

# SANITARY SURVEYS IN HAWAII: A FRAMEWORK



Prepared by

**TETRA TECH, INC.**

3746 Mt. Diablo Blvd., Suite 300  
Lafayette, California 94549  
(925) 283-3771

September 2003 (Revised January 2004)

Prepared for

**U.S. EPA Region IX**  
and

**Hawaii Department of  
Health**

# SANITARY SURVEYS IN HAWAII: A FRAMEWORK

Prepared by:

Tetra Tech, Inc.  
3746 Mt. Diablo Boulevard, Suite 300  
Lafayette, California 94549

Prepared for:

U.S. Environmental Protection Agency, Region IX  
75 Hawthorne Street  
San Francisco, California

and

Hawaii Department of Health  
919 Ala Moana Boulevard  
Honolulu, Hawaii

September 30, 2003 (Revised January 2004)

# TABLE OF CONTENTS

---

---

1.	BACKGROUND.....	1
2.	INTRODUCTION.....	3
3.	WATERSHED.....	4
4.	POTENTIAL CONTAMINANT SOURCES.....	7
5.	WATERSHED CONTROL AND MANAGEMENT PRACTICES.....	22
6.	WATER QUALITY.....	32
7.	CONCLUSIONS AND RECOMMENDATIONS.....	35

## 1.0 BACKGROUND

---

Bacterial contamination is very prevalent nationwide, especially in areas having urban development. The issue of bacterial contamination in Hawaii is not unique. However, since tourism and recreation provide a significant source of income for the state, there is an acute awareness of the potential for bacterial contamination to affect its beaches and near coastal areas. The near coastal areas in Hawaii are frequently surveyed by Hawaii's Department of Health in an attempt to monitor and maintain the waters free from bacterial contaminants and protective of their designated beneficial uses.

Fecal bacteria have been used as an indicator of the possible presence of pathogens in surface waters and the risk of disease, based on epidemiological evidence of gastrointestinal disorders from the ingestion of the contaminated surface water or raw shellfish. Contact with contaminated water can lead to ear or skin infections. Inhalation of contaminated water can cause respiratory diseases. The pathogens responsible for these diseases can be bacteria, viruses, protozoans, fungi, or parasites that live in the gastrointestinal tract and are shed in the feces of warm-blooded animals.

However, because of the difficulties in analyzing for and detecting the many possible pathogens or parasites, concentrations of fecal bacteria, including fecal coliforms, enterococci, and *Escherichia coli*, are used as the primary indicators of fecal contamination. The latter two are considered to have a higher degree of association with outbreaks of certain diseases than fecal coliforms and were recommended as the basis for bacterial water quality standards in the Draft Implementation Guidance for *Ambient Water Quality Criteria for Bacteria – 1986* (EPA-823-D-00-001, January 2000). This document recommends that both enterococci and *E. coli* be used as indicators for freshwater contamination and that only enterococci be used as an indicator of marine contamination. The standards are defined as a concentration of the indicator above which the health risk from waterborne disease is unacceptably high.

Fecal bacteria are imperfect indicators of the possible presence of pathogens like *Cryptosporidium*, *Giardia*, *Leptospira* and viruses that are potentially very harmful to humans (especially children, the elderly, and those having compromised immune systems) and their presence does not guarantee either the presence or absence of the more harmful forms. Additionally, there are numerous sources of contamination (both human and non-human).

These uncertainties lead to the need to use better tools to monitor and assess the potential threat from waterborne bacteria to the designated beneficial uses of waterbodies in Hawaii.

This Sanitary Survey Framework is designed to be turn-key, enabling the end user to assess the existing and potential sources of bacterial contamination as well as the risks associated with their presence in Hawaiian waterbodies.

Since this Framework is designed to focus on bacterial contamination, emphasis has been placed on the most significant existing and potential sources. However, since this is a framework to perform a sanitary survey, all sources of contamination are considered, albeit to a lesser degree. It should also be noted that since surface water provides a very efficient means for bacteriological transport from the upper watershed down to the near coastal areas, the sanitary survey includes an assessment of all potential sources in the watershed and not just in the near coastal areas.

With a completed sanitary survey report, a more accurate assessment of the risk of recreational activities to public health can be made.

There are several tools that are available to assist the researcher in performing sanitary surveys in Hawaii. These include the following:

- *Hawaii's Coastal Nonpoint Pollution Control Program Plan*
- *Hawaii Polluted Runoff Control Program Reports*
- *Hawaii Safe Water Assessment Program*
- *EPA's Safe Water Drinking Act*
- *National Beach Guidance and Performance Criteria for Recreation Waters*
- *EPA's Guidance Manual for Conducting Sanitary Surveys of Public Water Systems; Surface Water and Ground Water Under the Direct Influence (GWUDI) (EPA 815-R-99-016)*
- *Watershed Sanitary Survey Guidance Manual (American Water Works Association - December 1993).*

## **2.0 INTRODUCTION**

---

This chapter provides the reader with the objectives of the water agency in conducting the sanitary survey and information on how the survey was conducted.

### **2.1 SANITARY SURVEY REQUIREMENTS**

Briefly discuss the requirements for the sanitary survey so that interested parties understand why the sanitary survey was conducted and how the water agency will use the information obtained in the sanitary survey.

### **2.2 OBJECTIVES**

State the objectives of your agency in conducting the sanitary survey. The objectives should not only include an assessment of potential threats to surface and/or groundwater supplies, but should also include some mechanism (e.g., tiered framework of investigations) to address potential risk.

### **2.3 CONDUCT OF THE STUDY**

Describe who conducted the study and how it was conducted. Describe what portions of the watershed are covered and how the field survey was conducted (e.g., via foot, car, boat, helicopter).

### **2.4 REPORT ORGANIZATION**

Describe how the sanitary survey report is organized. This will make it easier for the report to be reviewed by regulatory authorities and used by agency staff.

## **3.0 WATERSHED**

---

This chapter provides the reader with information on the watershed that forms the basis for the more detailed information presented in the following chapters.

### **3.1 WATERSHED**

Describe the location and general characteristics of the watershed and water bodies. Include a map of the watershed.

#### **3.1.1 Land Use and Natural Setting**

##### **3.1.1.1 Land Use**

Provide maps and brief discussions of:

- Major land uses (e.g., agricultural, urban),
- Land Ownership (rough estimate of public versus private ownership),
- Population centers/major towns (populations and a real extent).

