MacKenzie
Engineering & Planning, Inc.

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Memorandum

Digitally signed by Shaun G MacKenzie
Date: 2025.08.27 11:01:52 -04'00'

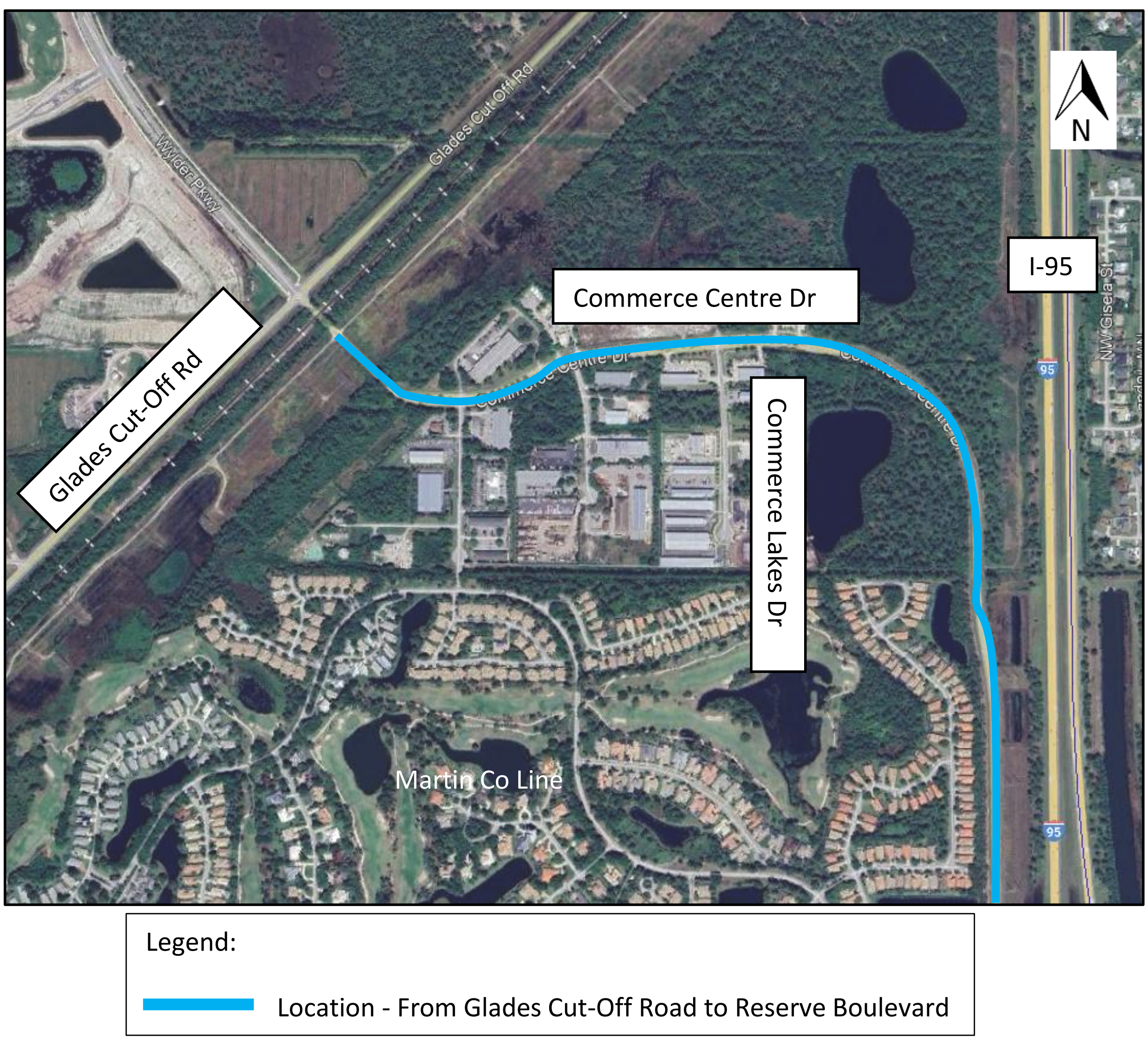
To: Dylan O'Berry, Art of Engineering, Inc.
From: Shaun G. Mackenzie, P.E.
Date: August 27, 2025
Re: Decorative Concrete Specialists ESAL Projections

INTRODUCTION

MacKenzie Engineering and Planning, Inc. (MEP) was retained by Art of Engineering, Inc to determine the ESAL value of the concrete truck and its impact to Commerce Centre Drive.

