Whitman, Requardt & Associates, LLP
Engineers · Architects · Environmental Planners Est. 1915

MEMORANDUM

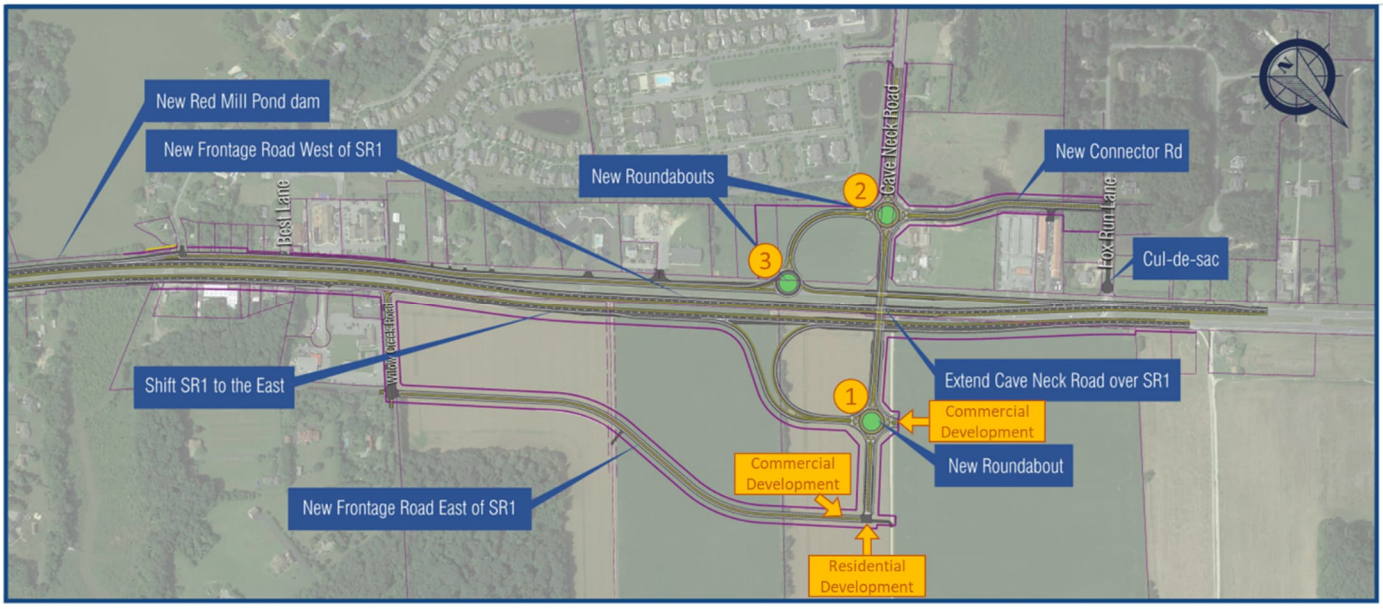
Date: October 17, 2023 **Update: December 21, 2023**

To: Annamaria Furmato, DelDOT
From: Steve Harr, WRA
Subject: Seaside Grade Separated Interchange (GSI) LOS Evaluation
CC: Mike DuRoss, DelDOT
Anson Gock, DelDOT
Sireen Muhtaseb, DelDOT
Jamie Snow, WRA
Andrea Trabelsi, WRA

Work Order Number: 32171-045
Project: DelDOT Planning Support

WRA has completed trip generation and traffic modeling of the proposed Seaside development along Cave Neck Road (extended), assuming completion of the SR 1 at Cave Neck Road Grade Separated Intersection (GSI) Project (T201912201). Using the current Project selected alternative concept drawing for the network geometry and the Seaside preliminary plans from recent TIS submission to determine the most appropriate way to assign development volumes to the network, WRA generated a *Synchro* model. Trip generation using the ITE Trip Generation Manual was performed and turning movement volumes were distributed through the network. See **Appendix** for ITE trip generation information and distributed 2050 turning movement volumes. **Figure 1** depicts the GSI project geometry, shows how the Seaside development volumes were added to the network, and identifies the three (3) project roundabouts analyzed.

Figure 1. Cave Neck Road GSI Selected Alternative with Seaside Development Network Access



Based on the *Synchro* analysis of forecasted 2050 AM, PM, and Saturday peak hourly volumes, all three roundabouts operate at acceptable levels of service during all 3 peaks, as shown in **Table 1.**

Table 1. *Synchro* Roundabout Analysis Results

	Delay (sec) / Level of Service		
	2050 AM Peak	**2050 PM Peak**	**2050 SAT Peak**
1: Cave Neck Rd @ SR 1 NB Ramps / Seaside Development	6.0 A	20.2 C	12.7 B
2: Cave Neck Rd @ Connector to SR 1 Frontage Rd	9.3 A	17.5 C	13.4 B
3: SR 1 SB Ramps @ Connector to Cave Neck Rd	8.7 A	8.3 A	9.3 A

Based on these results, the current projected development levels would not require alteration of the GSI Project design.

Update: December 21, 2023

In addition to the Seaside development, there is another smaller proposed development on the northwest corner of the proposed Cave Neck Road GSI (Chappell Farm), as well as a an extremely large development approximately 2.5 miles away (Cool Spring) that is expected to increase traffic along Cave Neck Road. Development volumes from Cool Spring and Chappell Farm developments were added to the 2050 peak hour models of the three roundabouts in the GSI. These developments add a significant number of vehicles destined to SR 1 southbound and from SR 1 northbound. **Table 2** displays the updated projected delays and levels of service at the roundabouts.

Table 2. *Synchro* Roundabout Analysis Results – Including Other Nearby Development Volumes

	Delay (sec) / Level of Service		
	2050 AM Peak	**2050 PM Peak**	**2050 SAT Peak**
1: Cave Neck Rd @ SR 1 NB Ramps / Seaside Development	8.7 A	51.4 F	39.9 E
2: Cave Neck Rd @ Connector to SR 1 Frontage Rd	89.7 F	126 F	162 F
3: SR 1 SB Ramps @ Connector to Cave Neck Rd	14.0 B	13.0 B	17.0 C

Based on these results, the projected development levels including Seaside, Chappell Farm, and Cool Spring, as well as background growth to year 2050, **would** require alteration of the GSI Project design. **Table 3** is a sensitivity analysis of the over-capacity roundabouts in each peak, showing how much total volume would need to be reduced in the 2050 design year to achieve a LOS E or D. The Cave Neck Rd at SR 1 NB Ramps / Seaside Development roundabout (#1) is only slightly over capacity in the most critical peaks if all development volume occurs as predicted.

