

# READY TO DESIGN A GREENWAY?

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DESIGN BEST PRACTICES + FIELD STUDY



CAROLINA  
THREAD  
TRAIL



# INTRODUCTIONS



**IONA THOMAS** AICP  
vice president, strategy + public  
client development



**NICK LOWE** RLA  
senior landscape architect



**JIMMY PRESTWOOD** PE  
bicycle + pedestrian engineer



**WILL WASHAM**  
transportation planner





# OVERVIEW + DISCUSSION TOPICS

- › Double Session Schedule
  - Classroom (9:40 am – 10:40 am)
  - Break (10:40 am – 11:00 am)
  - Site Visit (11:00 am – noon)
- › Classroom Discussion Topics
  - Overview of Design Phase
  - Design Criteria + Considerations
- › Site Visit
  - Real-world Example + Application



Liberty Park - Mooresville, NC



# WHAT IS A GREENWAY TRAIL?



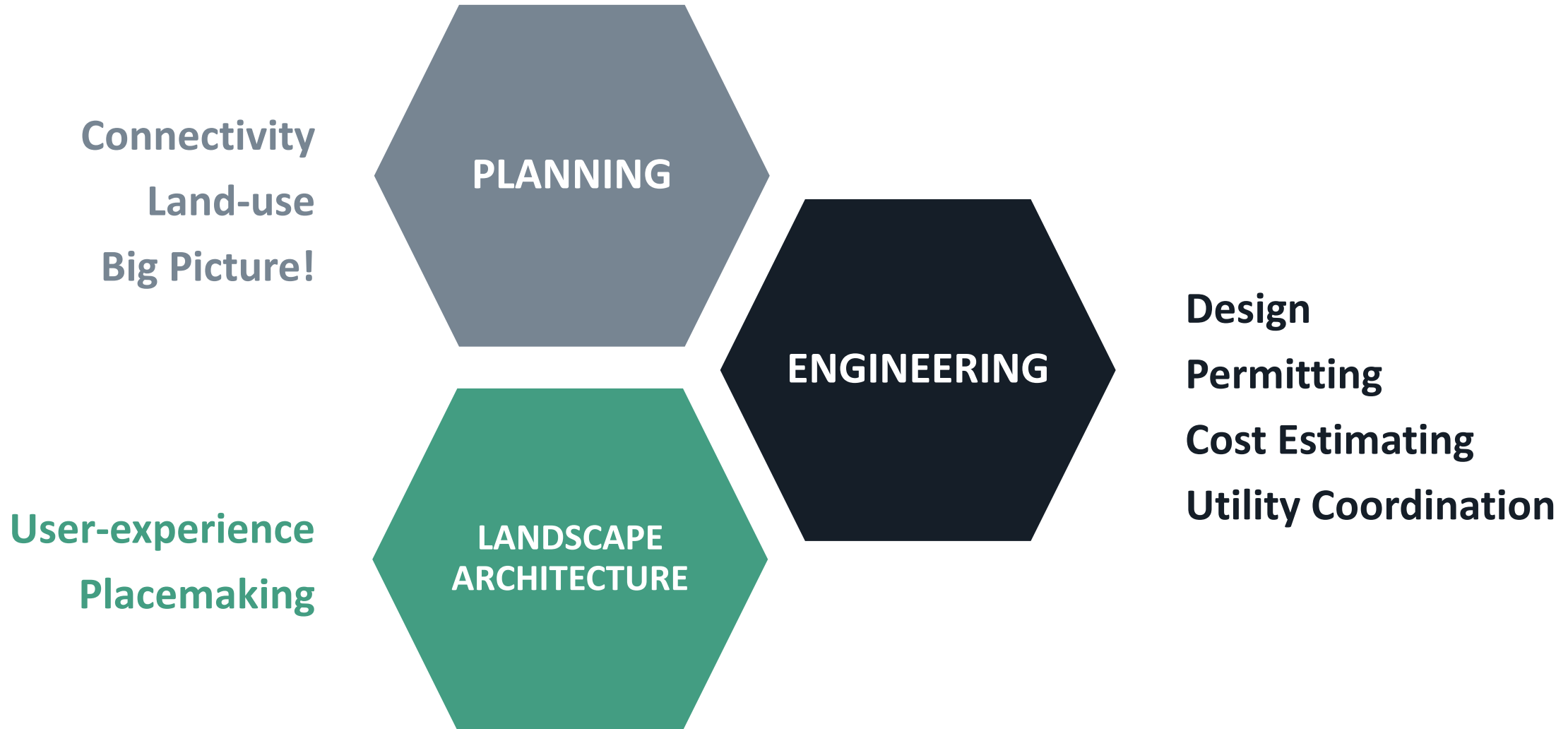
Little Sugar Creek Greenway  
Charlotte, NC



- › Who has planned a greenway?
- › Who has designed a greenway?
- › Who has constructed or maintained a greenway?
- › Who has reviewed a greenway or been asked technical questions about one?

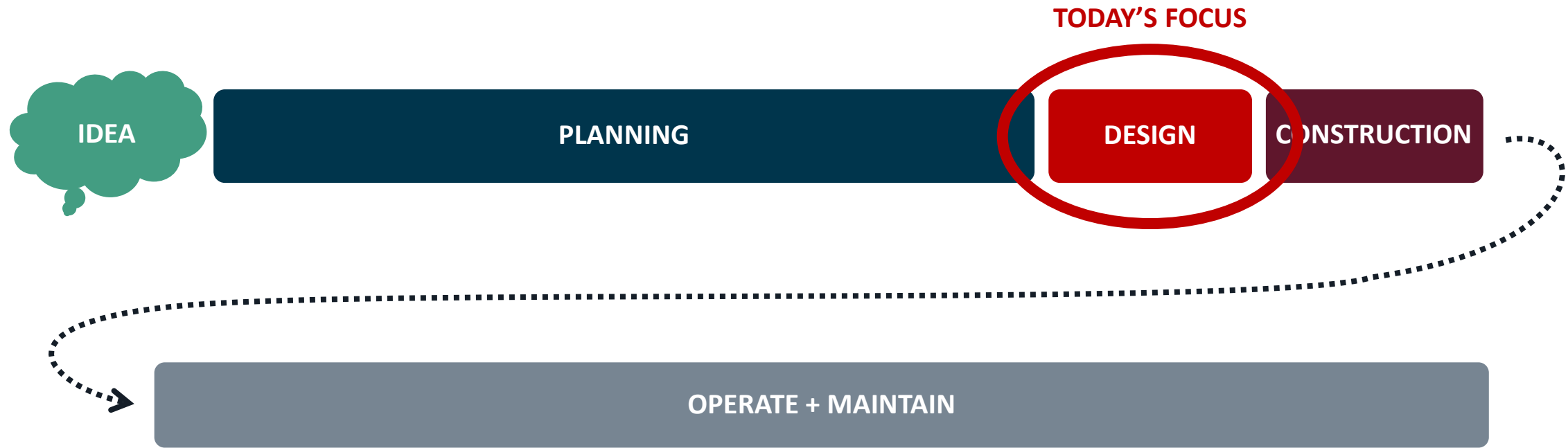


# IT TAKES A VILLAGE





# LIFE CYCLE





# COMMON DESIGN CONDITIONS

## GREENWAY

- > ENVIRONMENTAL
  - > FLOODPLAIN/FLOODWAY
  - > WETLANDS/STREAMS
  - > BUFFERS
- > STRUCTURES
- > PROPERTY IMPACTS

## SIDEPATH

- > COORDINATION W/  
DOT/MUNICIPALITY
- > SEPARATION METHODS
- > UTILITIES
- > AT-GRADE CROSSINGS
- > ROADWAY DRAINAGE

## RAIL TRAIL

- > ENVIRONMENTAL
  - > CHEMICALS
- > RAILBED
- > STRUCTURE REHAB
- > LEGACY ENCROACHMENTS



MCADAMS

# KEY DECISIONS BEFORE OR EARLY ON IN DESIGN PROCESS

## HAS A FEASIBILITY STUDY BEEN PERFORMED?

### FUNDING

- > If federal, additional set of requirements
- > Time to complete by?

