CLEAN WATER ACT’S STORMWATER PROGRAM
Stormwater is a leading cause of water quality impairment and its impact is growing

- Urban stormwater is a leading source of impairment
- Fast growing water quality concern
  - Approximately 800,000 acres being developed every year, growing to over 1.0 million acres by 2039
- Development increases the amount of impervious cover in the landscape
- Small increase in impervious cover leads to big impacts in receiving waters
- Development upstream can cause downstream impacts in communities
Stormwater Impacts: 
Pollution, Flooding, and Property Losses

- Stormwater pollutants
  - Cause beach closures and swimming illnesses through bacterial contamination and algal blooms
  - Impact fisheries and shellfish harvesting through excess sedimentation, nutrients, bacteria, metals, and temperature
  - Increase the costs of treating drinking water supplies

- Stream impacts
  - Increase stormwater volume and velocity causing flooding, scouring and sewer overflows
  - Reduce groundwater recharge impacting water supplies
Existing Program

- Many communities have waterbodies that are already polluted by stormwater discharges from impervious areas.
- Communities are working hard to address stormwater and are looking for cost-effective solutions moving forward.
- Developers play an important role in finding these cost-effective stormwater solutions.

Current coverage
- Primarily in urbanized area
- Accounts for much of the population
- Only about 2% of the land area
Changing the Paradigm of Stormwater Management

Traditional approach

- Convey stormwater quickly from site to waterbody or detention ponds
- Manage peak flows for flood control, drainage and large scale downstream erosion.

New approach - Integrate green infrastructure in the design of the project

- View stormwater as a resource
- Slow down the flow, allow to infiltrate
- Manage stormwater on-site
- Reduces pollutant loads to waterbodies
New Directions

- Incorporate green infrastructure into sites as they are being developed and redeveloped
  - Provides most cost-effective opportunity to control stormwater at its source
  - Prevents water quality degradation in healthy waters
  - Helps restore impaired waters

- Looking at the problem on a watershed basis will be more cost effective

- Incentives for sustainable practices that provide numerous other economic and quality of life benefits to communities

Using green infrastructure is a sustainable way to control stormwater.
If We Don’t Take This New Direction –
It Will Cost a Lot More

- If sites do not incorporate sustainable stormwater controls in growing communities, waterbodies will become impaired and these communities will face extremely high costs to restore the waters.

- If sites do not incorporate sustainable stormwater controls in growing communities, the quality of our urban waters will worsen and the cities will be less appealing places to live.

- Communities will not realize the many other benefits of green infrastructure, including:
  - Reduced flooding
  - More liveable communities
  - Increased property values
Establish performance standards for discharges from newly developed and redeveloped sites

- Builds upon innovative approaches developed by many communities and developers already
- Helps to revive urban streams
- Creates level playing field
- Prevents pollution
- Avoids costly stream restoration
- Reduces flooding
- Creates local jobs
Encourage watershed approaches for managing municipal stormwater discharges

Helps ensure stormwater controls are properly implemented which could reduce the need for expensive retrofits later
Performance Standards

- Considering a retention-based performance standard to require that sustainable stormwater controls be incorporated into sites as they are developed and redeveloped
  - Reduce pollutants
  - Reduce volume and velocity of discharges
- Considering a standard that varies according to an area’s climate and other location-specific characteristics
  - e.g. certain percentile storm event
- Considering many flexibilities
  - For sites
  - For alternative local programs
- There are cost-effective ways to meet the standard
  - Incorporate controls in the site design by preserving vegetation and/or reducing impervious cover
  - Integrate green infrastructure practices into landscape or other common areas

About 1/3 of states and many local communities already have some sort of treatment or retention-based performance standard
Performance Standards (Cont’d)

- Considering relaxed standard for redevelopment
  - Recognizes site constraints and benefits to reusing already developed site
  - Encourages redevelopment to revitalize urban communities
  - Considering additional incentives for smart growth and brownfields development

- The standard could be directly applied to newly developed and redeveloped sites nationwide or only those sites discharging to regulated MS4s or watersheds including MS4s

Applying the standard nationwide would create a level playing field for developers among municipalities and protect downstream communities from upstream development.
Performance Standards (Cont’d)

- Could accommodate site constraints (including water rights laws)
  - Managed through treatment
  - Off-site mitigation
  - Payment-in-lieu
  - Banking or trading programs
- Allow sites to do their own analyses based on site-specific information
- Allow phased implementation
- Allow watershed plans that control pollutants/flows
- Would credit alternative programs that are better suited to their needs, but that are as protective as the national standard
- Allow alternative green infrastructure plan in-lieu-of a new and/or redevelopment standard
Encourage Watershed Approaches

- Encourage MS4s in same watershed to work together
  - Watersheds surrounding existing regulated MS4s
- Encourage sound stormwater programs as growth occurs
- Population threshold 10,000
- MS4 light, watershed permits, guidelines, recognition/certification
Innovative communities across the U.S. already have on-site retention standards in place and are seeing the benefits.

### Water-Based Benefits
- Improved recreational, aesthetic and non-use values
- Lower drinking water treatment costs
- Lower dredging costs for navigational channels
- Reduced siltation of water storage reservoirs
- Reduced downstream flooding damage
- Groundwater recharge
- Small stream erosion and water quality impacts

### Vegetation-Based Benefits
- Improved air quality and reduced human health impacts
- Higher off-site property values associated with green infrastructure
- Carbon uptake by plants
- Reduced energy use by buildings and associated air quality and carbon footprint benefits

**Benefits of a Proposed Stormwater Rule**
Complete Street Cost-Effective Solutions

Green infrastructure stormwater controls like rain gardens and vegetated curb bump-outs can be part of complete street designs.

This sustainable, complete street is welcoming for pedestrians, bicyclists, and transit while maintaining plentiful street greenery and managing stormwater. 
Photo: Dan Burden, Walkable and Livable Communities Institute.
Cost-Effective Solutions in Residential Areas

- Pervious pavement
- Bioswales, raingardens
- Curb cuts, green streets
- Downspout disconnection
- Narrower streets, driveways, roads
Integrate curb cuts into parking islands to allow water to infiltrate

Smaller parking lots

Pervious pavement

Cisterns
US EPA Region 6

Water Quality Protection Division

Division Director:

William (Bill) Honker
(214) 665-7101

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Green Roads Introduction

Nicole Hayes, P.E., LEED AP
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WALTER P MOORE

All Photos & Images ©Walter P Moore and Associates, Inc., unless otherwise noted.
What is **does** a Green Road **do**?
What is (does) a Green Road (do)?

- enhance street function
- target pollutants
- require less maintenance
- increase mobility
- reduce material use
- improve safety
- connect modes of transport
- establish identity (place making)
- attract people to local businesses
Full Life-Cycle Approach
PAVEMENT TECHNOLOGY
MATERIALS & RESOURCES
ACCESS & EQUITY
CONSTRUCTION ACTIVITY
ENVIRONMENT & WATER
ped./bicycle access
recycled materials
bus rapid transit
fewer emissions
art
CSS
LID stormwater
native vegetation
regional material
quality construction

-slide excerpted from Greenroads Master Presentation, the Greenroads Foundation and the University of Washington
Suburban or Rural
long-lasting pavement

life cycle cost analysis

warm mix asphalt

env. mgmt. sys.

local material

natural cut slope

recycled materials

LID stormwater

quality construction

scenic views
PR-8 Low Impact Development
Use low-impact development (LID) stormwater management solutions where appropriate to better mimic pre-development hydrological conditions.

Swale with weirs (left) and pervious concrete sidewalk (right) in Seattle, WA
Resources and Guidelines
Questions?

Thank You!

Nicole Hayes, P.E., LEED AP
NHayes@walterpmoore.com
Green Streets and Transportation Planning

September 25, 2013
Arlington, TX

Sponsored by the Environmental Protection Agency (Region 6) and the Federal Highway Administration (Texas Division)

Jim Thorne, FHWA
Workshop Objectives

- Describe characteristics and goals of green streets.
- Identify opportunities to improve planning and decision making processes to be more informed on green streets.
- Describe storm water management practices used in green streets.
- Discuss green streets planning, design, operations and maintenance considerations.
- List resources available for green streets.
- Explain tools available for addressing sustainability in planning and project development.
Our Agenda

8:00  Welcome and Introductions
8:05  EPA’s Green Infrastructure Program
8:30  Introduction to Green Streets
9:00  Addressing Green Streets in the Transportation Planning Process
9:30  Break
9:40  ASCE’s ISI Rating System
10:00 Green Streets Planning to O&M – Bagby Street, Houston
11:45 – 1:00pm  Lunch (on your own)
1:00  Green Streets Planning and Design – Mesquite Thomasson Square
1:45  Green Streets Planning to O&M – Dallas Urban Reserve
2:30  Break
2:45  Green Streets Planning to O&M – The Green at College Park
3:30  Introduction to FHWA INVEST Tool
4:00  NCTCOG’s Efforts to Utilize INVEST in the Dallas
4:30  Closing Remarks and Adjourn
EPA’s Green Infrastructure Program

Bill Honker and Suzanna Perea
Introduction to Green Streets
Nicole Hayes
Addressing Green Streets in Transportation Planning
Session Outline

- Planning Process and Products
- Opportunities to Plan Green
- Example
- Resources
On an average day in the United States, how many people die in traffic crashes?