The Cave Neck Rd at Connector to SR 1 Frontage Rd roundabout (#2) is further over capacity and over capacity during all peaks. The *Sycnhro* reports (included in the Appendix) show that the primary cause of the failing LOS is the eastbound Cave Neck Road approach, which includes an extremely high right-turning volume. This suggests that a design alteration to provide an extra “slip” right-turn movement (with upstream storage and downstream receiving lane) may partially or completely mitigate the failing condition.

Table 3. *Synchro* Roundabout Sensitivity Analysis

	Delay (sec) / Level of Service	Percent Total Intersection Volume Reduction Required for	
	2050 AM Peak	LOS E	LOS D
2: Cave Neck Rd @ Connector to SR 1 Frontage Rd	89.7 F	11%	16%
	2050 PM Peak	LOS E	LOS D
1: Cave Neck Rd @ SR 1 NB Ramps / Seaside Development	51.4 F	1%	7%
2: Cave Neck Rd @ Connector to SR 1 Frontage Rd	126 F	16%	21%
	2050 SAT Peak	LOS E	LOS D
1: Cave Neck Rd @ SR 1 NB Ramps / Seaside Development	39.9 E	0%	3%
2: Cave Neck Rd @ Connector to SR 1 Frontage Rd	162 F	23%	27%

Intersection	
Intersection Delay, s/veh	8.7
Intersection LOS	A

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	582	310	635	108
Demand Flow Rate, veh/h	593	316	648	110
Vehicles Circulating, veh/h	66	615	111	754
Vehicles Exiting, veh/h	798	144	548	177
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	7.5	10.8	8.9	7.8
Approach LOS	A	B	A	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	593	316	648	110
Cap Entry Lane, veh/h	1290	737	1232	640
Entry HV Adj Factor	0.981	0.980	0.980	0.979
Flow Entry, veh/h	582	310	635	108
Cap Entry, veh/h	1266	722	1207	626
V/C Ratio	0.460	0.429	0.526	0.172
Control Delay, s/veh	7.5	10.8	8.9	7.8
LOS	A	B	A	A
95th %tile Queue, veh	2	2	3	1

Intersection	
Intersection Delay, s/veh	89.7
Intersection LOS	F

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	1277	783	142	33
Demand Flow Rate, veh/h	1302	798	145	33
Vehicles Circulating, veh/h	299	84	532	871
Vehicles Exiting, veh/h	605	593	1069	11
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	149.4	10.8	6.5	7.1
Approach LOS	F	B	A	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	1302	798	145	33
Cap Entry Lane, veh/h	1017	1267	802	568
Entry HV Adj Factor	0.981	0.981	0.979	0.993
Flow Entry, veh/h	1277	783	142	33
Cap Entry, veh/h	997	1243	785	564
V/C Ratio	1.280	0.630	0.181	0.058
Control Delay, s/veh	149.4	10.8	6.5	7.1
LOS	F	B	A	A
95th %tile Queue, veh	45	5	1	0

Intersection	
Intersection Delay, s/veh	14.0
Intersection LOS	B

Approach	EB	NB	SB
Entry Lanes	1	1	1
Conflicting Circle Lanes	1	1	1
Adj Approach Flow, veh/h	1049	5	152
Demand Flow Rate, veh/h	1070	5	155
Vehicles Circulating, veh/h	11	0	5
Vehicles Exiting, veh/h	149	1081	0
Ped Vol Crossing Leg, #/h	0	0	0
Ped Cap Adj	1.000	1.000	1.000
Approach Delay, s/veh	15.6	2.6	3.6
Approach LOS	C	A	A

Lane	Left	Left	Left
Designated Moves	R	L	TR
Assumed Moves	R	L	TR
RT Channelized			
Lane Util	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976
Entry Flow, veh/h	1070	5	155
Cap Entry Lane, veh/h	1364	1380	1373
Entry HV Adj Factor	0.980	1.000	0.979
Flow Entry, veh/h	1049	5	152
Cap Entry, veh/h	1338	1380	1344
V/C Ratio	0.784	0.004	0.113
Control Delay, s/veh	15.6	2.6	3.6
LOS	C	A	A
95th %tile Queue, veh	9	0	0

Intersection	
Intersection Delay, s/veh	51.4
Intersection LOS	F

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	718	250	1157	440
Demand Flow Rate, veh/h	732	255	1180	448
Vehicles Circulating, veh/h	105	1136	272	931
Vehicles Exiting, veh/h	1274	316	565	460
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	10.1	22.9	88.6	37.3
Approach LOS	B	C	F	E

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	732	255	1180	448
Cap Entry Lane, veh/h	1240	433	1046	534
Entry HV Adj Factor	0.981	0.979	0.981	0.981
Flow Entry, veh/h	718	250	1157	440
Cap Entry, veh/h	1216	424	1025	524
V/C Ratio	0.590	0.589	1.129	0.839
Control Delay, s/veh	10.1	22.9	88.6	37.3
LOS	B	C	F	E
95th %tile Queue, veh	4	4	31	9

Intersection	
Intersection Delay, s/veh	125.9
Intersection LOS	F

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	1174	1250	272	33
Demand Flow Rate, veh/h	1198	1275	277	33
Vehicles Circulating, veh/h	488	155	610	1419
Vehicles Exiting, veh/h	964	732	1076	11
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	215.7	69.8	9.8	12.9
Approach LOS	F	F	A	B

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	1198	1275	277	33
Cap Entry Lane, veh/h	839	1178	741	325
Entry HV Adj Factor	0.980	0.980	0.981	0.993
Flow Entry, veh/h	1174	1250	272	33
Cap Entry, veh/h	822	1155	727	322
V/C Ratio	1.428	1.082	0.374	0.102
Control Delay, s/veh	215.7	69.8	9.8	12.9
LOS	F	F	A	B
95th %tile Queue, veh	52	28	2	0

