

# **Green Infrastructure: A Sustainable and High- Value Option for Your Community**

**18<sup>th</sup> Annual Land Use Conference**



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# AWARE Colorado

An initiative of the League of Women Voters of  
Colorado Education Fund

Funded by: Colorado Department of Public Health and Environment through a  
grant from the U.S. Environmental Protection Agency

## Urban Drainage and Flood Control District

A metro area special district funded by property taxes that performs flood  
control and channel stabilization for the region.



# Key Concepts

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- ◆ Typical stormwater management collects and conveys water resources out of the watershed. "Pave it and Drain it."
- ◆ Drainage-based design has offsite impacts from excess urban runoff volume (EURV): increased erosion, sedimentation and water quality changes.
- ◆ Mimicking predevelopment hydrology with infiltration techniques helps recharge groundwater, protect water resources, and preserve riparian ecosystems.

# Stormwater is managed for three purposes

- ◆ Flood Control – large storm detention
- ◆ Channel protection
- ◆ Stormwater Quality

# Stormwater Quality Management Summary

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I'm not concerned about all hell breaking loose, but that a PART of hell will break loose... and it'll be much harder to detect.

George Carlin

*Comedian and actor (1937 - 2008)*



# Flood Events

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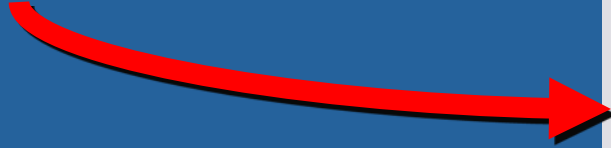
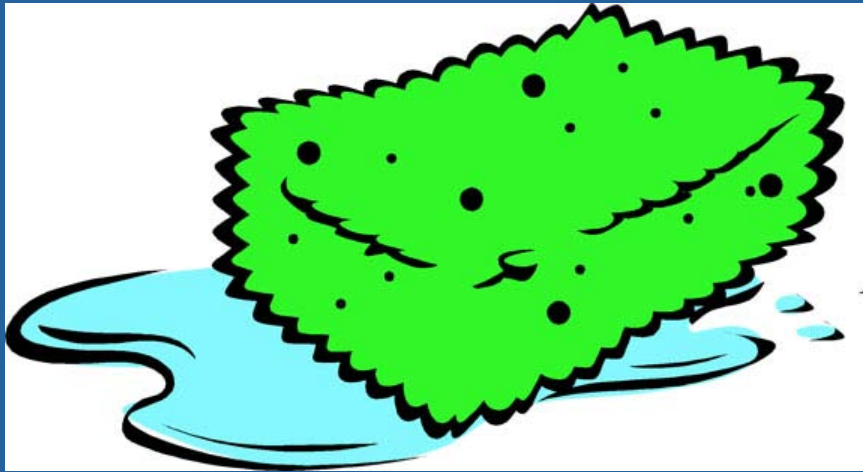
# Water Quality Impacts

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# CHANGING A GREEN SPONGE INTO A GRAY FUNNEL

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# INCREASED POLLUTANT LOAD

- Sediment and nutrients
- Metals and other toxic chemicals
- Bacteria, viruses and other pathogens



# Runoff - Undeveloped Land

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Undeveloped land in Denver area absorbs about an inch of precipitation before producing runoff.



# Pave It and Drain It

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Development with directly connected impervious area changes historic runoff. Roofs and pavement drain to inlets then waterways. Small flows that were previously absorbed are turned into runoff (EURV).

40-65% of impervious area is for car habitat. Think about social value, LID overlay effectiveness.

# Before Land Disturbance

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Riparian area is hydraulically connected to waterway. A change in historic runoff will destabilize waterway.

# Typical Front Range Waterway Today

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Post Development and Pre Stabilized: Wetlands and the floodplain have become hydraulically disconnected. This waterway is deeper with unstable banks. Riparian areas are dewatered.

# Stabilized Waterway

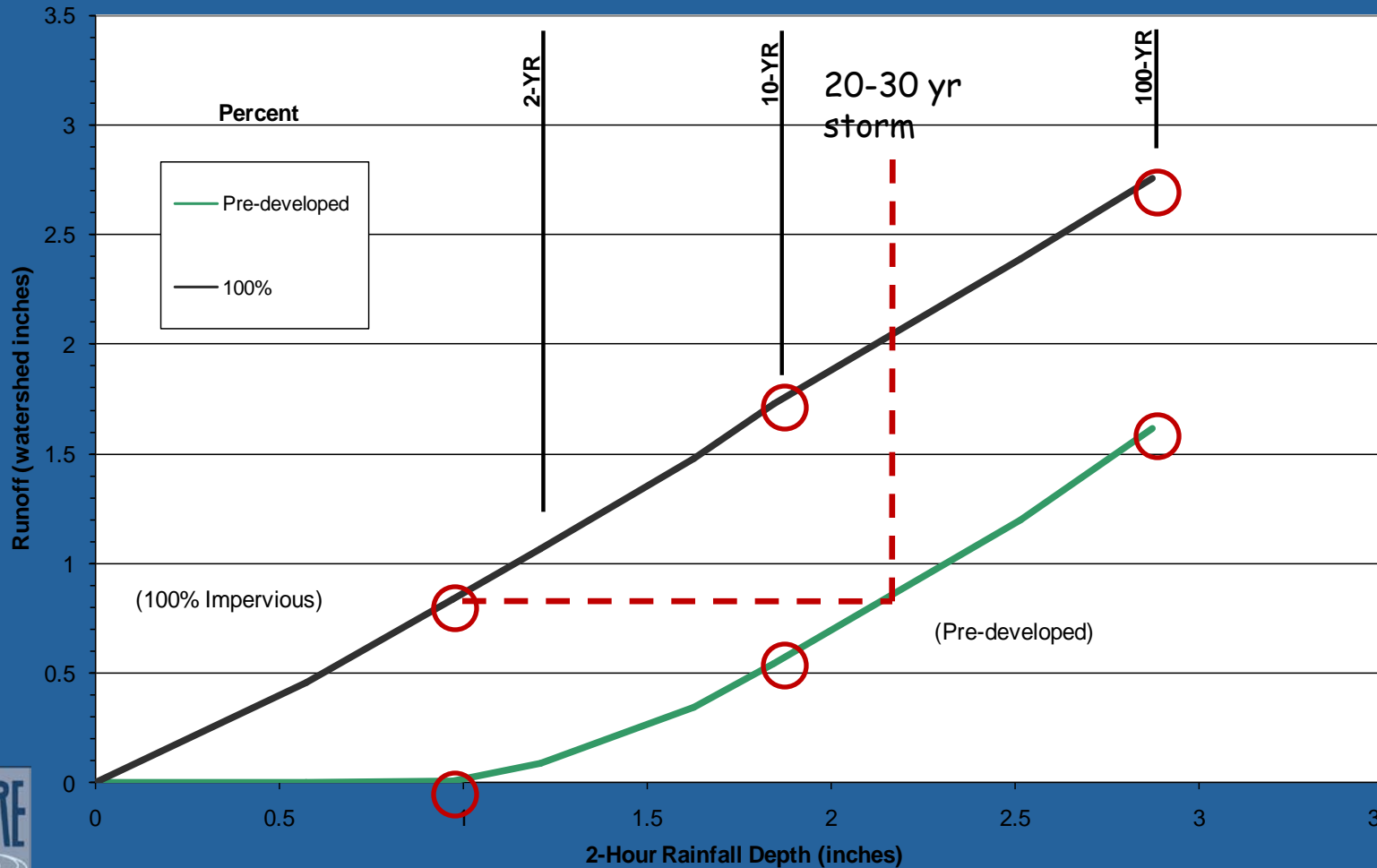
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After Stabilization Project: Construction cost about \$2-4 million/mile.