- A. 26
- B. 55
- C. 94
- D. 140
Transportation Planning Factors

a) Support **economic vitality**
b) Increase **safety**
c) Increase **security**
d) Increase **accessibility** and **mobility**
e) Protect and enhance the **environment**
f) Enhance **connectivity** across and between **modes**
g) Promote efficient **system management** and **operation**
h) **Preserve** the existing transportation system
``(E) protect and enhance the
environment, promote energy
conservation, improve the quality of life,
and promote consistency between
transportation improvements and State
and local planned growth and economic
development patterns;


A Few Key Products of the Transportation Planning Process

- Long Range Transportation Plan (LRTP)
- Transportation Improvement Programs (S/TIPs)
- Unified Planning Work Program (UPWP)
- State Planning and Research Work Program (SPR)
Other Planning Efforts

- Modal planning (freight, transit, ped/bike)
- New Starts project planning
- Corridor or Subarea studies
- Site or community studies
- Congestion Management Process (CMP)
- Collaborative Multi-Agency Planning Efforts
- Linking Transportation and Land Use
- Support of Broader Community Goals and Efforts
What Do We Want From Our Streets?
Complete Streets

- Roadways that serve all users—vehicle drivers, pedestrians, bicyclists, transit riders
- Interconnected, Multimodal networks
- Safe for all ages and abilities
- Vary by context (e.g., urban/rural)
- Based on community desires
- Outcome of good planning and design
Complete Streets May Include:

- Wider sidewalks
- Narrower travel lanes, traffic calming features
- Crosswalks, curb ramps, accessible pedestrian signals
- Median islands
- Universal design features
- Bike lanes
- Wide paved shoulder
- Bus stops, shelters, bus pull outs
- Curb extensions
Green Streets are . .

Natural stormwater management approach that uses plants and soil to slow, filter and cleanse stormwater from streets.

Designed to allow stormwater to penetrate into the ground rather than be diverted to a conveyance system.

Natural systems approach to reduce stormwater flow, improve water quality, reduce urban heating, enhance safety, and beautify neighborhoods.

Some define green streets more broadly, including traffic reduction, narrow widths, encourage multimodal, or complete streets features.
Green Street Elements

- Plants and Soils
- Vegetated curb extensions
- Sidewalk planters
- Landscaped medians
- Vegetated swales
- Permeable pavement
- Street trees
- Alternative street designs (widths)
Linking Planning

Opportunities to support multiple community goals and improve quality of life

Integrated Approach

Land Use System
Transportation System
Water Resources System
Other Natural, Cultural Resource Systems
Livability is about using the quality, location, & type of transportation facilities & services available to help achieve broader community goals such as access to good jobs, affordable housing, quality schools, & safe streets.

Livability, sustainability, smart growth, walkable communities, new urbanism, healthy neighborhoods, active living, transit oriented development, complete streets, . . .
Creating Livable Communities

How the transportation decision making process can support more livable community outcomes

Federal Highway Administration
October 2011

Photograph of roadway under construction for a green streets project in Arlington, Virginia. Project includes pedestrian intersection improvements and the creation of a bio-retention swale in the median. This project is part of the county’s Neighborhood Conservation Program which directly engages citizens in identifying project scope and needs within their neighborhoods and prioritizing projects annually.
Green Streets as Community Revitalization Strategy
US EPA Region 5 & FHWA Webinar, 2011
One source for images: www.urban-advantage.com
Making a Greener Complete Street
Great Streets

- Are representative of their places
- Allow people to walk comfortably and safely
- Contribute to economic vitality
- Are functionally complete
- Provide mobility and access
- Facilitate placemaking
- Are green
What is the St. Louis Great Streets Initiative?

**East-West Gateway** launched the St. Louis Great Streets Initiative in early 2006 to expand the way communities think of their streets. Rather than viewing a roadway project as solely a way to move more cars and trucks faster, the goal of the St. Louis Great Streets Initiative is to trigger economic and social benefits by centering communities around interesting, lively and attractive streets that serve all modes of transportation. Learn More ▸

**What is a Place Type? Click Here to Learn More!**

**Resources**
- Document Library
- Design Tutorial
- Related Events
- Demonstration Projects
Where and How to Plan Green

Metropolitan Transportation Plan
a) Goals, Objectives, Performance Measures
b) Project Evaluation and Selection
   Sustainability, Livability Criteria
c) Policy Recommendations
   Complete, Green, Great Streets, Livability

Transportation Improvement Program
a) Project Selection Criteria
b) Program/Project Funding
   Livable/Sustainable Communities Initiatives
c) Implement regional policies
Regional Vision:
Greater Kansas City is a sustainable region that increases the vitality of our society, economy, and environment for current residents and future generations.

Transportation Vision:
A safe, balanced, regional multimodal transportation system that is coordinated with land-use planning, supports equitable access to opportunities, and protects the environment.
MARC Transportation Outlook 2040

Transportation System Goals:

- **Accessibility** - Maximize mobility and access to opportunity for all area residents

- **Climate Change & Energy Use** - Decrease the use of fossil fuels through reduced travel demand, technology advancements and a transition to renewable energy sources

- **Economic Vitality** - Support an innovative, competitive 21st-century economy

- **Environment** - Protect and restore our region's natural resources (land, water and air) through proactive environmental stewardship

- **Place Making** - Coordinate transportation and land-use planning as means to create quality places in existing and developing areas, and strengthen the quality of the region

- **Public Health** - Facilitate healthy, active living

- **Safety & Security** - Improve safety and security for all transportation users

- **System Condition** - Ensure transportation system is maintained in good condition

- **System Performance** - Manage the system to achieve reliable and efficient performance

**New plan goals for Transportation Outlook 2040**
Link environmental and transportation planning.

Natural Resources Inventory
The digital inventory maps valuable natural assets and ecological features in the region to help communities proactively conserve or restore natural resources during development.

Implement region's Clean Air Action Plan.
Reduce emissions
The region's Clean Air Action Plan contains formal commitments from area governments and businesses to voluntarily reduce ozone-forming emissions.

Fund and implement the MetroGreen® regional trails and greenways plan.
Fund Metrogreen®
This proposed 1,144-mile interconnected system of public and private open spaces, greenways and trails would link seven counties in the Kansas City metropolitan area.
## MARC Goal Related Performance Measures

### Environment

<table>
<thead>
<tr>
<th>Factor</th>
<th>Measure</th>
<th>Data</th>
<th>Goal</th>
<th>Actual</th>
<th>Trend</th>
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<tr>
<td>MetroGreen® network</td>
<td>Completed Metro Green® network miles</td>
<td>2010: 230 miles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2011: 242 miles</td>
<td></td>
<td></td>
<td>+5.22%</td>
</tr>
</tbody>
</table>

Source: Mid-America Regional Council Environmental Services, MetroGreen® database.

Note: The network has continued to expand and currently is estimated at 21.2 percent complete to its planned vision of a 1,144-mile system.
Complete Streets Efforts

- Regional Plan – agreement on concepts
- Collaboration with local government partners
- Good Practice/Guidance documents
- Funding and programming eligibility and criteria
MAP-21

Moving Ahead for Progress in the 21st Century

MAP-21, the Moving Ahead for Progress in the 21st Century Act (P.L. 112-141), was signed into law by President Obama on July 6, 2012. Funding surface transportation programs at over $105 billion for fiscal years (F.Y) 2013 and 2014, MAP-21 is the first long-term highway authorization enacted since 2005.

MAP-21 is a milestone for the U.S. economy and the Nation’s surface transportation program. By transforming the policy and programmatic framework for investments to guide the system’s growth and development, MAP-21 creates a streamlined and performance-based surface transportation program and builds on many of the highway, transit, bike, and pedestrian programs and policies established in 1991.

