APPENDIX A

Scoping Letter, NOP/NOI, and NOP Comments

THE CITY OF SAN DIEGO

THE CITY OF SAN DIEGO
DEVELOPMENT SERVICES DEPARTMENT

Date of Notice: August 4, 2016

PUBLIC NOTICE
OF THE PREPARATION OF AN ENVIRONMENTAL IMPACT REPORT AND SCOPING MEETINGS

INTERNAL ORDER No. 21003699

PUBLIC NOTICE: The City of San Diego, as the lead agency, has determined that the project described below will require the preparation of an Environmental Impact Report/Environmental Impact Statement (EIR/EIS) in compliance with the California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA). This Notice of Preparation of an EIR/EIS and Scoping Meetings was publicly noticed and distributed on August 4, 2016. This notice was published in the *San Diego Daily Transcript* and placed on the City of San Diego website at http://www.sandiego.gov/city-clerk/officialdocs/notices/index.shtml.

SCOPING MEETING: Two public scoping meetings will be held by the City of San Diego's Development Services Department: one on August 23, 2016 from 6:00 p.m. to 7:30 p.m. at the Scripps Miramar Ranch Public Library located at 10301 Scripps Lake Drive, San Diego, California 92131, and one on August 25, 2016 from 6:30 p.m. to 8:00 p.m. at the City of San Diego Public Utilities Department, located at 9192 Topaz Way, San Diego, California 92123. Depending on the number of attendees, the meeting could end earlier than the end times noted above. Verbal and written comments regarding the scope and alternatives of the proposed EIR/EIS will be accepted at the meetings.

Written/mail-in comments may also be sent to the following address: Mark Brunette, Senior Environmental Planner, City of San Diego Development Services Department, 1222 First Avenue, MS 501, San Diego, California 92101, or via email to DSDEAS@sandiego.gov. Include the project name and number in the subject line, and send within 30 days of the date of this Public Notice, above. Responsible agencies are requested to indicate their statutory responsibilities in connection with this project when responding. An EIR incorporating public input will then be prepared and distributed for the public to review and comment.

Project Name/No: Pure Water San Diego Program, North City Project EIR/EIS / 499621
Community Area: University, Mira Mesa, Scripps Miramar Ranch, Clairemont Mesa, Linda Vista, Kearny Mesa, Tierrasanta, Navajo
Council District: 1, 2, 5, 6, 7

Project Description: The Bureau of Reclamation and the City of San Diego will prepare a joint Environmental Impact Report/Environmental Impact Statement to evaluate the effects of the North City Project, the first phase of the Pure Water San Diego Program (Pure Water Program). The Pure Water Program is a water and wastewater facilities plan to produce potable water from recycled water. The Pure Water Program consists of the design and construction of new advanced water treatment facilities, wastewater treatment facilities, pump stations, and pipelines.

The proposed project will expand the existing North City Water Reclamation Plant and construct an adjacent North City Pure Water Facility with a purified water pipeline to Miramar Reservoir. A project alternative would install a longer pipeline to deliver product water to the larger San Vicente Reservoir.

Other project components include: a new pump station and forcemain to deliver additional wastewater to the North City Water Reclamation Plant, a brine discharge pipeline, and upgrades to the existing Metropolitan Biosolids Center to accommodate additional biosolids from the increased treatment capacity at the North City Water Reclamation Plant.

A new electrical transmission line is proposed, connecting the North City Water Reclamation Plant to the future cogeneration facility at the Metropolitan Biosolids Center to deliver power for North City Project components. The electrical transmission line would cross Marine Corps Air Station Miramar and will require approval by the United States Marine Corps.

Figure 1 shows the location of the proposed facilities and pipelines. Figure 2 shows the location of the proposed facilities and pipelines for the San Vicente Alternative.

Applicant: City of San Diego, Public Utilities Department

Recommended Finding: Pursuant to Section 15060(d) of the CEQA Guidelines, it appears that the proposed project may result in significant environmental impacts in the following areas: Land Use, Visual Effects and Neighborhood Character, Air Quality/Odor, Biological Resources, Energy, Environmental Justice, Geology/Soils, Greenhouse Gases, Health and Safety, Historical Resources/Indian Trust Assets, Hydrology and Water Quality, Noise, Paleontological Resources, Public Services, Public Utilities, Transportation/Circulation/ Parking, and Water Supply.

Availability in Alternative Format: To request this Notice of the City's letter to the applicant detailing the required scope of work (EIR Scoping Letter) in alternative format, call the Development Services Department at 619.446.5189.

Additional Information: For environmental review information, contact Mark Brunette at 619.446.5379. The Scoping Letter and supporting documents may be reviewed, or purchased for the cost of reproduction, in the Development Services Department on the 5th floor of the Development Services Center. For information regarding public meetings/hearings on the project, contact the Project Manager, Keli Balo at 858.292.6423 or via email: kbalo@sandiego.gov. This notice was published in the SAN DIEGO DAILY TRANSCRIPT and distributed on August 4, 2016.

Distribution: See Attached

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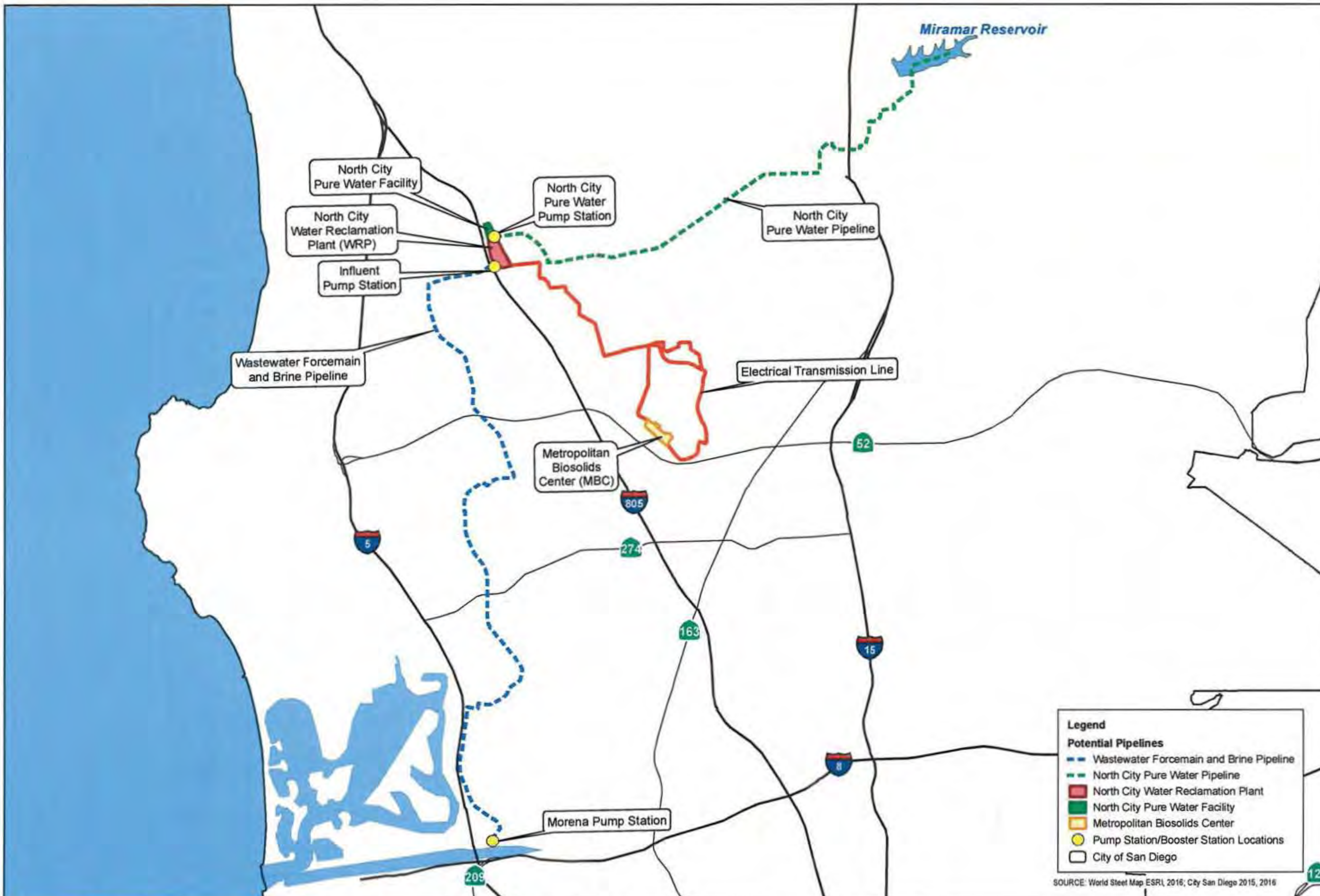

North City Project - Proposed Project - Miramar Reservoir

Pure Water San Diego Program North City Project EIR/EIS Notice of Preparation

CITY OF SAN DIEGO

FIGURE 1

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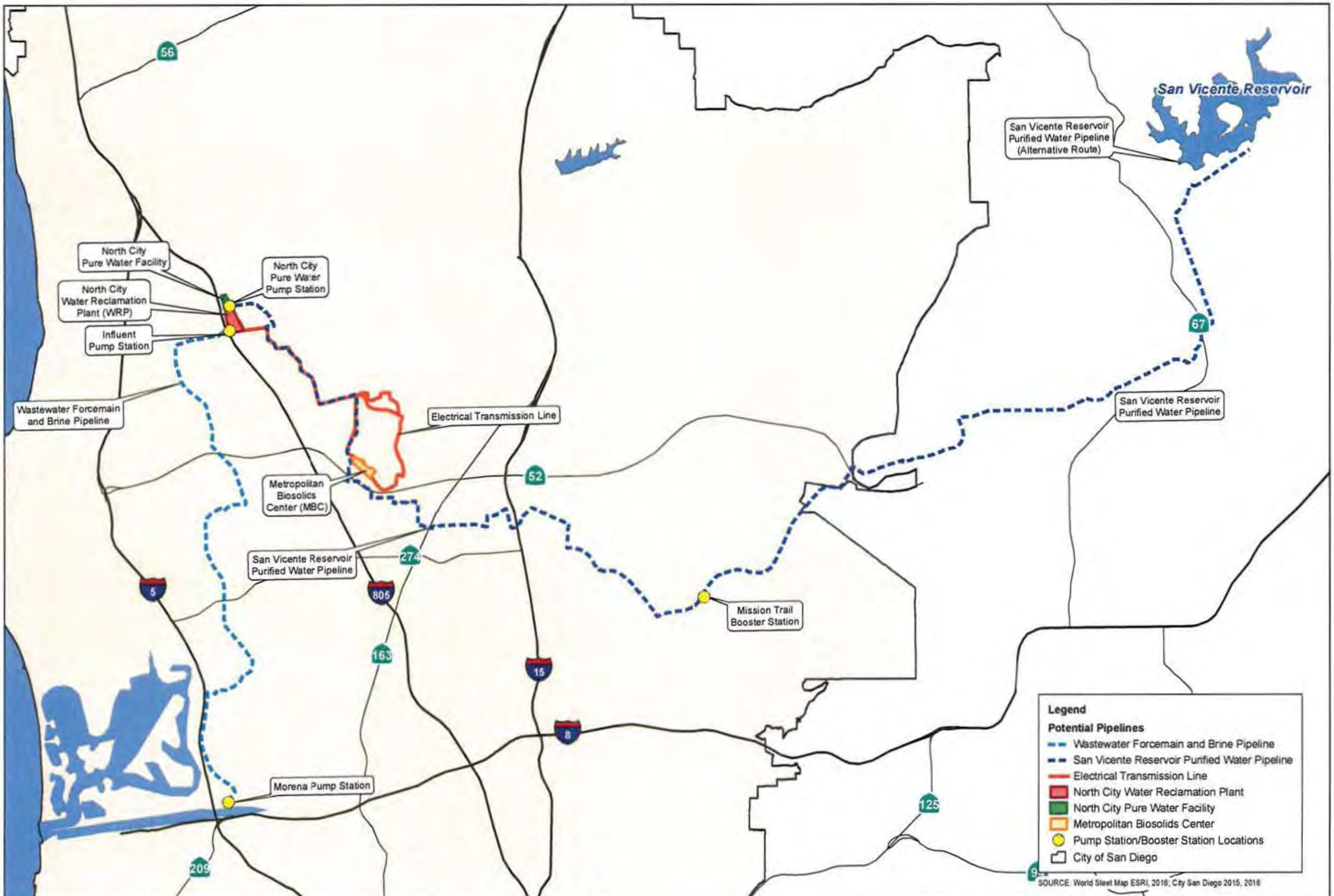

North City Project - Alternative A - San Vicente Reservoir

Pure Water San Diego Program North City Project EIR/EIS Notice of Preparation

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FIGURE 2

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August 4, 2016

Subject: Scope of Work for Draft Environmental Impact Report/Environmental Impact Statement for the Pure Water San Diego Program North City Project (project). Project No. 499621/SCH No. Pending

Based on review of the project application and pursuant to Section 15060(d) of CEQA, the Environmental Analysis Section of the City of San Diego Development Services Department determined that the above-referenced project may have a significant effect on the environment, and preparation of an EIR/EIS is required.

The purpose of this Scoping Letter is to identify specific issues to be addressed in the EIR/EIS, which will be prepared in accordance with the *City of San Diego Environmental Impact Report Guidelines* (updated December 2005) and *California Environmental Quality Act – Significance Determination Thresholds* prepared by the Development Services Department (January 2011). A Notice of Preparation (NOP) will be distributed to Trustee and Responsible Agencies and others who may have an interest in the project in accordance with CEQA Section 21083.9(a)(2) for projects with statewide, regional, or area-wide environmental impacts. Scoping Meetings are scheduled for August 23 and August 25, 2016. Changes or additions to the scope of work may be required as a result of input received in response to the Scoping Meetings and NOP. Should the project scope be modified during the scoping stage, EIR/EIS review process, and/or by the applicant, these changes will be disclosed in the EIR/EIS under the section "History of Project Changes," and be accounted for in the EIR/EIS impacts analysis to the extent required by CEQA and NEPA.

Each section and issue area of the EIR/EIS will provide a descriptive analysis of the project followed by a comprehensive evaluation. The EIR/EIS will also include sufficient graphics and tables, which, in conjunction with the relevant narrative discussions, will provide a complete and meaningful description of all major project features, the environmental impacts of the project, cumulative impacts, mitigation of significant impacts, and alternatives to the project.

Project Description

The Pure Water San Diego Program (Pure Water Program) is the City of San Diego's Public Utilities Department proposed program to provide a safe, secure, and sustainable local drinking water supply for San Diego. Advanced water purification technology would be used to produce potable water from recycled water. The Pure Water Program would consist of the design and construction of new advanced water treatment facilities, wastewater treatment facilities, pump stations, transmission lines, and pipelines.

The City of San Diego is proposing to move forward with the first phase of the Pure Water Program with the North City Project. Components included in the first phase are summarized below. The City is initiating the processing of a joint EIR/EIS, with the United States Bureau of Reclamation (Reclamation) as federal lead agency, to cover the Pure Water Program activities. The joint North City Project EIR/EIS is envisioned to be a project-specific summary and analysis that includes all components associated with the North City Project, Phase 1 of the Pure Water Program. The document must include all environmental impacts and a comprehensive mitigation strategy.

North City Project – Miramar Reservoir (Preferred Alternative)

The North City Project includes expansion of the existing North City Water Reclamation Plant, and construction of a new full-scale advanced water purification facility adjacent to the reclamation plant, pipelines, and support facilities such as pump stations. The purified water produced at the new purification facility would be piped to the Miramar Reservoir.

North City Water Reclamation Plant Expansion

The North City Water Reclamation Plant would be expanded from its current treatment capacity of 30 million gallons a day to 52 million gallons a day. To increase capacity, a number of new process units and tankage would be required. Process units requiring expansion would consist of influent screening, primary sedimentation, flow equalization, aeration basins, secondary clarification, and tertiary filtration. A new influent pump station would be located at the reclamation plant site and would pump tertiary effluent via a pipeline across Eastgate Mall Road connecting the reclamation plant to the purification facility. Additional wastewater flows to the expanded plant would be delivered from the new Morena Pump Station and wastewater force main.

North City Pure Water Facility

The new North City Pure Water Facility would be located on the vacant lot owned by the City of San Diego, across Eastgate Mall Road to the north of the existing water reclamation plant and would be designed to produce 30 million gallons a day of purified water. The water purification facility would use multiple treatment processes including an ozone system, biological activated carbon filtration, membrane filtration, reverse osmosis and ultraviolet/advanced oxidation process, before it is stabilized and chlorinated prior to being pumped out to the Miramar Reservoir.

North City Pure Water Pump Station and Pipeline

A new pump station and a purified water pipeline would be needed to convey the purified water produced at the North City Pure Water Facility to the Miramar Reservoir.

Morena Pump Station, Wastewater Force Main, and Brine Conveyance

To use the proposed expanded capacity of the water reclamation plant, additional wastewater flows that would normally be conveyed to the Point Loma Wastewater Treatment Plant would be diverted to the North City Water Reclamation Plant to be recycled. The Morena Pump Station is proposed to be located near the intersection of Friars Road and Interstate 5 to collect wastewater flows from a combination of trunk sewers and sewer interceptors to pump the diverted flows to the reclamation plant through a new wastewater force main. Additional brine from the reverse osmosis process at the water purification facility would be conveyed via a gravity flow line back to the proposed Morena Pump Station in the same corridor as the wastewater force main. The brine line would discharge downstream of the diversion structures back to into the sewer system.

Electrical Transmission

A new electrical transmission line is proposed to connect the North City Water Reclamation Plant to the future cogeneration facility at the Metropolitan Biosolids Center to deliver power to North City Project components. The electrical transmission line would cross Marine Corps Air Station (MCAS) Miramar property and require approval by the United States Marine Corps.

Metropolitan Biosolids Center Improvements

Process improvements would be required for handling future flows from the expanded North City Water Reclamation Plant. These improvements would upsize existing equipment and provide additional units to handle the increased flows. Improvements may include replacement of raw solids feed pumps, expansion of the grit removal facility, installation of one new grit separator, and installation of one new clarifier, snail, and screw conveyor.

Project Location

The Project would include a variety of facilities located throughout the central coastal areas of San Diego County in the North City geographic area. Figure 1 shows the location of proposed facilities. The new advanced water purification facility, proposed pipelines and three pump stations would be located within the corporate boundaries of the City. Potential electrical transmission facilities would traverse federal lands within MCAS Miramar.

General Background and Project History

On average, eighty five percent of the City of San Diego's water supply is imported from the Colorado River and Northern California. This reliance on imported water causes San Diego to be vulnerable to supply shortages and price increases. With few local water supply options, the City has explored non-potable and potable re-use options of treated wastewater.

The Pure Water Program would create 83 million gallons per day (MGD) of locally controlled water, reducing inflows to the Point Loma Wastewater Treatment Plant, which would ultimately reduce total suspended solids discharged while recycling a valuable and limited resource that is currently discharged to the ocean. The Pure Water Program would be implemented in two phases over a 20-year period. The Pure Water Program facilities are grouped into geographical areas to facilitate delivery: North City, Central Area, and South Bay.

The North City Project would be the first group of facilities to be constructed; construction is scheduled to be completed by 2021, and the project would produce 30 MGD of purified water. The Central Area and South Bay projects are scheduled to be completed by 2035 and would produce a combined total up to 53 MGD.

Ocean discharge from the City's Point Loma Wastewater Treatment Plant is regulated by the California Regional Water Quality Control Board under National Pollutant Discharge Elimination System (NPDES) Permit No. CA0107409. The NPDES permit is modified by a variance under Clean Water Act Sections 301(h) and (j)(5), approved by the Environmental Protection Agency, that allows ocean discharge with a waiver of full secondary treatment requirements.

The modified NPDES permit expired on July 30, 2015, and the City applied for renewal in January 2015. The new permit application is based on the City's commitment to reduce future Point Loma Ocean Outfall discharge flows by implementing the Pure Water Program. The Pure Water Program would reduce influent flows and solids loads to the PLWTP so that the ultimate discharge of total suspended solids would be reduced to levels comparable to secondary treatment standards (i.e., secondary treatment equivalency).

The Pure Water Program would include property and easement acquisition, discretionary permitting, construction, facility startup, testing, operation and maintenance of new facilities, and public education and community engagement.

EIR/EIS Format and Content

The EIR/EIS will serve to inform governmental agencies and the public of the project's environmental impacts. Emphasis must be on identifying feasible solutions to environmental problems. The objective is not simply to describe and document impacts, but to actively create and suggest mitigation measures or project alternatives that would avoid or substantially reduce significant adverse environmental impacts. The adequacy of the EIR/EIS will depend greatly on the thoroughness of this effort. The EIR/EIS must be written in an objective, clear, and concise manner, and must meet the requirements of CEQA and NEPA. Wherever possible, graphics will be used to replace extensive word descriptions and to assist in clarification. Conclusions will be supported by substantial evidence that is presented in the EIR/EIS or otherwise contained in the administrative record, with quantitative and qualitative information to the extent practicable.

Prior to distribution of the Draft EIR/EIS, conclusions for the project will be prepared. These conclusions will not be prepared until an approved draft has been submitted and accepted for release by the City. The EIR/EIS will include a title page that will include the project number, State Clearinghouse Number (SCH No.), date of publication, and an executive summary. The executive summary will reflect the EIR/EIS outline for each issue area identified below, but need not contain every element of the EIR/EIS. Additional information regarding specific content and formatting of the EIR/EIS can be found in the City's Environmental Impact Report Guidelines (updated December 2005), as outlined below.

I. Introduction

Introduce the proposed project with a brief discussion on the intended use and purpose of the EIR/EIS. Describe and/or incorporate by reference any previously certified environmental documents that address the project site. Briefly describe areas where the proposed project is in compliance or non-compliance with assumptions and mitigation contained in these previously certified documents. Provide projected time lines for the start and completion of the project. It shall also note the history of environmental documents prepared for the existing operations.

II. Environmental Setting

The EIR/EIS should (i) describe the precise location of the proposed project and present it on a detailed topographic map and regional map; (ii) provide a local and regional description of the environmental setting of the project, as well as adjacent land uses, area topography, drainage characteristics and vegetation; and (iii) include any applicable land use plans/overly zones that affect the project site, such as the City of San Diego's Multiple Species Conservation Program (MSCP)/Multi-Habitat Planning Area (MHPA), environmentally sensitive lands such as steep hillsides, wetlands, and the

Federal Emergency Management Agency (FEMA) 100-year floodplains or flood ways that intersect with the project components.

III. Project Description/Alternatives

The EIR/EIS shall include a detailed discussion of the goals and objectives of the project and a project description. The project description/alternatives chapter shall provide a discussion of all applicable discretionary actions required for the project (e.g., Planned Development Permit, Site Development Permit, Community Plan Amendment, Rezone), as well as a discussion of all permits and approvals required by federal, state, and other regulatory agencies.

CEQA Guidelines Section 15126.6(e) and NEPA regulations (40 CFR 1502.14) require that the EIR/EIS shall describe a range of reasonable alternatives to the proposed project, including "substantial treatment" of each of alternative. The EIR/EIS should analyze reasonable alternatives that can avoid or substantially reduce the proposed project's significant environmental impacts. These alternatives should be identified and discussed in detail, and should address all significant impacts associated with the project. A section entitled "Alternatives Considered but Not Carried Forward to Analysis" shall follow the detailed discussion of alternatives. This section should include a discussion of preliminary alternatives that were considered but not analyzed in detail. The reason for rejection should also be explained.

At a minimum, the following alternatives shall be considered and described in the EIR/EIS at a comparable level of detail as the proposed project:

i. No Project Alternative

CEQA Guidelines Section 15126.6(e) and NEPA regulations (40 CFR 1502.14(d)) require that a No Project (CEQA) and No Action (NEPA) Alternative be analyzed in an EIR and an EIS to allow decision makers to compare the impacts of not approving the action with those of approving the action.

Under the No Project/No Action Alternative, the proposed project would not be implemented. The North City Advanced Water Purification Facility and the associated improvements at other treatment facilities and pumping and conveyance facilities would not be constructed. Therefore, 30 MGD of purified water would not be produced. Instead, potable water demand would continue to be met through imported water supplies. In addition, current levels of wastewater flows would continue to the Point Loma Wastewater Treatment Plant. It is anticipated that the Point Loma Wastewater Treatment Plant would continue operating under a modified permit.

ii. San Vicente Reservoir Alternative

The San Vicente Reservoir (SVR) Alternative would produce 30 MGD annual average daily flow of purified water at a new advanced water purification facility located across Eastgate Mall Road to the north of the North City Water Reclamation Plant. Purified water would be pumped approximately 28 miles to the San Vicente Reservoir. An additional pump station, the Mission Trails Booster Station, would be located approximately halfway along the pipeline alignment along Mission Gorge Road. The advanced water purification facility would include microfiltration, reverse osmosis, and ultraviolet advanced oxidation process within the treatment process, but would not include an ozone system or biological activated carbon. Under this alternative, at least 30 MGD of purified water would be produced by the City by December 31, 2021.

IV. History of Project Changes

This section of the EIR/EIS shall outline the history of the project and any physical changes that have been made to the project in response to environmental concerns raised during the City's review of the proposed project.

V. Existing Conditions/Affected Environment

The EIR/EIS shall describe the physical, social, and regulatory setting for each of the following key environmental issue areas: land use; aesthetics/visual effects and neighborhood character; air quality and odor; biological resources; energy; environmental justice; geology and soils; greenhouse gas emissions; health and safety/hazards; historical resources/Indian trust assets; hydrology and water quality; noise; paleontological resources; public services; public utilities; transportation, circulation, and parking; and water supply.

This chapter shall summarize the current conditions related to each key environmental issue area as they relate to the potential effects of each of the alternatives. The chapter shall include a brief discussion of the geographic area for each given resource (covering the entire potential affected area for all alternatives), and, as needed, include the history, development, past disturbances, natural events, and interactions that have helped shape current conditions.

VI. Environmental Analysis/Environmental Consequences

The potential for significant environmental impacts must be thoroughly analyzed and mitigation measures identified that would avoid or substantially lessen any such significant impacts. The EIR/EIS must represent the independent analysis of the City of San Diego as lead agency; therefore, all impact analysis must be based on the City's current CEQA Significance Determination Thresholds.

The analysis shall include all potential project components that may be implemented and would provide a comprehensive approach to outlining potential environmental effects.

Below are key environmental issue areas that have been identified for this proposed project that have issue statements that must be addressed individually. Discussion of each issue statement will include an impact analysis, significance determination, and appropriate mitigation. The impact analysis will address potential direct, indirect, and cumulative impacts that could be created through implementation of the proposed project/proposed action. The impact analysis should also include a thorough analysis of the potential direct, indirect, and cumulative impacts of each of the alternatives. Identification of a reasonable range of mitigation measures for each identified potentially significant impact should be included.

A. Land Use

Issue 1: Would the proposed project be inconsistent or conflict with the environmental goals, objectives, and recommendations of the City of San Diego General Plan (General Plan), the City of San Diego Municipal Code, or the various community plans where the project would be located, or other applicable land use plans?

Issue 2: Would the proposed project result in a conflict with the provisions of the MSCP or other adopted environmental plans for the area?

Issue 3: Would the proposed project result in land uses which are not compatible with an adopted Airport Land Use Compatibility Plan (ALUCP)?

The EIR/EIS should evaluate how the proposed project accomplishes or fails to implement the environmental goals, objectives, and recommendations of the General Plan, San Diego Municipal Code, City of San Diego's Land Development Code, and relevant community plans. If any inconsistencies are identified, the Land

Use Section of the EIR/EIS should also identify if these inconsistencies would result in a direct or indirect environmental impact. The EIR/EIS should also address land use compatibility with the final MSCP Plan (August 1998), the City's MSCP Subarea Plan (March 1997), and other environmental plans.

B. Visual Effects and Neighborhood Character

Issue 1: Would the proposed project result in a substantial change to natural topography or other ground surface relief features through landform alteration?

Issue 2: Would implementation of the proposed project result in the blockage of public views from designated open space land areas, roads, or to any significant visual landmarks or scenic vistas?

Issue 3: Would the proposed project result in substantial alteration to the existing character of the area?

Issue 4: Would the proposed project be compatible with surrounding development in terms of bulk, scale, materials, or style?

To the extent feasible, the EIR/EIS should include an evaluation of potential impacts on the natural landforms resulting from implementation of project components. The City's Significance Determination Thresholds include the following in determining such impacts: exceed the allowed height or bulk regulations and existing patterns of development in the surrounding area by a significant margin, and/or located in a highly visible area and would strongly contrast with the surrounding development or natural topography through excessive bulk, signage, or architectural projection. If any project components include such elements, this section of the EIR/EIS should include a conceptual description and analysis of the allowed building mass, bulk, height, and architectural style that could result from the proposed project. The EIR/EIS shall also analyze the use of materials or components that could emit or reflect a significant amount of light or glare, and any potential effect on light-sensitive species or on adjacent aviation uses. Renderings, cross-sections, and/or visual simulations of new or modified structures and buildings proposed to be built should be incorporated into the EIR/EIS section when possible.

C. Air Quality/Odor

Issue 1: Would the proposed project conflict with or obstruct the implementation of the applicable air quality plans?

Issue 2: Would the proposed project result in a violation of any air quality standard or contribute substantially to an existing or projected air quality violation?

Issue 3: Would implementation of the proposed project result in air emissions that would substantially deteriorate ambient air quality, including the exposure of sensitive receptors to substantial pollutant concentrations?

Issue 4: Would the proposed project create objectionable odors affecting a substantial number of people?

Issue 5: Would the proposed project exceed 100 pounds per day of respirable particulate matter (PM_{10}) or 55 pound per day of fine particulate matter ($PM_{2.5}$)?

The EIR/EIS should describe the area's climatological setting within the San Diego Air Basin and the basin's current attainment levels for state and federal Ambient Air Quality Standards (AAQS). It should discuss the potential stationary and non-stationary air emission sources related to the land use modifications associated with the project, particularly vehicle and facility emission sources and dust creation during construction.

The EIR/EIS will include a quantitative analysis of potential impacts to air quality and compliance with AAQS associated with implementation of the proposed project, including quantification of construction-related emissions estimated to occur with construction activities associated with treatment plants and pipelines, and operational emissions associated with facilities.

The EIR/EIS should discuss the proposed project's impact on the ability of the San Diego Air Basin to meet regional air quality strategies (RAQS). It should discuss any short-term, long-term, and cumulative impacts the proposed project may have on regional air quality, including construction- and transportation-related sources of air pollutants, and potential impacts from the increase in vehicle trips to the RAQS, the overall air quality impacts from such trips, and any proposed mitigation measures.

The EIR/EIS should also discuss consistency with the Federal Air Quality Act.

D. Biological Resources

Issue 1: Would the proposed project result in impacts to a sensitive habitat or sensitive natural community as identified in local, regional, state, or federal plans, policies, or regulations?

Issue 2: Would the proposed project result in an impact on City, state, or federally regulated wetlands through direct removal, filling, hydrological interruption or other means?

Issue 3: Would implementation of the proposed project result in a reduction in the number of any unique, rare, endangered, sensitive, or fully protected species of plants or animals?

Issue 4: Would the proposed project result in interference with the movement of any native resident or migratory wildlife through linkages or wildlife corridors?

Issue 5: Would the proposed project conflict with provisions of adopted local habitat conservation plans or policies protecting biological resources?

Issue 6: Would the proposed project introduce land uses within or adjacent to the MHPA that would result in adverse edge effects?

Issue 7: Would the proposed project introduce invasive species into natural open space areas?

A series of diverse habitats and sensitive species could potentially be directly or indirectly affected by the proposed project and should be fully discussed in this section of the EIR/EIS. A Biological Resources Technical Report, based on existing inventory, vegetation mapping, and species-specific surveys, should be prepared. The analysis must identify any rare and sensitive species (including species listed as threatened or endangered under the Endangered Species Act), MSCP covered and narrow endemic flora and fauna that are known to be, or to have a potential to exist, in the proposed project area, and an inventory of sensitive habitat types and wetlands.

The impacts to identifiable wetland habitat should be addressed within this section of the EIR/EIS. Wetland habitat types should be shown graphically and include recommendations to sustain their functionality. If impacts to any wetlands or wetlands buffers are identified, a discussion of the feasibility or infeasibility of avoiding such impacts should be included. The analysis must identify whether the proposed project and associated components would have any adverse effects on existing reservoirs or related habitat.

Project components may be located within and/or adjacent to the MHPA and would, therefore, require conformance with the Land Use Adjacency Guidelines. The analysis will discuss how the project would be in conformance with the guidelines related to land use, drainage, toxic substances, lighting, noise, invasive plant species, and predator and pedestrian management.

E. Energy

Issue 1: Would the construction and operation of the proposed project facilities result in the use of excessive amounts of electrical power or use excess amounts of fuel?

Appendix F of the State CEQA Guidelines requires that potentially significant energy implications of a project be considered in an EIR to the extent relevant and applicable to the project. Particular emphasis on avoiding or reducing inefficient, wasteful, and unnecessary consumption of energy should be included in this section. The EIR/EIS section shall address the estimated energy use for the proposed project and assess whether the proposed project would generate a demand for energy (electricity and/or natural gas) that would exceed the planned capacity of the energy suppliers, and would include any water-saving project features. This section would be cross-referenced with the greenhouse gas emissions discussion section of the EIR/EIS, as appropriate; shall describe any proposed measures included as part of the proposed project directed at conserving energy and reducing energy consumption; and shall address all applicable issues described within Appendix F of the CEQA Guidelines.

F. Environmental Justice

Issue 1: Would the proposed project result in a disproportionately high and adverse human health or environmental effect on minority populations or low-income populations?

Significance thresholds or standards for environmental justice effects are not generally provided under CEQA Guidelines Section 15131. CEQA does not address environmental justice effects unless it can be demonstrated that a physical effect on the environment will result. An EIS considers the effects of a proposed project on the human environment consistent with NEPA, and considers the effects on minority populations and low-income populations as described in Executive Order 12898. The EIR/EIS shall determine the affected geographical area, determine the demographic characteristics of the geographic area, determine whether the populations within the affected geographic area include an environmental justice community, and determine whether potential adverse effects of the proposed project would disproportionately affect environmental justice communities.

G. Geology/Soils

Issue 1: Would the proposed project expose people or property to geologic hazards such as earthquakes, landslides, mudslides, liquefaction, ground failure, or similar hazards?

Issue 2: Would the proposed project increase potential for erosion of soils on site or off site?

Issue 3: Would the proposed project be located on a geological unit or soil that is unstable or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?

The geologic and subsurface conditions in the proposed project area will be described in this section, along with existing topography, geology (surface and subsurface), tectonics, and soil types. The impact analysis should include issues such as the potential for liquefaction, slope instability, and rockfall hazards. Any secondary issues due to soils/geology (e.g., excavation of unsuitable soils) should be addressed.

H. Greenhouse Gases

Issue 1: Would the project generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?

Issue 2: Would the project conflict with any applicable plan, policy, or regulation of an agency adopted for the purpose of reducing the emissions of greenhouse gases?

This section shall present an overview of greenhouse gas (GHG) emissions, including the most recent information regarding the current understanding of the mechanisms behind current conditions and trends, and the broad environmental issue related to global climate change. A discussion of current legislation, plans, policies, and programs pertinent to global climate change shall also be included. The EIR/EIS shall provide details of the project's sustainable features that meet the criteria outlined in the Conservation Element of the General Plan and the Climate Action Plan Consistency Checklist.

The analysis of greenhouse gas impacts shall include a discussion of the project's compatibility with the City of San Diego's Climate Action Plan (CAP). If the project is determined to be consistent with CAP, as determined through the use of the Climate Action Plan Consistency Checklist, it may rely on the CAP for the cumulative impacts analysis of GHG emissions. If the project is determined not to be consistent with the CAP, preparation of a comprehensive project-specific analysis of GHG emissions, including quantification of existing and projected GHG emissions and incorporation of the measures as detailed within the checklist to the extent feasible shall be provided. Cumulative GHG impacts would be significant for any project that is not consistent with the CAP.

I. Health and Safety

Issue 1: Would the proposed project expose people or property to health hazards, including fire?

Issue 2: Would the proposed project create future risk of an explosion or the release of hazardous substance (including, but not limited to gas, oil, pesticides, chemicals, or radiation)? Would the proposed project expose people or the environment to a significant hazard through the routine transport, use, or disposal of hazardous materials?

Issue 3: Would any component of the proposed project interface or intersect with a site that is included on a hazardous material sites list compiled pursuant to Government Code Section 6596.25 and, as a result, pose a potential hazard to the public or environment?

Issue 4: Would the proposed project result in a safety hazard for people working in a designated airport influence area?

Various aspects of water treatment employ the use of chemicals, gases, and potentially hazardous processes. The EIR/EIS shall provide an analysis of the hazardous materials to be stored, used, and transported for the proposed project, and assess the potential for significant human health and safety impacts.

The project proposes to supplement the region's drinking water supply with purified water. The EIR/EIS shall discuss the potential of water contamination from mishandling, error, or equipment malfunction, and the potential for significant human health or public safety impacts.

The EIR/EIS will include a description of potential hazards and hazardous materials issues that intersect or interface with the proposed project area, including disclosure of sites on a list maintained by the state that has been compiled in accordance with Government Code Section 6596.25.

J. Historical Resources/Indian Trust Assets

Issue 1: Would the proposed project result in the alteration or destruction of a prehistoric or historic archaeological site, or any adverse physical or aesthetic effects to a prehistoric or historic building, structure, object, or site?

Issue 2: Would the proposed project result in any impact to existing religious or sacred uses or result in the disturbance of any human remains within the potential impact area?

Issue 3: Would the proposed project result in impacts to Indian trust assets including changes in the value of Indian trust assets?

The proposed project would include improvements located in or near areas where archeological sites have been previously recorded. The project could have a potentially significant impact on these sites. A cultural resources report would be prepared for the proposed project (including facilities and pipelines) to address existing conditions, potential impacts related to cultural and historic resources within the project area, and proposed mitigation. The analysis would include a records search of local databases and pedestrian surveys of undisturbed areas where proposed improvements would occur. A report would be prepared in accordance with the City of San Diego's Land Development Code Historical Resources Guidelines (amended April 30, 2001) and discussed in the EIR/EIS. Based on background research and review of archaeological site records, the EIR/EIS would identify areas of high, moderate, and low sensitivity, and provide recommendations for further evaluation to determine significance when applicable, and include recommendations for appropriate mitigation. The EIR/EIS would identify requirements for archaeological monitoring during grading operations and specific mitigation requirements for discoveries. This section must also include a discussion of potential impacts to Native American cultural resources, and include an ethnographic discussion of the San Diego tribal community relative to the project study area.

"Indian trust assets" are defined as lands, natural resources, money, or other assets held by the federal government in trust or that are restricted against alienation for Native American tribes and individual Native Americans (Bureau of Indian Affairs 303 DM 2.5.C). The EIR/EIS will describe the Indian trust assets that could be affected by the proposed project. The impact assessment will be based on changes in asset value attributable to the proposed project. Pursuant to Section 106 of the National Historic Preservation Act of 1966, the lead federal agency shall consult with the identified State Historic Preservation Officer to identify whether any historic properties will be affected.

K. Hydrology and Water Quality

Issue 1: Would the proposed project increase impervious surfaces and associated increased runoff?

Issue 2: Would the proposed project result in a substantial alteration to on- and off-site drainage patters due to changes in runoff flow rates or volumes?

Issue 3: Would the proposed project create discharges into surface or ground water, or in any alteration of surface or ground water quality, including, but not limited to, temperature, dissolved oxygen or turbidity? Would there be increases in pollutant discharges including downstream sedimentation?

Issue 4: Would the proposed project, when considered in combination with past, current, and future projects in the affected watersheds, result in cumulatively significant impacts on hydrology and water quality?

Hydrology deals with the properties, distribution, and circulation of surface water, ground water, and atmospheric water. The quantity of water that flows in a creek or river is calculated based on historic climatic conditions combined with the watershed characteristics. The slope and shape of the watershed, soil properties, recharge area, and relief features are all watershed characteristics that influence the quantity of surface flows. The EIR/EIS will address the existing conditions and potential impacts related to hydrology resources within the project study area.

Water quality is affected by sedimentation caused by erosion, runoff carrying contaminants, and direct discharge of pollutants (point-source pollution). Also, as land is developed, the impervious surfaces send an increased volume of runoff containing oils, heavy metals, pesticides, fertilizers, and other contaminants (non-point source pollution) into adjacent watersheds. Degradation of water quality could impact human health and wildlife systems. Sedimentation can cause impediments to stream flow. In addition, oxygen availability is affected by sedimentation, which can significantly influence aquatic and riparian habitats. Therefore, the EIR/EIS will discuss how the proposed project could affect water quality within the project area, in discharge reservoirs, and downstream. The EIR/EIS will address the existing conditions and potential impacts related to water quality within the project study area.

L. Noise

Issue 1: Would the proposed project result in or create a significant increase in the existing ambient noise level?

Issue 2: Would the construction noise associated with implementation for any component of the proposed project exceed the City's adoption noise ordinance or noise levels as established by the General Plan?

A Noise Technical Report will be prepared that will consist of a comparison of the change in noise levels projected along affected roadways (as identified in the traffic study) and in surrounding areas resulting from project implementation. This analysis and the discussion in the EIR/EIS will focus on areas that would be subject to potentially significant noise impacts as a result of the proposed project, and will include discussion of potential measures that could be used to reduce noise levels.

The noise analysis will also address potential construction-related impacts, including a general delineation of noise-sensitive uses located in proximity to project components, and a description of noise levels associated with typical construction activities, including general quantification of typical construction activity type noise levels at interval distances (e.g., confined earthmoving equipment with a typical noise level of 90 A-weighted decibels (dBA) at 50 feet would result in noise levels of approximately 84 dBA at 100 feet, 78 dBA at 200 feet, 72 dBA at 400 feet).

M. Paleontological Resources

Issue 1: Would the proposed project result in the loss of significant paleontological resources?

The proposed project would have facilities constructed in the following high-sensitivity geologic formations: Ardath Shale, Stadium Conglomerate, Friars Formation, Mission Valley Formation, and San Diego Formation. As such, there is potential for the project to impact paleontological resources due to excavation in high-resource-potential areas. The EIR/EIS would include a paleontological resources discussion that identifies the underlying soils and formations within the geographic area of the proposed project and the likelihood of the project to uncover paleontological resources during grading and excavation activities. The EIR/EIS will identify requirements for paleontological monitoring during grading operations and specific mitigation requirements for discoveries.

N. Public Services

Issue 1: Would the proposed project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services?

The EIR/EIS analysis of public facilities would determine if the proposed project would result in impacts to police or fire-rescue services within the project area. The EIR/EIS would describe the public services currently available and how they intersect or interface with proposed project.

O. Public Utilities

Issue 1: Would the proposed project result in new systems or require substantial alterations to existing utilities including solid waste disposal, the construction of which would create a physical effect on the environment? These systems include communications systems, storm water drainage and solid waste disposal.

The proposed project would involve construction of new and expansion of existing water and wastewater facilities. This section will discuss the existing public utilities that serve the area and how they intersect or interface within the proposed project, as well as potential conflicts. The EIR/EIS analysis would determine if the project would result in significant impacts to solid waste facilities.

P. Transportation/Circulation/Parking

Issue 1: Would implementation of the proposed project result in an increase in projected traffic specifically associated with project-related construction that is substantial in relation to the capacity of the existing and planned circulation system?

Issue 2: Would the proposed project create alterations to present circulation movements in the areas including effects on existing public access points?

The EIR/EIS would include a traffic analysis that estimates vehicular trip generation, temporary traffic impacts associated with construction, and operational traffic associated with operations of all North City facilities. Construction trip generation estimates will be developed for each of the proposed staging areas along the pipeline alignments. The operational analysis will evaluate the impact of operational trips generated by the AWPF at both intersections and roadway segments. The traffic analysis would form the basis of the impacts analysis for this section of the EIR/EIS. The traffic analysis and EIR/EIS would include descriptions and applicable graphics of the existing transportation/circulation conditions within the project area.

Q. Water Supply

Issue 1: Would the project affect the ability of water serving agencies to provide water?

The proposed project would involve development of a water resource that diversifies the regional's potable water sources. The proposed project's effect on water agencies will be analyzed in this section of the EIR/EIS.

VII. Comparison of Alternatives

This section of the EIR/EIS will include a brief summary of the detailed analysis of alternatives to be provided under Chapter VI, Environmental Analysis/Environmental Consequences, including a matrix comparing the potential impacts of each in relation to the other alternatives.

VIII. Cumulative Impacts

When the proposed project is considered with other past, present, and reasonably foreseeable projects in the project area, implementation could result in significant environmental changes that are individually limited but cumulatively considerable.

Therefore, in accordance with Section 15130 of the CEQA Guidelines, potential cumulative impacts should be discussed in a separate section of the EIR/EIS.

Issue 1: What are the cumulative impacts of the proposed project in conjunction with other approved or proposed projects within the region?

CEQA requires a discussion of cumulative impacts when they are significant. The determination of cumulative significance calls for reasonable effort to discover and disclose other related projects. The direct and indirect impacts of each related project need to be identified and looked at comprehensively. CEQA provides various alternative methods to achieve an adequate discussion of cumulative impacts (see CEQA Guidelines Section 15130, noting the repealed Sections 15064(i)(4) and 15130(a)(4)). Specific sections of the City's Significance Thresholds provide significance determination criteria for cumulative impacts under individual issue areas (e.g. biology, air quality, traffic). However, in general, the following should apply for determining significant cumulative impacts:

i. If there are known documented existing significant impacts occurring in a community, additional increments would exacerbate the impact (e.g., an overloaded transportation system).

ii. If a community plan and/or precise plan identifies cumulative impacts in the community-wide EIR, individual projects which contribute significantly to the community-wide impacts would be considered cumulatively significant.

iii. A large-scale project (usually regional in nature) for which direct impacts are mitigated by the collective number of individual impacts results in a cumulative impact.

As defined in Section 15355, a cumulative impact consists of an impact that is created as a result of the combination of the project evaluated in the EIR/EIS with other projects causing related impacts. An EIR should not discuss impacts that do not result from the project evaluated in the EIR/EIS.

Section 15355 defines "cumulative impact" as follows:

Cumulative impacts refers to two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts.

i. The individual effects may be changes resulting from a single project or a number of separate projects;

ii. The cumulative impact from several projects is the change in the environment which results from the incremental impact of the project when added to other closely related past, present and reasonably foreseeable probable future projects. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time.

The EIR/EIS cumulative analysis would be based on a summary of projections contained in adopted general plans, community plans, and other related long-range planning documents. The cumulative analysis would also include a list of relevant projects to determine the proposed project's contribution to a cumulative effect.

IX. Effects Not Found To Be Significant

A separate section of the EIR/EIS would include a brief discussion of issue areas that were not considered to be potentially significant, such as agricultural resources, recreation, mineral resources, and population/housing. If these or other potentially significant issue areas arise during detailed environmental investigation of the project, however, consultation is recommended to determine if these other issue areas need to be addressed in the EIR/EIS. Additionally, as supplementary information is submitted, the EIR/EIS may need to be expanded to include additional issue areas. The City of San Diego's Public Utilities Department will consult with the Development Services Department to determine if subsequent issue area discussions need to be added to the EIR/EIS. The justification for these findings will be summarized in the EIR/EIS.

X. Other CEQA/NEPA Required Sections

i. Significant/Adverse Environmental Effects Which Cannot Be Avoided If The Proposed Project Is Implemented

This section will describe the significant unavoidable impacts of the proposed project, including those significant impacts that can be mitigated but not reduced to below a level of significance.

ii. Significant Irreversible Environmental Changes/Irreversible and Irretrievable Commitments of Resources

In conformance with CEQA Section 15126.2(b) and (c) and NEPA Section 1502.16, the EIR/EIS will discuss the significant environmental effects that cannot be avoided if the proposed project is implemented, and the significant irreversible changes that would result from implementation of the proposed project. This section will address the use of nonrenewable resources during the construction and life of the project.

iii. Relationship Between Local Short-Term Uses of [the] Environment and the Maintenance and Enhancement of Long-Term Productivity

In conformance with NEPA Section 1502.16, the EIR/EIS will discuss potential short-term effects on and uses of the environment (i.e., during construction), and the long-term effects (i.e., during operation and maintenance).

iv. Growth Inducement

The EIR/EIS will address the potential for growth inducement through implementation of the proposed project. The EIR/EIS will discuss the ways in which the proposed project could foster economic or population growth either directly or indirectly. Accelerated growth could further strain existing community facilities or encourage activities that could significantly affect the environment. This section need not conclude that growth-inducing impacts, if any, are significant unless the project would induce substantial growth or concentration of population.

XI. Mitigation Monitoring and Reporting Program

For each of the issue areas discussed above, mitigation measures, if necessary, will be clearly identified and discussed, and their effectiveness assessed in each issue section of the EIR/EIS. A Mitigation Monitoring and Reporting Program (MMRP) for each mitigation measure must be included. At a minimum, the project will identify (1) the City department or entity responsible for the monitoring, (2) the monitoring and reporting schedule, and (3) the completion requirements. The separate MMRP will also be contained (verbatim) as a separate chapter within the EIR/EIS.

XII. Other

The EIR/EIS will include sections for references, individuals and agencies consulted, and a certification page. Appendices will be included in the Table of Contents, but will be bound under separate cover and/or be included on a CD attached to the back page of the EIR/EIS. In addition, other specific direction regarding formatting, content, and processing of the EIR/EIS will be provided by environmental staff prior to submittal of the first screencheck draft EIR/EIS for internal staff review.

DISTRIBUTION:

United States Government

Federal Aviation Administration
Naval Facilities Engineering Command, SW Division, Environmental Planning
MCAS Miramar
Marine Corps Recruit Depot Facilities Div.
Environmental Protection Agency
U. S. Fish and Wildlife Service
USDA Natural Resources Conservation Services
Army Corps of Engineers
Bureau of Reclamation

State of California

Caltrans District 11
Department of Fish and Wildlife
Cal Recycle
Dept of Health Services Division of Drinking Water & Environmental Mgmt
California Environmental Protection Agency
Department of Toxic Substance Control
State Parks
Department of Parks and Recreation
Natural Resources Agency
Regional Water Quality Control Board, Region 9
Department of Water Resources
State Clearinghouse
California Coastal Commission
California Air Resources Board
California Transportation Commission
California Transportation Commission
California Boating & Waterways
California State Coastal Conservancy
State Water Resources Control Board Division of Clean Water Programs
Native American Heritage Commission
California Energy Commission
California Dept. of Conservation
California State Lands Commission
Department of Transportation
State Office of Historic Preservation

San Diego County

Agriculture Department
Air Pollution Control Board
Planning and Land Use

Planning and Development
Parks Department
Noise Control Hearing Board
Public Works
County Water Authority
Department of Environmental Health

<u>City of San Diego</u>
Office of the Mayor
  Scott Chadwick
  Stacey LoMedico
  Paz Gomez
  David Graham
  Ron Villa
Office of the City Attorney
  Shannon Thomas
  Christine Leone
Council President Lightner, District 1
Councilmember Zapf, District 2
Councilmember Gloria, District 3
Councilmember Cole, District 4
Councilmember Kersey, District 5
Councilmember Cate, District 6
Councilmember Sherman, District 7
Councilmember Alvarez, District 8
Councilmember Emerald, District 9

<u>Public Utilities Department (Applicant)</u>
Halla Razak, Director
John Helminski
Amy Dorman
Keli Balo

<u>Planning Department</u>
Jeff Murphy, Director
Myra Herrmann
Kristy Forburger
Alyssa Muto

<u>Development Services Department</u>
Robert Vacchi, Director
Kerry Santoro
Anita Eng
Leonard Wilson

Mark Brunette
Helene Deisher

Public Works Department
James Nagelvoort, Director
Marnell Gibson
Carrie Purcell

Economic Development
Russ Gibbon
Jim Davies

Park and Recreation Department
Herman Parker, Director
Chris Zirkle

Fire-Rescue Department
Chief Javier Mainar
Fire and Life Safety Services
Kenneth Barnes, Fire –Rescue Dept Logistics

Police Department
Chief Shelley Zimmerman

Environmental Services Department
Mario Sierra, Director
Darren Greenhalgh
Lisa Wood

Transportation & Storm Water Department
Kris McFadden, Director
Andrew Kleis
Ruth Kolb

Real Estate Assets Department
Cybele Thompson, Director
Barry Slotten

Libraries
Central Library, Government Documents
Balboa Branch Library
Beckwourth Branch Library
Benjamin Branch Library
Carmel Mountain Ranch Branch Library

Carmel Valley Branch Library
City Heights/Weingart Branch Library
Clairemont Branch Library
College-Rolando Branch Library
Kensington-Normal Heights Branch Library
La Jolla/Riford Branch Library
Linda Vista Branch Library
Logan Heights Branch Library
Malcolm X Library & Performing Arts Center
Mira Mesa Branch Library
Mission Hills Branch Library
Mission Valley Branch Library
North Clairemont Branch Library
North Park Branch Library
Oak Park Branch Library
Ocean Beach Branch Library
Otay Mesa-Nestor Branch Library
Pacific Beach/Taylor Branch Library
Paradise Hills Branch Library
Point Loma/Hervey Branch Library
Rancho Bernardo Branch Library
Rancho Peñasquitos Branch Library
READ San Diego
San Carlos Branch Library
San Ysidro Branch Library
Scripps Miramar Ranch Branch Library
Serra Mesa Branch Library
Skyline Hills Branch Library
Tierrasanta Branch Library
University Community Branch Library
North University Branch Library
University Heights Branch Library

City Government
Civic San Diego
San Diego Housing Commission
Community Forest Advisory Board
Small Business Advisory Board
La Jolla Shores PDO Advisory Board

City Advisory Committees
Mission Bay Park Committee
Airports Advisory Committee
Historical Resources Board

Park and Recreation Board
Wetlands Advisory Board
Community Forest Advisory Board

<u>Other City Governments</u>
City of Chula Vista
City of Coronado
City of Del Mar
City of El Cajon
City of Escondido
City of Imperial Beach
City of La Mesa
City of Lemon Grove
City of National City
City of Poway
City of Santee
San Diego Association of Governments
San Diego Unified Port District
San Diego County Regional Airport Authority
Metropolitan Transit System
San Diego Gas & Electric
San Dieguito River Park JPA

<u>School Districts</u>
Chula Vista School District
Grossmont Union High School District
La Mesa-Spring Valley School District
National School District
Poway Unified School District
San Diego Unified School District
San Ysidro School District
Santee School District
South Bay Unified School District
San Diego Community College District
UCSD Library

<u>Community Groups, Associations, Boards, Committees and Councils</u>
Community Planners Committee
Balboa Park Committee
Black Mountain Ranch –Subarea I
Otay Mesa - Nestor Planning Committee
Otay Mesa Planning Committee
Clairemont Mesa Planning Committee
Greater Golden Hill Planning Committee

Serra Mesa Planning Group
Kearny Mesa Community Planning Group
Linda Vista Community Planning Committee
La Jolla Community Planning Association
La Jolla and Golden Triangle Chamber of Commerce
City Heights Area Planning Committee
Kensington-Talmadge Planning Committee
Normal Heights Community Planning Committee
Eastern Area Planning Committee
Midway/Pacific Highway Community Planning Group
Mira Mesa Chamber of Commerce
Mira Mesa Community Planning Group
Mira Mesa Town Council
Mission Beach Precise Planning Board
Mission Valley Unified Planning Organization
Navajo Community Planners Inc.
Carmel Valley Community Planning Board
Del Mar Mesa Community Planning Board
North Park Planning Committee
Ocean Beach Planning Board
Old Town Community Planning Committee
Pacific Beach Community Planning Committee
Pacific Highlands Ranch – Subarea III
Rancho Peñasquitos Planning Board
Peninsula Community Planning Board
Point Loma Ecological Conservation Area Working Group
Rancho Bernardo Community Planning Board
Sabre Springs Community Planning Group
San Pasqual - Lake Hodges Planning Group
San Ysidro Planning and Development Group
Scripps Ranch Civic Association
Scripps Ranch Recreation Council
Scripps Ranch Community Planning Group
Scripps Ranch Villages HOA
Miramar Ranch North Planning Committee
Skyline - Paradise Hills Planning Committee
Torrey Hills Community Planning Board
Southeastern San Diego Planning Committee
Encanto Neighborhoods Community Planning Group
College Area Community Planning Board
Tierrasanta Community Council
The Promontory and Scripps Lake HOA
Torrey Highlands – Subarea IV
Torrey Pines Community Planning Board

University City Community Association
University City Community Planning Group
Uptown Planners

Town/Community Councils
Town Council Presidents Association
Barrio Station, Inc.
Downtown Community Council
Harborview Community Council
Clairemont Town Council
Serra Mesa Community Council
La Jolla Town Council
Rolando Community Council
Oak Park Community Council
Darnell Community Council
Mission Beach Town Council
Mission Valley Community Council
San Carlos Area Council
Carmel Mountain Ranch Community Council
Ocean Beach Town Council, Inc.
Pacific Beach Town Council
Rancho Penasquitos Town Council
Rancho Bernardo Community Council, Inc.
San Dieguito Planning Group
United Border Community Town Council
Tierrasanta Community Council
Murphy Canyon Community Council

Other Agencies, Organizations and Individuals
San Diego Chamber of Commerce
Building Industry Association
San Diego River Park Foundation
San Diego River Coalition
Sierra Club
San Diego Canyonlands
San Diego Natural History Museum
San Diego Audubon Society
Jim Peugh
San Diego River Conservancy
Environmental Health Coalition
California Native Plant Society
San Diego Coast & Baykeeper
Citizens Coordinate for Century 3
Endangered Habitats League

San Diego Tracking Team
League of Women Voters
National City Chamber of Commerce
Carmen Lucas
South Coastal Information Center
San Diego Historical Society
San Diego Archaeological Center
Save Our Heritage Organization
Ron Chrisman
Clint Linton
Frank Brown - Inter-Tribal Cultural Resource Council
Campo Band of Mission Indians
San Diego County Archaeological Society Inc.
Kuumeyaay Cultural Heritage Preservation
Kuumeyaay Cultural Repatriation Committee
Native American Distribution
- Barona Group of Capitan Grande Band of Mission Indians
- Campo Band of Mission Indians
- Ewiiaapaayp Band of Mission Indians
- Inaja Band of Mission Indians
- Jamul Indian Village
- La Posta Band of Mission Indians
- Manzanita Band of Mission Indians
- Sycuan Band of Mission Indians
- Viejas Group of Capitan Grande Band of Mission Indians
- Mesa Grande Band of Mission Indians
- San Pasqual Band of Mission Indians
- Ipai Nation of Santa Ysabel
- La Jolla Band of Mission Indians
- Pala Band of Mission Indians
- Pauma Band of Mission Indians
- Pechanga Band of Mission Indians
- Rincon Band of Luiseno Indians
- San Luis Rey Band of Luiseno Indians
- Los Coyotes Band of Mission Indians

Otay Valley Regional Park CAC – John Willett
Tijuana River National Estuarine Reserve
Chuck Tanner – County San Diego OVRP Rep
Downtown San Diego Partnership
Deron Bear – Marion Bear Natural Park Recreation Council
Tecolote Canyon Citizens Advisory Committee
Friends of Tecolote Canyon
Tecolote Canyon Rim Owner’s Protection Association
Friends of Switzer Canyon

Marion Bear Natural Park Recreation Council
UCSD Natural Reserve System
Theresa Quiroz
John Stump
Chollas Lake Park Recreation Council
Friends of Los Peñasquitos Canyon Preserve, Inc.
Surfer's Tired of Pollution
Debbie Knight
League of Conservation Voters
Mission Bay Lessees
San Diego River Conservancy
Friends of the Mission Valley Preserve
River Valley Preservation Project
Mission Trails Regional Park Citizens Advisory Committee
Carmel Valley Trail Riders Coalition
Carmel Mountain Conservancy
Los Peñasquitos Canyon Preserve Citizens Advisory Committee
Ocean Beach Merchant's Association
Friends of Rose Canyon
San Dieguito Lagoon Committee
San Dieguito River Park CAC
Friends of San Dieguito River Valley
San Dieguito River Valley Conservancy
RVR PARC
Beeler Canyon Conservancy
Jim Dawe
Mission Trails Regional Park
Scott Andrews
Sandy Wetzel-Smith
Richard Gilb
Joel Young
Barbara Zarogoza
Ted Anasis
Ed Spriggs
McMillin-NTC, LLC
Water Reliability Coalition
Laborers International Union of North America/Local Union 89
Lozeau Drury LLP
Raymond Paulson
Al Lau
Save Everyone's Access
Water Reliability Coalition

Independent Rates Oversight Committee (IROC)

Jeff Justus
Gordon Hess
Christopher Dull
Irene Stallard-Rodriguez
Jack Kubota
Tiffany Mittal
Jim Peugh
Gail Welch
Ken Williams
Jerry Jones
Jim Peasley
Yen Tu

County Water Authority and Member Agencies

County Water Authority
Carlsbad MWD
City of Del Mar
City of Escondido Utilities Department
Fallbrook Public Utility Dist
Helix Water District
Lakeside Water District
City of National City
City of Oceanside
Olivenhain MWD
Otay Water District
Padre Dam MWD
Pendleton Military Preservation
City of Poway
Rainbow MWD
Ramona MWD
Rincon Del Diablo MWD
San Dieguito Water District
Santa Fe Irrigation District
South Bay Irrigation District
Sweetwater Authority
Vallecitos Water District
Valley Center MWD
Vista Irrigation District
Yuima MWD

Metro Wastewater Joint Powers Authority

Lori Anne Peoples
Steven Miesen
Roberto Yano
Jerry Jones, Vice-Chair
Mike James
Bill Sandke
Ed Walton
Sherryl Parks
Eric Minicilli
Tony Ambrose
Dennis Davies
Brian Bilbray
Hank Levien
Chris Helmer
Bill Baber
Greg Humora
Albert Mendivil
Kuna Muthusamy
Jose Lopez
Mark Robak
Jim Peasley
Al Lau
John Mullin
Mike Obermiller
Dianne Jacob
Dan Brogadir

Pure Water Working Group

Council District 3
Water Reliability Coalition
San Diego Regional Chamber of Commerce
NAIOP/BOMA
Asian Business Association
Hospital Association of San Diego and Imperial Counties
League of Women Voters of San Diego
Building Industry Association of San Diego
Navy Region Southwest
Qualcomm
SDG&E
CONNECT
Industrial Environmental Association
San Diego County Medical Society

Asian Pacific American Coalition
San Diego Audubon Society
Community Planners Committee
Surfrider San Diego
NAIOP/BOMA
Urban League of San Diego County
City 10
San Diego Unified Council of PTAs
Council District 8
Coastal Environmental Rights Foundation
San Diego Coastkeeper
University Community Planning Group
Council District 6
BIOCOM
Council District 4
Council District 7
San Diego County Apartment Association
San Diego State University
Sharp HealthCare
Metro Wastewater JPA
San Diego Regional Chamber of Commerce
Water Reliability Coalition
San Diego Regional Economic Development Corporation
Greater San Diego Association of Realtors
Food & Beverage Association of San Diego
San Diego County Taxpayers Association
Council District 9
Council District 1
San Diego Taxpayers Association
BIA
Cox Communications

4332-90

DEPARTMENT OF THE INTERIOR

Bureau of Reclamation

[RR03510000, XXXR0680R1, RR171260120019400]

Notice of Intent to Prepare an Environmental Impact Report/Environmental Impact Statement for the Pure Water San Diego Program, North City Project, San Diego County, California.

AGENCY: Bureau of Reclamation, Interior.

ACTION: Notice.

SUMMARY: The Bureau of Reclamation and the City of San Diego will prepare a joint Environmental Impact Report/Environmental Impact Statement to evaluate the effects of the North City Project, the first phase of the Pure Water San Diego Program (Pure Water Program). The Pure Water Program is a water and wastewater facilities plan to produce potable water from recycled water.

Interested parties are invited to comment on the scope of the environmental analysis and the proposed alternatives. Two public meetings are scheduled.

DATES: Please submit written comments on or before [INSERT DATE 30 DAYS FROM DATE OF PUBLICATION IN THE FEDERAL REGISTER].

Public meeting dates:

1. August 23, 2016, 6 p.m. to 7:30 p.m., Scripps Miramar Ranch Public Library.

2. August 25, 2016, 6:30 p.m. to 8 p.m., City of San Diego Public Utilities Department.

ADDRESSES: Send written comments to Doug McPherson, Southern California Area

Office, Bureau of Reclamation, 27708 Jefferson Avenue, Suite 202, Temecula, CA 92590; or e-mail to dmcpherson@usbr.gov.

Public meeting locations:

1. Scripps Miramar Ranch Public Library, 10301 Scripps Lake Drive, San Diego, CA.

2. City of San Diego Public Utilities Department, 9192 Topaz Way, San Diego, CA.

FOR FURTHER INFORMATION CONTACT: Doug McPherson, Southern California Area Office general telephone number 951-695-5310; or e-mail dmcpherson@usbr.gov.

SUPPLEMENTARY INFORMATION: This notice is provided pursuant to the National Environmental Policy Act (NEPA) (42 U.S.C. 4332 (2) (c)), and Department of the Interior regulations for implementation of NEPA (43 CFR Part 46).

North City Project

The proposed project will expand the existing North City Water Reclamation Plant and construct an adjacent Advanced Water Purification Facility with a purified water pipeline to Miramar Reservoir. A project alternative would install a longer pipeline to deliver product water to the larger San Vicente reservoir.

Other project components include: a new pump station and forcemain to deliver additional wastewater to the North City Water Reclamation Plant, a brine discharge pipeline, and upgrades to the existing Metropolitan Biosolids Center to accommodate additional biosolids from the increased treatment capacity at the North City Water Reclamation Plant.

A new electrical transmission line is proposed, connecting the North City Water Reclamation Plant to the future cogeneration facility at the Metropolitan Biosolids Center to deliver power for North City Project components. The electrical transmission line would cross Marine Corps Air Station Miramar and will require approval by the United States Marine Corps.

Background

On average, eighty-five percent (85%) of the City's water supply is imported from the Colorado River and northern California. This reliance on imported water causes San Diego to be vulnerable to supply shortages and price increases.

With few local water supply options, the City has explored potable and non-potable reuse options of treated wastewater. In 2011, the City started operating a one million gallon per day (MGD) demonstration scale advanced water purification facility at the North City Water Reclamation Plant site and confirmed that the purified water complied with all federal and state drinking water standards.

Pure Water San Diego Program

The Pure Water Program will ultimately produce 83 MGD of locally-controlled water, recycling a valuable and limited resource that is currently discharged to the Pacific ocean. The program will be implemented in phases over a 20-year period, grouped by geographical area: North City, Central Area and South Bay.

The North City Project will produce 30 MGD of purified water and is scheduled to be operational in 2021. The Central Area and/or South Bay projects are scheduled to be completed by December 31, 2035 and will produce a combined total up to 53 MGD.

The Pure Water Program will make San Diego more water independent while providing increased protection of the ocean environment. The City made a commitment to begin implementing the Pure Water Program in their application to renew the Clean Water Act §301(h) modified ocean discharge permit for the Point Loma Wastewater Treatment Plant (NPDES permit no. CA0107409).

Authority

Federal assistance is authorized by the Reclamation Wastewater and Groundwater Study and Facilities Act of 1992 (Title XVI of Pub. L. 102–575). Section 1612, San Diego Area Water Reclamation Program, directs the Secretary of the Interior, in cooperation with the city of San Diego, to participate in the planning, design, and construction of demonstration and permanent facilities to reclaim and reuse water in the San Diego metropolitan service area. This authority is delegated to the Bureau of Reclamation. The Federal share of the costs of the facilities shall not exceed 25 per cent of the total. Federal Funds for the operation or maintenance of the project are not authorized.

Scoping Process

The City is filing a Notice of Preparation pursuant to the California Environmental Quality Act, and will hold two public scoping meetings. To avoid duplication with State and local procedures, we plan to use the scoping process initiated by the City. The Notice of Preparation, Notice of Scoping Meetings, and a proposed Scope of Work are available at https://www.sandiego.gov/planning/programs/ceqa.

The site proposed for the Advanced Water Purification Facility contains vernal pool habitat supporting endangered species. The City is preparing a Vernal Pool Habitat Conservation Plan to comply with the Endangered Species Act.

Pipeline alignments and/or drinking water service areas may include areas of low income and minority populations. Environmental justice issues are not anticipated, but will be evaluated. No known Indian Trust Assets are associated with the proposed action.

Written comments are requested to help identify alternatives and issues that should be analyzed. Federal, State and local agencies, tribes, and the general public are invited to participate in the environmental review process.

Public Disclosure

Before including your address, phone number, e-mail address, or other personal identifying information in your comment, you should be aware that your entire comment—including your personal identifying information—may be made publicly available at any time. While you can ask us in your comment to withhold your personal identifying information from public review, we cannot guarantee that we will be able to do so.

Dated: ______________________________

Signed: ______________________________
Terrance J. Fulp, Ph.D.
Regional Director, Lower Colorado Region

LIST OF PERSONS, ORGANIZATIONS, AND PUBLIC AGENCIES THAT COMMMENTED ON THE NOTICE OF PREPARATION OF AN ENVIRONMENTAL IMPACT REPORT FOR THE PURE WATER SAN DIEGO PROGRAM, NORTH CITY PROJECT

Scoping Period:

The following is a listing of the names and addresses of persons, organizations, and public agencies that commented during this public review period.

	Name	Date	Address
Federal Agencies			
1	U.S. Army Corps of Engineers	08-Aug-2016	Shari Johnson 5900 La Place Court, Suite 100 Carlsbad, CA 92008
2	United States Environmental Protection Agency Region IX	06-Sept-2016	75 Hawthorne Street, San Francisco, CA 94105-3901
State Agencies			
3	State of California, Native American Heritage Commission	10-Aug-2016	Gayle Totton Native American Heritage Commission 1550 Harbor Blvd. Room 100 West Sacramento, CA 95691
4	Department of Toxic Substances Control	18-Aug-2016	Johnson P. Abraham 5796 Corporate Avenue Cypress, California 90630
5	Caltrans, District 11	24-Aug-2016	Jacob Armstrong 4050 Taylor St, MS 240 San Diego, CA 92110
6	California Department of Fish and Wildlife (CDFW)	01-Sept-2016	Gail K. Sevrens 3883 Ruffin Road, San Diego, CA 92123
County, City And Other Local Agencies			
7	County of San Diego Planning and Development Services	30-Aug-2016	Joe Farace, Group Program Manager 5510 Overland Avenue, Suite 310 San Diego, CA 92123
Local Organizations			
8	Rincon Band of Luiseno Indians	15-Aug-2016	Vincent Whipple Rincon Culture Resources Dept 1 W. Tribal Road Valley Center, CA 92082
9	San Diego County Archaeological Society, Inc.	01-Sept-2016	
10	WateReuse	02-Sept-2016	WaterReuse 1199 North Fairfax St, Suite 410 Alexandria, VA 22314

	Name	Date	Address
Individuals			
11	John Stump		John Stump 2413 Shamrock Street City Heights, CA 92105
12	Lozeau Drury	25-Aug-2016	410 12th Street, Ste 250 Oakland, CA 94607
13	Scott Andrews (1)	03-Sept-2016	Scott300@earthlink.net
14	Scott Andrews (2) –Save Everyone's Access	04-Sept-2016	Scott300@earthlink.net
Other			
	Scripps Miramar Ranch Library Scoping Comments	23-Aug-2016	
	PUD MOC II Scoping Comments	25-Aug-2016	
	Scoping Meeting Transcript (1)	23-Aug-2016	
	Scoping Meeting Transcript (2)	25-Aug-2016	
Internal (Not Official Scoping Comments)			
	City of SD Storm Water Division & Transportation	01-Sept-2016	Mark Stephens

UNITED STATES MARINE CORPS
MARINE CORPS AIR STATION MIRAMAR
P.O. BOX 452001
SAN DIEGO, CA 92145-2001

IN REPLY REFER TO:
5090 4725
S7 15 NOV 2016

From: Deputy Director of Environmental, Marine Corps Air Station Miramar

To: Mr. William J. Steele
Area Manager, U.S. Bureau of Reclamation
Lower Colorado Region
Southern California Area Office
27708 Jefferson Avenue
Temecula, CA 92590-2628

Ref: (1) Marine Corps Order 5090.2A Ch3

Encl: (a) Survey map(s)

Dear Mr. Steele:

SUBJECT: PURE WATER SAN DIEGO PROGRAM NORTH CITY PROJECT

Thank you for your recent letter inviting the U.S. Marine Corps to be a cooperating agency in preparation of the joint Environmental Impact Statement/Environmental Impact Report (EIS/EIR) for the Pure Water San Diego Program, North City project in San Diego County, California. We accept your invitation in accordance with the National Environmental Policy Act (NEPA) and Council on Environmental Quality (CEQ) regulations, consistent with Marine Corps Order (MCO) 5090.2A Ch 3.

The proposed federal action would incorporate two utility easements across portions of Marine Corps Air Station (MCAS) Miramar. The first would expand an existing easement running generally north-south between the Miramar Landfill and the North City Water Reclamation Plant. This easement crosses the Miramar National Cemetery between those points. The second easement would run east-west under a portion of Miramar Road between

Miramar Mall and a point short of the BNSF Railway crossing (see enclosed survey maps).

For this federal action we anticipate staff involvement from three Marine Corps organizations: Headquarters Marine Corps (HQMC), Marine Corps Installations West (MCIWEST) and MCAS Miramar. We have a particular interest in how the proposed federal action may affect MCAS Miramar operations and security, the Marine Corps mission, and any sensitive resources aboard the air station.

Our role as a cooperating agency during document preparation will be technical in nature, and this assistance does not abridge or otherwise affect our responsibilities for independent review of the draft and final joint (or related technical) document(s) under NEPA, CEQ regulations, and/or MCO 5090.2A Ch3.

The Marine Corps lead contact for this project will be Ms. Susan VanWinkle, Deputy Director of Environmental at MCAS Miramar (858.577.1134 or susan.vanwinkle@usmc.mil). Ms. VanWinkle will be coordinating with the MCIWEST Regional Planner, Mr. Zachery H. Likins (760.763.7948 or zachery.likins@usmc.mil) who will coordinate with HQMC staff, as appropriate. At this time, we do not anticipate the need for a memorandum of agreement formalizing our participation.

We look forward to working with the Bureau of Reclamation and the other participating agencies in this important infrastructure project that will help ensure San Diego's future water security position.

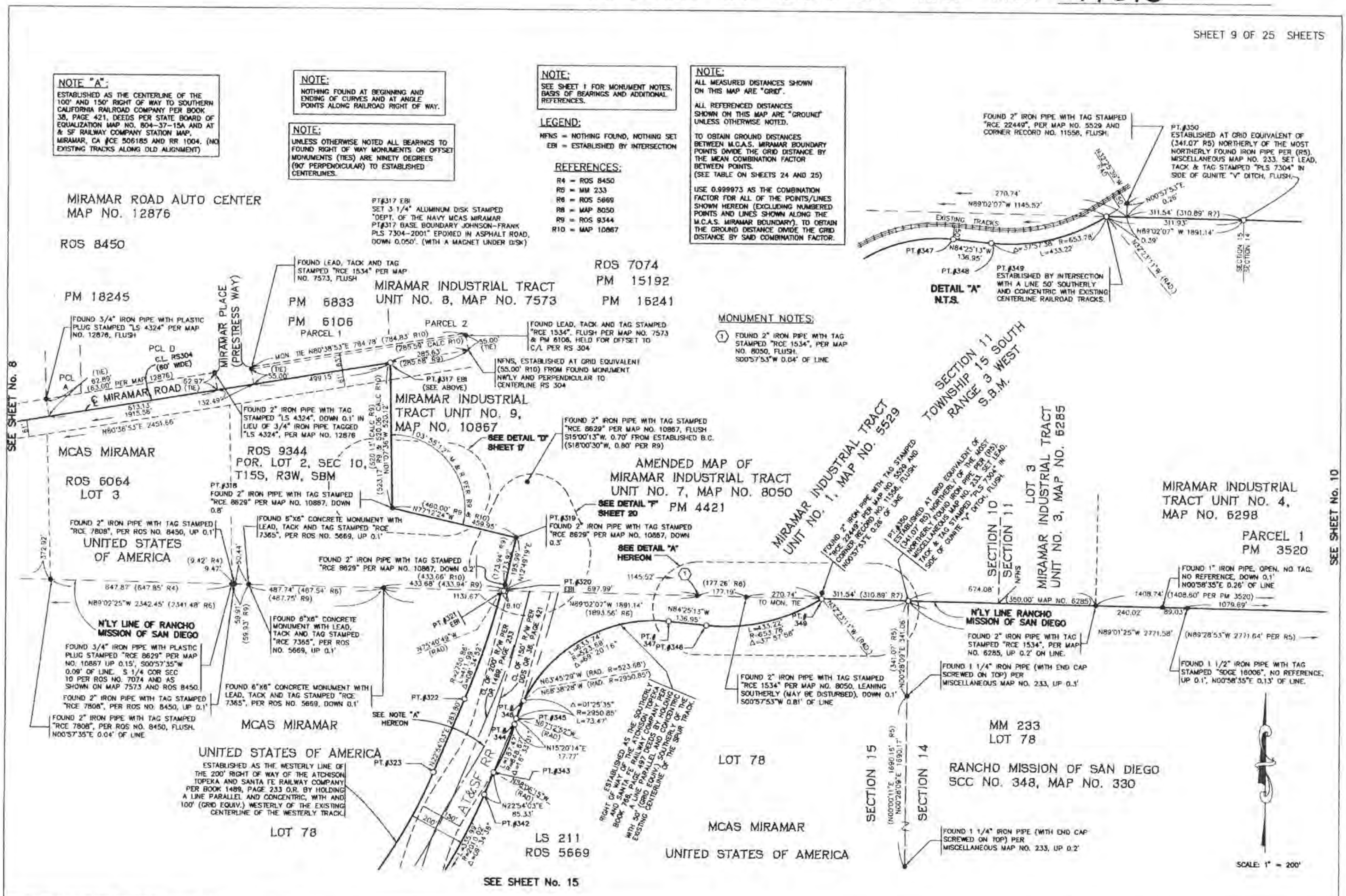
Sincerely,

S. M. VanWinkle

S. M. VanWinkle
By Direction
of the Commanding Officer

Copy to: MCIWEST CG

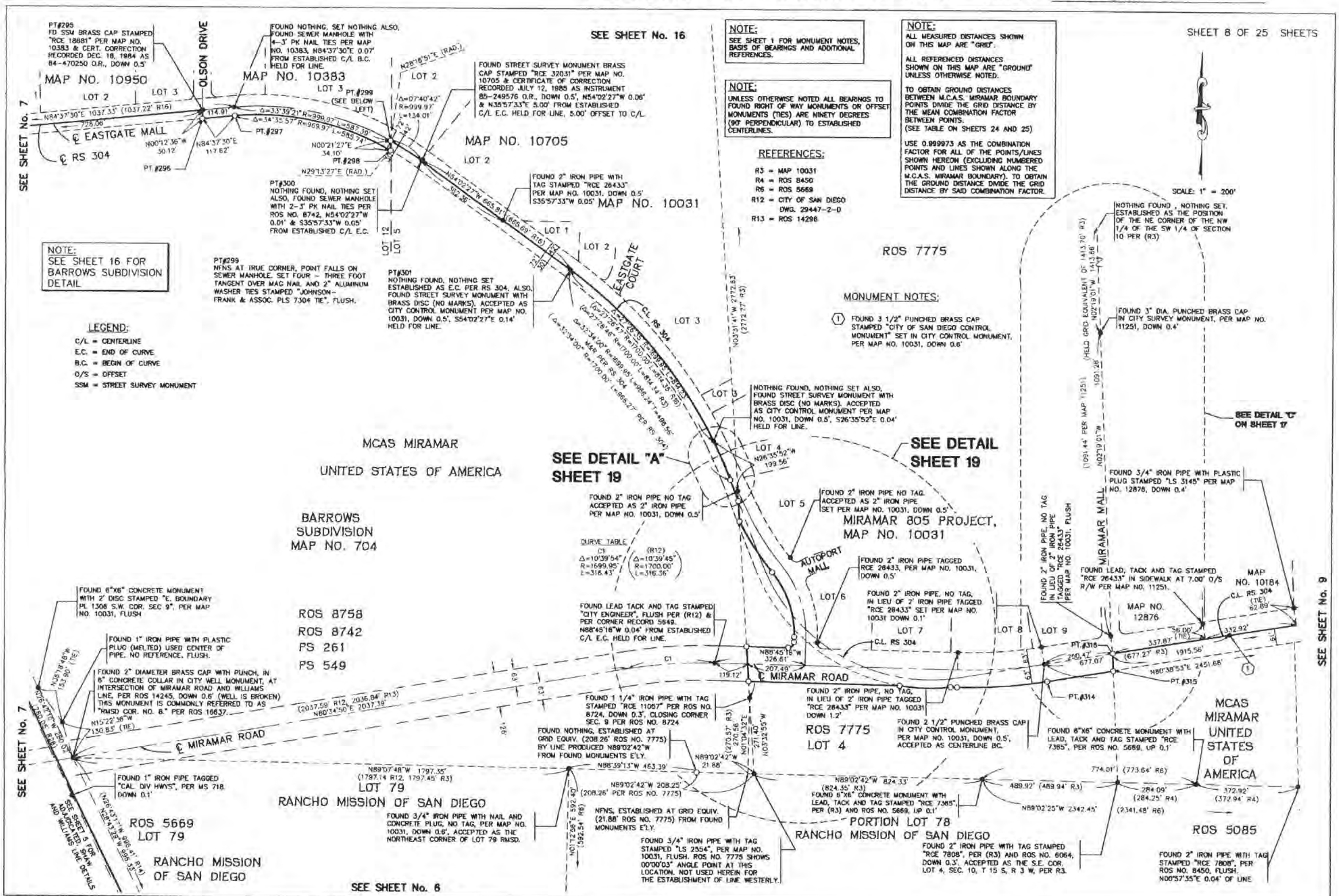
RECORD OF SURVEY MAP NO. 17316



JOHNSON-FRANK & ASSOC., INC.
LAND SURVEYING – MAPPING
5150 E. HUNTER AVENUE
ANAHEIM, CALIFORNIA 92807-2049

ASSESSOR PARCEL NO. 343-040

RECORD OF SURVEY MAP NO. 17316



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(714) 777-8877 FAX (714) 777-1641

ASSESSOR PARCEL NO. 343-020

DEPARTMENT OF VETERANS AFFAIRS
Office of Construction & Facilities Management
Washington DC 20420

Mr. Doug McPherson
United States Department of the Interior
Bureau of Reclamation
Lower Colorado Region, Southern California Area Office
27708 Jefferson Avenue, Suite 202
Temecula, CA 92590-2628

Subject: Pure Water Sand Diego Program, North City Project

Dear Mr. McPherson:

On behalf of VA's National Cemetery Administration (NCA), the Office of Real Property (ORP) would like to accept your invitation to become a NEPA cooperating agency in the development of the Environmental Impact Statement/Environmental Impact Report (EIS/EIR) for an existing easement through Miramar National Cemetery.

As a cooperating agency, VA understands it has retained the right to review and comment on administrative drafts of the EIS/EIR at various milestones throughout its preparation. As a preliminary matter, we do not agree to the proposed easement expansion, or the proposal of a new easement, due to the significant negative impact these actions would have on the burial capacity of the Miramar National Cemetery.

I know that Kent Walker of my staff, as well as other VA stakeholders, have already communicated many of these concerns. We will follow up shortly with additional documentation regarding our position.

If you have questions, please contact Kent Walker, Realty Specialist, at (202) 632-5129 or Kent.Walker@va.gov.

Thank you,

Amanda Hendry
Director, Real Property Western Region

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
Carlsbad Fish and Wildlife Office
2177 Salk Ave, Suite 250
Carlsbad, California 92011

In Reply Refer To:
FWS-SDG-15B0078-17TA0076

November 18, 2016
Sent by Email

Mr. Doug McPherson
Environmental Protection Specialist
Bureau of Reclamation
Southern California Area Office
27708 Jefferson Ave, Suite 202
Temecula, California 92590

Subject: Comments on the Notice of Intent to Prepare an Environmental Impact Statement/Environmental Impact Report for the Pure Water San Diego Program, North City Project

Dear Ms. Herrmann:

The U.S Fish and Wildlife Service (Service) has reviewed your October 19, 2016, letter and the Notice of Intent (NOI) to prepare an Environmental Impact Statement/Environmental Impact Report (EIS/EIR) for the Pure Water San Diego Program, North City Project (project) dated August 5, 2016. The Service has identified potential effects of this project on wildlife and sensitive habitats. The project details provided herein are based on the information provided in the NOP and our knowledge of sensitive and declining vegetation communities in the region, and our participation in the Multiple Species Conservation Program (MSCP) and the City of San Diego's (City) MSCP Subarea Plan (SAP).

The primary concern and mandate of the Service is the protection of public fish and wildlife resources and their habitats. The Service has legal responsibility for the welfare of migratory birds, anadromous fish, and endangered animals and plants occurring in the United States. The Service is also responsible for administering the Federal Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq*.), including habitat conservation plans (HCP) developed under section 10(a)(1)(B) of the Act. The City participates in the Service's HCP program by implementing its SAP.

According to the NOI and your letter, the project is the first phase of the Pure Water San Diego Program and proposes to expand the North City Water Reclamation Plant and construct the adjacent North City Pure Water Facility with a pipeline that will extend to the Miramar Reservoir or an alternative pipeline to San Vicente Reservoir. In addition the project will include a new pump station and force-main, a brine discharge pipeline, upgrades to the Metropolitan Bio-solids Center and a new electrical line connecting the reclamation plant with the bio-solids center.

Your letter includes an invitation for the Service to be a cooperating agency in the development of the EIR/EIS. While we appreciate the invitation, the Service will not be a cooperating agency. However we offer the enclosed comments and recommendations to assist the Bureau of Reclamation in avoiding, minimizing, and adequately mitigating project-related impacts to biological resources, and to ensure that the project is consistent with the City's SAP.

We appreciate the opportunity to comment on this NOI. We are hopeful that further consultation among our agencies will ensure the protection we find necessary for the biological resources that would be affected by this project. If you have questions or comments regarding this letter, please contact Patrick Gower (760) 431-9440.

Sincerely,

Digitally signed by
DAVID ZOUTENDYK
Date: 2016.11.18
11:47:21 -08'00'

for Karen A. Goebel
Assistant Field Supervisor
U.S. Fish and Wildlife Service

Enclosure

Enclosure

Wildlife Agency Comments and Recommendations on the Notice of Intent (NOI) to Prepare an Environmental Impact Statement/Environmental Impact Report (EIS/EIR) for the Pure Water San Diego Program

Specific Comments

1. The EIS/EIR should explain the relationship of the Pure Water San Diego Program to, and evaluate consistency with, the City's SAP and Biology Guidelines. The direct, indirect and cumulative impact analysis should include figures of the designated MSCP preserve areas that exist within and adjacent to the entirety of the project boundaries, as well as address the current status and long-term management obligations associated with these areas and any potential impacts to these areas that may result from the proposed project.

2. If the project proposes to impact federally listed species not covered under the MSCP or if the project is not consistent with the provisions of the MSCP, consultation under section 7 of the Act may be required.

3. The San Vicente Reservoir purified water pipeline would extend into key locations associated with the County of San Diego's MSCP SAP. If the analysis from this document is intended to be used to satisfy future County of San Diego permit requirements, the Pure Water San Diego Program should also evaluate consistency with the County of San Diego's Biological Mitigation Ordinance, Resource Protection Ordinance, and MSCP SAP.

4. The Service emphasizes that one of the purposes of the EIS/EIR is to "prevent significant, avoidable damage to the environment by requiring changes in projects through the use of alternatives or mitigation measures when the governmental agency finds the changes to be feasible." Because of the proximity of the project site to sensitive species and habitats that could be negatively affected or lost by the proposed project, the alternatives analysis for this project is extremely important. We are particularly interested in the EIS/EIR describing a range of reasonable alternatives to the project (particularly options to maximize open space), which would feasibly attain most of the basic objectives of the project but would avoid or substantially lessen any of the significant effects of the project, and evaluate the comparative merits of the alternatives. The range of feasible alternatives should be selected and discussed in a manner to foster meaningful public participation and informed decision making. The Service will consider the alternatives analyzed in the context of their relative impacts on biological resources on both a local and regional level.

5. The expansion of the North City Water Reclamation Plant may impact vernal pools. Project activities that alter hydrology, increase vernal pool habitat fragmentation, or decrease land types suitable for vernal pool formation have the potential to limit the survivability and recovery of federally listed vernal pool species such as the San Diego fairy shrimp (*Branchinecta sandiegonensis*), Riverside fairy shrimp (*Streptocephalus woottoni*), San Diego mesa mint (*Pogogyne abramsii*), and San Diego button celery (*Eryngium aristulatum* var. *parishii*). The EIR/EIS should include measures to avoid/minimize impacts to vernal pools and evaluate consistency with the City's draft Vernal Pool HCP.

6. For those portions of the project area that have the potential to support the federally-listed Quino checkerspot butterfly (*Euphydryas editha quino*; Quino), the Service recommends the City survey for Quino consistent with the Service's 2014 Quino Checkerspot Survey Guidelines.

7. To guide project planning to avoid/minimize impacts to listed species, we recommend that protocol-level surveys be conducted for any listed species with the potential to occur within the project site. Surveys should be performed no more than one year prior to an application for a permit from the Service, and the EIR/EIS should include the survey results.

8. All construction and post-construction best management practices (BMPs) should be located within the development footprint (i.e., included in the impact analysis as loss of habitat). The EIR/EIS should include a figure depicting the location of BMPs in relation the development footprint.

9. Native plants should be used to the greatest extent feasible in landscaped areas adjacent to and/or near mitigation/open space areas and/or wetland/riparian areas. The applicant should not plant, seed, or otherwise introduce invasive exotic plant species to landscaped areas adjacent to and/or near native habitat areas. Exotic plant species not to be used include those species listed on the California Invasive Plant Council's (Cal-IPC) Invasive Plant Inventory. This list includes such species as: pepper trees, pampas grass, fountain grass, ice plant, myoporum, black locust, capeweed, tree of heaven, periwinkle, sweet alyssum, English ivy, French broom, Scotch broom, and Spanish broom.[1] In addition, landscaping adjacent to native habitat areas should not use plants that require intensive irrigation, fertilizers, or pesticides. Water runoff from landscaped areas should be directed away from mitigation/open space and/or wetland/riparian areas and contained and/or treated within the development footprint.

General Comments

To enable us to adequately review and comment on the proposed project from the standpoint of the protection of plants, fish and wildlife, we recommend the following information be included in the EIS/EIR:

1. A complete discussion of the purpose and need for, and description of, the proposed project, including all staging areas and access routes to the construction and staging areas.

2. A complete list and assessment of the flora and fauna within and adjacent to the project area, with particular emphasis upon identifying State or federally listed rare, threatened, endangered, or proposed candidate species, California Species-of-Special Concern and/or State Protected or Fully Protected species, and any locally unique species and sensitive habitats. Specifically, the EIR/EIS should include:

    a. A thorough assessment of Rare Natural Communities on site and within the area of impact. We recommend following the California Department of Fish and Wildlife's Guidelines for Assessing Impacts to Rare Plants and Rare Natural Communities.

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[1] A copy of the complete list can be obtained by contacting the California Invasive Plant Council at 1442-A Walnut Street, Suite #462, Berkeley, California 94709, or by accessing their web site at http://www.cal-ipc.org.

b. A current inventory of the biological resources associated with each habitat type on site and within the area of impact.

c. An inventory of rare, threatened, and endangered species on site and within the area of impact.

d. Discussions regarding seasonal variations in use by sensitive species of the project site as well as the area of impact on those species, using acceptable species-specific survey procedures as determined through consultation with the Service. Focused species-specific surveys, conducted in conformance with established protocols at the appropriate time of year and time of day when the sensitive species are active or otherwise identifiable, are required.

3. A thorough discussion of direct, indirect, and cumulative impacts expected to adversely affect biological resources. All facets of the project should be included in this assessment. Specifically, the EIS/EIR should provide:

a. Specific acreage and descriptions of the types of wetlands, coastal sage scrub, and other sensitive habitats that will or may be affected by the proposed project or project alternatives. Maps and tables should be used to summarize such information.

b. Discussions regarding the regional setting with special emphasis on resources that are rare or unique to the region that would be affected by the project. This discussion is critical to an assessment of environmental impacts.

c. Detailed discussions, including both qualitative and quantitative analyses, of the potentially affected listed and sensitive species (fish, wildlife, plants), and their habitats on the proposed project site, area of impact, and alternative sites, including information pertaining to their local status and distribution. The anticipated or real impacts of the project on these species and habitats should be fully addressed.

d. Discussions regarding indirect project impacts on biological resources, including resources in nearby public lands, open space, adjacent natural habitats, riparian ecosystems, and any designated and/or proposed NCCP reserve lands. Impacts on, and maintenance of, wildlife corridor/movement areas, including access to undisturbed habitats in adjacent areas, should be fully evaluated and provided. A discussion of potential adverse impacts from lighting, noise, human activity, exotic species, and drainage. The latter subject should address: project-related changes on drainage patterns on and downstream of the project site; the volume, velocity, and frequency of existing and post-project surface flows; polluted runoff; soil erosion and/or sedimentation in streams and water bodies; and post-project fate of runoff from the project site.

e. Discussions regarding possible conflicts resulting from wildlife-human interactions at the interface between the development project and natural habitats. The zoning of areas for development projects or other uses that are nearby or adjacent to natural areas may inadvertently contribute to wildlife-human interactions.

f. An analysis of cumulative effects. General and specific plans, and past, present, and anticipated future projects, should be analyzed concerning their impacts on similar plant communities and wildlife habitats.

g. If applicable, an analysis of the effect that the project may have on completion and implementation of regional and/or subregional conservation programs. We recommend that the Lead Agency ensure that the development of this and other proposed projects do not interfere with the goals and objectives of established or planned long-term preserves and that projects conform with other requirements of the NCCP program.

4. Mitigation measures for unavoidable adverse project-related impacts on sensitive plants, animals, and habitats. Mitigation measures should emphasize avoidance, and where avoidance is infeasible, reduction of project impacts. For unavoidable impacts, off-site mitigation through acquisition and preservation in perpetuity of the affected habitats should be addressed. We generally do not support the use of relocation, salvage, and/or transplantation as mitigation for impacts on rare, threatened, or endangered species. Studies have shown that these efforts are experimental in nature and largely unsuccessful.

5. This discussion should include measures to perpetually protect the targeted habitat values where preservation and/or restoration is proposed. The objective should be to offset the project-induced qualitative and quantitative losses of wildlife habitat values. Issues that should be addressed include restrictions on access, proposed land dedications, monitoring and management programs, control of illegal dumping, water pollution, increased human intrusion, etc. Plans for restoration and revegetation should be prepared by persons with expertise in southern California ecosystems and native plant revegetation techniques. Each plan should include, at a minimum:

a. the location of the mitigation site;

b. the plant species to be used;

c. a schematic depicting the mitigation area;

d. time of year that planting will occur;

e. a description of the irrigation methodology;

f. measures to control exotic vegetation on site;

g. success criteria;

h. a detailed monitoring program;

i. contingency measures should the success criteria not be met; and

j. identification of the entity(ies) that will guarantee achieving the success criteria and provide for conservation of the mitigation site in perpetuity.

Mitigation measures to alleviate indirect project impacts on biological resources must be included, including measures to minimize changes in the hydrologic regimes on site, and means to convey runoff without damaging biological resources, including the morphology of on-site and downstream habitats.

6. As discussed previously, descriptions and analyses of a range of alternatives to ensure that alternatives to the proposed project are fully considered and evaluated. The analyses must include alternatives that avoid or otherwise reduce impacts to sensitive biological resources. Specific alternative locations should be evaluated in areas of lower resource sensitivity where appropriate.

Balo, Keli

From: Johnson, Shari SPL <Shari.Johnson@usace.army.mil>
Sent: Monday, August 08, 2016 2:38 PM
To: Balo, Keli
Subject: RE: North City Project (UNCLASSIFIED)

CLASSIFICATION: UNCLASSIFIED

Dear Ms. Balo:

It has come to our attention that you are evaluating the North City Project.

This activity may require a U.S. Army Corps of Engineers permit.

A Corps of Engineers permit is required for:

a) structures or work in or affecting "navigable waters of the United States" pursuant to Section 10 of the Rivers and Harbors Act of 1899. Examples include, but are not limited to,

1. constructing a pier, revetment, bulkhead, jetty, aid to navigation, artificial reef or island, and any structures to be placed under or over a navigable water;

2. dredging, dredge disposal, filling and excavation;

b) the discharge of dredged or fill material into, including any redeposit of dredged material other than incidental fallback within, "waters of the United States" and adjacent wetlands pursuant to Section 404 of the Clean Water Act of 1972. Examples include, but are not limited to,

1. creating fills for residential or commercial development, placing bank protection, temporary or permanent stockpiling of excavated material, building road crossings, backfilling for utility line crossings and constructing outfall structures, dams, levees, groins, weirs, or other structures;

2. mechanized landclearing, grading which involves filling low areas or land leveling, ditching, channelizing and other excavation activities that would have the effect of destroying or degrading waters of the United States;

3. allowing runoff or overflow from a contained land or water disposal area to re-enter a water of the United States;

4. placing pilings when such placement has or would have the effect of a discharge of fill material;

c) the transportation of dredged or fill material by vessel or other vehicle for the purpose of dumping the material into ocean waters pursuant to Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972;

d) any combination of the above.

An application for a Department of the Army permit is available on our website:

http://www.usace.army.mil/Portals/2/docs/civilworks/permitapplication.pdf .

If you have any questions, please contact me (contact information below).

Shari Johnson
Regulatory Assistant
U.S. Army Corps of Engineers, Los Angeles District Regulatory Division, Carlsbad Field Office
5900 La Place Court, Suite 100
Carlsbad, CA 92008
Tel 760.602.4829; Fax 760.602.4848

Assist us in better serving you! Please complete our brief customer survey, located at the following link:
http://corpsmapu.usace.army.mil/cm_apex/f?p=regulatory_survey

CLASSIFICATION: UNCLASSIFIED

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

SEP 0 6 2016

Doug McPherson
U.S. Bureau of Reclamation
Southern California Area Office
27708 Jefferson Ave. Suite 202
Temecula, CA 92590

Subject: Notice of Intent to Prepare a Draft Environmental Impact Statement/Draft Environmental Impact Report for the Pure Water Project, San Diego County, CA

Dear Mr. McPherson:

The U.S. Environmental Protection Agency has reviewed the Federal Register Notice published August 5, 2016 requesting comments on the U.S. Bureau of Reclamation's decision to prepare a Draft Environmental Impact Statement / Environmental Impact Report for the Pure Water Project. Our comments are provided pursuant to the National Environmental Policy Act, Council on Environmental Quality regulations (40 CFR Parts 1500-1508), and our NEPA review authority under Section 309 of the Clean Air Act.

Reclamation, in partnership with the City of San Diego, intends to prepare a joint Draft EIS/EIR to evaluate the effects of the North City Project, the first phase of the Pure Water San Diego Program (Pure Water Program). Federal assistance from Reclamation for this project includes planning, design, and construction of demonstration and permanent facilities to reclaim and reuse water in the San Diego metropolitan area. EPA supports San Diego's plans to develop potable reuse capacity to reduce the region's reliance on imported supplies. We have several recommendations for your consideration in preparing the Draft EIS/EIR. Please see our attached detailed comments.

We appreciate the opportunity to provide comments on this Notice of Intent. Please send one hard copy and one CD of the Draft EIS to this office (mail code ENF-4-2) at the same time it is officially filed with our Washington D.C. Office. If you have any questions, please contact me at (415) 972-3098 or gordon.stephanieS@epa.gov

Sincerely,

Stephanie Gordon

Stephanie Gordon
Environmental Review Section
Enforcement Division

Enclosures: EPA's Detailed Comments

Cc via email: Keli Balo, Project manager kbalo@sandiego.gov

EPA DETAILED SCOPING COMMENTS ON THE PURE WATER PROJECT, SAN DIEGO COUNTY, CALIFORNIA, SEPTEMBER 6, 2016

Purpose and Need

The Draft EIS for the proposed project should clearly identify the underlying purpose and need that is the basis for proposing the range of alternatives (40 CFR 1502.13). The *purpose* of the proposed action is typically the specific objectives of the activity, while the *need* for the proposed action may be to eliminate a broader underlying problem or take advantage of an opportunity.

The purpose and need should be a clear, objective statement of the rationale for the proposed project, as it provides the framework for identifying project alternatives. The Draft EIS should concisely identify why the project is being proposed, why it is being proposed now, and should focus on the specific desired outcomes of the project (e.g. secure reliable water supply, maximize beneficial use of recycled water). The purpose and need should also clearly describe Reclamation's role and federal action in the project, particularly as it relates to funding availability and mechanisms.

Regulatory Framework

The Draft EIS for the proposed project should include a comprehensive description of the regulatory context of the project. This section should include a description of any permits and/or modifications to those permits that the project will require (e.g. National Pollutant Discharge Elimination System permits for discharges to Waters of the United States). Additionally, Reclamation should discuss the project in the context of the State Water Resources Control Board's updated "General Waste Discharge Requirements for Recycled Water Use"[1] published on June 3, 2014 and the upcoming "Uniform Water Recycling Criteria for Direct Potable Reuse."[2]

The Draft EIS/EIR should discuss how the proposed action would support or conflict with the objectives of federal, state, tribal or local land use plans, policies and controls in the project areas. The term "land use plans" includes all types of formally adopted documents for land use planning, conservation, zoning and related regulatory requirements. Proposed plans not yet developed should also be addressed it they have been formally proposed by the appropriate government body in a written form (CEQ's Forty Questions, #23b).

Range of Alternatives

All reasonable alternatives that fulfill the project's purpose and need should be evaluated in detail, including alternatives outside the legal jurisdiction of Reclamation (40 CFR Section 1502.14(c)). The Draft EIS should provide a clear discussion of the reasons for the elimination of alternatives which are not evaluated in detail.

A robust range of alternatives will include options for avoiding significant environmental impacts. The Draft EIS should clearly describe the rationale used to determine whether impacts of an alternative are significant or not. Thresholds of significance should be determined by considering the context and intensity of an action and its effects (40 CFR 1508.27).

The environmental impacts of the proposal and alternatives should be presented in comparative form, thus sharply defining the issues and providing a clear basis for choice among options by the decision maker and the public (40 CFR 1502.14). The potential environmental impacts (including benefits) of

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[1] http://www.waterboards.ca.gov/board_decisions/adopted_orders/water_quality/2014/wqo2014_0090_dwq_revised.pdf

[2] http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/RecycledWater.shtml

each alternative should be quantified to the greatest extent possible (e.g. acres of wetlands impacted; change in water quality parameters).

The No Action Alternative should clearly describe the current wastewater discharge regimes in San Diego. It should specify the regulatory vehicle that governs the discharge regimes and include details of all permits and transfers related to the current discharge. The description of the No Action Alternative should also indicate the recipients and volumes of water currently discharged from the North City Water Reclamation Plant.

The Draft EIS/EIR should describe the methodology and criteria used for determining the pipeline and transmission line route and alternative routes. The alternatives analysis should include a discussion of environmentally preferable routes for the pipeline, as well as alternative sites and configurations for any access roads and ancillary facilities.

Water Supply

Water supply and demand for the San Diego region should be throughly discussed in the Draft EIS/EIR. Reclamation should present the information in the context of imported water from the Colorado River and Sacramento San Joaquin Bay Delta region, and how the project will contribute to or alleviate ongoing stressors in each of those systems.

The Draft EIS/EIR should discuss the water supply needs for all the customers that would receive water from the Pure Water Program. The document should describe and quantify the proposed percentage distribution of project water for irrigation, groundwater recharge, drinking water, and other uses and the framework by which this distribution might change over time as the project is implemented for all Alternatives, including the No Action.

Water Quality

Each of the Action Alternatives should include a robust discussion of impacts to water quality.

This should include identifying the applicable water quality standards and beneficial uses of receiving waters that receive discharges from the proposed project. This should include a brief discussion of the current demonstration program.

The analysis should include a description of the impacts from increased or decreased discharge volume to the current discharge locations and waters, including, but not limited to, any impacts to the quantity and quality of water in the reservoirs in the proposed Alternatives.

Aquatic Resources

Geographic Extent of Waters of the United States

The project applicant should coordinate with the U.S. Army Corps of Engineers to determine if the proposed project requires a Section 404 permit under the Clean Water Act. Section 404 regulates the discharge of dredged or fill material into waters of the United States (WUS), including wetlands and other special aquatic sites. The Draft EIS/EIR should describe all WUS that could be affected by the project alternatives, and include maps that clearly identify all such waters within the project area. The discussion should include acreages and channel lengths, habitat types, values and functions of these waters. The EPA recommends that Reclamation include a jurisdictional delineation for all WUS, including ephemeral drainages, in accordance with the 1987 *Corps of Engineers Wetlands Delineation Manual and the December 2006 Arid West Region Interim Regional Supplement to the Corps of*

Engineers Wetland Delineation Manual: Arid West Region. A jurisdictional delineation will confirm the presence or absence of WUS in the project area and help determine whether or not the proposed project would require a Section 404 permit.

If a permit is required, the EPA may review the project for compliance with *Federal Guidelines for Specification of Disposal Sites for Dredged or Fill Materials* (40 CFR 230), promulgated pursuant to Section 404(b)(1) of the CWA. Pursuant to 40 CFR 230, any permitted discharge into WUS must be the *least environmentally damaging practicable alternative* available to achieve the project purpose. The Draft EIS/EIR should include an evaluation of the project alternatives in this context in order to demonstrate the project's compliance with the 404(b)(1) Guidelines. If, under the proposed project, dredged or fill material would be discharged into WUS, the Draft EIS/EIR should discuss alternatives to avoid those discharges.

Biological Resources, Habitat and Wildlife

The Draft EIS/EIR should identify all petitioned and listed threatened and endangered species and critical habitat that might occur within the project area. The document should identify and quantify which species or critical habitat might be directly, indirectly, or cumulatively affected by each alternative and mitigate impacts to these species. Emphasis should be placed on the protection and recovery of species due to their status or potential status under the federal or state Endangered Species Act. Pipeline and transmission line rights of way are anthropogenic disturbances which alter the spatial structure of habitat elements, creating linear patches or line corridors which in turn impact ecological integrity by modifying ecological processes (abiotic & biotic) at various scales. Pipeline Right-of-Ways can result in habitat fragmentation and increased habitat edge effects, affecting individual species with different intensity.

The Draft EIS/EIR should include a discussion of how the proposed action would comply with ESA requirements, including any necessary ESA Section 7 consultation efforts with the U.S. Fish and Wildlife Service. We recommend that any relevant documents associated with the ESA Section 7 consultation process, including Biological Assessments and Biological Opinions, be summarized and included in an appendix in the Draft EIS/EIR.

We also recommend that Reclamation coordinate across field offices and with USFWS and California Department of Fish and Wildlife to ensure that current and consistent surveying, monitoring, and reporting protocols are applied in protection and mitigation efforts.

Analysis of impacts and mitigation on covered species should include:

- Baseline conditions of habitats and populations of the covered species.
- A clear description of how avoidance, mitigation and conservation measures will protect and encourage the recovery of the covered species and their habitats in the project area.
- Monitoring, reporting and adaptive management efforts to ensure species and habitat conservation effectiveness.

If the applicant is to acquire compensation lands, the location(s) and management plans for these lands should be discussed in the Draft EIS/EIR. Information on the compensatory mitigation proposals (including quantification of acreages, estimates of species protected, costs to acquire compensatory lands, etc.) for unavoidable impacts to waters of the State and biological resources, as applicable should be incorporated.

Reclamation should identify compensatory mitigation lands or quantify, in the Draft EIS/EIR, available lands for compensatory habitat mitigation for this project, as well as reasonably foreseeable projects in the area. The EIS should specify provisions that will ensure habitat selected for compensatory mitigation will be protected in perpetuity. It should also incorporate, into the Draft EIS/EIR, mitigation, monitoring, and reporting measures that result from consultation with the USFWS and CDFW, and that incorporate lessons learned from other pipeline projects and recently released guidance to avoid and minimize adverse effects to sensitive biological resources.

The Draft EIS/EIR should describe the potential for habitat fragmentation and obstructions for wildlife movement from the construction of this project and other projects in the area.

We recommend that the need for monitoring, mitigation, and if applicable, translocation management plans for the sensitive biological resources be discussed. This could include, but is not limited to, an Avian or Invertebrate Monitoring, Management, and Control Plan, and Special-Status Plant Impact Avoidance and Mitigation Plan.

The Draft EIS/EIR should describe the extent of construction, installation, and maintenance and the associated impacts on habitat and threatened and endangered species. We encourage habitat conservation alternatives that avoid and protect high value habitat and create or preserve linkages between habitat areas to better conserve the covered species.

Climate Change

We recommend that climate change issues be analyzed consistent with the Council on Environmental Quality's (CEQ) August 5, 2016 final guidance for Federal agencies' consideration of GHG emissions and climate change impacts when conducting environmental reviews under NEPA. Accordingly, we recommend the Draft EIS include an estimate of the GHG emissions associated with the project, qualitatively describe relevant climate change impacts, and analyze reasonable alternatives and/or practicable mitigation measures to reduce project-related GHG emissions. More specifics on those elements are provided below. In addition, we recommend that the NEPA analysis address the appropriateness of considering changes to the design of the proposal to incorporate GHG reduction measures and resilience to foreseeable climate change. The Draft EIS/EIR should make clear whether commitments have been made to ensure implementation of design or other measures to reduce GHG emissions or to adapt to climate change impacts.

More specifically, we suggest the following approach:

"Affected Environment" Section

- Include in the "Affected Environment" section of the Draft EIS a summary discussion of climate change and ongoing and reasonably foreseeable climate change impacts relevant to the project, based on U.S. Global Change Research Program[3] assessments, to assist with identification of potential project impacts that may be exacerbated by climate change and to inform consideration of measures to adapt to climate change impacts. (Among other things, this will assist in identifying resilience-related changes to the proposal that should be considered).

[3] http://www.globalchange.gov/

"Environmental Consequences" Section

- Estimate the GHG emissions associated with the proposal and its alternatives. Example tools for estimating and quantifying GHG emissions can be found on CEQ's NEPA.gov website[4]. For actions which are likely to have less than 25,000 metric tons of CO2-e emissions/year, provide a qualitative estimate unless quantification is easily accomplished. *In most cases quantification of GHG emissions involves a relatively straightforward calculation.* In addition to estimating emissions caused by the proposal itself, we recommend estimating the reasonably foreseeable emissions from "upstream" and "downstream" activities indirectly caused by the proposal.[5]

- The estimated GHG emissions can serve as a reasonable proxy for climate change impacts when comparing the proposal and alternatives. In disclosing the potential impacts of the proposal and reasonable alternatives, consideration should be given to whether and to what extent the impacts may be exacerbated by expected climate change in the action area, as discussed in the "affected environment" section.

- Describe measures to reduce GHG emissions associated with the project, including reasonable alternatives or other practicable mitigation opportunities and disclose the estimated GHG reductions associated with such measures. The DEIS alternatives analysis should, as appropriate, consider practicable changes to the proposal to make it more resilient to anticipated climate change. EPA further recommends that the Record of Decision commits to implementation of reasonable mitigation measures that would reduce or eliminate project-related GHG emissions.

- We recommend that the project discuss energy usage for all aspects of the Pure Water program, including in particular the new pump station. Reclamation should explore the feasibility of powering the pump station with renewable energy and quantify the reduction in greenhouse gas emissions that could result.

Hazardous Materials/Hazardous Waste/Solid Waste

The Draft EIS/EIR should address potential direct, indirect and cumulative impacts of hazardous waste from construction and operation of the proposed pipeline and other project components, including the potential disinfection and pumping facilities. The Draft EIS/EIR should identify projected hazardous waste types and volumes, and expected storage, disposal, and management plans. It should address the applicability of state and federal hazardous waste requirements. Appropriate mitigation should be evaluated, including measures to minimize the generation of hazardous waste (i.e., hazardous waste minimization). Alternate industrial processes using less toxic materials should be evaluated as mitigation since such processes could reduce the volume or toxicity of hazardous materials requiring management and disposal as hazardous waste.

Floodplain Executive Orders

On January 30, 2015 President Obama issued Executive Order 13690 – Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input, which amends Executive Order 11988 – Floodplain Management. Section 2(i) of E.O. 13690 establishes

[4] https://ceq.doe.gov/current_developments/GHG_accounting_methods_7Jan2015.html

[5] Recognizing that climate impacts are not attributable to any single action, but are exacerbated by a series of smaller decisions, we do not recommend comparing GHG emissions from a proposed action to global emissions. As noted by the CEQ guidance, "[t]his approach does not reveal anything beyond the nature of the climate change challenge itself: [t]he fact that diverse individual sources of emissions each make relatively small additions to global atmospheric GHG concentrations that collectively have huge impact."

a new definition of the term "floodplain." Rather than basing the floodplain on the area subject to a one percent or greater chance of flooding in any given year, the floodplain would be established using one of the following approaches:

> Unless an exception is made under paragraph (2), the floodplain shall be:
> (i) the elevation and flood hazard area that result from using a climate-informed science approach that uses the best-available, actionable hydrologic and hydraulic data and methods that integrate current and future changes in flooding based on climate science. This approach will also include an emphasis on whether the action is a critical action as one of the factors to be considered when conducting the analysis;
> (ii) the elevation and flood hazard area that result from using the freeboard value, reached by adding an additional 2 feet to the base flood elevation for non-critical actions and by adding an additional 3 feet to the base flood elevation for critical actions;
> (iii) the area subject to flooding by the 0.2 percent annual chance flood; or
> (iv) the elevation and flood hazard area that result from using any other method identified in an update to the Federal Flood Risk Management Standards.

EPA recommends that the Draft EIS explain how each alternative would be consistent with the directives in Executive Order 13690. For more information, go to: https://www.fema.gov/federal-flood-risk-management-standard-ffrms.

Public Health and Safety – Valley Fever

Coccidioidomycosis, (kok-sid-oy-doh-my-KOH-sis), or Valley Fever, is a fungal infection that is almost always acquired from the environment via the inhalation of fungal spores. It can affect humans, many species of mammals and some reptiles.[6] The fungus, *Coccidioides*, is endemic in the soil of the southwestern United States, Mexico, and parts of Central and South America. *Coccidioides* can live for long periods of time in soil under harsh environmental conditions including heat, cold, and drought.[7] *Coccidioides* can be released into the air when soil containing the fungus is disturbed, either by strong winds or activities such as farming or construction. Distribution of the fungus is typically patchy, but in some "hot spots," up to 70% of the human population has been infected.

The number of reported Valley Fever cases in the U.S. has risen from less than 5,000 in 2001 to more than 20,000 cases in 2011.[8] An estimated 150,000 more cases go undiagnosed every year. The majority of reported cases are located in Arizona and California.[9] The California Department of Public Health 2015 Yearly Summary report, reported 107 cases in San Diego County. The reason for the recent increase in cases, however, is unclear. Dust storms in endemic areas are often followed by outbreaks of coccidioidomycosis. If the dust storms are severe, the fungal spores can be carried outside the endemic area into neighboring counties, where outbreaks follow.[10]

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[6] Coccidioidomycosis, Technical Fact Sheet, The Center for Food Security and Public Health, 2010. Accessed on June 12, 2013, from http://www.cfsph.iastate.edu/Factsheets/pdfs/coccidioidomycosis.pdf
[7] Coccidioidomycosis Fact Sheet, California Department of Public Health. Accessed on June 12, 2013, from http://www.cdph.ca.gov/HealthInfo/discond/Pages/Coccidioidomycosis.aspx.
[8] Centers for Disease Control and Prevention. December 2012. Fungal pneumonia: a silent epidemic Coccidioidomycosis (valley fever) Fact Sheet. Accessed on June 12, 2013, from http://www.cdc.gov/fungal/pdf/cocci-fact-sheet-sw-us-508c.pdf.
[9] Centers for Disease Control and Prevention. Increase in Reported Coccidioidomycosis – United States, 1998-2011. MMWR 2013;62: 217-221. Accessed on June 12, 2013, from http://www.cdc.gov/mmwr/pdf/wk/mm6212.pdf.
[10] Pappagianis, D. & H. Einstein. 1978. Tempest from Tehachapi takes toll or Coccidioides immitis conveyed aloft and afar. West J. Med. 129: 527–530.

The Draft EIS/EIR should assess potential exposures to the fungus, *Coccidioides*, and susceptibilities of workers and nearby residents to Valley Fever due to soil-disturbing activities of the project. Mitigation or prevention measures that may be used to protect workers and nearby residents should also be described.

Cumulative and Indirect Impacts

The cumulative impacts analysis should identify how resources, ecosystems, and communities in the vicinity of the project have already been, or will be, affected by past, present, or future activities in the project area. These resources should be characterized in terms of their response to change and capacity to withstand stresses. Trends data should be used to establish a baseline for the affected resources, to evaluate the significance of historical degradation, and to predict the environmental effects of the project components.

For the cumulative impacts assessment, we recommend focusing on resources of concern or resources that are "at risk" and/or are significantly impacted by the proposed project, before mitigation. For this project, Reclamation should conduct a thorough assessment of the cumulative impacts to aquatic and biological resources, especially in the context of the other developments occurring and proposed in the area.

The EPA assisted in the preparation of a guidance document for assessing cumulative impacts in California that we find to be very useful. While this guidance was prepared for transportation projects in California, the principles and the 8-step process outlined therein can be applied to other types of projects and offers a systematic way to analyze cumulative impacts for a project. The guidance is available at: http://www.dot.ca.gov/ser/cumulative_guidance/purpose.htm. In accordance with this guidance, the EPA recommends that the Draft EIS/EIR identify which resources are analyzed, which ones are not, and why. For each resource analyzed, the Draft EIS/EIR should:

- Identify the current condition of the resource as a measure of past impacts. For example, the percentage of species habitat lost to date.
- Identify the trend in the condition of the resource as a measure of present impacts. For example, the health of the resource is improving, declining, or in stasis.
- Identify all on-going, planned, and reasonably foreseeable projects in the study area, including all phases of the Pure Water Program, which may contribute to cumulative impacts.
- Identify the future condition of the resource based on an analysis of impacts from reasonably foreseeable projects or actions added to existing conditions and current trends.
- Assess the cumulative impacts contribution of the proposed alternatives to the long-term health of the resource, and provide a specific measure for the projected impact from the proposed alternatives.
- When cumulative impacts are identified for a resource, mitigation should be proposed.
- Disclose the parties that would be responsible for avoiding, minimizing, and mitigating those adverse impacts.
- Identify opportunities to avoid and minimize impacts, including working with other entities.

The Draft EIS/EIR should consider the cumulative impacts associated with other development projects proposed in the area and the potential impacts on various resources including: water supply, endangered species, and habitat.

The Draft EIS/EIR should quantify cumulative impacts across resources areas, as well as describe and evaluate feasible mitigation measures to avoid and minimize the identified adverse cumulative impacts. Although these mitigation measures may be outside the jurisdiction of the lead agency or project proponents, describing them in the Draft EIS/EIR would serve to alert other agencies or officials who can implement these extra measures (CEQ 40 Questions No. 19(b)).

NATIVE AMERICAN HERITAGE COMMISSION
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August 10, 2016

Mark Brunette
City of San Diego
1222 First Avenue, MS-501
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sent via e-mail:
DSDEAS@sandiego.gov

RE: SCH# 2016081016; Pure Water San Diego Program, North City EIR/EIS (PTS No. 477184) Project, Notice of Preparation for Draft Environmental Impact Report, San Diego County, California

Dear Mr. Brunette:

The Native American Heritage Commission has received the Notice of Preparation (NOP) for the project referenced above. The California Environmental Quality Act (CEQA) (Pub. Resources Code § 21000 et seq.), specifically Public Resources Code section 21084.1, states that a project that may cause a substantial adverse change in the significance of an historical resource is a project that may have a significant effect on the environment. (Pub. Resources Code § 21084.1; Cal. Code Regs., tit.14, § 15064.5 (b) (CEQA Guidelines Section 15064.5 (b)). If there is substantial evidence, in light of the whole record before a lead agency, that a project may have a significant effect on the environment, an environmental impact report (EIR) shall be prepared. (Pub. Resources Code § 21080 (d); Cal. Code Regs., tit. 14, § 15064 subd.(a)(1) (CEQA Guidelines § 15064 (a)(1)). In order to determine whether a project will cause a substantial adverse change in the significance of a historical resource, a lead agency will need to determine whether there are historical resources with the area of project effect (APE).

CEQA was amended significantly in 2014. Assembly Bill 52 (Gatto, Chapter 532, Statutes of 2014) (AB 52) amended CEQA to create a **separate category of cultural resources**, "tribal cultural resources" (Pub. Resources Code § 21074) and provides that a project with an effect that may cause a substantial adverse change in the significance of a tribal cultural resource is a project that may have a significant effect on the environment. (Pub. Resources Code § 21084.2). Public agencies shall, when feasible, avoid damaging effects to any tribal cultural resource. (Pub. Resources Code § 21084.3 (a)). **AB 52 applies to any project for which a notice of preparation or a notice of negative declaration or mitigated negative declaration is filed on or after July 1, 2015.** If your project involves the adoption of or amendment to a general plan or a specific plan, or the designation or proposed designation of open space, on or after March 1, 2005, it may also be subject to Senate Bill 18 (Burton, Chapter 905, Statutes of 2004) (SB 18). **Both SB 18 and AB 52 have tribal consultation requirements.** If your project is also subject to the federal National Environmental Policy Act (42 U.S.C. § 4321 et seq.) (NEPA), the tribal consultation requirements of Section 106 of the National Historic Preservation Act of 1966 (154 U.S.C. 300101, 36 C.F.R. § 800 et seq.) may also apply.

The NAHC recommends **lead agencies consult with all California Native American tribes** that are traditionally and culturally affiliated with the geographic area of your proposed project as early as possible in order to avoid inadvertent discoveries of Native American human remains and best protect tribal cultural resources. Below is a brief summary of portions of AB 52 and SB 18 as well as the NAHC's recommendations for conducting cultural resources assessments. **Consult your legal counsel about compliance with AB 52 and SB 18 as well as compliance with any other applicable laws.**

AB 52

AB 52 has added to CEQA the additional requirements listed below, along with many other requirements:

1. Fourteen Day Period to Provide Notice of Completion of an Application/Decision to Undertake a Project: Within fourteen (14) days of determining that an application for a project is complete or of a decision by a public agency to undertake a project, a **lead agency** shall provide formal notification to a designated contact of, or tribal representative of, traditionally and culturally affiliated California Native American tribes that have requested notice, to be accomplished by at least one written notice that includes:
    a. A brief description of the project.
    b. The lead agency contact information.
    c. Notification that the California Native American tribe has 30 days to request consultation. (Pub. Resources Code § 21080.3.1 (d)).
    d. A "California Native American tribe" is defined as a Native American tribe located in California that is on the contact list maintained by the NAHC for the purposes of Chapter 905 of Statutes of 2004 (SB 18). (Pub. Resources Code § 21073).

2. Begin Consultation Within 30 Days of Receiving a Tribe's Request for Consultation and Before Releasing a Negative Declaration, Mitigated Negative Declaration, or Environmental Impact Report: A **lead agency** shall begin the consultation process within 30 days of receiving a request for consultation from a California Native American tribe that is traditionally and culturally affiliated with the geographic area of the proposed project. (Pub. Resources Code § 21080.3.1, subds. (d) and (e)) and prior to the release of a negative declaration, mitigated negative declaration or environmental impact report. (Pub. Resources Code § 21080.3.1(b)).
   - **a.** For purposes of AB 52, "consultation shall have the same meaning as provided in Gov. Code § 65352.4 (SB 18). (Pub. Resources Code § 21080.3.1 (b)).

3. Mandatory Topics of Consultation If Requested by a Tribe: The following topics of consultation, if a tribe requests to discuss them, are mandatory topics of consultation:
   - **a.** Alternatives to the project.
   - **b.** Recommended mitigation measures.
   - **c.** Significant effects. (Pub. Resources Code § 21080.3.2 (a)).

4. Discretionary Topics of Consultation: The following topics are discretionary topics of consultation:
   - **a.** Type of environmental review necessary.
   - **b.** Significance of the tribal cultural resources.
   - **c.** Significance of the project's impacts on tribal cultural resources.
   - **d.** If necessary, project alternatives or appropriate measures for preservation or mitigation that the tribe may recommend to the lead agency. (Pub. Resources Code § 21080.3.2 (a)).

5. Confidentiality of Information Submitted by a Tribe During the Environmental Review Process: With some exceptions, any information, including but not limited to, the location, description, and use of tribal cultural resources submitted by a California Native American tribe during the environmental review process shall not be included in the environmental document or otherwise disclosed by the lead agency or any other public agency to the public, consistent with Government Code sections 6254 (r) and 6254.10. Any information submitted by a California Native American tribe during the consultation or environmental review process shall be published in a confidential appendix to the environmental document unless the tribe that provided the information consents, in writing, to the disclosure of some or all of the information to the public. (Pub. Resources Code § 21082.3 (c)(1)).

6. Discussion of Impacts to Tribal Cultural Resources in the Environmental Document: If a project may have a significant impact on a tribal cultural resource, the lead agency's environmental document shall discuss both of the following:
   - **a.** Whether the proposed project has a significant impact on an identified tribal cultural resource.
   - **b.** Whether feasible alternatives or mitigation measures, including those measures that may be agreed to pursuant to Public Resources Code section 21082.3, subdivision (a), avoid or substantially lessen the impact on the identified tribal cultural resource. (Pub. Resources Code § 21082.3 (b)).

7. Conclusion of Consultation: Consultation with a tribe shall be considered concluded when either of the following occurs:
   - **a.** The parties agree to measures to mitigate or avoid a significant effect, if a significant effect exists, on a tribal cultural resource; or
   - **b.** A party, acting in good faith and after reasonable effort, concludes that mutual agreement cannot be reached. (Pub. Resources Code § 21080.3.2 (b)).

8. Recommending Mitigation Measures Agreed Upon in Consultation in the Environmental Document: Any mitigation measures agreed upon in the consultation conducted pursuant to Public Resources Code section 21080.3.2 shall be recommended for inclusion in the environmental document and in an adopted mitigation monitoring and reporting program, if determined to avoid or lessen the impact pursuant to Public Resources Code section 21082.3, subdivision (b), paragraph 2, and shall be fully enforceable. (Pub. Resources Code § 21082.3 (a)).

9. Required Consideration of Feasible Mitigation: If mitigation measures recommended by the staff of the lead agency as a result of the consultation process are not included in the environmental document or if there are no agreed upon mitigation measures at the conclusion of consultation, or if consultation does not occur, and if substantial evidence demonstrates that a project will cause a significant effect to a tribal cultural resource, the lead agency shall consider feasible mitigation pursuant to Public Resources Code section 21084.3 (b). (Pub. Resources Code § 21082.3 (e)).

10. Examples of Mitigation Measures That, If Feasible, May Be Considered to Avoid or Minimize Significant Adverse Impacts to Tribal Cultural Resources:
    - **a.** Avoidance and preservation of the resources in place, including, but not limited to:
      - i. Planning and construction to avoid the resources and protect the cultural and natural context.

    ii. Planning greenspace, parks, or other open space, to incorporate the resources with culturally appropriate protection and management criteria.
  b. Treating the resource with culturally appropriate dignity, taking into account the tribal cultural values and meaning of the resource, including, but not limited to, the following:
    i. Protecting the cultural character and integrity of the resource.
    ii. Protecting the traditional use of the resource.
    iii. Protecting the confidentiality of the resource.
  c. Permanent conservation easements or other interests in real property, with culturally appropriate management criteria for the purposes of preserving or utilizing the resources or places.
  d. Protecting the resource. (Pub. Resource Code § 21084.3 (b)).
  e. Please note that a federally recognized California Native American tribe or a nonfederally recognized California Native American tribe that is on the contact list maintained by the NAHC to protect a California prehistoric, archaeological, cultural, spiritual, or ceremonial place may acquire and hold conservation easements if the conservation easement is voluntarily conveyed. (Civ. Code § 815.3 (c)).
  f. Please note that it is the policy of the state that Native American remains and associated grave artifacts shall be repatriated. (Pub. Resources Code § 5097.991).

11. Prerequisites for Certifying an Environmental Impact Report or Adopting a Mitigated Negative Declaration or Negative Declaration with a Significant Impact on an Identified Tribal Cultural Resource: An environmental impact report may not be certified, nor may a mitigated negative declaration or a negative declaration be adopted unless one of the following occurs:
  a. The consultation process between the tribes and the lead agency has occurred as provided in Public Resources Code sections 21080.3.1 and 21080.3.2 and concluded pursuant to Public Resources Code section 21080.3.2.
  b. The tribe that requested consultation failed to provide comments to the lead agency or otherwise failed to engage in the consultation process.
  c. The lead agency provided notice of the project to the tribe in compliance with Public Resources Code section 21080.3.1 (d) and the tribe failed to request consultation within 30 days. (Pub. Resources Code § 21082.3 (d)).

  This process should be documented in the Cultural Resources section of your environmental document.

The NAHC's PowerPoint presentation titled, "Tribal Consultation Under AB 52: Requirements and Best Practices" may be found online at: http://nahc.ca.gov/wp-content/uploads/2015/10/AB52TribalConsultation_CalEPAPDF.pdf

SB 18

SB 18 applies to local governments and requires **local governments** to contact, provide notice to, refer plans to, and consult with tribes prior to the adoption or amendment of a general plan or a specific plan, or the designation of open space. (Gov. Code § 65352.3). Local governments should consult the Governor's Office of Planning and Research's "Tribal Consultation Guidelines," which can be found online at: https://www.opr.ca.gov/docs/09_14_05_Updated_Guidelines_922.pdf

Some of SB 18's provisions include:

1. Tribal Consultation: If a local government considers a proposal to adopt or amend a general plan or a specific plan, or to designate open space it is required to contact the appropriate tribes identified by the NAHC by requesting a "Tribal Consultation List." If a tribe, once contacted, requests consultation the local government must consult with the tribe on the plan proposal. **A tribe has 90 days from the date of receipt of notification to request consultation unless a shorter timeframe has been agreed to by the tribe.** (Gov. Code § 65352.3 (a)(2)).
2. No Statutory Time Limit on SB 18 Tribal Consultation. There is no statutory time limit on SB 18 tribal consultation.
3. Confidentiality: Consistent with the guidelines developed and adopted by the Office of Planning and Research pursuant to Gov. Code section 65040.2, the city or county shall protect the confidentiality of the information concerning the specific identity, location, character, and use of places, features and objects described in Public Resources Code sections 5097.9 and 5097.993 that are within the city's or county's jurisdiction. (Gov. Code § 65352.3 (b)).
4. Conclusion of SB 18 Tribal Consultation: Consultation should be concluded at the point in which:
  a. The parties to the consultation come to a mutual agreement concerning the appropriate measures for preservation or mitigation; or
  b. Either the local government or the tribe, acting in good faith and after reasonable effort, concludes that mutual agreement cannot be reached concerning the appropriate measures of preservation or mitigation. (Tribal Consultation Guidelines, Governor's Office of Planning and Research (2005) at p. 18).

Agencies should be aware that neither AB 52 nor SB 18 precludes agencies from initiating tribal consultation with tribes that are traditionally and culturally affiliated with their jurisdictions before the timeframes provided in AB 52 and SB 18. For that reason, we urge you to continue to request Native American Tribal Contact Lists and "Sacred Lands File" searches from the NAHC. The request forms can be found online at: http://nahc.ca.gov/resources/forms/

NAHC Recommendations for Cultural Resources Assessments

To adequately assess the existence and significance of tribal cultural resources and plan for avoidance, preservation in place, or barring both, mitigation of project-related impacts to tribal cultural resources, the NAHC recommends the following actions:

1. Contact the appropriate regional California Historical Research Information System (CHRIS) Center (http://ohp.parks.ca.gov/?page_id=1068) for an archaeological records search. The records search will determine:
   - **a.** If part or all of the APE has been previously surveyed for cultural resources.
   - **b.** If any known cultural resources have been already been recorded on or adjacent to the APE.
   - **c.** If the probability is low, moderate, or high that cultural resources are located in the APE.
   - **d.** If a survey is required to determine whether previously unrecorded cultural resources are present.

2. If an archaeological inventory survey is required, the final stage is the preparation of a professional report detailing the findings and recommendations of the records search and field survey.
   - **a.** The final report containing site forms, site significance, and mitigation measures should be submitted immediately to the planning department. All information regarding site locations, Native American human remains, and associated funerary objects should be in a separate confidential addendum and not be made available for public disclosure.
   - **b.** The final written report should be submitted within 3 months after work has been completed to the appropriate regional CHRIS center.

3. Contact the NAHC for:
   - **a.** A Sacred Lands File search. Remember that tribes do not always record their sacred sites in the Sacred Lands File, nor are they required to do so. A Sacred Lands File search is not a substitute for consultation with tribes that are traditionally and culturally affiliated with the geographic area of the project's APE.
   - **b.** A Native American Tribal Consultation List of appropriate tribes for consultation concerning the project site and to assist in planning for avoidance, preservation in place, or, failing both, mitigation measures.

4. Remember that the lack of surface evidence of archaeological resources (including tribal cultural resources) does not preclude their subsurface existence.
   - **a.** Lead agencies should include in their mitigation and monitoring reporting program plan provisions for the identification and evaluation of inadvertently discovered archaeological resources per Cal. Code Regs., tit. 14, section 15064.5(f) (CEQA Guidelines section 15064.5(f)). In areas of identified archaeological sensitivity, a certified archaeologist and a culturally affiliated Native American with knowledge of cultural resources should monitor all ground-disturbing activities.
   - **b.** Lead agencies should include in their mitigation and monitoring reporting program plans provisions for the disposition of recovered cultural items that are not burial associated in consultation with culturally affiliated Native Americans.
   - **c.** Lead agencies should include in their mitigation and monitoring reporting program plans provisions for the treatment and disposition of inadvertently discovered Native American human remains. Health and Safety Code section 7050.5, Public Resources Code section 5097.98, and Cal. Code Regs., tit. 14, section 15064.5, subdivisions (d) and (e) (CEQA Guidelines section 15064.5, subds. (d) and (e)) address the processes to be followed in the event of an inadvertent discovery of any Native American human remains and associated grave goods in a location other than a dedicated cemetery.

Please contact me if you need any additional information at gayle.totton@nahc.ca.gov.

Sincerely,

Gayle Totton

Gayle Totton, M.A., PhD.
Associate Governmental Program Analyst

cc: State Clearinghouse

Department of Toxic Substances Control

Matthew Rodriquez
Secretary for
Environmental Protection

Barbara A. Lee, Director
5796 Corporate Avenue
Cypress, California 90630

Edmund G. Brown Jr.
Governor

August 18, 2016

Mr. Mark Brunette
Senior Environmental Planner
City of San Diego Development Services Department
1222 First Avenue, MS 501
San Diego, California 92101

NOTICE OF PREPARATION (NOP) FOR PURE WATER SAN DIEGO PROGRAM, ENVIRONMENTAL IMPACT REPORT, NORTH CITY PROJECT EIR/EIS 499621 (SCH# 21003699)

Dear Brunette:

The Department of Toxic Substances Control (DTSC) has received your submitted document for the subject project. As stated in your document: "The Pure Water Program is a water and wastewater facilities plan to produce potable water from recycled water. The Pure Water Program consists of the design and construction of new advanced water treatment facilities, waste water treatment facilities, pump station, and pipelines."

Based on the review of the submitted document DTSC has the following comments:

1. The Environmental Impact Report (EIR) should identify and determine whether current or historic uses at the project site may have resulted in any release of hazardous wastes/substances.

2. The EIR should identify any known or potentially contaminated sites within the proposed project area. For all identified sites, the EIR should evaluate whether conditions at the site may pose a threat to human health or the environment.

3. If during construction/demolition of the project, soil and/or groundwater contamination is suspected, construction/demolition in the area should be ceased and appropriate health and safety procedures should be implemented and appropriate government agency be notified.

If you have any questions regarding this letter, please contact me at (714) 484-5476 or email at Johnson.Abraham@dtsc.ca.gov.

Sincerely,

Johnson P. Abraham
Project Manager
Brownfields Restoration and School Evaluation Branch
Brownfields and Environmental Restoration Program - Cypress

cc: Governor's Office of Planning and Research (via e-mail)
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P.O. Box 3044
Sacramento, California 95812-3044

CEQA Tracking Center
Department of Toxic Substances Control
Office of Environmental Planning and Analysis
1001 I Street, 22nd Floor, M.S. 22-2
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Mr. Guenther W. Moskat, Chief (via e-mail)
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CEQA# 21003699

DEPARTMENT OF TRANSPORTATION
DISTRICT 11, DIVISION OF PLANNING
4050 TAYLOR ST, M.S. 240
SAN DIEGO, CA 92110
PHONE (619) 688-6960
FAX (619) 688-4299
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August 24, 2016

11-SD-VAR
Pure Water San Diego Program
North City Project
Notice of Preparation
SCH # 2016081016
PTS No. 499621

Mr. Mark Brunette
City of San Diego
1222 First Avenue, MS-501
San Diego, CA 92101

Dear Mr. Brunette:

The California Department of Transportation (Caltrans) has reviewed the Notice of Preparation (NOP) for the Pure Water San Diego Program North City Project (PTS No. 499621). Caltrans has the following comments:

Caltrans policy with regard to freeway and expressways is to exclude utilities from within access controlled highway rights-of-way (R/W), to the extent practicable. Requests for utility encroachment or utility access within freeway or expressway R/W are considered an exception to policy and are to be submitted to the Division Chief of the Division of Design (DOD, Chief) for approval. See the PDPM, Chapter 17 for Caltrans policy and justification for exceptions to policy.

http://www.dot.ca.gov/hq/oppd/pdpm/chap_pdf/chapt17.pdf

Caltrans recommends that the environmental documents for this project specifically identify the potential for any environmental impacts to Caltrans facilities, highways and resources that are within the state R/W, and describe measures to avoid, minimize, or mitigate those impacts. This includes identifying all utility work within Caltrans' R/W, as well as traffic control plans.

Storm Water Compliance:
The City proposes trenchless methods which is largely dependent upon the anticipated ground conditions. Trenchless methods typically require excavation of jacking and receiving pits with shoring and bracing system. The construction footprint at grade is heavily dependent of the selected method and contractor's decisions on staging, means and methods. Steel pipes are typically required for Caltrans highways and railroads crossings.

Hazardous Waste/Materials:
Any work done within our R/W that proposes to disturb unpaved soil may get into elevated or hazardous levels of Aerially Deposited Lead (ADL). Prior to disturbance, they would need to complete an ADL study.

Any work performed within Caltrans R/W will require discretionary review and approval by Caltrans and an encroachment permit will be required for any work within the Caltrans R/W prior to construction.

As part of the encroachment permit process, the applicant must provide an approval final environmental document including the California Environmental Quality Act (CEQA) determination addressing any environmental impacts within the Caltrans' R/W, and any corresponding technical studies. If these materials are not included with the encroachment permit application, the applicant will be required to acquire and provide these to Caltrans before the permit application will be accepted. Identification of avoidance and/or mitigation measures will be a condition of the encroachment permit approval as well as procurement of any necessary regulatory and resource agency permits. Encroachment permit submittals that are incomplete can result in significant delays in permit approval.

If you have any questions, or require further information, please contact Vanessa De La Rosa at (619)688-4289 or email at Vanessa.DeLaRosa@dot.ca.gov.

Sincerely,

JACOB ARMSTRONG, Branch Chief
Development Review Branch

State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
South Coast Region
3883 Ruffin Road
San Diego, CA 92123
(858) 467-4201
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EDMUND G. BROWN JR., Governor
CHARLTON H. BONHAM, Director

September 1, 2016

Mark Brunette, Senior Environmental Planner
City of San Diego Development Services Department
1222 First Avenue, MS 501
San Diego, CA 92101
DSDEAS@sandiego.gov

Subject: Comments on the Notice of Preparation of a Draft Environmental Impact Report for the Pure Water San Diego Program, North City Project EIR/EIS Project Number 499621; SCH# 2016081016

Dear Mr. Brunette:

The California Department of Fish and Wildlife (CDFW) has reviewed the above-referenced Notice of Preparation (NOP) for the Pure Water Program, North City Project (proposed project) Draft Environmental Impact Report (DEIR).

Thank you for the opportunity to provide comments and recommendations regarding those activities involved in the Project that may affect California fish and wildlife. Likewise, we appreciate the opportunity to provide comments regarding those aspects of the Project that CDFW, by law, may be required to carry out or approve through the exercise of its own regulatory authority under the Fish and Game Code.

CDFW ROLE

CDFW is California's Trustee Agency for fish and wildlife resources, and holds those resources in trust by statute for all the people of the State. (Fish & G. Code, §§ 711.7, subd. (a) & 1802; Pub. Resources Code, § 21070; CEQA Guidelines § 15386, subd. (a).) CDFW, in its trustee capacity, has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and habitat necessary for biologically sustainable populations of those species. (*Id.*, § 1802.) Similarly for purposes of CEQA, CDFW is charged by law to provide, as available, biological expertise during public agency environmental review efforts, focusing specifically on projects and related activities that have the potential to adversely affect fish and wildlife resources.

CDFW is also a Responsible Agency under CEQA. (Pub. Resources Code, § 21069; CEQA Guidelines, § 15381.) CDFW may need to exercise regulatory authority as provided by the Fish and Game Code. As proposed, for example, the Project may be subject to CDFW's lake and streambed alteration regulatory authority. (Fish & G. Code, § 1600 et seq.) Likewise, to the extent implementation of the Project as proposed may result in "take" as defined by State law of any species protected under the California Endangered Species Act (CESA) (Fish & G. Code, § 2050 et seq.), related authorization as provided by the Fish and Game Code will be required.

CDFW also administers the Natural Community Conservation Planning (NCCP) program. The City of San Diego (City) participates in the NCCP program by implementing its' approved Multiple Species Conservation Program (MSCP) Subarea Plan (SAP).

Project Location: The proposed project would include a variety of facilities located throughout the central coastal areas of San Diego County in the North City geographic area. The new advanced water purification facility, proposed pipelines and three pump stations would be located within the corporate boundaries of the City. Potential electrical transmission facilities would traverse federal lands within Marine Corps Air Station (MCAS) Miramar.

Project Description/ Objective: The objective of the project is to create 83 million gallons per day (MGD) of locally controlled drinking water, reducing inflows to the Point Loma Wastewater Treatment Plant, which would ultimately reduce total suspended solids discharged while recycling water that is currently discharged to the ocean. Primary project activities include two phases over a 20-year period. The Pure Water Program facilities are grouped into geographical areas to facilitate delivery: North City, Central Area, and South Bay. The proposed project would consist of the design and construction of new advanced water treatment facilities, wastewater treatment facilities, pump stations, transmission lines, and pipelines. Phase one of the proposed project includes:

<u>North City Water Reclamation Plant Expansion</u>. The North City Water Reclamation Plant would be expanded from its current treatment capacity of 30 MGD to 52 million MGD. To increase capacity, a number of new process units and tankage would be required. Process units requiring expansion would consist of influent screening, primary sedimentation, flow equalization, aeration basins, secondary clarification, and tertiary filtration. A new influent pump station would be located at the reclamation plant site and would pump tertiary effluent via a pipeline across Eastgate Mall Road connecting the reclamation plant to the purification facility. Additional wastewater flows to the expanded plant would be delivered from the new Morena Pump Station and wastewater force main.

<u>North City Pure Water Facility</u>. The new North City Pure Water Facility would be located on the vacant lot owned by the City of San Diego, across Eastgate Mall Road to the north of the existing water reclamation plant and would be designed to produce 30 MGD of purified water. The water purification facility would use multiple treatment processes including an ozone system, biological activated carbon filtration, membrane filtration, reverse osmosis and ultraviolet/advanced oxidation process, before it is stabilized and chlorinated prior to being pumped out to the Miramar Reservoir.

<u>North City Pure Water Pump Station and Pipeline</u> A new pump station and a purified water pipeline would be needed to convey the purified water produced at the North City Pure Water Facility to the Miramar Reservoir.

<u>Morena Pump Station, Wastewater Force Main, and Brine Conveyance</u>. To use the proposed expanded capacity of the water reclamation plant, additional wastewater flows that would normally be conveyed to the Point Loma Wastewater Treatment Plant would be diverted to the North City Water Reclamation Plant to be recycled. The Morena Pump Station is proposed to be located near the intersection of Friars Road and Interstate 5 to collect wastewater flows from a combination of trunk sewers and sewer interceptors to pump the diverted flows to the reclamation plant through a new wastewater force main. Additional brine from the reverse

osmosis process at the water purification facility would be conveyed via a gravity flow line back to the proposed Morena Pump Station in the same corridor as the wastewater force main. The brine line would discharge downstream of the diversion structures back to into the sewer system.

Electrical Transmission. A new electrical transmission line is proposed to connect the North City Water Reclamation Plant to the future cogeneration facility at the Metropolitan Biosolids Center to deliver power to North City Project components. The electrical transmission line would cross MCAS Miramar property and require approval by the United States Marine Corps.

Metropolitan Biosolids Center Improvements. Process improvements would be required for handling future flows from the expanded North City Water Reclamation Plant. These improvements would upsize existing equipment and provide additional units to handle the increased flows. Improvements may include replacement of raw solids feed pumps, expansion of the grit removal facility, installation of one new grit separator, and installation of one new clarifier, snail, and screw conveyor.

COMMENTS AND RECOMMENDATIONS

CDFW offers the following comments and recommendations to assist the City in adequately identifying and/or mitigating the project's significant, or potentially significant, direct and indirect impacts on fish and wildlife (biological) resources.

Specific Comments

Feasible Project Alternatives

1. Given the geographic reach and varied habitat types traversed by the proposed project, it is critical that the DEIR provide a range of alternatives to the proposed project alignment. At the time of the NOP, only one alternative is identified, Alternative A, which utilizes the San Vincente Reservoir rather than Miramar Reservoir for treated water storage. The NOP does not provide alternative locations or alignments associated with the pipelines, pump stations, or transmission lines. The DEIR should present a range of feasible alternatives which, at a minimum, include alternative alignments designed to avoid and minimize project impacts. The DEIR should include a comparative discussion of each alignment alternative and the merits and detractors of each proposal. Alignments should focus on minimizing impacts to biological resources and, to the maximum extent feasible, conform to City Environmentally Sensitive Lands (ESL) regulations section 143.0150. In addition to the ESL regulations and CEQA tenets of avoiding and minimizing impacts, Council Policy number 600-13 and 600-14 (City of San Diego, 2002) make clear it is in the City's best interest to minimize public utility impacts to canyons and ESL to minimize environmental impacts, while concurrently facilitating routine and timely maintenance. While Council Policies 600-13 and 600-14 specifically address sewer lines, the same principles of minimizing environmental impacts and improving facility access apply to water distribution facilities and should be analyzed with respect to proposed project.

2. In an effort to minimize the proposed project's impacts to biological resources, the DEIR should focus on alternatives that collocate pipelines, transmission lines, lift stations and other project features with existing infrastructure including but not limited to roadways, and

disturbed utility right-of-ways (ROW). According to the NOP, the first phase (North City) of the proposed project is anticipated to be completed in 2021; thus sufficient time remains to negotiate easements, ROWs, and encroachments to collocate the proposed project with existing infrastructure, outside of Multi-Habitat Planning Area (MHPA).

Project Figures and Maps

3. The DEIR should include project figures depicting the location of the proposed project and specific infrastructure in relation to MHPA and other biological resources. Project figures should be appropriately scaled and include a figure depicting the entirety of the proposed project within the regional context and large scale maps for each alignment. The maps should complement each other allowing the reader to quickly cross reference the small scale maps with the large scale maps depicting site-specific biological resources such that "[t]he location and extent of each resource must be clearly identified on a map of an appropriate scale (same scale as development drawings), on which the acreage of each vegetation community must be provided" (City Biological Guidelines, 2012). CDFW requests that these maps and the project alignments be provided to us in either an ESRI shape file or ESRI geodatabase.

Project Purpose and Need

4. The purpose and need for the Morena Pump Station and associated pipeline should be clearly articulated in the DEIR. While the NOP cites that "...[t]o use the proposed expanded capacity of the water reclamation plant, additional wastewater flows that would normally be conveyed to the Point Loma Wastewater Treatment Plant would be diverted to the North City Water Reclamation Plant to be recycled" it is not clear if the expanded capacity of the water reclamation plant could not be leveraged utilizing nearer wastewater sources that require no or fewer impacts to natural habitats associated with pipeline infrastructure.

5. Similarly, the DEIR should analyze alternative sources of energy using existing or readily upgradeable infrastructure. If the Metropolitan Biosolids Center's electrical demand cannot be met with existing transmission lines, the DEIR should evaluate the existing transmission infrastructure (e.g., transmission towers and other physical structures) for improvements to accommodate a new transmission line without the need for ground disturbing activities, easement acquisition, or right of way acquisition. Should the DEIR find that existing transmission towers cannot be upgraded due to physical design limitations, the DEIR should analyze an underground transmission alternative.

Recreational Fisheries

6. The programmatic environmental impact report (PEIR; SCH # 2014111068), which the current DEIR for the proposed project tiers from, states on page 11-20 'If...Miramar Reservoir and Lake Murray were converted to primarily purified water reservoirs, impacts could result to the fisheries supported by the reservoir, resulting in indirect impacts to recreation.' The PEIR identifies that the Pure Water Program could result in indirect impacts to recreational fishing at Miramar Reservoir. Accordingly, the DEIR should address these potential impacts and provide an analysis of the proposed project's effect on recreational angling at Miramar Reservoir and how those affects will be mitigated. We are concerned that the project's proposal to introduce 30 MGD of treated water (by year 2021) will negatively

impact fishery resources by reducing nutrient availability. Miramar Reservoir already suffers from decreased nutrients in the water as a result of quagga mussels (*Dreissena rostriformis bugensis*). Quagga mussels are prolific breeders and filter feeders, which can quickly eliminate the planktonic food sources of juvenile game fish and the forage species on which adult fish rely (Loomis et al. 2011.) A single quagga mussel can filter between 3 to 7 gallons per day (Link, 2010). The introduction of purified, nutrient deficient, treated water will result in a lower concentration of nutrients in the reservoir and is likely to increase competition between mussels and resident fish species for nutrients and resources (e.g., phytoplankton and diatoms). Nutrient deficient waters decrease juvenile recruitment of game fish and planktivorous fish that will reduce fish size and abundance in greater trophic levels. Furthermore, the introduction of nutrient deficient waters may lead to a decrease in avian resources at Miramar Reservoir if fisheries resources decline as ospreys, grebes, cormorants, herons, and others species would have difficulty finding sufficient prey species.

Miramar Reservoir has a long history of producing trophy largemouth bass with five of the top 25 bass in the world caught at Miramar (sdfish.com), the largest weighing 20.9 lbs. In 2014, two 16 pound largemouth bass were caught. At the request of the City's constituents CDFW stocks rainbow trout in the reservoir to improve fishing opportunities. CDFW gages reservoir fishing success by examining the catch-per-unit effort (CPUE), typically expressed in number of fish caught per hour fished. CDFW seeks to attain CPUEs of 1.0 fish per hour or greater. A reservoir fishery is classified as good to excellent if the CPUE is 1.0 fish per hour or greater, fair to good if the CPUE is 0.5 to 1.0 fish per hour, and poor to fair if the CPUE is 0.0 to 0.5 fish per hour. In 2014, CDFW surveyed 38 anglers at Miramar Reservoir; the CPUE was 0.9 fish per hour, which would classify fishing in this reservoir as fair to good (CDFW file report).

CDFW is concerned with the proposed project's potential to result in Miramar Reservoir (or any other recreational fishery reservoir) becoming oligotrophic or nutrient deficient, which will negatively impact the aquatic resources in the lake. To understand the potential negative aquatic impacts the City should demonstrate that the treated water has sufficient nutrient concentrations to maintain current fisheries populations and that the water storage time is sufficient to allow for those nutrients to be adequately stored in the reservoir.

To mitigate for the loss of aquatic resources the City should investigate the following mitigation options: 1) supplemental fish stocking; 2) create and maintain fish habitat (e.g., woody debris, brush shelters); 3) increase nutrient loading (e.g., reservoir seeding); and 4) adjust facility treatment levels to allow more nutrients to be deposited in Miramar Reservoir. CDFW recommends that a recreational angling monitoring and management plan be identified within the DEIR as a condition of project approval. An appropriate monitoring program needs to have record of environmental indicators (data that are scientific, practical, and applicable to the program). Indicators should have the following qualities that are: measurable/quantitative, sensitive to perturbation, discriminatory, accurate, and referential to a benchmark or baseline. With the establishment of measurable and quantifiable indicators, an appropriate baseline of conditions can be used as a reference to which all future data can be compared.

General Comments

Lake and Streambeds

7. CDFW has responsibility for wetland and riparian habitats. It is the policy of CDFW to strongly discourage development in wetlands or conversion of wetlands to uplands. We oppose any development or conversion which would result in a reduction of wetland acreage or wetland habitat values, unless, at a minimum, project mitigation assures there will be "no net loss" of either wetland habitat values or acreage. Development and conversion include but are not limited to conversion to subsurface drains, placement of fill or building of structures within the wetland, and channelization or removal of materials from the streambed. All wetlands and watercourses, whether ephemeral, intermittent, or perennial, should be retained and provided with substantial setbacks which preserve the riparian and aquatic values and maintain their value to on-site and off-site wildlife populations. Mitigation measures to compensate for impacts to mature riparian corridors must be included in the DEIR and must compensate for the loss of function and value of a wildlife corridor.

    a) The CDFW also has regulatory authority over activities in streams and/or lakes that will divert or obstruct the natural flow, or change the bed, channel, or bank (which may include associated riparian resources) of any river, stream, or lake or use material from a river, stream, or lake. For any such activities, the project applicant (or "entity") must provide written notification to CDFW pursuant to section 1600 et seq. of the Fish and Game Code. Based on this notification and other information, CDFW determines whether a Lake and Streambed Alteration Agreement (LSA) with the applicant is required prior to conducting the proposed activities. CDFW's issuance of a LSA for a project that is subject to CEQA will require CEQA compliance actions by CDFW as a Responsible Agency. CDFW as a Responsible Agency under CEQA may consider the local jurisdiction's (lead agency) Negative Declaration or Environmental Impact Report for the project. To minimize additional requirements by CDFW pursuant to section 1600 *et seq.* and/or under CEQA, the document should fully identify the potential impacts to the stream or riparian resources and provide adequate avoidance, mitigation, monitoring and reporting commitments for issuance of the LSA.[1]

To enable CDFW to adequately review and comment on the proposed project from the standpoint of the protection of plants, fish, and wildlife, we recommend the following information be included in the DEIR. The document should contain a complete discussion of the purpose and need for, and description of, the proposed project, including all staging areas and access routes to the construction and staging areas.

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1 A notification package for a LSA may be obtained by accessing the Department's web site at www.wildlife.ca.gov/habcon/1600.

Biological Resources within the project's Area of Potential Effect

8. The document should provide a complete assessment of the flora and fauna within and adjacent to the project area, with particular emphasis upon identifying endangered, threatened, sensitive, and locally unique species and sensitive habitats. This should include a complete floral and faunal species compendium of the entire project site, undertaken at the appropriate time of year. The DEIR should include the following information.

   a) CEQA Guidelines, section 15125(c), specifies that knowledge on the regional setting is critical to an assessment of environmental impacts and that special emphasis should be placed on resources that are rare or unique to the region.

   b) A thorough, recent floristic-based assessment of special status plants and natural communities, following CDFW's Protocols for Surveying and Evaluating Impacts to Special Status Native Plant Populations and Natural Communities (see http://www.dfg.ca.gov/habcon/plant/). CDFW recommends that floristic, alliance-based and/or association-based mapping and vegetation impact assessments be conducted at the Project site and neighboring vicinity. The Manual of California Vegetation, second edition, should also be used to inform this mapping and assessment (Sawyer et al. 2008), or R.F. Holland codes per the SAP Bio Guidelines, attachment II).

   c) Adjoining habitat areas should be included in this assessment where site activities could lead to direct or indirect impacts offsite. Habitat mapping at the alliance level will help establish baseline vegetation conditions.

   d) A current inventory of the biological resources associated with each habitat type on site and within the area of potential effect. CDFW's California Natural Diversity Data Base in Sacramento should be contacted at www.wildlife.ca.gov/biogeodata/ to obtain current information on any previously reported sensitive species and habitat, including Significant Natural Areas identified under Chapter 12 of the Fish and Game Code.

   e) An inventory of rare, threatened, endangered and other sensitive species on site and within the area of potential effect. Species to be addressed should include all those which meet the CEQA definition (see CEQA Guidelines, § 15380). This should include sensitive fish, wildlife, reptile, and amphibian species. Seasonal variations in use of the project area should also be addressed. Focused species-specific surveys, conducted at the appropriate time of year and time of day when the sensitive species are active or otherwise identifiable, are required. Acceptable species-specific survey procedures should be developed in consultation with CDFW and the U.S. Fish and Wildlife Service.

Analyses of the Potential Project-Related Impacts on the Biological Resources

5. To provide a thorough discussion of direct, indirect, and cumulative impacts expected to adversely affect biological resources, with specific measures to offset such impacts, the following should be addressed in the DEIR.

   a) A discussion of potential adverse impacts from lighting, noise, human activity, exotic species, and drainage should also be included. The latter subject should address: project-related changes on drainage patterns on and downstream of the project site; the volume, velocity, and frequency of existing and post-project surface flows; polluted runoff; soil erosion and/or sedimentation in streams and water bodies; and post-project fate of runoff from the project site. The discussions should also address the proximity of the extraction activities to the water table, whether dewatering would be necessary, and the potential resulting impacts on the habitat, if any, supported by the groundwater. Mitigation measures proposed to alleviate such impacts should be included.

b) Discussions regarding indirect project impacts on biological resources, including resources in nearby public lands, open space, adjacent natural habitats, riparian ecosystems, and any designated and/or proposed or existing reserve lands (e.g., preserve lands associated with a NCCP). Impacts on, and maintenance of, wildlife corridor/movement areas, including access to undisturbed habitats in adjacent areas, should be fully evaluated in the DEIR.

c) The zoning of areas for development projects or other uses that are nearby or adjacent to natural areas may inadvertently contribute to wildlife-human interactions. A discussion of possible conflicts and mitigation measures to reduce these conflicts should be included in the environmental document.

d) A cumulative effects analysis should be developed as described under CEQA Guidelines, section 15130. General and specific plans, as well as past, present, and anticipated future projects, should be analyzed relative to their impacts on similar plant communities and wildlife habitats.

<u>Mitigation for Project-related Biological Impacts</u>

6. The DEIR should include measures to fully avoid and otherwise protect Rare Natural Communities from project-related impacts. CDFW considers these communities as threatened habitats having both regional and local significance.

7. The DEIR should include mitigation measures for adverse project-related impacts to sensitive plants, animals, and habitats. Mitigation measures should emphasize avoidance and reduction of project impacts. For unavoidable impacts, on-site habitat restoration or enhancement should be discussed in detail. If on-site mitigation is not feasible or would not be biologically viable and therefore not adequately mitigate the loss of biological functions and values, off-site mitigation through habitat creation and/or acquisition and preservation in perpetuity should be addressed.

8. For proposed preservation and/or restoration, the DEIR should include measures to perpetually protect the targeted habitat values from direct and indirect negative impacts. The objective should be to offset the project-induced qualitative and quantitative losses of wildlife habitat values. Issues that should be addressed include restrictions on access, proposed land dedications, monitoring and management programs, control of illegal dumping, water pollution, increased human intrusion, etc.

9. CDFW recommends that measures be taken to avoid project impacts to nesting birds. Migratory nongame native bird species are protected by international treaty under the Federal Migratory Bird Treaty Act (MBTA) of 1918 (Title 50, § 10.13, Code of Federal Regulations). Sections 3503.5 and 3513 of the California Fish and Game Code prohibit take

of all raptors and other migratory nongame birds and section 3503 prohibits take of the nests or eggs of all birds. Proposed project activities (including, but not limited to, staging and disturbances to native and nonnative vegetation, structures, and substrates) should occur outside of the avian breeding season which generally runs from February 1 to September 1 (as early as January 1 for some raptors) to avoid take of birds or their eggs. If avoidance of the avian breeding season is not feasible, CDFW recommends surveys by a qualified biologist with experience in conducting breeding bird surveys to detect protected native birds occurring in suitable nesting habitat that is to be disturbed and (as access to adjacent areas allows) any other such habitat within 300 feet of the disturbance area (within 500 feet for raptors). Project personnel, including all contractors working on site, should be instructed on the sensitivity of the area. Reductions in the nest buffer distance may be appropriate depending on the avian species involved, ambient levels of human activity, screening vegetation, or possibly other factors.