The roadway segment location is shown in Figure 1.

Figure 1 – Roadway Segment Location Map



ESAL CALCULATION

An ESAL(Equivalent single axial load) is calculated by using Table D.4 (based on single axles flexible pavement with p_t 2.5) and Table D.5 for tandem axles, and Table D.6 for triple axles from AASHTO's "Guide for Design of Pavement Structures (1993)". A structural number of 3 was considered.

ESAL calculations for empty and fully loaded concrete trucks are shown in the below Table 1.

Table 1. 18-kip ESAL Projections for Empty and Fully Loaded Concrete Truck

	Weight of Concrete Truck in lbs	Number of Axles	Steer Axle Load in lbs	ESAL (Equivalent Single Axle Load)	Tandem /Triple Axle Load in lbs (each)	ESAL (Equivalent Single Axle Load)	Total ESAL (Equivalent Single Axle Load)
Empty Concrete Truck	30,000	3	9,000	0.09	21,000	0.20	0.29
Fully Loaded Concrete Truck	70,000	4	14,000	0.40	56,000	1.90	2.30

ESAL PROJECTIONS

The 18-kip ESAL of empty and fully loaded concrete truck were multiplied with the project trips to estimate the total ESALs on a daily, weekly, and annual basis. The ESAL calculations are shown in the below Table 2.

Table 2. Daily, Weekly, and Annual ESAL projections

	ESAL (Equivalent Single Axle Load)	Project Trips (Trucks only)	ESAL Per Day	ESAL Per Week	ESAL Per Year
Empty Concrete Truck	0.29	54	15.7	79	4,108
Fully Loaded Concrete Truck	2.30	54	124.2	621	32,292
Total					36,400

The total ESALs were determined from annual ESALs from Table 2 and estimating the impacts for a 10-year period. The resulting 10-year ESALs were used to calculate the ESALs for Commerce Centre Drive, north and south of Commerce Lakes Drive. The ESALs calculations for Commerce Centre Drive are shown below Table 3.

Table 3. ESALs for Commerce Centre Drive

	Total ESAL per year	Total ESAL per 10-years	Assigned Project trips	ESAL Impact
Commerce Centre Drive North of Commerce Lake Drive	36,400	364,000	40%	145,600
Commerce Centre Drive South of Commerce Lake Drive	36,400	364,000	60%	218,400

CONCLUSION

The total ESAL impact on Commerce Centre Drive north and south of the Commerce Lake Drive is 145,600 and 218,400 ESALs, respectively.

EXHIBITS

Exhibit 1 - Trip Generation - Decorative Concrete Specialists

Exhibit 2 - Traffic Assignment - Decorative Concrete Specialists

Exhibit 3 - AASHTO - Tables D.4, D.5, and D.6

If you have any questions, please do not hesitate to contact Shaun Mackenzie at shaun@mackenzieengineeringinc.com or (772) 834-8909.

Sincerely,

Shaun MacKenzie

Shaun G. MacKenzie, P.E.
Transportation Engineer
Florida Registration Number 61751
Engineering Business Number 29013

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Exhibit 1 - Trip Generation

	Trucks		Site Employees		Truck Drivers		Deliveries		Total Trips		
Time	Enter	Exit	Enter	Exit	Enter	Exit	Enter	Exit	Total	Enter	Exit
7:00			**8**		**12**				**20**	**20**	**0**
8:00		11			6		1	1	19	7	12
9:00		7					1	1	9	1	8
10:00	7	7					2	2	18	9	9
11:00	11	11					1	1	24	12	12
12:00			2	2			1	1	6	3	3
13:00	11	11					1	1	24	12	12
14:00	7	7					1	1	16	8	8
15:00	7					6	1	1	15	8	7
16:00	**11**			**8**		**12**	**1**	**1**	**33**	**12**	**21**
17:00									0	0	0
Total	54	54	10	10	18	18	10	10	184	92	92

