

Protection of Karst Features During Project Development and Construction

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Outline

- Legal Protection of Karst Resources
- History
- Purpose
- Indiana Karst Region
- Procedure
- Karst and IPaC
- Other Resources
- SR 64 Small Structure Replacement, Harrison County

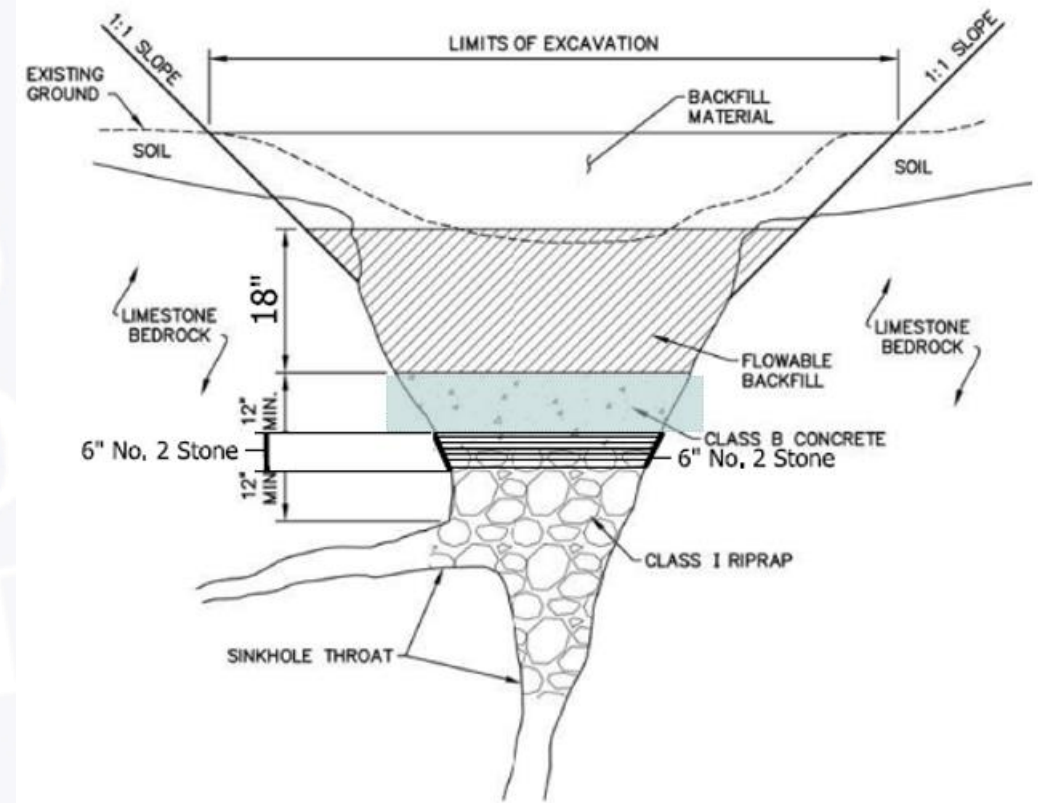
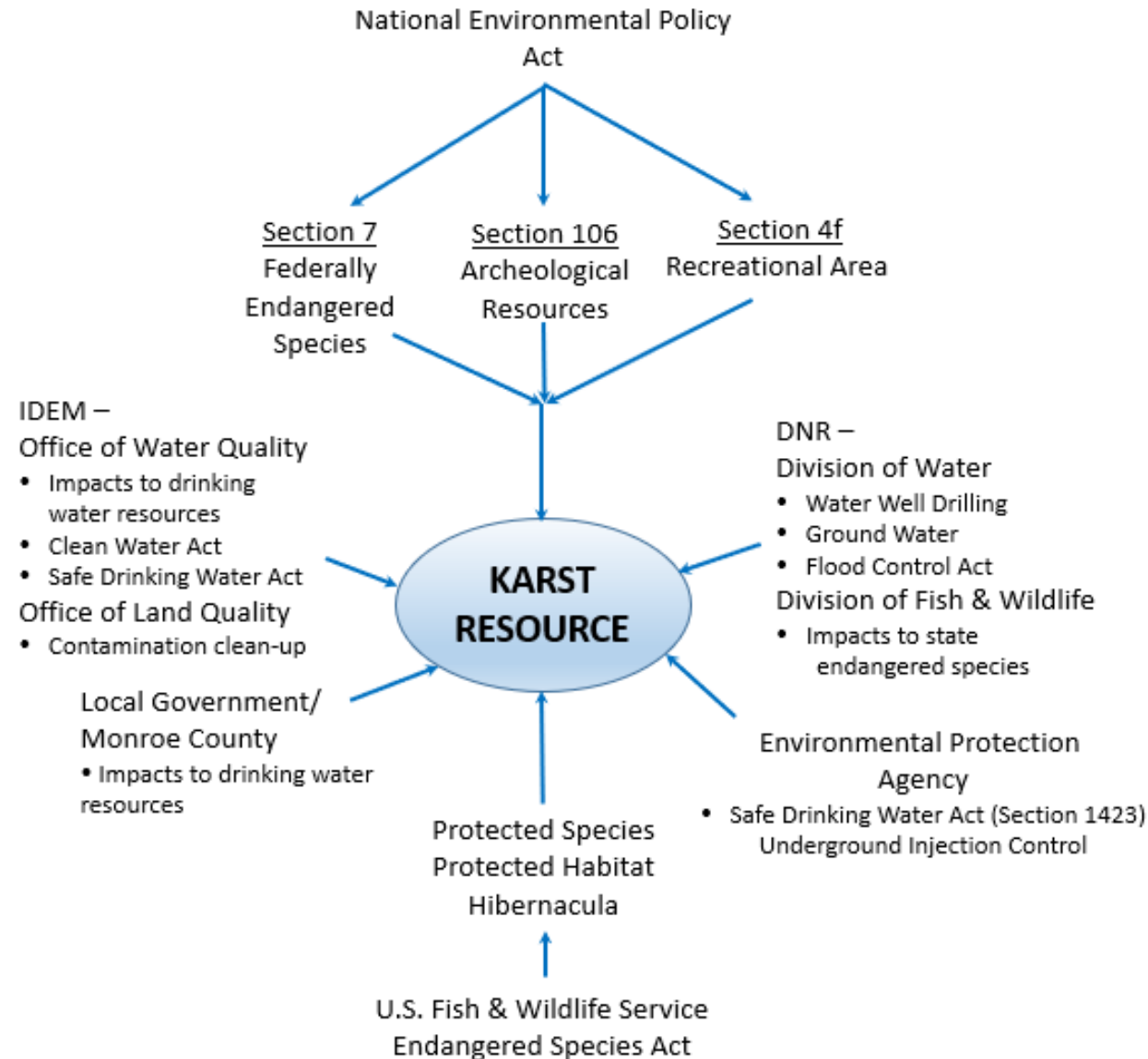


Figure 6. Typical sinkhole treatment concrete cap
Source INDOT

Legal Protection of Karst Resources



History

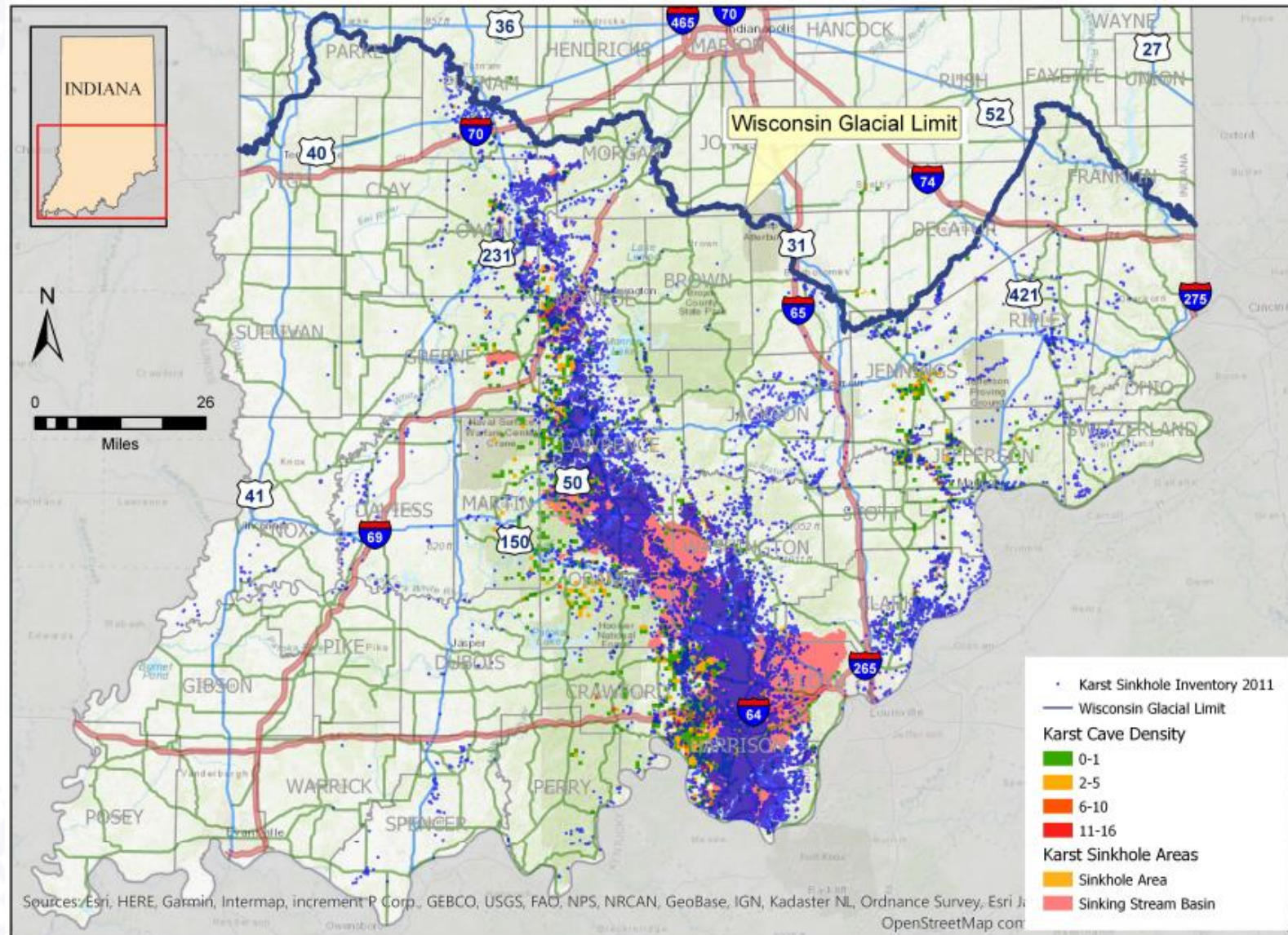
- 1993 Memorandum of Understanding
 - Replacement did not require approval of agency signatories
 - Applicability to karst resources outside of designated area unclear
 - Not applicable to current procedures or resources
 - New MOU would require resigning every two years
 - Format not allow for detail
 - Difficult to modify



