Appendix K
Analysis of Implementation Alternatives Technical Memorandum

CH:CDM

Santa Monica Bay Beaches Wet Weather Bacteria TMDL Implementation Plan

Technical Memorandum Task 9: Analysis of Implementation Alternatives

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1.0 Introduction

1.1 Background

The CH:CDM team is assisting Jurisdiction Groups 2 and 3 in developing an Implementation Plan to address the requirements of the Santa Monica Bay (SMB) Beaches Wet Weather Bacteria Total Maximum Daily Load (TMDL). This TMDL sets a limit on wet weather bacteria exceedance days per year based on monitoring at the SMB beaches.

There are seven jurisdictions, organized by watersheds, which are impacted by this TMDL. Of these seven jurisdictions, the City of Los Angeles is the lead agency for Jurisdiction 2 and is a significant participant in three other Jurisdictions (1, 3 and 7). The City of Santa Monica is the lead in Jurisdiction 3 and is a participant in Jurisdiction 2. Other responsible agencies within Jurisdictions 2 and 3 include El Segundo, the County of Los Angeles, and Caltrans. This technical memorandum (TM) pertains to the joint implementation planning effort for Jurisdictions 2 and 3.

In support of the Jurisdictions' efforts to prepare the Implementation Plan, the CH:CDM team is under contract to provide the following tasks:

Task 1: Assist with TMDL Development Planning
Task 2: Provide Staff Support for the Development of Integrated Implementation Plan
Task 3: Regulatory Requirements
Task 4: Detailed Hydrologic Study
Task 5: Beneficial Use Evaluation
Task 6: Treatment and Management Options Evaluation
Task 7: Coastal Collection System Evaluation and Conceptual Alternatives
Task 8: Research Potential Sites for Collection, Treatment and Diversion Facilities

Task 9: Analysis of Implementation Alternatives
Task 10: Prepare TMDL Implementation Plan
Task 11: Task Management

This Technical Memorandum (TM) is the deliverable for Task 9: Analysis of Implementation Alternatives.

1.2 Purpose

The purpose of this TM is to compile the technical and regulatory information from Tasks 3 through 8 and to develop alternatives that could be implemented to meet the requirements of the TMDL. This analysis includes additional hydrologic modeling to establish a risk assessment methodology as well as the development of alternative evaluation criteria as a means to compare the alternatives.

Three different alternatives were developed and evaluated for the Implementation Plan. These alternatives are designed as integrated solutions that will each meet the objectives of the TMDL. Each alternative was comprised of a combination of several runoff management options. This TM presents the approach for defining and evaluating the alternatives. As a result of this evaluation, a preferred alternative that is a hybrid of the initial three was identified.

2.0 Approach

A summary of the initial hydrologic analysis performed to quantify the runoff from the theoretical target storm was presented in TM 4. This work was based on the concept of managing a volume of wet weather runoff per subwatershed from the theoretical target storm. For the alternatives analysis, additional hydrologic modeling was conducted to refine and determine theoretical target volumes for varying levels of TMDL compliance risk across the subwatersheds. This effort is summarized in Section 3 of this TM. The resulting estimated runoff volumes were used in preparing alternatives designed to accommodate these levels of compliance risk.

Runoff management options were developed in TMs 5 and 6 and are summarized in Section 4 of this TM. The runoff management options were combined to form three initial alternatives, each with a different theme. It is important that the alternatives have significant differences to understand the various trade-offs that may be involved. The three initial alternatives are defined in Section 5. The three initial alternatives were then compared based on several criteria presented in Section 6. This relative comparison was used to formulate a fourth alternative, the preferred alternative described in Section 7, that is a hybrid containing elements from the initial alternatives. Some runoff management options, such as the Institutional Solutions that include non-structural components, were included in all of the alternatives. Other options were included in only one or more of the alternatives. For this project, the following three themes were used in developing the three alternatives (see Figure 1):

- **Low Cost** –includes options that will meet the minimum regulatory requirements with the least capital and maintenance costs. This alternative does not include a high amount of beneficial use of runoff and may pose a higher risk of non-compliance with the TMDL.
- **Low Risk** – includes options that will minimize the risk of non-compliance with the TMDL without regard to cost or optimizing the beneficial use of runoff.
- **Maximum Beneficial Use** – includes options that will maximize the amount of runoff that can be beneficially used. This alternative assumes the same risk of non-compliance with the TMDL as the low risk alternative.

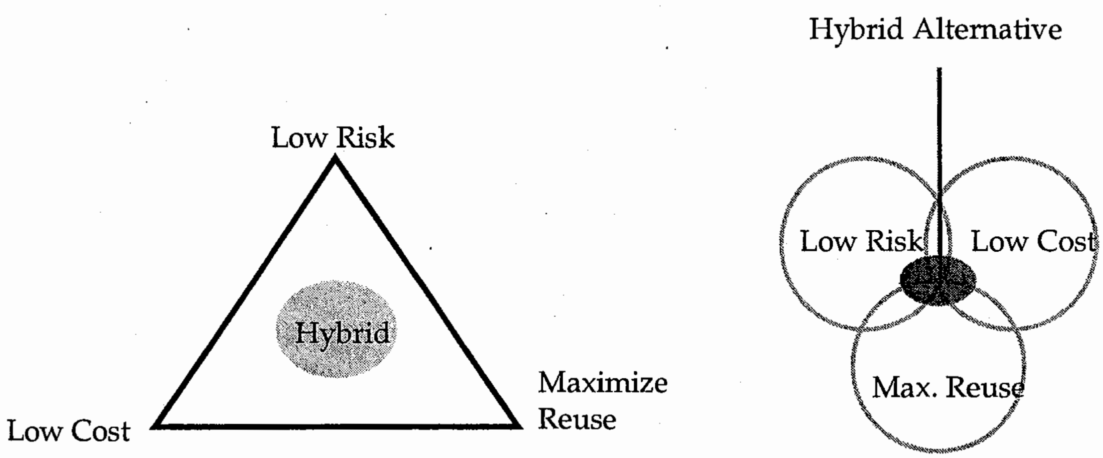


Figure 1. Graphic Depiction of Alternatives

The themed alternatives were compared using criteria developed through the stakeholder process, interactions with the Jurisdiction 2 and 3 agencies, and engineering and technical experience. A summary of these criteria follows:

- Amount of runoff beneficially used
- Regulatory compliance
- Design complexity and constructability
- Facilities siting difficulty
- Reliability
- Compatibility with a phased approach

Based on this relative comparison, a hybrid alternative was developed. This alternative is the preferred alternative that includes elements from the other three. This alternative balances the cost of implementation with the risk of compliance and the amount of beneficial use of runoff.

3.0 Hydrology Analysis

The hydrology analysis conducted and described in TM 4 was based on the concept of managing a theoretical target volume of wet weather runoff per subwatershed in order to comply with the TMDL. Each target volume was determined by modeling runoff from each subwatershed based on land use, topography, and historic rainfall data. This represented a capture volume, expressed in million gallons. This volume would theoretically capture runoff from all storm events necessary to not exceed the 17 day exceedance target in any given year. By increasing the theoretical target runoff volume to manage, less runoff bypasses capture, less runoff reaches the beach, and the risk of violating the TMDL decreases. Conversely, when capture volumes are decreased, more runoff bypasses capture and reaches the beach, and the risk of violating the TMDL increases. TM 4 included a range of preliminary target volumes and their corresponding risk of violations. A detailed description of the basic hydrologic model (XP-SWMM), assumptions, and methods is included in TM 4.

For the alternatives analysis, additional hydrologic modeling was conducted to refine and determine theoretical target volumes for varying levels of risk across the subwatersheds. These scenarios considered the hypothetical construction of operational storage facilities (representing theoretical target volumes) that were 1/4, 1/8, and 1/16 the previously-estimated capacity. In all cases, the captured runoff in operational storage would be managed and storage emptied in 24 hours to be available for the next wet weather event. For each subwatershed, under each scenario, the number of estimated discharge (bypass) days per year were established. The total number of discharge days that exceeded 17 in any given year were then listed as violation days.

The modeled data points were plotted and a relationship between capture volume and violation days was developed. Based on a historical record of 50 years (i.e., using 50 years of precipitation records), the theoretical number of violation days were then estimated for each storage volume.