10. CDFW generally does not support the use of relocation, salvage, and/or transplantation as mitigation for impacts to rare, threatened, or endangered species. Studies have shown that these efforts are experimental in nature and largely unsuccessful.

11. Plans for restoration and revegetation should be prepared by persons with expertise in southern California ecosystems and native plant revegetation techniques. Each plan should include, at a minimum: (a) the location of the mitigation site; (b) the plant species to be used, container sizes, and seeding rates; (c) a schematic depicting the mitigation area; (d) planting schedule; (e) a description of the irrigation methodology; (f) measures to control exotic vegetation on site; (g) specific success criteria; (h) a detailed monitoring program; (i) contingency measures should the success criteria not be met; and (j) identification of the party responsible for meeting the success criteria and providing for conservation of the mitigation site in perpetuity.

CONCLUSION

CDFW appreciates the opportunity to comment on the NOP to assist the City in identifying and mitigating project impacts on biological resources. Questions regarding this letter or further coordination should be directed to Eric Weiss, Senior Environmental Scientist at (858) 467-4289 or eric.weiss@wildlife.ca.gov.

Sincerely,

Gail K. Sevrens
Environmental Program Manager
South Coast Region

ec: Office of Planning and Research, State Clearinghouse, Sacramento
Doreen Stadtlander, USFWS
Patrick Gower, USFWS
John O'Brien, CDFW

REFERENCES

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County of San Diego

MARK WARDLAW
DIRECTOR
PHONE (858) 694-2962
FAX (858) 694-2555

PLANNING & DEVELOPMENT SERVICES
5510 OVERLAND AVENUE, SUITE 310, SAN DIEGO, CA 92123
www.sdcounty.ca.gov/pds

DARREN GRETLER
ASSISTANT DIRECTOR
PHONE (858) 694-2962
FAX (858) 694-2555

August 30, 2016

Mark Brunette
Senior Environmental Planner
City of San Diego Development Services Department
1222 First Avenue, MS 501
San Diego, CA 92101

Via email to DSDEAS@sandiego.gov

COMMENTS ON NOTICE OF PREPARATION OF AN ENVIRONMENTAL IMPACT REPORT AND SCOPING MEETINGS FOR THE PURE WATER SAN DIEGO PROGRAM, NORTH CITY PROJECT - 4999621

Dear Mr. Brunette,

The County of San Diego (County) has reviewed the Notice of Preparation of an Environmental Impact Report and Scoping Meetings for the Pure Water San Diego Program, North City Project - 4999621, and appreciates this opportunity to provide input. The County has completed their review and has the following comments regarding the proposed project.

WATERSHED PROTECTION

1. The project must demonstrate compliance with the adopted San Diego Municipal Storm Water Permit Order No. R9-2013-0001, (as amended by Order Nos. R9-2015-0001 and R9-2015-0100). Pending the project category (i.e. – Priority Development Project), the project may be required by the Regional Water Quality Control Board to implement permanent Site Design, Storm Water Treatment, and Hydromodification Management pollutant control and flow control Best Management Practices (BMPs) in accordance with the County's BMP Design Manual since Alternative A is located within lands regulated by the County Watershed Protection Ordinance.

FLOOD CONTROL

1. Project Alternative A could potentially result in impacts to County Flood Control facilities. Close coordination with the County for the Alternative A design would be required.

2. Alternative A alignment would impact the FEMA and County-mapped Floodway/Floodplain of the San Diego River. Any changes to the base flood elevation or limits due to the proposed work would require a County Letter of Map Revision (LOMR) to be processed through the County and FEMA in accordance with the Flood Damage Prevention Ordinance (FDPO) Section 811.503(b). Any proposed work in the Floodway would require a "No-Rise" Certificate and Analysis in accordance with the FDPO Section 811.506.

PLANNING & DEVELOPMENT SERVICES

1. Please describe more specifically, or demonstrate through finer scaled graphics, the locations where proposed project elements are within the unincorporated portion of San Diego County.

2. It appears that certain elements of the proposed project would be located within the unincorporated County, but the NOP does not specify what, if any discretionary actions will be requested of the County. Please clearly describe any and all the approvals and authorities needed by the City as it relates to the location of construction and construction staging for the project in areas within the County's jurisdiction.

3. For each resource area that is evaluated for consistency with an applicable plan or regulation, or where the potential impact is addressed by plans or regulations, please specify which plan or regulation is referenced. Please also explain how they preclude potential impacts from occurring. For all City Plans and Regulations referenced, please describe how they are comparable or exceed the corresponding County Plan or Regulation listed below. The County Guidelines for Determining Significance include:

    - Agricultural Resources
    - Air Quality
    - Airport Hazards
    - Biological Resources
    - Cultural Resources
    - Dark Skies and Glare
    - Emergency Response Plans
    - Geology/Geologic Hazards/Soils
    - Groundwater
    - Hazardous Materials and Existing Contamination
    - Hydrology/Water Quality
    - Mineral Resources
    - Noise
    - Paleontological Resources
    - Transportation and Traffic
    - Unique Geology
    - Vectors

- Visual Resources
- Water Quality
- Wildland Fire and Fire Protection/Fire Hazards

Additional County Planning Documents include:

- Revegetation Planning
- Zoning Ordinance
- Grading Ordinance
- General Plan

The County looks forward to receiving future documents and/or notices related to this project and providing additional assistance at your request. If you have any questions regarding these comments, please contact Danny Serrano, Land Use / Environmental Planner at (858) 694-3680, or via email at daniel.serrano@sdcounty.ca.gov.

Sincerely,

Joe Farace, Group Program Manager
Advance Planning Division
Planning & Development Services

Email cc:

Taylor Dupont, Legislative Assistant, Board of Supervisors, District 2
Keith Corry, Policy Advisor, Board of Supervisors, District 3
Melanie Wilson, Board of Supervisors, District 4
Megan Jones, Group Program Manager, LUEG
Jeff Kashak, Planner, Department of Public Works
Peter Eichar, Land Use and Environmental Planning Manager, Planning & Development Services

RINCON BAND OF LUISEÑO INDIANS
Environmental Department
1 W. Tribal Road · Valley Center, California 92082
(760) 297-2330 Fax:(760) 297-2339

August 15, 2016

Mark Brunette
City of San Diego
Development Services Department
1222 First Avenue, MS 501
San Diego, CA 92101

Re: Pure Water San Diego Program, North City Project No. 499621

Dear Mr. Brunette:

This letter is written on behalf of the Rincon Band of Luiseño Indians. Thank you for inviting us to submit comments on the Pure Water San Diego Program, North City Project No. 499621. Rincon is submitting these comments concerning your projects potential impact on Luiseño cultural resources.

The Rincon Band has concerns for the impacts to historic and cultural resources and the finding of items of significant cultural value that could be disturbed or destroyed and are considered culturally significant to the Luiseño people. This is to inform you, your identified location is not within the Luiseño Aboriginal Territory. We recommend that you locate a tribe within the project area to receive direction on how to handle any inadvertent findings according to their customs and traditions.

If you would like information on tribes within your project area, please contact the Native American Heritage Commission and they will assist with a referral.

Thank you for the opportunity to protect and preserve our cultural assets.

Sincerely,

Vincent Whipple
Manager
Rincon Cultural Resources Department

San Diego County Archaeological Society, Inc.

Environmental Review Committee

1 September 2016

To: Mr. Mark Brunette
Development Services Department
City of San Diego
1222 First Avenue, Mail Station 501
San Diego, California 92101

Subject: Notice of Preparation of a Draft Environmental Impact Report
Pure Water San Diego Program, North City Project
Project No. 499621

Dear Mr. Brunette:

Thank you for the Notice of Preparation for the subject project, received by this Society last month.

We are pleased to note the inclusion of historical resources in the list of subject areas to be addressed in the DEIR, and look forward to reviewing it during the upcoming public comment period. To that end, please include us in the distribution of the DEIR, and also provide us with a copy of the cultural resources technical report(s).

SDCAS appreciates being included in the City's environmental review process for this project.

Sincerely,

James W. Royle, Jr.

James W. Royle, Jr., Chairperson
Environmental Review Committee

cc: SDCAS President
File

WATEREUSE
1199 North Fairfax St, Suite 410 • Alexandria, VA 22314

September 2, 2016

Mr. Doug McPherson
Southern California Area Office
Bureau of Reclamation
27708 Jefferson Avenue, Suite 202
Temecula, CA 92590

Dear Mr. McPherson:

WateReuse fully supports the Pure Water San Diego Program, North City Project in San Diego County, California. WateReuse encourages the Bureau of Reclamation to consider both the principal and ancillary environmental benefits of this project, including project benefits to regional water supply, as it prepares the Environmental Impact Report/Environmental Impact Statement (FR Doc. 2016-18616).

Most importantly, this project will provide a safe, reliable, locally-controlled water supply to the families and businesses of Southern California. Water supply managers in areas with limited water sources require extensive, flexible toolkits to meet the demands of their communities and reusing wastewater for potable purposes provides a resilient water supply, in the face of climate change, while protecting traditional sources.

On behalf of the more than 200 utilities represented by WateReuse, thank you for your consideration.

Sincerely,

Melissa L. Meeker
Executive Director

JOHN W. STUMP
2413 SHAMROCK STREET
CITY HEIGHTS, CALIFORNIA 92105
VOICE: 619-281-4663 EMAIL: **mrjohnstump@cox.net**

City of San Diego via First Class USPS and Email to cityclerk@sandiego.gov purewatersd@sandiego.gov
Development Services; & Storm Water Departments kbalo@sandiego.gov; HMDeisher@sandiego.gov;
202 C Street cityattorney@sandiego.gov; planningcommission@sandiego.gov
San Diego, California 92101

California Regional Water Quality Control Board, San Diego Region
San Diego Storm Water Permit, Implementation, Monitoring and Enforcement
2375 Northside Drive, Suite 100 via USPS & Email: sandiego@waterboards.ca.gov; Rebecca.Stewart@waterboards.ca.gov
San Diego, CA 92108 Main Phone Number: 619-516-1990

RE: PURE Toilet to Tap Water project and Scoping for Pending Studies (Projects: 438188 SCH No. 2014111068 & City Number 21003699) and related, including any request for any California Federal Drinking Water or Sewage Permits

Dear City of San Diego and Regional Water Board,

The City of San Diego appears to be engaged in a program to foster uncontrolled and unsustainable growth by providing an artificial water supply based on new technologies and the expenditure of significant public resources without adequate notice; inadequate consideration of alternatives; and failure to consider the known and cumulative impacts of entering into this project and its components. My testimony and letter of November 17, 2014 (**RE: ITEM-330: Point Loma Wastewater Treatment Plant - National Pollutant Discharge Elimination System (NPDES) Permit Application. (Citywide.) for MEETING OF TUESDAY, NOVEMBER 18, 2014, AT 2:00 PM,)** on file with the San Diego City Clerk and incorporated herein by reference, raised many of the points I present and highlight again.

These proposals are for an expanded approach and direction for regional water production and waste water processing. It assumes a Billion dollar construction program and significant new energy demands for combined sewer water processing and redelivery systems. I am requesting a California environmental review before this proposal becomes the permanent policy of the City. "If CEQA is scrupulously followed, the public will know the basis on which its responsible officials either approve or reject environmentally significant action, and the public, being duly informed, can respond accordingly to action with which it disagrees. The EIR process protects not only the environment but also informed self-government." *Sierra Club* at 13-14 (citing *Laurel Heights Improvement Assn. v. Regents of the University of California.*

The City's Web page states: "Water System Improvement Projects are funded by the rate increases." (SEE: http://tinyurl.com/jrt2n6y). The Notice of the plans and projects under consideration or in progress are inadequate, as they fail to give the public and potential ratepayers any reasonable notice of the plans of the government. These notices should be included in the Water and Sewer bill for the persons currently served by the system. The Notice should be in the languages used in the City of San Diego, under Election Law. These notices should give a reasonable range of the money spent to date and the treasure required in the future. Ratepayers should know that if these plans continue Water, Sewer, and Storm water will increase significantly and the cost of housing will become proportionally less affordable. Please Notice these plans in regular billings. A "…notice must be "reasonably calculated" to inform known parties…" ***Mullane v. Central Hanover Bank & Trust Co.***, 339 U.S. 306 (1950),

The City now has a legally enforceable Climate Action Plan , incorporated by reference herein, which is presented in an article in the May 18, 2016 San Diego Union Tribune newspaper (See: http://tinyurl.com/je49vx6) and a City Attorney Memorandum on Climate Action Plan (See: http://tinyurl.com/zbposv2). These projects and proposals must be evaluated and analyzed against the goals, standards and features of the referenced Climate Action Plan to determine if any project or proposal, including, but not limited to, its energy usages and growth inducing effects are consistent with the Plan. The Climate Action Plan requires change and one of the alternatives that must be considered to obtain Plan compliance must be alternatives that limit growth to sustainable levels, within existing resources.

The City is under a Municipal Storm Water permit and there have several been several enforcement actions imposed or pending concerning the City's lack of compliance with the permit and regulations, particularly on projects it has built for its own purposes or operation, the Municipal Storm Water Permit and Compliance matters are incorporated into these comments by reference (See: http://tinyurl.com/zsktyul). The proposed project and programs must specifically be analyzed for how these programs and projects foster the goals and objects of the Municipal permit. The Municipal Storm Water Permit requires change and one of the alternatives that must be considered to obtain Permit compliance must be alternatives that limit growth to sustainable levels, within existing resources. Please analyze and present reasonable information on how continued growth will contribute to obtainment of the standards required of the permit and settlement agreements. It is inconceivable that the City could continue to provide processed toilet to tap water to foster growth and yet not increase the amount of polluted storm water run-off to the water sheds and ocean. Analysis must include the conjoined effects and induced growth, waste generation, water and sewer demands that result from continued growth of San Diego and its larger sister City Tijuana. San Diego is a linked city like Budapest. We need to think San Dejuana not just North of the wall. Demand is generated together.

In addition to my demands for reasonable Notice and analysis to determine how the proposed projects will foster obtainment and timely compliance with regulatory permits, plans, and regulations, illustrated above without exclusion of other permits and regulations that the City is subject to, I have some specific matters for consideration. These are listed below:

1. Is the system or systems being proposed going to require rate increases and in what range(s);
2. Is the system or systems being proposed based on specific proprietary vendors or suppliers rather than generic methods? If proprietary systems are being proposed what are they and why are they being locked in or chosen?
3. What waste materials and volumes are likely to result from this program and projects operation? Specifically, address what filters and chemicals are going to be used? How will these filters be disposed of? How will used filters and the materials filtered out by the PURE toilet to tap operations be stored and disposed of? What volumes of materials are anticipated? Will this waste increase over the reasonably foreseeable life of the program and project? Are any of these materials classified as Hazardous or radioactive, by California or Federal standards?
4. What, if any, Homeland Security, Police, Fire or related costs will be required to build and operate the facilities proposed by this project or program? Would alternative approaches reduce these costs?;
5. Will all instructions and warnings for this program and project be posted in multiple local languages?
6. Has an emergency procedure manual and procedures been developed for the safety of operational and emergency personnel?
7. On the first day of operation will the proposed program or project fully conform to California and Federal permits? Will any continuing or new waivers of California or Federal law or regulations be required? Please additionally discuss whether the program or project will continue to use chloramine (SEE: http://tinyurl.com/h6cjtw2) and will regardless of the program or project selected will the City be in compliance with current orders to improve the disinfect ion of potable water? Is there any compliance to current orders or standards being held captive to this new approach? ;
8. Will the program or project, by the time of initial operation, have removed all water pipes and facilities containing asbestos. Where and how will any asbestos decommission by this program or project be disposed of? ;
9. The proposed project or program appears to require a new electrical transmission line. How much new power is required and how is it being generated? What is the resultant carbon load from this new project an? Are any carbon offsets being proposed? If the project was not operated how much carbon monoxide and related global warming pollutants would be avoided? Is this project scalable to mitigate and minimize impacts? ;
10. Has the City explored the reuse of the natural gas Rainbow pipeline 1600 to deliver recycled water South of the I-8 Freeway , In Council Districts 3, 4, 8, and 9 where the City has major parks, public facilities and landscaping; so as to reduce water demands? Specifically address the impacts on water demands if recycled water was used at the SD Airport, Balboa Park, SD Zoological, KELCO, Cholas Lake, and other Southern area major water using facilities , to reduce demand and thus the need for the project or a program at this scale. Would more purple pipe supply reduce demand? ;
11. Please analyze whether the rate increases, employment outcomes, and availability of recycled water, in the Southern area, adversely effects persons of color or low income ; so as not to advance Environmental Justice? ;
12. Please discuss and analyze whether the cost of filtering and/or processing of the waters from this program or project will increase the costs of health care, at dialysis or surgical centers, dental or other human care facilities; high technology manufacturing or research facilities; Specifically address how environmental justice is promoted if costs increase or economic costs limit health care, housing affordability, and employment opportunities? ; and
13. Please analyze the externalities that are generated by this program and project. This program and projects should not result in a transfer of costs to the general taxpayers. For example, a filter provider should not be able to provide us a filter that causes extra costs to dispose of it. They should be required to recycle all of that waste. In economics, an **externality** is the cost or benefit that affects a party who did not choose to incur that cost or benefit.[1] Economists often urge governments to adopt policies that "internalize" an externality, so that costs and benefits will affect mainly parties who choose to incur them. [2] [See: https://en.wikipedia.org/wiki/Externality]. I urge the staff planners to be more conscious of the trend towards externalities and suggest consideration of the SEEA Environmental Accounting document standards http://tinyurl.com/hdp6y94 .

I request written responses to my comments and inquiries. I request that my comments be published in the same size font as the response document is presented. I request timely notice of all future opportunities to comment and participate in any public hearings on these matters. These studies should be re-noticed by using both the annual Safe Drinking Water Report and the regular billings for Water, Storm Water, and Sewer. Please prevent even the appearance of ex parte communications consistent with local, State and Federal Law, as expressed in City Attorney Legal Opinion LO 90-2 (See: http://tinyurl.com/hyw7d76.) .

All the best,

/s/ **John W. Stump, San Diego resident, ratepayer, and taxpayer**

LOZEAU DRURY LLP
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Via Email and U.S. Mail

August 25, 2016

Mark Brunette, Senior Planner
City of San Diego
Development Services Department
1222 First Avenue, MS 501
San Diego, CA 92101
dsdeas@sandiego.gov

Elizabeth Maland, City Clerk
City of San Diego
202 C. Street, Second Floor
San Diego, CA 92101
cityclerk@sandiego.gov

Keli Balo, Project Manager
City of San Diego
Public Utilities Department
525 B Street
San Diego, CA 92101
KBalo@sandiego.gov

Doug McPherson, Environmental Protection Specialist
Bureau of Reclamation, So. CA. Office,
27708 Jefferson Avenue, Suite 202
Temecula, CA 92590
dmcpherson@usbr.gov

Re: CEQA and Land Use Notice Request for the Pure Water Program, North City Project EIR/EIS 49962

Dear Mr. Brunette, Ms. Maland, Ms. Balo and Mr. McPherson:

I am writing on behalf of the Laborers International Union of North America, Local Union 89 and its members living in the City and County of San Diego ("LiUNA"), regarding the Pure Water Program, North City Project EIR/EIS 49962 (SCH 2016081016), including all actions related or referring to the expansion of the existing North City Water Reclamation Plant and construction of an adjacent North City Pure Water Facility with a purified water pipeline to Miramar or San Vicente Reservoirs , new pump station and forcemain to delivery additional wastewater to the North City Water Reclamation Plant, a brine discharge pipeline, and upgrades to the existing Metropolitan Biosolids Center. ("Project").

We hereby request that the City of San Diego ("City") send by electronic mail or U.S. Mail to our firm at the address below notice of any and all actions or hearings related to activities undertaken, authorized, approved, permitted, licensed, or certified by the City and any of its subdivisions, and/or supported, in whole or in part, through contracts, grants, subsidies, loans or other forms of assistance from the City, including, but not limited to the following:

- Notice of any public hearing in connection with the Project as required by California Planning and Zoning Law pursuant to Government Code Section 65091.

- Any and all notices prepared for the Project pursuant to the California Environmental Quality Act ("CEQA"), including, but not limited to:

    - Notices of any public hearing held pursuant to CEQA.
    - Notices of determination that an Environmental Impact Report ("EIR") is required for a project, prepared pursuant to Public Resources Code Section 21080.4.
    - Notices of any scoping meeting held pursuant to Public Resources Code Section 21083.9.
    - Notices of preparation of an EIR or a negative declaration for a project, prepared pursuant to Public Resources Code Section 21092.
    - Notices of availability of an EIR or a negative declaration for a project, prepared pursuant to Public Resources Code Section 21152 and Section 15087 of Title 14 of the California Code of Regulations.
    - Notices of approval and/or determination to carry out a project, prepared pursuant to Public Resources Code Section 21152 or any other provision of law.
    - Notices of approval or certification of any EIR or negative declaration, prepared pursuant to Public Resources Code Section 21152 or any other provision of law.
    - Notices of determination that a project is exempt from CEQA, prepared pursuant to Public Resources Code section 21152 or any other provision of law.
    - Notice of any Final EIR prepared pursuant to CEQA.

Please note that we are requesting notices of CEQA actions and notices of any public hearings to be held under any provision of Title 7 of the California Government Code governing California Planning and Zoning Law. **This request is filed pursuant to Public Resources Code Sections 21092.2 and 21167(f), and Government Code Section 65092**, which requires agencies to mail such notices to any person who has filed a written request for them with the clerk of the agency's governing body.

Please send notice by electronic mail or U.S. Mail to:

Richard Drury
Theresa Rettinghouse
Lozeau Drury LLP
410 12th Street, Suite 250
Oakland, CA 94607
510 836-4200
richard@lozeaudrury.com, theresa@lozeaudrury.com

Please call should you have any questions. Thank you for your attention to this matter.

Sincerely,

Theresa Rettinghouse

Theresa Rettinghouse
Paralegal
Lozeau | Drury LLP

Megan Lawson

From:	Brunette, Mark <MBrunette@sandiego.gov>
Sent:	Tuesday, September 6, 2016 8:25 AM
To:	Balo, Keli; McPherson, Douglas; Megan Lawson; Shawn Shamlou
Cc:	Lavan, Tiffany
Subject:	FW: Pure Water Proposal Phase 1] Project 49961 EIR/EIS Scoping Comments -- Part 1 of 2

NOP comment letter part 1 from Scott Andrews.

From: Scott Andrews [mailto:scott300@earthlink.net]
Sent: Saturday, September 03, 2016 3:05 PM
To: DSD EAS
Cc: Scott Andrews; john McNab; davidkennedydds@gmail.com; shellifun@yahoo.com; dmitrovich@sbcglobal.net
Subject: Pure Water Proposal Phase 1] Project 49961 EIR/EIS Scoping Comments -- Part 1 of 2

To: Development Services Department, City of San Diego
Re: Pure Water Proposal Public Comments re North City Project [Phase 1] EIR/EIS No. 49961

September 3, 2016

Note: The Pure Water proposal has now been split into three phases, with each requiring a separate EIR/EIS, these in addition to the Programmatic EIR (PEIR).
The original unphased proposal is now listed as Alternative 1A, so we assume and request that all Save Everyone's Access (SEA) and Scott Andrews' prior verbal testimony and written comments still apply, and will be forwarded to each consultant team doing the multiple subsequent EIRs. To facilitate this process, I provided the City at the Phase 1 hearing a second hard copy of the stack of scientific studies we submitted for the PEIR. We request notice when the PEIR is available for review.

"The objective is not to simply to describe and document impacts, but to actively create and suggest mitigation measures or project alternatives that would avoid lor substantially reduce significant adverse environmental impacts."
Pg 13

ENVIRONMENTAL IMPACTS AND MULTIPLE MITIGATIONS TO REPAIR AND PROTECT THE PACIFIC OCEAN,
and IMPAIRED WATER BODIES MISSION BAY AND SAN DIEGO BAY
The Pure Water proposal (project) comes as the City of San Diego is operating it's Pt. Loma (and likely South Bay) sewage treatment and discharge facility[ies] under a third, unprecedented, and now lapsed five year waiver to the Clean Water Act (CWA).
The impacts from this 50 billion gallons per year of under treated discharge to the Pacific Ocean and its nursery bays would apparently continue forever under legal and scientific immunity under a proposal fatal flaw.
We request immediate clarification as to whether the City is negotiating with EPA or RWQCB a perpetual NPDES discharge permit waiver to the CWA.
CURRENT AND MISSING BASELINE DATA
Effective mitigation for San Diego, and the cross border region, depends on studies or discharger/regulator reportage of

baseline data re amounts of discharge, projections of population increases for San Diego and the equally-populated Tijuana, Mexico, direction of local offshore currents, known area NOAA reported marine life species declines and extinctions,
and data interpretation/analysis of trending annual outfall zone cumulative impacts.
Accurate and timely data collection can inform computer graphing projections which should be requisite for any $3.5 billion
proposal involving both human health and marine species' viability.

WAIVERS' IMPACTS

SEA demands the cumulative damage to the marine ecosystem under the City's three waivers, as described in the prior waiver request's Heal the Bay and NRDC scientists' 2009 letter and the new Scripps' oceanographic study be fully mitigated by the discharger City and regulator RWQCB.
This mitigation would be to divert project funds to install the full treatment to protect an ocean now subjected to:
global warming, acidification, eutraphication, and significant species declines due to overfishing, pollution, and uncontrolled disease epidemics from offshore aquaculture.

OCEAN, BAY MITIGATIONS

• Full mitigation is also demanded by an unprecedented three waivers, and if nearby City aquifers are in fact too contaminated for underground filtration like that employed in Orange County, some quantity of discharge could be deposited there, a method apparently used to close Florida offshore outfalls.
• Ocean discharge could also be mitigated by the City fully deploying a purple pipe system to increase sewage treated for
gray water use on freeway landscaping, golf courses, air conditioning. Reclaimed water might also be pumped to any
county aquifers deemed safe for the natural underground filtration that adds to protection of humans subjected to ingestion
of treated sewage, and as county wells are drying up due to a drought-induced sinking water table, any appropriate
aquifers are likely also increasing in volume capacities.
The above mitigations could mitigate the exposure of human and marine lives to sewage viruses, bacteria, chemicals, chloramines, phosphorus, household chemicals, pharmaceuticals, and estrogen mimics now discharged, and discharged
in raw sewage when the Pt. Loma plant is overrun by storm incidents. Is Point Loma adequate to current population levels? Adequate to SANDAG's estimated one million more residents? What are population projects for the Tijuana, Baja California region?
If Pt. Loma is overwhelmed during rains, those unpermited releases raise the question of current and future plant capacity to handle another one million residents' effluent.
What are accurate current, capacity, and anticipated discharge amounts from Pt. Loma and South Bay in both 2035 and 2050
under SANDAG projections?

DUAL BAY IMPACTS

The Pacific and two major regional bays, San Diego Bay and Mission Bay, are also impacted by the strong tidal surges,
which inject the bays with contaminated ocean water. SEA requests the City and regulators provide baseline fish,
invertebrate, and bird population studies for both bays so that significant environmental impacts, if any, can be analyzed.
Re the issue of current and continued discharge, do ocean discharge levels contribute to bay contaminants that currently
impose fishing advisories?

DUAL POLLUTION SOURCES — REGIONAL DOUBLE BENTHIC LOADING FROM U.S., MEXICO

Another major, and international environmental impact to address is Mexican sewage that travels on northern offshore currents from Rosarito Beach and Tijuana municipal sources. A third of the latter river plant's discharge is purportedly viral untreated
raw sewage. SEA requests the study include plant discharge gallonage from this international source.
As with the City of San Diego, it is time these cities' unfunded water pollution infrastructure be brought up to priority standard. These are the region's most significant sources of contamination. What are the population projections for the Tijuana, Baja California region?

HUMAN EXPOSURE IMPACTS OF RECYCLED SEWAGE

Sewage recycling, unlike desalination, is a much newer and unproven technology, very limited in use, so follow up human health and disease studies and data collections should be provided or ordered in the PEIR and project phase EIRs for review.

CUMULATIVE IMPACTS OF SEWAGE DISCHARGE ON MARINE LIFE

San Diego's ecosystem has been exposed to over 15 years of under treated sewage discharge, documented by the aforementioned damage to outfall zone marine life in the aforementioned Heal the Bay and NRDC review. Does City
reportage include levels of plant contaminants such as heavy metals, and, if so, is there evidence of cumulative intake over time?

NEW TECHNOLOGICAL ALTERNATIVES

San Diego's sewage disposal issue is international, and the study should access international advances in treatment
technology, new natural additives, and disposing methodologies.

NATURAL, NON CHEMICAL UNDERGROUND STORAGE FILTRATION ALTERNATIVE

Project proponents cite and promote as a model the Orange County, California sewage "toilet-to-tap" operation. SEA understands that facility employs the natural underground filtration the San Diego project lacks. What is the state and
condition of San Diego regional aquifers?

PROJECT RESERVOIR SWITCH

An August/September 2016 Union Tribune article quoted a project spokesman that because the new, closer Lake Miramar repository is smaller than original project's San Vicente Reservoir, more treatment chemicals "will be needed" and will
apparently completely absorb any cost savings in the reservoir switch.
What are holding capacities and anticipated holding times of sites? Do either contain of serve wildlife or recreation? Please identify and quantify the treatment chemical, and the additional required to treat at Miramar. What are the pipe-to-tap chemicals? Provide studies re the human and pet health of mixing of new fluoridation additives with City reservoir project product treatment chemicals.

PROJECT SECURITY ANALYSIS

Stream-fed and pipe-served open bodies of water are of course subject to sabotage exposure that closed systems like a
desalination plant are not. These exposures demand cost, feasibility, and proficiency review.

From: [Brunette, Mark]
To: [Balo, Keli]; [McPherson, Douglas]; [Megan Lawson]; [Shawn Shamlou]
Cc: [Lavan, Tiffany]
Subject: FW: Part 2 of 2 Pure Water Proposal [Phase 1] Project 49961 EIR/EIS Scoping Comments
Date: Tuesday, September 6, 2016 8:27:17 AM

NOP comment letter from Scott Andrews part 2.

From: Scott Andrews [mailto:scott300@earthlink.net]
Sent: Sunday, September 04, 2016 1:07 PM
To: DSD EAS
Cc: Scott Andrews; john McNab; davidkennedydds@gmail.com; shellifun@yahoo.com; dmitrovich@sbcglobal.net
Subject: Part 2 of 2 Pure Water Proposal [Phase 1] Project 49961 EIR/EIS Scoping Comments

To: Development Services Department, City of San Diego
Re: Pure Water Proposal Public Comments The North City Project [Phase 1] EIR/EIS No. 49961

September 4, 2016

[SEA comment letter Part 2 of 2]

LEGAL COMPLIANCE ALTERNATIVE
By any measure, the Pacific's marine ecosystem is declining. The City of San Diego, however, delaying CWA compliance
over three successive EPA waivers, has now demonstrated its intention to avoid compliance with Clean Water Act standards
for sewage discharge to the Pacific Ocean and area bays.
The City now apparently wants to provide new water for development while cementing the waiver, claiming a Pt. Loma plant upgrade would be expensive, and impossible due to space limitations.
The Heal the Bay and NRDC 2009 waiver opposition letter re extensive Pt. Loma outfall marine life harm is dramatic, and six additional years of cumulative impacts require a comprehensive and independent study of the area that employs baseline fish and invertebrate population counts and annual heavy metals tracking under an ocean impacts review.
The last few years have seen the death of a famous San Diego surfer due to viral exposure, and sea star die-offs that echo NOAA-cited forage species' declines.
WAIVER EXCEEDENCES' CUMULATIVE MARINE LIFE DAMAGE
MITIGATION: IMPROVING HUMAN HEALTH
BY IMPROVING EXISTENT CITY WATER QUALITY & MARINE LIFE PROTECTION VIA PT. LOMA UPGRADE
The City Development Services Department NOP fails to note that Pt. Loma expansion can be sited up pipe a bit off the water, like all the new plants in its Pure Water proposal.
The City estimate to upgrade Pt. Loma has doubled to $2B, still well below its proposal's $3.5B estimate.
Re human health impacts, proposal maps show city residents and pets are exposed to concentrated municipal and industrial contaminants at "the end of the pipe", the Colorado River, which calls to question the real ability to purify the City's existing drinking water at present.
The science shows that numerous contaminants are not tested for, or do not have health impact or Maximum Daily Load (MDL) standards set by federal or state regulators. and therefore go

untested for and untreated prior to consumption. The funding of improved treatment of the City’s current drinking water supply merits study as mitigation for past exposure.

DESCAPING ALTERNATIVE

Drought resistant planting and descaping, initially state-subsidized, have reduced water use, and merit study as to the extent of water savings.

CONSERVATION ALTERNATIVE

Drought-driven and governor-ordered statewide conservation, has successfully resulted in a San Diego savings of a significant twenty percent [20%]. Reduced water usage upstate makes more canal supply available here.

DESALINATION ALTERNATIVE

Numerous Southern California cities, Camp Pendleton federal property, and Rosarito Beach, Mexico are in the process of
installing new desalination plants, the Coastal Commission have declared policy to mitigate issues raised by sea water intakes
and briny discharge. Cities to the north will draw less canal water as plants go on line, which makes more canal water theoretically available for San Diego.

PROJECT REDUNDANCY TO STATED ALTERNATIVES

Quantify measures listed that have already increased City supply to date.
What are the established and proposed desalination plants in California and northern Baja, Mexico?
What are their projected drinking water production figures? Will this new privately-financed supply in toto not dwarf
Pure Water’s 83MGD?

PROJECT GROWTH INDUCEMENT

The City Development Services Department NOP does not mention SANDAG’s projected population increase of one million residents. A project consultant admitted that this increase over time would negate any temporary discharge drop due to
project installation, so EIR/EIS study of cumulative impacts of today’s annual 50BGYr level of under treated ocean sewage
discharge, as well as a likely unmitigated projected population and discharge increase for northern Baja, Mexico, is justified.

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U-T

More drinking water for San Diego

By David Schubert

September 12, 2008

Like many communities throughout the world, San Diego has a drinking problem. However, rather than intoxicating alcohol, the problem is toxic pharmaceuticals and consumer goods such as cosmetics that make their way into our drinking water supply from homes, hospitals, businesses and farms.

They primarily pass through sewage (wastewater) systems with only partial removal. The treated wastewater is released into rivers and lakes and ends up in downstream water supplies, like San Diego's. While the concentrations of individual toxins in drinking water is often quite low, there is growing evidence that the amounts are sufficient to cause reproductive problems in aquatic animals and to lead to antibiotic resistance in pathogenic bacteria.

Although scientists and government health agencies have known about this problem for nearly 20 years, little has been done in the United States to stem the flow of these toxins into the environment. It seems to have taken a recent, widely publicized investigation by the Associated Press to raise public concern.

The appearance of pharmaceuticals in rivers, lakes and streams was first reported in Europe in the early 1990s. It was initially believed that these chemicals came exclusively from manufacturing facilities, and indeed some of them did. However, further investigation showed that the majority came from the effluents of community wastewater treatment plants.

Using standard treatment regimes, most of the toxins entering treatment plants are released into the environment in the treated wastewater. The geology of Europe makes the water circulation there more of a closed system than in most other parts of the world.

In some cases, half of the volume of a river is from treated wastewater. Since it is difficult to remove toxins during the subsequent preparation of municipal drinking water, there has been an intense effort in Europe to improve the sewage treatment facilities such that most of the toxins are removed before discharge.

This has not happened in the United States. With a growing population, greater water reuse along the rivers that supply our drinking water, and an overall decrease in the volume of our water supplies, there has been a significant increase in concentrations of toxins in many of our waterways, ground waters and in the drinking water of San Diego.

How can this trend be reversed to eliminate a very real threat to public health? San Diego receives most of its water from the Sacramento River Delta area near San Francisco and from the Colorado River.

Water flowing through the Delta includes agricultural runoff (chemicals and pesticides) and municipal wastewater discharges from cities such as Sacramento. Colorado River water has passed through multiple cities, including Las Vegas, which draws its water from Lake Mead and then discharges reclaimed water back into the lake, which flows into the Colorado River for our downstream consumption.

The best way to reduce the toxin problem along these waterways, as well as at the national level, is to follow the example of Europe and try to remove 80 percent to 90 percent of the toxins at the wastewater treatment facilities. This approach requires a longer retention time in the biological treatment step used by wastewater treatment plants to allow for the degradation of toxins by microbes and oxidation. It also places an additional cost on the operation of these plants, but this is a cost that society should be willing to pay.

However, the only truly effective way of removing the vast majority of the these toxins from our drinking water supply is via the technology currently being proposed for San Diego's poorly named "toilet-to-tap" program. The toilet-to-tap program was created because it is imperative that San Diego find other sources of water besides the Sacramento River Delta and the Colorado River.

The Delta water supply is subject to elimination by an earthquake or a judicial cutback due to a threatened species such as the Delta smelt. Some have estimated that at the current rate of consumption Lake Mead will be dry by 2021, and the water transport system from the Colorado River to San Diego is also subject to earthquake damage.

Since local groundwater supplies are few and of limited volume, alternative water sources for San Diego are very limited. These include seawater desalination, planned for Carlsbad, and reclaimed water, which is taken from treated wastewater.

Reclaimed water is already used in San Diego for landscape watering. This water is heavily chlorinated, so if the reclamation plant is functioning properly, there is minimal risk of infection. But it does contain significant levels of toxins and other contaminants.

For the toilet-to-tap project, this reclaimed water would be taken through three additional purification steps: micro-filtration and reverse osmosis, followed by exposure to a strong oxidant or high intensity ultraviolet light. These extra steps reduce the toxins to undetectable levels, creating essentially pure water. It is so pure that it cannot be used for agriculture unless minerals are added back into it, for example by diluting it into imported water in the San Vicente reservoir.

The purification procedures for the proposed San Diego drinking water program are already being used to recharge the drinking water aquifers under Orange County with advanced treated reclaimed sewage water. Singapore has installed a similar recycling system, called NEWater, so that it is not dependent upon Malaysia for its water supply.

For San Diego to become less dependent upon imported water, it is mandatory that it creates other sources. The production of ultrapure water from our wastewater facilities is a step in this direction, and it should be supported along with conservation and seawater desalination. Perhaps only through these measures will we be able to continue to enjoy a healthy life in a coastal desert.

▪ Schubert is a professor at the Salk Institute for Biological Studies in La Jolla.

»Next Story»

List of Documents Provided
NRDC Heal the Bay letter to EPA Opposing NPDES Permit N301(h) waiver for Pt. Loma WWTP, Jan 28, 2009.
CCC Federal Consistency Certification, City of San Diego, Secondary Treatment Waiver,Oct 7, 2009.
-Heal the Bay/NRDC Comment Letter, Oct 2 2009
West Coast Ocean Acidification and Hypoxia Science Panel, April 2016.
Ocean Outfall Study, Final Report, Department of Environmental Engineering Sciences for Florida Dept. of Environmental Protection, April 2006.
"The Effects of Sewage on Aquatic Ecosystems", Cambell, Kirstin. Web article science.opposing views.com
Electrocoagulation Report, Removal of Metals, Micro Algae and Phosphates,
10th Annual International Cleaning Technology Exposition, Conference March 3-5, 2003.
Removal of 6 Estrogenic Endocrine -Disrupting Compounds (EDCs) from Municipal Wastewater using Alumininum Electrocoagulation
Letter USF, Bench Test Removals of pathogens and viruses using electrocoagulation, August 2010.
"More Drinking Water for San Diego" by David Schubert. San Diego Union Tribune, September 12, 2008.
"Tijuana River Sewage Raises Ocean Pollution Levels" by Aleksandra Konstantinovic, Dec 2014. City New Service.
California Ocean Wastewater Discharge, Report and Inventory, Prepared by Heal the Ocean, March 2010.
California Fish Populations are Declining, Scrippts Institute of Oceanography. October 29, 2015.
Leading Ocean Scientist Recommend Immediate, Coordinated Action Plan to Combat Changes to West Coast Seawater Chemistry. Scrippts Scientific Panel, April 6, 2016.
1988/89 Grand Jury Reports, Water for the City of San Diego.
Cooperative Agreement with CSD for Non-opposition to CWA 301(h) Waiver, Jan 29, 2009.
Marco Gonzalez, Coast Law Group, LLP for Surfrider, San Diego Chapter, and San Diego Coastkeeper.

Additional Electronic Documents
FAQS on Sewage Sludge/Biosolids Annual Reporting - 2014

http://www.waterencyclopedia.com/Po-Re/Pollution-of-the-Ocean-by-Sewage-Nutrients-and-Chemicals.html

https://www3.epa.gov/npdes/pubs/primer.pdf

https://www.epa.gov/npdes/municipal-wastewater

http://vtdigger.org/2015/12/08/state-secures-funds-for-sewage-plant-upgrades/

https://www.epa.gov/eg https://www.epa.gov/biosolids

http://noc.ac.uk/science-technology/seas-under-threat/marine-pollution/sewage

http://www.seaweb.org/resources/briefings/toxic.php

http://wwf.panda.org/about_our_earth/blue_planet/problems/pollution/

http://blog.nature.org/conservancy/2011/09/16/what-a-waste-why-human-sewage-is-laying-waste-to-coral-reefs-globally/

http://www.motherjones.com/politics/2006/03/marine-pollution-how-ocean-became-toxic-waste-dump

Pew: http://www.fws.gov/southeast/grants/pdf/oceans_summary.pdf

http://issues.org/21-1/safina-3/

GREAT One: http://www.iatp.org/files/Marine_Pollution_in_the_United_States.htm

http://library.cqpress.com/cqresearcher/document.php?id=cqrglobal2007100000

http://library.cqpress.com/cqresearcher/document.php?id=cqresrre2005110400

http://oceana.org/our-campaigns/stop_ocean_pollution/campaign

http://www.seashepherd.org/commentary-and-editorials/2015/04/03/the-dilemma-of-toxic-cultures-on-a-toxic-planet-698

ewg Environmental Working Group
http://www.ewg.org/research/water-treatment-contaminants

Water Board
http://www.swrcb.ca.gov/water_issues/programs/owts/docs/disinfection.pdf

Analysis

No mention of aquifer recharge, well injection, or other land based recycling options. After the mixing of recycled water, after a very long pumping ride from PLWWTP, with the two surface bodies of water, reservoirs (name). Eventually the salinity with be restored, why not supplement now with the systems we already have that are recycling.

A shorter pipe gallery would suffice to more local aquifers. In fact from the EPA guidance document, and the best examples cited by your study, the Orange County project, they are getting a 6 month retention time through the aquifer. An aquifer provides a much longer and a more cleansing voyage (retention time) via time honored natural features.

It is likely that this was not considered because of polluted aquifers, but this option was not considered at all. Injection wells, or even well augmentation. You have skipped over this option with miles of pipeline to the two reservoirs. A better and more diverse portfolio as was stated in the report will build resiliency into our whole watershed.

My confidence is much higher for this method rather than adding directly to a fresh body of water that may not respond well to tertiary (H_2O_2 and uv light) treated water. Anything less than that level of treatment would risk our health. While there are ways to measure retention time and mixing in an open body of water, my confidence increases with distance traversed through an aquifer, a time honored tradition of natural treatment.

Because of the lack of confidence of treated wastewater, you realize you only get one chance to get it wrong? If you miss a contaminant because of some process upset, it goes unchecked directly to a reservoir, rather than to a more resilient aquifer.

If recycled water has a few impurities, the worst it can do is kill a little grass, not the people.

Security, Safety and Testing

At some point, when testing recycled water for safety, you can only test for so many pollutants and pathogens, and then treat to remove them. Then hope that nature will scrub some out, and the next step of treatment before tap will get the rest.

It is reprehensible to even think this way, but what about the fringe person who realizes they can flush anything down the toilet and poison the water supply? What about pharmaceuticals, or household hazardous wastes that regularly get flushed down the toilet? By nature nano particulates are not captured by demonstrated technologies, and most packaging is not required by law to state to the consumer that it contains nano particulates.

The current utilities are engineered, secured, and closed to the general public. They are not likely targets for terrorist or fringe acts of destruction.

Where is the mention of adoption of treatment standards for pathogens in recycled ww effluent?

My other concern is the focus and vast expense of what is basically an institutionalized conservation measure, focusing our efforts on a dwindling and unreliable source of water. The aquifers and surface water that provide 80% of our potable water, are borrowed from water resources that are at roughly a third of their historical capacity, hence our efforts. However from the math presented, recycling gets back only about 25% of that, a typical number for these kinds of efforts.

No other conservation methods are mentioned. Our population is getting dense enough that small communities of HOA's can be retrofitted or new ones built only with the caveat of recycled water systems intrinsic to the property. It is the vertical densities that are causing the growth and demand on our water supply. Not to mention the current trend of building Manhattan along our waterfront.

Capture of Stormwater

The best effort I have seen for capture and cleaning of stormwater is Los Angeles. They have created holding ponds that they have turned into water features and constantly reach out to the community to protect this important resource. Surface impoundments or parks, you can't tell the difference up there, and their program is reproducible and successful. We have the real estate to copy this effort, it's called Balboa Park. Flood a section of the park as opposed to the Mission Valley basin.

http://www.lastormwater.org/

Fix Your Leaks

In order to get the most out of the older infrastructure, use current technology such as infrared cameras to locate and fix large leaks. With the kind of pipe ages noted, leak testing and fixes will help increase our efficiencies.

Desalination

Recently, 50 mgd just came on line in Carlsbad, already half of what is expected from recycling, another plant is coming online in Rosarita, Mexico. Considering that we take the last remaining drop of water from the riverbed, I would think they would trade us some desal water for some simple sewer technology. Any master plan that involves basic resources such as water and sewerage should involve Tijuana as part of the scope. We share the same ocean corridor with all its wildlife, and pollution alike. We can't afford to point fingers or be the water villain, this relationship is too important.

Camp Pendelton is also planning to build a desal plant, get in there a get us a slice of that.

Despite the fact that the Point Loma effluent pipe was lengthened, and spills greatly reduced, we are still experiencing blowback via our own discharges coupled with that of Tijuana by way of the North --- current.

Santa Barbara Desalination plant is coming back on-line, and they spent about $1 billion. Poseiden was built without any capital output, just an agreement for fees. What are you waiting for? Spend a billion and stop polluting with our sewage.

Go ahead and recycle from Point Loma but just do one simple pipeline to the farmers, and hand it off at the county line, or send it to Mexico. The Rio Grande will be great again.

The source water for this option is basically limitless and getting larger via freshwater melt from the various ice shelfs in the world, via global warming and sea rise. Currently we are at 8", while the west Greenland ice shelf is losing 5 billion tons per year. The whole ice shelf would raise sea levels 18" on its own, not accounting for any other ice sheet. Water, water, everywhere and not a drop to drink.

Don't forget that your original purpose was to provide potable water to the people in a reliable way. This project does a great job of recycling but does not appear to be cost effective nor does it fill the bill since the sourcing will certainly dwindle as global warming progresses.

My concern is that after expending $3.5B that you be sued for malfeasance, since this is all for creating potable water from a dwindling source. If the drought continues, toilet to tap is useless, as the source water continues to reduce.

Global warming has come home to roost.

This technology is reliable, practiced worldwide and hence a large community of consultants to field problems, and the potable water is very clean as a result of the filtration method. The effects of the brine return from local desalination plants is often offset by mixing with effluent from the wastewater treatment plants. This mixing is best done without adding the polluted solids from the treatment process. ASCE Journal reference.

With good stewardship concentrated saline augmented with some recycled water, and two more desalination plants, we suffer no ill will from what seems to be our permanent drought conditions.

Permanent Drought Measures by Household

Tax breaks for household reductions.

Against NPDES Permit Waiver

It is beyond my comprehension that you are proposing a permit waiver for sewage discharge to the ocean. Even tertiary treatment is harmful to ocean ecosystems. At some point the discharge waters from Point Loma have to be treated to tertiary or better before being recycled back into the environment. Why not start now with simple technologies?

At this point in the project, approaching $ 4 billion, the elimination of the outfall to the ocean is entirely possible. Treatment and removal of solids, and either high heat, or electrocoagulation along with the current cogeneration will eliminate the need to throw away valuable compost material that could be stored at the landfill and used by the public for landscaping.

The MagnaGas option in part or in full will bake the solids, sanitize the liquids, and produce a clean gas that can be burned to feed the grid. Again net zero carbon, balancing out the trips to the landfill in trucks instead of the pipeline that the slurry of solids make to the landfill currently. I recently learned that Magnegas now has a municipal wastewater treatment plant functioning in Italy.

I am not convinced that expansions and hence higher levels of treatment, tertiary even, of the Point Loma treatment plant cannot be accomplished because of space constraints. There are other technologies that can be easily put in place to accomplish this task, without addition of yet stronger chemicals.

There is no guarantee of the destruction of other pathogens, such as viral, antibiotic resistant bacterias, not to mention the endocrine disruptors, and nano particulate matter. Mere chemical treatment does not guarantee sanitization of these vectors. Alternate and efficient technologies can, such as Powell Electrocoagulation, a report summary attached. Note the letter from the College of Marine Science, stating the removal of common viruses and bacteria to undetectable levels.

GHS's

While the plan does do some cursory mathematics for the GHG impact of the projects based on current requirements, there is no mention of offsets if a certain threshold is reached if these calculations are found to be in error once the project commences. Since the calculations indicated the project would actually come in far under the threshold, no other carbon emission offsets were considered. Since we are on the edge of a vast marine environment, kelp supplementation is low hanging fruit as an offset for carbon emissions.

Growing and maintaining a kelp bed for carbon sequestration on behalf of ourselves and the planet cannot be done as effectively if we are still poisoning that environment with untreated or poorly treated sewage.

Also, using oil converting algaes for wastewater treatment was not addressed. what is left behind is an oil laden algae that can be easily extracted to capture the oil and the husks safely composted. Burning of the oil is then net zero carbon emission. This oil can also be sold to our military who are already using this technology in their operations.

At a minimum, having some sort of active program to offset our cities carbon footprint because of the clogged freeways, is in order. A simple process of algae growth as in

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Reference and Abstract: Carbon **Edited by Rao Y. Surampalli, Tian C. Zhang, R. D. Tyagi, Ravi Naidu, B. R. Gurjar, C. S. P. Ojha, Song Yan, Satinder K. Brar, Anushuya** Stock No. 47891 / ISBN: 9780784478912

Reference and Abstract: Carbon Capture and Storage, **Edited by Rao Y. Surampalli, Tian C. Zhang, R. D. Tyagi, Ravi Naidu, B. R. Gurjar, C. S. P. Ojha, Song Yan, Satinder K. Brar, Anushuya**

Sponsored by the Carbon Capture and Storage Task Committee of the Technical Committee on Hazardous, Toxic, and Radioactive Waste Engineering of the Environmental Council of the Environmental and Water Resources Institute of ASCE

Carbon Capture and Storage: Physical, Chemical, and Biological Methods presents comprehensive information on the principles of carbon capture and sequestration (CCS). Among the various climate change mitigation strategies currently being explored, CCS technology allows for the continuous use of fossil fuels and provides time to make a changeover to other energy sources in a systematic way. Many factors decide CCS applicability worldwide, such as technical development, overall potential, flow and shift of the technology to developing countries and their capability to apply the technology, regulatory aspects, environmental concerns, public perception, and costs.

This book provides in-depth information on the principles of CCS technology, different environmental applications, recent advances, critical analysis of new CCS methods and processes, and directions toward future research and development of CCS technology.

Topics include:

- carbon dioxide sequestration and leakage
- monitoring, verification, and accounting of carbon dioxide in different settings
- carbon reuses for a sustainable future
- applications of CCS for the coal-powered electricity industry
- carbon dioxide scrubbing processes and applications
- carbon sequestration via mineral carbonation
- carbon burial and enhanced soil carbon trapping
- algae-based carbon capture
- carbon immobilization enhanced by photosynthesis
- enzymatic sequestration and biochar technology for CCS

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- carbon sequestration in the ocean
- modeling of carbon dioxide storage in deep geological formations

Engineers, scientists, students, government officers, process managers, and practicing professionals will find this book an essential reference on carbon capture and sequestration technology.

I have attached 4 documents that are herein incorporated as part of my comments by reference. These attachments are a History of San Diego Water; The 2015 budget of the Public Utilities Department; City Attorney Opinion restricting Council discussion of CEQA matters; and Section 215 of the SD City Charter on Public record etc.

NRDC
THE EARTH'S BEST DEFENSE

Heal the Bay

January 28, 2009

U.S. Environmental Protection Agency Region IX, WTR-5
75 Hawthorne Street
San Francisco, CA 94105-3901
Attn: Robyn Stuber
stuber.robyn@epa.gov

Re: NPDES Permit and 301(h) Waiver for Point Loma Wastewater Treatment Plant (NPDES Permit No. CA0107409, Tentative Order No. R9-2009-0001)

Dear Ms. Stuber,

We are writing to oppose the reissuance of a waiver of Clean Water Act standards for the E.W. Blom Point Loma Metropolitan Wastewater Treatment Plant and Ocean Outfall ("Plant" or "PLOO"). The Plant is one of the largest sewage treatment plants in California, dumping about 200 million gallons of wastewater into the Pacific Ocean every day. Despite the fact that publicly owned treatment works ("POTW") were required to upgrade to secondary treatment standards over 30 years ago, the Plant continues to operate under a waiver from these federal standards. In fact, the Plant is the *only* POTW in California with a waiver that is not in the process of upgrading to secondary treatment. As a policy matter, continuing to treat our oceans as a dumping ground for minimally-treated sewage is unjustified and unacceptable. As a legal matter, the Plant has failed to meet its burden of proof to obtain another 301(h) waiver under the Clean Water Act; EPA and the San Diego Regional Water Quality Control Board's tentative decision granting the waiver is thus unsupported by evidence.

Applicable Legal Standards

To be eligible to receive a 301(h) waiver, the applicant must demonstrate that it can meet the "environmentally stringent criteria" under the Clean Water Act.[1] In conjunction with nine criteria enumerated under section 301(h), the applicant must demonstrate that it complies with Clean Water Act standards for total suspended solids, biochemical oxygen demand, and pH. Additionally, the Clean Water Act requires that discharge under a 301(h) waiver not conflict with other applicable federal laws.[2] The state water quality requirements with which the

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[1] *In re Mayaguez Regional Sewage Treatment Plant Puerto Rico Aqueduct and Sewer Authority*, 4 E.A.D. 772 (1993); 33 U.S.C. § 1311(h).

[2] 40 C.F.R. § 125.59(b)(3).

applicant must show compliance are the requirements in the California Water Code, the California Ocean Plan, and the Basin Plan.[3] These requirements center on the protection and restoration of beneficial uses, and include limitations on bacteria and other pollutants that are harmful to human health and the coastal marine environment.[4] The stringent nature of these requirements means the applicant carries a heavy burden of proof.

In deciding whether to grant another 301(h) waiver, one of the chief obligations of the Regional Board and EPA is to make clear how the agencies arrived at their conclusion by presenting in a written determination a thorough analysis of the evidence and the applicable legal factors or standards.[5] Decisions must "connect the dots" and explain the rationale used by the agencies in reaching conclusions.

Monitoring Program

Failure to demonstrate compliance with any one of the 301(h) criteria precludes issuance of a waiver. One of the criteria is the establishment of a monitoring program pursuant to 40 C.F.R. § 125.63. The monitoring program in general must be "designed to provide data to evaluate the impact of the modified discharge on the marine biota, demonstrate compliance with applicable water quality standards or water quality criteria . . . and measure toxic substances in the discharge . . . ."[6] More specifically, the monitoring program must be designed to demonstrate compliance with 40 C.F.R § 125.62, including that:

- The applicant's outfall and diffuser are "located and designed to provide adequate initial dilution, dispersion, and transport of wastewater such that the discharge does not exceed at and beyond the zone of initial dilution . . . all applicable water quality standards."[7]
- The discharge must allow for "the attainment or maintenance of water quality which assures protection and propagation of a balanced indigenous population of shellfish, fish, and wildlife."[8]

At least three reports demonstrate that, among other deficiencies, the Plant's monitoring program is inadequate and therefore the Plant is unable to assure compliance with water quality standards, the protection and propagation of a balanced indigenous population, or compliance

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[3] *See* State Water Board WDR Order No. 98-15, at 3.

[4] *See id.* at 2-9.

[5] *See, e.g., Topanga Ass'n for a Scenic Community v. County of Los Angeles*, 11 Cal. 3d 506, 515 (1974).

[6] 40 C.F.R. § 125.63(a)(i)(A).

[7] 40 C.F.R. § 125.62(a)(1)(i).

[8] 40 C.F.R. § 125.63(c).

with the Ocean Plan. Moreover, it does not appear that EPA included these reports in its tentative decision analysis, despite the reports' clear relevance.[9]

Scripps Institute of Oceanography Report (2004)

After being hired by the City of San Diego to assess the adequacy of the Plant's monitoring program, Scripps Institute of Oceanography released its findings in 2004. Among other findings, Scripps bluntly concluded, "We don't know where the water goes, or where the plume goes."[10] Scripps described a number of other inadequacies in the Plant's monitoring program:

- "The City does not adequately monitor or understand the physical circulation of the coastal waters relevant to the Point Loma Ocean Outfall in terms of spatial and temporal variability and synoptic patterns (e.g., seasonal variability or in response to episodic events), or the geographic extent of the 'receiving waters.'"

- "The location, movement, and dispersal of the plume from the outfall is also inadequately monitored and understood."

- "Because of the lack of knowledge of the plume's location, its impact on the planktonic community is unclear. The spatial and temporal resolution, and the types of measurements currently made are inadequate to quantify the effects of chronic nutrient loading on the plankton relative to natural nutrient sources and other anthropogenic sources."

- "Understanding the impact of the outfall on the benthic environment requires modification of the existing monitoring program, primarily to provide more appropriate control stations. Currently the control sites, because they are substantially different in the character of their sediments from the other monitoring sites, and because they may be contaminated from sources other than Point Loma, do not provide a basis for evaluating benthic impacts with confidence."

- "Present monitoring does not include integration of littoral transport cells. Therefore, it is possible that contaminated sediments are accumulating downslope from the shelf, and because this area is not monitored, there is presently no way to know if the effects of the PLOO or other sources of contaminants are accumulating in these areas."[11]

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9 EPA, Tentative Decision of the Regional Administrator (Dec. 2, 2008), at 95-97.

10 Scripps Institute of Oceanography, "Point Loma Outfall Project" (Sep. 2004), at 26.

11 Scripps Institute of Oceanography, "Point Loma Outfall Project" (Sep. 2004), at 3.

Further, the report states that in 2004 the City was considering an increase in the Plant's daily discharge from 175 mgd to the Plant's full capacity of 240 mgd. In response, Scripps stated, "A major conclusion of this review is that *there is currently insufficient information to determine how the projected increase in the discharge at Point Loma would affect water quality* . . . ."[12] Although it does not appear that the Plant made changes to its monitoring program in light of Scripps' findings,[13] the Plant has in fact increased its daily discharge to 208 mgd for 2009, and is projected to further increase to 219 mgd for 2014.[14] It follows that the Plant's monitoring program is inadequate to determine how this current and projected increased discharge affects water quality.

Assessment of Water Conditions at Cabrillo National Monument (2006)

Just to the south of the Plant lies the Cabrillo National Monument, part of the National Park Service ("Cabrillo"). In 2006, scientists at the Marine Science Institute at the University of California, Santa Barbara and the Bodega Marina Laboratory released a study of the water quality conditions at Point Loma for the National Park Service's Water Resources Division.[15] Like the Scripps report, this report discusses the problems that arise from insufficient information about the effluent plume:

> This raises the possibility that the PLOO contributes to background concentrations of these constituents in the coastal ocean (i.e., farfield effects). Four of the analytes detected (copper, silver, cyanide and ammonia) were concentrated enough on average in effluent during 2004 to exceed EPA daily maxima or acute exposure criteria for marine life. Although the circumstances that could result in cross-shore transport of the PLOO effluent plume all the way to [Cabrillo] have not been described, it is possible that exposure to poorly diluted effluent could harm some biota. Such an exposure occurred in 1992 at [Cabrillo] when the outfall pipe was ruptured near shore. . . . [We] do not know if the PLOO can be reasonably ruled out as a source of these pollutants in the ocean near [Cabrillo]."[16]

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[12] *Id.* at 26 (emphasis original).

[13] See Application for Renewal of NPDES CA0107409 and 301(h) Modified Secondary Treatment Requirements, Point Loma Ocean Outfall, at I-1. The Plant made changes to its monitoring program in 2003 according to a SCCWRP study but there is no indication that they made changes after the Scripps' report in 2004.

[14] EPA Tentative Decision, at 17.

[15] Engle, D. and Largier, J., "Assessment of Coastal Water Resources and Watershed Conditions at Cabrillo National Monument, California" (Aug. 2006).

[16] *Id.* at 141.

University of California, San Diego Report (2007)

The City of San Diego also requested a scientific review of the impact of the Plant by the Environment and Sustainability Initiative at the University of California, San Diego. The report, which was released in 2007, did not conduct new research, but rather reviewed existing analyses and reports as requested by the City. Like in the 2004 report, the 2007 report found that the Plant's monitoring program was insufficient to track the effluent plume:

- "[T]he complexity of the oceanographic conditions in the Point Loma area demands more observations before any conclusions can be made about the transport of the plume."[17]

- "The physical oceanographic data at present is inadequate to predict with certainty either the location or the dilution rate of the plume."[18]

This report also noted that PCB levels in rockfish caught close to the outfall were "significantly higher" than PCB levels in fish north of the outfall. This may indicate an absence of a balanced indigenous population in the vicinity of the outfall. Yet due to the inadequacies of the monitoring program, there "currently is no way to know definitively whether the elevated levels" were due to the Plant or another source.[19]

Conclusion

This is not meant to be an exhaustive analysis of the Plant's application. Rather, these three reports demonstrate that in at least one of the criteria to obtain a waiver, the Plant has failed to meet its burden of proof—the monitoring program fails to assure compliance with water quality standards, the protection and propagation of a balanced indigenous population, or compliance with the Ocean Plan. For example, the Plant cannot demonstrate compliance with the Ocean Plan, which forbids the discharge of any waste into Areas of Special Biological Significance, because the Plant cannot meet its burden of showing that the plume does not enter either of the two Areas of Special Biological Significance that lie to the north of the Plant. Similarly, EPA and the Regional Board cannot conclude that the discharge meets water quality standards that allow for recreational use, because the Plant cannot meet its burden of showing that the effluent plume does not flow towards the shore and pose a potential health risk to the public. These are merely a few examples of how the Plant cannot meet its heavy burden to qualify for a waiver, because it lacks information needed to track the Plant's discharge.

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[17] Environment and Sustainability Initiative, University of California, San Diego, "Final Report: Point Loma Outfall Review" (Oct. 1, 2007), at 4.

[18] *Id.* at 16.

[19] *Id.* at 9.

Next Tuesday, the State Water Resources Control Board will pass a comprehensive policy to increase water recycling statewide to combat California's increasing water scarcity due to climate change, growth, and recent water rights court decisions. The use of water recycling has never been more important to augment local water supplies and to move California to sustainable water management.

San Diego's neighbors to the north have redoubled their water recycling efforts—Orange County Water District and West Basin Municipal Water District produce nearly 100 mgd of recycled wastewater, and recently the LA County Sanitation Districts agreed to a long term goal in the recently updated Santa Monica Bay Restoration Plan of over 200 mgd from their secondary treatment plant in Carson. Meanwhile, Point Loma continues to operate at primary treatment and San Diego continues to have a poor record on water recycling.

The Point Loma Plant needs to upgrade to full secondary treatment to create water recycling opportunities in San Diego. The region has aggressively moved forward on a controversial desalination plant in Carlsbad with considerable environmental impacts and extensive financial and energy costs, so clearly San Diego has already expressed an interest in finding new, reliable sources of local water. Upgrading the Plant is the smart way for San Diego to create this reliable source of local water.

Sincerely,

Michelle Mehta
Attorney, Water Program
Natural Resources Defense Council

David Beckman
Senior Attorney and Co-Director, Water Program
Natural Resources Defense Council

Mark Gold
President
Heal the Bay

cc: California Regional Water Quality Control Board, San Diego Region
9174 Sky Park Court, Suite 100
San Diego, CA 92123-4353
Attn: Melissa Valdovinos
mvaldovinos@waterboards.ca.gov

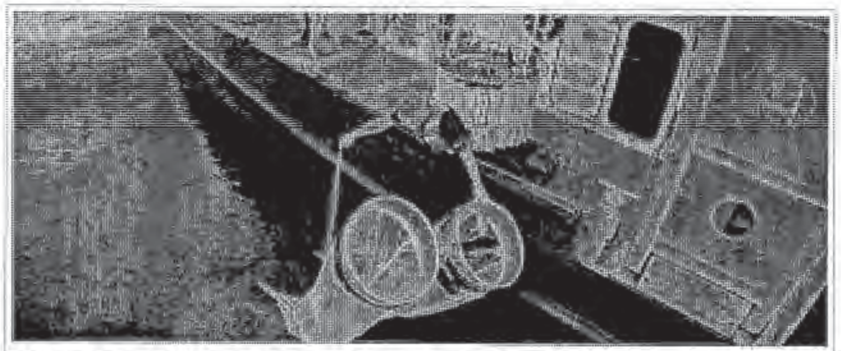
California's Fish Populations Are Declining

Two independent data sets show changing ocean conditions adversely impact fish off California

Oct 29, 2015

Media Contact: (http://scripps.ucsd.edu/news/contact-us) Mario Aguilera |

Phone: 858-534-3624 | Email: scrippsnews@ucsd.edu (mailto:scrippsnews@ucsd.edu)



Credit: James Wilkinson/Scripps Oceanography CalCOFI.

The California Current is home to many marine animals, including marine fishes, which are the most diverse vertebrates on Earth and critical to marine ecology. Two independent long-term time series now reveal strikingly similar trends of wide-ranging declines in fish populations in the California Current.

Tony Koslow and John McGowan, researchers from Scripps Institution of Oceanography at UC San Diego, and Eric Miller of MBC Applied Environmental Sciences of Costa Mesa, compared two independently collected data sets from the California Cooperative Oceanic Fisheries Investigations (CalCOFI) (http://www.calcofi.org/) and power plant cooling water intakes (PPI) from five sites along the California coastline.

The data show that fish abundance from both studies has declined sharply since 1970, with a 72 percent decline in overall larval fish abundance in the CalCOFI data set and a 78 percent decline in fishes from the PPI sampling. Although there was limited overlap in species between the nearshore PPI samples and the more offshore CalCOFI sampling, the correlation between the two time series was about 0.85. The study was published (http://www.int-res.com/abstracts/meps/v538/p221-227/) in

Videos

CalCOFI 15...

Climate th...

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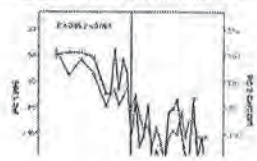
California Fish Decline



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"It is notable that these two very distinct data sets tell us that the larval fish populations collected by CalCOFI and near shore fish species observed by PPI data are both declining at nearly the same rates," said Scripps researcher John McGowan.

CalCOFI was formed 70 years ago. Originally designed to study the ecology of the west coast sardine population, the ongoing CalCOFI surveys of the physical and biological oceanography and fisheries off California is today the longest-serving multi-disciplinary ocean observation program in the world. CalCOFI is a unique partnership led by Scripps Oceanography, NOAA Fisheries Service, and the California Department of Fish & Wildlife.

"The similarity in trends between the two data sets is amazing given the differences in life history strategies monitored by the two programs. While the CalCOFI program samples larval fish, several of the species integral to the PPI data set were surfperch, fishes that do not have a larval stage," said Eric Miller of MBC.

These results also dispel previous speculation that commercial fishing or seawater intakes are always primary causes of fish population declines. The PPI data do not include many commercial fish species but do include species with no larval stage that could not be captured during CalCOFI surveys. The CalCOFI time series shows a decline in both commercial and non-commercial fish species. These facts point to a more basal cross-cutting factor, or factors, forcing the observed changes in fish populations.

"The CalCOFI data were originally used to track sardines and now track the larval abundance of a broad range of fish species in the California Current system. Larval fish abundance is a strong indicator of adult fish populations, and the regular CalCOFI sampling indicates decreased abundance primarily for cool-water species," said Koslow, a Scripps researcher and first author of the paper.

The study concludes that changes in the California Current ecosystem are the likely cause of this decline in fish abundance. Overall, fishes with an affinity for cool-water conditions, such as northern anchovy, Pacific hake, and several rockfish and midwater fish species are among the most abundant in the ecosystem. Over the thirty-year period, these have declined most dramatically off southern California. However, whether this is due to a movement of cool-water species northward or an overall decline throughout the California Current is a key question for future investigation.

"Changes in temperature, current, or other factors do not cause day-to- day changes in fish populations, but over a period of time, these changes are observed and reinforce the hypothesis that the California Current is changing," said McGowan.

"The fish populations in the California Current have declined for four decades with no signs of reversal. This reflects large-scale change in environmental conditions, potentially including the transport of the California Current, salinity, zooplankton productivity, and other factors," said Koslow.

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3 Comments Scripps Institution of Oceanography Login

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sayonara kitty • 16 days ago

taking into account the billion gallons of sewage that mike before me speaks of...i am curious if possibly anyone there has considered the 400 tons of highly radioactive water that has been hemorrhaging into the ocean each day for over five years, from fukushima daiichi? also, is "fish abundance decline" the same as a species collapse, and if so, has anyone checked the numbers from 2011 thru the present?

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Scripps Inst. of Oceanography Mod → sayonara kitty • 3 days ago

Scripps Oceanography helps monitor the marine environment off the coast of California though California Cooperative Oceanic Fisheries Investigations (CalCOFI) in cooperation with California Department of Fish & Wildlife and NOAA Fisheries Service. Among other samples, water collected during quarterly CalCOFI cruises and at Scripps Pier are sent to Ken Buesseler at Woods Hole Oceanographic Institution for analysis, with the results posted at http://ourradioactiveocean.org....

An update posted in December noted that "levels of contamination remain well below government-established safety limits for human health or to marine life."

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Mike Beanan • 5 months ago

Around one billion gallons of secondary sewage is discharged each day into Southern California ocean waters. Offshore islands create the Gulf of Santa Catalina so sewage is retained in local gyres to elevate water temps. If we love the ocean and want fish to survive, maybe we should stop dumping sewage into the sea.

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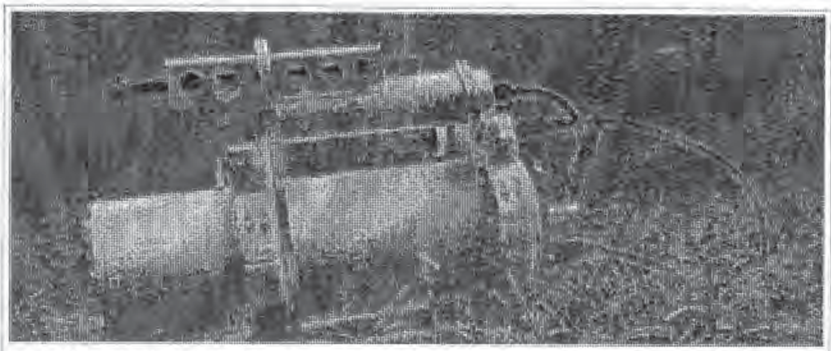
Leading Ocean Scientists Recommend Immediate, Coordinated Action Plan to Combat Changes to West Coast Seawater Chemistry

Scientific panel including Scripps Oceanography geochemist warns on accelerating rate of ocean acidification along West Coast

Apr 06, 2016

Media Contact: (http://scripps.ucsd.edu/news/contact-us) Robert Monroe |

Phone: 858-534-3624 | Email: scrippsnews@ucsd.edu (mailto:scrippsnews@ucsd.edu)



SeapHOx instruments developed by Scripps scientist Todd Martz observe conditions related to ocean acidification

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Global carbon dioxide emissions are triggering permanent changes to ocean chemistry along the North American West Coast that require immediate, decisive action to combat.

That action includes development of a coordinated regional management strategy, concluded a panel of scientific experts including Andrew Dickson, a professor of marine chemistry at Scripps Institution of Oceanography at UC San Diego.

A failure to adequately respond to this fundamental change in seawater chemistry, known as ocean acidification, is anticipated to have devastating ecological consequences for the West Coast in the decades to come, the 20-member West Coast Ocean Acidification and Hypoxia Science Panel warned in a comprehensive report unveiled April 4.

"Increases in atmospheric carbon dioxide emissions from human activities are not just responsible for global climate change; these emissions also are being absorbed by the world's oceans," said Alexandria Boehm, co-chair of the Panel and a professor of Civil and Environmental Engineering at Stanford University. "Our work is a catalyst for management actions that can address the impacts of ocean acidification we're seeing today and to get ahead of what's predicted as ocean chemistry continues to change."

Because of the way the Pacific Ocean circulates, the North American West Coast is exposed to disproportionately high volumes of seawater at elevated acidity levels. Already, West Coast marine shelled organisms are having difficulty forming their protective outer shells, and the West Coast shellfish industry is seeing high mortality rates during early life stages when shell formation is critical. The acidity of the world's oceans is anticipated to continue to accelerate in lockstep with rising atmospheric carbon dioxide emissions.

Dickson said the regional focus of the report sets it apart from other analyses of the risks of ocean acidification that have traditionally considered the problem at either a local scale or global scale. The report is also significant in accounting for the complexity of the issue. In particular, it recognizes the likely interactions between multiple simultaneous stresses acting on marine ecosystems, he said.

"This can be viewed at once a problem and a benefit," said Dickson. "The problem is there is no single fix for marine ecosystems; the benefit, that although reducing atmospheric CO_2 levels may seem a distant goal, reducing stresses of any type, and especially local contamination that increases CO_2 or reduces O_2 levels, can benefit marine ecosystems and may help them to be more resilient to those stresses that remain, including the longer-term threat of anthropogenic ocean acidification."

The panel was convened in 2013 to explore how West Coast government agencies could work together with scientists to combat the effects of ocean acidification and a related phenomenon known as hypoxia, or low dissolved oxygen levels.

The panel's final report, titled "Major Findings, Recommendations and Actions," summarizes the state of the science around this pressing environmental issue and outlines a series of potential management actions that the governments of the states of California, Oregon, and Washington, and the province of British Columbia, can immediately begin implementing to offset and mitigate the economic and ecological impacts of ocean acidification.

The panel is urging ocean management and natural resource agencies to develop highly coordinated, comprehensive multi-agency solutions, including:

- Exploring approaches that involve the use of seagrass to remove carbon dioxide from seawater.
- Supporting wholesale revisions to water-quality criteria that are used as benchmarks for improving water quality, as existing water-quality criteria were not written to protect marine organisms from the damaging effects of ocean acidification.

- Identifying strategies for reducing the amounts of land-based pollution entering coastal waters, as this pollution can exacerbate the intensity of acidification in some locations.
- Enhancing a West Coast-wide monitoring network that provides information toward development of coastal ecosystem management plans.
- Supporting approaches that enhance the adaptive capacity of marine organisms to cope with ocean acidification.

Although ocean acidification is a global problem that will require global solutions, the panel deliberately focused its recommendations around what West Coast ocean management and natural resource agencies can do collectively to combat the challenge at the regional level.

"One of the most exciting aspects of the panel's work is that it scales a challenging, global problem down to a local and regional level, providing a roadmap to guide measurable and meaningful progress immediately," said Deborah Halberstadt, executive director of the California Ocean Protection Council, a government agency that served as the impetus for the panel's formation.

West Coast policymakers will use the panel's recommendations to continue to advance management actions aimed at combatting ocean acidification and hypoxia. This work will be coordinated through the Pacific Coast Collaborative, a coalition of policy leads from the offices of the governors of California, Oregon, Washington, and the premier of British Columbia, which have been working together on West Coast ocean acidification since 2013. The Pacific Coast Collaborative has been engaging state and federal agencies across multiple jurisdictions to elevate the need for action along the West Coast.

The panel, which was convened for a three-year period that ended in February 2016, also has recommended the formation of a West Coast Science Task Force to continue to advance the scientific foundation for comprehensive, managerially relevant solutions to West Coast ocean acidification.

"Communities around the country are increasingly vulnerable to ocean acidification and long-term environmental changes," said NOAA Chief Scientist Richard Spinrad. "It is crucial that we comprehend how ocean chemistry is changing in different places, so we applaud the steps the West Coast Ocean Acidification and Hypoxia Science Panel has put forward in understanding and addressing this issue. We continue to look to the West Coast as a leader on understanding ocean acidification."

****

History of the Panel

In September 2012, the California Ocean Protection Council (OPC), a state agency charged with protecting California's ocean and coastal ecosystems, requested that the nonprofit California Ocean Science Trust (OST) convene a science advisory panel to recommend a long-term management strategy for combatting the effects of ocean acidification and hypoxia. The State of California then joined forces with the States of Oregon and Washington and the Province of British Columbia to broaden the panel's focus to include the entire North American West Coast, a region that is particularly vulnerable to ocean acidification. As a result, panel membership was expanded to reflect the depth of expertise from across the region, and surveys were conducted at the state, regional, and federal levels to understand decision-makers' science needs. These surveys, and the work of the Washington State Blue Ribbon Panel on Ocean Acidification, formed the foundation for the work of what then became the West Coast Ocean Acidification and Hypoxia Science Panel. Over a three-year period, the 20-member panel examined the full range of impacts related to changing ocean conditions, going beyond ocean acidification and hypoxia to include related stressors and impacts. Its final report, "Major Findings, Recommendations, and Actions," is supported by a series of lengthier panel technical guidance documents aimed at providing more detailed information for water-quality and natural resource managers and their scientific staffs. Although the panel's term ended in February 2016, the OPC is taking the lead in advancing its findings on behalf of partners in Oregon, Washington and British Columbia. For more information about the Panel, go to http://westcoastoah.org (http://westcoastoah.org).

About the California Ocean Protection Council

The Ocean Protection Council is a state agency whose mission is to ensure that California maintains healthy, resilient, and productive ocean and coastal ecosystems for the benefit of current and future generations. The Council was created pursuant to the California Ocean Protection Act, which was signed into law in 2004 by Governor Arnold Schwarzenegger. For more information, visit www.opc.ca.gov (http://www.opc.ca.gov).

About the California Ocean Science Trust

The California Ocean Science Trust is a nonprofit organization established by the State of California to build trust and understanding in ocean and coastal science. Serving as a liaison between governments, scientists, and citizens, the Ocean Science Trust supports decision-makers with sound, independent science. For more information, go to www.oceansciencetrust.org (http://www.oceansciencetrust.org).

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List of Documents Provided

NRDC Heal the Bay letter to EPA Opposing NPDES Permit N301(h) waiver for Pt. Loma WWTP, Jan 28, 2009.

CCC Federal Consistency Certification, City of San Diego, Secondary Treatment Waiver,Oct 7, 2009.

-Heal the Bay/NRDC Comment Letter, Oct 2 2009

West Coast Ocean Acidification and Hypoxia Science Panel, April 2016.

Ocean Outfall Study, Final Report, Department of Environmental Engineering Sciences for Florida Dept. of Environmental Protection, April 2006.

"The Effects of Sewage on Aquatic Ecosystems", Cambell, Kirstin. Web article science.opposing views.com

Electrocoagulation Report, Removal of Metals, Micro Algae and Phosphates,

10th Annual International Cleaning Technology Exposition, Conference March 3-5, 2003.

Removal of 6 Estrogenic Endocrine -Disrupting Compounds (EDCs) from Municipal Wastewater using Alumininum Electrocoagulation

Letter USF, Bench Test Removals of pathogens and viruses using electrocoagulation, August 2010.

"More Drinking Water for San Diego" by David Schubert. San Diego Union Tribune, September 12, 2008.

"Tijuana River Sewage Raises Ocean Pollution Levels" by Aleksandra Konstantinovic, Dec 2014. City New Service.

California Ocean Wastewater Discharge, Report and Inventory, Prepared by Heal the Ocean, March 2010.

California Fish Populations are Declining, Scrippts Institute of Oceanography. October 29, 2015.

Leading Ocean Scientist Recommend Immediate, Coordinated Action Plan to Combat Changes to West Coast Seawater Chemistry. Scrippts Scientific Panel, April 6, 2016.

1988/89 Grand Jury Reports, Water for the City of San Diego.

Cooperative Agreement with CSD for Non-opposition to CWA 301(h) Waiver, Jan 29, 2009.

Marco Gonzalez, Coast Law Group, LLP for Surfrider, San Diego Chapter, and San Diego Coastkeeper.

S.E.A.'
copy of
comments

Additional Electronic Documents

FAQS on Sewage Sludge/Biosolids Annual Reporting - 2014

http://www.waterencyclopedia.com/Po-Re/Pollution-of-the-Ocean-by-Sewage-Nutrients-and-Chemicals.html

https://www3.epa.gov/npdes/pubs/primer.pdf

https://www.epa.gov/npdes/municipal-wastewater

http://vtdigger.org/2015/12/08/state-secures-funds-for-sewage-plant-upgrades/

https://www.epa.gov/eg https://www.epa.gov/biosolids

http://noc.ac.uk/science-technology/seas-under-threat/marine-pollution/sewage

http://www.seaweb.org/resources/briefings/toxic.php

http://wwf.panda.org/about_our_earth/blue_planet/problems/pollution/

http://blog.nature.org/conservancy/2011/09/16/what-a-waste-why-human-sewage-is-laying-waste-to-coral-reefs-globally/

http://www.motherjones.com/politics/2006/03/marine-pollution-how-ocean-became-toxic-waste-dump

Pew: http://www.fws.gov/southeast/grants/pdf/oceans_summary.pdf

http://issues.org/21-1/safina-3/

GREAT One: http://www.iatp.org/files/Marine_Pollution_in_the_United_States.htm

http://library.cqpress.com/cqresearcher/document.php?id=cqrglobal2007100000

http://library.cqpress.com/cqresearcher/document.php?id=cqresrre2005110400

http://oceana.org/our-campaigns/stop_ocean_pollution/campaign

http://www.seashepherd.org/commentary-and-editorials/2015/04/03/the-dilemma-of-toxic-cultures-on-a-toxic-planet-698

ewg Environmental Working Group
http://www.ewg.org/research/water-treatment-contaminants

Water Board
http://www.swrcb.ca.gov/water_issues/programs/owts/docs/disinfection.pdf

STATE OF CALIFORNIA – NATURAL RESOURCES AGENCY

CALIFORNIA COASTAL COMMISSION
45 FREMONT STREET, SUITE 2000
SAN FRANCISCO, CA 94105-2219
VOICE AND TDD (415) 904-5200

ARNOLD SCHWARZENEGGER, *Governor*

W21a

ADDENDUM TO COMMISSION PACKET

FOR

ENERGY, OCEAN RESOURCES AND FEDERAL CONSISTENCY DIVISION

For Wednesday, October 7, 2009

This addendum contains correspondence for Item No. W 21a

Correspondence and ex parte disclosure forms

Consistency Certification CC-056-09

City of San Diego, Secondary Treatment Waiver

RECEIVED
OCT 0 5 2009
CALIFORNIA
COASTAL COMMISSION

FORM FOR DISCLOSURE OF EX PARTE COMMUNICATIONS

Name or description of project, LPC, etc.: San Diego Waiver (Wed)

Date and time of receipt of communication: 10/2/09 @ 9:15am

Location of communication: La Jolla, Calif.

Type of communication (letter, facsimile, etc.): meeting

Person(s) initiating communication: Bruce Reznik, Lisa Bont, Dave Grubb

Detailed substantive description of content of communication:
(Attach a copy of the complete text of any written material received.)

Discussed the history of this item and their surprise at the last hearing on this item. They are interested in working with the city and improving water reclamation by working together on this project.

Date: 10/2/09

Signature of Commissioner: [signature]

If the communication was provided at the same time to staff as it was provided to a Commissioner, the communication is not ex parte and this form does not need to be filled out.

If communication occurred seven or more days in advance of the Commission hearing on the item that was the subject of the communication, complete this form and transmit it to the Executive Director within seven days of the communication. If it is reasonable to believe that the completed form will not arrive by U.S. mail at the Commission's main office prior to the commencement of the meeting, other means of delivery should be used, such as facsimile, overnight mail, or personal delivery by the Commissioner to the Executive Director at the meeting prior to the time that the hearing on the matter commences.

If communication occurred within seven days of the hearing, complete this form, provide the information orally on the record of the proceeding and provide the Executive Director with a copy of any written material that was part of the communication.

Form for Disclosure of Ex Parte Communication

Date and time of communication: September 25, 2009, 10:00 AM

Location of communication: Hill Street Cafe, 524 S Coast Hwy, Oceanside, CA 92054-4009

Person(s) initiating communication: Bruce Reznik

Speaking on behalf of: San Diego Coastkeeper

Person(s) receiving communication: Esther Sanchez

Name and descripion of project:

Agenda Item 21.a., October 7, 2009
CC-056-09 (City of San Diego Secondary Treatment Waiver, San Diego) Resubmitted Consistency Certification by City of San Diego for secondary treatment waiver (i.e., Environmental Protection Agency (EPA) Reissuance, under Section 301(h) of the Clean Water Act, of a modified National Pollutant Discharge Elimination System (NPDES) Permit) for Point Loma Wastewater Treatment Plant Discharges offshore of San Diego, San Diego County. (MPD-SF)

Detailed substantive description of content of communication:

Discussed San Diego Coastkeeper's agreement with City of San Diego to study long term treatment of sewage to potable water instead of simply treating to secondary at Point Loma Outfall. Also discussed Commission possibly crafting conditions of approval for consistency determination.

Date

Signature of Commissioner

Commissioner Name (please print)

Coastal Commission Fax: 415.904.5400

WEDNESDAY, ITEM 21a

DISCLOSURE OF EX PARTE COMMUNICATIONS

Name or description of project:
CC-056-09 (City of San Diego Secondary Treatment Waiver, San Diego) Resubmitted Consistency Certification by City of San Diego for secondary treatment waiver (i.e., Environmental Protection Agency (EPA) Reissuance, under Section 301(h) of the Clean Water Act, of a modified National Pollutant Discharge Elimination System (NPDES) Permit) for Point Loma Wastewater Treatment Plant Discharges offshore of San Diego, San Diego County.

Date and time of receipt of communication:
September 21, 2009 at 11:00 am

Location of communication:
Oceanside City Hall

Type of communication:
In person meeting

Person(s) in attendance at time of communication:
Brent Eidson, Jim Barrett, Alan Langworthy, Susan McCabe

Person(s) receiving communication:
Esther Sanchez

Detailed substantive description of the content of communication:
(Attach a copy of the complete text of any written material received.)
I received a briefing from the project representatives in which they described the City of San Diego's secondary treatment waiver request and provided background on the history of the permitting process to date. The representatives described their efforts to work with staff and to respond to concerns raised at the August hearing. They explained the City's extensive and on-going monitoring efforts and informed me that wastewater discharges have been proven to comply with secondary treatment waiver requirements and California Ocean Plan standards, which contain policies comparable to the marine resource, fishing, and recreation protection policies of the Coastal Act. The City has also upgraded its facilities, improved wastewater reclamation facilities, and maintained mass emission levels below the levels initially recommended by the Commission and required by the RWQCB. The results of an additional water reclamation study discussed by opponents are pending. The City anticipates a positive staff recommendation and support from Surfider and Coastkeeper.

Date:

Signature of Commissioner: ____________________

Heal the Bay
1444 9th Street
Santa Monica CA 90401
ph 310 451 1550
fax 310 496 1902
info@healthebay.org
www.healthebay.org

October 2, 2009

Chairperson Neely and Commissioners
California Coastal Commission
45 Fremont Street Suite 2000
San Francisco, CA 94105-2219

Sent via Email [mdelaplaine@coastal.ca.gov]

Re: Comments on Consistency Certification No. CC-056-09 *Reissuance of CWA Section 301(h) Secondary Treatment Waiver for Point Loma Wastewater Treatment Plant Discharges offshore of San Diego* dated September 16, 2009.

Dear Chairperson Neely and Commissioners,

On behalf of Heal the Bay and the Natural Resources Defense Council ("NRDC"), we appreciate the opportunity to provide the following comments on the above referenced Consistency Certification. Heal the Bay is an environmental organization with over 13,000 members dedicated to improving water quality in Santa Monica Bay and Southern California coastal waters for people and marine life. NRDC is a national environmental organization which has 1.2 million members and activists, 250,000 of whom are Californians.

We are extremely disappointed to see that this Consistency Certification is being reheard by the Coastal Commission after an August 13, 2009 unanimous vote by the Commission to deny consistency. We agreed with the Commissioners who spoke against the waiver at the August 13th hearing and believe that all of these points are still valid. As there is no significant new information being presented in the Staff Report dated September 16, 2009, it is unclear why this item is being reheard. Bringing an item back for a re-vote only a month later sets a horrible precedent and sends a message to the public that this is a political decision, especially considering that there is no new information. The Commission requires six months to elapse before allowing a permit resubmission. By allowing a resubmission so soon after a decision, the Commission sends the message to the regulated community – if at first you don't succeed, just try again. We urge the Commission to stand firm on the well-grounded technical and policy concerns they articulated in August.

Regardless, we submit these comments in opposition to the Consistency Certification for the reissuance of a waiver of Clean Water Act standards for the E.W. Blom Point Loma Metropolitan Wastewater Treatment Plant and Ocean Outfall ("Plant" or "PLOO"). Our

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comments include some new insights since our last letter dated August 11th on additional issues that clearly demonstrate that the Plant has not met its burden of proof to obtain another 301(h) waiver under the Clean Water Act or the California Coastal Act.

The Plant is one of the largest sewage treatment plants in California, dumping nearly 200 million gallons of wastewater into the Pacific Ocean every day. Despite the fact that publicly owned treatment works were required to upgrade to secondary treatment standards over 30 years ago, the Plant continues to operate under a waiver from these federal standards. As mentioned in the Staff Report, "in California, the City of San Diego is the only municipal ocean discharger that has not either achieved or committed to implementing full secondary treatment." Staff Report at 2. From a technical standpoint, every other municipal POTW in California has proven upgrading to secondary treatment is entirely feasible. As a policy matter, allowing one major discharger to continue to treat our oceans as a dumping ground for minimally-treated sewage is unjustified and unacceptable, especially at a time when water recycling is a critical part of the solution to California's water crisis. A minimum of secondary treatment is essential for any water recycling effort. As a legal matter, the Plant has failed to meet its burden of proof to obtain another 301(h) waiver under the Clean Water Act and has failed to comply with Sections 30230 and 30231 of the California Coastal Act. The Coastal Commission Staff recommendation to concur with the City of San Diego's consistency certification is thus unsupported by evidence and inappropriate.

Applicable Legal Standards

As discussed in NRDC and Heal the Bay's January 28, 2009 letter to USEPA, the Plant has not met its burden of proof to obtain another 301(h) waiver under the Clean Water Act. To be eligible to receive a 301(h) waiver, the applicant must demonstrate that it can meet the "environmentally stringent criteria" under the Clean Water Act.[1] For many similar reasons, the discharge is also not consistent with applicable sections of the California Coastal Act. Specifically, we disagree with Staff's statement that the City's discharges under the renewal of the waiver from secondary treatment requirements would be consistent with the water quality and marine resources policies of the Coastal Act (Sections 30230, 30231). Staff Report at 3.

Section 30230 states,

"Marine resources shall be maintained, enhanced, and where feasible, restored. Special protection shall be given to areas and species of special biological or economic significance. Uses of the marine environment shall be carried out in a manner that will sustain the biological productivity of coastal waters and that will maintain healthy populations of all species of marine

[1] *In re Mayaguez Regional Sewage Treatment Plant Puerto Rico Aqueduct and Sewer Authority*, 4 E.A.D. 772 (1993); 33 U.S.C. § 1311(b).

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organisms adequate for long-term commercial, recreational, scientific, and educational purposes."

Section 30231 states,
"The biological productivity and the quality of coastal waters, streams, wetlands, estuaries, and lakes appropriate to maintain optimum populations of marine organisms and for the protection of human health shall be maintained and, where feasible, restored through, among other means, minimizing adverse effects of waste water discharges and entrainment, controlling runoff, preventing depletion of ground water supplies and substantial interference with surface waterflow, **encouraging waste water reclamation**, maintaining natural vegetation buffer areas that protect riparian habitats, and minimizing alteration of natural streams. [Emphasis added]"

The practice of dumping minimally treated sewage in the ocean is not consistent with these sections of the California Coastal Act, as it does not lead to maintenance, enhancement, or restoration of marine resources. Also as discussed in further detail below, current water reclamation efforts are inadequate and the monitoring program is insufficient as it does not adequately capture the movement of the plume and hence characterize the influence of the outfall on areas of special biological significance.

Water Reclamation

As cited above, the California Coastal Act looks towards water reclamation as a key component in protecting coastal waters and habitats. The Point Loma Plant must upgrade to at least full secondary treatment to create much needed water recycling opportunities in San Diego. The region has aggressively moved forward on a controversial desalination plant at Carlsbad with considerable environmental impacts and extensive financial and energy costs, so clearly San Diego has already expressed an interest in finding new, reliable sources of local water. Upgrading the Plant is a smart way for San Diego to create this reliable source of local water, yet San Diego refuses to embrace water recycling as a solution to significantly augment their increasingly scarce water supplies.

San Diego's neighbors to the north have redoubled their water recycling efforts—Orange County Water District, Los Angeles County Sanitation Districts, and West Basin Municipal Water District produce nearly 150 MGD of recycled wastewater, and recently the LA County Sanitation Districts agreed to a long term goal in the recently updated Santa Monica Bay Restoration Plan of over 200 MGD from their secondary treatment plant in Carson. Meanwhile, Pt. Loma continues to operate at primary treatment and San Diego continues to have a poor record on water recycling.

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Earlier this year, the State Water Resources Control Board passed a comprehensive policy to increase water recycling statewide to combat California's increasing water scarcity due to climate change, growth, and recent water rights court decisions. The state made water recycling easier and set a goal of an additional one million acre feet per year of recycled water statewide by 2020 and 2 million acre feet by 2030. The use of water recycling has never been more important to augment local water supplies and to move California to sustainable water management.

Unfortunately, San Diego has provided no water recycling goals or milestones for the coming years. The commitment that has apparently been reached by certain stakeholders and the City to go forward on a recycled water study is much different than an actual *commitment* to recycle a certain volume of water by a date certain. In light of the California water crisis and the recently approved State water recycling policy, commitments to doing studies are not enough.

The City projects that the total suspended solids loadings from the WTP will be capped at 15,000 MT/yr for the life of the permit. Further the BOD loading is expected to be greater than that of a secondary treatment plant with BOD removal not less than 58%. As the WTP has been discharging to the ocean for over 45 years, this is a significant loading of pollutants. Thus at a minimum, San Diego should commit to recycling enough water within 5 to 10 years so that the BOD loadings from Point Loma are the same as the projected BOD loadings if the POTW went to full secondary treatment. Upstream water recycling is a way to get the loadings to a full secondary treatment equivalent level. In addition, TSS reduction to 30 mg/l can be reached at the plant through advanced primary treatments. This commitment would be a creative way to comply with the requirements of the Clean Water Act and increase the use of a precious resource.

For instance, the approximate current TSS and BOD loadings are 21.6 million lbs/yr[2] and 61.1 million lbs/yr[3], respectively. Thus, this equates to an additional loading of 2.5 million lbs/yr TSS and 42 million lbs/yr BOD compared to the loading if the 30 mg/l TSS and 30 mg/l BOD requirements for secondary treatment were in place. This extra loading must be addressed, in order to protect the marine environment.

Although we strongly oppose a consistency determination by the Commission, in the event that the Commission changes their mind and determines that San Diego's application deserves a consistency determination, please adopt the following condition:

[2] Assume average TSS of 34 mg/l and flow of 208 MGD.
[3] Assume average BOD of 96 mg/l and flow of 208 MGD.

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By 2020, San Diego shall reduce the pollutant loadings of BOD from the Point Loma discharge to a loading equivalent of reaching full secondary treatment at 208 MGD. Also by 2020, Point Loma shall reduce TSS concentrations to 30 mg/l.

This condition provides an incentive for increased water recycling in the region and greatly enhanced primary treatment at the Point Loma POTW.

Discharge Impacts

New Disinfection Facilities

As stated in the USEPA's Tentative Decision, "[p]rototype effluent disinfection facilities have been installed at the Point Loma WTP to allow the discharge to comply with recreational body-contact bacteriological standards throughout the water column (ocean surface to ocean bottom) in all State regulated waters (within three nautical miles of the coast)." EPA Decision at 14. The City began adding sodium hypochlorite to the effluent discharge on September 3, 2008, after exceedances of single sample maximum and geometric mean bacterial objectives at shoreline stations. EPA Decision at 79.

We are concerned about disinfection byproducts formed by Point Loma WTP's new chlorination practices. As you know, sewage has high concentrations of organic matter, nitrates, nitrites and ammonia. Chlorination of sewage forms chloramines very quickly, and it also likely forms a wide variety of chlorinated organics. The formation of chlorinated petroleum based organics, furanones, fulvics and other non-volatile organics are of great concern. A major disinfection byproduct is the potent carcinogen N-nitrosodimethylamine (NDMA). Specifically, NDMA, an emerging disinfection byproduct from the use of chloramines as disinfectant, has been linked to the occurrence of gastric cancer[4]. As there is no de-chlorination, any residual chlorine or free chlorine available by the time the effluent hits ocean water may lead to the formation of a wide variety of brominated organics. These byproducts are toxic in the marine environment. Although additional monitoring is proposed, we are concerned that some of these toxic byproducts will, in fact, be formed and discharged to the marine environment, leading to marine impacts. Also, chlorinated effluent is far more toxic than effluent without disinfection. There is simply not enough information known about the potential impacts of this new process in preparation for the upcoming permit cycle.

There is no discussion of toxicity or water quality data for effluent post chlorination within the Staff Report. This is concerning because monitoring pre-chlorination gives a gross underestimate

[4] D Pobel, et al. (1995 Feb) Nitrosamine, nitrate and nitrite in relation to gastric cancer: a case-control study in Marseille, France. European Journal of Epidemiology.;11 (1):67-73

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of the concentrations and loadings of disinfection byproducts and the effluent toxicity. The loading of disinfection byproducts is enormous, especially from primary treated effluent. The lack of analysis of disinfection impacts and increased disinfection byproduct loadings is yet another example of San Diego failing to meet the burden of proof to earn a waiver.

Benthic Macrofauna Impacts

In order to meet its burden to obtain a 301(h) waiver under the CWA, the discharger must demonstrate that there is a balanced indigenous population of organisms outside the zone of initial dilution of discharge. The EPA decision document includes an assessment of the health of the benthic macrofauna community off of the discharge.

Although the EPA determined that the City met its burden to obtain a waiver under the Clean Water Act, the benthic marcofauna data nevertheless demonstrated that the biologically sensitive species – *Amphiodia* (brittle stars) are reducing in density in the area near the outfall, but outside the ZID. For example – brittle star densities at E-14 and E-11 were significantly different than reference conditions. Also, the *Amphiodia* densities decreased by over 75% at E-14 from the pre discharge time period (1991-1993) to the period 10-15 years later (2001-2005). Meanwhile, brittlestar densities at the reference areas remained stable or increased during this same time period. This is a typical ecological response that is seen in areas of high organic enrichment. The Point Loma discharge is clearly degrading the benthic macrofauna community with the pollution sensitive *Amphiodia*'s density reduction as a clear example.

A similar, but more dramatic occurrence occurred near the Los Angeles County Sanitation Districts outfall at White Point in Palos Verdes. As the most sensitive taxa to pollution, brittlestar populations were reduced dramatically, but other echinoderms such as sea urchins, sea stars and sea cucumbers were also reduced in numbers. The EPA decision document did not provide an analysis of these other sensitive species.

The pollutant tolerant taxa tell a similar story. When sewage discharges impair benthic soft bottomed communities, certain species of invertebrates like *Euphilomedes* crustaceans, *Capitella* worms and *Parvilucina tenuisculpta* (a bivalve) often increase in densities in areas of high organic enrichment. The case at Point Loma is no different. Reference locations had significantly lower densities of the crustacean and bivalve than sites close to the ZID. *Euphilomedes* densities at the E-14 site near the discharge increased dramatically from the pre-discharge time period to 10 to 15 years later. At the same time, densities of *Euphilomedes* actually decreased at the reference location B-9. The densities of the crustacean were significantly different higher at the near discharge sites compared to the reference locations.

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Again, this biological response is typical for benthic communities impacted by high organic enrichment such as primary treated sewage. The same trend is seen for *Parvilucina* bivalves and *Capitella* worms. The *Capitella* story is particularly dramatic. These polychaete worms are rarely seen in healthy soft bottomed communities in the San Diego portion of the Southern California Bight. In fact, none of the pollution tolerant worms were found in the monitored area prior to the discharge. Now the area near the outfall has densities of up to 17.5 per 0.1 m^2 while the reference locations are still only at 0.1 worms per 0.1 m^2. This is a dramatic difference that demonstrates that Point Loma's discharge is negatively impacting the benthic community structure.

Although EPA focused on numerous other metrics to determine if the discharger met the heavy burden of demonstrating that there is a BIP outside the ZID, there is no question that the data demonstrates that sewage discharges are having significant negative impacts on sensitive species (*Amphiodia)* and increasing the densities of pollutant tolerant taxa at sites near the ZID. The discharger has failed to meet the biological requirements of 301(h) and the Coastal Act. Further, EPA's reliance on biological indices to grant the waiver misses an very important point. Indices rely on a wide variety of metrics for numerous species. An endangered species could go extinct in an area and still get a decent score on an index. It is far more appropriate to focus on species of concern and pollution sensitive and pollution tolerant species. As such, the City has not met its burden to obtain yet another five year waiver from the secondary treatment requirements.

Emerging Contaminants

A recent study confirms that emerging contaminants can be an even greater risk from lower-treatment WWTPs. Ramirez et al. found that, "the degree and nature of treatment processes has a substantial influence over the removal efficiency of pharmaceuticals from wastewater discharge. As a result, exposure, and consequently tissue accumulation, would be expectedly higher in organisms residing in water resources receiving discharge from WWTPs employing less advanced versus more advanced treatment." (p. 26.)[5]

The study explained that, "[t]he most significant entry route for human pharmaceuticals into the aquatic environment is the point-source release from wastewater treatment plants (WWTPs)." The study continues: "Although WWTPs are capable of removing a large proportion of pharmaceuticals through various treatment processes, not all compounds are eliminated completely, with removal efficiencies varying according to the wastewater treatment processes employed at individual facilities, resulting in potential discharge to receiving waters." Thus, the study found that "[s]ites with more advanced wastewater treatment . . . tended to demonstrate

[5] Ramirez AJ at al. *Pharmaceuticals and Personal Care Products in the Environment*. Occurrence of Pharmaceuticals and Personal Care Products in Fish: Results of a National Pilot Study in the United States (unformatted, but citable, manuscript, 2009 Society of Environmental Toxicology and Chemistry)

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fewer detections, at lower concentrations and lower frequencies than sites with less advanced treatment" (p. 20.)

This study confirms that the risks to marine life exposed to the Plant's primary-treated effluent are at a higher risk for exposure to pharmaceuticals and personal care products than those in the zone of higher-treated effluent.

Two national-scale reconnaissance studies recently conducted by the USGS collected baseline information on the occurrence of pharmaceuticals and personal-care products (PPCPs), detergents, flame retardants, naturally occurring sterols, and other organic contaminants in ground water and untreated sources of drinking water in the United States. The results of these studies show the presence of these contaminants in 80% of the 139 streams tested across 30 states.[6] These contaminants are commonly derived from municipal, agricultural, and industrial wastewater sources and pathways[7].

Emerging contaminants exist in the environment in small amounts, but even these small amounts, alone or via the synergistic effects of multiple contaminants, can have significant effects on beneficial uses. Studies demonstrate that a number of these substances pose a threat to human health, marine ecosystems, and other wildlife.

Research demonstrates that pharmaceuticals and personal care products (PPCPs) are very important contributors to toxicity in wastewater[8]. Significant amounts of PPCPs enter the environment from various inputs, including animal feedlots, land application of organic materials, and wastewater treatment plants that treat residential, commercial, and/or industrial wastewater[9]. In addition disinfection byproduct such as NDMA and halogenated organics are also CECs. Numerous studies have shown detrimental impacts of PPCPs on wildlife. For example, studies have shown that certain synthetic musks found in fragrances (commonly found in perfumes, shampoos, and lotions) have been found to cause mutation in lab rats[10], and to inhibit the toxin defense system of certain marine mussels[11]. In addition, N-

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[6] Barnes, K. et al. (2002). Water-Quality Data for Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in U.S. Streams, 1999-2000 Iowa City, Iowa. USGS http://toxics.usgs.gov/pubs/OFR-02-94/index.html#abstract Accessed Nov 4, 2008.
[7] Daughton, C.G. (2004). Non-regulated water contaminants: emerging research. Environmental Impact Assessment Review 24 711– 732. U.S. EPA.
[8] Munoz, I. et al. (2008) Ranking potential impacts of priority and emerging pollutants in urban wastewater through life cycle impact assessment. posted Science Direct. Oct. 2008.
[9] Daughton, T. (1999). Pharmaceuticals and personal care products in the environment: agents of subtle change? Environmental Health Perspectives, December 1999, Vol. 107.
[10] Ibid.
[11] Luckenbach, Epel (2005). Nitromusk and Polycyclic Musk Compounds as Long-Term Inhibitors of Cellular Xenobiotic Defense Systems Mediated by Multidrug Transporters. Environmental Health Perspectives. Jan 2005. Vol 113, No. 1, p. 17-24.

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nitrosodimethylamine (NDMA), an emerging disinfection byproduct from the use of chloramines as disinfectant, has been linked to the occurrence of gastric cancer[12].

As for pharmaceuticals, the state of California has already taken action to reduce the incidence of them in the environment by passing Senate Bill 966, a bill aimed to prevent the flushing of unused medical prescriptions down the toilet. These constituents are often found in treated wastewater because they are continually input, are sometimes recalcitrant, and require high level treatment methods for removal.[13] The State's action demonstrates the recognition by California that regulatory actions are appropriate at this time to protect public health.

Studies performed in California have demonstrated evidence of exposure and effects of emerging contaminants on marine life on a local basis. According to study performed by the Pacific Estuarine Ecosystem Indicator Research Consortium (PEEIR), reproductive abnormalities and endocrine disruption is evident in longjawed mudsucker (*Gillichthys mirabilis)*, a salt marsh fish considered a sentinel species, at five wetland sites along California's coast where runoff and sewage treatment effluent are discharged[14]. In addition studies in southern California have revealed hormone alterations, and reproductive abnormalities in coastal flatfish near treatment plant outfalls due to exposure to emerging contaminants. Gender ratios of the hornyhead turbot (*Pleuronichthys verticalis*) showed a trend toward masculinization at the Orange County Sanitation District outfall.[15] Furthermore, endocrine disruption was potentially evident at this site as male fish were shown to have equivalent concentrations of blood egg yolk protein as those observed in female fish[16]. These are merely a few examples of the studied impacts of emerging contaminants on the environment. There are a multitude of concerns, given existing research demonstrates how marine life is already being impacted by these contaminants. Human health may be at risk as we directly consume affected species, irrigate crops with water containing harmful levels of PPCPs, perpetuate environmental bacteria developing a resistance to antibiotics that make their way into waterways, or even drink water containing traces of these constituents.

Due to the increased risk of CEC discharge from primary treatment plants and the potential marine life and human health impacts, this provides yet another case where the Plant has not demonstrated that it can meet the "environmentally stringent criteria" under the Clean Water Act.

[12] D Pobel, et al. (1995 Feb) Nitrosamine, nitrate and nitrite in relation to gastric cancer: a case-control study in Marseille, France. European Journal of Epidemiology.;11 (1):67-73
[13] Ibid.
[14] PEEIR: Pacific Estuarine Ecosystem Indicator Research Consortium. Reproductive Impairment of a Salt Marsh Fish as an Indicator of Pollutant Effects Brochure.
http://www.bml.ucdavis.edu/PEEIR/Brochures/Fish_Reproductive_Impairment.pdf Accessed Nov. 5, 2008
[15] Rempel, M. et al. (2006) Evaluation of relationships between reproductive metrics, gender and vitellogenin expression in demersal flatfish collected near the municipal wastewater outfall of Orange County, California, USA. Aquatic toxicology 2006, vol. 77, no.3, pp. 241-249
[16] Schlenk, D. (2006). Environmental Monitoring and Assessment of Environmental Estrogens in Marine, UC Marine Council. Coastal Environmental Quality Initiative.

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Monitoring Program

In order to ensure that marine resources are maintained as required by the California Coastal Act, an adequate monitoring program is necessary. Although Commission staff members have stated that the monitoring program has improved since the last waiver in 2002, we have yet to see these improvements. In fact at least three reports demonstrate that, among other deficiencies, the Plant's monitoring program is inadequate and therefore the Plant is unable to assure compliance with water quality standards, the protection and propagation of a balanced indigenous population, or compliance with the Ocean Plan.

- Scripps Institute of Oceanography Report (2004)
- Assessment of Water Conditions at Cabrillo National Monument (2006)
- University of California, San Diego Report (2007)

Scripps Institute of Oceanography Report (2004)

After being hired by the City of San Diego to assess the adequacy of the Plant's monitoring program, Scripps Institute of Oceanography released its findings in 2004. Among other findings, Scripps bluntly concluded, "We don't know where the water goes, or where the plume goes."[17] Scripps described a number of other inadequacies in the Plant's monitoring program:

- "The City does not adequately monitor or understand the physical circulation of the coastal waters relevant to the Point Loma Ocean Outfall in terms of spatial and temporal variability and synoptic patterns (e.g., seasonal variability or in response to episodic events), or the geographic extent of the 'receiving waters.'"

- "The location, movement, and dispersal of the plume from the outfall is also inadequately monitored and understood."

- "Because of the lack of knowledge of the plume's location, its impact on the planktonic community is unclear. The spatial and temporal resolution, and the types of measurements currently made are inadequate to quantify the effects of chronic nutrient loading on the plankton relative to natural nutrient sources and other anthropogenic sources."

- "Understanding the impact of the outfall on the benthic environment requires modification of the existing monitoring program, primarily to provide more appropriate control stations.

[17] Scripps Institute of Oceanography, "Point Loma Outfall Project" (Sep. 2004), at 26.

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Currently the control sites, because they are substantially different in the character of their sediments from the other monitoring sites, and because they may be contaminated from sources other than Point Loma, do not provide a basis for evaluating benthic impacts with confidence."

- "Present monitoring does not include integration of littoral transport cells. Therefore, it is possible that contaminated sediments are accumulating downslope from the shelf, and because this area is not monitored, there is presently no way to know if the effects of the PLOO or other sources of contaminants are accumulating in these areas."[18]

Further, the report states that in 2004 the City was considering an increase in the Plant's daily discharge from 175 mgd to the Plant's full capacity of 240 mgd. In response, Scripps stated, "A major conclusion of this review is that there is currently insufficient information to determine how the projected increase in the discharge at Point Loma would affect water quality ...."[19] According to the Staff Report, the Plant made changes to its monitoring program (Page 5); however, the details of the changes were not provided in the staff report. Also, it is not indicated that these changes were made in light of Scripps' findings. Since the Plant has increased its daily discharge to 208 mgd for 2009, and is projected to further increase to 219 mgd for 2014,[20] it follows that the Plant's current monitoring program is inadequate to determine how its current increased discharge affects water quality. As such, San Diego has failed to meet the burden of proof laid out in Section 301(h) of the Clean Water Act.

Assessment of Water Conditions at Cabrillo National Monument (2006)

Just to the south of the Plant lies the Cabrillo National Monument, part of the National Park Service ("Cabrillo"). In 2006, scientists at the Marine Science Institute at UC Santa Barbara, and the Bodega Marina Laboratory, released a study of the water quality conditions at Point Loma for the National Park Service's Water Resources Division.[21] Like the Scripps report, this report discusses the problems that arise from insufficient information about the effluent plume:

This raises the possibility that the PLOO contributes to background concentrations of these constituents in the coastal ocean (i.e., farfield effects). Four of the analytes detected (copper, silver, cyanide and ammonia) were concentrated enough on average in effluent during 2004 to exceed EPA daily maxima or acute exposure criteria for marine life. Although the circumstances that could result in cross-shore transport of the PLOO effluent plume all the way to [Cabrillo]

[18] Scripps Institute of Oceanography, "Point Loma Outfall Project" (Sep. 2004), at 3.
[19] *Id.* at 26 (emphasis original).
[20] EPA Tentative Decision, at 17.
[21] Engle, D. and Largier, J., "Assessment of Coastal Water Resources and Watershed Conditions at Cabrillo National Monument, California" (Aug. 2006).

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have not been described, it is possible that exposure to poorly diluted effluent could harm some biota. Such an exposure occurred in 1992 at [Cabrillo] when the outfall pipe was ruptured near shore. . . . [We] do not know if the PLOO can be reasonably ruled out as a source of these pollutants in the ocean near [Cabrillo]."[22]

University of California, San Diego Report (2007)

The City of San Diego also requested a scientific review of the impact of the Plant by the Environment and Sustainability Initiative at the University of California, San Diego. The report, which was released in 2007, did not conduct new research, but rather reviewed existing analyses and reports as requested by the City. Like in the 2004 report, the 2007 report found that the Plant's monitoring program was insufficient to track the effluent plume:

- "[T]he complexity of the oceanographic conditions in the Point Loma area demands more observations before any conclusions can be made about the transport of the plume."[23]

- "The physical oceanographic data at present is inadequate to predict with certainty either the location or the dilution rate of the plume."[24]

This report also noted that PCB levels in rockfish caught close to the outfall were "significantly higher" than PCB levels in fish north of the outfall. This may indicate an absence of a balanced indigenous population in the vicinity of the outfall. Yet due to the inadequacies of the monitoring program, there "currently is no way to know definitively whether the elevated levels" were due to the Plant or another source.[25]

Plume Study

In the latest Staff Report, the City *acknowledges* that "the behavior of the Point Loma wastewater plume (wastefield) is not well known at the present . . ." Staff Report at 10. This echoes the concerns articulated in other monitoring studies which Heal the Bay and NRDC brought to the Commission's attention in our August 11 letter and reiterated above. In this Staff Report, the City describes a study it is undertaking to learn more about the plume, but the results of this study will not be known until at least mid-2011. Staff Report at 11. This plume study is meant to "address two primary concerns of operating the ocean outfall in its current configuration: (1) possible effects to beach and near-surface water quality and (2) its risk to the coastal marine environment. This study addresses beach and surface water quality concerns by

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[22] *Id.* at 141.
[23] Environment and Sustainability Initiative, University of California, San Diego, "Final Report: Point Loma Outfall Review" (Oct. 1, 2007), at 4.
[24] *Id.* at 16.
[25] *Id.* at 9.

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determining whether the wastewater plume surfaces and encroaches upon beaches, and if so, the frequency of such behavior." (*Id.*)

Thus, this discussion in the latest Staff Report confirms that insufficient information is known at this time about the plume and its impacts in order for the City to meet its burden under the Clean Water Act. Further as the study will not be completed until at least mid-2011, the extent of impacts from the discharge is unknown for the upcoming permit cycle.

In sum, Point Loma WTP has not met its burden of proof to obtain another 301(h) waiver under the Clean Water Act or the Coastal Act. Lack of adequate information about the fate of the Plant's effluent plume, increased loadings, the discharge of disinfection byproducts and emerging contaminants, and the creation of benthic macrofauna impacts are just a few of the reasons why consistency should be denied. Further, the gaps in monitoring do not provide a complete picture of the impacts of the primary discharge. Thus, we urge the Commission to concur with the original, unanimous decision to deny consistency.

Thank you for the opportunity to comment. If you have any questions, please contact us at 310-451-1500.

Sincerely,

Mark Gold

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PLEASE DISTRIBUTE TO THE MEMBERS OF THE COMMISION

Oct. 3, 2009

Dear Commissioners and Staff of the Coastal Commission:

On Aug. 13, in San Francisco, the Coastal Commission refused "consistency" determination to the San Diego sewage waiver.

Purely based on instinct, San Diego continue to struggle to retain their waiver to avoid (at the least) full secondary treatment standards for sewage before it's dumped onto the Ocean. But really, why are we wasting water dumping it into the Ocean at all?

The Commission has given San Diego a chance to re-evaluate its position, and realize that the only sensible desalination is reclaiming wastewater; and that their big problem is the high cost of MWD water.

Expensive seawater desalting schemes, even if subsidies push off some of the cost onto more prudent Californians, are not going to supply the water we need. Barring some sort of divine water intervention, San Diego's water supply future is bleak, unless recycling of wastewater is contemplated.

Orange County has proven that it can be done, and done without hugely higher cost. San Diego has challenges, such as a lack of an aquifer, and Tijuana's sewage; but obstacles are made to be conquered, not avoided.

SAN DIEGO: THE LAST WAIVER.

San Diego is the very last, outside of small fishing communities, the last sewage waiver. What makes us think it's OK for San Diego to dump poorly treated sewage, while other places go to great lengths to treat the sewage? Well, San Diego HATES to install infrastructure, from fire stations to water, needed for the huge growth that fueled the wealth of the top honchos running the city.

So there really hasn't been much in the way of sewage investment at San Diego, it's pretty much all ***DEFERRED MAINTENANCE.*** But San Diego might feel picked-upon, because even if they cleaned up their sewage, Tijuana would still be dumping on them.

So the Coastal Commission has been asked to hear the item again, this time in Oceanside, Item 21 a, CC-056-09 (City of San Diego Secondary Treatment Waiver, San Diego) Resubmitted Consistency Certification by City of San Diego for secondary treatment waiver http://documents.coastal.ca.gov/reports/2009/10/W21a-10-2009.pdf

The STAFF is recommending to approve the waiver.
There are two problems with the staff report, and two issues to consider, as well as a synthesis of both sides and a pathway to resolution.

1. On page two, Staff fundamentally misrepresents the process of ***ENDING*** a waiver; the report states, erroneously, that even after a POTW gives up the waiver, "interim waivers" may be needed. However, the distinction is between GIVING UP THE WAIVER and retaining it.

If a POTW discharger decides to give up the waiver, and if the process will take longer than 5 years, a "Settlement Agreement" is reached, which gives the discharger a permit WITHOUT the waiver, but suspends enforcement of penalties for the period -- which may be 10, 15 or even 25 years, or more -- so long as a schedule to upgrade is followed.

But the point is, the discharger agrees to bring the sewage up to at least secondary standards; often, they want to do much more, as Orange County or Morro Bay, because, after all, water is scarce and not getting any cheaper.

It's not an immediate process at all; OCSD, for example, gave up the waiver in 2002, but received 10 years, longer than it needed, to come into compliance. There is NO SUCH THING as an "interim waiver", and Staff misrepresents the legal situation, muddying the basic idea.

The important thing is to come into compliance and avoid a waiver (which the EPA likes to call a "variance", but it's still dumping sewage!).

2. The Staff Report spends a lot of time regurgitating the "studies" purporting to prove that the sewage is actually good, or at least doing no harm. These are needed to prove that the sewage waiver is legal under the Clean Water Act, which otherwise would require secondary standards.

It's a big DIVERSION to waste time arguing that paid-off researchers are only going to find what you want them to find.

But wait a minute.

Isn't this just a ... diversion?? We're not looking to find it legal under the Clean Water Act, the Coastal Commission is doing a CONSISTENCY DETERMINATION, which is an entirely different piece of legal machinery.

The Commission is acting under authority of the 1972 Coastal Zone Management Act ("CZMA"), which extends and empowers the Coastal Act as a piece of federal legal machinery, giving the Commission the power to determine if an activity is in accordance with the enforceable policies of the ***COASTAL ACT***, with the force of federal law.

There is no bar from the Commission using the CZMA to invalidate the sewage waiver; and no argument that the sewage dumping is in accordance with the 1976 amendments to the Clean Water Act can be used to overturn such a finding by the Coastal Commission, unless there's some provision that sewage is immune from the Coastal Act.

Basically, the Commission has the power to determine if the dumping is in accordance with the "enforceable policies" of the Coastal Act. These are, to avoid damage to the recreational, habitat and other values of the near-shore Ocean. Sewage dumping can't be good for the reputation, if nothing else. "We're the last sewage beach on the Coast...".

It's true that, under Sect. 307, the Secretary of Commerce has the power to over-ride; and it's true that there is federal pre-emption for federal agencies, which are just charged with avoiding impacts and not violating local law "as much as possible".

But there's no exemption for City of San Diego, at least not without appeal; and good luck on that one, asking special permission to dump sewage into the Ocean.

The Commission should make its ruling, which it presaged in San Francisco, that the sewage waiver is outlandish, shameful, anachronistic, and not in accordance, not "consistent", with the Coastal Act.

Thus, if this is right, all Staff's arguments that the Waiver is in conformity with the Clean Water Act's 301(h) provision is not relevant to its status under the Coastal Act. If they dare, let Commerce reverse the facts and argue for the sewage.

3. A third point is that everyone, even those arguing for the Waiver, admits that water recycling is needed; some of the sewage dumpers even want to pay for seawater desalination schemes. San Diego is at "the end of the [MWD] pipe" and pays the highest rate for fresh water; yet dumps about 200 million gallons per day of wastewater instead of recycling it.

Of course, it's easier to cleanse the water ***BEFORE*** it's mixed in with the seawater, because in waste materials processing, source control is the name of the game. Trying to unpack biological waste and industrial waste, for example, is, well, just a plain waste of resources; much easier to control it before it's mixed.

Poseidon resources
http://www.youtube.com/watch?v=GVjVwfw_gGk
ran into trouble in Tampa Bay, their one running project, because they hadn't considered the fecundity of the
Ocean. The Reverse Osmosis filters become clogged with sea-life, which actually grows on the membrane. This requires constant backflushing, and treatment with expensive chemicals. On one occasion, during the recent Florida water crisis, they reported that the plant could only operate at two-thirds capacity, presumably because a third of the membranes needs flushing at all times, and cannot be in constant service.

Desalting sewage, or briny aquifers, might make sense, but desalting sewage mixed in the Ocean is like unpacking the puzzle after it's waterlogged. Much better to solve it the right way, cleanse the sewage first.

So the REAL issue is whether a CERTAIN, CONCRETE AGREEMENT should replace San Diego's VAGUE and INDEFINITE wish to recycle the water. And do it in accordance with a time-frame to make bringing San Diego's wastewater treatment into the modern age more than a pipe-dream and fantasy.

4. For those objecting to the cost, wait a minute!! This is JUST the sort of thing that Congress funded, back in 1972, when it passed the original Clean Water Act; but even if San Diego has to fund it all, where does the money go, other than into local businesses and the local economy??

It's not like we're asking the Japanese or Russians to treat our sewage; it's not like sending billions to buy oil that funds terrorists, leaving us only pollution.

It's funds that stay ***RIGHT HERE***, in the local community. It's hiring local firms to implement a long-term plan for sewage improvement, hiring locally and providing ***GOOD, LONG-TERM JOBS*** building plant to recycle the water.

Makes common sense. If San Diego needs federal funding to help treat Tijuana's sewage, let's lobby for it. But let's get started now, and start healing the Ocean.

A PATH TO AGREEMENT. All those concerned agree that water is valuable, and that the sewage will have to be recycled, not just dumped into the Ocean; for one thing, if desalination is to be used, it's a lot easier to do on sewage before it's dumped into seawater. So, really, the only issue is when, and how.

IF WE CAN UNDERSTAND THE PROCESS OF GIVING UP A WAIVER, that it's not instantaneous, it involves a commitment to improve sewage facilities in a real way during a specified time, we should all agree on giving up the waiver in exchange for a decade-or-more period of fixing the problem and implementing water recycling.

After all, San Diego agrees it's going to need more water, anyway; Mayor Sanders appears on a video segment extolling the virtues of desalination.

Holding on to the waiver while promising to upgrade is like crossing your fingers when testifying.

It can't be both ways.

The Coastal Commission should insist on ending the waiver, based on the Coastal Act, not the Clean Water Act, and San Diego should agree cheerfully. All should agree we need to work to retrieve the huge amounts of wastewater currently -- well, currently "wasted".

Doug Korthof
Director, Ocean Outfall Group
1020 Mar Vista
Seal Beach, CA 90740-5842
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714-496-1567

DIANNE JACOB
SUPERVISOR, SECOND DISTRICT
SAN DIEGO COUNTY BOARD OF SUPERVISORS

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Agenda Item: W21a
Consistency Certification CC-056-09
County of San Diego
In Support

September 30, 2009

California Coastal Commission
Chairperson Neely
45 Fremont Street, Suite 2000
San Francisco, CA 94105

Attention: Mark Delaplaine

SUBJECT: Coastal Commission Meeting, Wednesday October 7, 2009

Item W21a. Consistency Certification CC-056-09 (City of San Diego) Re-submitted Consistency Certification by City of San Diego for secondary treatment waiver (i.e., Environmental Protection Agency (EPA) Reissuance, under Section 301(h) of the Clean Water Act, of a modified National Pollutant Discharge Elimination System (NPDES) Permit) for Point Loma Wastewater Treatment Plant Discharges offshore of San Diego, San Diego County. (MPD-SF)

Dear Commissioners:

On behalf of the San Diego County Board of Supervisors, I support the reissuance of the 301(h) modified NPDES permit for the City of San Diego's E.W. Blom Point Loma Wastewater Treatment Plant.

The Point Loma Plant is a major component of the Metropolitan Sewerage System operated by the City of San Diego, with the participation of fifteen other municipalities and agencies, including the County of San Diego. Nearly one third of the total flow to the system originates from these participating agencies. As a participating agency, the County has a unique interest in decisions that affect the operation of the Metro system.

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(619) 531-5522 • FAX: (619) 696-7253 • TOLL FREE: 800-852-7322
250 E. MAIN STREET, SUITE 169 • EL CAJON, CALIFORNIA 92020-3941
www.diannejacob.com

The County feels strongly that the combination of chemically assisted primary treatment, the deep ocean outfall, located 320 feed deep and 4.5 miles from the shoreline, and the City of San Diego's exemplary record of compliance with the State Ocean Plan during the last 15 years have proven to be protective of the public health and environment in the local area. Also, comprehensive ocean monitoring over the past 15 years, along with scientific analysis, has not revealed any harmful impacts to the ocean environment.

The County of San Diego strongly supports the U.S. Environmental Protection Agency's Approval Decision, as well as the San Diego Regional Water Quality Control Board's unanimous decision to approve the modified permit, because it continues to protect the environment while being fiscally prudent with public resources.

Without the Waiver of secondary treatment, costs to County ratepayers are estimated to go from $10 million a year to approximately $17.7 million a year. A nearly double rate increase would be extremely burdensome on ratepayers when there is no valid reason to do so.

Therefore, I urge the California Coastal Commission to make the finding that San Diego's modified waiver complies with the California Coastal Management Program and that it will be conducted in a manner consistent with this program.

Sincerely,

Dianne Jacob

DIANNE JACOB
Chairwoman

DJ:nc

CITY OF POWAY

DON HIGGINSON, Mayor
CARL KRUSE, Deputy Mayor
MERRILEE BOYACK, Councilmember
JIM CUNNINGHAM, Councilmember
BETTY REXFORD, Councilmember

Agenda Item: W21a
Consistency Certification CC-056-09
City of Poway
In Support

September 29, 2009

California Coastal Commission
Chairperson Neely
45 Fremont Street, Suite 2000
San Francisco, CA 94105-2219

Attention: Mark Delaplaine

Subject: Coastal Commission Meeting, Wednesday, October 7, 2009

Item W21a. Consistency Certification CC-056-09 (City of San Diego)
Resubmitted Consistency Certification by City of San Diego for secondary treatment waiver (i.e., Environmental Protection Agency (EPA) Reissuance under Section 301(h) of the Clean Water Act, of a modified National Pollutant Discharge Elimination System (NPDES) Permit) for Point Loma Wastewater Treatment Plant Discharges offshore of San Diego, San Diego County. (MPD-SF)

Dear Commissioners:

The City of Poway would like to express its full support for the reissuance of the 301(h) modified NPDES permit for the City of San Diego's E. W. Blom Point Loma Wastewater Treatment Plant.

The Point Loma Wastewater Treatment Plant is a major component of the Metropolitan (Metro) Sewerage System, which is operated by the City of San Diego with the participation of fifteen other municipalities and agencies. Nearly one-third of the total flow to the Metro system originates from these participating agencies, and as a participating agency, the City of Poway has a unique interest in decisions that affect the operation of the system. Additionally, as a member of the greater San Diego area community, we are also concerned that the public health and environment of our local waters are protected.

The City of Poway has been actively involved in all the secondary waiver processes at Point Loma, and our elected officials are educated in this subject. We believe strongly that the combination of chemically assisted primary treatment, the deep ocean outfall (located 320 feet deep and 4.5 miles from the shoreline), and the City of San Diego's exemplary record of compliance with the State Ocean Plan during the last 15 years have proven to be protective of the public health and environment in the local area. Additionally, the comprehensive ocean monitoring over the past 15 years, along with scientific analysis, has not revealed any harmful impacts to the ocean environment. The City of Poway supports the U.S. Environmental Protection Agency's Approval Decision, as well as the San Diego Regional Water Quality Control Board's unanimous decision to approve the modified permit, because this decision continues to protect the environment while being fiscally prudent with public resources.

Therefore, the City of Poway urges the California Coastal Commission to make the finding that San Diego's modified waiver complies with the California Coastal Management Program and that it will be conducted in a manner consistent with this program.

Very truly yours,

Don Higginson

Don Higginson
Mayor

City of Imperial Beach, California

www.cityofib.com

OFFICE OF THE MAYOR

September 24, 2009

Chairperson Neely and Commissioners
California Coastal Commission
45 Fremont Street, Suite 2000
San Francisco, CA 94105-2219

Subject: Reissuance of the Permit for the Point Loma Wastewater Treatment Plant

Dear Chairperson Neely and Commissioners,

The City Council of Imperial Beach supports the City of San Diego's request for the Coastal Commission to approve the reissuance of the secondary water treatment waiver for the Point Loma Wastewater Treatment Plant. We believe the waiver is environmentally responsible and will allow San Diego to use ratepayer funds in a prudent manner during the term of the permit. Granting the waiver will also be consistent with your staff's recommendation of August 13, 2009.

In the longer term we hope that San Diego will continue its work to enhance the region's capacity to use reclaimed water and identify future opportunities to increase recycling of water.

Our support for the use of reclaimed water should not in any way be interpreted as support for delaying or rejecting the waiver.

Please approve the Secondary Treatment Waiver for the Point Loma Wastewater Treatment Plant. Thanks in advance for moving ahead on this topic.

Sincerely,

James C. Janney
Mayor
City of Imperial Beach

cc: Diana Lilly and Commission Staff

825 Imperial Beach Blvd., Imperial Beach, CA 91932 Tel: (619) 423-8303 fax: (619) 628-1395

CALIFORNIA
NATIONAL CITY
1887
INCORPORATED

September 24, 2009

California Coastal Commission
Chairperson Neely
45 Fremont Street, Suite 2000
San Francisco, CA 94105-2219

Attention: Mark Delaplaine

SUBJECT: Coastal Commission Meeting, Thursday, August 13, 2009

Item 11b. Federal Consistency CC-043-09 (City of San Diego) Consistency Certification by City of San Diego for secondary treatment waiver (i.e., Environmental Protection Agency (EPA) Reissuance under section 301 (h) of the clean Water Act, of a modified National Pollutant Discharge Elimination System (NPDES) Permit for Point Loma Wastewater Treatment Discharges offshore of the San Diego, San Diego County. (MPD-SF)

Dear Commissioners:

The City of National City would like to express its support of the reissuance of the 301 (h) modified NPDES permit for the City of San Diego's E. W. Blom Point Loma Wastewater Treatment Plant.

The Point Loma Wastewater Treatment Plant is a major component of the Metropolitan Sewerage System, which is operated by the City of San Diego, with the participation of fifteen other municipalities and agencies. Nearly one third of the total flow to the system originates from these participating agencies. As a participating agency, the City of National City and its residents have a vested interested in any decisions that affect the operation of the Metro system.

As a participating member of the Metro JPA the City of National City has been actively involved in the secondary waiver at the Point Loma Treatment Plant. We feel that the combination of chemically assisted primary treatment, deep ocean outfall (located 320 feet deep and 4.5 miles from the shoreline) and the City of San Diego's exemplary record of compliance with the State Ocean Plan during the last 15 years have proven to be protective of the public health and environment in the local area. As well, comprehensive ocean monitoring over the past 15 years, along with scientific analysis, has not revealed any harmful impacts to the ocean's environment. The City of National City supports the U. S. Environmental Protection Agency's approval decision, as well as the San Diego Regional Water Quality Control Board's unanimous decision to approve the modified permit, because this decision continues to protect the environment while being fiscally prudent with public resources.

Therefore, the City of National City urges the California Coastal Commission to make the finding that San Diego's modified waiver complies with the California Coastal Management Program and that it will be conducted in a manner consistent with the program.

Sincerely,

Ron Morrison

Ron Morrison
Mayor

cc. City Council
City Manager
Public Works Director

Mayor Ron Morrison
1243 National City Boulevard, National City, CA 91950-4301
619/336-4233 Fax 619/336-4239 www.nationalcityca.gov

CITY OF CORONADO
OFFICE OF THE MAYOR
CASEY TANAKA

1825 STRAND WAY • CORONADO, CA 92118 • (619) 522-7320 • CTANAKA@CORONADO.CA.US

Agenda Item: W21a
Consistency Certification CC-056-09
City of Coronado
In Support

September 29, 2009

California Coastal Commission
Chairperson Neely
45 Fremont Street, Suite 2000
San Francisco, CA 94105-2219

Attention: Mark Delaplaine

SUBJECT: Coastal Commission Meeting, Wednesday, October 7, 2009.

Item W21a. Consistency Certification CC-056-09 (City of San Diego) Re-submitted Consistency Certification by City of San Diego for secondary treatment waiver (i.e., Environmental Protection Agency (EPA) Reissuance under section 301(h) of the Clean Water Act, of a modified National Pollutant Discharge Elimination System (NPDES) Permit) for Point Loma Wastewater Treatment Plant Discharges offshore of San Diego, San Diego County. (MPD-SF)

Dear Commissioners:

The City of Coronado would like to express its complete support for the reissuance of the 301(h) modified NPDES permit for the City of San Diego's E. W. Blom Point Loma Wastewater Treatment Plant.

The Point Loma Wastewater Treatment Plant is a major component of the Metropolitan Sewerage System, which is operated by the City of San Diego with the participation of fifteen other municipalities and agencies. Nearly one-third of the total flow to the system originates from these participating agencies. As a participating agency, the City of Coronado has a unique interest in decisions that affect the operation of the Metro system. As a coastal city with approximately 9.75 miles of ocean coastline, home to the world-renowned Coronado Central Beach and Hotel del Coronado, Coronado's beaches are located south of the Point Loma outfall and north of the South Bay outfall. Due to our proximity to these outfalls, our community has a heightened concern that the public health and environment of our local waters are protected.

The City of Coronado has been actively involved in all the secondary waiver processes at Point Loma, and the City Council is educated in this subject. We feel strongly that the combination of chemically-assisted primary treatment, the deep ocean outfall (located 320 feet deep and 4.5 miles from the shoreline) and the City of San Diego's exemplary record of compliance with the State Ocean Plan during the last 15 years have proven to be protective of the public health and environment in the local area. As well, comprehensive ocean monitoring over the past 15 years, along with scientific analysis, has not revealed any harmful impacts to the ocean environment. The City of Coronado supports the U. S. Environmental Protection Agency's Approval Decision, as well as the San Diego Regional Water Quality Control Board's unanimous decision to approve the modified permit, because this decision continues to protect the environment while being fiscally prudent with public resources.

Therefore, the City of Coronado urges the California Coastal Commission to make the finding that San Diego's modified waiver complies with the California Coastal Management Program and that it will be conducted in a manner consistent with this program.

Sincerely,

Casey Tanaka

Casey Tanaka
Mayor

CT/lh

METRO WASTEWATER **JPA**

276 Fourth Avenue Chula Vista, CA 91950 619-476-2557

www.metrojpa.org

Ernest Ewin, Chairman

Agenda Item: W21a
Consistency Certification CC-056-09
Metro Joint Powers Authority (JPA) San Diego
In Support

October 1, 2009

California Coastal Commission
Chairperson Neely
45 Fremont Street, Suite 2000
San Francisco, CA 94105-2219

Attention: Mark Delaplaine

SUBJECT: Coastal Commission Meeting, Wednesday, October 7, 2009.

Item W21a. Consistency Certification CC-056-09 (City of San Diego)
Re-submitted Consistency Certification by City of San Diego for secondary treatment waiver (i.e., Environmental Protection Agency (EPA) Reissuance under section 301(h) of the Clean Water Act, of a modified National Pollutant Discharge Elimination System (NPDES) Permit) for Point Loma Wastewater Treatment Plant Discharges offshore of San Diego, San Diego County. (MPD-SF)

Dear Commissioners:

The Metro Wastewater Commission and JPA (together "Metro JPA") would like to express their complete support for the reissuance of the 301 (h) modified NPDES permit for the City of San Diego's E. W. Blom Point Loma Wastewater Treatment Plant.

The Point Loma Wastewater Treatment Plant is a major component of the Metropolitan Sewerage System, which is operated by the City of San Diego, with the participation of fifteen other municipalities and agencies. Nearly one third of the total flow to the system originates from these participating agencies and, therefore, the Metro JPA, the coalition of municipalities and special districts sharing in the use of the City of San Diego's regional wastewater facilities, has an interest in decisions that affect the operation of the Metro system. Additionally, with coastal communities as participating agencies, we have a concern that the public health and environment of our local waters are protected.

The Metro JPA has been actively involved in all the secondary waiver processes at Point Loma, and the elected officials of the participating agencies are educated in this subject. We feel strongly that the combination of chemically assisted primary treatment, the deep ocean outfall (located 320 feet deep and 4.5 miles from the shoreline) and the City of San Diego's exemplary record of compliance with the State Ocean Plan during the last 15 years have proven to be protective of the public health and environment in the local area. As well, comprehensive ocean monitoring over the past 15 years, along with scientific analysis, has not revealed any harmful impacts to the ocean environment. The Metro JPA supports the U. S. Environmental Protection Agency's Approval Decision, as well as the San Diego Regional Water Quality Control Board's unanimous decision to approve the modified permit, because this decision continues to protect the environment while being fiscally prudent with public resources.

Therefore, the Metro JPA urges the California Coastal Commission to make the finding that San Diego's modified waiver complies with the California Coastal Management Program and that it will be conducted in a manner consistent with this program.

Sincerely,

Ernest Ewin
Chair Metro Wastewater JPA and Metro Commission

CITY OF
CHULA VISTA
OFFICE OF THE MAYOR

CHERYL COX
MAYOR

September 25, 2009

California Coastal Commission
Chairperson Neely
45 Fremont Street, Suite 2000
San Francisco, CA 94105-2219

Attention: Mark Delaplaine

SUBJECT: Coastal Commission Meeting, Wednesday, October 7, 2009

Item 21a. Federal Consistency CC-056-09 (City of San Diego Secondary Treatment Waiver, San Diego) Resubmitted Consistency Certification by City of San Diego for secondary treatment waiver (i.e., Environmental Protection Agency (EPA) Reissuance, under Section 301(h) of the Clean Water Act, of a modified National Pollutant Discharge Elimination System (NPDES) Permit) for Point Loma Wastewater Treatment Plant Discharges offshore San Diego, San Diego County. (MPD-SF)

Dear Commissioners:

The City of Chula Vista supports the reissuance of the 301(h) modified NPDES permit for the City of San Diego's Point Loma Wastewater Treatment Plant.

The Point Loma Wastewater Treatment Plant is a major component of the Metropolitan Sewerage System, which is operated by the City of San Diego, with the participation of 15 other municipalities and agencies. Nearly one-third of the total flow to the system originates from these participating agencies. As the second largest participating agency, the City of Chula Vista has a definite interest in decisions that affect the operation of the Metro system.

As the City of Chula Vista Metro Wastewater Joint Powers Authority representative, on September 1, 2009, I provided our City Council with an update of this issue. The combination of chemically assisted primary treatment, the deep ocean outfall (located 320 feet deep and 4.5 miles from the shoreline) and the City of San Diego's exemplary record of compliance with the State Ocean Plan during the last 15 years, have protected public health and the local environment.

276 Fourth Avenue • Chula Vista • California 91910 • (619) 691-5044 • Fax (619) 476-5379
ccox@chulavistaca.gov

Comprehensive Ocean monitoring over the past 15 years and scientific analysis has not revealed any harmful impacts to the ocean environment. The City of Chula Vista supports the U.S. Environmental Protection Agency's approval decision and the San Diego Regional Water Quality Control Board's unanimous decision to approve the modified permit. This decision continues to protect the environment while being fiscally prudent with public resources.

The City of Chula Vista urges the California Coastal Commission to make the finding that San Diego's modified waiver complies with the California Coastal Management Program and that it will be conducted in a manner consistent with this program.

Respectfully,

Cheryl Cox
Mayor

Cc: Scott Tulloch, Assistant City Manager
Richard Hopkins, Director of Public Works

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City of Imperial Beach, California

www.cityofib.com

OFFICE OF THE MAYOR

September 24, 2009

Chairperson Neely and Commissioners
California Coastal Commission
45 Fremont Street, Suite 2000
San Francisco, CA 94105-2219

Subject: Reissuance of the Permit for the Point Loma Wastewater Treatment Plant

Dear Chairperson Neely and Commissioners,

The City Council of Imperial Beach supports the City of San Diego's request for the Coastal Commission to approve the reissuance of the secondary water treatment waiver for the Point Loma Wastewater Treatment Plant. We believe the waiver is environmentally responsible and will allow San Diego to use ratepayer funds in a prudent manner during the term of the permit. Granting the waiver will also be consistent with your staff's recommendation of August 13, 2009.

In the longer term we hope that San Diego will continue its work to enhance the region's capacity to use reclaimed water and identify future opportunities to increase recycling of water.

Our support for the use of reclaimed water should not in any way be interpreted as support for delaying or rejecting the waiver.

Please approve the Secondary Treatment Waiver for the Point Loma Wastewater Treatment Plant. Thanks in advance for moving ahead on this topic.

Sincerely,

James C. Janney
Mayor
City of Imperial Beach

CITY OF LEMON GROVE "Best Climate On Earth"

Office of the Mayor

Agenda Item: W21a
Consistency Certification CC-056-09
City of Lemon Grove
In Support

October 1, 2009

California Coastal Commission
Chairperson Neely
45 Fremont Street, Suite 2000
San Francisco, CA 94105-2219

Attention: Mark Delaplaine

SUBJECT: Coastal Commission Meeting, Wednesday, October 7, 2009

Item W21a. Consistency Certification CC-056-09 (City of San Diego)
Re-submitted Consistency Certification by City of San Diego for secondary treatment waiver (i.e., Environmental Protection Agency (EPA) Reissuance under section 301(h) of the Clean Water Act, of a modified National Pollutant Discharge Elimination System (NPDES) Permit) for Point Loma Wastewater Treatment Plant Discharges offshore of San Diego, San Diego County. (MPD-SF)

Dear Chairperson:

The City of Lemon Grove Sanitation District would like to express its full support for the reissuance of the 301 (h) modified NPDES permit for the City of San Diego's E. W. Blom Point Loma Wastewater Treatment Plant.

The Point Loma Wastewater Treatment Plant is a major component of the Metropolitan Sewerage System, which is operated by the City of San Diego, with the participation of fifteen other municipalities and agencies (including the City of Lemon Grove). Nearly one third of the total flow to the system originates from these participating agencies and, therefore, the Metro JPA, the coalition of municipalities and special districts sharing in the use of the City of San Diego's regional wastewater facilities, has an interest in decisions that affect the operation of the Metro system. Additionally, with coastal communities as participating agencies, we have a concern that the public health and environment of our local waters are protected.

The City of Lemon Grove Sanitation District has been actively involved in the secondary waiver processes at Point Loma, and our elected officials are educated in this subject. We feel strongly that the combination of chemically assisted primary treatment, the deep ocean outfall (located

320 feet deep and 4.5 miles from the shoreline) and the City of San Diego's exemplary record of compliance with the State Ocean Plan during the last 15 years have proven to be protective of the public health and environment in the local area. As well, comprehensive ocean monitoring over the past 15 years, along with scientific analysis, has not revealed any harmful impacts to the ocean environment. The City of Lemon Grove supports the U. S. Environmental Protection Agency's Approval Decision, as well as the San Diego Regional Water Quality Control Board's unanimous decision to approve the modified permit, because this decision continues to protect the environment while being fiscally prudent with public resources.

Therefore, the City of Lemon Grove urges the California Coastal Commission to make the finding that San Diego's modified waiver complies with the California Coastal Management Program and that it will be conducted in a manner consistent with this program.

Sincerely,

Mary T. Sessom

Mary T. Sessom, Chairperson
Lemon Grove Sanitation District Board of Directors

Cc: Jerry Jones, Lemon Grove Sanitation District Board Member / Metro JPA Liaison
Jerry Selby, Lemon Grove Sanitation District Board Member
Mary England, Lemon Grove Sanitation District Board Member
George Gastil, Lemon Grove Sanitation District Board Member
Graham Mitchell, Executive District Director
Patrick Lund, District Engineer

PADRE DAM
Municipal Water District

September 29, 2009

California Coastal Commission
Chairperson Neely
45 Fremont Street, Suite 2000
San Francisco, CA 94105-2219

Attention: Mark Delaplaine

SUBJECT: Coastal Commission Meeting, October 7, 2009
Consistency Certification No. CC-056-09 (City of San Diego)
Reissuance of the Modified Permit for the Point Loma Wastewater Treatment Plant

Dear Commissioners:

Padre Dam Municipal Water District ("Padre Dam") would like to express its complete support for the reissuance of the 301 (h) modified NPDES permit for the City of San Diego's Point Loma Wastewater Treatment Plant.

Padre Dam along with fourteen other municipalities and agencies contract for wastewater treatment services through the City of San Diego. Collectively we are responsible for approximately 35 percent of the cost associated with the Metropolitan Sewerage System and therefore have a vested interest in decisions that affect the operation of the system.

We continue to support the City in its applications efforts, not only to spare our ratepayers an unnecessary financial burden, but also because the application for a modified permit is scientifically supported and meets the requirements of the Clean Water Act.

Therefore, Padre Dam urges the California Coastal Commission to concur with the consistency certification made by the City of San Diego for the proposed waiver, finding that the waiver is consistent with the enforceable policies of the California Coastal Management Program.

Sincerely,

Douglas S. Wilson
CEO/General Manager

OFFICE 9300 FANITA PARKWAY, SANTEE CA 92071 MAIL POST OFFICE BOX 719003, SANTEE CA 92072-9003
TEL 619 448 3111 FAX 619 449 9469 WEB WWW.PADREDAM.ORG

Mark Delaplaine

From:	doug korthof [doug@seal-beach.org]
Sent:	Sunday, October 04, 2009 2:33 PM
To:	Mark Delaplaine
Subject:	Sewage and Desal: joint issue Oct. 7 in Oceanside

Hello,

It's one Ocean, and what San Diego dumps into it concerns everyone ("THE WORST, THE MOST, THEY'RE DUMPING ON OUR COAST").

San Diego should give up its shameful sewage waiver, and start recycling its wastewater -- as all should agree is the ultimate goal.

But more importantly, San Diego's reticence to end the sewage waiver is going to COST US MONEY.

Whatever San Diego decides to do with its wastewater, it affects us all, right in the pocketbook.

There's 200 million gallons of wastewater discarded every day down the sewage pipe; and San Diego is short of fresh water. Instead of reclaiming or recycling this immense waste, San Diego is planning, extolling, crowing about its commitment to POSEIDON'S SEAWATER-SEWAGE DESALTING SCHEME.

Poseidon claims that desalting the sewage after it's mixed with seawater will only cost $1100 per Acre-Foot (twice what the most expensive water now costs San Diego); but ALL OF SOUTHERN CALIFORNIA will be taxed with paying a subsidy of $250 per Acre-Foot via the Metropolitan Water District (MWD). But that's not the worst of it.

Poseidon claims that, if the project is a disaster, as I fully expect, that they will be the ones who lose out, that it won't cost the cities or Agencies a red cent. As we see, that's just not true; but it's not just the "cost shifting" that's threatening to rip-off unknowing California taxpayers.

Poseidon's cost claims are based on NO DOCUMENTATION. Poseidon brings only failure to the table; their project in Tampa Bay had to be taken over by the locals. So what are their credentials, and what is their financing? We look into it and find that there is LITTLE or NOTHING.

In reality, Poseidon has applied to the State for tax-free state bonds that would fund their proposed plant to the tune of $485,000,000 (485 M dollars). If the plant proves worthless, guess who pays for those bonds (plus interest -- it's a low interest, but does grow). We the Taxpayers, that's who.

This $485M may only be the FIRST installment, if as expected construction costs rise.

As any creditor finds, when the first tranche of money is spent by the debtor, and, like Trump, the threat is to lose it all, it's easy to throw good money after bad, instead of just admitting failure. So once Poseidon has spent the money, we will be called on to advance more, or else lose it all.

But that's not the worst of it. If, as expected, Poseidon lays down 30-year-contracts for supplying water at a fixed price, and if, on the basis of that supply, new development goes in, there's no guarantee that the cost won't rise. In the face of "force majeure", that is, inability to perform, all contracts can be VOIDED and the price adjusted to meet costs, as we see in the case of General Motors' and other companies' "promises".

Thus, the Taxpayer and Ratepayer are really on the hook for unlimited sums, untold barrels of money that Poseidon may extort from all California based on San Diego's folly in not securing adequate water supplies and not treating the sewage properly.

San Diego, overwhelmed by growth, reaches out to Poseidon like the thirsty man in the desert reaching for a beautiful mirage of unlimited, shining water. Like the desert mirage, Poseidon likely will yield only acrid dirt and empty illusions.

Instead of funding Poseidon, what if San Diego properly treated, and began recycling, its wastewater?

Perhaps desalting schemes might work, if used on tertiary-treated wastewater. Perhaps San Diego should look to success stories, such as Orange County.

To do this, all San Diego has to do is start.

By agreeing to end the sewage waiver, perhaps in 15 years, San Diego need not simply throw money at the obsolete, creaking, overloaded plant on Point Loma; for less than the ultimate cost of the Poseidon scheme, San Diego could build new, more rational sewage treatment plants, ones sited far from the Coast, ones that don't depend on flushing out the sewage after an 11-hour settling process that leaves the toxins in the discharges.

There are two paths before San Diego: one, the path of success, proven recycling of wastewater, chosen by Orange County and other places; the other, the path of failure, guided by the uncertain lantern of a firm called Poseidon, which has no track record of success, little credibility, and questionable financial resources. Are they, in fact, any more than a "three guys and a coat-rack" kind of operation?

San Diego should save us all a bundle of money, and treat its sewage. Don't put us all on the hook for Poseidon's flickering lantern. There's debt, waste and folly, not water, in that mirage.

/Doug

Oceanside City Council Chambers, 300 North Coast Hwy., Oceanside, CA 92054 WEDNESDAY, OCTOBER 7, 2009.

> The SEWAGE WAIVER is being heard as ITEM 21 a, ostensibly in the very late afternoon; but watch it, when the Commission wants to slip a fast one, they can "trail" an item to the morning, to suit the developer or polluter. They did this, for example, at Santa Barbara to cater to Hellman.

"...21. FEDERAL CONSISTENCY...
a. CC-056-09 (City of San Diego Secondary Treatment Waiver, San Diego) Resubmitted Consistency Certification by City of San Diego for secondary treatment waiver (i.e., Environmental Protection Agency (EPA) Reissuance, under Section 301(h) of the Clean Water Act, of a modified National Pollutant Discharge Elimination System (NPDES) Permit) for Point Loma Wastewater Treatment Plant Discharges offshore of San Diego, San Diego County. (MPD-SF)..." http://documents.coastal.ca.gov/reports/2009/10/W21a-10-2009.pdf
----

California Coastal Commission, Voice 415-904-5200
45 Fremont Street, Suite 2000
San Francisco, CA 94105-2219
415-904-5400 (FAX)
619-767-2384 (San Diego FAX)

PLEASE DISTRIBUTE TO THE MEMBERS OF THE COMMISION

Oct. 2, 2009

Dear Commissioners and Staff of the Coastal Commission:

On Aug. 13, in San Francisco, the Coastal Commission refused "consistency" determination to the San Diego sewage waiver.

Purely based on instinct, San Diego continues to struggle to retain their waiver to avoid (at the least) full secondary treatment standards for sewage before it's dumped onto the Ocean. But really, why are we wasting water dumping it into the Ocean at all?

The Commission has given San Diego a chance to re-evaluate its position, and realize that the only sensible desalination is reclaiming wastewater; and that their big problem is the high cost of MWD water.

Expensive seawater desalting schemes, even if subsidies push off some of the cost onto more prudent Californians, are not going to supply the water we need. Barring some sort of divine water intervention, San Diego's water supply future is bleak, unless recycling of wastewater is contemplated.

Orange County has proven that it can be done, and done without hugely higher cost. San Diego has challenges, such as a lack of an aquifer, and Tijuana's sewage; but obstacles are made to be conquered, not avoided.

SAN DIEGO: THE LAST WAIVER.

San Diego is the very last, outside of small fishing communities, the last sewage waiver. What makes us think it's OK for San Diego to dump poorly treated sewage, while other places go to great lengths to treat the sewage? Well, San Diego HATES to install infrastructure, from fire stations to water, needed for the huge growth that fueled the wealth of the top honchos running the city.

So there really hasn't been much in the way of sewage investment at San Diego, it's pretty much all DEFERRED MAINTENANCE. But San Diego might feel picked-upon, because even if they cleaned up their sewage, Tijuana would still be dumping on them.

So the Coastal Commission has been asked to hear the item again, this time in Oceanside, Item 21 a, CC-056-09 (City of San Diego Secondary Treatment Waiver, San Diego) Resubmitted Consistency Certification by City of San Diego for secondary treatment waiver http://documents.coastal.ca.gov/reports/2009/10/W21a-10-2009.pdf

The STAFF is recommending to approve the waiver.
There are two problems with the staff report, and two issues to consider, as well as a synthesis of both sides and a pathway to resolution.

1. On page two, Staff fundamentally misrepresents the process of ENDING a waiver; the report states, erroneously, that even after a POTW gives up the waiver, "interim waivers" may be needed. However, the distinction is between GIVING UP THE WAIVER and retaining it.

If a POTW discharger decides to give up the waiver, and if the process will take longer than 5 years, a "Settlement Agreement" is reached, which gives the discharger a permit WITHOUT the waiver, but suspends enforcement of penalties for the period -- which may be 10, 15 or even 25 years, or more -- so long as a schedule to upgrade is followed.

But the point is, the discharger agrees to bring the sewage up to at least secondary standards; often, they want to do much more, as Orange County or Morro Bay, because, after all, water is scarce and not getting any cheaper.

It's not an immediate process at all; OCSD, for example, gave up the waiver in 2002, but received 10 years, longer than it needed, to come into compliance. There is NO SUCH THING as an "interim waiver", and Staff misrepresents the legal situation, muddying the basic idea.

The important thing is to come into compliance and avoid a waiver (which the EPA likes to call a "variance", but it's still dumping sewage!).

2. The Staff Report spends a lot of time regurgitating the "studies" purporting to prove that the sewage is actually good, or at least doing no harm. These are needed to prove that the sewage waiver is legal under the Clean Water Act, which otherwise would require secondary standards.

It's a big DIVERSION to waste time arguing that paid-off researchers are only going to find what you want them to find.

But wait a minute.

Isn't this just a ... diversion?? We're not looking to find it legal under the Clean Water Act, the Coastal Commission is doing a CONSISTENCY DETERMINATION, which is an entirely different piece of legal machinery.

The Commission is acting under authority of the 1972 Coastal Zone Management Act ("CZMA"), which extends and empowers the Coastal Act as a piece of federal legal machinery, giving the Commission the power to determine if an activity is in accordance with the enforceable policies of the COASTAL ACT, with the force of federal law.

There is no bar from the Commission using the CZMA to invalidate the sewage waiver; and no argument that the sewage dumping is in accordance with the 1976 amendments to the Clean Water Act can be used to overturn such a finding by the Coastal Commission, unless there's some provision that sewage is immune from the Coastal Act.

Basically, the Commission has the power to determine if the dumping is in accordance with the "enforceable policies" of the Coastal Act. These are, to avoid damage to the recreational, habitat and other values of the near-shore Ocean. Sewage dumping can't be good for the reputation, if nothing else. "We're the last sewage beach on the Coast...".

It's true that, under Sect. 307, the Secretary of Commerce has the power to over-ride; and it's true that there is federal pre-emption for federal agencies, which are just charged with avoiding impacts and not violating local law "as much as possible".

But there's no exemption for City of San Diego, at least not without appeal; and good luck on that one, asking special permission to dump sewage into the Ocean.

The Commission should make its ruling, which it presaged in San Francisco, that the sewage waiver is outlandish, shameful, anachronistic, and not in accordance, not "consistent", with the Coastal Act.

Thus, if this is right, all Staff's arguments that the Waiver is in conformity with the Clean Water Act's 301(h) provision is not relevant to its status under the Coastal Act. If they dare, let Commerce reverse the facts and argue for the sewage.

3. A third point is that everyone, even those arguing for the Waiver, admits that water recycling is needed; some of the sewage dumpers even want to pay for seawater desalination schemes. San Diego is at "the end of the [MWD] pipe" and pays the highest rate for fresh water; yet dumps about 200 million gallons per day of wastewater instead of recycling it.

Of course, it's easier to cleanse the water BEFORE it's mixed in with the seawater, because in waste materials processing, source control is the name of the game. Trying to unpack biological waste and industrial waste, for example, is, well, just a plain waste of resources; much easier to control it before it's mixed.

Poseidon resources
http://www.youtube.com/watch?v=GVjVwfw_gGk
ran into trouble in Tampa Bay, their one running project, because they hadn't considered the fecundity of the Ocean. The Reverse Osmosis filters become clogged with sea-life, which actually grows on the membrane. This requires constant backflushing, and treatment with expensive chemicals. On one occasion, during the recent Florida water crisis, they reported that the plant could only operate at two-thirds capacity, presumably because a third of the membranes needs flushing at all times, and cannot be in constant service.

Desalting sewage, or briny aquifers, might make sense, but desalting sewage mixed in the Ocean is like unpacking the puzzle after it's waterlogged. Much better to solve it the right way, cleanse the sewage first.

So the REAL issue is whether a CERTAIN, CONCRETE AGREEMENT should replace San Diego's VAGUE and INDEFINITE wish to recycle the water. And do it in accordance with a time-frame to make bringing San Diego's wastewater treatment into the modern age more than a pipe-dream and fantasy.

4. For those objecting to the cost, wait a minute!! This is JUST the sort of thing that Congress funded, back in 1972, when it passed the original Clean Water Act; but even if San Diego has to fund it all, where does the money go, other than into local businesses

and the local economy??

It's not like we're asking the Japanese or Russians to treat our sewage; it's not like sending billions to buy oil that funds terrorists, leaving us only pollution.

It's funds that stay RIGHT HERE, in the local community. It's hiring local firms to implement a long-term plan for sewage improvement, hiring locally and providing GOOD, LONG-TERM JOBS building plant to recycle the water.

Makes common sense. If San Diego needs federal funding to help treat Tijuana's sewage, let's lobby for it. But let's get started now, and start healing the Ocean.

A PATH TO AGREEMENT. All those concerned agree that water is valuable, and that the sewage will have to be recycled, not just dumped into the Ocean; for one thing, if desalination is to be used, it's a lot easier to do on sewage before it's dumped into seawater. So, really, the only issue is when, and how.

IF WE CAN UNDERSTAND THE PROCESS OF GIVING UP A WAIVER, that it's not instantaneous, it involves a commitment to improve sewage facilities in a real way during a specified time, we should all agree on giving up the waiver in exchange for a decade-or-more period of fixing the problem and implementing water recycling.

After all, San Diego agrees it's going to need more water, anyway; Mayor Sanders appears on a video segment extolling the virtues of desalination.

Holding on to the waiver while promising to upgrade is like crossing your fingers when testifying.

It can't be both ways.

The Coastal Commission should insist on ending the waiver, based on the Coastal Act, not the Clean Water Act, and San Diego should agree cheerfully. All should agree we need to work to retrieve the huge amounts of wastewater currently -- well, currently "wasted".

Doug Korthof
Director, Ocean Outfall Group
1020 Mar Vista
Seal Beach, CA 90740-5842
562-430-2495
714-496-1567

Mark Delaplaine

From: JonV3@aol.com

Sent: Monday, October 05, 2009 12:00 AM

To: Mark Delaplaine

Subject: Comments on San Diego Waiver Agenda Item: Wed Oct 7, Item 21a

October 4, 2009

Dear Mr. Delaplaine:

Please distribute the following comments to the Coastal Commissioners for the Wednesday October 7, 2009 meeting, agenda item W21a -10-2009. Thank you.

