"LOW IMPACT DEVELOPMENT" INITIATIVE

For

OAKLAND HILLS SUBDIVISION

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Prepared By:

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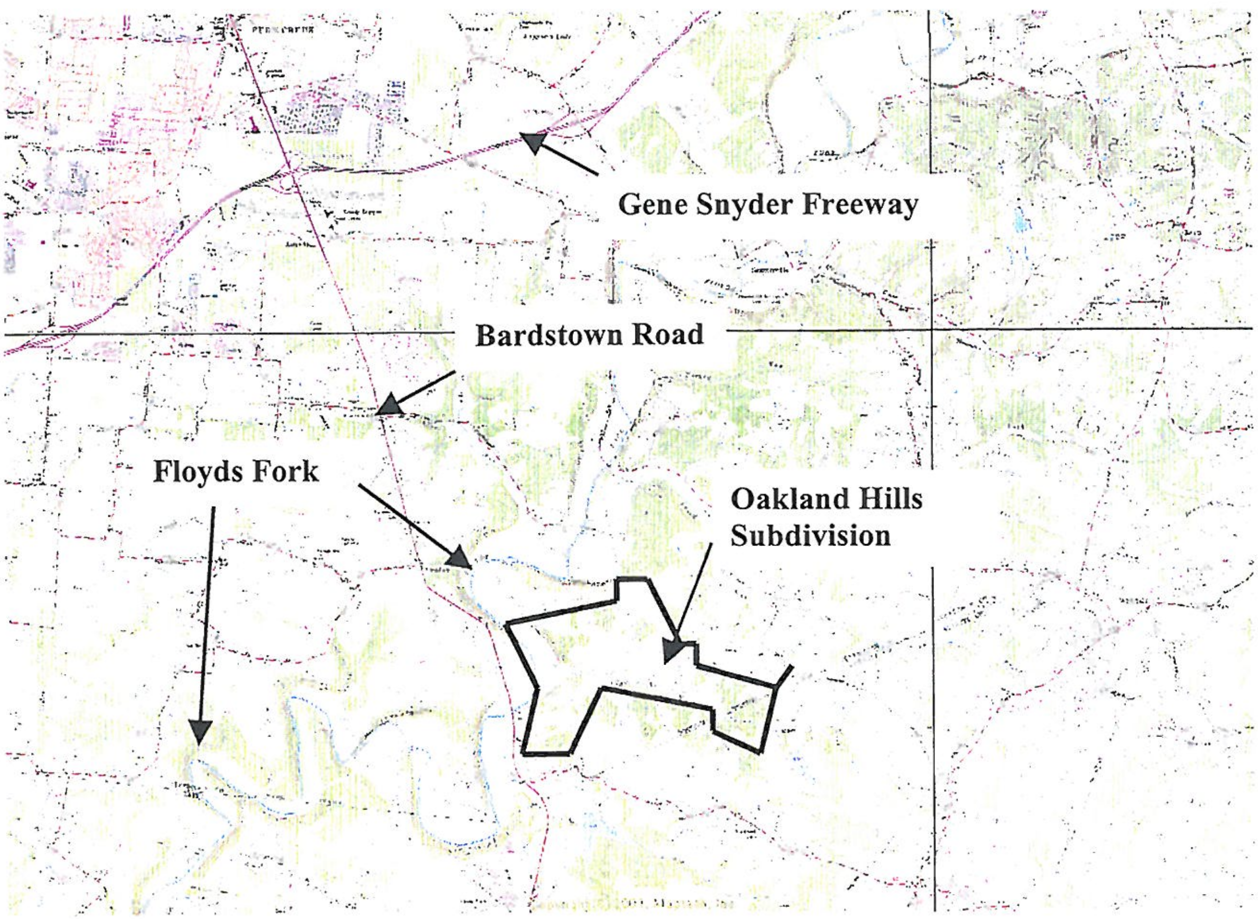
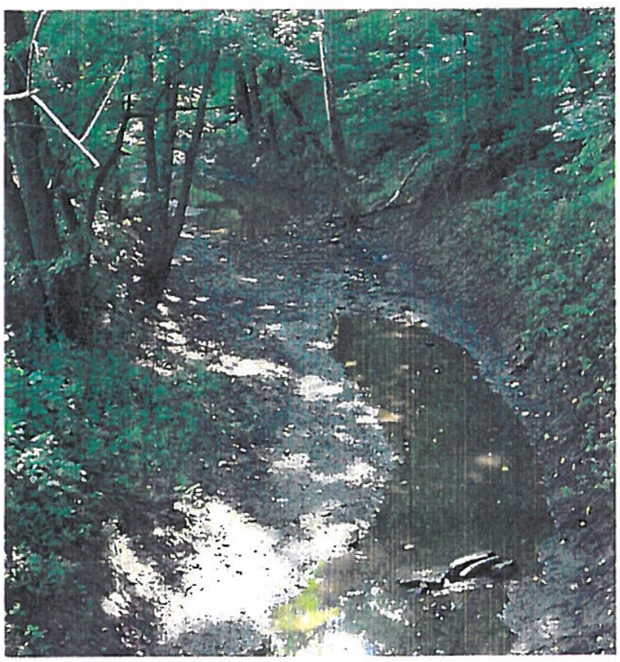
1. SITE LOCATION & PHYSICAL CHARACTERISTICS

