New Appendix Appendix C

LOW IMPACT DEVELOPMENT

The Low Impact Design (LID) techniques may be used in lieu of, or in combination with traditional SWM techniques to manage the storm water runoff from a development. The County encourages the use of these techniques; however, the use of LID practices is only an alternative to other SWM practices.

LID is a design strategy with the goal of maintaining or replicating the pre-development hydrologic regime through the use of design techniques to create a functionally equivalent hydrologic site design. Hydrologic functions of storage, infiltration and ground water recharge, as well as the volume and frequency of discharges are maintained through the use of integrated and distributed micro-scale storm water retention and detention areas, reduction of impervious surfaces, and the lengthening of runoff flow paths and flow time. Other strategies include the preservation/protection of environmentally sensitive site features such as riparian buffers, wetlands, steep slopes, valuable (mature) trees, flood plains, woodlands, and highly permeable soils.

LID introduces new approaches to SWM by providing micromanagement and multifunctional landscape features (bioretention areas, swales and conservation areas) that help replicate hydrologic functions and maintain the integrity of receiving streams.

The focus of LID is to replicate the predevelopment hydrology to the extent practicable by using environmentally sound land development practices. LID, if properly designed, can mimic the predevelopment hydrology by minimizing storm water runoff (reducing impervious surfaces) and by maximizing the groundwater infiltration potential (retaining pervious surfaces such as open spaces as much as practicable) so that the runoff peak and volume before and after the development remains about the same.

Integrated Management Practice (IMP) means low impact development micro-scale and distributed management techniques used to maintain the predevelopment site hydrology. IMPs are basically specific small LID controls that reduce runoff by integrating storm water controls throughout the site in small discrete units. IMPs focus on source controls, and may include, but not limited to, dry wells, filter/buffer strips, grass swales, infiltration trenches and amended soils as specified in the Low-Impact Development Design Manuals. IMPs are distributed throughout the site to retain, detain, and filter the storm water runoff closer to the site it originates, to the maximum extent practicable.

Bioretention Facilities also known as rain gardens treat storm water runoff by using a conditioned planting soil bed and planting materials to filter runoff stored in shallow depression. Bioretention facilities are one of the most commonly used practices for controlling storm water runoff using LID approach.

A. LID PRINCIPLES

The following principles may be applied, wherever feasible in LID designs:

1. Minimize impervious areas and clearing and grading to the maximum extent practicable. Wherever practicable, clearing and grading should be limited to build lots, allow access and provide fire protection.

2. Consider alternatives in street layout planning to decrease street lengths and increase the preservation of open space areas.

3. Limit the number of parking spaces closer to the minimum and under-utilized and spill over parking spaces should incorporate alternative pervious paving surfaces, such as, porous pavements, wherever soil and ground water table conditions are suitable.

4. Wherever feasible, treat the parking lot runoff using bioretention areas, filter strips and/or other practices that can be integrated into required landscaping areas and parking islands.

5. Decrease the driveway lengths by locating the houses closer to the front to decrease the impervious areas associated with driveways.

6. Where practical, direct rooftop runoff to pervious areas, such as yards, open swales, or vegetated areas and avoid routing rooftop runoff to the roadway and the storm drainage system. Provide infiltration and filtration in a manner that ensures adequate drainage while utilizing landscapes to diffuse, filter and infiltrate storm water runoff.

7. Disconnect impervious cover areas and disperse storm water runoff to pervious areas to the maximum extent practicable.

8. Conservation: Conservation of any natural lands within a development site may have a direct effect on the site hydrology of minimizing impervious cover that would otherwise generate higher rates and volume of runoff. Indirect benefits of conservation can be derived by locating and protecting certain hydrologic features such as drainage paths, permeable soils, steep slopes, etc.; and, in accordance with zoning and subdivision requirements, strategically locating setbacks, easements, woodland conservation zones, buffers, utility corridors, and other permanent site features to enhance the overall goals of maintaining the pre-development hydrology.