# Rainfall and Runoff Chart

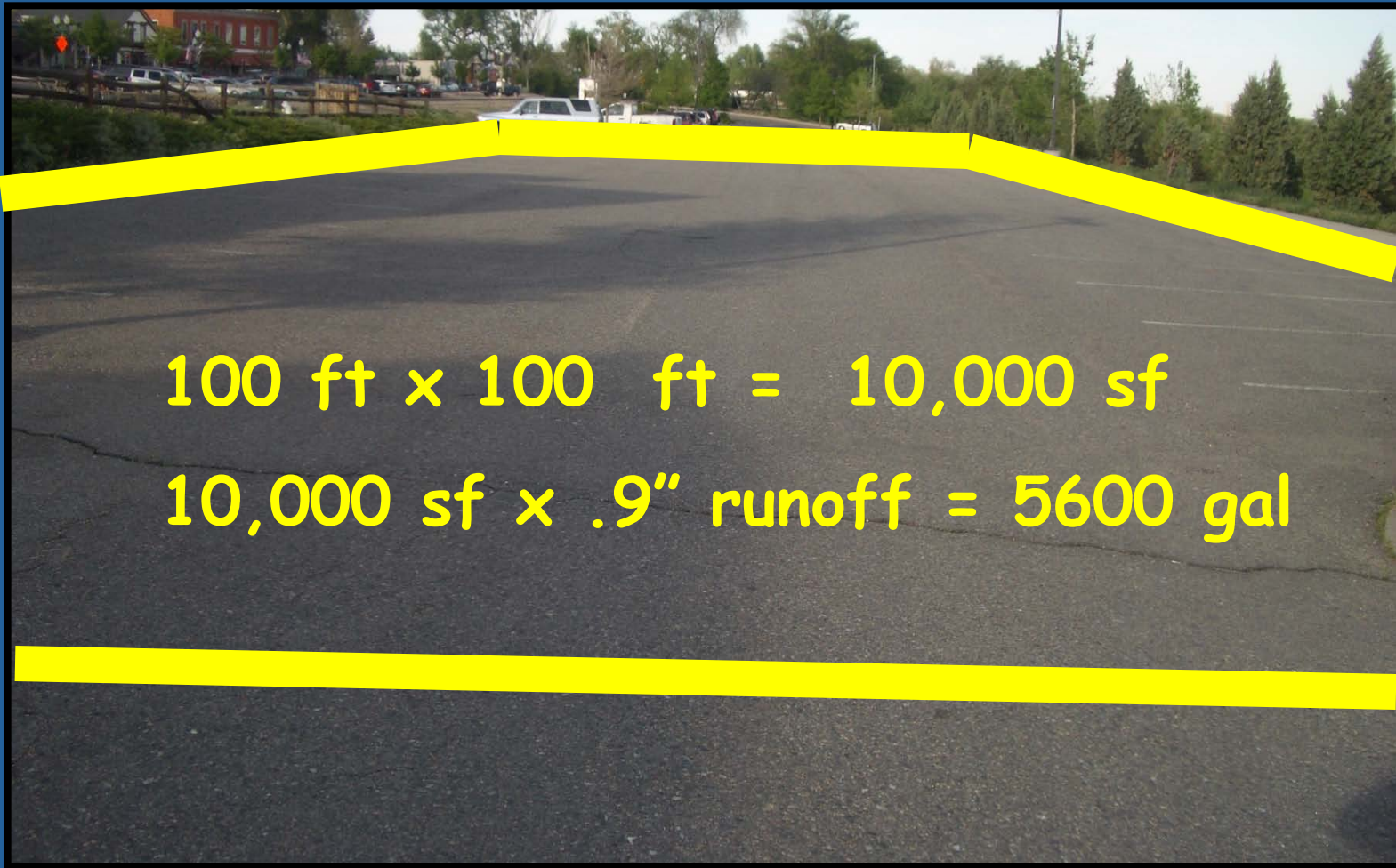
## Comparing Rainfall and Runoff for Pre-developed Land and 100% Imperviousness



The chart is based on Full Spectrum Detention research by Jim Wulliman at Muller Engineering and Ben Urbonas from Urban Drainage and Flood Control District .



# How much runoff ?



# Some Runoff Math

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Consider the runoff from 10,000 sf of property:

|             | <u>1" precip.</u> | <u>10 yr</u> | <u>100yr</u> |
|-------------|-------------------|--------------|--------------|
| Undeveloped | NONE              | 3700 g       | 10,000 g     |
| Developed   | 5600 g            | 11,000 g     | 17,000 g     |

One inch of precipitation on developed property looks like more than a 10 yr storm.

After development - 20-30 runoff events/yr instead of one.



# What is 5000 gallons?



# Capital Improvement Examples

Some homes that were constructed near waterway are now experiencing bank collapse from down cutting.



# Capital Improvement Examples

Taxpayer funded repair (general fund or stormwater utility fund).  
Precipitated by upstream development and externalized costs.