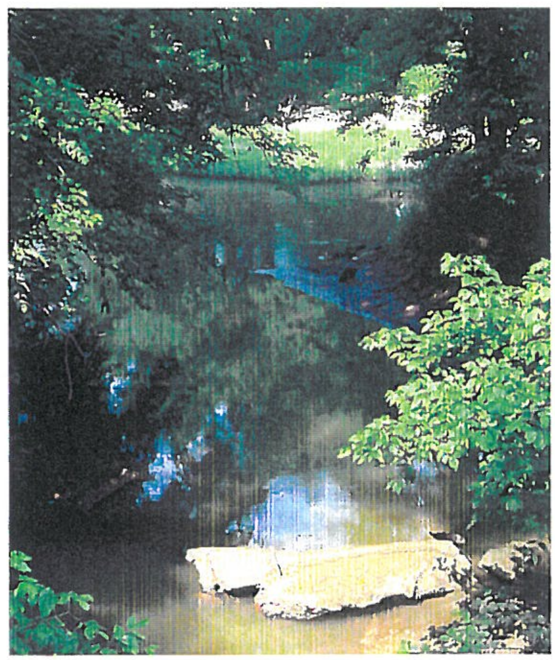
A. LOCATION. The Oakland Hills Subdivision is located on a 668 acre site located approximately 3.5 miles south of the Gene Snyder Freeway on the east side of Bardstown Road. The developer has acquired a hotel site at an existing median in Bardstown Road which will serve as the primary means of access.



B. HYDROLOGY. Floyds Fork and it's associated floodplain are the dominant features along the eastern part of the property and serve to separate residential development from the Bardstown Road corridor. Old Mans Run is a 'blue-line" stream traversing the property from west to east and discharges into Floyds Fork. The total watershed area for Old Mans Run measures approximately 2100 acres, of which over 500 acres is on the Smith Property. A series of heavily wooded, steeply sloping drainage valleys discharge into Old Mans Run. Four (4) of these stream valleys are classified as intermittent "blue-line" streams. Virtually the entire property drains into Old Mans Run or Floyds Fork.



View of Old Mans Run



View of Confluence of Old Mans Run/ Floyds Fork

C. SOILS AND GEOLOGY. Fairmount soils are the dominant soil type along the steam valleys. Huntington Soils are present within the Floyds Fork Floodplain. Upland plateau areas and ridgetops contain predominantly Russellville and Otway soil series with isolated areas of Crider and Beasley. Depth of soil cover along ridgetops varies between 3 and 8 ft.

D. SLOPES. The sites topographic features can be described in 3 distinct areas: 1) an upland plateau region featuring a mix of woodland and meadow areas with some agricultural production, 2) steeply sloping, wooded stream valleys which channel runoff to Old Mans Run and 3) the Floyds Fork and Old Mans Run floodplain / bottomland. This area is characterized by meadow grasses with some agricultural production. Digital mapping of slopes on the property indicates 67% of the site as having 0-20% slopes, 28% of the site having 20-30% slopes, and 5% of the site having slopes in excess of 30%.

E. ZONING. ~~197.43~~ 199.67 acres of the site is located in the Floyds Fork DRO District and is zoned RR, permitting 5 acre lots. This part of the site is proposed to be rezoned to R4. The balance of the property in Jefferson County is planned to remain as R-4 zoning.

