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# 3.23 KARST IMPACTS

## 3.23.1 Introduction

The following substantive changes have been made to this section since the Draft Environmental Impact Statement (DEIS) was published:

- Impacts for Alternative R and Refined Preferred Alternative P (RPA P) have been added.
- Footnote one has been updated for clarity.
- Text edits in sections 3.23.3.1 and 3.23.3.3 have been included for clarity.

Karst areas have special issues with regard to water quality, threatened and endangered cave obligate species, recreation, construction and mineral resources. Karst refers to "landscapes characterized by caves, sinkholes, underground streams, and other features formed by the slow dissolving, rather than mechanical eroding of bedrock" (Neuendorf, K. E., 2005). Karst in Southern Indiana has been studied and its features mapped for more than 150 years (Owen, 1862). Karst was important in alternative selection for preliminary alternative development and alignment refinements. Extensive karst data and mapping have been compiled by the Indiana Geological & Water Survey as an important component of their GIS datasets. This mapping is being used for the Mid-States EIS. See **Appendix X – Geographical Information System Technical Documentation** for details.

Karst forms as water and carbon dioxide combine to form carbonic acid in the atmosphere and soil. Carbonic acid dissolves carbonate and evaporite bedrock. Limestone is the principal carbonate bedrock type, along with dolomite, found in the Indiana karst.

Karst areas within the Mid-States alternatives occur predominantly in the Crawford Upland and Mitchell Plain physiographic regions. Alternatives M and O in Lawrence, Orange and Martin counties are proximate to extensive areas of karst. Karst is rare in Daviess and Dubois counties. Additional discussion of impacts to karst ecosystems and water quality can be found in **Section 3.16 – Threatened and Endangered Species, Section 3.20 – Groundwater Impacts, Section 3.21 – Forest Impacts and Section 3.22 – Mineral Resource Impacts**. Maps showing the karst features, such as sinkhole areas and sinking-stream basins, cave openings densities and karst springs for each alternative are included in **Volume 3 – Environmental Atlas** of this DEIS. Additional details about the analysis of karst-related impacts presented in this section are provided in **Appendix Y – Karst Impact Analysis**.

## 3.23.2 Methodology

Potential impacts to karst features were analyzed using the project GIS. For each alternative, the working alignment was superimposed on GIS layers portraying karst-related features. These include layers depicting cave density, springs and dye tracings and sinkholes and sinking-stream basins. For details of use of the project GIS, see **Section 3.1 – Overview and Methodology** and **Appendix X**.

## 3.23.3 Analysis

Several figures in the following section depict the location of karst resources in the Study Area in relation to Alternatives B, C, M, O, P, RPA P and R. As noted above, these features are concentrated near Alternatives M and O in Lawrence, Orange, and Martin counties. Karst features are rare in Davies and Dubois counties.

The following subsections provide maps and a high-level discussion of the potential resource impacts presented in **Table 3.23-1**.

| Karst Impacts | | | | | | | |
|---|---|---|---|---|---|---|---|
| Alternatives* | Caves within 1 Km (#) | Dye Points (#) | Dye Line Crossings (#) | Springs (#) | Sinkholes (#) | Sinkhole Areas (acres) | Sinking Stream Basins (acres) |
| B | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| C | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| M | 28 | 4 | 3 | 2 | 55-57 | 388 - 398 | 86 |
| O | 21 | 0-2 | 8 - 10 | 1 | 22-36 | 78 - 158 | 235 - 307 |
| P | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RPA P | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| R | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

* Tier 1 Alternative impacts are reported in ranges including all the local improvements, facility types, and bypass variations. Facility type 1, freeways, has been removed from consideration. Therefore, no modifications to existing US 231 in Section 1 are anticipated.

**Table 3.23-1: Karst Resource Impacts by Alternative**

## 3.23.3.1 Caves

Alternatives B, C, P, RPA P and R are outside of karst areas and do not intersect with one square kilometer (0.39 square mile) IGS cave entrance density tiles. Alternatives M and O have 28 and 21 cave entrances respectively within one kilometer tiles intersecting their working alignment[1].

