2018 Midwest Geotechnical Workshop

Geotechnical Asset Management Implementation for Transportation Agencies - Outcomes from Project 24-46

Mark Vessely, P.E.
BGC Engineering, Golden, Colorado

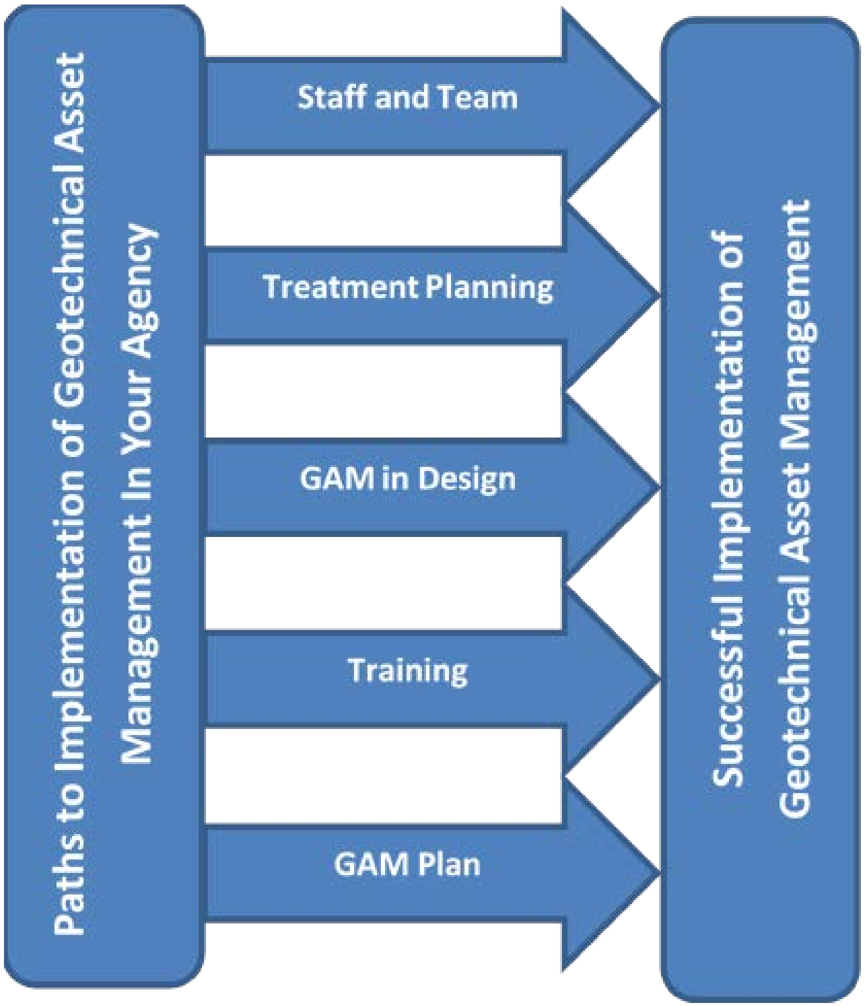
bgcengineering.com

BGC

Finding Success in Your Agency

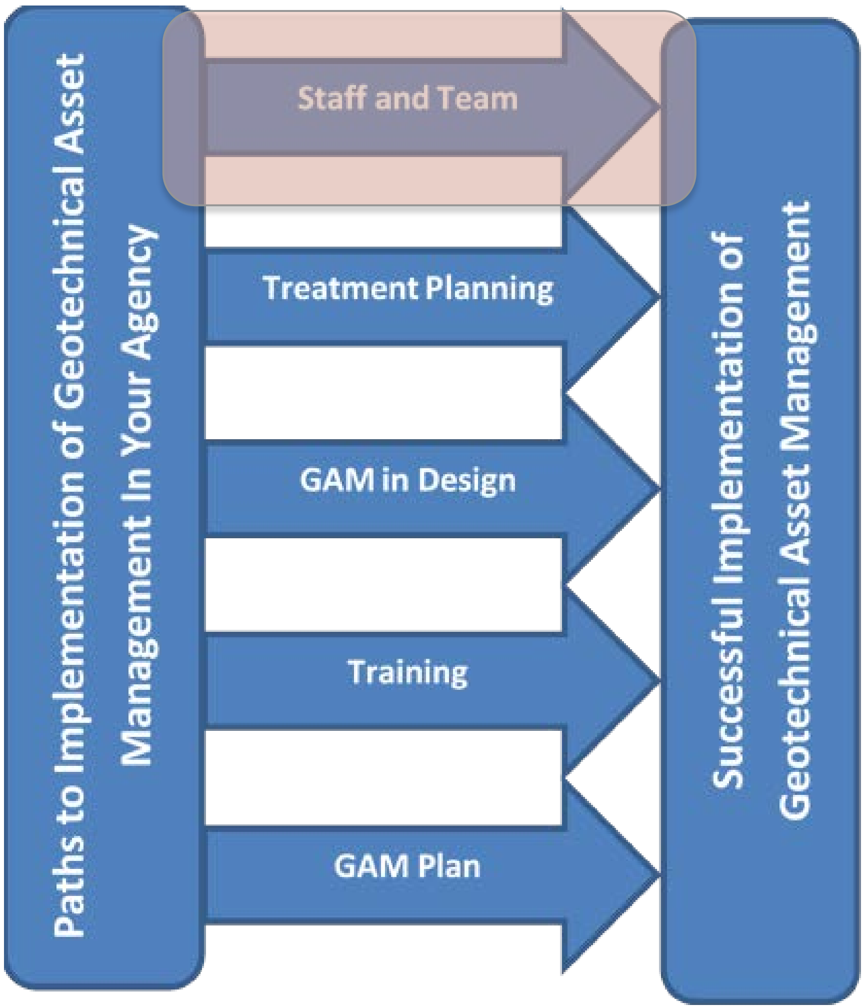
- Implementation should be flexible to allow adaptation to various:
  - Performance objectives
  - Agency cultures
  - Department processes
  - Systems

