# Using System Analysis Methodology To Enhance Efficiency Of Best Management Practices For Capturing Stormwater– Case Study; District Of Columbia

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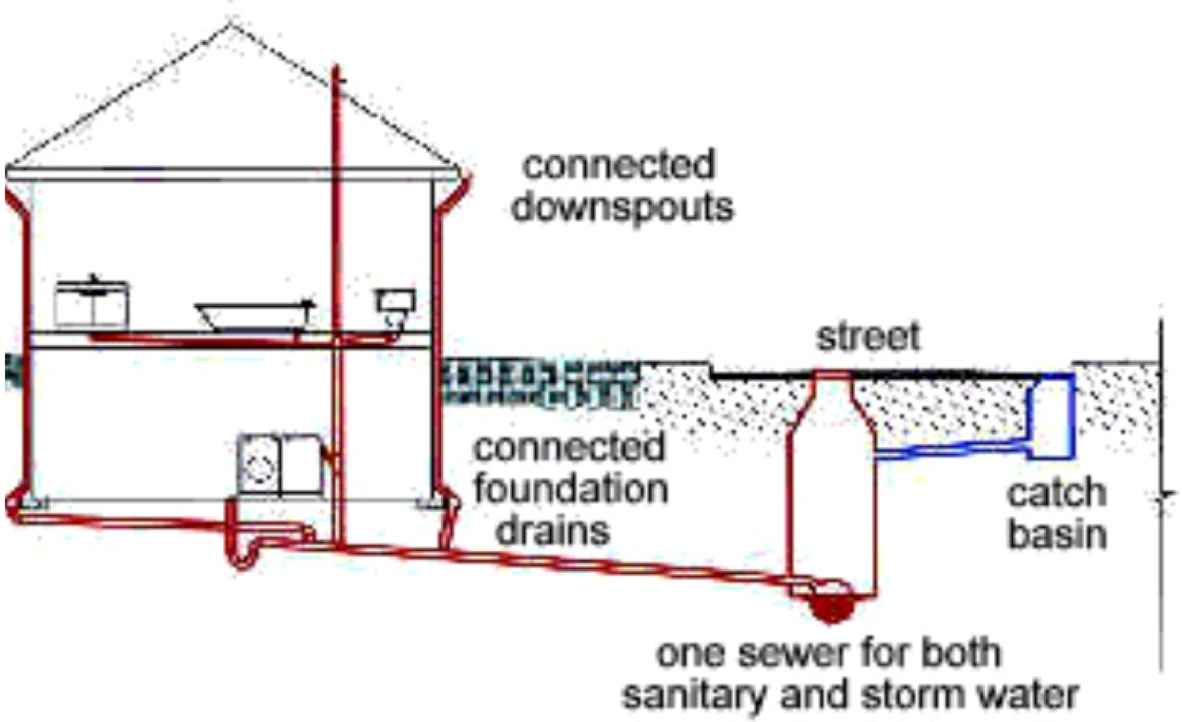
# Agenda

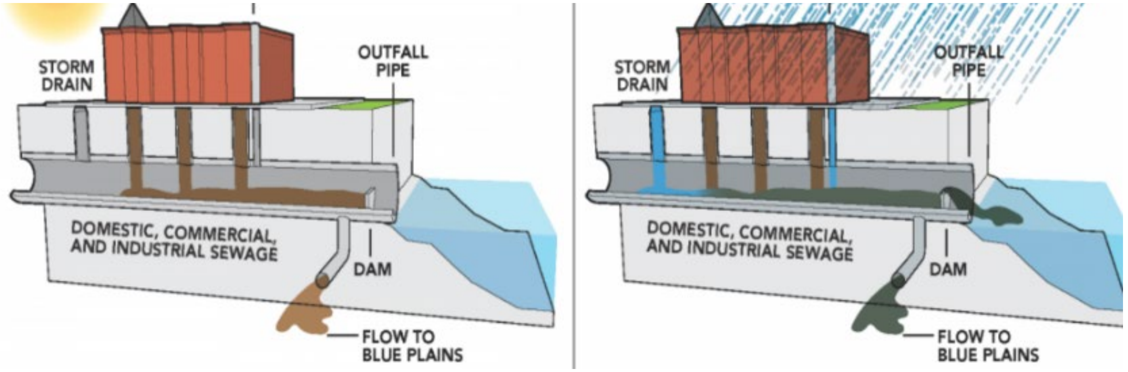
- Background
- Objective
- Method
  - System Development Life Cycle (SDLC)
    - Conceptual Model
    - Use Case Model
    - Object-Oriented Model – Problem Solution
- Conclusion
- References

# Background

**Sanitary Sewer Overflow (SSO):**
untreated sewage is discharged from a sanitary sewer into the environment prior to reaching sewage treatment facilities.

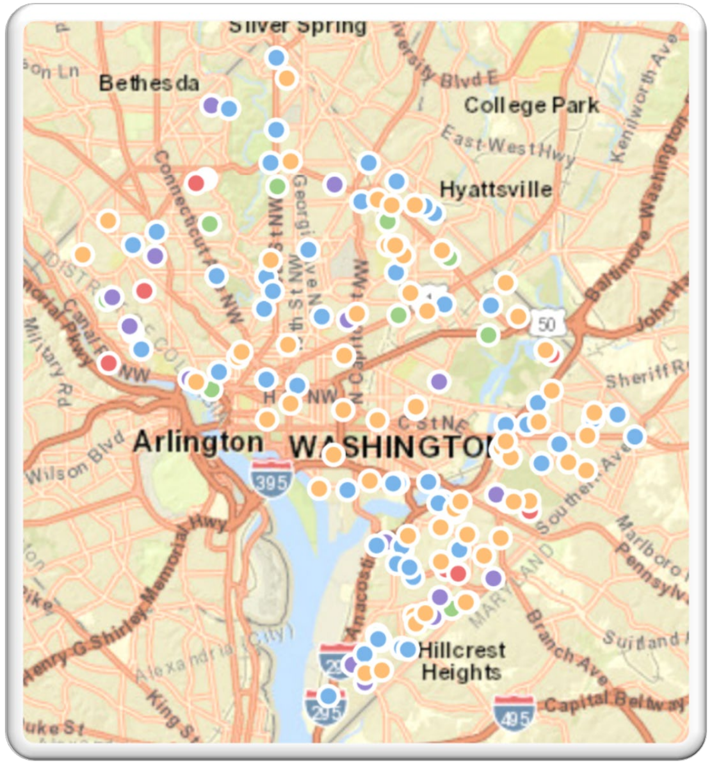

**Combined Sewer Overflow (CSO):**
To avoid flood, regulators are designed to let the excess flow, which is a mixture of stormwater and sanitary wastes, be discharged directly into the rivers and creeks.

# Background

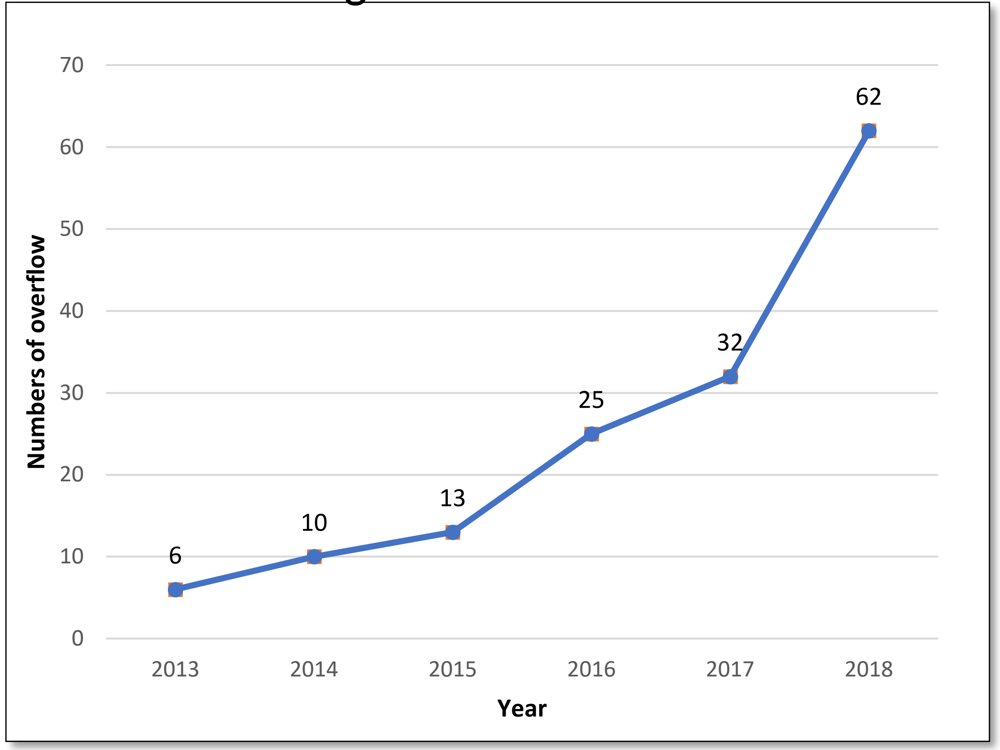
Location of the SSOs:






