Rear Lot Supply Remediation Plan

DRAFT 2

August 1, 2014

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- Robert Horner
- Dan Deschamps
- Larry MacDonald
- Ray McFadden
- Barry Stephens

1. Executive Summary

This report reviews the existing rear lot supply system at PowerStream. It summarizes the inventory, configurations, condition, concerns, managing options, methodology, and remediation plan for the rear lot supply system.

There are many operating and customer service concerns associated with rear lot supply. Although some of the concerns can be mitigated through maintenance practices, customer communication and customer compliance; to manage the issues effectively, PowerStream must develop an overall long-term remediation plan.

The report recommends a long-term remediation program which starts in 2015, at a cost of $3.2M per year (2013 dollars), and continues for 15 years to 2029, until all rear lot locations have been addressed. A “large” location may be divided into smaller portions and implemented in phases over a number of years. A group of “small” locations may be implemented in a given year. The high level total cost of the program is $57M. This long-term plan is recommended to strike a balance between addressing operating and customer service concerns and at the same time, smoothing out the impact of capital budget increase. PowerStream will manage the risk by monitoring the condition of the rear lot supply system and adjust the remediation plan as required.

In addition to the capital work program, it is recommended that Lines department develop contingency plan for outage response at some high risk locations.

The report recommends an approach to remediate the rear lot system. Under this approach, on a prioritized basis, as assets at specific rear lot locations come to end-of-life and require replacement, PowerStream will evaluate all available options and select the preferred remediation options for implementation at those locations. The methodology includes three steps described below.

First, determine end-of-life priority at a location, using of the following criteria:

- Asset Age
- Asset Condition
- Imminent Health, Safety and Environmental Issues
- Standards/Directive Violation, and Obsolescence/Non-compliance
- Capacity Adequacy for Existing and Future Loading
- Criticality of the Circuit
- Failure Statistics
- Customer Complaint

Second, analyse the remediation options:

- Option 1 – Replace existing rear lot with new rear lot overhead
- Option 2 – Replace existing rear lot with new front lot overhead
- Option 3 – Hybrid – Install primary cable & transformer at front lot underground; replace/keep pole & secondary at rear lot
- Option 4 – Replace existing rear lot with new front lot underground

Third, select the preferred remediation options, using the following criteria:

- Life Cycle Cost Net Present Value Analysis
- Cost versus Risk
- Asset Condition
- Reliability/Customer Service Impact
- Health & Safety, Environmental, and Operating Impact
- Long-Term Distribution Configuration

The recommended remediation capital program is shown below.

On an on-going basis, as more information becomes available, additional analysis will be conducted and the remediation capital program will be adjusted accordingly.

Rear Lot Priority List 2015-2029

Year	Location Reference #	Municipality	Project	# of Customers	Project Cost (Budgeted)	Annual Cost
2015	1	Barrie	Shirley/ Vine	20	$1,065,718	$3,196,778
	2	Barrie	Blake/ Kempenfelt	21		
	4	Barrie	North Park/ Park Dale	40		
	46	Markham	Royal Orchard Phase 1	376	$2,131,060	
2016	22	Tottenham	Queen to Eastern and top of Eastern and Wilson - Phase 1	68	$1,091,614	$3,274,457
	28	Tottenham	North of Mill St. and South of George and West of Queen	16		
	46	Markham	Royal Orchard Phase 2	195	$2,182,843	
2017	22	Tottenham	Queen to Eastern and top of Eastern and Wilson - Phase 2	67	$1,117,968	$3,353,511
	21	Tottenham	Frazer Ave. 3 Phase line & Perdue Pl/ Alphonsus Crt.	62		
	46	Markham	Royal Orchard Phase 3	257	$2,235,543	
2018	24	Tottenham	Queen St. to Adeline Ave. and Rogers to Brown St. North Side - Phase 1	85	$1,144,795	$3,433,987
	46	Markham	Royal Orchard Phase 4	129	$1,025,367	
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2019	24	Tottenham	Queen St. to Adeline Ave. and Rogers to Brown St. North Side - Phase 2	46	$1,212,199	$3,636,175
	29	Tottenham	East of Queen from George to Ryan Ln.	27		
	45	Markham	Main St. Unionville & Carlton(SW) - {NW side of Hwy 7/Kennedy} - Phase 2	155	$2,423,976	
2020	23	Tottenham	Queen St. to Keogh St. and Wilson to Dilane St. E - Phase 1	89	$1,248,565	$3,745,261
	45	Markham	Main St. Unionville & Carlton(SW) - {NW side of Hwy 7/Kennedy} - Phase 3	155	$2,496,696	
2021	23	Tottenham	Queen St. to Keogh St. and Wilson to Dilane St. E - Phase 2	30	$1,286,022	$3,857,618
	27	Tottenham	West side of Queen from #146 to Lionel Stone	58		
	48	Markham	Steeles & Henderson (NE & NW) - {NW Side of Steeles/Bayview} - Phase 1	190	$2,571,596	
2022	8	Barrie	Marian/ Pratt/ Shannon - Phase 1	93	$1,324,602	$3,973,347
	49	Markham	Bayview & Steeles (NE) - Phase 1	191	$1,653,302	
	48	Markham	Steeles & Henderson (NE & NW) - {NW Side of Steeles/Bayview} - Phase 2	115	$995,443	
2023	8	Barrie	Marian/ Pratt/ Shannon - Phase 2	29	$1,364,340	$4,092,547
	5	Barrie	Johnathan/ Bathwell	73		
	49	Markham	Bayview & Steeles (NE) - Phase 2	191	$2,004,183	
	42	Aurora	Yonge & Wellington (NW) - Phase 1	69	$724,024	
2024	6	Barrie	Ottoway Ave.	91	$1,400,647	$4,201,455
	49	Markham	Bayview & Steeles (NE) - Phase 3	191	$1,422,751	
	42	Aurora	Yonge & Wellington (NW) - Phase 2	185	$1,378,057	
2025	9	Barrie	Alexander/ Oliver	40	$1,439,536	$4,318,110
	11	Alliston	Queen/ Victoria E.	21		
	20	Penetanguishene	Tessier at west of Main St.	18		
	19	Penetanguishene	Robert St. at Main north side	16		
	42	Aurora	Yonge & Wellington (NW) - Phase 3	185	$2,878,574	
2026	17	Penetanguishene	Maria St. near robert St. E	9	$1,478,424	$4,434,764
	18	Penetanguishene	Shannon Rd. at Main St.	11		
	14	Beeton	Main W./ Centre N.	13		
	26	Tottenham	Brown St. from Railway to Queen St.	36		
	15	Penetanguishene	Burke/ Country Club	10		
	16	Penetanguishene	Maria/ Edward	12		
	47	Markham	Hwy 7 & McCowan (SE) - Phase 1	148	$2,956,339	
2027	7	Barrie	Gunn/ Oakley Park Sq./ St. Vincent	92	$1,517,313	$4,551,417
	47	Markham	Hwy 7 & McCowan (SE) - Phase 2	147	$3,034,104	
2028	3	Barrie	Wellington/ Oak	68	$1,556,202	$4,668,071
	13	Alliston	Sir Frederick Banting/ Victoria E.	8		
	44	Markham	Major Mackenzie & Warden (SW)	63	$3,111,869	
	43	Vaughan	Islington & Seville (NE & SE) - {NE Side of Major Mackenzie/ Islington}-Phase 1	114		
2029	12	Alliston	Victoria W. of Downey	8	$1,595,091	$4,784,725
	25	Tottenham	North side of Adeline from Rogers to Brown St.	33		
	10	Alliston	Regional Rd 15/Victoria	21		
	30	Tottenham	Eastern Ave. backing onto railway from Wilson to Park	18		
	43	Vaughan	Islington & Seville (NE & SE) - {NE Side of Major Mackenzie/ Islington}-Phase 2	64	$3,189,634	
Program Total:				4,625		$59,522,223

2. Background and Purpose

PowerStream has a number of pockets of customers being supplied by rear lot construction. In general, the rear lot areas are older neighbourhoods, and the electrical supply systems are ageing and deteriorating. The rear lot supply system poses many reliability, operations, safety, and customer service concerns. The concerns are grouped and addressed as follows:

- **Customer Request Level** – How to handle customer's request for underground service in a rear lot supply area?
- **System Level** – What is PowerStream's short-term and long-term plan on rear lot supply system?

At the **Customer Request Level**, from time to time, PowerStream receives requests from customers (who are located within an established rear lot supply area) requesting a service upgrade, an underground rear lot supply, or an underground front lot supply. In many cases, the requests impose difficulty due to the constraints and limitations of existing equipment capacity and design configuration. PowerStream staff needed consistent guidelines as to how to handle these customer requests. This issue was addressed in December 2012 when System Planning issued guidelines applicable to the following configurations:

- Pole line is inside of customer property
- Pole line is outside of customer property
- Potential future customers, with existing underground system nearby
- Potential future customers, no nearby underground system

Since this concern (Customer Request) has been addressed, it is excluded from this report.

At the **System Level**, PowerStream Reliability Committee has requested System Planning to develop a remediation plan to address the following items:

- Create an inventory of all rear lot supply locations
- Determine the criteria for end-of-life conditions for rear lot assets
- Create cost/benefit analysis methodology and template for analysing remediation options at each location
- Make preliminary recommendations for which option to select at each high priority location
- Determine the best option for high priority locations as they arise from Design and Construction
- Assess capital budget impact
- Present the report to the Reliability Committee

This report will cover the above topics.

3. Inventory and Condition

For the purpose of this report, only residential customer rear lot supply is considered. Cases of rear lot supply to commercial/industrial customers are not discussed since accessibility to overhead plant supplying commercial/industrial customers is manageable.

Figure 1 shows the summary of rear lot demographics in comparison with the total asset at PowerStream:

Rear Lot Demographics					
	North	**South**	**Rear Lot Total**	**PowerStream Total**	**Rear Lot % of Total**
Number of Customers	1,484	3,141	4,625	366,107	1.3%
Number of Poles	500	817	1,317	43,347	3.0%
Number of Transformers	105	293	398	7,280	5.5%
Total Circuit Length (OH only)	17,623	34,616	52,239	2,584,000	2.0%

Figure 1 – Rear Lot Demographics

There are 49 rear lot locations located in 8 municipalities throughout PowerStream service territory.

The average installation year of all rear lot supply is 1967 (45 years old).

Figure 2 shows the number of customers, average asset age, condition, and circuit length at each location.

Refer to Figure 13 – Figure 18 in Appendix E for overview maps indicating locations containing rear lot supply in the PowerStream system.

Refer to Figure 19 – Figure 52 in Appendix E for the detailed maps of each location with the location reference number.

Rear Lot Demographics												
Location Reference #	Municipality	Project	Grid Number	Installation YearAge of poles	Operating Voltage (kV)	Number of Customers	Number of Poles	Number of Poles Code A (Poor)	Number of Poles Code B (Fair)	Number of Poles Code C (Good)	Number of Transformers	Length of Circuit (m)
1	Barrie	Shirley/Vine		1958	2.4	20	13	2		11	2	534
2	Barrie	Blake/Kempenfelt		1948, 1955	2.4	21	10		4	6	2	186
3	Barrie	Wellington/Oak		1956 and 1960	2.4	68	28			20	0	977
4	Barrie	North Park/ParkDale		1968	2.4	40	23		B	2	4	806
5	Barrie	Johnathan/Bothwell		1957-1960	2.4	73	26			13	5	868
6	Barrie	Ottaway Ave.		1968	2.4	91	24			24	3	706
7	Barrie	Gunn/Oakley park Sq./St. Vincent		1955-1960	2.4	92	37	1		36	4 but all In front	1,297
8	Barrie	Marion/Pratt/Shannon		1955 - 1960	2.4	122	30			30	6	1,214
9	Barrie	Alexander/Oliver		1960-1964	2.4	40	14			14	1	481
10	Alliston	Regional Rd. 15/Victoria		1970	13.8	21	7			7	0	530
11	Alliston	Queen/Victoria E		1950 - 1987	8	21	19		5	9	5	1,080
12	Alliston	Victoria w of Downey		1955	8	8	4			8	3	200
13	Alliston	Sir Frederick Banting/Victoria E		2006	8	8	6				1	240
14	Beeton	Main W/Centre N		1989	8	13	9			3	2	360
15	Penetanguishene	Burke/Country Club		1 2005, 2 are 1975	2.4	10	6			3	0	210
16	Penetanguishene	Maria/Edward		1968, 1974, 1992	4.16	12	3			3	2-3ph banks	106
17	Penetanguishene	Maria st. near Robert st. E		1988	2.4	9	4			2	3	116
18	Penetanguishene	Shannon Rd. at Main St.		1975	2.4	11	1			1	1	32
19	Penetanguishene	Robert St. at Main North side		1986, 1976, 1968	2.4	16	4			4	2	108

Figure 2 - Rear lot Demographics in Each Location

Location Reference #	Municipality	Project	Grid Number	Installation YearAge of poles	Operating Voltage (kV)	Number of Customers	Number of Poles	Number of Poles Code A (Poor)	Number of Poles Code B (Fair)	Number of Poles Code C (Good)	Number of Transformers	Length of Circuit (m)
20	Penetanguishene	Tessier at west of Main St.		97, 87, 73, 03	2.4	18	4			4	2	55
21	Tottenham	Frazer Ave. 3 ph line & Perdue Pl./Alphonsus Crt.		1988 for 3 phase line 1950's and 1960s for	8.32	62	22		7	15	2	1,000
22	Tottenham	Queen to Eastern and top of Eastern to Wilson		between 1965 and 1997	8.32	135	38		15	23	12	1,360
23	Tottenham	Queen St to Keogh St and Wilson to Dilane St E		1965 to 1996	8.32	119	44		13	31	14	1,150
24	Tottenham	Queen St to Adelaine Ave and Rogers to Brown St North side		1980 to 1996	8.32	131	32		18	14	10	1,000
25	Tottenham	North side of Adeline from Rogers to Brown St.		1971-1980	8.32	33	15				3	595
26	Tottenham	Brown Street from railway to Queen St.		2010	8.32	36	18				3	500
27	Tottenham	West side of Queen from #146 to Lionel Stone		1968	4.8	58	27			27	8	848
28	Tottenham	North of Mill St. and south of George and west of Queen		1973-2000	8.32	16	10				3	234
29	Tottenham	East of Queen from George to Ryan Ln.		1968	4.8	27	12				0	490
30	Tottenham	Eastern Ave. backing onto railway from Wilson to park		1974	8.32	18	10	2	2	6	2	340
42	Aurora	Yonge & Wellington (NW)	A09	1968	8	439	126	11	7	108	6	4,600
44	Markham	Major Mackenzie & Warden (SW)	M40	2006	16	63	30	1	4	25	21	1,360
45	Markham	Main St. Unionville & Carlton (SW) - {NW Side of Hwy 7/Kennedy}	M33	1964	16	466	134	10	24	100	42	4,932
46	Markham	Bayview & Royal Orchard (NW&NE) - {SW Side of Bayview/Hwy 407}	M52	1965	4.8	957	178	30	67	81	67	5,600
47	Markham	Hwy 7 & McCowan (SE)	M20	1982	16	295	86	0	2	84	24	2,840
48	Markham	Steeles & Henderson (NE & NW) - {NW Side of Steeles/Bayview}	M51	1994	16	305	97	5	14	78	34	3,440
49	Markham	Bayview & Steeles (NE)	M49	1962	16	573	106	20	2	84	80	9,364
43	Vaughan	Islington & Sevilla (NE & SE) - {NE Side of Major Mackenzie/Islington}	V54	2005	16	178	60	0	0	60	19	2,480
					Totals	4,625	1,317	82	184	936	392	52,239

Figure 3 (Figure 2 Continued) - Rear lot Demographics in Each Location

4. Advantage and Disadvantage

This section will discuss the advantages and disadvantages of rear lot supply to both the customers and PowerStream.

Advantages

Advantages to Customers

- Aesthetically pleasing from the street view:
  Because the pole line is located in rear lot, there are no visible poles, overhead transformers and overhead conductors located at the front of customer property. Most customers prefer to have no equipment in front of their property.

Advantages to PowerStream

- Lower installation cost:
  In general, overhead systems are less expensive than underground systems. For example, in the Romfield Phase 3 project (more details in Section 5), the installation cost of the overhead option is $1,362,279 compared to $3,336,017 for the underground option.

- Shorter distance from main feeder:
  In many cases, it is the shortest distance to bring electricity to a neighbourhood from the main street. This is particularly true when the local street does not intersect with the main street. In those cases, it is less expensive to install a pole line along the easement at rear lot.

Disadvantages

Disadvantages to Customers

- Long outage restoration time due to difficult accessibility for PowerStream crews:
  In comparison to front lot customers, rear lot customers have to wait longer for the crews to restore power during an outage. The crews have to gain access to the back yard to identify, locate, isolate, and repair/replace equipment. In heavily vegetated areas, the crews must also clear or trim the vegetation before they can access the equipment.
  If the replacement of major equipment (e.g. pole, transformer) is necessary, the outage time will extend because the crews need specialized equipment (e.g. large crane) to reach over customer houses to the rear lot.

- More frequent outages due to vegetation, animal contact, and lack of access for PowerStream crews:
  When a rear lot supply was first constructed, the area was likely clear of obstruction. Over time, however, trees/ bushes have grown near the electrical equipment, and may make contact with the power line. The growth of vegetation also increases the risk of animals (e.g. squirrels) coming into contact with electrical equipment.

- Safety risk associated with close proximity to power line in the backyard:
  Although the Electrical Safety Code and easement terms specify minimum clearance between customer facilities and power line, there are cases that customers do not follow the safety rules and install facilities too close to power line. Examples are shed, storage, playground, trampoline, swimming pool, patio deck, landscape, house extension, etc. This encroachment creates a safety hazard for both customers and crews.

Disadvantages to PowerStream

- Decreased system reliability:
  Higher outage frequency and longer outage duration will negatively impact PowerStream system reliability.

- Difficult accessibility for crew and equipment:
  Due to obstructions such as trees and customer construction, crews may find it difficult to gain access, bring in equipment, and create a safe working space in the rear lot. As a result, it is difficult to inspect, maintain, repair and replace equipment. Under emergencies, it is difficult to identify/isolate faulted components and perform switching. Accessibility for service vehicles is often impractical. In some cases, large cranes may be needed to reach over the rear lot from the street. In addition, system security is also at risk because the pole line is out of sight. This increases the risk of equipment being neglected and left deteriorated.

- Safety risk associated with reduced clearance due to encroachment of power line:
  Over time, growth of vegetation and obstruction due to customer facilities may jeopardize the minimum clearance requirements and restrict crew mobility. Occasionally dogs may also be a safety hazard to the crews.

- Difficulty in addressing issues with customer:
  Customers may install facilities in the backyard that encroach on easements and violate the vertical and horizontal clearance.

- Additional cost in tree trimming:
  In comparison to front lot pole line, rear lot pole line requires more frequent tree trimming.

- Management of easements:
  Rear lot supply requires easement agreements with customers. As a result, time is required to manage the easements.

5. Remediation Options

When assets at a rear lot location come to end-of-life, there are four remediation options:

1. Replace existing rear lot with new rear lot overhead
2. Replace existing rear lot with new front lot overhead
3. Hybrid – Primary & transformer to front lot underground; pole & secondary at rear lot
4. Replace existing rear lot with new front lot underground

The four options are discussed below.

<u>Option 1 – Replace existing rear lot with new rear lot overhead</u>
Under this option, the existing rear lot plant is replaced with new overhead plant in the rear lot.
When the replacement project is implemented, the following design parameters should be considered:

- Convert to higher voltage system (e.g. from 4.16 kV to 27.6 kV). This would involve higher new poles (to obtain maximum clearance from trees)
- Install critical components (e.g. fuse, switch, transformer) as close to street as possible to increase accessibility for the crews

An example drawing of this option is shown below. The example project involves 177 customers. The cost is estimated at $1,362,279. This results to a unit cost of $7,696 per customer

Figure 4. Example of Option 1 – Replace existing rear lot with new rear lot overhead

In 2005 PowerStream completed a similar project in Vaughan (Kleinburg Conversion, see Figure 54 in Appendix E). In this project, all existing 8.32 kV rear lot assets were removed and replaced with new 27.6 kV rear lot plant.

<u>Option 2 – Replace existing rear lot with new front lot overhead</u>
Under this option, the existing rear lot plant is removed and new overhead plant is installed in front lot. This option, however, is not considered a feasible option. It will definitely be faced with extreme protest and opposition by local residents and politicians. Customers who never had overhead pole line in front of

their houses will view the installation of front lot overhead pole line as a step backward which will reduce the value of their houses. In other jurisdictions, customers were able to lobby politicians and blocked the projects. As a result, this scenario has been excluded as a feasible option regardless of the life cycle cost analysis. For completeness, however, it is assumed that the installation cost will be similar to the cost of Option 1 (rear lot overhead).