### REAL ESTATE

- > Already have property along corridor?
- > Connections into adjacent neighborhoods may require additional negotiations

### BEGIN / END POINTS

- > Avoid isolation and lack of connectivity
- > Consider future plans

### COORDINATION W/ OTHER INFRASTRUCTURE PROJECTS

- > Park, Sewer, Roadway, Water, Stream Restoration, Bridge replacement, etc.

### TRAIL WIDTH

- > Can be affected by funding source
- > Additional width cost
- > Updated standards from past plan?

### LEVEL OF COMMUNITY ENGAGEMENT

- > Has there been any from past plan? Any expected backlash?
- > Deeper into design it pushes...becomes more informational



# TYPICAL DESIGN EVOLUTION

BEGINNING ..... BIDDING

## PRELIMINARY DESIGN (25%)

- > Typical sections
- > Horizontal + Vertical alignment
- > Construction limits
- > Structure Locations/Siting

FIELD SURVEY

ENVIRONMENTAL  
INVESTIGATION

## SCHEMATIC DESIGN (50%)

- > Drainage Design
- > Floodplain Modeling
- > Construction Access Plans
- > Cross Sections
- > Preliminary Structure Plans

PUBLIC  
ENGAGEMENT

GEOTECHNICAL  
INVESTIGATION

## DESIGN DEVELOPMENT (75%)

- > Pavement Markings + Signage
- > Traffic Control
- > Erosion Control
- > Utilities (By Others)
- > Final Structure Plans
- > ROW/Easements

REAL ESTATE  
ACQUISITION  
COMPLETE

PERMITTING  
COMPLETE

## CONSTRUCTION DOCS (100%)

- > Specifications
- > Signed & Sealed Plans
- > Final Cost Estimate/Bid tabs

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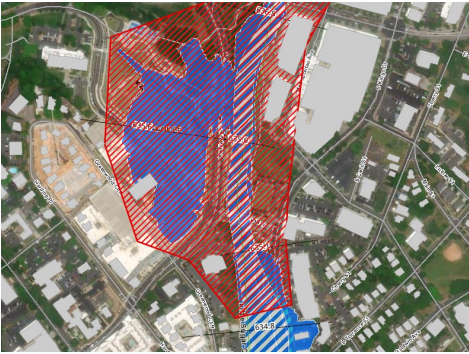
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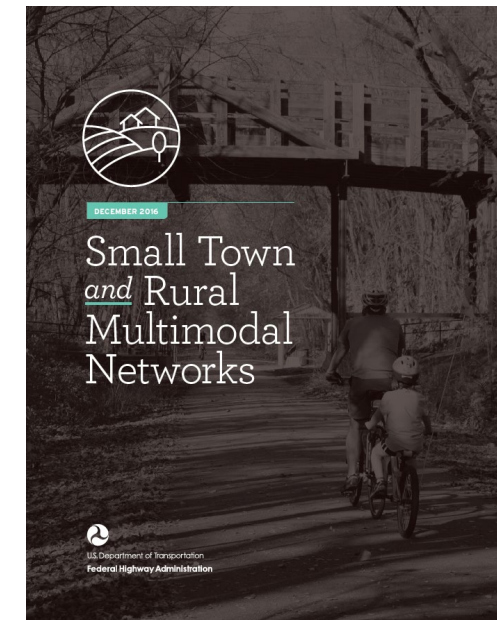
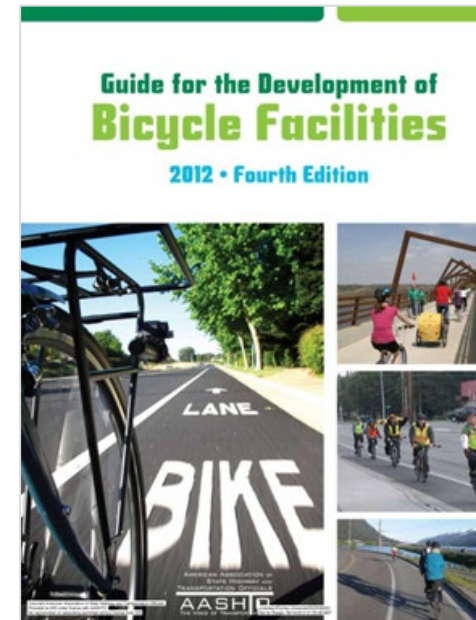
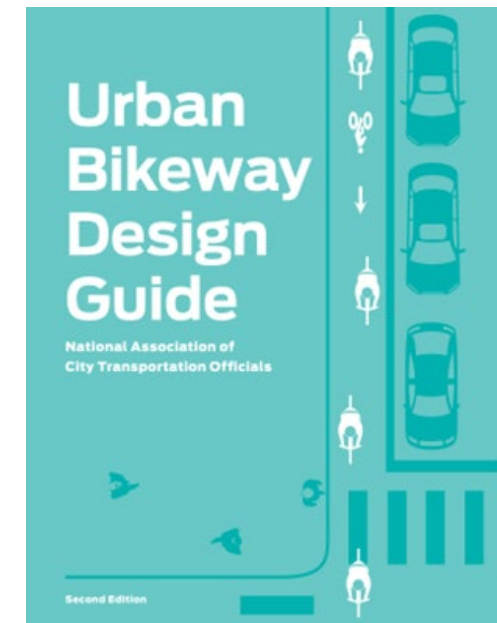
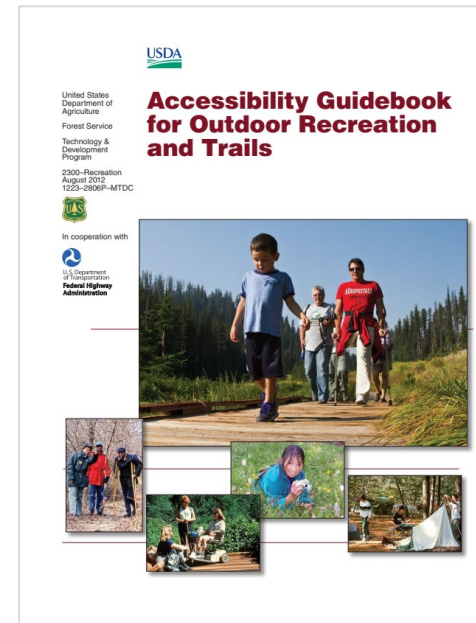
# CRITICAL COORDINATION ITEMS/POTENTIAL SCHEDULE PUSHERS





# DESIGN RESOURCES

- › AASHTO Guide for the Development of Bicycle Facilities (2012)
  - Ch. 5, Design of Shared Use Paths
- › FHWA Small Town and Rural Multimodal Networks (2016)
- › US Forest Service Accessibility Guidebook for Outdoor Recreation and Trails (2012)
- › NACTO Urban Bikeway Design Guide (2011 w/ new release in 2024)
- › US Access Board Public Right-of-Way Accessibility Guidelines (Final Rule Published Aug 2023)





DEPENDENT ON CONTEXT, VOLUME, AND USER MIX

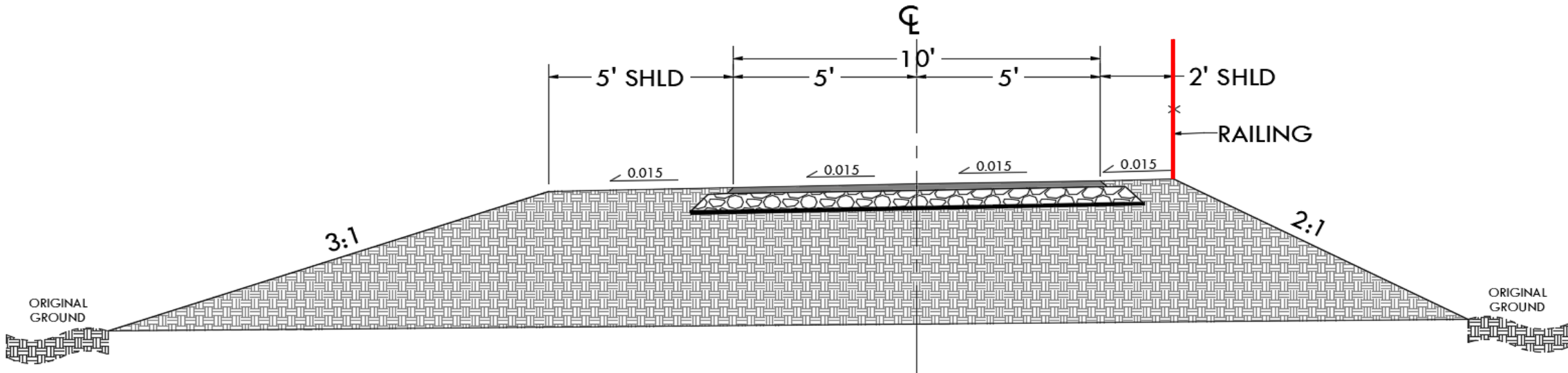
## WIDTH

- › 10' for 2-way traffic (8' absolute min. in constrained areas)