Intersection	
Intersection Delay, s/veh	13.0
Intersection LOS	B

Approach	EB	NB	SB
Entry Lanes	1	1	1
Conflicting Circle Lanes	1	1	1
Adj Approach Flow, veh/h	1054	5	266
Demand Flow Rate, veh/h	1075	5	271
Vehicles Circulating, veh/h	0	0	5
Vehicles Exiting, veh/h	276	1075	0
Ped Vol Crossing Leg, #/h	0	0	0
Ped Cap Adj	1.000	1.000	1.000
Approach Delay, s/veh	15.2	2.6	4.3
Approach LOS	C	A	A

Lane	Left	Left	Left
Designated Moves	R	L	TR
Assumed Moves	R	L	TR
RT Channelized			
Lane Util	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976
Entry Flow, veh/h	1075	5	271
Cap Entry Lane, veh/h	1380	1380	1373
Entry HV Adj Factor	0.980	1.000	0.982
Flow Entry, veh/h	1054	5	266
Cap Entry, veh/h	1353	1380	1347
V/C Ratio	0.779	0.004	0.197
Control Delay, s/veh	15.2	2.6	4.3
LOS	C	A	A
95th %tile Queue, veh	9	0	1

Intersection	
Intersection Delay, s/veh	39.9
Intersection LOS	E

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	816	293	1027	528
Demand Flow Rate, veh/h	832	299	1048	539
Vehicles Circulating, veh/h	128	1048	338	737
Vehicles Exiting, veh/h	1148	338	622	610
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	12.8	23.2	70.5	31.1
Approach LOS	B	C	F	D

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	832	299	1048	539
Cap Entry Lane, veh/h	1211	474	978	651
Entry HV Adj Factor	0.980	0.980	0.980	0.980
Flow Entry, veh/h	816	293	1027	528
Cap Entry, veh/h	1187	464	958	638
V/C Ratio	0.687	0.631	1.072	0.828
Control Delay, s/veh	12.8	23.2	70.5	31.1
LOS	B	C	F	D
95th %tile Queue, veh	6	4	24	9

Intersection	
Intersection Delay, s/veh	161.6
Intersection LOS	F

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	1256	1125	245	33
Demand Flow Rate, veh/h	1281	1148	250	33
Vehicles Circulating, veh/h	566	89	671	1226
Vehicles Exiting, veh/h	693	832	1176	11
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	315.4	27.4	10.0	10.4
Approach LOS	F	D	B	B

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	1281	1148	250	33
Cap Entry Lane, veh/h	775	1260	696	395
Entry HV Adj Factor	0.981	0.980	0.979	0.993
Flow Entry, veh/h	1256	1125	245	33
Cap Entry, veh/h	760	1235	682	393
V/C Ratio	1.654	0.911	0.359	0.084
Control Delay, s/veh	315.4	27.4	10.0	10.4
LOS	F	D	B	B
95th %tile Queue, veh	69	15	2	0

Intersection	
Intersection Delay, s/veh	17.0
Intersection LOS	C

Approach	EB	NB	SB
Entry Lanes	1	1	1
Conflicting Circle Lanes	1	1	1
Adj Approach Flow, veh/h	1152	5	239
Demand Flow Rate, veh/h	1175	5	244
Vehicles Circulating, veh/h	0	0	5
Vehicles Exiting, veh/h	249	1175	0
Ped Vol Crossing Leg, #/h	0	0	0
Ped Cap Adj	1.000	1.000	1.000
Approach Delay, s/veh	19.7	2.6	4.1
Approach LOS	C	A	A

Lane	Left	Left	Left
Designated Moves	R	L	TR
Assumed Moves	R	L	TR
RT Channelized			
Lane Util	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976
Entry Flow, veh/h	1175	5	244
Cap Entry Lane, veh/h	1380	1380	1373
Entry HV Adj Factor	0.980	1.000	0.980
Flow Entry, veh/h	1152	5	239
Cap Entry, veh/h	1353	1380	1345
V/C Ratio	0.852	0.004	0.178
Control Delay, s/veh	19.7	2.6	4.1
LOS	C	A	A
95th %tile Queue, veh	12	0	1

