FWD Testing and Pavement Recommendations for ITR Truck Plaza at MP 108

FINAL REPORT

Prepared for:

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Introduction

Applied Research Associates, Inc. (ARA) was retained by the ITR Concession Company, LLC (ITRCC) to conduct a pavement evaluation and prepare pavement rehabilitation recommendations for the existing truck parking plazas on either side of the Indiana Toll Road (ITR), signed as Interstate 80 and 90, near Milepost 108. The truck parking plazas, serving both eastbound and westbound traffic, are located approximately one mile east of the Exit 107 interchange (U.S. Route 131 / State Route 13) in Middlebury, Indiana (York Township, Elkhart County). Figure 1 below shows the locations of these parking plazas.

Figure 1. Location of truck parking plazas east of Exit 107.

The existing parking pavements in both the eastbound and westbound lots are heavy rutted in both the parking stalls and driving lanes. To evaluate and develop recommendations for these parking plazas, ARA conducted a review of previously prepared engineering documents, conducted non-destructive Falling Weight Deflectomter (FWD) load/deflection testing and analysis, and consulted several relevant design manuals. Results of these evaluations follow in the sections below.

Existing Pavement Condition

Pavement condition was reviewed through a visual evaluation during the FWD testing site visit. The visual evaluation showed an aged pavement in both parking areas. Extensive rutting and cracking were observed throughout. Ravelling was also observed, leading to pothole development in some areas. The parking stalls were noticed to be heavily stained by oil and other fluids. Some localized patching has been performed. General photographs of the pavement surface and typical distresses are shown in Figure 2 and Figure 3.

Figure 2. Typical pavement condition in westbound truck parking plaza (north side of ITR).

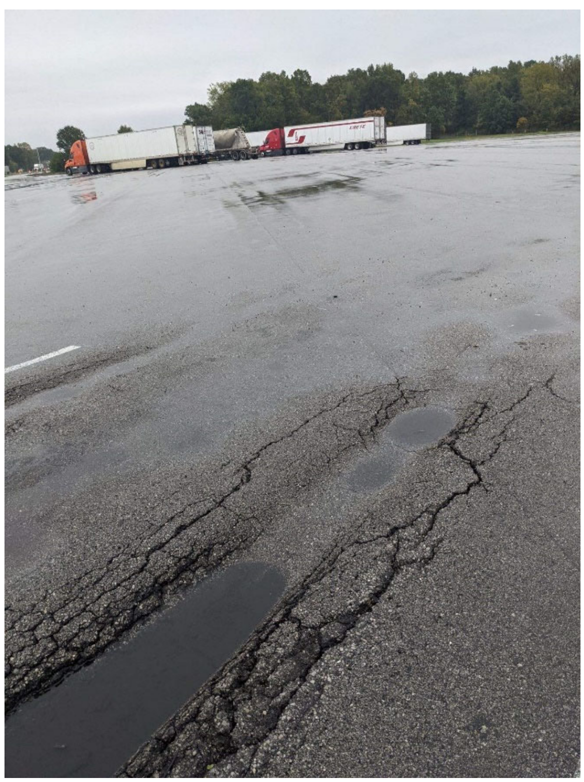


Figure 3. Typical pavement condition in eastbound truck parking plaza (south side of ITR).

Falling Weight Deflectometer (FWD) Data Collection

The Falling Weight Deflectometer (FWD) is an impulse deflection device that applies a dynamic load by dropping a weight onto a circular load plate placed on the pavement surface, and deflection transducers measure the resulting pavement deflections. Figure 4 illustrates this concept. For this project, one transducer was located at the center of the loading plate, with the remaining six of the seven remaining sensors spaced at intervals of 8, 12, 18, 24, 36, 48, and 60 inches from the plate. The ninth sensor was located 12 inches behind the plate, as shown in Figure 5. At each test point, three drops were applied at target loads of 6, 9, and 12 kips.

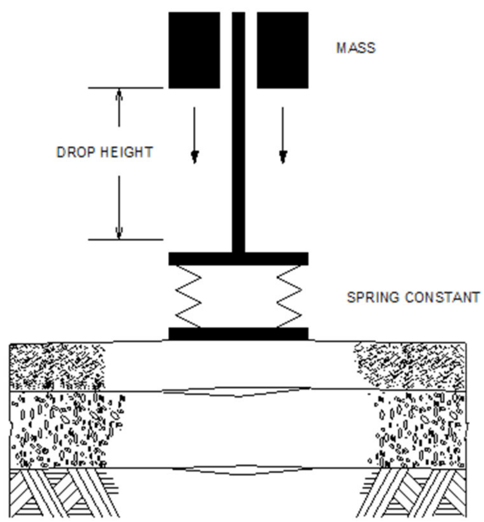


Figure 4. FWD concept

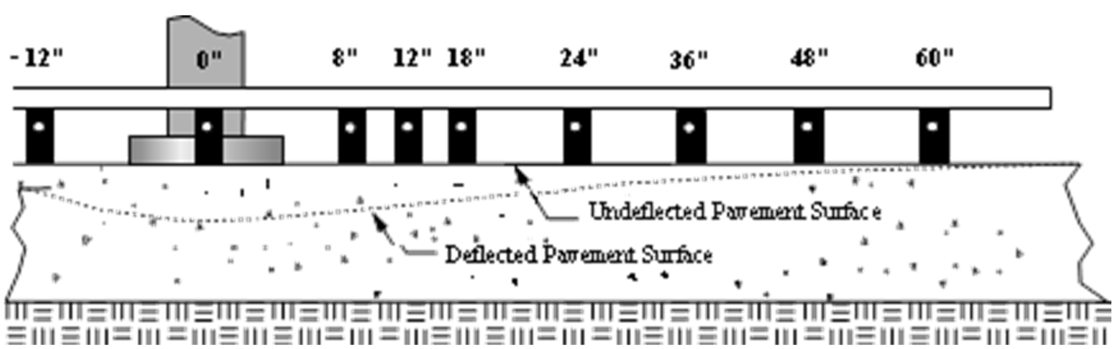


Figure 5. FWD deflection sensor positions.

ARA performed FWD testing using a Foundation Mechanics JILS 20T FWD. Tests were conducted in a grid pattern, distributed across the drive aisles and parking lanes. Test points were effectively spaced at 50 feet intervals. FWD tests were completed at a total of 275 test locations: 151 tests in the eastbound truck parking plaza and 124 tests in the westbound truck parking plaza. Given the grid nature of the FWD testing program, all tests have been referenced to a test point number, associated with a set of coordinates (latitude/longitude), measured using a Global Positioning System (GPS) unit.

Pavement Layer Information

A soil boring investigation of the truck parking plazas was performed Materials Inspection & Testing, Inc. (MIT) of Fort Wayne, Indiana in 2019. Two boreholes were advanced in the north parking plaza and one borehole was advanced in the south parking plaza. The boreholes were drilled to a depth of 10 feet below ground surface. The three borings showed a consistent pavement structure of approximately 16.0 inches of hot mix asphalt, underlain by a firm to very dense moist fine brown sand, with little fine gravel, extending to the bottom of the boring depth. This borehole data was used in the subsequent FWD data analysis.

FWD Results

The response (deflection) of a loaded pavement surface is a function of the rate and magnitude of the loading, the size and location of the loaded area, the thickness and stiffness of the pavement layers, and the subgrade support conditions. Using the load and deflection data, gathered using the FWD, supplemented with pavement thickness information, computer software can be used to "backcalculate" various pavement structural parameters.

Given the flexible pavement structure encountered, the analysis was carried out according to the procedures outlined in the 1993 AASHTO Guide for Design of Pavement Structures. The maximum normalized dynamic deflection (D_0) was first determined. Subsequently, the subgrade resilient modulus (M_r) was calculated. This was followed by determination of the effective pavement modulus (E_P), determined using the center deflection and subgrade modulus as inputs. Finally, an effective structural number (SN_{eff}) was determined from effective modulus and the total pavement thickness above the subgrade.

The results of the FWD analysis are summarized in the following sections. The full FWD testing results are presented in Appendix A.

Normalized Maximum Deflections (D_0)

The maximum normalized deflection (D_0), measured in the center of the load plate, is a good indicator of overall pavement strength. The measurements at this location are a function of all individual pavement layer stiffnesses, as well as the support capacity of the subgrade.

The maximum deflections at each point were normalized to represent the deflections that would be seen at 9,000 pounds and 68 °F. This process of normalization removes the effect of load variability on each drop and equalized the change in stiffness caused by varying temperatures, which has a dramatic impact on the strength of a pavement at any given time. In general, low D_0 values are indicative of stiffer (stronger) pavement sections.

The normalized maximum deflection statistics are presented in Table 1.

Table 1. Statistical Overview of Normalized Maximum Deflections

	Normalized Maximum Deflections, D_0 (mil)			
	Min	**Max**	**Average**	**Std Dev**
Eastbound Truck Plaza	2.91	9.00	5.61	1.30
Westbound Truck Plaza	2.36	9.41	5.43	1.52

The deflections are shown graphically in Figure 6. Note that the test point number does not necessarily reflect the location of the test point relative to the others spatially. All results have been plotted on a Google Earth map, indicating their true spatial location, included as an appendix to the report. Overall, the deflections in both truck parking plazas were relatively low and consistent, i.e. less than 10 mils.

