MID-STATES CORRIDOR

APPENDIX M – GROUNDWATER IMPACT ANALYSIS

Mid-States Corridor
Tier 1 Environmental Impact Statement

Prepared for

Indiana Department of Transportation

Mid-States Corridor Regional Development Authority

DECEMBER 22, 2021 *UPDATED FEBRUARY 11, 2023*

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INDIANA DEPARTMENT OF TRANSPORTATION INDOT

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Introduction

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

- Impacts for Alternative R and Refined Preferred Alternative P (RPA P) have been added.
- Impacts for Alternative B, C, M, O and P were updated.

The purpose of this section is to provide additional details regarding the potential groundwater impacts of project alternatives. The summary table, **Table 3.20-1**, in **Volume I, Section 3.20.3** provides an overview of potential groundwater impacts by range, the subsequent tables in this appendix isolate the impacts according to the extended alternative variations (e.g., Super-2 vs Expressway).

As described in **Section 3.20.1**, **Volume I**, the majority of the United States obtains its drinking water from groundwater supplies. Construction projects have the potential to impact both surface water and groundwater resources. Private residential wells may also be affected directly by nearby potential construction activities or potential construction activities up gradient (INDOT, 2011). Protection of groundwater, or underground water resources, is required by law and helps to ensure safe drinking, or potable, water supplies.

The 1974 Safe Drinking Water Act (SDWA), "was established to protect the quality of drinking water in the U.S. This law focuses on all water actually or potentially designed for drinking use, whether from above ground or underground sources." (EPA, "Summary of Safe Drinking Water," n.d.). The 1996 amendments to the SDWA, "require that EPA consider a detailed risk and cost assessment, and best available peer-reviewed science, when developing these standards." (EPA, "Summary of Safe Drinking Water," n.d.). The Indiana Department of Environmental Management (IDEM) is the state agency charged with implementing programs to comply with SDWA, as established with 327 IAC 8 Public Water Supply (IGA, 2021). To satisfy the requirements of the 1996 amendments to the SDWA, IDEM has developed and instituted a Source Water Protection Program (SWPP). The SWPP incorporates several programs that include the Source Water Assessment Program (SWAP) and Wellhead Protection Program (WHPP). The SWAP identifies, "the areas that are sources of public drinking water, assess the susceptibility of water-supply systems to contamination, and inform the public of the results." (IDEM, "Source Water Protection," n.d.). The WHPP is the primary ground water element of the SWAP. The WHPP is "designed to protect Community Public Water Systems that use ground water as their water source." (IDEM, "Source Water Protection," n.d.). In order to provide additional safeguards and other baseline criteria public water systems can use to protect and prevent underground water supply sources from becoming contaminated, a Wellhead Protection Area (WHPA) is delineated and approved by IDEM (IDEM, "Source Water Protections," n.d.).

A significant percentage of the State's residents access residential well water that falls outside of these regulations. As a result, in 2008 the IDEM Groundwater Section established the Groundwater Monitoring Network (GWMN) to collect untreated water samples from groundwater wells throughout the state. One of the primary goals of groundwater sampling collection is to determine the quality of the

groundwater in the state's aquifers (IDEM, "Statewide Groundwater Monitoring Network," n.d.). Furthermore, the transport of contaminants from the surface to the groundwater table primarily occurs during the migration of surface water to the groundwater table, or "recharge" of groundwater. Therefore, recharge rates that are higher or lower within a larger watershed are used as the basis for determining the sensitivity of the aquifer to contamination (IG&WS, "Map of Indiana Showing Near-Surface Aquifer Sensitivity," 2015). The Indiana Geological & Water Survey, Indiana University developed a GIS aquifer sensitivity layer mapping that ranked aquifer sensitivity using 5 classifications that range from very low to very high based on recharge rates (inches/year). The classifications were also cross checked with databases of contaminants in groundwater. For the purposes of this study, only the aquifers with a sensitivity ranking of moderate to very high were used in the impact determination, meaning aquifers with recharge rates of 4.3 inches/year or higher were included (IGS, 2015).

