Louisiana's Geotechnical Asset Management

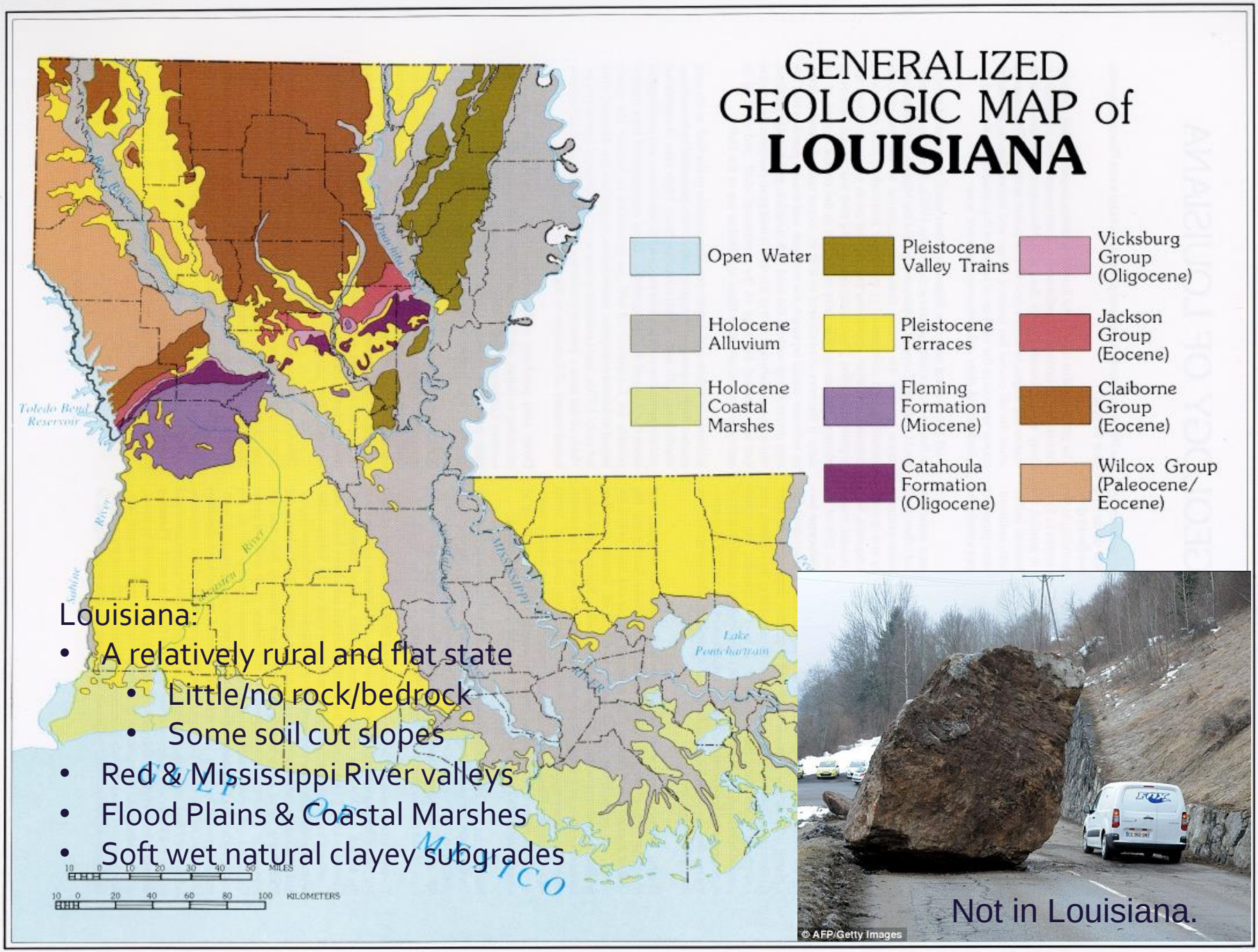
LTRC Research: 18-4GT

Gavin Gautreau, P.E., M.ASCE

Geotechnical Research Engineer

Louisiana Transportation Research Center (LTRC)

LTRC is sponsored Jointly by the Louisiana Department of Transportation and Development (DOTD) and Louisiana State University (LSU)



Louisiana:

- A relatively rural and flat state
  - Little/no rock/bedrock
  - Some soil cut slopes
- Red & Mississippi River valleys
- Flood Plains & Coastal Marshes
- Soft wet natural clayey subgrades

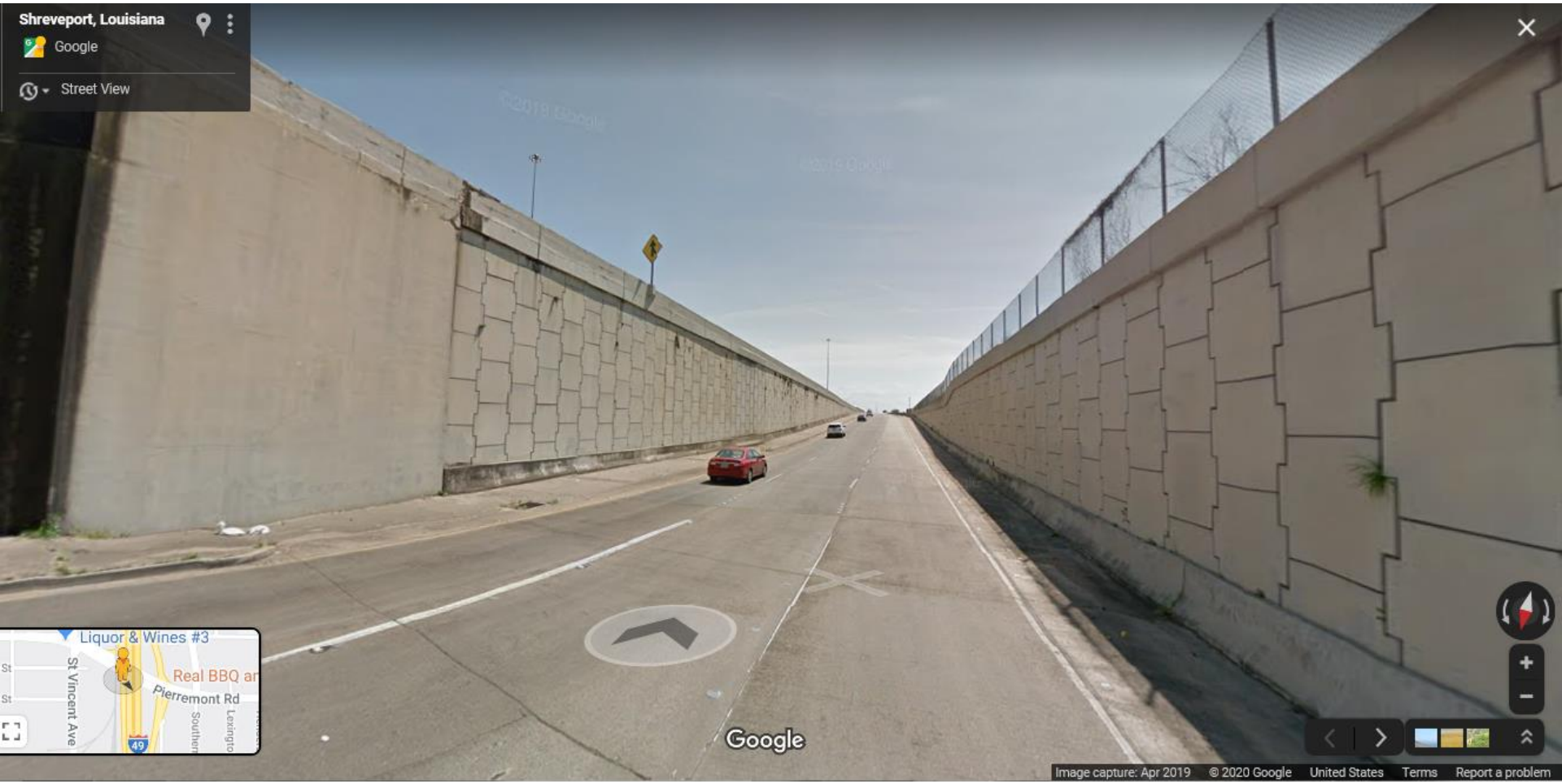
Not in Louisiana.

