



INTEGRATED RESILIENCY PLANNING CITY TO CITY COOPERATION ON EVALUATION OF FLOOD RISK AND CO-BENEFITS FROM MITIGATION MEASURES

RENE HOEIJMAKERS, EXECUTIVE DIRECTOR RAMBOLL WATER

BACKGROUND – CITY TO CITY AGREEMENT KNOWLEDGE SHARING ON INTEGRATED RESILIENCY PLANNING

- Copenhagen and New York City both impacted by extreme weather events causing flood damages of billions of USD
- Mutual interest in in-depth, bilateral knowledge sharing of best practices
- Copenhagen's experience from cloudburst management with focus on co-benefits and cost-benefit analysis
- New York's experience from storm surge management planning



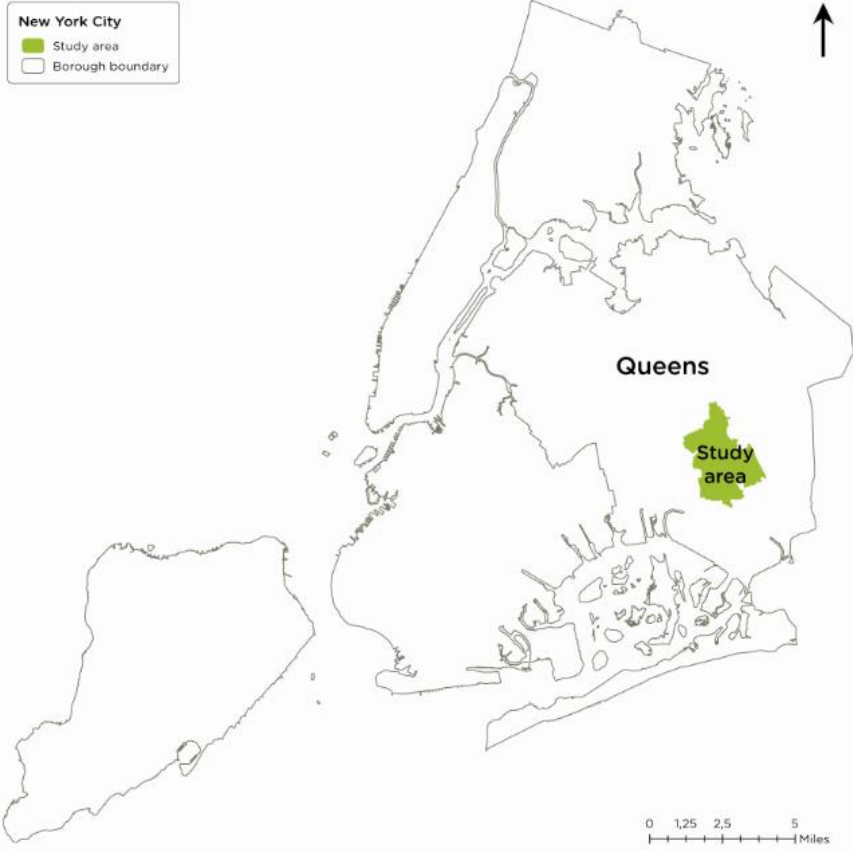
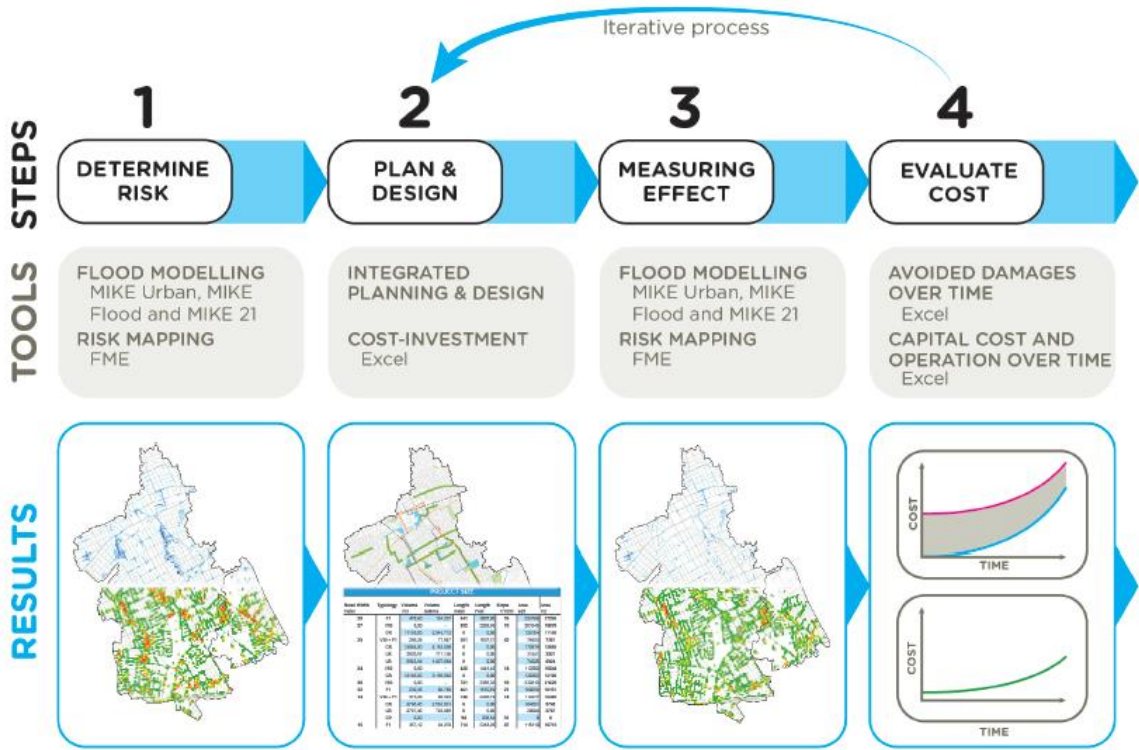
BACKGROUND – CITY TO CITY AGREEMENT FRAMEWORK

- 3 year program with city agencies from both sides and Danish experts
- Intention to prepare a cloudburst management plan for a main catchment in New York City
- Plan for implementation of pilot projects
- Methodology to be used on a city-wide scale in New York City
- Actual implementation



