

Appendix 8

Traffic Impact Assessment



**PENGROWTH ENERGY CORPORATION
LINDBERGH SAGD EXPANSION PROJECT
RANGE ROAD 50 & PENGROWTH ACCESS**

NEAR BONNYVILLE, AB
(SE 13-58-5-W4M)

TRAFFIC IMPACT ASSESSMENT

DECEMBER 2013

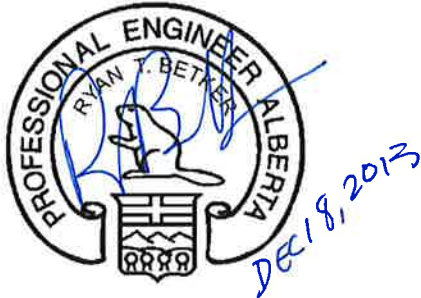
SUBMITTED BY
McELHANNEY CONSULTING SERVICES LTD.

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Project File No: 2131 00179-0

Transmittal Page

Report Prepared by:



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Patrick Wong, P.Eng
Transportation Engineer

This Report has been prepared based on provided information and forward traffic projections specific to the Pengrowth Lindbergh SAGD Expansion Project site. Additional development on this site or future development within the area has not been considered as part of this Traffic Impact Assessment.

1 STUDY PURPOSE AND OBJECTIVE

Pengrowth Energy Corporation (Pengrowth) is proposing to develop the Lindbergh SAGD Expansion Project (the Project), which will expand bitumen production of the Lindbergh SAGD Project (Phase 1) from 1,987 m³/day (12,500 barrels per day (bpd)) to 4,770 m³/day (30,000 bpd). The development of Pengrowth's steam assisted gravity drainage (SAGD) projects on their Lindbergh lease is presented in [Table 1](#).

Project	Phase	Status	Production Capacity
Lindbergh SAGD Pilot Project	Pilot	Operational	200 m ³ /day (1,258 bpd)
Lindbergh SAGD Project	Phase 1	Under Construction	1,987 m ³ /day (12,500 bpd)
Lindbergh SAGD Expansion Project	Phase 2	Proposed	4,770 m ³ /day (30,000 bpd)

The Project is located approximately 24 km southeast of Bonnyville, within the County of St. Paul No. 19 and the Municipal District of Bonnyville No. 87. All facilities will be located within Townships 58 and 59 and Ranges 4 and 5, west of the 4th Meridian ([Figure 1](#)). Planned facilities for the Project (Phase 2) include a number of well pads and well pairs, with associated infrastructure including roads, above ground gathering and distribution pipeline systems. The Central Processing Facility (CPF) for the Phase 1 Project which is currently under construction, is located in SW 25-58-5-W4M and will be expanded for the Phase 2 expansion.

As a part of the development plans, the existing access road will be realigned to intersect Range Road 50 (locally known as "Murphy Road") at 90 degrees. McElhanney Consulting Services Ltd. (McElhanney) has been commissioned to prepare a traffic impact study for the Project access location. The objective of this Traffic Impact Study is to recommend any necessary intersection improvements that will maintain acceptable traffic operations at the Range Road 50 intersection for the 25 year life of the Project. This TIA will be included as part of the development approvals from the local road authority, the County of St. Paul.

The study analyzed the average weekday morning and afternoon peak hours in compliance with typical terms of reference and procedures as published by the Institute of Transportation Engineers (ITE).

2 INTRODUCTION

2.1 Access Location

The Project access road connects to Range Road 50 and is located in SE 13-58-5-W4M, approximately 400m north of Township Road 582. Range Road 50 is a rural 2-lane undivided highway with a posted speed of 100 km/h. The Pengrowth access road is currently a gravel roadway with a posted speed limit of 30 km/h and a stop condition at the Range Road 50 intersection. The posted speed of the new access road will be 50 km/h following the planned realignment.

The existing intersection is classified as a Type Ia configuration according to standard at-grade intersection layouts for two-lane highways in Alberta Transportation's Highway Geometric Design Guide Figure D-7a.

2.2 Development Description

The Project will increase production from the approved 12,500 bpd production rate (expected to be operational by Q4 2014) to 30,000 bpd by 2017. The site access will be situated adjacent to the existing Pilot Project development site, with no additional accesses required. An access layout plan is shown in [Figure 2](#).

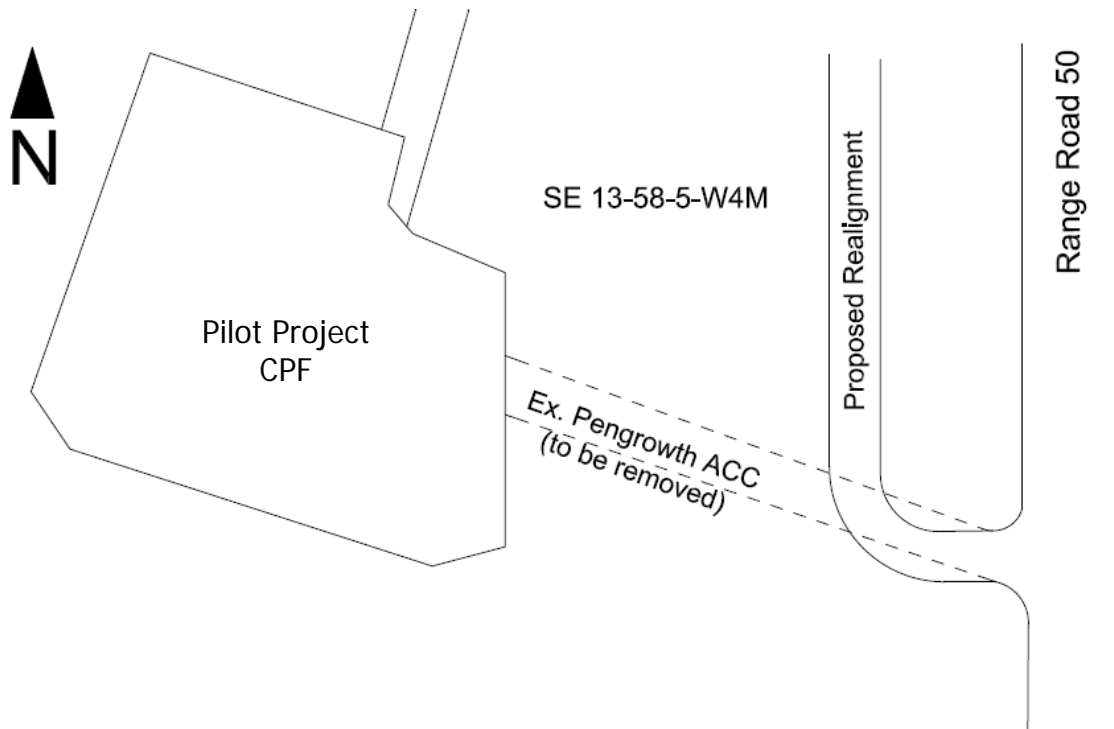
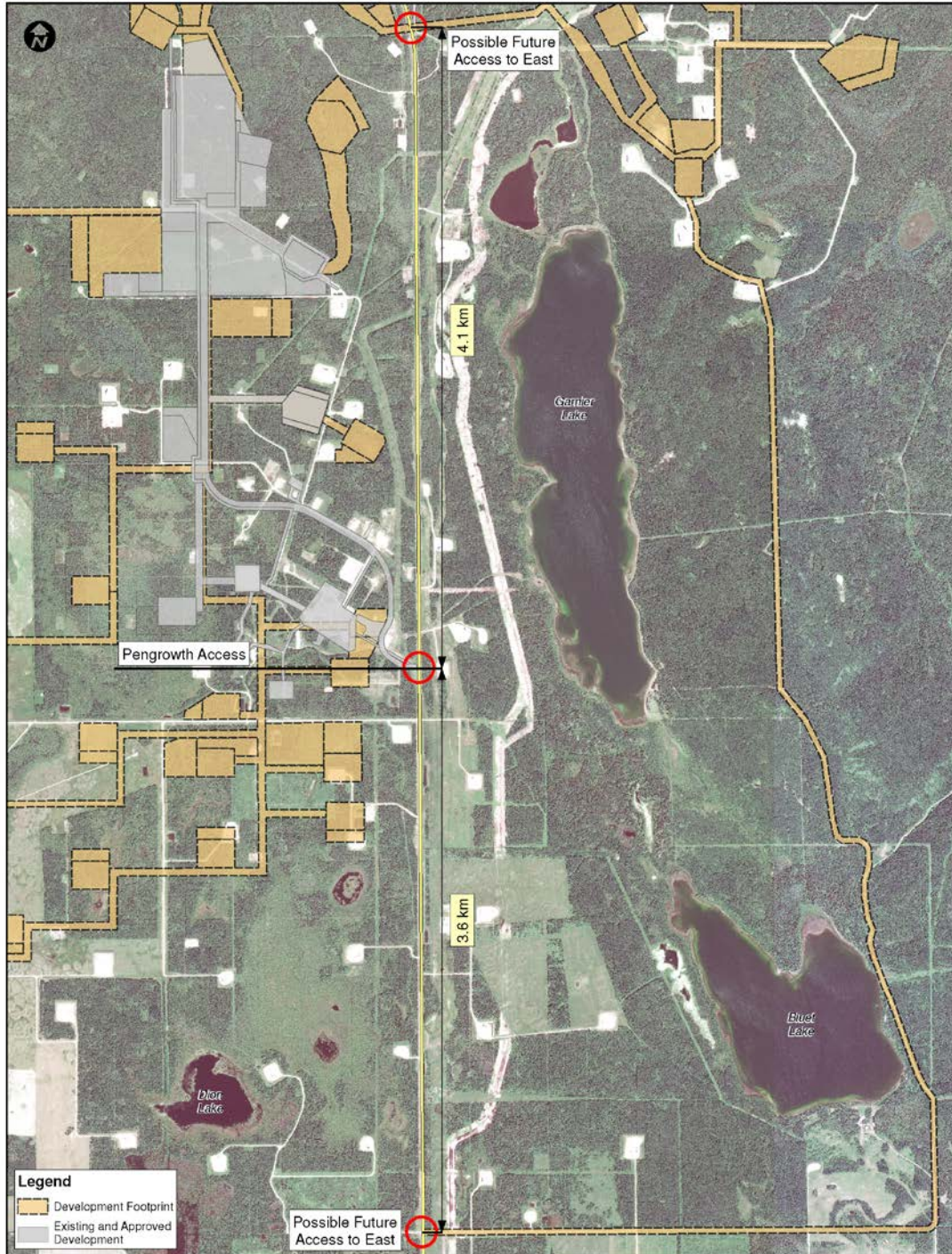


Figure 2: Site Access Plan (Not to Scale)

Future development plans may include accesses to the east of Range Road 50, as shown in **Figure 3**. These potential accesses are situated far enough away from the existing access location that operations should remain unaffected.

Figure 3: Potential Future Accesses



2.3 Existing Traffic Volumes

A 12-hour traffic count was performed from 7am to 7pm on November 7, 2012 at the intersection of Range Road 50 and the existing Pengrowth access road. This count and the ensuing calculations were performed to Alberta Transportation (AT) standards. Results of the count (detailed count summary sheets) are presented in [Appendix A](#). Of note is the high percentage of heavy truck traffic utilizing the roadway, currently at nearly 50% of observed traffic volumes along Range Road 50.

Figure 4 shows 2012 average annual daily traffic (AADT), as well as the 100th highest AM and PM peak hour volumes.

