STORMWATER MANAGEMENT STRATEGY

The site plan for H2O represents a tremendous opportunity for creating a sustainable urban development plan for lower Davidson Branch tributary. Devising a rainwater management strategy that looks the application of rainwater as a long term environmental resource will help to ensure that the site maintains a physical connection with the natural surroundings. The plan for H2O seeks to manage the inflow of accumulated rainwater into the Davidson Branch by using a distributed network of water management devices and facilities. The Environmental Protection Agency supports the development of High Density Development as a way to ensure regional protection of water resources, even identifying that the placement of high density developments can be an effective best practice in and of itself.

Whereas the H2O project is located at the bottom of the 2,000 acre Davidson Branch catchment area, accumulated rainwater will not have a dramatic effect on upstream users, and in fact, upstream users will have a tremendous impact with regard to the natural resources of Davidson Branch. Soils on the site are moderately well draining making them applicable to a host of on-lot infiltration and retention strategies. The H2O site however is somewhat separated from the upstream conditions as the US 70/Charlotte Pike thoroughfares provide a restriction point above. This allows the site to adopt a more independent rainwater management approach. The waterway which Davidson Branch empties into is a controlled waterway with a managed normal pool elevation reducing concerns about the management of the adjacent floodplain. Maintenance of undisturbed riparian buffers can offer great benefits to sites, however, the majority of this site has been intensive developed in the past and not off of the site is conducive to a naturalistic riparian buffer. However, an urban waterfront will help to make the waterfront district more accessible for public users.

The development team has identified four principal goals that are consistent with Metro-Nashville water quality regulations and will allow for the effective management of accumulated rainwater in the H2O project.

- Stormwater management techniques will be integrated appropriately and considerate of the character and scale of the proposed development.
- Contiguous open space, sensitive ecological areas, and existing drainage patterns within the watershed will be enhanced.
- Retention, filtration, treatment processes will be replicated from natural systems without sacrificing urban form.
- Rainwater management devices will satisfy all regulatory concerns.

These are consistent with Metro-Nashville water quality regulations. The application of micro-controls on the site will go a long way to reducing the accumulation at the source. It is a challenge to use natural features as part of the stormwater management system in this previously disturbed and highly urban setting, however, looking to natural systems for examples of infiltration, retention, storage, and treatment will help maintain site-wide ecological legibility, a critical element of an effective urban rainwater management approach.

Rainwater management implementation strategies at H2O use a specialized collection of small-scale, well-integrated techniques designed to maximize the continuity of high quality water resources. Staying parallel with Metro-Nashville stormwater management strategies the following tenets are fundamental to the planning and design of H2O's comprehensive approach to rainwater management:

1. Accumulated rain water must be reduced, redirected, and slowed down starting at its source of generation.
2. Spreading rain water around over a broad area will help to distribute accumulation, velocity and total volume.
3. Getting it into the ground will help maintain even "base flow" from streams and wetlands in and around the site.

Seven specific strategies are identified to address stormwater concerns at H2O. These strategies are applicable to local and statewide regulatory intentions and use an approach that includes a series of sequential interventions by integrating specific elements of rainwater management. They are as follows:

1. Green Roofing
2. Rainwater Planters (storage or flow-through)
3. On-lot Rainwater Harvesting
4. Rain Gardens (Bioretention facilities)
5. Bioswales
6. Infiltration Gardens, and
7. Porous Material or Pervious Pavement

These seven strategies are capable of isolating specific rainwater management concerns such as peak flow attenuation, yet can operate together addressing collective concerns in a strategic and comprehensive manner. As each element has specific sizing criteria, functional limitations, and operational requirements, the stormwater management system requires careful planning and engineering, and has been considered throughout the design process.

To ensure that the project design tenets are implemented properly, it is necessary to apply them at the block, lot and building scale. At H2O there are three types of buildings that integrate rainwater management strategies from the ground up. They are:

1. Large podium buildings with integrated parking structures
2. Medium-size buildings with surface parking
3. Small residential structures with on-lot and off-lot parking storage

Streets and public spaces integrate additional rainwater management strategies to account for stormwater impacts in the public realm, on parks or other locations throughout the site.