Sixteen cave entrances of significant size, known length > 100 feet, are within one kilometer of Alternative M[2]. Three of these cave entrances are located near Alternative M's planned interchange with SR 37.

Eighteen caves of significant size have entrances within one kilometer of Alternative O. Three of these cave entrances are proximate to Alternative O's planned interchange with SR 37. Three are proximate to the Orangeville Rise.

**Figure 3.23-1** shows cave entrance densities proximate to all alternatives.

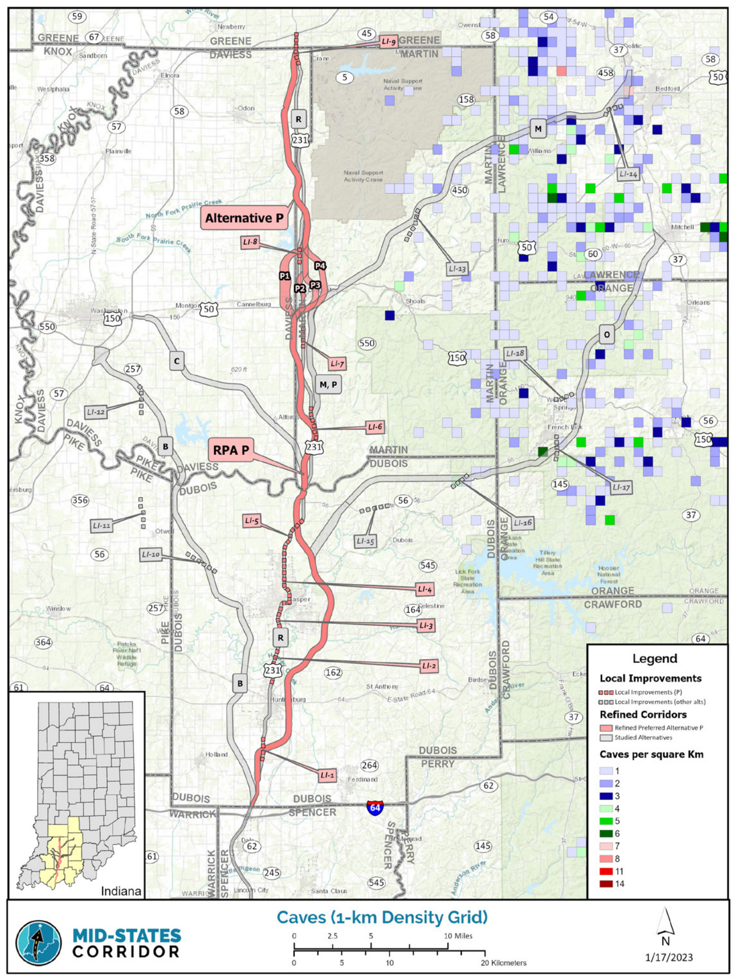


**Figure 3.23-1: Cave Density in Study Area**

1 Cave entrance density data provided by Indiana Geological and Water Survey records are compiled in metric units and are not available in English units. For reference, a kilometer is approximately 0.62 mile; a square kilometer is approximately 0.39 square mile. Caves were analyzed using a count of cave entrances that are documented in the Indiana Geological and Water Survey's (IGWS) one kilometer cave entrance density tiles and Indiana Cave Survey's (ICS) cave database within one kilometer of each working alignment.

2 Significant cave entrance data are provided by Indiana Cave Survey private records.

## 3.23.3.2 Spring and Dye Traces

Alternatives B, C, P, RPA P and R are outside of karst areas and do not impact any springs or dye traces[3]. Alternatives M and O impact nine Springs/Dye Traces and 13 Springs/Dye traces, respectively.

