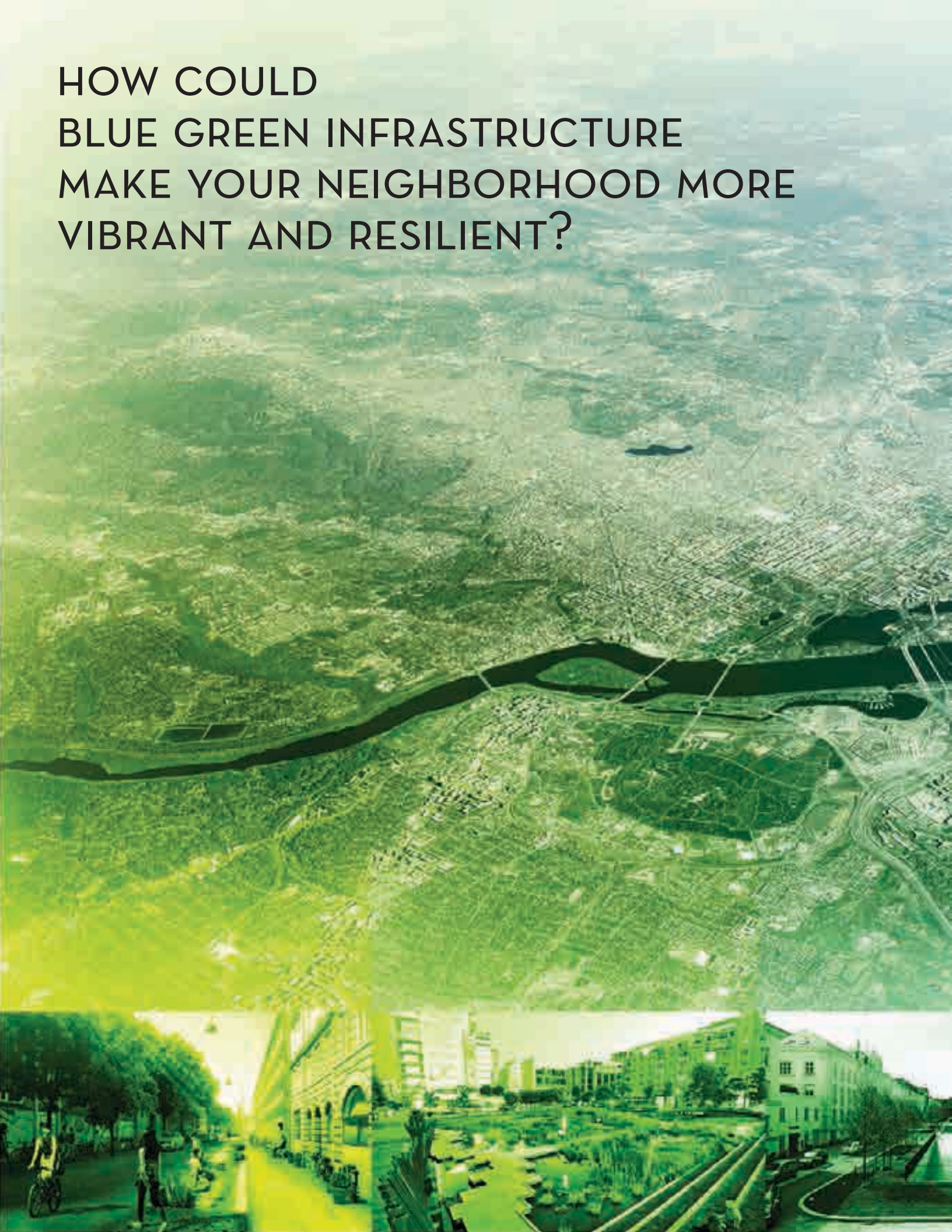
BLUE GREEN INFRASTRUCTURE

CLOUDBURST MANAGEMENT STRATEGIES

FOR THE DISTRICT OF COLUMBIA

HOW COULD BLUE GREEN INFRASTRUCTURE MAKE YOUR NEIGHBORHOOD MORE VIBRANT AND RESILIENT?



