

## APPLICATION #600: YMCA OF MARTHA'S VINEYARD ADDENDUM NO. 1

### WASTEWATER:

- *How will wastewater be handled?*

The Y plans to join the High School in pumping to the Oak Bluffs Wastewater Treatment Facility and pumping back to a leaching field on the High School property. This plan is pending approval by the HS Land Use Sub-committee, High School Committee, and OB Waste Water Commissioners. The High School will provide a written update at the 7/18 hearing.

- *Would the Y be willing to de-nitrify the wastewater of neighbors such as Community Services if that would get them under the MVC nitrogen loading limit? Could they do a package treatment plant that would create greater capacity and take in future systems?*

The Y cannot commit to solving other organization's loading issues; a commitment such as this could have significant financial impacts for the Y later on in the project. The Y can commit only to their own system or a joint effort with the High School or other organizations.

### STORMWATER:

- *Do we have the storm water plans and calculations?*

Stormwater calculations are being submitted under separate cover to Bill Wilcox with full size Civil site plan drawings (half-size Civil drawings are attached).

- *Investigate vegetated swales used by hospital for bio-retention.*

RFS has considered the concept of bio-retention areas, as suggested by the MVC. Towards this end, we researched available literature on the topic, and reviewed the site plans for the Martha's Vineyard Hospital, which employs multiple bio-retention areas for nitrogen removal and other benefits.

Unfortunately, our site is more confined than the Hospital's, and we are faced with a further tree-cutting constraint related to the NHESP habitat concerns – both of which limit the ability to employ extensive bio-retention for the YMCA project. Nevertheless, we find that we are able to include one bio-retention basin and to expand the use of bio-retention swales on our site. Revised plans are submitted herewith. The basin will serve to treat runoff from the northeast parking lot, and the swales are located adjacent to the other parking lots.

The bio-retention area follows the conventional design of a sediment forebay followed by an absorption area with plantings. The swales are adaptations of the same concept,

but employ low stone check dams to retard velocities for the sediment function and depressed grades at the receiving catch basins to promote shallow ponding and absorption after each runoff event.

Enclosed herewith is an article from the Low Impact Design web site, indicating that bio-retention areas have an average nitrogen removal of 60%. (See attached article: Watershed Benefits of Bioretention Techniques.) There does not seem to be much available quantitative removal information on swales, as there is for bio-retention areas. It seems obvious that removals will be less, but superior to conventional grass swales and receiving catch basins. We feel 25% removal is a conservative estimate.

Enclosed are revised nitrogen loading calculations. The changes from the calculations originally submitted with the DRI application are shown in italics. It indicates that the overall nitrogen loading of 11.45 kg/yr, down from 13.66 kg/yr.

#### TRAFFIC AND PARKING:

- *Commissioners would like more information about the VTA's statement that they should reduce parking.*

74 new spaces are proposed on Y property; Angela Grant of the VTA is anticipated to attend and speak to the 7/18 hearing on this issue.

- *A commissioner wants details of what a proposed white fence and flashing lights at highly visible cross walks would look like.*

See attached images provided by MS Transportation.

- *A commissioner would like more information on the safety of pedestrians crossing Vineyard Haven-Edgartown Road.*

The Y is committed to resolving this issue and sharing in the cost with other involved entities such as the High School and the Town of Oak Bluffs. See attached images provided by MS Transportation for possible options for pedestrian crossings.

- *Clarify the status of Vineyard Haven-Edgartown Road ownership and control.*

The VH-Edgartown Road is Town owned, but State funded; the State has veto power over anything that is proposed. The Town of Oak Bluffs maintains the road.

- *What happened to the visual baffle at the main vehicular entry?*

The site plan has been revised, see the attached revised Civil Site Plan; the entry drive to the Y and the Arena from the VH/Edgartown Road is slid to the east to baffle the view of the drive and parking.

- *A commissioner would like more information on traffic coordination during construction and with other projects on the Island.*

The construction managers for the Y will coordinate heavy load deliveries with construction managers from the MV Hospital and the Beach Road drawbridge projects to minimize traffic impacts.

- *Apply speed bumps near cross walks. How will speed bumps and crosswalks be constructed on the site?*

Raised internal cross walks will be incorporated in two locations as noted on the MS Transportation Campus Plan drawing; locations provided at walk from Y front door and at crosswalk in shared Y/Arena access drive.