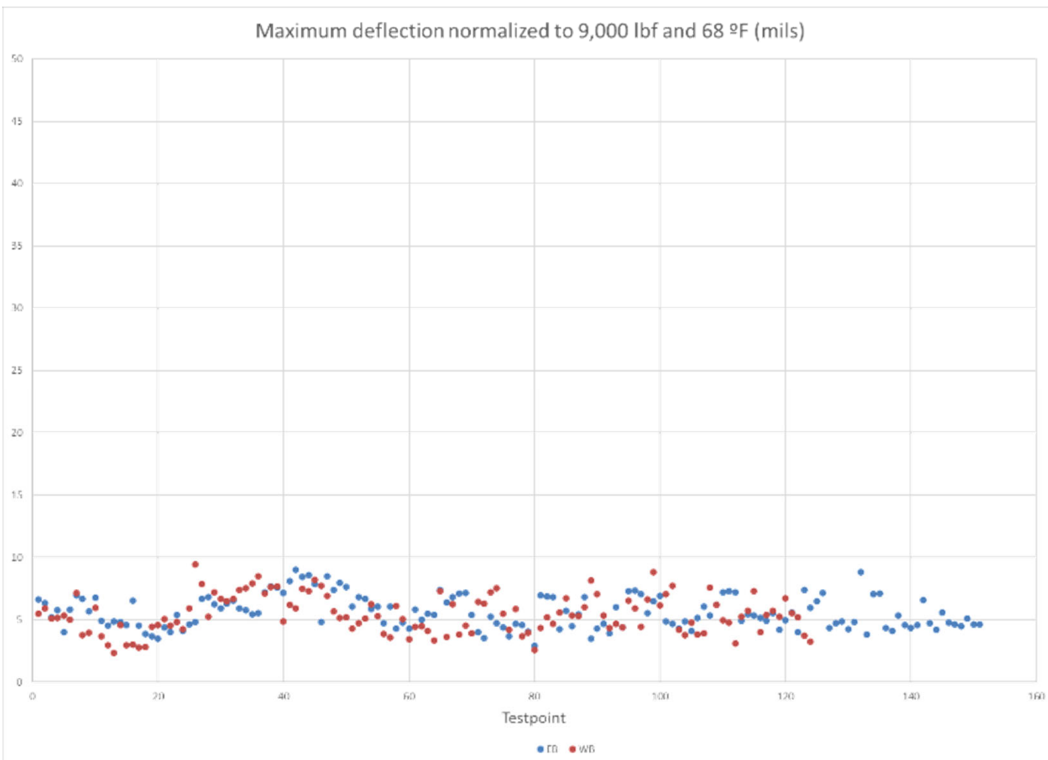


Figure 6. Normalized maximum deflections for both MP108 truck parking plazas.

Subgrade Resilient Modulus (M_r)

The strength of underlying subgrade soils is typically characterized using the resilient modulus (M_r). The resilient modulus is a measure of subgrade material stiffness or resistance to deformation under load. Subgrade resilient modulus is a key input in the AASHTO pavement design method.

M_r values can be estimated using FWD testing. At a sufficiently large distance from the load, the deflection measured at the pavement surface is almost entirely due to subgrade deformation only. Ensuring that the deflections are outside of the zone of influence of the stress bulb, the measured deflection values can be used to determine the Mr of the subgrade soil. When the dynamic backcalculated value is corrected to the static value, strong correlation between laboratory triaxial test values is typically achieved.

The subgrade resilient modulus statistics are presented in Table 2, and shown graphically in Figure 7.

Table 2. Statistical Overview of Subgrade Resilient Modulus

	Subgrade Resilient Modulus, M_r (psi)			
	Min	**Max**	**Average**	**Std Dev**
Eastbound Truck Plaza	7,050	15,981	11,279	2,171
Westbound Truck Plaza	6,405	17,913	11,579	2,910

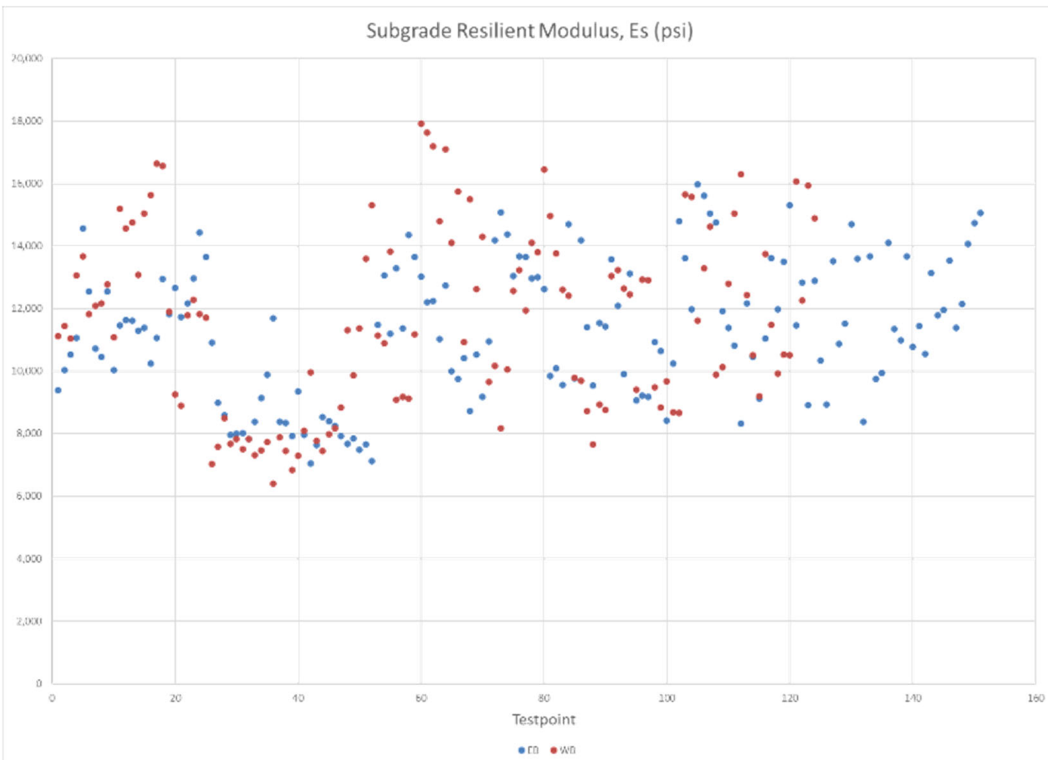


Figure 7. Subgrade resilient modulus for both MP108 truck parking plazas.

Effective Pavement Modulus (E_P)

The effective elastic modulus of the existing pavement (E_p) is a parameter that reflects a composite elastic modulus value for all pavement layers (bound and unbound) above the subgrade, i.e. the asphalt concrete and granular base layers. Using the AASHTO analysis procedures, this parameter can be calculated knowing the center deflection and the subgrade resilient modulus.

The subgrade resilient modulus statistics are presented in Table 3, and shown graphically in Figure 8.

Table 3. Statistical Overview of Effective Pavement Modulus

	Effective Pavement Modulus, E_p (psi)			
	Min	**Max**	**Average**	**Std Dev**
Eastbound Truck Plaza	152,237	928,371	311,730	115,322
Westbound Truck Plaza	146,136	1,232,216	349,828	172,032

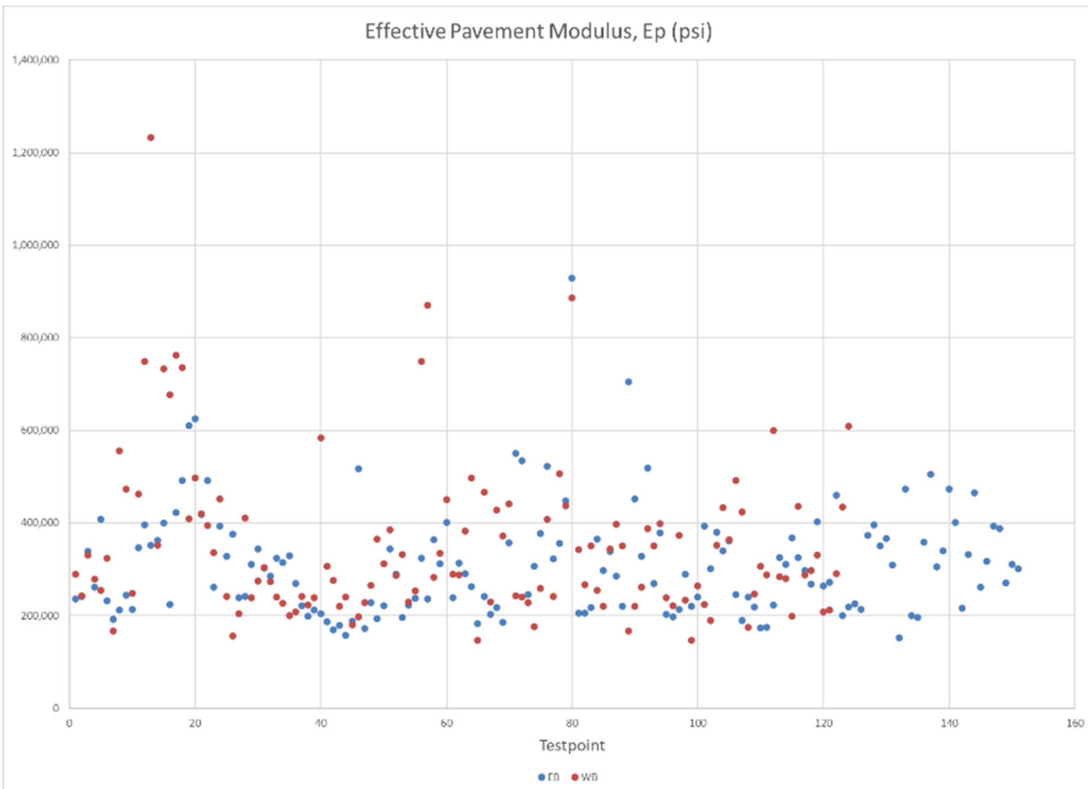


Figure 8. Effective pavement modulus for both MP108 truck parking plazas.

Effective Structural Number (SN_{eff})

The effective structural number represents the structural capacity of the existing pavement. This value is determined by backcalculation of the FWD results rather than using the AASHTO structural coefficients. The structural number, a value reported in inches, represents the equivalent thickness of a theoretical, homogenous material to which all other pavement materials can be compared using commonly acceptable equivalency factors. For example, newly placed, high quality hot-mix asphalt has a typical structural coefficient of 0.40-0.44 while virgin aggregate base has a structural coefficient of 0.08-0.14.

The SN_{eff} is a representation of the in-situ pavement's structural capacity, as determined using deflection measurements collected with the FWD. Higher SN_{eff} values are indicative of a higher structural capacity, or alternatively, the ability to carry more traffic.

The effective structural number statistics are presented in Table 4, and illustrated graphically in Figure 9.

