 was critically dry, 2008 was normal, 2009 was dry, 2010 was normal, and 2011 was wet.
Figure 5-3: Annual Geometric Mean of Total Coliform from Detectable Results for SLVWD

Water Year

*Note that 2013 is only based off of 2 results

Total Coliform (MPN/100mL)
5.4.2 Turbidity

Anecdotally, many water purveyor and County staff report that treatment challenges are caused by turbidity peaks during the wet, winter months. Disruption of the river and creek beds, small to large landslides, and runoff from barren earth areas tend to extend high turbidity events. These are common occurrences in California caused by the geology, topography, and climate. Many of the water utilities experience treatment problems during the initial few days of high stormwater runoff periods. For example, the SCWD operational practices stops using water from the San Lorenzo River when turbidities exceed 10 NTU at the Coast Pump station and before first flush storm events and recommences diversion when levels drop to below 25 NTU. It is often useful to distinguish ‘persistent turbidity’ as a set of issues with different causes and likely responses. The definition of persistent turbidity as accepted by the County as turbidity which precludes diversions for more than about 3 days for smaller streams, and up to 5 days for the San Lorenzo River after a significant storm. In Liddell Spring, according to the 1964 County-CEMEX contract, persistent turbidity is increases in turbidity over the baseline which exceed 2 units for 48 hours following the storm event. Usually, persistent turbidity occurs in streams receiving a continuing supply of fine-grained sediment from banks, tributaries, or cut slopes. The continuing supply often can be traced to a particular disturbance, such as a landslide, poorly-executed timber harvest, road failure, or large wildfire.

Because high turbidity has correlated with increased protozoa concentrations in surface waters, it is prudent to have some contingency treatment plan during the initial “flush” of the wet year. Avoiding highly turbid water and relying on alternative sources in the short-term seems to be good, well-practiced policy and is implemented in the City’s Source Selection Policy to the greatest extent possible.

Streams which experience extensive disturbances (such as might be caused by a major landslide or fire) are often 10 to 100 times as turbid as baseline, or best-case conditions, at least for the first year or two following the event. The same streams which take longer to clear after a storm are usually also affected by excess turbidity persisting into late spring or early summer. These include creeks downstream from large impoundments which can continue to be turbid for a year or longer.

As summarized earlier in Section 4, on May 16, 2003, the RWQCB Central Coast Region adopted a TMDL for sediment for the San Lorenzo River, Carbonera Creek, Lompico Creek and Shingle Mill Creek and incorporated the TMDL and associated Implementation Plan into the Basin Plan, which states:

“The natural processes of erosion and sedimentation in the San Lorenzo River Watershed have been accelerated due to anthropogenic watershed disturbances. Studies conducted by various authors have concluded erosion rates were two to four times the natural rates … The TMDL was based on reductions necessary to achieve desired streambed sediment parameters (embeddedness and fraction of sediment particles less than 4mm in diameter). Desired conditions taken from values published in scientific literature were 27% lower on average for the San Lorenzo River, Carbonera Creek and Shingle Mill Creek, and 24% lower on Lompico Creek, than measured values in these waterbodies, respectively.”
The RWCQB documented various actions implemented by the City, County, and RCD to reduce sediment loading over the past five years, namely reducing the risk of culvert failure and road erosion (Rose, 2011):

- The City completed culvert removals/improvements in the Newell Creek watershed, estimated to prevent up to 500 yards of sediment from being discharged to Newell Creek over this time period.

- The County used GIS to prioritize erosion problems based on soils and high erosion hazards and implemented six high-priority sediment reduction projects, including five cross-culvert repairs along Kings Creek and one culvert retrofit along Gold Gulch. Implementation of these projects will reduce the risk of culvert failure and the deposition of an estimated 2,378 cubic yards of sediment. The County also completed two other sediment reduction projects on Upper East Zayante and Glenwood Drive estimated that they will reduce sediment transported into the San Lorenzo River watershed by 0.54 tons/year and 3.58 tons/year respectively.

- The RCD implements a rural roads erosion control assistance program, which provides technical and cost share assistance to private road associations to facilitate the implementation of erosion control projects using best management practices to reduce sediment delivery associated with roads. This program also provides education and outreach workshops and trainings that promote the stewardship of healthy watersheds. Between December 1, 2006 and November 30, 2009, the RCDSCC rural roads erosion control assistance program implemented 16 erosion control projects on rural non-county roads in the San Lorenzo River watershed. Additionally, four demonstration projects were completed in October 2010. Over the next 10 years, these projects will prevent approximately 5,837 tons of sediment from entering the San Lorenzo River.

Parke and others (2010) monitored streamflow and suspended-sediment in water year 2009 and 2010 and used sequential used sequential rating-curve analysis\textsuperscript{22} to compare sediment-transport rates over the past three decades for Zayante Creek, the San Lorenzo River, and Soquel Creek. A substantial decrease in transport at a given flow can be seen in each case, although lumping all of the 1970s and 1980s data probably disproportionately increases the earlier yields, as this period includes several episodic or disruptive events, most notably the January 1982 storms.\textsuperscript{23} With possible load reductions between 464- and 106-percent, it is important to note that these differences are large relative to the 24- to 27-percent reductions sought as part of the San Lorenzo Sediment TMDL staff report.

To demonstrate progress towards achieving load-based allocations and beneficial use protection, RWQCB staff recommends revision of the San Lorenzo Sediment TMDL to replace existing numeric targets with the sediment and biological indicators recommended in Herbst et al. (2011) (Rose, 2011).

\textsuperscript{22} An increase in sediment transport at a given flow generally means that more sediment is readily available on the bed for transport, and (generally) that habitat conditions have deteriorated; conversely, less transport at a given flow is usually associated with improvements in bed conditions and in the relative success of erosion-control efforts.

\textsuperscript{23} Episodic events do increase sediment yields and do temporarily move sediment-rating curves ‘upward’, or to the left (Hecht, 2007), sometimes substantially.
5.4.2.1 Santa Cruz Water Department

SCWD currently has the capability to use different water sources if turbidity increases for one or more of the sources for reasons other than rainfall (e.g., landslides). During heavy rain events, however, all surface sources and Liddell Spring are not used due to elevated turbidity, leaving Loch Lomond Reservoir as the only source with which to meet customer demands. During moderate events Liddell and Laguna can be available for use. The evaluation findings are:

Figure 5-4 and Figure 5-5 show the turbidity trends for the San Lorenzo River and North Coast sources, respectively. There is no apparent overall increasing or decreasing trend over the entire period and variations appear to be storm-related, as expected.

Figures 5-6 and 5-7 show similar data as above, but as a 10 sample running average to clarify the trends over the past 5 years. All sources, except Majors Creek, show relatively higher storm-related increases in turbidity in normal and wet years as compared with dry years, e.g., 2006 versus 2007. The North Coast sources experience significantly less turbidity than the San Lorenzo River sources. Overall, these North Coast sources provide consistent low turbidity, treatable water.

5.4.2.2 SLVWD

SLVWD provided a single result per year for Turbidity, so no continuous plot of Turbidity has been provided. Table 5-3 below, shows the turbidity results taken from eight raw surface water sources within SLVWD. With the exception of the 2008 results, most of the data between 2009 and 2012 was sampled in the month of April or early May.

<table>
<thead>
<tr>
<th>Year</th>
<th>Bennett Spring</th>
<th>Bull Springs 1</th>
<th>Bull Spring 2</th>
<th>Clear Creek</th>
<th>Fall Creek</th>
<th>Foreman Creek</th>
<th>Peavine Creek</th>
<th>Sweetwater Creek</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>0.42</td>
<td>0.44</td>
<td>0.46</td>
<td>0.42</td>
<td>4.3</td>
<td>0.49</td>
<td>0.46</td>
<td>0.39</td>
</tr>
<tr>
<td>2009</td>
<td>0.52</td>
<td>0.44</td>
<td>0.44</td>
<td>0.43</td>
<td>0.62</td>
<td>0.52</td>
<td>0.71</td>
<td>0.45</td>
</tr>
<tr>
<td>2010</td>
<td>0.59</td>
<td>0.95</td>
<td>1.1</td>
<td>0.74</td>
<td>1.2</td>
<td>2.1</td>
<td>0.63</td>
<td>1.1</td>
</tr>
<tr>
<td>2011</td>
<td>0.39</td>
<td>0.51</td>
<td>0.48</td>
<td>0.54</td>
<td>1.5</td>
<td>1.9</td>
<td>1.4</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>0.52</td>
<td>0.48</td>
<td>N/A</td>
<td>0.72</td>
<td>1.3</td>
<td>0.63</td>
<td>1.1</td>
<td>2.2</td>
</tr>
</tbody>
</table>

5.4.2.3 LCWD

LCWD currently samples raw turbidity on a daily basis using a grab sample. However, at this time the data were not available in a format that could be summarized in this report.

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24 At Majors Creek, however, continuous turbidity data shows that flows of 2 to 3 cfs can elevate turbidity to 10 NTU (Hastings, unpublished data). Based on field reconnaissance of Upper Majors Creek, there appears to be a chronic supply of sediment, much of which from the East Branch, underlain by weakly cemented Lompico sandstone that weathers by scour and mass wasting. Measurable sources of sediment were found in-channel storage (behind logjams or filling pools) (Hastings and Strudley, 2011).
Figure 5-4. Turbidity in SCWD’s San Lorenzo River Sources, 2001-2011. Turbidity data is collected once or twice a month. Mean daily flows from San Lorenzo River at Big Trees are shown for reference to sediment transport conditions.
Figure 5-5. Turbidity in SCWD's North Coast Sources, 2001-2011. Turbidity data is collected once or twice a month. Mean daily flows from San Lorenzo River at Big Trees are shown for reference to sediment transport conditions.
Figure 5-6. Turbidity in SCWD's San Lorenzo River Sources, 2006-2011. 10 point running average shown for clarity; data taken at varying intervals. Mean daily flows from San Lorenzo River at Big Trees are shown for reference to sediment transport conditions.
Figure 5-7. Turbidity in SCWD's North Coast Sources, 2006-2011. 10 point running average shown for clarity, data taken at varying intervals. Mean daily flows from San Lorenzo River at Big Trees are shown for reference to sediment transport conditions. Majors Creek shows similar turbidity regardless of water year. Observations indicate significant sediment stored in the system, and flows of 2 to 3 cfs can elevate turbidity to 10 NTU (Hastings, unpublished data).
5.4.3 Nitrate

The MCL for nitrate in drinking water is 10 mg/L as nitrogen, or 45 mg/L as nitrate. The nitrate concentrations in the surface water systems located within the watersheds do not approach this limit. However, in response to the 303(d) listing for nutrient impairment and implementation of the resulting nitrate TMDL, the County and the Regional Board have implemented numerous management and regulatory actions to reduce nitrate loadings to the river and tributary creeks. The primary source of nitrate is from septic leach fields located in sandy soil areas (Santa Margarita sandstone), mostly located east of the San Lorenzo River. Other key sources are septic systems near waterways, a community leach field at the Boulder Creek Country Club, and the Scotts Valley nitrate plume.

<table>
<thead>
<tr>
<th>Utility/Location</th>
<th>Nitrate (mg/L as N)</th>
<th>No. of Samples</th>
<th>Water Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average  Median Low High</td>
<td>From   To</td>
<td></td>
</tr>
<tr>
<td>Santa Cruz Water District¹</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liddell Spring</td>
<td>0.49 0.41 0.29 1.18</td>
<td>27 2006 2011</td>
<td></td>
</tr>
<tr>
<td>Laguna Creek</td>
<td>0.14 0.14 0.05 0.26</td>
<td>26 2006 2011</td>
<td></td>
</tr>
<tr>
<td>Majors Creek</td>
<td>0.36 0.39 0.06 0.63</td>
<td>23 2006 2011</td>
<td></td>
</tr>
<tr>
<td>Loch Lomond</td>
<td>0.23 0.20 0.07 0.41</td>
<td>23 2006 2011</td>
<td></td>
</tr>
<tr>
<td>SLR @ Tait Street</td>
<td>0.34 0.34 0.14 0.61</td>
<td>29 2006 2011</td>
<td></td>
</tr>
<tr>
<td>SLR @ Henry Cowell</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Park Bridge</td>
<td>0.48 0.50 0.15 0.77</td>
<td>25 2006 2011</td>
<td></td>
</tr>
<tr>
<td>San Lorenzo Valley Water District²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bennett Spring</td>
<td>N/A N/A &lt;0.1 &lt;1.0</td>
<td>4 2009 2012</td>
<td></td>
</tr>
<tr>
<td>Bull Springs-1</td>
<td>N/A N/A &lt;0.1 &lt;0.1</td>
<td>3 2009 2012</td>
<td></td>
</tr>
<tr>
<td>Bull Springs-2</td>
<td>N/A N/A &lt;0.1 &lt;1.0</td>
<td>4 2009 2012</td>
<td></td>
</tr>
<tr>
<td>Clear Creek</td>
<td>N/A N/A &lt;0.1 &lt;1.0</td>
<td>11 2002 2012</td>
<td></td>
</tr>
<tr>
<td>Fall Creek</td>
<td>N/A N/A &lt;0.1 &lt;0.1</td>
<td>2 2009 2012</td>
<td></td>
</tr>
<tr>
<td>Foreman Creek</td>
<td>N/A N/A &lt;0.1 &lt;1.0</td>
<td>11 2002 2012</td>
<td></td>
</tr>
<tr>
<td>Peavine Creek</td>
<td>N/A N/A &lt;0.1 &lt;1.0</td>
<td>11 2002 2012</td>
<td></td>
</tr>
<tr>
<td>Sweetwater Creek</td>
<td>0.20 N/A &lt;0.1 &lt;1.0</td>
<td>11 2002 2012</td>
<td></td>
</tr>
</tbody>
</table>

¹Source: SCWD
²Source: SLVWD
SLR = San Lorenzo River

5.4.3.1 Santa Cruz Water Department

SCWD has monitored the nitrate levels in their water sources since the late 1960's. The following paragraphs describe the key findings of the nitrate evaluation.
Figure 5-8 shows the nitrate data over the past 10 years for the SCWD’s San Lorenzo River sources. While values are higher for the two river sources compared to Loch Lomond, all three sources have relatively high values around 2007, which was a very dry year with relatively high contributions of groundwater (versus direct runoff) to streams. There are also some high values associated with first flush events (e.g., Dec. 22, 2001) and large winter storms (Jan. 25, 2008), possibly due to overflowing septic systems or sanitary sewers. Overall, sample concentrations are less than 1.0 mg/L as N and have remained relatively unchanged since 2006. Figure 5-9 provides an additional historic perspective on nitrate concentrations. Two time based lines of best fit have been provided for the data with the first time period from 1967 to 1990 and a second time period from 1991 to 2011 that indicate slightly different slopes. Long-term evaluation of nitrate data should be continued in the future to assess the continued focus on water quality, and particularly on-site wastewater management, that has occurred since about 1995.

Figure 5-10 shows the nitrate trend over the past 10 years for the SCWD’s North Coast sources. While Laguna Creek has the lowest concentrations, all these sources also show relatively higher values in 2007. Liddell Springs does not have any nitrate spikes since CEMEX ceased operation of the quarry in 2010. Values are similar for the San Lorenzo River and North Coast sources.

5.4.3.2 SLVWD

The summary of nitrate data for the SLVWD surface water sources is included in Table 3-2. The nitrate results were often found to be below reporting limits, and for this reason no graph illustrating these results was provided.

5.4.3.3 LCWD

Nitrate data for Lompico Creek were only available electronically for 2011 and 2012; the five samples values ranged from 0 to 0.153 mg/L as NO3 with an average of 0.049 mg/L which is below the 0.5 mg/L MCL.

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25 Groundwater typically has a higher dissolved ion concentration than direct runoff, which presumably enters the channel shortly after precipitation with little residence time in the groundwater reservoir and limited contact with soil or vegetation.

26 Early winter events act as “first flush events” and mobilize high dissolved ion concentration baseflow that has been accumulating in the stream since the last storm event of the last year.
Figure 5-8. Nitrate Concentrations in the SCWD's San Lorenzo River Sources, 2001-2011. Mean daily flows from San Lorenzo River at Big Trees are shown for reference to runoff conditions.
Figure 5-9. Nitrate Concentrations in the SCWD River Sampling Sites, 1967-2011

Numbers in parenthesis are median values. Trend lines drawn for each site based on a linear best fit.
Figure 5-10. TON measured in SCWD’s San Lorenzo River Sources, 2001-2011. Odor data is collected twice a month. Mean daily flows from San Lorenzo River at Big Trees are shown for reference to runoff conditions. SCWD confirmed high odor values by checking original data sheets and other data collected during those same samplings. Values greater than or equal to 20 correspond with significant rainfall, with the highest numbers during severe storm events.
5.4.4 Odors

Odors of raw water typically relate to natural organic matter and algae degradation products. The SCWD has extensive data on the Threshold Odor Numbers (TON) parameter. Raw and treated TONs were monitored more aggressively starting in the mid-1980s, primarily because of customer complaints.

SCWD sources have observed a wide range of TONs. Results include:

Figure 5-11 shows TON values for the SCWD’s San Lorenzo River sources over the last 10 years. TON at Loch Lomond, Tait Street, and the Felton Diversion appear relatively constant which may align with both a focus on odor and a stabilizing in the nitrate concentrations and therefore a relatively lower algae production rate.

Figure 5-12 shows TON values for SCWD’s North Coast sources over the same 10-year period. TON at Liddell Spring is much lower than at Laguna and Majors Creeks. Values are higher for the San Lorenzo River than the North Coast sources.

SLVWD’s surface water sources all had TON less than 1.0 for the 2008 – 2012 years. LCWD did not have TON values available.

5.4.5 Organic Contaminants

Generally, state-mandated Title 22 sampling reports indicate very little presence of contamination of surface water sources with man-made organic constituents. The four contamination sources described in previous sections, the dry-cleaner, two service stations, and manufacturing facility have discharged PCE, TCE, TPH, benzene or toluene to surface or groundwater of the San Lorenzo River Watershed. Trace amounts of these compounds have been detected at the Felton Diversion. All values have been less than the MCL. As previously mentioned in Section 3, corrective and/or modified action is currently under review by the RWQCB or in development.
Figure 5-11. TON measured in SCWD’s North Coast Sources, 2001-2011. Odor data is collected twice a month. Mean daily flows from San Lorenzo River at Big Trees are shown for reference to runoff conditions.
Figure 5-12. TON measured in SCWD’s North Coast Sources, 2001-2011. Odor data is collected twice a month. Mean daily flows from San Lorenzo River at Big Trees are shown for reference to runoff conditions.
5.4.6 Other Water Quality Parameters

Tables 5-5 through 5-18 summarize the recent historical data for other water quality parameters in the general mineral categorie. The data includes summary tables for Total Hardness, calcium, magnesium, sodium, potassium, alkalinity, sulfate, chloride, fluoride, pH, Total Dissolved Solids (TDS), conductivity, color and Methylene Blue Active Substances (MBAS) which are indicative of soaps/detergents:

5.4.6.1 Total Hardness

Table 5-5: Total Hardness — Most data indicates that most area surface waters are moderately hard, with values around 125 to 150 mg/l as CaCO3. One SCWD source, Liddell Spring, has average and medium hardness values of about 255 mg/l as CaCO3. This is most likely caused by the extensive limestone (karst) geology in the spring vicinity. LCWD had 2 hardness samples in 2011 that indicated that the Lompico Creek hardness ranged from 98.4 to 111.9 mg/L. Both SLVWD and LCWD waters are significantly lower hardness than SCWD waters.

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<th>No. Samples</th>
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†Source: SCWD
²Source: SLVWD
5.4.6.2 Calcium

Table 5-6: Calcium — This table lists similar results as for hardness; moderate values for most sources (e.g., about 50 mg/l) except for Liddell Springs (e.g., almost 80 mg/l). LCWD had 2 calcium analyses in 2011 that indicated a range from 24.4 to 28.1 mg/L. Some of SLVWD’s calcium values are more similar to those of SCWD while others are lower and similar to LCWD.

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Source ²: SLVWD
5.4.6.3 Magnesium

Table 5-7: Magnesium — Magnesium concentrations are low compared to calcium. This indicates most of the total hardness is from calcium, as expected considering the geologic formations throughout the watershed area. LCWD had 2 magnesium analyses in 2011 that indicated a range from 9 to 10 mg/L. Some of SLVWD’s sources were slightly higher in magnesium than those of LCWD and SCWD.

Table 5-7: Magnesium Summary of Available Data (mg/L)

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<th>Utility/Location</th>
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Source²: SLVWD
### 5.4.6.4 Sodium

Table 5-8: Sodium — The average sodium content in SCWD waters ranges from about 10 to 40 mg/l. LCWD had 2 sodium analyses in 2011 that indicated a range from 17.5 to 20 mg/L which are higher than SLVWD’s sources and more similar to most of SCWD’s sources.

#### Table 5-8: Sodium Summary of Available Data (mg/L)

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<th>Utility/Location</th>
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*Source<sup>1</sup>: SCWD* Median based on 2005 – 2010 values
*Source<sup>2</sup>: SLVWD
5.4.6.5 Potassium

Table 5-9: Potassium — The typical potassium content in SCWD waters is about 1 to 3 mg/l. LCWD had 2 potassium analyses in 2011 that indicated a range from 1.1 to 1.4 mg/L which is similar to both those of SLVWD and SCWD.

<table>
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<th>Utility/Location</th>
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Source¹: SCWD * Median based on 2005 – 2010 values  
Source²: SLVWD
5.4.6.6 Alkalinity

Table 5-10: Alkalinity — Alkalinity varies widely in SCWD, presumably because of high runoff periods. The average values for Liddell Springs is 204 mg/l as CaCO3, due to karst bedrock geology, and about 95 to 125 mg/l as CaCO3 for the other sources. LCWD had 2 total alkalinity analyses in 2011 that indicated a range from 50.7 to 61.2 mg/L which is similar to most of the SLVWD’s more upstream sub-watersheds.

**Table 5-10: Alkalinity Summary of Available Data (mg/L as CaCO₃)**

<table>
<thead>
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<th>Utility/Location</th>
<th>Average</th>
<th>Median</th>
<th>Low</th>
<th>High</th>
<th>No. Samples</th>
<th>Sample Dates (WY)</th>
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</tr>
<tr>
<td>Liddell Spring</td>
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</tr>
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<td>Laguna Creek</td>
<td>122.8</td>
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</table>

Source¹: SCWD
Source²: SLVWD
### 5.4.6.7 Sulfate

Table 5-11: Sulfate — The secondary MCL for sulfate is 250 mg/l. The maximum measured in annual samples of SCWD water was 74 mg/l in Loch Lomond. Averages range from 15 to 71 mg/l. LCWD had 2 sulfate analyses in 2011 that indicated a range from 17.3 to 21.4 mg/L. SLVWD’s sulfate values are lower than both SCWD and LCWD.