F. UTILITES / SEWER SERVICE. No sanitary sewers are presently available, however construction has recently begun on Little Spring Farm, a residential subdivision west of the site opposite Bardstown Road. Sanitary sewers will be available upon completion of Phase 1 improvements at Little Spring Farm by the ~~first~~ third quarter of 2003. Water, gas, and electric services are presently available.

2. MASTER PLAN AND PROPOSED LAND USE.

The proposed development program for the Smith Property will consist of single family detached homes. Land usage can be summarized as follows:

- Residential Home sites: 749 lots
- Common Open Space: 313 acres
- Area in Public Right-of-Way: 71 acres

Approximately ~~46%~~ 47% of the site will be protected in common open space. The gross density will be ~~1.13~~ 1.12 units per acre. The main entrance will be along Bardstown Road with a secondary entrance to Waterford Road through an adjoining property owned by Red Bud Development. Street connections to adjoining undeveloped property will also be provided. An entrance to Broad Run Road will be gated to provide emergency access pending improvements to Broad Run Road.

No bridge crossings or disturbance is proposed to Floyds Fork. A trail system may be provided through the open space and linking residential neighborhoods with the open space and community center and a proposed countywide public trail.

3. LOW-IMPACT DEVELOPMENT INITIATIVES.

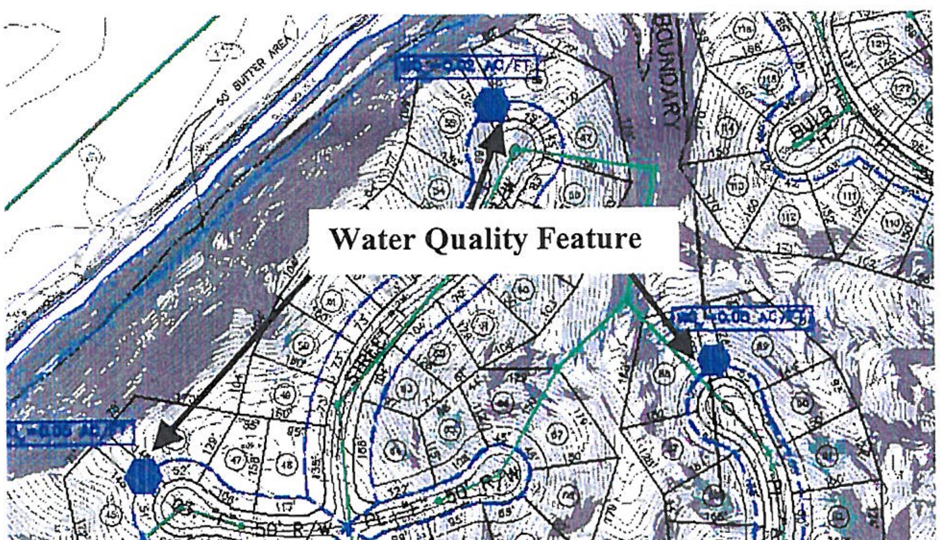
Because of the site's location along Floyds Fork, the amount of steep slopes, sensitive stream valleys, the following design features are proposed to minimize development impacts.

a. Stream valley crossings have been minimized and locations chosen to have the least amount of impact.
b. The roadway pattern follows existing ridge lines and allows for the development of desirable home sites with "walkout" basements which complement the hillside, work with the terrain, and minimize the amount of site disturbance.
c. A 200 ft building setback and a 100 ft buffer is observed along Floyds Fork, in accordance with the Floyds Fork DRO guidelines. In addition, a 200' building setback and a 100' stream buffer (per Table 4.8.1 – Type "B" of the Land Development Code) has been extended along Old Mans Run.
d. A 50 ft minimum buffer zone of native vegetation is provided along each side of Old Mans Run and four (4) intermittent "blue-line" streams.
e. Total impervious coverage (streets, curbs, sidewalks, houses, and driveways) amounts to approximately 99 acres (13% of the gross site area).
f. An extensive and interconnected open space network will protect existing wooded areas and stream valleys from development.
g. Individual lot approvals will be issued by MSD for certain lots affected by cross-lot drainage to ensure proper drainage and minimize site disturbance.

h. Due to the site's terrain, it's location along a "blue-line" stream (Old Mans Run) and Floyds Fork, water quality enhancements are proposed to minimize the impact of site development. The following represent practical and minimally-invasive strategies proposed to enhance water quality:

i. Water quality/infiltration features will be sized to treat the first ½ inch rainfall. The location of these features will be sited so as to treat pavement/impervious runoff prior to discharge into existing stream valleys. According to the attached exhibit reprinted from the "Low Impact Development Center", removal of sediments and pollutants using these techniques can result in substantial reductions in Total Suspended Solids (TSS), Chemical Oxygen Demand (COD) and Oil and Grease.