Table 4. Statistical Overview of Effective Structural Number

	Effective Structural Number, SN_{eff} (in)			
	Min	**Max**	**Average**	**Std Dev**
Eastbound Truck Plaza	3.84	7.02	4.82	0.55
Westbound Truck Plaza	3.79	7.72	4.97	0.72

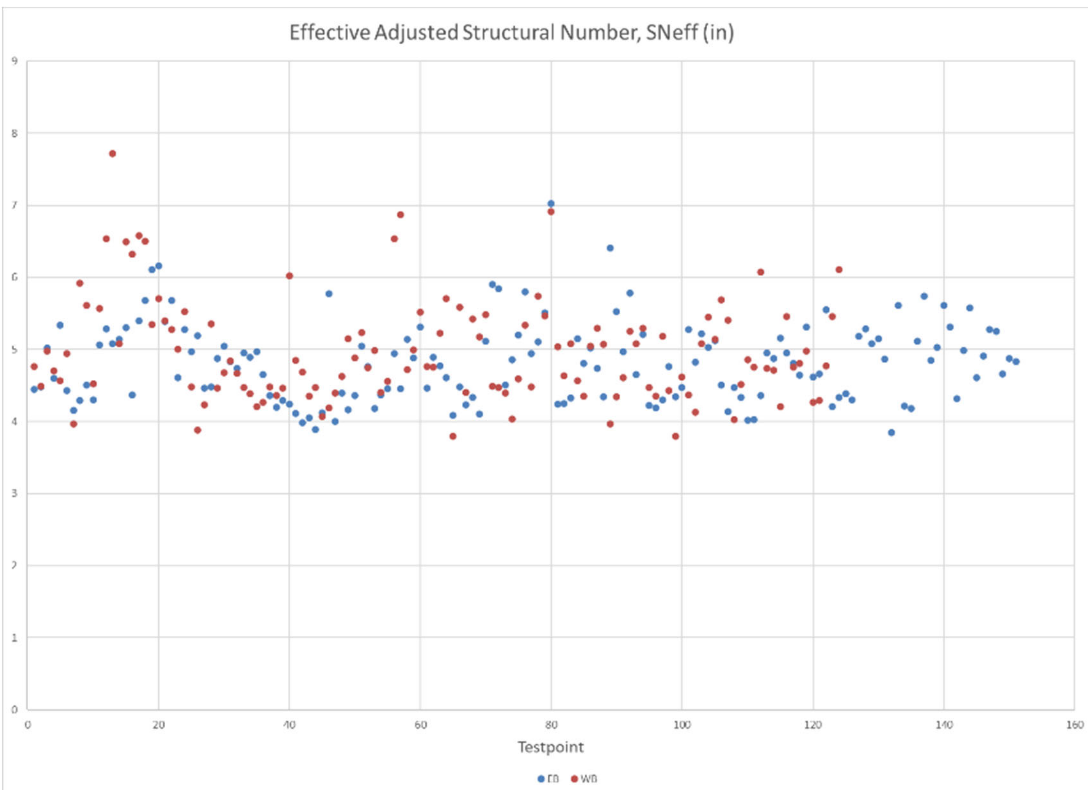


Figure 9. Effective structural number for both MP108 truck parking plazas.

With an in-situ hot mix asphalt layer of 16.0 inches, the expected structural numbers range from 4.0 to 6.4 inches. As seen in Figure 9, most test points yielded values within or above the expected range. A handful of test points, mostly in the eastbound parking area, are slightly below the bottom of the expected range.

Design Considerations

This assignment included the development of pavement rehabilitation alternative to restore the quality of the parking areas and extend their service life. Key inputs for the rehabilitation designs include existing pavement layer materials (types, thicknesses, and condition), current and projected traffic data (vehicle volumes and distributions), and consideration of the facility purpose and utilization.

Design Alternatives

A literature review was performed on possible design alternatives. In consideration of the pavement type, the observed pavement condition/distresses and the objective of service life extension, reduction or elimination of rutting and cracking will be required to accomplish the most cost-effective long-term rehabilitation strategy.

Several pavement design and rehabilitation strategies were considered for the MP108 parking areas. The results of our review are summarized in Table 5.

Table 5. Design Alternative Review

Alternative	Consideration Status	Reasons
Localized Patching	Rejected	Short term solution. Lowest cost. Does not properly extent of distresses present.
Mill and Overlay (Single or Multiple Lifts)	Rejected	Reduced service life. Poor condition of base asphalt would result in reduced service life (reflective cracking).
Full Depth Reclamation	Rejected	Impractical, given thickness of in-situ asphalt layers. Would require extensive removals.
Asphalt Reconstruction	Rejected	High initial cost. Would require extensive removals. Does not take advantage of value of in-situ materials.
Concrete Reconstruction	Rejected	High initial cost. Would require extensive removals. Does not take advantage of value of in-situ materials.
Bonded Concrete Overlay	Rejected	In-situ asphalt in poor condition. Extensive reflective cracking/joint degradation expected.
Unbonded Concrete Overlay	Selected	Maximizes service life while maximizing reuse of in-situ materials. Cost-effective solution.

Following a review of seven design alternatives, concrete unbonded overlay was selected as the preferred option for technical and economic reasons.

Unbonded concrete overlays of existing asphalt pavements is often called whitetopping. These pavements are generally designed as new concrete pavement structures. The typical thickness ranges from 4 to 12 inches. Unbonded overlays provide an alternative solution to hot-mix asphalt for rehabilitating distressed flexible pavements that exhibit distresses, such as rutting, shoving, and alligator cracking. Pre-overlay repair of badly distressed or failed areas is required, and milling of the existing asphalt surface is commonly performed to eliminate ruts and other surface irregularities before overlay placement.

Details on the input data used for the pavement design is given in the following sections.

Pavement Design

American Concrete Institute (ACI) 330R-08 (*Guide for the Design and Construction of Concrete Parking Lots*) was selected as the pavement design methodology for the unbonded concrete overlay design. The following inputs were used in the ACI design procedure:

- Overlay type: Jointed Plain Concrete Pavement (JPCP)
- Subgrade-subbase support = medium (130-170 psi/in, based on FWD results and interpolation)
- Modulus of rupture, MOR = 500 psi
- Traffic category (Truck parking areas, multiple units (tractor trailer units with one or more trailers):
    - Parking areas and interior lanes: Category C
    - Entrance and exterior lanes: Category D
- No dowels at joints
- 20-year service life

The resultant design thicknesses for the unbonded overlay from Table 3.4 of ACI 330R-08 ranged from 6.5 to 8.0 inches. For constructability purposes, a consistent pavement design thickness should be used throughout. Therefore, the recommended overlay thickness is 8.0 inches.

Recommendations

The proposed pavement rehabilitation design for the Milepost 108 truck parking plazas is the placement of an 8.0 inch thick unbonded concrete overlay. The slab dimensions should be 12 ft wide by 12 ft long. No dowels at the joints are required.

Prior to the placement of the overlay, the parking areas should be cold milled to a depth of 1.5 inches to remove any surface irregularities. Any highly distressed or failed areas should be removed and replaced with new hot mix asphalt prior to overlay placement.

All materials and construction should meet INDOT requirements.

Closure

The analysis presented is based on design inputs provided by others, supplemented by ARA's experience with projects of this type. It is strongly recommended that all materials and construction methods used for this project comply with current INDOT standards and that detailed quality control and quality assurance programs be established to verify that the as-constructed pavements meet or exceed the design assumptions. Details of the investigation and the recommendations given in this report are considered to be complete. However, should any questions arise, please do not hesitate to contact our office.

Appendix A

FWD Results

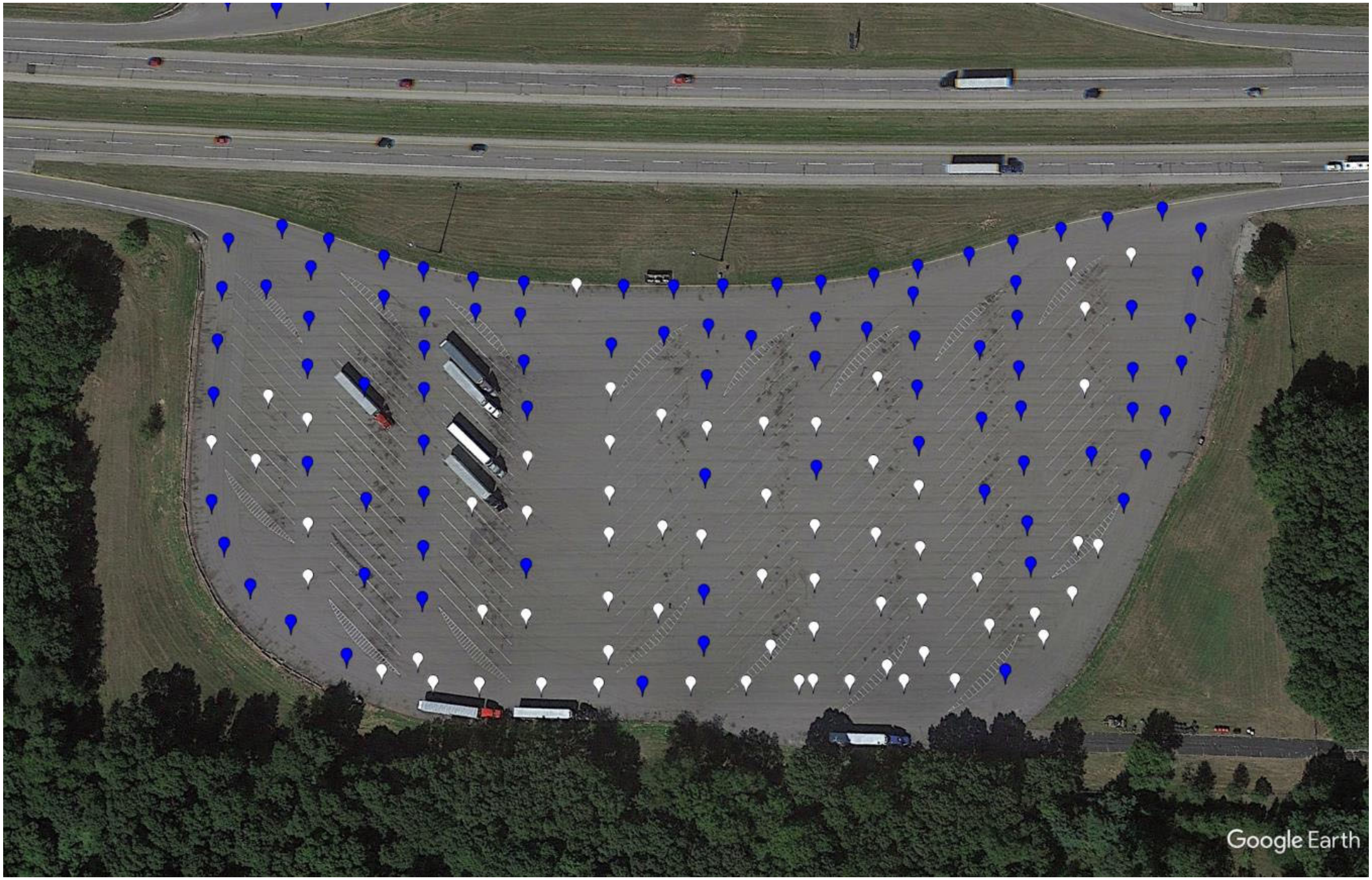
FWD Results – Eastbound Truck Parking Plaza

