TULE WIND PROJECT

MAJOR USE PERMIT

STORM WATER MANAGEMENT PLAN

County of San Diego

(MUP 09-019)

Prepared for:

Iberdrola Renewables, Inc.
1125 NW Couch Street, Suite 700
Portland, Oregon

Prepared by:

HDR Engineering, Inc.
8690 Balboa Avenue, Suite 200
San Diego, California 92123
858-712-8400

November 2010

Appendices

Tables

Figures

EXECUTIVE SUMMARY

The purpose of this Storm Water Management Plan (SWMP) is to investigate Best Management Practices (BMPs) for the Tule Wind Project (Project). This report is intended to accompany and support the Major SWMP form from Appendix C of the San Diego County Standard Urban Storm Water Mitigation Plan (SUSMP) in support of a Major Use Permit (MUP) submittal. The following documents and guidelines apply to the water quality for the Project:

- Clean Water Act of 1977 Section 311 and 402, United States Code Title 33 Section 1342, Code of Federal Regulations Title 40 Parts 123-136;
- California Porter-Cologne Water Quality Control Act 1998, California Water Code Section 13000-14957, Division 7;
- California State Water Resources Control Board National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated With Construction and Land Disturbance Activities, Order No. 2009-0009-DWQ (General Construction Permit);
- San Diego County Standard Urban Storm Water Mitigation Plan (SUSMP), March 25, 2010,
- County of San Diego Watershed Protection, Storm Water Management and Discharge Control Ordinance (County Ordinance 9589),
- County of San Diego Stormwater Standards Manual,
- California Regional Water Quality Control Board San Diego Region Order No. R9-2007-0001, NPDES No. CAS0108758.

Project development is outside of the Phase I NPDES permit for the County of San Diego, so General Construction Permit criteria will control analysis and implementation of BMPs. However, since the Project is within the County of San Diego (County) and is required to be reviewed by the County this SWMP will address the County SUSMP requirements. Based on these governing documents the following items are included in the SWMP:

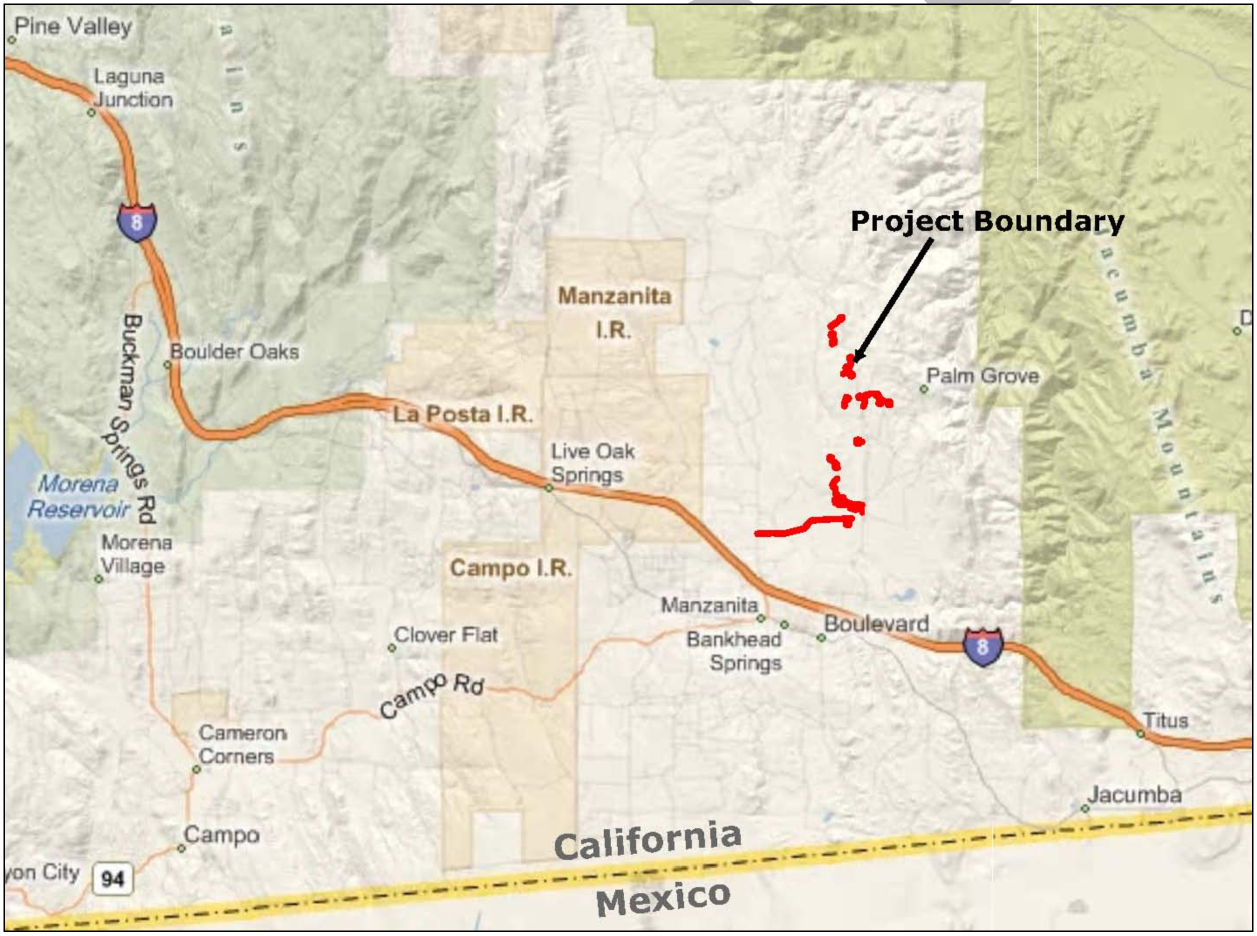
- Project description and vicinity map,
- Site map defining drainage patterns, existing storm drain systems, proposed drainage crossings, soil types, existing land types, and existing and proposed slopes,
- Identification of Pollutants of Concern,
- Identification of Conditions of Concern,
- Identification of Site Design BMP recommendations,
- Preliminary Hydromodification analysis and discussion,
- Identification of Source Control BMPs,
- BMPs for Individual Priority Project Categories,
- Identification of Treatment Control BMP recommendations, and
- Storm Water BMP maintenance discussion.

Water quality investigations completed for the currently applicable regulations identified limited potential impacts to water quality resulting from Project development. Minimal impervious areas are included with Project development and a number of site design and source control BMPs will be implemented to mitigate any potential impacts. Additionally, post construction BMPs will be implemented per the new General Construction Permit to address treatment BMP and hydromodification concerns. A full operation and maintenance plan will be developed during final engineering to identify procedures to maintain performance of the Project BMPs. Mitigation measures will be implemented to the maximum extent practicable and operated and maintained by the developer.

1.0 PROJECT DESCRIPTION

The Tule Wind Project proposes to develop a wind turbine “farm” for power generation, in the County of San Diego in the State of California. Portions of the Project discussed in this report are limited to areas on private property within the County of San Diego. A majority of the overall Project will be developed on Bureau of Land Management (BLM) Federal land, outside the County of San Diego Planning Department jurisdiction. Total Project site area proposed on County of San Diego regulated lands is approximately 1,982 acres, which will permanently impact approximately 77 acres. Total disturbed areas, including temporary construction impacts (widened access roads, trenching, etc), are approximately 127 acres. From a water quality standpoint, all analysis and design addresses permanent impacts only, as additional temporary impacts will be returned to a naturally vegetated state upon completion of the Project. The Project is located just north of Interstate 8 east of Ribbonwood Road, approximately two and half miles northeast of the community of Boulevard, California. Given the rural nature of the Project area, only the western side of the site is bounded by a physical feature, Ribbonwood Road.

Figure 1. Vicinity Map



Under existing conditions the Project site is mainly undeveloped naturally vegetated rocky hills. A number of existing access roads traverse the area, providing service routes to existing utility facilities, commercial facilities, rural houses, agricultural facilities, and a landing strip. Existing topography is fairly steep with some flatter drainage courses at the base of some of the hills and gullies. Naturally occurring native vegetation is predominant throughout the site, with periodic scattered unvegetated rock outcroppings.

Development to be completed on private County of San Diego property will consist of 13 wind turbines, turbine pads, access roads, 5-acre collector substation site, 5-acre operation and maintenance building site, collector power lines, and the associated revegetation and transformer pads. Turbines are approximately 320-feet to 500-feet tall with a 48-foot diameter concrete foundation. Concrete foundations slope away from the centrally located turbine and will be buried greater than half a foot, so that exposed concrete foundations are approximately 6-inches to 8-inches thick and 18-feet to 20-feet in diameter. Turbines also include five-foot by nine-foot concrete pads for transformer foundations. Graded dirt pads around the turbines will be approximately 400-feet in diameter.

Access roads between turbines will be 36-feet wide to accommodate self propelled cranes and supply trucks, while access roads to the turbine strings will only need to be 24-feet wide, as the crane and other assembly equipment can be brought onsite in pieces. Thirty-six foot access roads between turbines are intended to be temporary for construction activities and will be allowed to revegetate to a 24-foot width, pending construction completion. Proposed access road alignments will follow existing access roads to the maximum extent practicable to limit the amount of additional disturbed areas. New access roads will follow existing contours to maximum extent practicable to limit the amount of disturbed areas resulting from grading cuts. Appendix A contains preliminary details for Project features.

Operation and maintenance facility pads and substation pads will be graded to allow for construction of the required facilities and the accompanying access and operation spaces. Impervious areas associated with these facilities will be minimal, limited to the structures themselves. All access and parking areas will be constructed of permeable materials. Additionally, there is the potential for detention basins attached to these graded pads, in order to adequately address water quality concerns. A number of operation and maintenance facility alternative locations were considered in Project development (See Exhibit B for operation and maintenance facility locations). All alternatives are included in analysis to conservatively account for multiple configurations.

Electrical collector lines for the Project will be a combination of overhead and buried, with a majority being buried. Overhead collector lines will supported by single steel or wood poles; typically 60-feet to 80-feet in height. Foundation footprints for collector line poles will be similar to the diameter of the pole itself. Collector line disturbed widths are assumed to be 24-feet to allow construction vehicle access and trenching or pole erection. Natural vegetation surrounding the turbine pads, access roads, and any power poles will be established after construction. Buried collector lines will be completely revegetated after construction.

Analysis of the Project water quality is limited to the permanent impact areas, as temporary impacts will be returned to naturally vegetated conditions after construction. Project development will increase impervious areas by a very small amount. Each turbine pad represents approximately 360 square feet of impermeable area in addition to the footprints of the operation and maintenance pad and substation pads. Overall Project development proposes to increase impervious area by approximately 23,669 square feet (0.7% of the 77 acres of permanently disturbed area) or .003% of the total basin area.

1.1 PROJECT REQUIREMENTS

A Stormwater Intake Form for Development Projects was completed for the Project and is included in Appendix B. Based on the checklist Tule Wind Project is considered a priority project and is required to adhere to Major SWMP requirements. A completed Major SWMP form is included in Appendix C. Priority project criteria are outlined in the SUSMP Priority Development Project matrix as shown in Table 1. Since the Project will develop more than 5,000 square feet of hillside and will create light industrial facilities, development will require site design, source control, priority project BMPs, and treatment control BMPs, to be discussed in Sections 4, 5, 6, and 7, respectively.

Table 1. Priority Development Project Matrix

Yes	No	A	Housing subdivisions of 10 or more dwelling units. Examples: single-family homes, multi-family homes, condominiums, and apartments.
☐	☑		
Yes	No	B	Commercial—greater than one acre. Any development other than heavy industry or residential. Examples: hospitals; laboratories and other medical facilities; educational institutions; recreational facilities; municipal facilities; commercial nurseries; multi-apartment buildings; car wash facilities; mini-malls and other business complexes; shopping malls; hotels; office buildings; public warehouses; automotive dealerships; airfields; and other light industrial facilities.
☑	☐		
Yes	No	C	Heavy industry—greater than one acre. Examples: manufacturing plants, food processing plants, metal working facilities, printing plants, and fleet storage areas (bus, truck, etc.).
☐	☑		
Yes	No	D	Automotive repair shops. A facility categorized in any one of Standard Industrial Classification (SIC) codes 5013, 5014, 5541, 7532-7534, or 7536-7539.
☐	☑		
Yes	No	E	Restaurants. Any facility that sells prepared foods and drinks for consumption, including stationary lunch counters and refreshment stands selling prepared foods and drinks for immediate consumption (SIC code 5812), where the land area for development is greater than 5,000 square feet. Restaurants where land development is less than 5,000 square feet shall meet all SUSMP requirements except for structural treatment BMP and numeric sizing criteria requirements and hydromodification requirements.
☐	☑		
Yes	No	F	Hillside development greater than 5,000 square feet. Any development that creates 5,000 square feet of impervious surface and is located in an area with known erosive soil conditions, where the development will grade on any natural slope that is twenty-five percent or greater.
☑	☐		
Yes	No	G	Environmentally Sensitive Areas (ESAs). All development located within or directly adjacent to or discharging directly to an ESA (where discharges from the development or redevelopment will enter receiving waters within the ESA), which either creates 2,500 square feet of impervious surface on a proposed project site or increases the area of imperviousness of a proposed project site to 10% or more of its naturally occurring condition. "Directly adjacent" means situated within 200 feet of the ESA. "Discharging directly to" means outflow from a drainage conveyance system that is composed entirely of flows from the subject development or redevelopment site, and not commingled with flows from adjacent lands.
☐	☑		
Yes	No	H	Parking lots 5,000 square feet or more or with 15 or more parking spaces and potentially exposed to urban runoff.
☐	☑		
Yes	No	I	Street, roads, highways, and freeways. Any paved surface that is 5,000 square feet or greater used for the transportation of automobiles, trucks, motorcycles, and other vehicles.
☐	☑		
Yes	No	J	Retail Gasoline Outlets (RGOs) that are: (a) 5,000 square feet or more or (b) a projected Average Daily Traffic (ADT) of 100 or more vehicles per day.
☐	☑		

2.0 POLLUTANTS OF CONCERN

Under existing conditions pollutants generated by the Project site include sediments, oil and grease. Based on the County of San Diego SUSMP anticipated pollutants for hillside developments and commercial developments are sediment, nutrients, organic compounds, oil & grease, trash and debris, oxygen demanding substances, bacteria and viruses, and pesticides. Table 2 outlines the pollutants of concern as shown in the County of San Diego SUSMP. However, based on the minimal amount of development that is proposed anticipated pollutants are more likely sediment from dirt roads and pads, and oil and grease from the roads and turbines.

Table 2. Anticipated and Potential Pollutants Generated by Land Use Type.

	General Pollutant Categories								
Priority Project Categories	Sediments	Nutrients	Heavy Metals	Organic Compounds	Trash & Debris	Oxygen Demanding Substances	Oil & Grease	Bacteria & Viruses	Pesticides
Detached Residential Development	X	X			X	X	X	X	X
Attached Residential Development	X	X			X	P(1)	P(2)	P(1)	X
Commercial Development >1 Acre	P(1)	P(1)		P(2)	X	P(5)	X	P(3)	P(5)
Heavy industry/industrial development	X		X	X	X	X	X		
Automotive Repair Shop			X	X(4)(5)	X		X		
Restaurants					X	X	X	X	
Hillside Development >5,000 ft^2	X	X			X	X	X		X
Parking Lots	P(1)	P(1)	X		X	P(1)	X		P(1)
Retail Gasoline Outlets			X	X	X	X	X		
Streets, Highways & Freeways	X	P(1)	X	X(4)	X	P(5)	X		

X = anticipated
P = potential
(1) A potential pollutant if landscaping exists on-site.
(2) A potential pollutant if the project includes uncovered parking areas.
(3) A potential pollutant if land use involves food or animal waste products.
(4) Including petroleum hydrocarbons.
(5) Including solvents.

2.1 RECEIVING WATERS

A number of existing streams will convey flows generated by the Project. A majority of the Project drains to Tule Creek via McCain Valley and Lark Canyon. These flows are conveyed into Tule Lake which discharges into Tule Canyon, then Carrizo Wash in Carrizo Gorge. A northern eastern portion of the Project drains into Carrizo Wash through Rodando and Palm Grove. Carrizo Wash continues in a northerly direction to a junction with an unnamed wash that drains the northern most part of the Project. Finally, all flows are conveyed north into Carrizo Creek, into San Felipe Creek, and finally into the Salton Sea. The Salton Sea is a minimum of approximately 45 miles downstream of the Project. See Figure 2 below.

Based on the Project location and the existing conditions, there are no dry weather flows for drainages associated with this Project. There are minimal existing rural developments within the Project drainage basins that would generate flows during dry weather. Frequent site visits during the dry season confirmed that no flows were present in drainages associated with the Project.
All Project areas, Tule Creek, McCain Valley, Lark Canyon, Tule Lake, and Carrizo Creek are located in the McCain hydrologic sub-area in the Jacumba hydrologic area in the Anza Borrego watershed, defined by hydrologic unit number 722.71. Carrizo Creek drains through the Carrizo hydrologic sub-area in the Agua Caliente hydrologic area (722.61) where it confluences with San Felipe Creek in the Ocotillo Lower Felipe hydrologic area (722.20).

Based on the 303(d) list approved by the United States Environmental Protection Agency (USEPA) in 2006, only the Salton Sea is listed for nutrients, salinity, and selenium. Pollutant sources are identified as agricultural, major industrial, point source, or out of state.

Currently there are no Region 9 State Water Resources Control Board special requirements for any water bodies that will be impacted by this Project. Based on the available information there are no High Risk Areas within the Project limits.

Comparison of the anticipated pollutants and the receiving water bodies' impairments indicates there are no primary pollutants of concern. Secondary pollutants of concern are sediment and oil and grease.

HDR
ONE COMPANY | *Many Solutions*℠

Receiving Waters

FIGURE 2

424914 - Iberdrola Renewables | 115965 - Tule Wind Energy

3.0 CONDITIONS OF CONCERN

A CEQA Drainage Study dated September 2010 was completed by HDR under a separate cover and discusses the existing and proposed drainage patterns for the Project. A review of this drainage summary is presented below.

3.1 EXISTING DRAINAGE PATTERNS

Project areas are drained by three major drainage basins:

1. Tule Creek Basin – 18,250 acres
2. Southern Unnamed Wash Basin – 486 acres
3. Eastern Unnamed Wash Basin – 734 acres

Tule Creek drains the majority of the Project site to the southeast into Tule Lake. Tule Lake empties into Carrizo Wash, which ultimately discharges into the Salton Sea. Two small northwestern portions of the Project site are drained by two unnamed tributaries to Carrizo Wash. The southern of the two unnamed washes discharges into Carrizo Wash 2.4 miles upstream of the eastern unnamed wash and approximately 10 miles downstream of Tule Lake. Site visits identified existing stream locations and access road crossings. Refer to Exhibit A for an existing conditions drainage map.

All basins have similar drainage patterns. Runoff sheet flows across the ground surface until it encounters rivulets which then discharge into larger streams which ultimately discharge into Tule Creek or Carrizo Wash. Precipitation that falls on typical access roads sheet flows off the side of the roads where it is either collected in swales running parallel to the road or continues to sheet flow across the natural terrain. Swales carry runoff to streams crossing the access road, where they are then conveyed to major drainage features.

There are no major improvements to the drainage features within the basin. However, a number of culverts have been installed on portions of the Tule Creek Basin to facilitate the construction of access roads across the smaller drainage features. An unnamed tributary to Tule Creek along the northeastern edge of the Tule Creek Basin crosses a number of public and private roads via culverts just east of the landing strip. Several access roads utilize a depressed on grade type crossing, where flows are conveyed across the top of the road, rather than constructing culverts to carry flows under the road.

3.2 PROPOSED DRAINAGE PATTERNS

Proposed Project improvements will mimic existing drainage patterns and will minimize redirection of any flows. Improvements include graded pads, access roads, and utility lines, and constructed crossings at each drainage feature.

Tule Creek Basin has an access road running east-west between Ribbonwood Road and McCain Valley Road which will cross approximately six drainages, two of which are larger streams. Drainage of access roads will be completed by brow ditches/swales parallel to proposed roads, which will convey flows to existing surface drainage features. Project development within the southern unnamed wash basin does not propose any crossing of existing surface drainage features. Access roads located within the eastern unnamed wash basin will cross approximately nine drainages, one of which is the main drainage channel for the basin.

Precipitation falling on the turbine pads will sheet flow off the proposed features and finished surfaces to brow ditches/swales that will collect runoff. Runoff will then be directed to the existing natural surface drainage features, with flow patterns intended to mimic existing conditions.

Proposed electrical collector lines will be located mainly in the northeastern corner of the Project. Any impacts on drainage patterns from collector lines will only be prevalent during construction. Once the collector lines are either hung or buried the surrounding vegetation and grades will be restored to existing conditions to the greatest extent practicable. Proposed drainage patterns are illustrated on Exhibit B.

A complete discussion of the Project drainage is completed in the report CEQA Drainage Study, dated September 2010, published under a separate cover by HDR.

3.3 HYDROMODIFICATION

Based on the County of San Diego Major Storm Water Management Plan form this Project is required to complete a Hydromodification Plan (HMP). However, discussions with the County of San Diego Department of Public Works concluded the Project is outside of the Phase I NPDES permit jurisdiction and as such will not be required to complete a hydromodification analysis for the County. General Construction Permit post-construction BMPs are intended to address hydromodification for areas outside of Phase I and Phase II NPDES permits, which will apply to the Project. These post-construction BMP requirements will go into effect September 2012, and are expected to evolve over the upcoming implementation period. As the criteria currently stand, the Project will be required to complete a Water Balance Calculator summary to identify increases in flows of concern. Mitigation measures are included in the Water Balance Calculator and will be used to address any impacts from Project development on the watersheds. Given the preliminary level of planning and the undetermined direction of the General Construction Permit post-construction BMPs, Project design will account for these requirements throughout the planning and permitting process. Revisions to the SWMP during final engineering will clearly identify any needed mitigation features for the Project.

4.0 SITE DESIGN BMPS

LID and site design strategies outlined in the County of San Diego Storm Water Management Plan Form are presented below. Site design BMPs listed below are all those listed on the County of San Diego Storm Water Management Plan Form, however some may not apply given the limited amount of development proposed. Since the Project is in the preliminary stages of planning, site design BMPs could change as planning progresses.

1. Conserve natural areas, soils, and vegetation
    - Preserve well draining soils (Type A or B);
    - Preserve significant trees;
    - Preserve critical (or problematic) areas such as floodplains, steep slopes, wetlands, and areas with erosive or unstable soils.
2. Minimize disturbance to natural drainages
    - Set-back development envelope from drainages;
    - Restrict heavy construction equipment access to planned green/open space areas.
3. Minimize and disconnect impervious surfaces (see 5)
    - Clustered lot design;
    - Items checked in 5.
4. Minimize soil compaction
    - Restrict heavy construction equipment access to planned green/open space areas;
    - Re-till soils compacted by construction vehicles/equipment;
    - Collect and re-use upper soil layers of development site containing organic materials.
5. Drain runoff from impervious surfaces to pervious areas
    - LID Street and Road Design
        - Curb-cuts to landscaping;
        - Rural swales;
        - Concave median;
        - Cul-de-sac landscaping design.
    - LID parking lot design
        - Permeable pavements;
        - Curb cuts to landscaping.
    - LID driveway, sidewalk design
        - Permeable pavements;
        - Pitch pavements toward landscaping.
    - LID building design
        - Cisterns and rain barrels;
        - Downspout to swale;
        - Vegetated roofs.

- LID landscaping design
    - Soil amendments;
    - Reuse of native soils;
    - Smart irrigation systems;
    - Street trees.

6. Minimize erosion from slopes
    - Disturb existing slopes only when necessary;
    - Minimize cut and fill areas to reduce slope lengths
    - Incorporate retaining walls to reduce steepness of slopes or to shorten slopes;
    - Provide benches or terraces on high cut and fill slopes to reduce concentration of flows;
    - Rounding and shaping slopes to reduce concentrated flow;
    - Collect concentrated flows in stabilized drains and channels.

Project development will implement all of number 1, all soils, trees, and critical areas will be conserved during development to the maximum extent practicable.

Disturbance to natural drainages will be limited by restriction of heavy construction equipment access to planned green/open space areas. All heavy equipment will be limited to roads, pads, or construction right of way.

Minimized and disconnected impervious surfaces will be facilitated by LID design features. Proposed streets will not have gutters and will drain directly to parallel rural swales. Road surfaces will also be constructed of a permeable gravel material. Parking lots will be constructed similarly to streets, draining directly to surrounding landscaping or rural swales. All parking lot surfaces will be constructed of permeable gravel type materials. All sidewalks and driveways will be constructed in a similar manner.

Building design impacts will be mitigated by drainage of all runoff from proposed structures into surrounding vegetated swales. Landscaping will reuse existing native soils to the maximum extent practicable.

Soil compaction will be minimized by limiting heavy equipment access to designed roads, pads, and construction right of way. There should be no heavy equipment use outside of the disturbed areas.

Erosion from slopes will be minimized by limiting the amount of disturbance to existing slopes, minimized cut and fill areas thereby reducing slope lengths, providing benches on high cut and fill slopes to reduce concentration of flows, and collections of flows in stabilized drains and channels. Road and pad grading aims to limit elevation differences between proposed and existing grades, which will limit cut and fill heights. Any of the cut or fill slopes that are higher than 30-feet will incorporate benches to break up flow concentrations. Swales and brow ditches will be provided at the bottom of slopes to limit erosion at the bottom of slopes.

Project development aims to maintain the existing natural flow patterns as much as possible and includes limited impervious areas. Limited impervious areas will drain immediately to permeable or vegetated pads or drainage features, eliminating any directly connected impervious areas.

5.0 SOURCE CONTROL BMPS

Source control BMPs outlined in the County of San Diego SWMP form is discussed below. Given the preliminary stage of Project development the following source control BMPs are recommended and will be updated during planning to better reflect utilized source control BMPs. Based on the limited amount of structural development a number of the source control BMPs do not apply to the Project. Site features with source control BMPs identified by the County of San Diego are:

A. On-site storm drain inlets
B. Interior floor drains and elevator shaft sump pumps
C. Interior parking garages
D1. Need for future indoor and structural pest control
D2. Landscape/outdoor pesticide use
E. Pools, spas, ponds, decorative fountains, and other water features
F. Food service
G. Refuse areas
H. Industrial processes
I. Outdoor storage of equipment or materials
J. Vehicle and equipment cleaning
K. Vehicle/Equipment repair and maintenance
L. Fuel dispensing areas
M. Loading docks
N. Fire sprinkler test water
O. Miscellaneous drain or wash water
  - Boiler drain lines;
  - Condensate drain lines;
  - Rooftop equipment;
  - Drainage sumps;
  - Roofing, gutters, and trim
P. Plazas, sidewalks, and parking lots

Current project planning will require source control BMPs for interior floor drains, need for future indoor and structural pest control, landscape/outdoor pesticide use, refuse areas, roofing, gutters, and trim, and sidewalks, and parking lots.

Interior floor drains will be constructed to connect directly to the sanitary sewer for the structure. There will be inspection of the interior drains performed frequently to ensure there is no clogging and no potential for runoff from drain overflow.

Pest control BMPs will include building design features which discourage entry of pests. Integrated pest management information will also be provided to the owners and operators of the facility to ensure proper pest management. Outdoor pesticide use BMPs will consist of preservation of existing native trees, shrubs, and ground cover to the maximum extent practicable. Landscaping will likely not require irrigation, but any minimal irrigation will aim to minimize runoff, promote surface infiltration, and limit the amount of fertilizer and pesticide treated areas serviced which could contribute to runoff. Plants selected for landscaping will be appropriate for the desired land use;

such as, saturated conditions for any low lying sump areas and dry for any high areas. All landscaping will consider pest resistant plants that are appropriate for the site soils, slopes, climate, sun, wind, rain, land use, air movement, ecological consistency, and plant interactions.

