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Urban Farms

A Green Infrastructure Tool for the Chesapeake Bay

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Cover Photo: Real Food Farm's Perlman Place Site in Baltimore, MD.
Photo Credit: Civic Works' Real Food Farm

Table of Contents

Executive Summary

Cities are constantly increasing the amount of impervious surfaces, such as roads, parking lots, and buildings, to meet the needs of a growing population. These surfaces do not allow rain to be absorbed into the ground resulting in high volumes of polluted water that pools or flows into storm drains. These drains empty into nearby streams and rivers and negatively impact their water quality. This is a significant problem for the Chesapeake Bay. Green infrastructure is being used as a tool to help solve these problems by restoring natural ground cover, allowing rainfall to infiltrate into the soil. This reduces runoff that would have previously flowed off of the site into storm drains. Urban agriculture is becoming an innovative green infrastructure tool because it provides many more additional benefits than traditional stormwater management alone.

Many city residents around the country suffer from food insecurity, lack outdoor spaces to enjoy, and live in areas with deteriorating vacant lots. City governments lack the tools to easily combat all of these issues; however urban agriculture is a solution that addresses all of these problems at once. Urban farms increase the nutritional health of the community by providing affordable and accessible fruits and vegetables, improve the local economy by increasing property values, and provide residents with a greenspace to care for. For these reasons, cities across the country, especially in the Chesapeake Bay watershed, should integrate urban agriculture into their planning materials and zoning codes as an allowed land use in order to mitigate stormwater runoff into their local waterway and improve their communities.

The following ten recommendations can help guide cities to increase their land use devoted to urban agricultural practices to benefit communities and clean water:

1. Provide training and education for urban farmers through accessible workshops on best stormwater management practices.
2. Identify viable vacant lots to be converted for the purpose of urban agriculture.
3. Eliminate the barriers to purchasing or obtaining a long term lease of a vacant lot.
4. Offer farmers access to funding opportunities for the incorporation of green infrastructure.
5. Allow a tax credit for farms that include green infrastructure into their farm design.
6. Include urban agriculture as a permitted use in city zoning code.
7. List stormwater management as a benefit or definition of urban agriculture in planning materials and zoning codes.
8. Require urban farms to develop a stormwater management plan if they increase the amount of impervious surface on the lot.
9. Require soil tests and a nutrient management plan if using soil amendment.
10. Continue communication with the farms to ensure they are compliant with the city's urban agriculture ordinance.

Introduction

What if there was a way to diminish stormwater runoff as well as provide access to healthy food in low income urban areas? What if this practice was being done in cities across the nation? Would you include this practice in your city's planning materials?

Farms are not just for rural areas. The practice of growing food plants is a growing trend in inner-city neighborhoods across the country and is being used to provide healthy food to city residents and reduce stormwater runoff. Using urban agriculture as a green stormwater infrastructure practice can greatly reduce the amount of nutrients that flow into the Chesapeake Bay. This paper examines how urban agriculture can contribute to stormwater management, including case studies and recommendations to help cities in the Chesapeake Bay watershed integrate urban agriculture practices with their stormwater management planning.

Green infrastructure is a water management system or practice that uses natural processes to infiltrate or evapotranspirate stormwater runoff on the site where the runoff is generated. Urban agriculture can be used as a green infrastructure tool because it creates a pervious surface where an impervious surface once was and plants have a propensity to soak up rainwater. In addition, urban farming provides multiple community benefits thereby making urban agriculture a popular green infrastructure practice for cities across the country to consider incorporating into their plans.

Civic Work's Real Food Farm | PHOTO: **Jenny Hughes**

A Nutrient Problem in the Chesapeake Bay

The Chesapeake Bay watershed covers 64,000 miles across Delaware, Washington D.C., Pennsylvania, Maryland, West Virginia, Virginia, and New York.[1] The watershed is home to 150 major rivers and streams as well as 11,684 miles of shoreline.[2] Any precipitation that falls within this expansive watershed ultimately makes its way into the Chesapeake Bay. Land use is an important factor in the way precipitation impacts rivers, lakes, streams, and the Bay. Precipitation in urban areas picks up pollutants such as heavy metals, oil, and grease as it flows across impervious surfaces such as streets, parking lots, and roofs. Runoff in urban areas either flows untreated directly into local waterbodies or into storm drains. If a municipality has a combined sewer system for sewage and stormwater the runoff can cause an overflow of the system resulting in untreated sewage and stormwater being directly discharged into a waterway.

Polluted runoff is a major source of water pollution in the Chesapeake Bay.[3] Within the Chesapeake Bay watershed, polluted runoff from urban and suburban areas impairs 1,570 miles of streams and contributes an estimated 16% of sediment, 15% of phosphorous, and 8% of nitrogen loads to the Bay.[4] Increased development and urbanization, combined with expensive water infrastructure updates, have communities across the country starting to incorporate innovative approaches to manage stormwater runoff,[5] such as urban agriculture, which in turn will protect clean water and public health.

The Clean Water Act's Regulation of Nutrients

The Clean Water Act (CWA) requires the regulation of stormwater runoff through the National Pollutant Discharge Elimination System, a permitting program that controls discharges into waterways. The CWA distinguishes between "point-source" discharges of stormwater that are conveyed through pipes or ditches and discharged into local water, and "non-point source" discharges, runoff that flows freely over land and streets into local waters.[6]

Under section 303(d) of the CWA, every two years states must list waters that fail to meet state water quality standards.[7] From these 303(d) lists, states must then develop Total Maximum Daily Load (TMDL) allocations. TMDLs are essentially pollution caps that have an accompanying restoration plan for waters identified as impaired.[8] The EPA has found that stormwater, a non-point source, is a significant conveyer nationally of five of the most common pollutants that impair waters on the 303(d) lists.[9] Communities within the Chesapeake Bay watershed are subject to the Chesapeake Bay TMDL allocations.

The Chesapeake Bay TMDL sets pollution limits for nitrogen, phosphorous, and sediment loads from both point and non-point sources that are significantly impairing the Bay.[10] The ultimate goal of the Chesapeake Bay TMDL is to achieve 60% of the reductions needed to restore the Bay by 2017 and all of the reductions by 2025.[11] The TMDL process is a critical driver in the Chesapeake Bay watershed for addressing urban stormwater runoff and the implementation of cost-effective solutions that protect clean water and provide multiple benefits to communities.

Urban Agriculture

Neighborhoods in many cities are grappling with the problem of vacant lots that are unused and often overrun with vegetation and trash. The City of Baltimore alone has approximately 17,000 vacant lots.[12] To address this underutilized real estate, cities have started renting the vacant lots to groups for greening projects. Greenspace helps to reduce stormwater runoff by allowing the water to soak into the ground rather than flow into nearby streams and rivers. Recently, urban farms have become a popular way to add more green to cityscapes.

Urban agriculture can play a substantial role in helping cities across the country meet their stormwater management goals by reducing impervious surfaces that create stormwater runoff. It can also be used to improve the local economy, increase nutritional health, and connect communities to their local environment.[13]

Improves Local Economy

By transforming vacant land into farms, urban agriculture can be a powerful tool to help combat a struggling economy. Vacant lots are usually unmaintained spaces and therefore, provide minimal value to the city and surrounding neighborhood. The creation of a farm on those lots turns this unused and unattractive land into a productive greenspace. This in turn increases the value of the lot.[14] Studies have shown that surrounding property values also increase with when greenspace is added.[15] In addition to increasing property values, urban farms can reduce the amount of money families spend buying healthy food options due to the presence of fresh and affordable produce close by.[16] A study done in Vermont found that when comparing grocery store to farmers' market prices, buying organically at a farmers' market results in a lesser cost.[17] Shopping for affordable food close to home makes it easier for families to improve their nutritional health.