9. Minimization of Impacts: Minimization of impacts refers to reducing the extent of construction and development practices that adversely impact the hydrologic conditions of the site. This includes limiting the clearing and grading of land to the minimum needed to construct a development and associated infrastructure, as well as locating the land disturbances so as to avoid impacting hydrologically sensitive areas. The designer must conduct a thorough analysis of the existing

topography and site geometry when locating fixed improvements such as roads, houses or buildings, sanitary and storm sewer utility corridors, etc., in order to minimize unnecessary grading and/or compaction of the natural soil horizon, clearing of trees, and creating of impervious surfaces.

10. Preserve Pre-development Runoff Rate and Pattern: Preserving the site pre-developed runoff rate and patterns are two of the overall objectives in replicating the pre-developed hydrology (other objectives include maintaining the pre-developed volume, frequency, and duration of runoff). Effectively implementing conservation practices and minimizing impacts, as described above, represent the first steps in achieving these objectives. Further steps involve evaluating how certain design choices can influence the post-developed hydrologic processes to reduce the rate and volume of runoff. These design choices include disconnecting impervious cover in order to maintain sheet flow conditions, lengthening the developed condition time of concentration (Tc), etc. Ideally the post-development drainage divides should replicate those of the pre-developed condition.

11. Integrated Management Practices (IMPs); IMPs refer to decentralized small-scale (source control) storm water retention and detention structural BMPs integrated uniformly throughout the site or drainage area. These practices can be integrated into the landscape, buildings, and overall development infrastructure to reduce the volume and rate of storm water runoff. These systems are designed to emulate the natural processes of detention, retention, interception, evaporation, transpiration, and groundwater recharge, in order to replicate the pre-developed hydrology. Common examples of IMPs include: bioretention cells (or rain gardens), water quality swales, green roofs, and other small scale runoff attenuation practices.

B. GENERAL GUIDELINES FOR USING LID PRACTICES

1. If bioretention facilities are proposed in residential areas, the facilities shall be located in common areas unless the minimum lot size is ~~1~~ 20,000 square feet or more and the facility is serving one lot only. LID designs are relatively more difficult to implement in higher density areas. If only LID practices are used as a stand alone approach to meeting the SWM requirements, the County recommends that in residential subdivisions, LID be applied only if the lot sizes are 20,000 square feet or more.

2. LID practices may be used to meet the SWM requirements in any nonresidential development.

3. LID practices may be used in any development, if used in combination with the conventional SWM practices. However, bioretention facilities shall not be located within residential lots less than 1 acre in size.

5. Stand alone LID techniques shall not be applied to satisfy the SWM requirements in critical watershed areas or for developments which are upstream of existing residential developments with required minimum lot sizes less than one acre and located adjacent to special flood hazard areas, as delineated in County's FIRM. Stand alone LID techniques shall not also be used for SWM in areas identified by the County with known flooding and erosion problems, unless LID technique is used in combination with other conventional SWM techniques. The engineer should consult with the Department of Public Works for information.

6. Due consideration towards the on-going maintenance of bioretention facilities must be given while designing a site with bioretention facilities.

7. A LID Concept Plan must be submitted to the Department of Public Works for approval, prior to the final plan submission, if stand alone LID practices are predominantly proposed to meeting the SWM requirements in residential subdivisions.

C. DESIGN GUIDES AND MANUALS FOR LID

The following documents and manuals may be used for the design of LID practices. Other available design documents may also be used as a reference, subject to approval of the director of Public Works.

(1) Prince William County's DCSM.

(2) The Virginia Storm Water Management Handbook, Volumes I and II.

(3) Low-Impact Development Design Strategies: An Integrated Design Approach, United States Environmental Protection Agency, Office of Water, EPA 841-B-00-003 dated June1999 and subsequent modifications and updates thereof.

(4) Low-Impact Development Hydrologic Analysis, United States Environmental Protection Agency, Office of Water, EPA 841-B-00-002 dated June 1999 and subsequent modifications and updates thereof.

(5) Northern Virginia BMP Handbook.