#### Table 5-11: Sulfate Summary of Available Data (mg/L)

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<tr>
<th>Utility/Location</th>
<th>Average</th>
<th>Median</th>
<th>Low</th>
<th>High</th>
<th>No. Samples</th>
<th>Sample Dates (WY)</th>
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</table>

Source¹: SCWD  
Source²: SLVWD
5.4.6.8 Chloride

Table 5-12: Chloride — The secondary MCL for chloride is 250 mg/l. The maximum measured in SCWD water was 30 mg/l (at Felton). Averages range from 9 to 33 mg/l. LCWD had 2 chloride analyses in 2011 that indicated a range from 16.4 to 16.9 mg/L, which is similar to most of the other source waters except for Majors Creek.

Table 5-12: Chloride Summary of Available Data (mg/L)

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<th>Utility/Location</th>
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<td>2002  2012</td>
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<td>2002  2012</td>
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</tbody>
</table>

Source¹: SCWD
Source²: SLVWD
5.4.6.9 Fluoride

Table 5-13: Fluoride — The primary MCL for fluoride is 2.0 mg/l (see Appendix B). The maximum value measured in annual samples of SCWD water is 0.30 mg/l in Loch Lomond. Averages range from 0.03 to 0.18 mg/l, with the North Coast sources having lower levels than the San Lorenzo River. LCWD had 2 fluoride analyses in 2011 that indicated a range from 0.15 to 0.21 mg/L which is similar to the upper range of fluoride for the other source waters.

<table>
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<th>Utility/Location</th>
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<th>Sample Dates (WY)</th>
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</table>

Source¹: SCWD
Source²: SLVWD
5.4.6.10 pH

Table 5-14: pH — The pH values for SCWD waters have ranged from 7.2 to 8.6 units, with median values between 7.4 and 8.1. LCWD had 2 pH levels reported in 2011 that indicated a range from 8.0 to 8.1 which is at the upper end of pH for the various source waters.

**Table 5-14: Summary of Available pH Data (units)**

<table>
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<th>Utility/Location</th>
<th>Average</th>
<th>Median</th>
<th>Low</th>
<th>High</th>
<th>No. Samples</th>
<th>Sample Dates (WY)</th>
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<td>2002 2012</td>
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Source¹: SCWD  
Source²: SLVWD
5.4.6.11 TDS and Conductivity

Tables 5-15 and 5-16: TDS and Conductivity — The secondary MCL for TDS is 500 mg/l. The maximum value measured in annual samples of SCWD water is 312 mg/l at Liddell Spring, with averages ranging from 207 to 295 mg/l. Conductivity (or specific conductance) can be used as a surrogate parameter for TDS. The secondary MCL for specific conductance is 900 umhos/cm, while the maximum value observed was 705 umhos/cm (again, at Liddell Spring). Median values from all sources have ranged from 265 to 460 umhos/cm. LCWD had no conductivity and 2 TDS analyses in 2011 that indicated a range from 186 to 207 mg/L which is similar to the other values in the watersheds.

Table 5-15: Total Dissolved Solids Summary of Available Data (mg/L)

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<th>Median</th>
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<th>High</th>
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<tr>
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<td>Laguna Creek</td>
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<td>222.0</td>
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<tr>
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<td>224.0</td>
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<tr>
<td>Loch Lomond</td>
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<td>245.0</td>
<td>275.0</td>
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</tr>
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<td>264.5</td>
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<td>270.0</td>
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</tr>
<tr>
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<td>Bennett Spring</td>
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<tr>
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<td>310.0</td>
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<td>Bull Springs-2</td>
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<td>250.0</td>
<td>230.0</td>
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<td>Fall Creek</td>
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<td>140.0</td>
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<tr>
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<td>2002-20112</td>
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<td>Peavine Creek</td>
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<td>70.0</td>
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<td>11</td>
<td>2002-2012</td>
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<td>124.0</td>
<td>94.0</td>
<td>130.0</td>
<td>11</td>
<td>2002-2012</td>
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</table>

Source¹: SCWD
Source²: SLVWD
### Table 5-16: Conductivity Summary of Available Data (μmhos/cm)

<table>
<thead>
<tr>
<th>Utility/Location</th>
<th>Average</th>
<th>Median</th>
<th>Low</th>
<th>High</th>
<th>No. Samples</th>
<th>Sample Dates (WY)</th>
</tr>
</thead>
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</tr>
<tr>
<td>Liddell Spring</td>
<td>470.9</td>
<td>460.0</td>
<td>370.0</td>
<td>705.0</td>
<td>130</td>
<td>2005 2011</td>
</tr>
<tr>
<td>Laguna Creek</td>
<td>256.5</td>
<td>265.0</td>
<td>110.0</td>
<td>330.0</td>
<td>135</td>
<td>2005 2011</td>
</tr>
<tr>
<td>Majors Creek</td>
<td>279.9</td>
<td>295.0</td>
<td>125.0</td>
<td>350.0</td>
<td>125</td>
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<tr>
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<td>120</td>
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<tr>
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<td>346.4</td>
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<td>185.0</td>
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<td>142</td>
<td>2005 2011</td>
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<tr>
<td>SLR @ Felton Diversion</td>
<td>349.9</td>
<td>370.0</td>
<td>160.0</td>
<td>430.0</td>
<td>143</td>
<td>2005 2011</td>
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<tr>
<td>San Lorenzo Valley Water District²</td>
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<tr>
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<tr>
<td>Bull Springs-2</td>
<td>447.5</td>
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<td>2009 2012</td>
</tr>
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<td>Clear Creek</td>
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<td>145.0</td>
<td>106.0</td>
<td>170.0</td>
<td>11</td>
<td>2002 2012</td>
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<tr>
<td>Fall Creek</td>
<td>232.5</td>
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<td>220.0</td>
<td>260.0</td>
<td>4</td>
<td>2009 2012</td>
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<tr>
<td>Foreman Creek</td>
<td>144.5</td>
<td>140.0</td>
<td>130.0</td>
<td>160.0</td>
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<td>2002 2012</td>
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<tr>
<td>Peavine Creek</td>
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<tr>
<td>Sweetwater Creek</td>
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<td>190.0</td>
<td>142.0</td>
<td>220.0</td>
<td>11</td>
<td>2002 2012</td>
</tr>
</tbody>
</table>

Source¹: SCWD  
Source²: SLVWD
5.4.6.12  Color

Table 5-17: Color — Apparent color of SCWD source waters can be as high as 200 units, with the higher values from the San Lorenzo River and Majors Creek sources. Median values range from 2 to 22 units. Treated water typically has very little or no detectable color. LCWD had 2 apparent color analyses in 2011 that indicated a range from 24 to 25 units which is similar to the SLR source waters of the SCWD.

Table 5-17: Apparent Color Summary of Available Data (units)

<table>
<thead>
<tr>
<th>Utility/Location</th>
<th>Average</th>
<th>Median</th>
<th>Low</th>
<th>High</th>
<th>No. Samples</th>
<th>Sample Dates (WY)</th>
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<td>Santa Cruz Water Department¹</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Liddell Spring</td>
<td>2.0</td>
<td>2.0</td>
<td>1.0</td>
<td>8.0</td>
<td>130</td>
<td>2005 2011</td>
</tr>
<tr>
<td>Laguna Creek</td>
<td>6.5</td>
<td>5.0</td>
<td>1.0</td>
<td>40.0</td>
<td>137</td>
<td>2005 2011</td>
</tr>
<tr>
<td>Majors Creek</td>
<td>14.8</td>
<td>8.0</td>
<td>3.0</td>
<td>150.0</td>
<td>125</td>
<td>2005 2011</td>
</tr>
<tr>
<td>Loch Lomond</td>
<td>23.5</td>
<td>22.0</td>
<td>8.0</td>
<td>100.0</td>
<td>120</td>
<td>2005 2011</td>
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<tr>
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<td>24.2</td>
<td>16.0</td>
<td>8.0</td>
<td>200.0</td>
<td>142</td>
<td>2005 2011</td>
</tr>
<tr>
<td>SLR @ Felton Diversion</td>
<td>24.0</td>
<td>16.0</td>
<td>8.0</td>
<td>200.0</td>
<td>143</td>
<td>2005 2011</td>
</tr>
<tr>
<td>San Lorenzo Valley Water District²</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bennett Spring</td>
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<td>&lt;3.0</td>
<td>&lt;3.0</td>
<td>&lt;3.0</td>
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</tr>
<tr>
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<td>&lt;3.0</td>
<td>&lt;3.0</td>
<td>&lt;3.0</td>
<td>5</td>
<td>2008 2012</td>
</tr>
<tr>
<td>Bull Springs-2</td>
<td>&lt;3.0</td>
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<td>&lt;3.0</td>
<td>&lt;3.0</td>
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</tr>
<tr>
<td>Clear Creek</td>
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<tr>
<td>Fall Creek</td>
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<td>2002 2012</td>
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<tr>
<td>Peavine Creek</td>
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<td>4.5</td>
<td>&lt;3.0</td>
<td>8.0</td>
<td>11</td>
<td>2002 2012</td>
</tr>
<tr>
<td>Sweetwater Creek</td>
<td>4.5</td>
<td>4.5</td>
<td>&lt;3.0</td>
<td>6.0</td>
<td>11</td>
<td>2002 2012</td>
</tr>
</tbody>
</table>

Source¹: SCWD  
Source²: SLVWD
### 5.4.6.13 MBAS

Table 5-18: MBAS (Foaming Agents) — The MCL for MBAS, or foaming agents, in drinking water is 0.5 mg/l. The maximum measured in annual samples of SCWD waters is 0.07 mg/l, with averages ranging from 0.00 to 0.01 mg/l. LCWD had 2 MBAS analyses in 2011 that indicated a range from 0.0003 to 0.005 mg/L which are in alignment with the values from SCWD’s SLR sources.

<table>
<thead>
<tr>
<th>Utility/Location</th>
<th>Average</th>
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<th>No. Samples</th>
<th>Sample Dates (WY)</th>
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<td>0.00</td>
<td>6</td>
<td>2005 2010</td>
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<tr>
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<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>6</td>
<td>2005 2010</td>
</tr>
<tr>
<td>Laguna Creek</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>6</td>
<td>2005 2010</td>
</tr>
<tr>
<td>Majors Creek</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>6</td>
<td>2005 2010</td>
</tr>
<tr>
<td>Loch Lomond</td>
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<td>0.00</td>
<td>0.00</td>
<td>6</td>
<td>2005 2010</td>
</tr>
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<td>2005 2010</td>
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<td></td>
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<tr>
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<td>&lt;0.05</td>
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<td>&lt;0.05</td>
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<td>2009 2012</td>
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<td>&lt;0.05</td>
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<td>2009 2012</td>
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<td>N/A</td>
<td>N/A</td>
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<td>&lt;0.05</td>
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<td>2002 2012</td>
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<tr>
<td>Fall Creek</td>
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<td>N/A</td>
<td>&lt;0.025</td>
<td>&lt;0.05</td>
<td>4</td>
<td>2009 2012</td>
</tr>
<tr>
<td>Foreman Creek</td>
<td>N/A</td>
<td>N/A</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>11</td>
<td>2002 2012</td>
</tr>
<tr>
<td>Peavine Creek</td>
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<td>N/A</td>
<td>&lt;0.02</td>
<td>&lt;0.05</td>
<td>11</td>
<td>2002 2012</td>
</tr>
<tr>
<td>Sweetwater Creek</td>
<td>N/A</td>
<td>N/A</td>
<td>&lt;0.02</td>
<td>&lt;0.25</td>
<td>11</td>
<td>2002 2012</td>
</tr>
</tbody>
</table>

Source¹: SCWD
Source²: SLVWD
5.4.6.14  **E. Coli, Cryptosporidium and giardia**

As part of the LT2 sampling, SCWD conducted monthly sampling at the GHWTP for *E.coli*, *Cryptosporidium* and *Giardia*, for the period from April 2007 through March 2009. The sample was collected from a composite of all of the raw water treated at GHWTP. A summary of the data are presented in Table 5-19 below.

Table 5-19:  *E. Coli, Cryptosporidium and Giardia*

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Average</th>
<th>Median</th>
<th>Low</th>
<th>High</th>
<th>No. Samples</th>
<th>Sample Dates (WY)</th>
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<td><em>E. Coli</em></td>
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<td>0.2</td>
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<td>2006 2008</td>
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<td><em>Giardia</em></td>
<td>0.029</td>
<td>0</td>
<td>0</td>
<td>0.2</td>
<td>24</td>
<td>2006 2008</td>
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SECTION 6: CONCLUSIONS AND RECOMMENDATIONS

This section begins by discussing conclusions related to the Surface Water Treatment Rule (SWTR) and AWWA/Department of Health Services Guidance Manual, then presents specific conclusions related to contaminant sources, monitoring programs, and overall watershed management.

6.1 SWTR Disinfection Compliance Requirements

The SWTR requires a minimum of 4 log (or 99.99 percent) virus and 3 log (99.9 percent) Giardia cyst removal/inactivation. DPH requires utilities that report monthly median total coliform concentrations greater than 1,000 MPN/100 ml to increase the minimum level of pathogen inactivation at their treatment plant. As discussed earlier, the 13 July 1998 letter from DPH’s predecessor agency DHS, to SCWD requires a 5 log (or 99.999 percent) virus and 4 log (99.99 percent Giardia cyst removal/inactivation because the SCWD’s August 1996 to March 1998 median monthly total coliform concentrations exceeded 1,000 MPN/100 ml in 12 out of 16 months. The SCWD has collected bi-monthly total coliform samples from the intakes of each water source and since 1996, has also monitored total coliform and E. coli in the blended water as well as E. coli in the individual sources entering the Graham Hill WTP. LCWD is under similar stringent requirements.

Participating utilities other than SCWD and LCWD which have measured raw water total coliform have had very low to moderate concentrations. These generally have stream intake structures located upstream of human developed areas (e.g., SLVWD) or downstream from open space areas. Therefore, it appears that these utilities need to remove and inactivate 4 log viruses and 3 log Giardia cysts as is currently required. More total coliform data are needed to verify the log removal and inactivation requirements for each system.

The one raw water source of most concern is the SCWD San Lorenzo River intake at the Tait Street Diversion. Between 2006 and 2011, the highest annual median values of total coliform were measured at the Felton and Tait Street Diversions as has occurred in prior years as shown on Figure 5-1. These sources are not used during the first seasonal rains which significantly increase turbidity and coliform counts. When used, San Lorenzo River at Tait intake is usually blended with North Coast and/or Tait Street Well water, which contain significantly lower total and E. coli coliform concentrations. Felton Diversion water is not pumped directly to GHWTP, rather is pumped to Newell Creek Reservoir (Loch Lomond) and blended before use at GHWTP. The San Lorenzo River sources are used again after turbidity and color return to baseline levels. However, the SCWD should continue to evaluate the need to modify the required level of treatment and disinfection, especially if in-stream flow requirements for fisheries result in source adjustments that do not allow the source blending that currently occurs.

6.2 Significant Contaminant Sources

From the survey findings, there are several sources of contaminants, detailed in Section 3, that are potentially significant to the drinking water sources (especially the San Lorenzo River). These sources include wastewater including septic discharges, urban runoff, confined animal
facilities/stables, unauthorized activity that can contribute microbial contaminants, and timber harvest and geologic hazards which can contribute sediments.

Recent listing of some pesticides/herbicides as impairment to the San Lorenzo River by the Regional Water Quality Control Board have changed this from a non-significant to a significant contaminant source. These and several other parameters are contaminants that are regulated beyond the drinking water regulations which also poses complexities in managing these contaminants because they are not all under the control of the water purveyors. Table 6-1 associates the existing and proposed TMDLs discussed in Section 4.10 with the contaminants associated with these sources. Table 6-1 also summarizes the progress made in the watershed with addressing the TMDL sources. Discussion of individual sources of contamination follow in the sections that follow.

### 6.2.1 Significance of Contaminants

Distinguishing between significant and less-than-significant sources is often difficult but is important, especially in Santa Cruz County, which is 100 percent reliant on local streams and aquifers for its water sources – a relatively rare situation in most of California. As described in the Watershed Sanitary Survey Guidance Manual, the significance of a potential contaminant source is intended to be comparative within the watershed and can be evaluated on a case-by-case basis. The relative significance of a contaminant source can be based on the relative health significance, the distance to the intake, the magnitude of the contaminant source as well as other factors. Microbial contaminants may result in acute illnesses while many chemical contaminants result in chronic illnesses.

Contaminant sources that contribute sediment or indirectly increase bed sedimentation can represent microbial contaminants and influence the reliability and robustness of water supplies. For example, maintaining aquatic habitat requires less water in a channel free of excess sediment, so if sediment is allowed to accumulate in the channel, purveyors will have less water available for supply after meeting the minimum habitat conditions that community standards and regulatory requirements demand.

Another burden in assigning contaminant significance is that some sources become significant only during years of extreme conditions or following episodic events. An additional threshold in establishing significance is the possibility that one or more sources may be permanently lost or lost long-term to any number of causes. Within this context of significance, a discussion of each contaminant source and potential recommendations are provided in the following paragraphs. Table 6-2 summarizes the significant contaminant sources, their relevance to the SCWD’s water sources, implementation of past recommendations and summarizes current recommendations which are detailed in the sections that follow.
Table 6-1. Total Mass Daily Load (TMDL) Projects and Primary Sources: San Lorenzo Valley, Loch Lomond Reservoir and Upper Newell Creek, and North Coast Watersheds

<table>
<thead>
<tr>
<th>Potential Contaminant Sources</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wastewater (septic systems)</td>
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</tr>
<tr>
<td>Urban runoff</td>
<td></td>
</tr>
<tr>
<td>Livestock/stables</td>
<td></td>
</tr>
<tr>
<td>Timber harvests/ logging</td>
<td></td>
</tr>
<tr>
<td>Unauthorized activity</td>
<td></td>
</tr>
<tr>
<td>Geologic Hazards and Fires</td>
<td></td>
</tr>
<tr>
<td>Progress over the last 5 years</td>
<td></td>
</tr>
</tbody>
</table>

San Lorenzo River Watershed

Pathogen TMDL (May 8, 2009)
- Fecal coliform 30-day log mean < 200 MPN, where 10-percent of samples < 400 MPN/g
- Continued implementation of the County Wastewater Management Program which has been the model for State on-site wastewater regulations
- City adopted a stormwater ordinance
- City, County and Scotts Valley have stormwater management plans
- County is developing waste load allocations
- Ecology Action's Livestock and Land program has reduced manure loads.
- City working to obtain conservation easements on private lands in the County adjacent to creeks in order to limit unauthorized activities
- City has increased funding for patrols of riparian corridors upstream of the Tait St.
- Sheriff's department conducts homeless camp cleanups on an as needed basis
- City partnered with the Santa Cruz RCD to improve community awareness of the watershed by installing signs identifying the creeks and watersheds throughout the County.
- SWRCB has drafted policy for on-site wastewater treatment systems pursuant to AB885 which may further improve meeting nitrogen and pathogen TMDLs.

Sediment TMDL (May 16, 2003)
- The sediment TMDL target is currently based on numeric targets for pool volumes for fish habitat and particle size and percent of fines for spawning gravel.
- RWQCB staff recommends revision of the San Lorenzo Sediment TMDL to replace existing numeric targets with the sediment and biological indicators recommended in Herbst and others (2011).
- County implemented 5 culvert repairs along Kings Creek and 1 culvert retrofit along Gold Gulch (reduce the risk of failure and the deposition of an estimated 2,378 cu yds. of sediment), and completed 2 projects on Upper East Zayante and Glenwood Drive estimated to reduce sediment by 0.54 tons/year and 3.58 tons/year, respectively;
- City completed culvert removals/improvements in the Newell Creek watershed, estimated to prevent up to 500 cu yds of sediment;
- RCD implements a rural roads erosion control assistance program. Between Dec. 1, 2006 and Nov. 30, 2009, implemented 16 projects on rural non-county roads, and in October 2010, completed 4 demonstration projects. Over the next 10 years, these projects will prevent approximately 5,837 tons of sediment (Rose, 2011).
- County riparian, grading, erosion control ordinances
- City stakeholder and school outreach including signs on creek crossings
- City regulatory interaction including timber harvest review, County code violations, etc.
- City retains certified erosion control specialist for road mgmt

Nitrate TMDL (September 15, 2000)
- Nitrate as nitrate levels <1.5 mg/L.
- (Nitrate as nitrogen levels < 0.34 mg/L)
- Continued implementation of the Wastewater Program has resulted in significant declines in on-site wastewater system failure rates and stopped the rise of nitrate.
- Sewering of areas close to sanitary sewer collection systems has occurred on a periodic basis.
- SWRCB has drafted policy for on-site wastewater treatment systems pursuant to AB885.

Chlordane TMDL
- TMDL to be developed by 2021 Sources unknown

Chlorpyrifos TMDL
- TMDL to be developed by 2021 Sources unknown

PCBs TMDL
- TMDL to be developed by 2021 Sources unknown

Majors Creek Watershed
- Sediment TMDL Application submitted; pending approval.
- The City has conducted sediment transport data collection on Major's Creek.