Option 3 – Hybrid (Primary & transformer to front lot underground; pole & secondary at rear lot)
Under this option, the existing rear lot primary conductors, switches and transformers are removed. New underground primary cable and padmount transformers are installed in front lot. The existing rear lot poles and secondary conductors will be replaced with new plant and kept at the rear lot.
Most or all of the houses will be supplied from secondary bus at rear lot. To address the voltage drop issue, some of the houses may be supplied underground from the front. This can be achieved by installing underground secondary conduit and cable, from padmount transformer to the customer's service entrance at the side or at the back of the house.
In 2013 PowerStream plans to complete a similar project in Markham (Romfield Phase 3, see Figure 4 below). The project cost is estimated at $2,190,805 and involves 177 customers. This results to a unit cost of $12,377 per customer.

Figure 5. Example of Option 3 Hybrid – Primary & transformer to front lot underground; pole & secondary at rear lot

Option 4 – Replace existing rear lot with new front lot underground
Under this option, the existing rear lot plant is removed and new underground components (padmount transformer, primary cable, and secondary cable) are installed in front lot. This option is the most complicated and expensive option. Since customer service entrance (service mast) and electrical panel are located at the back of the house, to bring the supply from front lot to the back of the house, directional boring/tunnelling is required. This work could be difficult due to customer's landscaping and installations.

Because this option requires significant construction work, it will cause disruptions and inconvenience to the residents. Therefore, if this option is selected in an area, it is important that PowerStream proceed with appropriate preparation work such as customer communication and customer involvement. Refer to Appendix D for the proposed process for large scale project to replace rear lot overhead with front lot underground. The intent is to engage and communicate with customers so that the work undertaken will become a positive experience with the local residents.

An example drawing of this option is shown below. The example project involves 177 customers. The cost is estimated at $3,336,017. This results to a unit cost of $18,848 per customer

Figure 6. Example of Option 4 – Replace existing rear lot with new front lot underground

6. Managing Approach

On a prioritized basis, as the rear lot assets at specific locations come to end-of-life and require replacement, PowerStream will evaluate all available options and select the preferred remediation options for implementation at those locations.

The methodology to address rear lot supply includes three steps described below:

First, determine end-of-life status at a location, using of the following end-of-life criteria:

- Asset Age (older than useful life)
- Asset Condition of Key Assets (e.g. pole, conductor, transformer) ("very poor" and "poor"
-
- condition)
- Imminent Health, Safety and Environmental Issues (accidents are about to occur)
- Standards/Directive Violation, and Obsolescence/Non-compliance
- Capacity Adequacy for Existing and Future Loading (requires capacity increase to supply customers)
- Criticality of the Circuit (is reliability of this rear lot supply impacting other part of the distribution system?)
- Failure Statistics (did this area experience more failures than average?)
- Customer Complaint (did PowerStream receive high number of customer complaints within this area?)

Second, analyse the following four remediation options:

- Option 1 – Replace existing rear lot with new rear lot overhead
- Option 2 – Replace existing rear lot with new front lot overhead
- Option 3 – Hybrid – Install primary cable & transformer at front lot underground; replace/keep pole & secondary at rear lot
- Option 4 – Replace existing rear lot with new front lot underground

Third, select the preferred remediation options, using the following factors**:**

- Life Cycle Cost Net Present Value Analysis
- Cost versus Risk
- Asset Condition
- Reliability/Capacity/Customer Service Impact
- Health & Safety, Environmental, and Operating Impact
- Long-Term Distribution Configuration

To determine the Life Cycle Net Present Value, the following items should be considered:

- Initial installation cost
- Frequency of failure
- Outage duration
- Consequence of failure
- Risk cost (failure probability x consequence cost)
- Maintenance cost
- Customer Minutes of Interruption (CMI)

Operations inputs and inspection and maintenance results are taken into consideration. Discussions among various groups will also add value in identifying and prioritizing candidate locations.
Should a large scale project for conversion of rear lot to front lot be approved, it is proposed that the process as outlined in Appendix A be followed to create a positive experience for the local residents.

In addition to the remediation capital plan, PowerStream also should develop contingency plan to handle the emergencies at high risk locations.

7. Remediation Capital Plan

The priorities of all locations are indicted below in Table 1. The cost is calculated using the Hybrid option. The annual cost is increased by 3% per year to account for general inflation.

Rear Lot Priority List 2015-2029						
Year	Location Reference #	Municipality	Project	# of Customers	Project Cost (Budgeted)	Annual Cost
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	27	Tottenham	West side of Queen from #146 to Lionel Stone	58		
	48	Markham	Steeles & Henderson (NE & NW) - {NW Side of Steeles/Bayview} - Phase 1	190	$2,571,596	
2022	8	Barrie	Marian/ Pratt/ Shannon - Phase 1	93	$1,324,602	$3,973,347
	49	Markham	Bayview & Steeles (NE) - Phase 1	191	$1,653,302	
	48	Markham	Steeles & Henderson (NE & NW) - {NW Side of Steeles/Bayview} - Phase 2	115	$995,443	
2023	8	Barrie	Marian/ Pratt/ Shannon - Phase 2	29	$1,364,340	$4,092,547
	5	Barrie	Johnathan/ Bathwell	73		
	49	Markham	Bayview & Steeles (NE) - Phase 2	191	$2,004,183	
	42	Aurora	Yonge & Wellington (NW) - Phase 1	69	$724,024	
2024	6	Barrie	Ottoway Ave.	91	$1,400,647	$4,201,455
	49	Markham	Bayview & Steeles (NE) - Phase 3	191	$1,422,751	
	42	Aurora	Yonge & Wellington (NW) - Phase 2	185	$1,378,057	
2025	9	Barrie	Alexander/ Oliver	40	$1,439,536	$4,318,110
	11	Alliston	Queen/ Victoria E.	21		
	20	Penetanguishene	Tessier at west of Main St.	18		
	19	Penetanguishene	Robert St. at Main north side	16		
	42	Aurora	Yonge & Wellington (NW) - Phase 3	185	$2,878,574	
2026	17	Penetanguishene	Maria St. near robert St. E	9	$1,478,424	$4,434,764
	18	Penetanguishene	Shannon Rd. at Main St.	11		
	14	Beeton	Main W./ Centre N.	13		
	26	Tottenham	Brown St. from Railway to Queen St.	36		
	15	Penetanguishene	Burke/ Country Club	10		
	16	Penetanguishene	Maria/ Edward	12		
	47	Markham	Hwy 7 & McCowan (SE) - Phase 1	148	$2,956,339	
2027	7	Barrie	Gunn/ Oakley Park Sq./ St. Vincent	92	$1,517,313	$4,551,417
	47	Markham	Hwy 7 & McCowan (SE) - Phase 2	147	$3,034,104	
2028	3	Barrie	Wellington/ Oak	68	$1,556,202	$4,668,071
	13	Alliston	Sir Frederick Banting/ Victoria E.	8		
	44	Markham	Major Mackenzie & Warden (SW)	63	$3,111,869	
	43	Vaughan	Islington & Seville (NE & SE) - {NE Side of Major Mackenzie/ Islington}-Phase 1	114		
2029	12	Alliston	Victoria W. of Downey	8	$1,595,091	$4,784,725
	25	Tottenham	North side of Adeline from Rogers to Brown St.	33		
	10	Alliston	Regional Rd 15/Victoria	21		
	30	Tottenham	Eastern Ave. backing onto railway from Wilson to Park	18		
	43	Vaughan	Islington & Seville (NE & SE) - {NE Side of Major Mackenzie/ Islington}-Phase 2	64	$3,189,634	
Program Total:				4,625		$59,522,223

Table 1: Rear Lot Remediation Priority List

The report recommends a long-term remediation program which starts in 2015, at a cost of $3.2M per year (2013 dollars), and continues for 15 years to 2029, until all rear lot locations have been addressed. A "large" location may be divided into smaller portions and implemented in phases over a number of years. A group of "small" locations may be implemented in a given year. The high level total cost of the program is $57M. This long-term plan is recommended to strike a balance between addressing operating and customer service concerns and at the same time, smoothing out the impact of capital budget increase. PowerStream will manage the risk by monitoring the condition of the rear lot supply system and adjust the remediation plan as required.

8. Recommendations

It is recommended that:

1. System Planning continue to monitor the performance of existing rear lot locations.
2. Should assets in a rear lot location become end-of-life and require replacement, System Planning will conduct a detailed analysis and recommend the preferred remediation option for implementation. Inputs from Lines, Control Room, and Customer Services will be taken into consideration.
3. Lines Department develop contingency plan for high risk locations (i.e. locations that are planned for the next three years).
4. Start the remediation capital program in 2015 as indicated in the plan.

Appendix A - Typical Rear Lot Supply Configuration

It should be noted that there are a variety of rear lot supply configurations within PowerStream service territory. The specific design parameters depend on the following factors:

- Exact location of the neighbourhood in relation with the main distribution system
- The number of risers from overhead to underground and vice versa
- Voltage level
- Whether the purpose of the rear lot portion is at the beginning (i.e. to connect the upstream main distribution system to the downstream neighbourhood), or at the end (i.e. to only supply a group of customers in the neighbourhood)

A typical rear lot supply configuration consists of pole lines carrying primary conductors, overhead transformers, and secondary conductors through the backyard of residential property. An example is shown below.

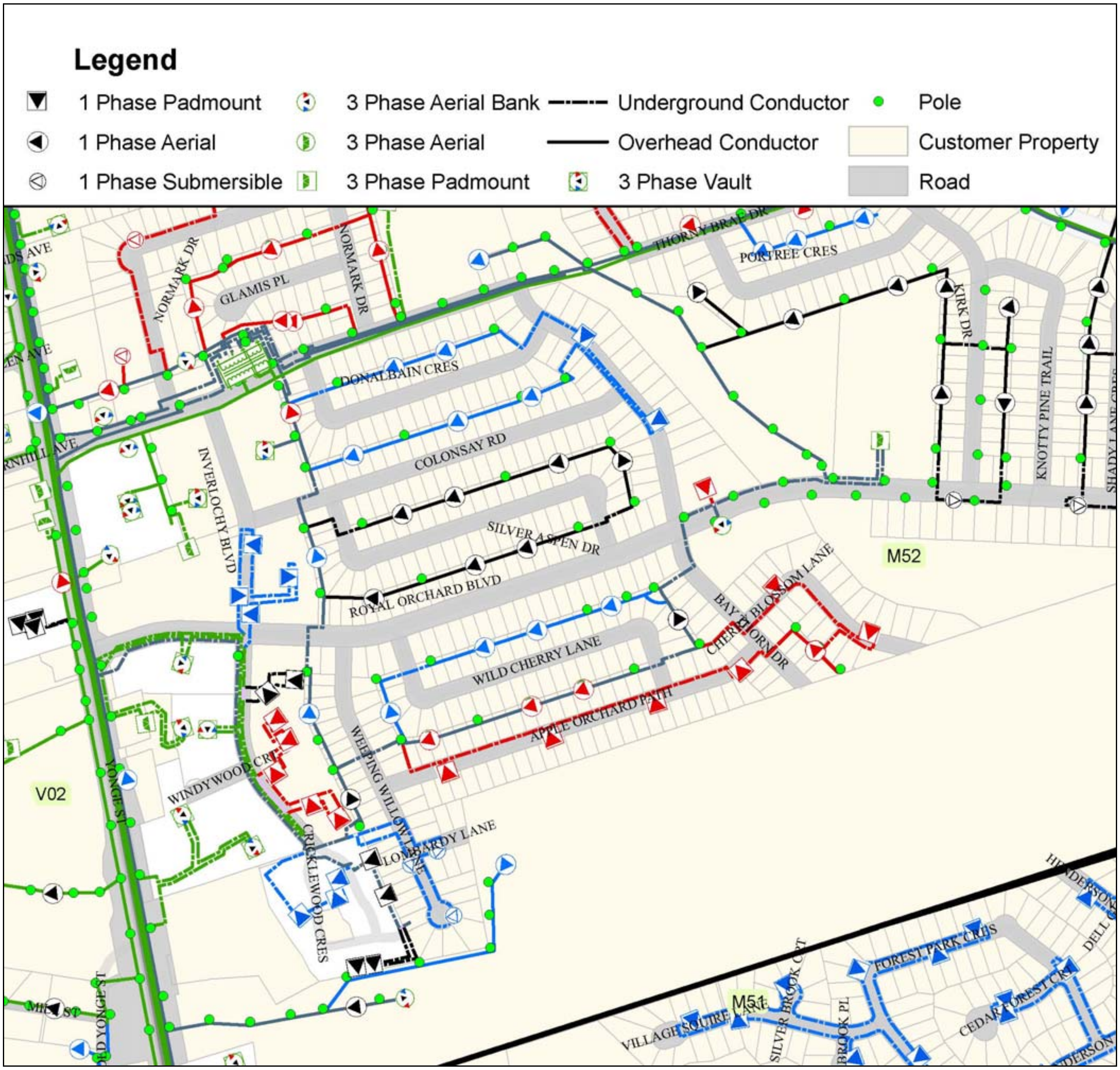


Figure 7. Example of rear lot in the PowerStream system

Example photographs that were taken in the field are shown below.

Figure 8. Reasonably accessible pole at rear lot

Figure 9. Obstruction of equipment caused by large trees

Figure 10. Inaccessible pole in poor condition (cracked and rotten)

Figure 11. Pole obstruction caused by customer construction

Figure 12. Pole and transformer surrounded by vegetation

As seen from the above example photographs, each rear lot location has its own characteristic and challenges.

Appendix B - Life Cycle Cost NPV Example

To determine the Life Cycle Cost Net Present Value (NPV), the following cost items are considered:

- Initial installation cost
- Frequency of failure
- Consequence of failure
- Risk cost (failure probability x consequence cost)
- Maintenance cost
- Customer Minutes of Interruption (CMI)

The details are listed below.

Interest Rate: 6.77%

Comparison Duration: 100 years

Depreciation Duration: 45 years, straight line.

General Inflation: 3%. All costs are escalated by 3% annually to account for general inflation.

Initial Installation Cost: the initial installation costs are estimated below (disregarding general inflation).
Option 1 – $1,362,279
Option 2 – $1,362,279
Option 3 – $2,190,805
Option 4 – $3,336,017

Outage Duration: the outage duration is a factor in determining the Consequence of Failure and the CMI. The outage duration for each option is estimated below.
Option 1 – 5 hours
Option 2 – 3 hours
Option 3 – 4 hours
Option 4 – 3 hours

Frequency of Failure: the annual frequency of failure for each option is estimated as follows.
The Annual Frequency of Failure will depend on the number of units and the failure probability of the asset according to the Annual Probability of Failure Curve from the ACA Model. The failure probability will be different for each year depending on the age of the asset.

1). Use Distribution Transformer Annual Probability of Failure Curve from the ACA Model as a proxy for Frequency of Failure for transformer and pole in the area. This curve is for 1 transformer (1 unit). Therefore if there are a total of 16 transformers and 31 poles, we can multiply the unit frequency of failure by 16 times to get the Frequency of Failure for the total transformer population; and multiply by 31 times to get the Frequency of Failure for the total pole population.

2). Use a multiplier factor to account for the additional failures due to complexity of rear lot system (summed) as follows.
Underground: Factor = 0.8
Front Lot Overhead: Factor = 1
Hybrid: Factor = 0.9
Rear Lot Overhead: Factor = 1

Consequence of Failure: the consequence of failure for each option is estimated as follows.
Depending on the nature of the failure, the cost will vary. For example, if there is a pole failure, then a large crane is needed to get access to rear lot and police will be required for road closure. In general, it is very difficult to replace components in rear lot. The emergency replacement costs are estimated as

follows.
Option 1 – $40,000
Option 2 – $20,000
Option 3 – $20,000
Option 4 – $20,000

An example to illustrate the calculation is shown below.
Customer Interruption Cost (residential): use $2 per kW for frequency cost, and $4 per kWh for duration cost
PowerStream Emergency Cost = $40,000 each time
PowerStream Loss of Revenue = 177 customers x 3 kW x 5 hours (outage duration) x $0.024 per kWh (delivery charge) = $64; divided by 2 (half loop) = $32
Customers Interruption Cost = (177 x 3 kW x $2/kw) + (177 x 3 kW x 5 hours (outage duration) x $4/kWh) = $11,682; divided by 2 (half loop) = $5,841
Total Consequence = $40,032 (PowerStream) + $5,841 (Customer) = $45,873 each time

Risk Cost:
Risk to PowerStream = Annual Frequency of Failure x Consequence of Failure for that year
Risk to Customer = Annual Frequency of Failure x Consequence of Failure for that year
Total Risk Cost = Risk to PowerStream + Risk to Customer for that year

Maintenance Cost:
The costs for inspection/maintenance and tree trimming are estimated below.
Option 1 – $10,000
Option 2 – $1,500
Option 3 – $3,000
Option 4 – $1,000

Customer Minutes of Interruption (CMI):
An example to illustrate the calculation is shown below.
The CMI for Option 1 in 2012 (year 1) was calculated as follows:
CMI = Annual Frequency of failure x number of customer x outage duration (hours) x 60 minutes / 2 (half loop)
CMI = 0.389 x 177 customers x 5 hours x 60 minutes / 2 (half loop) = 10,328 CMI

Refer to Figure 12 in Appendix C for an example of the Net Present Value template.

Appendix C – Template for Life Cycle Cost NPV

Option	Replace existing Rear Lot with new Rear Lot overhead								
Installation Type:	RL	1							
Interest Rate:	6.77%								
Comparison Duration	10								
Depreciation Duration	4								
General Inflation	3%								
Year		1	2	3	4	5	6	7	8
Probability of Failure (1 unit)		0.00	0.00	0.01	0.02	0.04	0.06	0.09	0.12
Frequency of Failure (Total)		0.00	0.00	0.00	0.01	0.01	0.02	0.04	0.05
Installation Cost		$1,362,279							
Depreciation		$15,13	$30,27	$30,27	$30,27	$30,27	$30,27	$30,27	$30,27
Maintenance Cost		$10,00	$10,30	$10,60	$10,92	$11,25	$11,59	$11,94	$12,29
Risk Cost per year (PowerStream)		$	$4	$19	$44	$81	$1,30	$1,94	$2,72
Risk Cost per year (Customers)		$	$	$2	$6	$11	$19	$28	$39
Total		$1,387,415	$40,62	$41,10	$41,70	$42,46	$43,36	$44,43	$45,69
Factor to calculate NPV		0.932	0.869	0.811	0.756	0.705	0.658	0.613	0.572
NPV		$1,293,989	$35,33	$33,34	$31,55	$29,96	$28,54	$27,279	$26,159
Total NPV 100 Years		**$2,251,943**							

Figure 13. Portion of NPV template for Option 1 (up to 8th year)

Note that due to space limit of the report, the above NPV table is truncated to show only up to year 8; the full template continues until year 101. Since the useful life of equipment is assumed to be 45 years, the installation cost would be repeated on the 46th year within the template (inflated by 3% per year).

Appendix D - Process for Projects to Replace Rear Lot with Front Lot

After a large scale project is approved by PowerStream, the project should be implemented in a well-coordinated fashion to minimize surprises and disruptions to the neighbourhood. The intent is to engage and communicate with customers so that the work undertaken will become a positive experience with the local residents.

The following steps are recommended.

Pre-Construction

- Approach the local municipality and present proposal so they can assist in the execution of the project.
- Municipality may also consider upgrading infrastructure in the same area (e.g. street lighting, cable/lighting or conduits for future projects such as water sewers).
- Joint effort with telecommunication companies (Bell, Rogers) – relocating of plant.
- Joint effort with gas companies - upgrade of existing plant.
- Installation of spare conduits for future renting to telecommunication providers.
- Small trial pocket area.
- Comprehensive capital design including Customer Care input on placement of padmount transformers (e.g. not in front of picture windows).
- Involvement of residents.
- Set up area designated as head office showing extent of work for view by the area residents.
- Provide information on costs and potential rate increase (if applicable).
- Provide statistics of outages due to back yard supply.
- Customer Service to advise the home owner that meter base and PowerStream service cable will be rated for 200 amps.
- Customer Care to advise the customer if they would like to upgrade their existing 100 amp service to 200 amps during the conversion.
- Send letter to home owner with sketches of work to be performed on the property. Sketch to be signed and returned prior to the commencement of work on the property.
- Designate PowerStream contacts (Customer Care) during construction.
- PowerStream to offer the customer a fixed amount to remove the old overhead service (i.e. mast or meter socket) and make their own repairs to the building as required.
- Set up mock padmount transformer for customer to visualize installation in their neighborhood.
- Set up mock new meter base positioned on a residence (max 3ft from front of the house).
- Arborist to check site to ensure minimal tree root damage and tree loss.