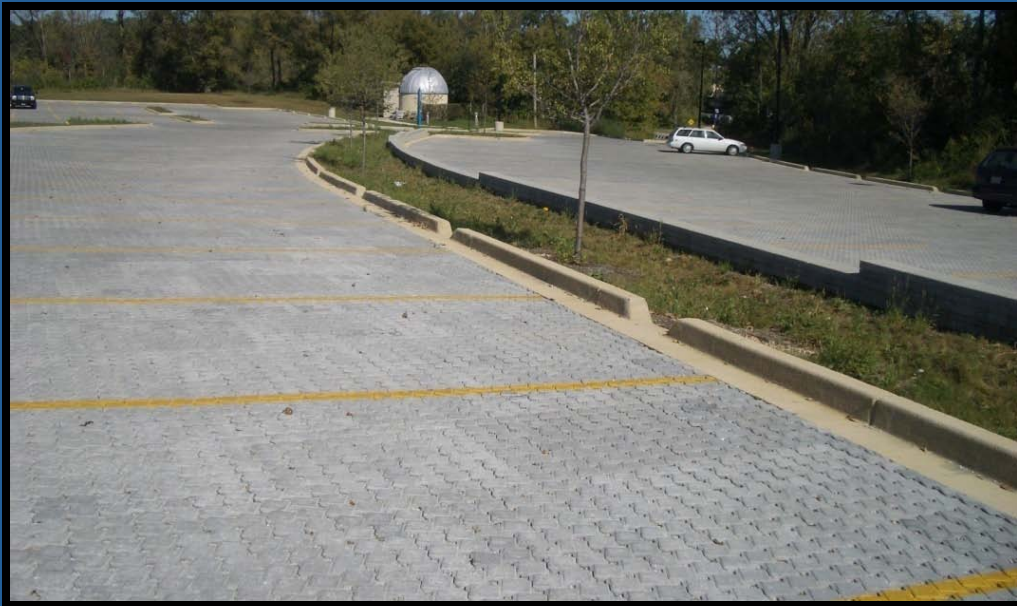


# Low Impact Development Goals

developed land

=

the hydrologic  
function of  
undeveloped land

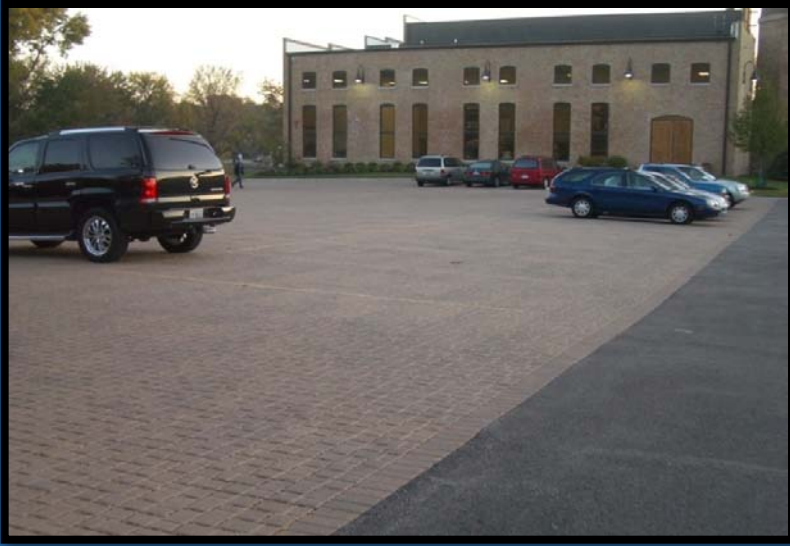


# Planning: The first Low-Impact Development BMP

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# Prevention vs. Repair



or



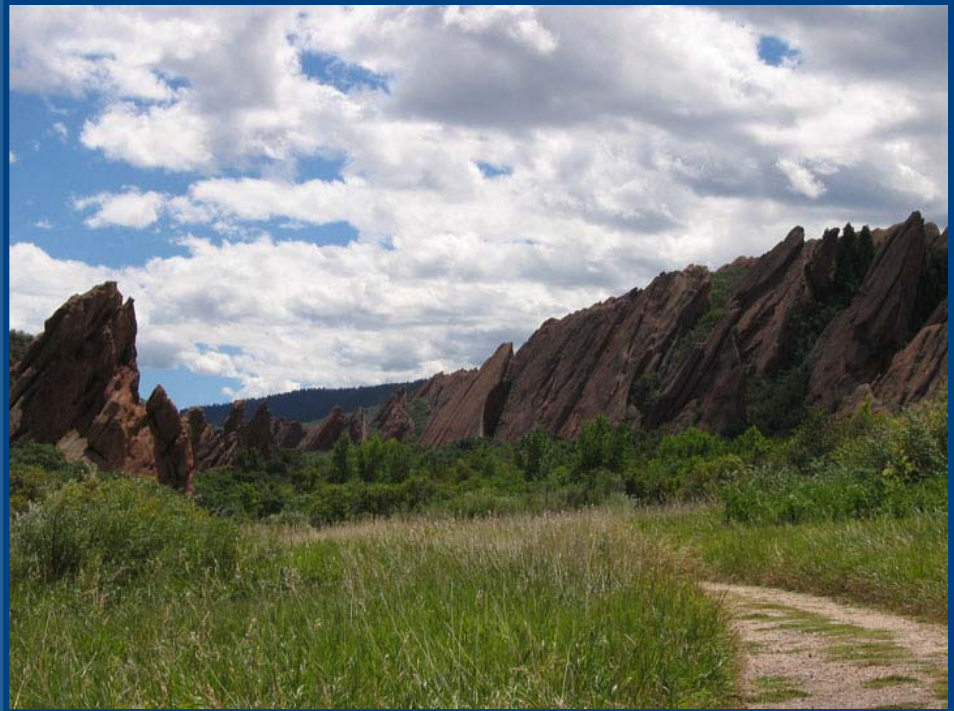
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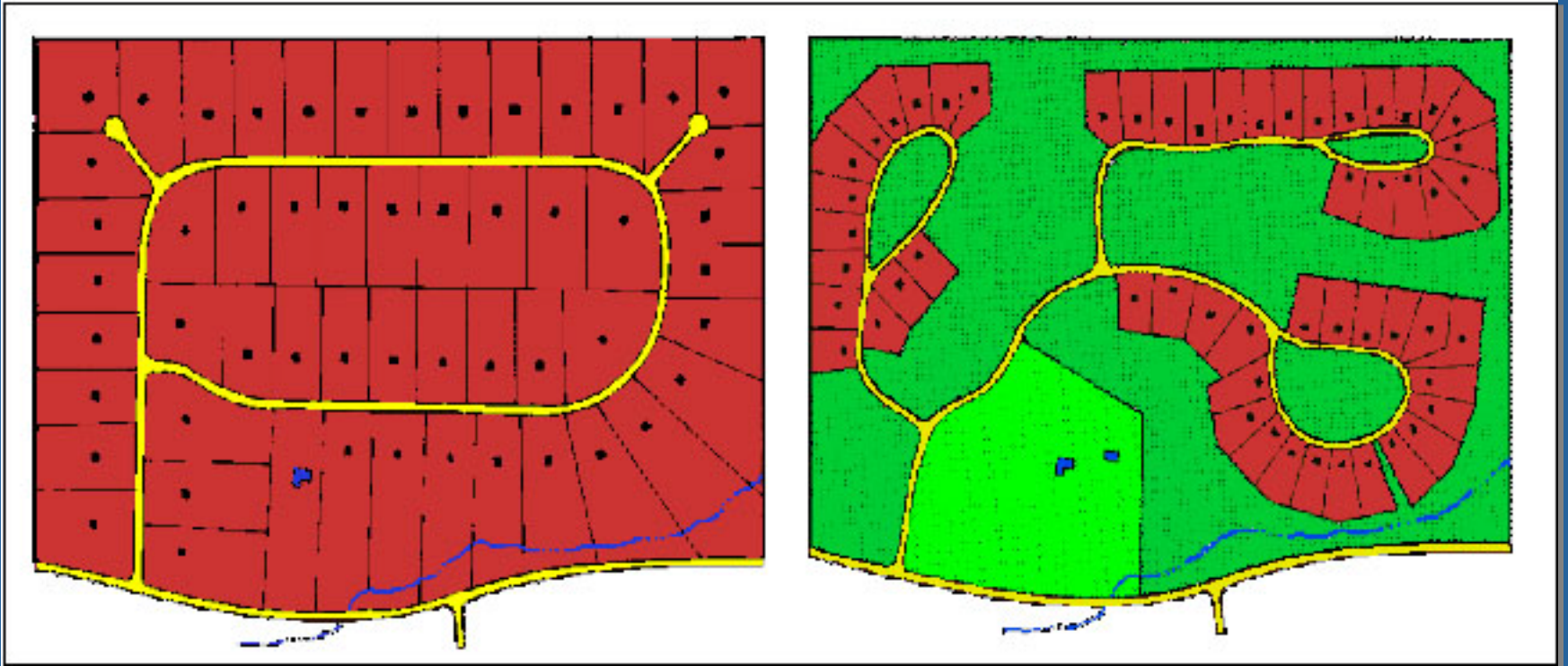
# NATURAL RESOURCES INVENTORY

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**An Important  
First Step**

