CDM

Technical Memorandum Task 7.3: Facility Siting Plan for the Malibu Creek Bacteria TMDL

To: *Carolina Hernandez, County of Los Angeles Watershed Division*

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1.0 Introduction

This Technical Memorandum (TM) has been prepared as a step in developing a Bacteria TMDL Implementation Plan (TMDL IP) for Malibu Creek and provides analyses of specific locations for potential regional structural best management practices (BMPs) to reduce bacteria in runoff. An overview of the methods used to identify potential sites, detailed descriptions of the selected sites, and a feasibility assessment for regional BMP opportunities at each site are included in Sections 2 through 4 respectively. Section 5 provides a summary of recommendations following this preliminary facility siting exercise.

Analysis of various geographical information system (GIS) layers was performed to identify a list of potential parcels for siting regional structural best management practices (BMPs) within each high priority water quality area of concern (AOC) for the Malibu Creek Bacteria TMDLIP. GIS layers used to assess potential sites included parcels, drainage features, soils, zones of landslide or liquefaction potential, slope, recreational areas, and aerial photography. The final result of this analysis was a list of potential lands for siting regional structural BMPs.

Aerial photography provided by Los Angeles County (2001) and Ventura County (2005) was used to assess actual ground conditions and determine the feasibility of the lands that were identified as potential regional structural BMP opportunities. Aerial photographs were observed to further screen out sites that would not be feasible due to competing uses and conversely, recapturing sites that were initially removed that appear to offer some opportunity for structural BMPs. This was done by panning across the entirety of each high priority AOC and using best engineering judgment to assess the feasibility of siting regional structural BMPs.

Twelve locations in Los Angeles County and four locations in Ventura County were preliminarily selected as the best opportunities for siting regional structural BMPs. To assist with completion of Task 7-1 "Concept Hydrology", the Los Angeles County Department of Public Works (LACoDPW) utilized a newly adopted approach to estimate target runoff hydrographs at each of these locations for compliance with the Malibu Creek Bacteria TMDL (TMDL Compliance Hydrograph). This hydrological analysis is used in Section 4 of this technical memorandum for evaluating the feasibility of each regional BMP opportunity.

The following regional structural BMP options were evaluated in this preliminary feasibility assessment and facility siting plan:

- Infiltration Basin
- Conventional Disinfection Facility
- Free Surface Flow (FSF) Constructed Wetland
- Sub-Surface Flow (SSF) Constructed Wetland

In addition to the regional structural BMPs, additional flow conveyance, storage, and appurtenances will be needed to divert flows from storm drains or streams into the facility and in all cases except for the infiltration basin, to return treated effluent to receiving waters. These facilities will vary greatly depending upon site layouts and were only roughly estimated in this preliminary facility siting plan. In addition, some of the locations may offer opportunities for multiple site uses (parks, recreation, parking, etc.), which may enhance their value. This level of detailed investigation was not undertaken.

1.1 Infiltration Basins

Regional infiltration facilities generally consist of a large shallow basin, capable of detaining the entire volume of a design storm and infiltrating this volume over a specified period. For this preliminary facility siting plan a 48-hour drawdown requirement was used for infiltration basin capacity estimates. The primary mechanism for bacteria removal in regional infiltration basins would be volume reduction to receiving waters and, for storms smaller than the design storm, complete removal of bacteria by preventing any surface discharge. Infiltration facilities achieve high levels of treatment of bacteria and other pollutants by impounding water and allowing it to slowly percolate into the ground.

Application of regional infiltration facilities for control of bacteria in the MCW is heavily dependent on the suitability of soils for infiltration and the availability of appropriately-located open space. Infiltration rates for specific infiltration basin BMP sites were estimated using a combination of geologic properties based on geologic maps (Dibblee, 1992, 1993a, 1993b; Yerkes and Showalter, 1991, 1993; Yerkes and Campbell, 1997) and soil properties derived from the State Soil Geographic (STATSGO) database, the Soil Survey Geographic (SSURGO) database, and the Los Angeles County Hydrology Manual (2006). The more detailed SSURGO database is not complete for Los Angeles County, in particular this western portion, and so the STATSGO data were reviewed to fill in information for some sites. These infiltration rates are presented for the potential regional structural BMP sites in Table 1.1. Soils with infiltration capacity in the low category were not considered as potential BMP opportunities.

Variable soil horizons and depths to underlying bedrock at each site will impact actual infiltration characteristics for a specific location, thus infiltration testing will be necessary to determine actual infiltration response. The values reported in Table 1.1 are a generalized estimate of possible infiltration based on the local soils. Site specific infiltration rates will depend not only on site specific soil and geologic conditions, but also on design of the basin. In particular, final depth below grade for basin bottom will control infiltration rates.

Table 1-1
Estimated Infiltration Rates at Regional Structural BMP Opportunity Sites

Infiltration Site	Geologic Setting	Estimated Infiltration Rate*	Estimated Infiltration Capacity
Lower Lindero Creek Subwatershed	Tertiary Volcanic Formations	Low	Low
Upper Medea Creek Subwatershed	Tertiary Volcanic Formations	Low	Low
Upper Lindero Creek Subwatershed	Alluvium on Tertiary Volcanic Formations	Moderate-High	Low-Moderate
Triunfo Flood Control Channel	Alluvium on Tertiary Volcanic Formations	Moderate	Low-Moderate
Three Springs Park	Alluvium on Tertiary Volcanic Formations	Low-Moderate	Low-Moderate
Chumash Park	Alluvium on Tertiary Volcanic Formations	Moderate	Low-Moderate
Lake Lindero Country Club	Alluvium on Tertiary Volcanic Formations	Moderate-High	Moderate
Liberty Canyon Creek	Alluvium on Tertiary Volcanic Formations	Low-Moderate	Low-Moderate
Reyes Adobe Park	Tertiary Volcanic Formations	Low	Low
Sumac Park	Alluvium on Tertiary Sedimentary Formations	Moderate-High	Moderate-High
Las Virgenes Creek near De Anza Park	Alluvium on Tertiary Volcanic Formations	Moderate-High	Moderate
Las Virgenes Creek below 101 Freeway	Alluvium on Tertiary Volcanic Formations	Moderate	Moderate
Upper Lindero Creek at County Line	Alluvium on Tertiary Sedimentary Formations	Moderate-High	Moderate-High
Russell Creek at Westlake High School	Quaternary landslide on Tertiary Sedimentary Formations	Moderate	Moderate
Oak Canyon Community Park	Mesozoic Bedrock Formations	Low	Low
Medea Creek Park	Alluvium on Tertiary Sediments	Moderate-High	Moderate-High

Infiltration capacity for each site is controlled by both the local soil properties, which controls surface infiltration rates, and the underlying geologic formation, which controls subsurface infiltration rates and storage capacity. In general, alluvial deposits will have higher infiltration rates and more storage capacity than Tertiary sedimentary formations. The Tertiary sedimentary formations will, in general, have higher infiltration rates and more storage capacity than Tertiary volcanic formations. The storage capacity controls long term, or seasonal, infiltration rates. The sites with higher infiltration storage capacity will be less likely to have slower infiltration rates and lower capacity later in the wet season.

Based on the analysis of soil data, expected infiltration capacity for "Low-Moderate", "Moderate", and "Moderate-High" soils are 0.5 in/hr, 0.6in/hr, and 0.75 in/hr, respectively. Sediment in infiltrated runoff is filtered by the soil, resulting in the potential for infiltration basins to clog over a period of use. For this reason, reported infiltration rates may not be sustained over long terms of operation. The California Stormwater Quality Association (CASQA) BMP Handbooks suggest a reduction of 50% in the design infiltration rate when developing design criteria for infiltration basins. Based on this reduction factor, infiltration capacities used to develop preliminary siting plans for sites with "Low-Moderate", "Moderate", and "Moderate-High" soils are 0.25 in/hr, 0.3in/hr, and 0.38 in/hr, respectively. Soils with "Low" infiltration rates, approaching 0 in/hr, were not considered.

The CASQA Handbooks also recommend a regular maintenance program to aid in sustaining the expected infiltration rate of the basin. Every three to five years, the infiltration basin should undergo scraping of the basin bottom to remove clogged sediments. As well, the soils in the basin should be disked or otherwise reaerated following the same schedule.

1.2 Conventional Disinfection Facilities

Conventional treatment regional BMPs considered here include ozone, ultra-violet (UV) irradiation, and biocides/peracetic acid (PAA) disinfection facilities. Other disinfection options, such as chlorination, were considered for storm water treatment but due to the safety concerns of transport and storage of chlorine compounds and the potentially harmful release of chlorination byproducts, ozone, UV, and PAA were deemed more feasible. Ozone and UV have been applied successfully to dry weather flows, but limited information on successful application to wet weather flows is available. Wet weather flows are typically larger and more variable than dry weather in flow rate, bacteria concentration, and turbidity, making disinfection more difficult than with dry weather flows. PAA has been used in combined sewer overflow (CSO) applications, but not directly for wet weather urban runoff.

The availability of land for placement of a conventional treatment facility and the necessary upstream detention/sedimentation facility is a critical factor in evaluating implementation feasibility. The required footprint area depends on the storage volume of the detention facility and the treatment rate of the disinfection facility. By integrating distributed BMPs throughout the subwatershed to reduce runoff rates and volumes, the area required for treatment can be reduced.

The following paragraphs describe each of the different conventional treatment regional BMPs that could be utilized within the MCW. A comparison of the advantages and disadvantages of each of these BMPs is found in Technical Memorandum 7.2, "Wet Weather Treatment Plan" for the Malibu Creek Bacteria TMDL.

Ozonation Facilities
Ozone is chemically unstable (rapidly decomposing to oxygen) and must be generated onsite. This reduces the transportation hazards associated with supplying a facility with a disinfectant agent. An ozonation facility consists of equipment used to produce ozone from air using electrical power, followed by devices to mix and dissolve the ozone gas into solution to react with pollutants in the water. Ozone is effective against viruses, bacteria, amoeba, and protozoans including Giardia (Hoff, 1987) and Cryptosporidium (Korich et. al., 1990). In addition, ozone reduces BOD and COD, enhances dissolved oxygen, removes adverse taste and color, and oxidizes oil and grease, organophosphorus pesticides, and inorganic compounds. It also increases coagulation and helps remove iron and manganese (US EPA, 1999). Although ozone has been documented as an effective disinfectant in the treatment of wastewater and combined sewer overflows (CSO), its use in the storm water industry is relatively new. Contact time is an important parameter that can influence the performance of an ozonation facility. Suspended sediment and biological material increases the ozone demand and shields microbes from treatment. High nitrate levels can also reduce the effectiveness of ozone (Metcalf & Eddy, 2003), so any upstream BMP that reduces nitrate concentrations would also improve the performance of an ozonation facility.

Ultra-Violet Irradiation Facilities
Ultra-violet (UV) light is in a broad spectrum below visible light. Between approximately 220 to 320 nanometers, UV light has a germicidal effect that peaks at about 260 nanometers (Metcalf & Eddy, 2003). A UV treatment system generally consists of a power supply, ballast or capacitors, high-intensity lamps, reaction chamber, cleaning apparatus, and controls and instrumentation. Storm water applications of UV disinfection are rare, but are beginning to become more popular. For example the, City of Encinitas, CA recently installed a UV disinfection system to treat storm water discharges to Moonlight Beach (City of Encinitas, 2006). In a similar application, the City of Coronado, CA installed a UV disinfection system for treating both groundwater and storm water (combined system) prior to discharging to the ocean (Woodward Clyde, 1998).