Potential Information Sources:

- General knowledge of EPA and DOH staff,
- USDA, Soil and Water Conservation Districts, community-based watershed groups,
- GIS, aerial photographs,
- City, county, and community/neighborhood general plans,
- Maps of the watershed,
- Population statistics from governmental agencies,
- Any large federal landowners (e.g., military, US Fish & Wildlife Service, National Park Service)

##### **3.1.1.2 Natural Setting**

Provide maps and brief discussions of:

- Topography (general feeling for how mountainous or flat terrain is; relevance is to erosion potential, potential for spills on hair-pin turns),
- Geology (overview of geologic conditions; relevance is to hazards such as landslides, earthquake zones, flood plane, tsunami zone),
- Soils (overview of soil conditions; relevance is to erosional and permeability potential),
- Vegetation (overview of vegetation; relevance is to soil erosion, wildlife habitat over and near water bodies, and root damage to in-ground septics),
- Wildlife (overview of types and numbers of animal populations; relevance is to wildlife sources of fecal pathogens).

Potential Information Sources:

- United States Geological Survey (USGS) topographic maps and geologic maps and reports,
- GIS, aerial photographs,
- U.S. Natural Resources Conservation Service maps and reports,
- Environmental Impact Assessments and Statements prepared for projects in the watershed,
- GIS maps to delineate land-use percentages

### 3.1.2 Existing Hydrology

Describe the existing hydrologic characteristics of the watershed. These include:

- Precipitation patterns (mean annual, seasonal, and monthly rainfall, geographic variability),
- Number of significant rainfall events (e.g., more than 1 inch in 24 hours during the past year) that might have contributed to pathogen contamination,
- Average high water temperature,
- Water temperature during the last 30 days,
- Average flow of the beach if the beach is on a river or an estuary,
- Average flow during the past 30 days if the beach is on a river or an estuary,
- Water movement if the beach is on the ocean, a lake, or other non-flowing waterbody with or without a tide,
- Stream flow characteristics (drainage area, description of major tributaries, average runoff, mean monthly flows during dry, normal, and wet years, effects of reservoir operations on stream flow, location and amount of in-basin diversions, effects of storm drainage systems),
- Reservoir or lake characteristics (capacity, depth, seasonal effects, algal blooms, color),
- Wetlands characteristics (a real extent, proximity to intake)

- Groundwater recharge (discussion of any areas with significant recharge of groundwater to a surface water body), and
- Highest high tide and groundwater table elevations

Potential Information Sources:

- National Oceanic and Atmospheric Administration (NOAA) climatological data and reports,
- Various state, county, and private climatological data and reports,
- Department of Health (CWB and EPO), Department of Agriculture (irrigation systems), Agribusiness Development Corporation (irrigation systems) flow data and reports,
- USGS flow data and reports,
- Department of Land and Natural Resources,
- University of Hawaii (research projects),
- Interviews with reservoir operators,
- water well records,
- septic system permits, and
- injection well (UIC) permits

## 3.2 EMERGENCY PLANS

Briefly describe emergency plans for natural, accidental, or vandal-caused disasters, chemical spills from trucks or treatment facilities, fire, equipment failure, serious power failure, and deliberate water fouling. Emergency plans may include seismic/volcanic risk evaluations, inundation studies, emergency response plans, disaster preparedness programs, hurricane and tsunami contingency plans, etc. Emergency plans should include water monitoring, alarm capabilities, and chain of communication procedures from a 911 report, etc. to the water agency.

Potential Information Sources:

- Emergency plans (military commands, non-military government facilities, fire departments, State Civil Defense, State Emergency Response Commission (DOH) and its local (county) emergency planning committees.

## 4.0 POTENTIAL CONTAMINANT SOURCES

---

This chapter contains a discussion of the survey methods, potential contaminant sources in the watershed, growth in the watershed, and projected changes in the sources, types, or quantities of contaminants in the future.

### 4.1 SURVEY METHODS

Describe methods used to conduct the survey. These may include, but are not limited to windshield surveys, walking, boat trip, aerial overflight, existing reports, aerial photos, USGS maps, public agency file documents, personal interviews, and telephone conversations.

### 4.2 POTENTIAL CONTAMINANT SOURCES

Describe and show on a map potential sources of contaminants in the watershed and discuss key contaminants of concern associated with each source. Identify contaminant sources that directly relate to microbiological sources as well as other contaminant sources that are troublesome in the watershed (e.g., stormwater runoff, contaminated groundwater recharge, or waste disposal facilities).

#### 4.2.1 Wastewater

Wastewater treatment plant discharges, collection system leakage, septic tank leach fields, and cesspools can result in contamination of surface waters. The key contaminants of concern are pathogenic organisms, nutrients, and oxygen demanding substances. For industrial discharges, key contaminants will be specific to the specific type of industry (e.g., sugarcane and pineapple processing facilities).

##### 4.2.1.1 Wastewater Discharges.

Show the location of all municipal and industrial discharges on a map. Include those that discharge to surface waters and those that do not discharge directly to surface waters. Describe:

- Number of point source dischargers within one mile of this area (include off-shore outfalls),
- Nearest publicly owned treatment works (POTWs),

- Number of POTWs within five miles of the beach,
- Location of the discharge with respect to adjacent waterbodies (e.g., beaches)
- Existing flow and treatment process,
- Location of privately owned treatment works,
- Waste discharge requirements, including effluent limitations on constituents of concern and flow limitations,
- Effluent monitoring data,
- Significant spills of raw sewage or other waste discharge requirement violations that occurred at the plant in the past 5 to 10 years,
- For non-surface water discharge facilities, describe the type of disposal (e.g., evaporation, percolation, leachfield, etc.), and
- Sludge disposal practices.

Potential Information Sources:

- Hawaii DOH NPDES and UIC programs,
- Engineering reports or EIR about discharge, and
- Regional planning reports regarding discharges, including Areawide Wastewater Management Plan (for Section 208 of the Clean Water Act), and Water Quality Control Plans (for Section 303(E) of the Clean Water Act).

#### 4.2.1.2 Wastewater Collection Systems.

Because of the potential for raw sewage spills, describe:

- The location of wastewater/collection storage tanks,
- The locations of wastewater pumping stations from which overflow could reach surface water and beaches,
- The overflow prevention characteristics of these stations, including alarms, spill containment structures, and the availability of standby power or pumps. (*Including injection wells that are used for overflow contaminants at pump out stations*),
- Significant spills from these pumping stations or pipelines for the last 5 to 10 years,
- Area subject to combined sewer overflows (CSOs) or sanitary sewer overflows (SSOs), and
- Number, duration, and extent of CSOs and SSOs in the area for the last 5 to 10 years.