Enabling GAM Success



- Optional and flexible steps that can enable GAM success

Steps Towards GAM Success



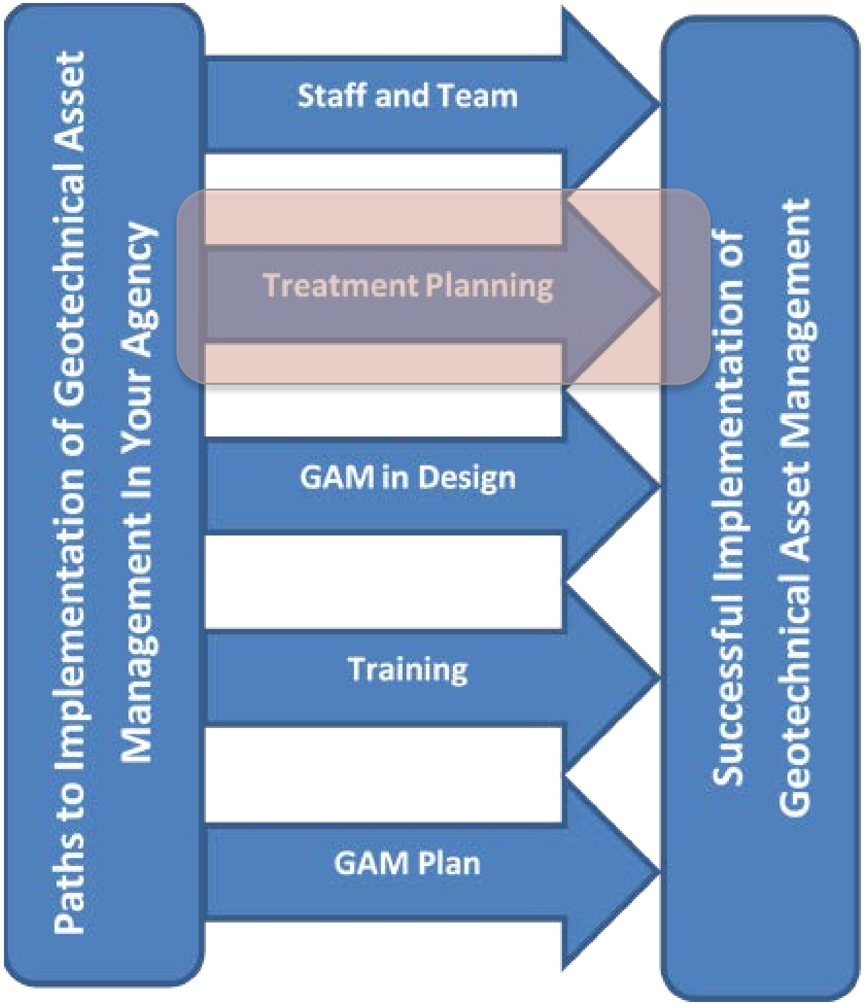
Organization Structure

- Advanced programs have individuals who have full time capacity for GAM
  - Aspirational goal that limit distractions from typical design or construction duties
- Implementation Manual recommends designation of a geotechnical asset manager who interacts with TAM and performance program managers

GAM Team Options

- Who could it be?
  - Geotechnical/Geology staff
  - TAM staff
  - Maintenance staff
  - Bridge Inspection staff
  - Others?

Steps Towards GAM Success

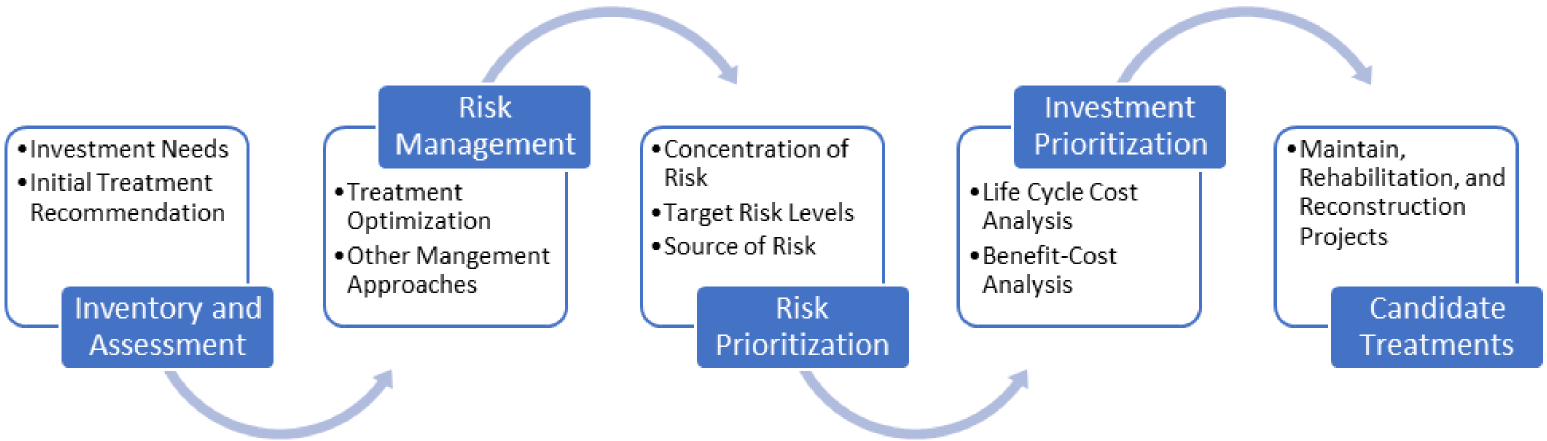


The Need to Prioritize Planning

- GAM will indicate needs far exceed reasonable investment strategies

- Additional prioritization steps guide the process to treatments that provide the greatest value to the organization
  - Objectives will vary by agency and by time within an agency so flexibility is necessary for sustained success