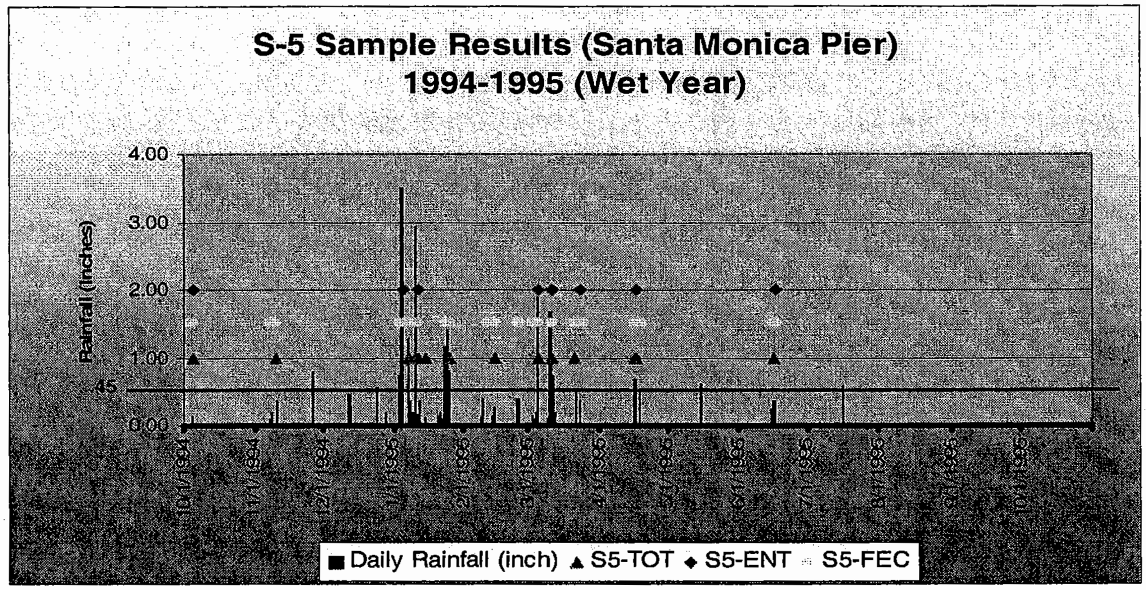
The following table represents the theoretical volumes that would have resulted in 1 violation year (more than 17 exceedance days) in 50 years, 2 years in 50, and 5 years in 50 for each subwatershed. In those instances where values needed to be either extrapolated or interpolated, linear regression between the two most relevant data points provided the basis of the predicted value. Therefore, these theoretical target runoff volumes represent three different levels of uniform risk across the subwatersheds.

Table 1 Estimated Target Volumes by Frequency of Violation Years				
		Volume (MG)		
Subwatershed	Area	1 year in 50	2 years in 50	5 years in 50
Castle Rock	4,982	2	2	1
Santa Ynez	1,226	6	5	3
Pulga Canyon	1,984	3	1	0
Santa Monica Cyn	10,125	29	25	7
Santa Monica	9,152	76	75	73
Venice Beach	109	<0.1	<0.1	<0.1
Dockweiler	6,879	54	53	52
Totals	34,457	169	161	136

The above result is a range of theoretical target volumes that provides a basis for making decisions when forming different alternatives. For example, the low cost alternative was formed to potentially manage smaller runoff volumes, however, the theoretical risk of violating the TMDL is higher. On the other hand, the low risk alternative was formed to potentially manage larger runoff volumes, and the risk of TMDL violation is reduced.

These volumes represent upper limits, or theoretical goals. In actuality, Jurisdiction 2 and 3 agencies recognize that achieving full implementation of these theoretical target runoff volumes would require aggressive implementation of regional, end-of-pipe solutions, which have major challenges and multiple significant constraints. Moreover, implementation of institutional and local solutions in an iterative, adaptive fashion may contribute to a higher percent success of reductions in bacteria exceedances and may minimize the need for regional options or in some areas, may eliminate their necessity altogether.

Upon a closer look at several typical years of rainfall and exceedance data at historical monitoring locations, there is more evidence to support the approach of first focusing on managing smaller storms through implementation of institutional and local solutions and monitoring their effectiveness before considering implementation of regional solutions.



The above graph shows rainfall, in inches, recorded for the 1994-95 rain year at sample location S-5 (Santa Monica Pier). It also plots the instances of bacteria exceedances for each of the indicators (total coliform, enterococcus, and fecal coliform) on the dates they occurred. The graph illustrates that the majority of the exceedances at this location are in fact caused by smaller storms. This was found to be typical for varied locations and rain years. This correlation supports the preferred approach to implementation, which is to first manage the more frequent, smaller storms through source control (institutional) and local solutions. Thus, the alternatives focus on implementation of institutional and local solutions, with the potential for consideration of regional solutions if it becomes necessary to achieve compliance goals.

4.0 Runoff Management Options

Based on work conducted under Tasks 5, 6, and 7, three categories of potential runoff management options have emerged for Jurisdictions 2 and 3. The options were chosen because they not only manage runoff volume, but they also specifically help to reduce bacteria concentrations in the runoff. Many of these options help to reduce concentrations of other pollutants as well. Runoff management options will be considered for inclusion into the alternatives in three categories:

1. Institutional (Non-structural) Source Control Options

2. Local Options
    a. Cisterns (Residential rooftop capture and direct reuse without treatment)
    b. On-Site Storage and Reuse (Capture and reuse, limited treatment necessary)
    c. Small Scale Capture and Infiltration
    d. Re-directing Downspouts

3. Regional Options
   a. Divert to Wastewater Treatment
   b. Capture, Store, Treat, and Discharge
   c. Capture, Store, Treat, and Reuse as Irrigation Supply
   d. Large-scale Infiltration Projects
   e. Capture, Store, Treat, and Inject
   f. Ocean Outfall Discharge

The first set of options, non-structural source control (institutional solutions), is discussed below in Section 4.1. The other options have been discussed in previous TMs and are reviewed briefly in Sections 4.2 and 4.3.

4.1 Institutional (Non-structural) Source Control Options

Institutional options are program level activities that provide source control measures intended to prevent or reduce levels of bacteria, or bacteria sources (e.g. garbage and trash) from initially being picked up by runoff whether on-site, in the curb/street, or in the storm drain system. They generally do not reduce the volume of runoff to be managed. Institutional solutions may only be of limited or minimal effectiveness in reducing bacteria exceedances at the beach by themselves, but their effectiveness will increase if implemented in an integrated, area-focused manner.

The City of Los Angeles recently revised its Best Management Practices (BMP) program as presented in their Development Best Management Practices Handbook (DPW BOS, 2002). The BMP Handbook identifies 14 BMPs that provide control measures to reduce or eliminate pollutant levels at their source. A list of these practices is presented in this section followed by a discussion of the current programs (Sections 4.1.1 to 4.1.7) in place by the agencies of Jurisdictions 2 and 3 to implement these BMPs and other source control measures. Although specific efforts by the Cities of Los Angeles and Santa Monica are highlighted here, El Segundo, Caltrans, and the County of Los Angeles have similar programs in place. These programs include public education and outreach, street maintenance, storm drain maintenance, land use planning and management, ordinances and codes, and enforcement. Following the discussion of the current programs, some additional institutional solutions that could be considered are summarized in Section 4.1.8. These measures are included in each alternative considered in this implementation plan.

4.1.1 BMP Program

The City of Los Angeles Stormwater Program is managed by the Department of Public Works' (DPW) Bureau of Sanitation's (BOS') Watershed Protection Division (WPD), but extends over many City departments and bureaus. The WPD is responsible for a variety of support activities and act as technical advisors to City Departments, outside agencies and the public on the use of Best Management Practices (BMPs). These activities include the identification, analysis and testing of potential BMPs for City use. Critical factors such as cost, pollutant removal, suitability of location, ease of implementation and maintenance are considered to evaluate the effectiveness of the BMPs before implementation.

A summary of the City's BMP program is presented in *Reference Guide for Stormwater Best Management Practice.* (City of Los Angeles, 2000). A list of the current BMPs for source control follows:

S-1 - Housekeeping Practice
S-2 - Public Education/Participation
S-3 - Employee Training
S-4 - Conserve Natural Areas/Vegetation Controls
S-5- Protect Slopes and Channels
S-6 – Provide Storm Drain System, Stenciling and Signage
S-7 – Trash Storage Areas
S-8 – Outdoor Material Handling and Storage Areas
S-9 - Loading/Unloading Dock Areas
S-10 - Waste handling and Disposal
S-11 – Vehicle Fleet Maintenance
S-12 – Repair/Maintenance Bays
S-13 – Parking Areas
S-14 – Provide Proof of Ongoing BMP Maintenance

4.1.2 Education and Outreach Programs

The Countywide Stormwater NPDES permit requires a comprehensive educational public outreach program to measurably increase the knowledge of the target audiences regarding the storm drain system, the impacts of urban runoff pollution on receiving waters, and potential solutions to implement BMPs to reduce pollution; and to change behavior by encouraging the target audiences to implement appropriate solutions. The City has developed and implemented stormwater outreach programs for the four target audiences (General Public, Industrial/Commercial, Schools, and Public Agency Employees) as outlined in the LACDPW Stormwater/Urban Runoff Public Education Program, Five-Year Public Education Plan.

4.1.2.1 General Public

The City of Los Angeles' public education program consists of a combination of printed materials, videos, as well as presentations and performances. These include a speaker's bureau to deliver presentations on the Stormwater Program to community groups and to conduct interviews with the media; participation in community festivals and other events; and the use of various media to reach a wide audience (e.g., billboards, bus ads, etc.) This activity also includes catch basins stenciling, which the City conducted since 1993. Over 30,000 catch basins have been stenciled with the "NO DUMPING – THIS DRAINS TO OCEAN" message.

The BOS also works in partnership with other agencies to develop and execute programs and educational materials. For example, in partnership with the City of Los Angeles' Department of Animal Services, the Stormwater Program Public Education staff created the guide *What's the Scoop* for pet owners that provides information about pet adoption, picking up pet waste when in public areas, spaying and neutering, and washing pets indoors using less toxic shampoos.

The City of Santa Monica has similar public education programs. For example, the Stormwater Environmental Educational Partnership (SWEEP) pilot program was funded by the Santa Monica Bay Restoration Project and is being implemented by the City in partnership with Heal the Bay. The program aims to increase public awareness about urban runoff pollution by training local junior high and high school students to make presentations to business and community groups and to distribute public education door hangers throughout the community. The City has also produced educational videos about urban runoff that have aired on the Santa Monica cable television station and have a catch basin stenciling program. They have developed and distributed educational posters and posters for the restaurant and auto maintenance industries outlining BMPs to reduce urban runoff contamination and volume due to their operations.

