



**MID-STATES
CORRIDOR**

APPENDIX LL- Mineral Resources

Mid-States Corridor Tier 1 Environmental Impact Statement

Prepared for

Indiana Department of Transportation

Mid-States Corridor Regional Development Authority

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1. 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.

This appendix provides additional details regarding mineral resource impacts by the Mid-States alternatives. The tables in this appendix report impacts by individual working alignment variations including local improvements and sections. It contains resource maps. As described in **Volume I – Section 3.22**, mineral resources potentially impacted include hydrocarbon fuels (oil and gas, gas storage and coal), clay, sand and gravel, limestone, and gypsum. Mineral resource calculations are provided for coal, oil and gas, clay, sand, and gravel.

2. RESOURCE ANALYSIS

Coal

Active mining permits are valid for five years and can be renewed for additional five-year terms. Information on active coal mine permits was obtained from the Indiana Department of Natural Resources (IDNR) Coal Mine Information System (CMIS) website, CMIS Map Viewer (<http://dnrmapping.dnr.in.gov/apps/cmismapviewer>) (**Table 1, Figure 1**). The mine operating entity may control other parcels of mineable coal within a 5-mile buffer that are unpermitted for mining. Applications for these resources may be pending or filed in the future. Determining such plans would require consultation with coal operators during Tier 2 studies.

Coal resources for the western margin of the Study Area were analyzed directly from spatial data, maps of past mining activities and interpretation of known coal seams. Smaller area coal resources in the central and eastern part of the Study Area were analyzed by georeferencing a 1964 coal map from the Indiana Geological Survey (IGS). All impacts are associated with Alternatives B, C, P, R and RPA P. The reserves in central Dubois County west of Jasper and Huntingburg (Alternative B area) are smaller and discontinuous. It is less likely that these will be mined in the future. Alternative B impacts occur in Section 2, while Alternative C impacts occur in Section 3. **Table 2** presents coal resources in the working alignment right-of-way for unique alternative variations and sections, while **Figure 2** displays the distribution of coal resources in the Study Area.



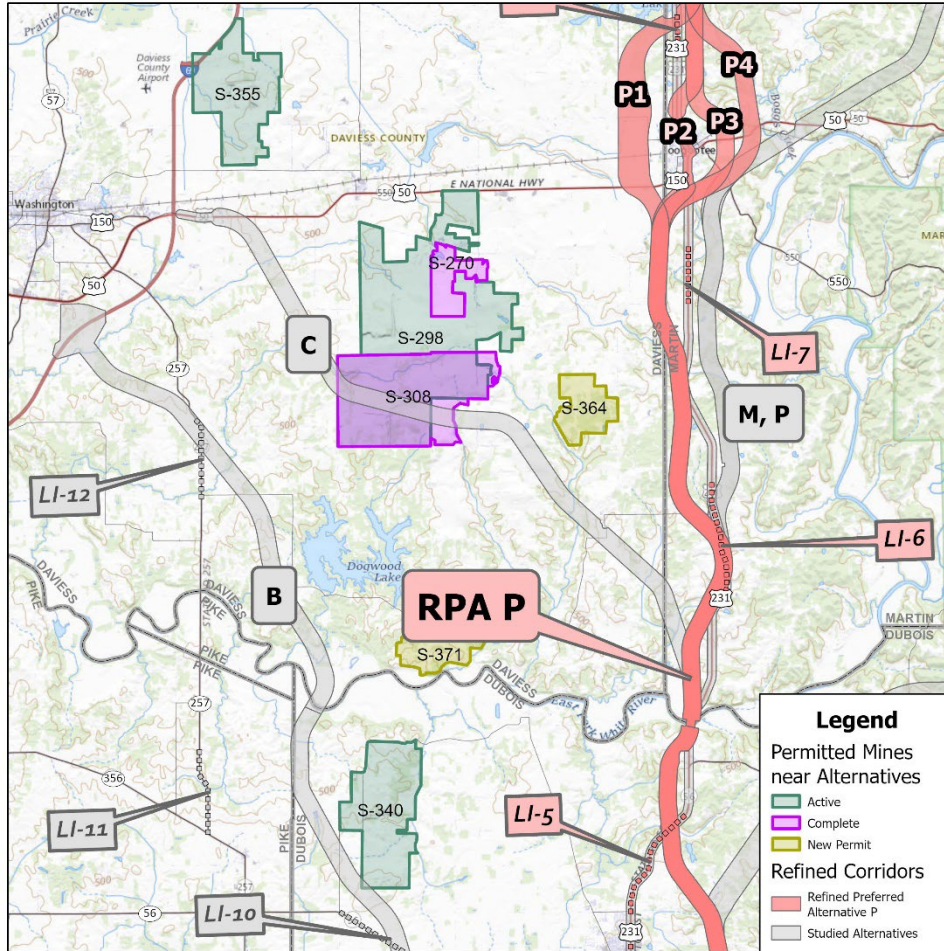
TABLE 1: ACTIVE MINE PERMITS NEAR MID-STATES ALIGNMENTS

Active Surface Coal Mine Permits Near Working Alignments*			
Nearby Build Alternatives	Status	Permit	Name
C	Reclamation	S298	Solar Sources Cannelburg Mine
C	Complete	S308	Peabody Midwest Mining, Viking, Corning Pit
B	Active	S340	Solar Sources Shamrock Mine
C	Active	S355	Solar Sources Antioch Mine
C, P, RPA P, R	New	S364	Solar Sources Alfordsville Mine
B, C	New	S371	Trust Resources LLC, Vigo Captain Daviess Mine
<p>* Indiana Department of Natural Resources (IDNR) Coal Mine Information System (CMIS) website, CMIS Map Viewer (http://dnrmmaps.dnr.in.gov/apps/cmisis.htm)</p>			



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FIGURE 1: ACTIVE MINE PERMITS NEAR MID-STATES ALIGNMENTS





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TABLE 2: COAL RESOURCES IN THE ALTERNATIVES BY SECTION

DEIS - Coal Mine Impacts (Acres)												
Alternative*	B		C		M		O		P			
Variation	B2	B3	C2	C3	M2	M3	O2	O3	P2e	P2w	P3e	P3w
Active Coal Mine Permit Areas												
Section 2	-	-	-	-	-	-	-	-	-	-	-	-
Section 2 - LI**	-	-	-	-	-	-	-	-	-	-	-	-
Section 3	-	-	251	204	-	-	-	-	-	-	-	-
Section 3 - LI	-	-	-	-	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-	-	-	-	-
Total - LI	-	-	-	-	-	-	-	-	-	-	-	-
Grand Total	-	-	251	204	-	-	-	-	-	-	-	-
Surface Mines (1880s - 2016) (Acres)												
Section 2	156	131	-	-	-	-	-	-	-	-	-	-
Section 2 - LI	-	-	-	-	-	-	-	-	-	-	-	-
Section 3	12	10	272	225	0.4	0.2	-	-	0.4	2	0.3	1
Section 3 - LI	-	-	-	-	4	4	-	-	4	4	4	4
Total	167	140	272	225	0.4	0.2	-	-	0.4	2	0.3	1
Total - LI	-	-	-	-	4	4	-	-	4	4	4	4
Grand Total	167	140	272	225	4	4	-	-	4	5	4	5
Underground Mines (1880s - 2016) (Acres)												
Section 2	17	14	0.4	0.4	0.4	0.4	-	-	0.4	0.4	0.4	0.4
Section 2 - LI	-	-	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Section 3	0.2	0.2	-	-	-	-	-	-	0.02	0.02	0.02	0.02
Section 3 - LI	-	-	-	-	0.4	0.4	0.1	0.1	0.4	0.4	0.4	0.4
Total	17	14	0.4	0.4	0.4	0.4	-	-	0.4	0.4	0.4	0.4
Total - LI	-	-	0.1	0.1	0.5	0.5	0.2	0.2	0.5	0.5	0.5	0.5
Grand Total	17	14	0	0	1	1	0	0	1	1	1	1

