Adapting Stormwater Management to Climate Change

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SUMMARY

- Urbanization has adverse hydrologic impacts, including increased flooding, diminished water quality, and decreased baseflow.

- Conventional and emerging storm-water management practices are based on historical climate.

SUMMARY

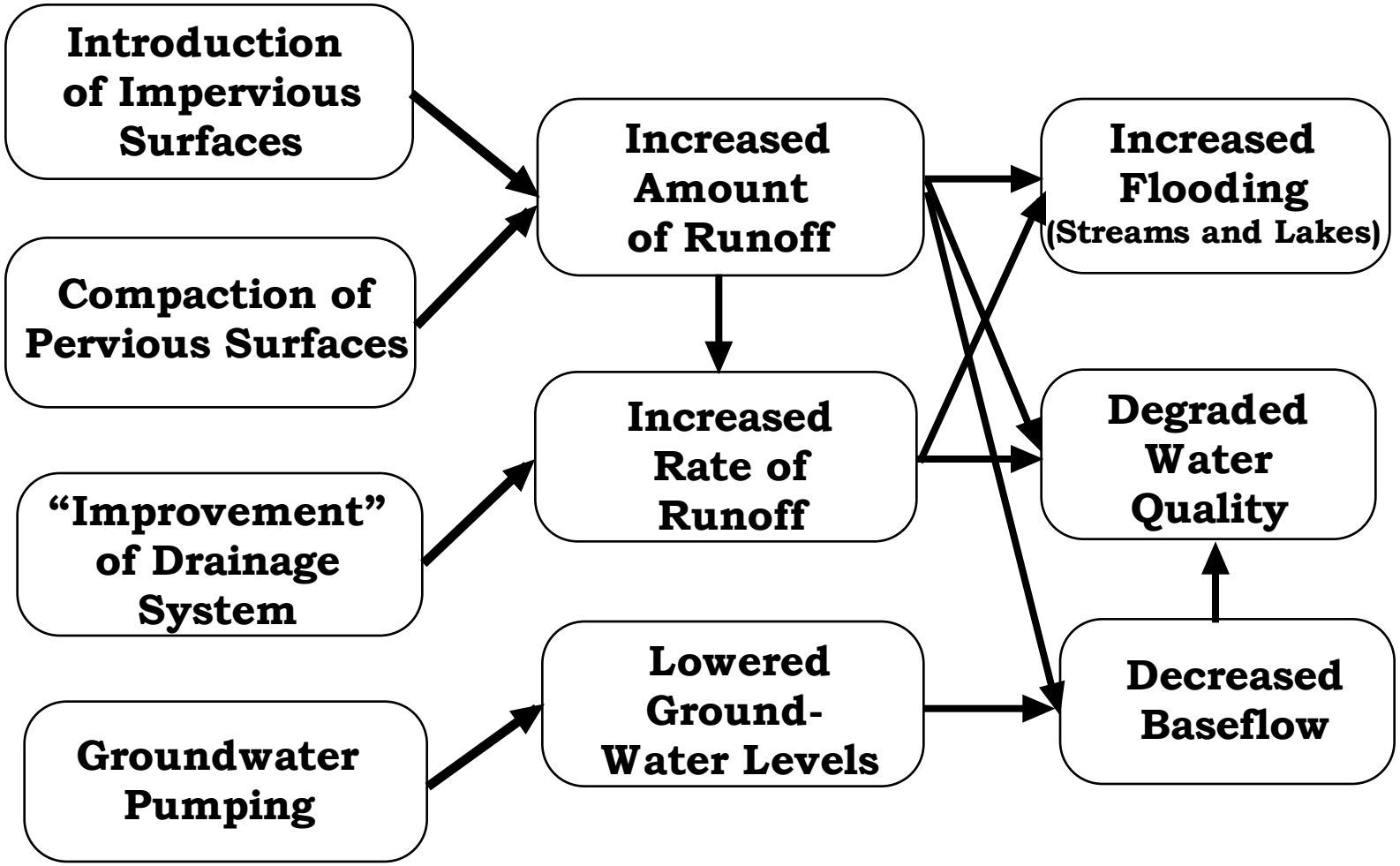
- We may very well not know how local climates will change until after the fact.