Civil Contractor

- PowerStream to forward project design to civil contractor for quote and preview of project.
- Civil contractors quote to include ESA permits and sub contractor’s costs.
- Pre inspection (by qualified electrical contractor hired by the civil contractor) of each residence internal main service entrance equipment for potential issues.
- Review Arborist report of site to ensure minimal tree root damage and tree loss.
- Photos or video before and after construction (civil and electrical) on premises (i.e. meter socket installation and conduits on residence).

Post-Construction

- Follow up letters re excavation, sod watering.
- Follow up survey sent to customer to see if improvement is required for next proposed site.

Appendix E – Rear Lot Locations

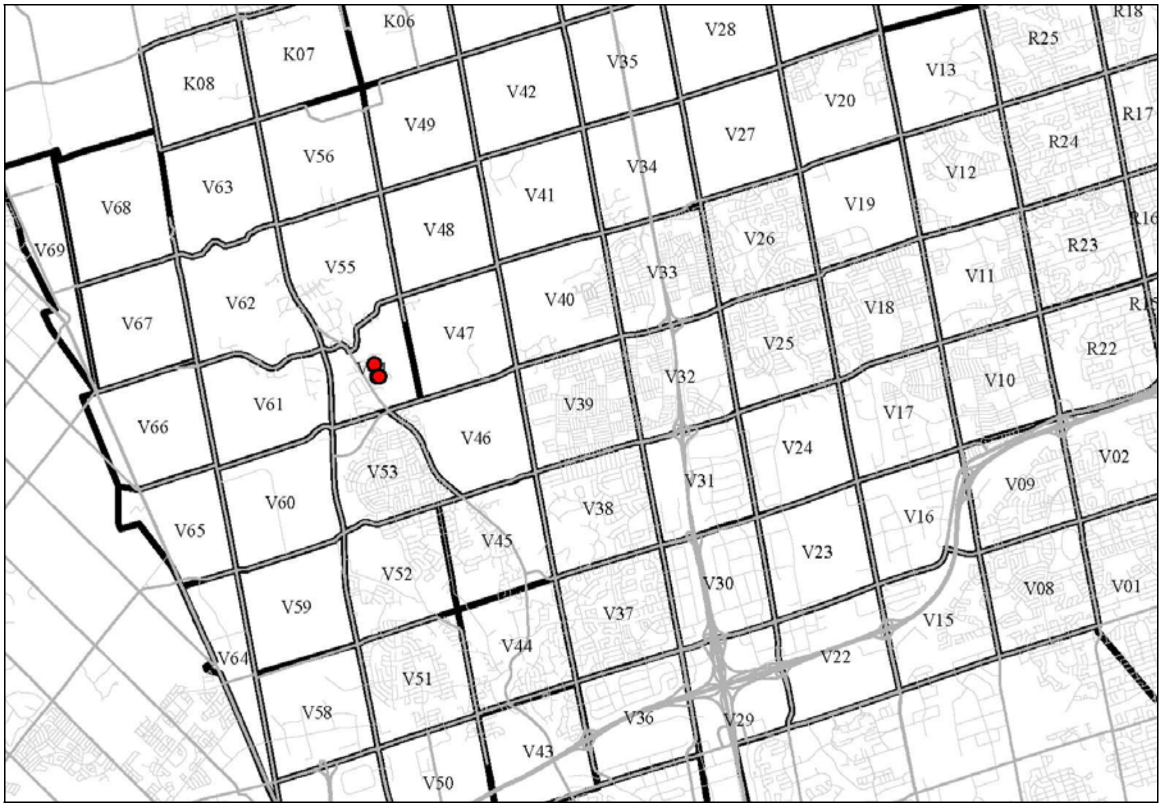


Figure 14. Rear lot supply in Vaughan

Figure 15. Rear lot supply in Alliston

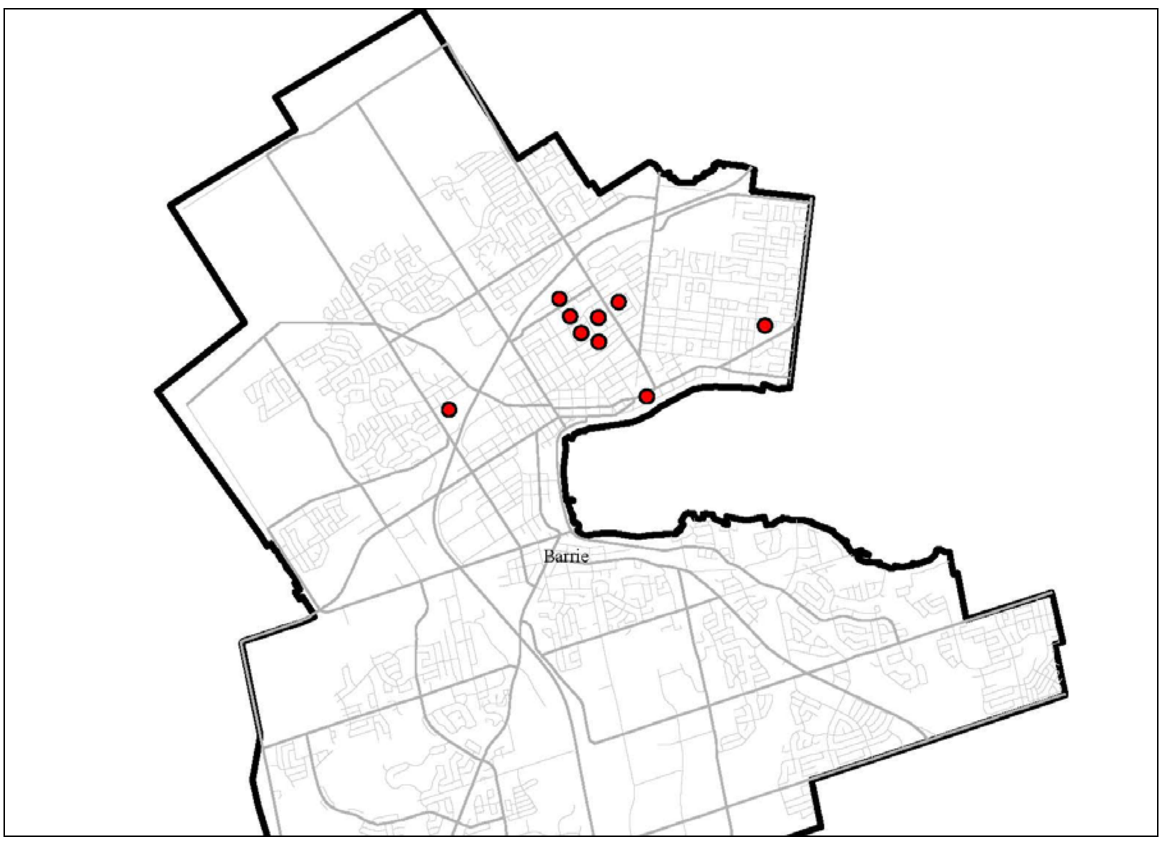


Figure 16. Rear lot supply in Barrie

Figure 17. Rear lot supply in Tottenham

Figure 18. Rear lot supply in Beeton

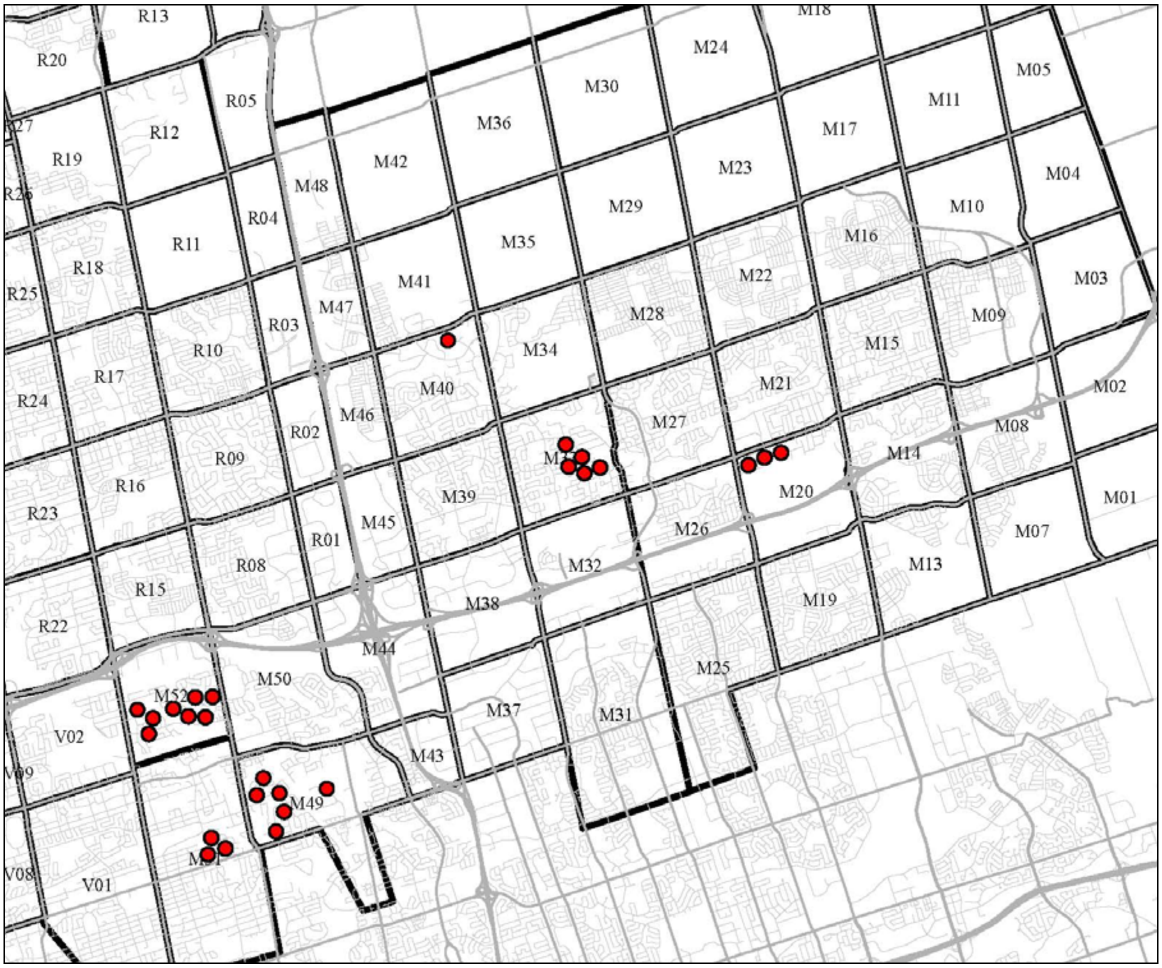


Figure 19. Rear lot supply in Markham

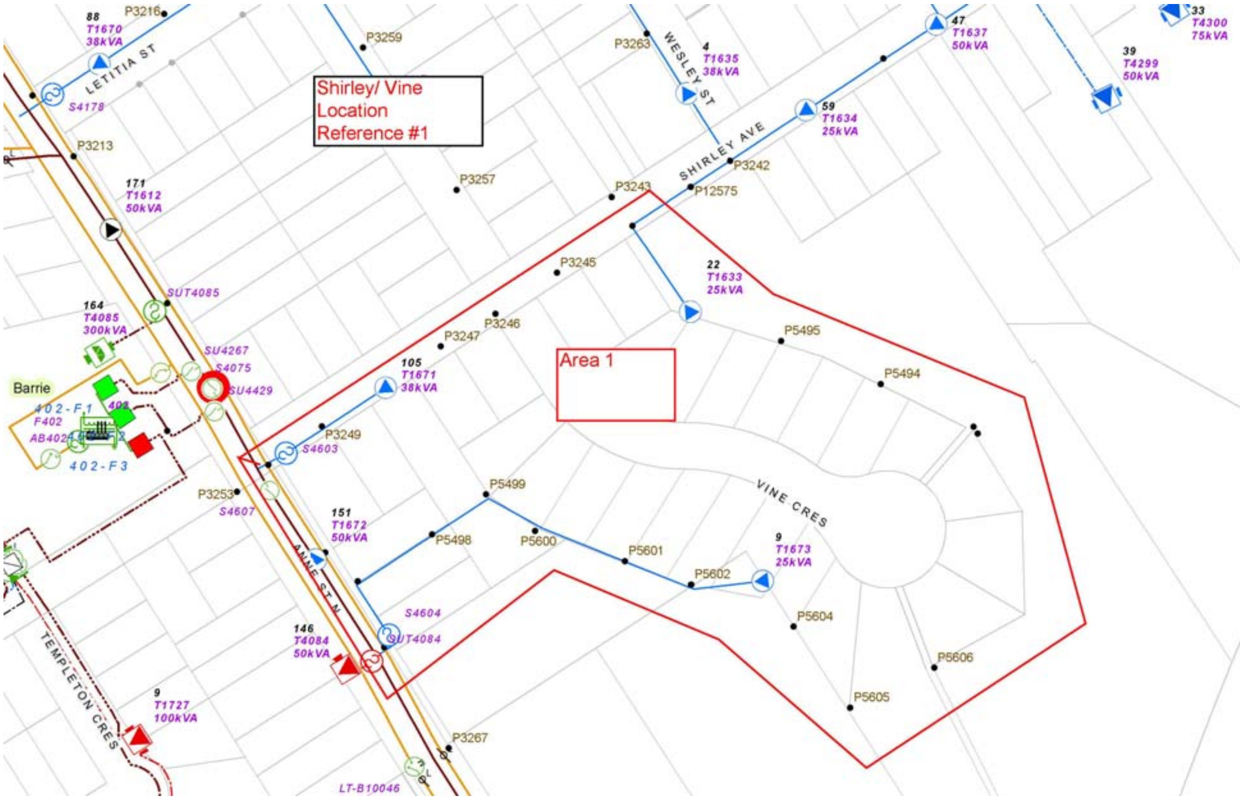
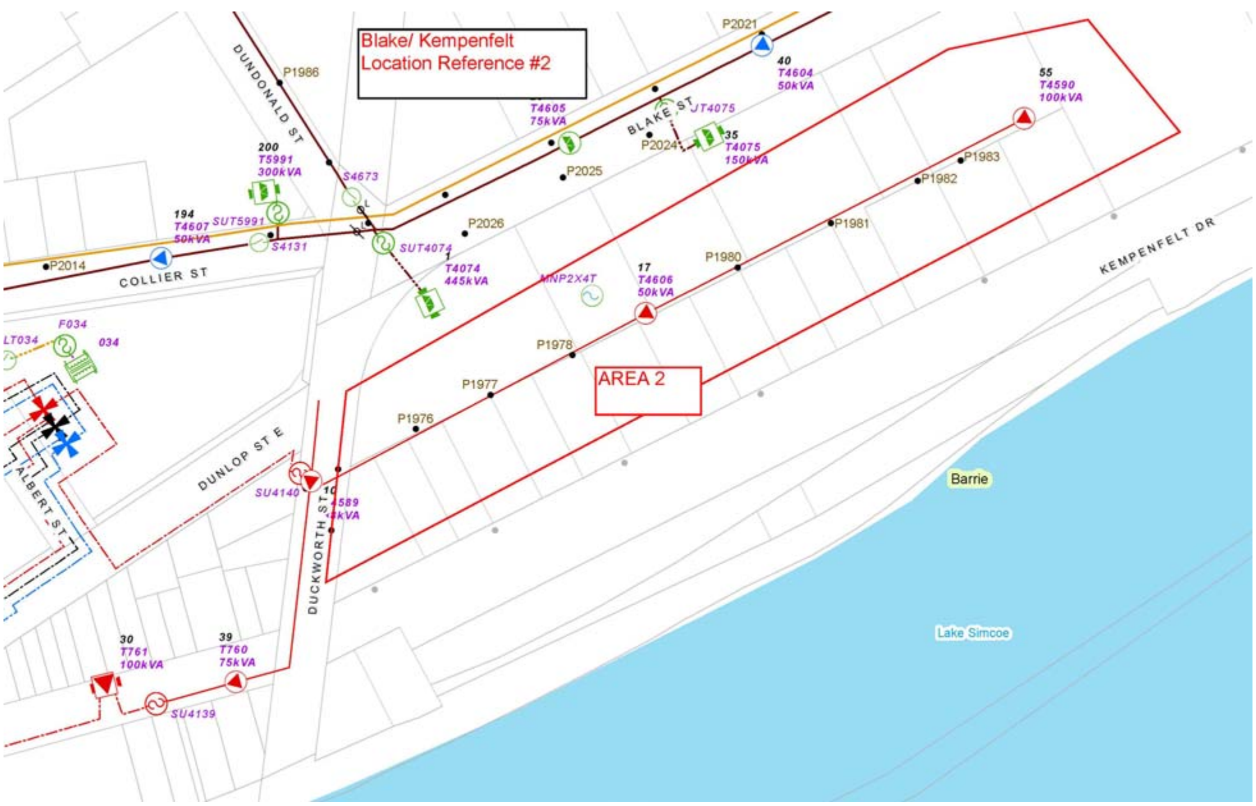


Figure 19. Location Reference #1



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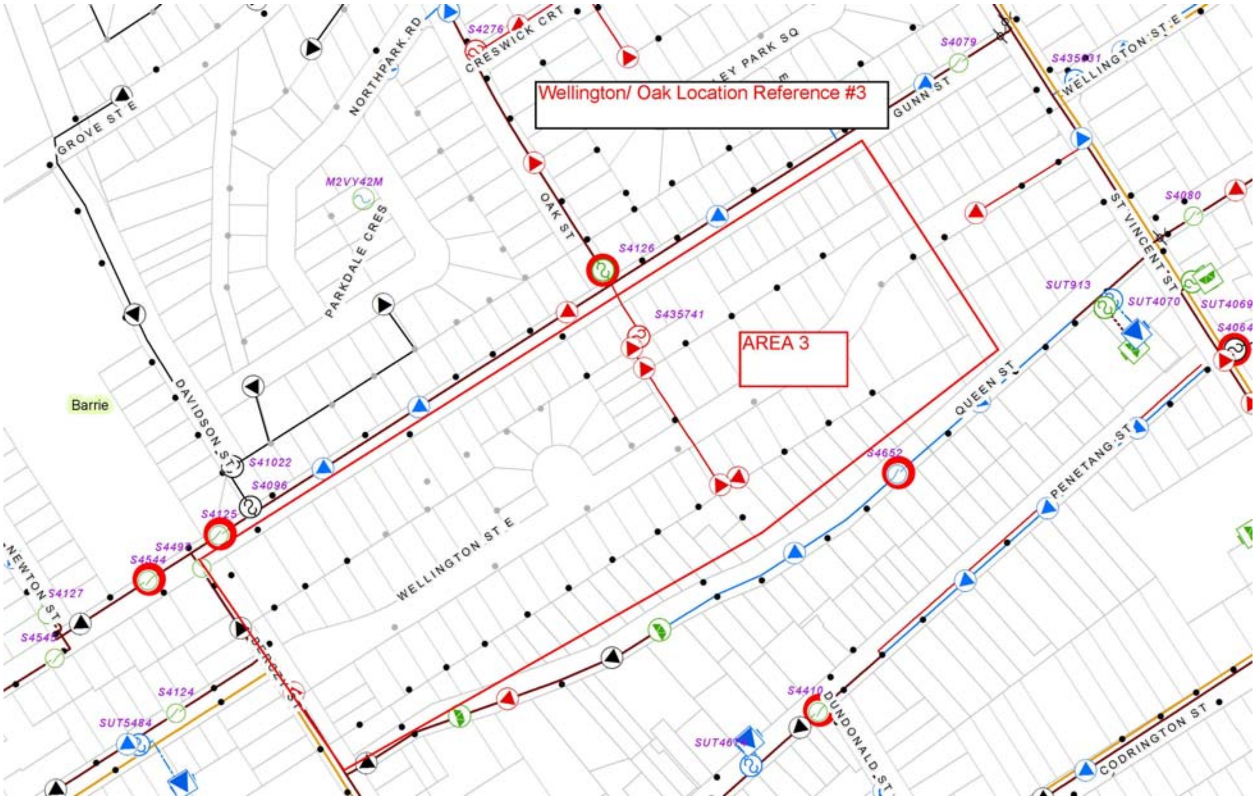