Increases Nutritional Health

According to the USDA, in 2013 about 49.1 million people lived in a household without access to nutritious food.[18] Many inner city residents around the country live in food deserts, neighborhoods that lack access to healthy and affordable food.[19] Grocery stores with healthy food options can be expensive and inaccessible to inner city residents because they are too far away. This leaves residents with few options to purchase fresh fruits and vegetables, so they often resort to eating

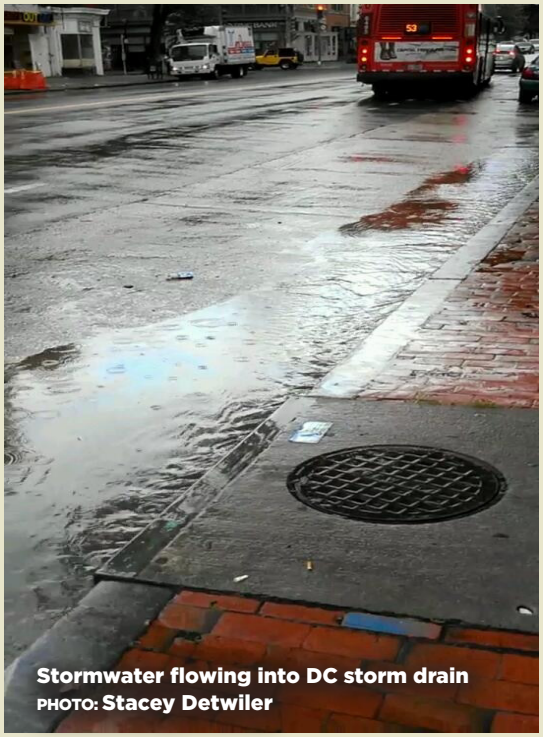
at fast food restaurants or shopping at local convenience stores with few healthy choices.[20] For example, Baltimore City lost 15% of its supermarkets between 2000 and 2002, leaving corner stores as the only option.[21] According to Johns Hopkins Center to Eliminate Cardiovascular Health Disparities, these corner stores raise the prices of food essentials 20% higher than supermarkets. Urban farms offer easy access to fruits and vegetables at a reasonable price, which can increase a population's vitamin intake and improves food security. [22]

Connects Communities to Their Environment

Inner city residents often do not have access to greenspace they can use for congregating or recreating. A neighborhood farm allows for more community engagement, collaboration, and social activities, giving people a reason to step outside of their homes. When city residents use their neighborhood greenspace, more people keep an eye on their surroundings, which can in turn lead to a reduction in the number of criminal incidents.[23] When individuals profit from the many benefits of a productive farm, they start to take an interest in the farm and help to care for it which promotes a sense of responsibility for their environment. [24]

Urban Agriculture as a Green Infrastructure Tool for Stormwater Management

Urban farms can decrease the amount of polluted stormwater that would otherwise flow to an already overwhelmed storm drain by increasing the amount of water that the land can soak up. Water infiltration is important in cities because it reduces the volume of stormwater flow and helps to filter the pollutants before they reach nearby streams and rivers. Farms located in heavily impervious areas where stormwater runoff is an issue should have a stormwater management plan incorporated into their design. Municipalities should consider the following urban agriculture policies and practices to complement stormwater programs and benefit both the farms and the city.



Stormwater flowing into DC storm drain
PHOTO: **Stacey Detwiler**

Soil Quality

Traditional farming techniques typically have negative impacts on water quality — by contributing excessive pollutants to stormwater (including fertilizers and manure). However, creating an urban farm in a city's vacant lots can actually reduce the amount of polluted stormwater runoff, thus improving water quality. Typically vacant lots are made up of poor quality soils that are compacted and provide little, if any infiltration. The soil of vacant lots is often contaminated with heavy metals and unsuitable for the growth of food plants.[25] Urban agriculture transforms these once hard and barren lots with compost and tilling to allow for safe plant growth and increased stormwater absorption.[26] Proper tillage will loosen up the soil allowing more water to infiltrate which nourishes plants and decreases runoff. After loosening the soil, compost can be added to naturally increase the nutrient content of the soil. A study done in the Twin Cities of Minnesota found that a combination of tilling and the addition of compost allowed for three to six times higher infiltration rates than an untreated plot.[27]

Research conducted at the University of Washington concluded that the addition of compost not only nearly doubled infiltration rates; it also lowered the amount of phosphorous runoff.[28] However, excessive compost can lead to high levels of nitrogen, phosphorous, and other nutrients in stormwater runoff.[29] Nutrients that are not utilized by plants will runoff in stormwater affecting the water quality of nearby streams and rivers. Excessive nutrients are a problem for streams and rivers because they can increase the amount of algae which can cause low oxygen levels in the water which will negatively impact aquatic species. Soil testing should be conducted before nutrients are added to soil, so that the nutrient content can be determined and the minimum amount of compost to support healthy crops can be applied.[30] Tilling and using cover crops will help to stabilize the compost, preventing it from being washed into storm drains.

Erosion

Soil on urban farms needs to be secured and kept away from adjacent impervious surfaces in order to prevent it from contaminating stormwater runoff. There are several common practices that can be used in urban agriculture to reduce soil loss leading to excess nutrients in storm-water. Urban farms are constantly planting and growing crops, but when a plot of land is not currently in use, planting cover crops can reduce erosion and improve soil quality.[31] Mulching is another technique used to hold soil in place. It can also hold in rainwater, which decreases the need to irrigate crops by keeping the soil moist for longer periods of time.[32] Care should be taken to use mulch that does not float, so that it is not carried away by stormwater. The creation of a berm (mound of soil) along edges where the impervious surface and farm meet is another useful way to prevent erosion.

Water

In an urban setting, providing water sufficient for growing food can put a strain on an already stressed water system. Instead of relying on the city to provide water access for a fee, urban farms can install cisterns to capture rainwater to use for watering plants. This technique reduces the amount of stormwater flowing to storm drains, saves money, and conserves the city's freshwater reserve. Water falling directly on the farm-site is generally fine; however there are safety concerns about using water running off from rooftops or parking lots to hydrate edible plants. According to North Carolina State University, it is recommended that any water collected from a roof be treated before utilizing for potable uses. This is because rooftop runoff has been known to contain excessive amounts of fecal coliforms, aluminum, lead, and zinc.[33] Similar precautions should be taken with water collected from roads. There are examples where water passing through permeable pavers has been reused for irrigation, as permeable pavers provide some filtration. However, there are many variables to consider and local experts should be consulted before utilizing this type of water for crop irrigation.

Hoop Houses

A hoop house is an arched structure covered with polyethylene film that provides cover and temperature control for crops.[34] These structures allow farmers to extend their production season, which is beneficial for urban areas that are in short supply of fresh food.[35] Hoop houses also divert rainwater from falling onto the crops, which prevents nutrient rich stormwater runoff from the raised beds inside. However, hoop houses can reduce up to 90% of a field's pervious surface, which will increase runoff.[36] By installing a rainwater re-use system, water can be captured and filtered into an underground tank for later crop irrigation use. The amount of water collected can sustain plants in the hoop house for up to a few weeks.[37] Planting cover crops along the base of a hoop house is a great way to absorb runoff through ground infiltration.[38] Farmers should keep stormwater in mind if installing hoop houses in order to better irrigate their crops as well as improve water quality in the surrounding watershed.

Location

Determining the location of green infrastructure as urban agriculture can be difficult, due to the space limitations of the urban environment. Four site characteristics should be considered when locating urban agriculture: viewshed, visibility, access, and proximity. Simply put, an urban garden should provide an aesthetic improvement, be visible to the community, be easily accessible, and be close to the community. One of the advantages green stormwater infrastructure has over traditional infrastructure is that it is more visually appealing and can act as a community enhancement.[39] Urban agriculture increases the community benefits of green infrastructure while reducing stormwater pollution. But the process of food production for urban agriculture means that it has additional siting requirements such as the need for constant access for maintenance during the growing season. However, the evolution of gateway gardens into stormwater management space provides some insight into finding appropriate locations for urban agriculture.