## CLEARANCE

- › Horizontal (2' min. with exceptions)
  - Shy distance against vertical elements (retaining walls, railing/fencing, curb)
- › Vertical (10' recommended, 8' min.)
  - Roadway underpasses, Tunnels/Culverts, Tree limbs, aerial utilities





## CROSS SLOPE

- › 2.0% max (1.5% recommended)
- › When transitioning, 10' per 1% change

## SIDE SLOPES

- › 3:1 recommended (stable + traversable)
- › 2:1 in constrained cases

## SHOULDERS

- › 2' min. (5' recommended)

## RAILING

- › 42" min. height (48" recommended)
- › If 5' shoulder provided, not required
- › If less than 5' shoulder, required when:
  - 3:1 slope + 6' dropoff
  - 2:1 slope + 4' dropoff



ADA

- › 5.0% max. (4.5% recommended)
- › 8.33% for 30', 2% for 5'

PROWAG

- › Match but do not exceed adjacent roadway grade

RECREATIONAL TRAIL ACCESSIBILITY GUIDELINES

- › No more than 30% of overall length may exceed 8.33%
- › Grades shall never exceed 12%

Table 2—Maximum Running Slope and Segment Length		
Running Slope of Trail Segment		Maximum Length of Segment
Steeper Than	But Not Steeper Than	
1:20 (5%)	1:12 (8.33%)	200 feet
1:12 (8.33%)	1:10 (10%)	30 feet
1:10 (10%)	1:8 (12%)	10 feet

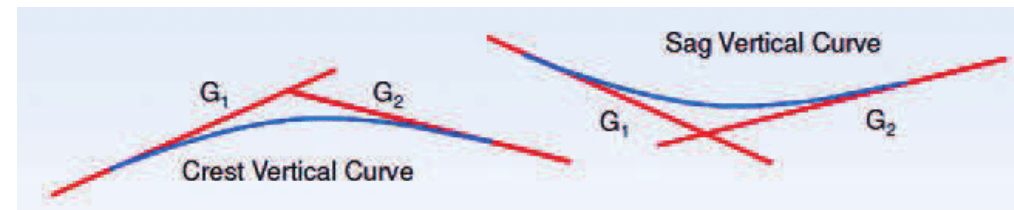
BASED ON 20 MPH DESIGN SPEED, 20 DEGREE LEAN ANGLE

## HORIZONTAL CURVES

- › Min. curve radius = 75' (100' recommended)
- › Special Considerations if minimum can't be met:
  - Advanced warning signage
  - Use solid centerline stripe
  - Curve widening