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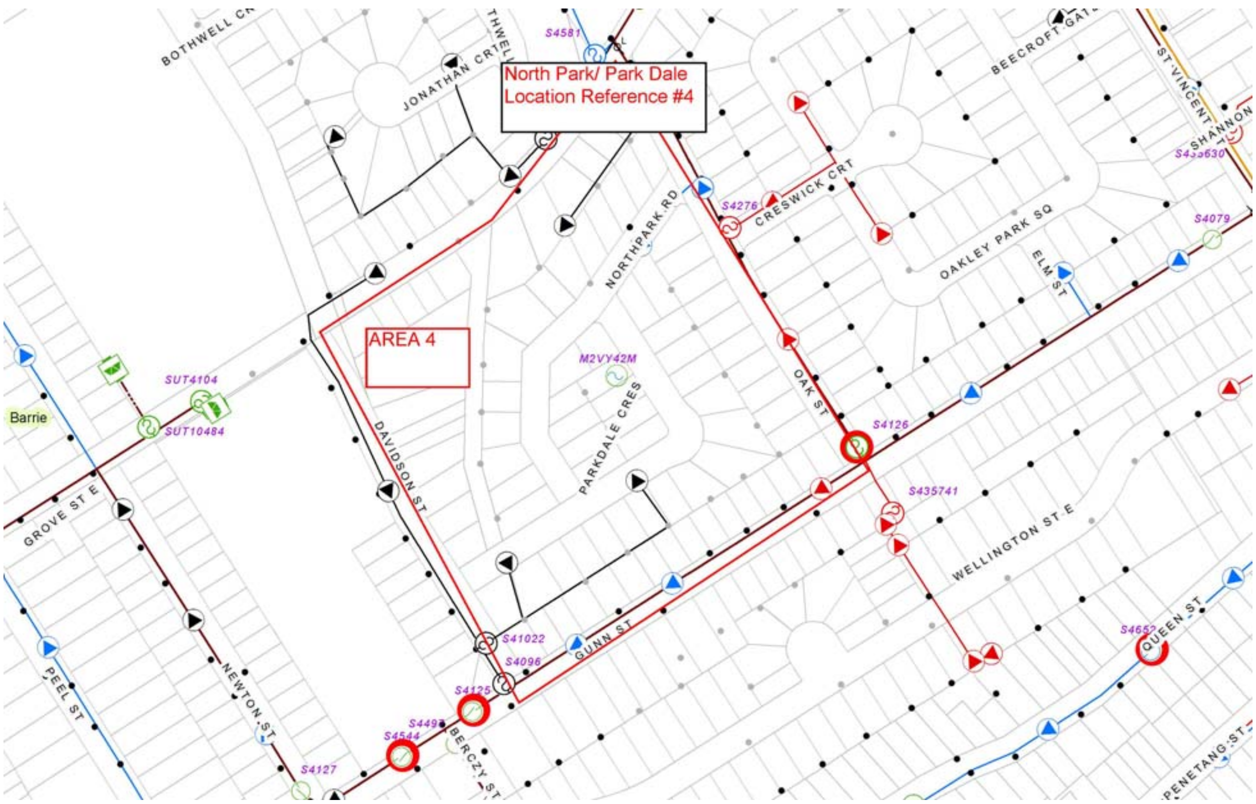


Figure 22. Location Reference #4

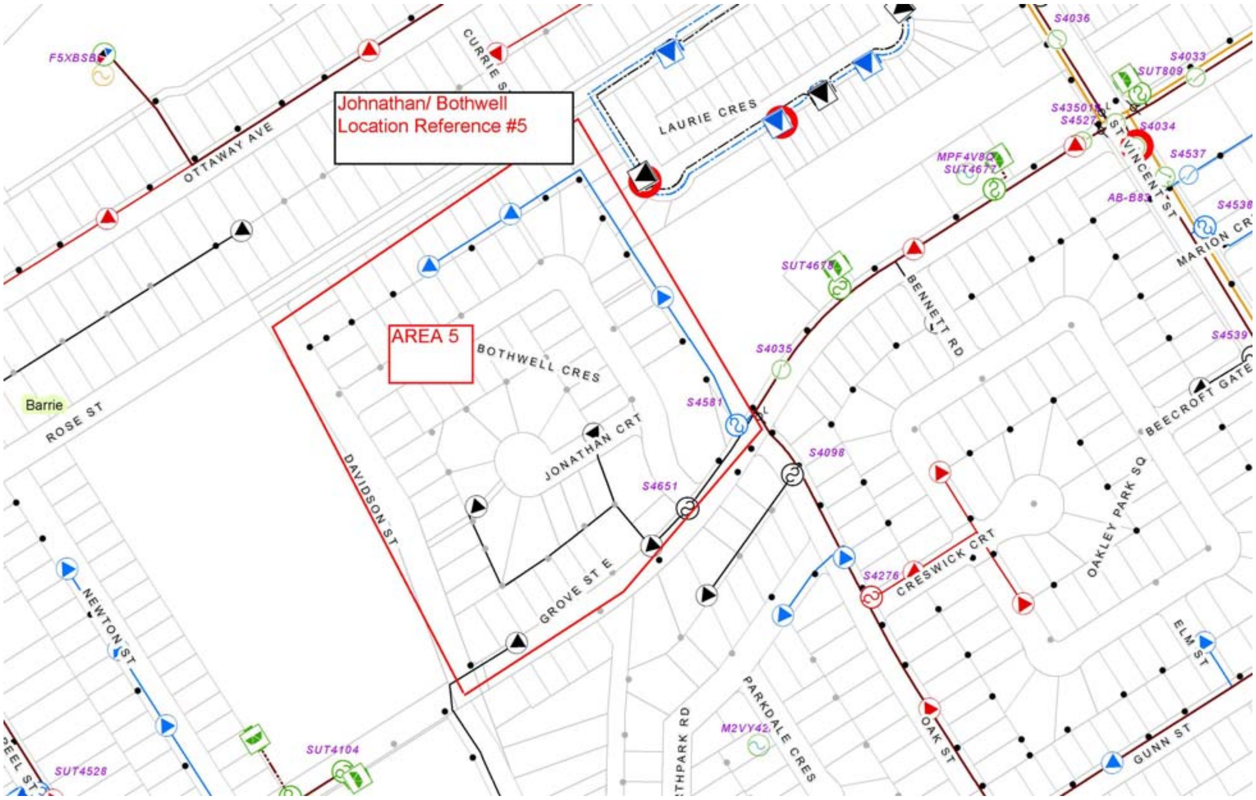
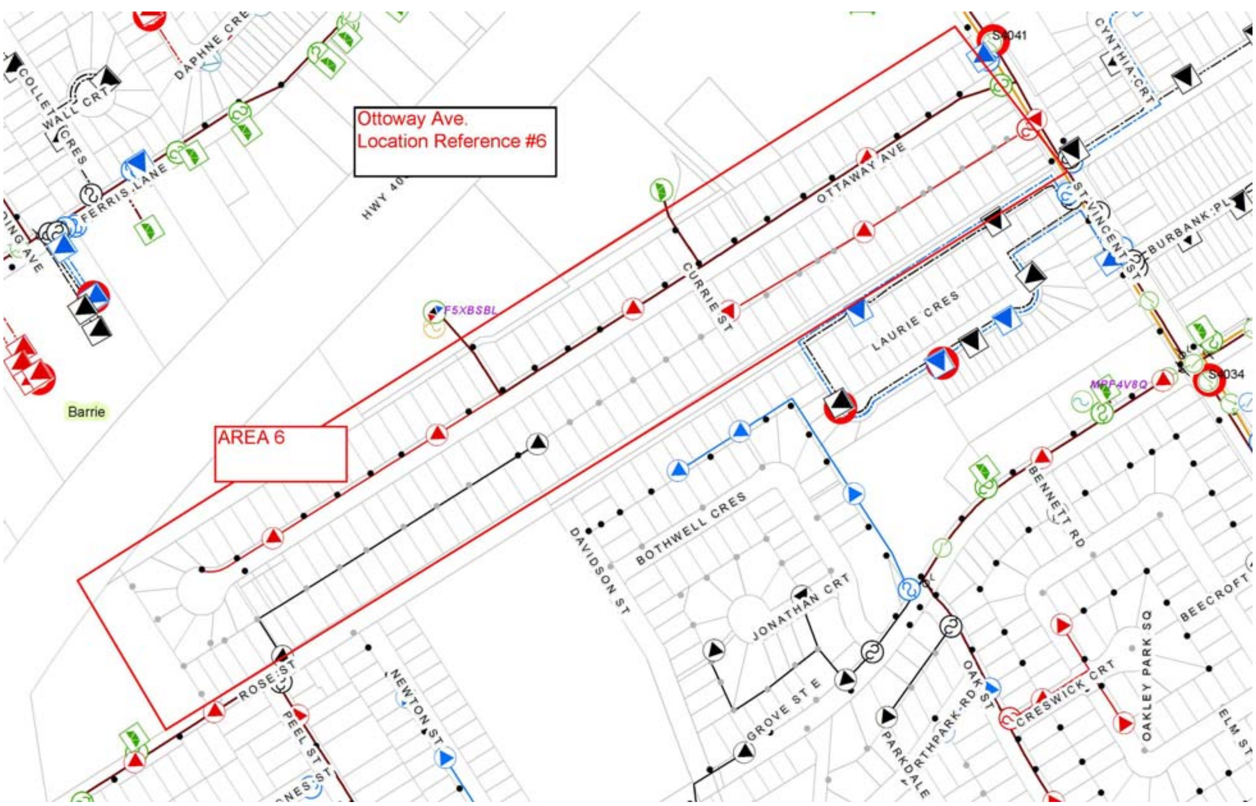


Figure 23. Location Reference #5



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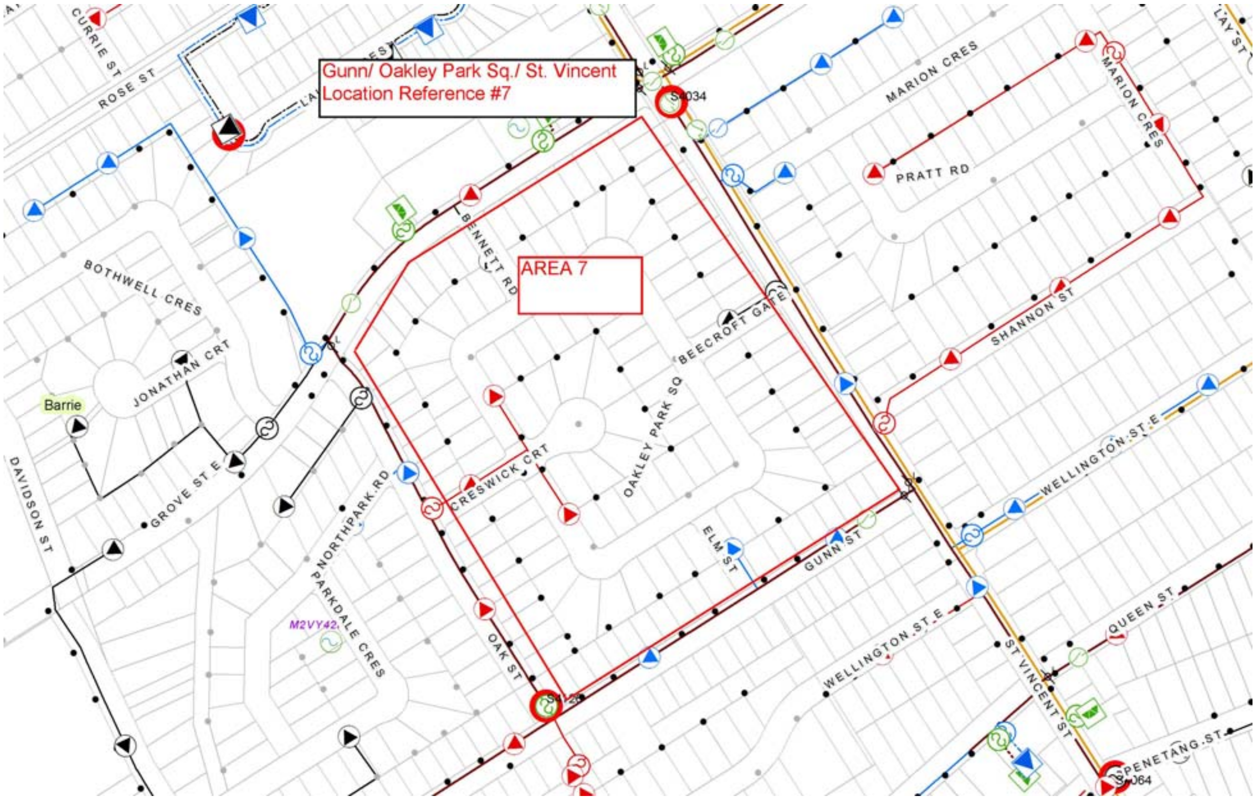

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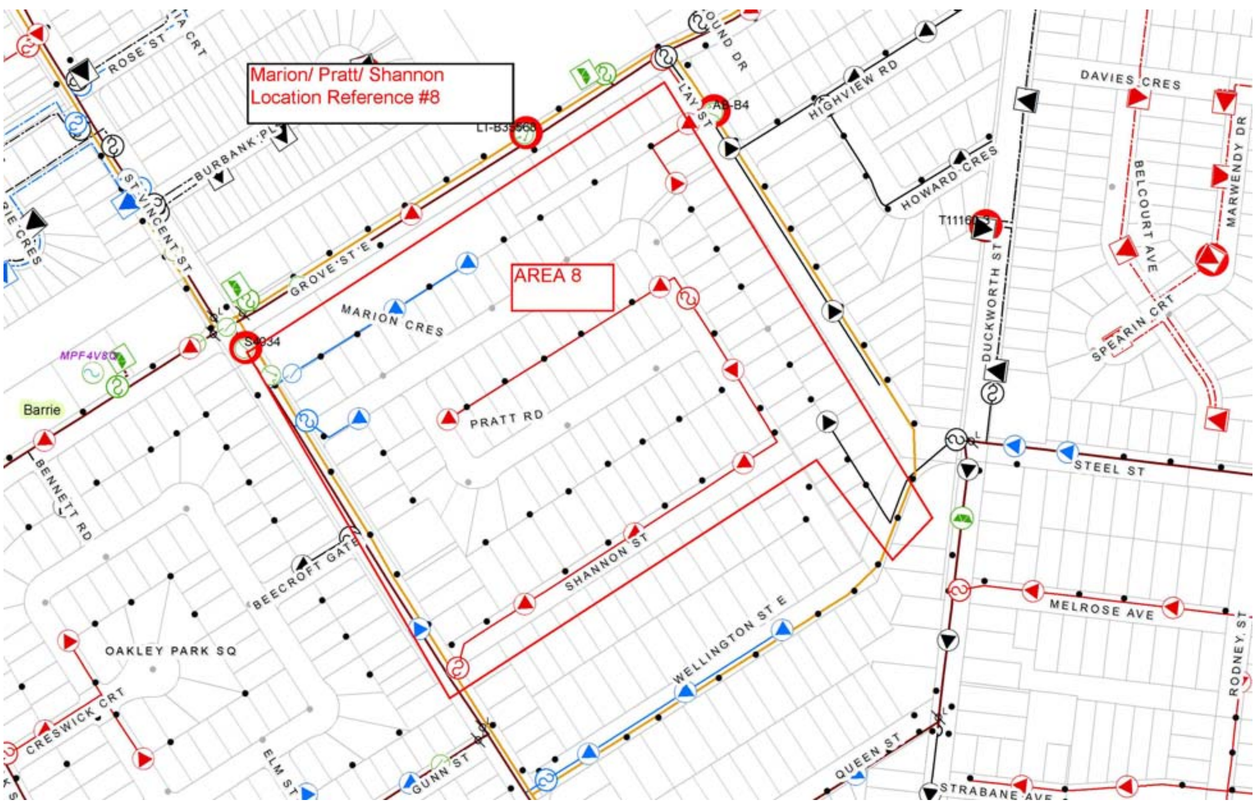

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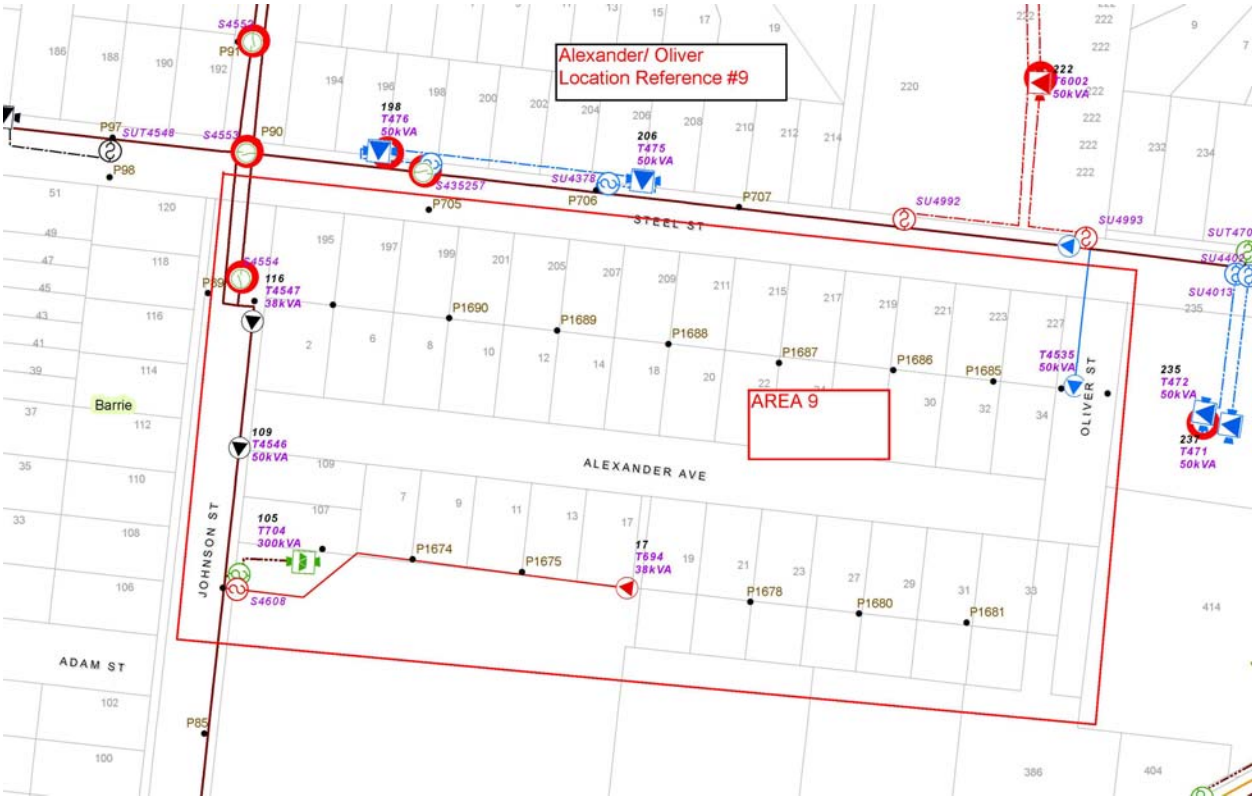

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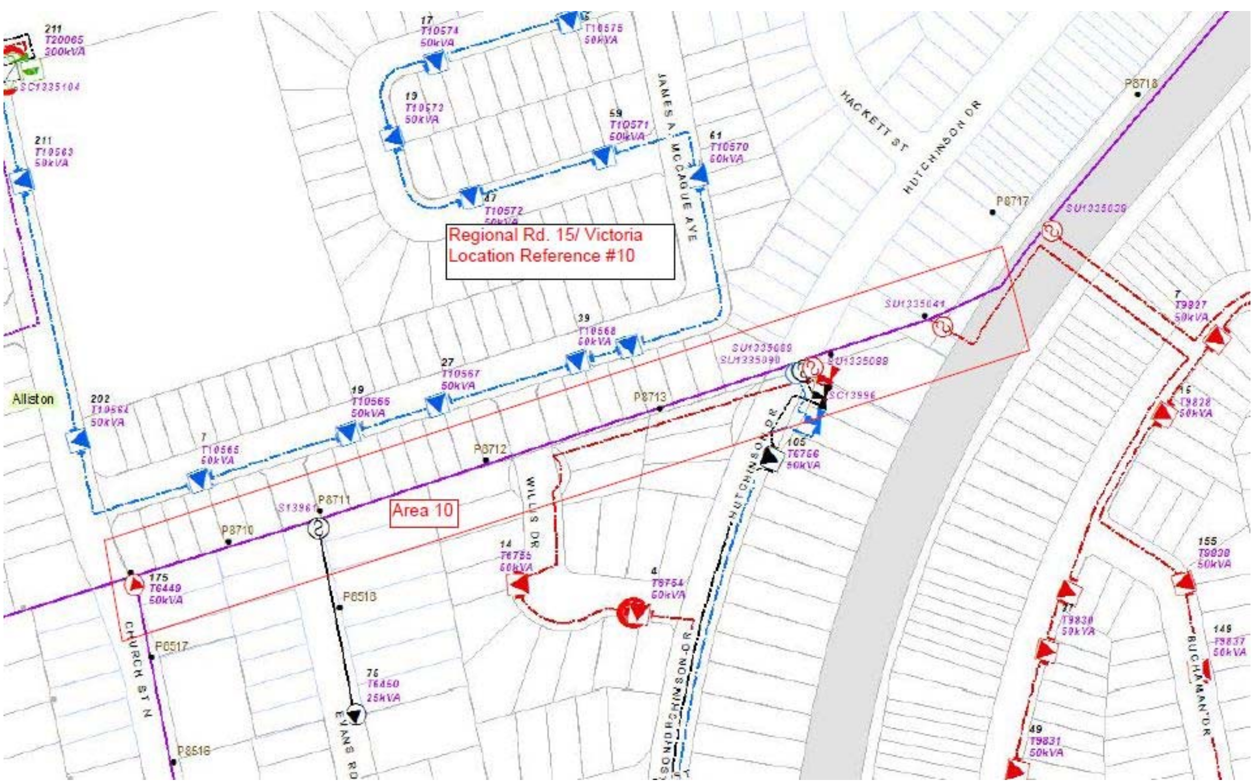

