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Economic Comparison of Pervious Concrete to Conventional Stormwater Management Strategies

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Acknowledgements:
Huiying Zhu (Research Assistance), Liv Haselbach (Pervious Concrete Research Team Lead)
CMAT Funding, Carolinas Ready Mix Concrete Association (CMAT Partner)

ACE Coastal Training Program (CTP) and the Town of Hollywood, SC:
The Use of Pervious Concrete for Stormwater Management

Poplar Grove Boat House – Hollywood, SC
April 25, 2007

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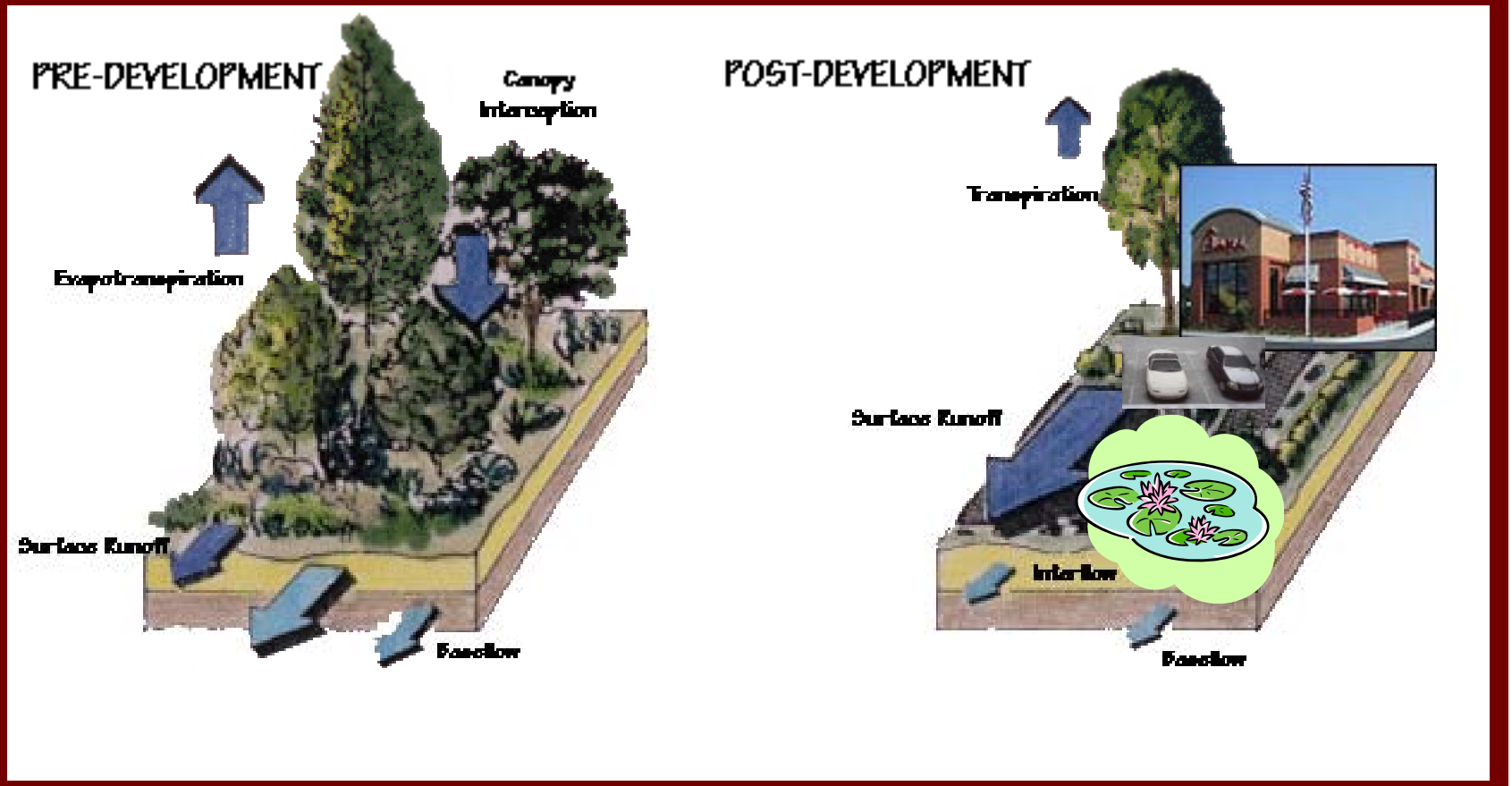
Development & Impervious Areas



