Attenuating and managing flows through source control principles within sewer systems

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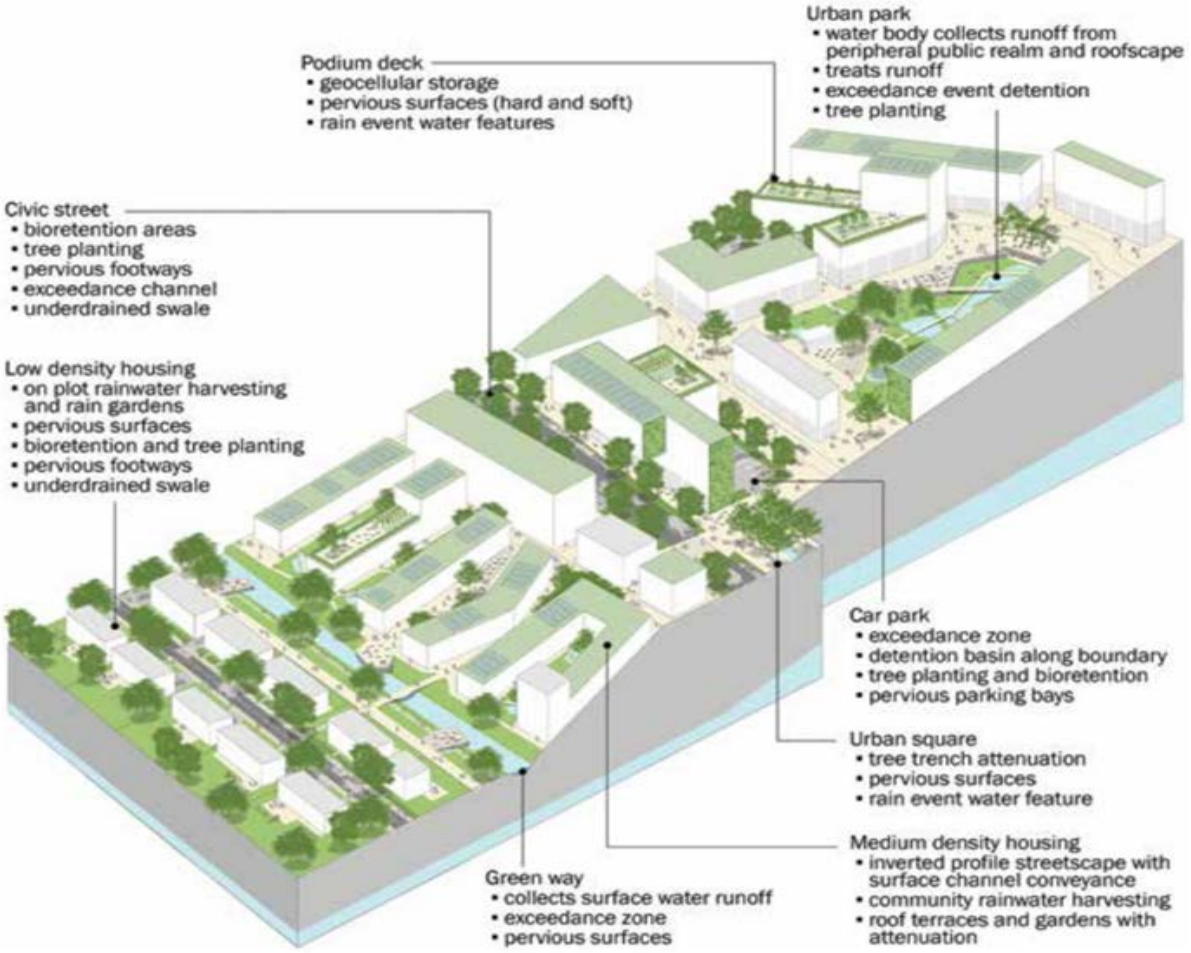
Turning Water Around...®

