DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL

Utilizing Brownfield Sites for Green Space:

Urban Farming and Gardening, and Stormwater Management Practices

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Preface

This review was prepared in defense of *An Urban Agriculture Water Framework* for the Delaware Urban Farm and Food Coalition (DEUFFC). It is focused on the City of Wilmington, Delaware. As a pilot program, Wilmington was chosen because of its demographic, environmental, and environmental justice scale. As an urban land use drama, Wilmington reflects all of the socio-economic ills and externalities of other larger cities in the region. In particular is its denotation as a food desert whereby un-empowered residents lack access to health and nutritional food options.

Numerous cities and ventures over the years have touched on the urban food shortage issue and in urban gardening/farming as a potential solution. Far too often, however, higher priorities have received the lion's share of attention. Issues involving crime, under-employment, red-lining and inadequate access to health opportunities are the prime drivers in the hierarchy of need analysis. The DEUFFC is unique in Delaware in that its sole focus is the food and urban farming/gardening crisis. DEUFFC's mission is to work with the affected communities in concert with governmental and stakeholder support to promote a unified, consensus-driven framework.

It is with that mission in mind that DNREC has prepared this analysis of the environmental benefits of urban farming/gardening to the City, particularly to stormwater pollution prevention and best management practices. Stormwater, and water access issues in general, is at the heart of Wilmington's proposed *Clean Waterways Wilmington* watershed based approach. The goal of the analysis is to facilitate the understanding that what is being sought in DEUFFC's Urban Agriculture Water Framework is achievable and imperative to meet the needs of the community.

Throughout all of this work and analysis, including the incredible multi-faceted benefits of urban farming and gardening, it must be remembered that any farming/gardening project, especially in the urban setting, has potential risks. Many of these projects are located on brownfields and as such must be properly characterized and remediated if necessary. The need to make nutritional foods more accessible while preserving and cleaning our vital waterways is not achieved without planning and appropriate protections.

Introduction

Green space within urban areas has become more prevalent with the growing concern for the environment combined with the concern for public health. Development of inner city food systems has been of interest to local government officials and their advocates but face challenges with location, condition and history of selected properties (Hendrickson et al 2012). Urban gardens also serve as pervious surfaces for increased stormwater infiltration into the subsurface, thus decreasing the influx of drainage into stormwater treatment facilities. Underdeveloped urban properties, such as brownfields sites, could be re-purposed into green space, such as farms and gardens, to benefit local communities. Additional benefits would include prevention of localized flooding, decreased soil erosion, increased oxygen production, reduction of the heat island effect and, where appropriate, as a remedial action.

Purpose

The DNREC-SIRS Brownfield Development Program (hereinafter BDP) was created to help encourage the redevelopment of "any vacant, abandoned or underutilized real property the development or redevelopment of which is hindered by the reasonably held belief that the real property may be environmentally contaminated" 7 Del. C. §9102(3). Once an investigation is performed, typical redevelopment plans would include residential, commercial or industrial uses. With growing interest and acceptance of going "green" in urban areas, utilizing urban farming and gardening (aka urban agriculture) as a potential redevelopment plan for Brownfield sites could benefit the community in many ways. Reduction of stormwater runoff and decreased contaminant migration are amongst the strongest supporting benefits of this proposition. Green space allows rain water to slowly infiltrate the subsurface, eliminating the pathway of stormwater into drainage systems. Many cities provide tax and fee reductions for implementation of projects that can demonstrate reduced stormwater runoff. This manuscript presents several methods including urban farming and gardening where reduced stormwater runoff has been documented.

Development and benefits

Rain gardens

Figure 1: Rain garden example (U.S. EPA 2013).