- A potentially effective strategy is to design ***conservatively*** to hedge against possible increases in storm intensities.

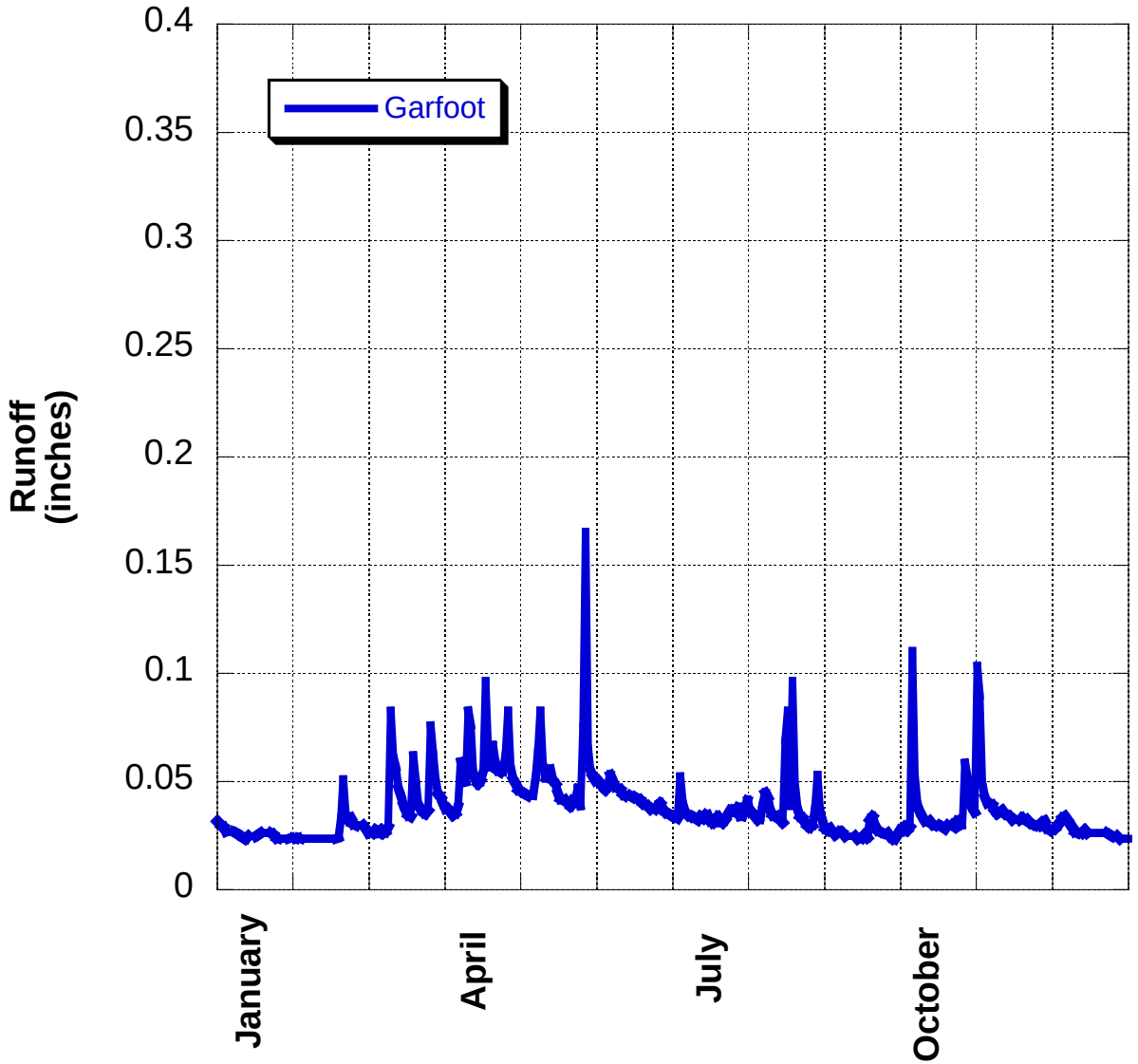
SUMMARY

- Other potential strategies are to
  - Improve performance of existing ***systems*** based on monitoring and modeling;
  - Introduce capacity for ***real-time*** management.

