PRELIMINARY STORM WATER MITIGATION PLAN

Burkett & Wong Engineers, March 3, 2009

PRELIMINARY
STORM WATER
MITIGATION PLAN

Permit No. ______.

Forrester Creek Industrial Park

Weld Boulevard and Cuyamaca Street
El Cajon, California
APN: 387-190-06

Prepared By

BURKETT & WONG ENGINEERS

3434 Fourth Avenue
San Diego, CA 92103
B/W Project No. 8844UPS

For

Legacy Building Services, Inc.
2505 Congress Street
San Diego, CA 92110

May 15, 2008
Revised: October 29, 2008
Revised March 3, 2009

ATTACHMENTS

A. Location Map

B. Project Map

C. BMP Map

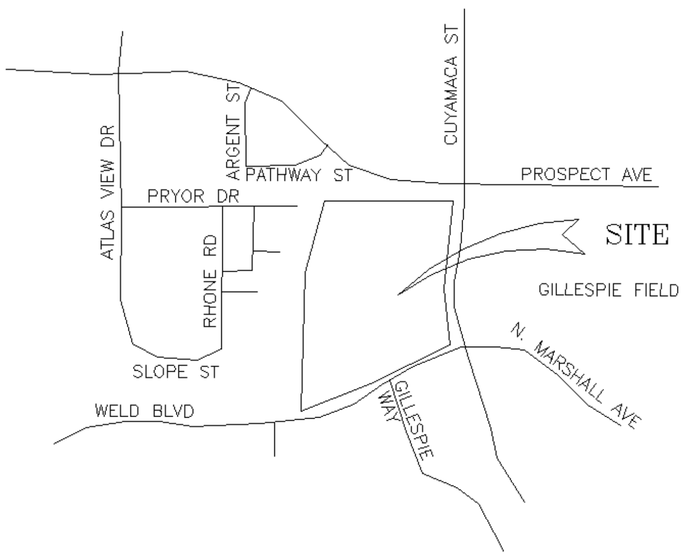
D. BMP Datasheets for proprietary controls (only)

1.0 INTRODUCTION

A Storm Water Mitigation Plan (SWMitP) is required under the City of El Cajon Municipal Code 16.60 and Municipal Permit Order 2007-01. The purpose of this SWMitP is to address the water quantity and quality from the proposed project. Proposed Best Management Practices (BMPs) applied for this project address long-term solutions to water quality. BMP fact sheets are from the CASQA BMP Handbook and from the County of San Diego LID manual. This SWMitP is also intended to ensure the effectiveness of the BMPs through proper maintenance that is based on long-term fiscal planning. The SWMitP is subject to revisions as needed by the engineer.

1.1 PROJECT DESCRIPTION

The Forrester Creek project will consist of 4 industrial buildings, associated parking, access roads, and driveways per table 1-1. The site is located immediately northwest of the intersection of Weld Boulevard and Cuyamaca Street in the city of El Cajon, California (See Vicinity Map).



VICINITY MAP
NO SCALE

The site is presently undeveloped except for the remains of an abandoned building. The current site topography consists of steep slopes along the western boundary which transition to a gentle sloping terrain, except for a knob at approximately the center of the property. Surface runoff from the site generally flows in an easterly to northeasterly direction towards Forrester Creek, which is a concrete-lined trapezoidal channel along the easterly portion of the site. The proposed development will maintain the on-site flows toward the Forrester Creek channel. Existing drainage patterns will be maintained to the maximum extent practicable.

TABLE 1-1 (Check all that apply)

Priority Project Categories	
>10 SFR	
>1 acre Commercial	X
Automotive	
Restaurants	
Hillside Development > 5,000 sq ft	
Parking Lots > 5,000 sq ft or > 15 spaces	X
Streets, roads, highways, freeways that create new paved surface > 5000 sq ft	X
Retail Gas Outlets	

1.2 HYDROLOGIC UNIT CONTRIBUTION

Water Quantity

Natural open space was maintained and protected with easements where possible. The use of landscaped areas throughout the site was maximized and curb cuts are being used at landscaped medians to minimize directly connected impervious areas. Building roof drains are connected to vegetated swales where possible. An underground extended detention basin with landscaping on top is also being proposed. The basin will be designed to detain the 100-year storm event and release storm water from the site at a flow rate that mimics existing conditions before discharging into Forrester Creek. BMPs are designed to treat the 85^{th} percentile flow. Drainage structures detain and convey the 100-year peak flow without flooding the proposed buildings.

Water Quality

The site discharges to Forrester Creek in both existing and proposed conditions. Forrester Creek has been listed as a 303(d) impaired body for fecal coliform, dissolved oxygen, pH, phosphorous, and total dissolved solids. The sources of these potential pollutants are urban runoff, storm sewers, industrial point sources, habitat modification, spills, agricultural return flows, and flow regulation/modification.

2.0 WATER QUALITY ENVIRONMENT

Terms for Use in Calculations

% Impervious – the amount of square footage covered by pavement (concrete or asphalt, buildings, roofs, patios, and sidewalks. Includes future paved areas depending on size of lot such as proposed patio and RV parking.

Runoff Coefficient – calculate using % impervious and known soil type.
Time of Concentration – the amount of time for the first drop of water at the furthest point within a basin to travel to the discharge point without turning more than 45 degrees in a natural-lined conveyance.
Flow Length – the path water from the furthest point to discharge point without turning more than 45 degrees in a natural-lined conveyance.

2.1 PRE-CONSTRUCTION CONDITIONS AND FLOW

The site is presently undeveloped except for the remains of an abandoned building. Surface runoff from the site generally flows in an easterly to northeasterly direction towards Forrester Creek, which is a concrete-lined trapezoidal channel along the easterly portion of the site. For pre-construction hydrologic calculations see Appendix E.

Total Project Area= 31.5 acres

Existing Impervious Areas= 2.1 acres, 7% impervious

2.2 POST-CONSTRUCTION CONDITIONS AND FLOW

The proposed development will maintain the on-site drainage patterns toward the Forrester Creek channel. For post-construction hydrologic calculations see Appendix E.

The hydrologic methodology found in Appendix E resulted in a total existing and proposed condition flow rates from the site and its tributary areas to be 54 and 79 cfs, respectively. A detention analysis was performed to determine the approximate storage volume needed to reduce the proposed condition 100-year flow rate from 79 to 54 cfs to mimic existing conditions.