- Major FHWA actions (complete and pending) in implementing MAP-21 [PDF] [HTML]

To view PDF files, you can use the Acrobat® Reader®.

Recently Added
- 8/8 - Emergency Relief Q&As Updated
- 7/15 - Performance Management Q&As Updated
Context Sensitive Solutions

- Integrate land use, transportation, etc.
- Meaningful stakeholder participation
- Keep human and natural context foremost in mind
- Produce a plan for a transportation system that will be an asset to the community

http://www.contextsensitivesolutions.org/
FHWA Livability Website

http://www.fhwa.dot.gov/livability/

Livability Initiative

A Few Words from Victor Mendez, Federal Highway Administrator

Welcome to the Federal Highway Administration’s (FHWA) Livable Communities webpage. This webpage is intended to provide information on the FHWA Livability Initiative as well as provide updates on the HUD/DOT/EPA Partnership for Sustainable Communities.

I am honored to be a part of the most exciting time in the history of American highways. I will work to continue...
DOT Launches New Livable Communities Discussion Board

In July, DOT released the Livable Communities Discussion Board, a "community of practice," or online public forum to share information and ask questions about different topics related to livable communities. The site is an online community of practitioners in public, private, and non-profit agencies and organizations at the local, State, and Federal levels, who are interested in helping communities provide more transportation choices, encourage access to good jobs and affordable housing, support quality schools, and promote safer streets and roads. Join today!

Sustainable Communities

Sustainable communities are places that balance quality of housing and transportation choices with other development goals. They are places where people can walk and bike to quality jobs, schools, and services, with easy access to safe, affordable housing. With help from the Partnership for Sustainable Communities, communities can create more livable places where people want to live, work, and raise their families.
Good Things to Do?

- Consider complete, green streets in one planning process
- Connected street networks
- Connect transportation projects with broader community objectives
- Adopt context sensitive approach
Jim Thorne  
Community Planner  
FHWA Resource Center  
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708-283-3538
Construction Ecoservices. Walter P Moore Design Workshop
Green Streets Planning to O&M- Bagby Street, Houston.
PRESENTERS

- Charlie Penland, PE, LEED AP Principal, Walter P Moore
- Philip Koske, PLA, LEED AP Associate, Design Workshop
- David Batts, LEED AP Director of System Solutions, Construction Ecoservices
PRESENTATION OVERVIEW

I. General Information
II. Planning
III. Design
IV. Construction
V. Operations and Maintenance
VI. Greenroads™ Certification Process
1. GENERAL INFORMATION
• Pedestrian-oriented urban community
• Centrally located in heart of Houston
• Vibrant, densely populated mixed use neighborhood
• Popular restaurants and dynamic nightlife
• State of Texas Cultural Arts and Entertainment District
• Midtown Redevelopment Authority / Tax Increment Reinvestment Zone (TIRZ) created in 1995

• Abandoned and blighted area with insufficient infrastructure

• TIRZ formed to foster economic development and eliminate blight

• Funding provided through incremental taxes generated in Zone

• Initial focused on multi-family developer agreements to increase number of residents

• Currently administers proactive Capital Improvements Program (CIP) to stimulate development
MIDTOWN, HOUSTON

- Blighted areas transformed into thriving, pedestrian-friendly mixed use neighborhoods
- Vibrant, culturally diverse community
- Active lifestyle
- Increase in Population
  - 1995 - under 1000 residents
  - 2012 - ~ 9500 residents
- Increase in Property Tax Base
  - 1995 - $157 million
  - 2012 - $1.2 billion
Scope of work:

- Traffic Impact and Physical Analysis
- Public engagement throughout the design and implementation process
- Full street paving replacement
- Consolidation of overhead utilities
- Upgrades to sewer, storm sewer and water lines
- New sidewalks, intersection treatments, lighting, planting, and irrigation system
- Greenroads™ Certification
II. PLANNING
PLANNING OBJECTIVES:

Redefine the role of a public space in the lives of its user base.

Quality of life is the central driver for return on investment for our projects; Our clients expect us to maximize all potential to improve quality of life for residents and visitors.
PLANNING METHODOLOGY:

We quickly understood that there is no single street section or standard approach for this project.

Context Sensitive Design- We understood that the corridor as a whole had several common traits, but each block had a unique relationship with the street.

To do this, the project team must measure existing conditions and test assumptions:

1. Understand and Embrace Stakeholders
2. Thorough Analysis
3. Budgeting and Management Capacity
4. Policy vs. Process
Stakeholders can be partners or adversaries; you get to choose at the outset of a project.

Stakeholders often have a better idea of how activity along corridors works than you do.

Commerce and daily life will be greatly impacted during construction. Your engagement of the public should not stop after the planning phase.

Greenroads™ requires a public meeting as a prerequisite. Many third party validation systems consider engagement as part of sustainable planning.

South Grand Boulevard, St. Louis MO
2. PROJECT ANALYSIS

- Pedestrian, Automobile and Transit Circulation and Safety
- Traffic Analysis (speed, counts, etc.)
- Existing Land Use Analysis
- Overhead Utility Analysis
- Lighting (footcandle) Analysis
- Tree Analysis (health, shade, etc.)
- Existing Parking
- Walking Distance
- Heat Island Effect
- Opportunity for Redevelopment/Reinvestment
- Existing Public and Private Irrigation
CIRCULATION AND TRAFFIC

• All aspects of the design have an impact on quality of life and usability.
LAND USE

• Analysis of underdeveloped blocks and potential land use changes
• Opportunities for redevelopment and streetscape design
EXISTING TREES AND PEDESTRIAN FEATURES

- Trees were evaluated to determine their value to the community and human comfort.
- Tree health, root growth conditions, soils, canopy disturbance, species.
- Expanded rapid taper root zone area and advanced soil amendments.
  ...42% increase in tree growth area.

Tree canopy has a direct impact on both water quantity and air quality.
HUMAN COMFORT AND WALKABILITY

- The Texas Summer Problem: high humidity, high temperatures, low winds
- How to create summer disruption: value of shade and breezes
HUMAN COMFORT AND HEAT ISLAND

- Understanding surface temperatures in July
- Choice of hardscape materials
- Increase in softscape materials

Heat Island - Temperature of Various Materials on Site

Measurements were taken using a hand-held infrared thermometer at 12” above the surface. All measurements were taken in the sun on the same day with the same ambient temperature.
ON STREET PARKING VALUE

- Mapping existing parking opportunities
- Designing in additional on street parking facilities: convenience and revenue
3. Budgeting and Management Capacity

• Utilize cost modeling so that you do not over-promise.
• Use public feedback and/or previous planning efforts to prioritize improvements.
• Develop a plan for understanding staff and budget demands related to maintenance; reach out to installers or municipal groups that have installed similar features.
• Plan for dog waste and circulation through/around linear features.

“Lack of maintenance of infiltration systems has a considerably high impact on (perception of) aesthetic qualities.”

Frank Sleegers, Potentials and Limitations of Implementing Linear Infiltration Systems on Urban Streets
4. POLICY VS. PROCESS

• Unless you are in Portland, “Green Streets” generally represents change.
• Policy is generally not good at adapting to change quickly.
• Fire, EMS and other public safety often have heavy influence in the function of our street network…which also means they greatly influence the overall quality of those spaces for the public.
• Houston is remarkably flexible regarding back of curb improvements; Approval of improvements within the right of way can be very complex depending on regulations.
TRAFFIC PLANNING ISSUES

• Number of lanes (traffic impact analysis)
• Pedestrian friendly, but traffic effective
• Accommodating on street parking
• Intersection design for high turning movements
• Freeway off ramp impacts
EXISTING STREET SECTIONS

- Between St. Joseph and Webster
- Between Webster and Tuam

R.O.W. (Right of Way)
- VAR 4'-6' SW
- VAR
- 12' TURN LANE
- 2% MIN
- 2% MIN
- 8' PARKING
- 20' SIDEWALK

R.O.W. (Right of Way)
- VAR 4'-14' SW
- VAR
- 8' PARK
- 2% MIN
- 2% MIN
- 39' 22'
- 8' VAR
- 4'-20' SIDEWALK
- VAR

BUILDING

END ROAD WORK
2010 MAJOR THOROUGHFARE PLAN, CITY OF HOUSTON
III. DESIGN
New Street Section

Additional right turn lanes up to Webster Street.
Overall Configuration
Background LOS (2035) – AM
1% Growth Rate

Legend
A Below Capacity
E At Capacity
F Above Capacity
Proposed LOS (2035) – AM
Improved Timings - 1% Growth Rate

Legend
A Below Capacity
E At Capacity
F Above Capacity
Background LOS (2035) – PM
1% Growth Rate
Improved traffic flow has a direct impact on air quality and the quality of the pedestrian experience.
I-45 OFF RAMP
Traffic Calming Transitions
ON-STREET PARKING

• Preservation of parking was critical to both the Client and local stakeholders.