- *Explain bus loops into Y for safety.*

The Vineyard Transit Authority buses will enter the site at the Y/Arena access drive and loop counterclockwise in front of the Y onto Village Road and back out to the Edgartown/VH Road. A dedicated bus drop off and shelter will be located on the west end of the drive in front of the Y; the VTA will provide the structure, lighting and signage for the shelter. Buses will stop at the Y one time per hour; additional stops will be made at the Skate Park stop on the Vineyard Haven-Edgartown Road. The bus loop is indicated on the attached Revised Campus Site Plan.

- *How was the number of parking spaces determined for the Y and the Arena? Can we increase the commitment to share and decrease the amount of paved areas?*

The Y programming consultants, Triangle 2 Partners, recommended a total of 250 parking spaces for the facility based on national YMCA standards. The Y is adding a total of 74 spaces on their lot: 53 for exclusive use by the Y and 21 to be added to the shared parking with the Arena. Adding these 74 spaces to the 89 shared spaces at the Arena provides 163 spaces available to the Y. (40 additional shared spaces are currently in use by the Arena for tour bus parking.)

To meet the programmed parking recommendation, the additional 87 spaces will be accommodated at the 170 spaces available at the High School lot immediately across the street and at the Community Services (100 at the High school and 70 at Community Services).

#### Parking Summary:

74 new spaces on Y 5-acre lot:

53 exclusive to Y

21 added to shared parking

+ 89 shared spaces on Arena & HS property

163 spaces available for Y

+87 spaces at HS and MVCS  
250 recommended spaces

**ECONOMIC IMPACT:**

- *What is the Y's commitment to long term buying local and using local construction?*

The Y is committed to buying local products whenever possible but realizes that some items like commercial pool supplies and equipment may not be available on the Island. The Y is committed to providing qualified Island-based subcontractors the opportunity to bid on the project.

- *Are there going to be scholarships for those who cannot afford a Y membership?*

The Y will make every effort to find a membership level that is affordable to individuals and families. We believe that everyone should pay something to join the Y but understand there are always special circumstances. The Y's endowment and annual fundraising will help keep membership rates low.

- *How do we know this is the right size building / operation for our community?*

We don't want to build something that we find in five years is too expensive for the community to support. Our plan allows for a phased build-out to meet future needs as they arise. The YMCA of Martha's Vineyard spent more than thirty thousand dollars to complete a feasibility study to determine the viability and sustainability of a YMCA on the Island. The national firm chosen for the study has completed hundreds of such studies for communities across the United States. The study asked Islanders a series of questions regarding their likelihood of joining a Y, the membership rate they would pay, their program preferences, facility location and a host of other indicators to help determine the number of memberships and the fees Islanders would be willing to pay to join the Y. From this data, membership revenue was projected and overlaid against operational costs of Y facilities of varying sizes to help determine the size and sustainability of the Y on Martha's Vineyard. The study showed the Island community could sustain a building in the 35,000 to 45,000 sq ft range. Our Phase I plan is for a 35,000 sq. ft. facility.

- *The DRI application says that 78% of the community is not now affiliated with an exercise / wellness facility and that is the Y's target population. (DRI application, page 25). As a member of the other 22%, it is my firm impression that the percentage of the population that will join an exercise / wellness facility is probably pretty steady. What data does the Y have on this issue?*

The same marketing study referenced above also indicated that "health seekers," the Y's primary membership target, were not being serviced or sought after on the Island. Many "health seekers" do actually join a wellness facility only to stop going after a number of weeks. These individuals cited a lack of programs designed to match their beginner fitness level, little if any ongoing communication or relationship with facility

staff, a lack of support to help them reach their goals and too few holistic approaches to health – such as healthy dieting, food preparation and stress management, all issues that can derail individuals from achieving their goals. Y's are unique in their ability to deliver programs and services in a fun, supportive and community atmosphere – often involving activities for the entire family. Studies conducted by YMCA's across the nation demonstrate that this personalized and nurturing environment can attract "health seekers," and reduce membership attrition.

- *How saturated is the market? Obviously, the market for a community pool is basically untapped but the market for health clubs may be pretty mature. I ask these questions not because I feel we should protect existing businesses like the Mansion House (I don't, they have to survive in the market like anyone else) but because I want to be sure that what the Y proposes to build is a good "fit" for the community and is a viable, sustainable operation.*

We believe the Y will be the first facility of its kind on the island to offer programs and services in a holistic approach. We feel the "yet to be fit" or "health seeker" is an untapped market. The Y will provide a venue for intergenerational activities, providing programs for young children, families and individuals of any age or level of fitness.