Proposed Impervious Areas=24.5 acres, 78% impervious

To satisfy Low Impact Development (LID) BMP requirements, the proposed site plan includes drainage swales, an extended detention basin, curb cuts that minimize directly connected impervious areas, and building roof drains that outlet to vegetated swales (See Appendix C for locations)

SUSMP FORM

SUSMP Development or Re-Development (Circle)

SUSMP Triggers (list all applicable categories): _> 1 Acre commercial , Parking Lots >5,000 SF, Streets >5,000

Address: _Weld Boulevard and Cuyamaca Street________________________________

Pre-Q: __54 cfs______________________ Post – Q: ____79 cfs________________

Maintenance
Plan/Notes:_TBD____

Apply all General Site Design and at least one of each control. (Please note that all of the following General Site Design and control items have to be considered and applied to the project. Explain what Best Management Practices (BMPs) were implemented to achieve the General Site Design and controls or justify why the item was not feasible for this project).

General Site Design	**Applied**	**Justification**
1. Control Peak runoff rates (Required)	Yes	Extended Detention Basin designed to reduce peak runoff and to accommodate LID practices.
2. Minimize impervious areas (Required)	Yes	Minimize impervious areas by including landscaped areas and maintaining natural open space where possible.
3. Conserve Natural Areas (Required)	Yes	Conserve natural areas by siting buildings and roadway away from existing natural areas where possible. Grant open space easements where possible.
4. Protect\slopes\and channels (Required)	Yes	Prepare Erosion control plans to ensure protection of proposed slopes. An extended detention basin will maintain existing condition runoff rates to Forester Creek.
5. Minimize effective imperviousness (Required)	Yes	Minimize impervious areas with landscaped medians and open space areas.
6. Construct low traffic areas (walkways, trails, patios, parking lots, alleys, etc.) of permeable surfaces	No	Permeable surfaces not used due to use of grassy swales along perimeters of parking lots and in landscaped medians.
7. Maximize canopy interception by preserving existing trees and shrubs	Yes	Preserve canopy interception on the existing slopes at the southwest portion of the site.
8. Preserve natural drainage systems	Yes	The post-construction drainage pattern mimics the pre-construction pattern and drains to Forester Creek. A proposed extended detention basin maintains the pre-construction flow rate to the Forester Creek.

9. Minimize Directly Connected Impervious Areas (DCIAs) [Drain rooftops, sidewalks, walkways, trails and patios to landscaping]	Yes	Proposed roof drains of the buildings to be connected to vegetated swales along the buildings where applicable.
10. Other		

Source Controls[1]	**Applied**	**Justification**
1. Storm drain message and signage (Required)	Yes	Include details of storm drain stenciling and signage in the construction documents.
2. Outdoor storage area design (Required)	Yes	Design outdoor storage areas, if used, to comply with city and state standards
3. Trash storage area design Must be secured, bermed, and covered. (Required and in accordance with California Fire Code section 1103.2.2)	Yes	Design trash storage areas to be secured, bermed, and covered per city and state standards (Attachment No. 2)
4. Use efficient irrigation systems & landscape design	Yes	Plans prepared by a licensed landscape architect will use efficient irrigation systems.
5. Incorporate requirements of the applicable priority project category: a. Loading/unloading dock area design (Required) b. Repair/maintenance bay design (None Proposed) c. Vehicle/Equipment/Accessory washing area (None Proposed) d. Fueling area design (None Proposed) e. Private Roads (None Proposed) f. Residential Driveways & Guest Parking (None Proposed) g. Outdoor Processing Areas (None Proposed) h. Parking Areas i. Roadways j. Hillside Landscaping	Yes	a. Loading/unloading dock areas will drain into sewer system. h. Parking areas and j. Hillside Landscaping, where feasible, will drain to grass swales before continuing to a hydrodynamic separator and exiting into an extended detention basin before discharging into Forrester Creek. i. Roadways (Gillespie Way and Weld Blvd) will be treated by structural stormwater devices before discharging to Forrester Creek.

6. Proof of control measure maintenance (Required)	Yes	Proof of control measure maintenance will be provided per city and state requirements
7. Other	N/A	N/A

Treatment Controls (Require two controls, at a minimum) [1]	**Applied**	**Justification**
1. Inlet Filters[2]	No	Inlet filters are not used on-site due to low effectiveness and high maintenance requirements. Inlet filters may be used in the public ROW (Gillespie Way and Weld Blvd)
2. Grass strip filter	No	Grass Strip Filter not used due to poor infiltration rate of soils.
3. Grass swale filter	Yes	Grass Swale Filters used to collect runoff from the parking lots through curb cuts at the landscaped medians. Minimizes directly connected impervious areas.
4. Extended detention basin	Yes	Extended Detention Basin used to match peak discharge rate with to existing conditions.
5. Wet detention basin	No	Wet Detention Basin not feasible due to FAA regulations regarding wildlife attractants.
6. Constructed wetland	No	Constructed Wetland not feasible due to FAA regulations regarding wildlife attractants.
7. Sand filter	No	Sand Filter not used due to entire site being within soil group “C” which represents a soil with high runoff potential and low infiltration
8. Hydrodynamic Separator	Yes	Stormceptor unit located at all locations discharging to the

		extended detention basin to filter trash and sediment.
9. Infiltration basin or trench	No	Infiltration Basin or Trench not used due to entire project being within soil group “C” which represents a soil with high runoff potential and low infiltration. Further feasibility studies to be conducted during final engineering.
10. Media filter	No	Media Filter not used for this project due to other treatment controls making up the treatment train.
11. Proprietary controls	No	Proprietary controls not used for this project due other treatment controls making up the treatment train.
12. Other	N/A	N/A

1. Proposed source and treatment controls need to be shown in the grading/drainage plan along with engineering details and/or specifications
2. Not to be used alone.

3.0 POLLUTANTS

3.1 POLLUTANTS GENERATED from AFTER CONSTRUCTION ACTIVITIES AND BMPs APPLIED TO MITIGATE

Terms

Activity – any action taking place outdoors or resultant liquid/solid is disposed outdoors.

Pollutants – sediment (dirt); metals (from dirt , paint, or chemicals); organic material (vegetation or food); grease; petroleum; sewage; detergents/soap; fertilizers; pesticides; trash/debris, and toxics (acids, corrosives).

Post-Construction BMPs – Design controls, Source controls, Treatment structures

Effectiveness – Based on manufacturer, industry; government; or other private studies. List Source.