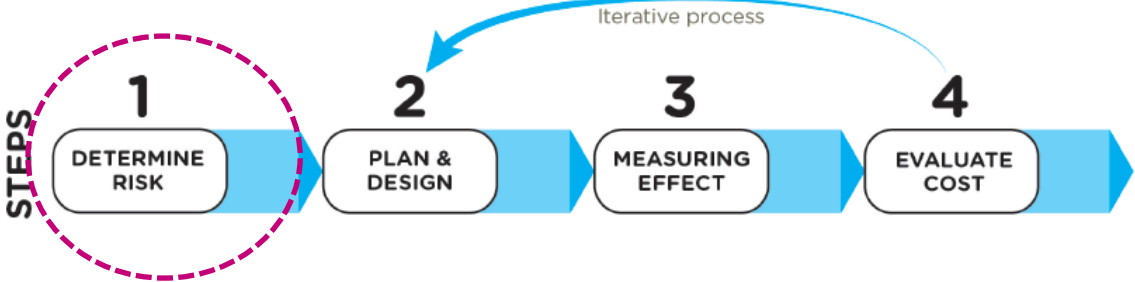
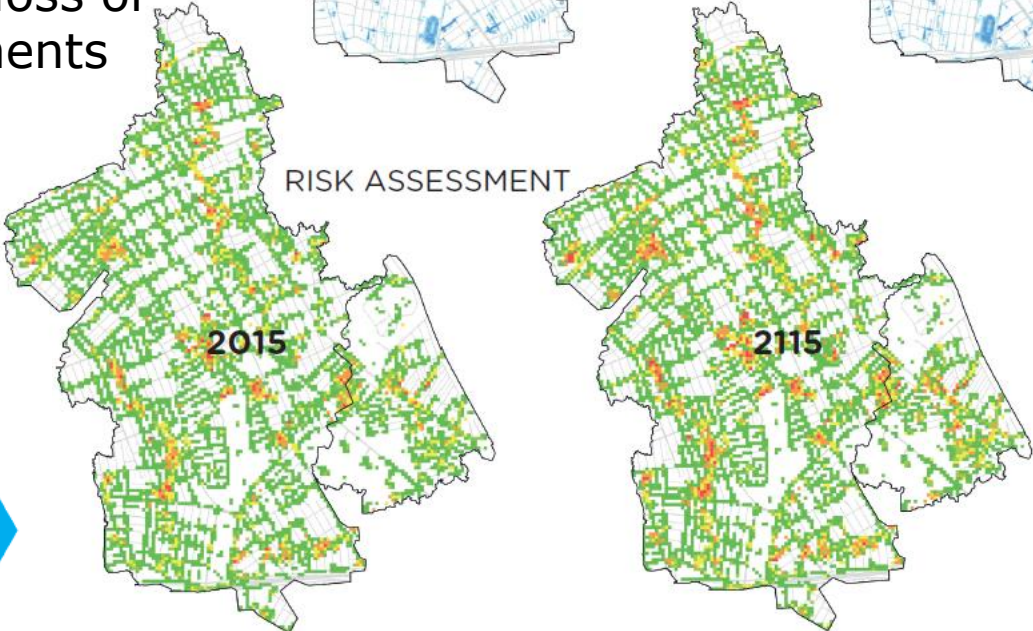
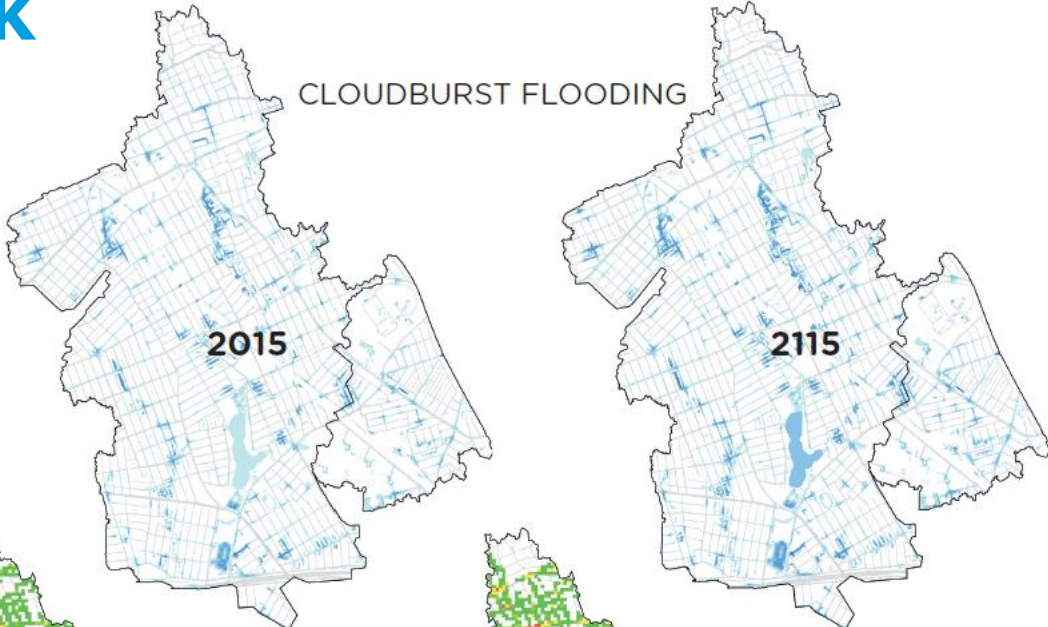
NYC – CLIMATE RESILIENCY STUDY APPROACH

- 4-step approach to cloudburst resiliency planning
 - An iterative process
- Cost analysis vs. Cost-Benefit Analysis