Potential Information Sources:

- Wastewater collection agency maps, reports, and engineering staff,
- Hawaii Office of Emergency Services (HAZMAT) division, and

- Hawaii DOHS

#### 4.2.1.3 Septic Tank Systems and Cesspools.

Isolated individual septic tank systems and cesspools on most rural residential lots or farms usually will not be a significant contamination source but should be included in the survey (the relative risk associated with a single source that is isolated from a waterbody is less than the risks associated with larger sources that are closer to a waterbody). The sanitary survey should focus on large subdivisions, rural lots immediately adjacent to a stream or beach, large capacity cesspools, or in areas where septic systems and cesspools are known or suspected to be failing. DOH maintains a catalog of cesspool cards and the locations and numbers of cesspools can be manually counted if the researcher knows beforehand the street names of the area in question. This section should provide a detailed description of the following:

- Approximate number and size of septic systems and cesspools in the watershed and the number of septic systems within 5 miles of the beach,
- Estimated age of septic systems and cesspools,
- Septic tank and cesspools maintenance/inspection programs,
- Large subdivisions or areas that are on septic tank systems or cesspools, particularly those that are close to surface waters (e.g., rivers, streams, beaches, etc.),
- The present and potential number of septic tanks and cesspools, together with their status relative to being connected to a wastewater collection system,
- Large capacity cesspools that will have to upgrade treatment or hook up to sewer,
- Areas known or suspected as having failing septic tank systems or cesspools and corrective actions are being taken, and
- Water quality monitoring data for surface waters near areas served by septic tanks and cesspools.

#### Potential Information Sources:

- Hawaii DOH (including Wastewater Branch: maps of wastewater critical areas, UIC maps),
- County Health Department records and staff - especially if they have a cesspool pumping program,
- County parcel maps, and
- Sewer system maps and water service billing information can be used to estimate unconnected parcels.

#### 4.2.2 Reclaimed Water

The use of reclaimed water for irrigation and impoundments can result in the application of harmful microorganisms and organic chemicals to the watershed and eventual contamination of recreational areas.

This section should contain a description of:

- The location of water reclamation projects, the type of use, and the reclaimed water quality used,
- The level of treatment, and
- The water quality compliance and site containment records.

Potential Information Sources:

- Hawaii DOH (including Wastewater Branch) and
- County Board of Water Supply

### **4.2.3 Urban Runoff and Industrial Area Runoff**

The key contaminants of concern in urban runoff discharges are pathogens, heavy metals (cadmium, lead, copper, and zinc), hydrocarbons, and suspended solids. There may also be additional contaminants of concern specific to different industrial areas depending on the type of industrial activity. Both urban and industrial activities are regulated under the NPDES Permit program as well as the UIC program for storm water drainage wells (all storm water drainage wells are required to have a UIC permit and application) and should be discussed in the same section of the Sanitary Survey report. Where industrial activity is significant in a watershed, and is not associated with an urban area (e.g., sugarcane processing facilities, etc.), that activity should be discussed in a separate section of the Sanitary Survey report.

The following should be described in this section:

- The population and location of urban areas in the watershed (include a map),
- The number, size, and location of major municipal and industrial urban runoff discharges and injection wells (include a map),
- The status of the urban and industries with respect to the NPDES and UIC Permit program,
- The impact of urban runoff on the receiving waters (e.g., beaches, estuaries, rivers, groundwater, etc.),
- Urban runoff control measures in the watershed, and
- The seasonal, episodic nature of storm generated versus dry weather urban runoff.

Potential Information Sources:

- NPDES Permits,

- UIC permit applications
- GIS and aerial photographs,
- Population statistics (HI Dept. of Finance),
- Field survey observations,
- City and county public works departments,
- Hawaii DOH,
- Hawaii Department of Transportation,
- Coastal Zone Management Program, and
- Non point source program

#### 4.2.4 Agricultural Crop Land Use

This land use type is not of primary interest as a source of microbiological contamination unless animal manures are applied to croplands or there is the potential for irrigation return water from pondfields and fishponds. If this non-point source is included in the survey, the mapped locations of these areas should be shown.

This section should contain brief descriptions of the following:

- The types of crops grown,
- Areas where animal manures are applied to croplands,
- Locations and descriptions of pondfields and fishponds,
- Area subject to agricultural runoff during storms,
- Available data related to application quantities or runoff concentrations of constituents of concern (e.g., pathogens, total dissolved solids, nutrients, pesticides and herbicides, sodium, etc.). This type of data might be difficult to obtain or may not even exist in some cases, and
- Groundwater contamination, which could be an indicator of historical surface water problems.

Potential Information Sources:

- State and/or County Agricultural Commissioner (Department of Agriculture),
- GIS and aerial photographs,
- Farm Bureau offices,
- University of Hawaii Cooperative Extension Service,
- Soil and Water Conservation District,
- Natural Resources Conservation Service,
- Major farm operators, and
- DOH- groundwater contamination maps

#### 4.2.5 Grazing Animals

The impact of grazing animals in a watershed can be very significant due to the potential for the animals to be carriers of *Giardia* and *Cryptosporidium*. This section should contain descriptions of the following:

- The location and numbers of grazing animals on private land (the location might be difficult to define without a very intensive field effort and cooperation of the landowners due to a lack of record-keeping on this type of information. Nevertheless, an attempt should be made to define areas where the animals could be by using land-use maps),
- Access of grazing animals to tributary waterbodies.

Potential Information Sources:

- County land use and zoning maps,
- GIS and aerial photographs,
- Landowner surveys,
- Conservation districts, and
- UH cooperative extension service.

#### 4.2.6 Concentrated Animal Facilities

Concentrated animal facilities include dairies and feedlots where many animals are contained in a relatively small area. The contaminants of concern include pathogenic organisms, nutrients, and oxygen demanding chemicals. This section should contain:

- The location and types of facilities (including manure holding tanks or pits, composting or other processing areas),
- The number of animal feeding operations (AFOs, feedlots, slaughterhouses) or concentrated animal feeding operations (CAFOs) within the watershed,
- The number of aquaculture facilities within the watershed,
- The nature of discharges from AFOs, CAFOs, and aquaculture facilities to the waterbodies in the watershed,
- Waste discharge requirement permits,
- History of any problems and runoff control measures employed at the facilities,
- Status of the facilities with respect to the Industrial Stormwater Permit,
- The owner and operator of the facility, and
- Large capacity cesspools at slaughterhouses, industrial waste discharge or stormwater wells.