• As constructed, the project has an 8% net decrease in parking assuming cars in the existing condition scenario were parked efficiently.

• Adequate and convenient crossings of liner features is critical.
INTERSECTIONS

- The new design reduces crossing distances by 30-50%.

Bagby Street was defined by broad intersections and wide paving areas.
UTILIES

- Water and Sewer
- OH Utilities
  - Strategic rerouting
  - UG routing options
- Service interruptions
Existing Waterline

In service 1997

In service 1970’s

In service 1999

In service 1999
Existing Wastewater Collection

- Poor condition laterals
- Poor condition collectors
- Outfalls to 69” N. on San Jacinto
- Rehab in 2004

- 8” to be rehabbed by COH*
- 8” to be rehabbed by COH*
- Poor condition laterals
- Poor condition laterals

*COH: Construction and Operations Group
Franchise Utility Clean Up Options
DRAINAGE ISSUES

- Large 60” offsite pass through storm line
- City Standards potential conflicts
  - 24” minimum storm line
  - Inlet standards
- Impact mitigation
- Water Quality
Residents are interested in the function of LID features but more interested in positive impacts on downstream recreational amenities.
BACK OF CURB IMPROVEMENTS

• Street furnishings
• Sidewalks and pathways
• Lighting and electric service
• Curb ramps
• Wayfinding and signage
• Crosswalk equipment
• Irrigation
• Plantings
• Street trees
• Existing trees
• Rain Gardens
RAIN GARDEN DESIGN

• Use the largest trees you can afford
• If detention is not a goal, consider stepping interior elevations
• Be sure proposed plant material will grow to heights that complement the depth of the feature
• Spend as much as you can on soils within the rain garden. This is particularly important if you have an impervious liner at the bottom of the feature. At best, 1 tree = 1,000cf of soil!
• When surveyed, observers rank trees highest and standing water lowest
• Understand the requirements and limitations of building features around utilities
• Provide edge protections and adequate crossings
EPHEMERAL INTERPRETATION
IV. CONSTRUCTION
Street Trees Were Integral

- Typical Biofiltration Wasn’t an Option
- Needed an Efficient Approach
- High Performance Soils Allowed for Smaller Solution
Street Trees Were Integral

- Typical biofiltration would have required biofiltration soils and underdrain along the entire planter box
Street Trees Were Integral

- High Performance Modular Biofiltration System’s footprint was small enough to remain outside the rootzone of street trees.
Rain Garden Design

- Learning From Past Mistakes
- How Engineered Soils Drain
- Understanding “Bridging”
- Flow Dissipation
Learning From Past Mistakes
Learning From Past Mistakes

NEW 2½”-3” CALIPER TREES & PERENNIAL RAIN-GARDEN PLANTINGS
CONC. CURB W/ 5' WIDTH NYCDEP STANDARD CAST IRON CURB PIECE INLET/OUTLET
EXISTING ASPHALT ROADBED

STREET SLOPE TO CURB INLET

PARKING LANE

2'-0" CONC. WALK 5'-0" WIDTH RAIN-GARDEN BED

11' WIDTH CONCRETE SIDEWALK

2" MULCH CONC. CURB & TREE PROTECTION RAIL

SIDEWALK SLOPE 2%

4" CORRUGATED PERFORATED DRAINAGE PIPE ACT AS STORMWATER RESERVOIR

SPECIAL SOIL MIX: NATURAL SANDY LOAM W/ 7%-12% HUMUS, TO PROVIDE THE RISE OF WATER BY CAPILLARY ACTION TO THE PLANT ROOT ZONE

GEOTEXTILE
BROKEN STONE BED, ASTM C-33, SIZE #3 (2" TO 1")
Understanding Engineered Soils

Hydraulic Conductivity

Hydraulic Conductivity (cm/h)

22-Aug 19-Sep 17-Oct 14-Nov 12-Dec 9-Jan 6-Feb 6-Mar 3-Apr 1-May 29-May 26-Jun
“Bridge” Aggregates

- 3" Shredded Hardwood Barkmulch (No Fines)
- 18" High Flow Media
  100'/HR (Min.)
  (See Specifications)
- 6" Bridging Stone
  (See Specifications)
- Structural Underdrain
  (Depth Varies)
- 3" Compacted Base (Min.)
“Bridge” Aggregates
“Bridging” Prevents Clogging
Flow Dissipation is Critical
Rain Garden Construction

- Quality Assurance / Quality Control
- Working Around Utilities
- Protecting the Systems
- Signage
- Performance Verification
Quality Assurance
Modularity Aids in Field Modifications

Flexibility is Essential to success
Protection During Construction

- Protecting the System is Imperative
- Prevents Premature Sedimentation
- Simple “Activation” Protocol
Signage

- Use Signage When Possible
- Communicate Message in English and Spanish
- Action Items Must be Complete Prior to Activation
Measuring Performance

- Hydraulic Conductivity Test
- Pass / Fail
- Manufacturer / Contractor Must Prove It Works
V. OPERATIONS AND MAINTENANCE

- Staff training vs. contracted maintenance
- Indicators of system problems/failure
- Like typical planting areas, LID features require regular cleaning
- Plantings should be simple enough to intuitively maintain
- Re-application of mulch
- Keep water entry points clean and clear
ENVIRONMENT

- First GreenRoads certified project in the State of Texas (final stages)
- 300 tons of CO2 saved through fly ash in concrete
- 33% of right of way stormwater enters into rain gardens
- 70% tree canopy throughout corridor (32% existing)
- 16% decrease in noise decibel levels (peak) in key pedestrian areas (50 db to 42 db)
- 14% decrease in surface temperatures (108 degrees to 95 degrees avg)
COMMUNITY

- 4 lanes to 2 lanes (with periodic turn lanes) without reducing LOC below standard
- Pedestrian crossing distance reduced by nearly 45% (42' to 24' avg)
- 88% of the sidewalks are in shade (compared to 49%)
- Foot candle increase from .1 avg. to .45 average
- 15% more on street parking throughout the corridor
- 276% increase in pedestrian areas (16,291 SF to 44,983 SF)
- 350% Increase of bicycle facilities (12 to 42)
- 38% increase in seating and social gathering areas
EVIDENCE

ECONOMICS

- Approximately $25m in private development since project was announced
- 20% Rental market increase ($1.40 to $1.75 avg p/SF p/month)
- Project has remained in acceptable construction budget
- 218% increase in tree canopy throughout corridor (32% to 70%)
- Water quality credit for rain gardens that can be transferred to development (PER)

ART

- Custom furniture, signage, lighting and paving
- Custom interpretive rain gardens
- Enhanced planting design based on color, texture, form, structure, seasonality
What is Greenroads?

- Rating system
- Similar to LEED system
- Includes, but not limited to sustainable design / LID
- Nonprofit Organization focused on Education and the advancement of roadway and bridge initiatives
- Bagby expecting Certified or Silver certification
Credits

- 11 Project Requirements
- Optional Credits
  - Environmental and Water
  - Access and Equity
  - Construction Activities
  - Materials
  - Pavement
  - Custom
Construction activities
Lessons Learned

- Starts with planning (commit early)
  - Determine the benefits to be achieved
  - Requires owner buy in
  - Plan with the end results in mind
- Important as a design tool
- Important to track progress throughout
- Construction contract must address requirements
- Should be a major part of the pre-bid and pre-con meetings
Discussion and Questions
Stormwater that percolates through the filtration layers of the reed and cypress rain gardens, is conducted via a storm pipe into a filtration pond. The pond serves as a water source in the summer and the home lots are connected to the street space via individual bridges seen in the photo above.

(Left) To establish spatial definition to the eastern street edge, bald and pond cypress trees are organized in parallel layers to the street. These species are resilient to deluge and the extreme heat and drought of central Texas summers. (Middle) *Equisetum sp.* establish a vigorous fabric under the cypress. Slotted curbs communicate rainwater into the biofiltration gardens. (Right) The asymmetrically sloped street produces a low or “wet side” and a high or “dry side,” seen in this photo. The dry side contains a single row of un-irrigated desert willows set in a continuous surface of decomposed granite dust.
ZONE A
The Entrance and Ecological Field
In lieu of the expected features and walls, entrance is established with a transitional field of ecological plantings that legitimates the volunteer and itinerant species of the site, which propagated to its location from the adjacent subdivisions.