Direction	Test Point Number	Max. Normalized Deflection (D_0, mils)	Subgrade Resilient Modulus (M_r, psi)	Effective Pavement Modulus (E_p, psi)	Effective Structural Number (SN_{eff}, in)	Latitude	Longitude
EB	1	6.61	9,390	235,364	4.45	41.748012	-85.667817
EB	2	6.33	10,027	241,237	4.48	41.747878	-85.667781
EB	3	5.18	10,529	338,254	5.02	41.747737	-85.667734
EB	4	5.79	11,069	260,949	4.60	41.747596	-85.667684
EB	5	4.02	14,559	407,662	5.34	41.747472	-85.667636
EB	6	5.83	12,540	232,565	4.43	41.747321	-85.667566
EB	7	6.96	10,716	191,986	4.15	41.747223	-85.667475
EB	8	6.66	10,450	212,014	4.29	41.747138	-85.667340
EB	9	5.66	12,543	244,607	4.50	41.747078	-85.667165
EB	10	6.75	10,037	213,655	4.30	41.747035	-85.666943
EB	11	4.91	11,465	347,054	5.06	41.747021	-85.666810
EB	12	4.56	11,624	396,295	5.29	41.747029	-85.666627
EB	13	4.85	11,605	351,466	5.08	41.747057	-85.666471
EB	14	4.83	11,282	363,249	5.14	41.747099	-85.666264
EB	15	4.58	11,392	399,740	5.30	41.747138	-85.666072
EB	16	6.53	10,242	223,499	4.37	41.747170	-85.665926
EB	17	4.53	11,055	422,119	5.40	41.747204	-85.665765
EB	18	3.88	12,940	491,589	5.68	41.747244	-85.665580
EB	19	3.66	11,819	610,944	6.11	41.747283	-85.665403
EB	20	3.49	12,666	625,755	6.16	41.747318	-85.665233
EB	21	4.41	11,733	418,507	5.39	41.747357	-85.665051
EB	22	4.00	12,167	491,682	5.68	41.747394	-85.664880
EB	23	5.38	12,964	261,683	4.61	41.747451	-85.664717
EB	24	4.12	14,432	393,423	5.28	41.747565	-85.664615
EB	25	4.65	13,654	327,934	4.97	41.747695	-85.664551
EB	26	4.83	10,901	375,501	5.19	41.747835	-85.664499
EB	27	6.70	8,988	238,854	4.47	41.747970	-85.664445
EB	28	6.81	8,585	241,322	4.48	41.748101	-85.664402
EB	29	6.22	7,962	310,372	4.87	41.748232	-85.664368
EB	30	5.91	7,994	343,913	5.04	41.748379	-85.664349
EB	31	6.28	8,022	302,685	4.83	41.748500	-85.664350
EB	32	6.54	7,826	285,335	4.74	41.748635	-85.664361
EB	33	5.93	8,374	324,539	4.95	41.748760	-85.664383
EB	34	5.77	9,131	314,489	4.90	41.748790	-85.664538
EB	35	5.43	9,873	328,819	4.97	41.748721	-85.664726
EB	36	5.55	11,693	269,206	4.65	41.748657	-85.664884
EB	37	7.20	8,376	221,580	4.36	41.748586	-85.665044
EB	38	7.66	8,334	198,170	4.20	41.748520	-85.665189
EB	39	7.56	7,918	212,492	4.30	41.748448	-85.665360
EB	40	7.15	9,351	203,926	4.24	41.748391	-85.665507
EB	41	8.09	7,958	186,294	4.11	41.748333	-85.665688
EB	42	9.00	7,050	169,489	3.98	41.748294	-85.665840
EB	43	8.45	7,636	178,074	4.05	41.748252	-85.666030
EB	44	8.59	8,526	157,541	3.89	41.748213	-85.666202

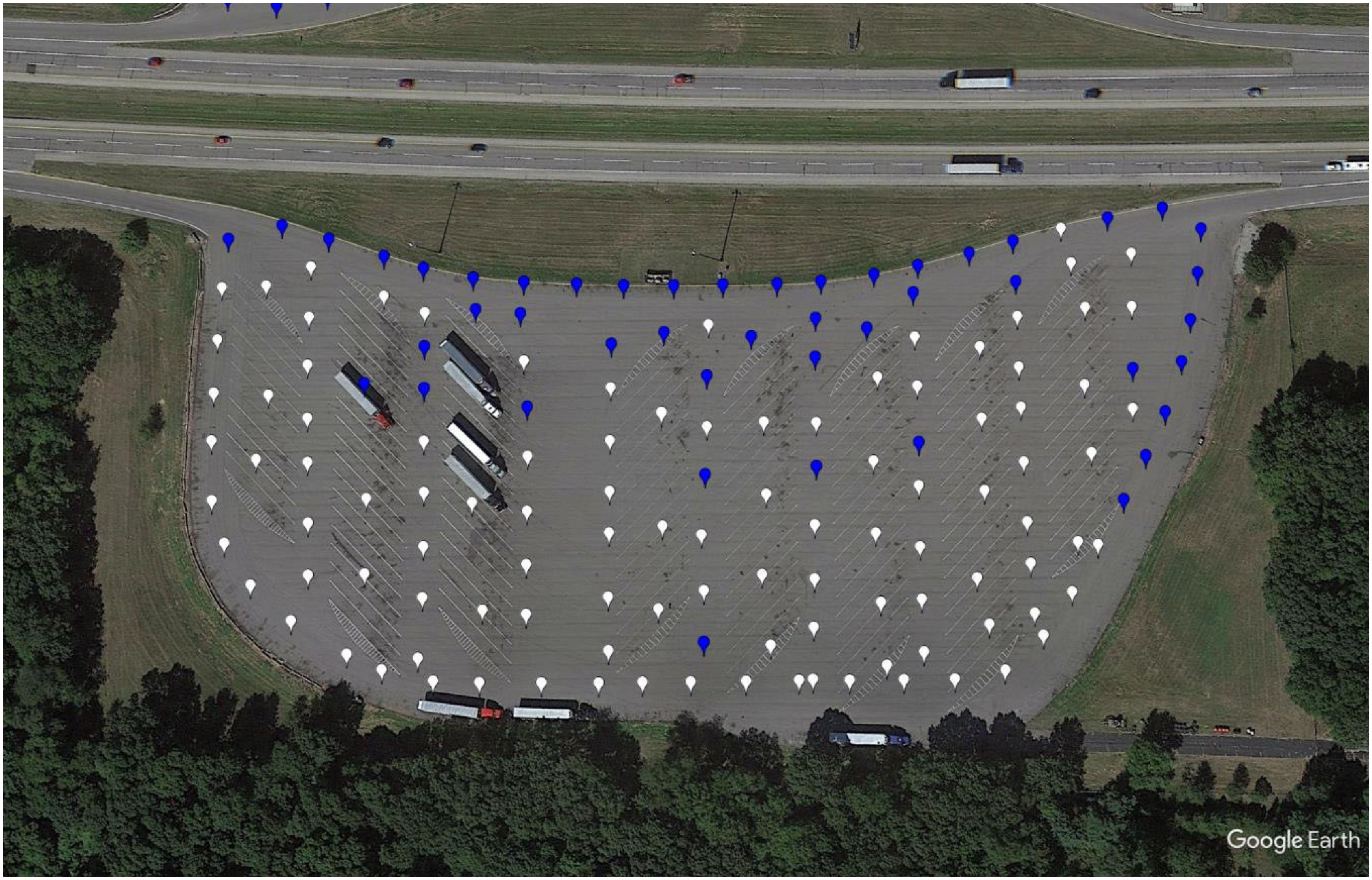
Direction	Test Point Number	Max. Normalized Deflection (D_0, mils)	Subgrade Resilient Modulus (M_r, psi)	Effective Pavement Modulus (E_p, psi)	Effective Structural Number (SN_{eff}, in)	Latitude	Longitude
EB	45	7.85	8,404	187,804	4.12	41.748177	-85.666378
EB	46	4.80	8,240	516,892	5.78	41.748147	-85.666545
EB	47	8.48	7,921	171,419	4.00	41.748113	-85.666732
EB	48	7.40	7,682	227,967	4.40	41.748087	-85.666914
EB	49	7.97	7,841	194,031	4.17	41.748077	-85.667099
EB	50	7.61	7,475	221,685	4.36	41.748080	-85.667251
EB	51	6.05	7,648	343,876	5.04	41.748086	-85.667465
EB	52	6.82	7,120	289,001	4.76	41.748088	-85.667645
EB	53	6.67	11,488	196,118	4.18	41.747998	-85.667495
EB	54	5.86	13,063	223,146	4.37	41.747863	-85.667443
EB	55	6.07	11,186	237,149	4.46	41.747736	-85.667393
EB	56	4.75	13,287	323,374	4.94	41.747598	-85.667333
EB	57	6.04	11,375	236,355	4.45	41.747485	-85.667283
EB	58	4.29	14,360	364,469	5.14	41.747332	-85.667214
EB	59	4.77	13,656	312,507	4.89	41.747202	-85.667157
EB	60	4.28	13,017	401,313	5.31	41.747074	-85.666701
EB	61	5.81	12,210	238,809	4.47	41.747226	-85.666748
EB	62	5.01	12,250	313,655	4.89	41.747354	-85.666798
EB	63	5.48	11,022	290,984	4.77	41.747491	-85.666853
EB	64	5.41	12,741	262,601	4.61	41.747622	-85.666908
EB	65	7.38	9,999	182,358	4.08	41.747759	-85.666964
EB	66	6.41	9,756	240,937	4.48	41.747869	-85.667009
EB	67	6.83	10,416	202,951	4.23	41.747959	-85.667045
EB	68	7.13	8,727	217,891	4.33	41.748026	-85.666710
EB	69	7.15	10,532	185,483	4.11	41.747903	-85.666648
EB	70	5.40	9,171	357,799	5.11	41.747784	-85.666588
EB	71	4.00	10,944	550,653	5.90	41.747657	-85.666536
EB	72	3.55	14,193	534,337	5.84	41.747516	-85.666482
EB	73	5.23	15,082	244,740	4.50	41.747381	-85.666431
EB	74	4.70	14,369	307,198	4.86	41.747257	-85.666382
EB	75	4.41	13,044	377,734	5.20	41.747224	-85.666070
EB	76	3.66	13,663	522,666	5.80	41.747357	-85.666122
EB	77	4.69	13,660	323,139	4.94	41.747519	-85.666181
EB	78	4.56	12,960	356,343	5.10	41.747625	-85.666220
EB	79	4.05	12,999	448,412	5.51	41.747756	-85.666269
EB	80	2.92	12,621	928,371	7.02	41.747895	-85.666319
EB	81	6.97	9,848	204,910	4.24	41.748011	-85.666361
EB	82	6.88	10,095	205,463	4.25	41.748133	-85.666041
EB	83	6.84	9,549	217,588	4.33	41.747996	-85.665997
EB	84	4.24	14,706	365,282	5.15	41.747862	-85.665948
EB	85	5.74	9,770	297,049	4.80	41.747736	-85.665908
EB	86	4.49	14,191	338,466	5.02	41.747579	-85.665864
EB	87	5.45	11,404	285,143	4.74	41.747440	-85.665804
EB	88	6.81	9,534	219,582	4.34	41.747311	-85.665757
EB	89	3.47	11,542	705,218	6.41	41.747295	-85.665357
EB	90	4.31	11,423	452,144	5.53	41.747425	-85.665399