Potential Information Sources:

- Hawaii DOH,
- GIS and aerial photographs,

- Industrial Stormwater Permit Issuers,
- UIC permits, and
- Field survey observations.

#### 4.2.7 Pesticide and Herbicide Use

This potential contaminant source is not of primary interest as a source of microbiological contamination, but could be very significant for other Safe Drinking Water Act (SDWA) contaminants. At the present time there are no known usable data for the largest volume of pesticide/herbicide used, (i.e., over-the-counter sales to individuals). However, sales of registered chemicals to individual operators are recorded by the State of Hawaii Department of Agriculture, and could be used to infer locations where significant known quantities and types of chemicals may be applied. If this source is included in the survey, to the extent that data are available, describe:

- Locations where significant known quantities and types of pesticides/herbicides are used (e.g., termatocides used in homes, golf courses, parks, agricultural crop land, roadway and railway shoulders, and other uses by county, state, and federal agencies).

Potential Information Sources:

- County Departments of Public Works,
- Natural Resource Conservation Service,
- Farm Services Agency,
- University of Hawaii Cooperative Extension Service,
- Dept. of Agriculture,
- Hawaii DOH,
- Hawaii Dept. of Pesticide Regulation, or similar agency, and
- USGS - stream monitoring for pesticides, particularly for termatocides.

#### 4.2.8 Wild Animals

Mammals are significant sources of microbiological contamination (including *Leptospira*) in watersheds, estuaries, harbors, and embayments. The description of wild animals should focus on:

- The presence or known absence of animals that could be present in the watershed in significant numbers. A map should be included that shows the locations and approximate densities of wildlife in the watershed,
- The presence or known absence of warm blooded aquatic life inhabiting or frequenting the waterbody of interest. Specifically focusing on birds, pennipeds and cetaceans,

- Approximate number of birds per hour that frequent a typical 50-meter length of this waterbody,
- Approximate number of non-human mammals (including domesticated animals) that frequent a typical 50-meter length of this waterbody, and
- The seasonal presence or absence of wild animals (especially rodents) in the watershed that have access to this waterbody.

Potential Information Sources:

- Hawaii DOH,
- GIS and aerial photographs,
- Commission on Water Resource Management,
- Dept. of Land and Natural Resources,
- Coastal Zone Management Program,
- U.S. Army Corps of Engineers,
- U.S. Fish and Wildlife Service,
- National Marine Fisheries Service.

#### 4.2.9 Solid and Hazardous Waste Disposal Facilities

Solid waste disposal facilities can contaminate stormwater runoff with fecal material (from disposable diapers and pet waste). Hazardous waste disposal facilities do not generally contribute to the bacterial contaminant load but could be a source of other Safe Drinking Water Act (SDWA) contaminants. Contaminants of concern are iron, lead, copper, dissolved solids, nutrients, and a variety of organic chemicals. The mapped locations of these areas should be shown. This section should contain brief descriptions of the following:

- The location and type of disposal facilities,
- History of problems and control measures,
- Water quality monitoring data,
- The owner and operator of the facilities.

Potential Information Sources Include:

- Dept. of Land and Natural Resources,
- GIS, aerial photographs,
- Hawaii DOH/counties' solid waste landfill permits,
- Disposal site operator, and
- Field survey observations.

Note: In February 2003, a study was commissioned by state legislature to look at leaking landfills.

#### 4.2.10 Logging

Although logging is not a significant industry in Hawaii, poor management practices during timber harvesting can lead to significant erosion problems, which can be a source of microbiological organisms in nearby surface water bodies. This section should briefly describe the following:

- Available information regarding the location of lands (public and private) on which logging can occur (include a map that provides the location, type of logging, and ownership statistics),
- Areas where logging took place within the past 3 to 5 years, and an estimate of the acres logged during that same time period, and
- Water quality data collected prior to, during, or after logging operations.

Potential Information Sources Include:

- Dept. of Land and Natural Resources,
- GIS, aerial photographs,
- DOH,
- County Planning Departments,
- County Departments of Public Works,
- Soil and Water Conservation Districts,
- Individual logging companies,
- Fire suppression authorities, and
- EIRs for logging on federal lands, and Timber Harvesting Plans prepared by logging companies.

#### **4.2.11 Recreational Use**

Recreational use of surface water bodies, aside from being a designated beneficial use, is also a significant source of microbiological contamination. This section should include mapped locations and definitions of significant recreation sites in the watershed and should describe:

- The location of recreational areas where microbiological contamination is possible (e.g., county, state, and national parks, state recreation areas, and recreation sites on private land, National Forest Service land, and other federal agency land),
- Annual number of users,
- Types of recreation in watershed (equestrian use, backpacking, camping, swimming, etc.),
- Type, number, and accessibility of restroom facilities available (vault, septic system, cesspools, portable, other),
- Whether or not water-contact recreation takes place. If water-contact recreation occurs, include the number of people involved on a peak-use day,

- The record of compliance with county bathing water bacteriological standards (Note: compliance is based on state recreational waters criteria listed in HAR Chapter 11-54),
- Presence and type of marina (e.g., allows ‘live aboard’),
- Number and type of pleasure craft having on-board sanitary holding tanks,
- Number and type of working craft having on-board sanitary holding tanks,
- Whether or not boat holding tank pump-out stations are available, and the number of marinas and berths, and
- Pollution prevention and abatement efforts in this area.

Potential Information Sources Include:

- Dept. of Land and Natural Resources,
- State Commission on Water Resource Management,
- GIS, aerial photographs,
- Coastal Zone Management Program,
- Hawaii DOH,
- U.S. Army Corps of Engineers,
- County Planning Departments,
- U.S. Fish and Wildlife Service,
- Staff and records of state, county, city, regional, or other local parks and park districts,
- Individual recreational areas and marinas, if information is not available from public agency records, and
- Field surveys.

#### 4.2.12 Unauthorized Activity

Examples of unauthorized activity include dumping of on-board sanitation tank contents, chemicals, paints, or any other toxic material into a surface water. This section should describe:

- Known locations of illegal dump sites,
- Known incidents in which existing regulations or policies of any agency have been intentionally violated, resulting in surface water quality degradation.