Problematic Slopes & Embankments

- Lots of Heavy Clays with Poor Drainage
- Average Rainfall: ~60 inches per year
- Generally have room for flatter slopes
- Historical Projects: Old/No soil Specs

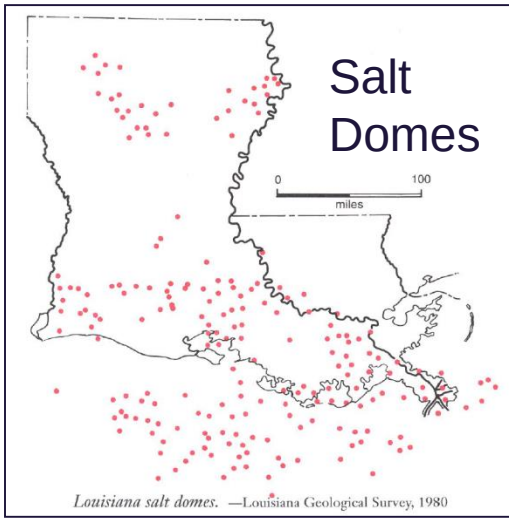
Mechanically Stabilized Earth (MSE) Walls … "Retaining Walls"

- How many do we have? …How old are they?



Other Assets

- Emergency Repair Data
  - Document (GIS links) what was done for future
- Levees near Highways
  - Mississippi River, and Flood/Surge Protection
- Tunnels with Retaining Walls
  - Harvey, Houma, & Belle Chase, Louisiana
- Petrochemical Industry
  - Salt Domes and Sinkholes
  - Bayou Corne Sinkhole endangered Hwy 70 (2012)
  - By-products: "Green Materials"
  - Calcium Sulfate allowed as alternate fill & base course material
  - Potential for Ettringite "heave", if cement is added later in futu
- Geotechnical Boring Data
  - Valuable information "Asset"
  - gINT ➔ HoleBase
    - GIS Linear Features: Walls as a layer

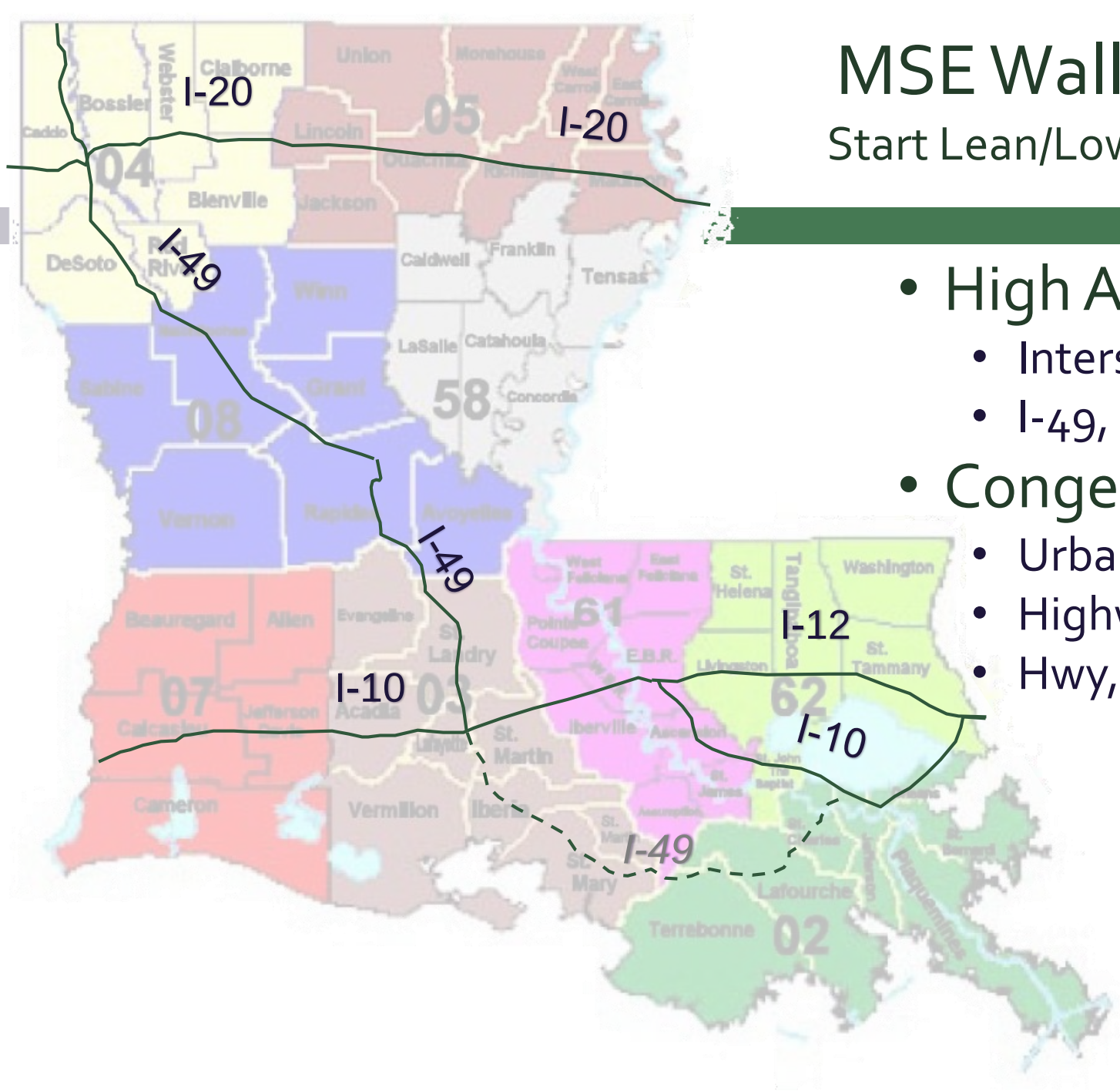


Keynetix

HoleBASE SI

MSE Wall Inventory

Start Lean/Low Hanging Fruit:



- High ADT Corridors
  - Interstates I-10, I-20
  - I-49, I-12, I-210
- Congested areas
  - Urban – Limited ROW
  - Highway Crossings:
  - Hwy, Rail,& Water

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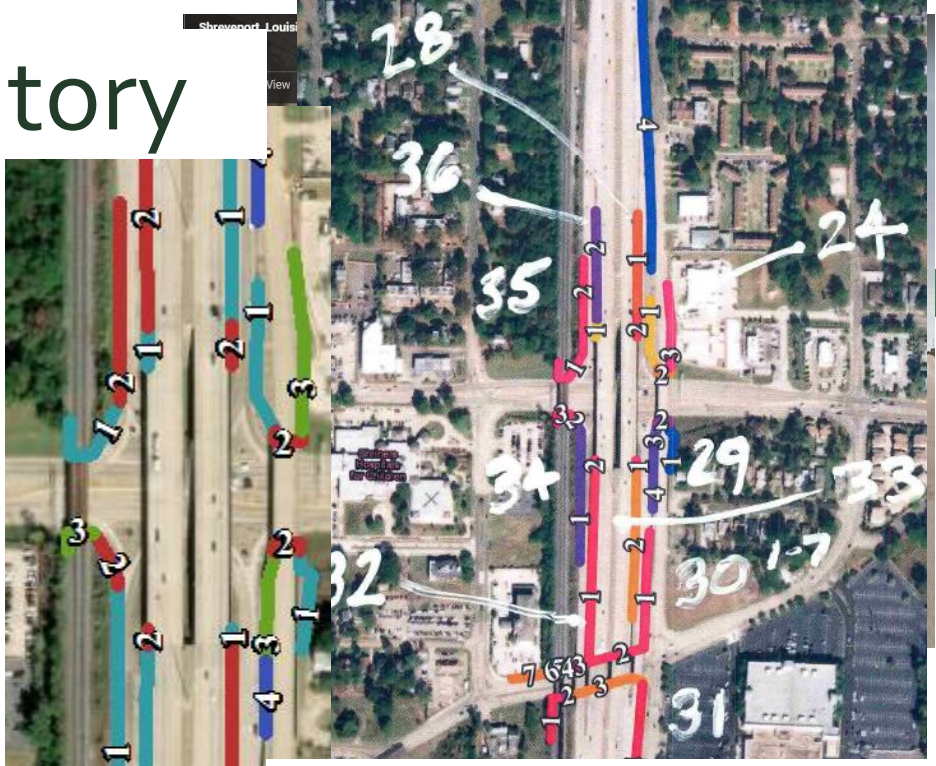
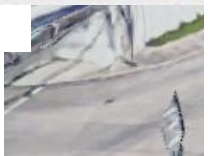
Methodology - Inventory

- Google Earth & Maps
  - Street and 3D view references
    - Wall start/stop, types, facing
    - Quick and Safe info
      - From Office vs. Field Trips
    - Fly-over scans of Major Hwys
- Draw in ArcGIS ArcMap
  - Agile Assets Future – Non GIS
- Segment breaks
  - Location, Purpose, Facing
  - Linear Referencing -LRS ID
  - Segments → Continuous Walls





Technicians:

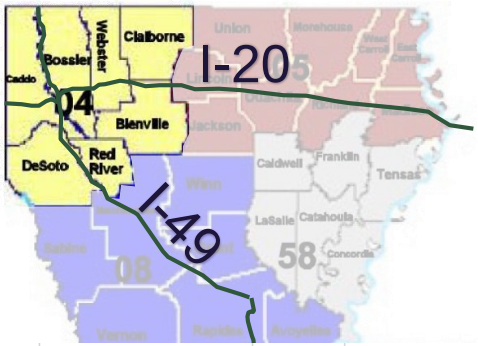
- Excel vs. ArcMap
- Wall Types/Face
- Elevations
- Blocks/Height
- ADT, Project #
- Plans, if available