Center for Watershed Protection, 1999

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Economic tradeoffs

- E.g., Asphalt vs. Pervious concrete

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Tradeoffs

Factor	Asphalt	*Pervious*
Uncertainty**	Known	"Young"
Lighting needs**	More	Less
Human Factors*	Known	Unknown
Clogging*	Not Applic.	Possible
Heat Island*	high	Lower by?
Greenhouse*	bad	better?
Water flow*	→ SW	→ GW
Pollutant flow**	→ SW	→ GW
Cost per sq. ft*	low	high
System Cost	← PIT Tool	→

*USC pervious research **USC planned research

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Development & Impervious Areas

- Increased runoff causes …
  - Channel deformation
  - Decreased groundwater (GW) recharge and base flows in streams
  - Flooding risk
  - Water temperature
  - Pollutant runoff

→ *Pervious pavements considered a BMP*

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Best Management Practices (BMPs)

- Any technique or device used to improve stormwater quantity / quality
- Permanent or construction phase
- Nonstructural or structural practices
  - Detention or Retention Basin: "stormwater ponds"
  - Soil and Erosion Controls (SECs)
    - Silt fence

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What is Pervious Concrete ?

- A special mixture that creates voids
- The voids make the product highly porous
- The porosity allow rainfall & surface water to percolate through the concrete to a permeable base

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What is Pervious Concrete ?

- Mixture of :
  - Coarse aggregate,
  - Cementitious material,
  - Admixtures, and
  - Water.
- Carefully controlled amounts of water & cementitious materials are used to create a paste that form a thick coating around aggregate particles without flowing off during mixing & placing.


Scale & Texture of Pervious Concrete

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Pervious Impervious Tradeoff (PIT) Model

- Tool to support pervious/impervious surface decisions/policies
  - current focus: small box (10,000 sq. ft) parking lots in coastal areas
- Incorporate/guide research findings of USC Pervious concrete program
- Educational tool