Since 1994, the Santa Monica Bay Restoration Commission has offered Los Angeles communities the Public Involvement and Education (PIE) Program. Through this mini-grants program, the SMBRC encourages communities, local organizations, and businesses to take a leadership role in educating peers and residents about the need to protect and restore the Bay.

The City of Santa Monica adopted a new community outreach program called the Green Team Project in 1999. These teams consist of six to eight members that meet six times over a twelve-week period. They work together to improve their quality of life through adopting sustainable practices, such as reducing household waste, limiting toxic chemicals in the home and work place, and increasing individual community involvement. The participants receive step-by-step guidance and support from Green Team Project staff.

4.1.2.2 Public Agency

The City of Los Angeles BOS has prepared a Public Agency Activities Stormwater Guide describing the NPDES permit requirements applicable to City activities that may have an impact on storm water quality, organized according to the following major categories of activities performed by City staff:

- Sewage Systems Operations;
- Public Construction Activities Management;
- Vehicle Maintenance/Material Storage Facilities Management;

- Landscape and Recreational Facilities Management;
- Storm Drain Operation and Management;
- Streets and Roads Management;
- Parking Facilities Management;
- Public Industrial Activities; and
- Emergency Procedures.

In addition to listing specific NPDES permit requirements (such as catch basin cleaning and street sweeping), each section of the Guide highlights BMPs that may be implemented to further improve the quality of stormwater and nonstormwater runoff. Over 290 copies of the Guide have been distributed to 47 City departments and agencies. Training of City employees on the Guide emphasizes the impact their daily activities can have on the quality of urban runoff.

Most of the City facilities that conduct vehicle and equipment repairs, painting, fueling, lubrication, serve as salvage yards, serve as chemical storage facilities, have landscaping or parking facility management, or serve as temporary storage areas for waste oil are required to develop and implement site-specific Stormwater Pollution Prevention Plans (SWPPPs). SWPPPs identify potential sources of pollution that may affect the quality of stormwater discharge from a facility and also describe and ensure the implementation of BMPs to reduce the pollutants. Employee training programs for the SWPPPs are also conducted at these facilities. The City conducts both planned and surprise audits of its facilities to assure compliance with the SWPPPs.

The City of Santa Monica provides NPDES Urban Runoff Training for City Employees. The City's Stormwater Coordinator conducts urban runoff training sessions for City field crews at the City Yards and the Airport, as required by the City's NPDES permit. The training involves a presentation on urban runoff concerns and BMPs related to City operations as well as feedback from the employees on how to improve stormwater management at their job sites. The training sessions have resulted in significant improvement of the City's stormwater pollution prevention plans due to employee recommendations of procedural and structural changes to help reduce runoff volume and toxicity.

4.1.2.3 Industrial/Commercial

Site visits by the Industrial/Commercial Education Program are primarily intended to be educational and to provide designated businesses with information regarding the City of Los Angeles Stormwater Program and guidance in complying with stormwater regulations using Best Management Practices. The inspectors visit the targeted businesses at least twice to ensure that the facilities have been furnished with all the necessary information they need to reduce the discharge of pollutants from their business operations into the storm drain system. These facilities vary from small restaurants to large refineries.

The City has also created several posters and brochures that are applicable to specific business types. There are posters specific to industries such as the automobile repair industry and the food and restaurant industry. There are a series of pamphlets that describe storm drain protection for different industries measures as follows:

- Auto Maintenance & Car Care
- Food Service Industry
- Fresh Concrete & Mortar Application
- General Construction & Site Supervision
- Heavy Equipment & Earthmoving Activities
- Home Repair & Remodeling
- Horse Owners & Equine Industry
- Landscaping, Gardening & Pest Control
- Painting
- Pet Care
- Private Sewage Disposal Systems
- Roadwork & Paving

4.1.2.4 School Education Program

The City of Los Angeles' school education program consists of a combination of printed materials, videos for classroom discussion and presentations and performances at school assemblies. In addition, the City has developed colored vinyl stickers with sayings such as "Oil Makes Eels Ill", "You Otter Not Pollute" and others. The "Clean Water Patrol" coloring book for children teaches them about their "urban forest" and how neighborhood behavior can affect the environment.

4.1.3 Street Maintenance

Street maintenance is an important element in reducing or eliminating the amount of pollutants, including bacteria that are swept into the stormwater collection system during a rain event. It includes street sweeping, picking up litter, and maintaining trash receptacles.

The City of Los Angeles Bureau of Street Services provides roadway maintenance of approximately 7,300 miles of public streets, alleys, pedestrian tunnels and public stairways. They clean these facilities using a variety of methods including machine sweeping in commercial, industrial, and residential areas on a daily, weekly, and monthly basis. They remove litter and illegally dumped debris from public streets and alleys. They also provide special cleaning before and after parades and special civic events.

The Bureau services over 3,000 trash receptacles citywide. Bureau policy is to install litter receptacles on public property at major intersections, bus stops, and crosswalks where heavy pedestrian traffic generates considerable litter. During the day, litter receptacles and curb returns are serviced on various frequencies.

Under the Adopt-a-Basket program, litter baskets are furnished by the Bureau of Street Services to civic or community organizations or individuals provided that service responsibility is assumed by the participant(s). Organizations or individuals may request placement of a limited number of special green receptacles at approved locations. They are not intended for the convenience of individual property owners. Receptacles placed under this program are monitored and, if adequate service levels are not maintained, they are removed by Bureau forces.

The City Council has also approved a bus bench franchise whereby the franchisee shall supply, maintain, and service trash receptacles at bench site locations determined by the Bureau. Under this bus bench program, up to 2,000 trash receptacles will be placed, however, it is anticipated that half of these receptacles will be placed where the Bureau has an existing receptacle. In this case, the Bureau's receptacle will be relocated to a different location. In addition to these programs, there are 1,140 receptacles at bus shelters which are currently serviced by Metropolitan Transit Authority.

As part of the Sustainable City Program, the City of Santa Monica sweeps all city streets at least once per week.

4.1.4 Storm Drain Maintenance

Storm drain maintenance includes cleaning catch basins and inspecting and cleaning the storm drain pipe and channels on a monthly, quarterly, or as-needed basis. The City of Los Angeles, through the Wastewater Collection Systems Division that is part of the Bureau of Sanitation, cleans catch basins throughout the year. For example, in the 2000/2001 fiscal year, over 36,550 catch basins were cleaned and over 1,170 tons of material were removed. They also repair broken and blocked storm drains on an as-needed basis. They have several phone contact persons to accept the public observations and complaints and to provide information regarding planned cleanup operations and repair operations.

As part of the Sustainable City Program, the City of Santa Monica removes debris and contaminants from the streets and catch basins that might otherwise be carried onto the beaches and into the Bay by stormwater flow. The City's 824 catch basins are cleaned on a quarterly or monthly schedule as needed.

4.1.5 Land Use Planning and Management

Standard Urban Storm Water Mitigation Plans (SUSMPs) are intended to address storm water pollution from new development and redevelopment by the private sector as well as equivalent public works projects. The SUSMP is a specific requirement of the Development Planning Model Program element required by the NPDES permit. It outlines the necessary BMP design standards that must be incorporated into design for private and commercial development as well as parking lots, restaurants, gas stations, and auto repair shops. The SUSMP does not directly regulate public development (other than parking lots and auto repair or gas stations that may be owned by a public agency); rather it is a part of the Stormwater Program that the City must implement.

The Countywide NPDES permit requires that prior to the issuance of any building or grading permit, appropriate Wet Weather Erosion Control Plans (WWECPs) and SWPPPs must be prepared to include appropriate construction BMPs. These BMPs are intended to minimize the impact of construction activities, including earth disturbance, erosion, sedimentation, fertilization of new landscaping, and construction debris including wash water runoff and handling of cleaning agents and other construction materials. The WWECP is required for projects that will entail soil disturbance during the rainy season.

To support this effort, the City prepared the *Development Best Management Practices Handbook*, a handbook to guide private developers and contractors in the selection, design, and the application of urban runoff BMPs (City of Los Angeles, 2002). City plan checking, engineering, and inspection staff has been trained in the requirements for construction activities. These requirements also apply to public projects. The City has a construction activity inspection program in place to monitor compliance with these requirements.

4.1.6 Ordinances and Codes

Several of the ordinances within the City of Los Angeles's municipal code that provides source control for stormwater are described here. The City's Stormwater and Urban Runoff Pollution Control Ordinance No. 172176 became effective on October 1, 1998. This ordinance provides the City with the necessary legal authority to comply with the requirements of the NPDES permit. The scope of the ordinance is to provide for control and regulation of discharges to the storm drain system and receiving waters through a program of education and enforcement of general and specific prohibitions and requirements. Specifically, the ordinance prohibits illicit discharges into storm drains. The ordinance applies to all discharges in the City into any storm drain or receiving water from any discharger. The City's DPW administers the ordinance. Violations are considered a misdemeanor.

The City drafted an ordinance of the Los Angeles Municipal Code to provide the necessary legal authority to enforce the requirements for the implementation of SUSMPs that was effective on February 15, 2001. This ordinance has the following goals:

- Minimize impacts from urban runoff on the geological integrity of natural drainage systems and water bodies;
- Maximize the percentage of permeable surfaces to allow more percolation of storm water into the ground;
- Minimize the amount of urban runoff directed to impermeable areas and to the storm drain system;
- Minimize parking lot pollution; and
- Provide permanent controls to reduce the pollutant load from urban runoff produced by the development.
- Establish limits on the clearing of vegetation from the project site.