Refuse areas will be located inside of the operation and maintenance facilities and will be located such that no precipitation comes in contact with refuse. All trash disposed of onsite will be located at the operation and maintenance facility, with trash generated at any remote turbine locations immediately removed by the active work crew. In addition, all trash receptacles at the operation and maintenance facility will include signage prohibiting disposal of hazardous materials.

Roofing, gutters, and trip will not be constructed of materials that will leach pollutants into stormwater runoff, typically copper.

Sidewalks and parking lots will mainly be constructed of permeable gravel materials. There potentially could be short distances of concrete sidewalk; however, these will drain immediately to surrounding permeable areas. Due to the gravel construction of the majority of parking lots and sidewalks, sweeping will not be feasible.

6.0 TREATMENT CONTROL BMPS

Discussions with the County of San Diego identified that Project development would not require treatment BMPs, based on the County guidelines, since the Project was located outside of Phase I and Phase II NPDES permits and the Project did not contribute flows to a Municipal Separate Storm Sewer System (MS4). However, based on the Project location, General Construction Permit post-construction BMPs will be required. General Construction Permit post-construction BMPs are intended to reduce the impacts from project development on existing natural drainages. These impacts are typically increased channel erosion or deposition resulting from changes in runoff patterns from the Project site, also known as hydromodification. It has been found that the flows that actually cause the most impact to existing drainages are associated with the high frequency lower volume storms, which is the focus of the General Construction Permit. Project impacts are quantified in the General Construction Permit by a Water Balance Calculator, which identifies the changes in Project runoff and allows for mitigation of these impacts through numerous LID and local detention features. Water Balance Calculator analysis gives mitigation credit to the following Project features:

- Porous pavement,
- Tree planting,
- Downspout disconnection,
- Impervious area disconnection,
- Green roof
- Vegetated swales,
- Rain barrels/cisterns, and
- Soil quality.

Project development proposes to use vegetated swales, downspout disconnection, and potentially several detention basins for the operation and maintenance area and/or substation areas. Additionally, all impervious areas will be disconnected and will be drained via natural features. A comparison of these features with the County of San Diego SUSMP requirements was completed in order to better identify mitigation benefits. Table 3 contains Table 2-3: Treatment Control Selection Matrix, from the County of San Diego SUSMP.

There are no primary pollutants of concern for the Project, and the Project will not contribute pollutants to a 303 (d) listed water body. With no primary pollutants of concern, the County of San Diego SUSMP requires the Project to focus on the secondary pollutants of concern. Secondary pollutants of concern are trash and oil and grease; which represent course sediment and trash as well as pollutants that tend to associate with fine particles during treatment. Table 5 identifies settling basins and LID bioretention facilities as having high removal efficiencies for all pollutants of concern. Based on this, the selection of swales/brow ditches and detention basins for General Construction Permit post-construction BMP requirements, also meets the intent of the County of San Diego SUSMP.

Table 3. Groups of Pollutants and Relative Effectiveness of Treatment Facilities

Pollutant of Concern	Bioretention Facilities (LID)	Settling Basins (Dry Ponds)	Wet Ponds and Wetlands	Infiltration Facilities or Practices (LID)	Media Filters	High-rate Biofilters	High-rate Media Filters	Trash Rack & Hydro-dynamic Devices
Course Sediment and Trash	High	High	High	High	High	High	High	High
Pollutants that tend to associate with fine particles during treatment	High	High	High	High	High	Medium	Medium	Low
Pollutants that tend to be dissolved following treatment	Medium	Low	Medium	High	Low	Low	Low	Low

Further design of these post-construction BMPs will be required during final Project engineering. As the planning process progresses more detail will be available as to the opportunities and locations for these features. Exhibit C includes a BMP Map which defines potential locations for treatment BMPs as well as typical site design and source control BMPs. The BMP Map is only intended to be representative of potential or typical BMP locations and is not intended to exclude additional locations of features. Additional CASQA BMP information is located in Appendix E.

Responsible parties for the capital costs associated with construction of the treatment control BMPs are presented in Table 4.

Table 4. Treatment Control BMP Capital Cost Responsible Party

Treatment Control BMP	Responsible Party
Detention Basins	Iberdrola Renewables
Swales/Brow Ditches	Iberdrola Renewables

7.0 STORM WATER BMP MAINTENANCE

In accordance with Section 5 of the County of San Diego SUSMP the Project BMPs will be classified as First Category. BMPs will largely "maintain themselves" via the natural process of vegetation growth cycles. Vegetated swales/natural drainages and open spaces for impervious area disconnection will be seeded with local naturally occurring plant types, which will be allowed to grow naturally in these facilities. Permeable paving surfaces will be maintained by Iberdrola to provide uniform access roads. Any erosion issues associated with the unvegetated drive surface will be immediately addressed to limit any sediment discharge from the site. Table 5 defines the anticipated BMP responsible parties.

Table 5. BMP Maintenance Responsibility

Treatment Control BMP	Responsible Party
Detention Basins	Iberdrola Renewables
Swales/Brow Ditches	Iberdrola Renewables

All operation and maintenance required by these BMPs will be the responsibility of Iberdrola. More specific operation and maintenance of the BMPs will be established during final Project design and discussed in a Maintenance Plan report.

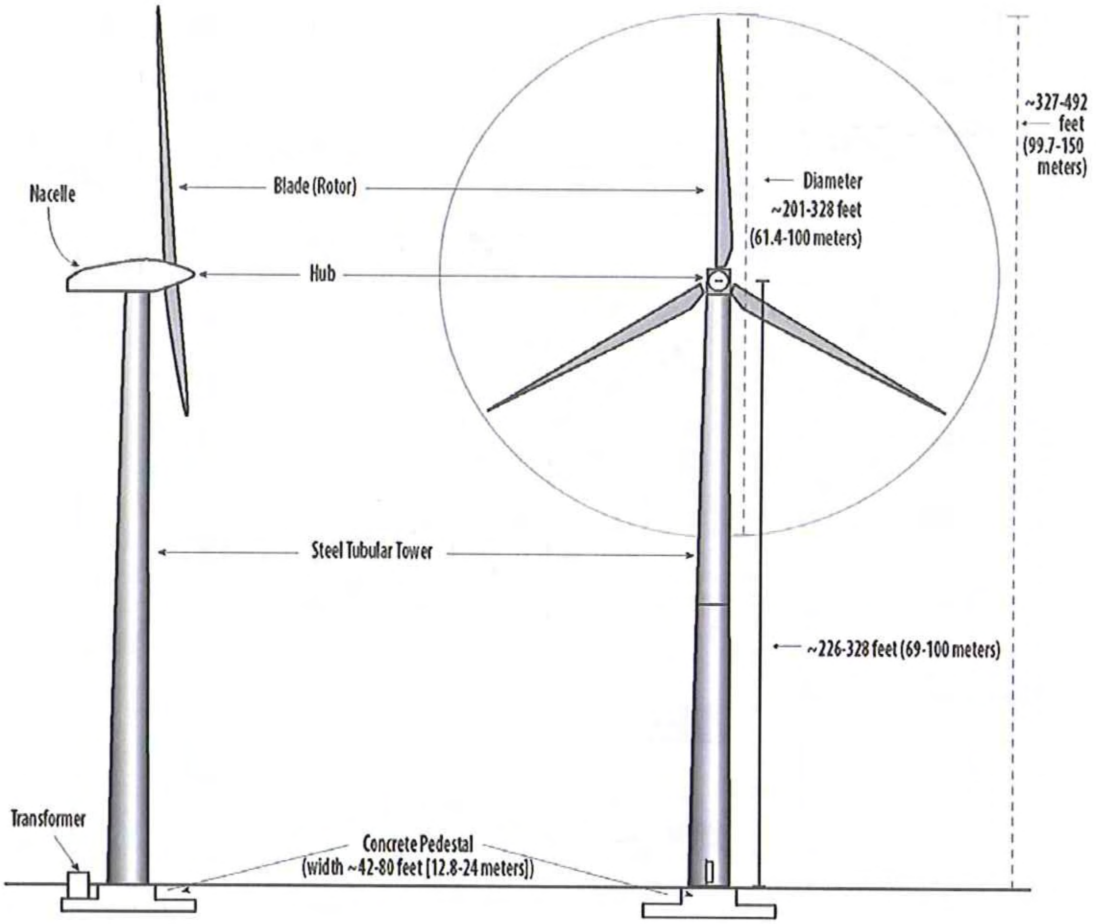
8.0 CONCLUSION

Based on the currently applicable water quality requirements, an analysis of the potential impacts was completed for the Tule Wind Project in support of a MUP submittal to the County of San Diego. This analysis determined that the Project would have low potential for water quality impacts to the surrounding water bodies. Minimal impervious area increases are proposed with Project disturbance placement intended to limit the impacts to surrounding water bodies. Based on the minimal level of impervious surfaces proposed as part of the project and implementation of applicable site design BMPs, source control BMPs, LID features, and storm water BMP maintenance, the project will not substantially degrade water quality. Mitigation measures are implemented to the maximum extent practicable to address the limited numbers of potential impacts. Operation and maintenance of the BMPs should be minimal, due to their natural operation conditions, with responsibility for these features performance over the life of the Project being the developers.

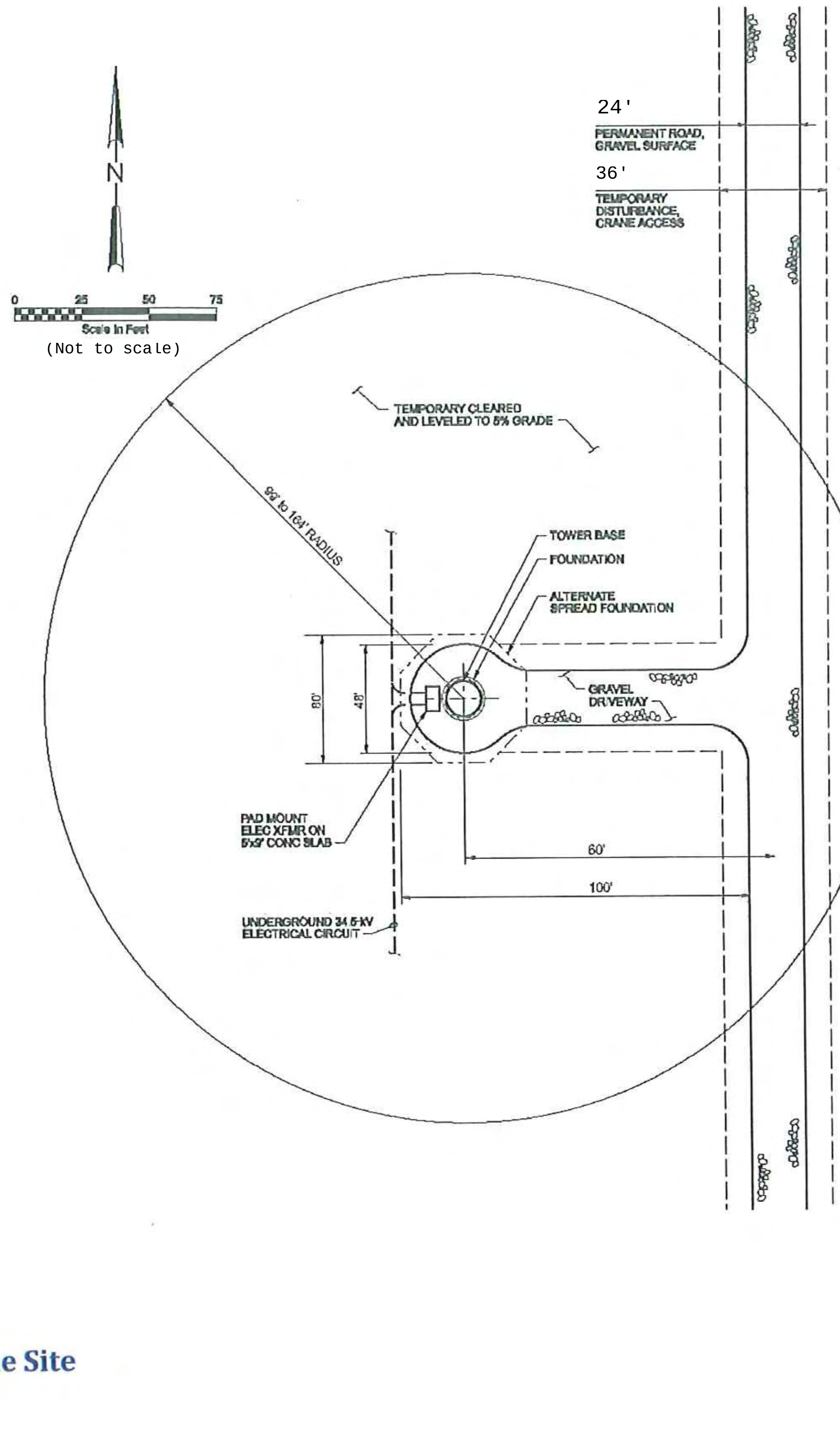
APPENDIX A

Preliminary Project Details

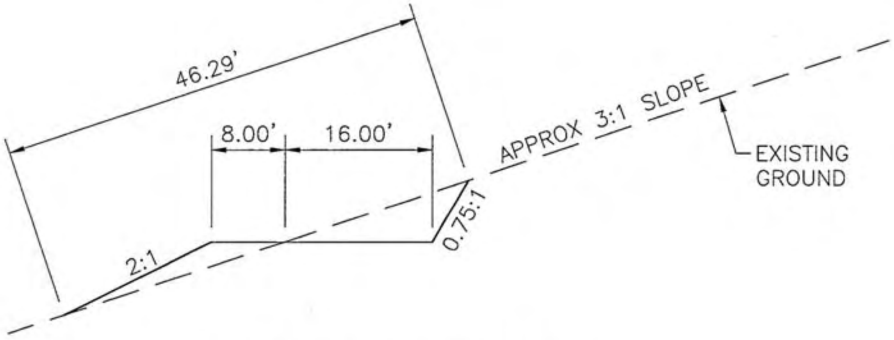
Typical Turbine Schematic
Typical Turbine Site
Typical Access Road Sections
Typical Substation Facility
Typical Operation and Maintenance Facility Site
Typical Operation and Maintenance Facility Elevations
Typical Collector Line Power Pole
Typical Buried Collector Line



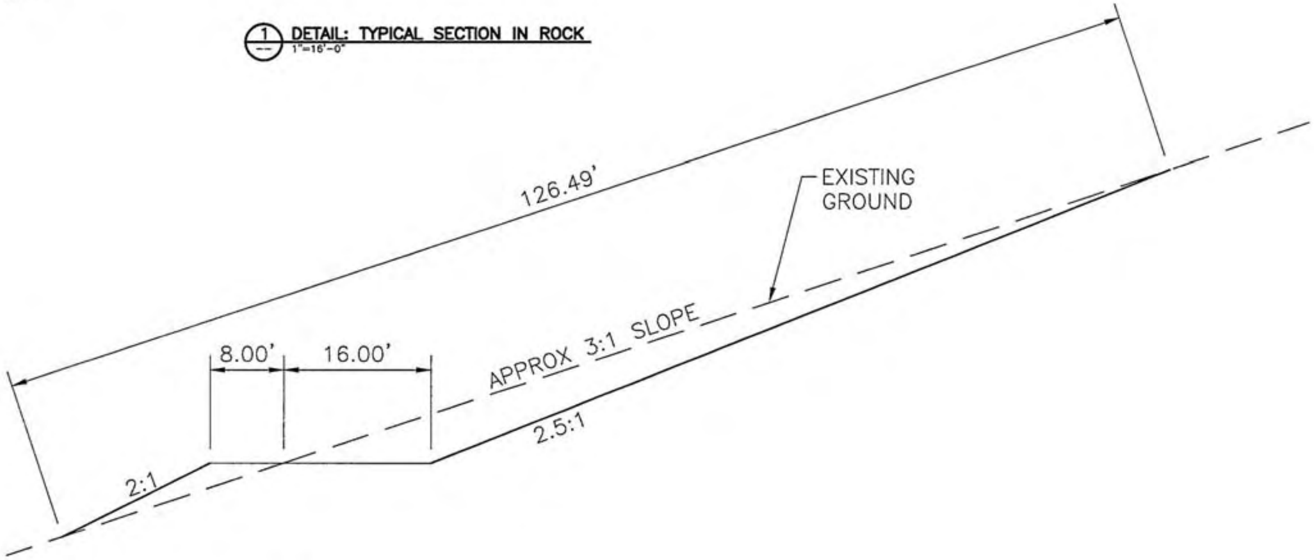
Turbine Schematic



Turbine Site

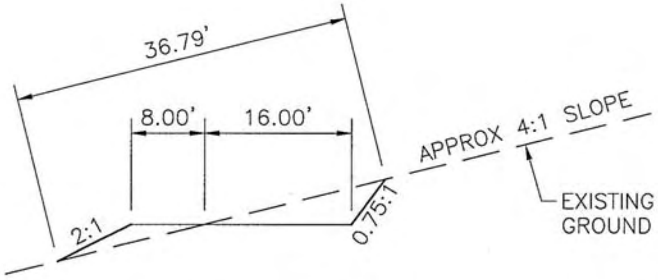


① DETAIL: TYPICAL SECTION IN ROCK
1"=16'-0"

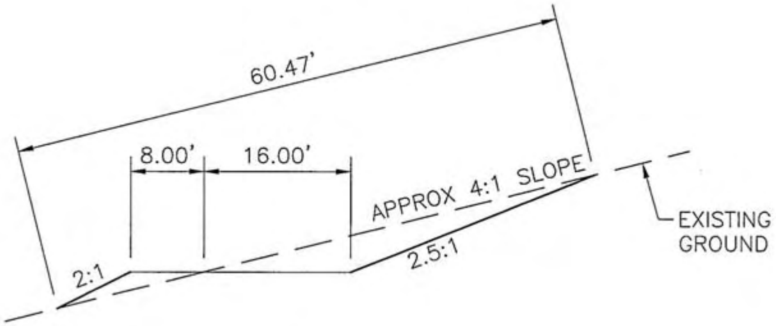


② DETAIL: TYPICAL SECTION IN SOIL
1"=16'-0"

Typical Access Road Cross Sections



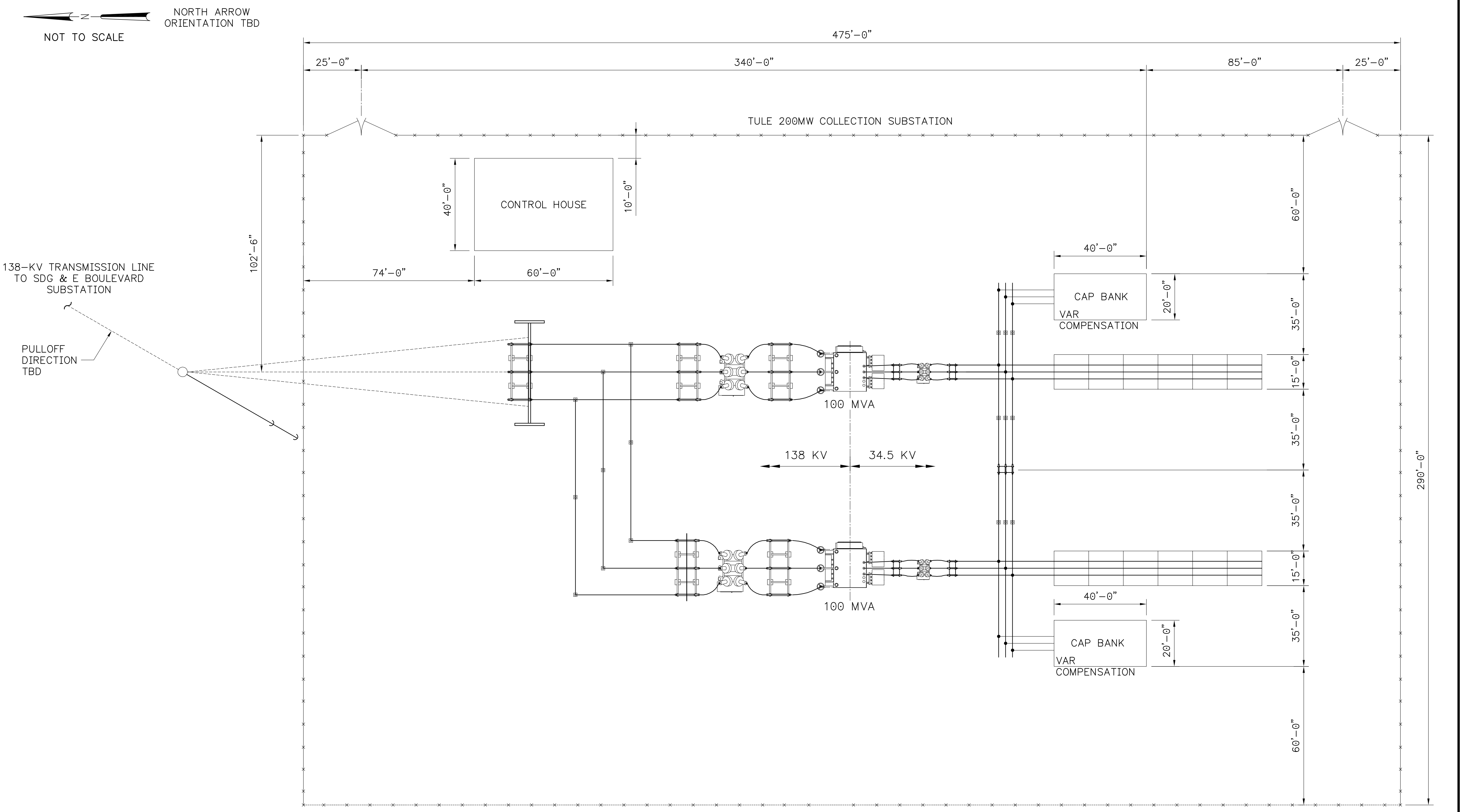
① DETAIL: TYPICAL SECTION IN ROCK
1"=16'-0"



② DETAIL: TYPICAL SECTION IN SOIL
1"=16'-0"

Typical Access Road Cross Sections

10/20/2009 11:12 AM TWEBSTER Z:\TWW_VAN\IBERDROLA\TULE\2009 ASSISTANCE\DWGS\FIGURE4.DWG



PRELIMINARY

TriAxis
Engineering, Inc.

DSGN J KING
DR FIGURE4.DWG T WEBSTER
CHK G ORMSBY
APVD G ORMSBY

NO.	DATE	REVISION	BY	APVD

REUSE OF DOCUMENTS

THIS DOCUMENT, AND THE IDEAS AND DESIGNS INCORPORATED HEREIN, AS AN INSTRUMENT OF PROFESSIONAL SERVICE, IS THE PROPERTY OF TRIAXIS ENGINEERING, INC. AND IS NOT TO BE USED, IN WHOLE OR IN PART, FOR ANY OTHER PROJECT WITHOUT THE WRITTEN AUTHORIZATION OF TRIAXIS ENGINEERING, INC.

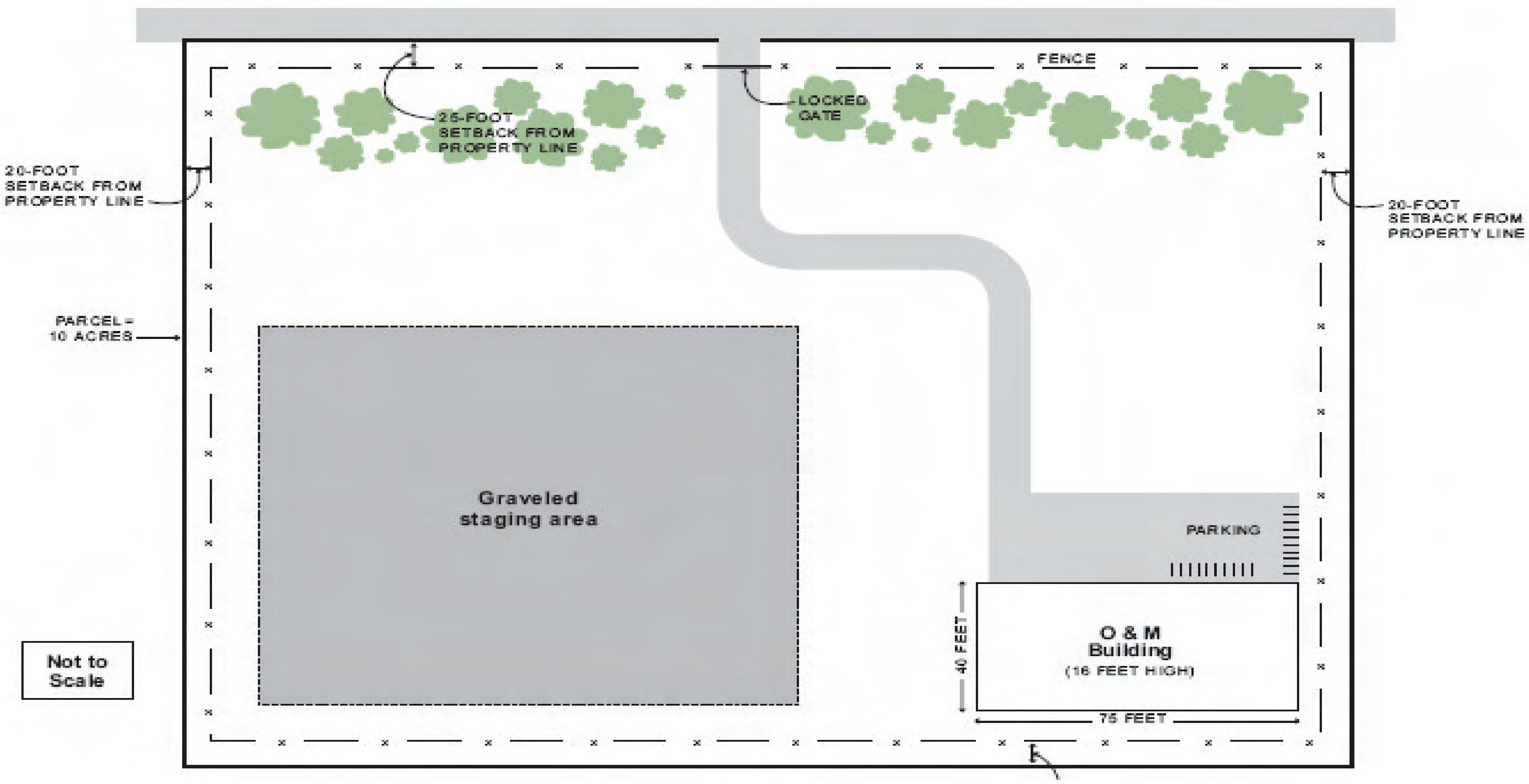
VERIFY SCALES
BAR IS ONE HALF INCH ON ORIGINAL DRAWING
0 ▬ 1/2"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

TULE SUBSTATION
IBERDROLA RENEWABLES

TULE WIND PROJECT
FIGURE 4
200MW COLLECTION SUBSTATION
PLAN VIEW

SHEET
DWG NO. FIGURE4
DATE DEC 2009
PROJ NO. Y8773

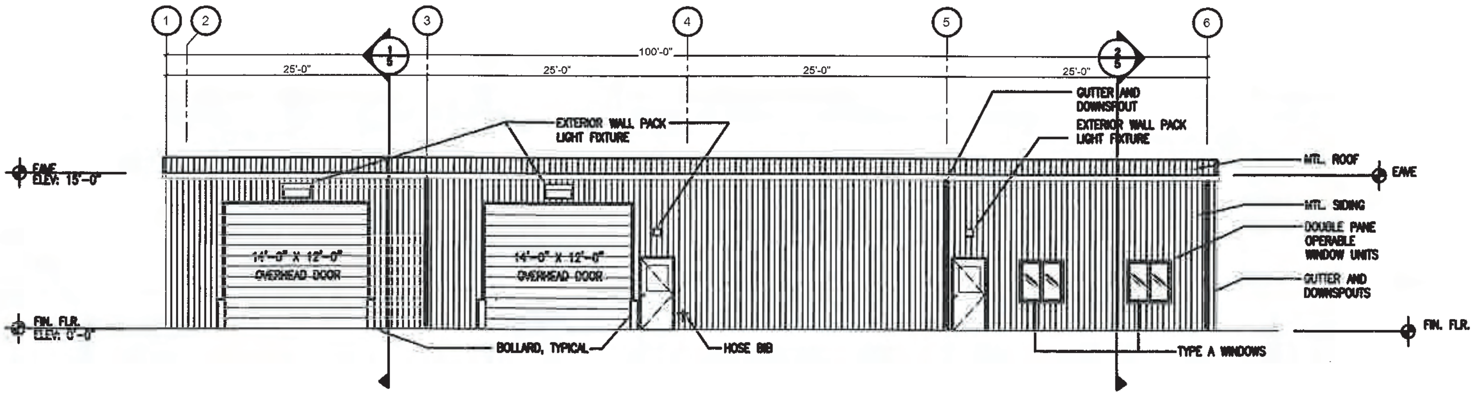
Source: Iberdrola, 2009 | G:/Projects\IberdrolaRenew_424914\TuleWindEnergy_115965\14_00_GIS_MODELS\14_02_Graphics\14_02_01_docs\Ltr_Landscp_master.ai | Last Updated : 12-24-2009