Estimated Truck Fill Time ~ 5 mins = 12 truck per hour

Total Service Time ~ 10 mins per truck = -1 truck during initial loading time

Exhibit 2 - Traffic Assignment

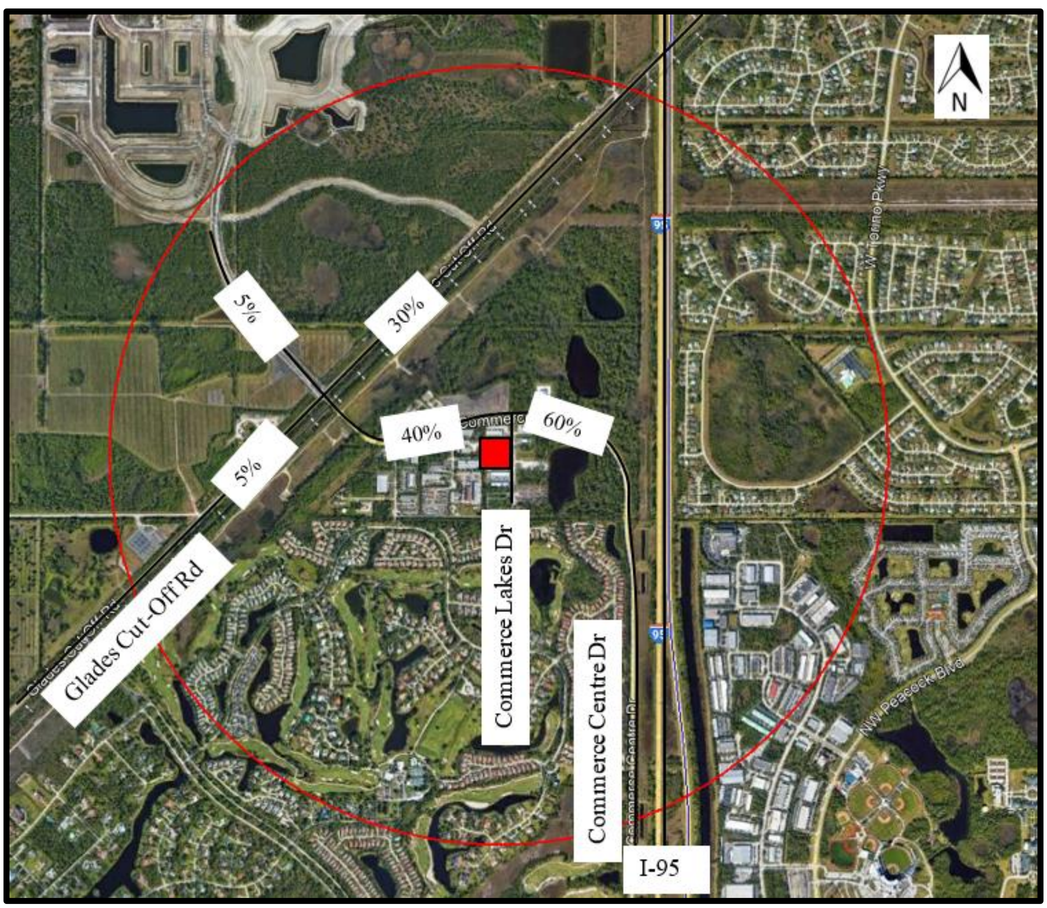

Exhibit 3.1 - Table D.4 Axle load equivalency factors for flexible pavements single axles and p_t 2.5

Table D.4. Axle load equivalency factors for flexible pavements, single axles and p_t 2.5.

Axle Load (kips)	Pavement Structural Number (SN) 1	2	3	4	5	6
2	.0004	.0004	.0003	.0002	.0002	.0002
4	.003	.004	.004	.003	.002	.002
6	.011	.017	.017	.013	.010	.009
8	.032	.047	.051	.041	.034	.031
10	.078	.102	.118	.102	.088	.080
12	.168	.198	.229	.213	.189	.176
14	.328	.358	.399	.388	.360	.342
16	.591	.613	.646	.645	.623	.606
18	1.00	1.00	1.00	1.00	1.00	1.00
20	1.61	1.57	1.49	1.47	1.51	1.55
22	2.48	2.38	2.17	2.09	2.18	2.30
24	3.69	3.49	3.09	2.89	3.03	3.27
26	5.33	4.99	4.31	3.91	4.09	4.48
28	7.49	6.98	5.90	5.21	5.39	5.98
30	10.3	9.5	7.9	6.8	7.0	7.8
32	13.9	12.8	10.5	8.8	8.9	10.0
34	18.4	16.9	13.7	11.3	11.2	12.5
36	24.0	22.0	17.7	14.4	13.9	15.5
38	30.9	28.3	22.6	18.1	17.2	19.0
40	39.3	35.9	28.5	22.5	21.1	23.0
42	49.3	45.0	35.6	27.8	25.6	27.7
44	61.3	55.9	44.0	34.0	31.0	33.1
46	75.5	68.8	54.0	41.4	37.2	39.3
48	92.2	83.9	65.7	50.1	44.6	46.5
50	112.	102.	79.	60.	53.	56.