Potential Information Sources Include:

- Hawaii DOH,
- Police and Fire Services,
- Hawaii Department of Transportation,
- County Departments of Public Works,
- Federal agency staff who make routine trips into the watershed,

- Personnel of state, county, regional, or local parks in the watershed, and
- EPA Criminal Investigation Division

#### 4.2.13 Traffic Accidents/Spills

The vast majority of spills resulting from accidents on highways, local streets, railroads, or other transportation systems will be primarily related to toxic or hazardous materials and not specific to microbiological contaminants. However, there is always the possibility that accidents involving either septic tank pumper trucks, vehicles transporting livestock, fish, animal waste and slop, or medical shipments of microbiological samples could occur.

This section should include a discussion of the following:

- History of spills resulting in surface water contamination due to accidents in a transportation corridor of any type (primarily road or rail);
- Highway segments in the watershed in which the Highway Patrol has designated as either a primary route for carrying specific hazardous materials, or a route on which the number and types of hazardous materials are restricted;
- Materials which railroads are permitted to carry through the watershed;
- If motor vehicle accidents and spills are a special issue, traffic conditions on highways and streets can be defined in terms of (1) the classification of significant roadways and (2) known present characteristics such as calculated traffic capacity, existing traffic (peak hour) volume, the total number of accidents within the past several years, and a resulting estimate of accident probabilities.

Potential Information Sources Include:

- Hawaii DOH, Hazardous Evaluation and Emergency Response (HEER) office,
- Highway Patrol,
- Department of Emergency Services,
- Department of Hazardous Waste Control,
- Department of Public Safety, and
- Individual railroad companies.

#### 4.2.14 Groundwater Which Influences Surface Water Quality

There may be conditions in some watersheds in which artesian uncapped wells (drinking water, gas, oil, geothermal) affect a surface water supply. Groundwater recharge of streams is another potential area to investigate. The most likely concern with groundwater discharges is the higher salinity of groundwater compared to the surface water quality. **Note: in Hawaii, the ground water is**

**usually of better quality than the surface water with respect to TDS and acidity.** Various other contaminants such as nitrate levels could be of concern depending upon the specific conditions in the watershed. If this source is included in the survey, this section should include a discussion of:

- The location of groundwater influence areas,
- The history of the groundwater discharge and any control measures that are planned or in place, and
- The identity of the owner and operator (if applicable).

Potential Sources of Information Include:

- Hawaii DOH,
- State Commission on Water Resource Management (archives registered water sources indicates locations of many flowing springs)
- USGS (groundwater to streams),
- Groundwater discharge facilities staff,
- Department of Land and Natural Resources for water wells.

#### 4.2.15 Geologic Hazards

This potential contaminant source is not of primary interest as a source of microbiological contamination. However, geologic hazards such as earthquakes, landslides, mudslides, and volcanic activities have the potential to destroy portions of the water supply system. At the very least, they contribute large quantities of suspended solids to the source of supply in a short period of time. The long term effects can include higher loadings of suspended solids, microbiological organisms and other contaminants associated with the solids. This section should include a discussion of the following:

- The types of hazards present in the watershed,
- The historical record of these events,
- Location of past events,
- Knows sensitive areas in the watershed, and
- Water quality data collected during past events

Potential Sources of Information Include:

- USGS,
- Department of Land and Natural Resources,
- Field survey observations,
- University of Hawaii.

#### 4.2.16 Fires

This potential contaminant source is not of primary interest as a source of microbiological contamination. However, fires in the watershed can contribute large loads of suspended solids and organic matter to waterbodies during and immediately after the fire and for some period of time until the fire area is stabilized. This section should include a discussion of:

- The likely locations of fires in the watershed,
- History of major occurrences,
- Responsible agencies,
- The response after past events (earth stabilization, re-vegetation, etc.),
- Water quality monitoring data before and after the fire, and
- Plan for response to future events.

Potential Sources of Information Include:

- Fire departments,
- Military commands (Forest Service Riverside Fire Laboratory),
- USFWS and National Parks Service and
- State Department of Land and Natural Resources.

#### **4.2.17 Significance of Potential Contaminant Sources**

This section should provide a comparative assessment of the potential contaminant sources of concern in the watershed. Several factors can be used to assess the significance of these sources on a case-by-case basis. These factors include the following:

- Disease outbreaks caused by the contaminant source,
- Other known water quality problems caused by a contaminant source,
- The relative health significance of the type of contaminants, e.g., microbial contaminants and toxic substances would have a higher priority than inorganic constituents like nutrients and total dissolved solids (TDS),
- The distance or travel time between the contaminant source and a recreational area,
- The duration and extent of the contamination, and
- The magnitude of the contaminant source, (e.g., one dwelling on a septic tank or cesspool system near a stream or beach versus a 100 home subdivision using septic tank or cesspool systems, or a wastewater discharge of 50,000 gallons per day versus one of 5 million gallons per day).

### **4.3 Anticipated Growth and Projected Changes in Sources of Contaminants**

This section should contain a description of planned or anticipated growth in the watershed that is likely to affect the sources of contaminants to surface waters in

the near future (next 10 years). The discussion should include projected population increases; location of planned new developments or industrial facilities; the construction or closing of a wastewater discharge, subdivisions on septic tank systems that are planned to be connected to a wastewater collection system, the planned opening or closing of solid/hazardous waste disposal facilities; measures to be used to protect the water supply system from new developments (e.g., best management practices for urban runoff control, replacement of septic systems with wastewater collection systems, etc.); major changes in timber harvesting practices; the planned expansion, closing, or opening of a recreational facility.

Potential Sources of Information Include:

- County and City Planning Departments,
- EIRs for new developments and facilities,
- Population statistics, and
- Large federal agency landowners (e.g., Military commands)

---

## **5.0 WATERSHED CONTROL AND MANAGEMENT PRACTICES**

---

This chapter contains a discussion of existing and recommended watershed management practices that protect surface water quality. Management practices used by the water agency and by other agencies that have control over the watershed are described.

### **5.1 WATER AGENCY MANAGEMENT PRACTICES**

The degree of control the water agency has over the watershed depends largely on the amount of watershed land that is owned and directly controlled by the water agency. This section contains a discussion of water agency management practices.

#### **5.1.1 Organizational Structure**

Describe the management objectives, management structure, and roles and responsibilities of offices or work groups associated with watershed management.