D. LID DESIGN

This Section applies only to the design of SWM facilities, such as, bioretention, filter strips and other LID practices. When a site is designed in combination with conventional SWM practices, this Section applies only to the design of LID practices.

1. The post development peak rate of runoff for a 2-year 24 hour duration storm event shall be controlled to predevelopment levels.

2. The post development runoff volume for a 2-year 24 hour duration storm event shall be controlled to predevelopment levels.

3. In some watersheds, the director of Public Works may only require the peak rate and the volume of runoff to be controlled for a one-year 24-hour duration storm event only. This design issue will be evaluated during the concept plan stages of plan submission.

4. The receiving channels should be adequate in accordance with Section 700 of DCSM.

5. All storm sewers shall be designed to convey the storm water runoff from a 10-year storm event, with the exception of road culverts that must be designed for the appropriate storm frequency.

6. The DCSM requirement for 10-year detention may be met alternatively in developments using LID techniques only, subject to the written approval of the director of Public Works. One such alternative could be to satisfy the adequate outfall requirement by improving the receiving channel to handle the10-year post development flows. In some situations, the director may waive the 10-year detention requirement when the receiving streams/channels are subject to 100-year flood hazard area requirements for the ultimate development conditions, and when other factors justify the request.

7. Low impact development storm water management design plans developed consistent with the requirements of this LID Section shall be considered as satisfying the water quality and quantity performance criteria.

8. Planting for bioretention facilities in parking lot islands may be credited towards meeting the interior parking lot landscaping requirement in nonresidential areas, subject to approval of the Director of Public Works.

9. The key factor in LID design is to increase the time of concentration. The following approaches may be employed, as applicable, to increase the time of concentration:

    a) Open Drainage
    b) Use Green Space
    c) Disperse Drainage
    d) Lengthen Flow Paths
    e) Save Headwater Areas
    f) Use vegetated Swales
    g) Maintain Natural Flow Paths

h) Increase Distance From Streams
i) Maximize Sheet Flow
j) Use Multifunctional Landscape
k) Hydraulically Disconnect Impervious Areas
l) Use Micro-Management Techniques to Micro-Manage Runoff
m) Create Depression in around Trees and Shrubs
n) Control Runoff at the Source
o) Reduce Impervious Cover
p) Disconnect roof drains and directing flows to vegetated areas
q) Break up Flow Directions from large Paved Areas.

10. The applicability and effectiveness of LID practices on development projects will be influenced by physical site characteristics such as:

- Soil suitability
- Depth to water table
- Tidal effects
- Topography
- Karst topography
- Drainage area size
- Maintenance Considerations
- Expansiveness of impervious cover
- Density/Intensity of use ~~of on-site structures~~
- Overall spatial constraints
- Downstream drainage and runoff conveyance infrastructure

D. HYBRID DESIGN

When the use of LID practices on a particular site is limited by physical constraints or other factors, or if the storm water requirements cannot be satisfied solely with the use of LID design techniques, then a "hybrid" design may be employed. A hybrid design employs both LID and conventional BMPs or detention practices (centralized BMPs) to meet storm water requirements. Such a design might conserve specific natural features and provide open space to the greatest extent possible, while detention practices or centralized BMP's are also implemented to provide peak rate or quantity control beyond the site-specific capabilities of the LID strategy. Another example of a hybrid design is one that incorporates LID for both the attenuation and infiltration of small storm events, and centralized BMP's to provide storage for larger storm events.

Once LID site design strategies and practices have been evaluated and employed to the greatest extent practicable, and, where needed, additional SWM controls have been added, the engineer shall provide computations for the target performance of the design in satisfying DCSM requirements.

E. DESIGN CONSIDERATIONS FOR BIORETENTION FACILITIES

1. If bioretention facilities are proposed, the underlying soils at the bottom of the facility must have a minimum saturated permeability rate of 0.5 inch per hour, unless an under drainage system that discharges the runoff away from the foundation is proposed. The under drainage system proposed shall be of approved material and have a hydraulic capacity greater than the planting soil infiltration rate. Under drainage system must be built with a cleanout well. Under drains shall be perforated with ½ inch openings, 6 inches center to center, along two or three longitudinal rows.