TABLE 3-1 (Highlight Pollutants from Categories in Table 1-1)

Priority Project Categories	Sediment	Nutrient	Heavy Metals	Org Cpds	Trash & Debris	ODS	Oil & Grease	Bacteria & Viruses	Pesticides
>10 SFR	X	X			X	X	X	X	X
1 acre Commercial	P	P		P	X	P	X	P	P
Automotive			X	X	X		X		
Restaurants					X	X	X	X	
Hillside Development	X	X			X	X	X		X
Parking Lots	P	P	X		X	P	X		P
New Streets > 5000 sq. ft.	X	P	X		X	P	X		P
> 5,000 sq ft Redevelopment	X	P	P	P	X	P	P	P	P
X- anticipated P – Potential		ODS – Oxygen Demanding Substances							

TABLE 3-2 (Highlight the combination of BMPs for the Project that most effectively treats the Pollutants from Table 3-1) Efficiencies are in ()

Pollutants	**BMPS**
Sediment	Biofilters (Medium) Detention Basins (High) Infiltration Basins (High) Wet Ponds or Wetlands (High) Inlet Filters (Low) Filtration (High) Hydrodynamic Systems (Medium)
Nutrients	Biofilters (Low) Detention Basins (Medium) Infiltration Basins (Medium) Wet Ponds or Wetlands (Medium) Inlet Filters (Low) Filtration (Medium) Hydrodynamic Systems (Medium)
Metals	Biofilters (Medium) Detention Basins (Medium) Infiltration Basins (Medium) Wet Ponds or Wetlands (High) Inlet Filters (Low) Filtration (High) Hydrodynamic Systems (Low)
Organic Compounds	Biofilters (Unknown) Detention Basins (Unknown) Infiltration Basins (Unknown) Wet Ponds or Wetlands (Medium) Inlet Filters (Low)

	Filtration (Medium) Hydrodynamic Systems (Low)
Trash and Debris	Biofilters (Low) Detention Basins (High) Infiltration Basins (Unknown) Wet Ponds or Wetlands (High) Inlet Filters (Medium) Filtration (High) Hydrodynamic Systems (Medium)
Oxygen Depleting Substances	Biofilters (Low) Detention Basins (Medium Infiltration Basins (Medium) Wet Ponds or Wetlands (Medium) Inlet Filters (Low) Filtration (Medium) Hydrodynamic Systems (Low)
Oil & Grease	Biofilters (Medium) Detention Basins (Medium) Infiltration Basins (Unknown) Wet Ponds or Wetlands (Unknown) Inlet Filters (Low) Filtration (High) Hydrodynamic Systems (Low)
Bacteria	Biofilters (Unknown) Detention Basins (Unknown) Infiltration Basins (High) Wet Ponds or Wetlands (High) Inlet Filters (Low) Filtration (Medium) Hydrodynamic Systems (Low)
Pesticides	Biofilters (Unknown) Detention Basins (Unknown) Infiltration Basins (Unknown) Wet Ponds or Wetlands (Low) Inlet Filters (Low) Filtration (Unknown) Hydrodynamic Systems (Low)

4.0 CONSTRUCTION AND POST-CONSTRUCTION BMPS

4.1 CONSTRUCTION BMPS

TABLE 4-1

ACTIVITY	POLLUTANTS	CONSTRUCTION BMP	EFFECTIVENESS
Entrance/Exit of	Sediment	TC-1	High

Project Site			(CASQA)
Pouring Concrete	Metals; pH	WM-8	High (CASQA)
Port-o-Let	Bacteria; Organics	WM-9 (Modified with secondary containment and strapped to a secure source to prevent tipping	High (CASQA)

4.2 POST-CONSTRUCTION BMPS

To satisfy the new adopted Low Impact Development (LID) BMP’s, the site has proposed vegetated grass swales, an extended detention basin, curb cuts, and connecting the industrial building roof drains to vegetated swales (See Appendix C for locations and Table 3-2 for identification of pollutants associated with each BMP and their effectiveness)

5.0 TREATMENT BMPS

Treatment BMPs are designed to treat to the 85th percentile of the design storm.

The proposed site plan attempts to minimize the impacts of post-construction storm water runoff. Parking areas are broken up with landscaped medians and grass swales. Grass swales connect to hydrodynamic systems and hydrodynamic systems connect to an extended detention basin before storm water discharge to Forrester Creek.

6.0 LOW-IMPACT DEVELOPMENT (LID)

The project design incorporates Low Impact Development (LID) Best Management Practices (BMPs) for compliance with the California Regional Water Quality Board (San Diego Region) Order No. R9-2007-0001. An electronic copy of the County of San Diego Low Impact Development Handbook can be found online at:
http://www.co.san-diego.ca.us/dplu/docs/LID-Handbook.pdf
LID BMPs occur through planning, design and integrated management.

Site planning LID BMPs incorporated into this site include the following:

- Conserving natural areas, soils and vegeatation
- Minimizing disturbances to natural drainages
- Minimizing and disconnecting impervious surfaces
- Draining runoff from impervious surfaces to pervious areas

Design LID BMPs incorporated into this site include the following:

- Vegetated swales with check dams
- Roof drainage directed into landscaping
- Infiltration islands

- Grass swales
- Curb cuts to direct runoff to swales
- Proper loading dock design

Integrated management LID BMPs incorporated into this site include the following:

- Biofilters (rock and vegetated swales)

7.0 MAINTENANCE

7.1 CONSTRUCTION BMPs

Maintenance of construction BMPs will start at the time of first soil disturbance and will continue through the life of the project. Maintenance will end when a 70% coverage of disturbed areas is established. The contractor will have stockpiles on hand to maintain and repair BMPs.

7.2 POST-CONSTRUCTION BMPs

Post-construction BMPs will be maintained in perpetuity by the owner and all successive owners.

Typical maintenance activities for grass swales will include regular inspections for debris, litter, and areas of sediment accumulation. Mowing for safety or aesthetics or to suppress weeds and woody vegetation; the application of fertilizers should be minimal. Sediment accumulating near culverts in channels should be removed when it builds up to 3 inches at any spot, or covers vegetation

Typical maintenance activities for the hydrodynamic separator system should include the following key components. The regular sweeping and removal of debris within vehicle parking lots, yards and immediate surrounding areas, especially around the drainage inlet, should be collected and removed. Regular inspections based on manufacturer recommendations should be performed.

Typical maintenance activities for the detention basin should include regular inspections for debris, litter, and areas of sediment accumulation. Regular inspections for structural integrity and blockages should also occur.

Typical maintenance activities for the possible inlet filters in the public right of way include regular inspections for debris, litter, and areas of sediment accumulation.

8.0 SUMMARY/CONCLUSIONS

The Forrester Creek Industrial Park development strives to minimize its impact on the environment both during and after construction. Site design and site grading for the development maximizes the conservation of natural open spaces, maintains existing drainage patterns and mimics flow volumes and velocities as they discharge to Forrester Creek.