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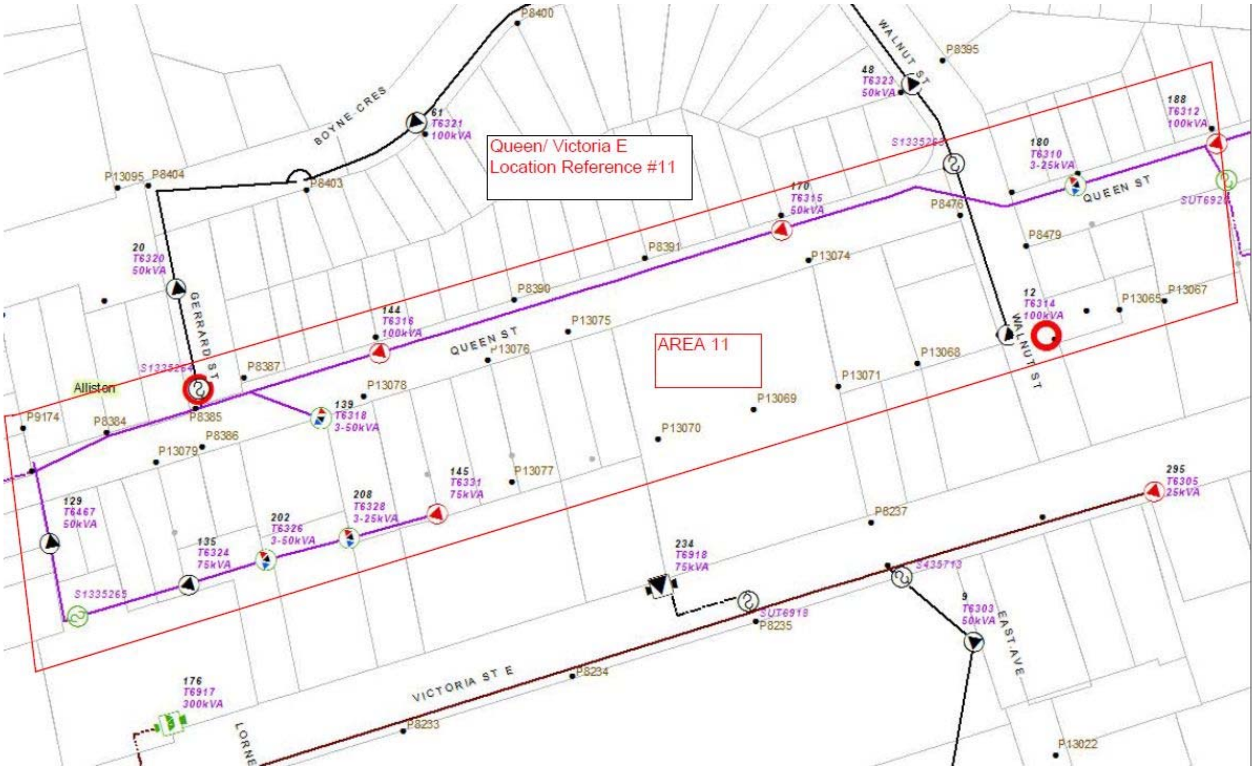

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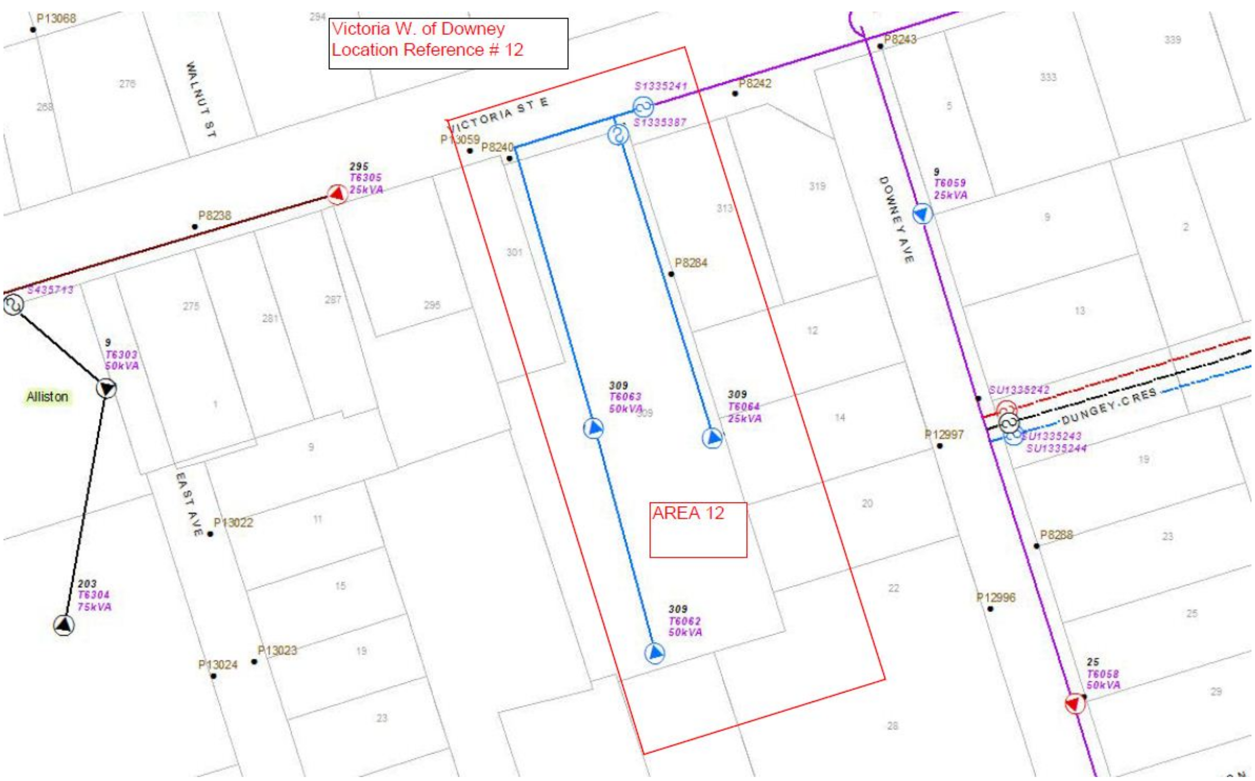

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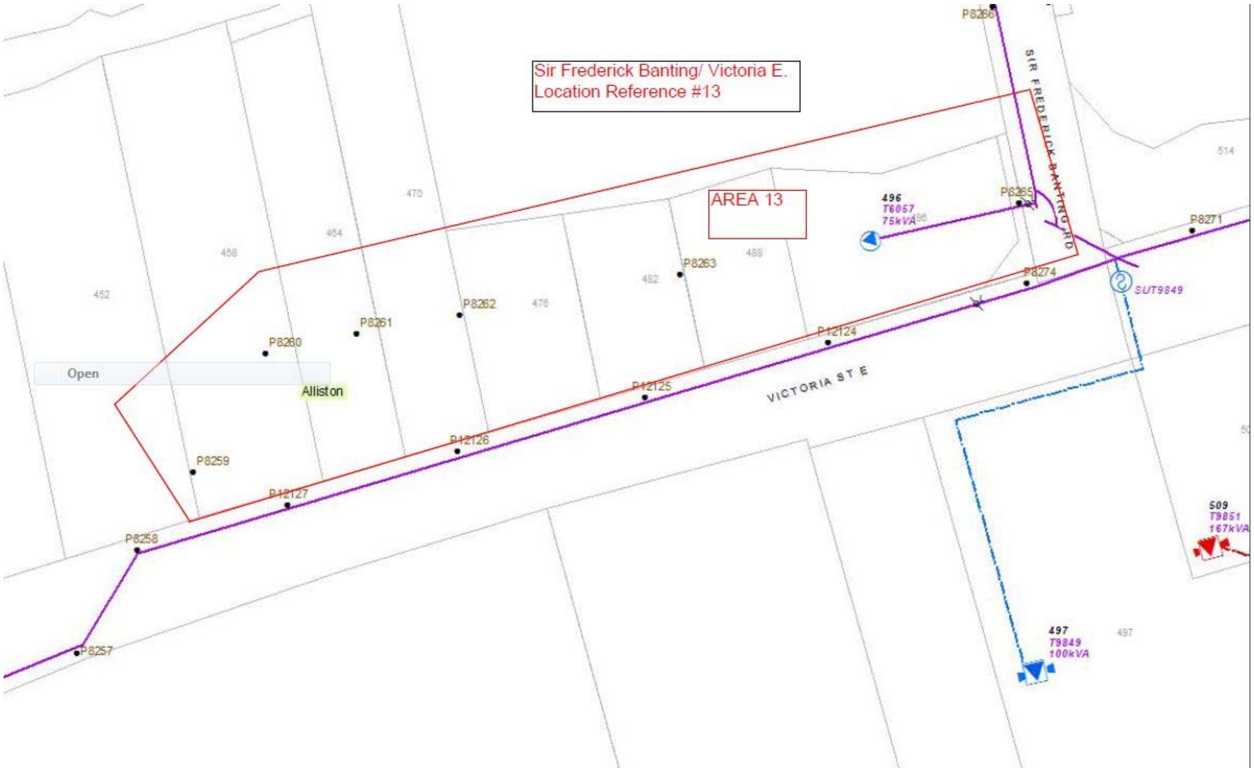

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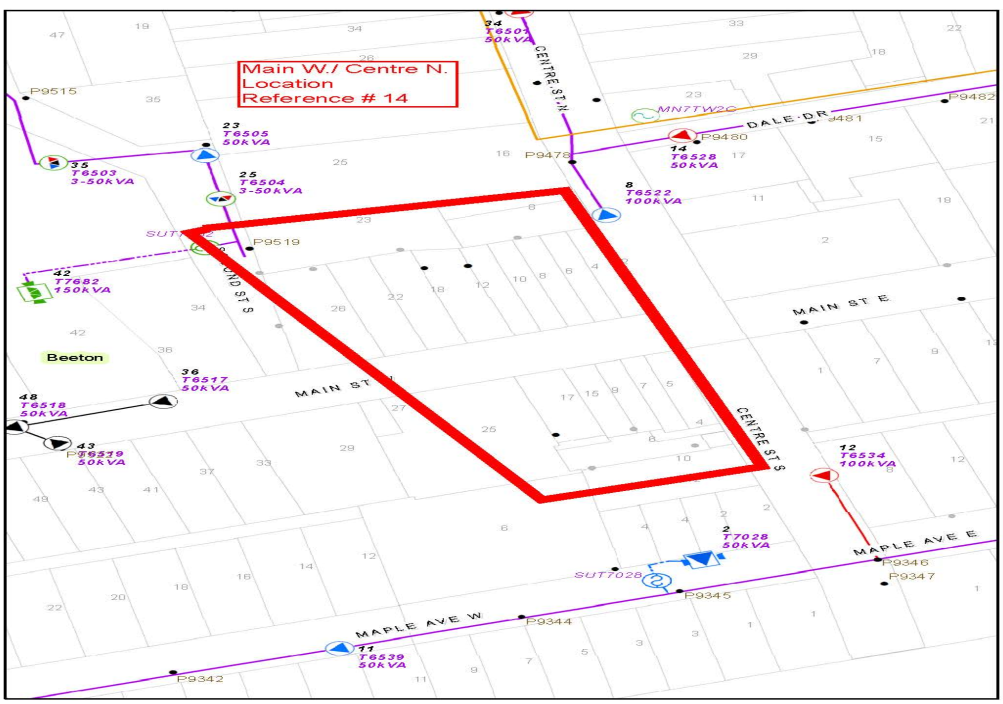

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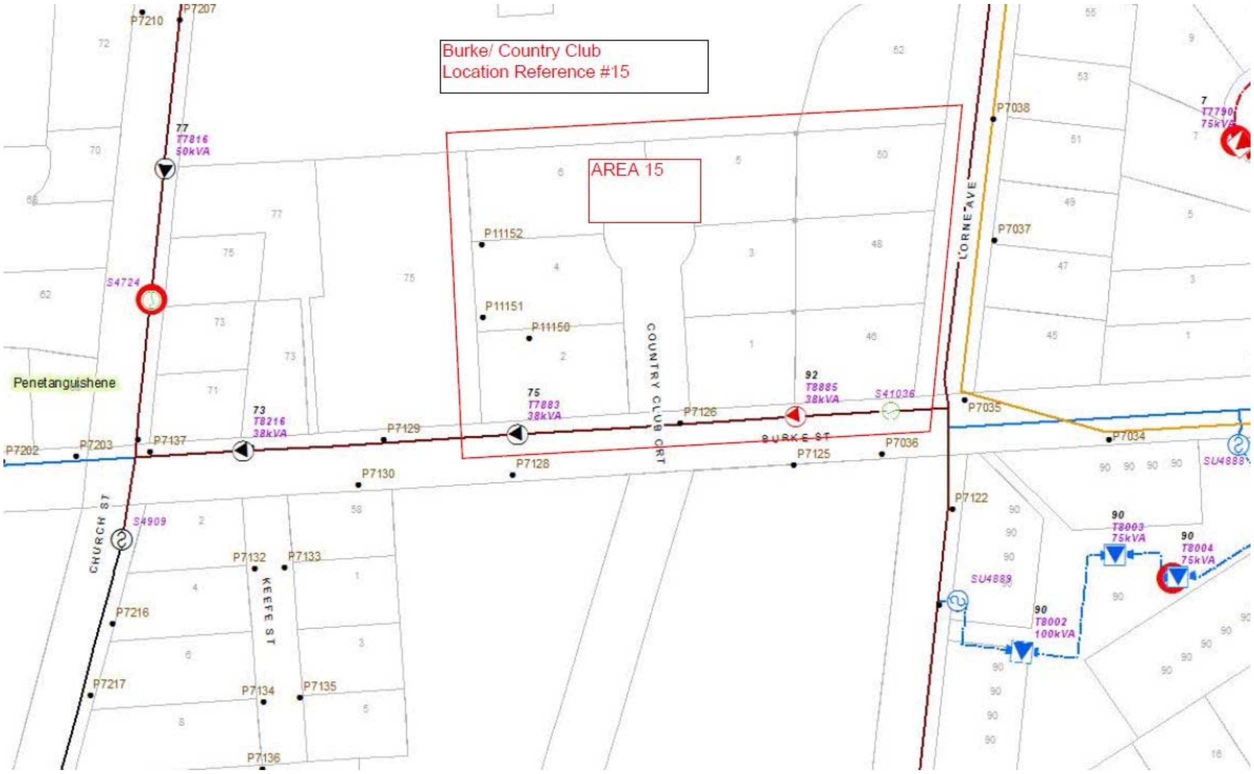

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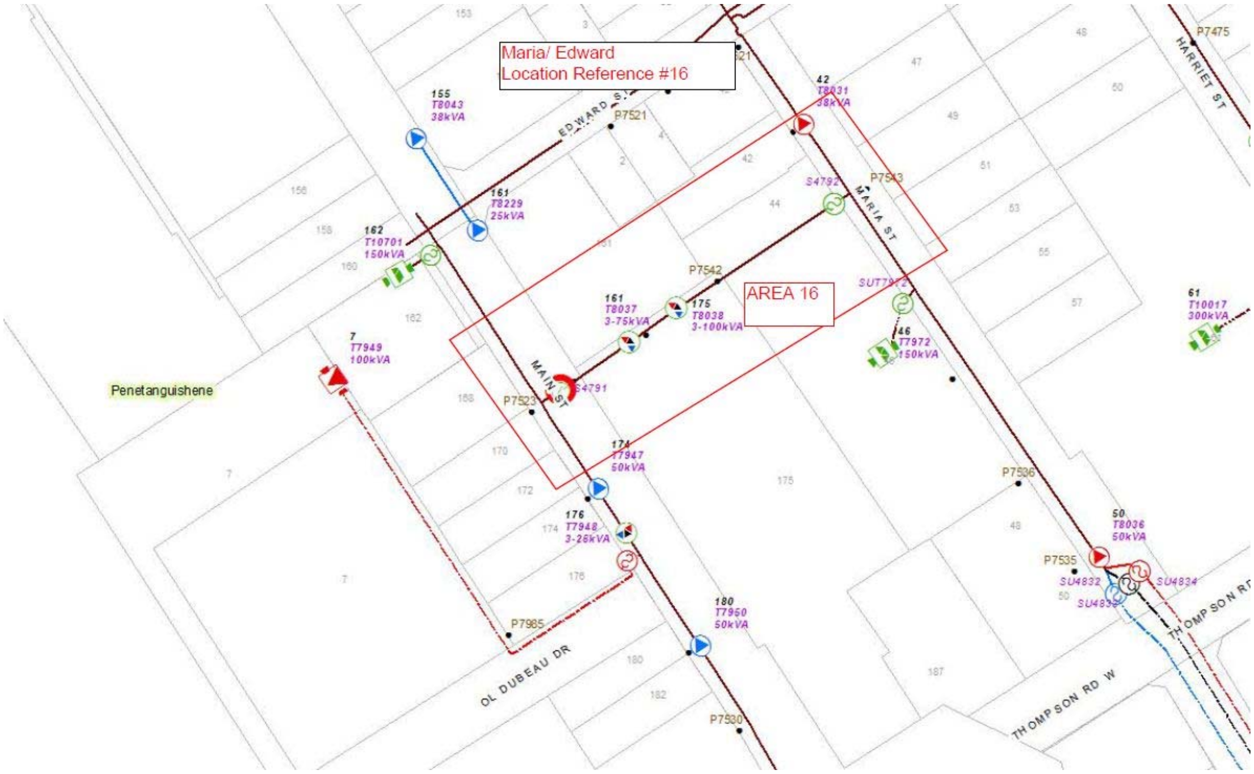