Ultraviolet (UV) light immobilizes stormwater-borne pathogens by penetrating pathogen cell walls and causing the formation of double bonds within the pathogens. This prevents replication and/or causes death of the organism (Metcalf & Eddy, 2003). The effectiveness of UV disinfection depends primarily on the uniformity of flow velocities and the clarity of the influent water. Solid particles can greatly affect the performance of a UV system by minimizing light penetration and shielding bacteria. Furthermore, the characteristics of the target organisms and the chemical characteristics of the influent may have an affect on UV effectiveness. Hydraulic controls and conveyances designed to achieve a nearly uniform velocity field through the reaction chamber would enhance performance. The UV lamp encasements must be routinely cleaned so that the UV light is not hindered by algal growth and calcium deposits (Metcalf & Eddy, 2003).

Peracetic Acid
PAA is an emerging product that can be used in storm water treatment. PAA is a stabilized equilibrium solution concentrate that is a mixture of peracetic acid, acetic acid, and hydrogen peroxide. PAA is more effective than chlorine dioxide and has virtually no odor at end-use concentrations. It degrades to acetic acid (vinegar), water, carbon and oxygen. It does not have disinfection byproducts like chlorine, but does have a residual concentration, which is non-toxic and readily biodegradable in receiving waters. These features make PAA a good alternative to common disinfectants such as chlorine, potassium permanganate, or hydrogen peroxide alone. PAA is primarily used in the food and beverage industry, but it also has potential wastewater and storm water treatment applications. Peracetic acid oxidizes the outer cell membranes of microorganisms and can be applied for the deactivation of bacteria and viruses. The oxidation mechanism consists of electron transfer. When a stronger oxidant is used, the electrons are transferred to the microorganism much faster, causing the microorganism to be deactivated rapidly.

1.3 Constructed Wetlands

Constructed wetlands are different from natural wetlands in that they are designed and maintained primarily for water quality treatment. These facilities have gained acceptance in recent years as a practical and cost-effective approach for treating runoff and wastewater. Constructed wetlands make use of processes that occur in natural wetlands as well as in conventional wastewater treatment plants, but are simpler than conventional technologies because they do not require advanced containment and control systems.

These facilities are not intended to provide stand-alone treatment of storm water runoff. Often a detention facility is required upstream to mitigate peak flows and provide a more steady inflow. Constructed wetlands can become clogged with sediments and lose their effectiveness. To counter this drawback, these facilities can be integrated with other BMPs to provide better performance and longevity of the facility. Any upstream BMP that effectively reduces sediment loads, including but not limited to biofiltration facilities, media filters, and sedimentation basins, could be integrated with constructed wetlands for better longevity and more reliable treatment.

Free Surface Flow (FSF) Constructed Wetland

FSF constructed wetlands are characterized by shallow ponded water at varying depths above the ground surface. The mechanisms for bacterial control in a constructed wetland include filtration, sedimentation, oxidation, antibiosis, predation, and competition (Davies and Bavor, 2000). Solar irradiation is also thought to contribute to bacterial removal. Constructed wetlands can be applied as either inline or offline facilities, and can be integrated into other habitat enhancement projects. However, to mimic the natural function of wetlands they require comparatively large areas of relatively flat land. This could limit their implementation significantly in the MCW.

FSF constructed wetlands can be designed with a variety of alternatives, including single cell shallow marshes with permanent pools of 6" to 18"; multi-cell systems that utilize a wet pond to reduce sediment in runoff and flow velocity, followed by a shallow marsh for additional treatment of pollutants; extended detention wetlands that incorporate greater topographic relief to facilitate different zones of wetting, and allow depths of water to reach 3 feet during a storm event; and pocket wetlands for smaller watersheds where runoff volume storage is reduced to allow for greater fraction of treatment area.

Each of these wetland types should be designed to include a sediment forebay that has the capacity to store at least 10% of the treatment volume at a depth of 4 to 6 feet. The outlet structure of the wetland area should also include a micropool that has the capacity to store at least 10% of the runoff volume in order to prevent clogging the outflow drain. Trash racks or hoods on the outflow riser will also help to prevent clogging. In addition, the outlet drain can be reverse-sloped to prevent clogging.

To prevent sediment buildup in the wetland, the CASQA BMP Handbooks recommend that the wetland be monitored regularly for sediment accumulation and that sediment be removed when it occupies more than 10% of the basin volume, if plants are choked, or if the wetland becomes eutrophic. Additionally, the sediment forebay should be regularly dredged every five to seven years.

The size of a FSF constructed wetland is dependent upon the residence time necessary to obtain the desired pollutant removal. For bacteria reduction, a 7-day residence time was assumed to be sufficient to achieve reductions to below recreational water quality objectives. FSF wetlands should be designed to maximize the ratio of length to width in order to increase the length of the flowpath, which controls the residence time of the treated volume. Additionally, within the wetland, elevated zones should be situated perpendicular to the primary flowpath to facilitate meanders, thus increasing residence time within the wetland.

The 7-day residence time can create a vector issue in a FSF constructed wetland. The wetland should be designed to reduce opportunities for mosquito breeding to prevent vector problems associated with open water channels. When possible, the wetland design should avoid the allowance of dead zones to prevent stagnant water ideal for mosquito breeding. Periodic dredging of the wetland can improve flow rates and prevent stagnant water as well. Additions to the wetland may be possible to control the mosquito population, such as supplying the dry-weather channel with mosquito fish if constant flow is expected, or applying pesticides to help control mosquito populations. Larvicides can be applied in chemical form, but there also exist two species of bacteria, *Bacillus thuringiensis israelensis* and *Bacillus sphaericus*, which release toxins that kill the larvae when ingested (Willott, 2006). These bacteria do not survive long and therefore would not be expected to impact downstream water quality, however this form of larvicide must be reapplied regularly and evenly to the wetland to maintain effectiveness.

Plants must be chosen that can accommodate the frequency and depth of water. The dry-weather channel will be permanently wet, however the water level should not regularly exceed ½ ft. These conditions can support several plant species, including softstem bulrush, common three-square, pickerelweed, sedges, rushes, and arrow arum (Davis). The stormwater treatment area must contain plants that can withstand flooding during wet-weather events, but also thrive during drier periods. Recommended plants include trees such as black willow and river birch, shrubs such as buttonbush and chokecherry, as well as softstem bulrush, sedges, switchgrass, and rice cutgrass. When possible, native plants should be used in order to prevent invasive species from thriving.

While removal mechanisms ideally are the dominant processes concerning bacteria in a wetland treatment system, in some cases, increases in bacteria concentration have been reported. The primary concern for bacteria increase is the addition of pathogens due to wildlife that is attracted to wetland habitat. Measures can be taken to prevent many animals from entering a wetland, such as constructing fences, however a sufficient means does not exist to prevent birds from excreting within the wetland perimeter. As long as waste is not introduced at the outlet, it is subject to a residence time and pathogens can be at least partially eliminated through the removal mechanisms above. However waste introduced at the outlet of the wetland is likely to pollute the receiving water.

Subsurface Flow (SSF) Constructed Wetland

In SSF wetlands, water flows through the sub-surface soil matrix, rarely surfacing. Wetland plant species are planted within the soil matrix and remove pollutants by uptake. The presence of aerated and anoxic zones is also thought to enhance removal. Due to enhanced filtration processes, an anaerobic environment, reduced residence time, and a lack of inhabiting animals contributing to bacteria loads, SSF wetlands are considered to be more effective for bacteria removal than FSF wetlands. Therefore, where possible, SSF wetlands should be considered first. Various modifications have been made to specifics designs of SSF wetlands in order to enhance treatment capabilities. One modification is the use of a backflow pump to purge the wetlands of fine sediments and other potentially clogging materials. Another is the addition of nutrients to SSF wetlands to promote vegetative and bacterial growth. This is generally required when an inert substrate such as sand is used. A required design element that enhances performance and increases the lifespan of SSF wetlands is to provide removal of suspended solids upstream of the wetland.

The subsurface wetlands should be constructed in parallel media beds. The media should be at least 3/8″ gravel to prevent mechanical and biological clogging. Minimum porosity and conductivity of the coarse grained materials should be on the order of 0.3-0.35 and 1-100 cm/s, respectively. A layer of fine organic substrate is required on the ground surface for establishment of the vegetative cover. The dimensions of each media bed should be on the order of 10 feet wide, 20 feet long, and about 4-5 feet deep. Wider cells are possible, but the length of the flow path should generally be limited to about 20-40 feet (depending on media type) to minimize head drop across the cell. The media bed would be constructed by simple excavation, with a slope of about ½ to 1 percent from inlet to outlet. Note that subsurface wetlands can be constructed above ground as well. The media bed should be lined to prevent infiltration and interaction with the groundwater. Common liner materials are 30-mil PVC or HDP pond liners. Other options include compacted clay or concrete.

The inlet and outlet works can be distribution trenches that are filled with high permeability materials (or open structures) to help distribute flows uniformly across the media bed. There is flexibility in the type of media used in the distribution trenches, including large gravel and stones, wire mesh gabions filled with stones, pipe networks, or synthetic, high porous, high strength plastic modular infiltration blocks, such as the Atlantis Water Management System. Influent can simply be distributed over the surface of the inlet trench, or alternatively could be distributed in a buried perforated pipe manifold. The outlet pipe can be a slotted collection pipe that is buried in the outlet trench, and is connected to a level control device to control water levels in the media bed or a collector trench.

Subsurface flow wetlands should have a minimum retention time of 1-day, which has been shown to provide excellent removal of indicator bacteria. In practice the actual average retention time will be less than the theoretical retention time due to deviations from uniform flow conditions. An actual retention time of approximately 75 percent of the theoretical maximum has been suggested. Based on the media bed dimensions and the retention time above, the treatment capacity for each media cell is estimated at 210 cf/d. On a per acre basis, this is roughly equivalent to 0.5 cfs/acre or 0.33 MGD/acre. This area estimate only includes the media bed area, which will be the vast majority of the area requirement.

2.0 Criteria for Evaluating Regional Structural BMP Opportunities

Preliminary siting plans and feasibility assessments for pre-screened potential regional structural BMP opportunities were developed based on several important criteria, including effectiveness, cost, and community and environmental impacts. These factors were evaluated at 17 sites throughout the Malibu Creek Watershed (MCW) for each of the regional structural BMP types described above. An overview of the criteria used in evaluating regional structural BMP opportunities for the each BMP type is discussed in detail below.

Potential locations identified for BMPs include both public and private parcels that initial investigations indicate could be suitable and potentially available for acquisition or use. It may be determined in the future that these locations are not available, or that a private owner is unwilling to sell. Acquisition of properties by eminent domain for the installation of water quality BMPs is not supported by the responsible agencies.

2.1 Effectiveness

The bacteria removal effectiveness of regional structural BMPs is impacted by the amount of flow that can be treated within the space available, as well as the bacteria removal expected from different types of regional structural BMPs.

The amount of space available for regional structural BMPs may exclude the use of those BMPs that require more land. Conversely, a smaller BMP that manages only a portion of the target flow may be an option for consideration. Space requirements are based on the amount of surface or subsurface area needed to treat or control runoff with a BMP and the ability of that practice to be incorporated into existing site constraints or infrastructure. In order to treat the runoff volume from the TMDL Compliance Hydrograph, the BMP must have sufficient storage to ensure capture of the peak of the hydrograph, and provide sufficient treatment capacity to drawdown the stored runoff prior to a subsequent runoff event (48 hours was used in this BMP sizing analysis). Both FSF and SSF constructed wetland systems are effective methods for reducing bacteria, but require more space to allow for higher residence times.