Resource Analysis

As noted in **Section 3.20.2**, **Volume I**, Source Water Assessment Areas are part of the IDEM Source Water Assessment Program (SWAP). These serve to meet EPA federal requirements to "identify the areas that are sources of public drinking water, assess the susceptibility of water-supply systems to contamination, and inform the public of the results." (IDEM, *"Source Water Protection,"* n.d.). Four Source Water Assessment Areas (SWAAs) have been identified with new alignment of alternatives. These include Jasper Municipal Water Utility for Alternatives C, M, O, R and RPA P; Winslow Water Works for Alternative B and R; Huntingburg Municipal Water for Alternative R, and Bedford City Utilities for Alternative O. Additionally, the local improvement elements 4, 5, 10, 15 and 16 each fall within one of these SWAAs. LI-4 and 5 are part of Alternatives C, M, O and P (Jasper Municipal Water Utility); LI-10 is part of Alternative B (Winslow Water Works); and LI-15 and 16 are part of Alternative O (Bedford City Utilities).

Two noteworthy groundwater resources are Wellhead Protection Areas (WHPAs) and Sole Source Aquifers (SSA). There is only one SSA identified in Indiana. The St. Joseph Aquifer System is located in the north central portion of the State, primarily in St. Joseph and Elkhart counties, which is not in close proximity to the project area (INDOT, 2011).

As noted in **Section 3.20.1**, **Volume I**, the project area has multiple drinking water sources, including private water wells and WHPAs. One WHPA has been identified as impacted by Alternative M.

Figure 1 illustrates that the majority of each alternative travels through highly sensitive aquifers. Alternatives in Orange, Crawford, Lawrence, Martin, and Dubois counties traverse areas dominated by karst topography. As cited in IDEM Proper Investigative Techniques in Karst, the U.S. Geological Survey (USGS) defines karst as "a terrain generally underlain by limestone or dolomite in which the topography is chiefly formed by the dissolving of rock, and which may be characterized by sinkholes, sinking streams, closed depressions, subterranean drainage, and caves" (IDEM, 2019). Karst features are at or near the surface in all or portions of Orange, Crawford, Lawrence, Martin, and Dubois counties. Groundwater resources in karst areas are sensitive to contamination. Karst features allow surface flows to enter groundwater quickly, with little or no soil filtration (IDEM, "Proper Investigative Techniques in Karst ", 2019). A more detailed discussion of potential karst impacts is contained in **Section 3.22**, **Volume I**.

Groundwater impacts were summarized in **Section 3.20.3**, **Volume I** using three resources: 1) water wells (public and private) within and outside of dominant limestone regions and total number of wells, 2) WHPAs, and 3) sensitive aquifers (see **Figure 1**). Impacts to wells were determined by their presence

within 500 feet of the ROW or within 1,000 feet of the ROW in dominant limestone areas. The potential impact to WHPAs provided by IDEM were based on the working alignment's proximity to designated areas. Only alternative working alignments traversing aquifers with sensitivity classified as moderate, high, and very high are reflected in this analysis. A brief summary of these impacts are as follows:

- Alternative R has the greatest potential impact to total wells and wells outside of a dominant limestone area.
- Alternative B has the least potential impact to total wells.
- Only alternatives M and O impact wells within a dominant limestone area.
- Alternative O has the least potential impact to wells outside of a dominant limestone area, and the most impact to wells inside a dominant limestone area.
- Alternative M impacts a WHPA.
- Alternatives B, C, O, and P do not impact a WHPA.
- Refined Preferred Alternative P (RPA P) has the greatest potential impact to sensitive aquifers, followed closely by Alternatives P and M.
- Alternative B has the least potential impact to sensitive aquifers.