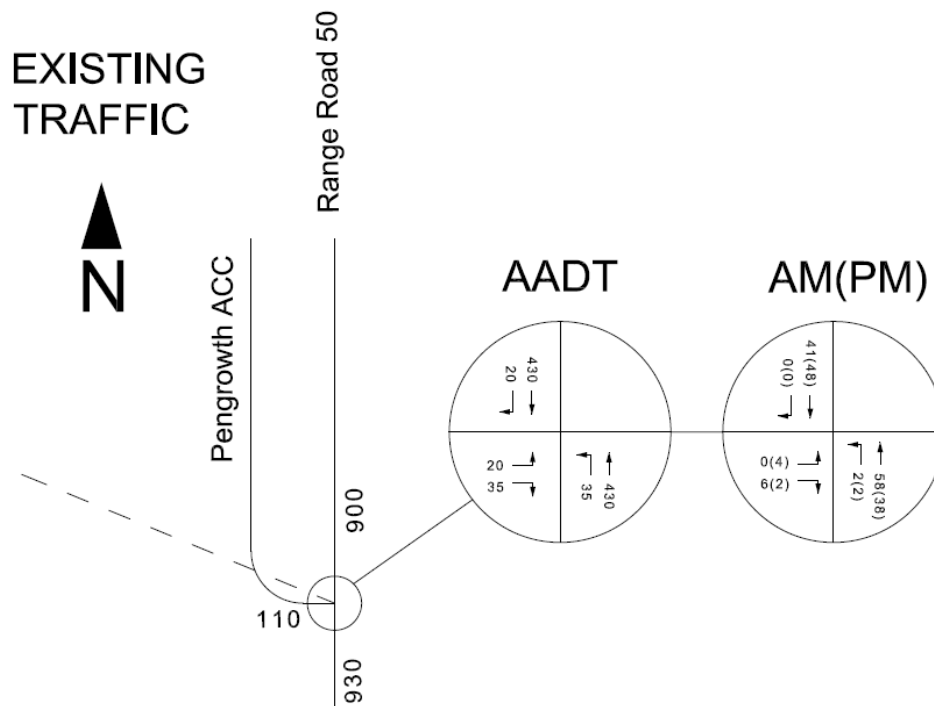


Figure 4: Existing (2012) Traffic Volumes

3 PROJECTED TRAFFIC

3.1 Projected Traffic Volumes

The existing through traffic was projected with a growth rate of approximately 2.3% per year (consistent with historical growth in the area) for 25 years, the estimated operation lifespan of the proposed development, following the projected completion of Phase 2 in 2017. The background site traffic was assumed to remain at existing levels for the projection.

Figure 5 shows the projected 2042 background traffic volumes.

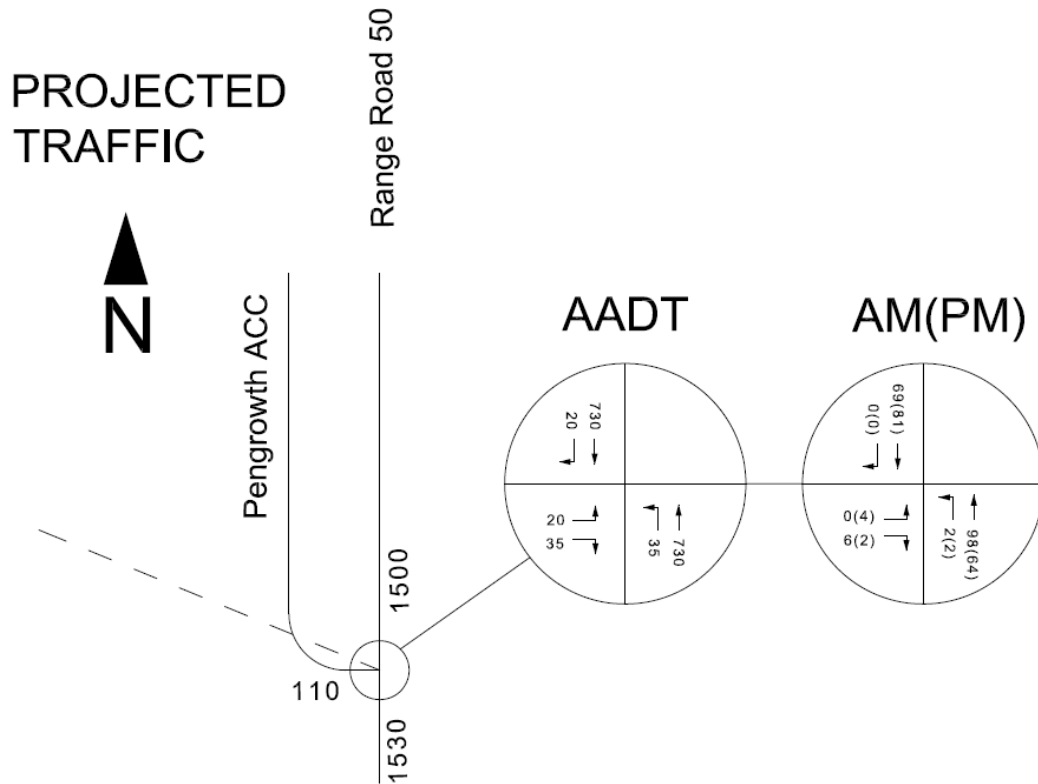


Figure 5: Projected 2042 Background Traffic Volumes

3.2 Trip Generation & Distribution

The Institute of Transportation Engineers (ITE) Trip Generation Handbook does not include an adequate representation to estimate the daily trips for the proposed development. The expansion to 30,000 bpd production rate will require an additional 200 trucks to access the Project daily. Pengrowth also expects that the existing development traffic will increase by a factor of 1.2 to account for additional employees and deliveries needed for operation and maintenance.

The trips were assumed to follow the 40/60 distribution pattern of existing traffic accessing the development from the north and south on Range Road 50. An in/out directional split of 50/50 was also used to determine the possible effects of the development traffic.

3.3 Combined Trips

Figure 6 shows the projected 2042 traffic volumes, combined with the proposed project expansion trips.

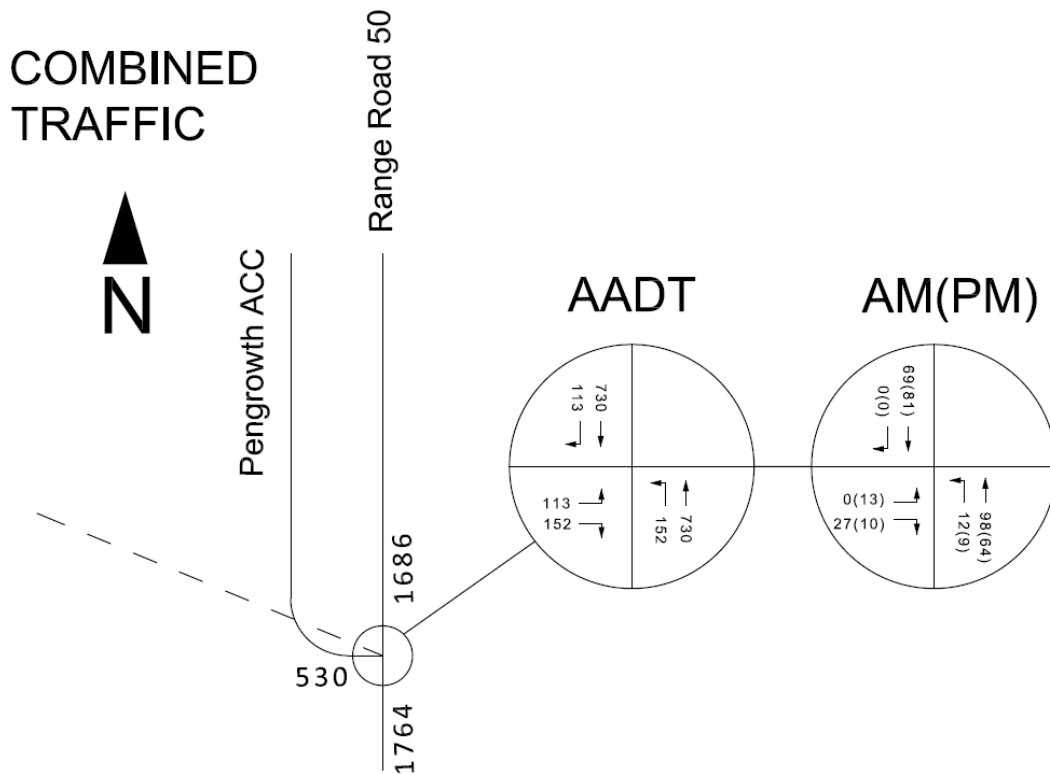


Figure 6: Combined 2042 Traffic Volumes (Background + Development)

4 TRAFFIC ANALYSIS

4.1 Intersection Performance

Intersection performance was conducted with Synchro 8 software. The Level of Service (LOS) for the intersection with current configuration is presented in [Table 2](#). For Level of Service, an “A” is deemed very good performance, a LOS “C” is the minimum acceptable performance for Alberta Transportation and a LOS “F” is a deemed failure at the intersection with significant travel delays.

Table 2: LOS for Range Road 50 / Access Intersection

Condition	Intersection Level of Service		Stop Controlled Movement	
	AM	PM	AM	PM
Background	A	A	A	A
2042 Projected	A	A	A	A
Combined	A	A	A	A

This intersection is anticipated to continue operating at an adequate Level of Service in an unsignalized, stop controlled configuration for the 25 year operating horizon. Synchro LOS analysis outputs are attached in [Appendix B](#).

While the intersection upgrades will require a temporary increase in traffic along with a reduction in speed on Range Road 50, our analysis shows that the performance of the roadway will not be affected; the plant expansion itself will occur subsequent to the access construction, which will be designed and built to handle 2042 traffic volume requirements.

For the Phase 1 facility, the construction load traffic is anticipated to be approximately 100 equipment deliveries over a four month period. The additional planned expansion in 2017 will require approximately 140 deliveries over a similar construction period. These temporarily increased volumes will not exceed the projected 2042 operational volumes and therefore will not affect the recommended intersection treatment for the development.

4.2 Intersection Treatment

Alberta Transportation’s Highway Geometric Design Guide (HG DG) provides criteria for the selection of an appropriate at-grade intersection treatment on a two-lane rural highway. According to Figure D-7.4, the proposed intersection treatment is a function of AADT on the main road and the intersecting road. Following this methodology, the intersection of Range Road 50 and the Pengrowth Access currently falls within the threshold between a Type I & Type II intersection, and will require minimum upgrades to a Type II intersection in 2042, as shown in [Figure 7](#).