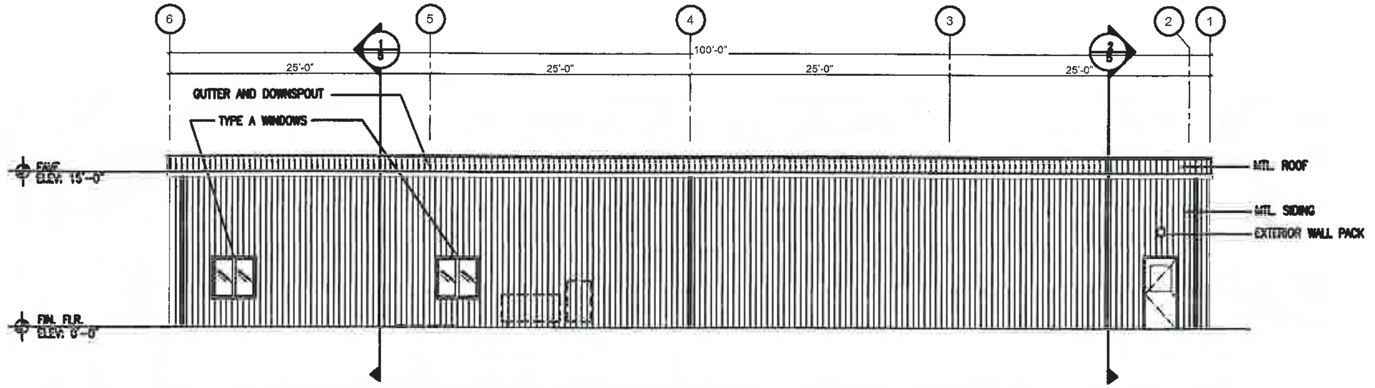
Typical Operations and Maintenance Facility Site

FIGURE 2.0-9a

Source: Iberdrola, 2009 | G:/Projects\IberdrolaRenew 424914\TuleWindEnergy 115965\14 00 GIS MODELS\14 02 Graphics\14 02 01 docs\Ltr Landscp master.ai | Last Updated : 12-24-2009



1 SOUTH ELEVATION



2 NORTH ELEVATION

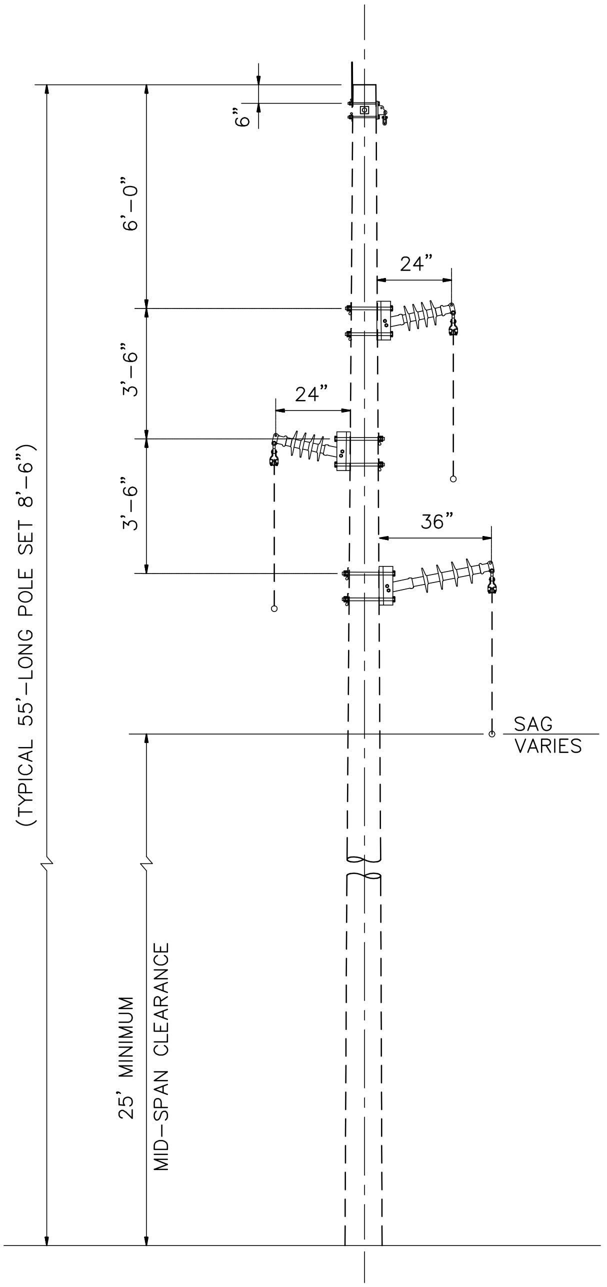
Typical Operations and Maintenance Facility Elevations

FIGURE 2.0-9b

ONE COMPANY | *Many Solutions* SM

Iberdrola | Tule Wind Project | Applicant's Environmental Document

2/11/10   X:\Iberdrola\Tule - San Diego\EMF Calcs\Structure Concepts\FIG-1 35KV SC.dwg



DESIGN ASSUMPTIONS:

- 1590 KCMIL "COREOPSIS" AAC
- 280' MAX SPAN

NOTES:

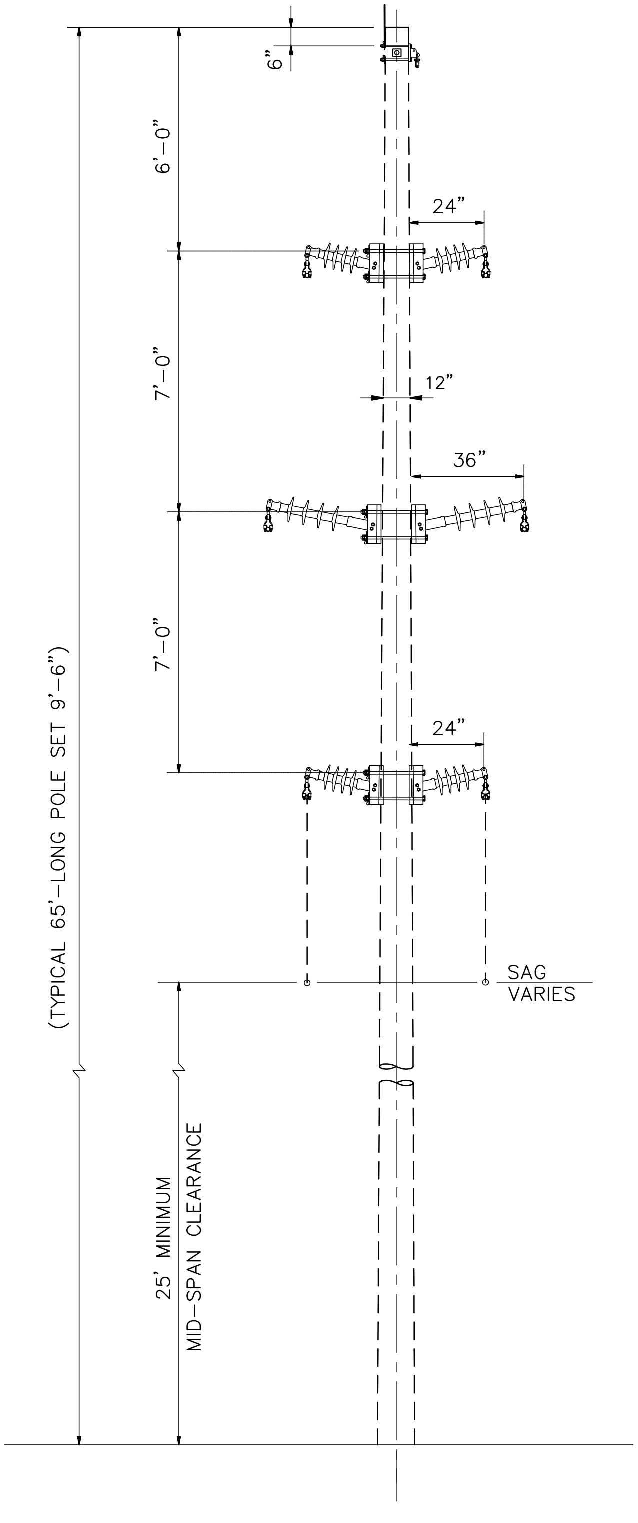
1. STRUCTURE DIMENSIONS ARE APPROXIMATE. ACTUAL DIMENSIONS MAY VARY.
2. DIMENSIONS ARE TO ATTACHMENT HOLES.
3. DRAWING IS NOT TO EXACT SCALE

IBERDROLA
TULE WIND
PROJECT

TriAxis
Engineering, Inc.

TYPICAL
34.5-KV HORIZONTAL LINE POST
TANGENT SINGLE-CIRCUIT CONFIGURATION

DSGN MCF	DR JHR	DATE FEB 2010	FIG 1



DESIGN ASSUMPTIONS:

- 1590 KCMIL "COREOPSIS" AAC
- 280' MAX SPAN

NOTES:

1. STRUCTURE DIMENSIONS ARE APPROXIMATE. ACTUAL DIMENSIONS MAY VARY.
2. DIMENSIONS ARE TO ATTACHMENT HOLES.
3. DRAWING IS NOT TO EXACT SCALE

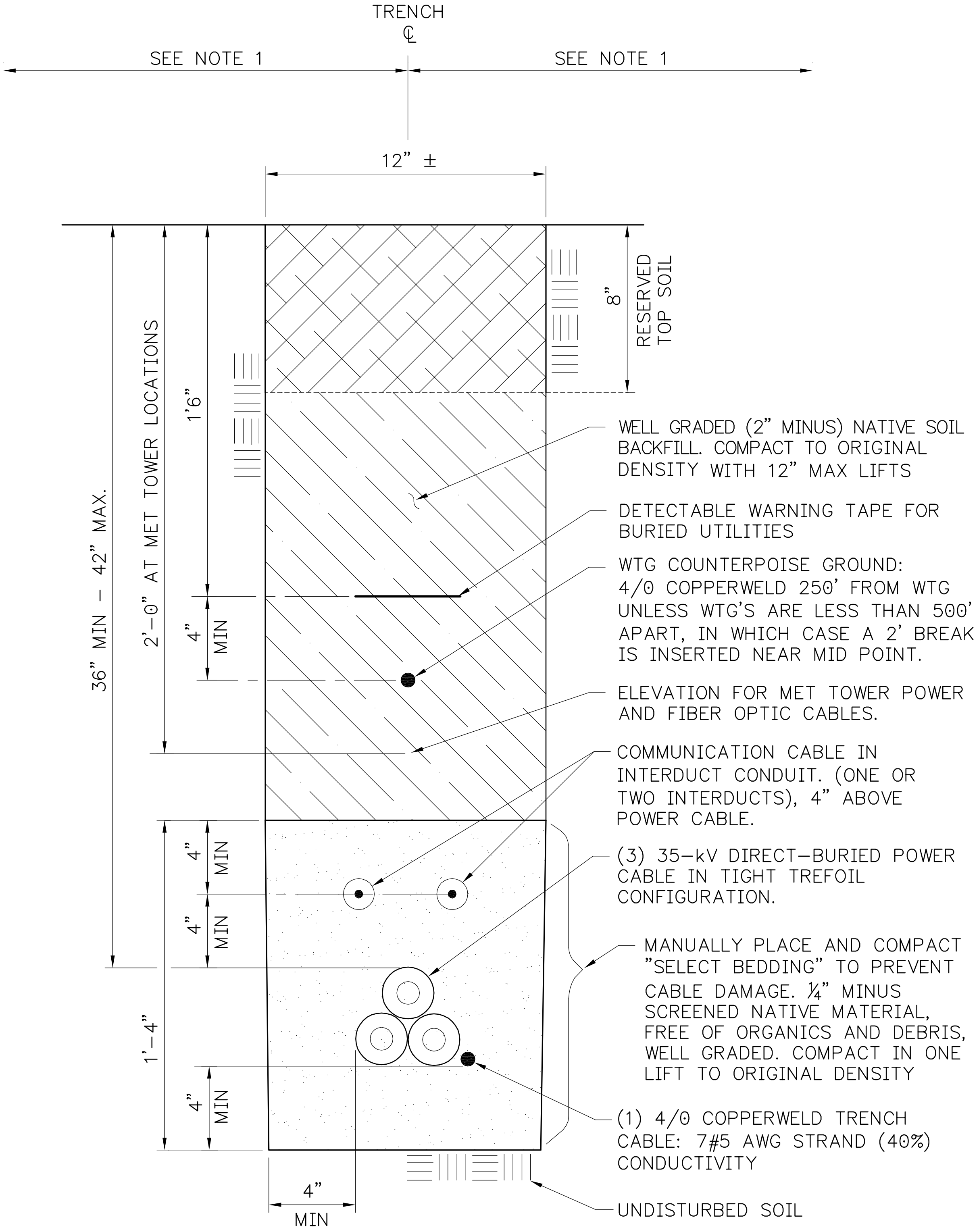
IBERDROLA
TULE WIND
PROJECT

TriAxis
Engineering, Inc.

TYPICAL
34.5-KV HORIZONTAL LINE POST
TANGENT DOUBLE-CIRCUIT CONFIGURATION

DSGN MCF | DR JHR | DATE FEB 2010 | FIG 2

12/01/2009



NOTES:

1. EACH 3-PHASE CABLE TRENCH SHALL BE SEPARATED FROM ALL OTHER CABLE TRENCHES BY 10'-6" MINIMUM, CENTERLINE-TO-CENTERLINE UNLESS OTHERWISE NOTED ON DRAWINGS.
2. ROCKS SHALL NOT COME IN CONTACT WITH CABLES.

IBERDROLA RENEWABLES TULE WIND PROJECT	FIGURE 2 DIRECT BURIED 34.5-KV UNDERGROUND CABLE TRENCH DETAIL	**TriAxis** *Engineering, Inc.*

tww_van\IBERDROLA\Tule\2009 assistance\dwgs\figure2.DWG

APPENDIX B

County of San Diego Stormwater Intake Form for Development Projects

County of San Diego Stormwater Intake Form for Development Projects

County of San Diego

STORMWATER INTAKE FORM FOR DEVELOPMENT PROJECTS

This form must be completed in its entirety and accompany applications for any of the discretionary or ministerial permits and approvals referenced in Sections 67.803(c)(1) and 67.803(c)(2) of the County of San Diego Watershed Protection, Stormwater Management and Discharge Control Ordinance (WPO).

STEP 1: IDENTIFY RELEVANT PROJECT INFORMATION

Applicant Name: Andrew Linehan

Contact Information: Jeffrey Durocher

Project Address: Multiple Properties

APN(s): See APN list

Permit Application #:

STEP 2: DETERMINE PRIORITY DEVELOPMENT PROJECT STATUS

WPO Section 67.802(w) defines the criteria for determining whether your project is considered a Priority Development Project (PDP). If you answer "Yes" to any of the questions below, your project is a PDP subject to review and approval of a Major Stormwater Management Plan (SWMP). If you answer "No" to all of the questions below, your project is subject to review and approval of a Minor SWMP.

1. *Residential subdivision of 10 or more dwelling units (Single-family, Multi-family, Condo, or Apartment Complex)* ...... Yes [✓ No]
2. *Commercial development that includes development of land area greater than one (1) acre* .... [✓ Yes] No
3. *Industrial development greater than one (1) acre* .... Yes [✓ No]
4. *Automotive repair shop* .... Yes [✓ No]
5. *Restaurant or restaurant facilities with an area of development of 5,000 square feet or greater* .... Yes [✓ No]
6. *On a steep hillside (>25% natural slope) AND proposes 5,000 square feet of impervious surface or more, or includes grading of any natural slope >25%* (1) .... [✓ Yes] No
7. *Located within 200 feet of an Environmentally Sensitive Area AND creates 2,500 square feet or more of impervious surface or increases the area of imperviousness of a site to more than 10% of its naturally occurring condition* (1) (2) ...... Yes [✓ No]
8. *A parking lot that is 5,000 square feet or greater OR proposes at least 15 new parking stalls* .... Yes [✓ No]
9. *Streets or roads that create a new paved surface that is 5,000 square feet or greater* .... Yes [✓ No]
10. *Retail gasoline outlet* .... Yes [✓ No]

---

(1) In lieu of a Major SWMP, Ministerial Permit Applications for residential dwellings/additions on an existing legal lot answering "Yes" may be able to utilize the Minor Stormwater Management Plan upon approval of a county official. Please note that upon further analysis, staff may determine that a Major SWMP will be required.

(2) A County technician will assist you in determining whether your project is located within 200 feet of an Environmentally Sensitive Area.

STOP **If you answered "Yes" to any of the questions, please complete a Major SWMP for your project.**

Instructions and an example of the form can be downloaded from http://www.co.san-diego.ca.us/dpw/watersheds/land_dev/susmp.html

If you answered "NO" to all of the questions above, please complete a Minor SWMP for your project.

Instructions and an example of the form can be downloaded from http://www.sdcounty.ca.gov/dplu/docs/LUEG-SW.pdf

STEP 3: SIGN AND DATE THE CERTIFICATION

APPLICANT CERTIFICATION: I have read and understand that the County of San Diego has adopted minimum requirements for managing urban runoff, including stormwater, from construction and land development activities. I certify that this intake form has been completed to the best of my ability and accurately reflects the project being proposed. I also understand that non-compliance with the County's WPO and Grading Ordinance may result in enforcement by the County, including fines, cease and desist orders, or other actions.

Applicant :

Date:

APPENDIX C

County of San Diego Storm Water Management Plan for Priority Projects (Major SWMP) Form

County of San Diego Major SWMP Form

Major Stormwater Management Plan
(Major SWMP)
For
Tule Wind Project
MUP 3300-09-019

Preparation/Revision Date: September 2010

Prepared for:

Iberdrola Renewables, Inc.
1125 Northwest Couch, Suite 700
Portland, OR 97209

Prepared by:

Brinton Swift, P.E.
HDR Engineering
8690 Balboa Avenue, Suite 200
San Diego, CA 92123
Telephone: 858-712-8335

The selection, sizing, and preliminary design of stormwater treatment and other control measures in this plan have been prepared under the direction of the following Registered Civil Engineer and meet the requirements of Regional Water Quality Control Board Order R9-2007-0001 and subsequent amendments.

Name, RCE # Date

The Major Stormwater Management Plan (Major SWMP) must be completed in its entirety and accompany applications to the County for a permit or approval associated with certain types of development projects. To determine whether your project is required to submit a Major or Minor SWMP, please reference the County's Stormwater Intake Form for Development Projects.

Project Name:	Tule Wind Project
Project Location:	
Permit Number (Land Development Projects):	MUP 3300-09-019
Work Authorization Number (**CIP only**):	
Applicant:	Iberdrola Renewables, Inc.
Applicant's Address:	Portland,OR
Plan Prepared By (*Leave blank if same as applicant*):	HDR Engineering
Preparer's Address:	San Diego, CA
Date:	May, 2010

The County of San Diego Watershed Protection, Storm Water Management, and Discharge Control Ordinance (WPO) (Ordinance No. 9926) requires all applications for a permit or approval associated with a Land Disturbance Activity to be accompanied by a Storm Water Management Plan (SWMP) (section 67.806.b). The purpose of the SWMP is to describe how the project will minimize the short and long-term impacts on receiving water quality. Projects that meet the criteria for a priority development project are required to prepare a Major SWMP.

Since the SWMP is a living document, revisions may be necessary during various stages of approval by the County. Please provide the approval information requested below.

Project Stages	Does the SWMP need revisions?		If YES, Provide Revision Date
	YES	NO	

Instructions for a Major SWMP can be downloaded at http://www.sdcounty.ca.gov/dpw/watersheds/susmp/susmp.html

Completion of the following checklists and attachments will fulfill the requirements of a Major SWMP for the project listed above.

STEP 1

PRIORITY DEVELOPMENT PROJECT DETERMINATION

TABLE 1: IS THE PROJECT IN ANY OF THESE CATEGORIES?

Yes ☐	No ☑	A	**Housing subdivisions of 10 or more dwelling units.** Examples: single-family homes, multi-family homes, condominiums, and apartments.
Yes ☑	No ☐	B	**Commercial—greater than one acre.** Any development other than heavy industry or residential. Examples: hospitals; laboratories and other medical facilities; educational institutions; recreational facilities; municipal facilities; commercial nurseries; multi-apartment buildings; car wash facilities; mini-malls and other business complexes; shopping malls; hotels; office buildings; public warehouses; automotive dealerships; airfields; and other light industrial facilities.
Yes ☐	No ☑	C	**Heavy industry—greater than one acre.** Examples: manufacturing plants, food processing plants, metal working facilities, printing plants, and fleet storage areas (bus, truck, etc.).
Yes ☐	No ☑	D	**Automotive repair shops.** A facility categorized in any one of Standard Industrial Classification (SIC) codes 5013, 5014, 5541, 7532-7534, or 7536-7539.
Yes ☐	No ☑	E	**Restaurants.** Any facility that sells prepared foods and drinks for consumption, including stationary lunch counters and refreshment stands selling prepared foods and drinks for immediate consumption (SIC code 5812), where the land area for development is greater than 5,000 square feet. Restaurants where land development is less than 5,000 square feet shall meet all SUSMP requirements except for structural treatment BMP and numeric sizing criteria requirements and hydromodification requirements.
Yes ☑	No ☐	F	**Hillside development greater than 5,000 square feet.** Any development that creates 5,000 square feet of impervious surface and is located in an area with known erosive soil conditions, where the development will grade on any natural slope that is twenty-five percent or greater.
Yes ☐	No ☑	G	**Environmentally Sensitive Areas (ESAs).** All development located within or directly adjacent to or discharging directly to an ESA (where discharges from the development or redevelopment will enter receiving waters within the ESA), which either creates 2,500 square feet of impervious surface on a proposed project site or increases the area of imperviousness of a proposed project site to 10% or more of its naturally occurring condition. "Directly adjacent" means situated within 200 feet of the ESA. "Discharging directly to" means outflow from a drainage conveyance system that is composed entirely of flows from the subject development or redevelopment site, and not commingled with flows from adjacent lands.
Yes ☐	No ☑	H	**Parking lots 5,000 square feet or more** or with 15 or more parking spaces and potentially exposed to urban runoff.
Yes ☐	No ☑	I	**Street, roads, highways, and freeways.** Any paved surface that is 5,000 square feet or greater used for the transportation of automobiles, trucks, motorcycles, and other vehicles.
Yes ☐	No ☑	J	**Retail Gasoline Outlets (RGOs)** that are: (a) 5,000 square feet or more or (b) a projected Average Daily Traffic (ADT) of 100 or more vehicles per day.

To use the table, review each definition A through K. If any of the definitions match, the project is a Priority Development Project. Note some thresholds are defined by square footage of impervious area created; others by the total area of the development. Please see special requirements for previously developed sites and project exemptions on page 6 of the County SUSMP.

STEP 2

PROJECT STORMWATER QUALITY DETERMINATION

Total Project Site Area ___1,982_______ (Acres)

Estimated amount of disturbed acreage: ____127____ (Acres)
(If >1 acre, you must also provide a WDID number from the SWRCB) WDID: ________

Complete A through C and the calculations below to determine the amount of impervious surface on your project before and after construction.

A. Total size of project site: ___77_______ (Acres)

B. Total impervious area (including roof tops) before construction ___0__ (Acres or ft^2)

C. Total impervious area (including roof tops) after construction ___0.54____(Acres)

Calculate percent impervious before construction: B/A = ___0_____%
Calculate percent impervious after construction: C/A = ____0.7____%

Please provide detailed descriptions regarding the following questions:

TABLE 2: PROJECT SPECIFIC STORMWATER ANALYSIS

<table>
<tr><td>1.</td><td>Please provide a brief description of the project.</td></tr>
<tr><td colspan="2">The Tule Wind Project is a large project that proposes to develop a wind turbine “farm," for power generation, in the County of San Diego in the State of California. Portions of the project discussed in this report are limited to areas within private properties within the County of San Diego. A majority of the overall project will be developed on Bureau of Land Management (BLM) Federal land, outside the County of San Diego Planning Department jurisdiction. Project development proposed on County of San Diego regulated lands is located just north of Interstate 8 off Ribbonwood Road, approximately two and half miles northeast of the community of Boulevard, California. Given the rural nature of the Project area, only the western side of the site is bounded by a physical feature, Ribbonwood Road. Proposed development will include the construction of electrical generating wind turbines, access roads, power transmission lines, maintenance facilities, and all the associated additional appurtenances. See Tule Wind Project Storm Water Management Plan for further discussion of Project.</td></tr>
<tr><td>2.</td><td>Describe the current and proposed zoning and land use designation.</td></tr>
<tr><td colspan="2">Project areas and surrounding areas are zoned general agricultural and general rural. Existing land use and surrounding land use is in line with the zoning, consisting of agricultural uses, scattered residential, scattered commercial, and open space. Future land use is envisioned to remain consistent with the existing zoning.</td></tr>
<tr><td>3.</td><td>Describe the pre-project and post-project topography of the project. (Show on Plan)</td></tr>
<tr><td colspan="2">Pre-project topography consists of steep mountainous areas with deep gullies and valleys, which convey stormwater runoff to flatter offsite areas. Existing slopes are primarily less than 15%, however, Project areas to include some slopes over 50%. Post-project topography will closely match pre-project topography. Access roads will be graded to match existing contours and transmission lines will not impact existing contours. Wind turbine pads, maintenance facility pads, and transformer sub-station pads will be the only areas graded flatter than existing slopes. These facilities have small localized footprints.</td></tr>
<tr><td>4.</td><td>Describe the soil classification, permeability, erodibility, and depth to groundwater for LID and Treatment BMP consideration. (Show on Plan) If infiltration BMPs are proposed, a Geotechnical Engineer must certify infiltration BMPs in Attachment E.</td></tr>
<tr><td colspan="2">All soil types A, B, C, and D are present on the Project. A majority of the site is vegetated with low level ground cover and low level bushes which stabilize the soil. Higher elevation portions of the Project consist of large rock formations. Existing wells in the vicinity of Rough Acres Ranch have the minimum observed depth to groundwater of 11-30 feet. In the event infiltrations BMPs are selected, further review of either existing or planned geotechnical studies will be completed to determine performance characteristics.</td></tr>
<tr><td>5.</td><td>Describe if contaminated or hazardous soils are within the project area. (Show on Plan)</td></tr>
<tr><td colspan="2">Based on the California Environmental Protection Agency identification program the McCain Valley Adult Conservation Camp located at 2550 McCain Valley Road is identified</td></tr>
</table>

as containing a Leaking Underground Storage Tank (LUST). Storage tank contents were historically diesel. Contamination is listed as potential aquifer and generates hazardous waste. Contaminated soil is likely very small and is below the ground surface, isolated from contact with surface water runoff.