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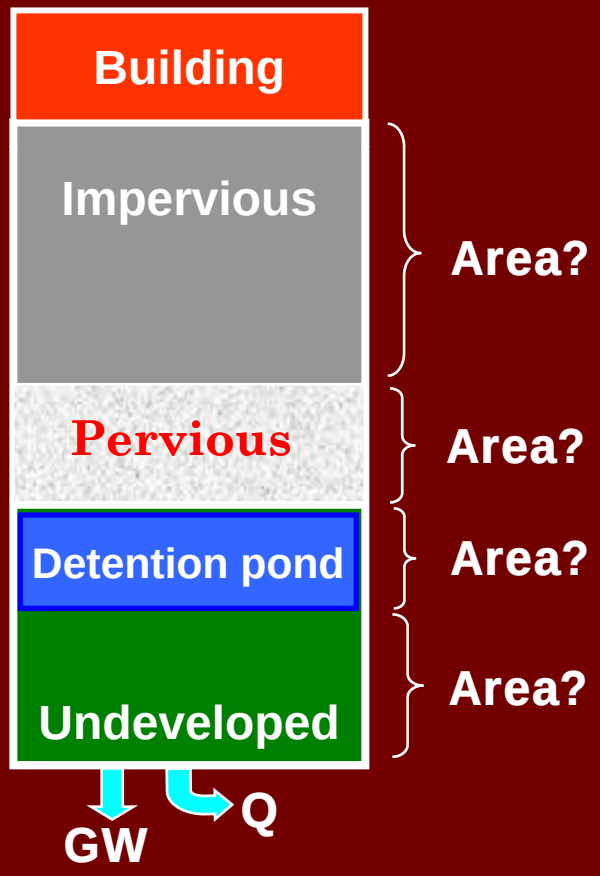
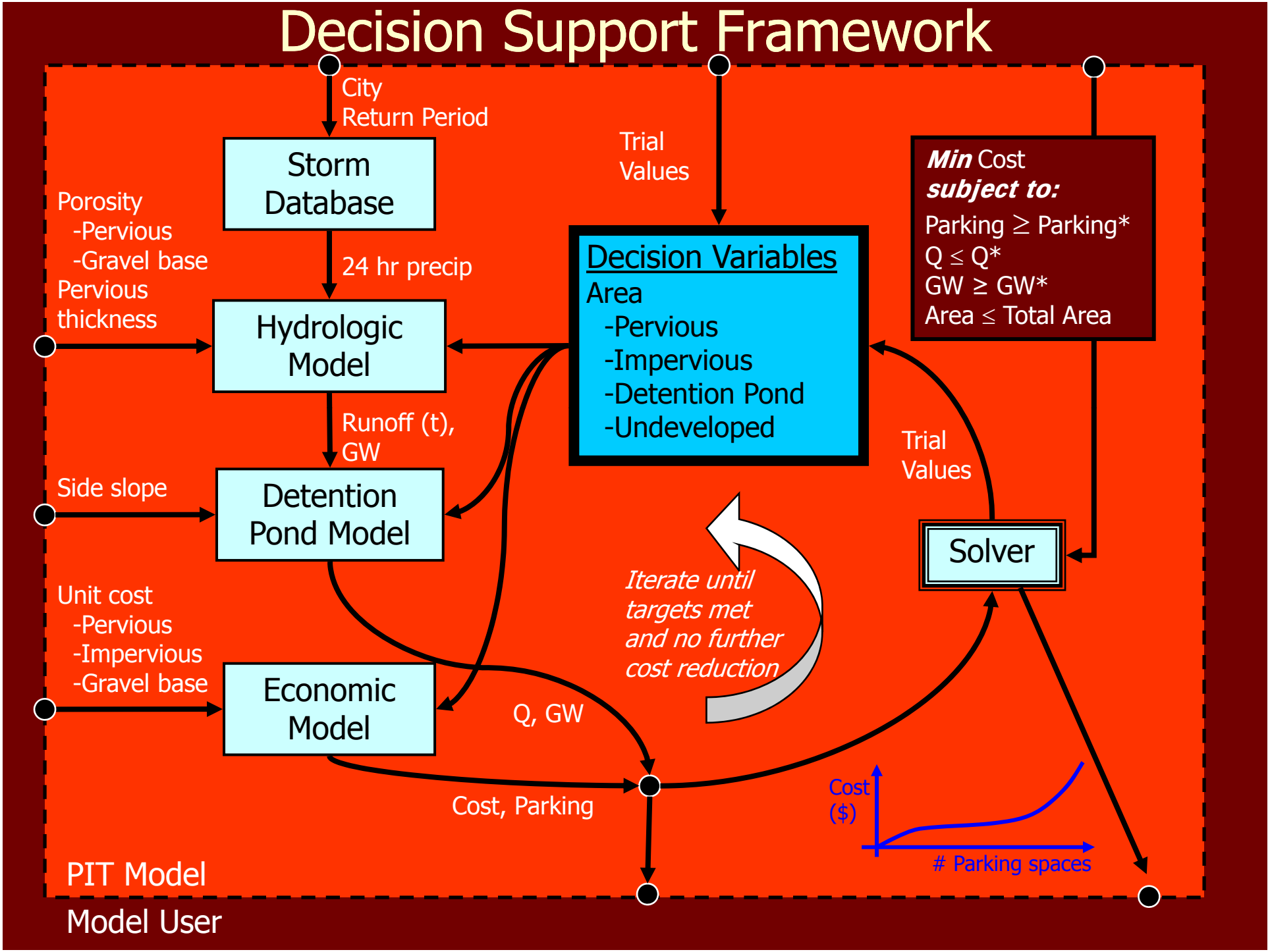
Design Problem



Min Cost
subject to:
Parking ≥ Parking*
Q ≤ Q*
GW ≥ GW*
Area used ≤ Area available