The community gateway garden concept began as a means of improving the aesthetics of transportation gateways into communities. The Western Pennsylvania Conservancy started a program in the 1990's utilizing a large volunteer base to plant colorful gardens at high-traffic entry points.[40] Today more than 135 gardens maintained with corporate sponsorship in and around Pittsburgh receive five million views daily.[41]

In Virginia, architect Proctor Harvey developed the Lynchburg Expressway Appearance Fund (LEAF) to encourage local business investment in community beautification at gateway sites for Lynchburg. One significant hurdle to the success of the LEAF program was meeting highway department requirements for site access for planting and maintenance, and finding room for corporate sponsorship signage in the garden.[42] In response, Mr. Harvey and his architecture firm, Harvey Design Land

Architects (HDLA), worked with Virginia's highway administration to amend code[43] and create a statewide program, Stormwater Alternatives through Green Infrastructure (SAGE) in 2005.[44]

Since then, HDLA partnered with the University of Maryland's Environmental Finance Center (EFC) and Hampton, Virginia to demonstrate the capacity gateway gardens have when developed as raingardens: they help urban municipalities meet stormwater control requirements and also serve as a community amenity and drive local business support.[45] The demonstration succeeded because the added stormwater function created additional benefits without adding considerable complication. The runoff retention and filtration function of the raingardens required slightly different site characteristics but the highway proximity provided ample stormwater to manage and the long-term maintenance needs of the raingardens were typical of roadside beautification gardens.

Attempting to create additional benefits through urban agriculture at gateway gardens adds challenges green infrastructure typically doesn't have. The first challenge is the lack of aesthetic appeal year-round of urban agriculture sites, especially in seasonal climates. One solution to unaesthetic fallow fields is a combination of border and/or cover crops with year-round beauty and stormwater management capacity, such as vegetated berms, and use of hoop houses away from the public view but adjacent or sufficiently close to the gateway site to maintain continuity of the overall function of the site. The cautions described in the prior section concerning the imperviousness of hoop houses would need to be accounted for and the location's area would need to be large enough to include the bordering berm or other vegetation to offset the hoop house itself and its impact. The second challenge is need for considerable access to maintain and operate agricultural production. Solutions to the need for access at gateway sites would require case by case consideration but likely require liberal interpretation of a community gateway to include sites within communities that receive high public traffic yet are bordered by parking areas such as school yards or parks.

The critical siting lesson to be learned from the gateway garden concept is to be innovative with limited space. An example of this is the use of green living walls as vertical farms. These increasingly popular vertical vegetated features can be thought of as extreme sloped green roofs—they provide similar stormwater management benefits as green roofs but they are typically placed on the side of buildings instead of on rooftops. Vertical farms range in scale within urban environments and include units that can be mobile to occupy pop-up space.[46] As urban agriculture they are a strong community asset, able to reach urban cores and challenging neighborhoods such as Skid Row in Los Angeles.[47] Edible green living walls may be the easier solution to the access and aesthetic locational challenges of urban agriculture at gateway or other high visibility urban locations.

Urban Agriculture in the City of Baltimore, Maryland

Baltimore City is one of many cities around the US supporting urban agriculture. The City provides a unique case study in the use of urban agriculture as a water quality practice due to the City's location in the heavily regulated Chesapeake Bay watershed, and that it has more paved surfaces than anywhere else in Maryland.[48] Many efforts are ongoing to try to reduce the impact Baltimore's polluted stormwater runoff has on the Chesapeake Bay, including planting farms on the City's vacant lots. Baltimore's initiatives are strong examples of how urban agriculture, when used as a green stormwater infrastructure tool, can produce significant benefits.

Farms

Baltimore City's Farm Alliance is a network of 13 farms located across the city that work together to increase the amount of food options available to Baltimore's residents.[49] All of the farms' produce is available for an affordable price to the surrounding communities through Community Supported Agriculture Programs (CSA's), roadside stands and farmers markets, benefiting both the local economy and the residents. There are a series of requirements a farm must comply with in order to become a member of the alliance, including supporting the alliance's mission, meeting minimum production requirements, and completing either formal or informal training to prepare farm managers to operate a successful farm.[50] In addition, there are member standards each farm must uphold, which include following organic growing practices, submitting annual soil tests, and creating farm food safety plans. Resources are available through their website that provides easy access to city laws and regulations pertaining to urban agriculture for those interested in starting an urban farm. In addition, the Alliance offers trainings and workshops that educate farmers, gardeners and advocates on topics such as urban soils, marketing, nutrition and cooking, and community engagement. The Farm Alliance collaborates with many state, local, non-profit and government partners to provide fresh fruits and vegetables to the neighborhoods of Baltimore City while increasing the profitability of urban growers.

A prime example of integrating stormwater practices into urban farming is Real Food Farm. Real Food Farm is a member of the Farm Alliance that works to provide just and sustainable food by fulfilling four goals: improve neighborhood access to healthy food, develop Baltimore's vibrant agriculture sector, provide hands on education opportunities to the city's youth, and protect the environment and improve the watershed.[51] In addition to producing fresh food, Real Food Farm has included green infrastructure practices in their plans to reduce the stormwater runoff that flows from their site into the Harris Creek watershed. In 2011, the Chesapeake Bay Trust awarded Civic Works, a non-profit that works to strengthen Baltimore's communities,[52] with a grant to install a water re-use project that collects stormwater runoff from Real Food Farm's hoop houses and stores it in an underground cistern where it can be kept until needed for crop irrigation.[53] The farm has also incorporated a retention pond, a bioswale, and several berms to help limit stormwater runoff. Furthermore, Real Food Farm conducts soil tests and monitors the amount of compost they administer in order to lessen the chance of nutrient runoff from their crops.

Real Food Farm's Perlman Place Site
PHOTO: **Civic Works' Real Food Farm**

Real Food Farm's on site swale
PHOTO: **Jenny Hughes**

Real Food Farm's Water Re-Use System | PHOTO: Jenny Hughes

"The Farm Alliance looks forward to offering its members additional opportunities for training and professional development towards the goal of exemplifying best practices in environmental stewardship, including but not limited to nutrient management and stormwater management." ***— Allison Marshall, Farm Alliance***

The City of Baltimore's Advancement of Urban Agriculture Through Policy

There are several programs and ordinances that apply to urban agriculture and stormwater management in the City of Baltimore. Some of these are City initiatives and some are state. Urban agriculture is a fairly new practice and Baltimore is still in the process of regulating it as well as promoting it as a stormwater reduction method.

Sustainability Plan

The City of Baltimore has a Sustainability Plan that lays out an agenda for the City to follow in order to meet the communities' needs today and allow future residents to develop agendas for their needs. There are 7 sections to Baltimore's Sustainability plan, 29 goals, and 131 strategies that will help Baltimore become more sustainable.[54] The fourth section of the plan is entitled "Greening".[55] The purpose of this section is to take full advantage of ecosystems services and natural amenities to provide, "habitat, shade, water and air purification, food, and recreational opportunities…."[56] One of the goals of the Greening program is to establish the City of Baltimore as a leader in sustainable, local food systems. Baltimore recognizes that food systems have an impact on "public health, quality of life, environmental stewardship, and greenhouse gas emissions."[57] Baltimore has developed six strategies to help meet their goal, including a plan to "increase the percentage of land under cultivation for agricultural purposes."[58] This strategy includes modifying the zoning regulations to accommodate urban agriculture and increasing the number of farms on vacant lots and other public spaces.[59] Another great strategy that the Plan provides is to "develop an urban agriculture plan."[60] The plan will help to identify where new urban farms should be located in order to best serve the community.[61]

Land Acquisition

Baltimore's Sustainability Plan, includes a land leasing initiative through Homegrown Baltimore, a program developed by Baltimore's Department of Planning and the Department of Housing and Community Development.[62] This program leases land to farmers who have at least a year of agricultural production experience.[63] The lease is for a vacant City-owned lot for five years with an option to renew at the end of the five-year term.[64]

The City of Baltimore also has the Power in Dirt Program, which allows community associations to adopt Baltimore City-

owned vacant lots to be used as community open spaces.[65] The permissible uses for the vacant lots are for community gardens and farms, green spaces, and parks.[66] The City and the community association are bound by a license agreement, which is renewable.[67] The license can be revoked with 30 days notice.[68] However, the City does have discretion to let the licensee finish its growing season but is under no obligation to do so.[69] Once the group has been using the land for five years, there is the possibility that they could apply to become part of a private land trust which would permanently protect the open space.[70]