6. Describe the existing site drainage and natural hydrologic features. (Show on Plan).

Project areas are drained by three major drainage basins:

- Tule Creek Basin – 18,250 acres
- Southern Unnamed Wash Basin – 485 acres
- Eastern Unnamed Wash Basin – 734 acres

Tule Creek drains the majority of the Project site to the southeast into Tule Lake. Tule Lake empties into Carrizo Wash, which ultimately discharges into the Salton Sea. Two small northwestern portions of the Project site are drained by two unnamed tributaries to Carrizo Wash. The southern of the two unnamed washes discharges into Carrizo Wash 2.4 miles upstream of the eastern unnamed wash and approximately 10 miles downstream of Tule Lake. All basins have similar drainage patterns. Runoff sheet flows across the ground surface until it encounters rivulets which then discharge into larger streams which ultimately discharge into Tule Creek or Carrizo Wash. Precipitation that falls on existing access roads sheet flows off the side of the roads where it is either collected in swales running parallel to the road or continues to sheet flow across the natural terrain. Swales carry runoff to streams crossing the access road, where they are then conveyed to major drainage features.

There are no major improvements to the drainage features within the basin. However, a number of culverts have been installed on portions of the Tule Creek Basin to facilitate the construction of access roads across the smaller drainage features. An unnamed tributary to Tule Creek along the northeastern edge of the Tule Creek Basin crosses a number of public and private roads via culverts just east of the landing strip. Several access roads utilize a depressed on grade type crossing, where flows are conveyed across the top of the road, rather than constructing culverts to carry flows under the road.

7. Describe site features and conditions that constrain, or provide opportunities for stormwater control, such as LID features.

Project development proposed little paved surfaces or impermeable site features. Any impervious area will drain to a surrounding impervious area prior to discharging into existing natural facilities. This provides an excellent opportunity for vegetated swales or buffers around all impervious features. There is also the opportunity to construct extended detention basins for the larger graded pads to address runoff rates and water quality. Some areas of the Project are located over soil type C and soil type D which makes natural infiltration options more difficult. Extensive rock outcropping throughout the Project could make extensive grading required for numerous detention facilities undesirable. Overall there will be excellent opportunities for use of vegetated swales and buffers to create impervious area disconnection and runoff treatment.

8. Is this project within the environmentally sensitive areas as defined on the maps in Appendix A of the *County of San Diego Standard Urban Storm Water Mitigation Plan for Land Development and Public Improvement Projects?*

Yes	**No**

9.	Is this an emergency project?
Yes	**No**

CHANNELS & DRAINAGES

Complete the following checklist to determine if the project includes work in channels.

TABLE 3: PROJECT SPECIFIC STORMWATER ANALYSIS

No.	CRITERIA	YES	NO	N/A	COMMENTS
1.	Will the project include work in channels?	X			If YES go to 2 If NO go to 13.
2.	Will the project increase velocity or volume of downstream flow?		X		If YES go to 6.
3.	Will the project discharge to unlined channels?	X			If YES go to. 6.
4.	Will the project increase potential sediment load of downstream flow?			X	If YES go to 6.
5.	Will the project encroach, cross, realign, or cause other hydraulic changes to a stream that may affect downstream channel stability?			X	If YES go to 8.
6.	Review channel lining materials and design for stream bank erosion.			X	Continue to 7.
7.	Consider channel erosion control measures within the project limits as well as downstream. Consider scour velocity.	X			Continue to 8.
8.	Include, where appropriate, energy dissipation devices at culverts.	X			Continue to 9.
9.	Ensure all transitions between culvert outlets/headwalls/wingwalls and channels are smooth to reduce turbulence and scour.	X			Continue to 10.
10.	Include, if appropriate, detention facilities to reduce peak discharges.	X			Continue to 11.
11.	"Hardening" natural downstream areas to prevent erosion is not an acceptable technique for protecting channel slopes, unless pre-development conditions are determined to be so erosive that hardening would be required even in the absence of the proposed development.			X	Continue to 12.
12.	Provide other design principles that are comparable and equally effective.			X	Continue to 13.

No.	CRITERIA	YES	NO	N/A	COMMENTS
13.	End				

TEMPORARY CONSTRUCTION BMPS

Please check the construction BMPs that may be implemented during construction of the project. The applicant will be responsible for the placement and maintenance of the BMPs incorporated into the final project design.

☑ Silt Fence
☑ Fiber Rolls
☐ Street Sweeping and Vacuuming
☐ Storm Drain Inlet Protection
☑ Stockpile Management
☑ Solid Waste Management
☑ Stabilized Construction Entrance/Exit
☐ Dewatering Operations
☑ Vehicle and Equipment Maintenance

☑ Desilting Basin
☑ Gravel Bag Berm
☑ Sandbag Barrier
☑ Material Delivery and Storage
☑ Spill Prevention and Control
☑ Concrete Waste Management
☑ Water Conservation Practices
☐ Paving and Grinding Operations

☑ Any minor slopes created incidental to construction and not subject to a major or minor grading permit shall be protected by covering with plastic or tarp prior to a rain event, and shall have vegetative cover reestablished within 180 days of completion of the slope and prior to final building approval.

EXCEPTIONAL THREAT TO WATER QUALITY DETERMINATION

Complete the checklist below to determine if a proposed project will pose an "exceptional threat to water quality," and therefore require Advanced Treatment Best Management Practices during the construction phase.

TABLE 4: EXCEPTIONAL THREAT TO WATER QUALITY DETERMINATION

No.	CRITERIA	YES	NO	INFORMATION
1.	Is all or part of the proposed project site within 200 feet of waters named on the Clean Water Act (CWA) Section 303(d) list of Water Quality Limited Segments as impaired for sedimentation and/or turbidity? Current 303d list may be obtained from the following site: http://www.swrcb.ca.gov/tmdl/docs/303dlists2006/approved/r9_06_303d_reqtmdls.pdf		X	If YES, continue to 2. If NO, go to 5.
2.	Will the project disturb more than 5 acres, including all phases of the development?			If YES, continue to 3. If NO, go to 5.
3.	Will the project disturb slopes that are steeper than 4:1 (horizontal: vertical) with at least 10 feet of relief, and that drain toward the 303(d) listed receiving water for sedimentation and/or turbidity?			If YES, continue to 4. If NO, go to 5.
4.	Will the project disturb soils with a predominance of USDA-NRCS Erosion factors k_f greater than or equal to 0.4?			If YES, continue to 6. If NO, go to 5.
5.	Project is not required to use Advanced Treatment BMPs.			Document for Project Files by referencing this checklist.
6.	Project poses an "exceptional threat to water quality" and is required to use Advanced Treatment BMPs.			Advanced Treatment BMPs must be consistent with WPO section 67.811(b)(20)(D) performance criteria

Exemption potentially available for projects that require advanced treatment: Project proponent may perform a Revised Universal Soil Loss Equation, Version 2 (RUSLE 2), Modified Universal Soil Loss Equation (MUSLE), or similar analysis that shows to the County official's satisfaction that advanced treatment is not required

STEP 3

HYDROMODIFICATION DETERMINATION

The following questions provide a guide to collecting information relevant to hydromodification management issues.

TABLE 5: HYDROMODIFICATION DETERMINATION

	QUESTIONS	YES	NO	Information
1.	Will the proposed project disturb 50 or more acres of land? (Including all phases of development)	X		If YES, continue to 2. If NO, go to 6.
2.	Would the project site discharge directly into channels that are concrete-lined or significantly hardened such as with rip-rap, sackcrete, etc, downstream to their outfall into bays or the ocean?		X	If NO, continue to 3. If YES, go to 6.
3.	Would the project site discharge directly into underground storm drains discharging directly to bays or the ocean?		X	If NO, continue to 4. If YES, go to 6.
4.	Would the project site discharge directly to a channel (lined or un-lined) and the combined impervious surfaces downstream from the project site to discharge at the ocean or bay are 70% or greater?		X	If NO, continue to 5. If YES, go to 6.
5.	Project is required to manage hydromodification impacts.		X	Hydromodification Management Required as described in Section 67.812 b(4) of the WPO.
6.	Project is not required to manage hydromodification impacts.	X		Hydromodification Exempt. Keep on file.

An exemption is potentially available for projects that are required (No. 5. in Table 5 above) to manage hydromodification impacts: The project proponent may conduct an independent geomorphic study to determine the project's full hydromodification impact. The study must incorporate sediment transport modeling across the range of geomorphically-significant flows and demonstrate to the County's satisfaction that the project flows and sediment reductions will not detrimentally affect the receiving water to qualify for the exemption.

STEP 4

POLLUTANTS OF CONCERN DETERMINATION

WATERSHED

Please check the watershed(s) for the project.

☐ San Juan 901	☐ Santa Margarita 902	☐ San Luis Rey 903	☐ Carlsbad 904
☐ San Dieguito 905	☐ Penasquitos 906	☐ San Diego 907	☐ Sweetwater 909
☐ Otay 910	☐ Tijuana 911	☐ Whitewater 719	☐ Clark 720
☐ West Salton 721	☑ Anza Borrego 722	☐ Imperial 723	

http://www.waterboards.ca.gov/sandiego/water_issues/programs/basin_plan/index.shtml

HYDROLOGIC SUB-AREA NAME AND NUMBER(S)

Number	Name
722.71	Jacumba hydrologic sub area

http://www.waterboards.ca.gov/sandiego/water_issues/programs/basin_plan/index.shtml

SURFACE WATERS that each project discharge point proposes to discharge to. List the impairments identified in Table 7.

SURFACE WATERS (river, creek, stream, etc.)	Hydrologic Unit Basin Number	Impairment(s) listed [303(d) listed waters or waters with established TMDLs]	Distance to Project
Tule Creek	722.71	None	0 mi
Carrizo Creek	722.71	None	4.2 mi

http://www.waterboards.ca.gov/water_issues/programs/tmdl/docs/303dlists2006/epa/r9_06_303d_reqtmdls.pdf

GROUND WATERS

Ground Waters	Hydrologic Unit Basin Number	MUN	AGR	IND	PROC	GWR	FRESH	POW	REC1	REC2	BIOL	WARM	COLD	WILD	RARE	SPWN
Anza-Borrego	722.00	X	X	X												

http://www.waterboards.ca.gov/sandiego/water_issues/programs/basin_plan/index.shtml

+ Excepted from Municipal ● Existing Beneficial Use ○ Potential Beneficial Use

PROJECT ANTICIPATED AND POTENTIAL POLLUTANTS

Using Table 6, identify pollutants that are anticipated to be generated from the proposed priority project categories. Pollutants associated with any hazardous material sites that have been remediated or are not threatened by the proposed project are not considered a pollutant of concern.

TABLE 6: ANTICIPATED AND POTENTIAL POLLUTANTS GENERATED BY LAND USE TYPE

	General Pollutant Categories								
PDP Categories	Sediments	Nutrients	Heavy Metals	Organic Compounds	Trash & Debris	Oxygen Demanding Substances	Oil & Grease	Bacteria & Viruses	Pesticides
Detached Residential Development	X	X			X	X	X	X	X
Attached Residential Development	X	X			X	$P^{(1)}$	$P^{(2)}$	P	X
Commercial Development 1 acre or greater	$P^{(1)}$	$P^{(1)}$		$P^{(2)}$	X	$P^{(5)}$	X	$P^{(3)}$	$P^{(5)}$
Heavy industry /industrial development	X		X	X	X	X	X		
Automotive Repair Shops			X	$X^{(4)(5)}$	X		X		
Restaurants					X	X	X	X	
Hillside Development >5,000 ft^2	**X**	**X**			**X**	**X**	**X**		**X**
Parking Lots	$P^{(1)}$	$P^{(1)}$	X		X	$P^{(1)}$	X		$P^{(1)}$
Retail Gasoline Outlets			X	X	X	X	X		
Streets, Highways & Freeways	X	$P^{(1)}$	X	$X^{(4)}$	X	$P^{(5)}$	X		

X = anticipated
P = potential
(1) A potential pollutant if landscaping exists on-site.
(2) A potential pollutant if the project includes uncovered parking areas.
(3) A potential pollutant if land use involves food or animal waste products.
(4) Including petroleum hydrocarbons.
(5) Including solvents.

PROJECT POLLUTANTS OF CONCERN SUMMARY TABLE

Please summarize the identified project pollutant of concern by checking the appropriate boxes in the table below and list any surface water impairments identified. Pollutants anticipated to be generated by the project, which are also causing impairment of receiving waters, shall be considered the primary pollutants of concern. For projects where no primary pollutants of concern exist, those pollutants identified as anticipated shall be considered secondary pollutants of concern.

TABLE 7: PROJECT POLLUTANTS OF CONCERN

Pollutant Category	**Anticipated (X)**	**Potential (P)**	**Surface Water Impairments**
Sediments	X	X	None
Nutrients	X	X	None
Heavy Metals	X	X	None
Organic Compounds		X	None
Trash & Debris	X		None
Oxygen Demanding Substances	X	X	None
Oil & Grease	X		None
Bacteria & Viruses		X	None
Pesticides	X	X	None

STEP 5

LID AND SITE DESIGN STRATEGIES

Each numbered item below is a Low Impact Development (LID) requirement of the WPO. Please check the box(s) under each number that best describes the LID BMP(s) and Site Design Strategies selected for this project.

TABLE 8: LID AND SITE DESIGN

1. Conserve natural Areas, Soils, and Vegetation
☑ Preserve well draining soils (Type A or B)
☑ Preserve Significant Trees
☑ Preserve critical (or problematic) areas such as floodplains, steep slopes, wetlands, and areas with erosive or unstable soil conditions
☐ Other. Description:
2. Minimize Disturbance to Natural Drainages
☐ Set-back development envelope from drainages
☑ Restrict heavy construction equipment access to planned green/open space areas
☐ Other. Description:
3. Minimize and Disconnect Impervious Surfaces (see 5)
☐ Clustered Lot Design
☑ Items checked in 5?
☐ Other. Description:
4. Minimize Soil Compaction
☑ Restrict heavy construction equipment access to planned green/open space areas
☐ Re-till soils compacted by construction vehicles/equipment
☐ Collect & re-use upper soil layers of development site containing organic Materials
☐ Other. Description:
5. Drain Runoff from Impervious Surfaces to Pervious Areas
<u>LID Street & Road Design</u>
☑ Curb-cuts to landscaping
☑ Rural Swales
☐ Concave Median
☐ Cul-de-sac Landscaping Design
☑ Other. Description: Nearly all roads will be gravel
<u>LID Parking Lot Design</u>
☑ Permeable Pavements
☑ Curb-cuts to landscaping

☐ Other. Description:

LID Driveway, Sidewalk, Bike-path Design

☑ Permeable Pavements
☑ Pitch pavements toward landscaping
☐ Other. Description:

LID Building Design

☐ Cisterns & Rain Barrels
☑ Downspout to swale
☐ Vegetated Roofs
☐ Other. Description:

LID Landscaping Design

☐ Soil Amendments
☑ Reuse of Native Soils
☐ Smart Irrigation Systems
☐ Street Trees
☐ Other. Description:

6. Minimize erosion from slopes

☑ Disturb existing slopes only when necessary
☑ Minimize cut and fill areas to reduce slope lengths
☐ Incorporate retaining walls to reduce steepness of slopes or to shorten slopes
☑ Provide benches or terraces on high cut and fill slopes to reduce concentration of flows
☐ Rounding and shaping slopes to reduce concentrated flow
☑ Collect concentrated flows in stabilized drains and channels
☐ Other. Description:

STEP 6

SOURCE CONTROL

Please complete the checklist on the following pages to determine Source Control BMPs. Below is instruction on how to use the checklist. (Also see instructions on page 40 of the *SUSMP)*

1. Review Column 1 and identify which of these potential sources of stormwater pollutants apply to your site. Check each box that applies.

2. Review Column 2 and incorporate all of the corresponding applicable BMPs in your Source Control Exhibit in Attachment B.

3. Review Columns 3 and 4 and incorporate all of the corresponding applicable permanent controls and operational BMPs in a table in your Project-Specific SUSMP.

Describe your specific BMPs in an accompanying narrative, and explain any special conditions or situations that required omitting BMPs or substituting alternatives.

Project development will incorporate the source control BMPs for indoor and structural pest control, outdoor pesticide use, refuse areas, and roofing, gutter, and trim material selection. Parking areas will be constructed of permeable gravel materials and as such will not be swept as listed in the County of San Diego SUSMP. All materials will be stored inside operation and maintenance facilities. No external storage areas are proposed. All other source control features identified in the County of San Diego SUSMP are considered for Project development. Refer to accompanying SWMP for more details on source control BMPs.

Use the format in Table 9 below to summarize the project Source Control BMPs. Incorporate all identified Source Control BMPs in your Source Control Exhibit in Attachment B.

TABLE 9: PROJECT SOURCE CONTROL BMPS

Potential source of runoff pollutants	*Permanent source control BMPs*	*Operational source control BMPs*
B. Interior floor drains	Interior floor drains will be plumbed to the sanitary sewer	Interior floor drains will be inspected and maintained to prevent blockage and overflow
D1. Need for future indoor and structural pest control	Building design features that discourage entrance of pests	Provide integrated pest management practice information to building owners and operators
D2. Landscape/Outdoor Pesticide Use	Native trees, shrubs, and ground cover will be preserved to the maximum extent practicable. Any landscaping will be designed	Landscaping will be maintained with minimum or no pestecides.

	to minimize runoff, promote surface infiltration, and minimize the use of fertilizers. Where landscaping is used to retain or detain stormwater, plants that are tolerant of saturated conditions will be used. Pest resistant plants will be used to the maximum extent practicable. Plants will be selected that are appropriate for site soils, slopes, climate, sun, wind, rain, land use, air movement, ecological consistency, and plant interactions	
G. Refuse areas	Refuse containers will either be contained indoors or will include a covered facility or trash receptacle lids to prevent runon or runoff. Signs will be posted on the receptacles stating "Do Not Dump Hazardous Materials Here" or similar.	The following practices will be implemented : Inspect receptacles regularly; repair or replace leaky receptacles. Keep receptacles covered. Prohibit/prevent dumping of liquid or hazardous wastes. Post "no hazardous materials" signs. Inspect and pick up litter daily and clean up spills immediately. Keep spill control materials available on-site.
O. Roofing, gutters, and trim	Roofing, gutter, and trim will avoid use of copper or other unprotected metals.	
P. Parking lots		Parking lots will be constructed of permeable gravel materials and as such will not be swept.

IF THESE SOURCES WILL BE ON THE PROJECT SITE …	… THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Source Control Exhibit, Attachment B	3 Permanent Controls—List in SUSMP Table and Narrative	4 Operational BMPs—Include in SUSMP Table and Narrative
☐ A. **On-site storm drain inlets**	☐ **Locations of inlets.**	☐ **Mark all inlets with the words “No Dumping! Flows to Bay” or similar.**	☐ **Maintain and periodically repaint or replace inlet markings.** ☐ **Provide stormwater pollution prevention information to new site owners, lessees, or operators.** ☐ **See applicable operational BMPs in Fact Sheet SC-44, “Drainage System Maintenance,” in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com** ☐ **Include the following in lease agreements: “Tenant shall not allow anyone to discharge anything to storm drains or to store or deposit materials so as to create a potential discharge to storm drains.”**
☑ B. **Interior floor drains and elevator shaft sump pumps**		☑ **State that interior floor drains and elevator shaft sump pumps will be plumbed to sanitary sewer.**	☑ **Inspect and maintain drains to prevent blockages and overflow.**
☐ C. **Interior parking garages**		☐ **State that parking garage floor drains will be plumbed to the sanitary sewer.**	☐ **Inspect and maintain drains to prevent blockages and overflow.**

IF THESE SOURCES WILL BE ON THE PROJECT SITE …	… THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Source Control Exhibit, Attachment B	3 Permanent Controls—List in SUSMP Table and Narrative	4 Operational BMPs—Include in SUSMP Table and Narrative
☑ D1. **Need for future indoor & structural pest control**		☑ **Note building design features that discourage entry of pests.**	☑ **Provide Integrated Pest Management information to owners, lessees, and operators.**

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Source Control Exhibit, Attachment B	3 Permanent Controls—List in SUSMP Table and Narrative	4 Operational BMPs—Include in SUSMP Table and Narrative
☑ D2. **Landscape/ Outdoor Pesticide Use** **Note: Should be consistent with project landscape plan (if applicable).**	☑ **Show locations of native trees or areas of shrubs and ground cover to be undisturbed and retained.** ☐ **Show self-retaining landscape areas, if any.** ☐ **Show stormwater treatment facilities.**	**State that final landscape plans will accomplish all of the following:** ☑ **Preserve existing native trees, shrubs, and ground cover to the maximum extent possible.** ☑ **Design landscaping to minimize irrigation and runoff, to promote surface infiltration where appropriate, and to minimize the use of fertilizers and pesticides that can contribute to stormwater pollution.** ☑ **Where landscaped areas are used to retain or detain stormwater, specify plants that are tolerant of saturated soil conditions.** ☑ **Consider using pest-resistant plants, especially adjacent to hardscape.** ☑ **To insure successful establishment, select plants appropriate to site soils, slopes, climate, sun, wind, rain, land use, air movement, ecological consistency, and plant interactions.**	☑ **Maintain landscaping using minimum or no pesticides.** ☑ **See applicable operational BMPs in Fact Sheet SC-41, "Building and Grounds Maintenance," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com** ☐ **Provide IPM information to new owners, lessees and operators.**

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Source Control Exhibit, Attachment B	3 Permanent Controls—List in SUSMP Table and Narrative	4 Operational BMPs—Include in SUSMP Table and Narrative
☐ E. **Pools, spas, ponds, decorative fountains, and other water features.**	☐ **Show location of water feature and a sanitary sewer cleanout in an accessible area within 10 feet.**	☐ **If the local municipality requires pools to be plumbed to the sanitary sewer, place a note on the plans and state in the narrative that this connection will be made according to local requirements.**	☐ **See applicable operational BMPs in Fact Sheet SC-72, "Fountain and Pool Maintenance," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com**
☐ F. **Food service**	☐ **For restaurants, grocery stores, and other food service operations, show location (indoors or in a covered area outdoors) of a floor sink or other area for cleaning floor mats, containers, and equipment.** ☐ **On the drawing, show a note that this drain will be connected to a grease interceptor before discharging to the sanitary sewer.**	☐ **Describe the location and features of the designated cleaning area.** ☐ **Describe the items to be cleaned in this facility and how it has been sized to insure that the largest items can be accommodated.**	☐

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Source Control Exhibit, Attachment B	3 Permanent Controls—List in SUSMP Table and Narrative	4 Operational BMPs—Include in SUSMP Table and Narrative
☑ G. **Refuse areas**	☑ **Show where site refuse and recycled materials will be handled and stored for pickup. See local municipal requirements for sizes and other details of refuse areas.** ☐ **If dumpsters or other receptacles are outdoors, show how the designated area will be covered, graded, and paved to prevent run-on and show locations of berms to prevent runoff from the area.** ☐ **Any drains from dumpsters, compactors, and tallow bin areas shall be connected to a grease removal device before discharge to sanitary sewer.**	☑ **State how site refuse will be handled and provide supporting detail to what is shown on plans.** ☑ **State that signs will be posted on or near dumpsters with the words "Do not dump hazardous materials here" or similar.**	☐ **State how the following will be implemented:** **Provide adequate number of receptacles. Inspect receptacles regularly; repair or replace leaky receptacles. Keep receptacles covered. Prohibit/prevent dumping of liquid or hazardous wastes. Post "no hazardous materials" signs. Inspect and pick up litter daily and clean up spills immediately. Keep spill control materials available on-site. See Fact Sheet SC-34, "Waste Handling and Disposal" in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com**
☐ H. **Industrial processes.**	☐ **Show process area.**	☐ **If industrial processes are to be located on site, state: "All process activities to be performed indoors. No processes to drain to exterior or to storm drain system."**	☐ **See Fact Sheet SC-10, "Non-Stormwater Discharges" in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com**

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Source Control Exhibit, Attachment B	3 Permanent Controls—List in SUSMP Table and Narrative	4 Operational BMPs—Include in SUSMP Table and Narrative
☐ I. **Outdoor storage of equipment or materials. (See rows J and K for source control measures for vehicle cleaning, repair, and maintenance.)**	☐ **Show any outdoor storage areas, including how materials will be covered. Show how areas will be graded and bermed to prevent run-on or run-off from area.** ☐ **Storage of non-hazardous liquids shall be covered by a roof and/or drain to the sanitary sewer system, and be contained by berms, dikes, liners, or vaults.** ☐ **Storage of hazardous materials and wastes must be in compliance with the local hazardous materials ordinance and a Hazardous Materials Management Plan for the site.**	☐ **Include a detailed description of materials to be stored, storage areas, and structural features to prevent pollutants from entering storm drains.** **Where appropriate, reference documentation of compliance with the requirements of local Hazardous Materials Programs for:** ▪ **Hazardous Waste Generation** ▪ **Hazardous Materials Release Response and Inventory** ▪ **California Accidental Release (CalARP)** ▪ **Aboveground Storage Tank** ▪ **Uniform Fire Code Article 80 Section 103(b) & (c) 1991** ▪ **Underground Storage Tank**	☐ **See the Fact Sheets SC-31, "Outdoor Liquid Container Storage" and SC-33, "Outdoor Storage of Raw Materials " in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com**

☐ J. Vehicle and Equipment Cleaning	☐ Show on drawings as appropriate: (1) Commercial/industrial facilities having vehicle /equipment cleaning needs shall either provide a covered, bermed area for washing activities or discourage vehicle/equipment washing by removing hose bibs and installing signs prohibiting such uses. (2) Multi-dwelling complexes shall have a paved, bermed, and covered car wash area (unless car washing is prohibited on-site and hoses are provided with an automatic shut-off to discourage such use). (3) Washing areas for cars, vehicles, and equipment shall be paved, designed to prevent run-on to or runoff from the area, and plumbed to drain to the sanitary sewer. (4) Commercial car wash facilities shall be designed such that no runoff from the facility is discharged to the storm drain system. Wastewater from the facility shall discharge to the sanitary sewer, or a wastewater reclamation system shall be installed.	☐ If a car wash area is not provided, describe measures taken to discourage on-site car washing and explain how these will be enforced.	Describe operational measures to implement the following (if applicable): ☑ Washwater from vehicle and equipment washing operations shall not be discharged to the storm drain system. ☐ Car dealerships and similar may rinse cars with water only. ☐ See Fact Sheet SC-21, "Vehicle and Equipment Cleaning," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com

☐ K. **Vehicle/Equipment Repair and Maintenance**	☑ **Accommodate all vehicle equipment repair and maintenance indoors. Or designate an outdoor work area and design the area to prevent run-on and runoff of stormwater.** ☐ **Show secondary containment for exterior work areas where motor oil, brake fluid, gasoline, diesel fuel, radiator fluid, acid-containing batteries or other hazardous materials or hazardous wastes are used or stored. Drains shall not be installed within the secondary containment areas.** ☑ **Add a note on the plans that states either (1) there are no floor drains, or (2) floor drains are connected to wastewater pretreatment systems prior to discharge to the sanitary sewer and an industrial waste discharge permit will be obtained.**	☑ **State that no vehicle repair or maintenance will be done outdoors, or else describe the required features of the outdoor work area.** ☑ **State that there are no floor drains or if there are floor drains, note the agency from which an industrial waste discharge permit will be obtained and that the design meets that agency's requirements.** ☑ **State that there are no tanks, containers or sinks to be used for parts cleaning or rinsing or, if there are, note the agency from which an industrial waste discharge permit will be obtained and that the design meets that agency's requirements.**	**In the SUSMP report, note that all of the following restrictions apply to use the site:** ☑ **No person shall dispose of, nor permit the disposal, directly or indirectly of vehicle fluids, hazardous materials, or rinsewater from parts cleaning into storm drains.** ☑ **No vehicle fluid removal shall be performed outside a building, nor on asphalt or ground surfaces, whether inside or outside a building, except in such a manner as to ensure that any spilled fluid will be in an area of secondary containment. Leaking vehicle fluids shall be contained or drained from the vehicle immediately.** ☑ **No person shall leave unattended drip parts or other open containers containing vehicle fluid, unless such containers are in use or in an area of secondary containment.**

☐ L. **Fuel Dispensing Areas**	☐ **Fueling areas[1] shall have impermeable floors (i.e., portland cement concrete or equivalent smooth impervious surface) that are: a) graded at the minimum slope necessary to prevent ponding; and b) separated from the rest of the site by a grade break that prevents run-on of stormwater to the maximum extent practicable.** ☐ **Fueling areas shall be covered by a canopy that extends a minimum of ten feet in each direction from each pump. [Alternative: The fueling area must be covered and the cover's minimum dimensions must be equal to or greater than the area within the grade break or fuel dispensing area[1].] The canopy [or cover] shall not drain onto the fueling area.**		☐ **The property owner shall dry sweep the fueling area routinely.** ☐ **See the Business Guide Sheet, "Automotive Service—Service Stations" in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com**

---

[1] **The fueling area shall be defined as the area extending a minimum of 6.5 feet from the corner of each fuel dispenser or the length at which the hose and nozzle assembly may be operated plus a minimum of one foot, whichever is greater.**

☐ M. **Loading Docks**	☐ Show a preliminary design for the loading dock area, including roofing and drainage. Loading docks shall be covered and/or graded to minimize run-on to and runoff from the loading area. Roof downspouts shall be positioned to direct stormwater away from the loading area. Water from loading dock areas should be drained to the sanitary sewer where feasible. Direct connections to storm drains from depressed loading docks are prohibited. ☐ Loading dock areas draining directly to the sanitary sewer shall be equipped with a spill control valve or equivalent device, which shall be kept closed during periods of operation. ☐ Provide a roof overhang over the loading area or install door skirts (cowling) at each bay that enclose the end of the trailer.		☐ Move loaded and unloaded items indoors as soon as possible. ☐ See Fact Sheet SC-30, "Outdoor Loading and Unloading," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com
☐ N. **Fire Sprinkler Test Water**		☐ Provide a means to drain fire sprinkler test water to the sanitary sewer.	☐ See the note in Fact Sheet SC-41, "Building and Grounds Maintenance," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com

O. Miscellaneous Drain or Wash Water ☐ Boiler drain lines ☐ Condensate drain lines ☐ Rooftop equipment ☐ Drainage sumps ☑ Roofing, gutters, and trim.		☐ Boiler drain lines shall be directly or indirectly connected to the sanitary sewer system and may not discharge to the storm drain system. ☐ Condensate drain lines may discharge to landscaped areas if the flow is small enough that runoff will not occur. Condensate drain lines may not discharge to the storm drain system. ☐ Rooftop mounted equipment with potential to produce pollutants shall be roofed and/or have secondary containment. ☐ Any drainage sumps on-site shall feature a sediment sump to reduce the quantity of sediment in pumped water. ☑ Avoid roofing, gutters, and trim made of copper or other unprotected metals that may leach into runoff.	
☑ P. Plazas, sidewalks, and parking lots.			☐ Plazas, sidewalks, and parking lots shall be swept regularly to prevent the accumulation of litter and debris. Debris from pressure washing shall be collected to prevent entry into the storm drain system. Washwater containing any cleaning agent or degreaser shall be collected and discharged to the sanitary sewer and not discharged to a storm drain.