Rainwater management solutions have a specific relationship to the individual building types at H2O ensuring that design interventions have built-in redundancy. The combination of the selected rainwater management best practices reduce potential failures more commonly associated with larger facilities (such as retention ponds or dry-detention facilities) designed to address single, very large rain events and allow rainwater management to occur in smaller storms and regular seasonal showers.

For the larger podium buildings, the principal water retention techniques will include intensive green roofs, rainwater planters along the building's principal façade, underground cisterns and extensive landscaping in public areas. Intensive green roofing will significantly in the attenuation of stormwater. Recent studies indicate that well designed green roofing can reduce the rate and volume of runoff from a structure. The volumetric and velocity reductions range between 50% and 90% depending on the depth and type of soils media. Additionally, rainwater can be diverted into permanent storage containers, cisterns, and rain tanks allowing for full integration into the building systems providing a supply of non-potable water that can be used for toilets, cooling systems and other non-potable water uses.

Medium size buildings shall use a combination of rainwater planters, rain gardens (bioretention) and bioswales for the control and management of accumulated rainwater runoff. Ground level rainwater planters provide the ability to collect, store and cleanse rooftop generated runoff prior to leaving the immediate structure. Appropriately sized planters at integral locations such as location of downspouts have an important relationship to flow attenuation. Like the green rooftops on the larger podium structures, rainwater planters located at strategic places offer a mitigating influence on locally generated runoff. Stormwater planters cannot fully account for all runoff from the largest rain events, but they do offer a significant contribution to flow attenuation delay the time of concentration for most rain events. For a connected series of best management practices, the use of stormwater planters become important, complementary options that enhance both the urbanism and architecture on a site. Surface parking lots shall use a combination of evergreen and canopy vegetation to provide additional abstraction locations for rainwater and bioretention cells for storage and treatment. Infiltration beds in public opens spaces will offer an approach to storage, cleansing and elimination of accumulated rainwater on medium and larger sized buildings at H2O. Public spaces, plazas and planters provide locations for additional rainwater storage and infiltration. Underdrains with amended soil profiles enhance drainage in heavy, compacted urban soils. Adjacent open spaces should serve as overflow storage areas if necessary.

For the smaller buildings that are more residential in character a combination of rooftop planters and on-lot rainwater harvesting techniques that include use of rain barrels, cisterns, seepage pits, wet wells and recharge beds store, cleanse and eliminate accumulated rainwater. Off-lot community rain gardens located in parks or in rear lane brambles will provide a location for overflow storage areas. The maximum practical amount of rainwater shall be captured on individual lots in mandatory rainwater harvesting devices. Controlled releases ensure the available storage volume securing the ability to be prepared for sequential rain events. Overflows from heavy rains that surpass the volumetric ability of on-lot devices will be routed into conveyance networks utilizing bioswales or open channels and directing the accumulated rainwater into community facilities. Devices will be sized to be useful in small and large storms helping both regulatory agencies and homeowners. Most importantly, rainwater harvesting techniques will help to reduce the demand on potable water supplies by providing an adequate source of water for irrigation or residential wash water.

Streets shall be served by linear bioswales along naturalistic roadways and urban "flow-through" planters along urban street sections. Flow-through planters are effective at reducing the peak flow and total water quality volume from a wide range of design storms. Overflow outlets will direct accumulated runoff into larger community served facilities, however, the time of concentration will be greatly reduced due to the storage capacity provided in each bay, however, the Street Edge Alternative project in King County Washington reports that as much as 97% of runoff has been reduced greatly affecting the capacity of storm sewers in the area. Each flow-through planter bay will be sized in accordance with the adjacent street type. For example, wider streets with wider sidewalks will have more impervious surface and therefore require more storage capacity, where as narrow streets will require less. Pervious pavement is intended wherever practical and has a dramatic effect on reducing total runoff and extending the time of concentration from highly impervious areas. Low volume roads, parking shoulders, and parking lots can incorporate pervious pavement. Roadbeds that use pervious materials shall maintain functional underdrains to aid in elimination of water where soils do not permit adequate infiltration.

Regardless of the specific design elements, there are several important similarities that affect each of the three general building categories and the strategy for streets and public spaces.