The City's Annual Weed Abatement Ordinance includes removing illegally deposited debris from approximately 5,000 private and public lots.

The Pick Up After Your Pet ordinance is presented in the Los Angeles Municipal Code Section 53.49. This ordinance requires that anyone walking a dog must carry a pooper scooper or plastic bag to pick up the pet's waste. Otherwise, animal waste- carrying bacteria can wash into gutters and storm drains.

The City of Los Angeles' Building and Safety Code currently requires that site storm water drainage be directed to the street.

4.1.7 Enforcement

Enforcement activities that facilitate stormwater source control include site visits by the City of Los Angeles's Inspection and Enforcement Unit and the City's Illicit Connections and Discharges Program. Although the primary emphasis of the Inspection and Enforcement Unit is educating business owners, in cases of serious violations of the Stormwater Ordinance, the staff is trained to work with other environmental agencies (i.e. D.A.'s, State Attorney

General, U.S. Attorney's Offices) to ensure proper and effective punishment and recovery of punitive damages.

The City's Illicit Connections and Discharges Program meets the permit requirements of identifying and eliminating illicit connections and illicit discharges to the storm drain system to the maximum extent practicable.

To support these efforts, the Watershed Protection Division operates the Stormwater Hotline to receive public complaints and reports of abandoned wastes, chemical spills, dumping of pollutants and illicit discharges affecting City streets, alley sidewalks and storm drain systems. The Hotline is operated by an Inspector or Duty Officer who dispatches two other Inspectors to respond to the reported incidents, by way of coordinating cleanups and abatements, and performing investigations. The inspectors perform investigations and coordinate cleanup operations if necessary. Enforcement actions are taken if a violation occurs and if the responsible party is determined. Over 2,000 calls were received in Fiscal Year 1999/2000 alone.

Over 1000 incidents of waste abandonment and accidental spills were abated. A total of 23,000 liters and 55,000 kilograms of hazardous wastes were removed from the City's alleys and sidewalks. Among the most commonly abandoned wastes were waste oil, organic solvents and solids, and household wastes. The Inspectors also investigated 625 cases of illicit discharges and storm drain connections, most of which resulted in the cessation of the discharges.

4.1.8 Additional Measures to be Considered

The following measures have been identified for consideration in expanding the institutional solutions to prevent or reduce levels of bacteria, or bacteria sources (e.g. garbage and trash) from initially being picked up by runoff whether on-site, in the curb/street, or in the storm drain system. Each of the alternatives, which are defined in Section 5, includes implementation of these measures.

- Public trash receptacles – The Cities of Los Angeles and Santa Monica have an extensive program of providing trash receptacles in public areas. This measure involves identifying additional opportunities for educating the public regarding litter, increasing enforcement of existing ordinances about littering, and for providing additional public trash receptacles. Litter often contains materials that are a source of bacteria or provide nutrients that enhance bacterial growth. Reducing the amount of litter that is swept into the stormwater collection system will reduce the bacterial load within the stormwater discharges. Convenient access to trash receptacles along with increased education and enforcement should further reduce the litter in public areas.

- Improved restaurant and grocery store trash management – Restaurant and grocery store wastes that are not contained can provide a pathway for bacteria to enter the stormwater system. This measure involves an expanded program to increase restaurant and store operator aware of this issue and more frequent trash pickups where existing receptacles are full before the pickup is scheduled.

- Portable bathrooms – Uncontained human waste is a source of bacterial contamination within the stormwater collection system. This problem is especially prevalent in areas of high densities of homeless individuals. Providing portable bathrooms in these areas would reduce this source. Care must be taken in implementing this measure, however, to ensure that these units do not increase the opportunities for illegal activities such as drug sales, drug use, and prostitution.

- Business improvement district expansion – These districts are currently focused on security and cleanliness. This measure involves expanding these programs to include educating businesses about runoff reduction techniques such as reduced pavement areas, improved landscaping, and porous pavement.

- Public education – The public education programs supported by the Cities of Los Angeles and Santa Monica involve speakers bureaus and participation in public festivals as described in the Public Education subsection. This measure involves increasing the funding to these programs to provide additional opportunities to demonstrate to the public and to local businesses the benefits of reducing the sources of bacteria that enter the collection system. These opportunities could include permanent education tools such as signs in parks and kiosks located in high pedestrian traffic areas.

- Incentives – Incentives are a way to increase the cooperation of residents and businesses in measures designed to reduce urban runoff and bacterial sources. Incentives should be included for all new programs where some installation by individual owners is involved. For example, providing funding to assist in installing residential rooftop drain diversions and cisterns and to use porous pavement in driveways where the soils conditions are appropriate would reduce the runoff volumes during many rain events. Youth organizations or other community-based organizations could be used to direct these funding programs and could provide some or all of the labor to install them as a source of income.

4.2 Local Options

Local options provide an important step in managing wet weather runoff at the individual lot or street level by reducing runoff volumes and improving runoff quality prior to entering the storm water collection system. These options include managing runoff that is on-site as well as adjacent off-site. Based on work conducted in TMs 5 and 6, four local options have been identified for Jurisdictions 2 and 3: 1) cisterns, 2) on-site storage and reuse, and 3) small-scale capture and infiltration projects, and 4) redirecting downspouts. Since runoff would be retained and not discharged, bacteria and other pollutants would not be discharged and would therefore be effectively removed.

It should be recognized that local options, like non-structural source control options, may not fully mitigate the impacts of pollutant loading, but their implementation could contribute to integrated water quality solutions, and could contribute to the reduction of the magnitude and extent of downstream (regional) options.

4.2.1 Cisterns

Cisterns collect diverted runoff from impervious roof areas into on-site, typically above-ground, storage reservoirs ranging from 60 to 10,000 gallons in volume. Cisterns can reduce the volume of runoff from a site, and, for smaller storm events, delay and reduce the peak runoff flow rates. The runoff stored in the cistern provides a source of chemically untreated 'soft water' for gardens and compost, free of most sediment and dissolved salts. Individual cisterns could be located beneath each downspout, or the desired storage volume could be provided in one large, common cistern that collects rainwater from several sources.

For the alternatives, use of cisterns will be considered at single family and multi-family residences. An evaluation of the potential of this option to manage runoff volume was presented in TM 5. As stated in TM 5, although the cistern option alone would not manage sufficient quantities of runoff to eliminate the need for other runoff management options, it should be encouraged due to its positive effect from a water conservation standpoint, and its ability to eliminate low flow runoff from very small storm events. More information regarding cisterns, including costs, is presented in the TM 6.

4.2.2 On-Site Storage and Reuse

On-site storage/reuse involves capturing runoff from rooftops and other hardscaped areas, performing limited treatment, and storing it for subsequent reuse on-site in a much larger (on the order of 100,000 gallons) underground-type of storage. Reuse would require careful management and consideration of water distribution systems. The Open Charter School Demonstration Project in the Ballona Creek watershed is an example of this option.

Potential sites for this option are public parks, urban vacant lots, government facilities, and schools; at which the runoff could be reused for irrigation under specific, controlled conditions without needing to meet full Title 22 treatment standards (requiring filtration and disinfection). This option is described in more detail in TM 6, and potential sites are discussed in TM 8.

4.2.3 Small-scale Capture and Infiltration Projects

Small-scale capture and infiltration involves capturing runoff from hardscaped areas and infiltrating into the soil. Various methods for on-site infiltration include porous pavement, retention grading, dry wells, and bioretention (discussed in TM 6). Installation of sunken street medians and permeable bottoms on catch basins are also included in this category of projects. As described in TM 5, due to the nature of surface soils in Jurisdictions 2 and 3, very limited opportunities exist for on-site infiltration projects that will lead to quantifiable reductions in runoff volumes. There may be some opportunities, however, along the beach areas of the Venice Beach and Dockweiler subwatersheds. In the Venice beach area, a small-scale infiltration project could be implemented. (Larger, regional infiltration projects in the Dockweiler area will be discussed under Regional Options). As described in TM 6, runoff from boardwalk and street areas near the beach could be routed to a treatment system to remove grit and oil, and then routed to an infiltration system located in the sandy area. The infiltration system would consist of a perforated culvert that could store the runoff until it is infiltrated. A 48-inch perforated culvert, located parallel to the coast, would have a storage capacity of 94 gallons per foot of culvert. In some cases, this volume may be infiltrated in a 24-hour period. A small-scale infiltration project consisting of 1,000 feet of culvert could be implemented, for example, in the southern area of Venice beach where the historical bacteria exceedances are more of a concern than in the northern section of Venice beach. Subsurface monitoring of the saturated zone (groundwater) would be recommended to watch for potential migration of bacteria from the infiltration project through the beach sands that might exfiltrate into the surf zone.

4.2.4 Re-directing Downspouts

A relatively simple yet effective on-site solution is to re-direct rooftop drain downspouts to discharge onto grassy areas instead of driveways and hardscape. This option can be implemented at single-family and multi-family residences, as well as at public and commercial buildings. Although this option will not manage appreciable volumes of runoff, it is a runoff conservation measure that will assist with source control quality and quantity. Costs may include minimal re-routing of piping, and in some cases may not include new piping at all. Efforts to implement this option could be combined with public education or consumer water use audits.

