

Reliability Improvement Through System Automation



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Powering forward. Together.



Project Drivers

- Over the past 3 years SMUD has faced declining system reliability performance due to a significant increase in “uncontrollable” outage events such as non-preventable tree outages and car-pole events.

Project Drivers

- After analysis of SMUD's 2016 reliability performance was complete, a trend emerged which showed only a handful of outage events (17) accounted for **40%** of the total SAIFI and **37%** of SAIDI impacts to SMUD's system performance for the entire year.
- These outages (17 out of 2,661), representing **0.64%** of the total events, were single handedly driving the significant decline in reliability performance.

2016 Significant Outages

Outage Date	Circuit	Cause	Customers Affected	SAIFI	SAIDI	% of SAIFI	% of SAIDI
1/14/2016	Foothill FDR 2	Vehicle Accident	12,995	0.02	0.74	1%	1%
1/17/2016	Natomas FDR 1	Vehicle Accident	10,004	0.02	2.11	1%	2%
3/5/2016	Hurley FDR 2	Equipment Failure	15,838	0.03	3.78	2%	4%
3/5/2016	Hurley FDR 3	Non-Preventable Tree	10,847	0.02	1.7	1%	2%
3/8/2016	Orangevale FDR 7	Vehicle Accident	16,114	0.03	1.4	2%	1%
3/10/2016	Hurley FDR 4	Unknown	23,719	0.04	1.76	3%	2%
4/13/2016	Orangevale FDR 7	Vehicle Accident	16,800	0.03	1.93	2%	2%
4/22/2016	Pocket FDRs 5-8	Animal	47,957	0.08	2.9	5%	3%
5/15/2016	Elk Grove FDR 4	Grass Fire	11,508	0.02	1.18	1%	1%
5/17/2016	Elk Grove FDR 7	Vehicle Accident	16,907	0.03	2.88	2%	3%
6/16/2016	Orangevale FDR 1-8	230kV Breaker Failure	78,613	0.13	6.19	8%	7%
8/27/2016	Pocket FDR 7	Vehicle Accident	13,922	0.02	1.16	1%	1%
9/30/2016	Orangevale FDR 3	Non-Preventable Tree	29,448	0.05	3.33	3%	4%
10/9/2016	Hedge FDR 4	Vehicle Accident	11,529	0.02	1.22	1%	1%
12/5/2016	Elk Grove FDR 3	Unknown	21,045	0.03	0.18	2%	0%
12/6/2016	Elk Grove FDR 3	Non-Preventable Tree	21,055	0.03	1.07	2%	1%
12/23/2016	Pocket FDR 4	Unknown	12,911	0.02	1.36	1%	1%
		Total	316,201	0.62	34.89	40%	37%

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What Can We Do?

- Since the nature of many of these outage events make it difficult, if not impossible to foresee where and when they might occur, completely preventing them from occurring would be a costly and potentially impossible task.
- **HOWEVER...** even if we cannot prevent an outage from occurring, we can minimize its impact on our customers and system reliability performance.

System Automation

- Concept –
 - Installing remotely controlled and monitored switches with line sensors on SMUD's 69kV sub-transmission system will allow distribution system operators to immediately narrow down where an outage event has occurred (fault location functionality)
 - Remote operation of automated 69kV line switches will allow DSO to isolate the faulted portion of our system within seconds to minutes (5 minutes has been proven to be more than sufficient time for DSOs to analyze SCADA screens and make switching decisions)

System Automation

- Concept Continued—
 - Once faulted line sections have been successfully isolated, additional remote operation of automated switches allows DSO to restore service to large groups of customers without having to wait for troubleshooters to respond to the event location and perform manual switching. (This has been successfully accomplished routinely in less than 5 minutes by our DSOs)
 - This expedited service restoration already has had a tremendous impact on improving SAIDI.

Whats Next?

- Concept Expanded/Future Possibilities
 - Once SMUD deploys a fully functional Distribution Management System (DMS), the automated switching procedures currently executed “manually” could be allowed to automatically occur, allowing the system to identify a fault, isolate the affected sections of the system, and reconfigure the system through switching actions to almost immediately restore power to large groups of our customers.
 - If these switching actions all occur in under the “momentary outage” time frame, a significant improvement in BOTH SAIDI & SAIFI will be achieved.