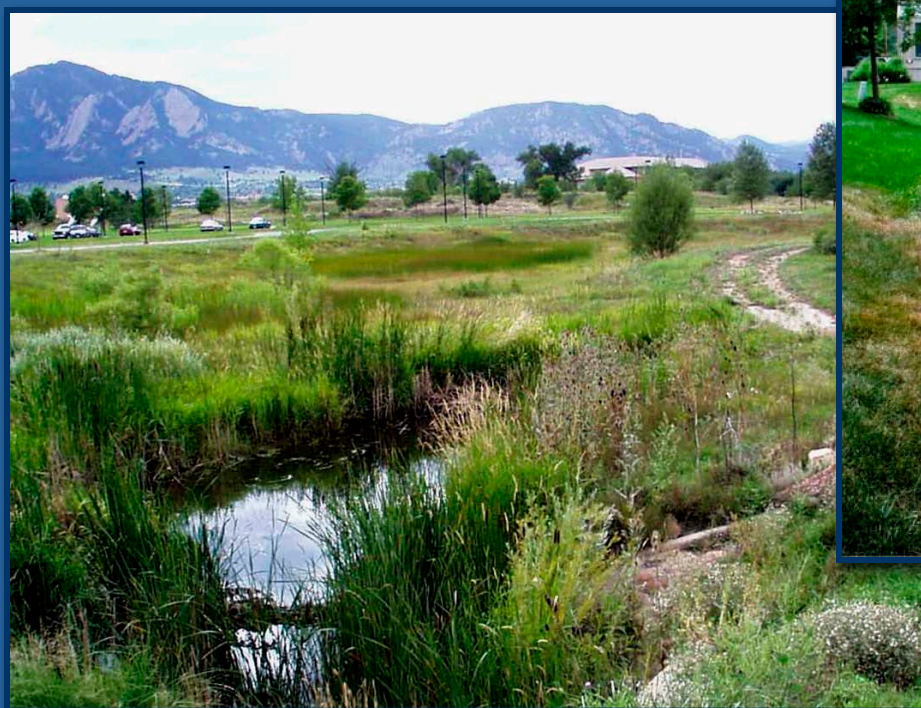


# CLUSTER DEVELOPMENT



Same number of building sites, less impervious surface

# RIPARIAN BUFFERS



# STREETS AND ROADS

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# ALTERNATIVE TURNAROUNDS



40-foot cul-de-sac with  
landscaped island



30-foot radius  
cul-de-sac



T-shaped  
hammerhead



Loop road

## Four alternative turnarounds for residential streets

(Modified from Better Site Design Fact Sheet: Alternative Turnarounds)



# SWALES

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# SIDEWALKS AND TRAILS



Sidewalk on one side of the street



With adjoining reinforced grass, sidewalk doubles as emergency vehicle access

# SIDEWALKS AND TRAILS



Detached sidewalk reduces directly connecting impervious surfaces



Gravel trail replaces sidewalk

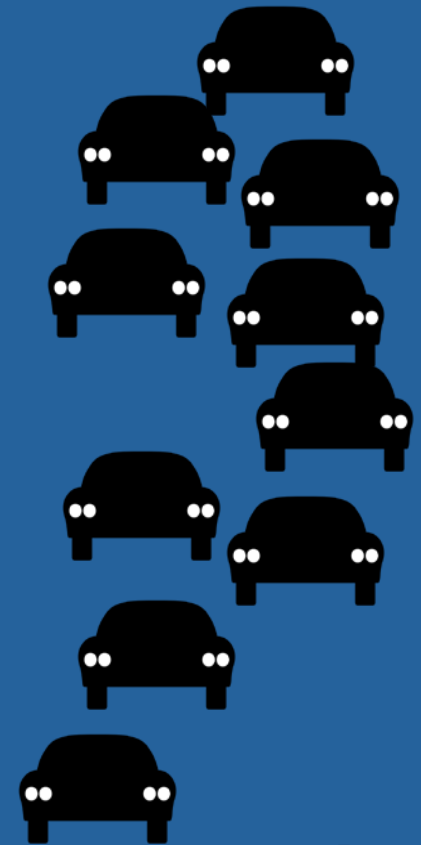
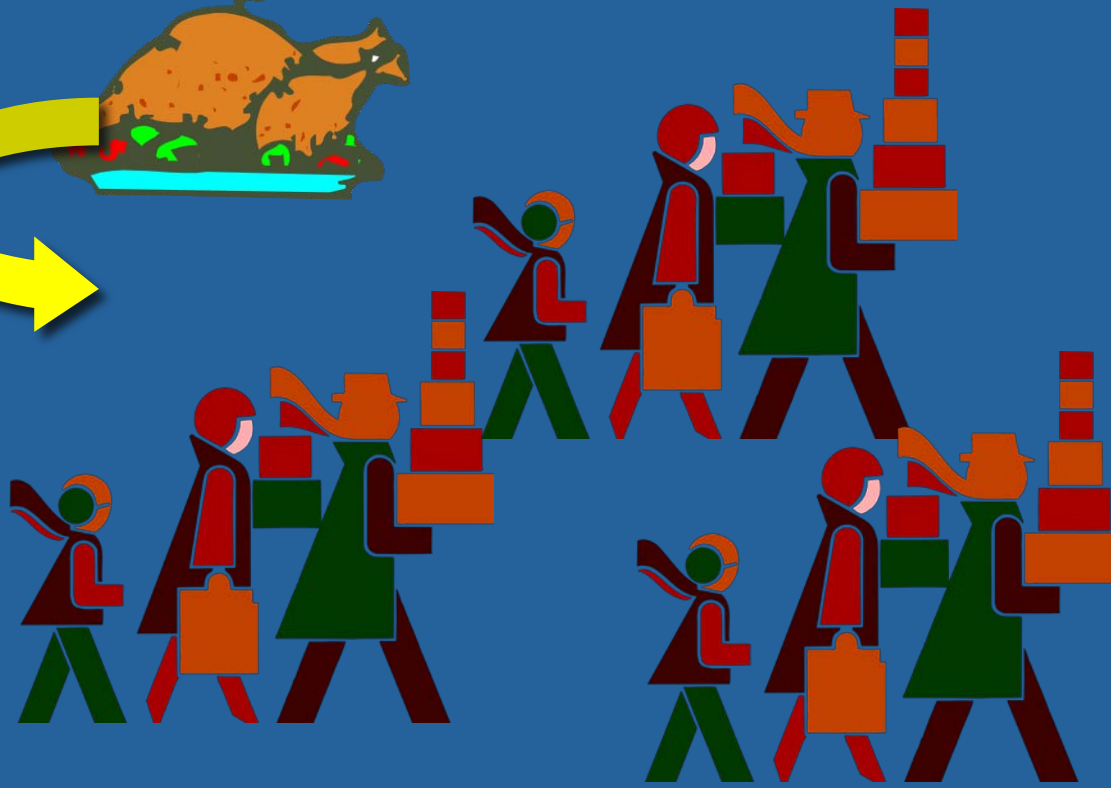
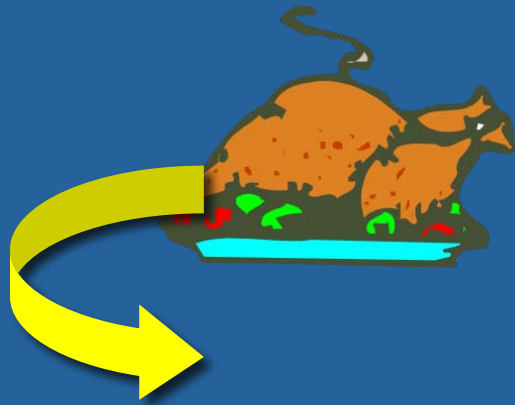
# STREET EDGE ALTERNATIVE (SEA) STREETS

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Photo Courtesy Tracy Tackett - Seattle SEA Street Project

# Parking Lot Size



# A BETTER APPROACH

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# SAVING AND AMENDING TOPSOIL

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Replacing topsoil or amending soil with organic matter re-establishes porosity.