"Rain gardens" can serve as a low-cost, environmentally friendly use of vacant lots and/or brownfield sites in urban setting. Development of rain gardens utilizes measurable space to control stormwater runoff from sewer systems. Roughly 45% of all surface area is impervious in urban areas and typically contain compacted soils that can hinder infiltration and increase storm-water runoff and flooding (Kloss & Calarusse 2006; Yang & Zhang 2011). Utilizing these spaces can redistribute stormwater runoff volume via soil infiltration, which reduces sewer overflow events (Shuster et al 2014). Rain gardens promote slow infiltration rather than rapid runoff by storing water at a property, which can decrease pollutant loads in drainage systems as limited runoff occurs (Knizhnick 2012).

Rain gardens also decrease erosion and topsoil removal through productive planting (U.S. EPA 2011). Grasses and forbs, a flowering plant found mostly in meadows and grasslands can be

more effective in runoff reduction due utilizing larger amounts of water (Knizhnick 2012). Rain gardens being utilized in urban settings include improved air quality by consuming carbon dioxide, reduction of heat island effect and creation of enhanced, organic rich soils (U.S. EPA 2011; Knizhnik 2012). Neighboring wetlands can also benefit because of the reduction of negative impacts due to flooding that kill or drown tree and plant life.

Composting / Soil Amendment

The community can also aid in the growth and success of urban rain gardens by contributing compost. Compost programs with gardening sites can reuse food and yard waste to fertilize plants, which also reduces the amount of product going to landfills (Loria 2011). Typically in industrial countries, ~36% of landfill material is considered food or landscaping waste and can range up to ~66% in developing countries (Gardener 1997). Incorporating composting practices improves water retention, porosity, bulk density, and concentrations of carbon and nitrogen needed for new plant growth. Land modified with compost has a 1.5 to 10.5 times higher infiltration rate than that of an unamended plot (Pit et al 1999). Insects utilize compost as a food source and in doing so, enrich and aerate the soil. Overall utilizing compost benefits soil and plant health while reducing the amount of waste traveling and being stored at landfills.

Development of gardens may be considered a remedial action at appropriate sites because of the combination of potential remedy and reuse. A long-term remedial solution called phytoremediation utilizes plants to remediate soils and water impacted with a variety of contaminants such as oils, solvents and heavy metals (U.S. EPA 2011). Certain plants and micro-organisms can clean and filter soil as well as water as it travels through soil (Gardenworks 2006). Certain microbes within garden soil can also help the degrading process for specific contaminants (Hendrickson et al 2012). This technique reduces exposure to contaminated media via stabilizing soil.

Rainwater receptacles

Rain barrels or cisterns can also be utilized to contain diverted stormwater and be used to irrigate urban gardens. For example, a system collecting water from a 1,000 ft^2 roof would

collect 6,000 gallons if a storm generates 10 inches of rain (Knizhnick 2012). The subject property as well as adjacent properties can be used to gather rain water in barrels, cisterns or even below ground receptacles for garden use. This then further reduces the load of excess water to the local stormwater systems. Drip irrigation within urban gardens utilizing collection receptacles can also reduce city water usage saving the landowner funds to further continue maintenance of the subject property. Design of such systems can include a relief drain above an impermeable liner containing contaminated media in the subsurface to convey excess water to a nearby storm sewer or an alternative discharge (U.S. EPA 2013).

Figure 2: Rain barrels distributed by DNREC, State of Delaware spring 2014.

Contained gardens

If the property selected for an urban garden has been sampled and determined to contain hazardous substances, greenhouses can be erected to avoid contact or migration of such contaminants. Greenhouses are typically designed without the use of ground penetration, which can avoid interaction with underground contaminants (Hendrickson et al 2012). Within greenhouses raised beds, container gardens, or hydroponic systems can be constructed. Greenhouses typically utilized rainwater receptacles and act as their own rain water collection system, which continue to mitigate runoff of stormwaters while using precipitation as a medium for plant growth (Loria 2011).

Figure 3: Greenhouse with container gardens (U.S. EPA 2011).