Jan D. Vandersloot, MD

Letter To Chair Kruer and California Coastal Commission:

California Coastal Commission
45 Fremont Street, Suite 2000
San Francisco, CA 94105-2219

Re: W21a-10-2009
Recommend Deny the Waiver

c/o Mark Delaplaine
mdelaplaine@coastal.ca.gov

Dear Chair Kruer and Coastal Commissioners:

This is a request that you uphold your decision on August 13, 2009 to deny the San Diego 301 (h) waiver. There is no new information that would cause you to change your decision and it is appropriate for you to vote again to deny San Diego the last 301 (h) waiver on the California coast. It is time that San Diego joined the ranks of civilized responsible sewage dischargers in coastal California and treated its sewage to full secondary before discharging into the Pacific Ocean.

The slides presented at the Coastal Commission meeting in August did indeed show harm to the ocean with a loss of biodiversity in the benthic response index by about a third, from 150 to 102, near the outfall. This means that more pollution tolerant species are living there, an adverse impact that will get worse after the volumes of discharge are increased over the next several years.

The City of San Diego need look no further than the Orange County Sanitation District on how to go about treating its sewage without a waiver. Under pressure by the citizens group Ocean Outfall Group, as well as many other opponents of the waiver, OCSD gave up its waiver in 2002, and moved towards full secondary treatment by 2012, only three years from now. OCSD is showing how to institute full secondary using limited space by installing vertical trickling filters among other innovative strategies to achieve full secondary treatment without a waiver. By doing so, it is supplying the Orange County Water District clean enough wastewater to be run through the GWRS water reclamation system.. These trickling filters are stacked vertically and simulate natural conditions to clean the sewage.

Vertical trickling filters are one of the technologies that exist for implementation of secondary treatment by San Diego. Although vertical trickling filters could be located on the limited space available at Point Loma, in reality, these trickling filters and other secondary treatment methods should be located inland from the Point Loma treatment plant. The Point Loma treatment plant itself is obsolete, run down, and an embarrassment to society. San Diego should be ashamed for the sorry condition of the plant located on the side of a cliff. Perhaps photographs of the treatment plant facilities are not allowed because they don't want the public to know how bad it is. The City of San Diego should not be rewarded for the shabby condition of the plant by giving it another waiver. Instead, denial of the waiver will force the city to upgrade its facilities to the 21st century. Ultimately, this plant on the cliff should be dismantled and the sewage treated to full secondary at inland locations where the wastewater can be reclaimed in a process similar to GWRS in Orange County.

Feasible technology exists for full secondary if San Diego is required to give up the waiver. Otherwise, there is no sure way that they will ultimately follow the rules that the rest of California has to follow and treat its sewage to full secondary, a necessary step to go to full reclamation of wastewater.

In this day and age, water is increasingly a scarce resource. Reclaiming wastewater like Orange County is the wave of the future. Denying the waiver for San Diego and requiring full secondary treatment of wastewater will allow this resource to be used for reclamation.

San Diego has no excuses to avoid proper full secondary treatment. You should not be led down the primrose path by promises of further studies on recycling water and promises on studies on plume behavior, etc. If San Diego were serious about these promises, the studies would have been done ago. Denying the waiver ensures that the city will have to go beyond mere promises and actually take concrete action to solve its wastewater problem, which in turn leads to a solution for its water supply problems as well.

Thank you for your past action in denying the waiver. Please ratify your decision and vote again to deny the waiver on Wednesday.

Sincerely,

Jan D. Vandersloot, MD
Director, Ocean Outfall Group
2221 E 16th Street
Newport Beach, CA 92663
949-548-6326

Mark Delaplaine

From: Charlotte Pirch [dpirch@socal.rr.com]
Sent: Monday, October 05, 2009 3:15 PM
To: Mark Delaplaine
Subject: Agenda Item W 21a-10-2009. Oppose San Diego Waiver

October 5, 2009

California Coastal Commission
45 Fremont Street, Suite 2000
San Francisco, CA 94105-2219

Re: W21a-10-2009
Recommend Deny the Waiver

c/o Mark Delaplaine
mdelaplaine@coastal.ca.gov <mailto:mdelaplaine@coastal.ca.gov>

Dear Chair Kruer and Coastal Commissioners:

This is a request that you uphold your decision on August 13, 2009 to deny the San Diego 301 (h) waiver. There is no new information that would cause you to change your decision and it is appropriate for you to vote again to deny San Diego the last 301 (h) waiver on the California coast. It is time that San Diego joined the ranks of civilized responsible sewage dischargers in coastal California and treated its sewage to full secondary before discharging into the Pacific Ocean.

The slides presented at the Coastal Commission meeting in August did indeed show harm to the ocean with a loss of biodiversity in the benthic response index by about a third, from 150 to 102, near the outfall. This means that more pollution tolerant species are living there, an adverse impact that will get worse after the volumes of discharge are increased over the next several years.

The City of San Diego need look no further than the Orange County Sanitation District on how to go about treating its sewage without a waiver. Under pressure by the citizens group Ocean Outfall Group, as well as many other opponents of the waiver, OCSD gave up its waiver in 2002, and moved towards full secondary treatment by 2012, only three years from now. OCSD is showing how to institute full secondary using limited space by installing vertical trickling filters among other innovative strategies to achieve full secondary treatment without a waiver. By doing so, it is supplying the Orange County Water District clean enough wastewater to be run through the GWRS water reclamation system.. These trickling filters are stacked vertically and simulate natural conditions to clean the sewage.

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In this day and age, water is increasingly a scarce resource. Reclaiming wastewater like Orange County is the wave of the future. Denying the waiver for San Diego and requiring full secondary treatment of wastewater will allow this resource to be used for reclamation.

San Diego has no excuses to avoid proper full secondary treatment. You should not be led down the primrose path by promises of further studies on recycling water and promises on studies on plume behavior, etc. If San Diego were serious about these promises, the studies would have been done ago. Denying the waiver ensures that the city will have to go beyond mere promises and actually take concrete action to solve its wastewater problem, which in turn leads to a solution for its water supply problems as well.

Thank you for your past action in denying the waiver. Please ratify your decision and vote again to deny the waiver on Wednesday.

Sincerely,
Charlotte Sumrow-Pirch
9826 Lewis Avenue, Fountain Valley
714-968-5634

Mark Delaplaine

From: Donald Schulz [surfdad@hotmail.com]

Sent: Monday, October 05, 2009 1:50 PM

To: Mark Delaplaine

Subject: San Diego 301(h) waiver (oppose).

Dear Chair Kruer and Coastal Commissioners:

This is a request that you uphold your decision on August 13, 2009 to deny the San Diego 301 (h) waiver. There is no new information that would cause you to change your decision and it is appropriate for you to vote again to deny San Diego the last 301 (h) waiver on the California coast. It is time that San Diego joined the ranks of civilized responsible sewage dischargers in coastal California and treated its sewage to full secondary before discharging into the Pacific Ocean.

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Thank you for your past action in denying the waiver. Please ratify your decision and vote again to deny the waiver on Wednesday.

Sincerely,
Don Schulz
Senior Member, Surfrider Foundation

Mark Delaplaine

From: Welsh, Terry [Terry.Welsh@ahmchealth.com]
Sent: Monday, October 05, 2009 10:26 AM
To: Mark Delaplaine
Subject: No Full Treatment Waiver for San Diego

No Full Treatment Waiver for San Diego, please

Terry Welsh,

Costa Mesa, CA
714-432-1385

mdelaplaine@coastal.ca.gov

mdelaplaine@coastal.ca.gov Please modify your contacts with my new e-mail address. It is Terry.Welsh@ahmchealth.com

Thank you

Mark Delaplaine

From:	Iryne Black [ayeblack@sbcglobal.net]
Sent:	Monday, October 05, 2009 10:26 AM
To:	Mark Delaplaine
Subject:	San Diego request for 301h waiver

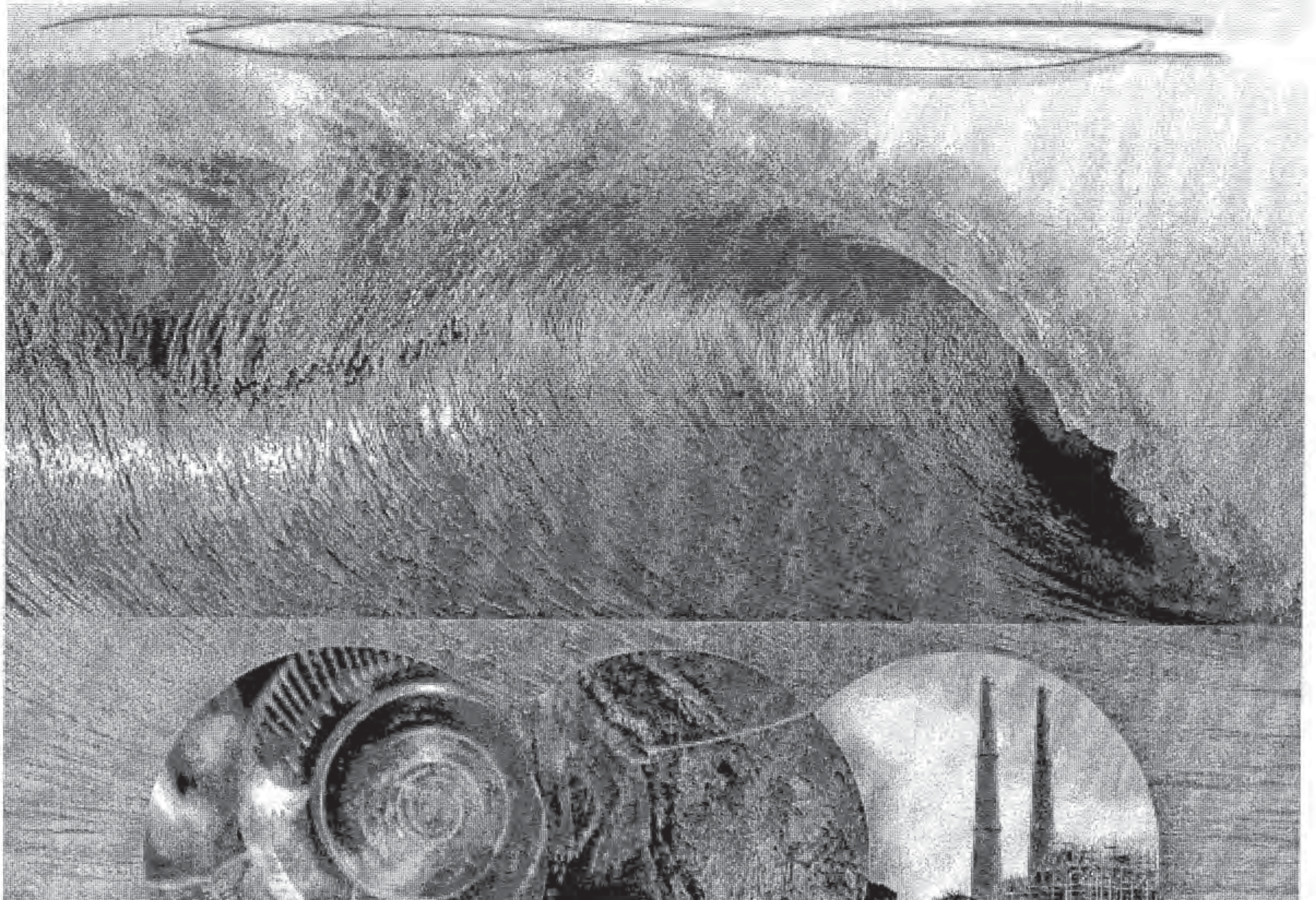
To Members of the California Coastal Commission

Please reassert your denial of a 301 H Waiver to the City of San Diego. There are other means to meet the problem without placing the health of our oceans in jeopardy.

Thank you. Iryne Black
1646 Irvine Ave. Newport Beach 92660

The West Coast Ocean Acidification and Hypoxia Science Panel

MAJOR FINDINGS, RECOMMENDATIONS, AND ACTIONS



APRIL 2016

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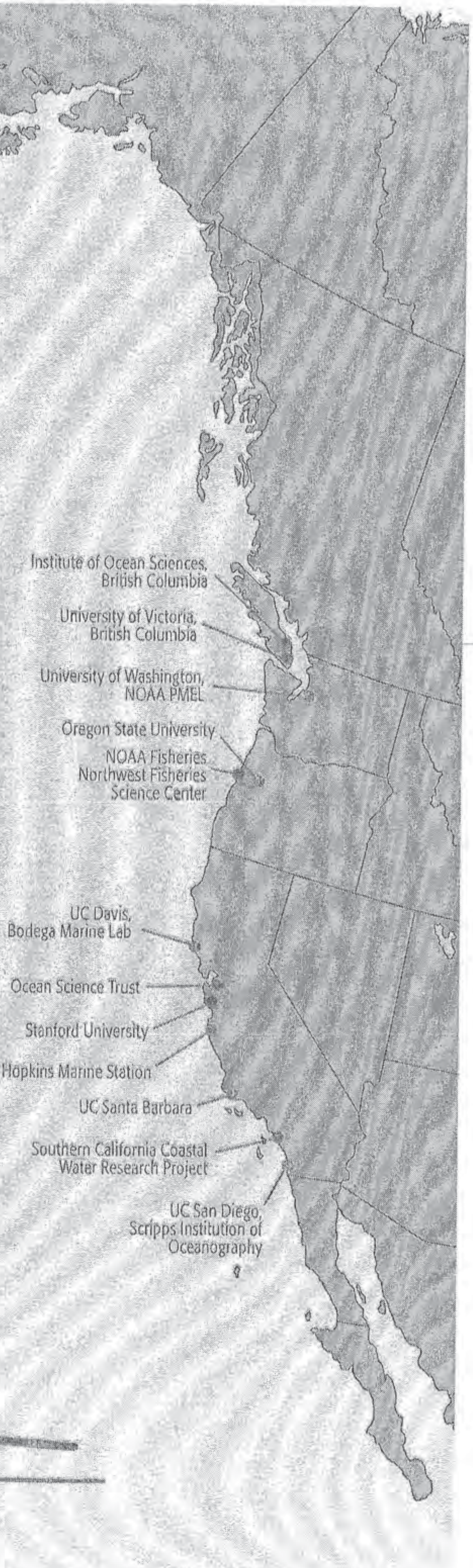
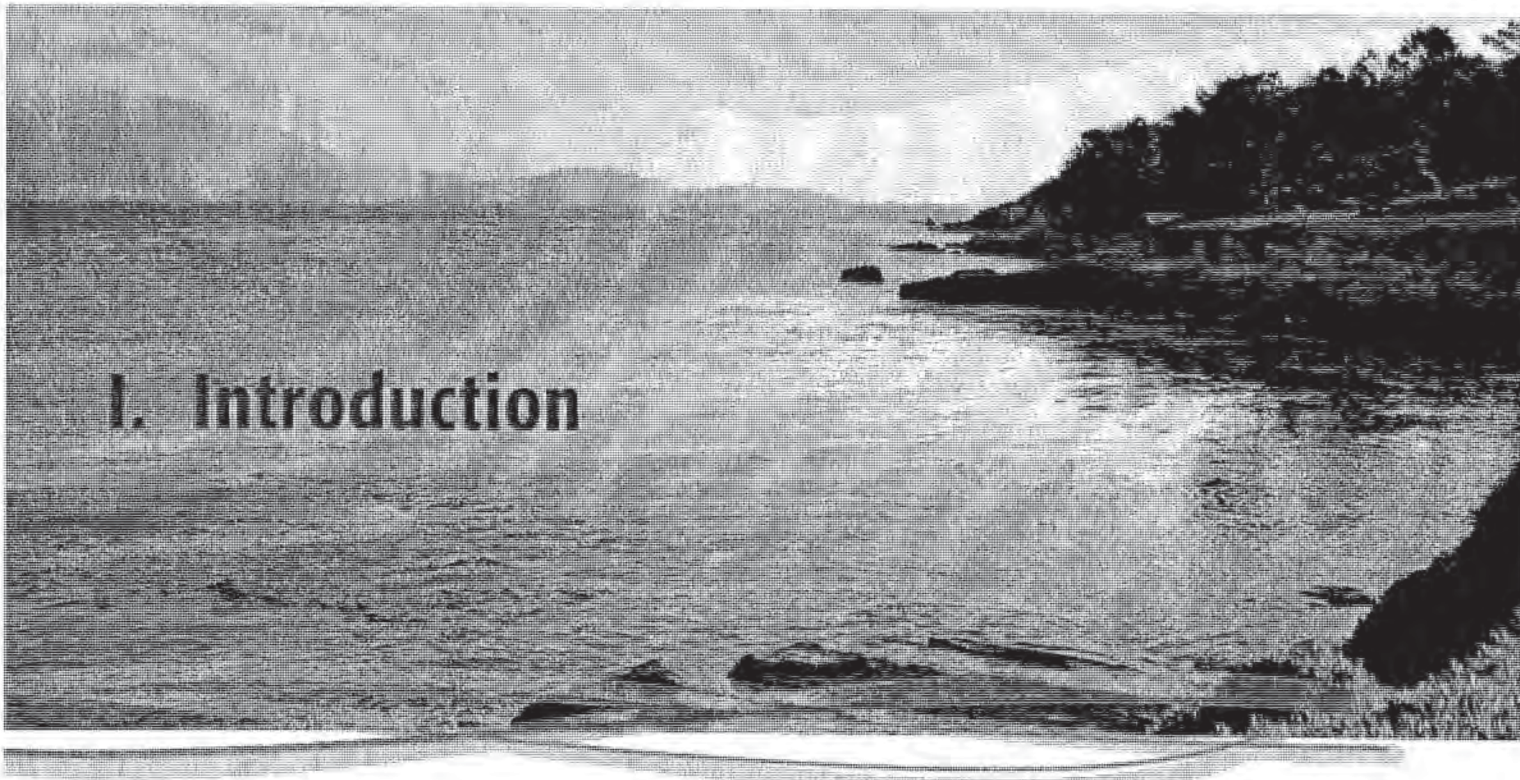




I. Introduction

Global carbon dioxide (CO_2) emissions over the past two centuries have altered the chemistry of the world's oceans, threatening the health of coastal ecosystems and industries that depend on the marine environment. This fundamental chemical alteration is known as ocean acidification (OA), a phenomenon driven by the oceans absorbing approximately one-third of atmospheric CO_2 generated through human activities. Scientists initially observed the impacts of OA on calcifying marine organisms that were having difficulty forming their shells, but additional evidence now indicates that growth, survival and behavioral effects linked to OA extend throughout food webs, threatening coastal ecosystems, and marine-dependent industries and human communities (see Appendix A).

Although OA is a global phenomenon, emerging research indicates that, among coastal zones around the world, the West Coast of North America will face some of the earliest, most severe changes in ocean carbon chemistry. The threats posed by OA's progression will be further compounded by other dimensions of global climate change, such as the intensification and expansion of low dissolved oxygen – or hypoxic – zones. In the coming decades, the impacts of ocean acidification and hypoxia (OAH), which are already being felt across West Coast systems, are projected to grow rapidly in intensity and extent. Even if atmospheric CO_2 emissions are stabilized today, many of the ongoing chemical changes to the ocean are already "locked in" and will continue to occur for the next several decades. Given these challenges, decision-makers must act decisively and in concert now.

In an effort to develop the scientific foundation necessary for West Coast managers to take informed action, the California Ocean Protection Council in 2013 asked the California Ocean Science Trust to establish and coordinate a scientific advisory panel in collaboration with California's ocean management counterparts in Oregon, Washington and British Columbia. The resulting West Coast Ocean Acidification and Hypoxia Science Panel, comprised of 20 leading scientific experts (see V. The Panelists, page 32), was charged with summarizing the current state of knowledge and developing scientific consensus about available management options to address OAH on the West Coast.

This document, "**Major Findings, Recommendations, and Actions**" of the Panel, summarizes the Panel's work and presents **Actions** that can be taken now to address OAH. The appendices to this document contain a series of two-page synopses that provide more detail on many of the key concepts that are mentioned in the main body. In addition to this document, the Panel has produced a number of longer supporting documents intended for agency program managers and technical audiences (see VI. Additional Panel Products Supporting the "Major Findings, Recommendations, and Actions," page 36).

Why ocean acidification AND hypoxia?

OA and hypoxia refer to distinct phenomena that trigger a wide range of marine ecosystem impacts. The Panel considered them together because they frequently co-occur and present a collective West Coast challenge. In particular, OA and hypoxia share a common set of drivers – increased atmospheric CO_2 levels and local nutrient and organic carbon inputs. Consequently, OA and hypoxia can be managed synergistically via an overlapping set of management strategies.

The Panel's products are more focused on OA because our understanding of the effects of OA and its interaction with hypoxia is only beginning to grow. In contrast, scientists have built a sizeable body of research on hypoxia, so its impacts on marine environments are better understood. Note that when the Panel uses the term OAH, it is a deliberate reference to both phenomena collectively; the terms OA, hypoxia and OAH cannot, however, always be used interchangeably.

II. Major Findings

The Panel's scientific experts reached consensus on six **Major Findings**:

1. **OAH will have severe environmental, ecological and economic consequences for the West Coast, and requires a concerted regional management focus.**

   OAH is a problem that is expected to grow in intensity with far greater impacts to come, particularly along the West Coast, where regional ocean circulation patterns dramatically heighten the potentially devastating effects of OAH. Local governments alone do not have the capability to halt fundamental, widespread changes to the chemistry of coastal waters. Decision-makers need a common core of scientific information that will enable them to use limited resources in a strategic, coordinated, regional fashion to best serve the ecological and socioeconomic needs of the entire West Coast region. Appendix B provides more detail about the trajectory of OAH-triggered change, and why the West Coast is more vulnerable than other coastal regions.

2. **Global carbon emissions are the dominant cause of OA.**

   Although this document is focused on how the West Coast is impacted by OA and the associated intensification of hypoxia, OA is a global problem that will require global solutions. Given that the dominant cause of OA is global carbon dioxide emissions, the Panel stands firmly behind multinational efforts to reduce atmospheric carbon dioxide emissions worldwide; humankind's ability to reduce the levels of CO_2 being absorbed by the world's oceans will be the single most important, effective strategy for mitigating OA. To that end, the Panel encourages West Coast leadership to develop a regional carbon management strategy, expanding on initiatives such as California's AB 32 and Washington's Climate Action Team.

3. **There are actions we can take to lessen exposure to OA.**

   Although local actions cannot wholly undo the global impacts of OA, West Coast managers can take action to improve local conditions by managing local factors that contribute to declining water quality. In particular, opportunities exist to implement better controls on nutrients and organic matter pollution that flow from land into coastal waters, as these chemicals provide nourishment for algae and bacteria that, in turn, can trigger hypoxia and exacerbate acidification. In selecting specific areas in which to implement these controls, managers should work closely with scientists, as these actions are typically costly and will not be equally effective everywhere; monitoring and modeling results can be used to inform best options.

4. **We can enhance the ability of ecosystems and organisms to cope with OA.**

   West Coast managers are not limited to mitigating OA; they also can take actions to reduce the negative biological and ecological impacts from OA. Fostering ecosystem resilience – that is, taking management actions intended to support an ecosystem's ability to withstand the impacts of OA – offers a near-term strategy for maintaining functional ecosystems along the West Coast as the environment changes. Managing for resilience can be achieved by expanding and adjusting approaches already in place along the West Coast, including the use of protected areas, ecosystem approaches to fisheries management, and integrated coastal management techniques. The concept of enhancing resilience is more thoroughly explored in Appendix C.

5. **Accelerating OA science will expand the management options available.**

   The state of knowledge about OA and its interaction with hypoxia is rapidly evolving, but is still limited and thus able to inform only a limited suite of management options to date. West Coast managers should be looking for opportunities to foster rigorous, managerially relevant research, develop coordinated cost-effective monitoring programs that continue to provide information about the projected trajectories of OAH, and integrate knowledge from multiple domains into decision-making. As scientific understanding of OAH grows, so will the options available for devising effective, fiscally prudent management strategies.

6. **Inaction now will reduce options and impose higher costs later.**

   It is becoming increasingly clear that OA will cause significant ecosystem changes, with widespread negative consequences that diminish valuable ecosystem benefits and services. Over time, OA conditions will intensify, diminishing opportunities for managers and West Coast communities to adapt to the changing marine environment. Delaying action now could render future management interventions far less effective (detailed further in Appendix D). Actions taken now based on best available science offer the possibility of forestalling at least some of the negative consequences for ecosystems and society.

III. Panel Recommendations

Consistent with these **Major Findings**, the Panel has formulated eight **Recommendations** to guide management responses. These **Recommendations** are divided among three themes:

1. Address local factors that can reduce OAH exposure;
2. Enhance the ability of biota to cope with OAH stress; and,
3. Expand and integrate knowledge about OAH.

For each **Recommendation**, the Panel provides specific **Actions** that can be implemented immediately and largely accomplished within a one-year timespan. The Panel's **Recommendations** and **Actions** highlight avenues where new science can quickly catalyze management options for addressing OAH.

By The Numbers

THREE THEMES

Eight Recommendations

Fourteen Actions

THEME 1: ADDRESS LOCAL FACTORS THAT CAN REDUCE OAH EXPOSURE

Recommendation	Actions
RECOMMENDATION 1: Reduce local pollutant inputs that exacerbate OAH	Action 1.1: Generate an inventory of areas where local pollutant inputs are likely to exacerbate OA. Action 1.2: Develop robust predictive models of OAH. Action 1.3: Develop an incentive-based strategy for reducing pollutant inputs.
RECOMMENDATION 2: Advance approaches that remove CO_2 from seawater	Action 2.1: Use demonstration projects to evaluate which locations are optimal for implementing CO_2 removal strategies. Action 2.2: Generate an inventory of locations where conservation or restoration of aquatic vegetated habitats can be successfully applied to mitigate OA. Action 2.3: Consider CO_2 removal during the habitat restoration planning process.
RECOMMENDATION 3: Revise water quality criteria	Action 3.1: Agree on parameters that will be part of OAH criteria.

THEME 2: ENHANCE THE ABILITY OF BIOTA TO COPE WITH OAH STRESS

Recommendation	Actions
RECOMMENDATION 4: Reduce co-occurring stressors on ecosystems	Action 4.1: Integrate OA effects into the management of ocean and coastal ecosystems and biological resources.
RECOMMENDATION 5: Advance the adaptive capacity of marine species and ecosystems	Action 5.1: Inventory the co-location of protected areas and areas vulnerable to OAH. Action 5.2: Evaluate the benefits and risks to active enhancement of adaptive capacity.

THEME 3: EXPAND AND INTEGRATE KNOWLEDGE ABOUT OAH

Recommendation	Actions
RECOMMENDATION 6: Establish a coordinated research strategy	Action 6.1: Create agreement among the multiple organizations that fund OAH research to establish joint research priorities.
RECOMMENDATION 7: Build out and sustain a West Coast monitoring program that meets management needs	Action 7.1: Define gaps between monitoring efforts and management needs. Action 7.2: Enhance comparability of and access to OAH data.
RECOMMENDATION 8: Expand scientific engagement to meet evolving management needs	Action 8.1: Create a science task force.

THEME 1: ADDRESS LOCAL FACTORS THAT CAN REDUCE OAH EXPOSURE

Recommendation 1: Reduce local pollutant inputs that exacerbate OAH.

While elevated atmospheric CO_2 levels are a major driver of OA, local discharge of organic carbon and nutrients can exacerbate OA. Upon discharge, organic carbon is broken down by bacteria, which consume dissolved oxygen during the decomposition process, triggering hypoxic conditions, increasing CO_2 levels and lowering pH. When nutrients such as nitrogen and phosphorus are introduced to coastal waters, they can trigger proliferation of algae that, following their death, are decomposed by bacteria that further decrease dissolved-oxygen levels and increase acidity. The Panel's recommendation to reduce local inputs is tempered by the recognition that scientists do not yet have adequate information to precisely identify locations where reductions in local inputs can meaningfully mitigate OAH effects. In general, the effectiveness of local actions will be greatest in semi-enclosed water bodies, such as estuaries, where local processes dominate over oceanic forcing. Site-specific evaluations are needed to determine which local input(s) (wastewater discharges vs. non-point source pollution in river discharge or atmospheric deposition) should be the targets of nutrient reduction efforts. Because of uncertainties concerning which local-control strategies will be most effective in reducing OA, West Coast managers may find it advantageous to pursue more than a purely regulatory enforcement strategy. For example, upgrades to wastewater treatment plants or investment in water reuse could be incentivized to design facilities that reduce nutrient discharges. Regardless of whether incentive-based or regulation-based approaches are used to achieve desired outcomes, managers can support the expedited development of predictive OA models that will guide decisions about how to best implement local source controls.

- **Action 1.1: Generate an inventory of areas where local pollutant inputs are likely to exacerbate OA.**

  While local nutrient- or other discharge-related control programs will not be effective everywhere, there are a number of locations where local nutrient inputs are thought to exacerbate OA. West Coast managers should compile an inventory of those locations to focus their initial management efforts, as these locations can serve as testing grounds for understanding the relative successes that can be achieved by reducing local inputs.

- **Action 1.2: Develop robust predictive models of OAH.**

  One method to determine where reduction of local inputs will result in the greatest gains in water quality is through use of coupled physical-biogeochemical models. These models quantify to what degree various nutrient, carbon, and CO_2 inputs influence OAH, and project how these inputs will exacerbate OAH. Several research groups on the West Coast are in various stages of developing such models, but before they can be used to support OAH-related management decisions, further investment is required to enhance and coordinate modeling efforts, and to link them to managerially relevant endpoints. A more thorough discussion of how West Coast managers can enhance the usefulness of these modeling efforts appears in Appendix E. Once models are operational, model outputs should be made accessible for comparisons among models and with monitoring data.

- **Action 1.3: Develop an incentive-based strategy for reducing pollutant inputs.**

  West Coast managers can develop grants, loans and other programs to create financial incentives for both the public and private sector to work proactively toward reducing local inputs that can exacerbate OAH, as well as promote reductions in atmospheric CO_2 emissions.

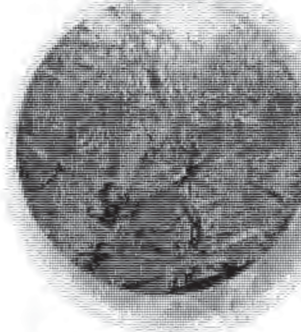
In general, the effectiveness of local actions will be greatest in semi-enclosed water bodies, such as estuaries, where local processes dominate over oceanic forcings.

Recommendation 2: Advance approaches that remove CO_2 from seawater.

Seagrass and kelp beds remove CO_2 from seawater as they grow. This removal of CO_2 has the potential to offset the reductions in pH from OA. Emerging research suggests that conservation or restoration of aquatic vegetation habitats may indeed act to measurably lessen the severity of OA exposure. However, important uncertainties remain about when, where and how broadly local habitat conservation and restoration will mitigate OA exposure (see Appendix F). West Coast managers should actively explore the utility of this mitigation approach.

- **Action 2.1: Use demonstration projects to evaluate which locations are optimal for implementing CO_2 removal strategies.**

  Scientists have conducted research that demonstrates substantive positive benefits from coastal aquatic vegetation on CO_2 removal from seawater. The next step is to transition from these small-scale and short-term research efforts to larger-scale proof of concept demonstration studies across a range of habitats, providing managers with the opportunity to explicitly evaluate under which conditions protection and restoration of vegetated habitats will sufficiently remove CO_2 to meaningfully mitigate OA. These demonstration projects should be accompanied by rigorous monitoring, and physical and biogeochemical modeling to evaluate efficacy of such measures in reducing exposure to OA stress.



Emerging research suggests that conservation or restoration of aquatic vegetated habitats may indeed act to measurably lessen the severity of OA exposure.

- **Action 2.2: Generate an inventory of locations where conservation or restoration of aquatic vegetation habitats can be successfully applied to mitigate OA.**

  The knowledge gained from demonstration projects in Action 2.1 can be used to identify and inventory locations across the West Coast where CO_2 removal strategies can be applied. This inventory can inform comprehensive planning for how local CO_2 removal approaches can be applied relative to other Actions to reduce local inputs of CO_2, non-OA stressors, and enhance ability of biota to cope with stressors.

- **Action 2.3: Consider CO_2 removal during the habitat restoration planning process.**

  A number of investments have already been made to promote aquatic habitat restoration. Carbon offset protocols are also under development in some instances to value the co-benefits from long-term carbon storage of such restoration. However, they do not incorporate the potential benefits of local reductions in OA stress. Accounting for this local ecosystem benefit will assist in better accounting for the full societal value of habitat restoration and management.

Recommendation 3: Revise water quality criteria.

Water quality criteria serve as the foundation for many management activities, providing managers with thresholds to objectively determine the condition of a water body and to set targets for clean-up efforts. As such, they are an initiation point for both planning and implementation activities. However, existing water quality criteria, which were created four decades ago, are not scientifically appropriate for assessing OA conditions. Even when existing water quality criteria for seawater pH are met, a wide range of severe biological impacts of OA are observed. New criteria are needed. The Panel further recommends that OA water quality criteria be expanded to include other acidification parameters, as pH is only one of several possible parameters for describing the carbonate system. One such alternative, aragonite saturation state, has been found to be biologically relevant to a number of calcifying organisms. Appendix G provides additional insight about the need for revised water quality criteria.

- **Action 3.1: Agree on parameters that will be part of OAH criteria.**

  Water quality agencies should lead efforts among water quality and acidification experts to develop scientific consensus about which parameters are most appropriate for inclusion in new water quality criteria. In the immediate future, a scientific workshop is needed to identify appropriate biologically relevant indicators and thresholds to assess OA, and prioritize short-term research needs to support criteria development.

THEME 2: ENHANCE THE ABILITY OF BIOTA TO COPE WITH OAH STRESS

Recommendation 4: Reduce co-occurring stressors on ecosystems.

The ability of marine organisms to grow, survive, and reproduce in the face of OAH is partly dependent on the number, intensity, and interactions of other, non-OAH stressors they encounter, such as physical disturbances to nearshore habitats, warming temperatures, toxic contaminants, biological invasion, and harvest. Thus, it is important for West Coast managers to consider management plans and actions in the context of these multi-stressor effects. For example, the growing adoption of ecosystem approaches to fisheries management offers opportunities to consider the potential regional effects of OAH within the context of other ecological stressors as fisheries management plans are updated.

- **Action 4.1: Integrate OA effects into the management of ocean and coastal ecosystems and biological resources.**

  OA is likely to influence ecosystems along the West Coast via impacts on fish behavior, impaired calcification of shelled organisms, and fundamental changes in food web dynamics. Managers should work to understand and incorporate the probable impacts of OA into management plans for marine managed areas and fisheries. In some instances, this will require bilateral collaboration, for example, between the U.S. and Canada. For fisheries, the most promising avenue for advancing ecosystem-based fishery management along the West Coast is the Fishery Ecosystem Plan (FEP), adopted by the Pacific Fishery Management Council in 2013. The FEP is intended to improve and coordinate fishery management within the California Current Ecosystem by informing decisions made under each individual Fishery Management Plan with broader considerations about the ecosystem. Future updates of the FEP will provide an important opportunity to integrate improved OA knowledge into fishery management decisions, including ways that individual fisheries can be better managed to enhance ecosystem resilience and adaptive capacity under OA.

Recommendation 5: Advance the adaptive capacity of marine species and ecosystems.

Marine species and ecosystems have, to varying degrees, the ability to adjust and persist in the face of changing environmental conditions, a concept known as adaptive capacity. West Coast managers can support their adaptive capacity through relatively passive measures, such as use of protected areas. Managers can also undertake more proactive approaches, such as selective breeding, translocation of organisms that have shown adaptive capacity, and direct modification of genetic material. Genetic intervention efforts are already being explored as a means to improve the adaptive capacity of marine species to OA. The Panel recognizes that these more proactive approaches raise important concerns regarding their potential unintended consequences. Thus, such strategies should only be considered when other means of maintaining and promoting genetic adaptation are infeasible, and only when safety concerns have been addressed.

- **Action 5.1: Inventory the co-location of protected areas and areas vulnerable to OAH.**

  The West Coast includes five National Marine Sanctuaries, five National Estuarine Research Reserves, 15 National Wildlife Refuges, two Canadian marine protected areas, two Canadian Areas of Interest, multiple Essential Fish Habitat conservation areas created by the Pacific Fishery Management Council, 34 Areas of Special Biological Significance established by State of California, and numerous state-managed protected areas. Most protected areas, however, were designed and are being managed without regard to their vulnerability to OAH impacts, because little was known about OAH processes or impacts when most of the areas were established. Nevertheless, some of these protected areas could serve to promote adaptive capacity to OAH. Enhanced diversity and productivity of fish and invertebrate populations and preservation of ecological function within protected areas can strengthen the ability of populations and communities to cope with future OAH impacts. This may be particularly beneficial in instances where protected areas overlap with locations that are likely to face moderated exposure to OAH stress. In contrast, protected areas that are co-located with OAH hotspots offer an environment where biota that develop genetic tolerances to OAH are preserved. Both environments are important to maintaining adaptive capacity. West Coast managers should inventory the co-location of protected areas and areas vulnerable to OAH to assess the number of locations they presently have in the two categories.

...protected areas that are co-located with OAH hotspots offer an environment where biota that develop genetic tolerances to OAH are preserved.

- **Action 5.2: Evaluate the benefits and risks to active enhancement of adaptive capacity.**

  West Coast managers should facilitate the establishment of a working group of scientists and managers from relevant sectors to engage in joint fact-finding about the potential risks, benefits, and costs of active genetic intervention, such as through the selection, manipulation, and/or translocation of genetic varieties as a strategy for enhancing the persistence of species in mariculture settings and in natural ecosystems under intensifying OAH. Such intervention-based options are already being explored for OA but are occurring in the absence of deliberative guidance from the scientific and management communities. Historically, introductions of new genetic varieties and species on land and in the oceans have caused unintended harmful ecological or economic consequences that outweighed their benefits. The establishment of an active genetic intervention working group will set the stage for assessing the policy context for evaluating and regulating planned genetic interventions.

THEME 3: EXPAND AND INTEGRATE KNOWLEDGE ABOUT OAH

Recommendation 6: Establish a coordinated research strategy.

OA research is still in its infancy, with 75% of all acidification science studies published in the last five years, and only a handful of studies to date that have addressed the combined effects of OA and hypoxia, or OA and temperature, or OA and any other stressor. These constraints limit the ability to formulate options for effective management actions grounded in sound science. Generating more options will require further investment in directed research on OAH and its impacts on marine ecosystems. The research should be driven by management needs and should focus on evaluating the breadth of responses available to management, including scale and cost. The Panel has developed a comprehensive set of recommendations about which research topics are most likely to yield the greatest expansion of management options (see Appendix H), and Appendix H is supported by a separate and more extensive technical document outlining recommendations for research priorities ("*Ocean Acidification and Hypoxia Research Priorities to Inform Decisions and Develop Solutions*").

- **Action 6.1: Create agreement among the multiple organizations that fund OAH research to establish joint research priorities.**

  OAH research is taking place at multiple levels – across a range of federal, state, provincial, local and nonprofit funding sources. West Coast leadership should develop a coordinated long-term vision and funding plan to achieve a sustained, leveraged OAH research strategy for the region. West Coast managers should meet with funding entities to help unify their research around focused management goals and ensure that research efforts are effectively coordinated.

...research should be driven by management needs and should focus on evaluating the breadth of responses available to management, including scale and cost.

Recommendation 7: Build out and sustain a West Coast monitoring program that meets management needs.

Monitoring is a cornerstone of effective environmental management, highlighting spatial differences in OAH condition, and revealing the trajectory of conditions and providing a means for assessing effectiveness of management actions. OAH monitoring programs have often focused on measuring chemical parameters – such as pH and dissolved oxygen – but managers need a comprehensive program that assesses an array of interrelated physical oceanographic, chemical and biological variables and indices. Moreover, most West Coast monitoring is focused on addressing local issues, but these can readily be coordinated to achieve a regional-level program that addresses management needs coast-wide. A more thorough description about the need and opportunities for enhanced monitoring appears in Appendix I and in a supporting Panel technical document that describes a desired monitoring framework ("*Ocean Acidification and Hypoxia Monitoring Network: Tracking the Impacts of Changing Ocean Chemistry to Inform Decisions*").

- **Action 7.1: Define gaps between monitoring efforts and management needs.**

  West Coast managers should cultivate partnerships between monitoring practitioners and decision-makers to better define OAH information needs across ecosystem types and for diverse uses. First, they should build on existing efforts to complete a comprehensive inventory of existing oceanographic and ecological monitoring programs on the West Coast; the goal being to identify what monitoring is being conducted, what management questions these efforts address, what synergies and enhancements could be achieved, what measurements are missing, and what geographic areas have inadequate coverage to meet management needs.

- **Action 7.2: Enhance comparability of and access to OAH data.**

  Data comparability among disparate programs is necessary to achieve an understanding of OAH. West Coast managers should facilitate training and quality assurance procedures that will enhance comparability among programs. Furthermore, managers should work toward a consistent level of data discoverability, ensuring that the OAH community can make effective use of OAH data. Development of centralized portals for OAH monitoring data will allow this key information to be linked and shared, ensuring that monitoring can be used effectively to inform further research and ultimately management actions. This portal can also be used to access OAH model outputs.

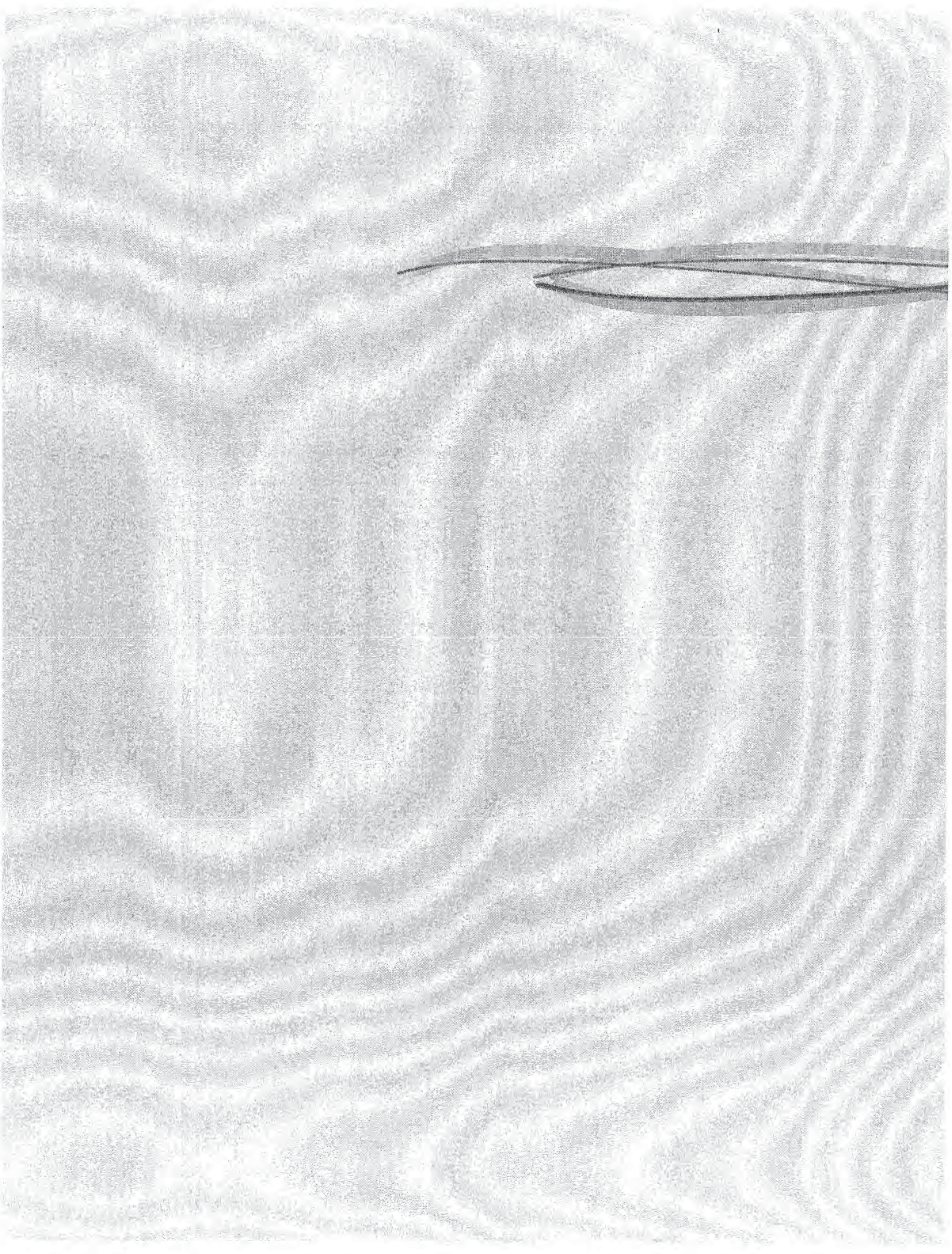
Recommendation 8: Expand scientific engagement to meet evolving management needs.

Over the past two years, the Panel has not only created a set of written products outlining its "**Major Findings, Recommendations, and Actions**," but has also taken advantage of an unprecedented opportunity to network, convey relevant scientific perspectives, and build a community within a relatively nascent research area. Going forward, the region will benefit from this continued thoughtful interaction among scientists that is simultaneously focused and region-wide, and enhanced dialogue between scientists and managers. This is a rapidly evolving field, so cross-boundary communication is crucial to ensuring that new science products developed from research initiatives are appropriately vetted and communicated for use by the management community.

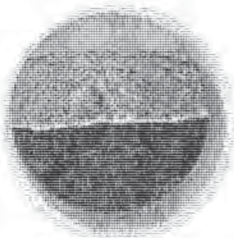
- **Action 8.1: Create a science task force.**

  West Coast managers will need a highly qualified body of scientists to advise them as new science develops in this rapidly evolving field. Given our West Coast-wide scientific commitment, investment, and momentum, this should remain a West Coast regional body with representation from California, Oregon, Washington, British Columbia, Alaska and Mexico as this issue will transcend state and federal geographic boundaries. The task force can evolve from the existing OAH Panel, but it should be refined to focus expertise on topic areas that align with management needs. A West Coast science task force will ensure that managers and legislators continue to be equipped with the most up-to-date information to make important decisions to protect the West Coast.

A West Coast science task force will ensure that managers and legislators continue to be equipped with the most up-to-date information to make important decisions to protect the West Coast.



IV. Appendices



APPENDIX A:
Why West Coast managers should care about ocean acidification

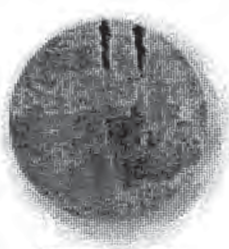
APPENDIX B:
Why the West Coast is vulnerable to ocean acidification - and what we can learn from it

APPENDIX C:
Managing for resilience to address ocean acidification and hypoxia

APPENDIX D:
The cost of inaction

APPENDIX E:
Using modeling to enhance understanding

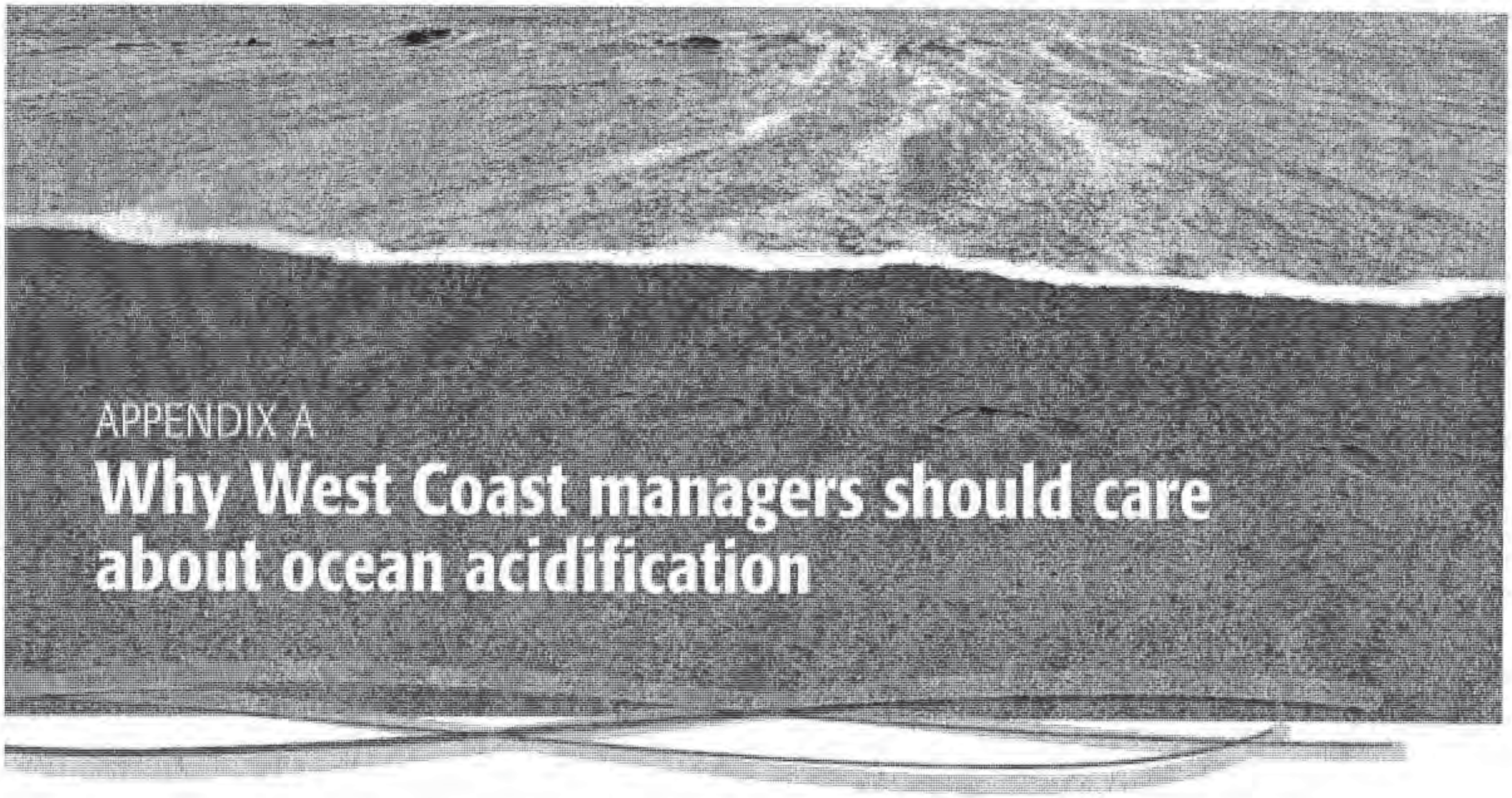
APPENDIX F:
Approaches to reduce CO_2 in seawater



APPENDIX G:
Existing water quality criteria are inadequate to protect marine ecosystems

APPENDIX H:
Establishing ocean acidification and hypoxia research priorities

APPENDIX I:
Tracking changing ocean chemistry through an ocean acidification and hypoxia monitoring network



APPENDIX A

Why West Coast managers should care about ocean acidification

Ocean acidification is already posing a substantial threat, even if it's just beginning to enter the public consciousness.

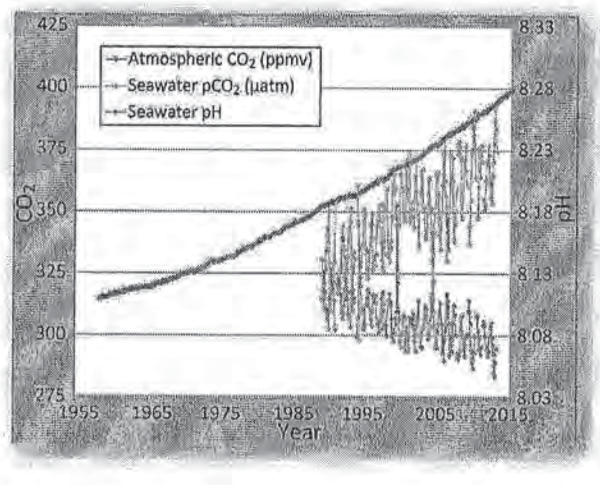
In the same way that legacy pollutants in the marine environment inspired a generation of environmental activism in the 1970s and 80s, ocean acidification (OA) will define West Coast environmental management in the coming decades. OA endangers not only the biological health of marine organisms but also the numerous economic and societal benefits that stem from the West Coast's dependence on its coastal waters. The Panel unanimously and vigorously affirms that acidification of coastal waters is an undeniable, pervasive issue whose impacts have only begun to be felt.

1. Ocean chemistry is changing at an alarming rate, with no projected end or slowdown in sight.

- **Rapid change:** The fundamental alteration of the ocean's chemistry from continued absorption of atmospheric CO_2 is indisputable. At the current rate of global CO_2 emissions, the average acidity of the surface ocean is expected to double over pre-industrial levels by the end of this century.
- **Consequential change:** Seemingly small changes in ocean pH – which serves as a measure of acidification – are anything but small, as pH is expressed on a logarithmic scale. The 0.1 pH units of change that the ocean has recently experienced is equivalent to a 30% increase in acidity. For some organisms, this can be the difference between being able to grow a shell and having their shell dissolved.

...the average acidity of the surface ocean is expected to double over pre-industrial levels by the end of this century.

Credit: Modified after R.A. Feely, Bulletin of the Meteorological Society, July 2008.

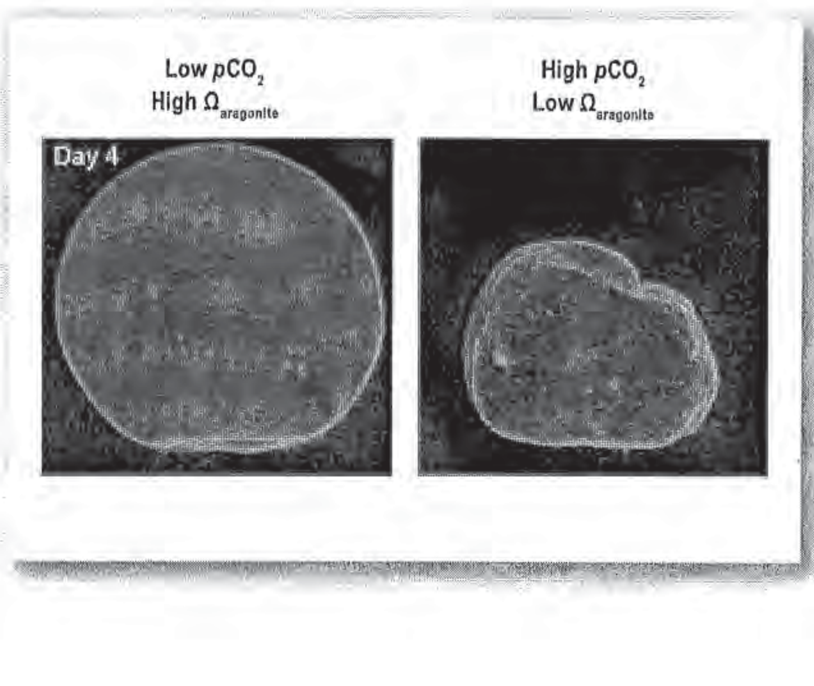


2. West Coast ecosystems are already facing the pervasive impacts of OA.

- **Shell-forming abilities crippled:** Even small increases in acidity of the local water can dramatically reduce the ability of marine organisms to properly grow shell or skeletal structures. Shellfisheries are particularly vulnerable. Oyster hatcheries are seeing high mortality rates during early life stages when shell formation is critical. In 2007, hatchery managers began to experience a severe loss of oyster seed stock as a consequence of OA, which led to acute shortages available to oyster growers up and down the West Coast.
- **Reverberation through food webs:** Microscopic algae and zooplankton that form carbonate structures during their life cycle are at risk, resulting in consequences for marine food webs. For example, swimming sea snails known as pteropods, serve as an important food source for many West Coast fisheries species, including herring, mackerel and salmon. In some locations, more than 50% of these sea snails are already showing signs of shell dissolution. The evidence is compelling, with studies demonstrating that the percentage of pteropods affected by shell dissolution corresponds with local acidity levels.
- **Effects extend beyond shelled organisms:** Rising CO_2 in seawater has been found to disrupt basic neural function and sensitive skeleton structure in marine fishes. These disruptions adversely affect critical behaviors such as orientation, distinguishing predators from prey, finding food, and identifying appropriate habitats. Scientists' understanding of how OA impacts organisms and ecosystems continuously expands, so effects will likely extend beyond those described here.

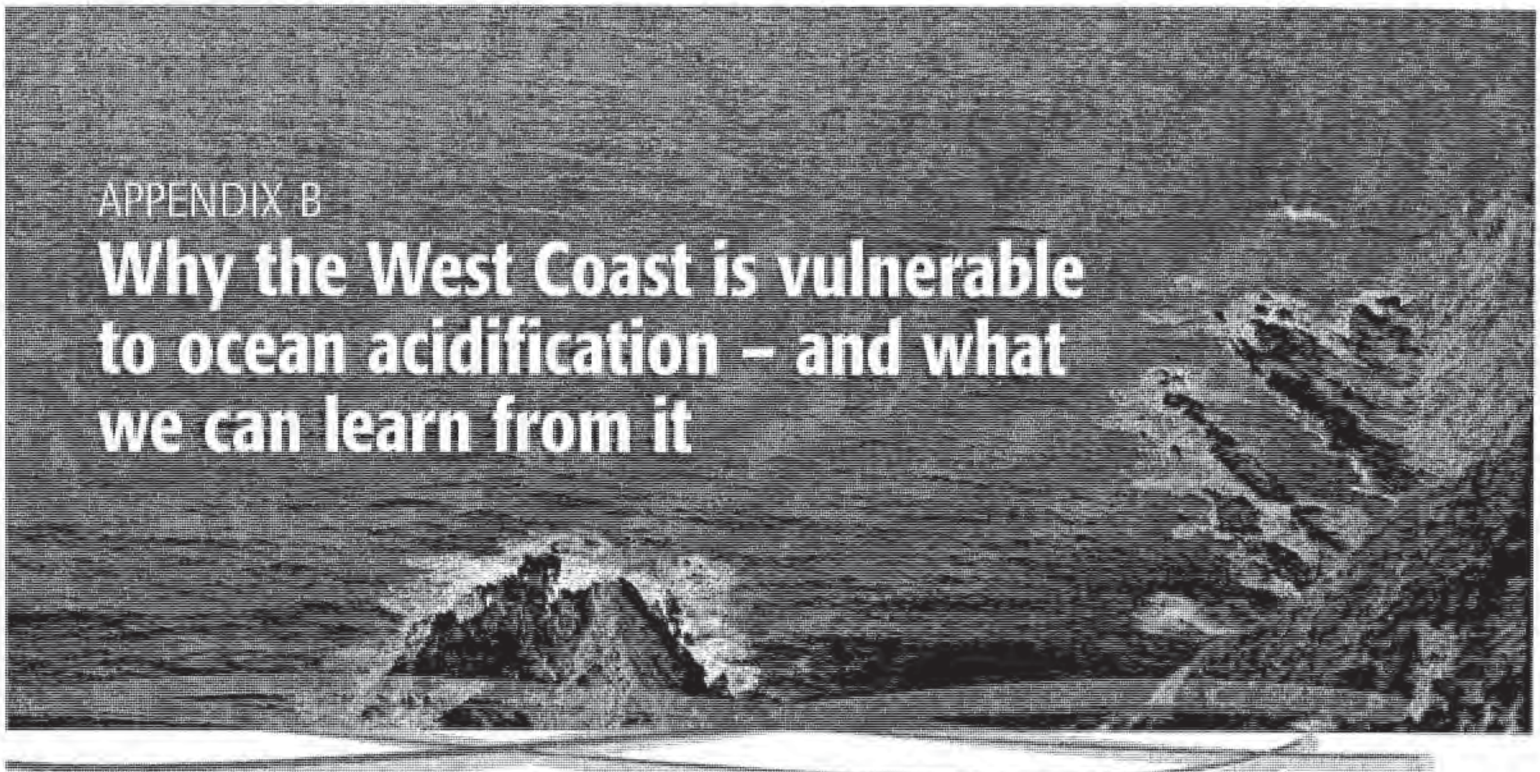
3. The consequences of OA are affecting ocean industries, with effects projected to worsen over time.

- **Operational disruption:** A West Coast shellfish farmer has relocated his hatchery to Hawaii, where exposure to low-pH marine waters is less than along the West Coast. Other hatcheries have invested in building expensive monitoring and water conditioning systems as necessary to maintain their West Coast operations.
- **Economic loss:** Oyster production in the Pacific Northwest declined 22% between 2005 and 2009 (13% decline in gross sales). In Washington and Oregon alone, two of the three major West Coast oyster seed hatcheries experienced production declines of up to 80% from 2006 to 2009. A Canadian company reported that it lost $10 million during its scallop harvest in 2014 in part due to OA. As the OA trajectory continues, a range of shellfish industries, including those for oysters, mussels and crabs, will be subject to economically devastating losses.
- **Domino effects of job losses:** Washington State's commercial and recreational fishing industries generate $8 billion in sales and 65,000 in jobs annually. In Oregon, the commercial and recreational fishing industries generate $1.5 billion in sales, and 19,000 jobs annually. Lastly, sales generated by the commercial and recreational fishing industries in California are $25.7 billion, and 158,000 jobs generated annually. As these industries endure future increases in acidification, the impacts could set off a domino effect of job losses throughout coastal communities, particularly in places where the fishing industry and coastal tourism provide the economic base.



Even small increases in acidity of the local water can dramatically reduce the ability of marine organisms to properly grow shell or skeletal structures.

Figure. Pacific oyster larvae from the same spawn, raised by the Taylor Shellfish Hatchery in natural waters of Dabob Bay, WA having favorable (left, pCO_2 = 403 ppm, $\Omega_{aragonite}$ = 1.64, and pH (total) = 8.00) and unfavorable (right column, pCO_2 = 1418 ppm, $\Omega_{aragonite}$ = 0.47, and pH (total) = 7.49) carbonate chemistry during the spawning period.
Photo credit: Brunner/Waldbusser.



APPENDIX B

Why the West Coast is vulnerable to ocean acidification – and what we can learn from it

Ocean acidification (OA) is a global problem triggered by the world's oceans absorbing society's CO_2 emissions from the atmosphere, but the effects of OA will manifest unevenly in different regions of the world. The West Coast of North America – among the first and most prominent regions being impacted by OA – is especially vulnerable because of a confluence of factors affecting this ecologically and economically significant region. However, as OA's global impacts intensify, other regions of North America – from the fisheries-dependent Gulf Coast to the slow-flowing embayments of New England – also will be altered by OA. Thus, the West Coast can and should serve both as a harbinger of OA's impacts worldwide and as a case study on how to develop a highly effective, region-specific science strategy for reducing the threat of OA on the West Coast and other regions of North America.

A confluence of factors makes the West Coast particularly vulnerable to ocean acidification; a regional, coordinated science approach is the best strategy to mitigate impacts.

A confluence of factors makes the West Coast especially vulnerable to OA

OA along the West Coast is being driven by a confluence of conditions that will create increasingly severe impacts over the foreseeable future. There are two primary natural phenomena that work in concert to heighten the region's vulnerability to global CO_2 emissions:

1. **Ocean currents:** Acidification of West Coast waters originates with oceanic currents that transport waters across the northern Pacific Ocean from Asia to the West Coast. The journey for these waters – which takes about 30 years but can be as long as 50 years – begins off the coast of Japan, where surface waters absorb atmospheric CO_2 produced through global human activity and then sink hundreds of feet beneath the ocean's surface. As these subsurface waters move toward the West Coast, CO_2 levels rise even more as natural respiration processes break down sinking organic matter (and deplete dissolved oxygen). Because these deep waters are naturally enriched in CO_2, the added CO_2 from atmospheric emissions has a disproportionately large impact on ocean chemistry.
2. **Coastal upwelling:** Along the West Coast, winds that blow southward push surface waters away from the coastline. As surface waters are displaced, the deep waters rich in CO_2 and poor in dissolved oxygen (DO) are pulled to the surface in a process known as upwelling. Upwelling spreads CO_2–enriched waters across the entire continental shelf, pushing chemical conditions past biological thresholds for harm in many coastal zones.

Because these physical and biogeochemical processes play out over a multi-decade timeframe, the effects of West Coast OA are projected to become increasingly severe over time. Three decades ago, atmospheric CO_2 levels were about 16% lower than they are today. Thus, the waters already in transit to the West Coast will carry an increasingly heavy anthropogenic CO_2 burden as they arrive on West Coast shores. In fact, even if atmospheric CO_2 emissions could immediately be stabilized, the West Coast would still be grappling with increasingly CO_2-rich waters for at least the next three decades.

Compounding these challenges is global climate change, which is also triggered by rising CO_2 emissions. As the world's oceans warm, seawater will become less able to hold DO, and the difference in temperatures between surface waters and deeper waters will grow bigger, reducing the oxygen resupply to deeper waters. Both trends will result in larger and more severe low oxygen, or hypoxic zones. Meanwhile, West Coast upwelling is projected to intensify as the winds that drive upwelling strengthen in response to global warming. Because upwelled waters are also depleted in DO, the progression of OA in many parts of the West Coast will take place against a backdrop of increasing risk of hypoxia events. This co-occurrence of hypoxia poses further challenges for organisms already subject to OA stress, increasing the vulnerability of the West Coast region to the effects of rising CO_2 emissions.

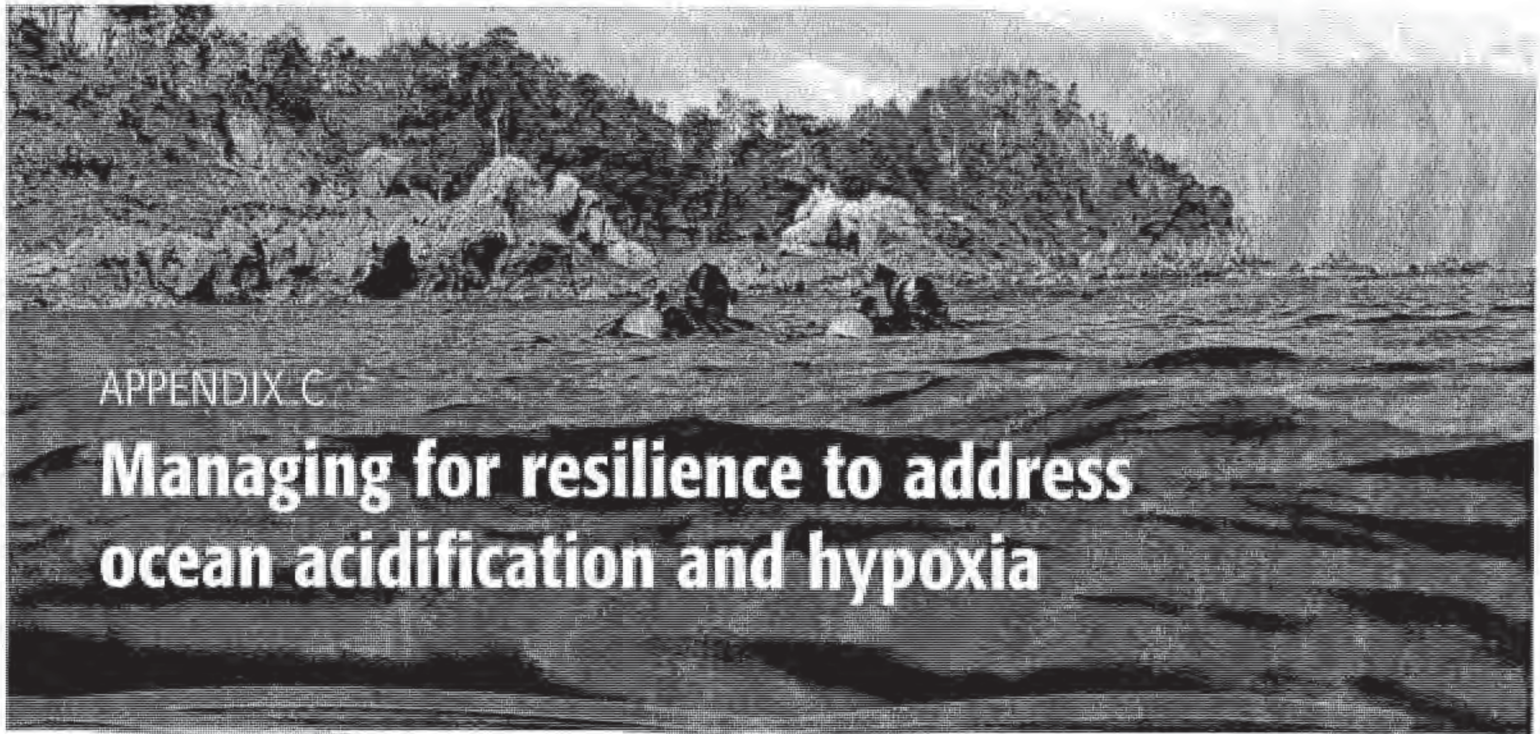
The most effective way to reduce West Coast vulnerability is through coordinated science

Because OA is a regional problem for the West Coast, the best way to mitigate OA's impacts is a regionally coordinated scientific research and monitoring strategy. Scientists and managers from across the West Coast can work together toward reducing OA's impacts on coastal ecosystems. A coordinated approach can take advantage of scientific commonalities that link the geographically and ecologically disparate areas that make up the West Coast region. For example, while Southern California's highly urbanized coastline may bear little resemblance to the minimally developed outer coast of Washington, they share many species of marine life in common. In fact, many important fishery species such as hake, tuna, and sardines move readily across state and national borders. Even for bottom-dwelling invertebrates such as Dungeness crabs, clams, and mussels, local populations can be genetically connected over large distances by the dispersal of planktonic young on ocean currents. Insights into biological vulnerability gained from one region can thus quickly inform information needs in another. Likewise, projections of ocean chemistry changes in any local ecosystem will require input from coast-wide models that set the stage for broader-scale patterns and trends in exposure. The development of such crucial coast-wide models is already underway and offers another avenue to accelerate access to knowledge needed across the region.

While local modeling and monitoring efforts are critical, they can have tremendous added value when they are linked together in a region-wide context that matches the regional scope of West Coast OA. By forming collaborative partnerships that leverage regional expertise and resources, and reduce redundancies, the West Coast can take advantage of economies of scale to mount a strong defense against this intensifying region-wide problem. OA knows no political boundaries and cannot be managed within defined jurisdictional borders, underscoring the value of highly coordinated, leveraged science.

The West Coast can serve as a proving grounds for strategic OA management

The West Coast will be a harbinger for the types of OA impacts that will be widely felt across coastal North America in the coming decades. By working in a coordinated fashion, scientists can provide managers with useable knowledge and information that informs and supports their OA management decisions. Just as importantly, the West Coast can serve as a proving ground for strategic OA management in other regions of North America and the world. Even within the West Coast region, "one size fits all" approaches are unlikely to be successful, as local factors that amplify or dampen OA vulnerability will differ with geography. Consequently, the vast and varied West Coast region offers the opportunity to test and compare diverse strategies, models and guides that can be transferred to other regions of North America.



APPENDIX C

Managing for resilience to address ocean acidification and hypoxia

The term "resilience," as applied here, refers to the adaptive capacity of ecological systems to cope with and recover from the impacts of ocean acidification and hypoxia (OAH) and other stressors. Here we provide the Panel's suggestions for how the management community can support ecological resilience under conditions of intensifying OAH by undertaking targeted actions that preserve or enhance the capacity for ecological systems to cope with and recover from OAH. Managing for resilience includes adaptation measures that seek to proactively lessen the impacts of OAH, and mitigation approaches that reduce exposure to co-occurring stressors. Such actions can be applied now to address impending changes in ocean chemistry. While intensifying OAH conditions may eventually cause some ecosystems to change substantially or irreversibly, over the near-term, managing for resilience represents an important strategy for "buying time" to slow the onset and reduce the scope of harmful ecosystem changes.

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Ecological concepts that underlie managing for resilience

Resilience spans many scales of biological organization, ranging from short-term physiological adjustments that take place within individual organisms, expression of adaptive capacity through evolutionary changes in populations, to the maintenance of ecological function by species turnover at the scale of ecosystems. Despite the number and complexity of biological and ecological processes that contribute to ecological resilience, scientists have been able to identify a specific set of desired attributes of resilient systems that are well-suited for protection or enhancement via management intervention. These general attributes include diversity, redundancy, modularity, connectivity, and adaptive capacity. For example, diversity in the form of a species-rich and functionally-redundant community of aquatic vegetation can be fostered by habitat protection measures. The resilience of fish populations can be promoted through harvest regulations that maintain broad distributions in age class structure and the contribution of sub-populations to a fishery. Population connectivity and, to a lesser extent, modularity, are already central elements in the design of coastal protected area networks.

Managers can also develop solutions that foster resilience by focusing on stressors that co-occur with OAH, such as physical disturbances to nearshore habitats, warming temperatures, toxic contaminants, biological invasion, and harvest. Co-occurring stressors can diminish the ability of ecological systems to cope with OAH, but may be amenable to control through management action.

Maximizing benefits from managing for resilience

Although managing for resilience is a useful near-term management strategy for coping with OAH, the adaptive capacity of West Coast ecosystems is not limitless. Managing for resilience is likely to become less and less effective as OAH intensifies and degrades precisely the biological and ecological attributes that confer resilience to populations, communities, and ecosystems. Where and when managing for resilience is likely to be most successful is also likely to vary greatly among systems and from place to place, but understanding of this variation is poorly developed for OAH. Identifying priority candidate fisheries or systems where the development and implementation of resilience-focused management plans are most likely to be beneficial would be an important first step in managing for resilience across the region.

Resilience management can involve actions to prevent the loss of resilience from status quo conditions, or interventions that enhance the resilience of a system in the face of intensifying OAH stress. The effectiveness of either approach will depend on establishing metrics of resilience, defining targets and goals, and developing the ability to track changes in resilience and intervene adaptively if goals are not met. Because preserving and enhancing resilience to OAH are not currently explicit goals of natural resource management, metrics to quantify resilience, targets for those metrics and approaches to monitor changes in resilience have yet to be fully developed.

Increasing the capacity to hone such tools is an important opportunity to advance managing for resilience from conceptual strategy to concrete implementation. For now, managers will need to work with scientists to develop, test, and refine such approaches in real world applications.

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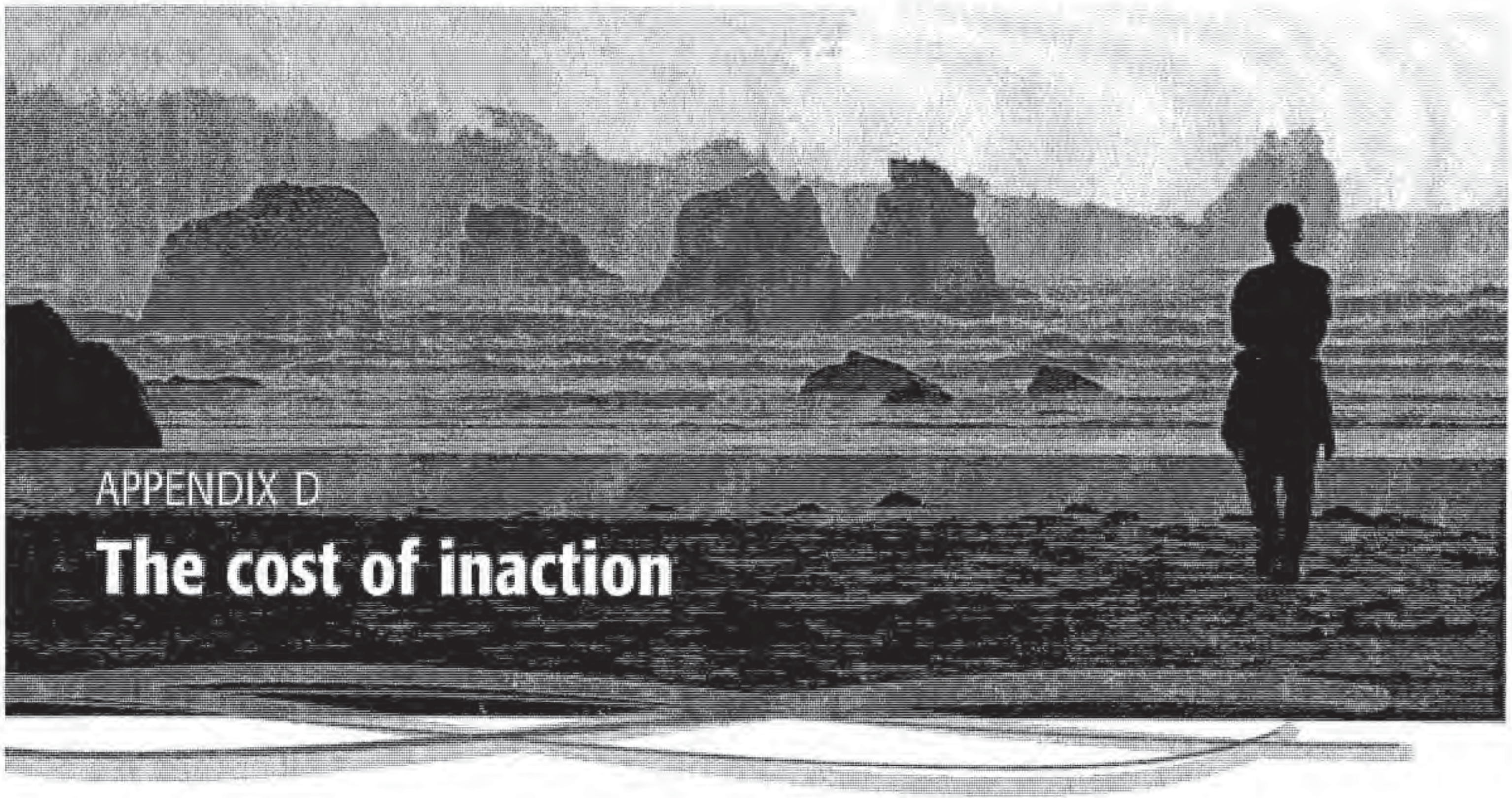

APPENDIX D
The cost of inaction

Failure to take action will reduce management options and trigger more severe ecological harm

Marine ecosystems, and the industries that depend on them, face growing risks of widespread harm that will become increasingly difficult to reverse as rising CO_2 emissions intensify ocean acidification and hypoxia (OAH). Thus, the cost of inaction on OAH, in the form of reduced management options and wider ecological changes, will rise over time. Scientists are working to understand where and when OAH's aggregate impacts will cross thresholds, or "tipping points," where ecosystems switch to significantly degraded or altered states from which recovery becomes increasingly unlikely. Scientists also are continuing to evaluate what actions West Coast managers can take now to slow the progression of OAH and mitigate its most ecologically and economically threatening impacts.

The full scope of ecological changes ahead is not yet well understood or described, and, as with any area of scientific projection, understanding will come qualified by caveats about scientific and statistical uncertainty. While skeptics might argue that West Coast managers should wait to take action until these uncertainties are resolved, the Panel strongly disagrees with that assessment. OAH science allows researchers to link various observational and modeling data to develop reasoned, informed projections that can help bound expectations about what the world might look like in 1 year, in 10 years, in 50 years. These projections will change as scientific understanding of OAH improves, but the general trends are clear.

...the cost of inaction on ocean acidification and hypoxia, in the form of reduced management options and wider ecological changes, will rise over time.

Science supports the decision to act now to start addressing OAH

The Panel's rationale for why West Coast managers should take action now includes:

1. Larger and more rapid changes in ocean chemistry lie ahead.

Continued atmospheric CO_2 emissions will alter the chemistry of coastal waters in ways that will fundamentally make it more difficult to support ecosystems and the benefits that they provide to humans today. These changes in ocean chemistry are not projected to occur in a simple incremental fashion, as non-linearities in the carbonate system amplify the impacts of future rise in seawater CO_2 content. Larger and more rapid changes can also arise from processes associated with climate change and nutrient inputs that enhance inorganic carbon loading and the intensity of ocean hypoxia.

2. The risk of crossing biological and ecological thresholds will increase as OAH stress intensifies.

In addition to non-linear changes in ocean chemistry, scientists also expect impacts on marine life populations and ecological communities will rise non-linearly as the intensification of OAH stress exceeds the physiological tolerance of an increasingly large suite of species that interact within coastal food webs.

3. Predictive power will decrease as the effects of OAH move deeper into uncharted territory.

As the West Coast moves away from presently observable states of ocean chemistry and ecology, it will become harder for scientists to predict with confidence how ecological systems will be affected by OAH. Thus, West Coast managers will benefit from slowing OAH's impacts, as it will help to preserve access to the best-constrained assessments of risks and options.

4. Degraded systems may become less resilient to OAH stress.

Emerging science suggests that as ecosystems become degraded by OAH and other stressors, they become less resilient and less able to withstand increased OAH stress going forward. This suggests that taking actions now to prevent the loss of resilience can lessen the impacts of OAH in the future.

5. Reversing OAH degradation later will involve greater effort and/or longer lag times.

Preventing declines in populations or ecosystems is often more tractable and less costly than reversing declines once they have occurred. For example, challenges in rebuilding fish populations once genetic diversity is lost, or restoring habitats once they have shifted into a less desired state, illustrate the difficulty of reversing ecological degradation. By allowing more changes to manifest before taking management action, OAH effects may become more difficult and perhaps impossible to reverse.

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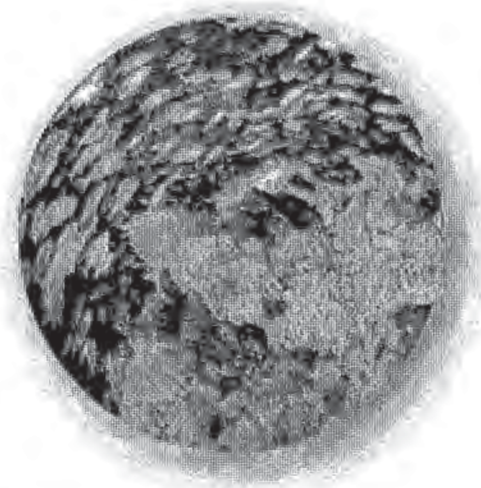
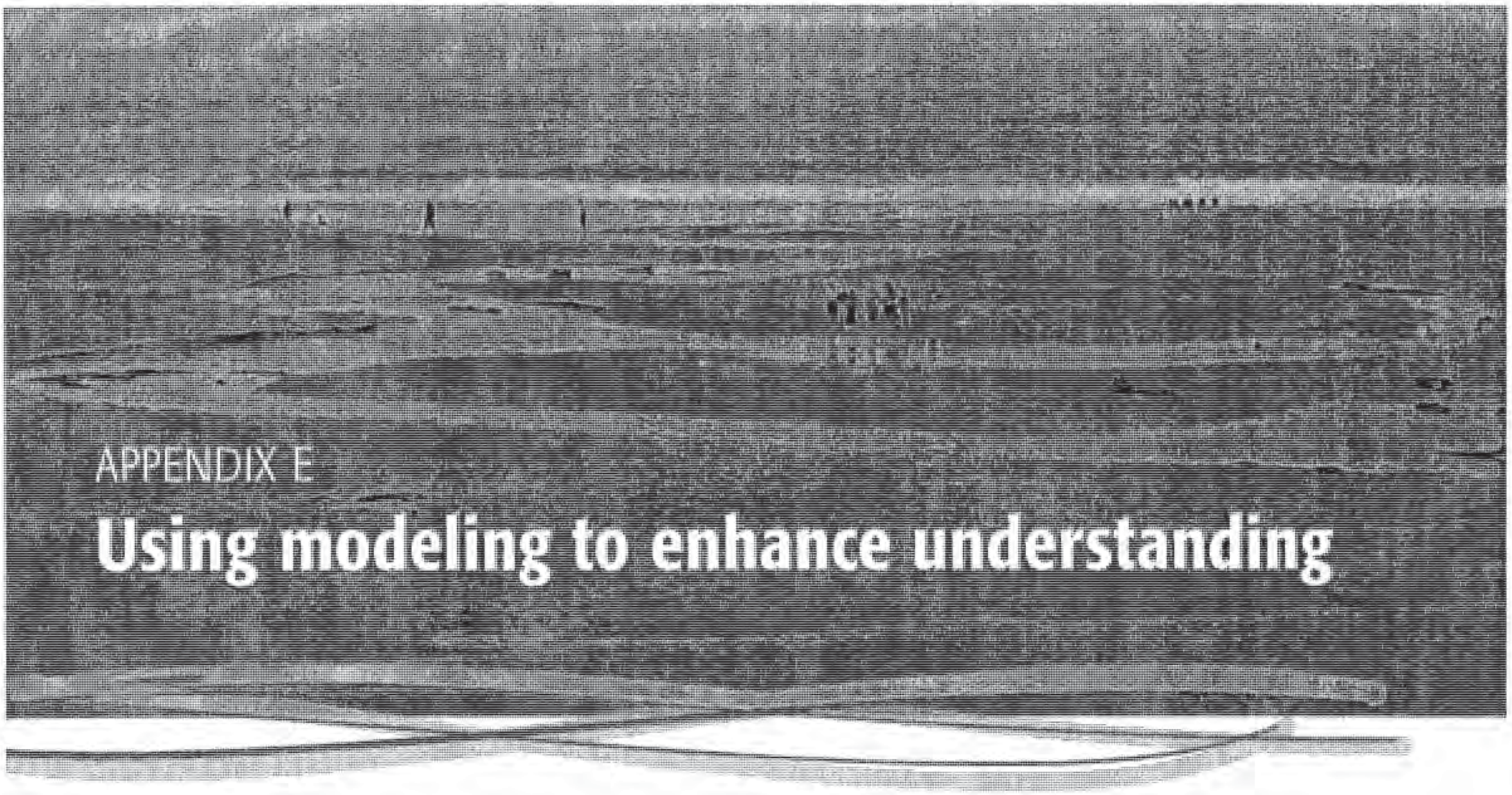




APPENDIX E

Using modeling to enhance understanding

Predictive mathematical models that provide insight into the potential ramifications of ocean acidification and hypoxia (OAH) play an instrumental role in scientists' ability to offer a suite of management options that address OAH in an informed, scientifically defensible fashion. Modeling tools allow scientists to forecast what future conditions will look like, to interpolate limited data sets to build a comprehensive picture of conditions, to evaluate likely success of potential management actions, to prioritize data gaps, and to evaluate monitoring plans.

OAH models will allow coastal managers to make better-informed decisions about implementing controls on local pollution sources that are exacerbating OAH, and to engage in ecosystem-scale resource management planning. Multiple research groups are already in various stages of developing such models, but efforts to date are limited in several respects. First, OAH model development has primarily focused on large oceanic scales, leaving important knowledge gaps in scientists' ability to predict OAH dynamics in near-coastal waters, estuaries and bays that are the primary focus of potential management action. Second, physical models that describe the movement of ocean water across space and time have not yet been systematically coupled with biogeochemical models, which describe how various environmental elements together exert collective effects on OAH chemistry, or with ecosystem models that integrate physical, biogeochemical and ecological properties to predict effects on marine life populations and whole ecosystems.

Thus, additional investments in OAH modeling work are needed to enhance, coordinate and link existing modeling efforts to OAH-related management decisions. The Panel recommends that West Coast managers and the scientific community move forward by building and improving upon both coupled physical-biogeochemical models and fishery and ecosystem models. These models should be validated with management endpoints in mind and against various settings. The modeling community would also benefit from a modeling forum to promote collaboration and interaction with managers. These recommendations are outlined in greater detail here.

OAH models will allow coastal managers to make better-informed decisions about implementing controls on local pollution sources...

OAH Modeling Recommendations

1. Invest in a suite of coupled ocean-margin physical and biogeochemical models.

Although a nested set of physical and, to a lesser extent, biogeochemical models has already been developed for the West Coast, these models have coarse resolution that inhibits their application in areas that are the focus of management concern. West Coast managers should build capacity for downscaling these physical models, extending them closer to shore, and integrating them with biogeochemical models to create high-resolution, coupled models.

2. Improve fishery and ecosystem models.

Although a broad suite of models are currently employed to inform fishery management and predictions of ecosystem changes along the West Coast, the objectives of these efforts have generally fallen outside the scope of OAH management needs. Fishery and ecosystem models will be crucial for understanding and predicting the full extent of OAH impacts. The utility of these models, however, will depend on how biological and ecological responses of OAH are parameterized, and how outputs from coupled physical-biogeochemical models are utilized. To better support marine resource decisions, scientists should prioritize research that yields parameterize-able understanding of the biological and ecological impacts of OAH, and improvement in the capability of fishery and ecosystem models to be informed by advances in coupled physical-biogeochemical models.

3. Validate the models.

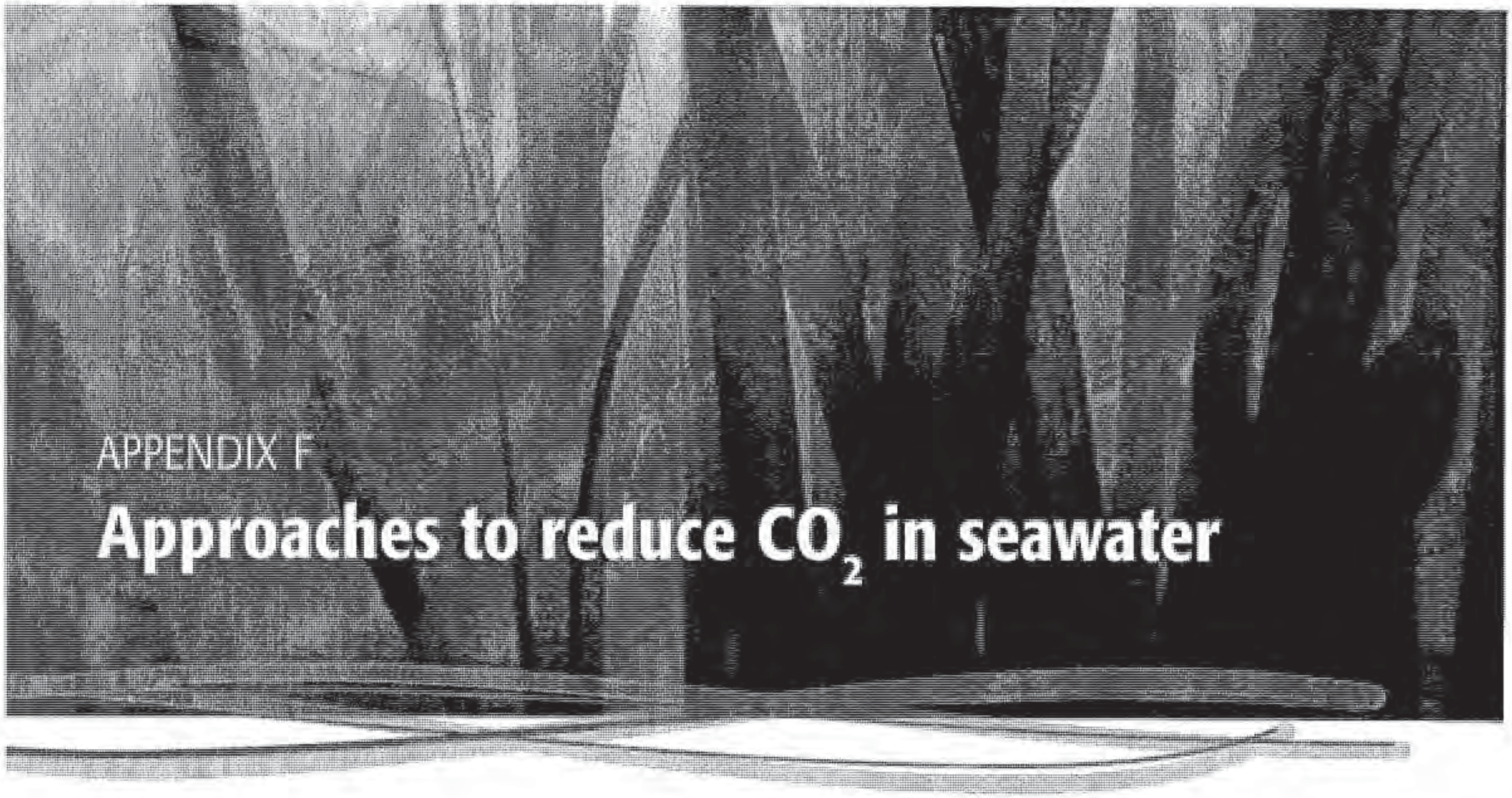
The management decisions that will be based on model outputs are likely to be costly. As such, models should be validated and improved with endpoint management decisions in mind, and with a focus on identifying knowledge gaps and quantifying uncertainty. Validation efforts should extend explicitly into near-coastal areas where temporal and spatial variability are the highest, and where a large number of management decisions are concentrated. Scientists should first seek to validate existing models using observational data for a broad range of climate and ecosystem states, with a focus on quantifying uncertainties and identifying key gaps in data and modeling infrastructure. Second, scientists should compare the outputs of multiple models to constrain uncertainty in their projections, which could ultimately pave the way for development of the next generation of models.

4. Collect data to support model development and refinement.

The ability of models to make accurate predictions of future ecosystem changes – be it aragonite saturation state, dissolved oxygen, biodiversity, or fish populations – is limited by the availability of data that can be used to parameterize those key attributes. In turn, confidence in model outputs will depend on a clear understanding of the ability of models to accurately reproduce features of the ecosystem that are of greatest management interests. This understanding will require diverse datasets that test model performance across different regions or habitats, and across different seasons and years as ocean and ecosystem conditions change. Investments in the sustained collection of integrated oceanographic and ecological data sets will be crucial for refining the performance of predictive models and their utility in informing decisions. There also should be effort to create a central repository for observational data and model output so that they are used effectively to inform further research, and ultimately management action.

5. Establish a forum to advance coastal ocean modeling.

The West Coast would benefit from creation of a forum that brings scientists and managers together to synthesize local and regional management needs, and to ensure that scientists are working in a coordinated, synergistic fashion to address those management needs. An organized community of modelers, observational researchers, and managers will serve to: (1) provide a vehicle for dialogue on management goals and scenarios, (2) encourage discussion on the use of model outputs to illustrate outcomes of management options to reach those goals, (3) facilitate discussion about the level of validation needed to use models to support management decisions, and (4) coordinate modeling products among different technical specialists. A first critical action is to convene a series of workshops to summarize key regional and local management needs, and identify the status of existing models to support those needs.



APPENDIX F

Approaches to reduce CO_2 in seawater

The impacts of rising atmospheric CO_2 concentrations on seawater carbonate chemistry can be reduced using two possible approaches. The first is biologically-based, making use of the natural ability of the ocean's photosynthetic organisms (algae and plants) to capture CO_2. For example, seagrasses, kelps and other macrophytes remove CO_2 from seawater and convert it into living tissue. This CO_2 uptake can occur at sufficiently rapid rates to significantly improve water quality for organisms sensitive to carbon chemistry changes. Although a substantial fraction of this organic carbon is released as CO_2 when plant tissue decomposes, active photosynthesis may offer a means to locally reduce CO_2 in shallow coastal environments.

There has been considerable interest along the West Coast in protecting and restoring aquatic vegetation as a means to reduce CO_2 in coastal aquatic ecosystems. Seagrass beds and kelp forests are among the world's most productive habitats, with rates of net primary production that can exceed those of tropical forests. The ability of aquatic vegetation to influence coastal chemistry is evident from estuarine monitoring data that show day to night swings in pH whose magnitude can exceed near-term declines projected from OA.

The second approach uses abiotic methods to mitigate OA exposure. Abiotic methods can be used to increase chemical buffering capacity (alkalinity) of seawater or physically remove CO_2. Synthetic base chemicals or natural base minerals can be added to seawater to increase its alkalinity. This in turn neutralizes seawater acidity and buffers against the effects of increasing CO_2 on seawater chemistry. CO_2 can be directly removed from seawater using engineered approaches such as electrochemistry, electrodialysis, vacuum extraction, and aeration with a CO_2-depleted gas.

...coastal vegetated habitats hold some of the highest concentration of organic carbon of any ecosystem on the planet, and serve as a globally important sink for carbon (i.e., blue carbon).

There are potential co-benefits of habitat protection and restoration

While one potential benefit of protecting and enhancing aquatic vegetation is reducing CO_2 in seawater, additional co-benefits may also be realized. A portion of the CO_2 converted into vegetation can be buried in sediments. This process represents the potential long-term storage or sequestration of CO_2. On an areal basis, coastal vegetated habitats hold some of the highest concentration of organic carbon of any ecosystem on the planet, and serve as a globally important sink for carbon (i.e., blue carbon). Consequently, their conservation and restoration could one day become eligible for carbon offsets in carbon trading markets, such as the one established in California, or for other funding that promotes carbon sequestration. We also note the distinction between short-term removal of CO_2 and the long-term sequestration of CO_2 by vegetated habitats. For example, kelp forests, while highly productive and active in CO_2 removal on a daily and seasonal basis, grow on hard bottom habitats where local sediment burial and the potential for long-term carbon sequestration may be minimal. In contrast, emergent marsh vegetation uses CO_2 from the atmosphere for photosynthesis and releases CO_2 to surrounding waters through root respiration. Yet, these systems can be highly effective in trapping and sequestering carbon-rich sediments, or removing nutrients that may otherwise contribute to acidification or hypoxia in downstream habitats.

Another benefit of protecting and enhancing aquatic vegetation is the creation of habitat for fish and other biota. One of the Panel's **Actions** is considering the ability of aquatic vegetation to remove CO_2 from seawater in addition to its habitat value during habitat restoration planning. Accounting for both of these ecosystem benefits will assist in better achieving the full societal value of habitat restoration and management.

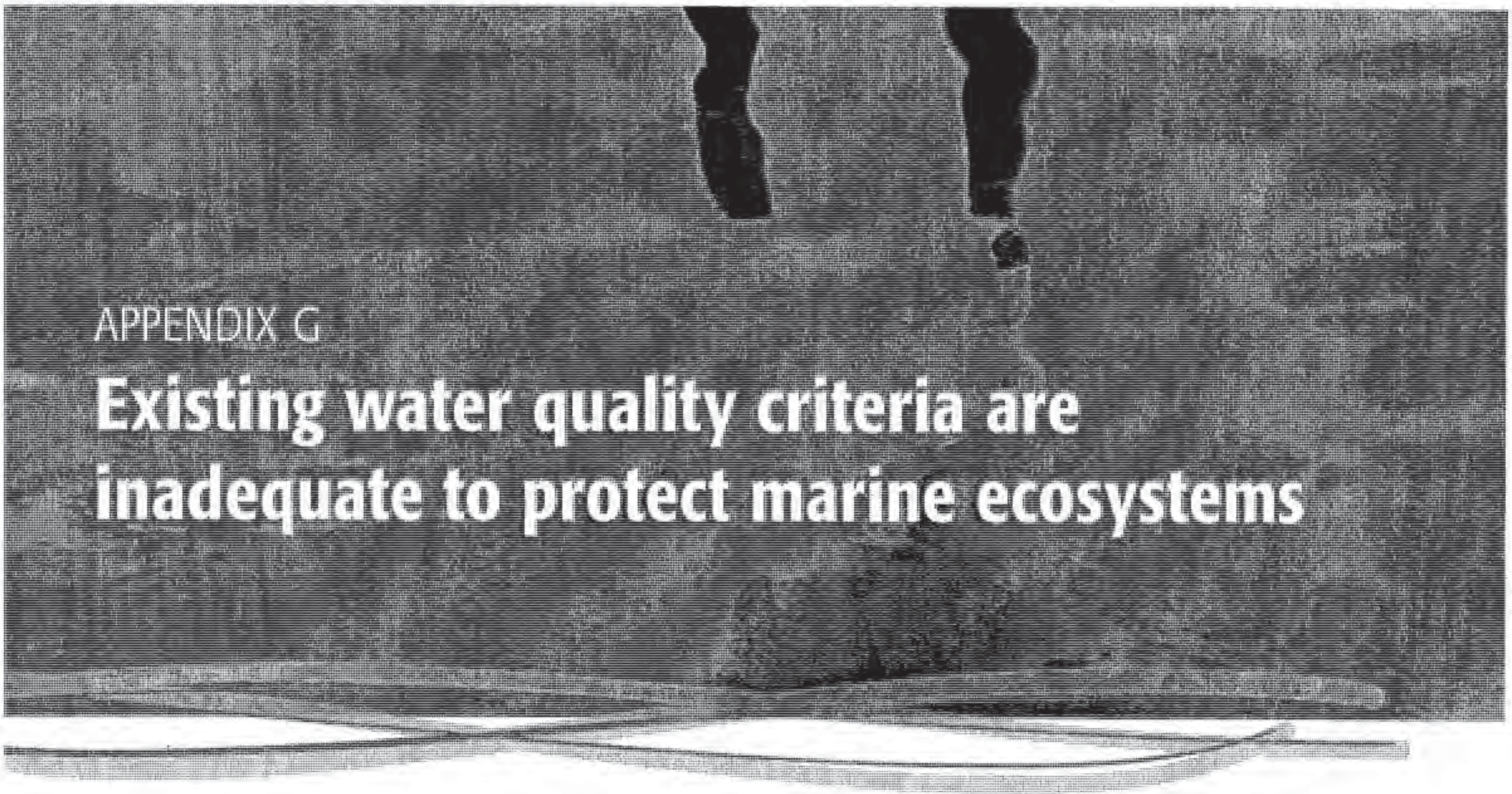
Advancing research to increase management options

Across the West Coast, researchers are actively investigating approaches for restoring aquatic vegetation, their role in locally modifying coastal seawater chemistry, and the daily to seasonal patterns of carbon uptake of these environments. In the K'ómoks Estuary on Eastern-central Vancouver Island, the transplanting of eelgrass from donor beds to previously disturbed estuaries has been successful in establishing new beds. Dive surveys have confirmed a transplant success rate of 95%. In Washington, pilot studies have reported elevated daytime pH in waters over seagrass beds relative to bare sediment habitats. In Oregon, oyster hatchery managers at Netarts Bay have begun to selectively draw seawater into the hatchery during hours when photosynthesis in the seagrass-rich system has reduced CO_2 to levels acceptable for their operations.

These examples highlight the potential applications of aquatic vegetation protection and restoration as actions to reduce CO_2 and ameliorate, if not offset, OA in local ecosystems. If successful, such actions can increase the range of options available to managers to address OA. Important questions nonetheless remain as to the effectiveness of aquatic vegetation CO_2 reduction as an OA mitigation strategy and must be answered before implementation. For example: Will the benefits of photosynthesis be offset by increases in the daily and seasonal swings in carbon chemistry? How far does the spatial "footprint" of such effects extend? What are the range of settings and locations where vegetation protection and restoration will be most successful and beneficial? Can such measures be employed in concert with other management actions to maximize conservation benefits? These questions can be addressed directly in larger-scale, proof-of-concept demonstration studies. When conducted across a range of habitats, these efforts can provide managers with new, useable knowledge of if and where protection and restoration of vegetated habitats will sufficiently remove CO_2 to meaningfully mitigate OA.

Options from engineering approaches

Human intervention to mitigate OA through engineering addition of basic materials and removal of aqueous CO_2 is still in early development. The effective scale, ecological consequences, and carbon footprint of such efforts remain uncertain but can offer important options for impacted industries. For example, shellfish growers on the West Coast have begun to use alkalinity management to offset the increase in carbonate mineral corrosivity from OA in hatchery settings. Although currently available approaches remain likely tractable only at localized scales and in controlled environments, future technological advances may broaden the applications of engineering approaches. Further research will be needed to determine the safety, cost effectiveness and potential scale of such efforts in countering the ongoing global progression of OA and its regional expression on vulnerable West Coast ecosystems.



APPENDIX G

Existing water quality criteria are inadequate to protect marine ecosystems

Water quality criteria are the management foundation of the Clean Water Act. They provide a basis for assessing water body condition, determining the level of discharge that will maintain a water body in an ecologically acceptable condition, and objectively determining when a water body is impaired. Most importantly, water quality criteria serve as targets for water body planning and mitigation projects, even outside of the regulatory framework.

Unfortunately, the existing water quality criteria for pH are not scientifically valid for application to ocean acidification (OA). They were developed 40 years ago, and the Panel has determined that they are neither based on current science nor are they ecologically relevant. Damage to ocean biological communities has been documented at thresholds that are well within the criteria's legally permissible range.

...the existing water quality criteria for pH are not scientifically valid for application to ocean acidification.

Shortcomings of existing criteria

Existing OA criteria are based on two types of pH thresholds: a requirement that pH should not fall below 6.5, and a requirement that pH should deviate no more than 0.2 pH units from natural conditions. Both types of thresholds are flawed for the purposes of application to acidification.

The minimum pH of 6.5 is inadequate because numerous studies have shown diverse biological impacts routinely manifest at pH levels well above 7.5, at which acidity (hydrogen ion concentration) is an order of magnitude higher than pH 6.5 (pH is on a logarithmic scale). The Panel's publication, "*What changes in the carbonate system, oxygen, and temperature portend for the northeastern Pacific Ocean: a physiological perspective*," provides more detail about the range of biological responses that occurs even as existing pH criteria are met.

The second part of the criteria, which calls for a deviation of no more than 0.2 pH units from natural, is flawed because it is impractical to apply. "Natural" conditions cannot be established spatially because the entire West Coast region is undergoing change due to global atmospheric inputs, and it is difficult to establish temporally because there are few long-term data sets with enough precision and accuracy to capture this level of change. This is compounded because measurement imprecision of the technology used in discharge monitoring programs is greater than 0.2 pH units, creating a margin of error that can mask ecologically relevant pH changes. Criteria inadequacies regarding establishing "natural" conditions are further described in the Panel supporting document "*Water quality criteria for acidifying oceans: Challenges and opportunities.*"

Water quality criteria should be expanded to encompass other acidification parameters

Although developing an alternative pH criteria represents an important first step, revisions to water quality criteria should be expanded to include other biologically relevant acidification parameters. pH is only one of several possible parameters for describing effects of acidification, and it is unclear if pH is even the most biologically relevant variable for many species. Aragonite saturation state, another viable candidate indicator, has been found to be more biologically relevant than pH for shell-building in calcifying organisms. Considerable scientific evidence, particularly from studies of oysters and pteropods -- a shelled zooplankton at the base of the food web – is already available for establishing both chronic and acute thresholds for aragonite saturation state. In addition, parameters such as pCO_2 have been found to be biologically relevant for fish, affecting their behavior and ability to navigate.

...revisions to water quality criteria should be expanded to include other biologically relevant acidification parameters.

In developing ecologically relevant thresholds for OA parameters, managers should account for potential interactions of OA with co-occurring stressors such as hypoxia. There is a growing recognition that the most acidified regions of the ocean are also low in oxygen, with recent studies showing that dual effects of low pH and hypoxia are more severe than the predicted effects of either stressor alone. In the immediate future, a scientific workshop is needed to identify appropriate biologically relevant indicators and thresholds to assess OA, and to prioritize short-term research needs for informing criteria and threshold development.

Development of biological criteria will improve assessment of acidification effects

The Clean Water Act provides an opportunity for assessing ocean health by examining condition of the biological communities that live within it, which has advantages over using pH or other chemical criteria alone. Traditional chemistry thresholds and associated monitoring are limited because they provide information about a relatively narrow portion of the environment at a discrete point in time. In contrast, bioassessment accounts for exposure to multiple stressors over extended time periods, and provides a more integrated reflection of aquatic ecosystem condition.

Incorporating biological criteria into a management context requires linking population and community effects with specific stressors. Effective biological criteria should provide early-warning management cues, before significant ecosystem alteration has already taken place. However, biological criteria also need to relate to effects on growth, survival, reproductive success or other metabolic functions that have repercussions at the population level, as opposed to simply quantifying exposure to a stressor. For example, pteropods might prove useful as a biologically relevant criterion for linking acidification stress to biological response, as they are an important food source for economically important fish and are among the first organisms to be affected by acidification in a marine ecosystem. Pteropods have thin aragonitic shells and narrow optimum windows for calcification, leading them to display rapid responses to corrosive waters. Acidification effects on their calcification have been studied under both field and laboratory circumstances and such indicators could offer a more integrated understanding of acidification effects.

Using ecologically relevant criteria to support OA management

Water quality criteria are typically used as regulatory tools, such as making decisions under the Clean Water Act Section 303(d) regarding whether a water body is impaired. The Panel recognizes that this is one application of water quality criteria, but the Panel also recognizes that credible water quality criteria can be effective in other decision-making contexts. For example, water quality criteria provide essential context for interpreting monitoring data or the output of model predictions about the likely effects of potential management actions. They also become part of a shared toolkit with managers from other sectors, providing a common framework for discussions about appropriate actions for fisheries and marine reserves. Additionally, scientifically-founded OA criteria can also be used to educate the public about OA and its effects on local waters.

APPENDIX H

Establishing ocean acidification and hypoxia research priorities

A strategy for aggressively expanding options for management action

To manage effectively for ocean acidification and hypoxia (OAH), West Coast managers need an arsenal of tools and options that are grounded in sound science. However, OAH research is still largely in its infancy, generally limiting the management options available. While the amount of OAH research being conducted has exploded over the past decade, many critical knowledge gaps remain. This document outlines the Panel's recommendations for aggressively expanding the breadth and depth of OAH research in order to meet the demands for management-relevant information on the West Coast and beyond. Organized around five major research areas, this research portfolio has been designed with the assessment that absent a coordinated and strategic prioritization of research foci, current research trajectories are unlikely to meet growing needs for management-relevant knowledge. To that end, scientists must go beyond answering academically stimulating questions; they also must maintain a relentless focus on providing managers with concrete, actionable options for immediately combatting the threats posed by OAH. Scientists are invested in seeing their OAH work translated into viable management options, but need help from West Coast managers in coalescing around a shared research vision and coordinating efforts for maximum impact and efficiency. The recommendations outlined in this Appendix are expanded in the Panel's more detailed document "*Research Priorities to Inform Decisions and Develop Solutions.*"

While the amount of OAH research being conducted has exploded over the past decade, many critical knowledge gaps remain.

Understand drivers of OAH

Scientists understand at a conceptual level that local nutrient and carbon inputs can exacerbate the impacts of OAH. However, management recommendations about reducing these local inputs are qualified by the lack of clear understanding about precisely where on the West Coast local inputs are sufficiently large to be meaningful relative to the global scale inputs that drive OAH. Furthermore, more clarity is needed about the relative importance among local inputs (non-point source vs. wastewater discharge vs. local atmospheric inputs) to prioritize for reduction. Thus, the Panel recommends investing in research that enhances our understanding of the relative importance of local vs. global contributions to OAH. West Coast managers should focus on developing key datasets, and coupled physical-biogeochemical models, validated with observations, that quantify the relative impacts of various nutrient, carbon and carbon dioxide sources on exacerbating OAH. Investments should also continue in developing new, accurate, cost-effective and easily deployed ocean sensors for OAH parameters. These models should be evaluated in the context of decision-making processes, and observational data should be collected to enhance model validation. As scientists learn more, they can adjust and adapt strategy options for source reduction that will maximize effectiveness and minimize cost.

Assess vulnerability to changing conditions

A key management information need is understanding how fast seawater chemistry is changing, at what locations seawater chemistry will change the most, and what levels of chemical change will trigger substantial changes in biological communities. Scientists along the West Coast are in various stages of developing coordinated monitoring programs, conducting laboratory and field experiments, and refining numerical models to address such questions. However, additional research is needed to transition these studies from individual research projects to more concerted, connected sets of research activities that address the underlying management questions. In addition, current efforts need to be expanded to downscale global models to project change along the West Coast, elucidate the biological effects of multiple stressors within the context of real-world exposure conditions and enhance the translation of physiology-scale findings to population- and ecosystem-scale projections.

Understand evolutionary response to OAH

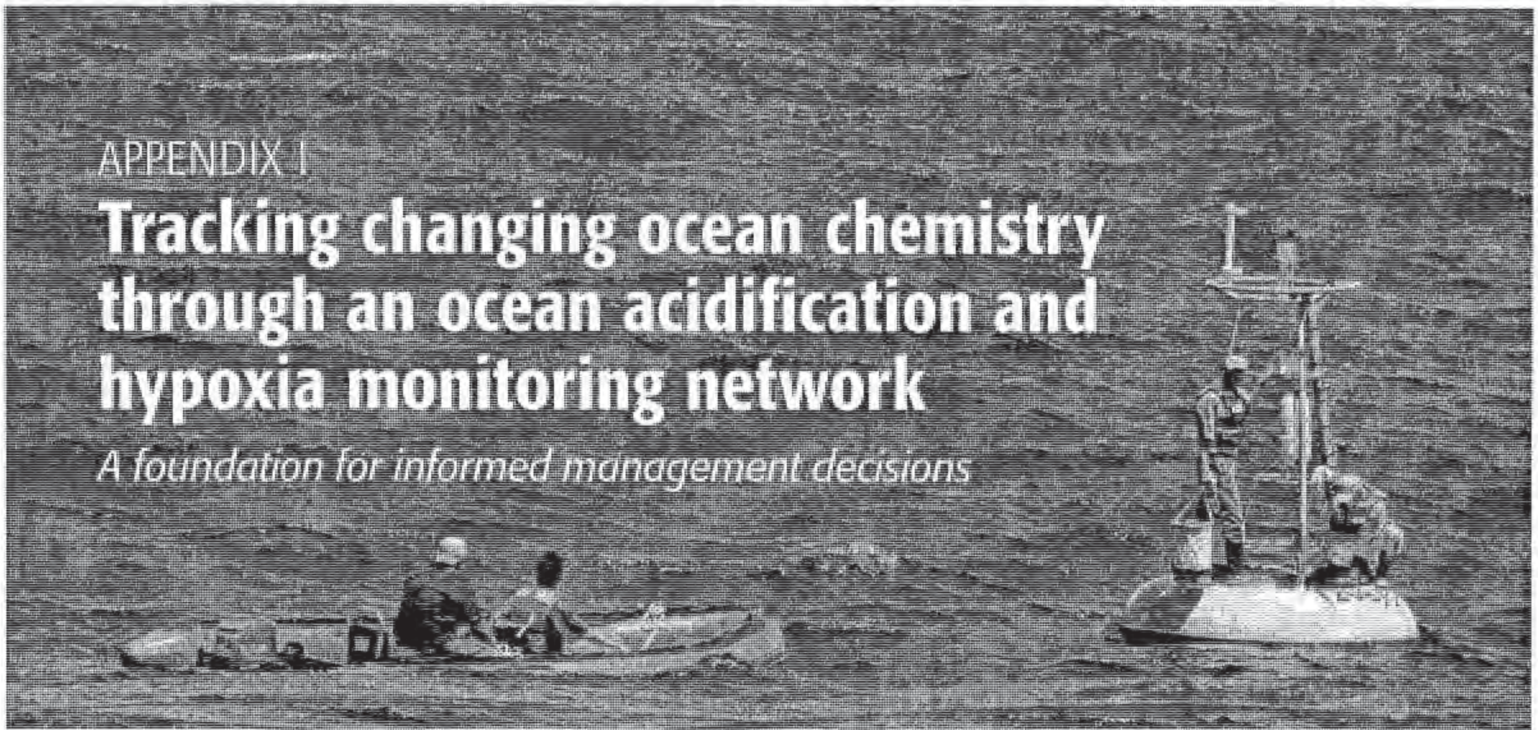
Although organisms have the potential for evolutionary adaptation to cope with OAH stress, scientists have insufficient information to predict whether, where, and how fast that genetic adaptation will occur. Thus, research is needed to understand rates of natural genetic change in response to OAH, and how evolutionary potential is distributed among taxa and localities. Moreover, West Coast managers need to understand how this potential for adaptation can best be incorporated into management strategies, such as use of refugia to protect the genetic diversity that now exists in local biota, especially those that are routinely exposed to high levels of OAH stress. Research will also allow assessment of the potential value and consequences of purposeful interventions, such as selective breeding and translocation. With sufficient knowledge, managers can determine whether and where opportunities exist to use evolutionary potential to address OAH's impacts on biological communities.

Explore sequestration and other carbon removal solutions

The acidification of seawater can be mitigated in two main ways: a) a biologically-based approach, in which seagrasses, kelp and other vegetation remove carbon dioxide from seawater and convert it into living tissues, and b) a chemically-based approach, in which the addition of base minerals such as carbonates is used to neutralize acidity. These approaches are appealing because they operate at the local level, but their applications to date have been limited and focused mostly on laboratory or small-scale settings. The Panel recommends supporting research on the type, capacity, cost-effectiveness, and safety of these removal processes as a means to determine which, if any, of these could become part of an effective marine conservation strategy.

Advance living marine resources management

Because the Panel has recommended that managers undertake actions that enhance the ability of organisms to cope with increasing OAH stress – critically important in the context of managing living marine resources such as commercial fisheries – the growing adoption of ecosystem approaches to fisheries management offers opportunities for fisheries managers to consider the potential regional effects of OAH as they update fisheries management plans. Critical to understanding OAH in an ecosystems context is that different areas are more vulnerable or resistant than others. Ecosystem models that support ecosystem-based fisheries management need to be developed and validated on local scales, and ecological risk assessments that increase understanding of fisheries vulnerabilities need to be conducted.



APPENDIX I

Tracking changing ocean chemistry through an ocean acidification and hypoxia monitoring network

A foundation for informed management decisions

Ocean acidification and hypoxia (OAH) monitoring programs dot the West Coast, as monitoring plays an invaluable role in scoping the severity of OAH-related problems, determining the trajectory of the problem (i.e., is it getting worse, and at what rate?), and assessing the effectiveness of past and planned management actions. Many monitoring programs were developed to address specific research or management needs. As a consequence, they do not adequately operate on the spatial and temporal scales over which OAH is occurring. Furthermore, traditional OAH monitoring focuses on measuring basic chemical parameters, such as pH and dissolved oxygen, rather than the full array of interrelated variables that collectively define OAH's impacts.

The Panel recommends establishment of a sustained, strategic and adaptive monitoring network that is founded on integration, coordination, and harmonization of existing efforts and their expansion in ways that will inform policy and management decisions. A regional OAH monitoring network will link decision-makers with a common pool of scientific data that will enable them to evaluate how, when, and where to act to serve the best interests of the region and society as a whole.

The monitoring network envisioned by the Panel explicitly includes physical, chemical, biological, and ecological monitoring to track change, understand impacts, and evaluate management actions. It leverages and enhances existing assets (e.g., observing systems, ecological time-series), technologies, protocols, partnerships, data systems and management frameworks (e.g., protected areas) to achieve a strategic, efficient network. The Panel's foundational requirements for a rigorous regional monitoring program are provided in a separate technical document entitled "*Ocean Acidification and Hypoxia Monitoring Network: Tracking the Impacts of Changing Ocean Chemistry to Inform Decisions.*"

A regional OAH monitoring network will link decision-makers with a common pool of scientific data that will enable them to evaluate how, when, and where to act...

Here we describe the key actions needed to achieve that desired monitoring network.

1. Define management needs from OAH monitoring.

Cultivate and enhance existing partnerships between monitoring practitioners, modelers, and decision-making users to better define OAH information needs across ecosystem types, and for diverse uses.

2. Assess how well existing monitoring efforts meet those management information needs.

Complete a comprehensive inventory of the geographic distribution, data quality, and operational status of existing monitoring programs that provide information relevant to OAH management. Use this inventory to address how well these monitoring assets are positioned to address management questions and support OAH forecast models. Use OAH model outputs to evaluate the information value of existing and proposed monitoring locations.

3. Evaluate and prioritize needs for new investment.

Enhance existing monitoring efforts to fully address management questions. Assess the feasibility of adding new measurements and analytical capacity to existing monitoring efforts. Establish regular communication and connections among managers, scientists, system operators, and end-users to iteratively assess the strength of alignment between monitoring activities and decision-making needs.

4. Enhance consistency among programs through training and quality assurance.

Many monitoring programs on the West Coast were established independently and thus have unique procedures for data procurement and management. Measurement techniques and data archiving should be harmonized among monitoring efforts. Staff involved in monitoring requires training in these procedures, and quality assurance activities should be performed to ensure reliability and comparability of data.

5. Develop a centralized portal for accessing OAH monitoring data.

Develop a simple means for accessing diverse monitoring data sets as well as OAH model output that inform OAH management. This will allow data to be catalogued, combined, compared, and shared, ensuring that monitoring data and model output are used effectively to inform further research, and ultimately management action. Establish community protocols for submitting new data into common data portals.

6. Develop and sustain intellectual capacity.

It is not enough to just make measurements and run models - it is also critical to maintain the intellectual capacity to interpret and communicate the findings. Investments in data analysis and data distribution are critical pieces of a monitoring network, as they will ensure the data are used to inform the management decisions the program was designed to support.

7. Communicate information widely.

Develop tools and technologies to promote greater two-way communication regarding observations and analyses, and data synthesis products. Incentivize regular information exchange activities that engage the broader user community.

Enhance existing monitoring efforts to fully address management questions.

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VI. Additional Panel products supporting the "Major Findings, Recommendations, and Actions"

The Panel has produced a series of products that anchor the Panel's "**Major Findings, Recommendations, and Actions**" and attached appendices on a foundation of the best available science. The documents fall into two categories: technical guidance documents targeted for program managers, and foundational science documents targeted for subject-matter experts. For Panel products, visit www.westcoastOAH.org.

Technical guidance documents

The primary audience for Technical guidance documents is program managers who are responsible for programmatic implementation. These documents are intended to help program managers translate the "**Major Findings, Recommendations, and Actions**" into initiatives and policy.

- **Ocean Acidification and Hypoxia Monitoring Network: Tracking the Impacts of Changing Ocean Chemistry to Inform Decisions**

  The Panel has outlined a strategic framework for ocean acidification and hypoxia (OAH) related monitoring intended to provide rigorous decision-support to policymakers and managers at a West Coast-wide regional scale. This document describes key attributes of an OAH monitoring network, and recommends practical steps for implementing a West Coast network.

- **Modeling Tools: Summary of Needs to Enhance Understanding of Ocean Acidification and Hypoxia in Coastal Oceans**

  Numerous Panel discussions have underscored the need for improved modeling tools to assess the effectiveness of any potential OAH-related management action. This document outlines specific modeling needs for coupled oceanic physical and biogeochemical models as well as for ecosystem models. This document also outlines specific steps that will help build on existing infrastructure and enhance prioritization and coordination within the modeling community for meeting management needs.

- **Multiple Stressor Considerations: Ocean Acidification in a Deoxygenating Ocean and Warming Climate**

  The Panel recognizes that understanding changes to ocean chemistry is confounded by factors that may co-vary or counter-vary with OA. The outcomes of interacting environmental changes are likely to exert important compounding effects on species and ecosystems. This document describes the need for considering acidification in the context of multiple stressors to marine ecosystems.

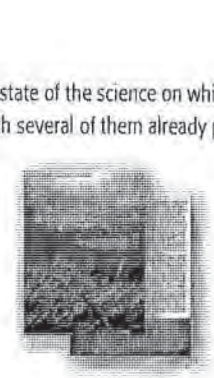
- **Ocean Acidification and Hypoxia Research Priorities to Inform Decisions and Develop Solutions**

  This document prioritizes research initiatives focused on providing the knowledge needed to effectively manage the West Coast and oceans in the face of multiple stressors. This document is designed to help decision-makers to strategically hone in on knowledge gaps that inhibit thoughtful action on OAH.

Foundational science documents

The Panel has authored a series of in-depth scientific documents intended for subject-matter experts that summarize the state of the science on which the Panel has developed its recommendations. These documents are intended for publication as scientific journal articles, with several of them already published.

- **Ocean Acidification Science Needs for Natural Resource Managers of the North American West Coast** *(published in the journal Oceanography)*

  This document describes potential management actions and associated science needs that will assist managers in making decisions around whether and how best to address OA. Although decision-makers with a role to play in responding to OA come from diverse sectors, some commonalities emerge in their information needs, including a need for a comprehensive monitoring program and a range of models that identify areas that are most and least vulnerable to future OA-triggered changes.

- **What Changes in the Carbonate System, Oxygen, and Temperature Portend for the Northeastern Pacific Ocean: A Physiological Perspective** *(published in the journal BioScience)*

  The northeastern Pacific Ocean is undergoing changes in temperature, carbonate chemistry, and dissolved oxygen concentration. Here, the Panel examines how single- and multiple-stressor effects on physiology may drive changes in individual or species behavior, and the structure of marine ecosystems.

- **Water Quality Criteria for an Acidifying Ocean: Challenges and Opportunities** *(in press in the journal Ocean and Coastal Management)*

  When monitoring data indicate that water quality standards are not being met, management agencies have the option under Section 303(d) of the Clean Water Act to list the water body as impaired. This document describes the state of the science for making an impairment assessment in the context of this Clean Water Act process, and in cases where data needed to perform assessments are limited. The document also recommends strategies for improving monitoring programs and water quality criteria.

- **Supporting Ecosystem Resilience to Address Ocean Acidification and Hypoxia**

  This product provides practical guidance about the opportunities to incorporate OAH management strategies into existing ecosystem-based management frameworks – an important near-term, actionable management approach intended to ameliorate the likely impacts of OAH on marine resources and ecosystems.

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The West Coast Ocean Acidification and Hypoxia Science Panel, April 2016

www.westcoastoah.org

Ocean Outfall Study

FINAL REPORT

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- Chuck Steinbergs, Orange County Water District, Fountain Valley, California
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- Earle C. Hartling, Sanitation Districts of Los Angeles County, Whittier, California
- Terry Anderson, South East Water Limited, Heatherton, Victoria, Australia
- Mark Elsner and Donna Rickabus, South Florida Water Management District, West Palm Beach, Florida
- Rod Williams, Water & Sewerage Directorate, Gosford City Council, Gosford, New South Wales, Australia
- James Crook, Norwell, Massachusetts
- Bahman Sheikh, San Francisco, California

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Executive Summary

The purpose of the study was to evaluate the status and efficacy of effluent management options for the six municipal facilities in Florida's Palm Beach, Broward and Miami-Dade Counties that discharge secondarily treated wastewater through ocean outfalls. Urban water requirements in this region are rising due to rapid population growth, while water supply problems loom due to uncertainties in the time-phasing and funding of water resources projects. Southeast Florida's natural and artificial reef resources—some located near the outfalls—provide habitat and protection for marine organisms and contribute over 61,000 jobs and $1.9 billion in yearly income for residents of the three counties. An underutilized water management option in the region is water reuse, which could help Southeast Florida meet its water requirements while decreasing or eliminating reliance on ocean outfalls. The State has a reuse capacity of 1.2 BGD and expects to reclaim and reuse 65% of all domestic wastewater by 2020, up from 40% today. The study reviewed previous work describing the effects of ocean wastewater disposal on ocean biota and human health risks as well as past examples of obstacles and successes of water reuse in Florida, the U.S. and abroad. Four alternative ocean outfall strategies—involving varying degrees of reuse, nutrient removal and ocean outfall use— were considered. The alternatives were evaluated at each wastewater treatment plant according to four performance measures: 1) amount of freshwater saved relative to a base case with no reuse, 2) reduction in nitrogen and phosphorus discharged via ocean outfalls relative to the base case, 3) public acceptance, and 4) costs. Management recommendations based on these evaluations are presented.

Current and projected flows at the six wastewater treatment plants (WWTPs) are compared to their permitted capacities in Exhibit ES-1. The 2025 wastewater influent flow exceeds the 2005 permitted capacity at each WWTP; thus all of the facilities face important decisions regarding their future wastewater management options. According to current plans of the utilities, 7% of the total wastewater handled by the facilities will be reclaimed for traditional (public access) reuse in 2025, up from 4% currently.

Exhibit ES-1. Permitted, 2005, and Projected 2025 Flows at WWTPs with Ocean Outfalls

	Boynton-Delray	Boca Raton	Broward/ North	Hollywood	M-D/ North	M-D/ Central	Total
Permitted flow (MGD)	24.0	17.5	84.0	42.0	112.5	143.0	423
2005 flow (MGD)	19	16	84	40	108	129	396
2005 reuse[1] (MGD)	3.7	5.2	2.4	2.6	0.1	0	14
2005 reuse[1] (%)	19	33	3	7	< 1	0	4
2025 flow (MGD)	27	22	94	54	126	151	474
2025 reuse[1,2] (MGD)	7.5	15.9	5.3	3.6	0.1	0	32.4
2025 reuse[1,2] (%)	28	73	6	7	0.1	0	7

[1]Excluding onsite reuse for process

[2]Based on utilities' plans extending to 2025

Several studies have been made of the impacts of the outfalls on the ocean. Surfacing plumes are present at all six WWTP outfalls throughout the year. Rapid dilution in the immediate vicinity of the outfall continues for 6 to 41 miles downstream. One of the conclusions of a US EPA relative risk assessment involving deep well injection, aquifer recharge, discharge to ocean outfalls and surface waters as disposal options was that:

> Human health risks are of some concern, both within the 400-m mixing zone and outside of it, primarily because treatment of effluent prior to discharge via ocean outfalls does not include filtration to remove *Cryptosporidium* and *Giardia*. The most probable human exposure pathways include fishermen, swimmers, and boaters who venture out into the Florida Current and experience direct contact, accidental ingestion of water, or ingest fish or shellfish exposed to effluent. Otherwise, there is a very small, but not nonzero, chance for onshore or nearshore recreational or occupational users to be exposed to effluent constituents, since there is a small (10%) chance that currents will change direction to east or west.

Natural and artificial reefs near the six ocean outfalls contribute significantly to the tourist business in South Florida. Recent studies suggest that the outfall discharge at Boynton Beach may be having an adverse effect on Lynn's Reef, but did not establish a link between pollutant discharges and the relative importance of pollutant concentrations at a specific reef. A biomarker study indicates that the reefs have been impacted in some cases. Based on $\delta 15N$ analyses of macroalgae, sponges and gorgonian corals recently collected from reefs in Palm Beach and Broward counties, researchers believe that sewage nitrogen is a contributor to the nitrogen pool in the area's coastal waters. No complete report is available for this ongoing study. These recent and ongoing studies could provide valuable new insights into the extent of the cause-effect linkage between outfall discharges and impaired reefs in Southeast Florida and indicate whether or not current wastewater treatment levels are sufficient to protect water quality in general and the reefs in particular.

Spatial analysis of the consumptive permit user database in Southeast Florida indicates that large users with individual permits in Palm Beach County and northern Broward County have the highest demands for landscape irrigation. These large users are typically golf courses, parks, and other recreational areas. Miami-Dade County has the highest potential industrial demand. The Turkey Point Power Plant is an example of an industrial user not currently being supplied with reclaimed water. A case study of the area near the Broward/North WWTP indicates that reclaimed water can be cost effectively supplied to larger irrigation users within 12 metropolitan miles (measured along streets) of the reclamation facility.

Four alternative ocean outfall strategies were examined under the defined scope of this study. Under the Currently Planned Use alternative (Alt I), ocean outfalls would be used at currently planned levels. Under the Limited Use Alternative (Alt II), ocean outfall disposal would be limited to flows remaining after traditional reuse options were maximized and underground injection flows reached full 2005 permitted capacity. Under the Ocean Outfalls as Backups alternative (Alt III), ocean disposal would only be used during wet weather periods to handle flow that would otherwise go to traditional reuse. Complete elimination of ocean outfalls was considered under the No Use alternative (Alt IV). The assumption was made that permitted capacities of the ocean outfalls would be maintained at 2005 levels and that no additional ocean outfalls would be permitted. It was also assumed that Class I injection control wells for effluent disposal would be held at 2005 permitted capacities and, furthermore, that Class I injection wells for effluent disposal that were in testing or under construction during 2005 would not receive permits. Current and potential treatment requirements employed in the evaluation of ocean outfall alternatives are summarized in Exhibit ES-2

Exhibit ES-2. Current and Potential Treatment Requirements of Wastewater Management Options

Option	Treatment requirements	
	Current	**Potential**
Ocean outfalls	Secondary with basic-level disinfection	Intermediate or full nutrient control with basic-level disinfection
Class I injection wells	Secondary with no disinfection	Secondary with filtration and high-level disinfection
Traditional reuse	Secondary with filtration and high-level disinfection	
Groundwater recharge	Full treatment and disinfection	

The following conclusions and recommendations were reached from the present study:

- Water reuse (traditional and groundwater recharge) offers advantages to Southeast Florida—in terms of conserving water, augmenting available water resources, and reducing discharges to the ocean environment.
- Considering impending water shortages in Southeast Florida, continued use of ocean outfalls and deep injection wells for effluent disposal represents an unsustainable export of freshwater from the region.
- The weight of indirect evidence of reef damage by ocean outfalls is cause for concern and justification for additional actions to address these issues.
- The success of water reuse in large urban areas in the U.S. and abroad indicates that difficulties to reuse posed by the highly urbanized nature of Southeast Florida can be overcome.
- Satellite water reclamation facilities can effectively serve distant users of reclaimed water in regional wastewater systems and improve reclaimed water quality in collection systems impacted by saltwater intrusion.
- Traditional (public access) reuse for the Boynton-Delray and Boca Raton WWTPs could substantially reduce nutrient loads to the ocean. Substantial reduction of nutrient loads from the other four facilities can be achieved through groundwater recharge, since traditional reuse opportunities are more limited in these areas.
- Substantial reductions in nitrogen loads are achievable through intermediate and full nutrient removal technologies. Given the relatively low total phosphorus concentrations in effluents from the WWTPs, only full nutrient removal technology can reduce phosphorus loads. Substantial reductions in phosphorus load will require moving toward either traditional reuse or groundwater recharge.

- The average freshwater savings are essentially equal to traditional reuse volumes under alternatives I (currently planned use of ocean outfalls) and II (limited use of ocean outfalls) and range from 24 to 64% at the Boynton-Delray and Boca Raton WWTPs and from 1 to 18% at the other four facilities.
- Under alternatives III (use of ocean outfalls as backups) and IV (no use of ocean outfalls), average freshwater savings range from 64 to 87%.
- Public acceptance of traditional reuse is expected to be high at all of the facilities because the reclaimed water is used primarily for irrigation.
- Public acceptance of alternatives featuring large-scale groundwater recharge could be moderate or lower. However, public education programs and community involvement throughout the planning, implementation, and continued use of water reuse projects should help mitigate public concerns.
- Trends between costs and the average of percent freshwater savings and nutrient load reduction indicate that alternatives emphasizing traditional reuse and nutrient control technology are somewhat more cost effective than those emphasizing groundwater recharge. The ability to generate revenues from traditional reuse further increases the attractiveness of this approach.
- At the facilities with lesser densities of consumptive use permittees (Hollywood, Miami-Dade/North and Miami-Dade/Central), extensive groundwater recharge would be required to achieve a 50% average of freshwater savings and nutrient load reduction unless industries and residential users are added to the reclaimed water customer base.
- Over the period 2005–2025, the costs of liquid treatment, reuse and disposal to achieve a 50% average of freshwater savings and nutrient load reduction would range from \$1.00/1,000 gal at the Boca Raton WWTP to \$1.90/1,000 gal at the Hollywood WWTP, averaging \$1.50/1,000 gal. Increasing this average to 75% would raise the average cost to \$2.60/1,000 gal.

1. Introduction

The Florida Department of Environmental Protection (FL DEP) contracted with the University of Florida to conduct a study on ocean outfalls in Southeast Florida. The purpose of the study is to evaluate the status and efficacy of wastewater disposal options in Southeast Florida, where the extent of water reuse is limited. Six publicly owned wastewater treatment plants (WWTPs) with ocean outfalls are considered in this report. The names of these facilities in geographical order (north to south) are given below. Also given for each facility is a shorter name that will be used henceforth in the report.

- City of Delray Beach, South Central Regional Wastewater Treatment Plant (Boynton-Delray WWTP)
- City of Boca Raton, Glades Road Wastewater Treatment Plant (Boca Raton WWTP)
- Broward County, North Regional Wastewater Treatment Plant (Broward/North WWTP)
- City of Hollywood, Southern Regional Wastewater Treatment Plant (Hollywood WWTP)
- Miami-Dade North District Wastewater Treatment Plant (Miami-Dade/North WWTP)
- Miami-Dade Central District Wastewater Treatment Plant (Miami-Dade/Central)

The State of Florida encourages and promotes water reuse as reflected in the state reuse objectives in Sections 403.064 and 373.250, Florida Statutes. Water reuse has been considered an important component of both wastewater management and water resource management in Florida. Benefits of water reuse include:

- Reuse decreases discharges of wastewater effluent to surface waters and deep injection wells and thus reduces environmental impacts associated with these disposal methods.
- Reclaimed water provides an alternative water supply for activities that do not require potable quality water such as irrigation and toilet flushing and helps to conserve potable quality water.
- High quality reclaimed water has the ability to recharge and augment existing water supplies.

Florida's reuse capacity has increased significantly in the past 20 years. By the year 2020, Florida is expected to reclaim and reuse 65% of all domestic wastewater. Some of the greatest challenges, but also the greatest potential benefits, of reuse implementation lie in highly urbanized Southeast Florida of Palm Beach, Broward, and Miami-Dade counties. According to the 2003 Reuse Inventory published by the Florida Department of Environmental Protection, Palm Beach, Broward, and Miami-Dade counties contain almost one-third of Florida's population and generate 39% of state's domestic wastewater (FL DEP 2004). However, they account for less than 10% of all reuse capacity in the state.

Broward and Miami-Dade counties rely heavily on ocean outfalls and deep well injection for effluent disposal, sending 510 million gallons per day (MGD) of their treated effluent to the ocean or deep, non-potable aquifers. Potential limitations on nutrient discharges to the coastal ocean and growing demands for water could alter both the economic and the hydrologic feasibility of this continuing export of fresh water.

The report includes ten chapters, as outlined in the Table of Contents. Wastewater treatment plants with ocean outfalls in Southeast Florida are reviewed in Chapter 2. Information on water supply facilities in the three counties with ocean outfalls is summarized in Chapter 3. Environmental risk associated with discharge or reuse of effluents in Southeast Florida is considered in Chapter 4. The socioeconomic impacts of reefs on Southeast Florida are also mentioned. U.S. and international case studies of water reuse in large urban areas outside Southeast Florida are reviewed in Chapter 5. Information on the withdrawal and reclamation of wastewater from mid and upper reaches of sewers—a practice known as satellite treatment—is also included. Methods for estimating the costs of traditional water reuse and groundwater recharge in Southeast Florida are presented in Chapter 6. Alternative strategies for management of treated effluents are proposed in Chapter 7, whereas indicators for evaluating the outcomes of these strategies are discussed in Chapter 8. Values of the indicators under various scenarios within the wastewater management alternatives are presented and discussed in Chapter 9. Findings of the report are summarized and conclusions are drawn in Chapter 10.

Three appendices are included in the report. Appendix 1 contains detailed information on the use of CapdetWorks 2.1 software for estimating wastewater treatment costs. Appendix 2 contains schematic diagrams of wastewater treatment process trains for meeting various effluent and water reclamation standards. Appendix 3 contains a glossary of terms used in the report. The Project Database contains in their entirety all relevant reports (in PDF format) that were obtained from consulting engineers and public agencies. The database also includes a searchable listing of the reports, as well as public domain articles on the topic of water reuse.

Reference

FL DEP (2004) 2003 Reuse Inventory. Florida Department of Environmental Protection, Division of Water Resource Management, Tallahassee, Florida. July 2004.

2. Wastewater Treatment Plants with Ocean Outfalls in Southeast Florida

Summary information on ocean outfalls and their associated wastewater treatment plants is given in the present chapter. The locations of the six ocean outfalls in Florida are shown from a statewide perspective in Figure 2-1. The three Florida Counties that are home to the outfalls are shown in Figure 2-2.

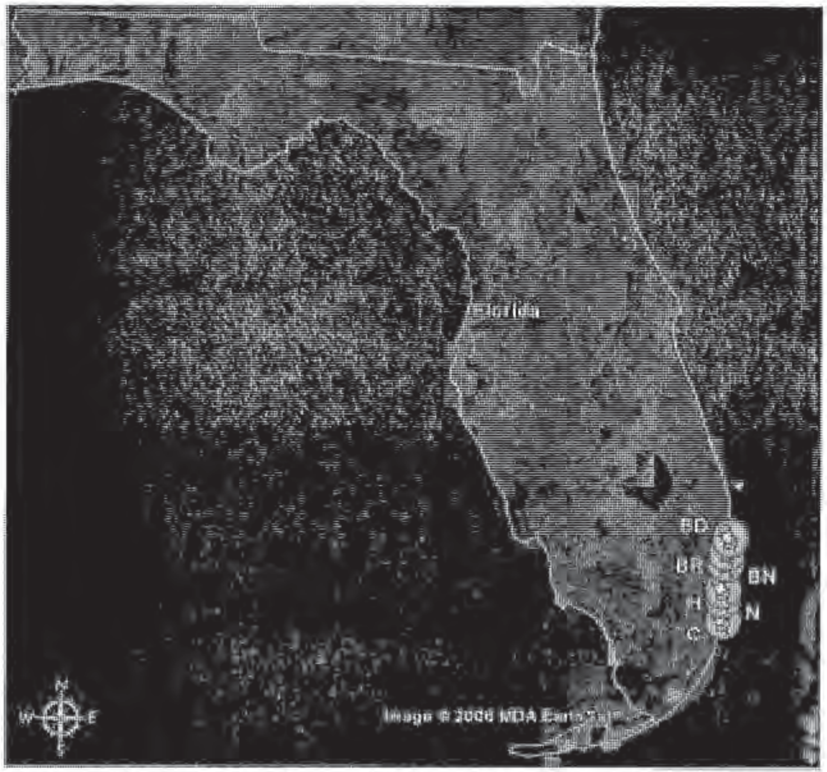

Figure 2-1. Ocean Outfalls in Florida. BD–Boyton-Delray, BR–Boca Raton, BN–Broward/North, H–Hollywood, N–Miami-Dade/North, C–Miami-Dade/Central. Photo from Google Earth (2005).

2.1 Boynton-Delray WWTP

An overview of the Boynton-Delray WWTP in Delray Beach and its associated facilities is given in Table 2-1. Included are brief descriptions of the treatment and alternative disposal methods, flows, reuse facilities, ocean outfall, and future plans. More extensive information is given below.

2.1.1 Description of Wastewater Treatment Plant

The Boynton-Delray WWTP, located at 1801 N. Congress Avenue, Delray Beach, was constructed in 1974 to provide wastewater treatment for the Cities of Boynton Beach and Delray Beach. The construction included two phases: Plant A with a 12 MGD design capacity was completed in 1979 with EPA grant funds and Plant B with the same design capacity was constructed in 1987. Subsequent facility improvements include conversion to fine bubble aeration, odor abatement, and installation of effluent pumping facilities. The Boynton-Delray WWTP is a complete-mix activated sludge plant. Liquid treatment facilities include screening, grit removal, flow equalization, aeration basins, clarifiers, chlorination and dechlorination. The design criteria of the aeration basins and secondary clarifiers are shown in Table 2-2. On-site solids processing includes thickening via a centrifuge or two dissolved air flotation units and lime stabilization to meet Class B criteria before being applied to land. Most of the wastewater is treated and then disposed of through an ocean outfall. A portion of the wastewater is reclaimed for water reuse. The current permitted plant capacity is 24 MGD annual average daily flow and 26.4 MGD maximum three-month average daily flow (Brown and Caldwell 1995). The plant site is constrained by housing developments on the west and by a freeway on the east (Fig. 2-3). Limited open area exists immediately south of the plant, whereas more extensive undeveloped area is located north of the WWTP.

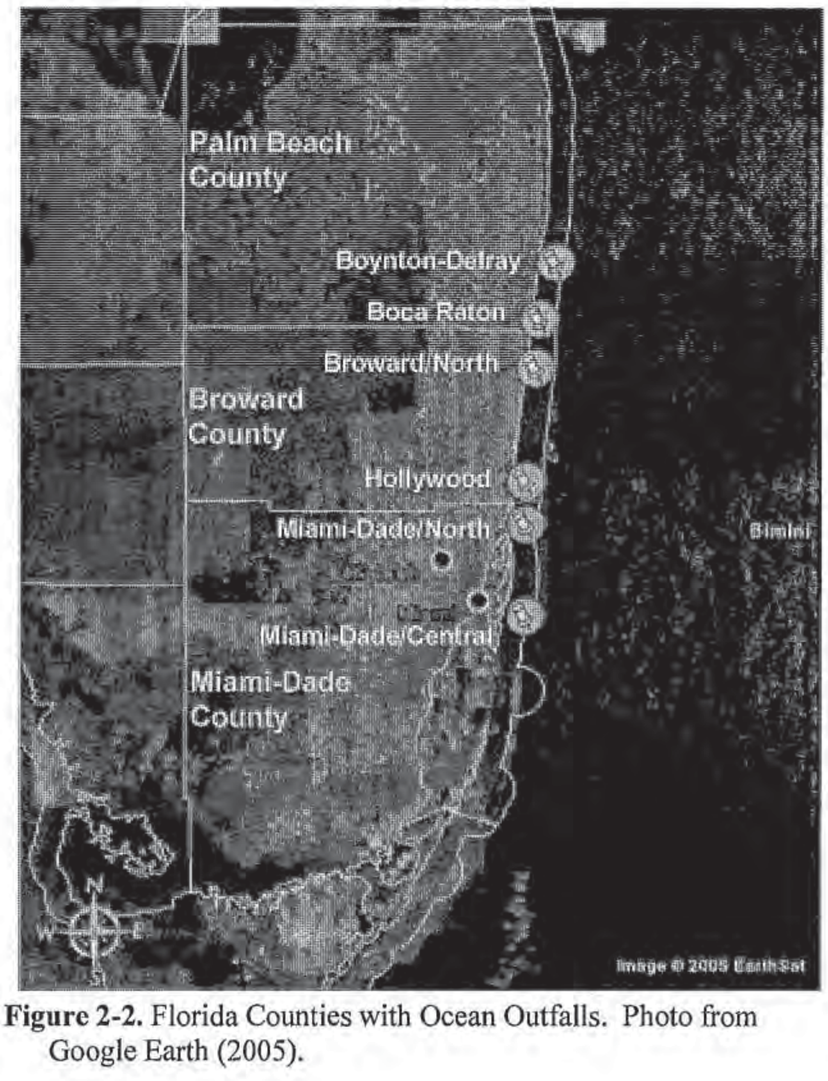

Figure 2-2. Florida Counties with Ocean Outfalls. Photo from Google Earth (2005).

Table 2-1. Overview of Boynton-Delray WWTP, Ocean Outfall and Associated Facilities

Treatment and alternate disposal	*Method*	Completely mixed activated sludge
	Disinfection level	High level for public access reuse Basic level for ocean outfall disposal
	Other disposal options	Emergency discharge to canal
2003 Flows	*Reuse*	4.3 MGD
	Ocean outfall	12.3 MGD
	Other disposal flow	- -
	Total treated flow	16.6 MGD
Reuse facilities	*Design capacity*	10 MGD
	Current flow	4.3 MGD
	Start up	1995 design
	Applications	On site; residential irrigation; golf course irrigation
Ocean outfall	*Latitude* *Longitude*	26° 27′ 72″ N 80° 02′ 53″ W
	Discharge depth	90 ft
	Distance offshore	5,200 ft
	Inside diameter	30 inches
	Number of ports	1
	Diameter of ports	30 inches
	Port orientation	Horizontal
Future plans	*WWTP*	Could not identify
	Reuse facilities	Expand design capacity to 24 MGD

2.1.2 Historical and Projected Flows and Concentrations

The Boynton-Delray WWTP served an estimated 210,500 people within its service area in 2005. This estimate is derived from historical population data from the Boynton-Delray Wastewater Treatment and Disposal Board (Brown and Caldwell 1995) extrapolated based on projected population growth rates for Palm Beach County (GEC 2003). The population for the Boynton-Delray WWTP service area is expected to increase to 294,300 by 2025, the end of the present study period. Population projections for the study period are presented in Table 2-3.

Table 2-2. Design Criteria for the Boynton-Delray WWTP

Treatment Facility	Value	Units
Aeration Basins		
Plant A		
No. of aeration basins	6	
Basin length	65	ft
Basin width	65	ft
Sidewater depth	16	ft
Volume per basin	0.5	MG
Total aeration basin volume	3	MG
Plant B		
No. of aeration basins	4	
Basin length of basins 1, 2	66	ft
Basin length of basins 3, 4	131.5	ft
Basin width of basins 1, 2, 3, 4	65	ft
Sidewater depth of basins 1, 2, 3, 4	15.35	ft
Total aeration basin volume	3	MG
Secondary Clarifiers		
Plant A		
No. of clarifiers	3	
Diameter of clarifiers	105	ft
Sidewater depth of clarifiers	14	ft
Total surface area of clarifiers	25,980	sf
Total volume of clarifiers	2.72	MG
Plant B		
No. of clarifiers	3	
Diameter of clarifiers	105	ft
Sidewater depth of clarifiers	16	ft
Total surface area of clarifiers	25,980	sf
Total volume of clarifiers	3.2	MG

Table 2-3. Population Projections for Boynton-Delray WWTP Service Area from 2005 to 2025. Based on data from Brown and Caldwell (1995) and GEC (2003)

Year	2005	2010	2015	2020	2025
Population	210,500	231,200	252,100	273,500	294,300

Figure 2-3. Aerial photograph of the Boynton-Delray WWTP (Google Earth 2005)

Based on an historical wastewater production rate of 92 gal/capita/day in Florida (Marella 1999), the projected 2005 average daily wastewater flow rate was 19.4 MGD. The average daily wastewater flow rate is expected to increase to 27.1 MGD by 2025, based on a constant wastewater production rate of 92 gal/capita/day. Projected wastewater flow rates for the study period are presented in Table 2-4.

Table 2-4. Wastewater Flow Projections for the Boynton-Delray WWTP from 2005 to 2025. Based on data from Brown and Caldwell (1995), GEC (2003) and Marella (1999)

Year	**2005**	**2010**	**2015**	**2020**	**2025**
Wastewater flow (MGD)	19.4	21.3	23.2	25.2	27.1

A review of the flow data indicated peaking factors for maximum month average daily flow/annual average daily flow and peak hourly flow/annual average daily flow of 1.45 and 2.15 respectively (Hodges 2003).

The average influent $CBOD_5$ and TSS concentrations from January 1994 to April 1995 were 131 and 146 mg/L, respectively. The annual average $CBOD_5$ and TSS reductions were 97% and 91%, resulting in average effluent $CBOD_5$ and TSS concentrations of 4.3 and 13.6 mg/L, respectively. The historical maximum month peaking factors for $CBOD_5$ and TSS were found to be 1.31 and 1.4 and did not change over time (Brown and Caldwell 1993; Brown and Caldwell 1995). A similar analysis was carried out from October 1991 to October 1992 (Brown and Caldwell 1993). Annual average influent and effluent ammonia concentrations in 1992 were 29 and 6 mg/L, respectively, representing an 80% decrease.

The City of St. Petersburg conducted research on chloride and TDS concentrations in reclaimed water and their impact on vegetation when used for irrigation purposes. These studies reported selected species and chloride tolerances. As a result of the study, the City of St. Petersburg tries to maintain chloride concentrations in reclaimed water below 400 mg/L to protect vegetation from adverse effects of high chloride concentrations (PBS&J 1992). The average effluent chloride concentration at the Boynton-Delray WWTP from April 1994 through April 1995 was 206 mg/L, which is below the guideline. However, chloride concentrations in 1992 exceeded 400 mg/L from time to time. Most of this contribution was attributed to the high volume of infiltration/inflow from the City of Delray Beach. Collection system improvements since 1992 have improved the effluent quality (Brown and Caldwell 1995).

The effluent limitations and monitoring requirements for ocean outfall disposal in southeast Florida are summarized in Table 2-5. The quality of effluent discharged from the Boyton-Delray WWTP complies with these requirements. This can be seen from the summaries of effluent water quality that are presented in Tables 2-6 and 2-7, which cover a 15-month monitoring period (8/31/03 to 10/31/04). The average effluent concentrations of $CBOD_5$ and TSS from August 2003 through October 2004 were 11 and 9 mg/L, respectively (Table 2-6). These values are below the respective discharge limits of 25 and 30 mg/L (Table 2-5). The removals for $CBOD_5$ and TSS during this period were 95% and 96%, respectively; much higher than the 85% requirement. The average effluent concentrations for total nitrogen and phosphorus were 18.7 and 1.7 mg/L, respectively. The annual average, 90^{th} percentile, geometric mean and maximum effluent fecal coliform values were 1, 1.2, 1 and 26.5 per 100 mL, respectively, as shown in Table 2-7. These values are well below the corresponding limits of 200, 400, 200 and 800 per 100 mL. The average influent concentrations for $CBOD_5$ and TSS were 220 and 229 mg/L for the same period, as shown in Table 2-8.

Table 2-5. Permit Requirements for Ocean Outfall Disposal in Southeast Florida

			Effluent Limitations				Monitoring Requirements		
Parameter	Units	Max/ Min	Annual Average	Monthly Average	Weekly Average	Single Sample	Monitoring Frequency	Sample Type	Notes
$CBOD_5$	mg/L	Max	25 30 [2]	25 30 [2]	40 45 [2]	60	Daily	24-hr FPC [3]	5
$CBOD_5$ removal	%	Min		85					
TSS	mg/L	Max	30	30	45	60	Daily	24-hr FPC [3]	5
TSS removal	%	Min		85					
Total Nitrogen as N	mg/L and lbs/day[1]	Max	None	None	_	None	Weekly	24-hr FPC [3]	6
Total Ammonia as N	mg/L and lbs/day[1]	Max	None	None	_	None	Weekly	24-hr FPC [3]	7
Total Nitrite+Nitrate as N	mg/L and lbs/day[1]	Max	None	None	_	None	Weekly	24-hr FPC [3]	7
Total Phosphorus	mg/L and lbs/day[1]	Max	None	None	_	None	Weekly	24-hr FPC [3]	6
Fecal Coliform Bacteria	See [4]						Daily	Grab	8

Sources: (FL DEP 2000), (FL DEP 2002), (FL DEP 2003b), (FL DEP 2003a), (PBS&J 2003)

[1] mg/L (Annual Avg, Monthly Avg and Single Sample) and lbs/day (Annual Avg and Monthly Avg)

[2] Effluent limitations for Miami-Dade/North

[3] Flow proportioned composite

[4] *[62-600.440(4)c]*

- The arithmetic mean of the monthly fecal coliform values collected during an annual period shall not exceed 200 per 100 mL of effluent sample.
- The geometric mean of the fecal coliform values for a minimum of 10 samples of effluent each collected on a separate day during a period of 30 consecutive days (monthly) shall not exceed 200 per 100 mL of sample.
- No more than 10 percent of the samples collected (the 90th percentile value) during a period of 30 consecutive days shall exceed 400 fecal coliform values per 100 mL of sample.
- Any one sample shall not exceed 800 fecal coliform values per 100 mL of sample.

[5] Only Monthly Avg and Weekly Avg requirements for Miami-Dade/Central, Expansion of Hollywood WWTP includes discharge limitations for $CBOD_5$ (20 mg/L, 25 mg/L, 40 mg/L and 60 mg/L) and TSS (20 mg/L, 30 mg/L, 45 mg/L and 60 mg/L).

[6] Only mg/L and lbs/day Single Sample requirements for Broward/North, only mg/L Monthly Avg requirements for Miami-Dade/North and Miami-Dade/Central

[7] Required only for Boynton-Delray, Boca Raton and Hollywood plants

[8] Only Geometric Mean and Single Sample requirements for Miami-Dade/North and Miami-Dade/Central plants

Table 2-6. Ocean Outfall Discharge Composition of the Boynton-Delray WWTP from 8/31/03 to 10/31/04. Data from Florida DEP Discharge Monitoring Reports

Parameter	Average of monthly averages	Maximum monthly average
TSS (mg/L)	9	12.9
$CBOD_5$ (mg/L)	11	15.6
TSS removal (%)	96	–
$CBOD_5$ removal (%)	95	–
Total N (mg-N/L)	18.7	22.2
Ammonia N (mg-N/L)	11.7	15.4
Nitrite+Nitrate N (mg-N/L)	4.1	7.1
Total P (mg-P/L)	1.7	4.0

Table 2-7. Ocean Outfall Fecal Coliform Concentrations at the Boynton-Delray WWTP from 8/31/03 to 10/31/04. Data from Florida DEP Discharge Monitoring Reports

	Value (# /100 mL)
Average of monthly averages	1
90th percentile	1.2
Geometric mean	1
Maximum	26.5

Table 2-8. Average Influent Concentrations at the Boynton-Delray WWTP from 8/31/03 to 10/31/04. Data from Florida DEP Discharge Monitoring Reports

Parameter	Average of monthly averages
TSS (mg/L)	229
$CBOD_5$ (mg/L)	220

Note: The monthly averages for the TSS and $CBOD_5$ on 1/31/04 were 267 mg/L and 264 mg/L respectively, which gives the highest sum (531 mg/L) of monthly averages for TSS and $CBOD_5$.

2.1.3 Reuse Facilities

According to the 2003 Florida DEP Reuse Inventory (FL DEP 2004), the reuse system has a design capacity of 10 MGD, of which 43% (4.3 MGD) is being utilized for in-plant, residential and golf course irrigation. The reuse system was designed in 1995 and includes filtration, chlorination and storage facilities. Three Tetra deep bed downflow sand filters, with a total surface area of 1,254 ft^2 and a design capacity of 10 MGD, are being used (Brown and Caldwell 1995). The reuse system is currently being expanded.

2.1.4 Ocean Outfall

Treated effluent from the Boynton-Delray WWTP is discharged through a 30 inch pipe that extends 5,200 ft from the shoreline and reaches a depth of 90 ft. The permitted capacity of the outfall is 24 MGD annual average daily flow and 26.4 MGD maximum three-month average daily flow (FL DEP 2000). The Boynton-Delray WWTP ocean outfall was inspected by volunteer divers on October 18 and November 8, 2003 to observe effluent plume characteristics and to collect water samples. The discharge pipe was found at 26° 27′ 71.5″ N, 80° 02′ 52.5″ W, at a different location than specified on the permit, at a depth of 95 feet and inclined toward the surface at approximately 30 degrees. A buoyant, freshwater effluent was found to exit the pipe with some force and traveled toward the surface. The plume was pushed northward with the current while it moved toward the surface and formed a boil several hundred yards down-current of the discharge point (Tichenor 2004).

2.1.5 Disposal Methods in Addition to Ocean Outfalls

The City of Delray Beach has no disposal method besides its ocean outfall. The Boynton-Delray WWTP has an emergency bypass system to discharge treated effluent to the L-30 Canal (FL DEP 2000).

2.1.6 Future Plans

The reclaimed water system at the Boynton-Delray WWTP will be expanded to 24 MGD so that all of the wastewater can be reclaimed for water reuse. A reclaimed water master plan was developed for the City of Delray Beach in November 2003. The City is currently constructing the first phase (Area 1) of the reclaimed water system. In March 2005, the City applied for a permit to add additional users in Areas 2 and 3 as part of the next phase of implementation (Matthews Consulting 2003).

The first phase of the plant expansion included construction of a 2 million gallon storage tank to increase reclaimed water production for area golf courses. The cost of the Crom Corporation tank was $900,000, of which $300,000 was funded by a grant from the South Florida Water Management District. In the second phase, the filtration system and chlorine contact facility will be enlarged, reclaimed water equalization will be added before the filters, and additional pumping capability will be provided. The Board applied for $6.6 million of federal funds to pay for the work. Another grant from the South Florida Water Management District was received for the Year 2005 to continue the expansion work (Smith 2004). The cities of Boynton Beach and Delray Beach are searching for additional large users of reclaimed water and are discussing with the Florida DEP the possibility of using the ocean outfall pipeline to distribute reclaimed water to users on the barrier island (Hodges 2003).

2.2 Boca Raton WWTP

An overview of the Boca Raton WWTP in Boca Raton and its associated facilities is given in Table 2-9. Included are brief descriptions of the treatment and alternative disposal methods, flows, reuse facilities, ocean outfall, and future plans. More extensive information is given below.

2.2.1 Description of Wastewater Treatment Plant

The original WWTP in the City of Boca Raton started operation in 1974 and had a design capacity of 10 MGD. In the mid 1980s, the plant was modified to increase its design capacity to 12 MGD (Boca Raton 2005b). The Boca Raton facility provides secondary treatment and on-site biosolids processing. Liquid treatment facilities include screening and grit removal, primary clarification, an activated sludge system with mechanical and diffused aeration, final settling tanks and chlorine addition. The design criteria of the aeration basins and secondary clarifiers are shown in Table 2-10. The biosolids processing facilities include gravity belt and rotary drum thickeners, anaerobic digesters and sludge dewatering. Most of the wastewater is treated and then discharged through an ocean outfall. Some of the wastewater is reclaimed for water reuse. The plant is permitted to treat a 17.5 MGD annual average daily flow, 20 MGD maximum month average daily flow and 40 MGD peak hourly flow (Hazen and Sawyer 1997b). The Boca Raton WWTP site is constrained on the north by athletic fields and a runway, on the west and south by freeways, and on the east by the Boca Raton Water Treatment Plant (Fig. 2-4).