#### **Y ORGANIZATION/ MISSION:**

- *A commissioner would like a written response from the state work force investment board and how the mission statement focuses decision making? How do you design programs to respond to your mission statement?*

The Y's mission statement of being "dedicated to improving the quality of life for children, individuals, families, and the island community by helping all people realize their fullest potential through development of the body, mind and spirit," is directly reflected in our current and future program offerings. We design our programs to increase the quality of life, health and wellness of all those who participate in our programs. The Y's four core values of Honesty, Respect, Caring and Responsibility will be a theme throughout all of our programs.

#### **AFFORDABLE HOUSING:**

- *What is the Affordable Housing offer?*

The YMCA will be serving many of the same Islanders who qualify for local housing programs. Through the Y's subsidized membership program, it's likely we'll be serving the same community. Through affordable memberships that provide access to Y programs, the Y will help to improve the quality of life for families much the same way affordable housing advocates seek to change the lives of the individuals and families they serve by stabilizing their living situations.

- *Will there be any affordable housing supplied to the staff?*

The Y is looking at providing some employee housing in Phase II of our building. The Y is planning on paying competitive wages with benefits to Y employees, enabling them to live in Martha's Vineyard.

**ENERGY IMPACT:**

- *How is the building being prepped for solar panels?*

Future solar panels in addition to the panels on the south facing roof being used to heat domestic hot water, are to be mounted on the flat roof of the pool structure. The building is prepared for these panels because the structure of the pool roof has been designed to accept their weight, and the underside of the roof is exposed structure with exposed mechanical and electrical systems, making the installation of future piping and wiring practical. Staging would be erected over the pool during the installation process.

The Y is still in its fundraising stage. The solar panels for domestic hot water are planned for the first phase of construction; however the energy saving measures listed below have the highest priority.

- *Can you provide more details on the goal of reaching LEED certification to a Silver standard?*

The LEED rating system has four levels, Certified (26 points), Silver (33 points), Gold (39 points) and Platinum (52 points). There is a process of documentation of LEED points that occurs throughout the design, submittal, and construction periods, a process which is only complete after the completion of construction. At this stage in the tracking process the Y has 33 points (Silver), with a possible 12 more.

- *Have we protected ground water from possible leakage from underground oil tank? What is being done to protect the groundwater from the 10,000 gallon oil tank?*

In accordance with accepted practice and Mass DEP requirements, the underground oil tank will be a double-wall unit with interstitial monitoring for volatile compounds (i.e., leak detection). The piping will also be double-wall with monitoring.

- *Should we be concerned that the Y is getting water from the Oak Bluffs water supply during summer water bans?*

The YMCA will be using approximately 53% less water than a typical building of its size. The Oak Bluffs summer water bans have to do with outdoor water use. The Y will not be using Town water for outdoor water use, only collected and recycled rain water.

- *How is a 14-21% energy savings for the building achieved? Have we considered geothermal?*

Energy savings is being achieved by:

1. Improved wall and roof insulation
2. Improved window assembly U value
3. Improved window assembly solar heat gain coefficient
4. Exhaust air energy recovery
5. Higher efficiency boilers
6. CEE Premium efficiency motors
7. Demand control ventilation
8. Occupancy based airflow/temperature setback
9. Efficient DX selection
10. Occupancy based lighting control
11. Daylighting controls.

The Y has considered geothermal. A geothermal system is not more “renewable” than a standard DX air conditioner. Both require electricity that has to come from somewhere. The benefit of a geothermal system is an improvement in compressor performance associated with lower condensing temperatures. In the summer, there is an energy benefit due to the increased compressor efficiency. In the winter, there is an energy benefit locally versus oil fired equipment but the operating cost is close to equal given the comparative cost between electricity and oil.

#### **POOL WATER:**

- *How will pool water be treated, with chlorine or non-chlorine?*

The pool water will be treated with Miox. Miox is a water purifying system that uses salt electrolysis to create mixed oxidants and chlorine (HOCL) to treat pool water.

- *How will the pool be heated?*

Pool water is heated with a plate and frame heat exchanger, where 180 degree water from the boiler transfers heat to the pool water supply.

In this climate, solar hot water heating of the pool is only possible with an additional conventional pool water heating system. A heat regulator is required to coordinate the heat contribution of each heating system to the pool water to maintain constant pool water temperature.

