Let it Snow, Rain and Drain

A Conversation on Street Drainage and Usability

Houston, Miami, Minneapolis
Donald Buaku, AICP, aAIA  
Planner Manager / Urban Design Studio Lead  
Houston Public Works

Josiel Ferrer-Diaz, P.E.  
Deputy Director / Chief Operations & Maintenance Officer  
Miami-Dade County

Bryan Dodds  
Deputy Director / City Engineer  
Minneapolis
Houston  
Miami-Dade  
Minneapolis
Houston
Resilient Sidewalks Plan

Donald Buaku, AICP, assoc. AIA | City of Houston
By the Numbers

- 4th Largest city in the country
- Most diverse city in the country
- 671 square miles across Houston
- 16,000 lane miles of streets (the distance between Houston and Tokyo and back)
- Over 1 million traffic signs
- 2,500 traffic signals
- 1,371 bridges
- 4,500 miles of sidewalks
- 3,900 miles of stormwater lines
- 2,800 miles of roadside ditches
What is Urban RESILIENCE?

The capacity of individuals, communities, institutions, businesses, and systems within an urban area to survive, adapt and thrive no matter what kinds of chronic stresses and acute shocks they experience.

– Resilient Houston
Quick Background

- **August 2017**: Hurricane Harvey devastates Houston

- **CDBG DR 17** (Disaster Recovery) funding received by COH for planning activities.
  
  - 6 Resilience Planning Studies,
  - 1 modeling effort,
  - 1 Hazard Mitigation Plan, and
  - 3 Housing planning support initiatives
$835 M available for Hurricane Harvey Recovery (CDBG-DR 17 program) through the Texas GLO, from HUD.

February 2018

Local Action Plan released allocating $23 M for planning efforts

- Project Awarded to Consulting Team
- Council Approval
- Project Underway

Procurement Processes

Project Completion

We are here!
Project Charge

- Two (2) Neighborhood Sidewalk Plans
  - Kashmere Gardens
  - Gulfton

- A City-wide toolkit.

- Address safety, drainage, accessibility, alternative materials, innovative design, **funding**, maintenance requirements, etc.
Principles - considerations

Resilient Sidewalks Plan

- Kashmere Gardens Community Plan
- City-wide Toolkit
- Gulfton Community Plan
Principles – sidewalk performance

DRAINAGE

MOBILITY
Project Scope

Previous Plans & Status Quo

This Plan!

Future Offshoots

Further Studies

Specific Plans

- DVD NTSC
- DVD PAL
- 720p
- 1080p
- 1280x720
- 1920x1080
- 3840x2160
- 2160p/4K
Project Scope

- Planning level
- Examine sidewalks for mobility and drainage
- Create a menu of options
- Contribute to a Resilient Pedestrian Network
Resilient Pedestrian Network – beyond the sidewalk

1. Off-Street Trails
   This type of connection serves adjacent to a natural resource and consists of pedestrian-only or shared pedestrian-bike infrastructure. It is fully separated from vehicular traffic.

2. Mid-Block Alley & Shared Streets
   These connections provide shared access for pedestrians, bicyclists, wheelchair users, and vehicles on slow-moving 'boulevard' streets. It may be a mid-block alley or a regular street with multiple building entries.

3. Privately Owned Pedestrian Connections
   These serve as connections through large developments such as medical and educational institutions to access community amenities. While they are located on private property, public access and use is maintained.

4. Ped and Bike Shared Multi-Use Pathway
   These serve as shared pedestrian and bicycle connections on one side of a public street with multiple building entries. Pedestrians and bicyclists are physically separated from moving traffic.

5. Utility Corridors
   This connection leverages the land set aside for utilities to create a desirable pedestrian condition separated from vehicles. These must be coordinated with local utilities to retain their service access.
Wins Here & There

Space City Sweeper - 2022

Bagby Street Improvements - 2021
Wins Here & There

Protected Intersections
Gray & Austin Streets
2020

Lawndale St Improvements
2022

11th Street Improvements
March 2023
Existing Conditions
Existing Conditions

Open Ditch

- Open ditch next to roadway with no sidewalks
- Open ditch next to property line with no sidewalks
- Open ditch next to roadway with sidewalk on one side
- Open ditch next to property line with sidewalk on one side
- Open ditch next to roadway with sidewalk on both sides
- Open ditch next to property line with sidewalk on both sides
- Open ditch between narrow roadway or property line