STEP 7

LID AND TREATMENT CONTROL SELECTION

A treatment control BMP and/or LID facility must be selected to treat the project pollutants of concern identified in Table 7 "Project Pollutants of Concern". A treatment control facility with a high or medium pollutant removal efficiency for the project's most significant pollutant of concern shall be selected. It is recommended to use the design procedure in Chapter 4 of the SUSMP to meet NPDES permit LID requirements, treatment requirements, and flow control requirements. If your project does not utilize this approach, the project will need to demonstrate compliance with LID, treatment and flow control requirements. Review Chapter 2 "Selection of Stormwater Treatment Facilities" in the SUSMP to assist in determining the appropriate treatment facility for your project.

<table>
<tr><td colspan="2">Will this project be utilizing the unified LID design procedure as described in Chapter 4 of the Local SUSMP? <i>(If yes, please document in Attachment D following the steps in Chapter 4 of the County SUSMP)</i></td></tr>
<tr><td>Yes</td><td>No</td></tr>
<tr><td colspan="2">If this project is not utilizing the unified LID design procedure, please describe how the alternative treatment facilities will comply with applicable LID criteria, stormwater treatment criteria, and hydromodification management criteria.</td></tr>
<tr><td colspan="2">Based on discussions with County of San Diego Department of Public Works staff, the Project is not required to address SUSMP stormwater treatment criteria or hydromodification management criteria.

However, Project development does not propose to increase impervious areas by significant amounts, with the majority of improvements being constructed of permeable materials. Every impervious area of the Project will drain to permeable surrounding surfaces prior to discharging to surrounding natural drainage features. There are no connected impervious conveyance facilities proposed for the Project. Stormwater treatement will be achieved through site design and source control as well as post-construction BMPs required by the Water Resources Control Board Order No. 2009-0009-DWQ General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activities. Hydromodification will also be addressed at a later time by the State General Construction Permit.</td></tr>
</table>

- Indicate the project pollutants of concern (POCs) from Table 7 in Column 2 below.

TABLE 10: GROUPING OF POTENTIAL POLLUTANTS of Concern (POCs) by fate during stormwater treatment

Pollutant	**Check Project Specific POCs**	**Coarse Sediment and Trash**	**Pollutants that tend to associate with fine particles during treatment**	**Pollutants that tend to be dissolved following treatment**
Sediment	X	X	X	
Nutrients			X	X
Heavy Metals			X	
Organic Compounds			X	
Trash & Debris	X	X		
Oxygen Demanding			X	
Bacteria			X	
Oil & Grease	X		X	
Pesticides			X	

- Indicate the treatment facility(s) chosen for this project in the following table.

TABLE 11: GROUPS OF POLLUTANTS and relative effectiveness of treatment facilities

Pollutants of Concern	Bioretention Facilities (LID)	Settling Basins (Dry Ponds)	Wet Ponds and Constructed Wetlands	Infiltration Facilities or Practices (LID)	Media Filters	Higher-rate biofilters*	Higher-rate media filters*	Trash Racks & Hydro -dynamic Devices	**Vegetated Swales**
Coarse Sediment and Trash	High	High	High	High	High	High	High	High	High
Pollutants that tend to associate with fine particles during treatment	High	High	High	High	High	Medium	Medium	Low	Medium
Pollutants that tend to be dissolved following treatment	Medium	Low	Medium	High	Low	Low	Low	Low	Low

- Please check the box(s) that best describes the Treatment BMP(s) and/or LID BMP selected for this project.

TABLE 12: PROJECT LID AND TC-BMPS

Bioretention Facilites (LID)
☐ Bioretention area
☐ Flow-through Planter
☐ Cistern with Bioretention Facility

Settling Basins (Dry Ponds)
☐ Extended/dry detention basin with grass/vegetated lining
☐ Extended/dry detention basin with impervious lining
Infiltration Facilities or Practices (LID)
☐ Infiltration basin
☐ Dry well
☐ Infiltration trench
Wet Ponds and Constructed Wetlands
☐ Wet pond/basin (permanent pool)
☐ Constructed wetland
Vegetated Swales (LID(1))
☐ Vegetated Swale
Media Filters
☐ Austin Sand Filter
☐ Delaware Sand Filter
☐ Multi-Chambered Treatment Train (MCTT)
Higher-rate Biofilters
☐ Tree-pit-style unit
☐ Other___________________________________
Higher-rate Media Filters
☐ Vault-based filtration unit with replaceable cartridges
☐ Other___________________________________
Hydrodynamic Separator Systems
☐ Swirl Concentrator
☐ Cyclone Separator
Trash Racks
☐ Catch Basin Insert
☐ Catch Basin Insert w/ Hydrocarbon boom
☐ Other___________________________________
Self-Treating or Self-Retaining Areas (LID)
☐ Pervious Pavements
☐ Vegetated Roofs
☐ Other___________________________________

(1) Must be designed per SUSMP "Vegetated Swales" design criteria for LID credit (p. 65).

For design guidelines and calculations refer to Chapter 4 "Low Impact Development Design Guide" in the SUSMP. Please show all calculations and design sheets for all treatment facilities proposed in Attachment D.

- Create a Construction Plan SWMP Checklist for your project.

Instructions on how to fill out table

1. Number and list each measure or BMP you have specified in your SWMP in Columns 1 and Maintenance Category in Column 3 of the table. Leave Column 2 blank.

2. When you submit construction plans, duplicate the table (by photocopy or electronically). Now fill in Column 2, identifying the plan sheets where the BMPs are shown. List all plan sheets on which the BMP appears. This table must be shown on the front sheet of the grading and improvement plans.

Stormwater Treatment Control and LID BMP's			
Description / Type	Sheet	Maintenance Category	Revisions

* BMP's approved as part of Stormwater Management Plan (SWMP) dated xx/xx/xx on file with DPW. Any changes to the above BMP's will require SWMP revision and Plan Change approvals.

- Please describe why the chosen treatment BMP(s) was selected for this project. For projects utilizing a low performing BMP, please provide a feasibility analysis that demonstrates utilization of a treatment facility with a high or medium removal efficiency ranking is infeasible.

Based on the locations of the project site, drainage patterns, site constraints, treatment efficiencies, maintenance concerns, the recommended treatment control devices are:

Runoff from the Project does not enter a Municipal Separate Storm Sewer System (MS4) and is outside of Phase I and Phase II NPDES permits for the Regional Water Quality Control Board. This Project is therefore not subject to the regulations of Order No. R9-2007-0001, which requires the use of Treatment Control BMPs to reduce pollutants to runoff from priority projects. As such Treatment Control BMPs are not required.

However, the State Water Resources Control Board Order No. 2009-0009-DWQ General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activities applies to the Project and requires post-construction BMPs. These BMPs are intended to mitigate hydromodification impacts through a number of different alternatives quantified by a Water Balance Calculator. Project development will meet these requirements through the use of any number of vegetated swales, extended detention basins, or impervious area disconnection designed and discussed in the documentation required for the State General Construction Permit. Site runoff will still be treated with LID site design and source control BMPs per the County of San Diego SUSMP.

A Treatment BMP must address runoff from developed areas. Please provide the post-construction water quality treatment volume or flow values for the selected project Treatment BMP(s). Guidelines for design calculations are located in Chapter 4 of the County SUSMP. Label outfalls on the BMP map. The Water Quality peak rate of discharge flow (Q_{WQ}) and the Water Quality storage volume (V_{WQ}) is dependent on the type of treatment BMP selected for the project.

Outfall	**Tributary Area (acres)**	**Q_{WQ} (cfs)**	**V_{WQ} (ft^3)**

STEP 8

OPERATION AND MAINTENANCE

- Please check the box that best describes the maintenance mechanism(s) for this project.

TABLE 13: PROJECT BMP CATEGORY

CATEGORY	**SELECTED**		**BMP Description**
	YES	**NO**	
First		X	
Second[1]		X	
Third[2]		X	
Fourth		X	

Note:

1. A recorded maintenance agreement will be required.
2. Project will be required to establish or be included in a Stormwater Maintenance Assessment District for the long-term maintenance of treatment BMPs.

- Please list all individual LID and Treatment Control BMPs (TC-BMPs) incorporated into project. Please ensure the "BMP Identifier" is consistent with the legend in Attachment C "LID and/or TC-BMP Exhibit". Please attach the record plan sheets upon completion of project and amend the Major SWMP where appropriate. For each type of LID or TC-BMP provide an inspection sheet in Attachment F "Maintenance Plan".

TABLE 14: PROJECT SPECIFIC LID AND TC-BMPS

BMP Identifier*	LID or TC-BMP Type	BMP Pollutant of Concern Efficiency (H,M,L) – Table 11	Final Construction Date *(to be completed by County inspector)*	Final Construction Inspector Name *(to be completed by County inspector)*

* For location of BMP's, see approved Record Plan dated _XX/XX/XX_, plan (TYPE) sheet _(#) _.

- Responsible Party for Long-term Maintenance:

Identify the parties responsible for long-term maintenance of the BMPs identified above and Source Controls specified in Attachment B. Include the appropriate written agreement with the entities responsible for O&M in Attachment F. Please see Chapter 5 "Private Ownership and Maintenance" on page 94 of the County SUSMP for appropriate maintenance mechanisms.

Name:
Company Name: Iberdrola Renewables
Phone Number: 503-796-7781
Street Address: 1125 Northwest Couch Street, Suite 700
City/State/Zip: Portland, OR 97209
Email Address: Jeffrey.durocher@iberdrolausa.com

- Funding Source:

Provide the funding source or sources for long-term operation and maintenance of each BMP identified above. By certifying the Major SWMP the applicant is certifying that the funding responsibilities have been addressed and will be transferred to future owners.

Site design and source control BMPs are mainly self maintaining through normal vegetation cycles or require little to no maintenance. However, Iberdrola will be responsible for operation and maintenance of all BMPs on the Project site.

ATTACHMENTS

Please include the following attachments.

ATTACHMENT		COMPLETED	N/A
A	Project Location Map	X	
B	Source Control Exhibit	X	
C	LID and/or TC-BMP Exhibit	X	
D	Drainage Management Area (DMA) Maps, Sizing Design Calculations and BMP/IMP Design Details		X
E	Geotechnical Certification Sheet		X
F	Maintenance Plan		X
G	Tracking Report		X
H	Addendum		X

Note: Attachments B and C may be combined.

APPENDIX D

Project Exhibits

Exhibit A – Existing Conditions Drainage Map
Exhibit B – Proposed Conditions Drainage Map
Exhibit C – BMP Map

HDR
ONE COMPANY | *Many Solutions*

Existing Conditions Drainage Map

EXHIBIT A

424914 - Iberdrola Renewables | 115965 - Tule Wind Energy | Water Quality Study

HDR
ONE COMPANY | *Many Solutions*™

Proposed Conditions Drainage Map

EXHIBIT B

424914 - Iberdrola Renewables | 115965 - Tule Wind Energy | Water Quality Study

HDR
ONE COMPANY | *Many Solutions*™

BMP Map

EXHIBIT C

424914 - Iberdrola Renewables | 115965 - Tule Wind Energy | Water Quality Study

APPENDIX E
Additional BMP Information

CASQA Site Design and Facility Design
CASQA Site Design and Landscape Planning
CASQA Vegetated Swale
CASQA Extended Detention Basin

Section 3
Site and Facility Design for Water Quality Protection

3.1 Introduction

Site and facility design for stormwater quality protection employs a multi-level strategy. The strategy consists of: 1) reducing or eliminating post-project runoff; 2) controlling sources of pollutants; and 3), if still needed after deploying 1) and 2), treating contaminated stormwater runoff before discharging it to the storm drain system or to receiving waters.

This section describes how elements 1), 2), and 3) of the strategy can be incorporated into the site and facility planning and design process, and by doing so, eliminating or reducing the amount of stormwater runoff that may require treatment at the point where stormwater runoff ultimately leaves the site. Elements 1) and 2) may be referred to as "source controls" because they emphasize reducing or eliminating pollutants in stormwater runoff at their source through runoff reduction and by keeping pollutants and stormwater segregated. Section 4 provides detailed descriptions of the BMPs related to elements 1) and 2) of the strategy. Element 3) of the strategy is referred to as "treatment control" because it utilizes treatment mechanisms to remove pollutants that have entered stormwater runoff. Section 5 provides detailed descriptions of BMPs related to element 3) of the strategy. Treatment controls integrated into and throughout the site usually provide enhanced benefits over the same or similar controls deployed only at the "end of the pipe" where runoff leaves the project site.

3.2 Integration of BMPs into Common Site Features

Many common site features can achieve stormwater management goals by incorporating one or more basic elements, either alone or in combination, depending on site and other conditions. The basic elements include infiltration, retention/detention, biofilters, and structural controls. This section first describes these basic elements, and then describes how these elements can be incorporated into common site features.

Infiltration

Infiltration is the process where water enters the ground and moves downward through the unsaturated soil zone. Infiltration is ideal for management and conservation of runoff because it filters pollutants through the soil and restores natural flows to groundwater and downstream water bodies. See Figure 3-1.

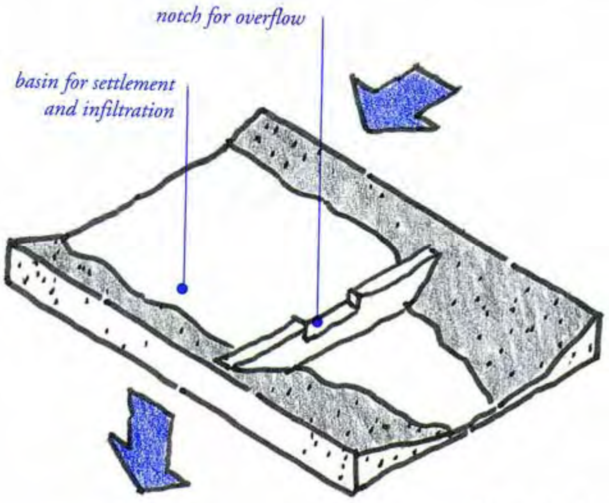


Figure 3-1
Infiltration Basin

The infiltration approach to stormwater management seeks to "preserve and restore the hydrologic cycle." An infiltration stormwater system seeks to infiltrate runoff into the soil by allowing it to flow slowly over permeable surfaces. The slow flow of runoff allows pollutants to settle into the soil where they are naturally mitigated. The reduced volume of runoff that remains takes a long time to reach the outfall, and when it empties into a natural water body or storm sewer, its pollutant load is greatly reduced.

Infiltration basins can be either open or closed. Open infiltration basins, include ponds, swales and other landscape features, are usually vegetated to maintain the porosity of the soil structure and to reduce erosion. Closed infiltration basins can be constructed under the land surface with open graded crushed stone, leaving the surface to be used for parking or other uses. Subsurface closed basins are generally more difficult to maintain and more expensive than open filtration systems, and are used primarily where high land costs demand that the land surface be reclaimed for economic use.

Infiltration systems are often designed to capture the "first flush" storm event and used in combination with a detention basin to control peak hydraulic flows. They effectively remove suspended solids, particulates, bacteria, organics and soluble metals and nutrients through the vehicle of filtration, absorption and microbial decomposition. Groundwater contamination should be considered as a potential adverse effect and should be considered where shallow groundwater is a source of drinking water. In cases where groundwater sources are deep, there is a very low chance of contamination from normal concentrations of typical urban runoff.

Retention and Detention

Retention and detention systems differ from infiltration systems primarily in intent. Detention systems are designed to capture and retain runoff temporarily and release it to receiving waters at predevelopment flow rates. Permanent pools of water are not held between storm events. Pollutants settle out and are removed from the water column through physical processes. See Figure 3-2.

Retention systems capture runoff and retain it between storms as shown in Figure 3-3. Water held in the system is displaced by the next significant rainfall event. Pollutants settle out and are thereby removed from the water column. Because the water remains in the system for a period of time, retention systems benefit from biological and biochemical removal mechanisms provided by aquatic plants and microorganisms. See Figure 3-3.

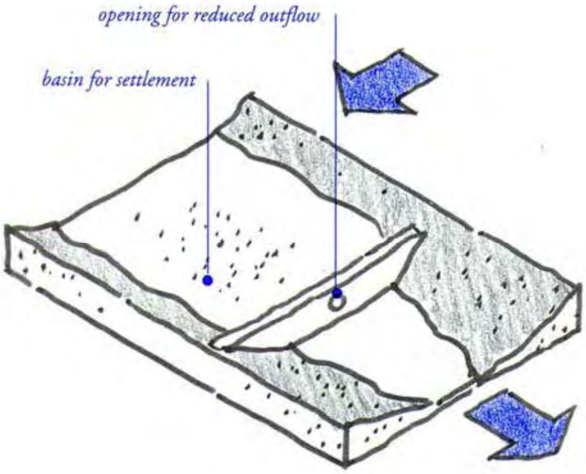


Figure 3-2
Simple Detention System

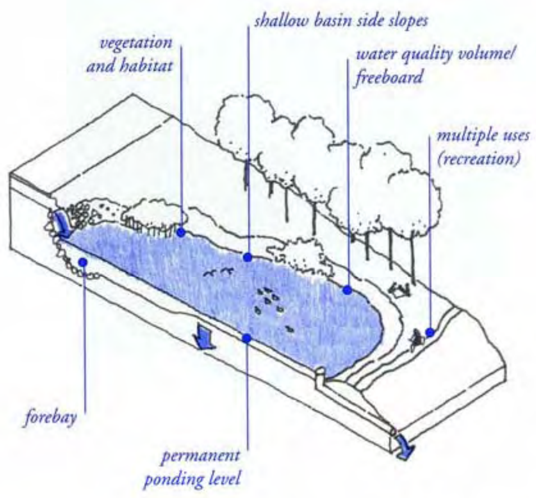


Figure 3-3
Retention System

Retention/detention systems may release runoff slowly enough to reduce downstream peak flows to their pre-development levels, allow fine sediments to settle, and uptake dissolved nutrients in the runoff where wetland vegetation is included.

Bioretention facilities have the added benefit of aesthetic appeal. These systems can be placed in parking lot islands, landscaped areas surrounding buildings, perimeter parking lots, and other open space sections. Placing bioretention facilities on land that city regulations require developers to devote to open space efficiently uses the land. An experienced landscape architect can choose plant species and planting materials that are easy to maintain, aesthetically pleasing, and capable of effectively reducing pollutants in runoff from the site.

Constructed wetland systems retain and release stormwater in a manner that is similar to retention or detention basins. The design mimics natural ecological functions and uses wetland vegetation to filter pollutants. The system needs a permanent water source to function properly and must be engineered to remove coarse sediment, especially construction related sediments, from entering the pond. Stormwater has the potential to negatively affect natural wetland functions and constructed wetlands can be used to buffer sensitive resources.

Biofilters

Biofilters, also known as vegetated swales and filter strips, are vegetated slopes and channels designed and maintained to transport shallow depths of runoff slowly over vegetation. Biofilters are effective if flows are slow and depths are shallow (3% slope max.). The slow movement of runoff through the vegetation provides an opportunity for sediments and particulates to be filtered and degraded through biological activity. In most soils, the biofilter also provides an opportunity for stormwater infiltration, which further removes pollutants and reduces runoff volumes. See Figure 3-4.

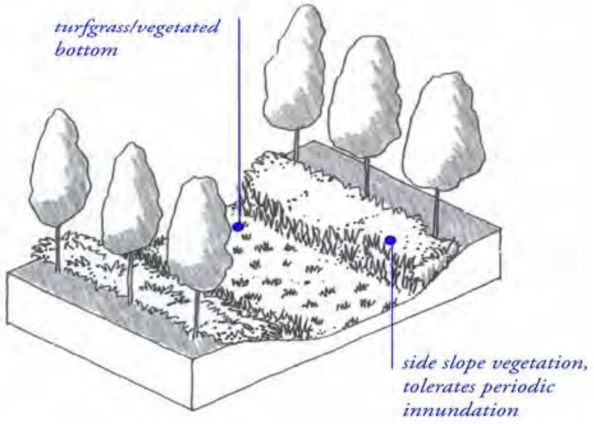


Figure 3-4
Vegetated Swale

Swales intercept both sheet and concentrated flows and convey these flows in a concentrated, vegetation-lined channel. Grass filter strips intercept sheet runoff from the impervious network of streets, parking lots, and rooftops and divert stormwater to a uniformly graded meadow, buffer zone, or small forest. Typically, the vegetated swale and grass strip-planting palette can comprise a wide range of possibilities from dense vegetation to turf grass. Grass strips and vegetated swales can function as pretreatment systems for water entering bioretention systems or other BMPs. If biofilters are to succeed in filtering pollutants from the water column, the planting design must consider the hydrology, soils, and maintenance requirements of the site.

Appropriate plantings not only improve water quality, they provide habitat and aesthetic benefits. Selected plant materials must be able to adapt to variable moisture regimes. Turf grass is acceptable if it can be watered in the dry season, and if it is not inundated for long periods. Species such as willows, dogwoods, sedge, rush, lilies, and bulrush tolerate varying degrees of soil moisture and can provide an attractive plant palette year round.

Structural Controls

Structural controls in the context of this section include a range of measures that prevent pollutants from coming into contact with stormwater. In this context, these measures may be referred to as “structural source controls” meaning that they utilize structural features to prevent pollutant sources and stormwater from coming into contact with one another, thus reducing the opportunity for stormwater to become contaminated. Examples of structural source controls include covers, impermeable surfaces, secondary containment facilities, runoff diversion berms, and diversions to wastewater treatment plants.

3.2.1 Streets

More than any other single element, street design has a powerful impact on stormwater quality. Street and other transportation-related structures typically can comprise between 60 and 70% of the total impervious coverage in urban areas and, unlike rooftops, streets are almost always directly connected to an underground stormwater system.

Recognizing that street design can be the greatest factor in development’s impact on stormwater quality, it is important that designers, municipalities and developers employ street standards that reduce impervious land coverage. Directing runoff to biofilters or swales rather than underground storm drains produces a street system that conveys stormwater efficiently while providing both water quality and aesthetic benefits.

On streets where a more urban character is desired, or where a rigid pavement edge is required, curb and gutter systems can be designed to empty into drainage swales. These swales can run parallel to the street, in the parkway between the curb and the sidewalk, or can intersect the street at cross-angles, and run between residences, depending on topography or site planning. Runoff travels along the gutter, but instead of being emptied into a catch basin and underground pipe, multiple openings in the curb direct runoff into surface swales or infiltration/detention basins.

In recent years, new street standards have been gaining acceptance that meets the access requirements of local residential streets while reducing impervious land coverage. These standards create a new class of street that is narrower and more interconnected than the current local street standard, called an “access” street. An access street is at the lowest end of the street hierarchy and is intended only to provide access to a limited number of residences.

Street design is usually mandated by local municipal standards. Officials must consider the scale of the land use as they select stormwater and water quality design solutions. Traffic volume and speeds, bicycle lane design criteria, and residential and business densities influence the willingness of decision makers to permit the narrow streets that include curbless design alternatives.

Emergency service providers often raise objections to reduced street widths. Street designs illustrated here meet national Fire Code standards for emergency access. An interconnected grid system of narrow streets also allows emergency service providers with multiple access routes to compensate for the unlikely possibility that a street may be blocked.

Many municipal street standards mandate 80 to 100% impervious land coverage in the public right-of-way, and are a principal contributor to the environmental degradation caused by development.