ZONE B
The System Landscape and Biofiltration Street
The central length of the street is designed as a repetitive system of elements that transform the street into a biofilter. This new prototype rethinks the typical residential street of the city by its demonstration at the Urban Reserve.

ZONE C
The Broadmead Connection at the Public Park
The area at the terminus of the street visually merges with the riparian landscape of a public linear park system – White Rock Creek Linear Park – by means of an alternative set of grasses added to the system landscape.

PROJECT CONTEXT
Public and Private Landscape
The context east of the Urban Reserve is a socially diverse 1950’s subdivision typified by one half and one-quarter acre detached lots.
Innovative Green Projects 2009

URBAN RESERVE, DALLAS

Green Points: Urban Reserve is a modern Dallas neighborhood with specially created landscaping suitable for Dallas' hot, dry summers. The neighborhood is about 10 acres (4 hectares) and is organized along a single street approximately 1,000 feet (305 m) long. Landscape architect Kevin Sloan tilted the street 2 percent asymmetrically so all the water flows to one side. This "wet" side has cypress trees and other plants that can sustain flooding. The other side of the street—the "dry" side—uses a xeriscaping strategy. No irrigation is needed and the trees are hardy species that can exist in places where there isn't a lot of rain. The ground plane consists of decomposed granite, a paving material that creates a fine gravel that is comfortable to walk on, similar to what is found in the Luxembourg Gardens in Paris. Before being developed, the land had been used as a dumping ground; it was littered with debris, earthfill, concrete slabs, and broken-up masonry. The team reused that waste to build walls, make pavement and prevent erosion around detention facilities.

People: Landscape architect, Kevin Sloan Studio, Dallas
Photos: Courtesy of Charles Davis Smith, AIA

Posted with permission from the July/August 2009 issue of eco-structure, Innovative Green Projects 2009. © Harley Wood 11-2078826

photo courtesy Kevin Sloan Studio
The Numbers

### Development costs:

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rain gardens</td>
<td>$224,952</td>
</tr>
<tr>
<td>Street paving</td>
<td>$88,467</td>
</tr>
<tr>
<td>Additional cost of rain gardens</td>
<td>$136,485</td>
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</tbody>
</table>

### Development costs -- minimized:

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rain gardens with fewer trees and lesser ground cover</td>
<td>$188,546</td>
</tr>
<tr>
<td>Street paving</td>
<td>$88,467</td>
</tr>
<tr>
<td>Additional cost of rain gardens</td>
<td>$100,079</td>
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</table>

### Utility cost:

<table>
<thead>
<tr>
<th>Year</th>
<th>Water</th>
<th>Electric</th>
<th>Total</th>
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<tbody>
<tr>
<td>2007</td>
<td>$4,420</td>
<td>$364</td>
<td>$4,784</td>
</tr>
<tr>
<td>2008</td>
<td>$4,841</td>
<td>$862</td>
<td>$5,703</td>
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<tr>
<td>2009</td>
<td>$1,438</td>
<td>$1,490</td>
<td>$2,928</td>
</tr>
<tr>
<td>2010</td>
<td>$2,743</td>
<td>$1,369</td>
<td>$4,112</td>
</tr>
<tr>
<td>2011</td>
<td>$5,568</td>
<td>$1,789</td>
<td>$7,357</td>
</tr>
<tr>
<td>2012</td>
<td>$7,812</td>
<td>$2,063</td>
<td>$9,875</td>
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<tr>
<td>2013</td>
<td>$3,298</td>
<td>$1,158</td>
<td>$4,456</td>
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<tr>
<td>Total</td>
<td>$30,121</td>
<td>$9,095</td>
<td>$39,216</td>
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</table>

Average annual utility cost: $5,602

### Area irrigated:

<table>
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<tr>
<th>Description</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common areas</td>
<td>75,779 SF</td>
</tr>
<tr>
<td>Front yards of built homes</td>
<td>10,920 SF</td>
</tr>
<tr>
<td>Total area</td>
<td>86,699 SF</td>
</tr>
</tbody>
</table>

Average annual cost of water + electric per SF: $0.06

Average annual cost of water + electric per lot per month: $9.34
Urban Reserve

Goals

1. Architecture of its time and of its place
2. Energy and water conservation
3. LEED certified homes to guarantee conservation
4. Create a neighborhood based on what people love in life...nature, exercise, modern architecture and modern art
5. Exterior materials of a naturally weathering nature with limited painted surfaces so the neighborhood ages gracefully
6. Control public landscape for a cohesive look and reasonable maintenance
Landscape Concept

1. Recycle rain water via ponds and rain gardens
2. Create ribbons of landscape...west/dry side with crushed green granite and desert willows, street, rain gardens with pond and bald cypress and horsetail reeds, east/west side with live oaks and purple winter creeper
3. Rain gardens hold several inches of water rather than several feet of water
Successes

1. We filter dirty water from our site plus upstream...we are a net positive on the environment
2. The streetscape is human scale creating more interaction with neighbors
3. The street is 22’ wide rather than the standard of 36’...less concrete reduces heat island effect and encourages slower driving with the benefit of less runoff from hardscape
Consider Changes for the Future

1. Different plant material than horsetail reed...perhaps love grass or buffalo grass... need to lessen the purchase of City water in the hot summer
2. Consider aesthetics of pond edges as water level drops during minimal rain periods
3. Grade rain gardens to hold up to 12” of storm water at the deepest point
LEADING PEDESTRIAN INTERVAL (LPI)
WHY – GETS PEDESTRIANS ESTABLISHED IN CROSSWALK
Problem/Background

- High rate of collisions between left-turning motorists and pedestrians during WALK interval
- LPI - 3 intersections
- Pedestrian crossings averaged 60 per hour
- No public outreach / awareness to ensure unbiased results
CASE STUDY: LPI
(ST. PETERSBURG, FL)

Details

- Installed 3-second LPI
- Studies pedestrian behavior and conflicts with turning vehicles
- Each street had four lanes & high traffic volume
- 30 mph posted speed
- Data collected for:
  - pedestrian/motor vehicle conflicts
  - pedestrians beginning to cross during the 5-second period at the start of the WALK interval
  - pedestrians starting to cross during the remainder of the WALK interval
Results

- Conflicts virtually eliminated for pedestrians departing during start of the WALK interval
  - Before: average of 2-3 conflicts per 100 pedestrians
  - After: no observation period had more than 2 conflicts per 100 pedestrians & 34 of the 41 periods had no conflicts
- Smaller reduction in conflicts during the remainder of the WALK interval
- Four months after installation, no reduction in effectiveness
ITE Toolbox: Modify signal phasing to implement LPI - associated with a 5% decrease in pedestrian crashes.

Reference
- Institute of Transportation Engineers (2004). Toolbox of Countermeasures and Their Potential Effectiveness to Make Intersections Safer, Briefing Sheet 8, FHWA.
- Orlando, Florida study (2000)
- CMF Star Rating: Cannot be rated – Insufficient information about study
CRF 37% pedestrian crashes

At intersections with high pedestrian volumes and high conflicting turning vehicle volumes, a brief leading pedestrian interval, during which an advance WALKING PERSON (symbolizing WALK) indication is displayed for the crosswalk while red indications continue to be displayed to parallel through and/or turning traffic, may be used to reduce conflicts between pedestrians and turning vehicles.

Section 4E.06, Paragraph 19
Guidance:
If a leading pedestrian interval is used, the use of accessible pedestrian signals (see Sections 4E.09 through 4E.13) should be considered.

Vision-impaired pedestrians use the sound of moving traffic to start crossing.

If No APS, How do Vision Impaired Pedestrians Know When to Cross?
If a leading pedestrian interval is used, it should be at least 3 seconds in duration and should be timed to allow pedestrians to cross at least one lane of traffic or, in the case of a large corner radius, to travel far enough for pedestrians to establish their position ahead of the turning traffic before the turning traffic is released.

If a leading pedestrian interval is used, consideration should be given to prohibiting turns across the crosswalk during the leading pedestrian interval.
HOW MANY SECONDS TO LEAD WITH?

MUTCD minimum is 3 seconds - but is there good guidance to determine other values?