Expected bacteria removals from each of the four BMP types that are considered in this feasibility assessment are moderate to high. Infiltration basins not only completely remove bacteria, but also reduce downstream runoff volume, which reduces bacteria transport mechanisms and inflow to other regional BMPs downstream. However, infiltration is only effective where soil infiltration rates are high enough to drawdown the stored runoff prior to another storm event and the underlying depth to groundwater is large enough for the infiltration to be effective. UV disinfection systems are capable of treating bacteria to very low levels; however facilities should be designed to be cost effective and therefore target bacteria concentrations in effluent would be just below water quality objectives.

2.2 Cost

Planning level unit capital and O&M costs associated with each of the evaluated regional structural BMP types are included in Technical Memorandum 7.2, "Wet Weather Treatment Plan" for the Malibu Creek Bacteria TMDL. These costs were developed for an assumed 100 acre reference watershed. Larger facilities may have lower unit cost due to economies of scale. Table 2-1 summarizes the unit costs provided in Technical Memorandum 7.2 for the four regional structural BMP types described above and for detention facilities that will be necessary for all of the opportunities to reduce sediment and control inflow rates to treatment systems. Unit capital costs for regional structural BMPs are estimated per acre-foot of treated volume. FSF wetlands, infiltration basins, and SSF wetlands are similar in unit capital cost, ranging from $43,000 to $74,000 per acre-foot of constructed volume. The size of these BMPs varies based on the necessary residence time for bacteria removal and therefore the total cost will have a wider range. Package treatment plants, such as a UV disinfection facility, have a much greater cost, but in some cases may be a better, or the only feasible, solution because they require less space and have a lower risk of non-compliance. Annual O&M costs are also estimated per acre foot of constructed BMP volume.

Table 2-1
Normalized Capital and O&M Costs for Regional Structural BMPs

BMP Type	Unit Capital Cost ($/ac-ft constructed volume)	Unit O&M Cost ($/ac-ft/yr constructed volume)
Infiltration Basins	$69,000	$1,400
Constructed SF Wetlands	$43,000	$900
SSF Wetlands	$74,000	$1,200
Package Treatment Plant	$1,130,000	$25,000
Dry Detention Basin	$38,000	$400

Land acquisition cost also must be considered when assessing regional structural BMPs on privately owned lands. Based on some commercial and industrial properties for sale in the cities of Thousand Oaks and Calabasas, a normalized cost of $850,000 per acre was used to develop a planning level cost estimate for each project location evaluated in this facility siting plan.

2.3 Community Impact

Regional structural BMPs can have a relatively large footprint that will alter the landscape in the surrounding areas. Open space that is sufficient for locating regional structural BMPs within the MCW is commonly within city parks and other public use areas such as schools. Some alternatives such as conventional treatment may reduce the site footprint, which would reduce the encroachment upon high recreational use open space. Other alternatives such as FSF wetlands can be designed to enhance recreation by attracting wildlife and providing environmental education opportunities. FSF wetlands and infiltration basins can be a source of poor odors, which would have a significant impact upon the local community. Similarly, the appearance of regional structural BMPs can impact the overall aesthetics of an area.

Another concern related to locating regional structural BMPs in close proximity to residential development is the potential for introducing mosquitoes and other vectors for disease. Regional structural BMPs that avoid the need for standing water, such as SSF constructed wetlands and conventional treatment systems would not cause vector concerns, unlike infiltration basins and FSF constructed wetlands. These issues related to the surrounding community need to be addressed prior to construction of a regional structural BMP. Neighborhood support can be achieved by utilizing a multiple stakeholder decision making process for a proposed project.

The vast open space within Malibu Creek State Park and the Santa Monica Mountains National Recreation Area is very hilly and not directly downstream of urbanized land uses; however several opportunities do exist for stream enhancement type BMPs in these areas and should be further investigated.

2.4 Environmental Impact

The conversion of an existing open space or undeveloped land area to a constructed regional structural BMP can result in removal of natural habitats. Facilities can be designed to attempt to enhance wetland species habitat, but construction within sensitive ecological areas (SEAs) is would not be permissible.

Infiltrating stormwater runoff through contaminated soils can leach contaminants into ground water supplies, aggravating ground water quality problems. Additionally, contaminated runoff may exceed the pollutant removal capacity of the soil resulting in ground water contamination. A basic understanding of the connectivity of groundwater resources may help determine the overall threat that a particular BMP may pose to receiving waters and drinking water supplies.

Regional structural BMPs, when improperly designed can be sources of bacteria, sediment, and other pollutants. For example, improperly designed inlets and outlets and placement of BMPs on steep slopes may cause scour, erosion, and slope instability.

3.0 Descriptions of Potential Sites for Regional BMPs

For this preliminary facility siting plan, a total of eighteen sites have been identified and could be considered as potential opportunities for regional BMPs in six of the ten high priority subwatersheds within the Malibu Creek Watershed (Figure 3-1). Potential opportunities exist on private, public, and city or county owned land in the Malibu Lagoon, Westlake, Lower Lindero Creek, Upper Lindero Creek, Upper Medea Creek, and Lower Las Virgenes Creek Subwatersheds. Table 3-1 gives information on the subwatershed, city or community, and county where these opportunities are located, as well as whether the site is publicly or privately owned. These locations are described further in the following subsections.

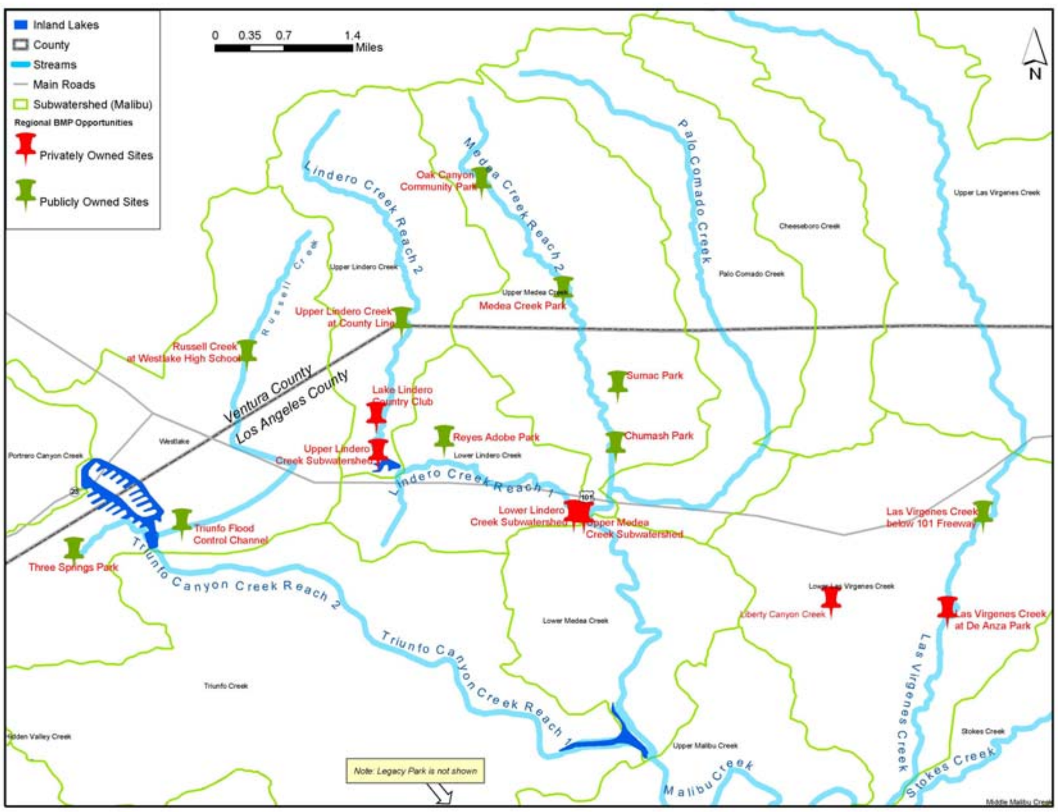

Figure 3-1. Potential Sites for Regional BMPs.

Table 3-1

Location and Ownership of Potential Sites for Regional BMPs				
Site Name	Subwatershed	City/Community	County	Public / Private
Chumash Park	Upper Medea Creek	Agoura Hills	Los Angeles	Public
Lake Lindero Country Club	Upper Lindero Creek	Agoura Hills	Los Angeles	Private
Las Virgenes Creek near De Anza Park	Lower Las Virgenes Creek	Calabasas	Los Angeles	Private
Las Virgenes Creek below 101 Freeway	Lower Las Virgenes Creek	Calabasas	Los Angeles	Public
Legacy Park	Malibu Lagoon	Malibu	Los Angeles	Public
Liberty Canyon Creek	Lower Las Virgenes Creek	Agoura Hills	Los Angeles	Private
Lower Lindero Creek Subwatershed	Lower Lindero Creek	Agoura Hills	Los Angeles	Private
Lower Medea Creek	Lower Medea Creek	Agoura Hills	Los Angeles	Private
Medea Creek Park	Upper Medea Creek	Oak Park	Ventura	Public
Oak Canyon Community Park	Upper Medea Creek	Oak Park	Ventura	Public
Reyes Adobe Park	Lower Lindero Creek	Agoura Hills	Los Angeles	Public
Russell Creek at Westlake High School	Westlake	Thousand Oaks	Ventura	Public
Sumac Park	Upper Medea Creek	Agoura Hills	Los Angeles	Public
Three Springs Park	Westlake	Westlake Village	Los Angeles	Public
Triunfo Flood Control Channel	Westlake	Westlake Village	Los Angeles	Public
Upper Lindero Creek Subwatershed	Upper Lindero Creek	Agoura Hills	Los Angeles	Private
Upper Lindero Creek at County Line	Upper Lindero Creek	Thousand Oaks	Ventura	Public
Upper Medea Creek Subwatershed	Upper Medea Creek	Agoura Hills	Los Angeles	Private

3.1 Malibu Lagoon Areas

Legacy Park

The Legacy Park site is a large field on the north side of the Pacific Coast Highway between Cross Creek Road and Stuart Ranch Road in Malibu (Figure 3-2a). The catch basins to the east of this site are subject to a good deal of trash and other source of pollution (Figure 3-2b), which is carried to the waters of Malibu Lagoon State Beach (Figure 3-2c). Signs are posted at the entrance to the beach and lagoon area stating that the water quality is poor and therefore it is unsafe to swim or even wade (Figure 3-2d).

Figure 3-2. Photos of the Legacy Park Opportunity

Although this parcel is located at the downstream end of the Malibu Creek Watershed, there is not much direct drainage to the Legacy Park site. The storm drains that pass near the site originate only a short distance north, following Stuart Ranch Road to Civic Center Way and out to Malibu Creek. The City of Malibu is currently developing a constructed wetland project at this site to treat urban runoff in part of the City upstream of Malibu Lagoon.

Figure 3-3. Aerial Map of the Legacy Park Opportunity

3.2 Westlake

Triunfo Flood Control Channel

The Triunfo Flood Control Channel opportunity encompasses the drainage to the Triunfo Flood Control Channel at the intersection of Lakeview Canyon Road and Lindero Canyon Road in Westlake Village (Figure 3-4a), where the channel, which runs along the south side of Lindero Canyon Road, begins flowing underground towards Westlake Lake (Figure 3-4b). This intersection features a fire station and parking lot on the southeast corner, a parking area and community buildings on the southwest corner, and houses on the north side of Lindero Canyon Road. Because there is not sufficient open space for a regional BMP directly around this location, it would be necessary to convey flow to a nearby location for storage or treatment. The proposed location is Berniece Bennett Park, located northeast of the creek at this site. The park features a good deal of open space (Figure 3-4c), as well as a pavilion, picnic tables, walking path, basketball courts, and a playground (Figure 3-4d).