Owning the lot or having access to long-term licensing and leasing programs can be very beneficial to farmers and nearby streams and rivers. The ability to own or have a longer term contract to use a lot for farming provides more incentive for farmers to invest in their farm and in stormwater practices. It can also help attract other funders to invest in the farm. Most funders do not want to invest in a temporary project, they would rather their money go to a more permanent community endeavor. The City of Baltimore recognizes the benefits to owning your own farm and is incentivizing it by implementing a 90% tax credit on the land if farmers grow and sell at least $5000 of produce.[71]

Zoning

Because the idea of farming in urban settings is fairly new, some zoning codes do not allow for it. Currently the City of Baltimore's zoning code does not recognize urban agriculture as a permitted use; it is categorized as a temporary use.[72] However, the City of Baltimore's zoning code is undergoing changes and under the new code urban agriculture will be a conditional use in most districts of Baltimore.[73] A conditional use is an exception granted by the Zoning Board that may contain conditions and restrictions.[74] When considering an application for a conditional use permit, the Board will assess the impact the use will have on the public. The City has a right to place conditions on a conditional use permit such as hours of operation, setbacks, and types of activities.[75] The Office of Sustainability is reporting that under the new zoning code there are conditional uses for soil on urban farms.[76] Urban farms that use any sort of fertilizer must submit a soil management plan for approval.[77] Also, soil must be tested prior to planting food that will be used for human consumption or clean soil must be imported.[78] By requiring a soil management plan, the City is taking steps to ensure the growth of safe food as well preventing excess nutrients from running off with stormwater.

Regulating Stormwater

The City of Baltimore has an ordinance that requires a stormwater management plan to control or manage runoff if there is a disturbance of 5,000 square feet or more.[79] In order to successfully obtain a permit, the potential permitee must submit a stormwater management plan as well as erosion and sediment control plans.[80] However, agriculture is exempt from stormwater management and erosion and sediment control.[81] Also, if covering a pervious surface, such as installing a hoop house, there may be additional requirements.[82] If an urban farm is exempt from implementing a stormwater management plan then the farm will have to do a soil conservation and water quality plan instead. Urban farms in Baltimore are currently working with City officials and representatives from Baltimore County Conservation District to develop these practices.[83]

The State of Maryland requires a nutrient management plan for farms that gross more than $2,500 per year in order to account for the fertilization of crops.[84] A nutrient management plan must specify how much fertilizer, manure, or other nutrient sources may be safely applied to crops in order to achieve maximum yield yet prevent excess nutrient runoff.[85] This is so nitrogen and phosphorus inputs can be monitored. To date no farms in Baltimore City have submitted a nutrient management plan, however as the practice urban farming grows this will be an important law to enforce in order to help the Chesapeake Bay reduce its nutrient load from stormwater runoff.[86]

Urban Agriculture in Smaller Chesapeake Bay Cities

The development of urban agriculture policy has naturally occurred in larger cities instead of smaller cities because there is a greater likelihood for food deserts, challenges transporting fresh food, more impervious land cover, and less room for private backyard gardens resulting in a greater opportunity to use vacant or public land. Recent reports identifying cities leading the urban agriculture movement consistently identify large cities and omit small cities with rare exceptions.[87]

Globally, two-thirds of total urban area is comprised of small to medium sized cities so promoters of urban agriculture advocate a shift in attention to smaller cities to reach a larger number of urban dwellers and because smaller cities with less density should be able to produce agriculture in greater volume or with more ease.[88] In the Chesapeake Bay watershed, urban agricultural promoters have highlighted large cities, such as Baltimore and Washington, DC, but urban agriculture is also a topic of discussion, and even beginning to show within city codes and ordinances, in some smaller Chesapeake Bay cities where increasing attention is given to greener stormwater management approaches to benefit communities and clean the Bay.

Petersburg, VA— James River Watershed

Petersburg, Virginia created an urban agriculture education objective for its Park planning in the city's 2011 comprehensive plan[89] In addition, state legislator Delores McQuinn initiated a legislature commissioned report on food deserts in Virginia.[90] The result for the underserved city of Petersburg was a three-year U.S. Department of Agriculture grant to transform vacant indoor space into a large community garden, effectively transforming unproductive impervious cover into highly productive yet equally impervious area, with the exception of some outdoor border space devoted to raised garden beds. [91]

Harrisonburg, VA— Shenandoah River watershed

In 2014, two entrepreneurial James Madison University students sought to amend the zoning code in the city of Harrisonburg, VA to accommodate commercial urban agriculture. City staff felt urban agriculture was consistent with City values and so they helped shepherd a zoning code amendment through City Council. Unfortunately, the students' venture, Collicello Gardens, failed due

to their lack of business experience, but a commercial urban agricultural zoning amendment did pass, laying groundwork for Harrisonburg's next urban farm.[92] Specifically, the Central Business District Home Occupation-Uses Permitted by Right section of code was amended to allow what the City called "Business Gardens."[93] Criteria for Business Gardens had some consistency with stormwater management such as defining a balance between building and agricultural coverage on the site, but was mostly focused on business operation such as requiring transactions to occur off-site.

Binghamton, NY—headwaters Susquehanna River watershed

Urban agriculture has been a growing practice in this headwaters city since 2007. The City has urban farm sites manned by volunteers including a youth core and with product distribution through a Community Supported Agriculture (CSA) model. Urban agriculture activity is orchestrated through a non-profit venture called Volunteers Improving Neighborhood Environments (VINES) that works with support from the city, local businesses, state and regional foundations, local civic organizations, and a strong volunteer base.[94]

Because VINES accelerated interest in urban agriculture, in 2013 the City proposed zoning updates to accommodate land use devoted to food production within the city. Unlike Harrisonburg's code change that focused on Business Gardens, Binghamton's proposal addressed farmer's markets, composting, community gardens and poultry, rabbits and bees. Unlike Harrisonburg, Binghamton had several years to identify zoning needs that shaped this comprehensive approach. The City's broad approach became the stumbling block to passage of the zoning code proposal. The draft failed because of concerns about bee-keeping and the potential for larger livestock such as goats[95] missing the opportunity to advance agricultural activity that would contribute to water management objectives of the City.

What the proposal did accomplish was greater clarity defining urban agriculture and what the scope of activities could mean for the city: requirements of 'community gardens' where products are intended to be consumed by the gardener included soil testing and limits on livestock, fertilizers and mechanization; requirements for 'market gardens' where products are sold required a new land use category to permit business transactions and a new category for 'Minor Farmers' Markets' for up to five vendors within residential neighborhoods. Rooftop gardens required a building permit to insure structural capacity but these were categorized as acceptable accessory uses that also reduced energy consumption and captured rainwater.[96]

Future attempts to amend city code to accommodate urban agriculture may focus more on the services agricultural

PHOTO: **Binghamton VINES Urban Farm 2011**

production can provide that is complementary or consistent to stormwater management to help ensure passage. A large part of downtown Binghamton is designated by the Federal Emergency Management Agency (FEMA) as a flood zone and VINES is already looking at coupling food production goals with sound flood reduction goals such as developing 'edible food forests' to provide energy and aesthetic benefits to communities, soils stability, and retention of runoff in addition to harvestable food. Further the City is actively engaging citizens in its comprehensive plan, Blueprint Binghamton. The associated Action Plan[97] includes greening and green infrastructure in its flood management, stormwater management, water conservation, and tree cover modules. Urban agriculture is promoted in the Action Plan to support community health and as an interim land use prior to redevelopment without cross-referencing any water management sections.

Lancaster and York, PA—lower Susquehanna River watershed

Lancaster and York, Pennsylvania are located in an area with a strong agricultural history that supported the cities' development. Although the City of Lancaster houses the oldest continuously operating

farmer's market in the country and the City of York prides itself on its own farmer's market, each city's footprint is less agricultural than in decades or centuries past. The timing is right for these small cities to initiate blending urban agriculture into urban infrastructure and its associated planning, operation and maintenance for the benefit of the community and clean water.