- **D.C. has 117 intersections with LPI**
  - Most of these intersections have LPI on all four approaches
  - Typically use 3 sec
  - Rare occasions 7 or 8 sec used for unusual geometrics.
  - No chart or diagram for calculating time

- **Philadelphia has about 24 LPI intersections**
  - Use 3 sec

- **Phoenix has 3 LPI intersections**
  - Use 5 sec
  - Intersections have time of day LPI
LPI INTERSECTION - PHOENIX

- Two one-way streets
- 5 sec LPI
- Heavy left-turn movement conflicts with heavy crossing
- Outside City Hall & City Court and main marking structure for both
• Heavy northbound left-turn conflicts
• 5 Sec LPI provided for north/south pedestrians crossing with 3rd Ave traffic
## LPI CAN BE FIXED-TIME OR ACTUATED

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Red Light Duration</th>
<th>Green Light Duration</th>
<th>White Light Duration</th>
<th>LPI Actuated Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>3rd Ave – LPI Actuated</td>
<td>58 sec</td>
<td>27.5 sec</td>
<td>19.5 sec</td>
<td>3 Y</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3 Y</td>
<td></td>
</tr>
<tr>
<td>3rd Ave – LPI NOT Actuated</td>
<td>53 sec</td>
<td>32.5 sec</td>
<td>19.5 sec</td>
<td>3 Y</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3 Y</td>
<td></td>
</tr>
</tbody>
</table>

### Fixed-time:
- 24-hours
- Time-of-day

### Push-button actuated
“NO RIGHT TURN ON RED” sign highly recommended

What NTOR sign works best for various circumstances?
Too many to list but two are: TCT8000, TMP390

Older signal controllers may need to utilize a new/additional phase for LPI interval, allowing the WALK to occur before the green interval and holding all of the other movements in red. Typically requires creation of a dummy phase to link the LPI with the rest of the WALK and pedestrian clearance interval

- Can be done with concurrent operating phases or controllers capable of pedestrian overlaps
- Can be more complex to establish left-turn phases with LPI because of increased number of phases utilized & limitations of older controllers
Examples: ASC/2 or ASC/3

Use Delayed Green feature (DLY GRN)

- Defined (per the ASC/3 Programming Manual) as: “The time that the vehicle green indication will be delayed from the start of the WALK interval. The delay is ignored if there is no pedestrian service call when the phase is started (actuated mode). If the delay time is greater than the WALK time, the WALK is extended to the end of the delay green.”

- For fixed-time or non-actuated operation, delayed green (for LPI) will be provided for every signal cycle.

- Per the ASC/3 Programming Manual, the delayed green can be set from 0 to 255 seconds

- Can be push-button, automated detection, or time-of-day

- D.C. DOT implements LPI through a central controller
ISSUES

- Left Turn Arrows – Best with lagging protected arrows
- Synchronization with other signals – should not be an issue
- One-Way Streets – Treat left-turn LPI same as right-turn – May want to add a few more seconds in some instances
- NTOR – RTOR prohibitions highly recommended for LPI to work for pedestrians
- Congestion – separating pedestrians from turns should help reduce congestion
HOW TO INCREASE LPI EFFECTIVENESS

- Provide enough LPI time for pedestrians to occupy crosswalk
- Prohibit turns on red
- Provide APS for vision-impaired pedestrians
COST

- **Low** (if new controller not needed)
- **Time & effort to program & implement**
- **NTOR signs**
- **APS push buttons** (Highly Desirable)
CASE STUDIES
CASE STUDY: LPI
(STATE COLLEGE, PA)

Details

- High pedestrian-vehicle crash rates, especially in central business district
- LPIs installed at 10 intersections downtown
- Each street had two through lanes
- 12,000 - 13,500 ADTs
Details

- 25 mph speed limit
- Pedestrians: 100 to 1,000 per hour
  - Fluctuation due to university class schedules
- LPI - 3 seconds
Results

- Study in 2010 compared the 10 sites with LPIs to other STOP-controlled intersections in the borough*

- Crash counts for 4-year before and 3-year after period: LPIs resulted in a 46.2 - 71.3% reduction in crashes

- LPIs resulted in cost savings of $92,130 per intersection per year

## Listing of LPI Signals


<table>
<thead>
<tr>
<th>Street</th>
<th>Borough</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broadway at West 225th Street</td>
<td>the Bronx</td>
</tr>
<tr>
<td>East 147th Street at Willis Avenue</td>
<td>the Bronx</td>
</tr>
<tr>
<td>East 149th Street at Morris Avenue</td>
<td>the Bronx</td>
</tr>
<tr>
<td>East 161st Street at Gerard Avenue</td>
<td>the Bronx</td>
</tr>
<tr>
<td>East 233rd Street at Carpenter Avenue</td>
<td>the Bronx</td>
</tr>
<tr>
<td>East Tremont Avenue at Ericson Place/Hutchinson</td>
<td>the Bronx</td>
</tr>
<tr>
<td>River Parkway exit ramp</td>
<td></td>
</tr>
<tr>
<td>River Avenue at East 162nd Street</td>
<td>the Bronx</td>
</tr>
<tr>
<td>Sedgwick Avenue at Dickinson Avenue</td>
<td>the Bronx</td>
</tr>
<tr>
<td>West Fordham Road at University Avenue</td>
<td>the Bronx</td>
</tr>
<tr>
<td>108th Street at Oits &amp; Van Cleef Streets</td>
<td>Queens</td>
</tr>
<tr>
<td>178th Street at Hillside Avenue</td>
<td>Queens</td>
</tr>
<tr>
<td>188th Street at Grand Central Parkway Service Road North</td>
<td>Queens</td>
</tr>
<tr>
<td>73rd Avenue at Bell Boulevard</td>
<td>Queens</td>
</tr>
<tr>
<td>99th Street at Horace Harding Expressway Service Road North</td>
<td>Queens</td>
</tr>
<tr>
<td>Archer Avenue at Parsons Boulevard</td>
<td>Queens</td>
</tr>
<tr>
<td>Archer Avenue at Sutphin Boulevard</td>
<td>Queens</td>
</tr>
<tr>
<td>Broadway at 21st Street</td>
<td>Queens</td>
</tr>
<tr>
<td>Corporal Kennedy Street at 26th Avenue</td>
<td>Queens</td>
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<tr>
<td>Cross Bay Boulevard at 157th Avenue</td>
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<td>Eliot Avenue at 71st Street</td>
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<td>Grand Avenue at 69th Street</td>
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<td>Grand Avenue at Long Island Expressway North</td>
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<tr>
<td>Grand Avenue at Long Island Expressway South</td>
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<tr>
<td>Hempstead Avenue at Springfield Boulevard</td>
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<tr>
<td>Jamaica Avenue at 162nd Street</td>
<td>Queens</td>
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<tr>
<td>Jamaica Avenue at Parsons Boulevard</td>
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<td>Junction Boulevard at Long Island Expressway South Service Road</td>
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<td>Kips Bay Boulevard at Eider Avenue</td>
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<tr>
<td>Kissena Boulevard at Sanford Avenue</td>
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<td>Main Street at 40th Road</td>
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<td>Northern Boulevard at Main Street</td>
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<td>Queens Boulevard at 32nd Place</td>
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<td>Queens Boulevard at 33rd Street</td>
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<td>Queens Boulevard at 47th Street</td>
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<tr>
<td>Roosevelt Avenue at Main Street</td>
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<tr>
<td>Union Turnpike at Springfield Boulevard</td>
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<tr>
<td>Whitestone Expressway Service Road at 20th Avenue</td>
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</tr>
</tbody>
</table>
MUTCD Section 4E.06 Pedestrian Intervals and Signal Phases

"Safety Effectiveness of Leading Pedestrian Intervals Using the Empirical Bayes Method." TRB 88th Annual Meeting Compendium of Papers CD-ROM. Washington, DC (2009). Study Citation: Fayish, and Gross
THE GREEN AT COLLEGE PARK
UNIVERSITY OF TEXAS ARLINGTON
CREDIT 2.1:

Intent:
Conduct an accurate and detailed assessment of site conditions and explore options for sustainable outcomes prior to design to inform decisions about site design, construction, operation, and maintenance.

Requirements:
HYDROLOGY: Topography and direction of overland water flow on site and its effects on the watershed as a whole.