* Tier 1 Alternative impacts are reported in ranges including all the local improvements, facility types, and variations. Facility type 1, freeways, has been removed from consideration.
 ** LI = Local Improvement

TABLE 2A: COAL RESOURCES RPA P AND ALTERNATIVE R

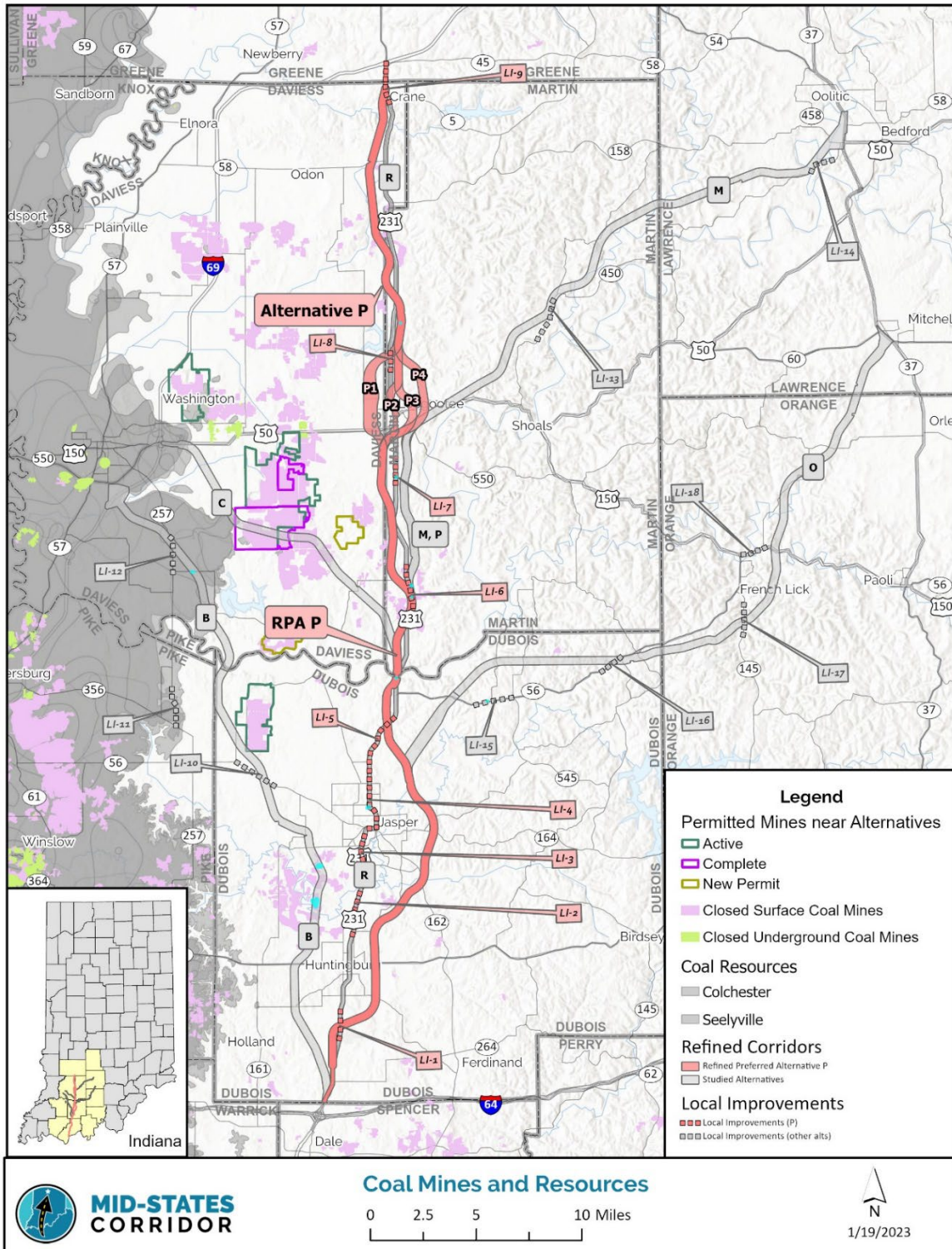
FEIS - Coal Mine Impact (Acres)					
Alternative*	R	P			
Variation		RPA P1	RPA P2	RPA P3	RPA P4
Active Coal Mine Permit Areas					
Grand Total	-	-	-	-	-
Surface Mines (1880s - 2016) (Acres)					
Grand Total	4	5	5	5	4 - 5
Underground Mines (1880s - 2016) (Acres)					
Grand Total	1	1	1	1	1

* Tier 1 Alternative impacts are reported in ranges including all the local improvements, facility types, and variations. Facility type 1, freeways, has been removed from consideration.



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FIGURE 2: COAL RESOURCES IN THE MID-STATES STUDY AREA





Oil, Gas, and Gas Storage

Oil, gas, and gas storage sites were analyzed directly from spatial layers. Oil and Gas wells and fields were mapped by the IGS (2015) from its Petroleum Database Management System (PDMS) (Figure 3). GIS analysis was used to identify and count all well locations that intersected alternatives. Analysis of petroleum fields within alignment variations are presented in Tables 3-5. Petroleum fields are a generalized occurrence method of analysis. Given current technology and extraction processes, the construction of any alternative should not impact access to these petroleum field resources at depth below ground. Individual well count analysis is a more specific analysis where potential impacts may exist in the manner of loss of production, direct cost of production, or plugging of wells located within a final right-of-way.

TABLE 3: PETROLEUM FIELD RESOURCES IN THE ALTERNATIVES BY SECTION

Local Improvements*				Petroleum Fields Impacts (acres)
LI-#	Existing Road	Alternatives	Section	
LI-1	US 231	B, C, M, O, P, RPA P	2	-
LI-2	US 231	B, C, M, O, P, RPA P	2	-
LI-3	US 231	B, C, M, O, P, RPA P	2	-
LI-4	US 231	C, M, O, P, RPA P	2	1
LI-5	US 231	C, M, O, P, RPA P	2	-
LI-6	US 231	M, P, RPA P	3	12
LI-7	US 231	M, P, RPA P	3	15
LI-8	US 231	P, RPA P	3	17
LI-9	US 231	P, RPA P	3	-
LI-10	SR 56	B	2	2
LI-11	SR 257	B	2	2
LI-12	SR 257	B	3	29
LI-13	SR 450	M	3	-
LI-14	SR 450	M	3	-
LI-15	SR 56	O	3	18
LI-16	SR 56	O	3	-
LI-17	SR 145	O	3	-
LI-18	US 150	O	3	-

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



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TABLE 3A: PETROLEUM FIELD RESOURCES RPA P AND ALTERNATIVE R

FEIS - Petroleum Fields Impacts (acres)		
Alternative*	Variation	Grand Total*
R		208
RPA-P	RPA P1	575-768
	RPA P2	461
	RPA P3	498-699
	RPA P4	534-735

*Tier 1 Alternatives are reported as a ranges for Expressway and Super 2 facility types. Only the Super 2 facility type is under consideration for RPA P2.