Table 2-9. Overview of Boca Raton WWTP, Ocean Outfall and Associated Facilities

Treatment and alternate disposal	*Method*	Conventional activated sludge
	Disinfection level	High level for public access reuse Basic level for ocean outfall disposal
	Other disposal options	None
2003 Flows	*Reuse*	5.6 MGD
	Ocean outfall	10.7 MGD
	Other disposal flow	- -
	Total treated flow	16.3 MGD
Reuse facilities	*Design capacity*	9 MGD
	Current flow	5.6 MGD
	Start up	1989 on-site; 1993 Florida Atlantic University irrigation
	Applications	On site; residential irrigation; golf course irrigation; other public access areas
	Notes	- -
Ocean outfall	*Latitude* *Longitude*	26°21′00″N 80°03′16″W
	Discharge depth	90 feet
	Distance offshore	5,166 feet
	Inside diameter	36 inches
	Number of ports	1
	Diameter of ports	36 inches
	Port orientation	Up 45° from horizontal
Future plans	*WWTP*	Could not identify
	Reuse facilities	Expand design capacity to 15 MGD

Table 2-10. Design Criteria for the Boca Raton WWTP

Treatment Facility	Value	Units
Aeration Basins		
No. of aeration basins	3	#
Basin length	255	ft.
Basin width	85	ft.
Sidewater depth	13	ft.
Volume per basin	2.11	MG
Total aeration basin volume	6.32	MG
Secondary Clarifiers		
No. of clarifiers	5	#
Diameter of clarifiers 1, 2	105	ft.
Diameter of clarifiers 3, 4, 5	110	ft.
Sidewater depth of clarifiers 1,2	12	ft.
Sidewater depth of clarifiers 3, 4, 5	14	ft.
Total surface area of clarifiers	45,829	sf
Total volume of clarifiers	4.54	MG

Figure 2-4. Aerial photograph of the Boca Raton WWTP. A portion of the Boca Raton Water Treatment Plant is visible in the lower right corner of the photo (Google Earth 2005).

2.2.2 Historical and Projected Flows and Concentrations

The Boca Raton WWTP serves an estimated 138,200 people within its service area in 2005. This estimate is derived from historical population data from the City of Boca Raton Utility Services Department (Hazen and Sawyer 1997b) extrapolated based on projected population growth rates used for the entirety of Palm Beach County issued in the United States Army Corps of Engineers Comprehensive Everglades Restoration Plan Update (GEC 2003). The population for the Boca Raton WWTP service area is expected to increase to 193,200 by the Year 2025. Population projections for the study period are presented in Table 2-11.

Table 2-11. Population Projections for the Boca Raton WWTP Service Area from 2005 to 2025. Based on data from Hazen and Sawyer (1997b) and GEC (2003)

Year	2005	2010	2015	2020	2025
Population	138,200	151,700	165,400	179,500	193,200

Based on an historical wastewater production rate of 113 gal/capita/day prepared for the United States Geological Survey study to assess wastewater discharge trends in Florida (Marella 1999), the 2005 average daily wastewater flow rate is projected at 15.6 MGD. The average daily wastewater flow rate is expected to increase to 21.8 MGD in 2025, based on a constant wastewater production rate of 113 gal/capita/day. Wastewater flow rates for the study period are presented in Table 2-12.

Table 2-12. Wastewater Flow Projections for the Boca Raton WWTP from 2005 to 2025. Based on data from Hazen and Sawyer (1997b), GEC (2003) and Marella (1999)

Year	2005	2010	2015	2020	2025
Wastewater flow (MGD)	15.6	17.1	18.7	20.2	21.8

The average influent $CBOD_5$ and TSS concentrations during 1996 were 136 and 124 mg/L, respectively. The annual average $CBOD_5$ and TSS reductions were 91% and 95%, resulting in average effluent $CBOD_5$ and TSS concentrations of 12 and 6 mg/L. This effluent quality was typically achieved utilizing two out of three aeration basins and three out of five secondary clarifiers (Hazen and Sawyer 1997b).

The average effluent concentrations for $CBOD_5$ and TSS from August 2003 through October 2004 were 3 and 6 mg/L (Table 2-13), which are below the respective discharge limits of 25 and 30 mg/L. The removals of $CBOD_5$ and TSS were 98% and 96%, respectively; much higher than the 85% requirement. The average effluent concentrations of total nitrogen and total phosphorus were 16.9 and 0.7 mg/L, respectively. The annual average, 90^{th} percentile, geometric mean and maximum effluent fecal coliform concentrations were 3, 10.1, 3.1 and 74.8 per 100 mL, respectively, as shown in Table 2-14. These values are well below the corresponding limits of 200, 400, 200 and 800 per 100 mL. The average influent concentrations for $CBOD_5$ and TSS were 190 and 185 mg/L for the same period (Table 2-15).

Table 2-13. Ocean Outfall Discharge Composition of Boca Raton WWTP from 8/31/03 to 10/31/04. Data from Florida DEP Discharge Monitoring Reports

Parameter	Average of monthly averages	Maximum monthly average
TSS (mg/L)	6	7.9
$CBOD_5$ (mg/L)[1]	3	4.6
TSS removal (%)	96	–
$CBOD_5$ removal (%)	98	–
Total N (mg-N/L)	16.9	19.9
Ammonia N (mg-N/L)[1]	10.5	14.2
Nitrite+Nitrate N (mg-N/L)[1]	3.3	3.8
Total P (mg-P/L)	0.7	1.3

[1] Monitoring period between 2/29/04 and 10/31/04

Table 2-14. Ocean Outfall Fecal Coliform Concentrations at the Boca Raton WWTP from 8/31/03 to 10/31/04. Data from Florida DEP Discharge Monitoring Reports

	Value (# /100 mL)
Average of monthly averages[1]	3
90^{th} percentile	10.1
Geometric mean	3.1
Maximum	74.8

[1] Monitoring period between 8/31/03 and 7/31/04 and 11/30/03 value is not reported

Table 2-15. Average Influent Concentrations at the Boca Raton WWTP from 8/31/03 to 10/31/04. Data from Florida DEP Discharge Monitoring Reports

Parameter	Average of monthly averages
TSS (mg/L)	185
$CBOD_5$ (mg/L)	190

Note: The monthly averages for the TSS and $CBOD_5$ on 1/31/04 were 299 mg/L and 241 mg/L respectively, which gives the highest sum (540 mg/L) of monthly averages for TSS and $CBOD_5$.

2.2.3 Reuse Facilities

The Boca Raton WWTP added capability to produce a limited quantity of reclaimed water for process water and landscape irrigation onsite in 1989. Two automatic backwash filters with a total design capacity of 3 MGD were operated (CDM 1990). In 1993, Florida Atlantic University was being irrigated and Phase I of the reuse system construction was continuing to expand reclaimed water distribution to public access areas. The current reuse system includes chemical filter aid, filtration and high level disinfection. Six automatic backwash medium-depth mono-media sand filters with a total surface area of 3450 ft^2 and a design capacity of 9 MGD are being used (Brown and Caldwell 1993). According to the 2003 Florida DEP Reuse Inventory (FL DEP 2004), the reuse system has a design capacity of 9 MGD, of which 62% (5.6 MGD) is being utilized. The reuse system IRIS (In-city Reclamation Irrigation System) provides service to Boca Raton's Sabal Park/Pinelands area, Florida Atlantic University, Mizner Park and a number of commercial green spaces along Federal Highway, residential customers and golf courses (Boca Raton 2005a).

2.2.4 Ocean Outfall

The ocean outfall pipe from the Boca Raton WWTP consists of three sections with 42, 30 and 36 inch diameters. Treated effluent is discharged 5,166 ft from the shoreline at a depth of 90 ft. The permitted capacity of the wastewater effluent through the ocean outfall is 17.5 MGD annual average daily flow. In addition, the outfall is permitted to carry a 4.5 MGD annual average daily flow (7 MGD maximum daily flow) of membrane softening concentrate from the water treatment plant (FL DEP 2003b).

2.2.5 Disposal Methods in Addition to Ocean Outfalls

The City of Boca Raton has no disposal method besides its ocean outfall.

2.2.6 Future Plans

The City of Boca Raton submitted a capacity analysis report during permit renewal to the Florida DEP for a rerating of the Boca Raton WWTP's annual average daily flow from 17.5 MGD to 23 MGD, corresponding to a maximum month average daily flow of 26.5 MGD and a peak hourly flow of 46 MGD. The peaking factor for maximum month average daily flow/annual average daily flow is proposed to remain at 1.15, whereas peak hourly flow/annual average daily flow ratio is suggested to be reduced to 2.0, based on a review of historical hourly flow data from 1995 to 1996. The treatment processes limiting the rerated capacity were the primary clarifiers, return activated sludge pumping and sludge thickening. The peak flow to the outfall based on pumping capacity was estimated to be 28 MGD. The available total equalization capacity is 5.5 million gallons, consisting of a 2.5 million gallon effluent equalization tank and a 3.0 million gallon reuse system storage tank. The facilities were found to be adequate for the proposed 46 MGD peak hourly flow, considering a committed reuse flow of 2.0 MGD, 28 MGD ocean outfall and 4.0 million gallons of equalization required for a peak hourly flow rate duration of 6 hours (Hazen and Sawyer 1997b).

The reclaimed water master plan prepared by CDM for the City of Boca Raton proposed a reclaimed water system IRIS with a design capacity of 15 MGD to be completed by 2000. The service district included 2,480 acres of green space, including five large users (Florida Atlantic University and four golf courses), all public and commercial properties, multi-family condominium and rental complexes, and 12,773 single family homes. The reclaimed water system was found to reduce the annual water consumption by 25 to 30% and had the potential to eliminate the 10 MGD expansion of the water treatment plant and related water supply wells with an estimated capital cost of between 7.7 and 8.7 million dollars (CDM 1990). However, the water treatment plant was expanded in 1991, before the reclaimed water system was completed. The implementation of IRIS has been slower than planned.

2.3 Broward/North WWTP

An overview of the Broward/North WWTP in Broward County and its associated facilities is given in Table 2-16. Included are brief descriptions of the treatment and alternative disposal methods, flows, reuse facilities, ocean outfall, and future plans. More extensive information is given below.

2.3.1 Description of Wastewater Treatment Plant

The initial Broward/North WWTP, with a design capacity of 20 MGD and located at 2401 N. Powerline Road, Pompano Beach, started providing wholesale wastewater treatment service to large users in 1975. The plant underwent its first major expansion in 1980, which increased the design capacity to 66 MGD annual average daily flow. The plant reached 80 MGD annual average daily flow capacity through a second major expansion that was completed in 1992.

In 2001, a rerating was requested for the Broward/North WWTP from 80 MGD to 84 MGD and a capacity of 84 MGD annual average daily flow was permitted in 2003. The Broward County Office of Environmental Services started planning in 1995 to expand the Broward/North WWTP to 100 MGD design capacity. Sludge stabilization and dewatering improvements projects were completed in 2001 as part of the expansion (Hazen and Sawyer 2004).

The Broward/North WWTP provides secondary treatment and on-site biosolids processing. There are four individual treatment trains (Modules A, B, C, D). The liquid treatment facilities include screening, grit removal, an activated sludge system, secondary clarifiers, and chlorine contact tanks. The design criteria of the aeration basins and secondary clarifiers are shown in Table 2-17. Solids treatment facilities consist of dissolved air flotation thickeners, anaerobic digesters, and sludge dewatering. After the sludge is digested and dewatered, it is disposed of by land filling and land spreading. The sludge is rated as Class B, which is suitable for application to agricultural sites with restricted public access. Some of the wastewater is treated and then disposed of through an ocean outfall, another portion is treated and then disposed of through six Class I injection wells, and the remainder is reclaimed for water reuse (Hazen and Sawyer 2004). Some area remains open on the Broward/North WWTP site (Fig. 2-5). Commercial developments constrain the site boundaries on all four directions, although a parcel of undeveloped land extends from the northwest corner of the plant site.

Table 2-16. Overview of the Broward/North WWTP, Ocean Outfall and Associated Facilities

Treatment & alternate disposal	*Method*	Conventional activated sludge
	Disinfection level	High level for public access reuse Basic level for ocean outfall disposal
	Other disposal options	Class I injection wells
2003 Flows	*Reuse*	4.5 MGD
	Ocean outfall	36.5 MGD
	Other disposal flow	29.1 MGD
	Total treated flow	69.8 MGD
Reuse facilities	*Design capacity*	10 MGD
	Current flow	4.5 MGD
	Start up	1991
	Applications	On site; other facility; other public access
	Notes	Effluent from Modules B and C is further treated to produce reclaimed water for reuse
Ocean outfall	*Latitude* *Longitude*	26°15′00″N 80°03′45″W
	Discharge depth	107 ft
	Distance offshore	7,300 ft
	Inside diameter	54 inches
	Number of ports	1
	Diameter of ports	54 inches
	Port orientation	Horizontal
Future plans	*WWTP*	Expand to 100 MGD design capacity
	Reuse facilities	Utilize 10 MGD reuse design capacity

2.3.2 Historical and Projected Flows and Concentrations

The Broward/North WWTP serves an estimated 724,000 people within its service area in 2005, as presented by the Broward County Office of Environmental Services (Hazen and Sawyer 2004). The population for the Broward/North WWTP service area is expected to increase to 978,300 by 2025. Population projections for the study period are presented in Table 2-18.

Detailed flow data and projections for the Broward/North WWTP were available, indicating that the 2005 average daily wastewater flow rate would be 84.2 MGD (116 gal/capita/day). The average daily wastewater flow rate is expected to increase to 94.1 MGD in 2025. This flow rate reflects an anticipated reduction in wastewater production per capita from 116 gal/capita/day at the beginning of the study period to 96 gal/capita/day in 2025. The reduction in the per capita wastewater production is expected to result from increased residential population density. The increase in density per residential unit is anticipated since there is very little undeveloped land in the county, whereas migration to the area should continue. Projected wastewater flow rates over the study period are presented in Table 2-19.

Table 2-17. Design Criteria for the Broward/North WWTP

Treatment Facility	Value	Units
Aeration Basins		
No. of modules (A, B, C, D)	4	#
No. of aeration basins per module	4	#
Total no. of aeration basins	16	#
Basin length	225	ft.
Basin width	75	ft.
Sidewater depth	15.5	ft.
Volume per basin	1.96	MG
Total aeration basin volume	31.3	MG
Secondary Clarifiers		
No. of clarifiers per module	4	#
Total no. of clarifiers	16	#
Diameter of clarifiers	105	ft.
Sidewater depth of clarifiers in modules A, B, C	12	ft.
Sidewater depth of clarifiers in modules D	15	ft.
Total surface area of clarifiers	138,560	sf

Figure 2-5. Aerial photograph of the Broward/North WWTP (Google Earth 2005).

Table 2-18. Population Projections for Broward/North WWTP Service Area from 2005 to 2025 (Hazen and Sawyer 2004)

Year	2005	2010	2015	2020	2025
Population	724,000	790,600	856,300	919,500	978,300

Table 2-19. Wastewater Flow Projections for Broward/North WWTP from 2005 to 2025 (Hazen and Sawyer 2004)

Year	2005	2010	2015	2020	2025
Wastewater Flow (MGD)	84.2	88.6	90.8	92.2	94.1
Per Capita Usage (gal/day)	116	112	106	100	96

The average influent $CBOD_5$ and TSS concentrations during 2002 were 136 and 241 mg/L, respectively. The annual average $CBOD_5$ and TSS reductions were both 97%, resulting in average effluent $CBOD_5$ and TSS concentrations of 3.3 and 5.9 mg/L, respectively. This effluent quality was achieved with an average of ten out of sixteen aeration basins in service (Hazen and Sawyer 2004). The average influent $CBOD_5$ and TSS concentrations from 1997 to 2001 were 142 and 248 mg/L, respectively (Hazen and Sawyer 2002).

Additional monitoring data were summarized for the period August 2003 through October 2004. Effluent $CBOD_5$ and TSS concentrations averaged 4 and 7 mg/L, respectively as shown in Table 2-20. These values are well below the corresponding discharge limits of 25 and 30 mg/L. The removals for $CBOD_5$ and TSS were both 97%; much higher than the requirement of 85%. The average effluent concentrations of total nitrogen and phosphorus were 14.8 and 1.3 mg/L, respectively. Annual average, 90^{th} percentile, geometric mean and maximum effluent fecal coliform concentrations were 14, 25, 7 and 53 per 100 mL, respectively as shown in Table 2-21. These values are below the corresponding limits of 200, 400, 200 and 800 per 100 mL. The average influent concentrations for $CBOD_5$ and TSS were 130 and 217 mg/L, respectively, for the same period as shown in Table 2-22.

Table 2-20. Ocean Outfall Discharge Composition of Broward/North WWTP from 8/31/03 to 10/31/04. Data from Florida DEP Discharge Monitoring Reports

Parameter	Average of monthly averages	Maximum monthly average
TSS (mg/L)	7	13
$CBOD_5$ (mg/L)	4	5
TSS removal (%)	97	–
$CBOD_5$ removal (%)	97	–
Total N (mg-N/L)	14.8	19.9
Total P (mg-P/L)	1.3	2.0

Table 2-21. Ocean Outfall Fecal Coliform Concentrations at the Broward/North WWTP from 8/31/03 to 10/31/04. Data from Florida DEP Discharge Monitoring Reports

	Value (# /100 mL)
Average of monthly averages	14
90^{th} percentile	25
Geometric mean	7
Maximum	53

Table 2-22. Average Influent Concentrations of the Broward/North WWTP from 8/31/03 to 10/31/04. Data from Florida DEP Discharge Monitoring Reports

Parameter	**Average of monthly averages**
TSS (mg/L)	217
$CBOD_5$ (mg/L)	130

Note: The monthly averages for the TSS and $CBOD_5$ on 5/31/04 were 339 mg/L and 144 mg/L respectively, which gives the highest sum (483 mg/L) of monthly averages for TSS and $CBOD_5$.

2.3.3 Reuse Facilities

A 10 MGD reclaimed water system together with approximately 2 miles of 24 inch transmission line terminating at the North Broward County Resource Recovery Facility was placed in service at the Broward/North WWTP in 1991. The current reclaimed water system consists of a filter feed pump station, filters, a chlorine contact tank, chemical feed facilities, storage tanks, and distribution pumping systems (Hazen and Sawyer 2004). Forty Parkson Dynasand single media upflow continuous backwash filters, with a total surface area of 2000 ft^2 and a design capacity of 10 MGD, are arranged in 10 individual basins with four units per basin (Hazen and Sawyer 1992). Clarified effluent from modules B and C is diverted to the filtration system. The existing reclaimed water demand is 45% (4.5 MGD) of the current design capacity

2.3.4 Ocean Outfall

Treated effluent from the Broward/North WWTP is discharged through a 54 inch ductile iron pipe at a depth of 107 ft that extends 7,300 ft from the shoreline. The permitted capacity of the outfall is 66 MGD annual average daily flow (FL DEP 2003a).

2.3.5 Disposal Methods in Addition to Ocean Outfall

The Class I injection well system at the Broward/North WWTP that was constructed in 1990-1991 consisted of an injection well pumping station, four Class I injection wells, and two dual zone Floridan aquifer monitoring wells. In 2000-2001, two additional Class I injection wells and two monitoring wells were constructed. The combined design capacity of the ocean outfall/injection well systems with one injection well out of service is 174 MGD peak hourly flow and 87 MGD average daily flow with a peaking factor of 2.0 (Hazen and Sawyer 2002). The permitted peak hourly flow capacity for the six wells is 60 MGD (FL DEP 2003a). An average flow of 29.1 MGD was discharged to the wells during 2003 (FL DEP 2004).

Water quality issues have been encountered for one of the monitoring wells. The U.S. EPA published a draft rule change in 2000 and 2003 that requires operators of wells with questionable data to either demonstrate non-endangerment of the underground source of drinking water or provide higher levels of treatment, described as possibly filtration and high level disinfection (Hazen and Sawyer 2004). U.S. EPA published new rules governing Class I injection wells in 24 Florida Counties including Palm Beach, Broward and Miami-Dade Counties on 11/22/05. These federal rules became effective on 12/22/05.

2.3.6 Future Plans

Plans for expansion of the Broward/North WWTP to a design capacity of 100 MGD include construction of an additional treatment module (E) with 20 MGD annual average daily flow capacity, new sludge dewatering and storage facilities, expansion and improvements of preliminary treatment facilities and anaerobic digestion facilities, improvements to disinfection facilities, construction of new Class I injection wells, and updating of the plant distributed control system (Hazen and Sawyer 2004). The design criteria of the aeration basins and secondary clarifiers in Module E are shown in Table 2-23.

Broward County Office of Environmental Services has plans to utilize the 10 MGD design capacity of the reuse system. A portion of this capacity is already committed. An additional 2 MGD will be needed when the Broward/North WWTP is expanded to 100 MGD. There is an agreement with Wheelabrator Environmental Services to provide up to 2 MGD of reclaimed water and up to 2.3 MGD if the company adds boilers at the North Broward County Resource Recovery Facility. The Broward County Office of Environmental Services has started providing irrigation water for a portion of the Pompano Beach Park of Commerce, which is under development next to the plant (Hazen and Sawyer 2004).

Table 2-23. Design Criteria for Module E

Module E	Value	Units
Aeration Basins		
No. of aeration basins	4	#
Basin length	335	ft.
Basin width	52	ft.
Sidewater depth	15.5	ft.
Volume per basin	2	MG
Total aeration basin volume	8	MG
Secondary Clarifiers		
No. of clarifiers	3	#
Diameter of clarifiers	125	ft.
Sidewater depth	16	ft.
Total surface area of clarifiers	36,816	sf

The City of Pompano Beach has ongoing efforts to expand its own reclaimed water treatment design capacity and service area. This community tapped into the outfall line from the Broward North WWTP, built a filtration and high-level disinfection facility, and supplies reclaimed water within Pompano Beach. This utilization of a water resource that was previously being wasted results in an increase in the percentage of Broward/North WWTP flows that is reused (Hazen and Sawyer 2004).

Coconut Creek and the North Springs Improvement District have expressed interest in receiving reclaimed water from Broward/North WWTP for roadway median irrigation. An initiative to fund this project was introduced in 2003 by the State but was not accepted. The project was resubmitted in January 2004. If funding is obtained, the Broward County Office of Environmental Services is prepared to upgrade its facilities to meet this demand (Hazen and Sawyer 2004).

2.4 Hollywood WWTP

An overview of the Hollywood WWTP in Broward County and its associated facilities is given in Table 2-24. Included are brief descriptions of the treatment and alternative disposal methods, flows, reuse facilities, ocean outfall, and future plans. More extensive information is given below.

Table 2-24. Overview of Hollywood WWTP, Ocean Outfall and Associated Facilities

Treatment & alternate disposal	*Method*	Pure oxygen activated sludge
	Disinfection level	High level for public access reuse Basic level for ocean outfall disposal
	Other disposal options	Class I injection wells (in testing)
2003 Flows	*Reuse*	2.6 MGD
	Ocean outfall	39.5 MGD
	Other disposal flow	- -
	Total treated flow	42.1 MGD
Reuse facilities	*Design capacity*	4 MGD
	Current flow	2.6 MGD
	Start up	1994 Public access reuse
	Applications	Golf course irrigation
	Notes	- -
Ocean outfall	*Latitude*	26°01′04″N
	Longitude	80°05′04″W
	Discharge depth	93 ft
	Distance offshore	10,000 ft
	Inside diameter	60 inches
	Number of ports	1
	Diameter of ports	60 inches
	Port orientation	Horizontal
Future plans	*WWTP*	Expand to 50 MGD design capacity in two phases
	Reuse facilities	Increase reuse flow by 1.1 MGD

2.4.1 Description of Wastewater Treatment Plant

The Hollywood WWTP, located at 1621 N. 14th Avenue, Hollywood, has been operating since the 1940s. In 1973, trickling filters were replaced with a pure oxygen activated sludge system and the plant was expanded to 36 MGD. The design capacity was increased to 38 MGD in 1981 (Public Utility Management and Planning Services and Hazen and Sawyer 2001). The current design capacity of the plant is 45 MGD annual average daily flow as mentioned in the permit (FL DEP 2002). The permitted capacity reported in the Florida DEP (2002) permit and SFRPC (2005) are 42 and 48.75 MGD, respectively. The City started implementing a program in 1999 to expand the design capacity to 50 MGD in two phases (Hazen and Sawyer 1988; Hazen and Sawyer 1999a). The current activated sludge plant includes bar screens, grit tanks, influent pumps, oxygenation tanks, clarifiers, chlorination, effluent pumps, and post lime sludge stabilization facilities (Public Utility Management and Planning Services and Hazen and Sawyer 2001; Hollywood 2005c). The design criteria of the aeration basins and secondary clarifiers are shown in Table 2-25. Most of the wastewater is treated and then discharged through an ocean outfall. The remainder is reclaimed for water reuse. Two 24 inch Class I injection wells were constructed as part of an expansion process. The plant is sited within a golf course that is ringed with housing developments on the west, south, and east and by a recreational complex to the north (Fig. 2-6).

Table 2-25. Design Criteria for the Hollywood WWTP

Treatment Facility	Value	Units
Aeration Basins		
No. of trains (1, 2, 3, 4)	4	#
No. of aeration basins per train	4	#
Total no. of aeration basins	16	#
Basin length in trains 1, 2	58	ft.
Basin length in trains 3, 4	36	ft.
Basin width in trains 1, 2	58	ft.
Basin width in trains 3, 4	36	ft.
Sidewater depth in trains 1, 2	14	ft.
Sidewater depth in trains 3, 4	18	ft.
Volume per basins in trains 1, 2	0.35	MG
Volume per basins in trains 3, 4	0.17	MG
Total aeration basin volume	4.2	MG
Secondary Clarifiers		
Length of clarifiers no. 1-4	135	ft.
Width of clarifiers no. 1-4	135	ft.
Sidewater depth of clarifiers no. 1-4	12	ft.
Diameter of clarifiers no. 5-6	120	ft.
Sidewater depth of clarifiers no. 5-6	14	ft.
Total surface area of clarifiers	95,508	sf
Total volume of clarifiers	9.06	MG

Figure 2-6. Aerial photograph of the Hollywood WWTP (Google Earth 2005)

2.4.2 Historical and Projected Flows and Concentrations

The Hollywood WWTP serves an estimated 312,200 people within its service area in 2005. This estimate is derived from historical population data (Marella 1999) extrapolated based on projected population growth rates for Broward County presented in the United States Army Corps of Engineers Comprehensive Everglades Restoration Plan Update (GEC 2003). The population for the Hollywood WWTP service area is expected to increase to 425,600 by 2025. Population projections for the study period are presented in Table 2-26.

Based on an historical wastewater production rate of 128 gal/capita/day (Public Utility Management and Planning Services and Hazen and Sawyer 2001), the 2005 average daily wastewater flow rate was projected at 40.0 MGD. The average daily wastewater flow rate is expected to increase to 54.5 MGD in 2025, based on a constant wastewater production rate of 128 gal/capita/day. Projected wastewater flow rates for the study period are presented in Table 2-27.

The annual average influent BOD_5 and TSS concentrations from November 1985 through December 1987 were 86 and 84 mg/L. The low wastewater strength was caused by the infiltration/inflow in the Hollywood collection system (Hazen and Sawyer 1988). Effluent $CBOD_5$ concentrations for the Hollywood WWTP during high flow occurrence days in July and August 1989 were in the range of 5 to 19 mg/L (Hazen and Sawyer 1999a). The average effluent $CBOD_5$ concentration from May through October 1992 was 4 mg/L (Hazen and Sawyer 1993).

Table 2-26. Population Projections for Hollywood WWTP Service Area from 2005 to 2025. Based on data from Public Utility Management and Planning Services and Hazen and Sawyer (2001) and GEC (2003)

Year	2005	2010	2015	2020	2025
Population	312,200	340,100	368,400	397,500	425,600

Table 2-27. Wastewater Flow Projections for Hollywood WWTP from 2005 to 2025. Based on data from Public Utility Management and Planning Services and Hazen and Sawyer (2001), GEC (2003) and Marella (1999)

Year	2005	2010	2015	2020	2025
Wastewater flow (MGD)	40.0	43.5	47.2	50.9	54.5

The average effluent concentrations for $CBOD_5$ and TSS from August 2003 through October 2004 were 8 and 17 mg/L, respectively, as shown in Table 2-28. These values are below the respective discharge limits of 25 and 30 mg/L. The removals for $CBOD_5$ and TSS were 94% and 87%, respectively. The average effluent concentrations for total nitrogen and phosphorus were 16.6 and 1.1 mg/L, respectively. Several months of coliform data were missing from the data report, as explained in the footnotes to Table 2-29. Based on available data, values for the annual average, 90th percentile, geometric mean effluent fecal coliform concentrations were 7, 20.9 and 2.7, respectively, which are below the corresponding limits of 200, 400 and 200 per 100 mL. However, the maximum was 2,120 per 100 mL, which is above the limit of 800 per 100 mL. The average influent concentrations for $CBOD_5$ and TSS were 139 and 136 mg/L for the 15-month period, as shown in Table 2-30. The influent wastewater strength has increased due to infiltration/inflow reduction programs (Hazen and Sawyer 1988).

Table 2-28. Ocean Outfall Discharge Composition of the Hollywood WWTP from 8/31/03 to 10/31/04. Data from Florida DEP Discharge Monitoring Reports

Parameter	Average of monthly averages	Maximum monthly average
TSS (mg/L)	17	26.6
$CBOD_5$ (mg/L)	8	17.9
TSS removal (%)[1]	87	–
$CBOD_5$ removal (%)[1]	94	–
Total N (mg-N/L)	16.6	21.2
Ammonia N (mg-N/L)	11.9	15
Nitrite+Nitrate N (mg-N/L)	1.2	4.8
Total P (mg-P/L)	1.1	1.4

[1] Calculated based on the given influent and effluent monthly average data

Table 2-29. Ocean Outfall Fecal Coliform Concentrations at the Hollywood WWTP from 8/31/03 to 10/31/04. Data from Florida DEP Discharge Monitoring Reports

	Value (# /100 mL)
Average of monthly averages	7
90th percentile[1]	20.9
Geometric mean[1]	2.7
Maximum[2]	2120

[1] 11/30/03, 12/31/03, 1/31/04, 4/30/04 and 8/31/04 values were not reported

[2] 8/31/03, 11/30/03, 12/31/03, 1/31/04, 4/30/04, 8/31/04 and 9/30/04 values were not reported

Table 2-30. Average Influent Concentrations at the Hollywood WWTP from 8/31/03 to 10/31/04. Data from Florida DEP Discharge Monitoring Reports

Parameter	**Average of monthly averages**
TSS (mg/L)	136
$CBOD_5$ (mg/L)	139

Note: The monthly averages for the TSS and $CBOD_5$ on 5/31/04 were 158 mg/L and 162 mg/L respectively, which gives the highest sum (320 mg/L) of monthly averages for TSS and $CBOD_5$.

2.4.3 Reuse Facilities

Reclaimed water was used only for on-site processes until 1993, when process and storage facilities were installed to enable 4 MGD of public access reuse. In 1994 a transmission system was constructed to supply reclaimed water to golf courses (Public Utility Management and Planning Services and Hazen and Sawyer 2001). The current reuse system includes an 8 MGD continuous backwash tertiary filter system, high level disinfection and contact tanks, 0.5 MG of on-site reuse storage, pumping facilities and a reuse transmission and distribution system (Hollywood 2005b). The current reuse system has a permitted capacity of 4 MGD and is providing 2.6 MGD of reclaimed water to six local golf courses (FL DEP 2004). There are ongoing discussions with more users to provide an additional 1.1 MGD (FL DEP 2002).

Reuse has been found beneficial in Hollywood by reducing water withdrawals from the surficial aquifer system, helping to prevent saltwater intrusion. The City of Hollywood determined that about 4 MGD of off-site reuse was economically feasible, but it received resistance from users. The City therefore sponsored legislation to require reclaimed water to be used where it is available and reliable. Residential reuse was also considered. Capital cost for residential reuse (or dual distribution) water systems was estimated as \$21 to \$30 per gal/day of reuse capacity, whereas golf course irrigation was estimated as less than \$2 per gal/day of reuse capacity. The City concluded that the cost of residential reuse in Hollywood was too expensive and inconvenient for single-families with small lots that utilize limited amounts of water for irrigation (Public Utility Management and Planning Services and Hazen and Sawyer 2001).

2.4.4 Ocean Outfall

The treated wastewater from the Hollywood WWTP is transported to the Atlantic Ocean through a 60 inch diameter outfall pipe that extends 10,000 ft off-shore, reaching a depth of 93 ft. The outfall pipe will be at or exceeding its recommended maximum hydraulic capacity when the plant is uprated to 50 MGD. Class I injection wells are therefore being constructed to serve as an additional disposal method (Hazen and Sawyer 1994). The City has an agreement with the Town of Davie and Cooper City to dispose of treated wastewater through the existing effluent disposal system. The permitted capacity with these flows is 46.3 MGD annual average daily flow (FL DEP 2002).

In September 1976, the 60 inch outfall pipeline failed near Michigan Street, at a point 1,200 ft off the Hollywood Beach. Repairs to the 96 ft of damaged pipe required several weeks. The Hollywood Beach was closed during this period. The failure was caused by trapped air and associated localized pressure surges (Hazen and Sawyer 1999a).

The Southeast Florida Outfall Experiment II (SEFLOE II) study characterized the minimum initial dilution properties of the outfall system at a design flow of 54 MGD. This flow was determined considering flows of 42 MGD from the Hollywood WWTP, 6.75 MGD from the Cooper City/Davie treatment plants, 2.2 MGD of reverse osmosis and membrane softening brines from the proposed water treatment plant, and 3 MGD of planned future flows. The minimum flux average dilution in the zone of initial dilution was 28.4:1, which is above the minimum of 20:1 established by regulations. The initial dilution characteristics of the Hollywood and Miami-Dade/Central outfall systems were compared. Hollywood was found to be superior to the multiport system in Miami-Dade/Central. It was therefore concluded that effluent from the Hollywood outfall undergoes rapid dilution (Hazen and Sawyer 1994).

2.4.5 Disposal Methods in Addition to Ocean Outfall

During the plant uprating process, effluent disposal options were reviewed and construction of two Class I injection wells (the Florida DEP requires a minimum of two) was chosen from among several options. Construction permits have been obtained by the City to install two 24 inch diameter Class I injection wells. Currently the two wells are under operational testing, as required to eventually obtain an operation permit. The tentative permitted capacity of the Class I injection well system is 18.6 MGD (Hazen and Sawyer 1999b).

2.4.6 Future Plans

The Hollywood WWTP is being expanded to 50 MGD (Hollywood 2005a). For upgrade to 45 MGD annual average daily flow, the following improvements were made (Public Utility Management and Planning Services and Hazen and Sawyer 2001; FL DEP 2002):

- Upgrade of influent pump station
- Installation of a third emergency generator for the influent pump station and other facilities on the south side of the WWTP
- Installation of a fourth emergency generator for the effluent and other facilities on the north side of the WWTP

- Construction of a 120 ft diameter clarifier (No. 7)
- Construction of return activated sludge pumping station (No. 4)
- Construction of a 24 inch diameter deep injection well
- Replace existing flow meter with a magnetic flow meter

Ugrading to 50 MGD annual average daily flow includes the following improvements:

- Construction of oxygenation train No. 5, consisting of four cells
- Construction of a 120 ft diameter clarifier No. 8
- Construction of second 24 inch diameter deep injection well
- Rehabilitation of oxygenation trains No. 1 and 2 and rehabilitation of clarifiers No. 1–4

The on-site storage for reclaimed water is limited during extreme storms. The possibility of using golf course ponds for additional storage during these periods is therefore being explored by the City of Hollywood. In the long term, the City is investigating the possibility of emergency discharge of reclaimed water mixed with golf course pond water to inland surface waters. The City is seeking this approach to get some relief for 5 to 10 years, but is aware of the difficulty of obtaining such a regulatory permit (Hazen and Sawyer 1999a).

2.5 Miami-Dade/North WWTP

An overview of the Miami-Dade/North WWTP in Miami-Dade County and its associated facilities is given in Table 2-31. Included are brief descriptions of the treatment and alternative disposal methods, flows, reuse facilities, ocean outfall, and future plans. More extensive information is given below.

2.5.1 Description of Wastewater Treatment Plant

The Miami-Dade/North WWTP located at 2575 N.E. 151st St., North Miami, started operation in the late 1970s. Liquid treatment facilities include bar screens, primary clarifiers, pure oxygen trains, secondary clarifiers and chlorination facilities. The design criteria of the aeration basins and secondary clarifiers are shown in Table 2-32. The sludge transfer pumping station pumps the primary sludge, waste activated sludge, and scum to the Miami-Dade/Central WWTP for biosolids treatment. Most of the treated effluent is disposed of through an ocean outfall. A portion of the wastewater is reclaimed for water reuse. Four Class I injection wells have been constructed, but a testing program must be completed before the wells may be placed in service. The maximum flow that can be discharged to the wells is 45 MGD. The plant has a rated capacity of 120 MGD annual average daily flow and is permitted to treat an annual average daily flow of 112.5 MGD (PBS&J 2003). The plant site has undeveloped land available to the north, east and south, with a freeway bounding the site on the west (Fig. 2-7).

Table 2-31. Overview of Miami-Dade/North WWTP, Ocean Outfall and Associated Facilities

Treatment & alternate disposal	*Method*	Pure oxygen activated sludge
	Disinfection level	High level for public access reuse Basic level for ocean outfall disposal
	Other disposal options	Class I injection wells (in testing)
2003 Flows	*Reuse*	2.3 MGD
	Ocean outfall	80.6 MGD
	Total treated flow	82.9 MGD
Reuse facilities	*Design capacity*	4.4 MGD
	Current flow	2.3 MGD
	Start up	1997 Florida International University irrigation
	Applications	On-site; Florida International University irrigation
	Notes	Influent from northwestern Miami with lower chloride concentrations is reclaimed for water reuse
Ocean outfall	*Latitude*	25°55′48″N
	Longitude	80°05′04″W
	Discharge depth	108 ft
	Distance offshore	11,700 ft
	Inside diameter	90 inches
	Number of ports	12
	Diameter of ports	24 inches
	Port orientation	Horizontal
Future plans	*WWTP*	Reactivate old ocean outfall for wet weather flows
	Reuse facilities	Could not identify

Table 2-32. Design Criteria for the Miami-Dade/North WWTP

Treatment Facility	Value	Units
Aeration Basins		
No. of trains	5	#
No. of aeration basins per train	4	#
Basin length	61	ft.
Basin width	61	ft.
Sidewater depth	15	ft.
Volume per basin	0.39	MG
Total aeration basin volume	7.8	MG
Secondary Clarifiers		
No. of clarifiers	12	#
Diameter of clarifiers	160	ft.
Sidewater depth of clarifiers	12	ft.
Total surface area of clarifiers	241,200	sf
Total volume of clarifiers	24.24	MG

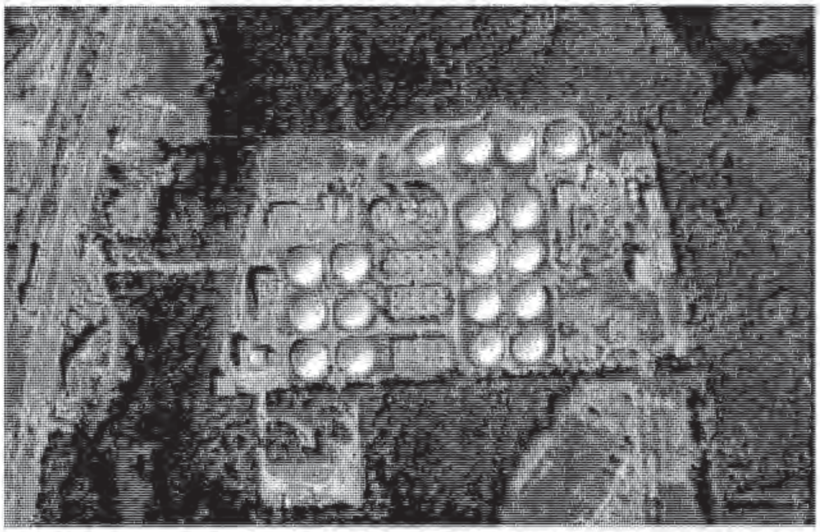

Figure 2-7. Aerial photograph of the Miami-Dade/North WWTP (Google Earth 2005)

2.5.2 Historical and Projected Flows and Concentrations

The Miami-Dade/North WWTP serves an estimated 635,400 people within its service area in 2005. Data on population for the entire district, which includes three wastewater treatment facilities (North, Central, and South) was obtained from the Miami-Dade Water and Sewer Department for 2001 (PBS&J 2003). The population of the service area for the Miami-Dade/North WWTP was estimated by dividing the wastewater flow for the Miami-Dade/North WWTP by the total wastewater handled by all three treatment plants, and then multiplying by the total number of residents within the three service areas. Data is presented by the Miami-Dade Water and Sewer Department through the year 2015. To obtain extrapolated population data for the years 2020 and 2025, the average population increase for the previous two projection years (2010 and 2015) were averaged and the increase percent was extrapolated linearly for the final two entries of the study period. The population for the Miami-Dade/North WWTP service area is expected to increase to 777,500 by 2025. Population projections for the study period are presented in Table 2-33.

Table 2-33. Population Projections for Miami-Dade/North WWTP Service Area from 2005 to 2025. Based on data from PBS&J (2003)

Year	2005	2010	2015	2020	2025
Population	635,400	658,800	700,600	735,800	777,500

The Miami-Dade Water and Sewer Department presents wastewater flow estimates for the Miami-Dade/North WWTP for the year 2005 in their Wastewater Management Master Plan (PBS&J 2003). The wastewater flow for 2005 was estimated by the Miami-Dade Water and Sewer Department to be 107.9 MGD, or 170 gal/capita/day. The data from the Miami-Dade Water and Sewer Department extends to the Year 2015. Wastewater flow data for 2020 and 2025 were extrapolated based on the per capita wastewater generation rate and includes the decrease in per capita production reflected in the Department's data between 2010 and 2015.

The decrease was extended linearly to obtain a per capita wastewater production of 165 gal/capita/day for 2020 and 162 gal/capita/day for 2025. The average daily wastewater flow rate is expected to increase to 126.3 MGD in the Year 2025. Projected wastewater flow rates for the study period are presented in Table 2-34.

Table 2-34. Wastewater Flow Projections for Miami-Dade/North WWTP from 2005 to 2025. Based on data from PBS&J (2003)

	2005	2010	2015	2020	2025
Wastewater flow (MGD)	107.9	111.9	116.6	121.3	126.3
Per capita usage (gal/day)	170	170	166	165	162

The average influent BOD_5 and TSS concentrations during 2001 were 99 and 127 mg/L, respectively. The annual average BOD_5 and TSS reductions were 94% and 89%, resulting in average effluent BOD_5 and TSS concentrations of 5.6 and 13.6 mg/L (PBS&J 2003). The average influent BOD_5 and TSS concentrations from 1984 through 1997 were 127 and 157 mg/L, respectively. The annual average BOD_5 and TSS reductions were 89% and 88%, resulting in average effluent BOD_5 and TSS concentrations of 14 and 19 mg/L (PBS&J 1998).

The wastewater effluent quality was reviewed for a variety of constituents. The Miami-Dade/North WWTP was found to have chloride concentrations of 580 mg/L. The impacts of high chloride concentrations on public access reuse, specifically with urban and agricultural irrigation, were evaluated in the 1992 Reuse Feasibility Study (PBS&J 1992). Infiltration/inflow reduction programs in the wastewater collection and transmission system were found to be useful for reducing high chloride concentrations in reclaimed water. The Miami-Dade/North WWTP treats wastewater influents with high and low chloride concentrations in two separate trains. Influent wastewater from North Miami and Miami Beach contains chloride concentrations or 1,000 mg/L or higher, whereas influent from the northwestern portion of the county has chloride concentrations in the vicinity of 135 mg/L. Effluent from the low chloride train, which has chloride concentrations less than 400 mg/L, is reclaimed for reuse applications. Further treatment of the WWTP effluent with membrane technology or dilution to reduce chloride concentrations was considered for the case where reclaimed water from the high chloride train is used to increase reuse capacity (PBS&J 1998).

Monitoring data reported to the Florida DEP from August 2003 through July 2004 were examined. The average $CBOD_5$ and TSS effluent concentrations during this period were 6 and 10 mg/L, respectively, as shown in Table 2-35. These values are below the respective discharge limits of 30 and 30 mg/L. The removals for $CBOD_5$ and TSS were not reported and could not be calculated because the influent average monthly concentrations for $CBOD_5$ and TSS were not reported. The average effluent concentrations for total nitrogen and phosphorus were 17.5 and 1.7 mg/L, respectively. Annual average and 90^{th} percentile effluent fecal coliform values were not reported. The geometric mean and maximum concentrations were 1.2 and 67 per 100 mL, respectively, as shown in Table 2-36. These values are below the corresponding limits of 200 and 800 per 100 mL.

Table 2-35. Ocean Outfall Discharge Composition of the Miami-Dade/North WWTP from 8/31/03 to 7/31/04. Data from Florida DEP Discharge Monitoring Reports

Parameter	Average of monthly averages	Maximum monthly average
TSS (mg/L)	10	12.4
$CBOD_5$ (mg/L)	6	9.2
TSS removal (%)	–	–
$CBOD_5$ removal (%)	–	–
Total N (mg-N/L)	17.5	20.5
Total P (mg-P/L)	1.7	2.1

Table 2-36. Ocean Outfall Fecal Coliform Concentrations at the Miami-Dade/North WWTP from 8/31/03 to 7/31/04. Data from Florida DEP Discharge Monitoring Reports

	Value (# /100 mL)
Annual average	–
90^{th} percentile	–
Geometric mean	1.2
Maximum	67.3

2.5.3 Reuse Facilities

The Miami-Dade/North WWTP has an on-site reuse system that consists of filtration, chlorination and pumping facilities and reclaimed water storage tanks. Three down flow filters with a total surface area of 510 ft^2 and a design capacity of 3 MGD, two continuous backwash filters with a total surface area of 200 ft^2 and a design capacity of 1.4 MGD, a down flow deep bed filter with a total surface area of 154 ft^2 and a design capacity of 1.6 MGD, and a dual media down flow filter with a total surface area of 150 ft^2 and a design capacity of 1.1 MGD are currently in use. The reclamation system started in 1997 to provide reclaimed water to Florida International University for landscape irrigation. The reuse system capacity is 2.9 MGD for on-site and 1.5 MGD for the university's applications. During 2003, the reclaimed water flow was 2.3 MGD (FL DEP 2004). The wastewater influent from northeastern Miami contains high chloride concentrations due to the infiltration/inflow of brackish groundwater. It is therefore not reclaimed for irrigation reuse. The influent from Northwestern Miami has lower chloride concentrations and is processed in a separate train for reuse applications (PBS&J 1998).

2.5.4 Ocean Outfall

The Miami-Dade/North Outfall was constructed in 1975. It consists of a 90 inch reinforced concrete pipe that extends 11,700 ft from the shoreline and discharges effluent through 12 ports at a depth of 108 ft. The permitted capacity of the outfall is 112.5 MGD annual average daily flow (PBS&J 2003).

2.5.5 Disposal Methods in Addition to Ocean Outfall

Four Class I injection wells were constructed at the Miami-Dade/North WWTP, but a testing program must be completed before the wells are allowed to operate. The maximum flow discharge to the wells is about 45 MGD (PBS&J 2003).

2.5.6 Future Plans

The Miami-Dade Water and Sewer Department developed alternatives for Miami-Dade County to handle wastewater increases from population growth and wet-weather flows. The alternatives included two Comprehensive Everglades Restoration Plan projects. In the first project, the South District WWTP would be expanded from 112.5 MGD to 131.25 MGD and would be converted to advanced wastewater treatment such as membrane treatment to meet effluent discharge requirements for the coastal wetlands next to Biscayne Bay. In the second project, a reclaimed water plant with a design capacity of 20 MGD would be constructed at the Bird Drive Basin. The reclaimed water from this plant would be used for aquifer recharge. Among the seven alternatives considered, the chosen alternative includes the use of an abandoned ocean outfall at the Miami-Dade/North WWTP and construction of a new 120 inch ocean outfall at the Miami-Dade/Central WWTP to handle future demands (PBS&J 2003).

2.6 Miami-Dade/Central WWTP

An overview of the Miami-Dade/Central WWTP in Miami-Dade County and its associated facilities is given in Table 2-37. Included are brief descriptions of the treatment and alternative disposal methods, flows, reuse facilities, ocean outfall, and future plans. More extensive information is given below.

2.6.1 Description of Wastewater Treatment Plant

The Miami-Dade/Central WWTP is located on Virginia Key at 3989 Rickenbacker Causeway, Miami. The initial 47 MGD facility (Plant 1) started operation in 1956. The treatment capacity was increased to 70 MGD in 1974 by adding two more aeration tanks. Plant 2, a 55 MGD pure oxygen activated sludge plant, became operational in 1980. Plant 1 was down-rated to 60 MGD the same year. An upgrade of Plant 1 to pure oxygen activated sludge was completed in 1999. Plant 2 was re-rated to 83 MGD. The complete facility has a permitted capacity of 143 MGD annual average daily flow. Plants 1 and 2 are operated independently of each other.

There is no influent screening at the site, as the wastewater is screened at Pumping Stations 1 and 2. Liquid treatment facilities include aerated grit chambers, pure oxygen trains, secondary clarifiers and chlorination facilities. The design criteria of the aeration basins and secondary clarifiers are shown in Table 2-38. Biosolids treatment facilities consist of gravity sludge thickening, anaerobic digestion, centrifuge dewatering and disposal to landfills or land application sites. After chlorination, the effluents from both plants are mixed in the effluent pumping station. Most of the treated wastewater is disposed of through an ocean outfall. A small portion of the wastewater is reclaimed for water reuse (PBS&J 2003). The site of the Miami-Dade/Central WWTP is bordered by Miami Bay on the west, north and east. An undeveloped area of Virginal Key lies to the south of the plant (Fig. 2-8).

Table 2-37. Overview of Miami-Dade/Central WWTP, Ocean Outfall and Associated Facilities

Treatment and alternate disposal	*Method*	Pure oxygen activated sludge
	Disinfection level	Basic level for ocean outfall disposal
	Other disposal options	None
2003 Flows	*Reuse*	8.9 MGD
	Ocean outfall	104.6 MGD
	Other disposal flow	- -
	Total treated flow	113.5 MGD
Reuse facilities	*Design capacity*	8.5 MGD
	Current flow	8.9 MGD
	Start up	1994 Public access reuse
	Applications	On-site
	Notes	All influent has high chloride concentrations
Ocean outfall	*Latitude* *Longitude*	25°44′31″N 80°05′10″W
	Discharge depth	100 ft
	Distance offshore	18,800 ft
	Inside diameter	90 and 120 inches
	Number of ports	5
	Diameter of ports	48 inches
	Port orientation	Vertical
Future plans	*WWTP*	Construct a new 120 inch ocean outfall
	Reuse facilities	Could not identify

2.6.2 Historical and Projected Flows and Concentrations

The Miami-Dade/Central WWTP served an estimated 761,700 people within its service area in 2005. The population for the Miami-Dade/Central WWTP service area is expected to increase to 932,100 by the Year 2025. Population projections for the study period are presented in Table 2-39. Methodology for population estimates for the Miami-Dade/Central WWTP are similar to those discussed in Section 2.5.2.

The average daily wastewater flow rate is expected to increase to 151.3 MGD in the Year 2025. Projected wastewater flow rates for the study period are presented in Table 2-40. Methodology for wastewater flow projections was similar to that discussed in Section 2.5.2.

The average influent BOD_5 and TSS concentrations during 2001 were 148 and 194 mg/L, respectively. The annual average BOD_5 and TSS reductions were 95.8% and 97.4%, resulting in respective average effluent BOD_5 and TSS concentrations of 6.2 and 4.9 mg/L (PBS&J 2003). The average influent BOD_5 and TSS concentrations from 1984 through 1997 were 117 and 104 mg/L, respectively. The annual average BOD_5 and TSS reductions were 84% and 87%, resulting in respective average effluent BOD_5 and TSS concentrations of 19 and 14 mg/L (PBS&J 1998).

Table 2-38. Design Criteria for the Miami-Dade/Central WWTP

Treatment Facility	Value	Units
Aeration Basins		
Plant 1		
No. of tanks	6	#
No. of aeration channels per tank	3	#
Channel length	210	ft.
Channel width	22	ft.
Sidewater depth	13	ft.
Volume per channel	0.45	MG
Total aeration tank volume	8.1	MG
Plant 2		
No. of trains	4	#
No. of aeration stages per train	6	#
Stage length	78.33	ft.
Stage width	39.17	ft.
Sidewater depth	10.17	ft.
Volume per stage	0.24	MG
Total aeration train volume	5.8	MG
Secondary Clarifiers		
Plant 1		
No. of tanks	6	#
No. of clarifier channels per tank	3	#
Channel length	275	ft.
Channel width	18	ft.
Sidewater depth	11	ft.
Total surface area of clarifiers	89,250	sf
Total volume of clarifiers	7.32	MG
Plant 2		
No. of tanks	10	#
No. of clarifier channels per tank	3	#
Channel length	275	ft.
Channel width	18	ft.
Sidewater depth	11	ft.
Total surface area of clarifiers	148,750	sf
Total volume of clarifiers	12.2	MG

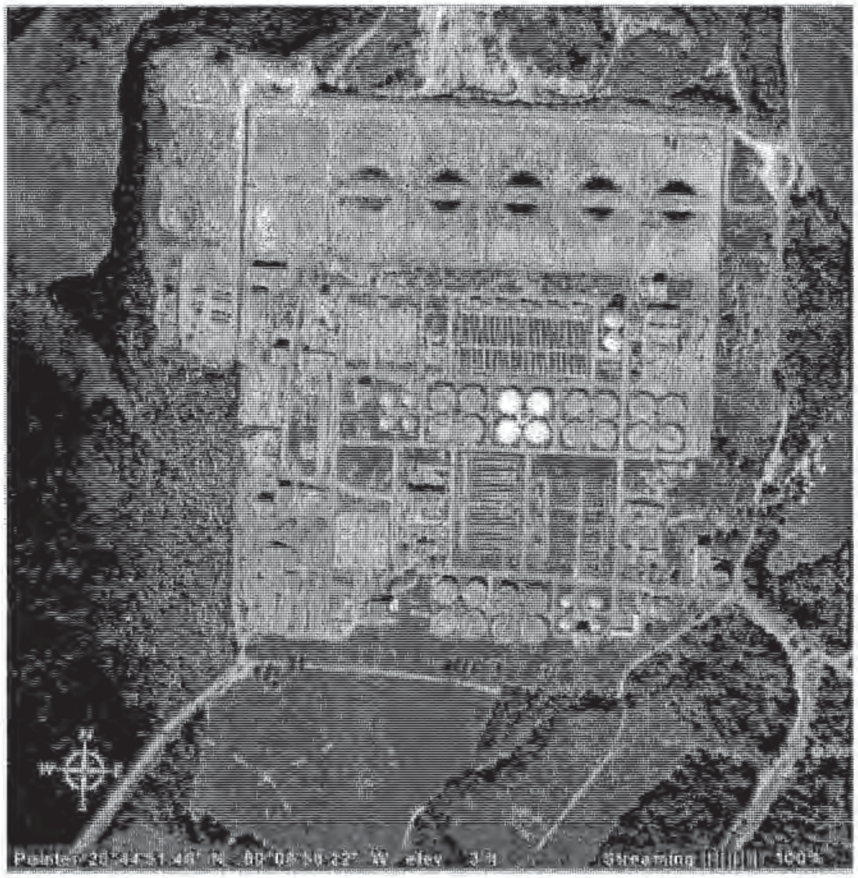

Figure 2-8. Aerial photograph of the Miami-Dade/Central WWTP (Google Earth 2005)

Table 2-39. Population Projections for Miami-Dade/Central WWTP Service Area from 2005 to 2025. Based on data from PBS&J (2003)

Year	2005	2010	2015	2020	2025
Population	761,700	789,800	839,900	882,000	932,100

Table 2-40. Wastewater Flow Projections for Miami-Dade/Central WWTP Service Area from 2005 to 2025. Based on data from PBS&J (2003)

Year	2005	2010	2015	2020	2025
Wastewater flow (MGD)	129.4	134.1	139.8	145.4	151.3
Per capita usage (gal/day)	170	170	166	165	162

An irrigation pilot study at the Miami-Dade/Central WWTP site was planned to evaluate the feasibility of using reclaimed water with high chloride concentrations for golf course irrigation. The landscape vegetation on Virginia Key and Key Biscayne was found to be naturally tolerant to high chlorides, due to the barrier island conditions (PBS&J 1992).

Influent wastewater at the Miami-Dade/Central WWTP contains high chloride levels due to the infiltration/inflow of brackish groundwater into the collection system. The combined effluent chloride concentration at the Miami-Dade/Central WWTP was 1,089 mg/L in 1994. Reclaimed water from this source was found to be unsuitable for irrigation without membrane treatment. On-site irrigation at the Miami-Dade/Central WWTP was considered because the landscape vegetation is tolerant to high chloride concentrations and most of this vegetation is turf grass, which tolerates chloride concentrations greater than 1,000 mg/L (PBS&J 1998).

Monitoring data reported to the Florida DEP from August 2003 through October 2004 were examined. The average effluent concentrations for $CBOD_5$ and TSS were 6 and 10 mg/L, respectively, as shown in Table 2-41. These values are below the respective discharge limits of 25 and 30 mg/L. The removals for $CBOD_5$ and TSS were both 95%, which is higher than the requirement of 85%. Average effluent total nitrogen and total phosphorus concentrations were 16.8 and 1.6 mg/L, respectively. The annual average and 90^{th} percentile effluent fecal coliform values were not reported. The geometric mean and maximum concentrations were 1.3 and 19.6 per 100 mL, respectively, as shown in Table 2-42. These values are below the corresponding limits of 200 and 800 per 100 mL. The average influent concentrations of $CBOD_5$ and TSS were 131 and 201 mg/L, respectively, for the same period, as shown in Table 2-43. There were no violations of effluent quality requirements.

Table 2-41. Ocean Outfall Discharge Composition of the Miami-Dade/Central WWTP from 8/31/03 to 10/31/04[1]. Data from Florida DEP Discharge Monitoring Reports

Parameter	Average of monthly averages	Maximum monthly average
TSS (mg/L)	10	16
$CBOD_5$ (mg/L)	6	11
TSS removal (%)	95	–
$CBOD_5$ removal (%)	95	–
Total N (mg-N/L)	16.8	22.5
Total P (mg-P/L)	1.6	3.4

[1] For all the data 1/31/04, 2/29/04 and 4/30/04 values were not reported

Table 2-42. Ocean Outfall Fecal Coliform Concentrations at the Miami-Dade/Central WWTP from 8/31/03 to 10/31/04[1]. Data from Florida DEP Discharge Monitoring Reports

	Value (# /100 mL)
Average of monthly averages	–
90^{th} percentile	–
Geometric mean	1.3
Maximum	19.6

[1] For all the data 1/31/04, 2/29/04 and 4/30/04 values were not reported

Table 2-43. Average Influent Concentrations at the Miami-Dade/Central WWTP from 8/31/03 to 10/31/04[1]. Data from Florida DEP Discharge Monitoring Reports

Parameter	Average of monthly averages
TSS (mg/L)	201
$CBOD_5$ (mg/L)	131

[1] For all the data 1/31/04, 2/29/04 and 4/30/04 values were not reported

Note: The monthly averages for the TSS and $CBOD_5$ on 3/31/04 were 248 mg/L and 156 mg/L respectively, which gives the highest sum (404 mg/L) of monthly averages for TSS and $CBOD_5$.

2.6.3 Reuse Facilities

The Miami-Dade/Central WWTP has on-site reuse systems for Plants 1 and 2. Each of the reuse systems includes a chlorine contact tank, reclaimed water and chlorine injector pumps, and strainers. The Plant 2 reuse system supplies reclaimed water to the sludge dewatering building, as well as the Plant 2 processes. The plant influent contains high chloride concentrations from infiltration/inflow of brackish groundwater and was found unsuitable for off-site irrigation (PBS&J 1998). The reuse system capacity and flow in 2003 were 8.5 and 8.9 MGD, respectively (FL DEP 2004).

2.6.4 Ocean Outfall

The initial ocean outfall that was placed online in 1956 included a gravity pipeline that extended 4,500 ft off-shore and discharged at a depth of 18 ft. Most of the onshore portion of the outfall pipeline consisted of 108 inch diameter reinforced concrete pipe. The offshore portion included a 90 inch diameter reinforced concrete pipe. In the 1970s, during expansion of the Miami-Dade/Central WWTP, an additional 14,296 ft of 120 inch diameter reinforced concrete pressure pipe was constructed to discharge effluent to a depth of 90 ft (Hazen and Sawyer 1997a).

The effect of Tropical Storm Gordon and Hurricane Andrew on the ocean outfall pipeline was evaluated and the pipeline was found to be hydraulically and structurally stressed (Rust Environment and Infrastructure 1995). The ocean outfall was rehabilitated in 2000. Both onshore and offshore portions of the original 108/90 inch portion of the outfall pipeline were changed. Modification of the onshore portion involved installation of 1600 ft of 120 inch pipe from the pumping station to the shoreline about 100 ft north of the existing 90 inch outfall pipe. Modification of the offshore portion included the addition of 4,442 ft of 120 inch pipe extending from shoreline to the existing 120 inch pipe (Hazen and Sawyer 1997a).

The current Miami-Dade/Central Outfall consists of parallel 120 and 90 inch pipes that connect to a single 120 inch pipe offshore. The offshore pipe extends 18,800 ft from the shoreline. The effluent is discharged through five 48 inch ports at a depth of about 100 ft. The permitted capacity of the outfall is 143 MGD annual average daily flow. The gravity flow is limited to 116 MGD by high tide conditions. An effluent pumping station is used to pump effluent through the outfall when flows exceed the maximum that can be conveyed by gravity (PBS&J 2003).

2.6.5 Disposal Methods in Addition to Ocean Outfall

The Miami-Dade/Central WWTP has no disposal method other than its ocean outfall.

2.6.6 Future Plans

Future plans for the Miami-Dade/Central WWTP were discussed in Section 2.5.6.

2.7 Summary of Flows in the Six WWTPs and Three County Area

Data collected and recorded by the United State Geological Survey, presented in Table 2-44, indicate that domestic wastewater discharged by municipal systems declined between the Years 1995 and 2000 in Broward and Miami-Dade Counties and marginally increased in Palm Beach County. These data suggest a substantial reduction in per capita usage, as much as 26% for Broward County.

Table 2-44. Wastewater Flows for the Three County Area for the Years 1995 and 2000 (Marella 1999; Marella 2004)

	1995 Average Daily Flow (MGD) (gal/capita/day)	**2000 Average Daily Flow** (MGD) (gal/capita/day)	**Percent Difference**
Palm Beach	107.7 (140)	108.1 (114)	0.3 (-18.5)
Broward	191.2 (175)	190.3 (129)	-0.5 (-26.4)
Miami-Dade	323.9 (206)	311.1 (170)	-4.0 (-17.3)

Despite the observed reduction in per capita usage, wastewater production is expected to increase over the next twenty years due to population increases, as shown in Table 2-45. Figure 2-9 depicts the projected increase in wastewater production over the study period.

Table 2-45. Summary of Six WWTP Projected Flows in MGD, 2005-2025

Year	2005	2010	2015	2020	2025
Boynton-Delray	19.4	21.3	23.2	25.2	27.1
Boca Raton	15.6	17.1	18.7	20.2	21.8
Broward/North	84.2	88.6	90.8	92.2	94.1
Hollywood	40.0	43.5	47.2	50.9	54.5
Miami-Dade/North	107.9	111.9	116.6	121.3	126.3
Miami-Dade/Central	129.4	134.1	139.8	145.4	151.3

Additional data reported by the USGS show that in 1995, the service areas of the Boynton-Delray and the Boca Raton WWTPs comprised 31% of the population and 28% of the total wastewater flow in Palm Beach County, as shown in Table 2-46. The service areas of the Broward/North and Hollywood WWTPs in Broward County accounted for 53% of both population and wastewater flow in the county during the same year, as shown in Table 2-47. The service areas of the Miami-Dade/North and Miami-Dade/Central WWTPs in Miami-

Dade County comprised 77% of the population and 71% of the total wastewater flow (Table 2-48).

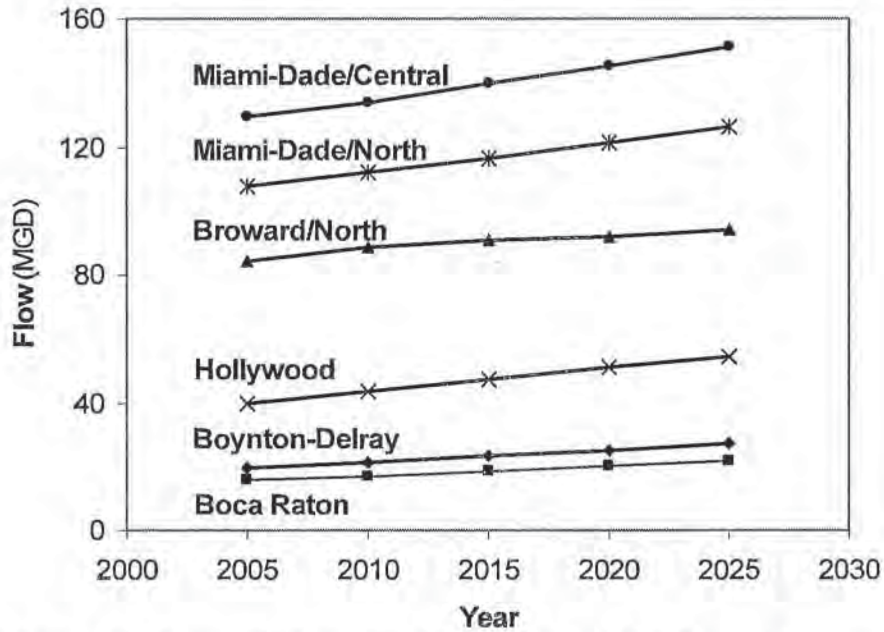

Figure 2-9. Projected Wastewater Flows for the six WWTPs with ocean outfalls from 2005–2025

Table 2-46. Palm Beach County Wastewater Flows in MGD by Service Area for the Year 1995 (Marella 1999)

	Population Served	Permitted Capacity	Total	Ground	Injection Well	Surface
Acme	17,000	4.8	2.4	0	2.4	0
Belle Glade	12,000	3	3.0	0	3.0	0
Boca Raton	**65,000**	**20**	**13.7**	**0**	**0**	**13.7**
Delray Beach	**175,000**	**24**	**16.6**	**0**	**0**	**16.6**
Loxahatchee	40,000	8	4.3	2.5	1.9	0
Pahokee	7,000	1.2	1.1	0	1.1	0
Palm Beach County Utilities Century	NA	1	0.4	0	0.4	0
Palm Beach County Utilities North	NA	4.5	1.5	0	1.5	0
Palm Beach County Utilities Southern	115,000	40	14.1	1.2	12.9	0
Royal Palm Beach Utilities	16,015	2.2	1.6	0	1.6	0
Seacoast Utilities	48,000	8	8.0	0	8.0	0
South Bay	4,000	1.4	0.8	0	0.8	0
U.S. Sugar Ritta Village	820	0.1	0.1	0.1	0	0
U.S. Sugar Bryant	1,300	0.1	0.1	0.1	0	0
West Palm Beach	267,000	40	40.1	0	40.1	0
United Technologies	NA	0.2	0.1	0	0.1	0
Total	768,135	158.5	107.8	3.8	73.8	30.2

Table 2-47. Broward County Wastewater Flows in MGD by Service Area for the Year 1995 (Marella 1999)

	Population Served	Permitted Capacity	Total	Ground	Injection Well	Surface
Broward County Utilities	**400,000**	**80**	**66.5**	**0**	**23**	**43.5**
Cooper City	12,600	1.3	1.3	0	0	1.3
Coral Springs	20,000	1.3	1.3	0	0	1.3
Davie	5,020	3	2.2	0	0	2.2
Ferncrest Utilities	5,500	0.6	0.3	0	0	0.3
Fort Lauderdale	224,420	43	40.7	0	40.7	0
Hollywood	**180,000**	**42**	**33.2**	**0**	**0**	**33.2**
Margate	47,279	8	8.1	0	8.1	0
Pembroke Pines	12,000	3.5	3.6	0	3.6	0
Plantation	75,184	15	12.8	0	12.8	0
Pompano Beach	NA	2.5	1.5	1.5	0	0
South Broward Utilities	5,267	0.5	0.5	0.5	0	0
Sunrise STP 1	40,000	7.5	7.1	0	7.1	0
Sunrise STP 2	14,480	3	1.5	0	1.5	0
Sunrise STP 3	50,000	8.5	7.4	0	7.4	0
Total	1,091,750	220.0	187.8	2.0	104.1	81.7

Table 2-48. Miami-Dade County Wastewater Flows in MGD by Service Area for the Year 1995 (Marella 1999)

	Population Served	Permitted Capacity	Total	Ground	Injection Well	Surface
American Village	1,000	0.2	0.6	0.6	0	0
Homestead	22,500	2	2.4	2.4	0	0
Miami-Dade/Central	**400,000**	**90**	**135.8**	**0**	**0**	**135.8**
Miami-Dade North	**800,000**	**121**	**95.2**	**0**	**0**	**95.2**
Miami-Dade South	350,000	75	90.5	0	90.5	0
TOTAL	1,573,500	288	324	3	90	231

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3. Water Supply Facilities in the Three Counties

South Florida is experiencing rapid population growth and attendant increases in water demands. The freshwater consumption rate in this region is expected to increase to 4.9 billion gallons per day by 2020, a 26% increase from 1995 (FL DEP 2002). The Everglades Comprehensive Everglades Restoration Plan (CERP) includes expansion of water supplies to restore the environment and partially meet the needs of a growing population. CERP plans to build 18 reservoirs among many innovative alternative water supplies. However, as the Florida Council of 100 (2003) notes, considerable uncertainty exists in the time-phasing and funding of these projects. Florida's water management districts are authorized to restrict water use due to water shortage conditions (Fumero 2003), thus shortfalls in water supply due to drought or delayed water infrastructure projects could lead to restriction or denial of consumptive use permits. Increased use of reclaimed water will directly reduce the increasing need for freshwater.

Summary information on sources of potable quality water, which are generally from the surficial aquifers in Southeast Florida, are noted in this chapter and past demands and population trends are utilized to develop future potable water demand projections. Information about water treatment plants (WTPs), including present capacities and plans for expansion, is also given in the present chapter.

Due to differences between potable water service areas and wastewater service areas, all of the water treatment facilities within the counties are listed. The potable water service areas that most closely cover the wastewater service areas are highlighted and summarized to develop a correspondence between water demand and wastewater production within a particular wastewater service area. It should be noted that there may be discrepancies between the actual water demand of the population within the six wastewater treatment plant (WWTP) service areas due to this lack of a clearly defined overlap between the utility service areas.

Future potable water demands are compared with design capacities to assess the potential future potable water demand that could be supplanted by reuse of reclaimed water for domestic landscape irrigation. Chapter 5 incorporates information from this chapter in the discussion of utilizing reclaimed water.

3.1 Palm Beach County

3.1.1 Water Sources and Water Demands

The population of the Palm Beach County wastewater service areas, that is, the areas served by the Boynton-Delray and Boca Raton WWTPs, relies primarily on groundwater to meet its potable water demand. In some parts of the County, the surficial aquifer is unnamed, while in other parts of the County, the surficial aquifer is the Biscayne Aquifer. These unconfined sources provide most of the raw water that is treated and distributed for the potable water service area.

Utilities in the potable water service areas have implemented water management methods to enhance their potable water supply. During times of drought, treated raw water is blended with finished water at the Boynton Beach West WTP to increase water supplies (Boynton Beach 2005a). Additionally, an aquifer storage and recovery well has been installed to store treated water for subsequent recovery when needed. Aquifer storage and recovery helps to reduce over-utilization of the shallow aquifer.

As shown in Table 3-1, the 297,000 residents within the potable water service area utilized 52.34 MGD in 1995. In 2000, the population had increased to 315,000 and the usage increased to 56.64 MGD The corresponding per capita usage was 176 gal/capita/day and 180 gal/capita/day, respectively (Brown and Caldwell 1995; Hazen and Sawyer 1997; Marella 1999; Marella 2004). In the year 2000, the Boynton-Delray wastewater service area had a per capita usage rate of 164 gal/capita/day, compared to 203 gal/capita/day in the Boca Raton wastewater service area, reflecting a higher per capita demand in the more affluent Boca Raton community.

Table 3-1. Historic Potable Water Demand for Wastewater Service Areas within the Palm Beach County Study Area. Based on data from Brown and Caldwell (1995), Hazen and Sawyer (1997), Marella (1999) and Marella (2004)

Year	**1995**	**2000**
Water usage (MGD)	52.3	56.6
Per capita usage (gal/capita/day)	176	180

As noted in Section 2.1, the population for the Palm Beach County area is expected to increase at a rate consistent with the high population influx typical for the region (GEC 2003). Table 3-2 indicates the projected potable water demand for the residents of the study area for the period from 2005 to 2025, utilizing the 2000 per capita usage of 180 gal/capita/day throughout the study period and the population projection estimated from the United States Army Corps of Engineers (GEC 2003). The potable water demand for the Palm Beach County study area is expected to increase from 62.5 MGD in 2005 to 87.4 MGD in 2025.

Table 3-2. Potable Water Demand Projections for Wastewater Service Areas within the Palm Beach County Study Area from 2005–2025. Based on data from Brown and Caldwell (1995), Hazen and Sawyer (1997), Marella (Marella 1999), Marella (2004), and GEC (2003)

Year	**2005**	**2010**	**2015**	**2020**	**2025**
Water demand (MGD)	62.5	68.7	74.9	81.2	87.4

3.1.2 Water Treatment Facilities and Future Plans

There are four WTPs in the service area within Palm Beach County. The Delray Beach, Boynton Beach East, and Boynton Beach West water treatment facilities are located within the wastewater service area of the Boynton-Delray WWTP, and the Boca Raton Glades Road WTP lies within the service area of the Boca Raton WWTP. Table 3-3 shows eight WTPs located within Palm Beach County; the WTPs that provide potable water to the population of the wastewater service areas that have WWTPs that discharge to ocean outfalls are shown in bold.

Table 3-3. Palm Beach County Water Treatment Plants (SFRPC 2005). WTPs listed in boldface type have service areas in common with the South Central Regional and Glades Road WWTPs.

Plant Name	Plant Address/ Location	Design Capacity (MGD)	Treatment process	Source of water	Ref.
Delray Beach WTP	**600 S.W. 2nd Ave., Delray Beach**	**26.0**	**Lime softening**	**Surficial aquifer**	**Delray Beach (2005b; 2005a)**
Boynton Beach East WTP	**1620 S. Seacrest Blvd., Boynton Beach**	**19.0**	**Lime softening**	**Surficial aquifer**	**Boynton Beach (2005b; 2005a)**
Boynton Beach West WTP	**5469 W. Boynton Beach Blvd., Boynton Beach**	**9.0**	**Membrane filtration**	**Surficial aquifer**	**Boynton Beach (2005b; 2005a)**
Glades Road WTP	**Glades Rd., Boca Raton**	**70.0**	**Lime softening & Membrane filtration**	**Biscayne Aquifer**	**(Boca Raton 2005)**
Palm Beach County WTP #2	Suburban Lake Worth	14.5	Lime softening + ozone treatment	Surficial aquifer	(Palm Beach County 2005a)
Palm Beach County WTP #3	Suburban Delray-Boynton Beach	30.0	Membrane filtration	Surficial aquifer	(Palm Beach County 2005b)
Palm Beach County WTP #8	Suburban West Palm Beach	20.0	Lime softening + ozone treatment	Surficial aquifer	(Palm Beach County 2005c)
Palm Beach County WTP #9	Suburban Boca Raton	27.0	Membrane filtration	Surficial aquifer	(Palm Beach County 2005d)

a) Delray Beach WTP. The Delray Beach WTP, located at 600 S.W. 2nd Ave., is a 26.0-MGD (design and permitted capacity) lime softening treatment facility (Delray Beach 2005b). Raw water is aerated to remove natural gases and lime is added in a clarifier for softening, color removal, and iron removal. The facility utilizes filtration, disinfection, and fluoride injection prior to distribution (Delray Beach 2005a).

b) Boynton Beach East and West WTPs. Two WTPs are operated to serve the City of Boynton Beach. The Boynton Beach East WTP, located at 1620 S. Seacrest Boulevard, was built in 1962 with a design capacity of 8 MGD and was expanded to 17.5 MGD in late 1970s (Brown and Caldwell 1993). The WTP currently has a design and permitted capacity of 19.0 MGD and uses advanced lime-softening and filtration treatment process. The Boynton Beach West WTP, located at 5469 W. Boynton Beach Blvd., Boynton Beach, started operation in 1994. This WTP utilizes membrane softening technology and has a design and permitted capacity of 9.0 MGD (Boynton Beach 2005b).

The Boynton Beach West WTP has one aquifer storage and recovery well with a permitted capacity of 6.4 MGD and is planning to install a second well in 2005 (Boynton Beach 2005a).

c) Glades Road WTP, Boca Raton. Boca Raton's first WTP was constructed in 1927 where the City Hall stands today. A new WTP was built in the northwest corner of Glades Road and Boca Raton Boulevard with a capacity of 2.0 MGD in 1956, which was subsequently replaced by a 20.0-MGD WTP in the current Utility Services Complex. The WTP design capacity was increased with a 10.0 MG storage tank to supplement the existing 7.5-MG tank. The number of filters was increased to eight by constructing a third filter building consisting of two new filters and the design capacity to expand with a ninth filter. The raw water supply was recently increased by permitting seven additional 2.0 MGD wells. An additional 40.0 MGD membrane softening water treatment facility was completed in 2004. The Glades Road WTP currently has a design and permitted capacity of 70.0 MGD (Boca Raton 2005).

3.2 Broward County

3.2.1 Water Sources and Water Demands

The public utilities within Broward County rely solely on the Biscayne Aquifer, a surficial aquifer unique to South Florida (Marella 1999).

As shown in Table 3-4, the 858,000 residents within the wastewater service areas of the Broward/North and Hollywood WWTPs utilized 138.5 MGD of potable water in 1995, increasing to 942,000 residents and 152.2 MGD in 2000. This potable water demand represents an increase of 9.9% in five years (Hazen and Sawyer 2001; Hazen and Sawyer 2004).

Table 3-4. Historic Potable Water Demand for Wastewater Service Areas within the Broward County Study Area. Based on data from Hazen and Sawyer (2001; 2004)

Year	**1995**	**2000**
Water usage (MGD)	138.5	147.2
Per capita usage (GPD)	162	162

The population within the potable water service area is expected to continue to increase in Broward County, although at a rate slightly below that of the past, decreasing from the 9.9% seen between 1995 and 2000 to an estimated 6.6% growth rate from 2020 to 2025 (Hazen and Sawyer 2001; GEC 2003; Hazen and Sawyer 2004). Table 3-5 indicates the projected water demand for the residents of the potable water service area from years 2005 to 2025, based on figures obtained from Hazen and Sawyer (2001; 2004) and a per capita usage of 162 gal/capita/day obtained from historical water demand and population values (Hazen and Sawyer 2001; GEC 2003; Hazen and Sawyer 2004). The potable water demand for the study area is projected to increase from 167.3 MGD in 2005 to 226.7 MGD in 2025.

Table 3-5. Water Demand Projections for Wastewater Service Area within the Broward County Study Area from 2005–2025. Based on data from Hazen and Sawyer (2001b; 2004) and GEC (2003)

Year	2005	2010	2015	2020	2025
Water demand (MGD)	167.3	182.6	197.8	212.7	226.7

The Broward County Office of Environmental Services is planning alternative technologies in case current sources of raw water prove to be inadequate. This alternative is the Floridan Aquifer, an artesian water supply located about 1,000 feet underground. Floridan Aquifer water is higher in total dissolved solids than water from the Biscayne Aquifer and thus needs to be treated with reverse osmosis membrane technology to meet regulatory requirements. The City of Hollywood and the Town of Jupiter currently use the Floridan Aquifer for a portion of their drinking water supply (Hazen and Sawyer 2004).

An integrated water resource plan will be used to develop alternative sources of raw water and innovative management methods, such as increasing water conservation, expanding reuse of reclaimed water, increasing utilization of stormwater through improved operations of the secondary canal system, and applying aquifer storage and recovery technology to meet potable water demands through 2025 (Hazen and Sawyer 2004).

3.2.2 Water Treatment Facilities and Future Plans

Table 3-6 indicates the locations of twenty eight WTPs identified in Broward County (SFRPC 2005). The WTPs that are in the service area of Broward/North WWTP are the Broward County 1A and 2A, City of Coral Springs, City of Lauderhill, and City of Tamarac Utilities West WTP; the Deerfield Beach East and West WTPs, Fiveash WTP, Hillsboro Beach WTP; North Springs Improvement District, Pompano Beach WTP, and the Springtree WTP–Sunrise #1 WTP. The WTPs that are in the service area of the Hollywood WWTP are the City of Dania Beach, City of Hallandale Beach, and Hollywood WTPs, Miramar West Water Plant, and the Pembroke Pines WTP #2.

Capacities and future plans for each WTP are shown in Table 3-7. Total permitted and design capacities for these WTPs are 415.9 and 490.7 MGD, respectively. The maximum day potable water demand is 319.0 MGD (76.7% of permitted capacity) while the annual average daily flow (AADF) is 242.0 MGD (58.2% of permitted capacity). The largest providers of potable water in the County are the Broward County, the City of Hollywood, Sunrise WTPs, and the Fiveash WTP in Fort Lauderdale. A design capacity of 37.0 MGD will be added by 2008 through expansion of eight of these WTPs (SFRPC 2005). Further information about the WTPs within the study area in Broward County is presented in the following sections.

Table 3-6. Broward County Water Treatment Plant Locations (SFRPC 2005). WTPs listed in boldface type have service areas in common with the Broward/North and Hollywood WWTPs.

Plant Permit #	FL DEP Facility ID	Plant Name	Plant Address	City
06-58-00009	**4060167**	**Broward County 1A WTP**	**3701 North State Road 7**	**Lauderdale Lakes**
06-58-00010	**4060163**	**Broward County 2A WTP**	**1390 N.E. 50th St.**	**Pompano Beach**
4060209	**4060209**	**City of Coral Springs WTP**	**3800 N.W. 85th Ave.**	**Coral Springs**
4060253	**4060253**	**City of Dania Beach WTP**	**1201 Stirling Road**	**Dania Beach**
FL4060573	**4060573**	**City of Hallandale Beach WTP**	**215 N.W. 6th Ave.**	**Hallandale Beach**
FL4060787	**4060787**	**City of Lauderhill WTP**	**2101 N.W. 49th Ave.**	**Lauderhill**
06-58-00059	4060845	City of Margate WTP	1001 West River Drive	Margate
4061429	**4061429**	**City of Tamarac Utilities West WTP**	**7805 N.W. 61st St.**	**Tamarac**
4060282	4060282	Cooper City Utilities WTP	11791 S.W. 49th St.	Cooper City
4060291	4060291	Coral Springs Improvement District WTP	10300 N.W. 11th Manor	Coral Springs
06-58-00027	4060344	Davie WTP System I	3790 S.W. 64th Ave.	Davie
06-58-00028	4060344	Davie WTP System III	3500 N.W. 76th Ave.	Hollywood
4060254	**4060254**	**Deerfield Beach East Water Plant**	**101 N.W. 2nd Ave.**	**Deerfield Beach**
4060254	**4060254**	**Deerfield Beach West Water Plant**	**290 Goolsby**	**Deerfield Beach**
4060419	4060419	Ferncrest Utilities WTP	3015 S.W. 54th Ave.	Fort Lauderdale
FL40604861 -01	**4060486**	**Fiveash Water Plant – Fort Lauderdale WTP**	**1500 S. State Road 7/4321 NW 9th Ave**	**Fort Lauderdale**
4060615	**4060615**	**Hillsboro Beach Water Plant**	**925 N.E. 36th St.**	**Pompano Beach**
4060642	**4060642**	**Hollywood WTP**	**3441 Hollywood Blvd.**	**Hollywood**
W11035	**4060925**	**Miramar West Water Plant**	**2600 S.W. 66th Terrace**	**Miramar**
4064390	**4064390**	**North Springs Improvement District WTP**	**9700 N.W. 53rd Court**	**Coral Springs**
4061407	**4061407**	**Park City WTP– Sunrise #2**	**8700 S.W. 19th Place**	**Fort Lauderdale**
4061083	**4061083**	**Pembroke Pines WTP #2**	**7960 Johnson St.**	**Pembroke Pines**
4061121-01	4061121	Plantation Central WTP	400 N.W. 73rd Ave.	Plantation
4061121-02	N/A	Plantation East WTP	N/A	N/A
06-58-00078	**4061129**	**Pompano Beach WTP**	**301 N.E. 12th St.**	**Pompano Beach**
4061408	4061408	Sawgrass WTP– Sunrise #3	777 Sawgrass Corporate Parkway	Sunrise
4064326	4064326	Southwest (S. Broward) WTP	15450 Stirling Road	Davie
4061410	**4061410**	**Springtree WTP– Sunrise #1**	**4350 Springtree Drive**	**Sunrise**

Table 3-7. Broward County WTP Capacities and Future Plans (SFRPC 2005). WTPs listed in boldface type have service areas in common with the Broward/North and Hollywood WWTPs.

Plant Name	Design Capacity (MGD)	Permitted Capacity (MGD)	Peak Flow (MGD)	AADF (MGD)	Additional Capacity (MGD/yr)
Broward County 1A WTP	**60.0**	**16.0**	**9.0**	**8.3**	**NR**[1]
Broward County 2A WTP	**40.0**	**30.0**	**17.4**	**15.4**	**NR**
City of Coral Springs	**16.0**	**16.0**	**10.3**	**8.4**	**NR**
City of Dania Beach WTP	**3.0**	**4.0**	**3.4**	**2.8**	**4.5/2007**
City of Hallandale Beach	**10.0**	**10.0**	**7.0**	**5.8**	**6.0/2006**
City of Lauderhill	**16.0**	**8.1**	**8.6**	**6.9**	**NR**
City of Margate WTP	18.0	13.5	9.1	7.0	NR
City of Tamarac Utilities West	**20.0**	**8.3**	**13.1**	**6.4**	**NR**
Cooper City Utilities	7.0	7.0	5.7	2.9	NR
Coral Springs Improvement District	7.1	5.8	5.5	4.2	NR
Davie WTP System I	3.4	3.4	1.2	1.0	NR
Davie WTP System III	4.0	4.0	3.5	3.4	4.0/2006
Deerfield Beach East Water Plant	**16.8**	**16.8**	**7.9**	**2.0**	
Deerfield Beach West Water Plant	**18.0**	**18.0**	**14.9**	**12.6**	**3.5/2008**
Ferncrest Utilities	1.0	1.0	0.9	0.8	NR
Fiveash Water Plant – Fort Lauderdale	**75.0**	**67.3**	**57.1**	**42.5**	**NR**
Hillsboro Beach Water Plant	**2.0**	**1.0**	**1.3**	**1.1**	**NR**
Hollywood WTP	**61.0**	**57.5**	**32.8**	**26**	**NR**
Miramar West Water Plant	**7.5**	**7.5**	**6.5**	**5.8**	**3.0/2007**
North Springs Improvement District	**6.8**	**6.5**	**5.4**	**4.1**	**NR**
Park City WTP– Sunrise #2	**6.0**	**6.0**	**5.5**	**2.9**	**NR**
Pembroke Pines WTP #2	**18.0**	**16.2**	**15.5**	**13.5**	**6.0/2005– 2007**
Plantation Central WTP	12.0	12.0	10.6	7.0	NR
Plantation East WTP	12.0	12.0	8.2	6.8	NR
Pompano Beach WTP	**50.0**	**24.0**	**21.9**	**17.2**	**NR**
Sawgrass WTP– Sunrise #3	18.0	18.0	12.2	8.8	6.0 – 2006
Southwest (S. Broward) WTP	2.0	2.0	1.9	0.5	NR
Springtree WTP– Sunrise #1	**24.0**	**24.0**	**22.7**	**17.9**	**4.0/2006**
County Total	490.7	415.9	319.0	242.0	37.0 by 2008

[1] None Reported

a) Broward County District 1A and 2A WTPs. The Broward County Office of Environmental Services owns and operates the District 1A and 2A WTPs. The District 1A WTP, located at 3701 North State Road 7, Lauderdale Lakes, started operation in 1960 with a design capacity of 3.0 MGD. The WTP was expanded to 10.5 MGD in 1979 and achieved its current design capacity of 16.0 MGD in 1994. Upflow clarifiers and multimedia filtration are provided in conjunction with lime softening treatment of the raw water from the District 1A well field (Hazen and Sawyer 2004).

The District 2A WTP, located at 1390 N.E. 50th Street, Pompano Beach, started with a 20.0-MGD design capacity in 1972 and was brought to its current design capacity of 40.0 MGD in 1994. The permitted operating capacity is 30.0 MGD. Upflow clarifiers and multimedia filtration are provided together with lime softening treatment of the raw water from the 2A and North Regional well fields (Hazen and Sawyer 2004).

The Broward County Office of Environmental Services is working on rebuilding substantial portions of the water systems to overcome deficiencies in handling existing and projected potable water demands. The improvement projects for Districts 1, 2 and 3 are anticipated to be completed by 2008, 2010 and 2005 at estimated costs of $320 million, $167 million and $95 million, respectively (Hazen and Sawyer 2004).

b) Hollywood WTP. The Hollywood WTP, located at 3441 Hollywood Blvd., Hollywood, started operation in 1925 with a design capacity of 0.5 MGD. In 1935, a water softening system was added to the WTP to improve potable water quality. In late 1970s, the WTP was expanded with a lime softening system. The City of Hollywood decided to utilize membrane treatment in the 1980s and the WTP was upgraded with a 16.0-MGD membrane treatment facility in 1996. The membrane treatment facility has the ability to be expanded to 300 MGD. The lime softened and membrane treated waters are blended together (Hollywood 2005b). The design capacity is 61.0 MGD and the permitted capacity is 57.5 MGD (SFRPC 2005). The emergency power capabilities at the Hollywood WTP are being upgraded, a new well field is being installed, and the south well field is being rehabilitated for future demands (Hollywood 2005a).

3.3 Miami-Dade County

3.3.1 Water Sources and Water Demands

The public utilities within Miami-Dade County rely only upon the Biscayne Aquifer, a surficial aquifer unique to South Florida (Miami-Dade County 2005).

As shown in Table 3-8, the 1,282,000 residents within the service area of the Miami-Dade/North and Miami-Dade/Central District WWTPs in Miami-Dade County utilized an average of 219.3 MGD in 1995. In the year 2000, 1,343,000 residents used 229.7 MGD, an increase in water usage of 4.7% (PBS&J 2003).

Table 3-8. Historic Potable Water Demand for Wastewater Service Areas within the Miami-Dade County Study Area. (PBS&J 2003)

Year	**1995**	**2000**
Water usage (MGD)	219.3	229.7
Per capita usage (GPD)	171	171

The 1995 and 2000 values presented in PBS&J (2003) are based on per capita usage of 171 gal/capita/day. The same per capita usage was used in developing the projections shown in Table 3-9. Projected water demands for the service area increase from 238.9 MGD in 2005 to 292.4 MGD in 2025.

Table 3-9. Water Demand Projections for Wastewater Service Area within the Miami-Dade County Study Area from 2005–2025. Based on data from PBS&J (2003) and GEC (2003)

Year	**2005**	**2010**	**2015**	**2020**	**2025**
Water demand (MGD)	238.9	247.7	263.4	276.6	292.4

3.3.2 Water Treatment Facilities and Future Plans

The locations of seven WTPs that serve Miami-Dade County (SFRPC 2005) are shown in Table 3-10. The WTPs that are in the service area of the North District WWTP are the City of N. Miami Winson, Hialeah-Preston and Norwood Water Plants. There are no WTPs that lie exclusively in the service area of the Central District WWTP. The Alexander Orr WTP is on the border of the Central and South District WWTP service areas.

Detailed information and future plans for each WTP are shown in Table 3-11. Total permitted and design capacities for the WTPs are 453.8 and 500.5 MGD, respectively. The peak demand is 412.4 MGD (90.9% of permitted capacity) while the annual average daily flow (AADF) is 380.3 MGD (83.8% of permitted capacity). The largest providers in the County are the Alexander Orr and Hialeah-Preston WTPs. Additional water supply of 111.3 MGD will be completed by 2013 through expansion of five of these facilities (SFRPC 2005). The Alexander Orr and Hialeah-Preston WTPs are operated by the Miami-Dade Water and Sewer Department. Additional information about these facilities is given below.

The Alexander Orr and Hialeah-Preston WTPs include lime softening, disinfection, fluoridation, and filtration treatment. They have a common distribution system that covers most of Miami-Dade County (MDWASD 2005). The WTPs were designed for a capacity of 225.0 and 217.7 MGD, respectively, and are permitted for 199.2 and 203.1 MGD, respectively (SFRPC 2005). The Hialeah-Preston WTP, located at 1100 West 2nd Ave., Hialeah, treats water from the northwest and other nearby well fields to serve the residents north of Flagler St. The Alexander Orr WTP, located at 6800 S.W. 87th Ave., Miami, receives its water from the Alexander Orr, Snapper Creek and Southwest well fields, and serves the southern part of the county, down to SW 264th Street. Air stripping facilities were installed at the Hialeah and Preston WTPs in 1992 to restore the contaminated Hialeah and Miami Springs well fields that were out of service (PBS&J 2003).

An aquifer storage and recovery program is underway to store surplus Biscayne aquifer water in the Upper Floridan Aquifer during the wet season and retrieve this water for dry season supply. Several aquifer storage and recovery wells have been installed and others are being constructed or planned. The South Florida Water Management District (SFWMD) developed VISION 2050 for South Florida, which emphasizes development of non-traditional water sources such as reclaimed water, salt water, and deeper aquifers. In the future, the lower east coast of Florida will depend less on the regional water management system and more on local water storage, aquifer storage and recovery, water reuse, and advanced water treatment technologies. As part of this plan, a 23,000-acre freshwater lake in Northwest Miami-Dade County is proposed for water supply during the dry season (PBS&J 2003).

Table 3-10. Miami-Dade County Water Treatment Plant Locations. WTPs listed in boldface type are within the service areas of the Miami-Dade/North and Miami-Dade/Central WWTPs

Plant Permit #	FDEP Facility ID	Plant Name	Plant Address	City
13-00017-W		**Alexander Orr**	**6800 S.W. 87th Ave.**	**Miami**
13-00046-W	4130645	City of Homestead	505 N.W. 9th St.	Homestead
13-00059-W	**PWO-000017**	**City of N. Miami Winson Water Plant[1]**	**12100 N.W. 11th Ave.**	**North Miami**
13-00029-W	4130255	Florida City	461 N.W. 6th Ave.	Florida City
13-00037-W		**Hialeah-Preston**	**1100 West 2nd Ave.**	**Hialeah**
13-00060-W	**4131618**	**Norwood Water Plant – N. Miami Beach[2]**	**19150 N.W. 8th Ave.**	**Miami Gardens**
13-00040-W		South Miami-Dade WTP[3]	11800 S.W. 208th St.	Miami

[1]The City of North Miami receives 50% of its water service from WASD, while the Winson Plant provides the other 50%. The Winson Plant also provides water service to Biscayne Park and parts of Unincorporated Miami-Dade County.

[2]The City of North Miami Beach receives 50% of its water service from WASD, while the Norwood Water Plant provides water to the other 50%. The Norwood Plant also provides water service to Sunny Isles Beach, Miami Gardens, Golden Beach, and Aventura.

[3]The South Miami-Dade WTP is currently under construction. The data provided are the cumulative total for five small WTPs (Leisure City WTP, Everglades Labor Camp WTP, Newton WTP, Elevated Tank WTP, and Naranja Lakes WTP) that the County uses. These WTPs will be taken out of service after the South Miami-Dade WTP is completed.

Table 3-11. Miami-Dade County Water Treatment Plant Capacities and Future Plans

Plant Name	**Design Capacity** (MGD)	**Permitted Capacity** (MGD)	**Peak Flow** (MGD)	**AADF** (MGD)	**Additional Capacity** (MGD/yr)
Alexander Orr	217.7	203.1	185.5	171.9	60.3/2013
City of Homestead	16.7	11.7	10.9	8.5	5.0/2008
City of N. Miami Winson Water Plant	9.0	9.3	10.0	8.5	NR[1]
Florida City	4.03	3.51	3.6	3.0	NR
Hialeah-Preston	225.0	199.2	177.6	166.1	10.0/2005
Norwood Water Plant – N. Miami Beach	16.0	16.0	16.0	15.5	16.0/2006
South Miami-Dade WTP	12.0	10.9	8.8	6.8	20.0/2006
County Total	**500.5**	**453.8**	**412.4**	**380.3**	**111.3 by 2013**

[1]None Reported

3.4 Summary of Three County Area

Water demands for the three county area are expected to continue increasing throughout the study period, but the projected increase could be reduced by the implementation of water conservation programs and technologies. The projections given in this report provide estimates of the region's water demand that are inclusive of current water demand trends using presumed minimal water conservation efforts.

As summarized in Table 3-12, aggregate water demand for the three county area have increased from 410.2 MGD in 1995 to 468.7 MGD in 2005. Population growth in the region is expected to continue this upward trend in water demand (Fig. 3-1), resulting in an aggregate water demand of 606.5 MGD by the year 2025. The service areas for Palm Beach County are expected to see about a 40% increase in water demand between the years 2005 and 2025. The service areas for Broward and Miami-Dade Counties are anticipated to experience 36% and 22% increases in water demand, respectively, over the same period.

Table 3-12. Summary of Historical and Projected Water Demands in MGD for the Three County Area from 1995–2025

	1995	2000	2005	2010	2015	2020	2025
Palm Beach	52.3	56.6	62.5	68.7	74.9	81.2	87.4
Broward	138.5	147.2	167.3	182.6	197.8	212.7	226.7
Miami-Dade	219.3	229.7	238.9	247.7	263.4	276.6	292.4
Total	410.2	433.5	468.7	499.0	536.1	570.6	606.5

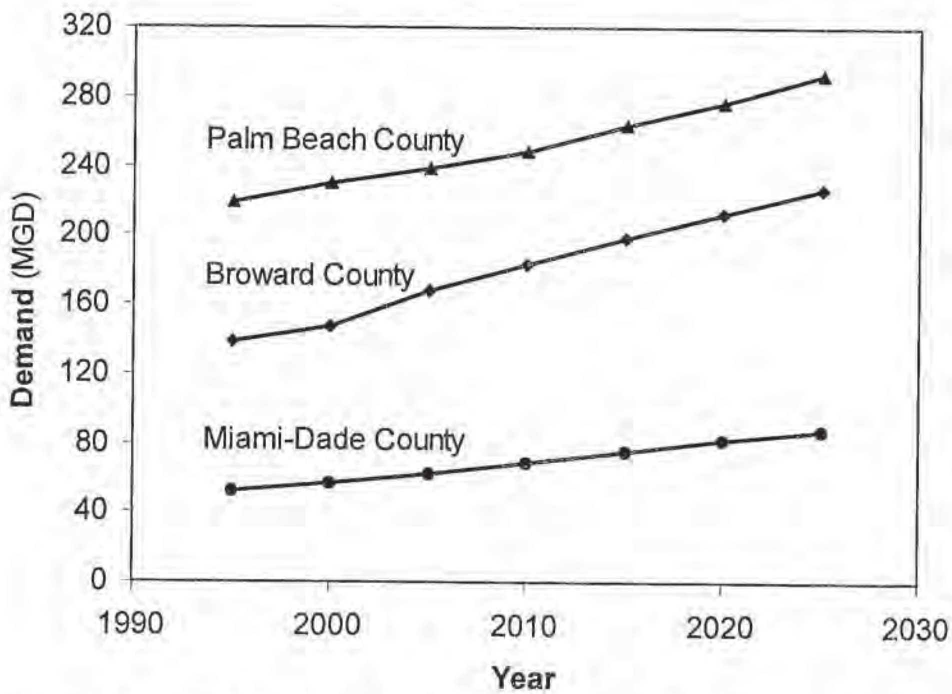

Figure 3-1. Historical and Projected Water Demands by County from 1995–2025

Each of the service areas within the three counties was analyzed to determine the future water demand in relation to the planned potable water design capacity for each of the 5-year projections. "Design capacity" indicates the amount of water that a WTP can deliver without having to incur physical modification and is preferred to the "permitted capacity", which is the amount of water that a WTP is permitted to deliver without a permit modification. In some instances where the "design capacity" is greater than the "permitted capacity", a WTP can have its "permitted capacity" increased without any physical modification to the WTP. In the case where a WTP has a "permitted capacity" less than a "design capacity", the increase in "permitted capacity" can be increased by requesting a re-rating of the WTP by the Florida Department of Environmental Protection. "New water" is the water demand in excess of the existing or planned water supply (design capacity) of the water treatment facility.

The analysis for "new water" can be used to identify WTPs where reclaimed water can be substituted for other, less available or more costly new water sources. For example, since approximately 40% of all residential potable water use is for irrigation (Heaney et al. 2000), reclaimed water can supplement current potable water supplies for landscape irrigation, potentially reducing the need for identifying new sources of potable water. Reclaimed water can be used for groundwater recharge, where applicable, or a component in an aquifer storage and recovery (ASR) systems. Additionally, reclaimed water can be utilized for make up water as part of the Comprehensive Everglades Restoration Program (CERP), a United States Army Corps of Engineers rehabilitation program that aims to improve the quality of the Everglades. Subsequent chapters of this report provide detailed information indicating the water quality standards for each of the water reuse options and the levels of treatment recommended to achieve water quality standards.

The new water analysis for Palm Beach County (Table 3-13) indicates that Palm Beach County has sufficient WTP design capacity to meet its needs until at least 2025.

Table 3-13. Summary of Projected Water Demands and WTP Design Capacities for Palm Beach County

Facility	**Design Capacity** (MGD) **2005**		**Flow projections** (MGD) **2005**	**2010**	**2015**	**2020**	**2025**
Boca Raton Glades Road WTP	70.0	Total	44.0	48.4	52.7	57.2	61.6
		New water*	0.0	0.0	0.0	0.0	0.0
Boynton Beach WTP	28.0	Total	15.4	16.9	18.4	20.0	21.5
		New water	0.0	0.0	0.0	0.0	0.0
Delray Beach WTP	26.0	Total	14.9	16.4	17.9	19.4	20.9
		New water	0.0	0.0	0.0	0.0	0.0
Total	124.0	Total	74.4	81.7	89.1	96.6	104.0
		New water	0.0	0.0	0.0	0.0	0.0

*Demand in excess of capacity

As depicted in Table 3-14, Broward County has 16 WTPs that provide potable water to the service areas of the Broward North and Hollywood WWTPs. The County presently has insufficient design capacity to meets its 2025 water demand. However, the water utilities within the County are planning five improvement programs during the study period to increase the design capacity by 26.9 MGD for a total of 426.8 MGD by the year 2008, which is sufficient to meet water demands throughout the study period.

Table 3-14. Summary of Projected Water Demands and WTP Design Capacities for Broward County

Facility	**Design Capacity** (MGD) **2005**		**Flow projections** (MGD) **2005**	**2010**	**2015**	**2020**	**2025**
City of Dania Beach WTP	3.0 (7.5 by 2007)	Total	3.0	3.3	3.6	3.9	4.2
		New water*	0.0	0.0	0.0	0.0	0.0
City of Lauderhill WTP	16.0	Total	7.5	8.2	8.8	9.5	10.2
		New water	0.0	0.0	0.0	0.0	0.0
City of Tamarac Utilities WTP	20.0	Total	7.0	7.6	8.3	8.9	9.6
		New water	0.0	0.0	0.0	0.0	0.0
Coral Springs WTP	16.0	Total	9.2	10.0	10.8	11.7	12.5
		New water	0.0	0.0	0.0	0.0	0.0
Deerfield Beach East WTP	16.8	Total	2.2	2.4	2.6	2.8	3.0
		New water	0.0	0.0	0.0	0.0	0.0
Deerfield Beach West WTP	18.0 (21.5 by 2008)	Total	13.8	15.0	16.2	17.5	18.8
		New water	0.0	0.0	0.0	0.0	0.0
District 1A WTP	16.0	Total	9.1	9.9	10.7	11.5	12.4
		New water	0.0	0.0	0.0	0.0	0.0
District 2A WTP	40.0	Total	16.8	18.3	19.9	21.4	22.9
		New water	0.0	0.0	0.0	0.0	0.0
Fiveash Water Plant	75.0	Total	46.4	50.6	54.8	59.1	63.3
		New water	0.0	0.0	0.0	0.0	0.0
Hallandale Beach WTP	10.0 (16.0 by 2006)	Total	6.3	6.9	7.5	8.1	8.6
		New water	0.0	0.0	0.0	0.0	0.0
Hillsboro Beach WTP	2.0	Total	1.2	1.3	1.4	1.5	1.6
		New water	0.0	0.0	0.0	0.0	0.0
Hollywood WTP	61.0	Total	28.4	30.9	33.5	36.2	38.7
		New water	0.0	0.0	0.0	0.0	0.0
Miramar Beach WTP	7.5 (10.5 by 2007)	Total	6.3	6.9	7.5	8.1	8.6
		New water	0.0	0.0	0.0	0.0	0.0
North Springs WTP	6.5	Total	4.5	4.9	5.3	5.7	6.1
		New water	0.0	0.0	0.0	0.0	0.0
Pompano Beach WTP	50.0	Total	18.8	20.5	22.2	23.9	25.6
		New water	0.0	0.0	0.0	0.0	0.0
Springtree–Sunrise #1 WTP	24.0 (28.0 by 2006)	Total	19.6	21.3	23.1	24.9	26.7
		New water	0.0	0.0	0.0	0.0	0.0
Total	399.9 (426.8 by 2008)	Total	214.9	234.1	253.5	273.6	293.0
		New water	0.0	0.0	0.0	0.0	0.0

*Demand in excess of capacity

Considerable improvements are necessary within Miami-Dade County to meet future water demands within the service area of the Miami-Dade/North and Miami-Dade/Central WWTPs (Table 3-15). The County is planning three improvement programs during the study period to increase its design capacity by 86.3 MGD for a total of 554.0 MGD by the year 2025. However, based on current plans for future improvements, the County will still need to identify sources for an additional 26.7 MGD by 2025.

Table 3-15. Summary of Projected Water Demands and WTP Design Capacities for Miami-Dade County

Facility	Design Capacity (MGD) 2005		Flow projections (MGD) 2005	2010	2015	2020	2025
Alexander Orr WTP	217.7 (278.0 in 2013)	Total	200.3	226.0	239.5	253.3	266.5
		New water*	0.0	8.3	0.0	0.0	0.0
Hialeah-Preston WTP	225.0 (235.0 in 2005)	Total	193.5	218.4	231.4	244.7	257.5
		New water	0.0	0.0	0.0	9.7	22.5
North Miami Winson WTP	9.0	Total	9.9	11.2	11.8	12.5	13.2
		New water	0.9	2.2	2.8	3.5	4.2
North Miami Beach Norwood WTP	16.0 (32.0 in 2006)	Total	18.1	20.4	21.6	22.8	24.0
		New water	2.1	0.0	0.0	0.0	0.0
Total	467.7 (554.0 by 2025)	Total	421.8	476.0	504.3	533.3	561.2
		New water	3.0	10.5	2.8	13.2	26.7

*Demand in excess of capacity

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4. Environmental Impacts of Ocean Outfalls

4.1 Introduction

The primary motivation for reducing discharges of pollutants to land and/or receiving waters is to protect water quality and avoid adverse impacts to public health, recreation, and the environment in general. Traditional indicators of water quality include dissolved oxygen (DO) levels in streams and rivers where levels below 4 or 5 mg/L under low flow conditions in the river or stream can lead to fish kills and other obvious manifestations of water quality problems. Nutrients (nitrogen and phosphorus) are other popular indicators of water quality. Excess nutrients cause algal blooms and other undesirable impacts in lakes and rivers. Florida has experienced some dramatic recent incidences lately of these impacts ranging from Lake Okeechobee to the lower St. Johns River wherein algal blooms occurred from Palatka to the mouth of the St. Johns River east of Jacksonville during the summer of 2005. Red tide outbreaks along the Gulf Coast have further heightened public awareness that human activities are having a detrimental impact on important receiving waters. In addition to DO and nutrients, bacterial water quality is used as an indicator of water quality.

The traditional concern with treated wastewater was where to dispose of it. Stricter regulations against discharge to receiving waters in Florida led to aggressive use of land disposal via effluent irrigation. In the past 25 years, there has been growing realization that this highly treated water could be reused. Thus, these land options were more properly referred to as reuse or recharge facilities.

In this study, the focus is on the six wastewater treatment plants that discharge to ocean outfalls in Southeast Florida. The following sections discuss this practice including studies of the relative risks of ocean disposal vs. other options. The relative risk approach is important to use since all disposal and reuse options have various impacts associated with them.

4.2 Description of Selected Ocean Outfall Studies

The six WWTPs in southeast Florida discharge treated effluent to the Atlantic Ocean via ocean outfalls as described in Chapter 2. Several studies have been made of the impacts of these discharges on the ocean and the associated reefs that are located near these outfalls. Summaries of these studies are presented below.

4.2.1 Southeast Florida Outfall Experiments (SEFLOE I and II)

The Southeast Florida Outfall Experiment I (SEFLOE I), initiated by utilities in Broward, Miami-Dade and Palm Beach Counties, characterized the impacts of ocean outfall wastewater disposal in Southeast Florida. Initial and subsequent dilutions were obtained through field dye and salinity data processing. The initial dilution, current meter and effluent discharge data were analyzed with dimensional analysis and regression to obtain semi-empirical relations. Dye concentration and salinity data were used to determine total physical dilutions as a function of distance from the surface boil. The Broward North and Hollywood outfall plumes were found to undergo enhanced dilution within the 100 meter range. This rapid dilution was attributed to an internal hydraulic jump. Subsequent mixing of plumes was dominated by buoyant spreading for several hundred meters from the boil. In the Miami-Dade North and Miami-Dade Central outfalls, the effluent was initially distributed over a wider area due to the multi-port diffusion. However, the dilutions were not as rapid as the Broward and Hollywood outfall plumes. Subsequent mixing of plumes was dominated by buoyant spreading and oceanic turbulence (Proni and Dammann 1989; Englehardt et al. 2001).

The SEFLOE II study was conducted between 1991 and 1994 as a cooperative effort of state, federal and local government agencies, together with Hazen and Sawyer (1994). Ocean outfalls at the North Regional and Southern Regional WWTPs in Broward County and the North and Central District WWTPs in Miami-Dade County were studied to provide site specific information. Physical, chemical, and biological data from field studies were analyzed to characterize outfall plumes and associated environmental conditions. Englehardt et al., (2001) summarize the results of the SEFLOE studies as follows:

- Bacteria—no organisms could be detected more than 800 meters from the outfall.
- Nutrients—Concentrations of ammonia, TKN, total phosphorous, and nitrate were found to reach background levels within 400 meters from the discharge points.
- Oil and grease—Visual field observations indicated no oil or grease sheens within plumes at the surface.

4.2.2 Comparative Assessment of Human and Ecological Impacts from Municipal Wastewater Disposal Methods in Southeast Florida

Englehardt et al. (2001) present a comparative assessment of the human and ecological impacts from municipal wastewater disposal in Southeast Florida. Their assessment includes ocean disposal from the six WWTPs. Ocean discharge differs from other surface water discharge due to the higher density of the saline ocean waters and the much greater dilution of the ocean. The buoyancy of the plume, marine currents and turbulence result in three distinct phases of dilution (Englehardt et al. 2001):

- Initial plume dilution takes less than two minutes from the time the effluent leaves the outfall until it reaches the ocean's surface. The freshwater-saltwater mixture creates a turbulent, rising plume with strong mixing. The mixing is further improved by the horizontal movement of the Florida Current. The plume rises to the surface downstream of the outlet by at least 10 meters. Englehardt et al. (2001) define the initial dilution as the ratio of the constituent in the effluent to the maximum concentration at the boil.
- Near-field dilution occurs after the effluent reaches the surface.
- Far-field dilution is the result of the interaction of the mixing plume and surface convective processes.

Field investigations revealed that surfacing plumes were present at all six WWTP outfalls throughout the year (Englehardt et al. 2001). All of the outfalls are in at least 28 meters of water and 2 miles offshore. They are located in the westerly boundary of the strong Florida Current, a tributary of the Gulf Stream.

Wanninkhof et al. (2006) evaluated farfield dilution of sewage outfall discharges in southeast Florida. Their studies indicate that the rapid dilution observed in the immediate vicinity of the outfall continues to occur in the 10 to 66 km downstream distances. They estimate that the dilution ratio is 212*distance (km). Thus, a unit of pollutant is diluted to 1/212 of its original value in one km. These authors do not address issues of reef impacts or pollutant control.

4.2.3 Relative Risk Assessment of Management Options for Treated Wastewater in South Florida

The 2003 US EPA relative risk assessment study involved deep well injection, aquifer recharge, discharge to ocean outfalls and surface waters as disposal options. Rapid-rate infiltration basins were chosen as the aquifer recharge option because, unlike slow-rate land application systems, they do not require back-up disposal methods, such as discharge to a storage area or to deep well injection, for wet-weather conditions (US EPA 2003).

A risk characterization was done initially for each disposal option to identify and describe the associated risks, the potential magnitude of the risks and the potential impacts on human and ecological health. The data and knowledge gaps for all disposal options were identified as part of the risk analysis. A relative risk assessment was then used to compare risks among the four wastewater disposal options. Each option had its own specific stressors, exposure pathways, receptors, and effects. A quantitative comparison was found to be infeasible because the parameters relevant to one disposal option were not necessarily relevant to the other options. The overall comparisons were presented as relative risk assessment matrices (US EPA 2003).

Treatment levels before disposal and attenuation factors, like travel distance and time, biological degradation, and adsorption, filtration through geologic media, dispersion by groundwater or ocean currents were found to control the concentrations of stressors received by the receptor. The human health risk from pathogenic microorganisms was higher for deep well injection and discharge to ocean outfalls compared to aquifer recharge and discharge to surface waters. Filtration significantly reduced the level of pathogenic protozoans in treated wastewater. Excess nutrients were found to cause ecological problems (US EPA 2003).

Human health risks from the four disposal options were low. The risk increased with less treatment or short exposure pathways. Filtration, together with high-level disinfection, reduced the risk for all options. The risk increased if there was a coincidence of the disposal location and recreational uses in surface and ocean waters. The risk also increased if harmful algal blooms occurred. The human health risks from deep well injection and aquifer recharge options included the potential impact on drinking water supplies (US EPA 2003).

Ecological health risks from deep well injection and aquifer recharge were found to be very low. The ecological risk from surface water disposal was low due to the advanced level of treatment. However, since the surface waters of South Florida are already impaired, the risk was higher. The ecological risk from ocean outfalls was low outside the mixing zones. The risk increased if harmful algal blooms or bioconcentration in food webs were caused. Risk to coral reefs would increase with the construction of new ocean outfalls (US EPA 2003).

Specific findings for ocean outfalls from this study are listed below.

- *The SEFLOE studies provide a risk assessment and a prediction that there should not be any adverse effects resulting from ocean discharge of secondarily-treated effluent. This prediction is based largely on the rapid dispersal and dilution of the effluent plumes by the Florida Current and the relatively low concentrations of stressors in the treated effluent.*
- *Prevailing directions and fast speeds of the Florida Current are major factors that decrease risk for the six ocean outfalls. Current speeds can be more than 60 or 70 cm/sec, while speeds of 20 to 40 cm/sec commonly occur. Northerly flow with the fastest speeds occurs approximately 60% of time. Southerly flow with similar or lesser speeds occurs about 30% of time. Westerly flow towards the east coast of Florida, which represents the highest risk, is estimated to occur less than approximately 4% of the time.*
- *Other factors that decrease risk are the distance of the outfalls from land. The lowest risk outfalls are farthest from land (Miami-Dade Central outfall), while the highest risk outfalls are closest to land (Boca Raton, Delray Beach).*
- *The use of multiport diffusers, compared to the use of single-port diffusers, appears to aid in dispersal of the effluent plume over a wider area, decreasing potential risk. Discharging the effluent at a fast initial speed also appears to increase the rate of dispersal and dilution of the effluent plume.*
- *Based on toxicity testing of marine organisms, there is no evidence that the diluted effluent causes acute toxic effects or short-term chronic effects.*
- *Based on nitrogen isotope studies of organic matter in sediments and nutrients in the water column, it does not appear that the nitrogen in outfall effluent is taken up in significant amounts by phytoplankton in the area. This may be because of the rapid dilution of the effluent nitrogen by the Florida Current.*
- *The State of Florida requires that Class III water quality standards be met outside a mixing zone of 400 m around the outfall. This mixing zone allows for dispersal, mixing, and dilution of the effluent plume.*
- *Concentrations of pathogens are controlled at the treatment plant through chlorination to meet water-quality standards within the required mixing zone; viruses and most bacteria are expected to be adequately inactivated by chlorine. However, there is no filtration to remove* Cryptosporidium *and* Giardia. *Lack of treatment to remove pathogenic protozoans probably constitutes the greatest human health risk posed by this wastewater management option.*
- *Pathogenic protozoans may also pose significant ecological risks related to infections of marine mammals. The effects of pathogenic protozoans on aquatic organisms need to be further investigated.*
- *The results of the SEFLOE study for metals monitoring indicates that, in general, water-quality standards are met at 400 m or 800 m.*
- *The chlorinated discharged effluent largely meets Class III water-quality standards for all regulated wastewater constituents within 400 m of the outfalls, with exceptions as noted.*
- *The lack of long-term ecological, microbial pathogen, and chemical monitoring studies makes it difficult to evaluate whether the conclusions of the SEFLOE studies will continue to hold true in the future.*

- *Human health risks are of some concern, both within the 400-m mixing zone and outside of it, primarily because treatment of effluent prior to discharge via ocean outfalls does not include filtration to remove* Cryptosporidium *and* Giardia. *The most probable human exposure pathways include fishermen, swimmers, and boaters who venture out into the Florida Current and experience direct contact, accidental ingestion of water, or ingest fish or shellfish exposed to effluent. Otherwise, there is a very small, but not nonzero, chance for onshore or nearshore recreational or occupational users to be exposed to effluent constituents, since there is a small (10%) chance that currents will change direction to east or west.*

4.3 Impacts on Coral Reefs Near Ocean Outfalls

Numerous natural and artificial reefs exist in the vicinity of the six ocean outfalls. Coral reefs represent a specific receptor that can be impaired by ocean outfall discharges. A thorough investigation of the extent of this impact would include quantification of the sources of the constituents in the water at the reefs as well as an evaluation of the impacts.

Recent studies by Tichenor (2004) suggest that the outfall discharge at Boynton Beach may be having an adverse effect on Lynn's Reef. However, the experimental design for the studies by Tichenor (2004) did not include a direct linkage of pollutant discharges and the relative importance of the concentrations of these discharges at a specific reef. Fauth et al. (2006) conducted a biomarker study that indicates that these reefs have been impacted in some cases. Lapointe et al. (2004) were able to directly link wastewater discharges in the Florida Keys with detrimental impacts to the nearby shallow seagrass and coral reef communities. This linkage was much easier to show since the discharges occurred directly offshore without the use of ocean outfalls and the extent of dilution and mixing is much less. Johns et al. (2001) present strong evidence that natural and artificial reefs are an important part of the tourist business in South Florida. A variety of initiatives are underway to foster better understanding and management of Florida's reefs. The Southeast Florida Coral Reef Initiative (SEFCRI) is described by Collier (2005). She suggests that research is needed to determine the relative importance of sewage outfall discharges on reef health. Lapointe and Risk (undated) conclude that $\delta 15N$ analyses of macroalgae, sponges and gorgonian corals recently collected from reefs in Palm Beach and Broward counties, Florida indicate a significant contribution of sewage nitrogen to the nitrogen pool in the coastal waters of the area. No complete report is available for this ongoing study. These recent and ongoing studies could provide valuable new insights into the extent of the cause-effect linkage between outfall discharges and impaired reefs in Southeast Florida. If the regulatory agencies feel that current wastewater treatment levels are insufficient to protect water quality in general and the reefs in particular, then more stringent regulations such as additional treatment requirements may be imposed in the future. The costs of added treatment are estimated elsewhere in this report.

4.4 Offshore Impacts of Wastewater Discharges in the Florida Keys

The land-based nutrient pollution in shallow seagrass and coral reef communities between the Content Keys (southern Florida Bay) and Looe Key (south of Big Pine Key) in the Lower Florida Keys were studied by LaPointe et al. (2004). The impacts of physical forcing (rainfall, wind and tides) and water management on mainland South Florida on the nutrient enrichment and blooms of phytoplankton, macroalgae, and seagrass epiphytes were evaluated (Lapointe et al. 2004). Phase I of the study included daily sampling in 1996 at three stations (inshore, nearshore, offshore) between Big Pine Key and Looe Key for dissolved inorganic nitrogen (DIN) and soluble reactive phosphorus (SRP) concentrations in the water column and phytoplankton biomass (chlorophyll a) before, during, and following episodic physical forcing events. Phase II of the study involved sampling of macroalgae for stable nitrogen isotope ratios from Content Keys to Big Pine Key in the summer (wet season) of 2000 and the spring (dry season) of 2001 (Lapointe et al. 2004). The Florida Keys National Marine Sanctuary (FKNMS) was found to be affected by sewage pollution. Contaminated groundwater with high DIN and SRP from the on site sewage disposal systems entered the ocean waters through submarine groundwater discharges (Lapointe et al. 2004). Land-based nutrient enrichment was found to be the primary factor in the seasonal development of phytoplankton, macroalgae, and seagrass epiphyte blooms in the inshore, nearshore, and offshore waters of the FKNMS. Chronic nutrient enrichment of coastal waters from local (sewage) and regional (agricultural) land-based sources were responsible for the elevated ammonia and SRP concentrations which caused eutrophication and macroalgal harmful algal blooms (Lapointe et al. 2004).

4.5 Socioeconomic Importance of Reefs

Johns et al. (2001) presented the results of a major study of the benefits of reefs in Southeast Florida. Over 6,000 surveys were given to residents, boat owners, and tourists regarding the economic value of natural and artificial reefs. This study did not address water quality directly. They estimate that visitors and residents spent 22.8 million person days using artificial and natural reefs in the three counties between June 2000 and May 2001. About two thirds of these visits were to natural reefs. About one half of these visits were for fishing and most of the balance was for snorkeling and scuba diving. Their results indicate that the residents and visitors to the three counties are willing to spend $24.51 million per year in additional fees to maintain the reefs in their present condition. This study does quantify the overall economic importance of reefs. However, it does not address the relative importance of the reefs that might be affected by the six ocean outfalls.

4.6 Summary and Conclusions

Several studies have been made of the impacts of the outfalls on the ocean. Surfacing plumes are present at all six WWTP outfalls throughout the year (Englehardt et al. 2001). Rapid dilution in the immediate vicinity of the outfall continues for 6 to 41 miles downstream (2006). Existing evidence suggests that the human and ecological risks from the six ocean outfalls are generally low because the wastewater is treated to reduce the contaminants and the rapid mixing and dilution reduces residual pollutant concentrations to very low levels (US EPA 2003). One concern cited by the US EPA (2003) was the risk posed to both humans and marine mammals by *Cryptosporidium* and *Giardia* in the unfiltered wastewater effluent.

Natural and artificial reefs near the six ocean outfalls contribute significantly to the tourist business in South Florida (2001). Recent studies by Tichenor (2004a; 2004b) suggest that the outfall discharge at Boynton Beach may be having an adverse effect on Lynn's Reef, but did not establish a link between pollutant discharges and the relative importance of pollutant concentrations at a specific reef. A biomarker study by Fauth et al. (2006) indicates that the reefs have been impacted in some cases. Offshore wastewater discharges with limited dilution and mixing in the Florida Keys were linked to detrimental impacts to the nearby shallow seagrass and coral reef communities (2004). Based on δ15N analyses of macroalgae, sponges and gorgonian corals recently collected from reefs in Palm Beach and Broward counties, Lapointe and Risk (undated) believe that sewage nitrogen is a significant contributor to the nitrogen pool in the area's coastal waters. No complete report is available for this ongoing study. These recent and ongoing studies could provide valuable new insights into the extent of the cause-effect linkage between outfall discharges and impaired reefs in Southeast Florida and indicate whether or not current wastewater treatment levels are sufficient to protect water quality in general and the reefs in particular.

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5. Water Reuse Options, Experience, and Potential

The greatest use of reclaimed water has been in regions suffering water scarcity or severe restrictions on disposal of treated effluents. Water utilities facing these difficulties have devised and implemented a variety of innovative approaches that utilize reclaimed water to help meet their communities' needs. Case studies of these projects have been summarized in several excellent reviews published over the last few years, e.g., Crook (2004), Radcliffe (2004), and Law (2003), as well as in journal papers, reports and Web sites prepared by water and wastewater utilities. A sampling of the experiences of some of the larger utilities is given in the present chapter. The current status of satellite water reclamation systems is also reviewed. These systems could reduce distribution costs for reclaimed water and also alleviate salinity problems of waters reclaimed from sewers in low-lying coastal areas such as Southeast Florida. The chapter ends with an analysis of the potential for traditional water reuse in Southeast Florida. The analysis sets up a new approach in identifying large users that are well-suited for traditional reuse. The methods introduced will be further used in a case study in Chapter 6 to produce feasible traditional reuse demand flow values that can alleviate the flows currently going to ocean outfalls. Traditional reuse demand flows are projected for the six wastewater treatment plants of interest and used in the evaluation of alternatives to ocean outfalls in Chapter 7 by using the methods presented in this chapter.

5.1 Experience of Large Utilities in the U.S.

The water reuse industry in the U.S. has experienced rapid growth in recent years. The State of Florida, which publishes a yearly Reuse Inventory, is a well-documented example of the increasing significance of water reuse in water management. Over the 18 year period from 1986 to 2004, both reuse flow and capacity in Florida have increased by more than 300% (Fig. 5-1), reaching 630 MGD and 1,270 MGD, respectively, in 2004 (FL DEP 2005a). California has seen its deliveries of reclaimed water increase from 150 MGD in 1970 to over 500 MGD in 2002 (DWR 2003). Statistics such as these firmly establish the feasibility of water reuse and its expanding role in water resources management.

While California, Arizona and Florida have practiced water reuse for many years, other states such as Texas are implementing their own programs as they recognize the value of water reuse as an integral component of water resources management. In this section, case studies from across the U.S. are described, emphasizing those operated by large municipal utilities. General locations of the case studies are shown in Figure 5-2.

5.1.1 Green Acres Project

a) Service area. The Green Acres Project serves users in the Los Angeles area, including Fountain Valley, Huntington Beach, Costa Mesa, Newport Beach, and Santa Ana, California (Fig. 5-3).

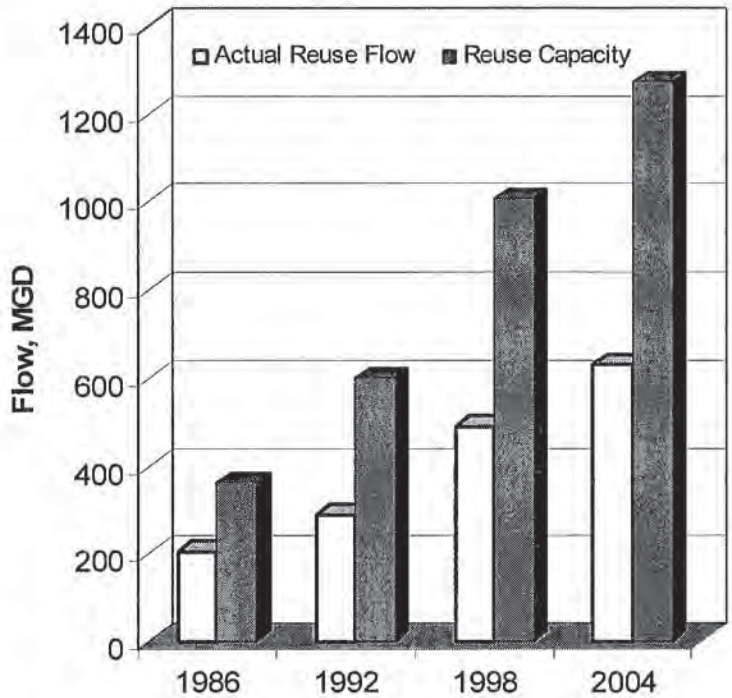

Figure 5-1. Growth of Water Reuse in Florida (FL DEP 2005a)

Figure 5-2. Selected Sites of Water Reuse in the USA. Photo from Google Earth.

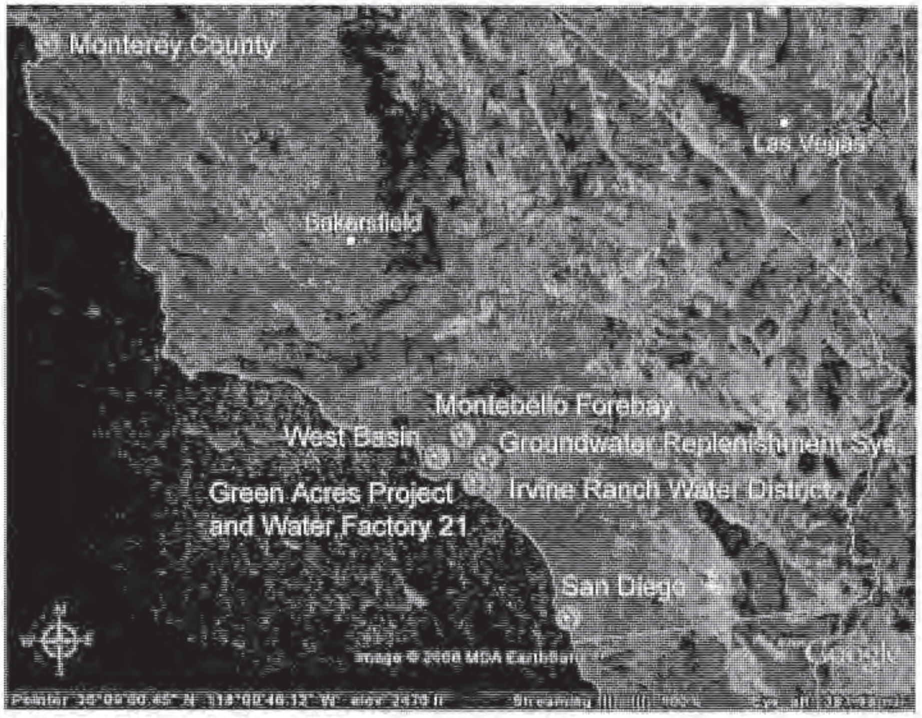

Figure 5-3. Selected Sites of Water Reuse in California. Photo from Google Earth.

b) Reclaimed water quality control. Reclaimed water is obtained from the Green Acres Project water reclamation plant during the summer months. During the winter months, the Green Acres Project plant is taken out of service and reclaimed water is obtained from the 15 MGD Irvine Ranch Water District's Michelson Water Reclamation Plant. Municipal wastewater undergoes filtration and disinfection in addition to secondary treatment at each facility. The water meets the disinfected tertiary recycled water requirements of California Title 22, which include a weekly median total coliform concentration no higher than 2.2/100 mL, a single sample maximum total coliform concentration of 23/100 mL, and an average daily turbidity no higher than 2 nephlometric turbidity units (NTU). Maximum limits also are specified in Title 22.

c) Reclaimed water distribution and customers. More than 6 MGD of reclaimed water, on the average, is delivered through 32 miles of pipelines to users in Fountain Valley, Huntington Beach, Costa Mesa, Newport Beach, and Santa Ana. Pipeline sizes range from 6 to 42 inches in diameter. A potential extension into central Huntington Beach would add 0.9 MGD of flow. The reclaimed water is used for landscape irrigation (parks, schools, golf courses, etc.) and industrial purposes such as cooling and process washdown.

d) Problem encountered. A carpet dyer found that the reclaimed water caused occasional spotting of dyed carpets and discontinued its use of the water. The Orange County Water District is exploring means to resolve the water quality issues involved.

e) Project costs. Capital cost of the project, including assistance for end-user retrofits, was $49M. Annual operations and maintenance costs are $0.9M. The Orange County Water District wholesales the reclaimed water to various water agencies.

f) Information sources. Information for this case study was taken from OCWD (2001) and Crook (2004).

5.1.2 Irvine Ranch Water District

a) Service area. The Irvine Ranch Water District is located in Orange County, California, and includes the City of Irvine (Fig. 5-3). The District serves a population of 316,000 and has a service area of 133 square miles. Reclaimed water makes up 20% of the Irvine Ranch Water District water supply.

b) Reclaimed water quality control. Reclaimed water is provided by the 15 MGD Michelson Water Reclamation Plant (WRP) and the 5.5 MGD Los Alisos WRP. Water drawn from the open reservoirs in the distribution system may be further treated before introduction to the transmission and distribution pipelines. Treatment operations that may be applied include straining, pressure filtration, and disinfection. The water meets the advanced tertiary standards of California Title 22 requirements, which include weekly median total coliform concentrations no higher than 2.2/100 mL and daily average turbidity no higher than 2 NTU.

c) Reclaimed water distribution and customers. A yearly average of 11 MGD is supplied to 1,750 customers. Most of the service area has access to a reclaimed water distribution system, which consists of 300 miles of reclaimed water pipelines. Some of the reclaimed water distribution lines were retrofitted. In new developments, distribution lines for reclaimed water are installed along with lines for domestic water and sewer. Reclaimed water is stored in winter months. The supply system is interconnected with that of the Orange County Water District to provide the opportunity for shut-down for maintenance.

There are over 3,400 metered connections to the reclaimed water distribution system. The combined capacity of the reclaimed water storage reservoirs is 656 MG. Two of the reservoirs are open, whereas the others are closed concrete or steel tanks. A total of 15 pump stations are located throughout the reclaimed water distribution system.

The primary use of reclaimed water is landscape irrigation, with 80% of all business and public area landscaping (parks, school grounds, golf courses, a cemetery, freeway landscapes, city-maintained streetscapes, common areas managed by homeowner associations, front and back yards at individual residential dwellings) irrigated with this water source. Additional uses include food crop irrigation, toilet and urinal flushing in 12 dual-plumbed office buildings, and commercial office cooling towers. Use of reclaimed water is mandated for high-rise buildings. The additional cost of providing a dual system in new buildings over seven stories adds only 9% to the cost of plumbing.

d) Problems overcome. More frequent reservoir tank cleaning, increased control valve maintenance, and potential damage to mainline valve body seats from higher chlorine levels are noted in the reclaimed water distribution system, in comparison to potable water distribution systems. The Irvine Ranch Water District now specifies a type of valve seat that has higher resistance to chlorine. Possible cross connections are checked for once a year. Leaks or spills are routed wherever possible to the sanitary sewer system instead of storm drains, or may be collected and trucked back to the plant. Salinity is an ongoing challenge. A significant source of total dissolved solids is self-generating water softeners. These were prohibited for many years by a City of Irvine ordinance. However, such bans by water agencies elsewhere in California were overturned by a court decision in 1997. The District is seeking legislation that would restore its ability to control salinity.

e) Education and outreach. The District uses brochures, videos, workshops, and other means to educate and involve the public about water reuse. Tours of the WRPs and water quality laboratory are held on a regular basis. The need for conserving water is taught at all grade levels. In addition, the concept of water reuse is introduced in the fifth grade.

f) Project costs and rate structure. Annual operations and maintenance costs in fiscal year 2002–2003 were \$6.6M. The base reclaimed water rate is \$0.82/1000 gal, which is 90% of the base domestic water rate. The District penalizes excess usage of reclaimed water with an ascending block rate.

g) *Future plans.* Conversion of an existing open reservoir will add 813 MG of seasonal storage of reclaimed water. The Irvine Desalter Project, currently in the planning stage, will treat water from a plume of trichloroethylene-contaminated groundwater using reverse osmosis, air stripping with activated carbon filters, and disinfection. The product water will be added to the reclaimed water system, providing an additional 1.6 MGD of flow. Plans call for the capacity of the Michelson WRP to be increased to 33 MGD by 2025 and eventual expansion of the Los Alisos plant to 7.8 MGD.

h) Information sources. Information for this case study was taken from Anderson (Anderson 2003), Crook (2004), Mantovani et al. (2001), Radcliffe (2004) and US EPA (2005).

5.1.3 Montebello Forebay Groundwater Recharge Project

a) Service area. Reclaimed water from three satellite water reclamation plants (WRPs) is used to recharge groundwater for the Central Basin, which is the main groundwater basin underlying the greater Los Angeles metropolitan area (Fig. 5-3). Additional reclaimed water from these facilities is used by the County Sanitation Districts of Los Angeles County for nonpotable applications such as landscape and agricultural irrigation, industrial process water, recreational impoundments, and wildlife habitat. The management of the WRPs and responsibility for monitoring reclaimed water quality is borne by the County Sanitation Districts of Los Angeles County. Management of the recharge facilities, including the river conveyance and spreading basins, is assumed by the Los Angeles Department of Public Works. Overall management of the groundwater basin, including groundwater monitoring, is the responsibility of the Water Replenishment District.

b) Reclaimed water quality control. The treatment plants are the Whittier Narrows WRP, the 100 MGD San Jose Creek WRP and the 13 MGD Pomona WRP. Each of these facilities provides biological nitrogen removal, filtration and disinfection in addition to secondary treatment. The biosolids generated at the plants are returned to one of the major trunk sewers and are subsequently treated at the Joint Water Pollution Control Plant near the coast in Carson. This decreases the complexity of the facilities and reduces both capital and operations and maintenance costs.

Reclaimed water produced by the WRPs meets primary drinking water standards and contains no more than 2.2 total coliforms/100 mL and 2 NTU of turbidity. Extensive sampling of the reclaimed water for viruses and parasites has shown it to be essentially free of measurable levels of pathogens.

c) Method of addition to natural waters. Reclaimed water from the San Jose Creek and Whittier Narrows WRPs is spread in an unconfined region of the Central Basin known as the Montebello Forebay. Available reclaimed water from the Pomona WRP is discharged to San Jose Creek, a tributary of the San Gabriel River, and ultimately becomes a source of recharge in the Montebello Forebay. Up to 60,000 acre-ft of reclaimed water in a single year or up to a running three-year average of 50,000 acre-ft/yr may be applied. Stormwater runoff and imported surface water are used along with reclaimed water for recharge. The running three-year percentage of reclaimed water in this mix should not exceed 35% of total recharge.

The total area available for spreading recharge water is 698 acres. Additionally, percolation occurs over 133 acres of the unlined San Gabriel River. Batteries of spreading basins are normally operated on a 21-day cycle, consisting of 7 days each of filling, emptying (through percolation), and drying. The vadose zone underlying the basins is generally 10 ft or more in thickness.

d) Health effects studies. Four different heath effects studies, the latest in 1999, have concluded that there is no evidence that populations consuming groundwater—estimated to contain as much as 31% reclaimed water in the Montebello Forebay—had a higher risk of cancer, mortality, infectious disease, or adverse birth outcomes than those using other water sources.

e) Project benefits. The Montebello Forebay Groundwater Project has helped reduce the cumulative groundwater overdraft in the Central Basin. It provides a new water supply that meets the demand of 250,000 persons. Use of reclaimed water in lieu of imported water saves the Districts $12M/yr.

f) Information sources. Information for the present case study was taken from Crook (2004).

5.1.4 Monterey County Water Recycling Project

a) Service area. Reclaimed water is distributed within the Salinas Valley, which lies in the northern part of Monterey County, California (Fig. 5-3). The water reaches 222 parcels of farmland in the 12,000 acre service area.

b) Reclaimed water quality control. A 30 MGD regional wastewater recycling facility was constructed adjacent to the regional secondary treatment plant to provide tertiary treated, reclaimed water for agricultural applications. The tertiary treatment includes flocculation, dual media filtration and chlorine disinfection. The facility delivers 20 MGD of reclaimed water.

c) Distribution system and customers. The reclaimed water distribution system includes 46 miles of water transmission and distribution pipelines, 22 supplemental wells to augment reclaimed water flows at times of peak demand and 111 flow-metered connections. Equalization storage is provided to smooth diurnal inflow variations. Three booster pump stations maintain pressure in the system. Crops irrigated include lettuce, celery, broccoli, cauliflower, artichokes, and strawberries.

d) Problems overcome. Minor problems have included the need to flush construction debris from the system, excessive sand in the water extracted from wells, and a few pipeline breaks. The system is run by a three-person crew on a continuous basis. No adverse effects to the crops, soil or field workers have been noticed. Salinity control is an ongoing challenge. The reclaimed water has a sodium absorption ratio of 4.7, compared to the ratio of 1.7 for good quality well water. The blend of reclaimed and well water used for irrigation typically has a sodium absorption ratio somewhat above 3.0, which is the maximum desired by the growers. Soils irrigated with the blend of reclaimed and well water have a higher sodium absorption ratio and exchangeable sodium percentage than soils irrigated with well water. The Monterey Regional Water Pollution Agency is currently focusing on source control as a means of limiting salt concentration in reclaimed water.

e) Education and outreach. A Water Quality and Operations Committee was formed early in the project to gain input from users. A proactive education plan was developed in 1977 to address perception issues.

f) Project costs and rate structure. Construction cost of the project was $75 million. The total cost to treat and deliver recycled water to agricultural areas is $0.90/1000 gallons. This amount excludes secondary treatment costs, but includes debt service from loans and operations and maintenance for tertiary treatment and distribution. Revenue is provided from land assessments ($233/acre/yr) and a water delivery charge of $0.05/1000 gal.

g) Information sources. Information for the present case study was taken from Crook (2004) and Sheikh (2004).

5.1.5 Water Factory 21 and Groundwater Replenishment System

a) Service area. The Orange County Water District has operated Water Factory 21, an advanced water reclamation facility, since 1976. The Orange County Water District began construction in 2003 of the Groundwater Replenishment System, which will provide 70,000 acre-ft/yr (62.5 MGD) of reclaimed water (Fig. 5-3).

b) Reclaimed water quality control. The treatment train of the 15 MGD Water Factor 21 includes secondary treatment (provided by an adjacent wastewater treatment plant operated by the Orange County Sanitation District), lime clarification, filtration, reverse osmosis, and UV/hydrogen peroxide disinfection/advanced oxidation. The reverse osmosis units were found to remove sufficient nitrogen from the reclaimed water, so the air stripping towers were removed from service in 1986. The treatment train for the Groundwater Replenishment System, located in Fountain Valley, will include secondary treatment, microfiltration, reverse osmosis, and hydrogen peroxide/UV advanced oxidation/disinfection.

c) Method of addition to natural water body. After treatment by reverse osmosis and activated carbon, reclaimed water from Water Factor 21 is mixed with deep well water and injected into four aquifers prone to seawater intrusion using multi-point injection wells. Most of the injected water flows inland to augment groundwater used as a potable supply source. Reclaimed water for the Groundwater Replenishment System will be pumped through a 14 mile long, 78 inch force main to deep spreading basins near Anaheim. Depending on the time of year, 15 to 40 MGD of the water will be diverted to an expanded Talbert Gap Seawater Intrusion barrier currently served by Water Factory 21. Some of the reclaimed water could be made available for irrigation, industrial process water, or other approved uses by connections to the conveyance pipeline.

d) Health effects studies. No evidence of significant risks from this practice has emerged.

e) *Outreach.* Water user telephone surveys, mailings, print and cable television advertising, and meetings with community groups, businesses, hospitals, and elected officials have been used to inform water users on the need for the project and the water quality.

f) Project costs, rate structure and benefits. Both of the Orange County groundwater recharge systems protect coastal aquifers against seawater intrusion and replenish the groundwater. The Groundwater Replenishment System is estimated to cost $454M with an annual operations and maintenance budget of $22M. Funding has been provided by several agencies, including $92.5M in federal and state grants and a State Revolving Fund loan of $145M.

g) Information sources. Information for the present case study was taken from Crook (2004) and GRS (2004).

5.1.6 San Diego, California

a) Service area. Reclaimed water is distributed from the North City WRP (Fig. 5-3). The North City Distribution System extends from the coast to the City of Poway and provides service to Mira Mesa, Miramar Ranch North, Scripps Ranch, University City, and Torrey Pines. The South Bay Distribution System will eventually connect to facilities being constructed by the Otay Water District. The system also delivers reclaimed water to the adjacent International Boundary and Water Commission Wastewater Treatment Plant.

b) Reclaimed water quality control. The treatment sequence at the 30 MGD North City WRP includes primary settling, activated sludge with anoxic selectors to control filamentous bacteria and anthracite coal filters. A portion of the filtrate is demineralized using electrodialysis reversal process in order to decrease the salinity of the reclaimed water. The demineralized stream is combined with filtrate prior to chlorine disinfection. The quality level of the reclaimed water is suitable for irrigation of food crops, parks, playgrounds, etc. Control of the North City plant is transferred to the utility's communications center in

Kearny Mesa from 12:30 am to 5:30 am each night, with an operator on call in the event of an emergency. The North City WRP currently treats 22.5 MGD.

The 15 MGD South Bay WRP has a similar sequence of treatment processes as described above. Disinfection is accomplished through ultraviolet irradiation and there is no process for demineralization. The facility is staffed from 6:00 am to 4:00 pm Monday through Friday. Plant control is accomplished from the utility's communications center outside these hours. The facility currently discharges up to 9 MGD of secondarily treated wastewater that is disposed of via an ocean outfall.

c) Reclaimed water distribution and customers. Reclaimed water from the North City WRP is distributed through 79 miles of pipeline, two storage tanks and two pump stations. There are 356 metered connections, including a single metered connection with the City of Poway, which serves an additional 193 customers. The single largest use of reclaimed water is landscape irrigation. Additional uses include industrial processes, cooling towers, soil compaction, dust suppression, circuit board washing and urinal flushing. Customers include General Atomics, Motorola, CalTrans, University of California at San Diego, Torrey Pines Municipal Golf Course, Nissan Design, Burnham Institute, Metro Biosolids, Miramar Landfill and the City Poway. The City has a guaranteed water program that exempts research and development or industrial manufacturing firms from mandatory water restrictions during periods of drought in exchange for participation in daily water conservation programs that include use of reclaimed water.

The South Bay Distribution System currently consists of a pipeline along Dairy Mart Road. It will eventually tie in with facilities being constructed by the Otay Water District.

d) Education and outreach. Businesses, public agencies, homeowners' associations and academic institutions with proximity to the optimized system are being contacted to retrofit their properties and receive education on the use of reclaimed water.

e) Project costs and rate structure. The cost for reclaimed water started at $1.34 per hundred cubic feet of water ($1.79/1000 gal) in 1997. This was lowered by the San Diego City Council to $0.80 per hundred cubic feet ($1.07/1000 gal) in 2001 to encourage use of reclaimed water. This rate is 57% less than the current potable water rate of $1.87 per hundred cubic feet ($2.50/1000 gal).

f) Future plans. A pricing structure that covers the actual cost of producing reclaimed water will be considered by the City Council in 2006.

g) Information sources. Information for this case study was taken from the City of San Diego (City of San Diego 2005; City of San Diego undated-e; City of San Diego undated-b; City of San Diego undated-d).

5.1.7 West Basin Municipal Water District, California

a) Service area. The West Basin Municipal Water District is a public agency that wholesales water to local cities, mutual water companies, private companies and investor-owned utilities in a 200-square mile area of southwest Los Angeles County. It obtains secondarily treated wastewater from the Hyperion Wastewater Treatment Plant in Los Angeles and pumps it through five miles of 60 inch force main to the District reclamation facility in El Segundo (Fig. 5-3).

b) Reclaimed water quality control and customers. The El Segundo WRP provides filtration and disinfection in addition to secondary treatment and meets California Title 22 standards for tertiary quality reclaimed water. About 2.5 MGD of this water is used for irrigation through the Water Replenishment District. The El Segundo WRP also feeds three satellite plants, each of which polishes the water for a specific industrial user. One satellite plant provides nitrification and disinfection for a flow of 7.4 MGD that is used for industrial cooling makeup water. A second satellite plant applies lime treatment, reverse osmosis, and disinfection to a flow of 6.5 MGD, producing drinking quality water that is used for recharge of groundwater to provide a barrier to seawater intrusion as part of the West Coat Basin Barrier Project. The third satellite plant provides microfiltration, reverse osmosis, and disinfection to a flow of 5.8 MGD that is used for low pressure boiler feed water. Another 2.4 MGD of reclaimed water from the third satellite plant is passed through the reverse osmosis process a second time and then used as high pressure boiler feed water. The reject water (concentrate) from the reverse osmosis units is returned to the Hyperion Wastewater Treatment Plant for disposal by ocean outfall.

c) Education and outreach. An extensive ongoing public outreach program is maintained by the West Basin Municipal Water District, including a children's education program, reclaimed water marketing and school education.

d) Project cost and rate structure. The selling price of the reclaimed water is 20 to 40% less than imported water. (Imported water sells for $510/acre-ft.) Nitrified water sells for 20% less than imported water. Reclaimed water receiving reverse osmosis treatment is sold at the same rate or slightly higher than imported water.

e) Plans for expansion of services. The West Basin Municipal Water District has begun a 10 MGD expansion of Title 22 water production. A 5 MGD expansion of Barrier water production is also underway. The increased flow of Barrier water will shift the proportions of reclaimed water and natural water used for groundwater recharge from 50:50 to 75:25.

f) Information sources. Information for the present case study was taken from Crook (2004) and Miller (2003).

5.1.8 Phoenix

a) Reclaimed water production and customers. Situated in an arid desert, the City of Phoenix, Arizona has practiced water reuse since the turn of the century. Water reclamation facilities are co-located with the City's wastewater treatment plants. The total wastewater treated is 140,000 acre-ft/yr (125 MGD), of which nearly 80,000 acre-ft/yr (71 MGD) is reused. The ratio of reclaimed water use to wastewater treated (57%) is one of the highest reuse ratios among large municipalities in the U.S.

i) 23rd Avenue WWTP. Up to 30,000 acre-ft annually (27 MGD) of reclaimed water is produced for delivery to farms in the nearby Roosevelt Irrigation District. In return, the District sends groundwater to the Salt River Project—a canal bringing water to the Phoenix area from a series of reservoirs on the Salt River—for use as raw water for the City's surface water treatment plants. Delivery of reclaimed water in excess of exchanged groundwater is credited to the City as groundwater recharge, giving the City flexibility to pump more groundwater during drought or for specific projects.

ii) *91st Avenue WWTP.* The Palo Verde Nuclear Generation Plant is contracted to receive as much as 105,000 acre-ft per year (94 MGD) of reclaimed water from the 91st Avenue WWTP. Actual usage for the Palo Verde plant has been 70,000 acre-ft/yr (62 MGD).

iii) Cave Creek Water Reclamation Facility. Golf courses and other turf users in the northern portions of Phoenix are served by the Cave Creek Water Reclamation Facility, which has a capacity of 8 MGD.

b) Future plans. Several innovative projects are underway to help assure dependable water availability in the future. Realization of these projects would enable Phoenix to reclaim more than 90% of its wastewater, totaling over 200,000 acre-ft/yr (179 MGD).

i) Tres Rivers Demonstration Project. A pilot study involving 12 acres of free-water-surface wetlands is underway at the convergence of the Salt, Gila and Agua Fria rivers. The Tres Rios Demonstration Project is developing design criteria for a wetlands system that could meet upcoming effluent quality standards.

ii) Agua Fria Linear Recharge Project. A conceptual plan was developed for groundwater recharge along the Agua Fria River using a portion of the reclaimed water from the 91st Avenue WWTP. The project involves discharging water into the dry riverbed at several locations and allowing the water to percolate into the aquifer. As much as 60,000 acre-ft/yr (54 MGD) of reclaimed water could be applied in this project, generating pumping credits available to all owners of the 91st Avenue WWTP. Phoenix and its partners would develop strategies for recovering the water, which in some instances would be treated for potable use.

iii) *The Market Resource Center.* A recommendation of the 25-yr Master Plan for the 91st Avenue WWTP was to treat available wastewater (remaining after commitments) to the highest water quality standards. This new source of water would be offered to identify future markets.

c) Information sources. Information for the present case study was obtained from Gritzuk and Conway (2004).

5.1.9 San Antonio

a) Reclaimed water quality control. Four major water recycling centers (WRCs) are operated by the San Antonio Water System (Fig. 5-2). The combined output of these plants is 116

MGD. The facilities provide treatment to meet Texas regulations for Type I reclaimed water, which applies to water that is likely to come into contact with humans. These regulations specify BOD_5 and turbidity should be no higher than 5 mg/L and 3 NTU, respectively, on a 30-day average basis. The geometric mean for fecal coliforms must be no higher than 20 CFU/100 mL, while the maximum concentration of fecal coliforms in any grab sample must not exceed 75 CFU/100 mL.

b) Distribution system and customers. Downstream water rights are allocated 49% of San Antonio Water System reclaimed water. The Dos Rio WRC discharges treated reclaimed water to the San Antonio River, from which the City's municipally-owned electric generating facility withdraws up to 36 MGD of reclaimed water to cooling water lakes. The electric generating facility pays the San Antonio Water System $0.153/1000 gal for use of this water. A reclaimed water distribution system containing 75 miles of pipeline was recently completed to provide up to 31 MGD to additional water users. The Salado Creek and Leon Creek WRCs currently feed the system, providing more than 14 MGD to 45 customers that include industrial cooling water, river maintenance, golf courses, schools and commercial sites. The overall transmission and distribution system includes 11 operational pump and storage facilities.

c) Problems overcome. One of the problems encountered was water quality degradation during startup of the distribution system, due to microbial growth in supply lines and tanks. This was attributed to stagnation of water in the system associated with low flows. Chlorination points were installed within the distribution system to maintain a chlorine residual of at least 1 mg/L throughout the system. Additionally, storage tanks are drained and cleaned of sediment periodically. Another problem in the first few years of operation was a series of pipeline failures. Two of the incidents involved joint failures in the main transmission lines. Concern was expressed that high levels of dissolved salts, particularly chlorides, could adversely affect vegetation. In response, the San Antonio Water System included assurances in the reclaimed water agreement that total dissolved solids would be no higher than 1500 mg/L and that the sodium absorption ratio would not exceed 5.0.

In 2002, a cross-connection between the non-potable and potable water system at a golf course was discovered. To preclude further incidents, the San Antonio Water System now provides training for customer workers involved in routine system operation before reclaimed water service begins. A five-step process is followed to ensure complete separation between the reclaimed and potable water systems. After initiation of reclaimed water service, the San Antonio Water System staff rechecks and tests the reclaimed water system.

d) Project costs and rate structure. The price of reclaimed water in the San Antonio Water System is $0.98/1000 gal, which is 49% of the potable water rate. The rates vary somewhat based on season and amount of water used. A lower amount ($0.25/1000 gal) is charged to customers who trade pumping withdrawal rights to the local aquifer in return for reclaimed water.

e) Information sources. Information for the present case study was taken from Coker (2004), Crook (2004) and Fletcher (2006).

5.1.10 Pinellas County

a) Service area. Pinellas County is located in the west central region of Florida, bounded by the Gulf of Mexico on the west and by Tampa Bay to the south and east (Fig. 5-4).

b) Reclaimed water quality control. Pinellas County Utilities operates two regional water reclamation facilities (WRFs). The William E. Dunn WRF, located in the northern part of the county, has a capacity of 9.0 MGD and produces 6.5 MGD of reclaimed water on the average. Wastewater undergoes nitrogen and phosphorus removal, filtration and high-level disinfection in addition to secondary treatment. All of the reclaimed water from the Dunn WRF is sent to the reclaimed water distribution system. In addition, up to 0.8 MGD of reclaimed water is purchased from the City of Oldsmar and up to 3 MGD is purchased from the City of Clearwater. The South Cross Bayou WRF in the southern part of the county has a capacity of 33 MGD and produces an average of 26 MGD of treated effluent. On the average, 7.4 MGD is reclaimed for water reuse. The remaining reclaimed water is discharged to a tidal creek. Like the Dunn WRF, the wastewater receives nitrogen and phosphorous removal and high-level disinfection in addition to secondary treatment.

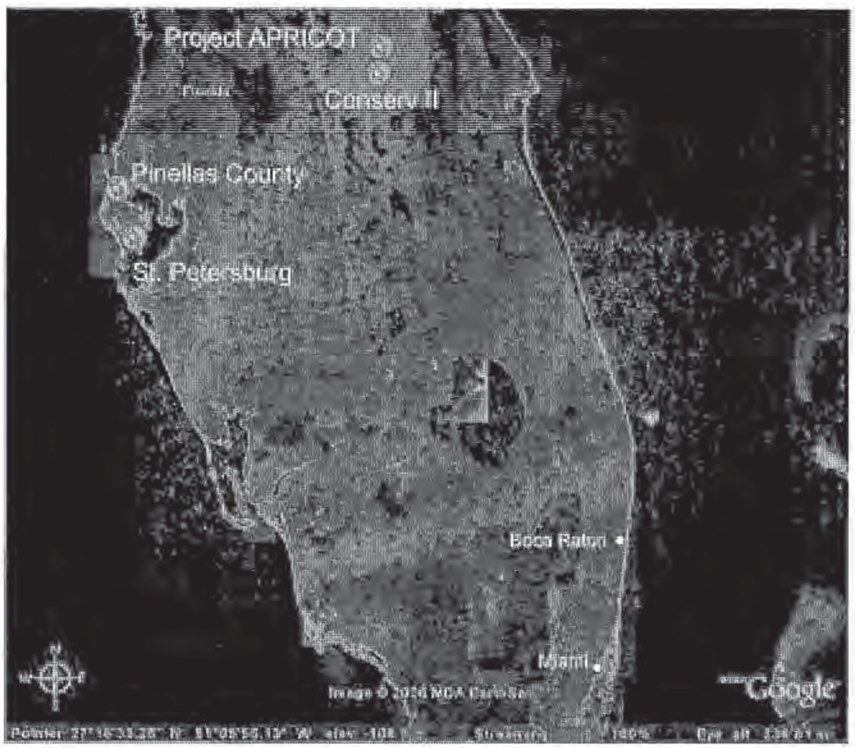

Figure 5-4. Selected Sites of Water Reuse in Florida. Photo from Google Earth.

c) Distribution system and customers. The Dunn WRF includes a 63 MG storage pond and 17 MG reject pond. Strainers are installed in the outlet line of the storage pond to remove particulate material that could clog irrigation systems. In 2002, Pinellas County had 10,400 users of reclaimed water who were supplied with an average of 14.7 MGD. Types of use included golf courses, parks, playgrounds, schools and residences.

d) Problems overcome. One problem encountered was algae growth in pipelines, due to stagnant conditions that resulted from delays in connecting to the system. This was corrected by a flushing program. Connection procedures were changed to remedy the root cause of the problem.

e) Project costs and rate structure. Reclaimed water use by residential customers is not metered. An availability charge of $7/month is mandatory and irrigation customers pay an additional $2/month for unrestricted use. Multi-family and nonresidential customers pay the availability charge plus $0.29/1000 gal.

f) Information sources. Information for the present case study was taken from Crook (2004).

5.1.11 Project APRICOT

a) Service area. Project APRICOT (A Prototype Realistic Innovative Community of Today) is located in Altamonte Springs, Florida (Fig. 5-4).

b) Reclaimed water quality control. Reclaimed water is produced by activated sludge treatment with anoxic and aerated zones for nitrogen removal, followed by alum addition, flocculation, and deep bed denitrifying filters for additional nitrogen removal. The water is then re-aerated and disinfected with chlorine prior to distribution. The capacity of this reuse system is 14.6 MGD and about 5.9 MGD of reclaimed water was reused in 2004.

c) Distribution system and customers. A dual distribution was installed throughout the city, consisting of 83 miles of 4 inch through 30 inch transmission mains, with 6,000 residential service connections and several hundred commercial connections. One elevated 0.5 MG storage tank and a surface storage/augmentation facility are included in the system in addition to two 3 MG storage tanks at the reclamation facility. Commercial and multi-family dwellings are required to connect to the system, as well as all new single-family houses constructed after January 1989. The system involves extensive efforts to get reclaimed water into existing residential subdivisions. Reclaimed water is used for household irrigation, fire mains, ornamental fountains and ponds and for toilet flushing in commercial buildings. Interestingly, one of the commercial customers is a car wash. Vegetable growing is allowed, provided that they are peeled, skinned, cooked or thermally processed before consumption, or that a drip irrigation system is used. Aboveground outside taps at individual households are prohibited, whereas belowground taps in lockable boxes are allowed. Hoses must be disconnected after use.

d) Challenges. Shortages occur in hot weather, requiring importation of sewage from other utilities for treatment to meet the demand. The City is actively managing demand by enforcing mandatory watering restrictions.

e) Education and outreach. The City has engaged in a detailed communication program with its residents. A full-time information liaison position was created within the Public Works

Department. This person issued press releases, coordinated with homeowners and condominium associations, and generally acted as a spokesperson for APRICOT. Two videos and several brochures discussing water quality issues were produced by the City.

f) Project costs and rate structure. The distribution network was constructed over a 15 year period at a cost of $40 million, all of which was funded locally. Reclaimed water supplied to commercial buildings and multi-unit dwellings is metered, whereas reclaimed water supplied to single family houses is not. Commercial users and condominiums were charged $0.82/1000 gal in 1997 (40% of potable water rates). Single family dwellings paid a flat fee of $10/month.

g) Information sources. Information for the present case study was taken from Altamonte Springs (1997), FDEP (2005b; 2005a), (Helgeson 2004; 2005b), Mantovani et al. (2001), Radcliffe (2004), York (2005) and Williams (1996).