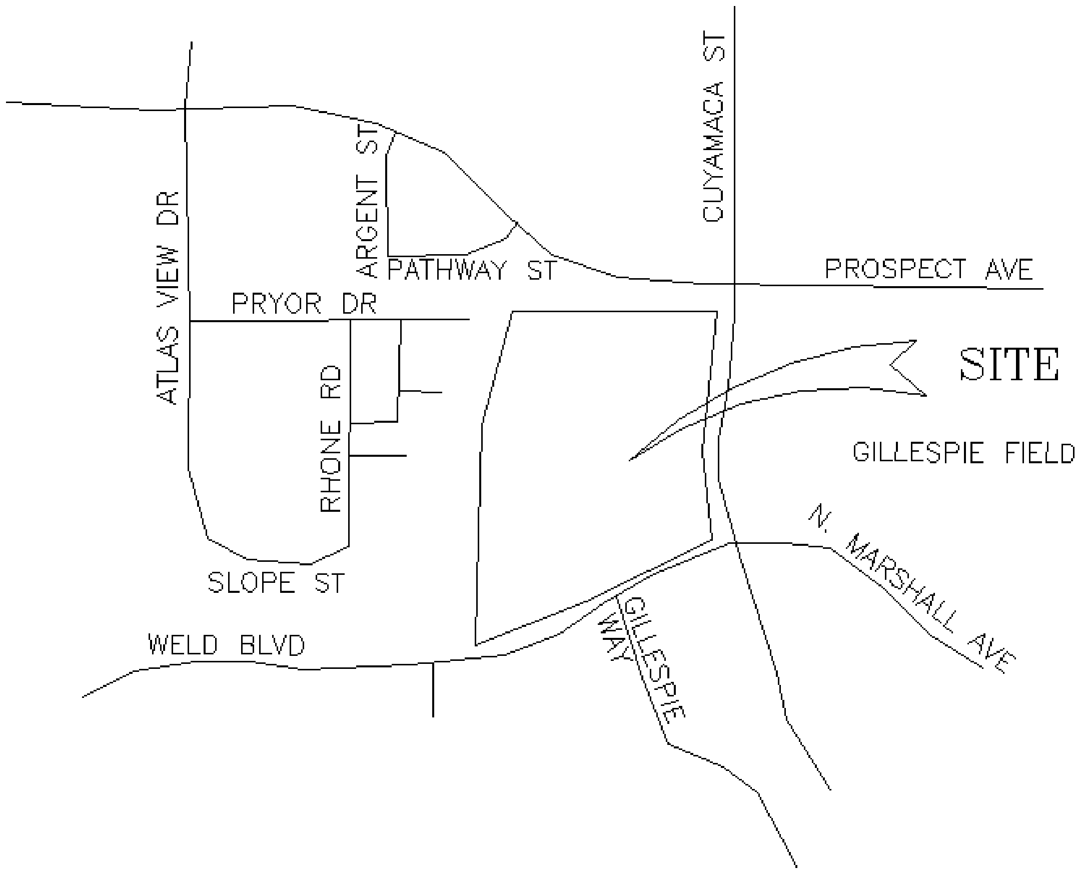
The site runoff will be treated using both standard and low impact development BMPs designed to treat the 85th percentile storm event and to detain the 100-year peak flow. Vegetated swales collect runoff from roof drains and parking lot curb cuts which minimize directly connected impervious areas. Runoff that is conveyed in the underground storm drain system is treated with hydrodynamic separators before being detained in an underground basin. The underground basin is designed to detain the runoff from a 100-year storm and release the stormwater into Forrester Creek at a flow rate that mimics existing conditions. The Forrester Creek Industrial Park development will have a positive effect on the storm water runoff quantity and quality leaving the project site.

CERTIFICATION

This Storm Water Mitigation Plan has been prepared under the direction of the following Registered Civil Engineer. The Registered Civil Engineer attests to the technical information contained herein and the engineering data upon which recommendations, conclusions, and decisions are based.