In 2015 the City of Lancaster took a first step toward aligning urban agriculture with stormwater management regulation by adding clarification to planning for earth disturbance activities within its stormwater ordinance. The change is a response to a growing Latino demographic with an inherent interest in fresh farm products that are not produced locally, and the city's progressive 'greening' to address stormwater and wastewater management.[98] The ordinance change exempts city gardens from requirements to submit stormwater management plans so long as the agricultural area does not increase impervious coverage and the site meets other stormwater management criteria. The code change protects the City's stormwater planning objectives and permits flexibility of the community to develop agriculture within the city.

If community interest warrants, Lancaster may consider edible food forests, as Binghamton has. The city recognizes the benefit of urban and riparian trees[99] and identifies within the city code "the urban forest as a necessary part of the City's infrastructure."[100]

Across the Susquehanna River from Lancaster, the City of York is poised to advance urban agriculture and incorporate practices into planning and codes.[101] Community gardens have been developed in York, including Hope Street Garden and Learning Labs Initiate begun in 2012 to create a healthier York through youth engagement.[102] And in 2015, conditional approval was given to redevelop a brownfield site to benefit a local food bank.[103]

Food scarcity and food deserts are not the driving factor for the adoption of urban agriculture in these smaller Chesapeake Bay watershed cities — it is increasing community interest. Due to this growing interest, combined with a need to improve stormwater management to protect the Bay, the timing is right to introduce the concept of urban agriculture as stormwater management. While urban agriculture may not be *necessary* to city infrastructure, it can be complementary and is an increasingly important community service.

Small cities in the Chesapeake Bay watershed are demonstrating an interest in urban agriculture — for urban revitalization, sustainability, or creating a sense of community. Further, these smaller cities illustrate the value of proactively developing codes and ordinances to direct urban agricultural practices in ways that are compatible with community interests and city obligations.

What Other Cities Across the Country Are Doing

Cities across the country are incorporating urban agriculture into their planning and zoning codes as a permitted activity. It is important that a city addresses urban agriculture in their codes and ordinances as a permitted green infrastructure tool that can be used to meet stormwater goals and provide low income residents with access to affordable, fresh, and healthy food. Below are examples of cities that are supportive of urban agriculture as a storm water management tool.

Washington, DC

DC Greenworks is a non-profit organization that promotes the environmental health of DC and the Chesapeake watershed.[104] With the financial help of the District Department of the Environment and other grant opportunities, DC Greenworks has installed more than 70 green roofs across the city. In May 2010, DC Greenworks helped Bread for the City, an organization that provides food, clothing, medical help, legal and social

Bread for the City's Green Roof
PHOTO: **Bread for the City**

services to low income residents of DC, transform their green roof into DC's largest urban rooftop farm, growing a variety of vegetables and herbs in 30 raised beds.[105] The farm has also installed rain barrels to capture rainwater for crop irrigation. Bread for the City's rooftop farm has captured 54,000 gallons of stormwater since May 2010.[106] By capturing this stormwater, Bread for the City is able to reduce the amount of runoff going into storm drains leading to the Potomac River as well as irrigate their farm which grows healthy food for inner-city residents. This is an example of another farm that is actively engaged in improving the water quality of the local streams and rivers that flow to the Chesapeake Bay.

New York City, New York

The New York City Department of Environmental Protection (DEP) hosts a grant program that is available to private property owners undertaking projects that will locally manage one inch of storm-water runoff in combined sewer areas.[107] In June of 2011, fifteen projects were awarded $3.8 million in grants to support green infrastructure.[108] According to the NYC DEP Public Affairs' press release, one of the grant winners was a 40,000 square foot commercial rooftop farm at Brooklyn Navy Yard. In partnership with Brooklyn Grange, the rooftop farm will collect over one million gallons of stormwater a year. This initiative will not only improve the water quality of the surrounding rivers, it will also create new jobs, educate residents, and provide fresh food for neighboring communities. The project is a great example of a financial incentive program prioritizing green infrastructure, meeting stormwater management performance standards, and promoting urban agriculture.

Boston, Massachusetts

In December of 2013, the City of Boston passed Article 89, which addresses urban agriculture as a permitted use within the city.[109] To create this new zoning code, the Boston Redevelopment Authority (BRA) worked with the Mayor's Office of Food Initiatives and the Mayor's Urban Agriculture Working Group to gather public input by holding 18 open public meetings and 11 neighborhood meetings.[110] Article 89 Made Easy, an informational guide, provides Boston residents an understandable way to navigate the policies on starting an urban farm.[111] According to Article 89, farming on ground-level land that occupies less than one acre is allowed in all of the city's zoning districts, however permits may be required dependent on size and location. A farm that exceeds 10,000 square feet will require a Comprehensive Farm Review (CFR), an administrative review completed by BRA staff members. In order to com-plete the CFR process, a farm must submit a sketch of the farm's layout, including any structures and signage. In addition, a farm must submit proposed plans for irrigation and controls for stormwater runoff as required by the Boston Water and Sewer Commission. Article 89 Made

Easy provides best practices to avoid soil contamination and requires soil testing if bringing in new soil. If compost is used, it may only occupy up to 7.5% of a ground-level farm's property. The creation of this urban agriculture code allows farmers to identify and address the barriers to urban farming as well as assure compliance with the city's water management policies.

Seattle, Washington

Seattle passed a new municipal code for urban farms and community gardens in August of 2010.[112] The code supports and expands opportunities for urban agriculture in the city. According to the revised code, if a residential farm exceeds 4,000 square feet, a management plan should be submitted to obtain an administrative conditional use permit. This plan must include a site plan, explanation of equipment use, disclosure of chemical or pesticide use, disclosure of disturbance involving 750 square feet or more of land, and a proposed sediment and erosion control plan. To approve a farm, potential impacts and mitigation are considered. Specifically, how the farm's proposed sediment and erosion control measures will affect the impacts of irrigation runoff on the surrounding watershed is considered. In addition to the code, the City of Seattle offers urban agriculture tips to guide the permitting process.[113] This document addresses rainwater capture as a beneficial use for gardens, and encourages soil testing. King County Conservation District provides free soil nutrient testing on up to five samples, including compost. Their goal is to help farmers use soil amendments responsibly, which prevents water pollution.

Recommendations

Based on the above discussion of urban agriculture as a tool for green infrastructure, we offer the following ten recommendations that city officials in the Chesapeake Bay watershed should consider:

1) **Provide training and education for urban farmers through accessible workshops on best stormwater management practices.** Farmers may be unaware of the benefits of incorporating stormwater management practices into their farm design. Workshops or guides explaining best practices, such as using compost responsibly, capturing rainwater, and preventing erosion through the use of cover crops and berms, will help cities meet their stormwater management goals.

2) **Identify viable vacant lots to be converted for the purpose of urban agriculture.** Cities can determine which sites contain relatively healthy soil for agricultural practices and work with urban farmers to create site plans to meet the city's requirements, reduce runoff, and grow sustainable crops.

3) **Eliminate the barriers to purchasing or obtaining a long term lease of a vacant lot.** Allowing farms to make long term commitments will incentivize farmers and potential funders to invest in stormwater infrastructure. This will provide long term benefits to rivers and streams.

4) **Offer farmers access to funding opportunities that will support the use of green stormwater infrastructure.** Stormwater infrastructure can be expensive, preventing farmers from being able to incorporate it into their farms. To help, cities can create grant programs, offer guidance on the application process, and communicate existing funding opportunities.

5) **Provide tax credits for farms that include green infrastructure in their farm design.** Many cities offer tax credits to incentivize home owners to install rain barrels or gardens in their home to reduce stormwater runoff. Urban farms should also be encouraged to implement rainwater capture systems through this type of incentive.

6) **Include urban agriculture as a permitted use in city zoning codes.** Many cities do not address urban agriculture in their zoning codes, making it seem that it is a prohibited use of land. Listing urban agriculture as a permitted use shows the city is supportive of efforts to provide neighborhoods access to healthy food and to create pervious greenspace.

7) **List stormwater management as a benefit or definition of urban agriculture in planning materials and zoning codes.** Urban agriculture can be an effective green infrastructure practice. Identifying the stormwater management benefits of urban agriculture helps increase acceptance and adoption of urban agriculture and ensures that urban farms contribute to municipal stormwater management.