9 0.09

Exhibit 3.2 - Table D.5 Axle load equivalency factors for flexible pavements tandem axles and p_t 2.5

Table D.5. Axle load equivalency factors for flexible pavements, tandem axles and p_t of 2.5

Axle Load (kips)	Pavement Structural Number (SN) 1	2	3	4	5	6
2	.0001	.0001	.0001	.0000	.0000	.0000
4	.0005	.0005	.0004	.0003	.0003	.0002
6	.002	.002	.002	.001	.001	.001
8	.004	.006	.005	.004	.003	.003
10	.008	.013	.011	.009	.007	.006
12	.015	.024	.023	.018	.014	.013
14	.026	.041	.042	.033	.027	.024
16	.044	.065	.070	.067	.047	.043
18	.070	.097	.109	.092	.077	.070
20	.107	.141	.162	.141	.121	.110
22	.160	.198	.229	.207	.180	.166
24	.231	.273	.315	.292	.260	.242
26	.327	.370	.420	.401	.364	.342
28	.451	.493	.548	.534	.495	.470
30	.611	.648	.703	.695	.658	.633
32	.813	.843	.889	.887	.857	.834
34	1.06	1.08	1.11	1.11	1.09	1.08
36	1.38	1.38	1.38	1.38	1.38	1.38
38	1.75	1.73	1.69	1.68	1.70	1.73
40	2.21	2.16	2.06	2.03	2.08	2.14
42	2.76	2.67	2.49	2.43	2.51	2.61
44	3.41	3.27	2.99	2.88	3.00	3.16
46	4.18	3.98	3.58	3.40	3.55	3.79
48	5.08	4.80	4.25	3.98	4.17	4.49
50	6.12	5.76	5.03	4.64	4.86	5.28
52	7.33	6.87	5.93	5.38	5.63	6.17
54	8.72	8.14	6.96	6.22	6.47	7.16
56	10.3	9.6	8.1	7.2	7.4	8.2
58	12.1	11.3	9.4	8.2	8.4	9.4
60	14.2	13.1	10.9	9.4	9.6	10.7
62	16.5	15.3	12.6	10.7	10.8	12.1
64	19.1	17.6	14.5	12.2	12.2	13.7
66	22.1	20.3	16.6	13.8	13.7	15.4
68	25.3	23.3	18.9	15.6	15.4	17.2

21

0.20

Exhibit 3.3 - Table D.6 Axle load equivalency factors for flexible pavements triple axles and p_t 2.5

Table D.6. Axle load equivalency factors for flexible pavements, triple axles and p_t of 2.5.

Axle Load (kips)	Pavement Structural Number (SN) 1	2	3	4	5	6
2	.0000	.0000	.0000	.0000	.0000	.0000
4	.0002	.0002	.0002	.0001	.0001	.0001
6	.0006	.0007	.0005	.0004	.0003	.0003
8	.001	.002	.001	.001	.001	.001
10	.003	.004	.003	.002	.002	.002
12	.005	.007	.006	.004	.003	.003
14	.008	.012	.010	.008	.006	.005
16	.012	.019	.018	.013	.011	.010
18	.018	.029	.028	.021	.017	.016
20	.027	.042	.042	.032	.027	.024
22	.038	.058	.060	.048	.040	.035
24	.053	.078	.084	.068	.057	.051
26	.072	.103	.114	.095	.080	.072
28	.098	.133	.151	.128	.109	.099
30	.129	.169	.195	.170	.145	.133
32	.169	.213	.247	.220	.191	.175
34	.219	.268	.308	.281	.246	.228
36	.279	.329	.379	.352	.313	.292
38	.352	.403	.461	.436	.393	.388
40	.439	.491	.554	.533	.487	.459
42	.543	.594	.651	.644	.597	.567
44	.666	.714	.781	.769	.723	.692
46	.811	.854	.918	.911	.868	.838
48	.979	1.015	1.072	1.069	1.033	1.005
50	1.17	1.20	1.24	1.25	1.22	1.20
52	1.40	1.41	1.44	1.44	1.43	1.41
54	1.65	1.66	1.66	1.66	1.66	1.68
56	1.95	1.93	$\boxed{1.90}$	1.90	1.91	1.93
58	2.29	2.25	2.17	2.16	2.20	2.24
60	2.67	2.60	2.48	2.44	2.51	2.58
62	3.09	3.00	2.82	2.78	2.85	2.95
64	3.57	3.44	3.19	3.10	3.22	3.36