Figure 3-4. Photos of the Triunfo Flood Control Channel Opportunity

Drainage to this site comes from Ventura County at Windhaven Drive running parallel to the Triunfo Flood Control Channel. The intersection, shown as a red star on Figure 3-5, is the location of the outlet of a major drain which runs parallel to the creek from the intersection of Lindero Canyon Road and the 101 Freeway, and receives flow from many smaller drains.

Figure 3-5. Aerial Map of the Triunfo Flood Control Channel Opportunity

Russell Creek at Westlake High School

The Russell Creek at Westlake High School opportunity encompasses the area north of Thousand Oaks Boulevard between Lakeview Canyon Road and North Via La Merida (Figure 3-6a) in Thousand Oaks (Figure 3-6b). The expansive area available for this opportunity is hilly, with Russell Creek running in a valley parallel to North Via La Merida (Figure 3-6c). The creek appears to be un-impacted, with no evidence of scouring or trash in the water. There are residential developments to the northeast, some scattered buildings on the north and west sides, and Westlake High School to the south.

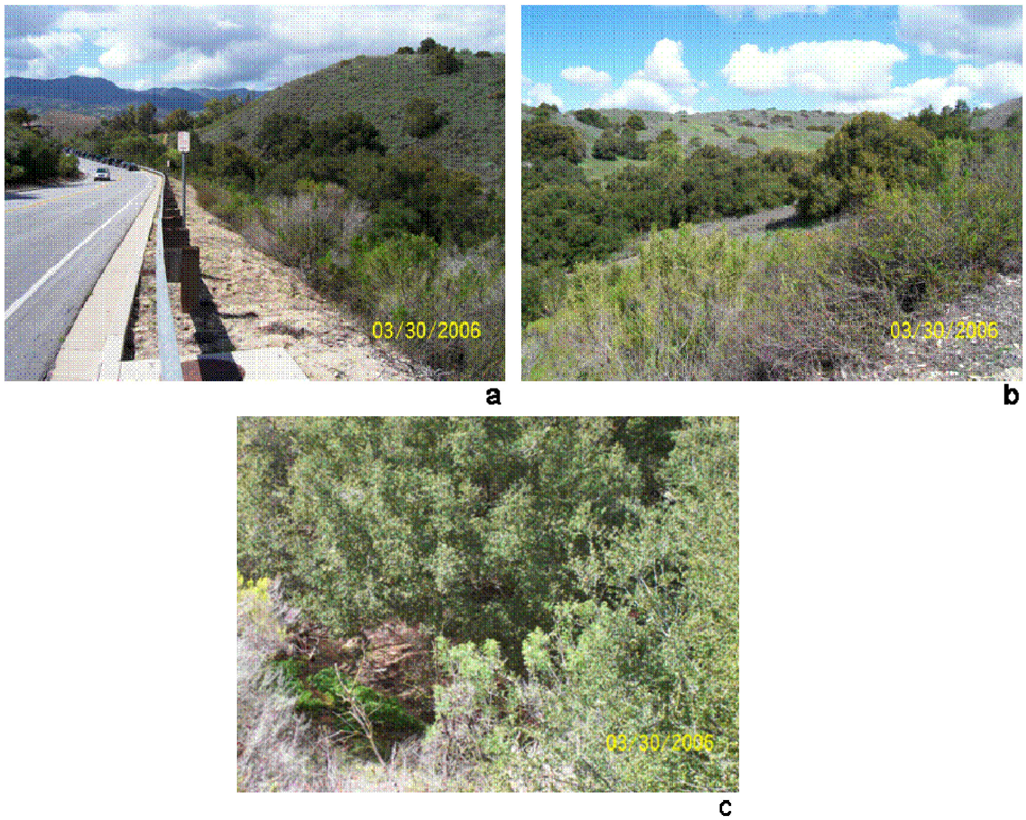

Figure 3-6. Photos of the Russell Creek at Westlake High School Opportunity

This location is upstream of the Russell Creek above Westlake Lake opportunity and receives drainage from low density upstream development. Stormwater flows through a drain originating at Windhaven Dr. and running along the creek, however there do not appear to be any drain outlets to the creek upstream of this location.

Figure 3-7. Aerial Map of the Russell Creek at Westlake High School Opportunity

Three Springs Park

Three Springs Park is located on a residential street at 3000 Three Springs Drive in Westlake Village. The park has a lower elevation than the surrounding street and the northwest side of the park has a grass berm separating it from Three Springs Drive (Figure 3-8a). At the northernmost point in the park, adjacent to the berm, is a concrete structure with a 3 foot storm drain (Figure 3-8b). Three Springs Creek brings flow from Las Virgenes Reservoir and runs along the northeast side of the park (Figure 3-8c) at the base of a hill, and another hill borders the park on the south side, separating it from the Las Virgenes Reservoir. The Las Virgenes Municipal Water District Westlake Pump Station is situated on the southern end of the park (Figure 3-8d), and the remainder of the park features basketball courts, a playground, barbeques, picnic tables, a large grassy field, and a path around the perimeter.

Figure 3-8. Photos of the Three Springs Park Opportunity

There is a small amount of development upstream of this location and all drainage originates in residential neighborhoods. The main drainage upstream of Three Springs Park begins where Kirsten Lee Drive meets Sycamore Canyon Drive and continues to west of Barrett Drive where it enters the Barrett Basin. The Barrett Basin also receives drainage in this area from lines along Barrett Drive and Three Springs Drive, as well as flow from Three Springs Creek.

Figure 3-9. Aerial Map of the Three Springs Park Opportunity

3.3 Lower Lindero Creek

Lower Lindero Creek Subwatershed

The Lower Lindero Creek Subwatershed opportunity is located at the southwest corner of the intersection of Agoura Road and Kanan Road in Agoura Hills (Figure 3-10). Just downstream of this intersection is the location at which the Lindero Creek flows into the Medea Creek and opportunities may be possible along both creeks, both upstream and downstream of this confluence. There is very little development directly surrounding this area, however this location is the downstream point for many other sites that are being considered for BMPs.


a


b


c

Figure 3-10. Photos of the Lower Lindero Creek Subwatershed Opportunity

The Lower Lindero Creek Subwatershed opportunity location receives flow from the entire Lindero Creek Subwatershed. The creek, which begins north of the intersection of Kanan Road and Collingswood Court in Ventura County, receives drainage from surrounding development along the entire length, including points along Lindero Canyon Road, Canwood Street, and Agoura Road.

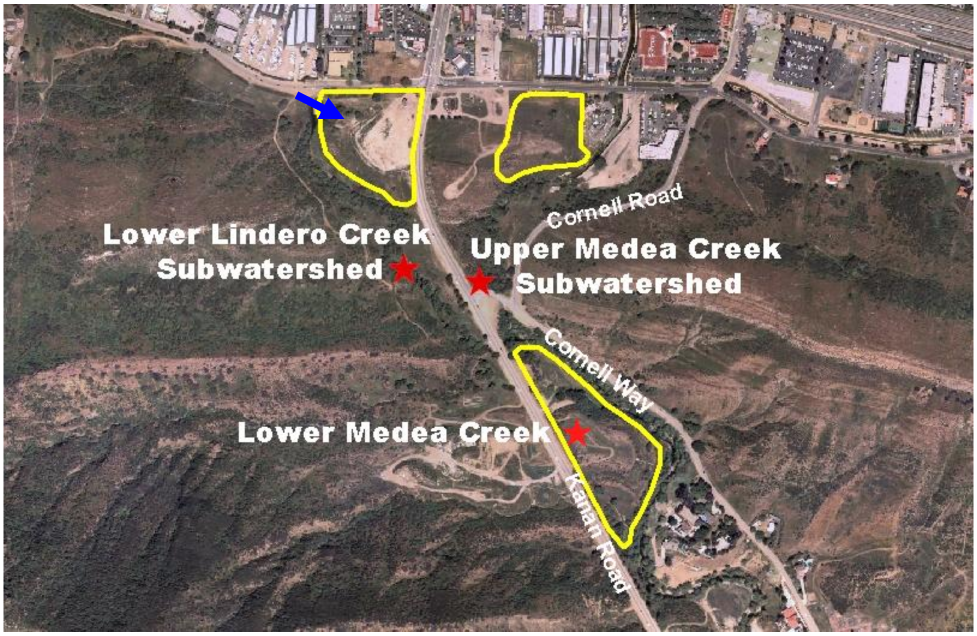

Figure 3-11. Aerial Map of the Lower Lindero Creek Subwatershed Opportunity

Reyes Adobe Park

Reyes Adobe Park is located on a residential street at 31400 Rainbow Crest Drive, Agoura Hills (Figure 3-12a). The east side of the park is the location of the historic Reyes Adobe, built around 1850 and one of Agoura Hill's earliest homes. Along the western side of the Reyes Adobe runs a small stream which flows into a drain at the southern side of the park (Figure 3-12b). The area is fairly hilly except for an area on the eastern side (Figure 3-12c) and the land slopes towards the residences on the southern side (Figure 3-12d). The park features a playground, restrooms, a picnic area with barbeques, and a parking lot on the flatter, eastern portion of the parcel.

Figure 3-12. Photos of the Reyes Adobe Park Opportunity

There is a fair amount of drainage passing under and around Reyes Adobe Park from the surrounding, primarily residential neighborhood. The main drain originates shortly upstream of the intersection of Reyes Adobe Road and Stonecrest Drive. There also appears to be a subsurface creek tributary to the Lindero Creek which passes under the west side of the park.

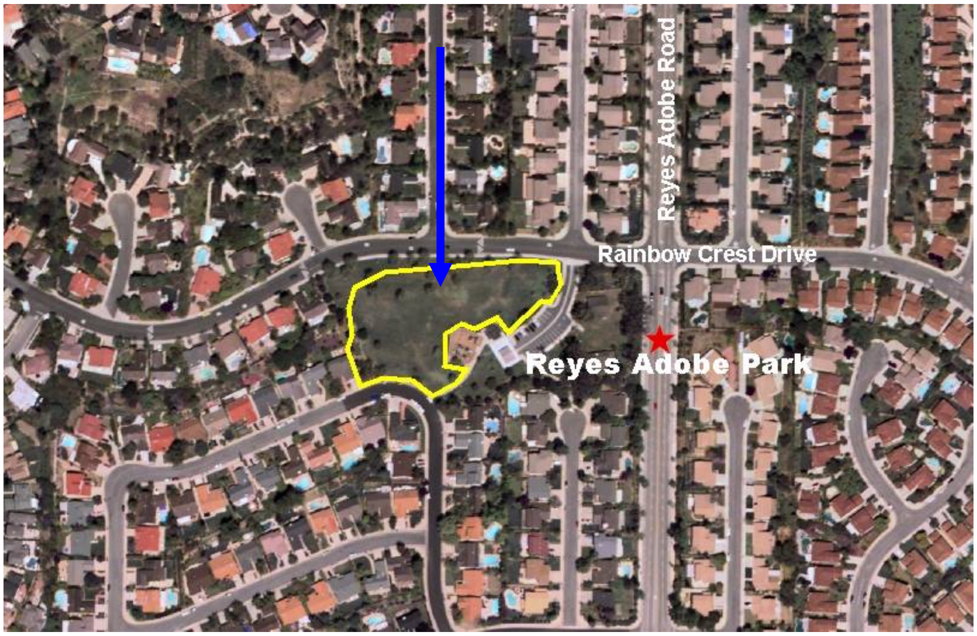

Figure 3-13. Aerial Map of the Reyes Adobe Park Opportunity

3.4 Upper Lindero Creek

Lake Lindero Country Club

The Lake Lindero Country Club is located at 5719 Lake Lindero Drive in Agoura Hills (Figure 3-14a). The area features developed and landscaped buildings and green space, including a golf course (Figure 3-14b).