Figure 34. Location Reference #16

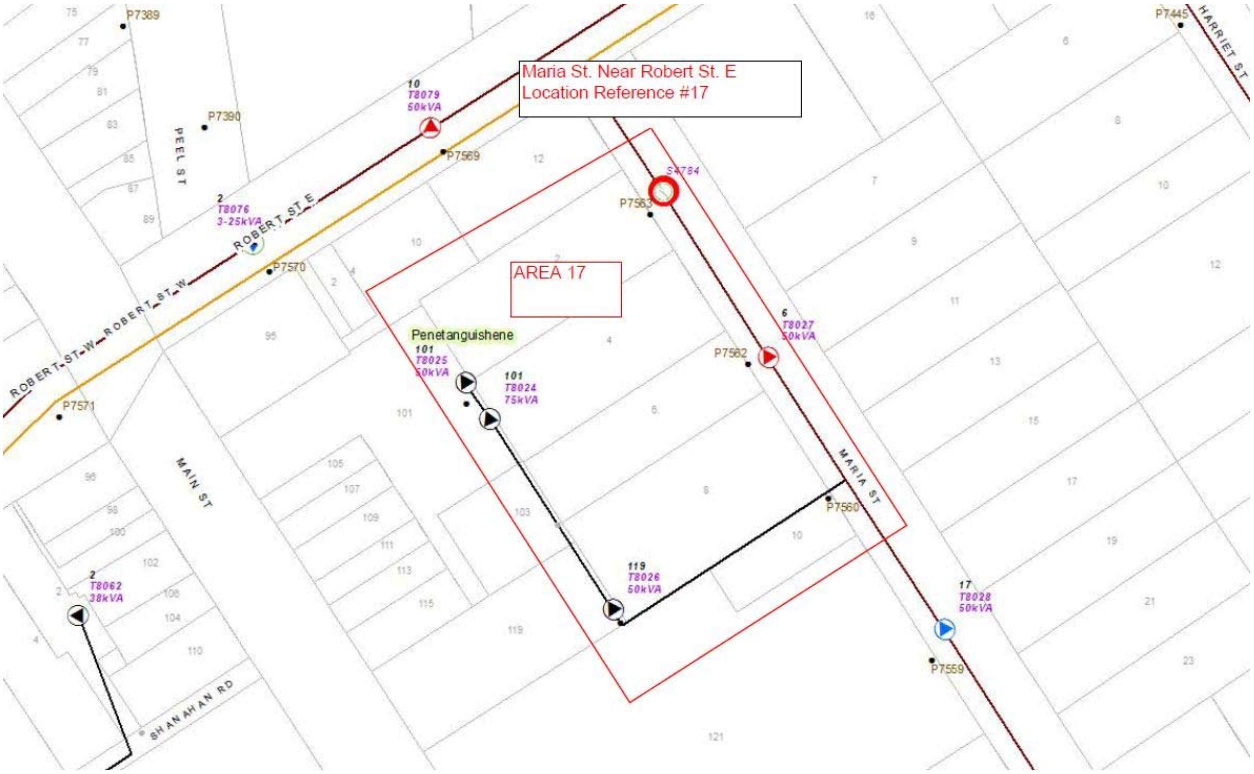


Figure 35. Location Reference #17

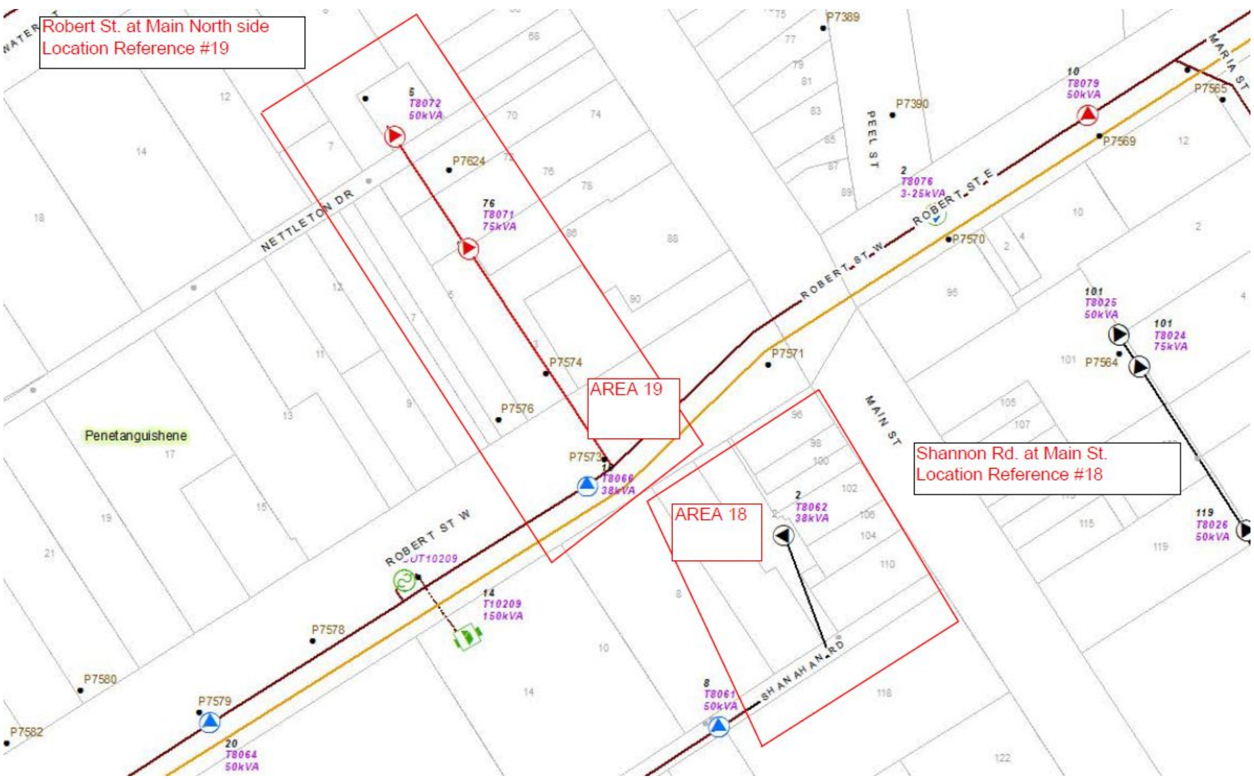
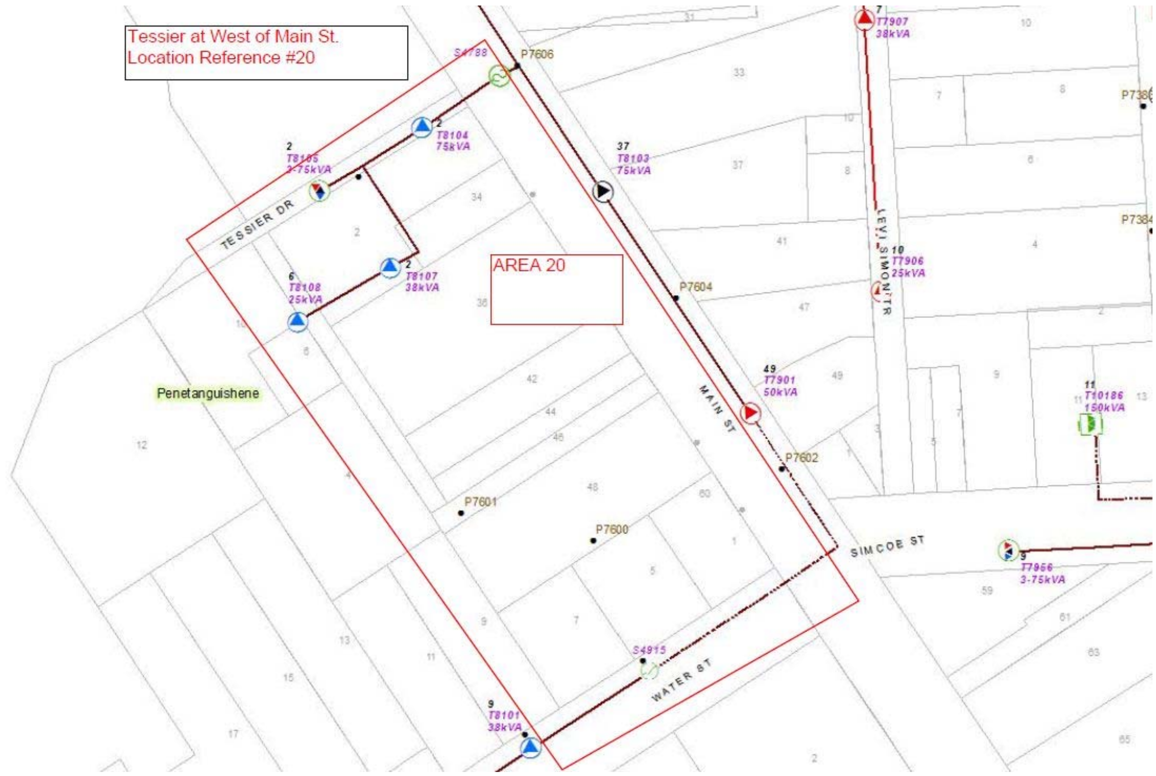


Figure 36. Location Reference #18 and #19



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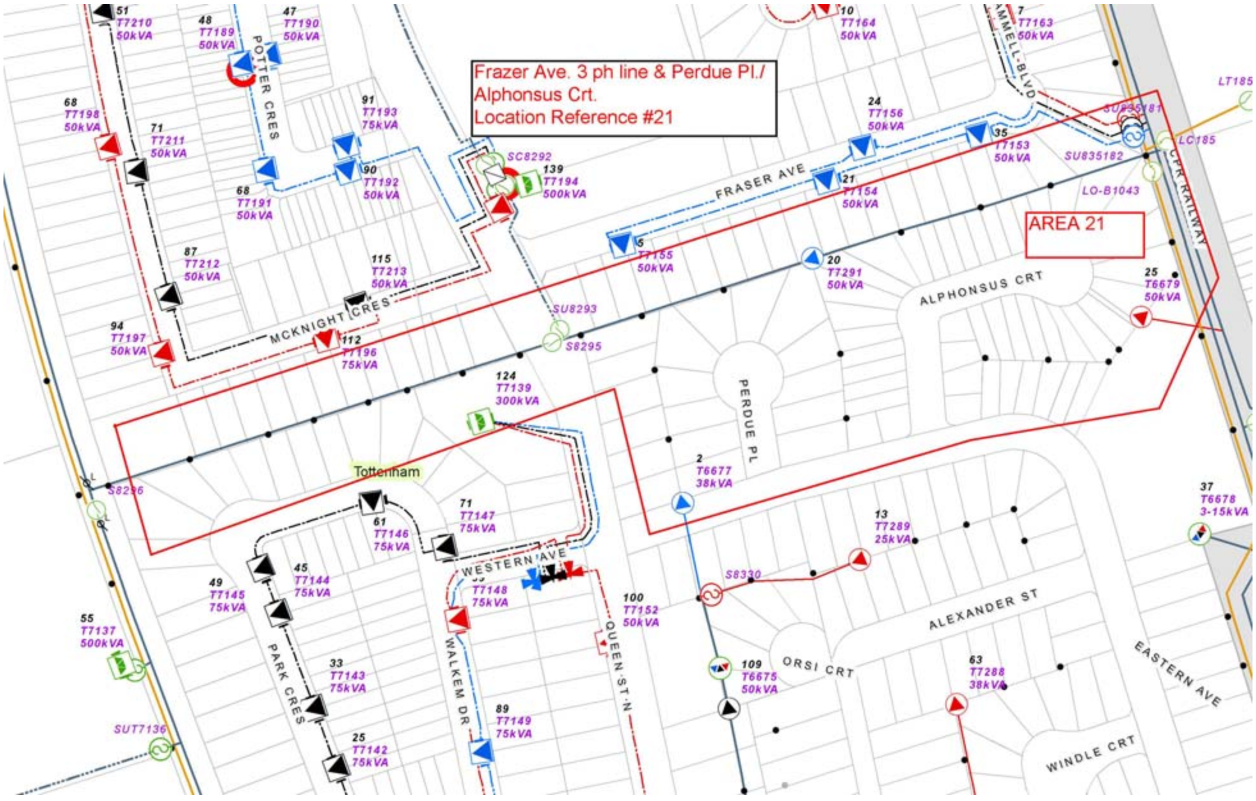

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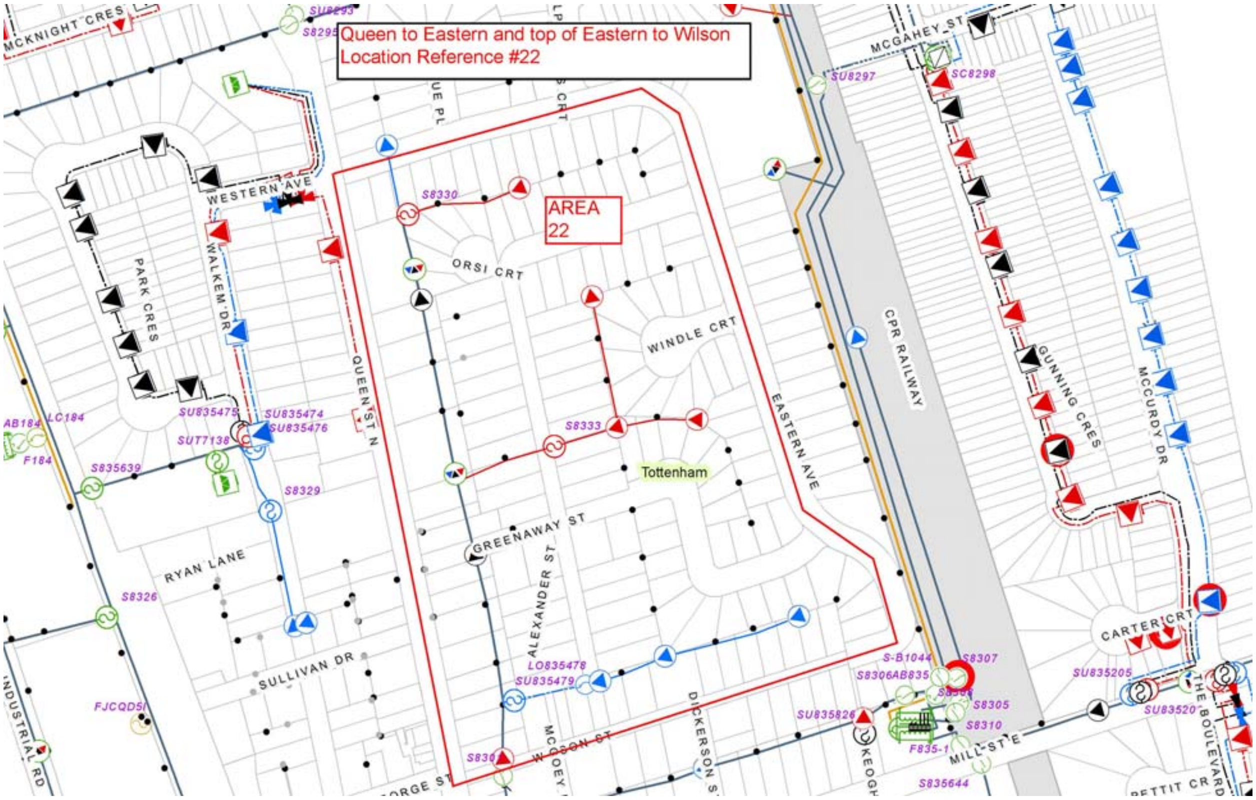

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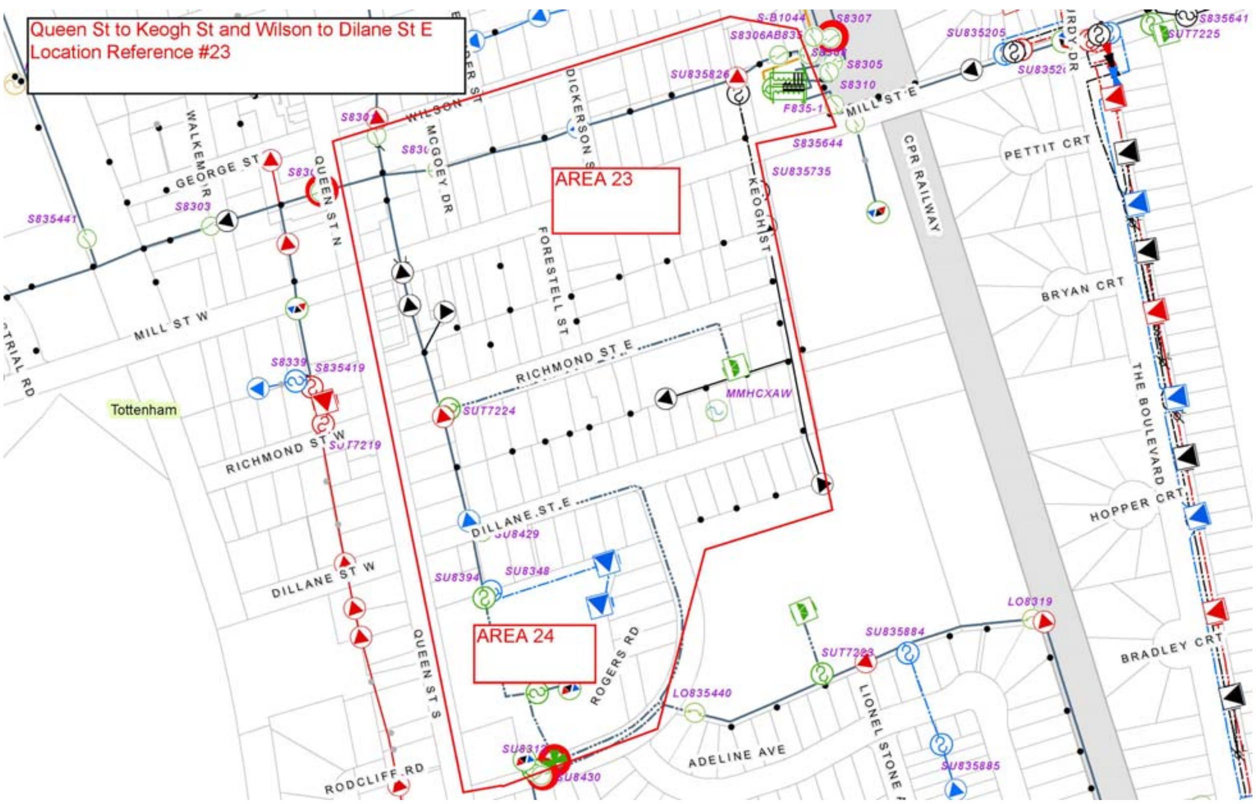

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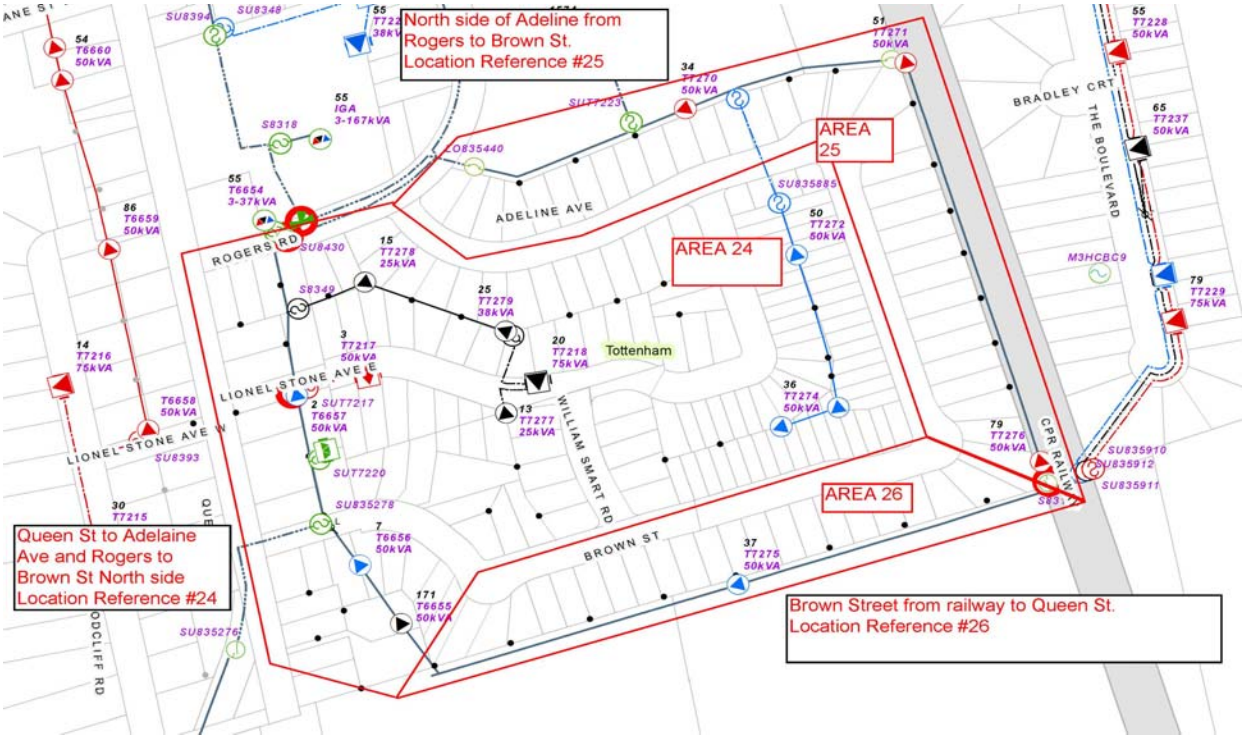
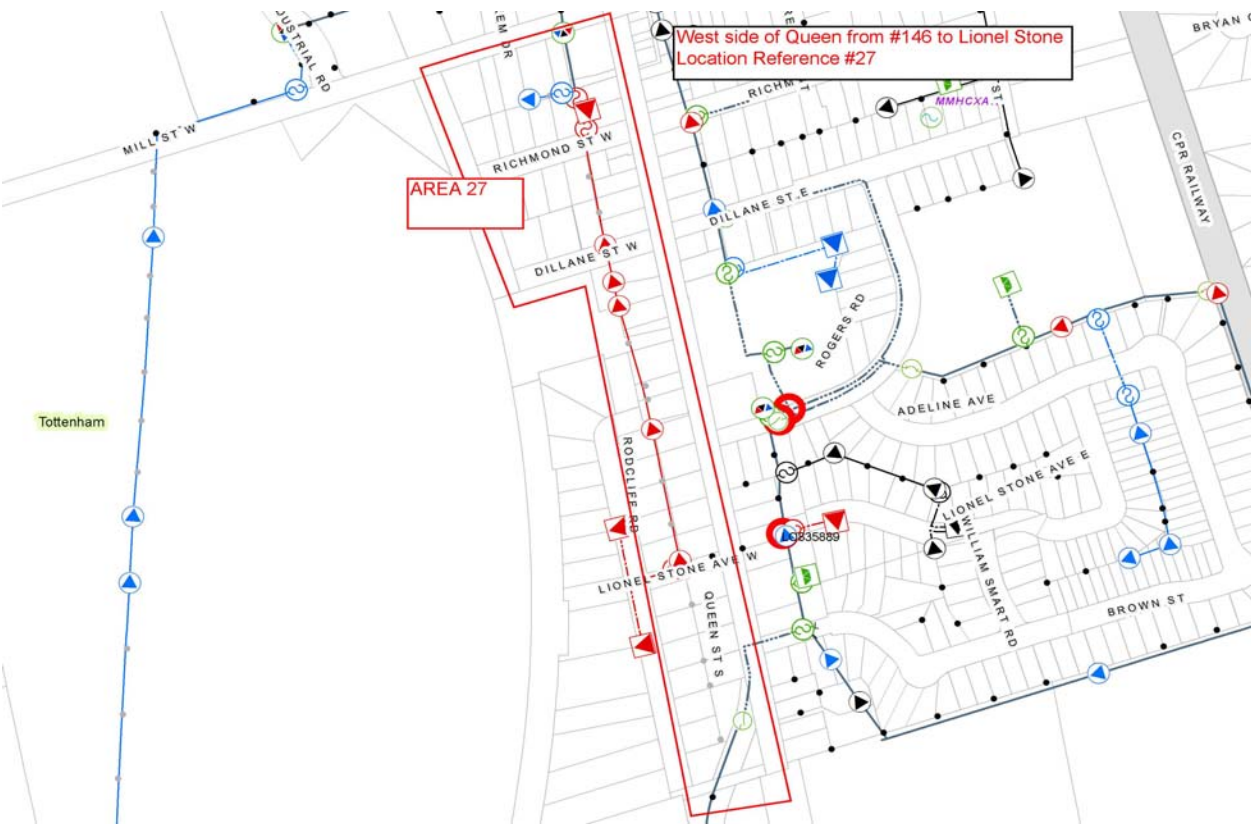