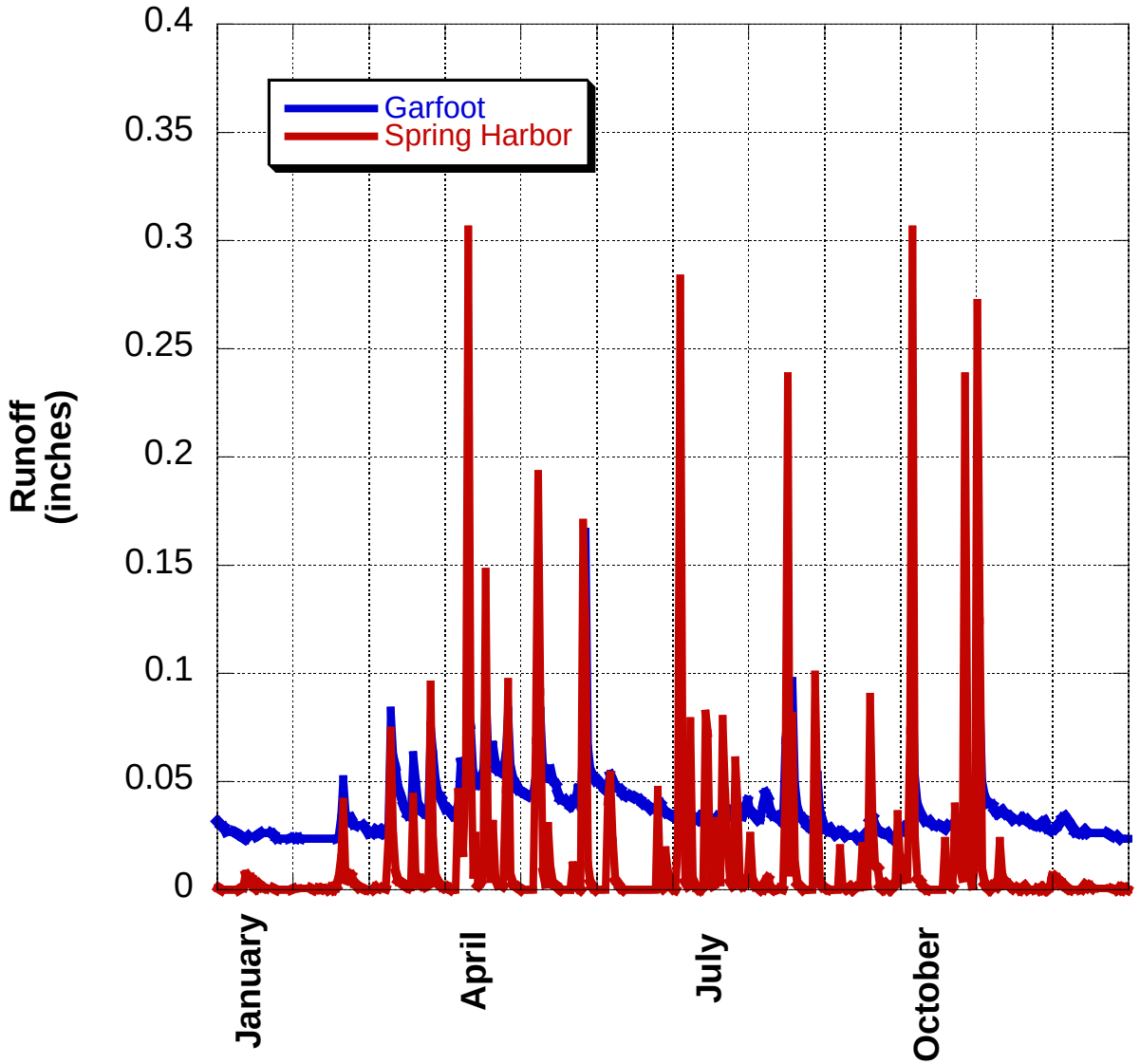
HYDROLOGICAL IMPACTS OF URBANIZATION



1995 RUNOFF
GARFOOT CREEK



1995 RUNOFF
GARFOOT CREEK AND
SPRING HARBOR STORMSEWER



STORMWATER MANAGEMENT PRACTICES

- Conveyance, through storm sewers and engineered channels
- **Storage, to prevent increases in runoff peaks and improve water quality**
- **Infiltration, to decrease runoff volumes and increase ground water recharge**
- Filtration, to improve water quality

CLIMATE AND DESIGN

- Stormwater management design is commonly based on design storms, such as the 10-year, 24-hour storm.

- There is general belief that the magnitude of these storms will increase a a result of climate change.

- How should stormwater managers proceed?