FIGURE D-7.4 TRAFFIC VOLUME WARRANT CHART FOR AT-GRADE INTERSECTION TREATMENT ON TWO-LANE RURAL HIGHWAYS (DESIGN SPEEDS 100, 110, 120 km/h)

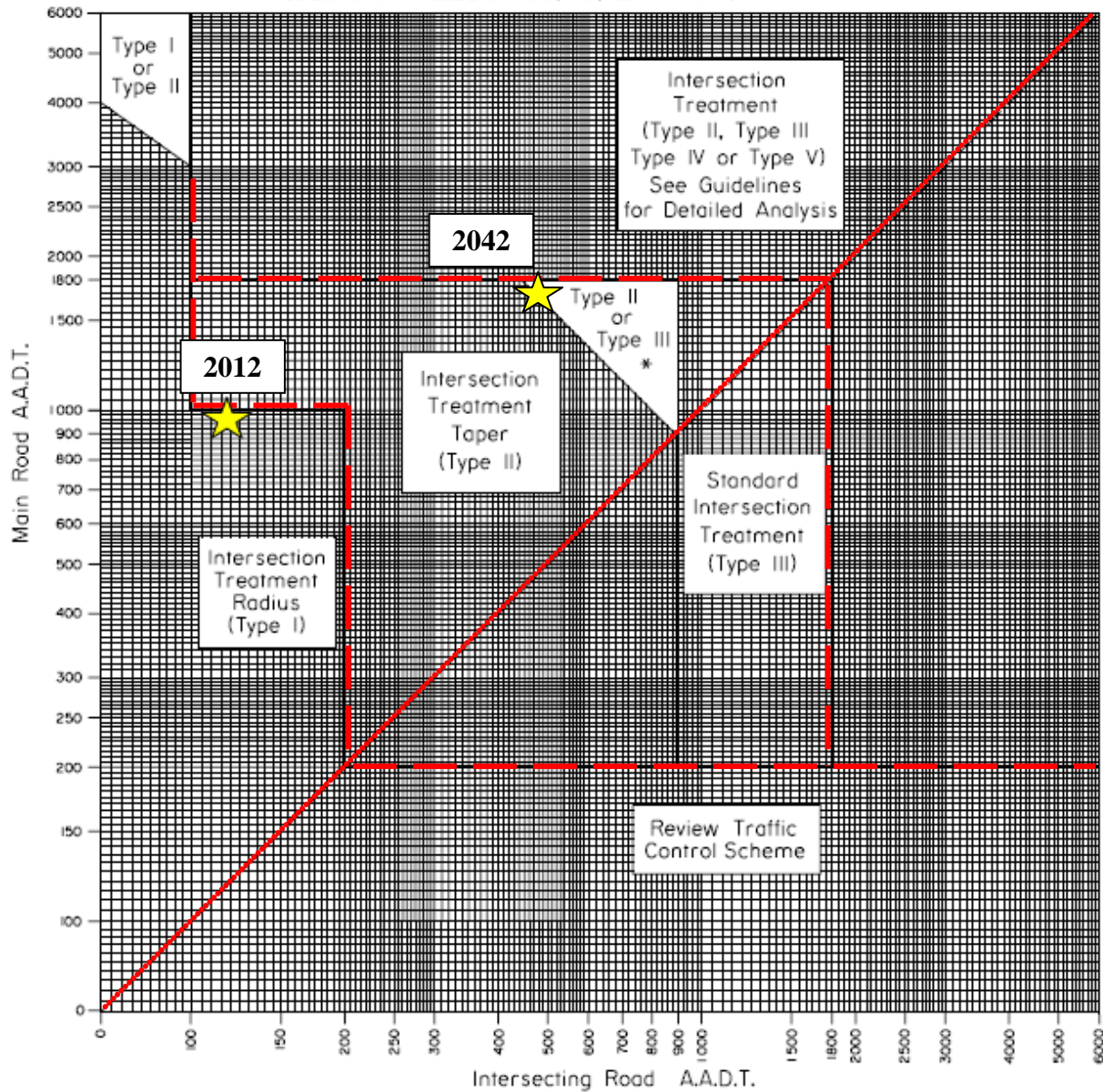


Figure 7: Modified from HGDG Figure D-7.4

5 RECOMMENDATIONS & CONCLUSIONS

According to the Highway Geometric Design Guide, the projected 2042 traffic volumes at the intersection of Range Road 50 and the Pengrowth access will require a minimum upgrade from the existing Type Ia intersection to a Type IIa intersection as a part of the plans to expand the oil recovery plant. Type IIa intersections feature a 25:1 taper preceding and following all intersection legs, as well as a 40 m auxiliary through lane to accommodate the left turn movement off the main road (see attached diagram in [Appendix C](#)).

However, due to the large percentage of trucks anticipated to be present, both along Range Road 50 and the intersecting access road, a Type IIIa configuration is recommended over the minimum requirement of Type IIa. Type IIIa intersections feature a larger 40:1 taper and an additional length of 40 m for the through lane to allow passing vehicles to continue without stopping (see attached diagram in [Appendix C](#)). This will also accommodate driver expectation as a longer taper provides for a more gradual reduction in speed for through vehicles approaching the intersection, thereby increasing the operational safety.

At future design stages, additional safety concerns such as lighting, signing and sight distance will require further review, as this TIA addresses only the required geometric configuration of the access from a traffic operations perspective.

If additional access locations are required during future development stages, intersection improvement requirements should be revisited for all access locations to assess any upstream and downstream effects between each proposed access point off this paved roadway.

Appendix A:

Traffic Count Summary Sheets

TURNING MOVEMENT SUMMARY DIAGRAM

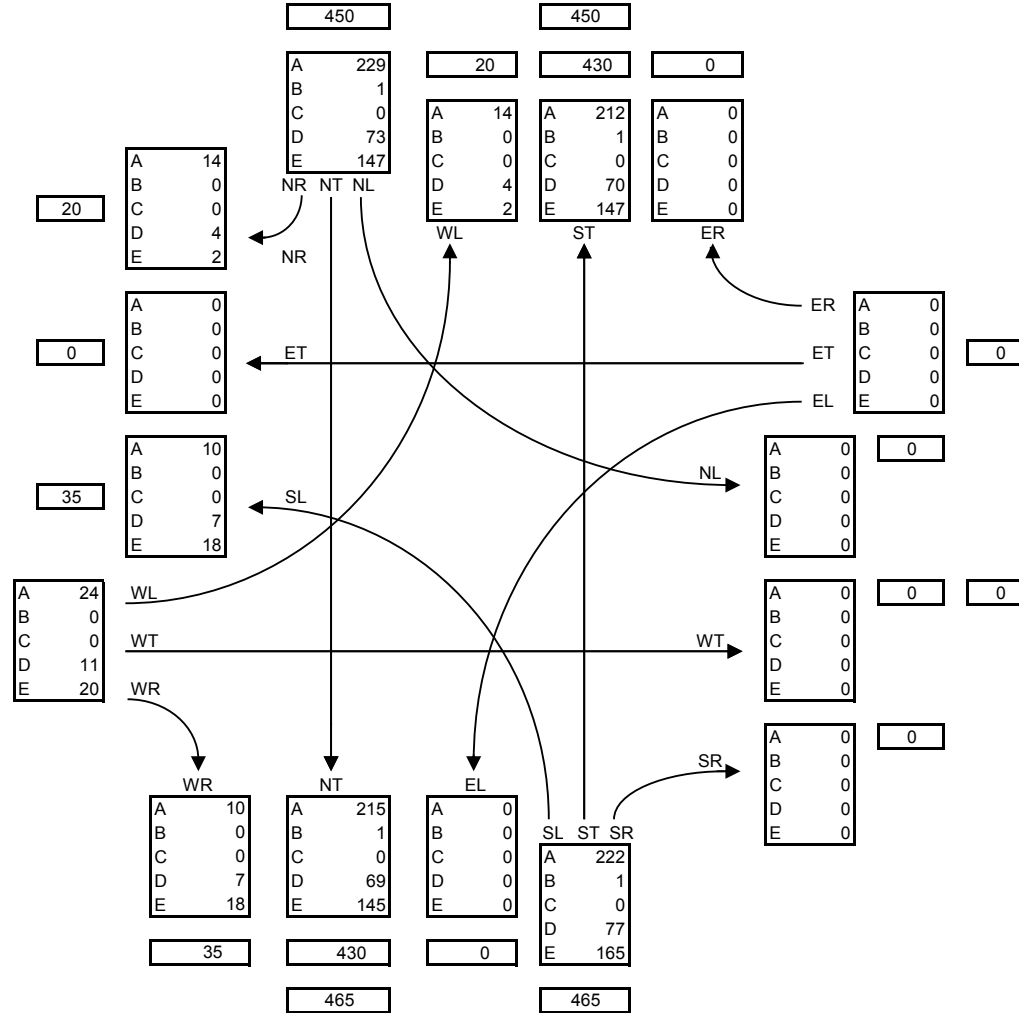
**INTERSECTION OF: RGE RD 50 & PENGROWTH ACC.
(NE OF ELK POINT)**

2012 AADT & ASDT ESTIMATES

NORTH ON		RGE RD 50	
VEH TYPE	VOL	%	
A: PASSENGER VEHICLES	455	50.56	
B: RECREATION VEHICLES	2	0.22	
C: BUSES	0	0.00	
D: SINGLE UNIT TRUCKS	147	16.33	
E: TRACTOR TRAILER COMB.	296	32.89	
ASDT	1010	AADT	900

WEST ON		PENGROWTH ACC	
VEH TYPE	VOL	%	
A: PASSENGER VEHICLES	48	43.64	
B: RECREATION VEHICLES	0	0.00	
C: BUSES	0	0.00	
D: SINGLE UNIT TRUCKS	22	20.00	
E: TRACTOR TRAILER COMB.	40	36.36	
ASDT	120	AADT	110

EAST ON			
VEH TYPE	VOL	%	
A: PASSENGER VEHICLES	0	0.00	
B: RECREATION VEHICLES	0	0.00	
C: BUSES	0	0.00	
D: SINGLE UNIT TRUCKS	0	0.00	
E: TRACTOR TRAILER COMB.	0	0.00	
ASDT	0	AADT	0



TURNING MOVEMENT ABBREVIATIONS

- NL : TRAFFIC FROM NORTH TURNING LEFT
- NT : TRAFFIC FROM NORTH PROCEEDING THROUGH
- NR : TRAFFIC FROM NORTH TURNING RIGHT
- SL : TRAFFIC FROM SOUTH TURNING LEFT
- ST : TRAFFIC FROM SOUTH PROCEEDING THROUGH
- SR : TRAFFIC FROM SOUTH TURNING RIGHT
- EL : TRAFFIC FROM EAST TURNING LEFT
- ET : TRAFFIC FROM EAST PROCEEDING THROUGH
- ER : TRAFFIC FROM EAST TURNING RIGHT
- WL : TRAFFIC FROM WEST TURNING LEFT
- WT : TRAFFIC FROM WEST PROCEEDING THROUGH
- WR : TRAFFIC FROM WEST TURNING RIGHT

SOUTH ON		RGE RD 50	
VEH TYPE	VOL	%	
A: PASSENGER VEHICLES	447	48.06	
B: RECREATION VEHICLES	2	0.22	
C: BUSES	0	0.00	
D: SINGLE UNIT TRUCKS	153	16.45	
E: TRACTOR TRAILER COMB.	328	35.27	
ASDT	1040	AADT	930