Purpose

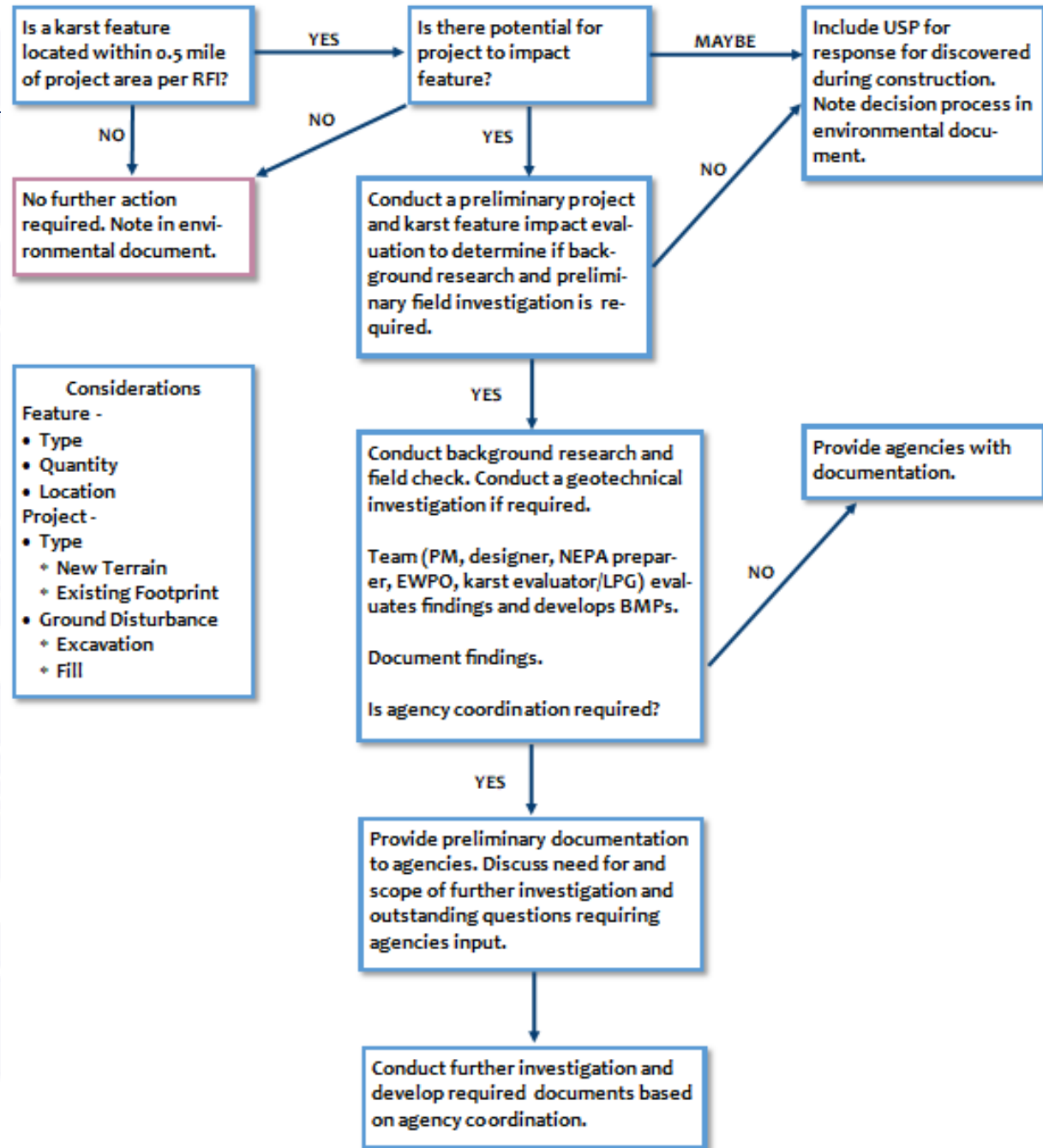
- Provide guidelines for the construction and maintenance of transportation facilities in karst regions of the state.
- Cooperate in the identification, study, and treatment of drainage in karst regions related to the construction and maintenance of transportation projects.
- Ensure the transportation needs of Indiana are met in an environmentally sensitive manner that protects the habitat of all species.
- Support use of design and construction practices that protect groundwater quality, public health and safety, and the environment from degradation.

Indiana Karst Region



Procedure

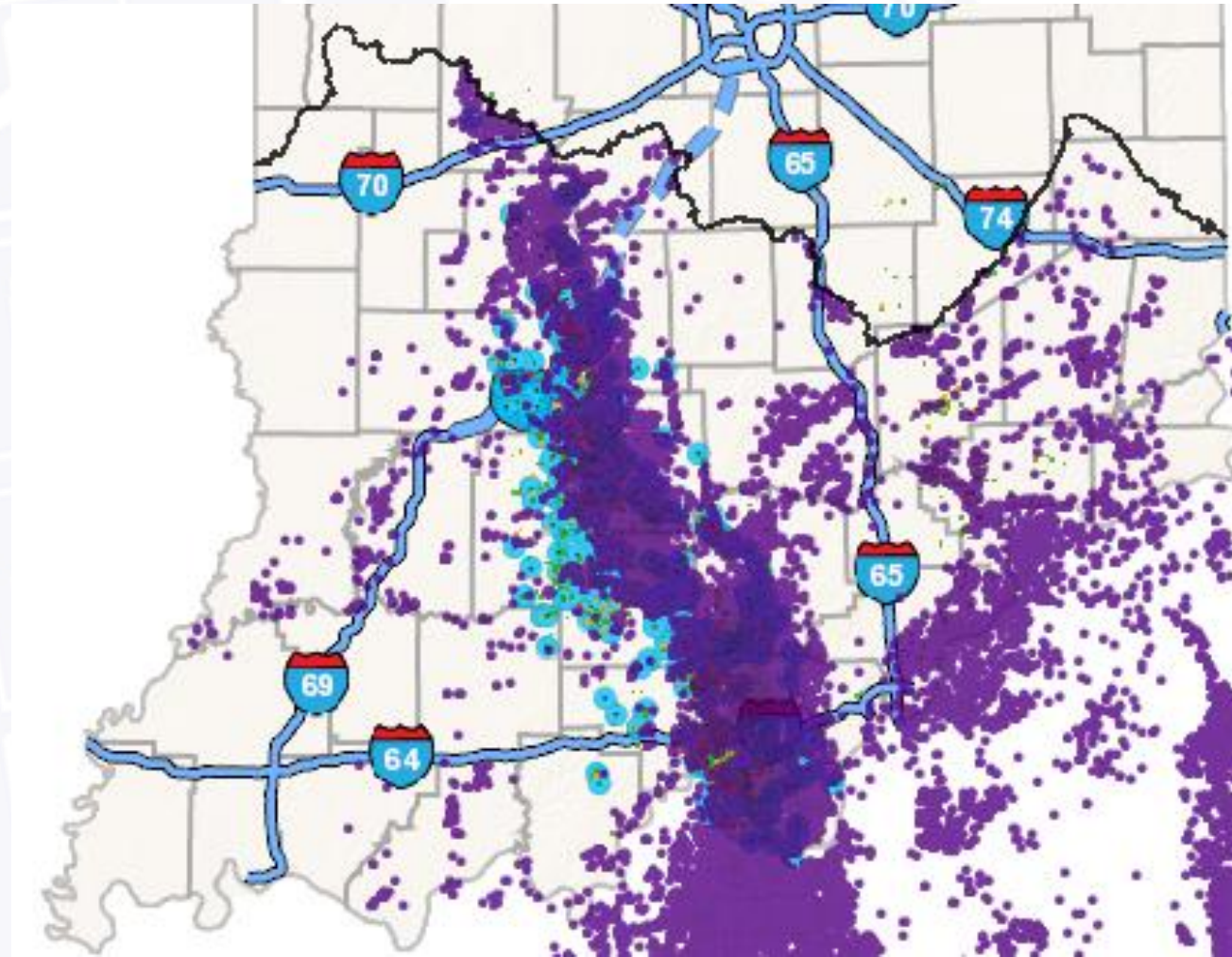
- Timing of karst analysis vs RFI
- Check location vs karst features in GIS
- Large portion of area should drop as “No”
- Other projects automatic “Yes”
- In between?