REGISTERED CIVIL ENGINEER
AMBROSE T. WONG
DATE: February 5, 2009

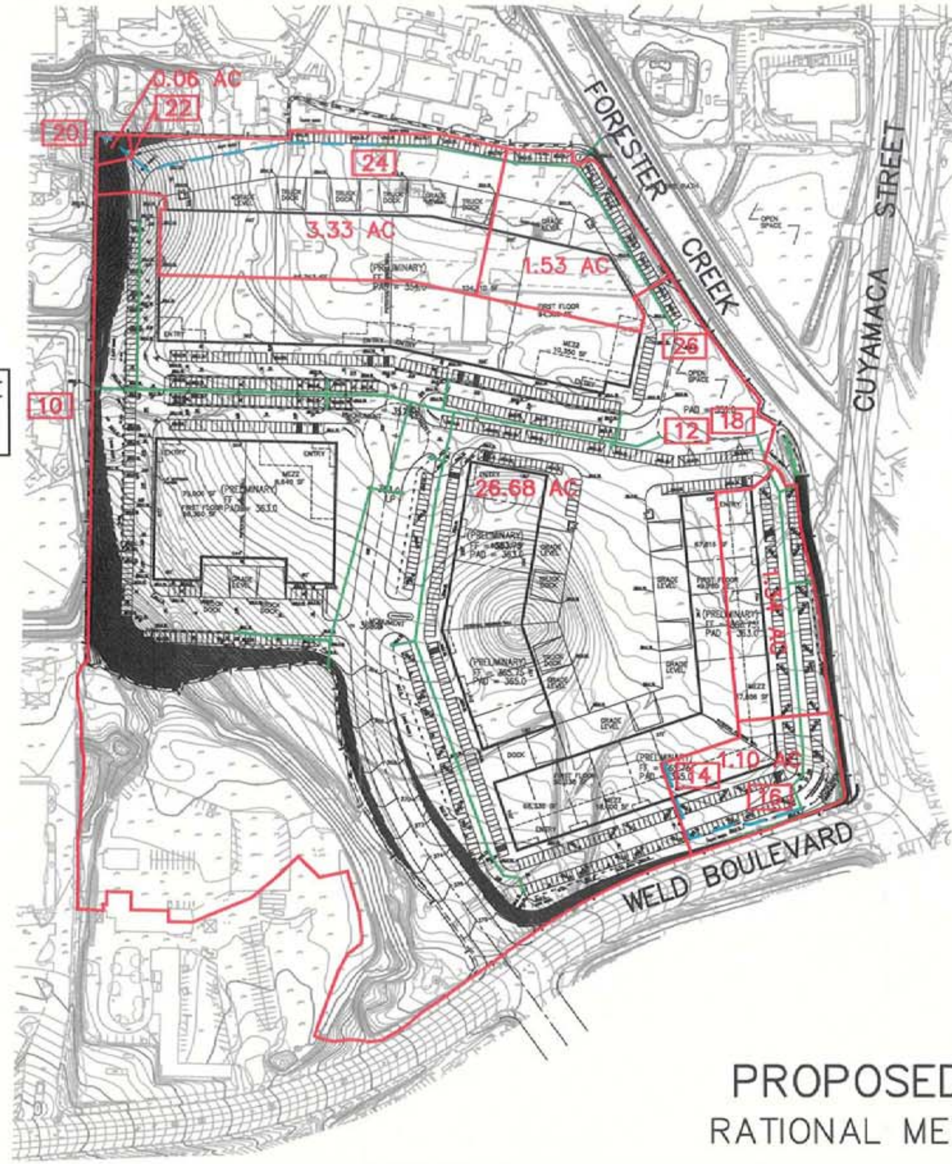
ATTACHMENT A
LOCATION MAP



VICINITY MAP

NO SCALE

ATTACHMENT B
PROJECT MAP



Q100=17.5 CFS AT NODE 10 FROM LOS CASTILLOS SUBDIVISION

1" = 200'

0 200

LEGEND:

- DRAINAGE BASIN BOUNDARY
- FLOW PATH
- PROPOSED STORM DRAIN
- 3.62 AC DRAINAGE BASIN AREA
- 10 RATIONAL METHOD NODE NUMBER

PROPOSED CONDITION

RATIONAL METHOD WORK MAP

ATTACHMENT C
Post-Construction BMP MAP

BMP LOCATION

SCALE:" 1"=60'-0"

burkett & wong
engineers & surveyors
3434 fourth ave. san diego ca.
92103-5704 * (619) 299-5550

ATTACHMENT D
Post-Construction BMP DATASHEETS

Description

Vortex separators: (alternatively, swirl concentrators) are gravity separators, and in principle are essentially wet vaults. The difference from wet vaults, however, is that the vortex separator is round, rather than rectangular, and the water moves in a centrifugal fashion before exiting. By having the water move in a circular fashion, rather than a straight line as is the case with a standard wet vault, it is possible to obtain significant removal of suspended sediments and attached pollutants with less space. Vortex separators were originally developed for combined sewer overflows (CSOs), where it is used primarily to remove coarse inorganic solids. Vortex separation has been adapted to stormwater treatment by several manufacturers.

California Experience

There are currently about 100 installations in California.

Advantages

- May provide the desired performance in less space and therefore less cost.
- May be more cost-effective pre-treatment devices than traditional wet or dry basins.
- Mosquito control may be less of an issue than with traditional wet basins.

Limitations

- As some of the systems have standing water that remains between storms, there is concern about mosquito breeding.
- It is likely that vortex separators are not as effective as wet vaults at removing fine sediments, on the order 50 to 100 microns in diameter and less.
- The area served is limited by the capacity of the largest models.
- As the products come in standard sizes, the facilities will be oversized in many cases relative to the design treatment storm, increasing the cost.
- The non-steady flows of stormwater decreases the efficiency of vortex separators from what may be estimated or determined from testing under constant flow.
- Do not remove dissolved pollutants.

Design Considerations

- Service Area
- Settling Velocity
- Appropriate Sizing
- Inlet Pipe Diameter

Targeted Constituents

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

Legend ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

CASQA

CALIFORNIA STORMWATER

- A loss of dissolved pollutants may occur as accumulated organic matter (e.g., leaves) decomposes in the units.

Design and Sizing Guidelines

The stormwater enters, typically below the effluent line, tangentially into the basin, thereby imparting a circular motion in the system. Due to centrifugal forces created by the circular motion, the suspended particles move to the center of the device where they settle to the bottom. There are two general types of vortex separation: free vortex and dampened (or impeded) vortex. Free vortex separation becomes dampened vortex separation by the placement of radial baffles on the weir-plate that impede the free vortex-flow pattern

It has been stated with respect to CSOs that the practical lower limit of vortex separation is a particle with a settling velocity of 12 to 16.5 feet per hour (0.10 to 0.14 cm/s). As such, the focus for vortex separation in CSOs has been with settleable solids generally 200 microns and larger, given the presence of the lighter organic solids. For inorganic sediment, the above settling velocity range represents a particle diameter of 50 to 100 microns. Head loss is a function of the size of the target particle. At 200 microns it is normally minor but increases significantly if the goal is to remove smaller particles.

The commercial separators applied to stormwater treatment vary considerably with respect to geometry, and the inclusion of radial baffles and internal circular chambers. At one extreme is the inclusion of a chamber within the round concentrator. Water flows initially around the perimeter between the inner and outer chambers, and then into the inner chamber, giving rise to a sudden change in velocity that purportedly enhances removal efficiency. The opposite extreme is to introduce the water tangentially into a round manhole with no internal parts of any kind except for an outlet hood. Whether the inclusion of chambers and baffles gives better performance is unknown. Some contend that free vortex, also identified as swirl concentration, creates less turbulence thereby increasing removal efficiency. One product is unique in that it includes a static separator screen.

- Sized is based on the peak flow of the design treatment event as specified by local government.
- If an in-line facility, the design peak flow is four times the peak of the design treatment event.
- If an off-line facility, the design peak flow is equal to the peak of the design treatment event.
- Headloss differs with the product and the model but is generally on the order of one foot or less in most cases.

Construction/Inspection Considerations

No special considerations.