TURNING MOVEMENT SUMMARY DIAGRAM

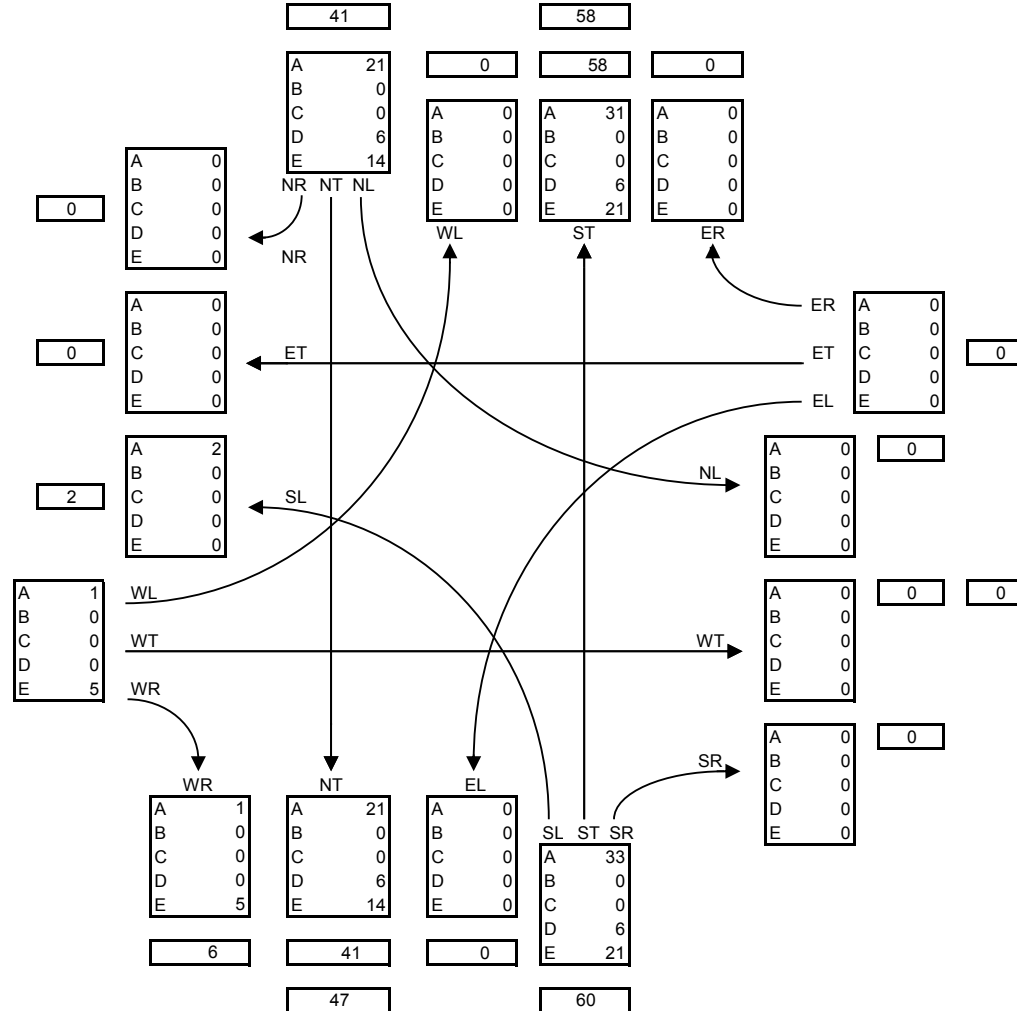
**INTERSECTION OF: RGE RD 50 & PENGROWTH ACC.
(NE OF ELK POINT)**

2012 AM 100TH HIGHEST HOUR TRAFFIC VOLUMES

NORTH ON		RGE RD 50	
VEH TYPE	VOL	%	
A: PASSENGER VEHICLES	52	52.53	
B: RECREATION VEHICLES	0	0.00	
C: BUSES	0	0.00	
D: SINGLE UNIT TRUCKS	12	12.12	
E: TRACTOR TRAILER COMB.	35	35.35	
TOTAL	99		

WEST ON		PENGROWTH ACC	
VEH TYPE	VOL	%	
A: PASSENGER VEHICLES	3	37.50	
B: RECREATION VEHICLES	0	0.00	
C: BUSES	0	0.00	
D: SINGLE UNIT TRUCKS	0	0.00	
E: TRACTOR TRAILER COMB.	5	62.50	
TOTAL	8		

EAST ON		
VEH TYPE	VOL	%
A: PASSENGER VEHICLES	0	0.00
B: RECREATION VEHICLES	0	0.00
C: BUSES	0	0.00
D: SINGLE UNIT TRUCKS	0	0.00
E: TRACTOR TRAILER COMB.	0	0.00
TOTAL	0	



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- ER : TRAFFIC FROM EAST TURNING RIGHT
- WL : TRAFFIC FROM WEST TURNING LEFT
- WT : TRAFFIC FROM WEST PROCEEDING THROUGH
- WR : TRAFFIC FROM WEST TURNING RIGHT

SOUTH ON		RGE RD 50	
VEH TYPE	VOL	%	
A: PASSENGER VEHICLES	55	51.40	
B: RECREATION VEHICLES	0	0.00	
C: BUSES	0	0.00	
D: SINGLE UNIT TRUCKS	12	11.21	
E: TRACTOR TRAILER COMB.	40	37.38	
TOTAL	107		

TURNING MOVEMENT SUMMARY DIAGRAM

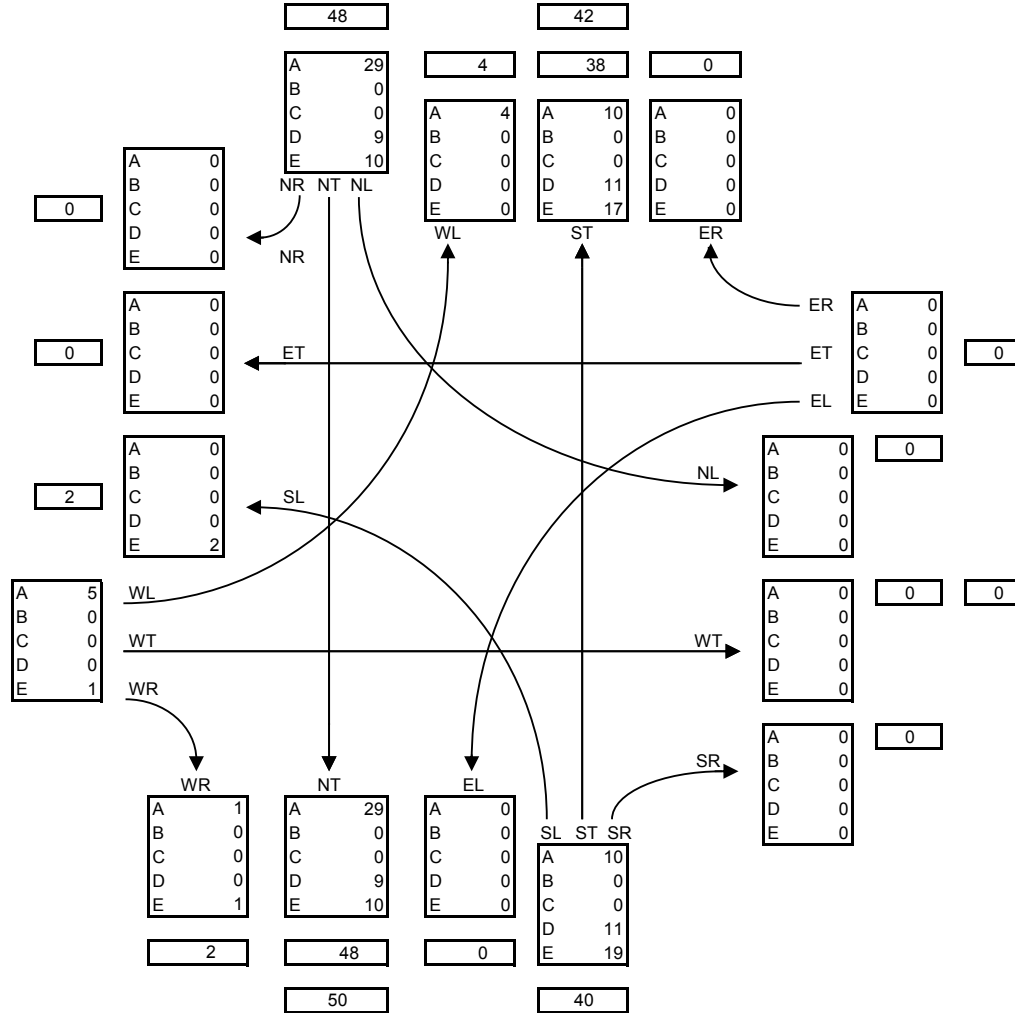
**INTERSECTION OF: RGE RD 50 & PENGROWTH ACC.
(NE OF ELK POINT)**

2012 PM 100TH HIGHEST HOUR TRAFFIC VOLUMES

NORTH ON		RGE RD 50	
VEH TYPE	VOL	%	
A: PASSENGER VEHICLES	43	47.78	
B: RECREATION VEHICLES	0	0.00	
C: BUSES	0	0.00	
D: SINGLE UNIT TRUCKS	20	22.22	
E: TRACTOR TRAILER COMB.	27	30.00	
TOTAL	90		

WEST ON	PENGROWTH ACC	
	VOL	%
A: PASSENGER VEHICLES	5	62.50
B: RECREATION VEHICLES	0	0.00
C: BUSES	0	0.00
D: SINGLE UNIT TRUCKS	0	0.00
E: TRACTOR TRAILER COMB.	3	37.50
TOTAL	8	

EAST ON		
VEH TYPE	VOL	%
A: PASSENGER VEHICLES	0	0.00
B: RECREATION VEHICLES	0	0.00
C: BUSES	0	0.00
D: SINGLE UNIT TRUCKS	0	0.00
E: TRACTOR TRAILER COMB.	0	0.00
TOTAL	0	



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- WT : TRAFFIC FROM WEST PROCEEDING THROUGH
- WR : TRAFFIC FROM WEST TURNING RIGHT

SOUTH ON		RGE RD 50	
VEH TYPE	VOL	%	
A: PASSENGER VEHICLES	40	44.44	
B: RECREATION VEHICLES	0	0.00	
C: BUSES	0	0.00	
D: SINGLE UNIT TRUCKS	20	22.22	
E: TRACTOR TRAILER COMB.	30	33.33	
TOTAL	90		

TURNING MOVEMENT SUMMARY DIAGRAM

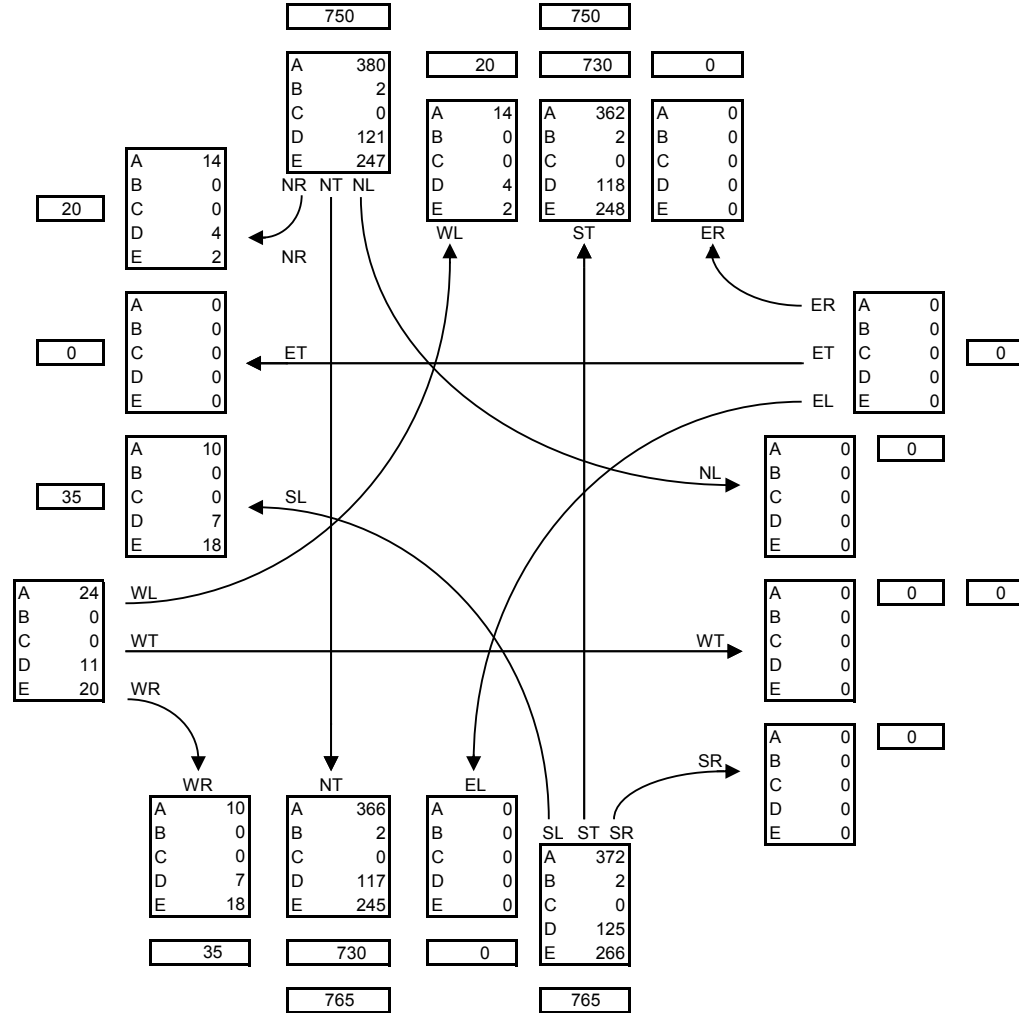
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(NE OF ELK POINT)**