TABLE 4: PETROLEUM FIELD RESOURCES IN THE LOCAL IMPROVEMENTS

Local Improvements*				Petroleum Fields Impacts (acres)
LI-#	Existing Road	Alternatives	Section	
LI-1	US 231	B, C, M, O, P, RPA P	2	-
LI-2	US 231	B, C, M, O, P, RPA P	2	-
LI-3	US 231	B, C, M, O, P, RPA P	2	-
LI-4	US 231	C, M, O, P, RPA P	2	1
LI-5	US 231	C, M, O, P, RPA P	2	-
LI-6	US 231	M, P, RPA P	3	12
LI-7	US 231	M, P, RPA P	3	15
LI-8	US 231	P, RPA P	3	17
LI-9	US 231	P, RPA P	3	-
LI-10	SR 56	B	2	2
LI-11	SR 257	B	2	2
LI-12	SR 257	B	3	29
LI-13	SR 450	M	3	-
LI-14	SR 450	M	3	-
LI-15	SR 56	O	3	18
LI-16	SR 56	O	3	-
LI-17	SR 145	O	3	-
LI-18	US 150	O	3	-

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



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TABLE 5: OIL AND GAS WELL RESOURCES IN THE ALTERNATIVES BY SECTION

Impacts to Petroleum Wells (Oil, Gas, and Gas Storage)							
Alternatives*	Variation	Section	Abandoned Gas Storage Wells (count)	Gas Wells (count)	Gas Storage Wells (count)	Oil Wells (count)	Other Petroleum Test Wells** (count)
B	B2	2	-	3	4	1	6
		3	1	-	-	2	6
		Total	1	3	4	3	12
	B3	2	-	3	3	1	5
		3	1	-	-	2	6
		Total	1	3	3	3	11
C	C3	2	-	-	-	-	4
		3	-	-	-	-	7
		Total	-	-	-	-	11
	C3	2	-	-	-	-	2
		3	-	-	-	-	6
		Total	-	-	-	-	8
M	M2	2	-	-	-	-	4
		3	-	-	-	-	7
		Total	-	-	-	-	11
	M3	2	-	-	-	-	2
		3	-	-	-	-	7
		Total	-	-	-	-	9
O	O2	2	-	-	-	-	6
		3	-	-	-	-	5
		Total	-	-	-	-	11
	O3	2	-	-	-	-	3
		3	-	-	-	-	6
		Total	-	-	-	-	9
P	P2east	2	-	-	-	-	4
		3	-	-	-	-	7
		Total	-	-	-	-	11
	P2west	2	-	-	-	-	4
		3	1	-	-	-	13
		Total	1	-	-	-	17
	P3east	2	-	-	-	-	2
		3	-	-	-	-	6
		Total	-	-	-	-	8
	P3west	2	-	-	-	-	2
		3	1	-	-	-	10
		Total	1	-	-	-	12



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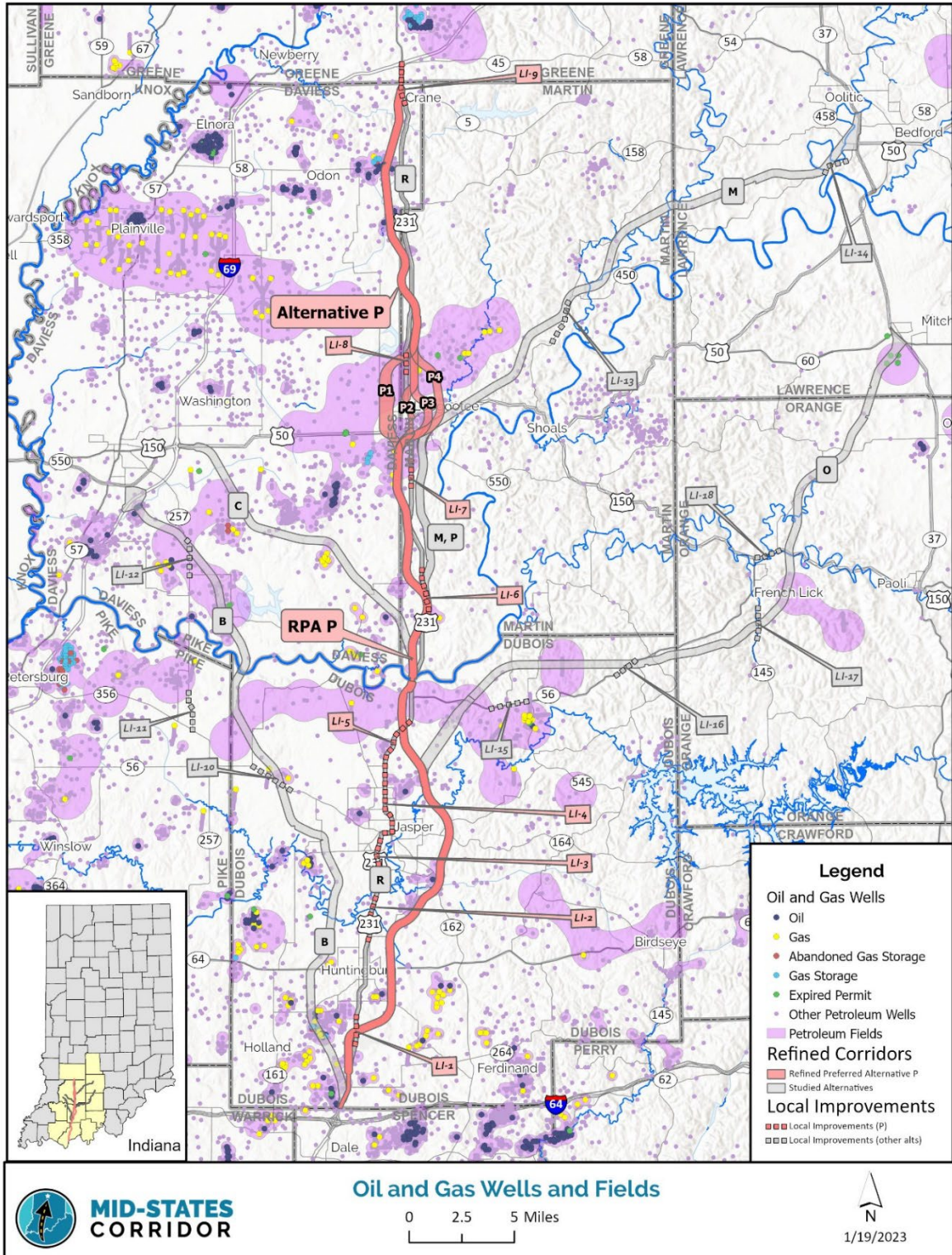
TABLE 5A: OIL AND GAS WELL RESOURCES RPA P AND ALTERNATIVE R

FEIS - Impacts to Petroleum Wells (Oil, Gas, and Gas Storage)					
Alternative*	R	P			
Variation		RPA-P 1	RPA-P 2	RPA-P 3	RPA-P 4
Abandoned Gas Storage Wells (count)					
Total	-	-	-	-	-
Gas Wells (count)					
Grand total	-	-	-	-	-
Gas Storage Wells (count)					
Grand Total	-	-	-	-	-
Oil Wells (count)					
Grand Total	-	-	-	-	-
Other Petroleum Test Wells** (count)					
Grand Total	-	11-16	12	12-17	12-18
<p>*Tier 1 Alternative impacts are reported in ranges including all the local improvements, facility types, and variations. Facility type 1, freeways, has been removed from consideration. No impacts to petroleum wells occur in the Local Improvements segments of the Alternatives.</p> <p>** The "Other Test Wells" category includes dry holes, abandoned injection wells, borings, structure tests, and abandoned oil wells. Impacts to these wells will not impact the resource, but may require more detailed hazardous materials investigation before construction.</p> <p>*** Petroleum fields can be accessed deep in the ground, even if some working alignments overlay their location. No resource impacts are expected.</p>					