INTRODUCTION

In 2006, heavy rains (or cloudbursts), over Federal Triangle caused flooding that submerged the basements of federal office buildings and national museums with multiple feet of water, causing millions of dollars in damage and exposing the priceless collections of the country's museums. In 2012, heavy rains over the Bloomingdale neighborhood overwhelmed the storm sewer system and flooded streets and the basements of homes. In 2016, another cloudburst over Cleveland Park sent water rushing down the Metro station escalators and submerged the tracks with water, closing the station. These three events are examples of the District of Columbia's (the District's) vulnerability to interior flooding caused by cloudbursts/heavy rain. The intensity and frequency of these severe rain storms is only expected to increase in the District as a result of global climate change.

The Department of Energy and Environment (DOEE) is working with sister agencies to identify opportunities to use blue-green infrastructure (BGI) and cloudburst management strategies that will reduce the city's risk of flooding from intense rainfall.[1] This report details the concepts of this new approach and the results of a workshop held in March 2019 where District agencies and stakeholders gathered to learn more about the concepts and explore how they could be applied in the District.[2]

[1] *In addition to flooding from intense rainfall (often called cloudburst, interior, or urban flooding), the District is also vulnerable to coastal and riverine flooding. DOEE leads the District's Flood Risk Management Program that aims to reduce risk from all three types of floods, as well as increase flood risk awareness, and review and regulate development in floodplains. Learn more about DOEE's flood risk management program here: https://doee.dc.gov/service/flooding*

[2] *The Blue Green Infrastructure report and workshop were funded through a FEMA Cooperating Technical Partners (CTP) grant.*

BACKGROUND

Cities and their decision-makers today face many complex challenges that are associated with balancing urban development and its impact on the environment. Around the world, including Washington, DC, enormous investments are required to upgrade and maintain aging infrastructure stock as well as constructing new infrastructure to accommodate population growth. There is growing recognition that the traditional, “gray” approach to infrastructure will be insufficient to meet the growing pressures of urbanization and stresses associated with climate change.

In the District, the DOEE’s focus is to find ways to store and convey cloudburst generated flood waters in a way that can also create inspiring urban areas with added value for the citizens, local businesses, and the city. With limited resources to fund flood risk reduction projects and public projects in general, it is more important than ever to build projects that are not just single purpose, but can deliver on multiple goals for the city. Together, integrated planning and BGI are two approaches that can meet this need.

INTEGRATED PLANNING

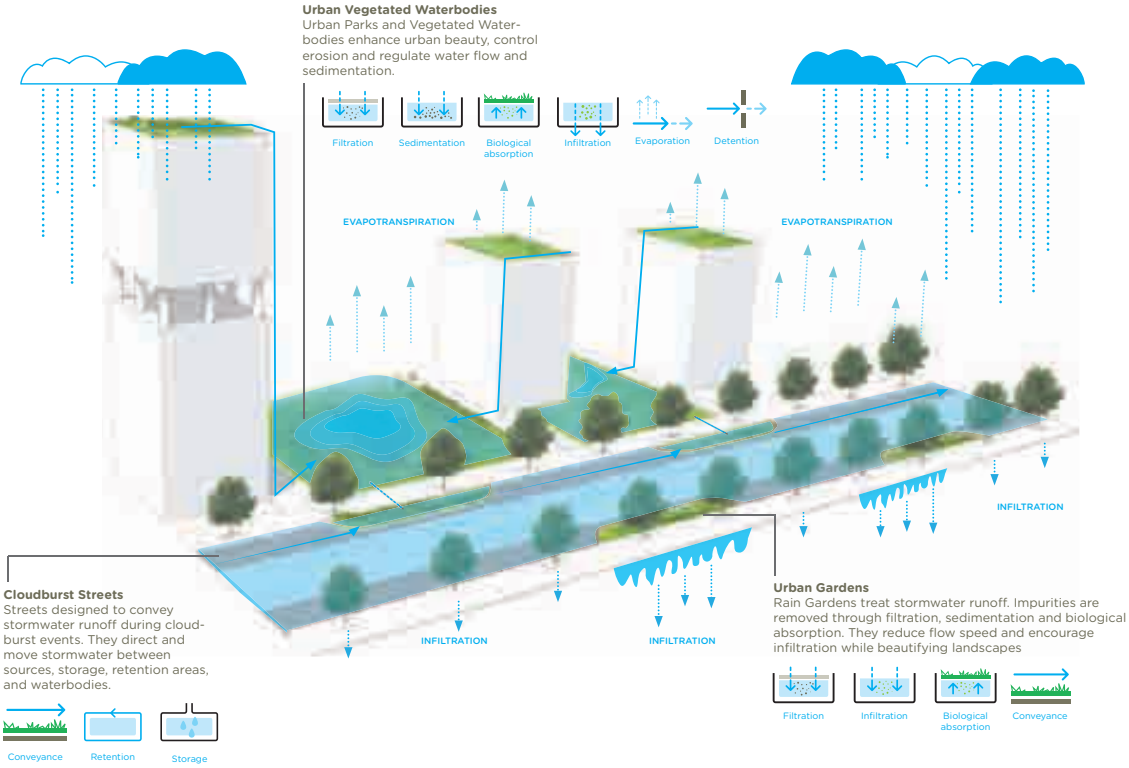
Integrated Planning comprises a system of interlinked actions which seeks to bring about a lasting improvement in the physical, social, and cultural conditions of a city or an area. Creating livable urban environments encompasses a wide range of interrelated aspects of city life from governance, economy and planning to physical infrastructure, sustainable buildings, climate adaptation and environment. Integrated Planning can achieve this balanced approach and foster increased cooperation and capacity building across the city.