2042 AADT & ASDT ESTIMATES

NORTH ON		RGE RD 50	
VEH TYPE	VOL	%	
A: PASSENGER VEHICLES	756	50.40	
B: RECREATION VEHICLES	4	0.27	
C: BUSES	0	0.00	
D: SINGLE UNIT TRUCKS	243	16.20	
E: TRACTOR TRAILER COMB.	497	33.13	
ASDT	1690	AADT	1500

WEST ON		PENGROWTH ACC	
VEH TYPE	VOL	%	
A: PASSENGER VEHICLES	48	43.64	
B: RECREATION VEHICLES	0	0.00	
C: BUSES	0	0.00	
D: SINGLE UNIT TRUCKS	22	20.00	
E: TRACTOR TRAILER COMB.	40	36.36	
ASDT	120	AADT	110

EAST ON			
VEH TYPE	VOL	%	
A: PASSENGER VEHICLES	0	0.00	
B: RECREATION VEHICLES	0	0.00	
C: BUSES	0	0.00	
D: SINGLE UNIT TRUCKS	0	0.00	
E: TRACTOR TRAILER COMB.	0	0.00	
ASDT	0	AADT	0



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- WT : TRAFFIC FROM WEST PROCEEDING THROUGH
- WR : TRAFFIC FROM WEST TURNING RIGHT

SOUTH ON		RGE RD 50	
VEH TYPE	VOL	%	
A: PASSENGER VEHICLES	748	48.89	
B: RECREATION VEHICLES	4	0.26	
C: BUSES	0	0.00	
D: SINGLE UNIT TRUCKS	249	16.27	
E: TRACTOR TRAILER COMB.	529	34.58	
ASDT	1720	AADT	1530

TURNING MOVEMENT SUMMARY DIAGRAM

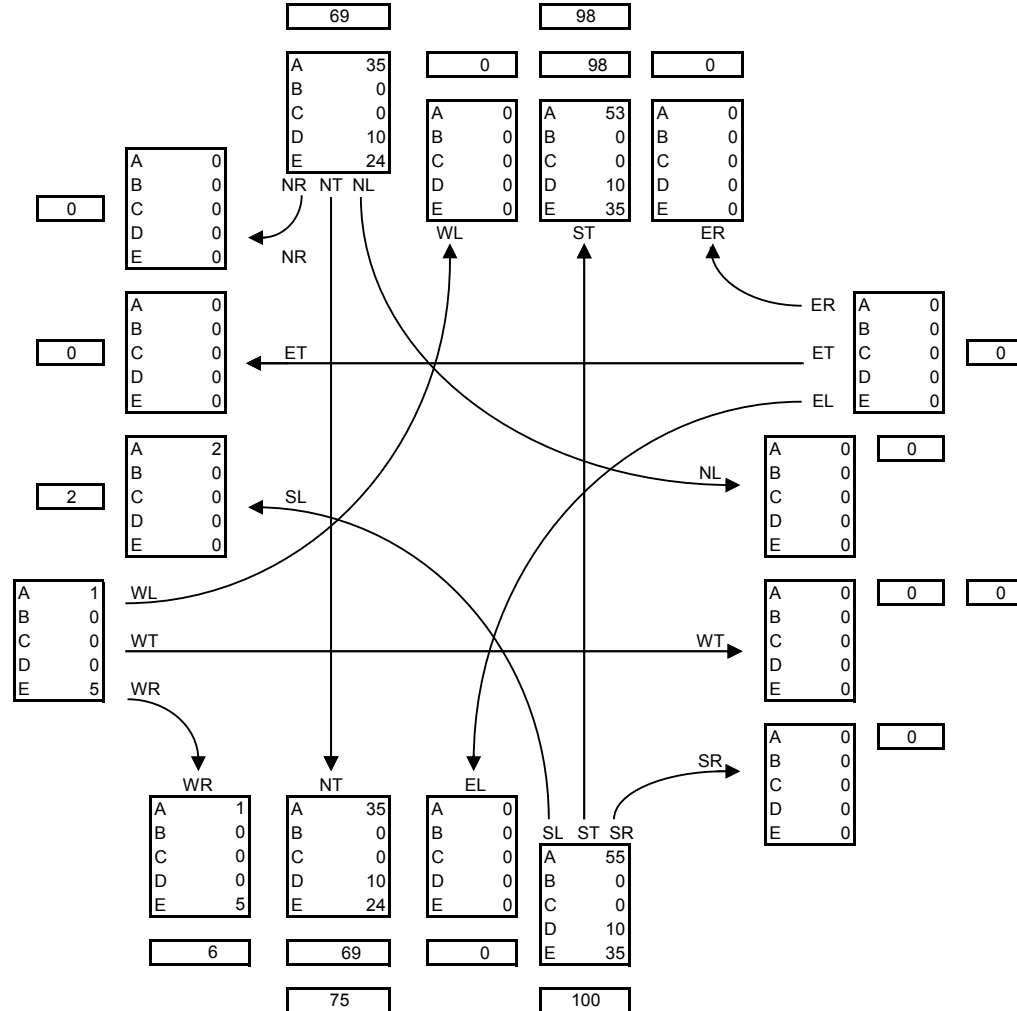
**INTERSECTION OF: RGE RD 50 & PENGROWTH ACC.
(NE OF ELK POINT)**

2042 AM 100TH HIGHEST HOUR TRAFFIC VOLUMES

NORTH ON		RGE RD 50	
VEH TYPE	VOL	%	
A: PASSENGER VEHICLES	88	52.69	
B: RECREATION VEHICLES	0	0.00	
C: BUSES	0	0.00	
D: SINGLE UNIT TRUCKS	20	11.98	
E: TRACTOR TRAILER COMB.	59	35.33	
TOTAL	167		

WEST ON		PENGROWTH ACC	
VEH TYPE	VOL	%	
A: PASSENGER VEHICLES	3	37.50	
B: RECREATION VEHICLES	0	0.00	
C: BUSES	0	0.00	
D: SINGLE UNIT TRUCKS	0	0.00	
E: TRACTOR TRAILER COMB.	5	62.50	
TOTAL	8		

EAST ON		
VEH TYPE	VOL	%
A: PASSENGER VEHICLES	0	0.00
B: RECREATION VEHICLES	0	0.00
C: BUSES	0	0.00
D: SINGLE UNIT TRUCKS	0	0.00
E: TRACTOR TRAILER COMB.	0	0.00
TOTAL	0	



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- WT : TRAFFIC FROM WEST PROCEEDING THROUGH
- WR : TRAFFIC FROM WEST TURNING RIGHT

SOUTH ON		RGE RD 50	
VEH TYPE	VOL	%	
A: PASSENGER VEHICLES	91	52.00	
B: RECREATION VEHICLES	0	0.00	
C: BUSES	0	0.00	
D: SINGLE UNIT TRUCKS	20	11.43	
E: TRACTOR TRAILER COMB.	64	36.57	
TOTAL	175		

TURNING MOVEMENT SUMMARY DIAGRAM

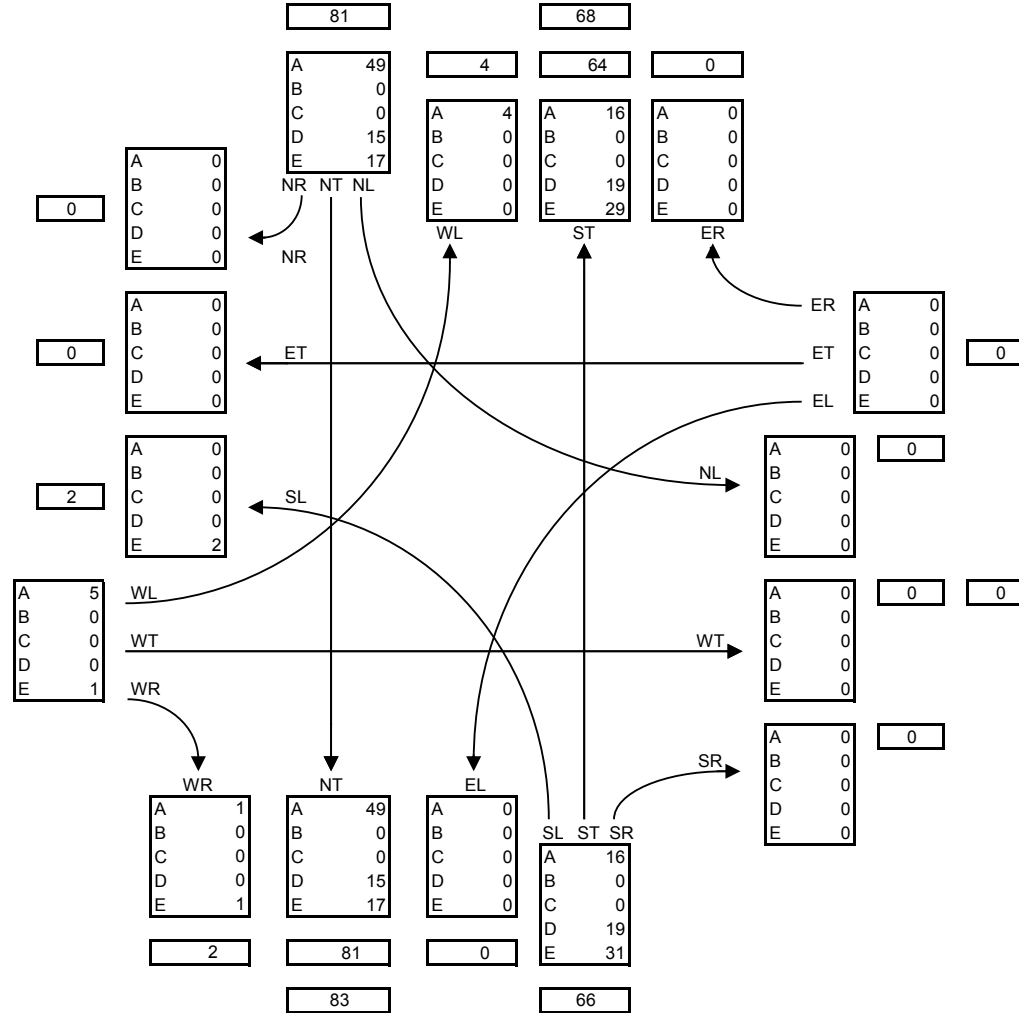
**INTERSECTION OF: RGE RD 50 & PENGROWTH ACC.
(NE OF ELK POINT)**

2042 PM 100TH HIGHEST HOUR TRAFFIC VOLUMES

NORTH ON		RGE RD 50	
VEH TYPE	VOL	%	
A: PASSENGER VEHICLES	69	46.31	
B: RECREATION VEHICLES	0	0.00	
C: BUSES	0	0.00	
D: SINGLE UNIT TRUCKS	34	22.82	
E: TRACTOR TRAILER COMB.	46	30.87	
TOTAL	149		