8) **Require urban farms to develop stormwater management plans if they increase the amount of impervious surface on the lot.** Placing structures on vacant lots, such as hoop houses, increases the lot's impervious surface and creates increased runoff. Some cities and farms address this problem by incorporating water re-use systems that collect runoff from structures and re-use in plant production.

9) **Require soil tests and a nutrient management plan if using soil amendments.** If nutrients are added to the soil, it is important to monitor the addition to avoid nutrient runoff into nearby streams and storm drains. Municipalities should require farms to conduct soil testing to determine the appropriate application of compost. This ensures improved filtration without causing a nutrient runoff problem.

10) **Continue communication with farm owners, managers, and staff to ensure they are compliant with the city's urban agriculture ordinance**. Creation of an urban agriculture working group enables farmers and city officials to address barriers to urban agriculture and determine new farming policies to address those barriers together.

Endnotes

[1] *Facts & Figures.* Chesapeake Bay Program. Retrieved from http://www.chesapeakebay.net/discover/bay101/facts

[2] *Facts & Figures.* Chesapeake Bay Program. Retrieved from http://www.chesapeakebay.net/discover/bay101/facts

[3] *Stormwater Runoff.* Chesapeake Bay Program. Retrieved from http://www.chesapeakebay.net/issues/issue/stormwater_runoff

[4] U.S. Environmental Protection Agency. (2010). *Chesapeake Bay Total Maximum Daily Load for Nitrogen, Phosphorous, and Sediment.* Retrieved from http://www.epa.gov/reg3wapd/pdf/pdf_chesbay/FinalBayTMDL/CBayFinalTMDLExecSumSection1through3_final.pdf

[5] U.S. Environmental Protection Agency. (2008). *Clean Watersheds Needs Survey 2008 Report to Congress.* Retrieved from http://water.epa.gov/scitech/datait/databases/cwns/upload/cwns2008rtc.pdf

[6] *What is a Nonpoint Source Pollution?* U.S. Environmental Protection Agency. Retrieved from http://water.epa.gov/polwaste/nps/whatis.cfm

[7] *Water Quality Standards and Implementation Plans.* 33 U.S.C. 1313(d). (2013). Retrieved from http://uscode.house.gov/view.xhtml?req=%28title:33%20section1313%29&f=treesort&edition=prelim&num=0&jumpTo=true section1313%29&f=treesort&edition=prelim&num=0&jumpTo=true

[8] U.S. Environmental Protection Agency. (2012). *Impaired Waters and Total Maximum Daily Loads.* Retrieved from http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/index.cfm

[9] Roseen, R. M., T. V. Janeski, M. Simpson, et. al. (March 2012). Economic and Adaptation Benefits of Low Impact Development, Conference Proceedings. Retrieved from http://www.unh.edu/unhsc/sites/unh.edu.unhsc/files/pubs_specs_info/JEE%20FTL%203-30-12.b.pdf

[10] U.S. Environmental Protection Agency. (2010). *Chesapeake Bay Total Maximum Daily Load for Nitrogen, Phosphorous, and sediment.*

[11] U.S. Environmental Protection Agency. (2010). *Chesapeake Bay Total Maximum Daily Load for Nitrogen, Phosphorous, and sediment.*

[12] *Vacant Lots.* City of Baltimore. Retrieved from https://data.baltimorecity.gov/Housing-Development/Vacant-Lots/gf6h-35ki

[13] *Brownfields.* United States Environmental Protection Agency. Retrieved from http://www.epa.gov/brownfields/urbanag/basic.htm

[14] Smit, J., J. Nasr, & A. Ratta. (2001). Benefits of Urban Agriculture. In *Urban Agriculture: Food Jobs and Sustainable Cities.* The Urban Agriculture Network, Inc. Retrieved from http://www.jacsmit.com/book/Chap07.pdf

[15] Voicu, I., & V. Been. (2008). *The Effect of Community Gardens on Neighboring Property Values.* Real Estate Economics, 36(2), 241-283. Retrieved from http://furmancenter.org/files/publications/The_Effect_of_Community_Gardens.pdf

[16] Nugent, R. The Impact of Urban Agriculture on the Household and local Economies. Retrieved from http://wentfishing.net/farmlit/Theme3.pdf

[17] Claro, J. (January 2011). V*ermont Farmers' Markets and Grocery Stores: A Price Comparison.* Northeast Organic Farming Association of Vermont. Retrieved from http://nofavt.org/sites/default/files/NOFA%20Price%20Study.pdf

[18] F*ood Security in the United States.* (2015, January 15). United States Department of Agriculture. Retrieved from http://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/key-statistics-graphics.aspx

[19] *Food Deserts.* United States Department of Agriculture, Agricultural Marketing Service. Retrieved from http://apps.ams.usda.gov/fooddeserts/fooddeserts.aspx

[20] Detwiler, S. (June 2012). *Growing Green: How Green Infrastructure Can Improve Community Livability and Public Health.* American Rivers. Retrieved from http://www.americanrivers.org/assets/pdfs/green-infrastructure-docs/growing-green-how-green-infrastructure-can-improve-community-livability.pdf

[21] *Food Access.* Johns Hopkins Center to Eliminate Cardiovascular Health Disparities. Retrieved from http://www.jhsph.edu/research/centers-and-institutes/johns-hopkins-center-to-eliminate-cardiovascular-health-disparities/about/influences_on_health/food_access.html

[22] Brown, K. H., M. Bailkey, A. Meares-Cohen, J. Nasr, J. Smit, & T. Buchanan. (February 2002). *Urban Agriculture and Community Food Security in the United States:* Farming from the City Center to the Urban Fringe. Urban Agriculture Committee of the Community Food Security Coalition. Retrieved from http://ocfoodaccess.org/wp-content/uploads/2013/08/Urban-Agriculture-Food-Security_CFSC-2002.pdf

[23] Kuo, F. E. & W. C. Sullivan. (2001) *Environment and Crime in the Inner City: Does Vegetation Reduce Crime?* Environment and Behavior, 33, 343-367. Retrieved from http://nfs.unl.edu/documents/communityforestry/KuoSullivanenvironmentandcrime.pdf

[24] Herod, M. R. *Cultivating Community: Connecting community gardens and crime prevention.* Retrieved from https://uwaterloo.ca/environment-resource-studies/sites/ca.environment-resource-studies/files/uploads/files/ThesisCultivatingCommunityMay-2012herod.pdf

[25] Sharma, K., N. Basta, & P. S. Grewal. *Heavy metal contamination in urban vacant lots and its influence on structure and function of the soil food web.* The Ohio State University Environmental Science Graduate Program. Retrieved from http://fic.osu.edu/HeavyMetal_Kuhuk.pdf

[26] Knizhnik, H. L. (August 2012). *The Environmental Benefits of Urban Agriculture on Unused, Impermeable and Semi-Permeable Spaces in Major Cities with a Focus on Philadelphia, PA.* University of Pennsylvania. Retrieved from http://repository.upenn.edu/cgi/viewcontent.cgi?article=1044&context=mes_capstones

[27] Olson, N & J. Gulliver. (2011). *Remediating Compacted Urban Soils with Tillage and Compost.* Retrieved from http://www.cura.umn.edu/sites/cura.advantagelabs.com/files/publications/Reporter-41-3&4-Gullliver.pdf

[28] Harrison, R. B., M. A. Grey, C. L. Henry, & D. Xue. (1997, May 30). *Field Test of Compost Amendment to Reduce Nutrient Runoff.* University of Washington, College of Forest Resources. Retrieved from http://depts.washington.edu/esrm311/Autumn%202014/Documents%202014%20Au/05_FIELD%20TEST%20OF%20COMPOST%20AMENDMENT%20TO%20REDUCE%20NUTRIENT%20RUNOFF_Harrison%20et%20al_1997.pdf

[29] Rosen, C. J. & P. M. Bierman. *Using Manure and Compost as Nutrient Sources for Vegetable Crops.* University of Minnesota, Department of Soil, Water, and Climate. Retrieved from http://www.extension.umn.edu/garden/fruit-vegetable/using-manure-and-compost/docs/manure-and-compost.pdf

[30] Darlington, W. *Compost—A Guide for Evaluating and Using Compost Materials as Soil Amendments.* Soil and Plant Laboratory, Inc. Retrieved from http://www.soilandplantlaboratory.com/pdf/articles/CompostAGuideForUsing.pdf