#### **TOWN APPROVALS:**

- *Will you apply for a variance to the Town for the height?*

The Y has been indicated to be an educational use by the Oak Bluffs zoning office and should, therefore, be exempt from zoning restrictions. If the Building Department does refer the project to the Zoning Board of Appeals, the Y will apply for a height variance.

The project is located within an R-3 Residential zone with a height limitation of 32'. The proposed height of the highest roof is approximately 36'; the height is required to

provide natural ventilation to all of the spaces on the south side of the building thereby reducing the need for air-conditioning and the energy consumption of the building.

- *What officials from OB have participated in the campus plan?*

John Bradford, Planning Board Chairman; Priscilla Sylvia, High School Committee and Land Bank Advisory Board; and Michael Dutton, Town Administrator, all participated in the development of the campus plan during 2006.

The project has been reviewed preliminarily with Jerry Weiner, Building Inspector; Adam Wilson, Zoning Official; and Shirley Fauteux, Board of Health officer.

**OTHER:**

- *What about bike and walking trails connecting to the Southern Woodlands?*

An existing bike and walking trail connects Village Road to the Holmes Hole Road path providing access to the network of paths off of Holmes Hole, including the Land Bank Southern Woodlands property to the north. The proposed plan re-routes the path around the northwest 32-car parking area which interrupts the existing path.

- *What is bicycle and pedestrian access?*

The existing paved path that follows along the east side of the Village Road provides access to the paved bike path along the VH/Edgartown Road and the unpaved paths accessed from the Old Holmes Hole Road. The existing path will be maintained and repaired where interrupted, providing access by foot and bicycle to the Y site.

- *Update on Natural Habitat and Endangered Species Program*

The Natural Habitat and Endangered Species Program has accepted the site for development of the Y project, and has provided the following suggestions, for negotiation, to reduce the impact of the project on the moth habitat:

1. Consider eliminating the 32 parking space lot to the north-west of the building.
2. Move the building and the drive in front of the Y to the south.
3. Reduce or eliminate the cleared playing area to the north-west adjacent to the building.
4. Place a development restriction on the undisturbed site area to the north of the building.
5. Reduce the extent of the future build-out.
6. Enhance open space for pitch pine growth by selectively cutting deciduous trees to promote pitch pine growth.
7. The goal is to increase the area of contiguous undisturbed land on the site to the north.



At the time of this MVC submission, the Y is formulating a response and revised plan for submission to the NHESP; a revised plan will be available for the July 18<sup>th</sup> hearing.

Attachments:

Watershed Benefits of Bioretention Techniques, fr. Low Impact Development Center website

Nitrogen Loading Calculation, RFS, revised 7.5.07

11 x 17 Attachments:

C0.1 Civil Notes and Legends, RFS, 7.18.07

C.1.0 Existing Consition & Demolition Plan, , RFS, 7.18.07

C2.0 Overall Site Plan, RFS, 7.18.07

C2.1 Drainage & Grading Plan Area "A" , RFS, 7.18.07

C2.2 Drainage & Grading Plan Area "B" , RFS, 7.18.07

C3.1 Civil Details, RFS, 7.18.07

C3.2 Civil Details, RFS, 7.18.07

A2 Revised Campus Site Plan, AMM, 7.11.07

Proposed Internal Traffic Sign Plan, Campus Site Plan, MS Transportation Systems, Inc.

Conceptual Details, MS Transportation Systems, Inc., 6/28/07

Pedestrian Crossing images, MS Transportation Systems, Inc.

Attachments under separate Cover:

Stormwater/Drainage Calculations, prepared by RFS

## NITROGEN LOADING CALCULATION

### YMCA of Martha's Vineyard

5-Jul-07 (Revised) John L. Scott, P.E. Rist-Frost-Shumway Engineering, P.C.

From Interim MVC Policy, Nitrogen limit for Lagoon Pond watershed = 3.4 kg/acre/yr

Project site is 5.0 acres; nitrogen limit if  $5.0 \times 3.4 = 17.0$  kg/yr

#### Wastewater Contribution

Assumed to be negligible as the project will connect to the proposed community treatment facility.

