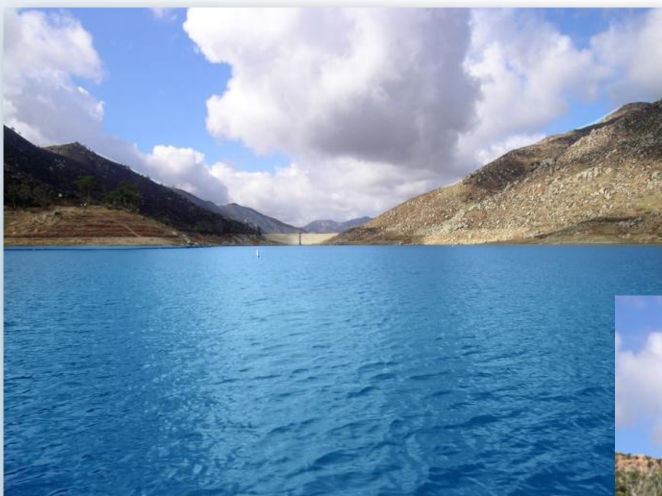
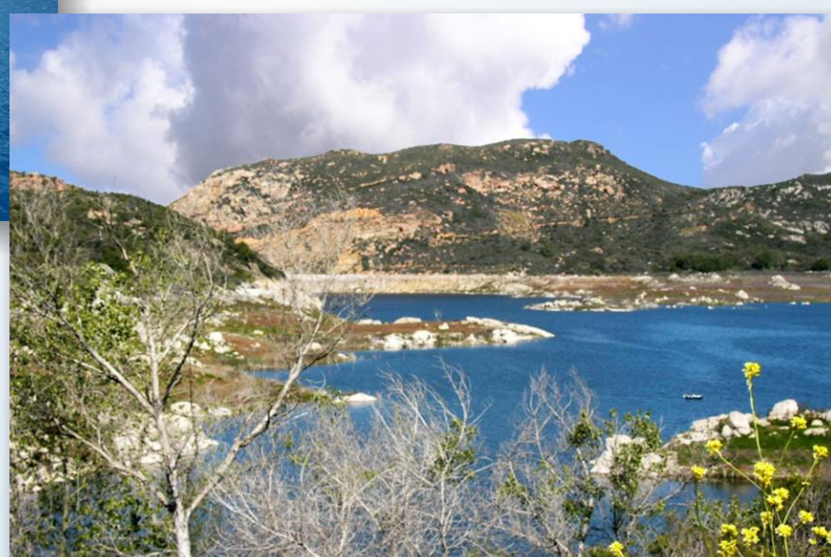
# Source Water Protection Guidelines for New Development





January 2004

BROWN AND CALDWELL

KATZ & ASSOCIATES

UltraSystems
environmental management planning

## TABLE OF CONTENTS

Page

Introduction ....1

What Pollutants of Concern are Important in the Reservoir Watersheds? ....3
– Water Quality Objectives and Goals ....4
– Pollutants of Concern ....4

Determining the Sensitivity of Your Project ....6

Selecting the Right BMPs for Your Project ....7
– Project Design BMPs ....7
– Source Control BMPs ....8
– Treatment Control BMPs ....9

Additional Approaches to Improve Runoff Water Quality ....9
– Treatment Trains ....10
– Regional, Watershed-Based Approaches ....10

Runoff Calculations ....11

How to Use the Guidelines ....11

Using the Treatment BMP Technologies Matrix ....18

Source Water Protection Guidelines ....20
– Project Evaluation Worksheet ....20
– Decision Guide A: Project Design BMPs ....22
– Decision Guide B: Source Control BMPs ....23
– Decision Guide C: Treatment Control BMPs ....24
– Decision Guide D: Pre-Treatment and Post-Treatment BMPs ....25
– Treatment BMP Technologies Matrix ....26

## TABLE OF CONTENTS
## (Continued)

### List of Tables


1 Water Quality Objectives and Goals for San Diego Source Water Reservoirs .................5
E-1 Example Maintenance Requirements of Selected BMPs ............................................E-1
F-1 Summary of Land Use Considerations Used to Determine Runoff Coefficients in San Diego County Jurisdictions ...................................................................F-4


### List of Figures


1 Reservoir Watershed Index Map .......................................................................12
– 1a- Portions of Hodges, Sutherland, San Vicente, and El Capitan Watersheds..13
– 1b- Portions of Hodges, San Vicente, and El Capitan Watersheds.....................14
– 1c- Portions of Otay, El Capitan, Barrett, and Morena Watersheds....................15
– 1d- Portions of Morena Watershed and Otay, Dulzura, and Barrett Watersheds.16
2 Overall Process for Use of Source Water Protection Guidelines ...................................17


### List of Appendices


Appendix A Supplemental Information on Project Design BMPs .........................................A-1
Appendix B Supplemental Information on Source Control BMPs .......................................B-1
Appendix C Supplemental Information on Treatment Control BMPs ...................................C-1
– Filtration Systems .....................................................................................C-2
– Infiltration Systems.....................................................................................C-3
– Detention/Settling Systems.........................................................................C-6
– Biofiltration Systems ..................................................................................C-8
– Miscellaneous BMPs.................................................................................C-11
Appendix D Supplemental Information on Pre-treatment and Post-treatment BMPs ............D-1
Appendix E BMP Maintenance Considerations ...................................................................E-1
Appendix F Runoff Estimates Methodologies and BMP Sizing Criteria ................................F-1
Appendix G References and Acknowledgements................................................................G-1

# SOURCE WATER PROTECTION GUIDELINES

## INTRODUCTION

The City of San Diego Water Department (Water Department) has written Source Water Protection Guidelines for new developments to guide future activities in the San Diego County watersheds that drain into drinking water reservoirs. The Guidelines were prepared to assist municipal agencies, designers, land planners, developers, and laypersons conduct site design planning and select best management practices (BMPs) that protect or improve the quality of runoff draining into the reservoirs. Although rainfall is relatively low in San Diego in an average year, the City derives as much as 20 percent of its drinking water from local runoff. Thus, this resource must be protected from pollution. The Guidelines are necessary because the reservoirs have different pollutants of concern than those that are typically addressed under the current storm water regulations (e.g., nutrients, organic carbon). Specifically, the Guidelines provide a stepwise, simplified BMP selection process to ensure that preferred source water protection BMPs are considered. The Source Water Protection Guidelines are a succinct package consisting of:

- Project Evaluation Worksheet
- Four Decision Guides (Decision Guide A – Project Design BMPs; Decision Guide B – Source Control BMPs; Decision Guide C – Treatment Control Considerations; and Decision Guide D – Pre-Treatment and Post-Treatment BMPs)
- Treatment BMP Technologies Matrix
- Seven appendices providing summary data on BMPs with links to Internet resources, guidance for calculating runoff volumes, references, and acknowledgements.

Seven of the nine drinking water reservoirs owned and operated by the Water Department warrant the protection these Guidelines offer because their surroundings are presently largely rural and undeveloped. As development occurs, the potential for increased runoff volumes and associated pollutants also increases. A window of opportunity exists now to establish recommendations that protect the drinking water resources into the future. The reservoir watersheds governed by these Guidelines include:

- Barrett Reservoir
- El Capitan Reservoir
- Hodges Reservoir
- Morena Reservoir
- Otay Reservoir
- San Vicente Reservoir

- Sutherland Reservoir

The Water Department also operates drinking water reservoirs at Miramar Lake and Lake Murray; however, because water quality control measures are already in place and the watersheds are mostly built-out, these two watersheds are not the focus of these Guidelines.

Lands within the watersheds of concern are mostly outside the City of San Diego, and are largely within the jurisdiction of the County of San Diego; cities of Chula Vista and Escondido; and state, federal, and Indian lands. Although use of these Guidelines is therefore voluntary, many of the water quality protection principles included herein are consistent with other federal, state, and local regulations and protocols. In particular, the guidance provided here is consistent with state and local storm water permit requirements, as well as local planning protocols. Considering these Guidelines in the project planning stages is highly recommended to further safeguard drinking water supplies. Through this process, a project proponent or reviewer can determine whether or not the proposed project is subject to a Standard Urban Stormwater Mitigation Plan (SUSMP), which is mandatory for certain projects in San Diego County, and can compare various BMPs that may be appropriate for the project (Step 5 of the Project Evaluation Worksheet).

These Guidelines do not address water quality concerns during construction activities, but rather are designed to help project proponents and reviewers address potential water quality issues over the life of the project by incorporating better site designs and source controls to protect source water. This process is applicable to nearly all projects. In addition, for large or complex projects, the Guidelines help focus the selection of treatment BMPs that are most effective (based on published studies) at reducing the pollutants of concern for drinking water protection in San Diego County.

Project proponents should be aware that the following policies and regulations provide legal authority for reviewing development projects and making recommendations relative to proper storm water management. These polices provide guidance for incorporating storm water management practices and methods into land development for water quality protection. Useful information may be obtained at the following websites:

City of San Diego:

- Model Standard Urban Storm Water Mitigation Plan for San Diego County, Port of San Diego, and Cities in San Diego County, February 7, 2002. See: http://www.swrcb.ca.gov/rwqcb9/programs/stormwater/sd%20permit/Approved%20Final%20Model%20SUSMP.PDF
- San Diego Municipal Code, Land Development Manual, Storm Water Standards, A Manual for Construction & Permanent Storm Water Best Management Practices Requirements, May 30, 2003. See: http://www.sannet.gov/development-services/news/pdf/stormwatermanual.pdf.

- San Diego Municipal Code, Land Development Manual, Storm Water Standards, A Manual for Construction & Permanent Storm Water Best Management Practices Requirements, May 30, 2003. See: http://www.sannet.gov/development-services/news/pdf/stormwatermanual.pdf

County of San Diego:

- San Diego County Storm Water permit. See: http://www.swrcb.ca.gov/rwqcb9/programs/sd_stormwater.html
- County of San Diego Municipal Department of Public Works, Storm Water Standards. See: http://www.sdcounty.ca.gov/dpw/stormwater/stormwater.html

Chula Vista:

- Development and Redevelopment Projects Storm Water Management Standards Requirements Manual. See: http://www.chulavistaca.gov/City_Services/Development_Services/Engineering/stormWaterManual.asp

Escondido:

- Storm Water Management Requirements and Local Standard Urban Storm Water Mitigation Plan. See: http://www.ci.escondido.ca.us/depts/pw/utilities/stormwater/construction/manual.pdf

**WHAT POLLUTANTS OF CONCERN ARE IMPORTANT IN THE RESERVOIR WATERSHEDS?**

"Pollutants," in the context of urban runoff, may include solid or dissolved constituents that otherwise would not be present in clean runoff. They may be hazardous (such as chemicals and pesticides) or non-hazardous (such as sediment or fertilizers), but can still cause water quality impairment when washed into creeks and drinking water reservoirs. The Water Department places a high priority on improving and maintaining the quality of its drinking water supply reservoirs. High quality water is needed to provide for long-term safety of the region's drinking water supply and for sustainable, cost-effective water treatment, and to support other beneficial uses of the reservoirs, like aquatic life and recreation.

Protecting reservoir water quality requires that the quality of water entering the reservoirs is maintained or improved. Local runoff to the reservoirs provides an average of about 20 percent of the Water Department's total water supply. Runoff can also affect the quality of imported water from the Colorado River and the State Water Project that is stored in the reservoirs, which is on average another 20 percent of the total water supply. Given that 40 percent or more of the City's drinking water comes from the water supply reservoirs and is vulnerable to impacts from low quality runoff entering the system, it is critically important to maintain high quality runoff and to protect the reservoirs from any adverse impacts to drinking water quality.

**Water Quality Objectives and Goals**

To provide a framework for the Source Water Protection Guidelines, the Water Department has established quantitative water quality goals and objectives for over a dozen indicator constituents to be applied to their source water reservoirs (Table 1). The objectives are based on the Water Quality Control Plan for the San Diego Basin (Basin Plan, San Diego Regional Water Quality Control Board [RWQCB], 1994). "Enhanced water quality goals" have also been established, based on upcoming regulatory requirements and state-of-the-science knowledge, to more fully address emerging contaminants that can adversely affect drinking water supply. In addition to the numeric objectives and goals, an underlying anti-degradation policy from the Basin Plan also provides a broader requirement to maintain existing high quality conditions. Together, the water quality objectives and enhanced goals can be applied to quantify the current health of the water supply reservoirs and to provide a benchmark for the protection of high quality water in the future.

**Pollutants of Concern**

Water quality goals and objectives have been compared to available water quality information to evaluate existing reservoir conditions, and to help prioritize future needs to improve and protect water quality. Given the extent of growth and urbanization expected in the region, the Water Department has also anticipated the effects of future residential and commercial development in the target watersheds.

Several pollutants are a particular concern for the City's drinking water reservoirs, based on an analysis of existing water conditions (Brown and Caldwell [BC] 2003). The potential effects of future urban runoff adds another layer of concern and urgency in applying source controls and best management practices to adequately address water quality.

A review of the City's water quality monitoring data (both in the reservoirs and tributary streams) indicated that the following constituents are the highest priority for protection of reservoir source waters:

- Nutrients (i.e., nitrogen and phosphorus) and related algae, and taste and odor compounds
- Total organic carbon (TOC)
- Total dissolved solids (TDS)

**Table 1. Water Quality Objectives and Goals for San Diego Source Water Reservoirs**

| Constituent | Existing Water Quality Objectives[1] | Rationale for Objective | Enhanced Water Quality Goals | Rationale for Goal |
|---|---|---|---|---|
| **Field** | | | | |
| Total dissolved solids (mg/L) | 300 - San Vicente & El Capitan; 500 - elsewhere | Basin Plan Secondary drinking water std. (500) | | |
| Dissolved oxygen (mg/L) | 6.0 | Basin Plan | | |
| pH (std. units) | 6.5-8.5 | Basin Plan | | |
| Turbidity (ntu) | 20 | Basin Plan | 5 | Experience with treatability at San Diego Water Dept. Water Treatment Plants |
| **Chemical** | | | | |
| Total phosphorus (mg/L) | 0.025 | Basin Plan | | |
| Total nitrogen (mg/L) | N:P < 10:1 | Basin Plan | | |
| Nitrate (mg/L-N) | 10 | Basin Plan Primary drinking water standard | | |
| Total organic carbon (mg/L) | | | 3 | Stage 1 D/DBP[2] Rule – midpoint of first removal bin |
| Total suspended solids (mg/L) | | | 90 | Secondary drinking water standard |
| Geosmin (mg/L) | None | | 15 in treated water | Human detection threshold; at greater levels a significant portion of the population finds water unpalatable |
| MIB (mg/L) | None | | 10 in treated water | Same as above |
| **Microbiological** | | | | |
| *E. coli* (cfu/100mL) | 126 | Basin Plan – Rec 1 "steady state" | 50 | LT2IESWTR[3] - trip level for crypto monitoring |
| Enterococcus (cfu/100mL) | 33 | Basin Plan – Rec 1 "steady state" | | |
| Fecal coliform (cfu/100mL) | Geo mean < 200 90% < 400 | Basin Plan – Rec 1 | | |
| Cryptosporidium (oocysts/L) | | | 0.075 | LT2IESWTR[3] - upper limit for Bin 1 |
| Giardia (cysts/L) | | | 1.0 | Treatment to 1-10 particles/ml, allows 99-99.9% certainty that <1 is Giardia |

1 Water Quality Control Plan for San Diego Basin (Basin Plan), Regional Water Quality Control Board – San Diego Region, September 1994.
2 Disinfection/Disinfectant By-Product Rule.
3 Long-term Interim Enhanced Surface Water Treatment Rule.

**Nutrients (Algae, Taste and Odor).** Many of the reservoirs experience seasonal problems with excessive algae growth and associated low dissolved oxygen conditions in the summer and fall (July through November), which are caused by excessive nutrients (nitrogen and phosphorus). Algal blooms also produce taste and odor producing compounds that can be present in significant quantities during the summer months. Levels of taste and odor compounds that exceed the City's goals (Table 1) can restrict the use of source water, require special treatment, result in occasional adverse taste and odor problems in finished water, and/or ultimately force Water Department operators to abandon a reservoir as a water source.

**Total Organic Carbon.** Relatively high levels of TOC in some of the Water Department reservoirs present another problem by acting as precursors to disinfection by-products (DBPs), which can be formed in the water treatment disinfection process and have been found to have adverse human health effects at low levels. Future regulations will require water treatment plants to reduce TOC levels, which could increase overall treatment costs, unless they can be reduced in the source water reservoirs. TOC in the reservoirs can be associated with algae produced from excess nutrients, and/or from decomposing vegetative material in storm water runoff. Existing TOC levels in several of the reservoirs regularly exceed the enhanced water quality goal of 3 mg/L.

**Total Dissolved Solids.** There are also concerns about levels of TDS in the Water Department water supply reservoirs. The reservoirs currently must maintain a delicate balance via water blending to offset high levels of TDS in imported water from the Colorado River to avoid exceeding the objective of 500 mg/L for blended water. Future increases in runoff TDS in local water supplies could offset that balance and make achieving water quality objectives more difficult.

### DETERMINING THE SENSITIVITY OF YOUR PROJECT

The Guidelines provide a framework for determining the extent to which a given project may impact reservoir water quality. The Project Evaluation Worksheet includes a series of questions designed to evaluate the relative impact of a given project. The Guidelines focus the selection of BMPs, based on which tier a particular project falls into. Projects are grouped into 3 "tiers," based on various factors.

- "Tier 1" projects are smaller projects (e.g., single family residences) or projects that do not trigger the SUSMP requirements.
- "Tier 2" projects (most projects) either trigger the SUSMP requirements or otherwise may cause or contribute pollutants in storm water runoff.
- "Tier 3" projects are the largest, most significant projects that warrant the highest consideration for source water quality protection.

## SELECTING THE RIGHT BMPS FOR YOUR PROJECT

There is a wide range of BMPs available in the "toolbox" that can be considered for the protection of source waters. It is critical that all stakeholders responsible for source water protection understand the array of available BMPs, and the advantages and disadvantages of each, so that the most cost-effective BMPs are selected to maximize the protection of source waters.

BMPs are categorized into the following three types:

- **Project Design BMPs –** These are BMPs that are low impact measures incorporated into projects during the planning and design phase that take advantage of natural processes to control pollutants in storm water runoff.

- **Source Control BMPs –**These are BMPs that minimize the exposure of pollutants to the environment and introduction of pollutants in runoff at the source, that is, before storm water contacts the pollutant source, picks up pollutants, and runs off the site.

- **Treatment Control BMPs –** These are BMPs that are located downstream from the point at which urban runoff contacts the pollutant source. These treatment devices treat or remove pollutants from storm water runoff, protecting downstream source waters.

The following sections provide the basic concepts and philosophies behind these three categories of BMPs. Later sections of these Guidelines provide procedures and criteria to focus the proper selection of site-specific BMPs from the available options.

### Project Design BMPs

Project Design BMPs are elements of project design that are incorporated during the planning and design stages of projects to capture and infiltrate and/or treat storm water, so that runoff of contaminated storm water to receiving waters is minimized. These BMPs are sometimes referred to as "low impact development" practices because they take advantage of basic natural processes such as infiltration to capture storm water as opposed to applying a higher impact process, such as a structural storm water treatment system. As such, Project Design BMPs, when carefully planned and designed, blend in seamlessly with other aspects of the project design, allowing for storm water discharge to be controlled, while having a minimal impact on the overall project design.

Examples of Project Design BMPs are minimizing paved areas in the project to reduce storm water runoff (both the surface area of paving and the degree to which paved areas are directly connected to drains), incorporating zero-discharge features (e.g., ponds, vegetated depressions) into project designs, and maximizing natural spaces and landscaping. Thus, any project design elements that can enhance natural infiltration or control of storm water volume can be considered Project Design BMPs.

All projects (i.e., Tiers 1, 2 and 3) should consider incorporating Project Design BMPs into their development designs. Guidelines for selecting Project Design controls for your project are provided in Decision Guide A.

**Source Control BMPs**

An effective way to minimize runoff of pollutants in storm water is to minimize the exposure and introduction of pollutants at the source. Source Control BMPs are basic techniques to minimize pollutants including preventing contact between rain and pollutants at the site, minimizing the sources of potential pollutants and minimizing dry weather flows that would carry pollutants.

Preventing contact between rain and pollutant sources ensures that undesirable constituents will not be transferred to storm water upon contact with rain. Techniques that can accomplish this include providing secure shelter for stored materials to prevent rain exposure, covering exposed storage of materials, and using berms to control run-on of storm water onto areas of material storage. The amount of hazardous materials and operations involving these materials can also be minimized to reduce potential for exposure. For example, the use of hazardous materials can be reduced, washdown water activities can be minimized and activities involving hazardous materials (e.g., vehicle maintenance) can be minimized or performed indoors.