If funding is unavailable to erect such a structure but an impervious cap is dictated as a requirement of the remedial plan, vegetated container boxes or hydroponic systems can still be utilized in conjunction with the cap due to no interactions with contaminated soils. Vegetated boxes have been utilized in a rooftop gardening project in Pittsburgh, PA and proved to absorb 96% of rainwater that fell within the boxes. Utilizing this system mitigated 22,500 gallons of stormwater within a collective 1,000 ft^2 area of vegetated boxes (Barreiro 2012). Rain barrels or

cisterns can be used in conjunction to store any un-used discharge from storm events to either be used for irrigation of the garden or discharged during times of no precipitation.

Figure 4: Raised bed container boxes (Southbridge Youth Garden, 06.2014).

Alternative uses

For property owners who do not want an active, daily role in maintaining an urban farm or garden or for brownfield sites that are not suitable for growing food grade produce, cultivating small scale crops for the ethanol industry can be a viable alternative. “The Energy Independence Security Act of 2007 mandates the production of 36 billion gallons of biofuel by 2022, including 21 billion gallons of advanced biofuels produced from cellulosic biomass feedstocks” (Hoff et al 2010). Due to this demand, crops such as corn or switch grass can be planted and harvested with little involvement as the plant grows. Irrigation can be installed and utilize stored stormwater from rain barrels or cisterns. Soil erosion can be an issue with row crops but utilizing no-till and spatially arranged planting techniques can reduce potential contaminated soil migration.

Special considerations

Special planning for urban farming/gardening projects must be done prior to installation to avoid mobilization of contaminants. If groundwater is already contaminated at a site, accelerated infiltration by gardens is not recommended without engineering controls (U.S. EPA 2013). It could create a larger plume of contamination leading into neighboring properties. Neighboring property use is also a concern when utilizing urban farming and gardening practices at Brownfield sites. Stormwater drainage from nearby properties such as gas stations or industrial operations can introduce oil, gas, etc. thus creating a higher risk for contaminating groundwater if drainage goes directly into one of these gardens.

Likewise, soils in urban areas may not be recommended as a growing medium depending on soil characteristics including pH, organic matter, nutrients, soil composition, texture or induced conditions such as contaminant types, concentrations, occurrence and distribution (U.S. EPA 2011; Hoff et al 2010). For sites that have contaminated soil and that have not been properly characterized, exposure through dermal contact, inhalation or ingestion can be a concern for human health. Food crops can intake contaminants along with nutrients making them unsuitable for human consumption. For example, strawberries, lettuce, spinach, endive, kale as well as orchards can uptake more inorganic contaminants, particularly heavy metals, if conditions of the soil (increase pH and irrigation) are changed to enhanced plant development (Hendrickson et al 2012; Hoff et al 2010). Utilizing decorative plants that uptake contaminants would avoid the ingestion risk. Dusts emitted from tilling practices can also create a greater risk in the form of inhalation for certain contaminants (Hoff et al 2010).

Special consideration and planning would need to be conducted to utilize Brownfield sites as green space. Thorough investigation to characterize distinct areas of concern is needed so remedial action plans such as installation of impervious surfaces or removal of contaminated media can be incorporated in the urban farm/garden/open space redevelopment plans.

Local Considerations – City of Wilmington, DE

Stormwater Management Program

The City of Wilmington's Stormwater Management Program (the Program) was developed to protect water resources while mitigating stormwater drainage issues. Management activities within this Program include waste water treatment plants, upgrades to sewers for overflow protection, construction stormwater management, and watershed planning for protection. The Program implemented a Stormwater Charge to provide a funding source to continue managing such activities. Each parcel within city limits is evaluated and given a stormwater class based on the amount of impervious areas that can generate potential runoff and overflow into sewage systems. The Stormwater Charge is properly generated based on a parcels assigned stormwater class and a corresponding runoff value.