Three short dye traces link injection points on either side of SR 37 near the junction with Alternative M to springs that feed Salt Creek. Two dye traces link injection points near the junction of Alternative O with SR 37 to Bluespring Caverns, a commercial cave, and East Fork White River. Seven dye traces beginning on either side of and crossing Alternative O are linked to the Orangeville Rise.

**Figure 3.23-2** maps karst springs and dye tracings proximate to all alternatives. **Figure 3.23-3** pictures the Orangeville Rise, which has links to seven identified dye-tracing paths.

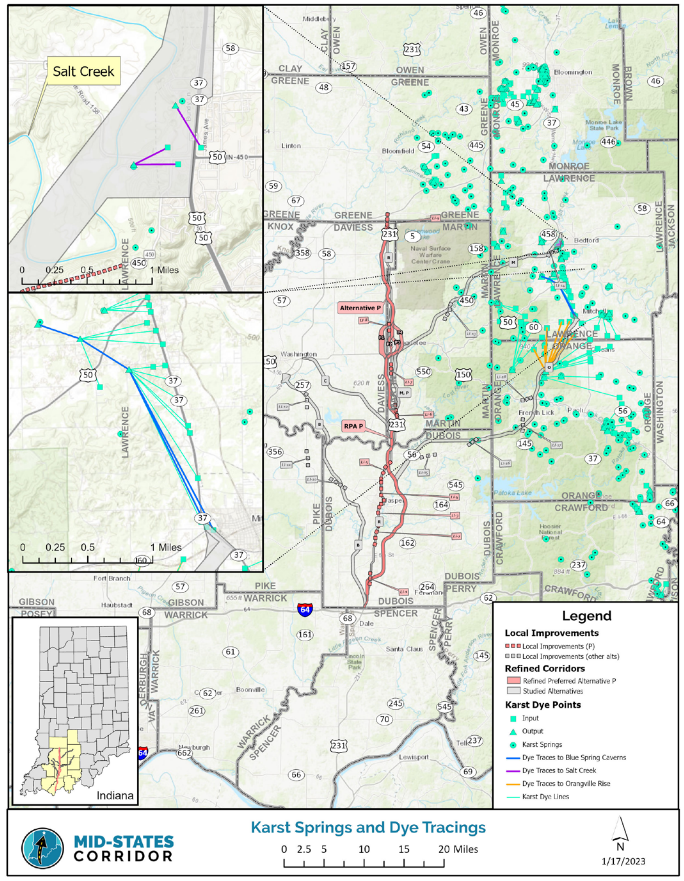


**Figure 3.23-2: Karst Springs and Dye Tracings in Study Area**

**Figure 3.23-3: Orangeville Rise National Natural Landmark**

## 3.23.3.3 Sinkholes and Sinkhole Areas

Alternatives B, C, P, RPA P, and R are outside of karst areas and do not impact any sinkholes[4] or sinkhole areas. Alternatives B, P and RPA P are outside of karst areas and potentially impact one mapped sinkhole for each alternative. These mapped sinkholes outside of the karst area are not anticipated to be karst sinkholes. Alternatives M and O impact[5] 55 to 57 sinkholes with 388 to 398 acres of impacts and 22 to 36 sinkholes with 78 to 158 acres of impacts, respectively. Sinkholes are concentrated where limestones of the Blue River Group are present at the surface. This generally occurs on the Mitchell Plain or where overlying bedrock has been eroded by rivers to expose Blue River Group limestones. The eastern portion of Alternative O is oriented north-northwest to skirt the border of the Blue River Group and West Baden Group. This limits the amount of the sinkhole-dense Mitchell Plain that it impacts. Alternative M is oriented east-northeast in its eastern half and traverses a large area of sinkhole-dense Mitchell Plain. This accounts for Alternative M's higher impacts to sinkholes.

3 A dye trace is an investigative tool used to identify groundwater flow paths. Fluorescent dye is introduced at a sinkhole and is detected on charcoal samples previously deployed in springs and streams. By determining where dye is detected, the approximate path of underground conduits are identified.