4.3 Regional Options

Regional options involve capturing runoff from the storm drain system after it has left individual properties and before it enters receiving waters. This section summarizes the potential regional options that have been identified for Jurisdictions 2 and 3: diversion to wastewater treatment facilities; capture, storage, treatment and then either discharging, beneficially reusing (i.e., for irrigation), or injecting runoff; large-scale infiltration projects, and direct discharge of the runoff using an ocean outfall.

As discussed in TM 8, all of the regional options involve diverting some or all of the runoff from the major storm drains before it is discharged to the ocean. All of the regional options also require short-term operational storage to balance the rainfall hydrograph inflow over much more limited outflow rates to treatment or reuse facilities so that the required facility design flowrate is more economical than at the peak runoff rate.

4.3.1 Divert to Wastewater Treatment

This option involves storing wet weather runoff and then routing it to the Hyperion Treatment Plant (HTP) for treatment. The HTP unit processes include grit removal, primary sedimentation, secondary treatment using high purity oxygen and secondary sedimentation, disinfection using chlorine, and ocean discharge. Portions of the treated effluent are routed to other agencies that provide further treatment to supply recycled water in the area. These treatment facilities were designed to meet ocean discharge requirements for collected wastewater and are assumed to meet these standards for discharging treated wet weather runoff. However, the collection system capacity available to convey runoff to the HTP is limited. An analysis of the treatment and conveyance capacity and the available volume to divert runoff is discussed in TM 7. The runoff would first be stored temporarily, and then released in a controlled manner into either the Coastal Interceptor Sewer (CIS) or, for Dockweiler subshed, into the Central Outfall Sewer (COS) or North Central Outfall Sewer (NCOS) for ultimate treatment at Hyperion.

4.3.2 Capture, Store, Treat and Discharge

In this option, runoff would be captured and stored in operational storage facilities. It would then be treated using newly constructed runoff treatment plants designed to meet the AB411 beach standards and discharged to the ocean (typically through the storm drain outfalls). Based on the design criteria presented in TM 6, treatment may consist of storage, influent pumping, bar screens to remove trash, sedimentation basins to remove settleable solids such as grit and organic material, and disinfection.

Although traditional treatment methods would likely be most applicable given the high wet weather runoff flowrates, there are various candidate treatment technologies that could potentially be utilized for treatment of bacteria, where discharges are released. The candidate treatments technologies have not been proven for this application but could possibly provide treatment on a small scale in localized drainage areas. These are discussed in more detail in TM 6 and include the following:

- Traditional treatment
- Stormwater Filtration Units
- Advanced Oxidation
- Peracetic Acid (PAA) and Other Bactericides
- Subsurface Constructed Wetlands

4.3.3 Capture, Store, Treat and Beneficially Reuse

This option is similar to the previous option, but instead of treating the runoff to beach standards and then discharging it, this option treats the runoff in facilities designed to Title 22 Standards (filtration and disinfection to meet a less than 2.2 MPN coliform standard), and then distributes it to sites where it can be reused. At reuse locations, seasonal storage may be necessary. Reuse options include landscape irrigation, industrial use, toilet flushing in buildings with dual piping systems, and other non-potable water uses.

The City of Los Angeles Department of Water and Power (DWP) and the City of Santa Monica provide water to users within Jurisdiction 2 and 3 and are thus responsible for coordinating recycled water supplies to potential customers. As summarized in the TM 5, when DWP and Santa Monica service areas are combined, the estimated total irrigation water demand within Jurisdictions 2 and 3 is approximately 3,795 acre-feet (AF) per year.

It should be noted that not all areas may be appropriate to use runoff as a source of supply. The DWP has current plans to meet the recycled demand in the Dockweiler region with new pipelines serving the Playa and Westchester areas. Because of this, wet weather runoff would not be considered a suitable source of supply for areas south of Santa Monica. However, the DWP does not have current plans or locally available sources of recycled water to supply areas north of Santa Monica with additional recycled water, so it may be appropriate to consider treated wet weather runoff as a source of supply for these subwatersheds.

4.3.4 Large-Scale Infiltration Projects

As mentioned previously, due to the favorable infiltration characteristics of the surface soils in the coastal area of the Dockweiler subwatershed, there may be opportunities for treatment through infiltration projects on a larger scale than those discussed in Section 3.2.3 for the Venice beach area. In the vacant land areas just inland from the beach sands, runoff could be captured and treated by infiltration into the soil.

4.3.5 Capture, Store, Treat and Inject

Groundwater injection is a method of groundwater recharge at a regional level that not only augments groundwater supplies, but also often serves an additional purpose of protecting the groundwater against seawater intrusion. The water (generally imported and/or reclaimed supplies) injected through a series of injection wells creates a pressure ridge that impedes the inland movement of the salt water front, and maintains protective groundwater elevations in the aquifers. TM 5 explores the possibility of injecting wet weather runoff, and concludes that while a separate injection project using runoff is not feasible, it may be worthwhile to explore the concept of supplying runoff as a low cost, low TDS source of supplemental supply to the West Basin Project. This would require careful review of the water quality issues, as well as contractual agreements in place between all parties.

4.3.6 Ocean Outfall Discharge

This option involves discharging the runoff using an outfall to extend the discharge point of runoff without treatment for bacteria/pathogens to beyond the surf/swim zone, thereby avoiding bacterial contamination of waters used for recreational purposes. As presented in TM 6, it was assumed that the only potential for this option is to consider routing runoff from the Dockweiler area to the existing Hyperion Treatment Plant (HTP) 1-mile outfall. Although this option does not improve water quality, it does reduce health risk along the beaches by relocating the point of discharge to beyond the surf zone.

5.0 Themed Alternatives

In this section, the runoff management options are combined to form alternatives, each with a different theme. The following alternatives are defined: 1) low cost, 2) low risk, and 3) maximum beneficial reuse. Each alternative includes components from Institutional Solutions, Local Solutions, and Regional Solutions for consideration. For each alternative there is an upper limit, theoretical goal of runoff volume to be managed. The purpose of this is to present a complete suite of options within each alternative. It is not intended to imply that all the options listed within an alternative are planned for implementation. The implementation of an alternative will be based on a phased approach that will start with the Institutional Solutions and some Local Solutions during the first stage. Then the performance of these options will be evaluated and the implementation plan will be adjusted to address the findings. Regional Solutions will be considered and may be included as part of the modification of the Implementation Plan.

5.1 Low Cost Alternative

The low cost alternative, by definition, is the alternative configured to have the lowest capital and O&M costs. This alternative assumes a higher level of risk of compliance with the TMDL then the other alternatives by having a smaller runoff management goal, as explained in the previous section. Thus, the theoretical target runoff management goal for the low cost alternative is up to 136 MG, which corresponds to a potential for 5 violation years in 50 years for all subwatersheds. The following runoff management options are included in the low cost alternative: 1) institutional (source-control) options, 2) local options, and 3) regional options.

5.1.1 Institutional Options

All of the alternatives will include the same recommended institutional options, which consist of new and expanded programs as described in Section 4.1.8.

5.1.2 Local Options

Since the Venice Beach subwatershed's theoretical target runoff volume to manage is relatively small (0.1 MG per storm event), and since the land use in the area is along the public beach sands, which were identified in TM 5 as an area with potentially "good" infiltration characteristics, the low-cost option to manage runoff in Venice Beach is through small-scale capture and infiltration projects. This option was described in Section 4.2.3 as a perforated culvert underneath the downstream side of the boardwalk to infiltrate runoff. As a priority, this option could be implemented in the southern area of Venice beach where the historical bacteria exceedances are more of a concern than in the northern section of Venice beach.

Other small-scale capture and infiltration projects, such as swales and biofiltration projects are not included in the low cost alternative. Likewise, local options such as residential cisterns and on-site storage and reuse projects (underground cisterns) are not included in the low cost alternative due to the expensive nature of implementation relative to the small amount of runoff that can be managed. For residential cisterns, a feasible installation of five to ten percent of available sites would capture approximately 96 to 191 acre-feet (AF) of wet weather runoff per year that could be beneficially used for irrigation. This translates to only 0.6 to 1.2 percent of the total annual wet weather runoff generated within Jurisdictions 2 and 3. Similarly, the on-site storage and reuse option (larger, underground cisterns) at schools, public properties, and golf courses would also generate a high expense versus the small quantity of runoff volume managed. Aside from the Venice Beach area, very limited opportunities exist for on-site infiltration projects to lead to quantifiable reductions in runoff volumes. The limited opportunities and associated high cost make on-site capture and infiltration incompatible with the low cost alternative.

However, in addition to capture and infiltration in Venice Beach, there are some low-cost local options that can be included on an opportunity basis. For example, rooftop drains at single-family and multi-family residences, as well as at public and commercial buildings can be re-routed to discharge on grassy areas instead of driveways and hardscape. It is assumed that varying amounts of the diverted runoff would be percolated due to the varying infiltration rates of the soils (refer to TM 5). Since the soils in the two most densely populated areas (Dockweiler and Santa Monica) have the poorest infiltration capacities, it is assumed that very little of the runoff would be infiltrated and that most would run off the site almost immediately. Although this option will not manage appreciable volumes of runoff, it is a runoff conservation measure that will assist with source control quality and quantity. Costs may include minimal re-routing of piping, and in some cases may not include new piping at all. Efforts to implement this option could be combined with public education or consumer water use audits. The main constraints regarding implementation of this option, due to its decentralized nature and the nature of the soils, is achieving high levels of successful installations and controlling vector issues.