Curb & Gutter

- Curb and gutter in a local street with no sidewalks
- Curb and gutter in a local street with buffered sidewalk on one side
- Curb and gutter in a local street with unbuffered sidewalks on both sides
- Curb and gutter in a local street with buffered sidewalks on both sides
- Curb and gutter in a major thoroughfare with no sidewalks
- Curb and gutter in a major thoroughfare with buffered sidewalk on one side
- Curb and gutter in a major thoroughfare with unbuffered sidewalks on both sides
- Curb and gutter in a major thoroughfare with buffered sidewalks on both sides
Community Involvement

Over 1000 Respondents!
City-wide Toolkit

Scenario OD-1: Existing
Open Ditch Next to Roadway

Existing Context
Primarily observed in local residential streets, this existing condition involves an open ditch on at least one side, directly adjacent to the roadway. The space between the open ditch and property line may include a sidewalk or completely lack pedestrian infrastructure. The roadway may contain parking on one or both sides of the street. Overhead and at-grade utilities are generally located at the edge of the ROW.

Scenario Applicability Criteria
- Right-of-Way (ROW): 40’ – 80’
- Travel Lanes: Two minimum
- Drainage: Open Ditch
- Pedestrian Infrastructure: No sidewalks; sidewalk on one side; sidewalk on both sides in poor condition

Preferred Solution OD-1.0
The proposed improvements include adding a sidewalk on at least one side of the ROW. Additional improvements include converting the open ditch into a bioswale to mitigate potential flooding created by adding additional impervious pavement. No change is proposed to the existing roadway.

Scenario Improvement Criteria
- Sidewalk/Pedestrian Zone: 5’ minimum (6’ preferred) standard concrete sidewalk
- Vehicular and Bike Access: 16’ minimum with two bi-directional lanes (20’ preferred)
- Refer to the City of Houston Bike Plan
- Drainage/Amenity Zone: 8’ minimum open ditch repurposed as bioswale

Alternative Solutions
- OD-1.1: Provide permeable sidewalk on at least one side of the street. Maintain existing open ditches and roadway.
- OD-1.2: Provide standard concrete sidewalk on at least one side of the street. Convert part or all of the roadway to porous asphalt to mitigate drainage issues. Maintain existing open ditches.
- OD-1.3: Reroute entire street and provide one consolidated bioswale in middle of ROW. Provide standard concrete sidewalks (raised with or without curbs) on both sides of the street.

* Will require modifications if located on a TOD Street, Major Thoroughfare, or within the Central Business District. May require modification approval if identified in the Walkable Places Plan.
Scenario OD-1: Proposed
Open Ditch Next to Roadway

Proposed Conditions: Renderings and Built Examples

OD-1.0 Rendering of proposed improvement on one side of street
OD-1.1 Rendering of permeable sidewalk on one side of the street next to open ditch

OD-1.0 Built example in Seattle, WA
OD-1.1 Built example of permeable sidewalk in Seattle, WA

Photo courtesy of Mark Holema
Photo courtesy of Greenworks

OD-1.0 Built example in Eagle Creek
OD-1.2 Built example of porous asphalt in Seattle, WA

Photo courtesy of Ecologic
Photo courtesy of Methun
Scenario OD-2: Existing
Open Ditch Next to Property Line

Prototypical Existing Conditions Section

Section 1: No Sidewalks on Both Sides of the Street

Sketch courtesy of the City of Houston

Section 2: Sidewalk on One Side of the Street

Sketch courtesy of the City of Houston

Rendering of an existing condition with no sidewalks on both sides of the street

Scenario OD-2: Proposed
Open Ditch Next to Property Line

Preferred Scenario Solution OD-2.0
Proposed improvements include adding a sidewalk on at least one side of the roadway with a six-inch vertical concrete slotted curb for protection allowing water to drain to the bioswale. This curb satisfies the safety buffer requirement of the IDM. Additional improvements include converting the open ditch into a bioswale or bioretention planter to mitigate potential flooding created by the addition of impervious pavement.