#### **5.1.2 Watershed and Reservoir Management Operations**

Some agencies have developed watershed plans that consider local conditions such as soil, slope, climate, hydrology, vegetation, recreation uses, fishery, wildlife, endangered species, etc. If a watershed plan has been developed, it should be referenced and the key elements should be described in this section. If a watershed plan has not been developed, the agency policies and actions (in terms of actual implementation) with respect to the following list should be described.

- Land use and planning review,
- Land ownership and right-of-way,

- Access control (permitting procedure, control of trespassing/loitering, etc.),
- Septic system and cesspool regulations,
- Urban stormwater runoff control and treatment,
- Grazing practices and wildlife management,
- Pesticide and herbicide applications,
- Domestic animal use/control,
- Mining and mine runoff,
- Forest management and logging practices,
- Erosion control (grading ordinances, etc.),
- Road maintenance,
- Off-road vehicle use,
- Recreational uses,
- Reservoir use restrictions,
- Emergency response programs (sewage spill, hazardous material containment and spill),
- Water quality monitoring,
- Vegetation management,
- Riparian management,
- Wetland management, and
- Public education and relations.

### **5.1.3 Inspection and Surveillance of the Watershed**

This section should be used to describe the water agency's watershed inspection and surveillance program. Program elements may include:

- Routine watershed patrol,
- Routine inspections of septic tank systems,
- Access permit and monitoring,
- Water quality monitoring program, and
- Cooperative programs for inspection, surveillance, and management with other agencies and landowners (e.g., cities, counties, federal resources agencies, state resources agencies, private corporations, etc.).

## 5.2 OTHER AGENCIES WITH WATERSHED CONTROL AUTHORITY

In addition to water agency specific watershed control measures, local, state, and federal agencies and large private landowners may also have watershed control authority through policies, programs, or regulations. Lease agreements with other agencies may include specific watershed or water quality protection requirements. In many cases, these policies and programs regulate the types of land uses, density of development, or discharge of contaminants within the watershed, and consequently are key elements in assessing the potential for future water quality preservation or degradation.

This section of the survey should:

- Identify other agencies and landowners that have control authority within the watershed;
- Summarize relevant policies, programs, regulations, ordinances and agreements that govern land uses, development density, recreation density, or water quality;
- Identify specific contaminant discharge requirements that have been imposed in the watershed; and
- Provide an analysis for the potential water quality impacts for all relevant policies, programs, etc. For example, a strict county general plan or zoning stipulation which prohibits extensive industrial development within a watershed represents a method of potentially preserving water quality and should be identified in the sanitary survey document.

Some of the other agencies' and/or landowners' policies, programs, and regulations that commonly impact watersheds or water quality within the watershed are identified below. The list is intended as guidance and any additional agencies that have control authority in your specific watershed should also be included in this section of the sanitary survey document.

### 5.2.1 County General Plan Policies

County General Plans typically act as guides for managing development within the county. Typically, policies outlined in the general plan are implemented through zoning ordinances which specify requirements which must be met in order for a defined type of activity or density of development to occur on a given parcel. This section should describe:

- General plan policies and zoning regulations for the types of land uses present in the watershed;

- Policies or regulations that restrict or encourage development, place restrictions on land uses or specifically require water quality protection measures; and
- The watershed and water quality protection potential of these policies.

Potential Sources of Information Include:

- The county general plan,
- The counties' planning department staff, and
- Local cities' planning department staff and reports.

### **5.2.2 Federal Agency Plans and Policies**

For watersheds where a significant portion of the watershed area is federally owned, describe the relevant sections of any plans and policies developed by the federal agency having ownership (e.g., Military commands).

Potential Sources of Information Include:

- Policies and plans developed by any large federal landowners (military commands) and
- Federal agency staff.

### **5.2.3 Wastewater Discharge Requirements**

Wastewater discharges to leachfield systems or engineered on-site systems may be regulated by a local county agency through health or sanitation ordinances. Typically, ordinances set guidelines for the siting and sizing of leachfield and engineered systems to promote effective treatment.

Given the potential for wastewater discharges to degrade water quality and the likelihood that discharges of human waste within the watershed will trigger increased log removal criteria for water treatment, it is important to be complete and specific in this section. This section should provide a discussion of:

- Local agency policies, ordinances, or guidelines regarding discharge to surface waters or to land within the watershed.

Potential sources of information include state and county health departments.

## 5.2.4 Stormwater Regulations

In Hawaii, urban stormwater discharges are regulated by the DOH through NPDES Permits. They are responsible for implementing provisions of the Federal Clean Water Act that govern urban runoff. The State of Hawaii has established permit processes governing municipal stormwater discharges, discharge of stormwater from construction sites and discharges of stormwater associated with industrial activity. Individual sites may be subjected to an individual permit, or fall under the umbrella of the statewide “General Permit”, which was adopted by the state and compliance is achieved by filing a “Notice of Intent” to comply with the provisions in the statewide permit.

This section should include a discussion of the implementation of best management practices at the local level, relevant to the watershed under consideration.

Potential Sources of Information Include:

- Hawaii Department of Health,
- NPDES-permitted entities (e.g., City and County of Honolulu, State Department of Transportation, and military commands),
- Local urban runoff program staff and reports.

## 5.2.5 Lease Agreements

In some watersheds, the water agency may have existing lease agreements with other agencies or private parties for recreation, grazing, or other land uses within the watershed. In many cases, the land uses have the potential to impact water quality and agreements should contain provisions which seek to preserve water quality directly or indirectly.

This section should describe:

- The relevant provisions in leases with other parties in the watershed that impact water quality and
- The time frame for the lease provisions, and if the language is general in nature, how the lease provisions are interpreted in practice.

Potential Sources of Information Include:

- Water agency files and staff,
- Large federal agency landowners and
- Any large private landowners in the watershed.

## 5.2.6 Mines/Mining Reclamation

Active mining or inactive mines are regulated by the Hawaiian Department of Land and Natural Resources. In cases where human health is impacted, DOH may also be involved.

In many cases, discharges from inactive mine sites represent a greater hazard to water quality than discharges from active mines. The primary contaminants of concern are heavy metals which may exceed water quality standards, but more commonly accumulate in sediments and/or aquatic organisms, posing a public health risk associated with consumption of the contaminated organisms. This section should include a discussion of the:

- Regulatory policies, requirements, discharge limitations, or cleanup requirements associated with active or inactive mine sites within the watershed and
- Structural or nonstructural controls required by the regulatory agencies and the effectiveness of these controls in protecting water quality.