BLUE GREEN INFRASTRUCTURE

BGI offers a feasible and valuable solution for urban areas facing the challenges of climate change. It complements and in some cases replaces the need for grey infrastructure. BGI connects urban hydrological functions (blue infrastructure) with vegetation systems (green infrastructure) in urban landscape design. It provides overall socioeconomic benefits that are greater than the sum of its individual components.

Taken together as a comprehensive system, these components of BGI projects strengthen urban ecosystems by employing natural processes in man-made environments. They combine the demand for sustainable water and stormwater management with the demands of adaptive urban life and planning.

A cloudburst masterplan refers to a network of mainly BGI projects implemented through integrated planning, acting together to provide multi-functional uses and added value to the city.



BGI System Strategies at various scales - building, block, district

LEARNING FROM COPENHAGEN

The City of Copenhagen is a leading city in stormwater management and their approach to cloudburst planning is a useful example for the District to consider.

On July 2nd, 2011, Copenhagen experienced a “Cloudburst” event in which they received almost 6 inches of rain with a 2-hour period causing $1 billion worth of damages. In the wake of this event it became evident that the city needed a better way to manage stormwater that inundated the infrastructure during extreme precipitation events.

In late 2011, the City of Copenhagen started work on its Cloudburst Management Plan. The work was divided into socio-economic and technical studies consisting of calculations of systems needed to handle large amounts of water, cost-benefit analyses and definition for a new level of service required for handling stormwater on the surface. The development of the Cloudburst Management Plan was carried out in the following steps:

1. Division of Copenhagen into water catchments based on topography and overland flow paths.
2. Approval of citywide Cloudburst Management Plan and catchment specific approach.
3. Development of catchment specific cloudburst masterplans: a network of mainly BGI solutions coupled to the existing sub-surface stormwater network. Developed with a special focus to provide added value on the social, environmental and economic aspects.

After the City Council’s approval of the catchment specific masterplans, the city and the utility co-developed the implementation plan, breaking each catchment masterplan into individual projects, including descriptions of the hydraulic measures and the potential for urban space improvement for each project. Currently, Copenhagen is working toward implementation of 300 projects that aim to work as a network for conveying stormwater and better manage flooding.

In terms of barriers, Copenhagen was challenged by the following legislation and regulations:

1. Storm and wastewater management is regulated through the “Water Sector Act” which describes the framework and financing of wastewater management.
2. The European Water Frame Directive calls for a reduction in sewer overflows and other measures to improve water quality in both marine and freshwater systems.
3. Balanced co-funding of multi-purpose BGI projects across city agencies.
4. Estimation of O&M practices and costs of new BGI typologies (incl. distribution of funding).