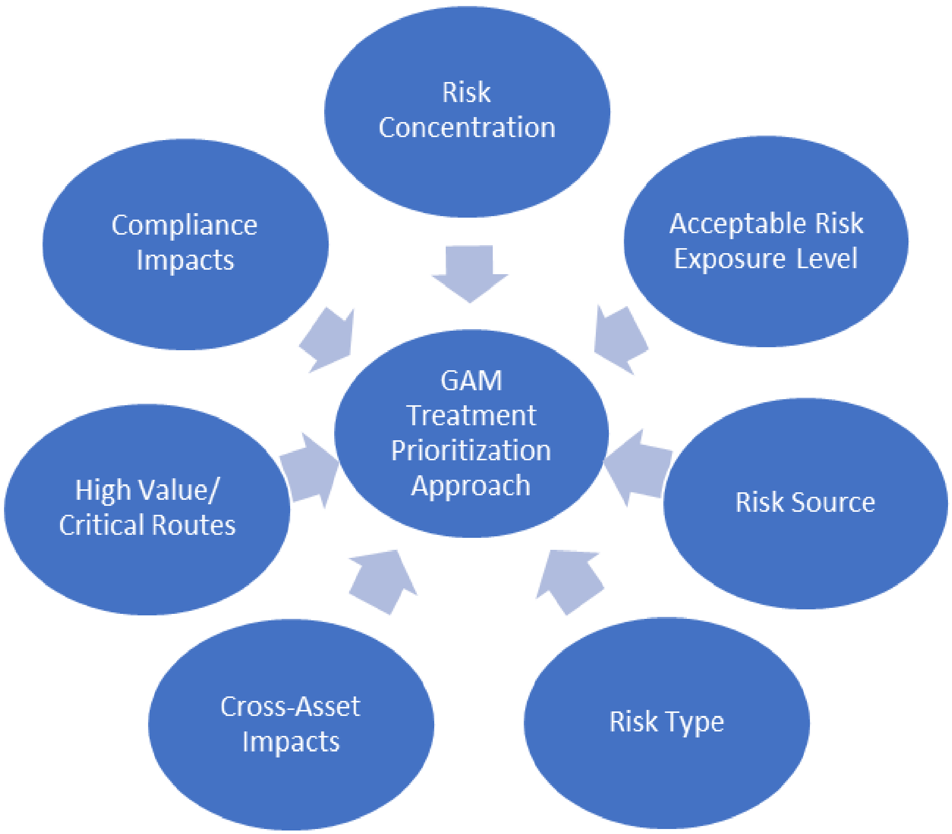
Treatment Planning



- Several approaches to prioritize treatments and enable GAM acceptance and investment support

Risk Prioritization

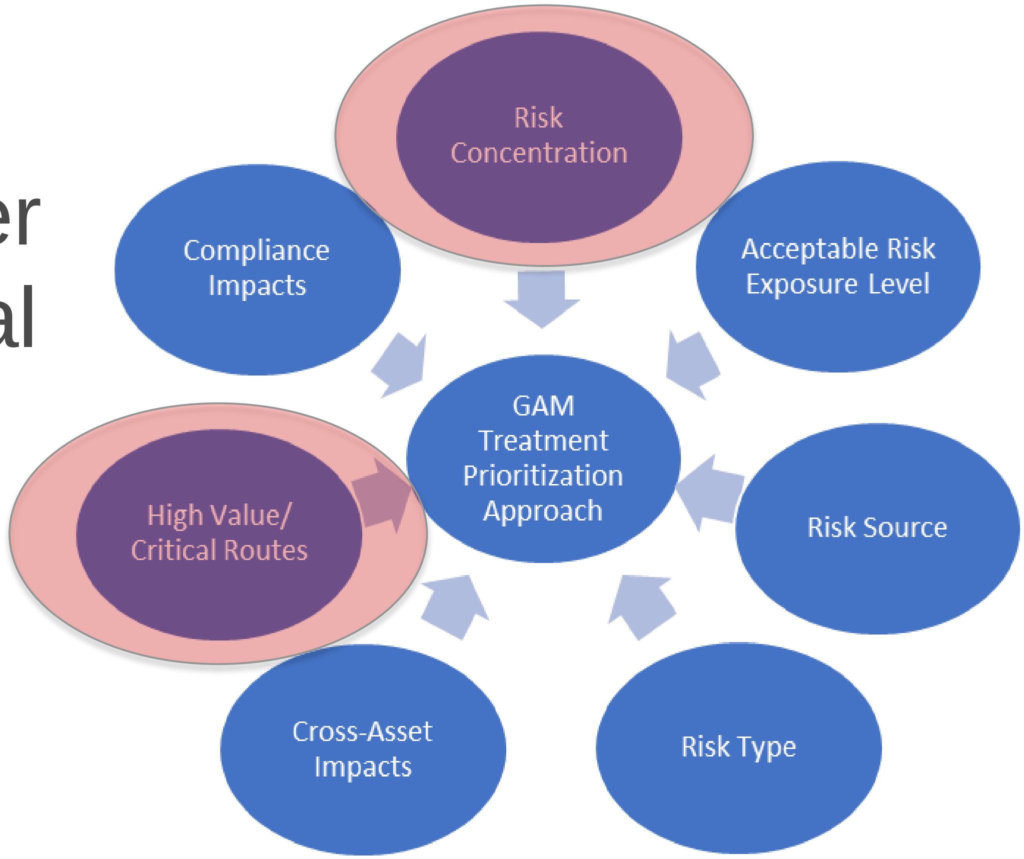
- Risk Prioritization is beneficial process for identifying and guiding treatment decisions that align with executive and stakeholder interest areas



Risk Prioritization

Example:

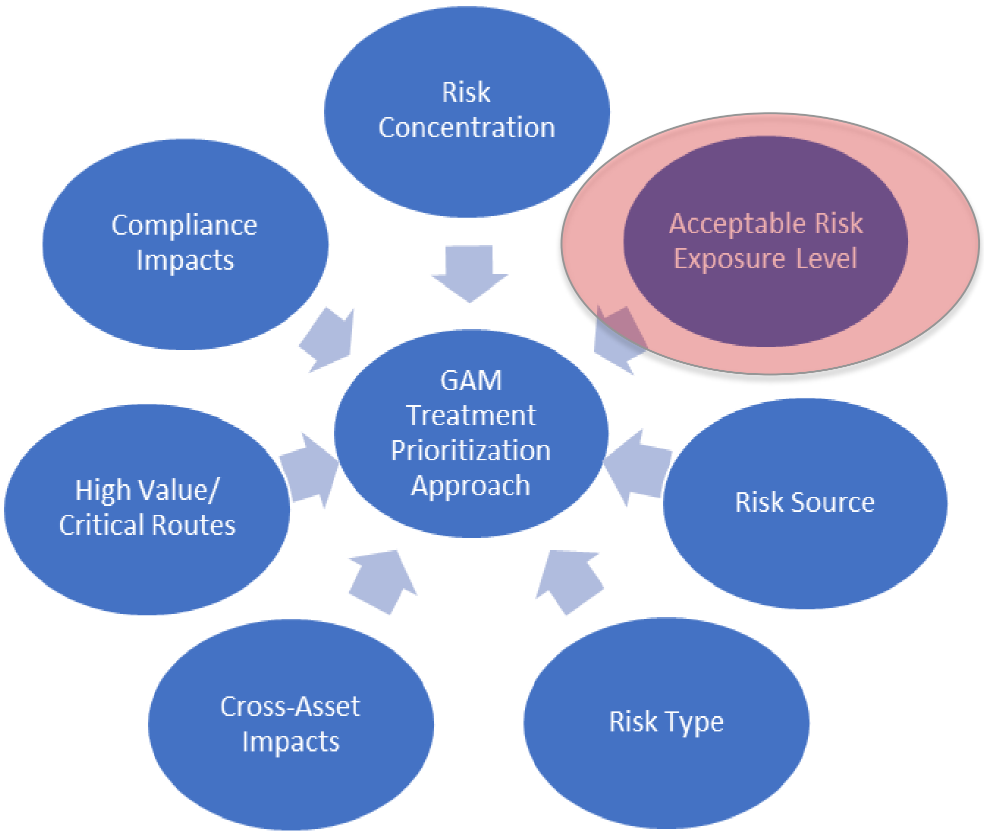
Important corridors and/or areas of higher risk from geotechnical assets