Figure 3-14. Photos of the Lake Lindero Country Club Opportunity

Lindero Creek passes directly through the Lake Lindero Country Club, and receives drainage along the entire length of the creek upstream of this point, which begins north of the intersection of Kanan Road and Collingswood Court in Ventura County. Within this parcel, the creek receives drainage from the residential communities along Lake Lindero Drive and Hedgewall Drive.

Figure 3-15. Aerial Map of the Lake Lindero Country Club Opportunity

Upper Lindero Creek at County Line

The Upper Lindero Creek at County Line opportunity encompasses a large area east of Lindero Canyon Road and north of Thousand Oaks Boulevard in Thousand Oaks (Figure 3-16a). The site is just north of a planned housing development (Figure 3-16b). Lindero Creek runs along the base of the hills and appears to be unimpacted, with no signs of trash or other pollution (Figure 3-16c), however there is evidence of scouring on the east side of the creek in the area directly opposite Blackbird Avenue (Figure 3-16d).

a b c d

Figure 3-16. Photos of the Upper Lindero Creek at County Line Opportunity

The Upper Lindero Creek at County Line opportunity is the most upstream potential regional BMP location along Lindero Creek, and receives drainage along the length of the creek upstream of this point, which begins north of the intersection of Kanan Road and Collingswood Court in Ventura County. The contributing area is primarily residential with some commercial areas along Lindero Canyon Road.

Figure 3-17. Aerial Map of the Upper Lindero Creek at County Line Opportunity

Upper Lindero Creek Subwatershed

The Upper Lindero Creek Subwatershed opportunity is located in the area between Lake Crest Drive and Lake Lindero in Agoura Hills. The area directly surrounding the lake is residential, however along the southern two-thirds of the lake, west of the residences, is Valley Oaks Memorial Park, which contains a large amount of open space and would be the likely location for regional BMPs in this area (Figure 3-18a). At the northern end of Lake Crest Drive, situated behind the residences, is the entrance of Lindero Creek into the lake via a concrete spillway (Figure 3-18b), with a concrete energy dissipater at the entrance to the lake. A 3 ft. storm drain and a drainage ditch from a shopping center parking lot connect to the creek upstream of the spillway, which also receives overland flow from a grassy area north of the residences (Figure 3-18c). The creek appears to be impacted by trash from this contributing drainage, with debris collecting in the streambed just upstream of the spillway (Figure 3-18d), and ultimately impacting the lake water quality.

Figure 3-18. Photos of the Upper Lindero Creek Subwatershed Opportunity

Lindero Creek enters Lake Lindero on the northwest side of the lake at this location and brings drainage from the entire length of the creek upstream of this point, which begins north of the intersection of Kanan Road and Collingswood Court in Ventura County. In addition to the drainage received at the nearby upstream opportunity at Lake Lindero Country Club, storm drains bring flow to this location from the residential and commercial areas to the north and west of the lake.

Figure 3-19. Aerial Map of the Upper Lindero Creek Subwatershed Opportunity

3.5 Upper Medea Creek

Chumash Park

Chumash Park is an L-shaped park with gentle slopes, located at 5500 Medea Valley Drive, Agoura Hills (Figure 3-20a). The park features a playground, restrooms, and trees in the middle portion, and a baseball diamond on the west side (Figure 3-20b). There is a trail that begins with a wooden bridge in the southwest corner of the park and runs south along a creek that is tributary to the Medea Creek. The bridge crosses a drainage ditch that can carry flow to the creek (Figure 3-20c). There is also a drainage ditch the runs along the southern side in the western portion of the park.

a

b

c

Figure 3-20. Photos of the Chumash Park Opportunity

Chumash Park does not appear to receive significant drainage, although the few drains that pass under the park, from the residential community to the east, do drain into Medea Creek just west of this location. There is also the tributary, non 303(d) stream originating to the north, east of Eagleton Street, which flows along the southern portion of the park and into Medea Creek.

Figure 3-21. Aerial Map of the Chumash Park Opportunity

Sumac Park

Sumac Park is located at 6000 Calmfield Avenue in Agoura Hills, adjacent to Sumac Elementary School in a mostly residential neighborhood. The park is fairly flat and features a playground and restrooms on the west side (Figure 3-22a), and picnic tables around the north and east sides. There are several catch basins located around the perimeter of the park (Figure 3-22b).

a b

Figure 3-22. Photos of the Sumac Park Opportunity

The storm drains passing directly under Sumac Park receive drainage from the surrounding residential communities to the north, south, and east. The main storm drains in the vicinity of this site flow along Eagleton Street, Carell Avenue, Kanan Road, and Calmfield Avenue.

Figure 3-23. Aerial Map of the Sumac Park Opportunity

Oak Canyon Community Park

The Oak Canyon Community Park opportunity includes an area south of the intersection of N. Napolean Avenue and Bromely Drive in Oak Park. The Medea Creek does not appear to be channelized in this area, however it does flow through a box culvert under Bromely Drive (Figure 3-24a) and there is a man-made cement dam (Figure 3-24b) as well as some other man-made features along the length of the creek. The surrounding neighborhood is primarily residential and the area adjacent to the creek features a trail leading down to Oak Canyon Community Park (Figure 3-24c) with educational signage explicating the natural and man-made features along the creek (Figure 3-24d), such as plant species and the dams.

Figure 3-24. Photos of the Oak Canyon Community Park Opportunity

There is a storm drain that runs parallel to the creek, from Lindero Canyon Road to the north; however upstream of this residential area, there does not appear to be additional drainage. The creek originates in the hills approximately one mile north of this opportunity.

Figure 3-25. Aerial Map of the Oak Canyon Community Park Opportunity

Medea Creek Park

The Medea Creek Park opportunity encompasses a large area around the creek along Oak Hills Drive in Oak Park. There is a good deal of space around the creek at the intersection of Oak Hills Drive and Medea Creek Lane (Figure 3-26a). There is additional space for regional BMP opportunities upstream along the west side of Oak Hills Drive (Figure 3-26b). This space currently includes an exercise course, fields, and areas with trees.

Figure 3-26. Photos of the Medea Creek Park Opportunity

Storm drains from primarily residential neighborhoods, as well as a non 303(d) tributary creek, enter Medea Creek at this location. An additional non 303(d) tributary, with a parallel storm drain, enters Medea Creek upstream of this location just south of Kanan Road.

Figure 3-27. Aerial Map of the Medea Creek Park Opportunity

Upper Medea Creek Subwatershed

The Upper Medea Creek Subwatershed opportunity is located north of the intersection of Cornell Road and Kanan Road in Agoura Hills. Just east of this intersection is the location at which the Lindero Creek flows into the Medea Creek and opportunities may be possible along both creeks, both upstream and downstream of this confluence. The creek is channelized on the north side of Agoura Rd (Figure 3-28a) and discharges to a natural condition at the opportunity site (Figure 3-28b).

a

b

Figure 3-28. Photos of the Upper Medea Creek Subwatershed Opportunity

The Upper Medea Creek Subwatershed opportunity is the most downstream potential regional BMP location in the subwatershed. This location receives all flow tributary to Oak Canyon Community Park, Medea Creek Park, Sumac Park, and Chumash Park, as well as additional drainage from the residential and commercial neighborhoods to the northeast. The 303(d) listed Palo Comado Canyon Creek delivers flow and associated drainage from a large upstream area to Medea Creek just north of this opportunity.

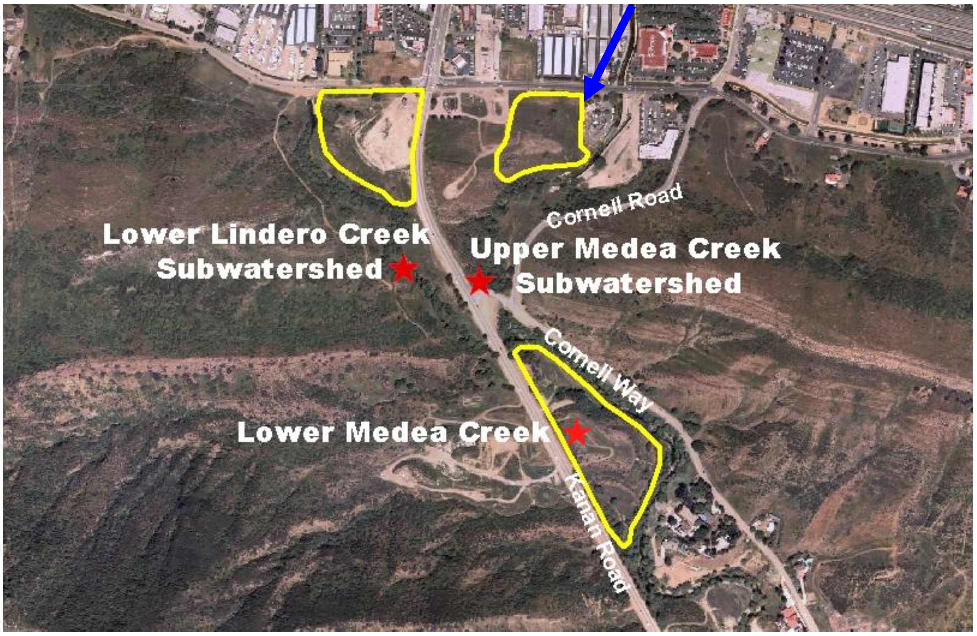

Figure 3-29. Aerial Map of the Upper Medea Creek Subwatershed Opportunity

3.6 Lower Las Virgenes Creek

Las Virgenes Creek near De Anza Park

The site evaluated as a potential regional structural BMP opportunity is located southeast of the intersection of Las Virgenes Road and Lost Hills Road. Las Virgenes

Creek is mostly channelized upstream of the site (Figure 3-30a), however shortly upstream of the site, the creek enters natural banks (Figure 3-30b). This opportunity is a privately owned agricultural field that may be no longer utilized (Figure 3-30c). Directly across Las Virgenes Road from the site and south of De Anza Park is a piece of relatively flat land that is part of Malibu Creek State Park. This area could also be considered for siting a regional structural BMP.

a

b

c

Figure 3-30. Photos of the Las Virgenes Creek near De Anza Park Opportunity

The Las Virgenes Creek near De Anza Park opportunity is the most downstream regional BMP location prior to the confluence of the Las Virgenes Creek and Malibu Creek. Las Virgenes Creek originates a far distance north of this location and receives flow directly from a large number of non 303(d) tributaries, along with the associated drainage from primarily small residential communities to the north. Immediately upstream of this opportunity site in the area south of the 101 Freeway is a mixed residential and commercial neighborhood that contributes significant urban runoff to this section of Las Virgenes Creek.