[31] Munniksma, L. 4 *Cover Crops that Do Double Duty.* Urban Farm Online. Retrieved from http://www.urbanfarmonline.com/urban-gardening/backyard-gardening/4-cover-crops-that-do-double-duty.aspx

[32] Dermitzel, D. (2011, April 13). *Healthier Rivers through Urban Agriculture. Mother Earth News.* Retrieved from http://www.motherearthnews.com/homesteading-and-livestock/healthy-rivers-urban-agriculture-zb0z11zkon.aspx

[33] DeBusk, K. M., W. F. Hunt, D. L. Osmond, Ph.D., & G. W. Cope, Ph.D. *Water Quality of Rooftop Runoff: Implications for Residential Water Harvesting Systems.* North Carolina Cooperative Extension. Retrieved from http://www.bae.ncsu.edu/stormwater/PublicationFiles/RooftopRunoff2009.pdf. Mandel, L. (2015, January 12). Ruminating on Rain Barrels. Eat Up. Retrieved from http://eatupag.com/2015/01/12/ruminating-on-rain-barrels/ explains that in order to make runoff from a roof safe to use for urban agriculture you must: determine if roofing material would result in unsafe water; add one ounce of bleach per 55 gallons of water to kill bacteria 24 hours before watering; water the soil and not the food; wash the harvested food; and clean the rain barrel frequently.

[34] *Greenhouse Types and Structures.* Retrieved from http://faculty.yc.edu/ycfaculty/ags250/week04/greenhouse_types_and_structures/Greenhouse_types_and_structures_print.html

[35] Waldman, K. B., D. S. Conner, A. D. Montri, M. W. Hamm, & J. A. Biernbaum. (December 2010). *Hoophouse Farming Startup: Economics, Efforts and Experiences from 12 Novice Hoophouse Farmers.* Michigan State University. Retrieved from http://hoophouse.msu.edu/assets/custom/files/Hoophouse%20Farming%20Startup.pdf

[36] *Hillslope Farming Runoff Management Practices Guide.* (February 2014). Resource Conservation District of Monterey County and Monterey County Agricultural Commissioner's Office. Retrieved from http://www.rcdmonterey.org/pdf/RCDMC%20Hillslope%20Guide-rvsd%202.11.14%20%28for%20web%29.pdf

[37] House, S. & L. Naeve. (January 2012). *Rainwater Catchment from a High Tunnel for Irrigation Use.* Iowa State University Extension and Outreach. Retrieved from https://www.leopold.iastate.edu/sites/default/files/pubs-and-papers/2012-01-rainwater-catchment-high-tunnel-irrigation-use.pdf

[38] *Hillslope Farming Runoff Management Practices Guide.* (February 2014). Resource Conservation District of Monterey County and Monterey County Agricultural Commissioner's Office. Retrieved from http://www.rcdmonterey.org/pdf/RCDMC%20Hillslope%20Guide-rvsd%202.11.14%20%28for%20web%29.pdf

[39] Echols, S. and Pennypacker, E., (2015). Artful Rainwater Design: Creative Ways to Manage Stormwater. Island Press.

[40] Eiler, B. & A. Bosco. (2013). *Highway Blooms: Western Pennsylvania Conservancy.* Retrieved from http://whirlmagazine.com/highway-blooms-western-pennsylvania-conservancy/

[41] Eiler, B. & A. Bosco. (2013).

[42] Proctor Harvey. Harvey Design Land Architects. Personal Communication. Lynchburg, VA. (2012).

[43] *Comprehensive Roadside Management Program 24 VAC 30-121.* Virginia Department of Transportation. Retrieved from http://townhall.virginia.gov/l/GetFile.cfm?File=C:%5CTownHall%5Cdocroot%5C78%5C1515%5C3070%5CAgencyStatement_VDOT_3070_v4.pdf

[44] *The Impact of SAGE Roadway Beautification.* (2012). Retrieved from http://go-sage.com/tag/lynchburg/

[45] Cotting, J. & B. McCloskey. (2012). *Public-Private Partnerships: An opportunity to make your dollar go further.* Presented at Financing Strategies for Green Infrastructure Programs: Solutions for York, PA.

[46] *Vertical Farms—GLT Food Factories and Mobile Edible Wall Units (MEWU).* Retrieved from http://agreenroof.com/vertical-urban-farms/

[47] Irwin, G. (2009). *Empowerment with Vertical Agriculture, Edible Walls & Urban Farming Food Chains.* Retrieved from http://www.greenroofs.com/content/green_walls005.htm

[48] *Baltimore Water Pollution Reduction Fee.* Retrieved from http://healthyharborbaltimore.org/uploads/file/Stormwater%20FAQ%20Baltimore.pdf

[49] *Farm Alliance Baltimore City.* Retrieved from http://www.farmalliancebaltimore.org/

[50] *City Laws and Resources.* Farm Alliance Baltimore City. Retrieved from http://www.farmalliancebaltimore.org/the-alliance/training/city-laws-resources/

[51] *About.* Real Food Farm. Retrieved from http://www.realfoodfarm.org/about/

[52] *About Us.* Civic Works. Retrieved from http://civicworks.com/about-us/

[53] *Model Projects.* Chesapeake Bay Trust. Retrieved from http://www.cbtrust.org/site/c.cjJVLbNOJIL6H/b.8635575/k.93F5/Model_Projects.htm

[54] Baltimore Commission on Sustainability. (2009). *Baltimore Sustainability Plan.* Retrieved from http://www.baltimoresustainability.org/sites/baltimoresustainability.org/files/Baltimore%20Sustainability%20Plan%20FINAL.pdf

[55] Baltimore Commission on Sustainability. (2009). *Baltimore Sustainability Plan.*

[56] Baltimore Commission on Sustainability. (2009). *Baltimore Sustainability Plan.*

[57] Baltimore Commission on Sustainability. (2009). *Baltimore Sustainability Plan*.

[58] Baltimore Commission on Sustainability. (2009). *Baltimore Sustainability Plan.*

[59] Baltimore Commission on Sustainability. (2009). *Baltimore Sustainability Plan.*

[60] Baltimore Commission on Sustainability. (2009). *Baltimore Sustainability Plan.*

[61] Baltimore Commission on Sustainability. (2009). *Baltimore Sustainability Plan.*

[62] Baltimore City Department of Planning and Department of Housing and Community Development. *Prequalification Application for the Homegrown Baltimore: Urban Agriculture Land Leasing Initiative.* Retrieved from http://www.baltimoresustainability.org/homegrown-baltimore-grow-local

[63] Baltimore City Department of Planning and Department of Housing and Community Development. *Prequalification Application for the Homegrown Baltimore: Urban Agriculture Land Leasing Initiative.*

[64] Baltimore City Department of Planning and Department of Housing and Community Development. *Prequalification Application for the Homegrown Baltimore: Urban Agriculture Land Leasing Initiative.*

[65] Power in Dirt. *Get Started.* Retrieved from http://www.powerindirt.com/how.html

[66] Baltimore Department of Housing and Community Development. (March 18, 2014). *Adopt A Lot License Agreement for Asset Management Project Properties.* Retrieved from http://www.powerindirt.com/download/AdoptionAgreement.pdf

[67] Baltimore Department of Housing and Community Development. (March 18, 2014). *Adopt A Lot License Agreement for Asset Management Project Properties.*

[68] Baltimore Department of Housing and Community Development. (March 18, 2014). *Adopt A Lot License Agreement for Asset Management Project Properties.*

[69] Lundberg Witt, B. (April 9, 2014). *City Laws & Land Workshop.* Retrieved from https://drive.google.com/file/d/0B26OnBlwFQgYdkxUbjJ4cXhaeTQ/view?pli=1

[70] Lundberg Witt, B. *City-Owned Land Handout.* Retrieved from https://drive.google.com/file/d/0B4XCyOCVE1uWblBFYTEyeThFRktreTduN1NaWjRNdnU1WUFJ/edit?pli=1

[71] The Maryland General Assembly passed a law enabling counties and Baltimore City to enact such a tax credit in order to encourage the use of private property for urban agriculture. Wenger, Y. *Baltimore City Council Approves Tax Credits for Urban Farms. (May 4, 2015).* Retrieved from http://www.baltimoresun.com/news/maryland/baltimore-city/bs-md-ci-urban-ag-20150504-story.html

[72] Baltimore Office of Sustainability. (2015). *Farming in Baltimore City: Regulations and Opportunities.* Retrieved from https://drive.google.com/file/d/0B26OnBlwFQgYd01GS2lwelFBZ0U/view?pli=1

[73] Baltimore Office of Sustainability. (2015). *Farming in Baltimore City: Regulations and Opportunities.*

[74] Aisenstark, A. Baltimore City Department of Legislative Reference. *Zoning Code of Baltimore City §3-103. (2015).* Retrieved from http://archive.baltimorecity.gov/portals/0/charter%20and%20Codes/code/Art%2000%20-%20Zoning.pdf

[75] Lundberg Witt, B. (April 9, 2014). *City Laws & Land Workshop.*

[76] Guillaume, J. & A. Cocke. Baltimore Office of Sustainability. Personal Communication. April 6, 2015.