Scenario Improvement Criteria

- Sidewalk/Pedestrian Zone*: 6’ minimum (7’ preferred) standard concrete sidewalk
- Vehicular and Bike Access: 18’ minimum (20’ preferred) with two bi-directional lanes
- Drainage/Amenity Zone: 8’ minimum open ditch repurposed as bioswale

Alternative Solutions

- OD-2.1: Provide permeable sidewalk with slotted curbs on at least one side of the street. Maintain existing open ditches.
- OD-2.2: Provide standard concrete sidewalk with slotted curbs on at least one side of the street. Convert part or whole of roadway to porous asphalt. Maintain existing open ditches.
- OD-2.3: Regrade entire street and provide one consolidated open ditch bioswale on one side of the ROW. Provide standard concrete sidewalk that is raised or with slotted curbs.

* Will require modification approval if located on a TDO Street, Major Thoroughfare, or within the Central Business District. May require modification approval if identified in the Walkable Places Plan.
Scenario OD-2: Proposed

Open Ditch Next to Property Line

Proposed Conditions: Renderings and Built Examples

OD-2.0 Rendering of proposed improvement on both sides of street

OD-2.1 Rendering of permeable paving sidewalk on one side of the street

OD-2.0 Built example in Houston

OD-2.3 Built example of regraded street with concrete sidewalk and a consolidated bioswale on one side of the street
Resiliency is Funding Too!

While our toolkit will produce an actionable plan, without funding, … implementation is not likely.

We have to elevate the many barriers observed, including but not limited to, lack of neighborhood-scale funding mechanisms, for further action.
Resiliency is Funding Too!

The case of “Funding Deserts”

- Lack of awareness and/or coverage of existing funding
Future Funding Strategies

• Sidewalk Fee-in-Lieu (COH)
  • City Council approved January 2023
  • Developers of new construction to pay a fee instead of providing sidewalks ($12 per sq. foot) where applicable
  • Projected revenue of $1.7m annually
  • City divided into sidewalk service areas – 70% spent in generating area, rest city-wide

• Target Infrastructure Grants (IRA, IIJA)

• Other Potential Strategies:
  • Neighborhood Partnering Program
  • Transportation Benefit Districts
  • Community Facility Districts
Prioritization & Phasing

- Develop a prioritization matrix to identify sidewalk scenarios/corridors that can be implemented first.
- Identify ways to phase sidewalk projects to offer immediate mobility.

- **Near Term** – safe & accessible tactical solutions
- **Long Term** – permanent capital projects as more funding becomes available
Prioritization & Phasing
Actionable Next Steps

- Produce an actionable toolkit
  - Plug into city docs like the IDM
  - Create a working document
  - Menu of options for all to work with
  - Inform & coordinate with city pilot projects

- Create a robust sidewalk inventory and a priority list

- Identify offshoot projects to be tackled

- Identify grant funding and partnerships
COH Pilot Projects – Malone Park, Winter St., Winzer Park
Contact – Resilient Sidewalks Plan on *Engage Houston*

---

**Resilient Sidewalks Plan**

**LOCATION** Kashmere Gardens, Gulfton, and City-wide

**COUNCIL DISTRICT** B, D

**TYPE** Plan

**START** Fall 2021

**COMPLETION** Winter 2023
Problem
- The most vulnerable are the most affected
- The environment is vulnerable to flooding but the community is prepared for alternative modes of transportation

Question
- Strategically plan bicycle corridors and transit corridors but not sacrifice connectivity
- Planning maintenance based on the user and not the condition
The Environment

Geology, groundwater, and elevation contribute to sunny day flooding which is further stressed by rain events.
Planning and Design Principles for Complete Streets

- Planning for complete streets without considering groundwater and stormwater management is not a complete story.

- Develop policy in minimum elevations, aesthetics, and harmonization but be flexible to local conditions and do not sacrifice connectivity.

- Design roads based on established hierarchy including all road users.
Stormwater Infrastructure Maintenance for All

- Stormwater maintenance plan must prioritize emergency routes, bicycle corridors, and transit corridors.

- Stormwater maintenance plan must work hand-in-hand with transportation master planning

- Establish road hierarchy for all users to inform drain cleaning cycles.

- Prioritize tree canopy and other alternative stormwater management practices that serve multiple purposes
Let it snow!