5.1.12 St. Petersburg

a) Service area. St. Petersburg is located in the west central part of Florida (Fig. 5-4). The city is largely confined to a peninsula bounded to the west by the Gulf of Mexico and Boca Ciega Bay and to the south and east by Tampa Bay.

b) Reclaimed water quality control. Wastewater from the City of St. Petersburg is treated in four regional water reclamation facilities (WRFs) that provide coagulation, filtration and high-level disinfection in addition to secondary treatment. The total outflow from the four WRFs in 2002 was 42 MGD, of which 21 MGD was reused. The remaining water was disposed of through deep well injection into a nonpotable aquifer.

c) Distribution system and customers. Reclaimed water is distributed to more than 10,500 customers through more than 200 miles of pipelines, including 100 miles of trunk and transmission mains and 190 miles of small diameter distribution pipe. Residences using the water for landscape irrigation account for 10,000 of the customers. Other customers include six golf courses, 95 parks, 64 schools and 335 commercial areas. Reclaimed water provides fire protection via more than 300 reclaimed water hydrants.

Covered storage tanks are included in the system at each of the WRFs. Five City-owned and four privately owned booster pump stations maintain pressure in the system for all applications. Top loading, double check valve, backflow prevention assemblies are used to protect potable water services at residences. Backflow prevention provisions for commercial users are specified according to the level of risk posed by the users' activities.

d) Problems overcome. Problems that cropped up during the early years of operation of the reclaimed water system included water heater pressure relief valves, high chloride concentrations and inadequate supply. Backflow assemblies installed on residential services caused problems in plumbing systems when pressure built up by the hot water heater caused a discharge at the heater's temperature and pressure relief valve. The City overcame this problem by providing to property owners pressure relief regulating devices that fit on the water heater's external spigot and directed discharges outside rather than inside the homes.

Alternative solutions were to install expansion tanks or flushometers on the toilets. Irrigation with reclaimed water containing chloride concentrations in excess of 400 mg/L was found to damage chloride-sensitive plants. The high chlorides were due to seawater infiltration into sewers near the coast. Programs were successfully implemented to decrease chloride levels. These included an infiltration/inflow correction program, mixing high-chloride reclaimed water with low-chloride reclaimed water, and diverting reclaimed water containing very high chloride concentrations to the deep injection wells. Shortages of reclaimed water occurred during the dry spring months when wastewater flows tended to be low, whereas irrigation demands were highest. Installation of more storage has been marginally successful in alleviating this problem.

e) Education and outreach. Public forums that address water quality issues, booklets and videos on water conservation, taped television messages broadcast weekly, a Web site with links to water conservation information, annual public recognition awards, and community events promoting water reuse and conservation have been used for adult education. Programs for youth education on water conservation have been created for use in schools and youth agencies.

f) Project costs and rate structure. A voluntary assessment program allows residential customers pay for the cost of extending distribution lines to serve them. This cost typically ranges from $500 to $1,200 per customer. The connection fees for a residence consist of a $180 tapping fee and $115 for a backflow prevention device on the potable water line. A charge of $11.36 is made for the first acre-ft/month ($0.035/1000 gal), with $6.51/acre-ft ($0.02/1000 gal) charged for additional water use in the same month. Not all commercial customers are metered. Metered commercial customers pay $0.33/1000 gal.

g) Information sources. Information for the present case study was taken from Crook (2004).

5.1.13 Water Conserv II

a) Service area. The Water Conserv II project consists of a network of rapid infiltration basins and irrigated agricultural land 20 miles west of Orlando, Florida (Fig. 5-4).

b) Reclaimed water quality control. Reclaimed water is provided by the City of Orlando Water Conserv II Water Reclamation Facility and the Orange County South Regional Water Reclamation Facility. They provide secondary treatment, nitrogen removal, filtration, and high level disinfection. Reclaimed water total suspended solids cannot exceed 5.0 mg/L in a single sample. The high level disinfection standard mandates no detectable fecal coliforms in at least 75% of samples in any 30-day period and no more than 25 fecal coliforms/100 mL at any time.

c) Distribution system and customers. The distribution system consists of 21 miles of transmission piping that links two water reclamation facilities to a distribution center. Reclaimed water is transported from the distribution center to 76 agricultural and commercial customers through a 49 mile pipeline network that can handle up to 75 MGD. The reclaimed water that is not used for irrigation is distributed to rapid infiltration basins for groundwater recharge. The rapid infiltration basin system consists of eight sites with 72 basins, taking up

3,725 acres. The project reuse capacity is 68 MGD, with the rapid infiltration basins accounting for 22 MGD. About 20 MGD of reclaimed water was used for irrigation and 16.7 MGD was used for groundwater recharge in 2003. The irrigated land includes 10,035 acres of citrus, 7 foliage and landscape nurseries, 2 tree farms, 3 ferneries, and the Orange County National Golf Center.

d) Problems overcome. The project began operations in 1986. Severe freezes in the 1980s put several growers out of business and encouraged others to move, decreasing the acreage of orange groves served. Research carried out in parallel with the project has shown that total juice production from the oranges grown on project land is as high as oranges from conventionally irrigated land, tree condition is at least as good as in groves irrigated with well water, and soil pH is maintained in a favorable range without lime addition, as required in groves irrigated with well water.

e) Project costs and rate structure. The capital costs of the reuse distribution system total \$278M and the current annual operating budget is \$4.8M. The U.S. EPA provided \$100M, with the rest coming from the City of Orlando and Orange County, Florida. Reclaimed water is provided at no cost to orange growers. This provision—extending for 20 years from the project startup—was included in the original project agreement to encourage participation by growers. Charges to residential and commercial users are \$0.84 and \$0.70 per 1000 gal, respectively. Residential users also pay \$3.14 monthly per connection.

f) Future plans. The project reuse capacity is slated to expand to 81 MGD, of which 53 MGD is planned for irrigation and the balance for groundwater recharge. New commercial customers are anticipated to include a large sand mining operation, an additional golf course, residential irrigation, and a major regional/municipal interconnect for landscape irrigation.

g) Information sources. Information for the present case study was taken from Crook (2004), Cross (Cross undated), and FDEP (2005b).

5.2 Experience of Large Utilities outside the U.S.

Worldwide, water reuse is becoming an increasingly common component of water resources planning due to due to limited opportunities for conventional water supply development and increasing costs of wastewater disposal (Williams 1996). The greatest water reuse occurs in regions suffering water scarcity, such as the Middle East and Australia, or in densely populated regions with severe restrictions on disposal of treated wastewater effluents, such as England and Germany (Marsalek et al. 2002) and Japan (Ogoshi et al. 2001). In this section, case studies of water reuse in Australia and Singapore are presented, providing examples of nonpotable and indirect potable reuse.

5.2.1 Rouse Hill, Australia

a) Service area. The Rouse Hill Development Area northwest of Sidney will eventually accommodate some 300,000 people (Fig. 5-5). The development incorporates a dual distribution system that supplies flush water for indoor toilets as well as water for landscape irrigation. Reclaimed water is also used for fire protection, allowing the potable water mains to be reduced in size. The number of homes serviced as of 2004 was 12,000.

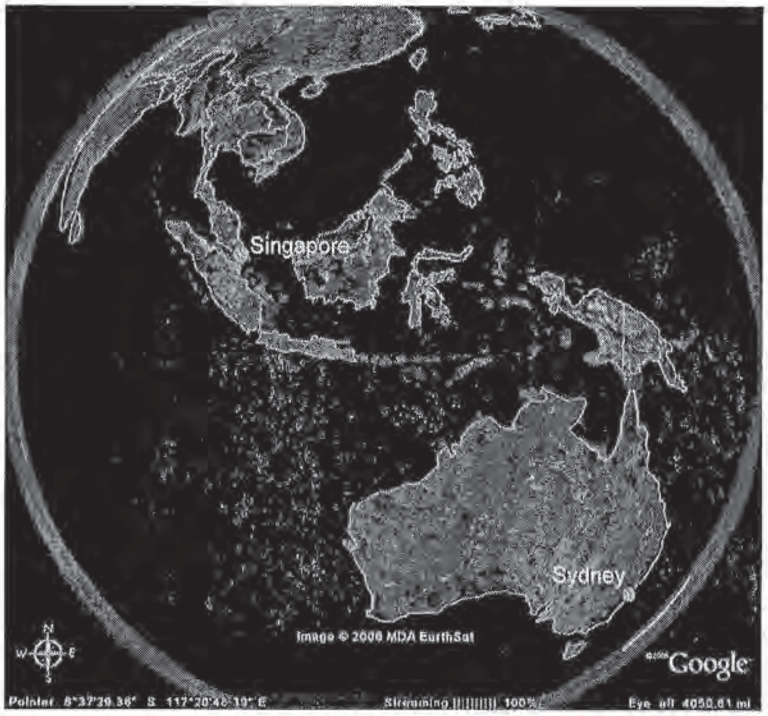

Figure 5-5. Selected Sites of Water Reuse outside the U.S. Photo from Google Earth.

b) Reclaimed water quality control. Reclaimed water is supplied by the Rouse Hill Sewage Treatment Plant, which can treat 4.4ML/d (1.2 MGD) for reuse by a treatment train consisting of activated sludge with biological nitrogen and phosphorus removal, coagulation and flocculation with alum addition, tertiary settling, filtration, ozonation, strainers, microfiltration and superchlorination. Microbiological water quality limits for reclaimed water are 1 fecal coliform/100 mL, 25 total coliforms/100 mL, 2 viruses/50 L, and 1 parasite/50 L. Limits are also placed on turbidity (2 NTU geometric mean; 5 NTU in 95% of samples) and color (15 TCU).

c) Distribution system and customers. The reclaimed water is pumped from the sewage treatment plant to three 2 ML (0.5 MG) elevated reservoirs, from which it flows through 34 km (21 miles) of distribution network to the homes. Each reservoir is equipped with dechlorination facilities to ensure that the chlorine residual at the consumers does not exceed 0.5 mg/L.

d) Problems overcome. The ozonation process has been unreliable. Consequently, microfiltration is relied upon for parasite removal and superchlorination is used to back up the ozonation process. Many errors were detected in the plumbing work done by private contractors between the Sydney Water main and the final house fittings. Training programs have been developed to assist plumbers and sales staff understand their roles in relation to public health. It is recognized that an ongoing effort will be needed at Rouse Hill to educate customers, as well as plumbers, about cross connection control. Complicating this issue are numerous differences between the National Plumbing and Drainage Code and State-based regulations.

e) Education and outreach. Research indicates that residents are proud of the Rouse Hill system and feel that they are helping to pave the way of future water management.

f) Project costs and rate structure. The capital cost for Stage 1 infrastructure was \$285M (Australian), of which \$35M was associated with the sewage treatment plant and \$22M with the reclaimed water distribution system. Charges for reclaimed water in Australian currency are \$0.28/kL, compared to \$0.98/kL for potable water. The modest charge for reclaimed water has encouraged consumption. In the summers between January 2001 and December 2002, Rouse Hill total consumption was 20% above the Sidney average. The production cost for reclaimed water is estimated at \$3–4/kL when the Rouse Hill system is fully operational.

g) Information sources. Information for the present case study was taken from Law (1996) and Radcliffe (2004).

5.2.2 Singapore

a) Reclaimed water quality control. A demonstration facility was operated at the Bedok Sewage Treatment Plant for two years, beginning in the year 2000 (Fig. 5-5). The demonstration facility included two parallel 5 ML/d (MGD) reverse osmosis trains, each fitted with thin film aromatic polyamide composite membranes configured for 80-85% recovery in a three-stage array. The UV system at this plant consisted of three UV units in series. Experience from the 24-month sampling, analytical testing and monitoring program showed that high turbidity (> 10 NTU) in secondary effluent has a deleterious impact on the performance of microfiltration. Inflows of tidal seawater into the sewer system through leakage ultimately resulted in reduced performance of the reverse osmosis component of the plant. Biological fouling of the reverse osmosis membranes reduced their effectiveness, but free chlorine could not be used to combat fouling because of deleterious effect on the membranes. In general, biological and other forms of fouling increased operating pressures and the required frequency of cleaning.

Three water reclamation plants are in use. These are the Bedok and Kranji Water Reclamation Plants, which were commissioned at the end of 2002, and the Seletar Water Reclamation Plant was commissioned in January 2004. The total capacity of the three water reclamation facilites is 92,000 m^3/d (20 MGD).

Effluent from secondary treatment is processed by microfiltration, reverse osmosis and UV disinfection. The reclaimed water meets all U.S. EPA and WHO primary and secondary standards for drinking water. It has better clarity, lower color, and lower particle content than Singapore's raw water sources (rivers and reservoirs) and is equivalent in these quality parameters to the tap water currently supplied in the city. The dissolved organic matter concentration in the reclaimed water is substantially lower that that in the tap water. Typical water quality parameter values for the reclaimed water are at or below 5 NTU turbidity, 100 mg/L total dissolved solids, and 5 Hazen units of color. Total coliforms and enterovirus are undetectable.

b) Nonpotable and indirect potable reuse. Reclaimed water from the Bedok and Kranji Water Reclamation Plants is supplied to wafer fabrication plants at Woodlands and Tampines/Pasir Ris and to other industries for nonpotable use. The Seletar Water Reclamation Plant supplies reclaimed water to a wafer fabrication plant at Ang Mo Kio. Singapore's goal is to increase use of reclaimed water for nonpotable applications to at least 15% of the total water demand by the year 2010.

The Public Utilities Board has begun adding 3 MGD of reclaimed water (1% of total daily water consumption) to the raw water reservoirs. The Board has a goal of increasing this amount to 2.5% of daily water consumption by 2011.

c) Studies. A review of the two-year demonstration study was carried out by an expert panel. It found that the plant operated at 80-82% recovery, required 0.7-0.9 kWh/m^3 of electrical energy, and achieved over 7 log (99.99999%) reduction of microorganisms. The panel concluded that the reclaimed water is suitable for human consumption and can be reliably produced. It recommended that the Singapore Government consider use of the reclaimed water to supplement the existing water supply. A health effects study was ongoing at the time the expert panel report was written. The study seeks to evaluate short and long term health effects on mice and fish. In addition, the effect of the reclaimed water on reproduction and development of the fish is being investigated. Preliminary results indicate the absence of a carcinogenic effect on the mice and fish and absence of reproductive and developmental effects on the fish.

d) Outreach. The Public Utilities Board coined the term "NEWater" for the high quality reclaimed water that is produced and built a NEWater Visitor Center at the site of the demonstration facility to inform the public about the need for water reuse, the rigorous treatment sequence applied for water reclamation, and the excellent quality of the product. Interactive computer, video and electronic presentations are emphasized in order to appeal to young Singaporeans.

e) Information sources. Information for the present case study was taken from Macpherson (2003), Ong (2002), PUB (undated) and Radcliffe (2004).

5.3 Comparisons between Case Studies

Key characteristics of the nonpotable reuse applications discussed in this chapter are compared in Table 5-1. The case studies are from California, Texas, Florida, Australia and Singapore. Six of the systems have in excess of 3,000 connections. The size of the distribution systems ranges from 5 to 300 miles and delivered flow ranges from 6 to 118 MGD. None of the nonpotable reuse applications has reported public health impacts. Challenges in system management include more frequent system cleaning relative to potable water distribution systems and high salinity relative to crop tolerances. Shortages of reclaimed water during warm weather were cited in several cases, attesting to the popularity of the delivered product. Every system has invested efforts at public education, both in the planning stages and continuing after the system is placed online.

Key characteristics of the systems for groundwater recharge to potable aquifers and indirect potable reuse that were discussed in this chapter are summarized in Table 5-2. The water reclamation sequence for groundwater recharge by direct injection and indirect potable reuse by supplementation of surface water supplies includes secondary treatment, lime clarification and filtration or membrane filtration, reverse osmosis, and UV disinfection. In the California systems, advanced oxidation is included at the disinfection stage. A sequence consisting of secondary treatment, nitrogen removal, filtration and high-level disinfection is applied for reclamation of water that is subsequently allowed to percolate through the vadose zone to underlying groundwater in the Montebello Forebay. All health effects studies have concluded that ingesting reclaimed water poses no additional risk to consumers. Controlling concentrations of chemicals of concern in reclaimed water was the main problem cited in these systems.

5.4 Satellite Water Reclamation Systems in the U.S. and Australia

5.4.1 Introduction

Regional wastewater management systems have become the norm in the cities of industrialized countries due to their success in protecting public health (Fane and Fane 2005). Regional systems also tend to be more cost-effective than distributed systems due to economies of scale when reuse is not included. However, regional systems may be more expensive if reuse is included because the reclaimed water needs to be returned to the original source areas over longer distances. The treatment plant in a regional collection system is typically located at the lower end of the system, far removed from many potential users of reclaimed water. Reclaimed water distribution costs can be reduced by integrating satellite facilities for water reclamation into regional systems (Butler and MacCormick 1996). Satellite facilities withdraw wastewater from a sewer, reclaim the liquid portion, and return the solids to the sewer (Okun 2000). They maintain economies of scale for biosolids management, since the biosolids are still processed in a regional facility. Satellite facilities lessen the hydraulic load on the regional treatment plant, thus delaying or ameliorating the need for capacity upgrades. They can also achieve higher qualities of reclaimed water. For example, wastewater chloride concentrations in coastal areas impacted by seawater intrusion tend to be high because of infiltration and inflow of salty groundwater. Wastewater from upper portions of the sewerage, where local groundwater is less impacted by saltwater intrusion, can serve as a better starting point for water reclamation.

A typical satellite facility is shown in Figure 5-6. Wastewater is withdrawn from the sewer and is treated by a series of unit processes to achieve requisite water quality, including biological treatment through a suspended growth process such as activated sludge. Primary settling is generally included to decrease aeration requirements and reduce the size of the biological treatment unit. After separation of activated sludge from mixed liquor in a final settling tank, the effluent is coagulated, filtered and disinfected. Chlorine may be added upstream of the filter in order to prevent attached growth in the filter media. Particulate matter removed in the treatment process, including primary and waste activated sludge, is returned to the sewer. The reclaimed water produced by the indicated sequence of treatment processes would meet the standards for unrestricted public access reuse.

Table 5-1. Comparison of Nonpotable Reuse Case Studies

Project	Locale	Flow (MGD)	Dist. sys. size (miles)	No. of connections	Status	Costs/Rate structure
Green Acres	Calif.	6.9	32	Wholesale provider	Demand to increase to 7.9 MGD	$49M project cost / $0.9M annual operations and maintenance
Irvine Ranch Water District	Calif.	11	300	3,400	Expanding storage and treatment capacity	$6.6M annual operations and maintenance / Base reclaimed water rate is $0.82/1000 gal (90% of domestic water rate)
Monterey County	Calif.	20	46	111	Aquifer storage and recovery to be added	$75M construction cost / $0.90/1000 gal delivery cost / revenue obtained from land assessments ($233/acre/yr) and delivery charge ($0.05/1000 gal)
San Diego	Calif.	22.5	79	549	South Bay Distribution System awaiting connections to customers	Reclaimed water price is $0.80/hundred cubic feet / Increase in price projected for 2006
West Basin Water Management District	Calif.	118	5	3+	Adding 10 MGD	Price charged is 20–40% less than imported water, which sells for $510/acre-ft
Phoenix	Ariz.	71	- -	- -	Planning increase to 179 MGD	- -
San Antonio Water System	Texas	50	75	45	67 MGD cap committed	$124M capital cost / Price charged is $0.98/1000 gal (49% of potable water rate) / $0.25/1000 gal charged if withdrawal rights to local aquifer are given up

Table 5-1 (continued)

Project	Locale	Flow (MGD)	Dist. sys. size (miles)	No. of connections	Status	Costs/Rate structure
Altamonte Springs	Florida	5.7	83	6,000+	Actively managing demand with mandatory watering restrictions	$40M capital cost for distribution system / $0.82/1000 gal charged to commercial users and condominiums / Single family dwellings pay $10/mo
Pinellas County	Florida	14.7	- -	10,400	Expanding	Fees include an availability charge of $7/mo / Multifamily and nonresidential customers pay an additional $0.29/1000 gal
Project APRICOT	Florida	5.9	83	6,000+	Shortages occurring in warm weather	$40 capital cost / Commercial users and multi-unit dwelling paid $0.82/1000 gal in 1997 (40% of potable water rates) / Single family dwellings paid $10/month
St. Petersburg	Florida	21	200	10,500	Need to develop additional potable water supply has been postponed	Metered commercial customers pay $0.33/1000 gal / Residential customers pay $0.035/1000 gal for the first acre-ft and $0.02/1000 gal thereafter / $500–1,200 connection fee
Water Conserv II	Florida	37	70	76	Reuse capacity to expand from 68 to 81 MGD	$278M capital cost and $4.8M annual operating budget / Growers currently pay no fee / Residential users pay $0.84/1000 gal plus $3.14/connection/mo / Commercial users pay $0.70/1000 gal

Table 5-1 (continued)

Project	Locale	Flow (MGD)	Dist. sys. size (miles)	No. of connections	Status	Costs/Rate structure
Rouse Hill	Sydney, Australia	1.2 (current capacity)	21	12,000	Will eventually serve 300,000 people	\$22M (Aus) capital cost for reclaimed water distribution system / Users pay \$0.28/kL (29% of potable water fee)
Singapore	--	--	--	3+	Intend to supply at least 15% (45 MGD) of total water demand by 2010	--

Table 5-2. Comparison of Groundwater Recharge and Indirect Potable Reuse Case Studies

Project	Location	Flow (MGD)	Treatment	Application method	Comments	Project Costs/Benefits
Montebello Forebay	Calif.	6	Secondary, nitrogen removal, filtration, disinfection	Infiltration	4 studies concluded no adverse health effects	Provides new water supply equivalent to demands of 250,000 persons / Saves \$12M/yr in water purchases
Orange County Water Factory 21	Calif.	15	Secondary, lime clarification, filtration, reverse osmosis, H_2O_2/UV oxidation/disinfection	Injection to potable aquifer	NDMA reduced to acceptable levels by applying RO plus UV/advanced oxidation	Both of the Orange County groundwater recharge systems protect against seawater intrusion and replenish groundwater
Orange Country Groundwater Replenishment System	Calif.	62.5	Secondary, membrane filtration, reverse osmosis, H_2O_2/UV oxidation/disinfection	Injection to potable aquifer	Under construction	\$454M capital cost and \$22M/yr operations and maintenance / Partial funding from \$92.5M in grants and \$145M in loans
Singapore	- -	3	Secondary, microfiltration, reverse osmosis, UV disinfection	Add to raw water reservoirs	2-yr water quality demonstration completed; parallel epidemiological study in progress	0.7-0.9 kWh/m^3

The potential for substituting compact membrane bioreactors for the aeration basin, final settling tank and filter as shown above has generated considerable interest on the part of water and wastewater utilities (Farmhand Foundation 2004; Wallis-Lage et al. 2004; Cupps and Morris 2005). The small footprint, automation capability, and "double" disinfection (once by the membrane and once by the disinfection unit) of such facilities make them a viable candidate for neighborhood scale water reclamation (Butler and MacCormick 1996; Fane and Fane 2005)

As the present review shows, satellite water reclamation facilities are well established, having been in use for over four decades. The facilities are diverse in size, with the largest producing 35 MGD of reclaimed water and the smallest treating 0.01 MGD. Examples are drawn from systems in the U.S. and Australia, where interest in this technology is highest.

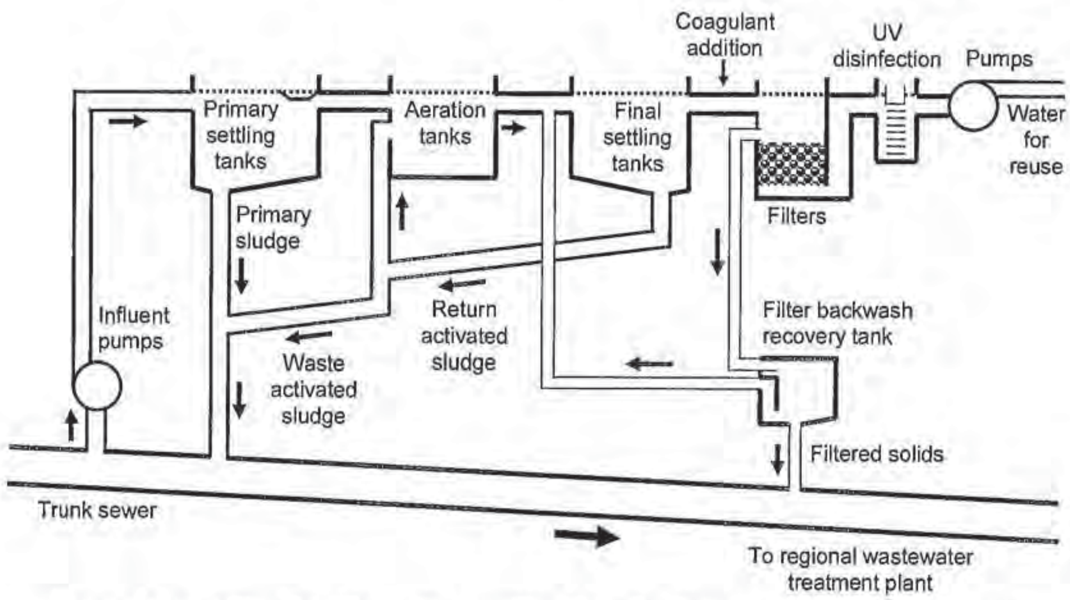

Figure 5-6. Profile of an Illustrative Satellite Water Reclamation Facility. Redrawn and modified from LACSD (undated)

5.4.2 Los Angeles and Orange Counties

Four satellite water reclamation systems are located in Los Angeles County and Orange County, California (Fig. 5-7). Two are operated by the Sanitation Districts of Los Angeles County, one by the City of Los Angeles, and one by the Irvine Ranch Water District in conjunction with the Orange County Sanitation District.

a) Sanitation Districts of Los Angeles County. The largest system of satellite water reclamation systems belongs to the Sanitation Districts of Los Angeles. It includes eight satellite facilities that together produce an average 73 MGD of reclaimed water (LACSD undated). The system spans a distance of 42 miles from the Joint Water Pollution Control Plant to the La Canada Water Reclamation Plant (WRP). Wastewater solids returned to the sewer from each of the satellite plants travel to the Joint Water Pollution Control Plant. Here, the solids are removed from the wastewater, anaerobically digested and dewatered.

Methane from anaerobic sludge digestion fuels a combined cycle power plant (gas turbines followed by boilers and a steam turbine) that provides enough electricity to make the plant self sufficient with respect to energy requirements.

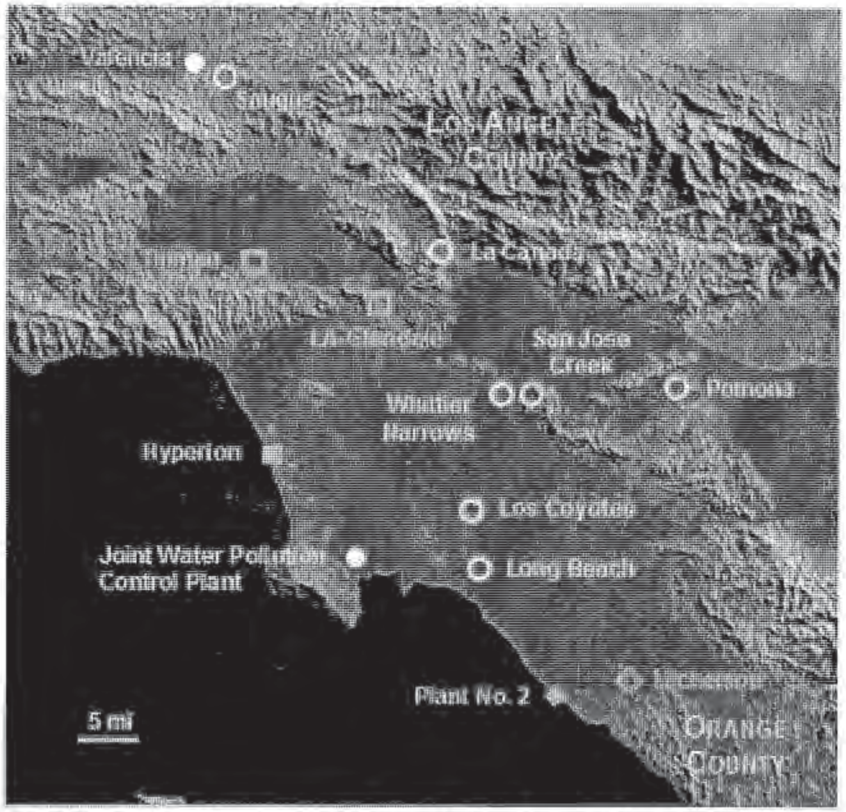

Figure 5-7. Satellite Water Reclamation Systems in Los Angeles County and Orange County, California (IRWD 2006; City of Los Angeles undated; LACSD undated). Open points denote satellite facilities and solid points represent regional treatment plants. Facilities operated by the Los Angeles County Sanitation Districts are represented by circles and facilities operated by the City of Los Angeles are represented by squares. The Michelson Water Reclamation Plant is operated by the Irvine Ranch Water District and Treatment Plant No. 2 is operated by the Orange County Sanitation District. Facility locations are shown on a digital relief map of California (USGS 2002).

The system includes the Whittier Narrows WRP, which is the pioneering satellite facility in the U.S., beginning operations in 1962. The facility currently produces 15 MGD of reclaimed water for groundwater recharge into the Rio Hondo and San Gabriel Spreading Grounds as part of the Montebellow Forebay Project. Reclaimed water is also used for irrigation at an adjacent nursery. The process train of the Whittier Narrows WRP is typical of the satellite facilities operated by the Sanitation Districts of Los Angeles County, consisting of primary settling with optional coagulation, activated sludge with polymer addition to the final settling tanks if needed, alum coagulation and filtration, and chlorination before and after filtration, with 90 minutes of chlorine contact time after filtration (CMHC 2006; LACSD undated). Wastewater solids, including primary sludge, waste activated sludge, and filtered solids are returned to the sewer. Reclaimed water that will be discharged to surface water is dechlorinated before leaving the plant.

Two additional satellite facilities produce reclaimed water for groundwater recharge as part of the Montebellow Forebay Project. The San Jose Creek WRP is the largest of the satellite facilities, with a capacity of 100 MGD. It produces 35 MGD of reclaimed water for reuse at 17 different sites, including irrigation of parks, schools and greenbelts, as well as groundwater recharge. The Pomona WRP produces 8 MGD of reclaimed water that is reused at over 90 different sites. The remainder of the reclaimed water is discharged into the San Jose Creek channel, where it makes its way to the unlined portion of the San Gabriel River and percolates into the groundwater.

The 5 MGD Los Coyotes WRP, along with the San Jose Creek WRP, provide reclaimed water for the Century and Rio Hondo Reclaimed Water Distribution Systems. These systems comprise a looped network of 65 miles of dedicated pipelines that distributes water to a number of municipal and private water purveyors. The reuse distribution system was developed by the Central Basin Municipal Water District in cooperation with the Sanitation Districts of Los Angeles County and 29 other public agencies and private entities, and delivers up to 22,000 acre-ft (20 MG) annually.

The La Canada WRP produces 0.2 MGD of reclaimed water for golf course irrigation. The Long Beach WRP, which treats a total flow of 25 MGD, produces 5 MGD of reclaimed water for reuse at over 40 sites, including repressurization of oil-bearing strata, as well as irrigation of schools, golf courses, parks and greenfields.

The second satellite water reclamation system operated by the Sanitation Districts of Los Angeles County is located in the northern part of the county and consists of the Saugus WRP, a satellite facility, and the Valencia WRP. The Saugus WRP incorporates biological nitrogen removal in its process train. Primary sludge from the Saugus WRP is returned to the sewer and flows 3 miles to the Valencia WRP, where it is removed, anaerobically digested, and thickened. Waste activated sludge from the Saugus WRP is pumped through a force main to air flotation tanks at the Valencia WRP for thickening prior to anaerobic digestion. Methane produced by sludge digestion is used as for plant fuel.

The Saugus WRP produces 7 MGD of reclaimed water for reuse applications. Water not reused is dechlorinated and discharged to the Santa Clara River.

b) City of Los Angeles. The City of Los Angeles operates two satellite water reclamation facilities (City of Los Angeles undated). The Donald C. Tillman WRP, northernmost of the two facilities, has a capacity of 80 MGD. Its sequence of unit processes includes primary settling, activated sludge with nitrification and denitrification, coagulation and filtration, and chlorination. Grit, screenings, primary and waste activated sludge, and filter backwash are returned to the sewer and travel 29 miles to the Hyperion Treatment Plant. Sludge is removed and anaerobically digested at the Hyperion Treatment Plant. Methane from digestion is piped to a nearby power plant in exchange for reduced electricity rates.

Landscaped Japanese gardens adjacent to the Tillman WRP are irrigated with reclaimed water from the plant. The reuse demand totals 26 MGD and includes in-plant applications and many users in the San Fernando Valley in addition to the gardens. The remainder of the reclaimed water is discharged to the Los Angeles River.

The southernmost satellite facility in the City of Los Angeles system is the LA-Glendale WRP, which treats 20 MGD of wastewater using a process train similar to that at the Tillman WRP. Solids removed in the treatment process are returned to the sewer and flow to the Hyperion Treatment Plant. Reclaimed water from the LA-Glendale WRP totaling 4.5 MGD is used for landscape irrigation, cooling water makeup, and irrigation of parks, freeway landscaping, local cemeteries and nearby golf courses. The plant is highly automated and staff can control processes from remote locations.

c) Irvine Ranch Water District/Orange County Sanitation District. The Michelson WRP is operated by the Irvine Ranch Water District and produces 11 MGD of reclaimed water (IRWD 2006). Its treatment train includes primary settling, activated sludge with nitrification and denitrification, dual media filtration, and chlorine disinfection. Primary and waste activated sludge are returned to the sewer and flow 7 miles to the Orange County Sanitation District Treatment Plant No. 2. Sludge is removed from the wastewater by primary settling at Treatment Plant No. 2, anaerobically digested, and dewatered. Methane recovered from the digesters is used to generate electricity for plant use.

Reclaimed water from the Michelson WRP is distributed through 250 miles of reclaimed water pipelines for use in landscape and agricultural irrigation as well as other applications. Excess reclaimed water is stored in several reclaimed water reservoirs and is supplied to the Orange County Sanitation District's Green Acres Project.

5.4.3 San Diego County

Two satellite water reclamation systems are operated by the Metropolitan Wastewater Department of San Diego (Fig. 5-8). The North City WRP currently treats 22.5 MGD of wastewater and has a capacity of 30 MGD (City of San Diego undated-b). The capacity for reclaimed water production is effectively 24 MGD when partial demineralization is practiced. The process train includes primary settling, activated sludge with anoxic selectors to control filamentous bacteria and anthracite coal filters. A portion of the filtrate is demineralized using an electrodialysis reversal process in order to decrease the salinity of the reclaimed water. The demineralized stream is combined with filtrate prior to chlorine disinfection. Primary and waste activated sludge are pumped 5 miles to the Metro Biosolids Center, where they are thickened, anaerobically digested, and dewatered. Methane collected from the digesters is burned at a co-generation facility that provides electricity and steam for the Metro Biosolids Center and the North City WRP. Control of the North City plant is transferred to the utility's communications center in Kearny Mesa from 12:30 am to 5:30 am each night, with an operator on call in the event of an emergency.

An average reclaimed water flow rate of 6 MGD from the North City WRP is distributed through 79 miles of pipeline, two storage tanks and two pump stations. There are 356 metered connections, including a single metered connection with the City of Poway, which serves an additional 193 customers. The single largest use of reclaimed water is landscape irrigation. Additional uses include industrial processes, cooling towers, soil compaction, dust suppression, circuit board washing and urinal flushing. Excess reclaimed water is conveyed to the Point Loma Wastewater Treatment Plant for disposal through ocean outfall.

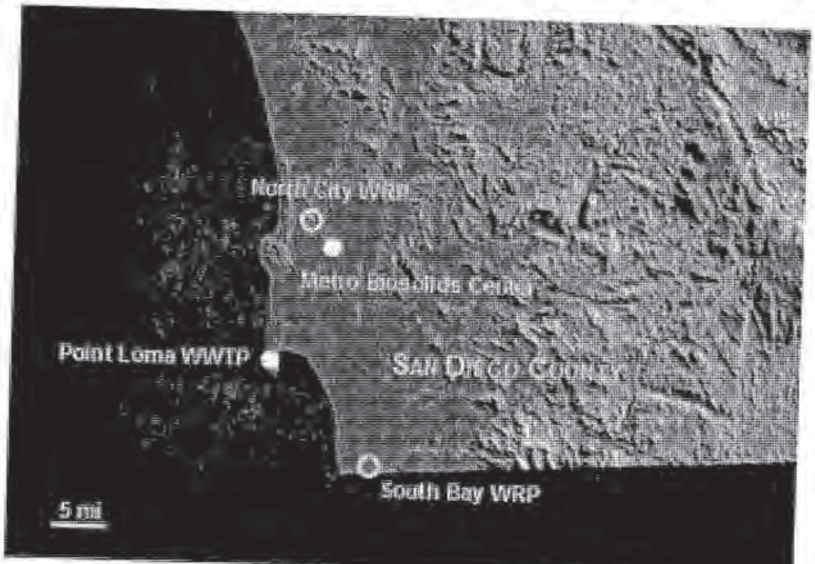

Figure 5-8. Satellite Water Reclamation Systems in San Diego County, California (City of San Diego undated-b; City of San Diego undated-e; City of San Diego undated-c; City of San Diego undated-a). Open points denote satellite facilities and solid points represent regional treatment plants. Facility locations are shown on a digital relief map of California (USGS 2002).

The treatment sequence of the South Bay WRP is a similar to that of the North City WRP, except that disinfection is accomplished through ultraviolet irradiation instead of chlorination and there is no process for demineralization. Primary and waste activated sludge is returned to the sewer and flows 22 miles to the Point Loma Wastewater Treatment Plant, where the sludge is removed, anaerobically digested, and then pumped 17 miles to the Metro Biosolids Center for dewatering.

The South Bay WRP has a capacity of 15 MGD and treats 5–6 MGD. Currently, 1.2 MGD of reclaimed water is applied for beneficial reuse, including 0.7 MGD supplied to the adjacent International Boundary and Water Commission Wastewater Treatment Plant. Total planned reuse with completion of ongoing projects is 7 MGD. Excess reclaimed water is piped to the ocean outfall at the Point Loma WWTP. The South Bay WRP is staffed from 6:00 am to 4:00 pm Monday through Friday. Plant control is accomplished from the utility's communications center outside these hours.

5.4.4 Thurston County

The Cities of Lacey, Olympia and Tumwater, Washington, together with Thurston County, formed the LOTT Alliance to plan for water and wastewater management (Cupps and Morris

2005). The Alliance's plan calls for three satellite water reclamation facilities to be completed over a 30-year period (Fig. 5-9). Construction of the first satellite facility, the Martin Way Reclaimed Water Plant (RWP), began in 2004 and startup is scheduled for mid-2006. Its treatment sequence includes grit removal, a membrane bioreactor using hollow fiber membranes, and chlorine disinfection (DE 2006). The quality of water produced will meet Class A standards, which include limits of 2 NTU for the monthly average operating turbidity, 5 NTU for the maximum turbidity at any time, 2.2 per 100 mL for the 7-day median total coliform concentration, and 23 per 100 mL for a single sample concentration of total coliforms. In addition, nitrate N and nitrite N are limited to 10 mg/L and 1 mg/L, respectively, for groundwater recharge.

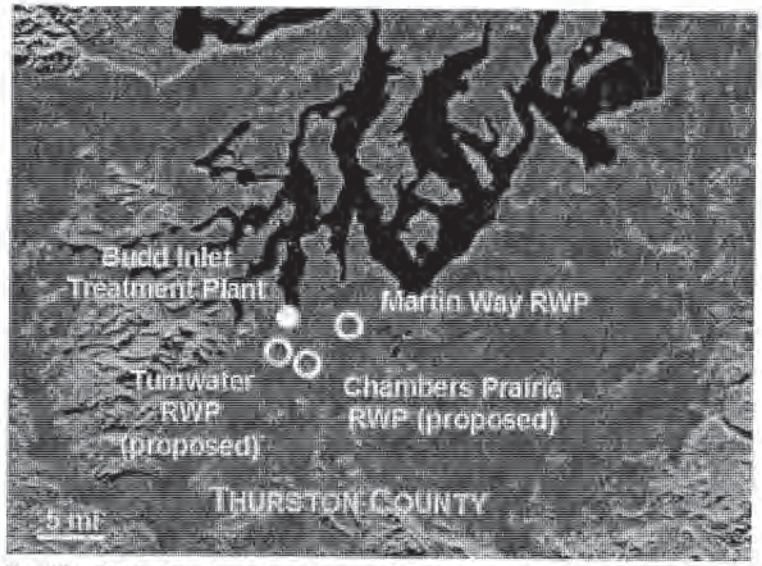

Figure 5-9. Satellite Water Reclamation Systems in Thurston County, Washington (LOTT Alliance 2005). Open points denote satellite facilities and the solid point represents the regional treatment plant. Facility locations are shown on a digital relief map of Washington State (USGS 2002).

The plant has an initial capacity is 2.0 MGD and is expandable to 5 MGD. Waste activated sludge will be returned to the Martin Way Pump Station and pumped 5 miles to the Budd Inlet Wastewater Treatment Plant, where it will be removed, thickened, anaerobically digested, and dewatered. Methane gas collected from the digesters is used as fuel for an engine generator that produces electricity and heat for the plant.

The $18.5 Martin Way RWP is designed to blend in with its neighborhood. Much of the plant equipment will be placed below a ground-level, flat roof that is covered with soil and native vegetation. Reclaimed water will be piped 3 miles to the $6.2 million Hawks Prairie Reclaimed Water Park, also under construction. The park includes 20 acres of constructed wetlands and groundwater recharge basins. Some of the reclaimed water will be used to irrigate parks and to supply commercial and industrial customers in the city of Lacey. The total cost of the satellite water reclamation facility, reclaimed water pipeline, and water park is $30 million (Dodge 2005).

The LOTT Alliance is currently acquiring land for groundwater recharge sites associated with two more satellite water reclamation facilities, one to be constructed in the Chambers Prairie area beginning in 2023 and the other to be constructed in Tumwater sometime after 2025. Each of these plants would have an initial capacity of 1 MGD and be capable of expansion to 5 MGD.

5.4.5 Clark County

Two satellite water reclamation systems are located in the Las Vegas area (Fig. 5-10). The Desert Breeze Water Resource Center (WRC) is a satellite facility operated by Clark County (Grinnell 2006; Clark County Water Reclamation District undated), which is responsible for treating wastewater from unincorporated parts of Clark County within the Las Vegas Valley, including most of the Las Vegas Strip. The capacity of the satellite facility is 5 MGD, expandable to 10 MGD. Available wastewater in the area limits reclaimed water production to 4.3 MGD.

The process train includes equalization, activated sludge with nitrification, final settling tanks, automatic backwash filters, UV disinfection, and hypochlorite addition for reclaimed water distribution. The tanks and most of the equipment are below ground, making the site unobtrusive to the neighborhood (Fig. 5-11). The reclaimed water meets a total coliform limit of 2.2 CFU per 100 mL on a 30-day average basis. Waste activated sludge is returned to the sewer and flows 14 miles to the Main Facility, where it is removed by primary settling, thickened, dewatered, and disposed of by landfilling.

The Desert Breeze WRC provides reclaimed water to four 18 hole golf courses and one 27 hole golf course, as well as 2 parks and 2 schools. The 2005 demand was 3.8 MGD, of which 2.7 MGD was satisfied using reclaimed water. The remainder was met using water extracted from a potable aquifer.

The City of Las Vegas operates two satellite facilities (City of Las Vegas 2005; Grinnell 2006). The larger of the two is the $37 million Durango Hills WRC, which has a capacity of 10 MGD. The process train is similar to that of the Desert Breeze WRC, with all treatment processes underground or under cover. Waste activated sludge is returned to the sewer and flows 18 miles to the Water Pollution Control Facility, where it is removed by primary settling, thickened, anaerobically digested, and dewatered. Methane collected from the anaerobic digesters is burned to heat the digesters and power some equipment, including blowers that supply air to the activated sludge process.

Reclaimed water from the Durango Hills WRC is supplied to 11 golf courses through a distribution system comprising one main pump station, a 2 MG storage reservoir, 17 miles of pipelines, two remote booster pumping stations, and four recharge wells. Reclaimed water production is limited by available wastewater flows, averaging 3.2 MGD in 2005, since the collection system is not yet built out. Excess reclaimed water is discharged to a storm drain during low demand periods.

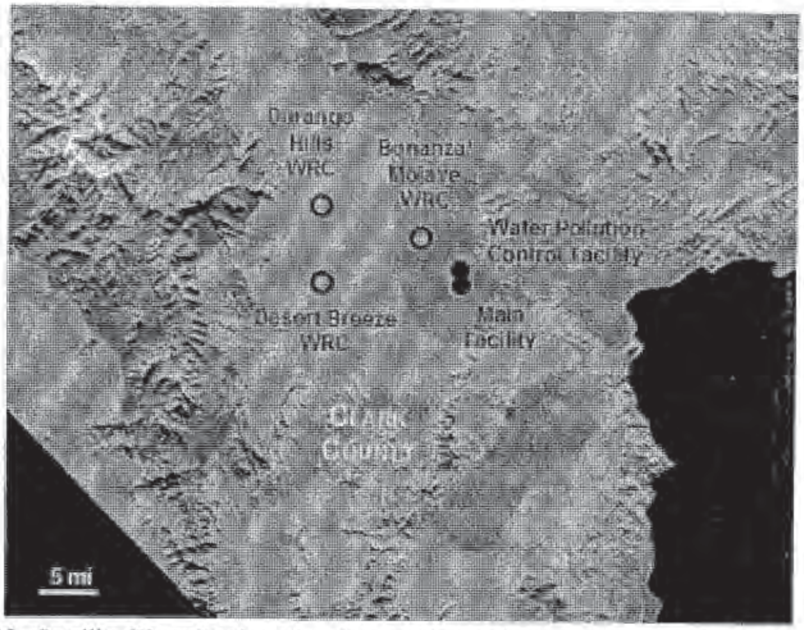

Figure 5-10. Satellite Water Reclamation Systems in Clark County, Nevada (City of Las Vegas 2005; Grinnell 2006; Clark County Water Reclamation District undated). Open points denote satellite facilities and the solid point represents the regional treatment plant. Facility locations are shown on a digital relief map of Nevada (USGS 2002).

Figure 5-11. Desert Breeze Water Resource Center (Clark County Water Reclamation District undated)

The Bonanza/Mojave WRC provides reclaimed water to a single 18 hole golf course. The facility's capacity is 1.1 MGD. The 2005 reclaimed water production averaged 0.2 MGD.

Waste activated sludge from this facility is returned to the sewer and is pumped 11 miles to the Water Pollution Control Facility.

5.4.6 Maricopa County

The Kyrene Water Reclamation Facility in Tempe, Arizona has recently been expanded to 9 MGD capacity and retrofitted with membrane technology (Zenon 2004; Nichols 2006). The facility is expected to resume operations in spring 2006. The flow treated before the upgrade was 4.5 MGD. The treatment sequence includes screening and grit removal, aerated equalization, activated sludge with nitrification and denitrification, a membrane system for separation of activated sludge from treated effluent, and UV disinfection (City of Tempe 2005). The entire process is located underground. Residual solids are returned to the sewer and flow to the 91st Avenue Wastewater Treatment Plant in Phoenix, where they are removed by primary settling, anaerobically digested, and spread on drying beds (PCA undated).

The completed Kyrene WRF will produce very high quality A+ reclaimed water suitable for a wide range of non-potable water uses in Tempe. Up to now, applications included cooling at the Salt River Project Kyrene Electrical Generating Station (1.2 MGD in 2004), irrigation use at the Tempe Ken McDonald Golf Course, and a small amount for groundwater recharge at the golf course. Excess reclaimed water is discharged to the Salt River. Reclaimed water reuse at the power plant and the golf course allow Tempe to receive surface water from the Salt River Project in exchange for reclaimed water deliveries to these sites. More extensive water reuse alternatives are being considered for the city's Reclaimed Water Master Plan, including possible replenishment of the Tempe Town Lake (Kamienski 2004).

5.4.7 Melbourne, Australia

The locations of satellite water reclamation facilities around Port Phillip Bay, Australia that are in operation or have been evaluated are shown in Figure 5-12. A 1,300 kL/d (0.34 MGD) facility on the eastern side of the bay has been in operation since 1974 (Farmhand Foundation 2004). All flow is used for irrigation. The solids removed during treatment are returned to the sewer and flow to the Eastern Treatment Plant (Melbourne Water undated).

A 30 L/d (0.01 MGD) membrane bioreactor was demonstrated at Kings Domain Gardens, 150 m from the South Yarra Main Sewer north of the bay (Mallia et al. 2003; Farmhand Foundation 2004). This unit, which was housed in a portable shipping container, has a process train consisting of a submersible grinder pump mounted directly in the channel beneath a manhole, screens with 3 mm apertures, Zenon Membrane Bioreactor containing hollow fiber membranes having a 0.04 micron nominal pore size, reverse osmosis unit containing Dow low-fouling membranes designed for brackish water, and calcium hypochlorite dosing. Solids removed during treatment were returned to the sewer and flowed to the Western Treatment Plant (Melbourne Water undated).

The unit was operated for three months. Class A water quality, which allows virtually unrestricted use of water for garden watering, closed toilet flushing, etc., was achieved even before hypochlorite dosing. A seed irrigation trial carried out in parallel with the demonstration showed no effect of the product water on the tested species.

A 35 kL/d (0.01 MGD) system that provides localized filtration of wastewater without need for biological digestion was demonstrated at Flemington Race Course in the northern bay area (Borton 2003; Waste Technologies of Australia 2006; WME 2006). The system is one-half the size of a portable shipping container (Fig. 5-13). Its process train consists of a 200 micron screen, chlorination of screened influent, microfiltration, reverse osmosis, and chlorination of reclaimed water. Solids removed in the treatment processes were returned to the sewer and flowed to the Western Treatment Plant (Melbourne Water undated).

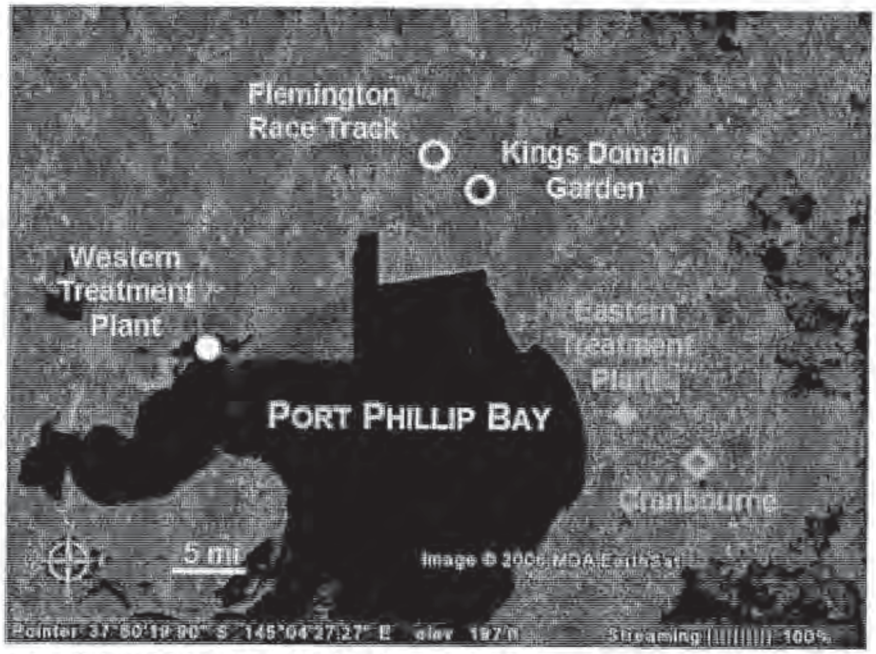

Figure 5-12. Satellite Water Reclamation Systems in Melbourne, Australia (Mallia et al. 2003; Farmhand Foundation 2004; WME 2006; Melbourne Water undated). Open points denote satellite facilities and the solid points represent regional wastewater treatment plants. Photo from Google Earth.

The membrane system produces Class A water and achieves a 7 log reduction in viruses and 6 log reduction in protozoan parasites. Cost of the water produced was estimated at $1 (Au) per 1000 L, with 20% of the cost due to energy requirements. Water from the unit was used to irrigate roses and other plants.

5.4.8 Canberra, Australia

A 300 kL/d (0.08 MGD) satellite water reclamation facility has been in operation in Southwell Park in the city of Canberra since 1995 (Butler and MacCormick 1996; Farmhand Foundation 2004; ActewAGL 2006). Reclaimed water produced by the unit is used to irrigate Southwell Park. The $2.4 million (Au) facility is housed in an odor-controlled building with a footprint of 180 sq m (1,900 sq ft) and has a process train consisting of lime assisted primary settling, fixed film reactor biological treatment with nitrification, microfiltration and hypochlorite dosing for disinfection. Its annual operating budget is

\$100,000 (Au). The solids removed during treatment are returned to the sewer and flow to the Lower Molonglo Water Quality Control Centre.

Figure 5-13. Flemington Racecourse Satellite Water Reclamation Facility (Waste Technologies of Australia 2006).

5.4.9 Summary

Satellite water reclamation facilities have been integrated into regional wastewater management systems since 1962. Most of the facilities use conventional process trains that include preliminary treatment to remove screenable materials and grit, primary settling, activated sludge, filtration, and disinfection with chlorine or UV. A few facilities with membrane bioreactors substituting for activated sludge and filtration are in operation, ranging in size from a 9 MGD plant in Tempe, Arizona to 0.01 MGD units demonstrated in Melbourne, Australia. Satellite water reclamation facilities greatly expand the potential for supplying reclaimed water to users throughout the sewer collection system at reasonable distribution costs. They also allow the continued use of regional biosolids management facilities and can improve the quality of reclaimed water over that produced at a regional water reclamation plant.

5.5 Potential for Traditional Water Reuse in Southeast Florida

Consumptive Use Permit data was obtained from the South Florida Water Management District and was used to determine the larger irrigation users who have separate permits for their water use. Attention was focused on the Consumptive Use Permit holders that are located in or near the service areas of the six wastewater districts that discharge to ocean outfalls. Analysis of data from the Consumptive Use Permits enables effective identification of such users.

All Consumptive Use Permit users were first arranged by land use. Six types of land uses were initially analyzed from the South Florida Water Management District data: golf courses, landscaped areas, agricultural areas, aquaculture areas, nurseries, and industrial uses. This study focused on golf courses and landscaped areas that constitute a relatively large proportion of the Consumptive Use Permits and tend to be located closer in distance to the wastewater treatment plants than other water-demanding activities. Industrial users, such as the Turkey Point Power Plant located in Princeton, are also attractive in the development of a reuse network. The potential industrial demand is concentrated in the two Miami-Dade wastewater districts as Consumptive Use Permit data indicate a demand of approximately 33 MGD, of which 17 MGD is located within 12 miles of the two WWTPs. However, industrial users need to be evaluated on a case by case basis due to their diverse needs and widely varied demand flow data as reported in the Consumptive Use Permit Database. Furthermore, the majority of the demand (12 MGD) is in the service area of the Miami-Dade/Central WWTP, which has saline inflow. The remaining golf and landscape areas were arranged by daily allocation. For the purposes of this study, a golf course or landscaped area was considered a "large user" if its demand was 0.05 MGD or higher. Urban users with unit demands of 0.05 MGD or more comprise 80-90% of the total Consumptive Use Permit demand.

The large users were entered into a GIS database along with the service areas of the six wastewater treatment plants that use ocean outfalls, and can be seen in Figures 5-14 through Figures 5-16. The service areas were described in reuse feasibility studies for the Boynton-Delray WWTP in Delray Beach (Brown and Caldwell 1995), the Boca Raton WWTP (Brown and Caldwell 1993), the Broward/North WWTP (Hazen and Sawyer 2004), the Hollywood WWTP (Public Utility Management and Planning Services and Hazen and Sawyer 2001), and the Miami-Dade/North and Miami-Dade/Central WWTPs (PBS&J 1992).

The large users were categorized according to their location. The first category includes users that are located within the service areas of one of the six WWTPs under consideration, with two exceptions. The Town of Davie and Cooper City in Broward County were considered part of the Hollywood WWTP service area. According to FL DEP (2002), these two areas send wastewater to the Hollywood WWTP. Similarly, Boynton Beach in Palm Beach County was included as part of the Boynton-Delray WWTP (Brown and Caldwell 1995).

The next category of large users included those lying outside these boundaries, but still within areas that could be served by traditional water reuse. Most of these outlying areas are now served by wells, but upcoming legislation could limit the availability of this water source. An area was considered as a possible annexation target for traditional water reuse provided that it did not lie within the service area of another wastewater treatment plant. The expanded service areas can be seen as part of Figures 5-14 through 5-16. Palm Beach County has several users in this outlying area that are candidates to receive reclaimed water. Broward County has fewer expansion candidates because there are several other wastewater treatment plants in this area. The service areas of Miami-Dade/North and Miami-Dade/Central WWTPs encompassed all large users.

Large users occupy 18% of the area of the Broward/North WWTP reuse district in Broward County, which consists of the defined WWTP service area plus the expanded area. Palm Beach County has the second largest proportion of large users; 13% of the reuse districts of the Boynton-Delray and Boca Raton WWTPs are occupied by large users. In contrast, only 5% of the reuse district of the Hollywood WWTP is occupied by large users. The reuse districts of the two WWTPs in Miami-Dade County that are under consideration have the lowest proportion of large users (2%).

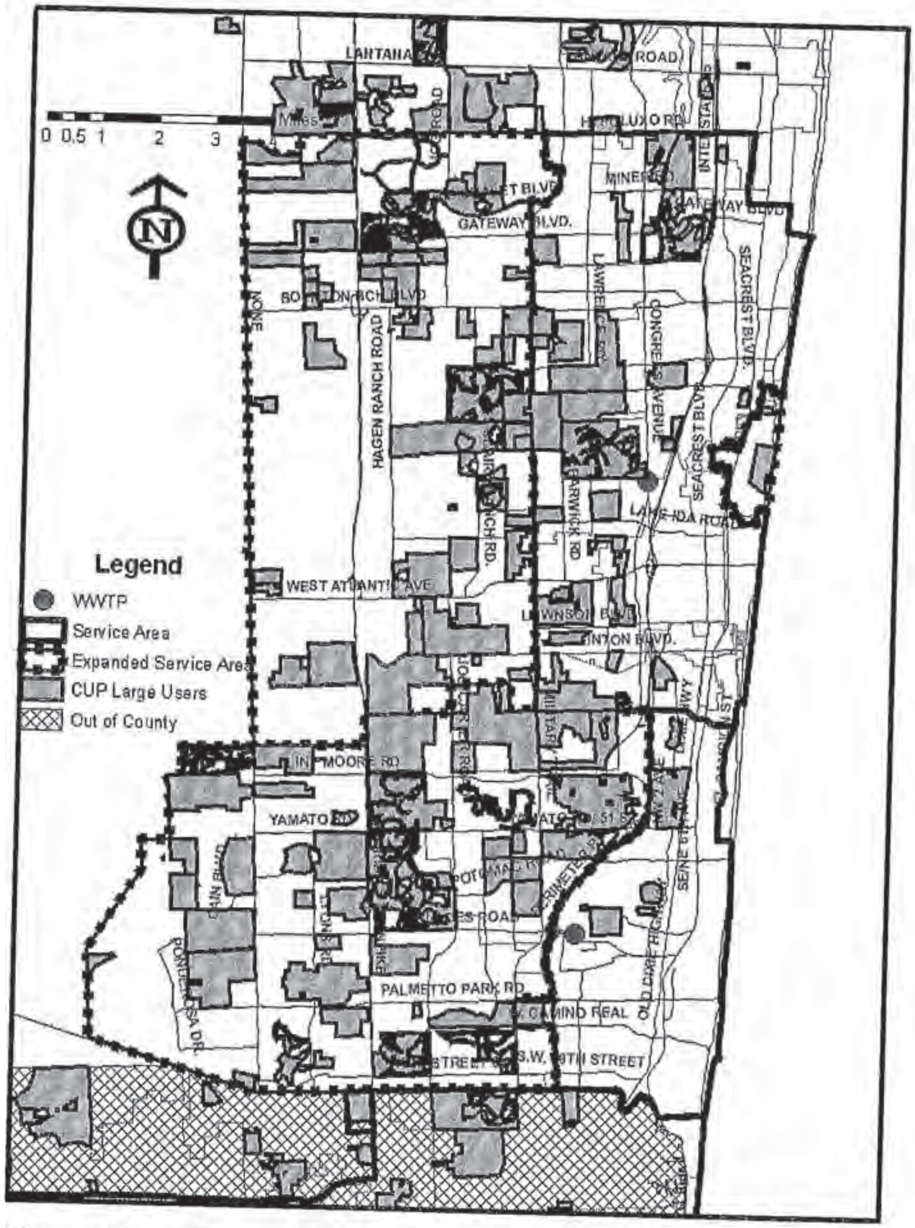

Figure 5-14. Palm Beach County Large Water Users with Separate Permits

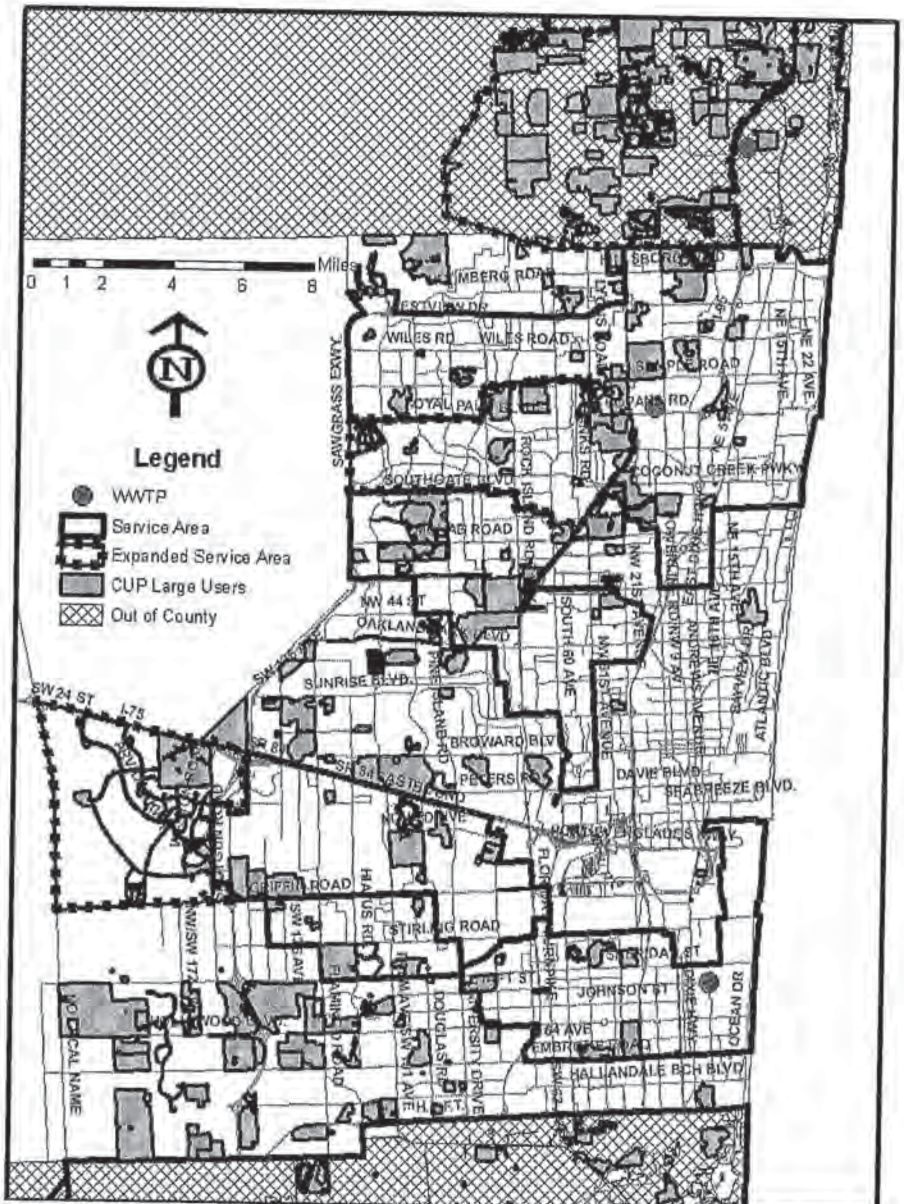

Figure 5-15. Broward County Large Water Users with Separate Permits

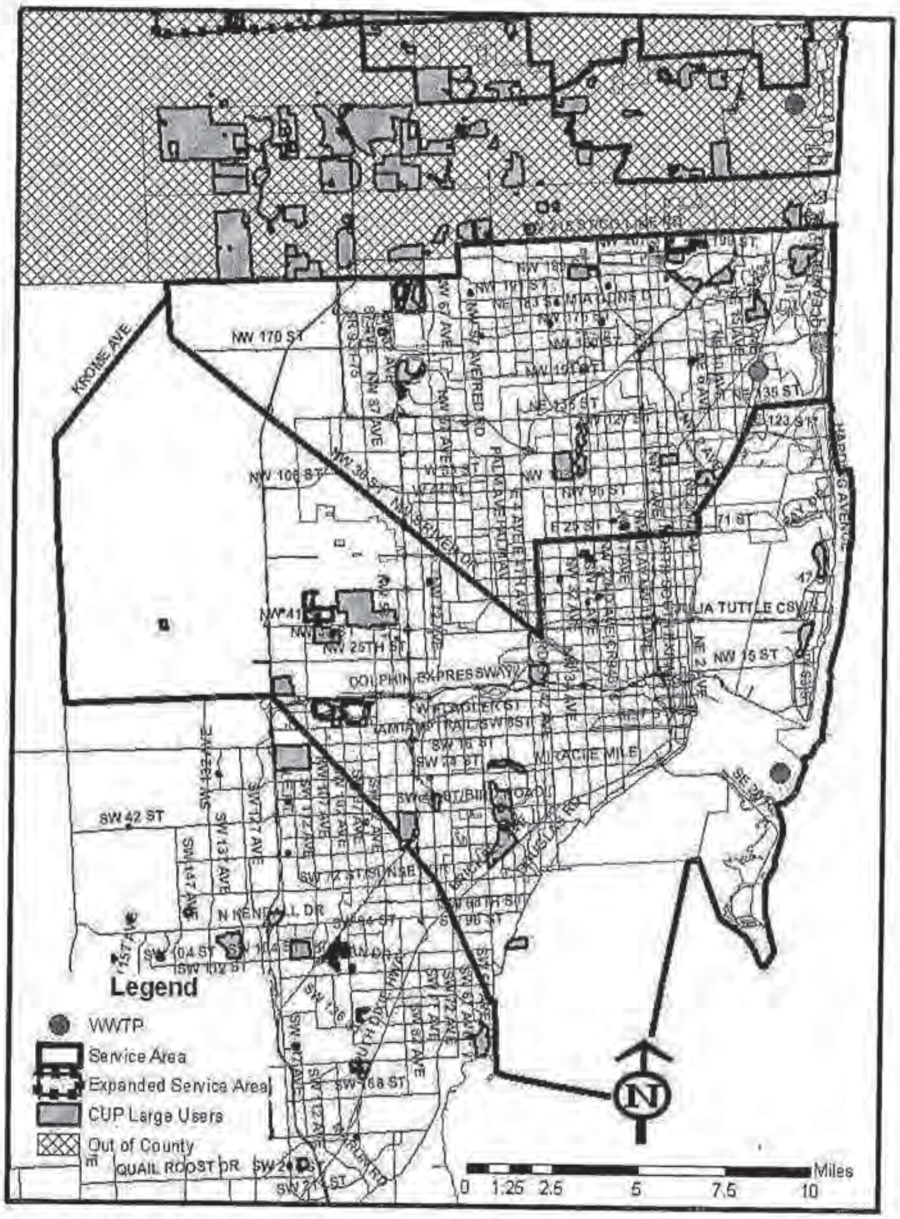

Figure 5-16. Miami-Dade County Large Water Users with Separate Permits

Large users are located randomly throughout the reuse districts, as evident by Figure 5-17. The histogram shows a breakdown of distance from the wastewater treatment plant for all large users in the three-county area.

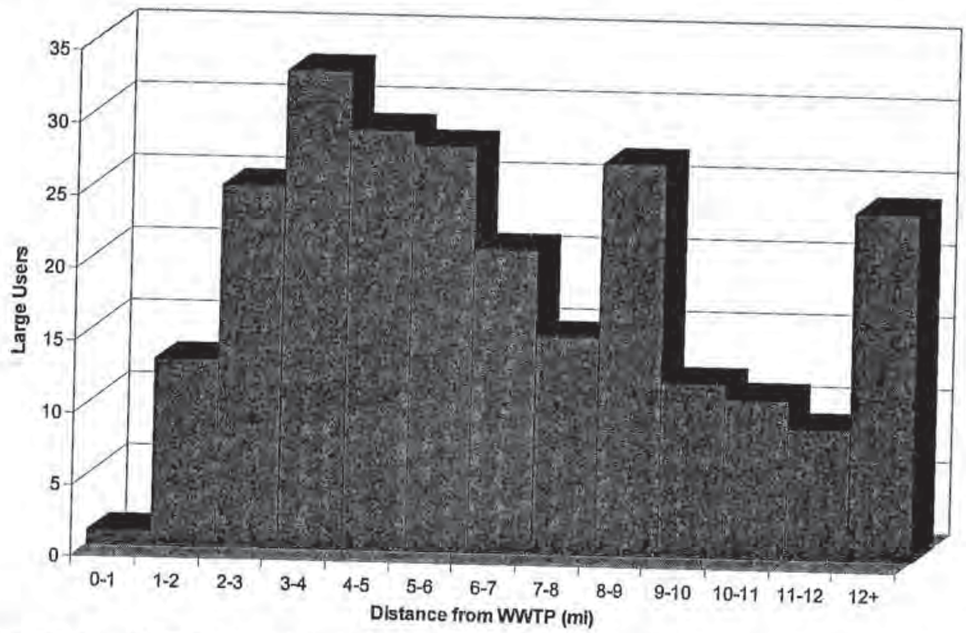

Figure 5-17. Distribution of Large Users' Distance from Wastewater Treatment Plant

The cumulative average demand of the large users, as given by permit data, was then plotted versus metropolitan distance[1] from the large users' respective wastewater treatment plants (Fig. 5-18). The reuse districts served by the Boynton-Delray, Boca Raton, and Broward/North WWTPs have much higher increments of water demand per mile than the districts served by the other three plants.

The slopes of the lines (MGD/mile) in Figure 5-18 fall into two groups. The cumulative demand of large users within 10 miles of the Boynton-Delray WWTP is 20 MGD. Cumulative demands for the reuse districts around the Boca Raton and Broward/North WWTPs have similar slopes. In contrast, the cumulative demand of large users within 10 miles of the Hollywood WWTP is only 3 MGD, or 15% of Delray Beach value. Similar relationships are seen for reuse districts around the Miami-Dade/North and Miami-Dade/Central WWTPs. Accordingly, the more promising opportunities for traditional water reuse are in Palm Beach County and northern Broward County.

[1] Distance measured in the directions of the street grid

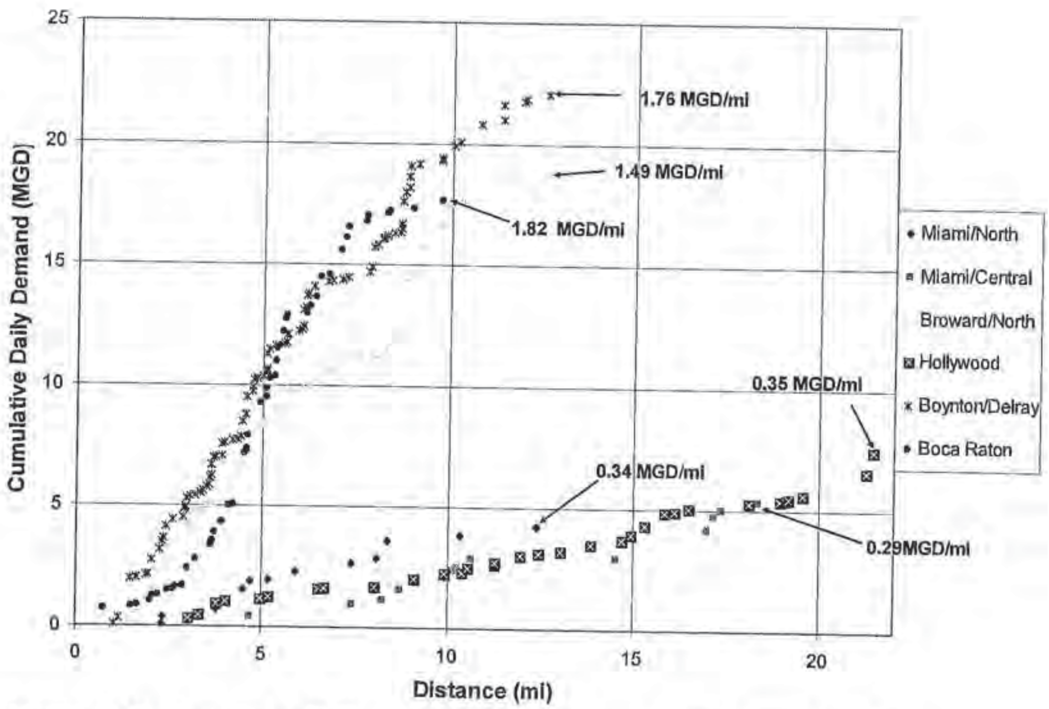

Figure 5-18. Cumulative Daily Demand versus Metropolitan Distance from the Wastewater Treatment Plants

5.6 Summary

Wastewater treatment in the United States has trended towards the construction of centralized treatment systems during the past 40 years for a number of reasons:

- Economies of scale from constructing larger treatment units offset the added piping costs associated with centralized systems
- Generous construction grants from the federal government during the 1970's and 1980's that favored centralized systems
- Problems with performance and reliability in smaller WWTPs.

The cost-effectiveness calculations for these systems did not typically include the possibility of water reuse. The case studies presented in this chapter illustrate how selected communities have integrated reuse systems into their overall wastewater management programs. These cities tend to be in areas where the demand for water is high and supplies are relatively scarce. As competition for water intensifies, more communities can be expected to incorporate reuse into retrofit and expansion plans for wastewater systems including evaluations of the best blend of centralized and decentralized WWTPs and reuse facilities.

As the case studies of water reuse indicate, irrigation of publicly accessible areas such as golf courses is a major application of reclaimed water. Augmentation of ground and surface water supplies with reclaimed water is growing in importance as areas subject to water deficits expand. Satellite water reclamation facilities greatly expand the potential for supplying reclaimed water to users throughout regional wastewater collection systems at reasonable distribution costs, while retaining the economy of scale of regional biosolids management systems. Satellite facilities also have the potential to improve the quality of reclaimed water by withdrawing wastewater upstream of areas that are impacted by inflow and infiltration of saline groundwater.

Traditional reuse (nonpotable reuse for public access applications) is seen from the analysis in Section 5.5 to have the greatest demand potential in Palm Beach County and the northern part of Broward County. A paucity of large urban irrigators lessens the demand potential of traditional reuse in southern Broward County and central and northern Miami-Dade County. There are opportunities to add industrial users in all three counties, although the potential is greatest in Miami-Dade County. Consumptive Use Permit data indicate a total industrial water demand of approximately 33 MGD, of which approximately half is located in proximity of the two WWTPs. The feasibility of adding these users would depend on the individual needs of the industries. Furthermore, the majority of the demand is in the Miami-Dade/Central service area, which has saline inflow. A further analysis would need to be conducted in order to evaluate the needs of large industrial users.

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6. Costs of Traditional Water Reuse and Groundwater Recharge in Southeast Florida

6.1 Introduction

Water reuse is an attractive option when it comes to saving water and reducing the amount of wastewater that is discharged to the ocean. This chapter studies groundwater recharge and traditional land irrigation, two of the more popular methods of water reuse. Several reports provide excellent cost information for the construction, operation and maintenance of the infrastructure required to provide water reuse. This information is used to estimate the costs of well fields for groundwater recharge. In addition, a case study for traditional water reuse is presented to determine if it is cost effective to implement. The results of this case study are used in projecting feasible traditional reclaimed water flows for the remaining five service areas with ocean outfalls, taking advantage of the methodology described in the previous chapter. These projections are used in Chapter 7 as part of the ocean outfall alternatives.

6.2 Methodology for Estimating Costs of Water Reuse Systems

The Florida Department of Environmental Protection (FL DEP 1991) requires that those responsible for domestic wastewater management provide a feasibility study of providing reclaimed water for reuse. The feasibility studies must assess different alternatives in providing water reuse, along with their present costs, costs that will be associated with the user, and the associated environmental and technical impacts.

The FL DEP (1991) guidelines prescribe four alternatives to evaluate:

1. No Action,
2. Minimal Reuse - less than 40% of the average wastewater flow
3. Medium Reuse - 40-75% of the average wastewater flow
4. Maximum Reuse - greater than 75% of the average wastewater flow

The guidelines present several options for reclaimed water, including irrigation of golf courses and other landscaped areas, agricultural uses, recharging groundwater, and industrial uses. Each of these uses requires that the wastewater be processed through secondary treatment and disinfection. Additional requirements for particulate matter and nutrients will be summarized in Chapter Seven.

The FL DEP (1991) methodology uses a net present value analysis, in which all revenues and costs that will be incurred over a twenty-year study period are brought back to the current year's dollar amount using the discount rate published by the United States Environmental Protection Agency. The costs that are to be considered include the capital costs to provide the required level of treatment to the wastewater, the transmission costs to provide water reuse to the users, and the operation and maintenance costs of these systems. A contingency is provided by taking a percentage of capital costs. The cost to pump and store the reclaimed water is identified in the capital costs. The guidelines consider treatment facilities already in operation as sunk costs. Salvage and replacement values are determined using the straight-line depreciation method. Finally, revenues from the sale of reclaimed water, connection fees, crops produced, or lease of lands are considered in the net present value analysis.

This initial present value is compared to a present value resulting from the amount of water saved by using reclaimed water. The water usage from a reuse alternative is subtracted from the water usage from the No Action alternative. This flow is multiplied by the average residential rate to produce a cost savings. This present value is subtracted from the present value of the costs described above to determine the final net present value.

6.3 Cost Estimation

6.3.1 Water Reclamation

The costs of treatment to produce reclaimed water suitable for discharge through ocean outfalls, deep well injection, traditional (public access) reuse, or groundwater recharge were evaluated using CapdetWorks 2.1 (Hydromantis Inc., Hamilton, Ontario, Canada) as well as information from the literature.

a) Methodology for estimating wastewater treatment costs using CapdetWorks. CapdetWorks computes land, equipment, and operation and maintenance requirements for a wastewater treatment process train and estimates costs using the 1977 CAPDET database (Harris et al. 1982) or a U.S. July 2000 database. Information required by the program includes average daily, maximum, and minimum flow, influent wastewater characteristics, unit operations and processes to include in the treatment train, and desired effluent quality. The user can provide values for allowable loadings, unit costs, and cost indices or rely on default values.

The general procedure in CapdetWorks was to input certain general factors such as cost indices and then construct a process flow train by assembling and connecting objects representing various unit operations and processes. Details of the methodology are given below. A detailed step by step example is provided in Appendix 1.

i) General. Costs are estimated in 2005 dollars throughout the present report. Cost index values between January 2005 and September 2005 were collected from *Engineering News Record* and *Chemical Engineering* and averaged. The averages were 7410 for the ENR 20-City Construction Cost, 1250 for the Marshall & Swift Index, and 620 for the Pipe Cost Index. These values were input to CapdetWorks.

CapdetWorks inflates unit costs based on inputs for the three cost indices specified above. However, the program does not inflate land costs. A representative land cost of \$100,000/acre in 1996 dollars was listed for urban areas by LEES (1997). The Marshall and Swift Index was used to inflate this cost to 2005 dollars (\$120,000/acre). The latter value was input to CapdetWorks.

The cost report produced by the program includes the total project cost (construction, land, and interest paid during construction) and the operation and maintenance cost (materials and supplies, energy, and labor). Land cost is also available. The difference between the total project cost and the land cost (i.e., capital cost excluding land) was annualized on the basis of a discount rate of 7% and process life of 20 years. The corresponding capital recovery factor was 0.094. The values of discount rate and process life are the same as those employed by LEES (1997). The land cost reported by CapdetWorks was annualized by applying the discount rate directly. The total annualized cost of wastewater treatment by a particular system was the sum of the annualized net capital cost, annualized land cost, and the operation and maintenance cost.

ii) Influent object. The CapdetWorks influent object allows the user to characterize the influent wastewater in terms of flow and composition. The maximum flow was computed as the product of the average daily flow and the peak hour peaking factor. The peaking factor was found in the consultants' reports. The value of the minimum flow was set equal to the average daily flow. This setting did not alter the value of project cost estimated by Capdetworks. This was verified for minimum flows of 10–100% of the average daily flow.

Design concentrations of influent five-day carbonaceous biochemical oxygen demand ($CBOD_5$) and total suspended solids (TSS) were found in consultants' reports, as summarized in Table 6-1. Design concentrations of influent total Kjeldahl nitrogen (TKN) and total phosphorus (TP) were generally not available in the reports. These concentrations were therefore estimated based on the TKN/BOD_5 ratio (40/220) and TP/BOD_5 ratio (8/220) in medium strength domestic wastewater (Metcalf & Eddy 1991). The estimated concentrations of TKN and total P are also included in Table 6-1. Concentrations of soluble BOD, chemical oxygen demand, soluble chemical oxygen demand, soluble TKN, and ammonia in the influent object were set to zero. The results of preliminary simulations indicated that this approach gave appropriate results.

Table 6-1. Influent Wastewater Parameters Entered for WWTPs

Parameter	Boynton-Delray	Boca Raton	Broward/North	Holly-wood	Miami Dade/North	Miami Dade/Central
Peaking Factor (max. hour)	2.26	2.28	2.3	2.28	2.26	2.28
TSS (mg/L)	250	150	248	150	250	150
BOD (mg/L)	225	200	142	150	225	150
TKN (mg/L)	40.9	36.4	26	27.3	41	27.3
TP (mg/L)	8.2	7.3	5	5.5	8	5.5

iii) Primary clarifier object. A primary clarifier object was included in the process trains of facilities that currently use this unit operation and omitted from the process trains of facilities that do not employ this unit operation. Design factors such as surface overflow rate and tank depth were left at the default settings when this object was used.

iv) SRT-based plug flow activated sludge object. The SRT-based plug flow activated sludge object was used to represent the activated sludge process employed at the six WWTPs with ocean outfalls to provide secondary treatment. The mixed liquor suspended solids was set at 2,000 mg/L and fine bubble aeration was selected unless design information for a facility indicated that coarse bubble aeration was in place. The solids residence time (SRT) was estimated using design information given in the consultants' reports.

v) Biological nutrient removal–3/5 stage object. The biological nutrient removal–3/5 stage object with 3 stages was employed to estimate costs of intermediate nutrient removal. An example of a 3 stage process is the A^2/O process (Metcalf & Eddy 1991). The object with 5 stages was used to estimate the costs of advanced nutrient removal. An example of a 5 stage process is the Bardenpho process (Metcalf & Eddy 1991). The treated effluent qualities associated with these levels of nutrient removal are described in Chapter 7. The mixed liquor suspended solids concentrations for both the 3 stage and 5 stage biological nutrient removal processes were set at 3,000 mg/L. Fine bubble aeration was selected. The solids residence time for nutrient removal was fixed at 6 days for 3 stage treatment and 9 days for 5 stage treatment. The values of solids residence time were selected based on default nitrification kinetics from the International Water Association activated sludge Model 2d (Henze et al. 2000). These solids residence times give simulated effluent ammonia levels of 0.2 mg/L, which provides a satisfactory safety factor for nitrification and also allow sufficient anoxic tank volume for adequate denitrification.

vi) Secondary clarifier object. The secondary clarifier is an integral component of the activated sludge process and was included in all of the process flow trains. The design factors were left at the default values.

vii) Filtration object. The object representing granular media filtration was used with default values for all design factors.

viii) Chlorination object. A contact time of 15 minutes at maximum flow and chlorine dose of 10 mg/L were input to the chlorination object to represent basic level chlorine disinfection. The contact time and chlorine dose were raised to 45 minutes and 16 mg/L, respectively, to represent high-level chlorine disinfection. All other design factors were left at the default values.

ix) Ultra-Violet disinfection object. The CapdetWorks model for UV disinfection requires that the allowable effluent concentration of coliforms be expressed in terms of total coliforms. The California Title 22 requirements for high-level disinfection, which limit maximum effluent total coliforms to 2.2/100 mL, may be considered equivalent to the FL DEP requirements for high-level disinfection, which specify that 75% or more of effluent samples should contain no detectable fecal coliforms. Therefore, a target effluent concentration of 2.2 total coliforms/100 mL after disinfection was employed in the CapdetWorks UV disinfection module. All other design factors were left at their default values.

x) Sludge processing and disposal. Objects representing unit operations and processes for sludge handling and disposal were not included in the wastewater treatment process trains. This is because the quantities of sludge produced by the alternative process trains are anticipated to change by an insignificant amount relative to the quantities produced by the secondary treatment processes now in operation. Upgrading biological treatment processes from secondary treatment to nitrogen removal generally decreases sludge production due to higher solids residence time. This would tend to offset a slight increase in solids production due to chemical precipitation of phosphorus remaining following application of processes for biological enhanced phosphate uptake.

b) Comparison of treatment upgrade costs obtained with CapdetWorks to costs reported by LEES (1997). A comparison of cost estimates for treatment upgrades obtained with CapdetWorks to those given by LEES (1997) was carried out. LEES (1997) gave annualized costs in 1996 dollars for adding a granular media filtration system to a secondary wastewater treatment system and for upgrading basic level chlorine disinfection to high level chlorine disinfection system. These two upgrades were simulated with CapdetWorks. To obtain a correct basis for comparison between the two approaches, the cost index values for 1996 (Marshall and Swift Index = 1040, ENR Cost Index = 5620, Pipe Cost Index = 514) were input to the program. The land value was input as $100,000/acre. Annualized costs estimated by the two approaches were very close at a flow rate of 20 MGD, but were off by a factor of 2 or more at the 1 MGD flow rate (Table 6-2). The capacities of the WWTPs evaluated are 15 MGD or higher. Hence, we would expect generally good agreement between costs estimated using CapdetWorks and costs estimated using the methodology of LEES (1997).

Table 6-2. Comparison of Costs for Adding Granular Media Filtration to a Process Train and Upgrading from Basic-Level to High-Level Chlorine Disinfection

	Filtration		Disinfection		
	1 mgd	20 mgd	1 mgd	20 mgd	
Law Engineering	0.33	0.11	0.098	0.044	$/1000 gal
CapdetWorks	0.17	0.10	0.040	0.041	$/1000 gal
Law Engineering/Capdetworks	1.9	1.1	2.4	1.1	

c) Estimation of costs for membrane filtration and reverse osmosis. CapdetWorks does not include objects for membrane filtration or reverse osmosis. A report by CDM (1998) that estimated the costs to add membrane filtration and reverse osmosis to a secondary wastewater treatment plant was used to find costs for these two unit operations. The capital and operation and maintenance costs of upgrading were estimated by the consulting engineers for a 10 MGD influent flow rate (Table 6-3). The capital cost was annualized using a discount rate of 7% and service life of 20 years. The annualized capital cost and operation and maintenance costs were added to give the total annualized cost of membrane filtration and reverse osmosis as $1.52/1000 gal. The base year for costing was not stated in the report. It was assumed that the costs were in 1997 dollars, since the report was published in 1998. The ENR Cost Indices for 2005 (7405) and 1997 (5825) were applied to inflate the annual cost to $1.93/1000 gal in terms of 2005 dollars.

The annual cost expressed in $/1000 gal was scaled in relation to flow. A scaling factor of 0.85 was determined on the basis of costs for a reverse osmosis process treating potable water (LEES 1997), which were given at several flow rates. The equation for estimating the unit cost of upgrading a secondary wastewater treatment plant with membrane filtration and reverse osmosis is thus

$$C = 0.272\,Q^{0.85} \tag{6-1}$$

where C is the cost is expressed in 2005 dollars/1000 gal and Q is the flow rate in MGD.

d) Estimation of costs for advanced oxidation. The Florida DEP suggested the use of advanced oxidation in a treatment train for full treatment and disinfection. However, costs for advanced oxidation were not available in either CapdetWorks or in LEES (1997). Daugherty et al. (2005) dosed 3 ppm of H_2O_2 immediately upstream of a UV disinfection system to achieve advanced oxidation of reclaimed water in Orange County, California. An H_2O_2 cost of $0.50/lb (Brown 2004; Burridge 2004) and a dose of 3 ppm were used to compute annualized chemical costs associated with advanced oxidation.

6.3.2 Traditional Water Reuse

The methods used to estimate costs for this project follow the general concepts outlined in the FL DEP (1991) guidelines with one major change. Instead of using a prespecified percentage of wastewater reuse for the calculations, the net present value was determined for a variety of reuse percentages. As shown in the previous chapter, the relative importance of large users varies widely across the six wastewater treatment plants. Accordingly, the cost-effectiveness of traditional reuse for these six wastewater treatment plants will also vary widely. The addition of more points along a net cost function graph will show to what degree the option is cost effective. The method of how traditional reuse flow levels were determined and their names differs from the FL DEP (1991) report. The "Status Quo" alternative describes a plant that is providing its current amount of reclaimed water. The "Low" alternative finds additional users to take the plant to its existing traditional reuse capacity. The "Medium" alternative encompasses all "large users" in the plant's service area. Large users are identified as having a demand greater than 0.05 MGD based on the Consumptive Use Permits and for application to golf courses and landscaped areas. Finally, the "Large" alternative is a combination of the large users in the service area combined with a selected amount of residential users. The residential users were determined by the Hazen and Sawyer (2004) report, based on their proximity to the traditional reuse line being designed to serve the large users.

Table 6-3. Estimated Costs for Adding Membrane Filtration and Reverse Osmosis to an Existing Secondary Treatment Facility, Based on Data from a 10 MGD pilot plant[1,2].

Construction	
Effluent Pump Station (Pump + Transmission)	690,000
Microfiltration Equipment (Equipment + MF Portion)	10,560,000
RO Feedwater Storage (Pump + Tanks)	425,000
RO Equipment (Membrane + Cartridge+RO Pump + Cleaning System + Building)	6,575,000
Degasification System (Tower + Blower + Pump)	935,000
Concrete Disposal	50,000
Reclaimed Water (Storage Tank + Water Pump Station)	1,110,000
Chemical Feed System (Sulfuric Acid + Antiscalent + Caustic Soda)	240,000
Site Facilities	770,000
Subtotal (Construction)	21,355,000
Other direct costs I	
Site Work (@5% Net Construction Cost)	1,067,750
Yard Piping (@5% Net Construction Cost)	1,067,750
Electrical and Instrumentation (@15% Net Construction Cost)	3,203,250
Subtotal (Construction + Other Direct Cost I)	26,693,750
Other direct costs II	
Bonds, Premiums, Mobilization, Indemnification, Demobilization, Insurance (8% (Net Construction + Other Direct Cost)	2,135,500
Subtotal (Construction + Other Direct Costs I, II)	28,829,250
Indirect costs	
Engineering, Legal and Administration (15% of Subtotal (Construction + Other Direct Cost I, II)	4,324,388
Contingency (10% of Subtotal (Construction + Other Direct Cost I, II)	2,882,925
Grand Total (Capital Cost) for MF/RO	36,036,563
Annualized capital cost	3,387,437 /yr
Operations and Maintenance	
Chemicals (MF Cleaning + Sulfuric Acid + Antiscalent + Caustic Soda + Chlorine)	296,380
Power	583,900
Labor	300,000
Replacement / Repair	968,380
Grand Total (O & M) for MF/RO	2,148,660 /yr
Total annual cost	5,536,097 /yr
Unit costs	
1997 basis	1.52 /1000 gal
2005 basis	1.93 /1000 gal

[1]All costs that feature in the table are in \$. All annualized costs reported in the table are in \$/yr. All unit costs reported in the table are in \$/1000 gal.
[2]Data from CDM (1998)

Water and wastewater infrastructure is very capital intensive with long service lives that extend to 100 years for some transmission systems. For this project, excellent information is available on how costs should be calculated. The LEES (1997) report incorporates estimation techniques for all costs sought after by the FL DEP (1991) report. These cost estimates were updated by SFWMD (2004). In addition, Hazen and Sawyer (2004) created a database from several reuse treatment facilities that is used to calculate treatment costs. The reuse facilities in this database include the Broward/North, Boynton-Delray, Hollywood, and Boca Raton Wastewater Treatment Plants.

The capital costs determined in this project include the cost to expand the capacity of the traditional reuse facility, the cost to pump the water on-site and throughout the traditional reuse network, the cost of storage tanks, if needed, along with booster stations throughout the service area, the cost of transmission lines required to provide the traditional reuse demand, and land costs for the booster stations. A contingency cost is added to these capital costs.

The cost to expand traditional reuse capacity is based on data from Hazen and Sawyer (2004) and is summarized in Table 6-4. In calculating these costs, the wastewater treatment plant's capacity to treat reclaimed water is subtracted from the alternative demand flow to account for the sunk cost of the plant. The costs presented in Table 6-4 represent the infrastructure required to treat the reclaimed water. It includes the cost to equalize the flow during peak flow events, the cost of a filter feed pumping station to transfer effluent from secondary treatment to the filtration process, and the cost to provide the facilities for chemical pre-treatment, filtration, and disinfection through chlorination. The unit costs used for materials and energy were held constant for all reclaimed water demands.

Table 6-4. Traditional Reuse Expansion Costs (Hazen and Sawyer 2004)

Item	Cost (\$/gal)
Facility Structures	0.825
Process Equipment	0.220
Auxiliary Equipment	0.055

The costs to pump the reclaimed water through the treatment process and the reuse network are combined into one category. These costs, along with the cost to store this reclaimed water, are found in a similar fashion. For a 45 MGD capacity system, Hazen and Sawyer (2004) found that a pump station would cost \$7.3 million. Additionally, Hazen and Sawyer (2004) estimated that storage for this system would total \$30 million. A cost function was implemented to determine the costs for all other flows demanded. The flow and the cost of this larger system are known. Costs are usually estimated using a power function, as shown in Equation 6-2. Using a typical exponent value of 0.7 for treatment systems (Heaney et al. 2002), and using the total cost and flow demand of the treatment system, the value of a can be calculated, where a in Equation 6-2 represents the cost of pumping or storing 1 MGD of this reclaimed water.

$$C = aQ^b \tag{6-2}$$

where C equals cost in dollars, Q equals flow in MGD, and a and b are parameters. This function can be used to obtain pumping and storage costs for any flow desired.

Booster stations and storage tanks are placed throughout the service area. It is assumed that the plant can store reclaimed water up to its current flow, and that storage tanks throughout the system need to be designed to hold 40% of the daily demand (Hazen and Sawyer 2004). In these calculations, 2.5 MG storage tanks are assumed. The amount of booster stations required is any flow above the "Status Quo" multiplied by 40% and then divided by 2.5 MG. Each booster station was estimated to cost $750,000 and is to be situated on a one-acre plot of land that is estimated to cost $250,000 (Hazen and Sawyer 2004). However, because land is assumed not to depreciate, the standard way to cost it out is the foregone revenue for using it during the twenty-year study period, or 7% of the land value per year. Therefore, the cost to use an acre of land is $17,500 per year, which is then calculated as a present value.

Transmission costs are based on the diameter of pipe required, the type of installation required, and the cost of crossing roadways and canals (Hazen and Sawyer 2004). Table 6-5 summarizes these transmission costs.

Table 6-5. Transmission System Unit Construction Costs (Hazen and Sawyer 2004)

Pipe Diameter (in)	Pipe Installation-Paved ($/ft)	Pipe Installation-Unpaved ($/ft)	Roadway Crossings ($/ft)	Canal Crossings ($/ft)
6	75	37.50		
8	100	50.00		
10	125	62.50		
12	150	75.00	1140	1240
16	200	100.00	1330	1330
18	225	112.50	1370	1520
20	250	125.00	1600	1770
24	300	150.00	1670	2150
30	375	187.50	1980	2280
36	450	225.00	2280	2510
42	525	262.50	2340	2730
48	600	300.00	2520	2960

The pipe costs shown in Table 6-5 can be put into equation form as follows:

$C_u = 6.25{*}D$ for unpaved areas, and (6-3)

$C_p = 12.50{*}D$ for paved areas (6-4)

where C = pipe installation costs in \$/foot and D = diameter in inches.

These transmission costs estimates are higher than those reported in South Florida Water Management District (2004), because the latter values, while including the cost to jack and bore underneath a roadway and the costs of valves, do not distinguish between paved and unpaved roadway installation. Finally, engineering, permitting, and administration costs are taken to be 25% of all capital costs.

Operation and maintenance costs are also calculated in Hazen and Sawyer (2004). These costs are shown in Table 6-6. This estimate takes into account that a larger distribution network capable of handling larger flows will require more maintenance. These costs also take into account that operation and maintenance costs historically increase throughout the service life. The percentage increases for years 6–10, 11–15, and 15–20 are 20%, 16%, and 14%, respectively.

Table 6-6. Annual Operation and Maintenance Cost Estimates (Hazen and Sawyer 2004)

	O&M Costs ($/1000 gal)			
Alternatives	**Years 1-5**	**Years 6-10**	**Years 11-15**	**Years 16-20**
Status Quo & Low	0.175	0.210	0.244	0.278
Medium & Large	0.215	0.258	0.299	0.341

The operation and maintenance costs are annualized over the twenty-year study period and brought back to a present value using a 7.0% discount rate. This rate corresponds to the value used in the LEES (1997) report. This value is combined with all capital costs to produce the present value of costs.

FL DEP (1991) regulations require a comparison of present cost values to a present value of savings enjoyed by the large users. Whitcomb (2005) provides water and sewer rates for Miami-Dade and Palm Beach Counties shown in Table 6-7.

Table 6-7. Miami-Dade and Palm Beach Counties Sewer and Water Service Costs (Whitcomb 2005)

Utility	Range in 1,000 gal./mo.	Water $/1,000 gal.	Sewer $/1,000 gal.	Total $/1,000 gal.
Miami-Dade	0 to 3.75	$ 0.50	$ 1.85	$ 2.35
Miami-Dade	3.75 to 7.5	$ 1.60	$ 2.90	$ 4.50
Miami-Dade	7.5 to 12.75	$ 2.20	$ 3.60	$ 5.80
Miami-Dade	> 12.75	$ 3.05	$ 3.60	$ 6.65
Palm Beach	0 to 4	$ 0.75	$ 1.00	$ 1.75
Palm Beach	4 to 10	$ 1.60	$ 2.00	$ 3.60
Palm Beach	> 10	$ 3.80	$ -	$ 3.80

Indoor water use for a typical family would correspond to the first rate category shown in Table 6-7. Irrigation use would be in the remaining categories. Assuming that outdoor water use is in the second category, the relevant savings are $4.50 per 1,000 gallons for Miami-Dade County and $3.60 per 1,000 gallons for Palm Beach County.

Hazen and Sawyer (2004) provide rates for Broward County. A residential customer using 7,000 gallons per month in 2002 was charged $2.35 per thousand gallons for sewer service and $1.69 per 1,000 gallons for water service, or a total of $4.04 per 1,000 gallons. These values are used to estimate the cost savings of implementing a traditional water reuse plan.

Sales of reclaimed water were not quantified in this report. In addition, salvage and replacement values for all capital costs were not calculated. This differs from FL DEP regulations, but is consistent with the methods used in the LEES (1997) report.

6.3.3 Groundwater Recharge

This section develops the groundwater recharge costs for the WWTPs with ocean outfalls. The groundwater recharge construction costs include the cost of the shallow injection wells and valves and the transmission costs from the WWTP to the injection site including pipe costs, jack and bore and canal crossings. Operation and maintenance costs include monitoring, as well as operation and maintenance, plus pumping through the transmission system.

The PBS&J (1992) reuse feasibility study reviewed the drainage wells in Miami-Dade County. The wells are located seaward of the salt front at locations where they will not interfere with other supply wells. The drainage wells, usually 14 to 16 inches in diameter, are typically drilled 60 to 80 feet deep near the coast into the most permeable strata of the aquifer and can drain up to an average of 2,000 gal/min (2.88 MGD) under a head of 1 to 3 ft, depending on site conditions and location. Background water level conditions are usually found at a distance of 500 feet from the recharge well. Under the worst conditions, the background water levels might not be reached in 800 to 1000 feet from the well. From this information it was found that a ten-well string spread 500 feet apart (ten to a mile) could recharge as much as 30,000 gal/min (43.2 MGD), and a system of several of these mile-long strings could be installed to control a wide frontal area of the coast. A pressurized system would allow for additional recharge. The study also mentioned where the shallow injection wells would be most beneficial. Injection wells could be spread along a broad front or concentrated where problems are occurring, such as near the coast where the salt front threatens existing well fields. They could also be installed near and around the control structures in canals to help increase the canal water levels.

The characteristics of the shallow injection wells and transmission lines at the six WWTPs are shown in Table 6-8. A shallow injection well AADF capacity of 2.0–2.85 MGD and an internal diameter of 12–16 inches were chosen for the six WWTPs based on the information presented in PBS&J (1992). The distance between the wells was set at 500 feet, as measured from the center of each well. Where possible, the injection wells were sited along a canal or where saltwater intrusion could be prevented. The locations of shallow injection wells at the respective WWTPs were determined after reviewing appropriate reports for each WWTP.

Table 6-8. Characteristics of the Shallow Injection Wells and Transmission Line

Plant	No, of wells	AADF per well (MGD)	Dia. of wells (inch)	TransTr mission length (feet)	ans-mission pipe dia. (inch)	Description of Transmission Line
Boynton-Delray	6	2	12	14,001	36	11,500 feet along the L-30 Canal, injection wells along the Military Trail
Boca Raton	4	2.15	14	1,501	36	Injection wells between the WWTP and I-95 Freeway
Broward/North	15	2.7	14	8,001	66	1,000 feet from the WWTP to the C-3 Canal, injection wells along the C-3 Canal
Hollywood	14	2.8	14	16,587	66	10,086 feet from the WWTP to I-95 Freeway along Taft Street, injection wells along I-95 Freeway
Miami-Dade/North	34	2.85	16	16,751	108	250 feet from the WWTP to Snake Creek Canal, injection wells along Snake Creek Canal and Sunny Isles Blvd.
Miami-Dade/Central	40	2.8	14	Up to 35 miles	60	See Figure 6-1

The location of the injection well system for the Boynton-Delray WWTP in Delray Beach is based on the Brown & Caldwell (1993) reclaimed water system feasibility study that evaluated the costs for aquifer recharge through canal recharge and wetlands construction. The Boca Raton WWTP is located next to the I-95 Expressway; therefore the injection wells will be located between the WWTP and I-95 Expressway. The location of the injection well system for the Broward/North WWTP is based on the Hazen & Sawyer (1994) reuse feasibility study that evaluated the costs for canal recharge to C-3 Canal. The location of the injection well system for the Miami-Dade/North is based on the PBS&J (1992) and (1998) Reuse Feasibility Studies which evaluated the costs for canal recharge to Snake Creek Canal. The Miami-Dade/Central includes four transmission lines from the Miami-Dade/Central WWTP to four shallow injection well sites. The Miami-Dade/Central WWTP is located on Virginia Island. The injection well sites were chosen on the mainland, which requires a long transmission line through Miami. The PBS&J (1992) reuse feasibility study found that several well fields would benefit from a seaward movement of the salt front. These included the Miami Springs Well Field, the Hialeah Well Field, the Alexander Orr Well Field, the Homestead Air Force Base Well Field and Leisure City Well Field, mentioned in the order of importance to the overall public water supply. Four sites that would benefit from a program to reduce saltwater intrusion were chosen, as shown in Figure 6-1.

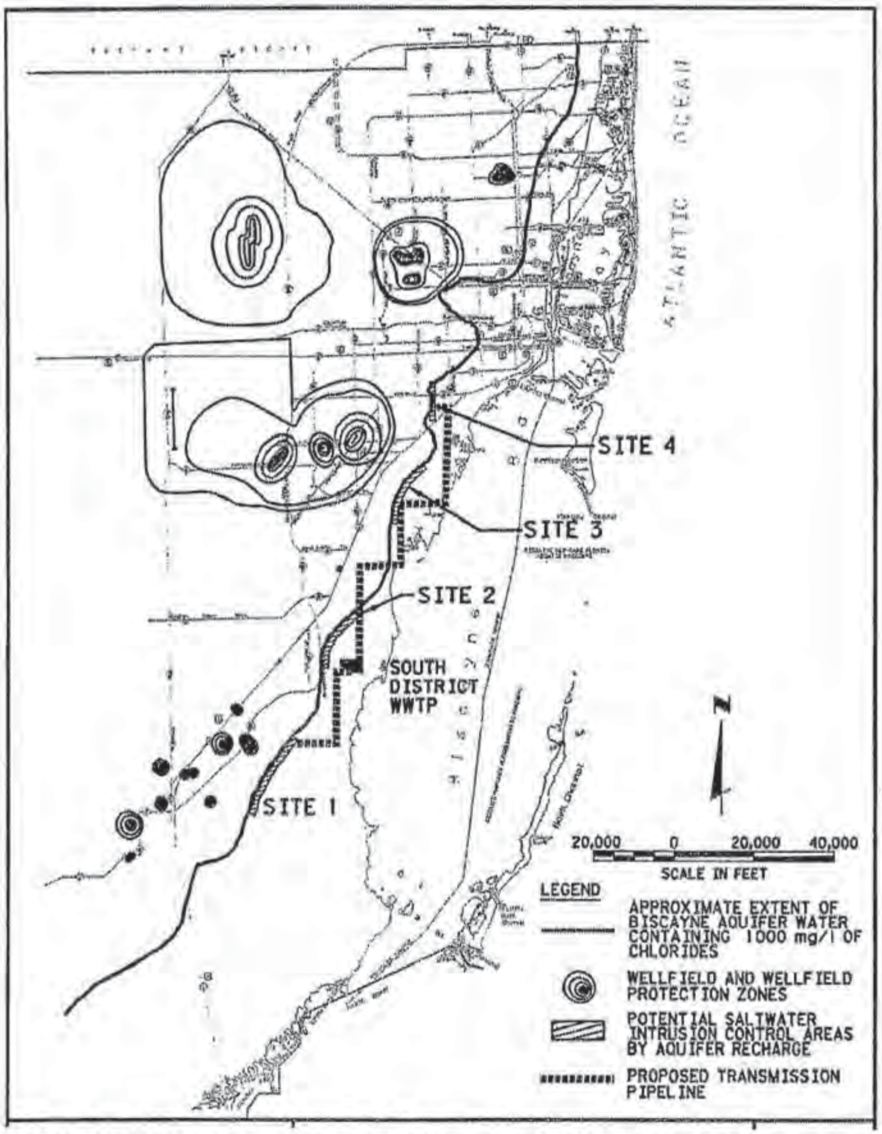

Figure 6-1. Miami-Dade/Central Shallow Injection Well Sites (PBS&J 1992)

A summary of the unit costs for shallow injection wells and transmission is given in Table 6-9. These unit costs were converted to 2005 dollars using the Engineering News Record Index. The injection well construction costs were calculated using values of \$9,000/MGD/well and \$5,000 for the automatic shut off valve at each well (PBS&J 1992). Transmission pipe costs were calculated from information in the Hazen & Sawyer (2004) reuse feasibility study. The unit cost of pipe installation through urban areas is given by Equation 6-4 (above). Roadway and canal crossing costs were calculated using values of \$80,000/roadway crossing and \$60,000/canal crossing (PBS&J 1992). Transmission pipes were sized based on information from Hazen and Sawyer (2004) and Brown and Caldwell (1993). The latter study examined a discharge of 12 MGD through a 36 inch transmission pipe to a pumping Station along E-3 canal. Hazen and Sawyer (2004) studied a discharge of about 69 MGD of reclaimed water through a 78 inch transmission pipe to C-3 Canal.

Table 6-9. Unit Costs for Shallow Injection Wells and Transmission

Item	Units	Unit Costs	Source
Injection wells	\$/MGD/well	**9,000** (1992 Dollars)	PBS&J (1992)
Valves	\$/valve	**5,000** (1992 Dollars)	PBS&J (1992)
Transmission Pipe for paved areas	\$/feet	**12.50*Diameter** of pipe in inches (2004 Dollars)	Hazen & Sawyer (2004)
Jack & Bore	\$/ roadway crossing	**80,000** (1992 Dollars)	PBS&J (1992)
Canal Crossing	\$/ canal crossing	**60,000** (1992 Dollars)	PBS&J (1992)

The lengths of transmission line for five of the injection well systems were calculated by adding the length of transmission line from the WWTP to the injection site and the length of transmission line between the wells, as shown in Equation 6-5.

$$Trans\ Length = Trans\ Line\ from\ WWTP\ to\ Site + 500 * (No.Wells - 1) + \frac{Well\ Dia}{12} \qquad (6\text{-}5)$$

The transmission costs for the Miami-Dade/Central WWTP were calculated using the information given in the PBS&J (1992) study. The transmission length given in Table 6-8 applies to transmission of reclaimed water from the Miami-Dade/South WWTP to the injection sites. Since the source of reclaimed water would actually be the Miami-Dade/Central WWTP, transmission costs were increased by \$16,000,000, as suggested by PBS&J (1992).

Operation and maintenance costs were estimated from information in reuse studies by Brown and Caldwell (1993) and Hazen and Sawyer (1992). The latter study gave costs for 56 injection wells with a total capacity of 8.25 MGD to recharge Dixie Wellfield using reclaimed water from the Plantation WWTP. The construction costs of \$6.69 million included the injection wells, manifold and the transmission pipeline. The operation and maintenance costs of \$0.16 million/yr included electricity for pumping and maintenance of the transmission lines and injection wells. The operation and maintenance costs were 2.41% of the construction costs. The Brown and Caldwell (1993) study gave costs for canal recharge of 12 MGD of reclaimed water from the Boynton-Delray WWTP. The construction costs of \$4.40 million included the canal discharge structure construction costs, transmission costs, canal use fee, valves and 15% contingency. The operation and maintenance costs of \$0.07 million/yr included operation, repair and replacement and monitoring costs. Operation and maintenance costs were 1.59% of the construction costs. Operation and maintenance costs were therefore calculated as 2.5% of the construction costs on an annual basis.

The calculations for the total construction and operation and maintenance costs in 2005 dollars are given for each plant in Tables 6-10 through Table 6-15. The total construction and operation and maintenance costs for each plant are summarized in Table 6-16. The annualized costs assuming a 7% discount rate over 20-year period are shown in Table 6-17.

The annualized costs in \$million/yr were scaled according to flow using the relationship shown in Equation 6-6.

$$\text{Cost} = aQ^b \qquad (6\text{-}6)$$

where Q is the design capacity of the system in MGD, b is a scaling coefficient, and a is a site-specific parameter. The value of b was assumed to be 0.7, which is appropriate for water and wastewater transmission systems. A cost scaling relationship is given for each system in Table 6-18.

Table 6-10. Boynton-Delray Shallow Injection Well Costs

Item	Units	Value	Item	Value
Flowrate	MGD	12	ENR (2005)	7405.3
Flowrate per well	MGD	2	ENR (2004)	7115
Total # of wells		6	ENR (1993)	5210
Distance between wells	LF	500	ENR (1992)	4985
Diameter of injection wells	Inches	12		
Diameter of transmission pipe	Inches	36		

Item	Quantity	Units	Unit Cost	Item Cost
CONSTRUCTION COST				
Injection Wells	6	EA	\$26,739	\$160,436
Valves	6	EA	7,428	\$44,565
Total Injection Wells				**\$205,001**
TRANSMISSION COST				
Transmission Pipe	14,001	LF	\$468	\$6,557,515
Jack and Bore	1	EA	\$118,841	\$118,841
Canal Crossing	1	EA	\$89,131	\$89,131
Total Transmission				**\$6,765,488**
TOTAL COST				**\$6,970,489**
O&M COST (\$/year)				**\$174,262**

Table 6-11. Boca Raton Shallow Injection Well Costs

Item	Units	Value	Item	Value
Flowrate	MGD	8.6	ENR (2005)	7405.3
Flowrate per well	MGD	2.15	ENR (2004)	7115
Total # of wells		4	ENR (1993)	5210
Distance between wells	LF	500	ENR (1992)	4985
Diameter of injection wells	Inches	14		
Diameter of transmission pipe	Inches	36		

Item	Quantity	Units	Unit Cost	Item Cost
CONSTRUCTION COST				
Injection Wells	4	EA	$28,745	$114,979
Valves	4	EA	7,428	$29,710
Total Injection Wells				**$144,689**
TRANSMISSION COST				
Transmission Pipe	1,501	LF	$468	$703,087
Jack and Bore	1	EA	$118,841	$118,841
Canal Crossing	0	EA	$89,131	$0
Total Transmission				**$821,929**
TOTAL COST				**$966,618**
O&M COST ($/year)				**$24,165**

Table 6-12. Broward/North Shallow Injection Well Costs

Item	Units	Value	Item	Value
Flowrate	MGD	40.5	ENR (2005)	7405.3
Flowrate per well	MGD	2.7	ENR (2004)	7115
Total # of wells		15	ENR (1993)	5210
Distance between wells	LF	500	ENR (1992)	4985
Diameter of injection wells	Inches	14		
Diameter of transmission pipe	Inches	66		

Item	Quantity	Units	Unit Cost	Item Cost
CONSTRUCTION COST				
Injection Wells	15	EA	$36,098	$541,471
Valves	15	EA	7,428	$111,414
Total Injection Wells				**$652,885**
TRANSMISSION COST				
Transmission Pipe	8,001	LF	$859	$6,870,289
Jack and Bore	1	EA	$118,841	$118,841
Canal Crossing	0	EA	$89,131	$0
Total Transmission				**$6,989,131**
TOTAL COST				**$7,642,015**
O&M COST ($/year)				**$191,050**

Table 6-13. Hollywood Shallow Injection Well Costs

Item	Units	Value	Item	Value
Flowrate	MGD	39.2	ENR (2005)	7405.3
Flowrate per well	MGD	2.8	ENR (2004)	7115
Total # of wells		14	ENR (1993)	5210
Distance between wells	LF	500	ENR (1992)	4985
Diameter of injection wells	Inches	14		
Diameter of transmission pipe	Inches	66		

Item	Quantity	Units	Unit Cost	Item Cost
CONSTRUCTION COST				
Injection Wells	14	EA	$37,435	$524,090
Valves	14	EA	7,428	$103,986
Total Injection Wells				**$628,076**
TRANSMISSION COST				
Transmission Pipe	16,587	LF	$859	$14,242,752
Jack and Bore	7	EA	$118,841	$831,889
Canal Crossing	2	EA	$89,131	$178,262
Total Transmission				**$15,252,903**
TOTAL COST				**$15,880,980**
O&M COST ($/year)				**$397,024**

Table 6-14. Miami-Dade/North Shallow Injection Well Costs

Item	Units	Value	Item	Value
Flowrate	MGD	96.9	ENR (2005)	7405.3
Flowrate per well	MGD	2.85	ENR (2004)	7115
Total # of wells		34	ENR (1993)	5210
Distance between wells	LF	500	ENR (1992)	4985
Diameter of injection wells	Inches	16		
Diameter of transmission pipe	Inches	108		

Item	Quantity	Units	Unit Cost	Item Cost
CONSTRUCTION COST				
Injection Wells	34	EA	$38,103	$1,295,519
Valves	34	EA	7,428	$252,538
Total Injection Wells				**$1,548,057**
TRANSMISSION COST				
Transmission Pipe	16,751	LF	$1,405	$23,536,989
Jack and Bore	1	EA	$118,841	$118,841
Canal Crossing	1	EA	$89,131	$89,131
Total Transmission				**$23,744,961**
TOTAL COST				**$25,293,018**
O&M COST ($/year)				**$632,325**

Table 6-15. Miami-Dade/Central Shallow Injection Well Costs

Item	Units	Value	Item	Value
Flowrate	MGD	112	ENR (2005)	7405.3
Flowrate per well	MGD	2.8	ENR (2004)	7115
Total # of wells		40	ENR (1993)	5210
Distance between wells	LF	500	ENR (1992)	4985
Diameter of injection wells	Inches	14		
Diameter of transmission pipe	Inches	60		

Item	Quantity	Units	Unit Cost	Item Cost
CONSTRUCTION COST				
Injection Wells	40	EA	$37,435	$1,497,401
Valves	40	EA	7,428	$297,103
Injection Wells Cost per site				$448,626
Total Injection Wells				**$1,794,504**
TRANSMISSION COST				
Transmission Pipe-Site 1	60,000	LF	$781	$46,836,051
Transmission Pipe-Site 2	19,000	LF	$781	$14,831,416
Transmission Pipe-Site 3	97,000	LF	$781	$75,718,282
Transmission Pipe-Site 4	127,400	LF	$781	$99,448,547
Jack and Bore-Site 1	1	EA	$118,841	$118,841
Jack and Bore-Site 2	1	EA	$118,841	$118,841
Jack and Bore-Site 3	1	EA	$118,841	$118,841
Jack and Bore-Site 4	2	EA	$118,841	$237,683
Canal Crossing-Site 1	1	EA	$89,131	$89,131
Canal Crossing-Site 2	2	EA	$89,131	$178,262
Canal Crossing-Site 3	6	EA	$89,131	$534,786
Canal Crossing-Site 4	8	EA	$89,131	$713,048
Transmission Cost-Site 1				$70,812,288
Transmission Cost-Site 2				$38,896,784
Transmission Cost-Site 3				$100,140,174
Transmission Cost-Site 4				$124,167,543
Total Transmission				**$334,016,789**
O&M Cost-Site 1				$1,781,523
O&M Cost-Site 2				$983,635
O&M Cost-Site 3				$2,514,720
O&M Cost-Site 4				$3,115,404
Total O&M Cost				**$8,395,282**
TOTAL COST				**$335,811,293**
O&M COST ($/year)				**$8,395,282**

Table 6-16. Summary Table for Shallow Injection Well Costs

Plant	AADF (MGD)	Construction Cost ($ million)	Capital Cost* ($ million)	O&M Cost ($million/yr)
Boynton-Delray	12	$6.97	$9.06	$0.17
Boca Raton	8.6	$0.97	$1.26	$0.02
Broward/North	40.5	$7.64	$9.93	$0.19
Hollywood	39.2	$15.88	$20.65	$0.40
Miami-Dade/North	96.9	$25.29	$32.88	$0.63
Miami-Dade/Central	112	$335.81	$436.55	$8.40

* 1.3 times the construction cost to account for engineering, legal, administrative and contingencies

Table 6-17. Annualized Shallow Injection Well Costs

Plant	AADF (MGD)	Annualized Capital Cost* ($ million/yr)	O&M Cost ($ million/yr)	Total Cost ($ million/yr)	Cost ($/1000 gal)
Boynton-Delray	12	$0.86	$0.17	$1.03	0.24
Boca Raton	8.6	$0.12	$0.02	$0.14	0.05
Broward/North	40.5	$0.94	$0.19	$1.13	0.08
Hollywood	39.2	$1.95	$0.40	$2.35	0.16
Miami-Dade/North	96.9	$3.10	$0.63	$3.74	0.11
Miami-Dade/Central	112	$41.21	$8.40	$49.60	1.21

Table 6-18. Shallow Injection Well Total Cost Equations for the Six Plants

Plant	Cost Equation ($million/yr)
Boynton-Delray	$0.1808*Q^{0.7}$
Boca Raton	$0.0317*Q^{0.7}$
Broward/North	$0.0846*Q^{0.7}$
Hollywood	$0.1799*Q^{0.7}$
Miami-Dade/North	$0.1520*Q^{0.7}$
Miami-Dade/Central	$1.8241*Q^{0.7}$

6.2.4 Reverse Osmosis Concentrate Disposal by Deep Well Injection

The procedure for estimating the concentrate costs from the reverse osmosis process for the WWTPs with ocean outfalls are described in this section. The concentrate construction costs include the costs for a conventional pump station that houses the pumps and drives and the costs for deep injection wells through which to dispose of the concentrate. It is assumed that the deep injection wells will be located at the plant sites and therefore no land costs were included. Injection wells are periodically taken out of service and tested to ensure their integrity. Accordingly, operation and maintenance costs include the costs for mechanical integrity testing of the wells. Testing procedures require a well to be out of service from 2 to 8 weeks, depending upon field conditions and status of the well (Hazen and Sawyer 1999).

The characteristics of the deep injection wells that would be required at the respective WWTPs are shown in Table 6-19. A criterion in the selection of the number of deep injection wells at each plant was to have sufficient capacity during non-peak events when one of the wells is out of service during the performance of mechanical integrity testing.

Table 6-19. Characteristics of the Deep Injection Wells for Concentrate Disposal

Plant	Number of wells	AADF per well (MGD)	Diameter of wells (inch)	Capacity per well (MGD)*
Boynton-Delray	2	1.5	12	4.6
Boca Raton	2	1.1	12	4.6
Broward/North	2	5.1	24	18.5
Hollywood	2	4.9	24	18.5
Miami-Dade/North	3	8.0	24	18.5
Miami-Dade/Central	3	9.3	24	18.5

* FDEP allows a peak hourly flow of 18.5 MGD to a 24 inch well (maximum velocity of 10 feet/sec)

The capital costs in 1998 dollars for the construction of a conventional pump station and one or two 24 inch deep injection wells were estimated as $11.1 million and $15.9 million, respectively according to the Hazen and Sawyer (1999) study. The engineering, legal, administrative and contingencies were assumed to be 20% of the construction costs. Based on this information, the construction costs were estimated at each plant and converted to 2005 dollars using the Engineering News Record Index.

Operation and maintenance costs in 2004 dollars were estimated from the Hazen and Sawyer (1992) reuse feasibility study. Mechanical integrity testing costs of four 16 inch wells were estimated as $0.12 million per year for the disposal system, assuming a full mechanical integrity test every 5 yrs and a partial test every 2.5 yrs. The amount needed for each well is therefore $30,000/year.

The total construction and operation and maintenance costs for each plant are summarized in Table 6-20. The annualized costs assuming a 7% discount rate over 20-year period are shown in Table 6-21. The annualized costs in $million/yr were scaled in relation to annual average daily flow using an expression having the form of Equation 6-6 (above). A cost scaling relationship is given for each system in Table 6-22.

Table 6-20. Summary Table for Deep Injection Well Costs

Plant	AADF (MGD)	Construction Cost ($ million)	Capital Cost* ($ million)	O&M Cost ($ million/yr)
Boynton-Delray	3	4.14	4.97	0.06
Boca Raton	2.1	4.14	4.97	0.06
Broward/North	10.1	16.57	19.89	0.06
Hollywood	9.7	16.57	19.89	0.06
Miami-Dade/North	24.1	21.58	25.89	0.09
Miami-Dade/Central	27.9	21.58	25.89	0.09

* 1.2 times the construction cost to account for engineering, legal, administrative and contingencies

Table 6-21. Annualized Deep Injection Well Costs

Plant	AADF (MGD)	Annualized Capital Cost* ($ million/yr)	O&M Cost ($ million/yr)	Total Cost ($ million/yr)	Cost ($/1000 gal)
Boynton-Delray	3	$0.47	$0.06	$0.53	0.49
Boca Raton	2.1	$0.47	$0.06	$0.53	0.69
Broward/North	10.1	$1.88	$0.06	$1.94	0.53
Hollywood	9.7	$1.88	$0.06	$1.94	0.55
Miami-Dade/North	24.1	$2.44	$0.09	$2.54	0.29
Miami-Dade/Central	27.9	$2.44	$0.09	$2.54	0.25

Table 6-22. Deep Injection Well Total Cost Equations for the Six Plants

Plant	**Cost equation** ($million/yr)
Boynton-Delray	$0.2465*Q^{0.7}$
Boca Raton	$0.3164*Q^{0.7}$
Broward/North	$0.3844*Q^{0.7}$
Hollywood	$0.3954*Q^{0.7}$
Miami-Dade/North	$0.2736*Q^{0.7}$
Miami-Dade/Central	$0.2469*Q^{0.7}$

6.4 Case Study of the Broward/North Wastewater Treatment Plant

A case study was performed on the Broward/North Wastewater Treatment Plant. Excellent cost estimation data was available for this service area as Hazen and Sawyer (2004) had conducted a feasibility study on this plant. In addition, this study identified large users that are compatible for traditional water reuse.

As mentioned before, this report differs when naming different levels of reuse in order to provide more data points to examine. Six different traditional reuse levels were examined in this report, including the "Status Quo," "Low," "Medium," and "Large" options. The

"Medium" alternative was subsequently broken up into smaller subgroups to show the effect that distance away from the wastewater treatment plant has in determining when an option become less cost effective. The "Status Quo" alternative is the current level of traditional water reuse being provided in the service area, which is approximately 4.5 MGD. The "Low" alternative takes the plant to near capacity at 9.34 MGD. The "Medium" alternative includes the addition of several large users determined by Hazen and Sawyer (2004), situated throughout the service area. The "Medium Reuse: Large Users North" includes large users that are situated to the north of the treatment plant, and takes the demand flow past the current capacity to 11.34 MGD. The "Medium Reuse: Large Users" option includes all of the large users identified by Hazen and Sawyer (2004) as suitable for traditional water reuse. The demand for this alternative is 19.31 MGD. The "Medium Reuse: Additional Large Users" alternative is an additional point to show a higher demand of traditional water reuse. This point includes all large users identified in the Hazen and Sawyer report, but shows a higher demand flow to account for users not identified but feasible for traditional water reuse as determined from Consumptive Use Permit data. Finally the "Large Reuse" option includes just the large users identified in Hazen and Sawyer (2004) along with a group of residential users that are in close proximity to the traditional reuse network setup. This takes the demand to 41.98 MGD. The different traditional reuse levels and their corresponding flows can be seen in Table 6-23.

Table 6-23. Traditional Reuse Flow Levels with Corresponding Flow Demands for Broward/North Reuse District

Description	Flow Demanded (MGD)
Status Quo	4.46
Low	9.34
Medium Reuse: Large Users North	11.34
Medium Reuse:Large Users	19.31
Medium Reuse:Addl Large Users	30.00
Large Reuse	41.98

The names of the large users and their traditional reuse level are presented in Table 6-24. The locations of these users can be seen in Figure 6-2 with an approximate location of the traditional reuse network. The Broward/North WWTP is located at the intersection of Copans Road and Powerline Road. The large Consumptive User Permit users constitute nearly 18% of the area within 12 miles of the WWTP. Thus, many opportunities exist for traditional water reuse.

Table 6-24. Large Users in Broward/North Reuse District

Status Quo	**Medium Reuse: Large Users**
NRWWTP On-site	Tradewinds Park
WES	Wynmoor Golf Course
Pompano Commerce Park	Palm Aire
Low	Pompano Race Track
NRWWTP On-site	Oriole Golf Course
WES	Palm Lakes Executive Golf Club
Pompano Commerce	Carolina Golf Club
Tam O'Shanter Golf Club	Brokenwoods (Continental) Golf Club
Crystal Lake Country Club	Mullins Park
Medium Reuse: Large Users North	Coral Springs Golf Club
Adios Golf Club	Coral Springs Cypress Park
Quiet Waters Park	Eagle Trace Golf Club
Deer Creek Golf Course	Woodmont Golf Club
Century Village Golf Club	Colony West Golf Club

The irrigation demand data from the Hazen and Sawyer (2004) feasibility study are based on an average annual demand of 1.5 inches per week. This application rate differs from the allocated flow in the Consumptive Use Permit data, but for the case study, the Hazen and Sawyer (2004) estimates were used. These flows will be compared to the flows from the permit data for the Broward/North Regional to show that the flows obtained are comparable and can be extrapolated to the other five ocean outfall regions.

Treatment and pumping costs are shown in Table 6-25 and were estimated using methods discussed before. The "Status Quo" and "Low" alternatives show no additional cost because the treatment plant can process the demand flow.

Storage costs, shown in Table 6-26, were estimated by the power function for the medium and large alternatives, as discussed previously. The "Low" alternative used a value found from Hazen and Sawyer (2004). The required volume of the storage tanks for the remaining alternatives was based on 40% of the daily demand. The "Low" scenario assumes that storage is handled on-site and therefore no booster stations or land costs were calculated for this option. The tanks required for the "Medium" and "Large" options take into account that the treatment plant can handle the flow that it currently processes. Also for the "Medium" and "Large" scenarios, no additional storage construction was assumed at the treatment plant as in the "Low" alternative. Instead, these storage tanks with booster stations are to be distributed throughout the service area.

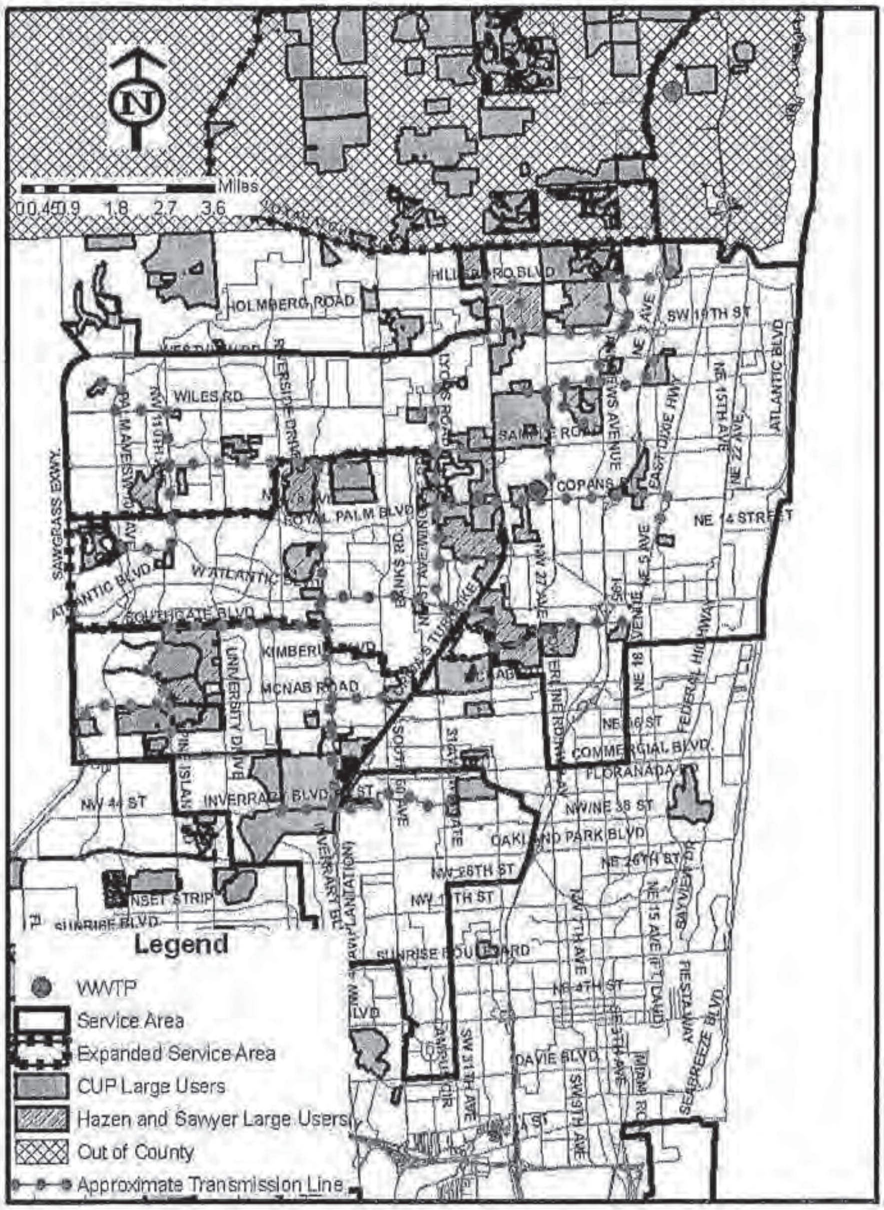

Figure 6-2. Broward/North Large Users and Transmission Line

Table 6-25. Treatment and Pumping Costs for Various Levels of Reuse

Description	Reclaimed Water Treatment	Process Equipment	Auxiliary Equipment	Pumps
Status Quo	$0	$0	$0	$0
Low	$0	$0	$0	$0
Medium Reuse: Large Users North	$1,105,500	$294,800	$73,700	$2,781,655
Medium Reuse:Large Users	$7,680,750	$2,048,200	$512,050	$4,037,585
Medium Reuse:Addl Large Users	$16,500,000	$4,400,000	$1,100,000	$5,496,155
Large Reuse	$26,383,500	$7,035,600	$1,758,900	$6,953,506

Table 6-26. Storage and Land Costs

Description	Storage	Tanks Reqd	Reuse and Booster Pump	Land
Status Quo	$0	0	$0	$0
Low	$1,250,000	0	$0	$0
Medium Reuse: Large Users North	$11,431,458	2	$1,500,000	$370,790
Medium Reuse:Large Users	$16,592,816	3	$2,250,000	$556,186
Medium Reuse:Addl Large Users	$22,586,939	5	$3,750,000	$926,976
Large Reuse	$28,576,050	6	$4,500,000	$1,112,371

Transmission costs are estimated based on the approximate location of the distribution network shown in Figure 6-2 (above). The values for the "Low," "Medium Reuse: Large Users North," and "Large Reuse" were calculated in Hazen and Sawyer (2004). A total of 55,000 residential users were used in the "Large Reuse" category, with an estimated cost of $4,800 per connection used (Hazen and Sawyer 2004). This price includes fifty feet of distribution pipe, a meter, and a dual check valve. The "Medium Reuse: Large Users" and the "Medium Reuse: Additional Large Users" options had the pipes downsized to account for the absence of residential flow. In completing this calculation, a velocity of five feet per second was assumed. These costs, along with the engineering, permitting, and administration costs, can be seen in Table 6-27. These added costs were estimated as 25% of all of the capital costs, not including land.

Table 6-27. Transmission and Engineering Costs

Description	Transmission and Distribution Cost	Engineering, Permitting, and Administration
Status Quo	$0	$0
Low	$1,231,500	$620,375
Medium Reuse: Large Users North	$9,419,866	$6,651,745
Medium Reuse:Large Users	$44,351,236	$19,368,159
Medium Reuse:Addl Large Users	$76,764,865	$32,649,490
Large Reuse	$349,886,170	$106,273,431

Finally, annual operation and maintenance costs were separated into five-year blocks and estimated as described previously. The values, seen in Table 6-28, were then brought back to a present value, which is 2004 dollars, using a discount rate of 7%.

Table 6-28. Annual Operation and Maintenance Costs

Description	O&M				
	1-5 years	6-10 years	11-15 years	16-20 years	PV @ i=7.0%
Status Quo	$284,883	$341,859	$396,556	$452,074	$3,665,843
Low	$596,593	$715,911	$830,457	$946,721	$7,676,900
Medium Reuse: Large Users North	$889,907	$1,067,888	$1,238,750	$1,412,175	$11,451,238
Medium Reuse:Large Users	$1,515,352	$1,818,423	$2,109,370	$2,404,682	$19,499,419
Medium Reuse:Addl Large Users	$2,354,250	$2,825,100	$3,277,116	$3,735,912	$30,294,282
Large Reuse	$3,294,381	$3,953,257	$4,585,778	$5,227,787	$42,391,798

All costs in 2004 dollars are added, and are converted to 2005 dollars using the Engineering News Record index. The present worth over the twenty-year period is calculated using a 7% discount rate in Table 6-29 and can then be converted to a daily cost and plotted against flow in thousands of gallons per day.

Table 6-29. Present Value and Equivalent Uniform Annual Costs

Description	Q (kgd)	Total Cost (2004$)	Total Cost (2005$)	Annual Costs, i=7.0%, N=20	Daily Cost
Status Quo	4,460	$3,665,843	$3,815,259	$360,133	$987
Low	9,340	$10,778,775	$11,218,106	$1,058,910	$2,901
Medium Reuse: Large Users North	11,340	$45,080,753	$46,918,197	$4,428,746	$12,134
Medium Reuse:Large Users	19,310	$116,896,401	$121,660,977	$11,483,936	$31,463
Medium Reuse:Addl Large Users	30,000	$194,468,706	$202,395,049	$19,104,661	$52,342
Large Reuse	41,980	$574,871,327	$598,302,484	$56,475,522	$154,727

The resulting graph, shown as Figure 6-3, has an excellent coefficient of determination (R^2) when a power function is fit to the data. The cost function was also plotted using the same users identified in the Hazen and Sawyer (2004) report, but with flows obtained from Consumptive Use Permit data. As mentioned before, the difference between the two data sets does not result in a large difference when calculating marginal costs.

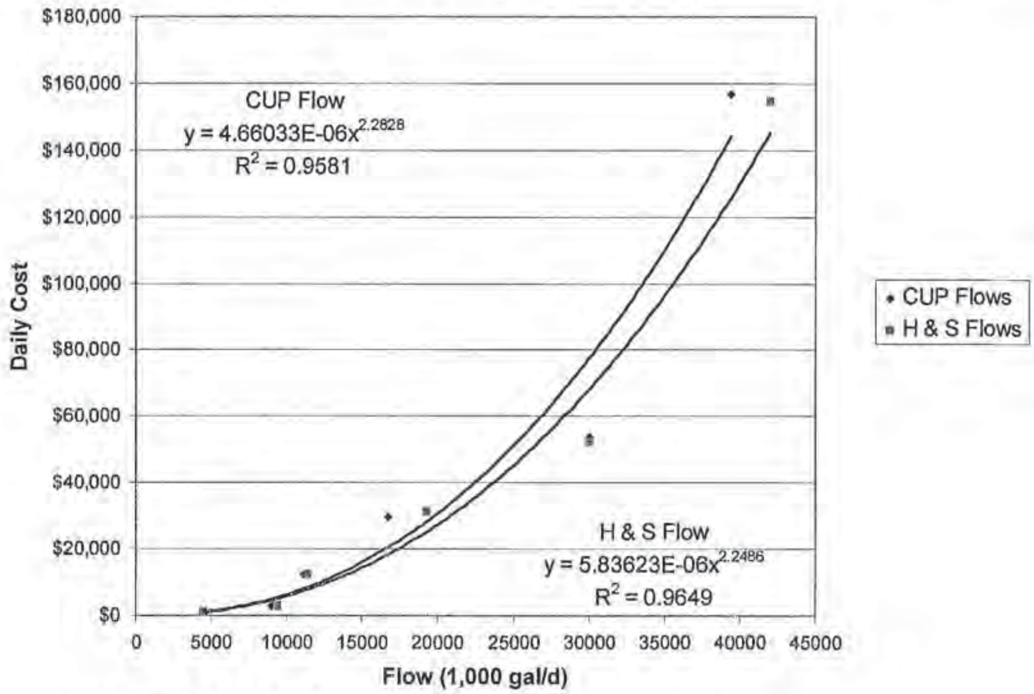

Figure 6-3. Daily Cost versus Flow

The resulting power function for the Hazen and Sawyer data was found to be:

$$C = .00000583623Q^{2.24859} \qquad (6\text{-}7)$$

where C equals total daily costs and Q equals flow in thousand gallons per day.

The derivative of this total cost function gives the marginal cost curve, as seen in Equation 6-8.

$$MC = ab^{*}Q^{b-1} \qquad (6\text{-}8)$$

Using the parameters from the total cost function, i.e., a = 5.83623 E-06 and b = 2.24859, the equation for the marginal cost is

$$MC = 1.29901\ E\text{-}05^{*}Q^{1.24859} \qquad (6\text{-}9)$$

where MC = marginal cost, \$/1,000 gallons, and Q = demand in 1,000 gal/day.

In economics parlance, the marginal cost curve is the supply curve. Customers who decrease irrigation demand on the central water system save an estimated \$4.04 per 1,000 gallons in 2002 dollars, or \$4.58 in 2005 dollars. Thus, the optimal amount of water reuse to provide in this case is about 26.5 MGD as shown in Figure 6-4. If user savings are \$2.00 per 1,000 gallons, then the optimal amount is about 14 MGD. Similarly, if the user savings are \$6.00 per 1,000 gallons, then the optimal amount of reuse is about 34 MGD. The use of intermediate data points allows these total and marginal cost curves to be generated more accurately.

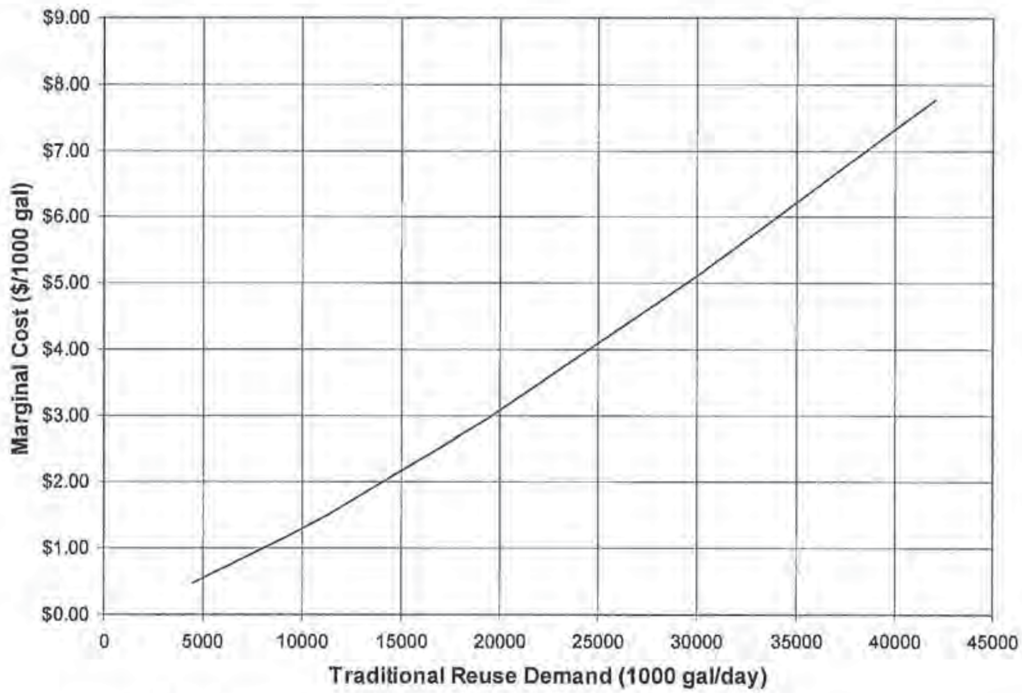

Figure 6-4. Marginal Cost of Providing Water Reuse.

Another, and equivalent, way to evaluate the benefits and costs is to look at total values. The total daily benefits and costs are presented in Table 6-30. If total values are used, then the objective function is to maximize total benefits minus total costs. If the value of water reuse is \$4.58/1,000 gallons, then the total benefits of reuse exceed the total costs over the entire range of flows. However, the best solution is where net benefits are maximized. For the indicated data, this occurs at 30 MGD. Using the fitted equation, as was done for the marginal cost analysis, the actual optimal amount turns out to be 26.2 MGD.

However, public utilities typically seek to break even rather than maximizing net revenues, that is, the daily benefits equaling the daily costs. As evident in Table 6-30, additional traditional reuse flow can be added until this situation occurs. Daily costs and daily benefits are plotted as a function of flow in Figure 6-5. If the two regression lines are set equal to one another, the total flow to satisfy a break-even condition is 52.6 MGD. This value should be used with caution, however. If additional residential users are added to achieve this flow, the costs will exceed the benefits before 52.6 MGD as the transmission costs increase greatly for residential use.

Table 6-30. Cost Savings

Description	Flow Demanded (MGD)	Potable Water Cost (2002$/1000gal)	Daily Benefits (2002$/day)	Daily Benefits (2005$/day)	Daily Benefits - Daily Costs ($/day)
Status Quo	4.46	$4.04	$18,018	$20,408	$19,421
Low	9.34	$4.04	$37,734	$42,737	$39,836
Medium Reuse: Large Users North	11.34	$4.04	$45,814	$51,889	$39,755
Medium Reuse:Large Users	19.31	$4.04	$78,012	$88,358	$56,895
Medium Reuse:Addl Large Users	30.00	$4.04	$121,200	$137,272	$84,931
Large Reuse	41.98	$4.04	$169,599	$192,090	$37,362

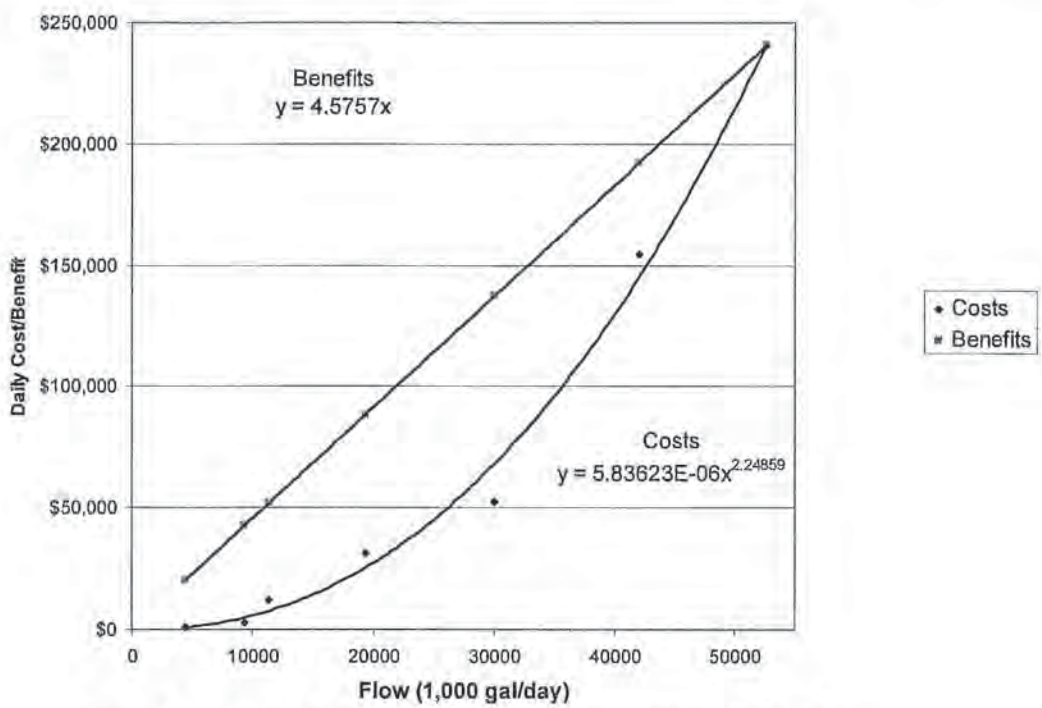

Figure 6-5. Daily Costs and Daily Benefits as a Function of Flow

It was mentioned before that the flows in the Hazen and Sawyer (2004) report were based on an irrigation rate of 1.5 inches per week using the irrigable acres for each of the large users. However, the flow values extracted for use in the other five regions used daily allocation values given in the Consumptive Use Permit data, as discussed earlier. It was discussed how this difference in flow values does not affect marginal cost; however Consumptive Use

Permit data also indicate more large users in the Broward/North Regional environs. In spite of this fact, by comparing the maps in Figure 5-5 and Figure 6-2 (both above), the golf courses and landscaped areas considered to be large users by the new designation are located close to the large users already identified by Hazen and Sawyer. Therefore they can be easily served by the traditional reuse distribution network setup for this case study and will not affect marginal cost values greatly with greater transmission lengths.

By looking at the analysis thus far, it can be seen that transmission costs, and therefore, distance away from the wastewater treatment plant plays a vital role in determining if a user should be considered for reuse. The users and demanded flow determined by Hazen and Sawyer (2004) are spread throughout the Broward/North Regional. However, at $2.95 per thousand gallons to provide traditional water reuse, it is considered quite attractive in spite of the distance from the wastewater treatment plant. It can also be seen from Figure 6-2 that while some users may be at larger distances from the wastewater treatment plant, they tend to be grouped together.

An analysis was conducted on one such group to the north of the Broward/North WWTP in Broward County to determine the effect of distance on marginal costs. Flow data from Consumptive Use Permits, with the exception of on-site use for the treatment plant, WES, and Quiet Waters Park, were employed for the twelve users in this group, as described in Table 6-31.

Table 6-31. Large Users to the North of the Broward/North WWTP

Large User	Flow, MGD
NRWWTP (ON-SITE)	5.390
CENTRAL SANITARY LANDFILL AND RECYCLING CENTER	0.078
WES	2.300
CRYSTAL LAKE COUNTRY CLUB/TAM O'SHANTER GOLF CLUB	0.682
HIGHLAND VILLAGE MOBILE PARK	0.064
DEERFIELD BEACH HIGH SCHOOL	0.050
MEADOWS OF CRYSTAL LAKE	0.055
CENTURY VILLAGE EAST	1.504
DEER CREEK COUNTRY CLUB COMMUNITY	0.316
DEER CREEK GOLF COURSE	0.439
DEERFIELD COUNTRY CLUB	0.224
THE WATERWAYS	0.412
QUIET WATERS PARK	0.330
ADIOS GOLF CLUB	0.242

Estimating the costs of these users was carried out in the same way as the overall cost estimation. The cost was estimated to provide traditional water reuse to one user, and then expanded by adding additional users until all twelve were served to see the effect of adding to the distribution network. The length of the transmission lines was estimated using Figure 6-2 and sized by dividing the demand by an assumed velocity of five feet per second. The costs of the transmission lines were estimated assuming paved construction only. The expansion of the traditional reuse distribution network along with present value costs and annual costs can be seen in Table 6-32. The flows shown in this table are the cumulative total flows and the large users are arranged in increasing distances from the Broward/North Wastewater Treatment Plant.

Table 6-32. Present and Annual Costs for Large Users North of Wastewater Treatment Plant

From Node (i)	To Node (j)	Distance (mi)	Flow Demanded (MGD)	Total Cost (2005$)	Annual Worth, i=7.0%, N=20
NRWWTP	NRWWTP (ON-SITE)	0.000	5.390	$4,610,817	$435,229
NRWWTP	CENTRAL SANITARY LANDFILL AND RECYCLING	1.412	5.468	$14,330,881	$1,352,734
NRWWTP	WES	2.501	7.768	$20,634,402	$1,947,742
NRWWTP	CRYSTAL LAKE COUNTRY CLUB/TAM O'SHANTER	3.560	8.450	$23,344,288	$2,203,536
NRWWTP	MEADOWS OF CRYSTAL LAKE	4.586	8.506	$23,975,514	$2,263,119
NRWWTP	HIGHLAND VILLAGE MOBILE PARK	5.717	8.570	$24,677,764	$2,329,406
NRWWTP	DEERFIELD BEACH HIGH SCHOOL	6.343	8.620	$25,092,357	$2,368,541
NRWWTP	CENTURY VILLAGE EAST	7.907	10.124	$34,708,050	$3,276,194
NRWWTP	DEER CREEK COUNTRY CLUB COMMUNITY	8.874	10.441	$36,798,925	$3,473,558
NRWWTP	DEER CREEK GOLF COURSE	9.036	10.880	$39,732,984	$3,750,513
NRWWTP	DEERFIELD COUNTRY CLUB	10.027	11.104	$41,608,800	$3,927,576
NRWWTP	THE WATERWAYS	12.023	11.517	$44,451,327	$4,195,891
NRWWTP	QUIET WATERS PARK	12.473	11.847	$46,153,783	$4,356,591
NRWWTP	ADIOS GOLF CLUB	13.934	12.088	$47,730,422	$4,505,414

A total cost function can again be plotted using daily cost versus flow in thousands of gallons per day as shown in Figure 6-6.

The power function fit to this equation is shown in Equation 6-10.

$$C = 0.0000108498Q^{2.22477} \tag{6-10}$$

The marginal costs for each expanded segment of the distribution network can be calculated by taking the derivative of this total cost function. The resulting marginal cost equation is Equation 6-11.

$$MC = 0.000024138Q^{1.22477} \tag{6-11}$$

The marginal costs at the various distances are shown in Table 6-33. They range from \$0.90/1,000 gallons to \$2.41/1,000 gallons at a distance of 13.9 miles. Distances are measured using the metropolitan metric to more accurately represent that pipelines would follow north-south, east-west pathways. Marginal costs increase with metropolitan distance from the wastewater treatment plant. However, due to the density of large users in this area, there are certain places where marginal cost remains relatively constant as distance increases. The large user is considered more attractive to serve if other large users that can share the cost of expanding the plant's traditional water reuse capacity surround it.

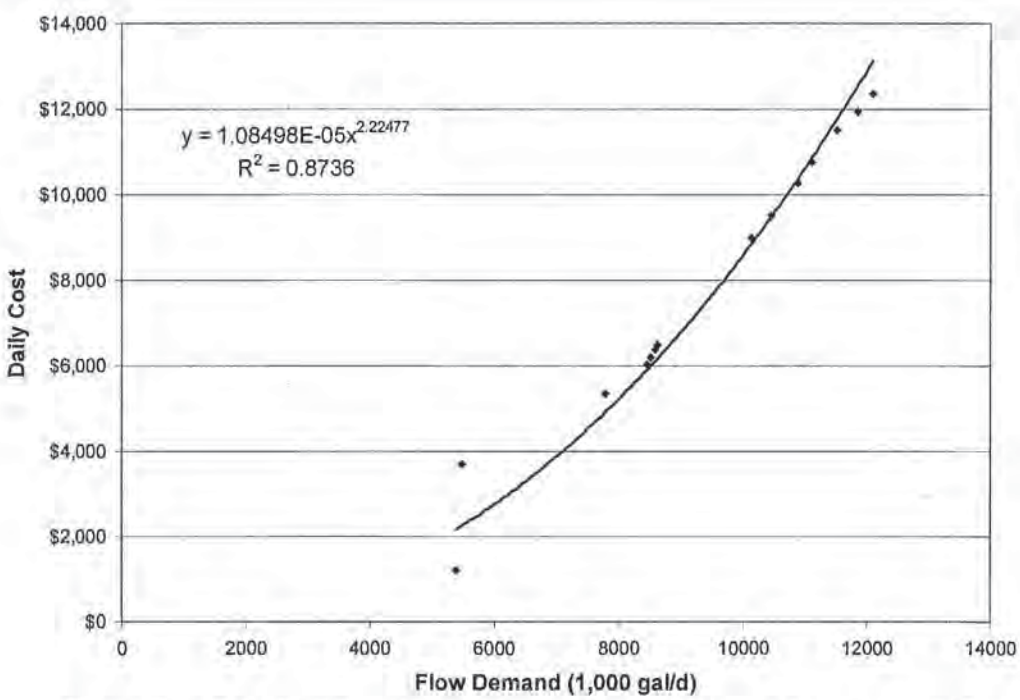

Figure 6-6. Total Cost Function for Users to North of Wastewater Treatment Plant

Table 6-33. Marginal Costs for Large Users North of Wastewater Treatment Plant

From Node (i)	To Node (j)	Distance (mi)	Flow Demanded (MGD)	Marginal $/k gal
NRWWTP	NRWWTP (ON-SITE)	0.000	5.390	$0.90
NRWWTP	CENTRAL SANITARY LANDFILL AND RECYCLING	1.412	5.468	$0.91
NRWWTP	WES	2.501	7.768	$1.40
NRWWTP	CRYSTAL LAKE COUNTRY CLUB/TAM O'SHANTER	3.560	8.450	$1.56
NRWWTP	MEADOWS OF CRYSTAL LAKE	4.586	8.506	$1.57
NRWWTP	HIGHLAND VILLAGE MOBILE PARK	5.717	8.570	$1.58
NRWWTP	DEERFIELD BEACH HIGH SCHOOL	6.343	8.620	$1.60
NRWWTP	CENTURY VILLAGE EAST	7.907	10.124	$1.94
NRWWTP	DEER CREEK COUNTRY CLUB COMMUNITY	8.874	10.441	$2.02
NRWWTP	DEER CREEK GOLF COURSE	9.036	10.880	$2.12
NRWWTP	DEERFIELD COUNTRY CLUB	10.027	11.104	$2.18
NRWWTP	THE WATERWAYS	12.023	11.517	$2.27
NRWWTP	QUIET WATERS PARK	12.473	11.847	$2.35
NRWWTP	ADIOS GOLF CLUB	13.934	12.088	$2.41

6.5 Developing Consumptive Use Permit Flows

The total cost function shown in Figure 6-6 (above) shows that the demand flows for traditional water reuse from Hazen and Sawyer (2004) compare well to the daily allocation values found in the Consumptive Use Permit data. Therefore, it is possible to extrapolate the Consumptive Use Permit data to all six wastewater treatment plants with ocean outfalls. This will permit an evaluation to how much wastewater can be allocated to traditional reuse, thereby reducing the flow discharged to the ocean. The methods discussed in Chapter 5 using Consumptive Use Permit flow data are also used in this evaluation.

Golf courses and landscaped areas within the urban areas of Palm Beach, Broward, and Miami-Dade Counties are summarized in Table 6-34. The first row shows the urbanized area of these counties, as approximated using GIS software. Broward County has the largest area of 386 square miles. The total urbanized area for the three counties is 962 square miles. The number of golf courses with Consumptive Use Permits varies widely, ranging from 98 for Palm Beach County to 26 for Miami-Dade County, and totals 164 among the three counties. Water use per golf course is fairly consistent across the three service areas, averaging 0.47 MGD. The total water demand for golf courses is 77.5 MGD, with Palm Beach County accounting for 47.9 MGD of this total. The 396 landscape large users have a total demand of 70.2 MGD, with an average demand of about 0.18 MGD per user. Palm Beach and Broward Counties account for 35.4 and 30.4 MGD, respectively, of this amount. The total demand for all large users is 148 MGD. Palm Beach County accounts for 83.3 MGD of this total. Broward County has a total large user demand of 49.3 MGD and Miami-Dade has a total large user demand of 15 MGD. These totals indicate that the more promising areas for traditional reuse are Palm Beach and Broward Counties.

Table 6-34. Summary of Urban Users

Attribute	Palm Beach	Broward	Miami-Dade	Total
Approximate Urban Area, sq. mi.	268	386	308	962
Golf Users	98	40	26	164
Golf Demand, MGD	47.949	18.920	10.615	77.484
Golf MGD per course	0.489	0.473	0.408	0.472
Landscape Users	228	140	28	396
Landscape Demand, MGD	35.377	30.423	4.373	70.173
Landscape MGD per user	0.155	0.217	0.156	0.177
Total Users	326	180	54	560
Total Demand, MGD	83.326	49.343	14.988	147.657
Average Irrigation Rate, in/yr	6.537	2.685	1.022	3.225

Traditional reuse flow for each of the six wastewater treatment plants with ocean outfalls is summarized in Table 6-35. The service areas of each wastewater treatment plant as described by their individual consultant reports are reported in the first line. The second portion of each section shows the number of large users as described earlier within each of the six service areas. The service areas for the Broward/North WWTP in Broward County and the Boynton-Delray WWTP in Delray Beach include the greatest amount of large users.