# TREE COVER

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- Reduces volume and velocity of runoff
- Minimizes heat effect
- Multiple benefits

# ROOF GARDENS

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A new concept in the arid West



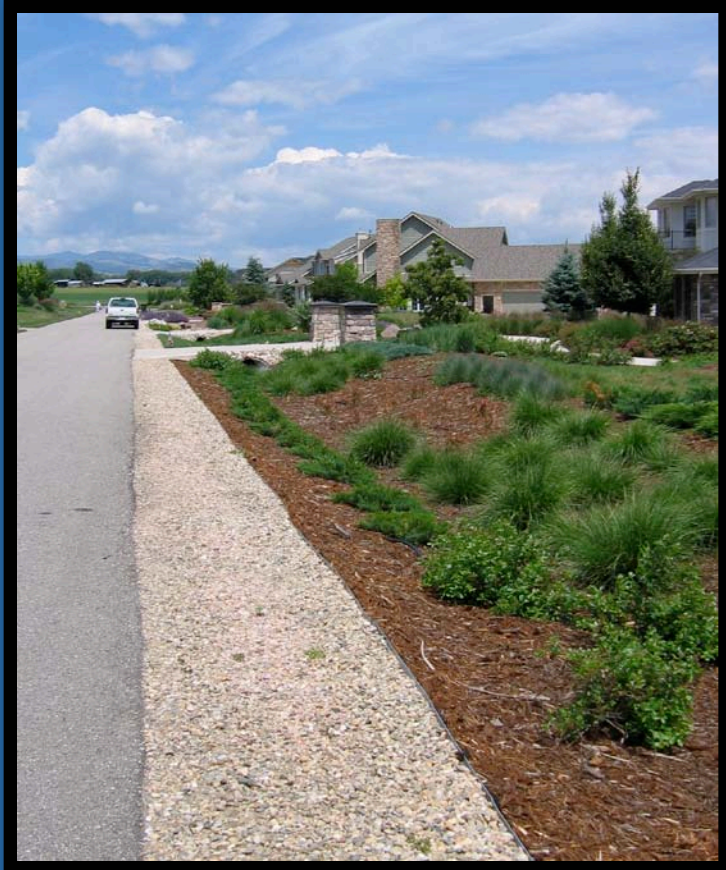
# The Next Step After Planning:

- Build what we plan for...

## LID Structural BMPs

# Flush Curbs and Swales

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# PARKING LOTS

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Traditional median



Parking lot sump

# PERMEABLE ALTERNATIVES

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Permeable pavers in Denver



# Rethinking Right of Way – not only for conveyance



Photo Courtesy - Low Impact Development Center & Larry Coffman

Landscape area could be designed to absorb runoff. Large flow bypass can be included.

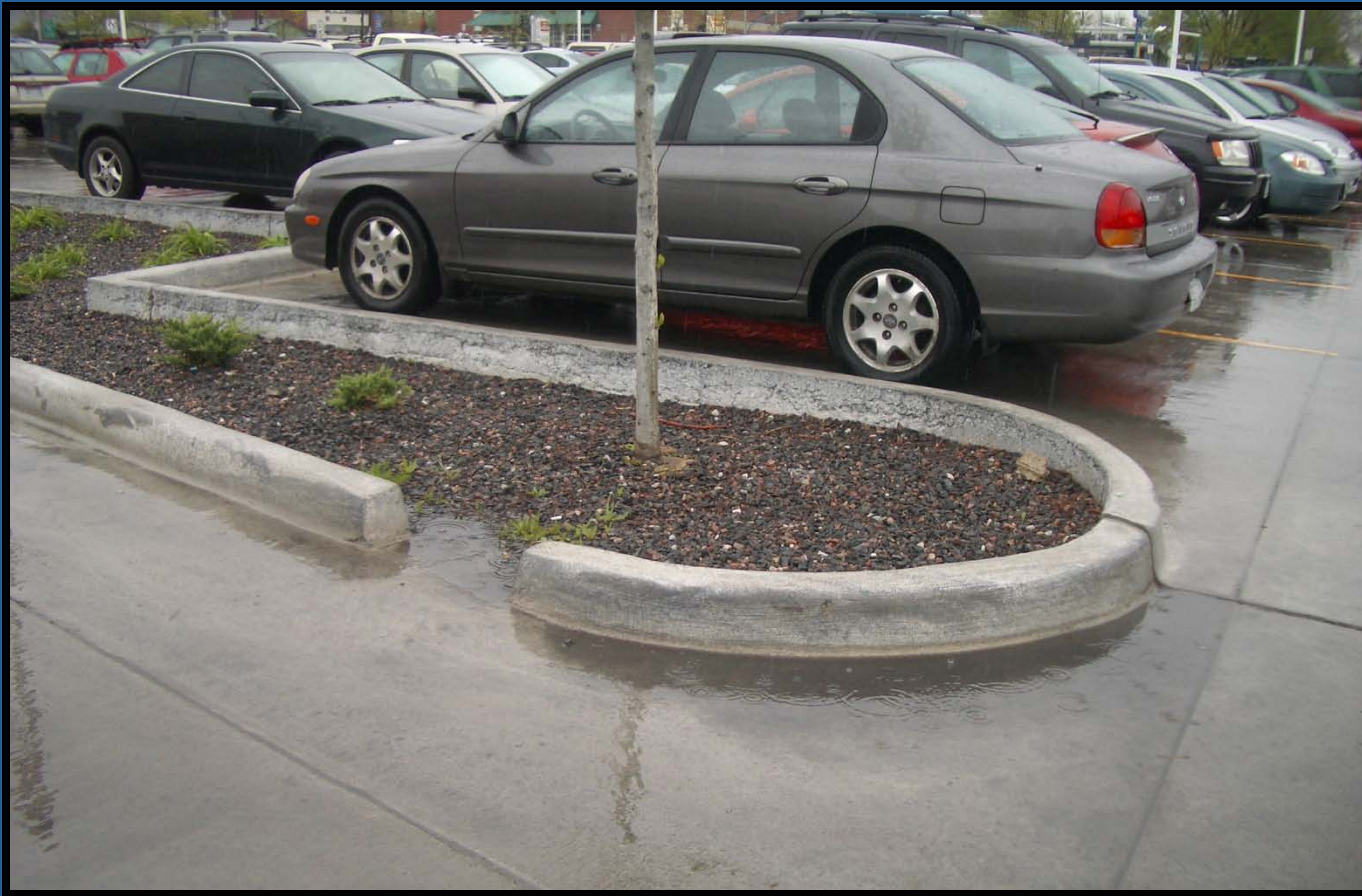
# Pave It and Drain It



Small storms are taking up capacity - requiring larger storm sewer pipes, trenching and single point detention structure. Also, lacking potential to create a beneficial, appealing space. Is there a social benefit from this design?