## VERTICAL CURVES

- › Curve lengths vary (crest vs sag)
- › Sight distance is key



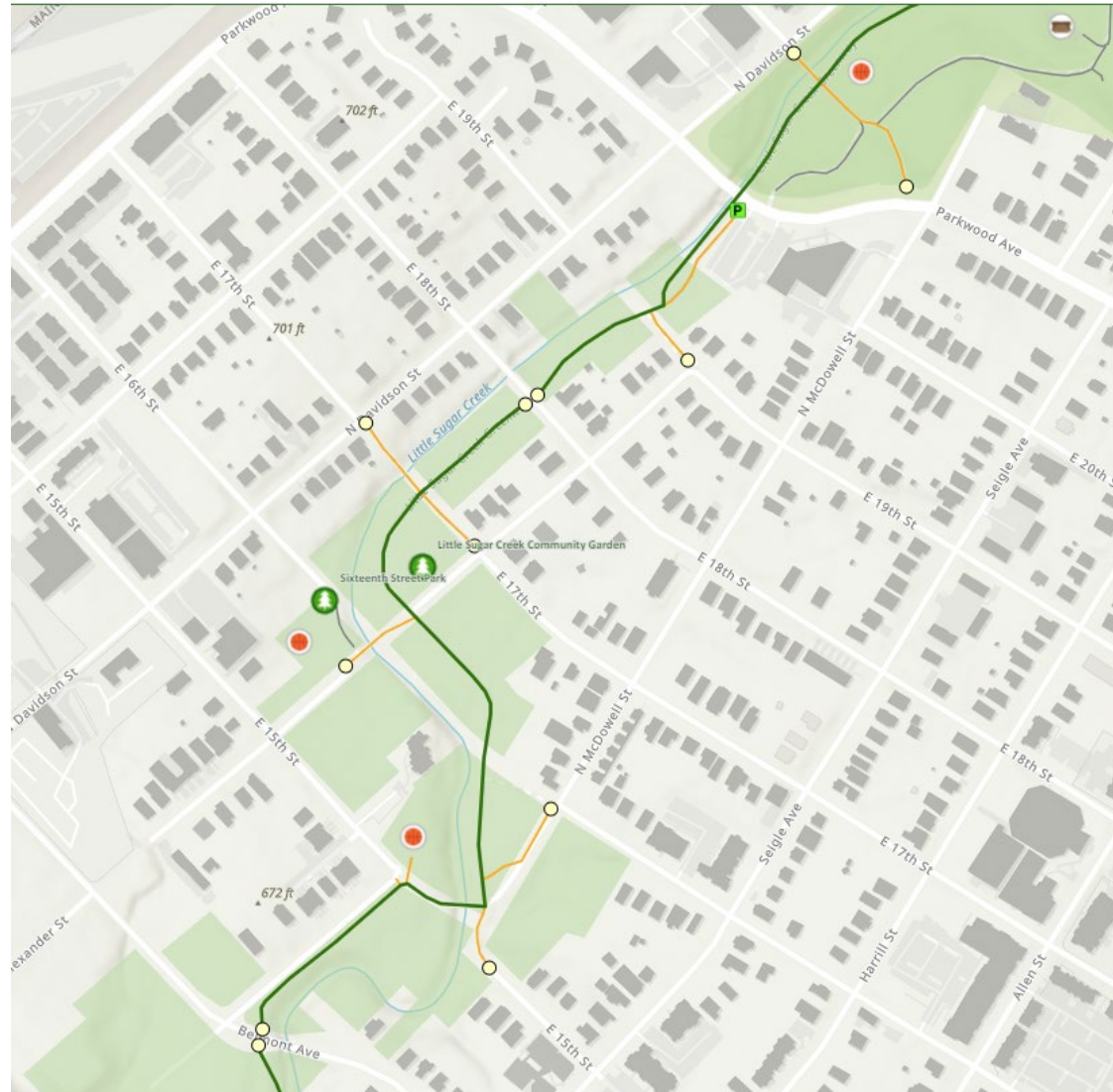


# DESIGN CONSIDERATIONS

# LAND-USE CONTEXT

## › URBAN

- Access

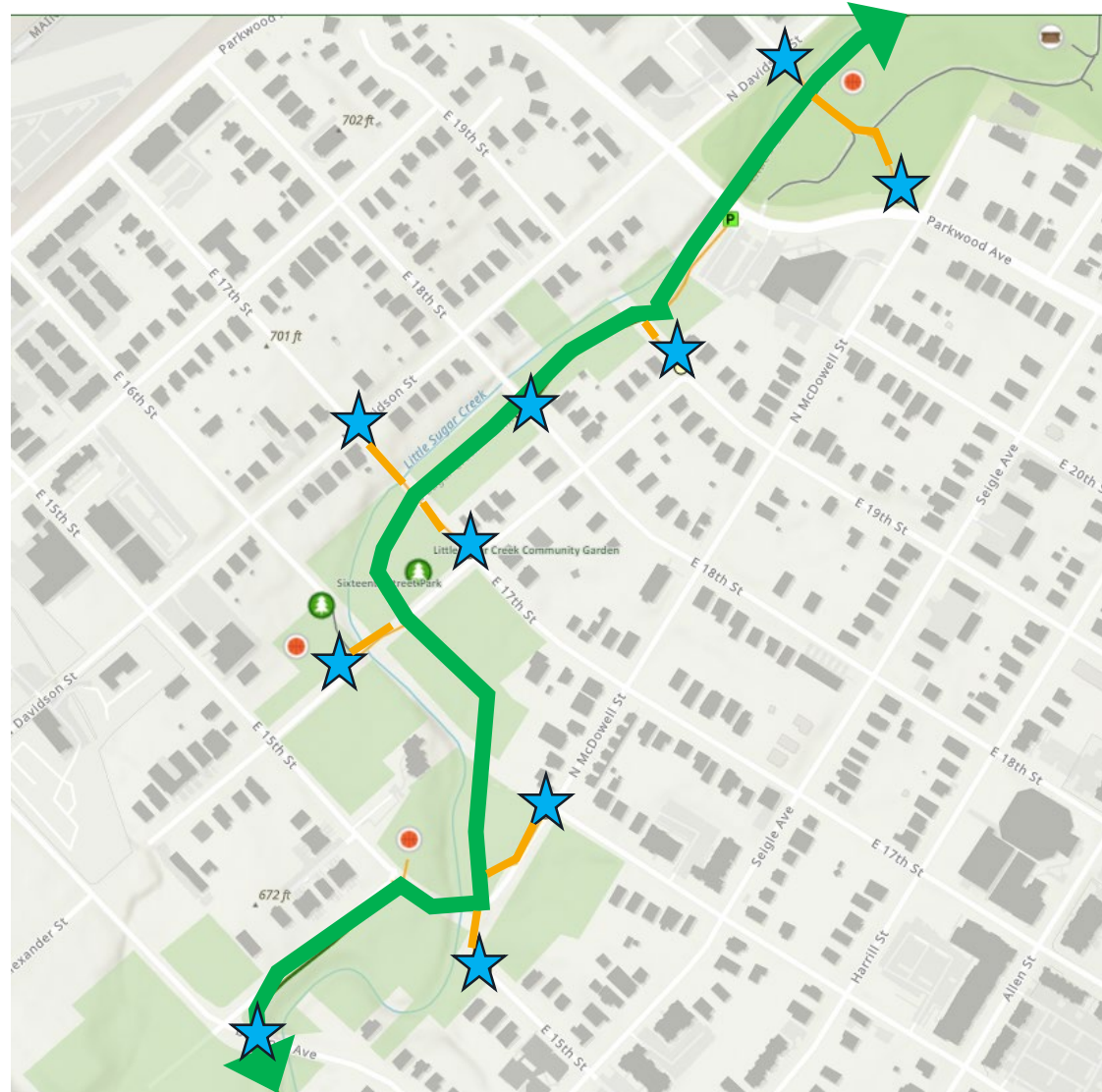


# DESIGN CONSIDERATIONS

# LAND-USE CONTEXT

## › URBAN

○ Access





## DESIGN CONSIDERATIONS

## LAND-USE CONTEXT

### › CONSTRAINTS





## DESIGN CONSIDERATIONS

## NATURAL SETTING

### › VIEWS



MCADAMS

## DESIGN CONSIDERATIONS

## NATURAL SETTING

### › VIEWS





# DESIGN CONSIDERATIONS

# STREET NETWORK INTERACTIONS

## › EVALUATE ALL CROSSINGS

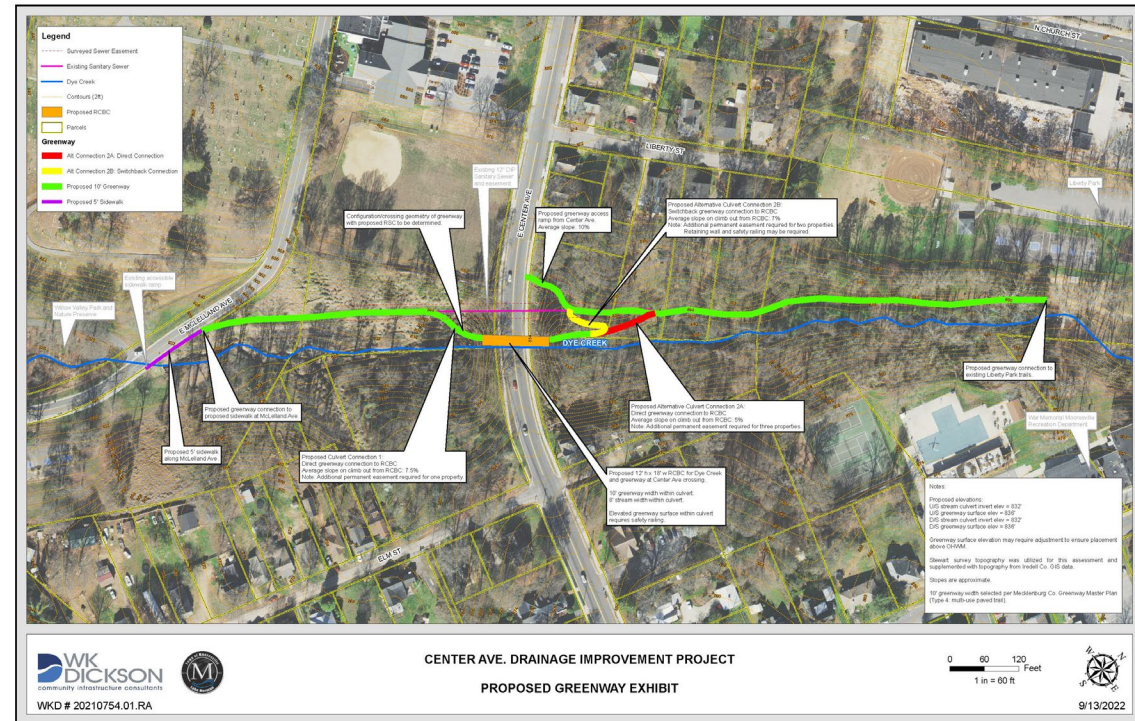
- Street classification
- Topographic conditions
- Existing bridge or culvert