WEST ON		PENGROWTH ACC	
VEH TYPE	VOL	%	
A: PASSENGER VEHICLES	5	62.50	
B: RECREATION VEHICLES	0	0.00	
C: BUSES	0	0.00	
D: SINGLE UNIT TRUCKS	0	0.00	
E: TRACTOR TRAILER COMB.	3	37.50	
TOTAL	8		

EAST ON		
VEH TYPE	VOL	%
A: PASSENGER VEHICLES	0	0.00
B: RECREATION VEHICLES	0	0.00
C: BUSES	0	0.00
D: SINGLE UNIT TRUCKS	0	0.00
E: TRACTOR TRAILER COMB.	0	0.00
TOTAL	0	



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- ET : TRAFFIC FROM EAST PROCEEDING THROUGH
- ER : TRAFFIC FROM EAST TURNING RIGHT
- WL : TRAFFIC FROM WEST TURNING LEFT
- WT : TRAFFIC FROM WEST PROCEEDING THROUGH
- WR : TRAFFIC FROM WEST TURNING RIGHT

SOUTH ON		RGE RD 50	
VEH TYPE	VOL	%	
A: PASSENGER VEHICLES	66	44.30	
B: RECREATION VEHICLES	0	0.00	
C: BUSES	0	0.00	
D: SINGLE UNIT TRUCKS	34	22.82	
E: TRACTOR TRAILER COMB.	49	32.89	
TOTAL	149		

TURNING MOVEMENT SUMMARY DIAGRAM

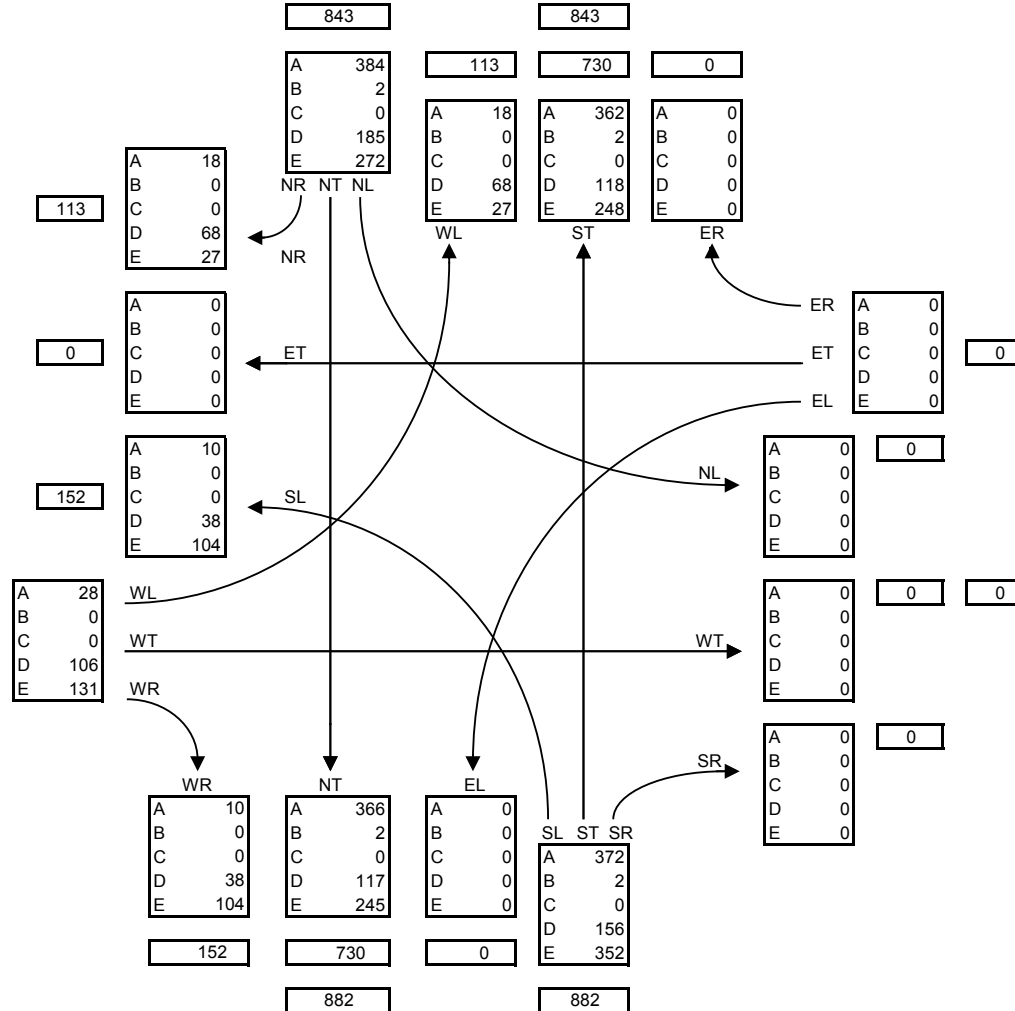
**INTERSECTION OF: RGE RD 50 & PENGROWTH ACC.
(NE OF ELK POINT)**

2042 AADT & ASDT ESTIMATES WITH ADDITIONAL TRUCKS

NORTH ON		RGE RD 50	
VEH TYPE	VOL	%	
A: PASSENGER VEHICLES	764	45.31	
B: RECREATION VEHICLES	4	0.24	
C: BUSES	0	0.00	
D: SINGLE UNIT TRUCKS	371	22.00	
E: TRACTOR TRAILER COMB.	547	32.44	
ASDT	1890	AADT	1686

WEST ON	PENGROWTH ACC		
	VOL	%	
A: PASSENGER VEHICLES	56	10.57	
B: RECREATION VEHICLES	0	0.00	
C: BUSES	0	0.00	
D: SINGLE UNIT TRUCKS	212	40.00	
E: TRACTOR TRAILER COMB.	262	49.43	
ASDT	600	AADT	530

EAST ON			
VEH TYPE	VOL	%	
A: PASSENGER VEHICLES	0	0.00	
B: RECREATION VEHICLES	0	0.00	
C: BUSES	0	0.00	
D: SINGLE UNIT TRUCKS	0	0.00	
E: TRACTOR TRAILER COMB.	0	0.00	
ASDT	0	AADT	0



SOUTH ON		RGE RD 50	
VEH TYPE	VOL	%	
A: PASSENGER VEHICLES	748	42.40	
B: RECREATION VEHICLES	4	0.23	
C: BUSES	0	0.00	
D: SINGLE UNIT TRUCKS	311	17.63	
E: TRACTOR TRAILER COMB.	701	39.74	
ASDT	1980	AADT	1764

TURNING MOVEMENT ABBREVIATIONS

- NL : TRAFFIC FROM NORTH TURNING LEFT
- NT : TRAFFIC FROM NORTH PROCEEDING THROUGH
- NR : TRAFFIC FROM NORTH TURNING RIGHT
- SL : TRAFFIC FROM SOUTH TURNING LEFT
- ST : TRAFFIC FROM SOUTH PROCEEDING THROUGH
- SR : TRAFFIC FROM SOUTH TURNING RIGHT
- EL : TRAFFIC FROM EAST TURNING LEFT
- ET : TRAFFIC FROM EAST PROCEEDING THROUGH
- ER : TRAFFIC FROM EAST TURNING RIGHT
- WL : TRAFFIC FROM WEST TURNING LEFT
- WT : TRAFFIC FROM WEST PROCEEDING THROUGH
- WR : TRAFFIC FROM WEST TURNING RIGHT

TURNING MOVEMENT SUMMARY DIAGRAM

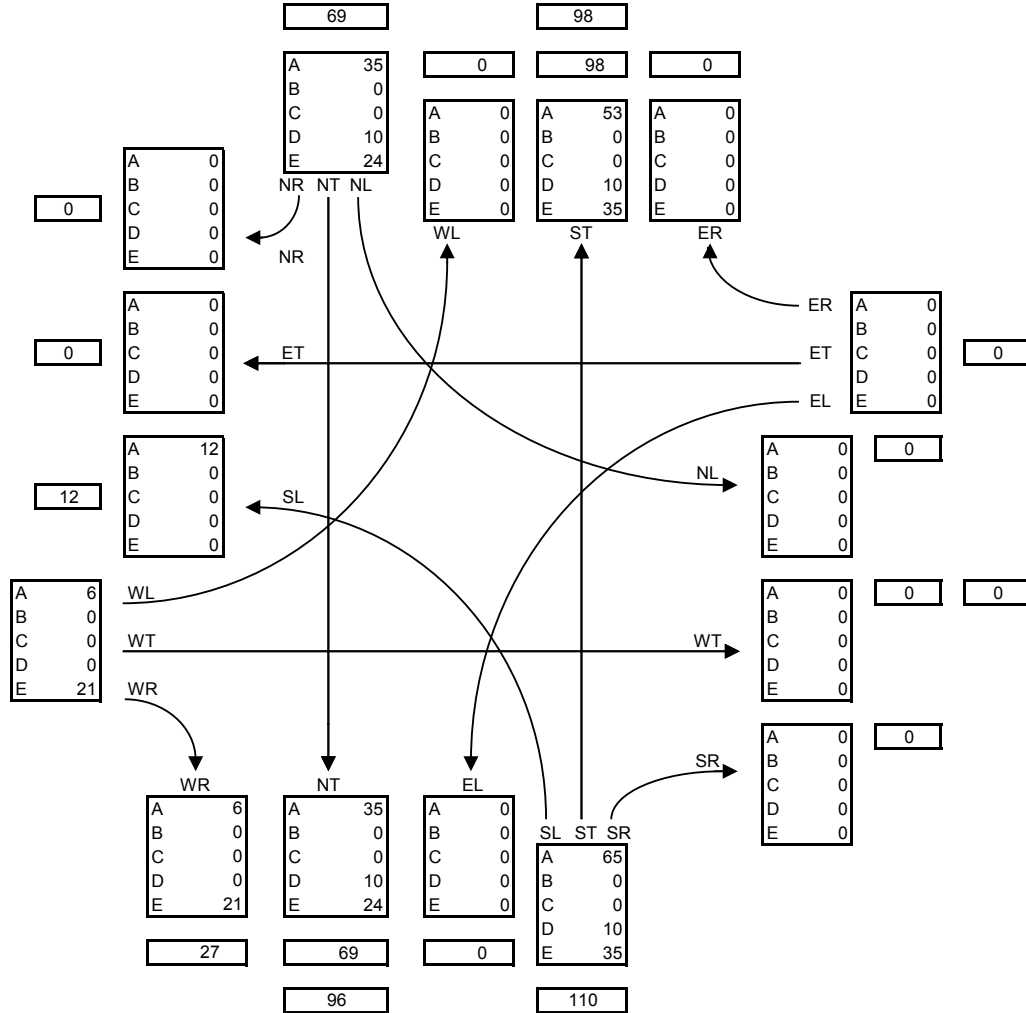
**INTERSECTION OF: RGE RD 50 & PENGROWTH ACC.
(NE OF ELK POINT)**

2042 AM 100TH HIGHEST HOUR TRAFFIC WITH ADDITIONAL TRUCKS

NORTH ON		RGE RD 50	
VEH TYPE	VOL	%	
A: PASSENGER VEHICLES	88	52.69	
B: RECREATION VEHICLES	0	0.00	
C: BUSES	0	0.00	
D: SINGLE UNIT TRUCKS	20	11.98	
E: TRACTOR TRAILER COMB.	59	35.33	
TOTAL	167		