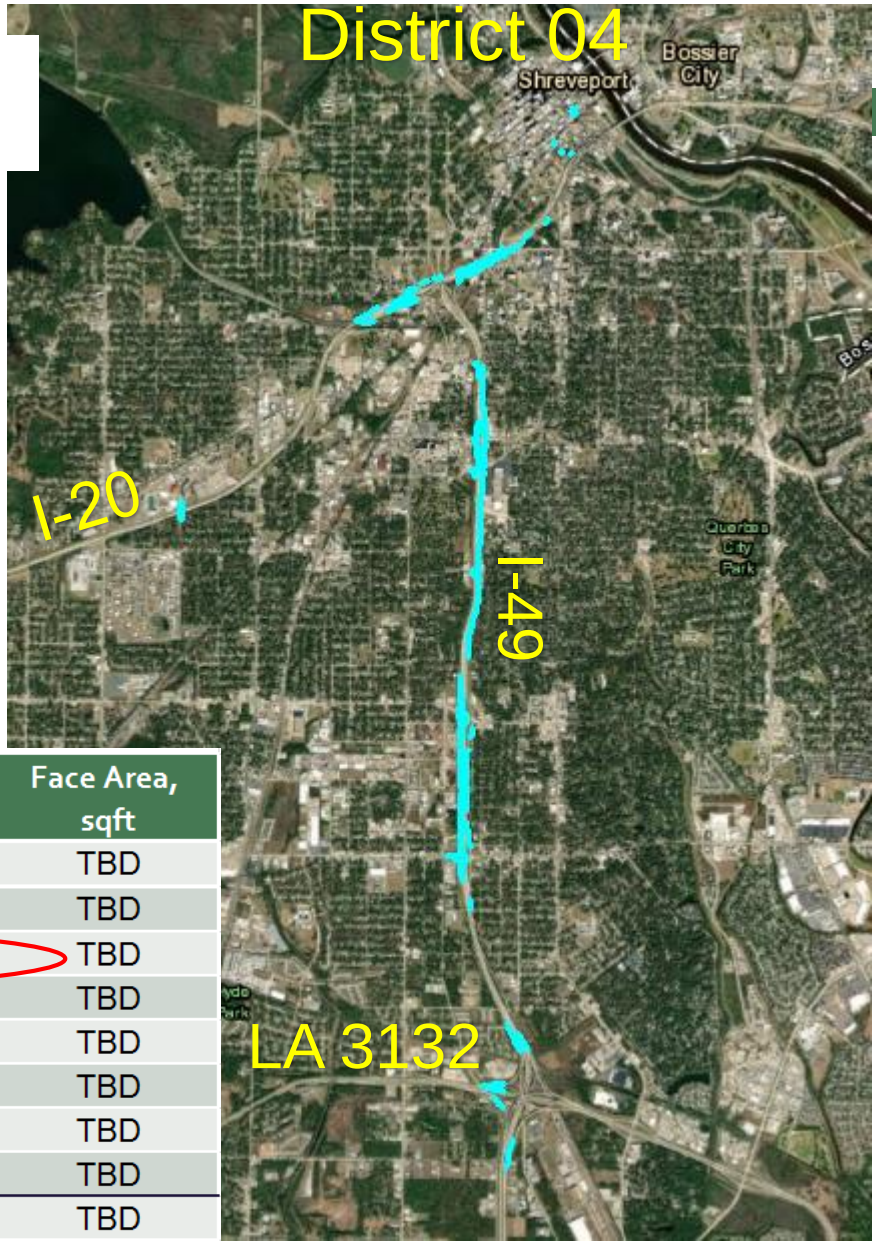
Inventory Example

Shreveport, LA

Newer Interstate, I-49, thru City of Shreveport
Less Space : Steeper Slopes ➔ Walls : $$$

Wall Segments: 154 (55 Continuous walls)
Linear Feet: 51,204.6 ft ➔ Miles: 9.70 mi





District	Segments (of 4/15/19)	# Walls	Linear, ft	Linear, mi	Linear % of Total	Face Area, sqft
2	50	20	9,964.80	1.89	9.3%	TBD
3	30	12	8,084.70	1.53	7.5%	TBD
4	154	55	51,204.60	9.7	47.8%	TBD
5	22	10	1,103.70	0.21	1.0%	TBD
61	38	17	18,155.30	3.44	16.9%	TBD
62	3	3	115.7	0.02	0.1%	TBD
7	31	15	11,647.40	2.21	10.9%	TBD
8	23	9	6,865.90	1.3	6.4%	TBD
Total	351	131	107,142.10	20.29	100.0%	TBD

Design Life

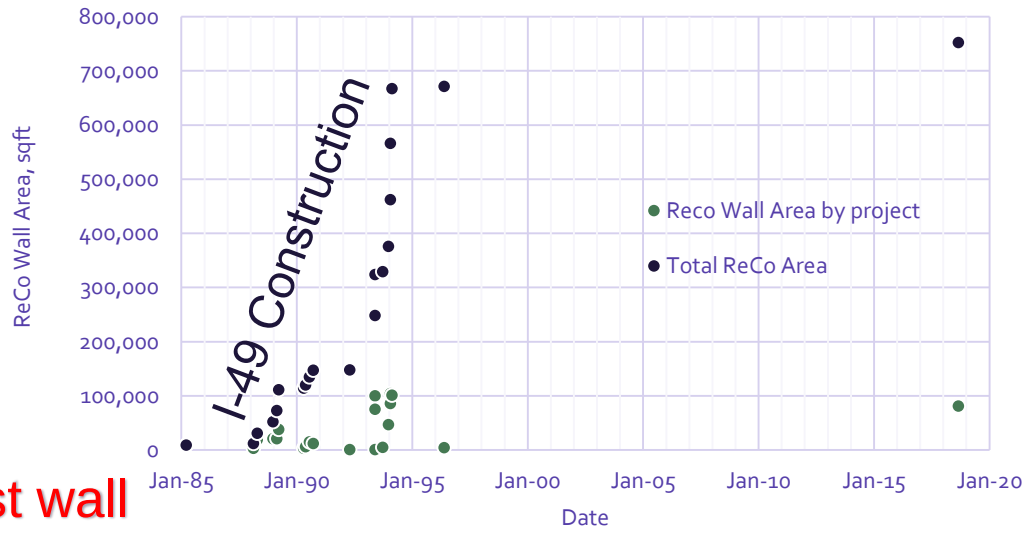
Permanent MSEW: 75-year design life.
Permanent MSEWs that support bridge abutments (without deep foundation support): 100-year design life

Year
2060 2065 2070
$ $$ $$$

Note: only 2 DOTD GRS supported bridges - so far

REINFORCED EARTH WALLS
LOUISIANA DOTD SUMMARY

AREA	WALL AREA, SF	# of WALLS
Shreveport	662,000	68 EA
Alexandria	78,000	14 EA
Lake Charles	12,000	4 EA
Lafayette	82,000	8 EA
TOTALS	834,000	94 EA



First wall
~35 yrs old

Almost halfway through 75 years

75 yrs

- Early walls utilized metal anchors - May exhume some walls to verify Louisiana corrosion rates.