## › GRADE SEPARATED CROSSINGS

- Require proper topography
- Investigate prior or during design phase



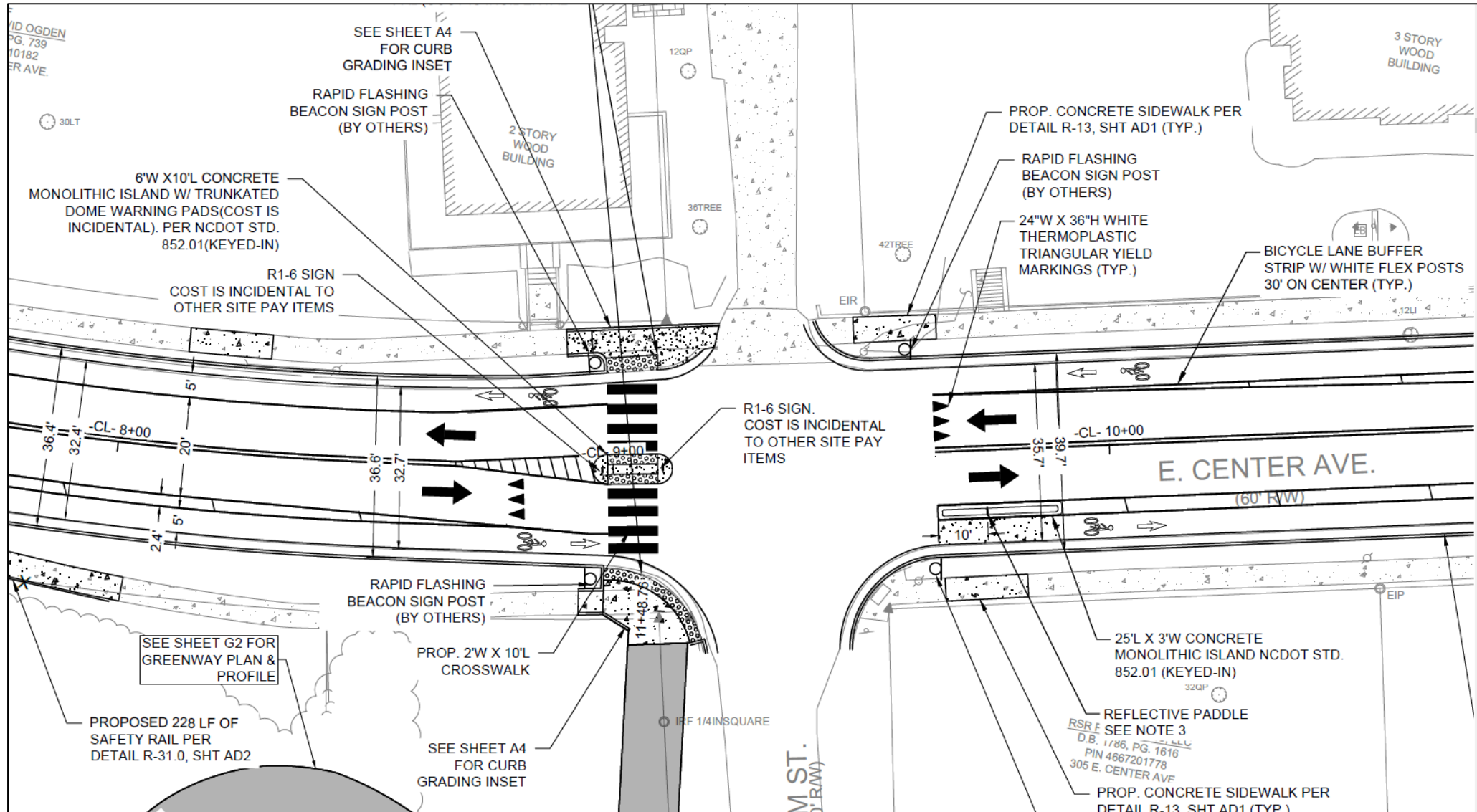
## › AT GRADE CROSSINGS

- Slow vehicle speeds
- Increase pedestrian visibility
- Shorten crossing distance
- Signalization
- Street improvements within greenway trail scope



# DESIGN CONSIDERATIONS

# STREET NETWORK INTERACTIONS





## › VOLUME/USE PROJECTIONS

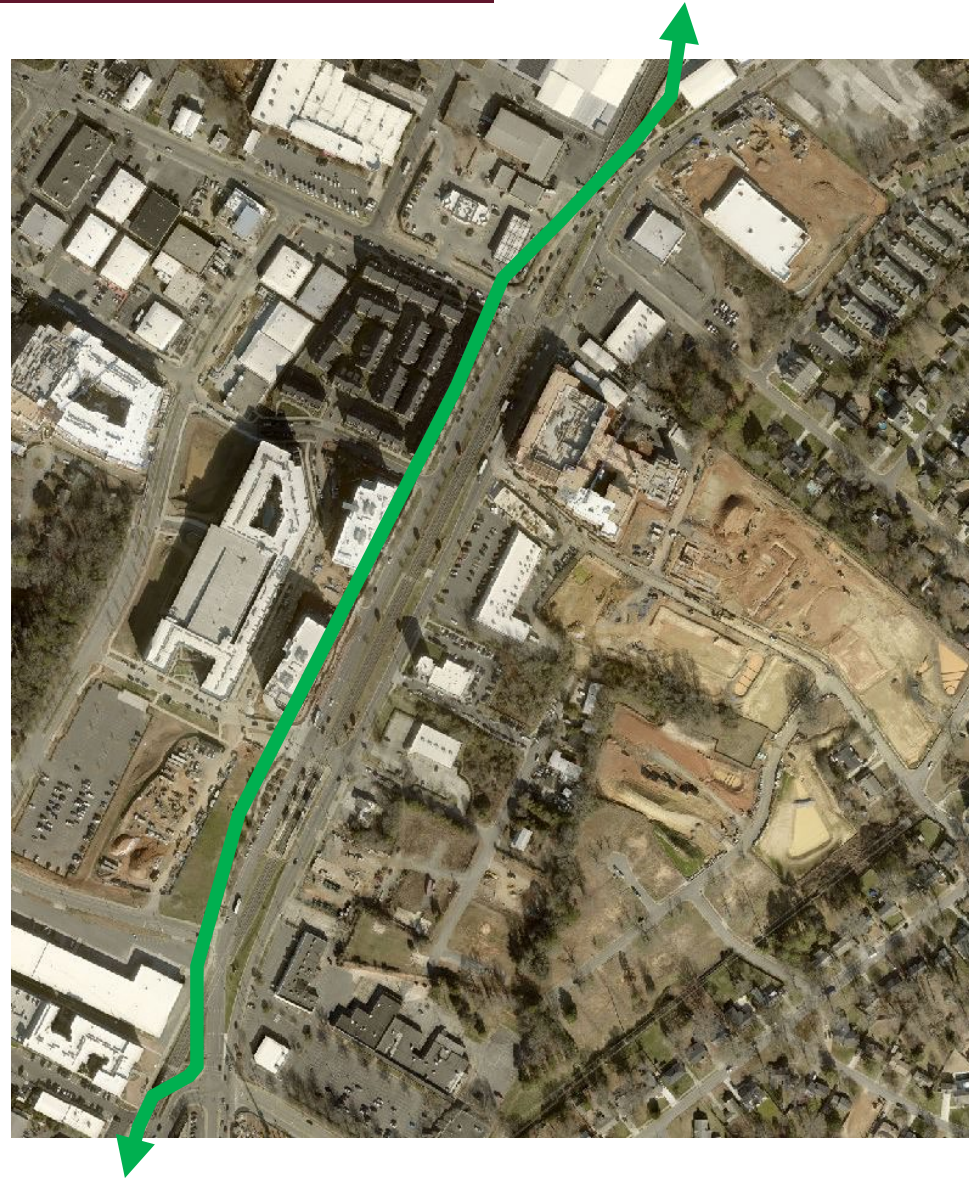
- Employment
- Residential uses
- Future development





## › VOLUME/USE PROJECTIONS

- Employment
- Residential uses
- Future development





## › HIGHER VOLUME CONSIDERATIONS

- Width
- Striping
- Sight distance
- Signage

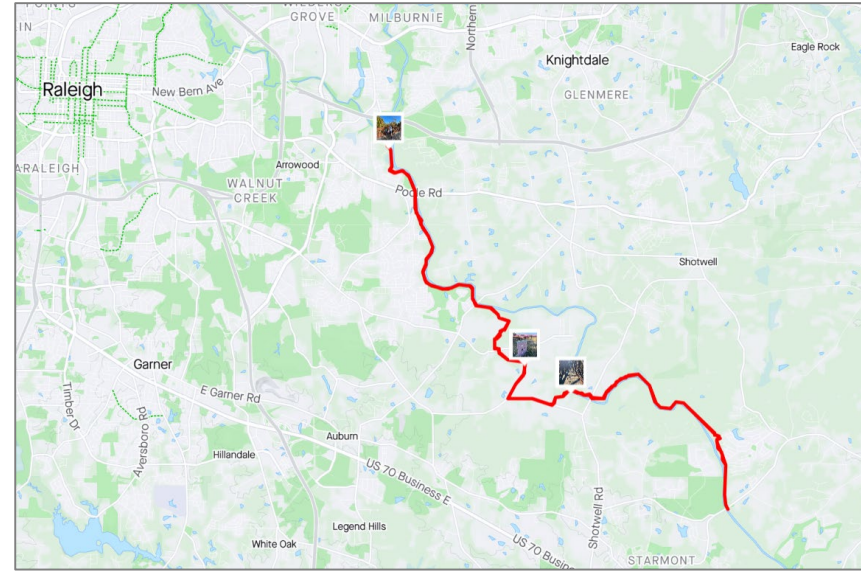


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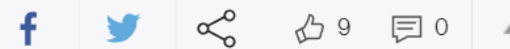
# BICYCLE CONSIDERATIONS