Decision Support Framework
City
Return Period
Storm
Database
24 hr precip
Porosity
-Pervious
-Gravel base
Pervious
thickness
Hydrologic
Model
Runoff (t),
GW
Side slope
Detention
Pond Model
Unit cost
-Pervious
-Impervious
-Gravel base
Economic
Model
Q, GW
Cost, Parking
Trial
Values
Decision Variables
Area
-Pervious
-Impervious
-Detention Pond
-Undeveloped
Min Cost
subject to:
Parking ≥ Parking*
Q ≤ Q*
GW ≥ GW*
Area ≤ Total Area
Trial
Values
Solver
Iterate until
targets met
and no further
cost reduction
Cost
($)
Parking spaces
PIT Model
Model User

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Implementation

- Criteria
  - Transparency
  - Ease of use
  - Soundness of approach
- Hydrologic modeling/Detention pond
  - Pervious modeling assumptions those of CRMCA model
  - Level pool routing
  - Tested with fixed detention pond shape type
- Solver
  - USC-coded bisection method for handling constraints

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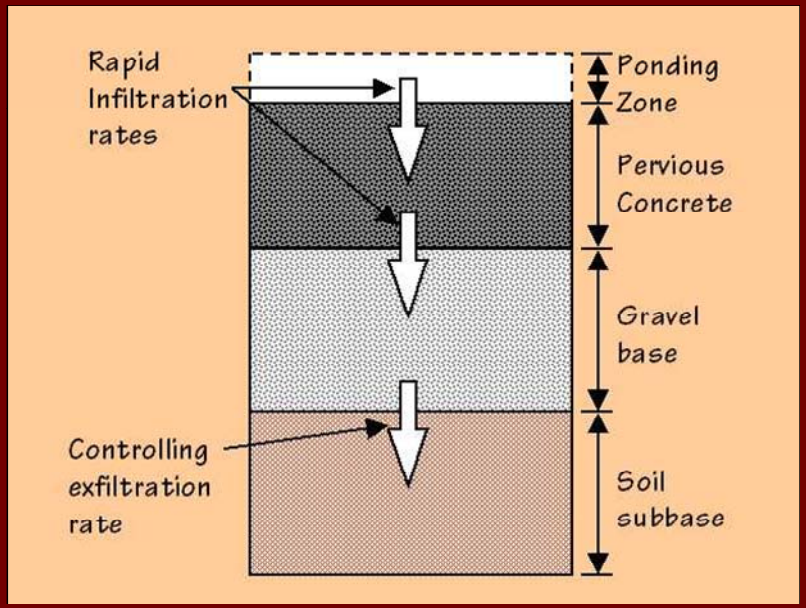
Assumptions

- Hydrologic
  - Those of CRMCA Pervious model



- Costing
  - Similar maintenance costs, no pervious clogging

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Model status

- Hydrologic modeling completed
- Costing defaults being finalized
- Ready for 'sophisticated user'
- Outstanding issues:
  - Clogging yet to be incorporated into costing

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Demo of PIT Model (Beta)

- Purpose
- Scenario
- Quick overview of tool
- "What if?" analysis
- Optimization

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Purpose of demo

- Understand tradeoff between
  - % of parking lot that is pervious
  - Size of detention pond
- With respect to
  - Peak discharge
  - Groundwater recharge
- Familiarization with PIT 'Beta' version
- Solicit your feedback to improve future versions

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Scenario

- Site Area: 10,000 sq ft
- Parking Area: 9,500 sq ft
- Contributing Area: 5,000 sq ft
- Design storm: SCS type II
- Must...
  - not exceed pre-development peak discharge of 1 cfs
  - not overtop of detention pond
- What fraction of parking lot should be pervious?
- How large a detention pond?