All alternatives have both Super-2 and expressway facility type. Only Alternative M is identified as potentially impacting a WHPA. **Tables 1-15** of this appendix presents the impacts associated with each of these alternative variations, excluding local improvements. **Table 16** includes those impacts associated with any Local Improvement which are part of the alternative. **Figure 1** highlights groundwater resources, excluding the WHPA. This was identified by IDEM and is not shown to maintain confidentiality.

Highly sensitive aquifers and water wells are present along each alternative. As the map and tables show, the number of water wells potentially impacted increases in more developed areas, such as the northern half of Alternative P and Alternative R. Alternative R has the greatest potential impacts to wells outside of a dominant limestone area. This is followed by Alternative P and RPA P, which have a similar maximum potential impact to total wells as Alternative M. Further, RPA P's total alternative length within potential sensitive aquifer areas is the highest of any alternative, but only slightly more than Alternatives P and M (**Table 11**).

Alternative B is in a less developed region outside of a dominant limestone area and has no WHPA. Alternative B's potential groundwater impacts (total wells and alternative length within sensitive aquifer areas) are the lowest of all alternatives. Alternatives B, C, P, RPA P and R do not impact wells within a dominant limestone area and Alternatives B, C, O, P, RPA P and R do not impact a WHPA.

In Section 2 only, Alternative O impacts slightly fewer wells outside of a dominant limestone area than Alternative B. Alternatives C, M, P, RPA P and R have a few less miles of sensitive aquifer impacts than Alternative B. Alternatives C, M, O, P and RPA P all share most of their working alignment in Section 2. Alternatives C, M, P and RPA P have the same potential impacts to wells, WHPA, and alternative length within a sensitive aquifer area impact in Section 2.

Figure 1 and **Tables 3-6 and 9-10** show that Alternatives C, M, P, and RPA P have identical impacts in Section 2. Alternative O also shares a significant amount of alignment with Alternatives C, M, P, and RPA P but diverts east south of the East Fork of the White River. Alternative B has its own alignment, sharing

no common centerline with the other alignments. Alternative R is unique in that it involves the upgrade of existing US 231 from end to end. Future alignment modifications within Section 2 would result in similar changes to potential groundwater impacts for each alternative, with the exception of Alternative B and Alternative R.