2050 AM Turning Movements

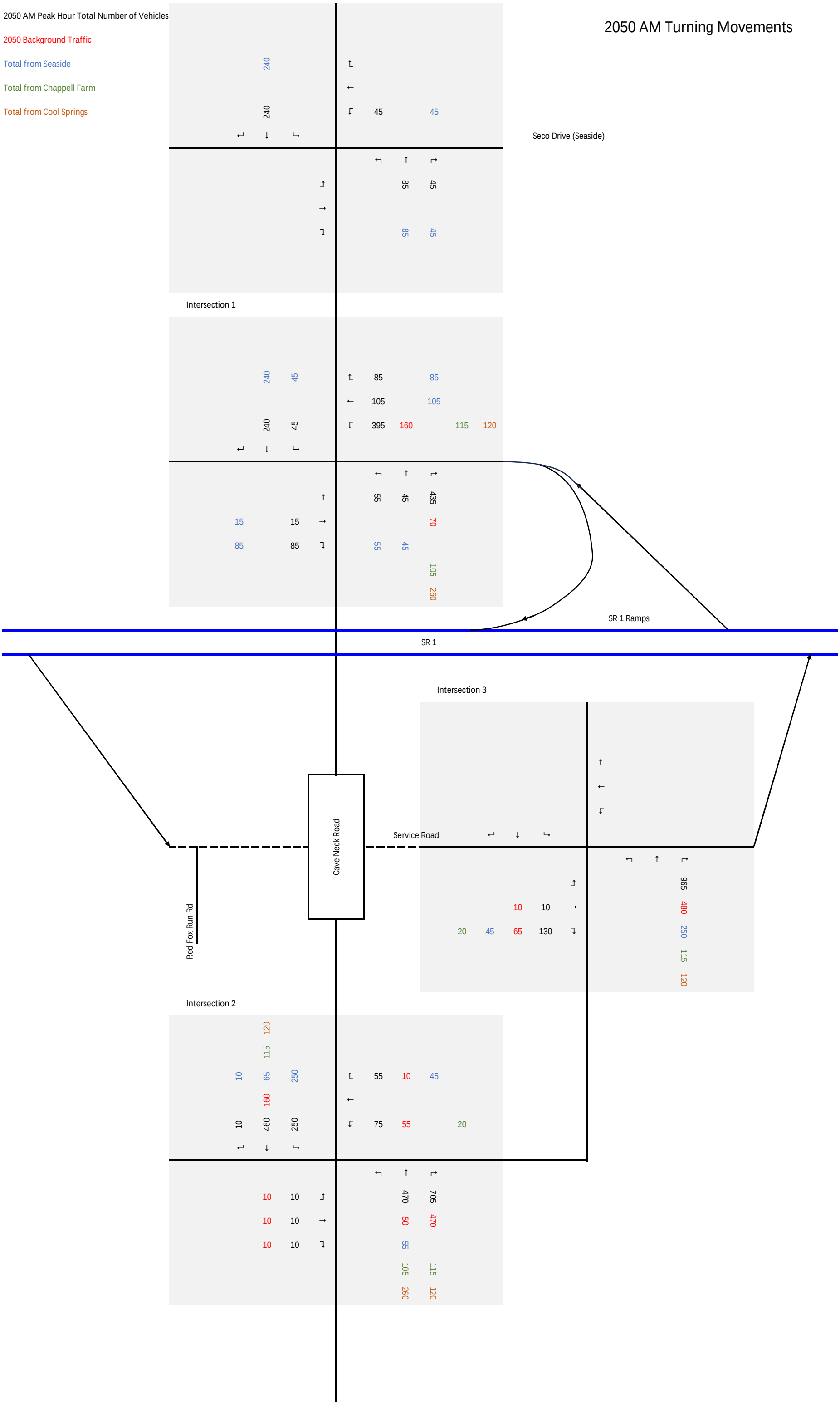
XX 2050 AM Peak Hour Total Number of Vehicles