Table 6-35. Summary of Traditional Reuse Demands

Broward/North			Boynton-Delray			Miami-Dade/North		
Approx Area	28	mi^2	Approx Area	46	mi^2	Approx Area	128.95	mi^2
Service Area			**Service Area**			**Service Area**		
Large Users	47		Large Users	40		Large Users	16	
Flow Demand	17.0	MGD	Flow Demand	9.1	MGD	Flow Demand	4.5	MGD
Expanded Service Area			**Expanded Service Area**			**Expanded Service Area**		
Large Users	53		Large Users	90		Large Users	16	
Flow Demand	18.8	MGD	Flow Demand	22.1	MGD	Flow Demand	4.5	MGD
Feasible Users			**Feasible Users**			**Feasible Users**		
Large Users	53		Large Users	90		Large Users	10	
Flow Demand	18.8	MGD	Flow Demand	22.1	MGD	Flow Demand	3.6	MGD
Hollywood			Boca Raton			Miami-Dade/Central		
Approx Area	46.66	mi^2	Approx Area	14.3	mi^2	Approx Area	253.35	mi^2
Service Area			**Service Area**			**Service Area**		
Large Users	26		Large Users	6		Large Users	17	
Flow Demand	4.8	MGD	Flow Demand	1.8	MGD	Flow Demand	5.5	MGD
Expanded Service Area			**Expanded Service Area**			**Expanded Service Area**		
Large Users	34		Large Users	47		Large Users	17	
Flow Demand	7.6	MGD	Flow Demand	17.7	MGD	Flow Demand	5.5	MGD
Feasible Users			**Feasible Users**			**Feasible Users**		
Large Users	17		Large Users	47		Large Users	9	
Flow Demand	3.2	MGD	Flow Demand	17.7	MGD	Flow Demand	2.9	MGD

The next grouping gives the number of large users and reclaimed water demand for the expanded service areas. The two service areas within Palm Beach County have the greatest potential to provide traditional water reuse by expansion. The Boynton-Delray WWTP could add a possible 50 users by expanding its service area, followed by the Boca Raton WWTP with a potential of 41 additional users. The two plants in Broward County are surrounded by other wastewater treatment plants and therefore have lesser potential. The Miami-Dade/North and Miami-Dade/Central WWTPs have no potential as their combined service area encompasses all Consumptive Use Permit holders.

Finally, the last set of values show the demand for users that were considered feasible for traditional water reuse service. This set of values takes into account large users within the defined service areas of the plants as well as the expanded service areas. In order to determine whether these users would be feasible to serve, the case study for the Broward/North WWTP was used. The case study determined that the flows demanded by large users could be met throughout the 28 square mile service area. Transmission costs are a key factor in determining whether it is feasible to serve a large user, as determined by an analysis completed on a group of large users to the north of the treatment plant. The largest distance from a large user to the Broward/North WWTP was twelve miles.

Additionally, cumulative daily demand was plotted against distance from the wastewater treatment plant for all six reuse districts, as originally shown in Chapter 5 (Fig. 5-7). As mentioned before, the Boynton-Delray, Boca Raton, and Broward/North WWTPs exhibit high flow per mile values. In addition, all of the large users could be reached with a transmission line that was less than twelve miles in length. Therefore, all of the large users identified in these service areas were determined to be feasible for traditional water reuse. Several large users in the remaining three reuse districts went beyond twelve miles, as seen in Figure 6-7. Therefore, the highest flow per mile value was found near this twelve-mile mark, and the users outside this mark were considered infeasible and therefore were excluded.

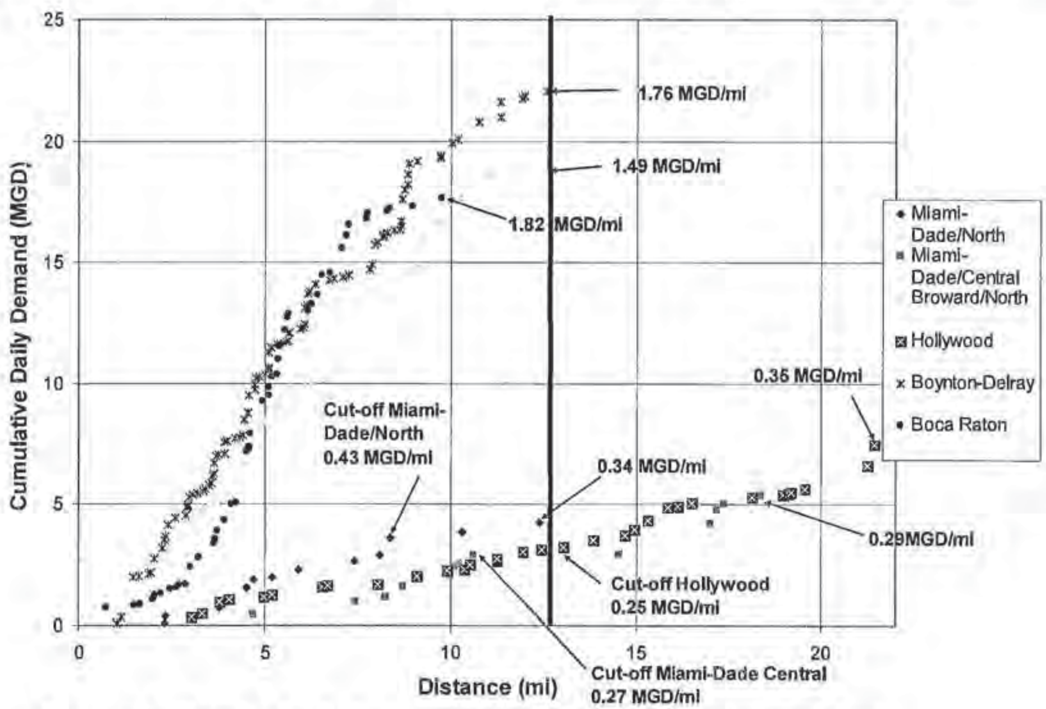

Figure 6-7. Cumulative Daily Demand versus Metropolitan Distance from Wastewater Treatment Plant

The twelve-mile cut-off is based on the marginal cost curve of Figure 6-4 for the Broward/North WWTP. The case study found that the benefits of using traditional water reuse were $4.58 per thousand gallons. If the benefits of using traditional water reuse are higher, as is the case in other counties, the optimal amount of flow would be greater, and the twelve-mile cut-off would be extended.

As evident in Table 6-35, there are large users with potential demand for traditional water reuse that are not feasible to serve from the central plant. The use of satellite treatment facilities could make it feasible to serve these users and the greatest potential lies in the Hollywood, Miami-Dade/North, and Miami-Dade/Central reuse districts. As discussed in Chapter 5, previous experience shows that satellite plants are capable of producing 0.01-35 MGD of reclaimed water with reasonable distribution costs. There is a potential traditional water reuse demand of 4.4 MGD (17 large users), 0.9 MGD (6 large users), and 2.6 MGD (8 large users) in the Hollywood, Miami-Dade/North, and Miami-Dade/Central reuse districts, respectively. Additionally, these large users tend to be grouped together spatially as the longest distance between two large users is less than 10 miles (using the metropolitan distance). Adding to the potential for satellite plants is the possible inclusion of industrial users. As mentioned in Chapter 5, there is industrial user demand in all six reuse districts, although it is mainly concentrated in the Miami-Dade/Central district. Consumptive Use Permit data indicate a total industrial water demand of approximately 27.5 MGD within the Miami-Dade Central reuse district, of which 15.4 MGD is located outside the twelve mile feasibility limit. If a further analysis is conducted in order to evaluate the needs of these large industrial users, the traditional water reuse demand could increase dramatically through the utilization of satellite plants in the Miami-Dade/Central reuse district.

6.6 Summary

This chapter was able to produce cost estimating strategies for groundwater recharge and traditional water reuse, which are two major alternatives to disposing effluent through ocean outfalls. As the data shows, the costs are dependent on the size of the system needed based on flow values and transmission requirements.

The case study in Section 6.4 shows that the large users selected in Chapter 5 can be served in a cost effective manner as the benefits of using a reuse water system minus the costs is at a maximum under that scenario. The introduction of residential users still allows for a breakeven situation, but was proven to not be as effective as the large user only scenario. A further step would be to use a select number of residential users identified by the Hazen and Sawyer (2004) report to find a proportion that does maximize benefits minus costs. An overall optimization problem on all six reuse districts can also be prepared to determine how the reuse network should be setup to maximize cost effectiveness.

The use of satellite plants has a potential to add traditional water reuse demand for the Hollywood, Miami-Dade/North, and Miami-Dade/Central reuse districts. All large users that were deemed infeasible due to their large distance from the central plants are within ten miles (metropolitan distance) of each other in the three districts. A properly placed satellite plant would provide additional water reuse while keeping the costs of distribution at a minimum.

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7. Wastewater Management Options for Alternative Ocean Outfall Strategies

7.1 Alternative Ocean Outfall Strategies

Four alternative ocean outfall strategies were examined under the defined scope of this study. Under the Currently Planned Use alternative (Alt I), ocean outfalls would be used at currently planned levels. Under the Limited Use Alternative (Alt II), ocean outfall disposal would be limited to flows remaining after traditional reuse options were maximized and underground injection flows reached full 2005 permitted capacity. Under the Ocean Outfalls as Backups alternative (Alt III), ocean disposal would only be used during wet weather periods to handle flow that would otherwise go to traditional reuse. Complete elimination of ocean outfalls was considered under the No Use alternative (Alt IV). Florida's 1.2 BGD reuse capacity clearly indicates that reuse is feasible within Florida and that state statutes (403.064 and 373.250, F.S.) encourage and promote water reuse. Therefore, it is assumed that unaccounted for flows will be directed to reuse in alternatives that involve some level of curtailment of ocean outfalls.

The assumption was made that permitted capacities of the ocean outfalls would be maintained at 2005 levels and that no additional ocean outfalls would be permitted. It was also assumed that Class I injection control wells for effluent disposal would be held at 2005 permitted capacities and, furthermore, that Class I injection wells for effluent disposal that were in testing or under construction during 2005 would not receive permits.

7.2 Priorities for Allocating Effluent and Reclaimed Water Flows

Four options for wastewater management in Southeast Florida were considered in this study: disposal of treated effluent through ocean outfalls, disposal of treated effluent through Class I injection wells, traditional reuse of reclaimed water, and groundwater recharge of reclaimed water. Groundwater can be recharged through surface spreading, vadose zone injection wells or direct injection of reclaimed water (CDM 2004). Canals in Southeast Florida can be used to recharge groundwater with reclaimed water. The present study examines only the direct injection method for groundwater recharge. A canal recharge option is being evaluated in another study that is still in progress. The surface water quality constraints on canal recharge may require similar treatment levels to those required for direct injection of reclaimed water.

In consideration of the above criteria, effluent and reclaimed water flows in the four ocean outfall alternatives were allocated as indicated below:

Alternative I—Ocean outfalls used at current levels

- Priority 1: Use utility's projections and plans (supplemented by UF projections) for flows to the existing ocean outfalls—capping flows at 2005 permitted capacities.
- Priority 2: Use utility's projections and plans (supplemented by UF projections) for flows to the existing underground injection wells—capping flows at 2005 permitted capacities.

- Priority 3: Use utility's projections and plans (supplemented by UF projections) for flows to traditional[1] reuse activities.
- Priority 4: Direct flows not allocated in Priorities 1–3 above to groundwater recharge[2].

Alternative II—Ocean outfalls used for flows not expected to be handled by reuse or other disposal options

- Priority 1: Use utility's projections and plans (supplemented by UF projections) for flows to traditional reuse activities.
- Priority 2: Use utility's projections and plans (supplemented by UF projections) for flows to the existing underground injection wells—capping flows at 2005 permitted capacities.
- Priority 3: Use utility's projections and plans (supplemented by UF projections) for flows to existing ocean outfalls—capping flows at 2005 permitted capacities.
- Priority 4: Direct flows not allocated in Priorities 1–3 above to groundwater recharge.

Alternative III—Ocean outfalls used as backups to traditional reuse activities

- Priority 1: Use utility's projections and plans (supplemented by UF projections) for flows to traditional reuse activities.
- Priority 2: Use utility's projections and plans (supplemented by UF projections) for flows to the existing underground injection wells—capping flows at 2005 permitted capacities.
- Priority 3: Use ocean outfalls only as backups to traditional reuse activities (no dry weather flows to the ocean)—capping flows at 2005 permitted capacities.
- Priority 4: Direct flows not allocated in Priorities 1–3 above to groundwater recharge.

Alternative IV—Ocean outfalls not used

- Priority 1: Ocean outfalls are not used.
- Priority 2: Use utility's projections and plans (supplemented by UF projections) for flows to traditional reuse activities.
- Priority 3: Use utility's projections and plans (supplemented by UF projections) for flows to the existing underground injection wells—capping flows at 2005 permitted capacities.
- Priority 4: Direct flows not allocated in Priorities 1–3 above to groundwater recharge.

Each of the four alternatives was evaluated over a 20-year planning period, beginning in 2005, for each of the WWTPs having ocean outfalls.

7.3 Effluent and Reclaimed Water Flow Distributions

Wastewater flow projections for the years 2005–2025 from Chapter 2 were used together with the priorities described above to determine the distributions of effluent and reclaimed water flow under the four alternatives. This exercise was carried out for each of the six WWTPs for the years 2005–2025 in five year increments as shown in Tables 7-3 through 7-8. The progression of flows to the respective reuse and disposal options is not necessarily the

[1] Part III activities—golf courses, parks, residential and Part VII industrial uses
[2] Permitted under Part V, injection to groundwater having TDS < 1000 mg/L

same as the flows that would be used in a constructed alternative. This is because the implementation schedule of various treatment capabilities in a constructed alternative would be optimized over the appropriate project period (e.g., the years 2005–2025), whereas the flows in the tables were determined by the priorities defined in Chapter 7, Section 7.2, along with the feasible extent of public access reuse based on methodology explained in Chapters 5 and 6. A number of the alternatives involve construction of groundwater recharge treatment units in 2005 which are later replaced by traditional reuse treatment units. The useful life of these groundwater recharge facilities would be 20 years; thus implementation of traditional reuse would be a reasonable alternative for retrofitting them.

The reclaimed water flows to traditional reuse for each of the six WWTPs under Alternative I are summarized in Table 7-1. The flows to traditional reuse for each of the six WWTPs under Alternatives II, III and IV are summarized in Table 7-2.

7.3.1 Effluent and Reclaimed Water Distribution for the Boynton-Delray WWTP

The distribution of effluent and reclaimed water from the Boynton-Delray WWTP under the four ocean outfall alternatives is summarized in Table 7-3. The rationale for the flow allocations is discussed below.

a) Flows to traditional reuse under Alternative I. The utility currently delivers 3.7 MGD flow for traditional reuse, which includes 2.2 MGD for golf course irrigation (5 golf courses), 0.8 MGD for residential irrigation (FL DEP 2004) and 0.7 MGD for on-site irrigation at the WWTP. The on-site irrigation was estimated by subtracting the on-site process use from the total on-site use of 1.3 MGD (FL DEP 2004). The on-site process use was calculated using the information given for Broward/North WWTP. This plant will need about 0.5 MGD for process use when the plant is expanded from 80 to 100 MGD (Hazen and Sawyer 2004). Therefore it was assumed that 2.5% of the plant capacity will be used for process use. The utility plans to provide reclaimed water to new users, including 0.8 MGD for irrigation of four golf courses and 0.4 MGD for residential irrigation, by the year 2010 (FL DEP 2005). Traditional reuse is expected to increase to 6.2 MGD in 2015 through additional flows of 1.4 MGD for golf course and residential irrigation in Areas 1 through 8 (Matthews Consulting 2003). The water reclamation capacity is expected to increase to 7.5 MGD by 2025, after a reclaimed water flow of 1.3 MGD is provided to Areas 9 through 16 via the ocean outfall pipeline, as suggested by Matthews Consulting (2003).

b) Flows to traditional reuse under Alternatives II, III and IV. The Consumptive Use Permits were used, as explained in Chapters 5 and 6, to project traditional reuse demand. Reuse flows of 6.5 MGD by year 2010, 12.9 MGD by year 2015, and 19.7 MGD by year 2020 are expected as the large users within 3, 6, and 9 mile metropolitan distances of the WWTP are connected. A reclaimed water flow of 22.7 MGD is expected by 2025 through inclusion of all large users within a metropolitan distance of 12.6 miles of the WWTP.

Table 7-1. Traditional Reuse and On-site Process Flows under Alternative I

Year	Boynton-Delray[1]	Boca Raton[2]	Broward/North[3]	Hollywood[4]	Miami-Dade/North[5]	Miami-Dade/ Central[6]
2005	- 0.6 MGD for on-site process use, - 3.7 MGD for golf course, on-site and residential irrigation	- 0.4 MGD for on-site process use, - 5.2 MGD for golf course, on-site, residential and other public access areas irrigation	- 2.1 MGD for on-site process use, - 2.4 MGD at another facility, on-site and other public access areas irrigation	- 2.6 MGD for golf course irrigation	- 2.2 MGD for on-site process use - 0.1 MGD for other public access areas irrigation	- 8.9 MGD for on-site process use
2010	Add 1.2 MGD for golf course and residential irrigation	Add 3.7 MGD for golf course, residential and other public access areas irrigation	- Add 2 MGD for on-site process use, - Add 1.8 MGD for another facility and other public access areas irrigation	Add 1.1 MGD for golf course and other public access areas irrigation	-	-
2015	Add 1.4 MGD for golf course and residential irrigation in Areas 1-8	Add 2.4 MGD for residential and other public access areas irrigation	Add 1 MGD for golf course irrigation	-	-	-
2020	Increase reuse capacity to 24 MGD	Add 2.4 MGD for residential and other public access areas irrigation	-	-	-	-
2025	Add 1.3 MGD for public access reuse in Areas 9-16	Add 2.4 MGD for residential and other public access areas irrigation	-	-	-	-

Sources: [1] (PBS&J 2003; FL DEP 2004); (FL DEP 2005), [2] (PBS&J 2003; FL DEP 2004), [3] (Hazen and Sawyer 2004), [4] (FL DEP 2004), [5, 6] (PBS&J 2003; FL DEP 2004)

Table 7-2. Traditional Reuse and On-site Process Flows under Alternatives II, III and IV

Year	Boynton-Delray[1]	Boca Raton[2]	Broward/North[3]	Hollywood[4]	Miami-Dade/North[5]	Miami-Dade/Central[6]
2005	- 0.6 MGD for on-site process use, - 3.7 MGD for golf course, on-site and residential irrigation	- 0.4 MGD for on-site process use, - 5.2 MGD for golf course, on-site, residential and other public access areas irrigation	- 2.1 MGD for on-site process use, - 2.4 MGD at another facility, on-site and other public access areas irrigation	- 2.6 MGD for golf course irrigation	- 2.2 MGD for on-site process use - 0.1 MGD for other public access areas irrigation	- 8.9 MGD for on-site process use
2010	Add 2.8 MGD by large users within 3 mile*	Add 0.9 MGD by large users within 2 mile*	- Add 2 MGD for on-site process use, - Add 1.8 MGD for another facility and other public access areas irrigation	Add 1.1 MGD for golf course and other public access areas irrigation	Add 0.4 MGD by large users within 3 mile*	Add 0.4 MGD by large users within 5 mile*
2015	Add 6.4 MGD by large users within 6 mile*	Add 3.5 MGD by large users within 4 mile*	Add 5.2 MGD by large users within 4 mile*	Add 0.6 MGD by large users within 5 mile*	Add 1.5 MGD by large users within 5 mile*	Add 0.6 MGD by large users within 8 mile*
2020	Add 6.8 MGD by large users within 9 mile*	Add 8.5 MGD by large users within 6 mile*	Add 6.1 MGD by large users within 8 mile*	Add 1 MGD by large users within 10 mile*	Add 0.4 MGD by large users within 7 mile*	Add 1.1 MGD by large users within 10 mile*
2025	Add 3 MGD by large users within 12.6 mile*	Add 3.2 MGD by large users within 7.2 mile* (Alternatives II and IV)**	Add 7.5 MGD by large users within 12.6 mile*	Add 0.9 MGD by large users within 12.5 mile*	Add 1.3 MGD by large users within 8.4 mile*	Add 0.8 MGD by large users within 10.6 mile*

Sources: [1,2,3,4,5,6] (PBS&J 2003; FL DEP 2004), [3] (Hazen and Sawyer 2004), [4] (FL DEP 2004)
* Metropolitan distance of the WWTP
** Add 1.6 MGD by large users within 6.5 mile (Alternative III)

Table 7-3. Flow distribution for Boynton-Delray WWTP

Alt.	Year	WWTP effluent (MGD)	Ocean outfall (MGD)	Traditional reuse (MGD)	Groundwater recharge (MGD)	RO concentrate (MGD)
I	2005	19.4	15.7	3.7	0.0	0.0
	2010	21.3	16.4	4.8	0.0	0.0
	2015	23.2	17.0	6.2	0.0	0.0
	2020	25.2	19.0	6.2	0.0	0.0
	2025	27.1	19.6	7.5	0.0	0.0
II	2005	19.4	15.7	3.7	0.0	0.0
	2010	21.3	14.7	6.5	0.0	0.0
	2015	23.2	10.3	12.9	0.0	0.0
	2020	25.2	5.4	19.7	0.0	0.0
	2025	27.1	4.4	22.7	0.0	0.0
III	2005	19.4	0.4	3.7	12.2	3.1
	2010	21.3	0.7	6.5	11.2	2.8
	2015	23.2	1.4	12.9	7.1	1.8
	2020	25.2	2.1	19.7	2.7	0.7
	2025	27.1	2.4	22.7	1.5	0.4
IV	2005	19.4	0.0	3.7	12.5	3.1
	2010	21.3	0.0	6.5	11.8	2.9
	2015	23.2	0.0	12.9	8.2	2.1
	2020	25.2	0.0	19.7	4.4	1.1
	2025	27.1	0.0	22.7	3.5	0.9

c) Flows to ocean outfall and groundwater recharge. Under Alternatives I and II, the flows remaining after allocation to traditional reuse are sent to ocean outfalls. Since the flows to ocean outfalls would remain below the 2005 permitted capacity of 24 MGD, there would be no flow to groundwater recharge.

Under Alternative III, the ocean outfalls were used only as backups to traditional reuse during wet weather periods. The wet weather period was chosen as the days receiving greater than 0.4 inches of rain. For Boynton-Delray WWTP the wet weather period was 35.5 days. The ocean outfall flow was calculated multiplying the traditional reuse flow with the ratio of the wet and dry days. Flow remaining after allocation to traditional reuse and ocean outfall is directed to groundwater recharge. The groundwater recharge flow is projected to decrease from 12.2 MGD in 2005 to 1.5 MGD in 2025, as flow to traditional reuse increases.

Under Alternative IV, no flow is allowed to the ocean outfall. Flow remaining after allocation to traditional reuse is therefore directed to groundwater recharge. The groundwater recharge flow is projected to decrease from 12.5 MGD in 2005 to 3.5 MGD in 2025. The flow of reverse osmosis concentrate was assumed to be 25% of the reverse osmosis permeate flow that is injected to the potable aquifer for recharge (i.e., 20% of reverse osmosis influent flow). Thus, reverse osmosis concentrate flow varies in proportion to the groundwater recharge flow.

7.3.2 Effluent and Reclaimed Water Distribution for the Boca Raton WWTP

The distribution of effluent and reclaimed water from the Boca Raton WWTP under the four ocean outfall alternatives is summarized in Table 7-4. Rationale for the flow allocations is discussed below.

a) Flows to traditional reuse under Alternative I. The utility currently delivers 5.2 MGD of reclaimed water, including 0.8 MGD for golf course irrigation (2 golf courses with 224 acres), 1.5 MGD for residential irrigation, 2.2 MGD for other public access areas including 0.9 MGD for Florida Atlantic University (FL DEP 2004) and 0.7 MGD for on-site irrigation at the WWTP. The on-site irrigation was estimated by subtracting the on-site process use of 0.4 MGD from the total on-site use of 1.1 MGD. The CDM (1990) reclaimed water system master plan identified reuse demands of 2.1 MGD for golf courses, 9.9 MGD for residences, 2.4 MGD for other public access areas (landscape areas, green spaces, multi-family houses, highway medians, cemeteries, parks, recreational facilities, other public properties) and 0.9 MGD for Florida Atlantic University irrigation. It was assumed that golf course irrigation demand will be met by the year 2010, when 1.3 MGD is delivered to two more golf courses with 135 acres of land, as suggested by CDM (1990). It was also assumed that reclaimed water flows of 2.1 MGD for residential irrigation and 0.3 MGD for irrigation of other public access areas would be added every five years between the years 2010 and 2025 to satisfy the suggested residential and other public access irrigation reclaimed water demand.

b) Flows to traditional reuse under Alternatives II, III and IV. The reuse flow is projected to increase to 6 MGD by year 2010, 9.5 MGD by year 2015, and 18 MGD by year 2020 as large users within metropolitan distances of 2, 4 and 6 miles are connected to the reuse system. Under Alternatives III and IV reuse flows of 19.6 and 21.3 MGD would be reached by year 2025 through inclusion of all large users within 6.5 and 7.2 metropolitan miles of the WWTP.

c) Flows to ocean outfall and groundwater recharge. Under Alternatives I and II, the flows remaining after allocation to traditional reuse are sent to the ocean outfall. Since the flows to the ocean outfall would remain below the 2005 ocean outfall permitted capacity of 17.5 MGD, there would be no flow to groundwater recharge.

Under Alternative III, the wet weather period was 35.5 days for Boca Raton WWTP. The ocean outfall flow was calculated multiplying the traditional reuse flow with the ratio of the wet and dry days. Flow remaining after allocation to traditional reuse and ocean outfall is directed to groundwater recharge. The groundwater recharge flow of 8.3 MGD in 2010 is projected to diminish by 2025, as flow to traditional reuse increases.

Table 7-4. Flow distribution for Boca Raton WWTP

Alt.	Year	WWTP effluent (MGD)	Ocean outfall (MGD)	Traditional reuse (MGD)	Groundwater recharge (MGD)	RO concentrate (MGD)
I	2005	15.6	10.4	5.2	0.0	0.0
	2010	17.1	8.3	8.8	0.0	0.0
	2015	18.7	7.5	11.2	0.0	0.0
	2020	20.2	6.7	13.6	0.0	0.0
	2025	21.8	5.8	15.9	0.0	0.0
II	2005	15.6	10.4	5.2	0.0	0.0
	2010	17.1	11.1	6.0	0.0	0.0
	2015	18.7	9.1	9.5	0.0	0.0
	2020	20.2	2.2	18.0	0.0	0.0
	2025	21.8	0.5	21.3	0.0	0.0
III	2005	15.6	0.6	5.2	7.9	2.0
	2010	17.1	0.6	6.0	8.3	2.1
	2015	18.7	1.0	9.5	6.5	1.6
	2020	20.2	1.9	18.0	0.2	0.0
	2025	21.8	2.1	19.6	0.0	0.0
IV	2005	15.6	0.0	5.2	8.3	2.1
	2010	17.1	0.0	6.0	8.9	2.2
	2015	18.7	0.0	9.5	7.3	1.8
	2020	20.2	0.0	18.0	1.8	0.4
	2025	21.8	0.0	21.3	0.4	0.1

No flow may be sent to the ocean outfall under Alternative IV. The flow remaining after allocation to traditional reuse is therefore directed to groundwater recharge. The groundwater recharge flow under Alternative IV is projected to decrease from 8.9 MGD in 2010 to 0.4 MGD in 2025. Reverse osmosis concentrate flow varies in proportion to groundwater recharge flow.

7.3.3 Effluent and Reclaimed Water Distribution for the Broward/North WWTP

The distribution of effluent and reclaimed water from the Broward/North WWTP under the four ocean outfall alternatives is summarized in Table 7-5. Rationale for the flow allocations is discussed below.

a) Flows to traditional reuse under Alternative I. The utility currently delivers 2.4 MGD of flow for traditional reuse, which includes 1.3 MGD for on-site irrigation at the WWTP and 1.1 MGD for off-site use at the Broward County Office of Environmental Services septage receiving facility, Wheelabrator Environmental Services, and Pompano Commerce Park. The on-site irrigation was estimated by subtracting the on-site process use of 2.1 MGD from the total on-site use of 3.4 MGD. The utility plans to increase the total on-site and off-site reuse flow to 9.3 MGD by the year 2024 (Hazen and Sawyer 2004). The increase in traditional reuse to 4.2 MGD in 2010 includes the following reuse demands: 0.5 MGD for Pompano Commerce Park and 1.3 MGD for Wheelabrator Environmental Services if the company adds boilers at its resource recovery facility. Also, by the year 2010 a 2 MGD of reclaimed water will be added for on-site process use for WWTP expansion to 100 MGD. The next increase in traditional reuse to 5.3 MGD in 2015 includes 0.6 MGD for the Tam O'Shanter Golf Club and 0.4 MGD for the Crystal Lake Country Club.

Table 7-5. Flow distribution for Broward/North WWTP

Alt.	Year	WWTP effluent (MGD)	Ocean outfall (MGD)	Underground injection control wells (MGD)	Traditional reuse (MGD)	Groundwater recharge (MGD)	RO concentrate (MGD)
I	2005	84.2	51.7	30.0	2.4	0.0	0.0
	2010	88.6	54.3	30.0	4.2	0.0	0.0
	2015	90.8	55.5	30.0	5.3	0.0	0.0
	2020	92.2	56.9	30.0	5.3	0.0	0.0
	2025	94.1	58.8	30.0	5.3	0.0	0.0
II	2005	84.2	51.7	30.0	2.4	0.0	0.0
	2010	88.6	54.3	30.0	4.2	0.0	0.0
	2015	90.8	51.3	30.0	9.4	0.0	0.0
	2020	92.2	46.6	30.0	15.6	0.0	0.0
	2025	94.1	41.1	30.0	23.0	0.0	0.0
III	2005	84.2	0.3	30.0	2.4	41.2	10.3
	2010	88.6	0.4	30.0	4.2	43.1	10.8
	2015	90.8	1.0	30.0	9.4	40.3	10.1
	2020	92.2	1.6	30.0	15.6	36.0	9.0
	2025	94.1	2.4	30.0	23.0	30.9	7.7
IV	2005	84.2	0.0	30.0	2.4	41.4	10.3
	2010	88.6	0.0	30.0	4.2	43.5	10.9
	2015	90.8	0.0	30.0	9.4	41.1	10.3
	2020	92.2	0.0	30.0	15.6	37.3	9.3
	2025	94.1	0.0	30.0	23.0	32.8	8.2

b) Flows to traditional reuse under Alternatives II, III and IV. Traditional reuse demand under Alternatives II, III and IV is the same as under Alternative I until the year 2010. The reclaimed water demand is expected to increase to 9.4 MGD by the year 2015, which includes large users within 4 metropolitan miles of the WWTP. Connecting large users within 8 metropolitan miles of the WWTP by the year 2020 would increase the reuse demand to 15.6 MGD. A reuse demand 23 MGD by year 2025 would be realized by inclusion of all large users within 12.6 metropolitan miles of the WWTP.

c) Flows to ocean outfall and groundwater recharge. Flow to the underground injection wells is projected to remain at 30 MGD under all four alternatives. This is the current flow and is also the maximum flow that can be delivered to the wells according to their total 2005 permitted peak hourly flow of 60 MGD with a hourly peaking factor of 2.0.

Under Alternatives I and II, the flow remaining after allocation to traditional reuse and underground injection wells is sent to the ocean outfall. Since the flow to the ocean outfall remains below the 2005 ocean outfall capacity of 66 MGD, no flow is directed to groundwater recharge.

Under Alternative III, the wet weather period was 34.8 days for Broward/North WWTP. The ocean outfall flow was calculated multiplying the traditional reuse flow with the ratio of the wet and dry days. Flow remaining after allocation to traditional reuse, ocean outfall and underground injection wells is directed to groundwater recharge. The groundwater recharge flow is expected to decrease from 43.1 MGD in 2010 to 30.9 MGD by 2025, as flow to traditional reuse increases.

No flow to the ocean outfall is allowed under Alternative IV. In this case, the flow remaining after allocation to traditional reuse and underground injection wells is directed to groundwater recharge. The groundwater recharge flow is projected to decrease from 43.5 MGD in 2010 to 32.8 MGD in 2025 as flow to traditional reuse increases. Reverse osmosis concentrate flows vary in proportion to the groundwater recharge flow.

7.3.4 Effluent and Reclaimed Water Distribution for the Hollywood WWTP

The distribution of effluent and reclaimed water from the Hollywood WWTP under the four ocean outfall alternatives is summarized in Table 7-6. Rationale for the flow allocations is discussed below.

a) Flows to traditional reuse under Alternative I. The utility currently delivers 2.6 MGD of reclaimed water flow to six golf courses. There are plans to add infrastructure to supply reclaimed water for a golf course and other landscape irrigation, bringing capacity to 4 MGD (FL DEP 2004). It was assumed that this reuse demand will be met by the year 2010.

b) Flows to traditional reuse under Alternatives II, III and IV. Reuse demand under Alternatives II, III and IV will remain the same as under Alternative I through 2010. Reclaimed water flow would be increased to 4.2 MGD by year 2015, 5.2 MGD by year 2020, and 6.1 MGD by year 2025 through connection of the large users within 5, 10 and 12.5 metropolitan miles of the WWTP.

c) Flows to ocean outfall and groundwater recharge. Under Alternatives I, II and III, the flow remaining after allocation to traditional reuse is sent to the ocean outfall and groundwater recharge. The ocean outfall 2005 permitted capacity of 46.3 MGD would be reached by year 2020 under Alternative I. Groundwater recharge flow under this alternative is projected at 0.8 MGD in 2020, increasing to 3.6 MGD by 2025. Under Alternative II, the ocean outfall is expected to reach its capacity by the year 2025. The groundwater recharge flow in this year is projected at 1.7 MGD.

Table 7-6. Flow distribution for Hollywood WWTP

Alt.	Year	WWTP effluent (MGD)	Ocean outfall (MGD)	Traditional reuse (MGD)	Groundwater recharge (MGD)	RO concentrate (MGD)
I	2005	40.0	37.4	2.6	0.0	0.0
	2010	43.5	39.9	3.6	0.0	0.0
	2015	47.2	43.5	3.6	0.0	0.0
	2020	50.9	46.3	3.6	0.8	0.2
	2025	54.5	46.3	3.6	3.6	0.9
II	2005	40.0	37.4	2.6	0.0	0.0
	2010	43.5	39.9	3.6	0.0	0.0
	2015	47.2	42.9	4.2	0.0	0.0
	2020	50.9	45.6	5.2	0.0	0.0
	2025	54.5	46.3	6.1	1.7	0.4
III	2005	40.0	0.3	2.6	29.7	7.4
	2010	43.5	0.4	3.6	31.6	7.9
	2015	47.2	0.4	4.2	34.0	8.5
	2020	50.9	0.6	5.2	36.1	9.0
	2025	54.5	0.6	6.1	38.2	9.5
IV	2005	40.0	0.0	2.6	29.9	7.5
	2010	43.5	0.0	3.6	31.9	8.0
	2015	47.2	0.0	4.2	34.3	8.6
	2020	50.9	0.0	5.2	36.5	9.1
	2025	54.5	0.0	6.1	38.7	9.7

Under Alternative III, the wet weather period was 34.8 days for Hollywood WWTP. The ocean outfall flow was calculated multiplying the traditional reuse flow with the ratio of the wet and dry days. The groundwater recharge flow is projected to increase from 29.7 MGD in 2005 to 38.2 MGD in 2025.

No flow to the ocean outfall is allowed under Alternative IV. Accordingly, all flow remaining after allocation to traditional reuse flow would be directed to groundwater recharge. The projected groundwater recharge flow is very similar to the flows under Alternative III. Reverse osmosis concentrate varies in proportion to the groundwater recharge flow.

7.3.5 Effluent and Reclaimed Water Distribution for the Miami-Dade/North WWTP

The distribution of effluent and reclaimed water from the Miami-Dade/North WWTP under the four ocean outfall alternatives is summarized in Table 7-7. Rationale for the flow allocations is discussed below.

a) Flows to traditional reuse under Alternative I. The utility currently uses 2.2 MGD of reclaimed water for on-site process use and 0.1 MGD for irrigation at Florida International University. There are no plans to increase the reclaimed water flow (PBS&J 2003; FL DEP 2004).

Table 7-7. Flow distribution for Miami-Dade/North WWTP

Alt.	Year	WWTP effluent (MGD)	Ocean outfall (MGD)	Traditional reuse (MGD)	Groundwater recharge (MGD)	RO concentrate (MGD)
I	2005	107.9	107.8	0.1	0.0	0.0
	2010	111.9	111.8	0.1	0.0	0.0
	2015	116.6	112.5	0.1	3.2	0.8
	2020	121.3	112.5	0.1	6.9	1.7
	2025	126.3	112.5	0.1	10.9	2.7
II	2005	107.9	107.8	0.1	0.0	0.0
	2010	111.9	111.4	0.5	0.0	0.0
	2015	116.6	112.5	2.0	1.7	0.4
	2020	121.3	112.5	2.4	5.1	1.3
	2025	126.3	112.5	3.7	8.0	2.0
III	2005	107.9	0.0	0.1	86.2	21.6
	2010	111.9	0.1	0.5	89.1	22.3
	2015	116.6	0.2	2.0	91.5	22.9
	2020	121.3	0.3	2.4	94.9	23.7
	2025	126.3	0.4	3.7	97.7	24.4
IV	2005	107.9	0.0	0.1	86.2	21.6
	2010	111.9	0.0	0.5	89.1	22.3
	2015	116.6	0.0	2.0	91.7	22.9
	2020	121.3	0.0	2.4	95.1	23.8
	2025	126.3	0.0	3.7	98.0	24.5

b) Flows to traditional reuse under Alternatives II, III and IV. The reclaimed water flow could be increased to 0.5 MGD by year 2010, 2 MGD by year 2015, 2.4 MGD by year 2020, and 3.7 MGD by year 2025 by connecting the large users within 3, 5, 7 and 8.4 metropolitan miles of the WWTP.

c) Flows to ocean outfall and groundwater recharge. Under Alternatives I, II and III the flow remaining after allocation to traditional reuse is sent to the ocean outfall and groundwater recharge. Under Alternative I, the ocean outfall 2005 permitted capacity of 112.5 MGD would be reached by 2015, with a groundwater recharge flow of 3.2 MGD in that year, increasing to 10.9 MGD by year 2025. Similarly under Alternative II, the ocean outfall permitted capacity would be reached by the year 2015, with a groundwater recharge flow in that year of 1.7 MGD, increasing to 8.0 MGD by the year 2025.

Under Alternative III, the wet weather period was 38.5 days for Miami-Dade/North WWTP. The ocean outfall flow was calculated multiplying the traditional reuse flow with the ratio of the wet and dry days. The groundwater recharge flow is projected to increase from 86.2 MGD in 2005 to 97.7 MGD in 2025.

Under Alternative IV there is no flow to the ocean outfall. The flow remaining after allocation to traditional reuse would be directed to groundwater recharge. The groundwater recharge flows are very similar to the flows under Alternative III. Reverse osmosis concentrate flow varies in proportion to groundwater recharge flow.

7.3.6 Effluent and Reclaimed Water Distribution for the Miami-Dade/Central WWTP

The distribution of effluent and reclaimed water from the Miami-Dade/Central WWTP under the four ocean outfall alternatives is summarized in Table 7-8. Rationale for the flow allocations is discussed below.

a) Flows to traditional reuse under Alternative I. The utility currently uses 8.9 MGD for on-site process use. There are no plans to increase reclaimed water flow (PBS&J 2003; FL DEP 2004).

b) Flows to traditional reuse under Alternatives II, III and IV. The demand for traditional reuse could be increased to 0.4 MGD by year 2010, 1 MGD by year 2015, 2.1 MGD by year 2020, and 2.9 MGD by year 2025 through inclusion of the large users within 5, 8, 10 and 10.6 metropolitan miles of the WWTP. Since the chloride levels are high at the Miami-Dade/Central WWTP, users with landscapes resistant to high-chloride levels would be required.

c) Flows to ocean outfall and groundwater recharge. Under Alternatives I, II and III the flow remaining after allocation to traditional reuse is sent to the ocean outfall and groundwater recharge. Under Alternatives I and II, the ocean outfall 2005 permitted capacity of 143 MGD would be reached by 2020. Under Alternative I, groundwater recharge flow will be 1.9 MGD in that year, increasing to 6.7 MGD by year 2025. Under Alternative II, groundwater recharge flow will increase to 4.4 MGD by the year 2025.

Under Alternative III, the wet weather period was 38.5 days for Miami-Dade/Central WWTP. The ocean outfall flow was calculated multiplying the traditional reuse flow with the ratio of the wet and dry days. The groundwater recharge flow is projected to increase from 103.5 MGD in 2005 to 118.5 MGD in 2025.

Table 7-8. Flow distribution for Miami-Dade/Central WWTP

Alt.	Year	WWTP effluent (MGD)	Ocean outfall (MGD)	Traditional reuse (MGD)	Groundwater recharge (MGD)	RO concentrate (MGD)
I	2005	129.4	129.4	0.0	0.0	0.0
	2010	134.1	134.1	0.0	0.0	0.0
	2015	139.8	139.8	0.0	0.0	0.0
	2020	145.4	143.0	0.0	1.9	0.5
	2025	151.3	143.0	0.0	6.7	1.7
II	2005	129.4	129.4	0.0	0.0	0.0
	2010	134.1	133.7	0.4	0.0	0.0
	2015	139.8	138.9	1.0	0.0	0.0
	2020	145.4	143.0	2.1	0.2	0.1
	2025	151.3	143.0	2.9	4.4	1.1
III	2005	129.4	0.0	0.0	103.5	25.9
	2010	134.1	0.1	0.4	106.9	26.7
	2015	139.8	0.1	1.0	111.0	27.8
	2020	145.4	0.2	2.1	114.5	28.6
	2025	151.3	0.3	2.9	118.5	29.6
IV	2005	129.4	0.0	0.0	103.5	25.9
	2010	134.1	0.0	0.4	106.9	26.7
	2015	139.8	0.0	1.0	111.1	27.8
	2020	145.4	0.0	2.1	114.6	28.7
	2025	151.3	0.0	2.9	118.8	29.7

Under Alternative IV, no flow may be sent to the ocean outfall. The flow remaining after allocation to traditional reuse would be directed to groundwater recharge. The projected groundwater recharge flow is very similar to the flows under Alternative III. Reverse osmosis concentration varies in proportion to groundwater recharge flow.

7.4 Wastewater Management Options and their Water Quality Requirements

Current and potential treatment requirements for the considered wastewater management options are summarized in Table 7-9.

Dischargers to Class I injection wells were required to provide secondary treatment with no disinfection. The U.S. EPA published new rules governing Class I underground injection wells in 24 Florida Counties including Palm Beach, Broward and Miami-Dade Counties on 11/22/05. These federal rules became effective on 12/22/05. The new requirements for underground injection wells include secondary treatment with filtration and high-level disinfection. Secondary treatment with filtration and high-level disinfection is required for reclaimed water supplied for traditional (public access) reuse activities. Groundwater recharge would require full treatment and disinfection. The regulatory requirements for these wastewater management options are shown in Table 7-10. Ocean outfall dischargers are currently required to provide secondary treatment with basic-level disinfection as explained in Chapter 2, Table 2-5. The future requirements for ocean outfalls could include intermediate or full nutrient control (Table 7-11) with basic-level disinfection. Reclaimed water suitable for groundwater recharge would also be sufficiently low in phosphorus concentration (< 10 μg/L) for use as makeup water for the Everglades.

Table 7-9. Current and Potential Treatment Requirements of Wastewater Management Options*

Option	Treatment requirements	
	Current	**Potential**
Ocean outfalls	Secondary with basic-level disinfection (T2)	Intermediate or full nutrient control w/ basic-level disinfection (T4/T5)
Class I injection wells	Secondary with no disinfection (T1)	Secondary w/ filtration & high-level disinfection (T3)
Traditional reuse	Secondary w/ filtration & high-level disinfection (T3)	
Groundwater recharge	Full treatment and disinfection (T6)	

*Process trains (T1, T2, etc.) capable of meeting the requirements are described in Figure 7-1

In order to conceptualize the linkage between process trains and the different wastewater management options, a code is appended to each treatment requirement in Table 7-9. This code (T1, T2, etc.) identifies a specific process train that has been conceptualized for meeting the effluent quality requirements of the associated wastewater management option. The process trains are presented in Figure 7-1. Schematic diagrams of the process sequences along with information about the application of each process train and the effluent quality standards that the process train is capable of meeting are given in Appendix 2. There are many options for process sequences that could meet the requirements shown in Table 7-9. The appropriate choice would be influenced by site-specific conditions.

Table 7-10. Regulatory Requirements for Different Wastewater Management Options

Parameter	Units	Limit	Class I Injection Wells *	Public Access Reuse	Groundwater Recharge
$CBOD_5$	mg/L	Maximum annual average	20	20	-
TSS	mg/L	Maximum annual average	20	5.0	-
Total Nitrogen as N	mg/L	Maximum annual average	-	-	10
Total Phosphorus as P	mg/L	Maximum annual average	-	-	-
Total Dissolved Solids (TDS)	mg/L	Maximum annual average	-	-	500
Total Organic Carbon (TOC)	mg/L	Maximum monthly average	-	-	3.0
Total Organic Halogen (TOX)	mg/L	Maximum monthly average	-	-	0.2
Fecal Coliforms			-	**	***

* These requirements are for secondary treatment with no disinfection and do not include the new rules by U.S. EPA published on 11/22/05 and became effective on 12/22/05.

** *[62-600.440(5)f]*

- Over a 30-day period, 75 percent of the fecal coliform values shall be below the detection limits.
- Any one sample shall not exceed 25 fecal coliform values per 100 mL of sample.
- Any one sample shall not exceed 5.0 milligrams per liter of TSS at a point before application of the disinfectant.

*** Total coliforms undetectable, any one sample shall not exceed 4 total coliform values per 100 mL of sample.

Table 7-11. Assumed Annual Effluent Limits for Ocean Outfall Disposal

Parameter	Units	Level of nutrient control	
		Intermediate	Full
$CBOD_5$	mg/L	10.0	5.0
TSS	mg/L	10.0	5.0
Total Nitrogen	mg/L as N	10.0	3.0
Total Phosphorus	mg/L as P	3.0	1.0

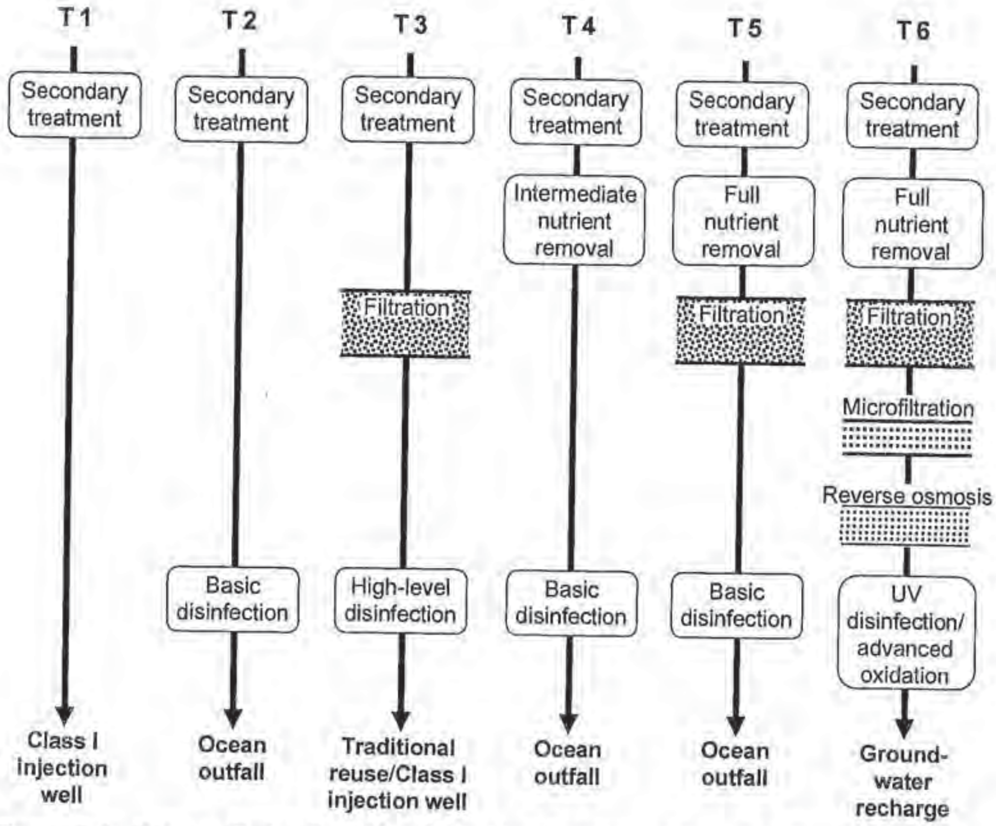

Figure 7-1. Process Trains Capable of Meeting Current and Potential Treatment Requirements of Wastewater Management Options

7.5 Summary

- The Boynton-Delray and Boca Raton WWTPs are reclaiming 19% and 33%, respectively, of their 2005 total wastewater flows for traditional reuse
- The Broward/North and Hollywood WWTPs are reclaiming 3% and 7%, respectively, of their 2005 total wastewater flows for traditional reuse
- The Miami-Dade/North and Miami-Dade/Central WWTPs are using small amounts of reclaimed water—mainly for on-site process use; therefore traditional reuse constitutes 0% of their 2005 total wastewater flows
- Under current plans (Alternative I), the Boynton-Delray and Boca Raton WWTPs would increase their reuse percentages to 28% and 73%, respectively, by 2025
- Under current plans (Alternative I), the Broward/North would increase its reuse percentage slightly (to 6%) by 2025
- Under current plans (Alternative I), the Hollywood, Miami-Dade/North and Miami-Dade/Central WWTPs would see no increase in their reuse percentages by 2025

- Under Alternatives II, III and IV, the Boynton-Delray and Boca Raton WWTPs would increase their reuse percentages to 84% and greater than 90%, respectively
- Under Alternatives II, III and IV, the Broward/North and Hollywood WWTPs would increase their reuse percentages to 24% and 11%, respectively
- Under Alternatives II, III and IV, the Miami-Dade/North and Miami-Dade/Central WWTPs would increase their reuse percentages to 3% and 2%, respectively

As seen from Alternatives II, III and IV, the WWTPs in Palm Beach County (Boynton-Delray and Boca Raton) have large potential for traditional reuse. The WWTPs in Miami-Dade County (Miami-Dade/North and Miami-Dade/Central) have small potential for traditional reuse but high potential for groundwater recharge. However, groundwater recharge costs for the Miami-Dade/Central WWTP are high relative to the estimated groundwater recharge costs for other five facilities due to the large transmission costs from the WWTP to groundwater recharge sites on the mainland.

References

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Matthews Consulting (2003) Reclaimed Water Master Plan. Prepared for City of Delray Beach, Florida. November 2003.

PBS&J (2003) Wastewater Facilities Master Plan Including Interim Peak Flow Management Plan. Prepared for Miami-Dade County Water and Sewer Department, Engineering Division. October 2003.

8. Indicators

The 2003 Reuse Strategies Report (Reuse Coordinating Committee and the Water Conservation Initiative Water Reuse Work Group 2003) presented the following vision for water reuse in Florida in 2020:

- Water reuse will be employed by all domestic wastewater treatment facilities having capacities of 0.1 million gallons per day (MGD) and larger. Statewide, on the order of 65 percent of all domestic wastewater will be reclaimed and reused for beneficial purposes.
- Effluent disposal using ocean outfalls, other surface discharges, and deep injection wells will be largely limited to facilities that serve as backups to water reuse facilities.
- Regulatory agencies, health agencies, utilities, and the public will embrace a "water is water" philosophy and will fully and readily accept the full range of water reuse options and the full range of alternative water supplies.
- Reclaimed water will be used in an efficient and effective manner, as a means to conserve and recharge potable quality water resources. Newer reuse systems will have potable quality water offsets and/or recharge fractions of 75 percent or larger.
- Groundwater recharge and indirect potable reuse projects will become common practice.
- Membrane treatment technologies will be widely used for the production of high-quality reclaimed water, particularly for the control of pathogens and organic compounds.
- Ultraviolet (UV) disinfection will be the norm for water reuse and domestic wastewater facilities.
- Use of satellite facilities will be common practice, particularly in the larger urban areas, as a means for enabling effective use of reclaimed water.
- Reclaimed water will be widely used to flush toilets in commercial facilities, industrial facilities, hotels and motels, and multiple-family residential units in Florida.

The second of the above goals relates to the stated desire to reduce disposal of treated wastewater via ocean outfalls and deep injection wells. This study focuses on evaluating current prospects for reuse based on specific evaluations of the six ocean outfalls in Southeast Florida.

The 2003 Reuse Strategies Report (Reuse Coordinating Committee and the Water Conservation Initiative Water Reuse Work Group 2003) used the following three criteria to rank a variety of water conservation initiatives including water reuse:

- Amount of water saved (maximum of 5 points)
- Cost effectiveness (maximum of 3 points)
- Ease of implementing (maximum of 3 points)

These three criteria are used in this report with a fourth criterion and a point system was not used during the evaluation of these indicators.

- Public health and Environmental impact

Definitions of these criteria and how they are measured are presented below.

8.1 Amount of Water Saved

Whitcomb (2005) provides data on water use throughout Florida for single family homes. His summary statistics can be used to estimate indoor and outdoor water use for the six water utilities in southeast Florida. Based on a detailed evaluation of the tax assessor's database for every parcel in Florida, Whitcomb (2005) developed the following median attributes of residential users:

- Property value = $84,330
- Year built = 1979
- House size = 1,747 square feet
- Lot size = 9,931 square feet (0.23 acres).

Heaney (1998) and Mayer (1999) summarized the results of a nationwide evaluation of water use in 1,200 houses in 12 cities across North America, including Tampa, Florida. The average annual water use for the 100 residences in Tampa was 98,900 gallons per year of which 54.5% was indoor and 45.5% was outdoor. Using the Tampa numbers to calibrate the estimates for Southeast Florida yields the following irrigation estimates for SE Florida:

- People/house = 2.5
- Indoor gal./capita/day = 60
- Irrigation rate, feet/year = 3.0
- % of non-house area that is irrigated = 25%

These calibrated estimates indicate the following median water use per residence in Southeast Florida:

- Indoor water use = 54,750 gallons per year
- Irrigation water use = 45,800 gallons per year
- Irrigable area per house about 2,000 square feet.

Water use per square foot of house and irrigated area are similar (31 vs. 23 gal/sq ft/yr). At this rate, each added person has an average annual outdoor demand equivalent to applying 3 feet of water on 800 square feet of area.

A study by GEC (2003) indicates that water users in Southeast Florida are often classified by the water utilities as being high outdoor water users if their outdoor water use is about 65% of total use. Similarly, medium outdoor water use is defined as 50% outdoor water use and low outdoor water use is considered to be 35% of total use.

Water utilities in Southeast Florida employ conservation rate structures wherein the first block is assumed to represent indoor water use. Whitcomb (2005) lists the initial block as monthly water use up to 4,000 gallons for Palm Beach County and 3,750 gallons for Miami-Dade County. These numbers are slightly less than our estimate of outdoor use for Tampa of 4,500 gallons per month.

Whitcomb (2005) estimates the following percentages of residential customers who use individual wells for irrigation.

- Miami-Dade—27%
- Palm Beach—20%
- Broward—No estimate provided
- Average for Florida—28%

Local data are needed to get accurate information on individual irrigation wells. Using the average of the three estimates shown above results in an estimate that 25% of the residential customers have individual irrigation wells. We could not find any data that showed the spatial distribution of individual wells.

Irrigation is the largest water user in Florida and in many parts of the United States. Most of this irrigation is for agricultural purposes. As mentioned above, irrigation accounts for roughly 40 to 60% of residential water use in urban areas. Outdoor water use is much more sensitive to increasing prices. Whitcomb (2005) recently completed the largest study ever conducted on how water rates affect single-family residential water use in Florida. An illustrative increasing block rate structure for water supply is shown in Figure 8-1 (SWFWMD 2005). The lowest rate of $1.50/1,000 gallons is for the initial 5,000 gallons per month which approximates indoor water usage for a typical family. The rate then jumps to $2.50/1,000 gallons for the next 7,500 gallons per month. This range would represent the outdoor water use by a typical family. Usage beyond 12,500 gallons per month is charged an even higher rate of $3.50/1,000 gallons. The purpose of the conservation rate structure is to assure that people can have access to relatively inexpensive water for their more critical indoor needs. However, it also tries to reduce outdoor water use that is less critical by charging higher rates for this less vital use of water.

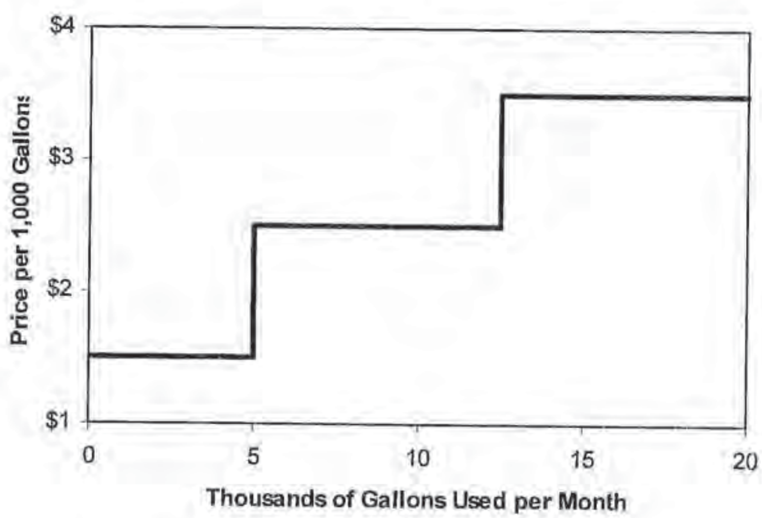

Figure 8-1. Inclining Block Rate Structure Example

Whitcomb (2005) divided single-family residential water customers into four profiles based on assessed property values of homes, with Profile 1 being the homes with the lowest assessed value and Profile 4 the highest. Demand curves for water in Florida are shown in Figure 8-2. The report takes several factors into account when calculating water demand per household. Factors such as net irrigation rate, people per household, pool data, and irrigation restriction data were normalized in this calculation and shown as such in Figure 8-2. At relatively low water prices of $2.00/1,000 gallons, per capita demand for a Profile 2-3 user would be about 180 gal/capita/day. Profile 2-3 represents the average single-family residential water customer based on property value and is represented in Figure 8-2 by interpolating between the Profile 2 and Profile 3 demand curves. Indoor water use is about 60-70 gal/capita/day so about 2/3 of the water use is outdoor. If the water price is $4.00/1,000 gallons, then the demand for the profile 2-3 user decreases sharply to about 120 gal/capita/day, a 33% reduction. Now the mix of indoor and outdoor water use is about equal. This is about where we are in Southeast Florida at present. If water prices are $6.00/1,000 gallons, then total water use drops to about 90 gal/capita/day and outdoor water use is only about 33% of total use. Finally, at $8.00/1,000 gallons, water demand is about 70 gal/capita/day with outdoor water use constituting an even smaller percentage of total water use. As prices increase, indoor water use can be expected to decline. Best estimates at present are that indoor water use will decrease from 60 to about 40 gal/capita/day due to the installation of low-flush toilets and other water saving devices. Thus, given expected increasing scarcity of water, prices will increase and people will use water more efficiently.

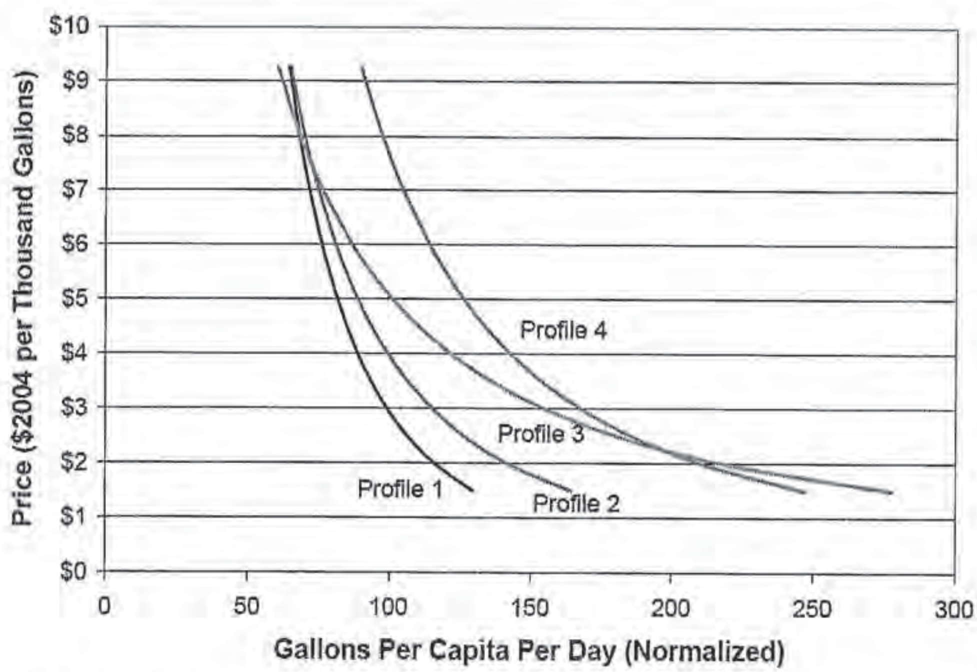

Figure 8-2. Demand for water as a function of price in Florida for four wealth profiles (Whitcomb 2005)

Irrigation water use per family can also be expected to decline due to smaller irrigable area per family. About one half of the future housing starts in southeast Florida will be multi-family dwellings. As land use intensifies, irrigable area per family can be expected to decline. Thus, overall, future outdoor water use per family should decrease. However, additional population growth can be expected to offset these savings. Also, the need for much more high quality water going to the Everglades will further intensify competition for the available fresh water supply. It is reasonable to assume that a larger percentage of future water use will be for indoor purposes. The water demand forecasts presented in Chapter 3 assumed a constant per capita usage over the planning horizion from 2005 to 2025. These estimates were based on the best available information from published reports by consultants and planning agencies in Southeast Florida. They probably did not take into account the very recent results of Whitcomb (2005) that were described in this section. In terms of reuse planning, it is probably more accurate to assume that per capita outdoor water use will decline due to a combination of decreased irrigable area and more efficient irrigation practices in response to the growing scarcity and cost of water. On the other hand, water use forecasts for Southeast Florida need to more fully incorporate the demand for fresh water associated with the Everglades Restoration.

8.2 Public Health and Environmental impact

A wide range of pollutants are removed by wastewater treatment processes. Water quality regulations are typically based on key indicators of water quality that are most important for a receiving water. Total maximum daily loads are being calculated for receiving waters throughout the State of Florida. Drew (2005) summarizes the first five years of this program. She notes that Florida has 52,000 miles of rivers and streams, nearly 800 lakes, 4,500 square miles of estuaries, and more than 700 springs. Drew (2005) points out three open issues with regard to assessing receiving water quality in Florida as described below:

- *Most Florida waterways are identified as Class III, "fishable and swimmable." It has become clear in recent years that this classification, which includes rivers, streams, lakes and estuaries as well as wetlands, urban drainage ditches, urban lakes, and canal systems, is too broad. Some of these water bodies or water body types never did and indeed should not be expected to provide the same quality of "swimmable or fishable" recreation as others.*
- *Florida's freshwater dissolved oxygen (DO) criterion requires oxygen levels in surface waters to be at or above five milligrams per liter (5 mg/l) at all times at all places, ostensibly in an effort to protect water quality. In fact, wetlands, springs, drainage ditches, and canals do not typically exist, whether naturally or as artificially created, with DO levels as high as 5 mg/l, often because of the significant inflow of low-oxygen groundwater into surface waters. In effect, some water bodies are being required to meet unnatural conditions or conditions that are not otherwise caused by pollutants.*
- *The state's criteria for nutrients (nitrogen and phosphorous, for example) are narrative rather than numeric, which on occasion has led to differing interpretations by third parties on DEP's determination as to whether a water body is impaired by excessive nutrients.*

Drew (2005) listed the primary pollutants that are causing the impairment of Florida's surface waters and the number of water body segments impaired. These were:

- *Nutrients, such as nitrogen and phosphorus, which promote the growth of algae and other aquatic plants that cause wide swings in oxygen levels and lead to fish kills and damaged habitat-373 segments*
- *Bacteria, which may threaten public health and can close waters to swimming or shellfish harvesting-236 segments*
- *Metals, such as iron, silver, copper, cadmium, and zinc that adversely affect the health and reproduction of aquatic organisms-61 segments*
- *Mercury, based largely on the existence of Department of Health fish consumption advisories. (It generally is agreed that mercury is predominately the result of atmospheric deposition, but the relative contributions of local, regional and even global sources remains the subject of debate.)-40 segments*

Water reuse is an important benefit of a total maximum daily load program. For a given receiving water, a determination is made of the allowable load of the constituent(s) of interest. Then, a combination of point and nonpoint controls must be installed to avoid exceeding this allowable load. Reclaimed water can be given full credit for eliminating a discharge to a receiving water. Thus, it is very attractive from this point of view for most receiving waters.

In the case of ocean disposal via outfalls, the assimilative capacity of the ocean is extremely large. Thus, total maximum daily loads have not been developed for these cases. From a total maximum daily load perspective, discharge to an ocean outfall or landside water reuse eliminates a direct source of pollution to a receiving water.

For ocean disposal via outfalls, one may distinguish two different environments:

1. Discharge to open marine waters
2. Discharge to open marine waters that are near reefs.

Existing evidence suggests that the human and ecological risks from ocean outfalls are low because the wastewater is treated to reduce the contaminants and the rapid mixing and dilution reduces residual impacts to low levels (US EPA 2003). Studies by Tichenor (Tichenor 2003; Tichenor 2004b; Tichenor 2004a) suggest that the outfall discharge at Boynton Beach may be having an adverse effect on Lynn's Reef. A biomarker study by Fauth et al. (Fauth et al. 2006) also indicates that reefs are being impacted. However, neither of these studies attempted to directly link the outfall discharges to reef impacts by measuring the concentrations of contaminants from the outfalls. LaPointe et al. (2004) have shown how wastewater discharges can detrimentally impact reefs in the Florida Keys. In this case, the wastewater discharges are not by ocean outfalls and the effluents are discharged in close proximity to the reefs with much less dilution. If scientific evidence demonstrates that current wastewater treatment levels are insufficient to protect water quality, then more stringent treatment requirements such as intermediate or full nutrient control may be imposed in the future. However, the current water quality impacts near these six ocean outfalls are less obvious than in other receiving waters in the State of Florida that have experienced more apparent impacts such as widespread algal blooms.

8.3 Cost Effectiveness

8.3.1 Cost of the Reuse System

Water and wastewater infrastructure are very capital intensive with long service lives that extend to 100 years for some transmission systems. For this project, excellent information is available on how costs should be calculated. The Florida DEP (1991) developed guidelines for estimating costs for reuse projects. The Reuse Coordinating Committee (1996) for the State of Florida expanded on the 1991 FL DEP guidelines. The 1996 Reuse Feasibility Study Guidelines deal with preparation of reuse feasibility studies by water users (applicants for consumptive use permits). The LEES (1997) report contains excellent cost information for water and wastewater systems. This database was updated and refined by SFWMD (2004) as part of the South Florida Water Management District's water supply planning program. In addition to these general references, numerous consulting reports on water and wastewater infrastructure in Southeast Florida provided additional cost information. Finally, state of the art wastewater treatment cost estimating software called CapdetWorks was used to do more detailed process-level cost estimating (Hydromantis Inc., Hamilton, Ontario, Canada). All costs are expressed in July 2005 dollars. A discount rate of 7% and a service life of 20 years are assumed, consistent with the LEES (1997) report.

8.3.2 Benefits of the Reuse System

As described above, customers on the central water supply system are paying in the range of \$4.00 per 1,000 gallons for water. Typically, they would be paying this rate as the second step in the water use rate structure. Thus, if reclaimed water is available, they would save this amount assuming that the reclaimed water was provided free of a separate charge.

8.3.3 Determining the Optimal Amount of Reuse

As detailed in Chapter 6, two definitions of optimality can be used for this problem. If the utility follows a profit maximizing objective, then the optimal amount of reclaimed water is found by maximizing total benefits minus total costs. This model is typically used by private enterprise. However, public utilities have traditionally used a breakeven objective of finding that flow where total benefits = total costs. Public utilities are regulated as monopolies. Thus, they are typically restricted to recovering their costs including a "fair" rate of return on their investment (AWWA 1990; AWWA 1999). This is an important point as illustrated by the simple example shown below.

Assume that total benefits from reuse, $TB = 3x$ and total costs for reuse, $TC = x^2/2$ where x = amount of reuse. Thus, the net benefits (NB) are given by

$$NB = TB - TC = 3x - x^2/2 \tag{8-1}$$

This net benefit function is plotted in Figure 8-3.

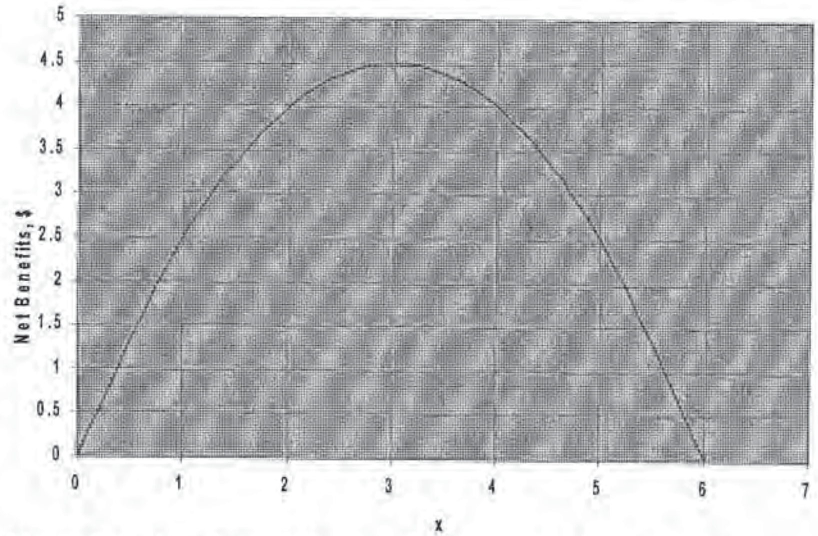

Figure 8-3. Hypothetical Net Benefit Function for Water Reuse

If the utility seeks to maximize net benefits, then the optimal solution is a net benefit of $4.50 and 3 units of reclaimed water would be provided. However, if the utility seeks to maximize the amount of reclaimed water provided subject to breaking even, i.e., net benefits = 0, then 6 units of reclaimed water will be provided. The breakeven objective has been used traditionally for public utilities. Both solutions were presented for the cost effectiveness analysis.

8.4 Ease of Implementation

The results of three recent surveys of public acceptance of reuse are shown in Table 8-1. Public acceptance is very high for irrigation types of reuse. It is also high for other non-human contact uses such as street sweeping, fire protection, concrete production, vehicular wash water and dust control. Toilet flushing is also considered to be an acceptable use. However, toilet flushing is not widely used at this time with the exception of newer high rise construction. Discharge of reclaimed water to augment streams and wetlands is less favored and also has significant regulatory hurdles. Water reuse associated with human contact and/or ingestion is less popular (Marks 2003; Po et al. 2003; CDM 2004; Hartley 2006) Similarly, early social-psychological studies of Bruvold (1988) showed that greater than 94% of the respondents were positive towards using reclaimed water for irrigation purposes whereas 77% were positive towards using reclaimed water to recharge groundwater and 44% were positive towards drinking reclaimed water. Proactive utilities (Orange County, CA and Singapore, for example) have successfully implemented projects involving groundwater recharge and indirect potable reuse, respectively. This was achieved through engagement of the public throughout the planning, implementation and operational phases of the projects, documentation of the ability of the water reclamation system to reliably meet water quality goals, and scientific validation of the absence of health impacts from ingestion of reclaimed water (FSAWWA Water Conservation Committee 1999; Macpherson et al. 2003; Crook 2004). A good example of the public engagement is the approach developed by the City of

San Diego to study all aspects of a viable water reuse program (City of San Diego 2005). Steps of the study approach are

- Assemble stakeholders and identify issues
- Develop a public involvement program
- Identify reuse opportunities and investigate issues
- Assess reuse opportunities based on community values

It should also be noted that generating public acceptance of traditional reuse activities such as irrigation of public access landscapes may translate to greater potential for generating public support for indirect potable reuse and groundwater recharge.

Table 8-1. Positive and Negative Responses* to Potential Alternatives for Reclaimed Water. Adapted from CDM (2004)

Use	% Yes WW operators	% Yes Tampa	% Yes San Fran.
Concrete production	90%		
Golf course irrigation	89%		96%
Street cleaning	87%		96%
Irrigation of highway right of way	85%		
Fire protection	84%		98%
Irrigation of parks			96%
Irrigation of athletic fields	84%		
Wetland creation	84%		
Dust control	82%		
Irrigation of agricultural crops	82%		
Irrigation of office parks and business campuses	82%	94%	
Toilet flushing	80%		92%
Industrial process water	78%		
Vehicle wash water	76%		
Residential landscape irrigation & maintenance	74%	84%	
Stream augmentation	67%		
Ornamental ponds/fountains	56%		
Potable reuse-indirect	40%		
Irrigation of crops for direct human consumption	30%		
Potable reuse-direct	18%		
Pools/spas	15%		

*Based on a survey of 50 wastewater treatment plant operators and managers and 15,000 Tampa customers

8.5 Summary

Four indicators of amount of water saved (freshwater savings), cost effectiveness, public health and environmental impact (nutrient load reduction) and ease of implementation (public acceptance) are used in the evaluation of the alternatives without a point system applied.

- Several studies have shown that residential irrigation accounts for 35 to 65% of residential water use in urban areas. In terms of reuse planning, it is expected that per capita outdoor water use will decline due to a combination of decreased irrigable area and more efficient irrigation practices in response to the growing scarcity and cost of water. The indoor water use is also estimated to decrease from 60 to about 40 gal/capita/day due to the installation of low-flush toilets and other water saving devices.
- Nutrients (nitrogen and phosphorus) are found to be among the primary pollutants that are causing the impairment of Florida's surface waters. Some studies have shown evidence for reef damage from ocean outfalls. However, there is need for definitive studies that explore the link between wastewater disposal through ocean outfalls and reefs.
- The water users in the second step of the rate structure are paying in the range of $4.00 per 1,000 gallons for water. If reclaimed water is available, they would save this amount assuming that the reclaimed water was provided free of a separate charge.
- Public acceptance of reclaimed water used for irrigation is higher than groundwater recharge. Public education programs and community involvement throughout the planning, implementation, and continued use of water reuse projects can help mitigate public concerns.

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9. Evaluation of Ocean Outfall Strategies

An evaluation of the four ocean outfall strategies (use at current levels, limited use, use as backup for traditional reuse, and no use) with respect to four indicators (pollutant load reduction, cost effectiveness, amount of freshwater saved and public acceptance) is presented in this chapter. Methods for quantifying the indicators are described in Section 9.1, followed by presentation of indicator outcomes in Sections 9.2–9.7, comparison of the outcomes among the six WWTPs in Section 9.8, and a summary in Section 9.9.

9.1 Methods for Quantifying Indicators

Methods for estimating freshwater savings, nutrient load reductions, and costs for liquid treatment, reuse and disposal are described below.

9.1.1 Definition of the Base Case

A base case against which the outcomes of the various ocean outfall alternatives can be compared is defined as follows:

- Treatment level: secondary with basic level disinfection for disposal using ocean outfalls and no disinfection for disposal using Class I injection wells
- Disposal method: discharge of 100% of flow to ocean outfalls or, in the case of the Broward/North WWTP, discharge of 100% of flow to ocean outfalls and Class I injection wells.

Flows and nutrient loads to the ocean associated with the base case are summarized in Table 9-1.

9.1.2 Estimation of Freshwater Savings

Freshwater may be saved by substituting reclaimed water for water from a potable supply. Thus, a savings of 1.0 gallon of freshwater per gallon of reclaimed water provided for traditional reuse was assumed. No credit for offsetting municipal water treatment demands was taken, since consumptive use permittees withdraw water from local wells rather than public supplies. Water savings from groundwater recharge was taken as 0.8 gallons of freshwater per gallon of reclaimed water recharged. Selection of the recharge value was based on the assumption that the groundwater recharge fraction for injection through shallow wells near the coast is intermediate to recharge fractions for canals and rapid infiltration basins, which are given as 0.7 and 0.95, respectively, in the *2003 Reuse Strategies Report* (Reuse Coordinating Committee and the Water Conservation Initiative Water Reuse Work Group 2003). Freshwater savings in percent are expressed relative to the ocean outfall flows under the base case as defined in Section 9.1.1 (Table 9-1).

9.1.3 Estimation of Nutrient Load Reductions

Nitrogen and phosphorus are of documented concern with respect to the health of reefs in the coastal waters of southeast Florida. These nutrients are therefore used as model pollutants. Nutrient loads to the ocean can be decreased by reducing flows to ocean outfalls and by tertiary treatment to remove nutrients from wastewater. Nutrient load reductions in percent are expressed relative to ocean nutrient loads under the base case as defined in Section 9.1.1 (Table 9-1).

Table 9-1. Flows and Nutrient Loads to the Ocean associated with the Base Case

	Effluent conc.* (mg/L)	Year	Flows (MGD) Influent	UIC wells**	Ocean outfall	Loads to ocean (tons/yr) TN	TP
Boynton-Delray	Total N	2005	19.4	0	19.4	551	50.1
	18.7	2010	21.3	0	21.3	605	55.0
	Total P	2015	23.2	0	23.2	660	60.0
	1.7	2020	25.2	0	25.2	716	65.1
		2025	27.1	0	27.1	771	70.1
		Avg	23.2	0	23.2	661	60.1
Boca Raton	Total N	2005	15.6	0	15.6	401	16.6
	16.9	2010	17.1	0	17.1	440	18.2
	Total P	2015	18.7	0	18.7	480	19.9
	0.7	2020	20.2	0	20.2	520	21.6
		2025	21.8	0	21.8	560	23.2
		Avg	18.7	0	18.7	480	19.9
Broward/ North	Total N	2005	84.2	30	54.2	1,220	107.2
	14.8	2010	88.6	30	58.6	1,320	115.9
	Total P	2015	90.8	30	60.8	1,369	120.3
	1.3	2020	92.2	30	62.2	1,400	123.0
		2025	94.1	30	64.1	1,444	126.8
		Avg	90.0	30	60.0	1,351	118.6
Hollywood	Total N	2005	40.0	0	40.0	1,010	66.9
	16.6	2010	43.5	0	43.5	1,100	72.9
	Total P	2015	47.2	0	47.2	1,192	79.0
	1.1	2020	50.9	0	50.9	1,286	85.2
		2025	54.5	0	54.5	1,376	91.2
		Avg	47.2	0	47.2	1,193	79.0
Miami-Dade/ North	Total N	2005	107.9	0	107.9	2,874	279.2
	17.5	2010	111.9	0	111.9	2,980	289.5
	Total P	2015	116.6	0	116.6	3,107	301.8
	1.7	2020	121.3	0	121.3	3,230	313.8
		2025	126.3	0	126.3	3,363	326.7
		Avg	116.8	0	116.8	3,111	302
Miami-Dade/ Central	Total N	2005	129.4	0	129.4	3,308	315.0
	16.8	2010	134.1	0	134.1	3,430	326.6
	Total P	2015	139.8	0	139.8	3,575	340.5
	1.6	2020	145.4	0	145.4	3,717	354.0
		2025	151.3	0	151.3	3,870	368.6
		Avg	140.0	0	140.0	3,580	341

*From 31 Aug. 2003 through 31 Oct. 2004 Monthly Discharge Reports
**Class I

9.1.4 Estimation of the Costs for Liquid Treatment, Reuse and Disposal

The costs reported in this chapter are the sum of liquid treatment, reuse and disposal costs. Methods employed to estimate these costs are described below.

a) Costs of liquid treatment. Costs of primary treatment, secondary treatment, nutrient removal, filtration, basic level disinfection with chlorine, high level disinfection with chlorine, and high level disinfection with UV were estimated using CapdetWorks 2.1. Costs of microfiltration, reverse osmosis and advanced oxidation were estimated on the basis of case studies. Details of these methods are given in Chapter 6.

b) Costs of reclaimed water distribution for traditional reuse. Equation (6-7) gives the sum of costs for treatment beyond secondary (filtration and the difference between high level and basic level disinfection) and distribution costs as a function of flow for traditional reuse. Data used in the fitting of this equation are given in Table 6-29. Since the costs of treatment for reuse are included in the CapdetWorks simulations, the costs of treatment beyond secondary must be removed from Equation (6-7) in order to avoid double-counting.

The capital costs for treatment beyond secondary are given in Table 6-25. These costs were annualized on the basis of a 20 year service life and 7% discount rate and then subtracted from the annual costs in Table 6-29. Operation and maintenance costs for treatment beyond secondary are not separated from reclaimed water distribution costs in the Hazen and Sawyer (2004) database. They were therefore estimated using CapdetWorks. The results, expressed in power equation form, are given by

$$C = 24{,}330\,Q^{0.8506} \tag{9-1}$$

where C is the operations and maintenance cost for treatment beyond secondary in \$/yr and Q is the reclaimed water flow in MGD. The operations and maintenance costs thus estimated were also subtracted from the annual costs in Table 6-29. The remaining costs of reclaimed water distribution within the applicable range of flows (4.46–30 MGD) were fitted to a power relationship, giving

$$C = 8{,}167\,Q^{2.3496} \tag{9-2}$$

where C and Q have the same units described previously. Equation 9-2 is used to estimate the cost of distributing reclaimed water to large users in the present chapter.

Equation (9-2) is specific to the service area of the Broward/North WWTP in Broward County. Costs reflected in this equation are influenced by the density of large users. The densities of large consumptive use permittees in the service areas of the Boynton-Delray and Boca Raton WWTPs are similar to the density near the Broward/North plant. Equation (9-2) should therefore provide a reasonably good approximation for these plants. Densities of large consumptive use permittees in the Hollywood, Miami-Dade/North and Miami-Dade/Central WWTP service areas are lower. As a result, Equation (9-2) will underestimate reclaimed water distribution costs at these facilities. Because the projected traditional reuse demands for the Hollywood, Miami-Dade/North and Miami- Dade/Central WWTPs are low (10% or less of the total wastewater treated), underestimation of traditional reuse distribution costs will have a negligible effect on overall cost trends that are projected for these facilities. For example, the Hollywood WWTP has the highest traditional reuse among the three facilities with low densities of consumptive use permittees. The maximum contribution of traditional reuse distribution cost to the cost of liquid treatment, reuse and disposal at this facility is estimated to be less than 3%.

c) Costs of reclaimed water injection through shallow wells. The methodology for estimating costs to inject highly treated reclaimed water through shallow wells was described in Chapter 6.

d) Disposal costs. It is assumed that the permitted capacities of the ocean outfalls and Class I UIC wells will be held constant. Therefore, no costs are allocated for these disposal methods. Deep well injection is assumed as a disposal method for concentrate from the reverse osmosis process. Costs for this disposal method are based on case studies, as described in Chapter 6.

9.2 Boynton-Delray WWTP

A summary of the projected flow allocations and costs for liquid treatment, reuse and disposal for the Boynton-Delray WWTP is given in Table 9-2. A matrix of indicator outcomes for the 2005–2025 projection period is shown in Table 9-3.

Freshwater savings. Total wastewater flows are expected to increase from 19.4 MGD in 2005 to 27.1 MGD in 2025 for all four alternatives. The current level of ocean outfall discharge of 15.7 MGD is expected to increase to 19.6 MGD under alternative I (currently planned use of ocean outfalls). Under alternative II (limited use of ocean outfalls), traditional reuse would grow from 3.7 to 22.7 MGD. If groundwater recharge and concentrate are included, then ocean outfall discharges in 2025 can be reduced to 2.4 MGD or eliminated.

Freshwater savings of 24–56% are achieved in the first two alternatives through traditional reuse. The freshwater savings for alternative III (use of ocean outfalls as backups) is 80% while that for alternative IV (no use of ocean outfalls) is 84%. Much of the freshwater savings under the latter two alternatives comes from groundwater recharge (24% and 28% of the flow treated, respectively).

Nutrient load reduction. In scenario A (secondary treatment of ocean-bound wastewater), ocean discharge of nitrogen and phosphorus is decreased by 24% under alternative I and 56% under alternative II. These percentages are identical to the respective freshwater savings under the two alternatives and represent diversions of the nutrients from the ocean to land. Greater load reductions (up to 93% for nitrogen and 74% for phosphorus) are achieved by applying nutrient removal processes to ocean-bound wastewater.

Table 9-2. Summary of Projected Flow Allocations and Costs for Liquid Treatment, Disposal and Reuse for the Boynton-Delray WWTP

Alterna-tive	Year	Flows (MGD) WWTP	Ocean outfall	Trad. Reuse	GW recharge	Concen-trate	Cost ($/1000 gal) Scenario* A	C	E
I	2005	19.4	15.7	3.7	0	0	0.90	1.22	1.50
	2010	21.3	16.4	4.8	0	0	0.91	1.21	1.48
	2015	23.2	17.0	6.2	0	0	0.93	1.21	1.46
	2020	25.2	19.0	6.2	0	0	0.91	1.18	1.44
	2025	27.1	19.6	7.5	0	0	0.95	1.19	1.44
II	2005	19.4	15.7	3.7	0	0	0.90	1.22	1.50
	2010	21.3	14.7	6.5	0	0	0.97	1.24	1.49
	2015	23.2	10.3	12.9	0	0	1.29	1.50	1.66
	2020	25.2	5.4	19.7	0	0	1.91	2.03	2.12
	2025	27.1	4.4	22.7	0	0	2.21	2.27	2.33
III	2005	19.4	0.4	3.7	12.2	3.1	4.10	4.10	4.10
	2010	21.3	0.7	6.5	11.2	2.8	3.64	3.64	3.64
	2015	23.2	1.4	12.9	7.1	1.8	3.14	3.14	3.14
	2020	25.2	2.1	19.7	2.7	0.7	2.78	2.78	2.78
	2025	27.1	2.4	22.7	1.5	0.4	2.80	2.80	2.80
IV	2005	19.4	0	3.7	12.5	3.1		4.13	
	2010	21.3	0	6.5	11.8	2.9		3.70	
	2015	23.2	0	12.9	8.2	2.1		3.25	
	2020	25.2	0	19.7	4.4	1.1		2.96	
	2025	27.1	0	22.7	3.5	0.9		3.02	

*The scenarios for ocean outfall treatment requirements preceding basic level disinfection are: A--secondary, C--intermediate nutrient removal, and E--full nutrient removal. These scenarios are applicable to alternatives I, II, and III, which involve use of ocean outfalls.

Table 9-3. Outcomes of Indicators for Ocean Outfall Alternatives at the Boynton-Delray WWTP

		Treatment applied for ocean outfall discharge		
		A--Secondary treatment	**C**--Intermediate nutrient removal	**E**--Full nutrient removal
Alternative I-- Ocean outfalls used at current levels	N load reduction	24%	60%	88%
	P load reduction	24%	24%	56%
	Freshwater savings	24% (including 0% from groundwater recharge)		
	Public acceptance	High		
Alternative II-- Limited use of ocean outfalls	N load reduction	56%	77%	93%
	P load reduction	56%	56%	74%
	Freshwater savings	56% (including 0% from groundwater recharge)		
	Public acceptance	High		
Alternative III-- Ocean Outfalls as backups	N load reduction	94%	97%	99%
	P load reduction	94%	94%	96%
	Freshwater savings	80% (including 24% from groundwater recharge)		
	Public acceptance	Low-Moderate to Moderate-High		
Alternative IV-- No use of ocean outfalls	N load reduction	100%		
	P load reduction	100%		
	Freshwater savings	84% (including 28% from groundwater recharge)		
	Public acceptance	Low-Moderate to Moderate-High		

Discharge of nutrients to the ocean is decreased by 94–99% under alternative III. The nutrient load reduction in alternative III is high compared to alternatives I and II, due to the low volumes of treated effluent that are discharged through the ocean outfall. The nutrient load reduction in alternative III increases slightly as the degree of treatment is increased from secondary to full nutrient removal. Discharge of nutrients to the ocean is decreased by 100% under alternative IV, where use of the ocean outfall is eliminated.

Public acceptance. The public acceptance of alternatives I and II is anticipated to be high because water reuse is primarily for irrigation by large users. Groundwater recharge in alternative III at 24% could be expected to lead to low-to-moderate public acceptance, but a concerted effort to engage and educate the public could boost this level to moderate-to-high. Public acceptance of alternative IV—with groundwater recharge accounting for 28% of the flow treated—would be similar to that for alternative III.

Cost-effectiveness. The costs for the three liquid treatment scenarios range from $0.90 to $1.50/1,000 gallons in 2005 under both alternatives I and II. They increase to the range of $0.95 to $1.40/1,000 gallons in 2025 under alternative I and $2.20–2.30/1,000 gal under alternative II. Increases of costs due to higher degrees of treatment of ocean-bound wastewater are limited under alternative II because most of the flow is reused. The costs under alternative IV are in the range of $3.00 to $4.10/1,000 gal. These costs are high because full treatment (including membrane filtration and reverse osmosis) is applied to flow not destined for traditional reuse. Additionally, the highly treated reclaimed water must be transported to the injection site and the reverse osmosis concentrate must be disposed of. The costs of alternative IV decrease between 2005 and 2025 because more flow is applied for traditional reuse in 2025 and therefore less is groundwater injected. Alternative III allows use of ocean outfalls as backups and therefore involves slightly lower recharge flows. This leads to slightly lower costs than alternative IV.

Summary. The benefits, costs and public acceptance of the ocean outfall alternatives for the Boynton-Delray WWTP are compared in Figure 9-1. The benefit is the average of percent freshwater savings and overall nutrient (N, P) load reduction. Public acceptance is rated on a scale of high = 97%, moderate = 71%, and low = 45%, as suggested by the survey from CDM (2004).

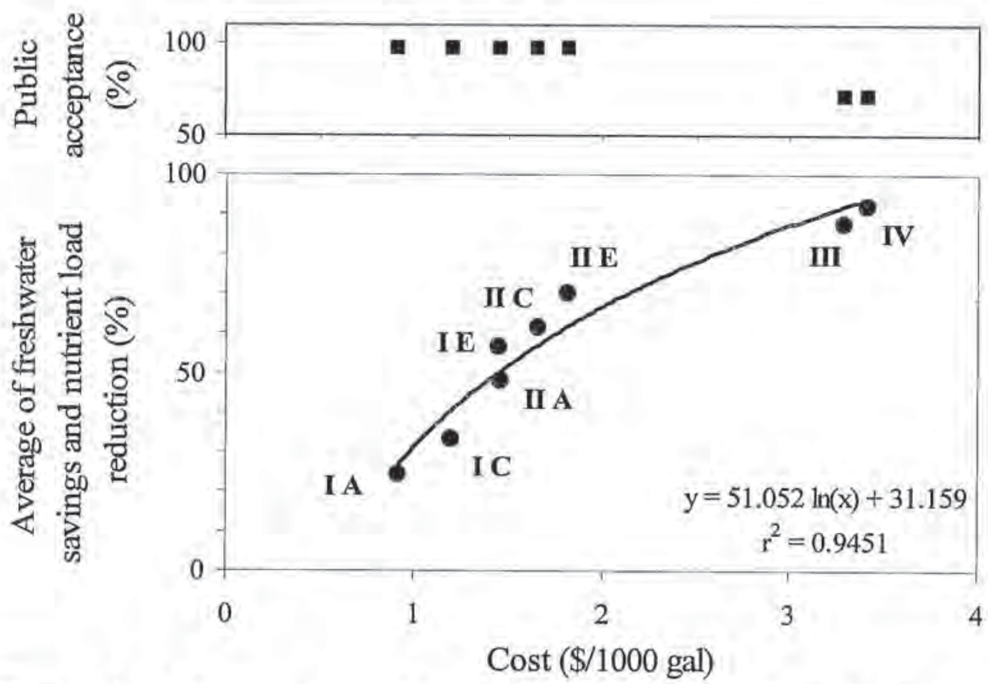

Figure 9-1. Public Acceptance and the Average of Percent Freshwater Savings and Nutrient Load Reduction versus Cost of Ocean Outfall Alternatives for the Boynton-Delray WWTP. Alternatives are Currently Planned Use (I), Limited Use (II), Ocean Outfalls as Backups (III) and No Use (IV). The scenarios for ocean outfall treatment are: A–secondary, C–intermediate nutrient removal, and E–full nutrient removal.

A benefit of up to 70% is achieved through various combinations of traditional reuse and nutrient control technology (alternatives I and II). These are also the alternatives with the highest public acceptance. The alternatives involving groundwater recharge (III and IV) achieve the highest benefits (87–92%), but are also most expensive and receive a lower level of public acceptance. The cost to achieve a benefit of 50% is $1.40/1,000 gal. The cost to achieve a benefit of 75% increases to $2.40/1,000 gal.

9.3 Boca Raton WWTP

A summary of the projected flow allocations and costs for liquid treatment, reuse and disposal for the Boca Raton WWTP is given in Table 9-4. A matrix of indicator outcomes over the years 2005–2025 is shown in Table 9-5.

Freshwater savings. Freshwater savings of 59–64% are achieved in the first two alternatives (currently planned and limited use of ocean outfalls) through implementation of traditional reuse. The freshwater recovery under alternative III (use of ocean outfalls as backups) is 82%, while that under alternative IV (no use of ocean outfalls) is 87%. Much of the freshwater savings under alternatives III and IV is from groundwater recharge, which accounts for savings of 20 to 23% relative to total flow treated.

Nutrient load reduction. Management options that include currently planned or limited use of ocean outfalls (alternatives I and II, respectively) reduce ocean discharge of nitrogen by up to 94% and phosphorus by up to 64% through a combination of effluent diversion to traditional reuse and application of nutrient control treatment technology. Limitation of phosphorus discharge under alternatives I and II is achieved exclusively through effluent diversion to reuse, since the secondary effluent phosphorus concentration of 0.8 mg/L is below the target effluent qualities of either the intermediate or full nutrient removal technologies. Discharge of nutrients to the ocean is decreased by 93–99% under alternative III and by 100% under alternative IV.

Public acceptance. The public acceptance of alternatives I and II is anticipated to be high since all freshwater savings are achieved through traditional reuse. A groundwater recharge level of 20% could result in a low-to-moderate level of public acceptance in alternative III. However, misgivings about groundwater recharge could be substantially mitigated by public education efforts and community participation in the planning process, boosting the acceptance level to the moderate-to-high range. Alternative IV has a similar level of groundwater recharge and is thus expected to receive the same level of public acceptance.

Cost-effectiveness. The costs under the first two alternatives range from $1.05 to $1.40/1,000 gal in 2005 under alternatives I and II and increase to the range of $1.65–2.40/1,000 gal in 2025. Under alternative II, in 2025, there is little variation in costs between treatment scenarios because most of the flow is reused. The costs under alternative IV range from $2.50 to $3.90/1,000 gal, decreasing from 2005 to 2025 because of increasing traditional reuse, which leads to less recharge. The costs under alternative III are slightly lower, since a small portion of the flow is discharged to the ocean.

Table 9-4. Summary of Projected Flow Allocations and Costs for Liquid Treatment, Disposal and Reuse for the Boca Raton WWTP

Alternative	Year	Flows (MGD) WWTP	Ocean outfall	Trad. Reuse	GW recharge	Concentrate	Cost ($/1000 gal) Scenario* A	C	E
I	2005	15.6	10.4	5.2	0	0	1.05	1.21	1.40
	2010	17.1	8.3	8.8	0	0	1.20	1.33	1.49
	2015	18.7	7.5	11.2	0	0	1.33	1.45	1.58
	2020	20.2	6.7	13.6	0	0	1.48	1.58	1.69
	2025	21.8	5.8	15.9	0	0	1.65	1.74	1.83
II	2005	15.6	10.4	5.2	0	0	1.05	1.21	1.40
	2010	17.1	11.1	6.0	0	0	1.05	1.22	1.42
	2015	18.7	9.1	9.5	0	0	1.20	1.33	1.48
	2020	20.2	2.2	18.0	0	0	1.99	2.04	2.08
	2025	21.8	0.5	21.3	0	0	2.35	2.37	2.38
III	2005	15.6	0.6	5.2	7.9	2.0	3.84	3.84	3.84
	2010	17.1	0.6	6.0	8.3	2.1	3.76	3.76	3.76
	2015	18.7	1.0	9.5	6.5	1.6	3.22	3.22	3.22
	2020	20.2	1.9	18.0	0.2	0.0	2.31	2.31	2.31
	2025	21.8	2.1	19.6	0.0	0.0	2.15	2.15	2.15
IV	2005	15.6	0	5.2	8.3	2.1		3.90	
	2010	17.1	0	6.0	8.9	2.2		3.83	
	2015	18.7	0	9.5	7.3	1.8		3.32	
	2020	20.2	0	18.0	1.8	0.4		2.57	
	2025	21.8	0	21.3	0.4	0.1		2.47	

*The scenarios for ocean outfall treatment requirements preceding basic level disinfection are: A--secondary, C--intermediate nutrient removal, and E--full nutrient removal. These scenarios are applicable to alternatives I, II, and III, which involve use of ocean outfalls.

Table 9-5. Outcomes of Indicators for Ocean Outfall Alternatives at the Boca Raton WWTP

		Treatment applied for ocean outfall discharge		
		A--Secondary treatment	C--Intermediate nutrient removal	E--Full nutrient removal
Alternative I-- Ocean outfalls used at current levels	N load reduction	59%	76%	93%
	P load reduction	59%	59%	59%
	Freshwater savings	59% (including 0% from groundwater recharge)		
	Public acceptance	High		
Alternative II-- Limited use of ocean outfalls	N load reduction	64%	79%	94%
	P load reduction	64%	64%	64%
	Freshwater savings	64% (including 0% from groundwater recharge)		
	Public acceptance	High		
Alternative III Ocean outfalls as back up	N load reduction	93%	96%	99%
	P load reduction	93%	93%	93%
	Freshwater savings	82% (including 20% from groundwater recharge)		
	Public acceptance	Low-Moderate to Moderate-High		
Alternative IV-- No use of ocean outfalls	N load reduction	100%		
	P load reduction	100%		
	Freshwater savings	87% (including 23% from groundwater recharge)		
	Public acceptance	Low-Moderate to Moderate-High		

Summary. The benefits, costs and public acceptance of the ocean outfall alternatives for the Boca Raton WWTP are compared in Figure 9-2. The benefit is the average of percent freshwater savings and overall nutrient (N, P) load reduction. Public acceptance is rated on a scale of high = 97%, moderate = 71%, and low = 45%, as suggested by the survey from CDM (2004).

A benefit of up to 71% is achieved through various combinations of traditional reuse and nutrient control technology (alternatives I and II). These are also the alternatives with the highest public acceptance. The alternatives involving groundwater recharge (III and IV) achieve the highest benefits (88–93%), but are also most expensive and receive a lower level of public acceptance. The cost to achieve a benefit of 50% is \$1.00/1,000 gal. The cost to achieve a benefit of 75% increases to \$2.00/1,000 gal.

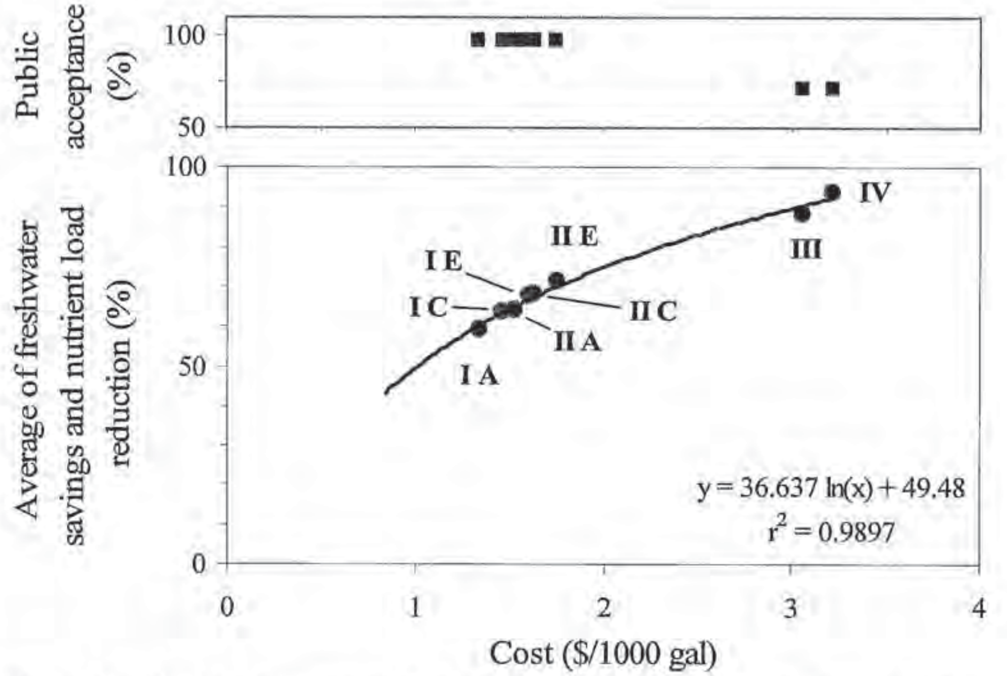

Figure 9-2. Public Acceptance and the Average of Percent Freshwater Savings and Nutrient Load Reduction versus Cost of Ocean Outfall Alternatives for the Boca Raton WWTP.

9.4 Broward/North WWTP

A summary of the projected flow allocations and costs for liquid treatment, reuse and disposal for the Broward/North WWTP is given in Table 9-6. A matrix of indicator outcomes over the years 2005–2025 is shown in Table 9-7.

Freshwater savings. Freshwater savings of 8–18% are achieved under alternatives I and II. The values of freshwater savings are expressed relative to the wastewater flow not discharged to Class I injection wells. The freshwater recovery under alternative III is 69%, which includes savings of 51% from groundwater recharge. The freshwater recovery under alternative IV is 71%, which includes savings of 52% from groundwater recharge.

Nutrient load reduction. Management options that include currently planned or limited use of ocean outfalls (alternatives I and II, respectively) limit ocean discharge of nitrogen by up to 83% and discharge of phosphorus by up to 37% through a combination of effluent diversion to traditional reuse and application of advanced treatment technology. The secondary effluent phosphorus concentration of the Broward/North WWTP averages 1.3 mg/L, which is less than the target effluent quality of intermediate nutrient removal technology and only slightly higher than the target effluent quality of full nutrient removal technology. Most of the phosphorus discharge limitation is therefore achieved through effluent diversion to reuse. Discharge of nutrients to the ocean is decreased by 98–100% under alternative III and by 100% under alternative IV.

Table 9-6. Summary of Projected Flow Allocations and Costs for Liquid Treatment, Disposal and Reuse for the Broward/North WWTP

		Flows (MGD)						Cost ($/1000 gal)					
								Scenario[2]					
Alt	Year	WWTP	Ocean outfall	UIC wells[1]	Trad. reuse	GW re-charge	Concen-trate	A	B	C	D	E	F
I	2005	84.2	51.7	30.0	2.4	0	0	0.60	0.68	0.75	0.82	0.92	0.99
	2010	88.6	54.3	30.0	4.2	0	0	0.61	0.68	0.76	0.83	0.91	0.98
	2015	90.8	55.5	30.0	5.3	0	0	0.61	0.68	0.76	0.83	0.91	0.98
	2020	92.2	56.9	30.0	5.3	0	0	0.61	0.68	0.76	0.82	0.92	0.98
	2025	94.1	58.8	30.0	5.3	0	0	0.61	0.68	0.76	0.82	0.92	0.98
II	2005	84.2	51.7	30.0	2.4	0	0	0.60	0.68	0.75	0.82	0.92	0.99
	2010	88.6	54.3	30.0	4.2	0	0	0.61	0.68	0.76	0.83	0.91	0.98
	2015	90.8	51.3	30.0	9.4	0	0	0.66	0.72	0.79	0.85	0.94	1.00
	2020	92.2	46.6	30.0	15.6	0	0	0.77	0.83	0.89	0.95	1.02	1.08
	2025	94.1	41.1	30.0	23.0	0	0	1.01	1.07	1.11	1.17	1.22	1.28
III	2005	84.2	0.3	30.0	2.4	41.2	10.3	2.58	2.66	2.58	2.66	2.58	2.66
	2010	88.6	0.4	30.0	4.2	43.1	10.8	2.54	2.61	2.54	2.61	2.54	2.61
	2015	90.8	1.0	30.0	9.4	40.3	10.1	2.49	2.55	2.49	2.55	2.49	2.55
	2020	92.2	1.6	30.0	15.6	36.0	9.0	2.36	2.42	2.36	2.42	2.36	2.42
	2025	94.1	2.4	30.0	23.0	30.9	7.7	2.37	2.43	2.37	2.43	2.37	2.43
IV	2005	84.2	0	30.0	2.4	41.4	10.3		2.58[3]			2.66[4]	
	2010	88.6	0	30.0	4.2	43.5	10.9		2.54			2.61	
	2015	90.8	0	30.0	9.4	41.1	10.3		2.50			2.56	
	2020	92.2	0	30.0	15.6	37.3	9.3		2.38			2.44	
	2025	94.1	0	30.0	23.0	32.8	8.2		2.40			2.46	

[1] Class I

[2] The scenarios are defined in terms of ocean outfall treatment requirements preceding basic level disinfection (A, B--secondary; C, D--intermediate nutrient removal; E, F--full nutrient removal) and level of disinfection for discharge to Class I injection wells (A, C, E--none; B, D, F--high level). These scenarios are applicable to alternatives I, II and III, which involve use of ocean outfalls.

[3] No disinfection of effluent discharged to Class I UIC wells

[4] High-level disinfection of effluent discharged to Class I UIC wells

Public acceptance. The public acceptance of alternatives I and II is anticipated to be high because reclaimed water is used primarily for irrigation by larger users. The more substantial degree of freshwater savings due to groundwater recharge under alternatives III and IV will present a challenge in gaining public acceptance. However, misgivings about groundwater recharge may be substantially mitigated by public education efforts and community participation in the planning process. Thus, public acceptance is considered low-to-moderate for alternatives III and IV.

Cost-effectiveness. The costs range from $0.60 to $1.30/1,000 gal under alternatives I and II and $2.40 to $2.70/1,000 gal under alternatives III and IV. The Broward/North WWTP is the only facility of the six with Class I injection wells for effluent disposal in operation at the time the dataset for the present study was collected. Differences in costs between scenarios

A and B, C and D, and E and F represent an upgrade from no disinfection to high level disinfection for discharge to these wells. Accordingly, the costs increase somewhat between each pair of scenarios. Slight increments in the costs are also apparent as the degree of treatment for ocean-bound wastewater is increased from secondary (scenarios A and B) to intermediate nutrient removal (scenarios C and D) and finally to full nutrient removal (scenarios E and F). Under alternatives III and IV, costs are seen to decrease somewhat from 2005 to 2025. This is because the extent of traditional reuse increases with time, diminishing the flow that is recharged.

Table 9-7. Outcomes of Indicators for Ocean Outfall Alternatives at the Broward/North WWTP

		Secondary treatment for ocean outfall discharge		Intermediate nutrient removal for ocean outfall discharge		Full nutrient removal for ocean outfall discharge	
	Scenario*	A	B	C	D	E	F
Alt. I-- Ocean outfalls used at current levels	N load reduction	8%	8%	38%	38%	81%	81%
	P load reduction	8%	8%	8%	8%	29%	29%
	Freshwater savings	8% of wastewater not injected to Class I inection wells (including 0% from groundwater recharge)					
	Public acceptance	High					
Alt. II-- Limited use of ocean outfalls	N load reduction	18%	18%	45%	45%	83%	83%
	P load reduction	18%	18%	18%	18%	37%	37%
	Freshwater savings	18% of wastewater not injected to Class I injection wells (including 0% from groundwater recharge)					
	Public acceptance	High					
Alt III-- Ocean outfalls as backups	N load reduction	98%	99%	99%	98%	100%	100%
	P load reduction	98%	98%	98%	98%	99%	99%
	Freshwater savings	69% of wastewater not injected to Class I injection wells (including 51% from groundwater recharge)					
	Public acceptance	Low-Moderate					
Alt. IV-- No use of ocean outfalls	N load reduction	100%			100%		
	P load reduction	100%			100%		
	Freshwater savings	71% of wastewater not injected to Class I injection wells (including 52% from groundwater recharge)					
	Public acceptance	Low-Moderate					

*Scenarios: A, C, E--no disinfection for discharge to Class I injection wells; B, D, F--high level disinfection for discharge to Class I injection wells

Summary. The benefits, costs and public acceptance of the ocean outfall alternatives for the Broward/North WWTP are compared in Figure 9-3. The benefit is the average of percent freshwater savings and overall nutrient (N, P) load reduction. Public acceptance is rated on a scale of high = 97%, moderate = 71%, and low = 45%, as suggested by the survey from CDM (2004).

A benefit of up to 39% is achieved through various combinations of traditional reuse and nutrient control technology (alternatives I and II). These are also the alternatives with the highest public acceptance. The alternatives involving groundwater recharge (III and IV) achieve the highest benefits (84–85%), but are also most expensive and receive a lower level of public acceptance. The cost to achieve a benefit of 50% is \$1.30/1,000 gal. The cost to achieve a benefit of 75% increases to \$2.10/1,000 gal.

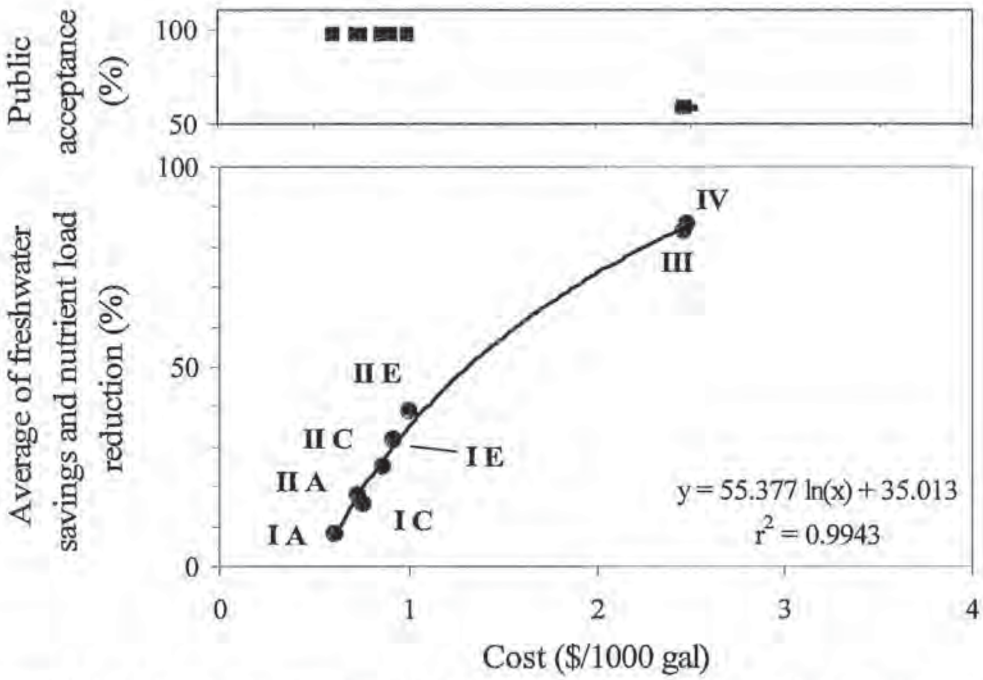

Figure 9-3. Public Acceptance and the Average of Percent Freshwater Savings and Nutrient Load Reduction versus Cost of Ocean Outfall Alternatives for the Broward/North WWTP.

9.5 Hollywood WWTP

A summary of the projected flow allocations and costs for liquid treatment, reuse and disposal for the Hollywood WWTP is given in Table 9-8. A matrix of indicator outcomes over the years 2005–2025 is shown in Table 9-9.

Freshwater savings. Freshwater savings of 9 to 10% are achieved under alternatives I and II, due mostly to the limited extent of traditional reuse. There is a modest level of groundwater recharge under these two alternatives, which also contributes to the freshwater savings. The freshwater savings under alternatives III and IV are 67%, which includes savings of 57–58% from groundwater recharge.

Nutrient load reduction. Management options that include currently planned or limited use of ocean outfalls (alternatives I and II, respectively) limit ocean discharge of nitrogen by up to 84%. The maximum limitation of phosphorus discharge for these alternatives is 18%, due to the limited extent of traditional reuse and the effluent total phosphorus concentration of 1.1 mg/L, which is only slightly higher than the target effluent quality for full nutrient removal technology. Discharge of nutrients to the ocean is decreased by 99–100% under alternative III and by 100% under alternative IV.

Table 9-8. Summary of Flow Allocations and Costs for Liquid Treatment, Disposal and Reuse for the Hollywood WWTP

Alternative	Year	Flows (MGD)					Cost ($/1000 gal)		
							Scenario*		
		WWTP	Ocean outfall	Trad. Reuse	GW recharge	Concentrate	A	C	E
I	2005	40.0	37.4	2.6	0	0	0.62	0.95	1.17
	2010	43.5	39.9	3.6	0	0	0.62	0.93	1.15
	2015	47.2	43.5	3.6	0	0	0.61	0.92	1.14
	2020	50.9	46.3	3.6	0.75	0.19	0.72	1.01	1.23
	2025	54.5	46.3	3.6	3.6	0.9	1.08	1.36	1.53
II	2005	40.0	37.4	2.6	0	0	0.62	0.95	1.17
	2010	43.5	39.9	3.6	0	0	0.62	0.93	1.15
	2015	47.2	42.9	4.2	0	0	0.62	0.92	1.15
	2020	50.9	45.6	5.2	0	0	0.63	0.91	1.13
	2025	54.5	46.3	6.1	1.7	0.4	0.86	1.13	1.31
III	2005	40.0	0.3	2.6	29.7	7.4	3.96	3.96	3.96
	2010	43.5	0.4	3.6	31.6	7.9	3.86	3.86	3.86
	2015	47.2	0.4	4.2	34.0	8.5	3.81	3.81	3.81
	2020	50.9	0.6	5.2	36.1	9.0	3.72	3.72	3.72
	2025	54.5	0.6	6.1	38.2	9.5	3.66	3.66	3.66
IV	2005	40.0	0.0	2.6	29.9	7.5		3.96	
	2010	43.5	0.0	3.6	31.9	8.0		3.88	
	2015	47.2	0.0	4.2	34.3	8.6		3.84	
	2020	50.9	0.0	5.2	36.5	9.1		3.76	
	2025	54.5	0.0	6.1	38.7	9.7		3.71	

*The scenarios for ocean outfall treatment requirements preceding basic level disinfection are: A--secondary, C--intermediate nutrient removal, and E--full nutrient removal. These scenarios are applicable to alternatives I, II, and III, which involve use of ocean outfalls.

Public acceptance. The public acceptance of alternatives I and II is anticipated to be high because reclaimed water is used primarily for irrigation by larger users. The substantial degree of freshwater savings due to groundwater recharge under alternatives III and IV presents a challenge in gaining public acceptance. Accordingly, public acceptance is considered to be low-to-moderate for these two alternatives.

Cost-effectiveness. The costs under alternatives I and II range from $0.60 to $1.50/1,000 gal, while the projected costs for alternatives III and IV range between $3.70 and $4.00/1,000 gal. Increments in the costs are apparent as the degree of treatment for ocean-bound wastewater is increased from secondary to full nutrient removal. The inflow to the plant is projected to exceed the ocean outfall permitted capacity of 46.3 MGD sometime before the year 2015. The amount of inflow in excess of this value must be handled by a combination of traditional reuse and groundwater recharge. Projected traditional reuse flows will be insufficient to handle the excess towards the end of the projection period, necessitating a modest flow to groundwater recharge. The higher extent of traditional reuse projected under alternative II results in lowered costs for this alternative.

Table 9-9. Outcomes of Indicators for Ocean Outfall Alternatives at the Hollywood WWTP

		Treatment applied for ocean outfall discharge		
		A--Secondary treatment	C--Intermediate nutrient removal	E--Full nutrient removal
Alternative I-- Ocean outfalls used at current levels	N load reduction	10%	46%	84%
	P load reduction	10%	10%	18%
	Freshwater savings	9% (including 2% from groundwater recharge)		
	Public acceptance	High		
Alternative II-- Limited use of ocean outfalls	N load reduction	10%	46%	84%
	P load reduction	10%	10%	18%
	Freshwater savings	10% (including 1% from groundwater recharge)		
	Public acceptance	High		
Alternative III-- Ocean outfalls as back up	N load reduction	99%	99%	100%
	P load reduction	99%	99%	99%
	Freshwater savings	67% (including 57% from groundwater recharge)		
	Public acceptance	Low-Moderate		
Alternative IV-- No use of ocean outfalls	N load reduction	100%		
	P load reduction	100%		
	Freshwater savings	67% (including 58% from groundwater recharge)		
	Public acceptance	Low-Moderate		

Summary. The benefits, costs and public acceptance of the ocean outfall alternatives for the Hollywood WWTP are compared in Figure 9-4. The benefit is the average of percent freshwater savings and overall nutrient (N, P) load reduction. Public acceptance is rated on a scale of high = 97%, moderate = 71%, and low = 45%, as suggested by the survey from CDM (2004).

A benefit of up to 30% is achieved through various combinations of traditional reuse, groundwater recharge and nutrient control technology (alternatives I and II). These are also the alternatives with the highest public acceptance. The alternatives involving extensive groundwater recharge (III and IV) achieve the highest benefits (83%), but are also most expensive and receive a lower level of public acceptance. The cost to achieve a benefit of 50% is $1.90/1,000 gal. The cost to achieve a benefit of 75% increases to $3.25/1,000 gal.

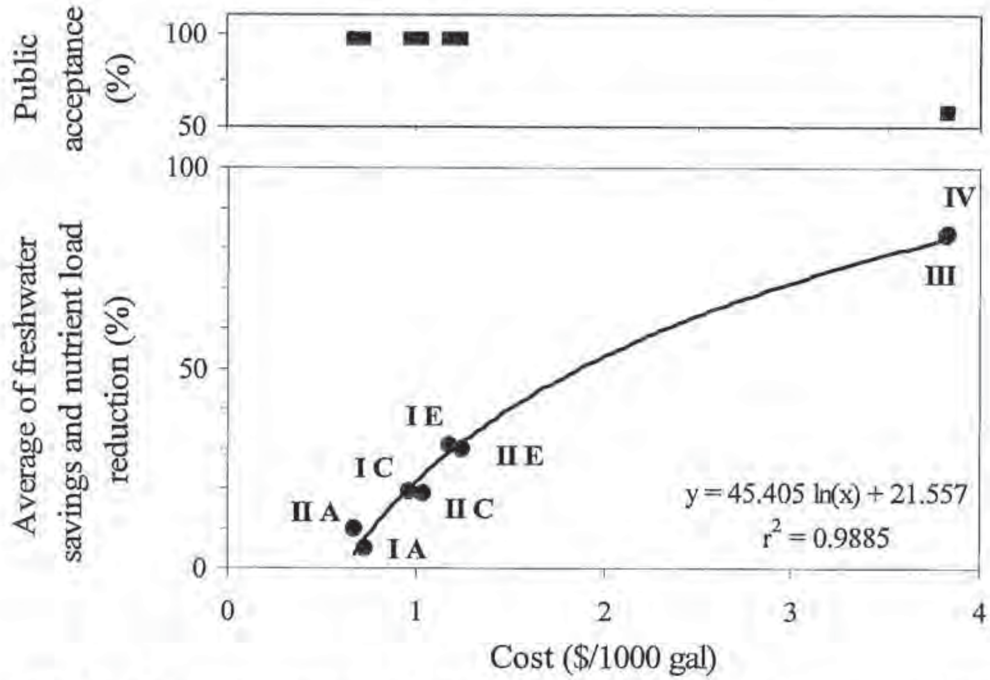

Figure 9-4. Public Acceptance and the Average of Percent Freshwater Savings and Nutrient Load Reduction versus Cost of Ocean Outfall Alternatives for the Hollywood WWTP.

9.6 Miami-Dade/North WWTP

A summary of the projected flow allocations and costs for liquid treatment, reuse and disposal for the Miami-Dade/North WWTP is given in Table 9-10. A matrix of indicator outcomes over the years 2005–2025 is shown in Table 9-11.

Freshwater savings. Modest freshwater savings of 3% under alternative I and 4% under alternative II are achieved, with half or more of the savings deriving from groundwater recharge. The freshwater savings under alternatives III and IV is 64–65%, which includes savings of 63% from groundwater recharge.

Pollutant load reduction. Management options that include currently planned or limited use of ocean outfalls (alternatives I and II, respectively) limit ocean discharge of nitrogen by up to 84% and discharge of phosphorus by up to 44%. Nutrient load reduction under alternatives III and IV is 100%.

Public acceptance. The public acceptance of alternatives I and II is anticipated to be high because of the very limited extent of water reuse. The substantial degree of freshwater savings due to groundwater recharge under alternatives III and IV poses a challenge to gaining public acceptance. However, a concerted public education efforts and community participation in the planning process could overcome this challenge. Thus, the degree of public acceptance is considered to be low-moderate for this alternative.

Table 9-10. Summary of Flow Allocations and Costs for Liquid Treatment, Disposal and Reuse for the Miami-Dade/North WWTP

		Flows (MGD)					Cost ($/1000 gal)		
Alterna-tive	Year	WWTP	Ocean outfall	Trad. Reuse	GW recharge	Concen-trate	Scenario* A	C	E
I	2005	107.9	107.8	0.1	0.0	0.0	0.55	0.84	1.08
	2010	111.9	111.8	0.1	0.0	0.0	0.54	0.83	1.07
	2015	116.6	112.5	0.1	3.2	0.8	0.68	0.97	1.19
	2020	121.3	112.5	0.1	6.9	1.7	0.84	1.11	1.32
	2025	126.3	112.5	0.1	10.9	2.7	0.96	1.22	1.43
II	2005	107.9	107.8	0.1	0.0	0.0	0.55	0.84	1.08
	2010	111.9	111.4	0.5	0.0	0.0	0.54	0.83	1.07
	2015	116.6	112.5	2.0	1.8	0.4	0.60	0.89	1.13
	2020	121.3	112.5	2.4	5.1	1.3	0.78	1.06	1.25
	2025	126.3	112.5	3.7	8.1	2.0	0.85	1.12	1.32
III	2005	107.9	0.0	0.1	86.2	21.6	3.15	3.15	3.15
	2010	111.9	0.1	0.5	89.1	22.3	3.10	3.10	3.10
	2015	116.6	0.2	2.0	91.5	22.9	3.05	3.05	3.05
	2020	121.3	0.3	2.4	94.9	23.7	3.00	3.00	3.00
	2025	126.3	0.4	3.7	97.7	24.4	2.95	2.95	2.95
IV	2005	107.9	0.0	0.1	86.2	21.6		3.15	
	2010	111.9	0.0	0.5	89.1	22.3		3.10	
	2015	116.6	0.0	2.0	91.7	22.9		3.05	
	2020	121.3	0.0	2.4	95.1	23.8		3.00	
	2025	126.3	0.0	3.7	98.0	24.5		2.95	

*The scenarios for ocean outfall treatment requirements preceding basic level disinfection are: A--secondary, C--intermediate nutrient removal, and E--full nutrient removal. These scenarios are applicable to alternatives I, II, and III, which involve use of ocean outfalls.

Cost-effectiveness. The projected costs under alternatives I and II range from $0.55 to $1.40/1,000 gal, whereas the projected costs for alternatives III and IV are in the range of $2.95 to $3.15/1,000 gal. Increments in the costs are apparent as the degree of treatment for ocean-bound wastewater is increased from secondary to full nutrient removal. The inflow to the plant is projected to reach the permitted capacity of the ocean outfall (112.5 MGD) by the year 2010. Flows in excess of 112.5 MGD must be handled by a combination of traditional reuse and groundwater recharge. The higher extent of traditional reuse projected under alternative II thus leads to somewhat lower costs.

Table 9-11. Outcomes of Indicators for Ocean Outfall Alternatives at the Miami-Dade/North WWTP

	Treatment applied for ocean outfall discharge		
	A--Secondary treatment	C--Intermediate nutrient removal	E--Full nutrient removal
N load reduction	5%	45%	84%
P load reduction	5%	5%	44%
Freshwater savings	3% (almost all from groundwater recharge)		
Public acceptance	High		
N load reduction	5%	46%	84%
P load reduction	5%	5%	44%
Freshwater savings	4% (including 2% from groundwater recharge)		
Public acceptance	High		
N load reduction	100%	100%	100%
P load reduction	100%	100%	100%
Freshwater savings	64% (including 63% from groundwater recharge)		
Public acceptance	Low-Moderate		
N load reduction	100%		
P load reduction	100%		
Freshwater savings	65% (including 63% from groundwater recharge)		
Public acceptance	Low-Moderate		

Summary. The benefits, costs and public acceptance of the ocean outfall alternatives for the Miami-Dade/North WWTP are compared in Figure 9-5. The benefit is the average of percent freshwater savings and overall nutrient (N, P) load reduction. Public acceptance is rated on a scale of high = 97%, moderate = 71%, and low = 45%, as suggested by the survey from CDM (2004).

A benefit of up to 34% is achieved through various combinations of traditional reuse, groundwater recharge and nutrient control technology (alternatives I and II). These are also the alternatives with the highest public acceptance. The alternatives involving extensive groundwater recharge (III and IV) achieve the highest benefits (82%), but are also most expensive and receive a lower level of public acceptance. The cost to achieve a benefit of 50% is \$1.70/1,000 gal. The cost to achieve a benefit of 75% increases to \$2.70/1,000 gal.

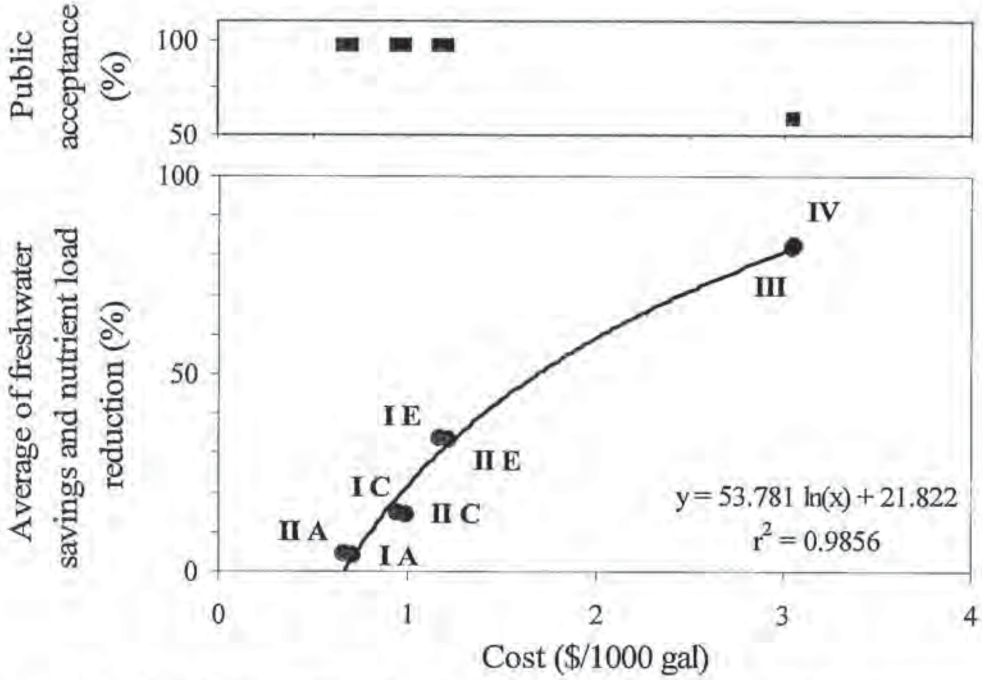

Figure 9-5. Public Acceptance and the Average of Percent Freshwater Savings and Nutrient Load Reduction versus Cost of Ocean Outfall Alternatives for the Miami-Dade/North WWTP.

9.7 Miami-Dade/Central WWTP

A summary of the projected flow allocations and costs for liquid treatment, reuse and disposal for the Miami-Dade/Central WWTP is given in Table 9-12. A matrix of indicator outcomes over the years 2005–2025 is shown in Table 9-13.

Freshwater savings. Very modest freshwater savings of 1% under alternatives I and II are achieved, due to the limited extent of traditional reuse. The freshwater savings under alternatives III and IV are 64%, which includes savings of 63% from groundwater recharge.

Pollutant load reduction. Management options that include currently planned or limited use of ocean outfalls (alternatives I and II, respectively) limit ocean discharge of nitrogen by up to 83% and discharge of phosphorus by up to 39%. Nutrient load reduction under alternatives III and IV is 100%.

Public acceptance. The public acceptance of alternatives I and II is anticipated to be high because of the very limited extent of water reuse. The substantial extent of groundwater recharge under alternatives III and IV presents a challenge in gaining public acceptance. Depending on the extent and success of the community involvement and public education efforts, a public acceptance of low-to-moderate could be expected.

Table 9-12. Summary of Flow Allocations and Costs for Liquid Treatment, Disposal and Reuse for the Miami-Dade/Central WWTP

Alterna-tive	Year	Flows (MGD)					Cost ($/1000 gal)		
		WWTP	Ocean outfall	Trad. Reuse	GW recharge	Concen-trate	Scenario* A	C	E
I	2005	129.4	129.4	0.0	0.0	0.0	0.50	0.87	1.12
	2010	134.1	134.1	0.0	0.0	0.0	0.50	0.87	1.12
	2015	139.8	139.8	0.0	0.0	0.0	0.49	0.86	1.12
	2020	145.4	143.0	0.0	1.9	0.5	0.54	0.90	1.15
	2025	151.3	143.0	0.0	6.7	1.7	0.60	1.00	1.25
II	2005	129.4	129.4	0.0	0.0	0.0	0.50	0.87	1.12
	2010	134.1	133.7	0.4	0.0	0.0	0.50	0.86	1.11
	2015	139.8	138.9	1.0	0.0	0.0	0.49	0.86	1.11
	2020	145.4	143.0	2.1	0.2	0.1	0.50	0.86	1.11
	2025	151.3	143.0	2.9	4.4	1.1	0.58	0.94	1.19
III	2005	129.4	0.0	0.0	103.5	25.9	3.96	3.96	3.96
	2010	134.1	0.1	0.4	106.9	26.7	3.90	3.90	3.90
	2015	139.8	0.1	1.0	111.0	27.8	3.82	3.82	3.82
	2020	145.4	0.2	2.1	114.5	28.6	3.77	3.77	3.77
	2025	151.3	0.3	2.9	118.5	29.6	3.72	3.72	3.72
IV	2005	129.4	0	0.0	103.5	25.9		3.96	
	2010	134.1	0	0.4	106.9	26.7		3.91	
	2015	139.8	0	1.0	111.1	27.8		3.83	
	2020	145.4	0	2.1	114.6	28.7		3.78	
	2025	151.3	0	2.9	118.8	29.7		3.72	

*The scenarios for ocean outfall treatment requirements preceding basic level disinfection are: A--secondary, C--intermediate nutrient removal, and E--full nutrient removal. These scenarios are applicable to alternatives I, II, and III, which involve use of ocean outfalls.

Cost-effectiveness. The costs under alternatives I and II range from $0.50 to $1.25/1,000 gal, whereas costs under alternatives III and IV range from $3.70 to $4.00/1,000 gal. Increments in the costs are apparent as the degree of treatment for ocean-bound wastewater is increased from secondary to full nutrient removal. The permitted ocean outfall capacity is 143 MGD. Projected traditional reuse will not be sufficient to handle flows in excess of this amount after the plant inflow reaches 143 MGD sometime between the years 2015 and 2020. Thus, a modest degree of groundwater recharge is required under alternative I and a lesser extent of groundwater recharge is required under alternative II.

Table 9-13. Outcomes of Indicators for Ocean Outfall Alternatives at the Miami-Dade/Central WWTP

		Treatment applied for ocean outfall discharge		
		A--Secondary treatment	C--Intermediate nutrient removal	E--Full nutrient removal
Alternative I-- Ocean outfalls used at current levels	N load reduction	2%	42%	82%
	P load reduction	2%	2%	39%
	Freshwater savings	1% (all from groundwater recharge)		
	Public acceptance	High		
Alternative II-- Limited use of ocean outfalls	N load reduction	2%	42%	83%
	P load reduction	2%	2%	39%
	Freshwater savings	1% (including 0.5% from groundwater recharge)		
	Public acceptance	High		
Alternative III-- Ocean outfalls as back up	N load reduction	100%	100%	100%
	P load reduction	100%	100%	100%
	Freshwater savings	64% (including 63% from groundwater recharge)		
	Public acceptance	Low-Moderate		
Alternative IV-- No use of ocean outfalls	N load reduction	100%		
	P load reduction	100%		
	Freshwater savings	64% (including 63% from groundwater recharge)		
	Public acceptance	Low-Moderate		

Summary. The benefits, costs and public acceptance of the ocean outfall alternatives for the Miami-Dade/North WWTP are compared in Figure 9-6. The benefit is the average of percent freshwater savings and overall nutrient (N, P) load reduction. Public acceptance is rated on a scale of high = 97%, moderate = 71%, and low = 45%, as suggested by the survey from CDM (2004).

A benefit of up to 31% is achieved through various combinations of traditional reuse, groundwater recharge and nutrient control technology (alternatives I and II). These are also the alternatives with the highest public acceptance. The alternatives involving extensive groundwater recharge (III and IV) achieve the highest benefits (82%), but are also most expensive and receive a lower level of public acceptance. The cost to achieve a benefit of 50% is $1.90/1,000 gal. The cost to achieve a benefit of 75% increases to $3.40/1,000 gal.

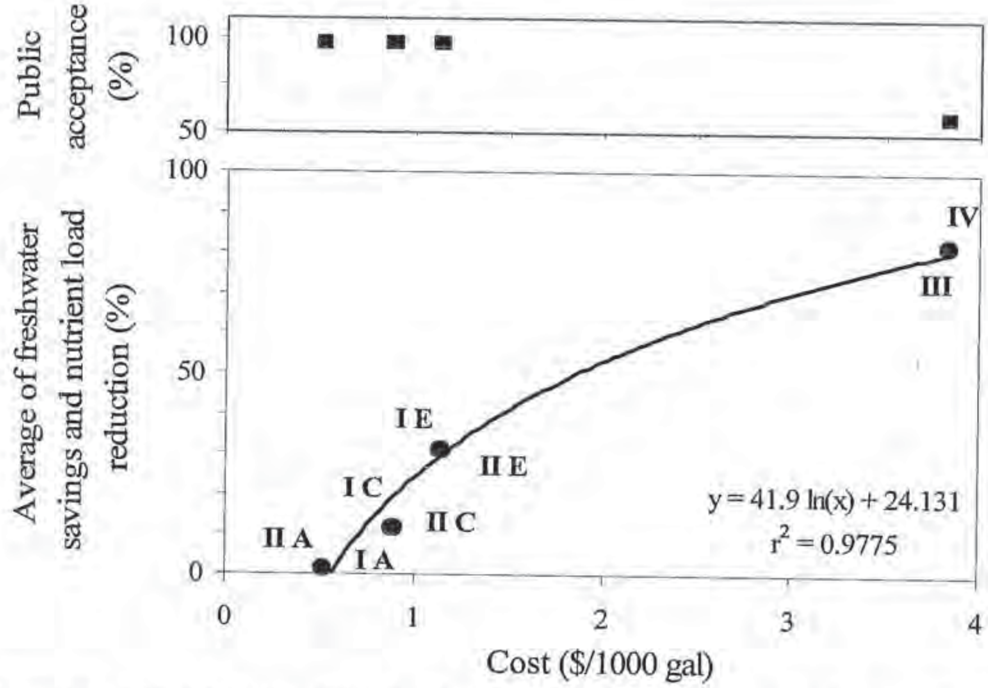

Figure 9-6. Public Acceptance and the Average of Percent Freshwater Savings and Nutrient Load Reduction versus Cost of Ocean Outfall Alternatives for the Miami-Dade/Central WWTP.

9.8 Comparison of Indicators among the Six WWTPs with Ocean Outfalls

Nutrient load reductions, freshwater savings and costs averaged over the 2005–2025 projection period are compared among the six WWTPs in this section. The Ocean Outfalls as Backups (Alt III) and No Use (Alt IV) alternatives have very similar values of these indicators. Therefore, values of the indicators under alternative IV are not discussed.

9.8.1 Nutrient Load Reductions

Reductions in nutrient load to the ocean are summarized in Figure 9-7 for three levels of treatment—secondary, intermediate nutrient removal and full nutrient removal—under the Currently Planned Use (Alt I), Limited Use (Alt II), and Use as Backups (Alt III) alternatives. Since the base case is defined on the basis of secondary treatment, nutrient reductions under the secondary treatment scenario are achieved by diverting flow from the ocean outfalls to reuse and are identical to the reuse percentages. The Boca Raton and Boynton-Delray WWTPs have the highest projected traditional reuse percentages and thus achieve the highest nutrient load reductions—57% and 64%, respectively, under alternative II (Fig. 9-7a, d). The Broward/North, Hollywood, Miami-Dade/North and Miami-Dade/Central WWTPs have lower projected traditional reuse percentages and therefore lower nutrient reductions—18% or less under alternative II. The results for alternative I are similar, but generally involve less reuse and therefore lower nutrient reductions.

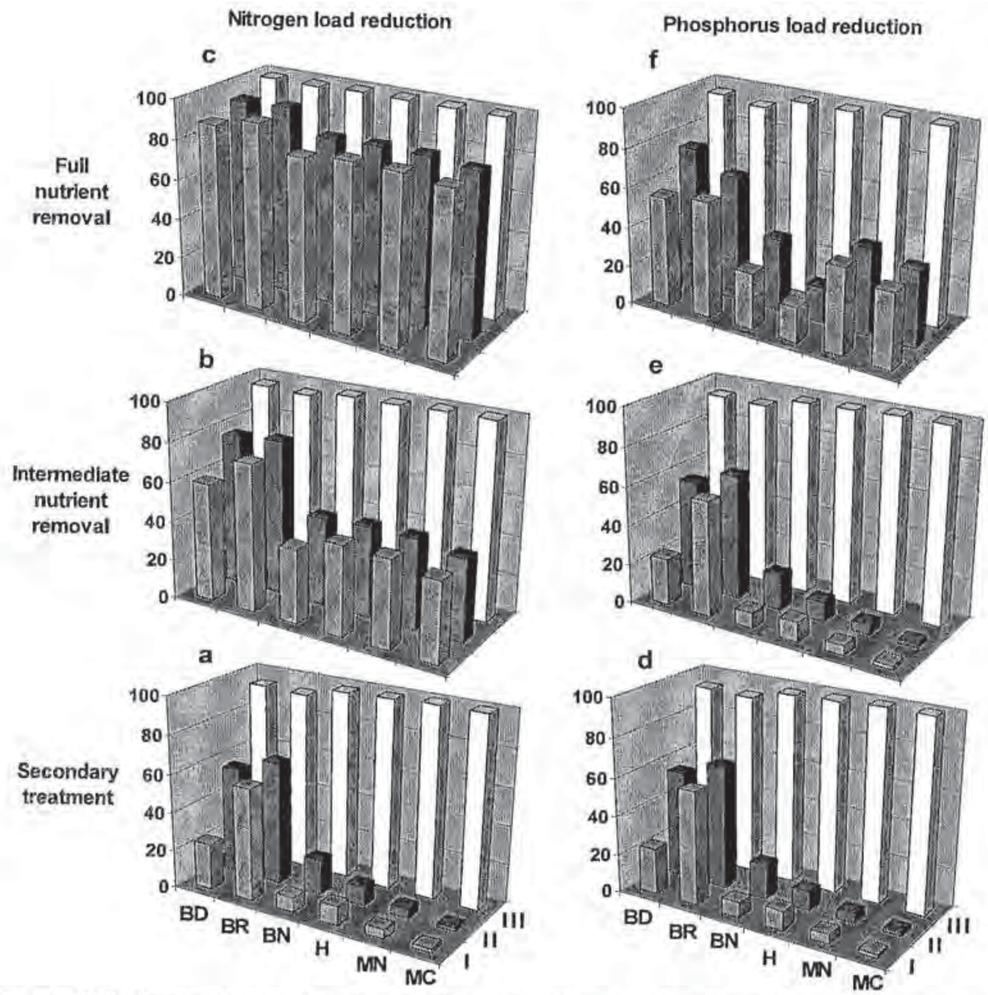

Figure 9-7. Percentage Reductions in Ocean Nutrient Load Achieved by Ocean Outfall Alternatives. I = currently planned use of ocean outfalls, II = limited use of ocean outfalls and III = ocean outfalls as backups; BD = Boynton-Delray, BR = Boca Raton, BN = Broward/North, H = Hollywood, MN = Miami-Dade/North, and MC = Miami-Dade/Central.

Intermediate nutrient control technology improves nitrogen load reductions at all the facilities relative to secondary treatment (Fig. 9-7b). Under alternatives I and II, the Palm Beach County facilities (Boynton-Delray, Boca Raton) reduce nitrogen loads by 77–79% whereas the Broward County (Broward/North, Hollywood) and Miami-Dade County (Miami-Dade/North, Miami-Dade/Central) facilities reduce nitrogen loads by 42–46%. Intermediate nutrient control technology does not improve phosphorus load reductions (Fig. 9-7e), since the effluent phosphorus levels in secondary effluents from all six facilities are below the concentration of 3 mg/L normally achievable by this technology.

Full nutrient removal technology brings the nitrogen load reductions at the Palm Beach County WWTPs to the range of 93–94% under alternatives I and II (Fig. 9-7c), which is comparable to that achieved under alternative III. Nitrogen load reductions at the Broward and Miami-Dade County facilities are somewhat lower—in the range of 83–84%—because of less traditional reuse. Phosphorus load reductions under alternatives I and II reach 64–74% at the Palm Beach County plants and 18–44% at the Broward County and Miami-Dade County plants (Fig. 9-7f).

9.8.2 Freshwater Savings

Freshwater savings relative to the base case, which has zero reuse, are summarized in Figure 9-8. Savings due to traditional reuse are highest at the Palm Beach County WWTPs, reaching 56–64% under alternatives II and III, compared to 18% or less under these alternatives at the Broward and Miami-Dade County WWTPs (Fig. 9-8a). Results for alternative I are similar, but involve less traditional reuse and therefore less freshwater savings. Groundwater recharge is negligible under alternatives I and II and accordingly there is little or no freshwater savings attributable to groundwater recharge under these alternatives (Fig. 9-8b). Groundwater recharge is extensive under alternative III, particularly at the facilities with limited traditional reuse. The Broward/North, Hollywood, Miami-Dade/North and Miami-Dade/Central WWTPs have freshwater savings of 51–63% due to groundwater recharge under alternative III, compared to 20–28% at the Boynton-Delray and Boca Raton WWTPs. The total freshwater savings are highest at the facilities with most extensive traditional reuse (Fig. 9-8c), ranging from 1% to 59% under alternative I, 1% to 64% under alternative II, and 64% to 82% under alternative III.

9.8.3 Costs

The costs of the various scenarios are compared among the six WWTPs in Figure 9-9. Under the Limited Use alternative (Alt II) and the secondary treatment scenario, costs vary in proportion to the extent of traditional reuse, ranging from \$0.50 to \$0.70/1,000 gal at the Broward County and Miami-Dade County facilities, where traditional reuse is least, to \$1.50/1,000 gal at the Palm Beach County WWTPs, where traditional reuse is greatest (Fig. 9-9a). Costs under the intermediate nutrient removal scenario increase to \$0.90–1.00/1,000 gal at the Broward County and Miami-Dade County facilities and \$1.60–1.70/1,000 gal at the Boynton-Delray and Boca Raton facilities (Fig. 9-9b). Under the full nutrient removal scenario, costs increase to \$1.00–1.20/1,000 gal at the Broward County and Miami-Dade County facilities and \$1.80/1,000 gal at the Palm Beach County facilities (Fig. 9-9c). The results under alternative I are generally similar.

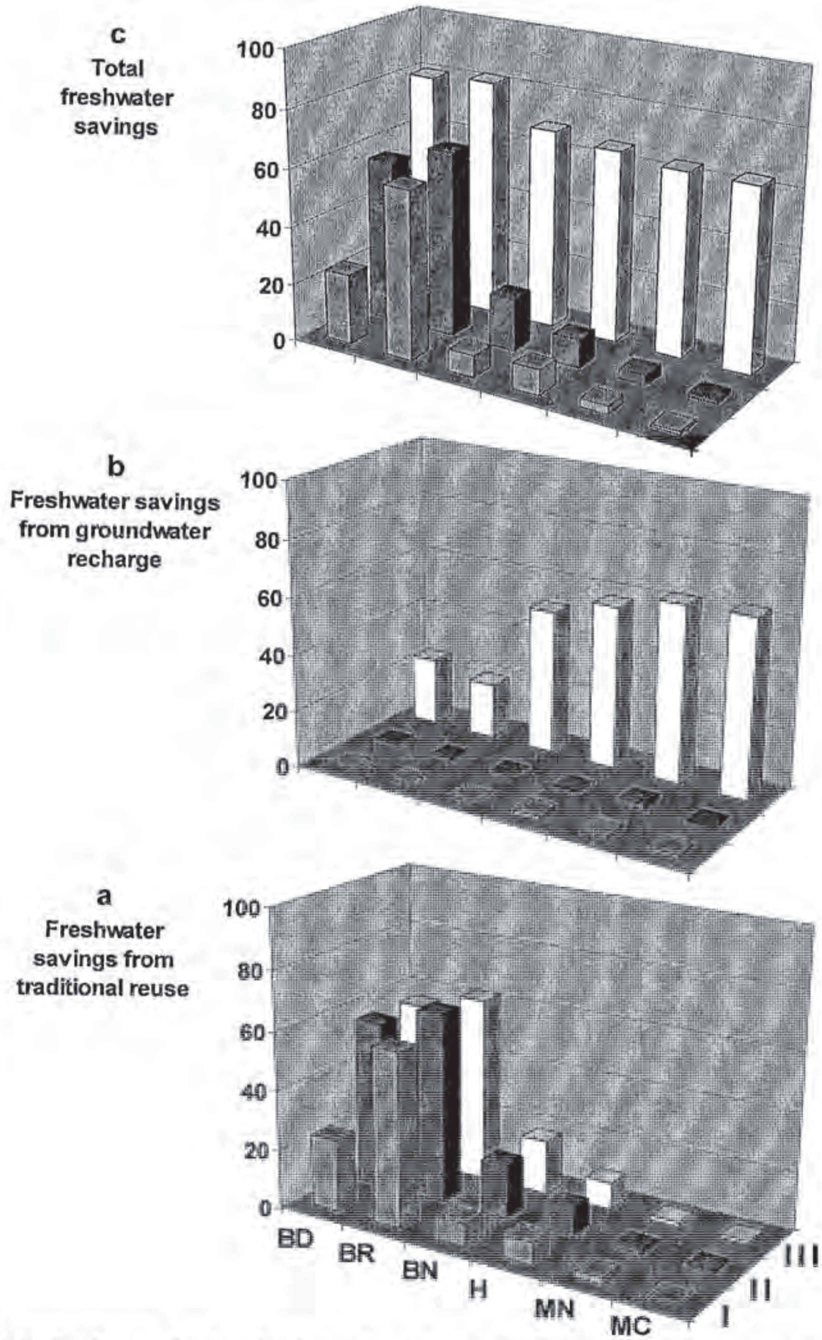

Figure 9-8. Freshwater Savings by Ocean Outfall Alternatives as Percent of Flow Treated. BD = Boynton-Delray, BR = Boca Raton, BN = Broward/North, H = Hollywood, MN = Miami-Dade/North, MC = Miami-Dade/Central. Alternatives are I–currently planned use of ocean outfalls, II–limited use of ocean outfalls, and III–use of ocean outfalls as backups. (Freshwater savings are expressed as percent of treated flow not discharged to Class I injection wells at the Broward/North WWTP.)

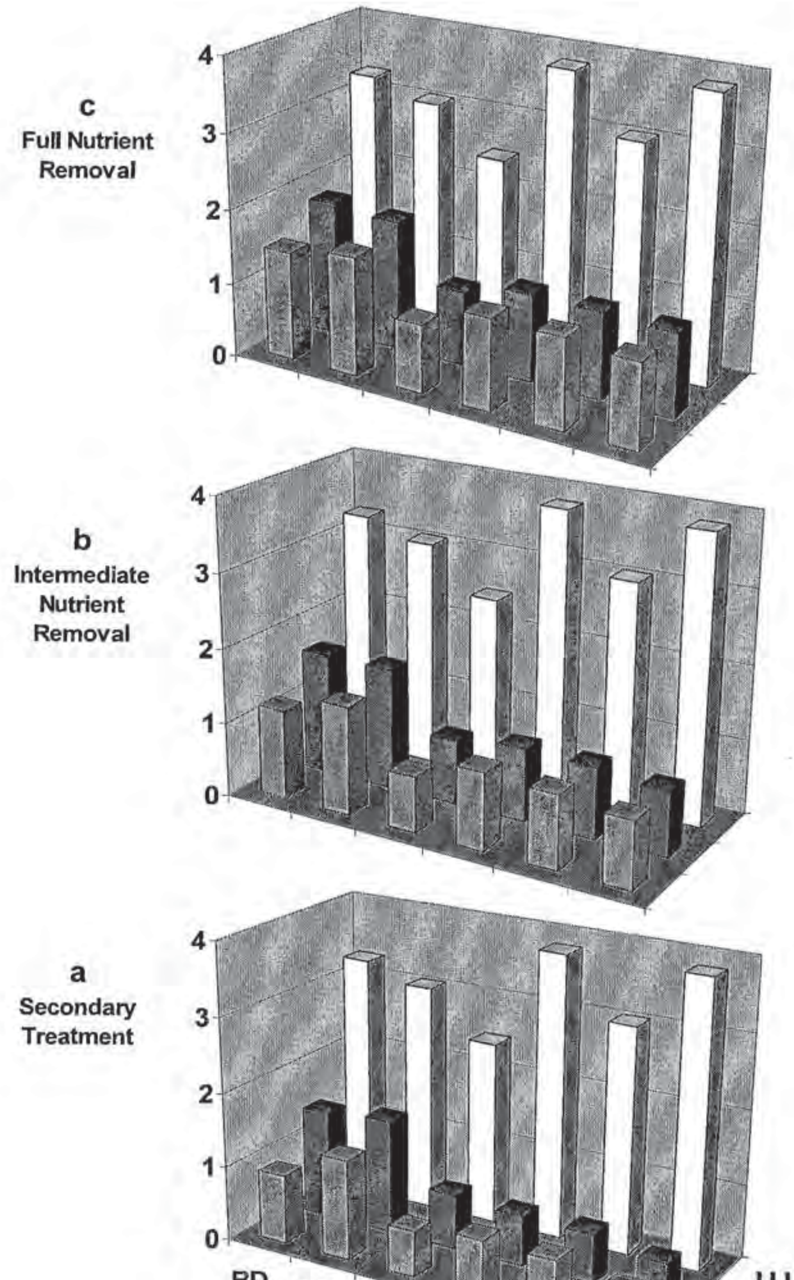

Figure 9-9. Costs for Ocean Outfall Alternatives in \$/1,000 gal. BD = Boynton-Delray, BR = Boca Raton, BN = Broward/North, H = Hollywood, MN = Miami-Dade/North, MC = Miami-Dade/Central. Alternatives are I–currently planned use, II–limited use, and III–backup use.

Very little flow reaches the outfalls under alternative III; therefore, the costs of this alternative are only slightly influenced by the level of treatment applied for ocean outfall disposal. The costs are highest ($3.80/1,000 gal) at the Miami-Dade/Central and Hollywood WWTPs. Both of these facilities have limited traditional reuse; therefore, most of the flow is handled by groundwater recharge under alternative III. The sites of recharge are very far (up to 35 miles) from the Miami-Dade/Central facility and hence high reclaimed water transmission costs are incurred. The Hollywood facility has a long transport distance to the recharge site and also has relatively high costs for concentrate disposal. Costs at the Broward/North WWTP are relatively low ($2.50/1,000 gal) because of relatively close proximity of recharge sites and a moderate level of traditional reuse. Costs at the other three facilities are in the range of $3.10 to $3.30/1,000 gal.

As shown earlier, the full nutrient control scenario under alternative II can achieve nitrogen load reductions that are on the same order as those achieved by alternative III. It is therefore interesting to express the cost of this scenario relative to that of alternative III. Costs of the full nutrient removal scenario at the Broward and Miami-Dade County WWTPs range from 29–40% of the costs of alternative III, while achieving nitrogen load reductions of 83–84%. At the Palm Beach County plants, the full nutrient removal scenario has costs that are 55–57% those of alternative III, while achieving nitrogen load reductions of 93–94%. However, corresponding phosphorus load reductions are less impressive, ranging from 18 to 74% at the six WWTPs.

9.9 Summary

Four alternative ocean outfall strategies were examined under the defined scope of this study. Under the Currently Planned Use alternative (Alt I), ocean outfalls would be used at currently planned levels. Under the Limited Use Alternative (Alt II), ocean outfall disposal would be limited to flows remaining after traditional reuse options were maximized and underground injection flows reached full 2005 permitted capacity. Under the Ocean Outfalls as Backups alternative (Alt III), ocean disposal would only be used during wet weather periods to handle flow that would otherwise go to traditional reuse. Complete elimination of ocean outfalls was considered under the No Use alternative (Alt IV). Varying degrees of treatment (secondary, intermediate nutrient removal, full nutrient removal) were considered for wastewater that is destined for ocean disposal. Secondary treatment with no disinfection vs. secondary treatment with filtration and high-level disinfection was considered for disposal through Class I injection wells. Four indicators (performance measures) were evaluated for each alternative: 1) amount of freshwater saved relative to a base case with no reuse, 2) reductions in nitrogen and phosphorus discharged via ocean outfalls relative to the base case, 3) public acceptance, and 4) costs. The results are given in a series of 13 tables and 9 figures.

The following conclusions and recommendations were reached from evaluation of the ocean outfall alternatives:

- Traditional (public access) reuse for the Boynton-Delray and Boca Raton WWTPs could substantially reduce nutrient loads to the ocean. Substantial reduction of nutrient loads from the other four facilities can be achieved through groundwater recharge, since traditional reuse opportunities are more limited in these areas.

- Substantial reductions in nitrogen loads are achievable through intermediate and full nutrient removal technologies. Given the relatively low total phosphorus concentrations in effluents from the WWTPs, only full nutrient removal technology can reduce phosphorus loads. Substantial reductions in phosphorus load will require moving toward either traditional reuse or groundwater recharge.
- The average freshwater savings are essentially equal to traditional reuse volumes under alternatives I (currently planned use of ocean outfalls) and II (limited use of ocean outfalls) and range from 24 to 64% at the Boynton-Delray and Boca Raton WWTPs and from 1 to 18% at the other four facilities.
- Under alternatives III (use of ocean outfalls as backups) and IV (no use of ocean outfalls), average freshwater savings range from 64 to 87%.
- Public acceptance of alternatives I and II is expected to be high at all of the facilities because the reclaimed water is used primarily for irrigation.
- Public acceptance of alternatives featuring large-scale groundwater recharge could be moderate or lower. However, public education programs and community involvement throughout the planning, implementation, and continued use of water reuse projects should help mitigate public concerns.
- Trends between costs and the percent average of freshwater savings and nutrient load reduction indicate that alternatives emphasizing traditional reuse and nutrient control technology are somewhat more cost effective than those emphasizing groundwater recharge. The ability to generate revenues from traditional reuse further increases the attractiveness of this approach.
- At the facilities with lesser densities of consumptive use permittees (Hollywood, Miami-Dade/North and Miami-Dade/Central), extensive groundwater recharge would be required to achieve a 50% average of freshwater savings and nutrient load reduction unless industries and residential users are added to the reclaimed water customer base.
- The costs of liquid treatment, reuse, and disposal to achieve a 50% average of freshwater savings and nutrient load reduction would range from $1.00/1,000 gal at the Boca Raton WWTP to $1.90/1,000 gal at the Hollywood WWTP, averaging $1.50/1,000 gal. Increasing this average to 75% would raise the average cost to $2.60/1,000 gal.

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Reuse Coordinating Committee and the Water Conservation Initiative Water Reuse Work Group (2003) Water Reuse for Florida: Strategies for Effective Use of Reclaimed Water. Florida Department of Environmental Protection, Tallahassee, Florida. June 2003. Accessed 28 February 2006 at http://www.dep.state.fl.us/water/reuse/flprog.htm.

10. Summary and Conclusions

The purpose of the study was to evaluate the status and efficacy of effluent management options for the six municipal facilities in Florida's Palm Beach, Broward and Miami-Dade Counties that discharge secondarily treated wastewater through ocean outfalls (Fig. 10-1). Urban water requirements in this region are rising due to rapid population growth, while water supply problems loom due to uncertainties in the time-phasing and funding of water resources projects. Southeast Florida's natural and artificial reef resources—some located near the outfalls—provide habitat and protection for marine organisms and contribute over 61,000 jobs and $1.9 billion in yearly income for residents of the three counties. An underutilized water management option in the region is water reuse, which could help Southeast Florida meet its water requirements while decreasing or eliminating reliance on ocean outfalls. The State has a reuse capacity of 1.2 BGD and expects to reclaim and reuse 65% of all domestic wastewater by 2020, up from 40% today. The study reviewed previous work describing the effects of ocean wastewater disposal on ocean biota and human health risks as well as past examples of obstacles and successes of water reuse in Florida, the U.S. and abroad. Four alternative ocean outfall strategies—involving varying degrees of reuse, nutrient removal and ocean outfall use— were considered. The alternatives were evaluated at each wastewater treatment plant according to four performance measures: 1) amount of freshwater saved relative to a base case with no reuse, 2) reduction in nitrogen and phosphorus discharged via ocean outfalls relative to the base case, 3) public acceptance, and 4) costs. Management recommendations based on these evaluations are presented.

Figure 10-1. Florida Counties with Ocean Outfalls. Photo from Google Earth (2005).

Current and projected flows at the six wastewater treatment plants (WWTPs) are compared to their permitted capacities in Table 10-1. The 2025 wastewater influent flow exceeds the 2005 permitted capacity at each WWTP; thus all of the facilities face important decisions regarding their future wastewater management options. According to current plans of the utilities, 7% of the total wastewater handled by the facilities will be reclaimed for traditional (public access) reuse in 2025, up from 4% currently.

Table 10-1. Permitted, 2005, and Projected 2025 Flows at WWTPs with Ocean Outfalls

	Boynton-Delray	Boca Raton	Broward/ North	Hollywood	M-D/ North	M-D/ Central	Total
Permitted flow (MGD)	24.0	17.5	84.0	42.0	112.5	143.0	423
2005 flow (MGD)	19	16	84	40	108	129	396
2005 reuse[1] (MGD)	3.7	5.2	2.4	2.6	0.1	0	14
2005 reuse[1] (%)	19	33	3	7	< 1	0	4
2025 flow (MGD)	27	22	94	54	126	151	474
2025 reuse[1,2] (MGD)	7.5	15.9	5.3	3.6	0.1	0	32.4
2025 reuse[1,2] (%)	28	73	6	7	0.1	0	7

[1]Excluding onsite reuse for process

[2]Based on utilities' plans extending to 2025

The primary source of potable water in Palm Beach County is the Surficial or the Biscayne Aquifer and in Broward and Miami-Dade Counties it is the Biscayne Aquifer. Population growth in the region should lead to a continued upward trend in demands, resulting in an aggregate water demand of 606 MGD by the year 2025. The Lower East Coast Water Supply Plan developed options for meeting future water supply needs, including Everglades National Park as part of the Everglades restoration, but did not make a detailed evaluation of reuse options. Ideally, the planned update of the 2000 Plan will address reuse in more detail.

Each of the service areas within the three counties was analyzed to determine the future water demand in relation to the available and planned potable water design capacity. The difference between water demand and potential water supply (design capacity) for the study period is termed "new water" demand. New water is the water demand in excess of the existing or planned water supply (design capacity) of the water treatment facility.

Palm Beach County has sufficient water treatment plant design capacity to meet its needs until at least 2025 (Table 10-2). Broward County has insufficient design capacity to meets its 2025 water demand; however, the water utilities within the County are planning five improvement programs during the study period to increase the design capacity by 26.9 MGD for a total of 426.8 MGD by the year 2008, which is sufficient to meet water demands throughout the study period. After three planned improvements to increase its design capacity by 86.3 MGD for a total of at least 554 MGD by the year 2025, Miami-Dade County will still need to identify sources for an additional 26.7 MGD by 2025.