Finally, dry-weather (non-storm water) flows which could carry pollutants can be minimized by using techniques that reduce water use while still maintaining site operations. For example, irrigation runoff can be reduced by using drip irrigation techniques, installing automatic irrigation shutoffs, and containing irrigation water onsite. Use of drought tolerant plants and native species can also reduce the need for irrigation water.

All projects (i.e., Tiers 1, 2 and 3) should consider implementing Source Control BMPs as part of project design and neighborhood covenants. Guidelines for selecting Source Controls for your project are provided in Decision Guide B.

**Treatment Control BMPs**

Treatment Control BMPs are further measures, or a third line of defense, that can be taken to control storm water runoff, in addition to Source Control and Project Design BMPs. Treatment Control BMPs are project elements located downstream from the point at which pollutants contact the source that are specifically designed to remove pollutants from storm water runoff.

A wide range of Treatment Control BMPs is available to remove pollutants. The selection of the proper Treatment Control BMP depends on a number of site-specific characteristics. For example, an extended detention basin may be appropriate for projects that have high groundwater tables, poorly draining soils, or large surface areas. Projects located in hilly areas could consider methods to reduce the velocity of storm water discharge such as check dams, gabions or baffle boxes. If erosion is a concern, BMPs such as settling basins or sand filters may be more appropriate than swales, which can clog with sediment and reduce their effectiveness.

Numerous scientific studies have shown that although fairly high pollutant removals may be achieved using various storm water treatment systems and technologies, many other structural BMPs are not effective in reducing nutrient concentrations. In addition, fewer studies have evaluated the effectiveness of BMPs in reducing TOC and TDS as compared to other urban runoff constituents. Scientific research also indicates that vegetated BMP systems that involve filtration, infiltration, and biological uptake are effective in reducing nutrients. The results of many recent scientific studies on pollutant removal effectiveness are summarized in the Treatment BMP Technologies Matrix.

Only some projects (i.e., Tiers 2 and 3) should consider Treatment Control BMPs, since these types of BMPs have higher costs for design, implementation, operation, and maintenance. In particular, maintenance requirements and associated costs must be considered when selecting treatment control BMPs. Guidelines for selecting Treatment Controls for your project are provided in Decision Guide C.

**ADDITIONAL APPROACHES TO IMPROVE RUNOFF WATER QUALITY**

Certain projects in the watersheds may be of such a large scale or have particular features that result in a higher than usual concern for water quality (Tier 3 projects). In these cases, project proponents may wish to consider more intensive BMP "systems" or regional facilities in addition to on-site treatment controls. These approaches may provide a higher level of protection for source water quality.

## Treatment Trains

"Treatment trains" are storm water BMPs applied in series to achieve greater improvement in water quality than can be achieved using a single BMP. Treatment trains often consist of pre-treatment and/or post-treatment controls installed upstream or downstream of a treatment BMP to enhance the performance and/or pollutant removal effectiveness of the BMP itself. Treatment trains are recommended in sensitive areas or for developments with greater potential to affect reservoir water quality.

## Regional, Watershed-Based Approaches

The Water Department encourages the application of regional, watershed-based, multi-use facilities for storm water treatment wherever possible. As new development occurs over large areas within the City's drinking water supply watersheds, there is a significant window of opportunity to apply more regional approaches, with several related benefits.

- **Greater overall improvements in water quality**. Regional facilities can enable significant reductions in urban runoff pollutants by capturing runoff from both existing and new or re-development areas and from dry- and wet-weather flows.
- **Improved long-term effectiveness**. Regional facilities include the designation and funding of a responsible agency to ensure regular maintenance and effective long-term operation to provide reliable treatment into the future.
- **Urban runoff as a resource.** Regional facilities can include an infiltration component, which will reduce urban runoff flows and will also provide for recharge of local aquifers, reducing dependence on imported water supplies.
- **Multiple uses.** Regional, watershed-based facilities provide more opportunities for multiple benefits, such as habitat improvements, green space preservation, and public parks or recreational facility creation or enhancement.
- **Lower cost to remove pollutants**. Regional facilities can help to make the most of local funds and provide more sustainable, cost-effective means to address urban runoff problems, which can be upgraded as necessary to meet downstream water quality objectives.

Guidelines for selecting BMP treatment trains (pre-treatment and post-treatment considerations) and regional approaches are provided in <u>Decision Guide D</u>.

## RUNOFF CALCULATIONS

Unlike the SUSMP, the Source Water Protection Guidelines do not specifically require calculation of runoff volume. However, the design and application of BMPs to implement the Guidelines will require you to calculate runoff volumes in order to size BMPs appropriately. As a general rule, you should estimate pre-development and post-development runoff volumes. Ensuring that pre-development and post-development volumes are equal minimizes the water quality impacts of the project. Calculation of post-development runoff is also necessary for sizing any treatment BMPs required for the project. Appendix B to these Guidelines includes a summary of runoff coefficients and a discussion of runoff estimate methodologies.

## HOW TO USE THE GUIDELINES

The Source Water Protection Guidelines are designed to be simple and easy to use. An overview of the Guidelines process is summarized on Figure 2 below. The process works as follows:

1. Review the Reservoir Watershed Index Map (Figure 1) to identify whether your project is located within a drinking water reservoir watershed.

2. If your project is located within a drinking water reservoir watershed, identify your project footprint on the applicable watershed map. See Figures 1 (a)-1(d) (attached as hard copy and included on CD accompanying these Guidelines).

3. Complete the Project Evaluation Worksheet to identify what tier of protection (Tier 1, 2, or 3) is applicable for your project.

4. Work through Decision Guides A and B to select appropriate site design and source control BMPs for your project.

5. If your project falls into Tier 2 or Tier 3, work through Decision Guide C to identify alternative treatment BMP technologies. Use the Treatment BMP Technologies Matrix to compare the pollutant removal effectiveness and other factors for the various alternatives.

6. If your project falls into Tier 3, also consider Decision Guide D to identify potential treatment train and/or regional BMP systems.

7. Include the completed Source Water Protection Guidelines package with selected BMPs in your project's first formal submittal to the planning department.

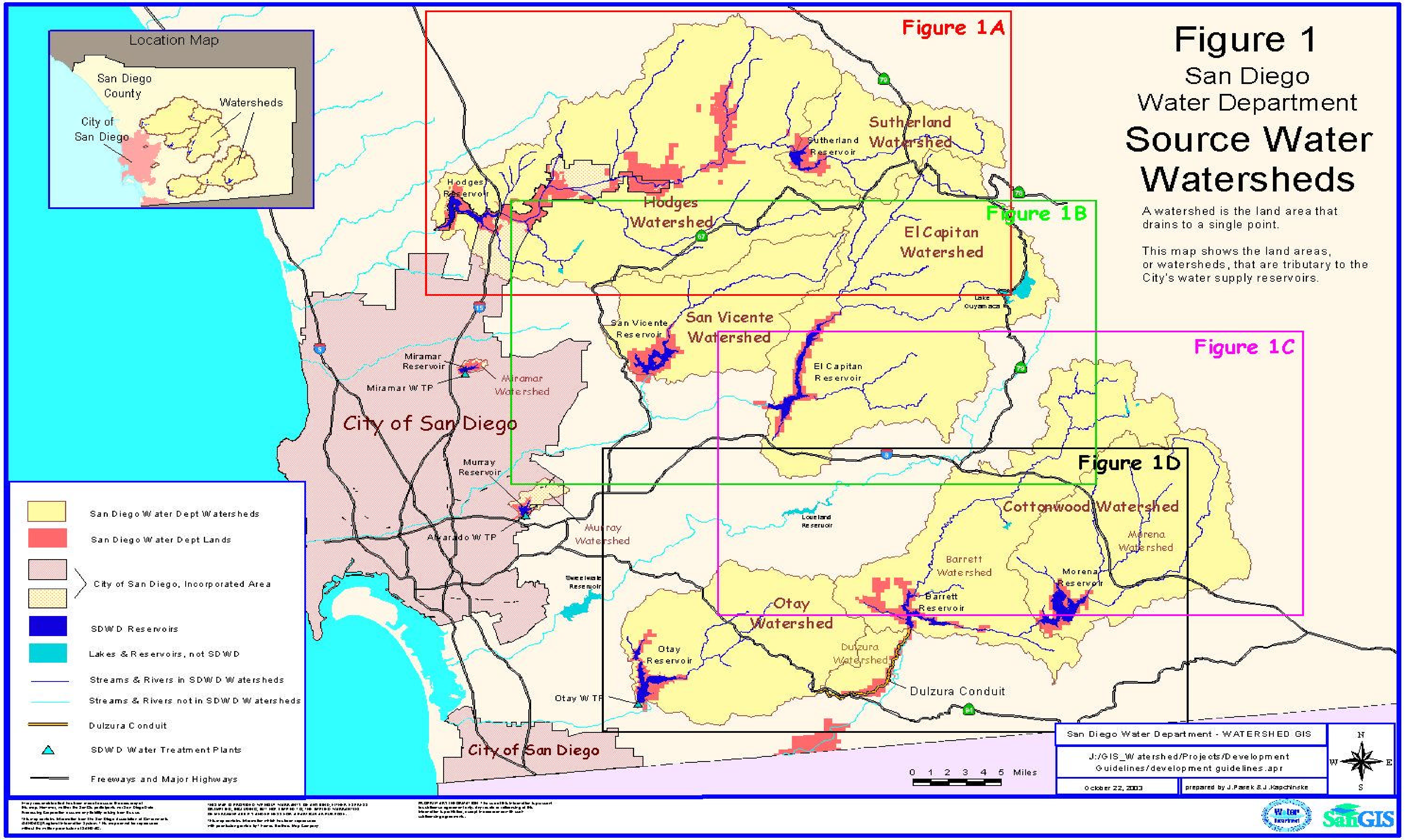



**Figure 1 – Reservoir Watershed Index Map**

<u>NOTE</u>:

Please call the City of San Diego Public Information Office at (619) 527-7413 if you have questions or need assistance determining whether your project is within one of the drinking water reservoir watersheds. Have your Assessors Parcel Number available. The San Diego Water Department thanks you for considering these Guidelines and your efforts to preserve the quality of our regional drinking water sources.

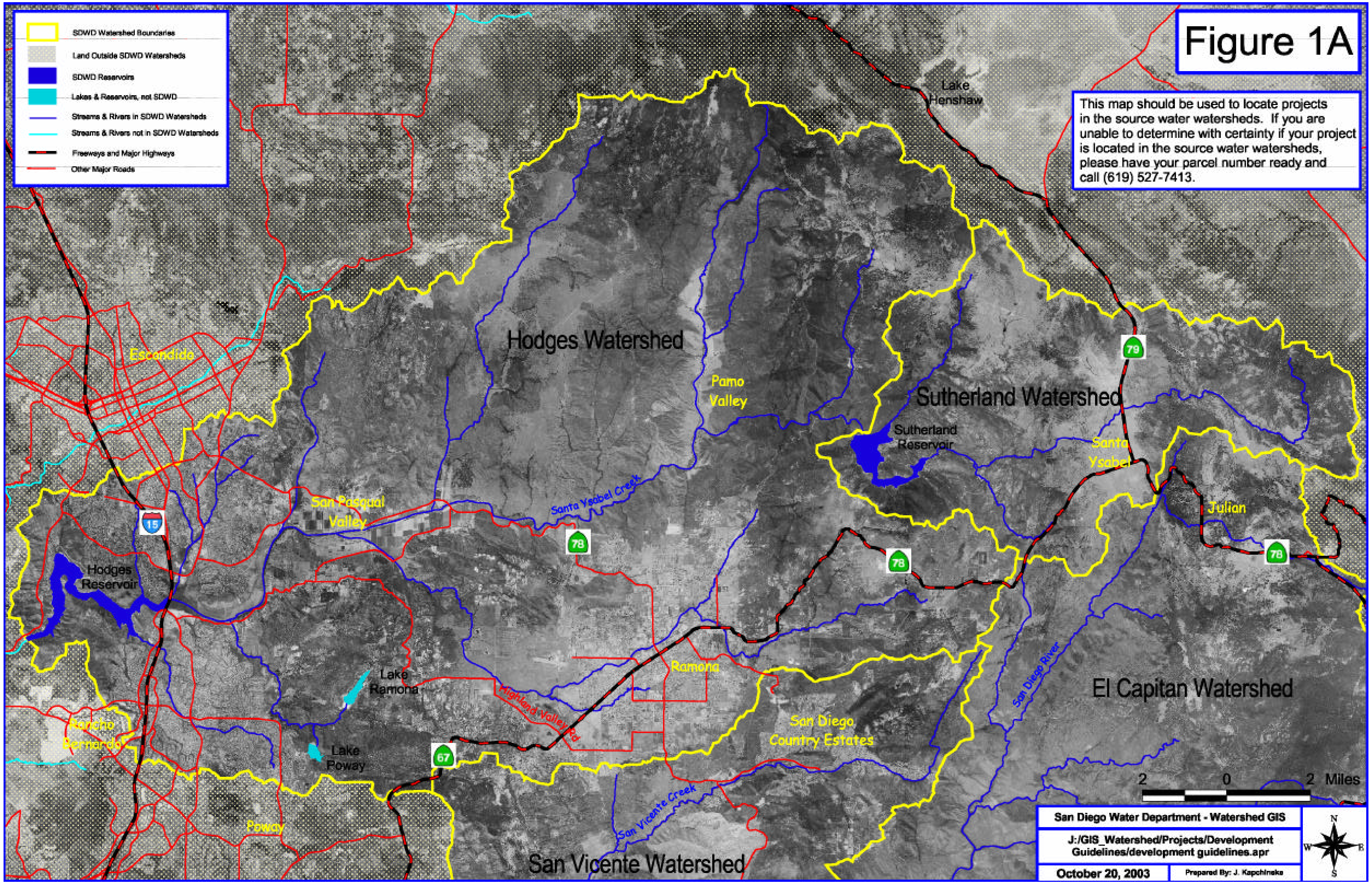


Figure 1A
This map should be used to locate projects in the source water watersheds. If you are unable to determine with certainty if your project is located in the source water watersheds, please have your parcel number ready and call (619) 527-7413.
SDWD Watershed Boundaries
Land Outside SDWD Watersheds
SDWD Reservoirs
Lakes & Reservoirs, not SDWD
Streams & Rivers in SDWD Watersheds
Streams & Rivers not in SDWD Watersheds
Freeways and Major Highways
Other Major Roads
Hodges Watershed
Sutherland Watershed
El Capitan Watershed
San Vicente Watershed
Lake Henshaw
Escondido
Pamo Valley
Sutherland Reservoir
Santa Ysabel
Julian
San Pasqual Valley
Santa Ysabel Creek
Hodges Reservoir
Lake Ramona
Lake Poway
Ramona
Highland Valley Rd
San Diego Country Estates
San Diego River
San Vicente Creek
Rancho Bernardo
Poway
15
78
79
67
2 0 2 Miles
San Diego Water Department - Watershed GIS
J:/GIS_Watershed/Projects/Development Guidelines/development guidelines.apr
October 20, 2003
Prepared By: J. Kapchinske
N
W
E
S

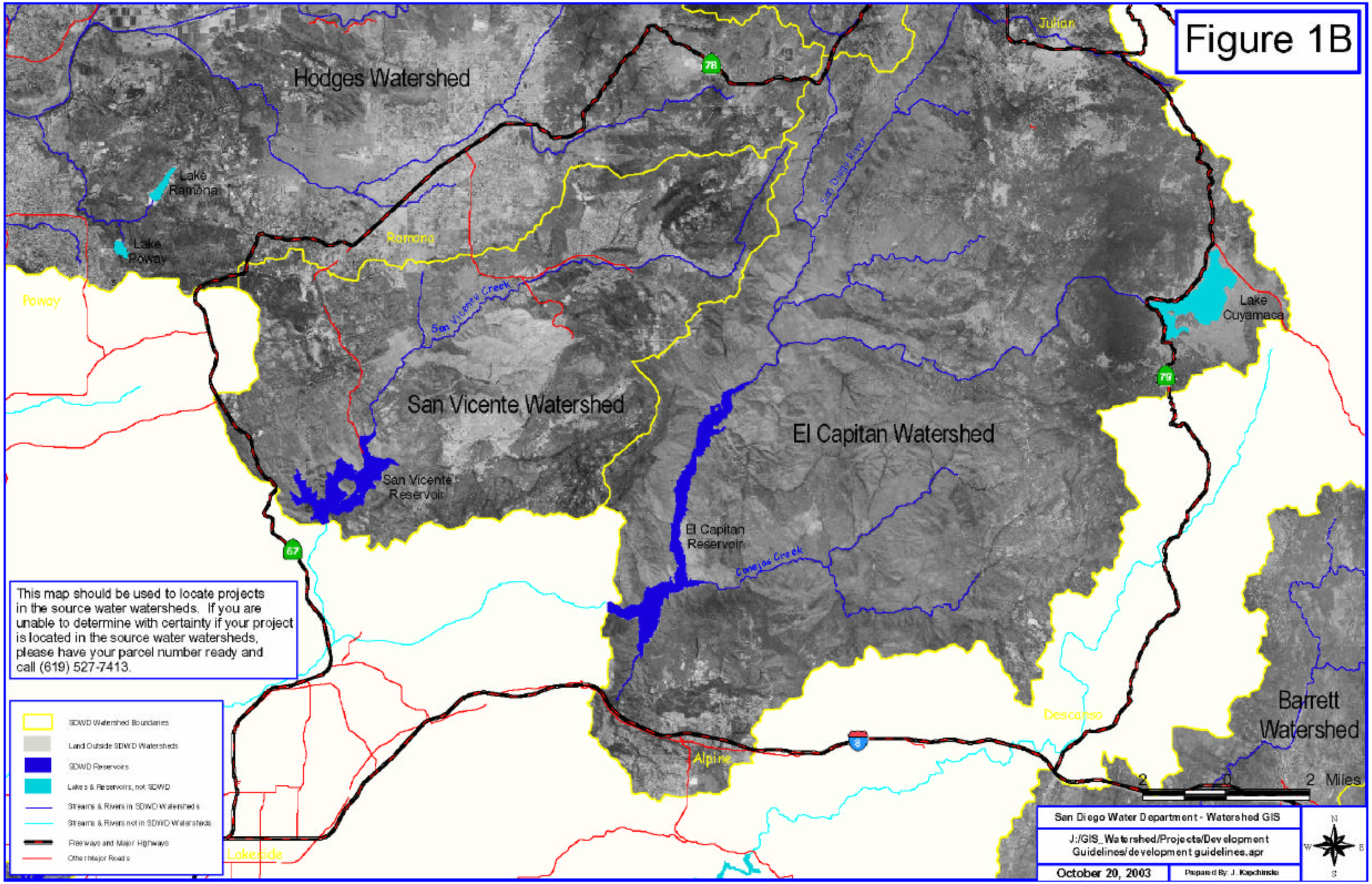


Figure 1B
Hodges Watershed
Lake Ramona
Lake Poway
Poway
Ramona
Julian
San Vicente Creek
San Diego River
San Vicente Watershed
San Vicente Reservoir
El Capitan Watershed
El Capitan Reservoir
Conejos Creek
Lake Cuyamaca
Barrett Watershed
Descanso
Alpine
Lakeside
78
79
67
8
This map should be used to locate projects in the source water watersheds. If you are unable to determine with certainty if your project is located in the source water watersheds, please have your parcel number ready and call (619) 527-7413.
SDWD Watershed Boundaries
Land Outside SDWD Watersheds
SDWD Reservoirs
Lakes & Reservoirs, not SDWD
Streams & Rivers in SDWD Watersheds
Streams & Rivers not in SDWD Watersheds
Freeways and Major Highways
Other Major Roads
2 0 2 Miles
San Diego Water Department - Watershed GIS
J:/GIS_Watershed/Projects/Development Guidelines/development guidelines.apr
October 20, 2003
Prepared By: J. Kapchinske
N
W
E
S