Procedure

Is project within 0.5 mile of a karst feature?

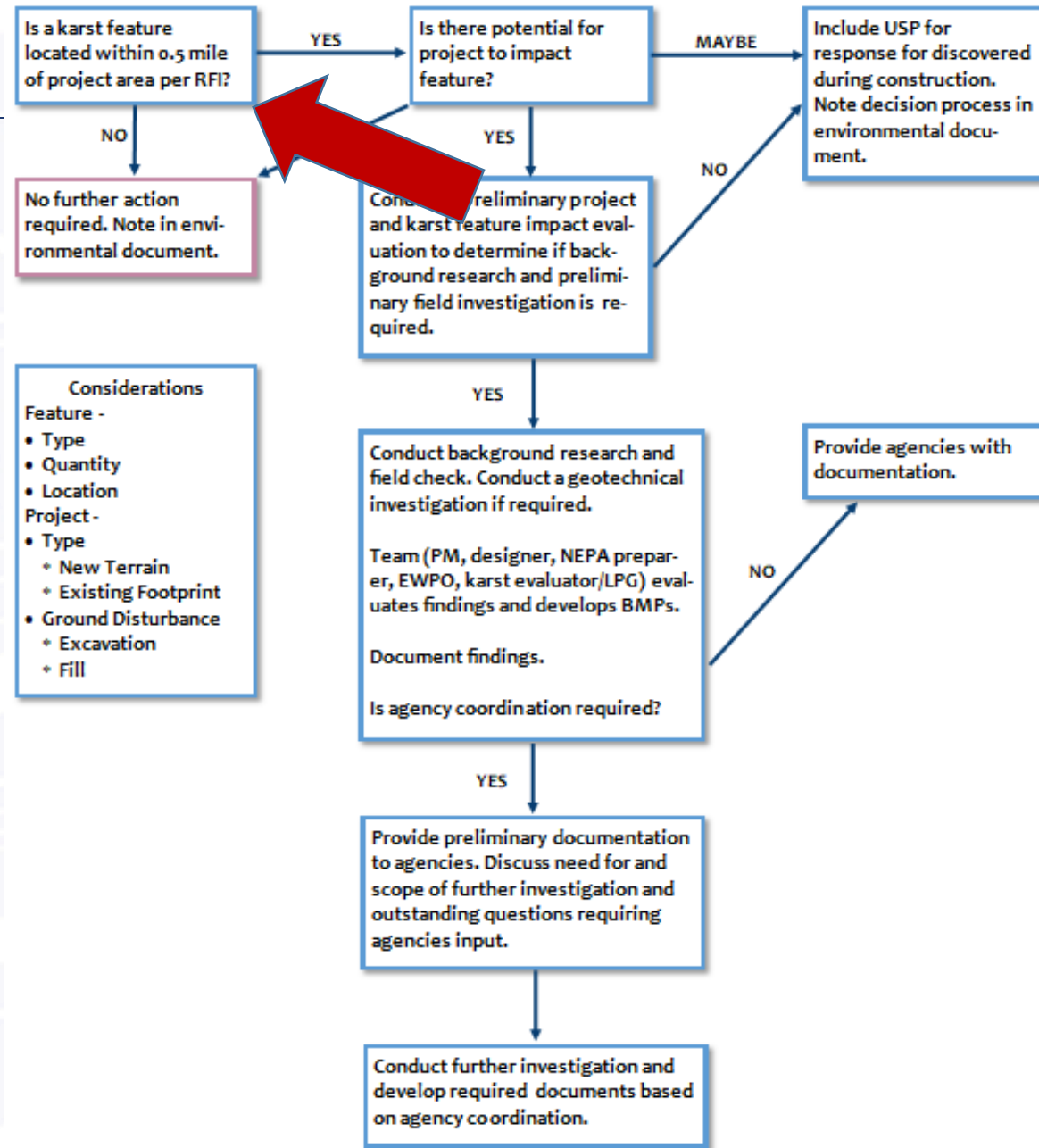
- GIS Layers
 - Sinkholes
 - Springs
 - Cave Density



Procedure

Is project within 0.5 mile of a karst feature?

- GIS Layers
 - Sinkholes
 - Springs
 - Cave Density
- **No** – No further action, note in environmental document
- **Yes** – Is there potential for project to impact feature?



Procedure

- Is there potential for project to impact feature?
- **Maybe** – Include USP

USP

DISCOVERY OF KARST FEATURES

If unknown karst features are discovered during construction, all work within 100 feet of the feature shall stop and the Engineer shall be notified immediately. Karst features include, but are not limited to, voids, caves, sinking streams, springs, seeps, and sinkholes. The Department will provide the treatment measures to be incorporated for the feature. The karst feature shall be protected from sedimentation runoff. Work shall not resume in the area until directed by the Engineer.

Procedure

Example -

- Small culvert replacement w/ down channel storm sewer to prevent flooding
- North of structure - karst cave area
- Analysis –
 - Caves located in hilly area above culvert
 - Excavation required for new culvert would be like existing
 - No karst features on record for storm sewer portion
 - Potential to locate karst with new sewer excavation
 - USP required

Procedure

- Is there potential for project to impact feature?
- **Yes** – Does impact evaluation determine that additional background research and preliminary field investigation is required?

Considerations

Karst Feature –

- Type
- Quantity
- Location

Project –

- Type
 - New Terrain
 - Existing Footprint
- Ground Disturbance
 - Excavation
 - Fill

Procedure

- Does impact evaluation determine that additional background research and preliminary field investigation is required?
- **No** - Include USP