Performance

Manufacturer's differ with respect to performance claims, but a general statement is that the manufacturer's design and rated capacity (cfs) for each model is based on and believed to achieve an aggregate reduction of 90% of all particles with a specific gravity of 2.65 (glacial sand) down to 150 microns, and to capture the floatables, and oil and grease. Laboratory tests of two products support this claim. The stated performance expectation therefore implies that a lesser removal efficiency is obtained with particles less than 150 microns, and the lighter, organic settleables. Laboratory tests of one of the products found about 60% removal of 50 micron sand at the expected average operating flow rate

Experience with the use of vortex separators for treating combined sewer overflows (CSOs), the original application of this technology, suggests that the lower practical limit for particle removal are particles with a settling velocity of 12 feet per hour (Sullivan, 1982), which represents a particle diameter of 100 to 200 microns, depending on the specific gravity of the particle. The CSO experience therefore seems consistent with the limited experience with treating stormwater, summarized above

Traditional treatment technologies such as wet ponds and extended detention basins are generally believed to be more effective at removing very small particles, down to the range of 10 to 20 microns. Hence, it is intuitively expected that vortex separators do not perform as well as the traditional wet and dry basins, and filters. Whether this matters depends on the particle size distribution of the sediments in stormwater. If the distribution leans towards small material, there should be a marked difference between vortex separators and, say, traditional wet vaults. There are little data to support this conjecture

In comparison to other treatment technologies, such as wet ponds and grass swales, there are few studies of vortex separators. Only two of manufactured products currently available have been field tested. Two field studies have been conducted. Both achieved in excess of 80% removal of TSS. However, the test was conducted in the Northeast (New York state and Maine) where it is possible the stormwater contained significant quantities of deicing sand. Consequently, the influent TSS concentrations and particle size are both likely considerably higher than is found in California stormwater. These data suggest that if the stormwater particles are for the most part fine (i.e., less than 50 microns), vortex separators will not be as efficient as traditional treatment BMPs such as wet ponds and swales, if the latter are sized according to the recommendations of this handbook.

There are no equations that provide a straightforward determination of efficiency as a function of unit configuration and size. Design specifications of commercial separators are derived from empirical equations that are unique and proprietary to each manufacturer. However, some general relationships between performance and the geometry of a separator have been developed. CSO studies have found that the primary determinants of performance of vortex separators are the diameters of the inlet pipe and chamber with all other geometry proportional to these two.

Sullivan et al. (1982) found that performance is related to the ratios of chamber to inlet diameters, D_2/D_1, and height between the inlet and outlet and the inlet diameter, H_1/D_1, shown in Figure 3. The relationships are: as D_2/D_1 approaches one, the efficiency decreases; and, as the H_1/D_1 ratio decreases, the efficiency decreases. These relationships may allow qualitative comparisons of the alternative designs of manufacturers. Engineers who wish to apply these concepts should review relevant publications presented in the References.

Siting Criteria

There are no particularly unique siting criteria. The size of the drainage area that can be served by vortex separators is directly related to the capacities of the largest models.

Additional Design Guidelines

Vortex separators have two capacities if positioned as in-line facilities, a treatment capacity and a hydraulic capacity. Failure to recognize the difference between the two may lead to significant under sizing; i.e., too small a model is selected. This observation is relevant to three of the five products. These three technologies all are designed to experience a unit flow rate of about 24 gallons/square foot of separator footprint at the peak of the design treatment event. This is the horizontal area of the separator zone within the container, not the total footprint of the unit. At this unit flow rate, laboratory tests by these manufacturers have established that the performance will meet the general claims previously described. However, the units are sized to handle 100 gallons/square foot at the peak of the hydraulic event. Hence, in selecting a particular model the design engineer must be certain to match the peak flow of the design event to the stated treatment capacity, not the hydraulic capacity. The former is one-fourth the latter. If the unit is positioned as an off-line facility, the model selected is based on the capacity equal to the peak of the design treatment event.

Maintenance

Maintenance consists of the removal of accumulated material with an eductor truck. It may be necessary to remove and dispose the floatables separately due to the presence of petroleum product.

Maintenance Requirements

Remove all accumulated sediment, and litter and other floatables, annually, unless experience indicates the need for more or less frequent maintenance.

Cost

Manufacturers provide costs for the units including delivery. Installation costs are generally on the order of 50 to 100 % of the manufacturer's cost. For most sites the units are cleaned annually.

Cost Considerations

The different geometry of the several manufactured separators suggests that when comparing the costs of these systems to each other, that local conditions (e.g., groundwater levels) may affect the relative cost-effectiveness.

References and Sources of Additional Information

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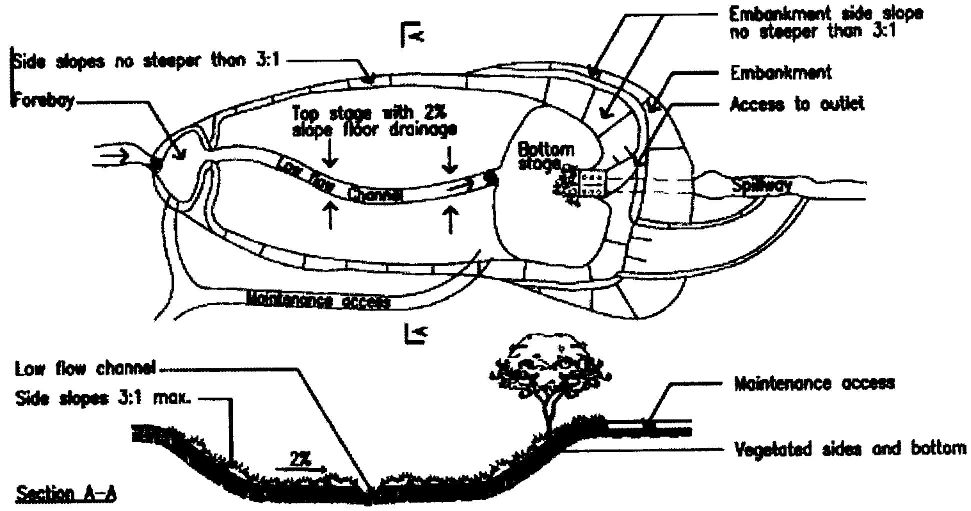
Sullivan, R.H., M.M. Cohn, J.E. Ure, F.F. Parkinson, and G. Caliana, 1974, The swirl concentrator as a grit separator device, EPA670/2-74-026, U.S. Environmental Protection Agency, Washington, D.C.

Sullivan, R.H., M.M. Cohn, J.E. Ure, F.F. Parkinson, and G. Caliana, 1978, Swirl primary separator device and pilot demonstration, EPA600/2-78-126, U.S. Environmental Protection Agency, Washington, D.C.

Fact Sheet 3. Extended detention (dry) ponds



Conditions, dimensions, and materials shown are typical. Modifications may be required for proper application, consult qualified professional.

Extended detention (dry) ponds store water during storms for a short period of time (from a few hours up to three days), and discharge water to adjacent surface waters. Stormwater design volumes are designed to be stored in such basins for more than 1 day to provide adequate settling time and maximize pollutant removal. The basins are dry between storms, and do not have a permanent pool of water. This tool is best suited for use as part of a treatment train in conjunction with other LID techniques.