There are many similarities, both in terms of barriers and opportunities in the legislation and regulation, between the two cities.

Copenhagen Cloudburst -
From flooding to city-wide concept

Image: Ramboll

Sankt Jørgens Lake, Copenhagen
The Blue-Green Masterplan Option lowered the lake level from +5.8m to +2.8m, creating a new cloudburst storage volume of 40,000m3 and a revitalized lakeside connection which had previously been only partially accessible

HOW MIGHT THE DISTRICT IMPLEMENT CLOUDBURST MANAGEMENT?

On March 26, 2019, DOEE hosted a workshop entitled Connecting the Drops: the Blue-green Infrastructure Approach. The purpose with the workshop was to introduce stakeholders to the concepts of integrated planning and blue-green infrastructure and to explore how the District might implement its own cloudburst management strategies. The workshop included presentations from Copenhagen and New York City, two cities that have worked actively with cloudburst masterplans. The workshop also included a charrette component where participants could share knowledge, and test the application of cloudburst tools on the District, as well as discuss how solutions would incorporate concepts of social equity, workforce development, and education.

OUTCOMES

Based on the participation and results of the workshop, it is clear that there is support for implementing cloudburst management strategies in the District. Broad support was heard from the participants, including public agencies, industry professionals, and design practitioners in the District. DOEE will continue to pursue integrated planning and BGI and work closely with international partners, sister agencies, and stakeholders to plan and build infrastructure that achieves multiple benefits.

SPEAKERS

- [redacted], Principal, Designgreen
- [redacted], Head of Program for Resilient and Sustainable City Solutions at the City of Copenhagen
- [redacted], Head of Resilience North America, Ramboll
- [redacted]Branch Chief, Water Resources Protection & Mitigation, DOEE
- [redacted], Managing Director of Integrated Water Management at the NYC Department of Environmental Protection.
- [redacted], Director, DOEE

PARTICIPATING AGENCIES

- Advisory Neighborhood Council
- Alliance for the Bay
- Anacostia River Waterfront Trust
- Arup
- Atkins Global
- Biohabitats
- Biophilia
- C40
- Can I Live
- Chesapeake Bay Program
- City of Copenhagen
- David Wooden Studio
- DC DOEE
- DC DOT
- DC EcoWomen
- DC HSEMA
- DC Office of Planning
- DC Water
- Environmental Finance Center
- EPA Bay Program
- Exp
- Federal Emergency Management Administration
- George Mason University/Polar Institute
- Georgetown University
- Green Vest
- Harvests of Hope
- HOK
- Jacobs
- Landscape Architecture Foundation
- Limnotech
- Montgomery County, MD
- Moody Graham
- Natural Resources Design
- NYC Department of Environmental Protection
- Rah Solutions
- Recurrent Innovative Solutions
- Riverbend Nursery
- RKK
- Smithsonian
- Studio AKA
- The Nature Conservancy
- Trust for Public Land
- University of Maryland
- University of the District of Columbia
- Urban Infrastructure Advisory
- US General Services Administration
- US Army Corp of Engineers
- Water Research Foundation

CHARRETTE QUESTIONS

TASK 1

What would Cloudburst Roads and Plazas in DC look like?

TASK 2

Applying Cloudburst Typologies:
How do you spot, select, and connect typologies?

TASK 3

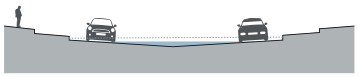
Applying Integrated Planning:
What does integrated planning look like in DC?

How do you include social equity in your stormwater planning?