The Minneapolis Perspective
Front and Underbody Plow Truck
Grader
Front End Loader
Front End Loader w/ Blower
Skid-Steer Loader
Skid-Steer - Blower
Pickup with Plow
Jeep with Plow
Jeep with Plow
Toolcat 5600 – Plow/Spreader
Toolcat 5600 – Brush/Spreader
Multihog CV
Multihog CV
Sidewalks and Bikeways
Snowplow Operator Training
Snowplow Operator Training
Snowplow Operator Training
Johnson St
After
Johnson St Cross Section
Johnson St
Parking Bay
Plymouth Ave
Before
Plymouth Ave After
## Plymouth Ave

### Snowfall Event Data

<table>
<thead>
<tr>
<th>Date</th>
<th>Snowfall</th>
<th>6' Sidewalk</th>
<th>6'4' Boulevard</th>
<th>5'4' Bike Lane</th>
<th>5'9' Boulevard</th>
<th>12' Drive Lane</th>
<th>10' Parking Lane</th>
<th>8' Bike Lane</th>
<th>6'9' Boulevard</th>
<th>5'6' Boulevard</th>
<th>6' Sidewalk</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.31 // 4.9 in</td>
<td>5.4 ft</td>
<td>5.4 ft</td>
<td>28.3 ft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5 ft</td>
<td>5.6 ft</td>
</tr>
<tr>
<td>01.08 // 2.1 in</td>
<td>5.8 ft</td>
<td>5.2 ft</td>
<td>26.7 ft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.5 ft</td>
<td>5.8 ft</td>
</tr>
<tr>
<td>01.26 // 4.7 in</td>
<td>5.2 ft</td>
<td>5.3 ft</td>
<td>24.6 ft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5 ft</td>
<td>5.5 ft</td>
</tr>
<tr>
<td>02.15 // 2.2 in</td>
<td>5.4 ft</td>
<td>3.5 ft</td>
<td>26.3 ft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.6 ft</td>
<td>4.8 ft</td>
</tr>
<tr>
<td>02.25 // 6.7 in</td>
<td>5.3 ft</td>
<td>0 ft</td>
<td>26.2 ft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0 ft</td>
<td>4 ft</td>
</tr>
<tr>
<td>03.09 // 3.3 in</td>
<td>4.7 ft</td>
<td>5.3 ft</td>
<td>25.8 ft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5.5 ft</td>
<td>4.8 ft</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td></td>
<td>5.3 ft</td>
<td>4.1 ft</td>
<td></td>
<td></td>
<td>26.3 ft</td>
<td></td>
<td></td>
<td></td>
<td>4.1 ft</td>
<td>5.1 ft</td>
</tr>
</tbody>
</table>
Plymouth Ave Parking Bay

<table>
<thead>
<tr>
<th>Date</th>
<th>Snowfall Event</th>
<th>Depth (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No snow</td>
<td></td>
<td>57.2 ft</td>
</tr>
<tr>
<td>12.31 // 4.9 in</td>
<td></td>
<td>43.2 ft</td>
</tr>
<tr>
<td>01.08 // 2.1 in</td>
<td></td>
<td>41.8 ft</td>
</tr>
<tr>
<td>01.26 // 4.7 in</td>
<td></td>
<td>34.6 ft</td>
</tr>
<tr>
<td>02.15 // 2.2 in</td>
<td></td>
<td>24.5 ft</td>
</tr>
<tr>
<td>02.25 // 6.7 in</td>
<td></td>
<td>18.1 ft</td>
</tr>
<tr>
<td>03.09 // 3.3 in</td>
<td></td>
<td>0 ft</td>
</tr>
</tbody>
</table>

Average: 27 ft
Plymouth Ave
Bryant Ave - Before
Bryant Ave - After
Bryant Ave - Before
Bryant Ave - After
Bryant Ave - Before
Bryant Ave - After
Bryant Ave
Bryant Ave
Bryant Ave

Roadway Snow

Buffer and Bikeway Snow

Sidewalk 5.5 ft
Buffer 5.5 ft
Parking 8 ft
Thru Lane 12 ft
Buffer 3 ft
2-Way Bike Lane 10 ft
Buffer 5.5 ft
Sidewalk 5.5 ft
Thank you!
Panel Discussion, Q&A
TALKING POINTS

- Industry Trends (and Best Practices) vs. Operations & Maintenance Realities
- Equity in Infrastructure Provision and Operations
- Funding and Prioritization
Donald Buaku, AICP, aAIA
Houston Public Works
donald.buaku@houstontx.gov

Josiel Ferrer-Diaz, P.E.
Miami-Dade County
josiel.ferrer-diaz@miamidade.gov

Bryan Dodds
Minneapolis
bryan.dodds@minneapolismn.gov