Newell Creek Watershed
- pH TMDL TMDL to be developed by 2021 Sources unknown

Notes
- 1 Date approved by RWQCB
- 2 Studies conducted by various authors have concluded erosion rates were two to four times the natural rates … Desired conditions taken from values published in scientific literature were 27% lower on average for the San Lorenzo River than measured values.
- Parke and others (2010) compared sediment transport in WY 2009 and 2011
### Table 6-2. Potential Contaminant Sources and Recommendations: San Lorenzo Valley, Loch Lomond Reservoir and Upper Newell Creek

<table>
<thead>
<tr>
<th>Source of Contaminant</th>
<th>Remedy Implemented</th>
<th>Action Recommended</th>
<th>Community Action Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater Erosion</td>
<td>Continue watershed land acquisition and implementation of Sandy soils BMP guidelines</td>
<td>maintained SWMP; and</td>
<td>increased SWMP; and</td>
</tr>
<tr>
<td>Wastewater (septic systems)</td>
<td>continue enforcement of County Riparian Ordinance, continue implementation of Sandy soils BMP guidelines and maintenance of SWMP; and</td>
<td>increased SWMP; and</td>
<td>increased SWMP; and</td>
</tr>
<tr>
<td>Urbanization of Sand Valleys</td>
<td>continue enforcement of County Riparian Ordinance, continue implementation of Sandy soils BMP guidelines and maintenance of SWMP; and</td>
<td>increased SWMP; and</td>
<td>increased SWMP; and</td>
</tr>
<tr>
<td>Water Supply Watersheds</td>
<td>continue enforcement of County Riparian Ordinance, continue implementation of Sandy soils BMP guidelines and maintenance of SWMP; and</td>
<td>increased SWMP; and</td>
<td>increased SWMP; and</td>
</tr>
<tr>
<td>Urban Runoff</td>
<td>continue enforcement of County Riparian Ordinance, continue implementation of Sandy soils BMP guidelines and maintenance of SWMP; and</td>
<td>increased SWMP; and</td>
<td>increased SWMP; and</td>
</tr>
<tr>
<td>Stormwater Management</td>
<td>continue enforcement of County Riparian Ordinance, continue implementation of Sandy soils BMP guidelines and maintenance of SWMP; and</td>
<td>increased SWMP; and</td>
<td>increased SWMP; and</td>
</tr>
<tr>
<td>Sediment/Erosion Control</td>
<td>continue enforcement of County Riparian Ordinance, continue implementation of Sandy soils BMP guidelines and maintenance of SWMP; and</td>
<td>increased SWMP; and</td>
<td>increased SWMP; and</td>
</tr>
<tr>
<td>Agriculture</td>
<td>continue enforcement of County Riparian Ordinance, continue implementation of Sandy soils BMP guidelines and maintenance of SWMP; and</td>
<td>increased SWMP; and</td>
<td>increased SWMP; and</td>
</tr>
<tr>
<td>Animal Waste</td>
<td>investigate possibility of using Prop. 50 funding for acquisition/conservation easements/partnerships with lands</td>
<td>investigation of potential land acquisition/conservation easements/partnerships with lands</td>
<td>investigation of potential land acquisition/conservation easements/partnerships with lands</td>
</tr>
<tr>
<td>Nonpoint Source</td>
<td>continue enforcement of County Riparian Ordinance, continue implementation of Sandy soils BMP guidelines and maintenance of SWMP; and</td>
<td>increased SWMP; and</td>
<td>increased SWMP; and</td>
</tr>
<tr>
<td>Point Source</td>
<td>continue enforcement of County Riparian Ordinance, continue implementation of Sandy soils BMP guidelines and maintenance of SWMP; and</td>
<td>increased SWMP; and</td>
<td>increased SWMP; and</td>
</tr>
<tr>
<td>Contaminant Type</td>
<td>continued enforcement of current requirements, additional requirements, if an</td>
<td>continued enforcement of current requirements, additional requirements, if an</td>
<td>continued enforcement of current requirements, additional requirements, if an</td>
</tr>
<tr>
<td>Impacted Waterbody</td>
<td>program to continue its success.</td>
<td>program to continue its success.</td>
<td>program to continue its success.</td>
</tr>
<tr>
<td>Water Quality Standards</td>
<td>continue enforcement of County Riparian Ordinance, continue implementation of Sandy soils BMP guidelines and maintenance of SWMP; and</td>
<td>increased SWMP; and</td>
<td>increased SWMP; and</td>
</tr>
<tr>
<td>Water Quality Parameters</td>
<td>continue enforcement of County Riparian Ordinance, continue implementation of Sandy soils BMP guidelines and maintenance of SWMP; and</td>
<td>increased SWMP; and</td>
<td>increased SWMP; and</td>
</tr>
<tr>
<td>Water Quality Monitoring</td>
<td>continue enforcement of County Riparian Ordinance, continue implementation of Sandy soils BMP guidelines and maintenance of SWMP; and</td>
<td>increased SWMP; and</td>
<td>increased SWMP; and</td>
</tr>
<tr>
<td>Water Quality Management</td>
<td>continue enforcement of County Riparian Ordinance, continue implementation of Sandy soils BMP guidelines and maintenance of SWMP; and</td>
<td>increased SWMP; and</td>
<td>increased SWMP; and</td>
</tr>
<tr>
<td>Water Quality Improvement Projects</td>
<td>continue enforcement of County Riparian Ordinance, continue implementation of Sandy soils BMP guidelines and maintenance of SWMP; and</td>
<td>increased SWMP; and</td>
<td>increased SWMP; and</td>
</tr>
<tr>
<td>Water Quality Monitoring</td>
<td>continue enforcement of County Riparian Ordinance, continue implementation of Sandy soils BMP guidelines and maintenance of SWMP; and</td>
<td>increased SWMP; and</td>
<td>increased SWMP; and</td>
</tr>
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<td>continue enforcement of County Riparian Ordinance, continue implementation of Sandy soils BMP guidelines and maintenance of SWMP; and</td>
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<td>increased SWMP; and</td>
<td>increased SWMP; and</td>
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<tr>
<td>Water Quality Management</td>
<td>continue enforcement of County Riparian Ordinance, continue implementation of Sandy soils BMP guidelines and maintenance of SWMP; and</td>
<td>increased SWMP; and</td>
<td>increased SWMP; and</td>
</tr>
<tr>
<td>Water Quality Improvement Projects</td>
<td>continue enforcement of County Riparian Ordinance, continue implementation of Sandy soils BMP guidelines and maintenance of SWMP; and</td>
<td>increased SWMP; and</td>
<td>increased SWMP; and</td>
</tr>
</tbody>
</table>
Table 6.2: Potential Contaminant Sources and Recommendations: San Lorenzo Valley, Loch Lomond Reservoir and Upper Newell Creek

<table>
<thead>
<tr>
<th>Source</th>
<th>Activity</th>
<th>Recommendation</th>
<th>Remaining Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Lorenzo Creek</td>
<td>Methamphetamine laboratories, marijuana cultivation</td>
<td>Continue to advocate and support homeowner outreach; collaborate with DFG and RWQCB for harvest permits</td>
<td></td>
</tr>
<tr>
<td>Upper Newell Creek</td>
<td>Methamphetamine laboratories, marijuana cultivation</td>
<td>Continue to advocate and support homeowner outreach; collaborate with DFG and RWQCB for harvest permits</td>
<td></td>
</tr>
<tr>
<td>Loch Lomond Reservoir</td>
<td>Methamphetamine laboratories, marijuana cultivation</td>
<td>Continue to advocate and support homeowner outreach; collaborate with DFG and RWQCB for harvest permits</td>
<td></td>
</tr>
</tbody>
</table>
TABLE 6-2. Potential Contaminant Sources and Recommendations: San Lorenzo Valley, Loch Lomond Reservoir and Upper Newell Creek

<table>
<thead>
<tr>
<th>Source</th>
<th>Type of Problem</th>
<th>Summary of Past Contaminant Impact</th>
<th>Post Recommendations</th>
<th>Status of Source Current Status</th>
<th>Outreach Activities</th>
<th>Cost</th>
<th>Risks and Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Lorenzo Valley</td>
<td>Contaminant likely introduced or impacted at a site where a contaminant source may potentially be introduced or impacted by flow, seepage, or erosion</td>
<td>Elevated sediment loading during the lowest historic flows in the Liddell Spring is primarily done on a small-scale, while reclamation a project at the CEMEX Bonny Doon quarry is stalled due to endangered species issues. Mining operators are implementing BMPs to manage sediment and water quality impacts at the Bonny Doon quarry.</td>
<td>Continue efforts to obtain water quality reports including closure and post-closure water quality monitoring reports. Consider modifying land use, land cover, and channel restoration at site to reduce or prevent flow from contaminant source.</td>
<td>Site investigation and monitoring required.</td>
<td>$100,000</td>
<td>Low</td>
<td></td>
</tr>
</tbody>
</table>

The Santa Cruz County Hazardous Materials Area of Concern includes multiple potential contaminant sources and recommendations. The following is a summary of past contaminant impacts and post recommendations:

- **San Lorenzo Valley**: Elevated sediment loading during the lowest historic flows in the Liddell Spring is primarily done on a small-scale, while reclamation at the CEMEX Bonny Doon quarry is stalled due to endangered species issues. Mining operators are implementing BMPs to manage sediment and water quality impacts at the Bonny Doon quarry.

- **Loch Lomond Reservoir**: Of the 4 quarries in the San Lorenzo Valley, the Hanson Quarry is currently active, while reclamation at the Olympia Quarry is complete, closed mines have been reclaimed, and reclamation is underway. Until reclamation is complete, closed mines may still impact water supplies.

- **Upper Newell Creek (Martin Fire in North Coast Watershed)**: There were 5 wildfires in Santa Cruz County in the past 10 years, with the Martin Fire in North Coast Watershed being the most significant. Following these fires, Community Wildfire Protection Plans were updated, and the Santa Cruz County Hazardous Materials Area of Concern has been designated as an asset at risk. The City installed a weather station at Loch Lomond to aid in decisions on how to prepare for future wildfires.

- **Continued efforts to obtain water quality reports including closure and post-closure water quality monitoring reports. Consider modifying land use, land cover, and channel restoration at the site to reduce or prevent flow from the contaminant source.**

**Additional Recommendations**:

- **Continue efforts to obtain water quality reports including closure and post-closure water quality monitoring reports.**

- **Consider modifying land use, land cover, and channel restoration at the site to reduce or prevent flow from the contaminant source.**

**Cost**: $100,000

**Risks and Impacts**: Low
Table 6-2. Potential Contaminant Sources and Recommendations: San Lorenzo Valley, Loch Lomond Reservoir and Upper Newell Creek, and North Coast Watersheds

<table>
<thead>
<tr>
<th>Contaminant Source</th>
<th>Summary of past recommendations</th>
<th>Past actions implemented</th>
<th>Next actions recommended</th>
<th>Information submitted to support significance</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pesticide and Herbicide Use</td>
<td>- RWQCB recommendation to list San Lorenzo River for chlordane and chlorpyrifos</td>
<td>- When algal blooms do occur or are predicted to occur, chemical algaecide applications are made to the Newell Creek Reservoir to protect against degradation of beneficial uses</td>
<td>- Sharp decrease in public agency use of chemicals to control weeds along roadways. Caltrans staff report that herbicide use along highway has been reduced 50 percent or more since the early 1990s under the agency's NPDES permit for roadside vegetation maintenance. While roadside maintenance in riparian areas involves herbicides for flood control purposes, the County is exploring alternatives, such as organic pesticides, to reduce the environmental impact conventional spraying.</td>
<td></td>
<td>1 Point source discharging regulated by the RWQCB do not exist in the watershed area</td>
</tr>
</tbody>
</table>

2 These recommendations are supportive of the draft Habitat Conservation Plan for Steelhead and Coho Salmon that has been prepared by the City of Santa Cruz and is scheduled to be approved in early 2012.
6.2.1.1 Conclusions

As discussed in Section 3.2, the San Lorenzo Valley has a large number of septic systems, on both sandy and non-sandy soils, which are a major source of nitrate to the river and its tributary streams. Wastewater septic system discharges, urban runoff, and horses, other domestic animals and pets also contribute to elevated nitrate levels. Microbial contaminants are associated with failing septic systems, urban runoff, and horse stables. The County’s wastewater management program is successfully addressing problem septic systems, promoting system upgrades where feasible, requiring alternative systems where appropriate, and encouraging connection to wastewater treatment/disposal systems that discharge outside the watershed as has occurred at the Rollingwood subdivision. The Bear Creek Estates package plant, serving 54 homes, was upgraded in 2005. The package plant at Boulder Creek Golf and Country Club was upgraded to reduce nitrates and wastewater spills from the force main. Implementation of the San Lorenzo River Nitrate TMDL and the County’s Nitrate Management Plan have apparently stabilized nitrate concentrations and resulted in water quality improvements.

Previous studies have indicated that septic systems, wildlife, livestock and pets, and urban runoff are all significant sources of microbial contaminants in the San Lorenzo River. More recently, homeless encampments adjacent to the rivers and tributaries have also been identified as a source of microbial contamination.

The County’s microbial source tracking study showed that, based on ribotyping, birds are the primary source of elevated levels of coliform bacteria in the San Lorenzo River. The San Lorenzo Valley does not have a system of curbs, gutters and storm drains to convey runoff to the River; thus, it is important to protect existing open space areas near stream banks to filter runoff, to focus public education on source control and prevent contamination of runoff, and to maintain the water treatment plants in optimal working condition. When considering the contaminant reduction in the six stream miles in Henry Cowell Redwoods State Park between southern Felton and northern Santa Cruz, it may also be that the reaches of stream between the communities – so characteristic of the San Lorenzo Valley – are one reason why nitrate and bacterial loadings have remained at lower levels than many experts predicted in the past.

6.2.1.2 Water Utilities Influenced

Utilities which obtain surface water from an urbanized watershed area are influenced by both septic system and urban runoff discharges to area streams. These include primarily the Santa Cruz Water Department and selected areas of the San Lorenzo Valley Water District.

6.2.1.3 Wastewater Discharge Recommendations

To minimize the impacts from wastewater treatment discharges, primarily septic systems, recommended actions include:

- The County should continue implementation of the Wastewater Management Plan and revise in accordance with AB885 as discussed in Section 4.9. Records of inspections and upgrades should be kept in both tabular and in map form, preferably on the County’s GIS system to allow focus on problem areas.
Purveyors should continue to collect, tabulate and review the water quality data on a frequent basis (e.g., annually) to evaluate the effectiveness of ongoing management programs. These data should be reviewed in collaboration with the County Environmental Health and the Regional Water Quality Control Board so that appropriate follow-up action can be taken by the appropriate agency.

The drinking water purveyors should inform County Environmental Health when elevated coliform or nitrate levels are detected in raw water sources. The need for an update of the nitrate study that resulted in the County’s 1995 Nitrate Management Plan should be evaluated.

Water purveyors should review development plans for sites upstream of their raw water intakes to verify that measures are in place that will address key issues such as septic system discharges and urban runoff. Specifically, SCWD (and secondarily, SLVWD) should work with County Environmental Health and Planning to review proposed developments upstream of their intakes, such as the Tait Street Diversion, to verify that acceptable control measures planned and that mitigation measures have been appropriately implemented and maintained.

### 6.2.1.4 Urban Runoff Recommendations

Recommendations to control water quality impacts from urban runoff include:

- Evaluate development of best management practices such as low impact development (LID), and management measures directed at the unique properties of sandy soils and watersheds, which call for a common set of measures to minimize nutrient loads, maintain aquifer recharge and the resulting baseflow, minimize erosion and channel incision, and protect springs/seeps/wetlands and riparian-zone resilience during dry months and dry years.

- The County should implement of the SWMP in the watersheds as accepted by the Regional Board. This includes conversion of existing urbanized areas to LID, especially in areas of high water quality benefit.

- Coordinate with Santa Cruz Integrated Regional Water Management (IRWM) program on stormwater management including implementing public education/involvement program to minimize contaminant loading from stormwater runoff. The IRWM program can be used to supplement efforts by the purveyors and the County to inform customers and watershed residents of the ongoing water quality and supply issues. Many residents are not aware or do not appreciate the dual nature of the San Lorenzo Valley – a rural residential area, locally approaching urban densities, and the central water-supply source for the region.

- The County should improve its enforcement of ordinances (e.g. grading, riparian corridor and wetlands protection, sensitive habitat protection, and water quality control) in coho recovery and water supply watersheds to maximize and protect riparian setbacks from drainageways and streams.

- The County should proceed with its planned strengthening of the riparian ordinance discussed in Section 4.9.1.2.
6.2.2 Confined Animal Facilities

6.2.2.1 Conclusions

Horses, the main confined animals in both the North Coast and San Lorenzo River watersheds, can be a major source of wet season nitrate and bacteria levels in surface waters, and a contributor to persistent turbidity as well. Nutrients and pathogens can be mobilized from uncovered manure piles. Trails which cross stream channels degrade stream banks and facilitate direct contamination of surface waters. Similar effects are observed where paddocks adjoin waterways and horses traverse stream banks to reach the water. The County, the NRCS, the RCD, Ecology Action and various equestrian and watershed groups have developed programs to educate horse owners and assist them with design, installation and funding of measures to control pollution from horsekeeping. The County requires that manure management programs are developed for all new permittees and is also able to apply its riparian ordinance to provide the buffers and access management required to minimize nutrient, bacterial, and sediment loadings to surface waters. Although this is an area where substantial improvements have been realized since the original 1996 sanitary survey, primarily through voluntary methods that are discussed in Section 3.6.2, continued sustained effort is needed on both education regarding voluntary programs as well as on enforcement of existing ordinances by the County.

6.2.2.2 Water Utilities influenced

Utilities which draw surface water downstream from bankside stables or areas intensively used by horses can observe higher turbidity and coliform counts. These entities include the Santa Cruz Water Department, San Lorenzo Valley Water District, and on occasions the Lompico County Water District.

6.2.2.3 Confined Animal Facilities Recommendations

It is recommended that the voluntary measures such as the Lifestock and Land Program, with particular focus on horse owners near the waterways, be continued and supported. In addition, it is recommended that the County track complaints and permit violations as well as conduct periodic inspection and monitoring targeting those stables closest to the streams and river. Prior to enforcement, it is suggested that these stable owners should be made aware of the voluntary programs, and only if non-compliance consistently and broadly occurs should enforcement (including referral to the RWQCB) or development of an ordinance be considered. If developed, an ordinance should include simple and effective control measures coordinated through user groups and/or non-regulatory entities with stricter enforcement reserved for significant non-compliance. As an alternative to enforcement, opportunities to develop conservation easements and/or partnerships with land trusts and alternative funding should be considered. Horse stable runoff control practices should be implemented regularly, but particularly emphasized during the fall months in order to minimize contaminant loading during the next rainy season.
6.2.3 Unauthorized Activity

6.2.3.1 Conclusions

Activities, such as non-permitted grading and mountain biking outside of designated areas, cause significant sediment loading to streams while homeless encampments can contribute microbes. As discussed in Section 3.13.1, illegal marijuana cultivation in the watershed appears to be increasing, although may be moving to indoor cultivation which has fewer environmental impacts. The cumulative impact of such activities in and near channels can significantly increase turbidity and other water quality threats in streams.

Changes to the City municipal code in 2004 facilitated code enforcement by authorizing rangers to take enforcement actions on City-managed lands. In addition a conservation easement program has been established to expand the City’s enforcement area to private lands between Tait and Sycamore Grove. Coordination with other officials in the watershed, e.g. State Parks has occurred and should continue.

6.2.3.2 Water Utilities Influenced

Utilities which use surface water collected from developed watershed areas are influenced by unauthorized activities. This includes the Santa Cruz Water Department, San Lorenzo Valley Water District, and the Lompico County Water District, as well as smaller purveyors throughout the survey area.

6.2.3.3 Unauthorized Activities Recommendations

As discussed in Section 3.13, unauthorized activities are considered a chronic and ongoing source of contamination. It is recommended that:

- Outreach to homeowners, perhaps through the existing programs such as Lands and Livestock, be continued regarding negative impacts of grazing
- Improved collaboration with State Parks, DFG, CalFire, and/or non-governmental agencies, regarding other threats so that water utilities can be prepared for potential contaminants.
- The SCWD should continue to advocate for and support removal of homeless encampments as well as developing conservation easements on riparian properties.
- Seeking compliance with existing ordinances and providing education and enforcement should be prioritized, with water-quality protection in mind.

6.2.4 Roads

6.2.4.1 Conclusions

As discussed in Section 3.3 Urban Runoff, Section 3.11 Timber Harvests/Logging, and Section 3.15 Geologic Hazards, roadways are a source of a range of contaminants including sediments and chemicals. This includes roads maintained by private landowners, as part of roads associated with residences and timber harvest and management, as well as public roads
maintained by the County Public Works Department, and by Caltrans. Clearing of landslide debris on roadways and poor maintenance of public and private roads increase erosion and sediment loading to local streams. Roads which require recurrent replacement due to failure of the underlying slopes disproportionately contribute to sedimentation, turbidity, and persistent turbidity.

### 6.2.4.2 Water Utilities Influenced

All of the drinking water purveyors which rely on surface water supplies located downstream from any roadway are influenced by this source.

### 6.2.4.3 Roadway Maintenance Recommendations

In the past, Caltrans and the County Public Works Department have taken significant measures to improve roadway debris control and general maintenance. This includes developing suitable practices to stabilize and dispose of landslide material and to control runoff from stockpiled material. The County, in consultation with water agencies, should identify areas suited to establish additional road maintenance service sites, and mechanisms to quickly move stockpiled material to long-term storage areas, such as has been implemented at the Cabrillo Quarry in Aptos.

As discussed in Section 4.7.1, the County has a Road Maintenance Manual that is used for road maintenance activities to minimize water quality impacts. In addition, the RCD and the NRCS have developed a Rural Roads Sediment Inventory Manual which evaluated rural private roads and developed a maintenance training program which has acquired a statewide reputation over the past 10 years. These programs and manuals help assure that appropriate measures are being implemented on both private and public roads. The County has also secured grants to evaluate improved roadside maintenance practices in riparian areas (herbicide reduction/elimination) and to prepare a new manual for road maintenance practices (erosion and sedimentation reduction). Herbicide use on road right of ways, discussed in Section 3.7.2, are likely the largest source of herbicides in the watersheds, therefore herbicide reduction should be a priority to the County. The inventory of potential sediment sources along county roads in the San Lorenzo Watershed identified priority projects for designed, permitting and implementation through the Integrated Watershed Restoration Program (IWRP) with funds from the Coastal Conservancy, State water bonds such as Proposition 84, and other sources.

Roads do, however, remain a major source of turbidity, and road systems periodically contribute large volumes of sediment when culverts are blocked or when concentrated runoff from roads cause incision: (a) into slopes between the road and the stream network, and (b) within the channels, by concentrating runoff and magnifying peak flows in streams.

It is recommended that:

- The County continue to use and augment the road maintenance measures and procedures developed by CalTrans and Public Works including measures to control the downstream incision and bank erosion described above, as well as pesticide and herbicide use measures;
• Water purveyors support the rural road program to private residential and timber-harvest roads within the County (especially those in proximity to diversions and intakes).

6.2.4.4 Timber Harvests Roadway Recommendations

The recommendations stated above for roadway maintenance should also be applied to roads allowing access for timber harvests by CalFire, owners, and other participants in THP review. Other recommendations are:

- For major portions of road networks, owners should require properly abandoned roads after logging activities are completed and regulatory agencies should confirm this with monitoring. This includes blocking access to the area and restoring road cuts to the original slopes, especially in areas where road densities exceed 3.0 miles per square mile (as recommended by NOAA Fisheries) within portions of a particular watershed within the THP ownership and adjacent to it.

- Purveyors should advocate for follow-up restoration of roads from NOAA fisheries road density analysis for key water-supply watersheds, using NOAA fisheries threshold of 3 mi./sq. mi. as an indicator of ecosystem health.

- Purveyors and the County should work with CalFire to aggressively enforce existing requirements to minimize area damage and maintain roadways, especially in segments close to streams, especially for emergency exemptions for salvage logging in high erosion hazard areas.

- Support effort to prohibit salvage logging in key municipal and public water district watersheds.

- Monitor RWQCB implementation of 2012 updated conditional waiver of waste discharge requirements for timber harvests.