XX 2050 Background Traffic

XX Total from Seaside

XX Total from Chappell Farm

XX Total from Cool Springs



2050 AM Peak Hour Vehicle Volume Required to Meet LOS D

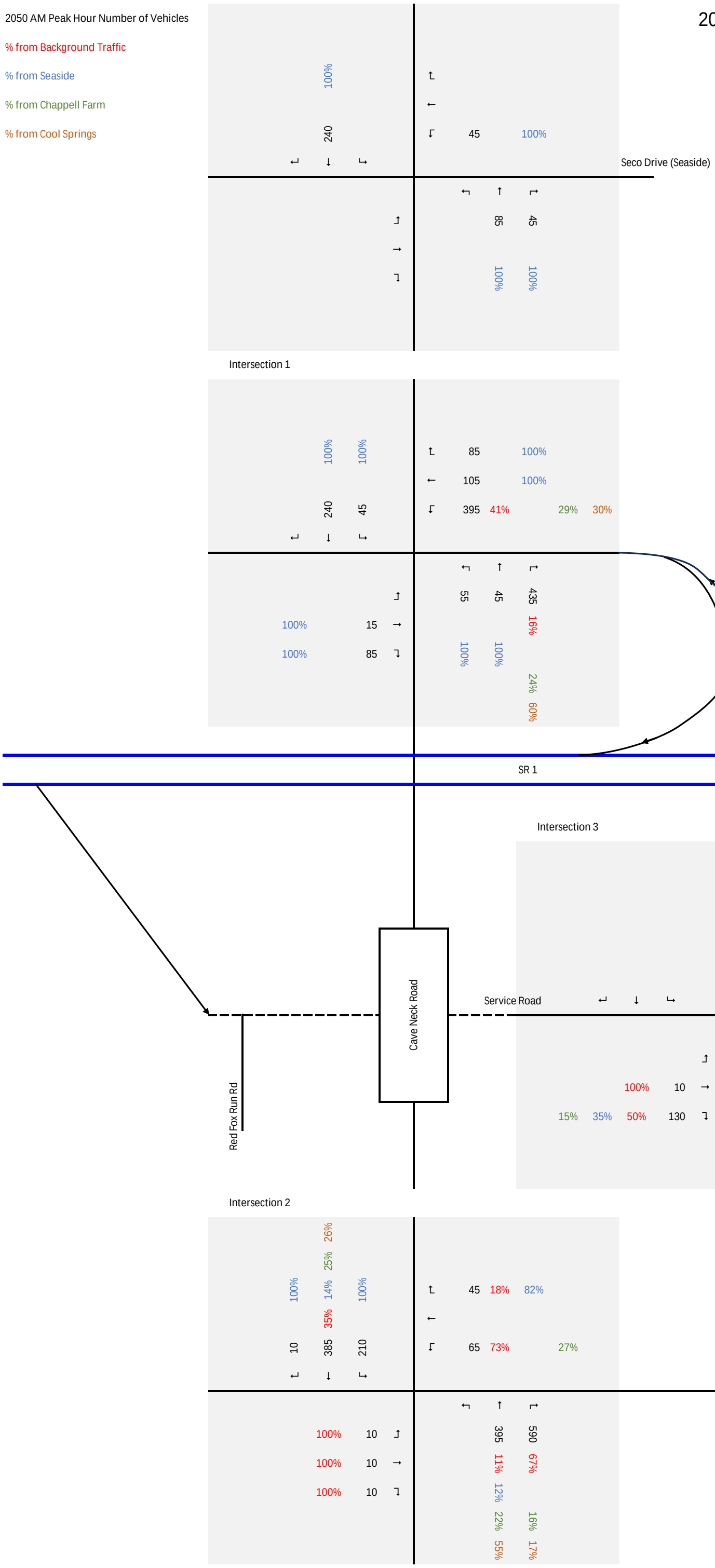
2050 AM Peak Hour Number of Vehicles

% from Background Traffic

% from Seaside

% from Chappell Farm

% from Cool Springs



2050 AM Peak Hour Vehicle Volume Required to Meet LOS E

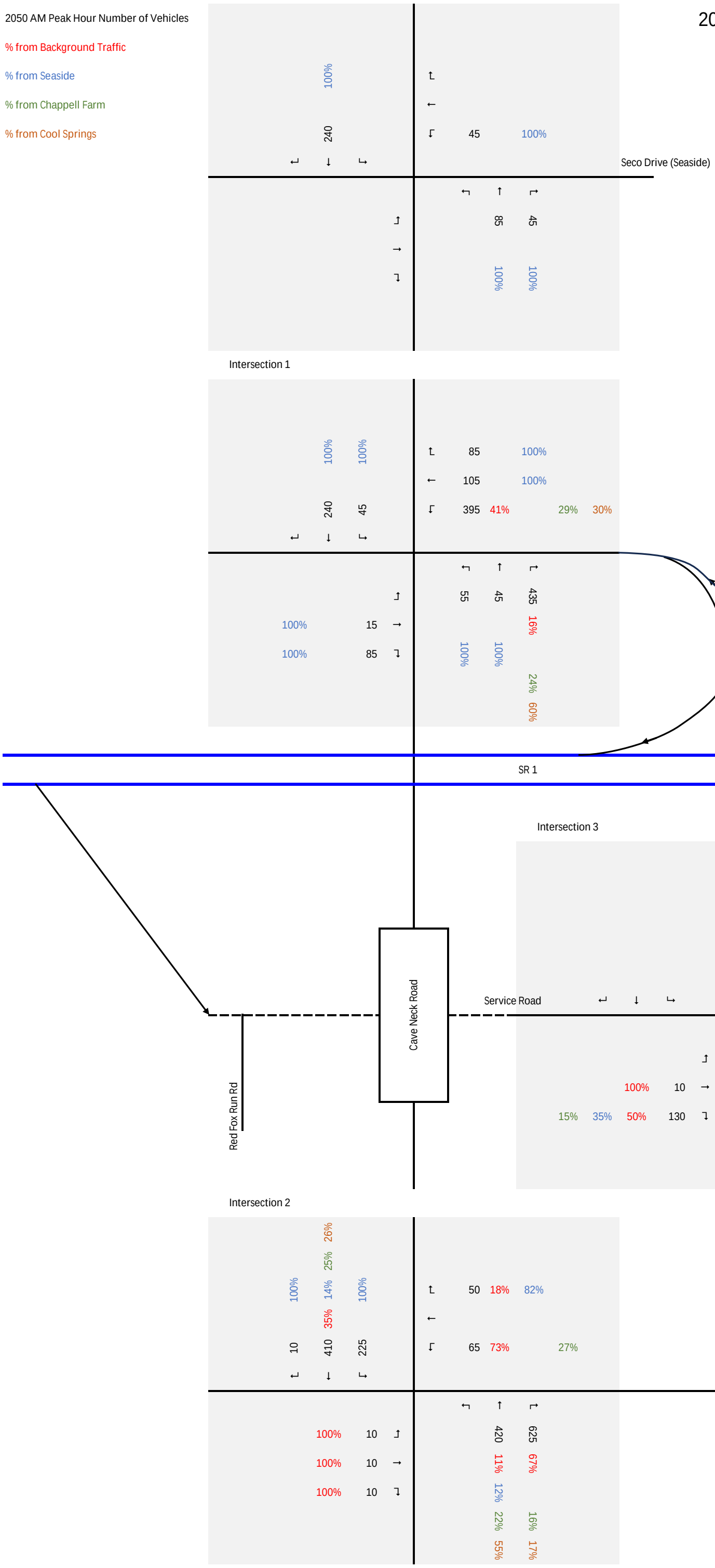
2050 AM Peak Hour Number of Vehicles