2. The location of bedrock and seasonal high groundwater table shall not conflict with the functionality of bioretention facilities. The bottom of the bioretention facility should be located at least 24 inches above the observed high groundwater table.

3. Ponding water within bioretention facilities should be designed to infiltrate the runoff within the 4-6 hour period.

4. Ponding depth within a bioretention facility shall be 9 inches or less.

5. The drainage area for the bioretention facility shall be 1 acre or less.

6. The bioretention facility should be constructed in an offline configuration, unless appropriate measures are proposed to divert excess runoff away from bioretention facility.

7. The bioretention facility shall have a non-erosive outfall.

8. Open swales carrying runoff (from more than one lot) for drainage areas up to 1.2 acres may be located within individual lots, subject to approval of the Director of Public Works, as long as the reasonable usability of the lot is ensured based on the location of the swale (and 100-year overland relief per DCSM is complied with). The minimum setback from the structure shall be 40 feet.

9. When designing a landscaping plan for bioretention facilities, select plant materials that can tolerate extreme hydrologic changes, pollutant loading, and highly variable soil mixture conditions.

10. Excess runoff shall be diverted away from bioretention facility by grading the elevation of the maximum surface ponding equivalent to the elevation at which runoff is discharging into the bioretention area.

11. A safe overland flow path for the excess runoff and use of erosion control techniques are required.

12. Sloped areas exceeding 20 percent shall not be used for locating bioretention facilities.

F. GENERAL CONSIDERATION DURING CONSTRUCTION

1. An interim sediment control facility may be situated in the same location as that of the bioretention facility, if precautions are taken not to hamper the effectiveness of bioretention facilities when they are constructed. In such situations, the proposed invert of bioretention facility must be at least 1 foot below the invert of the sediment control facility at that location. During the construction of the bioretention facility, the runoff must be directed away from the facility, and this shall be identified in the sequence of construction.

2. The engineer shall specify on the plan to avoid excessive compaction that can hamper the performance of the proposed bioretention facility, around bioretention facilities.

3. The plan should show that erosion controls around bioretention facilities are maintained with measures such as super silt fence until the drainage areas to these facilities are stabilized.

4. The notes on the final plan should indicate that a preconstruction meeting shall be held between the developer/contractor and the County's site inspector to determine the inspection points needed.

5. The notes on the final plan should indicate that the contractor shall leave the tags on bioretention plantings to facilitate inspection.

E. LID PLAN ELEMENTS AND SUBMISSION REQUIREMENTS

1. Concept Plan

Before submitting a LID plan, the engineer shall submit a storm water management concept plan describing, in general, how storm water runoff through and from the development will be conveyed and controlled.

The storm water management concept plan must be approved prior to the submission of a final plan for the subject development, or for portions with LID when LID is proposed predominantly to satisfy the SWM requirements.

During the concept phase, the site is first being evaluated to investigate the feasibility of LID practices. The engineer shall submit a concept plan to Public Works, to demonstrate conceptually how the integrated management practices (IMPs) with bioretention and/or other environmentally sensitive site design practices will be incorporated into the Plan.

During the conceptual phase, the engineer shall evaluate the feasibility of creating a hydrologically functional site design that satisfies the overall objective by completing the checklist at the end of this Chapter. The procedures in the checklist are aimed at disconnecting and minimizing the impervious areas and planning drainage flow paths so that the post development time of concentration of runoff can be maintained as close as possible to the predevelopment conditions. Maximizing the runoff travel time to closely approximate the predevelopment conditions is among the very first steps in LID design.

The concept phase should occur concurrently with the preliminary plan submission, when applicable.

The engineer should provide general information on preliminary soil test results to confirm the suitability of onsite soils for LID practices with the Concept Plan. Prince William County's Soil Survey may be used during the conceptual stages, with other supplemental information as needed.