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FIGURE 3: PETROLEUM RESOURCES IN THE MID-STATES STUDY AREA





Clay Minerals

Clay resources were analyzed with spatial data created by IGS from the ilITH Database of water well drilling logs through year 2000. The point data were interpolated to estimate clay thickness for the Study Area (**Figure 4**). Clay resources were analyzed by acres and the percentage of the alignment containing resources in three thickness ranges below the ground (**Tables 6-8**). Local Improvements were analyzed for acres of resource and percentage in the ROW (**Table 6**). For all alternatives, Section 3 contains a majority of the clay resources (**Table 7**). For Alternative B, clay resources are most abundant in the 20 to 50 foot thick group in Section 3. In Alternatives M and O, the 10 to 20 foot thickness is most abundant. Alternatives C, P, and RPA P have similar distributions across the 10 to 20 and 20 to 50 foot thickness groups. All alternatives have few resources in the >50 feet thick category. The largest such area is associated with Alternative C near Washington. The thick clay deposits of Alternative C are associated with both the glacial alluvial deposits and with the much earlier coal swamp sedimentation sequences associated with coals. Alternative M contains the most clay mineral resources. These are associated with the East Fork of White River and its tributaries in Martin and Lawrence counties. Other clay resources are interbedded with shales and coal seams in the area. Alternative R has the least impact to clay minerals resources (129 acres).

TABLE 6: CLAY RESOURCES BY THICKNESS IN THE LOCAL IMPROVEMENTS

Local Improvements*					Clay Resource Impacts							
LI-#	Existing Road	Alternatives	Section	ROW (acres)	10 -20 Feet Thick		20-50 Feet Thick		> 50 Feet Thick		Total Clay	
					Acres	% of LI ROW	Acres	% of LI ROW	Acres	% of LI ROW	Acres	% of LI ROW
LI-1	US 231	B, C, M, O, P, RPA P	2	275	0	0%	0	0%	0	0%	0	0%
LI-2	US 231	B, C, M, O, P, RPA P	2	1337	377	28%	435	33%	175	13%	987	74%
LI-3	US 231	B, C, M, O, P, RPA P	2	649	119	18%	345	53%	163	25%	627	97%
LI-4	US 231	C, M, O, P, RPA P	2	351	96	27%	137	39%	4	1%	237	67%
LI-5	US 231	C, M, O, P, RPA P	2	552	58	11%	127	23%	315	57%	500	91%
LI-6	US 231	M, P, RPA P	3	505	60	12%	159	32%	22	4%	241	48%
LI-7	US 231	M, P, RPA P	3	180	1	0.3%	166	92.3%	0	0%	167	92.6%
LI-8	US 231	P, RPA P	3	68	68	100%	0	0%	0	0%	68	100%
LI-9	US 231	P, RPA P	3	187	12	6%	172	92%	0	0%	184	98%
LI-10	SR 56	B	2	66	12	18%	1	2%	3	4%	16	24%
LI-11	SR 257	B	2	69	6	9%	41	60%	17	25%	64	93%
LI-12	SR 257	B	3	58	23	40%	35	60%	0	0%	58	100%
LI-13	SR 450	M	3	106	31	29%	0	0%	0	0%	31	29%
LI-14	SR 450	M	3	82	3	4%	74	91%	0	0%	77	94%
LI-15	SR 56	O	3	84	1	1%	0	0%	0	0%	1	1%
LI-16	SR 56	O	3	56	38	68%	13	23%	0	0%	51	91%
LI-17	SR 145	O	3	60	58	97%	2	3%	0	0%	60	100%
LI-18	US 150	O	3	45	31	69%	14	31%	0	0%	45	100%

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



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TABLE 7: CLAY MINERAL RESOURCES (ACRES) IN THE ALTERNATIVES BY SECTION

DEIS - Clay Resources Impacts (acres)												
Alternative*	B		C		M		O		P			
Variation	B2	B3	C2	C3	M2	M3	O2	O3	P2e	P2w	P3e	P3w
10-20 Foot Thickness (acres)												
Section 2	299	250	271	192	271	192	362	289	271	271	192	192
Section 2 - LI**	50	50	57	57	57	57	57	57	57	57	57	57
Section 3	152	131	281	233	1,332	1,180	1,246	1,088	602	624	483	497
Section 3 - LI	11	11	-	-	27	27	64	64	30	30	30	30
Total	451	381	552	425	1,603	1,372	1,608	1,377	873	895	675	689
Total - LI	61	61	57	57	84	84	121	121	87	87	87	87
Grand Total	512	443	609	482	1,686	1,456	1,729	1,497	960	982	762	776
20-50 Foot Thickness (acres)												
Section 2	78	61	247	170	247	170	138	108	247	247	170	170
Section 2 - LI	86	86	91	91	91	91	91	91	91	91	91	91
Section 3	895	853	309	250	803	693	132	49	397	418	326	313
Section 3 - LI	17	17	-	-	91	91	14	14	97	97	97	97
Total	973	914	556	420	1,050	863	270	157	644	665	496	483
Total - LI	103	103	91	91	182	182	105	105	188	188	188	188
Grand Total	1,077	1,017	648	512	1,232	1,045	375	263	832	853	684	672
> 50 Foot Thickness (acres)												
Section 2	-	-	33	24	33	24	17	14	33	33	24	24
Section 2 - LI	39	38	60	60	60	60	60	60	60	60	60	60
Section 3	1	2	182	149	88	63	-	-	64	25	48	21
Section 3 - LI	-	-	-	-	4	4	-	-	4	4	4	4
Total	1	2	215	173	121	87	17	14	97	58	72	45
Total - LI	39	38	60	60	64	64	60	60	64	64	64	64
Grand Total	40	40	275	233	185	151	77	74	160	122	136	109
Total Clay (acres)												
Section 2	377	311	551	386	550	386	516	411	551	551	386	386
Section 2 - LI	175	175	208	208	208	208	208	208	208	208	208	208
Section 3	1,049	985	773	632	2,223	1,935	1,379	1,136	1,063	1,067	857	831
Section 3 - LI	29	29	-	-	122	122	78	78	131	131	131	131
Total	1,426	1,296	1,324	1,018	2,773	2,321	1,895	1,547	1,614	1,618	1,243	1,217
Total - LI	204	204	208	208	330	330	286	286	339	339	339	339
Grand Total	1,629	1,500	1,532	1,226	3,103	2,651	2,181	1,834	1,953	1,957	1,582	1,556
<p>* Tier 1 Alternative impacts are reported in ranges including all the local improvements, facility types, and variations. Facility type 1, freeways, has been removed from consideration. Therefore, no modifications to existing US 231 in Section 1 are anticipated.</p> <p>** LI = Local Improvement</p>												



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TABLE 7A: CLAY MINERAL RESOURCES (ACRES) RPA P AND ALTERNATIVE R

FEIS - Clay Resources Impacts (acres)					
Alternative*	R	RPA P			
Variation		RPA P1	RPA P2	RPA P3	RPA P4
10-20 Foot Thickness (acres)					
Grand Total	308	775-982	679	680-870	764-976
20-50 Foot Thickness (acres)					
Grand Total	333	672-853	640	687-892	708-891
> 50 Foot Thickness (acres)					
Grand Total	86	109-122	112	111-120	109-123
Total Clay (acres)					
Grand Total	727	1,556-1,957	1,431	1,479-1881	1,581-1,989
*Grand Total includes Section 2 and 3 with all LI, Range represents difference between Expressway and Super 2 where both are considered.					