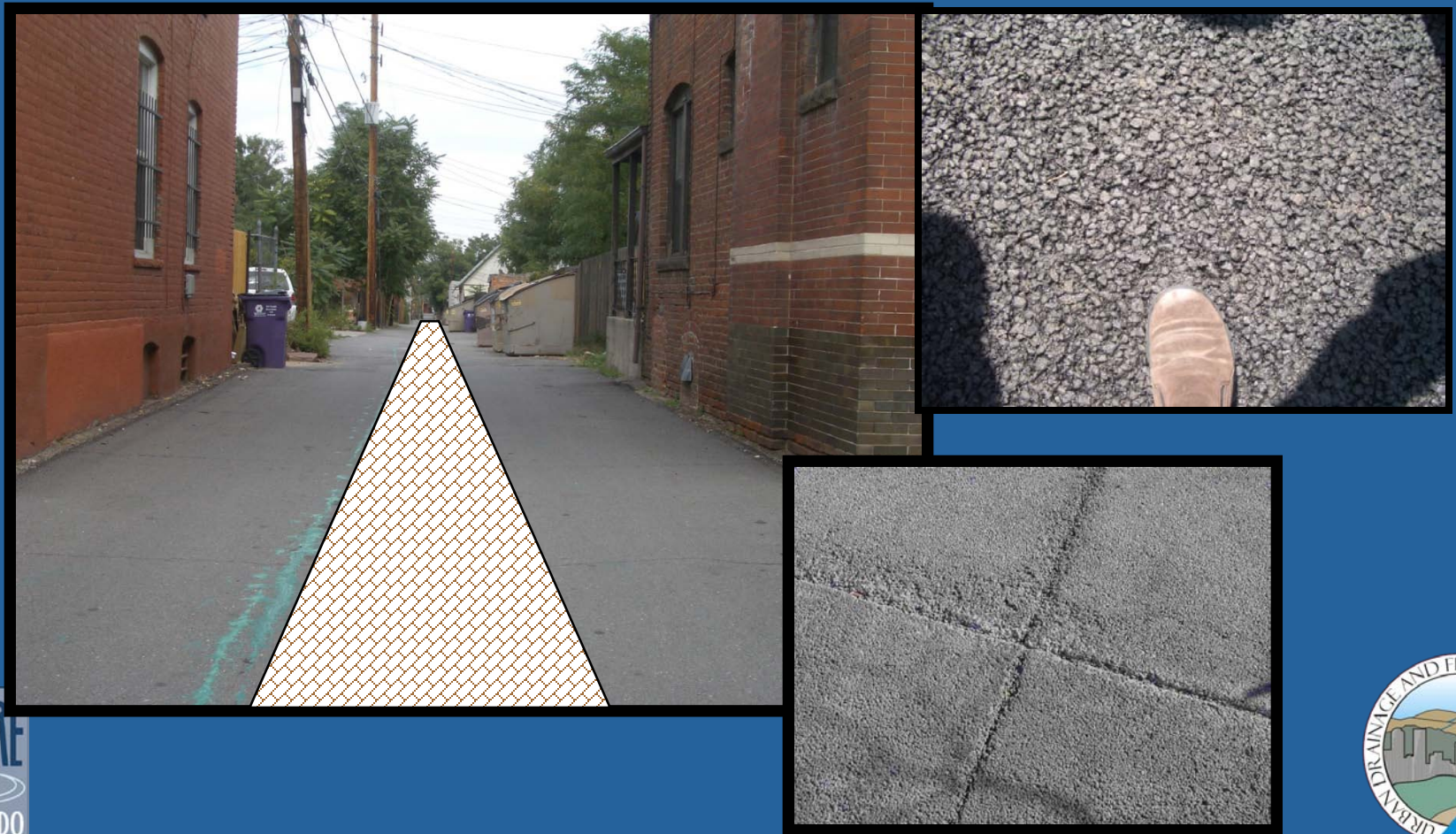
# Why don't we design for this? – split flow

Sumped landscaping islands allow small storm flows to be absorbed on site and mimic predevelopment hydrology.



# Redevelopment Opportunities

Retrofit center of alleyway with permeable pavers or porous pavement. Chicago "green alley" project.