First, a reduction in peak flow can occur through source control and design. Rainwater abstraction points such as green roofing and rainwater planters can help to contain and slow down the accumulation of high volumes of rainwater during all but the largest rain storms. Additionally, by disconnecting large expanses of pavement, parking or other impervious area a delay in time of concentration and a reduction in velocity can be achieved. Delaying the time of concentration is very important as the "slug" of high volume water that is typically designed into a pipe and outfall network can be spread out over a longer period, better replicating a hydrograph more similar to predevelopment conditions. This is important not just in very large events, but also in smaller, more frequent rain events, as even small rain storms can have an impact on stream channels and sedimentation of water resources. When designers are able to spread out the total water volume and maintain a steady flow over a longer period of time the elements of urban stormwater management infrastructure can be more finely scaled and be made more pedestrian compatible.

Secondly, accessing rainwater in a constructive way at the source of generation will provide users with the opportunity to connect and use the resource more wisely. Whether used to aid in building systems on large structures, or simply to provide a water garden for smaller residential dwellings, gaining regular access to rainwater will help to maintain a physical and emotional connection to an important natural resource and ensure longevity the devices at H2O. Increasing the effectiveness of the open space, public areas and pervious area by enhancing soils, providing rain gardens, or incorporating water based public art decreases the impacts of the development footprint as well.

For example, by adding a "filtration plaza" to a public space associated with a fully developed site will make it possible to reduce the impacts associated by creating dual purpose functionality, unlike conventional single use facilities. Conventional facilities that are not scaled for pedestrian environments are often relegated to some hidden corner of a site and forgotten about, often falling into disrepair or neglect requiring expensive repair and maintenance later. Features that are placed prominently in public space or built into neighborhood fabric become regular parts of the community and do not get forgotten about.

Lastly, conveyance networks remain exposed wherever practicable. Unlike conveyance networks in conventional pipe and carry applications, open conveyance networks remain exposed and visible to the people at H2O. Bioswales, channels, rills, and runnels all have an expression that is an important visual aid in urbanism. Like the application of exposed retention strategies mentioned earlier, maintaining a series of exposed conveyance rainwater networks will ensure that the public maintains a physical connection to important environmental resources.

Specific design will be necessary to determine the sizing and proportion of rainwater management facilities on site, however, urbanism provides an easy way to place the multiple smaller, well integrated facilities into the community fabric of H2O accentuating the environmental character specified in the plan.

BIBLIOGRAPHY

[1] Natural Approaches to Stormwater Management, Low Impact Development in Puget Sound. Puget Sound Action Team, 2003

[2] Green Roof Water Quality and Quantity Monitoring, Dr. Charles C. Glass, ASLA Green Roof Study-http://www.asla.org/land/050205/documents/Green_Roof_Water_Monitoring_Report.doc

[3] NCSU Bioretention, Green Roof and Permeable Pavement Research, Bill Hunt, NC State University, 2005

[4] Portland Bureau of Environmental Services Stormwater Manual http://www.portlandonline.com/bes/index.cfm?c=35117

[5] Portland Bureau of Environmental Services Stormwater Manual http://www.portlandonline.com/bes/index.cfm?c=35117 Appendix C

[6] Forests and Trees as a Stormwater Management BMP http://www.chesapeakebay.net/pubs/calendar/FWG_03-01-06_Presentation_1_7080.ppt

[7] Texas Rainwater Harvesting Manual (http://www.twdb.state.tx.us/iwt/rainwater.asp)

[8] "Environmental Limitations to Vegetation Establishment in Vegetated Stormwater Biofilters" http://depts.washington.edu/cwws/Research/Reports/rc2.htm

[9] Moving Toward High Performance Infrastructure, Mary Vogel, Urban Land, October 2006

[10] Natural Approaches to Stormwater Management, Low Impact Development in Puget Sound. Puget Sound Action Team, 2003

[11] Advances in Porous Pavement, Tara Hun-Dorris, Stormwater, The Journal for Stormwater Professionals, April 2005, http://www.forester.net/sw_0503_advances.html

KEY

G = Green Roof (drains to cisterns)

Bioswales

NOTE 1: STORMWATER PLANTERS AND PITS ON ALL STREETS.

NOTE 2: PERVIOUS PAVEMENTS FOR ON-STREET PARKING ON ALL STREETS

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Scale: 1" = 200'

0 100' 200' 400'