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TABLE 8: CLAY MINERAL RESOURCES (PERCENTAGE) IN THE ALTERNATIVES BY SECTION

DEIS - Clay Resources Impacts (% of ROW Subsection)												
Alternative*	B		C		M		O		P			
Variation	B2	B3	C2	C3	M2	M3	O2	O3	P2e	P2w	P3e	P3w
10-20 Foot Thickness (% of ROW Subsection)												
Section 2	26%	27%	22%	22%	22%	22%	30%	31%	22%	22%	22%	22%
Section 2 - LI**	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Section 3	14%	13%	32%	32%	42%	43%	59%	60%	39%	42%	39%	43%
Section 3 - LI	38%	38%	-	-	13%	13%	52%	52%	17%	17%	17%	17%
Total	20%	20%	26%	26%	36%	38%	48%	50%	32%	33%	32%	34%
Total - LI	21%	21%	20%	20%	17%	17%	30%	30%	19%	19%	19%	19%
Grand Total	20%	20%	25%	25%	34%	35%	46%	47%	30%	31%	30%	31%
20-50 Foot Thickness (% of ROW Subsection)												
Section 2	7%	7%	20%	19%	20%	19%	11%	12%	20%	20%	19%	19%
Section 2 - LI	34%	34%	33%	33%	33%	33%	33%	33%	33%	33%	33%	33%
Section 3	82%	83%	35%	34%	25%	25%	6%	3%	26%	28%	26%	27%
Section 3 - LI	59%	59%	-	-	44%	44%	11%	11%	54%	54%	54%	54%
Total	43%	47%	26%	26%	24%	24%	8%	6%	23%	25%	23%	24%
Total - LI	36%	36%	33%	33%	37%	37%	26%	26%	41%	41%	41%	41%
Grand Total	43%	46%	27%	27%	25%	25%	10%	8%	26%	27%	27%	27%
> 50 Foot Thickness (% of ROW Subsection)												
Section 2	-	-	3%	3%	3%	3%	1%	1%	3%	3%	3%	3%
Section 2 - LI	15%	15%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%
Section 3	-	-	20%	20%	3%	2%	-	-	4%	2%	4%	2%
Section 3 - LI	-	-	-	-	2%	2%	-	-	2%	2%	2%	2%
Total	-	-	10%	11%	3%	2%	1%	1%	4%	2%	3%	2%
Total - LI	14%	13%	22%	22%	13%	13%	15%	15%	14%	14%	14%	14%
Grand Total	2%	2%	11%	12%	4%	4%	2%	2%	5%	4%	5%	4%
Total Clay (% of ROW Subsection)												
Section 2	33%	34%	45%	43%	45%	43%	42%	44%	45%	45%	43%	43%
Section 2 - LI	68%	68%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%
Section 3	96%	96%	87%	86%	70%	70%	65%	62%	69%	73%	70%	72%
Section 3 - LI	100%	100%	-	-	59%	59%	64%	64%	74%	74%	74%	74%
Total	64%	67%	62%	63%	63%	64%	57%	56%	58%	60%	59%	60%
Total - LI	72%	72%	75%	75%	68%	68%	71%	71%	74%	74%	74%	74%
Grand Total	65%	68%	64%	65%	63%	64%	58%	58%	61%	62%	61%	62%

Percentages are calculated using the acres of resource in a subsection divided by the acres of that subsection. For example, B2 Section 2-LI is calculated by dividing the amount of impact acres in Alternative B2, Section 2-LI by the total acres of LI ROW in Section 2.

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

** LI = Local Improvement



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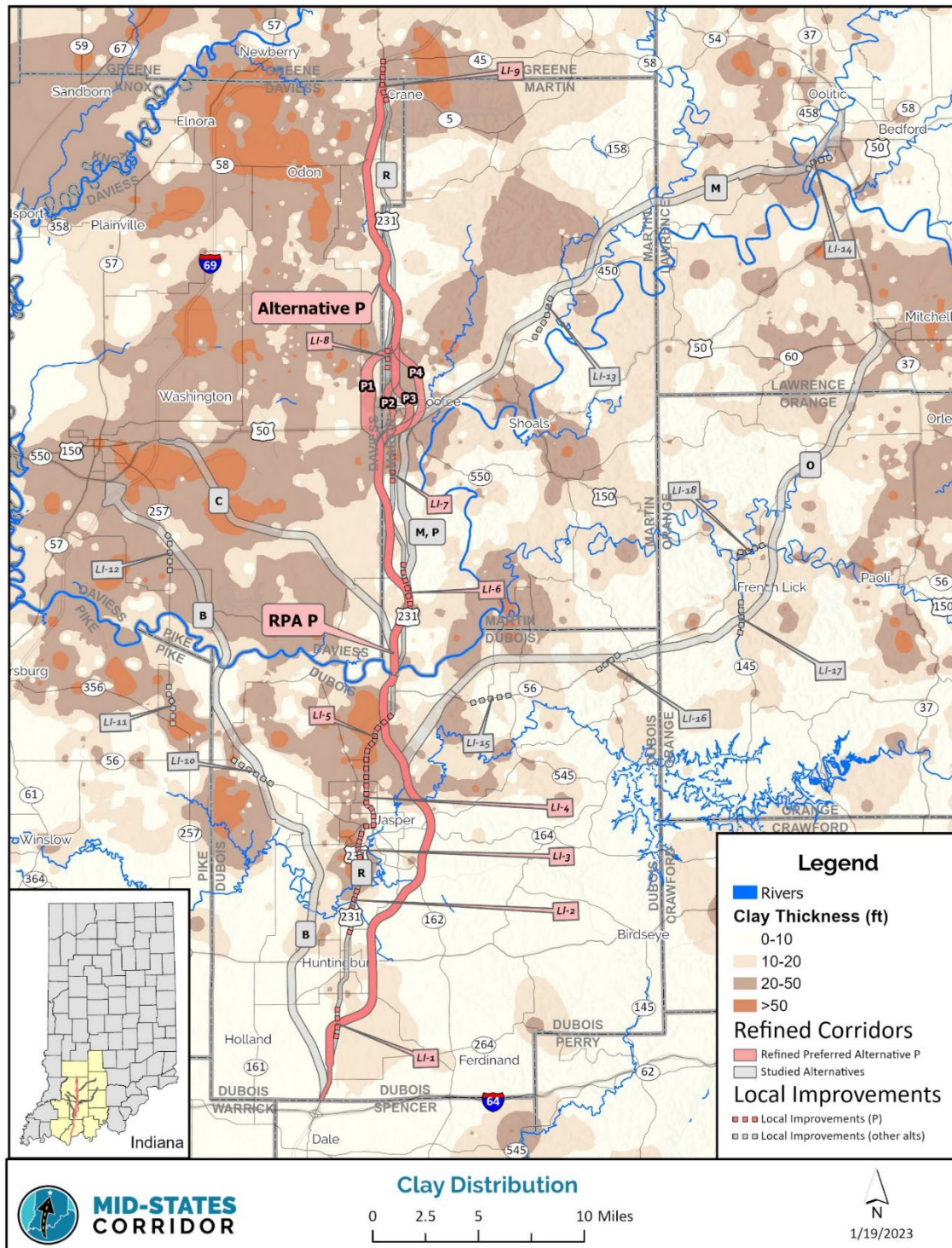
TABLE 8A: CLAY MINERAL RESOURCES (PERCENTAGE) RPA P AND ALTERNATIVE R

FEIS - Clay Resources Impacts (% of ROW Subsection)					
Alternative*	R	RPA P			
Variation		RPA P1	RPA P2	RPA P3	RPA P4
10-20 Foot Thickness (% of ROW Subsection)					
Grand Total	26%	31%	29%	22-28%	30%
20-50 Foot Thickness (% of ROW Subsection)					
Grand Total	28%	27%	27%	22-28%	28%
> 50 Foot Thickness (% of ROW Subsection)					
Grand Total	7%	4%	5%	4-5%	4%
Total Clay (% of ROW Subsection)					
Grand Total	61%	62%	60%	48-60%	62%
*Grand Total includes Section 2 and 3 with all LI, Range represents difference between Expressway and Super 2 where both are considered.					