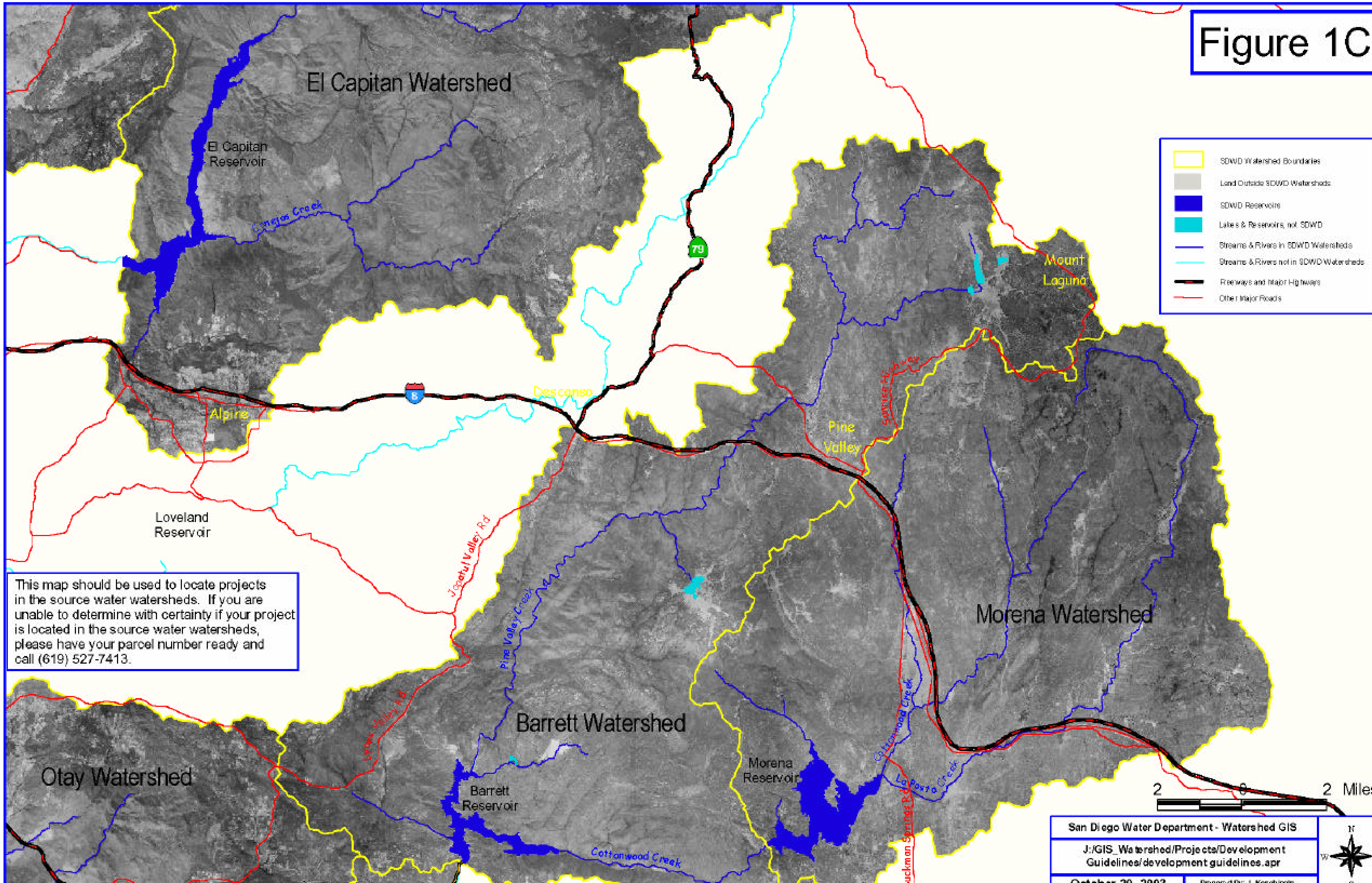


Figure 1C
El Capitan Watershed
El Capitan Reservoir
Conejos Creek
Alpine
Descanso
Loveland Reservoir
Japatul Valley Rd
Pine Valley
Sunrise Highway
Mount Laguna
Pine Valley Creek
Morena Watershed
Barrett Watershed
Otay Watershed
Barrett Reservoir
Morena Reservoir
Cottonwood Creek
La Posta Creek
Buckman Springs Rd
This map should be used to locate projects in the source water watersheds. If you are unable to determine with certainty if your project is located in the source water watersheds, please have your parcel number ready and call (619) 527-7413.
SDWD Watershed Boundaries
Land Outside SDWD Watersheds
SDWD Reservoirs
Lakes & Reservoirs, not SDWD
Streams & Rivers in SDWD Watersheds
Streams & Rivers not in SDWD Watersheds
Freeways and Major Highways
Other Major Roads
2 0 2 Miles
San Diego Water Department - Watershed GIS
J:/GIS_Watershed/Projects/Development Guidelines/development guidelines.apr
October 20, 2003
Prepared By: J. Kapchinske
N
W
E
S

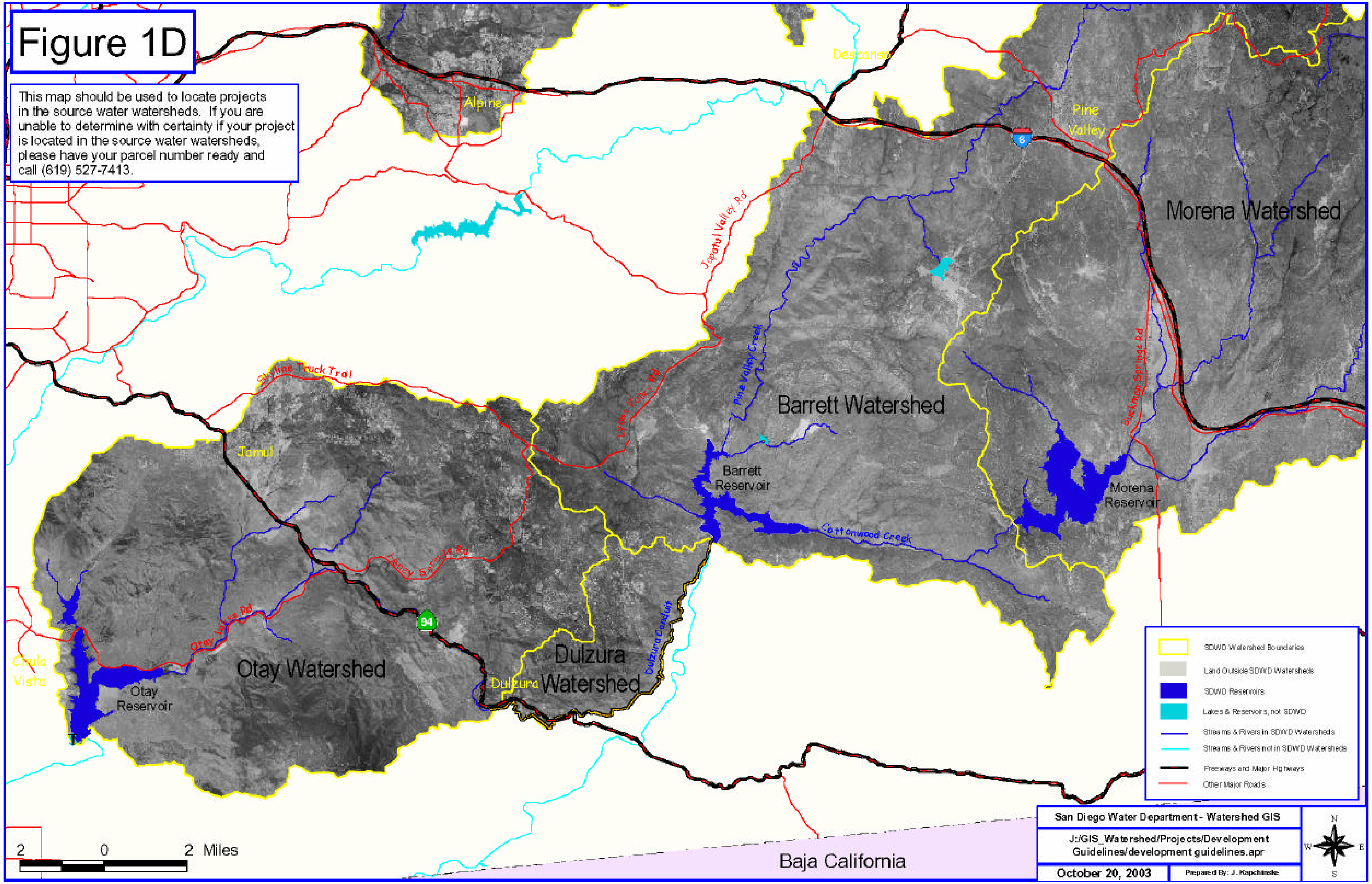


Figure 1D
This map should be used to locate projects in the source water watersheds. If you are unable to determine with certainty if your project is located in the source water watersheds, please have your parcel number ready and call (619) 527-7413.
Alpine
Descanso
Pine Valley
Morena Watershed
Barrett Watershed
Barrett Reservoir
Morena Reservoir
Cottonwood Creek
Jamul
Otay Watershed
Otay Reservoir
Chula Vista
Dulzura Watershed
Dulzura
Skyline Truck Trail
Japatul Valley Rd
Pine Valley Creek
Buckman Springs Rd
Otay Lakes Rd
Honey Springs Rd
Dulzura Creek
94
8
Baja California
2 0 2 Miles
SDWD Watershed Boundaries
Land Outside SDWD Watersheds
SDWD Reservoirs
Lakes & Reservoirs, not SDWD
Streams & Rivers in SDWD Watersheds
Streams & Rivers not in SDWD Watersheds
Freeways and Major Highways
Other Major Roads
San Diego Water Department - Watershed GIS
J:/GIS_Watershed/Projects/Development Guidelines/development guidelines.apr
October 20, 2003
Prepared By: J. Kapchinske
N
W
E
S

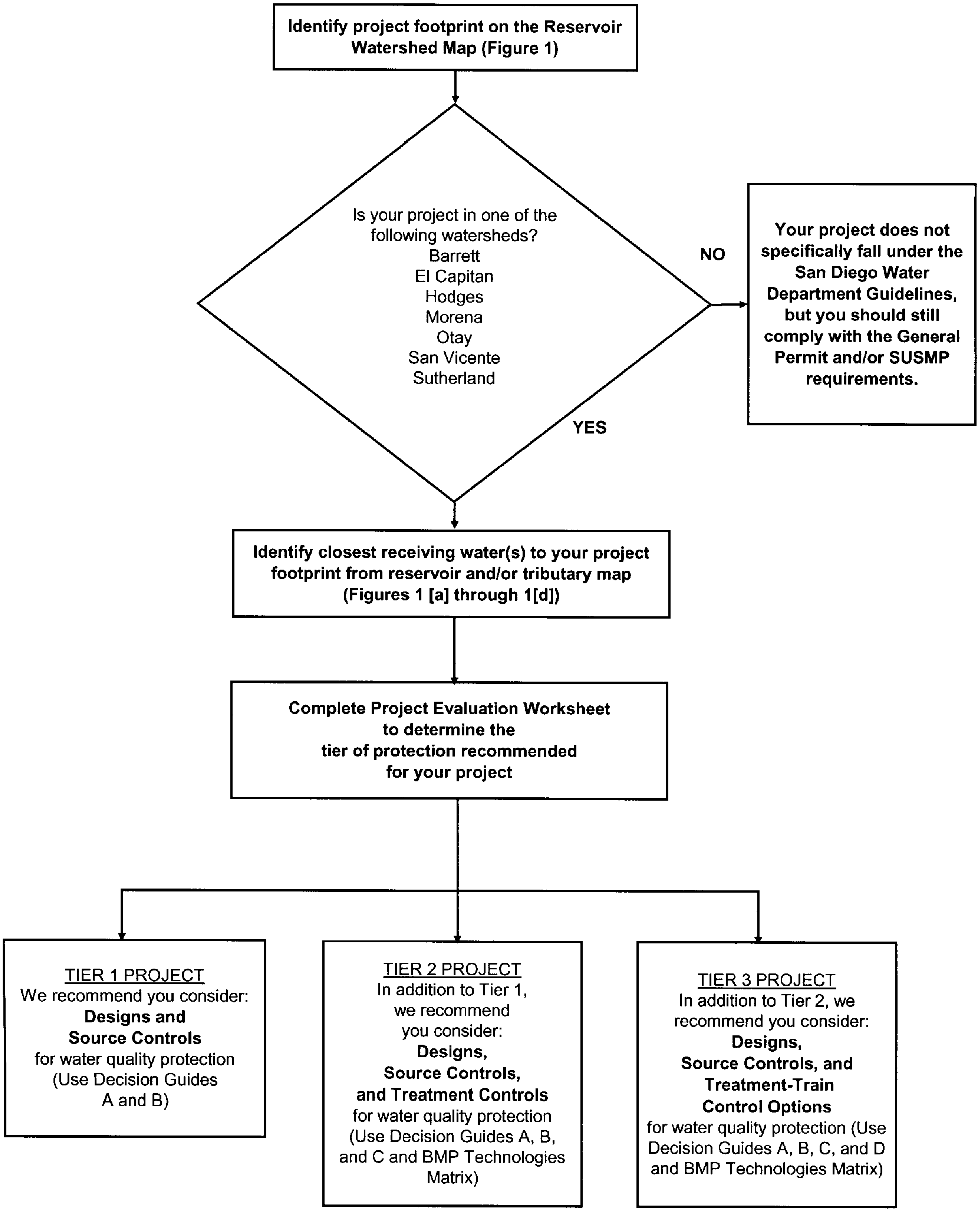



**Figure 2 - Overall Process for Use of Source Water Protection Guidelines**

## USING THE TREATMENT BMP TECHNOLOGIES MATRIX

This table presents a summary of BMP performance in removing the constituents of concern for San Diego source water protection. The first four columns (highlighted in yellow) present removal efficiencies for the source water pollutants of concern (i.e., nitrogen, phosphorus, TDS, and TOC). Additionally, a fifth column (total suspended solids, or TSS) is shaded in a lighter shade of yellow, since removal of TSS may also result in a decrease in phosphorus and TOC.

The table was developed by compiling the results of many recent published studies on BMP pollutant removal effectiveness. The majority of the studies looked at efficiencies as a percent reduction in constituent concentrations of effluent exiting the BMP, as compared to influent entering the BMP. This type of analysis yields an approximate assessment of performance; however, BMP efficiency studies are not uniform and precise, and results may vary considerably depending on local site conditions. In addition, recent research indicates that a simple percent reduction analysis may not be the best measure of BMP effectiveness. For example, CalTrans, 2002 found that sand filters function such that they will reduce the concentration of total suspended solids to a constant level (7.5 mg/L), regardless of the influent concentration of TSS. Thus, efficiency is a function of influent concentration rather than true removal efficiency. Where available, information is provided on the pollutant removal efficiencies for other constituents present in typical urban runoff.

The Treatment BMP Technologies Matrix is organized according to the following treatment categories:

Filtration: Gravity flow-through systems that filter runoff to remove solids and other pollutants from the water. These systems typically require about 4 to 6 feet of elevation difference (between inflow and outflow) to be successful.

Biofiltration: Vegetated systems that use grass, plants, shrubs, and/or trees to slow water velocity (promote sediment settling), absorb moisture, promote percolation into the soil, and uptake pollutants. These are most useful on relatively flat terrain with well-drained soils.

Infiltration: Systems that promote the percolation of surface runoff into the ground. Infiltration best management practices to capture urban runoff and reuse it as a resource for augmenting local groundwater supplies are recommended, wherever possible. These can be natural or fabricated systems that incorporate sand, gravel, rock, and various forms of vegetation. Well-drained soils and a low groundwater table are required. Consider pre-treatment as needed to limit adverse impacts on groundwater quality. Note the limitations where infiltration can be applied, as outlined in the San Diego County storm water permit and the Model SUSMP and summarized below.

- Not allowed in areas where seasonal high groundwater mark is within 10 feet or less from base of infiltration treatment BMP.
- Not allowed within 100 feet horizontally from any water supply wells.
- No dry-weather flows allowed (they must be diverted).
- Not allowed in areas to take drainage from industrial or light industrial areas.
- Pretreatment required for any urban runoff from commercial developments.
- Pollution prevention and source control BMPs are required to protect groundwater quality.
- Soil with appropriate physical and chemical characteristics.

Settling: Systems that capture runoff in large volumes to promote the settling or fall out of sediments.

- Detention systems hold back water temporarily. Water is released at slow, controlled rates to promote settling of solids, to reduce the volume of water discharged during storms, and to minimize downstream erosion.
- Retention systems store the captured runoff indefinitely. All solids and other pollutants associated with the captured water are retained in the unit or system. Water is lost over time through percolation and evaporation. These systems may require more maintenance than detention systems because more water is retained and not released. Vector control may also be an issue.

Appendices A through D to these Guidelines provides more information about the treatment BMPs included in the Treatment BMP Technologies Matrix. For each BMP, the following information is succinctly summarized in approximately one-half page:

- Name and brief description of the BMP
- Photo and/or schematic drawing
- Internet links to more detailed sources of information about the BMP

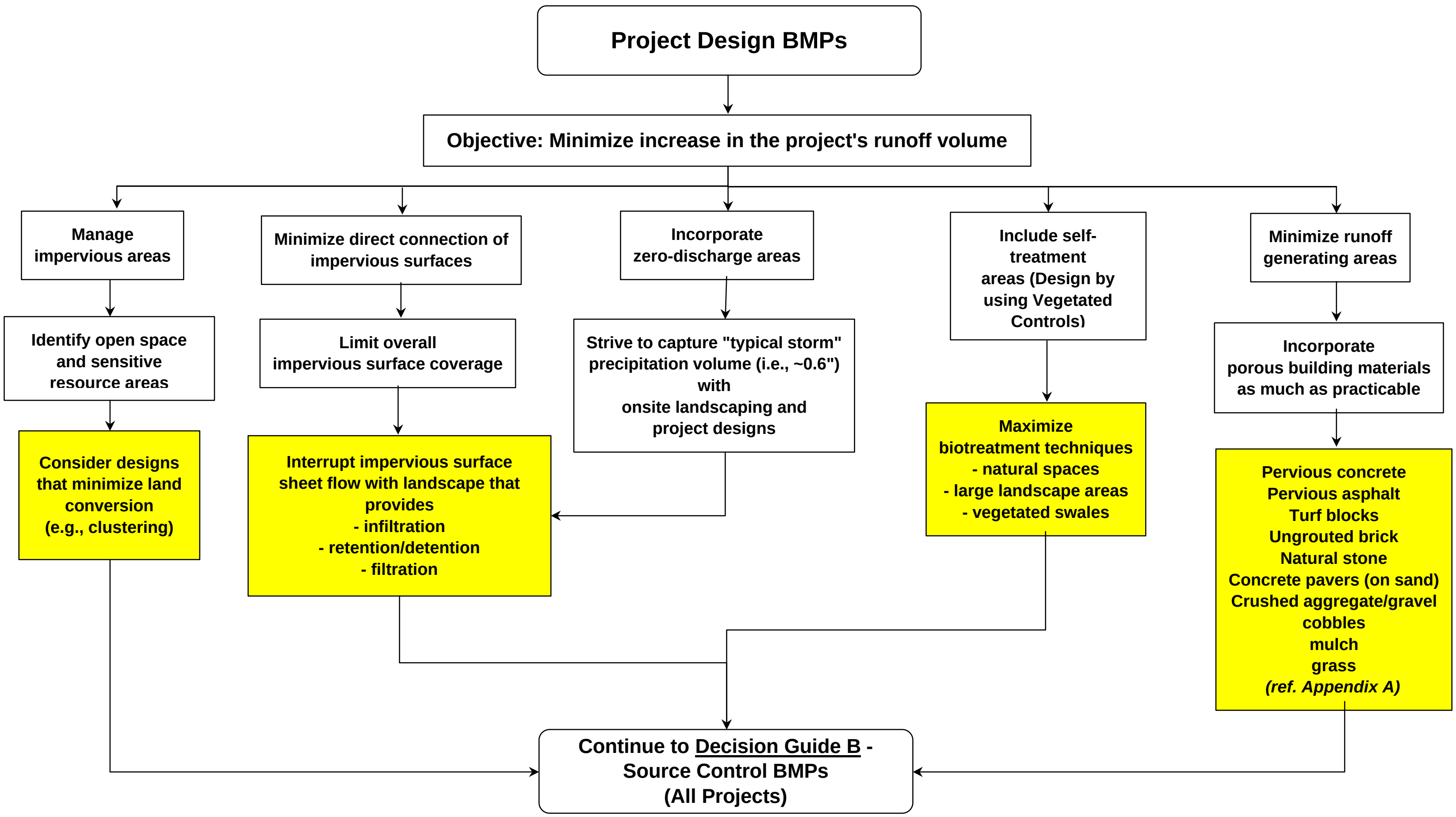
In addition, important information regarding BMP maintenance requirements is provided in Appendix E.