5.1.3 Regional Options

The low cost alternative includes two regional options for consideration. These options are included for assessment purposes only. 1) divert to wastewater treatment, and 2) capture, store, treat, and discharge. The low cost alternative also includes two optional items: 1) large-scale infiltration projects, and 2) ocean outfall discharge. The least expensive option is to divert a portion of runoff to the HTP for treatment. The Dockweiler and Santa Monica subwatersheds are the closest in proximity to the HTP, which makes them the most feasible areas to divert. Diverting from the closest subwatersheds will minimize the new infrastructure and pumping costs. Also, diverting runoff from subwatersheds north of Santa Monica would be limited by the conveyance capacity of the Coastal Interceptor Sewer (CIS). Therefore, the low cost alternative maximizes the option for diversions to Hyperion from the Dockweiler and Santa Monica subwatersheds only.

As described in TM 7, over a 24-hour period, a maximum of 10.7 MG from the Santa Monica subwatershed can be diverted to Hyperion for treatment. A maximum of 60.4 MG can theoretically be diverted from the Dockweiler subwatershed, but the target volume from Dockweiler for this level of risk is 51.9 MG (see Table 1), therefore, 51.9 MG can be diverted. This total maximum is 62.6 MG. Before the runoff is diverted to Hyperion for treatment, it would be captured from major storm drains and stored in temporary storage facilities as described in TM 8. While most of the HTP effluent is discharged to the ocean, a portion of the storm water runoff will be beneficially used, as portions of the treated effluent from the HTP are routed to other agencies that provide further treatment to supply recycled water in the area.

If managing more runoff volume becomes necessary, the need for regional treatment will be assessed. Implementation of this option involves capturing runoff from major storm drains in Santa Monica and areas north, storing it in temporary operational storage facilities as described in TM 8, and directing it to dedicated runoff treatment facilities (located at potential sites described in TM 8). Because the runoff would be discharged to the ocean, the new treatment facilities would treat the runoff to meet AB411 beach standards as described in Section 4.3.2.

Major constraints for implementation of regional treatment are siting and acquiring sufficient land for new treatment facilities. Nearby residents and other agencies may resist the use of parks and recreational areas. The construction of subsurface wetlands in the vicinity of LAX is being considered due to the availability of land area.

If the operational costs of diversions to wastewater are found to be too high, another option for the Dockweiler subwatershed would be to divert the runoff to vacant areas just inland from the beach sand and implement a large-scale infiltration project as described in Section 4.3.4.

The option of beneficial reuse for irrigation is substantially more expensive, because it not only includes the cost to treat and discharge, but also includes new distribution infrastructure and seasonal storage costs. Therefore, it was not included as part of the low cost alternative.

The option to capture, store, and deliver runoff to West Basin as a supplemental source water to the Hyperion effluent was not included in the low cost alternative because it creates potential water quality, contractual, permitting and operating issues. The variable quality, quantity and overall lack of reliability of wet weather runoff could lead to water quality issues when blending with the Hyperion effluent. Also, pre-existing contractual agreements between West Basin MWD and other parties could prevent this option from materializing.

Lastly, the option of disposing runoff using the existing one-mile outfall at the HTP is another optional method for managing runoff in a low-cost manner that is included for consideration in this alternative. Thus far, this alternative assumes that runoff from the Dockweiler area will be diverted to Hyperion for treatment because it is a solution without any additional capital cost. However, there may be significant operational costs associated with treating the diverted runoff at Hyperion. Because of this, the option of disposing runoff untreated via the existing Hyperion outfall should not be ruled out since it may truly be the lowest cost option. Another reason to consider discharge through the outfall is the capacity of the existing outfall pipe. If the outfall pipeline has the capacity to handle the runoff peak flowrate without the need for balancing storage facilities, then the physical constraints of diverting runoff straight to the outfall are significantly less than diverting runoff first to storage facilities and then to the wastewater treatment system. However, while discharging untreated runoff through the 1-mile outfall may prevent bacterial contamination of the near-shore surf zone, it does not prevent potential contamination from untreated runoff due to other potential pollutants of concern that may contribute to toxicity.

5.2 Low Risk Alternative

The low risk alternative is configured to manage the highest theoretical target runoff goal, and will include options that will minimize the compliance risk with the TMDL without regard to cost or optimizing the beneficial use of runoff. As discussed in Section 3, the target runoff management goal for the low risk alternative is up to 169 MG, which corresponds to a potential for one theoretical violation year in fifty years for all watersheds. The low risk alternative includes the same runoff management options as the low cost alternative. However, the low risk alternative is designed to manage additional runoff volume than the low cost alternative does. The following runoff management options are included as described below: 1) institutional (source control) options, 2) local options, and 3) regional options.

5.2.1 Institutional Options

All of the alternatives will include the same recommended institutional options, which consist of new and expanded programs as described in Section 4.1.8.

5.2.2 Local Options

Local solutions are not included in this alternative (not even capture and infiltration in Venice Beach) because their implementation will not substantially reduce the need to manage runoff regionally to ensure the lowest level of risk. Even achieving a high level of implementation of cisterns, on-site storage, and infiltration projects cannot guarantee the management of all the runoff generated from the subwatersheds. Although these options are considered as additional ways to manage runoff, they are not included in the low risk alternative.

5.2.3 Regional Options

The low risk alternative includes two regional options: 1) divert to wastewater treatment, and 2) capture, store, treat, and discharge. These options ensure the lowest risk of violation of the TMDL because they manage runoff on a regional basis. Diverting runoff to the HTP for treatment serves that purpose and is also the least expensive. The Dockweiler, Venice Beach, and Santa Monica subwatersheds are the closest in proximity to the HTP, which makes them the most feasible areas to divert. Also, diverting runoff from subwatersheds north of Santa Monica would be limited by the conveyance capacity of the Coastal Interceptor Sewer (CIS), which is discussed in TM 7. Therefore, the low risk alternative maximizes the option for diversions to Hyperion in the Dockweiler, Venice Beach, and Santa Monica subwatersheds.

As described in TM 7, over a 24-hour period, a maximum of 10.7 MG from the Santa Monica subwatershed can be diverted to Hyperion for treatment. All of the target runoff from Venice Beach, which is less than 0.1 MG, can be diverted. A maximum of 60.4 MG can theoretically be diverted from the Dockweiler subwatershed, but the target volume from Dockweiler for this level of risk is only 53.6 MG (see Table 1), therefore, 53.6 MG can be diverted. This total maximum is 64.3 MG. Before the runoff is diverted to Hyperion for treatment, it would be captured from major storm drains and stored in temporary storage facilities as described in TM 8. While most of the HTP effluent is discharged to the ocean, a portion of the storm water runoff will be beneficially used, as portions of the treated effluent from the HTP are routed to other agencies that provide further treatment to supply recycled water in the area.

If managing more runoff volume becomes necessary, regional treatment will be needed. Implementation of this option involves diverting runoff from the Santa Monica subwatershed and the areas north of Santa Monica. The runoff will be captured and diverted to temporary storage facilities as described in TM 8, pumped to the new facilities for treatment, and discharged to the ocean. Similar to the low cost alternative, the major constraints regarding implementation of this option include siting and acquiring sufficient land for new treatment facilities.

Additional options including beneficial reuse, injection, or the use of the existing ocean outfall have greater potential uncertainties and risks associated with implementation and are therefore not included as part of the low risk alternative.

5.3 Maximum Beneficial Reuse Alternative

The maximum beneficial reuse alternative is configured to manage the highest target runoff goal , and will include options that maximize the amount of runoff that can be beneficially reused. The target runoff management goal for the maximum beneficial reuse alternative, which is the same as the low risk alternative, is up to 169 MG, which corresponds to a potential for one theoretical violation year in fifty years. The maximum beneficial reuse alternative shares the same runoff management options as the low risk alternative, but includes additional options to beneficially reuse a portion of the runoff. The following runoff management options are included as described below: 1) institutional options, 2) local options, and 3) regional options.

5.3.1 Institutional Options

All of the alternatives will include the same recommended institutional options, which consist of new and expanded programs as described in Section 4.1.8.

5.3.2 Local Options

The maximum beneficial reuse alternative incorporates all of the following local options: 1) residential cisterns, 2) public on-site storage and reuse projects, 3) small-scale capture and infiltration projects, and 4) re-directing rooftop downspouts to discharge on grassy areas.

5.3.2.1 Residential Cisterns

For this alternative, residential cisterns will be implemented in a portion of the watershed to reduce runoff volume and, for smaller storm events, delay and reduce the peak runoff rates. In conjunction with other new and enhanced programmatic solutions, education and incentive programs will be implemented with the goal of achieving installation of cisterns at 5 to 10 percent of single-family and multi-family residential homes (1,000-gallon and 10,000-gallon sizes, respectively).

In TM 5, it was estimated that this 5 to 10 percent level of installation would be able to manage approximately 0.6 to 1.2 percent of the total annual wet weather runoff in the Jurisdiction 2 and 3 subwatersheds. One of the advantages of cisterns is that they may be proportionally more effective for managing runoff from small storms than from larger storms. Table 2 provides an estimate of the upper limit of runoff that can be managed via cisterns on a target storm basis, which equals 1.7 to 3.4 MG.