D.C. Water (2018)

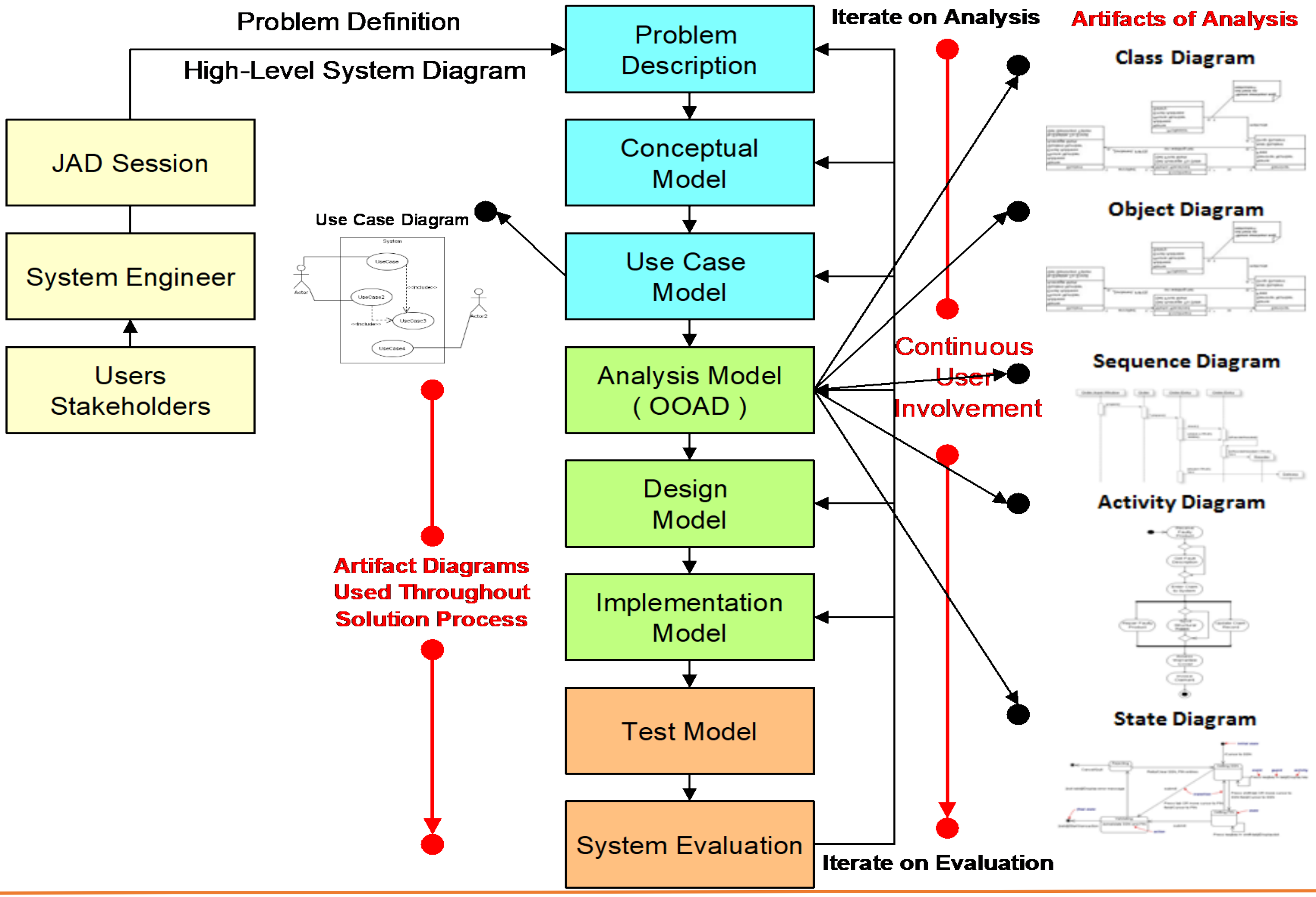
SSOs increasing trend since 2013:




D.C. Water (2018)

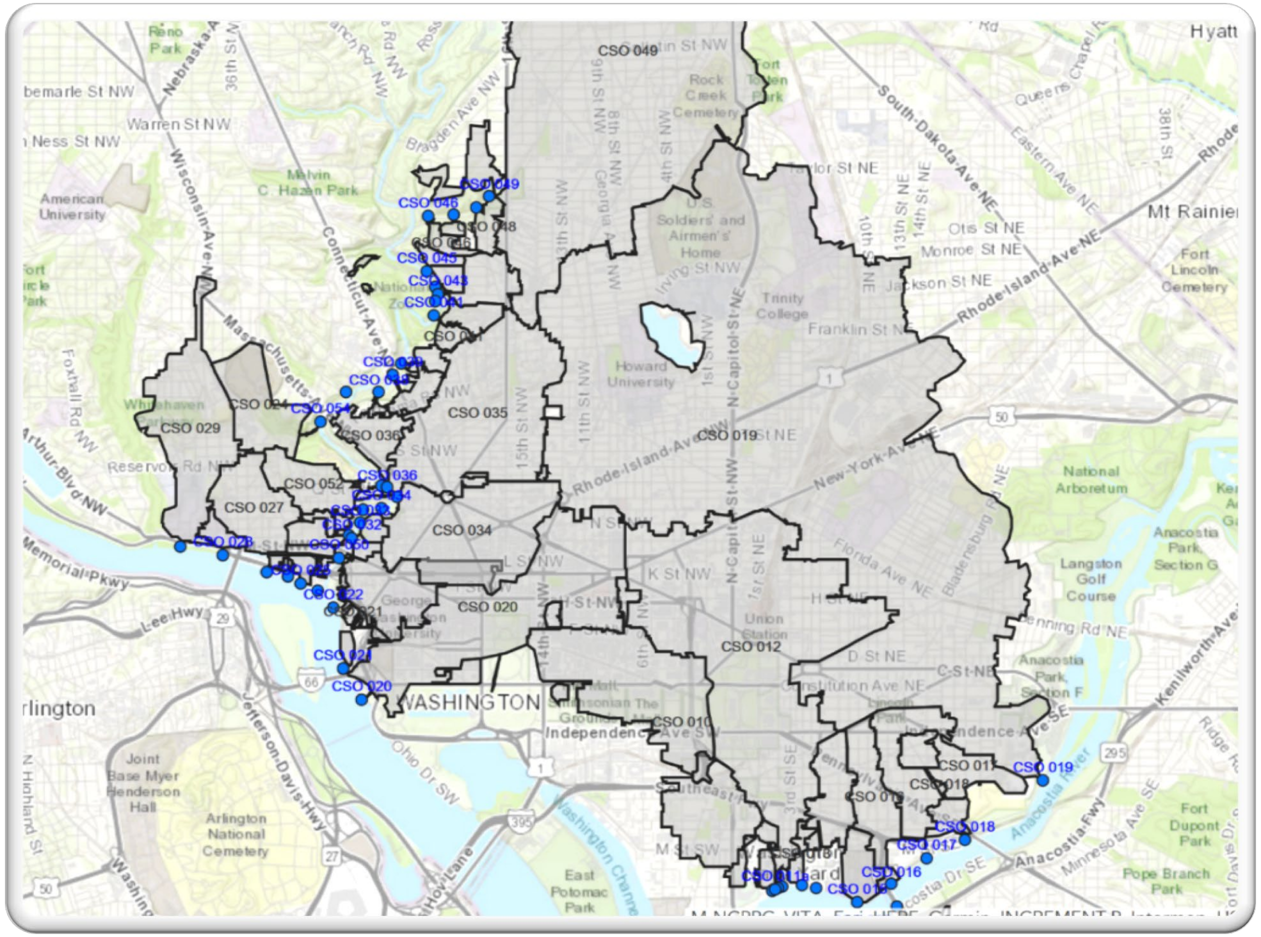
# The environment and scope of the project:


# System Development Life Cycle (SDLC)

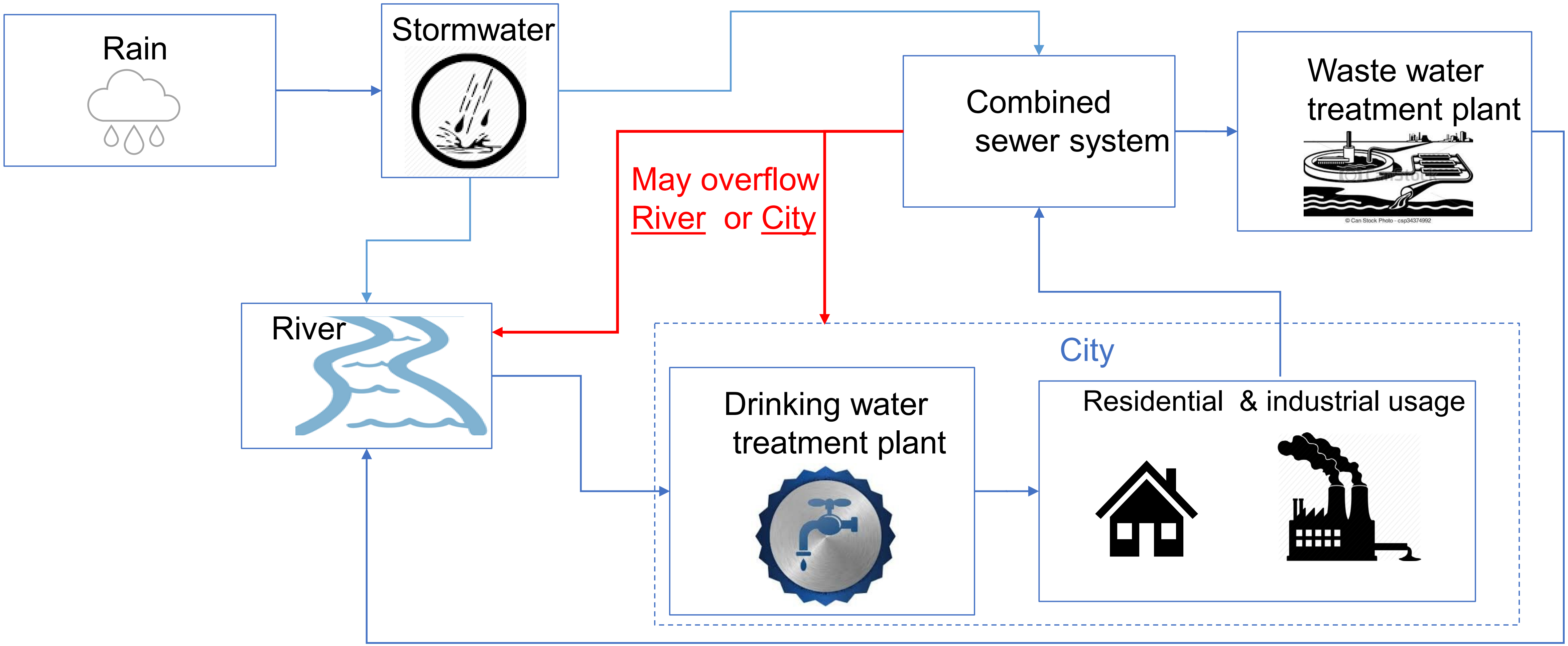


# Problem Definition

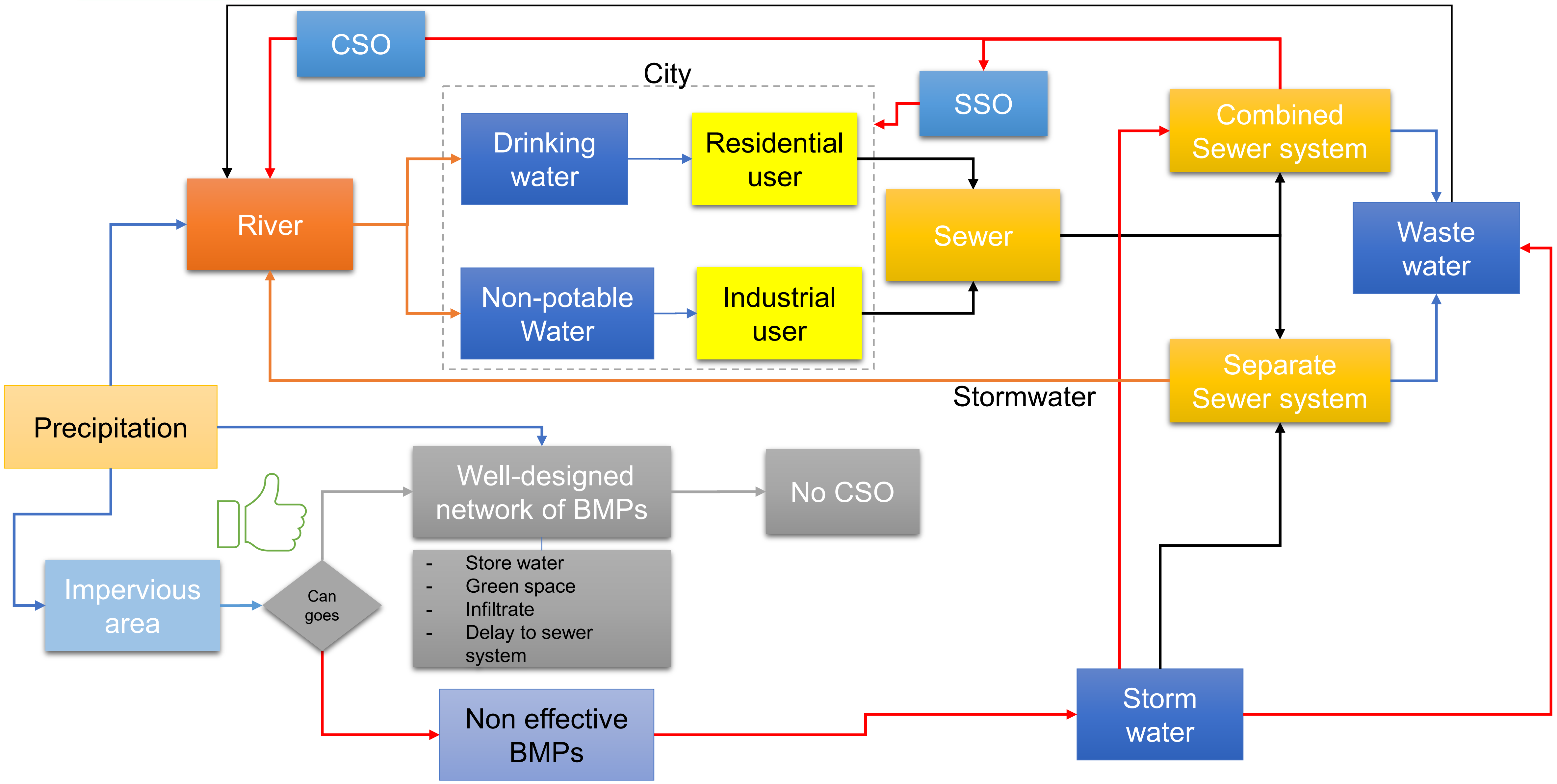
- Stormwater runoff pollutes river
- Usable water is wasted by  allowing to become stormwater