#### Stormwater Contribution

Unit nitrogen contributions, from Interim MVC Policy:

1.5 mg/l from regular paved areas

0.75 mg/l from roof areas

*From paved areas directed to bio-retention areas, use 0.6mg/l*

*From paved areas directed to bio-retention swales, use 1.125 mg/l*

Annual runoff: 90% of 46.9 inches = 42.2 in

Project roof area, sf (incl. future addns) 40,918

Project pavement area, sf

*Regular pavement 13,466*

*Pavement to b-r areas 6,356*

*Pavement to b-r swales 43,857*

Annual roof runoff:  $(42.2 / 12) \times 40,918 = 143,900$  cf

$143,900 \text{ cf} \times 28.32 \text{ l/cf} = 4,075,000$  liters

Annual pavement runoff:

*Regular pavement:  $(42.2/12) \times 13,466 \times 28.32 \text{ l/cf} = 1,341,000$  liters*

*Pavement to b-r areas:  $(42.2/12) \times 6,356 \times 28.32 \text{ l/cf} = 633,000$  liters*

*Pavement to b-r swales:  $(42.2/12) \times 43,857 \times 28.32 \text{ l/cf} = 4,368,000$  liters*

Annual roof nitrogen:  $(4,075,000 \text{ liters} \times 0.75 \text{ mg/l}) / 1,000,000 \text{ mg/kg} = 3.06 \text{ kg}$

Annual pavement nitrogen:

*Regular:  $1,341,000 \text{ l} \times 1.5 \text{ mg/l} / 1,000,000 \text{ kg/mg} = 2.01 \text{ kg}$*

*To b-r areas:  $633,000 \text{ l} \times 0.6 \text{ mg/l} / 1,000,000 \text{ kg/mg} = 0.38 \text{ kg}$*

*To b-r swales:  $4,368,000 \text{ l} \times 1.125 \text{ mg/l} / 1,000,000 \text{ kg/mg} = 4.91 \text{ kg}$*

*Subtotal stormwater nitrogen:  $3.06 + 2.01 + 0.38 + 4.91 = 10.36 \text{ kg/yr}$*

#### Lawn and Landscape Contribution

Unit nitrogen contribution, from Interim MVC Policy:

20% of 1.36 kg/yr/1,000 sf, or 0.272 kg/yr/1,000 sf

Max allowable lawn and landscaped area per parcel = 4,000 sf

Lawn and landscaped area nitrogen:  $4,000 \times 0.272 \text{ kg/yr}/1,000\text{sf} = 1.09 \text{ kg/yr}$

*TOTAL NITROGEN FROM SITE:  $10.36 + 1.09 = 11.45 \text{ kg/yr}$*

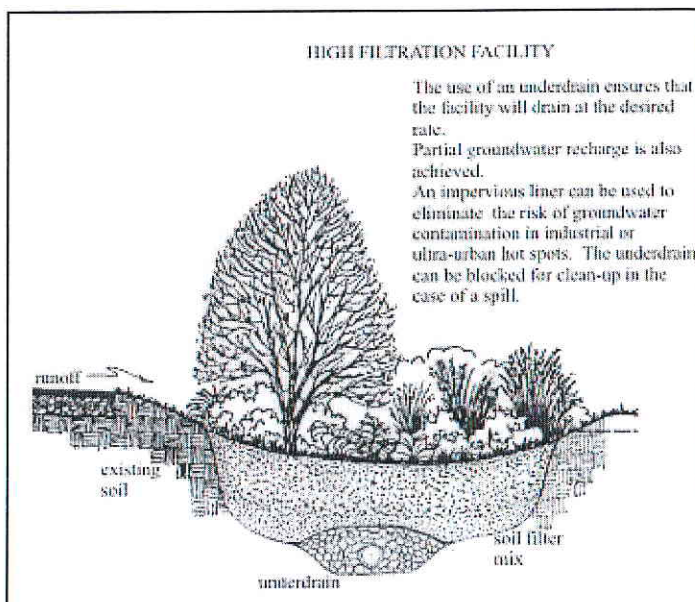


Low Impact  
Development Center, Inc.