Figure 41. Location Reference #24, #25 and #26



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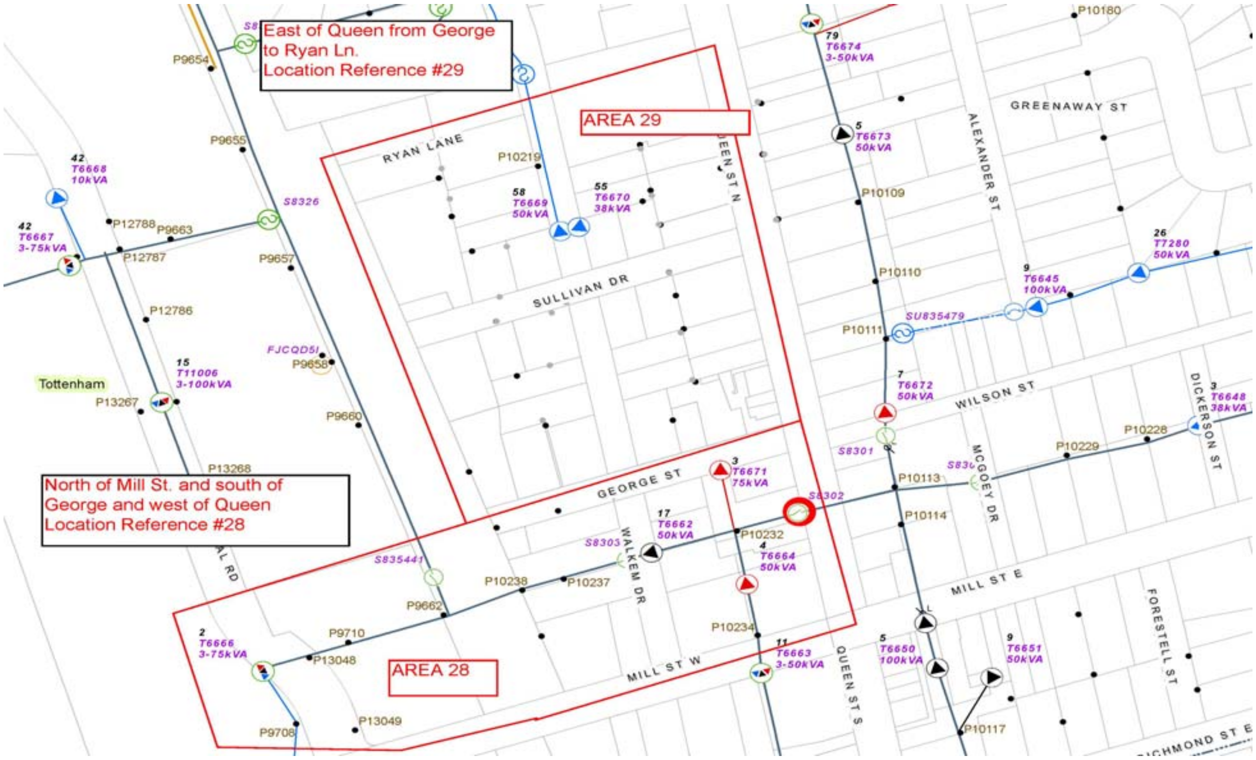
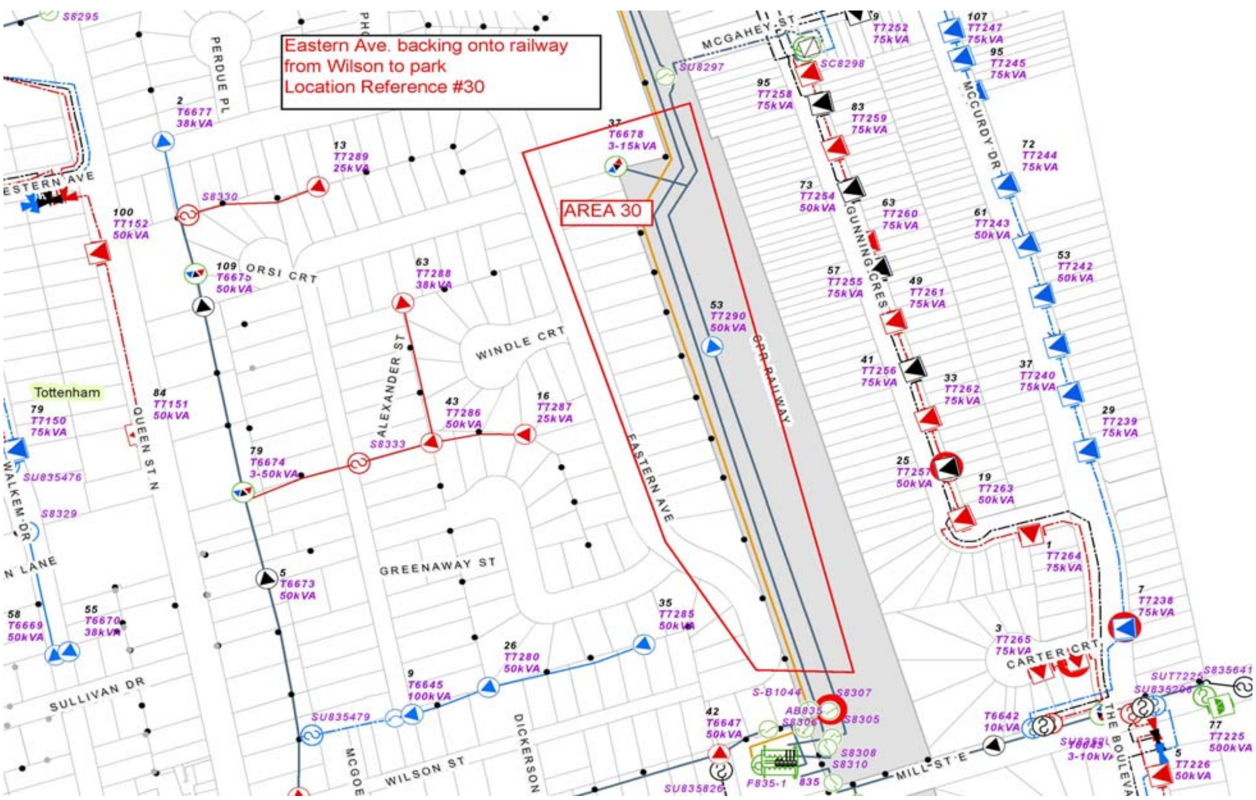


Figure 43. Location Reference #28 and #29



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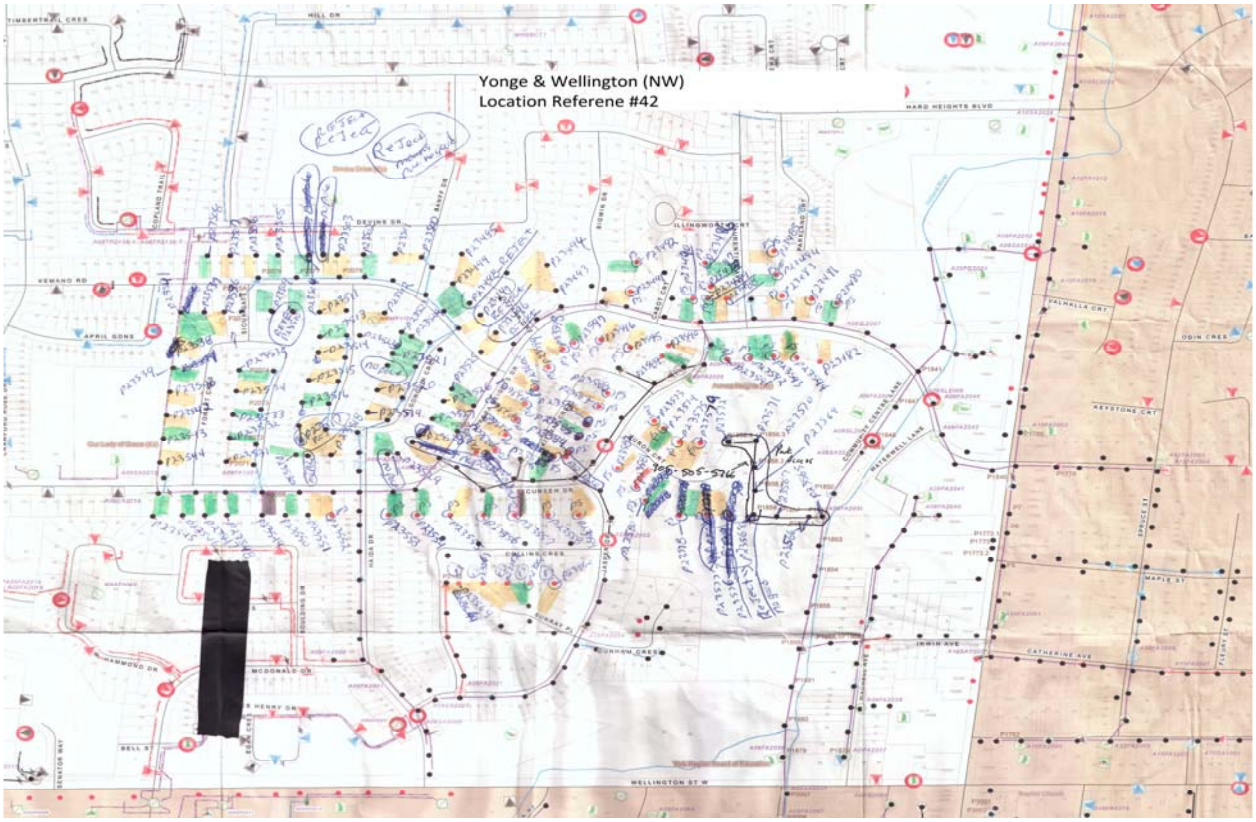

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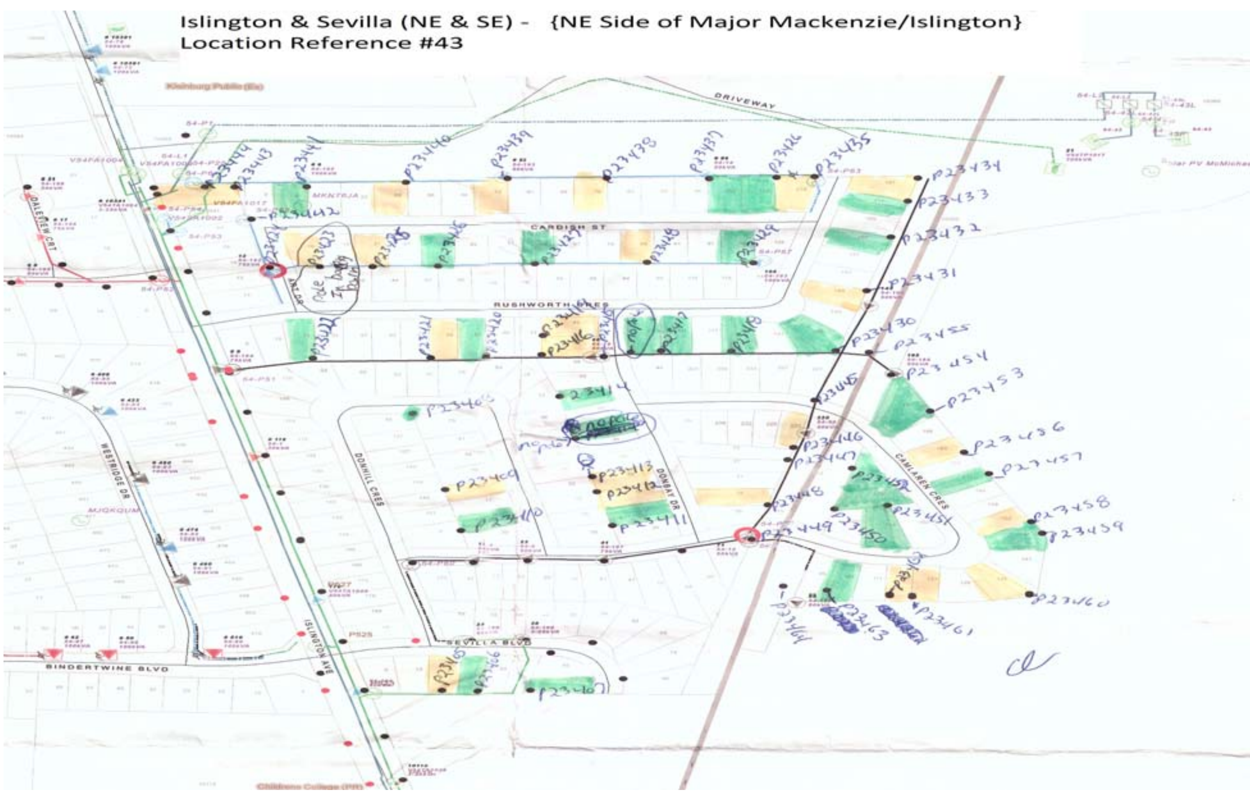

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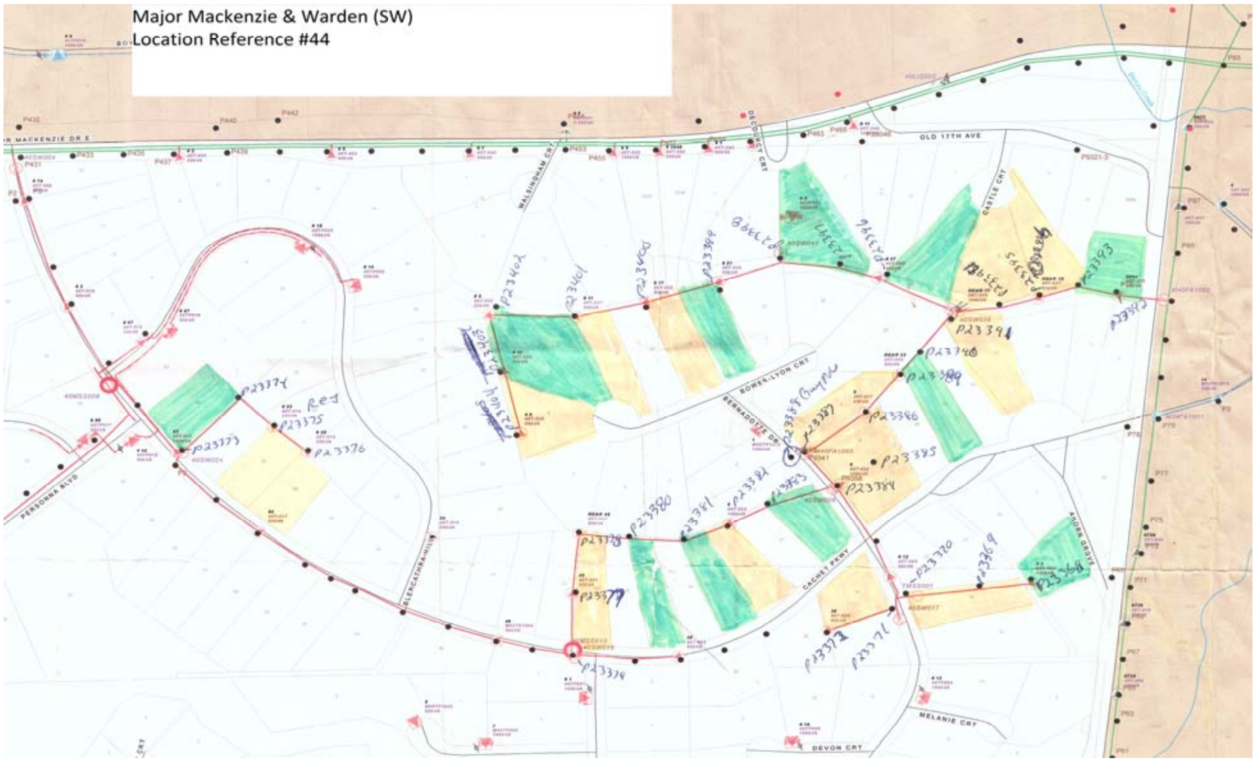

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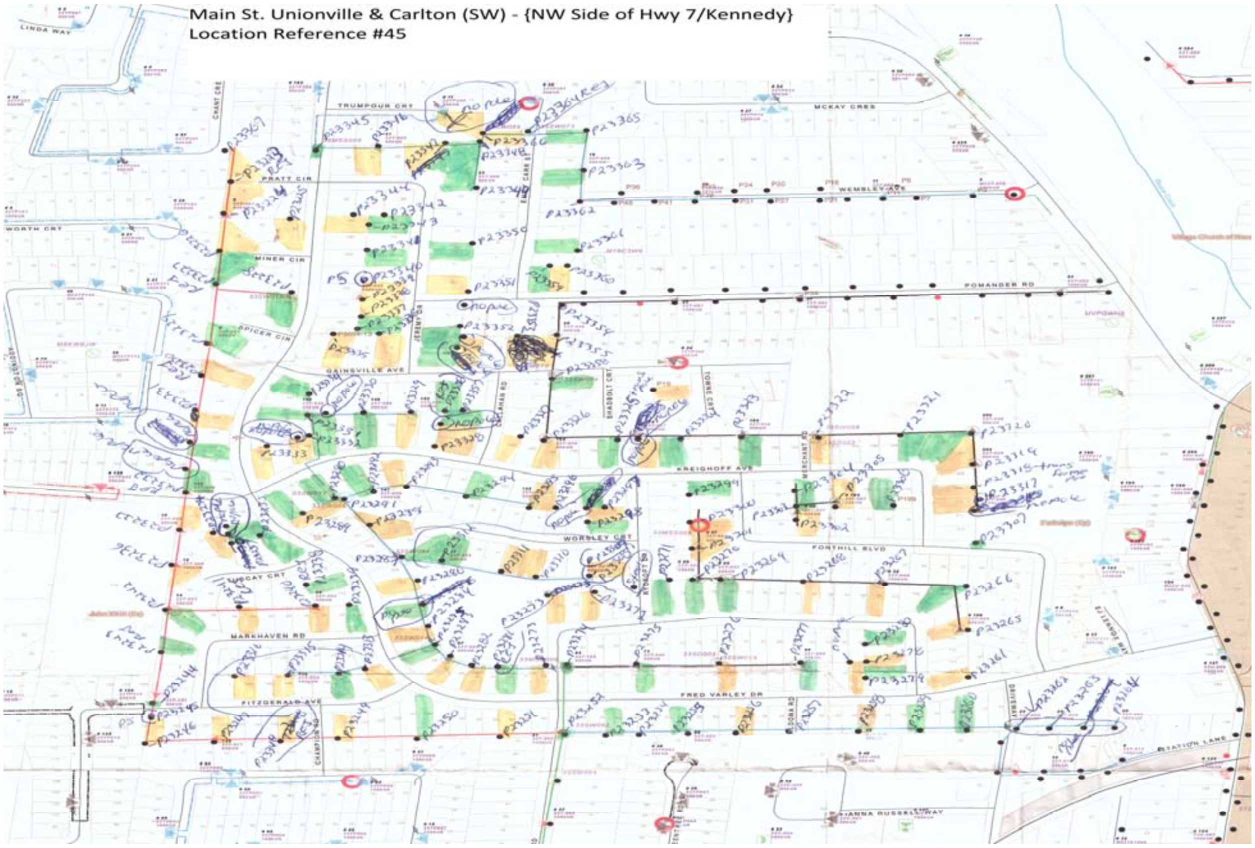