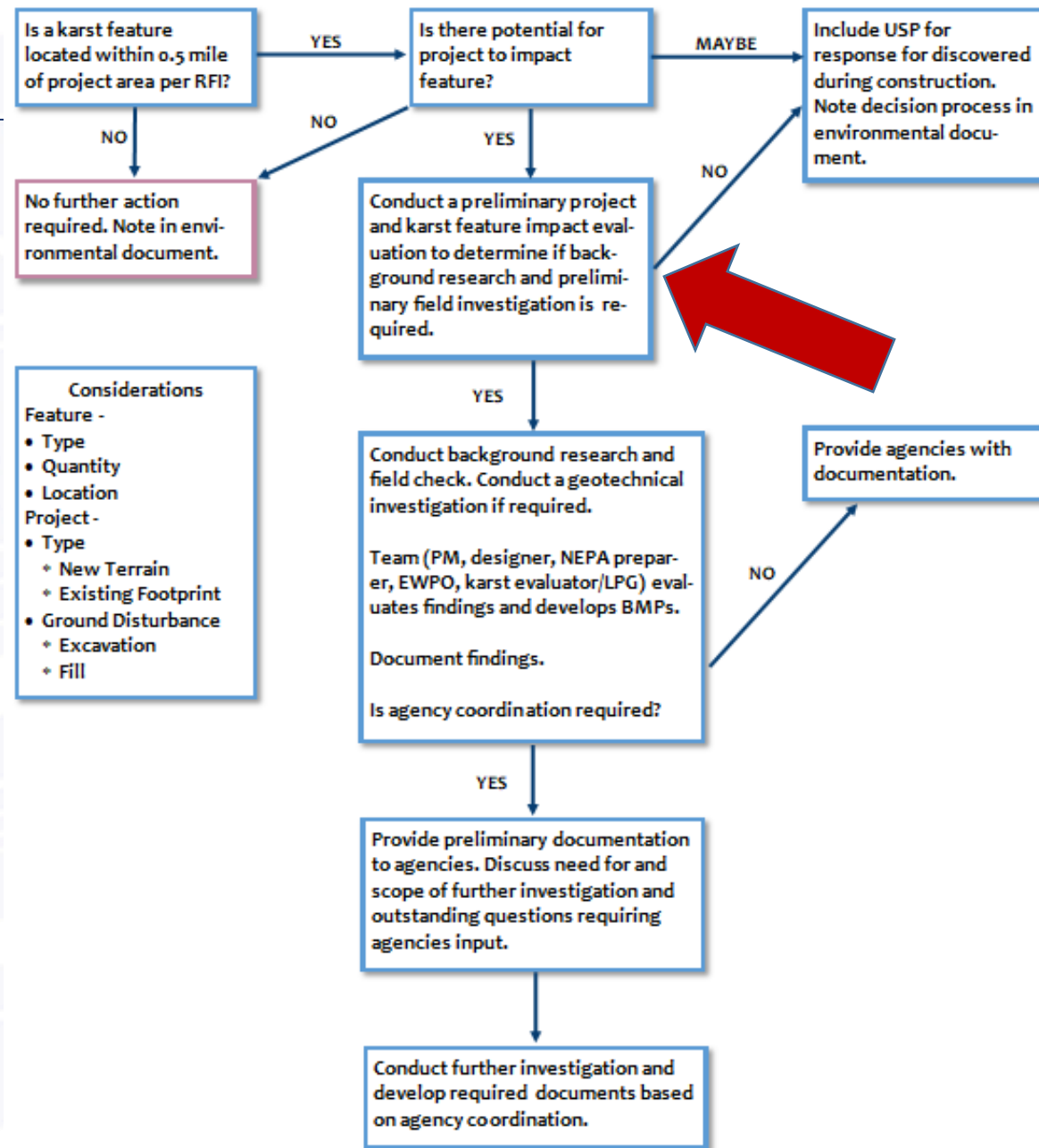
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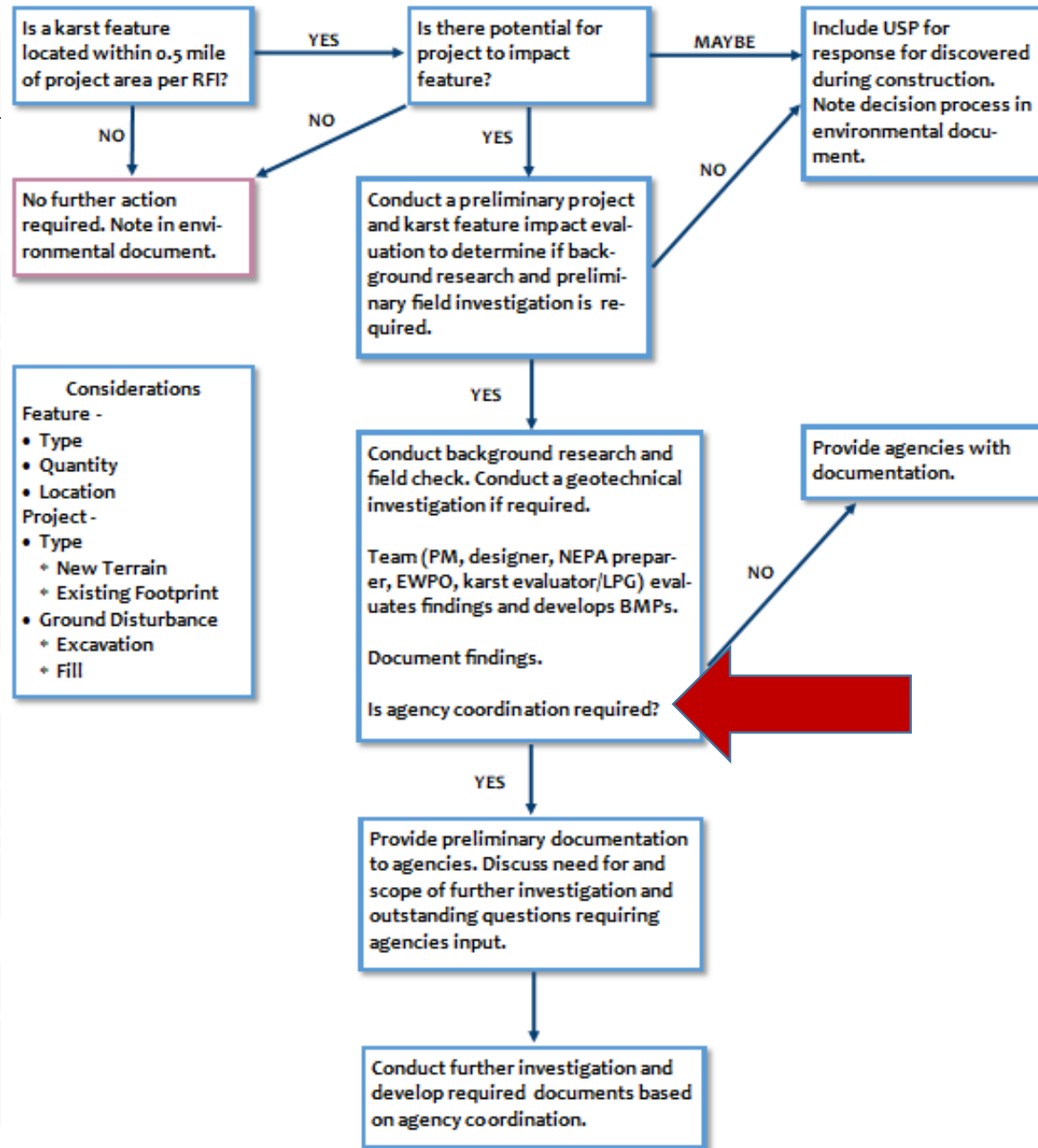
Procedure

- Does impact evaluation determine that additional background research and preliminary field investigation is required?
- **Yes** – Conduct additional work



Procedure

- Is agency coordination required?
- **No** – provide agencies with documentation
- **Yes** – provide agencies preliminary documentation, discuss, determine additional action required
- Implement guidance and finalize document



Discovery During Construction – US 50 Beaver Creek

- Mitchell Plateau
- Pre-Construction
 - Karst Reconnaissance Survey
 - Geotechnical Exploration
- Construction
 - Drill shaft into void
 - Work stopped
 - Void investigated with camera by LPG
 - Void not karst
 - Drilled adjacent (w/in 3 ft) shaft, void not present
 - Void filled with concrete and shaft redrilled

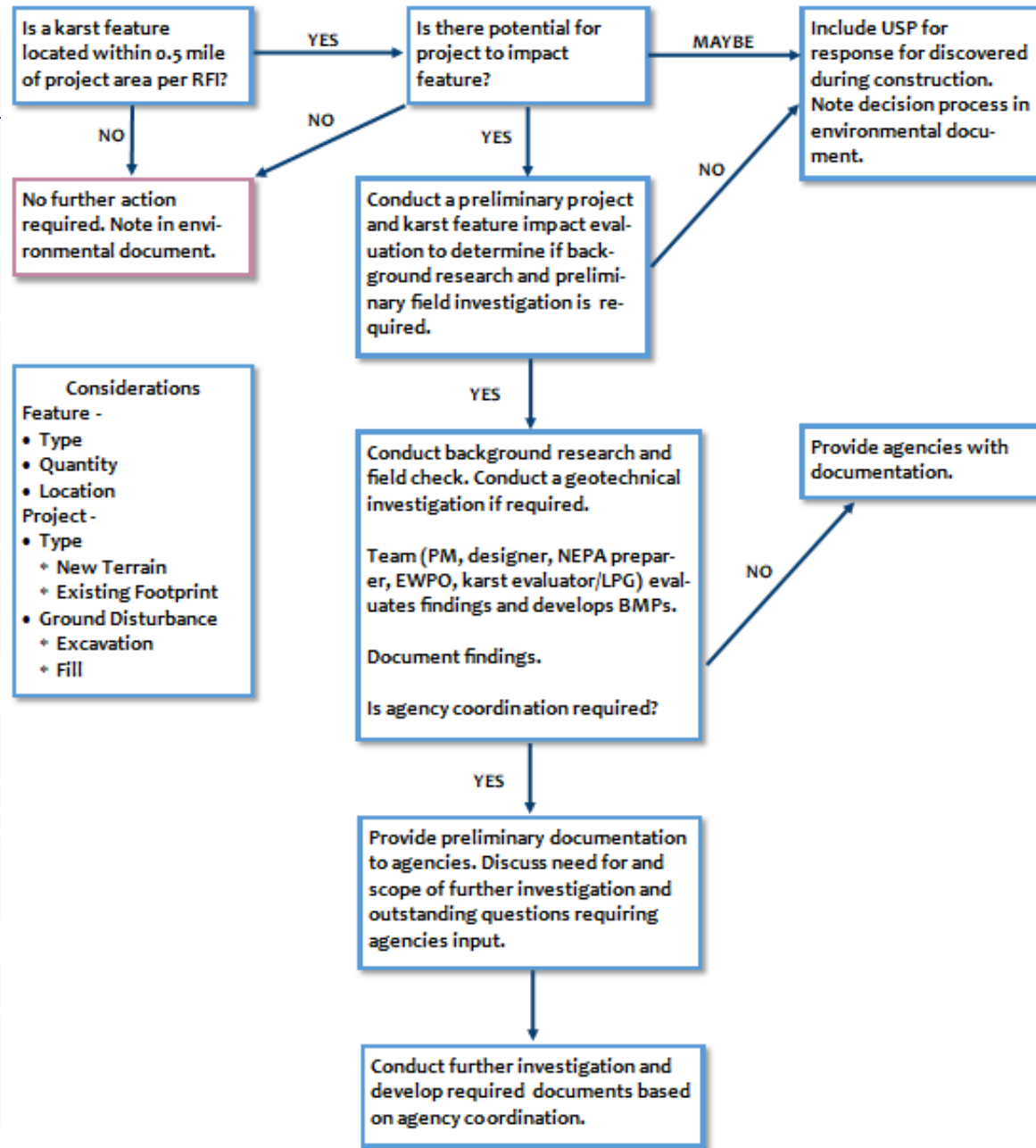
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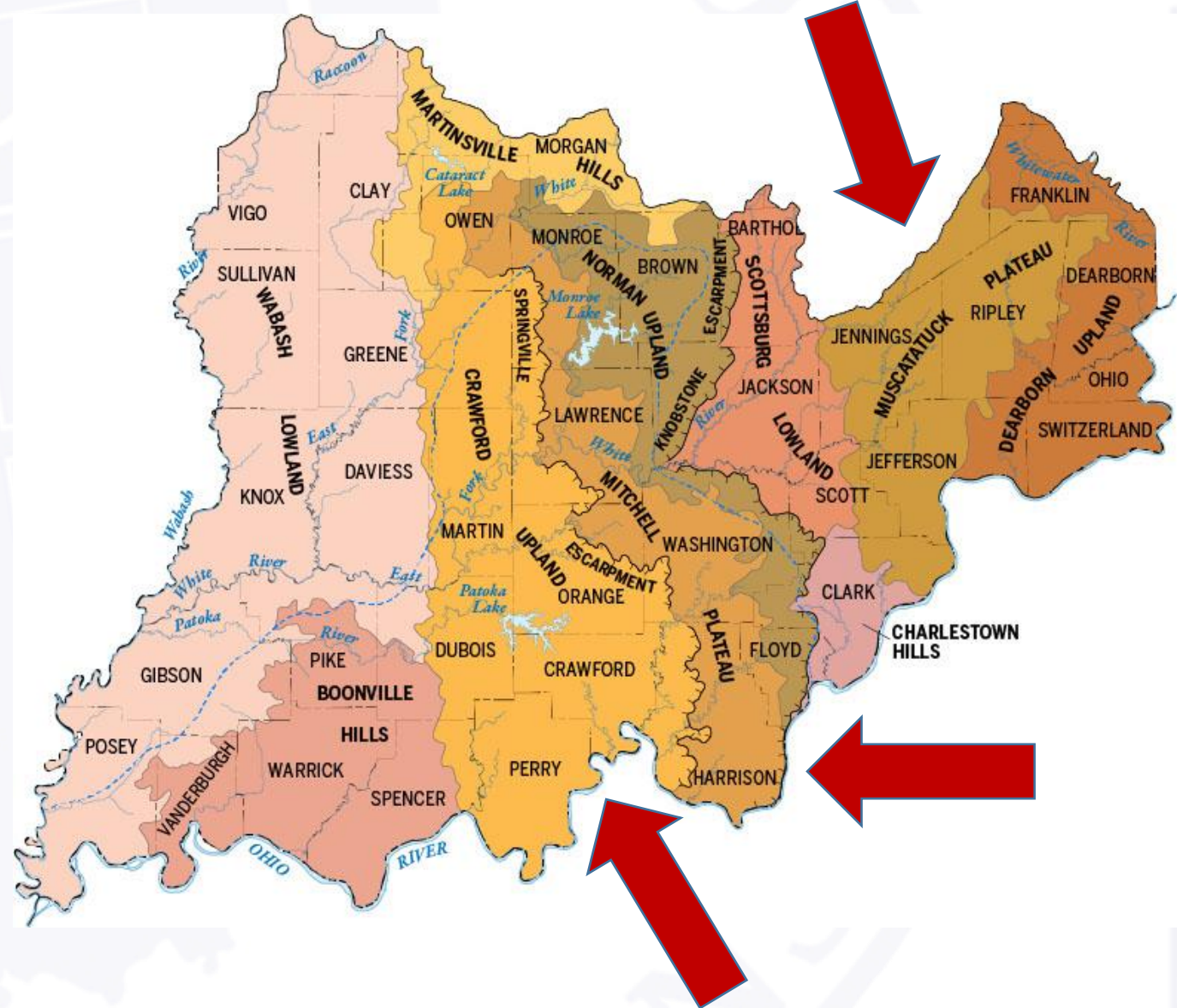
Procedure