- The SCWD and other water purveyors should lobby for inclusion in the official THP review team, rather than be limited to an advisory role particularly for those harvest that have high potential water quality risk.

6.2.5 Mining/Quarry Activities

6.2.5.1 Conclusions

Quarries have been identified as a potential source of sediment during major storm events, reportedly caused by the failure of on-site settling/retention ponds to contain event stormwater runoff. In the San Lorenzo River watershed, sediment contributions from quarries have been progressively decreasing during recent decades as sediment-control measures are implemented and quarry activity diminishes. In the North Coast watersheds, Bonny Doon Quarry operations, specifically blasting, have caused and contributed to periodic turbidity spikes at Liddell Spring which pose challenges at the SCWD’s water treatment plant.

However, as discussed in Section 3.9, the Bonny Doon Quarry is now closed and undergoing reclamation. Therefore this sediment source has been eliminated. In addition, nitrate data collected at Liddell Spring since 1967 suggests that background nitrate levels at the Spring had
been steadily increasing from about 0.3 mg/l in the late 1960s to values above 1.0 mg/l in the 1990s. More recent data from 2001 to 2011 as shown on Figure 5-8 show a peak value of 2.3 mg/l in 2001 with most values around 0.5 mg/l. A possible source of some of the elevated nitrate levels could be from quarry blasting (ammonium nitrate) at Bonny Doon Quarry – however, this was never confirmed and unlikely to be an issue with closure of the quarry.

6.2.5.2 Utilities influenced

The SCWD has been periodically influenced by turbidity increases in the Liddell Spring source. In the San Lorenzo River watershed, the SCWD is affected by sediment contributions from the one active sand quarry (Quail Hollow), one rock quarry (Felton) and from discontinued quarries (Olympia and Hanson) should stormwater containment facilities fail.

6.2.5.3 Quarries and Mines Recommendations

- The SCWD should advocate for water quality monitoring during closure and reclamation.
- The SCWD should also continue to review staff and EIR reports including closure and post-closure water quality monitoring reports.
- Quarry operators and downstream water users should also:
  - Develop trends of water quality data collected. This will help to identify effectiveness of implemented BMPs or any failure of on-site treatment practices, as well as promote meaningful input from purveyors into appropriate modifications of conditions during the 5-year permit-renewal process through the County.
  - Establish specific water quality objectives for springs and streams located downstream of quarries and request additional water quality data, if and where necessary.
  - Inspect quarries routinely, including visits in the fall period to verify the capacity and condition of on-site settling/retention ponds and erosion control structures, and that these are prepared for heavy rainfalls.
6.2.6 Geologic Hazards and Fires

6.2.6.1 Conclusions
Landslides are the most frequently occurring geologic event affecting the drinking water supply, causing elevated turbidities following major storm events. Earthquakes and erosion from fire areas can severely increase sediment and natural organic matter loading to surface waters, both initially and during the process of ‘recovery’ from these episodic events. Finally, erosion following major fires, floods, landslides and possibly droughts or earthquakes can disrupt use of some or many surface water intakes for periods ranging from several months to several years, or deliver a pulse of sediment to the channel which may take years to dissipate.

6.2.6.2 Utilities influenced
All utilities which use surface water can be influenced by geologic hazards and fires in these watersheds. Water treatment plant operators are usually aware of the potential turbidity spikes that may occur because these types of natural hazards are generally well publicized in the area.

6.2.6.3 Recommendations
Many of the recommendations from Section 6.2.4 for Roads are relevant for Geologic Hazards. Further recommendations regarding fires, some of which were discussed in Section 4.8, include:

- Continue to manage fuels and reduce wildfire hazards.

- For the Loch Lomond watershed, the City should continue to meet with fire management staff to communicate changes to security, field conditions, and other information necessary for fire management as well as incorporate recommendations of the fire plan for watersheds, when completed, for future reports.

- Enhance collaboration with CalFire on improving Community Wildfire Protection Plan (CWPP) projects and lobby for Loch Lomond recognition as an asset at risk under CWPP.

- Maintain fuel breaks on watershed lands including development of an Integrated Pest Management Program to address herbicide application for fuel break maintenance.

- Most purveyors drawing upon surface or spring supplies should anticipate extended turbidity events following a large fire in their watersheds. Planning should focus on alternative sources of supply during the months or years following the fire, and for protecting diversion or distribution facilities from post-fire erosion and slope instability.
6.2.7 Chemical Spills

6.2.7.1 Conclusions

Three ground-water chemical plumes in Felton have been reasonably contained by contemporary standards. Supplemental remedial activity is imminent at the former Chevron and Exxon stations, and may take place at Valeteria as well. The potential remains for chemical spills on highways, on major County roads such as Felton Empire Road or Smith Grade.

6.2.7.2 Utilities influenced

All utilities which obtain surface water from developed watershed areas are potentially influenced by spills on local roadways which should be managed by halting water diversion until clean up has been completed and the pollutant has passed. In addition, long-term discharges such as from leaking underground tanks can be a source that eventually make their way to the creeks and rivers. Currently, the Santa Cruz Water Department is the only utility which has detected any solvent-type chemicals in the water. One chemical, PCE has been detected at levels 5 to 10 times below the regulated limit at the Felton Diversion, and not at any intake used to supply water directly to the treatment plant.

6.2.7.3 Recommendations

In an effort to minimize the impacts of chemical spills, it is recommended that:

- Increased raw water for testing of chemical contaminants
- Collaboration with the County Hazardous Materials Section regarding notification of long-term spills and advocate for control of hazardous materials transport be improved through periodic calls/meetings; and
- Continue efforts to communicate with dispatchers at NetCom and on-scene responders to discuss water agency spill notification procedures.

6.2.8 Pesticides and Herbicides

6.2.8.1 Conclusions

The RWQCB is recommending that the San Lorenzo River be listed as impaired for chlordane and chlorpyrifos as well as for PCBs. The recent RWQCB listing supports that chemical usage may be becoming a more significant issue in these watersheds. However, data are limited to a few samples and chemical usage in the past has been limited.

6.2.8.2 Utilities influenced

All utilities which obtain surface water from watershed areas are potentially influenced by pesticides/herbicides, especially as illegally used for marijuana cultivation, in the watershed.
6.2.8.3  **Recommendations**

In an effort to minimize the impacts of pesticide/herbicide use, it is recommended that:

- Continued implementation of an Integrated Pest Management Program to address herbicide application for fuel break maintenance.
- Coordinate with agricultural users (e.g. vineyards and tree farms) to identify sources.
- Consider periodic pesticide/herbicide scans of raw water to identify in alignment with timing of application for vineyard/tree farm cultivation for potential frequency and severity of water quality impact.

6.3  **Potential Contaminant Sources That Are Not Significant**

Table 6-3 lists the potential contaminant sources which are not deemed to be significant contributors affecting public health at this time. The table lists the supporting information and exceptions when noted. Given the particular Santa Cruz County environment, most of these sources could become significant at times, conditions, or with events discussed above (Section 6.1). Conclusions for these potential contaminant sources are discussed in the following paragraphs.

6.3.1  **Agricultural Land Use**

Overall, agricultural acreage continues to remain very small in both total acreage and individual operations; effects on water supply remains limited. Vineyards potentially pose more a more serious challenge than Christmas tree plantations or organic vegetable farms, due to tillage disruption of steep slopes that result in erosion and use of chemicals for pest control. The chemical contributions from agriculture are discussed in Section 6.2.8 earlier.
<table>
<thead>
<tr>
<th>Contaminant Source</th>
<th>Supporting Information</th>
<th>Exceptions</th>
<th>General Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Agricultural Land Use</strong></td>
<td>Less than one tenth of one percent of area of the watersheds is cultivated although some expansion in the Majors Creek watershed has occurred. Wineries may require National Pollutant Discharge Elimination System (NPDES) permits for process waters.</td>
<td>Some small facilities or private-home vineyards need to improve their erosion control practices, particularly on steeper slopes.</td>
<td>Vineyards are generally not located near streams. Sediment contributions from these areas are usually attenuated before it reaches streams and intakes.</td>
</tr>
<tr>
<td><strong>Wildlife</strong></td>
<td>SLVWD staff indicate that feral pigs no longer appear to be an erosion problem near intakes.</td>
<td></td>
<td>Pigs and other wild animal populations do not appear to have a great potential for contamination of surface waters at this time.</td>
</tr>
<tr>
<td><strong>Solid/Hazardous Waste Facilities</strong></td>
<td>The Ben Lomond municipal landfill closed in 1987. No known hazardous waste facilities exist in the watershed.</td>
<td>Any remaining plume is not deemed a threat to water supply. County has needed to remove naturally-occurring cadmium which leaches from shales as a result of their exposure to the atmosphere as a result of landfill excavating activities.</td>
<td>Down-gradient monitoring indicates no contamination of surface waters.</td>
</tr>
<tr>
<td><strong>Recreation</strong></td>
<td>Recreational activities generally considered of most significance involve water contact recreation. However, an evaluation of the County fecal coliform bacteria data, conducted by the County Health Services Agency, found no significant increase in bacteria in the swimming areas of the San Lorenzo River system. Bacterial water quality appears to improve as the water passes through large open space parks (Henry Cowell State Park) or resides in a reservoir for extended periods (Loch Lomond Reservoir).</td>
<td>The introduction of fecal matter from horses may be significant, especially at stream crossings. The potential for erosion from hiking, horseback riding, and mountain biking may also be significant.</td>
<td>There is an apparent trend of decreasing coliform counts through reaches that pass through the State Parks, which are mostly open space. Erosion control measures have spread quickly throughout the survey area, both on public and private lands. Law enforcement has begun issuing tickets to bikers using illegal trails.</td>
</tr>
</tbody>
</table>
6.3.2  **Wildlife**

The microbial source assessment study identified birds as the major contributor to elevated bacteria levels in the San Lorenzo River and tributary streams. Other wildlife was also found to be a significant source of bacteria. Along with the SLVWD, all utilities with surface and/or spring water intakes in the upper watershed are potentially influenced by birds and other wild animals in the area. If wildlife access at diversions is occurring, fencing and providing alternative water supply should be considered.

6.3.3  **Grazing Animals and Livestock**

Grazing is not widespread in the subject watersheds. Most of the existing grazing occurs away from local streams.

6.3.4  **Solid or Hazardous Waste Facilities**

The one closed landfill in the San Lorenzo River watershed (the Ben Lomond Landfill) does not appear to be contaminating the nearest stream, Newell Creek. Overall, illegal dumping is not a significant contaminant source in any of the watersheds, with respect to drinking water quality.

6.3.5  **Recreational Uses**

The long-term fecal coliform data indicates that swimming may not appreciably impact the microbiological water quality of the streams. In addition, the number of summer swimming holes has decreased as inflatable dams for recreational swimming have been limited in the watershed; a summer dam on Zayante Creek has been observed in recent years. The most potentially significant recreational activities are horseback riding, trail maintenance and use of off-road vehicle of various types and sizes, all of which constitute locally significant sources of sediment. The increased vehicle use on City property and illicit recreational use in Henry Cowell State park may increase erosion and sedimentation. To the extent that these trails and uses are routed away from stream channels, or are at least separated from them by setbacks or open space areas, sediment and microbial contributions to the adjoining streams will be reduced.

The City is conducting a recreational use study for the Loch Lomond watershed which should be evaluated for both the significance of recreation as a contaminant source and future recommendations to reduce water quality impacts.

6.3.6  **NPDES Point Sources**

Only small wastewater facilities exist in the San Lorenzo watershed. These include the 1970s-vintage package treatment plant at the Boulder Creek Golf and Country Club, the Bear Creek Estates Wastewater Treatment Plan constructed in 1986 and upgraded in 2008, and the new facility at the San Lorenzo Valley schools in Felton. These facilities are currently located with on-site wastewater disposal and operated in a manner to minimize downstream water quality impacts. Furthermore, the Country Club is investigating the feasibility of reclaiming treated wastewater to a quality suitable for on-site irrigation.
6.4 Other Conclusions and Recommendations

6.4.1 Water-Quality Monitoring

6.4.1.1 Conclusions Regarding Water Quality Monitoring Programs

The drinking water purveyors participating in this study conduct the required monitoring for raw surface water quality. Results are submitted to regulatory agencies, and in many cases will be available to the public through various purveyor and County web sites. Bacterial data, collected weekly, are routinely tabulated with some analysis now conducted by staff. Although improved and standardized reporting and dissemination of results will help to make the data more useful to interested parties and the public at large; budget and staffing constraints continue to limit the ability to improve sharing of water quality data beyond what is currently available. The data collected are sufficient for water treatment plant operators to make real-time operating decisions regarding bypass of high turbidity source waters.

6.4.1.2 Recommendations Regarding Water Quality Monitoring Programs

Water purveyors should consider the following improvements to their monitoring programs:

- Weekly raw water blend and bi-weekly source water total coliform and *E. coli* data collection should be continued.

- As described earlier under Section 6.2.9 for Pesticides and Herbicides, the raw water-quality data programs should be augmented for pesticides and herbicides because of the potential vulnerability of the water source to this type of contamination. Augmentation should intrinsically include electronic recordation and dissemination of data.

- Evaluate the data regularly to identify any adverse or improving trends and the underlying cause(s) of significant changes.

- Store the data in computerized systems to facilitate easier transmittal of the data to other agencies or to generate graphical water quality trends. The data can then be electronically transferred to a lead agency/utility for routine evaluations.

- As discussed in Section 6.2.6 – Mining/Quarry Activities, current utility water quality databases should be augmented with data collected by quarry operators or other projects responsible for water-quality monitoring in surface or ground waters in either watershed.

- Purveyors and the County should seek an assessment of water-quality trends following episodic events, such as large wildfires, earthquakes, and major storms such as occurred in 1982 or 1998, such that trends may be anticipated, contingency plans developed, and any needed interties or backup facilities identified. Western Santa Cruz County appears to have an unusual number and range of such events, and the experience from such events in and near the County could be readily distilled such that responses to these types of events can be readily planned and implemented.
• Prepare for the next watershed sanitary survey update in 5 years by carefully noting and recording concerns or problem areas, and implementing control measures applicable to specific watershed conditions.

6.4.2 Watershed Management Practices

6.4.2.1 Conclusions Regarding Watershed Management Practices

Established policies, ordinances, and regulations in the County’s General Plan are available to improve surface water quality that are implemented by the County’s Health Services Agency and Planning Departments. As noted in the prior sanitary survey updates, the City has engaged in watershed management activities with a formal emphasis on source protection since 1997, and has developed a sustained staff with 3 full-time positions and support from other City staff. The City is developing a comprehensive watershed management plan which includes no commercial logging on City watershed lands. SLVWD is currently updating its watershed plan and has had a no-commercial logging policy in place since 1985. The County updated its Watershed Management Plan for the San Lorenzo River in 2001.

County and local non-profit organizations efforts have led to numerous structural improvements and involvement with citizen groups to educate the general public, most notably during prior County-wide effort to develop watershed assessment and enhancement plans for selected watersheds, including the San Lorenzo Valley. Multiple staff commitments, however, tend to interfere with watershed management program progress. Therefore, it seems prudent to dedicate County staff to a watershed management program or to augment program activities with water purveyor and local non-profit organization staff. Local non-profits have been successful, for example, in engaging private horse owners in improving stable and manure management.

6.4.2.2 Recommendations for Water Utilities

Most of the ongoing watershed management efforts are coordinated by County staff as part of the wastewater management program, regional erosion-control efforts, and programs to promote salmonid recovery. Therefore, the drinking water utilities should continue to be active in current watershed management programs, in part to meet the specific objectives for drinkable waters. Some programs to consider, many of which are discussed in prior recommendations are:

Public Education/Relations — Formalize coordination with local non-governmental organizations on public education program may be effective at minimizing soil disruption, improving erosion control practices, and reducing urban runoff contamination. Purveyors can increase programs to mail educational pamphlets or develop informational websites.

Increase Watershed Surveillance — Staff should report activities within the watershed which can impact water quality. For example, utilities can establish and publicize a watershed "hotline" telephone number to report illegal, unauthorized, or detrimental activities.

Political Support — Water utilities should lobby the County Board of Supervisors to increase enforcement of existing ordinances and to provide more resources to overall watershed control/management activities.
Special Sandy Soil Provisions – An integrated program meshing use of BMPs and other measures designed to minimize the erosion, sedimentation, nutrient and pathogen issues of Zayante and other sandy soils, plus protect the ground water, wetlands, and valuable stream habitats that they support should be developed and implemented. It will mean more recharge of aquifers with lower level of contaminants, less sand in streams, more water in wetlands and channels, and less maintenance of public facilities, in addition to cleaner water.

Road Restoration based on Road Density Analysis - Lobby Board of Supervisors and County Management to develop and fund road restoration program based on road density analysis for key water-supply watersheds developed as an indicator of ecosystem health.

San Lorenzo Valley Watershed Management Plan In 2001 County Environmental Health completed an update of the update to the 1979 Watershed Management Plan. Water utilities should emphasize to their staff and customers the benefits likely to accrue to drinking water quality from successfully achieving the programs goals. They should also continue their participation in the program, support implementation through the County’s Integrated Regional Water Management Plan, and to help shape subsequent updates.

6.4.2.3 Recommendations for Watershed Managers

Other issues the County and water utilities should consider when developing watershed management programs include:

Continue to investigate and implement feasible management practices. Descriptions of alternative practices are available from numerous sources, especially from such agencies as the American Water Works Association (AWWA) and Water Environment Federation (WEF). Both of these agencies have recently sponsored research projects and conferences to assist communities improve watershed management and protection.

Publicize the programs and materials: These are available from the Resource Conservation District, other County agencies, and local non-governmental organizations which describe specific practices to control erosion from hillsides and roadways, stabilize slopes, construct silt fences construct spring boxes, and to site, construct and maintain septic or advanced on-site waste-disposal systems:

Investigate methods to integrate watershed management projects with other benefits. Some of the projects to enhance watershed1 management may be able to obtain Federal and State funding if other benefits (e.g., fishery improvements and groundwater storage) are integrated into the existing watershed management program. Several watershed management projects are funded using this approach especially through the Department of Water Resources Integrated Regional Water Management (IRWM) program. Through IRWM program the City and County staff are able to meet with other agencies and utilities to discuss watershed management funding needs for specific programs. This includes establishing guidelines to propose projects to councils, boards, etc., and to request support from non-conventional sources for pilot programs, etc.

Development of a holistic approach to manage areas with sandy soils – As described earlier, these measures which (a) limit erosion, (b) reduce sedimentation of streams and drainage improvements, (c) maintain needed recharge to the sandy aquifers, critical to the region’s drought-year water supply, (d) sustain sufficient recharge to protect water quality and control...
nitrate accumulation in the aquifers, and (e) allow springs and wetlands supported by these aquifers to maintain their functions and values.

6.4.3 Emergency Plans

All water purveyors now have vulnerability assessments, and have or are updating emergency plans linked to 911 and emergency services agencies. Continued maintenance and updating of these plans by the purveyors is needed. Improved maps are available to emergency crews through the County’s GIS services, and via web-based mapping and aerial photography available through commercial websites at all times. As discussed in Section 6.2.8, continued efforts to improve notification of water utilities of chemical spills, and other water quality emergencies by dispatchers and on-scene planning is an important element of emergency planning.

6.5 Implementation

To implement the broad range of recommended actions much of which is outside SCWD control, collaboration with other agencies and non-governmental organizations is likely the most feasible means as reallocation of, or possibly additions to, existing staff is unlikely to occur. In addition, the City should continue to seek opportunities to fund projects/programs that could be implemented by City law enforcement and Watershed staff as well as by non-governmental organizations. Therefore, the drinking water utilities and County should discuss the watershed issues with other entities and develop an implementation plan, including the need for additional staffing, for the selected management practices.
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Appendix A: Final Draft Report: Graham Hill WTP
Operations Permit Assistance Study
Draft Report

Graham Hill
Water Treatment Plant
Operations Permit Assistance Study

20 July 2012

Prepared for
Santa Cruz Water Department
715 Graham Hill Road
Santa Cruz, California 95060

K/J Project No. 1268001*00
Table of Contents

List of Appendices...........................................................................................................i
Acronyms.......................................................................................................................ii

Section 1:  Introduction .................................................................................................1

Section 2:  Summary of Project Technical Memoranda .................................................2

Section 3:  Conclusions and Recommendations ..........................................................4

Section 4:  Recommended Next Steps ............................................................................7

References.......................................................................................................................8

List of Appendices

Appendix A:  Technical Memorandum No. 1 – Review of Microbial Source Water Quality and Graham Hill WTP Filter Performance Data
Appendix B:  Technical Memorandum No. 2 – Opportunities for Additional CT Credit at the Graham Hill WTP
Appendix C:  Technical Memorandum No. 3 – Improving Coagulation for DBP Reduction at Graham Hill WTP
## Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDPH</td>
<td>California Department of Public Health</td>
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<tr>
<td>Disinfection CT</td>
<td>disinfectant concentration times contact time</td>
</tr>
<tr>
<td>DBP</td>
<td>Disinfection Byproducts</td>
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<tr>
<td>DOC</td>
<td>dissolved organic carbon</td>
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<tr>
<td>floc/sed</td>
<td>flocculation/sedimentation</td>
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<tr>
<td>GHWTP</td>
<td>Graham Hill Water Treatment Plant</td>
</tr>
<tr>
<td>LT2ESWTR</td>
<td>Long-Term 2 Enhanced Surface Water Treatment Rule</td>
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<tr>
<td>SCWD</td>
<td>Santa Cruz Water Department</td>
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<tr>
<td>SDS</td>
<td>simulated distribution system</td>
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<tr>
<td>Stage 2 D/DBPR</td>
<td>Stage 2 Disinfectants and Disinfection Byproducts Rule</td>
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<td>SWTR</td>
<td>Surface Water Treatment Rule</td>
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<td>TM 1</td>
<td>Technical Memorandum No. 1</td>
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<tr>
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<td>Technical Memorandum No. 2</td>
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<tr>
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<td>Technical Memorandum No. 3</td>
</tr>
<tr>
<td>TOC</td>
<td>total organic carbon</td>
</tr>
<tr>
<td>WTP</td>
<td>water treatment plant</td>
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Section 1: Introduction

The Santa Cruz Water Department’s Graham Hill Water Treatment Plant (GHWTP) is a conventional surface water treatment plant that receives source water supplies from three North Coast sources (Laguna Diversion, Liddell Springs, and Majors Diversion), the San Lorenzo River (Tait St Diversion, Tait Wells, and Felton Diversion via Newell Creek Reservoir), and Newell Creek Reservoir (Loch Lomond Reservoir). The raw source water entering the GHWTP for treatment is often a blend of the different sources.