% from Background Traffic

% from Seaside

% from Chappell Farm

% from Cool Springs



12/21/2023

XX 2050 PM Peak Hour Total Number of Vehicles

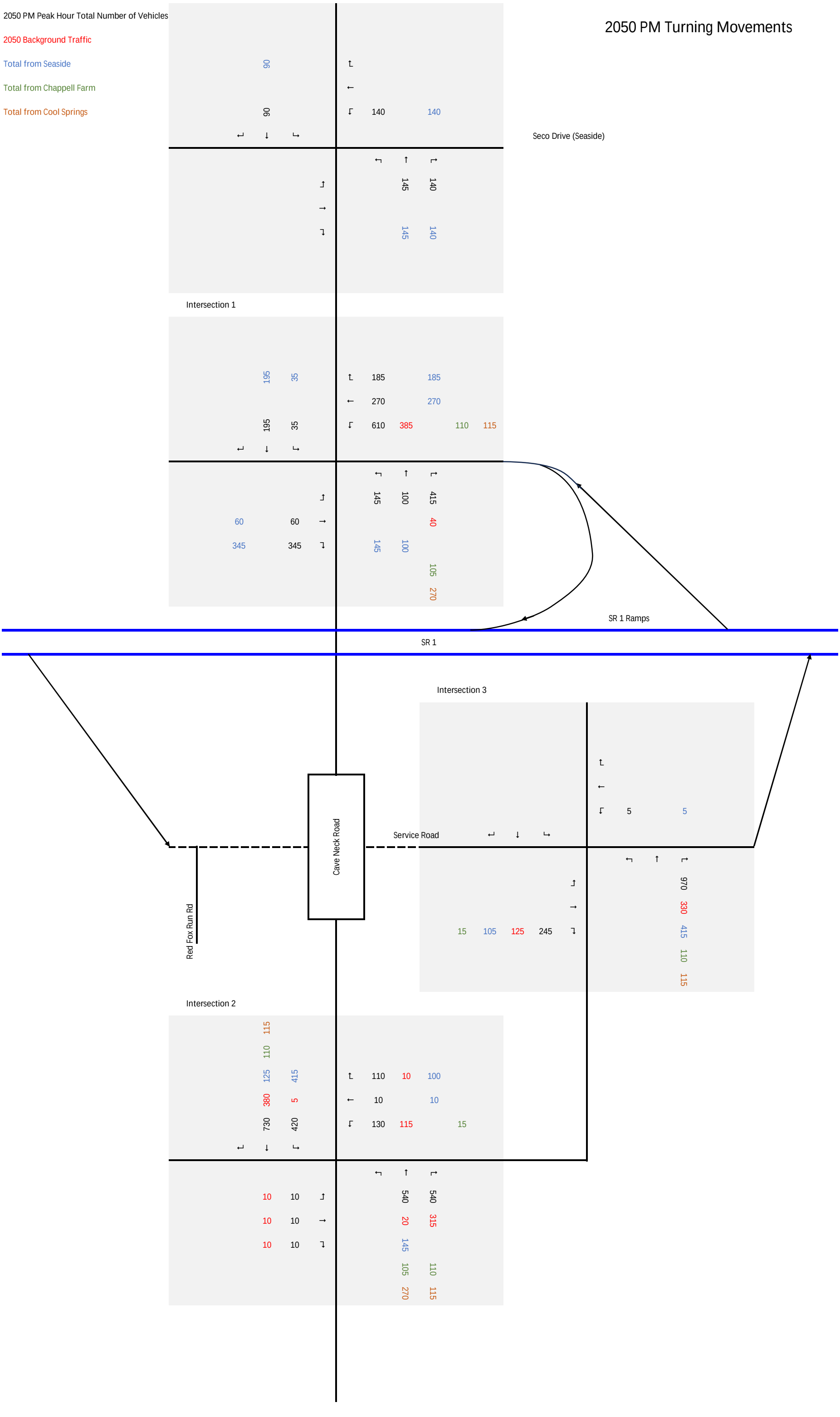
XX 2050 Background Traffic

XX Total from Seaside

XX Total from Chappell Farm

XX Total from Cool Springs

2050 PM Turning Movements



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2050 PM Peak Hour Vehicle Volume Required to Meet LOS D