- Agency coordination
 - Why not earlier?
- Coordinating agencies
 - USFWS
 - DNR
 - IDEM
 - EPA?
- Other
 - IGWS
 - Indiana Cave Survey
 - Indiana Karst Coalition



Karst and IPaC

- Major Karst Region – too broad
- IPaC question #9 – Is a project located in a karst area?
- “Yes,” if in following physiographic Regions
 - Crawford Upland
 - Mitchell Plateau
 - Muscatatuck Plateau



Other Included Topics

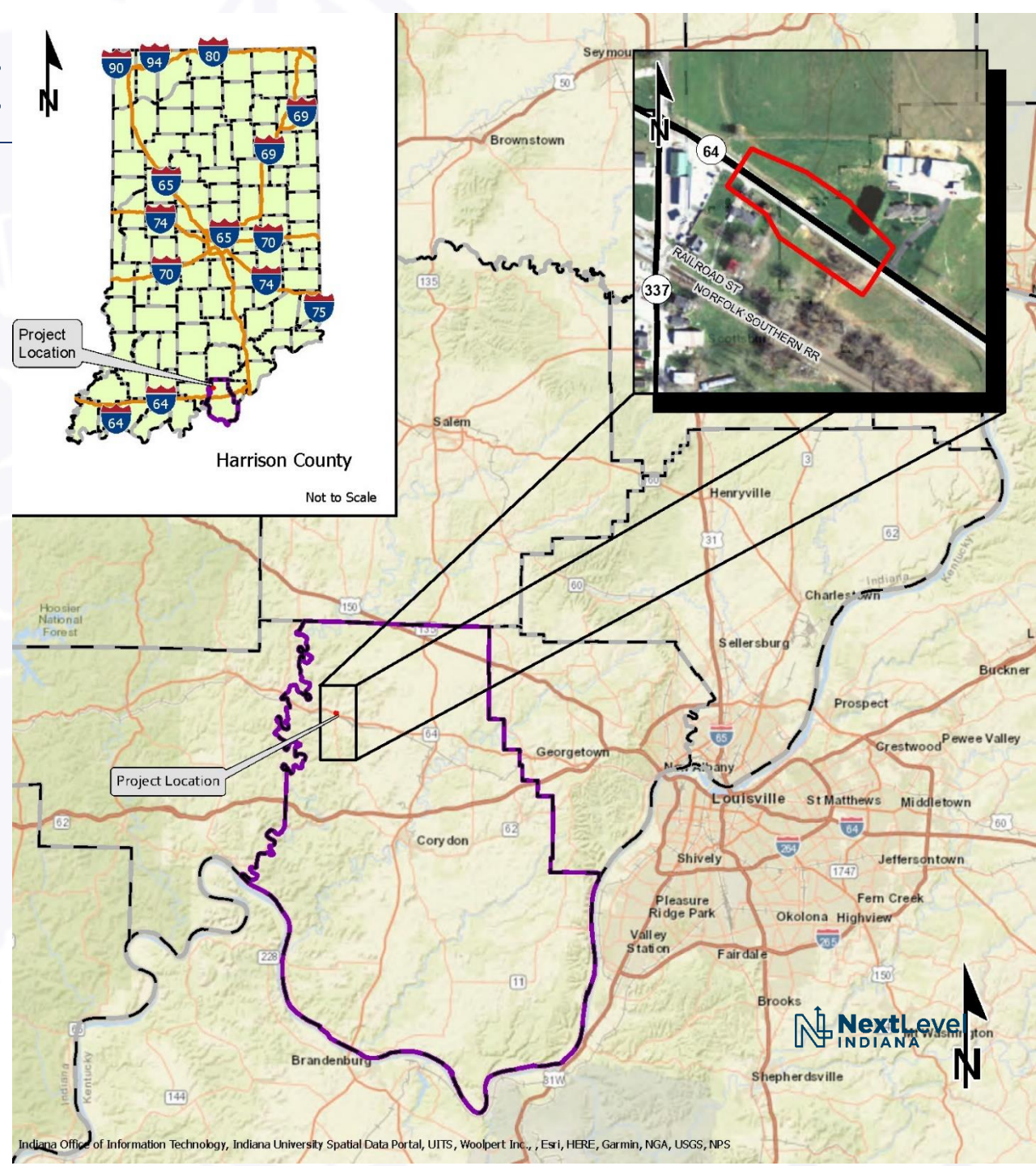
- Best management practices
 - Feature types and use
 - Table
- Accidental discovery
- Karst and INDOT maintenance
 - Road salt
 - Vegetation management
 - Signage
- Glossary
- Karst geology
- Karst biology