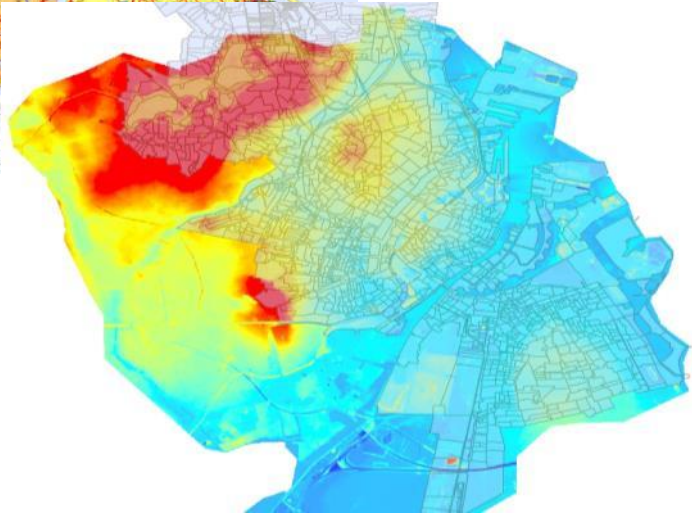
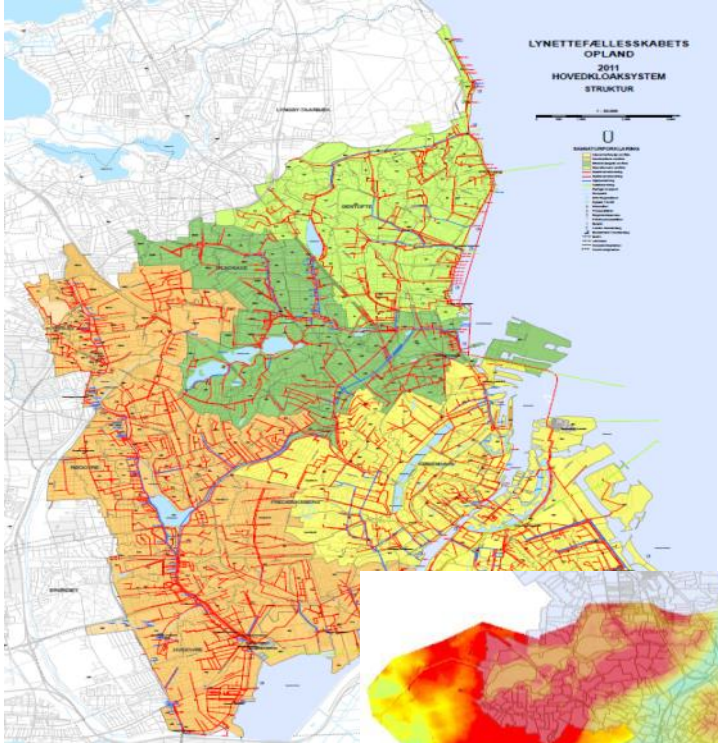
1. DETERMINING BASELINE RISK

- Fully dynamic hydraulic calculations in present and future climate
- Direct impacts based on insurance companies pay-outs, infrastructure owners etc.
- Indirect impacts from traffic delays, loss of revenue, health, decrease in investments
- Spatially distributed
- Calculate a baseline net-present value



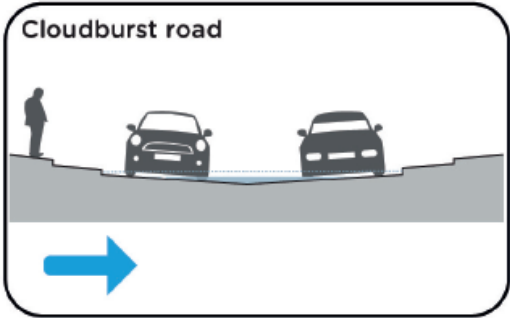
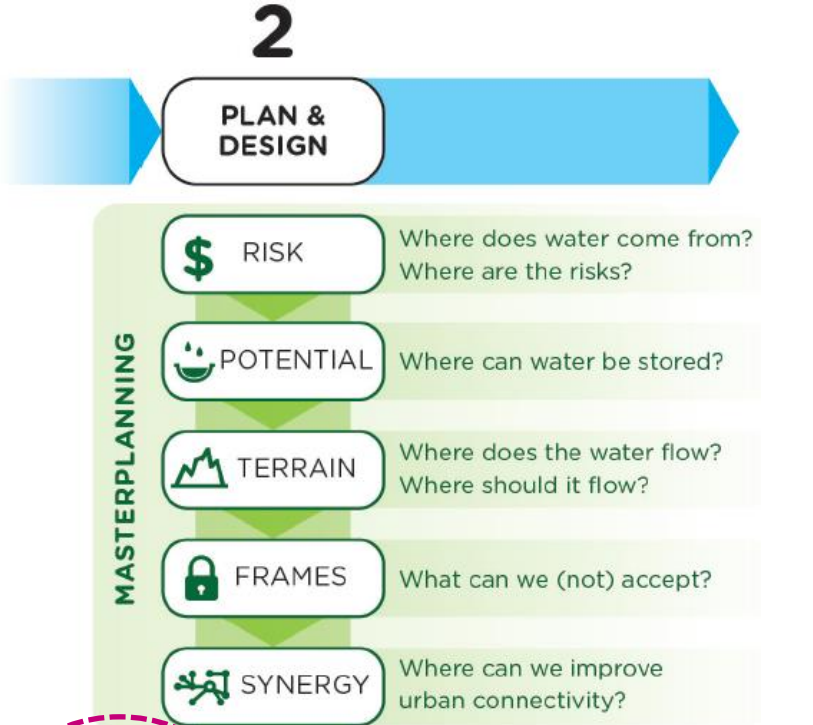
1. DETERMINING RISK – DETAILED HYDRAULIC MODELS

- 3 way coupled models with stormwater systems, urban rivers, lakes and digital elevation model

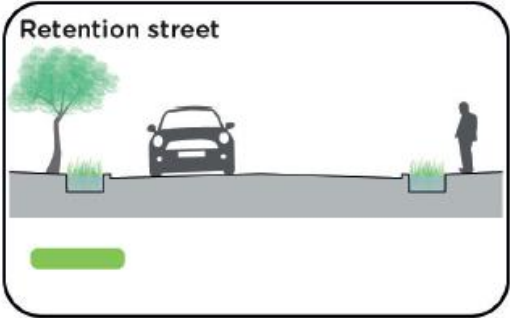


2. PLANNING AND DESIGN

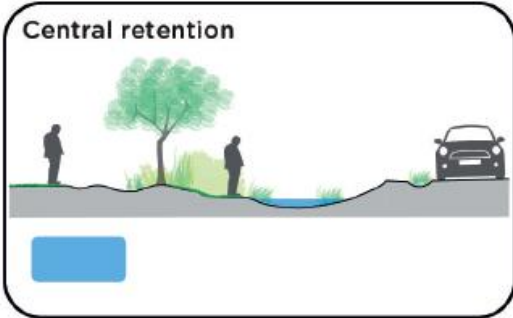
- Designing a masterplan with BGI Elements



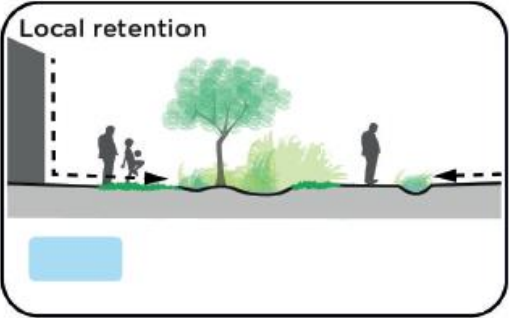
Used to convey water where the terrain is favourable