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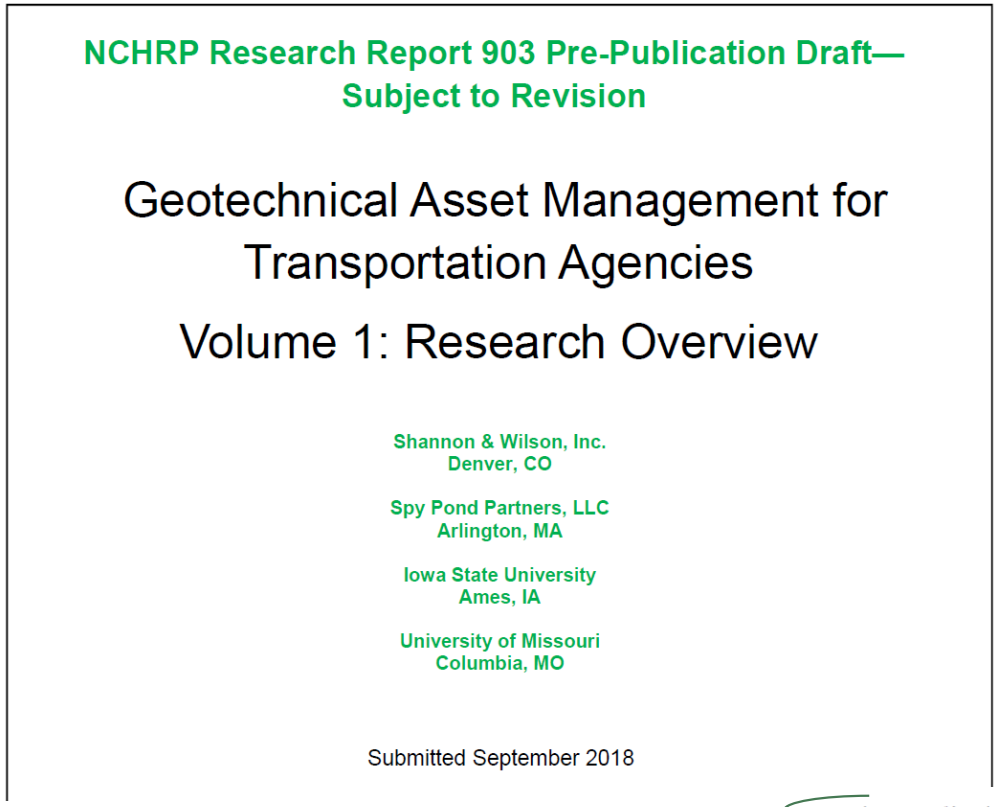
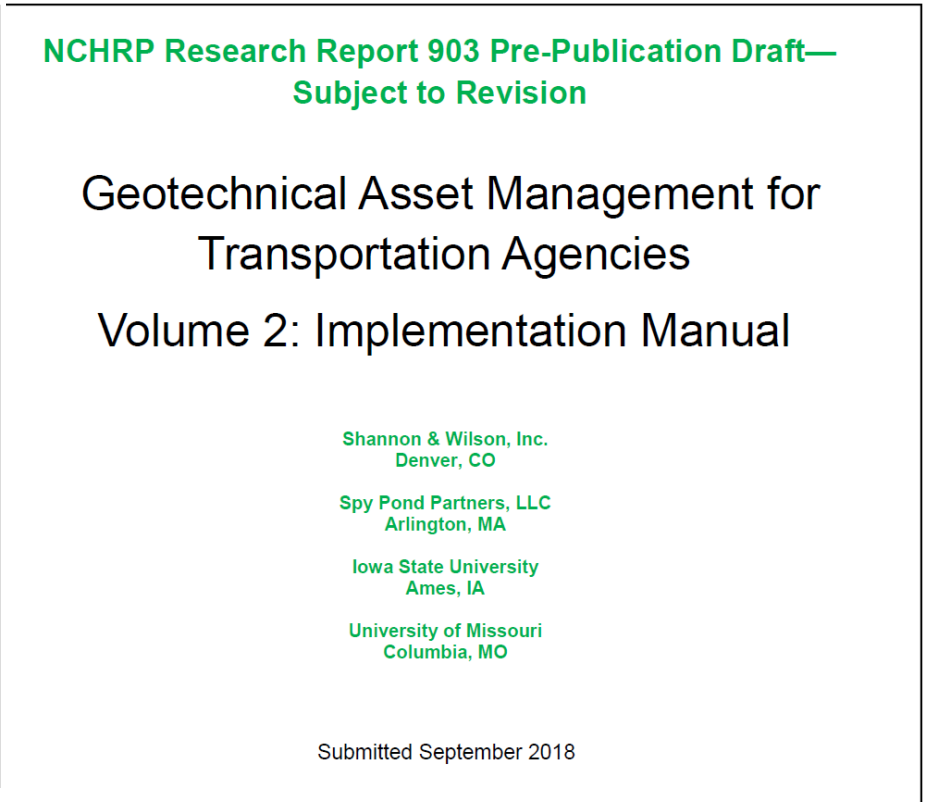
was NCHRP 24-46



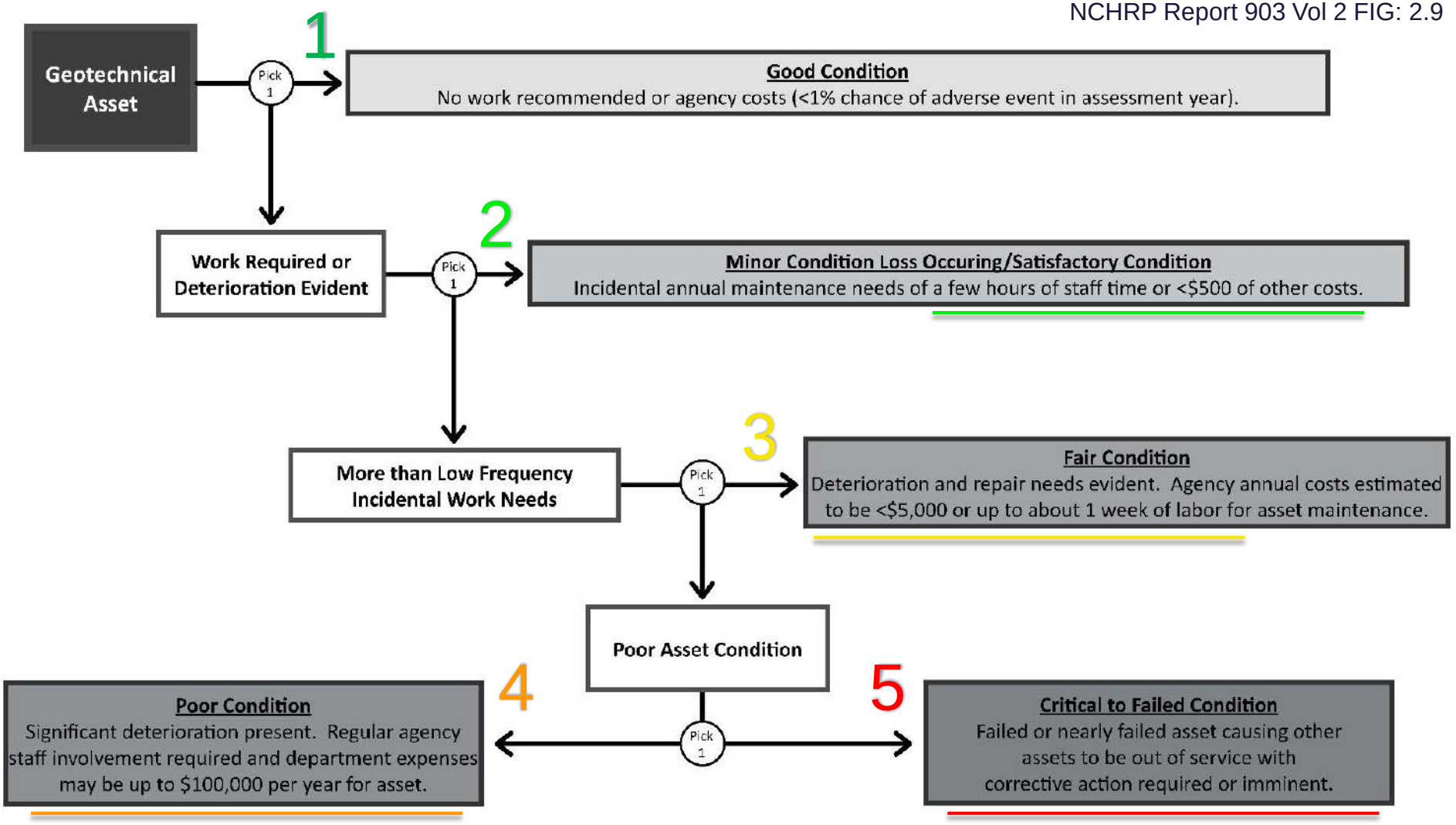


Appendices to *NCHRP Research Report 903: Geotechnical Asset Management for Transportation Agencies, Volume 2: Implementation Manual*