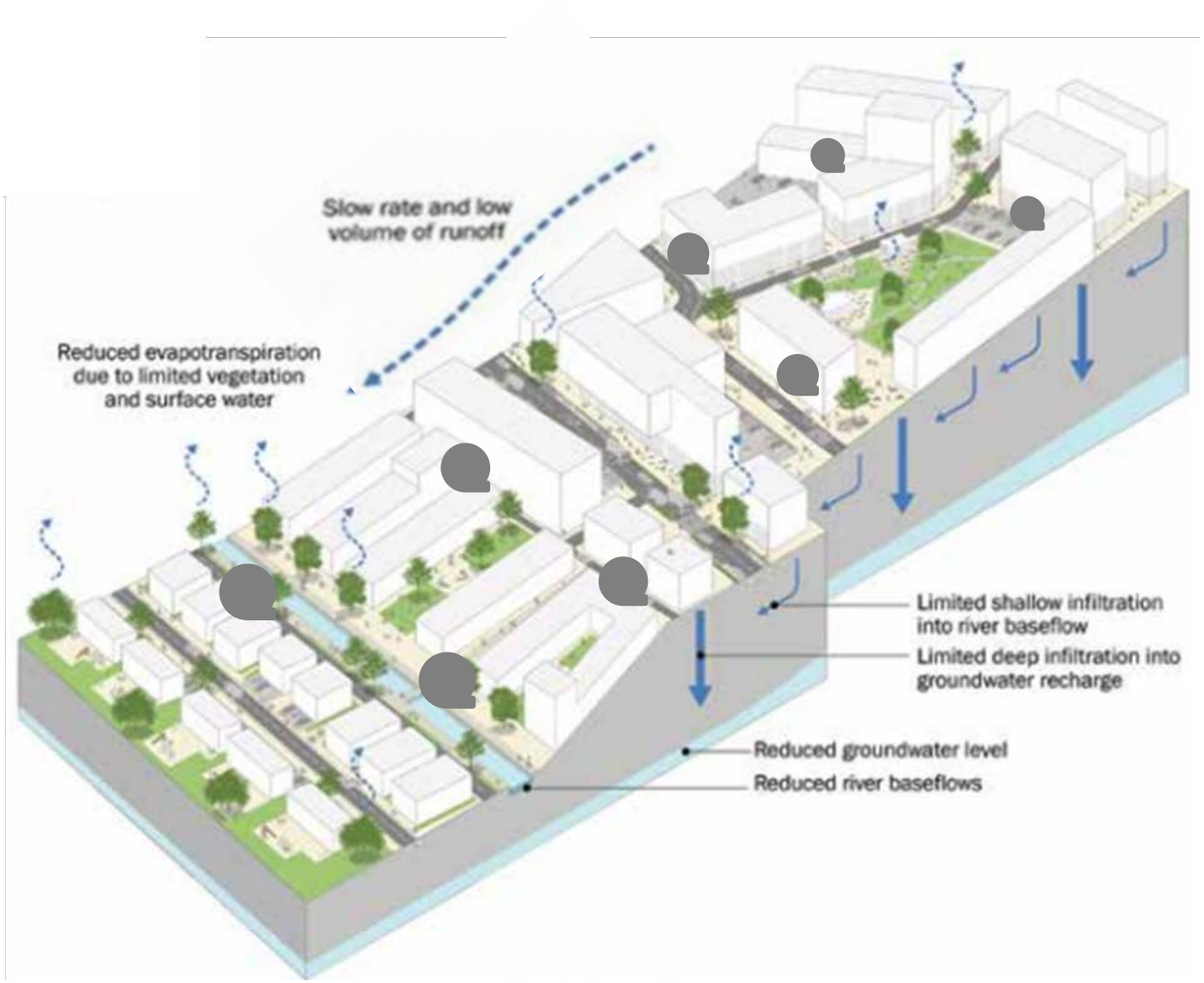
Agenda

- Design principles
- Source control & vortex flow controls
- Hypothetical case studies
- Conclusions