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Quick overview of tool

- Inputs
- Outputs

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"What if?" analysis

- Effects of…
  - Increasing pervious %
  - Increasing detention pond size

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Optimization

- Optimization by trial & error search
- Application of Solver

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Model improvement

- Please leave or email name, contact information if interested
- Web: www.ce.sc.edu
- My email: harriskw@engr.sc.edu
- What is your...
  - Occupation
  - Intended use
- Please provide comments

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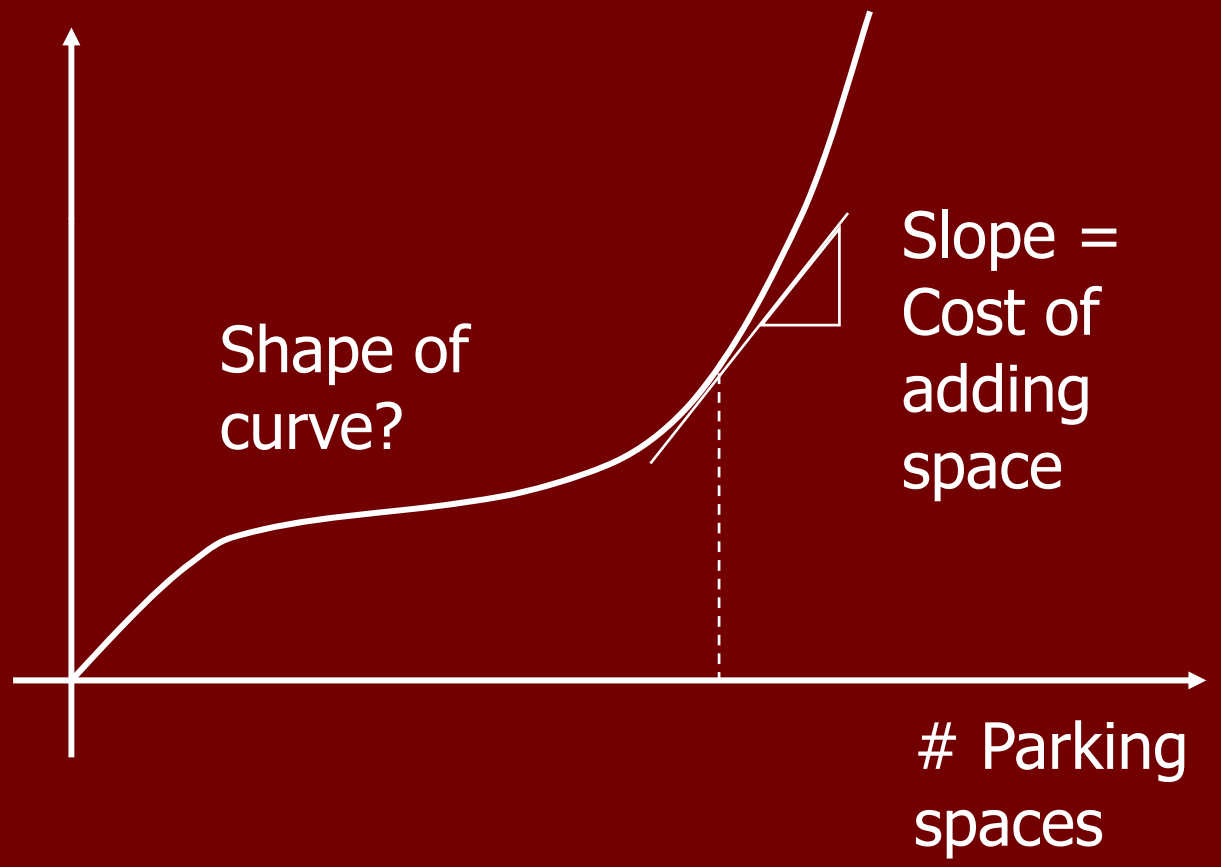
Tradeoff curve



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Conclusion # 1

- USC PIT model supports consideration of tradeoffs in selection between pervious and impervious surfaces for parking lot applications

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Conclusion # 2

- Parking lot (coastal applications), preliminary results, pervious, as compared to impervious
  - *cost per sq ft parking area higher*
  - *system cost can be lower* due to smaller/no detention pond to meet peak discharge laws and/or need to squeeze more spaces onto site
  - hybrid design can yield lowest system cost
  - results are site-specific