## › ADDITIONAL BICYCLE USE DRIVERS

- Long distance rides
- Connectivity to bikeway network
- Connectivity to mountain bike trails



will washam – Ride



2:30 PM on Thursday, October 27, 2022 · Raleigh, North Carolina

## Neuse never disappoints

Add a description



26.57 mi 1:56:35 654 ft 47  
Distance Moving Time Elevation Relative Effort

81 w 567 kJ  
Estimated Avg Power Energy Output

	Avg	Max
Speed	13.7 mi/h	24.3 mi/h
Elapsed Time	1:59:24	

Show More

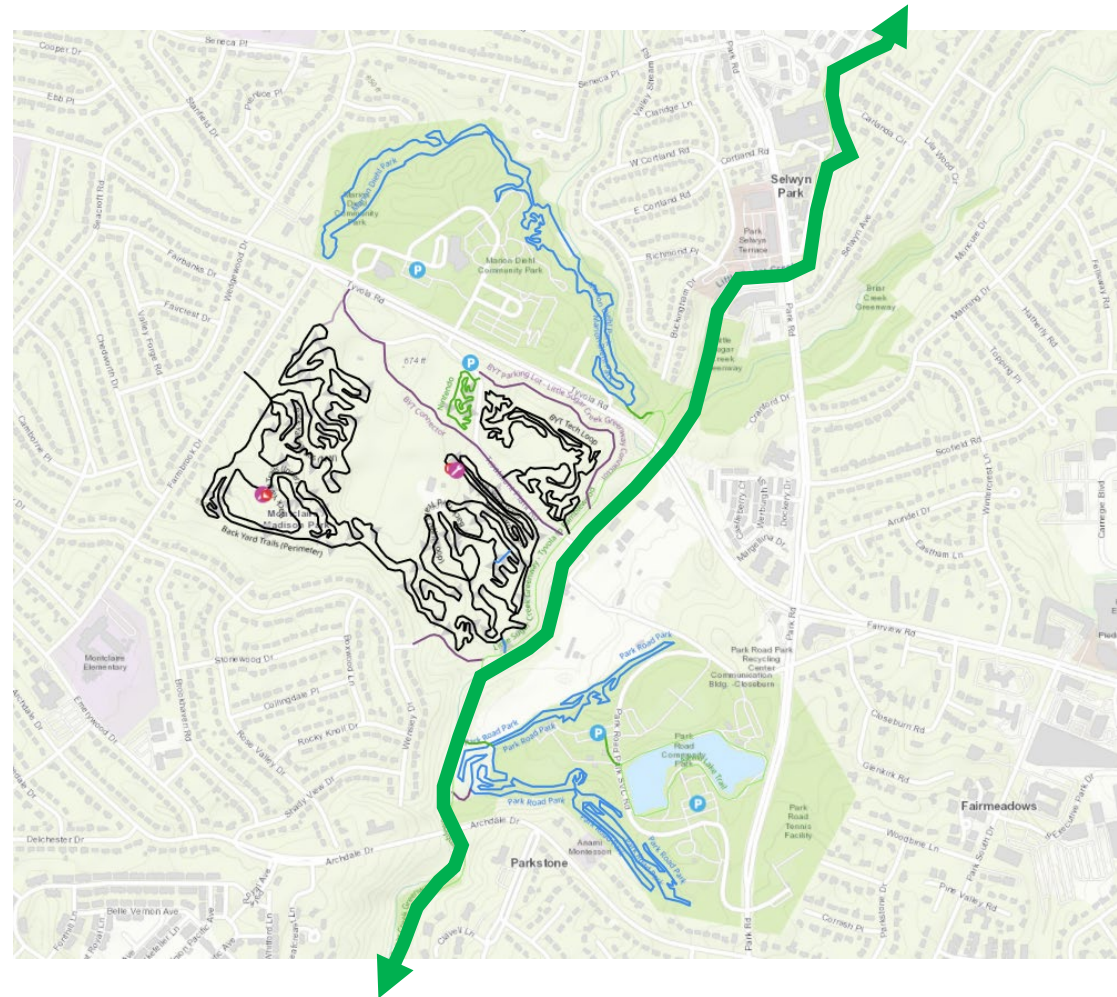


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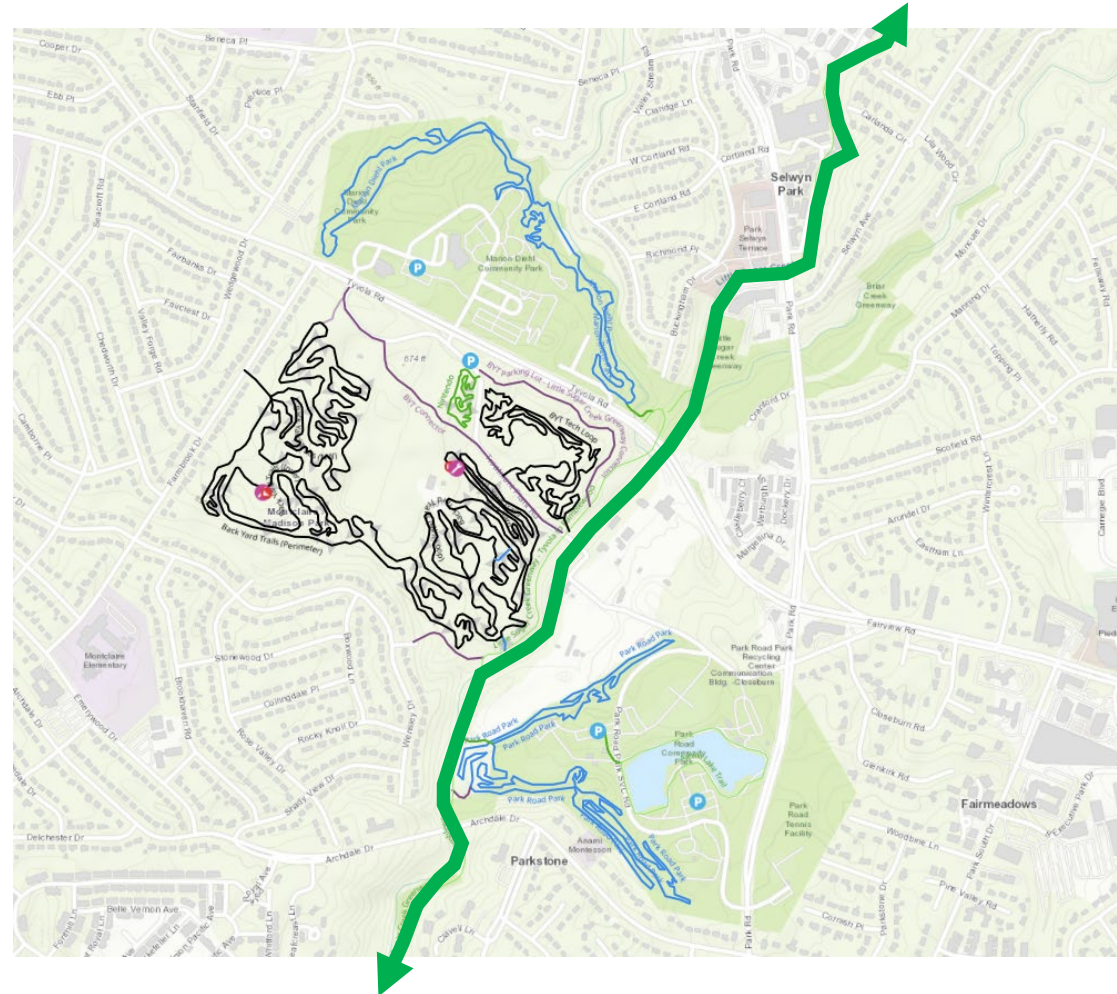


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## › GRADE

- Uphill effort
- Downhill speed
  - 18mph bicycle design speed on grade up to +/-2% (AASHTO)
  - Turning radius considerations with increased speed (20\* lean angle per AASHTO)
    - › Tradeoffs
    - › Widen path in curve?
    - › Widen path in general?
  - Materials for braking traction
    - › Bridge materials

Table 5-2. Minimum Radii for Horizontal Curves on Paved, Shared Use Paths at 20-Degree Lean Angle

U.S. Customary		Metric	
Design Speed (mph)	Minimum Radius (ft)	Design Speed (km/h)	Minimum Radius (m)
12	27	19	8
14	36	23	11
16	47	26	15
18	60	29	18
20	74	32	22
25	115	40	35
30	166	48	50