CHARACTERISTICS

- If properly designed, ponds can have a lifetime of 50 years.
- Clay or impervious soils should not affect pollutant removal effectiveness, as the main removal mechanism is settling.
- Pollutants removed primarily through gravitational settling of suspended solids, though a small portion of the dissolved pollutant load may be removed by contact with the pond bottom sediments and/or vegetation, and through infiltration.
- Moderate removal of suspended solids (sediment) and heavy metals.
- Low to moderate removal of nutrients and Biological Oxygen Demand (B.O.D.).
- Pollutant removal can be maximized by increasing residence time; two-stage pond design, with the addition of wetland vegetation to lower stages of the pond; sediment trapping forebay to allow efficient maintenance; regular maintenance and sediment cleanout; installing adjustable gate valves to achieve target detention times; designing pond outlet to detain smaller treatment volumes (less than two-year storm event).

APPLICATION

- May be initially used as construction settling basins, but must be re-graded and cleaned out before used as a post-construction pond.
- May be designed for both pollutant removal and flood control.
- May be appropriate for developments of 10 acres or larger.

- Potential for multiple uses including flood control basins; parks, playing fields, and tennis courts; open space; overflow parking lots.

DESIGN

- Coordinate pond design, location, and use with local municipal public works department and/or county flood control department to reduce potential downstream flooding.
- Default conditions for safety have been to fence basins with chain link. Consider aesthetic design elements with safety analyst to address pond barriers, such as fencing and/or vegetation, and shallow side slopes (8:1 to 12:1).
- See County of San Diego Drainage Design Manual

MAINTENANCE

- Regular inspection during wet season for sediment buildup and clogging of inlets and outlets (designing a forebay to trap sediment can decrease frequency of required maintenance, as maintenance efforts are concentrated towards a smaller area of the basin and less disruptive than complete basin cleaning).
- Clean inlet trash rack and outlet standpipe as necessary.
- Clean out basin sediment approximately once per year (this may vary depending on pond depth and design, and if forebay is used).
- Mow and maintain pond vegetation, replant or reseed as necessary to control erosion.

LIMITATIONS

- Limitation of available space.
- Dry detention ponds have only moderate pollutant removal when compared to some other structural treatment controls and are relatively ineffective at removing soluble pollutants.
- Basins must be designed with vector control (max 72 hour residence time), sediment and vegetation removal/maintenance considerations in mind.
- Not suitable on sites with steep slopes.

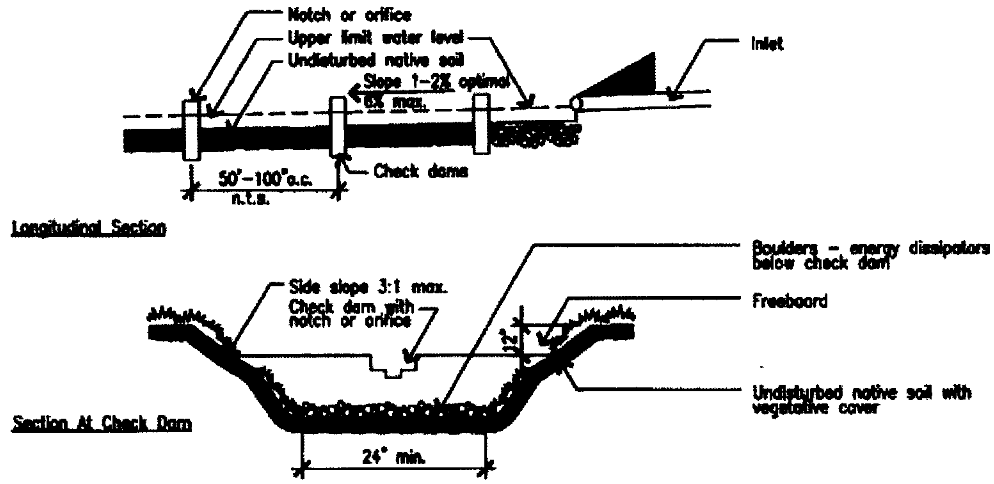
ECONOMICS

- Least expensive stormwater quality pond option available. 0-25% additional cost when added to conventional stormwater detention facilities.
- Construction cost $0.10-$5.00 per cubic foot of storage (savings from preparing silt basins used during construction for use as extended detention ponds).
- Maintenance cost 3-5% of construction cost annually.

REFERENCES

- California Stormwater Quality Association. (2003, January) California Stormwater BMP Handbook: New Development and Redevelopment.
- For additional information pertaining to extended detention ponds, see the works cited in the San Diego County LID Literature Index.

Fact Sheet 4. Vegetated Swale / Rock Swale



Conditions, dimensions, and materials shown are typical. Modifications may be required for proper application, consult qualified professional.

Vegetated / rock swales are vegetated or rock lined earthen channels that collect, convey, and filter site water runoff and remove pollutants. Swales are an alternative to lined channels and pipes; configuration and setting are unique to each site.

CHARACTERISTICS

- If properly designed and maintained, swales can last for at least 50 years.
- Can be used in all soil types, natural or amended.
- When swales are not holding water, they appear as a typical landscaped area.
- Water is filtered by vegetation/rocks and pollutants are removed by infiltration into the subsurface of the soil.
- Swales also serve to delay runoff peaks by reducing flow velocities.

APPLICATION

- Swales are most effective in removing coarse to medium sized sediments.
- Parking lot medians, perimeters of impervious pavements.
- Street and highway medians, edges (in lieu of curb and gutter, where appropriate).
- In combination with constructed treatment systems or sand filters.

DESIGN

- Vegetation of each swale is unique to the setting, function, climate, geology, and character of each site and climatic condition.
- Can be designed with natural or amended soils, depending on the infiltration rate provided by the natural condition versus the rate needed to reduce surface runoff .
- Grass swales move water more quickly than vegetated swales. A grass swale is planted with salt grass; a vegetated swale is planted with bunch grass, shrubs or trees.
- Rocks, gravel, boulders, and/or cobbles help slow peak velocity, allow sedimentation, and add aesthetic value.

- Pollutant removal effectiveness can be maximized by increasing residence time of water in swale using weirs or check dams.
- Swales are often used as an alternative to curbs and gutters along roadways, but can also be used to convey stormwater flows in recreation areas and parking lots.
- Calculations should also be provided proving the swale capable of safely conveying the 100-year flow to the swale without flooding adjacent property or infrastructure.
- See County of San Diego Drainage Design Manual for design criteria. (section 5.5) http://www.sdcounty.ca.gov/dpw/docs/hydrologymanual.pdf

MAINTENANCE

- Swale maintenance includes mowing and removing clippings and litter. Vegetated swales may require additional maintenance of plants.
- Periodically remove sediment accumulation at top of bank, in swale bed, or behind check dams.
- Monitor for erosion and reseed grass or replace plants, erosion control netting and mulch as necessary. Fertilize and replace vegetation well in advance of rainy season to minimize water quality degradation.
- Regular inspections and maintenance is required during the establishment period.