FIGURE 1: POTENTIAL GROUNDWATER IMPACTS

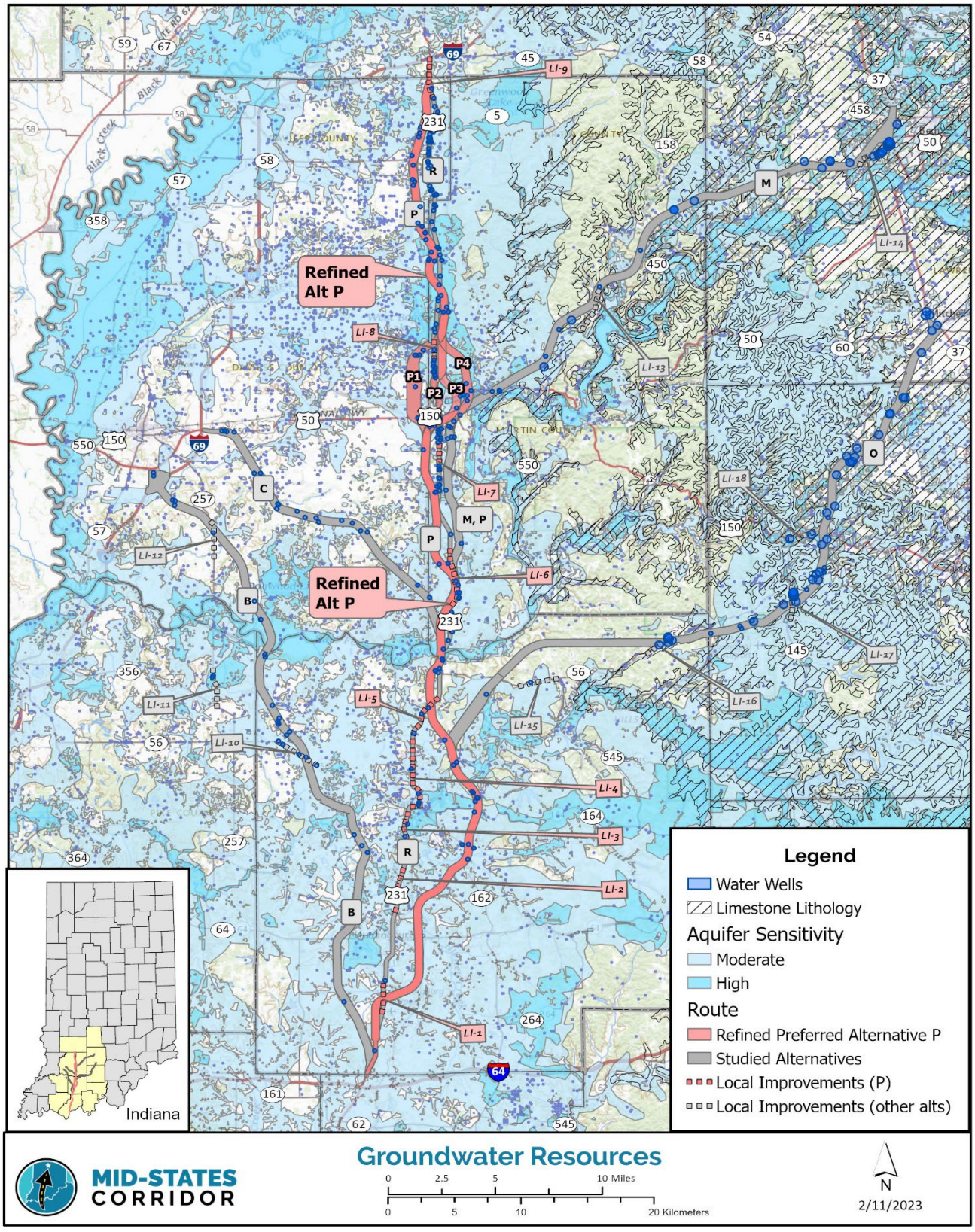

TABLE 1: POTENTIAL GROUNDWATER IMPACTS - WELLS, ALTERNATIVE B

Alternative		Section 2			Section 3		
		Wells in ROW Vicinity			Wells in ROW Vicinity		
Name	Facility*	Within Dominant Limestone	Outside Dominant Limestone	Total Wells	Within Dominant Limestone	Outside Dominant Limestone	Total Wells
B	Expressway	0	16	16	0	8	8
	Super 2	0	16	16	0	8	8

*Facility type 1, freeways, has been removed from consideration. Therefore, no modifications to existing US 231 in Section 1 and existing SR 37 in Section 3 are anticipated. No impacts are anticipated on either of these facilities.
This table does not include wells in the local improvements.

TABLE 2: POTENTIAL GROUNDWATER IMPACTS - OTHER, ALTERNATIVE B

Alternative		Section 2		Section 3	
Name	Facility*	Impacted Wellhead Protection Areas	Route Length within Sensitive Aquifer Areas (mi)	Impacted Wellhead Protection Areas	Route Length within Sensitive Aquifer Areas (mi)
B	Expressway	0	17.5	0	3.5
	Super 2	0	17.5	0	3.5

**Facility type 1, freeways, has been removed from consideration. Therefore, no modifications to existing US 231 in Section 1 and existing SR 37 in Section 3 are anticipated. No impacts are anticipated on either of these facilities.
This table does not include wells in the local improvements.

TABLE 3: POTENTIAL GROUNDWATER IMPACTS - WELLS, ALTERNATIVE C

Alternative		Section 2			Section 3		
		Wells in ROW Vicinity			Wells in ROW Vicinity		
Name	Facility*	Within Dominant Limestone	Outside Dominant Limestone	Total Wells	Within Dominant Limestone	Outside Dominant Limestone	Total Wells
C	Expressway	0	19	19	0	28	28
	Super 2	0	17	17	0	23	23

*Facility type 1, freeways, has been removed from consideration. Therefore, no modifications to existing US 231 in Section 1 and existing SR 37 in Section 3 are anticipated. No impacts are anticipated on either of these facilities.
This table does not include wells in the local improvements.