## Watershed Benefits of Bioretention Techniques

### Pollutant Filtering

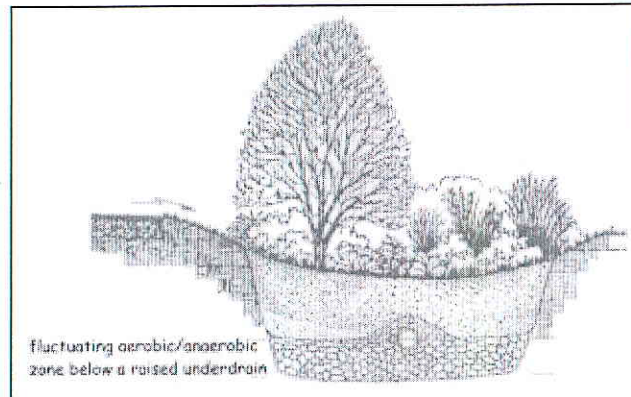
Bioretention areas function as soil and plant-based filtration devices that remove pollutants through a variety of physical, biological, and chemical treatment processes. The reduction of pollutant loads to receiving waters is necessary for achieving regulatory water quality goals. For example, several states, including Maryland, have agreed to work towards reducing nutrient runoff to the Chesapeake Bay by 40%. A number of laboratory and field experiments have been conducted by the University of Maryland in conjunction with Prince George's County Department of Environmental Resources and the National Science Foundation in order to quantify the effectiveness of bioretention cells in terms of pollutant removal.<sup>1</sup> A web site dedicated to this work can be found at <http://www.ence.umd.edu/~apdavis/Bioret.htm>.



In general, the studies have found that properly designed and constructed bioretention cells are able to achieve excellent removal of **heavy metals**. Users of this technique can expect typical copper (Cu), zinc (Zn), and lead (Pb) reductions of greater than 90%, with only small variations in results. Removal efficiencies as high as 98% and 99% have been achieved for Pb and Zn. The mulch layer is credited with playing the greatest role in this uptake, with nearly all of the metal removal occurring within the top few inches of the bioretention system. Heavy metals affiliate strongly with the organic matter in this layer. On the other hand, **phosphorus** removal appears to increase linearly with depth and reach a maximum of approximately 80% by about 2 to 3 feet depth. The likely mechanism for the removal of the phosphorus is its sorption onto aluminum, iron, and clay minerals in the soil. **TKN (nitrogen)**

removal also appears to depend on depth but showed more variability in removal efficiencies between studies. An average removal efficiency for cell effluent is around 60%.

Generally 70 to 80% reduction in **ammonia** was achieved in the lower levels of sampled bioretention cells. Finally, **nitrate** removal is quite variable, with the bioretention cells demonstrating a production of nitrate in some cases due to nitrification reactions. Currently, the University of Maryland research group is looking at the possibility of incorporating into the bioretention cell design a fluctuating aerobic/anaerobic zone below a raised underdrain pipe in order to facilitate denitrification and thus nitrate removal.<sup>2</sup>



*These studies indicate that in urban areas where heavy metals are the focal pollutants, shallow bioretention facilities with a significant mulch layer may be recommended. In residential areas, however, where the primary pollutants of concern are nitrogen and phosphorus, the depth dependence will require deeper cells that reach approximately 2 to 3 feet.*

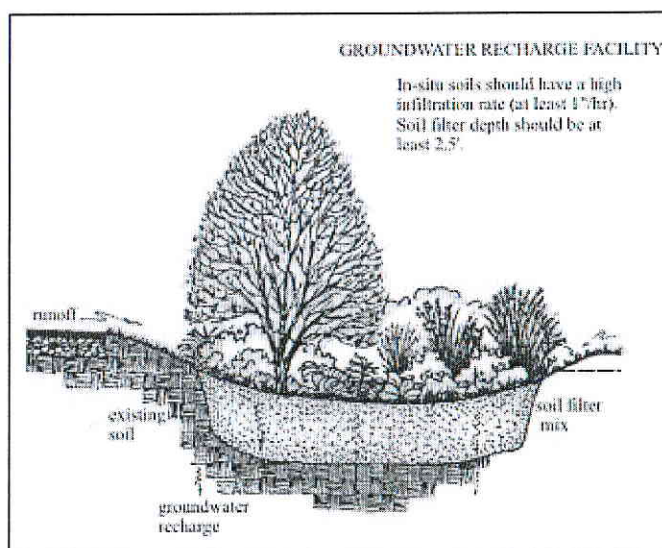
Other pollutants of concern are also addressed by the bioretention cells. For example, sedimentation can occur in the ponding area as the velocity of the runoff slows and solids fall out of suspension. Field studies at the University of Virginia have indicated 86% removal for **Total Suspended Solids (TSS)**, 97% for **Chemical Oxygen Demand (COD)**, and 67% for **Oil and Grease**.<sup>3</sup> Additional work with laboratory media columns at the University of Maryland has demonstrated potential bioretention cell removal efficiencies greater than 98% for total suspended solids and oil/grease.<sup>4</sup>