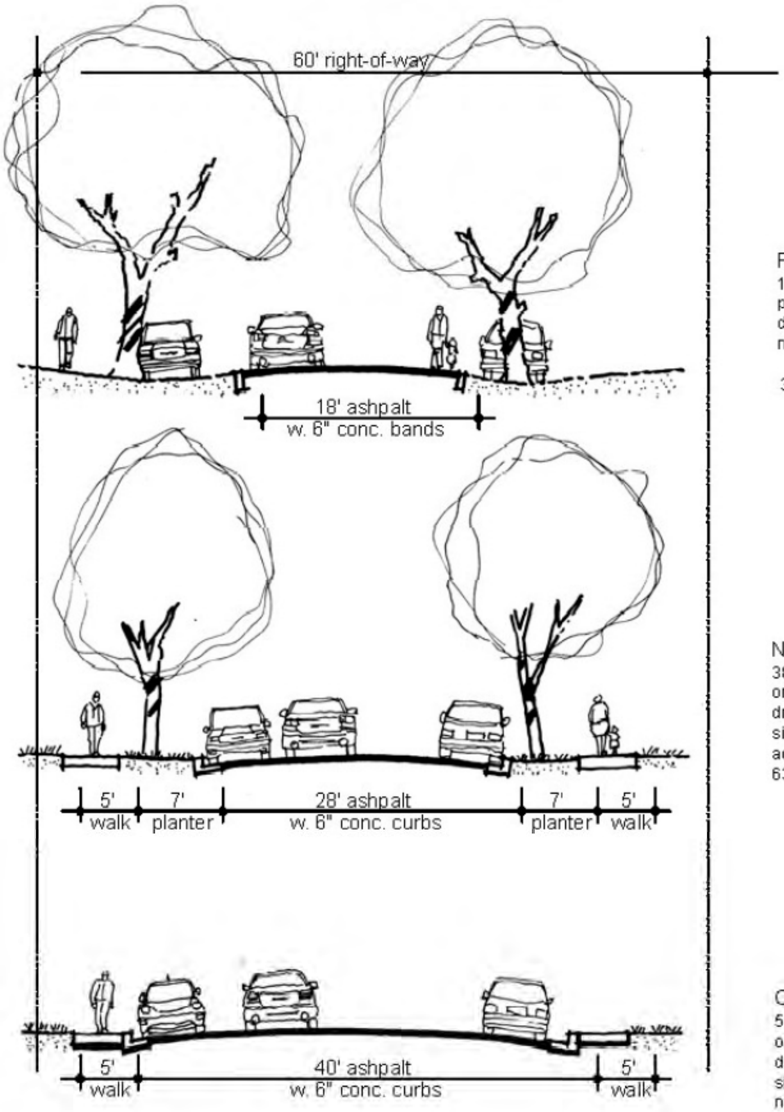
A street standard that allows an interconnected system of narrow access streets for residential neighborhoods has the potential to achieve several complimentary environmental and social benefits. A hierarchy of streets sized according to average daily traffic volumes yields a wide variety of benefits: improved safety from lower speeds and volumes, improved aesthetics from street trees and green parkways, reduced impervious land coverage, less heat island effect, and lower development costs. If the reduction in street width is accompanied by a drainage system that allows for infiltration of runoff, the impact of streets on stormwater quality can be greatly mitigated.

There are many examples of narrow streets, from both newly constructed and older communities, which demonstrate the impact of street design on neighborhood character and environmental quality. See Table 3-1.

Table 3-1 Adopted Narrow Street Standards (Typ. Cross-Sections, two-way traffic)

City of Santa Rosa	30 ft wide with parking permitted both sides, <1000 Average Daily Traffic (ADT) 26 – 28 ft with parking permitted one side 20 ft - no parking permitted 20 ft neck downs at intersections
City of Palmdale	28 ft wide with parking permitted both sides
City of San Jose	30 ft wide with parking permitted both sides, <21 Dwelling Units (DU) 34 ft wide with parking permitted both sides, <121 DU
City of Novato	24 ft wide with parking permitted both sides, 2-4 DU 28 ft with parking permitted both sides, 5-15 DU
County of San Mateo	19 ft wide rural pavement cross-section with parking permitted on adjacent gravel shoulders

A comparison of street cross-sections is shown in Figure 3-5.



RURAL
19' pavement
parking on gravel shoulder
drainage in gravel swale
no sidewalk- shared space

32% impervious land coverage

NEO-TRADITIONAL
38' pavement
on-street parking, both sides
drainage in concrete gutter
sidewalk both sides
adequate space for street trees
63% impervious land coverage

CONVENTIONAL
50' pavement
on-street parking both sides
drainage in concrete gutter
sidewalk both sides
no street trees
83% impervious land coverage

Figure 3-5
Comparison of Street Cross-Sections (two-way traffic, residential access streets)

3.2.2 Parking Lots

In any development, storage space for stationary vehicles can consume many acres of land area, often greater than the area covered by streets or rooftops. In a neighborhood of single-family homes, this parking area is generally located on private driveways or along the street. In higher density residential developments, parking is often consolidated in parking lots.

The space for storage of the automobile, the standard parking stall, occupies only 160 ft^2, but when combined with aisles, driveways, curbs, overhang space, and median islands, a parking lot can require up to 400 ft^2 per vehicle, or nearly one acre per 100 cars. Since parking is usually accommodated on an asphalt or concrete surface with conventional underground storm drain systems, parking lots typically generate a great deal of DCIA.

There are many ways to both reduce the impervious land coverage of parking areas and to filter runoff before it reaches the storm drain system.

Hybrid Parking Lot

Hybrid lots work on the principle that pavement use differs between aisles and stalls. Aisles must be designed for speeds between 10 and 20 mph, and durable enough to support the concentrated traffic of all vehicles using the lot. The stalls, on the other hand, need only be designed for the 2 or 3 mph speed of vehicles maneuvering into place. Most of the time the stalls are in use, vehicles are stationary. Hybrid lots reduce impervious surface coverage in parking areas by differentiating the paving between aisles and stalls, and combining impervious aisles with permeable stalls, as shown in Figure 3-6.

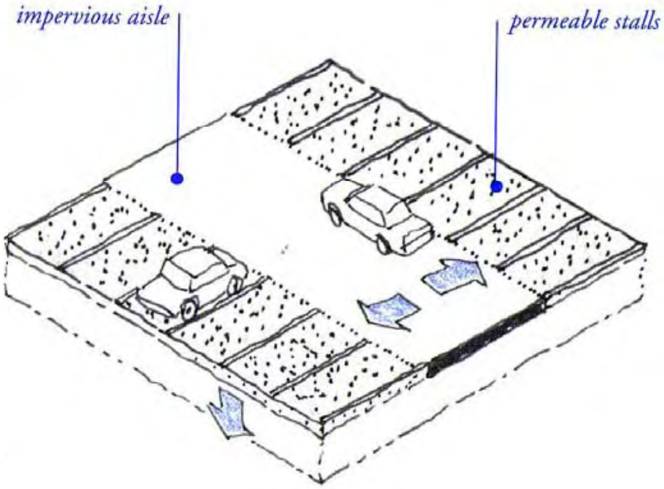


Figure 3-6
Hybrid Parking Lot

If aisles are constructed of a more conventional, impermeable material suitable for heavier vehicle use, such as asphalt, stalls can be constructed of permeable pavement. This can reduce the overall impervious surface coverage of a typical double loaded parking lot by 60% and avoid the need for an underground drainage system.

Permeable stalls can be constructed of a number of materials including pervious concrete, unit pavers such as brick or stone spaced to expose a permeable joint and set on a permeable base, crushed aggregate, porous asphalt, turf block, and cobbles in low traffic areas. Turf blocks and permeable joints are shown in Figures 3-7 and 3-8.

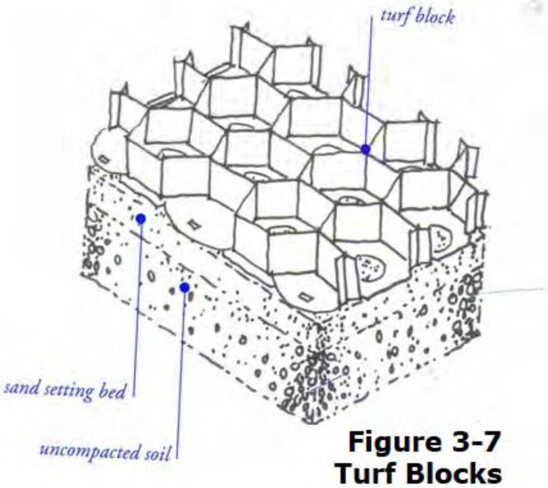


Figure 3-7
Turf Blocks

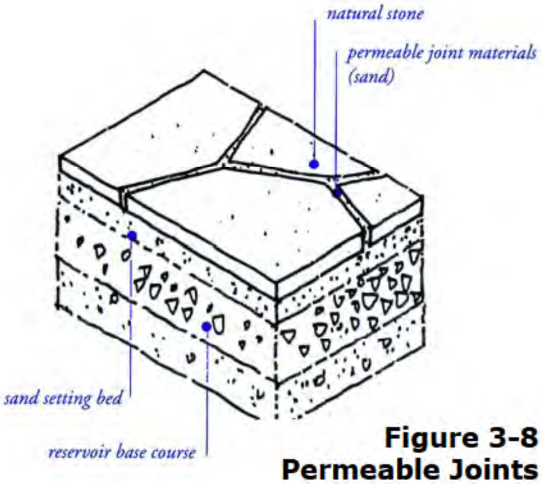


Figure 3-8
Permeable Joints

Parking Grove

A variation on the permeable stall design, a grid of trees and bollards can be used to delineate parking stalls and create a "parking grove." If the bollard and tree grids are spaced approximately 19 ft apart, two vehicles can park between each row of the grid. This 9.5 ft stall spacing is slightly more generous than the standard 8.5 to 9 ft stall, and allows for the added width of the tree trucks and bollards. A benefit of this design is that the parking grove not only shades parked cars, but also presents an attractive open space when cars are absent. Examples of parking groves are shown in Figures 3-9 and 3-10.

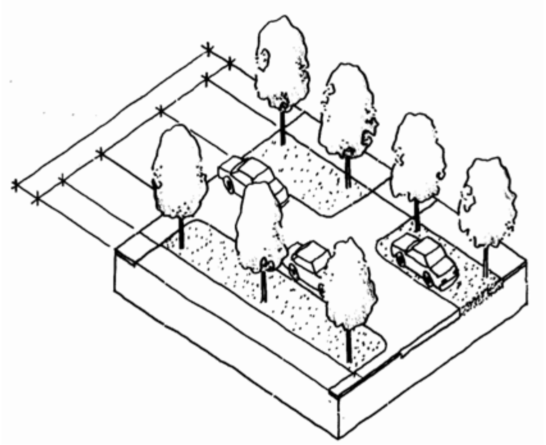


Figure 3-9
Parking Grove

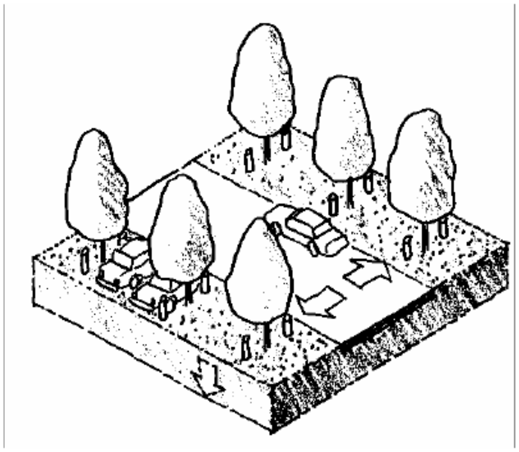


Figure 3-10
Parking Grove

Overflow Parking

Parking lot design is often required to accommodatepeak demand, generating a high proportion of impervious land coverage of very limited usefulness. An alternative is to differentiate between regular and peak parking demands, and to construct the peak parking stalls of a different, more permeable, material. This "overflow parking" area can be made of a turf block, which appears as a green lawn when not occupied by vehicles, or crushed stone or other materials. See Figure 3-11. The same concept can be applied to areas with temporary parking needs, such as emergency access routes, or in residential applications, RV, or trailer parking.

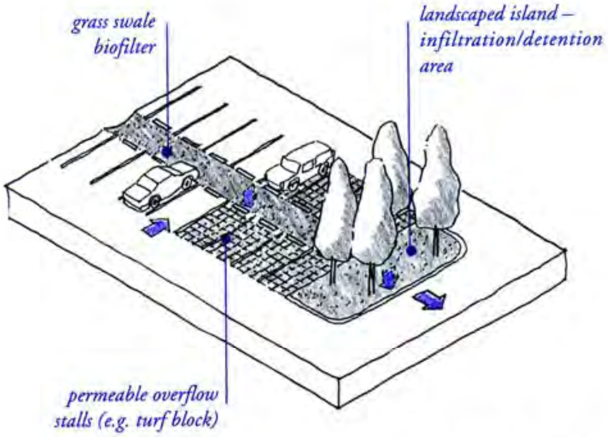


Figure 3-11
Overflows Parking

Porous Pavement Recharge Bed

In some cases, parking lots can be designed to perform more complex stormwater management functions. Constructing a stone-filled reservoir below the pavement surface and directing runoff underground by means of perforated distribution pipes can achieve subsurface stormwater storage and infiltration as shown in Figure 3-12. Subsurface infiltration basins eliminate the possibilities of mud, mosquitoes and safety hazards sometimes perceived to be associated with ephemeral surface drainage. They also can provide for storage of large volumes of runoff, and can be incorporated with roof runoff collection systems.

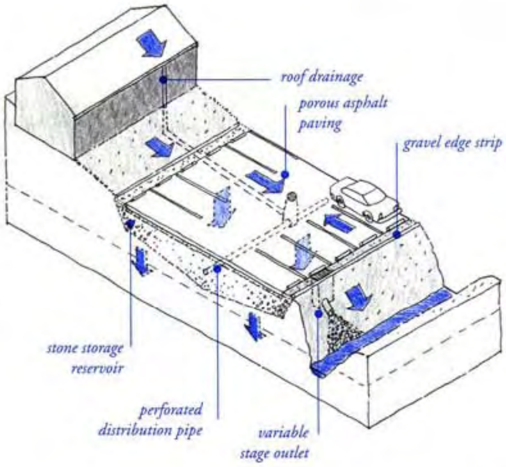


Figure 3-12
Porous Pavement Recharge Bed

3.2.3 Driveways

Driveways can comprise up to 40% of the total transportation network in a conventional development, with streets, turn-arounds, and sidewalks comprising the remaining 60%.

Driveway length is generally determined by garage setback requirements, and width is usually mandated by municipal codes and ordinances. If garages are setback from the street, long driveways are required, unless a rear alley system is included to provide garage access. If parking for two vehicles side by side is required, a 20 ft minimum width is required. Thus, if a 20 ft setback and a two-car-wide driveway are required, a minimum of 400 ft^2 of driveway will result, or 4% of a typical 10,000 ft^2 residential lot. If the house itself is compact, and the driveway is long, wide, and paved with an impervious material such as asphalt or concrete, it can become the largest component of impervious land coverage on the lot.

Municipalities can reduce the area dedicated to driveways by allowing for tandem parking (one vehicle in front of another on a narrow driveway). In addition, if shared driveways are permitted, then two or more garages can be accessed by a single driveway, further reducing required land area. Rear alley access to the garage can reduce driveway length, but overall impervious surface coverage may not be reduced if the alleys are paved with impervious materials and the access streets remain designed to conventional municipal standards.

Alternative solutions that work to reduce the impact of water quality problems associated with impervious land coverage on city streets also work on driveways. Sloping the driveway so that it drains onto an adjacent turf or groundcover area prevents driveways from draining directly to storm drain systems. This concept is shown in Figures 3-13 and 3-14. Use of turf-block or unit pavers on sand creates attractive, low maintenance, permeable driveways that filter stormwater. See Figure 3-15. Crushed aggregate can serve as a relatively smooth pavement with minimal maintenance as shown in Figure 3-16. Paving only under wheels (Figure 3-17) is a viable, inexpensive design if the driveway is straight between the garage and the street, and repaving temporary parking areas with permeable unit pavers such as brick or stone can significantly reduce the percentage of impervious area devoted to the driveway.

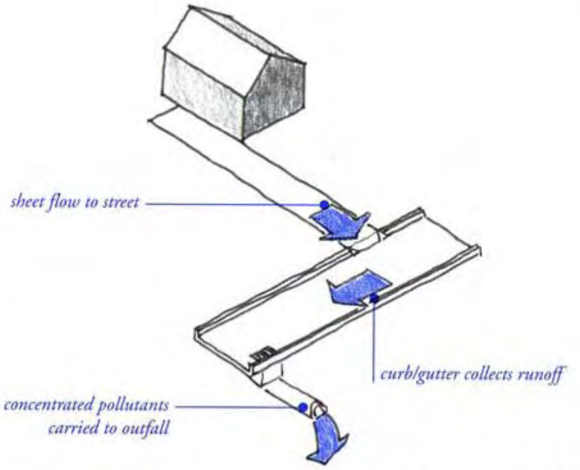


Figure 3-13
Traditional Design
Drains Flow Directly to Storm Drain

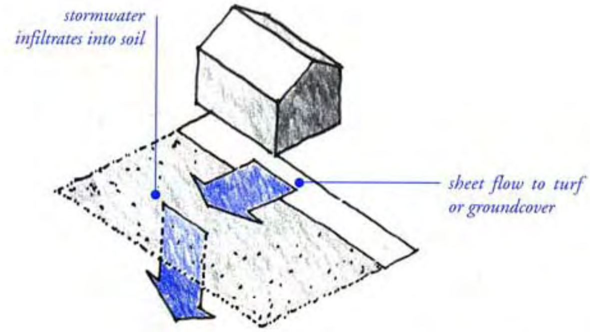


Figure 3-14
Alternative Solution
Slopes Flow to Groundcover

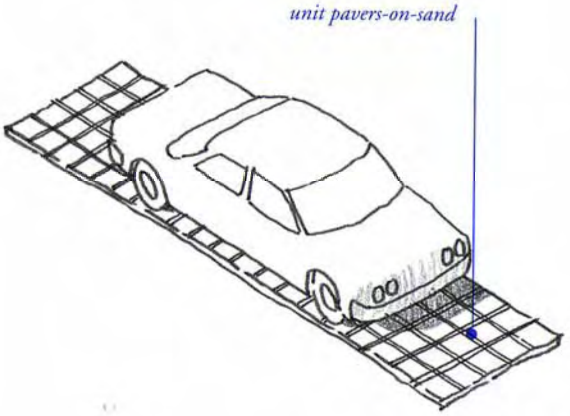


Figure 3-15
Unit Pavers

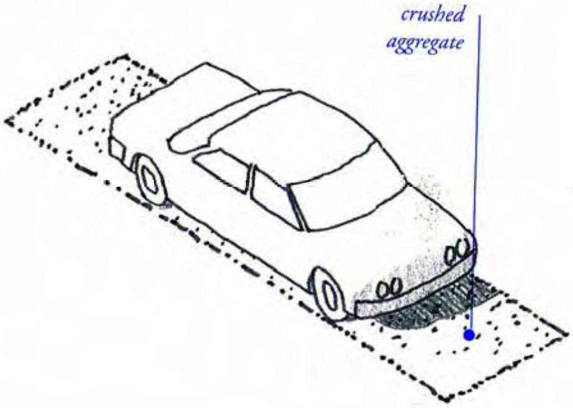


Figure 3-16
Crushed Aggregate

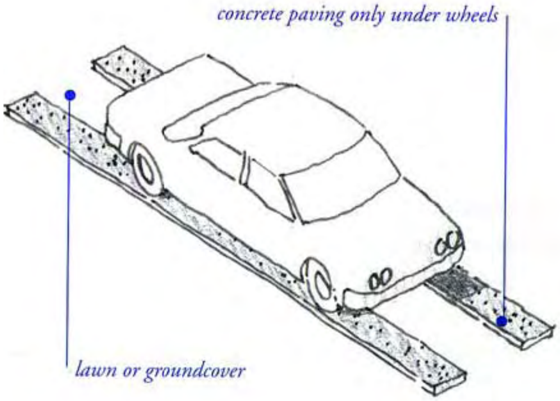


Figure 3-17
Paving Only Under Wheels

3.2.4 Landscape and Open Space

In the natural landscape, most soils infiltrate a high percentage of rainwater through a complex web of organic and biological activities that build soil porosity and permeability. Roots reach into the soil and separate particles of clay, insects excavate voids in the soil mass, roots decay leaving networks of macro pores, leaves fall and form a mulch over the soil surface, and earthworms burrow and ingest organic detritus to create richer, more porous soil. These are just a few examples of the natural processes that occur within the soil.

Maintenance of a healthy soil structure through the practice of retaining or restoring native soils where possible and using soil amendments where appropriate can improve the land's ability to filter and slowly release stormwater into drainage networks. Construction practices such as decreasing soil compaction, storing topsoil on-site for use after construction, and chipping wood for mulch as it is cleared for the land can improve soil quality and help maintain healthy watersheds. Practices that reduce erosion and help retain water on-site include incorporating organic amendments into disturbed soils after construction, retaining native vegetation, and covering soil during revegetation.

Subtle changes in grading can also improve infiltration. Landscape surfaces are conventionally graded to have a slight convex slope. This causes water to run off a central high point into a surrounding drainage system, creating increased runoff. If a landscape surface is graded to have a slightly concave slope, it will hold water. The infiltration value of concave vegetated surfaces is greater in permeable soils. Soils of heavy clay or underlain with hardpan provide less infiltration value. In these cases, concave vegetated surfaces must be designed as retention/detention basins, with proper outlets or under drains to an interconnected system.

Multiple Small Basins

Biofilters, infiltration, retention/detention basins are the basic elements of a landscape designed for stormwater management. The challenge for designers is to integrate these elements creatively and attractively in the landscape – either within a conventional landscape aesthetic or by presenting a different landscape image that emphasizes the role of water and drainage.

Multiple small basins can provide a great deal of water storage and infiltration capacity. These small basins can fit into the parkway planting strip or shoulders of street rights-of-way. If connected by culverts under walks and driveways, they can create a continuous linear infiltration system. Infiltration and retention/detention basins can be placed under wood decks, in parking lot planter islands, and at roof downspouts. Outdoor patios or seating areas can be sunken a few steps, paved with a permeable pavement such as flagstone or gravel, and designed to hold a few inches of water collected from surrounding rooftops or paved areas for a few hours after a rain.

All of these are examples of small basins that can store water for a brief period, allowing it to infiltrate into the soil, slowing its release into the drainage network, and filtering pollutants. An ordinary lawn can be designed to hold a few inches of water for a few hours after a storm, attracting birds and creating a landscape of diversity. Grass/vegetated swales can be integrated with landscaping, providing an attractive, low maintenance, linear biofilter. Extended detention (dry ponds) store water during storms, holding runoff to predevelopment levels. Pollutants settle and are removed from the water column before discharging to streams. Wet ponds serve a similar purpose and can increase property values by providing a significant aesthetic, and passive recreation opportunity.

Plant species selection is critical for proper functioning of infiltration areas. Proper selection of plant materials can improve the infiltration potential of landscape areas. Deep-rooted plants help to build soil porosity. Plant leaf-surface area helps to collect rainwater before it lands on the soil, especially in light rains, increasing the overall water-holding potential of the landscape.

A large number of plant species will survive moist soils or periodic inundation. These plants provide a wide range of choices for planted infiltration/detention basins and drainage swales. Most inundated plants have a higher survival potential on well-drained alluvial soils than on fine textured shallow soils or clays.

Maintenance Needs for Stormwater Systems

All landscape treatments require maintenance. Landscapes designed to perform stormwater management functions are not necessarily more maintenance intensive than highly manicured conventional landscapes. A concave lawn requires the same mowing, fertilizing, and weeding as a convex one and often less irrigation because more rain is filtered into the underlying soil. Sometimes infiltration basins may require a different kind of maintenance than conventionally practiced.

Typical maintenance activities include periodic inspection of surface drainage systems to ensure clear flow lines, repair of eroded surfaces, adjustment or repair of drainage structures, soil cultivation or aeration, care of plant materials, replacement of dead plants, replenishment of mulch cover, irrigation, fertilizing, pruning and mowing. In addition, dead or stressed vegetation may indicate chemical dumping. Careful observation should be made of these areas to determine if such a problem exists.

Landscape maintenance can have a significant impact on soil permeability and its ability to support plant growth. Most plants concentrate the majority of their small absorbing roots in the upper 6 in. of the soil surface if a mulch or forest litter protects the surface. If the soil is exposed or bare, it can become so hot that surface roots will not grow in the upper 8 to 10 in. The common practice of removing all leaf litter and detritus with leaf blowers creates a hard-crusted soil surface of low permeability and high heat conduction. Proper mulching of the soil surface improves water retention and infiltration, while protecting the surface root zone from temperature extremes.

In addition to impacting permeability, landscape maintenance practices can have adverse effects on water quality. Because commonly used fertilizers and herbicides are a source of organic compounds, it is important to keep these practices to a minimum, and prevent overwatering.

When well maintained and designed, landscaped concave surfaces, infiltration basins, swales and bioretention areas can add aesthetic value while providing the framework for environmentally sound, comprehensive stormwater management systems.

Street Trees

Trees improve water quality by intercepting and storing rainfall on leaves and branch surfaces, thereby reducing runoff volumes and delaying the onset of peak flows. A single street tree can have a total leaf surface area of several hundred to several thousand ft^2, depending on species and size. This aboveground surface area created by trees and other plants greatly contributes to the water holding capacity of the land. They attenuate conveyance by increasing the soil's capacity to filter rainwater and reduce overland flow rates. By diminishing the impact of raindrops on un-vegetated soil, trees reduce soil erosion. Street trees also have the ability to reduce ambient temperature of stormwater runoff and absorb surface water pollutants.

When using street trees to achieve stormwater management goals, it is important to use tree species with wide canopies. Street tree design criteria should specify species expected to attain 20 to 30 ft canopies at maturity. Planter strips with adequate width and depth of soil volume are necessary to ensure tree vitality and reduce future maintenance. Structural soils also provide rooting space for large trees and can be specified along narrow planter strips and underneath sidewalks to enable continuous belowground soil and root connections.

3.2.5 Outdoor Work Areas

The site design and landscape details listed in previous sections are appropriate for uses where low concentrations of pollutants can be mitigated through infiltration, retention, and detention. Often in commercial and industrial sites, there are outdoor work areas in which a higher concentration of pollutants exists, and thus a higher potential of pollutants infiltrating the soil. These work areas often involve automobiles, equipment machinery, or other commercial and industrial uses, and require special consideration.

Outdoor work areas are usually isolated elements in a larger development. Infiltration and detention strategies are still appropriate for and can be applied to other areas of the site, such as parking lots, landscape areas, employee use areas, and bicycle path. It is only the outdoor work area within the development – such as the loading dock, fueling area, or equipment wash area – that requires a different drainage approach. This drainage approach is often precisely the opposite from the infiltration/detention strategy – in other words, collect and convey.

In these outdoor work areas, infiltration is discouraged and runoff is often routed directly to the sanitary sewer, not the storm drain. Because this runoff is being added to the loads normally received by the water treatment plants (publicly owned treatment works – POTWs), it raises several concerns that must be addressed in the planning and design stage. These include:

- Higher flows that could exceed the sewer system capacity
- Catastrophic spills that may cause harm to POTW operation
- A potential increase in pollutants

These concerns can be addressed at policy, management, and site planning levels.

Policy

Piping runoff and process water from outdoor work areas directly to the sanitary sewer for treatment by a downstream POTW displaces the problem of reducing stormwater pollution. Municipal stormwater programs and/or private developers can work with the local POTW to develop solutions that minimize effects on the treatment facility. It should be noted that many POTWs have traditionally prohibited the discharge of stormwater to their systems. However, these prohibitions are being reviewed in light of the benefits possible from such diversions.

Management

Commercial and industrial sites that host special activities need to implement a pollution prevention program minimizing hazardous material use and waste. For example, if restaurant grease traps are directly connected to the sanitary sewer, proper management programs can mitigate the amount of grease that escapes from the trap, clogging sewer systems and causing overflows or damage to downstream systems.

Site Planning

Outdoor work areas can be designed in particular ways to reduce their impacts on both stormwater quality and sewage treatment plants.

- Create an impermeable surface such as concrete or asphalt, or a prefabricated metal drip pan, depending on the use.
- Cover the area with a roof. This prevents rain from falling on the work area and becoming polluted runoff.
- Berm or mound around the perimeter of the area to prevent water from adjacent areas to flow on to the surface of the work area.
- Directly connect runoff. Unlike other areas, runoff from these work areas is directly connected to the sanitary sewer or other specialized containment systems. This allows the more highly concentrated pollutants from these areas to receive special treatment that removes particular constituents. Approval for this connection must be obtained from the appropriate sanitary sewer agency.
- Locate the work area away from storm drains or catch basins. If the work area is adjacent to, or directly upstream from a storm drain or landscape drainage feature (e.g., bioswales), debris or liquids from the work area can migrate into the stormwater system.
- Plan the work area to prevent run-on. This can be accomplished by raising the work area or by diverting run-on around the work area.

These design elements are general considerations for work areas. In designing any outdoor work area, evaluate local ordinances affecting the type of work area, as many local jurisdictions have specific requirements.

Some activities are common to many commercial and industrial sites. These include garbage and recycling, maintenance and storage, and loading. These activities can have a significant negative impact on stormwater quality, and require special attention to the siting and design of the activity area.