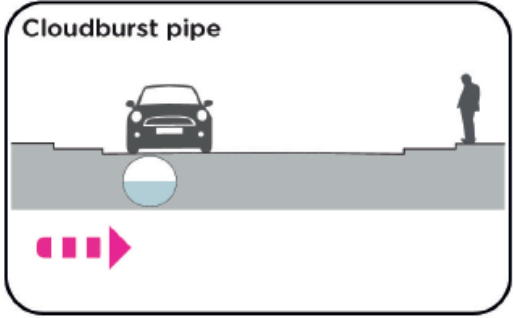
Used to retain water where the terrain is favourable



Used to retain water in a larger area connected to other BGI projects

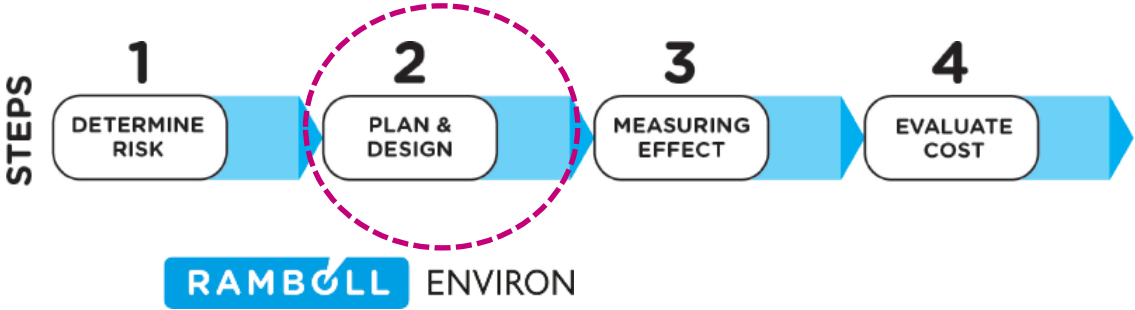


Used to retain water in larger areas from roofs and local surroundings



Used to convey water where the terrain does not permit BGI projects

2. PLANNING AND DESIGN – BUILT EXAMPLES



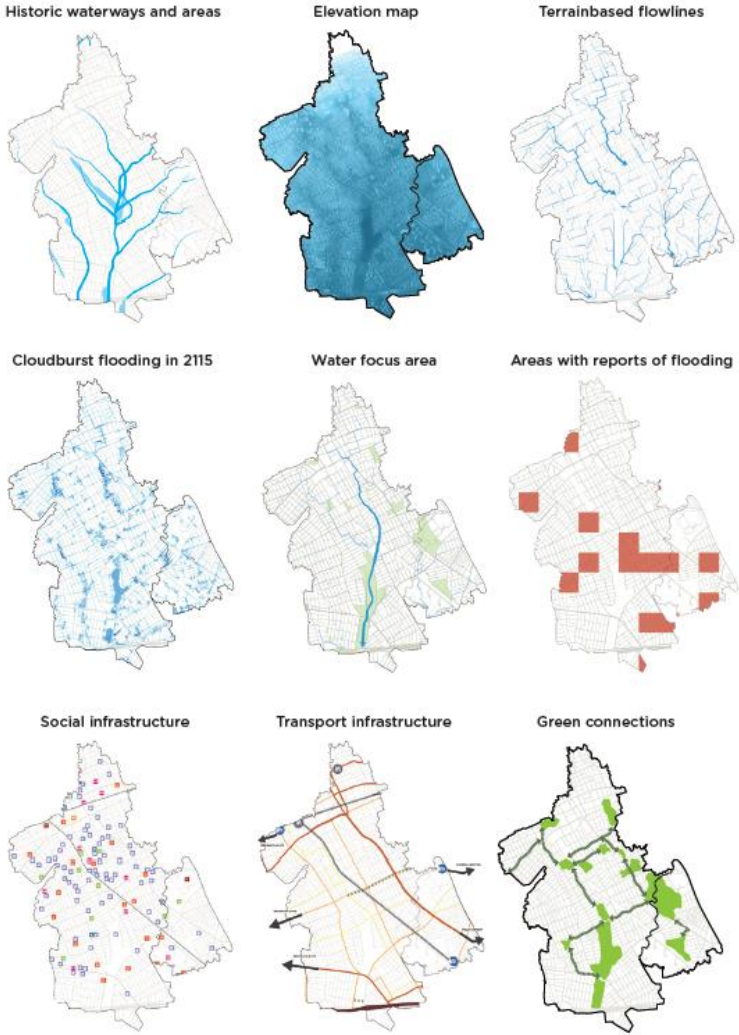
2. PLANNING AND DESIGN - WORKSHOPS

Initial analysis

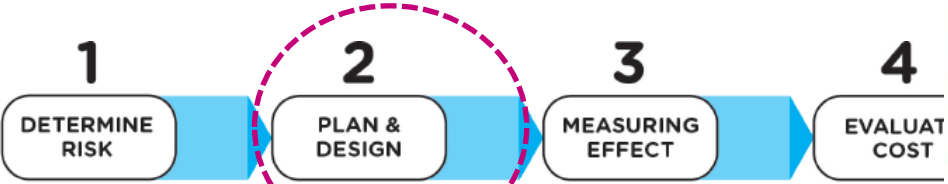
- Land-use data, visions and plans
- Terrain
- Infrastructure (transport and social)
- Green areas etc.
- Existing investment plans