<table>
<tr><td colspan="5"><u>Project Evaluation Worksheet</u><br>NOTE: WORK THROUGH ENTIRE WORKSHEET</td></tr>
<tr><th>STEP</th><th>CRITERIA</th><th>YES ✓</th><th>NO ✓</th><th>GUIDANCE DIRECTION</th></tr>
<tr><td>1.</td><td>Is your project in one of the following drinking water watersheds:<br>▪ Barrett Lake, or<br>▪ El Capitan Reservoir, or<br>▪ Lake Hodges, or<br>▪ Morena Reservoir, or<br>▪ Otay Reservoir, or<br>▪ San Vicente Reservoir, or<br>▪ Sutherland Reservoir.</td><td></td><td></td><td>If yes, go to Step 2.<br>If no, the project is not subject to the City of San Diego Water Department Watershed Protection Guidelines; however, we recommend you go to Step 7 to check if SUSMP requirements pertain to you.</td></tr>
<tr><td>2.</td><td>Will your project provide substantial additional sources of polluted runoff? (Per CEQA* checklist Item VIII(e), if you checked boxes indicating “potentially significant impact” or “less than significant with mitigation incorporation” as a result of additional sources of polluted runoff).</td><td></td><td></td><td>If yes, go to Step 4.<br>If no, go to Step 3.</td></tr>
<tr><td>3.</td><td>Will your project otherwise substantially degrade water quality? (Per CEQA* checklist Item VIII(f), if you checked boxes indicating “potentially significant impact” or “less than significant with mitigation incorporation”).</td><td></td><td></td><td>If yes, go to Step 4.<br>If no, go to Step 5.</td></tr>
<tr><td>4.</td><td></td><td></td><td></td><td>PROJECT IS TIER 3.<br>Use <u>Decision Guides A, B, C, and D</u> and the <u>Treatment BMP Technologies Matrix</u> AND go to Step 9.</td></tr>
</table>

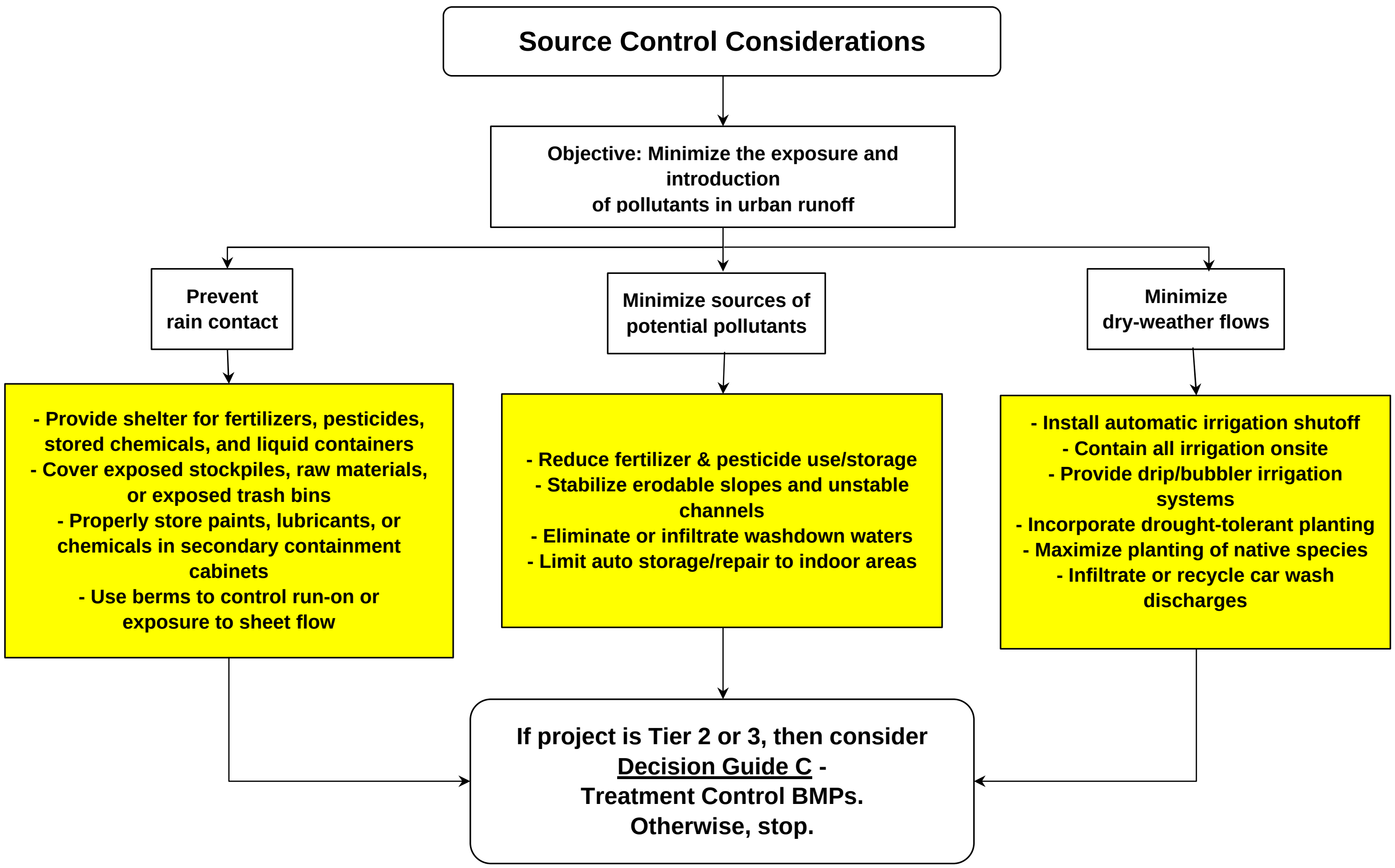
*If the project is in a jurisdiction where there are CEQA thresholds, use them. If not, please reference the 'Significance Determination Guidelines' for CEQA used by the City of San Diego, Development Services Department, Land Development Review Division, and Environmental Analysis Section.

| Project Evaluation Worksheet<br>NOTE: WORK THROUGH ENTIRE WORKSHEET | | | | |
|---|---|---|---|---|
| **STEP** | **CRITERIA** | **YES ✓** | **NO ✓** | **GUIDANCE DIRECTION** |
| 5. | Is your project:<br>▪ A residential project involving more than 10 units, **or**<br>▪ A commercial development involving more than 100,000 square feet of developed area, **or**<br>▪ An automotive repair shop, **or**<br>▪ A restaurant, **or**<br>▪ A hillside development greater than 5,000 square feet, **or**<br>▪ In the vicinity of an environmentally sensitive area (ESA), **or**<br>▪ Involving a parking lot greater than 5,000 square feet or more than 15 spaces, **or**<br>▪ Involving road or travel surfaces with a surface area of 5,000 square feet or more? | | | If yes, please check SUSMP requirements from the local municipality and we recommend you go to Step 7.<br><br>If no, go to Step 6. |
| 6. | Is runoff from your finished project likely to contain significant nutrients (nitrogen or phosphorous), or total organic carbon, or salts (total dissolved solids) or sediment that may impact reservoir water quality? | | | If yes, go to Step 7.<br>If no, go to Step 8. |
| 7. | | | | **PROJECT IS TIER 2.** Use Decision Guides A, B, and C and the Treatment BMP Technologies Matrix. Compliance with applicable SUSMP requirements and other pertinent design standards is recommended. Go to Step 9. |
| 8. | | | | **PROJECT IS TIER 1.** Use Decision Guides A and B and go to Step 9. |
| 9. | Attach this form and a list of selected BMPs to your project's first formal submittal to the Planning Department. | | | |

# Decision Guide A: Project Design BMPs
# [Applicable to ALL Projects - Tier 1, Tier 2, and Tier 3]



# Decision Guide B: Source Control BMPs [Applicable to ALL Projects - Tier 1, Tier 2 and Tier 3]



## Decision Guide C: Treatment Control BMPs
## [Applicable to Tier 2 and Tier 3 Projects]

| Condition | BMPs to Consider | | BMPs to Avoid |
|---|---|---|---|
| Does your site have high groundwater or poorly draining soils? | Extended detention basins*<br>Retention basins*<br>Wetland systems | | Porous pavement<br>Infiltration trench<br>Infiltration basin<br>Dry wells |
| Is your drainage area larger than 10 acres? | Treatment trains<br>Extended detention basins<br>Retention basins<br>Bioretention<br>Grass channels | | Bioretention<br>Biofiltration devices<br>Infiltration trench<br>Infiltration basin<br>Dry well<br>Vortex separators |
| Is your drainage area smaller than 2 acres? | Bioretention<br>Swales<br>Gravel-based wetland | Grass channels<br>Surface sand filters<br>Vortex separators | Wetlands<br>Dry ponds |
| Is the impervious area less than 10% of the total project area? | Surface or perimeter sand filters<br>Detention systems | Bioretention<br>Grass channels | N/A |
| Is the impervous area greater than 10% of the total project area? | Sand filters<br>Dry wells<br>Swales<br>Filter strips | Bioretention<br>Infiltration Basin<br>Trench<br>Porous pavement | N/A |
| Is the vertical change across your project 4 feet or more? | Extended detention systems<br>Sand filters<br>Dry wells | Bioretention<br>Swales | N/A |
| Hydraulic head less than 1 to 3 feet? | Filter strips | | Sand filters<br>Media filters<br>Gravel-based wetlands<br>Grass channels<br>Dry wells<br>Infiltration systems |
| Sensitive groundwater area? | Bioretention | | Infiltration trench<br>Infiltration basin<br>Porous pavement<br>Subsurface storage<br>Grassed swales<br>Wetlands |
| Area sensitive to visual impact? | Bioretention<br>Filter strips | Subsurface retention<br>Vortex separators | N/A |
| None of the above? | Filter strips<br>Buffers<br>Grass channels | | N/A |

↓

If Project is Tier 2, Consider the <u>Treatment BMP Technologies Matrix</u> to Compare Alternative BMP Options

↓

If Project is Tier 3, Consider the <u>Treatment BMP Technologies Matrix</u> and <u>Decision Guide D</u>

Note: Colors refer to categories of BMPs listed in the <u>Treatment BMP Technologies Matrix</u>.

N/A = Not Applicable

* - System should be designed to minimize infiltration

## Decision Guide D:  Pre-treatment and Post-Treatment BMPs

**Additional Treatment-Train Recommendations for Tier 3 Projects**

*(Refer to Treatment BMP Technologies Matrix for Additional Considerations)*

Pre-treatment and Post-treatment Considerations to Enhance Treatment Performance of BMPs at Large or Complex Project Sites

| Condition | Potential Solution |
|---|---|
| **Pre-treatment Considerations** | |
| Hilly terrain or steep slopes that will concentrate runoff flow to the BMP. | Reduce incoming velocity to the BMP through pretreatment concepts, such as baffle boxes, gabions, check dams, rip rap, forebays. |
| Drainage from surrounding area may carry substantial amounts of debris (sticks, leaves, sediment) that could potentially clog or disrupt the BMP. | Provide up-front screening devices or sediment capturing concepts to pre-treat incoming flow, such as grates, flip-up bar screens, rip rap, forebays, and in certain situations, in-ground systems like hydrodynamic separators may be appropriate. |
| Native, undisturbed area may be subject to erosion that could cause unwanted sediment to be carried away with runoff.<br>-OR-<br>Developed areas may require multiple seasons to completely establish vegetation, which may result in unwanted erosion. | Provide up-front sediment-capturing concepts to slow incoming flow for sediment fallout or to block high sediment loads from entering the BMP, such as check dams, gabions, rip rap, forebays, meandering riparian water courses, and in certain situations, in-ground systems like hydrodynamic separators may be appropriate. Swales are not appropriate for high sediment loads. |
| Project area will likely contribute substantial amounts of dry-weather flow from single family homes (irrigation, car washing, washdown, etc.). | Integrate interconnected water courses through open spaces, and perhaps residences, to route dry-weather flows in ways that are beneficial to the environment without significant discharge to surrounding drinking water sources. |

| **Post-treatment Considerations** | |
|---|---|
| Project drains to sensitive or impaired receiving water (303(d)-listed) stream or water body | Additional post-treatment may be required by providing treatment-train concepts to reduce the target pollutants of concern, such as:<br>- Bioretention basins or ponds (i.e., temporary/permanent water storage)<br>- Infiltration techniques (i.e., runoff reduction)<br>- Sand filters (post-treatment water quality "polishing") |
| Project or project area has limited space to accommodate BMPs that can provide adequate water volume capture/treatment. | Assess suitability for subregional or regional systems that can accommodate target storm volumes, such as:<br>offline riparian corridors or vegetative buffer zones, or interconnected storage systems (e.g., ponds, gravel trenches, depressed landscape) over several acres. |

## TREATMENT BEST MANAGEMENT PRACTICES TECHNOLOGIES MATRIX*

| BMPs | | Pollutants of Concern for Source Water** – Percent Removal | | | | Pollutants of Concern for Urban Runoff – Percent Removal | | | | | | | Community and Environmental Factors | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total Nitrogen | Total Phosphorous | Total Dissolved Solids | Total Organic Carbon | Total Suspended Solids | Total Copper | Total Lead | Total Zinc | Oil and Grease | Bacteria | Trash / Sediment | Aesthetics | Habitat | Relative Cost | Maintenance | Safety | Water Conservation |
| FILTRATION | Perimeter Sand Filter (i.e., Delaware) | 25% [e], 24% [g], 12.9% to 84.2% [y] Nitrate -55% [g], -674.2 to 66.8%%[y] TKN 44% [g], 0.0 to 90.4% [y] Ammonia N –100 to 75.6% [y] Nitrite N –236 to 92.9% [y] | 56.3 to 91.8% [y], -14.3 to 91.8% [y] 50% [e], 44% [g] Ortho-Phosphate 21% [g], -10 to 93.9% [y], 16.7 to 92.9% [y] | NA | 67% [l], -100 to 90% [y] | 80% [e], 81% [g], 41.2 to 96.4% [y], 15.4 to 96.4% [y] | 64% [g], 0 to 50% [r] Dissolved 64% [g] | 85% [g] Dissolved 43% [g] | 89% [g], 57.9 to 88.2% [y] Dissolved 92% [g] | TPH – Oil 55% [g] TPH – Diesel 47% [g] | Fecal Coliform 79% [g] | NA | ○ | ○ | ◐ | E | ● | ● |
| FILTRATION | Surface Sand Filter (i.e., Austin) | 21% [aa], 25% [e], 17% [g], 31% [r], 32% [r], 47% [r] Nitrate -71% [g] TKN 41% [g], 62% [r], 57% [r], 81% [r], 46% [aa] Nitrate + Nitrite -82% [r], -37% [r], -38% [r] Nitrate as Nitrogen 0% [aa] | 61% [r], 50% [r], 65% [r], 33% [aa], 50% [e], 39% [g], 55% [g] Ortho-Phosphate 6% [g] | 30% [r], -19% [r], 3% [r] | 61% [r], 38% [r], 87% [r], 48% [aa] | 80% [e], 90% [g], 87% [r], 70% [r], 86% [r], 70% [aa] | 50% [g], 60% [r], 20% [r], 71% [r] Dissolved 6% [g] | 87% [g], 80% [r], 85% [r], 79% [r], 45% [aa] Dissolved 39% [g] | 80% [g], 80% [r], 78% [r], 84% [r], 45% [aa] Dissolved 80% [g] | TPH – Oil 30% [g] TPH – Diesel 25% [g] | Fecal Coliform 65% [g], 36% [r], 22% [r], 69% [r], 76% [aa] | Sediment 85% [k] | ○ | ○ | ◐ | E | ● | ● |
| FILTRATION | Compost Filter System | Nitrate -34% [h] | 41% [h], 4% [h], 40% [g] | NA | NA | 95% [h], 85% [h] | Metals 61 to 88% [h], 44 to 75% [h] | Metals 61 to 88% [h], 44 to 75% [h] | Metals 61 to 88% [h], 44 to 75% [h] | NA | NA | Sediment 85% [k] | ◐ | ○ | ◐ | L | ◐ | ● |
| FILTRATION | Media Filter | 13% [g] Nitrate -7% [g] TKN 19% [g] | 24% [g] Orthophosphate 9% [g] | NA | NA | 40% [g], 92% [w], 43% [w] | 67% [g], 65% [w], 33% [w] Dissolved 26% [g] | 52% [g], 82% [w], 50% [w] Dissolved 29% [g] | 55% [g], 83% [w], 29% [w] Dissolved 23% [g] | TPH – Oil 52% [g] TPH – Diesel 67% [g], 81% [w], 74 to 69% [w] TPH 84% [w] | Fecal Coliform 47% [g] | NA | ◐ | ○ | ◐ | L | ● | ● |
| INFILTRATION | Porous Pavement | 65% [ee], 88% [kk] | 60% [kk], 49% [ee] Ortho-Phosphate 26% [ee] | NA | NA | 95% [kk], 73% [ee] | Metals 99% [kk] | Metals 99% [kk] 73% [ee] | Metals 99% [kk] 72% [ee] | NA | NA | NA | ● | ○ | ◐ | E | ● | ● |
| INFILTRATION | Infiltration Trench | 60% [e], 60% [z] | 60% [e], 60% [z], 55% [k] | NA | NA | 80% [e] | 75 to 80% [l] | 75 to 80% [l] | 75 to 80% [l] | NA | 90% [z] | Sediment 75% [k], 90% [z] | ◐ | ○ | ◐ | E | ● | ● |
| INFILTRATION | Infiltration Basin | 45 to 55% [ll], 60 to 70% [ll], 55 to 60% [ll], 16.9 mg/L[#g] Nitrate 0.4 mg/L[#g] TKN 0.4 mg/L[#g] | 50 to 55% [ll], 65 to 75% [ll], 60 to 70% [ll] 1.1 mg/L[#g] | NA | NA | 202 mg/L[#g], 75% [ll], 99% [ll], 90% [ll] | 0.002 mg/L[#g] Dissolved <0.001 mg/L[#g] Metals 75 to 80% [ll], 95 to 99% [ll], 85 to 90% [ll] | <0.001 mg/L[#g] Dissolved <0.001 mg/L[#g] Metals 75 to 80% [ll], 95 to 99% [ll], 85 to 90% [ll] | <0.001 mg/L[#g] Dissolved 0.002 mg/L[#g] Metals 75 to 80% [ll], 95 to 99% [ll], 85 to 90% [ll] | TPH-Oil <0.2 mg/L[#g] TPH-Gasoline <0.05 mg/L [#g] TPH-Diesel 0.188 mg/L[#g] | Fecal Coliform <200 MPN/100 mL[#g] 75% [ll], 90% [ll] | NA | ◐ | ◐ | ○ | V, L | ◐ | ● |

Note: See Legend on page 3 of Matrix.