Risk Prioritization

Example:

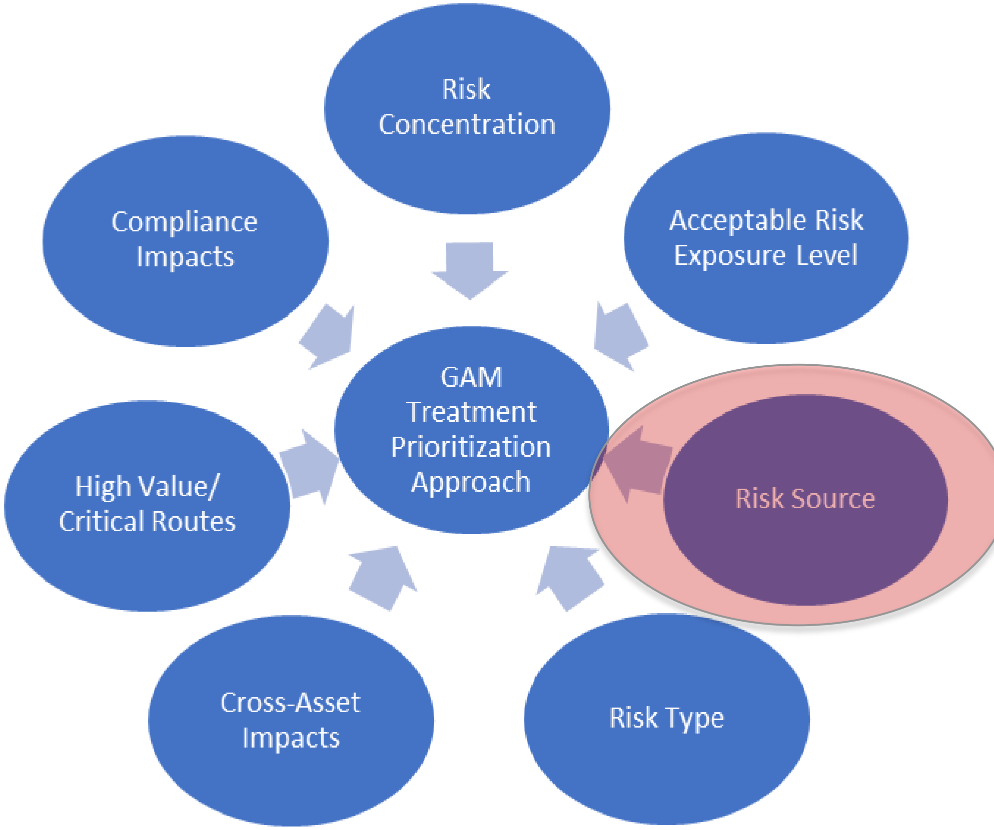
Agency tolerance for risk – is management okay with level of risk values of D or F?



Risk Prioritization

Example:

Source of risk from on ROW assets and/or beyond ROW features



Risk Prioritization

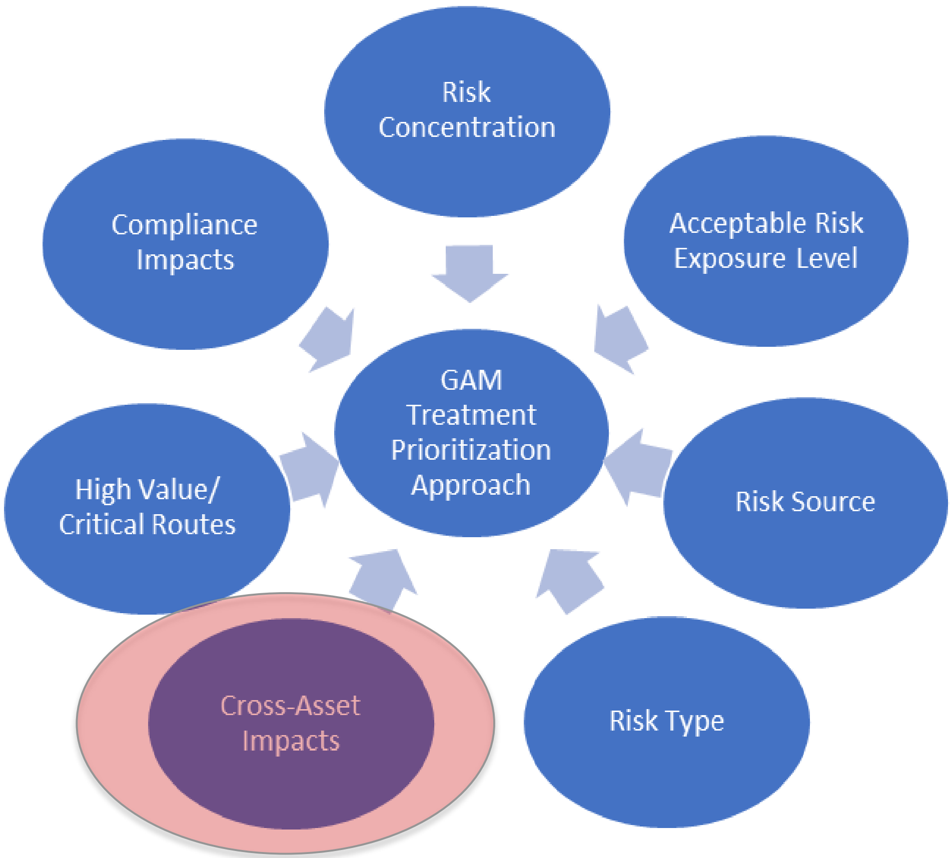
Example:

Examining the distribution between safety, mobility/ economic, or condition performance areas

Risk Prioritization

Example:

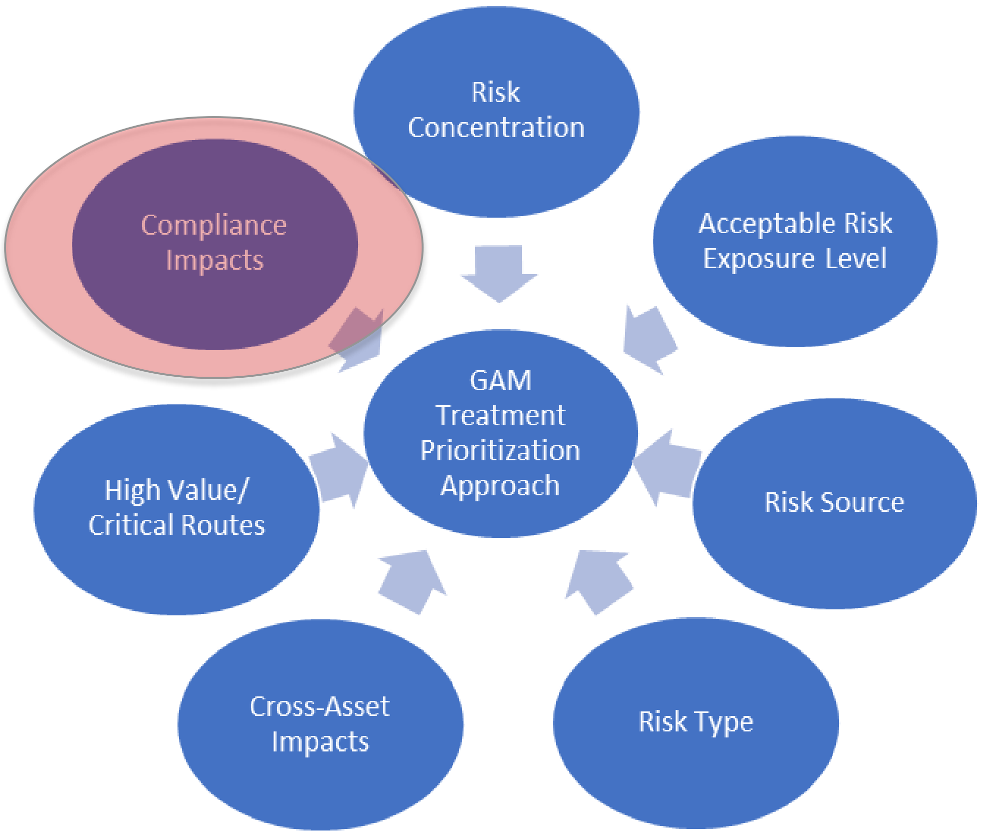
Interaction with other assets such as culverts, bridges, walls/embankments, etc.



Risk Prioritization

Example:

External performance areas such as environmental compliance, legal exposures, etc.



Life-Cycle Investment Prioritization

- Comparison of treatment alternatives at the asset/segment level to identify the optimum decision from economic perspective
  - Identify specific recommendations in the maintain, rehab, or reconstruction options, e.g.:
    - What are wall maintenance activities?
    - What is the best action for a slope rehabilitation?

Life-Cycle Prioritization

Geotechnical Asset	Treatment Category	Asset Specific Alternatives	Investment and Risk Considerations
Slope	Maintenance	Periodic scaling and debris removal	Each alternative will present a different threat to traveler safety and level of effort for maintenance staff
		Frequent ditch cleaning	
Slope	Rehabilitation	Draped Mesh	While lower initial cost, barrier or draped mesh alternatives may have a high threat to safety when compared to anchored mesh.
		Anchored Mesh	
		Barriers	
Slope	Reconstruction	Flatten slope inclination	One alternative may impact environmental resources or require property acquisition while the other adds a more complex asset to the network
		Retaining wall	

Life-Cycle Prioritization

Geotechnical Asset	Treatment Category	Asset Specific Alternatives	Investment and Risk Considerations
Wall	Maintenance	Cleaning and inspection of drainage elements	Cleaning and rinsing actions require annual investment and resources but can slow deterioration rates. I&M may have lower cost and provides early warning of problems but will not slow deterioration.
		Rinsing of elements	
		Instrumentation and monitoring (I&M)	
	Rehabilitation	Add structural reinforcement	Each alternative should consider service life of rehabilitation method relative to required remaining service life of wall asset
		Repair/replace deteriorated facing systems	
	Reconstruction	Rebuild wall to current design standard	Select wall type based on required service life and lowest life-cycle cost

Life-Cycle Prioritization

Geotechnical Asset	Treatment Category	Asset Specific Alternatives	Investment and Risk Considerations
Embankment	Rehabilitation	Install reinforcements	Each alternative will have a different design reliability that results in different impacts to future maintenance needs
		Partial re-construction	
		Install groundwater drainage	
		Add buttress fill	

Life-Cycle Prioritization

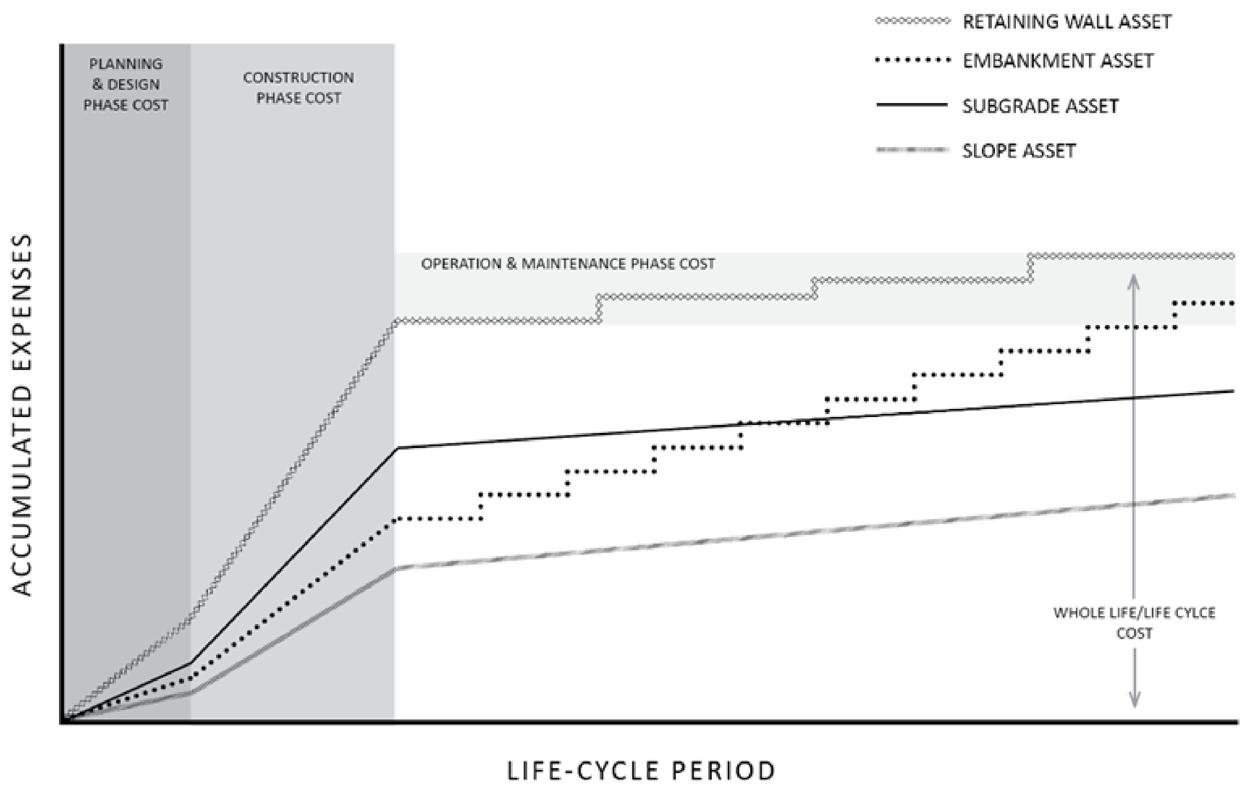
Geotechnical Asset	Treatment Category	Asset Specific Alternatives	Investment and Risk Considerations
Subgrade	Maintenance	Increased pavement treatment frequency	Evaluate tradeoff between higher initial cost and potential for reduced pavement maintenance
		Install and maintain drainage improvements	
	Rehabilitation	Install ground improvement	Several improvement technologies exist and can be evaluated using resources such as GeoTechTools.com
	Reconstruction	Reconstruct roadway and placed improved subgrade materials	Each alternative will have different initial costs, potential ROW impacts, O&M costs, and expected life-cycle duration that should be considered in a option selection process.
		Relocate roadway away from poor subgrade	
		Incorporate structural solution to bridge poor subgrade	