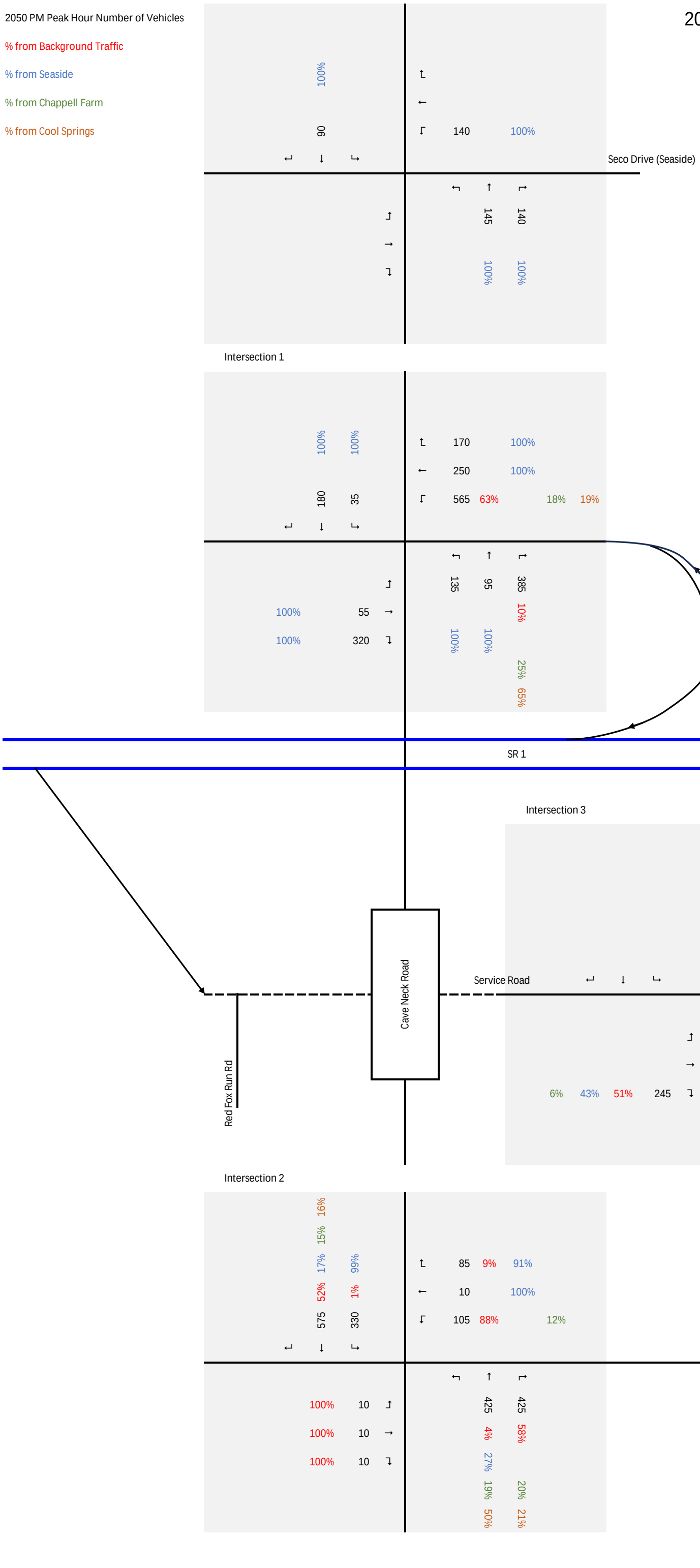
2050 PM Peak Hour Number of Vehicles

% from Background Traffic

% from Seaside

% from Chappell Farm

% from Cool Springs



2050 PM Peak Hour Vehicle Volume Required to Meet LOS E

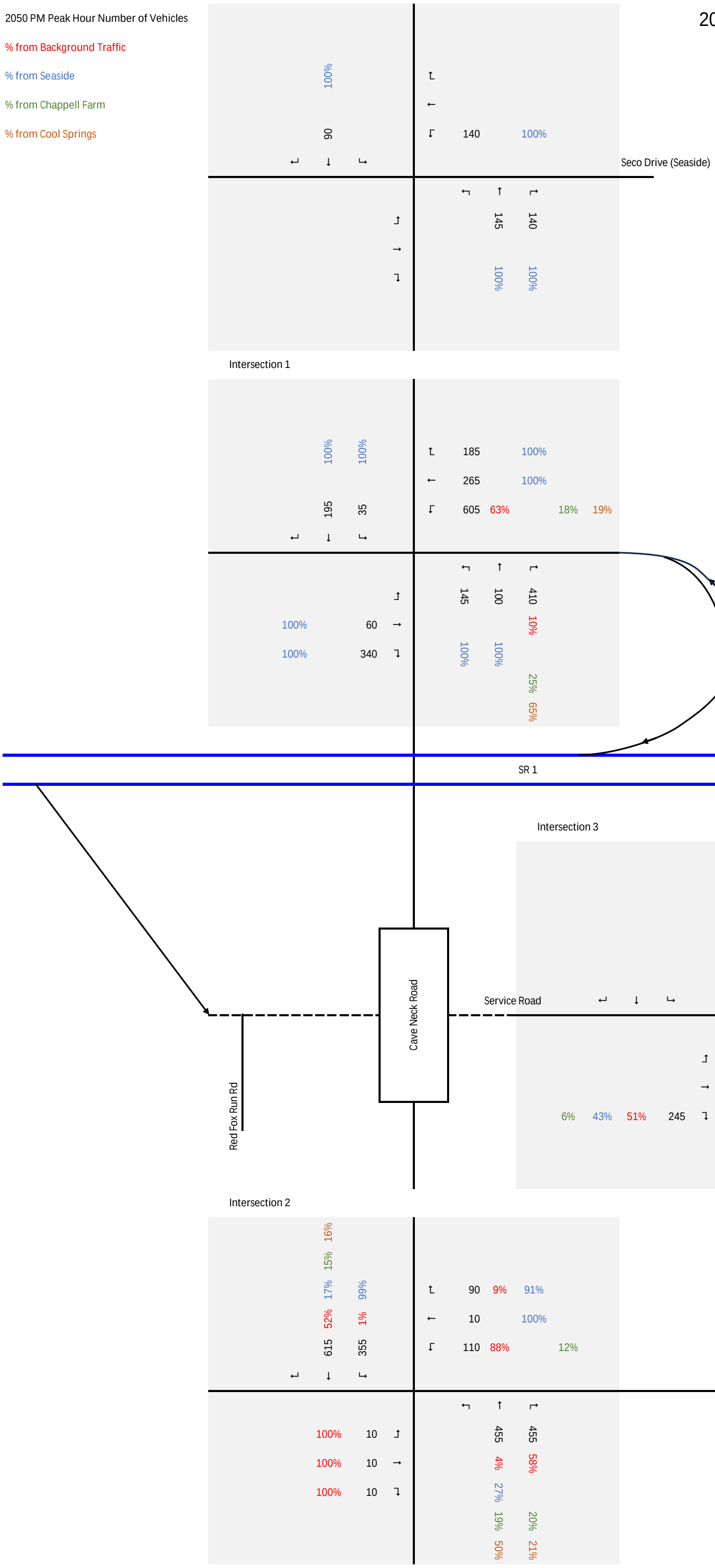
2050 PM Peak Hour Number of Vehicles

% from Background Traffic

% from Seaside

% from Chappell Farm

% from Cool Springs



2050 Summer Saturday Turning Movements

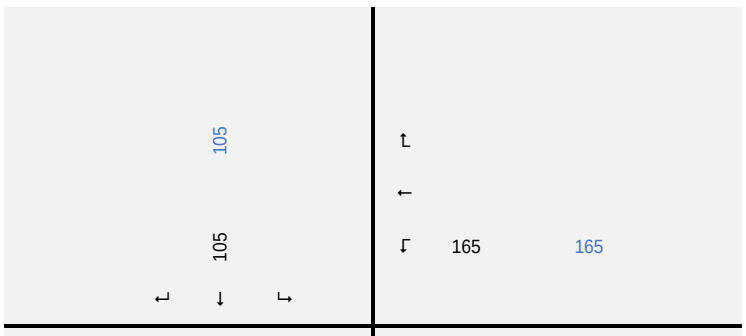
XX 2050 SS Peak Hour Total Number of Vehicles

XX 2050 Background Traffic

XX Total from Seaside

XX Total from Chappell Farm

XX Total from Cool Springs



Seco Drive (Seaside)