Figure 3-31. Aerial Map of the Las Virgenes Creek near De Anza Park Opportunity

Las Virgenes Creek below 101 Freeway

The opportunity along the Las Virgenes Creek south of the 101 Freeway is in a developed, commercial area around Agoura Road west of Las Virgenes Road in Calabasas. The Las Virgenes Creek runs under Agoura Road (Figure 3-32a) and into a fairly rocky, brush filled area between shopping centers and office buildings (Figure 3-32b). The creek flows over a series of concrete steps as it travels under the road.

a b

Figure 3-32. Photos of the Las Virgenes Creek below 101 Freeway Opportunity

The Las Virgenes Creek below 101 Freeway opportunity is a fairly downstream regional BMP location a short distance upstream from the Las Virgenes near De Anza Park opportunity. The Las Virgenes Creek originates a far distance northwest of this location and receives flow directly from a large number of non 303(d) tributaries, along with the associated drainage from primarily small residential communities to the north.

The area around this location, shown in Figure 3-33, is not suitable for the regional BMP opportunities under consideration due to lack of flat, open space.

Figure 3-33. Aerial Map of the Las Virgenes Creek below 101 Freeway Opportunity

Liberty Canyon Creek

The Liberty Canyon Creek opportunity is located along Liberty Canyon Road near the intersection with Park Vista Road in Agoura Hills. The channelized Liberty Canyon Creek runs along the eastern side of Liberty Canyon Road (Figure 3-34a) and enters a box culvert (Figure 3-34b) which carries flow under a grassy area north of Park Vista Road and downstream under the road to the south. The creek exits the box culvert approximately 700 feet south of Park Vista Road and flows through a series of energy dissipaters before entering a natural channel (Figure 3-34d). There is a good deal of open space on the west side of Liberty Canyon Road in this otherwise mostly residential neighborhood (Figure 3-34c). The open space just west of the channel is posted as a West Pointe Homes site and therefore some or all of the available open space may be a planned location for future development.

Figure 3-34. Photos of the Liberty Canyon Creek Opportunity

The Liberty Canyon Creek opportunity receives drainage from the primarily residential neighborhood immediately upstream of the opportunity location as well as flow from a tributary creek which meets Liberty Canyon Creek near Agoura Road. The tributary creek receives drainage from a residential neighborhood around Via Amistosa. Liberty Canyon Creek originates approximately 2 miles north of this location.

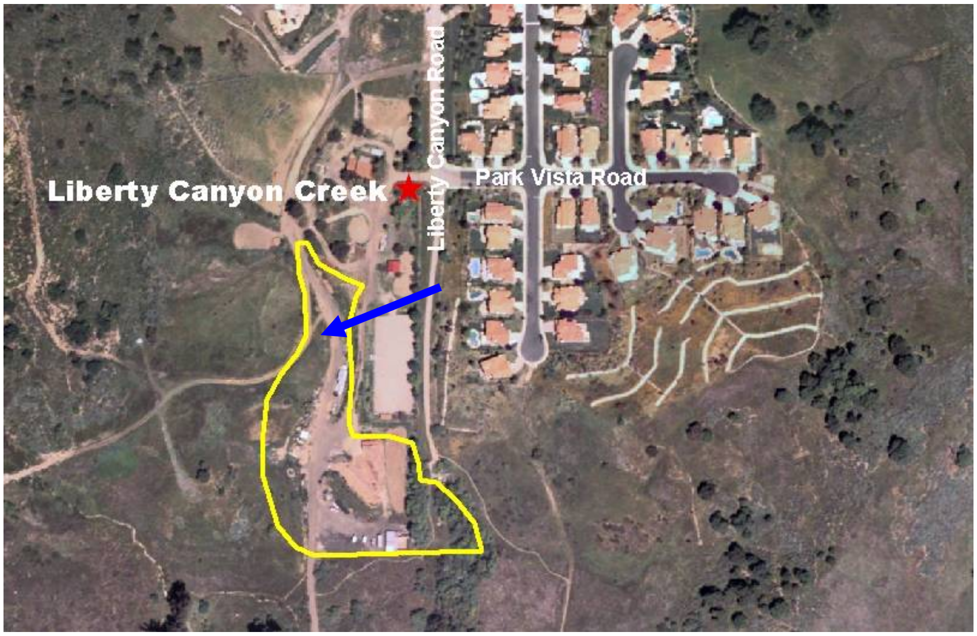

Figure 3-35. Aerial Map of the Liberty Canyon Creek Opportunity

3.7 Lower Medea Creek

Lower Medea Creek

The Lower Medea Creek opportunity is located on the southeast side of the intersection of Cornell Road and Kanan Road in Agoura Hills. Just east of this intersection is the location at which the Lindero Creek flows into the Medea Creek and opportunities may be possible along both creeks, both upstream and downstream of this confluence. There is a good deal of open space at this site as seen in Figure 3-36.

Figure 3-36. Photos of the Lower Medea Creek Opportunity

The Lower Medea Creek opportunity receives all flow tributary to both the Lower Lindero Creek Subwatershed and Upper Medea Creek Subwatershed opportunities, which are both directly upstream of this location.

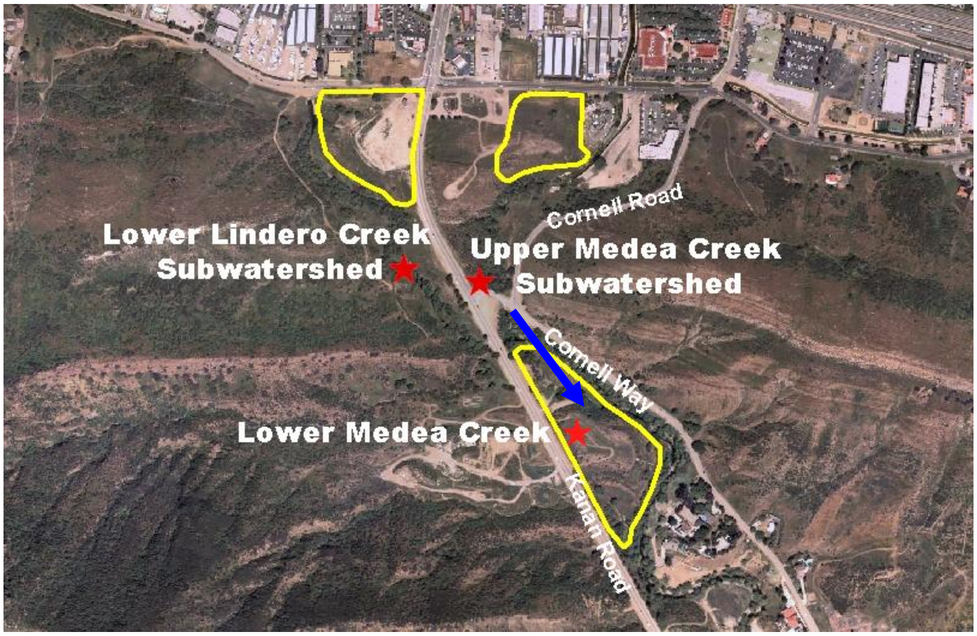

Figure 3-37. Aerial Map of the Lower Medea Creek Opportunity

4.0 Feasibility Assessment for Regional BMPs

4.1 Hydrologic Analysis

The Los Angeles County Water Resources Division conducted a hydrologic analysis of the potential regional BMP opportunities using a modified rational method model, in order to produce a target treatment rate based on MCW TMDL concept hydrology, which is based on the weighted average storm event (WASE) method. The results of the analysis are summarized in Table 4-1. The Legacy Park site has not been further considered as a location for a regional structural BMP, because there is presently a project planned at this location, discussed in Section 5-1.

Table 4-1 Hydrologic Properties and Model Results for Potential Sites for Regional BMPs

Site Name	Area [ac]	Treatment Rate (WASE) [cfs]	Peak Flow [cfs]
Chumash Park	352	2	12.32
Lake Lindero Country Club	2,293	9	33.87
Las Virgenes Creek near De Anza Park	9,543	24	76.73
Las Virgenes Creek below 101 Freeway	8,105	18	68.73
Liberty Canyon Creek	902	3	17.74
Lower Lindero Creek Subwatershed	4,255	19	59.65
Lower Medea Creek*	13,746	51	168.78
Medea Creek Park	1,759	5.87	21.91
Oak Canyon Community Park	541	1.78	10.40
Reyes Adobe Park	361	2	13.61
Russell Creek at Westlake High School	429	1.13	4.24
Sumac Park	521	2.8	15.95
Three Springs Park	1,068	6	43.08
Triunfo Flood Control Channel	1,923	13	61.54
Upper Lindero Creek Subwatershed	2,511	10	34.98
Upper Lindero Creek at County Line	1,929	8.2	34.72
Upper Medea Creek Subwatershed	9,491	32	109.13

*Lower Medea Creek based on sum of Lower Lindero Creek Subwatershed and Upper Medea Creek information

Regional structural BMP opportunities at each of the potential locations were designed to capture and treat the full concept storm volume based on the criteria described in Sections 1.1 through 1.3 of the technical memorandum. Different facility sizes were tested in an iterative procedure to optimize capture and treatment for opportunities where the entire concept storm runoff volume could not be managed within the site.

Detention of the peak of the concept storm hydrograph is necessary when the instantaneous flowrate exceeds the treatment rate. This detention storage volume required for runoff capture and treatment is equal to the volume of runoff during the part of the event that occurs above the capacity of the treatment system. This volume was calculated for each of the concept storm hydrographs provided by the Los Angeles County Water Resources Division.

For each site the assessment included the following steps:

1. Determine if all of the four BMP options are feasible, or if one or more would be eliminated due to site-specific constraints (i.e. sites with low permeability, infiltration was not considered feasible).

2. Determine whether the site would accommodate the full concept storm treatment rate for all or some of the BMP options. If the site was not capable of accommodating the full concept storm, determine what fraction could be captured and treated.

4.2 Regional BMP Opportunities at Potential Sites

Feasibility assessments were conducted for an infiltration basin, convention disinfection system, SSF wetland, and FSF wetland at each of the pre-screened potential locations for regional structural BMPs. The results of the feasibility assessments are presented in the following sections.

Capital costs, shown for each BMP opportunity and potentially feasible alternative, are complete project capital costs. The costs are intended to include full design, permits, project management services, construction services, and facility component costs. In addition, conveyance costs, including pumps, diversion structures, and piping have been included in the capital costs in this section.

4.2.1 Chumash Park

Chumash Park offers opportunities that would capture the entire concept storm runoff volume for all four types of regional structural BMPs evaluated in this preliminary siting plan. Infiltration is the least expensive alternative and would require less land to be taken from the remainder of the park uses. Alternatively, the constructed wetland alternatives could be constructed in a way to enhance wildlife and provide an environmental education opportunity.

Criteria	Infiltration	Detention/UV	SSF Wetland	FSF Wetland
Compliance Effectiveness				
Pollution Reduction Potential	High	High	High	High
Fraction of Concept Storm Treated	100%	100%	100%	100%
Cost				
Capital	$564,533	$4,627,533	$1,037,533	$1,708,033
O&M ($/yr)	$6,000	$100,000	$10,000	$22,000
Land	Public Land	Public Land	Public Land	Public Land
Community Impact				
Recreation Facilities	Negative Impact	Negative Impact	Negative Impact	Negative Impact
Odor	Potential	None	None	Potential
Vector Issues	Medium	Low	Low	High
Environmental Impact				
Impact on Habitat	Negative Impact	Negative Impact	Positive Impact	Positive Impact
SEA	No	No	No	No

4.2.2 Lake Lindero Country Club

This location is not large enough to capture and treat a significant fraction of the concept storm runoff volume in a constructed wetland or infiltration basin. At this site, the only regional structural BMP that could be considered feasible is a convention disinfection facility. Such a facility could have a significant negative aesthetic impact upon the Lake Lindero Country Club. The higher cost of such a plant should be weighed against other regional structural BMP opportunities upstream and distributed or non-structural BMPs.