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FIGURE 4: CLAY MINERAL THICKNESS IN THE MID-STATES STUDY AREA





Sand and Gravel

Sand and gravel are commonly recovered from a mixed deposit which is sorted by particle size, although some sand-only deposits may be found. Large areas of sand and gravel deposits occur adjacent to and along major rivers in Southern Indiana where they were washed out of melting glaciers upstream (**Figure 5**). The melt waters flowing in the stream channels further winnowed these deposits, separating the constituents by grain size. These include gravels, sands, and clay muds. Segregated by particle size, these deposits have been subsequently eroded and resorted, as they continue to migrate down river valleys. Economic concentrations of sand and gravel were analyzed for the alternatives using spatial data created by IGS (**Table 9 – 11**).

The spatial data was derived by assigning qualitative permissive tract assessments to each outcrop area in Gray, H. H., 1989, “Quaternary geologic map of Indiana: Indiana Geological Survey Miscellaneous Map 49”. The data set identified areas likely to contain economic concentrations of the resource as “potential” and areas that may contain economic concentrations of the resource as “low potential.” Most impacts for all alternatives are “low potential” resource areas (**Table 10**). Most acres of “potential” resources occur in Section 2. Only Alternative P and PRA P have likely potential resources in Section 3.

TABLE 9: SAND AND GRAVEL RESOURCES (ACRES AND PERCENTAGE) IN THE LOCAL IMPROVEMENTS

Local Improvements*					Impacts to Sand and Gravel Potential Resources^					
LI- #	Existing Road	Alternatives	Section	ROW (acres)	Potential^^ Resource		Low Potential Resource		Total Resource	
					Acres	% of LI ROW	Acres	% of LI ROW	Acres	% of LI ROW
LI-	US 231	B, C, M, O, P, RPA P	2	275	-	-	72	26%	72	26%
LI-	US 231	B, C, M, O, P, RPA P	2	1337	-	-	729	55%	729	55%
LI-	US 231	B, C, M, O, P, RPA P	2	649	-	-	649	100%	649	100%
LI-	US 231	C, M, O, P, RPA P	2	351	77	22%	143	41%	220	63%
LI-	US 231	C, M, O, P, RPA P	2	552	139	25%	308	56%	447	81%
LI-	US 231	M, P, RPA P	3	505	-	-	-	-	-	-
LI-	US 231	M, P, RPA P	3	180	-	-	-	-	-	-
LI-	US 231	P	3	68	-	-	-	-	-	-
LI-	US 231	P, RPA P	3	187	137	73%	19	10%	156	83%
LI-	SR 56	B	2	66	-	-	66	100%	66	100%
LI-	SR 257	B	2	69	-	-	24	34%	24	34%
LI-	SR 257	B	3	58	-	-	22	39%	22	39%
LI-	SR 450	M	3	106	-	-	3	3%	3	3%
LI-	SR 450	M	3	82	-	-	-	-	-	-
LI-	SR 56	O	3	84	-	-	-	-	-	-
LI-	SR 56	O	3	56	-	-	-	-	-	-
LI-	SR 145	O	3	60	-	-	46	77%	46	77%
LI-	US 150	O	3	45	-	-	45	100%	45	100%

^Indiana Geological Survey created the sand and gravel resource potential data in 2003 by assigning qualitative permissive tract assessments to each outcrop area in Gray, H. H., 1989, Quaternary geologic map of Indiana: Indiana Geological Survey Miscellaneous Map 49. The attribute table data was derived from Gray, H. H., 1973, Properties and uses of geologic materials in Indiana: Indiana Geological Survey Regional Geologic Map Supplementary Chart 1 and Carr, D. D., and Webb, W. M., 1970, Sand and gravel resources of Indiana: Indiana Geological Survey Bulletin 42-D, 31 p.

^^ "Potential resource" indicates that the surficial unconsolidated deposits are likely to contain economic concentrations of sand and gravel, "low potential" indicates that the surficial unconsolidated deposits may contain economic concentrations of sand and gravel.

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



TABLE 10: SAND AND GRAVEL RESOURCES (ACRES) IN THE ALTERNATIVES BY SECTION

DEIS - Impacts to Sand and Gravel Potential Resources [^]												
Alternative*	B		C		M		O		P			
Variation	B2	B3	C2	C3	M2	M3	O2	O3	P2e	P2w	P3e	P3w
Potential^{^^} Resource (acres)												
Section 2	125	106	71	44	71	44	2	2	71	71	44	44
Section 2 - LI**	-	-	22	22	22	22	22	22	22	22	22	22
Section 3	-	-	-	-	-	-	-	-	40	40	31	31
Section 3 - LI	-	-	-	-	-	-	-	-	34	34	34	34
Total	125	106	71	44	71	44	2	2	111	111	75	75
Total - LI	-	-	22	22	22	22	22	22	56	56	56	56
Grand Total	125	106	93	66	93	66	24	24	167	167	131	131
Low Potential Resource (acres)												
Section 2	492	378	342	249	342	249	304	227	342	342	249	249
Section 2 - LI	166	166	166	166	166	166	166	166	166	166	166	166
Section 3	319	301	104	84	382	334	92	80	245	285	202	217
Section 3 - LI	11	11	-	-	2	2	45	45	5	5	5	5
Total	811	679	446	333	724	583	396	307	587	627	451	466
Total - LI	177	177	166	166	168	168	211	211	171	171	171	171
Grand Total	988	856	612	499	892	751	607	518	758	798	622	637
Total Resource (acres)												
Section 2	617	484	414	294	414	294	306	229	414	414	294	294
Section 2 - LI	166	166	188	188	188	188	188	188	188	188	188	188
Section 3	319	301	104	84	382	334	92	80	286	325	233	248
Section 3 - LI	11	11	-	-	2	2	45	45	39	39	39	39
Total	936	785	518	378	796	628	398	309	700	739	527	542
Total - LI	177	177	188	188	190	190	233	233	227	227	227	227
Grand Total	1,113	962	705	566	985	817	630	541	927	965	753	769

[^]Indiana Geological Survey created the sand and gravel resource potential data in 2003 by assigning qualitative permissive tract assessments to each outcrop area in Gray, H. H., 1989, Quaternary geologic map of Indiana: Indiana Geological Survey Miscellaneous Map 49. The attribute table data was derived from Gray, H. H., 1973, Properties and uses of geologic materials in Indiana: Indiana Geological Survey Regional Geologic Map Supplementary Chart 1 and Carr, D. D., and Webb, W. M., 1970, Sand and gravel resources of Indiana: Indiana Geological Survey Bulletin 42-D, 31 p.

^{^^} "Potential resource" indicates that the surficial unconsolidated deposits are likely to contain economic concentrations of sand and gravel, "low potential" indicates that the surficial unconsolidated deposits may contain economic concentrations of sand and gravel.