## TREATMENT BEST MANAGEMENT PRACTICES TECHNOLOGIES MATRIX*

| | BMPs | Pollutants of Concern for Source Water** – Percent Removal | | | | Pollutants of Concern for Urban Runoff – Percent Removal | | | | | | | Community and Environmental Factors | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total Nitrogen | Total Phosphorus | Total Dissolved Solids | Total Organic Carbon | Total Suspended Solids | Total Copper | Total Lead | Total Zinc | Oil and Grease | Bacteria | Trash / Sediment | Aesthetics | Habitat | Relative Cost | Maintenance | Safety | Water Conservation |
| DETENTION / SETTLING | Wet Vault / Tank | NA | 30% [k] | NA | NA | NA | NA | NA | NA | NA | NA | Sediment 60% [g] | ○ | ○ | ◐ | V, L | ◐ | ◐ |
| | Underground Detention | NA | 20 to 40% [l] | NA | NA | 60 to 80% [l] | NA | 40 to 70% [l] | NA | NA | NA | NA | ○ | ○ | ○ | V, L | ● | ● |
| | Dry Detention | NA | 75% [k] | NA | NA | NA | NA | NA | NA | NA | NA | Sediment 90% [k] | ○ | ○ | ● | V, L | ● | ● |
| | Dry Extended Basin / Dry Extended Detention Pond | 25% [c]<br>Nitrate+Nitrite 4% [c] | 47% [c], 25% [k]<br>Soluble -6% [c] | NA | NA | 47% [c] | 26% [‡c] | NA | 26% [c] | NA | NA | Sediment 45% [g] | ◐ | ◐ | ○ | V, L | ◐ | ● |
| | Wet Extended Basin / Pond / Retention Pond | 33% [c], 31% [q]<br>30% [e], 39% [g]<br>Nitrate Nitrogen 153% [d]<br>TKN –28% [d], 27% [g]<br>Nitrate 61% [g]<br>Nitrate+Nitrite 43% [c], 24% [q] | 51% [c], 48% [q]<br>50% [e], 5% [g]<br>45% [k], 65% [k], 30-90% [s]<br>Dissolved Organic -47% [d]<br>Soluble 66% [c], 52% [q] | 6% [d] | NA | 80% [c], 74% [d],<br>80% [e], 93% [g], 67% [q],<br>50 to 90% [s],<br>80 to 90% [s] | -40% [d], 98% [g]<br>Dissolved 57% [g] | 51% [d], 99% [g]<br>Dissolved 76% [g] | -12% [d], -93% [g]<br>Dissolved 41% [g] | 27% [d]<br>TPH – Oil 38% [g]<br>TPH – Diesel 91% [g] | Fecal Coliform 64% [d], 99% [g] | Sediment 80% [g] | ● | ● | ○ | V, L | ○ | ● |
| | Unlined Extended Detention Basin | 16% [g]<br>Nitrate 15% [g]<br>TKN 17% [g] | 38% [g]<br>Dissolved<br>Ortho-Phosphate -8% [g]<br>Particulate 41% [g] | NA | NA | 69% [gs] | 58% [g], 57% [q]<br>Dissolved 5% [g]<br>Particulate 73% [g] | 72% [g]<br>Dissolved 33% [g]<br>Particulate 73% [g] | 72% [g], 66% [c], 51% [q]<br>Dissolved 24% [g]<br>Particulate 84% [g] | NA | NA | NA | ○ | ○ | ○ | V, L | ○ | ● |
| | Lined Extended Detention Basin | 13% [g]<br>Nitrate 8% [g]<br>TKN 16% [g] | 15% [g]<br>Dissolved<br>Ortho-Phosphate 10% [g]<br>Particulate 58% [g] | NA | NA | 40% [g] | 27% [g]<br>Dissolved 8% [g]<br>Particulate 50% [g] | 48% [g], 70 to 80% [s]<br>Dissolved 42% [g]<br>Particulate 55% [g] | 54% [g], 40 to 50% [q]<br>Dissolved 39% [g]<br>Particulate 65% [g] | TPH – Oil 11% [g]<br>TPH – Diesel<br>0% [g] | Fecal Coliform 12% [g] | NA | ○ | ○ | ○ | V, L | ○ | ◐ |
| BIOFILTRATION | Detention w/ Swales | 9% [b]<br>Nitrate + Nitrite,<br>Total -9% [b] | -87% [b] | -29% [b] | 14% [b] | NA | NA | 22% [b] | 12% [b] | NA | Fecal Coliform 47% [b]<br>Fecal Streptococci –520% [b] | NA | ○ | ○ | ● | V, L | ◐ | ● |
| | Extended Detention Wetland | NA | 53% [m], 69% [n] | NA | NA | 95% [m], 96% [n] | NA | 90% [m], 94% [n] | 92% [m], 90% [n] | NA | NA | NA | ● | ● | ◐ | V, L | ● | ● |
| | Constructed Wetlands / Stormwater Wetlands | Nitrate Nitrogen (55 lb/yr[†], 34.1%)[ff]<br>Nitrate, Nitrite Nitrogen (25 lb/yr[†], 15.4%)[ff]<br>Nitrate+Nitrite 67% [c], 67% [q],<br>28% [qq], 30% [c], 21% [q]<br>TKN (690 lb/yr[†],63.6%)[ff] | 49% [qq], 50% [o],<br>(33 lb/yr[†], 39.6%)[ff]<br>Soluble 35% [c], 39% [q], 49% [c],<br>51% [q] | NA | 65% [o], 34% [gg] | 41.3% [o], 67% [gg]<br>75% [c], 54% [q],<br>(8,629 lb/yr[†],<br>41.3%)[ff] | 51% [o], 40% [c], 39% [q], 41% [gg] | 62% [gg] | 45% [gg], 22.8% [o]<br>44% [c], 54% [q],<br>(13 lb/yr[†], 22.8%)[ff] | Petroleum Hydrocarbons 87% [gg] | 77% [gg] | NA | ● | ● | ◐ | V, L | ◐ | ● |
| | Gravel-Based Wetlands | 30% [e] | 40% [e] | NA | NA | 80% [e] | NA | NA | NA | NA | NA | NA | ◐ | ◐ | ◐ | V, L | ● | ● |
| | Bioretention / Bioinfiltration | TKN 68.6 to 80% [cc] | 60% [e], 70 to 83% [h, cc], 30% [k] | NA | NA | 80% [e], 90% [h, cc] | Metals 93 to 98% [h, cc] | Metals 93 to 98% [h, cc] | Metals 93 to 98% [h, cc] | NA | 90% [h,cc] | Sediment 75% [k] | ● | ◐ | ○ | L | ● | ● |
| | Wet Swale | 40% [e] | 25% [e] | NA | NA | 80% [e] | NA | NA | NA | NA | NA | NA | ◐ | ● | ◐ | L | ◐ | ● |
| | Grass Channel | Nitrate 31.4% [i]<br>Nitrate -25% [j] | 4.5%I, 45% [j],<br>29% [j] | NA | NA | 67.8% [i], 60% [j] | 42 to 62% [I],<br>2 to 16% [j],<br>46 to 73% [j] | 42 to 62% [I],<br>2 to 16% [j],<br>46 to 73% [j] | 42 to 62% [I],<br>2 to 16% [j],<br>46 to 73% [j] | NA | -100% [i], -25% [j] | NA | ◐ | ◐ | ● | L | ● | ● |
| | Grass Swale / Biofiltration Swale / Dry Swale | 26% [g], 50% [e], 67% [h], 841% [q]<br>Nitrate 11% [g],<br>66% [h], 38% [s]<br>TKN 31% [g]<br>Nitrate and Nitrite Nitrogen 31% [q] | 8% [h], 57% [f], 34% [q]<br>50% [e], 15% [k], 9% [s]<br>Dissolved 28% [f]<br>Soluble 38% [q] | NA | NA | 80% [e], 50% [g],<br>77% [h], 81% [s], 81% [q] | Dissolved 58% [f]<br>61% [g], 51% [s], 51% [q]<br>Dissolved 50% [g] | Dissolved 9% [f]<br>69% [g], 67% [s]<br>Dissolved 61% [g] | Dissolved 15% [f]<br>77% [g], 71% [s], 71% [q]<br>Dissolved 74% [g] | TPH – Oil 51% [g]<br>Hydrocarbons 62% [s] | Fecal Coliform 33% [g] | Sediment 65% [k] | ◐ | ◐ | ● | L | ● | ● |
| | Biofiltration Strip/ Filter Strip | 12% [g], (2.68 mg/L[¶],15%)[h]<br>Nitrate -1% [g],<br>(0.58 mg/L[¶],13%)[h]<br>TKN (2.10 mg/L[¶], 16%)[h],<br>16% [g] | (0.62 mg/L[¶], -52%)[h], 50% [k]<br>Dissolved<br>(0.46 mg/L[¶],<br>–206%)[h] | NA | NA | 74% [g,h] | 84% [g],<br>(0.009 mg/L[¶], 84%)[h]<br>Dissolved 77% [g],<br>(0.007 mg/L[¶],77%)[h] | 88% [g],<br>(0.006 mg/L[¶]. 88%)[h]<br>Dissolved 66% [g],<br>(0.002 mg/L[¶], 66%)[h] | 72% [g],<br>(0.055 mg/L[¶], 78%)[h]<br>Dissolved 57% [g],<br>(0.035 mg/L[¶], 65%)[h] | TPH – Oil 59% [g]<br>TPH – Diesel<br>66% [g] | Fecal Coliform 92% [g] | Sediment 50% [k] | ● | ◐ | ● | L | ● | ● |

Note: See Legend on page 3 of Matrix.

## TREATMENT BEST MANAGEMENT PRACTICES TECHNOLOGIES MATRIX*

| | BMPs | Pollutants of Concern for Source Water** – Percent Removal | | | | Pollutants of Concern for Urban Runoff – Percent Removal | | | | | | | Community and Environmental Factors | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total Nitrogen | Total Phosphorous | Total Dissolved Solids | Total Organic Carbon | Total Suspended Solids | Total Copper | Total Lead | Total Zinc | Oil and Grease | Bacteria | Trash / Sediment | Aesthetics | Habitat | Relative Cost | Maintenance | Safety | Water Conservation |
| MISCELLANEOUS | Vortex Type Separators | Nitrate + Nitrite 5% [bb] TKN 41% [hh] | 29% [v], 27% [v], 30% [v], 17% [bb] Dissolved 17% [bb] | -21% [bb] | 19/15% [hh] | 50% [v], 70% [v], 21% [bb], 51.5% [bb] 24% [hh], 63/50% [hh], 80% [hh], 26% [hh], 93% [hh], 53% [hh], 80% [hh], 84% [hh] | 21.5% [bb] 12% [hh], 33/25% [hh], 21% [hh] | 24% [bb], 51.2% [bb] 13% [hh], 47/33% [hh], 51% [hh] | 17% [bb], 39.1% [bb] 29% [hh], 26/18% [hh], 21% [hh], 39% [hh] | PAH 32% [bb], 36% [hh] 38% [hh], 43% [hh] Diesel 16% [hh] Motor Oil 33% [hh] TPH 82% [hh] | NA | NA | ◐ | ○ | ◐ | V, E | ● | ● |
| MISCELLANEOUS | Multi-Chambered Treatment Trains | Nitrate 24% [g], 14% [h], 75% [dd], 63% [dd], TKN 62% [dd] Nitrate -9% [dd] | 80% [h], 84% [h], 82% [dd] Ortho-phosphorus14% [dd] | 8% [dd] | 38% [dd] | 83% [g], 85% [h], 83% [h], 98% [h], 81% [dd] | 22% [g], 21% [dd] Dissolved 17% [g] Metals 65 to 90% [h], 91 to 100% [h], 83 to 89% [h] | 93% [g], 73% [dd] Dissolved 42% [g] Metals 65 to 90% [h], 91to100% [h], 83 to 89% [h] | 91% [g], 55% [dd] Dissolved 46% [g] Metals 65 to 90% [h], 91 to100% [h], 83 to 89% [h] | TPH – Oil 70% [g] TPH – Diesel 80% [g] | Fecal Coliform 14% [g] 78% [dd] | NA | ○ | ○ | ○ | V, E | ○ | ○ |
| MISCELLANEOUS | Oil-Water Separator – Water Quality Inlet | NA | 5% [k] | NA | NA | 49% [g] | NA | NA | NA | 83% [g] TPH – Diesel 52% [g] | NA | Sediment 15% [g] | ○ | ○ | ◐ | E | ● | ○ |
| MISCELLANEOUS | Gross Solids Removal Devices (GSRDs)/ Screens and Trash Racks/ Nets/Booms | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | §Gross Solids (Linear Radial: 98.4% [ii], 97% [ii], 93.7% [ii]), (Inclined Screen: 100% [ii], 82.7% [ii], 86.2% [ii]), (Baffle Box: 93.1% [ii], 99.6% [ii]) Litter (Linear Radial: 98% [ii], 93.9% [ii], 90.3% [ii]), (Inclined Screen: 100% [ii], 66.9% [ii], 81.2% [ii]), (Baffle Box: 87.2% [ii], 98% [ii]) | ◐ | ○ | ◐ | L, E | ◐ | ◐ |

* This list is intended to provide general guidance for selecting BMPs that are suitable for drinking water protection. The contents provided are not exhaustive. Project applicants are encouraged to conduct independent research if necessary. Data presented is from non-vendor sources—see footnotes below. Refer to Appendix A for additional sources of information regarding BMP technologies and water quality management approaches.

** Selecting BMPs should focus on controlling the pollutants of concern for source-water protection.
† Loading removal.
‡ Data based on fewer than 5 data points.
¶ Effluent Concentration.
\# Average concentration while BMP is in operation.

§ Percent removal information for GSRDs only.

● **– Best** ◐ **– Moderate** ○ **– Worst**
**E = Special equipment requirements** **V = Potential vector control** **L = High labor requirements**
NA: Not Available


[a] Megginis Ck. Marsh Tallahassee, FL. EPA, Florida Department of Environmental Regulation. http://www.bmpdatabase.org/
[b] Alta Vista Planned Development w/ swales, Austin, TX. USGS. http://www.bmpdatabase.org/
[c] National Pollutant Removal Performance Database for Stormwater Treatment Practices: 2nd Edition, http://www.cwp.org
[d] DUST Marsh Debris Basin (Retention Pond (wet) - Surface Pond with a Permanent Pool, Fremont, CA. http://www.bmpdatabase.org/
[e] Georgia Stormwater Management Manual. http://georgiastormwater.com
[f] EPCOT Biofilter - Grass Swale, Orlando, FL. http://www.bmpdatabase.org/
[g] CalTrans BMP Retrofit Pilot Program, Los Angeles/San Diego, CA.
[h] California Stormwater Quality Association (CASQA) New Development and Redevelopment Handbook (TC-30, TC-31, TC-32, TC-40) http://cabmphandbooks.com
[i] Dayton Avenue Swale Biofiltration Study, Seattle Engineering Study, Seattle, WA. http://www.bmpdatabase.org/
[j] Biofiltration Swale Performance. Seattle Metro and Washington Department of Ecology. Seattle, WA. http://www.bmpdatabase.org/
[k] Catalog of Stormwater BMPs for Idaho Cities and Counties. http://www.deq.state.id.us/water/stormwater_catalog/index.asp
[l] US DOT FHA Fact Sheet. – Detention Tanks and Vaults. Northern Virginia District Planning Commission. http://www.fhwa.dot.gov/environment/ultraurb/3fs6/htm
[m] US DOT FHA Fact Sheet. – Wetlands and Shallow Marsh Systems. Martin & Smoot, 1996. http://www.fhwa.dot.gov/environment/ultraurb/3fs5/htm
[n] US DOT FHA Fact Sheet. – Wetlands and Shallow Marsh Systems. Occoquan Watershed Monitoring Laboratories, 1990. http://www.fhwa.dot.gov/environment/ultraurb/3fs5/htm
[o] University of Virginia, 2000, Stormwater Management Research Team.
[p] North Griffin Regional Detention Pond-Wetland Filtration, City of Griffin, Georgia, 2001.
[q] National Pollutant Removal Performance Database for Stormwater Treatment Practices: 1st Edition, http://www.cwp.org
[r] Federal Highway Administration, www.highwayBMP.dfwinfo.com/FHWA_PDF/sand%20filter.pdf. Excerpted from Young, et. Al. Evaluation and Management of Highway Runoff Water Quality
[s] EPA fact sheet 832-F-99-006, http://www.epa.gov
[t] EPA fact sheet 832-F-99-048, http://www.epa.gov
[u] Wetland Vegetation, Dept. of Civil Engineering, University of Virginia.
[v] Rivertech, Inc., Breverd County, Florida, CDS Technologies.
[w] Larry Walker & Associates for Sacramento Stormwater Management Program.
[x] Rivertech, Inc., 13 Monitoring Studies Using Sand Filters.
[y] Delaware Sand Filter BMPs at Airpark, Alexandria, Virginia. www.fwha.dot.gov/environment/ultraurb/5mcs3.htm
[z] EPA fact sheet 832-F-99-019, www.epa.gov
[aa] EPA fact sheet 832-F-99-007, www.epa.gov
[bb] Clayton, R. *Performance of a Proprietary Stormwater Treatment Device – The Storm Ceptor.*
[cc] EPA fact sheet 832-F-99-012, www.epa.gov
[dd] Urban Stormwater Retrofitting Project Fact Sheet – Packed Bed Wetland Filter System, "Stormwater Treatment Train", City of Orlando. www.stormwater-resources.com/Library/ 103BFloridaRetrofits.pdf
[ee] Urban Stormwater Retrofitting Project Fact Sheet – Bath Club Concourse Stormwater Rehabilitation Project, Florida. www.stormwater-resources.com/Library/ 103BFloridaRetrofits.pdf
[ff] North Griffin Regional Detention Pond – Wetlands Filtration. www.forester.net/sw_0106_north.html
[gg] EPA fact sheet 832-F-99-025, www.epa.gov
[hh] Guidance Manual for On-Site Stormwater Quality Control Measures, City of Sacramento. http://www.sactostormwater.org/documents.htm#guide
[ii] Design and Performance of Non-Proprietary Devices for Highway Runoff Litter Removal. http://stormwater.water-programs.com/Papers/PP031.pdf
[jj] Performance of Urban Stormwater Best Management Practices. University of North Carolina. http://www.unc.edu/depts/geog/them/projects/BMP.html
[kk] US DOT FHA Fact Sheet. – Porous Pavements. MWCOG 1983 and Hogland Et. Al. 1987. http://www.fhwa.dot.gov/environment/ultraurb/3fs15/htm
[ll] US DOT FHA Fact Sheet. – Infiltration Basin. Schueler 1987. http://www.fhwa.dot.gov/environment/ultraurb/3fs2/htm


### Definitions of Community and Environmental Factors

Aesthetics: The visual appearance of a BMP. A rating of "best" indicates that the BMP may actually increase the appearance of the area (e.g., by incorporating attractive vegetation or water elements). A "moderate" rating indicates that the BMP does not measurably impact the appearance of the area, while a rating of "worst" indicates that the BMP is physically unattractive.

Habitat: The ability of a BMP to provide habitat for plants and/or animals. A rating of "best" indicates that the BMP may provide new habitat (for example, vegetated swales and constructed wetlands may provide opportunities for plants, birds, and other small animals). A rating of "moderate" indicates that the BMP is neutral: it neither creates nor reduces habitat. A rating of "worst" indicates the BMP replaces natural areas with manmade surfaces unsuitable as habitat.

Relative Cost: A generalized (non-numerical) gage of BMP cost (relative to other BMPs). A rating of "best" suggests the BMP is relatively more cost-effective. "Moderate" indicates the cost of the BMP is average, while "worst" indicates the BMP is more expensive/less cost effective.

Maintenance: The amount of labor and expense required to maintain proper function of the BMP (relative to other BMPs). A rating of "best" indicates that the BMP does not require much maintenance. "Moderate" implies an average amount of maintenance, while "worst indicates the BMP is labor-intensive or otherwise costly to maintain.

Safety: How safe the BMP is, with respect to public health and environmental protection. A rating of "best" means that the BMP poses little, if any, public health or environmental risk. "Moderate" indicates that there may be some risk (e.g., mosquito breeding), while "worst" indicates there are real potential safety risks that must be taken into consideration (e.g., risk of a person falling into a vault or pond).

Water Conservation: The extent to which a BMP helps or hinders water conservation efforts. A rating of "best" indicates that the BMP results in increased water conservation, either by not requiring additional water to function properly or by storing or re-using water (e.g., through enhanced infiltration). A rating of "moderate" is neutral, meaning that the BMP has little effect on water conservation, while a rating of "worst" indicates that the BMP actually requires additional water use.

# SOURCE WATER PROTECTION GUIDELINES

# APPENDIX A

# SUPPLEMENTAL INFORMATION ON PROJECT DESIGN BMPS

This Appendix provides narrative explanations to accompany Decision Guide A: Project Design BMPs. In addition, the Internet links to BMPs provided in this appendix are provided as reference material for the user. Although this appendix supplies a number of possible approaches to designing your project to better manage runoff, the contents do not represent an exhaustive information search. The project applicant is encouraged to further research appropriate water quality management approaches beyond those presented here.

The inclusion of any vendor-supplied BMPs, instruments, equipment, systems, and/or materials does not constitute an endorsement by the San Diego Water Department.

# Decision Guide A – Supporting Information

## PROJECT DESIGN CONSIDERATIONS

The overall objective of project design considerations is to minimize the increase in the project's runoff volume (as compared to pre-development conditions). Reducing the amount of runoff required to be captured and infiltrated and/or treated may be achieved by applying the following design philosophies during the planning and design stage of development:

- Manage Impervious Areas
- Minimize Direct Connection of Impervious Areas
- Incorporate Zero Discharge Areas
- Include Self-Treatment Areas
- Maximize Runoff-Reduction Areas

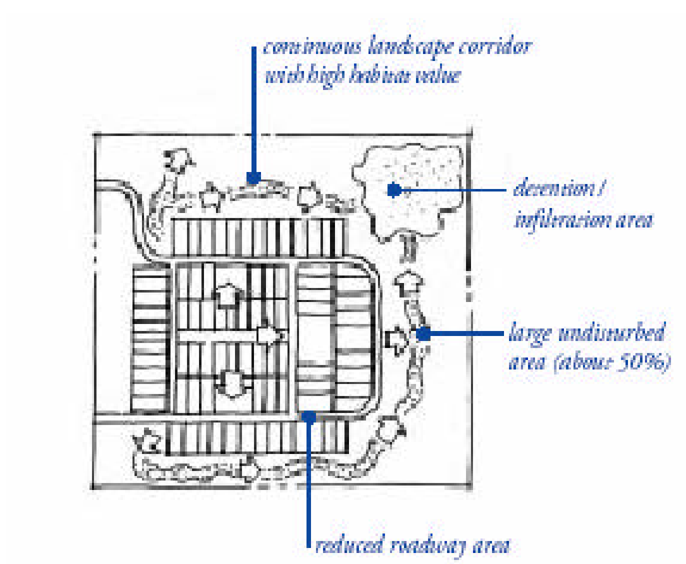
These storm water management techniques are sometimes referred to as low impact development, or LID, practices. An overview of LID practices is presented below.