Table 2. Runoff Managed with Cistern Installation

Land Use	Total Estimated Parcels in J2/3	Typical Rooftop Area (sq ft.)	% Capture	Target Storm (in/day)	Runoff Managed per Cistern (gallons)	100% Installation (MG)	5% Installation (MG)	10% Installation (MG)
Single Family Residential	42,500	2,000	90%	0.45	505	21.5	1.1	2.2
Multi Family Residential	9,286	5,000	90%	0.45	1,262	11.7	0.6	1.2
					Total =	**33.2**	**1.7**	**3.4**

Since the ability to achieve the above runoff management goals are largely dependent on individual, decentralized, effective cistern construction, operation, and maintenance; the volumes in the above table cannot be considered as an immediate, automatic decrease in the amount of runoff that may need to be managed on a regional basis in order to achieve full volume goals. However, as cistern use increases, the total runoff which enters the storm drain system will be reduced, which will lead to reductions in the size and costs of the regional systems.

5.3.2.2 On-Site Storage and Reuse

The maximum beneficial reuse alternative also includes on-site storage and reuse projects for potential sites such as schools, government and public facilities, vacant lots, golf courses, and public parks. This option, described in TM 8, involves capturing runoff from areas other than, or in addition to, rooftops and storing it for subsequent reuse on-site. Each system can be designed and sized to collect and treat runoff (from either on-site or additional street area) and stored underground in a system sized to appropriately supply a percentage of the irrigation demand.

To estimate the amount of the theoretical target runoff that can be managed through on-site storage and reuse projects, it is assumed that large underground cisterns (100,000-gallon capacity) will be installed at selected sites. Using a similar analysis as in the Task 5 TM, calculations are summarized in Table 3. One difference from the analysis in Task 5 is that because runoff can be captured from more than just roof areas, roof shadow percentages are not used. From this calculation, if 10 percent of these areas (which would be approximately 20 of the potential sites described in TM 8) implement on-site storage and reuse projects, an estimated 0.82 MG of the theoretical target runoff could be managed. Constraints regarding implementation of this option include siting and designing effective systems. In the case of vacant lots, land acquisition will be necessary.

Table 3

Runoff Managed with On-Site Storage and Reuse

Land Use	Total Area (acre)	Target Rainfall (in/day)	% Capture	Cistern Size (gallon)	% Effectiveness (efficiency)	Runoff Managed	
						100% Installation (MG)	10% Installation (MG)
Schools	540	.45	90%	100,000	60%	3.56	0.36
Government and Public	330	.45	90%	100,000	60%	2.18	0.22
Vacant Lots	65	.45	90%	100,000	60%	0.43	0.04
Public Parks	308	.45	90%	100,000	60%	2.03	0.20

Total	**1,243**					**8.2**	**0.82**

As is similar to residential cisterns, the volumes in the above table cannot be considered as an immediate, automatic decrease in the amount of runoff that may need to be managed on a regional basis in order to achieve full volume goals. However, as the use of on-site storage and reuse increases, the total runoff which enters the storm drain system will be reduced, which will lead to reductions in the size and costs of the regional systems.

5.3.2.3 Small-Scale Capture and Infiltration

This alternative also includes installation of various types of small-scale capture and infiltration projects, including porous pavement, retention grading, dry wells, and bioretention (discussed in TM 6). This also includes installation of sunken street medians and permeable bottoms in catch basins. On-site infiltration BMPs can be installed at public parks as well as commercial and residential communities. As discussed in TM 5, the ability of these types of projects to effectively manage runoff will need to be determined on a site by site basis. Constraints include achieving successful installations and managing vector issues.

In addition, similar to the low cost alternative, the maximum beneficial reuse alternative includes installation of a small-scale capture and infiltration project in the Venice Beach subwatershed.

5.3.2.4 Re-Directing Downspouts

As discussed in the low cost alternative, rooftop drains at single-family and multi-family residences, as well as at public and commercial buildings can be re-routed to discharge on grassy areas instead of driveways and hardscape. It is assumed that varying amounts of the diverted runoff would be percolated due to the varying infiltration rates of the soils (refer to TM 5). Since the soils in the two most densely populated areas (Dockweiler and Santa Monica) have the poorest infiltration capacities, it is assumed that very little of the runoff would be infiltrated and that most would run off the site almost immediately. Although this option will not manage appreciable volumes of runoff, it is a runoff conservation measure that will assist with source control quality and quantity. Costs may include minimal re-routing of piping, and in some cases may not include new piping at all. Efforts to implement this option could be combined with public education or consumer water use audits. The main constraint regarding implementation of this option, due to its decentralized nature and the nature of the soils, is achieving high levels of successful installations and managing vector issues.

5.3.3 Regional Options

The maximum beneficial reuse alternative includes four regional options for consideration: 1) divert to wastewater treatment, and 2) capture, store, treat, and discharge, 3) capture, store, treat, and beneficially reuse, and 4) capture, store, treat, and deliver to West Basin MWD for reuse and injection. These regional options are included for assessment purposes only. As an optional item, it also includes implementation of a large-scale infiltration project in the Dockweiler area.

5.3.3.1 Divert to Wastewater Treatment

The maximum beneficial reuse alternative includes some regional options identified for assessment as a future phase of the implementation plan. These can include apporximately the same volumes of wastewater diversions as the low risk alternative, from the same subwatersheds. Hence, the maximum beneficial reuse alternative includes the option to divert a maximum of 64.3 MG to Hyperion for treatment.

5.3.3.2 Capture, Store, Treat, and Discharge

Also similar to the low risk alternative, if managing more runoff volume becomes necessary, the need for regional treatment will be assessed. Implementation of this option involves capturing and diverting runoff to temporary storage facilities as described in TM 8, pumping it to new treatment facilities, and discharging it to the ocean.

5.3.3.3 Capture, Store, Treat, and Beneficially Reuse

This alternative includes beneficial reuse of regionally treated runoff. This option involves use of the same capture, operational storage, and base treatment facilities as the treat and discharge option. However, for this option, a portion of the runoff that would otherwise have been discharged is beneficially reused as irrigation supply. That portion is directed to an additional treatment train to treat the runoff to Title 22 standards (as discussed in Section 4.3.3). This additional treatment train can be located on the same site as the base treatment facility.

The treated runoff is then distributed to the point of reuse. If reuse cannot occur as water is produced, seasonal storage facilities will be required. As discussed in TM 8, siting seasonal storage facilities, appropriately sizing them, and making the complex system operationally simple are major constraints to achieving maximum potential reuse. From the Task 5 TM, the total potential irrigation demand in Jurisdictions 2 and 3 is 1,813 AF/yr. If it were possible to supply 400 AF/yr of runoff (on the order of 10 MG, or 20% of the total demand), at a price of approximately $300 per AF, this could result in a water supply savings of $120,000 per year. However, to accomplish this, additional treatment costs, distribution infrastructure, and seasonal storage facilities are required.

5.3.3.4 Capture, Store, Treat, and Inject

An additional option is to capture, store, and deliver runoff to West Basin MWD Advanced Water Recycling Facility as a supplemental source water along with Hyperion effluent. The runoff would be blended with Hyperion effluent as a feed to the West Basin Plant for treatment and then reused for irrigation or industrial uses or for injection into the West Basin aquifer. Even though this option provides some beneficial reuse, it could also create potential water quality, contractual, and permitting issues. Further study will have to be conducted before any decisions are made regarding the inclusion of this option. If this option were implemented, it would reduce the size of the diversions to HTP, or of treatment facilities that are dedicated for stormwater runoff.

5.3.3.5 Large-Scale Infiltration

If the operational costs of diversions to wastewater are found to be too high, another option for the Dockweiler subwatershed would be to divert the runoff to vacant areas just inland from the beach sand and implement a large-scale infiltration project as described in Section 4.3.4.

6.0 Alternatives Comparison

The themed alternatives were compared using criteria developed through the stakeholder process, interactions with the Jurisdiction 2 and 3 agencies, and engineering experience. A summary of this screening exercise is presented in this subsection. The criteria used for the comparison are as follows:

- Amount of runoff beneficially used
- Regulatory compliance
- Design complexity and constructability
- Facilities siting difficulty
- Reliability
- Compatibility with a phased approach

Rankings for each alternative were assigned on a scale of 1 to 3, 1 being the most preferable, and 3 being the least preferable. A summary of the options included for consideration in each alternative is presented in Table 4.

Table 4. Alternatives Summary

	Alternative		
Runoff Management Options	**Low Cost**	**Low Risk**	**Max. Beneficial Reuse**
Institutional Solutions	Included	Included	Included
Local Solutions			
Residential Cisterns *	---	---	Included
Public On-Site Storage and Reuse **	---	---	Included
Small-Scale Capture and Infiltration	Included (Venice Beach only)	---	Included
Redirecting Rooftop Downspouts	Included	---	Included

Regional Solutions			
Divert to Wastewater Treatment	Included for assessment	Included	Included for assessment
Capture, Store, Treat, and Discharge	Included for assessment	Included	Included for assessment
Capture, Store, Treat, and Beneficially Reuse	---	---	Included for assessment
Capture, Store, Treat, and Inject (West Basin)	---	---	Optional for assessment
Large-Scale Infiltration	Optional for assessment	---	Optional for assessment
Discharge to Ocean Through 1-mile Outfall	Optional for assessment	---	---

* Considered at single-family/multi-family residences, no treatment necessary
** Considered at schools, public properties, golf courses; some treatment necessary

6.1 Amount of Runoff Beneficially Reused

Runoff management options that have some beneficial reuse are options that either a) reduce the volume of runoff that enters the storm drain system, or b) reduce the amount of runoff sent to Hyperion or treated and discharged. Beneficial reuse options include all of the on-site options as well as the regional options of supplying runoff to the West Basin project, or treating runoff and distributing it for reuse as irrigation supply. The Maximum Beneficial Reuse Alternative includes the highest level of beneficial reuse. Thus, this alternative is rated the highest for this criteria. The low cost alternative is ranked second, because it includes some limited local options.