Table 10-2. Summary of Projected Water Demands and WTP Design Capacities for the Study Area

County	2005 Water Demand (MGD)	% of 2005 Total	2025 Water Demand (MGD)	% of 2025 Total	2005 Design Capacity (MGD)	2025 Design Capacity (MGD)	Demand in Excess of Capacity (MGD)
Palm Beach	62.5	13.3	87.4	14.4	124.0	124.0	0
Broward	167.3	35.7	226.7	37.4	399.9	426.8	0
Miami-Dade	238.9	51.0	292.4	48.2	467.7	554.0	26.7
Total	468.7	100.0	606.5	100.0	991.6	1104.8	26.7

The Southeast Florida Outfall Experiment I (SEFLOE I), initiated by utilities in Broward, Miami-Dade and Palm Beach Counties, characterized the impacts of ocean outfall wastewater disposal in Southeast Florida. Englehardt et al. (2001) present a comparative assessment of the human and ecological impacts from municipal wastewater disposal in Southeast Florida. Their assessment includes ocean disposal from the six WWTPs. Field investigations revealed that surfacing plumes were present at all six WWTP outfalls throughout the year (Englehardt et al. 2001). All of the outfalls are in at least 28 meters (92 ft) of water and 2 miles offshore. They are located in the westerly boundary of the strong Florida Current, a tributary of the Gulf Stream. Wanninkhof et al. (2006) evaluated farfield dilution of sewage outfall discharges in southeast Florida. Their studies indicate that the rapid dilution observed in the immediate vicinity of the outfall continues to occur in the 10 to 66 km (6 to 41 mi) downstream distances. These authors do not address issues of reef impacts or pollutant control. A 2003 US EPA relative risk assessment study involved deep well injection, aquifer recharge, discharge to ocean outfalls and surface waters as disposal options (US EPA 2003). One of the conclusions of this study was that:

> Human health risks are of some concern, both within the 400-m mixing zone and outside of it, primarily because treatment of effluent prior to discharge via ocean outfalls does not include filtration to remove *Cryptosporidium* and *Giardia*. The most probable human exposure pathways include fishermen, swimmers, and boaters who venture out into the Florida Current and experience direct contact, accidental ingestion of water, or ingest fish or shellfish exposed to effluent. Otherwise, there is a very small, but not nonzero, chance for onshore or nearshore recreational or occupational users to be exposed to effluent constituents, since there is a small (10%) chance that currents will change direction to east or west.

Natural and artificial reefs near the six ocean outfalls contribute significantly to the tourist business in South Florida (2001). Recent studies by Tichenor (2004a; 2004b) suggest that the outfall discharge at Boynton Beach may be having an adverse effect on Lynn's Reef, but did not establish a link between pollutant discharges and the relative importance of pollutant concentrations at a specific reef. A biomarker study by Fauth et al. (2006) indicates that the reefs have been impacted in some cases. Based on δ15N analyses of macroalgae, sponges and gorgonian corals recently collected from reefs in Palm Beach and Broward counties, Lapointe and Risk (undated) believe that sewage nitrogen is a contributor to the nitrogen pool in the area's coastal waters. No complete report is available for this ongoing study. These recent and ongoing studies could provide valuable new insights into the extent of the cause-effect linkage between outfall discharges and impaired reefs in Southeast Florida and indicate whether or not current wastewater treatment levels are sufficient to protect water quality in general and the reefs in particular.

The highly urbanized nature of Southeast Florida has been cited as an obstacle to water reuse. However, successes of water reuse systems in large urban areas are well documented. The West Basin Water Management District in the Los Angeles area provides 118 MGD of reclaimed water for traditional reuse. The Irvine Ranch Water District in California has 300 miles of reclaimed water distribution piping in place. The Pinellas County, St. Petersburg, Florida, and Rouse Hill, Australia systems each have upwards of 10,000 connections to their reclaimed water distribution systems, while the City of Cape Coral, Florida has 33,000 residential customers—the world's largest residential reuse system. Orange County, California, is building a 62.5 MGD system to supply highly treated reclaimed water for groundwater augmentation and limitation of seawater intrusion. Satellite water reclamation facilities offer a cost-effective means of serving users that are distant from regional water reclamation facilities. They vary in size from the 100 MGD San Jose Creek Water Reclamation Plant in Los Angeles County to 0.01 MGD units demonstrated in Melbourne, Australia. Satellite facilities can achieve higher reclaimed water qualities than regional facilities—with the same degree of treatment—in collection systems impacted by saline groundwater.

Spatial analysis of the consumptive permit user database in Southeast Florida indicates that large users[1] with individual permits in Palm Beach County and northern Broward County have the highest demands for landscape irrigation. These large users are typically golf courses, parks, and other recreational areas. Miami-Dade County has the highest potential industrial demand. The Turkey Point Power Plant is an example of an industrial user not currently being supplied with reclaimed water. A case study of the area near the Broward/North WWTP indicates that reclaimed water can be cost effectively supplied to larger irrigation users within 12 metropolitan miles (measured along streets) of the reclamation facility. A relationship between reclaimed water flow for traditional reuse and cost was developed for this system. Expressions for the cost of transporting and injecting highly treated reclaimed water for groundwater recharge and for disposing of concentrate from reverse osmosis were also determined.

Four alternative ocean outfall strategies were examined under the defined scope of this study. Under the Currently Planned Use alternative (Alt I), ocean outfalls would be used at currently planned levels. Under the Limited Use Alternative (Alt II), ocean outfall disposal would be limited to flows remaining after traditional reuse options were maximized and underground injection flows reached full 2005 permitted capacity. Under the Ocean Outfalls as Backups alternative (Alt III), ocean disposal would only be used during wet weather periods to handle flow that would otherwise go to traditional reuse. Complete elimination of ocean outfalls was considered under the No Use alternative (Alt IV). Florida's 1.2 BGD reuse capacity clearly indicates that reuse is feasible within Florida and state statutes (403.064 and 373.250, F.S.) encourage and promote water reuse. Therefore, it was assumed that unaccounted for flows would be directed to reuse in alternatives that involve some level

[1] Users of 0.05 MGD more are categorized as large users for the purposes of this study.

of curtailment of ocean outfalls. The assumption was made that permitted capacities of the ocean outfalls would be maintained at 2005 levels and that no additional ocean outfalls would be permitted. It was also assumed that Class I injection control wells for effluent disposal would be held at 2005 permitted capacities and, furthermore, that Class I injection wells for effluent disposal that were in testing or under construction during 2005 would not receive permits. Current and potential treatment requirements employed in the evaluation of ocean outfall alternatives are summarized in Table 10-3. Generalized process trains capable of achieving these treatment requirements are shown in Figure 10-2.

Four indicators (performance measures) for the various alternatives at each of the WWTPs were evaluated: 1) amount of freshwater saved relative to a base case with no reuse, 2) reductions in nitrogen and phosphorus discharged via ocean outfalls relative to the base case, 3) public acceptance, and 4) costs. Indicators were evaluated based on the complete data set throughout the projection period.

Table 10-4 gives averages of flows, freshwater savings, public acceptance, and costs over the 20-year projection period (2005–2025) for all scenarios considered at the six WWTPs. Costs in the table include the costs of liquid treatment, reuse and disposal. Table 10-5 gives average values for nutrient loads to the ocean under the base case as well as in all scenarios considered for the WWTPs. Percentage reductions in nutrient load achieved in the scenarios are also given.

Table 10-3. Current and Potential Treatment Requirements of Wastewater Management Options*

Option	Treatment requirements	
	Current	Potential
Ocean outfalls	Secondary with basic-level disinfection (T2)	Intermediate or full nutrient control w/ basic-level disinfection (T4/T5)
Class I injection wells	Secondary with no disinfection (T1)	Secondary w/ filtration & high-level disinfection (T3)
Traditional reuse	Secondary w/ filtration & high-level disinfection (T3)	
Groundwater recharge	Full treatment and disinfection (T6)	

*Treatment trains (T1, T2, etc.) capable of meeting the requirements are described in Figure 10-2

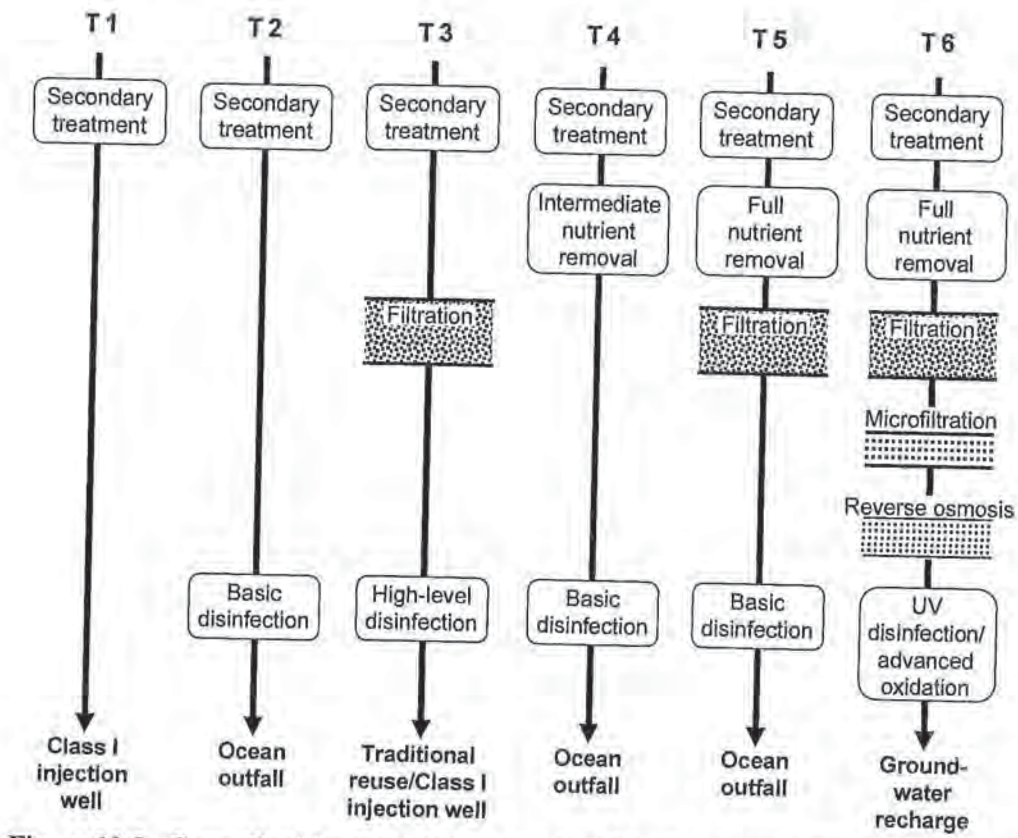

Figure 10-2. Generalized Process Trains Capable of Meeting Current and Potential Treatment Requirements of Wastewater Management Options

The averages of freshwater savings and nutrient load reductions and costs of the ocean outfall alternatives for the six WWTPs with ocean outfalls are compared in Figure 10-3. As the figure indicates, there are no maxima in the averages with respect to cost. Furthermore, the results for specific scenarios tend to lie near the general trend for each facility, indicating no substantial cost advantage of one scenario over another for a given level of freshwater savings and nutrient load reduction. The costs do not take into account the revenues that could be generated from providing reclaimed water to users as part of a traditional reuse system. When the potential for revenue generation is considered, scenarios emphasizing traditional reuse are likely to be more cost effective than those that do not.

The following conclusions and recommendations were reached from the present study:

- Water reuse (traditional and groundwater recharge) offers advantages to Southeast Florida—in terms of conserving water, augmenting available water resources, and reducing discharges to the ocean environment.
- Considering impending water shortages in Southeast Florida, continued use of ocean outfalls and deep injection wells for effluent disposal represents an unsustainable export of freshwater from the region.

Table 10-4. Flows, Freshwater Savings, Public Acceptance and Costs for Ocean Outfall Alternatives over the Period 2005–2025

			Flows as % of inflow					% Freshwater Savings			Cost ($/1000 gal) Scenarios[3]		
WWTP	Inflow (MGD)	Alt	Ocean outfall	UIC wells[1]	Trad. Reuse	GW re-charge	Concen-trate	Total	From GWR	Public acceptance[2]	A	C	E
Boynton-Delray	23.2	I	75.6	0.0	24.4	0.0	0.0	24	0	H	0.92	1.20	1.46
		II	43.5	0.0	56.5	0.0	0.0	56	0	H	1.46	1.65	1.82
		III	6.1	0.0	56.5	29.9	7.5	80	24	L/M to M/H	3.29	3.29	3.29
		IV	0.0	0.0	56.5	34.8	8.7	84	28	L/M to M/H		3.41	
Boca Raton	18.7	I	41.4	0.0	58.6	0.0	0.0	59	0	H	1.34	1.46	1.60
		II	35.7	0.0	64.3	0.0	0.0	64	0	H	1.53	1.63	1.75
		III	6.7	0.0	62.5	24.6	6.1	82	20	L/M to M/H	3.06	3.06	3.06
		IV	0.0	0.0	64.3	28.5	7.1	87	23	L/M to M/H		3.22	
Broward/ North	90.0	I	61.6	33.3	5.0	0.0	0.0	8	0	H	0.61	0.75	0.92
		II	54.5	33.3	12.2	0.0	0.0	18	0	H	0.73	0.86	1.00
		III	1.3	33.3	12.2	42.6	10.6	69	51	L to M	2.47	2.47	2.47
		IV	0.0	33.3	12.2	43.6	10.9	71	52	L to M		2.48	
Hollywood	47.2	I	90.4	0.0	7.2	1.9	0.5	9	1	H	0.73	1.04	1.24
		II	89.9	0.0	9.2	0.7	0.2	10	1	H	0.67	0.97	1.18
		III	1.0	0.0	9.2	71.8	18.0	67	57	L to M	3.82	3.82	3.82
		IV	0.0	0.0	9.2	72.6	18.2	67	58	L to M		3.83	
Miami-Dade/ North	116.8	I	95.4	0.0	0.1	3.6	0.9	3	3	H	0.71	0.99	1.22
		II	95.3	0.0	1.5	2.6	0.6	4	2	H	0.66	0.95	1.17
		III	0.2	0.0	1.5	78.7	19.7	64	63	L to M	3.05	3.05	3.05
		IV	0.0	0.0	1.5	78.8	19.7	65	63	L to M		3.05	
Miami-Dade/ Central	140.0	I	98.5	0.0	0.0	1.2	0.3	1	1	H	0.53	0.90	1.15
		II	98.3	0.0	0.9	0.7	0.2	1	1	H	0.51	0.88	1.13
		III	0.1	0.0	0.9	79.2	19.8	64	63	L to M	3.84	3.84	3.84
		IV	0.0	0.0	0.9	79.3	19.8	64	63	L to M		3.84	

[1] Class I [2] L = low, M = moderate, H = high

[3] The scenarios for ocean outfall treatment are: A–secondary, C–intermediate nutrient removal, and E–full nutrient removal. These scenarios are applicable to alternatives I, II, and III, which involve use.

Table 10-5. Averages for Nutrient Loads to the Ocean in Comparison to the Base Case over the 20-Year Projection Period

		Average Nutrient Loads to Ocean (tons/yr)								% Reductions in Nutrient Loads					
		Base case		Secondary		Inter. nut. rem.		Full nut. rem.		Secondary		Inter. nut. rem.		Full nut. rem.	
WWTP	Alt*	TN	TP	TN	TP	TN	TP	TN	TP	TN	TP	TN	TP	TN	TP
Boynton-Delray	I	661	60	500	45	267	45	80	27	24	24	60	24	88	56
	II	661	60	287	26	154	26	46	15	56	56	77	56	93	74
	III	661	60	40	3.7	22	3.7	6.5	2.2	94	94	97	94	99	96
Boca Raton	I	480	20	199	8.2	118	8.2	35	8.2	59	59	75	59	93	59
	II	480	20	171	7.1	101	7.1	30	7.1	64	64	79	64	94	64
	III	480	20	32	1.3	19	1.3	5.7	1.3	93	93	96	93	99	93
Palm Beach County	I	1,141	80	698	54	385	54	115	35	39	33	66	33	90	56
	II	1,141	80	459	33	255	33	77	22	60	58	78	58	93	72
	III	1,141	80	73	5.0	41	5.0	12	3.5	94	94	96	94	99	96
Broward/ North	I	1,351	119	1,249	110	844	110	253	84	8	8	38	8	81	29
	II	1,351	119	1,104	97	746	97	224	75	18	18	45	18	83	37
	III	1,351	119	26	2.3	18	2.3	5.3	1.8	98	98	99	98	100	99
Hollywood	I	1,193	79	1,079	71	650	71	195	65	10	10	46	10	84	18
	II	1,193	79	1,072	71	646	71	194	65	10	10	46	10	84	18
	III	1,193	79	12	0.8	7.0	0.8	2.1	0.7	99	99	99	99	100	99
Broward County	I	2,543	198	2,328	181	1,494	181	448	149	8	8	41	8	82	24
	II	2,543	198	2,176	168	1,392	168	418	139	14	15	45	15	84	30
	III	2,543	198	38	3.1	25	3.1	7	2.5	99	98	99	98	100	99
Miami-Dade/ North	I	3,111	302	2,968	288	1,696	288	509	170	5	5	45	5	84	44
	II	3,111	302	2,966	288	1,695	288	508	169	5	5	46	5	84	44
	III	3,111	302	5.5	0.5	3.1	0.5	0.9	0.7	100	100	100	100	100	100
Miami-Dade/ Central	I	3,580	341	3,525	336	2,098	336	629	210	2	2	41	2	82	38
	II	3,580	341	3,518	335	2,094	335	628	209	2	2	42	2	82	39
	III	3,580	341	3.8	0.4	2.3	0.4	0.7	0.2	100	100	100	100	100	100
Miami-Dade County	I	6,691	643	6,493	624	3,794	624	1,138	379	3	3	43	3	83	41
	II	6,691	643	6,484	623	3,789	623	1,137	379	3	3	43	3	83	41
	III	6,691	643	9	0.9	5	0.9	2	0.9	100	100	100	100	100	100

*A nutrient load of zero and nutrient load reduction of 100% are achieved under Alternative IV at each WWTP

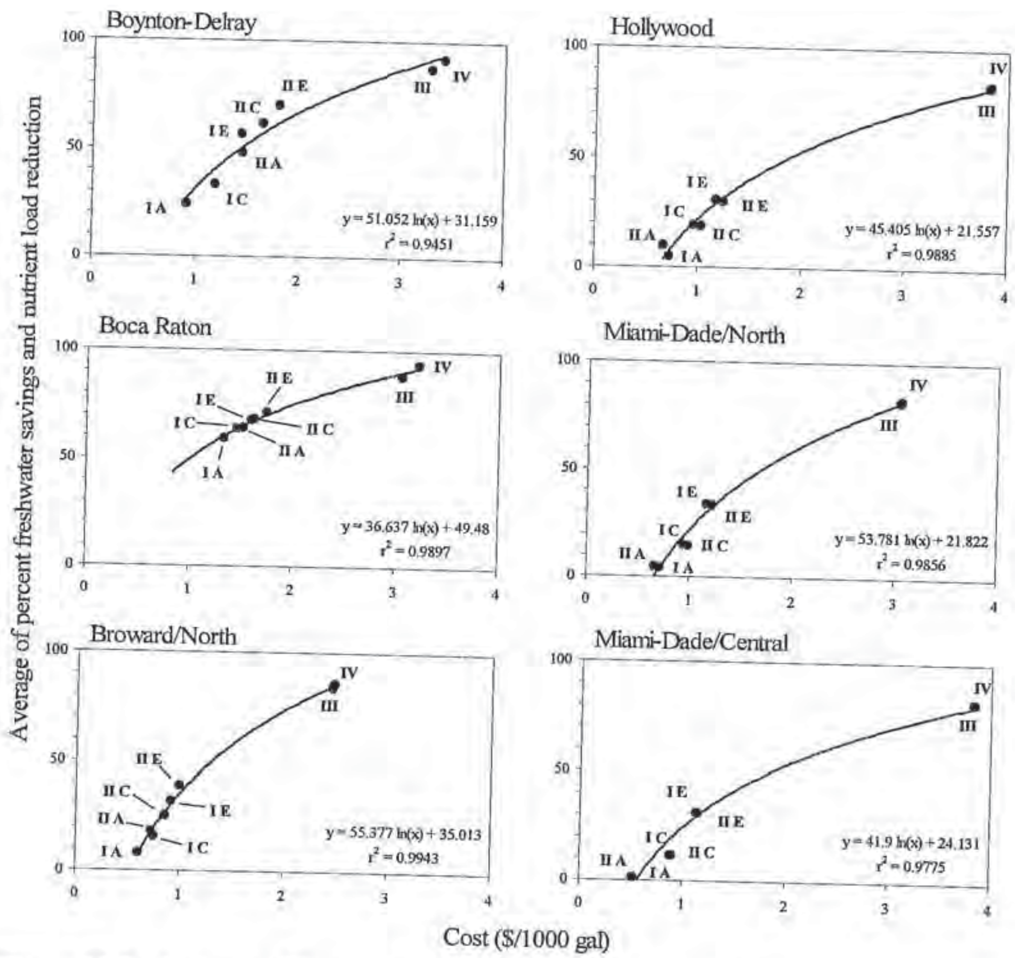

Figure 10-3. Averages of Percent Freshwater Savings and Nutrient Load Reduction versus Cost of Ocean Outfall Alternatives for WWTPs in Southeast Florida over the Period 2005–2025. Alternatives are Currently Planned Use (I), Limited Use (II), Ocean Outfalls as Backups (III) and No Use (IV). The scenarios for ocean outfall treatment are: A–secondary, C–intermediate nutrient removal, and E–full nutrient removal.

- The weight of indirect evidence of reef damage by ocean outfalls is cause for concern and justification for additional actions to address these issues.
- The success of water reuse in large urban areas in the U.S. and abroad indicates that difficulties to reuse posed by the highly urbanized nature of Southeast Florida can be overcome.
- Satellite water reclamation facilities can effectively serve distant users of reclaimed water in regional wastewater systems and improve reclaimed water quality in collection systems impacted by saltwater intrusion.

- Traditional (public access) reuse for the Boynton-Delray and Boca Raton WWTPs could substantially reduce nutrient loads to the ocean. Substantial reduction of nutrient loads from the other four facilities can be achieved through groundwater recharge, since traditional reuse opportunities are more limited in these areas.
- Substantial reductions in nitrogen loads are achievable through intermediate and full nutrient removal technologies. Given the relatively low total phosphorus concentrations in effluents from the WWTPs, only full nutrient removal technology can reduce phosphorus loads. Substantial reductions in phosphorus load will require moving toward either traditional reuse or groundwater recharge.
- The average freshwater savings are essentially equal to traditional reuse volumes under alternatives I (currently planned use of ocean outfalls) and II (limited use of ocean outfalls) and range from 24 to 64% at the Boynton-Delray and Boca Raton WWTPs and from 1 to 18% at the other four facilities.
- Under alternatives III (use of ocean outfalls as backups) and IV (no use of ocean outfalls), average freshwater savings range from 64 to 87%.
- Public acceptance of traditional reuse is expected to be high at all of the facilities because the reclaimed water is used primarily for irrigation.
- Public acceptance of alternatives featuring large-scale groundwater recharge could be moderate or lower. However, public education programs and community involvement throughout the planning, implementation, and continued use of water reuse projects should help mitigate public concerns.
- Trends between costs and the average of percent freshwater savings and nutrient load reduction indicate that alternatives emphasizing traditional reuse and nutrient control technology are somewhat more cost effective than those emphasizing groundwater recharge. The ability to generate revenues from traditional reuse further increases the attractiveness of this approach.
- At the facilities with lesser densities of consumptive use permittees (Hollywood, Miami-Dade/North and Miami-Dade/Central), extensive groundwater recharge would be required to achieve a 50% average of freshwater savings and nutrient load reduction unless industries and residential users are added to the reclaimed water customer base.
- The costs of liquid treatment, reuse and disposal to achieve a 50% average of freshwater savings and nutrient load reduction would range from $1.00/1,000 gal at the Boca Raton WWTP to $1.90/1,000 gal at the Hollywood WWTP, averaging $1.50/1,000 gal. Increasing this average to 75% would raise the average cost to $2.60/1,000 gal.

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Aerial photo of coast south of Imperial Beach. Photo courtesy U.S. Fish & Wildlife Service

Sewage-contaminated runoff from the Tijuana River has flowed into the Pacific Ocean south of Imperial Beach, and temporarily raised ocean pollution levels.

The affected water stretches from the end of Seacoast Drive in Imperial Beach south to the International Boundary.

San Diego Coastkeeper receives daily water quality information from the County of San

Diego, Department of Environmental Health and posts it on its Swim Guide.

The website called this area the number one location to witness urban runoff pollution.

"The river carries large amounts of raw sewage as well as trash and sediment straight through the estuary and onto the beaches near Imperial Beach," the list reads. "This location slots into #1 because of the severity of the polluted runoff, the amount of the water flowing in this spot and the complicated matter of finding solutions to polluted runoff that starts in the U.S., flows through Mexico and completes it journey back in America."

—*City News Service contributed to this report.*

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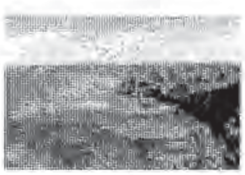

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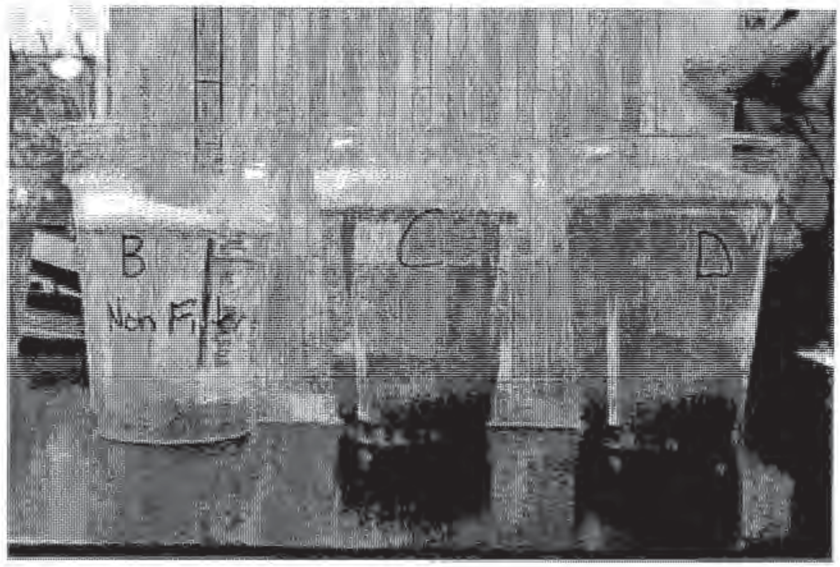

9/2/2010

Coagulation and Harvesting of Microalgae

On Aug 11, 2010, with the assistance of a leading equipment vendor and the generous cooperation of laboratory staff at the Napa Sanitation District, Aquagy personnel tested the efficacy of electrocoagulation (EC) equipment for coagulating, flocculating, settling, and harvesting microalgae from pond water. This report summarizes the results and findings from that experience, provides a brief summary of electrocoagulation as it applies to wastewater treatment, and a brief outline of EC's applications to primary, secondary, and tertiary treatment.

Electrocoagulation Report

COAGULATION AND HARVESTING OF MICROALGAE

Background

Electrocoagulation is the passing of electric current through water to induce strong oxidation and reduction reactions. Consumable metal plates, such as iron or aluminum, are used as sacrificial electrodes to continuously produce ions in the water. These ions neutralize the charges of particles suspended in the water, thereby initiating coagulation and either precipitation or flotation. The contaminants can thereafter be filtered out for beneficial reuse or disposal.

EC has been successfully used to treat a wide range of municipal, industrial, and commercial waste streams contaminated with heavy metals, virus, bacteria, pesticides, arsenic, MTBE, cyanide, BOD, TDS, TSS, nitrogen, phosphate, and others.

Electrocoagulation acts on a principle similar to that of chemical coagulation, by using cations to neutralize the charge on the surface of the suspended solids, so that they no longer repel one another and can coagulate (clump together). **However, EC offers certain advantages over chemical coagulation:**

- Simple and reliable operation with little maintenance
- Effective at smaller doses of metal cation
- More consistent results despite seasonal variations
- Colorless and odorless water produced
- Larger flocs
- It does not add salts or costly polymers to the water or to the separated biosolid;
- Whereas polymer coagulants produce a biosolid that is gelatinous and difficult to dewater, electrocoagulation produces a biosolid that repels water, dries easily, and facilitates subsequent handling. This drying property is readily evident even just a few hours following treatment.
- Finally, in most cases electrocoagulation is far more economical than chemical coagulation

Description and Methods

Four municipal wastewater districts from diverse parts of Central California chose to participate in this study by providing pond water samples that were high in algal solids. These four source ponds represent a wide range of hydraulic residence times, from a low of about 5 days to a high of several months, and this fact – along with the geographical and climatic variation represented – ensures that the study included a wide variety of algal species. To maintain confidentiality, the actual names of the sources are coded.

The algal concentrations, expressed as measurements of Total Suspended Solids (mg/L) and turbidity (NTU), also covered a wide range, with raw sample TSS ranging from 15 mg/L to 434 mg/L, and turbidity ranging from 18 to 124 NTUs.

We tested two types of anode for dosing the samples with metal ions: aluminum and iron. There is nothing unique or special about the blades themselves, and replacement pieces can be obtained locally from a metal shop or mill and are therefore the least expensive form of metal.

The sample waters were exposed to approximately one minute of hydraulic residence time (HRT) during treatment, at about 100 volts and 2-4 amps. The amperage measured is affected by the conductivity (salinity) of the water, such that water with higher conductivity can be successfully treated at lower voltage.

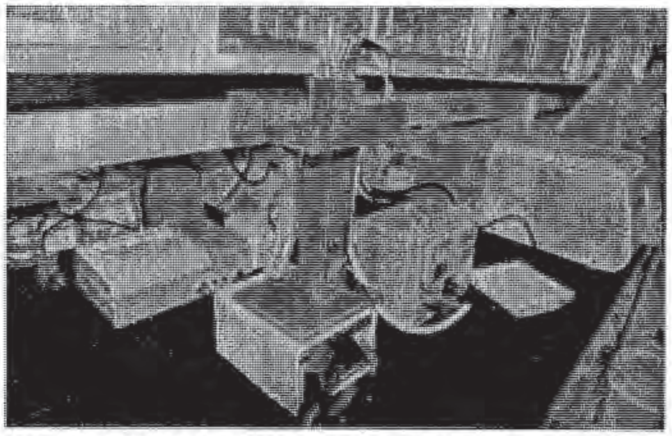

Figure 1. The bench-top electrocoagulation set-up, with capacity of 1 liter per minute, continuous flow.

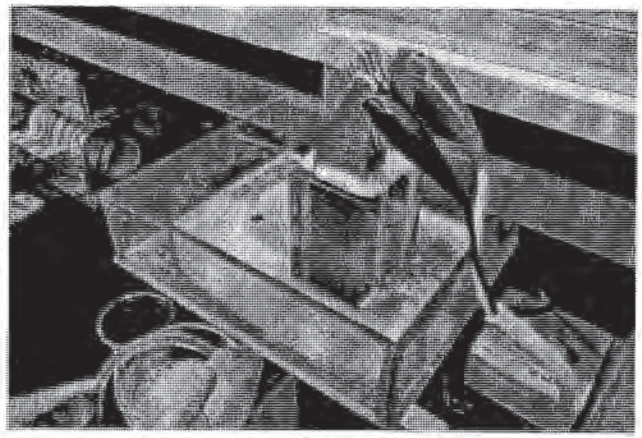

Figure 2. DC electrodes attached to the metal blade anodes. Treated water spills out the top of the tower-shaped treatment chamber in center.

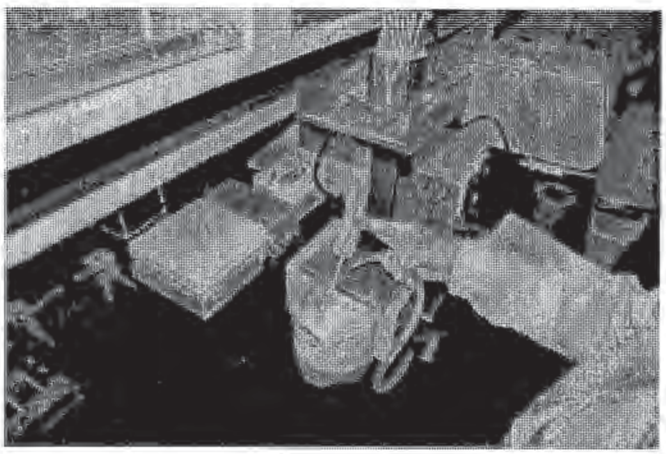

Figure 3. Electrocoagulated water exiting the bench-scale unit.

There is nothing unique about the iron or aluminum blades. Replacements can be purchased from the local mill and are the least expensive form of metal.

Results

After passing through the electrocoagulation chamber (approximately 1 min HRT), the microalgae immediately started to clump and flocculate. Initially, the majority of the flocs floated, apparently due to air bubbles adsorbing to the surface of the flocs. When the treated water was subjected to mild stirring so as to dissipate these bubbles, or if allowed to sit quietly for about 45-90 mins, the algal flocs began to settle to the bottom.

The quantitative results of the electrocoagulation testing are presented in Table 1. In all cases, EC treatment alone reduced turbidity to less than 9 NTU. A subsequent filtration step reduced turbidity to less than 2 NTU, and usually to less than 1 NTU.

Table 1: Results of Electrocoagulation Testing on Aug 11, 2010

	Turbidity (NTU)			TSS (mg/L)		
Sample	Raw	EC-Treated[1]	EC+Filtered[2]	Raw	EC+Filtered[2]	Notes
Aluminum blades:						
Sample A	41	7.0	0.43	28	n.d.	102 Volts, 2.5 amps
Sample B	18	1.6	0.23	15	n.d.	102 Volts, 2 amps
Sample C	72	1.7	1.15	128	n.d.	102 Volts, 3 amps
Sample D	124	8.2	0.50	434	n.d.	102 Volts, 4 amps
A, double amperage	40	1.3	1.72			100 Volts, 7 amps
Iron blades:						
Sample B	18		0.62			102 volts, 3 amps
Sample B (50% volt)	16	4.5	0.23			50 volts, 1.5 amps
Sample B (25% volt)	16		0.23			25 volts, 0.5 amps
Sample D	124	5.5	0.16	434	n.d.	100 volts, 4 amps
Sample D (50% volt)	123		0.70	434	n.d.	50 volts, 2 amps

n.d. = non-detect

[1] Unfiltered turbidities were measured after about 1-2 hours of settling.

[2] Filtration was through a Whatman #1 filter paper of nominal pore size = 11 microns to simulate the clarification achieved by passing through the sludge blanket in a conventional clarifier.

Qualitative Results

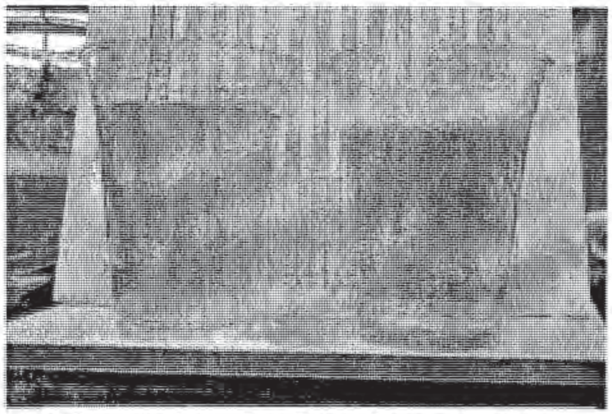

Figure 4. Immediately after EC treatment, coagulated solids tend to float.

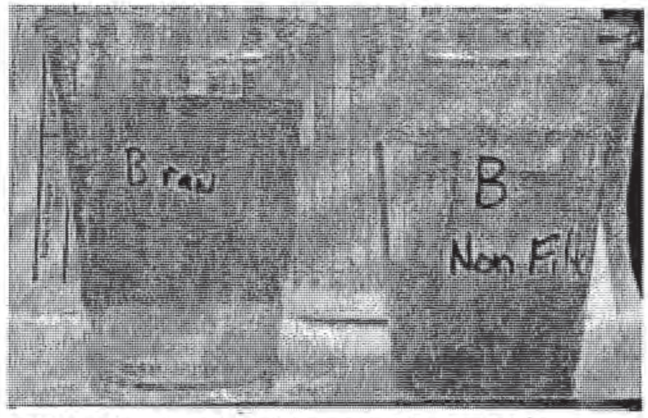

Figure 5. After about 1 hour of settling, solids settle to the bottom, leaving a clear supernatant.

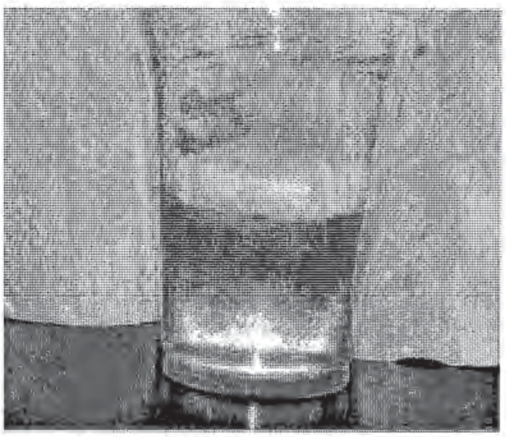

Figure 6. Coagulated microalgae (Sample A) immediately following EC treatment

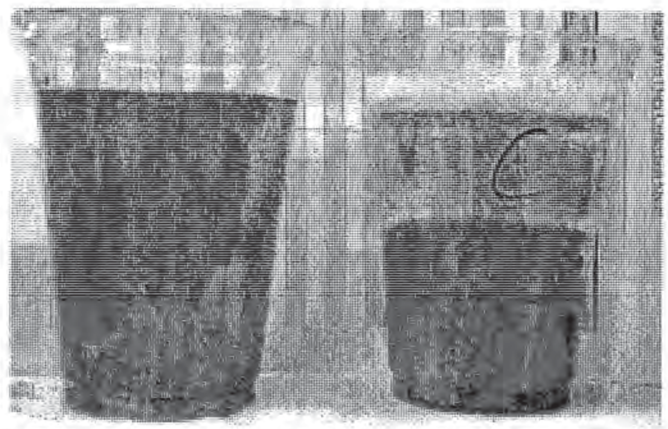

Figure 7. Raw pond water (left) from Sample C and coagulated algae after about 1 hour of settling (right). Very similar results were obtained with Sample D (see photo on cover page.)

Figure 8. Treatment of Sample B with full voltage and iron blades yielded rapid and complete settling.

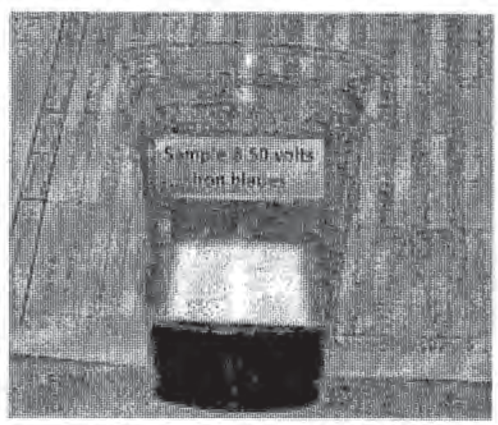

Figure 9. Treatment of Sample B at half voltage still yielded turbidity less than 5 NTU without filtration.

Figures 10 and 11. Following treatment at half voltage, settling after 24 hours (left photo) and 96 hours (right photo) in Sample D, illustrating the trade-off between power consumption and time required for adequate treatment.

Discussion

The vast majority of metal ions added during treatment precipitates out and is removed from the water along with the algal biosolids. Added iron may be beneficial for soil, plants or animal diet (depending on the final disposition of the biosolids), but causes the algae to take on a blue-black coloration and may contribute to temporary formation of orange bubbles at the water surface. Iron is not known as a biological toxin at these concentrations and has no known inhibition on anaerobic digestion processes.

In general, treatment with aluminum blades tends to yield very clean, clear water that has a certain sparkling quality to it. Aluminum is more expensive than iron, but is still affordable, readily available, and is low toxicity. Some treatment applications may require the use of blades made of more specialized metals such as titanium for the selective removal of particular contaminants, such as fluoride.

The cost of the metal consumed per volume of water treated is relatively low – iron cost is on the order of $0.04 to $0.07 per 1,000 gallons treated – especially compared to chemical polymers, which routinely cost $0.40 but can reach $1.00 per 1,000 gallons treated. The total cost of treatment with EC, including electricity, is typically less than one-half the cost of chemical coagulation.

Time constraints prevented us from doing a thorough study, but spot-testing indicated that satisfactory results may be attainable at significantly lower power consumption than the levels tested. Performance is specific to each of the source waters and depends largely on its conductivity. We obtained excellent clarification of Sample B water at 50% of the applied voltage, and even at 25% of the initial voltage. In Sample D, treatment at half voltage resulted in bulk settling, but with a persistent cloudiness left in the supernatant. This cloudiness eventually cleared, but it took several days, illustrating the trade-off between power (expense) and time.

When the voltage is decreased, the amperage decreases proportionately, so at 50% voltage, the actual power consumption is just 25% of the baseline.

It is worth noting that when we decrease the voltage, the amperage also decreases proportionately (Ohm's Law), so at 50% of the original voltage, there is also about 50% of the original amperage, and the actual power consumption is just 25% of the original baseline.

EC makes an excellent pre-treatment for gross solids removal before going through a microfilter. The coincidental formation of microbubbles at the cathode site in the EC chamber initially floats most solids, making EC also suitable for subsequent treatment in a dissolved air flotation (DAF) unit, although this is probably overkill for most applications. Gravity settling in a simple clarifier or settling pond is an economical and effective step for separation of the coagulated solids.

Applications

Electrocoagulation has applications in wastewater treatment during the primary, secondary and tertiary treatment stages. Because algae removal is of importance in meeting California discharge regulations, the application of EC to pond effluent can be used to economically increase the efficiency of settling and in the reduction of biosolids.

When given adequate residence time, effluent from the EC unit will naturally settle by gravity to the bottom of a settling pond constructed as the last segment of a treatment train. Such application will greatly enhance the removal of BOD, TDS, TSS, nitrogen and phosphate, providing an excellent secondary or tertiary effluent and an economical pre-treatment step for final filtration of recycled water, greatly improving the life and performance of the filter and aiding subsequent disinfection.

In treatment trains not employing ponds, standard clarifiers can be used to achieve similar removal efficiency and comparable enhancements to the tertiary process.

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Water Reuse Eliminates Government Required Treatments for Wastewater Discharges

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Abstract

The only way to eliminate the intrusion of continual government wastewater inspectors is to eliminate the water discharge. Clean electricity properly applied will cause a multitude of water contaminates to become separable from water. Electrocoagulation causes emulsified oil, textile dyes, heavy metals, turbidity, pesticides, bacteria, suspended solids, arsenic, phosphates, nitrates, zinc, biochemical oxygen demand, chrome, nickel, lead, copper, PCB's, chemical oxygen demand, sewage, and more to become separable from water, making the water suitable for reuse.

Background

Government discharge standards have been established for water discharge to the environment. The discharge standards are established to meet political needs and seem to be lowered as technology advances detection limits. The government regulators may enforce the discharge limits by fines, public humiliation, or by shutting down the production facility. The required water testing, monitoring, reporting, and spot inspections by the regulators consume valuable time and resources.

Water reuse on site is the best way to save this most precious natural resource. The recycled water can be cleaned up and conditioned to meet the specific reuse need. Water recycling can eliminate water discharge. With out water discharge the expense of testing, monitoring, reporting and spot government inspections is greatly reduced or eliminated. The cost of water purchases and water disposal is reduced.

Cleaning the water sufficiently to be reused can be accomplished in several ways including reverse osmosis, ion exchange, evaporation, chemical coagulation, and or electrocoagulation (EC). Each of the treatment methods, or a combination of the methods, has advantages and disadvantages depending upon the type of water to be reclaimed and the intended use of the reclaimed water. Water recovery on site allows the selection of the treatment based on the specifics of the water content to be recovered and the specific quality of water needed in the reclaimed water process.

Reverse osmosis separates contaminants from the portion of the water that permeates the membrane and concentrates contaminates in the reject water that does not pass through the membrane. The permeate water quality can be controlled by the type of membranes used. The reject water may be 30% of the total water stream. In addition to wasting the reject water, the disposal cost for the reject water may cost more that the reverse osmosis operating cost. The reverse osmosis process is not very effective in mixed streams containing oil, grease, bacteria, and silica, which cause membrane fouling.

Ion exchange captures specific ions in the water. Ion exchange adds one type of ion to water as a second type of ion is removed. A common type of ion exchange adds two sodium ions to the water in the process of removing one calcium ion from the water. The cost of ion exchange resin regeneration is significant in terms of water loss. When regulated heavy metal ions like chrome are removed from the water, the regeneration liquid is high in acid and metal content creating a costly hazardous waste.

Evaporation or distillation produces clean water. The solids separated during the distillation process can be concentrated in the bottoms. Energy consumption and capital cost are the main drawbacks.

Coagulation caused by altering the charge on metal ions, organics, and colloidal particles creates a large particle that can be settled or filtered out. Chemical coagulation typically uses a dissolved salt. Part of the salt will attach to the material in the water to be coagulated. The other part of the ion typically remains in the solution. Chemical coagulation creates a hydroxide sludge that attracts water. The hydrophilic sludge holds water, which increases the volume of sludge generated and increases the dewatering time.

Electrocoagulation adds electrons to the solution by passing alternating current or direct current through the solution from the power grid. The electrons destabilize the material in the water creating oxide sludge when sufficient activation energy is present. The oxide sludge repels water and filters well. The oxide sludge dewaters well, eliminating the bogging problem associated with polymer treated sewage sludges in landfills, which will stick a tractor for years. Heavy metal ions converted to metal oxides will pass the leach tests making them non hazardous. Metal oxides can be smelted to recover the metals in a usable form.

Steam cleaner wash water reclamation case study:

Valley Detroit Diesel Allison, Bakersfield, California, assembles Detroit Diesel Allison engines and performs semi tractor repair. The engines are covered with oil, dirt, grease, and normal road grime. The engines are steam cleaned prior to assembly or repair.

The steam cleaning is performed over a pad. The spent steam cleaner wash water is collect in a pit. The dirty steam cleaner wash water is designated as a hazardous waste due to the heavy metal content. During the rainy season, rain runoff water from the parking lot would also collect in the pit and mix with the dirty steam cleaner wash water.

The hazardous wastewater had to be measured, tested, and accounted for to the local government inspector. The hazardous wastewater was hauled off by vacuum trucks for disposal at a cost of $0.60 per gallon in the dry season and $2.30 per gallon in the rainy season. The government inspector would physically inspect the water volume and truck hauling records monthly at the facility.

Valley Detroit Diesel Allison decided to reclaim the steam cleaner wash water in 1988. A containment facility was built to store diesel fuel, motor oil, antifreeze, used motor oil for recycling, and water treatment. A 26,000-gallon holding tank stores the surges of parking lot rain run off water and used steam-cleaning water from the pit. The water is processed through a 2 gpm EC unit and clarifier. The oil, grease, dirt, and heavy metal solids separated from the clarifier are placed in the used oil storage tank for recycling. The clear water from the clarifier passes through a swimming pool. The reclaimed water is stored in a 1,000-gallon clean water storage tank for reuse in the steam cleaner. A float switch control system in the dirty water storage tank and clean water storage tank turn the unit on when there is dirty water to treat and room for clean water storage.

The clear water met all federal secondary drinking water standards with the exception of surfactants (soap) (Table 1). The recycled surfactants reduced the need to add soap at the steam cleaner. The sludge from the EC process contained 90 mg/kg oil and grease. The heavy metals were converted into oxides. The sludge passed the California states TTLC and STLC leach tests as required by CAC title 22 (Table 2). As a result the State Health Board approved the EC processed sludge as a non hazardous waste suitable for landfill disposal.

The government inspector stopped visiting the site after the first three months of water recycling. Because the water is recycled there is no water disposal records, no continual water testing, and no vacuum trucking fees. The EC unit requires about one hour of maintenance per forty hours of operation. The operating cost for electricity and blade replacement is less than one cent per gallon. The company purchased EC systems for each of their three locations.

Lab results:

Table 1. The recycled Steam cleaner wash water lab analysis follows: (004-263).

Constituent	**Wastewater ppm**	**EC water ppm**	**% Removal**
Antimony	<0.01	0.014	
Arsenic	0.30	<0.01	96.7% +
Barium	8.0	<0.10	98.7% +
Beryllium	<0.01	<0.01	
Cadmium	0.141	0.031	78.0%
Chromium	7.98	0.05	99.4%
Cobalt	0.13	<0.05	61.5% +
Copper	6.96	<0.05	99.3% +
Lead	7.4	1.74	76.5%
Mercury	0.003	<0.001	66.7% +
Molybdenum	0.18	0.035	80.7%
Nickel	0.4	<0.05	87.5%
Selenium	<0.005	<0.005	
Silver	<0.01	<0.01	
Thallium	<0.10	<0.10	
Vanadium	0.23	<0.01	95.7% +
Zinc	19.4	1.20	93.8%

Table 2. The dry sludge separated from the Steam cleaner wastewater listed above was tested for leach ability as follows (005-462):

Element	**TTLC Raw mg / kg**	**Max State**	**STLC Raw mg / l**	**Max State**
Antimony	2.4	500		
Arsenic	3.85	500		
Barium	307	10,000		
Beryllium	nd	75		
Cadmium	nd	100		
Chromium	59.2	2,500		
Cobalt	10.4	8,000		
Copper	498	2,500	3.8	25
Lead	790	1,000		
Mercury	0.15	20		
Molybdenum	21.3	3,500		
Nickel	25.5	2,000		
Selenium	nd	100		
Silver	2.7	500		
Thallium	14.2	700		
Vanadium	42.1	2,400		
Zinc	1,798	5,000	60	250
Oil & Grease	89,780			

Conclusion:

Electrocoagulation provides a cost effective, onsite way to recondition water for reuse. Water reconditioning for on site use eliminates governmental discharge concerns. Peace of mind results because proposed changes to government discharge regulation no longer apply. The water reconditioning equipment capital and operating cost is offset by water reuse, timesavings with government inspectors, discharge lab testing, and fines.

water

MDPI

Article

Removal of Six Estrogenic Endocrine-Disrupting Compounds (EDCs) from Municipal Wastewater Using Aluminum Electrocoagulation

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Abstract: Conventional wastewater treatment plant (WWTP) processes are primarily designed to reduce the amount of organic matter, pathogens, and nutrients from the incoming influent. However, these processes are not as effective in reducing the concentrations of micropollutants, including endocrine-disrupting compounds (EDCs), which notoriously evade traditional wastewater treatment technologies and are found even in tertiary-treated effluent. For WWTPs practicing deep-well injection or surface-water discharge, EDCs in the treated effluent are discharged into groundwater or the aquatic environment where humans and wildlife may potentially suffer the effects of chemical exposure. In the current laboratory-scale study, we tested a bench-top electrocoagulation (EC) unit utilizing aluminum blades for the removal of six estrogenic EDCs [estrone (E1), 17β-estradiol (E2), estriol (E3), 17α-ethinylestradiol (EE2), bisphenol-A (BPA), and nonylphenol (NP)]. Samples of municipal wastewater influent and tertiary-treated effluent were spiked with the six EDCs in order to test the removal efficiency of the EC unit. The mean concentration of each EDC component was statistically lower after EC treatment (removal range = 42%–98%). To our knowledge, this is the first study to investigate aluminum electrocoagulation for removal of these specific EDCs, including nonylphenol (without the ethoxylate chain), as well as natural and synthetic estrogens.

Keywords: micropollutant; endocrine disruption; chemical contaminants; pharmaceutical; water treatment; wastewater; estrogen; electrocoagulation

1. Introduction

Micropollutants are chemical contaminants found in the aquatic environment in the μg/L (ppb) or ng/L (ppt) concentration range that are considered to be potential threats to environmental ecosystems [1,2]. Both domestic and industrial wastewaters contain micropollutants, which are not entirely removed by conventional wastewater treatment plant (WWTP) processes and are, therefore, continually discharged into the aquatic environment [3]. The origin of micropollutant contamination is predominantly anthropogenic and the aquatic environment becomes the final resting place for the majority of these chemical compounds [4,5].

Endocrine-disrupting compounds (EDCs) are an important class of micropollutants that are defined as exogenous chemicals, or mixtures of chemicals, that can interfere with any aspect of hormone action [6]. EDCs are a particularly troublesome subset of micropollutants, due to their diverse nature, persistence in the environment, and ability to cause metabolic and reproductive disturbances at very low concentrations. EDCs can enter the aquatic environment directly (e.g., through effluent discharge) or indirectly (e.g., storm-water runoff), but the major transport of EDCs to the aquatic environment is through treated and untreated municipal wastewater discharge to rivers, streams, and surface waters [1,7,8]. Potable water resources, including both surface water and groundwater, can become contaminated through surface-water discharge or deep-well injection of WWTP effluent [4]. Effects of EDCs on wildlife (invertebrates, fish, amphibians, reptiles, birds, and mammals) include: abnormal blood hormone levels, altered gonadal development (e.g., imposex and intersex), induction of vitellogenin gene and protein expression in juveniles and males, masculinization/feminization, hermaphroditism, and decreased fertility and fecundity [9–12].

Estrogenic EDCs specifically target estrogen signaling. These include natural steroidal estrogens, synthetic estrogens, and industrial compounds which mimic estrogen. 17β-estradiol (E2) is the primary natural estrogen and has the greatest potency. Estrone (E1), a metabolite of E2, is a slightly weaker estrogen. Estriol (E3), considered to be the final metabolite, is the weakest natural estrogen, with only 10% of E2's potency. 17α-ethinylestradiol (EE2) is the synthetic steroidal estrogen component of contraceptives [13]. The overall estrogenicity of EE2 in effluent overshadows that of both E1 and E2 combined, due to its high estrogenic potency [14]. Bisphenol-A (BPA) is a monomer used in industry to produce lacquers, food-can liners, and thermal paper [15]. It has high water solubility and enters WWTPs through industrial discharges and leaching from BPA-based products. Nonylphenol (NP) is the persistent and estrogenic final product of the biodegradation of the non-ionic surfactant nonylphenol ethoxylate (NPEO) [16].

Conventional WWTP processes are designed primarily for the removal of organic matter, nitrogen, phosphorus, and pathogens; therefore, it is not surprising that the effluent from conventional WWTPs still contains EDCs at levels ranging from a few ng/L to several μg/L, which are sufficient to cause endocrine disruption in some species [17]. The concentrations of EDCs in WWTP influent vary according to geographic location and population served, while the level of EDC removal during treatment varies according to the WWTP processes employed [18,19]. Monitoring studies have demonstrated that some wastewater treatment processes are more effective than others for reducing EDCs and ultimately a combination of approaches may be necessary to reduce this diverse class of micropollutants. This manuscript focuses solely on the potential of electrocoagulation (EC) for EDC removal in municipal wastewater, since the efficacy of various WWTP processes (e.g., biological treatment with activated sludge, activated carbon treatment, nanofiltration, reverse osmosis, ozonation, and advanced oxidative processes) for reducing EDC concentrations has been reviewed extensively [20–22].

Electrocoagulation technology reduces contaminant levels by passing an electrical current through water, which generates coagulant precursors by electrolytic oxidation of sacrificial anode material—usually aluminum or iron. During the EC process, amorphous insoluble polymeric metal hydroxides and oxides are formed, which adsorb pollutants (particulate and dissolved) during precipitation, making them easily separable [23,24] (Figure 1). The most widely used electrode materials, aluminum and iron, are both inexpensive and effective against a wide range of pollutants, including soluble organic pollutants [25,26]. Patented over a century ago, EC has a long history as a water treatment technology. However, EC was abandoned by the 1930s due to high operation costs, as well as the availablilty of inexpensive chemicals for chemical coagulation treatment [27]. Recent technical and design improvements, combined with a growing need for cost-effective water treatment processes, have led to a re-evaluation of EC technology [27]; however, to our knowledge no studies have tested the efficacy of EC with aluminum blades for reducing EDCs from municipal wastewater. This study therefore sought to determine the removal efficiency of a laboratory-scale electrocoagulation unit with respect to six estrogenic endocrine-disrupting compounds in WWTP influent and tertiary-treated effluent.

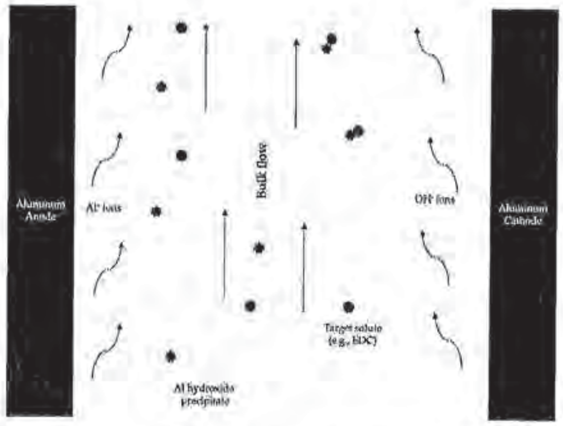


Figure 1. Representative schematic of water flow and interactions inside the reaction chamber. The two black vertical bars represent the electrodes where the power is attached, and the white in between them represents the sample solution flowing past the electrodes. Metal dissolution occurs at the anode which generates aluminum ions. Reduction reactions occur at the cathode which form hydroxide ions. The precipitation reaction occurs when the aluminum and hydroxide ions combine to form aluminum hydroxide (dark circles). The aluminum hydroxides form structures which adsorb contaminants (dark stars), enabling their removal.

2. Materials and Methods

2.1. *Electrocoagulation Unit*

The EC unit (Figure 2) is a 110-volt demonstration unit manufactured and supplied by Powell Water Systems, Inc. (Centennial, Colorado, USA; United States patent number 7211185 B2). The configuration used in this study has been previously examined for its ability to reduce concentrations of nutrients, personal care products, and microbial pathogens and indicators [28]. The power source is a 110-volt alternating current (AC) to direct current (DC) power converter (allowing direct line voltage to be converted from AC to DC) with voltage control. The pump is a Cole-Parmer®Masterflex Peristaltic Pump System (Vernon Hills, IL, USA) equipped with a 1/20-horsepower unidirectional motor and a separate single-turn speed control. The EC unit chamber (35.6 cm × 5.4 cm × 2.5 cm) is made of a non-conductive acrylic resin and has a total volume of 487.5 mL. Nine aluminum reaction blades (30.5 cm × 2.5 cm × 0.3 cm) were arranged vertically inside the chamber with an electrode gap of 3.18 mm. This vertical arrangement promotes a vertical flow of liquid through the chamber. The volume of one blade is 24.6 cm^3 and the volume of all nine blades equals 221.2 cm^3, leaving a residual chamber volume of 266.3 mL. The EC unit was operated with a three-lead arrangement of electrical connections (power attached to blades 1, 5 and 9; Figure 3) which results in a configuration of two anodes and one cathode. The inflow tube measures 1.2 m.

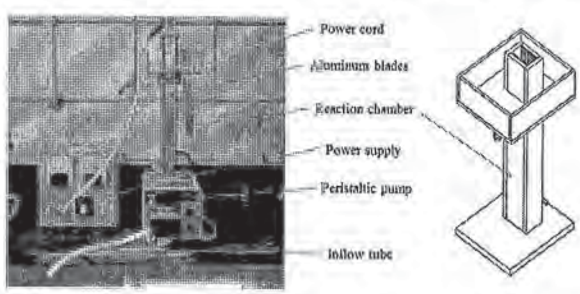


Figure 2. Schematic of laboratory-scale electrocoagulation unit.

Figure 3. Diagram and close-up picture of the nine aluminum blades showing the electrical connections to blades 1, 5, and 9. Anodes are indicated in blue by (+), cathode is indicated in red by (−), and arrows show the flow of electrons.

2.2. *Preliminary Tests and Optimization of Parameters*

The parameters used for this laboratory-scale study were chosen based upon a series of tests performed to evaluate EDC removal efficiency using different EC conditions and configurations (Supplementary Tables S1 and S2). The optimal parameters used for this study (Supplementary Table S3) were as follows: aluminum blades as the sacrificial electrodes, three-lead arrangement of electrical connections, sample retention time of 2 min/L in the EC reaction chamber, volts held in the range of 85 to 98, and amperes held in the range of 8.5 to 15.5. Inclusion of a precise cleaning step was important in the preliminary testing, as EDCs were found to "stick" to the walls of the unit and tubing. To ensure against cross-contamination between replicates, the EC unit was cleaned in between each run to remove any residual EDCs. The EC unit was cleaned by first removing the blades and rinsing the unit with tap water. The blades were scrubbed with steel wool in order to remove the build-up of the oxidizing layer. The scrubbed blades were then reset and the unit was flushed with 1 L ACS methanol to remove residual EDCs and 2 L deionized (DI) water to rinse the unit of residual methanol. Once the unit was cleaned, DI water laboratory blanks were passed through the unit (no power) to ensure that no EDCs remained in the unit. Polarity reversal of the electrodes was implemented between runs to help prevent the build-up of an oxidizing layer on the blade surface.

2.3. *Chemical Standards*

Analytical standards E1, E2, E3, EE2, BPA, NP, and 5α-androstanol (internal standard) were purchased from Sigma-Aldrich (St. Louis, MO, USA). Methanol (HPLC grade and Certified ACS) and pyridine (Certified ACS) were purchased from Fisher Scientific (Pittsburg, PA, USA). *N,O*-bis(trimethylsilyl)trifluoroacetamide (BSTFA) with 1% trimethylchlorosilane (TMCS) was purchased from Regis Technologies (Morton Grove, IL, USA). Ultrapure (DI) water was acquired from a US Filter PureLab Plus system.

2.4. *Wastewater*

Wastewater samples for the experiment were collected from South Cross Bayou Water Reclamation Facility, a tertiary treatment plant located in St. Petersburg, Florida (USA) which serves a population of approximately 260,000. The average wastewater flow per day is 20 million gallons (rated for 33 million gallons per day), and 85% of the wastewater is domestic in origin, while less than 15% is industrial in origin. South Cross Bayou's wastewater treatment processes follow the graphic in Figure 4.

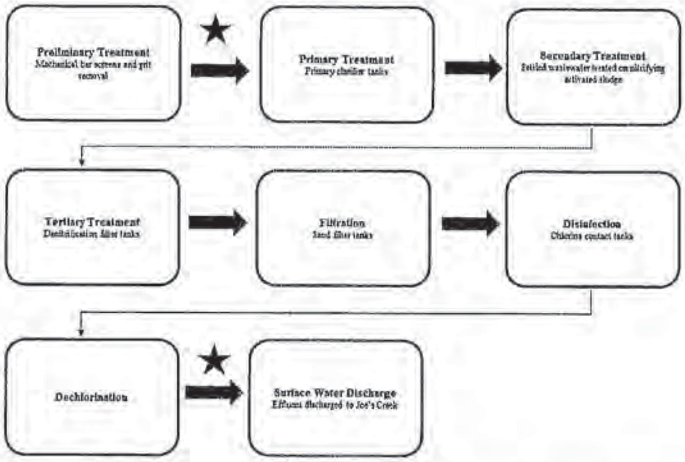


Figure 4. Illustration of the wastewater treatment processes at South Cross Bayou. Stars indicate the points of the raw influent and tertiary-treated effluent samples.

2.5. *Blanks*

Field blanks were taken at the sample site. Laboratory blanks (DI water spiked with internal standard) were extracted with each batch of samples. Gas chromatography-mass spectrometry (GCMS) instrument blanks (blank solvent injections) were performed every eight samples. All EDCs were undetectable in all the blank samples, including the DI water blanks that were run through the EC unit in between replicate runs, illustrating the effectiveness of the solvent cleaning step performed between runs.

2.6. *Experimental Design/Electrocoagulation Processing*

Both raw WWTP influent and tertiary-treated effluent were tested in this study in order to determine not only if the effectiveness of EC for reducing EDCs is matrix-dependent, but also to assess the possibility of using EC as a post-treatment addition to traditional WWTPs. Samples were collected the morning of the experiment in methanol-cleaned, 20 L high-density polyethylene carboys. Influent samples were taken at the headworks of the plant while effluent samples were collected after the dechlorination step. After sampling, the carboys were immediately transported to the lab and refrigerated at 4 °C until processing. In the lab, eight spiked-wastewater replicates (outlined below) were created. Half of the spiked-wastewater replicates ($n = 4$) went straight to analysis (pre-EC) and the other half ($n = 4$) were processed via electrocoagulation (post-EC). Due to the threat of BPA leaching from the Tygon tubing used in the experiment, BPA removal assays were conducted separately from the remaining EDCs.

Since background concentrations in the WWTP influent and effluent were too low to demonstrate significant removal potential by the EC unit, it was necessary to spike both with EDCs. High concentrations of EDC spikes were used to challenge the efficiency of the EC unit for removal. Stock standards were made up in methanol and, due to the low water solubility of steroids, were added to the pre-EC samples via methanol. Spikes were prepared for the four estrogens (estrone (E1), estradiol (E2), estriol (E3), ethinylestradiol (EE2)) at a concentration of 5 μg estrogen/250 μL methanol. Spikes were also prepared for the two industrial compounds (bisphenol-A (BPA) and nonylphenol (NP)) at a concentration of 20 μg industrial compound/250 μL methanol. Due to their relatively higher concentrations in wastewater, NP and BPA were added at higher levels than the estrogens. Three liters of WWTP influent were spiked with the estrogens and nonylphenol after being filtered through a 1.5 μm pore size, glass microfiber filter (Whatman 934-AH; Fisher Scientific, Pittsburgh, PA, USA). This resulted in a final concentration of 1.7 ppb for the estrogens in wastewater and 6.7 ppb for the industrial compounds in wastewater. Similarly, 3 L of WWTP effluent were spiked with the aforementioned EDCs.

In order to test the removal efficiency of the EC unit, 3 L of spiked WWTP influent ($n = 4$) and effluent ($n = 4$) were separately processed through the EC unit via a recirculation method, where the original sample was passed through the unit, discharged from the unit and then circulated back through the unit. The pump speed was set at eight which corresponded to a retention time of 2 min/L. The voltage fluctuated between 85 and 98 and the ampere readings fluctuated between 9 and 15.5 during EC treatment. Once the sample was collected from the EC unit, it was allowed to sit while coagulation began. After approximately 20 minutes, the EC-treated sample was filtered through two Whatman Grade 1 filters (pore size 11 μm) in order to separate the flocculent (sludge phase) from the treated water (aqueous phase). The final volume captured for analysis was 1 L.

For the BPA experiment, 3 L of WWTP influent ($n = 4$) and effluent ($n = 4$) were spiked with BPA and processed through the EC unit via a one-time flow-through method where the sample would not retouch the Tygon inflow tube (manufactured with BPA). Since the temperature of the EC effluent could get as hot as 69 °C, a one-time flow-through method was essential in order to prevent BPA leaching from the Tygon inflow tube. The pump speed was set at 2.2 which still corresponded to a retention time of 2 min/L. The voltage fluctuated between 94 and 98 and the ampere readings fluctuated between 8.5 and 14.5. The post-EC samples were collected as previously described after the flocculent was separated from the treated water.

2.7. *Solid Phase Extraction*

In order to determine the concentration of EDCs, the pre-EC and post-EC 1 L samples were processed via solid phase extraction (SPE) within 24 hours and subsequently analyzed via GCMS. An Evolute ABN (Acid, Base, Neutral) column (6 mL/200 mg, Biotage; Charlotte, NC, USA) was conditioned with methanol and equilibrated with DI water. The sample was then loaded onto the column at a flow rate of 15 mL/min using a large volume extraction tank (Biotage, USA) and an SPE vacuum pump. EDCs retained in the column matrix were eluted with 6 mL methanol. The eluate was spiked with 5 μg internal standard and evaporated to dryness under a gentle stream of nitrogen. Recoveries of all compounds were documented and accounted for in the final quantification.

2.8. *Determination of EDC Concentrations*

Samples were derivatized to their trimethylsilyl ethers by adding 250 μL of BSTFA + 1% TMCS and 250 μL of pyridine, followed by heating in a 60 °C water bath for 40 min in order to drive the derivatization reaction to completion. Samples were then transferred to a 2 mL vial via low volume insert for analysis by GCMS. The GCMS system (Bruker; Fremont, CA, USA) consisted of a Varian 3800 gas chromatograph coupled with a Varian 320 mass spectrometer. The GCMS was equipped with a 30 m × 0.25 mm (internal diameter) ZB-5MS (Phenomenex; Torrance, CA, USA) fused silica capillary column coated with a 5% phenyl arylene/95% dimethylpolysiloxane stationary phase (film thickness 0.25 μm). Helium (high purity) was used as the carrier gas at a flow rate of 1 mL/min. The GC oven temperature was programmed to begin at 150 °C with an initial hold time of 2 min, followed by a temperature ramp of 6 °C/min until reaching 310 °C. The final hold time was 6 min for a total run time of 35 min. The MS was operated in selected ion monitoring (SIM) mode for quantitative analysis using electron impact (EI) ionization at 70 electron volts (eV). The dwell time per atomic mass unit (amu) was 0.5 seconds, and the quantitative and confirmatory ion fragments are outlined in Table 1. Method detection limits (MDLs) were based on standard deviate protocol and were evaluated using GCMS at a signal-to-noise ratio between 5 and 10. Nine replicates were spiked near the detection limit (S/N between 5 and 10) and carried through the entire analytical procedure. Based upon the variability of the replicates, the MDL for each compound was calculated as the standard deviation multiplied by the t-value for nine observations (eight degrees of freedom; t-value = 2.896). MDLs were in the range of 1 to 3 ng/L (Table 1).

Table 1. Characteristics of estrogenic endocrine-disrupting compounds and internal standard.

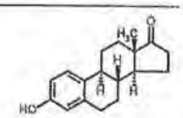
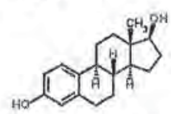
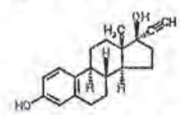
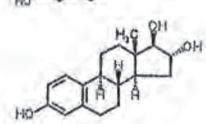
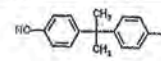
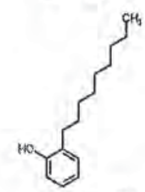
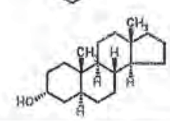
Compound	Type	Retention Time (min)	Quantitative Ion	Confirmatory Ion(s)	Method Detection Limit (ng/L)	Structure
Estrone (E1)	Natural estrogen	21.9	342	218, 257	2	
17β-Estradiol (E2)	Principal natural estrogen	22.4	416	129, 285	1	
17α-Ethinylestradiol (EE2)	Synthetic estrogen	23.8	425	440	1	
Estriol (E3)	Natural estrogen	24.8	504	386	3	

Table 1. *Cont.*

Compound	Type	Retention Time (min)	Quantitative Ion	Confirmatory Ion(s)	Method Detection Limit (ng/L)	Structure
Bisphenol-A (BPA)	Industrial estrogen mimic	16.2	357	358, 372	1	
Nonylphenol (NP)	Industrial estrogen mimic	11.8	179	180, 292	2	
5α-androstanol	Internal standard	18.0	333	258	N/A	

2.9. Statistical Analysis

SAS version 9.4 (SAS Institute Inc.; Cary, NC, USA) was used for statistical analysis of data retrieved from GCMS analysis. All values are reported as mean $\pm$ SD. MANOVA was run with four groups (raw influent not treated, raw influent EC-treated, effluent not treated, and effluent EC-treated) with the 6 quantitative variables (E1, E2, EE2, E3, BPA, and NP) using Pillai's Trace statistic. If the MANOVA results showed statistical significance, then *post hoc* testing was run between the raw influent groups (not treated and EC-treated) and between the effluent groups (not treated and EC-treated) for each EDC.

3. Results and Discussion

3.1. Removal of EDCs from Spiked-WWTP Influent by EC

The mean removal achieved for each of the six EDCs from spiked-WWTP raw influent samples is illustrated in Figures 5 and 6. The mean removal efficiency ranged from 56% (estriol, E3) to 81% (nonylphenol, NP). Furthermore, each EDC post-EC had a statistically lower mean concentration than pre-EC (Table 2) obtained from the post hoc test of the statistically significant MANOVA result. NP was removed to the greatest extent (81% removal). Other studies [29,30] have investigated the removal of nonylphenol ethoxylates (NPEOs), but to our knowledge this is the first study to test the removal of the estrogenic breakdown product, NP, by electrocoagulation.

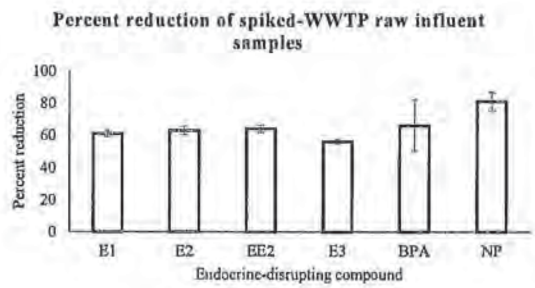


Figure 5. Percent reduction of endocrine-disrupting compounds from spiked-WWTP raw influent samples after electrocoagulation treatment. Error bars are mean +/- standard deviation.

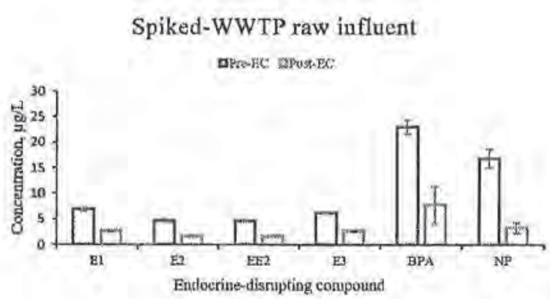


Figure 6. Mean concentrations plus or minus the standard deviation of six endocrine-disrupting compounds in spiked raw influent samples before and after electrocoagulation.

A significant finding was the 64% removal of EE2, which is important for two reasons: (1) this synthetic component of contraceptive products exhibits potent estrogenicity in the environment, with evidence of endocrine disruption at levels around 1 ng/L [10]; and (2) the removal of EE2 by other treatment processes has been historically problematic due to the recalcitrant nature of this compound [14].

Table 2. Percent removal of endocrine-disrupting compounds from spiked-WWTP raw influent samples.

EDC	Mean Pre-EC Conc ± SD (μg/L)	Mean Post-EC Conc ± SD (μg/L)	Test Statistic	*p* Value	% Removal
E1	7 ± 0.3	3 ± 0.1	F = 1194.45	<0.0001	61
E2	5 ± 0.2	2 ± 0.1	F = 954.56	<0.0001	63
EE2	5 ± 0.1	2 ± 0.1	F = 2079.79	<0.0001	64
E3	6 ± 0.2	3 ± 0.1	F = 1021.31	<0.0001	56
BPA	23 ± 1	8 ± 4	F = 85.15	<0.0001	66
NP	17 ± 2	3 ± 1	F = 133.28	<0.0001	81

E3 was removed to a lesser extent (56%) than any of the other compounds, which could be explained by its physico-chemical properties and its lower affinity for sorption onto organic solids. The octanol-water partition coefficient (K_{ow}) describes the partitioning behavior of a compound between water and organic phases. The higher the K_{ow}, the more hydrophobic the compound and the more likely it is to be removed from solution. Most EDCs are hydrophobic compounds with similar log K_{ow} values (e.g., log K_{ow} values of 3.5–4). Since these hydrophobic compounds readily adsorb onto sludge solids, sorption plays an important role in their removal from the aqueous phase [31]. However E3, with its three hydroxyl groups, is only weakly hydrophobic (log K_{ow} = 2.45–2.81) and is, therefore, less apt to bind to sludge [32]. Due to this, E3 likely does not have the same affinity for the flocculent produced during EC treatment. With more E3 in the aqueous phase (*i.e.*, not bound to the EC flocculent), more of it withstands filtration and passes into the EC-treated water sample.

BPA concentrations were reduced by 66%, which is important since BPA is one of the most highly produced chemicals in the world. BPA enters the WWTP at levels in the low ug/L range (concentration can be greatly increased if industrial discharges contribute to WWTP influent). Our findings support those of Govindaraj, *et al.* [33] who achieved 65% removal of BPA from aqueous solutions using aluminum electrocoagulation. Compared with NP, BPA is a more polar compound which explains its lower levels of removal. BPA does not tend to adsorb to sludge particles/sediment as much as NP.

Estrone and estradiol had similar removal levels at 61% and 63%, respectively. Of the natural estrogens, E2 has the greatest potency yet E1 still retains high estrogenicity. For this reason, it is important that both of these natural estrogens are reduced to a significant extent at the level of the WWTP. Since E1 retains estrogenicity and the amount of E1 discharged from WWTPs is more than ten times greater than that of E2, it has been suggested that E1 is the most important natural EDC [3].

3.2. *Removal of EDCs from Spiked-WWTP Tertiary-Treated Effluent by EC*

The mean removal achieved for each of the six EDCs from tertiary-treated effluent samples is illustrated in Figures 7 and 8. The removal efficiency ranged from 42% (BPA) to 98% (NP), and again each EDC post-EC had a statistically lower mean concentration than pre-EC (Table 3) obtained from the *post hoc* test of the statistically significant MANOVA result.

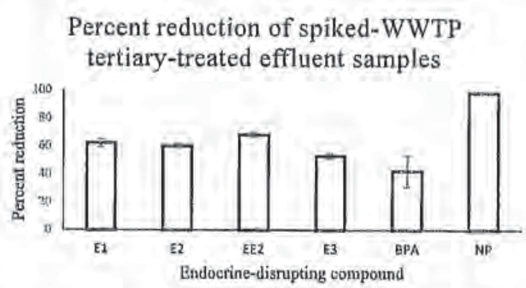


Figure 7. Percent reduction of endocrine-disrupting compounds from spiked-WWTP tertiary-treated effluent samples after electrocoagulation treatment. Error bars are mean +/- standard deviation.

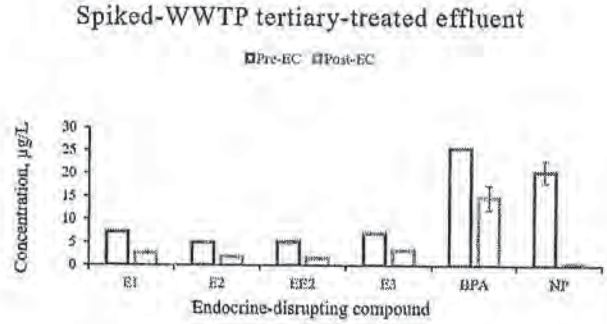


Figure 8. Mean concentrations plus or minus the standard deviation of six endocrine-disrupting compounds in spiked tertiary-treated effluent samples before and after electrocoagulation.

Table 3. Percent removal of endocrine-disrupting compounds from spiked-WWTP tertiary-treated effluent samples.

EDC	Mean Pre-EC Conc ± SD (µg/L)	Mean Post-EC Conc ± SD (µg/L)	Test Statistic	*p* Value	% Removal
E1	7 ± 0.1	3 ± 0.2	F = 1125.53	<0.0001	62
E2	5 ± 0.1	2 ± 0.1	F = 803.89	<0.0001	60
EE2	5 ± 0.1	2 ± 0.1	F = 2304.72	<0.0001	68
E3	7 ± 0.2	3 ± 0.1	F = 984.47	<0.0001	53
BPA	26 ± 0.2	15 ± 3	F = 36.01	<0.0001	42
NP	21 ± 2	0.4 ± 0.1	F = 250.89	<0.0001	98

Higher levels of removal were achieved for NP (98%) in the effluent than in the raw influent samples. However, even with 98% removal, the amount of NP in the final treated sample may still retain estrogenicity. This will be an important question in future testing of EC at environmentally-relevant concentrations. The amount of NP in our post-EC sample, 367 ng, may still be high enough to cause endocrine disruption due to the high initial spike. However, if 98% removal is still achieved at environmentally-relevant concentrations, it will be important to determine if the post-EC concentration is estrogenic or not. *In vitro* bioassays have the advantage of screening for estrogenicity without *a priori* knowledge of the pollutant present, and this will be a useful tool in future EC testing.

EE2 was removed to a high extent (68%) which again is important considering the potent estrogenicity of this compound in the environment as well as its recalcitrant behavior concerning most treatment processes. Estriol was reduced by 53% which is comparable to the raw influent. A lower removal was seen with BPA (42%) than in the raw influent samples. Estrone and estradiol were similarly removed (62% and 60%, respectively) as in the raw influent samples. Since the combination of E1 and E2 contribute largely to the estrogenicity of a sample, their removal is of considerable importance in water treatment processes.

3.3. *Implementation Considerations and Concluding Remarks*

A detailed comparison of the EDC removal results obtained using EC with typical removal levels achieved using other existing technologies has been presented in Cook *et al.* [34]. While it is clear that additional technologies are needed to reduce micropollutant concentrations, the decision to implement EC treatment requires a cost-benefit analysis, with the main costs of EC being energy consumption [35] and consumable blade materials. EC utilizes fairly simple equipment and can be easily integrated into existing WWTPs without extensive reorganization of the plant's structure and design. The lack of moving parts reduces the required maintenance [23], and the unit can be inserted into any point in the WWTP process, since the effectiveness of EC for reducing EDCs in this study did not depend on the matrix (water) type. For WWTPs that utilize tertiary treatments, like ozonation or filtration, EC could be incorporated as an additional pre-cleaning step before tertiary treatment. The effects of EC (e.g., reducing the amount of metal ions, heavy metals, colloids, oil wastes, dyes, suspended particles, *etc.*) would produce an effluent amenable to tertiary treatment and should reduce the fouling of these latter steps [25,36]. For WWTPs with no tertiary treatment, the EC process could be used to coagulate the raw sewage before going into the existing plant clarification unit. Not only would it reduce levels of chemical oxygen demand, turbidity and many contaminants [37], but it would also have the added benefit of EDC removal. EC can also be used to replace conventional chemical coagulation in plants where that technology is in use, since EC reduces the direct handling of corrosive chemicals and does not produce any secondary pollution caused by added chemical substances [35,37]. Furthermore, EC is a low-sludge producing technique, and the sludge formed tends to be readily settleable and easy to de-water [23].

Future testing should include environmentally-relevant concentrations in WWTP influent and effluent. Since these concentrations, especially for the natural and synthetic estrogens, are on the order of low ng/L, detection limits of analytical instruments used will need to be pushed to the pg/L range. Bioassays will also be an important tool in future testing to determine the final estrogenicity of samples due to the fact that pollutants rarely occur as isolated compounds in environmental matrices, but rather in complex mixtures where pollutants can act synergistically, antagonistically, or additively. Finally, future research should continue to explore the potential synergy of combining EC with additional emerging treatment technologies. For example, a recent study demonstrated that combining electro-enzymatic catalysis with EC results in efficient removal of BPA from water [38].

4. Conclusions

In conclusion, the electrocoagulation of wastewater (WWTP raw influent and tertiary-treated effluent) spiked with six estrogenic EDCs was tested for efficiency of removal using a laboratory-scale unit. EC, with the optimal operating parameters determined in this study, enabled statistically significant removal of all EDCs in both WWTP raw influent (56%–81% removal) and tertiary-treated effluent (42%–98% removal). Although determining the mechanisms responsible for EDC removal is beyond the scope of this study, it is likely that these compounds were removed through sorption onto the amorphous aluminum hydroxide flocs followed by filtration. These flocs, termed "sweep flocs", have large surface areas which promote rapid adsorption of soluble organic compounds [39]. In this study, all samples were spiked with EDCs to challenge the EC instrument with removal of significant quantities of contaminants. Overall, this study demonstrated that aluminum EC can reduce EDC concentrations in municipal wastewater influent and effluent, a property that merits further exploration in anticipation of future regulations regarding EDC discharge into the environment.

Supplementary Materials: The following are available online at www.mdpi.com/2073-4441/8/4/128/s1. Table S1: Preliminary Testing, June 2012; Table S2: Preliminary Testing, November 2012; Table S3: Replicate Experiment for Verification of Optimal Parameters.

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Author Contributions: All authors conceived and designed the experiments; Monica M. Cook, Erin M. Symonds, Bert Gerber and Armando Hoare performed the experiments and analyzed the data; Monica M. Cook wrote the paper; Monica M. Cook, Erin M. Symonds, Bert Gerber, Armando Hoare, Edward S. Van Vleet and Mya Breitbart edited and approved the final manuscript.

Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations

The following abbreviations are used in this manuscript:

WWTP	Wastewater treatment plant
EDC	Endocrine-disrupting compound
EC	Electrocoagulation
E1	estrone
E2	17β-estradiol
E3	estriol
EE2	17-ethinylestradiol
BPA	bisphenol-A
NP	nonylphenol
NPEO	nonylphenol ethoxylate
BSTFA	N, O-bis(trimethylsilyl)trifluoroacetamide
DI	deionized
GCMS	gas chromatography-mass spectrometry
MDL	method detection limit
TMCS	trimethylchlorosilane
EI	(electron impact)

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August 7, 2010

Dear Mr. Hamilton,

The purpose of this letter is to inform you of the results we have recently obtained from our tests of the Powell Water Systems Electrocoagulation unit for removal of biological pathogens and indicators from sewage.

We performed a trial using a single sample of raw sewage obtained from a municipal wastewater treatment facility in southwest Florida. Samples were tested to determine the abundance of two types of bacteria and four types of viruses before and after treatment with the electrocoagulation unit. The electrocoagulation process resulted in significant decreases in the concentration of all microorganisms tested, and in several cases reduced the concentration of the pathogens to below the detection limits of our assays. Electrocoagulation led to an approximately 4 log reduction in the concentrations of both fecal coliforms and Enterococci (approximately 99.999% decrease). Concentrations of phages (viruses that infect bacteria) infectious for *Eschericia coli* and *Bacillus subtilis* decreased from several thousand plaque forming units (pfu) per milliliter to less than one pful per milliliter. In addition, concentrations of human polyomaviruses were reduced from approximately 10,000 copies per milliliter to below assay detection limits, demonstrating that electrocoagulation removed human pathogenic viruses.

In addition, we determined the efficiency of electrocoagulation for removing *Pepper mild mottle virus* (PMMoV), which is a plant pathogen that has recently been found at extremely high concentrations in human sewage. PMMoV was found in the raw sewage at approximately 60,000 copies per milliliter and electrocoagulation reduced the PMMoV concentrations to below detection limits. This is extremely encouraging since we typically see PMMoV concentrations in excess of 10,000 copies per milliliter in final effluent from most commercial treatment plants.

My laboratory has spent several years studying the types of viruses and bacteria present in raw sewage and treated wastewater, with the goals of identifying pathogens that present a risk to public health as well as effective indicators that can be used for water quality testing. In our preliminary experiment, the Powell Electrocoagulation unit reduced all the tested biological agents (including both bacteria and viruses) with greater efficacy than current wastewater treatment practices.

Thank you for facilitating this trial, and I hope that we can continue to work together in the future to further evaluate this very promising treatment process.

Sincerely,

Dr. Mya Breitbart

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Water Reuse Eliminates Government Required Treatments for Wastewater Discharges

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Abstract

The only way to eliminate the intrusion of continual government wastewater inspectors is to eliminate the water discharge. Clean electricity properly applied will cause a multitude of water contaminates to become separable from water. Electrocoagulation causes emulsified oil, textile dyes, heavy metals, turbidity, pesticides, bacteria, suspended solids, arsenic, phosphates, nitrates, zinc, biochemical oxygen demand, chrome, nickel, lead, copper, PCB's, chemical oxygen demand, sewage, and more to become separable from water, making the water suitable for reuse.

Background

Government discharge standards have been established for water discharge to the environment. The discharge standards are established to meet political needs and seem to be lowered as technology advances detection limits. The government regulators may enforce the discharge limits by fines, public humiliation, or by shutting down the production facility. The required water testing, monitoring, reporting, and spot inspections by the regulators consume valuable time and resources.

Water reuse on site is the best way to save this most precious natural resource. The recycled water can be cleaned up and conditioned to meet the specific reuse need. Water recycling can eliminate water discharge. With out water discharge the expense of testing, monitoring, reporting and spot government inspections is greatly reduced or eliminated. The cost of water purchases and water disposal is reduced.

Cleaning the water sufficiently to be reused can be accomplished in several ways including reverse osmosis, ion exchange, evaporation, chemical coagulation, and or electrocoagulation (EC). Each of the treatment methods, or a combination of the methods, has advantages and disadvantages depending upon the type of water to be reclaimed and the intended use of the reclaimed water. Water recovery on site allows the selection of the treatment based on the specifics of the water content to be recovered and the specific quality of water needed in the reclaimed water process.

Reverse osmosis separates contaminants from the portion of the water that permeates the membrane and concentrates contaminates in the reject water that does not pass through the membrane. The permeate water quality can be controlled by the type of membranes used. The reject water may be 30% of the total water stream. In addition to wasting the reject water, the disposal cost for the reject water may cost more that the reverse osmosis operating cost. The reverse osmosis process is not very effective in mixed streams containing oil, grease, bacteria, and silica, which cause membrane fouling.

Ion exchange captures specific ions in the water. Ion exchange adds one type of ion to water as a second type of ion is removed. A common type of ion exchange adds two sodium ions to the water in the process of removing one calcium ion from the water. The cost of ion exchange resin regeneration is significant in terms of water loss. When regulated heavy metal ions like chrome are removed from the water, the regeneration liquid is high in acid and metal content creating a costly hazardous waste.

Evaporation or distillation produces clean water. The solids separated during the distillation process can be concentrated in the bottoms. Energy consumption and capital cost are the main drawbacks.

Coagulation caused by altering the charge on metal ions, organics, and colloidal particles creates a large particle that can be settled or filtered out. Chemical coagulation typically uses a dissolved salt. Part of the salt will attach to the material in the water to be coagulated. The other part of the ion typically remains in the solution. Chemical coagulation creates a hydroxide sludge that attracts water. The hydrophilic sludge holds water, which increases the volume of sludge generated and increases the dewatering time.

Electrocoagulation adds electrons to the solution by passing alternating current or direct current through the solution from the power grid. The electrons destabilize the material in the water creating oxide sludge when sufficient activation energy is present. The oxide sludge repels water and filters well. The oxide sludge dewaters well, eliminating the bogging problem associated with polymer treated sewage sludges in landfills, which will stick a tractor for years. Heavy metal ions converted to metal oxides will pass the leach tests making them non hazardous. Metal oxides can be smelted to recover the metals in a usable form.

Steam cleaner wash water reclamation case study:

Valley Detroit Diesel Allison, Bakersfield, California, assembles Detroit Diesel Allison engines and performs semi tractor repair. The engines are covered with oil, dirt, grease, and normal road grime. The engines are steam cleaned prior to assembly or repair.

The steam cleaning is performed over a pad. The spent steam cleaner wash water is collect in a pit. The dirty steam cleaner wash water is designated as a hazardous waste due to the heavy metal content. During the rainy season, rain runoff water from the parking lot would also collect in the pit and mix with the dirty steam cleaner wash water.

The hazardous wastewater had to be measured, tested, and accounted for to the local government inspector. The hazardous wastewater was hauled off by vacuum trucks for disposal at a cost of $0.60 per gallon in the dry season and $2.30 per gallon in the rainy season. The government inspector would physically inspect the water volume and truck hauling records monthly at the facility.

Valley Detroit Diesel Allison decided to reclaim the steam cleaner wash water in 1988. A containment facility was built to store diesel fuel, motor oil, antifreeze, used motor oil for recycling, and water treatment. A 26,000-gallon holding tank stores the surges of parking lot rain run off water and used steam-cleaning water from the pit. The water is processed through a 2 gpm EC unit and clarifier. The oil, grease, dirt, and heavy metal solids separated from the clarifier are placed in the used oil storage tank for recycling. The clear water from the clarifier passes through a swimming pool. The reclaimed water is stored in a 1,000-gallon clean water storage tank for reuse in the steam cleaner. A float switch control system in the dirty water storage tank and clean water storage tank turn the unit on when there is dirty water to treat and room for clean water storage.

The clear water met all federal secondary drinking water standards with the exception of surfactants (soap) (Table 1). The recycled surfactants reduced the need to add soap at the steam cleaner. The sludge from the EC process contained 90 mg/kg oil and grease. The heavy metals were converted into oxides. The sludge passed the California states TTLC and STLC leach tests as required by CAC title 22 (Table 2). As a result the State Health Board approved the EC processed sludge as a non hazardous waste suitable for landfill disposal.

The government inspector stopped visiting the site after the first three months of water recycling. Because the water is recycled there is no water disposal records, no continual water testing, and no vacuum trucking fees. The EC unit requires about one hour of maintenance per forty hours of operation. The operating cost for electricity and blade replacement is less than one cent per gallon. The company purchased EC systems for each of their three locations.

Lab results:

Table 1. The recycled Steam cleaner wash water lab analysis follows: (004-263).

Constituent	Wastewater ppm	EC water ppm	% Removal
Antimony	<0.01	0.014	
Arsenic	0.30	<0.01	96.7% +
Barium	8.0	<0.10	98.7% +
Beryllium	<0.01	<0.01	
Cadmium	0.141	0.031	78.0%
Chromium	7.98	0.05	99.4%
Cobalt	0.13	<0.05	61.5% +
Copper	6.96	<0.05	99.3% +
Lead	7.4	1.74	76.5%
Mercury	0.003	<0.001	66.7% +
Molybdenum	0.18	0.035	80.7%
Nickel	0.4	<0.05	87.5%
Selenium	<0.005	<0.005	
Silver	<0.01	<0.01	
Thallium	<0.10	<0.10	
Vanadium	0.23	<0.01	95.7% +
Zinc	19.4	1.20	93.8%

Table 2. The dry sludge separated from the Steam cleaner wastewater listed above was tested for leach ability as follows (005-462):

Element	TTLC Raw mg / kg	Max State	STLC Raw mg / l	Max State
Antimony	2.4	500		
Arsenic	3.85	500		
Barium	307	10,000		
Beryllium	nd	75		
Cadmium	nd	100		
Chromium	59.2	2,500		
Cobalt	10.4	8,000		
Copper	498	2,500	3.8	25
Lead	790	1,000		
Mercury	0.15	20		
Molybdenum	21.3	3,500		
Nickel	25.5	2,000		
Selenium	nd	100		
Silver	2.7	500		
Thallium	14.2	700		
Vanadium	42.1	2,400		
Zinc	1,798	5,000	60	250
Oil & Grease	89,780			

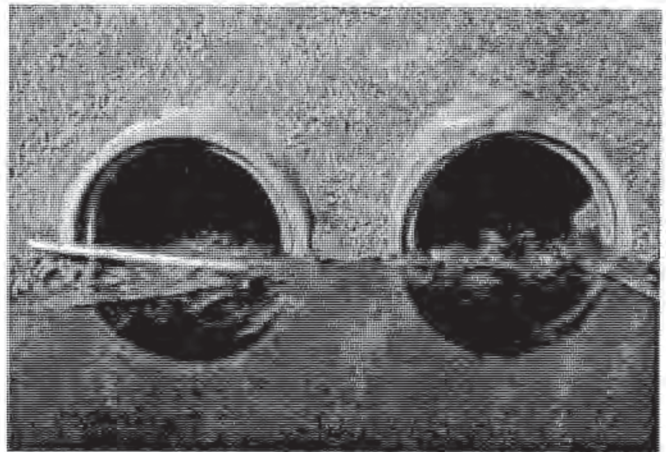
Conclusion:

Electrocoagulation provides a cost effective, onsite way to recondition water for reuse. Water reconditioning for on site use eliminates governmental discharge concerns. Peace of mind results because proposed changes to government discharge regulation no longer apply. The water reconditioning equipment capital and operating cost is offset by water reuse, timesavings with government inspectors, discharge lab testing, and fines.

ENVIRONMENT & GREEN LIVING

The Effects of Sewage on Aquatic Ecosystems

by Contributing Writer



Despite considerable effort to reduce sewage pollution, sewage is still a common pollutant of marine and fresh waters.

Treatment of municipal sewage has significantly reduced pollution of aquatic ecosystems, but the problem of sewage pollution persists. Sources of sewage pollution are overflow of raw sewage from over-burdened or poorly designed systems, inefficient treatment of sewage by treatment facilities, and farm effluent. Although widely acknowledged as a major problem, few countries strictly enforce rules regarding the discharge of farm effluent. Sewage pollution alters the balance of marine and freshwater ecosystems, causing them to function less efficiently.

Eutrophication

Sewage contains very high quantities of nutrients, primarily nitrogen and phosphorous. Under natural conditions, low concentrations of these nutrients limit the productivity of aquatic ecosystems. Sewage promotes excess growth of aquatic primary producers -- plants, algae and cyanobacteria -- in a process known as eutrophication. With increasing biomass of primary producers comes an increase in the number of primary consumers, such as zooplankton and herbivorous fish. Extra productivity is transferred up the food chain in this manner, eventually reaching predatory fish and mammals at the top of the food chain.

Community Dynamics

Physical habitat changes that arise from excess plant growth can dramatically change community dynamics. For instance, excess growth of aquatic plants can reduce available habitat for animals that require open water to live, such as filter feeding invertebrates. Plant growth can also change species dynamics, for example by creating more refuge for prey animals and thus reducing the feeding efficiency of predators. The availability of extra food may result in competitive inequality at all levels of the food chain, with animals that are more efficient at using the extra food source becoming dominant in the ecosystem. This typically results in aquatic ecosystems with high biomass but low species diversity.

Hypoxia

Sewage pollution promotes hypoxia, or oxygen depletion, in aquatic ecosystems in two ways. Firstly, sewage itself contains large amounts of organic matter which is directly available to bacteria in the water. Secondly, it promotes growth of plants and algae that become a source of organic matter when they die. When bacteria consume organic matter they also consume dissolved oxygen from the water. Hypoxia can kill animals or cause physiological stress that stunts growth and reproduction. A famous example of an aquatic ecosystem that suffers from hypoxia is the Gulf of Mexico Dead Zone. Many invasive species, like Asian carp, can tolerate low-oxygen conditions. Sewage pollution therefore facilitates the spread of invasive species by creating suitable habitat for them and eliminating competition.

Antibiotics and Hormones

Antibiotics and hormones are excreted by livestock and humans in urine and feces. Major sources of sewage containing these compounds are hospitals, intensively managed farms, and slaughterhouses. Once in the water, antibiotics can inhibit the growth of bacteria that play an important role in removing nitrogen from water. Antibiotics also promote the growth of resistant bacteria, upsetting the balance of bacterial communities. Synthetic hormones are known to disrupt the endocrine system -- a group of glands that produce hormones and control their release -- of mammals, fish, reptiles, amphibians and invertebrates. Synthetic versions of hormones, such as estradiol, can mimic natural hormones and alter the sensitivity of hormone receptors, causing abnormal growth and reproduction of exposed animals.

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- EPA: Endocrine disruption: Aquatic effects(http://www.epa.gov/ord/endocrinedisruption/aqueff.htm)
- ScienceDirect: Sewage impacts coral reefs at multiple levels of ecological organization(http://www.sciencedirect.com/science/article/pii/S0025326X09001775)
- ScienceDirect: Ecosystem response to antibiotics entering the aquatic environment(http://www.sciencedirect.com/science/article/pii/S0025326X04003881)
- JSTOR: Effects of Pollution on Freshwater Organisms(http://www.jstor.org/discover/10.2307/25045285?uid=2&uid=4&sid=21102198644761)

Resources

- Microbial Life: The Gulf of Mexico Dead Zone(http://serc.carleton.edu/microbelife/topics/deadzone/index.html)
- EPA: Endocrine disruption: Aquatic effects(http://www.epa.gov/ord/endocrinedisruption/aqueff.htm)
- USGS: Eutrophication(http://toxics.usgs.gov/definitions/eutrophication.html)
- Hypox: Consequences of hypoxia(http://www.hypox.net/upload/infomaterial/hypox0120706_policybriefs_on02.pdf)
- YouTube: Human Water Pollution | Biology | Ecology(http://www.youtube.com/watch?v=ACgv19b-n5E)

About the Author

Based in Vancouver, Kirsten Campbell has been a professional ecologist since 2006. She has worked with various governmental agencies and in the private sector. Campbell holds a Master of Science in ecology and conservation.

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California Ocean Wastewater Discharge Report and Inventory

Prepared by Heal the Ocean

March 15, 2010

A compilation and review of information by Heal the Ocean on wastewater treatment and wastewater facilities discharging into the Pacific Ocean along the coast of California.

Online "Google Fly-To" and Interactive Mapping
www.healtheocean.org/research/wdi/resources

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"The ocean! People don't understand the sustaining capacity and capability of the sea, the necessity of having clean water. There will be consequences."

Dr. Howard Kator, Environmental Microbiologist, University of Virginia, College of William & Mary, 1998.

"California is facing an unprecedented water crisis. The collapse of the Bay-Delta ecosystem, climate change, and continuing population growth have combined with a severe drought on the Colorado River and failing levees in the Delta to create a new reality that challenges California's ability to provide the clean water needed for a healthy environment, a healthy population, and a healthy economy, both now and in the future."

State of California Recycled Water Policy (adopted 5/14/2009).

"Based on the potential for additional recycled water..., recycled water could free up enough fresh water to meet the household water demands of 30 to 50 percent of... 17 million Californians. To achieve this potential, an investment of $11 billion would be needed"

Water Recycling 2030: Recommendations of California's Recycled Water Task Force," 2003.

About Heal the Ocean

Heal the Ocean is a highly regarded non-profit citizens' action group with nearly 3,000 members organized to halt practices that pollute the ocean. Since its formation in 1998, Heal the Ocean has hired engineers, scientists, hydrologists, and researchers to assess problem areas, to conduct testing, and to perform engineering and cost/feasibility studies to find better technological methods of handling human waste.

Heal the Ocean's accomplishments include:

- Successfully lobbying the County of Santa Barbara to establish Project Clean Water;
- Assisting in passage of Measure B to assure robust local funding for water quality programs in the city of Santa Barbara;
- Initiating bacterial DNA typing studies at Rincon Creek;
- Initiating successful septic to sewer projects along seven miles of beach in the Rincon and Carpinteria areas, and in certain areas of the city of Santa Barbara;
- Conducting virus sampling studies at popular swimming beaches;
- Successfully campaigning to end an official waiver at a major sewage treatment plant on the Santa Barbara south coast; and
- Completing of a revolutionary oceanographic/microbiology study of the transport and fate of sewage discharge in shallow water off a popular swimming beach in Montecito, California.

For further details, visit: www.healtheocean.org

Acknowledgments

Heal the Ocean wishes to acknowledge the help of our 3,000 supporters, and in particular, we thank the following people and foundations for the generous support that has funded our report on *Ocean Wastewater Discharge in the State of California:* The Johnson Ohana Family Charitable Foundation; Brian and Laurence Hodges of the WWW Foundation; the Ann Jackson Family Foundation; Adam and Kara Rhodes of the WWW Foundation; Yvon Chouinard; Julia Louis-Dreyfus and Brad Hall of The Hall Charitable Fund; Patagonia; the Tomchin Charitable Foundation, and last but not least, our numerous anonymous donors and foundations who have stuck with us through thick and thin.

We would also like to thank the many facility operators and City and State officials who contributed generously of their time to help provide the data necessary to produce this report.

Hillary Hauser, Executive Director
Heal the Ocean

Executive Summary

California's water supply involves complicated and challenging issues, including population increase (1), drought conditions (2), rising salinity (3), and climate change threats (4) (5) such as reduced snow pack (6) and ocean acidification (7). The use of potable (safe for drinking) water for waste disposal and its discharge to the ocean have become outdated practices and stand out as unwise uses of both our freshwater and ocean resources. Already known to carry a health risk (8), ocean wastewater discharge has become even more questionable as wastewater contains a growing number of contaminants of emerging concern (CECs). The State is taking steps to investigate new and newly suspected pollution problems related to wastewater and may make necessary updates to water quality standards for discharges. A recycled water policy is now in place as a measure to help extend the State's limited water supplies. These efforts must now be focused on solving the problems of ocean pollution and water shortages that come together in the subject of wastewater treatment.

California's coastal wastewater facilities need to increase their contribution toward these aims by reclaiming and reusing a much higher percent of wastewater rather than releasing it to the ocean. Yet before they can increase water reclamation, many plants will need improvements in order to address the problems of salinity and CECs. Successful prioritization and financing of improvements, and effective monitoring and reporting protocols, rely on a clear assessment of ocean discharging wastewater treatment and plants. However, the picture has remained unclear even as the State's wastewater administration has grown more integrated. Lack of a full and detailed overview makes it difficult to pursue coordinated statewide policies and plans. This *Report and Inventory* attempts to bring the picture into better focus.

In producing this work, Heal the Ocean hopes to provide a tool for use in understanding the big picture of wastewater disposal in the ocean and recommendations that will inspire political and financial support for infrastructure and administrative improvements to end ocean wastewater discharges in California. In doing so, we hope to contribute to the resolution of two major problems: pollution of the ocean and insufficient water to sustain California's social, economic and environmental future.

Key Points

1. In California, 43 wastewater treatment facilities discharge approximately 1.35 billion gallons daily (~1.5 million acre feet per year (AFY)) of treated effluent directly into the Pacific Ocean.[1]
2. These facilities reclaim or divert for reclamation only approximately 312 million gallons daily (MGD) (~ 200,480 AFY) for beneficial reuse.[2] Based on the volume discharged daily by the 43 facilities, about four times more than this amount could be reclaimed.
3. Increasing reclaimed water for reuse would decrease the demand on locally available water as well as dependence on imported supplies, reduce (or in some cases eliminate) ocean discharges, and reduce the stress on the environment that is caused by diversion of water from its natural flows.
4. Wastewater treatment facility discharges into the Pacific Ocean contain substantial volumes of materials known or suspected to cause environmental damage and/or to pose a risk to human health (8). Their discharge is monitored on an individual rather than integrated system-wide basis, which could potentially ignore or create cumulative environmental effects and human health risks.
5. Most CECs are not currently regulated and require research to better determine their risks to human health and to the environment. This is true particularly for those CECs that are not removed from most wastewater streams.
6. Existing treatment technology – including extended secondary treatment using longer retention times – is capable of removing some CECs (9), but many of the plants studied would need improvements or upgrades to achieve the treatment levels necessary.[3]

1 Source: treatment plant wastewater discharge requirements mainly for 2005, some for different year closest to time of data collection.
2 Source: responses from treatment plant operators with information on 38 (88%) of the 43 facilities surveyed; additional information from plant websites.
3 For a review of treatment processes needed to remove certain CECs, see Wastewater Treatment to Control CECs, Part two.

7. Institutional and financial barriers exist to increasing reclaimed water. Improved treatment methods make some regulations on reuse unnecessarily restrictive. However, funds for wastewater treatment plant improvements and upgrades to ensure high quality reclaimed water have been limited and difficult to obtain. This has resulted in a significant funding gap identified by the U.S. Environmental Protection Agency (U.S. EPA)(10). If substances presently identified as CECs become regulated, further wastewater plant improvements and upgrades would be needed to meet new water quality requirements.

8. Wastewater treatment plant standards are set on an individual basis in order to account for local conditions. However, reporting requirements are not standardized within California. Therefore it is: 1) difficult to compare wastewater treatment plant operations statewide; and 2) difficult to understand the magnitude of challenges and opportunities presented by the current status of wastewater treatment plant operations. The highly beneficial services provided by wastewater treatment plants are literally invisible to and barely understood by most of the public. Statewide, coordinated educational measures are needed to help raise public awareness about wastewater treatment plant processes, proper disposal of household chemicals (which include many CECs), and effects of consumer product choice on wastewater treatment plant operations and cost. Such measures, in addition to increased pretreatment by large scale and key sources (e.g., hospitals and industrial operations) would lead to fewer pollutants being added to wastewater and result in greater conservation of water.

Recommendations

Wastewater treatment plants are a key part of efforts to end ocean pollution and the release of pollutants into the environment in general. Although the State requires treatment plants to remove high percentages of numerous pollutants, it has not yet created legislation for the removal of CECs. Due to the potential risks of these contaminants, it is essential to advance wastewater plant operations and bring standards, source control, infrastructure, treatment, and public awareness up to date across California. In light of the information in this *Report and Inventory*, Heal the Ocean makes the following recommendations:

Recommendation 1:
Improve and upgrade existing wastewater treatment plants.

- Ensure optimum treatment levels with the aim of maximum removal of contaminants and in a manner that allows for efficient additional modifications in the future.
  - Apply best methods to do so on a case-by-case basis depending on influent, site location, populations served, types of reuse, etc., tailoring treatment accordingly.
  - Emphasize advanced secondary treatment (mainly longer holding times) as a means to decrease the necessity for and maximize the efficiency of advanced treatment.
- Capture methane to offset costs of improvements and increase energy efficiency.
- Utilize potential for treatment plant sites to generate non-waste fuel alternative energy.
- Prioritize the upgrade of ocean discharging plants ahead of inland plants, given the proximity of ocean discharges to major protected areas and areas of recreation and economic ocean uses, such as fishing, and given that less discharge to the ocean will help to balance natural water flows within watersheds.

Recommendation 2:
Increase the use of reclaimed water as a more economic alternative to potable water for non-potable uses.

- Create financial incentives to utilize reclaimed over potable water for non-potable uses.
- Use reclaimed water as a major supply for toilet flushing and irrigation–two significant ways in which potable water is wasted where recycled water can be easily substituted, recognizing that initial costs may be high, but that non-action will cost far more.
- Use reclaimed water as a major source for ground water recharge and other indirect potable use, where highly treated municipal water is discharged directly into groundwater or surface waters in order to augment water

supplies. In this application, treatment must remove all contaminants (including CECs).

- Increase storage and delivery capacity for reclaimed water.

- Reclaim all wastewater presently discharged to the ocean.

Recommendation 3:
Make public education and consumer awareness a priority

- Improve public education about wastewater treatment plant processes and effects of consumer product choice on wastewater treatment plant operations and cost.

- Aid consumers in making smart decisions about their choice and disposal of personal care products, chemicals, pharmaceuticals, and sodium and potassium-based water softeners.

- Educate the public about the benefits of high quality recycled water and the facts about its safety. Demonstrate its potential to be cleaner than many drinking water supplies in order to increase water conservation, support for needed legislative and regulatory changes, and public acceptance of reclaimed water.

Recommendation 4:
Support and increase efforts to prevent pollution at source.

- Make it easy for the public to dispose of products in ways that lessen the burden on wastewater treatment plants.

- Support and expand adequate pretreatment of wastewater from industrial, medical, and similar sources as another important way to lessen the burden on treatment plants.

- Increase and/or establish restrictions on manufacturing uses of contaminants of emerging concern and on products containing these substances, especially where better alternatives exist.

- Increase restrictions on the use of sodium and potassium-based water softeners to prevent an unnecessary increase in the salinity or chloride content of wastewater reaching the treatment plant and the resulting increased expense of reclaiming high quality water.

Recommendation 5:
Revise legislation and regulation as soon as possible to overcome barriers to use.

- Legislative revisions at the State level should be introduced and structured to accommodate new standards for safe levels of contaminants of emerging concern in water and wastewater.

- Make legislation and regulation consistent throughout the State.

- Tailor revisions deliberately to ensure the existence of outlets for reclaimed water throughout California and to avoid situations where restrictions on reuse lead to wasteful discharge, particularly of tertiary-treated wastewater.

Recommendation 6:
Support and expand collaborative planning and research.

- Support a State-funded assessment of the toxicity of contaminants of emerging concern through continued research on their effects on humans, other organisms, and the environment.

- Encourage further research exchange and partnerships at and across international, national, state, regional, and local levels by water, wastewater, and public health authorities, research scientists, political representatives, engineers, and additional stakeholders, such as the U.S. Department of Fish & Game, environmental groups, and public and corporate water users.

- Establish pilot projects in a range of locations to test the viability of new monitoring techniques, equipment, treatment, etc.

Recommendation 7:
Provide government support and funding mechanisms.
The $11.1 billion bond bill proposed during fall 2009 in the California legislature demonstrates political recognition of the State's water resource problems. However, carefully crafted and more focused legislation could help to secure California's water supply over the long term, and provide better incentives for water reclamation without measures that would be harmful to the environment, such as dam building and other projects which would divert natural water supplies.

- Maximize State funding mechanisms including those noted in the State's new Recycled Water Policy.

- Increase State, regional, and local aid for treatment plant upgrades to expand and ensure usable reclaimed water supplies.

- Provide adequate funding to increase storage and delivery capacity, including recycled water pipes needed to reach consumers.

Recommendation 8:
Revise the reporting protocols of the State Water Resources Control Board (SWRCB) and attendant regional boards.
Statewide reporting revisions are needed to address inconsistencies in levels and types of reporting by wastewater treatment plants. Reporting changes are also needed in order to address the fragmentation, incompleteness, and lack of reliability of the State's sources of information on wastewater operations and compliance.

- Continue measures to implement reliable statewide reporting, free of potentially distorting features, in formats that are easy to access and analyze.

- Require uniform statewide reporting formats to ensure consistency and clarity.

- Include reporting requirements that shed clearer light on treatment plant operations, measures to enhance water quality, and water reclamation.

- Revise wastewater standards to impose limits on contaminants of emerging concern, particularly to ensure the safety of recycled water.

Table of Contents

ADDITIONAL ONLINE RESOURCES

Can be found on the Heal the Ocean's Website: http://www.healtheocean.org/research/map *and include:*

- Online Summaries and Sources
- Interactive Maps:
  Google Earth Map:
  California Ocean Discharging Treatment Plant and Outfall Locations
  Heal the Ocean Interactive Online Site:
  Produced in ArcGIS Online by David Greenberg, Ph.D.

PART ONE

CALIFORNIA OCEAN DISCHARGES AND WASTEWATER TREATMENT

INTRODUCTION

In 2005, Heal the Ocean began an inventory of the amount of wastewater being discharged into the Pacific Ocean throughout the State of California. Our aim was simple: we wanted to create a perspective, as accurately as possible given the resources and technology we had at the time, about what goes into the ocean from coastal communities along the Pacific Ocean shoreline of California. The figures reported in the original *Ocean Wastewater Discharge Inventory for the State of California* turned out to be staggering, showing that over a billion gallons of treated effluent are discharged daily into ocean waters.

We discovered that two small treatment plants were discharging into the intertidal zone with no dilution of effluent, while other plants discharged into a marine sanctuary or an area of special biological significance (ASBS) under exemption from policies to protect such areas. We noted the coastal outfalls that discharge into shallow areas, close to shore, very near to the places where people swim in the ocean. As a result of these findings, Heal the Ocean contracted with environmental microbiologist Howard Kator to produce a report, "The dangers of swimming in secondary sewage," (included in the National Resources Defense Council's 2004 report to U.S. Congress, "*Swimming in Sewage,*" and provided in the Additional Online Resources for this report).

Almost immediately after distributing the *Inventory* we received comments pointing out errors and omissions. We took these constructive criticisms seriously and this newly revised *Ocean Wastewater Discharge in the State of California Report and Inventory* addresses those criticisms and other issues that have emerged since that earlier publication.

Heal the Ocean prepared this *Report and Inventory* for another important reason: the information it contains (including the compilation of treatment plant information) has not existed in any one place, including within any California agency, such as the State Water Resources Control Board (SWRCB). Our aim is to provide a resource to the SWRCB, State officials, related agencies, and researchers, to call out the risks and opportunities of the ongoing discharge of treated effluent, and also to make it easier to examine the environmental pressure these discharges put on the Pacific Ocean, including nearshore areas where people swim and surf. We have produced this report also to examine the opportunities to reclaim the wastewater presently discharged to the ocean. Reclaiming wastewater would help California to end the dangerously outdated practice of wasting enormous amounts of water while searching for new sources of water and devising expensive means of transporting water around the State. Diverting water from new sources instead of reclaiming water also makes little sense when a large proportion of fresh supplies ends up similarly discharged and therefore wasted.

California is divided into a total of nine regions administered by individual regional water quality control boards (RWQCBs) in the State (see Figure 1.1). The facilities included in this report are located within the six coastal regions. The wastewater treatment plants range from Crescent City, about 20 miles south of the Oregon border, to the International Wastewater Treatment Plant on the San Diego/Tijuana international boundary. Populations served by these treatment plants range from 12 people to over five million. This report shows that roughly half of the treated solids released into the ocean every day (more than 70 tons of the total 134 short tons released) receive only primary or secondary treatment <u>without disinfection</u>. These solids are suspended in 629 million gallons of the 1.35 billion gallons of treated effluent discharged daily.

The objective of eliminating ocean pollution by wastewater treatment plants clearly converges with the need to conserve California's water supply. Advanced treatment technologies can serve as mechanisms to help to achieve both. Extended and thorough treatment at all levels offers the best protection of the ocean and recreational beaches against the full set of contaminants, particularly those of emerging concern, and produces water that can be reclaimed for many beneficial uses.

Research for this report reveals a correlation between a measure of the relative efficiency (of removal of solids) of individual wastewater treatment plants[4] and their

4 Treatment plant efficiency calculated as a measure of total suspended solids divided by population (figures mainly from 2005; population used as a proxy for measure of influent).

ability to treat water at a tertiary level. Nine of the ten plants found to be most efficient (based on 2005 data) were processing at least a portion of their influent at a tertiary level. Presently, 20 of the 43 ocean-discharging facilities along the California coast have at least some tertiary capacity. This raises the need to research additional factors affecting efficiency and the potential for further improvements in water quality. Many plants lacking tertiary capacity divert a portion of their influent for tertiary treatment by other, more advanced, plants. While cost and site constraints act as obstacles, the lack of an overall State strategy for sewage treatment must also contribute to the variation of treatment capacity and persistence of large-scale discharge, including undisinfected effluent.

Aims:
In light of the wide range of treatment levels, and of the depth, distance, and quantities of treated wastewater discharges, this *Report and Inventory* aims to contribute to a broader perspective by:

- **Providing a complete statewide overview of specific features of coastal wastewater treatment plants and their ocean outfalls:**
    - Outfall location (depth & distance from shore), treatment plant processes, and amount of treated effluent and total suspended solids discharged.
- **Presenting a summary of important pollutant issues posing a challenge to wastewater treatment and water reclamation and reuse.**
- **Reviewing methods and issues related to assessment of plant performance in order to achieve:**
- Consistent and expanded reporting formats and support of continued work toward a reliable statewide reporting system;
    - Further coordination and alignment of treatment plant awards toward State policy and goals particularly for water reclamation.
- **Mapping and reporting on the spatial relationship[5] between wastewater discharge locations and beaches adjacent to 303(d) listed impaired water bodies and other sensitive ocean ecosystems throughout California.**

In this way, this *Report and Inventory* may help to: 1) provide a comparative perspective of current sewage treatment practices; 2) show where reporting of treatment plant data could be improved; 3) help to direct future research into controlling and eliminating human sources of ocean pollution; and 4) assist efforts by various stakeholders, such as facility managers, policy makers, community leaders, and environmental groups to improve California's water quality and supply.

Heal the Ocean regards the online interactive mapping and our recommendations as two of the most important elements of this report. We note the increasing attention paid to the potential risks posed by CECs and how to address those risks. Our recommendations support the need for ongoing research but also call for immediate action–action that amounts to the adaptive management needed now to meet the challenges of wastewater treatment and water supply in the State of California.

Wastewater Treatment and Ocean Discharges on the Coast of California

Every day, California coastal wastewater treatment plants discharge approximately 1.35 billion gallons of treated effluent into the Pacific Ocean (1.5 million acre feet per year (AFY)). This is about the amount of fresh water used every year by about two million average California households.[6] This is also the amount that California's Recycled Water Task Force estimates the State could potentially recycle in total (11), which shows that this estimate is feasible and possibly low. The effluent discharged includes approximately 270,000 pounds, or 135 short tons, of treated solid matter, all of it delivered daily to the Pacific Ocean off California. Annually, this amounts to 50,000 tons of treated solids dumped into the ocean – the equivalent of the weight of 16,000 Cadillac Hybrid Escalades.[7] The pollutants in treatment plant discharges have been drastically reduced since the introduction of the Clean Water Act (CWA) in 1972. Nevertheless, sewage treatment plants discharging off the coast of California remain a major source of ocean pollution from identifiable ("point") sources (12). The adaptation of treatment plants to new and future conditions could provide an opportunity to end the wasteful and polluting practice of ocean discharge and to decrease the climate impact of plants through increased energy efficiency and decreased emissions.

The treatment facilities included in this *Report and Inventory* receive wastewater collected from homes, businesses, and industrial premises, with pipelines used to transport the wastewater to and from the facilities. Household waste is generally not regulated at its source,

5 The spatial analysis produced for Heal the Ocean by David Greenberg, Ph.D. supplements the *Report and Inventory*.

6 Based on Water Use Facts, U.S. Department of Agriculture website (accessed October 2009). "An average California household uses between one half-acre foot and one-acre foot of water each year."
http://www.fs.fed.us/r5/publications/water_resources/html/water_use_facts.html

7 Based on curb weight, manufacturer claim: 6,016 lb, 2009 Cadillac Escalade Hybrid 4WD Full Test. Edmunds InsideLine website (accessed September 2009).
http://www.insideline.com/cadillac/escalade-hybrid/2009/2009-cadillac-escalade-hybrid-4wd-full-test.html

California Ocean Discharging Wastewater Treatment Plants by Region

	Wastewater treatment facility		Location served	NPDES* Permit
	Regional Board 1 – North Coast			
1	Crescent City Wastewater Treatment Facility		Crescent City	CA0022756
2	Arcata Municipal Wastewater Treatment Facility		Arcata	CA0022713
3	Greater Eureka Area / Elk River Wastewater Treatment Facility		Eureka	CA0024449
4	Humboldt County Resort Improvement District No. 1, Shelter Cove Wastewater Treatment Facility		Shelter Cove	CA0023027
5	Fort Bragg Municipal Improvement District No. 1 Wastewater Treatment Facility		Fort Bragg	CA0023078
6	Mendocino City Community Services District Wastewater Treatment Facility		Mendocino	CA0022870
7	Mendocino County Water Works District No. 2, Anchor Bay Wastewater Treatment & Disposal Facility		Anchor Bay (Gualala)	CA0024040
	Regional Board 2 – San Francisco Bay			
8	City & County of San Francisco Oceanside Water Pollution Control Plant *(sole combined plant in CA)*		San Francisco	CA0037681
9	Daly City (North San Mateo County Sanitation District) Wastewater Treatment Plant		Daly City	CA0037737
10	Half Moon Bay (Sewer Authority Mid-Coastline) Wastewater Treatment Plant		Half Moon Bay	CA0038598
	Regional Board 3 – Central Coast			
11	Santa Cruz Wastewater Treatment Plant		Santa Cruz	CA0048194
12	Watsonville Wastewater Treatment Facility		Watsonville	CA0048216
13	Monterey Regional Water Pollution Control Agency Regional Treatment Plant		Marina	CA0048551
14	Carmel Area Wastewater District WWTP & the Pebble Beach Community Services District		Carmel	CA0047996
15	Ragged Point Inn Wastewater Treatment Facility		Ragged Point	CA0049417
16	San Simeon Community Services District Wastewater Treatment Plant		San Simeon	CA0047961
17	Morro Bay and Cayucos Sanitary District Wastewater Treatment Plant		Morro Bay	CA0047881
18	Avila Beach Community Services District		Avila Beach	CA0047830
19	Pismo Beach Wastewater Treatment Facility		Pismo Beach	CA0048151
20	South San Luis Obispo County Sanitation District		Oceano	CA0048003
21	Goleta Sanitary District Wastewater Treatment Facility		Goleta	CA0048160
22	Santa Barbara (El Estero) Wastewater Treatment Facility		Santa Barbara	CA0048143
23	Montecito Sanitary District Wastewater Treatment Facility		Montecito (Santa Barbara)	CA0047899
24	Summerland Sanitary District Wastewater Treatment Plant		Summerland	CA0048054
25	Carpinteria Sanitary District Wastewater Treatment Facility		Carpinteria	CA0047364
	Regional Board 4 – Los Angeles			
26	Oxnard Wastewater Treatment Plant		Oxnard	CA0054097
27	City of Los Angeles (Hyperion Treatment Plant)		Los Angeles	CA0109991
28	County Sanitation Districts of Los Angeles County Joint Water Pollution Control Plant		Carson	CA0053813
29	Terminal Island Treatment Plant		San Pedro	CA0053856
30	Avalon Wastewater Treatment Facility		Avalon	CA0054372
31	US Naval Auxiliary Landing Field, San Clemente Island Wastewater Treatment Plant		San Clemente Island	CA0110175
	Regional Board 8 – Santa Ana			
32	Orange County Sanitation District, Reclamation Plant No. 1		Fountain Valley	CA0110604
	Orange County Sanitation District, Treatment Plant No. 2		Huntington Beach	CA0110604
	Regional Board 9 – San Diego			
33	SOCWA Joint Regional Treatment Plant**	*51 Permitted facility:* Aliso Creek Ocean Outfall	Laguna Niguel	CA0107611
34	SOCWA Coastal Treatment Plant**		Aliso Canyon, Laguna Niguel	
35	Irvine Ranch Water District Los Alisos Water Reclamation Plant**		Lake Forest	
36	El Toro Water District Water Recycling Plant**		Laguna Woods	
37	SOCWA JB Latham Treatment Plant**	*52 Permitted facility:* San Juan Creek Ocean Outfall	Dana Point	CA0107417
38	SOCWA Plant 3A**		Laguna Niguel	
39	Santa Margarita Water District Chiquita Water Reclamation Plant**		Rancho Santa Margarita	
40	San Clemente Reclamation Plant**		San Clemente	
41	Oceanside (San Luis Rey & La Salina Wastewater Treatment Plants)		Oceanside	CA0107433
42	Fallbrook Public Utility District WWTP No. 1		Fallbrook	CA0108031
43	US Marine Corps Base Camp Pendleton *(completely offline from March 2009)*		Camp Pendleton	CA0109347
44	Southern Region Tertiary Treatment Plant** *(replaced the Camp Pendleton plants)*			CA0109347
45	Encina Wastewater Authority Water Pollution Control Facility		Carlsbad	CA0107395
46	Escondido Hale Avenue Resource Recovery Facility		Escondido	CA0107981
47	San Elijo Powers Authority Water Reclamation Facility		Cardiff	CA0107999
48	E.W. Blom Point Loma Metropolitan Wastewater Treatment Plant		San Diego	CA0107409
49	South Bay Water Reclamation Plant		San Diego	CA0109045
50	International Boundary & Water Commission International Wastewater Treatment Plant		San Diego	CA0108928

**NPDES: National Pollutant Discharge Elimination System **Indirect discharge via outfall facility; No effluent data collected for the Discharge Inventory*

Table 1.1 California Ocean Discharging Wastewater Treatment Plants by Region, indicating location served and National Pollutant Discharge Elimination System permit number. Direct to ocean discharge by 43 facilities.

Ocean Discharging Wastewater Treatment Plants in California

Figure 1.1. Location of Coastal Regional Water Quality Control Board Jurisdictions and Treatment Plants Discharging into the Pacific Ocean

but industrial and certain business waste must meet standards that may require pre-treatment (treatment before delivery to a wastewater treatment plant). Removal of fats and oils from restaurant waste is a typical example. With a few exceptions, source control requirements have been mainly to protect collection and treatment operations of the plant, not to improve overall quality of effluent.
In general, current sewage treatment technology and standard practices focus on removal of solid materials, elimination of pathogenic bacteria, and in some cases reduction of nutrients or other chemical constituents.

Wastewater treatment is typically described as occurring in three stages (13).

- **<u>Primary</u> – removal of solids: initial sedimentation and clarification to remove suspended material that settles or floats.**
- **<u>Secondary</u> – biological treatment: use of microorganisms to convert dissolved and suspended organic waste into stabilized compounds. Secondary processes decompose and/or transform the organic matter and kill off bacteria.**
- **<u>Tertiary</u> – treatment beyond secondary processes to increase the removal of dissolved pollutants like sodium and chloride, and nutrients: tertiary level treatment uses advanced processes that can at best remove 99% of known pollutants, and the nutrients nitrogen and phosphorous, which can contribute to algae blooms (13, p.600).**

Today's typical wastewater treatment involves primary and/or secondary treatment but is not 100% effective in removing pollutants. Since regulations anticipate less than 100% effectiveness, discharges of treated effluent contain solids, bacteria, and dissolved contaminants, but generally at a level below requirements. Requirements are established by balancing technical, environmental, and financial factors. Waste treatment byproducts include microorganisms, brine (containing nutrients and salts), methane gas and biosolids – the modern and more accurate term for treated sewage sludge. Following stabilization in "digesters" (a unit in which bacterial action is induced and accelerated in order to breakdown organic matter) and sometimes with chemicals, biosolids are commonly disposed of as soil amendment. However, fertilizing and composting with biosolids may be unwise practices if CECs are not properly removed. Some wastewater treatment plants use biosolids to generate energy for the running of the plant. Unused biosolids may also be delivered to landfills for burial or for use as daily cover.[8] As the salinity management plans for areas such as Calleguas and Santa Ana show, discharge of brine waste directly into the ocean from treatment plants remains a standard practice.

8 Daily cover is the compressed soil laid on top of a day's deposition of waste at a landfill site in order to reduce odors and help stabilize the waste.

Opportunities and Challenges for Wastewater Treatment on the Coast of California

Collection, treatment, and discharge of wastewater are regulated under both State and federal law. Within infrastructure and financial limits, plant operators carry out extensive monitoring of pollutants and apply typically sophisticated technology to ensure permit limitations are not exceeded. But the standards under which they operate need critical overhaul for the following reasons:

- **CECs–including pharmaceuticals, personal care products, estrogenic compounds, and genetic material from bacteria that have become resistant to antibiotics–are now of significant concern to researchers, particularly as some can escape standard treatment and most are not monitored in waste streams;**
- **Current monitoring techniques do not employ tests for viruses;**
- **The movement of discharged effluent is not usually tracked. Its ultimate fate is unclear, and when discharged in relatively shallow water, wastewater may migrate to shore with limited dilution;**
- **Relatively high salinity levels in treated wastewater can and often do prevent its most common use: irrigation.**
- **No composite picture exists of the total load of pollutants from different wastewater treatment plants that discharge into the same areas of the ocean. This means that cumulative impacts are unknown.**

Key areas of challenge and opportunity

Meeting the substantial institutional, technical, social, and financial challenges related to wastewater treatment will bring opportunities not only to expand the use of reclaimed water, but also to reduce demand on local and other imported water supplies in key areas of the State.

Bacteria/viruses/pathogens

Current treatment focuses on eliminating risk from pathogenic bacteria and, to some extent, viruses. Treatment systems are generally effective in meeting this objective. However, the proliferation and widespread use of chemicals has increased the load of chemicals entering the waste stream, and reaching the wastewater treatment plant. Current State approved wastewater treatment standards do not require monitoring of most of these chemicals. Therefore, the potential exists for these substances to be released untreated into groundwater, drinking water supplies, and the ocean. Drugs passing through the human body or disposed of by toilet flushing, as well as antibiotics used to promote the growth of livestock have led to the development of MDRB (multi-drug resistant bacteria) and forms of antibiotic resistance, such as MRSA (methicillin-resistant staphylococcus aureus) (14) (15).

Contaminants of Emerging Concern

The term "CEC" has become increasingly accepted by scientists and researchers as their knowledge of the toxicity and sub-lethal effects of these substances has expanded and as the search has intensified for improved monitoring and ability to detect pollutants. National efforts to act on CECs are now underway, but guidelines and legislation are clearly lagging (16) (17). The quantity of such compounds in wastewater has been increasing while researchers have begun to understand the complexity of the interaction and degradation of CECs, and the dangers posed by new chemicals resulting from their degradation or exposure to ultra-violet treatment and/or sunlight. (18). As elsewhere, California wastewater treatment must address all aspects of CECs, particularly since water recycling has become a priority for the State.

Wasted nutrients

Wastewater typically contains nitrogen and phosphorous compounds. Although these soil nutrients and organic matter can serve as soil amendment, they are instead discharged. Because of the large overall quantity of wastewater discharge, the volume of these nutrients impacting the ocean is high. Nutrients at high levels can cause eutrophication – the over-stimulation of plant or algae growth that depletes the oxygen necessary to maintain other forms of life (19). As listed in the California National Pollution Discharge Elimination System (NPDES) Code of Regulations, nutrients are considered as non-priority pollutants (20). An SWRCB presentation[9] on "Water Quality Criteria: Nitrogen & Phosphorus Pollution" outlines how the U.S. Environmental Protection Agency (EPA) has concluded that "Nutrient Criteria cannot be developed as a single number for the Nation due to variability in background conditions and the role of other risk co-factors which affect nutrient processing within ecosystems" (21).

While a case-by-case pollutant assessment is needed for nutrients, the total quantities discharged off the coast of California need to be calculated. Nutrient loading of the total amount discharged would be prohibited if this amount were discharged from a single site. But situations of cumulative discharge by several plants into adjacent or overlapping ocean areas are escaping regulatory attention. No additional studies or monitoring programs would be needed to begin the reclamation of nitrogen and phosphorous for deliberate and controlled beneficial use. This would make more sense than nutrient discharge (frequently with water that could be reclaimed) in treated effluent. Advanced treatment could allow either capture of the nutrients or ensuring they are diverted specifically in water reclaimed for irrigation. In either case, the nutrients should not be discharged to the ocean with the attendant risk of ecosystem imbalance

Infrastructure investment

In 2002, the U.S. EPA concluded that if investment in water and wastewater systems remained flat, the United States would face a gap of $122 billion (the mid-range estimate) between the current funding available to the treatment plants and what is needed to bring them up to acceptable levels of treatment over the 2000-2019 period (10). The California and national budgets have been hit hard since this projection. But in 2009, the State Water Resources Control Board (SWRCB) began to take full advantage of national stimulus funds and other funding sources to kick-start treatment plant infrastructure projects, including water recycling facilities. The State Recycled Water Task Force concluded that, *"... recycled water could free up enough fresh water to meet the household water demands of 30 to 50 percent of... 17 million Californians. To achieve this potential, an investment of $11 billion would be needed"* (11).

Current financing methods based on population sizes, areas served, and the official requirements set for waste discharges lead to competition among wastewater treatment plants for State and national funding and loans. The regional and local district administrative system produces a case-by-case assessment of treatment plants, their needs, and pollution records. While such methods for evaluation provide a tight focus on day-to-day operations, pollution incidents, and performance goals, this narrow perspective bypasses opportunities for cooperation and information-sharing. Prioritization and research become more difficult, and awareness and communication among different stakeholders remains low (22).

Wasted water

When wastewater is treated to the highest possible level, producing essentially fresh water, and is then discharged into the ocean, the opportunity for reuse and conservation of water resources is lost. Sewage treatment plants discharge large volumes of such potentially re-usable water from areas that depend on imported supplies and that face shortages during drought. The San Diego region is an example: it discharges about 26 million gallons daily (MGD) (see Table 3.5) while simultaneously seeking new water sources. As water supplies diminish and demand increases, the production of high quality water through wastewater treatment presents a significant opportunity to decrease the use of drinking water for secondary uses such as irrigation and toilet flushing.

Demand for reclaimed water

The cost of recycled water is still higher than tap water, and there is a significant initial expense to install dual plumbing (a second pipe to convey recycled water for reuse). As a result, the use of reclaimed water has not kept pace with

9 Date unknown, but circa 2005.

recycled water supplies. The lack of demand acts as a disincentive to treatment plant upgrades and improvements necessary to meet standards for reclaimed water. Demand also falls for other reasons:

- Demand for direct reclaimed water use is less in wet-weather months and leads plants to discharge highly treated water.
- Low demand in general can stem from an unwillingness of potential consumers to pay the full price of reclaimed-water production.
- Lack of public acceptance poses an obstacle in some cases to the use of reclaimed water for indirect potable reuse.
- Lack of delivery and storage structure can lead to underutilization of highly treated water.
- Local regulation that unduly constrains or does not permit reuse can result in a waste of water that could be recycled. However, a delay in changes to regulations is necessary until new standards have been developed for CECs.

Taken together, these issues could appear to support delaying wastewater treatment plant upgrades until treatment technology improves and demand for water reuse increase. However, careful engineering design could allow facility modifications in a manner that would expedite subsequent upgrades that are sure to come. Given the known effects of pollutant discharges and existing constraints on State water supplies, there appears to be little benefit in delaying treatment plant upgrades that would increase reuse of water and/or address the known discharge of pollutants.

(See Part Two of this report for further details on key issues relating to reclaimed water.)

Ocean Wastewater Discharge Inventory Research Methods

The Inventory of wastewater discharge to the ocean and other aspects of wastewater treatment was completed in two phases. Phase 1 focused on collection of data and preparation of three data bases. Phase 2 comprised calculation of average flows, evaluation of compliance data, and selection of aspects for comparative presentation.

Phase 1 – Data Collection and Compilation

Data were compiled on outfall features, plant operation, and effluent characteristics for each of the California sewage treatment facilities that discharge into the Pacific Ocean. Information regarding regulatory compliance and water reclamation was also collected.

Database 1 – Wastewater treatment plant characteristics

Wastewater Discharge Requirement permits (WDRs) and other documents that provided data for the inventory were obtained from websites of the U.S. EPA, the SWRCB or from regional boards within California. Data came mainly from WDRs for 2005 and a few from slightly earlier or later years. From these reports, the following information was compiled:

- **Area receiving service and the size of the population receiving service;**
- **EPA classification of plants as a major or minor facilities;**
- **Treatment and disinfection process;**
- **Facility design and permit capacity;**
- **Longitude and latitude coordinates of the discharge and plant location;**
- **Depth below the water surface and distance from shoreline of ocean outfalls;**
- **Issuance and expiry dates of the WDR;**
- **Expected dilution ratio (seawater : effluent); and**
- **Type of wastewater (e.g., municipal or industrial).**

The WDR for each plant generally contained the data listed, but in some cases alternative sources had to be consulted. For example, census data, direct consultation with regional board staff and treatment plant managers, individual plant websites, U.S. EPA Facility Registry System, and Google Earth were all used to complete the data set. These alternative sources were necessary to provide missing information and coordinates or corrections to coordinates that are recorded in the WDRs for several treatment plants. Furthermore, the EPA online information about California wastewater treatment plants did not prove reliable in several cases. During completion of the *Report and Inventory*, more information has become available online, reflecting a trend toward greater access of data.

Database 1 Additions – Water reclamation and improvements made by wastewater treatment plants

After compilation of the two main databases, plant operators were surveyed in August 2009 by phone and email in order to collect current information and figures on water reclamation and on details of plant improvements made since 2005. Information was gathered from responses from 30 operators regarding 34 (79%) of the 43 facilities surveyed for the *Report and Inventory*.

Database 2 – Treated effluent

A second database was created to calculate the average amount and concentration of treated effluent that wastewater treatment facilities are discharging into the Pacific Ocean.

Data on specific pollutants were obtained from three sources:

- **the annual self monitoring reports (SMRs) compiled by each facility and submitted to the appropriate regional board;**
- **a few monthly SMRs provided by the treatment plants; and**
- **monthly SMR data collected and provided for the *Inventory* by the Southern California Coastal Water Research Project (SCCWRP).**

Annual SMRs were typically obtained directly from individual wastewater treatment plant managers, others were obtained by contacting regional board staff, and in a few cases a formal Public Records Act request was necessary. Data from the SCCWRP are for those plants within the Southern California Bight (the ocean area from Point Conception to the north to the US/Mexican border to the south). Parameters were chosen based on the existence of data for consistent comparison and based on parameters associated with 2006 303(d) listed impaired water bodies. This made it possible to identify any relationship between pollutants in effluent and the pollutants identified for beaches adjacent to water bodies on the CWA 303(d) list as impaired.

Database 3: Regulatory violations

The "Facility-at-a-Glance" online reports of the California Integrated Water Quality System (CIWQS) database provided a summary of the number of violations and enforcement actions. The CIWQS Interactive Violations Reports were also consulted to obtain detailed descriptions of the specific causes of violations and enforcement action taken. Large discrepancies were identified between the data reported on Facility-at-a-Glance and the data found on the Interactive Violations Reports. In addition, staff at some Regional Boards knew of certain cases involving court settlement proceedings but could not locate the enforcement documents. Heal the Ocean efforts to obtain the documents from the Superior Court were also unsuccessful. Difficult access and the inconsistencies in record keeping make it very difficult to track the regulatory compliance of the State's wastewater treatment plants. Heal the Ocean correspondence and conversation with plant operators confirmed that data recorded in the CIWQS were not always reliable.

Phase 2: Analysis & Calculations of Annual Discharge and Mass Emissions.

Annual average concentrations and mass emissions estimates were calculated based on the annual or monthly SMR results as available for a calendar year. Efficiency was calculated using effluent data and population served. The population served by each plant was used as a proxy for influent in calculations.[11] However, the lack of information about contributing factors such as historic storms renders unreliable any comparative assessment of a single year of treatment plant efficiency. Several plants, such as Morro Bay/Cayucos and Point Loma,[12] report their efficiency in percentage removal of total suspended solids (TSS), a practice that may be valuable to include as standard for treatment plant reporting as an indicator of overall plant efficiency. Without standardized, easily accessible presentation and uniform requirements for the inclusion of influent, effluent, and TSS figures in routine reporting, the tasks of identifying or calculating measures of efficiency are problematic.

Energy efficiency for wastewater treatment plants is reported in the CIWQS reporting system on a comparative basis, although it is possible that this information may be as unreliable as that for regulatory compliance, given the problems with the CIWQS reporting system at the time of research for the Report and Inventory. However, the inclusion of efficiency information in CIWQS shows how an online reporting system can accommodate various categories of information so that plant performance can be assesses in various ways.

The following equations represent the calculations used to determine the amount of treated water discharged annually by plants and their mass emissions as total suspended solids.

Annual Discharge (V) for each faculty

$$V = \sum_{i=1}^{12} aF_iD_i$$

F_i = Average Daily Flow for month i
D_i = # of days discharge occurred during month i
a = appropriate unit conversion factor for calculating volume in Gallons

Mass Emissions (ME) for each faculty

$$ME = \sum_{i=1}^{12} bF_iC_iD_i$$

F_i = average daily Flow for month i
D_i = # of Days discharge occurred during month i
C_i = constituent Concentration for month i
b = appropriate unit conversion factor for calculating ME in metric

Discharger Permits, Facility Information, Performance, and Reporting

Regulatory Framework

Wastewater treatment is regulated by the federal Clean Water Act (CWA) and California State law. The coastal facilities reviewed for this report each apply to their relevant regional board for an individual permit to discharge. Permits must be consistent with the federal National Pollution Discharge Elimination System (NPDES) and with the California Ocean Plan.[10]

The NPDES program rests on three major actions at the state level:

- **In California, ocean water quality standards are set by the California Ocean Plan in accordance with the CWA and the California Water Code.**
- **Under the CWA, states must make a list of water bodies that exceed pollutant limits designated in the Act.**
- **States must then list the Total Maximum Daily Load (TMDL) for pollutants in the water bodies identified as impaired. The resulting list is known as the 303(d) List of Impaired Waters.**

TMDLs are set at the level necessary to achieve the applicable water quality standards. NPDES permits must be consistent with the approved TMDLs and are issued to entities that discharge into an impaired body of water. Establishment of a TMDL may result in progressively stricter limitations of such discharges with time.

The U.S. EPA administers the NPDES and delegates regulatory authority to the California EPA. The California EPA in turn tasks the SWRCB with the administration of the nine regional water quality control boards that regulate water quality issues throughout the State. The regional boards under the SWRCB issue the individual WDRs to the plants.[11]

Wastewater treatment plants implement their permit requirements by meeting their WDR. WDRs set specific limits on the amount of various pollutants an individual plant is permitted to discharge. The plants are required to carry out periodic monitoring of these pollutants in their influent and treated effluent.

Discharger Information Sources

Information relating to permits, discharge requirements, and violations for all permitted sewage treatment facilities is made available to the public. The U.S. EPA operates the national Enforcement and Compliance History Online (ECHO) (23). At the State level, systematized and electronic reporting of compliance and monthly monitoring has long been adopted as a goal by the SWRCB. However, apart from all the treatment plants in Region Three, only a minority of wastewater treatment plants in other regions have adopted the present CIWQS. Technical, institutional, and financial problems have slowed the State's development of the System and have complicated electronic reporting. However, the CIWQS Review Panel believes the System can succeed under strong leadership and with a revised, narrower scope if it reflects user practices "down to the level of data entry," with constraints to ensure data integrity, and if subject to sufficient testing (24).

Work is underway through the CIWQS to develop the capacity to transfer needed data among dischargers and the federal NPDES system, and to make the data available to the public. As part of its recommendations, the CIWQS Review Panel recommends that: "... the State Water Board evaluate available alternatives for transferring needed data among dischargers, CIWQS, and the federal ICIS [Integrated Compliance Information System]-NPDES system. Because state and federal reporting and decision-making requirements differ, this interface should accommodate both state and federal needs and be developed in cooperation with the [U.S. EPA]."

Public reporting through ICIS-NPDES and ECHO, as well as the CIWQS, has emphasized access to permit violation information rather than to monitoring data itself. No interlinked comparative aspect has yet been included in these reporting systems. The move toward a much needed overview of wastewater treatment information for a region, or even California as a whole, has been encouraged by non-governmental organizations like Heal the Ocean and the SCCWRP.

Problems with existing information sources

During Heal the Ocean's data gathering and confirmation for compliance, it became clear that in addition to discrepancies in regulatory records, some violations had been recorded inaccurately. This *Report and Inventory* therefore leaves aside the regulatory information and uses the data collected only on the characteristics of each plant and outfall.[12]

10 For NPDES Permit Program Basics, see: http://cfpub.epa.gov/npdes/home.cfm?program_id=45

11 For a brief history and description of the SWRCB see: http://www.waterboards.ca.gov/about_us/water_boards_structure/history.shtml

12 California ocean dischargers include the San Francisco Oceanside plant, the only "combined' plant in the state that treats both sewage from the sanitary system and storm water runoff. It is the sole California plant that removes 100% of "first flush" storm water and treats the pollutants in this runoff. This major dual feature of the plant places it outside comparison

Thus, based on efforts associated with preparation of this report, Heal the Ocean has identified both a lack of integrated reporting and of significant data within the systems in place in the State of California. As a result, it is very difficult for any governing agency to assess the comparative operation, efficiency, and compliance of ocean-discharging treatment plants in California. The following problems arise:

1) Difficult access to information

Data is retrieved from waste discharge requirement documents, monthly monitoring reports, and annual reports. The lack of a complete and fully reliable online reporting system extends the time needed to gather the reports. Incomplete data also delay or prevent any measurement of plant efficiency.

- Electronic versions of reports have frequently been in a form that cannot be electronically searched (e.g., searching for key words), extending the time needed to find specific data.

2) Lack of consistency

While the unique characteristics in receiving waters produce a necessary and valuable variation in the standards set for each plant, unnecessary variation in reporting also occurs as follows:

- Reporting scope, style, format, depth, and occasionally units of measurement, vary considerably among regions and sometimes within regions. This raises obstacles of time and complexity to data gathering for any agency overseeing the comparative operations of wastewater treatment plants in California.

3) Data reliability

Heal the Ocean has learned from wastewater plant managers that on-line violation reports collected and administered by the SWRCB have also not always been accurate and therefore do not yet form a reliable basis for assessing compliance:

- Some violations have been incorrectly linked to plants where the violations did not occur;The online reporting database includes a number of violations resulting from errors or problems at contract analytical labs. The laboratory errors remain in the database and prevent a correct assessment of treatment plant operational errors;

- Multiple violations have been recorded for a single incident;

- Some violations may be under appeal by treatment plants whose staff believes they can prove the violations occurred for reasons unrelated to the actual operation of the plant;

- Violations remain on record even after investigation and dismissal after a finding that the treatment plant was not responsible or that the violation did not occur (as distinguished from violations confirmed and corrected).

Opportunities to Improve Performance

The contribution to regional board financing from fines on plants for permit violations raises the issue of incentives vs. penalties and which costs should be borne by the consumer. At present, while the administrative emphasis appears to focus on violations rather than on achievement, incentives are provided through treatment facility award schemes. Professional associations offer competitive awards and the State has developed an exhaustive competition-based recognition system for both individual operators and plants as a whole.[13] These competitions are intended to recognize and reward excellence in individual and system operation.

Some operators, however, have reported that they cannot justify the time taken to enter their plant into competition even when the same operators feel their facility deserves recognition for standards achieved. Violations receive attention automatically, while rewards for improvements do not. It could be advantageous for both regional administration and plant operations to shift their focus from simply decreasing violations and to permanently improved performance that is aligned with statewide water resource policies and plans. The following two areas are suggested as starting points:

1) Redirection of fines toward more source control

Sanitary districts are typically fined for permit violations (25). Plants can request to apply a portion of a fine assessed for an administrative civil liability (ACL) complaint to a Supplemental Environmental Project (SEP) or a Regional Water Quality Improvement Project (RWQIP) as included on a SWRCB list. SEPs are designed to reverse "the negative impacts on the environment caused by illicit discharges, legacy pollutants or other factors." RWQIPs "address problems requiring cleanup and abatement actions and other significant unforeseen water pollution problems that may not be undertaken in the absence of financial assistance (e.g., wastewater treatment facility projects in disadvantaged communities)" (26). Given the issues of CECs, greater emphasis on projects centered on pollution prevention or reduction, i.e., source control (preventing

with other plants in the State

13 See Wastewater Treatment Awards: Table under Additional Online Resources (Additional References, Summaries, & Sources section).

contaminants from entering the waste stream), including public education toward this end, could prove worthwhile as part of a long term strategy to decrease the pollutant load in the waste stream.

2) Finding new significance for treatment plant awards
Wastewater treatment plants in California participate quite extensively in award programs that offer titles such as "Regional Plant of the Year." This reflects the pride taken in performance by plant managers and may improve the chances of success in applications for funding. But in addition to standards of permit compliance as well as operations and maintenance, awards could and should focus on new categories relative to current needs. For example, achievements relating to wastewater reclamation and the recycling of water could be one such focus. The State's water recycling policy involves extensive consultation with regional water board representatives to agree on targets, but the mandate has not yet extended to the treatment plant itself in the form of new standards, reporting requirements or award categories.

A number of awards that provide official vehicles for evaluation of wastewater treatment plants are considered prestigious within the wastewater industry. The National Association of Clean Water Agencies (NACWA's) Peak Performance Awards are an example of recognition based on individual plant performance. This invites a line of inquiry about the sources used for compliance data and the procedures applied by awarding organizations to ensure consistency.

NACWA also runs the Excellence in Management Program to honor "member agencies that have implemented and sustained, for a continuous three-year period, successful programs that address the range of management challenges faced by public clean water utilities in today's competitive environment" (27). The EPA has run the Clean Water Act Awards program from 1985 to 2009, when it suspended the awards for a year to consider a significant redesign in order to "align the program more closely with its Sustainable Infrastructure goals and to the water industry through broader applicability' (28). Integrating objectives regarding water reuse and control of CECs with operational performance measures in awards would align new monitoring and policy directions with the desire of plant managers to improve their facility and to win recognition for doing so.

The awards reviewed appear to involve stringent criteria, and engage wastewater treatment plants in reporting extensive information about their operations. Since plant participation in awards is widespread, it may be useful to model changes to the official reporting systems on entry formats used for the awards, which could in turn assist in improving records and the tracking of operational and compliance performance. Alternatively, it may also prove effective and time saving to offer more recognition based on mandatory State and regional reporting rather than requiring separate and formal entry into a competition. This would offer opportunities and incentives as well as potentially improved reporting and related systems.

3) Assessment of NPDES permit fees based on actual effluent instead of design capacity
The SWRCB assesses permit fees based on the 'Permitted Flow' or 'Designed Flow' specified in each waste discharge permit" (29). In this case, two facilities, each rated at a capacity of 10 MGD for ocean discharge, will be charged the same fee. This occurs even if the community that owns one of them also builds a companion water reclamation facility to process water for beneficial use. In addition, the regional board also levies a second permit fee on the recycled water facility. In this way, the community taking effective action to conserve water and decrease pollution pays more in permit fees than the facility that simply discharges all of its wastewater to the ocean. As suggested by plant operators, a sliding scale based instead on millions of gallons actually discharged would provide an incentive to improve efficiency and increase the amount of water reclaimed by plants.

Suggestions for Improving Treatment Plant Reporting Protocol

Assessment of wastewater treatment plants in California would improve with full implementation of a standardized system of reporting. Improvements in reporting should shed clearer light on the treatment plant operations behind the reports and where changes could be made. To make the work of wastewater plants easier to comprehend, compare, and research, such a reporting system needs to include basic information related to plant technology, performance, and monitoring. Suggested improvements in reporting to increase the ease and value of evaluation are as follows:

- *Improved categorization of the size of treament plants:*
  This could be accomplished by using several more degrees of variation than the EPA classification of a plant as "major" or "minor," which is based on the number of gallons treated per day–over or under one million gallons respectively.

  The amount of treated wastewater discharged into the ocean by an individual sewage plant ranges from 0.01 million gallons daily (MGD) (Ragged Point Inn and Anchor Bay, Mendocino County) to 332.25

MGD (Hyperion). Out of a total of 43 wastewater facilities,[14] in 2005, 10 discharged under one; 18 facilities discharged between one and ten MGD; 11 discharged between 10 and 100 MDG; four plants discharged over 100 MGD (see Table 3.1). Basic information about a wastewater treatment plant needs to include: 1) its relative size based on how much it discharges; 2) its relative size also in terms of intake volume; and what proportion of influent wastewater ends up discharged. These figures would make it easier to compare treatment plant size, efficiency, and potential to reclaim water.

- *Characterization of community served:*
  A summary of community demographics and description of customer service classes would allow identification of source reduction opportunities and potential for water reuse.

- *Categorization by influent quantity and type, and by treatment processes used:*
  This would help to provide a quick reference for strategic assessment, for example, for the siting of pilot pre-treatment projects.

- *Standardization of monthly and annual reporting formats:*
  While the CIWQS remains under revision, an opportunity exists for improvements to reporting formats in order to bring greater consistency and provide more information about treatment plant operation and performance.

- *Standardized inclusion of performance goal reporting:*
  Besides plant regulatory standards, NPDES permits can also contain official performance goals that recognize the constraints on a particular plant in achieving certain water quality objectives. The 2008 NPDES permit for the new tertiary plant at Marine Corps Base Camp Pendleton provides an example and shows that individual plant reporting can provide more general information about effluent quality:

  The [reasonable potential analysis (RPA) procedure] results for [the Southern Region Tertiary Treatment Plant] discharge indicated that the effluent only has reasonable potential to cause exceedances of water quality objectives for chronic toxicity, copper, and total chlorine residual; therefore, water quality-based effluent limitations are included in the tentative order for these parameters. Performance goals, rather than effluent limitations, are included in the tentative order for all other toxic pollutant parameters of Table B of the Ocean Plan. Performance goals are not enforceable effluent discharge specifications or standards for the regulation of the discharge; however, inclusion of performance goals supports State and federal antidegradation policies and provides all interested parties with information regarding the expected levels of pollutants in the discharge that should not be exceeded to maintain the water quality objectives established in the Ocean Plan (30).

  Performance goals of this kind show the extent to which the official system of assessment can be tailored and how it can be extended without entailing enforcement per se. Creation of a standard method to report on performance goals would simplify the gathering of related information from different treatment plants. Pilot projects designed to test methods of monitoring prioritized CECs could include performance goals in WDRs as a formal measure that encompasses, ensures, and tests reporting before the monitoring of CECs becomes mandatory.

- *Differentiation in regulatory reporting and recording between one incident or several as the cause of recurring ACLs:*
  This would avoid the mistake of over-counting violations.

- *Clearer distinction between violations linked to discharges vs. those related to sanitary sewer overflows (SSOs):*
  Treatment plant water quality violations are recorded as NPDES permit violations. These are separate from SSOs, which occur before wastewater reaches the treatment plant. However, a review of the record of these incidents requires knowledge of the specific terms and an understanding of the difference between the direct implications for water quality of NPDES violations and the typically indirect consequences for water quality of SSOs. The use of simple categories for different types of violations would make assessment of water quality violations easier.

- *Clear distinction between administrative/technical violations and violations affecting water quality:*
  Assessment of regulatory compliance affecting water quality could occur more easily if the water quality violations were listed separately from violations of a technical or administrative nature.

- *Clear and consistent identification and pairing of ACL complaints and orders:*

14 Individual facility figures include those collected for 1) the Aliso Creek Outfall as the permitted facility discharging treated effluent from SOCWA Regional, SOCWA Coastal, Los Alisos, and El Toro wastewater treatment plants; and 2) the San Juan Creek Outfall as the permitted facility for the JB Latham, 3A, Chiquita, and San Clemente wastewater treatment plants.

In some regions, the ACL order and complaint are assigned the same identification number. However, other regions use different numbers, and reference the complaint number deep in the body of the text of the order rather than in the heading. Consistent use of the same number for both a complaint and its related order, and inclusion of the number at the head of both documents would make it easier to research and evaluate compliance.

PART TWO

Reclaimed water is water that, as a result of treatment of waste, is suitable for a direct beneficial use or a controlled use that would not otherwise occur. In this way, reclaimed water (also referred to as recycled water) is considered a valuable resource. "The degree of treatment provided for recycled water depends on the quality of water needed for the specific beneficial use and for public health protection." Such water may include effluent from primary, secondary, or tertiary wastewater treatment, or "advanced treatment" (1, p.F-8).

In 2003, when the Department of Water Resources (DWR) published Water Recycling 2030: Recommendations of California's Recycled Water Task Force, (WR 2030), the DWR task force estimated that by year 2030, "California has the potential to recycle up to 1.5 million acre feet (AF) [~1.3 billion gallons15] per year. This could free up freshwater supplies to meet approximately 30% of the household water needs associated with projected population growth" (1, p. xi). These figures may be modest given that California's ocean discharging plants alone release about 1.35 billion gallons daily. California's DWR task force calculated that $11 billion would be needed to build the infrastructure for the production and delivery of recycled water. This extrapolates to a unit cost of about $600 per AF (325,851 gallons) (1, p.48).

According to the *WR 2030* report, many of the recommendations made by the task force can be, "... implemented by State or local agencies without further legislative authorization or mandate and provide advice that can be used as a toolbox for communities to improve their planning for recycled water projects" (1, Letter of Transmittal).

In California, the State Water Code, together with the Health and Safety Code (in particular Title 22 on facilities and hazardous waste management), are the current statutes governing water reuse (2). The State Department of Public Health website summarizes these regulations and provides draft groundwater recharge reuse regulations, other related regulations, guidance documents and other reports.

The *WR 2030* report points out that, "...in terms of making the greatest impact on augmenting the State's water supply, emphasis should be placed on reusing recycled water that has no opportunity to be reused downstream" (1, p.10), and gives ocean discharges as an example of water that should be captured and recycled. In other words, ocean discharging wastewater treatment plants should be given priority over inland plants for water recycling.

Benefits of Reclaimed Water

In Florida, Seminole County has instituted advanced wastewater operations and has published a list of six advantages of reclaiming wastewater (3). As modified below, these advantages can provide the State of California with a cogent framework for a public education program as more reclaimed water projects are considered statewide.

1) **Environmental benefits**
   Environmental incentives are a strong motivation for recycling wastewater and should be a major basis for policy. In addition to avoiding the problems of salinity caused by over-pumping of groundwater, the diversion of wastewater discharges away from the ocean or freshwater bodies inhibits pollution by contaminants in effluent.

   Reclaimed water can also help to maintain the balance of natural water flows (the water budget) in a watershed, for example, by reducing the need to divert water for human use from trout streams. Many stream flows are now reliant on wastewater flow to maintain their function as habitat, and care is needed to avoid depleting such flows by ending the discharge of wastewater into them. Good examples of habitat protection by reclaimed water augmentation include saltwater marsh preservation around San Francisco Bay and around the South Bay close to the U.S./Mexico border (4).

2) **Financial advantages**
   As an August 2009 *Newsweek* online article states, "Climate models by the U.S. Global Change

15 1 million gallons per day = 1,120 acre feet per year. (Irvine Ranch Water District website: Water Equivalents http://www.irwd.com/MediaInfo/water_equivalents.php accessed October 2009.)

Research Program, the [California] state's water resources agency, and researchers at the University of California, Davis, all point to the same trend: the Sierra snowcaps that supply the state's water are disappearing" (5). If this forecast is accurate, the cost to import water from this source will increase and the available supply may not be capable of meeting established uses. The need to augment, or in some cases replace, this source (and others) may make reclaimed water a more attractive option.

3) **High-quality water**
Reclaimed water quality may be better for irrigation uses when the water contains nutrients such as nitrogen and phosphorus, as these elements are beneficial for agriculture, gardening, etc. As examples from Northern Virginia, Belgium, and the U.K. show, advanced secondary treatment alone can yield reclaimed water of a higher quality than that of standard water supplies (6). Tertiary treatment using reverse osmosis, as in Singapore, can produce very high quality water suitable even for specialized high-technology industrial processes (6, p.3). In California, the Orange County Groundwater Replenishment System was built on the premise that it would "produce water that is very similar to or better than bottled water quality" (6, p.3).

4) **Water conservation**
Conservation of potable water for human consumption occurs automatically when reclaimed water is used instead of potable water for irrigation and landscape watering, cooling or sanitary purposes (toilet flushing).