TABLE 4: POTENTIAL GROUNDWATER IMPACTS - OTHER, ALTERNATIVE C

Alternative		Section 2		Section 3	
Name	Facility*	Impacted Wellhead Protection Areas	Route Length within Sensitive Aquifer Areas (mi)	Impacted Wellhead Protection Areas	Route Length within Sensitive Aquifer Areas (mi)
C	Expressway	0	16.6	0	7.8
	Super 2	0	16.6	0	7.8

*Facility type 1, freeways, has been removed from consideration. Therefore, no modifications to existing US 231 in Section 1 and existing SR 37 in Section 3 are anticipated. No impacts are anticipated on either of these facilities.
This table does not include wells in the local improvements.

TABLE 5: POTENTIAL GROUNDWATER IMPACTS - WELLS, ALTERNATIVE M

Alternative		Section 2			Section 3		
		Wells in ROW Vicinity			Wells in ROW Vicinity		
Name	Facility*	Within Dominant Limestone	Outside Dominant Limestone	Total Wells	Within Dominant Limestone	Outside Dominant Limestone	Total Wells
M	Expressway	0	19	19	22	24	46
	Super 2	0	17	17	22	24	46

*Facility type 1, freeways, has been removed from consideration. Therefore, no modifications to existing US 231 in Section 1 and existing SR 37 in Section 3 are anticipated. No impacts are anticipated on either of these facilities.
This table does not include wells in the local improvements.

TABLE 6: POTENTIAL GROUNDWATER IMPACTS - OTHER, ALTERNATIVE M

Alternative		Section 2		Section 3	
Name	Facility*	Impacted Wellhead Protection Areas	Alternative Length within Sensitive Aquifer Areas (mi)	Impacted Wellhead Protection Areas	Alternative Length within Sensitive Aquifer Areas (mi)
M	Expressway	0	16.6	1	25.3
	Super 2	0	16.6	1	25.3

*Facility type 1, freeways, has been removed from consideration. Therefore, no modifications to existing US 231 in Section 1 and existing SR 37 in Section 3 are anticipated. No impacts are anticipated on either of these facilities.
This table does not include wells in the local improvements.

TABLE 7: POTENTIAL GROUNDWATER IMPACTS - WELLS, ALTERNATIVE O

Alternative		Section 2			Section 3		
		Wells in ROW Vicinity			Wells in ROW Vicinity		
Name	Facility*	Within Dominant Limestone	Outside Dominant Limestone	Total Wells	Within Dominant Limestone	Outside Dominant Limestone	Total Wells
O	Expressway	0	14	14	39	8	47
	Super 2	0	12	12	31	8	39

*Facility type 1, freeways, has been removed from consideration. Therefore, no modifications to existing US 231 in Section 1 and existing SR 37 in Section 3 are anticipated. No impacts are anticipated on either of these facilities.
This table does not include wells in the local improvements.

TABLE 8: POTENTIAL GROUNDWATER IMPACTS - OTHER, ALTERNATIVE O

Alternative		Section 2		Section 3	
Name	Facility*	Impacted Wellhead Protection Areas	Alternative Length within Sensitive Aquifer Areas (mi)	Impacted Wellhead Protection Areas	Alternative Length within Sensitive Aquifer Areas (mi)
O	Expressway	0	18.0	0	14.2
	Super 2	0	18.0	0	14.2

*Facility type 1, freeways, has been removed from consideration. Therefore, no modifications to existing US 231 in Section 1 and existing SR 37 in Section 3 are anticipated. No impacts are anticipated on either of these facilities.
This table does not include wells in the local improvements.