6.2 Preliminary Unit Cost Estimates

Unit costs for the various runoff management options are presented in Appendix A. These are planning level estimates. Unit costs and assumptions are generally consistent with those conducted for the City of Los Angeles' Integrated Resources Plan (IRP) Runoff Planning Estimates.

6.3 Regulatory Compliance

From a regulatory perspective, the Low Risk and the Maximum Beneficial Reuse Alternatives have the highest rating because they manage the most runoff volume and therefore result in the lowest risk of TMDL violation. They are not, however, equal from an operations standpoint. The Low Risk Alternative involves constructing new regional projects such as operational storage and runoff treatment plants and diverting runoff to the Hyperion Treatment Plant in the Southern portion of the study area. The Maximum Beneficial Reuse Alternative includes the same base treatment but with an additional reuse component. Reuse will involve treatment to a higher level (Title 22 standards are assumed) and continual monitoring of the reuse sites to ensure that public safety is maintained. Thus, this alternative is ranked lower than the Low Risk Alternative.

6.4 Design Complexity and Constructability

All three alternatives include consideration of regional options which would involve construction along the coast to capture and store (operational storage) runoff at the storm drains immediately upstream of their discharge points. The stored runoff would then be pumped to new conventional treatment facilities and to the Hyperion Treatment Plant in the southern portion of the study area. As described in the Task 6 Technical Memorandum, the technologies associated with runoff treatment are generally well documented and tested.

The operational storage facilities and associated piping would be constructed in beach areas as close to the drain outlets as possible. While care must be taken construct these facilities to accommodate a marine environment, there is significant operating experience with similar facilities.

The Maximum Beneficial Reuse Alternative also involves constructing more complex (Title 22) treatment plants, a recycled water distribution system, and seasonal storage near the reuse sites. The technologies associated with these facilities, however are well documented. With the exception of the siting issues associated with constructing the distribution pipeline and seasonal storage facilities, these do not have significant engineering or constructability issues.

6.5 Facilities Siting Difficulty

If regional options are implemented, there will be major constraints with siting new facilities for all three alternatives. As described in TM 8, diversions and temporary storage facilities will be necessary. Some of these diversions along the coast will be near residential areas. Their construction will require careful planning and community acceptance. Sufficient space, however, should be available to construct the operational storage facilities underneath existing beach parking areas.

The conventional treatment facilities for all of the alternatives would also be constructed near the coast to minimize piping and reduce the outfall length for discharging treated runoff. These facilities will be very challenging to site in the Jurisdiction 2 and 3 area, as discussed in TM 8.

The Maximum Beneficial Reuse Alternative will require constructing a pipeline to distribute treated runoff and seasonal storage in the locale of the reuse sites. The distribution piping will likely be constructed in existing roadways. This would be a very disruptive process. For this study, it is assumed that the seasonal storage facilities would be constructed at the individual reuse sites.

Based on these observations, siting for regional facilities will be extremely challenging for all of the alternatives, but will be have additional complexity for the Maximum Reuse Alternative.

6.6 Reliability

From a reliability perspective, the Low Cost and Low Risk Alternatives have the highest rating because they involve the least stringent discharge standards (AB 411). The conventional treatment processes required to meet discharge treated runoff include screening, settling and chlorination. These are highly reliable processes.

The Maximum Beneficial Reuse Alternative includes treatment to a higher level (Title 22 standards are assumed) and continual monitoring of the reuse sites to ensure that public safety is maintained. The required treatment processes in addition to those required for the other alternatives include coagulation, flocculation, and filtering. The disinfection standards for the treated runoff may also be higher.

In addition, the Maximum Beneficial Reuse Alternative involves providing treated runoff to customers for landscape irrigation. For the purposes of this study, it was assumed that the contract for supplying water to these customers will include a guaranteed water supply. The amount of treated runoff available will be rainfall dependant. In drought years, treated runoff may not be available. If new water uses are developed to create a market for the treated runoff, potable water will be required. A program to reduce potable water demands may in fact increase potable water demands when the supply is critical. Thus, this alternative is ranked lower than the Low Cost and Low Risk Alternatives.

6.7 Compatibility with a Phased Approach

The Maximum Beneficial Reuse Alternative includes the highest level of implementation of local solutions such as cisterns, storage and reuse on public lots, and capture and infiltration in areas that have soils with a good infiltration capacity. These types of projects are small and can be constructed on a piecemeal basis while additional monitoring is conducted. Thus, they fit well with a phased, iterative implementation approach.

The other alternatives' regional options can easily be phased as well. Overall, the Maximum Reuse alternative ranks higher because the various local solutions can begin implementation and on-going monitoring for their effectiveness.

6.8 Comparison Summary

A summary of the observations and ratings presented above is presented in Table 5. The Low Cost Alternative receives less favorable ratings (more 2s and 3s) because it does not include options that beneficially reuse runoff and is not most compatible with a phased implementation approach.

The Low Risk Alternative will have a higher capital cost due to the larger volume managed. The Maximum Reuse Alternative receives less favorable ratings due to the cost and difficulties associated with providing treated runoff for landscape irrigation. The on-site options for reuse provide many benefits without as many difficulties.

The results of the preliminary screening evaluation suggest that a modified version of the Low Cost Alternative with the local options included in the Maximum Reuse Alternative would result in improved rankings. A summary of this hybrid alternative is presented in the next section.

Table 5. Evaluation of Alternatives

Criteria	Low Cost Alternative		Low Risk Alternative		Max Reuse Alternative		Hybrid Alternative	
	Amount	Rank	Amount	Rank	Amount	Rank	Amount	Rank
Runoff Beneficially Reused (mgd)	low	2	none	3	high	1	high	1
Regulatory Compliance	-	3	-	1	-	2	-	2
Design Complexity and Constructability	-	1	-	1	-	1	-	1
Facilities Siting Difficulty	-	2	-	2	-	3	-	2
Reliability	-	2	-	2	-	3	-	2
Compatibility with a Phased Approach	-	2	-	2	-	1	-	1
Total Ranking =		**12**		**11**		**11**		**9**

7.0 Preferred Hybrid Alternative

The preferred alternative, similar to the low cost alternative, manages a lower theoretical goal volume of runoff. The preferred alternative also includes implementation of the maximum amount of on-site options which provide beneficial reuse of the runoff and are compatible with a phased implementation approach. Components of the preferred hybrid alternative are described in the following sections.

7.1 Institutional Options

Similar to the other alternatives, the preferred alternative will include the same recommended institutional options, which consist of new and expanded programs as described in Section 4.1.8.

7.2 Local Options

The preferred alternative includes the same levels of local options as the maximum beneficial reuse alternative. This includes: 1) residential cisterns, 2) public on-site storage and reuse projects, 3) small-scale capture and infiltration projects, and 4) redirecting rooftop downspouts to discharge on grassy areas as described in Section 5.3.2 above.

7.3 Regional Options

Following implementation of institutional and local options and results from additional monitoring, the preferred alternative includes possible consideration of the same regional options as the low cost alternative. This includes: 1) diversions to wastewater treatment, and 2) capture, treat, and discharge. Also included in this alternative is the optional item of a large-scale infiltration project in the Dockweiler area. These are described in detail in Section 5.1.3.

The option of treating and beneficially reusing runoff as irrigation supply is not included in the preferred alternative due to its many constraints and additional costs, as discussed in the evaluation section. The option to discharge untreated runoff through the existing outfall is also not included in the preferred alternative since it does not address other pollutants and therefore is not compatible with an integrated approach.

Table 6 provides a summary of the options included for consideration in the preferred alternative, as compared to the themed alternatives in Table 4.

Table 6. Preferred Hybrid Alternative Summary

Runoff Management Options	Preferred Hybrid
Institutional Solutions	Included
Local Solutions	
Residential Cisterns	Included
Public On-Site Storage and Reuse	Included
Small-Scale Capture and Infiltration	Included
Redirecting Rooftop Downspouts	Included
Regional Solutions	
Divert to Wastewater Treatment	Included for assessment
Capture, Store, Treat, and Discharge	Included for assessment
Capture, Store, Treat, and Beneficially Reuse	---
Capture, Store, Treat, and Inject (West Basin)	---

Large-Scale Infiltration	Optional for assessment
Discharge to Ocean Through 1-mile Outfall	---

8.0 References

City of Los Angeles, 2000. *Reference Guide for Stormwater Best Management Practice.* A guide prepared by the Stormwater Management Division, Bureau of Sanitation, Department of Public Works.

City of Los Angeles, 2002, *Development Best Management Practices Handbook.* A guide prepared by the Stormwater Management Division, Bureau of Sanitation, Department of Public Works.

http://www.lastormwater.org/

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http://pen1.santa-monica.org/government/choc/CommunityInvolve/442-GreenTeam.htm

Appendix A

Preliminary Unit Cost Estimates

Preliminary Estimate: Unit Costs

Option	Unit Cost
Institutional Solutions	$1M/year
Local Solutions	
On-Site Storage and Reuse Projects	$0.5-1M/per project
Regional Solutions	
Temporary Storage	$1.3M/mg
Treatment Facilities (assume discharge to ocean)	$2M/mgd
Land Acquisition	$1M/acre
Subsurface Constructed Wetlands	$0.2M/mgd
Additional Treatment to Meet Title 22 Standards	$2.3M/mgd