5) **Increased availability**
In times of drought, reclaimed water supplies will be steadier and more reliable than potable water and may be subject to fewer restrictions. This makes it possible for uses, particularly irrigation, to continue longer than when only potable supplies are available. Usage extended in this way forms the premise of the California Recycled Water Task Force's expectation that by 2030 recycled water could meet about 30% of the State's household water needs associated with projected population growth (7, p. xi). However, regional projections vary. The City of San Diego Water Department, which imports nearly 90% of its water from northern California and the Colorado River, concludes that, "…even the most optimistic projections" are that reclaimed water can meet only 20 to 25 percent of total demand (8).[16]

6) **Security of supply**
In September, 2008, this benefit of reclaimed water was summed up by David Nahai, CEO and General Manager of the Los Angeles Department of Water and Power, when he stated, "Moving forward with groundwater replenishment just makes sense. It provides a locally controlled source of water that is not at the mercy of drought, or court decisions, or politics" (9).

Two Key Water Reclamation Issues: Salinity and CECs

The degree to which reclaimed wastewater can be reused depends on a number of factors, including market demand, public acceptance, funding, local regulation, delivery and storage capacity, existing plant infrastructure, site size and location, background levels of pollutants, and the quality of the reclaimed water. But two key water quality issues, salinity and contaminants of emerging concern (CECs), must be addressed in any proposal to produce reclaimed water.

Before a wastewater treatment plant can begin to reclaim water, it has to ensure the final product will meet health criteria and not be so saline that it rules out many agricultural applications and/or causes salt stress in landscape plants or on golf courses and sports fields. The U.S. Environmental Protection Agency's (EPA) 2004 *Guidelines for Water Reuse* examine opportunities for, "substituting reclaimed water for potable water supplies where potable water quality is not required." Even this limited expectation for water reuse as a mechanism to conserve potable water supplies may need an improvement in reclaimed water quality. Water for indirect potable reuse in particular must meet health standards that increasingly need to take into account CECs. According to the *WR 2030* report, "…groundwater aquifers have been recharged with recycled water in California since the 1960s." For this long record to continue safely, the issues of salinity and CECs must be subject to careful scrutiny. Future regulation of CECs and the need to reduce salinity could require significant treatment improvements in order that recycled water will meet local beneficial use needs.

Water Reclamation Issue One: Salinity

Measured as total dissolved solids (TDS), salinity is the concentration of dissolved mineral salts in water. Typical salts include calcium, magnesium, sodium, sulfate and chloride (10).

16 North City Plant treatment capacity: 30 million gallons per day; South Bay Plant: 15 million gallons a day. San Diego's 2010 objectives include: a. Groundwater treatment program 10,000 acre-feet per year; b. Recycled water program 15,000 acre-feet per year; c. Groundwater storage program 20,000 acre-feet per year. d. Conservation program 32,000 acre-feet per year; e. Water transfer program 5,000 acre-feet per year. Also, by 2012: Develop and implement a desalination program (brackish groundwater and/or ocean water) (Source: City of San Diego Water Department web pages http://www.sandiego.gov/water/pdf/stratplan.pdf accessed December 2009).

The Southern California Salinity Coalition (SCSC), a ten-member coalition of water and wastewater agencies, lists the following consequences of excessive salinity:

- Detrimental effects on plant growth and crop yield
- Damage to wastewater and conveyance infrastructure
- Reduction of water quality
- Sedimentation problems
- Soil erosion

As pointed out on the City of Paso Robles website, "Water with salinity levels above 1,000 mg/l is of questionable use for irrigation and industrial customers" (11). Irrigation or watering with reclaimed water that is too saline can cause leaf burn, leaf drop, and plant death, which limits or rules out the use of such water for landscaping, agricultural, and sports field applications. Salt build-up negatively affects pipes and other infrastructure, thus limiting municipal, domestic, and industrial reuse. Without sufficient salt removal, reclaimed water used to recharge groundwater basins can cause a build-up of salt in the basins (12). The long list of negative effects of salt as a contaminant has led to the inclusion of TDS limits in wastewater.

Southwest Hydrology, a journal for consultants, regulators, researchers, water managers, lawyers, and policymakers working with water issues in semi-arid regions, has investigated the serious difficulties for wastewater treatment plants caused by brine discharges from industry and desalination plants in addition to the normal residential load. A March/April 2008 report in this journal states that, along with the loss of reclaimed water, other impacts of the combined saline influent "…can be significant, and include loss of hydraulic capacity of sewerage systems, infrastructure degradation of WWTPs from corrosion… lowering of the value of and ability to reuse biosolids, and mineral salt pollutants that adversely affect downstream reuse of the watershed supplies." The report quotes Walt Pettit, former executive director of the State Water Resources Control Board (SWRCB): "Salinity in Southern California is probably the biggest water problem that isn't being adequately addressed" (13).

Highly saline influent causes a serious obstacle to wastewater recycling because standard treatment processes remove very little salt. At present, reclaimed water is primarily used for irrigation, for example, spraying or drip feeding freeway plantings, parks, flower nurseries, agricultural fields, cemeteries, and golf courses. Reuse of this kind is highly desirable because irrigation and agriculture are the leading uses of water. Using recycled water for these purposes significantly reduces the demand for potable water and conserves its use for drinking. In some locations, however, reclaimed water must be mixed with equal volumes of potable water to reduce salinity to non-harmful levels.[17] Removing TDS from reclaimed water could greatly increase the amount of potable water available for drinking.

The financial cost of wastewater desalination is high. Nevertheless, a recent evaluation by the Rancho California Water District, in conjunction with Eastern and Western Municipal Water Districts of Riverside County, proposes that "…partially desalinated wastewater would be a cost-effective means to replace potable water currently used for irrigation" (14).

Salinity in wastewater has several causes: natural minerals dissolved in water flows; natural salt spring or seawater infiltration into freshwater flows; fertilizer runoff; byproducts of wastewater treatment chemicals such as chlorine, foods, and cleaning chemicals (15). A large influx of salt to the wastewater plant also comes from home water softeners.

Salt-based water softeners[18]

Water softeners offer real benefits to consumers. Hard water is abrasive to clothes, towels, etc., and can shorten the life of appliances such as washing machines and dishwashers. Hard water can also lead to mineral buildup and blockage in plumbing. The amount of energy needed to operate a water heater using hard water can increase by up to 30 percent (16). Where water softeners can be justified, the use of less salt is advised if an alternative is unavailable. The choice of alternatives to sodium salts is limited, however, particularly because the use of potassium chloride leads to the expensive problem of chloride removal (11).

Cutting the amount of salt entering the waste stream keeps salt removal costs down. In California, water softeners have come to be addressed as a major source of salinity in wastewater. In the Santa Clarita Valley Sanitation District, for example, water softeners are reported to be responsible for 20 per cent of chloride (17). Such sizeable contributions to the salinity problem have led local governments and water districts, such as Paso Robles, to emphasize the problems posed by water softeners in their public education programs.

In July 2008, California Governor Arnold Schwarzenegger vetoed AB 2270, a bill that would have made it easier for water districts to impose water softener bans.
The Governor's veto was predictably praised by the $500-million a year softener industry (18). But in October 2009, AB 1366 was signed into law, allowing the regional

17 Communication with plant operators revealed, however, that fifty-fifty mixing of overly saline water with potable water can be avoided by flushing fields that receive overly saline water at intervals typically of one month.

18 See basic description of water softener process: Wight, Chuck, How do water softeners work? Scientific American (2001) online, September 24, http://www.scientificamerican.com/article.cfm?id=how-do-water-softeners-wo.

water boards in certain hydrologic regions[19] to pass ordinances that would result in a reduction of the amount of sodium chloride released by water softeners, but only if those regional boards can prove such actions will "contribute to the achievement of water quality objectives" (17). According to the LA Times, the AB 1366 regulations allow the substitution of potassium chloride for sodium chloride (17), which proves just as problematic for water treatment plants because potassium chloride adds to the TDS load for chloride (11). The environmental problems associated with chloride are outlined on the website of the Madison (Wisconsin) Metropolitan Sewerage District, which states, "...high concentrations of chloride are harmful to aquatic plants and animals...Although it consists of potassium instead of sodium, [potassium chloride] still contains chloride...The technology to remove chloride is available, but it is very costly. It would involve microfiltration and reverse osmosis...One community determined that it would cost about twenty cents to add a pound of chloride at the water softener, and $5.00 to remove it at the treatment plant. Households can use up to 100 lbs of salt a month in their water softeners."

As residents face increased water rates to pay for augmented treatment to remove salt from wastewater, more bans on salt-based water softeners may succeed. Residents of the Santa Clarita Valley Sanitation District made their choice clear when they voted in 2008 to outlaw salt-discharging water softeners by 2009, with a six-month grace period (18). A comprehensive approach to reduce salinity by incorporating source control and treatment can be found in the 2004 recommendations of a Western Australia treatment plant. Recognizing a level of approximately 550 mg/l TDS as appropriate for sustainable use (with higher levels possibly acceptable for some uses), Melbourne Water and City West Water investigated the feasibility of: a) a reduction at source of influent salt loading by industry through cleaner practices; b) an education program with consumers and manufacturers to encourage a change to lower salinity domestic laundry detergents; and c) introduction of a desalination process to make up the shortfall in achieving the targeted salinity level (19). A similar set of measures could be effective for ocean discharging wastewater treatment plants in California.

Alternative water-softening devices are marketed, including some that use magnetic and electromagnetic softening methods, which reportedly alter the electrostatic properties of the ions instead of removing them from pipes and incoming water. But the effectiveness of these devices, especially on a small scale, is subject to debate (20). Other advertised softeners claim to use a "non-sacrificial catalytic alloy," but the process appears to be chemically impossible and one to be avoided. Some domestic systems based on reverse osmosis are available, but at a high price. In addition, energy use with reverse osmosis is high, and the process itself wastes water. A small Arizona community, the White Cliffs Mutual Domestic Water Users Association, decided the advantages of reverse osmosis outweigh its disadvantages and moved ahead with the installation of a reverse osmosis desalination system. Their action may serve as an example of a shared cost solution, which can be initiated inappropriate sites to achieve both source control and softened water, and to lessen the amount of salt reaching the wastewater treatment plant (21).

Brine Waste

Brine waste, which is wastewater high in salts, from industrial and wastewater treatment can contain a concentrated residual of CECs and poses a serious disposal problem. In the absence of CEC regulation, brine waste discharge to the ocean is included in long-term salinity management proposals. Water recycling that mixes brine waste in effluent possibly increases ocean pollution and cannot be considered a sensible solution, especially since future, revised standards could rule out ocean discharges of brine waste altogether.

The Water and Wastewater Salinity Management Project of the Eastern Municipal Water District of San Diego County is an example of salinity management that ultimately results in ocean discharge. The district serves an inland area and proposes to build as many as four brine-disposal pipelines to transfer non-recyclable brine waste from industry and the District's desalination program to existing brine management facilities. Waste from the Eastern Municipal Water District's brine management facilities is carried by the Santa Ana Regional Interceptor (SARI), to specially-equipped treatment plants operated by the Orange County Sanitation District (23), and from there to the Pacific Ocean (24). The stated aim of the project is to "...help protect existing groundwater supplies...and reduce the salinity of recycled water, both of which will reduce the need for additional imported water into Southern California" (22). Such discharge may meet current water quality standards, but the wastewater discharged to the ocean from the Salinity Management Pipeline (SMP) and San Diego County's SARI is highly treated and likely to contain CECs. The project fact sheets lists as a benefit that the SMP, "safely removes salts to the ocean where they cause no harm," but the issues surrounding CECs throw real doubt on this claim.

In Ventura County, the Calleguas Municipal Water District (CMWD) is bringing online a new Hueneme outfall and also an SMP (25). Like the Eastern Municipal District project in San Diego, Calleguas has a dual focus on

19 The regions stipulated in Assembly Bill 1366 are: South Coast, Central Coast, San Joaquin Valley, Tulare Lake and the lower half of the Sacramento Valley.

wastewater desalination and recycling, and any ultimate discharge of unused treated wastewater to the ocean must also contain the chemical residue of desalination. The CMWD project fact sheet states that, "By providing a discharge mechanism, the SMP will enable local brackish groundwater resources to be demineralized and utilized for potable purposes, reducing dependence on imported water and improving local water supply reliability. The SMP will also deliver recycled water to areas where it can be used and export salts out of the watershed to help achieve compliance with total maximum daily loads (TMDLs) for salts." The questions around CECs, however, could bring the stated benefits only at the cost of environmental pollution caused by the ocean discharge of brine wastes.

On another front, the Calleguas project illustrates the need for storage infrastructure to ensure capacity and delivery to as many users as feasible, along with reuse regulations that can make way for dual plumbing–the installation of secondary piping to convey reclaimed water. These measures would have the potential to increase demand. Without the right balance of such measures in place, districts like the CMWD will continue to discharge usable reclaimed water to the ocean when demand is low. Increases in water reclamation need to be accompanied by expansion of markets and usages to ensure full reuse and prevention of the waste of recyclable water.

Wastewater Treatment Plant Desalination Processes

In areas around the world where fresh water is scarce, desalination of ocean water is increasing despite its expense. The market analyst company BCC Research issued an industry report in 2008 on the membrane and separation technology used in desalination processes. The company predicted an annual global growth rate for desalination plants of 13.7% by 2012. The technology used in desalination plants is also employed by wastewater treatment plants to remove salts for the production of high quality reclaimed water, maximizing its potential for reuse. Using 2005 data gathered from the largest water reusers in Florida, California, Texas, and Arizona, the BCC Research report includes a survey showing the 13 most prevalent water recycling and reuse technologies in the U.S. (26). For those treatment plants using demineralization technologies, approximately 82.4% used ion exchange, approximately 11.8% used electrodialysis reversal (EDR),[20] and approximately 5.9% used deionization. No plants surveyed used electrodialysis or electrodeionization. For treatment plants using membrane-based filtration technologies, 22.4% used microfiltration, 32.7% used ultrafiltration, 4.1% used nanofiltration, and 40.8% used reverse osmosis.

Membrane Separation of Salts

The following methods that use membranes of different types and in different ways are currently employed to remove salinity from wastewater:

Reverse Osmosis (RO)

This is a process by which a solvent such as water is purified of solutes by being forced through a semi-permeable membrane through which the solvent, but not the solutes, may pass (27). (See also Nanofiltration.) Reverse osmosis uses a membrane to separate water from dissolved salts. No heating is required, but energy is needed to power a pump that pressurizes the seawater fed into the treatment plant. As the salt water squeezes against the membrane, some water molecules are pushed through minute pores, with a diameter roughly 100,000 times smaller than a human hair. This creates a stream of fresh water on the opposite side of the membrane (28).
If enough pressure is applied to the solution with the higher concentration of dissolved solids (such as saline water), the natural osmotic pressure can be overcome (reversed), forcing the solution through the membrane towards the solution with less dissolved solids and removing the dissolved solids in the solution of higher concentration (29).

Microfiltration (MF)

Microfiltration is the physical retention of particles behind a filter medium while the liquid in which they were suspended passes through the filter. Particles are retained because they are larger than the pores in the filter. Other factors affecting retention are fluid viscosity and chemical interactions between the membrane and the particles in the solution. Microfiltration removes particles with a pore size of .05 and 5.0 μm, including bacteria and some viruses (13).

Ultrafiltration (UF)

Processes using ultrafiltration work in basically the same way as microfiltration, except that the pore sizes are considerably smaller. Solutes are retained behind the filter on the basis of molecular size while the bulk of the liquid and dissolved salts pass through. A pressure gradient across the membrane, known as transmembrane pressure, drives the filtration process. Ultrafiltration membranes are designed for the concentration and separation of complex protein mixtures (13).

Ion Exchange

Ion exchange is a reversible interchange of one kind of ion present in an insoluble solid with another of like charge present in a solution surrounding the solid with the reaction being used especially for softening or demineralizing water,

20 Electrodialysis reversal was investigated by the authors of a report to the Food & Agriculture Organization (FAO) of the UN that includes an overview of plants in southeast mainland Spain and the Canary Islands and Balearic Islands, including some using desalination processes in wastewater treatment and providing water for irrigation. The authors found that "the process is particularly suitable for brackish water with total dissolved solids (TDS) up to 3,000 mg/litre because the amount of energy required is directly proportional to the amount of salts to be removed" (ftp://ftp.fao.org/agl/aglw/docs/lwdp5_e.pdf).

or for purifying chemicals, or separating substances.[21] The process relies on "the selective permeability of ionized inorganic and ionized organic exchange membranes" (26). During ion exchange, the scale-forming ions of calcium and magnesium are replaced with an equivalent amount of sodium ions from a synthetic resin or a naturally occurring resin, typically from zeolite clays. This method is effective with only moderate levels of hardness because the exchange capacity of the resin is limited.

Water Reclamation Issue Two: Contaminants of Emerging Concern

Several variations of description and definition relate to the concept of CECs. The European Commission Network of Reference Laboratories for Monitoring of Emerging Pollutants (NORMAN), established in 2005, distinguishes between "emerging substances" versus "emerging pollutants" and does not appear to use the term CEC (1). While the topics under study through NORMAN are being reviewed by the U.S. EPA, the EPA's official definition of CEC has still to be finalized and different definitions are used by the U.S. Geological Survey, the California Department of Toxicology, and the EPA Office of Water (2).[22] The U.S. EPA's official definition of CEC has still to be finalized, but the following is under official consideration by the EPA Office of Water: "The term 'contaminant of emerging concern' is being used within the Office of Water to replace 'emerging contaminant,' a term that has been used loosely since the mid-1990s by EPA and others to identify chemicals and other substances that have no regulatory standard, have been recently 'discovered' in natural streams...and potentially cause deleterious effects in aquatic life at environmentally relevant concentrations" (3). While the EPA has not made its official designation, the term "CEC" appears to have become increasingly used in related literature.

CECs can be summarized as chemicals whose behavior, fate, and effects are uncertain but thought possibly to be harmful in the following ways: 1) they are toxic to aquatic life, persist in the environment, and accumulate in tissues (including human tissues); and/or 2) they interfere with hormone systems governing reproduction and growth. As chemicals become suspected of causing these kinds of harm, they raise concern about their possible impacts in the coastal and marine environment. Wastewater monitoring programs focus only on a small list of priority contaminants that were identified decades ago. Production of new contaminants and contaminants of emerging concern, however, is continuing and could increase in the future, making the update of monitoring programs a matter of urgency.[23]

Treatment plants began to battle significantly with CECs following the discovery in 1974 of trihalomethanes as a byproduct of chlorine disinfection (4), particularly when used to treat influent containing high levels of organic matter (5). The potential threat of these compounds to human health led to regular monitoring of their concentration in municipal water and treatment systems (6). Over three decades later, N-Nitrosodimethylamine (NDMA), also a chlorine disinfection byproduct, remains a subject of concern, and is a current example of a CEC that needs tertiary treatment for removal, adding to the costs of reclaiming water for potable use and of avoiding unintentional NDMA contamination through indirect potable reuse (7). NDMA is a "classic" CEC, like perchlorate, 1, 4-Dioxane (a manufacturing solvent), MTBE (methyl tertiary-butyl ether; a solvent and gasoline additive),[24] and TBA (tertiary-butyl alcohol; a paint remover ingredient and gasoline additive), and has long been considered a risk to environmental and human health. NMDA is in fact an example of a CEC under local discharge regulation (under public health legislation), where its removal is required for direct aquifer injection (subsurface application) under several water recycling permits issued to reclamation plants by the Los Angeles Regional Water Quality Control Board RWQCB.

Work is underway at national and state levels to ensure that guidelines and legislation address CECs. Meanwhile, wastewater contains increasing amounts of these substances, and not enough is known about their individual and combined fate. Wastewater engineers are finding that they have to tackle both the greater quantity and the increased complexity of CECs and their interaction. In 1998, a U.S. EPA study of chemical hazard data revealed the scale of the problem in its finding that of the 3,000 chemicals imported or produced by the U.S. at the rate of more than one million pounds per year, "...43% of these high production volume chemicals [had] no testing data on basic toxicity and only seven percent [had] a full set of basic test data" (8). In the years since this chemical hazard study, research has increased and policy has begun to shift. However, the *WR 2030* report states that lack of funding for research on CECs is a critical issue, as is the lack of funding for infrastructure and public health concerns. The U.S. EPA Office of Water guidelines for deriving ambient water quality criteria (AWQC) (established in 1985 pursuant to the Clean Water Act (CWA)) are now being revised to take account of the need "to help assess and manage the potential risk of some CECs in the aquatic environment" (3).

In the meantime, the 2008 report on "Green Chemistry" by the University of California's Centers for Occupational and

21 Source: Merriam-Webster.com

22 The U.S. Geological Survey and the California Department of Toxicology refer to "emerging contaminants" and "emerging chemicals of concern" ("ECC") respectively (2).

23 Adapted from Southern California Coastal Waters Research Project: http://www.sccwrp.org/view.php?id=53 (accessed January 2010).

24 MTBE is monitored by Point Loma WTP.

Environmental Health (CCOEH) finds that the amount of chemicals produced or imported in the U.S. has increased since the 1998 EPA tally of one million pounds per year.

The quantity has increased to, "42 billion pounds of chemical substances ... produced or imported in the U.S. for commercial and industrial uses." The CCOEH report also points out that, "An additional 1,000 new chemicals are introduced into commerce each year" (9). EPA's recently appointed Administrator Lisa Jackson stated in September 2009 that, "Over the years, not only has [the Toxic Substances Control Act (TSCA) of 1976] fallen behind the industry it's supposed to regulate, it's been proven an inadequate tool for providing the protection against chemical risks that the public rightfully expects" (10). The EPA anticipates new legislation to strengthen TSCA and proposes six "Essential Principles for Reform of Chemicals Management Legislation" (11). These include a call for manufacturers and the EPA "to assess and act on priority chemicals, both existing and new, in a timely manner," for "green chemistry" to be encouraged, and for strengthened provisions assuring transparency and public access to information. Wastewater treatment is certain to be affected by new legislation and regulations that address CECs.

CEC Categories and Definitions

Several CECs are included in the EPA's 2009 Contaminant Candidate List 3 (CCL3),[25] which consists of 104 chemicals designated as "contaminants that are currently not subject to any proposed or promulgated national primary drinking water regulations that are known or anticipated to occur in public water systems." The list also includes 12 microbial contaminants, four of which cause mild gastrointestinal illness and two of which cause respiratory illness, as well as *Helicobacter pylori* (an uncommon bacterium that can colonize the human intestine and cause ulcers and cancer), hepatitis A (causing liver disease), *Escherichia coli* (a bacterium that can cause gastrointestinal illness and kidney failure), *Legionella pneumophila* (causing lung disease), *Mycobacterium avium* (causing lung disease in the severely immuno-compromised) and a parasite that can cause primary amoebic meningoencephalitis. The CCL3- listed microbes may become subject to regulation.

The field of CECs is becoming better defined due to research such as that of the U.S. EPA's 2005-2008 *Nine Publicly Owned Treatment Works* study, which investigated, "...the occurrence of Contaminants of Emerging Concern (CECs) in untreated and fully treated wastewater at POTWs [publicly owned treatment works]." The study lists five categories of CECs, with definitions, descriptions, and short summaries relating to each category (12). These categories are used below with some adapted and mainly additional content. The class of perfluorinated compounds (PFCs) is also summarized below, since the two CCL3-listed compounds perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) have recently received international attention and are being researched in relation to wastewater treatment (13). Additional chemicals being studied in relation to wastewater treatment include: the chlorinated organic compounds Dioxane (a manufacturing solvent) and the herbicides Acetochlor and diuron; and benzenes such as Dinitrobenzene and n-Propylbenzene (e.g., (14) (15)).

Pesticides

These are chemicals used to inhibit, repel, or kill pests that include compositions ranging from insecticidal soaps to formulations such as alachlor, malathion, carbaryl, and chlorhexidine. Many pesticides are persistent organic pollutants (POPs) and as such are "characterized by their long lifetime in the environment (persistence), their potential for long range transport and their capacity to build up to dangerous levels in predatory species"(16). Atrazine, DDT, lindane, and Carbofuran are among the most common pesticides found in water (17).

Between 1992 and 2001, an average of almost one billion pounds of conventional pesticides was used each year in the United States (18). Limits are already in place for many pesticide compounds, including organo-halides, but research continues into their individual, variant, and combined effects and their treatment in the wastewater process.

The U.S. EPA CCL3 list includes several pesticides such as Acrolein and Ethoprop. The older and well-known pesticide DDT presents a case of once-emerging and now ongoing concern at some ocean sites off California. Research on CECs should help to prevent a reoccurrence of the DDT story–an unsuspected, widely-used chemical that becomes a banned substance, but which continues to pollute.[26] DDT was banned in 1972 for most uses (19), but still contaminates the coastal waters of the Southern California Bight. Several harbor locations, including the Long Beach Outer Harbor, are listed as impaired due to contamination by DDT among other toxic chemicals (20). The Los Angeles RWQCB describes how, "The highest concentrations of DDT and PCB are in a layer of low density sewage-derived sediments around the main sewer outfalls at Whites Point on the Palos Verdes Shelf" (21). The DDT/PCB-contaminated area has been declared a

25 The US EPA's Contaminant Candidate List 3 is published every five years. The list is published on the U.S. EPA: website: http://www.epa.gov/ogwdw/ccl/ccl3.html

26 Chemicals that continue to pollute following an end to their use are known as "legacy" contaminants. Other CECs of this nature include the organochlorine (OCL) compounds dieldrin, chlordane, toxaphene, PCBs and dioxins (http://www.axysanalytical.com/services/organochlorine_legacy_compounds/)

Superfund Site by the U.S. EPA, which is investigating capping and other methods to remediate the sediments. The WDRs of most of the ocean-discharging wastewater treatment plants in the Southern California Bight (most of which provide secondary treatment) include monitoring for DDT. Methods including membrane filtration, solvent sublation, and activated carbon absorption remove DDT from wastewater by changing its chemical composition (18). To destroy DDT, a method known as the "Fenton Process" is used, but does not yield potable water. Research is ongoing into methods to improve the photodegradation of DDT (22).

Alkylphenols and Alkylphenol Ethoxylates (APEs)
These synthetic surfactants are used in some detergents, cleaning products, and paper. APEs can affect the reproductive systems of aquatic organisms. Nonylphenol ethoxylates (NPEs) are the most common form and are said to be removed at rates of 92% to 99% by wastewater treatment methods (23). However, new research presented at a SCCWRP/SWRCB 2010 meeting[27] suggests detrimental effects of nonylphenol buildup in marine life, with a wide range of sea animals exhibiting cancerous symptoms (tumors) over a wide area associated with septic system and wastewater discharge. As is the case with steroids, hormones and polybrominated diphenyl ethers (PBDEs)–which include flame retardants and plastics–APEs are hydrophobic, facilitating their removal through secondary treatment, but there is concern about the possibility of their buildup in the biosolids that are a byproduct of wastewater treatment (24).

Bisphenol A (BPA)
This is an organic, estrogenic compound used in the manufacture of polycarbonate plastic items such as eyeglass lenses, medical equipment, water bottles, CDs, DVDs, and many other consumer products, including paper. At least one study has shown that toilet paper is contaminated with BPA (and APEs) and is a source of this compound in wastewater (25).

The treatment of BPAs is the same as for APEs and PBDEs where the use of certain types of bacteria in secondary treatment has been found to biodegrade and remove BPA from wastewater (25).

Polybrominated Diphenyl Ethers (PBDEs)
These constituents of flame retardants are found in furniture foam, plastics for TV cabinets, consumer electronics, wire insulation, personal computers, small appliances, and clothes. PBDEs are related to PCBs and are a subcategory of brominated fire retardants (BFRs). Bromophenyl phenyl ether, manufactured as DecaPBDE, PentaPBDE, OctaPBDE, etc., is on the U.S. EPA's Priority Chemicals list (26).

The U.S. EPA's 2006 PBDE Project Plan notes that PBDEs are "...widely distributed in the environment and are present at increasing levels in people." The Project Plan also states that, "In recent years, scientists have measured PBDEs in human adipose tissues, serum and breast milk, fish, birds, marine mammals, sediments, sludge, house dust, indoor and outdoor air, and supermarket foods" and includes an account of the discovery of these compounds in San Francisco Bay area sewage effluent and sludge (27). A "Review of Available Scientific Research" by the Illinois EPA Toxicity Assessment Unit cites a study that found decaBDE "in glaucous gulls and polar bears from the Arctic" (28).[28] A 2008 study published in *Environmental Science & Technology* reports that, since the discovery of PBDEs in the environment in 1979, levels have soared, with the highest levels in the country of these chemicals now found in California residents (29) (30).

Two of the commercial forms of PBDEs, PentaBDE and OctaBDE, were withdrawn from the European market in 1998 (31). After the discovery of PBDEs in breast milk, the U.S. followed suit in 2004 (32). California became, in 2003, the first state to ban the two forms of PBDEs by 2008 (33). Production was scheduled to halt because PBDE has "...increased fortyfold in human breast milk since the 1970s" and holds the potential to contribute to low intelligence and learning disabilities (34). In 2008, the European Union restored Deca-BDE to its Registration, Evaluation, Authorisation and Restriction of Chemical substances (REACH) list[29] to be phased out, although it can be used without restriction in the meantime (31) (35). California began to phase out DecaPBDE in December 2009, with the use of DecaPBDE scheduled to end by 2013. Steve Owens, an assistant administrator at the U.S. EPA said that "studies have shown that DecaBDE persists in the environment, potentially causes cancer and may impact brain function...[and that] DecaBDE also can degrade to more toxic chemicals that are frequently found in the environment and are hazardous to wildlife" (36).

Studies reviewed by the EPA Unit in Illinois show that diet is the major route for human exposure to PBDEs, although a 2004 report by the Environmental Working Group, a non-profit research organization based in Washington, D.C., calculates that dust is a more potent route for children (37). Research reviewed by the Illinois Unit also found "high concentrations of decaBDE in municipal sewage sludge and [that] workers in sludge-related activities are potentially

27 Constituents of Emerging Concern Coastal & Marine Ecosystems Science Advisory Panel Meeting, January 12, 2010, Costa Mesa, California (www.sccwrp.org/view.php?id=574).

28 The Review also notes that PBDE levels have been found to be much higher in farm-raised salmon than in wild salmon. The difference is thought to stem from the diet of farmed salmon, which consists of concentrated feed high in fish oil and fishmeal from small open-ocean fish.

29 The EU REACH list was brought into law in 2007.

exposed to very high concentrations, primarily through inhalation" (28). Research at treatment plants in Tucson, Arizona, and Palo Alto, California, for example, shows that the resistance of PBDEs to wastewater treatment can lead to their accumulation in sediments where wastewater is discharged and in soils where biosolids are added (38) (39).

Steroids and Hormones

Steroids and hormones are naturally occurring and related synthetic copies of chemicals that serve as messengers between cells. "Many of the responses to hormone signals can be described as serving to regulate metabolic activity of an organ or tissue. Hormones also control the reproductive cycle of virtually all multicellular organisms" (40). Many hormones, body constituents, and drugs are steroids. Cholesterol is an example, the word "steroid" being derived from "sterol" (41). The category of steroids and hormones is included by many sources as a subset of Pharmaceuticals and Personal Care Products (PPCPs) since some originate in pharmaceutical products. Phthalates belong to this category and are included on the EPA's list of chemicals for priority review.

Several steroids and hormones come from sources such as dairy wastewater, aquaculture, and spawning fish (42). Endocrine disrupting compounds (EDCs) are substances that interfere with the normal functions of steroids and hormones. Steroids and hormones can themselves be EDCs. Studies have found that tiny amounts of biologically active natural and synthetic steroid estrogen hormones that survive sewage treatment, including the active ingredient of the contraceptive pill and naturally occurring female hormones, can disrupt the physiology of wild fish (43). The Office of Environmental Health Hazard Assessment of the California EPA has included butyl benzyl phthalate (BBP), di-n-butyl phthalate (DBP), and di-n-hexyl phthalate (DnHP) on the Proposition 65 list of chemicals known to cause reproductive toxicity (44). This listing, in compliance with the Safe Drinking Water and Toxic Enforcement Act of 1986, shows that phthalates fall into the category of endocrine disrupting compounds.

A British 2004-2005 study shows that conventional wastewater treatment does not completely remove EDCs; as a result these compounds can seep through river sediments and from there potentially into groundwater. This finding raises concern because, as pointed out by the authors of the study, it is less likely for these compounds to be neutralized by attaching to suspended solids (45).

Scientists from SCCWRP are investigating whether wastewater effluent or natural factors are the cause of unusual hormone levels in certain species of fish off the coast of California. A 2009 *Environmental Science & Technology* article summarizes: "With very few differences between the contaminated sites and the control site, [the] widespread pattern of odd endocrine levels could mean that the contamination is much more pervasive than scientists thought, or it could mean that these hormone levels are normal" (46). While the answer to this question is being determined, it is unknown whether regulatory changes affecting water reclamation will take a precautionary approach on suspect pollutants in order to avoid potential risk.

More research from the United Kingdom reviews how advanced technologies, such as activated carbon adsorption, ozonation, advanced oxidation processes, and nanofiltration/reverse osmosis, remove potential EDCs. However, the cost of these wastewater treatment methods and the scale of infrastructure and manpower needed to operate them, have led research engineers to experiment with supported biofilms in aeration tanks, taking note of by-product and additive issues (47). This alternative technology echoes the same approach of applying extended secondary treatment (longer holding times) to PBDEs and APEs for higher levels of removal, with the same cautions relating to byproducts and contaminant buildup in biosolids.

Pharmaceuticals and Personal Care Products (PPCPs)

PPCPs are a range of prescribed and over-the counter pharmaceuticals, and personal care products used for health or cosmetic purposes. The U.S. EPA considers "any product used by individuals for personal health or cosmetic reasons or used by agribusiness to enhance growth or health of livestock" to be a PPCP (48). Other examples include blood pressure, cholesterol and antidepressant medications, over-the-counter drugs, caffeine, detergents and soaps, lotions and cosmetics.

Excretion of medications from the body, the rinsing of cosmetics and soaps, and the disposal of prescription drugs through domestic plumbing are ways in which PPCPs enter sewage systems where a possibility may exist of onward transport to water bodies if they are not removed by treatment. Varying levels of PPCPs from point and non-point sources alike have been detected in measurable quantities in water bodies, both in the saline waters of oceans and the fresh waters of rivers, lakes, and groundwater aquifers (49) (50). It is unclear, though, at what levels these contaminants lead to manifested toxic events (51).

Among PPCPs, triclosan is a widely used nonprescription antibacterial/antimicrobial compound that illustrates how a single compound in the wastewater stream can have many sources. Triclosan is found in anti-gum disease toothpaste, deodorant soaps, deodorants, antiperspirants, body washes, detergents, dishwashing liquids, cosmetics, antimicrobial creams, lotions, and hand soaps, and is also used as an additive in plastics, polymers, and textiles to give these materials antibacterial properties (53). It also serves as an example of a PPCP coming under increasing scrutiny and monitoring by the EPA (54). The call in August 2009 by the Canadian Medical Association to the Canadian Government to ban all antibacterial household products (55) reflects the growing concern over the potential of such products to cause bacterial resistance.

Triclosan also serves as an example of a chemical of potential risk with many and varied fates. In 2002, a Swedish study published in *Chemosphere* found, "High levels of...Triclosan...in three out of five randomly selected human milk samples. It was also found in the bile of fish exposed to municipal wastewater and in wild living fish [exposed to] the receiving waters of the three wastewater treatment plants" (56). A 2003-2004 study for the U.S. Centers for Disease Control and Prevention detected triclosan in 74.6% of 2,517 urine samples. Exposure was thought to stem from use of consumer products that contain triclosan. The same study cites research showing that the chemical affects hormonal processes in frogs and rats but does not cause acute toxicity in humans (57). A risk assessment published in 2007 in Food and Chemical Toxicology concluded that, "... there is no evidence to indicate that the presence of a miniscule amount of triclosan in breast milk presents a risk to babies" (58). This range of findings shows the prevalence of triclosan in the environment, with known and unknown effects and risks for different species, but demonstrates the difficulty of determining if the substance should be regulated. The same problem applies to other PPCPs.

A study published in 2008 by the Washington Department of Ecology is an example of research into the fate and transport of PPCPs in relation to wastewater treatment. The researchers investigated "the potential for and status of PPCP contamination of area waters from application of tertiary treated wastewater via reuse programs and conventional land application" (50). The scientists conducted a screening analysis for 24 PPCPs in tertiary wastewater treatment plant effluents and nearby wells and creeks in the Sequim-Dungeness area of northwest Washington State. Sixteen compounds were detected in effluent: acetaminophen, caffeine, carbamazepine, cimetidine, codeine, cotinine, diltiazem, hydrocodone, ketoprofen, metformin, nicotine, paraxanthine, salbutamol, sulfamethoxazole, trimethoprim, and estrone. The study found that, "Only Caffeine, Nicotine, and the diabetes drug Metformin (tentatively identified) were consistently detected in the well and creek samples; concentrations were less than 25 ug/L."

The researchers concluded that, "These limited results give no indication that PPCPs represent a significant concern in the wells or creeks sampled." While the scientists considered additional monitoring for PPCPs to be a low priority for the two treatment plants involved, these results nevertheless show that tertiary-treated effluent can contain some PPCPs. However, the fact that most of the same PPCPs became undetectable in the downstream samples may provide evidence for the effectiveness of tertiary treatment in preventing PPCPs from reaching harmful levels in discharges.

The results of a national pilot study in the U.S. published in 2009 by the Society of Environmental Toxicology and Chemistry assessed "the accumulation of PPCPs in fish sampled from five effluent-dominated rivers that receive direct discharge from wastewater treatment facilities." The results show that better CEC-removal efficiency is achieved by advanced treatment. "Fish tissue analyses from the two sampling sites receiving more advanced treatment...showed lower overall concentrations of PPCPs, fewer compounds detected, and lower frequency of detection compared to the other three sampling sites... which employed less advanced treatment" (59). Modeling produced for the 2006 U.S. EPA's *Final Report on Occurrence and Fate in Drinking Water, Sewage Treatment Facilities, and Coastal Waters* by the National Center for Environmental Research (NCER) led to the conclusion that longer solids retention times should increase the removal of pharmaceuticals and antiseptics–a finding similar to those of studies investigating APEs as cited above (60).

The NCER findings on pharmaceuticals and antiseptics add to research that shows that removal and neutralization of PPCPs in influent is accomplished by biodegradation and biotransformation. A 2003-2004 British study of the removal specifically of triclosan by three different types of wastewater treatment works found that removal ranged from 58 to 96% using rotating biological contactors, 86 to 97% using trickling filters, and 95 to 98% through longer retention times in activated sludge (52). These results align with the U.S. EPA's review of studies of the fate and transport of triclosan, and its finding that, "the majority of published studies on the occurrence of triclosan in wastewater treatment plants, treatment plant efficiency, and open water measurements of triclosan suggest that aerobic biodegradation is one of the major and most efficient biodegradation pathways" (54). In 2009, the international journal *Environmental Pollution* published an assessment of removal efficiency indicating activated sludge with nitrogen treatment and membrane bioreactor achieves the most effective removal. Longer retention times during the activated sludge and membrane bioreactor phases of wastewater treatment allow for increased breakdown of PPCP organic compounds, resulting in large reductions in

PPCP concentrations in plant effluent (61) (62). Results of a Welsh study of the fate of PPCPs published in 2009 found that, "the [wastewater treatment plant] utilizing trickling filter beds resulted in, on average, less than 70% removal of all 55 PPCPs studied, while the WWTP utilizing activated sludge treatment gave a much higher removal efficiency of over 85%" (63).

Perfluorinated Compounds (PFCs)
A group of chemicals containing fluorine, PFCs are used to make household products and industrial materials stain resistant and non-stick. A 2009 review of PFCs by the Global Health & Safety Initiative (GH&SI), a collaboration of U.S. health care insurance providers, hospitals and non-governmental organizations, notes that PFCs are also used in food packaging, paints and lubricants. Products such as Teflon®, Stainmaster®, Scotchgard™, and NanoTex™ contain PFCs (13).

The GH&SI review summarizes how PFCs are highly persistent compounds that accumulate in the tissues of living organisms, including humans. The review found that PFC exposure is "nearly ubiquitous" and that PFCs can cross the placenta, "…directly exposing the developing fetus." According to the GH&SI, the existing data on toxicity of PFCs so far relates mainly to animal studies and tends to focus on two common PFC compounds–perfluorooctane sulfonate (PFOS), which is still used in fire-fighting foams and various surfactants because no alternatives are available, and perfluorooctanoic acid (PFOA), which is used in the manufacture of substances that provide non-stick surfaces on cookware as well as waterproof and breathable membranes for clothing. PFOS was added in May 2009 to the list of contaminants identified by the Stockholm Convention on Persistent Organic Pollutants (POPS) (16), and PFOS and PFOA are included on the U.S. EPA's CCL3 list.

A 2007 study by Stanford University researchers and the Santa Clara Valley Water District investigates perfluorochemicals in water reuse. The study focuses on PFOS and PFOA and their presence in wastewater effluent, particularly of three California treatment plants employing tertiary treatment, as well as their presence in ground and surface waters where the effluents are discharged (64). The study outlines the tertiary processes as follows: 1) dual media filtration and chlorination, followed by polymer treatment and repeated filtration for reclaimed wastewater; 2) dual media filtration and chloramination, followed by additional chloramination for reclaimed wastewater; 3) dual media filtration and chlorination; and 4) fixed growth reactor (ammonia removal), flocculation, dual media filtration, and chlorination, followed by additional flocculation, dual media filtration, and chlorination for reclaimed wastewater. PFCs were found "…to persist beyond the tertiary treatment steps…at concentrations [that] are consistent with reports for other municipal wastewaters which vary between plants."

Despite the persistence of these compounds beyond wastewater treatment, the researchers conclude, "Compared to the global perfluorochemical burden from sources such as wastewater discharge and rain, water recycling plays only a limited role." The authors indicate that nanofiltration and reverse osmosis tertiary treatment remove PFCs, although the filtered contaminants still remain intact in a post-treatment brine stream. To stop the flow of PFCs to the environment through the wastewater stream, the only apparent method is incorporation of disposal methods that completely avoid discharge into waters, including the ocean. Because, as the GH&SI review states, "Studies of the persistence of PFOS, for example, show that under *no conditions* does the chemical show any evidence of breaking down in the environment" (13), the logical precautionary approach would be a ban on the manufacture of PFOS.

Wastewater Treatment to Control CECs

Given the research available, improvements that optimize secondary biodegradation processes may prove to be the most cost-efficient and accessible way for wastewater treatment plants to increase the removal and neutralization of many CECs. Although research needs to continue on the subject of safe reuse of recycled water for agricultural irrigation, park facility application, public facility sanitation, industrial and commercial uses, several researchers find that extending secondary treatment can make a significant step towards this goal. The 2009 survey published in Environmental Pollution points out "activated sludge with nitrogen treatment and membrane bioreactors" as the most efficient process (61). Improvements to secondary treatment remove a high percentage of CECs, but thorough biological processing over long retention times is necessary to ensure that CECs do not accumulate in the resulting biosolids. Ternes et al find that many wastewater treatment plants in the U.S. and the EU do not operate with solid retention times long enough to achieve the necessary biological decomposition. Their report recommends that medium-sized and larger sewage plants upgrade to "a sludge age of 12–15 days by nitrification combined with denitrification" (62). Activated sludge operations and membrane bioreactors are relatively easy to incorporate and are compatible with the retrofitting of existing infrastructure. These methods do not create additional treatment side streams, and allow for the neutralization of many bioactive compounds without requiring including separate holding tanks and diversion infrastructure.

Advanced secondary treatment methods, optimized to treat influent content, also help to ensure the efficiency of tertiary treatment that follows, since the breakdown of CECs decreases the toxic load that goes on to more advanced processing (62). Higher levels of secondary treatment add the benefit also of a lesser amount of toxic residue after tertiary filtration.

However, these kinds of assessments of the effectiveness of treatment contrast with the findings of a wide-ranging review of treatment methods for pharmaceuticals. The review, published in 2009 in the Journal of Environmental Management, describes how advanced technologies all have shortcomings, which include: the effect on efficiency of the type of compound; undesirable changes to compounds caused by treatment; minimal improvement in elimination rates as a result of increased retention time; possible increase in antibiotic resistance as a result of treatment with bio-membrane reactors; high carbon dioxide emissions as a result of increased energy demands to operate advanced technologies; and unsustainability because they do not tackle the origin of the chemicals and are too expensive for many countries (65). The review describes how a life cycle assessment of three treatment processes to discover when the removal of micro-pollutants and reduction in toxicity would outweigh the increased resource- and energy consumption. The research found advanced treatment can induce more environmental impact than it removes. Unlike ozonization and membrane bioreactors, sand filtration was the only method found to have net benefits.

As a 2009 review for the journal Clean states, PPCPs and endocrine disrupting compounds, "are not completely removed in treatment plants" (66). The point that removal efficiencies depend on the chemistry of the compound being treated is also echoed. Nevertheless, the Clean review finds that, "Advanced posttreatment units (ozone, AOPs, activated carbon, membranes) may constitute reliable options for the removal of EDCs/PPCPs" However, techniques that are filtration-based *also generate a high-concentration pollution residual that is discarded in treated effluent if the pollutants are unregulated.* Such pollutants can remain in their raw form, and ideally should be subject to further biodeactivation treatment and careful disposal. Advanced treatment may maximize CEC removal, providing high-quality reclaimed water for agricultural irrigation, urban and industrial use, and even groundwater recharge, but its financial and energy costs are high. Many passes may be needed through the treatment process,[30] and typical disposal methods following treatment do not remove CECs from the waste stream.

30 Information from correspondence with treatment plant operators.

CECs and the Call for Analytical Methods, Research, and Water Quality Criteria

Wastewater treatment professionals face continual funding demands that only increase with new regulatory requirements and water recycling targets. These professionals will surely be the first to echo the U.S. EPA's Essential Principles for Reform of Chemicals Management Legislation. The U.S. EPA provides the principles in order to "help inform efforts underway in this Congress to reauthorize and significantly strengthen the effectiveness of the [Toxic Substances Control Act]. These Principles present Administration goals for updated legislation that will give U.S. EPA the mechanisms and authorities to expeditiously target chemicals of concern and promptly assess and regulate new and existing chemicals" (11). Action on the U.S. EPA's principles is needed to manage, or eliminate, the chemicals that flow daily into wastewater treatment plants and from there, into surface waters or the ocean. But action must be based on sound scientific research on substances whose rate of increase has so far greatly outstripped our understanding of their fate, transport, and consequences.

The need for the authors of the U.S. EPA's *Treatment Works* study to develop three analytical methods to detect the occurrence of CECs in wastewater illustrates the inadequacy of CEC analysis tools (12). The lack of CEC-analysis technologies as discussed in the study could alone justify a new U.S. EPA essential principle to set in place sustained funding for research to guide reform of chemicals management legislation. Changing environmental conditions, including ocean acidification, combined with an ever increasing chemical load, have raised the level of urgency for action on EPA's first new principle as set out under its pollution prevention strategy: "Chemicals should be reviewed against safety standards that are based on sound science and reflect risk-based criteria protective of human health and the environment" (11).

Hepatitis A is an example of a microbial CEC for which reliable and financially feasible monitoring methods are needed. A study published in 2006 in Water Science and Technology revealed that reclaimed water used to irrigate two golf courses in Spain and Portugal included somatic *E. coli* bacteriophages, enteric viruses (*entero-, hepatitis A* and *rota-*) and *Legionella pneumophila*. The study concluded that the wastewater treatment processes produced an adequate reduction in the number of indicator microorganisms. However, "...a significant correlation between pathogenic and indicator microorganisms tested was not found" (67). This lack of correlation between indicator and pathogenic microbes provides more evidence of the need for research to improve monitoring and testing protocols to ensure that wastewater treatment removes pathogens that may presently survive undetected through a range of processes.[31]

In July 2007, a Special Project of the State/EPA Water Quality Standards Workgroup began a survey on the issue of "emerging contaminants" (68). The survey was distributed to the Ambient Water Quality Standard (AWQS) contacts in all 52 states within the U.S. The results of the survey were published in 2008 and include a summary of responses elicited from 37 states as well as from interstate organizations in 27 states. Asked whether their state/organization defined "emerging chemicals," 13.5% responded "yes," 10.8% responded, "don't know, and 75.7% of the states answered, "no." Contacts were also asked about the level of interest of their state or organization in emerging chemicals, regulatory activities concerning these chemicals, and also about for near-term (1-year) and longer term (5-year) priorities to further develop a coherent "emerging chemicals program" in water quality regulation. Out of 37 responses, "only six indicated that their agencies already factored emerging chemicals into their programs." The proportion of agencies "interested enough to investigate ways to incorporate emerging chemicals into their agencies' programs" came to 62%. Another six agencies were "very interested, but not ready to implement" for the following reasons: "[1] Lack of national ambient water quality criteria; [2] Lack of state resources to develop and adopt standards; [3] Analytical methodologies are still in development; [4] [State] laboratories do not have necessary analytical capability; [5] Funds are insufficient to contract outside laboratories; [6] Toxicological research is still inadequate; [7] Acute and/or chronic aquatic life database still in development." Clearly, the need for research, new standards and for funding and administrative support regarding CECs and wastewater extends nationally.

The Water Quality Standards Workgroup survey also shows that considerable CEC research occurs in California and involves much collaboration, for instance, by the SWRCB with SCCWRP, and the Central Valley regional board with the University of California, Davis, and the U.S. EPA. Taking a lead role on the CEC issue, SCCWRP has convened two information-gathering panels at its headquarters in Costa Mesa, California: the SWRCB Advisory Panel on CECs in Recycled Water and the Advisory Panel for CECs in Coastal and Marine Ecosystems (69). The goal of these public sessions is to share and examine information about CECs for the purpose of developing a State policy for identifying the contaminants that should be monitored.

Increased monitoring and specialized treatment to remove CECs could help ensure reclaimed water quality reaches standards needed for safe reuse. However, present water shortages as seen, for instance, in Los Angeles and the San Joaquin Valley, combined with California's increasing population (70), could push water reclamation and recycling ahead of science, technology, and the establishment of new standards. Maximizing the potential to reclaim water from wastewater treatment plants is fast becoming a necessity. More action on the call made by the State's Recycled Water Task Force in 2003 for funding of research on recycled water issues has become urgent.

Four Advanced Treatment Offset Approaches

The cost of producing recycled or reclaimed water has in many cases inhibited wastewater treatment plants from moving forward with new technologies. One of the biggest problems in meeting technology improvement costs has been the resistance of ratepayers to rate increases, even though wastewater treatment rates are very low relative to fees for other household utilities (e.g., gas, electricity, cable). Researchers continue to investigate ways to reduce the cost of treatment plant processes both for desalination and the removal of CECs, processes that are expensive in terms of both equipment and energy costs. Related research on desalination covers topics such as membrane types, energy efficiency, and pretreatment, including methods such as enzyme enhancement (1). Factors affecting the cost of treatment to reduce or eliminate salinity include the type of technology used, the salinity level of feed water, the salinity level of product water, available energy sources, and the short and medium term demand for recycled water (2).[32] Whichever technology is used, desalination is a costly process.

Cogeneration

Many wastewater treatment plants use processes that allow for cogeneration–the simultaneous production of power/electricity, hot water, and/or steam from one fuel (3). Methane, a "biogas," is a typical plant biomass fuel, one produced in wastewater treatment facilities with anaerobic digesters. Bacteria in the digesters break down biosolids in sewage. Combustion of the resulting methane creates energy and also cuts emissions of this powerful greenhouse gas, which some plants flare off (4). Combined cycle power plants can be energy self-sufficient, as demonstrated by

31 Studies, however, such as Occupational Medicine's 2009 short report, "*Wastewater workers and hepatitis A virus infection*," provide some reassurance, for the research contributing to the report found that "...working in a wastewater treatment plant does not seem to be related to a greater prevalence of antibodies to hepatitis A. Moreover, the relative risk of HAV infection among (wastewater workers) seems to be correlated with low anti-HAV(+) prevalence in the general population" (16).

32 According to the above mentioned experts' report to the FAO, various recovery devices "can reduce energy requirements by as much as 50%." In addition, "Larger plant size... contributes to the economy of scale that is significant between a plant producing 1,000 m3/d and that producing 40,000 m3/d, where the capital cost per cubic metre of water can decrease by a factor of 2.5. However, RO plant sizes larger than 40 000 m3/d will not have any further considerable effect on cost reduction" (ftp://ftp.fao.org/agl/aglw/docs/lwdp5_e.pdf)

the Joint Water Pollution Control Plant in Los Angeles (JWPCP). JWPCP uses digester gas (mainly methane), to generate electricity and produce surplus energy that is sold back to a utility company. Installation of co-generation systems that are simultaneous with upgrades to achieve desalination may help, over time, to offset the costs of the upgrades.

Alternative Energy Generation
New site construction and, potentially, upgrades and improvements can provide opportunities not only for cogeneration, but also for use of plant facilities and/or space for the installation of energy-generating technologies such as solar power. Two wastewater treatment plants in California have installed solar photovoltaic (PV) systems: the Las Gallinas Valley wastewater treatment facility in the San Rafael, California area, and the San Joaquin water treatment plant, inland from Monterey, California (6).

The San Joaquin wastewater treatment plant formed an electricity-producing facility in 2005. With electricity costing about $400,000 annually, the District installed a solar project on property adjacent to the plant, in order to generate electricity for itself and to sell the excess into the Pacific Gas and Electric (PG&E) system. With incentives worth $6 million from the California Solar Initiative Program, it has been estimated that it will take 15 years for the long-term payback on the capital expenditure for the solar project.

The California Solar Initiative Program also contributed incentives in relation to the installation at the Las Gallinas Valley wastewater treatment plant. Near the shores of San Pablo Bay, the Las Gallinas plant sited a solar PV system in 2006 on a foundation of manmade bay-fill. The wastewater plant reports power production of over 1 GWh annually, "...meeting and exceeding the contract's levels" and saving $156,000 in its first year of operation. By November 2008, this wastewater treatment plant was meeting 100% of the facility's power needs.

Energy Efficiency
Both the San Joaquin and Las Gallinas districts contracted expert energy usage analysis with the aim of designing "... the smallest [PV] system with the largest rate of return." Several proposals were submitted to the districts for systems that would have supplied 100% of both plants' power needs. The Las Gallinas energy audit revealed, however, that the plants' energy use could be reduced by applying certain efficiency measures. A proposal was accepted that incorporated these measures and, as a result, required a smaller PV system than specified in proposals based on the plant's original energy needs. Following installation, the plants achieved a fifty percent cut in electricity use and a net savings on the project of $175,000. Energy audits of treatment plants throughout California would show where savings could be achieved, savings that could be applied to plant improvements and upgrades.

Public-Private Partnerships
In some cases, public-private partnerships can make plant improvements feasible. Since 1994 the privately-owned Pebble Beach Company (PBC) in California's Central Coast region has been the fiscal sponsor of modifications to the Carmel Area Wastewater Treatment Plant, working in partnership with the Carmel Area Wastewater District (CAWD), Pebble Beach Community Services District (PBCSD), and the Monterey Peninsula Water Management District (7). CAWD and the PBCSD own and operate the wastewater plant while PBC guarantees repayment of "certificates of participation" and pays annual operating expenses over and above the revenues derived from reclaimed water sales.

The Carmel plant produces about 800 AF of reclaimed wastewater annually [0.7 million gallons daily], "...which is used to irrigate the Pebble Beach golf courses and other recreational areas. This supply is replacing an equivalent quantity of potable water that was previously applied to these grassy areas." The other important result of using the high-quality effluent in this way is that "about 700,000 gallons of secondary effluent does not get discharged to Carmel Bay every day."
The Pebble Beach model may be applicable at other locations in California and serves as an example of a financial means to reduce CEC pollution in California as well as help realize the State's reclaimed water potential. The *Sacramento Bee* newspaper reported on a more recent example of a successful public-private partnership, with the March 2009 adoption by the Sacramento Regional County Sanitation District of, "a strategy to partner with buyers to recycle wastewater from the State Capitol's 1.4 million residents into a new municipal water source" (8). Similar opportunities may exist elsewhere in the State of California.

Water Reclamation: Conclusion

While the Water Recycling 2030 report summarizes key issues identified by the California Recycled Water Task Force and makes recommendations to increase water recycling (9), environmental and scientific findings in the years since the Task Force's report have led the National Water Research Institute (NWRI) to call in June 2009 for a re-prioritization of the report's recommendations. NWRI recommends an emphasis on communication with the public, followed by state leadership and advocacy, regulatory consistency, funding, and public support (10).

Heal the Ocean concurs based on its research for the *Report and Inventory,* and makes specific recommendations that fall under the following

- Public education and promotion of water reuse
- Research and technology development
- Updated and streamlined regulations
- Improved water quality treatment
- Financing

A concerted, concentrated effort is needed to address the problems of salinity and CECs in reclaimed water. Both issues present serious challenges to water reclamation and its benefits. While work is underway to find solutions, and while the health and environmental effects of CECs remain uncertain, the most cost-effective and immediately accessible wastewater treatment processes should be applied as soon as possible in order to reclaim water for basic uses such as irrigation and habitat preservation. New plans for treatment to remove salt and other contaminants for water reuse must include plans for the disposal of residual contaminants and should not include the method of ocean discharge. Contaminants that cannot be removed at reasonable cost by wastewater treatment need to be eliminated at source to prevent them entering the wastewater stream. Bans should be considered for CECs that are found to pose high risks.

Given that efforts to reclaim treated wastewater are increasing worldwide, opportunities exist for international exchange of both research and information emerging from cutting edge pilot projects that use potentially cheaper technologies and engineering. Ongoing collaborative efforts to examine and improve the control of toxic pollutants in California waters include those of the Bay Delta Conservation Plan, the Recycled Water Policy Science Advisory Panel, and the Advisory Panel for CECs in Coastal and Marine Ecosystems (11). In addition, many integrated regional water management plans now in process around the State are already proving to be effective in promoting pilot projects, research partnerships, and stakeholder involvement.

The reclamation of wastewater necessitates the building of appropriate infrastructure, including dual plumbing, to maximize wastewater capture, storage, and delivery. While implementation costs may be high, public-private partnerships, and energy efficiency, co-generation, and generation schemes can offer solutions for overcoming financial difficulties.

Source control needs to take priority as the most effective and economic method of preventing water pollution. Funding should be provided for sustained public education and pre-treatment. Wastewater treatment plants are nder siege from an ever-growing list of chemicals that plants are not typically designed to treat. Strong pre-treatment measures would help to combat the high costs of wastewater treatment by lessening the contaminant load in influent.

Publicly owned treatment works are designed mainly to process domestic wastewater. However, many facilities also receive wastewater from industrial or commercial sources. Regulations, and monitoring and inspection regimes for industrial wastewater are implemented by the local sanitary districts. Industrial wastewater is defined by the sanitation districts of Los Angeles County as, "all wastewater from any manufacturing, processing, institutional, commercial, or agricultural operation, or any operation where the wastewater discharged includes significant quantities of waste of non-human origin."[33] Sources employing particular industrial processes and/or discharging high volumes of wastewater are required to obtain a permit to discharge to the municipal sewer system, but local limits on discharge constituents apply to all industrial discharges. Recognizing the positive effects of source control, some districts such as the Montecito Sanitary District in Santa Barbara County, already provide pre-treatment assistance beyond any official program. Greatly expanded funding for source control programs could help districts and treatment plants significantly reduce the pollutant load reaching wastewater facilities and therefore increase the potential to reclaim water.

Water reclamation is currently undermined by outdated water quality standards, lack of demand, and outdated regulations for reuse. Public education is crucial to increase conservation, demand for reclaimed water, and to support relevant government action. All public education programs should focus on:

- the crucial role of the wastewater treatment plant in maintaining public and environmental health
- the urgent need for water conservation and the potential for safe water reclamation by wastewater treatment plants
- the need to support regulatory changes to facilitate reclamation
- the need for funding from sources, such as environmentally sustainable State bond measures and ratepayer increases, to pay for the increasingly demanding tasks of the wastewater treatment plant

Coordinated public education statewide would support the work of individual authorities to increase water

33 See 1) U.S. EPA web page: Pretreatment of Wastewater (Industrial Users) Compliance Monitoring http://www.epa.gov/compliance/monitoring/programs/cwa/wastewater.html
2) SWRCB NPDES Pretreatment Program: http://www.waterboards.ca.gov/water_issues/programs/npdes/pretreat.shtml
3) Sanitation Districts of Los Angeles County website: About the Industrial Waste Section http://www.lacsd.org/info/industrial_waste/default.asp

reclamation, enabling the replication of effective local campaigns such as the citywide program begun in 2008 by the Los Angeles Department of Water and Power (LADWP) that presents a dialogue with the public through its website. The LADWP cites this program as the start "of a multi-year outreach campaign to inform the public and raise awareness about the need for recycled water and groundwater replenishment to create a locally sustainable water supply in Los Angeles." A statewide campaign tailored to local needs and circumstances could ensure consistency of information and presentation, and add greater weight and urgency to local public education efforts.

A concerted effort should be made to bring consistency to the State regulations for reuse of reclaimed water. The State's Recycled Water Policy, effective from May 2009, and the proposal for a statewide dual plumbing code, indicate that California is beginning to move in the direction of achieving a more unified policy for water reclamation.

The case for reclaimed water in California is clear. The U.S. Geological Survey figures for water use in the year 2000 revealed that California accounted for "almost 11 percent of all freshwater used in the United States." California also consumes 22% of all the water used for irrigation in the U.S., making it the largest user in this category.(see Table 2.1) Replacement of potable flows with reclaimed water for irrigation alone could provide a considerable boost to the public drinking water supply in California.

Irrigation	Thermo-electric power	Public supply	Industry	Domestic (self-supplied)	Mining	Livestock, aquaculture
40 %	39 %	13 %	5 %	1 %	1%	less than 1 %

Table 2.1. Water uses in California in 2000 by percentage. Source: U.S. Geological Survey

It may not be long before the environmental stresses on California's water supply make reclaimed water an unquestioned, everyday reality for the general population, but an effective, coordinated communications campaign is needed. Meanwhile, it is a hopeful sign that the State has begun to invest in policy, research, and public funding of infrastructure and treatment upgrades to tackle the challenges of salinity and CECs. Contaminant removal and desalination, along with more storage capacity and delivery infrastructure, will increase water reclamation in California. Together with comprehensive new water quality standards, updated reuse regulation, and consistent, statewide public education, the statewide investment in wastewater treatment and water reclamation will help California combat its present and predicted water shortage. The most welcome side benefit of a concerted drive for reclaimed water in California will be a significantly reduced pollutant load on the Pacific Ocean.

Summary of Heal the Ocean Recommendations on Water Reclamation and Reuse

Public education and promotion of water reuse: The public should be engaged in an active dialogue in developing new regulations and planning water recycling projects. Curricula need to be developed for public schools and institutions of higher education addressing water reuse issues. Public service announcements and relevant agency media bulletins and websites should highlight water recycling.

Research and technology development: The State should expand funding sources to include increased and sustained funding for research on the full range of recycled water issues. *Updated and streamlined regulations:* State government should take a leadership role in improving consistency of policy within branches of State government. This should extend to regulations for indirect potable reuse to ensure adequate health and safety assurance for California residents. Regulation must be able to accommodate revised ambient water quality standards as research findings on CECs become clearer. A framework is also necessary for uniform regulations and revisions to be made to building and plumbing codes at local levels. Additionally, less burdensome regulatory mechanisms affecting incidental runoff of recycled water from use sites need to be implemented.

Improved water quality treatment and pollution prevention: Source control programs should be expanded and implemented in a wide-reaching campaign targeting and quickly engaging industrial wastewater dischargers and the general public for the long term. Local governments should have the ability to impose bans on, or require more stringent standards for, residential water softeners. Wastewater treatment plant improvements and upgrades should be at the most advanced level feasible and designed to efficiently accommodate enhanced treatment and increased water reuse in the future.

Financing: State funding for water reuse/recycling facilities and infrastructure should be increased beyond Propositions 50 and 84, and other current sources. A reliable and predictable funding procedure should be developed to provide local agencies with assistance through State and federal funding opportunities. State funding agencies should make better use of existing regional planning studies to determine the funding priority of projects. Funding sources should be expanded to include sustainable State funding for technical assistance and research, including flexibility to work on local and regional planning, emerging issues, and new technology.

Reclaimed Water – a Worldwide Effort

The need for increased water supplies worldwide has spurred a global campaign for recycled water, a campaign that is motivating improved wastewater treatment in many countries. A Queensland (Australia) Water Commission publication, *Fact Sheet* on *Purified Recycled Water*, states that the Commission's process for indirect re-use "…will be the world's best practice, underpinned by state-of-the-art technology, similar to that used in Singapore and Orange County." The *Fact Sheet* provides a useful guide to many technologies and operations in use by various wastewater plants around the world. The examples also show that California boasts at least one treatment plant known internationally for its water reclamation achievements (12).

Groundwater Reclamation Plant (GWR), Orange County (California). This facility is one of three U.S. examples of six summarized in the Queensland *Fact Sheet*. Treatment involves a dual membrane microfiltration process, reverse osmosis and advanced oxidation, yielding 70 million gallons daily of reclaimed, "near-distilled quality" water. The GWR website explains how the system received approval in 2008 "…to inject about half of the purified sewer water from the GWR System into OCWD's [Orange County Water District's] seawater intrusion barrier." On January 18, 2008, OCWD won final approval to allow for the release of the other half of the water to OCWD's groundwater spreading basins in Anaheim, and from there to be conveyed for indirect potable re-use.

Upper Occoquan, Northern Virginia. This treatment plant uses no membrane processes, but instead, incorporates aerobic treatment using activated sludge, high pH lime treatment, recarbonation, sand filtration, upflow carbon adsorption and chlorination. In 1998, this Northern Virginia plant reclaimed 87 million liters/23 million gallons of water, which was used to augment the Occoquan Reservoir. Monitoring results show the reclaimed water is "far cleaner" than other surface inflows.

Montebello Forebay Groundwater Recharge Project, Los Angeles County. The facility in this project uses sedimentation and activated sludge treatment, sand filtration and disinfection with chlorine before recharge of the aquifer. Influent is mainly domestic. Reclamation began in 1969 and contributes up to 38% of drinking water supplies, meeting "…drinking water standards for pesticides, heavy metals, minerals, trace organic compounds, microorganisms and radionuclides." The Queensland *Fact Sheet* states that, "studies examining health have found no negative impacts from drinking recycled water in this community." Further information from a technical bulletin of the Water Replenishment District of Southern California provides details of the of the recharge sources: "Since 1962/63, over 5.6 million acre feet (AF) of water has been recharged at the spreading grounds, including 2.23 million AF (40%) of storm water, 1.45 million AF (26%) of recycled water, and 1.92 million AF (34%) of imported water. Over time, recycled water amounts increased while imported water amounts decreased as the safety and reliability of the recycled water was proven through intensive sampling, monitoring, and research efforts. Currently, about 40% of the replenishment water is storm water, 40% is recycled water, and 20% is imported water" (13).

Torreele Reclamation Plant, Veurne-Ambacht, Flemish Coast, Belgium. In this tourist region, the local water supply comes from groundwater, which is under threat of seawater intrusion due to over-pumping of the groundwater. The Torreele plant treats wastewater from a nearby sewage plant to produce 660 million gallons annually of recycled water. Treatment consists of ultrafiltration, reverse osmosis, and ultraviolet disinfection. Following discharge into an infiltration basin, the water filters through sand dunes into the groundwater. A study published in January 2008 in the international (Elsevier) journal *Desalination* looked at the effectiveness of this case of indirect potable reuse. The study states that, "…due to the sensitive environmental nature of the dune area, the quality of the infiltration water is subject to stringent standards. The combination of membrane filtration techniques proved capable of producing this quality and enabled a sustainable groundwater management of both dune water catchments owned by the IWVA [Intermunicipal Water Company of the Veurne region]" (14).

Essex & Suffolk Water. Water reclamation in the County of Essex (United Kingdom) began in 1997. Using wastewater from a local sewage treatment plant, 128 million liters/134 million gallons per day of treated and UV-disinfected wastewater was mixed with river water and then sent into a reservoir. Extracted reservoir water was then treated with pre-ozonation, coagulation, settling, lime softening, rapid sand filtration, ozonation, granular activated carbon filtration and chlorination. Since 2003, a permanent system using these technologies now processes 40 million liters/40.5 million gallons per day. Wastewater receives advanced treatment at a reclamation plant before release to the river, which actually improves the river water quality. Downstream, all the water receives drinking water treatment before distribution to consumers, all of which augments the local drinking water supply by about 10 percent. The utility website states that the area served is one of the driest regions in the UK, "…with less water available for use than in many parts of Spain, Portugal and Italy (15).

Singapore. According to a *U.S. Water* news article, Singapore has been pumping reclaimed water into its water system since 2003. Today, with its new Changi plant producing up to 50 million gallons of per day, the government of Singapore has branded reclaimed water as "NEWater." Official promotion of NEWater by the State included the Prime Minister and his cabinet ministers drinking NEWater in public, along with the distribution of free, brightly labeled bottles of the reclaimed water at public functions. Although most of the reclaimed water supplies industrial uses, the quality achieved is so high that, "The water fabrication plant operators who require water quality more stringent than for drinking have reported savings of some 20 to 30%." The aim in Singapore is to produce 250 million liters per day for industry and 2.5% of drinking water by 2011. Treatment involves "membrane pre-treatment, reverse osmosis, UV disinfection and chlorination for control of bio-fouling and residual chlorine in NEWater. Unlike Water Factory 21 [Orange County's original 1976 reclamation plant], advanced oxidation is not required, (because) the level of n-nitrosodimethylamine (NDMA) in NEWater is low, at less than 10 parts per trillion. This could be attributed to wastewater mainly from domestic sources and to full secondary wastewater treatment" (12).

The Changi plant came on line in June 2009 and has a treatment capacity of 176 million gallons daily. The latest component of the country's deep tunnel sewage system, which was designed to treat and reclaim wastewater for 100 years, the system was named "Water Project of the Year" at the 2009 Global Water Awards held in Zurich (16) (17).

Moving beyond its long-established water conservation policy, the Singapore government plans to use nonconventional sources, including water reclamation and seawater desalination, to meet one third of the country's total water demand. Unused effluent is discharged through a five-mile ocean outfall (18).

Hong Kong. In 2001, the collection of sewage from five major areas around Victoria Harbour in Hong Kong received only chemically-enhanced primary treatment, and in 2005, disinfection was added (19). Improvements have accelerated since 2005 under the Hong Kong Government's Total Water Management program. Two pilot schemes promote the use of reclaimed water. Ngong Ping Sewage Treatment Works on Lantau Island has been operational since 2006 and is the first tertiary treatment works in Hong Kong to produce reclaimed water. The plant uses a sequencing batch reactor, dual media filter, and disinfection process to reduce organic pollutants, suspended solids, nutrients, and pathogens. The reclaimed water is used for local toilets, the Ngong Ping Cable Car Terminal, to raise aquarium fish, and for use in controlled irrigation within the sewage treatment works. The Shek Wu Hui Sewage Treatment Works also opened in 2006 and supplies reclaimed water to select nearby users, such as schools, senior citizen housing, decorative streams and fountains. The water is also used for domestic toilet flushing and unrestricted irrigation.

The Kingdom of Saudi. Reclaimed water is big business in Saudi Arabia. The Queensland Commission information states that, in 2009, "...the National Water Company described plans to set up joint-venture reclaimed water marketing companies in Riyadh and Jeddah that will be in charge of promotion and distribution of the TSE [treated sewage effluent], with the reclaimed water to be supplied by the new generation of advanced wastewater treatment plants being built in the Kingdom."

For California, like many of the above locations, leadership in wastewater treatment has become a necessity rather than a choice. The present push for more research and strong trend toward wide collaboration are signs of the progress toward new water quality standards and improved monitoring and reporting. The resulting new requirements will necessitate improvements in wastewater administration, infrastructure, and technology. But these improvements are already badly needed. The technology to remove or reduce CECs and salinity already exists. Water supplies are already growing scarce. Meanwhile, huge quantities of water that could be reclaimed are being wasted in ocean discharges that pollute the ocean. Support for improved wastewater treatment from State and federal funds, energy schemes, and public-private partnerships directed first to plants on the coast would represent a wise and overdue investment. In present times of uncertain supply and risk, investment now would help secure more than future water supplies. By acting together to reclaim high quality water, we would take a sensible and necessary step toward a sustainable, future for both the environment and the people of California.

The City *of*

SAN DIEGO *Development Services Department*

Public Scoping Meeting Sign In Sheet // August 23, 2016, 6:00PM – 7:30PM
Scripps Miramar Ranch Public Library // 10301 Scripps Lake Dr., San Diego, CA 92131

Pure Water San Diego Program, North City Project EIR/EIS, PTS No. 499621

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CITY OF SAN DIEGO

DEVELOPMENT SERVICES DEPARTMENT

PUBLIC SCOPING MEETING

Pure Water San Diego Program // AUGUST 23, 2016

This meeting is being held pursuant to the *California Public Resources Code Section 21083.9 et seq.*, and is provided to give the public and interested parties an opportunity to submit comments regarding the potential environmental impacts of the proposed project. This information will be used to develop the scope and content of the proposed Environmental Impact Report (EIR) for the project to be described at this meeting. Please record your comments in the space provided below and submit this form to City staff at the conclusion of the meeting, or you can mail to the address noted on the back of this form. Thank you.

Comment: (1) why was this not on the ballot for the public to vote on? Why do you call it "Pure water" instead of what it is "Recycled Sewer water" or "Toilet to tap"? It is not pure water.

(2) The potential for harm to ~~health~~ health is tremendous given industrial waste, dangerous diseases thru hospital waste, medications, etc being put down toilets. You have not proven that you can eliminate chemical pollutants.

(3) What is the plan for testing in the homes when sewer water is piped into my home? What happens when a problem arises?

(4) Tremendous potential to loss of property values if this proves to cause health or environmental impacts

(5) why was this meeting not publicized in SRCA calling it "Toilet to tap" or "Sewer water" so homeowners would be aware & have opportunity to object to your plan to impact Miramar Lake?

Name: RUTH FEATHER Signature: Ruth Feather

Address: 9899 Caminito Rogelio, San Diego CA 92131

email: drfeather@sbcglobal.net

Use back of sheet if additional space is needed.

CITY OF SAN DIEGO

DEVELOPMENT SERVICES DEPARTMENT

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Comment:

alternatives to be considered in the EIR should include expanding the "Purple pipe" program to underserved areas

The DEIR should address the negative consequences of reducing support for ~~recycled~~ reclaimed water for (purple pipe) agricultural, landscape recycled use and effects on fire danger

Please disclose impact of curtailing the purple pipe program

Name: Wallace Wulfeck Signature: [signature]

Address: 12517 FAIRBROOK Rd. 92131

Use back of sheet if additional space is needed.

CITY OF SAN DIEGO

DEVELOPMENT SERVICES DEPARTMENT

PUBLIC SCOPING MEETING

Pure Water San Diego Program // AUGUST 23, 2016

This meeting is being held pursuant to the *California Public Resources Code Section 21083.9 et seq.*, and is provided to give the public and interested parties an opportunity to submit comments regarding the potential environmental impacts of the proposed project. This information will be used to develop the scope and content of the proposed Environmental Impact Report (EIR) for the project to be described at this meeting. Please record your comments in the space provided below and submit this form to City staff at the conclusion of the meeting, or you can mail to the address noted on the back of this form. Thank you.

Comment:

Please consider an alternative Route for the pipeline from the Treatment plant to Miramar Reservoir.

- instead of under Miramar Rd, please consider ~~[illegible]~~ Routing thru Carroll Canyon under the new Carroll Canyon Rd.

Name: Wallace Wulfeck Signature: [signature]

Address: 12517 Fairbrook Rd 92131

Use back of sheet if additional space is needed.

The City of **SAN DIEGO** *Development Services Department*

Public Scoping Meeting Sign In Sheet // August 25, 2016, 6:30PM – 8:000PM
City of San Diego Public Utilities Department // 9192 Topaz Way, San Diego, CA 91923

Pure Water San Diego Program, North City Project EIR/EIS, PTS No. 499621

NAME	ORGANIZATION	EMAIL	MAILING ADDRESS
AL LAU	PDMWD	alau@padre.org	9300 Fanita Pkwy Santee, CA 92071
James Peasley	Metro Comm	jpeasley@padre.org	"
John Stump		jwstump@cox.net	2413 Shamrock City Heights 92105
Brian Aquino			10872 Hijos Way
Alex Aquino	BSA	aaquino012@gmail.com	10872 Hijos Way
Ray Paulson		Raymond.Paulson@gmail.com	6362 Camino Marcial SD CA 92111
Deborah Knight	Friends of Rose Canyon	rosecanyon@san.rr.com	PO Box 221051 S.D. 92192-1051
Doug McPherson	USBR	dmcpherson@usbr.gov	27708 Jefferson, Ste 202 Temecula 92590
SCOTT ANDREWS	SEA	scott3ed@earthlink.net	4245 DEL MAR SD CA 92107
Summer Adleberg	City of SD	Sadleberg@sandiego.gov	9192 TOPAZ WAY

The City of
SAN DIEGO

Development Services Department

Public Scoping Meeting Sign In Sheet // August 25, 2016, 6:30PM – 8:000PM
City of San Diego Public Utilities Department // 9192 Topaz Way, San Diego, CA 91923

Pure Water San Diego Program, North City Project EIR/EIS, PTS No. 499621

NAME	ORGANIZATION	EMAIL	MAILING ADDRESS
Jim Peugh	S.D. Audubon Soc.	peugh@cox.net	2776 Nipoma St San Diego 92106
Shelli Craig		shelli.craig7@gmail	7728 Laramie Ct. S.D. CA 92120
MARK STEPHENS	City of San Diego Storm Water Div.	MGSTEPHENS@SANDIEGO.GOV	9370 Chesapeake Dr. Suite 100 S.D. CA 92123 MS1900

The City *of*
SAN DIEGO

Development Services Department

Public Scoping Meeting Sign In Sheet // August 25, 2016, 6:30PM – 8:000PM
City of San Diego Public Utilities Department // 9192 Topaz Way, San Diego, CA 91923

Pure Water San Diego Program, North City Project EIR/EIS, PTS No. 499621

NAME	ORGANIZATION	EMAIL	MAILING ADDRESS
Robert Cheif	Vex Property	RLEIF@RLEIF.com	3345 Hopi Place San Diego, CA 92117

CITY OF SAN DIEGO

DEVELOPMENT SERVICES DEPARTMENT

PUBLIC SCOPING MEETING

Pure Water San Diego Program // AUGUST 25, 2016

This meeting is being held pursuant to the *California Public Resources Code Section 21083.9 et seq.*, and is provided to give the public and interested parties an opportunity to submit comments regarding the potential environmental impacts of the proposed project. This information will be used to develop the scope and content of the proposed Environmental Impact Report (EIR) for the project to be described at this meeting. Please record your comments in the space provided below and submit this form to City staff at the conclusion of the meeting, or you can mail to the address noted on the back of this form. Thank you.

Comment:

1. feasibility of another desalination plant.
2. ~~#~~ Cost of each option
3. analysis of impacts of marine ecosystems from continued discharges from Pt. Loma.

Name: Shelli Craig Signature: Shelli Craig

Address: 7728 Laramie Court

Use back of sheet if additional space is needed.

Comment continued:

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The City of
SAN DIEGO

Development Services Department
ATTN: Mark Brunette
1222 First Ave., MS 501
San Diego, CA 92101

CITY OF SAN DIEGO

DEVELOPMENT SERVICES DEPARTMENT

PUBLIC SCOPING MEETING

Pure Water San Diego Program // AUGUST 25, 2016

This meeting is being held pursuant to the *California Public Resources Code Section 21083.9 et seq.*, and is provided to give the public and interested parties an opportunity to submit comments regarding the potential environmental impacts of the proposed project. This information will be used to develop the scope and content of the proposed Environmental Impact Report (EIR) for the project to be described at this meeting. Please record your comments in the space provided below and submit this form to City staff at the conclusion of the meeting, or you can mail to the address noted on the back of this form. Thank you.

Comment:

(1) Potable water traditional supply shrinking with global warming - this will continue

(2) Reuse water sewage to tap 250% losses due to evaporation, leaks, treatment etc.

(3) therefore this will not solve drinking water shortage and is waste of public funds this can be litigated for a win for the public!

(4) The oceans are rising and can provide water until CO_2 < 350ppm to stabilize global warming -- w/ new graphene low energy RO filters OAK RIDGE NATIONAL LAB is developed.

Name: Ray Paulson Signature: Ray Paulson

Address: 6369 Caminito Marcial SD CA 92111

Use back of sheet if additional space is needed.

OVER

Comment continued: (5) Sewage to tap closed loop toilets not controlled - water can be sabotaged.

(6) ~~UCSD medical labs cannot ensure range of bacteria they evolve, diameter in size for treatment e.g. < nano in size etc... and higher resiliency to treatment.~~

(7) Therefore P.E. engineers cannot guarantee drinking water standards - - -

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Sustainability = (quality of water for community and quantity of supply) securing to water, ecological impact, economic;

this respect not good ...

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Development Services Department
ATTN: Mark Brunette
1222 First Ave., MS 501
San Diego, CA 92101

(8) Sewage to irrigation mitigates (reduces) potable water use - by installing gray water lines P!!! this a real solution for water reuse!!!
→ yet a shrinking supply of water!!!

(9) "www.magnegas.com" is lowest cost one step sewage treatment to irrigation water + a gas mixable w/ natural gas to feed the electrical grid backup to Solar replaces natural gas/ fracking brings monies saved - earned help pay for in income or cost avoidance! salt water to fresh!

JOHN W. STUMP
2413 SHAMROCK STREET
CITY HEIGHTS, CALIFORNIA 92105
VOICE: 619-281-4663 EMAIL: mrjohnstump@cox.net

City of San Diego via First Class USPS and Email to cityclerk@sandiego.gov purewatersd@sandiego.gov
Development Services; & Storm Water Departments kbalo@sandiego.gov; HMDeisher@sandiego.gov;
202 C Street cityattorney@sandiego.gov; planningcommission@sandiego.gov
San Diego, California 92101

California Regional Water Quality Control Board, San Diego Region
San Diego Storm Water Permit, Implementation, Monitoring and Enforcement
2375 Northside Drive, Suite 100 via USPS & Email: sandiego@waterboards.ca.gov; Rebecca.Stewart@waterboards.ca.gov
San Diego, CA 92108 Main Phone Number: 619-516-1990

RE: PURE Toilet to Tap Water project and Scoping for Pending Studies (Projects: 438188 SCH No. 2014111068 & City Number 21003699) and related, including any request for any California Federal Drinking Water or Sewage Permits

Dear City of San Diego and Regional Water Board,

The City of San Diego appears to be engaged in a program to foster uncontrolled and unsustainable growth by providing an artificial water supply based on new technologies and the expenditure of significant public resources without adequate notice; inadequate consideration of alternatives; and failure to consider the known and cumulative impacts of entering into this project and its components. My testimony and letter of November 17, 2014 (**RE: ITEM-330: Point Loma Wastewater Treatment Plant - National Pollutant Discharge Elimination System (NPDES) Permit Application, (Citywide.) for MEETING OF TUESDAY, NOVEMBER 18, 2014, AT 2:00 PM,**) on file with the San Diego City Clerk and incorporated herein by reference, raised many of the points I present and highlight again.

These proposals are for an expanded approach and direction for regional water production and waste water processing. It assumes a Billion dollar construction program and significant new energy demands for combined sewer water processing and redelivery systems. I am requesting a California environmental review before this proposal becomes the permanent policy of the City. "If CEQA is scrupulously followed, the public will know the basis on which its responsible officials either approve or reject environmentally significant action, and the public, being duly informed, can respond accordingly to action with which it disagrees. The EIR process protects not only the environment but also informed self-government." *Sierra Club* at 13-14 (citing *Laurel Heights Improvement Assn. v. Regents of the University of California.*

The City's Web page states: "Water System Improvement Projects are funded by the rate increases." (SEE: http://tinyurl.com/jrt2n6y). The Notice of the plans and projects under consideration or in progress are inadequate, as they fail to give the public and potential ratepayers any reasonable notice of the plans of the government. These notices should be included in the Water and Sewer bill for the persons currently served by the system. The Notice should be in the languages used in the City of San Diego, under Election Law. These notices should give a reasonable range of the money spent to date and the treasure required in the future. Ratepayers should know that if these plans continue Water, Sewer, and Storm water will increase significantly and the cost of housing will become proportionally less affordable. Please Notice these plans in regular billings. A "…notice must be "reasonably calculated" to inform known parties…" ***Mullane v. Central Hanover Bank & Trust Co.***, 339 U.S. 306 (1950).

The City now has a legally enforceable Climate Action Plan , incorporated by reference herein, which is presented in an article in the May 18, 2016 San Diego Union Tribune newspaper (See: http://tinyurl.com/je49vx6) and a City Attorney Memorandum on Climate Action Plan (See: http://tinyurl.com/zbposv2). These projects and proposals must be evaluated and analyzed against the goals, standards and features of the referenced Climate Action Plan to determine if any project or proposal, including, but not limited to, its energy usages and growth inducing effects are consistent with the Plan. The Climate Action Plan requires change and one of the alternatives that must be considered to obtain Plan compliance must be alternatives that limit growth to sustainable levels, within existing resources.

The City is under a Municipal Storm Water permit and there have several been several enforcement actions imposed or pending concerning the City's lack of compliance with the permit and regulations, particularly on projects it has built for its own purposes or operation, the Municipal Storm Water Permit and Compliance matters are incorporated into these comments by reference (See: http://tinyurl.com/zsktyul). The proposed project and programs must specifically be analyzed for how these programs and projects foster the goals and objects of the Municipal permit. The Municipal Storm Water Permit requires change and one of the alternatives that must be considered to obtain Permit compliance must be alternatives that limit growth to sustainable levels, within existing resources. Please analyze and present reasonable information on how continued growth will contribute to obtainment of the standards required of the permit and settlement agreements. It is inconceivable that the City could continue to provide processed toilet to tap water to foster growth and yet not increase the amount of polluted storm water run-off to the water sheds and ocean. Analysis must include the conjoined effects and induced growth, waste generation, water and sewer demands that result from continued growth of San Diego and its larger sister City Tijuana. San Diego is a linked city like Budapest. We need to think San Dejuana not just North of the wall. Demand is generated together.

In addition to my demands for reasonable Notice and analysis to determine how the proposed projects will foster obtainment and timely compliance with regulatory permits, plans, and regulations, illustrated above without exclusion of other permits and regulations that the City is subject to, I have some specific matters for consideration. These are listed below:

1. Is the system or systems being proposed going to require rate increases and in what range(s);
2. Is the system or systems being proposed based on specific proprietary vendors or suppliers rather than generic methods? If proprietary systems are being proposed what are they and why are they being locked in or chosen?
3. What waste materials and volumes are likely to result from this program and projects operation? Specifically, address what filters and chemicals are going to be used? How will these filters be disposed of? How will used filters and the materials filtered out by the PURE toilet to tap operations be stored and disposed of? What volumes of materials are anticipated? Will this waste increase over the reasonably foreseeable life of the program and project? Are any of these materials classified as Hazardous or radioactive, by California or Federal standards?
4. What, if any, Homeland Security, Police, Fire or related costs will be required to build and operate the facilities proposed by this project or program? Would alternative approaches reduce these costs?;
5. Will all instructions and warnings for this program and project be posted in multiple local languages?
6. Has an emergency procedure manual and procedures been developed for the safety of operational and emergency personnel?
7. On the first day of operation will the proposed program or project fully conform to California and Federal permits? Will any continuing or new waivers of California or Federal law or regulations be required? Please additionally discuss whether the program or project will continue to use chloramine (SEE: http://tinyurl.com/h6cjtw2) and will regardless of the program or project selected will the City be in compliance with current orders to improve the disinfect ion of potable water? Is there any compliance to current orders or standards being held captive to this new approach? ;
8. Will the program or project, by the time of initial operation, have removed all water pipes and facilities containing asbestos. Where and how will any asbestos decommission by this program or project be disposed of? ;
9. The proposed project or program appears to require a new electrical transmission line. How much new power is required and how is it being generated? What is the resultant carbon load from this new project an? Are any carbon offsets being proposed? If the project was not operated how much carbon monoxide and related global warming pollutants would be avoided? Is this project scalable to mitigate and minimize impacts? ;
10. Has the City explored the reuse of the natural gas Rainbow pipeline 1600 to deliver recycled water South of the I-8 Freeway , In Council Districts 3, 4, 8, and 9 where the City has major parks, public facilities and landscaping; so as to reduce water demands? Specifically address the impacts on water demands if recycled water was used at the SD Airport, Balboa Park, SD Zoological, KELCO, Cholas Lake, and other Southern area major water using facilities , to reduce demand and thus the need for the project or a program at this scale. Would more purple pipe supply reduce demand? ;
11. Please analyze whether the rate increases, employment outcomes, and availability of recycled water, in the Southern area, adversely effects persons of color or low income ; so as not to advance Environmental Justice? ;
12. Please discuss and analyze whether the cost of filtering and/or processing of the waters from this program or project will increase the costs of health care, at dialysis or surgical centers, dental or other human care facilities; high technology manufacturing or research facilities; Specifically address how environmental justice is promoted if costs increase or economic costs limit health care, housing affordability, and employment opportunities? ; and
13. Please analyze the externalities that are generated by this program and project. This program and projects should not result in a transfer of costs to the general taxpayers. For example, a filter provider should not be able to provide us a filter that causes extra costs to dispose of it. They should be required to recycle all of that waste. In economics, an **externality** is the cost or benefit that affects a party who did not choose to incur that cost or benefit.[1] Economists often urge governments to adopt policies that "internalize" an externality, so that costs and benefits will affect mainly parties who choose to incur them.[2] [See: https://en.wikipedia.org/wiki/Externality]. I urge the staff planners to be more conscious of the trend towards externalities and suggest consideration of the SEEA Environmental Accounting document standards http://tinyurl.com/hdp6y94 .

I request written responses to my comments and inquiries. I request that my comments be published in the same size font as the response document is presented. I request timely notice of all future opportunities to comment and participate in any public hearings on these matters. These studies should be re-noticed by using both the annual Safe Drinking Water Report and the regular billings for Water, Storm Water, and Sewer. Please prevent even the appearance of ex parte communications consistent with local, State and Federal Law, as expressed in City Attorney Legal Opinion LO 90-2 (See: http://tinyurl.com/hyw7d76.) .

All the best,

/s/ **John W. Stump, San Diego resident, ratepayer, and taxpayer**

B8 1 of 6

CITY OF SAN DIEGO

DEVELOPMENT SERVICES DEPARTMENT

PUBLIC SCOPING MEETING

Pure Water San Diego Program // AUGUST 25, 2016

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A. Comment: Please observe the prohibition on exparte communications to "decision makers" who foreseeably could serve in a quasi judicial manner. See City Attorney Legal Opinion 90-2. Please assure public that there have been NO contacts with planning commissioners or city Council outside of public hearings.

B. How much water is lost in the delivery system Before meter and other side of meter.

Name: John Stump Signature: [signature]

Address: 2413 Shamrock City Heights CA 92105

Use back of sheet if additional space is needed.

C *Comment continued:* What provisions have you made to PRESERVE & RESTORE Habitat. will project increase Habitat?

D. Please describe how current water supply is not "pure" Is our current water neither pure or safe?

E. Your slide on 5 steps indicates that water will be disinfected by "ozonization" are you representing that the project will eliminate all chloramine treatment. Is chloramine elimination of chloramine going to happen regardless of project alternative selected?

The City of
SAN DIEGO
Development Services Department
ATTN: Mark Brunette
1222 First Ave, MS 501
San Diego, CA 92101

F. You stated there is going to be a "Cogeneration plant" what is the market value of this Cogeneration? Is this cogeneration going to be sold at market rate & from one enterprise fund to another enterprise fund?

CITY OF SAN DIEGO

DEVELOPMENT SERVICES DEPARTMENT

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Comments: G. Why do you need to "Blend" water? Is it not pure when it is put in the reservior? How long must the the water mix before its pure?
H. How much ~~water~~ treasurer has been sunk into this scheme?
I. What will this cost the to ratepayers?
J. What are your estimates of Methane loss or venting from the Co generation? What

Name:

Signature:

Address: vented volumes?

Use back of sheet if additional space is needed.

Comment continued: K. What is the smallest chemical that will be pulled out of water than now.

L. Will over time and long operation, there be increased concentration in the rest reservoir or pured water?

M. Your presentation misrepresents your support from the environmental community. Please do not present that the environmental community supports this proposal. I have been an environmentalist for more than 50 years and I do not yet ~~suggest~~ support this project

N. What waivers are you asking for? What waivers are in place now? ~~to~~. How long have these waivers been in places. What sewer and water volumes have been waived?

PRA Request below in "P"! Page 5 of 6

CITY OF SAN DIEGO

DEVELOPMENT SERVICES DEPARTMENT

PUBLIC SCOPING MEETING

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Comment: Q. Your presentation refers to "aquifers" What are there ~~your~~ aquifers and what are there volumes and refresh rates?
P. Why are you not recharging aquifers as an alternative?
* Q Public Records Request for minutes agendas, and all documents concerning the consultations and formation of the listed environmental groups please respond in writing

Name: Signature:

Address:

Use back of sheet if additional space is needed.

Comment continued:

My letter of 8/25/16 is herein incorporated by reference

[signature]

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The City of
SAN DIEGO
Development Services Department
ATTN: Mark Brunette
1222 First Ave., MS 501
San Diego, CA 92101

Why not substitute this water Now for all the bottled water purchased by city departments like Mayor, Council and Fire

Pure Water Comments

Robert C. Leif, Ph.D., (619)582-0437. Rleif@rleif.com

August 25, 2016

1) Each member of a reverse osmosis array needs to have its own conductance detector.
2) A Ph.D. biomedical engineer, microbiologist, and/or molecular geneticist with perhaps postdoctoral training should be in charge of the management of the quality of the purified water. This person should have the right to report to the Mayor and Council on questions of water quality.
3) The results of purification of the following water samples need to be reported:
   a) Present Raw input (Colorado River) water
   b) Existing Method Purified Present Raw input
   c) Present Raw input after new purification method
   d) Recycled water starting material
   e) Recycled water after new purification method.
   f) Poseidon Water

PURE WATER SAN DIEGO PROGRAM NORTH CITY PROJECT

PUBLIC ENVIRONMENTAL SCOPING MEETING

AUGUST 23, 2016 - 6:00 P.M.

SCRIPPS MIRAMAR RANCH PUBLIC LIBRARY

10301 SCRIPPS LAKE DRIVE

SAN DIEGO, CALIFORNIA

REPORTED BY JULIA LENNAN, RPR, CSR, NO. 12843

AUGUST 23, 2016 - 6:05 P.M.
SAN DIEGO, CALIFORNIA

MARK BRUNETTE: Good evening, everyone. We're going to go ahead and get the scoping meeting started.

Thank you for coming for the environmental impact report public meeting for the Pure Water Program North City Project. My name is Mark Brunette. I am the senior environmental planner in the City of San Diego's Development Services Department. These meetings are referred to as EIR scoping meetings and are for the purpose of helping to define the scope of work for the EIR. The City's environmental review staff scheduled this meeting to gather public input prior to the preparation of the project's environmental documents.

Environmental review staff are required by the City's municipal code to provide the public and design makers with independently prepared environmental documents which disclose impacts to the physical environment. This information is used by decision makers as part of the deliberative process in approving or denying a project. The environmental document does not recommend approval of her denial but is provided as information on the environmental impacts of the project.

I'm going to go through a few comments about how we'll be conducting the meeting this evening. First, I'm going to provide a brief description of the project, followed by a short presentation by the Applicant.

This meeting is designed to get as much public input on areas that need to be addressed in the EIR in the time allotted; therefore, each speaker is asked to introduce themselves, state their address, and complete their comments within three minutes.

This entire meeting, if we have a lot of people -- if we get more people, would last approximately an hour and a half and would end at 7:30 p.m. If after the people who are here who comment have no more comments and there is no one else left, we will end the meeting early.

In addition to verbal comments, which are being recorded, there are forms available on the table over here from the City upon which you can provide written comments. We will need to have these comment forms submitted to City staff by the close of the meeting, or you can mail the completed form with your comments to the address listed on the back page. It is a three-fold sheet of paper, two-sided, so all you have to do is put a stamp on it, and you can mail it directly to me.

Please remember to put your name and address on the sign-in sheet before you leave the meeting if you would like to receive the notice of availability for the draft EIR, and if you have an email address, go ahead and put that on in place of your street address because we can mail a public notice which will have a link to the EIR at a later date.

Please refrain from conducting a debate on the merits of the project at this meeting as this is not the purpose for tonight's gathering. Rather, please focus your comments on those environmental impacts you would like thoroughly analyzed in the project's environmental document.

Lastly, I will be acting as the moderator and timekeeper for the duration of the meeting and, therefore, would respectfully request that you yield when notified that your three minutes are up.

Thank you for your patience, and we'll begin with the project description and then a brief presentation by the Applicant.

Oh, also we have a Spanish interpreter here. If anyone needs an interpreter, just let me know.

This meeting is being conducted in accordance with CEQA for the Pure Water Program's North City Project. Today is Tuesday, August 23rd, 2016. It's a little after 6:00 p.m.

The Bureau of Reclamation and the City of San Diego will prepare a joint Environmental Impact Report/Environmental Impact Statement to evaluate the effects of the North City Project, the first phase of the Pure Water San Diego Program or the Pure Water Program.

The Pure Water Program is a water and wastewater facilities plan to produce potable water from recycled water. The Pure Water Program consists of the design and construction of new advanced water treatment facilities, wastewater treatment facilities, pump stations, and pipelines.

The proposed project will expand the existing North City Reclamation Plant and construct an adjacent North City Pure Water facility with a purified water pipeline to Miramar Reservoir. A project alternative would install a longer pipeline to deliver product water to the larger San Vicente Reservoir.

Other project components include a new pump station and force main to deliver additional wastewater to the North City Water Reclamation Plant, a brine discharge pipeline, and upgrades to the existing Metropolitan Biosolids Center to accommodate additional biosolids from the increased treatment capacity at the North City Water Reclamation Plant.

A new electrical transmission line is proposed connecting the North City Water Reclamation Plant to the future cogeneration facility at the Metropolitan Biosolids Center to deliver power for North City Project components. The electrical transmission line will cross Marine Corps Air Station Miramar and will require approval of the United States Marine Corps.

With that I'm going to turn over the microphone to the Public Utilities Department staff, and they'll give a brief presentation.

BRENT EIDSON: Good evening. My name is Brent Eidson. I'm with the Public Utilities Department, and I'm here to provide you an overview of the Pure Water Program and then also to get into more of the specifics about what is included in the reason we're here today, the Phase 1 project of the Pure Water Program.

So first, a little bit about Public Utilities Department. We are both your wastewater and water service providers. We serve about 2.5 million wastewater customers versus 1.3 million water customers. Why the difference? We also have contractual obligations with 12 other agencies here in the region to treat their wastewater, and so we are a regional wastewater provider, not just the City of San Diego wastewater provider. As you can see from some of these other numbers, we're a fairly large department with a lot of activity that's happening.

First, I want to talk a little bit about our current water supply. We import between 85 to 90 percent of our water from outside of the region between the Colorado River and the Sacramento Bay Delta, and what's important to note on this screen as it's relative to the Pure Water Program is all of these dots that you see located here along these two watersheds. Those are different discharge permit holders upstream from us.

This gentleman asked me a question earlier how many upstream discharges are there from our water supply, and there's already over 400 that discharge into our water system or our water supply and conveyance systems. Because of this imported water challenge, we face a number of obstacles. First, as you can see from the graph on the right, the cost to buy that same drop of water has increased by three times since 2000, and now it costs us $1200 to buy an acre-foot of water versus $400 in 2000.

We also have to be mindful of recurring drought, which we've all witnessed over the last few years, and then also culminating with some State-mandated reductions. We have to be cognizant and prepared for population growth, as well as other factors that might impede our imported water supply, such as natural disasters along those two water supply lines.

So as we mentioned, we're in a pretty severe drought, and before the drought really took hold, we had already started talking about how can we become more independent for our water supply, and that's where Pure Water was born. And so in addition to Pure Water, though, we do have other activities underway. First and foremost is conservation, of course. We all have learned to get better and to use less water, and we appreciate that.

Recently the region has a new desalination plant providing about 7 percent of our treated water every day. The City is also working on some groundwater development. Admittedly, our groundwater basins are pretty small, and they're not connected, so the yield from those groundwater basins aren't as great as some you might see up in Orange county, LA, or in the Central Valley.

As you probably know, in this community we do have recycled water, which is tertiary treated water, and that water is eligible to be used for irrigation purposes, as well as some industrial purposes, and you'll notice it by the purple color of the piping. And then what we're here to talk about today is Pure Water, and this is our program that will convert recycled water into drinking water.

So we have done a lot of work on proving the technology, and this is definitely a safe, reliable, and it would be a cost-effective approach to providing new water supply for our city.

A little bit about our existing system: This graph, as you can see, starting here at the lower level, started with the reservoir. And whether that's from local runoff or imported water, our water goes to the reservoir, goes to a drinking water treatment plant, and then it's delivered to all of our customers in their homes and businesses.

Right now we have a little bit of water that goes to a water reclamation plant, but the majority of it is treated and discharged to the ocean. Pure Water will help close this water cycle by taking more of this water, treating it, and taking it to the reclamation plant, which, I'm going to talk about in a moment, is being expanded, and from there it will go to a Pure Water facility where it's treated to a very high standard, nearly purified water, before being reintroduced to the reservoir and continues the cycle again.

So we use at -- now, what I'm going to talk about here is after recycled water. So we're starting -- consider this starting at the purple pipe. We've already treated it to purple pipe standards, very high-quality standards.

From there we have five additional treatment processes before we transfer it to a reservoir. I don't know if they mean a whole lot to you, but I'll tell you what they are. They're ozonation -- you add ozone, actually, to the water. That helps clean it a bit -- biologically activated carbon -- that helps with further filtration -- and then also membrane filtration, which is like hollow straws that water molecules can pass through but many other elements in the water cannot. And then reverse osmosis is really the workhorse of this train, and this is where water is pressed through membranes at high pressure, and, essentially, the only thing that can pass through that is water molecules. But just to be safe, we also add UV light and advanced oxidation, which is a chemical reaction which, if anything was left in the water after reverse osmosis, would kill anything in the water.

We've been running this demonstration facility over at the North City Plant since 2011. In the last couple years, we added the first two elements of that treatment process. We ran it for the majority of the time with three treatment trains, which proved after 28,000 lab tests that we met or exceeded all state and federal drinking water standards for that demonstration water. The water quality is absolutely exceptional. In fact, if you come take a tour, you can taste it yourself, and tours are free to the public.

And then one of the major considerations is how much energy are you going to use. Well, think about how far we bring water from out of our community. We have to pump that water over several mountain passes, and so our energy use is going to be comparable to imported water, maybe even less, and I'll tell you why in a moment.

At the end of the program in 2035, we will be producing a third of our city's water right here in the county. The first phase would produce 30 million gallons per day, and that's what we're here to talk about tonight, and that will be at the North City, location, and it will transfer the water to the Miramar Reservoir.

Phases 2 and 3, as you can see, would be new facilities in the central area, and that water would either go to Lake Murray or San Vicente and, if needed, a new facility down in South Bay, which would then put the water to the Lower Otay Reservoir.

So Miramar, Murray, and Lower Otay is where the City has their already existing three drinking water treatment plants, which is, of course, an important component of this process, is to be able to push the water back through a drinking water treatment plant.

Today, though, what we're talking about is Phase 1, North City, and Phase 1, North City, is comprised of a new pump station essentially at the base of the University of San Diego down there along Morena Boulevard, and that will convey new wastewater because we need to expand our water -- North City Water Reclamation Plant, and then we'll build a new Pure Water facility and then pump station and pipeline. I have more slides on those. I'm not going to try to go over it quickly. I'll talk about them in a little more detail.

What's not part of the scoping, but it's important to know, is that because more solids will be created, we're working to expand our Metro Biosolid Center, working with a landfill to capture landfill gases and create new generation of electricity.

Remember, I told you it would be comparable to imported water? With this cogen facility, we'd be able to be using renewable energy right here in San Diego and not having -- we'll be able to reduce our need from SDG&E.

AUDIENCE MEMBER: Will you be capturing methane also from these plants and using that as an energy source or not?

BRENT EIDSON: Yeah, that's part of the cogen.

AUDIENCE MEMBER: Okay.

BRENT EIDSON: So this is a little bit about the schedule. I know these are hard to read, but just to give you a little sense, we've broken it down into, you know, different facets that we need to do, from outreach, to doing the environmental impact report, regulatory approval, and then, of course, construction of Phase 1. And so as you see, we're here in 2016, and we're out doing design and here starting the environmental documents and talking with you tonight about the scope of the plan.

First, let me give a little more detail about the Morena Pump Station and Pipeline. This will be a brand new facility down along Morena Boulevard, and from there we will have to construct two pipelines, one to move wastewater up to North City Water Reclamation Plant, which will be expanded, and then also a second pipeline that will bring brine -- which is, you know, a more concentrated byproduct of the treatment process --

back down to Point Loma for further treatment.

As you can see from the slide here, that we will also -- are cognizant of some very interested and impactful areas, including environmentally sensitive areas and high-traffic areas that we may be doing trenches, construction, to avoid those.

That Morena Pump Station and Pipeline will transfer that water to the existing North City Water Reclamation Plant, which, as we mentioned earlier, is where we treat our water to purple pipe standards, and then that will be expanded to allow for the expansion of -- to allow for the continued distribution of recycled water to our existing customers, as well as accounting for the new Pure Water Facility that's going to need product -- or source water, I should say.

So if you've been to the North City Plant -- hopefully, you have -- you've seen that -- this might mean something to you, but right now we have our Pure Water demonstration facility right here. Just to orient you, this is Interstate 805 northbound, and then this is eastbound Miramar Road.

So we have our existing demonstration facility, which, again, I really encourage you to come take a tour of, but this is the new type of outline of where the new structures will be in order to expand the plant to allow for the new amount of water we're going to need for Pure Water.

Across the street on property that the City already owns is where the new Pure Water Facility will be located. This is the facility that will have that five-step advanced treatment process we spoke about earlier.

Once that water has been purified, then, at this facility, we will be constructing a pump station -- again, those are the steps, sorry. You've already seen that -- we'll be constructing a pump station right on-site that will then help to convey the water through a new pipeline the eight miles out to Miramar Reservoir.

Again, as we mentioned, on Morena Boulevard Pump Station, we will be doing some mitigation of high-impact areas through either microtunneling or trenchless construction.

At the Miramar Reservoir, then, we will have to build a small dechlorination facility, and that is so that we have dechlorinated water going in at the pump station at the new purifying facility. We will add chlorine to make sure that nothing -- that the water is safe as it travels those eight miles, and then you dechlorinate it. And then it will be entered into the lake through an underwater pipeline, and that is necessary for us to be able to have the water enter at the point of the lake where we need it to enter.

So we're also committed to sustainability. I mentioned a bit about the cogeneration where we'll be able to have renewable energy that will be providing the power for this facility, but we're also going to meet silver certification for our facilities, and we'll be doing waste aversion and recycling of our construction materials. And at the end, this will provide us with, as we said, safe, reliable, and sustainable water supply.

To give you -- I didn't tell you earlier, but the first phase is 30 million gallons per day. The total all in both phases will be 83 million gallons per day, and that will get you to your third. So the 30 is about a 15 percent water supply for our city.

Over the years we've been working hard with our stakeholders and our community to get support. As you can see here, we've been able to get a lot of organizations, both from the environmental community as well as from business groups and education and other water agencies, to support the Pure Water Program.

So with that, that concludes my portion of the presentation, and I'll turn it back over to Mark, who will talk about --

AUDIENCE MEMBER: Will you take any questions at this point?

MARK BRUNETTE: Actually, what we'd like to do is get into the public comment, and possibly at the end of that, at the end of the meeting, we might be able to answer some questions, or put some questions on your comment form, but we'd like to get into public comment right now, so I'd say hold your questions until afterwards.

Well, thank you for the presentation and overview of the project. I will now open up the meeting to public comment. Please remember that all comments are limited to three minutes.

So, I guess, if you want to come up to the microphone here, anyone who wants to speak.

AUDIENCE MEMBER: Yeah, my name is David Feather. I live in Scripps Ranch.

You want my address?

MARK BRUNETTE: Please.

AUDIENCE MEMBER: 9899 Caminito Rogelio, San Diego, 92131.

And I have a question for Brent, and it's basically -- the full process starts with the purple pipe process, followed by a Pure Water process, and my question is: Is that identical process and the steps in it being followed by any other community, and if, what communities?

BRENT EIDSON: Sure. Orange County has a large hundred-million-gallon-per-day facility that uses the three treatment steps. So they start with recycled water, as we would, and then they go with microfiltration, reverse osmosis, and then UV with advanced oxidation. So Orange county uses the three treatment steps, and then they go and deliver it in -- with their product water in a groundwater basin.

AUDIENCE MEMBER: An aquifer.

BRENT EIDSON: In the aquifer, which we don't have, as I mentioned earlier, and so we are going through a reservoir.

So in working with the State regulators, we've come to a path forward where we're adding these two additional treatment steps at the front end, and that's why it's not exactly the same. We're actually giving more treatment than anybody else.

AUDIENCE MEMBER: But it hasn't been proven on an industrial scale. In other words, we're not replicating something that Orange County did.

BRENT EIDSON: It's --

MARK BRUNETTE: If I can interrupt, the purpose of the meeting is really to focus on comments, on issues you'd like the EIR to cover. So let's try to focus on those comments, and then possibly at the end of the -- again, at the end of the meeting, if we have time, maybe some questions can be answered, but let's focus on comments.

And I can give you the mike, but I don't know if it's --

AUDIENCE MEMBER: That's fine. Wes Danskin, 10387 Rue Finisterre, 92131. I'd like the EIR to address other places in the world where an identical system has been used, if any.

MARK BRUNETTE: Okay. Thank you.

And were there other comments?

AUDIENCE MEMBER: Have you all done a cost analysis as to whether it is cheaper purifying all of the water to a high degree or putting in separate pipelines for irrigation purposes versus potable water that you -- because most people -- more of the water is used for irrigation than it is for household tasks.

MARK BRUNETTE: That's certainly something that we're taking down in the record and we'll look at. We're not going to answer questions --

AUDIENCE MEMBER: I understand that.

MARK BRUNETTE: -- here today, but that comment is noted --

AUDIENCE MEMBER: Okay.

MARK BRUNETTE: -- and staff will look at that issue.

AUDIENCE MEMBER: Can I amplify on that? I'd like the EIR -- my name is Wally Wulfeck. I am the chair of the Scripps Ranch Planning Group. My address is 12517 Fairbrook Road, 92131.

I would like the EIR alternatives to consider expanding the purple pipe program and, alternatively, also analyzing the negative consequences of reducing support for the purple pipe program that has been the stated policy for the past several years of the water department.

Here in Scripps Ranch, we have -- a simple 1-mile extension down Miramar Road would open up the availability of recycled water to a large number of public City-owned parks, as well a bunch of HOA-maintained open space areas.

It makes no sense to purify water completely and then spray it on grass, so the EIR needs to analyze quite carefully the impacts on the purple pipe program as an alternative to this. It should be included as part of the program in order to expand it.

One other comment is, please consider an alternative route for the pipeline from -- instead of under Miramar Road. Instead, consider going through Carroll Canyon, the Corley area, that is expected over the next several years to become a major housing development. So it would be much smarter to put that new -- the new pipes under the to-be-constructed Carroll Canyon Road rather than digging up Miramar Road once again.

MARK BRUNETTE: Thank you.

AUDIENCE MEMBER: Hi. My name is Ruth Feather. I live at 9899 Caminito Rogelio in San Diego, 9213l, in Scripps Ranch here.

What precautions have been taken in the event of a power outage like we had in 2011 when we had -- when all -- we had a terrible power outage. What precautions are taken at these various facilities?

So if the pumps go down for untreated water or water that isn't treated properly coming into homes, will all the water just stop, or is untreated water that's not purified totally coming into our homes and therefore polluting all of our pipes, our homes? What's the plan on that?

MARK BRUNETTE: Thank you.

AUDIENCE MEMBER: My name is Larry Peranich. I live at 11745 La Colina Road, San Diego, California, 92131.

My main concern is about this -- while I support the project, from an environmental standpoint, I'd like to make sure that electrical usage is minimized, if at all possible; therefore, I'm assuming the alternative out to San Vicente Reservoir would use more electricity for pumping than Miramar. If that's the case, I'd support the Miramar Reservoir plan. So that's my main concern.

MARK BRUNETTE: Thank you.

AUDIENCE MEMBER: Hi, I'm Greg Lichtenstein, live at 12265 Rue Cheaumont, 92131.

And I don't see in the health and safety section here anybody addressing the issue of antibiotics in water. You mentioned that were downstream from 400 waste treatment sites. So as you know, people excrete antibiotics through urine and feces that they've been given. There's a concern about increasing antibiotic resistence in bacteria. I'm just wondering how effective, maybe, reverse osmosis is at removing the antibiotics so we don't keep recycling, recycling, recycling those contents.

MARK BRUNETTE: Thank you.

AUDIENCE MEMBER: John Todd, 11122 Promesa Drive, San Diego, 92124.

And for years we've been reading about how the

City of San Diego has failed to meet water quality standards for the discharge into the ocean.

What assurances are we going to have that they are going to suddenly be able to meet the standards that are called for in this project?

MARK BRUNETTE: Thank you. Any other comments?

AUDIENCE MEMBER: Wes Danskin, 10387 Rue Finisterre, 92131.

I'd like a robust field trial with measurable tracers in Miramar Lake to document the mixing that is believed to occur.

MARK BRUNETTE: Thank you.

Is there anyone else who wanted to make a verbal comment?

AUDIENCE MEMBER: Dave Feather again, 9899 Caminito Rogelio, San Diego 92131.

I'm sure this is answered, but for my edification if it hasn't been, could you please compare the cost per acre-foot of this process, total, from -- beginning with purple -- or including purple pipe step, followed by the Pure Water step -- what's its total cost, fully loaded -- with the Poseidon cost up in Carlsbad.

MARK BRUNETTE: Okay.

AUDIENCE MEMBER: I don't have a clue how they stack up.

MARK BRUNETTE: Thank you for your comment. We've got that on record. Thank you.

AUDIENCE MEMBER: Thank you.

MARK BRUNETTE: Were there any other comments?

Doesn't look like it. You also have the -- you can do written comments over at the table there if you'd like.

Again, thank you very much for your comments, and, again, no one else wishes to speak or offer a comment?

Okay. Seeing that there's no other members of the public that want to speak to the item, I'm going to go ahead and close this meeting and make a few closing remarks.

This closes the public environmental scoping meeting for the Pure Water San Diego Program North City Project. Your input will be transcribed, considered by City staff for use in the scope of the EIR, and included as part of the official record for the document.

Speakers and commenters who provided their contact information will also be placed on the notification list for further environmental review actions related to the project. So if you haven't put your name on the sign-in sheet, please do so before you leave, and you'll receive future notices.

I would also like to remind everyone that this is just the start of the environmental review process and opportunities for public input. There will be other opportunities to provide comments on the project, such as during public review of the draft environmental document and in any further public hearings on the project.

Thank you for taking the time to participate in the meeting, and have a great evening. Thank you.

(The proceedings concluded at 6:38 p.m.)

* * *

STATE OF CALIFORNIA)
)
COUNTY OF SAN DIEGO)

I, Julia Lennan, a Certified Shorthand Reporter for the State of California, No. 12843, and Registered Professional Reporter, No. 8269, do hereby certify:

That the foregoing proceedings were reported stenographically by me and later transcribed through computer-aided transcription under my direction and that the foregoing is a true record of the proceedings taken at that time.

I do further certify that I am in no way interested in the outcome of this action or connected with or related to any of the parties in this action or to their respective counsel.

In witness whereof, I have hereunto set my hand this 2nd day of September, 2016.

____

JULIA LENNAN, RPR, CSR NO. 12843

PURE WATER SAN DIEGO PROGRAM NORTH CITY PROJECT

PUBLIC ENVIRONMENTAL SCOPING MEETING

AUGUST 25, 2016 - 6:30 P.M.

SAN DIEGO PUBLIC UTILITIES DEPARTMENT

9192 TOPAZ WAY

SAN DIEGO, CALIFORNIA

REPORTED BY JULIA LENNAN, RPR, CSR, NO. 12843

AUGUST 25, 2016 - 6:35 P.M.

SAN DIEGO, CALIFORNIA

MARK BRUNETTE: Good evening, everyone. I'm going to go ahead and get started.

Thank you all for coming to the environmental impact report public meeting for the Pure Water Program North City Project. My name is Mark Brunette. I'm a senior environmental planner in the City of San Diego's Development Services Department.

These meetings are referred to as EIR scoping meetings and are for the purpose of helping to define the scope of work for the EIR. The City's environmental review staff scheduled this meeting to gather public input prior to the preparation of the project's environmental documents.

Environmental review staff are required by the City's municipal code to provide the public and decision makers with independently prepared environmental documents which disclose impacts to the physical environment. This information is used by decision makers as part of the deliberative process in approving or denying a project. The environmental document does not recommend approval or denial but is provided as information on the environmental impacts of a project.

I'm going to go through a few comments about how we'll be conducting the meeting this evening. First I'm going to provide a brief description of the project, followed by a short presentation by the Applicant.

This meeting is designed to get as much public input on areas that need to be addressed in the EIR in the time allotted; therefore, each speaker is asked to introduce themselves, state their address, and complete their comments within three minutes.

This entire meeting, if we end up having a lot of people, would last approximately an hour and a half and would end at 8:00 p.m. If after the people who are here who comment have no more comments and there is no one left, we will end the meeting early.

In addition to verbal comments which are being recorded, there are forms available on the table over here from the City upon which you can provide written comments. We will need to have these comment forms submitted to City staff by the close of meeting, or you can mail the completed form with your comments to the address listed on the back page. It is a three-fold sheet of paper, two-sided, so all you have to do is put a stamp on it, and you can mail it directly to me

Please remember to put your name and address on the sign-in sheet before you leave the meeting if you would like to receive the notice of availability of the draft EIR, and if you have an email address, go ahead and put that on in place of your street address because we can email the public notice which will have a link to the EIR later on.

Please refrain from conducting a debate on the merits of the project at this meeting, as this is not the purpose of tonight's gathering. Rather, please focus your comments on those environmental impacts you would like thoroughly analyzed in the project's environmental document.

Lastly, I will be acting as a moderator and timekeeper for the duration of the meeting and, therefore, would respectfully request that you yield when notified that your three minutes are up.

Thank you for your patience, and we'll begin with a project description and then a brief description by the Applicant. And I also need to mention we have a Spanish interpreter here. Just let us know if you need the interpreter to help you out.

This meeting is being conducted in accordance with CEQA for the Pure Water Program's North City Project. Today is Thursday, August 25th, 2016. It's a little after 6:30 p.m.

The Bureau of Reclamation and the City of

San Diego will prepare a joint Environmental Impact Report/Environmental Impact Statement to evaluate the effects of the North City Project, the first phase of the Pure Water San Diego Program or Pure Water Program.

The Pure Water Program is a water and wastewater facilities plan to produce potable water from recycled water. The Pure Water Program consists of the design and construction of new advanced water treatment facilities, wastewater treatment facilities, pump stations, and pipelines.

The proposed project will expand the existing North City Water Reclamation Plant and construct an adjacent North City Pure Water facility with a purified water pipeline to Miramar Reservoir. A project alternative would install a longer pipeline to deliver product water to the larger San Vicente Reservoir

Other project components include a new pump station and force main to deliver additional wastewater to the North City Water Reclamation Plant, a brine discharge pipeline, and upgrades to the existing Metropolitan Biosolids Center to accommodate additional biosolids from the increased treatment capacity at the North City Water Reclamation Plant.

A new electrical transmission line is proposed connecting the North City Water Reclamation Plant to the future cogeneration facility at the Metropolitan Biosolids Center to deliver power for North City Project components. The electrical transmission line would cross Marine Corps Air Station Miramar and will require approval by the United States Marine Corps.

With that, I'm going to turn over the microphone to the Public Utilities Department staff, and they'll give a brief presentation.

AMY DORMAN: Thank you. Good evening. My name is Army Dorman, and I'm with Public Utilities, and I'll go through this quick presentation to give you an overview of our program. These first few slides give you some information about the systems that we operate, as well as the key drivers as to why we have embarked on this Pure Water Program.

So Public Utilities operates both a water and wastewater system. On the water side, we serve 1.3 million customers, primarily within the city of San Diego, and on the wastewater side, our service area is much larger. It not only serves the City, but also 12 other agencies in the region, where we collect their wastewater and treat it at Point Loma.

Operating and maintaining a system requires a large capital investment to keep them in proper working order. We spent over 800 million in the last five years to maintain and keep them in proper working function. On an annual basis, the single largest line item on our annual budget is the cost of imported water. In this past year, we spent over $200 million on imported water purchases.

We have historically relied heavily on imported water. About 85 percent of the water that we need is imported to San Diego, and we are at the far downstream end of the line, and so as a result of this, we are using water that has already been used and reused hundreds of times over by the communities who are upstream of us.

And so with that heavy dependence on imported water comes a variety of challenges. First, there are court-ordered restrictions that limit how much we can pump from the Bay Delta. The pumps have to be shut off a couple times a year, and that's in order to protect the environment in that region.

Also, earthquakes are a threat to the infrastructure that delivers our water. If one was large enough, it could interrupt the aqueduct supplies to our region. And also the cost of the water has tripled since the year 2000, and there aren't any signs of that rate of increase slowing.

And then, finally, we are in our fifth year of drought. Our drought cycles are seeming to last longer with shorter breaks in between. This last winter we did get normal rainfall; however, as early as May, the State reported that our snowpack levels were already far below normal levels, so we're still in the thick of a drought.

So San Diego's approach is to develop a variety of local supplies, and conservation is one that we've actively done for the last -- well, the City has had a program in place for the last 30 years, and San Diegans have really embraced some of those principles. So in 1990 our water consumption was actually higher than it is now, and so that's a result of people changing out their plumbing fixtures and replacing their turf for more drought-tolerant landscape.

And then moving to desal, last year the region's first desal plant began operating up in Carlsbad, and it's run by the County Water Authority, and at a 50 MGD capacity, it serves about 7 percent of the County's water needs. And we are studying the potential we have for groundwater supply; however, our basins are limited.

In the late '90s, we began recycling more water, providing it to mostly irrigation and industrial customers who use it for nondrinking purposes, and now we would like to implement Pure Water.

So what is Pure Water? It's a local supply concept that's safe. It's based on proven technology. The technology is capable of producing water --

AUDIENCE MEMBER: Are we not getting pure water now?

AMY DORMAN: No, we're not getting it now.

AUDIENCE MEMBER: So it's polluted water or what is it? What kind of water do we get?

MARK BRUNETTE: Actually, if she can finish her presentation, and then --

AUDIENCE MEMBER: I don't want her to -- I want a factual presentation, not a presentation --

MARK BRUNETTE: Okay. Well --

AUDIENCE MEMBER: -- that leans us one way or another.

MARK BRUNETTE: If we can just let her finish her presentation, and then you can make comments when she's done. Thank you.

AUDIENCE MEMBER: Okay.

AMY DORMAN: So in addition to being safe, Pure Water is reliable. It's something that would be available in both normal rainfall years, as well as drought years, and it's cost-effective.

So we currently operate a primarily single-use system where we treat the water, provide it to our customers, and then we take their wastewater and treat it at Point Loma, after which it's discharged to the ocean.

We are able to recycle a small portion of that water. About 8 percent of our total water need is recycled for those nondrinking purposes that I described earlier, but, again, that's only 8 percent of our total need. And with Pure Water, we will be able to purify that recycled water so that it's safe to put back in our water supply reservoirs, and then we can complete that cycle and be able to utilize all of our recycled water.

So Pure Water is based on proven technology. We would treat the water to a tertiary level and then subject it to this five-step treatment process: It starts with ozonation. It's followed by biological filtration, then membrane filtration, reverse osmosis, and UV. And the purpose of using these treatment steps one after another is to just make sure that no contaminants are able to get through.

And so we have a 1 million-gallon-a-day test facility. It's up at our North City Reclamation Plant. We've been testing the technology for the last five years. Through that extensive testing, we've done numerous lab tests. Samples have been analyzed at outside labs, and the results all show that the water has exceptional quality.

So Pure Water is a program that we're going to implement in phases from now to 2035, and by that time our plan is to produce 83 million gallons a day, and that will be a third of our need. In Phase 1, which is the subject of this EIR, we'll be delivering the first 30 MGD by 2021, and the focus is all at North City. The remaining 53 will come from a combination of facilities located in the central and southern parts of the city, and in those phases we'll be utilizing other City reservoirs, Lake Murray and Lower Otay, and their adjacent treatment plants.

And so this slide just gives you a closer view of the Phase 1 facilities. It will start with the Morena Pump Station, which will be located near Morena Boulevard and Friars Road. We'll be building a new wastewater pump station, as well as an 11-mile force main, to send additional wastewater to North City.

We have an existing 3 million-gallon a day reclamation plant. We're going to expand that so we can continue to serve our purple pipe customers, as well as to provide recycled water to the new purification facility across the street. And this will house that five-step purification process to purify the water, and then it will be conveyed to our Miramar Reservoir about

8 miles away.

In addition to our Phase 1 Pure Water facilities, we'll also be building a cogen facility next to our Metro Biosolids Center, and this facility will take landfill gas and generate about 16 megawatts of power, and a portion of that will be transmitted to North City to support our new purification plant.

And this gives you a high-level look at our schedule. We are currently in design. All of our projects completed preliminary design last calendar year. Design is scheduled to complete in mid-2018 and then construction to start in early 2019 and be completed it 2021.

So these next slides walk you through the individual projects. Again, Morena, our new pump station, would be located off of Friars Road. We'll build an 11-mile pipeline to convey the wastewater up to North City, and then we'll also be taking waste from the purification process and bringing it back down to bypass that pump station so that it doesn't just recirculate.

AUDIENCE MEMBER: Can I ask you something while you're on that slide?

So is that the same -- you're going to have two separate pipes next to each other, one will be pumping north -- everything north, and the other will be pumping

south?
AMY DORMAN: Correct, two separate pipelines.
AUDIENCE MEMBER: And how far apart are they separated?
MARK BRUNETTE: Again, I want to try to wait on questions. This is really intended that she does her presentation, and then what I would suggest is that you can pose those questions in the comments when we have the comment period.
AUDIENCE MEMBER: But questions won't be part of the limitation on our comments, would it?
MARK BRUNETTE: No, no. I'm just saying --
AUDIENCE MEMBER: Okay. So we're going to have a comment -- or a question period and then a comment period.
AUDIENCE MEMBER: How are we going to know what to comment on if we can't --
MARK BRUNETTE: Well, actually, this isn't set up to be a dialogue and to be a question --
AUDIENCE MEMBER: It should be.
MARK BRUNETTE: -- and answer.
Well, I understand. That's the way it's set up, and we're here to take input from you. If there's time at the end of the meeting and if Public Utilities staff is available -- they may be available to answer

questions, but, again, the intent is for you to provide input for things that should be analyzed in the EIR. So let's let her finish her --

AUDIENCE MEMBER: I mean, we've got to know what's going on if we're going to make a comment, and without -- you know, Ms. Knight asked how many -- you look at the diagram, there's only one pipe.

MARK BRUNETTE: Okay. Well, again, I want to stay focused on letting her finish her presentation, and then I'll open it up to comments.

AUDIENCE MEMBER: Questions.

AMY DORMAN: Okay. So on to our North City Reclamation Plant. We will be expanding it from its current capacity, again, to continue supporting purple pipe demand and to provide tertiary feed water to the purification plant.

This is a preliminary site layout of the expansion. We will be building new basins, new filters, a pump station, and purifier. So it's quite complex, and we'll be carefully planning the sequencing of the construction just to ensure that the plant maintains operations at all times.

Across the street the Department owns a vacant parcel of land, and this will be the site for our future purification plant. It will be equipped with that five-step purification process. Again, those are ozone, biological filtration, membrane filters, RO, and UV with advanced oxidation.

The purified water will be conveyed to our Miramar Reservoir through a 30 MGD pump station located adjacent to the purification plants, and it also entails an 8-mile pipeline through Miramar Road and makes its way up to Scripps Ranch to our Miramar Reservoir.

The last mile or so of the pipeline will actually be installed within the reservoir, and the intent is to release the water at the west end -- or, I'm sorry, the east end, and this is to maximize the time the water is in the reservoir, as well as maximize blending with other supplies to the reservoir. We actually take water out on the west end of the lake.

So Pure Water is sustainable. Our buildings will be LEED certified, and during construction we'll be recycling our construction waste.

Just one last thing: Pure Water has received broad support over the years. These are the logos of organizations that have come together in organized support of the program. There are about 30 organizations shown here. So we have environmental community -- so groups like the Audubon Society and Coastkeeper -- along with the building industry and the

Taxpayers Association and many others.

So if you would like more information, you can visit our Web site at purewatersd.org or follow us on social media. So that concludes the formal presentation.

MARK BRUNETTE: Thank you for the presentation and overview of the project. I'll now open up the meeting to public comment. Please remember that all comments are limited to three minutes.

And I'm going to stress again, you can ask questions, but we're not going to answer them at this time. They will be recorded, and you can also do written comments, which will be given to staff preparing the document.

And, again, this is the first step in the process. You'll have many more opportunities to -- you know, if you put yourself on the list, you will get a copy of the draft document, and you can comment on that as well. So, again, just focus on comments. You can put questions in there, but we're not going to answer those tonight.

So I can either bring the microphone to you, or if we could come up here. What would you prefer?

AUDIENCE MEMBER: (Robert C. Leif) I prefer to go up there.

MARK BRUNETTE: Okay.

AUDIENCE MEMBER: This is a typical PR, rather than scientific engineering, meeting. It's not been peer reviewed. It should have been given as a seminar over at our major universities, a quick chemistry department would be fine.

I will now go that each member of your reverse osmosis array needs to have its own conductance detector. You need a PhD biomedical engineer, microbiologist, and molecular geneticist, someone well trained, postdoctoral training, to actually run this thing and have direct reporting rights to the mayor and council because it's a quality issue.

Now, you've never -- you talked about data, but you don't show it. What we need to know is what's the chemistry of the present raw input, primarily from the Colorado River, the existing method being applied to the present raw input, the present raw input after the new purification method, recycled water starting material, recycled water after the new purification method, and the competing Poseidon water. Without that data no one can make any rational decision.

We have a problem with the farm industry. Presently, they're discharging, as they should, to the ocean. There are certain things you can get away with.

Now, if you take that water and put it into the recycled water, I don't know, and I don't think anyone knows either.

By the way, in your assays it will be interesting to see how you measure your coliforms, what DNA you had in there, and all sorts of wonderful things in molecular biology, which I don't think you have anyone -- any real knowledge to do.

And, also, the methane production is poor. I realize it's the only way you can do coproduction now, but that has to eventually stop because the methane is such a rotten stuff when it comes to absorbing infrared light. It's much worse than Co2.

Do you have any questions, sir? Or I would put it this way: This is not a good way to have a discussion.

MARK BRUNETTE: Thank you.

AUDIENCE MEMBER: Hello. My name is Ray Paulson, and a few comments.

MARK BRUNETTE: Could you also do your address as well.

AUDIENCE MEMBER: Address?

MARK BRUNETTE: Yeah.

AUDIENCE MEMBER: My address is 6369 Caminito Marcial, San Diego, 92111.

MARK BRUNETTE: Thank you.

AUDIENCE MEMBER: I'm a registered professional mechanical engineer and also environmental engineer.

Back in 2001 the City of San Diego did a study on sewage treatment to tap. The engineer told the medical team he needed a microbiologist and those type professionals to certify what was in the water before he could design the system to treat it.

And they got some folks from UCSD medical team and the research scientists up there, and they came back with a comment that they couldn't certify what was in the water. They knew what they could measure for and the micro bacteria-type and virus-type stuff. They knew what they could look for with their instrumentation, but they couldn't guarantee there wasn't other things in the water.

In other words, the instrument you're looking with is limited. In life we're discovering this every day, and so how -- what's the smallest diameter bug you could have could not be answered. What's the spectrum, you know, that we can measure for, it couldn't answered. What they did say was that for what we can measure, we can tell you what's in there based on our current knowledge. So with that information the PE said, "I can't PE stamp a water treatment system for treating things that are unknown to the medical community."

How has this changed? Things evolve all the time. Like antibiotics work, and then ten years later they don't work because bugs evolve around treatment systems, and they evolve in diameter size for treatment. That's one big concern, and I haven't seen any data speaking to this.

When Orange County came down -- they've done this for some time, sewage to tap -- we've asked the same questions, and the engineer stalled and would not answer the questions, and they would not provide us data.

I think the City of San Diego -- I worked there years ago as a student engineer. Often things get rubber stamped in one district, and we start to assume they'll work in another district, and so we start to then -- we just assume things, and we don't check things out in enough detail.

The other concern is, you have -- if you take a good toxicology class at UCSD, you'll find that the medical teams will tell you they're discovering the results of poisons -- there's a lot of neat poisons out there, and when you have toilet to tap, every household is an uncontrolled source of potential sabotage of your water system.

And so there's been instances where the KKK and other terrorist groups -- like I know we have ISIS today. They're not real happy people, and they do things, and in our classes what they discussed were plans that terrorists have had to disrupt water supplies in the past, and it's very clever what they do, and it's very micro. It's below nano size in delivery systems, sometimes encapsulated in something so it won't dissolve, or it'll stay in solution, but filters can't catch it. So it's an order of magnitude below nano to get through a water treatment system. So you face an issue there because you've closed the loop.

MARK BRUNETTE: Sir, if you can kind of wrap up your comments.

AUDIENCE MEMBER: Yeah. So those are two issues. The third issue is, when you have -- global warming is not going away. I work for the Navy today, and sea rise is an issue. It's not going to turn around overnight because of the carbon released from the ocean is delayed 20 years, and we haven't reduced our combustion to date, so drought is going to be a reality for a while.

So what's filling our aquifers now, if you count on treating it with any method, your treatment -- your reject water, your evaporation, your waterline leaks, you get about a 50 percent loss when you go to treat. So you can't make up a hundred percent, and you're using a diminishing supply.

MARK BRUNETTE: Thank you for your comments, sir. We're going to have to wrap this up.

AUDIENCE MEMBER: Well, I'm wrapping up.

So it looks to be a waste of taxpayer monies to recycle sewage water, even if you could do it successfully, because you have diminishing supply.

What's promising and what the Navy is looking at is saltwater to tap because of the new graphene. Graphene is a new super material. Oak Ridge National Lab now has new RO filters with significantly reduced energy --

MARK BRUNETTE: I ask you to put the rest of it in written comments and --

AUDIENCE MEMBER: -- for treating saltwater to tap --

MARK BRUNETTE: -- three minutes each.

AUDIENCE MEMBER: -- which would -- where the money would be well spent for ensuring we have water security; otherwise, we may not. So there -- you can face major litigation on this choice for sewage to tap in these different ways.

MARK BRUNETTE: Thank you, sir.

AUDIENCE MEMBER: Deborah Knight. I'm the executive director of Friends of Rose Canyon, and one of the reasons why I was interested in asking questions is that my concerns relate to the physical construction required for this since it's an area we work on, Rose Canyon and the Rose Creek Watershed.

And a lot of the facilities that you are building, the force main -- the two force mains, as it turns out, cross Rose Canyon, and I certainly have questions about where they're chosen to cross Rose Canyon, Genesee, as opposed to going underground at Miramar.

Also, I hadn't realized that they were going to construct -- I know they're going to construct more facilities adjacent to the current plant that actually drains directly into Penasquitos Lagoon. So that's a concern.

And for the other -- the new facility on the vacant property is a property that we've actually worked to get protected in the past. Now I see something is going to be built there, but that also -- that is in the Rose Creek Watershed.

So there's a lot of construction going through and adjacent to the Rose Creek Watershed, and if I can't find out specific details about that, it's pretty difficult to comment on anything. You know, as I said, I didn't even know there were two -- you know, there were two mains. Where exactly are they going? Now I see a map. What are the other alternatives?

But I need to have some kind of information in order to make intelligent comments, suggestions, alternatives around the physical construction of facilities that will be required for this. Is there anywhere to get those? Is there someone I can call and ask those -- an engineer or someone I can call and ask those questions of?

MARK BRUNETTE: We'll see at the end of the meeting if we can --

AUDIENCE MEMBER: That would be helpful.

MARK BRUNETTE: -- give you a contact. I think the other thing is, you will also have a chance to comment on the draft EIR, which will go into much more detail and --

AUDIENCE MEMBER: Right, but once you're in -- once they've spent hundreds of thousands of dollars doing the draft EIR, they're not likely to consider options the way they are at this point. And the whole purpose of this point is to be able to make intelligent recommendations or suggested alternatives, and my experience is once you get the draft EIR, you're -- the horse is, you know, out of the barn, and legitimately so. You've spent a huge amount of money, and this is obviously going to be hugely expensive, the draft EIR. So I don't want to end up having to, you know, do this at a point way further down the line. I'd much rather be able to get the actual information and make some -- have intelligent discussions at this point in the process.

MARK BRUNETTE: And I hear what you're saying, and as I said, we'll see if we can put you in touch with someone at the end of the meeting. All of your comments have been recorded and will be given to the preparers of the EIR, but I'll see you at the end of the meeting and see if we could put you in touch with someone.

AUDIENCE MEMBER: Thank you.

MARK BRUNETTE: Thank you.

AUDIENCE MEMBER: Scott Andrews, 4745 Del Mar.

I've heard that we need to resubmit our comments. I object to that. I refuse to do that. They should be part of the record. It's the same project. It's just been phased, but in the interest of brotherhood, sisterhood, transgenderhood, I'm presenting our -- the large mass of our scientific documents to you in hard copies, but I want assurance that our prior comments by email and verbal testimony are still in the record. Shouldn't have to submit those twice.

Are you asking for a permanent Clean Water Act waiver? You're leaving basic facts out of your promotional material. We need to know that.

Is the EIR for Phase 1 only? You can answer that right now.

MARK BRUNETTE: It is.

AUDIENCE MEMBER: Okay. Then we -- contraindicated to phase an EIR on a massive project of this scale.

We want to know the ocean marine life impacts. We had the NRDC and Heal the Bay scientists comment on the 2009 waiver. They hold true today. And further, we want the cumulative impacts decade by decade, year by year.

And we want mitigation for the City of San Diego's failure to comply for over three waivers now. So we want to see what they're going -- what their offered mitigation is for that failure and that intentional noncompliance.

Ocean viruses as discharged by Point Loma killed a surfer, a famous surfer in '15, 2015. What are you doing to mitigate the danger of viruses from Mexico, a third of whose discharge is raw sewage, and the stuff coming out Point Loma that comes up the coast and is pushed onto the beach by wave action and wind?

What are your population projections? Are you accepting SANDAG's projections to 2035? the original date of 2050? We need to know what your baseline data is, and you're not supplying it.

What's the optimal reclaim potential for reclaim? What is the optimal conservation number? Understand it's averaged around 20 percent, City of San Diego. Public was very responsive. We want those numbers. We want those -- if you don't have the numbers, we want the projections.

What are the conditions of the -- well, I don't know of any aquifers. I've never seen an aquifer map provided by your department. Is there a Mission Valley aquifer? Is there a Downtown San Diego aquifer? What is their condition? What is their capacity? Why are they not being used for natural filtration, as is being done in your favorite model, Orange county?

MARK BRUNETTE: Could you wrap up your comments, please.

AUDIENCE MEMBER: Regarding desalination, we want to know the online in Southern California. We want to know the proposed in Southern California and northern Mexico, because all of these alternatives I've listed in my questions could render your project totally redundant. And we're going to watch to see if you break the law by promoting this project prior to adequate, complete study.

The last point I want to make is -- excuse me.

The last point I want to make is that your notice has been very deficit. You're not notifying ocean user groups, recreational user groups, environmental groups, taxpayers of potential hikes and spikes in their fees.

I've already complained about notice, and I've complained about the notice of your meetings: two days apart, fighting traffic up to get here. So those are some other concerns.

MARK BRUNETTE: Thank you.

AUDIENCE MEMBER: Shelli Craig. My address, 7728 Laramie Court, San Diego, 92120.

I'm happy to cede whatever time I have left to you, Scott, if you would like to finish whatever else you might like to say.

But I'm confused as to why there's not another desalination plant planned for the cost of $1 billion. That's what Carlsbad ended up being, and it's about the same project time when another plant would go live.

Also, this plan does not get us any closer to water independence. We are operating on the same ever-dwindling resource, water that's imported. So I just don't think the math comes out, spending three and a half billion dollars on something that is operating on water that takes so much effort to get it clean just to put into an open body of water.

This is not a recommended way to handle this kind of water according to the EPA guidance document. In fact, there's no -- there really isn't any good guidance on water reuse like this. Really it's reuse, not recycle. Recycle, for the most part, of water like this goes to recharge aquifers. That's not anything that you've addressed. There's a lot of local aquifers that really need help, especially the local farmers. So honestly, I think that study needs to be done as well.

We need to grow food. It's simple. So, you know, without air, one minute. Without water, one week. Without food, maybe three weeks. So I understand we're close, but this isn't the right plan.

MARK BRUNETTE: Thank you for your comment.

AUDIENCE MEMBER: Thanks for ceding your time.

So the environmental -- that's an extraordinary coalition you've formed. Wasn't that formed a year or two ago? So I want the records of the meetings that prompted all those groups to sign on to your project. I never heard about them. I want those official records and minutes because they were not -- they did not have the benefit of any environmental study.

Why would any environmental group sign in to a multi-billion dollar project that affects the health of the ocean, the people who use the ocean, and the people slated to drink your water, including hospital patients on dialysis? So I want to know -- I want -- I'm formally requesting the records of those minutes. That's pretty interesting.

Regarding the three phases, are we assured that they'll all be completed on time? In other words, you used to have a total project that's now being phased in, and I want to briefly speak, and I'll complete.

MARK BRUNETTE: Sir, that's the end of her ceded time. Thanks.

We have any speakers?

AUDIENCE MEMBER: Who wants my data?

MARK BRUNETTE: Yeah, why don't you bring it up here.

AUDIENCE MEMBER: It's from our last comment.

MARK BRUNETTE: Thank you.

Hi. I'm Jim Peugh. I'm the conservation chair of the San Diego Audubon Society. I live at 2776 Nipoma Street in San Diego, 92106, and the Audubon Society supports this project and has as it's been evolving.

As far as comments on -- scoping comments of -- we're really pleased to see that the Miramar alternative seems to be working. We hope that the process will do as much as it can to make sure that works to keep the energy use down for the project.

Greenhouse gas, to us, is really important. Climate change has a huge impact on the wildlife that we appreciate, and so we urge the process to do as much as possible to reduce the greenhouse, you know, particularly the carbon discharges, and while -- we understand that methane is going -- from landfills is going to be used for this project, so we urge that that be emphasized as much as possible, you know, One, to prevent the methane from escaping and then, Two, to displace the use of carbon.

San Diego has a lot of pipe breaks, and there are a lot of things that can go wrong with this system. So we hope that the EIR will actually look and analyze the failsafe provisions, you know, failsafe as far as water quality. As far as breaking sewer lines that could contaminate areas and in the sludge lines as well -- and something else I can't read -- oh, and the chemical handling that you're doing. We want to make -- you know, we hope that the EIR will look aggressively at making sure those are all as failsafe as possible.

And just in the design of the system for maintainability, you know, we have a hard time maintaining the infrastructure in San Diego. This is a lot of stuff, so just make sure that this is designed to be maintainable as well.

And we want to make sure -- we understand there's a lot of quality control for the drinking water, and we also urge that as much quality control go into the water that's going to be discharged back into the ocean.

That's all my comments. Thank you.

MARK BRUNETTE: Thank you. Any other speakers?

Do you want me to bring you the microphone or are you --

AUDIENCE MEMBER: No. I can come over there.

MARK BRUNETTE: Okay.

AUDIENCE MEMBER: If there's another speaker that wants to go while I work my way over, that would be good. Am I going to be the last one, then?

MARK BRUNETTE: Maybe. Take your time.

AUDIENCE MEMBER: Oh, thanks. I appreciate that.

AUDIENCE MEMBER: So I'll use -- can I use ten seconds for another question while he gets here?

MARK BRUNETTE: No. I actually would ask that you put it in writing.

AUDIENCE MEMBER: Could you put the slides back up, please.

MARK BRUNETTE: The slides back?

AUDIENCE MEMBER: Yeah, I'd like the slide of the five-step process.

Now, here's -- I'm submitting for the record some written comments, which I've also submitted by email earlier today. And I'll give one to the court reporter so that she's got my proper name and address on file. Here you go, ma'am.

Hello. I'm John Stump. My name and address is on file. I took great umbrage to several misrepresentations in this presentation. One misrepresentation was the environmental community was against that -- is supporting this.

I've been an environmentalist for 50 years. I don't know where I stand on this because I can't get the information I need, and your presentation denied the public the ability to ask questions. We can only give you comments.

On this five-step process, are you representing that the current chlorine introduction will be discontinued when this goes through?

You're not responding?

MARK BRUNETTE: This is not the forum to answer the questions, but that's something that will be --

AUDIENCE MEMBER: Okay. So --

MARK BRUNETTE: -- staff will have on record.

AUDIENCE MEMBER: Because this slide represents that.

How much money has been put into this project to date? What have we sunk into this?

The most important question is -- the first question in my comments is: What are the projected costs to the rate payer, how much is this going to cost me at home, and how much is this going to make housing unaffordable?

I've got some other written comments which I made during the meeting, and I'm making a public records request -- which I think Mr. Andrews made a good point concerning the minutes, agendas, and correspondence to these so-called environmentalists.

Did they fill out conflict of interest forms? Have they received any benefit from you?

On the cogeneration, is that going to be a cost to the program because it's one enterprise fund transferring to another? I think that's got to be made clear.

I really don't like the fact that you're supposed to be a neutral body telling us facts, and yet you use euphemisms and put your thumb on the scale.

You know, I asked the young woman, "Is our water not pure today? Is it not safe today?" You know, by using that term "pure," it's either not safe today and you're really catching up, or is it going to be as pure as the water we got today?

Oh, key point: You, sir, made a statement that you were going to provide information to decision makers. Well, in my letter -- it's the last paragraph, the last sentence -- I remind you of City Attorney Policy LO 90-2, which prohibits you or anyone else that's going to be involved in the CEQA process from having ex parte communications with the legislative body because --

MARK BRUNETTE: Sir, could you wrap up?

AUDIENCE MEMBER: I'm going to wrap it up.

MARK BRUNETTE: Okay. Thank you.

AUDIENCE MEMBER: Do you understand what I'm telling you? Don't communicate outside of public hearings with city council. Amongst yourselves at the executive branch and the mayor, that's okay, but we have a separation of powers now, and it is inappropriate, since they will be the quasi-judicial body, for you to have any communication outside the public hearing or a council meeting with that body.

Thank you very much. I've submitted written comments, and I've got some more that I'll submit at the end of the hearing.

MARK BRUNETTE: Thank you. We have anyone else who wanted to speak?

AUDIENCE MEMBER: May I -- I have a question, just simple.

Is the PowerPoint that you presented here today, is that on the Web site? And if not, would you put it on the Web site, please.

AMY DORMAN: I believe we can make it available. It's not currently.

AUDIENCE MEMBER: Okay. I mean, you can email it out to those of us here today, but you might want to just put it on the Web site, since you've gone to the effort to prepare it. One way or the other.

MARK BRUNETTE: Okay. Thank you very much for your comments. Seeing that there's no other members of the public that want to speak -- I don't think anyone else wants to speak who hasn't spoken yet -- I'm going to go ahead and close this meeting and make a few closing remarks.

This closes the public environmental scoping meeting for the Pure Water San Diego Program North City

Project. Your input will be transcribed, considered by City staff for use in the scope of the EIR, and included as part of the official record for the document.

Speakers and commenters who provide their contact information will also be placed on the notification list for further environmental review actions related to this project. So if you haven't put your name on the sign-in sheet over at the entrance on the table here, please do so.

I would also like to remind everyone that this is just the start of the environmental review process and opportunities for public input. There will be other opportunities to provide comments on the project, such as during public review of the draft environmental document and in any further public hearings on the project.

Thank you for taking the time to participate in the meeting, and have a great evening.

(The proceedings concluded at 7:25 p.m.)

* * *

STATE OF CALIFORNIA)
)
COUNTY OF SAN DIEGO)

I, Julia Lennan, a Certified Shorthand Reporter for the State of California, No. 12843, and Registered Professional Reporter, No. 8269, do hereby certify:

That the foregoing proceedings were reported stenographically by me and later transcribed through computer-aided transcription under my direction and that the foregoing is a true record of the proceedings taken at that time.

I do further certify that I am in no way interested in the outcome of this action or connected with or related to any of the parties in this action or to their respective counsel.

In witness whereof, I have hereunto set my hand this 3rd day of September, 2016.

____

JULIA LENNAN, RPR, CSR NO. 12843

From:	Brunette, Mark
To:	Balo, Keli; McPherson, Douglas; Megan Lawson; Shawn Shamlou
Cc:	Lavan, Tiffany
Subject:	FW: Pure Water San Diego Program North City Project EIR/EIS NOP / 499621
Date:	Tuesday, September 6, 2016 7:38:39 AM
Attachments:	NOP_PEIR_PureWater_MorenaPumpStation.pdf NOP_PEIR_PureWater_PublicUtilities_StormWaterDrainage.pdf

Please see the attached NOP comments from the City of San Diego Transportation and Storm Water Department.

From: Stephens, Mark
Sent: Thursday, September 01, 2016 5:44 PM
To: Brunette, Mark
Cc: Rom, Catherine; Fajardo, Jane-Marie; Rothman, Christine; Kalkirtz, Victoria; Thomsen, Douglas
Subject: Pure Water San Diego Program North City Project EIR/EIS NOP / 499621

Mark,

Hi! As briefly discussed, am sharing informal comments from the City Storm Water Division in response to the Notice of Preparation (NOP) issued for this EIR/EIS. A few general questions that I don't think were covered in the NOP or the scoping meeting attended: 1) Is a consultant assisting preparation of the EIR/EIS, and if so, what firm (mainly interested in who might be involved with hydrology and water quality)? 2) What role is the Bureau of Reclamation expected to play (perhaps potential federal funding assistance, or just a federal presence to serve as EIS lead agency for federal approvals required)? 3) For planning purposes, when should we expect to see a first screen check draft to review?

Page 19, Biology, Issue 6. The Morena Pump Station would be adjacent to Multi-Habitat Planning Area (MHPA) along the San Diego River. Both pipelines connecting to the pump station would cross through the MHPA at several different locations along the pipeline corridor. Existing Public Utilities Department mitigation sites are located upstream, and additional potential wetland mitigation opportunities may be of mutual interest.

Page 24, Hydrology and Water Quality. As pointed out through input to the Pure Water San Diego Program EIR completed, it's critical to recognize that water quality improvement plans (WQIPs) were prepared by watershed management area as directed by the Regional Water Quality Control Board, and watershed management area boundaries may not correspond directly with hydrologic units. The North City Project area includes portions of at least three WQIPs – those prepared for the San Diego River Watershed Management Area, Mission Bay Watershed Management Area, and Los Peñasquitos Watershed Management Area. Analysis of water quality impacts must recognize these diverse watershed management areas, and that highest priority water quality conditions vary in the respective WQIPs. For areas within City of San Diego jurisdiction, familiarity and compliance with the most current Jurisdictional Runoff Management Plan (JRMP) are also critical, as are familiarity and compliance with the most current Storm Water Standards and applicable provisions of the San Diego Municipal Code. The Draft EIR/EIS should address potential potable water discharges associated with testing or operation and maintenance. In Issue 2, correct the typo for "patterns."

Page 26, Public Utilities, Issue 1. The proposed wastewater force main and brine pipeline would start at the San Diego River, and cross Tecolote Creek and Rose Creek. All three streams are Clean Water Act Section 303(d) listed water bodies with associated storm water runoff and/or sedimentation issues. Address potential impacts during construction and/or location of the pipelines with existing infrastructure.

Page 27, Water Supply. One of our reviewers raised the question of whether opportunities for augmenting increased water supply through capturing storm water and/or dry weather runoff is under consideration, or might receive consideration as an alternative. Could the proposed Morena Pump Station facility accommodate collection of flows that would otherwise reach the San Diego River untreated.

Also, am attaching a couple of schematic graphics one of our reviewers (Catherine Rom) produced to help illustrate areas mentioned, including the streams potentially affected along the force main and brine line corridor, and existing infrastructure around the proposed Morena Pump Station.

Please let me know of any questions. Thank you!

Best regards,

- Mark Stephens

Mark G. Stephens, AICP
Associate Planner
City of San Diego
Transportation & Storm Water Department
Storm Water Division

T (858) 541-4361
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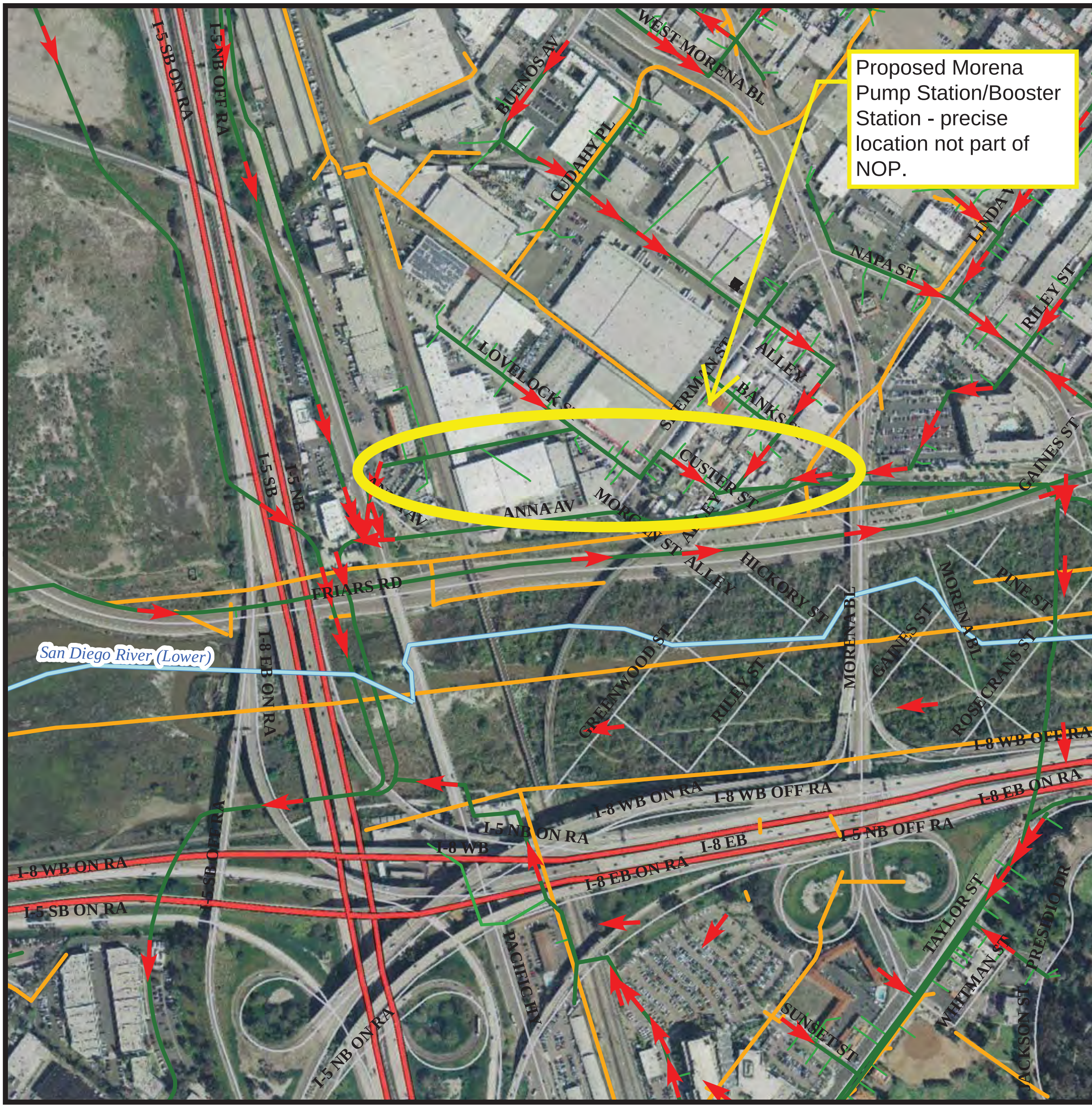
Pure Water San Diego Program
North City Project
Morena Pump Station

SENIOR PLANNER
Catherine Rom
(619) 527-7471



Sewer Mains

Storm Drain Pipe

Flow Direction Arrows

N
W E
S

No Scale

COMMUNITY NAME:
Linda Vista, Mission Valley

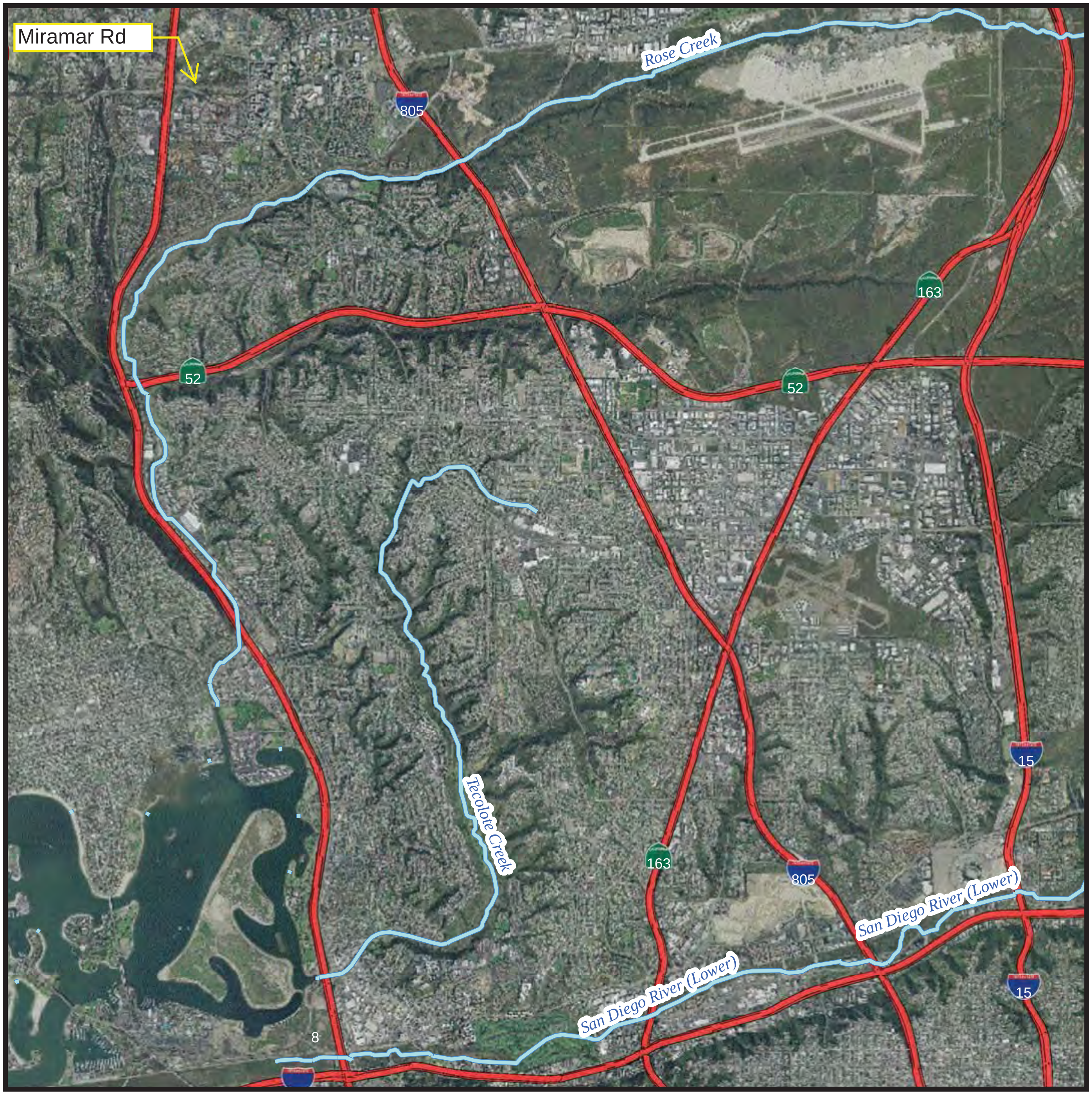
COUNCIL DISTRICT: 2, 7

SanGIS

Date: August 30, 2016

Pure Water San Diego Program
North City Project
Morena Pump Station

SENIOR PLANNER
Catherine Rom
(619) 527-7471



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No Scale

COMMUNITY NAME:
Linda Vista, Mission Valley

COUNCIL DISTRICT: 2, 7

SanGIS

Date: August 30, 2016