TABLE 9: POTENTIAL GROUNDWATER IMPACTS - WELLS, ALTERNATIVE P

Alternative			Section 2			Section 3		
			Wells in ROW Vicinity			Wells in ROW Vicinity		
Name	Facility*	Loogootee Bypass	Within Dominant Limestone	Outside Dominant Limestone	Total Wells	Within Dominant Limestone	Outside Dominant Limestone	Total Wells
P	Expressway	east	0	19	19	0	46	46
		west	0	19	19	0	47	47
	Super 2	east	0	17	17	0	46	46
		west	0	17	17	0	45	45

*Facility type 1, freeways, has been removed from consideration. Therefore, no modifications to existing US 231 in Section 1 and existing SR 37 in Section 3 are anticipated. No impacts are anticipated on either of these facilities.
This table does not include wells in the local improvements.

TABLE 10: POTENTIAL GROUNDWATER IMPACTS - OTHER, ALTERNATIVE P

Alternative			Section 2		Section 3	
Name	Facility*	Loogootee Bypass	Impacted Wellhead Protection Areas	Alternative Length within Sensitive Aquifer Areas (mi)	Impacted Wellhead Protection Areas	Alternative Length within Sensitive Aquifer Areas (mi)
P	Expressway	east	0	16.6	0	25.0
		west	0	16.6	0	26.1
	Super 2	east	0	16.6	0	25.0
		west	0	16.6	0	26.1

*Facility type 1, freeways, has been removed from consideration. Therefore, no modifications to existing US 231 in Section 1 and existing SR 37 in Section 3 are anticipated. No impacts are anticipated on either of these facilities.
This table does not include wells in the local improvements.

TABLE 11: POTENTIAL GROUNDWATER IMPACTS - WELLS, REFINED PREFERRED ALTERNATIVE P

Alternative			Section 2			Section 3		
			Wells in ROW Vicinity			Wells in ROW Vicinity		
Name	Facility*	Loogootee Bypass	Within Dominant Limestone	Outside Dominant Limestone	Total Wells	Within Dominant Limestone	Outside Dominant Limestone	Total Wells
RPA P	Expressway	P1	0	19	19	0	47	47
		P3	0	19	19	0	46	46
		P4	0	19	19	0	44	44
	Super 2	P1	0	17	17	0	45	45
		P2	0	17	17	0	43	43
		P3	0	17	17	0	41	41
		P4	0	17	17	0	42	42

*Facility type 1, freeways, has been removed from consideration. Therefore, no modifications to existing US 231 in Section 1 and existing SR 37 in Section 3 are anticipated. No impacts are anticipated on either of these facilities.
This table does not include wells in the local improvements.

TABLE 12: POTENTIAL GROUNDWATER IMPACTS - OTHER, REFINED REFERRED ALTERNATIVE P

Alternative			Section 2		Section 3	
Name	Facility*	Loogootee Bypass	Impacted Wellhead Protection Areas	Alternative Length within Sensitive Aquifer Areas (mi)	Impacted Wellhead Protection Areas	Alternative Length within Sensitive Aquifer Areas (mi)
RPA P	Expressway	P1	0	16.6	0	26.1
		P3	0	16.6	0	25.1
		P4	0	16.6	0	27.4
	Super 2	P1	0	16.6	0	26.1
		P2	0	16.6	0	25.1
		P3	0	16.6	0	27.1
		P4	0	16.6	0	27.4

*Facility type 1, freeways, has been removed from consideration. Therefore, no modifications to existing US 231 in Section 1 and existing SR 37 in Section 3 are anticipated. No impacts are anticipated on either of these facilities.
This table does not include wells in the local improvements.

TABLE 13: POTENTIAL GROUNDWATER IMPACTS - WELLS, ALTERNATIVE R

Alternative		Section 2			Section 3		
		Wells in ROW Vicinity			Wells in ROW Vicinity		
Name	Facility*	Within Dominant Limestone	Outside Dominant Limestone	Total Wells	Within Dominant Limestone	Outside Dominant Limestone	Total Wells
R	SUPER 2	0	16	16	0	108	108

*Facility type 1, freeways, has been removed from consideration. Therefore, no modifications to existing US 231 in Section 1 and existing SR 37 in Section 3 are anticipated. No impacts are anticipated on either of these facilities.
This table does not include wells in the local improvements.