WEST ON		PENGROWTH ACC	
VEH TYPE	VOL	%	
A: PASSENGER VEHICLES	18	46.15	
B: RECREATION VEHICLES	0	0.00	
C: BUSES	0	0.00	
D: SINGLE UNIT TRUCKS	0	0.00	
E: TRACTOR TRAILER COMB.	21	53.85	
TOTAL	39		

EAST ON		
VEH TYPE	VOL	%
A: PASSENGER VEHICLES	0	0.00
B: RECREATION VEHICLES	0	0.00
C: BUSES	0	0.00
D: SINGLE UNIT TRUCKS	0	0.00
E: TRACTOR TRAILER COMB.	0	0.00
TOTAL	0	



TURNING MOVEMENT ABBREVIATIONS

- NL : TRAFFIC FROM NORTH TURNING LEFT
- NT : TRAFFIC FROM NORTH PROCEEDING THROUGH
- NR : TRAFFIC FROM NORTH TURNING RIGHT
- SL : TRAFFIC FROM SOUTH TURNING LEFT
- ST : TRAFFIC FROM SOUTH PROCEEDING THROUGH
- SR : TRAFFIC FROM SOUTH TURNING RIGHT
- EL : TRAFFIC FROM EAST TURNING LEFT
- ET : TRAFFIC FROM EAST PROCEEDING THROUGH
- ER : TRAFFIC FROM EAST TURNING RIGHT
- WL : TRAFFIC FROM WEST TURNING LEFT
- WT : TRAFFIC FROM WEST PROCEEDING THROUGH
- WR : TRAFFIC FROM WEST TURNING RIGHT

SOUTH ON		RGE RD 50	
VEH TYPE	VOL	%	
A: PASSENGER VEHICLES	106	51.46	
B: RECREATION VEHICLES	0	0.00	
C: BUSES	0	0.00	
D: SINGLE UNIT TRUCKS	20	9.71	
E: TRACTOR TRAILER COMB.	80	38.83	
TOTAL	206		

TURNING MOVEMENT SUMMARY DIAGRAM

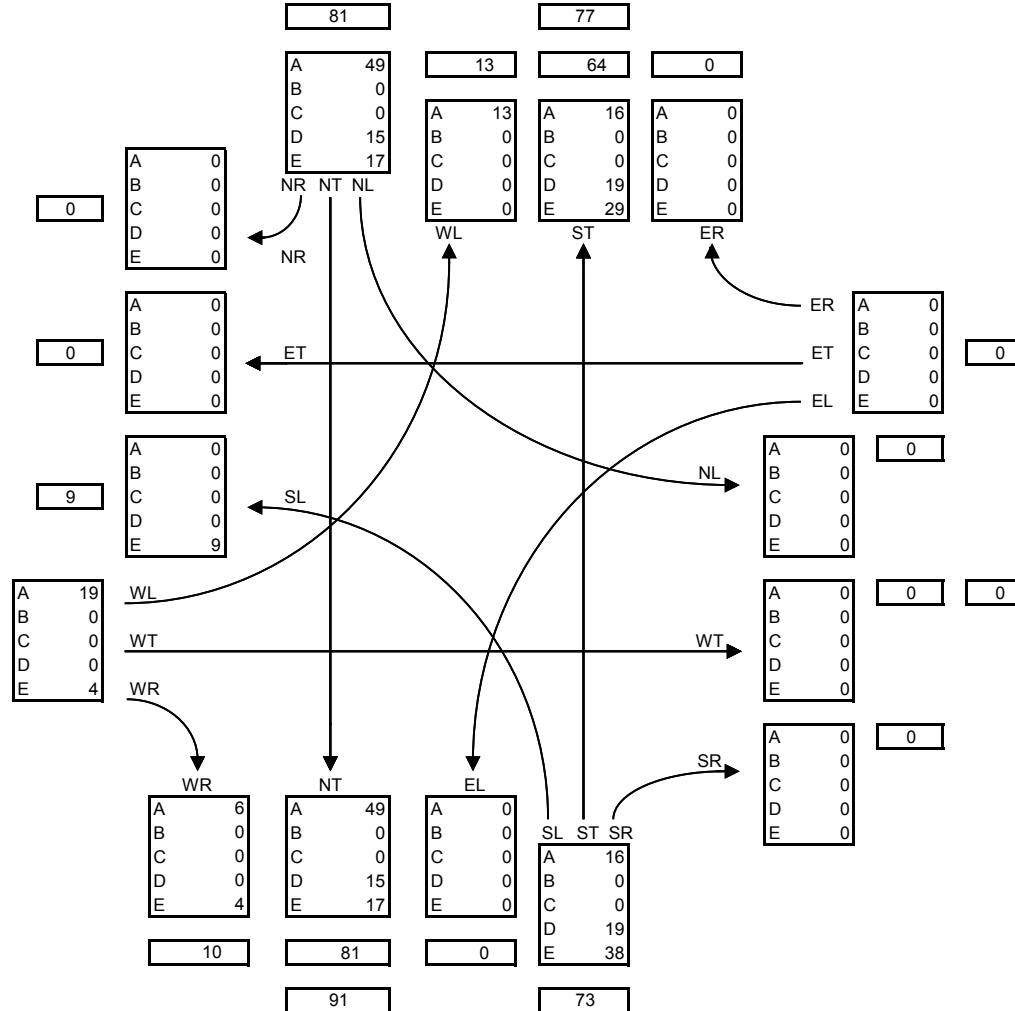
**INTERSECTION OF: RGE RD 50 & PENGROWTH ACC.
(NE OF ELK POINT)**

2042 PM 100TH HIGHEST HOUR TRAFFIC WITH ADDITIONAL TRUCKS

NORTH ON		RGE RD 50	
VEH TYPE	VOL	%	
A: PASSENGER VEHICLES	78	49.37	
B: RECREATION VEHICLES	0	0.00	
C: BUSES	0	0.00	
D: SINGLE UNIT TRUCKS	34	21.52	
E: TRACTOR TRAILER COMB.	46	29.11	
TOTAL	158		

WEST ON	PENGROWTH ACC	
	VOL	%
A: PASSENGER VEHICLES	19	59.38
B: RECREATION VEHICLES	0	0.00
C: BUSES	0	0.00
D: SINGLE UNIT TRUCKS	0	0.00
E: TRACTOR TRAILER COMB.	13	40.63
TOTAL	32	

EAST ON		
VEH TYPE	VOL	%
A: PASSENGER VEHICLES	0	0.00
B: RECREATION VEHICLES	0	0.00
C: BUSES	0	0.00
D: SINGLE UNIT TRUCKS	0	0.00
E: TRACTOR TRAILER COMB.	0	0.00
TOTAL	0	



TURNING MOVEMENT ABBREVIATIONS

- NL : TRAFFIC FROM NORTH TURNING LEFT
- NT : TRAFFIC FROM NORTH PROCEEDING THROUGH
- NR : TRAFFIC FROM NORTH TURNING RIGHT
- SL : TRAFFIC FROM SOUTH TURNING LEFT
- ST : TRAFFIC FROM SOUTH PROCEEDING THROUGH
- SR : TRAFFIC FROM SOUTH TURNING RIGHT
- EL : TRAFFIC FROM EAST TURNING LEFT
- ET : TRAFFIC FROM EAST PROCEEDING THROUGH
- ER : TRAFFIC FROM EAST TURNING RIGHT
- WL : TRAFFIC FROM WEST TURNING LEFT
- WT : TRAFFIC FROM WEST PROCEEDING THROUGH
- WR : TRAFFIC FROM WEST TURNING RIGHT

SOUTH ON		RGE RD 50	
VEH TYPE	VOL	%	
A: PASSENGER VEHICLES	71	43.29	
B: RECREATION VEHICLES	0	0.00	
C: BUSES	0	0.00	
D: SINGLE UNIT TRUCKS	34	20.73	
E: TRACTOR TRAILER COMB.	59	35.98	
TOTAL	164		

Appendix B:

Synchro LOS Analysis Outputs

HCM Unsignalized Intersection Capacity Analysis

Existing 2012_AM

11/8/2013



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	0	6	2	58	41	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	7	2	63	45	0
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	112	45	45			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	112	45	45			
tC, single (s)	6.9	6.7	4.6			
tC, 2 stage (s)						
tF (s)	4.0	3.8	2.7			
p0 queue free %	100	99	100			
cM capacity (veh/h)	780	904	1304			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	7	65	45			
Volume Left	0	2	0			
Volume Right	7	0	0			
cSH	904	1304	1700			
Volume to Capacity	0.01	0.00	0.03			
Queue Length 95th (m)	0.2	0.0	0.0			
Control Delay (s)	9.0	0.3	0.0			
Lane LOS	A	A				
Approach Delay (s)	9.0	0.3	0.0			
Approach LOS	A					
Intersection Summary						
Average Delay			0.7			
Intersection Capacity Utilization		14.7%		ICU Level of Service		A
Analysis Period (min)		15				

HCM Unsignalized Intersection Capacity Analysis

Existing 2012_PM

11/8/2013



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	4	2	2	38	48	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	4	2	2	41	52	0
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None		None	
Median storage (veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	98	52	52			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	98	52	52			
tC, single (s)	6.9	6.7	4.6			
tC, 2 stage (s)						
tF (s)	4.0	3.8	2.7			
p0 queue free %	99	100	100			
cM capacity (veh/h)	796	895	1295			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	7	43	52			
Volume Left	4	2	0			
Volume Right	2	0	0			
cSH	826	1295	1700			
Volume to Capacity	0.01	0.00	0.03			
Queue Length 95th (m)	0.2	0.0	0.0			
Control Delay (s)	9.4	0.4	0.0			
Lane LOS	A	A				
Approach Delay (s)	9.4	0.4	0.0			
Approach LOS	A					
Intersection Summary						
Average Delay			0.8			
Intersection Capacity Utilization			13.6%	ICU Level of Service	A	
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

Projected 2042 AM

11/8/2013



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	0	6	2	98	69	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	7	2	107	75	0
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	186	75	75			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	186	75	75			
tC, single (s)	6.9	6.7	4.6			
tC, 2 stage (s)						
tF (s)	4.0	3.8	2.7			
p0 queue free %	100	99	100			
cM capacity (veh/h)	704	868	1269			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	7	109	75			
Volume Left	0	2	0			
Volume Right	7	0	0			
cSH	868	1269	1700			
Volume to Capacity	0.01	0.00	0.04			
Queue Length 95th (m)	0.2	0.0	0.0			
Control Delay (s)	9.2	0.2	0.0			
Lane LOS	A	A				
Approach Delay (s)	9.2	0.2	0.0			
Approach LOS	A					
Intersection Summary						
Average Delay			0.4			
Intersection Capacity Utilization		16.8%		ICU Level of Service		A
Analysis Period (min)		15				