Potential Sources of Information Include:

- U.S. Census Bureau, Census of Mineral Industries and Mineral Industry Surveys,
- Hawaiian Department of Land and Natural Resources,
- DOH,
- Owners/operators of mine facilities.

### **5.2.7 Recreational Activities and Policies**

In many watersheds, the water agency does not directly control recreational activities. Often, a local, county, or regional recreation agency such as a parks district has responsibility for recreational activities within the watershed. The recreation agency may operate under the provisions of an agreement or lease with the water agency. This section should contain a discussion of the following:

- Which agencies have responsibility for recreation on fresh and marine waterbodies within the watershed;
- The nature of the relationship with the water agency (e.g., lease, agreement, easements, etc.) and the provisions of any formal agreements that impact water quality;
- Controls the water agency has over the nature and extent of recreation, and what review authority the water agency has over proposed changes in the type or intensity of recreation;
- Operating policies or procedures of the recreation agency that are designed to protect water quality and include an evaluation of the degree of protection those policies and procedures provide; and

- Structural or nonstructural controls that are implemented by the recreation agency to protect water quality.

Potential Sources of Information Include:

- Water agency files, policies, and staff,
- Recreation agency and specific recreation area files, policies, procedures and staff, and
- Large federal agency landowners.

### **5.2.8 Open Space Policies**

Open space policies are often established by local or regional land use agencies as a means of encouraging the preservation of open space where development is limited or prohibited. These policies are often reflected in general plans or zoning ordinances. In some cases, open space policies are applied to watershed lands to either protect water quality directly or to protect sensitive environmental resources. Open space policies can be an effective means of protecting water quality in the watershed. This section should include a discussion of the following:

- Open space policies that apply to lands within the watershed, particularly provisions that protect environmental resources or water quality directly, and
- The agency charged with administration of the policies and the vehicle for implementation (zoning ordinances, etc.).

Potential Sources of Information Include:

- City or county planning departments,
- Regional land use agencies such as local agency formation commissions, and
- Large federal agency landowners.

### **5.2.9 Erosion Control/Soil Management Policies**

Erosion and soil management policies and practices are usually developed locally for the specific conditions in a given locality. Often, counties have adopted grading ordinances which impose requirements associated with grading for roads or development. In many areas, the local office of the U.S. Natural Resources Conservation Service has established non-binding guidelines for a particular locale. These guidelines cover areas as diverse as erosion control, dairy waste management, range establishment, and location of cattle watering facilities. This section should include a discussion of the following:

- Applicable policies and guidelines for the types of land uses present in the watershed and
- Whether these guidelines are being followed and whether water quality protection is provided.

Potential Sources of Information Include:

- County planning departments,
- U.S. Natural Resources Conservation Service staff and reports,
- Large federal landowners and
- Any large private landowners in the watershed.

### **5.2.10 Fire Management**

Fire management can be an important component of good watershed management because any fire dramatically increases the potential for erosion. Prudent fire prevention practices are typically the responsibility of the landowner. However, many state, county, and regional fire suppression agencies will work with landowners to establish fire management plans which implement preventative measures designed to reduce the risk of fires. Additionally, local land use agencies may also have ordinances that specify prudent practices for preventing fires. This section should describe:

- Local ordinances, policies or plans for the watershed areas designated to prevent fires and
- Key elements of the fire management plan, if available.

Potential Sources of Information Include:

- Local fire suppression agencies,
- U.S. Natural Resources Conservation Service staff and reports,
- Large federal landowners and
- Any large private landowners in the watershed.

### 5.2.11 Other Ordinances, Policies, or Regulations

There may be other ordinances, policies, or regulations that affect water quality. Examples include Fish and Game Code provisions which prohibit the pollution of water bodies, County Environmental Health regulations, and specific city ordinances which apply to developed portions of the watersheds. These requirements should be included to the extent that they are clearly connected to protecting water quality. The intent is not to provide a listing of regulations of all types which apply to land of the watershed, just those that affect water quality. This section should provide a discussion of the following:

- Other relevant policies, local ordinances or regulations that apply to the watershed areas and have the potential to impact water quality.

## 5.3 WATER AGENCY COORDINATION MEASURES

This section specifies control measures currently being used by the water agency to protect watershed lands which are outside of their ownership and jurisdiction. One example of a control measure is to have the local planning jurisdiction (city or county) designate the drainage area lands for watershed protection on the General Plan land use map. The General Plan Land Use element would be amended to include policies to protect the watershed and allow for appropriate land uses. The Zoning Map and Ordinance would also be changed to reflect the General Plan Watershed land use designation policies. The zoning ordinance would specify development standards and criteria, also called performance zoning, which the water utility develops with the local planning staff. This same approach can be taken to protect a critical aquifer and recharge zone. Special-purpose ordinances can also be developed for watershed and recharge zone protection.

Another approach is the purchase of development rights on watershed lands. This option provides the potential for simultaneously keeping the property on the tax rolls and controlling land use. However, landowners may not be interested in just selling the development rights and not the entire property. Watershed easements should also be considered. This agreement between landowner and purveyor can provide tax benefits to the landowner while protecting the watersheds and recharge areas by restricting the uses on the land.

Some communities have a provision in their zoning ordinance to allow for the transfer of development rights (TDRs) to protect sensitive lands with public values. TDRs could compensate owners of watershed or recharge land who want to develop.

An Interagency Coordination Committee could be formed alone or in conjunction with the measures described above. The committee members may be composed of representatives from several agencies and would provide an objective review of all general plan amendments, zoning changes, and tentative map submittals within the watershed or aquifer recharge zone for potential water supply and quality impacts. Ideally, the committee would have authority to influence the approval process by requiring control measures and/or innovative site design which reduces negative impacts.

#### **5.4 RECOMMENDED CONTROL MEASURES**

This section should summarize existing watershed control measures being implemented by the water agency, other agencies, and any large private landowners with watershed authority that are providing effective water quality protection. It should also identify additional control measures that will be implemented to provide additional water quality protection based on the review of agency policies and regulations conducted for the sanitary survey. The intent of this section is to provide Hawaii DOH with a concise summary of control measures that the agency will use to protect water quality and to provide the water agency with a road map to guide them in implementation of watershed control measures.

## 6.0 WATER QUALITY

---

This chapter contains a discussion of water quality regulations and monitoring conducted by the water agency. Water quality data are compared to existing and proposed (if applicable) environmental standards and criteria.