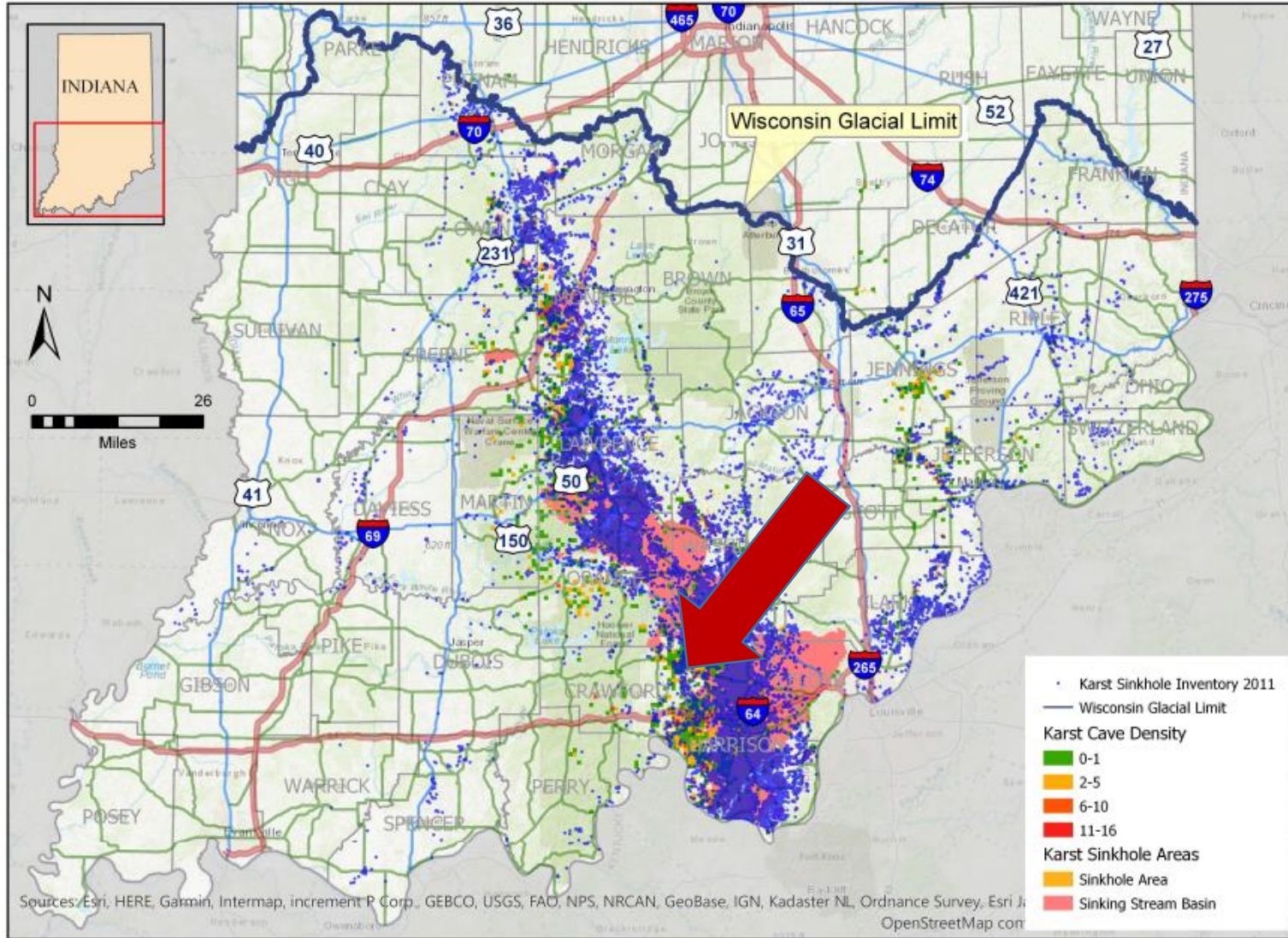
Rock ring U.S. 50 North Vernon Bypass

SR 64 Bridge Replacement

- Des. No. 1900066, INDOT Seymour District
- Location – Depauw, IN, Harrison County
- 0.11 mile east of SR 337
- Project scope:
 - Replace existing bridge
 - Install guardrail
 - Relocate drainage feature south of SR 64
 - Install riprap at base of bridge and along road slope



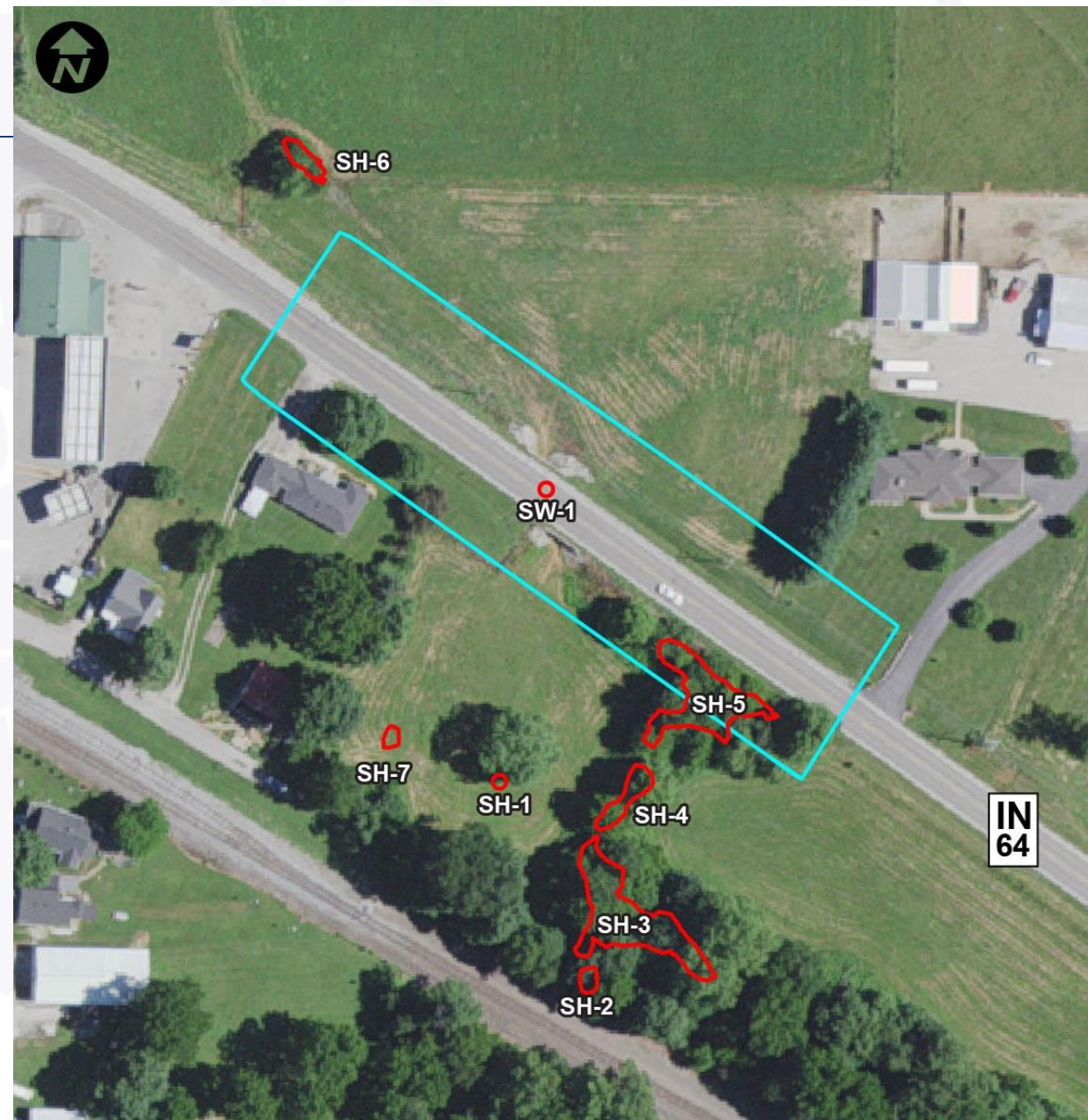
SR 64 Bridge Replacement



- Desktop Review/Initial Field Visit
 - Mapped sinkhole area
 - Crawford Upland/Mitchell Plateau
 - Bedrock of the Blue River Group
 - Depressions
 - Holes

SR 64 Bridge Replacement

- Coordinate with INDOT Ecology & Waterway Permitting
- Karst Survey by Hydrogeology Inc.
- Results
 - 104 potential sinkholes within 0.5 mile (Lidar)
 - Survey area – 7 sinkholes, 1 swallet, 1 sinking stream basin
 - Sinking stream basin drainage area – 1,500 acres
 - Dye trace link to Harrison Spring (largest spring in IN, historically significant)