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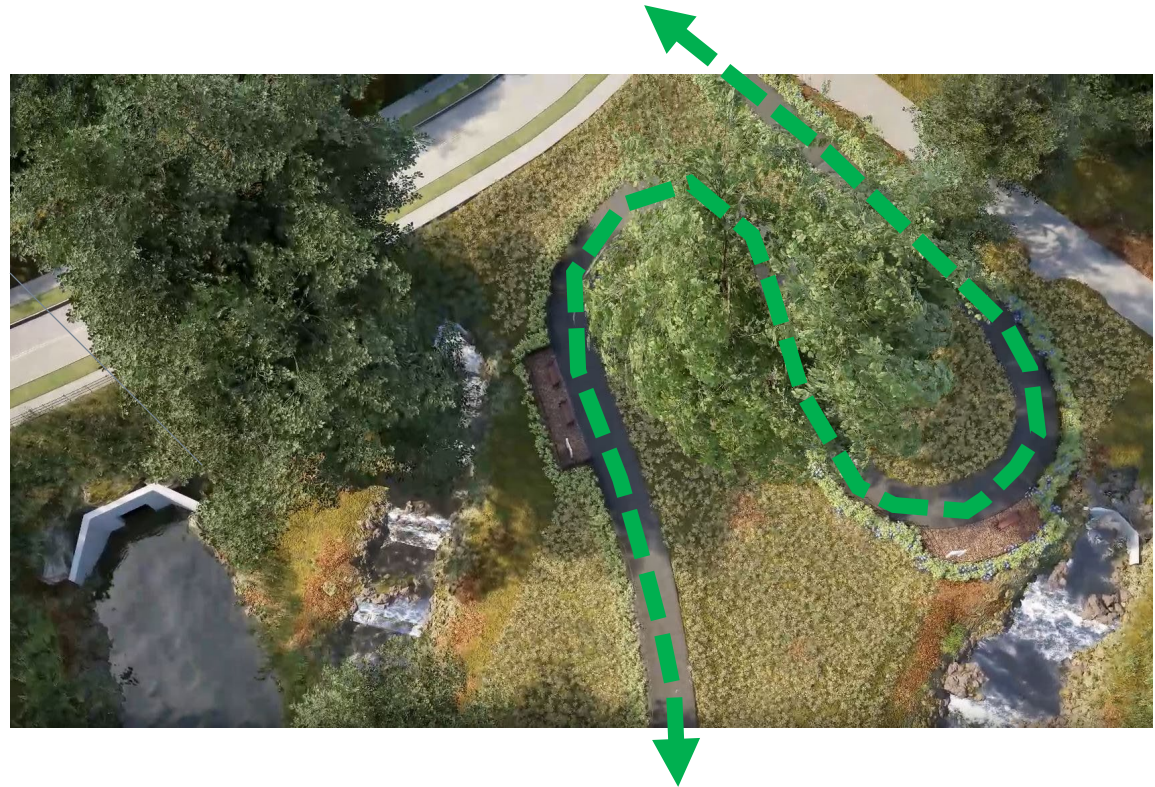


## DESIGN CONSIDERATIONS

## BICYCLE CONSIDERATIONS

### › GRADE

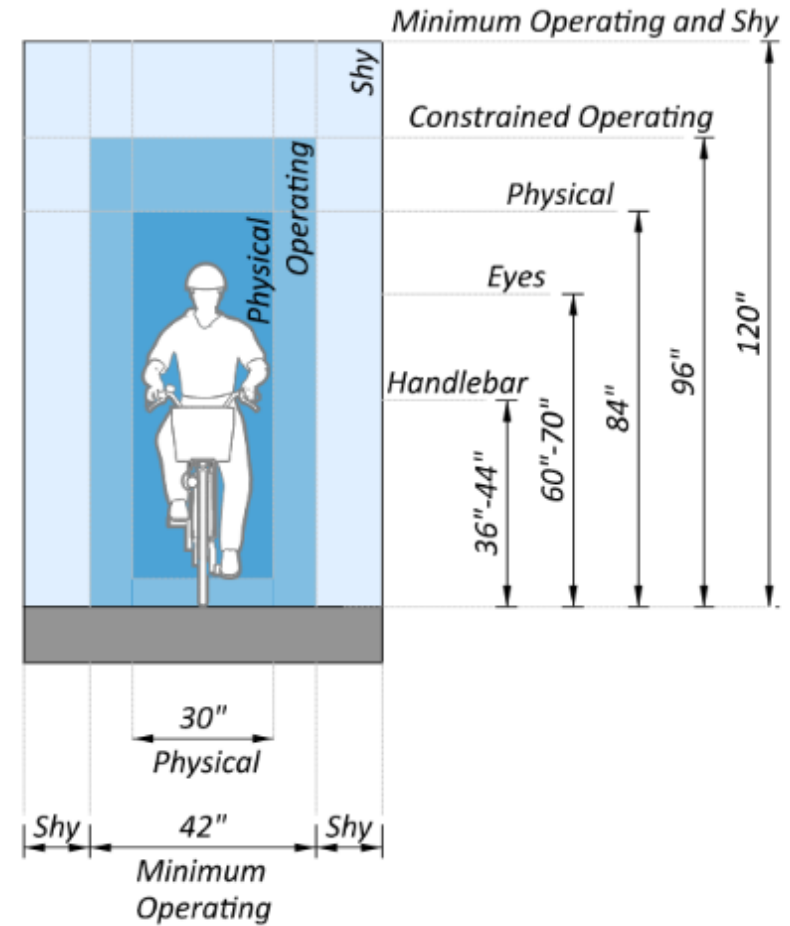
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## › Vertical Elements

- Other bicycles – 1'
- Intermittent (tree, planter) - 1'
- Continuous (fence, railing) - 2'
- Vertical curb – 1'

Figure 3-14: Typical Adult Bicyclist Operating Space





## DESIGN CONSIDERATIONS

## EFFECTIVE WIDTH

### › Vertical Elements

- Other bicycles – 1'
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# DESIGN CONSIDERATIONS

# STRUCTURES – PEDESTRIAN BRIDGES

- › Longer Single Spans over Jurisdictional Streams
- › Clear Width
- › Loading Requirements (H-5 vs. H-10)
  - Maintenance / Emergency Vehicle Access
- › Pre-Fabricated Truss vs. Low-Water Reinforced Concrete (Flood Model Considerations)
- › Approach Rails
- › Materials Selection
  - Weathering Steel
  - Painted Steel
  - Fiberglass





# DESIGN CONSIDERATIONS

## STRUCTURES – BOARDWALK

- › Shorter Spans (10' and 20') over wetlands, tributaries, to traverse steep side slopes
- › Clear Width
- › Loading Requirements (H-5 vs. H-10)
- › Railing Height (Toe Rail vs. Safety Rail)
- › Approach Rails
- › Materials Selection
  - Foundations (Timber Pile vs. Micro-Pile)
  - Decking (Timber vs. Cast-In-Place Concrete vs. Pre-Cast Concrete)
  - Railing (Timber vs. Metal)





## WALL TYPES

- › Segmental Block Gravity Wall
- › Cast-In-Place Gravity Wall
- › Mechanically Stabilized Earth (MSE) Wall
- › Soil Nail Wall

## WALL HEIGHT

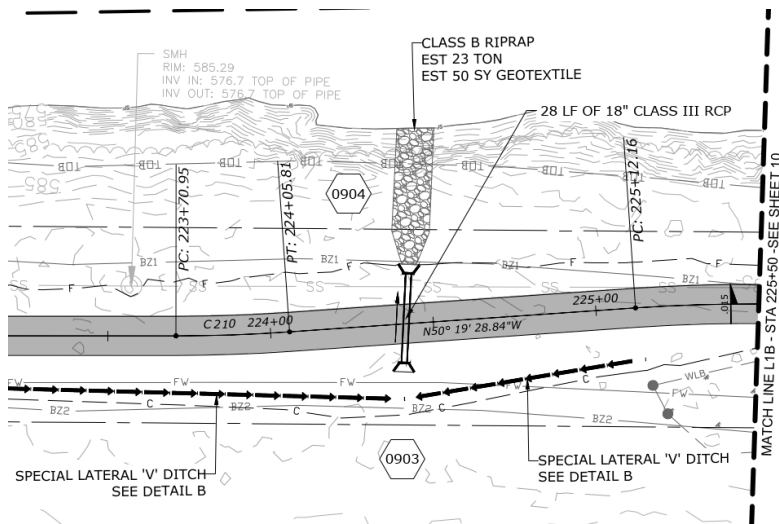
- › Special Inspections typically required for Walls greater than 4' high
- › Higher the wall, more restrictions as to wall types (especially within NCDOT right-of-way)