Life-Cycle Planning

Question:

- Could we consider monitoring as a possible action under the maintenance treatment category?
  - Predict/forecast failure
  - Manage consequences

Whole Life/Life-Cycle Cost



- O&M treatments escalate whole-life cost

Treatment Planning - Life-Cycle Investment Prioritization

- Life-Cycle Cost Analysis: Evaluation of cost over the life of the asset
  - Net Present Value (NPV) Analysis: An evaluation of direct costs among different options for a similar analysis period (e.g. 50 years for all options)
  - Cost Benefit Analysis: An evaluation of the direct costs compared to the financial and indirect (e.g. user) benefits over analysis period

Project Level NPV

Cost Type	Cost Description	Embankment Reconstruction	
		Option 1 **Gentle Side Slopes with ROW Purchase**	**Option 2** **Steep Side Slopes within ROW**
Design Cost	Design needs are similar between options	$10,000	$10,000
ROW Cost	Option 1 requires purchase of ROW	$20,000	0
Construction Cost	More embankment material required for Option 1	$100,000	$80,000
Total Initial Cost	Year 0 cost	$130,000	$90,000
Annual Maintenance	Option 2 O&M cost is three times greater due to need for erosion repairs on steeper slopes and roadway barrier maintenance	$1,000	$3,000
50-year Present Worth Value of Annual Maintenance	Cost in current dollars for 50 years of annual maintenance using a 4% discount rate	$21,500	$66,500
Net Present Value	**Sum of initial and annual maintenance costs in current dollars**	**$151,500**	**$156,500**

- Implementation Manual includes Microsoft Excel worksheet with a NPV analysis framework

Example
Project Level NPV

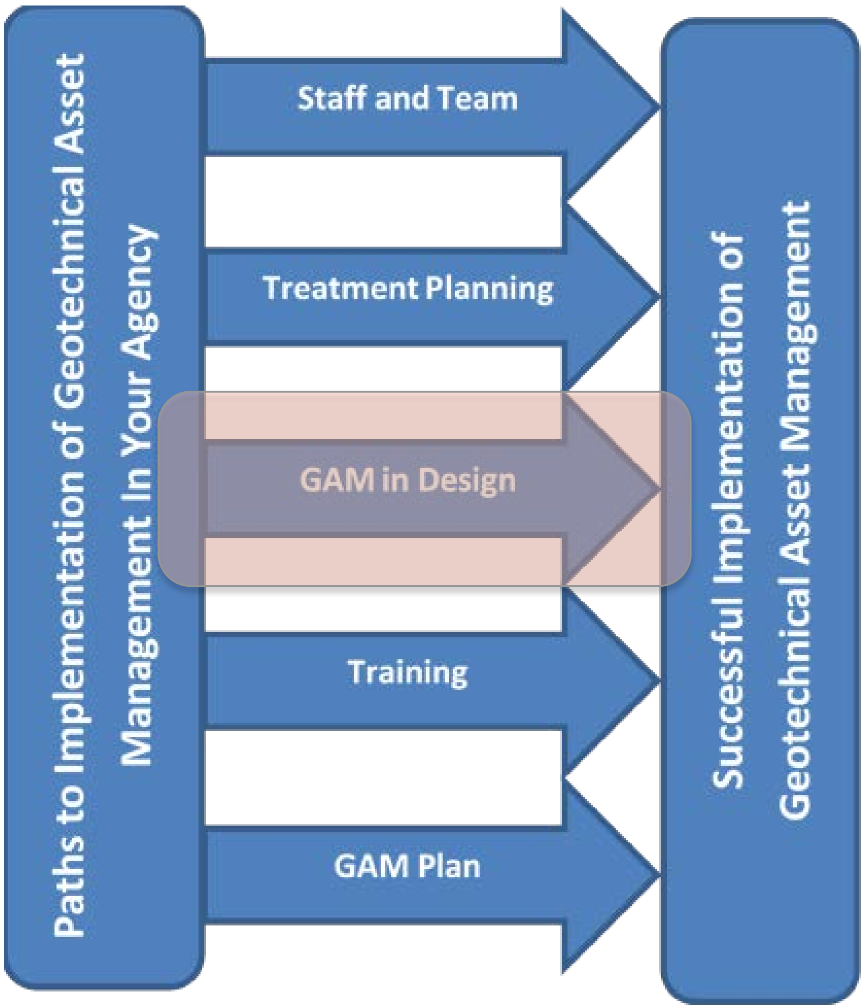
Data Driven Treatment Decisions

- GAM is a voluntary process that must compete on business case
- Guide staff to be able to answer the question:

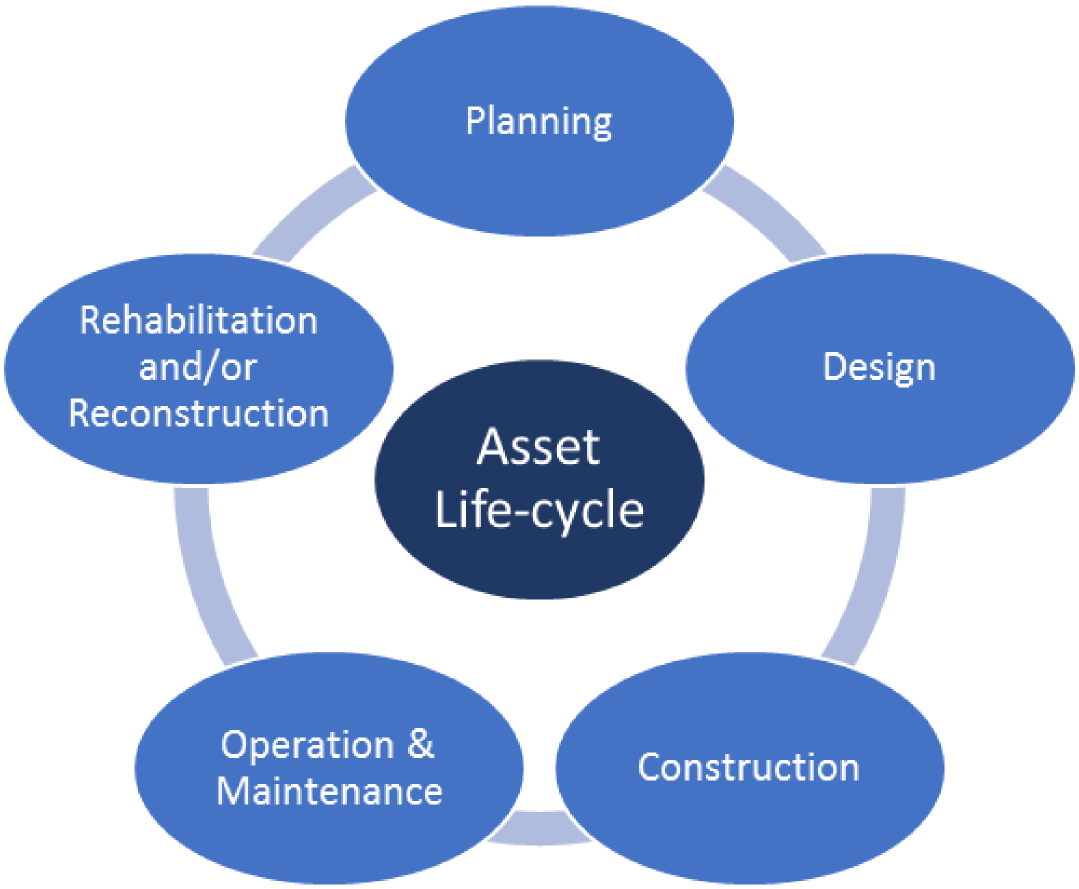
"***If given $X amount of dollars, what can be done for the greatest return of investment?***"

Starting small with gradual improvements may improve potential for success?