Since 1998, the California Department of Public Health (CDPH) has required the GHWTP to achieve in increased level of pathogen removal and inactivation—4-log *Giardia* cyst and 5-log virus reduction—through filtration and disinfection, to be in compliance with the California Surface Water Treatment Rule (SWTR). The basis for the increased removal-inactivation requirements is elevated levels of total coliform in the source waters to the GHWTP.

The GHWTP has been able to meet the increased requirements by providing pathogen inactivation (1.5-log *Giardia* inactivation) through chlorine addition ahead of the settling basins to achieve the required disinfection CT (disinfectant concentration times contact time). However, the reaction of natural organic matter and the chlorine disinfectant in the settling basins creates disinfection byproducts (DBP) that are regulated by the Stage 2 Disinfectants and Disinfection Byproducts Rule (Stage 2 D/DBPR). As more water from Loch Lomond is treated at the GHWTP, the higher levels of organics in this water could lead to higher levels of DBPs.

The Santa Cruz Water Department (SCWD) needs to meet SWTR requirements to control for both acute microbial health risks from pathogens (*Giardia*, *Cryptosporidium*, and viruses) as well as chronic health risks from chlorinated DBPs. Complying with both the SWTR and the Stage 2 D/DBP Rules requires a balance between providing removal and inactivation of pathogens while minimizing the formation of DBPs that come from the pathogen inactivation (disinfection) process.

Kennedy/Jenks Consultants (Kennedy/Jenks) worked with SCWD staff to review the GHWTP source water quality data, and evaluate plant CT data and previous jar test data to identify opportunities for potential changes to the GHWTP operations permit, operations and facilities to help reduce DBP formation. The goals of the potential changes include:

- Providing appropriate pathogen inactivation levels to meet the SWTR.
- Providing additional CT to permit moving disinfection to after the settling basins to reduce DBP formation.
- Reducing DBPs to help meet the Stage 2 D/DBPR.

This Report provides a summary of Kennedy/Jenks data review and recommendations for the SCWD to discuss these potential changes with CDPH, to help SCWD balance the pathogen inactivation and DBP formation at the GHWTP, to meet the SWTR and Stage 2 D/DBPR requirements.
Section 2: Summary of Project Technical Memoranda

Kennedy/Jenks worked with SCWD staff to review data for the source water and operations of the GHWTP and prepared three technical memoranda evaluating specific opportunities to balance and meet SWTR and Stage 2 D/DBR requirements.

- Technical Memorandum No. 1: Review of Microbial Source Water Quality and Graham Hill WTP Filter Performance Data
- Technical Memorandum No. 2: Opportunities for Additional CT Credit at the Graham Hill WTP
- Technical Memorandum No. 3: Improving Coagulation for DBP Reduction at Graham Hill WTP

The technical memoranda provide a detailed discussion of the data review, analysis and results of the respective evaluations. The technical memoranda are summarized below and provided as appendices to this report.

Technical Memorandum No. 1: Review of Microbial Source Water Quality and Graham Hill WTP Filter Performance Data

Technical Memorandum No. 1 (TM 1) summarizes a review of microbial source water quality data and filter performance data for the SCWD GHWTP. The objective of the review is to evaluate and provide supporting data for the SCWD to request modification of the GHWTP Operations Permit for either or both of the following:

- Reduce the current GHWTP *Giardia* log removal-inactivation requirement from 4-log to either 3.5- or 3--log based on source water microbial data.

- Increase the current GHWTP *Giardia* log removal credit from 2.5-log to either 3-log or 3.5-log based on plant treatment and filter performance data.

Achieving these objectives would reduce the *Giardia* inactivation requirements at the GHWTP, permit changes to the amount of chlorine used or dosing point for chlorine disinfection, and help to reduce DBP to help meet the Stage 2 D/DBPR criteria in the SCWD distribution system.

The approach to the review of the microbial source water quality data and filter performance data includes four possible strategies/potential approaches to support modification of the GHWTP Operations Permit in accordance with the Environmental Protection Agency and CDPH rules and guidance:

1. Evaluate median monthly source water total coliform and turbidity levels.
2. Evaluate source water *E. coli* or fecal *coliform* 90th percentile MPN Data.
3. Evaluate source water *Giardia*, *Cryptosporidium* and Total Coliform Data.
4. Evaluate Filter Performance Data.
Technical Memorandum No. 2: Opportunities for Additional CT Credit at the Graham Hill WTP

Technical Memorandum No. 2 (TM 2) describes opportunities for additional inactivation CT credit at the SCWD GHWTP. The objective of the CT credit review is to identify potential ways for SCWD to obtain additional inactivation CT contact time and/or credit and therefore modify the chlorine disinfection operations at GHWTP by one or both of the following:

- Reduce the chlorine residual.
- Move the chlorination point downstream of the current point, which is at the rapid mixer #2, ahead of the flocculation/sedimentation (floc/sed) basins.

The SCWD uses several different sources of water, some of which can have moderately high levels of DBP precursors. Combined with chlorine used during disinfection, these precursors can react to form regulated DBPs. These objectives would help to reduce DBPs to help SCWD comply with the Stage 2 D/DBP Rule in the distribution system.

TM 2 reviews past reports on GHWTP hydraulic efficiency and identifies opportunities for achieving additional disinfection CT credit for the GHWTP. The analysis in this TM evaluates opportunities for SCWD to achieve a 1.5-log *Giardia* disinfection credit and, based on the potential for reduced *Giardia* disinfection requirements as described in TM 1, also presents scenarios for SCWD to achieve a 1.0-log and 0.5-log *Giardia* disinfection requirement.

Technical Memorandum No. 3: Improving Coagulation for DBP Reduction at Graham Hill WTP

Technical Memorandum No. 3 (TM 3) describes opportunities to improve DBP precursor removal by enhanced coagulation at the SCWD GHWTP to reduce DBP formation. TM 3 includes a review of previous coagulation and DBP formation studies, jar test and bench test data, and additional data for total organic carbon (TOC), dissolved organic carbon (DOC), and UV absorbance at 254 nanometer wavelength. Based on these data and identified data gaps, this TM identifies opportunities for DBP precursor reduction and recommends additional testing to evaluate a recommended TOC reduction percentage to meet DBP requirements.
Section 3: Conclusions and Recommendations

Kennedy/Jenks worked with SCWD staff to review the GHWTP source water quality data, evaluate plant CT and identify opportunities for potential changes to the GHWTP operations permit, operations and facilities to balance and meet SWTR and Stage 2 D/DBR requirements. The recommended potential changes include:

- Requesting reduction of the GHWTP Giardia inactivation requirements consistent with the SWTR.
- Evaluating and providing additional CT with a dedicated disinfection contactor after the filters, to permit moving disinfection to after the settling basins to reduce DBP formation.
- Optimizing coagulation for both turbidity reduction and organics reduction to reduce DBP precursors to help meet the Stage 2 D/DBPR.

The following conclusions and recommendations are based on the analysis and evaluations in TMs 1, 2 and 3. Please refer to the respective TM for a more detailed discussion of each conclusion and recommendation.

1. Request CDPH revise the GHWTP Operations Permit to a 3-log Giardia and 5-log virus removal inactivation requirement based on source water Giardia data.

   The EPA provides criteria for treatment levels based on measured Giardia cyst concentrations in the source water. For average (geometric mean) source water cyst concentrations of <1 cyst per 100 L of water, the EPA criteria is a 3-log Giardia removal-inactivation requirement.

   While the source water has moderately high levels of total coliform, the measured Giardia levels are low. Based on the SCWD’s Long-Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) sampling from 2007 to 2009, the blended source water to the GHWTP meets the EPA SWTR criteria. Furthermore, there is no correlation between the moderately high total coliform and the Giardia in the source water. These data support a reduction in the Giardia removal-inactivation requirement from the current 4-log to 3-log. The SCWD could be required to institute a regular sampling program to demonstrate continued low levels of Giardia in the blended source water.

   Kennedy/Jenks recommends maintaining the current 5-log virus removal-inactivation requirement. The moderately high coliform levels in the source water are more often associated with bacterial and virus type pathogens. Therefore, the 5-log virus removal-inactivation requirement would be appropriate based on the source water total coliform data.

   The current 5-log virus removal-inactivation can be achieved within the proposed reduced disinfection CT to achieve 3-log Giardia removal-inactivation. Note that the CT to achieve 5-log virus inactivation with free chlorine at GHWTP is 10 mg/l min. The Disinfection CT to achieve 0.5-log Giardia inactivation is 23 mg/l-min. Therefore, in achieving a potential reduced Giardia inactivation goal, the current virus inactivation goal is also achieved.
Lastly, the SCWD has been working with property owners and the Trust for Public Land to develop riparian right-of-ways along the San Lorenzo River and other source waters to provide for installation of vegetation buffers and to permit City Police to enforce laws to maintain water quality. These efforts should further help maintain low levels of \textit{Giardia} in the source water and are described in the SCWD Watershed Sanitary Survey.

2. Discuss with CDPH the recent filter performance data that could further support the objective of a 0.5-log \textit{Giardia} inactivation requirement for the GHWTP.

The LT2ESWTR includes additional filter performance criteria that permit a water supplier to receive additional \textit{Cryptosporidium} removal credit by either 0.5-log or 1.0-log. Because \textit{Cryptosporidium} oocysts are generally smaller than \textit{Giardia} cysts, and the removal mechanism is similar for conventional treatment processes, it would be reasonable to request that CDPH permit SCWD to use the same filtered water turbidity performance criteria in the LT2ESWTR to potentially increase the GHWTP \textit{Giardia} removal credit.

The demonstrated performance of the GHWTP process meets the requirements that would permit increased removal credits of 1-log removal for \textit{Cryptosporidium}. If this were applied to \textit{Giardia}, the GHWTP would only need to achieve a 0.5-log \textit{Giardia} inactivation requirement to achieve the current operations permit requirement of 4-log \textit{Giardia} removal-inactivation.

Furthermore, planned improvements to the GHWTP filters to provide low profile underdrains (which would increase the media path length-to-diameter (L/d) ratio through deeper filter media bed depth) and improved surface wash or airwash for the filters should improve overall filter performance and would support this approach.

3. Evaluate and provide a dedicated CT Contactor after the filtration process.

Evaluating and converting the current filtered water tank into a dedicated disinfection contact tank could permit moving the dosing point for chlorine disinfection to after the settling basins and help to reduce DBPs to help meet the Stage 2 D/DBP Rule. If the \textit{Giardia} inactivation requirement is reduced from 1.5-log to 0.5-log, as recommended above, then SCWD may be able to move the chlorination point further downstream to after the filters, which would provide additional benefit.

4. Optimize coagulation for turbidity and color reduction and conduct enhanced coagulation testing.

Kennedy/Jenks recommends that SCWD evaluate current jar testing for both turbidity removal and color removal for optimizing the coagulation dose. SCWD should also conduct a study to evaluate enhanced alum coagulation for the purpose of removing TOC to reduce DBP formation. The study should include the following elements:

- Current plant profile sampling for TOC (or DOC), SUVA, and simulated distribution system (SDS) DBPs to benchmark current system performance.
- SDS DBP formation sampling with respect to different source water blends and filtered water TOC (or DOC) and SUVA to understand how TOC levels impact distribution system DBPs for the GHWTP and SCWD distribution system.
• Enhanced coagulation jar testing at 10 mg/L alum increments as described in Enhanced Coagulation Manual with associated SDS DBP testing.
Section 4: Recommended Next Steps

Kennedy/Jenks recommends the following next steps to put the above recommendations into action. While the different recommendations are related, the actions below do not need to be taken in any specific order. However, the SCWD should periodically review the results from each action or step and make adjustments to future steps as necessary.

- Send this Draft Report to the CDPH and request a meeting to discuss the potential for revising the GHWTP Operations Permit pathogen removal-inactivation requirements. Kennedy/Jenks would attend the meeting with CDPH to help support SCWD staff in the discussions on this topic.

- Make preparations to begin sampling for Giardia in the blended source water to the GHWTP in support of revising the Operations Permit.

- Conduct a condition assessment of the existing tanks at the GHWTP and prepare a conceptual design report of the concepts and costs of converting the existing treated water storage tank into a dedicated disinfection contactor.

- Start optimizing coagulation dose for organics reduction as well as turbidity removal and conduct plant profile and SDS DBP testing program.
References

See the attached TMs for references specific to each TM.
Appendix A

Technical Memorandum No. 1 – Review of Microbial Source Water Quality and Graham Hill WTP Filter Performance Data
20 July 2012

Technical Memorandum No. 1

To: Mr. Terry Tompkins, SCWD
From: Joe Drago, PhD, PE
        Julia Sorensen, PE
        Craig Thompson, PE, BCEE
Subject: Review of Microbial Source Water Quality and GHWTP Filter Performance Data
        SCWD Graham Hill WTP Operations Permit Assistance
        K/J 1268001*00

1 Introduction

This Technical Memorandum (TM) No. 1 summarizes a review of microbial source water quality data and filter performance data for the Santa Cruz Water Department’s (SCWD) Graham Hill Water Treatment Plant (GHWTP). The objective of the review is to evaluate and provide supporting data for the SCWD to request modification of the GHWTP Operations Permit for either or both of the following:

- Reduce the current GHWTP Giardia log removal-inactivation requirement from 4-log to either 3.5- or 3-log based on source water microbial data.
- Increase the current GHWTP Giardia log removal credit from 2.5-log to either 3-log or 3.5-log based on plant treatment and filter performance data.

Achieving these objectives would reduce the Giardia inactivation requirements at the GHWTP, permit changes to the amount of chlorine used or dosing point for chlorine disinfection, and help to reduce disinfection byproducts (DBP) to help meet the Stage 2 Disinfectants and Disinfection Byproducts (D/DBP) Rule criteria in the SCWD distribution system.

The approach to the review of the microbial source water quality data and filter performance data includes four possible strategies/potential approaches to support modification of the GHWTP Operations Permit in accordance with the EPA and California Department of Public Health (CDPH) rules and guidance:

1. Evaluate median monthly source water total coliform and turbidity levels
2. Evaluate source water E. coli or fecal coliform 90th percentile MPN Data
3. Compare source water Giardia, Cryptosporidium and Total Coliform Data
4. Evaluate Filter Performance Data
The TM describes the objectives and results of each evaluation in more detail in the sections below.

2 Background

2.1 Graham Hill WTP and Source Water Supplies

The GHWTP is a conventional surface water treatment plant with pre-oxidation, taste and odor treatment with permanganate and powdered activated carbon, rapid mix (flash) coagulation, flocculation, sedimentation, granular media filtration, free chlorine disinfection, and corrosion control. The GHWTP receives source water supplies from three North Coast sources (Laguna Diversion, Liddell Springs, and Majors Diversion), the San Lorenzo River (Tait St Diversion, Tait Wells, and Felton Diversion via Newell Creek Reservoir), and Newell Creek Reservoir (Loch Lomond Reservoir). The raw source water entering the GHWTP for treatment is often a blend of the different sources and is also sampled, in addition to the individual sources. Figure 1 shows a schematic of the source water supplies to the GHWTP.
2.2 Operations Permit Requirements

On July 13, 1998, the City received a letter from the California Department of Health Services (CDHS), the predecessor to CDPH, that instituted a requirement of a total of 4 log \textit{Giardia} cyst and 5 log virus reduction through the filtration and disinfection processes at the SCWD’s GHWTP to be in compliance with the California Surface Water Treatment Rule (SWTR). The basis for the increased removal-inactivation requirements was elevated levels of total coliform in the source waters to the GHWTP.

The CDPH allowed for the preparation of a watershed sanitary survey or continued monitoring to demonstrate that the SCWD’s source water supplies can be managed to permit returning to the standard 3-log \textit{Giardia} and 4-log virus reduction performance standard. The GHWTP is also required to comply with the Interim Enhanced Surface Water Treatment Rule (IEWSTR) and Long-Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR).

In addition to the \textit{Giardia} and virus reduction requirements of the SWTR, the GHWTP must also comply with the IESWTR that includes a 2-log \textit{Cryptosporidium} oocyst removal requirement that can be achieved by maintaining filtered water turbidity less than or equal to 0.3 NTU in at least 95 percent of the filtered water samples collected during each month. Furthermore, the LT2ESWTR includes a source water monitoring requirement that all water systems have completed to determine the statistically-based risk of \textit{Cryptosporidium} in the GHWTP’s source water supply. The source water LT2ESWTR \textit{Cryptosporidium} analysis is used to determine if additional treatment is required.

Since 1998, the SCWD has conducted periodic watershed sanitary surveys, implemented watershed control and monitoring programs, and sampled the different source waters regularly for total coliform, \textit{E. coli} and conducted sampling in accordance with CDPH requirements. These data are summarized and evaluated below.

3 Data Review

Source water quality data from 2001 to 2011 were reviewed for the SCWD’s individual and blended water sources to determine whether the microbial data would support requesting that the CDPH modify its 1998 finding that the GHWTP source water requires that the water treatment processes at the GHWTP provide 4-log \textit{Giardia} and 5-log virus reduction. The following documents and information were reviewed as part of this study:

- Letter dated November 1, 1991 from CDHS regarding SWTR requirements
- Letter dated July 13, 1998 from CDHS requiring 4 log \textit{Giardia} and 5 log virus reduction (removal plus inactivation)
Using the data listed above, the four analyses were conducted to determine if one or more set of data would support the objectives of this TM. The following sections discuss the findings of each of the four data evaluations.

3.1 Evaluation of Median Monthly Total Coliform Levels

3.1.1 Basis of Analysis

The CDPH Surface Water Treatment Staff Guidance Manual (SWTSGM) Appendix B classifies source waters by median monthly total coliform criteria to help provide guidance on appropriate levels of microbial removal and inactivation requirements for a surface WTP. Source waters with median monthly total coliform levels consistently less than 1,000 MPN/100 ml are classified as suitable for the standard 3-log Giardia and 4-log virus reduction requirement.

3.1.2 System Data Evaluation

The SCWD’s source water quality data were reviewed to evaluate how often the median monthly total coliform levels were consistently less than 1,000 MPN/100 ml.

Figure 2 shows total coliform data for the different sources over the period 2010 to 2011. Of the SCWD’s various sources of water, Liddell Spring has the lowest total coliform MPN, the Laguna and Majors Diversions and Newell Creek have moderate levels of total coliform MPN, and the San Lorenzo River diversions have the highest total coliform MPN. However, the blended raw
water was often above the 1,000 MPN/100 ml level, as shown in Figure 3 below for the period 2001 to 2011.

Kennedy/Jenks also evaluated if turbidity data could provide a conservative correlation with total *coli*form and could be used to serve as a conservative real-time indicator for source selection. As indicated in Figure 4, there was no distinct correlation between turbidity and total *coli*form for the raw blended water. There was no good correlation for the individual sources either. Analysis of monthly total *coli*form and turbidity data for each individual source water is included in Attachment 1.

**Figure 2. Total Coliform from Each Water Source, 2010 – 2011**
Figure 3. Raw Blend Total Coliform, 2001 – 2011
3.1.3 Analysis Conclusion

Based on the above analysis, the source water median monthly total coliform data do not provide information that would support the SCWD objectives.

3.2 Evaluation of *E. coli* 90th Percentile MPN Data

3.2.1 Basis of Analysis

Based on discussions with Kurt Souza, co-chair of the CDPH Water Treatment Committee, Table 6-3, “Impact of Source Water Quality and Filtration Process on Alternative Disinfection Benchmark”, in the USEPA Disinfection Profiling and Benchmarking Guidance Manual (page 6-8) could be used to determine whether the GHWTP source(s) would qualify for a 0.5-log (lower) *Giardia* removal requirement. Table 6-3 also classifies source waters by using either the fecal coliform or the *E. coli* 90th percentile MPN to provide guidance on appropriate levels of microbial removal and inactivation requirements for a surface WTP. If the *E. coli* 90th percentile MPN for each of the SCWD’s water sources is less than 20 or 30 per 100 ml, it may be possible to use Table 6-3 to reduce the current 4-log *Giardia* removal-inactivation goal to as low as 3.5-log.
3.2.2 System Data Evaluation

Figure 5 presents the *E. coli* data for the different GHWTP source waters during the period of January 2010 through July 2011. Although some of the City’s surface water sources have low *E. coli* MPN, not all of the sources had values less than 20 or 30 per 100 ml. As shown in Figure 5 below, the San Lorenzo River (SLR) sources, the Majors Diversion, and the raw blend consistently had *E. coli* MPN values greater than 20 or 30 per 100 ml.

**Figure 5. *E. coli* Data, January 2010 – July 2011**
Figure 6 presents a cumulative frequency distribution of the *E. coli* MPN values for the blended raw water to the GHWTP. Although some of the SCWD’s sources of water have low *E. coli* MPN, the 90th percentile value for the raw blend water is approximately 110 per 100 ml.

**Figure 6. Blend Water E-Coli 90th Percentile Distribution, 2001 – 2011**

### 3.2.3 Analysis Conclusion

Based on the above analysis, the *E. coli* 90th percentile MPN data approach does not provide data that would support the SCWD objectives.
3.3 Evaluation of *Giardia* and *E. coli* Data to Reduce 4-log *Giardia* Requirement

### 3.3.1 Basis of Analysis

The CDPH SWTSGM Appendix B permits a water supplier to conduct a watershed sanitary survey and to monitor for *Giardia lamblia* to more accurately document the assumed risk associated with the water supply source, if the water supplier feels median monthly total coliform approach is too restrictive. From the SWTSGM Appendix B, the EPA provides criteria for treatment levels based on measured *Giardia* cyst concentrations in the source water. For average (geometric mean) source water cyst concentrations of <1 cyst per 100 L of water, the EPA criteria is a 3-log *Giardia* removal-inactivation requirement.

### 3.3.2 System Data Evaluation

Table 1 presents the blended source water *Giardia*, *E. coli*, and *Cryptosporidium* results from the SCWD’s LT2ESWTR sampling program in 2007 through 2009. Based on the SCWD’s LT2ESWTR sampling, the average (geometric mean) source water cyst concentrations of the blended source water is <1 cyst per 100 L of water. These data support the SCWD’s objectives and could be used to justify a reduction in the *Giardia* removal-inactivation requirement from the current 4-log to 3-log. (Note that the current 5-log virus removal-inactivation requirement would likely still be appropriate.)
Table 1. SCWD GHWTP - LT2ESWTR Source Water Sampling Data, 2007 – 2009

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<th>Date</th>
<th>Giardia (organisms/100L)</th>
<th>E. coli (MPN)</th>
<th>Cryptosporidium (organisms/L)</th>
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In addition, an evaluation of the potential relationship between the blended source water Giardia and E. coli concentrations indicate that there does not appear to be a correlation between the blended source water Giardia and E. coli concentrations, as indicated in Figure 7. As the E. coli concentration increases, the Giardia concentration does not increase.
3.3.3 Analysis Conclusion

These microbial data appear to support the SCWD’s objectives. It is reasonable to propose that due to the measured low levels of *Giardia* in the blended source water (<1 per 100L) and the fact that there is no apparent correlation between the *Giardia* and *E. coli* concentrations, the *Giardia* removal-inactivation requirement should be reduced to 3-log. Since there does not appear to be a correlation between the *E. coli* and *Giardia* data and there is a relatively high likelihood that *E. coli* is a good indicator of the presence of enteric viruses, the GHWTP virus removal-inactivation goal should remain at the current 5-log.
If this approach is used to reduce the *Giardia* removal-inactivation requirement, the CDPH may require regularly scheduled *Giardia* source water monitoring to continue to document that the current low level of *Giardia* cysts in the blended source water to the GHWTP are maintained.