Design principles



Source control & flow controls



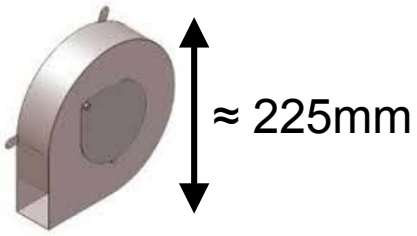
Case study methodology

- Flood resistance analysis
  - Measured depth of rainfall that caused flooding or over-discharge.
- Flood resilience analysis
  - Scaled rainfall hyetographs to cause the sewer systems to flood.
  - Measured total flood volume and number of nodes that flooded for each scenario

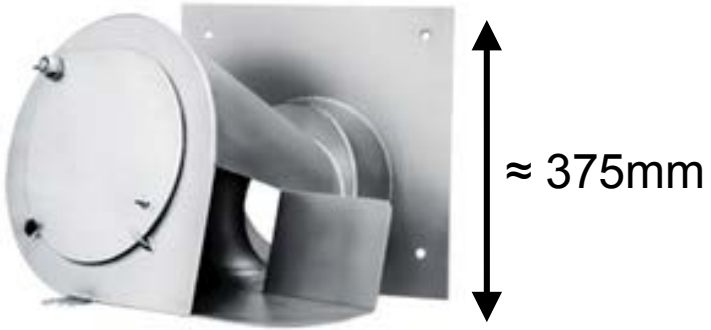
Case study methodology

- Four case study scenarios:
  1) **Base case** - No additional flow controls were installed into the sewer system;
  2) **In-sewer** - Only installing larger in-sewer flow controls into the sewer system;
  3) **Plot-based** - Installing individual plot-based flow controls on each dwelling in the catchment; and
  4) **Combination** - Installing a combination of plot-based flow controls and the larger in-sewer flow controls.

Dwelling flow controls:

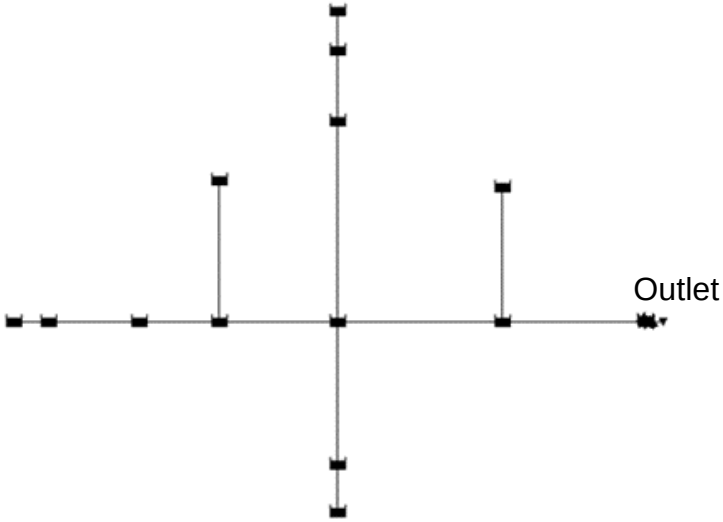


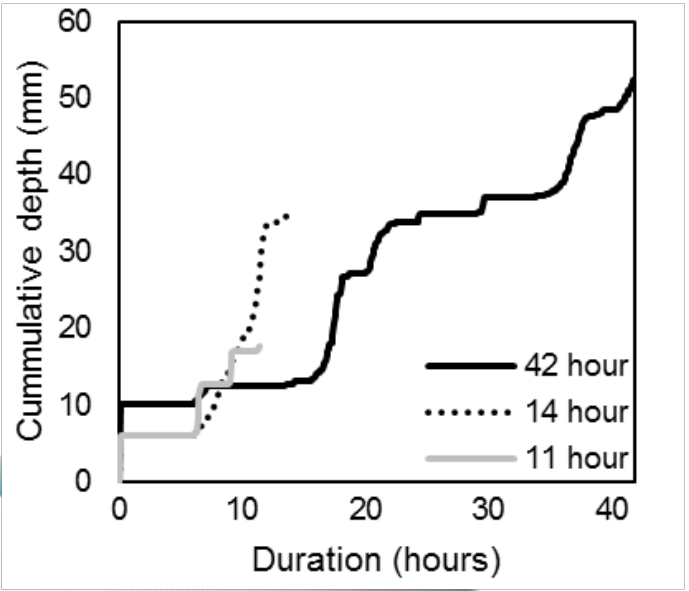
Sewer flow controls:



Case study – Small anonymised system

- Small anonymised sewer system:
  - South-west England
  - Stormwater network
  - 105 houses on the network
  - 13.2 l/s discharge consent

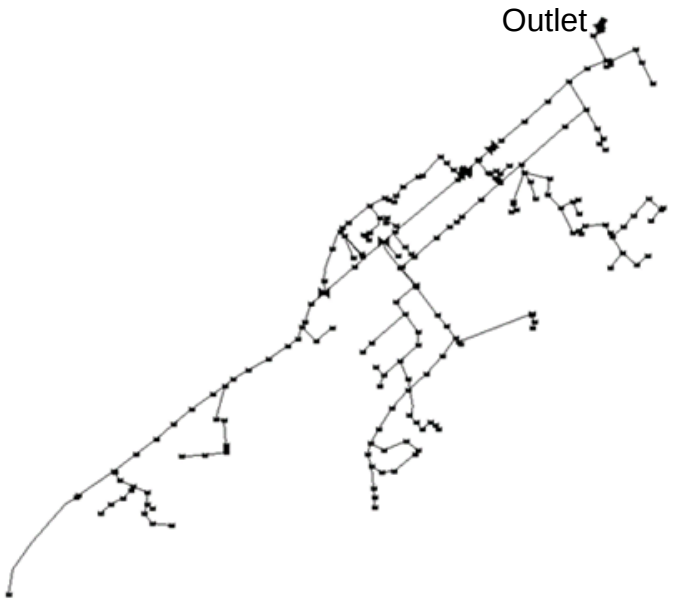


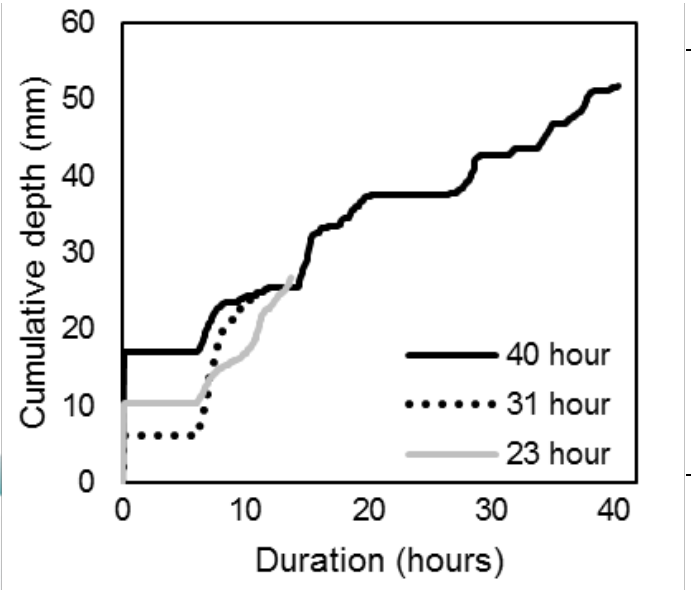


Scenario	Number of in-sewer flow controls	Number of plot flow controls
No additional flow controls	0	0
Only sewer flow controls	2	0
Only plot flow controls	0	105
Both plot & sewer flow controls	2	105

Case study – Large anonymised system

- Large anonymised sewer system:
  - North-west Scotland
  - Combined sewer system
  - 1,073 houses on the network
  - 22 l/s discharge consent
  - CSO in the centre of the system





Scenario	Number of in-sewer flow controls	Number of plot flow controls
No additional flow controls	0	0
Only sewer flow controls	8	0
Only plot flow controls	0	1,073
Both plot & sewer flow controls	8	1,073

Flood resistance analysis

- In both cases the plot-based flow controls reduced the risk of flooding.
- In the larger system, including both plot-based and sewer flow controls gave the greatest reduction.