### Runoff Volume and Timing

One of the primary objectives of LID site design is to minimize, detain, and retain post development runoff uniformly throughout a site so as to mimic the site's predevelopment hydrologic functions.<sup>5</sup> Originally designed for



providing an element of water quality control, bioretention cells can achieve **quantity control** as well. By infiltrating and temporarily storing runoff water, bioretention cells reduce a site's overall runoff volume and help to maintain the predevelopment peak discharge rate and timing. The volume of runoff that needs to be controlled in order to replicate natural watershed conditions changes with each site based on the development's impact on the site's curve number (CN). The bioretention cell sizing tool can be used to determine what cell characteristics are necessary for effective volume control. Keep in mind that the use of underdrains can make the bioretention cell act more like a filter that discharges treated water to the storm drain system than an infiltration device.<sup>6</sup> Regardless, the ponding capability of the cell will still reduce the immediate volume load on the storm drain system and reduce the peak discharge rate. Where the infiltration rate of *in situ* soils is high enough to preclude the use of underdrains (at least 1"/hr), increased **groundwater recharge** also results from the use of the bioretention cell. If used for this purpose, care should be taken to consider the pollutant load entering the system, as well as the nature of the recharge area. An additional hydrologic benefit of the bioretention cell is the **reduction of thermal pollution**. Heated runoff from impervious surfaces is filtered through the bioretention facility and cooled; one study observed a temperature drop of 12°C between influent and effluent water.<sup>7</sup> This function of the bioretention cell is especially useful in areas such as the Pacific Northwest where cold water fisheries are important.



### Additional Ecosystem Benefits

Bioretention cells are dynamic, living, micro-ecological systems.<sup>8</sup> They demonstrate how the landscape can be used to protect ecosystem integrity. The design of bioretention cells involves, among other things, the hydrologic cycle, nonpoint pollutant treatment, resource conservation, habitat creation, nutrient cycles, soil chemistry, horticulture, landscape architecture, and ecology<sup>8</sup>; the cell thus necessarily demonstrates a multitude of

benefits. Beyond its use for stormwater control, the bioretention cell provides attractive landscaping and a natural habitat for birds and butterflies. The increased soil moisture, evapotranspiration, and vegetation coverage creates a more comfortable local climate. Bioretention cells can also be used to reduce problems with on-site erosion and high levels of flow energy.

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Graphics were adapted from The Bioretention Manual, Prince George's County Department of Environmental Resources Programs and Planning Division, Maryland, 2001.

<sup>1</sup> Davis, A.P., M. Shokouhian, H. Sharma and C. Minami, 2001: Laboratory study of biological retention for urban stormwater management. Water Environment Research, 73(1), 5-14.

<sup>2</sup> Kim, H., E.A. Seagren and A.P. Davis, 2000: Engineered bioretention for removal of nitrate from stormwater runoff. WEFTEC 2000 Conference Proceedings on CDROM Research Symposium, Nitrogen Removal, October, Anaheim, California.

<sup>3</sup> Yu, S.L., X. Zhang, A. Earles and M. Sievers, 1999: Field testing of ultra-urban BMPs. Proceedings of the 26th Annual Water Resources Planning and Management Conference ASCE, 6-9 June, Tempe, Arizona.

<sup>4</sup> Hsieh, C. and A.P. Davis, 2002: Engineering bioretention for treatment of urban stormwater runoff. WEF Watershed 2002 Specialty Conference, 23-27 February, Ft. Lauderdale, Florida.

<sup>5</sup> Coffman, L.S., R. Goo and R. Frederick, 1999: Low impact development an innovative alternative approach to stormwater management. Proceedings of the 26th Annual Water Resources Planning and Management Conference ASCE, June 6-9, Tempe, Arizona.

<sup>6</sup> [Los Angeles County BMP Design Criteria](#)

<sup>7</sup> United States Environmental Protection Agency Office of Water, 2000: Bioretention Applications - Inglewood Demonstration Project, Largo, Maryland, and Florida Aquarium, Tampa, Florida. EPA-841-B-00-005A.

<sup>8</sup> Winogradoff, D.A. and L.S. Coffman, 1999: Bioretention water quality performance data and design modifications. Proceedings of the 26th Annual Water Resources Planning and Management Conference ASCE, June 6-9, Tempe, Arizona.

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