Direction	Test Point Number	Max. Normalized Deflection (D_0, mils)	Subgrade Resilient Modulus (M_r, psi)	Effective Pavement Modulus (E_p, psi)	Effective Structural Number (SN_{eff}, in)	Latitude	Longitude
EB	91	4.66	13,583	328,214	4.97	41.747547	-85.665439
EB	92	3.91	12,099	518,941	5.79	41.747685	-85.665486
EB	93	6.01	9,892	269,443	4.65	41.747837	-85.665533
EB	94	4.39	13,116	378,732	5.21	41.747951	-85.665573
EB	95	7.29	9,069	202,173	4.23	41.748124	-85.665637
EB	96	7.34	9,213	196,722	4.19	41.748229	-85.665672
EB	97	7.04	9,182	213,397	4.30	41.748370	-85.665352
EB	98	5.51	10,924	289,908	4.77	41.748251	-85.665307
EB	99	6.47	10,635	219,836	4.35	41.748121	-85.665255
EB	100	6.90	8,425	239,987	4.47	41.747973	-85.665200
EB	101	4.88	10,234	392,900	5.27	41.747860	-85.665163
EB	102	4.70	14,795	300,642	4.82	41.747703	-85.665107
EB	103	4.31	13,604	380,558	5.22	41.747571	-85.665057
EB	104	4.85	11,981	340,221	5.03	41.747440	-85.665006
EB	105	4.11	15,981	361,163	5.13	41.747615	-85.664662
EB	106	5.14	15,617	245,740	4.51	41.747739	-85.664715
EB	107	6.08	15,042	189,568	4.14	41.747843	-85.664760
EB	108	5.33	14,762	239,834	4.47	41.747997	-85.664820
EB	109	6.18	11,911	218,095	4.33	41.748140	-85.664875
EB	110	7.18	11,391	173,628	4.02	41.748246	-85.664916
EB	111	7.31	10,814	174,530	4.02	41.748382	-85.664964
EB	112	7.22	8,319	222,212	4.36	41.748476	-85.664999
EB	113	4.93	12,175	325,204	4.95	41.748640	-85.664613
EB	114	5.43	10,455	310,821	4.88	41.748493	-85.664568
EB	115	5.34	9,119	367,498	5.16	41.748325	-85.664515
EB	116	5.16	11,040	325,918	4.95	41.748217	-85.664484
EB	117	4.90	13,611	297,964	4.81	41.747237	-85.666533
EB	118	5.51	11,969	267,594	4.64	41.747435	-85.667043
EB	119	4.20	13,492	402,017	5.31	41.747630	-85.667494
EB	120	4.97	15,313	264,129	4.62	41.747456	-85.667462
EB	121	5.57	11,466	271,971	4.66	41.747245	-85.666968
EB	122	4.03	12,827	459,409	5.56	41.747499	-85.666678
EB	123	7.40	8,914	199,485	4.21	41.747729	-85.667176
EB	124	5.97	12,886	218,290	4.34	41.747915	-85.667629
EB	125	6.46	10,335	225,837	4.38	41.747973	-85.667206
EB	126	7.13	8,938	213,327	4.30	41.748004	-85.666871
EB	127	4.37	13,510	373,011	5.18	41.747362	-85.665941
EB	128	4.71	10,880	395,617	5.29	41.747729	-85.665680
EB	129	4.87	11,515	350,588	5.08	41.748116	-85.665401
EB	130	4.24	14,702	366,296	5.15	41.747574	-85.666005
EB	131	4.81	13,597	308,920	4.87	41.747915	-85.665755
EB	132	8.83	8,378	152,237	3.84	41.748240	-85.665483
EB	133	3.84	13,664	473,844	5.61	41.747862	-85.666117
EB	134	7.08	9,756	200,250	4.21	41.748133	-85.665880
EB	135	7.10	9,948	195,943	4.18	41.748080	-85.666189
EB	136	4.36	14,109	359,120	5.12	41.747521	-85.665621

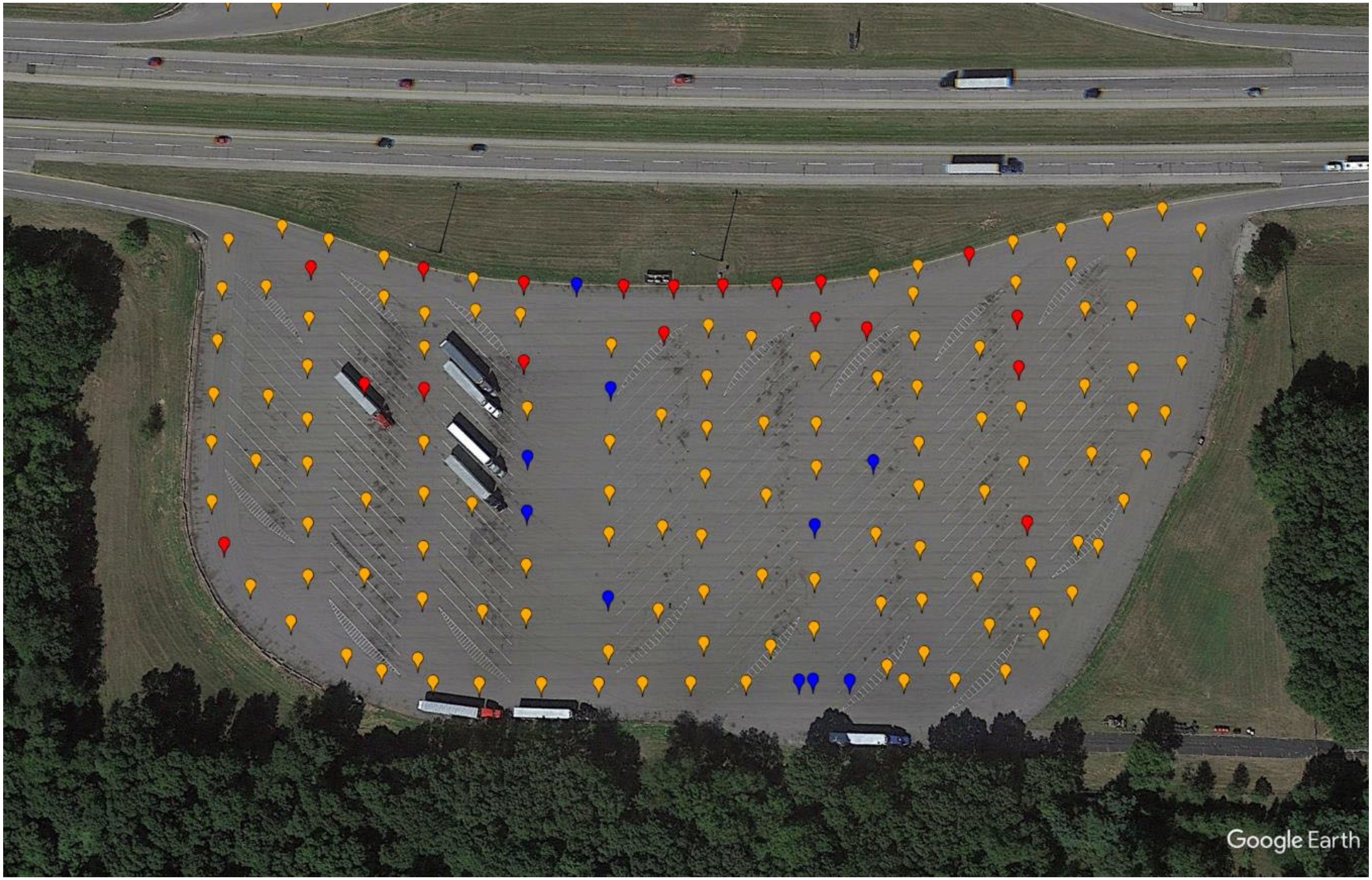
Direction	Test Point Number	Max. Normalized Deflection (D_0, mils)	Subgrade Resilient Modulus (M_r, psi)	Effective Pavement Modulus (E_p, psi)	Effective Structural Number (SN_{eff}, in)	Latitude	Longitude
EB	137	4.09	11,350	505,651	5.74	41.747892	-85.665341
EB	138	5.35	10,995	305,295	4.85	41.748272	-85.665070
EB	139	4.56	13,662	340,236	5.03	41.748569	-85.664819
EB	140	4.34	10,779	472,660	5.61	41.747350	-85.665529
EB	141	4.57	11,435	401,013	5.31	41.747707	-85.665270
EB	142	6.56	10,554	215,870	4.32	41.748082	-85.665003
EB	143	4.70	13,141	332,423	4.99	41.748456	-85.664732
EB	144	4.18	11,779	464,881	5.58	41.747534	-85.665193
EB	145	5.58	11,960	261,694	4.61	41.747894	-85.664932
EB	146	4.75	13,543	317,023	4.91	41.748246	-85.664671
EB	147	4.62	11,388	392,942	5.27	41.747381	-85.665120
EB	148	4.50	12,154	388,195	5.25	41.747664	-85.664886
EB	149	5.09	14,063	271,281	4.66	41.748070	-85.664593
EB	150	4.63	14,742	310,051	4.87	41.747555	-85.664807
EB	151	4.65	15,051	301,913	4.83	41.747828	-85.664570
Average		**5.61**	**11,281**	**311,879**	**4.82**		
Std. Deviation		**1.30**	**2,178**	**115,692**	**0.55**		
Minimum		**2.92**	**7,050**	**152,237**	**3.84**		
Maximum		**9.00**	**15,981**	**928,371**	**7.02**		