DC TOOLBOX

The DC Toolbox of Cloudburst Strategies is the first step in identifying the typologies of stormwater solutions that are best suited for the diverse physical and built context of the District. Cultivated through workshop participation and exploration, the following typologies provide explanations of their functions, include cross-section diagrams and built and visualized examples from around the world.A

CLOUDBURST ROADS

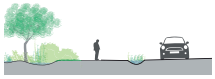


Cloudburst roads are used to channel and direct cloudburst water. These streets can be formed with a V-shaped profile and raised curbs to ensure water will flow in the middle of the road, away from the buildings. In addition, channels and swales can be established at the side of the road so that the water runs in urban rivers or green strips.
Example A: Copenhagen Cloudburst Street

RETENTION ALLEYS

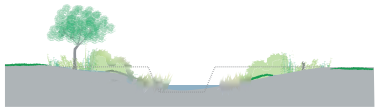
Retention alleys are typically located upstream of vulnerable low-lying areas. In these streets there should be a retention volume established and detention to slow the peak flow of water reducing flooding downstream. Detention streets allow slowed conveyance and possible retention through stormwater planters, hardscape channels, and permeable paving.
Example B: Hans Tavsens Park

GREEN STREETS



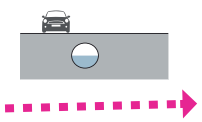
Green streets are proposed as upstream connections to all cloudburst roads or retention areas. The green streets should be established with a combination of small scale channels and stormwater planters or permeable paving. Stormwater should be collected, delayed, and then channeled toward the cloudburst roads.
Example C: Watts Branch, DC

STREAM RESTORATION



Stream Restoration and re-profiling existing urban water edges can help build capacity for stormwater through retention and detention. Additionally, redesign of stream or riverfront parks to allow for seasonal and cloudburst flooding can reduce downstream flooding in unwanted areas.
Example D: Capitol Heights, Maryland

CLOUDBURST PIPES



A cloudburst pipe handles rainwater in the same way as cloudburst roads. This is placed just below street level to ensure connection to other surface solutions. This solution is used if there is limited space for above ground conveyance.
Example E: Sankt Annae Plads, Copenhagen

FLOODABLE PARKS

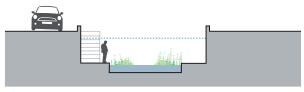
Floodable parks and recreation spaces present the greatest opportunity for large retention spaces within urban areas. They can be located throughout the watershed and receive stormwater conveyance systems or adjacent water bodies. They can provide a combination of hydrological services including water quality improvements via retention, detention, and infiltration.
Example F: Bishan Ang Mo-Kio Park, Singapore

WET PLAZAS

Wet plazas or floodable public spaces are another great opportunity for large retention capacity within denser urban environments. Typically hardscapes with some potential vegetation, these spaces collect, detain and retain stormwater to reduce flooding. Additionally, they can incorporate drainage connections to allow the plaza, courtyard, and other spaces to return to normal use quickly.
Example G: Enghave Park, Copenhagen

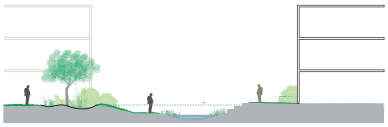
URBAN CANALS

Urban canals are larger infrastructure projects that typically involve daylighting of a stream or river within a dense urban area. They can be designed to create new and healthy oases in the city while increasing biodiversity and stormwater volume capacity.
Example H: Cheonggyecheon Canal, South Korea



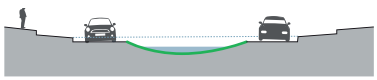
URBAN CREEKS

Urban creeks can involve daylighting historic streams, formalizing existing streams, or creating new streams as conveyance connections between other cloudburst elements. Typically smaller in scale, urban creeks can re-establish or create new neighborhood character and social spaces.
Example I: Arkadien Asperg, Stuttgart, Germany



RETENTION BOULEVARDS

Retention boulevards are similar in scale to cloudburst roads, but incorporate large, green, depressed medians that can detain and retain stormwater while allowing regular traffic use of the street. They require taking away space from existing roads, but can be very effective along larger urban arteries that are underutilized.
Example J: Sankt Annae Plads, Copenhagen



DEPARTMENT OF ENERGY & ENVIRONMENT
GOVERNMENT OF THE DISTRICT OF COLUMBIA

RAMBOLL

GOVERNMENT OF THE DISTRICT OF COLUMBIA
MURIEL BOWSER, MAYOR