# Redevelopment Opportunities

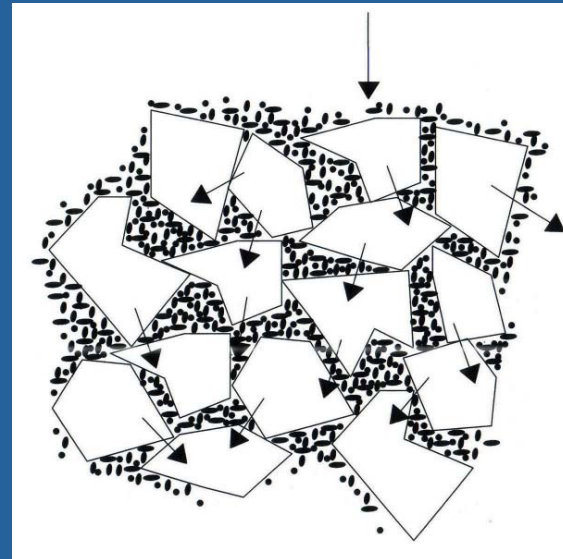


# Structural Soil

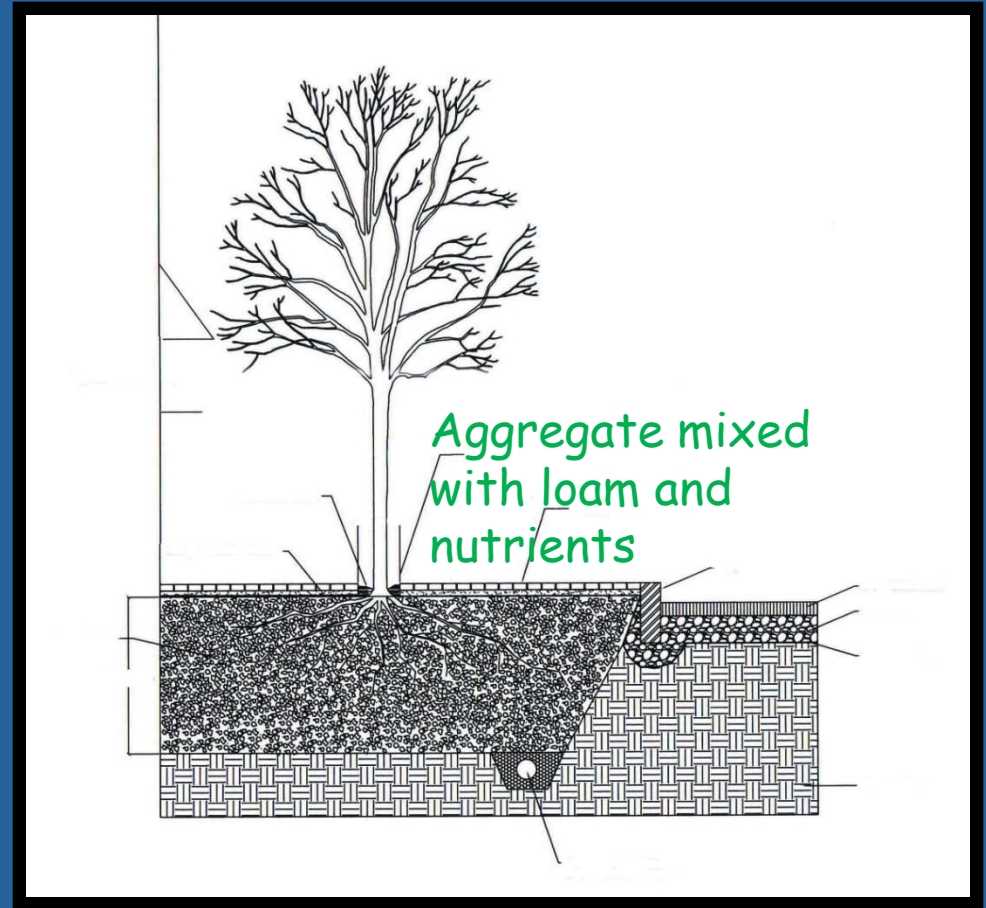


# Structural Soil

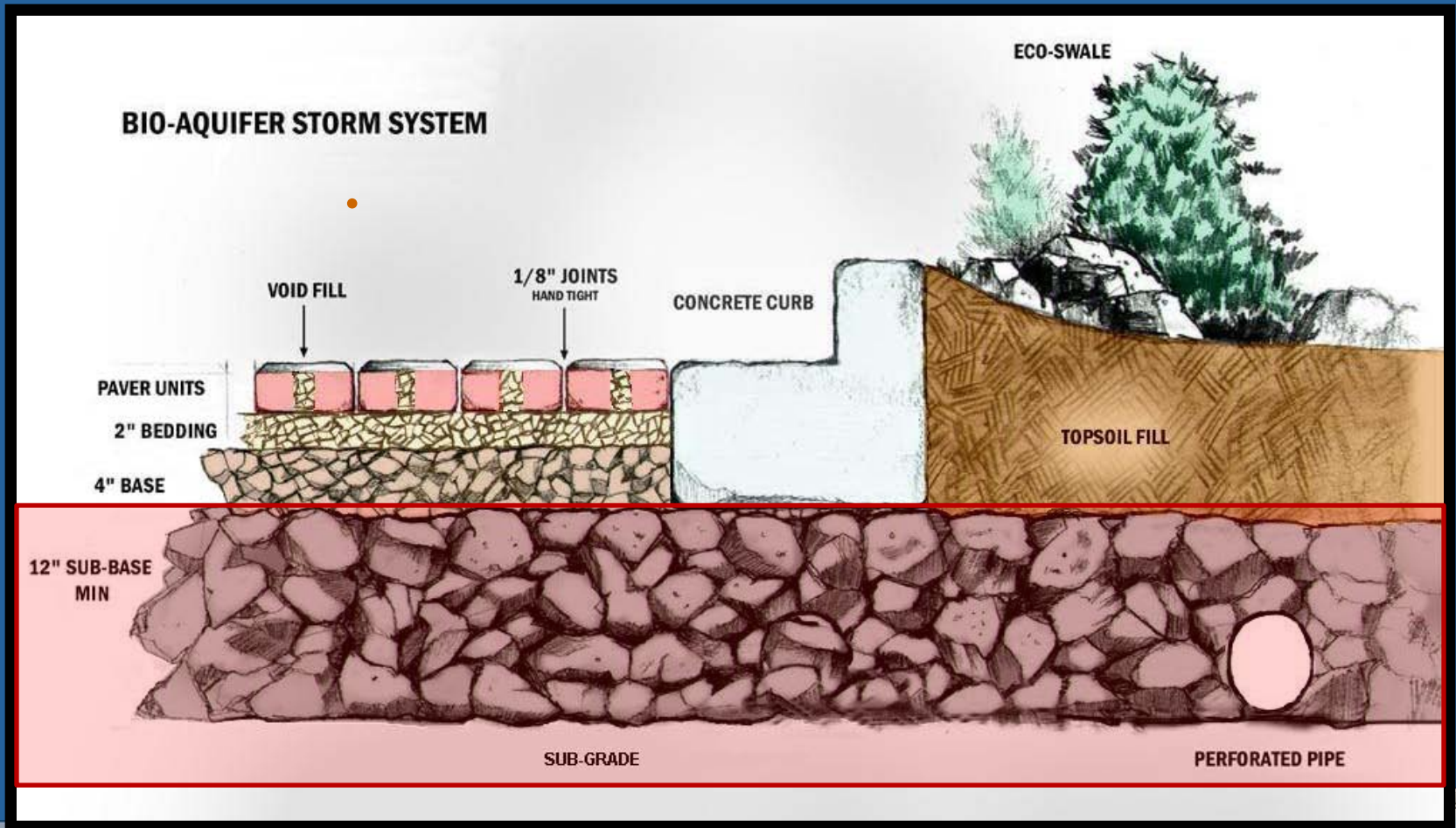
Courtesy of the Urban Horticulture Institute, Department of Horticulture, Cornell University, Ithaca, NY



# Structural Soil



# Structural Soil and Permeable Paver System Aggregate



BASS system design for Aqua-Bric provided by Advanced Pavement Technology

# LID-LEED Gap



LEED building on a non-LID or LEED property.

Why doesn't the innovation extend to the entire site?

# LID-LEED example

High Albedo Pavers. Urban heat island benefits, decrease lighting needs, improved security.