- Appendix A: Using the GAM Planner
- Appendix B: GAM Inventory Start Example
- Appendix C: GAM Model Formulation
- Appendix D: Geotechnical Asset Condition and Level-of-Risk Examples
- Appendix E: GAM Asset-Level Net Present Value Framework Worksheet
- Appendix F: GAM Plan Outline
- Appendix G: GAM Implementation Barrier Mitigation Strategy Matrix

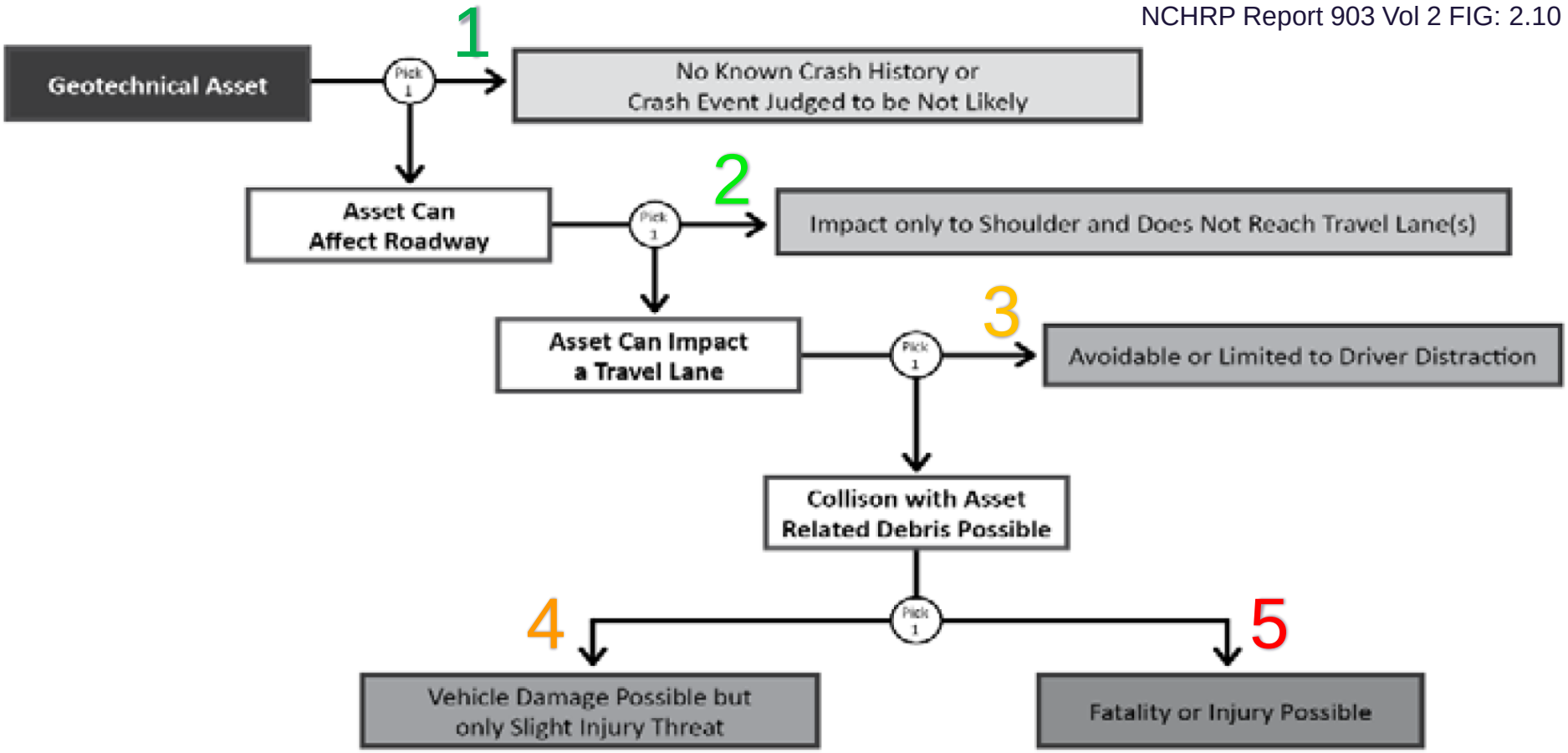
Operation and Maintenance Condition Tree (O&MC)

NCHRP Report 903 Vol 2 FIG: 2.9



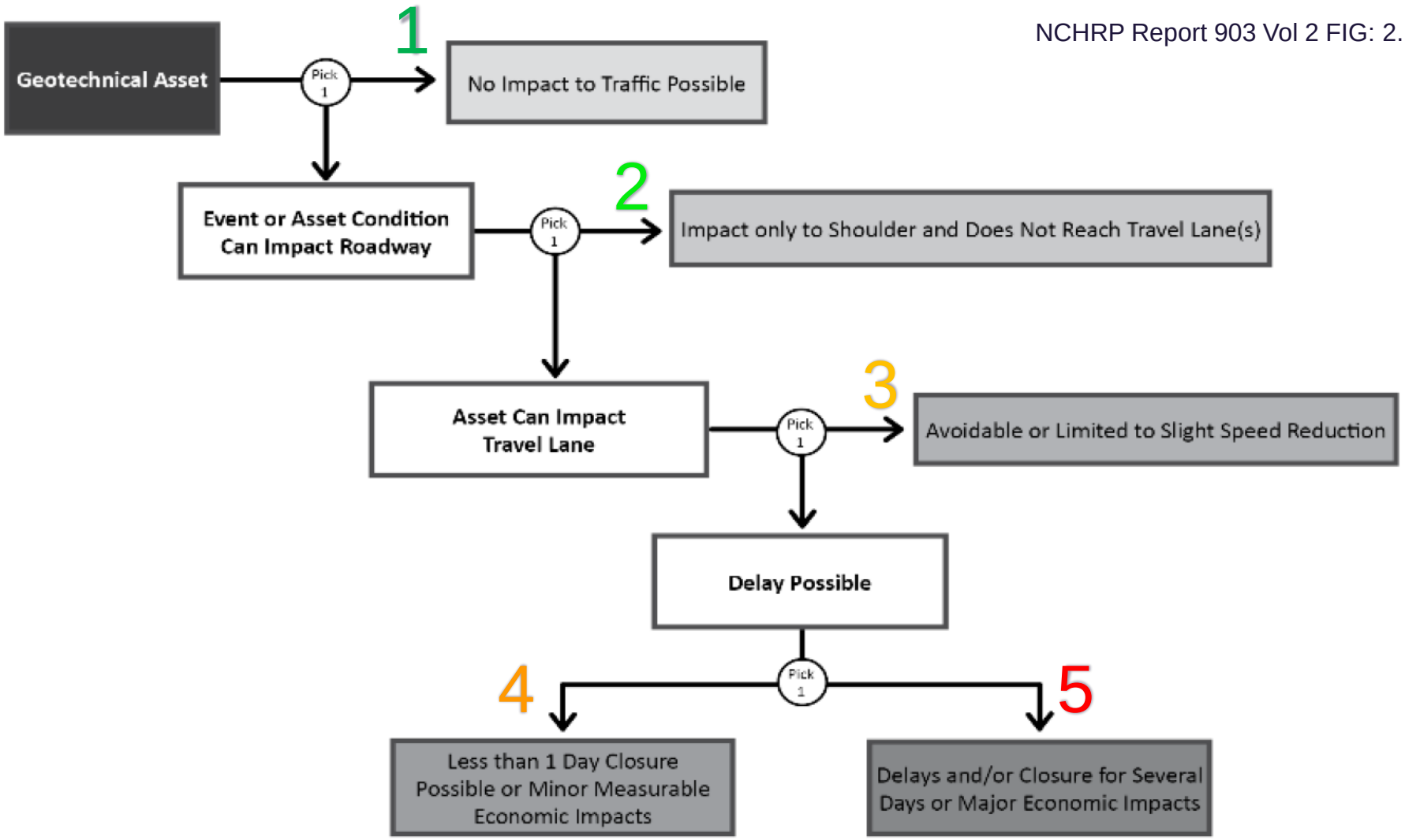
Safety Consequence Tree (SC)