Workshop I – Stakeholder engagement

- Local insight – opps and challenges
- Vision statement



STEPS



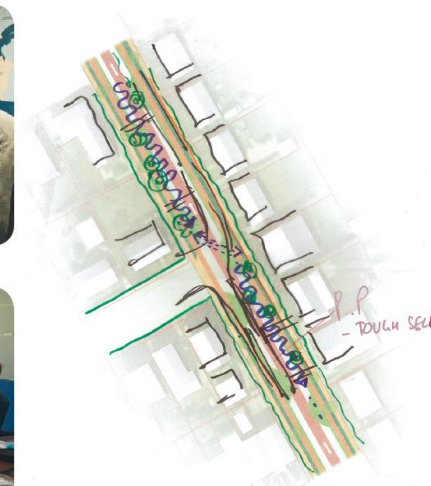
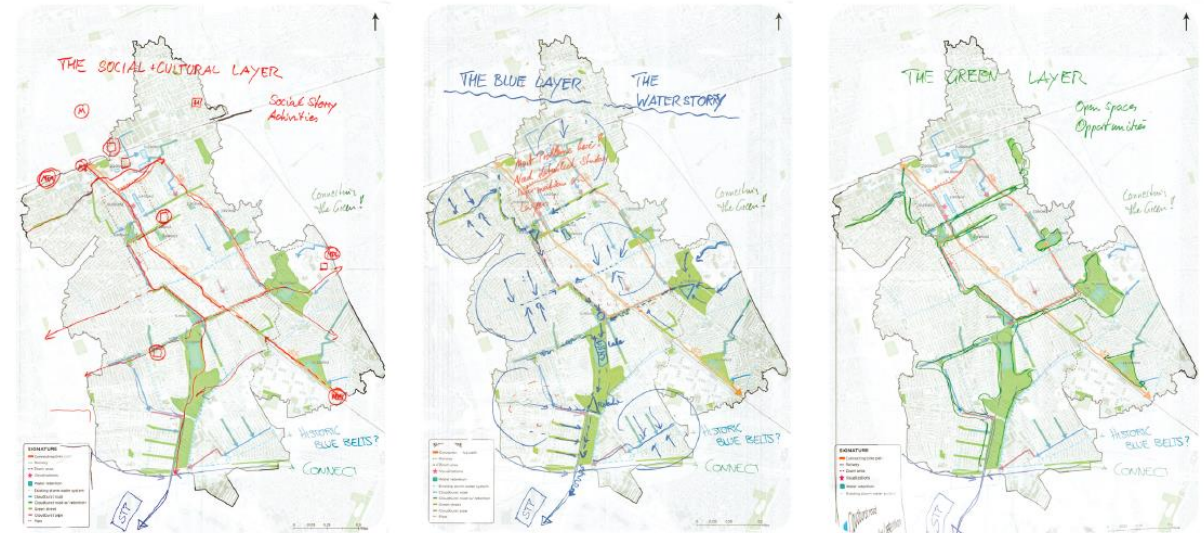
RAMBOLL ENVIRON



IFAT
MUNICH - MAY 2018

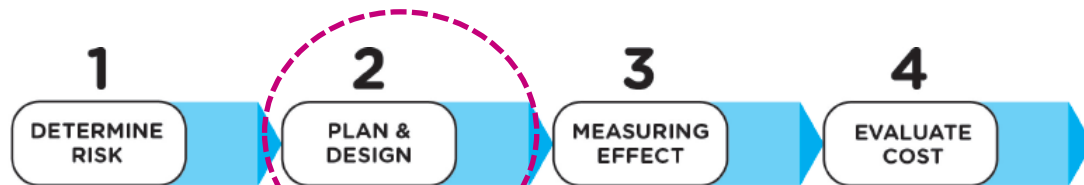
2. PLANNING AND DESIGN – DEVELOPING THE PLANS

- Detailed analysis
 - Flood modelling
 - GIS analysis
 - Risk mapping
 - Masterplan drafts
 - Key corridors identified
- Workshop II - Stakeholder consultation
 - Develop multi-disciplinary plans



Hand sketches illustrate potential in design roads

STEPS



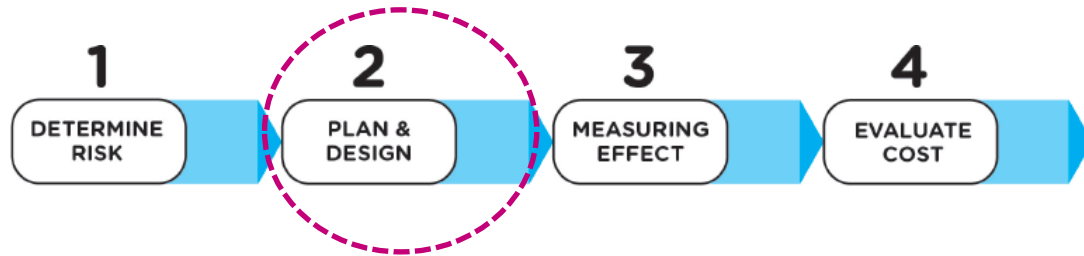
RAMBOLL ENVIRON

2. PLANNING AND DESIGN

- Final cohesion
 - Final masterplan
 - Final pilot projects
- Workshop III - Investment planning and priorities
 - Select pilots – parks, roads, housing...
 - Metrics for priorities



STEPS

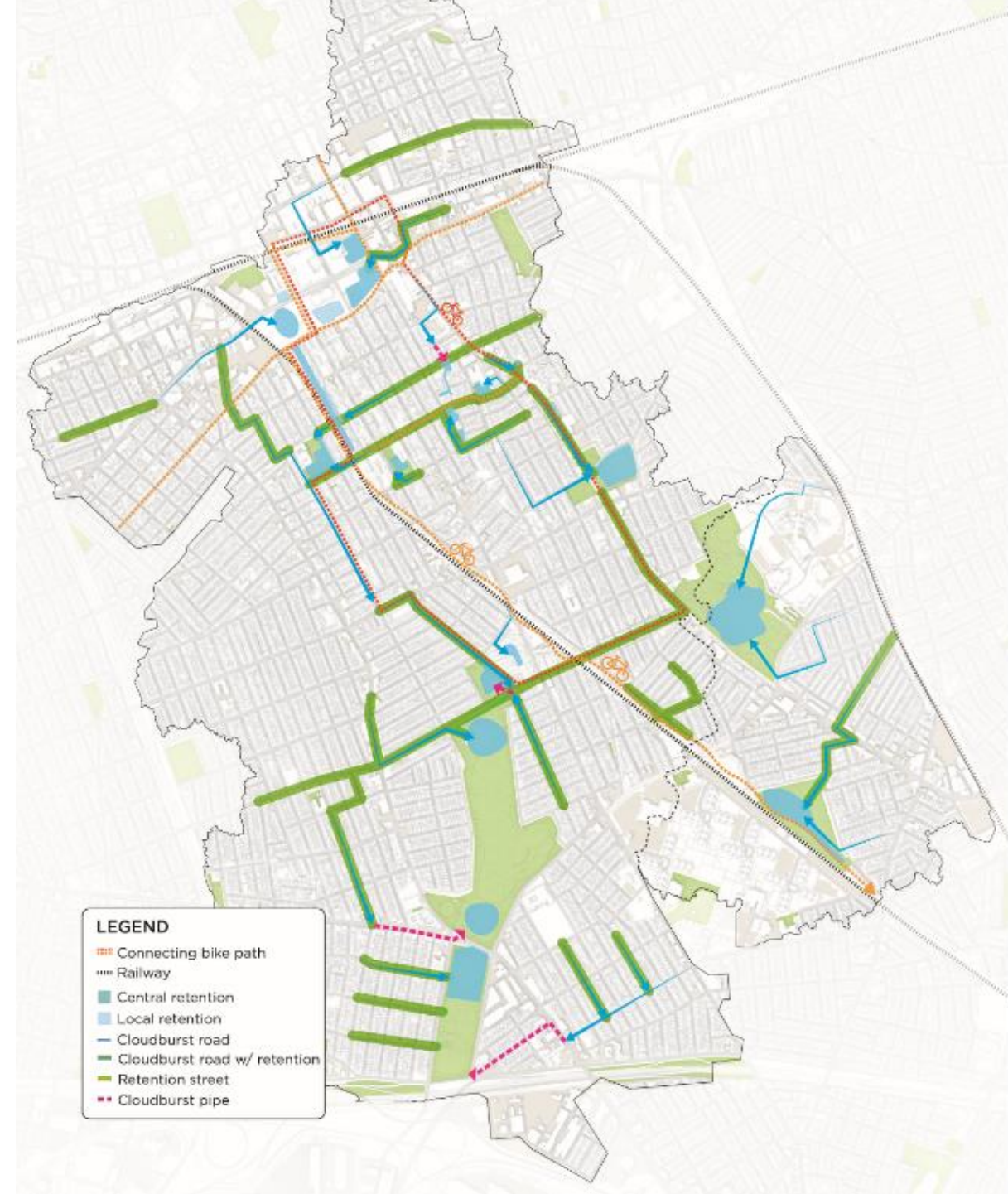
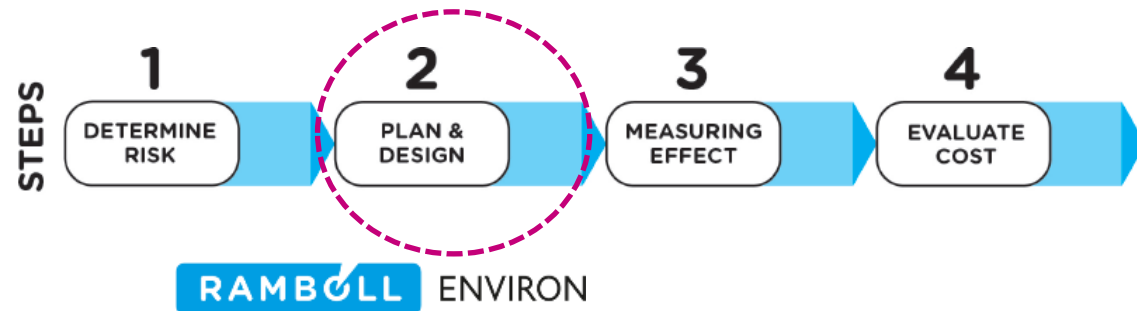