More detailed information regarding project design considerations and LID may be found on the following websites:

- http://www.lowimpactdevelopment.org
- http://www.ci.san-jose.ca.us/planning/sjplan/counter/stormwater/startatsource.pdf

### *Manage Impervious Areas*

Impervious areas are any surfaces that do not readily absorb water and that impede the natural infiltration of water into the soil. Common examples include roofs, concrete or asphalt streets, driveways, parking areas, sidewalks, patios, and decks. Extensive research by the Center for Watershed Protection has found that increased percentage of paved surfaces and rooftops (or impervious cover) in a watershed results in increased non-point source pollution that degrades the water quality of streams and other water bodies.




Source: http://www.scvurppp-w2k.com/basmaa_satsm.htm

Management strategies for minimizing the total amount of impervious surface in a new development include:

- Setting aside open space and sensitive resource areas
- Considering designs that minimize land conversion (e.g., clustering)
- Limiting road widths, parking lot and driveway areas spaces
- Using permeable materials for surfaces such as bicycle paths, parking spaces, pedestrian areas

### *Minimize Direct Connection of Impervious Areas*

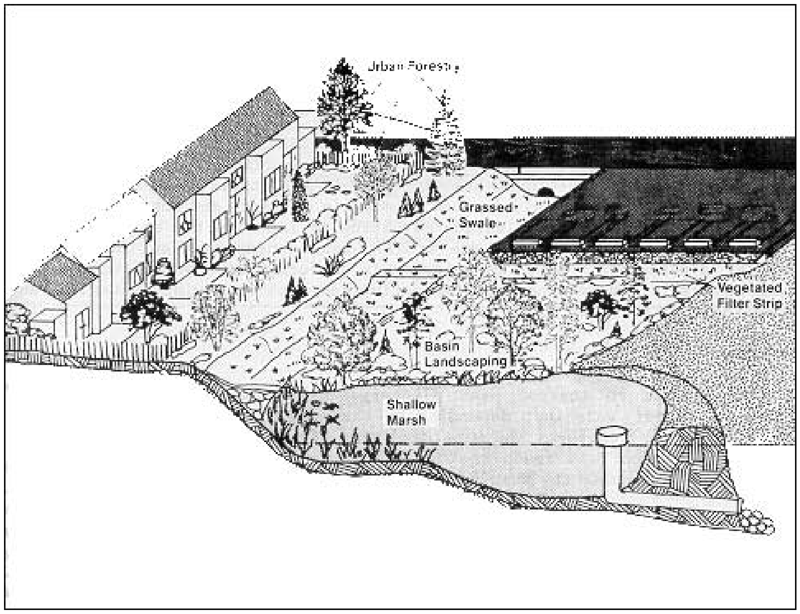
Any impervious surface that drains into a catch basin, area drain, or other conveyance structure is a "directly connected impervious area" (DCIA). Directly connected impervious areas (DCIA) are the impervious areas such as roofs and paving that drain directly to the street drainage system in an urban area. As storm water runoff flows across parking lots, roadways, and paved areas, the oils, metals, sediments, and other pollutants are picked up in the flow. In addition, the volume and velocity of the flow tend to increase, requiring larger capacity storm drain systems, and increasing flood and erosion potential. Minimization of DCIAs is considered to be one of the most effective methods of storm water quality and discharge control available. The benefits of reducing DCIAs include reduced storm water peak discharge rates and volumes, improved water quality by increased filtration through vegetation and reduced erosion, and enhanced groundwater recharge by maximizing infiltration.

Source: http://www.ecocreto.com/default2.htm

Strategies for minimizing DCIAs focus on limiting overall impervious surface coverage and/or directing runoff from impervious areas to pervious areas for infiltration, retention/detention, or filtration. This can be achieved using strategies such as:

- Taller, narrower buildings rather than lower spreading ones
- Sod or vegetative "green roofs" rather than conventional roofing materials
- Pervious pavement for light duty roads, parking lots and pathways
- Vegetated swales
- Vegetated basins (ephemeral- seasonally wet)
- Constructed ponds and lakes (permanent- always wet)
- Crushed stone reservoir base rock under pavements or in sumps
- Cisterns and tanks to capture roof drainage

- Infiltration basins
- Drainage trenches
- Dry wells

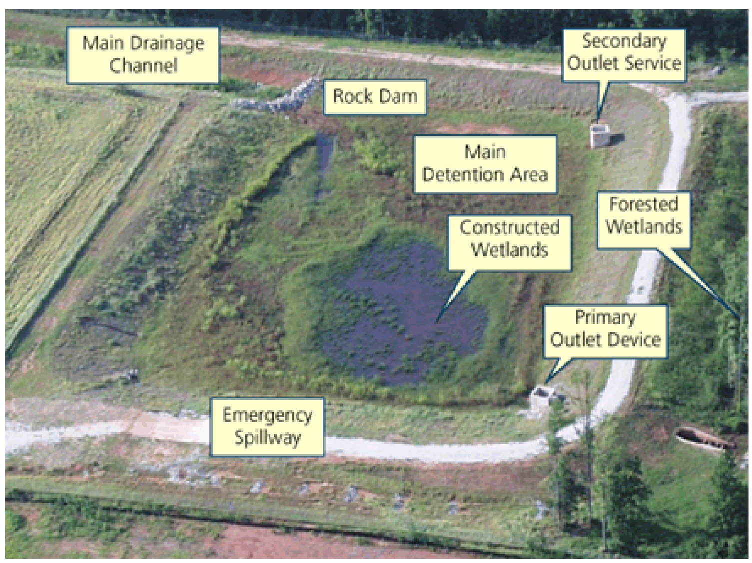



Source: http://www.cmhc-schl.gc.ca/en/imquaf/himu/wacon/images/Image9.jpg)

Unlike conveyance storm drain systems that convey water beneath the surface and work independently of surface topography, a drainage system for storm water infiltration can work with natural landforms and land uses to become a major design element of a site plan. Solutions that reduce DCIA prevent runoff, detain or retain surface water, attenuate peak runoff rates, benefit water quality and convey storm water. Site plans that apply storm water management techniques use the natural topography to suggest the drainage system, pathway alignments, optimum locations for parks and play areas, and the most advantageous locations for building sites. In this way, the natural landforms help to generate an aesthetically pleasing urban form integrated with the natural features of the site.

### *Incorporate Zero-Discharge Areas*

An area within a development or redevelopment project can be designed to completely infiltrate or retain the volume of runoff requiring treatment from that area. In such a case, the term “zero discharge” applies at storm water treatment design storm volumes.




Source: http://www.forester.net/sw_0106_north.html

“Zero discharge” areas such as wet ponds, retention ponds, and infiltration areas can be designed to provide treatment over and above the storm volume captured and infiltrated. For example, after a wet pond area has captured its required storm volume, additional storm volume may be treated via settling prior to discharge from the pond. In this case, the "zero discharge" area converts automatically into a treatment device for runoff from other areas, providing settling for storm volumes beyond treatment requirements. Another example is a grassy infiltration area that converts into a treatment swale after infiltrating its area-required treatment volume. The grassy infiltration area in this example becomes a treatment swale for another area within the development.

Site design strategies for zero-discharge areas include:

- Retention/Detention Pondshttp://www.ecocreto.com/default2.htm
- Wet Ponds
- Infiltration Areas
- Large Fountains
- Retention Rooftops
- Green roofs

Infiltration areas, ponds, fountains, and green/blue roofs can provide "dual use" functionality as storm water retention measures and development amenities. Retention ponds and infiltration areas can double as playing fields or parks. Wet ponds and infiltration areas can serve dual roles when meeting landscaping requirements, such as creating habitat, creating active or passive recreation, and improving aesthetics.

***Include Self-Treatment Areas***

Developed areas may provide "self-treatment" of runoff if they are properly designed and drained. Self-treating site design strategies include:

- Conserved Natural Spaces
- Large Landscaped Areas (including parks and lawns)
- Grass/Vegetated Swales
- Turf Block Paving Areas

Example of Turf Block
Source: http://www.nscc.govt.nz/Waterinfo/stormwater/swenviro-f.htm

The infiltration and bio-treatment inherent to such areas provides the treatment control necessary. These areas therefore act as their own BMP, and no additional BMPs to treat runoff should be required. Site drainage designs must direct runoff from self-treating areas away from other areas of the site that require treatment of runoff. Otherwise, the volume from the self-treating area will only add to the volume requiring treatment from the impervious area. Likewise under this philosophy, self-treating areas receiving runoff from treatment-required areas would no longer be considered self-treating, but rather would be considered as the BMP in place to treat that runoff. These areas could remain as self-treating, or partially self-treating areas, if adequately sized to handle the excess runoff addition.

***Maximize Runoff-Reduction Areas***

Using alternative surfaces with a lower runoff coefficient helps reduce runoff from developed areas. The runoff coefficient is a representation of a surface's ability to produce runoff. Surfaces that produce higher volumes of runoff are represented by higher runoff coefficients, such as paved surfaces. Surfaces that produce smaller volumes of runoff are represented by lower runoff coefficients, such as landscaped areas. See Appendix B for the various runoff coefficients in San Diego County. By incorporating more pervious, lower runoff coefficient surfaces into a development, lower volumes of runoff are produced. Lower volumes and rates of runoff translate directly to lower treatment requirements and smaller size treatment control facilities.

Site design strategies may be used to reduce the runoff coefficient of a developed area, reducing the amount of runoff requiring treatment, including:

- Pervious Concrete
- Pervious Asphalt
- Turf Block
- Brick (un-grouted)
- Natural Stone
- Concrete Unit Pavers
- Crushed Aggregate
- Cobbles
- Wood Mulch

Example of Porous Paving
Source: http://www.nscc.govt.nz/Waterinfo/stormwater/swenviro-f.htm

Other site design techniques such as disconnecting impervious areas, preservation of natural areas, and designing concave medians may be used to reduce the overall runoff coefficient of new development sites.

# SOURCE WATER PROTECTION GUIDELINES

# APPENDIX B

# SUPPLEMENTAL INFORMATION ON SOURCE CONTROL BMPS

This Appendix provides narrative explanations to accompany Decision Guide B: Source Control BMPs.  In addition, the Internet links to BMPs provided in this appendix are provided as reference material for the user. Although this appendix supplies a number of possible approaches to designing your project to better manage runoff, the contents do not represent an exhaustive information search. The project applicant is encouraged to further research appropriate water quality management approaches beyond those presented here.

The inclusion of any vendor-supplied BMPs, instruments, equipment, systems, and/or materials does not constitute an endorsement by the San Diego Water Department.

# Decision Guide B – Supporting Information

## SOURCE CONTROL BMPS

***The overall objective of source controls is to minimize the exposure and introduction of pollutants in urban runoff (storm water and dry-weather runoff).***

### *Prevent Runoff Contact*

The best source control is to keep runoff from contacting pollutants in the first place. Strategies for preventing contact between runoff and potential pollutants include: proper containment measures, spill prevention and cleanup, waste reduction, public education, illegal dumping controls, and illicit connection controls. These methods, which can result in significant water quality benefits, prevent pollutants from coming into contact with storm water and dry-weather runoff in a cost effective manner.

Example of Secondary Containment
Source:
http://www.interstateproducts.com/fuel_containment.htm

Secondary containment is a means of surrounding storage containers to collect chemicals or other fluids that may be released in the event a spill or leak. Examples of secondary containment include dikes or berms, curbing, drainage systems, or sumps. Berms and curbing create a physical barrier between the chemical storage area and a possible runoff area. Drainage systems and sumps provide a means of collecting and transporting runoff or spills to a more appropriate site.

Another method of preventing runoff from outside storage areas from entering the storm water collection system is to prevent rain from entering the storage area. Overhead coverages and roofs serve this purpose. Permanent structures such as galvanized metal roofs or temporary tents are examples of overhead structures.

### *Minimize Sources of Potential Pollutants*

Alternatives currently exist for most products including chemical fertilizers, pesticides, cleaning solutions, janitorial chemicals, automotive and paint products, and consumables (batteries, fluorescent lamps). The use of these alternatives is encouraged as a pollution prevention measure.

Key to the prevention of all environmental degradation and pollution is promoting efficient and safe housekeeping practices (storage, use, and cleanup), while responsibly managing potentially harmful materials like fertilizers, pesticides, cleaning solutions, paint products, automotive products, and swimming pool chemicals.

### *Minimize Dry-Weather Flows*

Dry-weather flows are discharges of runoff that originate from sources other than storm events. They may include natural sources such as springs, but in urbanized areas they often result from human activities such as excessive irrigation, car washing, and hosing off of pavement. These flows often contain high concentrations of pollutants such as nutrients (from lawn fertilizers), detergents (from car washing), and organics (e.g., pesticide). Some strategies for minimizing dry weather flows include:

- Installing automatic shutoff valves on irrigation systems
- Planting drought-tolerant plants that require less water (e.g., native plants)
- Directing car wash water onto vegetated areas where it can infiltrate, or collect and re-use it

Drought Tolerant
Concha California Lilac
Source: http://www.bewaterwise.com/gardensoft/plant_description.aspx?PlantID=1368

# SOURCE WATER PROTECTION GUIDELINES

# APPENDIX C

# SUPPLEMENTAL INFORMATION ON TREATMENT CONTROL BMPS

This Appendix provides narrative explanations to accompany Decision Guide C: Treatment Control BMPs. In addition, the Internet links to BMPs provided in this appendix are provided as reference material for the user. Although this appendix supplies a number of possible approaches to designing your project to better treat runoff, the contents do not represent an exhaustive information search. The project applicant is encouraged to further research appropriate water quality management approaches beyond those presented here.

The inclusion of any vendor-supplied BMPs, instruments, equipment, systems, and/or materials does not constitute an endorsement by the San Diego Water Department.

Be aware that most structural BMPs or other control devices that are used to divert, treat, or store storm water runoff may require some degree of engineering design or understanding for proper implementation, operation, and maintenance.

Refer to the Treatment BMP Technologies Matrix presented earlier for the applicability and typical uses of the structural BMPs referenced.

# Decision Guide C & Treatment BMP Effectiveness Matrix – Supporting Information

## FILTRATION SYSTEMS

Media filtration devices usually consist of a settling basin as a pretreatment component of the BMP to all gross pollutant capture and heavy-sediment settling before filtration through a filter. Sand filters are usually two-chambered stormwater treatment practices; the first chamber is for settling, and the second is a filter bed filled with sand or another filtering media. As stormwater flows into the first chamber, large particles settle out, and the finer particles and other pollutants are removed as stormwater flows through filtering media. There are several modifications of the basic sand filter design, including the Austin or surface sand filter, underground sand filter, Delaware or perimeter sand filter, organic media filter, and the Multi-Chamber Treatment Train (MCTT). All of these filtering practices operate on the same basic principle. Designers need to carefully consider conditions at the site level before using a sand or organic filter, and should incorporate design features to improve the longevity and performance, as well as minimizing their maintenance burden (http://www.stormwatercenter.net).

### *Sand Filters*

Types of Sand Filters:

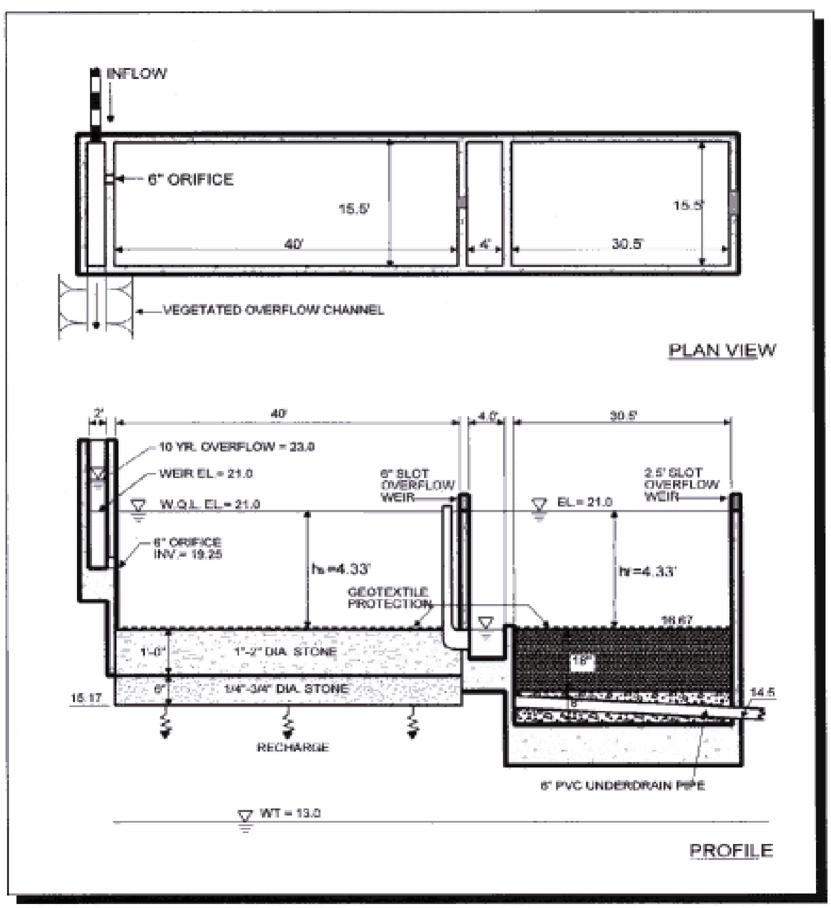
Austin – Field research done in Austin, Texas found that sand filters have a removal efficiency of suspended solids that is comparable to wet ponds and extended detention.

Delaware – For small catchments of a few acres, the underground "linear" filter used in Delaware is suitable.

Washington, D.C. This underground design accepts concentrated flow and utilizes a wet vault or water quality inlet as the pretreatment device.

Sources of Information:
http://www.cabmphandbooks.com/Documents/Development/TC-6.pdf

http://www.stormwatercenter.net

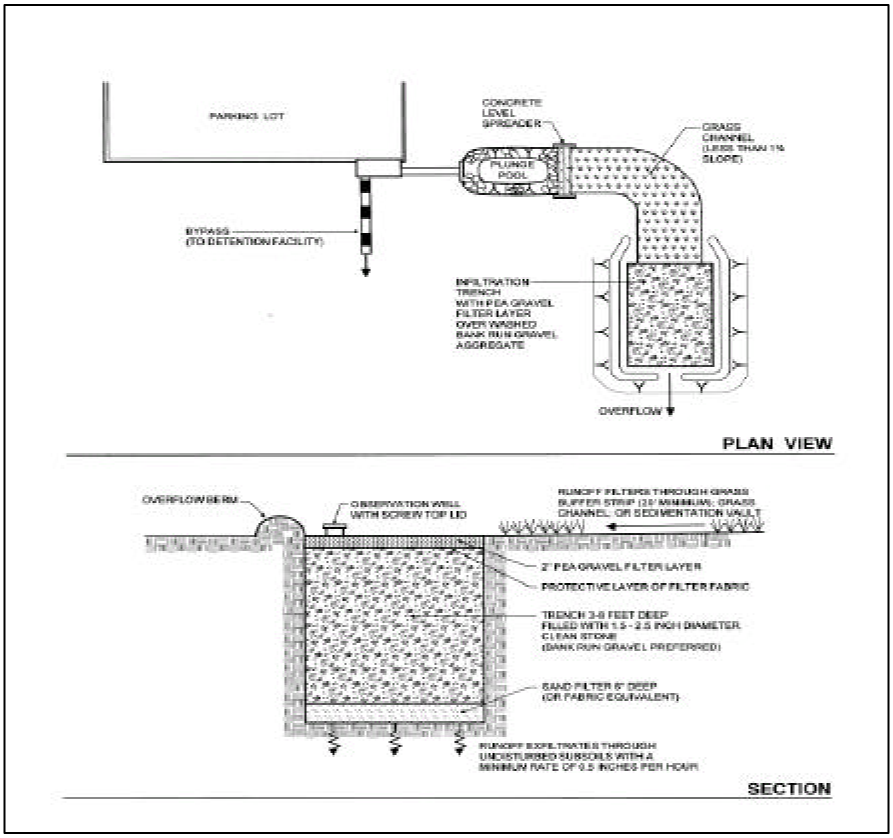


## INFILTRATION SYSTEMS

BMPs that use infiltration properties require careful consideration when proposing candidate sites for implementation. These BMPs, which may rely on the filtering properties of gravel-filled trenches or vaults, wide grassy buffer strips, catchment basins, porous pavement, dry wells, and concrete grids must ultimately consider subsurface soils geology for percolation. In clay-rich soils, these BMPs perform less effectively than in areas where fast-draining, sandy soils reside. However, the infiltration of pollutant-laden runoff into subsurface soils can threaten groundwater quality in areas where the groundwater table is shallow. There are also strict regulations governing the siting of these types of units, the types of flow they can accept and treat, and design characteristics.