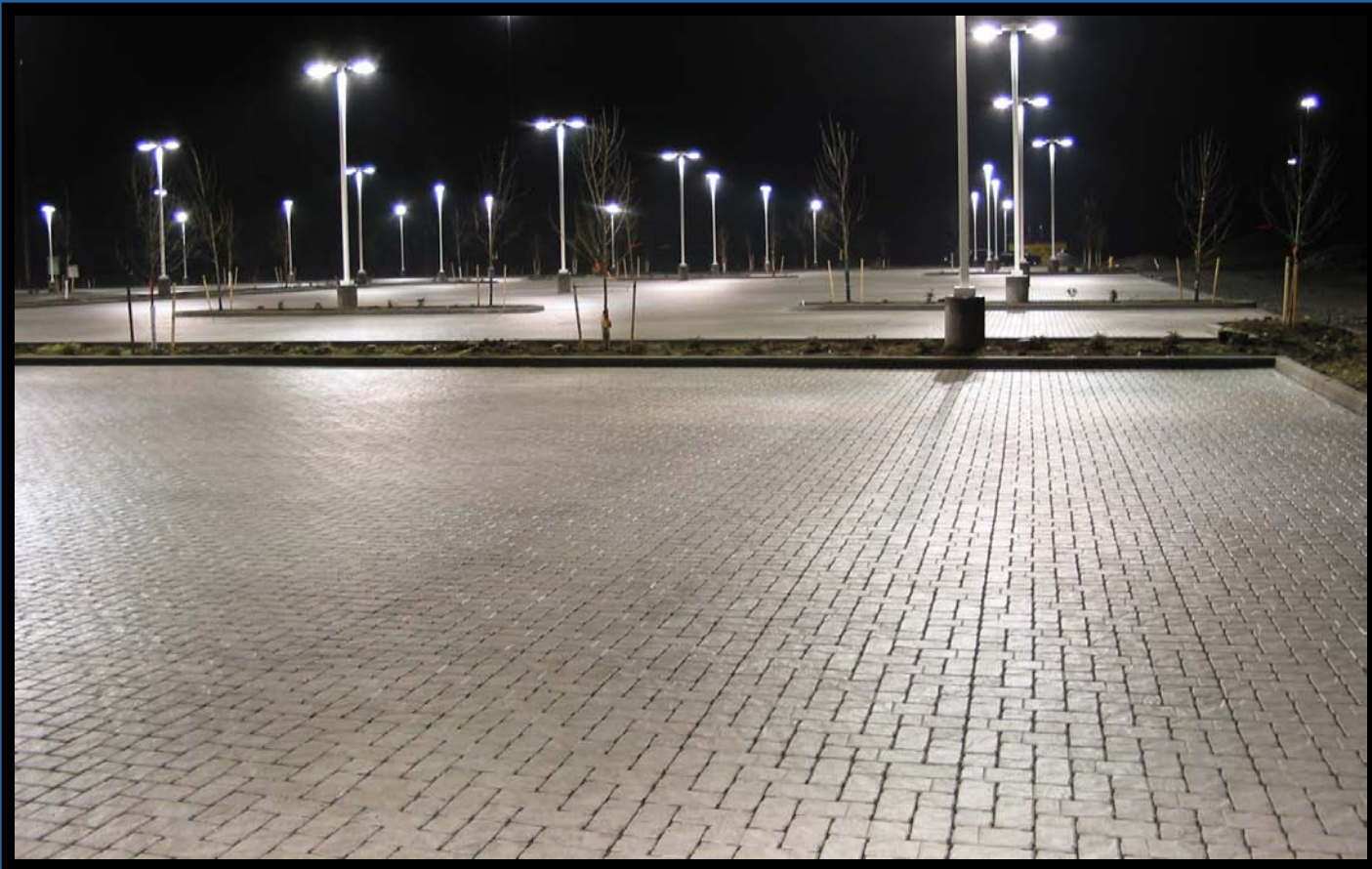


Photo courtesy Advanced Pavement Technology



# A SUSTAINABLE APPROACH

## Reduced and Delayed Stormwater Runoff Volumes

Protect riparian areas, aquatic ecosystems, wildlife habitat and recreation areas while reducing the cost of downstream stormwater infrastructure and capital improvement projects.

## Enhanced Groundwater Recharge

Maintains normal base flow rates in rivers and streams, protects riparian areas, aquatic ecosystems and drinking water supplies.

## Stormwater Pollutant Reductions

Protect aquatic ecosystems, wildlife and human health. Lower pollutant levels can also reduce water treatment costs.





# A SUSTAINABLE APPROACH

## Reduced Sewer Overflow Events

Due to reductions in the volume of stormwater entering a combined sanitary and storm sewer system during precipitation events.

## Additional Wildlife Habitat and Recreational Space

Resulting from cluster development and preservation of open space, which provides wildlife habitat and recreational areas.

## Increased Land Values

Resulting from open spaces and vegetation associated with LID and green infrastructure.



# SO WHY ISN'T LID HAPPENING

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What are the barriers?

- Keep It Clean Partnership Survey
- AWARE Colorado Focus Group/Interview Research



# FOCUS GROUP/INTERVIEW RESEARCH



- Four focus groups, 21 interviews
- Diverse communities in South Platte River Basin

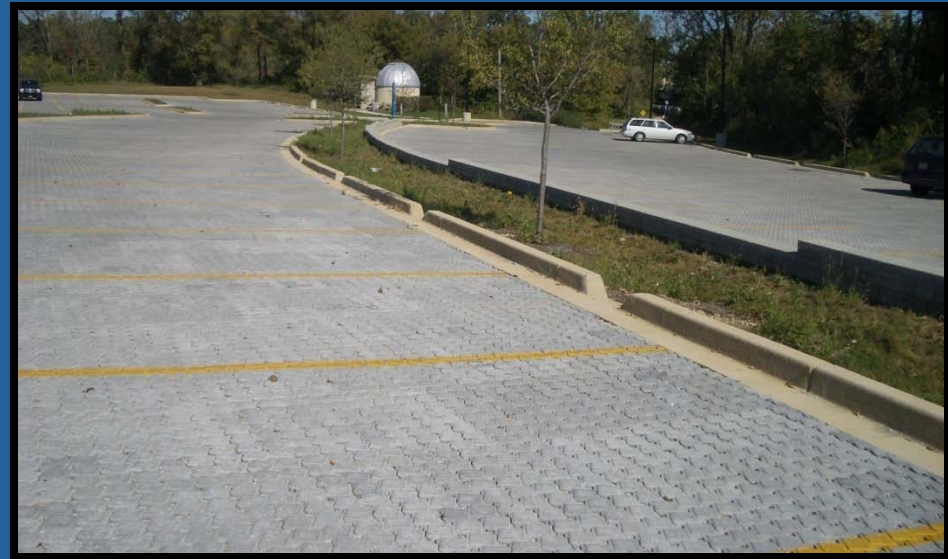


# FOCUS GROUP/INTERVIEW RESEARCH

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- Parking lot planning and structural BMPs

- Effectiveness/likelihood of implementation research
- Visible to community and stakeholders
- Transferability
- Impact



# KEY STAKEHOLDERS

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- Planning Staff
- Elected/Appointed Officials
- Developers
- Engineers
- Landscape Architects
- Stormwater Managers
- Landscape Maintenance



# WHAT DID WE LEARN?

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## Stakeholders:

- Are aware of the importance of stormwater management in their communities
- Recognize benefits of parking lot strategies
- Understand barriers and benefits of lid parking lot strategies
- Are motivated but vary in their ability to promote changes
- Identified needs: education, collaboration, advocacy, innovation, marketing and regulation



# STRATEGIES?

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- Using porous/pervious paving materials
- Planting trees
- Using landscaping designed to promote infiltration
- Using landscaping that reduces need for irrigation, fertilizer & pesticides
- Reduction of parking lots size, developing multi-use parking sites and shared parking



# BARRIERS?

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- Climate and Geology
- Costs
- Lack of Technical Information
  - Good examples for this climate
  - Costs of initial development and maintenance
  - Return-on-investment
  - Balance aesthetics with engineering
- Inertia and Reluctance to Change



# WHAT CAN BE DONE?

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- Knowledge
  - Colorado specific education
  - Citizens as an important stakeholder group
- Collaboration
- Advocacy
  - Local, state, federal and nonprofits
- Design and Innovation
  - Pilot projects to “prove” effectiveness
- Incentives
- Regulation

# NEXT STEPS: COMMUNITY-BASED SOCIAL MARKETING

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- Alternative to information intensive campaigns
- Draws on research in social psychology
- Community level and involves direct contact with stakeholders
- Goal -- behavior change
- Move from *telling* communities about LID/Green Infrastructure to achieving *action*



# CBSM: What are the tools?

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- Individuals
  - Commitment
  - Prompts
  - Norms
- Communities
  - Incentives
  - Removing external barriers
  - Regulation

# AWARE Colorado's Approach

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- Literature review
- Surveys
- Identify issues
- Focus groups
- Pilot projects
- Evaluation
- Implementation



# CONCLUSIONS

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- Land use affects water quantity, stream channel integrity and water quality.
- Low impact development and green infrastructure can reduce impacts and protect environmental, social and economic values.
- Engaging key stakeholders is crucial for adoption.
- Education, social marketing and regulatory approaches can be valuable tools.

# RESOURCES

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- **Sustainable Development Code**

[www.law.du.edu/index.php/rmlui/sustainable-community-development-code](http://www.law.du.edu/index.php/rmlui/sustainable-community-development-code)

- **AWARE Colorado**

[www.awarecolorado.org](http://www.awarecolorado.org)

- **CASFM Web site and photo database**

[www.casfm.org](http://www.casfm.org)

- **LID Development Review Checklists**

<http://bouldercommunity.net/basin/kicp//construction/LIDBarriersWhitePaperFINAL.pdf>



# Questions?

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Photos and graphics provided by:  
CASFM, Sue Donaldson, Kelly Hargadin, Loretta Lohman and David Winger