3.2.6 Maintenance and Storage Areas

To reduce the possibility of contact with stormwater runoff, maintenance and storage areas can be sited away from drainage paths and waterways, and covered. Implementing a regular maintenance plan for sweeping, litter control, and spill cleanup also helps prevent stormwater pollution.

Specifying impermeable surfaces for vehicle and equipment maintenance areas will reduce the chance of pollutant infiltration. A concrete surface will usually last much longer than an asphalt one, as vehicle fluids can either dissolve asphalt or be absorbed by the asphalt and released later. See Figure 3-18.

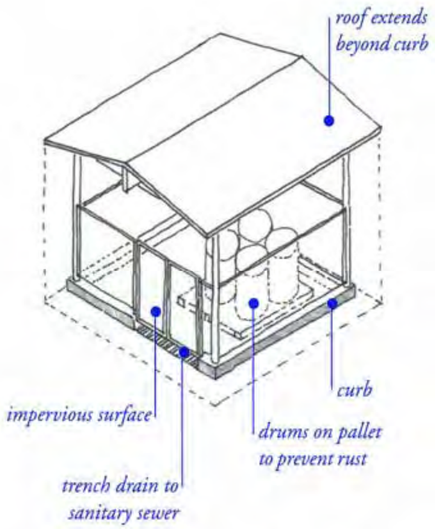


Figure 3-18
Material Storage

3.2.7 Vehicle and Equipment Washing Areas

It is generally advisable to cover areas used for regular washing of vehicles, trucks, or equipment, surround them with a perimeter berm, and clearly mark them as a designated washing area. Sumps or drain lines can be installed to collect wash water, which may be treated for reuse or recycling, or for discharge to the sanitary sewer. The POTW may require some form of pretreatment, such as a trap, for these areas.

Fueling and maintenance activities must be isolated from the vehicle washing facilities. These activities have specific requirements, described later in this section.

Storage of bulk materials, fuels, oils, solvents, other chemicals, and process equipment should be accommodated on an impervious surface covered with a roof. To reduce the chances of corrosion, materials should not be stored directly on the ground, but supported by a wire mesh or other flooring above the impervious pavement. In uncovered areas, drums or other containers can be stored at a slight angle to prevent ponding of rainwater from rusting the lids. Liquid containers should be stored in a designated impervious area that is roofed, fenced within a berm, to prevent spills from flowing into the storm drain.

If hazardous materials are being used or stored, additional specific local, state, or federal requirements may apply.

3.2.8 Loading Area

Loading areas and docks can be designed with a roof or overhang, and a surrounding curb or berm. See Figure 3-19. The area should be graded to direct flow toward an inlet with a shutoff valve or dead-end sump. The sump must be designed with enough capacity to hold a spill while the valve is closed. If the sump has a valve, it must be kept in the closed position and require an action to open it. All sumps must have a sealed bottom so they cannot infiltrate water. Contaminated accumulated waste and liquid must not be discharged to a storm drain and may be discharged to the sanitary sewer only with the POTW's permission. If the waste is not approved for discharge to the sanitary sewer, it must be conveyed to a hazardous waste (or other offsite disposal) facility, and may require pretreatment. Some specific uses have unique requirements.

3.2.9 Trash Storage Areas

Areas designated for trash storage can be covered to protect containers from rainfall. Where covering the trash storage area is not feasible, the area can be protected from run on using grading and berms, and connected to the sanitary sewer to prevent leaks from leaving the designated trash storage area enclosure.

3.2.10 Wash Areas

Areas designated for washing of floor mats, containers, exhaust filters, and similar items can be covered and enclosed to protect the area from rainfall and from overspray leaving the area. These areas can also be connected to the sanitary sewer to prevent wash waters from leaving the designated enclosures. A benefit of covering and enclosing these areas is that vectors may be reduced and aesthetics of the area improved.

3.2.11 Fueling Areas

In all vehicle and equipment fueling areas, plans must be developed for cleaning near fuel dispensers, emergency spill cleanup, and routine inspections to prevent leaks and ensure properly functioning equipment.

If the fueling activities are minor, fueling can be performed in a designated, covered, and bermed area that will not allow run-on of stormwater or runoff of spills.

Retail gasoline outlets and vehicle fueling areas have specific design guidelines. These are described in a Best Management Practice Guide for retail gasoline outlets developed by the California Stormwater Quality Task Force, in cooperation with major gasoline corporations. The practice guide addresses standards for existing, new, or substantially remodeled facilities. In addition, some municipal stormwater permits require RGOs to provide appropriate runoff treatment.

Fuel dispensing areas are defined as extending 6.5 ft from the corner of each fuel dispenser or the length at which the hose and nozzle assembly may be operated plus 1 ft, whichever is less. These areas must be paved with smooth impervious surfaces, such as Portland cement concrete, with a 2-4% slope to prevent ponding, and must be covered. The cover must not drain onto the work area. The rest of the site must separate the fuel dispensing area by a grade break that prevents run-on of stormwater.

Within the gas station, the outdoor trash receptacle area (garbage and recycling), and the air/water supply area must be paved and graded to prevent stormwater run-on. Trash receptacles should be covered.

Site Design & Landscape Planning SD-10

Design Objectives

- ☑ Maximize Infiltration
- ☑ Provide Retention
- ☑ Slow Runoff
- ☑ Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- Contain Pollutants
- Collect and Convey

Description

Each project site possesses unique topographic, hydrologic, and vegetative features, some of which are more suitable for development than others. Integrating and incorporating appropriate landscape planning methodologies into the project design is the most effective action that can be done to minimize surface and groundwater contamination from stormwater.

Approach

Landscape planning should couple consideration of land suitability for urban uses with consideration of community goals and projected growth. Project plan designs should conserve natural areas to the extent possible, maximize natural water storage and infiltration opportunities, and protect slopes and channels.

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment.

Design Considerations

Design requirements for site design and landscapes planning should conform to applicable standards and specifications of agencies with jurisdiction and be consistent with applicable General Plan and Local Area Plan policies.

CASQA
CALIFORNIA STORMWATER QUALITY ASSOCIATION

Designing New Installations

Begin the development of a plan for the landscape unit with attention to the following general principles:

- Formulate the plan on the basis of clearly articulated community goals. Carefully identify conflicts and choices between retaining and protecting desired resources and community growth.

- Map and assess land suitability for urban uses. Include the following landscape features in the assessment: wooded land, open unwooded land, steep slopes, erosion-prone soils, foundation suitability, soil suitability for waste disposal, aquifers, aquifer recharge areas, wetlands, floodplains, surface waters, agricultural lands, and various categories of urban land use. When appropriate, the assessment can highlight outstanding local or regional resources that the community determines should be protected (e.g., a scenic area, recreational area, threatened species habitat, farmland, fish run). Mapping and assessment should recognize not only these resources but also additional areas needed for their sustenance.

Project plan designs should conserve natural areas to the extent possible, maximize natural water storage and infiltration opportunities, and protect slopes and channels.

Conserve Natural Areas during Landscape Planning

If applicable, the following items are required and must be implemented in the site layout during the subdivision design and approval process, consistent with applicable General Plan and Local Area Plan policies:

- Cluster development on least-sensitive portions of a site while leaving the remaining land in a natural undisturbed condition.

- Limit clearing and grading of native vegetation at a site to the minimum amount needed to build lots, allow access, and provide fire protection.

- Maximize trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and promoting the use of native and/or drought tolerant plants.

- Promote natural vegetation by using parking lot islands and other landscaped areas.

- Preserve riparian areas and wetlands.

Maximize Natural Water Storage and Infiltration Opportunities Within the Landscape Unit

- Promote the conservation of forest cover. Building on land that is already deforested affects basin hydrology to a lesser extent than converting forested land. Loss of forest cover reduces interception storage, detention in the organic forest floor layer, and water losses by evapotranspiration, resulting in large peak runoff increases and either their negative effects or the expense of countering them with structural solutions.

- Maintain natural storage reservoirs and drainage corridors, including depressions, areas of permeable soils, swales, and intermittent streams. Develop and implement policies and regulations to discourage the clearing, filling, and channelization of these features. Utilize them in drainage networks in preference to pipes, culverts, and engineered ditches.

- Evaluating infiltration opportunities by referring to the stormwater management manual for the jurisdiction and pay particular attention to the selection criteria for avoiding groundwater contamination, poor soils, and hydrogeological conditions that cause these facilities to fail. If necessary, locate developments with large amounts of impervious surfaces or a potential to produce relatively contaminated runoff away from groundwater recharge areas.

Protection of Slopes and Channels during Landscape Design

- Convey runoff safely from the tops of slopes.
- Avoid disturbing steep or unstable slopes.
- Avoid disturbing natural channels.
- Stabilize disturbed slopes as quickly as possible.
- Vegetate slopes with native or drought tolerant vegetation.
- Control and treat flows in landscaping and/or other controls prior to reaching existing natural drainage systems.
- Stabilize temporary and permanent channel crossings as quickly as possible, and ensure that increases in run-off velocity and frequency caused by the project do not erode the channel.
- Install energy dissipaters, such as riprap, at the outlets of new storm drains, culverts, conduits, or channels that enter unlined channels in accordance with applicable specifications to minimize erosion. Energy dissipaters shall be installed in such a way as to minimize impacts to receiving waters.
- Line on-site conveyance channels where appropriate, to reduce erosion caused by increased flow velocity due to increases in tributary impervious area. The first choice for linings should be grass or some other vegetative surface, since these materials not only reduce runoff velocities, but also provide water quality benefits from filtration and infiltration. If velocities in the channel are high enough to erode grass or other vegetative linings, riprap, concrete, soil cement, or geo-grid stabilization are other alternatives.
- Consider other design principles that are comparable and equally effective.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Redevelopment may present significant opportunity to add features which had not previously been implemented. Examples include incorporation of depressions, areas of permeable soils, and swales in newly redeveloped areas. While some site constraints may exist due to the status of already existing infrastructure, opportunities should not be missed to maximize infiltration, slow runoff, reduce impervious areas, disconnect directly connected impervious areas.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Stormwater Management Manual for Western Washington, Washington State Department of Ecology, August 2001.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Vegetated Swale

TC-30

Design Considerations

- Tributary Area
- Area Required
- Slope
- Water Availability

Description

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 stormwater drainage system and can replace curbs, gutters and storm sewer systems.

California Experience

Caltrans constructed and monitored six vegetated swales in southern California. These swales were generally effective in reducing the volume and mass of pollutants in runoff. Even in the areas where the annual rainfall was only about 10 inches/yr, the vegetation did not require additional irrigation. One factor that strongly affected performance was the presence of large numbers of gophers at most of the sites. The gophers created earthen mounds, destroyed vegetation, and generally reduced the effectiveness of the controls for TSS reduction.

Advantages

- If properly designed, vegetated, and operated, swales can serve as an aesthetic, potentially inexpensive urban development or roadway drainage conveyance measure with significant collateral water quality benefits.

Targeted Constituents

☑	Sediment	▲
☑	Nutrients	●
☑	Trash	●
☑	Metals	▲
☑	Bacteria	●
☑	Oil and Grease	▲
☑	Organics	▲

Legend ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

- Roadside ditches should be regarded as significant potential swale/buffer strip sites and should be utilized for this purpose whenever possible.

Limitations

- Can be difficult to avoid channelization.
- May not be appropriate for industrial sites or locations where spills may occur
- Grassed swales cannot treat a very large drainage area. Large areas may be divided and treated using multiple swales.
- A thick vegetative cover is needed for these practices to function properly.
- They are impractical in areas with steep topography.
- They are not effective and may even erode when flow velocities are high, if the grass cover is not properly maintained.
- In some places, their use is restricted by law: many local municipalities require curb and gutter systems in residential areas.
- Swales are mores susceptible to failure if not properly maintained than other treatment BMPs.

Design and Sizing Guidelines

- Flow rate based design determined by local requirements or sized so that 85% of the annual runoff volume is discharged at less than the design rainfall intensity.
- Swale should be designed so that the water level does not exceed 2/3rds the height of the grass or 4 inches, which ever is less, at the design treatment rate.
- Longitudinal slopes should not exceed 2.5%
- Trapezoidal channels are normally recommended but other configurations, such as parabolic, can also provide substantial water quality improvement and may be easier to mow than designs with sharp breaks in slope.
- Swales constructed in cut are preferred, or in fill areas that are far enough from an adjacent slope to minimize the potential for gopher damage. Do not use side slopes constructed of fill, which are prone to structural damage by gophers and other burrowing animals.
- A diverse selection of low growing, plants that thrive under the specific site, climatic, and watering conditions should be specified. Vegetation whose growing season corresponds to the wet season are preferred. Drought tolerant vegetation should be considered especially for swales that are not part of a regularly irrigated landscaped area.
- The width of the swale should be determined using Manning's Equation using a value of 0.25 for Manning's n.

Construction/Inspection Considerations

- Include directions in the specifications for use of appropriate fertilizer and soil amendments based on soil properties determined through testing and compared to the needs of the vegetation requirements.

- Install swales at the time of the year when there is a reasonable chance of successful establishment without irrigation; however, it is recognized that rainfall in a given year may not be sufficient and temporary irrigation may be used.

- If sod tiles must be used, they should be placed so that there are no gaps between the tiles; stagger the ends of the tiles to prevent the formation of channels along the swale or strip.

- Use a roller on the sod to ensure that no air pockets form between the sod and the soil.

- Where seeds are used, erosion controls will be necessary to protect seeds for at least 75 days after the first rainfall of the season.

Performance

The literature suggests that vegetated swales represent a practical and potentially effective technique for controlling urban runoff quality. While limited quantitative performance data exists for vegetated swales, it is known that check dams, slight slopes, permeable soils, dense grass cover, increased contact time, and small storm events all contribute to successful pollutant removal by the swale system. Factors decreasing the effectiveness of swales include compacted soils, short runoff contact time, large storm events, frozen ground, short grass heights, steep slopes, and high runoff velocities and discharge rates.

Conventional vegetated swale designs have achieved mixed results in removing particulate pollutants. A study performed by the Nationwide Urban Runoff Program (NURP) monitored three grass swales in the Washington, D.C., area and found no significant improvement in urban runoff quality for the pollutants analyzed. However, the weak performance of these swales was attributed to the high flow velocities in the swales, soil compaction, steep slopes, and short grass height.

Another project in Durham, NC, monitored the performance of a carefully designed artificial swale that received runoff from a commercial parking lot. The project tracked 11 storms and concluded that particulate concentrations of heavy metals (Cu, Pb, Zn, and Cd) were reduced by approximately 50 percent. However, the swale proved largely ineffective for removing soluble nutrients.

The effectiveness of vegetated swales can be enhanced by adding check dams at approximately 17 meter (50 foot) increments along their length (See Figure 1). These dams maximize the retention time within the swale, decrease flow velocities, and promote particulate settling. Finally, the incorporation of vegetated filter strips parallel to the top of the channel banks can help to treat sheet flows entering the swale.

Only 9 studies have been conducted on all grassed channels designed for water quality (Table 1). The data suggest relatively high removal rates for some pollutants, but negative removals for some bacteria, and fair performance for phosphorus.

Table 1 Grassed swale pollutant removal efficiency data

Removal Efficiencies (% Removal)							
Study	**TSS**	**TP**	**TN**	**NO_3**	**Metals**	**Bacteria**	**Type**
Caltrans 2002	77	8	67	66	83-90	-33	dry swales
Goldberg 1993	67.8	4.5	-	31.4	42–62	-100	grassed channel
Seattle Metro and Washington Department of Ecology 1992	60	45	-	-25	2–16	-25	grassed channel
Seattle Metro and Washington Department of Ecology, 1992	83	29	-	-25	46–73	-25	grassed channel
Wang et al., 1981	80	-	-	-	70–80	-	dry swale
Dorman et al., 1989	98	18	-	45	37–81	-	dry swale
Harper, 1988	87	83	84	80	88–90	-	dry swale
Kercher et al., 1983	99	99	99	99	99	-	dry swale
Harper, 1988.	81	17	40	52	37–69	-	wet swale
Koon, 1995	67	39	-	9	-35 to 6	-	wet swale

While it is difficult to distinguish between different designs based on the small amount of available data, grassed channels generally have poorer removal rates than wet and dry swales, although some swales appear to export soluble phosphorus (Harper, 1988; Koon, 1995). It is not clear why swales export bacteria. One explanation is that bacteria thrive in the warm swale soils.

Siting Criteria

The suitability of a swale at a site will depend on land use, size of the area serviced, soil type, slope, imperviousness of the contributing watershed, and dimensions and slope of the swale system (Schueler et al., 1992). In general, swales can be used to serve areas of less than 10 acres, with slopes no greater than 5 %. Use of natural topographic lows is encouraged and natural drainage courses should be regarded as significant local resources to be kept in use (Young et al., 1996).

Selection Criteria (NCTCOG, 1993)

- Comparable performance to wet basins
- Limited to treating a few acres
- Availability of water during dry periods to maintain vegetation
- Sufficient available land area

Research in the Austin area indicates that vegetated controls are effective at removing pollutants even when dormant. Therefore, irrigation is not required to maintain growth during dry periods, but may be necessary only to prevent the vegetation from dying.

The topography of the site should permit the design of a channel with appropriate slope and cross-sectional area. Site topography may also dictate a need for additional structural controls. Recommendations for longitudinal slopes range between 2 and 6 percent. Flatter slopes can be used, if sufficient to provide adequate conveyance. Steep slopes increase flow velocity, decrease detention time, and may require energy dissipating and grade check. Steep slopes also can be managed using a series of check dams to terrace the swale and reduce the slope to within acceptable limits. The use of check dams with swales also promotes infiltration.

Additional Design Guidelines

Most of the design guidelines adopted for swale design specify a minimum hydraulic residence time of 9 minutes. This criterion is based on the results of a single study conducted in Seattle, Washington (Seattle Metro and Washington Department of Ecology, 1992), and is not well supported. Analysis of the data collected in that study indicates that pollutant removal at a residence time of 5 minutes was not significantly different, although there is more variability in that data. Therefore, additional research in the design criteria for swales is needed. Substantial pollutant removal has also been observed for vegetated controls designed solely for conveyance (Barrett et al, 1998); consequently, some flexibility in the design is warranted.

Many design guidelines recommend that grass be frequently mowed to maintain dense coverage near the ground surface. Recent research (Colwell et al., 2000) has shown mowing frequency or grass height has little or no effect on pollutant removal.

Summary of Design Recommendations

1) The swale should have a length that provides a minimum hydraulic residence time of at least 10 minutes. The maximum bottom width should not exceed 10 feet unless a dividing berm is provided. The depth of flow should not exceed 2/3rds the height of the grass at the peak of the water quality design storm intensity. The channel slope should not exceed 2.5%.

2) A design grass height of 6 inches is recommended.

3) Regardless of the recommended detention time, the swale should be not less than 100 feet in length.

4) The width of the swale should be determined using Manning's Equation, at the peak of the design storm, using a Manning's n of 0.25.

5) The swale can be sized as both a treatment facility for the design storm and as a conveyance system to pass the peak hydraulic flows of the 100-year storm if it is located "on-line." The side slopes should be no steeper than 3:1 (H:V).

6) Roadside ditches should be regarded as significant potential swale/buffer strip sites and should be utilized for this purpose whenever possible. If flow is to be introduced through curb cuts, place pavement slightly above the elevation of the vegetated areas. Curb cuts should be at least 12 inches wide to prevent clogging.

7) Swales must be vegetated in order to provide adequate treatment of runoff. It is important to maximize water contact with vegetation and the soil surface. For general purposes, select fine, close-growing, water-resistant grasses. If possible, divert runoff (other than necessary irrigation) during the period of vegetation

establishment. Where runoff diversion is not possible, cover graded and seeded areas with suitable erosion control materials.

Maintenance

The useful life of a vegetated swale system is directly proportional to its maintenance frequency. If properly designed and regularly maintained, vegetated swales can last indefinitely. The maintenance objectives for vegetated swale systems include keeping up the hydraulic and removal efficiency of the channel and maintaining a dense, healthy grass cover.

Maintenance activities should include periodic mowing (with grass never cut shorter than the design flow depth), weed control, watering during drought conditions, reseeding of bare areas, and clearing of debris and blockages. Cuttings should be removed from the channel and disposed in a local composting facility. Accumulated sediment should also be removed manually to avoid concentrated flows in the swale. The application of fertilizers and pesticides should be minimal.

Another aspect of a good maintenance plan is repairing damaged areas within a channel. For example, if the channel develops ruts or holes, it should be repaired utilizing a suitable soil that is properly tamped and seeded. The grass cover should be thick; if it is not, reseed as necessary. Any standing water removed during the maintenance operation must be disposed to a sanitary sewer at an approved discharge location. Residuals (e.g., silt, grass cuttings) must be disposed in accordance with local or State requirements. Maintenance of grassed swales mostly involves maintenance of the grass or wetland plant cover. Typical maintenance activities are summarized below:

- Inspect swales at least twice annually for erosion, damage to vegetation, and sediment and debris accumulation preferably at the end of the wet season to schedule summer maintenance and before major fall runoff to be sure the swale is ready for winter. However, additional inspection after periods of heavy runoff is desirable. The swale should be checked for debris and litter, and areas of sediment accumulation.

- Grass height and mowing frequency may not have a large impact on pollutant removal. Consequently, mowing may only be necessary once or twice a year for safety or aesthetics or to suppress weeds and woody vegetation.

- Trash tends to accumulate in swale areas, particularly along highways. The need for litter removal is determined through periodic inspection, but litter should always be removed prior to mowing.

- Sediment accumulating near culverts and in channels should be removed when it builds up to 75 mm (3 in.) at any spot, or covers vegetation.

- Regularly inspect swales for pools of standing water. Swales can become a nuisance due to mosquito breeding in standing water if obstructions develop (e.g. debris accumulation, invasive vegetation) and/or if proper drainage slopes are not implemented and maintained.

Cost

Construction Cost

Little data is available to estimate the difference in cost between various swale designs. One study (SWRPC, 1991) estimated the construction cost of grassed channels at approximately \$0.25 per ft^2. This price does not include design costs or contingencies. Brown and Schueler (1997) estimate these costs at approximately 32 percent of construction costs for most stormwater management practices. For swales, however, these costs would probably be significantly higher since the construction costs are so low compared with other practices. A more realistic estimate would be a total cost of approximately \$0.50 per ft^2, which compares favorably with other stormwater management practices.

Table 2 Swale Cost Estimate (SEWRPC, 1991)

Component	Unit	Extent	Unit Cost			Total Cost		
			Low	Moderate	High	Low	Moderate	High
Mobilization / Demobilization-Light	Swale	1	$107	$274	$441	$107	$274	$441
Site Preparation								
Clearing[b]................	Acre	0.5	$2,200	$3,800	$5,400	$1,100	$1,900	$2,700
Grubbing[c].............	Acre	0.25	$3,800	$5,200	$6,600	$950	$1,300	$1,650
General Excavation[d]...........	Yd³	372	$2.10	$3.70	$5.30	$781	$1,376	$1,972
Level and Till[e]........	Yd²	1,210	$0.20	$0.35	$0.50	$242	$424	$605
Sites Development								
Salvaged Topsoil Seed, and Mulch[f]..	Yd²	1,210	$0.40	$1.00	$1.60	$484	$1,210	$1,936
Sod[g]......................	Yd²	1,210	$1.20	$2.40	$3.60	$1,452	$2,904	$4,356
Subtotal	--	—	--	—	--	$5,116	$9,388	$13,660
Contingencies	Swale	1	25%	25%	25%	$1,279	$2,347	$3,415
Total	--	—	--	—	--	$6,395	$11,735	$17,075

Source: (SEWRPC, 1991)

Note: Mobilization/demobilization refers to the organization and planning involved in establishing a vegetative swale.

[a] Swale has a bottom width of 1.0 foot, a top width of 10 feet with 1:3 side slopes, and a 1,000-foot length.

[b] Area cleared = (top width + 10 feet) x swale length.

[c] Area grubbed = (top width x swale length).

[d] Volume excavated = (0.67 x top width x swale depth) x swale length (parabolic cross-section).

[e] Area tilled = $\left(\text{top width} + \frac{8(\text{swale depth}^2)}{3(\text{top width})}\right)$ x swale length (parabolic cross-section).

[f] Area seeded = area cleared x 0.5.

[g] Area sodded = area cleared x 0.5.

Table 3 Estimated Maintenance Costs (SEWRPC. 1991)

Component	Unit Cost	Swale Size (Depth and Top Width)		Comment
		1.5 Foot Depth, One-Foot Bottom Width, 10-Foot Top Width	3-Foot Depth, 3-Foot Bottom Width, 21-Foot Top Width	
Lawn Mowing	\$0.85 / 1,000 ft²/ mowing	\$0.14 / linear foot	\$0.21 / linear foot	Lawn maintenance area=(top width + 10 feet) x length. Mow eight times per year
General Lawn Care	\$9.00 / 1,000 ft²/ year	\$0.18 / linear foot	\$0.28 / linear foot	Lawn maintenance area = (top width + 10 feet) x length
Swale Debris and Litter Removal	\$0.10 / linear foot / year	\$0.10 / linear foot	\$0.10 / linear foot	–
Grass Reseeding with Mulch and Fertilizer	\$0.30 / yd²	\$0.01 / linear foot	\$0.01 / linear foot	Area revegetated equals 1% of lawn maintenance area per year
Program Administration and Swale Inspection	\$0.15 / linear foot / year, plus \$25 / inspection	\$0.15 / linear foot	\$0.15 / linear foot	Inspect four times per year
Total	--	**\$0.58 / linear foot**	**\$ 0.75 / linear foot**	--

Maintenance Cost

Caltrans (2002) estimated the expected annual maintenance cost for a swale with a tributary area of approximately 2 ha at approximately $2,700. Since almost all maintenance consists of mowing, the cost is fundamentally a function of the mowing frequency. Unit costs developed by SEWRPC are shown in Table 3. In many cases vegetated channels would be used to convey runoff and would require periodic mowing as well, so there may be little additional cost for the water quality component. Since essentially all the activities are related to vegetation management, no special training is required for maintenance personnel.

References and Sources of Additional Information

Barrett, Michael E., Walsh, Patrick M., Malina, Joseph F., Jr., Charbeneau, Randall J, 1998, "Performance of vegetative controls for treating highway runoff," *ASCE Journal of Environmental Engineering*, Vol. 124, No. 11, pp. 1121-1128.

Brown, W., and T. Schueler. 1997. *The Economics of Stormwater BMPs in the Mid-Atlantic Region*. Prepared for the Chesapeake Research Consortium, Edgewater, MD, by the Center for Watershed Protection, Ellicott City, MD.

Center for Watershed Protection (CWP). 1996. *Design of Stormwater Filtering Systems*. Prepared for the Chesapeake Research Consortium, Solomons, MD, and USEPA Region V, Chicago, IL, by the Center for Watershed Protection, Ellicott City, MD.

Colwell, Shanti R., Horner, Richard R., and Booth, Derek B., 2000. *Characterization of Performance Predictors and Evaluation of Mowing Practices in Biofiltration Swales*. Report to King County Land And Water Resources Division and others by Center for Urban Water Resources Management, Department of Civil and Environmental Engineering, University of Washington, Seattle, WA

Dorman, M.E., J. Hartigan, R.F. Steg, and T. Quasebarth. 1989. *Retention, Detention and Overland Flow for Pollutant Removal From Highway Stormwater Runoff. Vol. 1.* FHWA/RD 89/202. Federal Highway Administration, Washington, DC.

Goldberg. 1993. *Dayton Avenue Swale Biofiltration Study*. Seattle Engineering Department, Seattle, WA.

Harper, H. 1988. *Effects of Stormwater Management Systems on Groundwater Quality*. Prepared for Florida Department of Environmental Regulation, Tallahassee, FL, by Environmental Research and Design, Inc., Orlando, FL.

Kercher, W.C., J.C. Landon, and R. Massarelli. 1983. Grassy swales prove cost-effective for water pollution control. *Public Works*, 16: 53–55.