# DESIGN CONSIDERATIONS

# DRAINAGE

- › Roadway and greenway drainage are not the same
- › Matching existing conditions
  - Concentrated flow vs. sheet flow
  - Driver of cross slope direction
- › Areas designed to flood
- › Pipe material selection





## DESIGN CONSIDERATIONS

## MAINTENANCE + DURABILITY

- › Constructed Shoulders (compacted)
- › Mow-able Shoulders
- › Avoid small strips of grass between features (i.e. face of wall, back of curb)
- › Inclusion of geotextile separator fabric

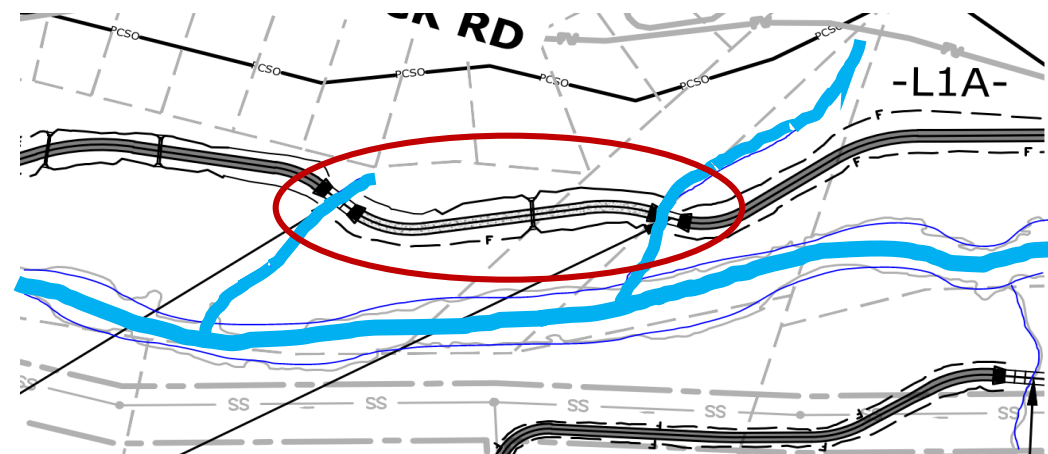


## ASPHALT

- › Paired with aggregate base + stabilization method
- › Paving equipment is often limiting (width, vertical clearance)

## CONCRETE

- › Can be reinforced, poured on compacted subgrade or aggregate base
- › Portability – (buggy, pump, etc.)
- › Best for isolated sections
- › Durability





## DESIGN CONSIDERATIONS

## UTILITY EASEMENTS

### TRANSMISSION

- › No structures allowed
- › Proposed slope limitations (4:1 max.)
- › Clear zones around towers/poles

### GAS

- › No structures allowed
- › Proposed slope limitations (4:1 max.)
- › Limit cut above underground lines

### SEWER

- › Limited use of structures allowed
- › Check use language
- › Be realistic about widths



# DESIGN CONSIDERATIONS

- › Site Context
- › Special Site Features
- › Amenities
- › Public Art
- › Connectivity

# PLACEMAKING





# DESIGN CONSIDERATIONS

- › Vegetation
- › Streams
- › Stormwater
- › Topography
- › Geology

# ENVIRONMENTAL FEATURES

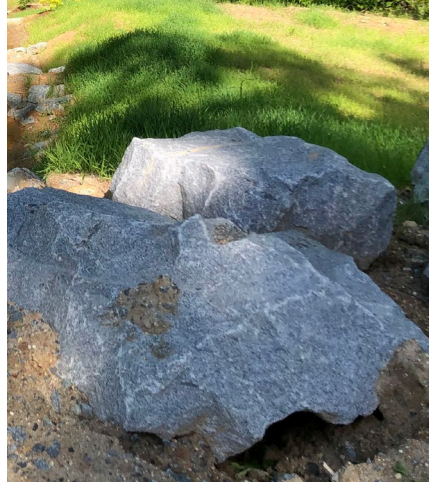




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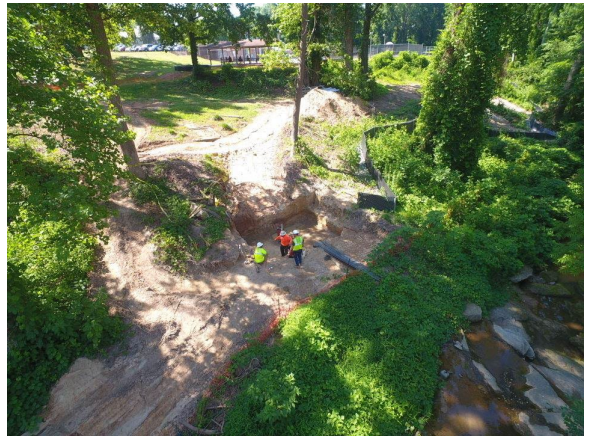
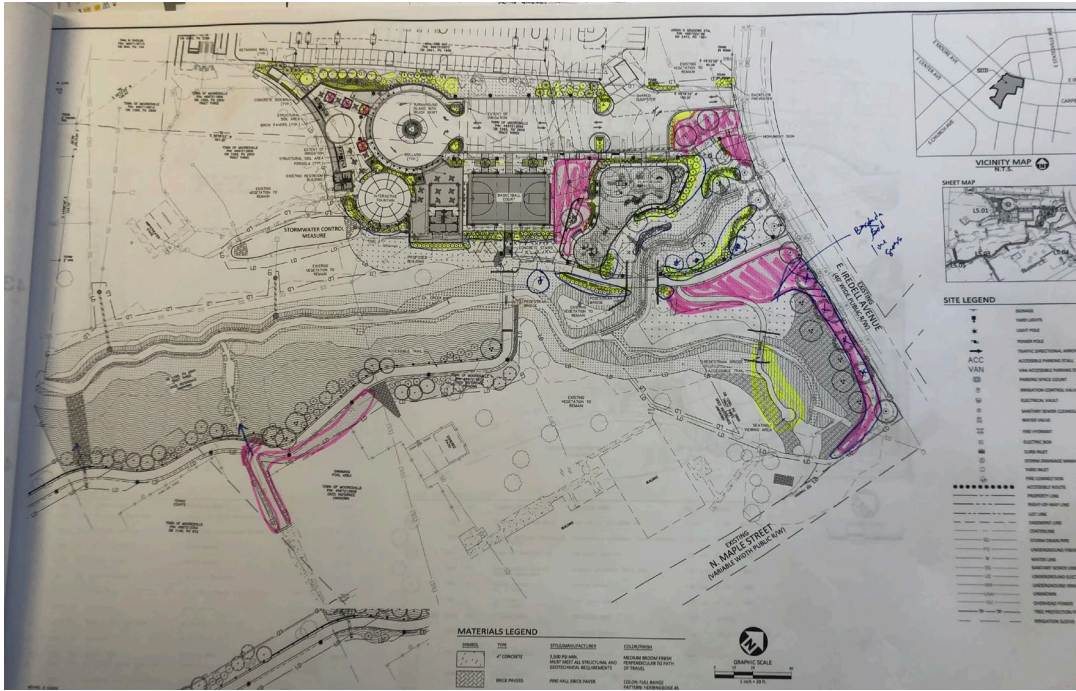
- › Durability
- › Maintenance
- › Constructability
- › Aesthetics

# MATERIALS





# BRINGING YOUR VISION TO REALITY







# THANK YOU! QUESTIONS?

## WHATS NEXT?

- > BREAK UNTIL 11:00
- > MEET BACK IN LOWRANCE ROOM (HERE)  
FOR SITE WALK (11:00 TO NOON)



# SITE VISIT PLAN

APPROX. 1 MILE OF WALKING