Criteria	Infiltration	Detention/UV	SSF Wetland	FSF Wetland
Compliance Effectiveness				
Pollution Reduction Potential	Low	High	Low	Low
Fraction of Concept Storm Treated	20%	100%	16%	3%
Cost				
Capital	$992,400	$20,958,400	$1,239,400	$843,400
O&M ($/yr)	$5,000	$448,000	$7,000	$4,000
Land	$2,675,000	$895,000	$2,675,000	$2,675,000
Community Impact				
Recreation Facilities	Negative Impact	Negative Impact	Negative Impact	Negative Impact
Odor	Negative Impact	No Impact	No Impact	Negative Impact
Vector Issues	Medium	Low	Low	High
Environmental Impact				
Impact on Habitat	Negative Impact	Negative Impact	Positive Impact	Positive Impact
SEA	No	No	No	No

4.2.3 Las Virgenes Creek near De Anza Park

An infiltration basin or SSF wetland at this location could capture and treat a fraction of the concept storm runoff volume. FSF constructed wetland alternatives would not have the capacity to treat a significant fraction of the concept storm runoff volume. Runoff from Las Virgenes Creek would have to be diverted under Las Virgenes Road to the site.

Criteria	Infiltration	Detention/UV	SSF Wetland	FSF Wetland
Compliance Effectiveness				
Pollution Reduction Potential	Medium	High	Low	Low
Fraction of Concept Storm Treated	34%	100%	26%	5%
Cost				
Capital	$3,635,993	$55,902,243	$4,855,743	$3,014,743
O&M ($/yr)	$25,000	$1,195,000	$30,000	$17,000
Land	$10,802,000	$1,558,000	$10,802,000	$10,802,000
Community Impact				
Recreation Facilities	Positive Impact	Positive Impact	Positive Impact	Positive Impact
Odor	Negative Impact	No Impact	No Impact	Negative Impact
Vector Issues	Medium	Low	Low	High
Environmental Impact				
Impact on Habitat	Negative Impact	Negative Impact	Positive Impact	Positive Impact
SEA	No	No	No	No

4.2.4 Las Virgenes Creek below 101 Freeway

This site was selected as a potential location for a regional structural BMP during the initial identification of opportunities, but it was determined to be inappropriate following a site visit. The open space surrounding Las Virgenes Creek is very steep and part of the natural river channel. Commercial development impinges on both of the creek banks eliminating any diversion opportunities.

Criteria	Infiltration	Detention/UV	SSF Wetland	FSF Wetland
Compliance Effectiveness				
Pollution Reduction Potential	None	None	None	None
Fraction of Concept Storm Treated	0%	0%	0%	0%
Cost				
Capital	N/A	N/A	N/A	N/A
O&M ($/yr)	N/A	N/A	N/A	N/A
Land	N/A	N/A	N/A	N/A
Community Impact				
Recreation Facilities	N/A	N/A	N/A	N/A
Odor	N/A	N/A	N/A	N/A
Vector Issues	N/A	N/A	N/A	N/A
Environmental Impact				
Impact on Habitat	N/A	N/A	N/A	N/A
SEA	N/A	N/A	N/A	N/A

4.2.5 Liberty Canyon Creek

An infiltration basin or SSF wetland at this location could capture and treat a fraction of the concept storm runoff volume and is far more economical than a conventional disinfection facility. FSF constructed wetland alternatives would not have the capacity to treat a significant fraction of the concept storm runoff volume.

Criteria	Infiltration	Detention/UV	SSF Wetland	FSF Wetland
Compliance Effectiveness				
Pollution Reduction Potential	Medium	High	Medium	Low
Fraction of Concept Storm Treated	53%	100%	62%	12%
Cost				
Capital	$1,082,721	$7,538,221	$1,601,721	$1,073,721
O&M ($/yr)	$5,000	$150,000	$9,000	$5,000
Land	$3,410,000	$632,000	$3,410,000	$3,410,000
Community Impact				
Recreation Facilities	Positive Impact	Positive Impact	Positive Impact	Positive Impact
Odor	Negative Impact	No Impact	No Impact	Negative Impact
Vector Issues	Medium	Low	Low	High
Environmental Impact				
Impact on Habitat	Negative Impact	Negative Impact	Positive Impact	Positive Impact
SEA	No	No	No	No

4.2.6 Lower Lindero Creek Subwatershed

The drainage area to this site encompasses the entire Lindero Creek subwatershed and therefore capture and treatment of the concept storm runoff volume would provide a significant load reduction for the entire MCW. However, the only regional structural BMP that could fit within this site is a conventional disinfection facility. The higher cost of such a plant should be weighed against other regional structural BMP opportunities upstream and distributed or non-structural BMPs.

Criteria	Infiltration	Detention/UV	SSF Wetland	FSF Wetland
Compliance Effectiveness				
Pollution Reduction Potential	None	High	Low	Low
Fraction of Concept Storm Treated	0%	100%	18%	4%
Cost				
Capital	N/A	$43,593,067	$2,191,567	$1,276,567
O&M ($/yr)	N/A	$946,000	$17,000	$9,000
Land	N/A	$1,290,000	$6,089,000	$6,089,000
Community Impact				
Recreation Facilities	N/A	Positive Impact	Positive Impact	Positive Impact
Odor	N/A	No Impact	No Impact	Negative Impact
Vector Issues	N/A	Low	Low	High
Environmental Impact				
Impact on Habitat	N/A	Negative Impact	Positive Impact	Positive Impact
SEA	N/A	No	No	No

4.2.7 Lower Medea Creek

The drainage area to this site encompasses the entire Lindero Creek and Upper Medea Creek subwatersheds and therefore capture and treatment of the concept storm runoff volume would provide a significant load reduction for the entire MCW. However, the only regional structural BMP that could fit within this site is a conventional disinfection facility. The higher cost of such a plant should be weighed against other regional structural BMP opportunities upstream and distributed or non-structural BMPs.

Criteria	Infiltration	Detention/UV	SSF Wetland	FSF Wetland
Compliance Effectiveness				
Pollution Reduction Potential	None	High	Low	Low
Fraction of Concept Storm Treated	0%	100%	9%	2%
Cost				
Capital	N/A	$116,166,600	$2,813,100	$1,617,600
O&M ($/yr)	N/A	$2,541,000	$22,000	$12,000
Land	N/A	$2,919,000	$7,944,000	$7,944,000
Community Impact				
Recreation Facilities	N/A	Positive Impact	Positive Impact	Positive Impact
Odor	N/A	No Impact	No Impact	Negative Impact
Vector Issues	N/A	Low	Low	High
Environmental Impact				
Impact on Habitat	N/A	Negative Impact	Positive Impact	Positive Impact
SEA	N/A	No	No	No

4.2.8 Medea Creek Park

The land available for a regional structural BMP at this location may impact areas surrounding the sports fields at Agoura High School. An infiltration basin or SSF constructed wetland could capture and treat a fraction of the concept storm runoff volume. At this site, the only regional structural BMP that could capture and treat the entire concept storm runoff volume is a convention disinfection facility. Such a facility would have a significant negative aesthetic impact upon the Agoura High School and surrounding neighborhood. The higher cost of such a plant should be weighed against other regional structural BMP opportunities upstream and distributed or non-structural BMPs.

Criteria	Infiltration	Detention/UV	SSF Wetland	FSF Wetland
Compliance Effectiveness				
Pollution Reduction Potential	Medium	High	Medium	Low
Fraction of Concept Storm Treated	60%	100%	46%	9%
Cost				
Capital	$1,387,805	$13,853,305	$1,817,805	$1,076,805
O&M ($/yr)	$11,000	$293,000	$13,000	$7,000
Land	Public Land	Public Land	Public Land	Public Land
Community Impact				
Recreation Facilities	Negative Impact	Negative Impact	Negative Impact	Negative Impact
Odor	Negative Impact	No Impact	No Impact	Negative Impact
Vector Issues	Medium	Low	Low	High
Environmental Impact				
Impact on Habitat	Negative Impact	Negative Impact	Positive Impact	Positive Impact
SEA	No	No	No	No

4.2.9 Oak Canyon Community Park

This regional structural BMP opportunity site is overlying soils that have very low infiltration capacity, but SSF constructed wetlands that have the capacity to capture ad treat the entire concept storm runoff volume could fit within the site footprint. Parts of the site are on a moderate grade; therefore some re-grading would have to take place. Also, the site extends into a part of the park that is being used for recreation and this area may be impacted depending upon the layout of the BMP.

Criteria	Infiltration	Detention/UV	SSF Wetland	FSF Wetland
Compliance Effectiveness				
Pollution Reduction Potential	None	High	High	Low
Fraction of Concept Storm Treated	0%	100%	100%	26%
Cost				
Capital	N/A	$4,579,035	$1,383,035	$1,047,035
O&M ($/yr)	N/A	$89,000	$9,000	$6,000
Land	N/A	Public Land	Public Land	Public Land
Community Impact				
Recreation Facilities	N/A	Negative Impact	Negative Impact	Negative Impact
Odor	N/A	No Impact	No Impact	Negative Impact
Vector Issues	N/A	Low	Low	High
Environmental Impact				
Impact on Habitat	N/A	Negative Impact	Positive Impact	Positive Impact
SEA	N/A	No	No	No

4.2.10 Reyes Adobe Park

This regional structural BMP opportunity site is overlying soils that have very low infiltration capacity. The constructed SSF wetland option could capture and treat a fraction of the concept storm runoff volume within the site footprint. Parts of the site are on a moderate grade; therefore some re-grading would have to take place. Also, the site covers much of the open area of the park. The only regional structural BMP that could capture and treat the entire concept storm runoff volume within this site is a conventional disinfection facility. The higher cost of such a plant should be weighed against other regional structural BMP opportunities upstream and distributed or non-structural BMPs

Criteria	Infiltration	Detention/UV	SSF Wetland	FSF Wetland
Compliance Effectiveness				
Pollution Reduction Potential	None	High	Medium	Low
Fraction of Concept Storm Treated	0%	100%	42%	8%
Cost				
Capital	N/A	$4,749,533	$605,533	$353,533
O&M ($/yr)	N/A	$100,000	$4,000	$2,000
Land	N/A	Public Land	Public Land	Public Land
Community Impact				
Recreation Facilities	N/A	Negative Impact	Negative Impact	Negative Impact
Odor	N/A	No Impact	No Impact	Negative Impact
Vector Issues	N/A	Low	Low	High
Environmental Impact				
Impact on Habitat	N/A	Negative Impact	Positive Impact	Positive Impact
SEA	N/A	No	No	No

4.2.11 Russell Creek at Westlake High School

This site was selected as a potential location for a regional structural BMP during the initial identification of opportunities, but it was determined to be inappropriate following a site visit. The open space surrounding Russell Creek is very steep and part of the natural river channel.