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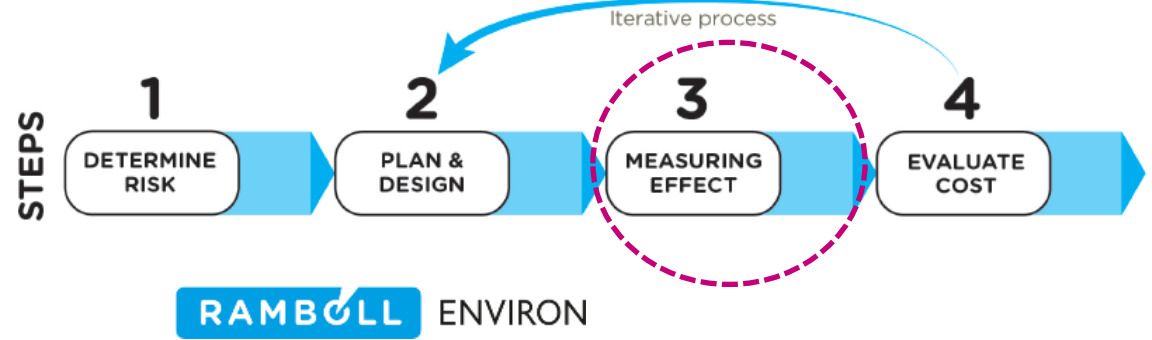
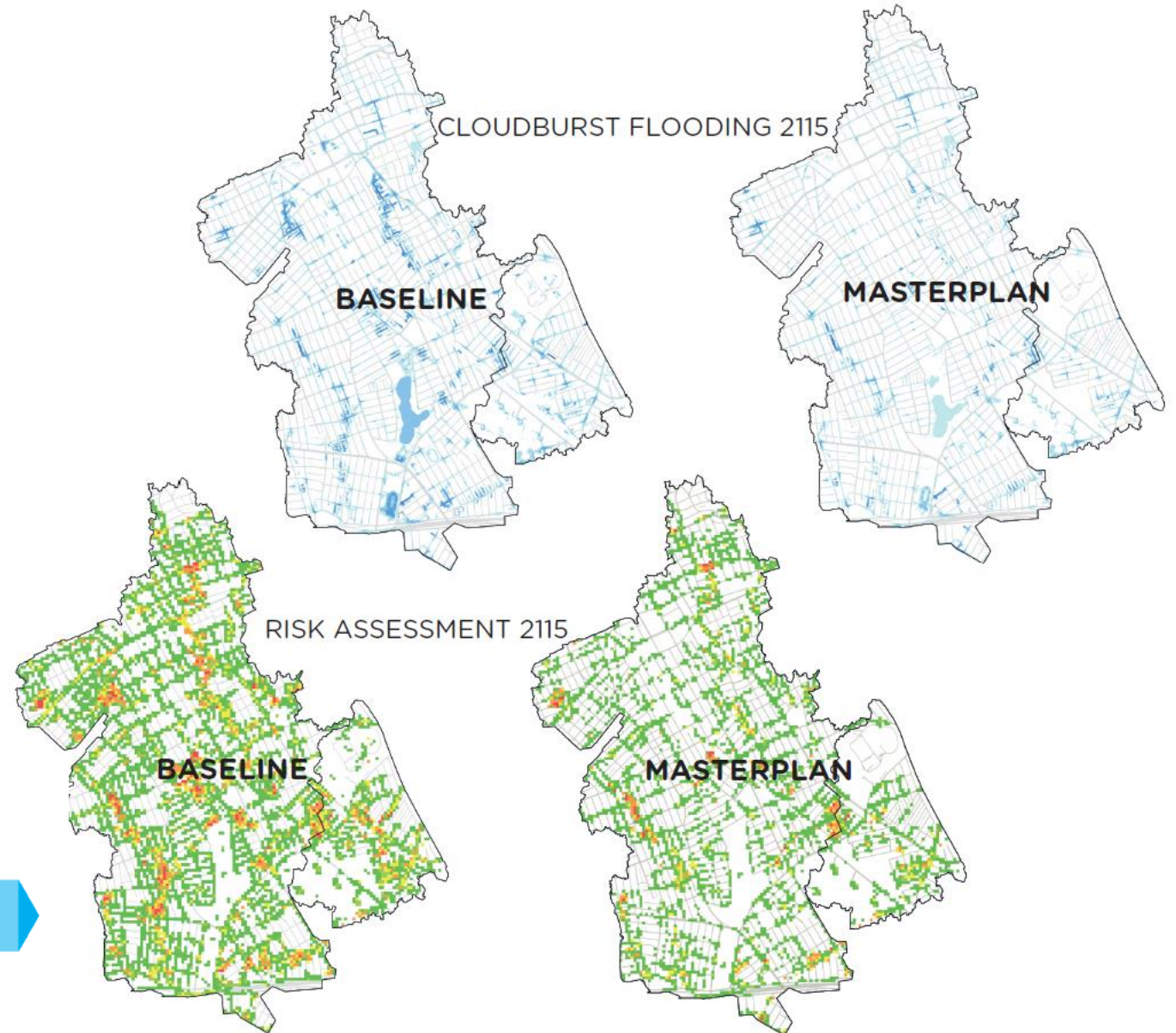
2. PLANNING AND DESIGN