TABLE 14: POTENTIAL GROUNDWATER IMPACTS - OTHER, ALTERNATIVE R

Alternative		Section 2		Section 3	
Name	Facility*	Impacted Wellhead Protection Areas	Route Length within Sensitive Aquifer Areas (mi)	Impacted Wellhead Protection Areas	Route Length within Sensitive Aquifer Areas (mi)
R	Super 2	0	15.9	0	24.6

*Facility type 1, freeways, has been removed from consideration. Therefore, no modifications to existing US 231 in Section 1 and existing SR 37 in Section 3 are anticipated. No impacts are anticipated on either of these facilities.
This table does not include wells in the local improvements.

TABLE 15: POTENTIAL GROUNDWATER IMPACTS SUMMARY

Alternatives**	Potential Groundwater Impacts*				
	Wells in ROW Vicinity			Wellhead Protection Areas	Route Length within Sensitive Aquifer Areas (mi)
	Within Dominant Limestone	Outside Dominant Limestone	Total		
B	0	24	24	0	21.0
C	0	40-47	40-47	0	24.4
M	22	41-43	85-87	1	41.9
O	31-39	20-22	51-61	0	32.2
P	0	62-66	62-66	0	41.6-42.7
RPA P	0	58-66	58-66	0	41.7-44.1
R	0	124	124	0	40.5

* Impacts are reported in ranges for all facility type options.

**Facility type 1, freeways, has been removed from consideration. Therefore, no modifications to existing US 231 in Section 1 and existing SR 37 in Section 3 are anticipated. No impacts are anticipated on either of these facilities.
This table does not include the local improvements.

TABLE 16: POTENTIAL GROUNDWATER IMPACTS SUMMARY – LOCAL IMPROVEMENTS

Local Improvements*				Groundwater Impacts			
LI-#	Existing Road	Alternatives	Section	Water Well Impacts^ (count)		Wellhead Protection Area	Sensitive Aquifer Area^^ Crossing (miles)
				Outside Dominant Limestone	Inside Dominant Limestone		
LI-1	US 231	B, C, M, O, P, RPA P	2	0	0		1.21
LI-2	US 231	B, C, M, O, P, RPA P	2	0	0		2.42
LI-3	US 231	B, C, M, O, P, RPA P	2	1	0		1.44
LI-4	US 231	C, M, O, P, RPA P	2	5	0		2.33
LI-5	US 231	C, M, O, P, RPA P	2	3	0		1.92
LI-6	US 231	M, P, RPA P	3	7	0		2.65
LI-7	US 231	M, P, RPA P	3	4	0		0.29
LI-8	US 231	P, RPA P	3	2	0		0.78
LI-9	US 231	P, RPA P	3	2	0		0.91
LI-10	SR 56	B	2	5	0		1.98
LI-11	SR 257	B	2	2	0		1.46
LI-12	SR 257	B	3	1	0		0
LI-13	SR 450	M	3	0	0		0.45
LI-14	SR 450	M	3	0	5		0.12
LI-15	SR 56	O	3	1	0		1.37
LI-16	SR 56	O	3	0	4		0
LI-17	SR 145	O	3	0	9		1.42
LI-18	US 150	O	3	0	2		1.07

^ Wells occurring in geology with a limestone dominant lithology were buffered by 1000 feet to capture the sensitivity to runoff. Wells outside this geology were buffered by 500 feet. The number presented is the count of well buffers intersected by the working alignment footprint.

^^ Analysis utilized IGS layer of Aquifer Sensitivity Near the Surface based on recharge rates. This analysis includes areas of moderate and high sensitivity, with recharge rates of 4.3 - 9.7 inches per year. No areas of very high sensitivity were present in the working alignment footprint.

* Local Improvements are associated with the alternative and do not change for variations within alternatives.