NCHRP Report 903 Vol 2 FIG: 2.10



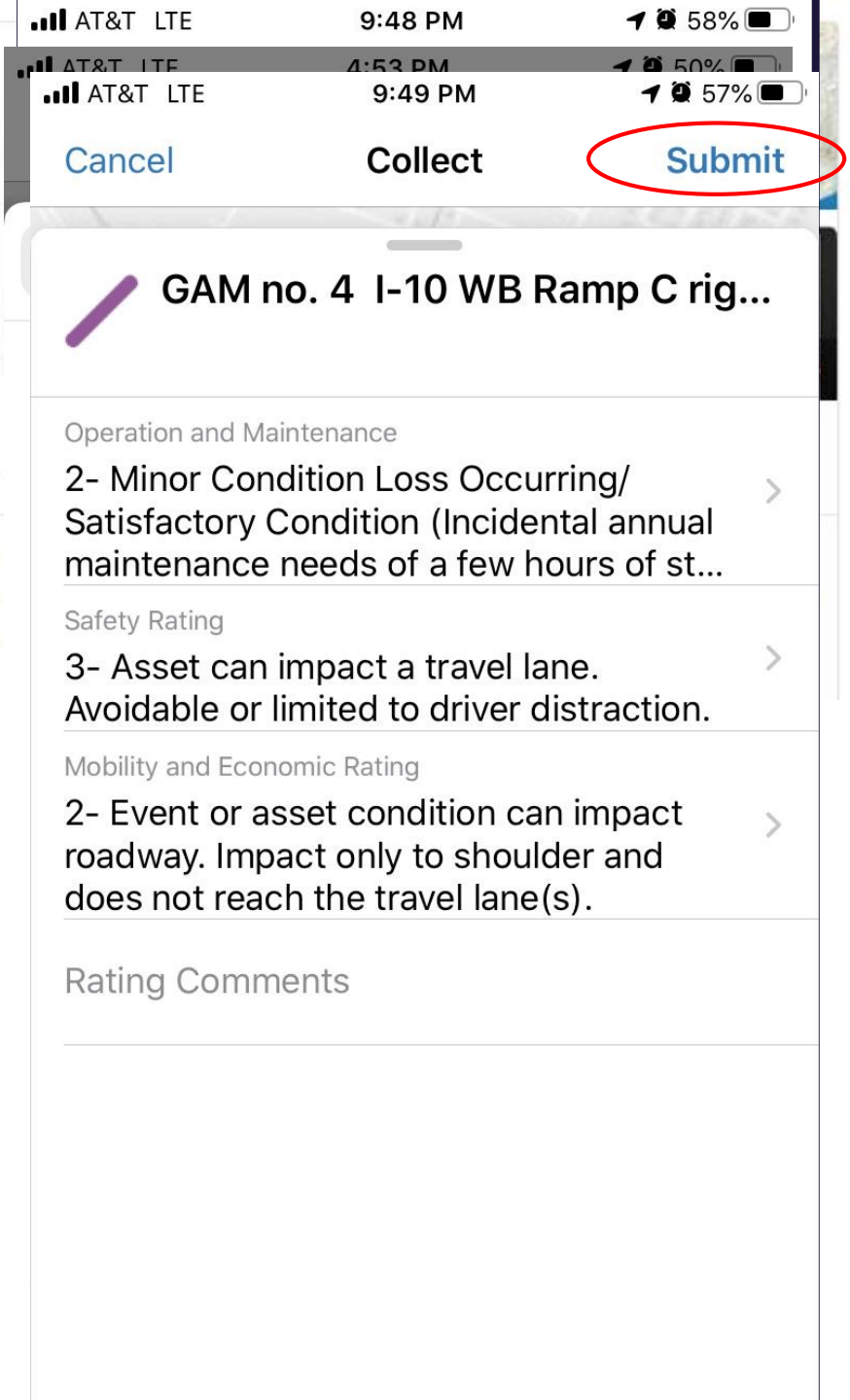
Mobility and Economic Consequence Tree (MEC)

NCHRP Report 903 Vol 2 FIG: 2.11



ArcGIS Collector

- Visual Interface (Web-App)
  - Links to GIS Database
  - Office or Field (phone)
  - Online or Off (sync later)
- Tracks total assets
  - Complete (one color)
  - Remaining (another color)
- District Ratings, by district
  - O&MC 1 2 3 4 5
  - SC 1 2 3 4 5
  - MEC 1 2 3 4 5



GAM Planner Model - Risk Analysis

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Assessments:

Operation & Maintenance Condition (O&MC) 1 2 3 4 5

Safety Consequence (SC) 1 2 3 4 5

Mobility/Economic Consequence (MEC) 1 2 3 4 5

Safety Risk Score = SC * O&MC

\+ Mobility/Economic Risk Score = MEC * O&MC

GAM LEVEL OF RISK

A = <10	A - less than $1,000 annual asset risk exposure
B = 10 - 20	B - $1,000 to $5,000 annual asset risk exposure
C = 20 - 30	C - $5,000 to $50,000 annual asset risk exposure
D = 30 - 40	D - $50,000 to $100,000 annual asset risk exposure
F = 40 - 50	F- Greater than $100,000 annual asset risk exposure

By assessing and sorting the entire list of assets, we can determine repair priorities and plan for necessary and future funding.

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Treatment Actions (NCHRP Report 903)

- **Do Minimum.** When the "do-minimum " treatment is performed, the asset may stay in the same state, deteriorate, or fail. Failure probabilities are specified by O&M condition and safety/mobility consequence. These probabilities are assumed to be independent. Thus, the overall failure probability for each state given application of the do-minimum treatment is calculated by combining them. Likewise, the agency and user costs of this treatment are calculated by adding the costs for the corresponding O&M condition and safety/mobility consequence levels.