# High Level System Model



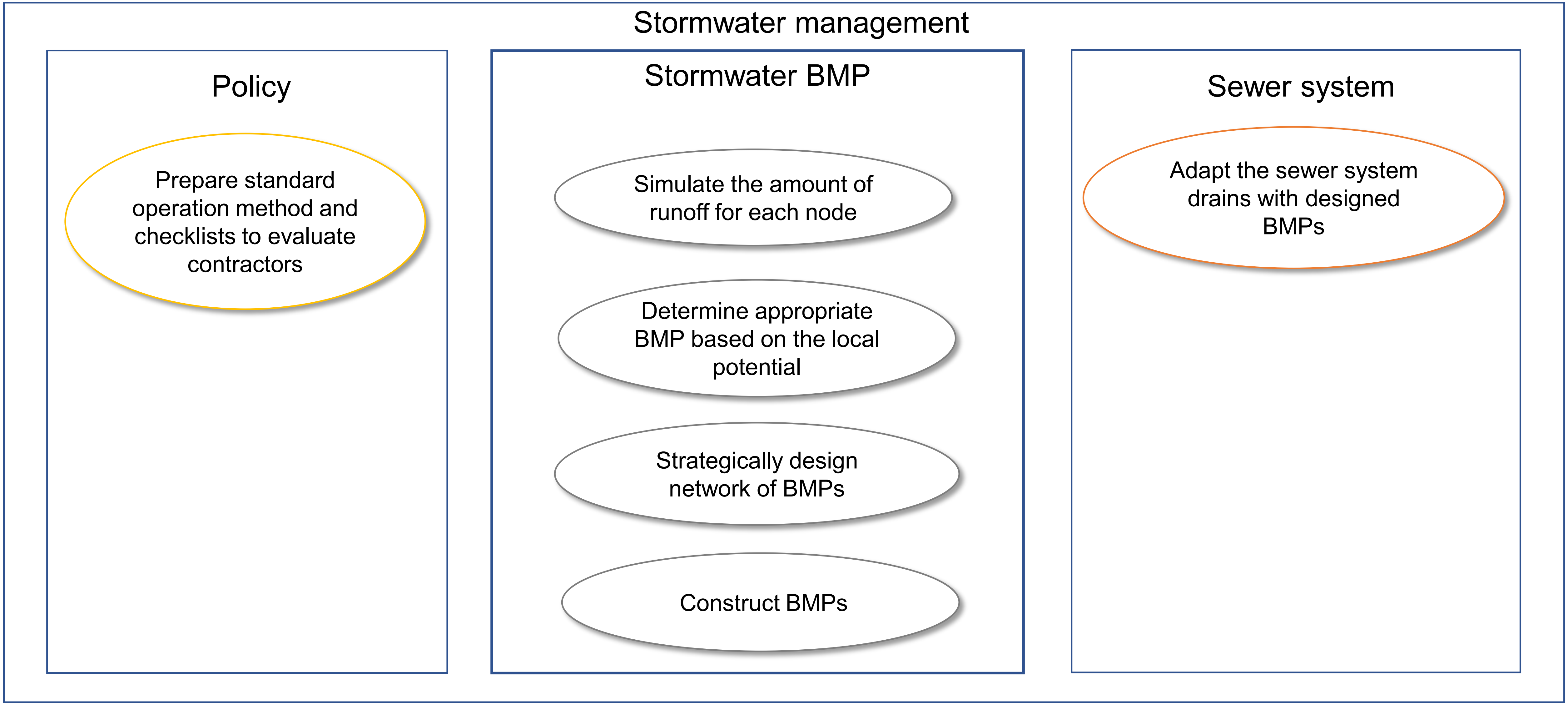
# Conceptual Model



# Users

- ❑ City
- ❑ Managers
- ❑ Contractor
- ❑ Researcher

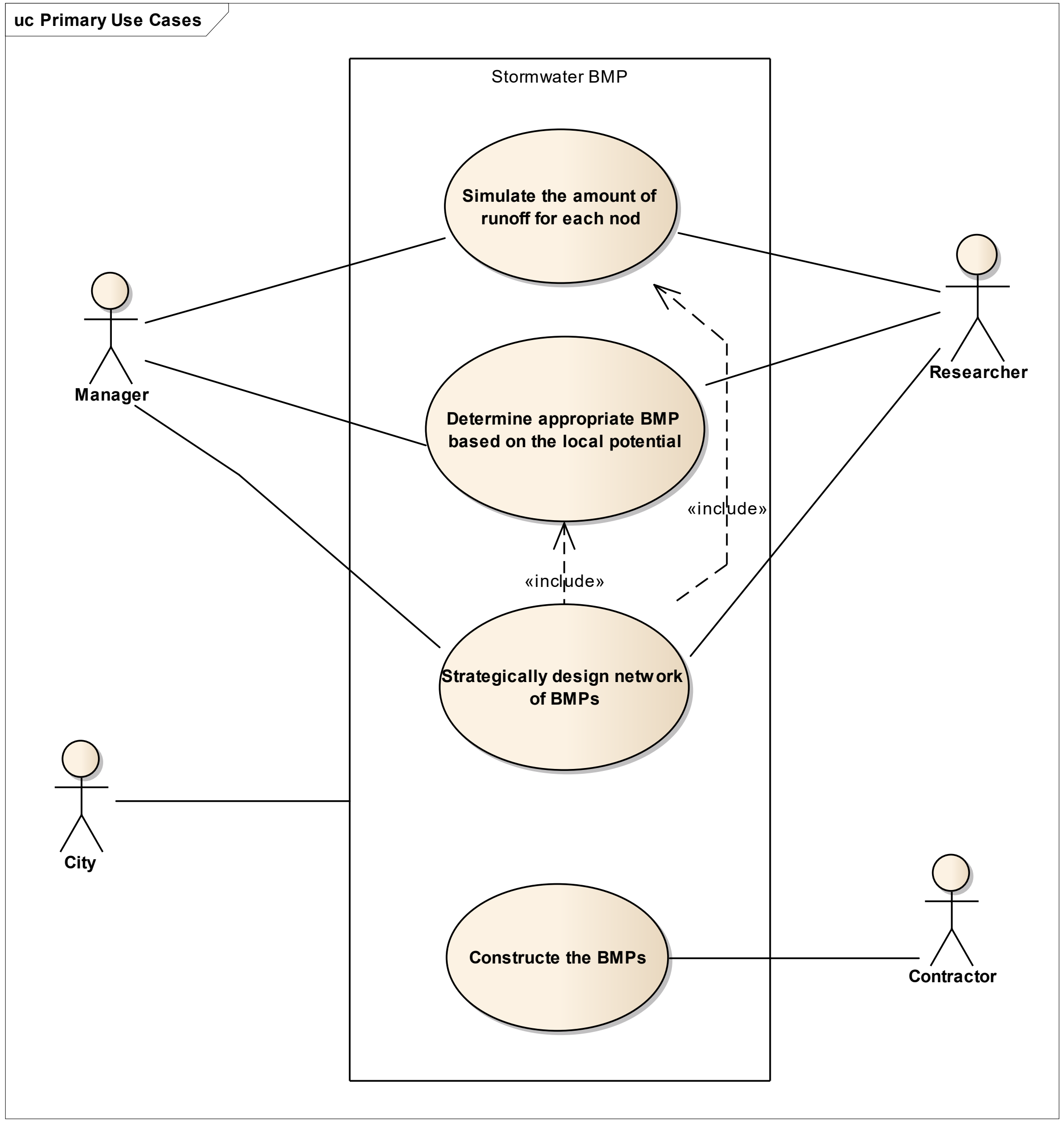
# Use case diagram



# Use case diagram - Water transfer infrastructure

Enterprise Architect software:

- A graphical tool
- Helps teams build robust and maintainable systems



# Use Case Scenarios

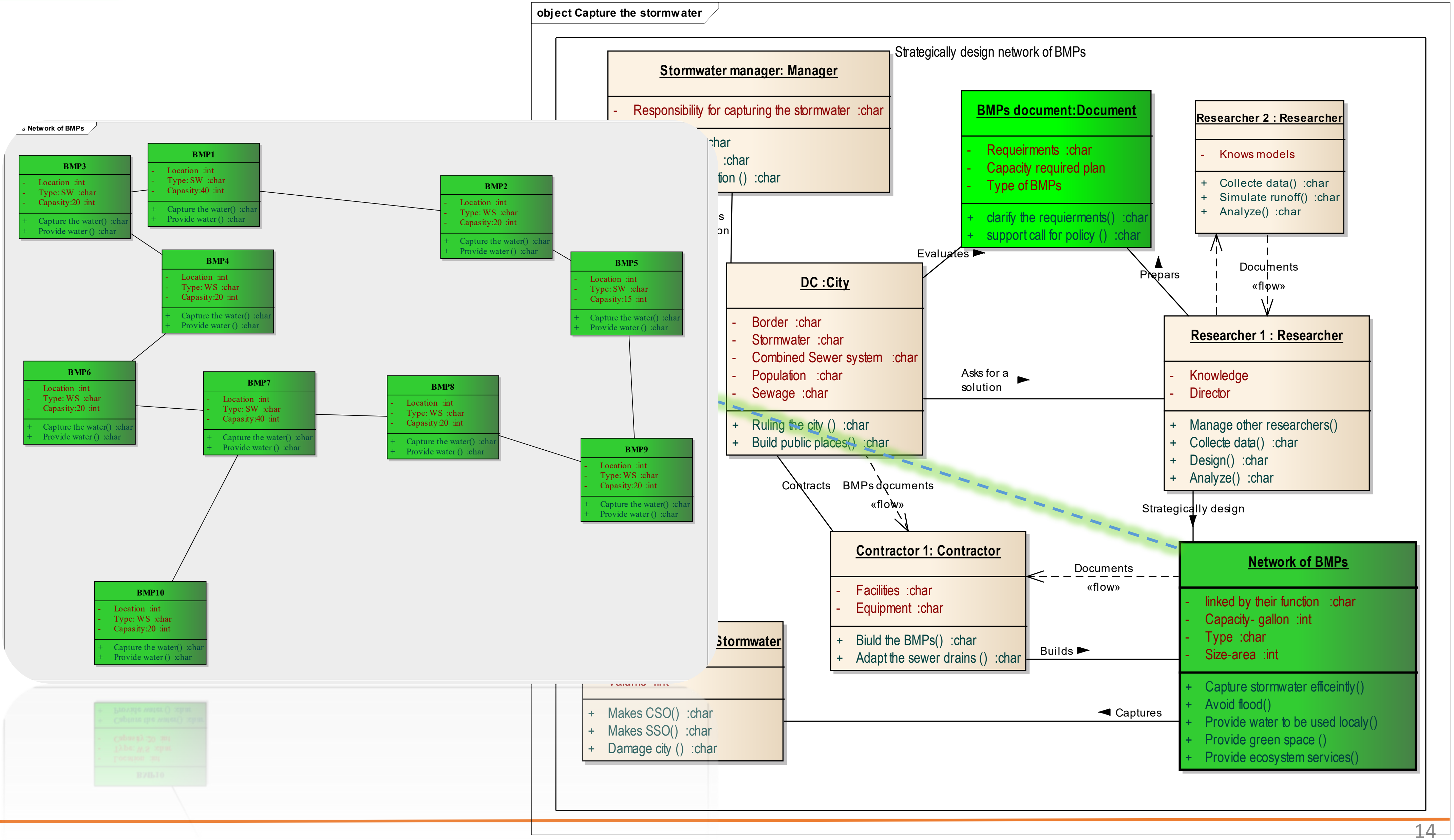
## Stormwater management

### Stormwater BMP

**Strategically design network of BMPs:**

1. Manager gives **mission** to city by new policies to capture stormwater.
2. City ask researcher for a comprehensive **plan** to capture stormwater.
3. Researcher **simulate** the amount of runoff stream for each sewer drain.
4. Researcher determine the best **type of BMPs** for each location based on the physical limits and runoff reduction.
5. Researcher prepare documents of required **capacity of BMPs** for given reliability.
6. City approves the **requirements**.
7. Researcher design strategical **network of BMPs**.
8. Researcher prepare type, location, size and material of the BMPs for the City to give it to the contractors.
9. Contractor **builds BMPs** using documents.
10. City **controls** and approves.

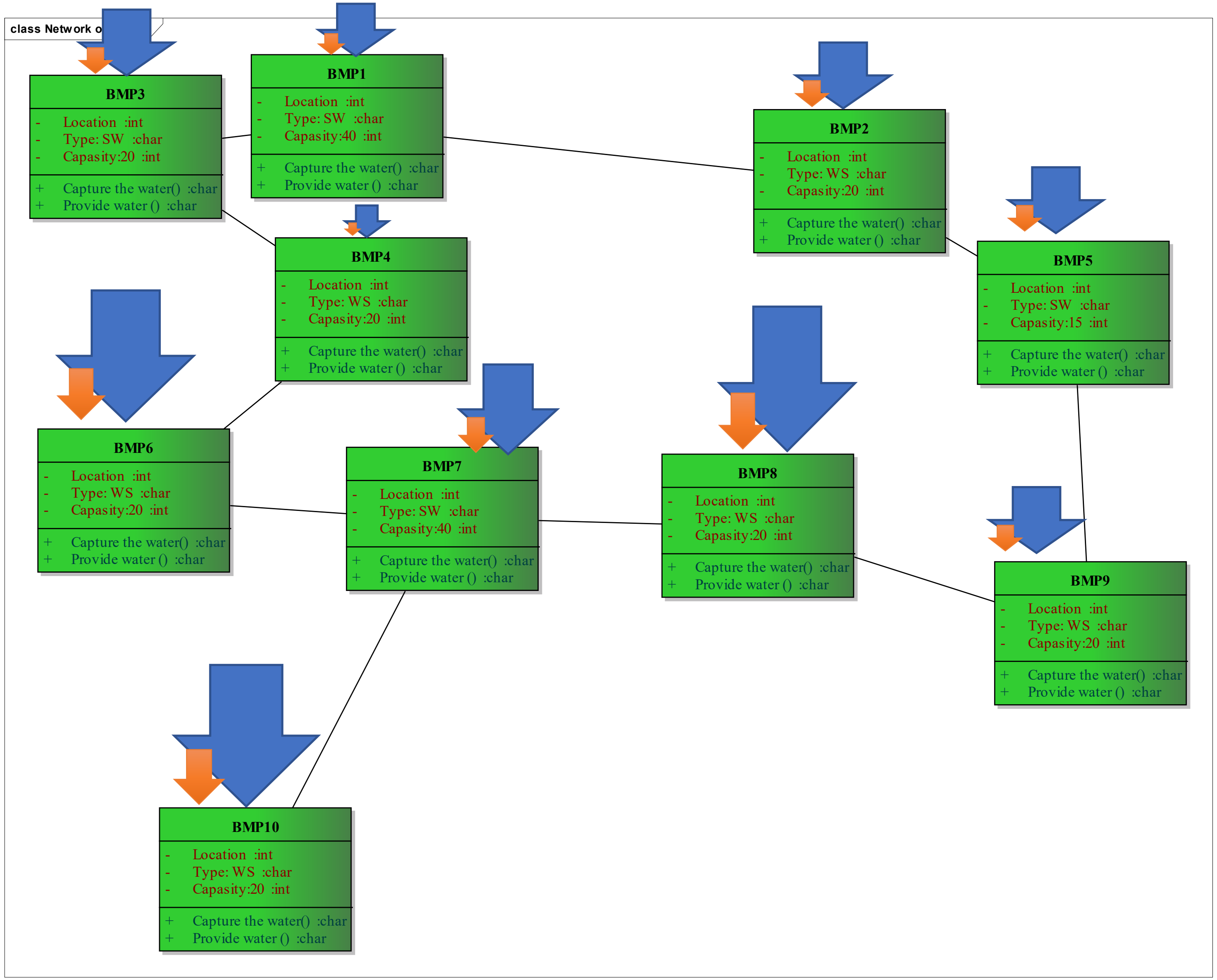
# Object Diagram- Capture the Stormwater:



# Network of BMPs

| Stormwater Practice | Runoff Reduction Rates from Literature (%)[a] |
|---|---|
| Green Roof | 45–60 |
| Rooftop Disconnection | 25–50 |
| Raintanks and Cisterns | Amount captured and reused |
| Pervious Parking | 45–75 |
| Grass Channel | 10–20 |
| Bioretention | 40–80 |
| Dry Swale | 40–60 |
| Wet Swale | Less than 10% |
| Infiltration | 50–90 |
| Extended Detention Pond | 0–15 |
| Soil Amendments | 50–75 |
| Filter Strip; Sheetflow to Open Space | 50–75 |
| Filtering Practice | Less than 10% |
| Constructed Wetland | Less than 10% |
| Wet Pond | Less than 10% |

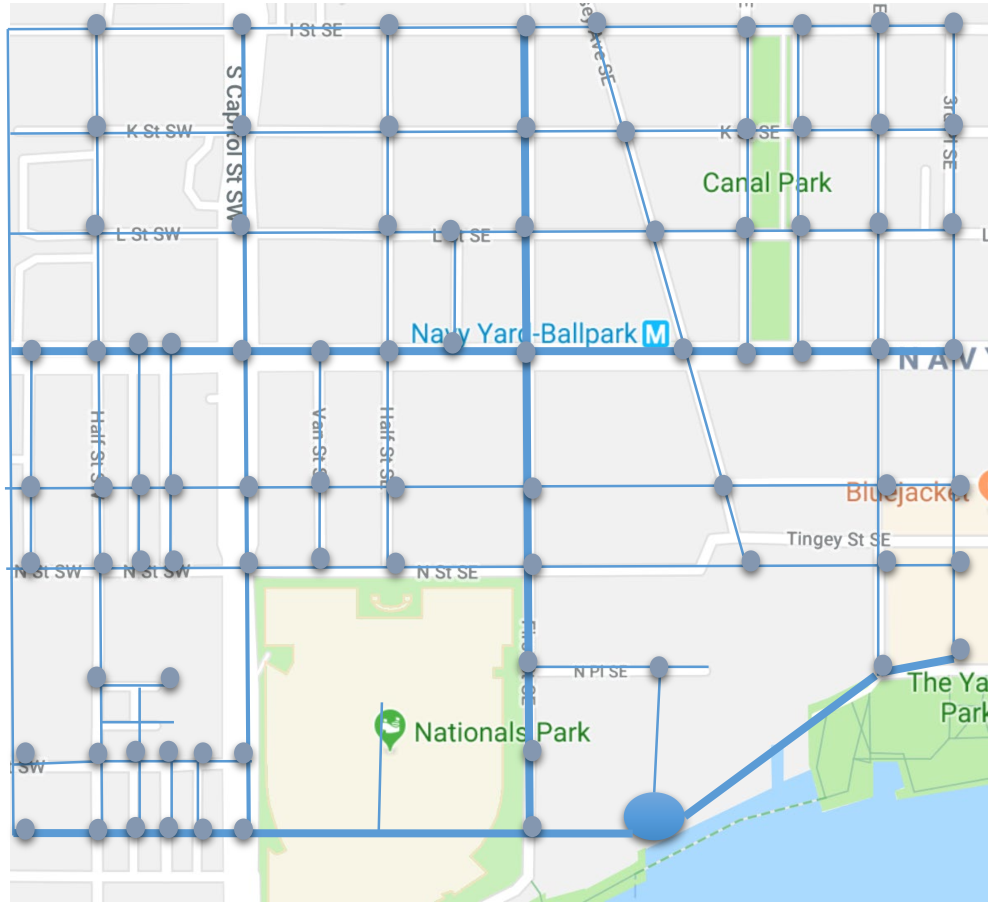
Hirschman et al. 2008.



# Sewer system network

Using models:

- Probability of precipitation
- Probability of runoff for each nodes
- Highest capacity determine by the highest precipitation
- Desire reliability determine the required capacity for BMPs.



# Sewer System Network With Layout of BMPs

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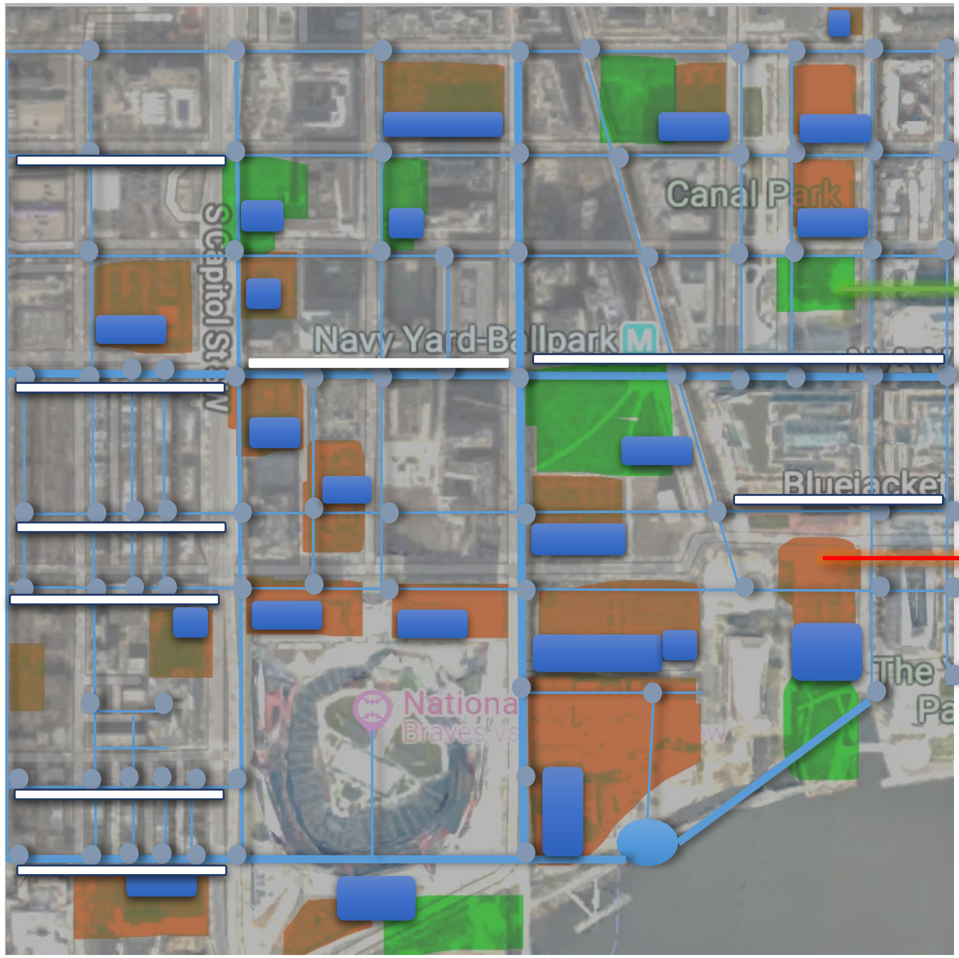


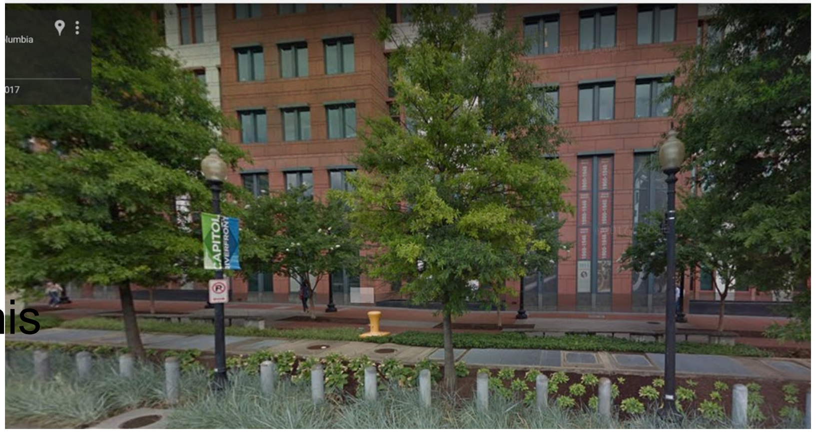

BMP “Bioretention ” type

BMP “Pervious Parking” type

Green space

Parking lot

There are some BMPs in this area but not adequate.