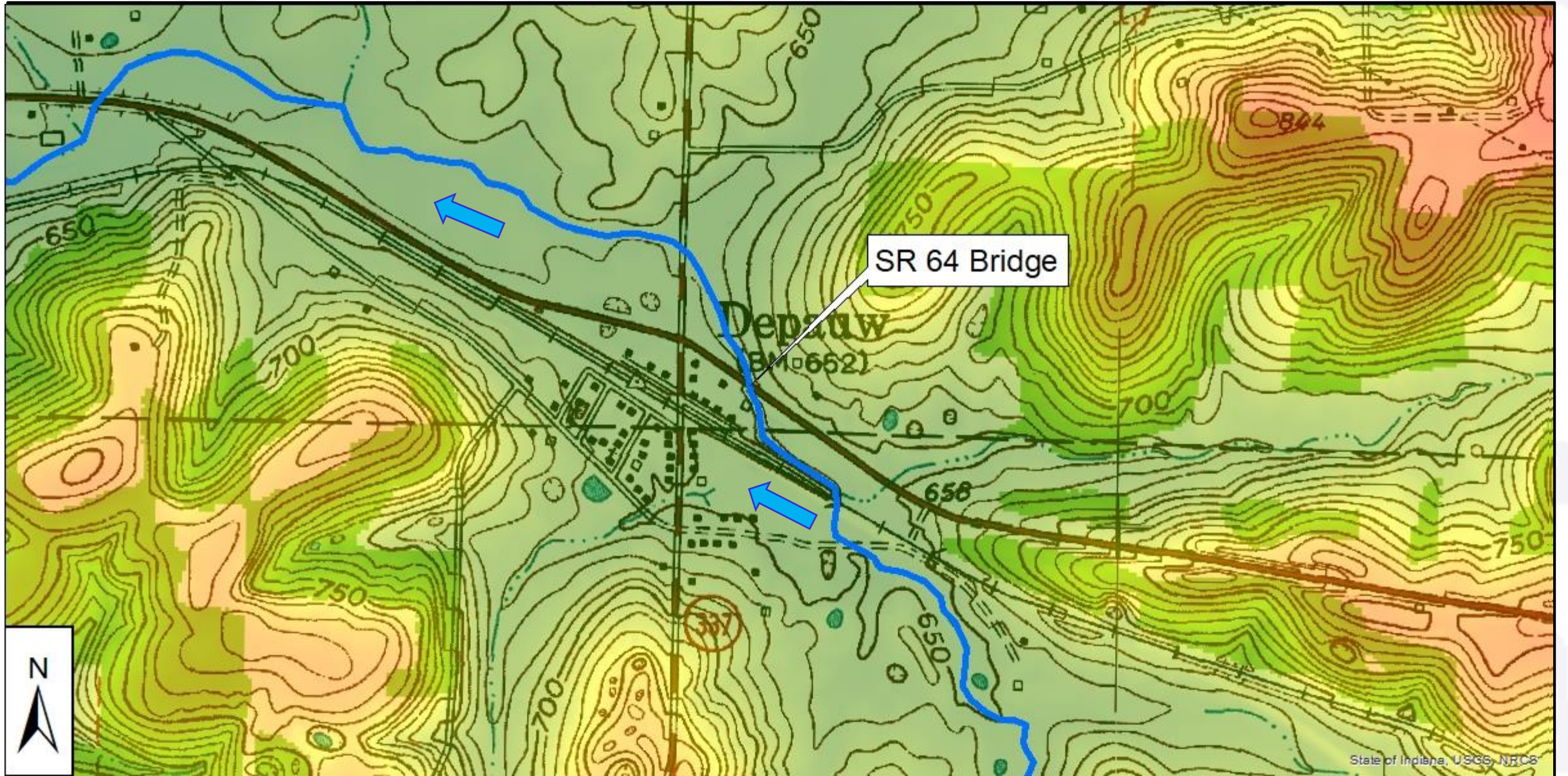


SR 64 Bridge Replacement



- Karst Treatment Recommendations
 - Dye trace sinking stream basin
 - SH-5: A karst expert should be present during any excavation work. If any voids are identified, it should be treated with an aggregate or concrete cap depending on its location relative to the road
 - Erosion and sediment control measures should be in place to protect karst features
 - Discovery of Karst Features USP
 - Treatment of stormwater runoff to karst features