LIMITATIONS

- Only suitable for grades between 1% and 6%; when greater than 2.5% should be paired with weir or check dam.
- "Turf" swales will commonly require irrigation and may not meet State water conservation goals.
- Irrigated vegetation is not appropriate in certain sites. Xeriscape techniques, natural stone and rock linings should be used as an alternative to turf.
- Wider road corridors may be required to incorporate swales.
- Contributing drainage areas should be sized to meet the stormwater management objective given the amount of flow that will be produced.
- When contributing flow could cause formation of low-flow channel, channel dividers must be constructed to direct flow and prevent erosion.

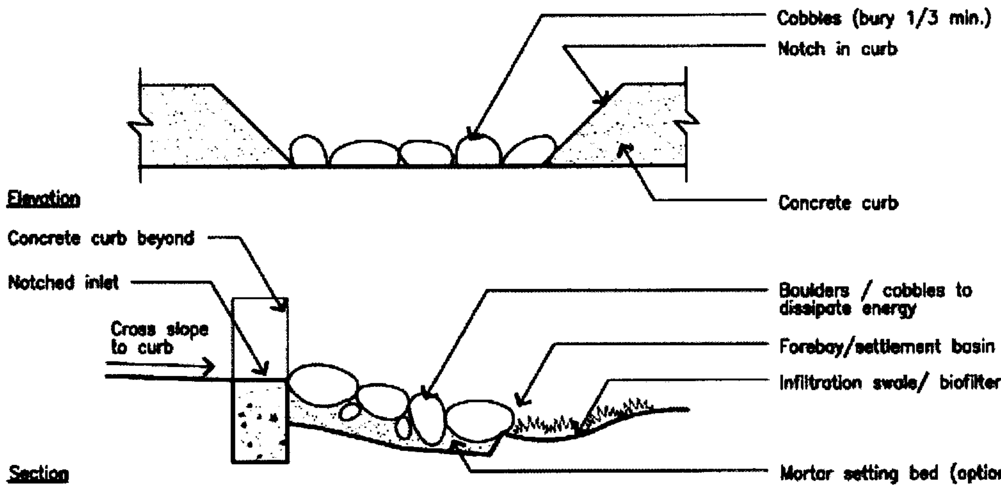
ECONOMICS

- Estimated grass swale construction cost per linear foot $4.50-$8.50 (from seed) to $15-20 (from sod), compare to $2 per inch of diameter underground pipe e.g., a 12" pipe would cost $24 per linear foot).
- $0.75 annual maintenance cost per linear foot

REFERENCES

- CALTRANS – Storm Water Handbook (cabmphandbooks.com)
- For additional information pertaining to Swales, see the works cited in the San Diego County LID Literature Index.

Fact Sheet 17. Curb-cuts



Conditions, dimensions, and materials shown are typical. Modifications may be required for proper application, consult qualified professional.

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. 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. If lined with ground cover or gravel/rock and gently sloped, these swales function as biofilters. Because concentration of flow will be highest at the curb opening, erosion control must be provided, which may include a settlement basin for ease of debris removal.

<u>Urban curb/swale</u> systems are a hybrid of standard urban curb and gutter with a more rural or suburban swale drainage system. It provides a rigid pavement edge for vehicle control, street sweeping, and pavement protection, while still allowing surface flow in landscaped areas for stormwater quality protection.

CHARACTERISTICS

- Runoff travels along the gutter, but instead of being emptied directly into catch basins and underground pipes, it flows into surface swales.
- Stormwater can be directed into swales either through conventional catch basins with outfall to the swale or notches in the curb with flow line leading to the swale.
- Swales remove dissolved pollutants, suspended solids (including heavy metals, nutrients), oil and grease by infiltration.

APPLICATION

- Can be created in existing and new residential developments, commercial office parks, arterial streets, concave median islands.

- Swale system can run either parallel to roadway or perpendicular to it, depending on topography and adjacent land uses.

DESIGN

- Size curb-openings or catch basins for design storm.
- Multiple curb openings closely spaced are better than fewer openings widely spaced because it allows for greater dissipation of flow and pollutants.
- Provide energy dissipaters at curb notches or catch basin outfall into swale.
- Provide settlement basin at bottom of energy dissipater to allow for sedimentation before water enters swale.
- Curb cuts should be at least 12 inches wide to prevent clogging.
- Curb cuts should have a vertical drop in addition to sufficient width to prevent clogging.

MAINTENANCE

- Annual removal of built-up sediment in settlement basin may be required.
- Catch basins require periodic cleaning.
- Inspect system prior to rainy season and during or after large storms.

LIMITATIONS

- Parking requirements and codes

ECONOMICS

- Cobble-lined curb opening may add marginal cost compared to standard catch basin.
- Swale system requires periodic landscape maintenance.

REFERENCES

- Village Homes subdivision, Davis, CA. Residential street network,
- Folsom, CA. Dual-drainage system,
- For additional information pertaining to Curb-cuts, see the works cited in the San Diego County LID Literature Index.

Fact Sheet 28. Downspout to Swale


Photograph Courtesy of EOA, Inc.

Discharging a roof downspout to landscaped areas via swales allows for polishing and infiltration of the runoff.

CHARACTERISTICS
- Runoff from the roof is directed into a rocky or vegetated swale area.
- The water flows through swale with overflow continuing to the storm drain.

APPLICATIONS
- Appropriate for most buildings with landscaped areas adjacent to the building where soil drainage is appropriate and water infiltration does not pose a risk to the foundation.

DESIGN
- The downspout can be directly connected to a pipe which daylights some distance from the building foundation, releasing the roof runoff into a rock lined swale towards a landscaped area.
- The roof runoff is slowed by the rocks, absorbed by the soils and vegetation, and remaining runoff flows away from the building foundation into the storm drain.
- Xeriscape techniques, natural stone and rock linings should be used as an alternative to turf.

MAINTENANCE
- Maintenance is similar to that necessary for other swale areas and will depend on the specific style chosen.

LIMITATIONS
- Only suitable for grades between 1% and 6%
- When a vegetated swale is used, the site requires adequate sunlight for vegetation growth
- Avoid infiltrating too close to foundations and underground utilities.

ECONOMICS
- Costs are similar to those associated with other swale devices.

REFERENCES
- For additional information pertaining to the Downspout to Swale technique, see the works cited in the San Diego County LID Literature Index.