### 3.4 Filter Performance Evaluation to Increase Removal Credit

#### 3.4.1 Basis of Analysis

The California IESWTR gives well-run conventional surface water treatment plants (that maintain CFE <0.3 NTU in at least 95% of the samples collected at ≤15 minute intervals during each month) 2-log removal credit for *Cryptosporidium* oocysts. The LT2ESWTR includes additional filter performance criteria that permit a water supplier to receive additional *Cryptosporidium* removal credit by either 0.5-log or 1.0-log. The additional filter performance above that required in the IESWTR that can be used to receive additional credit include:

a. An additional 0.5-log removal credit is available if either all of the individual filters’ filtered water turbidity is ≤0.10 NTU in at least 95% of the filtered water samples collected during each month or when the CFE turbidity is ≤0.10 NTU in at least 95% of the CFE samples collected during each month, or

b. An additional 1.0-log removal credit is available if all of the individual filters’ turbidity and the CFE turbidity also is ≤0.10 NTU in at least 95% of the samples analyzed during each month, when collected at 15 minute intervals (or less).

Because *Cryptosporidium* oocysts (~1 to 6 microns) are generally smaller than *Giardia* cysts (~6 to 14 microns), and the removal mechanism for both *Cryptosporidium* oocysts and *Giardia* cysts is similar for conventional treatment processes, it would be reasonable to request that CDPH permit SCWD to use the same filtered water turbidity performance criteria in the LT2ESWTR to increase the GHWTP *Giardia* removal credit by either 0.5-log or 1.0-log.

#### 3.4.2 System Data Evaluation

SCWD provided the GHWTP 15-minute filtered water turbidity data for the CFE and each of the filters, for the time period of February 2011 to February 2012. Figure 8 shows the 95th percentile turbidity values graphically for the CFE and filters 2 and 4. Table 2 summarizes the 95th percentile turbidity values numerically for all of the filters and the CFE for each month. As part of the data review, unusual turbidity data were confirmed with SCWD to have occurred during maintenance or other offline activities and were deleted from the filtered water turbidity data used to determine the 95th percentile values.
Figure 8. Filter Turbidity 95th Percentile Values, Feb 2011 – Feb 2012
3.4.3 Analysis Conclusion

The filter performance data for February 2011 through March 2012 meets the LT2ESWTR requirements to receive an additional 1.0-log removal credit for Cryptosporidium oocysts and it is reasonable to propose that the GHWTP be granted an additional 1.0-log Giardia (total of 3.5-log for the overall GHWTP) removal credit.

If this approach is used to increase the Giardia removal-inactivation credit, the CDPH may require evaluation of additional past years of filter performance data and possibly may require additional CFE and filter monitoring data each month. Planned improvements to the GHWTP filters to provide low profile underdrains (which would increase the media path length-to-diameter (L/d) ratio through deeper filter media bed depth) and improved surface wash or airwash for the filters should improve overall filter performance and would support this approach.

4 Summary and Conclusions

The SCWD needs to meet EPA and CDPH surface water treatment requirements to control for both acute microbial health risks from pathogens (Giardia, Cryptosporidium, and viruses) as well as chronic health risks from chlorinated disinfection byproducts (DBPs). Complying with both
The LT2SWTR and the Stage 2 D/DBP Rules require a balance between providing removal and inactivation of pathogens while minimizing the formation of DBPs that come from the pathogen inactivation (disinfection) process.

TM No. 1 reviewed microbial source water quality data and filter performance data for the GHWTP with the objective of provide supporting data for the SCWD to request modification of the GHWTP Operations Permit for either or both of the following:

- Reduce the current *Giardia* log removal-inactivation requirement from 4-log to either 3.5- or 3-log based on source water microbial data.

- Increase the current GHWTP *Giardia* log removal credit from 2.5-log to either 3-log or 3.5-log based on plant treatment and filter performance data.

Achieving these objectives would reduce the GHWTP *Giardia* inactivation requirement, permit changes to the amount of chlorine used or dosing point for chlorine disinfection, and help to reduce DBPs to help meet the Stage 2 D/DBP Rule throughout the SCWD distribution system.

Based on Kennedy/Jenks evaluation the GHWTP source water microbial characteristics and filter performance data, Kennedy/Jenks recommends proposing the following to the CDPH with the goal of reducing the GHWTP *Giardia* (only) inactivation requirement to 0.5-log.

- Reduce the GHWTP *Giardia* log removal-inactivation requirement to 3-log based on the LT2ESWTR source water *Giardia* data, and institute a regular sampling program to demonstrate continued low levels of *Giardia* in the blended source water. The virus combined log removal-inactivation requirement would stay at 5-log.

- Increase the GHWTP *Giardia* log removal credit from 2.5-log to 3.5-log based on the LT2ESWTR additional *Cryptosporidium* oocysts removal credit granted based on filter performance. (Assuming the GHWTP *Giardia* log removal-inactivation requirement remains at 4-log, the inactivation requirement for the GHWTP would be 0.5-log).

Kennedy/Jenks is available to assist and support the SCWD Staff in making this proposal to the CDPH.
References

Surface Water Treatment Rule, Final Rule. 40 CFR, Parts 141, 142, and 143.


Technical Memorandum No. 1
Review of Microbial Source Water Quality and GHWTP Filter Performance Data
20 July 2012
1268001*00
Page 18

Attachments

Attachment A – Total Coliform Data

Liddell Spring

Figure A-1 – Liddell Spring Total Coliform vs. E. coli
Figure A-2 – Liddell Spring Turbidity vs. Total Coliform
Laguna Diversion

Figure A-3 – Laguna Diversion Total Coliform vs. *E. coli*

Figure A-4 – Laguna Diversion Turbidity vs. Total Coliform
Majors Diversion

Figure A-5 – Total Coliform vs. *E. coli*

![Total Coliform vs. E. coli](image1)

Figure A-6 – Turbidity vs. Total Coliform

![Turbidity vs. Total Coliform](image2)
Newell Creek (Loch Lomond)

Figure A-7 – Total Coliform vs. \textit{E. coli}

Figure A-8 – Turbidity vs. Total Coliform
San Lorenzo River – Tait St Diversion

Figure A-9 – Total Coliform vs. E. coli

Figure A-10 – Turbidity vs. Total Coliform
San Lorenzo River – Felton Diversion

Figure A-11 – Total Coliform vs. *E. coli*

![Figure A-11](image1)

Figure A-12 – Turbidity vs. Total Coliform

![Figure A-12](image2)
Appendix B

Technical Memorandum No. 2 – Opportunities for Additional CT Credit at the Graham Hill WTP
18 May 2012

Technical Memorandum No. 2

To: Mr. Terry Tompkins, SCWD

From: Julia Sorensen, PE
Craig Thompson, PE, BCEE
Joe Drago, PhD

Subject: Opportunities for Additional CT Credit at the Graham Hill Water Treatment Plant
SCWD Graham Hill WTP Operations Permit Assistance
K/J 1268001*00

1 Introduction

This Technical Memorandum (TM) No. 2 describes opportunities for additional inactivation CT credit at the Santa Cruz Water Department’s (SCWD) Graham Hill Water Treatment Plant (GHWTP). The objective of the CT credit review is to identify potential ways for SCWD to obtain additional inactivation CT contact time and/or credit and therefore modify the chlorine disinfection operations at GHWTP by one or both of the following:

- Reduce the chlorine residual
- Move the chlorination point downstream of the current point, which is at the rapid mixer #2, ahead of the flocculation/sedimentation (floc/sed) basins

The SCWD uses several different sources of water, some of which can have moderately high levels of disinfection byproduct (DBP) precursors. Combined with chlorine used during disinfection, these precursors can react to form regulated DBPs. These objectives would help to reduce DBPs to help SCWD comply with the Stage 2 Disinfectants/Disinfectant Byproducts (D/DBP) Rule in the distribution system.

This TM reviews past reports on GHWTP hydraulic efficiency and identifies opportunities for achieving additional disinfection CT credit for the GHWTP. The analysis in this TM evaluates opportunities for SCWD to achieve a 1.5-log Giardia disinfection credit and, based on the potential for reduced Giardia disinfection requirements as described in TM No. 1, also presents scenarios for SCWD to achieve a 1.0-log and 0.5-log Giardia disinfection requirement.

2 Background

The GHWTP is a conventional surface water treatment plant with pre-oxidation, rapid mix (flash) coagulation, flocculation, sedimentation, granular media filtration and free chlorine disinfection. As described in TM No. 1, the California Department of Public Health (CDPH) currently requires a total of 4-log Giardia cyst and 5-log virus reduction (combined removal-inactivation) through the filtration and disinfection processes at the GHWTP. Currently, the 4-log Giardia cyst
reduction is achieved by a combined 2.5-log removal through sedimentation and filtration, and 1.5-log inactivation through disinfection.

Chlorine is currently added to the rapid mixer #2, upstream of the floc/sed basins and is measured downstream of the basins. Currently, the full required inactivation CT (the product of the chlorine residual concentration (C) and contact time (T)) is achieved in the floc/sed basins, because they provide the most contact time at the GHWTP.

The required CT value to achieve a specific log inactivation of *Giardia* varies based on temperature, pH, and the residual chlorine concentration. Based on a 1.5-log *Giardia* inactivation goal, a water temperature of 8 degrees Celsius, and a pH of 7.5, the estimated *Giardia* CT required is approximately 79 mg/L-min at a chlorine concentration of 1.0 mg/L. The SCWD Operators also desire to maintain an operational safety factor of approximately 1.5 times to ensure that the GHWTP meets the inactivation requirements. Therefore, including a safety factor of 1.5, the *Giardia* CT to achieve 1.5-log inactivation is approximately 120 mg/L-min at a chlorine concentration of 1.0 mg/L.

Note that the CT to achieve 5-log virus inactivation with free chlorine under the conditions described above is only 10 mg/l min. The Disinfection CT to achieve 0.5-log *Giardia* inactivation is 23 mg/l-min. Therefore, in achieving a potential reduced *Giardia* inactivation goal, the current virus inactivation goal is also achieved.

There is opportunity to receive additional disinfection CT credit in at the GHWTP with modifications to the facility as described below.

### 3 Data Review

The following documents and information were reviewed as part of this study:

- CDHS (December 1992) – Engineering Report for SCWD
- CDM (October 2007) – Water Quality and Systems Improvement Study, Summary Report
- CDM (June 1993) – Graham Hill Water Treatment Plant Tracer Study Report
- CDM (August 1991) – Letter regarding CT Compliance Evaluation
Technical Memorandum No. 2
Mr. Terry Tompkins, SCWD
18 May 2012
1268001*00
Page 3

- CDPH (dated November 1, 2010) – Letter regarding findings from the 2010 Sanitary Survey for the Santa Cruz Water Department
- SCWD (January 2012) – Excel file for CT Compliance for *Giardia lamblia* cysts by Free Chlorine
- SCWD (August 9, 1993) – Letter regarding Graham Hill WTP Tracer Study

### 4 Opportunities for Additional CT Contact Time and Credit

The chlorination point at GHWTP currently is upstream of both the floc/sed and filtration processes in order to take advantage of the relatively long contact time of the floc/sed basins. However, because DBP precursors are present in source water in the floc/sed basins, DBPs are formed during the chlorine inactivation process. A strategy to reduce DBP formation is to add chlorine after a significant portion of the DBP precursors have been removed in the sedimentation and filtration water treatment processes. Another strategy would be to provide additional contact time to permit reducing the chlorine residual levels through the GHWTP. This TM evaluates the following potential opportunities to provide additional disinfection contact time or disinfection credit at the GHWTP:

- Additional CT credit from existing filters
- Additional CT credit from existing filters with modifications to chlorine addition
- Additional CT credit from treated water pipelines
- Additional CT credit from a modified filtered water (FW) tank
- Combinations of the above

Table 1 below summarizes six different scenarios for achieving the required *Giardia* log inactivation CT at the GHWTP which combine the above opportunities for additional disinfection contact time or disinfection credit. For each alternative, Table 1 describes the processes which provide the CT, the modifications to the GHWTP, the relative potential for reducing distribution system DBPs and the relative qualitative cost or complexity of the modifications.

Figures 1 through Figure 6 show the six different scenarios graphically. The figures show the GHWTP processes and current and potential chlorine addition points, chlorine residual analyzer locations, and approximate process contact times and chlorine residuals to achieve a 1.5-log
Giardia inactivation. The figures show the required and calculated CT values for a plant flow of 18 MGD, water temperature of 8 degrees Celsius, a pH of 7.5, and the associated process chlorine residuals.

Following the figures, Kennedy/Jenks provides a brief description of the modifications to the GHWTP required for each scenario, and tabulates the chlorine residuals required to meet potential reduced 1.0-log and 0.5-log Giardia disinfection requirements at plant flows of 9 MGD and 18 MGD.

Table 1 – Alternatives to Provide Additional Disinfection CT at the GHWTP

<table>
<thead>
<tr>
<th>Alt.</th>
<th>CT Achieved In:</th>
<th>Summary Description/Change</th>
<th>Potential for DBP Reduction</th>
<th>Potential Cost and/or Complexity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>- Floc/Sed Basins</td>
<td>- Maintain existing conditions</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>2</td>
<td>- Floc/Sed Basins</td>
<td>- Filters</td>
<td>- Install chlorine analyzer downstream of filters to take credit for filter contact time</td>
<td>Low</td>
</tr>
<tr>
<td>3</td>
<td>- Floc/Sed Basins</td>
<td>- Filters</td>
<td>- Install chlorine addition point upstream of filters - Install chlorine analyzer downstream of filters</td>
<td>Low</td>
</tr>
<tr>
<td>4</td>
<td>- Floc/Sed Basins</td>
<td>- Filters</td>
<td>- Treated Water Pipelines</td>
<td>- Install chlorine analyzer in distribution pipelines just before first customer</td>
</tr>
<tr>
<td>5</td>
<td>- Filters</td>
<td>- FW tank</td>
<td>- Treated Water Pipelines</td>
<td>- Modify FW tank for CT - Install chlorine analyzer downstream of FW tank - Move chlorine addition to after the sedimentation process</td>
</tr>
<tr>
<td>6</td>
<td>- FW tank</td>
<td>- Treated Water Pipelines</td>
<td>- Move chlorine addition point upstream of Clearwell - Modify FW tank for CT - Add chlorine analyzer downstream of FW tank</td>
<td>High</td>
</tr>
</tbody>
</table>

The different alternatives are shown in the figures below and described in the following sections.
for 18 mgd, 1.5-log Giardia removal, 1.5 safety factor

Figure 1 – Current Disinfection Operation Floc/Sed CT Schematic (Alternative 1)

<table>
<thead>
<tr>
<th>Required CT (mg/L-min)</th>
<th>121</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculated CT (mg/L-min)</td>
<td>127</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Disinfection Chlorine Addition</th>
<th>T_{10} (min) 106</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Chlorination</td>
<td>Typical Residual, 1.1 - 1.3 mg/L</td>
</tr>
<tr>
<td>To Pasatiempo</td>
<td></td>
</tr>
<tr>
<td>To Customers</td>
<td></td>
</tr>
</tbody>
</table>

Calculated CT (mg/L-min) 127

Figure 2 – Floc/Sed + Filter CT Schematic (Alternative 2)

<table>
<thead>
<tr>
<th>Required CT (mg/L-min)</th>
<th>118</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculated CT (mg/L-min)</td>
<td>128</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chlorine Addition</th>
<th>T_{10} (min) 106</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Chlorination</td>
<td>T_{14} (min) 22</td>
</tr>
<tr>
<td>To Pasatiempo</td>
<td></td>
</tr>
<tr>
<td>To Customers</td>
<td></td>
</tr>
</tbody>
</table>

Calculated CT (mg/L-min) 128

Measured Chlorine Residual (mg/L) 1.2
Figure 3 – Floc/Sed + Filter CT + New Chlorination Point Schematic (Alternative 3)

<table>
<thead>
<tr>
<th>Required CT (mg/L-min)</th>
<th>120</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT (mg/L-min)</td>
<td>120</td>
</tr>
</tbody>
</table>

Figure 4 – Floc/Sed + Filter + Pipeline CT Schematic (Alternative 4)

<table>
<thead>
<tr>
<th>Required Pasatiempo Flowrate</th>
<th>510 gpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required CT (mg/L-min)</td>
<td>117</td>
</tr>
<tr>
<td>CT (mg/L-min)</td>
<td>129</td>
</tr>
</tbody>
</table>
Figure 5 – Floc/Sed + Filter + New FW Tank + Pipeline CT Schematic (Alternative 5)

- Required CT (mg/L-min) 122
- CT (mg/L-min) 127
- Chlorine Addition
- T₁₀ (min) 106
- Chlorine Addition
- T₁₀ (min) 22
- Measured Chlorine Residual (mg/L) 0.3

Figure 6 – New FW Tank + Pipeline CT Schematic (Alternative 6)

- Required CT (mg/L-min) 147
- CT (mg/L-min) 148
- Chlorine Addition
- Pipeline T₁₀ (min) 15.0
- To Pasatiempo
- Tank T₁₀ (min) 36
- Measured Chlorine Residual (mg/L) 2.9
4.1 Alternative 1 – Current Operations: Floc/Sed CT

This alternative provides a baseline to compare to the other alternatives. With just the floc/sed basins the GHWTP achieves 1.5-log *Giardia* inactivation. If SCWD is able to reduce its *Giardia* inactivation requirement to 1.0-log or 0.5-log, the chlorine residual requirement could be reduced as shown in Table 2. In all the scenarios below, this could help reduce DBP levels.

Table 2 – Alternative 1 Disinfection Requirements

<table>
<thead>
<tr>
<th>Flowrate (mgd)</th>
<th>1.5-log <em>Giardia</em> inactivation</th>
<th>1.0-log <em>Giardia</em> inactivation</th>
<th>0.5-log <em>Giardia</em> inactivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>0.6</td>
<td>0.4</td>
<td>0.2</td>
</tr>
<tr>
<td>18</td>
<td>1.2</td>
<td>0.8</td>
<td>0.4</td>
</tr>
</tbody>
</table>

4.2 Alternative 2 – Floc/Sed CT + Filter CT

Kennedy/Jenks reviewed the CDM (June 1993) – Graham Hill Water Treatment Plant Tracer Study Report and related correspondence with the CDPH. According to CDM Tracer Study Report, the filters could provide an additional 22 minutes of contact time at a plant flow rate of 18 MGD.

Alternative 2 would include installation of a second chlorine analyzer downstream of the filters, as shown in Figure 2, to take advantage of the contact time to and through the filters. At 18 mgd, this alternative would provide 22 additional minutes of contact time and allow the chlorine concentration to be reduced slightly to approximately 1 mg/L. While this is a relatively simple modification, this would likely have only a minimal impact on DBPs, if any.

Table 3 shows the Alternative 2 disinfection requirements for varying flowrates and inactivation targets.

Table 3 – Alternative 2 Disinfection Requirements

<table>
<thead>
<tr>
<th>Flowrate (mgd)</th>
<th>1.5-log <em>Giardia</em> inactivation</th>
<th>1.0-log <em>Giardia</em> inactivation</th>
<th>0.5-log <em>Giardia</em> inactivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>0.5</td>
<td>0.3</td>
<td>0.2</td>
</tr>
<tr>
<td>18</td>
<td>1.0</td>
<td>0.6</td>
<td>0.3</td>
</tr>
</tbody>
</table>
4.3 Alternative 3 – Floc/Sed CT + Filter CT + New Chlorination Point

Alternative 3 would include addition of a second chlorination point between the floc/sed basins and the filters (downstream of the first chlorine residual measurement) and installation of a second chlorine analyzer downstream of the filters, as shown in Figure 3. This alternative would allow the chlorine concentration to be slightly reduced at the floc/sed basin, where more DBP precursors are present, and bumped up after some of the DBP precursors have been removed through flocculation and sedimentation processes. While this is a relatively simple modification, this would likely have only a minimal impact on DBPs.

Table 4 shows the Alternative 3 disinfection requirements for varying flowrates and inactivation targets.

Table 4 – Alternative 3 Disinfection Requirements

<table>
<thead>
<tr>
<th>Flowrate (mgd)</th>
<th>Estimated Chlorine Residual (mg/L) to Achieve (residual after floc/sed / residual after filters)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.5-log <em>Giardia</em> inactivation</td>
</tr>
<tr>
<td>9</td>
<td>0.4 / 0.7</td>
</tr>
<tr>
<td>18</td>
<td>0.9 / 1.1</td>
</tr>
</tbody>
</table>

4.4 Alternative 4 – Floc/Sed CT + Filter CT + Pipeline CT

Alternative 4 would include installation of chlorine analyzers in both the main gravity distribution and the pumped Pasatiempo distribution pipelines just upstream of the first customers, as shown in Figure 4. At a plant flow rate of 18 MGD, this alternative could provide an additional 15 minutes of contact time.

The 15 minutes of contact time is determined by the main distribution pipeline size and flowrate. The Pasatiempo pipeline currently operates periodically when fixed speed pumps operate at approximately 1,100 gpm to fill a distribution system tank. At the fixed pump speed, the pipeline would provide approximately 7 minutes of contact time. To achieve 15 minutes of contact time to match the main distribution pipeline, the operation would have to change to pump the Pasatiempo flow more frequently but at a lower flow rate of 510 gallons per minute. (Alternatively, a UV system could be installed on the Pasatiempo pipeline to provide disinfection to avoid having to modify pumping operations.)

This approach is relatively more complicated but may provide greater opportunity to reduce DBPs, especially if the log inactivation requirement is reduced. Table 5 shows the Alternative 4 disinfection requirements for varying flowrates and inactivation targets.
Table 5 – Alternative 4 Disinfection Requirements

<table>
<thead>
<tr>
<th>Flowrate (mgd)</th>
<th>1.5-log Giardia inactivation</th>
<th>1.0-log Giardia inactivation</th>
<th>0.5-log Giardia inactivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>0.4</td>
<td>0.3</td>
<td>0.2</td>
</tr>
<tr>
<td>18</td>
<td>0.9</td>
<td>0.6</td>
<td>0.3</td>
</tr>
</tbody>
</table>

4.5 Alternative 5 – Filter CT + Pipeline CT + New FW Tank CT

As shown in Figure 5, Alternative 5 would include modifying the existing FW tank to be a flow-through tank for disinfection contact time, and adding inlet and outlet distribution with baffles to provide an estimated hydraulic efficiency of 50 percent. At 18-MGD, a modified tank could potentially provide an additional 36 minutes of contact time.