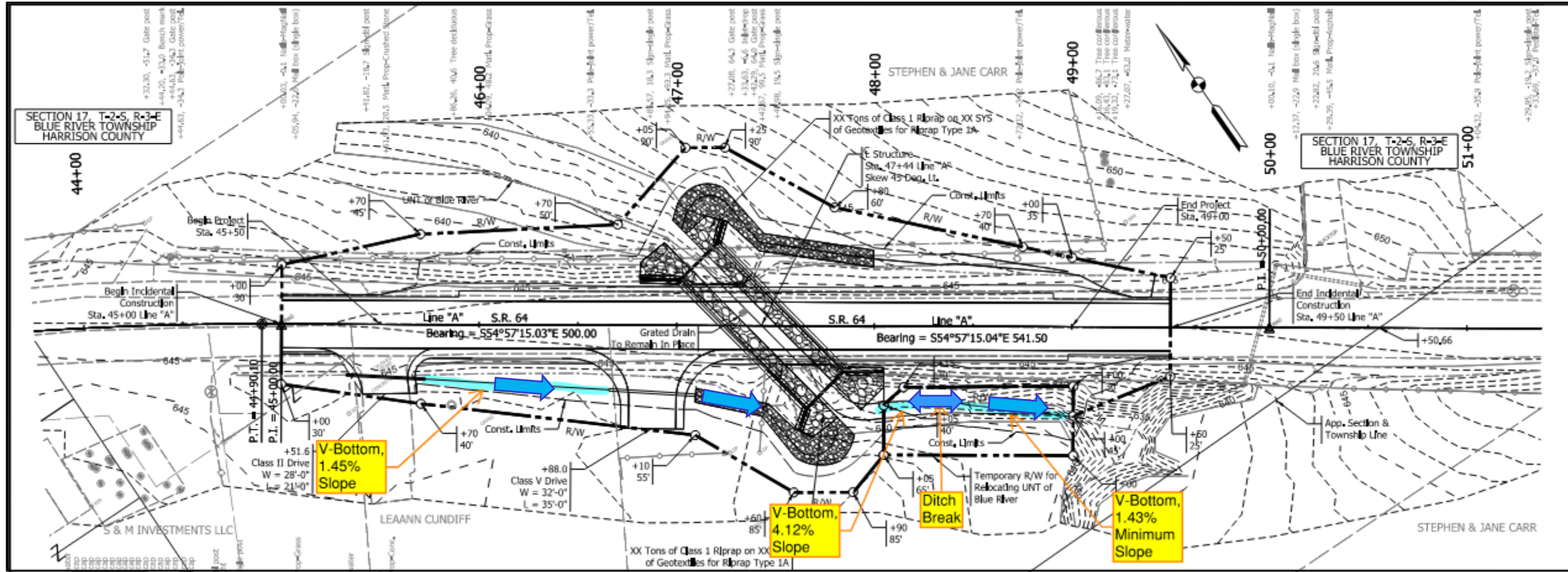
SR 64 Swale Design – Flow Patterns



SR 64 Swale Design – Local Flow Patterns

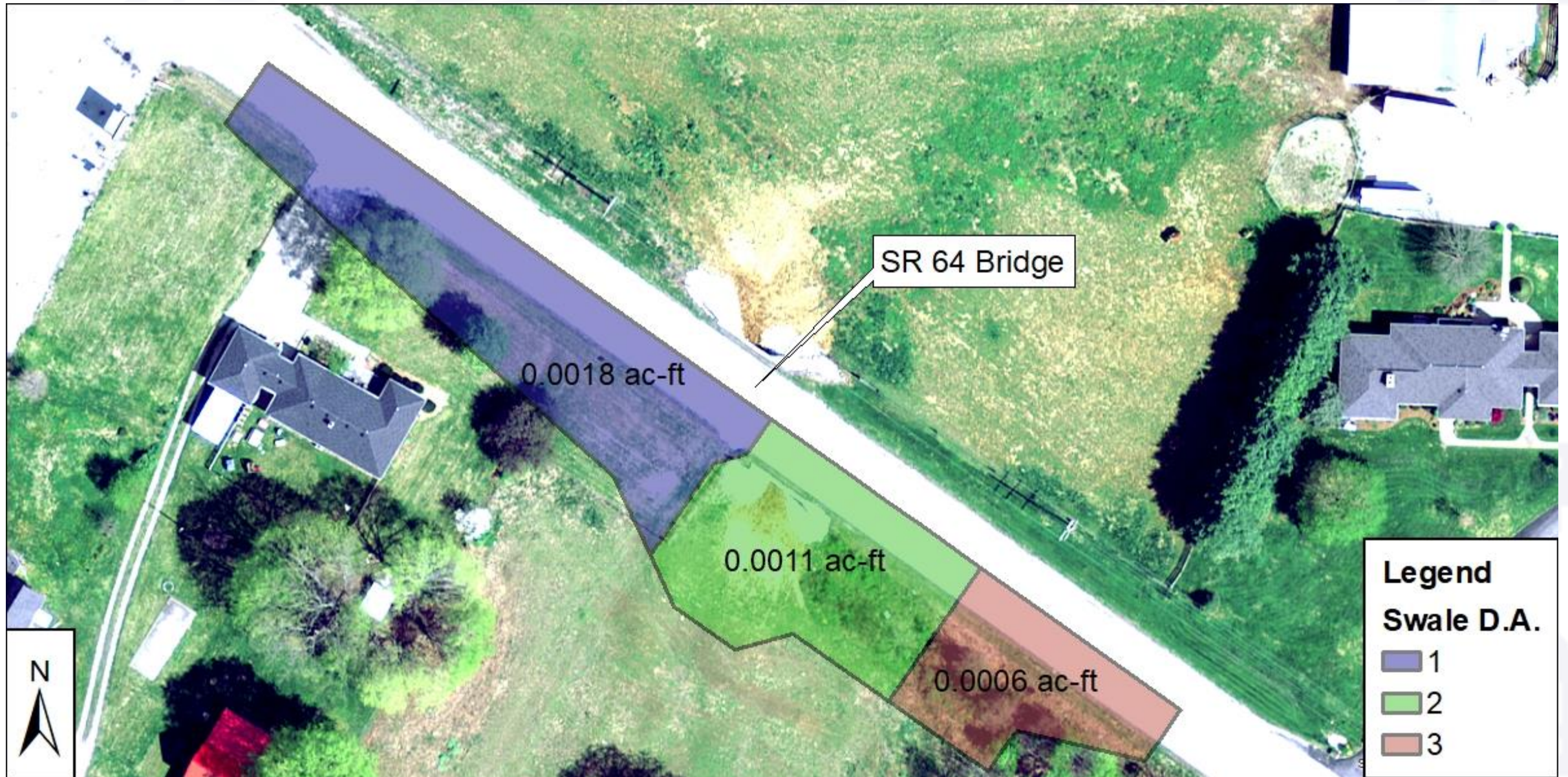


SR 64 Swale Design – Stage 1 Swale Geometry



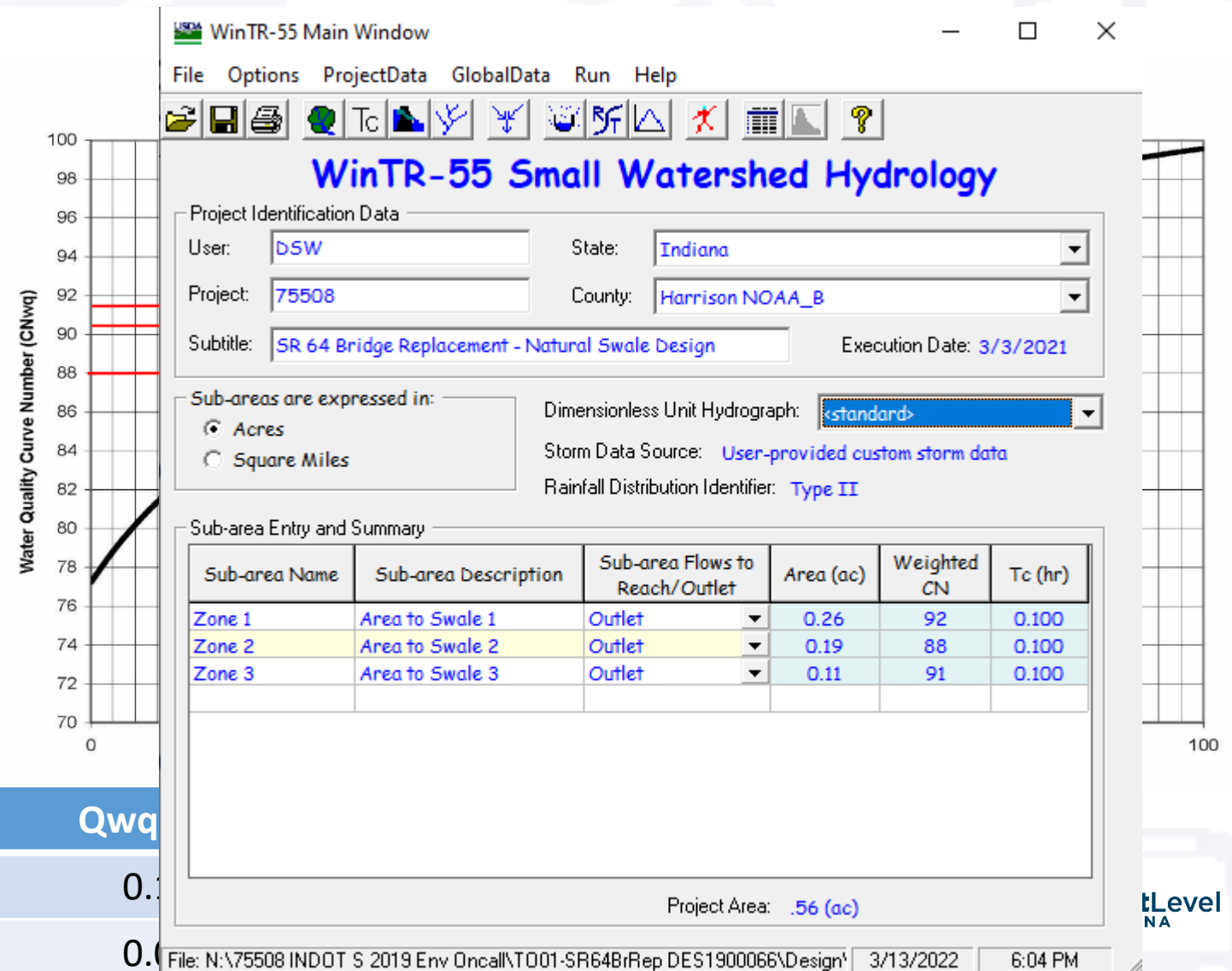
Goal: Redesign swales to act as Post-Construction Stormwater BMPs.

I-64 Swale Design – Water Quality Volume



I-64 Swale Design – Water Quality Treatment Rate

- Graphical method for CNwq
- TR-55 method for Tc
- WinTR-55 to model runoff
 - NRCS Type II rainfall distribution
 - 1 inch of rainfall
- Water Quality Treatment Rate, Qwq



Swale	CNwq	Tc (hr)	Qwq
1	92	0.10	0.1
2	88	0.10	0.0
3	91	0.10	0.06

I-64 Swale Design – Hydraulic Analysis

- Maximize Hydraulic Residence time during Water Quality Event and minimize impact to right-of-way
- Hydraulic Residence Time, Tahr

$$Tahr = (Lswale \div Vwq) \div 60$$

Where:

Lswale = Length of swale, feet

Vwq = Flow velocity during Water Quality Event, ft/s

FlowMaster CONNECT Edition

Worksheet: Swale 1

Solve For: Normal Depth

Friction Method: Manning Formula

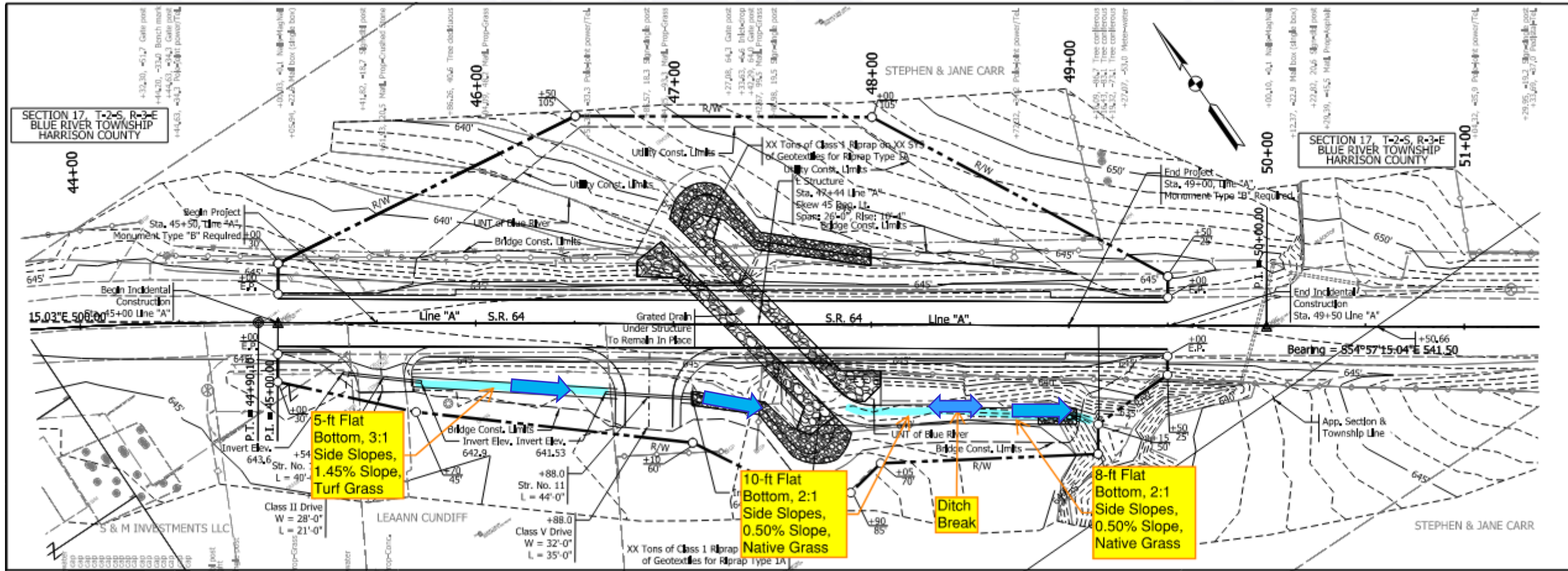
Roughness Coefficient:	0.150		Flow Area:	0.6	ft ²
Channel Slope:	0.015	ft/ft	Wetted Perimeter:	5.7	ft
Normal Depth:	1.4	in	Hydraulic Radius:	1.3	in
Left Side Slope:	3.000	H:V	Top Width:	5.68	ft
Right Side Slope:	3.000	H:V	Critical Depth:	0.4	in
Bottom Width:	5.00	ft	Critical Slope:	1.046	ft/ft
Discharge:	0.16	cfs	Velocity:	0.27	ft/s
			Velocity Head:	0.00	ft
			Specific Energy:	0.11	ft
			Froude Number:	0.144	
			Flow Type:	Subcritical	

Calculation Successful.

Swale	Lswale (ft)	Vwq (ft/s)	Tahr (min)
1	145	0.27	9
2	60	0.11	9
3	60	0.11	8

Water depth during Water Quality Event must be at or below the height of vegetation in the swale

I-64 Swale Design – Modified Proposed Geometry



Questions

- Protection of Karst Features During Project Development and Construction
- Contact Information
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