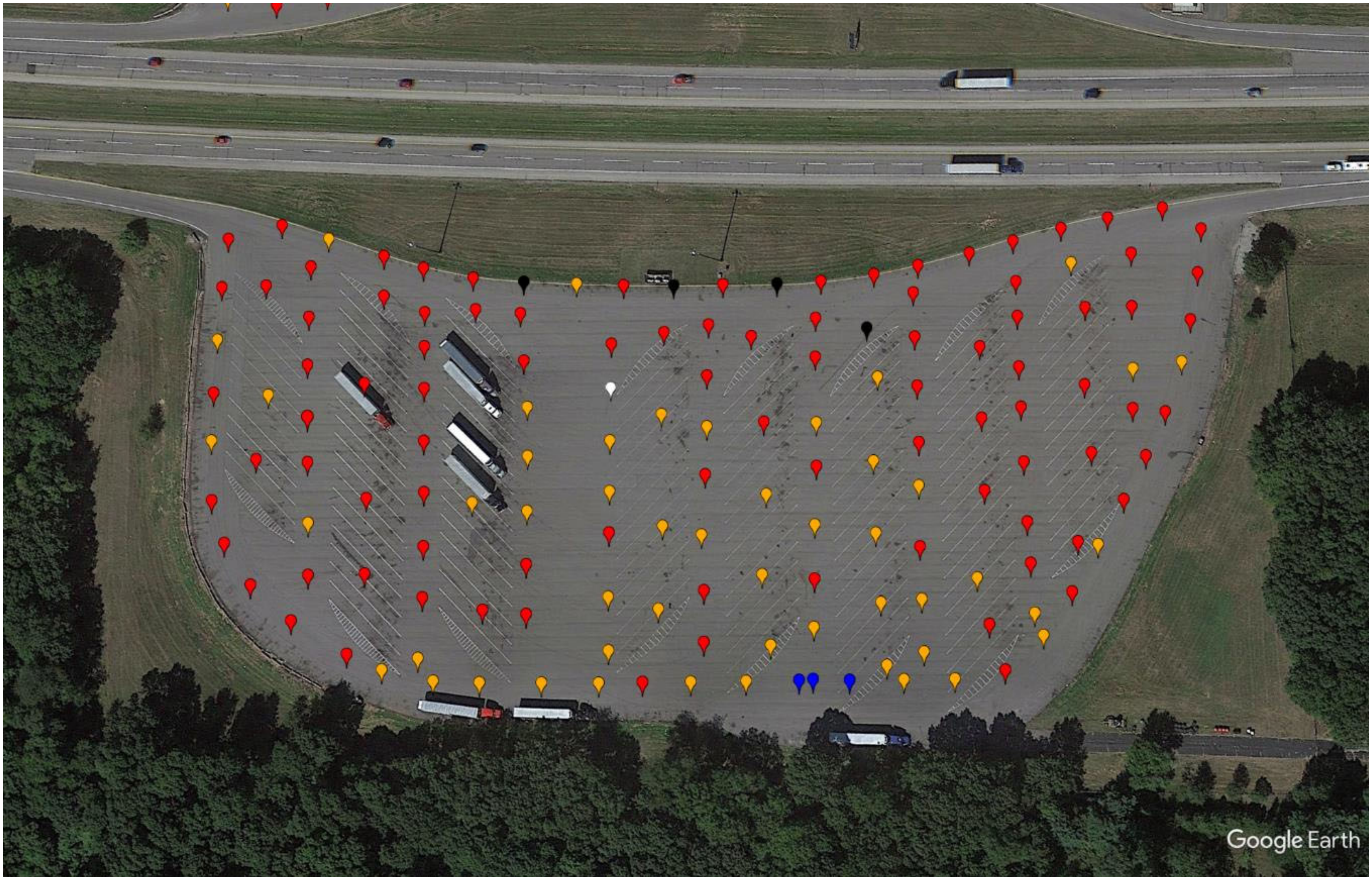
Maximum normalized deflection values for eastbound truck parking plaza.



Subgrade resilient modulus values for eastbound truck parking plaza.



Effective pavement modulus values for eastbound truck parking plaza.



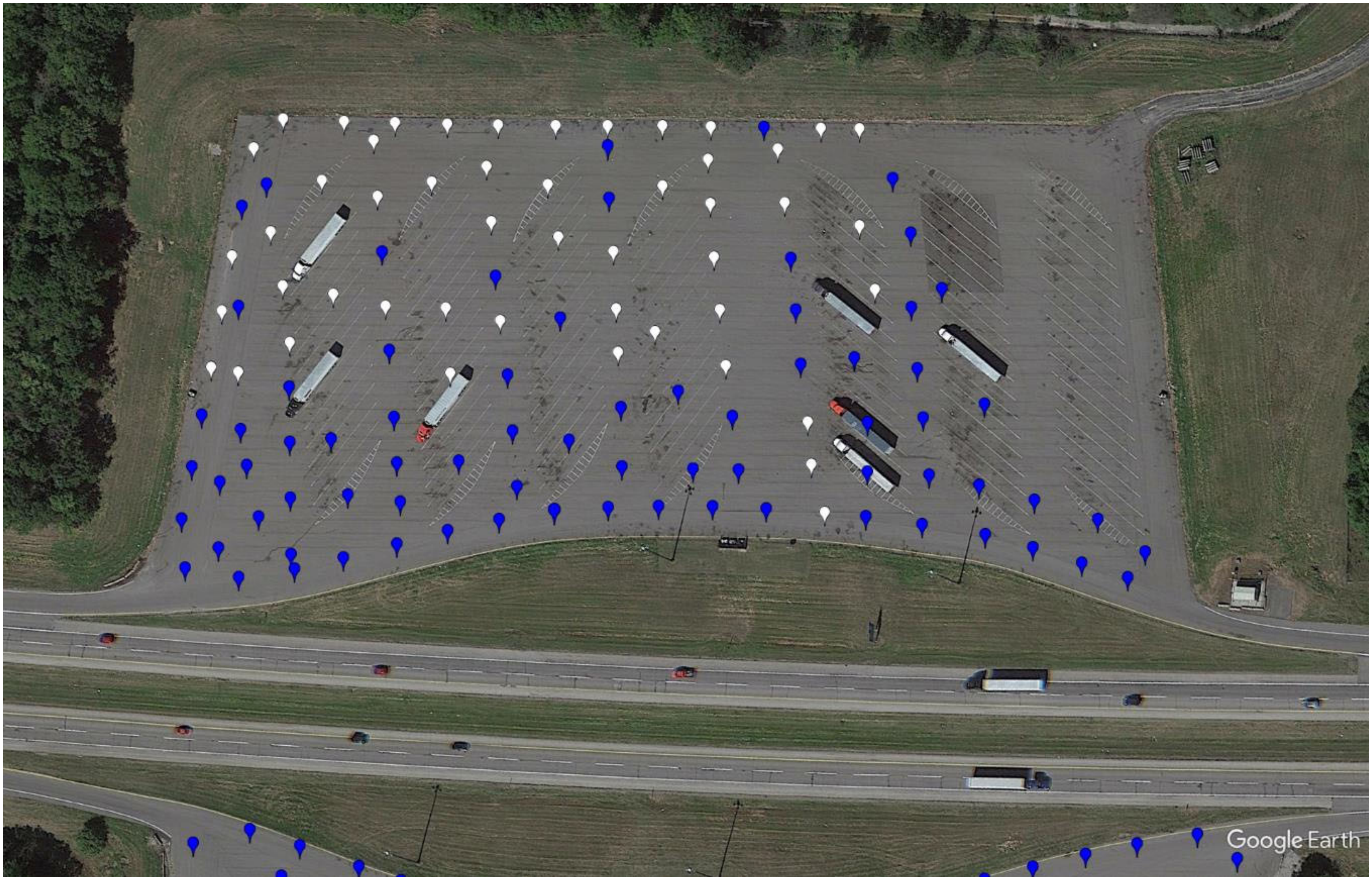
Effective structural number values for eastbound truck parking plaza.