Small anonymised sewer system:

Scenario	Rainfall hyetograph	42 hour	14 hour	11 hour	Minimum rainfall depth that caused system flooding (mm):
	No additional flow controls	73.2	33.9	17.7	17.7
	Only sewer flow controls	116.6	49.6	24.8	24.8
	Only plot flow controls	81.0	43.5	39.6	39.6
	Both plot & sewer flow controls	81.0	55.6	39.6	39.6

Large anonymised sewer system:

Scenario	Rainfall hyetograph	40 hour	31 hour	23 hour	Minimum rainfall depth that caused system flooding (mm):
	No additional flow controls	6.2	5.4	6.9	5.4
	Only sewer flow controls	7.8	4.8	8.6	4.8
	Only plot flow controls	6.7	6.0	7.5	6.0
	Both plot & sewer flow controls	8.8	6.9	9.9	6.9

Flood resilience analysis – Small system

- In-sewer flow controls reduced flood volume the most.
- With plot-based flow controls installed:
  - Flood volumes increased;
  - Number of flooded manholes increased;
  - Flood volume per flooded manhole decreased.

Small anonymised sewer system:

Scenario	Rainfall hyetograph	42 hour	14 hour	11 hour	Maximum flood volume predicted (m^3):
	Depth of rainfall applied (mm)	261.3	178.3	88.7	
	No additional flow controls	1,351	1,444	282	1,444
	Only sewer flow controls	613	1,004	5	1,004
	Only plot flow controls	1,690	1,590	630	1,690
	Both plot & sewer flow controls	1,340	1,198	630	1,340

Scenario	Rainfall hyetograph	42 hour	14 hour	11 hour	Maximum number of nodes that flooded:
	Depth of rainfall applied (mm)	261.3	178.3	88.7	
	No additional flow controls	7	2	2	7
	Only sewer flow controls	9	6	3	9
	Only plot flow controls	14	15	13	15
	Both plot & sewer flow controls	16	16	13	16

Flood resilience analysis – Large system

- In-sewer flow controls reduced flood volume the most.
- With plot-based flow controls installed:
  - Flood volumes increased;
  - Number of flooded manholes increased;
  - Flood volume per flooded manhole decreased.

Large anonymised sewer system:

Scenario	Rainfall hyetograph	40 hour	31 hour	23 hour	Maximum flood volume predicted (m^3):
	Depth of rainfall applied (mm)	51.8	29.9	34.3	
	No additional flow controls	3,034	1,276	2,022	3,034
	Only sewer flow controls	1,858	1,070	816	1,858
	Only plot flow controls	2,940	1,192	1,731	2,940
	Both plot & sewer flow controls	1,490	714	353	1,490

Scenario	Rainfall hyetograph	40 hour	31 hour	23 hour	Maximum number of nodes that flooded:
	Depth of rainfall applied (mm)	51.8	29.9	34.3	
	No additional flow controls	34	11	22	34
	Only sewer flow controls	38	19	27	38
	Only plot flow controls	53	8	8	53
	Both plot & sewer flow controls	59	19	10	59

Conclusions

- By applying flow controls:
  - Flood risk reduced; and
  - Flood resilience is increased.
- By applying plot-based flow controls:
  - Flood risk reduced (+124% and +28% increase in the depth of rainfall, respectively).
- By applying both in-sewer and plot-based flow controls:
  - Flood resilience is increased as maximum flood volumes reduced.
  - However, the number of flooded nodes increased.

Conclusions

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Thank you

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