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

** LI = Local Improvement



TABLE 10A SAND AND GRAVEL RESOURCES (ACRES) RPA P AND ALTERNATIVE R

FEIS - Impacts to Sand and Gravel Potential Resources [^]					
Alternative*	R	RPA P			
Variation		RPA P1	RPA P2	RPA P3	RPA P4
Potential ^{^^} Resource (acres)					
Grand Total	66	131-167	131	131-167	131-167
Low Potential Resource (acres)					
Grand Total	229	637-798	576	580-703	656-805
Total Resource (acres)					
Grand Total	295	768-965	707	711-870	787-972
<p>*Grand Total includes Section 2 and 3 with all LI, Range represents difference between Expressway and Super 2 where both are considered.</p> <p>[^]Indiana Geological Survey created the sand and gravel resource potential data in 2003 by assigning qualitative permissive tract assessments to each outcrop area in Gray, H. H., 1989, Quaternary geologic map of Indiana: Indiana Geological Survey Miscellaneous Map 49. The attribute table data was derived from Gray, H. H., 1973, Properties and uses of geologic materials in Indiana: Indiana Geological Survey Regional Geologic Map Supplementary Chart 1 and Carr, D. D., and Webb, W. M., 1970, Sand and gravel resources of Indiana: Indiana Geological Survey Bulletin 42-D, 31 p.</p> <p>^{^^} "Potential resource" indicates that the surficial unconsolidated deposits are likely to contain economic concentrations of sand and gravel, "low potential" indicates that the surficial unconsolidated deposits may contain economic concentrations of sand and gravel.</p>					



TABLE 11: SAND AND GRAVEL RESOURCES (PERCENTAGE) IN THE ALTERNATIVES BY SECTION

FEIS - Impacts to Sand and Gravel Potential Resources [^]												
Alternative*	B		C		M		O		P			
Variation	B2	B3	C2	C3	M2	M3	O2	O3	P2e	P2w	P3e	P3w
Potential^{^^} Resource (% of ROW Subsection)												
Section 2	11%	12%	6%	5%	6%	5%	0%	0%	6%	6%	5%	5%
Section 2 - LI^{**}	-	-	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%
Section 3	-	-	-	-	-	-	-	-	3%	3%	3%	3%
Section 3 - LI	-	-	-	-	-	-	-	-	19%	19%	19%	19%
Total	6%	5%	3%	3%	2%	1%	0%	0%	4%	4%	4%	4%
Total - LI	-	-	8%	8%	5%	5%	5%	5%	12%	12%	12%	12%
Grand Total	5%	5%	4%	3%	2%	2%	1%	1%	5%	5%	5%	5%
Low Potential Resource (% of ROW Subsection)												
Section 2	43%	41%	28%	28%	28%	28%	25%	24%	28%	28%	28%	28%
Section 2 - LI	65%	65%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Section 3	29%	29%	12%	11%	12%	12%	4%	4%	16%	19%	16%	19%
Section 3 - LI	38%	38%	-	-	1%	1%	37%	37%	3%	3%	3%	3%
Total	36%	35%	21%	21%	16%	16%	12%	11%	21%	23%	21%	23%
Total - LI	62%	62%	60%	60%	35%	35%	53%	53%	37%	37%	37%	37%
Grand Total	39%	39%	25%	26%	18%	18%	16%	16%	23%	25%	24%	26%
Total Resource (% of ROW Subsection)												
Section 2	54%	53%	34%	33%	34%	33%	25%	24%	34%	34%	33%	33%
Section 2 - LI	65%	65%	67%	67%	67%	67%	67%	67%	67%	67%	67%	67%
Section 3	29%	29%	12%	11%	12%	12%	4%	4%	19%	22%	19%	22%
Section 3 - LI	38%	38%	-	-	1%	1%	37%	37%	22%	22%	22%	22%
Total	42%	41%	24%	23%	18%	17%	12%	11%	25%	27%	25%	27%
Total - LI	62%	62%	67%	67%	39%	39%	58%	58%	50%	50%	50%	50%
Grand Total	44%	43%	29%	30%	20%	20%	17%	17%	29%	31%	29%	31%

Percentages are calculated using the acres of resource in a subsection divided by the acres of that subsection. For example, B2 Section 2-LI is calculated by dividing the amount of impact acres in Alternative B2, Section 2-LI by the total acres of LI ROW in Section 2.

[^]Indiana Geological Survey created the sand and gravel resource potential data in 2003 by assigning qualitative permissive tract assessments to each outcrop area in Gray, H. H., 1989, Quaternary geologic map of Indiana: Indiana Geological Survey Miscellaneous Map 49. The attribute table data was derived from Gray, H. H., 1973, Properties and uses of geologic materials in Indiana: Indiana Geological Survey Regional Geologic Map Supplementary Chart 1 and Carr, D. D., and Webb, W. M., 1970, Sand and gravel resources of Indiana: Indiana Geological Survey Bulletin 42-D, 31 p.

^{^^} "Potential resource" indicates that the surficial unconsolidated deposits are likely to contain economic concentrations of sand and gravel, "low potential" indicates that the surficial unconsolidated deposits may contain economic concentrations of sand and gravel.

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

** LI = Local Improvement



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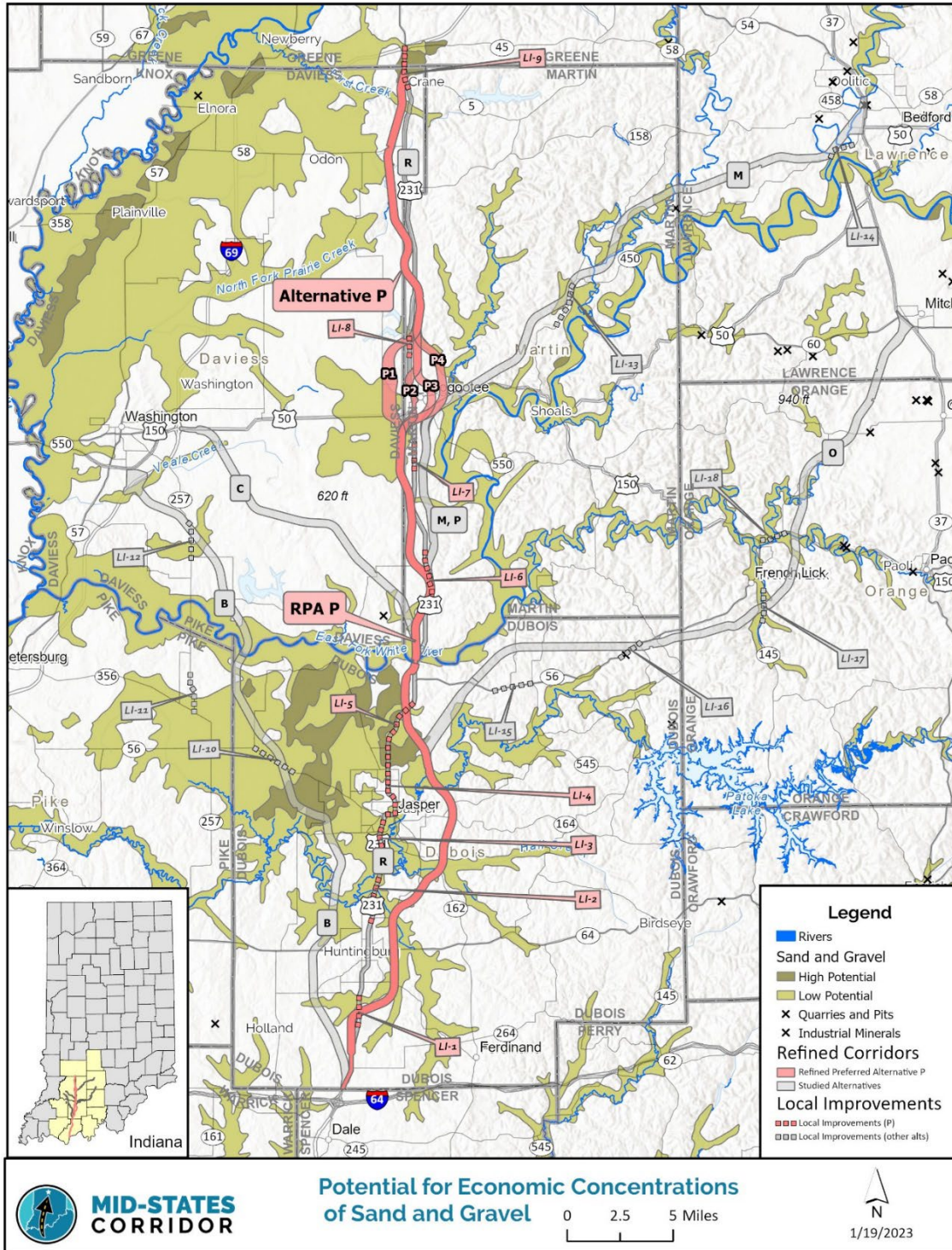
TABLE 11A: SAND AND GRAVEL RESOURCES (PERCENTAGE) RPA P AND ALTERNATIVE R