FWD Results – Westbound Truck Parking Plaza

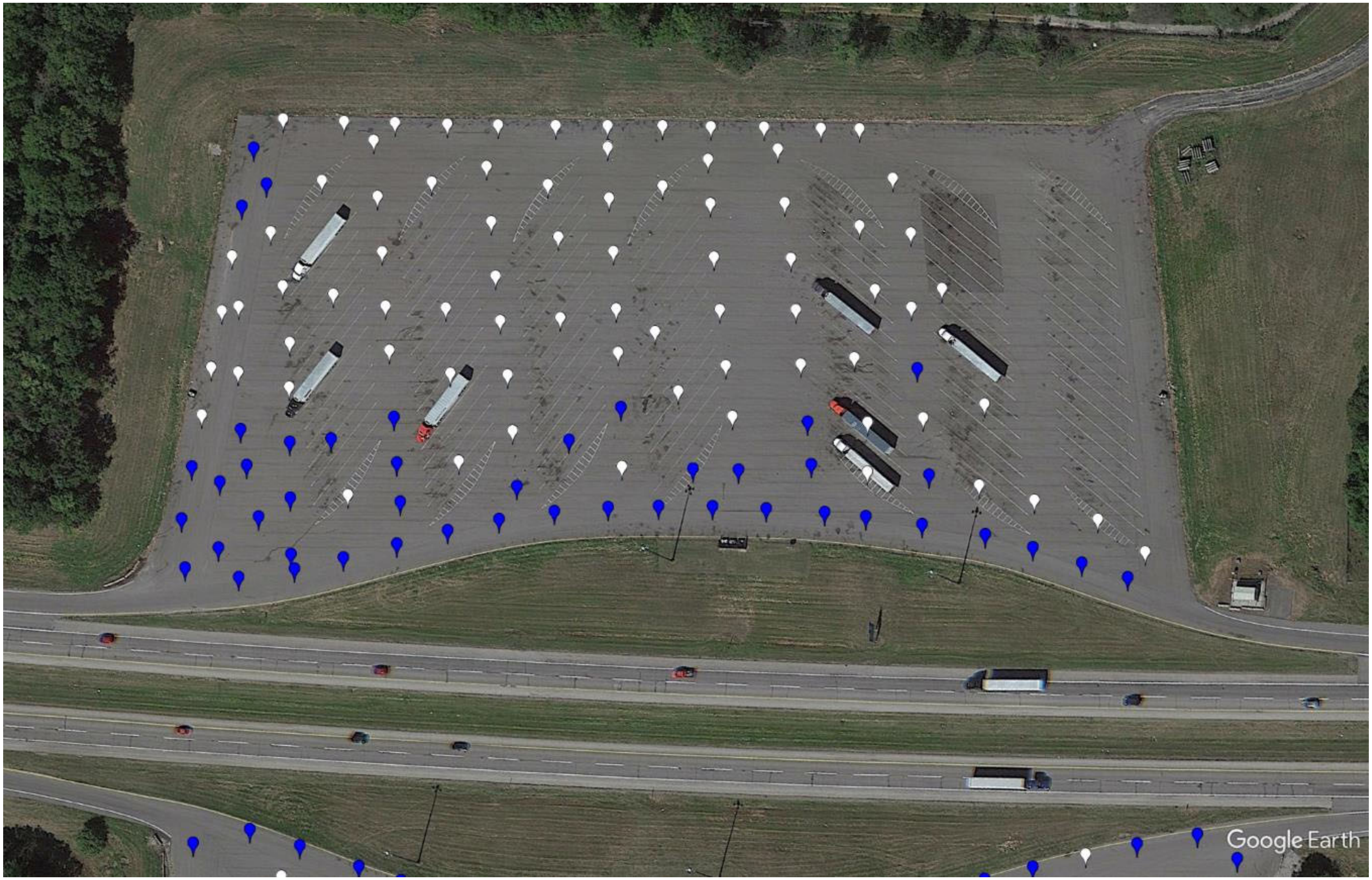
Direction	Test Point Number	Max. Normalized Deflection (D_0, mils)	Subgrade Resilient Modulus (M_r, psi)	Effective Pavement Modulus (E_p, psi)	Effective Structural Number (SN_{eff}, in)	Latitude	Longitude
WB	1	5.47	11,119	289,266	4.76	41.749440	-85.664994
WB	2	5.93	11,438	243,002	4.49	41.749484	-85.665182
WB	3	5.12	11,035	330,705	4.98	41.749483	-85.665409
WB	4	5.18	13,055	279,166	4.71	41.749680	-85.665669
WB	5	5.33	13,661	254,827	4.56	41.749930	-85.665925
WB	6	5.01	11,830	323,839	4.94	41.750042	-85.666083
WB	7	7.15	12,096	167,201	3.97	41.750162	-85.666197
WB	8	3.77	12,168	556,460	5.92	41.750258	-85.666356
WB	9	3.97	12,780	473,799	5.61	41.750230	-85.666483
WB	10	5.96	11,079	247,476	4.52	41.750190	-85.666670
WB	11	3.69	15,196	462,304	5.57	41.750151	-85.666845
WB	12	2.98	14,573	749,142	6.54	41.750117	-85.667004
WB	13	2.36	14,755	1,232,216	7.72	41.750076	-85.667184
WB	14	4.57	13,088	352,238	5.08	41.750037	-85.667354
WB	15	2.95	15,049	733,652	6.49	41.749995	-85.667543
WB	16	3.01	15,634	677,256	6.32	41.749959	-85.667710
WB	17	2.75	16,630	762,286	6.58	41.749923	-85.667883
WB	18	2.81	16,555	735,566	6.50	41.749888	-85.668051
WB	19	4.43	11,902	409,573	5.35	41.749848	-85.668253
WB	20	4.59	9,255	497,671	5.71	41.749755	-85.668320
WB	21	5.07	8,890	420,332	5.39	41.749604	-85.668300
WB	22	4.53	11,788	394,793	5.28	41.749475	-85.668282
WB	23	4.83	12,281	335,285	5.00	41.749333	-85.668260
WB	24	4.23	11,831	451,533	5.52	41.749187	-85.668238
WB	25	5.89	11,700	241,004	4.48	41.749064	-85.668221
WB	26	9.41	7,022	156,262	3.88	41.748930	-85.668201
WB	27	7.89	7,583	203,730	4.24	41.748795	-85.668182
WB	28	5.26	8,490	410,597	5.35	41.748678	-85.668121
WB	29	7.22	7,683	238,950	4.47	41.748695	-85.667936
WB	30	6.67	7,818	274,648	4.68	41.748758	-85.667762
WB	31	6.47	7,495	304,430	4.84	41.748822	-85.667613
WB	32	6.69	7,829	272,821	4.67	41.748896	-85.667452
WB	33	7.39	7,309	239,432	4.47	41.748967	-85.667299
WB	34	7.53	7,466	226,043	4.39	41.749033	-85.667142
WB	35	7.89	7,739	199,737	4.21	41.749094	-85.666969
WB	36	8.47	6,405	207,775	4.26	41.749144	-85.666797
WB	37	7.09	7,887	240,902	4.48	41.749185	-85.666633
WB	38	7.60	7,451	222,155	4.36	41.749225	-85.666456
WB	39	7.65	6,838	238,361	4.46	41.749260	-85.666278
WB	40	4.86	7,287	584,433	6.02	41.749295	-85.666083
WB	41	6.21	8,092	306,073	4.85	41.749316	-85.665944
WB	42	5.91	9,950	276,118	4.69	41.749339	-85.665752
WB	43	7.48	7,767	220,382	4.35	41.749362	-85.665535
WB	44	7.32	7,454	239,388	4.47	41.749366	-85.665366

Direction	Test Point Number	Max. Normalized Deflection (D_0, mils)	Subgrade Resilient Modulus (M_r, psi)	Effective Pavement Modulus (E_p, psi)	Effective Structural Number (SN_{eff}, in)	Latitude	Longitude
WB	45	8.22	7,981	180,089	4.07	41.749365	-85.665190
WB	46	7.74	8,177	197,204	4.19	41.749364	-85.665025
WB	47	6.91	8,839	227,827	4.40	41.749465	-85.665779
WB	48	5.68	11,303	265,170	4.63	41.749600	-85.665856
WB	49	5.15	9,856	365,444	5.15	41.749716	-85.665925
WB	50	5.21	11,366	311,451	4.88	41.749861	-85.666006
WB	51	4.28	13,600	385,227	5.24	41.750147	-85.666603
WB	52	4.74	15,306	287,163	4.75	41.750021	-85.666526
WB	53	5.09	11,133	331,555	4.98	41.749890	-85.666450
WB	54	6.25	10,891	229,398	4.41	41.749768	-85.666382
WB	55	5.31	13,819	253,926	4.56	41.749639	-85.666311
WB	56	3.85	9,091	748,724	6.54	41.749503	-85.666230
WB	57	3.59	9,176	869,757	6.87	41.749402	-85.666175
WB	58	6.09	9,119	282,242	4.72	41.749334	-85.666408
WB	59	5.06	11,178	334,088	5.00	41.749460	-85.666482
WB	60	3.46	17,913	450,145	5.52	41.749579	-85.666555
WB	61	4.43	17,639	289,803	4.76	41.749711	-85.666631
WB	62	4.50	17,188	288,070	4.76	41.749835	-85.666703
WB	63	4.12	14,799	383,077	5.23	41.749963	-85.666769
WB	64	3.36	17,100	496,686	5.70	41.750069	-85.666821
WB	65	7.29	14,099	146,471	3.80	41.750027	-85.667163
WB	66	3.61	15,753	466,330	5.58	41.750023	-85.667162
WB	67	6.25	10,924	229,504	4.41	41.749900	-85.667106
WB	68	3.81	15,505	427,434	5.42	41.749773	-85.667038
WB	69	4.52	12,630	371,564	5.18	41.749635	-85.666971
WB	70	3.90	14,289	440,719	5.48	41.749530	-85.666921
WB	71	6.42	9,654	242,539	4.49	41.749398	-85.666856
WB	72	6.30	10,173	239,915	4.47	41.749254	-85.666793
WB	73	7.19	8,171	227,700	4.40	41.749127	-85.667117
WB	74	7.52	10,046	175,770	4.03	41.749259	-85.667187
WB	75	5.49	12,558	259,109	4.59	41.749392	-85.667260
WB	76	4.21	13,234	408,285	5.34	41.749519	-85.667339
WB	77	5.84	11,930	241,196	4.48	41.749624	-85.667399
WB	78	3.66	14,104	506,653	5.74	41.749754	-85.667468
WB	79	3.98	13,795	437,373	5.47	41.749885	-85.667539
WB	80	2.58	16,445	886,829	6.92	41.749864	-85.667935
WB	81	4.36	14,960	342,317	5.04	41.749730	-85.667866
WB	82	5.19	13,757	266,283	4.63	41.749598	-85.667795
WB	83	4.66	12,597	351,005	5.08	41.749468	-85.667729
WB	84	5.57	12,407	254,459	4.56	41.749363	-85.667672
WB	85	6.72	9,784	220,412	4.35	41.749203	-85.667589
WB	86	5.35	9,694	344,350	5.05	41.749094	-85.667534
WB	87	5.27	8,713	396,861	5.29	41.749001	-85.667483
WB	88	5.99	7,658	350,337	5.08	41.748791	-85.667788
WB	89	8.16	8,925	166,840	3.96	41.748928	-85.667847
WB	90	7.08	8,766	220,008	4.35	41.749064	-85.667905