### 6.1 WATER FOR RECREATIONAL USE

This section should contain a summary of the water quality regulations pertaining to contact and non-contact recreational use of waterbodies within the watershed and a discussion of the specific constituents of concern in the watershed being evaluated. A table that summarizes the current and proposed (if applicable) water quality standards and criteria for Hawaii is a useful reference for water agency staff.

#### 6.1.1 Recreational Use Regulations

The basic water quality regulations that control both contact and non-contact recreational activities should be described so that the reader understands them and the rationale for including them in the sanitary survey.

#### 6.1.2 Constituents of Concern

Based on the sources of contaminants in the watershed, describe:

- Which constituents are of concern to the water agency and why they are of concern (e.g., what impact they have on contact and non-contact water recreation). Constituents can be grouped into the following major categories:
  - ✓ Microbiology (e.g., coliform, streptococcus, lactobacillus, staphylococcus, clostridia, *Leptospira*, Giardia, cryptosporidium, hepatitis A, rotaviruses, caliciviruses (Norwalk-like viruses), adenoviruses, enteroviruses, and reovirus);
  - ✓ Pesticides, herbicides, and PCB's;

- ✓ Nutrients and algal blooms;
  - ✓ Dissolved oxygen and pH;
  - ✓ Total dissolved and suspended solids;
  - ✓ Metals;
  - ✓ Organics;
  - ✓ Radiological constituents
- The relationship between the constituents of concern and the contaminant sources in the watershed (e.g., microbiologicals are of concern because there are numerous housing developments with in-ground septic tanks in the watershed close to, or downstream of a recreational area).

## 6.2 EXISTING WATER QUALITY

This section should include a discussion of existing monitoring programs, and evaluation of the water quality data, and recommendations for improvements in the monitoring program.

### 6.2.1 Monitoring Programs

The water agency may not be the only entity collecting water quality data in the watershed. An attempt should be made to obtain data from USGS, large land owners, and dischargers in the watershed. These monitoring programs should be discussed along with the monitoring program conducted by the water agency.

This section should include a description and map of the monitoring locations, and a description and table that presents the constituents monitored, the sampling frequency, duration of monitoring program, and analytical methods used.

Potential Sources of Information Include:

- USGS
- Hawaii Department of Health
- Hawaii Department of Land and Natural Resources
- Large federal agency landowners and
- Large private landowners
- EPA STORET database
- University of Hawaii
- Individual dischargers to the watershed (NPDES permitted entities)
- Coastal Zone Management Program
- USFWS

### 6.2.2 Evaluation of Monitoring Data

The data should be presented in tabular and graphical form to show spatial and temporal trends. This section should describe, at a minimum:

- Trends over time (temporal) to indicate if water quality is improving or degrading or if there are seasonal trends.
- Trends from upstream to downstream (spatial) in the watershed to indicate if contaminant sources in the watershed are degrading water quality.
- Comparison of surface water quality to existing water quality criteria to assess whether the water quality is meeting its beneficial uses.
- Any special monitoring studies conducted to examine the impacts of particular contaminant sources in the watershed.
- Projected changes in water quality as a result of anticipated changes in the watershed.

### **6.3 RECOMMENDED WATER QUALITY MONITORING PROGRAM**

The existing water quality monitoring programs should be evaluated to determine if they are adequate to assess the impacts of contaminant sources in the watershed. Recommendations should be made in this section for improving the monitoring program (e.g., sampling frequency, constituents to be monitored, reliability of analytical methods, QA/QC programs, etc.).

## 7.0 CONCLUSIONS AND RECOMMENDATIONS

---

This chapter should contain a discussion of the key conclusions drawn from the sanitary survey and recommendations to improve watershed and surface water quality.

### 7.1 CONCLUSIONS

Conclusions regarding system operational changes, contaminant sources in the watershed, watershed control and management, and water quality are discussed in this section.

### 7.2 RECOMMENDATIONS

Recommendations based on the conclusions discussed in the previous section are enumerated in this section. The recommendations should be specific so that the water agency staff understand the need and how to correct the problem that is addressed in the recommendation. For example, if the sanitary survey indicates that microbiological contaminants are impairing surface water quality, the recommendation may include increased monitoring of the watershed using tracers (e.g., dye, caffeine, human hormones) and a suite of indicators (e.g., bacterial enumeration and DNA tracking) to determine the source of the bacteriological and viral contamination. These tools can include:

*Traditional Bacteriological Enumeration* - Includes an undifferentiated enumeration of both human and non-human fecal bacteria counts. The benefits of using this tool include (1) its cost (relatively inexpensive ~\$100/sample) and, (2) since it is the most commonly used tool, it is easily comparable to other, existing data sources. This tool is limited, however, in its ability to assist the agency in locating the contaminant source(s) with any specificity and, as such it usually takes several samples collected throughout the watershed to locate the possible contaminant source.

*Bacterial Source Tracking* - This tool determines the DNA fingerprints of 5 colonies of *E. coli* and statistically differentiates it as being from human or animal sources. The primary benefits of using this tool are (1) it increases the ability of the agency to locate the source(s) of the contamination with some specificity and (2) blind samples can be used (i.e., a separate DNA fingerprint library does not have to be developed for Hawaii). The limitations of this tool include its cost (~\$300/sample) and, that it is a relatively new assessment tool. This tool can be used to differentiate between species (e.g., cattle vs. human).

*Human Fecal Virus Tracking* - Detection of human viruses in water samples can serve as an indicator of human contamination. Of particular concern are human enteric viruses. These viruses infect the gastrointestinal tract of human and animals, and are excreted in feces. More than one hundred different enteric viruses may be excreted in human fecal material and as many as 1,000,000 units of enteroviruses per gram may be present in the feces of a sick person.

The primary benefit to using this tool is its ability to isolate human-borne viral pathogens and provide a very sensitive indicator for potential human illnesses caused by contact with or consumption of contaminated surface water. The limitations of this tool include its cost (~\$350/sample) and, because it is a relatively new use for the technology, there are not a lot of existing data available.

Often, the best approach to take would be to use existing coliform data to “isolate” trouble areas and then use the DNA tracking techniques to determine whether the source of the observed contamination is human (e.g., failed septic or cesspools, leaking sanitary sewer pipelines, recreational use) or animal (e.g., concentrated animal facilities, wildlife, etc.). With this information, the water manager could implement best management practices to eliminate or contain the source of contamination.