- Masterplan (68 projects)
 - 11 cloudburst roads
 - 16 cloudburst roads with retention
 - 15 retention streets
 - 4 cloudburst pipes
 - 18 central retention
 - 4 local retention



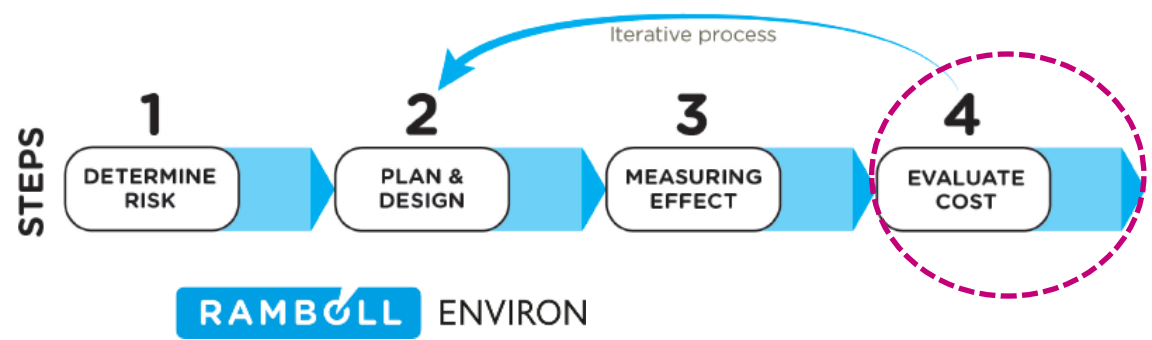
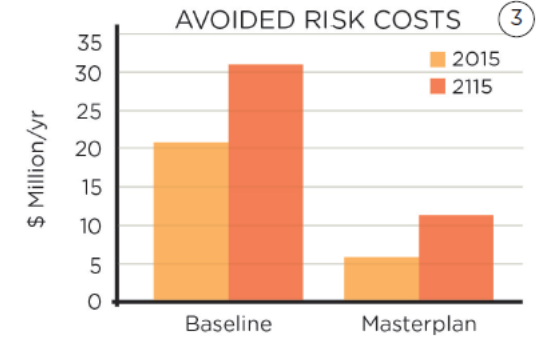
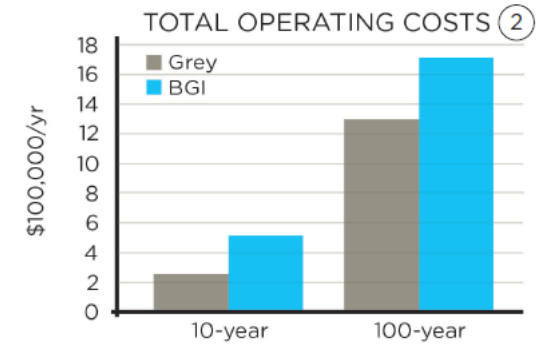
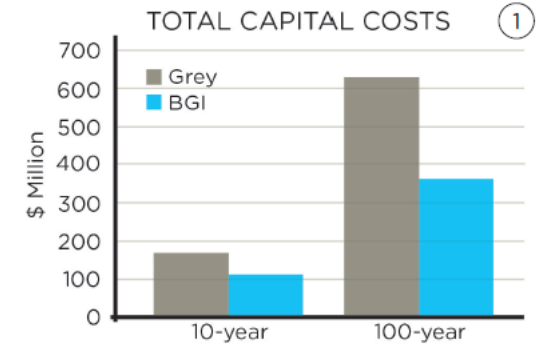
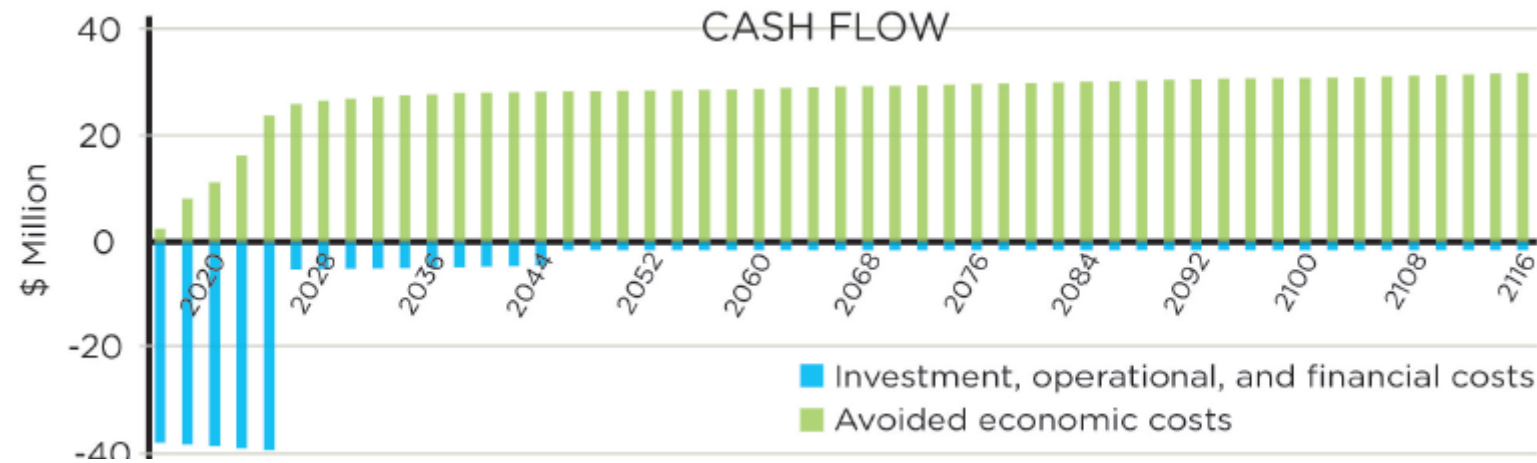
3. MEASURING EFFECT