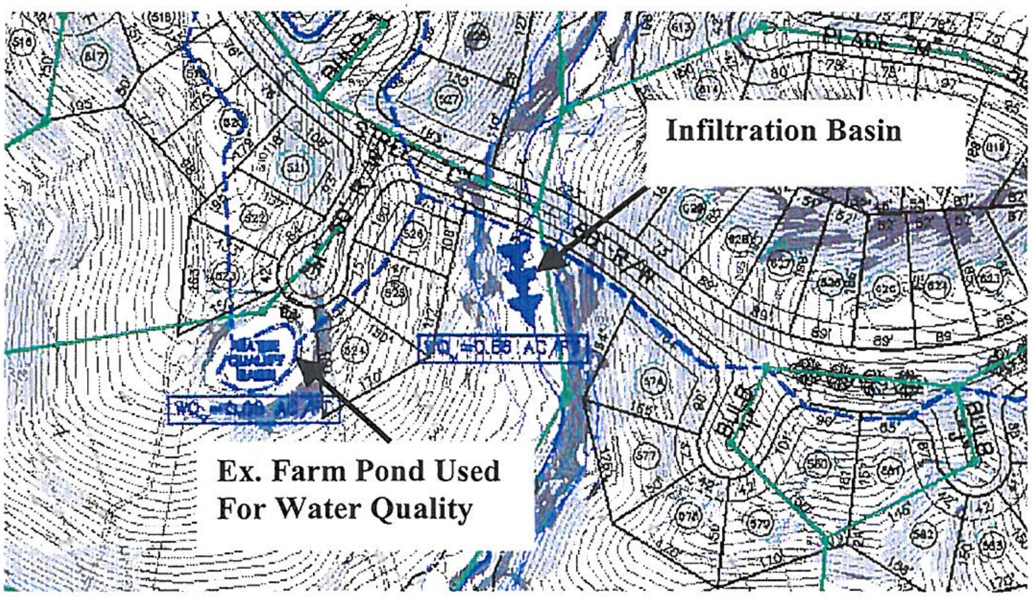
ii. Treat roadway runoff at upland locations prior to discharge down steeply sloping embankments. This may include the use of Stormceptors as stand-alone features, check dams and step pools (see attached detail), or dry grass swales, subject to site conditions.



iii. Utilize the best management practices (BMP's) for soil erosion protection and sedimentation control as contained in the Natural Resource Conservation Report as prepared by the USDA local office.

iv. Utilize existing farm ponds for water quality storage / management rather than filling.

v. Construct water quality filtration basins at stream valley and intermittent "blue-line" stream crossings. During site development and housing construction, these areas may serve as temporary sediment control structures.



Infiltration features are provided at stream valley crossings an existing farm ponds used for water quality.

vi. Avoid the use of concrete plugs to fill sinkholes or surface depressions. Use graduated stone and filter fabric to maintain subsurface drainage to these features, in accordance with the geo-technical engineer's recommendations.

vii. Provide a water quality basin immediately downstream of the proposed crossing to Old Mans Run to treat roadway runoff prior to discharge into Old Mans Run.

viii. Establish ~~Tree Protection Areas (TPA's)~~ Woodland Protection Areas and incorporate them into the deed restrictions of the property to maintain existing tree and ground cover within the open space areas and stream valleys as a means of naturally filtering rear yard drainage.

ix. Restrict construction of large water quality treatment basins at remote downstream locations requiring excessive amounts of clearing and grading. Preferred locations should be along roadways at culvert discharge points where they can serve as sediment basins during site development.

x. Utilize roadway medians as a means to infiltrate roadway drainage where possible, subject to final design review and approval of ~~Jefferson County Department of~~ Metro Public Works.

xi. Construction of surface treatments / water quality features shall be constructed on common open space land with MSD maintenance rights provided.