4 A sinkhole is a surface topographic depression in soil or underlying limestone bedrock associated with a karst drainage system.

5 The ranges of potential impacts for Alternatives M and O reflect the range of facility types and interchange/intersection types with SR 37.

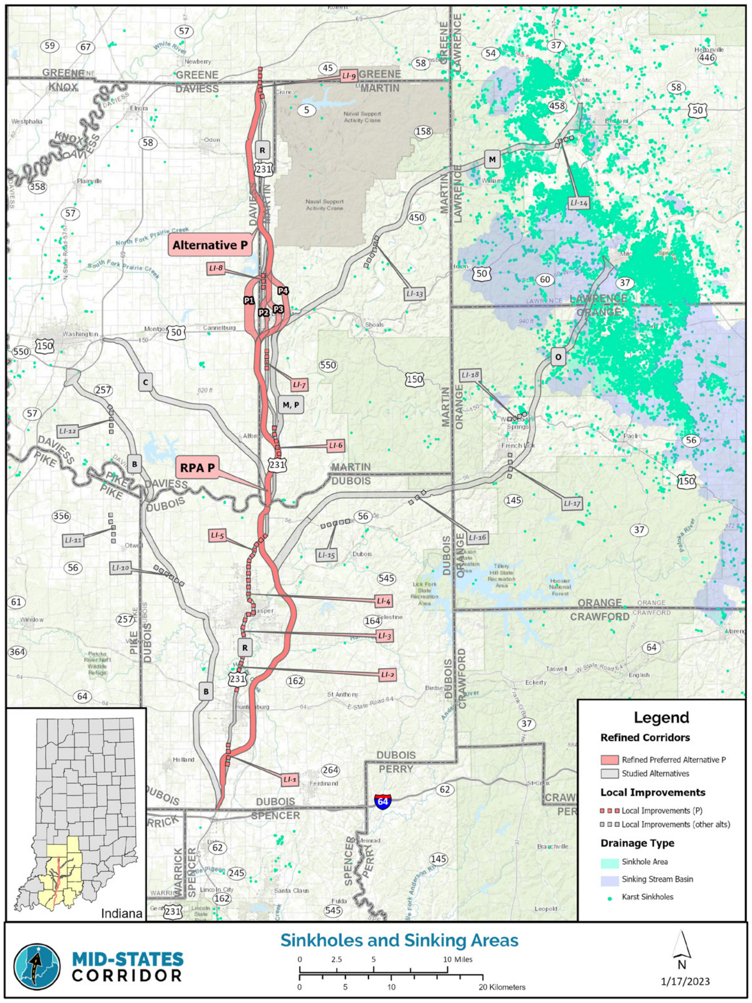


**Figure 3.23-4: Karst Sinkholes and Sinking Areas in Study Area**

**Figure 3.23-4** shows sinkhole and sinking stream basin areas (see **Section 3.23.3.4**) proximate to each alternative.

## 3.23.3.4 Sinking-Stream Basins

Alternatives B, C, P, RPA P and R are outside of karst areas and do not impact any sinking stream basins[6]. Alternatives M and O impact 86 acres and 235 to 307 acres of sinking-stream basins, respectively. Along Alternatives M and O, sinking-stream basins often occur where streams form on slopes dominated by bedrock not prone to the formation of karst. The streams then flow towards areas where karst-forming bedrock and sinkholes are present at the surface. At that point they sink into the ground. Alternative O skirts the border between the Crawford Upland and the Mitchell plain. Streams that develop in the uplands tend to flow towards and sink into the Mitchell Karst Plain. **Figure 3.23-4** depicts sinking stream basin areas proximate to each alternative.

The Lost River is an important sinking stream in the vicinity of Alternative O. In Orange County, the Lost River disappears into sinks in its bed and flows through underground karst passages. It re-emerges into a dry channel eight miles downstream. During high flow events, underground passages are filled to capacity and water is forced to flow in the typically dry surface channel. The Lost River intersects Alternative O approximately 1.8 miles north of US 150 northeast of West Baden Springs. Several karst features associated with The Lost River are locally and nationally recognized representatives of a unique karst landscape. **Appendix Y** includes a figure depicting the Lost River and associated karst features.