With the filtered water contactor, the primary chlorination point could be moved to between the floc/sed basin and the filters to allow for stopping chlorine addition to the floc/sed basin. As shown in Table 6, the amount of chlorine residual in the floc/sed basin could typically be eliminated, depending upon the plant flowrate and the inactivation requirement.

This approach is more complicated and more costly but would provide greater opportunity to reduce DBPs, especially if the log inactivation requirement is reduced.

Table 6 – Alternative 5 Disinfection Requirements

<table>
<thead>
<tr>
<th>Flowrate (mgd)</th>
<th>Estimated Chlorine Residual (mg/L) to Achieve (residual after floc/sed / residual after FW Tank)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.5-log Giardia inactivation / 1.0-log Giardia inactivation / 0.5-log Giardia inactivation</td>
</tr>
<tr>
<td>9</td>
<td>0 / 0.8 / 0.3</td>
</tr>
<tr>
<td>18</td>
<td>0 / 1.8 / 0.3</td>
</tr>
</tbody>
</table>

4.6 Alternative 6 – New FW Tank CT + Pipeline CT

As shown in Figure 6, Alternative 6 would move the chlorination point downstream of the filters and achieve contact time in the modified FW tank, as well as the distribution pipelines upstream of the first user. Although the required chlorine residual would be greater than SCWD prefers at high flowrates and a 1.5-log Giardia inactivation, the residual would be in a more typical range at lower flowrates or if the inactivation requirement was reduced, as shown in Table 7.
This approach is more complicated and more costly but would provide the greatest opportunity to reduce DBPs, because chlorination is postponed until after filtration.

Table 7 – Alternative 6 Disinfection Requirements

<table>
<thead>
<tr>
<th>Flowrate (mgd)</th>
<th>Estimated Chlorine Residual (mg/L) to Achieve</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.5-log <em>Giardia</em> inactivation</td>
</tr>
<tr>
<td>9</td>
<td>1.5</td>
</tr>
<tr>
<td>18</td>
<td>2.9</td>
</tr>
</tbody>
</table>

Moving the chlorination point downstream of the filters (Alternative 6) would provide the greatest opportunity for DBP reduction but would be a more appealing option if the GHWTP *Giardia* disinfection requirements are reduced to 1.0-log and 0.5-log, as discussed in TM No. 1. Figure 7 presents Alternative 6 if the *Giardia* requirement is relaxed to 0.5-log inactivation, noting the reduced chlorine residual requirement. Figure 8 shows a modified version of the alternative without using the contact time in the distribution pipelines, since SCWD may prefer to achieve the CT at the plant and not modify its Pasatiempo pumping operations.

5 Summary and Conclusions

The SCWD needs to meet EPA and CDPH surface water treatment requirements to control for both acute microbial health risks from pathogens (*Giardia, Cryptosporidium*, and viruses) as well as chronic health risks from chlorinated disinfection byproducts (DBPs). Complying with both the LT2SWTR and the Stage 2 D/DBP Rules require a balance between providing removal and inactivation of pathogens while minimizing the formation of DBPs that come from the pathogen inactivation (disinfection) process.

TM No. 2 reviewed tracer study data and opportunities for additional disinfection contact time and inactivation CT credit at the GHWTP with the objective of provide supporting data for the SCWD to request modification of the GHWTP Operations Permit. Achieving these objectives could permit changes to the amount of chlorine used or dosing point for chlorine disinfection, and help to reduce DBPs to help meet the Stage 2 D/DBP Rule throughout the SCWD distribution system.

Based on Kennedy/Jenks review of the tracer study data and evaluation the GHWTP, Kennedy/Jenks recommends:

- Work with CDPH to modify the GHWTP Operations Permit to require a *Giardia* log inactivation requirement for the GHWTP of 0.5-log, based on TM No.1.
Technical Memorandum No. 2
Mr. Terry Tompkins, SCWD
18 May 2012
1268001*00
Page 12

- Discuss opportunities for additional CT credit at the GHWTP as described in this TM.
- Conduct additional analysis on converting the existing FW tank to a disinfection contactor.
- Assess the impact of revising Pasatiempo pumping operations or installing a UV system to optimize CT credit.
- Consider the possibility of using one floc/sed basin as a contactor instead of the FW tank.

Kennedy/Jenks is available to assist and support the SCWD staff in making this proposal to the CDPH.
Technical Memorandum No. 2
Mr. Terry Tompkins, SCWD
18 May 2012
1268001*00
Page 13

References

Surface Water Treatment Rule, Final Rule. 40 CFR, Parts 141, 142, and 143.


Appendix C

Technical Memorandum No. 3 – Improving Coagulation for DBP Reduction at Graham Hill WTP
18 May 2012

Technical Memorandum No. 3

To: Mr. Terry Tompkins, SCWD

From: Julia Sorensen, PE
Craig Thompson, PE, BCEE
Joe Drago, PhD, PE

Subject: Improving Coagulation for DBP Reduction at GHWTP
SCWD Graham Hill WTP Operations Permit Assistance
K/J 1268001*00

1 Introduction

This Technical Memorandum (TM) No. 3 describes opportunities to improve disinfection byproduct (DBP) precursor removal by enhanced coagulation at the SCWD of Santa Cruz Water Department (SCWD) Graham Hill Water Treatment Plant (GHWTP) to reduce DBP formation in the distribution system. The TM includes a review the SCWD’s previous coagulation and DBP formation studies, jar test and bench test data, and additional data for total organic carbon (TOC), dissolved organic carbon (DOC), and UV absorbance at 254 nanometer wavelength (UV254). Based on these data and identified data gaps, this TM recommends additional testing to evaluate a recommended TOC or specific UV adsorption (SUVA) concentration or reduction percentage to meet DBP requirements.

2 Background

The California Department of Public Health (CDPH) currently requires a total of 4 log *Giardia* cyst and 5 log virus reduction (combined removal-inactivation) through the pretreatment, filtration and disinfection processes at the GHWTP to be in compliance with the California Surface Water Treatment Rule (SWTR). The 4 log *Giardia* cyst reduction currently is achieved by a combination of 2.5 log removal through the pretreatment and filtration process and 1.5 log inactivation through disinfection, using chlorine. Chlorine is added upstream of the flocculation/sedimentation basins and is measured downstream of the basins. In addition to the SWTR, the SCWD also must comply with the Stage 1 and Stage 2 Disinfectants/Disinfectant Byproducts (D/DBP) Rules, the IESWTR, and the LT2ESWTR. The GHWTP treats several different surface water sources, some of which have relatively high levels of DBP precursors. Combined with chlorine used during disinfection, these precursors can react to form DBPs.

Coagulation is used at GHWTP to remove DBP precursors and other constituents in the source water at the beginning of the treatment process. Currently, SCWD adds approximately 20 to 40 mg/L of alum based on Operations Staff jar testing to optimize the turbidity removal of the process. There is the opportunity to use an increased coagulation dose to further reduce DBP formation, while maintaining turbidity removal performance. The goal of this TM is to evaluate opportunities for enhanced coagulation for the purpose of removing TOC to a concentration that
helps reduces DBP formation. The following sections discuss the existing data and identify data gaps that need to be filled in through testing.

3 Data Review

The following data were reviewed as part of this task:

- Data from DBP formation study (MWH, 2008)
- TTHM data from various sampling points from June 2000 to December 2011
- HAA5 data from various sampling points from March 2004 to December 2011
- TOC, UVA, and SUVA data from November 2010 to January 2012

4 Identification of Target TOC Concentration

As a first step toward an enhanced coagulation program, we recommend identifying a post-coagulation TOC target that would help prevent DBPs from exceeding regulatory levels in the distribution system. This requires having TOC (or DOC) data corresponding to DBP formation data over time. Figure 1 shows an example from another project where DBP testing indicated that a treated water DOC concentration of approximately 1 mg/L was an appropriate goal for that source water and distribution system water age to achieve regulatory-compliant levels of DBPs.

The level of DBPs in a distribution system depends on the level of the DBPs and precursors (DOC) entering the system, the disinfection residual in the system and the water age. Programs to reduce the water age in a distribution system can provide significant benefit to reducing DBP levels and permitting higher levels of DOC entering the system. While the post-coagulation TOC target is often water system specific, a number of agencies that use free chlorine in the distribution system have a post-coagulation target TOC or DOC level of between 1 and 2 mg/l. Some agencies with longer water ages have targeted less than 1 mg/l for post-coagulation TOC levels.
The existing data from previous SCWD studies do not provide enough information to recommend a TOC target at this time. SCWD has data from 2011 that compare the Raw Blend DOC and the Filtered DOC versus the Filtered Water DBP concentration, as shown in Figure 2. However, these data represent a snapshot in time at Day 0 and do not represent the full picture of DBP formation over time through the distribution system.

The BDR, which measured the benefit of postponing chlorination downstream of the current application point, included 10 day DBP formation curves. However, this testing only coagulated at an alum dose of 20 mg/L, which may not provide enough coagulation, as described in Section 5.
The jar testing study conducted as part of the AER plots 7-day DBP concentrations versus UVA, which corresponds to the amount of reactive carbon. The figures indicate that TTHM concentrations reach the target maximum concentration of 64 ug/L (20% of the regulatory limit) at approximately 0.040 cm-1 UVA, and HAA5 concentrations reach the target maximum concentration of 48 ug/L at approximately 0.030 cm-1 UVA. The UVA relationship to TOC (specifically DOC) is measured as SUVA. SCWD data from 2011 and 2012 indicate that the raw blend SUVA is approximately 3.3 L/mg-m. However, the 2009 BDR reports SUVA levels between 9 and 14 L/mg-m.

We recommend further sampling of TOC and corresponding DBP formation before identifying a target TOC concentration. We also recommend analyzing the water for TOC and UV254 throughout the process to calculate SUVA. The SUVA value is an indicator of how reactive the
TOC is. If TOC reduction through coagulation or another process is minimal but the SUVA reduction is significant, that may indicate that the amount of reactive TOC has been reduced. Raw water SUVA has been calculated in past studies, but calculating SUVA throughout the treatment process also would be useful.

5    Enhanced Coagulation

5.1 Identification of Target Coagulation Dose

Once a target TOC level is established, a coagulation dose must be identified that reduces TOC to that concentration. Raw water TOC concentrations vary, from less than 1 mg/L reported in 2011 to approximately 3.9 mg/L as reported in the BDR and AER, so enhanced coagulation may only need to be implemented during periods of high raw water TOC. We understand that SCWD has a TOC analyzer and could use source water TOC from the analyzer to decide when to increase the coagulant dosage.

As outlined in the EPA Enhanced Coagulation and Enhanced Precipitative Softening Guidance Manual (Enhanced Coagulation Manual) (EPA, 1999), a strategy to identify an optimum coagulation dose is to test at increments of 10 mg/L alum equivalents. For every increment, the additional TOC reduction should be at least 0.3 mg/L more than the previous increment. The point at which the additional TOC reduction is less than 0.3 mg/L indicates the point of diminishing return. This serves as a guideline, but in practice, SCWD needs to keep in mind the target TOC concentration, rather than over-coagulating and increasing chemical costs and sludge production, or under-coagulating and not meeting DBP requirements.

Previous data indicate that SCWD may not be coagulating enough for optimized TOC reduction. The BDR suggests the need for increased coagulation above 20 mg/L alum when TOC concentrations in the raw water are above 2 mg/L. Following this suggestion, the GHWTP currently increases coagulant dose when Newell Creek Reservoir water is a significant part of the source water blend. The AER confirms that increased coagulation reduces DBP formation potential and also shows DBP concentrations for various coagulant doses, but does not show long-term DBP formation curves. We recommend that SCWD conduct enhanced coagulation testing in accordance with the Enhanced Coagulation Manual while considering the target TOC concentration described in Section 4. Enhanced coagulation may be an effective tool for periodic use during periods of higher than normal source water organics.

5.2 Identification of Target Coagulation pH

For source water with alkalinity between 60 and 120, Table 2-2 in the Enhanced Coagulation Manual recommends a target pH condition of 6.3. The SCWD source water has an average pH of approximately 7.4 and an average alkalinity of 110 mg/L (as listed in the BDR). Given the
relatively high source water alkalinity, the alum dosages tested previously, and the amount of alkalinity consumed by adding alum as a coagulant (about 0.5 mg/L alkalinity per 1 mg/L alum), the source water pH is not likely to drop significantly at the alum dosages that would likely be used (< 100 mg/L). The AER tested coagulation with ferric chloride and alum at varying pH levels and showed benefits for TOC reduction at lower pH levels as would be expected. However, the amount of a strong acid to lower the pH during the coagulation process could be significant due to the relatively high source water alkalinity. Post-treatment by adding caustic or lime to raise the pH would also be required to provide a non-corrosive water before distribution.

Polyaluminum Chlorohydrate (PACl) and aluminum chlorohydrate (ACH) coagulants can be effective at higher pHs and eliminate the need to reduce the pH for optimum coagulation. These types of coagulants could be jar tested and considered for the GHWTP.

5.3 Addition of Powder Activated Carbon (PAC)

An increased dose of PAC could potentially be used for organics adsorption to reduce DBPs. Kennedy/Jenks understands that PAC addition is currently used at levels below approximately 10 mg/l, for taste and odor events. According to SCWD Staff, at higher doses, the PAC levels could impact filter performance. Also, higher levels of PAC could react with and reduce chlorine residual in the settling basins, impacting CT calculations.

If the chlorine addition point for the GHWTP can be moved to after the settling basins, and with the planned improvements to the GHWTP filters (to provide low profile underdrains which would increase the media path length-to-diameter (L/d) ratio through deeper filter media bed depth and improved surface wash or airwash) increased PAC doses could potentially be used to further reduce DBP precursor levels.

5.4 Additional Considerations

Operational considerations and potential challenges with respect to increased coagulation include:

- Solids management: Increasing the coagulant dosage and PAC dose would increase solids production and could exceed SCWD’s current sewer discharge limit. SCWD could add a solids handling system or may need to work with the wastewater department to revise the discharge limit in order to utilize enhanced coagulation or increased PAC use to meet DBP regulations.

- Increased filter backwash: If more solids are created through increased coagulation or PAC addition, then the filters may need to be backwashed more frequently.
Balance with turbidity: Increased coagulation for TOC removal has the potential to reduce the efficacy of turbidity reduction. Coagulation destabilizes negatively charged TOC, but a higher coagulant dose could restabilize particles that create turbidity. This can be minimized, however, by polymer addition.

Distribution system water age: Since DBP formation increases over time, SCWD could consider revising their operations to reduce the water age in the distribution system to minimize some of the potential enhanced coagulation requirements.

Increased chemical costs and TDS: Additional chemicals for coagulation and pH adjustment would increase SCWD’s operational cost, as well as the TDS in the water.

**6 Recommendations for Further Study**

Based on the information presented above, we recommend that SCWD conduct a study to evaluate current and enhanced alum coagulation for the purpose of removing TOC to a concentration that reduces DBP formation below the target maximum concentration. The study should include the following elements:

- Current plant profile sampling for TOC (or DOC), SUVA, and simulated distribution system (SDS) DBPs to benchmark current system performance

- SDS DBP formation sampling with respect to different source water blends and filtered water TOC (or DOC) and SUVA to understand how TOC levels impact distribution system DBPs for the GHWTP and SCWD distribution system.

- Enhanced coagulation jar testing at 10 mg/L alum increments as described in Enhanced Coagulation Manual with associated SDS DBP testing

As described in TMs No. 1 and 2, respectively, SCWD plans to investigate reducing the chlorine disinfection requirement and moving the chlorination point downstream in the treatment process. These actions also would reduce DBP formation, so the recommendations in this TM should be integrated with the outcomes of these parallel studies to prepare a comprehensive DBP reduction plan.
Technical Memorandum No. 3

Mr. Terry Tompkins, SCWD
18 May 2012
1268001*00
Page 8

References


Surface Water Treatment Rule, Final Rule. 40 CFR, Parts 141, 142, and 143.

Appendix B: Primary and Secondary Maximum Contaminant Limits
<table>
<thead>
<tr>
<th>Contaminant</th>
<th>MCL or TTC (mg/L)</th>
<th>Potential health effects from long-term exposure above the MCL</th>
<th>Common sources of contaminant in drinking water</th>
<th>Public Health Goal (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acrylamide</td>
<td>TTC</td>
<td>Nervous system or blood problems; increased risk of cancer</td>
<td>Added to water during sewage/wastewater treatment</td>
<td>zero</td>
</tr>
<tr>
<td>Alachlor</td>
<td>0.002</td>
<td>Eye, liver, kidney or spleen problems; anemia; increased risk of cancer</td>
<td>Runoff from herbicide used on row crops</td>
<td>zero</td>
</tr>
<tr>
<td>Alpha/photons</td>
<td>15 picocuries per Liter (pCi/L)</td>
<td>Increased risk of cancer</td>
<td>Erosion of natural deposits of certain minerals that are radioactive and may emit a form of radiation known as alpha radiation</td>
<td>zero</td>
</tr>
<tr>
<td>Antimony</td>
<td>0.006</td>
<td>Increase in blood cholesterol; decrease in blood sugar</td>
<td>Discharge from petroleum refineries; fire retardants; ceramics; electronics; solder</td>
<td>0.006</td>
</tr>
<tr>
<td>Arsenic</td>
<td>0.010</td>
<td>Skin damage or problems with circulatory systems, and may have increased risk of getting cancer</td>
<td>Erosion of natural deposits; runoff from orchards; runoff from glass &amp; electronics production wastes</td>
<td>0</td>
</tr>
<tr>
<td>Asbestos (fibers &gt;10 micrometers)</td>
<td>7 million fibers per Liter (MFL)</td>
<td>Increased risk of developing benign intestinal polyps</td>
<td>Decay of asbestos cement in water mains; erosion of natural deposits</td>
<td>7 MFL</td>
</tr>
<tr>
<td>Atrazine</td>
<td>0.003</td>
<td>Cardiovascular system or reproductive problems</td>
<td>Runoff from herbicide used on row crops</td>
<td>0.003</td>
</tr>
<tr>
<td>Barium</td>
<td>2</td>
<td>Increase in blood pressure</td>
<td>Discharge of drilling wastes; discharge from metal refineries; erosion of natural deposits</td>
<td>2</td>
</tr>
<tr>
<td>Benzene</td>
<td>0.005</td>
<td>Anemia; decrease in blood platelets; increased risk of cancer</td>
<td>Discharge from factories; leaching from gas storage tanks and landfills</td>
<td>zero</td>
</tr>
<tr>
<td>Benzo(a)pyrene (PAHs)</td>
<td>0.0002</td>
<td>Reproductive difficulties; increased risk of cancer</td>
<td>Leaching from linings of water storage tanks and distribution lines</td>
<td>zero</td>
</tr>
<tr>
<td>Beryllium</td>
<td>0.004</td>
<td>Intestinal lesions</td>
<td>Discharge from metal refineries and coal-burning factories; discharge from electrical, aerospace, and defense industries</td>
<td>0.004</td>
</tr>
<tr>
<td>Beta photon emitters</td>
<td>4 millirems per year</td>
<td>Increased risk of cancer</td>
<td>Decay of natural and man-made deposits of certain minerals that are radioactive and may emit forms of radiation known as photons and beta radiation</td>
<td>zero</td>
</tr>
<tr>
<td>Bromate</td>
<td>0.010</td>
<td>Increased risk of cancer</td>
<td>Byproduct of drinking water disinfection</td>
<td>zero</td>
</tr>
<tr>
<td>Cadmium</td>
<td>0.005</td>
<td>Kidney damage</td>
<td>Corrosion of galvanized pipes; erosion of natural deposits; discharge from metal refineries; runoff from waste batteries and paints</td>
<td>0.005</td>
</tr>
<tr>
<td>Carbofuran</td>
<td>0.04</td>
<td>Problems with blood, nervous system, or reproductive system</td>
<td>Leaching of soil fumigant used on rice and alfalfa</td>
<td>0.04</td>
</tr>
<tr>
<td>Carbon tetrachloride</td>
<td>0.005</td>
<td>Liver problems; increased risk of cancer</td>
<td>Discharge from chemical plants and other industrial activities</td>
<td>zero</td>
</tr>
<tr>
<td>Chloramines (as Cl₂)</td>
<td>MRDL=4.0</td>
<td>Eye/noise irritation; stomach discomfort; anemia</td>
<td>Water additive used to control microbes</td>
<td>MRDLG=4</td>
</tr>
<tr>
<td>Chloride</td>
<td>0.002</td>
<td>Liver or nervous system problems; increased risk of cancer</td>
<td>Residue of banned termicide</td>
<td>zero</td>
</tr>
<tr>
<td>Chlorine (as Cl₂)</td>
<td>MRDL=4.0</td>
<td>Eye/noise irritation; stomach discomfort</td>
<td>Water additive used to control microbes</td>
<td>MRDLG=4</td>
</tr>
<tr>
<td>Chlorine dioxide (as ClO₂)</td>
<td>MRDL=0.8</td>
<td>Anemia; infants, young children, and fetuses of pregnant women: nervous system effects</td>
<td>Water additive used to control microbes</td>
<td>MRDLG=0.8</td>
</tr>
<tr>
<td>Chlorite</td>
<td>1.0</td>
<td>Anemia; infants, young children, and fetuses of pregnant women: nervous system effects</td>
<td>Byproduct of drinking water disinfection</td>
<td>0.8</td>
</tr>
<tr>
<td>Chlorobenzene</td>
<td>0.1</td>
<td>Liver or kidney problems</td>
<td>Discharge from chemical and agricultural chemical factories</td>
<td>0.1</td>
</tr>
<tr>
<td>Chromium (total)</td>
<td>0.1</td>
<td>Allergic dermatitis</td>
<td>Discharge from steel and pulp mills; erosion of natural deposits</td>
<td>0.1</td>
</tr>
<tr>
<td>Copper</td>
<td>TTC: Action Level = 1.3</td>
<td>Short-term exposure: Gastrointestinal distress. Long-term exposure: Liver or kidney damage. People with Wilson’s Disease should consult their personal doctor if the amount of copper in their water exceeds the action level</td>
<td>Corrosion of household plumbing systems; erosion of natural deposits</td>
<td>1.3</td>
</tr>
<tr>
<td>Cryptosporidium</td>
<td>TTC</td>
<td>Short-term exposure: Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)</td>
<td>Human and animal fecal waste</td>
<td>zero</td>
</tr>
</tbody>
</table>