[77] Lundberg Witt, B. (April 9, 2014). *City Laws & Land Workshop.*

[78] Lundberg Witt, B. (April 9, 2014). *City Laws & Land Workshop.*

[79] Aisenstark, A. (2013). Baltimore Code Article 7 Natural Resources §22-1. *Baltimore City Department of Legislative Reference.* Retrieved from http://law.resource.org/pub/us/code/md/baltimore.code.article.07.pdf

[80] Aisenstark, A. (2013). *Baltimore Code Article 7 Natural Resources §22-1.*

[81] Engineering Technologies Associates, Inc. (2003). *Baltimore City Stormwater Management Manual.* Retrieved from http://cityservices.baltimorecity.gov/dpw/generalservices/final_swm_manual.pdf

[82] Engineering Technologies Associates, Inc. (2003). *Baltimore City Stormwater Management Manual.*

[83] Guillaume, J. & A. Cocke. *Baltimore Office of Sustainability.* Personal Communication. April 6, 2015.

[84] *Agricultural Nutrient Management Program. Maryland Department of Agriculture.* Retrieved from http://mda.maryland.gov/resource_conservation/Pages/farmer_information.aspx

[85] *Agricultural Nutrient Management Program.* Maryland Department of Agriculture.

[86] Guillaume, J. & A. Cocke. Baltimore Office of Sustainability. Personal Communication. April 6, 2015.

[87] By example: Buczynski. (2013). Retrieved from http://www.care2.com/causes/the-five-best-and-worst-u-s-cities-for-urban-gardening.html & deBoer. (2012). Retrieved from http://popupcity.net/top-5-of-the-greatest-urban-rooftop-farms/ & Goldstein, M., et al (2011). *Urban Agriculture: A Sixteen City Survey of Urban Agriculture Practices Across the Country.* Turner Environmental law Clinic for Georgia Organics.

[88] Martellozzo, F., et al. (2014). *Urban Agriculture: a global analysis of the space constraint to meet urban vegetable demand.* IOP Publishing. Environmental Research Letters, DOI:10.1088/1748-9326/9/6/064025.

[89] City of Petersburg Comprehensive Plan (2011), accessed May 2015 at http://www.petersburg-va.org/DocumentCenter/View/509

[90] Grant, A. and J. Hairston (2014). Food Deserts in Virginia: Recommendations from the Food Desert task Force, available at http://pubs.ext.vt.edu/VCE/VCE-294/VCE-294.html

[91] Small, L. (2015), Petersburg works to combat the food desert program with indoor farm, accessed May 2015 at http://www.progress-index.com/article/20150426/NEWS/150429769/?Start=1&_suid=143284016684504652098581575578 3

[92] Jenner, A. (2014). *How Two Urban Farmers Inspired a Community (and Failed as a Business).* Retrieved from http://modernfarmer.com/2014/01/two-idealistic-young-urban-farmers-inspired-community-failed-business/

[93] *Ordinance Amending and Re-enacting Section Title 10 Chapter 3 of the Code of Ordinances, Article BB*. City of Harrisonburg, VA. Retrieved from http://www.harrisonburgva.gov/sites/default/files/CMO/Title%2010-Chapter%203.pdf

[94] Hughes, N. VINES. Personal Communication. May 2015.

[95] Hughes, N. VINES. Personal Communication. May 2015.

[96] City of Binghamton. (May 2013). *Community Food System Zoning Proposal Summary.* Retrieved from http://www.binghamton-ny.gov/sites/default/files/meetings/Community%20Food%20System%20Summary.pdf

[97] City of Binghamton. (2015). *Action Plan, Blueprint Binghamton.* Retrieved from http://blueprintbinghamton.com/files/2814/0751/9792/10_Action-Plan_BlueprintBinghamton.pdf

[98] Hocker, R. A. LEED. Personal Communication. City of Lancaster, PA. May 2015.

[99] U.S. Environmental Protection Agency. (2014). *The Economic Benefits of Green Infrastructure: A case study of Lancaster, PA.* Report No. EPA 800-R-14-007. Retrieved from http://water.epa.gov/infrastructure/greeninfrastructure/upload/CNT-Lancaster-Report-508.pdf

[100] *Tree Ordinance Code, section 273.1.* City of Lancaster, PA. Retrieved from http://www.cityoflancasterpa.com/tree-planting

[101] Gallup, N. City Planner, City of York, Pennsylvania. Personal communication. May 2015.

[102] Hope Street, Gardening and Learning Lab Initiative, accessed May 2015 at http://hopestreetyorkpa.weebly.com

[103] City of York, PA, Codified Ordinance, Zoning Ordinance, Section 1374.06, accessed May 2015 at http://yorkcity.org/user-files/file/City%20Council/2014-2015CODIFIEDORDINANCES/Article%201301-1379%20-%20Zoning%20Ordinance.pdf

[104] *Who We Are.* DC Greenworks. Retrieved from http://dcgreenworks.org/about-dcg/who-we-are/

[105] *About.* Bread for the City. Retrieved from http://www.breadforthecity.org/about-2/

[106] *Bread for the City.* DC Greenworks. Retrieved from http://dcgreenworks.org/bread-for-the-city/

[107] *Grant Program for Private Property Owners. NYC Environmental Protection.* Retrieved from http://www.nyc.gov/html/dep/html/stormwater/nyc_green_infrastructure_grant_program.shtml

[108] Sklerov, F. & M. Saucier. (2011, June 9). DEP *Awards $3.8 Million in Grants for Community-Based Green Infrastructure Program Projects. NYC Environmental Protection.* Retrieved from http://www.nyc.gov/html/dep/html/press_releases/11-46pr.shtml#.VUuxvyyrHSg

[109] *Article 89—Urban Agriculture. (2013, December 20).* Boston Redevelopment Authority. Retrieved from http://www.bostonredevelopmentauthority.org/getattachment/a573190c-9305-45a5-83b1-735c0801e73e

[110] *Urban Agriculture Rezoning Initiative. Boston Redevelopment Authority.* Retrieved from http://www.bostonredevelopmentauthority.org/planning/planning-initiatives/urban-agriculture-rezoning

[111] *Article 89 Made Easy: Urban Agriculture Zoning for the City of Boston. Boston Redevelopment Authority.* Retrieved from http://www.bostonredevelopmentauthority.org/getattachment/5579e854-b3c5-49e6-b910-fedaa2dd6306

[112] *Ordinance Number 123378.* (2010, August 23). Seattle Office of the City Clerk. Retrieved from http://clerk.ci.seattle.wa.us/~scripts/nph-brs.exe?s1=&s3=116907&s4=&s2=&s5=&Sect4=AND&l=20&Sect2=THESON&Sect3=PLURON&Sect5=CBORY&Sect6=HITOFF&d=ORDF&p=1&u=%2F~public%2Fcbory.htm&r=1&f=G

[113] *Tip 244—Urban Agriculture. (2010, November, 17).* Seattle Department of Planning and Development. Retrieved from http://www.seattle.gov/DPD/Publications/CAM/cam244.pdf

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