FEIS - Impacts to Sand and Gravel Potential Resources [^]					
Alternative*	R	RPA P			
Variation		RPA P1	RPA P2	RPA P3	RPA P4
Potential^{^^} Resource (% of ROW Subsection)					
Grand Total	6%	5%	6%	5%	5%
Low Potential Resource (% of ROW Subsection)					
Grand Total	19%	23-24%	24%	23-24%	25-26%
Total Resource (% of ROW Subsection)					
Grand Total	25%	31%	29%	28-29%	30-31%
<p>*Grand Total includes Section 2 and 3 with all LI, Range represents difference between Expressway and Super 2 where both are considered.</p> <p>[^]Indiana Geological Survey created the sand and gravel resource potential data in 2003 by assigning qualitative permissive tract assessments to each outcrop area in Gray, H. H., 1989, Quaternary geologic map of Indiana: Indiana Geological Survey Miscellaneous Map 49. The attribute table data was derived from Gray, H. H., 1973, Properties and uses of geologic materials in Indiana: Indiana Geological Survey Regional Geologic Map Supplementary Chart 1 and Carr, D. D., and Webb, W. M., 1970, Sand and gravel resources of Indiana: Indiana Geological Survey Bulletin 42-D, 31 p.</p> <p>^{^^} "Potential resource" indicates that the surficial unconsolidated deposits are likely to contain economic concentrations of sand and gravel, "low potential" indicates that the surficial unconsolidated deposits may contain economic concentrations of sand and gravel.</p>					



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FIGURE 5: SAND AND GRAVEL DISTRIBUTION IN THE MID-STATES STUDY AREA





Limestone

There are two types of limestone resources in the Study Area. They are surface resources and shallow bedded deposits (of the Mississippian age Blue River Group). Shallow deposits are typically quarried in surface mine pits in Southern Indiana. Quarries start on a hillside and excavate downward, extending into the valley floor at drainage level. That limestone can be mined below the ridges or valleys. There is no specific map showing where prospective limestone reserves are located in the Mid-States Study Area. Surface and underground limestone is pervasive in the Study Area. No definitive mapping of thickness or quality is available showing potentially mineable resources. No alternative impacts active limestone quarries. Regional bedrock geology containing limestone is mapped in **Figure 6**.

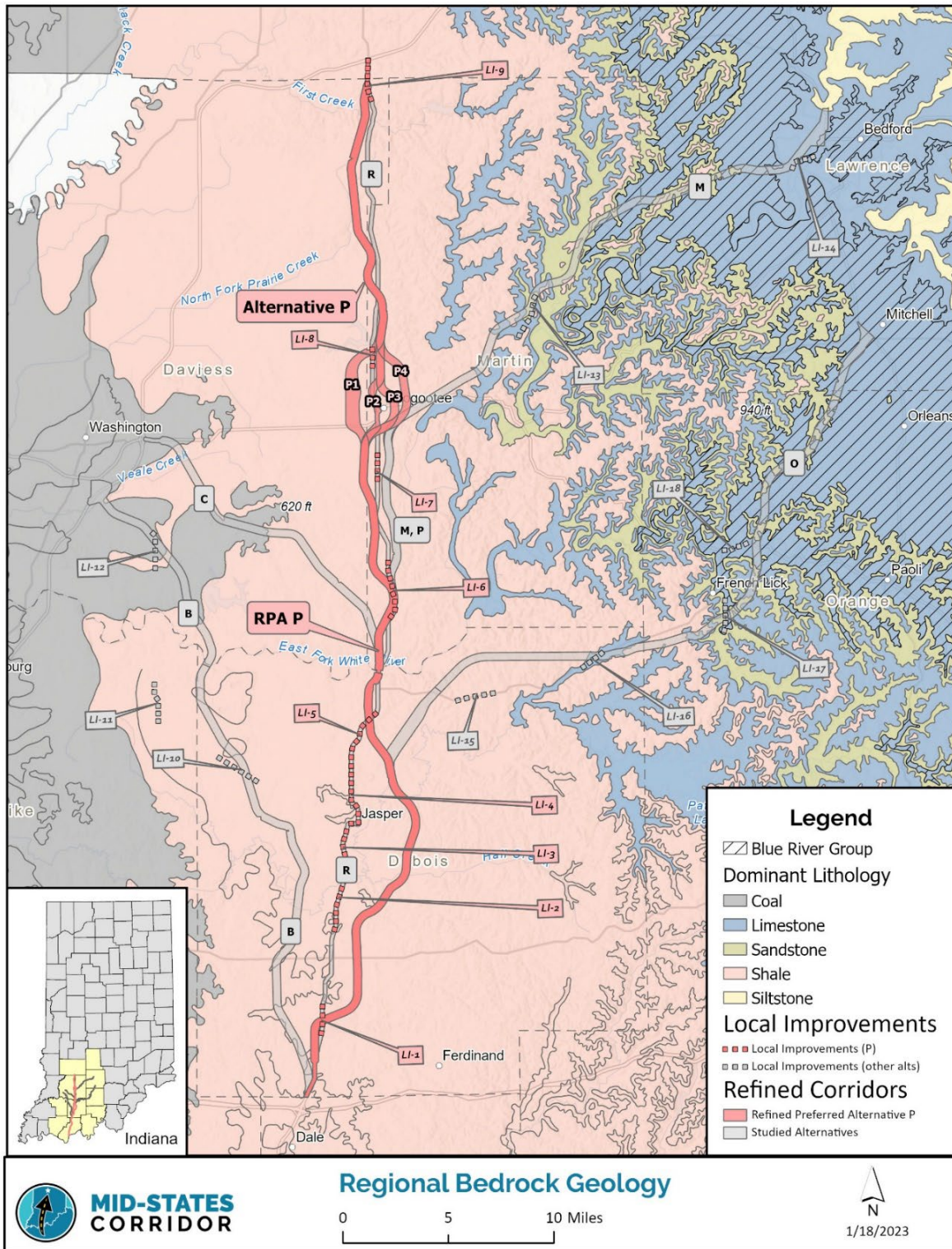
Gypsum

Indiana Geological Survey, Bulletin 42-A, "Gypsum Resources of Indiana," (1969) gives a general overview of the resources in Southern Indiana and where they may occur (**Figure 7**). Quantification of these gypsum deposits as mineable reserves has not been proven with drilling and testing. No Spatial data are available to determine whether potentially mineable areas of gypsum may exist along the alternative variations. The U.S. National Gypsum company mine and Processing Plant east of Shoals in Martin County is the only gypsum producer in Southern Indiana. It is located along U.S. 50 between alternatives M and O. No impacts to gypsum resources are expected from any alternative.



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FIGURE 6: DOMINANT LITHOLOGY OF THE MID-STATES STUDY AREA, HIGHLIGHTING LIMESTONE GROUPS





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FIGURE 7: GYPSUM POTENTIAL DISTRIBUTION IN THE MID-STATES STUDY AREA