Koon, J. 1995. *Evaluation of Water Quality Ponds and Swales in the Issaquah/East Lake Sammamish Basins*. King County Surface Water Management, Seattle, WA, and Washington Department of Ecology, Olympia, WA.

Metzger, M. E., D. F. Messer, C. L. Beitia, C. M. Myers, and V. L. Kramer. 2002. The Dark Side Of Stormwater Runoff Management: Disease Vectors Associated With Structural BMPs. Stormwater 3(2): 24-39.Oakland, P.H. 1983. An evaluation of stormwater pollutant removal through grassed swale treatment. In *Proceedings of the International Symposium of Urban Hydrology, Hydraulics and Sediment Control, Lexington, KY*. pp. 173–182.

Occoquan Watershed Monitoring Laboratory. 1983. Final Report: *Metropolitan Washington Urban Runoff Project*. Prepared for the Metropolitan Washington Council of Governments, Washington, DC, by the Occoquan Watershed Monitoring Laboratory, Manassas, VA.

Pitt, R., and J. McLean. 1986. *Toronto Area Watershed Management Strategy Study: Humber River Pilot Watershed Project*. Ontario Ministry of Environment, Toronto, ON.

Schueler, T. 1997. Comparative Pollutant Removal Capability of Urban BMPs: A reanalysis. *Watershed Protection Techniques* 2(2):379–383.

Seattle Metro and Washington Department of Ecology. 1992. *Biofiltration Swale Performance: Recommendations and Design Considerations*. Publication No. 657. Water Pollution Control Department, Seattle, WA.

Southeastern Wisconsin Regional Planning Commission (SWRPC). 1991. *Costs of Urban Nonpoint Source Water Pollution Control Measures*. Technical report no. 31. Southeastern Wisconsin Regional Planning Commission, Waukesha, WI.

U.S. EPA, 1999, Stormwater Fact Sheet: Vegetated Swales, Report # 832-F-99-006 http://www.epa.gov/owm/mtb/vegswale.pdf, Office of Water, Washington DC.

Wang, T., D. Spyridakis, B. Mar, and R. Horner. 1981. *Transport, Deposition and Control of Heavy Metals in Highway Runoff*. FHWA-WA-RD-39-10. University of Washington, Department of Civil Engineering, Seattle, WA.

Washington State Department of Transportation, 1995, *Highway Runoff Manual*, Washington State Department of Transportation, Olympia, Washington.

Welborn, C., and J. Veenhuis. 1987. *Effects of Runoff Controls on the Quantity and Quality of Urban Runoff in Two Locations in Austin, TX*. USGS Water Resources Investigations Report No. 87-4004. U.S. Geological Survey, Reston, VA.

Yousef, Y., M. Wanielista, H. Harper, D. Pearce, and R. Tolbert. 1985. *Best Management Practices: Removal of Highway Contaminants By Roadside Swales*. University of Central Florida and Florida Department of Transportation, Orlando, FL.

Yu, S., S. Barnes, and V. Gerde. 1993. *Testing of Best Management Practices for Controlling Highway Runoff*. FHWA/VA-93-R16. Virginia Transportation Research Council, Charlottesville, VA.

Information Resources

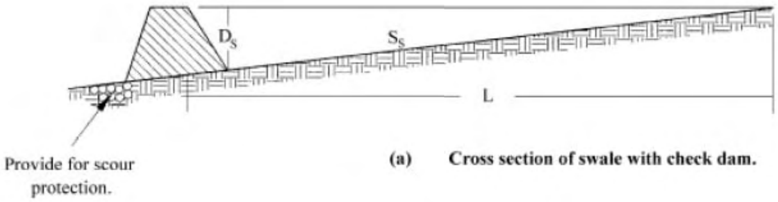
Maryland Department of the Environment (MDE). 2000. *Maryland Stormwater Design Manual*. www.mde.state.md.us/environment/wma/stormwatermanual. Accessed May 22, 2001.

Reeves, E. 1994. Performance and Condition of Biofilters in the Pacific Northwest. *Watershed Protection Techniques* 1(3):117–119.

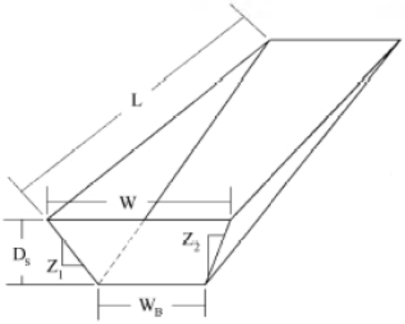
Seattle Metro and Washington Department of Ecology. 1992. *Biofiltration Swale Performance*. Recommendations and Design Considerations. Publication No. 657. Seattle Metro and Washington Department of Ecology, Olympia, WA.

USEPA 1993. *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*. EPA-840-B-92-002. U.S. Environmental Protection Agency, Office of Water. Washington, DC.

Watershed Management Institute (WMI). 1997. *Operation, Maintenance, and Management of Stormwater Management Systems*. Prepared for U.S. Environmental Protection Agency, Office of Water. Washington, DC, by the Watershed Management Institute, Ingleside, MD.



(a) **Cross section of swale with check dam.**



(b) **Dimensional view of swale impoundment area.**

Notation:
L = Length of swale impoundment area per check dam (ft)
D_S = Depth of check dam (ft)
S_S = Bottom slpe of swale (ft/ft)
W = Top width of check dam (ft)
W_B = Bottom width of check dam (ft)
$Z_{1\&2}$ = Ratio of horizontal to vertical change in swale side slope (ft/ft)

Extended Detention Basin TC-22

Description

Dry extended detention ponds (a.k.a. dry ponds, extended detention basins, detention ponds, extended detention ponds) are basins whose outlets have been designed to detain the stormwater runoff from a water quality design storm for some minimum time (e.g., 48 hours) to allow particles and associated pollutants to settle. Unlike wet ponds, these facilities do not have a large permanent pool. They can also be used to provide flood control by including additional flood detention storage.

California Experience

Caltrans constructed and monitored 5 extended detention basins in southern California with design drain times of 72 hours. Four of the basins were earthen, less costly and had substantially better load reduction because of infiltration that occurred, than the concrete basin. The Caltrans study reaffirmed the flexibility and performance of this conventional technology. The small headloss and few siting constraints suggest that these devices are one of the most applicable technologies for stormwater treatment.

Advantages

- Due to the simplicity of design, extended detention basins are relatively easy and inexpensive to construct and operate.
- Extended detention basins can provide substantial capture of sediment and the toxics fraction associated with particulates.
- Widespread application with sufficient capture volume can provide significant control of channel erosion and enlargement caused by changes to flow frequency

Design Considerations

- Tributary Area
- Area Required
- Hydraulic Head

Targeted Constituents

☑	Sediment	▲
☑	Nutrients	●
☑	Trash	■
☑	Metals	▲
☑	Bacteria	▲
☑	Oil and Grease	▲
☑	Organics	▲

Legend *(Removal Effectiveness)*

● Low ■ High

▲ Medium

CASQA
CALIFORNIA STORMWATER
QUALITY ASSOCIATION

relationships resulting from the increase of impervious cover in a watershed.

Limitations

- Limitation of the diameter of the orifice may not allow use of extended detention in watersheds of less than 5 acres (would require an orifice with a diameter of less than 0.5 inches that would be prone to clogging).

- Dry extended detention ponds have only moderate pollutant removal when compared to some other structural stormwater practices, and they are relatively ineffective at removing soluble pollutants.

- Although wet ponds can increase property values, dry ponds can actually detract from the value of a home due to the adverse aesthetics of dry, bare areas and inlet and outlet structures.

Design and Sizing Guidelines

- Capture volume determined by local requirements or sized to treat 85% of the annual runoff volume.

- Outlet designed to discharge the capture volume over a period of hours.

- Length to width ratio of at least 1.5:1 where feasible.

- Basin depths optimally range from 2 to 5 feet.

- Include energy dissipation in the inlet design to reduce resuspension of accumulated sediment.

- A maintenance ramp and perimeter access should be included in the design to facilitate access to the basin for maintenance activities and for vector surveillance and control.

- Use a draw down time of 48 hours in most areas of California. Draw down times in excess of 48 hours may result in vector breeding, and should be used only after coordination with local vector control authorities. Draw down times of less than 48 hours should be limited to BMP drainage areas with coarse soils that readily settle and to watersheds where warming may be determined to downstream fisheries.

Construction/Inspection Considerations

- Inspect facility after first large to storm to determine whether the desired residence time has been achieved.

- When constructed with small tributary area, orifice sizing is critical and inspection should verify that flow through additional openings such as bolt holes does not occur.

Performance

One objective of stormwater management practices can be to reduce the flood hazard associated with large storm events by reducing the peak flow associated with these storms. Dry extended detention basins can easily be designed for flood control, and this is actually the primary purpose of most detention ponds.

Dry extended detention basins provide moderate pollutant removal, provided that the recommended design features are incorporated. Although they can be effective at removing some pollutants through settling, they are less effective at removing soluble pollutants because of the absence of a permanent pool. Several studies are available on the effectiveness of dry extended detention ponds including one recently concluded by Caltrans (2002).

The load reduction is greater than the concentration reduction because of the substantial infiltration that occurs. Although the infiltration of stormwater is clearly beneficial to surface receiving waters, there is the potential for groundwater contamination. Previous research on the effects of incidental infiltration on groundwater quality indicated that the risk of contamination is minimal.

There were substantial differences in the amount of infiltration that were observed in the earthen basins during the Caltrans study. On average, approximately 40 percent of the runoff entering the unlined basins infiltrated and was not discharged. The percentage ranged from a high of about 60 percent to a low of only about 8 percent for the different facilities. Climatic conditions and local water table elevation are likely the principal causes of this difference. The least infiltration occurred at a site located on the coast where humidity is higher and the basin invert is within a few meters of sea level. Conversely, the most infiltration occurred at a facility located well inland in Los Angeles County where the climate is much warmer and the humidity is less, resulting in lower soil moisture content in the basin floor at the beginning of storms.

Vegetated detention basins appear to have greater pollutant removal than concrete basins. In the Caltrans study, the concrete basin exported sediment and associated pollutants during a number of storms. Export was not as common in the earthen basins, where the vegetation appeared to help stabilize the retained sediment.

Siting Criteria

Dry extended detention ponds are among the most widely applicable stormwater management practices and are especially useful in retrofit situations where their low hydraulic head requirements allow them to be sited within the constraints of the existing storm drain system. In addition, many communities have detention basins designed for flood control. It is possible to modify these facilities to incorporate features that provide water quality treatment and/or channel protection. Although dry extended detention ponds can be applied rather broadly, designers need to ensure that they are feasible at the site in question. This section provides basic guidelines for siting dry extended detention ponds.

In general, dry extended detention ponds should be used on sites with a minimum area of 5 acres. With this size catchment area, the orifice size can be on the order of 0.5 inches. On smaller sites, it can be challenging to provide channel or water quality control because the orifice diameter at the outlet needed to control relatively small storms becomes very small and thus prone to clogging. In addition, it is generally more cost-effective to control larger drainage areas due to the economies of scale.

Extended detention basins can be used with almost all soils and geology, with minor design adjustments for regions of rapidly percolating soils such as sand. In these areas, extended detention ponds may need an impermeable liner to prevent ground water contamination.

The base of the extended detention facility should not intersect the water table. A permanently wet bottom may become a mosquito breeding ground. Research in Southwest Florida (Santana et al., 1994) demonstrated that intermittently flooded systems, such as dry extended detention ponds, produce more mosquitoes than other pond systems, particularly when the facilities remained wet for more than 3 days following heavy rainfall.

A study in Prince George's County, Maryland, found that stormwater management practices can increase stream temperatures (Galli, 1990). Overall, dry extended detention ponds increased temperature by about 5°F. In cold water streams, dry ponds should be designed to detain stormwater for a relatively short time (i.e., 24 hours) to minimize the amount of warming that occurs in the basin.

Additional Design Guidelines

In order to enhance the effectiveness of extended detention basins, the dimensions of the basin must be sized appropriately. Merely providing the required storage volume will not ensure maximum constituent removal. By effectively configuring the basin, the designer will create a long flow path, promote the establishment of low velocities, and avoid having stagnant areas of the basin. To promote settling and to attain an appealing environment, the design of the basin should consider the length to width ratio, cross-sectional areas, basin slopes and pond configuration, and aesthetics (Young et al., 1996).

Energy dissipation structures should be included for the basin inlet to prevent resuspension of accumulated sediment. The use of stilling basins for this purpose should be avoided because the standing water provides a breeding area for mosquitoes.

Extended detention facilities should be sized to completely capture the water quality volume. A micropool is often recommended for inclusion in the design and one is shown in the schematic diagram. These small permanent pools greatly increase the potential for mosquito breeding and complicate maintenance activities; consequently, they are not recommended for use in California.

A large aspect ratio may improve the performance of detention basins; consequently, the outlets should be placed to maximize the flowpath through the facility. The ratio of flowpath length to width from the inlet to the outlet should be at least 1.5:1 (L:W) where feasible. Basin depths optimally range from 2 to 5 feet.

The facility's drawdown time should be regulated by an orifice or weir. In general, the outflow structure should have a trash rack or other acceptable means of preventing clogging at the entrance to the outflow pipes. The outlet design implemented by Caltrans in the facilities constructed in San Diego County used an outlet riser with orifices

Figure 1
Example of Extended Detention Outlet Structure

sized to discharge the water quality volume, and the riser overflow height was set to the design storm elevation. A stainless steel screen was placed around the outlet riser to ensure that the orifices would not become clogged with debris. Sites either used a separate riser or broad crested weir for overflow of runoff for the 25 and greater year storms. A picture of a typical outlet is presented in Figure 1.

The outflow structure should be sized to allow for complete drawdown of the water quality volume in 72 hours. No more than 50% of the water quality volume should drain from the facility within the first 24 hours. The outflow structure can be fitted with a valve so that discharge from the basin can be halted in case of an accidental spill in the watershed.

Summary of Design Recommendations

(1) Facility Sizing - The required water quality volume is determined by local regulations or the basin should be sized to capture and treat 85% of the annual runoff volume. See Section 5.5.1 of the handbook for a discussion of volume-based design.

Basin Configuration – A high aspect ratio may improve the performance of detention basins; consequently, the outlets should be placed to maximize the flowpath through the facility. The ratio of flowpath length to width from the inlet to the outlet should be at least 1.5:1 (L:W). The flowpath length is defined as the distance from the inlet to the outlet as measured at the surface. The width is defined as the mean width of the basin. Basin depths optimally range from 2 to 5 feet. The basin may include a sediment forebay to provide the opportunity for larger particles to settle out.

A micropool should not be incorporated in the design because of vector concerns. For online facilities, the principal and emergency spillways must be sized to provide 1.0 foot of freeboard during the 25-year event and to safely pass the flow from 100-year storm.

(2) Pond Side Slopes - Side slopes of the pond should be 3:1 (H:V) or flatter for grass stabilized slopes. Slopes steeper than 3:1 (H:V) must be stabilized with an appropriate slope stabilization practice.

(3) Basin Lining – Basins must be constructed to prevent possible contamination of groundwater below the facility.

(4) Basin Inlet – Energy dissipation is required at the basin inlet to reduce resuspension of accumulated sediment and to reduce the tendency for short-circuiting.

(5) Outflow Structure - The facility's drawdown time should be regulated by a gate valve or orifice plate. In general, the outflow structure should have a trash rack or other acceptable means of preventing clogging at the entrance to the outflow pipes.

The outflow structure should be sized to allow for complete drawdown of the water quality volume in 72 hours. No more than 50% of the water quality volume should drain from the facility within the first 24 hours. The outflow structure should be fitted with a valve so that discharge from the basin can be halted in case of an accidental spill in the watershed. This same valve also can be used to regulate the rate of discharge from the basin.

The discharge through a control orifice is calculated from:

$$Q = CA(2g(H-H_0))^{0.5}$$

where: Q = discharge (ft^3/s)
C = orifice coefficient
A = area of the orifice (ft^2)
g = gravitational constant (32.2)
H = water surface elevation (ft)
H_0= orifice elevation (ft)

Recommended values for C are 0.66 for thin materials and 0.80 when the material is thicker than the orifice diameter. This equation can be implemented in spreadsheet form with the pond stage/volume relationship to calculate drain time. To do this, use the initial height of the water above the orifice for the water quality volume. Calculate the discharge and assume that it remains constant for approximately 10 minutes. Based on that discharge, estimate the total discharge during that interval and the new elevation based on the stage volume relationship. Continue to iterate until H is approximately equal to H_0. When using multiple orifices the discharge from each is summed.

(6) Splitter Box - When the pond is designed as an offline facility, a splitter structure is used to isolate the water quality volume. The splitter box, or other flow diverting approach, should be designed to convey the 25-year storm event while providing at least 1.0 foot of freeboard along pond side slopes.

(7) Erosion Protection at the Outfall - For online facilities, special consideration should be given to the facility's outfall location. Flared pipe end sections that discharge at or near the stream invert are preferred. The channel immediately below the pond outfall should be modified to conform to natural dimensions, and lined with large stone riprap placed over filter cloth. Energy dissipation may be required to reduce flow velocities from the primary spillway to non-erosive velocities.

(8) Safety Considerations - Safety is provided either by fencing of the facility or by managing the contours of the pond to eliminate dropoffs and other hazards. Earthen side slopes should not exceed 3:1 (H:V) and should terminate on a flat safety bench area. Landscaping can be used to impede access to the facility. The primary spillway opening must not permit access by small children. Outfall pipes above 48 inches in diameter should be fenced.

Maintenance

Routine maintenance activity is often thought to consist mostly of sediment and trash and debris removal; however, these activities often constitute only a small fraction of the maintenance hours. During a recent study by Caltrans, 72 hours of maintenance was performed annually, but only a little over 7 hours was spent on sediment and trash removal. The largest recurring activity was vegetation management, routine mowing. The largest absolute number of hours was associated with vector control because of mosquito breeding that occurred in the stilling basins (example of standing water to be avoided) installed as energy dissipaters. In most cases, basic housekeeping practices such as removal of debris accumulations and vegetation management to ensure that the basin dewaters completely in 48-72 hours is sufficient to prevent creating mosquito and other vector habitats.

Consequently, maintenance costs should be estimated based primarily on the mowing frequency and the time required. Mowing should be done at least annually to avoid establishment of woody vegetation, but may need to be performed much more frequently if aesthetics are an important consideration.

Typical activities and frequencies include:

- Schedule semiannual inspection for the beginning and end of the wet season for standing water, slope stability, sediment accumulation, trash and debris, and presence of burrows.
- Remove accumulated trash and debris in the basin and around the riser pipe during the semiannual inspections. The frequency of this activity may be altered to meet specific site conditions.
- Trim vegetation at the beginning and end of the wet season and inspect monthly to prevent establishment of woody vegetation and for aesthetic and vector reasons.
- Remove accumulated sediment and re-grade about every 10 years or when the accumulated sediment volume exceeds 10 percent of the basin volume. Inspect the basin each year for accumulated sediment volume.

Cost

Construction Cost

The construction costs associated with extended detention basins vary considerably. One recent study evaluated the cost of all pond systems (Brown and Schueler, 1997). Adjusting for inflation, the cost of dry extended detention ponds can be estimated with the equation:

$$C = 12.4V^{0.760}$$

where: C = Construction, design, and permitting cost, and
V = Volume (ft^3).

Using this equation, typical construction costs are:

$ 41,600 for a 1 acre-foot pond

$ 239,000 for a 10 acre-foot pond

$ 1,380,000 for a 100 acre-foot pond

Interestingly, these costs are generally slightly higher than the predicted cost of wet ponds (according to Brown and Schueler, 1997) on a cost per total volume basis, which highlights the difficulty of developing reasonably accurate construction estimates. In addition, a typical facility constructed by Caltrans cost about $160,000 with a capture volume of only 0.3 ac-ft.

An economic concern associated with dry ponds is that they might detract slightly from the value of adjacent properties. One study found that dry ponds can actually detract from the perceived value of homes adjacent to a dry pond by between 3 and 10 percent (Emmerling-Dinovo, 1995).

Maintenance Cost

For ponds, the annual cost of routine maintenance is typically estimated at about 3 to 5 percent of the construction cost (EPA website). Alternatively, a community can estimate the cost of the maintenance activities outlined in the maintenance section. Table 1 presents the maintenance costs estimated by Caltrans based on their experience with five basins located in southern California. Again, it should be emphasized that the vast majority of hours are related to vegetation management (mowing).

Table 1 Estimated Average Annual Maintenance Effort

Activity	Labor Hours	Equipment & Material ($)	Cost
Inspections	4	7	183
Maintenance	49	126	2282
Vector Control	0	0	0
Administration	3	0	132
Materials	-	535	535
Total	56	$668	$3,132

References and Sources of Additional Information

Brown, W., and T. Schueler. 1997. *The Economics of Stormwater BMPs in the Mid-Atlantic Region*. Prepared for Chesapeake Research Consortium. Edgewater, MD. Center for Watershed Protection. Ellicott City, MD.

Denver Urban Drainage and Flood Control District. 1992. *Urban Storm Drainage Criteria Manual—Volume 3: Best Management Practices*. Denver, CO.

Emmerling-Dinovo, C. 1995. Stormwater Detention Basins and Residential Locational Decisions. *Water Resources Bulletin 31(3)*: 515–521

Galli, J. 1990. *Thermal Impacts Associated with Urbanization and Stormwater Management Best Management Practices*. Metropolitan Washington Council of Governments. Prepared for Maryland Department of the Environment, Baltimore, MD.

GKY, 1989, *Outlet Hydraulics of Extended Detention Facilities* for the Northern Virginia Planning District Commission.

MacRae, C. 1996. Experience from Morphological Research on Canadian Streams: Is Control of the Two-Year Frequency Runoff Event the Best Basis for Stream Channel Protection? In *Effects of Watershed Development and Management on Aquatic Ecosystems*. American Society of Civil Engineers. Edited by L. Roesner. Snowbird, UT. pp. 144–162.

Maryland Dept of the Environment, 2000, Maryland Stormwater Design Manual: Volumes 1 & 2, prepared by MDE and Center for Watershed Protection. http://www.mde.state.md.us/environment/wma/stormwatermanual/index.html

Metzger, M. E., D. F. Messer, C. L. Beitia, C. M. Myers, and V. L. Kramer. 2002. The Dark Side Of Stormwater Runoff Management: Disease Vectors Associated With Structural BMPs. Stormwater 3(2): 24-39.

Santana, F., J. Wood, R. Parsons, and S. Chamberlain. 1994. Control of Mosquito Breeding in Permitted Stormwater Systems. Prepared for Southwest Florida Water Management District, Brooksville, FL.

Schueler, T. 1997. Influence of Ground Water on Performance of Stormwater Ponds in Florida. *Watershed Protection Techniques* 2(4):525–528.

Watershed Management Institute (WMI). 1997. *Operation, Maintenance, and Management of Stormwater Management Systems*. Prepared for U.S. Environmental Protection Agency, Office of Water. Washington, DC.

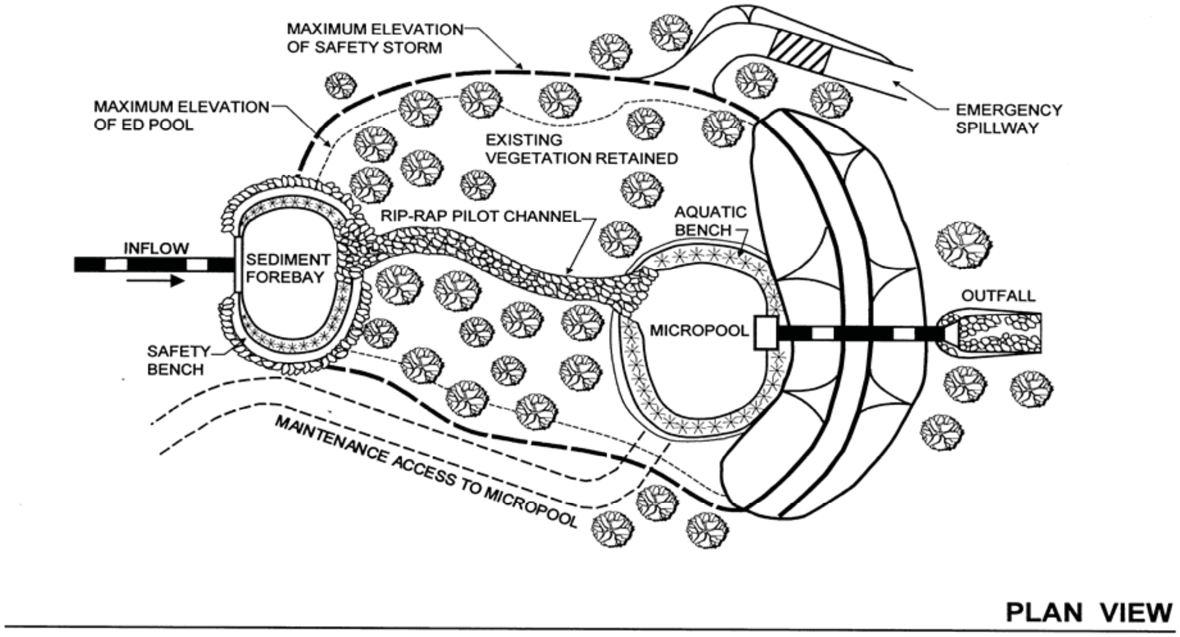
Young, G.K., et al., 1996, *Evaluation and Management of Highway Runoff Water Quality*, Publication No. FHWA-PD-96-032, U.S. Department of Transportation, Federal Highway Administration, Office of Environment and Planning.

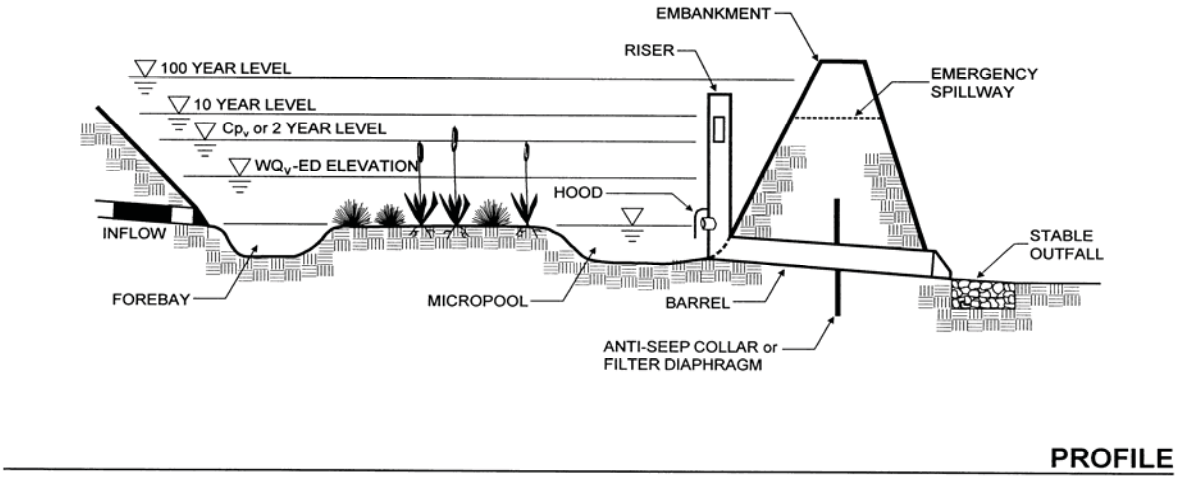
Information Resources

Center for Watershed Protection (CWP), Environmental Quality Resources, and Loiederman Associates. 1997. *Maryland Stormwater Design Manual*. Draft. Prepared for Maryland Department of the Environment, Baltimore, MD.

Center for Watershed Protection (CWP). 1997. *Stormwater BMP Design Supplement for Cold Climates*. Prepared for U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds. Washington, DC.

U.S. Environmental Protection Agency (USEPA). 1993. *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*. EPA-840-B-92-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC.





Schematic of an Extended Detention Basin (MDE, 2000)