Intersection 1

SR 1 Ramps

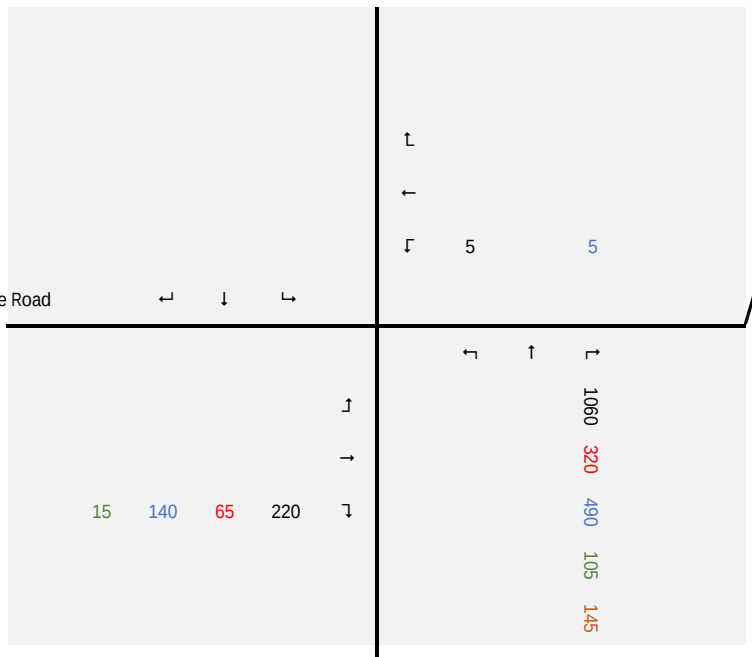
SR 1

Intersection 3

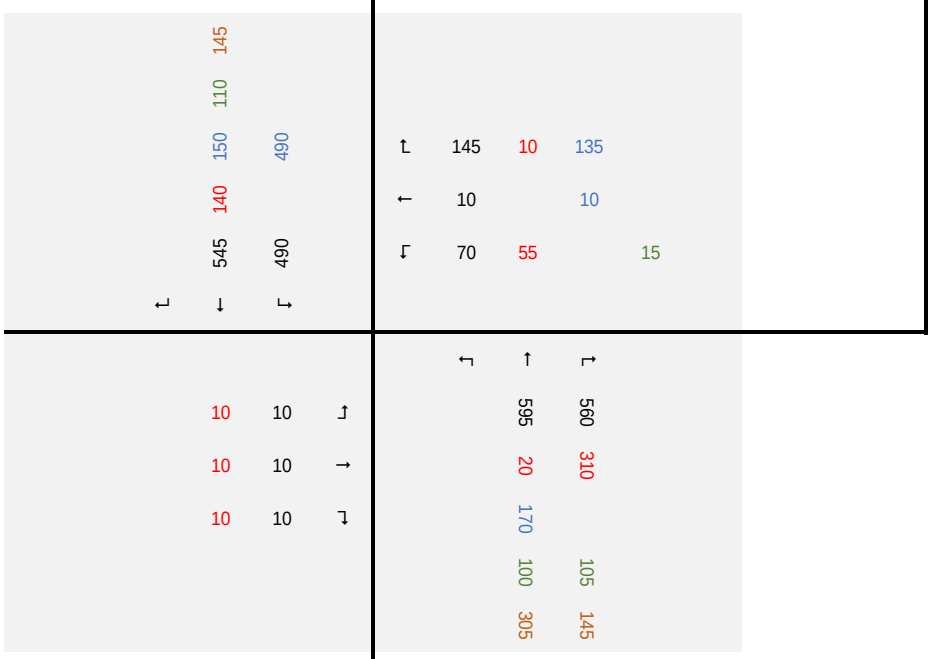
Cave Neck Road

Service Road

Red Fox Run Rd



Intersection 2



2050 Summer Saturday Peak Hour Vehicle Volume Required to Meet LOS D

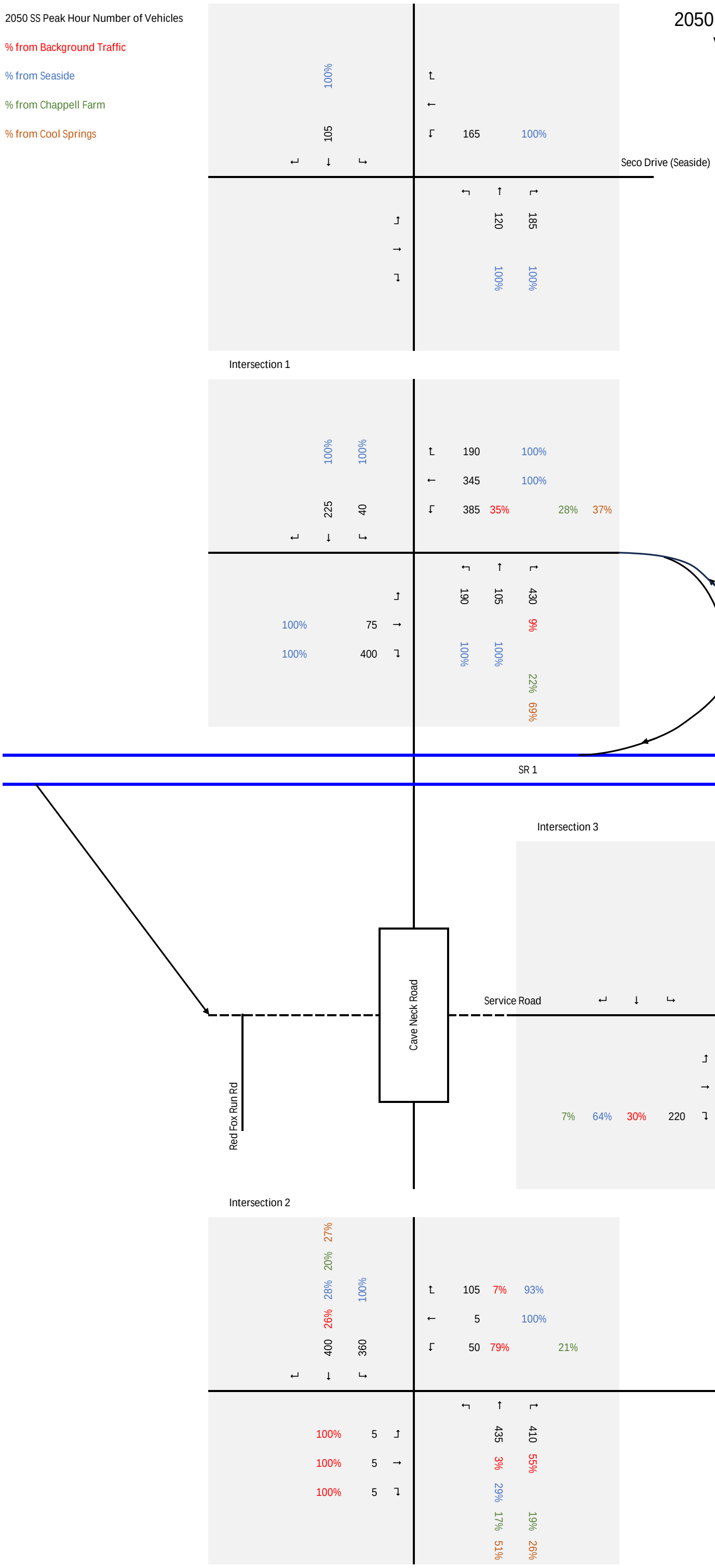
2050 SS Peak Hour Number of Vehicles

% from Background Traffic

% from Seaside

% from Chappell Farm

% from Cool Springs



2050 Summer Saturday Peak Hour Vehicle Volume Required to Meet LOS E

2050 SS Peak Hour Number of Vehicles

% from Background Traffic

% from Seaside

% from Chappell Farm

% from Cool Springs