- **Maintenance.** This treatment has the effect of maintaining the asset in its current state. An agency cost is specified for this treatment. If this treatment is applied, the do-minimum costs specified by O&M condition level are not applied, but the agency and user costs by safety/mobility consequence level are applied. In addition, the failure probability specified by safety mobility consequence level is applied for this treatment.

- **Rehab.** This treatment has a user-specified effect on O&M condition level. An agency cost is specified for this treatment. If this treatment is applied, the do-minimum costs specified by O&M condition level are not applied, but the agency and user costs by safety/mobility consequence level are applied. In addition, the failure probability specified by safety/mobility consequence level is applied for this treatment.

- **Reconstruction.** This treatment restores the asset to "State 1" (best O&M condition, lowest safety/mobility risk).An agency cost is specified for this treatment. If this treatment is applied, the do-minimum costs specified by O&M condition level are not applied, but the agency and user costs by safety/mobility consequence level are applied.

- **Restore.** This action is triggered in the event an asset fails, or reaches an O&M condition level of 5. The user specifies the resulting state in the event this treatment is triggered, as well as the agency and user costs of the treatment. The user may set these parameters to define what constitutes "failure" for a given asset type.

Louisiana DOTD GAM Challenges

- Walls are built, but fall off the radar after construction … until problems occur
- Walls are often subcontracted, so plans are not always included in DOTD files/Falcon/Content Mgr
- Wall Maintenance is often a reactionary process, vs. planning like bridge or pavement management
- Earliest walls (~1985) are roughly 35 years old.
  - Design life: almost halfway to 75year design life.
  - Check corrosion rates – normal plus any deicing salts
  - Large I-49 Collection will reach maturity simultaneously
- DOTD Priorities (Staffing and Funding)

Next Steps / Early Recommendations

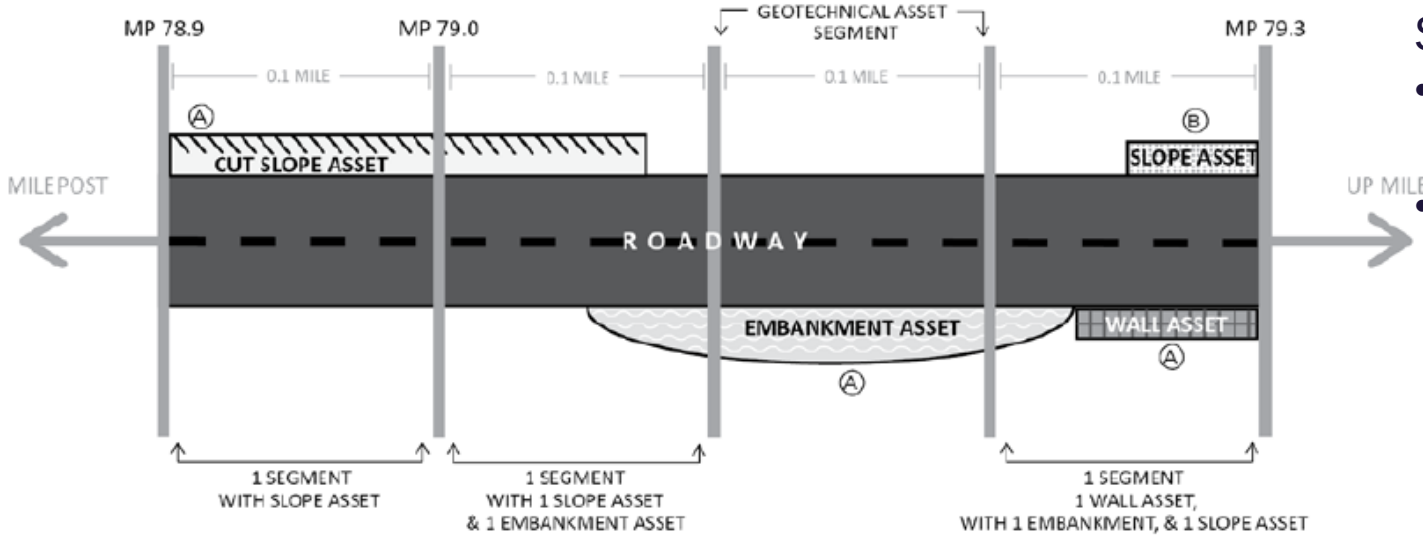
- Bridge / Geotechnical/ District Coordination
  - Subcontractor wall designs/ As-builts
    - Add wall details to project files early (Falcon /ContentMgr)
- Continue Inventory (350+ segments so far)
  - Age, ADT, Project #s, Verify with Districts, Missing, etc.
- Condition Assessments with District forces - Collector App
  - Operation & Maintenance Condition (1-5)
  - Safety Consequences (1-5)
  - Mobility / Economic Consequences (1-5)
- Calculate Risk Scores (A to F); Review Treatments
- Communicate Results: Report, Web-Apps, Database

Thank You!
Questions?

Geaux LSU!

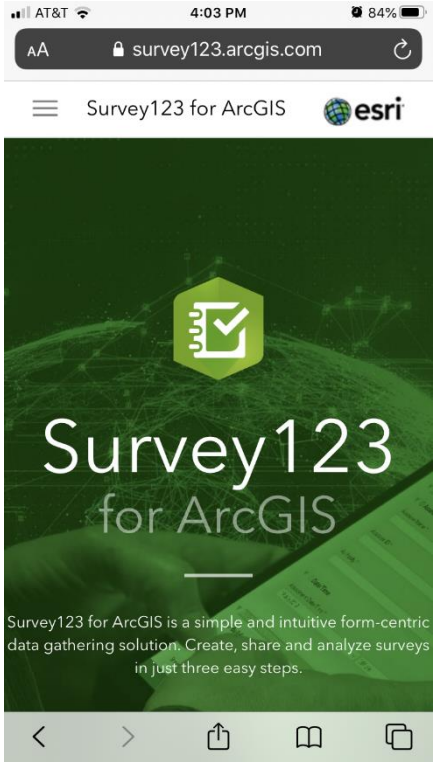
Gavin Gautreau, P.E.
Louisiana Transportation Research Center
Gavin.Gautreau@LA.GOV (225) 767-9110

Locating Assets (NCHRP Report 903)



Slopes & Culverts

- Surveyor or Collector Apps
- Funding Mechanism



GAM Inventory Example

ASSET ID	ASSET TYPE	TOTAL LENGTH IN SEGMENT
Highway MP 78.9	Cut Slope Ⓐ	400 feet
Highway MP 79.0	Cut Slope Ⓐ	400 feet
	Embankment Ⓐ	250 feet
Highway MP 79.1	Embankment Ⓐ	500 feet
Highway MP 79.2	Embankment Ⓐ	200 feet
	Wall Ⓐ	300 feet
	Slope Ⓑ	100 feet

e 2-7. Geotechnical Asset Segment and Location Process