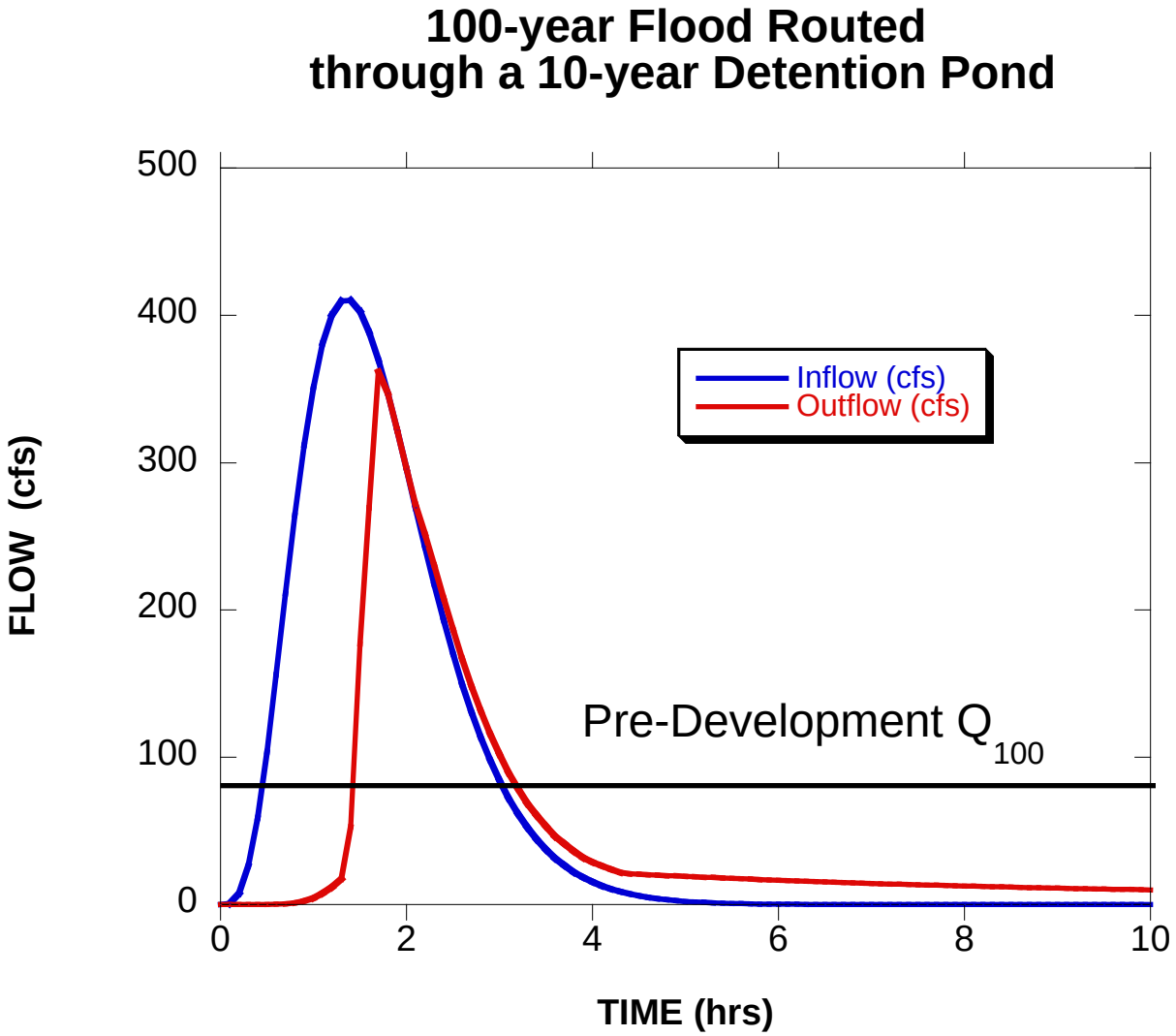
POTENTIAL STRATEGIES FOR ADAPTING TO CLIMATE CHANGE

- Design ***conservatively***.
- Improve performance of existing ***systems*** based on monitoring and modeling.
- Introduce capacity for ***real-time*** management.

CONSERVATIVE DESIGN

Requires a logical basis.

- **Regulate to the 100-year event.**
- Reduce consequences of events > design.
- Use regularly updated rainfall statistics.
- Use lowest pre-development CNs that can be justified.
- Aggressively infiltrate, but do not credit storage towards peak requirement.


100-year Flood Routed
through a 10-year Detention Pond
500
400
300
200
100
0
FLOW (cfs)
Inflow (cfs)
Outflow (cfs)
Pre-Development Q100
0
2
4
6
8
10
TIME (hrs)

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HYPOTHETICAL INFILTRATION CASE STUDY

- 160-acre development
- 50% impervious
- Pre- and post-development pervious CN
  - Case 1: 70 (B soils)
  - Case 1: 79 (C soils)
- Present climate: Midwestern Climate Center Bulletin 71
- Future climate: 15% increase in design rainfalls

PROCEDURE

- Designed a pond and outlet structure to control 100-year event.
- Routed a 100-year event based on +15% rainfall.