### *Infiltration Trench*

An infiltration trench is a long, narrow, rock-filled trench with no outlet that receives storm water runoff. Runoff is stored in the void space between the stones and infiltrates through the bottom and into the soil matrix. Infiltration trenches perform well for removal of fine sediment and associated pollutants. Pretreatment using buffer strips, swales, or detention basins is important for limiting amounts of coarse sediment entering the trench which can clog and render the trench ineffective.

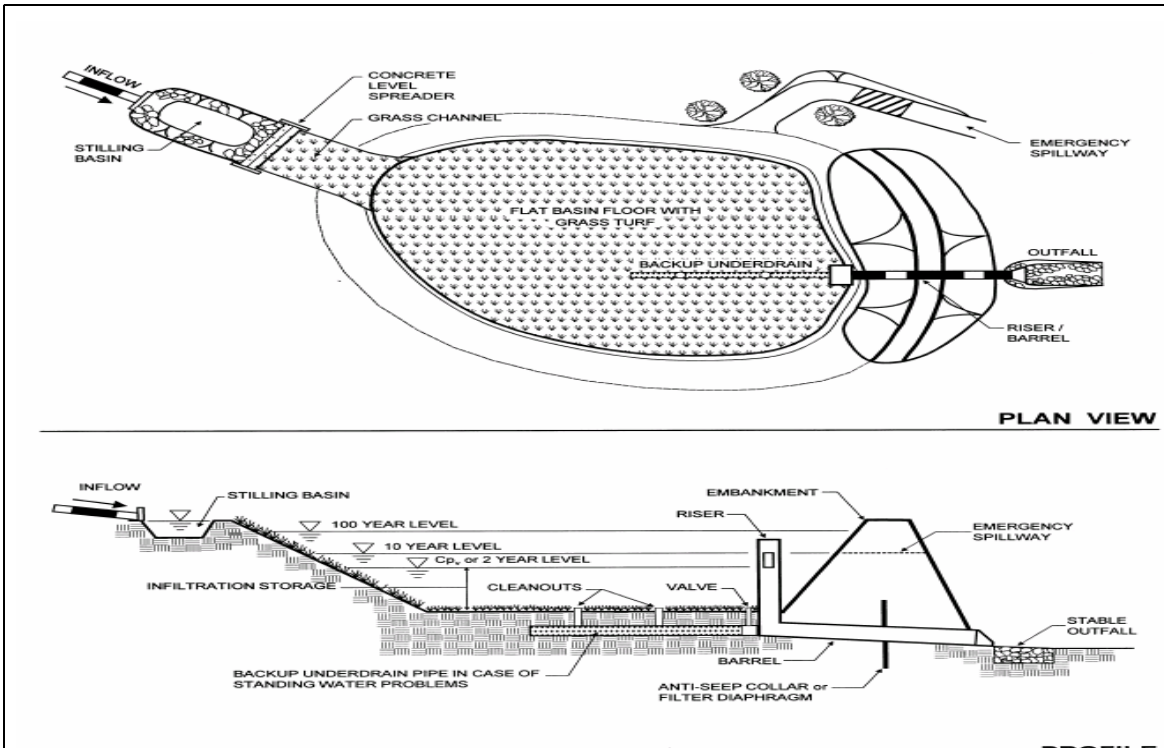



Sources of Information:
http://www.cabmphandbooks.com/Documents/Development/TC-10.pdf
www.stormwatercenter.net

## Infiltration Basin

An infiltration basin is a shallow impoundment that is designed to infiltrate storm water. Infiltration basins use the natural filtering ability of the soil to remove pollutants in storm water runoff. Infiltration facilities store runoff until it gradually exfiltrates through the soil and eventually into the water table. This practice has high pollutant removal efficiency and can also help recharge groundwater, thus helping to maintain low flows in stream systems. Infiltration basins can be challenging to apply on many sites, however, because of soils requirements. In addition, some studies have shown relatively high failure rates relative to other BMPs.

Sources of Information:
http://www.stormwatercenter.net
http://cabmphandbooks.com



## Porous Pavement

A substitute for conventional pavement designed to increase infiltration and minimize surface runoff. There are two basic designs of porous pavement , as follows:

Composed of asphalt or concrete which lacks the finer sediment found in conventional cement. This mixture is usually laid over a thick base of granular material.

Formed with modular, interlocking open-cell cement blocks placed over a base of coarse gravel. A geo-textile fabric placed under the gravel prevents the migration of soil upward into the gravel bed.

Use of porous pavement requires permeable soils with a deep water table. Traffic must be restricted to exclude heavy vehicles. It is not recommended for areas that are expecting high levels of sediment input and use of chemicals.

Sources of Information:
http://www.cabmphandbooks.com/Documents/Development/SD-20.pdf
http://h2osparc.wq.ncsu.edu/estuary/rec/urbstorm.html

## DETENTION/SETTLING SYSTEMS

### *Extended Detention Basins*

Dry extended detention basins are dry between storms. The basin fills during a storm, and a bottom outlet releases the stormwater slowly to give time for sediments to settle. Extended detention basins and vaults can work well in California because they do not require a dry-weather base flow to maintain water levels, such as wet ponds and constructed wetlands.

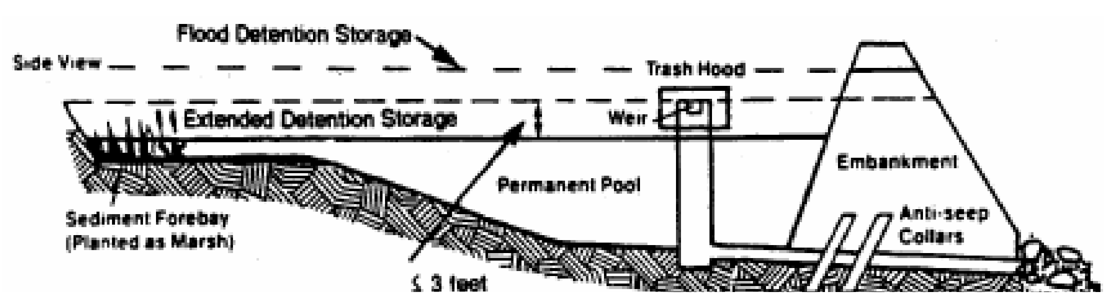
Sources of Information:
http://cabmphandbooks.com
http://www.udfcd.org/fhn2001/cover.htm

A wet extended detention basin combines the pollutant removal effectiveness of a permanent pool of water with the flow reduction capabilities of an extended storage volume. Wet extended detention ponds require careful planning in order to function correctly.

Sources of Information:

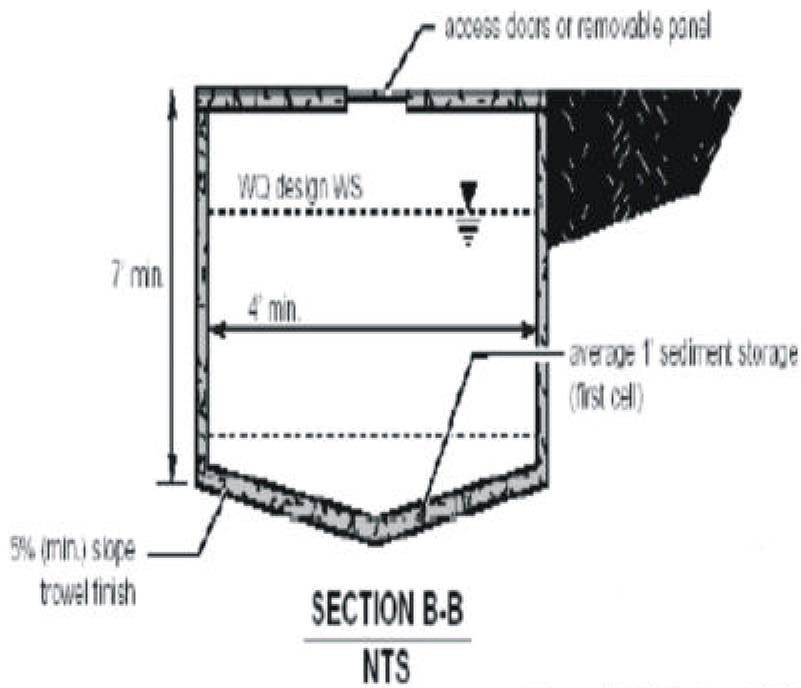
http://www.deq.state.id.us/water/stormwater_catalog/doc_bmp47.asp

http://www.ci.gresham.or.us/departments/des/stormwater/kmhpdfs/Section_4.pdf



### *Wet Vault/Tank/Underground Detention*

A wet vault is a vault with a permanent water pool, generally 3 to 5 feet deep. The vault may also have a constricted outlet that causes a temporary rise of the water level (i.e., extended detention) during each storm. This live volume generally drains within 12 to 48 hours after the end of each storm. Wet vaults can't provide the equivalent level of treatment accomplished by wet ponds because neither biological uptake nor vegetative filtration are available as pollutant removal mechanisms; however, re-use of storm water runoff for landscaping purposes does provide a beneficial nutrient treatment mechanism. As wet vaults are underground, they can be more difficult to inspect and maintain.




Source: 1998 King County Water Quality Manual

Sources of Information:
http://cabmphandbooks.com
http://www.ci.gresham.or.us/departments/des/stormwater/kmhpdfs/Section_4.pdf
http://www.deq.state.id.us/

## BIOFILTRATION SYSTEMS

### *Constructed Wetlands*

Constructed wetlands are built expressly for treating stormwater runoff. They are not meant to be mitigation for the loss of natural wetlands. For constructed wetlands, a considerable percentage of the land is covered by wetland vegetation. The simplest form of a constructed wetland is comprised of a rectangular basin with a forebay and wetland vegetation area.

Sources of Information:
http://www.cabmphandbooks.com
http://www.epa.gov/owow/wetlands/construc/martinez/12marsh.html

### Biofilters

Biofilters are of two different types: swale and strip. A swale is a vegetated channel that treats concentrated flow. It is comparable to but wider than a ditch, and is sized only to convey flow. A strip treats sheet flow and is placed parallel to the contributing surface. It is placed along the pavement edge.

Sources of Information:
http://cabmphandbooks.com

### Bioretention

The bioretention best management practice (BMP) functions as a soil and plant-based filtration device that removes pollutants through a variety of physical, biological, and chemical treatment processes. These facilities normally consist of a grass buffer strip, sand bed, ponding area, organic layer or mulch layer, planting soil, and plants. The runoff's velocity is reduced by passing over or through buffer strip and subsequently distributed evenly along a ponding area. Exfiltration of the stored water in the bioretention area planting soil into the underlying occurs over a period of days.

Source of Information:
http://cabmphandbooks.com

***Vegetated/Grass Swale***

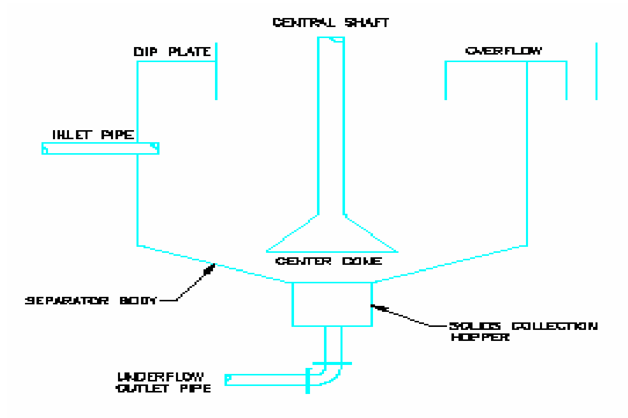
Vegetated swales are open, shallow channels with vegetation covering the side slopes and bottom that collect and slowly convey runoff flow to downstream discharge points. They are designed to treat runoff through filtering by the vegetation in the channel, filtering through a subsoil matrix, and/or infiltration into the underlying soils. Swales can be natural or manmade. They trap particulate pollutants (suspended solids and trace metals), promote infiltration, and reduce the flow velocity of stormwater runoff. Vegetated swales can serve as part of a storm water drainage system and can replace curbs, gutters and storm sewer systems.

Sources of Information:
http://cabmphandbooks.com

## MISCELLANEOUS BMPS

### *Vortex-Type Separators*

These units utilize hydrodynamic forces for separating solids and floatable material. When water enters the unit on a tangential plane, a circular flow pattern is established by the cylindrical shape of the unit, creating a vortex (tornado-like flow). The flow at the outer edge of the tank moves at a higher velocity than the flow in the center, and thus is more turbulent. As the flow spirals inward and upward the velocity slows down and becomes more stable. In general, the vortex flow tends to move denser material downward in the center, whereas floatables rise towards the surface on the outside of the flow.




Sources of Information:
http://www.wrc.org.za
http://cabmphandbooks.com
http://www.epa.gov/owm/mtb/hydro.pdf

### *Multi-Chambered Treatment Trains (MCTTs)*

The MCTT was primarily developed for treating stormwater at significant source areas with limited space (i.e., vehicle service facilities, parking areas, and fueling stations). The MCTT utilizes three treatment mechanisms in three different chambers. The initial chamber is a catch basin, which functions primarily as a screening process for the other two chambers. The settling chamber is the primary treatment area for removing settleable solids and associated constituents. Sorbent pads can also remove oil and grease. The media filter chamber is for final polishing of the effluent using a combination of sorption and ion exchange.

Sources of Information:

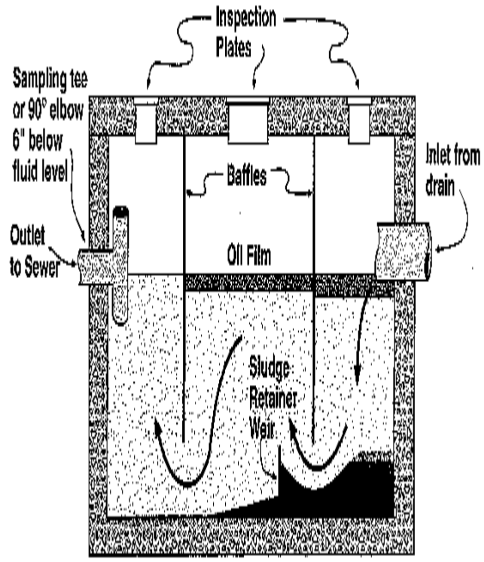
http://www.dot.ca.gov/hq/env/stormwater/ongoing/pilot_studies/bmps/details/mctt/rec/urbstorm.html

## *Oil/Water Separators*

Oil/water separators are mechanical devices produced by various industrial equipment manufacturers. These devices use various mechanisms to separate oil from stormwater, which is then discharged to a treatment plant or to receiving water. Oil-water separators typically call for support from the manufacturer and are best used where they can be properly maintained and frequently inspected, such as at industrial sites.

Another type of oil and grease removal device is the oil and grease trap catch basin (or oil and grit separator). These underground devices are used to remove oils, grease, other floating substances and sediment from stormwater before the pollutants can enter the storm sewer system. They are typically placed in such a way that they catch the oil and fuel that leak from automobiles and trucks in parking lots, service stations, and loading areas.

A third type of device is a simple skimmer and control structure used at the outlet of a sediment basin (forebay), frequently used prior to discharge into a larger detention device.




Sources of Information:
http://h2osparc.wq.ncsu.edu/estuary/rec/urbstorm.html

http://dnr.metrokc.gov/wlr/indwaste/oilfact.htm

### *Gross Solids Removal Devices (GSRDs)*

Litter capture devices designed to remove litter and vegetative debris (otherwise known as 'gross pollutants' and 'gross solids') from stormwater discharge. Different types of GSRDs include linear radial, baffle boxes, and inclined screens. The image on the right is known as a linear radial GSRD.

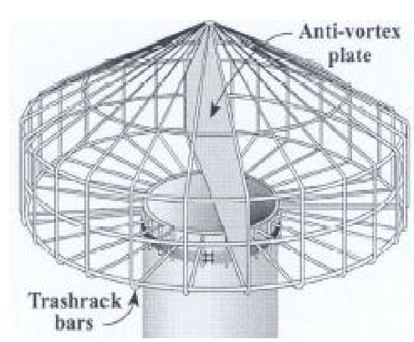
Sources of Information:
http://www.dot.ca.gov/hq/env/stormwater/workshop/online_presentations/12_01/pdfs/berger.pdf

### *Screens and Trash Racks*

Screens and trash racks are made of a series of horizontal and vertical bars or wires that catch floatables while letting water pass through the openings between the bars or wires.

Sources of Information:

http://www.in.gov/dnr/water/dam_levee/inspection_man/pdf/Part4-FactSheets/03-13DesignandMaintOfTrashRacks.pdf



### Nets

Two types of netting are typically used in capturing floatables: in-line netting, and floating units.

In-line netting can be mounted at strategic locations throughout the combined sewer system (CSS). The nets are installed in underground concrete vaults that hold one or more nylon mesh bags and a metal frame and guide system to support the nets. The nylon mesh bags are changed after every storm event.

Floating units are made up of an in-water containment area that channels CSO flow through a series of large nylon mesh nets.. The nets are for single use and are discarded after an overflow.

Sources of Information:

http://www.epa.gov/region1/assistance/ceitts/stormwater/techs/trashtrap.html

### Booms

Booms are containment systems that employ specially fabricated flotation devices with suspended curtains made to capture buoyant materials. They can also be designed with oils and grease in mind. Booms are usually anchored to a shoreline structure and they can be located downstream of one or more outfalls. They are sized according to the expected volume of floatables that occur during a storm event.

Sources of Information:
http://www.epa.gov

http://www.stormwater.com

# APPENDIX D

# SUPPLEMENTAL INFORMATION ON PRE-TREATMENT & POST-TREATMENT BMPS

This Appendix provides narrative explanations to accompany Decision Guide D: Pre-Treatment and Post-Treatment BMPs. Although this appendix supplies a number of possible approaches to designing your project to better manage and treat runoff, the contents do not represent an exhaustive information search. The project applicant is encouraged to further research appropriate water quality management approaches beyond those presented here.

The inclusion of any vendor-supplied BMPs, instruments, equipment, systems, and/or materials does not constitute an endorsement by the San Diego Water Department.

# Decision Guide D – Supporting Information

On-site controls, or SUSMPs, are required regardless of the location of the project, environmental effectiveness, availability of land for treatment, environmental sensitivity, or costs. Moreover, on-site controls may work in certain situations, but they are not uniformly effective, especially in treating many toxic pollutants restricted by TMDLs. In some cases, regional storm water facilities, which use infiltration, wetlands or "treatment trains," employing several mechanisms in a series to remove pollutants may offer more effective, reliable solutions (BC/CICWQ 2003).

## TREATMENT-TRAIN SYSTEMS

A treatment train, or multiple treatment system, uses two or more BMPs (such as a swale, detention basin, or an infiltration basin) in series or by stacking vertically.

Some series systems that have been used are:

**Extended detention basin - sand filter.** A settling basin should be used in order to evade excessive maintenance on the sand filter.

**Detention basin - sand filter - wetland.** These BMPs are used for settling, filtration, and absorption.

**Wet pond – wetland.** If an unusually high loading of sediment is probable, a full size wet pond, rather than just a forebay in the wetland, could be the answer in reducing the sediment reaching the wetland, where it is more expensive to remove.