The Orangeville Rise, a National Natural Landmark[7], is a karst groundwater-fed spring and a tributary of The Lost River. **Figure 3.23-3** depicts water rising from the Lost River System below the Mitchell Karst Plain. The Orangeville Rise is 0.3 mile southeast of Alternative O and five miles north of West Baden Springs. Seven dye trace lines that cross Alternative O have been traced to The Orangeville Rise. This indicates that surface waters recharging along Alternative O contribute to spring flow at The Orangeville Rise.

6 A sinking stream basin is a geomorphic closed depression or blind valley in limestone bedrock with a surface channel that sinks into the karst system.

7 National Natural Landmarks are recognized by the National Park Service to encourage conservation of outstanding geological and biological resources.

**Figure 3.23-5: Wesley Chapel Gulf National Natural Landmark**

**Figure 3.23-6: Tolliver Swallow Hole**

**Figure 3.23-5** shows the Wesley Chapel Gulf, a National Natural Landmark. It is an oval shaped, steep walled depression formed through the expansion and merger of several adjacent sinkhole collapse features. As with the Orangeville Rise, water at this location rises from the Lost River System below the Mitchell Karst Plain. This is a unique window into the underground network of the Lost River. Wesley Chapel Gulf is two miles east of the Orangeville Rise and 1.6 miles southeast of Alternative O.

**Figure 3.23-6** depicts the Tolliver Swallow Hole. This is a prominent sink along the surface channel of the Lost River through which water enters the subterranean Lost River System.

## 3.23.4 Mitigation

A mitigation plan for karst impacts will be further detailed in Tier 2 NEPA studies. It will be based upon *Protection of Karst Features during Project Development and Construction* (INDOT, July 2021). The focus of karst mitigation is maintenance of the quality and quantity of water entering karst features and maintenance of flow exiting karst features. Minimization of changes in water quantity and quality protects cave fauna and reduce potential destabilization caused by changing flow paths and volume. Mitigation measures include but are not limited to installation of vegetative buffers, construction of lined spill and runoff containment structures, filter strips and aggregate caps and plugging.

## 3.23.5 Summary

**Table 3.23-1** shows that Alternatives B, C, P, RPA P and R have no or negligible direct karst impacts. Alternatives B, C, P, RPA P and R are equally preferrable due to their minimal karst impacts. Alternative M is proximate to 28 cave entrances, four dye points, three dye line crossings and two springs. Alternative O is proximate to 21 caves, 0 to 2 dye points, 8 to 10 dye line crossings and one spring. Alternatives M and O have karst impacts in all categories. The number of caves, dye points and springs on Alternatives O and M are approximately equivalent. Alternative M has significantly greater sinkhole impacts than Alternative O. By contrast, Alternative O has about three times the impacts to sinking stream basins as Alternative M. Sinking stream basins tend to concentrate more surface water than sinkhole areas. Karst impacts associated with either Alternatives M or O would require substantial additional agency coordination and field studies during Tier 2 to analyze karst impacts in detail. Additionally, there would likely be impacts to currently unidentified karst features, systems and karst obligate species which would be discovered during subsequent project development. This would require additional coordination for mitigation/treatment resolution. Mitigation guidelines to minimize harm to karst resources would be included as Tier 1 mitigation commitments to address these concerns. Additional discussion in **Appendix Y** compares karst impacts of Alternatives M and O.

The recommended preferred Alternative RPA P is outside of the limestone bedrock exposure area with karst development and is not anticipated to have karst impacts. Additional field evaluation will be conducted during Tier 2. The current INDOT Karst Procedures, *Protection of Karst Features During Project Development and Construction*, will be followed to fully evaluate potential karst impacts.