- Modified runoff assuming infiltration practices that controlled 2-year event (8-in. depression; 12-in. subsurface storage; 6 in./hr. infiltration rate for engineered layers).
- Repeated routing with +15% rainfall.

RESULTS: CN = 70

		Q_{100} (cfs)
Current P	Pre-dev.	73
	Post-dev.	411
	Post dev. w/detention	73
1.15 P	Post-dev.	489 (+19%)
	Post dev. w/detention	170 (+100%)
	Post dev. w/detention & infiltration	74

RESULTS: CN = 79

		Q_{100} (cfs)
Current P	Pre-dev.	94
	Post-dev.	452
	Post dev. w/detention	94
1.15 P	Post-dev.	528 (+17%)
	Post dev. w/detention	188 (+100%)
	Post dev. w/detention & infiltration	113 (+20%)

RESULTS: CN = 79

Bioretention Area (% of total area)	Q_{100} (cfs)
7.0%	113 (+20%)
8.0%	104 (+11%)
9.0%	95 (+1%)

POTENTIAL STRATEGIES FOR ADAPTING TO CLIMATE CHANGE

- Design conservatively.
- **Improve performance of existing *systems* based on monitoring and modeling**.
- Introduce capacity for real-time management.

IMPROVING SYSTEM PERFORMANCE

- Monitor individual storages to verify assumed
  - Storage-outflow characteristics;
  - Hydrologic parameters.

- Model system using continuous simulation to identify ways to improves system performance.