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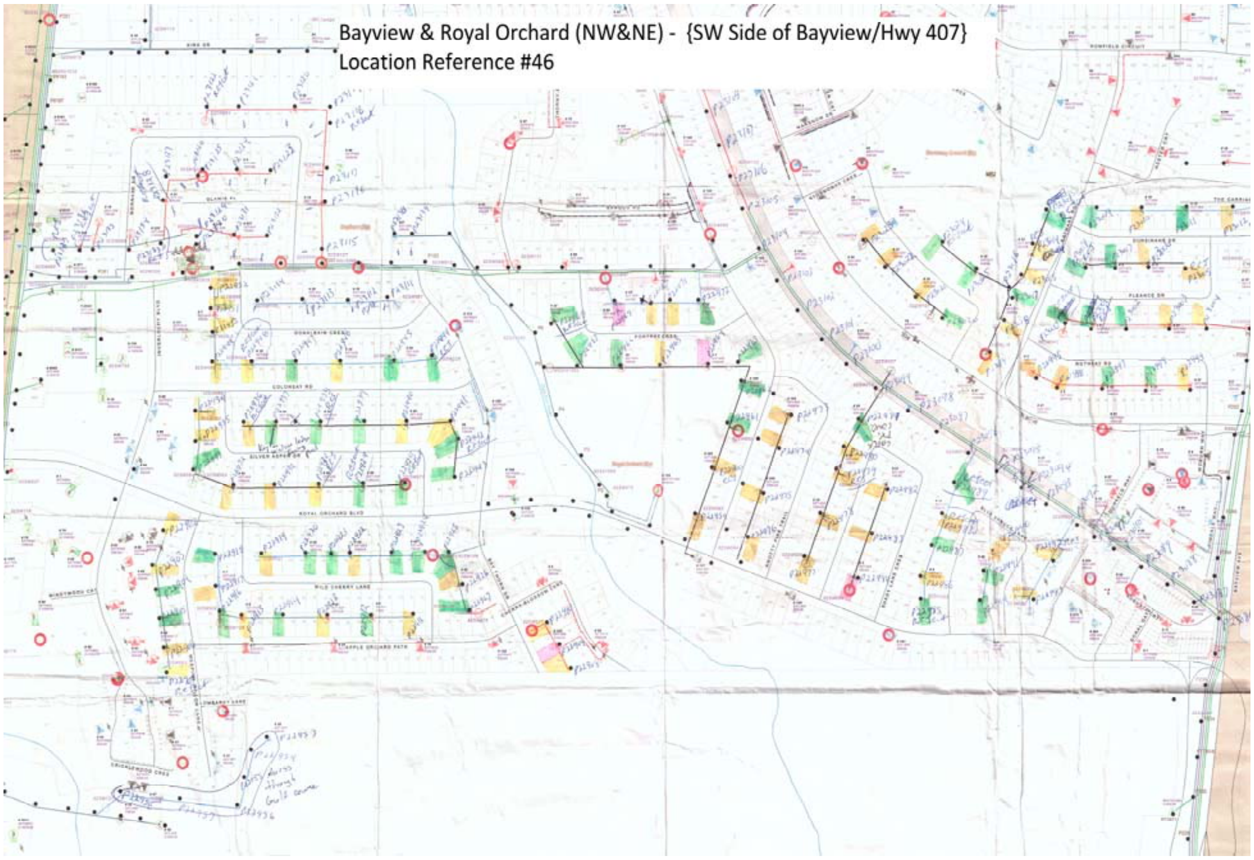

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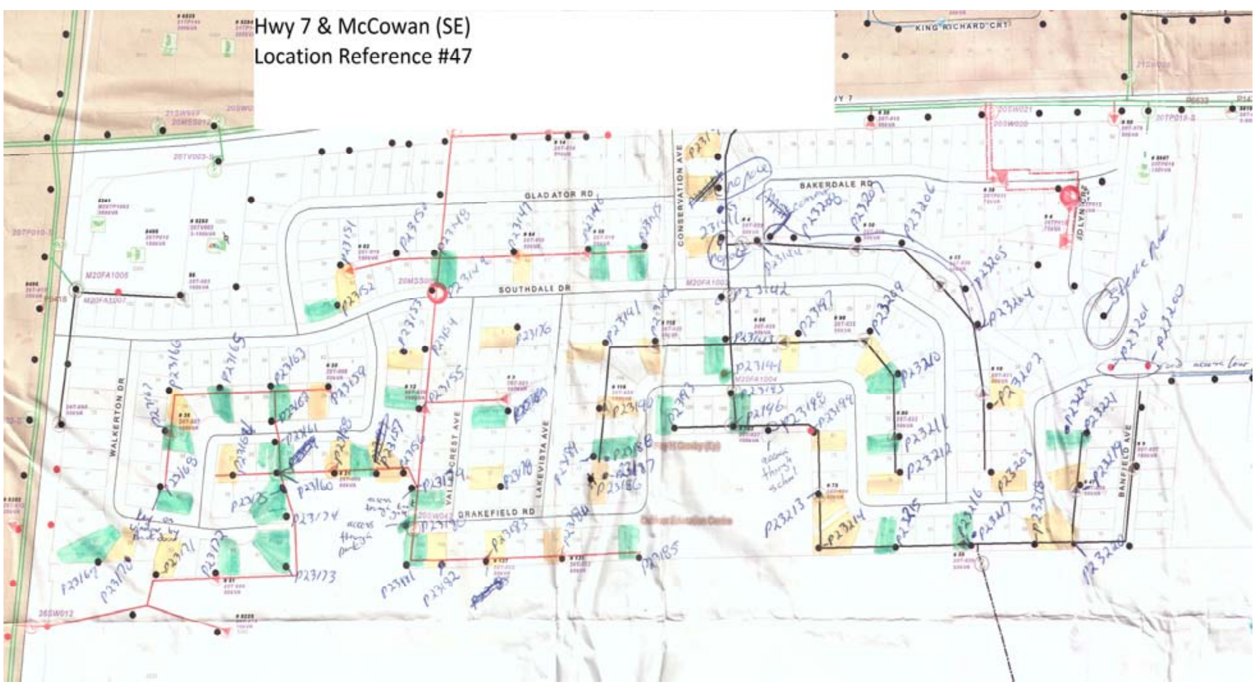

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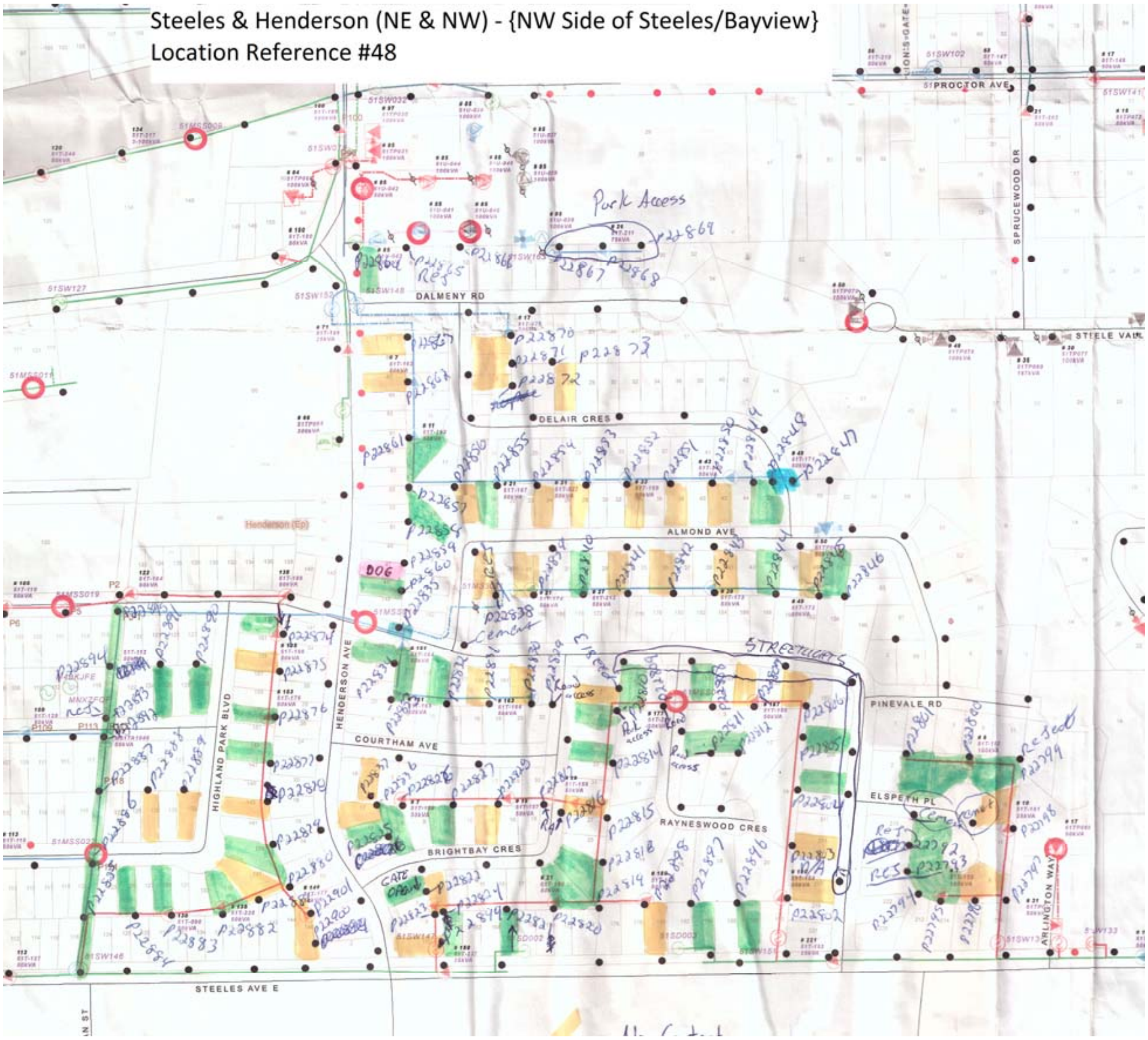

Figure 51. Location Reference #48

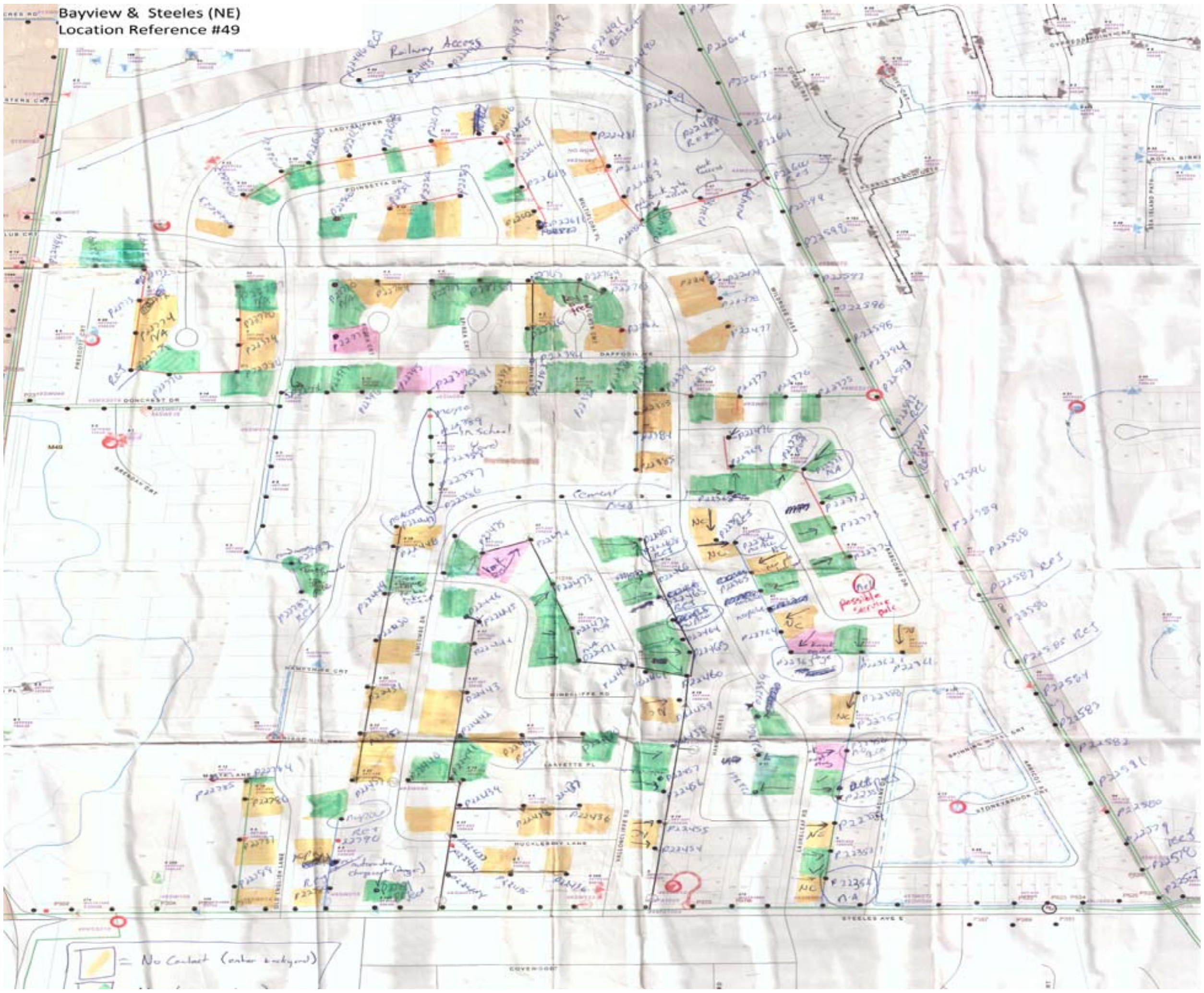

Figure 52. Location Reference #49

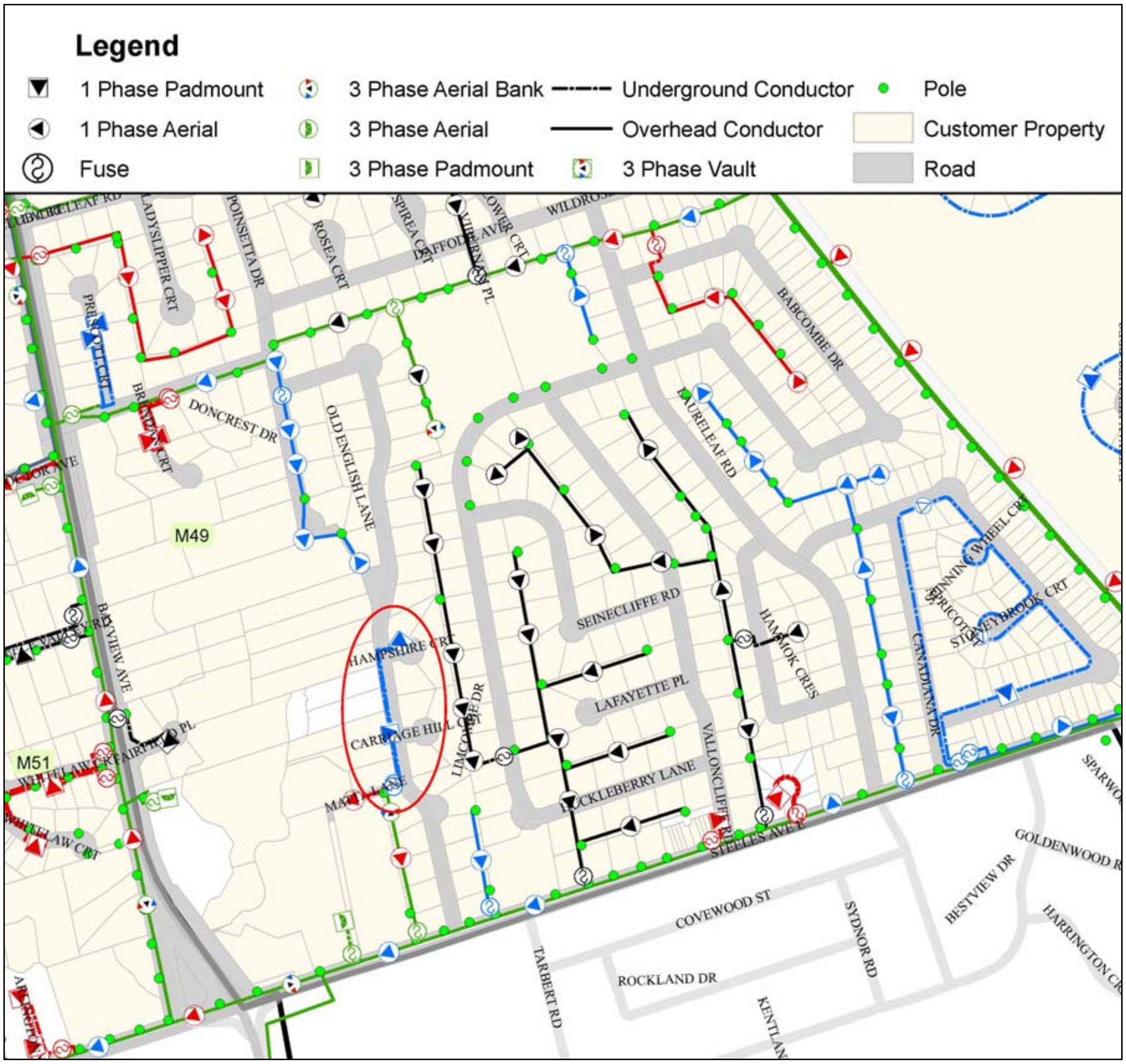

Figure 53. Actual example of future customers being supplied by underground front lot

The area circled in red in the above figure is an area where new customers came to a location generally supplied by rear lot. Rather than also be supplied at the rear, they were supplied through underground front lot.

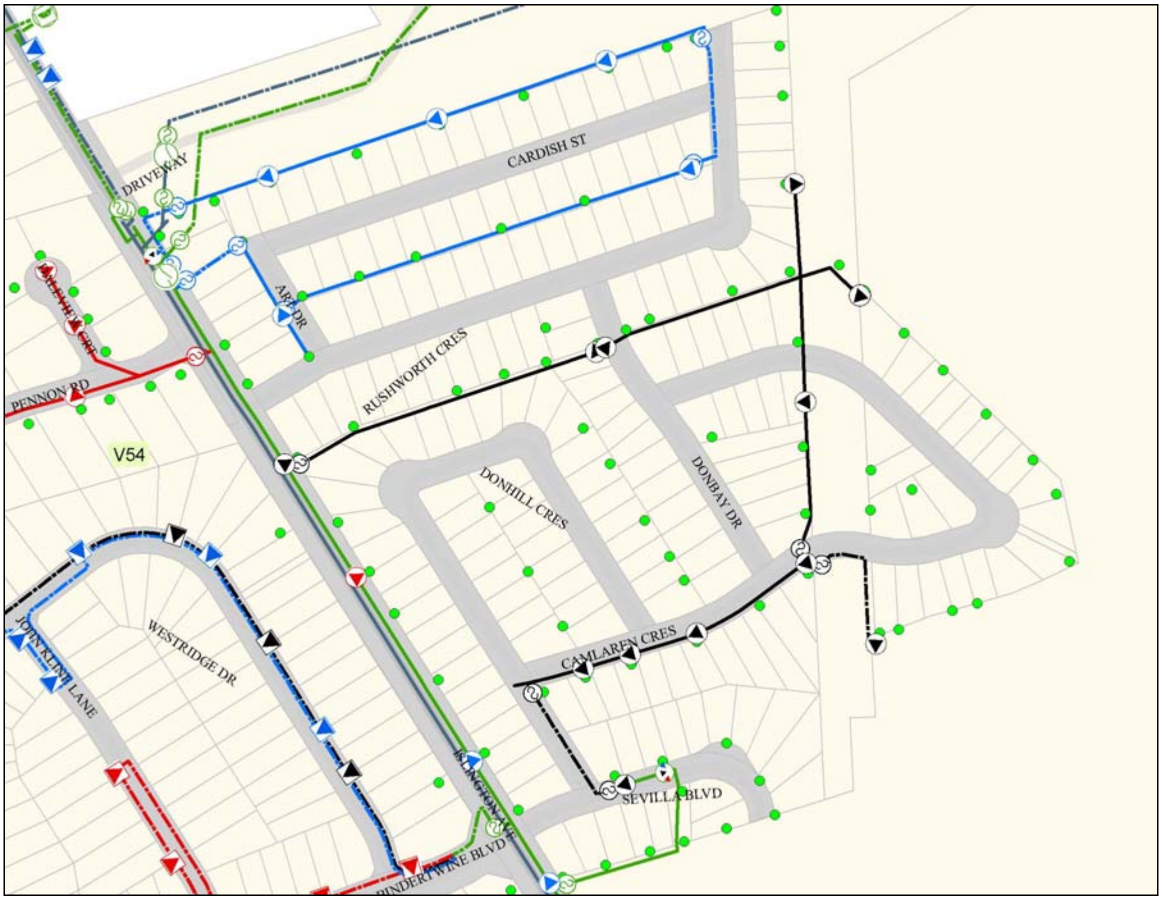

Figure 54. Option 1 example - Kleinburg subdivision