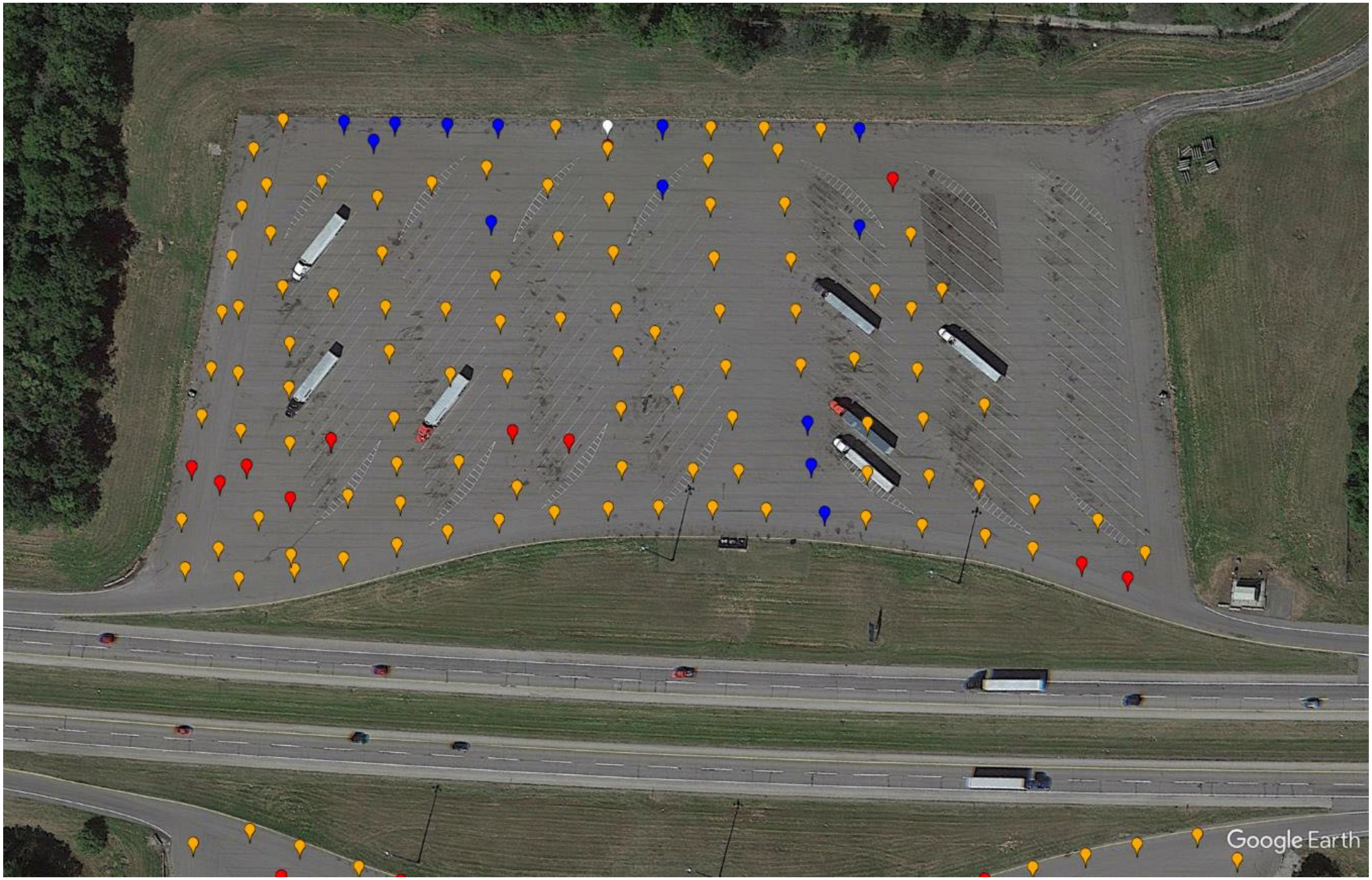
Direction	Test Point Number	Max. Normalized Deflection (D_0, mils)	Subgrade Resilient Modulus (M_r, psi)	Effective Pavement Modulus (E_p, psi)	Effective Structural Number (SN_{eff}, in)	Latitude	Longitude
WB	91	5.36	13,047	261,842	4.61	41.749198	-85.667963
WB	92	4.32	13,239	387,959	5.25	41.749307	-85.668006
WB	93	4.66	12,640	350,722	5.08	41.749440	-85.668086
WB	94	4.39	12,450	398,135	5.30	41.749563	-85.668180
WB	95	6.55	9,402	239,036	4.47	41.749677	-85.668242
WB	96	5.92	12,925	221,327	4.36	41.749357	-85.668210
WB	97	4.46	12,904	373,535	5.19	41.749196	-85.668145
WB	98	6.62	9,485	232,697	4.43	41.749058	-85.668079
WB	99	8.83	8,826	146,136	3.79	41.748975	-85.668023
WB	100	6.13	9,677	264,574	4.62	41.748858	-85.667932
WB	101	7.05	8,674	223,535	4.37	41.748752	-85.668032
WB	102	7.71	8,667	189,130	4.13	41.748914	-85.668094
WB	103	4.21	15,642	351,595	5.08	41.749727	-85.668064
WB	104	3.77	15,566	433,160	5.45	41.749806	-85.667703
WB	105	4.76	11,606	363,579	5.14	41.749458	-85.667912
WB	106	3.82	13,295	492,209	5.68	41.749887	-85.667320
WB	107	3.94	14,623	423,357	5.41	41.749509	-85.667530
WB	108	7.59	9,880	175,089	4.03	41.749103	-85.667773
WB	109	6.21	10,131	247,240	4.52	41.748979	-85.667662
WB	110	4.97	12,791	306,342	4.85	41.749353	-85.667449
WB	111	4.78	15,044	287,798	4.75	41.749767	-85.667233
WB	112	3.13	16,294	599,501	6.07	41.749970	-85.666943
WB	113	5.25	12,426	284,235	4.73	41.749571	-85.667145
WB	114	5.72	10,503	280,088	4.71	41.749145	-85.667333
WB	115	7.29	9,205	199,280	4.21	41.749279	-85.666993
WB	116	4.00	13,741	435,283	5.46	41.749609	-85.666821
WB	117	5.41	11,486	287,741	4.75	41.749481	-85.666685
WB	118	5.71	9,918	296,845	4.80	41.749302	-85.666558
WB	119	5.25	10,533	330,157	4.98	41.749426	-85.665984
WB	120	6.71	10,509	207,888	4.27	41.749478	-85.665605
WB	121	5.53	16,071	212,091	4.29	41.749547	-85.666033
WB	122	5.21	12,270	291,149	4.77	41.749695	-85.666142
WB	123	3.73	15,927	434,980	5.46	41.749877	-85.666143
WB	124	3.25	14,887	609,755	6.11	41.750021	-85.666258
Average		**5.43**	**11,575**	**349,340**	**4.97**		
Std. Deviation		**1.52**	**2,898**	**171,417**	**0.71**		
Minimum		**2.36**	**6,405**	**146,136**	**3.79**		
Maximum		**9.41**	**17,913**	**1,232,216**	**7.72**		



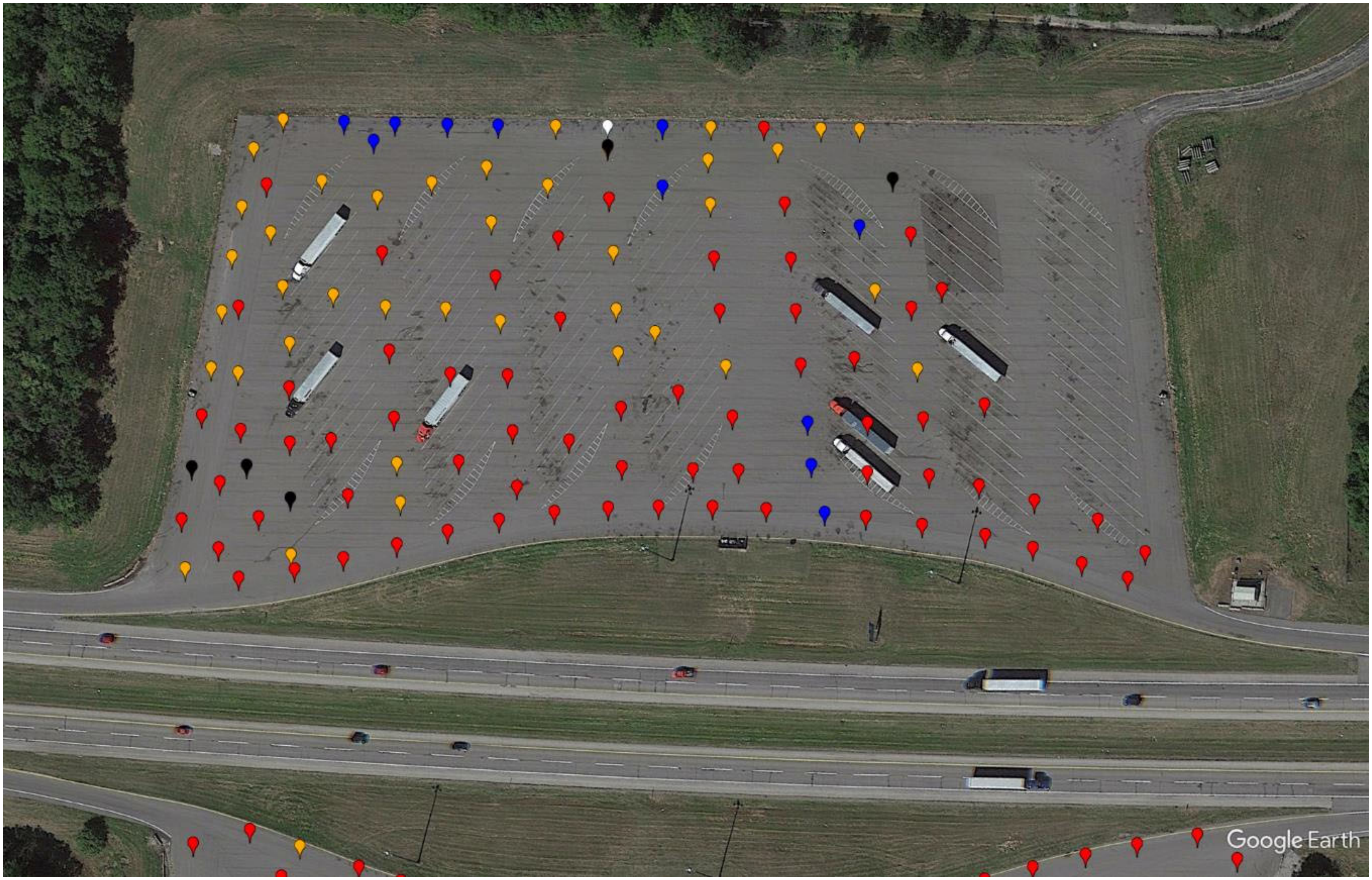
Maximum normalized deflection values for westbound truck parking plaza.



Subgrade resilient modulus values for westbound truck parking plaza.



Effective pavement modulus values for westbound truck parking plaza.



Effective structural number values for westbound truck parking plaza.