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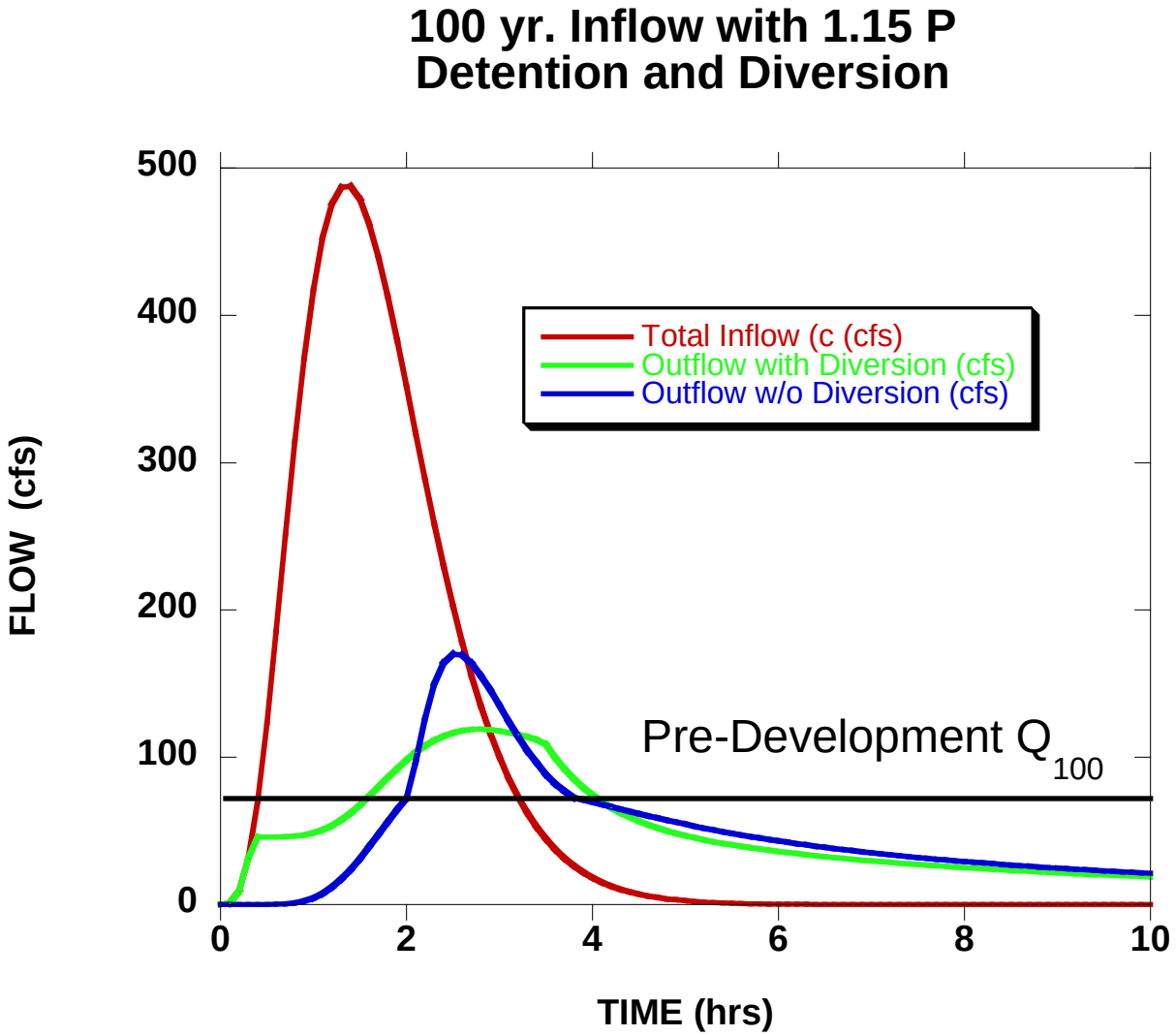
100 yr. Inflow with 1.15 P
Detention and Diversion
FLOW (cfs)
500
400
300
200
100
0
0
2
4
6
8
10
TIME (hrs)
Total Inflow (c (cfs)
Outflow with Diversion (cfs)
Outflow w/o Diversion (cfs)
Pre-Development Q100

SUMMARY AND CONCLUSIONS

- The local affects of climate change on stormwater are highly uncertain.
- There are a number of hedges against increases in storm intensities that can be easily justified.
- Aggressive use of infiltration practices is a promising example.

SUMMARY AND CONCLUSIONS

- Another promising strategy is to improve system performance using monitoring and modeling.
- Based on a preliminary analysis, it does not appear the real-time management will be effective.