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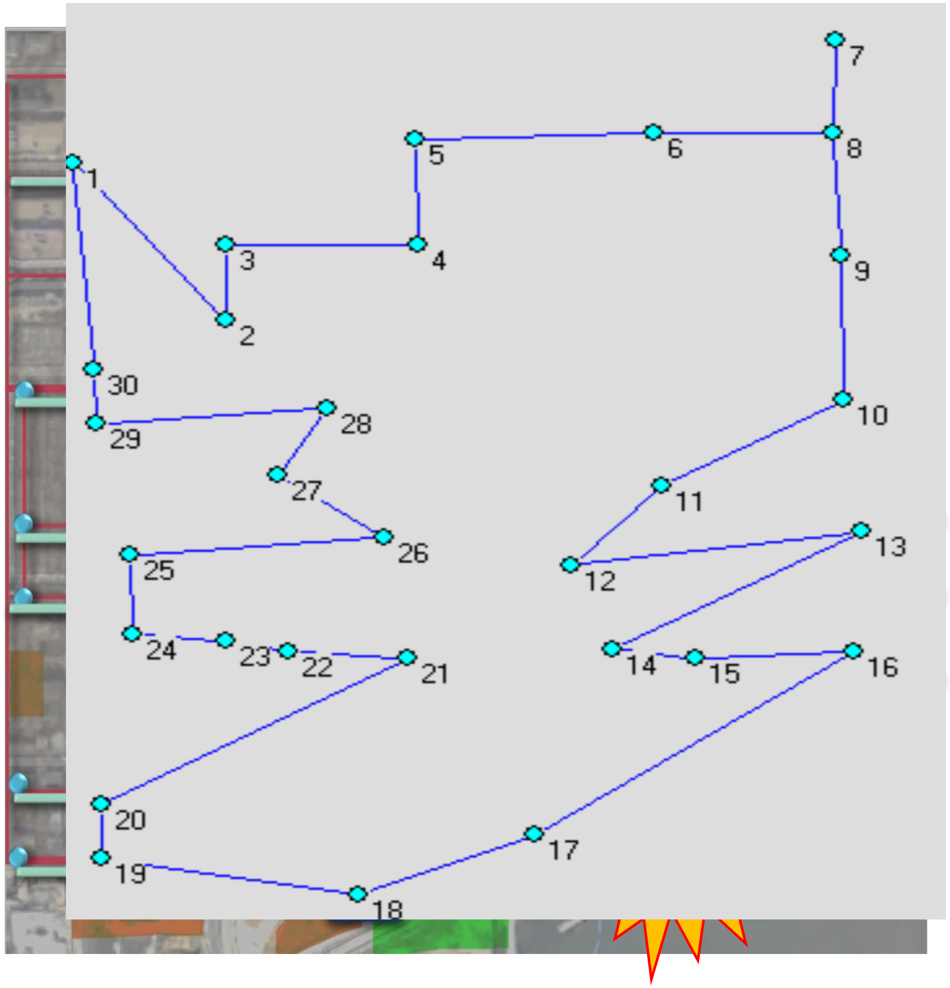
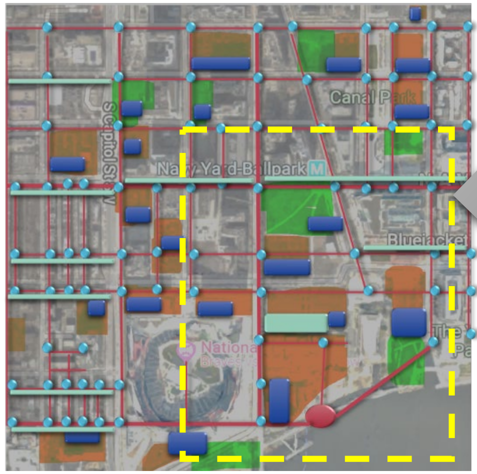
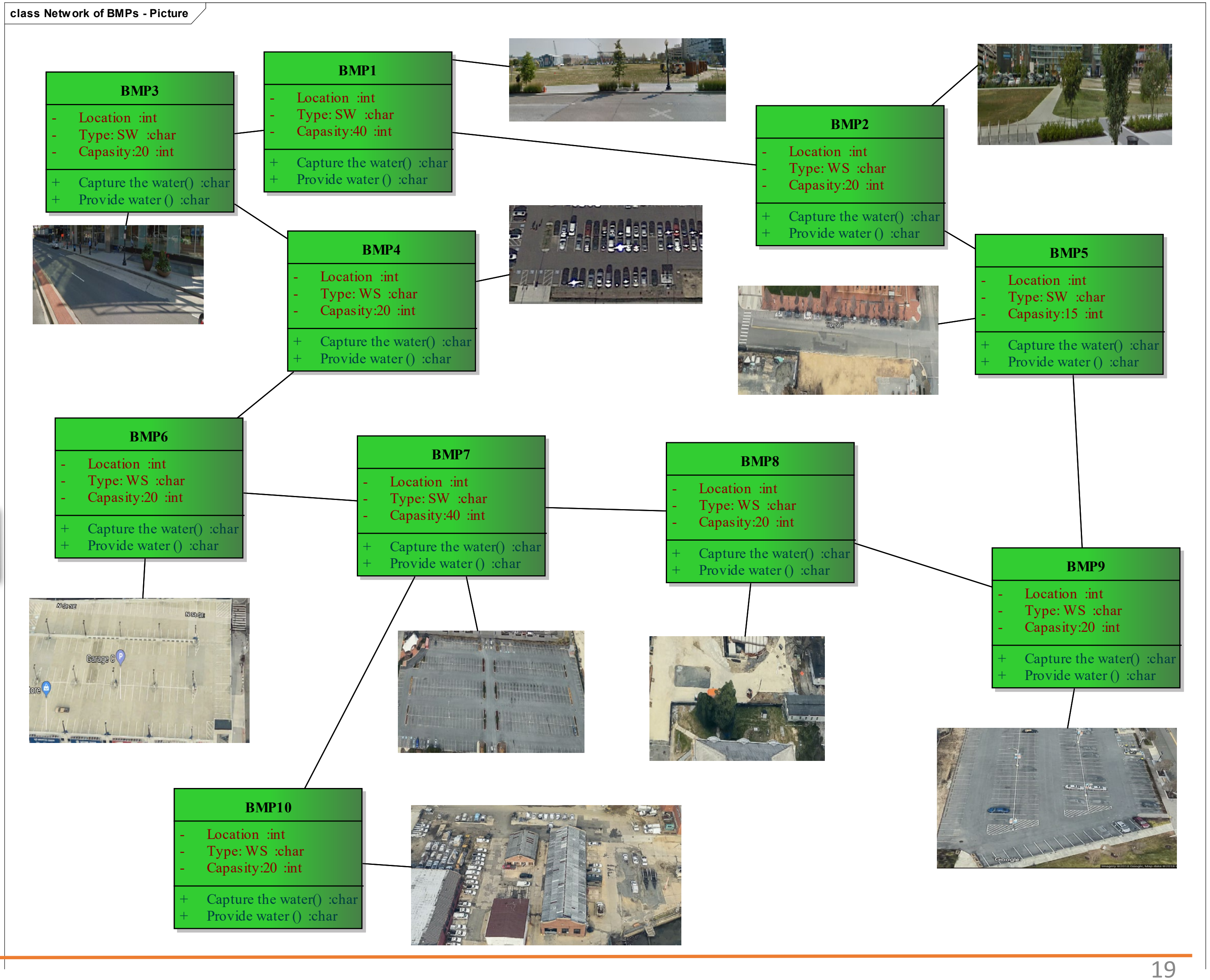
# How Network of BMPs cover the area:

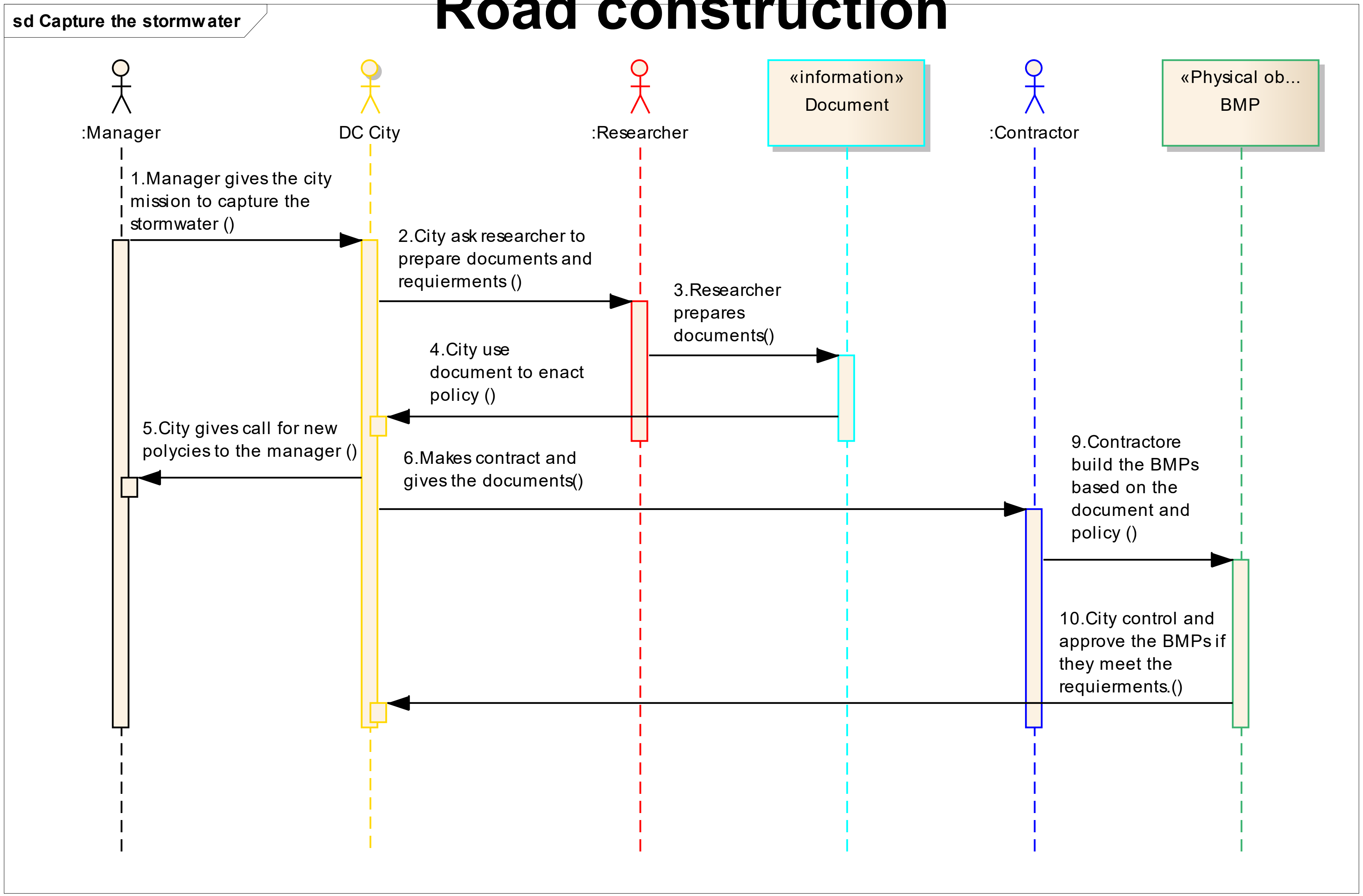


# Nodes of the network

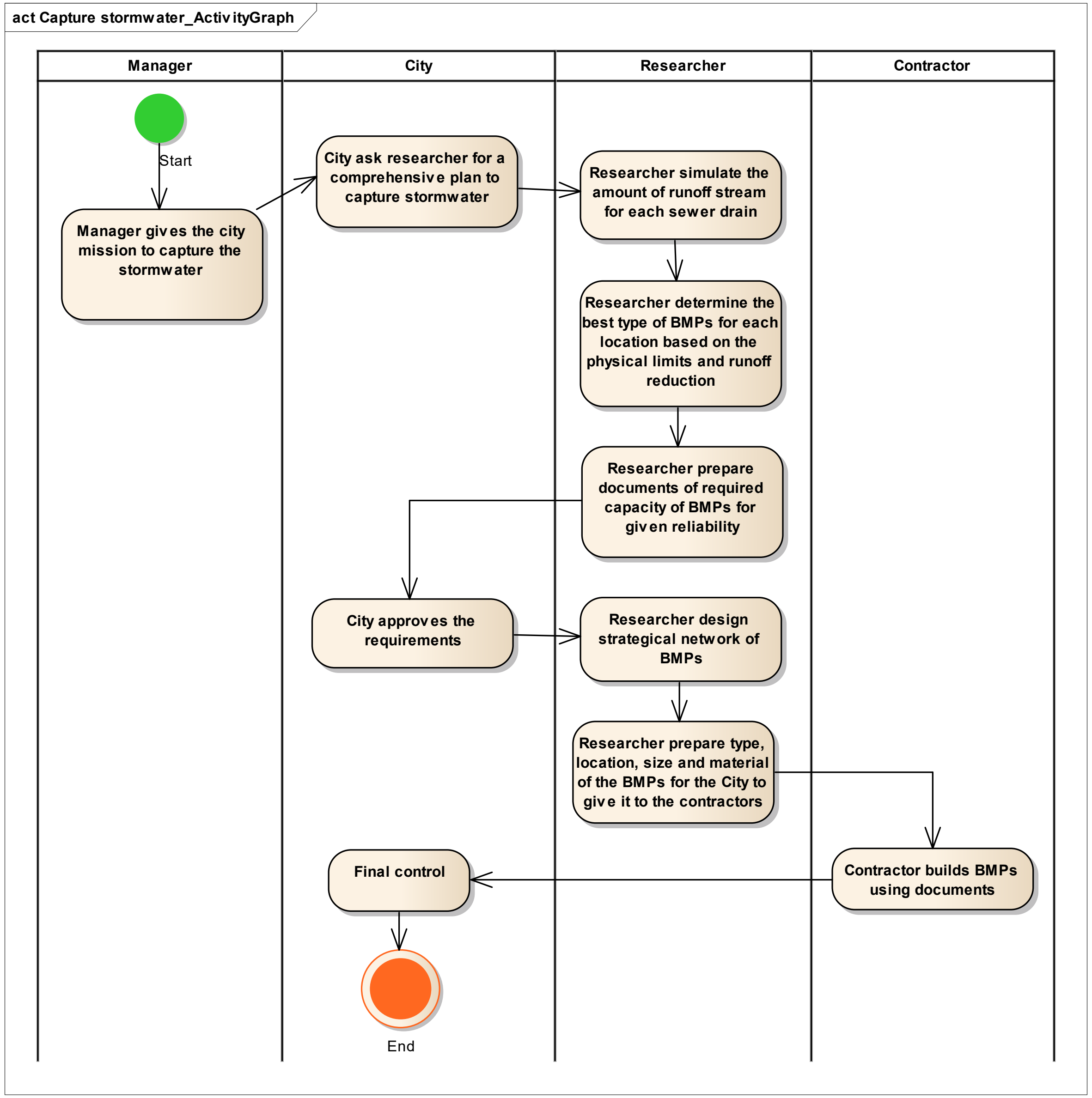




# Sequence diagram- Create new design for Road construction



# Activity Diagram- Crate new design for road construction



# Conclusion and future research

- Systems engineering is broadly concerned with the planning and management. Incorporating this system with water management,  can lead to the systematic solutions:
    - Determine responsibilities of all stakeholders or users.
    - Activity plan which is ready to be used by project managers for each specific section.
    - Detail oriented with holistic view.

# Thank you for your attention!

## Question?

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