Provided:
Hydrology Map
THE GREEN AT COLLEGE PARK
The University of Texas Arlington
THE GREEN AT COLLEGE PARK

HIERARCHY OF STORM WATER MANAGEMENT

■ Priority One – Design the site to be a green sponge
  ■ Encourage infiltration of storm water into the soil
  ■ Drain storm water from grey to green
  ■ Sheet flow storm water across the landscape
  ■ Reduce impervious surfaces
  ■ Slow down the flow of water
  ■ Create micro-depressions in the landscape to capture storm water
  ■ Amend soil with organic matter to encourage soil to function more like pre-development infiltration rates
HIERARCHY OF STORM WATER MANAGEMENT

- Priority Two – Improve quality of storm water
  - Filter water through vegetated areas
  - Filter water through soil
  - Slow down flow of water to allow sediment to settle
  - Select plants that break down pollutants in water
  - Slow down the flow of water
  - Provide a highly organic soil so microorganisms can break down pollutants
**Expected Pollutants:**
- Sediment,
- heavy metals and
- Petroleum compounds from adjacent parking

**BMP’s:**

**Rain Planters:**
- Designed to store and convey run-off and filter contaminants

**Biofilters:**
- Located between parking areas and rain garden
- Saw tooth curb added to allow stormwater to drain through biofilters
- biofilters contain native vegetation

**Rain Garden:**
- connects and flows into the Rain Garden.
- Water infiltrated into the rich planting media in the rain planters flows through the soil into the rain garden.

**Oval Lawn:**
- During large storm events run-off backs up and is stored in the oval lawn area.
- Drainage across the lawn sheet flows into the Rain Garden.
STORM PLANTER
CONDENSATE

FOUNTAIN
DRY STREAMBED
RAIN GARDEN
RAIN PLANTER

SCALE: 1" = 1'-0"
HIERARCHY OF STORM WATER MANAGEMENT

- Improve quality of storm water
  - Filter water through vegetated areas
  - Filter water through soil
  - Slow down flow of water to allow sediment to settle
  - Select plants that break down pollutants in water
  - Slow down the flow of water
  - Provide a highly organic soil so microorganisms can break down pollutants

THE GREEN AT COLLEGE PARK

**College Park Center Drainage** consists of surface runoff, storm water from roof drains and condensate from the air conditioning system.

The **Rain Channel** is a conveyance system that consists of a porous soil structure protected by a layer of rock mulch. This channel increases infiltration of runoff into the soil and filters total suspended solids.

The **Storm Spring** relieves pressure from the underground campus storm drainage system. During large storm events, it functions as a reverse inlet, allowing storm drainage from underground pipes to overflow into the oval lawn area for detention.

The **Detention Lawn** temporarily holds water during large storm events and gradually allows it to drain into the Bill Garden.

The **Bill Garden** is a complex system of vegetation that thrives in drought and flood conditions. Below the surface layer of the rock mulch is a porous soil structure that increases infiltration. The soil system, rock mulch and vegetation work together to remove pollutants from storm runoff. This garden replaces an eroded drainage channel, a hill that existed on the site.

The **Check Dam** helps to filter storm water and encourages infiltration by reducing velocity and increasing the amount of time storm water is detained on site.

**Overflow Structure** controls the amount of water that leaves the garden and drains to Johnson Creek. The controlled release also alleviates potential flooding of adjacent streets.

**Biofilter** is a vegetated system that removes total suspended solids from parking lot runoff before eventually draining into theBill garden.

**Microdepressions** are shallow depressions in the landscape that are sculpted to retain irrigation and storm runoff. Below the depressions are large rock sumps that store water and release it into the soil to be used by surrounding vegetation. Planted in the shallow areas are native plants that grow in wet soil conditions.
SIMPLE ADJUSTMENTS TO ACHIEVE SUSTAINABILITY

LIMIT TURF PLANTING
- More than 50% of municipal water use goes to irrigate residential lawns

USE THE SOIL AS A WATER BANK

PLANT NATIVE GRASSES AND PERENNIALS

IMPROVE ORGANIC CONTENT OF SOIL

DRAIN FROM GREY TO GREEN
THE SUSTAINABLE SITES INITIATIVE

“The Sustainable Sites Initiative™ (SITES™) is an interdisciplinary effort by the American Society of Landscape Architects, the Lady Bird Johnson Wildflower Center at The University of Texas at Austin and the United States Botanic Garden to create voluntary national guidelines and performance benchmarks for sustainable land design, construction and maintenance practices”

www.sustainablesites.org
SITES vs. LEED

SITES – Sustainable Sites Initiative (SITES)
- Site based
- Certification is on a 1, 2, 3, 4 Star rating system
- Just finished the pilot program phase
- Only one form of SITES is available
- 2009 Guidelines & Performance Benchmarks

LEED – Leadership in Energy and Environmental Design
- Building Based
- Certification is on a Silver, Gold & Platinum rating system
- Is an established rating system
- Is available in several forms
Novus Headquarters
St Charles, MI

The Green At College Park
Arlington, TX

Woodland Discovery Playground
Memphis, TN
How INVEST Can Help You

The Infrastructure Voluntary Evaluation Sustainability Tool
U.S. DOT Federal Highway Administration

Green Streets and Transportation Planning Workshop
Arlington, Texas
September 25, 2013
What is Sustainability?

The Sustainability Triple Bottom Line
Sustainability entails meeting human needs for the present and future, while:

- Preserving and restoring environmental and ecological systems;
- Fostering community health and vitality
- Promoting economic development and prosperity; and
- Ensuring equity between and among population groups and over generations.
Transportation and Sustainability

- Transportation system enhances quality of life through access to health care, education, employment, recreation, etc.

- Supports community, economic development.

- Negative impacts from congestion, fatalities and injuries, noise, air and water pollution, GHG, diminishing energy resources, and biological and ecosystem damage.

- Maximize benefits, minimize costs.
The Sustainable Highways Initiative supports programs and activities conducted across the Federal Highway Administration to facilitate balanced decision-making among environmental, economic and social values — the triple bottom line of sustainability.
WHY INVEST?

• Connects sustainability principles with action
• Measures sustainability specifically for transportation
• Helps stakeholders in the industry go above and beyond
Built for the Real World

- Voluntary - Use it how and where the agency wants
- Private - Data belongs to the user
- Practical - Relates to projects and planning the agency does every day
- Free - No licenses and no limits
Supporting the Entire Life Cycle

System Planning & Processes

Project Development

Operations & Maintenance
About INVEST

Welcome to INVEST Version 1.0!

Announcements

The Federal Highway Administration (FHWA) is seeking to partner with State departments of transportation (DOTs), metropolitan planning organizations (MPOs), Federal lands, and local governments on utilizing INVEST 1.0, FHWA's voluntary self-assessment tool, to assess and enhance the sustainability of their projects and programs. For more information, see the solicitation.

FHWA launched INVEST 1.0 on October 10, 2012. View the one-page summary and webinar launch, including remarks from Deputy Administrator Greg Nadeau, video footage of INVEST in action in four parts of the country, an overview of how the tool works, and interviews with transportation agencies that piloted the tool.

What do you want to do?

Learn

A guided tour through the INVEST website to learn about sustainable highways and integrating sustainability best practices into projects and programs.

Browse

A gateway to browse the complete set of INVEST criteria that can be used to evaluate the sustainability of projects and programs.
INVEST User Workspace

My Workspace

Scoring Tutorial

Start a new Project or Program

Continue Working on an Existing Project or Program:

System Planning and Processes

Test 1

Edit  Duplicate  Print-View  Score  Delete  Collaborate

Project Development

Test 2

Edit  Duplicate  Print-View  Score  Delete  Collaborate

Operations and Maintenance

Test 3

Edit  Duplicate  Print-View  Score  Delete  Collaborate
Scoring in INVEST

System Planning Criteria by Sustainability Principle

Criterion Number and Title

SP-1: Integrated Planning: Economic Development and Land Use
SP-2: Integrated Planning: Natural Environment
SP-3: Integrated Planning: Social
SP-4: Integrated Planning: Bonus
SP-5: Access & Affordability
SP-6: Safety Planning
SP-7: Multimodal Transportation and Public Health
SP-8: Freight and Goods Movement
SP-9: Travel Demand Management
SP-10: Air Quality
SP-11: Energy and Fuels
SP-12: Financial Sustainability
SP-13: Analysis Methods
SP-14: Transportation Systems Management & Operations
SP-15: Linking Asset Management and Planning
SP-16: Infrastructure Resiliency
SP-17: Linking Planning and NEPA

Criterion Details

SP-1 Integrated Planning: Economic Development and Land Use

Goal
Integrate statewide and metropolitan Long Range Transportation Plans (LRTP) with statewide, regional, and/or local land use plans and economic development forecasts and goals. Proactively encourage and facilitate sustainability through the coordination of transportation, land use, and economic development planning.

Sustainability Linkage
Integrating transportation planning with economic development and land use supports the economic triple bottom line principle by creating opportunities to improve access and mobility, and increase the social, environmental, and economic returns on both public and private investments in transportation projects and programs.