**Biofilter** – **wet pond.** Used often in order to enhance reliability.

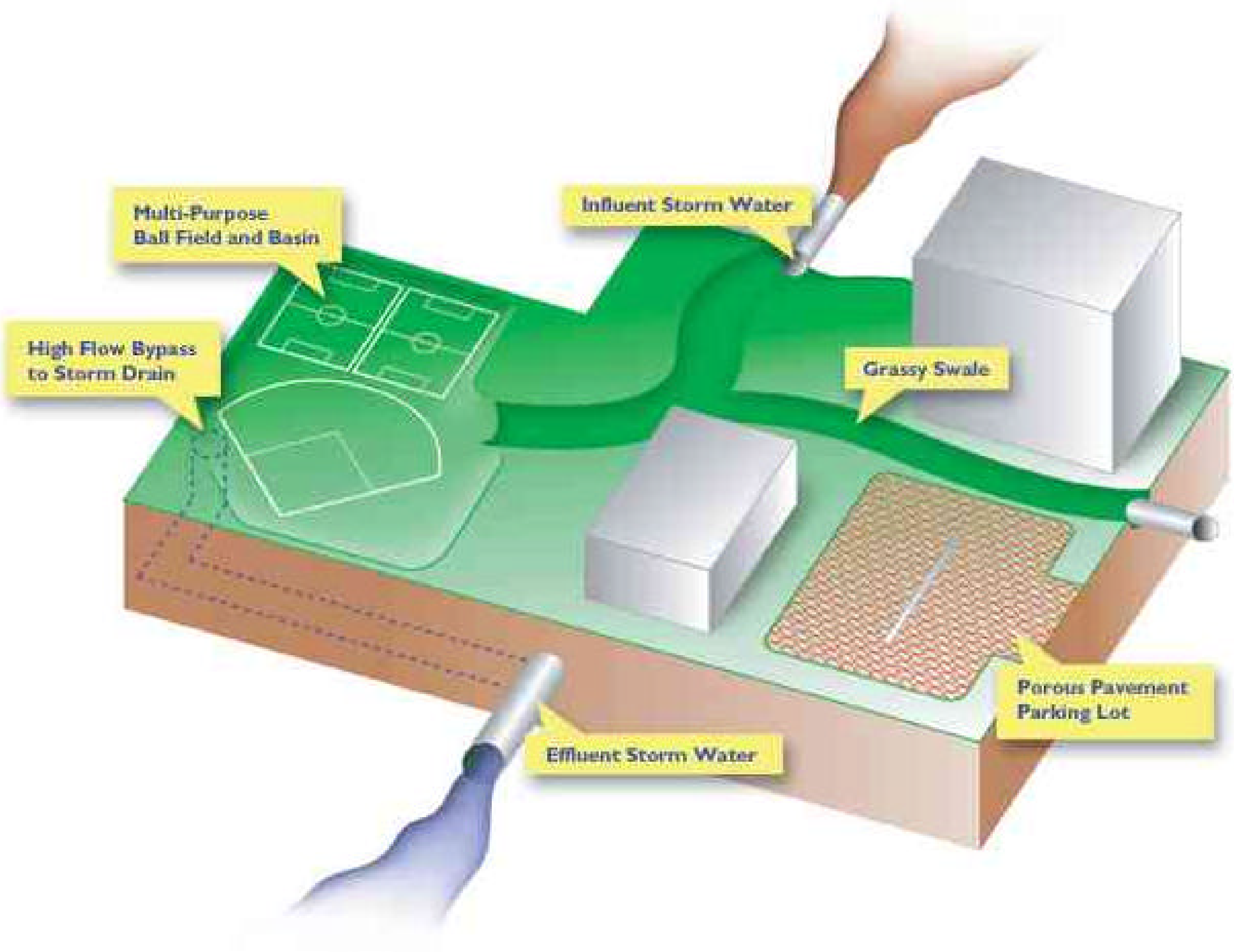
**Biofilter** – **infiltration trench**. The storm water is treated before it enters the infiltration system.

**Oil/water separator** – **wetland or biofilter.** The vegetated treatment system is protected against high concentrations of oil through the oil/water separator.

Examples of vertically stacked systems are:

**Extended detention above wet pond.** This treatment train is recommended because of the ambiguous performance of wet ponds.

**Wet pond above sand filter.** This treatment train is used due to the clogging of the sand filter by settleable solids.




Example of Multi-Purpose Regional BMP System

Source of Information:

BC/CICWQ 2003

# SOURCE WATER PROTECTION GUIDELINES

# APPENDIX E

# BMP MAINTENANCE CONSIDERATIONS

When considering BMPs for implementation, carefully consider the expected maintenance that would be required. General maintenance requirements of BMPs are summarized in Table E-1 below.

***Table E-1. Example Maintenance Requirements of Selected BMPs***

| BMP | Maintenance |
|---|---|
| Wet Detention Basins/Ponds | Inspect after the first rain event during the first few months after construction, and annually thereafter. Inspect, clean, and remove litter and floating materials after each rain event. Provide supplement water supply during dry season. Inspect condition of aquatic life, if any. |
| Vegetated Swales and Strips | Trim vegetation regularly to avoid woody growth and increase of vegetation density. Excessive vegetation may hinder infiltration. |
| Dry Ponds | Inspect regularly during rain season and remove trash, litter, debris, and other solid materials that hinder infiltration. Re-vegetate any eroded areas. |
| Infiltration Trenches | Inspect infiltration trench surface if evidence of clogging exists. Clear and remove litter and debris from the trench surface after each rain event. If an observation well is installed, measure groundwater depth before and after rain season. |

| BMP | Maintenance |
| --- | --- |
| Catch Basin Inserts | Inspect before rain season starts, remove trash and debris, inspect filter media and replace before start of rain season or as necessary. Service or replace defective system parts. Inspect after the first rain event and perform similar steps as above. After rain season, remove trash, debris, or oil accumulation from the insert manifold. |
| Media Filtration | Replace filter media/material at the beginning of rain season or as necessary when saturated with pollutants. |
| Vortex Type Separators | Inspect system for clogging before rain season starts and remove trash, debris, and other solids. Service or replace defective system parts. Inspect after the first rain event and perform similar steps as above. After rain season, remove trash, debris, or oil accumulation from the system. |

An additional maintenance issue that is common to all BMPs that store storm water is vector control. Vector control seeks to monitor small animals and insects that spread disease. The primary vectors of interest for storm water BMPs are mosquitoes. Mosquitoes transmit diseases such as malaria and West Nile virus, requiring water to complete there life cycles. Vector controls for storm water BMPs include inspecting sites, sampling the mosquito population present, and possibly applying environmentally benign pesticides. Often the local health department or vector control district will implement the control measures on a fee basis. The additional cost of the inspections should be taken into consideration when selecting a BMP.

Additional maintenance information can be found in Section 6 of the New Development and Redevelopment volume of the California Stormwater BMP Handbook (www.cabmphandbooks.com).

# APPENDIX F

# RUNOFF ESTIMATES METHODOLOGIES AND BMP SIZING CRITERIA

Estimates of storm water runoff are needed to size and design facilities for two purposes: 1) to safely capture, detain, and convey storm water flows (i.e., drainage quantity or flood control considerations); and 2) to provide treatment through the application of various structural Best Management Practices (i.e., urban runoff quality considerations). Runoff estimates for quantity considerations generally focus on peak runoff flows to ensure effective flood control, while BMP sizing criteria focus on capturing and treating a certain proportion of the total annual flow volume or certain flow rates.

A brief overview of existing and recommended methodologies for runoff estimates is presented below for both quantity (drainage) and quality (BMP sizing) criteria. The purpose of this section is to summarize the methodologies that are already being applied within the San Diego Water Department source water watersheds and to support greater consistency in the future among the relevant jurisdictions, but also flexibility to encourage more innovative approaches to improve water quality.

**Drainage Design Criteria - Quantity**

Numerous existing engineering methodologies are widely applied for the design of drainage facilities to control quantities of storm water runoff. Several drainage design guidance documents apply within the jurisdictions of the City of San Diego, the City of Chula Vista, the City of Escondido, and the County of San Diego, including the following.

- City of San Diego Municipal Code Land Development Manual, Storm Water Standards – A Manual for Construction & Permanent Storm Water Best Management Practices Requirements, Revised May 30, 2003.
- San Diego County Hydrology Manual, County of San Diego Department of Public Works Flood Control Section, August 2003.

- City of Chula Vista Subdivision Manual, General Design Criteria, Section 3-200, Hydrology/Drainage/Urban Runoff, July 1, 2002.
- City of Escondido Design Standards for the Design of Public Work Improvements, June 23, 1999 (Resolution 99-123).

The San Diego County Hydrology Manual provides particularly extensive and detailed guidance on runoff estimate methodologies.

Traditionally, drainage facilities for new developments have been required to provide on-site detention such that post-development flow rates for a given design storm size do not exceed pre-development flow rates out of the area to be developed. Within the study area, design storms have been defined as the 100-year frequency event for major drainage areas (e.g., over one square mile) and the 50-year frequency event for smaller tributary areas.

**Rational Method.** A number of methods are available to estimate peak runoff flow rates to size drainage facilities, as referenced in the documents for each jurisdiction listed above. In general, the rational method equation is the simplest approach, and can be applied to estimate peak runoff as follows.

$$Q = CIA$$

Where:

- Q = peak runoff flow (cubic feet per second)
- C = runoff coefficient, or proportion of rainfall that runs off the surface (no units)
- I = rainfall intensity (inches/hour)
    - Calculated as the rainfall intensity for a duration equal to the time of concentration for the area, or the time required for storm water runoff to flow from the most remote part of the watershed to the outlet point under consideration
    - Calculated as a function of the design storm size (e.g., 100-year or 50-year event) and generally for the 6-hour precipitation duration
- A = drainage basin area (acres)

Note – the unit conversion coefficient for this equation is negligible.

**Other Methods.** More complicated methods to estimate peak runoff are also available and may be appropriate for larger, more complex watersheds. For example, continuous simulation methods have been shown to be more accurate in determining capture volumes and peak runoff rates, which can be over-estimated using simpler methods (Stormwater Management Manual for Eastern Washington, Washington Department of Ecology, June, 2003).

**BMP Design Criteria – Quality**

Design criteria for water quality BMPs vary, depending on the design approach and objectives. Within the study area, the San Diego County storm water permit provides the primary guidance for BMP sizing criteria. The permit includes specific numeric sizing criteria for standard urban storm water management plans (SUSMPs) to address storm water quality from new development and re-development areas (San Diego County Municipal Stormwater Permit, February 21, 2001). The SUSMP sizing criteria from the permit have also been reflected in the Model SUSMP and the City of San Diego Land Development Manual Storm Water Standards (Revised May 30, 2003).

The San Diego County permit provides several sizing criteria options for volume-based BMPs (e.g., detention/retention ponds or other types of facilities that provide storage), and for flow-based BMPs (e.g., swales, filters, or other types of facilities that provide no storage). The SUSMP-related sizing requirements specify levels of treatment, as a function of the quantity or portion of storm water runoff to be captured and treated, rather than as a function of treated water quality concentration. In other words, the SUSMPs are not designed to meet specific water quality objectives or numeric targets, but are rather technology-based requirements. The SUSMPs also focus on wet-weather discharges and do not particularly address dry-weather flows.

**Volume-based criteria.** The county permit requires that volume-based BMPs be sized to mitigate the volume of runoff from the 24-hour $85^{th}$ percentile storm event (approximated by the 0.6 inch storm event for the San Diego area). Another means can also be applied, based on unit storage volume, to ensure the capture and treatment of 90% of the total annual runoff volume.

**Flow-based criteria.** The county permit generally requires that flow-based BMPs be sized to mitigate the maximum flow rate from a rainfall intensity of 0.2-inch rainfall. This can also be approximated as the $85^{th}$ percentile hourly rainfall intensity multiplied by a factor of two. Documents such as the ASCE Manual of Practice and California Stormwater Best Management Practices Handbook are also referenced by the county permit for more details on runoff estimate methodologies.

**Equivalent criteria.** The county permit also allows for "any equivalent method" to calculate the volume of flow to be mitigated or numeric sizing criteria, given approval of the San Diego Regional Water Quality Control Board.

**Runoff Coefficients**

One important runoff estimate factor that varies considerably among the various jurisdictions is the runoff coefficient. As summarized in Table 1 below, the jurisdictions use different land use considerations to determine runoff coefficients (e.g., impervious area, categories of development and/or slope and vegetation conditions).

***Table F-1. Summary of Land Use Considerations Used to Determine Runoff Coefficients in San Diego County Jurisdictions***

| Runoff Coefficient | San Diego County (see note below) | | City of Chula Vista | City of Escondido |
|---|---|---|---|---|
| | % Impervious | Land Use | | |
| 0.25 | 0 | Permanent Open Space | | Open space, parks, golf courses, cemeteries |
| 0.30 | 0-10 | Low residential (max 1.0 DU/A) | Parks, golf courses | |
| 0.35 | 10-20 | Low residential (max 2.0 DU/A) | Farm land | |
| 0.40 | 20-25 | Low residential (max 2.9 DU/A) | | |
| 0.45 | 25-30 | Low-Medium residential (max 4.3 DU/A) | Vegetated slopes, flat | Rural, over ½-acre lots Undeveloped land |
| 0.50 | 30-40 | Medium residential (max 7.3 DU/A) | Vegetated slopes, rolling | |
| 0.55 | 40-45 | Medium residential (max 10.9 DU/A) | Vegetated slopes, hilly –or- Suburban property (RE) | Single family |
| 0.60 | 45-50 | Medium residential (max 14.5 DU/A) | Vegetated slopes, steep | |
| 0.65 | 55-60 | | Barren slopes, flat -or- Normal residential (R1) | Mobile home |
| 0.70 | 65-70 | High residential (max 24.0 DU/A) | Barren slopes, rolling | Multiple units |
| 0.75 | 75-80 | High residential (max 43.0 DU/A) Neighborhood commercial | Barren slopes, hilly -or- Dense residential (R2, R3) | |
| 0.80 | 85 | General commercial | Barren slopes, steep | |
| 0.85 | 90 | Office professional/ commercial | Commercial area | Commercial |
| 0.90 | 90-95 | Limited industrial | Paved surface | |
| 0.95 | 95 | General industrial | | Industrial |

Notes:

For the purposes of this summary, representative conditions are presented for San Diego County, combining four categories of soil types .

The City of San Diego Storm Water Standards do not recommend specific runoff coefficients, but rather refer to the County Hydrology Manual.

**Accounting for effective impervious area**. In determining the runoff coefficient for a proposed development, the Water Department recommends considering effective impervious area, rather than relying on standard assumptions about runoff coefficients for various types or densities of development. Effective impervious area reflects only the impervious portion of the site that is directly connected to the storm sewer system and discounts areas that are not directly connected (e.g., roofs that drain to infiltrate on-site versus being transported off-site). The runoff coefficient for a basin should also be a weighted, or composite value, made up of the many different runoff coefficients for sub-areas of the basin, using the following equation.

$$\frac{CA = C_1A_1 + C_2A_2 + C_2A_2 + C_nA_n}{n}$$

Where:

$C_n$ = runoff coefficient for a given sub-area

A = area for given sub-area

n = number of different runoff coefficients considered

**Encouraging Low Impact Development.** The City of San Diego Water Department encourages the use of Low Impact Development (LID), as sustainable source control measures to limit adverse impacts of urban runoff on water quality by reducing runoff flows from new development. Such low impact development alternatives, are based on managing rainfall where it falls through enhancing infiltration and/or routing impervious runoff across pervious areas to allow for infiltration. To encourage source control techniques like low impact development, the Water Department recommends that effective impervious area be evaluated on a site-specific basis to determine runoff coefficients.

For example, if there were a medium density residential area that has applied LID techniques and can achieve lower effective impervious area than a standard assumed value of 40% or 45% (see Table F-1), then the developer should be able to calculate site-specific, effective impervious area and the associated runoff coefficient. The County of San Diego Drainage Design Manual could be used as a guide, while it presents runoff coefficients for various percent impervious levels. Allowing for site-specific effective runoff coefficients will provide incentive for developers to apply LID, as it can allow them to save costs by supporting the use of lower runoff coefficients and smaller size drainage facilities and BMPs.

**Recommended Approaches**

For the purposes of these Source Water Protection Guidelines for New Development, the San Diego Water Department recommends the use of consistent methodologies for estimating peak runoff flows and volumes to size treatment BMPs, where possible. The Water Department also recommends flexibility for equivalent methods to reflect site-specific conditions and to encourage more innovative approaches like low impact development and regional, multi-use treatment facilities. Composite runoff coefficients should be calculated to reflect effective impervious area, wherever possible, to encourage minimization of directly connected impervious areas, thus reducing runoff from new development areas.

Given that the SUSMP requirements are currently applied consistently throughout the county, the Water Department recommends that the numeric sizing criteria in the SUSMP continue to be applied as a default. However, on a site-specific basis, jurisdictional agencies may want to require more specific sizing criteria to achieve specific discharge quality objectives, especially where total maximum daily loads (TMDLs) might be required to improve the quality of impaired waters. The Water Department also encourages consideration of regional facilities, versus the on-site approach generally dictated by SUSMPs. Such regional approaches are allowed by the Localized Equivalent Area Drainage or LEAD approach, outlined in the County of San Diego's model SUSMP, and can provide greater water quality benefits, while also supporting other uses such as recreation and habitat.

# SOURCE WATER PROTECTION GUIDELINES

# APPENDIX G

# REFERENCES AND ACKNOWLEDGEMENTS

### Additional References


California Stormwater Quality Association Stormwater Best Management Practice Handbooks, www.cabmphandbooks.com, January 2003.

Caltrans, Proposed Final Report: BMP Retrofit Pilot Program, California Department of Transportation Report CTSW-RT-01-050, Sacramento, CA 2002.

City of Chula Vista Subdivision Manual, General Design Criteria, Section 3-200, Hydrology/Drainage/Urban Runoff, July 1, 2002.

City of Escondido Design Standards for the Design of Public Work Improvements, June 23, 1999 (Resolution 99-123).

City of San Diego Municipal Code Land Development Manual, Storm Water Standards – A Manual for Construction & Permanent Storm Water Best Management Practices Requirements, Revised May 30, 2003.

Pollutants of Concern Technical Memorandum, Brown and Caldwell, 2003.

Regional Solutions for Treating Stormwater in Los Angeles County: A Macrofeasibility Study, Brown and Caldwell/Construction Coalition on Water Quality, April 2003.

San Diego County Hydrology Manual, County of San Diego Department of Public Works Flood Control Section, August 2003.

San Diego County Municipal Stormwater Permit, February 21, 2001.

Stormwater Management Manual for Eastern Washington, Washington Department of Ecology, June 2003.

Water Quality Control Plan for San Diego Basin (Basin Plan), RWQCB – San Diego Region, September 1994.


### Acknowledgements


The project team for the Source Water Protection met monthly in order to discuss project activities. The members of the project team included:

- Marc Beutel (Brown and Caldwell)
- Bob Collins (City of San Diego Water Department)
- Arlene Dea Deeley (City of San Diego Water Department)
- Rick Fox (City of San Diego Water Department)
- Nancy Gardiner (Brown and Caldwell)
- Dan Herlihy (UltraSystems)
- Tedi Jackson (City of San Diego Water Department)
- Jesus Meda (City of San Diego Water Department)
- Lewis Michaelson (Katz and Associates)
- Monica Munoz (City of San Diego Water Department)
- Jeff Pasek (City of San Diego Water Department)
- Cindy Paulson (Brown and Caldwell)
- Rashee Rohatgi (Katz and Associates)
- Lisa Skutecki (Brown and Caldwell)
- Mike White (Conservation Biology Institute)

A Technical Advisory Committee (TAC), with representatives from key stakeholder groups, was formed to advise the Source Water Protection Guidelines project team. The TAC provided sustained, in-depth and insightful recommendations for the development of appropriate and effective Guidelines. The involvement and dedication of the TAC members also helped ensure that all potential types of users were considered throughout the development of the Guidelines to meet the team's objective of creating a user-friendly tool.

The City of San Diego Water Department and other members of the project team would like to thank TAC members for their invaluable support in the development of the Source Water Protection Guidelines. The following individuals comprised the TAC:

- Tom Adler (City of Chula Vista)
- Tom Brammell (Ramona Metropolitan Water District)
- Lombardo DeTrinidad (City of Chula Vista)
- Cheryl Filar (City of Escondido)
- Paul Gebert (San Diego County Water Authority)
- Liz Giffen (County of San Diego – Watershed)
- Troy Murphee (Sweetwater Authority)
- Jeff Murphy (County of San Diego - Watershed)
- David Noah (Santa Fe Irrigation District)
- John Ryan (Santa Fe Irrigation District and R.E. Badger Filtration Plant)
- Tory Walker (Hunsaker and Associates)
- Richard Wright (San Diego State University)

BROWN AND CALDWELL

. . . . . *Engineering for Success*