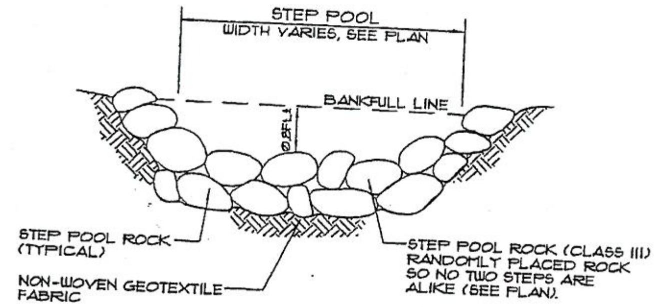
xii. Reduce the front yard setbacks along selected streets from 30' to 25' in order to bring homes closer to the street and minimize site disturbance.

xiii. Prepare a guide for future residents that advocates natural landscaping techniques using native species and requiring minimal maintenance and irrigation, similar to a "Residents Guide to Landscaping In The Woodlands" provided by MSD.

Based on preliminary discussions with MSD, no storm water detention will be provided. The construction cost of low-impact development / water quality enhancement measures will be credited toward the regional facility fee.

The following information is provided giving more detailed information on the stone check dam / filtration features:

- Typical Street Cross Section
- Stone Check Dam Details
- "Watershed Benefits of Bioretention Techniques" (3 pages)



CROSS SECTION B–B (STEP)

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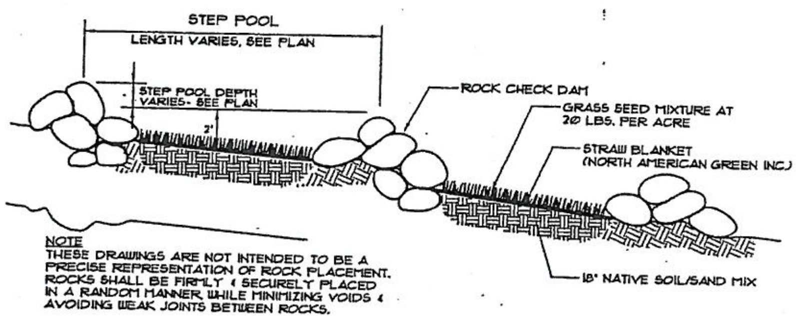

CHECK DAM PROFILE

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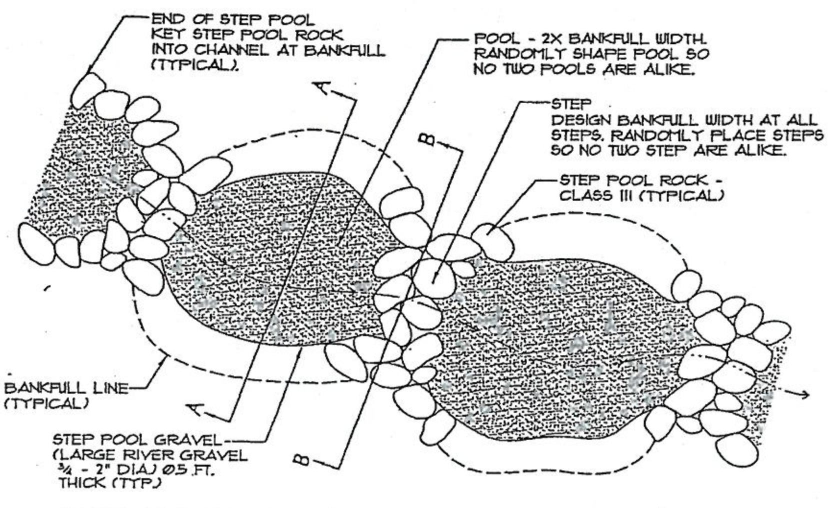