Stormwater Credit Program

A Stormwater Credit Program was developed to aid citizens owning property zoned non-residential by reducing fees associated with the Program. Credits are determined by developing and implementing management techniques that reduce the parcel's stormwater discharge. Quantity, quality and National Pollutant Discharge Elimination System (NPDES) permit credits are available with qualifications for each.

Quantity credits involve onsite structural stormwater management. Examples of such management techniques being implemented include, but are not limited to, retention or detention ponds, privately owned stormwater facilities and underground retention basins. Documentation demonstrating existence and functionality of such privately owned and maintained facilities must be provided. Credits can be given for a parcel that has facilities designed to support drainage that exceeds pre-construction discharge rates for 2, 10 and 100 year storm events. The City has the right to revoke such credits if in fact drainage management proves to become ineffective or poorly maintained.

Quality credits are available case by case and determined based on the effectiveness of decreasing pollutant levels onsite. Best Management Practices (BMPs) are designed to significantly decreasing pollutant levels in runoff waters. Criteria for credit could include BMPs

that allow the first inch of precipitation to infiltrate ground surface or "produce a total suspended solid removal rate of greater than 80% of suspended solids in runoff from impervious areas during a 2 inch storm event". Non-compliance of BMP standards are grounds for removal of credits. Rain gardens may qualify for quality or quantity credits due to its ability to store water during storm events for gradual subsurface infiltration as well as decreasing pollutant high runoff.

National Pollutant Discharge Elimination System (NPDES) permit credits are available to parcels with this permit issued by DNREC, State of Delaware. Two different permits can be issued: an Individual or a General NPDES Permit. Each permit must possess well-defined Monitoring and Stormwater Management Plans (SMPs). The parcel cannot have any NPDES violations within 24 months prior to issue or renewal of this credit and approved credits are valid for two years. If a property owner feels the parcel has been inaccurately assessed, a stormwater fee adjustment appeal may be filed. Appeals address inaccurate stormwater classification to residential impervious areas, inaccurate gross parcel area or to address impervious area estimation for non-residential parcels

Case studies

Development of progressive thinking in Chicago allowed it's citizens to utilize more vacant lots by implementing a city ordinance to "expand size limits for community gardens, relaxed fencing and parking requirements to allow the development of hydroponic and aquaponic systems" as well as bee keeping facilities (Loria 2011). Missouri's 96th General Assembly took urban gardening one step further by proposed a house bill in 2012 to include brownfield credits for urban agricultural clean-up (Loria 2011). Locally, Philadelphia has started implanting green space tactics throughout the city for a multitude of purposes and benefits (Knizhnik 2012).

The Greensgrow Farms program works within Philadelphia and has been nationally recognized for its urban agriculture. Greensgrow utilized an abandoned EPA brownfield site years after cleanup by incorporating "a greenhouse, three drained, irrigated raised beds with high tunnels, a 4,000 ft^2 hydroponic system for growing greens, a nursery hoophouse, flower beds, bee hives, a farm market, a retail nursery, and a vermiculture project" (Loria 2011). They produce a viable food source for the local community. The Philadelphia Water Department has been implementing green infrastructure measures such as rain gardens, porous pavement, green

roofs, and stormwater planters to help mitigate runoff (Knizhnick 2012). Their stormwater infrastructure is implemented to manage one inch of stormwater for every acre of impervious surface. Philadelphia implemented the Greenworks plan, which expands tree cover by planting 300,000 trees by 2015 and increases grass groundcover on vacant lots. Research in vacant lots of Philadelphia by Yan & Myers documented a 30% reduction in stormwater runoff on lots cleared of debris and planted with grass for groundcover (2007).

Philadelphia and Wilmington share similar geography, historical industry, age and infrastructure. Implementation of the successful green space, urban gardening or agriculture displayed in Philadelphia could be easily applied and executed in the city of Wilmington. Although both cities share similar traits, success greatly depends on the proper investigation and development of sites.

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