The engineer may use the checklist at the end of this Appendix as a guide in assessing the feasibility of a site for LID practices.

2. Final Plan

Once the LID SWM concept has been approved by the County, the engineer may submit a final plan to address SWM. In this phase, the engineer will determine how to distribute the bioretention and other environmentally sensitive design practices uniformly across the site by emphasizing on a source control approach. In this iterative phase, the engineer shall develop a plan to meet the SWM requirements. A detailed geotechnical report is performed at this time, or earlier, to evaluate the on-site soils for LID suitability.

In situations where the bioretention facilities are proposed within individual lots, the engineer shall describe the coordination process between the developer and the builder in reference to the construction of bioretention facilities within individual lots. For properties with bioretention facilities and LID components within individual lots, the County will not issue the building occupancy permits until these facilities and any other LID or IMP components shown on the plan within the lots are constructed.

The LID storm water management plan shall include a hydrologic/hydraulic analysis of the downstream watercourse for all concentrated surface waters that will be discharged from a developed property.

The LID storm water management design plan shall contain charts, graphs, tables, photographs, narrative descriptions, explanations, and citations to supporting references as appropriate to communicate the information required by the Low-Impact Development Design Manuals. At a minimum, the final LID plan shall contain the following:

1. Comprehensive hydrologic and hydraulic design calculations, including all assumptions and criteria, for the pre-development and post-development

conditions for the design storms. The Virginia SWM Handbook shall be used as a reference for the design of bioretention facilities.

2. Delineate watersheds and microwatershed areas.
3. Clearly define design storms controlled by LID.
4. Compile information on predevelopment conditions such as soils, slopes, land use, and imperviousness (connected and disconnected).
5. Evaluate predevelopment conditions and develop baseline measures.
6. Evaluate site planning alternatives, the locations of bioretention facilities, if applicable and compare with baseline predevelopment conditions.
7. Evaluate Integrated Management Practices. The location of IMPs should be identified on the site. Compare with the baseline by accounting for the hydrologic mitigation from IMPs.
8. Evaluate what supplemental measures are needed to control peak or volume of runoff.

F. LOCATION OF BIORETENTION FACILITIES

1. Bioretention facilities shall be setback at least 30 feet from the building foundation in residential developments.

2. It is recommended that the bottom of the bioretention facility be located at least 12 inches below the bottom of the building footing, wherever feasible. In situations where the underlying soils are relatively less pervious, but still meets the permeability criterion for bioretention facilities, the engineer shall propose an under drainage system which daylights the runoff away from the foundation.

3. Bioretention facilities shall not be installed between two property lines.

4. Bioretention facility shall be located down-gradient from the home or building location.

5. In commercial or industrial settings, design for overflow is more critical. The paved surfaces flowing into the facilities that are incorporated in the parking lot landscaping islands can generate large quantities of runoff. Therefore, overland conveyance of overflow water and flow-through bioretention facility designs is discouraged.

6. When the discharge flows exceeds 3 cfs, the engineer shall evaluate the potential for erosion to stabilized areas in and around bioretention facilities.

G. EASEMENTS FOR BIORETENTION FACILITIES

1. Storm drainage easements shall be recorded to identify the location of integrated management practices and bioretention facilities on lots or parcels. Some IMPs may not require an easement as identified by the County during plan review. The property owner shall not remove or structurally alter these facilities without prior

written authorization of the Director of Public Works.

2. For bioretention facilities, the easements shall correspond to the 9" ponding elevation over these facilities plus a width of 10 feet around the facilities.

3. A 10 foot-wide access easement, clear of any obstructions, shall be provided for the maintenance of bioretention facilities.

4. The director of Public Works may require provisions within the Home Owners' Association (HOA) document to facilitate the County's inspection of in-lot bioretention facilities. The homeowners will be required to conduct minor maintenance of bioretention and associated drainage areas leading into or out of bioretention areas. Also, specific language needs to be incorporated into HOA document that identifies an approach to encourage the homeowners to adhere to minor maintenance of bioretention facilities. The County may seek periodic assistance from HOA to notify homeowners of County's inspection dates for the bioretention facilities.