STEP POOL PLAN

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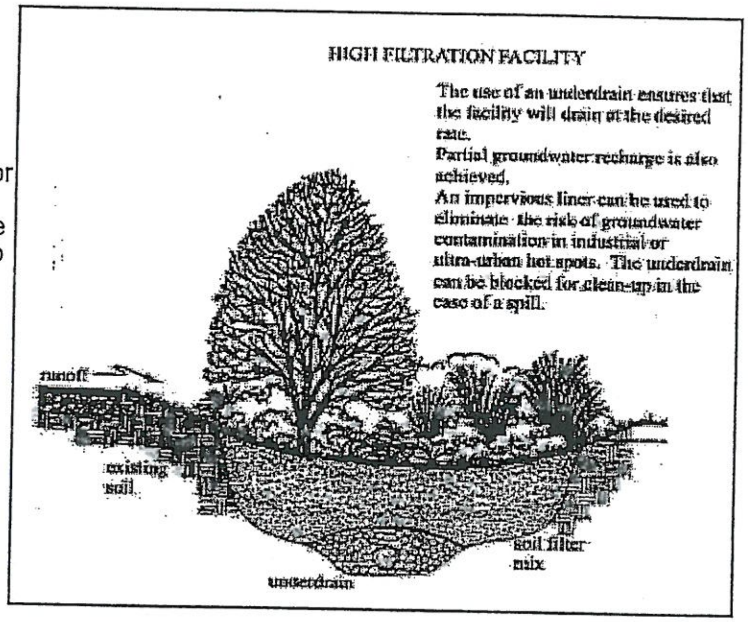
Low Impact Development Center, Inc.

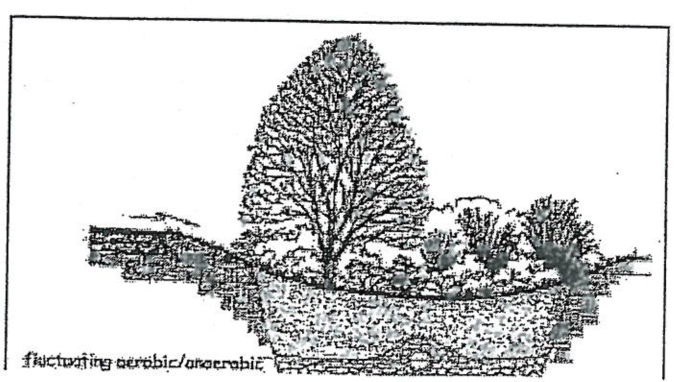
Watershed Benefits of Bioretention Techniques

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.[1] 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



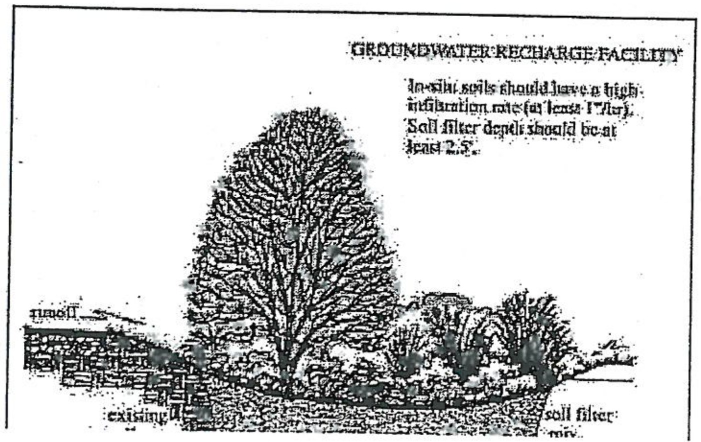
pipe in order to facilitate denitrification and thus nitrate removal.[2]

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.

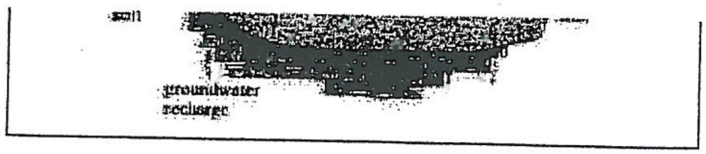
Other pollutants of concern are also addressed by the bioretention cells. For example, sedimentation can occur in the ponding area as the velocity of the runoff slows and solids fall out of suspension. Field studies at the University of Virginia have indicated 86% removal for **Total Suspended Solids (TSS)**, 97% for **Chemical Oxygen Demand (COD)**, and 67% for **Oil and Grease**. [3] 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.[4]

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.[5] 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.[6] 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.[7] 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.[8] 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[8]; 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.

[1] 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.

[2] 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.

[3] 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.

[4] 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.

[5] 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.

[6] Los Angeles County BMP Design Criteria

[7] 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.

[8] 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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