Steps Towards GAM Success



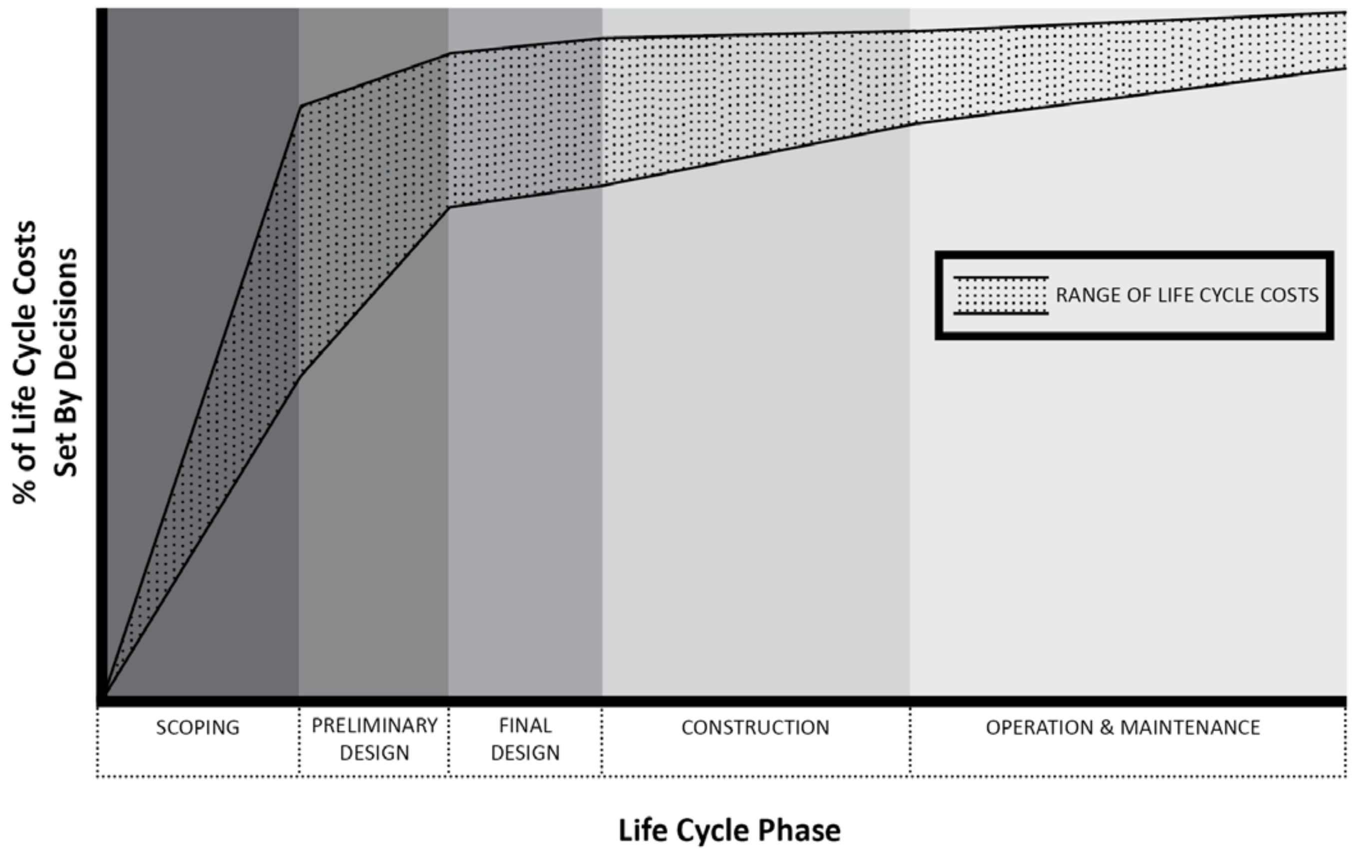
The Asset Life-Cycle



Incorporating GAM in Design

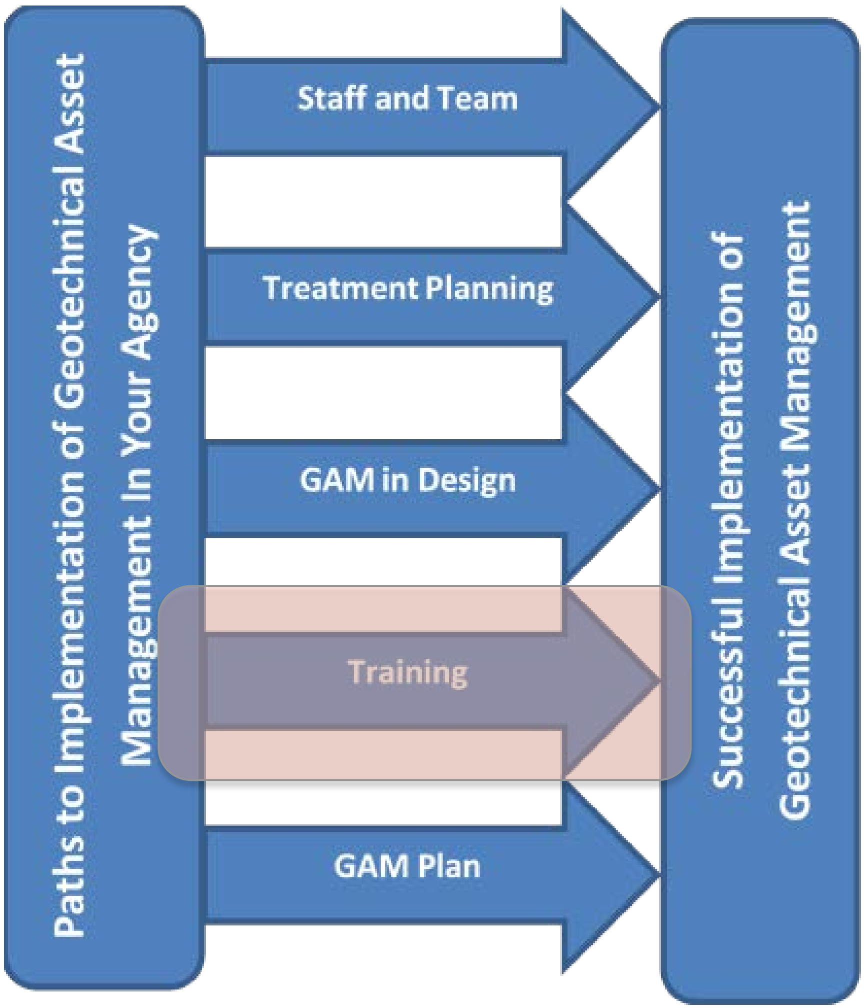
- For new assets and rehabilitation decisions designers can consider questions such as:
  - What is the desired life of the asset?
  - What is the estimated O&M cost for option?
  - What are the agency O&M capabilities and resources?
  - What design changes can influence life-cycle cost?

Incorporating GAM in Design



- Up to 80% of life-cycle cost may be locked in by preconstruction decisions

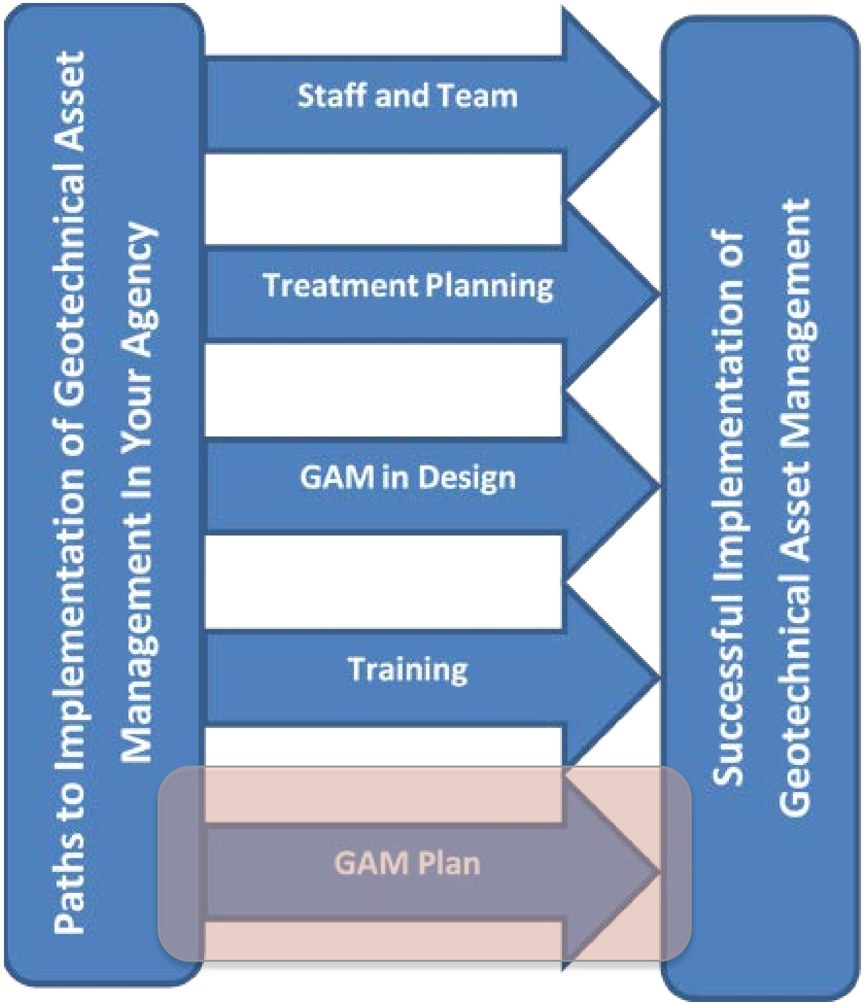
Steps Towards GAM Success



Training for GAM

- Asset management is a cross-functional process that can benefit from training in less familiar topics such as:
  - Transportation asset management
    - E.g. FHWA-NHI-136113 or 136106
  - Geotechnical assets
  - Risk and risk management
    - E.g. NHI, ASCE, etc.
  - Life-cycle cost analysis

Steps Towards GAM Success



Developing a GAM Plan

- GAM Plan can be a process improvement step and a “living” document
- GAM Plan is tool for communicating the strategy for geotechnical assets to cross-disciplinary stakeholders
- Drawing from the Network Rail experience, 7 versions of the GAM plan have been issued with the first version several years after starting implementation

Developing a GAM Plan

- Implementation Manual provides framework and annotated outline that can be used to author a simple GAM plan at the start of implementation
  - Includes recommended objectives and measures for
    - Tracking safety performance
    - Risk to safety, mobility, and economic vitality
    - Asset condition

Strategy Discussion on Overcoming Barriers and Questions

Future questions and feedback:
Mark Vessely
mvessely@bgcengineering
303-618-3264