HCM Unsignalized Intersection Capacity Analysis

Projected 2042 PM

11/8/2013



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	4	2	2	64	81	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	4	2	2	70	88	0
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	162	88	88			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	162	88	88			
tC, single (s)	6.9	6.7	4.6			
tC, 2 stage (s)						
tF (s)	4.0	3.8	2.7			
p0 queue free %	99	100	100			
cM capacity (veh/h)	728	853	1254			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	7	72	88			
Volume Left	4	2	0			
Volume Right	2	0	0			
cSH	765	1254	1700			
Volume to Capacity	0.01	0.00	0.05			
Queue Length 95th (m)	0.2	0.0	0.0			
Control Delay (s)	9.7	0.3	0.0			
Lane LOS	A	A				
Approach Delay (s)	9.7	0.3	0.0			
Approach LOS	A					
Intersection Summary						
Average Delay			0.5			
Intersection Capacity Utilization		15.0%		ICU Level of Service		A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

Combined 2042_AM

11/8/2013



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	0	27	12	98	69	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	29	13	107	75	0
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	208	75	75			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	208	75	75			
tC, single (s)	6.9	6.7	4.6			
tC, 2 stage (s)						
tF (s)	4.0	3.8	2.7			
p0 queue free %	100	97	99			
cM capacity (veh/h)	678	868	1269			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	29	120	75			
Volume Left	0	13	0			
Volume Right	29	0	0			
cSH	868	1269	1700			
Volume to Capacity	0.03	0.01	0.04			
Queue Length 95th (m)	0.8	0.2	0.0			
Control Delay (s)	9.3	0.9	0.0			
Lane LOS	A	A				
Approach Delay (s)	9.3	0.9	0.0			
Approach LOS	A					
Intersection Summary						
Average Delay			1.7			
Intersection Capacity Utilization		22.5%		ICU Level of Service		A
Analysis Period (min)		15				

HCM Unsignalized Intersection Capacity Analysis

Combined 2042_PM

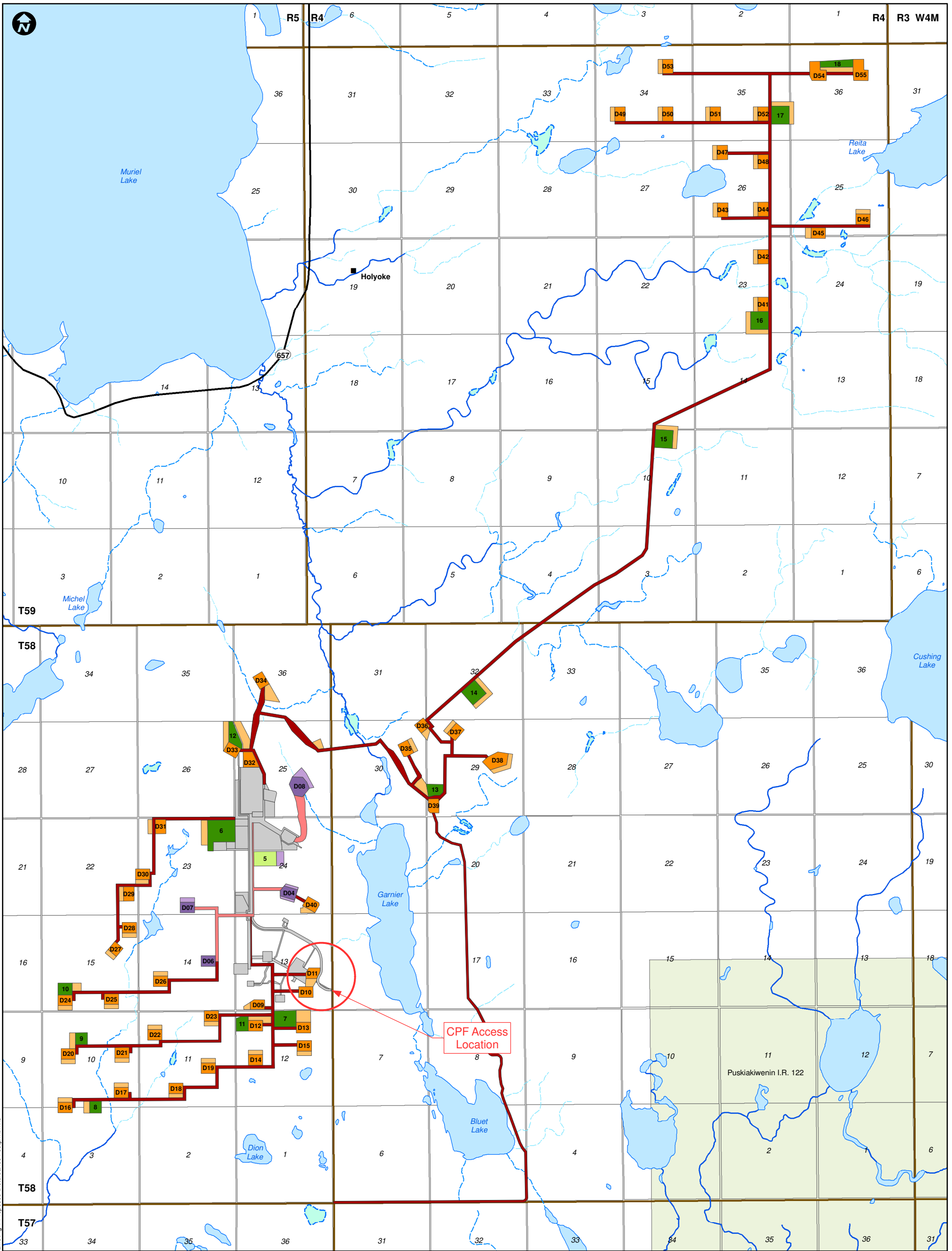
11/8/2013



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	13	10	9	64	81	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	14	11	10	70	88	0
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	177	88	88			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	177	88	88			
tC, single (s)	6.9	6.7	4.6			
tC, 2 stage (s)						
tF (s)	4.0	3.8	2.7			
p0 queue free %	98	99	99			
cM capacity (veh/h)	709	853	1254			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	25	79	88			
Volume Left	14	10	0			
Volume Right	11	0	0			
cSH	765	1254	1700			
Volume to Capacity	0.03	0.01	0.05			
Queue Length 95th (m)	0.8	0.2	0.0			
Control Delay (s)	9.9	1.0	0.0			
Lane LOS	A	A				
Approach Delay (s)	9.9	1.0	0.0			
Approach LOS	A					
Intersection Summary						
Average Delay			1.7			
Intersection Capacity Utilization		20.5%		ICU Level of Service		A
Analysis Period (min)			15			

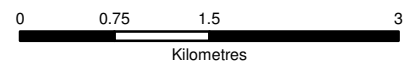
Appendix C:

Highway Geometric Design Guide Intersection
Treatment Type Diagrams



Legend

- | | |
|------------------------------|------------------------------------|
| Development Footprint | Existing and Approved Development |
| Initial Development | First Nations |
| Access/Utility Corridor | Railway |
| Well Pad | Secondary Highway |
| Soil Storage | Permanent Stream |
| Borrow Pit | Ephemeral Stream |
| Future Development | Drainages without Defined Channels |
| Access/Utility Corridor | Lakes and Ponds |
| Well Pad | Beaver Ponds |
| Soil Storage | |
| Borrow Pit | |

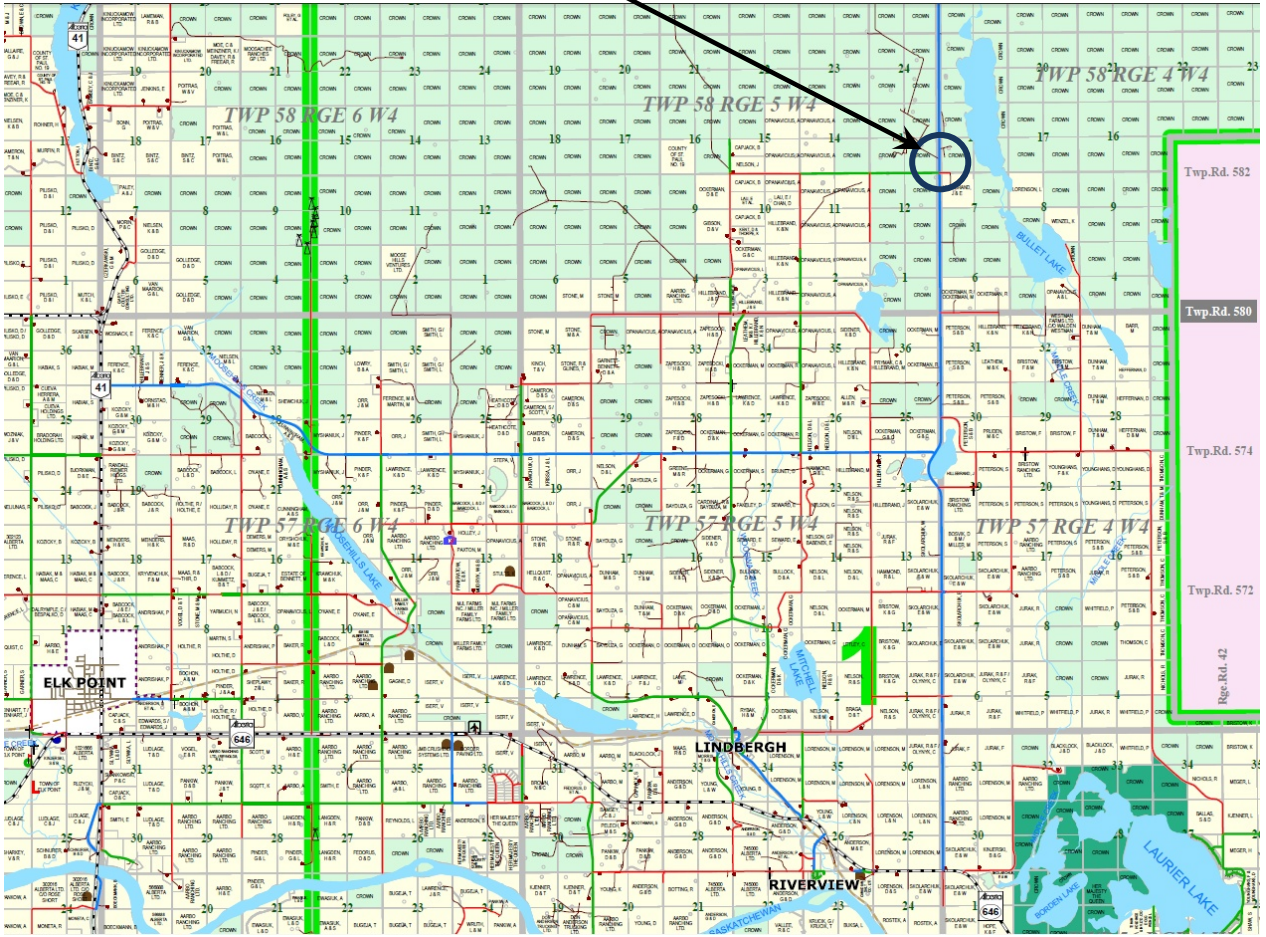


PROJECT:		DRAWN: SL		FIGURE:
Lindbergh SAGD Expansion Project		CHECKED: KK		1
		DATE: Dec 17/13		
TITLE:		PROJECT: 11-033		
Proposed Development Footprint				

PROJECT LOCATION MAP



Lindbergh SAGD Project Access
(SE 13-58-5-W4M)



Map courtesy of County of St. Paul No. 19