H. BIORETENTION FACILITY CONSTRUCTION NOTES

1. To the extent possible, bioretention facility shall be constructed after the site is stabilized.

2. When sediment traps are converted into bioretention facilities at the end of construction, the sediments must be removed and remaining surface scarified prior to constructing a bioretention facility. Wide-track equipment or light equipment with turf-type tires shall be used for the excavation to minimize unwanted compaction of on-site soils.

3. Bioretention facilities constructed prior to site stabilization shall be protected from sedimentation by the installation of silt fence around the facility. The sediment laden runoff shall be directed away from the facility where possible.

4. Stockpiled onsite topsoil to be used for bioretention planting soil shall consist of materials suitable for planting and shall be verified for an appropriate percolation rate by the geotechnical engineer of record. In addition to percolation rate, the planting soil for bioretention must be checked for pH, organic matter, magnesium, phosphorous, potassium and soluble salts. The standards are described under the state minimum standard 3.11 in the Virginia SWM Handbook. The engineer shall pick representative samples from the stockpile to conduct these tests.

5. Planting soil medium must have a percolation rate greater than 1.5 inches per hour. If native soil is not suitable, contractor shall install typical soil medium consisting of 20-30 percent top soil, 20-30 percent leaf compost, and 50

percent construction sand (coarse grained).

6. Prior to backfilling of the facility with gravel and soil, rototill 2-3 inches of sand into the bottom of the facility. Installation of the planting soil medium shall be in 12-18 inches depths.

7. The gravel sump shall consist of 12" of double washed #57 blue-stone (1/2 to 1 ½ inch diameter) overlaid with 6 inches of washed pea gravel.

8. When deemed necessary by the geotechnical engineer, planting soil shall be amended with construction sand (ASTM C-33 Concrete Sand) or leaf compost.

9. Mulch may be provided by onsite vegetation which has been shredded, stockpiled and aged for approximately 14 days. If green mulch is used, the contractor shall supplement green mulch with nitrogen fertilizer.

10. The developer shall warrant the plant materials for a minimum period of one year.

I.. MAINTENANCE NOTES FOR BIORETENTION FACILTIES MAINTAINED BY THE COUNTY

The following notes shall be on the plan to indicate the responsibilities of the fee title owner of the property where a bioretention facility is located and when the facility is County maintained.

1. Mulch should be applied at least once a year uniformly for 2-3 inches depth. Grass clippings are unsuitable as mulch.

2. Fee title owner is responsible for the periodic visual inspection, hand weeding, trimming, removal of trash and debris and informing the County for maintenance beyond his responsibility, if the bioretention facility is located on individual lot. HOA will be responsible for these items, if the bioretention facilities are located in common areas.

3. The County is responsible for periodic monitoring, replacement of landscaping within the facility (as determined by County inspector), facility repair and responsibility beyond the ability of the fee title owner.

J. BIORETENTION CONSTRUCTION SEQUENCING

The following items shall be included in the construction notes on the plan:

a) Prior to the construction of bioretention facilities, a meeting shall be scheduled between the contractor or his representative, and the County inspector to discuss construction sequencing in detail and to go over the inspection requirements for these facilities.

b) On-lot bioretention facilities shall be protected from sedimentation during individual lot grading and house construction.

c) Bioretention area shall not be placed in service, unless protected, until the contributing drainage area has been stabilized and approved by the County site inspector.

K. BMP EFFICIENCY

LID structural and non-structural practices can protect downstream waterways by reducing the post-developed pollutant loading through storm water runoff volume reduction and/or the filtering and settling of pollutants. Storm water volume reduction and the corresponding reduction in the peak rate of discharge can also serve to reduce water quality impacts associated with channel erosion.

The BMP efficiency for LID techniques, porous pavement and bioretention facilities will be in accordance with the Virginia SWM Handbook.

The Virginia SWM handbook shall be referred to for the design of porous pavement, filter strips, grassed swales and other environmentally sensitive BMPs.