Criteria	Infiltration	Detention/UV	SSF Wetland	FSF Wetland
Compliance Effectiveness				
Pollution Reduction Potential	None	None	None	None
Fraction of WASE Treated	0%	0%	0%	0%
Cost				
Capital	N/A	N/A	N/A	N/A
O&M ($/yr)	N/A	N/A	N/A	N/A
Land	N/A	N/A	N/A	N/A
Community Impact				
Recreation Facilities	N/A	N/A	N/A	N/A
Odor	N/A	N/A	N/A	N/A
Vector Issues	N/A	N/A	N/A	N/A
Environmental Impact				
Impact on Habitat	N/A	N/A	N/A	N/A
SEA	N/A	N/A	N/A	N/A

4.2.12 Sumac Park

An infiltration basin or SSF constructed wetland could capture and treat a fraction of the concept storm runoff volume. At this site, the only regional structural BMP that could capture and treat the entire concept storm runoff volume is a convention disinfection facility. Such a facility would have a significant negative aesthetic impact upon the adjacent elementary school and surrounding neighborhood. The higher cost of such a plant should be weighed against other regional structural BMP opportunities upstream and distributed or non-structural BMPs.

Criteria	Infiltration	Detention/UV	SSF Wetland	FSF Wetland
Compliance Effectiveness				
Pollution Reduction Potential	Medium	High	Low	Low
Fraction of Concept Storm Treated	37%	100%	31%	6%
Cost				
Capital	$293,347	$6,403,347	$460,347	$200,847
O&M ($/yr)	$3,000	$140,000	$4,000	$2,000
Land	Public Land	Public Land	Public Land	Public Land
Community Impact				
Recreation Facilities	Negative Impact	Negative Impact	Negative Impact	Negative Impact
Odor	Negative Impact	No Impact	No Impact	Negative Impact
Vector Issues	Medium	Low	Low	High
Environmental Impact				
Impact on Habitat	Negative Impact	Negative Impact	Positive Impact	Positive Impact
SEA	No	No	No	No

4.2.13 Three Springs Park

This location is not large enough to capture and treat a significant fraction of the concept storm runoff volume in a constructed wetland or infiltration basin. At this site, the only regional structural BMP that could be considered feasible is a convention disinfection facility. The higher cost of such a plant should be weighed against other regional structural BMP opportunities upstream and distributed or non-structural BMPs.

Criteria	Infiltration	Detention/UV	SSF Wetland	FSF Wetland
Compliance Effectiveness				
Pollution Reduction Potential	Low	High	Low	Low
Fraction of Concept Storm Treated	5%	100%	7%	1%
Cost				
Capital	$259,100	$31,746,600	$440,600	$313,100
O&M ($/yr)	$1,000	$696,000	$2,000	$1,000
Land	Public Land	Public Land	Public Land	Public Land
Community Impact				
Recreation Facilities	Negative Impact	Negative Impact	Negative Impact	Negative Impact
Odor	Negative Impact	No Impact	No Impact	Negative Impact
Vector Issues	Medium	Low	Low	High
Environmental Impact				
Impact on Habitat	Negative Impact	Negative Impact	Positive Impact	Positive Impact
SEA	No	No	No	No

4.2.14 Triunfo Flood Control Channel

The constructed SSF wetland and infiltration basins options could capture and treat a fraction of the concept storm runoff volume within the site footprint. The site covers much of the open area of the park. The only regional structural BMP that could capture and treat the entire concept storm runoff volume within this site is a conventional disinfection facility. The higher cost of such a plant should be weighed against other regional structural BMP opportunities upstream and distributed or non-structural BMPs.

Criteria	Infiltration	Detention/UV	SSF Wetland	FSF Wetland
Compliance Effectiveness				
Pollution Reduction Potential	Low	High	Low	Low
Fraction of Concept Storm Treated	22%	100%	21%	4%
Cost				
Capital	$3,043,698	$32,367,448	$4,368,948	$3,483,448
O&M ($/yr)	$9,000	$648,000	$13,000	$7,000
Land	Public Land	Public Land	Public Land	Public Land
Community Impact				
Recreation Facilities	Negative Impact	Negative Impact	Negative Impact	Negative Impact
Odor	Negative Impact	No Impact	No Impact	Negative Impact
Vector Issues	Medium	Low	Low	High
Environmental Impact				
Impact on Habitat	Negative Impact	Negative Impact	Positive Impact	Positive Impact
SEA	No	No	No	No

4.2.15 Upper Lindero Creek at County Line

This site has the opportunity to locate regional structural BMPs on either side of Lindero Creek. One alternative would be to use both areas in a multi-cell type BMP. An infiltration basin or SSF constructed wetland could capture and treat a fraction of the concept storm runoff volume. At this site, the only regional structural BMP that could capture and treat the entire concept storm runoff volume is a convention disinfection facility. The higher cost of such a plant should be weighed against other regional structural BMP opportunities upstream and distributed or non-structural BMPs.

Criteria	Infiltration	Detention/UV	SSF Wetland	FSF Wetland
Compliance Effectiveness				
Pollution Reduction Potential	High	High	Medium	Low
Fraction of Concept Storm Treated	71%	100%	54%	11%
Cost				
Capital	$1,986,087	$19,163,587	$2,641,587	$1,444,587
O&M ($/yr)	$18,000	$409,000	$22,000	$12,000
Land	Public Land	Public Land	Public Land	Public Land
Community Impact				
Recreation Facilities	Positive Impact	Positive Impact	Positive Impact	Positive Impact
Odor	Negative Impact	No Impact	No Impact	Negative Impact
Vector Issues	Medium	Low	Low	High
Environmental Impact				
Impact on Habitat	Negative Impact	Negative Impact	Positive Impact	Positive Impact
SEA	No	No	No	No

4.2.16 Upper Lindero Creek Subwatershed

The drainage area to this site encompasses the entire Upper Lindero Creek subwatershed and therefore capture and treatment of the concept storm runoff volume would provide a significant load reduction for the entire MCW. This site offers opportunities that would capture the entire concept storm runoff volume for infiltration basin, SSF wetlands, and a conventional disinfection facility. Infiltration is the least expensive alternative and would require less land to be taken from the remainder of the park uses. Alternatively, the constructed wetland alternatives could be constructed in a way to enhance wildlife and provide an environmental education opportunity. The site is not directly adjacent to Lindero Creek and therefore flows would have to be diverted from just upstream of the confluence with Lake Lindero and pumped into a regional structural BMP. In the case of infiltration, there would be no surface discharge following treatment. SSF constructed wetlands and conventional disinfection facility effluent would need to be routed into Lake Lindero.

Criteria	Infiltration	Detention/UV	SSF Wetland	FSF Wetland
Compliance Effectiveness				
Pollution Reduction Potential	High	High	High	Low
Fraction of Concept Storm Treated	100%	100%	100%	18%
Cost				
Capital	$3,631,743	$24,188,243	$5,492,243	$3,237,743
O&M ($/yr)	$30,000	$498,000	$41,000	$23,000
Land	$13,053,000	$914,000	$14,770,000	$14,770,000
Community Impact				
Recreation Facilities	Negative Impact	Negative Impact	Negative Impact	Negative Impact
Odor	Negative Impact	No Impact	No Impact	Negative Impact
Vector Issues	Medium	Low	Low	High
Environmental Impact				
Impact on Habitat	Negative Impact	Negative Impact	Positive Impact	Positive Impact
SEA	No	No	No	No

4.2.17 Upper Medea Creek Subwatershed

The drainage area to this site encompasses the entire Upper Medea Creek subwatershed and therefore capture and treatment of the concept storm runoff volume would provide a significant load reduction for the entire MCW. However, the only regional structural BMP that could fit within this site is a conventional disinfection facility. The higher cost of such a plant should be weighed against other regional structural BMP opportunities upstream and distributed or non-structural BMPs.

Criteria	Infiltration	Detention/UV	SSF Wetland	FSF Wetland
Compliance Effectiveness				
Pollution Reduction Potential	None	High	Low	Low
Fraction of Concept Storm Treated	0%	100%	7%	1%
Cost				
Capital	N/A	$73,097,533	$1,691,033	$1,088,033
O&M ($/yr)	N/A	$1,594,000	$11,000	$6,000
Land	N/A	$1,990,000	$3,977,000	$3,977,000
Community Impact				
Recreation Facilities	N/A	Positive Impact	Positive Impact	Positive Impact
Odor	N/A	No Impact	No Impact	Negative Impact
Vector Issues	N/A	Low	Low	High
Environmental Impact				
Impact on Habitat	N/A	Negative Impact	Positive Impact	Positive Impact
SEA	N/A	No	No	No

Section 5 Summary of Regional BMP Opportunities

5.1 Potential Regional BMP Projects

This preliminary facility siting plan was effective in identifying a number of feasible and potentially worthwhile regional structural BMP opportunities within the MCW. These opportunities are summarized in Table 5-1. In general, the regional structural BMPs that were identified as feasible alternatives are infiltration basins with a few constructed wetland opportunities. Conventional disinfection is an effective method for reducing bacteria at most of the evaluated sites, however the higher costs will need to be weighed against the cost of implementing other approaches for bacteria reduction throughout the watershed.

Further investigation of local grading conditions, property acquisition, community issues, geology, necessary flow diversions, and costs at each of these sites should be conducted as part of a preliminary design report (PDR).

Table 5-1 Summary of Feasibility Assessment of Evaluated Regional Structural BMPs in the Malibu Creek Watershed

	Infiltration Basin	FSF Wetland	SSF Wetland	Conventional Disinfection
Publicly Owned Sites				
Chumash Park	F	F	F	F
Las Virgenes Creek below 101 Freeway	I	I	I	I
Medea Creek Park	P	P	P	F
Oak Canyon Community Park	I	P	F	F
Reyes Adobe Park	P	P	P	F
Russell Creek at Westlake High School	I	I	I	I
Sumac Park	P	P	P	F
Three Springs Park	P	P	P	F
Triunfo Flood Control Channel	P	P	P	F
Upper Lindero Creek at County Line	P	P	P	F
Privately Owned Sites				
Lake Lindero Country Club	P	P	P	F
Las Virgenes Creek near De Anza Park	P	P	P	F
Liberty Canyon Creek	P	P	P	F
Lower Lindero Creek Subwatershed	I	P	P	F
Lower Medea Creek	I	P	P	F
Upper Lindero Creek Subwatershed	F	P	F	F
Upper Medea Creek Subwatershed	I	P	P	F

* F=Full Concept Storm Capture/Treatment, P=Partial Concept Storm Capture/Treatment, I=Infeasible

5.2 Existing Regional BMP Projects

Two regional structural BMP projects that are being developed that will reduce bacteria in the MCW are a stormwater infiltration system to treat urban runoff prior to being discharged to Las Virgenes Creek and a constructed wetland at the City of Malibu Legacy Park site to reduce bacteria reaching Malibu Lagoon from nearby storm drains.

The City of Calabasas has designed a facility to capture flow from a 102" diameter storm drain that outfalls to Las Virgenes Creek between Agoura Road and Cold Springs Street. The facility features a two-stage treatment process. In the first stage, Stormwater Management, Inc.'s Stormscreen provides gross solids removal, with a total filtering capacity of 3 cfs. Flow is then pumped to a HydroLogic Solutions' StormChambers system, which is an infiltration bed that utilizes a perforated HDPE dome pipe system. Water in the StormChambers is infiltrated across a 2,400 square foot area. When the capacity of the StormChambers is reached, filtered flow is returned to the storm drain upstream of the outfall to the creek.

The City of Malibu has planned a stormwater wetland detention facility at the Legacy Park site nearby Malibu Lagoon. The constructed wetland will receive flow from two storm drains systems in the Civic Center drainage area. The facility will feature either a permanent pond with seasonal stormwater detention storage or a linear wetland with riparian flood storage. Flow would be pumped from the wetland to a planned stormwater treatment facility. During large storm events that exceed the detention-treatment capacity, an overflow drain discharging to Malibu Creek would be provided.

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