- Considerable less flooding
- Considerable lower damage costs
- Introduction of additional green recreational areas
- Improved connectivity
- Budget synergies with NYCHA, DOT, Parks & Rec



4. EVALUATING COSTS

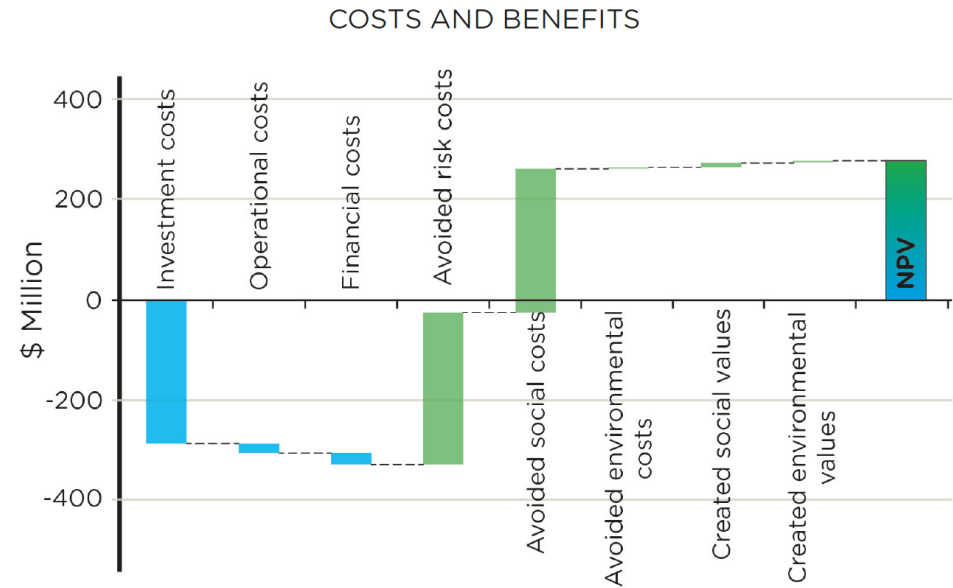
- Capital investment: \$330 mill.
 - Avoided risk costs: \$310 mill.
 - Area will densify considerably – avoided risk will increase
- ➔ Net loss



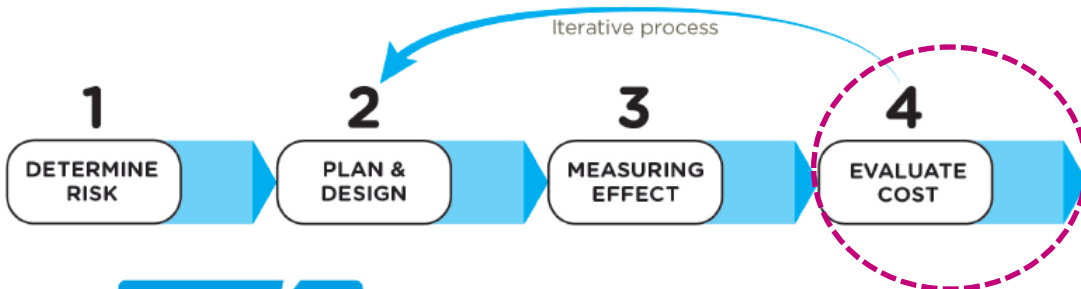
4. EVALUATING COSTS

- CBA
 - Property value
 - Environmental and social
 - Savings on sewer upgrades
 - Health benefits
- Avoided social and environmental costs and savings on sewer upgrades: \$290 mill.
- Created social and environ. costs: \$3 mill.

The **BENEFIT-COST RATIO** indicates that for every \$1 the City invests in BGI, the City makes \$1.9 in return in generated co-benefits in the local area.



STEPS

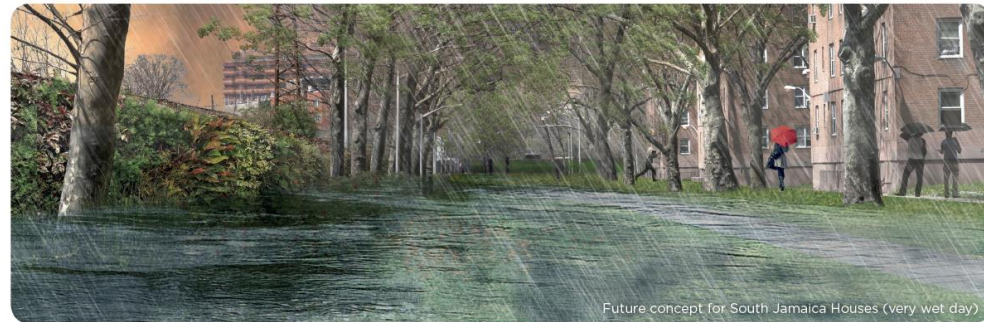


RAMBOLL ENVIRON

AVOIDED COSTS		CREATED VALUES	
SOCIAL	ENVIRONMENTAL	SOCIAL	ENVIRONMENTAL
Injuries	Improved water quality control	Health benefits	Pollutant removal
Mental stress and anxiety		Recreational value	Carbon sequestration
		Aesthetic value	

FROM MASTERPLAN TO PROJECT

South Jamaica Houses



NEXT STEPS

PLANS AND BASELINE

- Drainage master plan on city level

- Detailed hydraulic calculations

OPTIMUM LEVEL OF PROTECTION

- Risk mapping and overall protection scenarios
- CBA based optimum, balancing damages and cost

MASTERPLANS

- Preparation of multi-disciplinary master plans
- Multi-criteria prioritization



INTEGRATED PLANNING

- DEP
- DOT
- NYCHA
- Parks & Rec
- Schools and local stakeholders



THANK YOU

Christian Nyerup Nielsen

Global Division Director, Climate Adaptation and Landscape

Ramboll
Hannemanns Allé 53
DK-2300 Copenhagen S
Denmark

Gerhard Hauber

Executive Partner, Ramboll Studio Dreiseitl

Ramboll Studio Dreiseitl
Nussdorfer Strasse 9
88662 Überlingen
Germany