Scoring Requirements

Background
This criterion recognizes that each state and MPO has different land use and economic development regulatory, policy, and institutional frameworks, plans, and goals, and allows for flexibility in the activities and types of plans agencies use to measure integration. The intent of this criterion is to encourage agencies to integrate sustainability into transportation, land use, and economic development planning.
How INVEST Measures Sustainability

System Planning Scorecard

Program or Process: Test 1 edit

View full scorecard to save or print from your browser.

Criteria | Points
--- | ---
SP-01 Integrated Planning: Economic Development and Land Use | 15/15
Integrate statewide and metropolitan Long Range Transportation Plans (LRTP) with statewide, regional, and/or local land use plans and economic development forecasts and goals. Proactively encourage...

SP-02 Integrated Planning: Natural Environment | 15/15
Integrate ecological considerations into the transportation planning process, including the development of the long range transportation plan (LRTP) and TIP/STIP. Proactively support and enhance...

SP-03 Integrated Planning: Social | 15/15
The agency’s Long Range Transportation Plan (LRTP) is consistent with and supportive of the community’s vision and goals. When considered in an integrated fashion, these plans, goals and visions...

Score
Your Rating: Bronze
96 points needed for Silver
120 points needed for Gold
144 points needed for Platinum

Download
- Compendium - Web Version
- Compendium - Print Version
- Scorecard
Evaluate – Score – Improve

- Evaluate – Using the collaborative process can provide the most important outcome
- Score – Provides recognition for implementing sustainability best practices and identifying gaps
- Improve – Using the process to improve in practice and identify cost effective measures
INVEST Pilot Sites

By the Numbers

15 states had INVEST pilot projects
19 agencies pilot tested INVEST:
- 10 state DOTs
- 4 MPOs
- 3 local governments
- 2 Federal Lands Highway Divisions
North Central Texas Council of Governments (NCTCOG)

Large Multi-Modal Transportation Plan
**INVEST Role: System Planning & Processes**

- Rapid regional growth: 6.5M to 10M
- Projected funding shortfall of $45B
- Need to increase mobility, cut some improvements & reprioritize others
- Influence travel behavior & demand, improve transportation / land use links
- Extend life of existing assets, increase spending on O&M
- Used INVEST to validate assumptions, ID improvements in asset management and infrastructure resiliency
North Central Texas Council of Governments (NCTCOG)

Watch Video Case Study Here
Ohio Department of Transportation (ODOT)

Complex, Urban Project

**INVEST Role: Project Development**

- Largest project in ODOT history – replace bridge spans / expand lanes
- Involves coast-to-coast Interstate
- Affects historic district and high-traffic sports complex
- Targeted major savings in diesel fuel, steel, water and landfill
- Used INVEST to validate those savings assumptions
Ohio Department of Transportation (ODOT)

Watch Video Case Study Here
Western Federal Lands

National Scenic Parkway
INVEST Role: Project Development

- 70 years of traffic, weather, avalanches & rockslides
- Aggressive 20-year seasonal rehab program keeps road open but work moving ahead
- Reusing all existing stonework, re-seeding disturbed roadsides
- INVEST helped validate context sensitivity but also improve their documentation & communications
Western Federal Lands

Montana

Watch Video Case Study Here
Maintaining a State-Wide Highway System

*INVEST Role: Operations & Maintenance*

- Traffic monitoring & coordination across 6K+ center-line miles of highways
- Key goals: preserve infrastructure, optimize mobility, improve safety, strengthen the economy
- Budget pressures driving need for more sustainable practices
- Used INVEST to ID inexpensive ways to promote sustainability, like better data about pavement conditions
Utah Department of Transportation (UDOT)

Watch Video Case Study Here
INVEST Implementation Sites

By the Numbers

- 24 INVEST implementation projects in 17 states and DC
- By 18 agencies, including:
  - 4 state DOTs
  - 8 MPOs
  - 3/3 Federal Lands Highway Divisions
  - 3 other transportation agencies
INVEST: Sustainability throughout the Transportation Lifecycle

Affected Triple Bottom Line Principles

Voluntary • Private • Free • Flexible • Practical
Appendix: System Planning Criteria

SP-1 Integrated Planning: Economic Development and Land Use
SP-2 Integrated Planning: Natural Environment
SP-3 Integrated Planning: Social
SP-4 Integrated Planning: Bonus
SP-5 Access & Affordability
SP-6 Safety Planning
SP-7 Multimodal Transportation and Public Health
SP-8 Freight and Goods Movement
SP-9 Travel Demand Management
SP-10 Air Quality
SP-11 Energy and Fuels
SP-12 Financial Sustainability
SP-13 Analysis Methods
SP-14 Transportation Systems Management & Operations
SP-15 Linking Asset Management and Planning
SP-16 Infrastructure Resiliency
SP-17 Linking Planning and NEPA
## Appendix: Project Development Criteria

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<th>Pedestrian Access</th>
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<td>PD-9</td>
<td>Ecological Connectivity</td>
<td>PD-18</td>
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Appendix: Project Development Criteria

PD-19  Reduce and Reuse Materials
PD-20  Recycle Materials
PD-21  Earthwork Balance
PD-22  Long-Life Pavement Design
PD-23  Reduced Energy and Emissions in Pavement Materials
PD-24  Contractor Warranty
PD-25  Construction Environmental Training
PD-26  Construction Equipment Emission Reduction
PD-27  Construction Noise Mitigation
PD-28  Construction Quality Control Plan
PD-29  Construction Waste Management
## Appendix: Operations & Maintenance Criteria

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<th>Internal Sustainability Plan</th>
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<td>OM-14</td>
<td>Work Zone Traffic Control</td>
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</table>
FHWA Needs Feedback to Make it Even Better

To help FHWA make the next version of INVEST even better, click on the “Provide Comments” link at:

www.sustainablehighways.org
Try INVEST at:
www.sustainablehighways.org

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Diane Turchetta (diane.turchetta@dot.gov)
Transportation Sustainability in North Central Texas:
Using INVEST to Evaluate the Dallas-Fort Worth Metropolitan Transportation Plan

FHWA Green Streets and Transportation Workshop
September 25, 2013

Dan Lamers
Senior Program Manager, Transportation Planning
North Central Texas Council of Governments
Regional Perspective

• Big and getting bigger
• Major economic player

Population

• 2012: 6.7 million
• 2035: 9.8 million
• 4th Largest Metropolitan Area by Population

Area

• 12 county Metropolitan Planning Area
• 9,441 square miles (larger than New Hampshire)
• 2nd Largest Metropolitan Planning Area

Economy

• Home to 18 Fortune 500 Firms
• Ranked 6th in Gross Metropolitan Product
A New Planning Reality

• Mobility 2035 and Mobility 2035 – 2013 Update
  • Continued growth
  • Funding shortfalls
  • Air quality nonattainment

• A new approach was needed
  • Needs exceed available revenue
  • Can’t build our way out of congestion
  • Invest strategically in infrastructure
  • Maximize existing system
  • Use sustainable development strategies to reduce demand and provide multi-modal options
  • Emphasize environmental aspects and quality of life
What Did We Do?

• 2012 INVEST Pilot Study Participant
  – Evaluated all triple bottom line elements relative to our planning process and MTP
    • Brought together all relevant program areas
    • Many discussions as we attempted to score ourselves on each criteria
    • Found it difficult to fit our efforts into scoring options
      – Met vs Not Met, partial credit
  – Video

• Realized we had done a lot, but still had some work to do
Where Are We Now?

• Current Sustainability Initiatives
  – Environment
    • Air quality
    • Regional Ecosystem Framework
  – Land-Use and Transportation Connection
    • Sustainable development funding programs
  – Economic Development
    • Infrastructure investment

Current efforts focus on localized/project level implementation. Future efforts aim to address sustainability throughout the region at the system level.
How Can We Get There?

• Incorporate concepts from INVEST throughout plan development
• Mobility 2040 – the next metropolitan transportation plan
  – Received FHWA funds to focus on specific INVEST System Planning Criteria
    • Sustainability Performance Measure Development for about 10 measures
    • Planning and Environment Linkages (Landscape-scale analysis techniques and mitigation)
    • Linking Asset Management and Planning
    • Infrastructure Resiliency (Adaptation Strategies)
  – Coordinate with SHRP2 grant to update Regional Ecosystem Framework
  – Evaluate before and after
• Incorporate performance based planning efforts
• Understand “Texas Version” of context sensitive solutions
Contact Information

To find out more about the Mobility 2035 – 2013 Update, please visit [www.nctcog.org/mobility2035](http://www.nctcog.org/mobility2035) or contact:

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