**LEGEND**

- **D** Disinfectant
- **IOC** Inorganic Chemical
- **OC** Organic Chemical
- **R** Radionuclides
- **DBP** Disinfection Byproduct
- **M** Microorganism
<table>
<thead>
<tr>
<th>Contaminant</th>
<th>MCL or TT (mg/L)$^1$</th>
<th>Potential health effects from long-term$^2$ exposure above the MCL</th>
<th>Common sources of contaminant in drinking water</th>
<th>Public Health Goal (mg/L)$^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IOC</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyanide (as free cyanide)</td>
<td>0.2</td>
<td>Nerve damage or thyroid problems</td>
<td>Discharge from steel/metal factories; discharge from plastic and fertilizer factories</td>
<td>0.2</td>
</tr>
<tr>
<td>2,4-D</td>
<td>0.07</td>
<td>Kidney, liver, or adrenal gland problems</td>
<td>Runoff from herbicide used on row crops</td>
<td>0.07</td>
</tr>
<tr>
<td>Dalapon</td>
<td>0.2</td>
<td>Minor kidney changes</td>
<td>Runoff from herbicide used on rights of way</td>
<td>0.2</td>
</tr>
<tr>
<td>1,2-Dibromo-3-chloropropane (DBCP)</td>
<td>0.0002</td>
<td>Reproductive difficulties; increased risk of cancer</td>
<td>Runoff/leaching from soil fumigant used on soybeans, cotton, pineapples, and orchards</td>
<td>zero</td>
</tr>
<tr>
<td>o-Dichlorobenzene</td>
<td>0.6</td>
<td>Liver, kidney, or circulatory system problems</td>
<td>Discharge from industrial chemical factories</td>
<td>0.6</td>
</tr>
<tr>
<td>p-Dichlorobenzene</td>
<td>0.075</td>
<td>Anemia; liver, kidney or spleen damage; changes in blood</td>
<td>Discharge from industrial chemical factories</td>
<td>0.075</td>
</tr>
<tr>
<td>1,2-Dichloroethane</td>
<td>0.005</td>
<td>Increased risk of cancer</td>
<td>Discharge from industrial chemical factories</td>
<td>zero</td>
</tr>
<tr>
<td>1,1-Dichloroethylene</td>
<td>0.007</td>
<td>Liver problems</td>
<td>Discharge from industrial chemical factories</td>
<td>0.007</td>
</tr>
<tr>
<td>cis-1,2-Dichloroethylene</td>
<td>0.07</td>
<td>Liver problems</td>
<td>Discharge from industrial chemical factories</td>
<td>0.07</td>
</tr>
<tr>
<td>trans-1,2-Dichloroethylene</td>
<td>0.1</td>
<td>Liver problems</td>
<td>Discharge from industrial chemical factories</td>
<td>0.1</td>
</tr>
<tr>
<td>Dichloromethane</td>
<td>0.005</td>
<td>Liver problems; increased risk of cancer</td>
<td>Discharge from drug and chemical factories</td>
<td>zero</td>
</tr>
<tr>
<td>1,2-Dichloropropane</td>
<td>0.005</td>
<td>Increased risk of cancer</td>
<td>Discharge from industrial chemical factories</td>
<td>zero</td>
</tr>
<tr>
<td>Di(2-ethylhexyl) adipate</td>
<td>0.4</td>
<td>Weight loss, liver problems, or possible reproductive difficulties</td>
<td>Discharge from chemical factories</td>
<td>0.4</td>
</tr>
<tr>
<td>Di(2-ethylhexyl) phthalate</td>
<td>0.006</td>
<td>Reproductive difficulties; liver problems; increased risk of cancer</td>
<td>Discharge from rubber and chemical factories</td>
<td>zero</td>
</tr>
<tr>
<td>Dinoseb</td>
<td>0.007</td>
<td>Reproductive difficulties</td>
<td>Runoff from herbicide used on soybeans and vegetables</td>
<td>0.007</td>
</tr>
<tr>
<td>Dioxin (2,3,7,8-TCDD)</td>
<td>$0.0000003$</td>
<td>Reproductive difficulties; increased risk of cancer</td>
<td>Emissions from waste incineration and other combustion; discharge from chemical factories</td>
<td>zero</td>
</tr>
<tr>
<td>Diquat</td>
<td>0.02</td>
<td>Cataracts</td>
<td>Runoff from herbicide use</td>
<td>0.02</td>
</tr>
<tr>
<td>Endothall</td>
<td>0.1</td>
<td>Stomach and intestinal problems</td>
<td>Runoff from herbicide use</td>
<td>0.1</td>
</tr>
<tr>
<td>Endrin</td>
<td>0.002</td>
<td>Liver problems</td>
<td>Residue of banned insecticide</td>
<td>0.002</td>
</tr>
<tr>
<td>Epichlorohydrin</td>
<td>TT$^3$</td>
<td>Increased cancer risk; stomach problems</td>
<td>Discharge from industrial chemical factories; an impurity of some water treatment chemicals</td>
<td>zero</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>0.7</td>
<td>Liver or kidney problems</td>
<td>Discharge from petroleum refineries</td>
<td>0.7</td>
</tr>
<tr>
<td>Ethylene dibromide</td>
<td>$0.00085$</td>
<td>Problems with liver, stomach, reproductive system, or kidneys; increased risk of cancer</td>
<td>Discharge from petroleum refineries</td>
<td>zero</td>
</tr>
<tr>
<td><strong>M</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fecal coliform and E. coli</td>
<td>MCL$^*$</td>
<td>Fecal coliforms and E. coli are bacteria whose presence indicates that the water may be contaminated with human or animal wastes.</td>
<td>Human and animal fecal waste</td>
<td>zero$^6$</td>
</tr>
<tr>
<td><strong>IC</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluoride</td>
<td>4.0</td>
<td>Bone disease (pain and tenderness of the bones); children may get mottled teeth</td>
<td>Water additive which promotes strong teeth; erosion of natural deposits; discharge from fertilizer and aluminum factories</td>
<td>4.0</td>
</tr>
<tr>
<td>Giardia lamblia</td>
<td>TT$^3$</td>
<td>Short-term exposure: Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)</td>
<td>Human and animal fecal waste</td>
<td>zero</td>
</tr>
<tr>
<td>Glyphosate</td>
<td>0.7</td>
<td>Kidney problems; reproductive difficulties</td>
<td>Runoff from herbicide use</td>
<td>0.7</td>
</tr>
<tr>
<td>Halogenated acids (HAAs)</td>
<td>0.060</td>
<td>Increased risk of cancer</td>
<td>Byproduct of drinking water disinfection</td>
<td>n/a$^4$</td>
</tr>
<tr>
<td>Heptachlor</td>
<td>0.0004</td>
<td>Liver damage; increased risk of cancer</td>
<td>Residue of banned termicide</td>
<td>zero</td>
</tr>
<tr>
<td>Heptachlor epoxide</td>
<td>0.0002</td>
<td>Liver damage; increased risk of cancer</td>
<td>Breakdown of heptachlor</td>
<td>zero</td>
</tr>
<tr>
<td><strong>M</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heterotrophic plate count (HPC)</td>
<td>TT$^3$</td>
<td>HPC has no health effects; it is an analytic method used to measure the variety of bacteria that are common in water. The lower the concentration of bacteria in drinking water, the better maintained the water system is.</td>
<td>HPC measures a range of bacteria that are naturally present in the environment</td>
<td>n/a</td>
</tr>
</tbody>
</table>

**LEGEND**
- D: Disinfectant
- IOC: Inorganic Chemical
- IC: Organic Chemical
- M: Microorganism
- R: Radionuclides
- DBP: Disinfection Byproduct

$^1$ MCL: Maximum Contaminant Level

$^2$ TT: Tolerable Threshold

$^3$ MCL$^*$: Microbiological Contaminant Level

$^4$ n/a: Not applicable

$^5$ zero: Indicating no reported instances of exposure

$^6$ zero$^6$: Represents the lowest acceptable limit for fecal coliform levels.
<table>
<thead>
<tr>
<th>Contaminant</th>
<th>MCL or TT(^1) (mg/L) (^2)</th>
<th>Potential health effects from long-term (^3) exposure above the MCL</th>
<th>Common sources of contaminant in drinking water</th>
<th>Public Health Goal (mg/L) (^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OC</td>
<td>Hexachlorobenzene</td>
<td>0.001 Liver or kidney problems; reproductive difficulties; increased risk of cancer</td>
<td>Discharge from metal refineries and agricultural chemical factories</td>
<td>zero</td>
</tr>
<tr>
<td>OC</td>
<td>Hexachlorocyclopentadiene</td>
<td>0.05 Kidney or stomach problems</td>
<td>Discharge from chemical factories</td>
<td>0.05</td>
</tr>
<tr>
<td>IOC</td>
<td>Lead</td>
<td>TT5, Action Level=0.015 Infants and children: Delays in physical or mental development; children could show slight deficits in attention, span and learning abilities; Adults: Kidney problems; high blood pressure</td>
<td>Corrosion of household plumbing systems; erosion of natural deposits</td>
<td>zero</td>
</tr>
<tr>
<td>M</td>
<td>Legionella</td>
<td>TT7 Legionnaire’s Disease, a type of pneumonia</td>
<td>Found naturally in water; multiplies in heating systems</td>
<td>zero</td>
</tr>
<tr>
<td>OC</td>
<td>Lindane</td>
<td>0.0002 Liver or kidney problems</td>
<td>Runoff/leaching from insecticide used on cattle, lumber, gardens</td>
<td>0.0002</td>
</tr>
<tr>
<td>IOC</td>
<td>Mercury (inorganic)</td>
<td>0.002 Kidney damage</td>
<td>Erosion of natural deposits; discharge from refineries and factories; runoff from landfills and croplands</td>
<td>0.002</td>
</tr>
<tr>
<td>OC</td>
<td>Methoxychloride</td>
<td>0.04 Reproductive difficulties</td>
<td>Runoff/leaching from insecticide used on fruits, vegetables, alfalfa, livestock</td>
<td>0.04</td>
</tr>
<tr>
<td>IOC</td>
<td>Nitrate (measured as Nitrogen)</td>
<td>10 Infants below the age of six months who drink water containing nitrate in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.</td>
<td>Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits</td>
<td>10</td>
</tr>
<tr>
<td>IOC</td>
<td>Nitrite (measured as Nitrogen)</td>
<td>1 Infants below the age of six months who drink water containing nitrite in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.</td>
<td>Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits</td>
<td>1</td>
</tr>
<tr>
<td>OC</td>
<td>Oxamyl (Vydate)</td>
<td>0.2 Slight nervous system effects</td>
<td>Runoff/leaching from insecticide used on apples, potatoes, and tomatoes</td>
<td>0.2</td>
</tr>
<tr>
<td>OC</td>
<td>Pentachlorophenol</td>
<td>0.001 Liver or kidney problems; increased cancer risk</td>
<td>Discharge from wood-preserving factories</td>
<td>zero</td>
</tr>
<tr>
<td>OC</td>
<td>Picloram</td>
<td>0.5 Liver problems</td>
<td>Herbicide runoff</td>
<td>0.5</td>
</tr>
<tr>
<td>OC</td>
<td>Polychlorinated biphenyls (PCBs)</td>
<td>0.0005 Skin changes; thymus gland problems; immune deficiencies; reproductive or nervous system difficulties; increased risk of cancer</td>
<td>Runoff from landfills; discharge of waste chemicals</td>
<td>zero</td>
</tr>
<tr>
<td>R</td>
<td>Radium 226 and Radium 228 (combined)</td>
<td>5 pCi/L Increased risk of cancer</td>
<td>Erosion of natural deposits</td>
<td>zero</td>
</tr>
<tr>
<td>IOC</td>
<td>Selenium</td>
<td>0.05 Hair or fingernail loss; numbness in fingers or toes; circulatory problems</td>
<td>Discharge from petroleum and metal refineries; erosion of natural deposits; discharge from mines</td>
<td>0.05</td>
</tr>
<tr>
<td>OC</td>
<td>Simazine</td>
<td>0.004 Problems with blood</td>
<td>Herbicide runoff</td>
<td>0.004</td>
</tr>
<tr>
<td>OC</td>
<td>Styrene</td>
<td>0.1 Liver, kidney, or circulatory system problems</td>
<td>Discharge from rubber and plastic factories; leaching from landfills</td>
<td>0.1</td>
</tr>
<tr>
<td>OC</td>
<td>Tetrachloroethylene</td>
<td>0.005 Liver problems; increased risk of cancer</td>
<td>Discharge from factories and dry cleaners</td>
<td>zero</td>
</tr>
<tr>
<td>IOC</td>
<td>Thallium</td>
<td>0.002 Hair loss; changes in blood; kidney, intestine, or liver problems</td>
<td>Leaching from ore-processing sites; discharge from electronics, glass, and drug factories</td>
<td>0.0005</td>
</tr>
<tr>
<td>OC</td>
<td>Toluene</td>
<td>1 Nervous system, kidney, or liver problems</td>
<td>Discharge from petroleum factories</td>
<td>1</td>
</tr>
<tr>
<td>M</td>
<td>Total Coliforms</td>
<td>5.0 percent(^4) Coliforms are bacteria that indicate that other, potentially harmful bacteria may be present. See fecal coliforms and E. coli</td>
<td>Naturally present in the environment</td>
<td>zero</td>
</tr>
<tr>
<td>DBP</td>
<td>Total Trihalomethanes (THMs)</td>
<td>0.080 Liver, kidney or central nervous system problems; increased risk of cancer</td>
<td>Byproduct of drinking water disinfection</td>
<td>na(^a)</td>
</tr>
<tr>
<td>OC</td>
<td>Toxaphene</td>
<td>0.003 Kidney, liver, or thyroid problems; increased risk of cancer</td>
<td>Runoff/leaching from insecticide used on cotton and cattle</td>
<td>zero</td>
</tr>
<tr>
<td>OC</td>
<td>2,4,5-TP (Silvex)</td>
<td>0.05 Liver problems</td>
<td>Residue of banned herbicide</td>
<td>0.05</td>
</tr>
<tr>
<td>OC</td>
<td>1,2,4-Trichlorobenzene</td>
<td>0.07 Changes in adrenal glands</td>
<td>Discharge from textile finishing factories</td>
<td>0.07</td>
</tr>
<tr>
<td>OC</td>
<td>1,1,1-Trichloroethane</td>
<td>0.2 Liver, nervous system, or circulatory problems</td>
<td>Discharge from metal degreasing sites and other factories</td>
<td>0.2</td>
</tr>
<tr>
<td>OC</td>
<td>1,1,2-Trichloroethane</td>
<td>0.005 Liver, kidney, or immune system problems</td>
<td>Discharge from industrial chemical factories</td>
<td>0.003</td>
</tr>
<tr>
<td>OC</td>
<td>Trichloroethylene</td>
<td>0.005 Liver problems; increased risk of cancer</td>
<td>Discharge from metal degreasing sites and other factories</td>
<td>zero</td>
</tr>
</tbody>
</table>

**LEGEND**

- **D**: Disinfectant
- **IOC**: Inorganic Chemical
- **OC**: Organic Chemical
- **M**: Microorganism
- **R**: Radionuclides

**DBP**: Disinfection Byproduct
<table>
<thead>
<tr>
<th>Contaminant</th>
<th>MCL or TT (mg/L)</th>
<th>Potential health effects from long-term exposure above the MCL</th>
<th>Common sources of contaminant in drinking water</th>
<th>Public Health Goal (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbidity</td>
<td>TT</td>
<td>Turbidity is a measure of the cloudiness of water. It is used to indicate water quality and filtration effectiveness (e.g., whether disease-causing organisms are present). Higher turbidity levels are often associated with higher levels of disease-causing microorganisms such as viruses, parasites and some bacteria. These organisms can cause short term symptoms such as nausea, cramps, diarrhea, and associated headaches.</td>
<td>Soil runoff</td>
<td>n/a</td>
</tr>
<tr>
<td>Uranium</td>
<td>30µg/L</td>
<td>Increased risk of cancer, kidney toxicity</td>
<td>Erosion of natural deposits</td>
<td>zero</td>
</tr>
<tr>
<td>Vinyl chloride</td>
<td>0.002</td>
<td>Increased risk of cancer</td>
<td>Leaching from PVC pipes; discharge from plastic factories</td>
<td>zero</td>
</tr>
<tr>
<td>Viruses (enteric)</td>
<td>TT</td>
<td>Short-term exposure: Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)</td>
<td>Human and animal fecal waste</td>
<td>zero</td>
</tr>
<tr>
<td>Xylenes (total)</td>
<td>10</td>
<td>Nervous system damage</td>
<td>Discharge from petroleum factories; discharge from chemical factories</td>
<td>10</td>
</tr>
</tbody>
</table>

**Legend**

- **D**: Disinfectant
- **IOC**: Inorganic Chemical
- **OC**: Organic Chemical
- **DBP**: Disinfection Byproduct
- **M**: Microorganism
- **R**: Radionuclides
Maximum Contaminant Level Goal (MCLG)—The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals.

Maximum Contaminant Level (MCL)—The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable standards.

Maximum Residual Disinfectant Level Goal (MRDLG)—The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contaminants.

Maximum Residual Disinfectant Level (MRDL)—The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.

Treatment Technique (TT)—A required process intended to reduce the level of a contaminant in drinking water.

Units are in milligrams per liter (mg/L) unless otherwise noted. Milligrams per liter are equivalent to parts per million (ppm).

Health effects are from long-term exposure unless specified as short-term exposure.

Each water system must certify annually, in writing, to the state (using third-party or manufacturers certification) that when it uses acrylamide and/or epichlorohydrin to treat water, the combination (or product) of dose and monomer level does not exceed the levels specified, as follows: Acrylamide = 0.05 percent dosed at 1 mg/L (or equivalent); Epichlorohydrin = 0.01 percent dosed at 20 mg/L (or equivalent).

Lead and copper are regulated by a Treatment Technique that requires systems to control the corrosiveness of their water. If more than 10 percent of tap water samples exceed the action level, water systems must take additional steps. For copper, the action level is 1.3 mg/L, and for lead is 0.015 mg/L.

A routine sample that is fecal coliform-positive or E. coli-positive triggers repeat samples—if any repeat sample is total coliform-positive, the system has an acute MCL violation. A routine sample that is total coliform-positive and fecal coliform-negative or E. coli-negative triggers repeat samples—if any repeat sample is fecal coliform-positive or E. coli-positive, the system has an acute MCL violation. See also Total Coliforms.

EPA's surface water treatment rules require systems using surface water or ground water under the direct influence of surface water to (1) disinfect their water, and (2) filter their water or meet criteria for avoiding filtration so that the following contaminants are controlled at the following levels:

- Cryptosporidium: 99 percent removal for systems that filter. Unfiltered systems are required to include Cryptosporidium in their existing watershed control provisions.
- Giardia lamblia: 99.9 percent removal/inactivation
- Viruses: 99.99 percent removal/inactivation
- Legionella: No limit, but EPA believes that if Giardia and viruses are removed/inactivated according to the treatment techniques in the surface water treatment rule, Legionella will also be controlled.
- Turbidity: For systems that use conventional or direct filtration, at no time can turbidity (cloudiness of water) go higher than 1 nephelometric turbidity unit (NTU), and samples for turbidity must be less than or equal to 0.3 NTU in at least 95 percent of the samples in any month. Systems that use filtration other than conventional or direct filtration must follow state limits, which must include turbidity at no time exceeding 5 NTU.
- HPC: No more than 500 bacterial colonies per milliliter
- Long Term 1 Enhanced Surface Water Treatment: Surface water systems or ground water systems under the direct influence of surface water serving fewer than 10,000 people must comply with the applicable Long Term 1 Enhanced Surface Water Treatment Rule provisions (e.g. turbidity standards, individual filter monitoring, Cryptosporidium removal requirements, updated watershed control requirements for unfiltered systems).
- Long Term 2 Enhanced Surface Water Treatment: This rule applies to all surface water systems or ground water systems under the direct influence of surface water. The rule targets additional Cryptosporidium treatment requirements for higher risk systems and includes provisions to reduce risks from uncovered finished water storage facilities and to ensure that the systems maintain microbial protection as they take steps to reduce the formation of disinfection byproducts. (Monitoring start dates are staggered by system size. The largest systems (serving at least 100,000 people) will begin monitoring in October 2006 and the smallest systems (serving fewer than 10,000 people) will not begin monitoring until October 2008. After completing monitoring and determining their treatment bin, systems generally have three years to comply with any additional treatment requirements.)
- Filter Backwash Recycling: The Filter Backwash Recycling Rule requires systems that recycle to return specific recycle flows through all processes of the system’s existing conventional or direct filtration system or at an alternate location approved by the state.

Although there is no collective MCLG for this contaminant group, there are individual MCLGs for some of the individual contaminants:

- Haloacetates: dichloroacetic acid (zero); trichloroacetic acid (0.3 mg/L)
- Trihalomethanes: bromodichloromethane (zero); bromoform (zero); dibromochloromethane (0.06 mg/L)
National Secondary Drinking Water Regulation

National Secondary Drinking Water Regulations are non-enforceable guidelines regarding contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. EPA recommends secondary standards to water systems but does not require systems to comply. However, some states may choose to adopt them as enforceable standards.

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Secondary Maximum Contaminant Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>0.05 to 0.2 mg/L</td>
</tr>
<tr>
<td>Chloride</td>
<td>250 mg/L</td>
</tr>
<tr>
<td>Color</td>
<td>15 (color units)</td>
</tr>
<tr>
<td>Copper</td>
<td>1.0 mg/L</td>
</tr>
<tr>
<td>Corrosivity</td>
<td>noncorrosive</td>
</tr>
<tr>
<td>Fluoride</td>
<td>2.0 mg/L</td>
</tr>
<tr>
<td>Foaming Agents</td>
<td>0.5 mg/L</td>
</tr>
<tr>
<td>Iron</td>
<td>0.3 mg/L</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.05 mg/L</td>
</tr>
<tr>
<td>Odor</td>
<td>3 threshold odor number</td>
</tr>
<tr>
<td>pH</td>
<td>6.5-8.5</td>
</tr>
<tr>
<td>Silver</td>
<td>0.10 mg/L</td>
</tr>
<tr>
<td>Sulfate</td>
<td>250 mg/L</td>
</tr>
<tr>
<td>Total Dissolved Solids</td>
<td>500 mg/L</td>
</tr>
<tr>
<td>Zinc</td>
<td>5 mg/L</td>
</tr>
</tbody>
</table>

For More Information

EPA’s Safe Drinking Water Web site:
http://www.epa.gov/safewater/

EPA’s Safe Drinking Water Hotline:
(800) 426-4791

To order additional posters or other ground water and drinking water publications, please contact the National Service Center for Environmental Publications at:
(800) 490-9198, or email: nscep@bps-lmit.com.

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