Example

- Exactly how effective can this approach be to improving system reliability?
- Example..

Existing System Configuration

Pocket Feeder 7

18,624 Customers Served

Gloria - Florin
20MVA



6606
N.O.

Meadowview -
Freeport 1
20MVA



7678

6293



6562

7057

Meadowview -
Freeport 2
20MVA

6292

7661



24th - Gardendale
20MVA



6517

6172

6645

6279

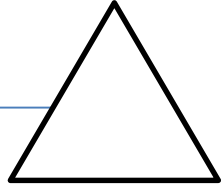


6078
N.O.



Line 7
Breaker
6922

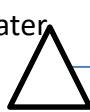
Pocket
224MVA



Freeport Water
Authority 1
16MVA



Freeport Water
Authority 2
16MVA



7693



7667



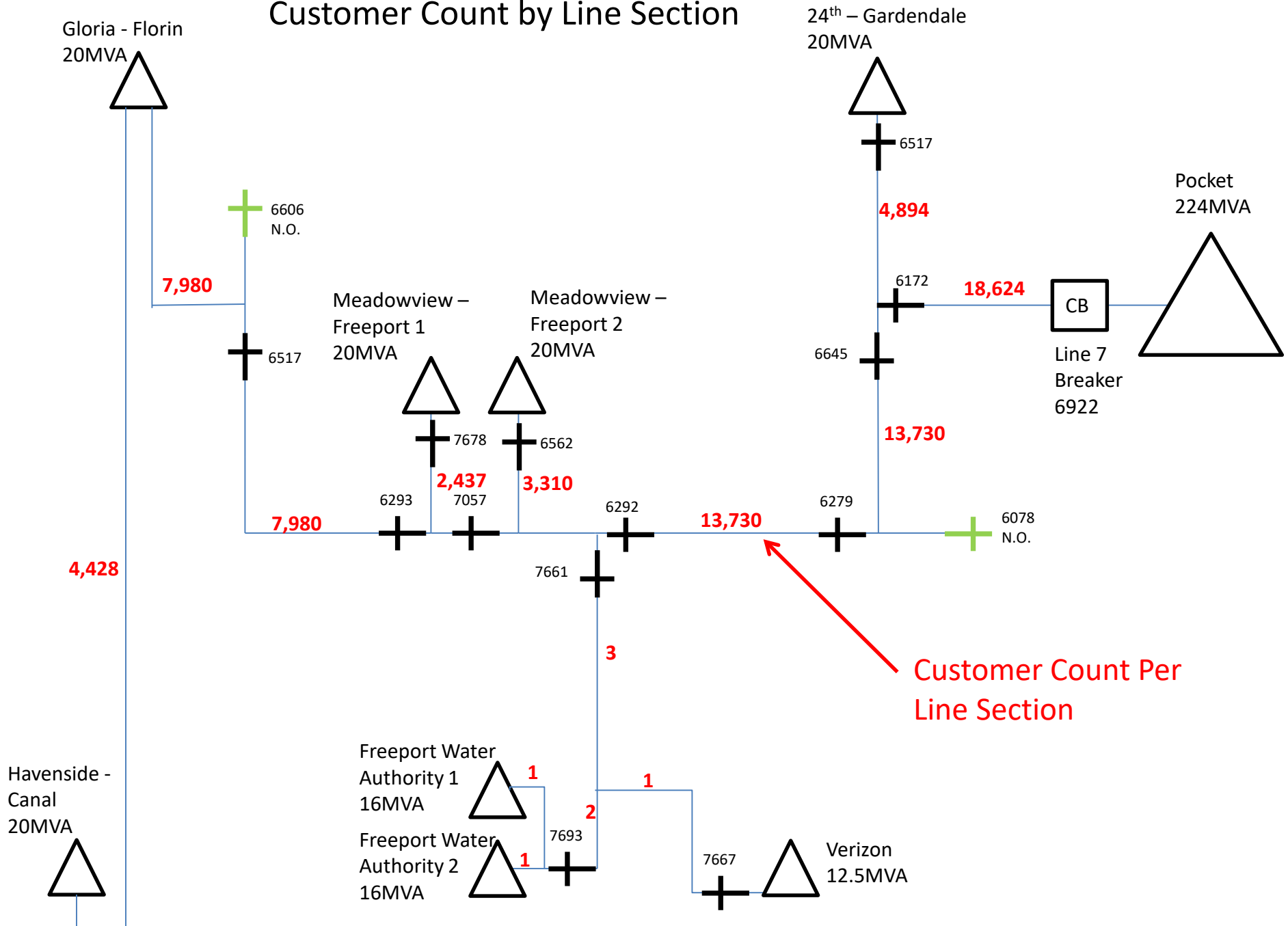
Verizon
12.5MVA



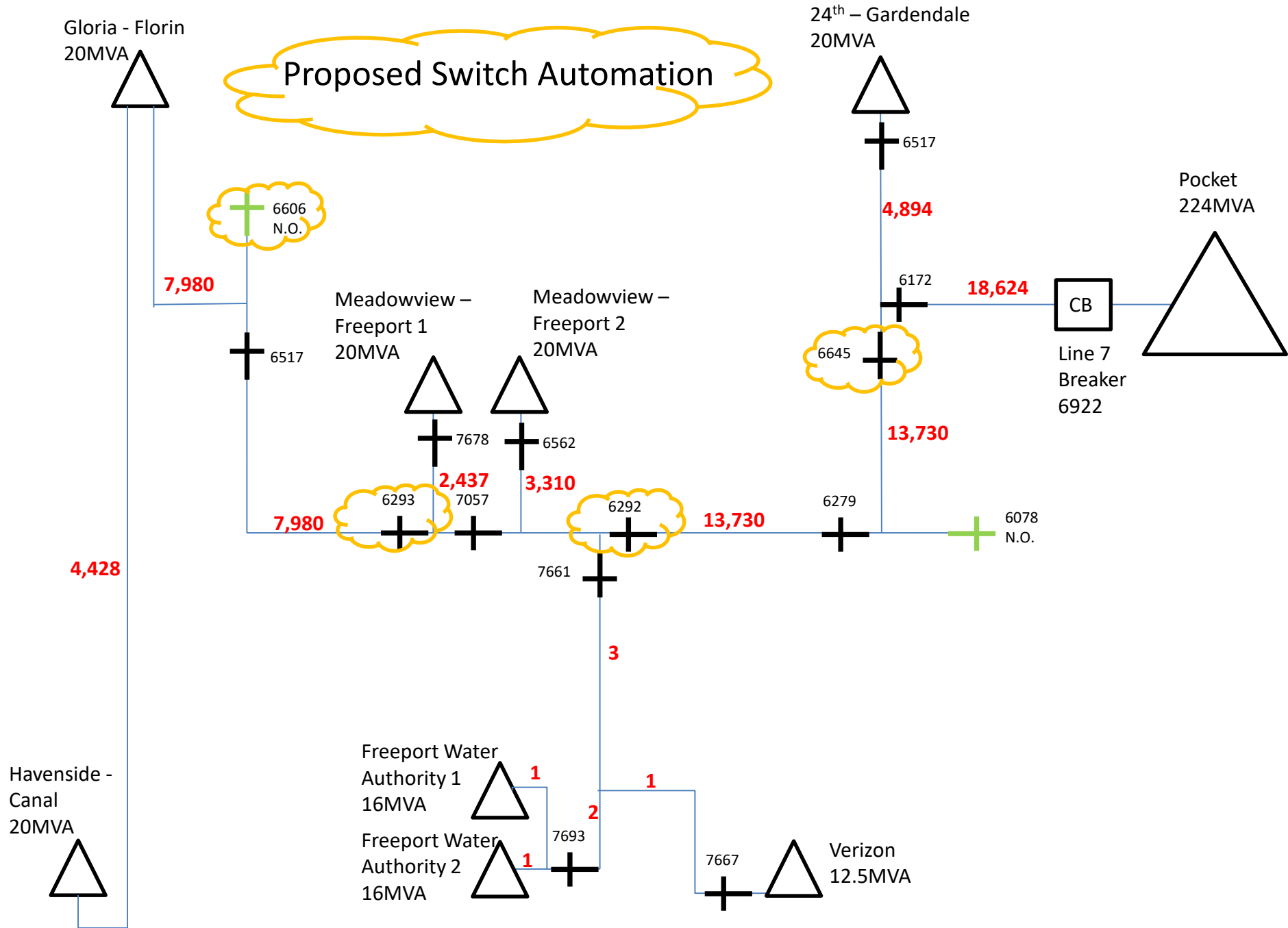
Havenside -
Canal
20MVA



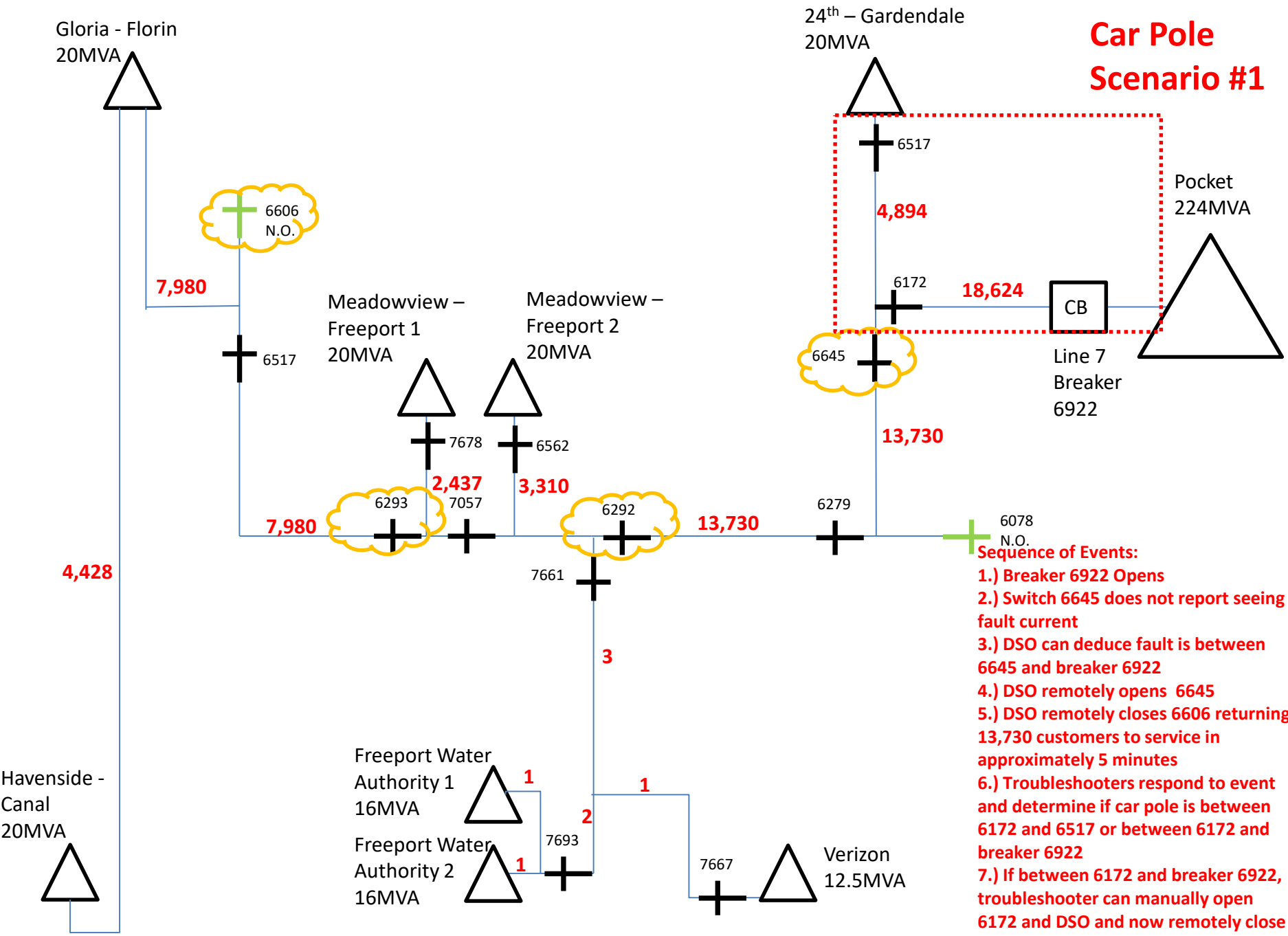
Customer Count by Line Section



Proposed Switch Automation

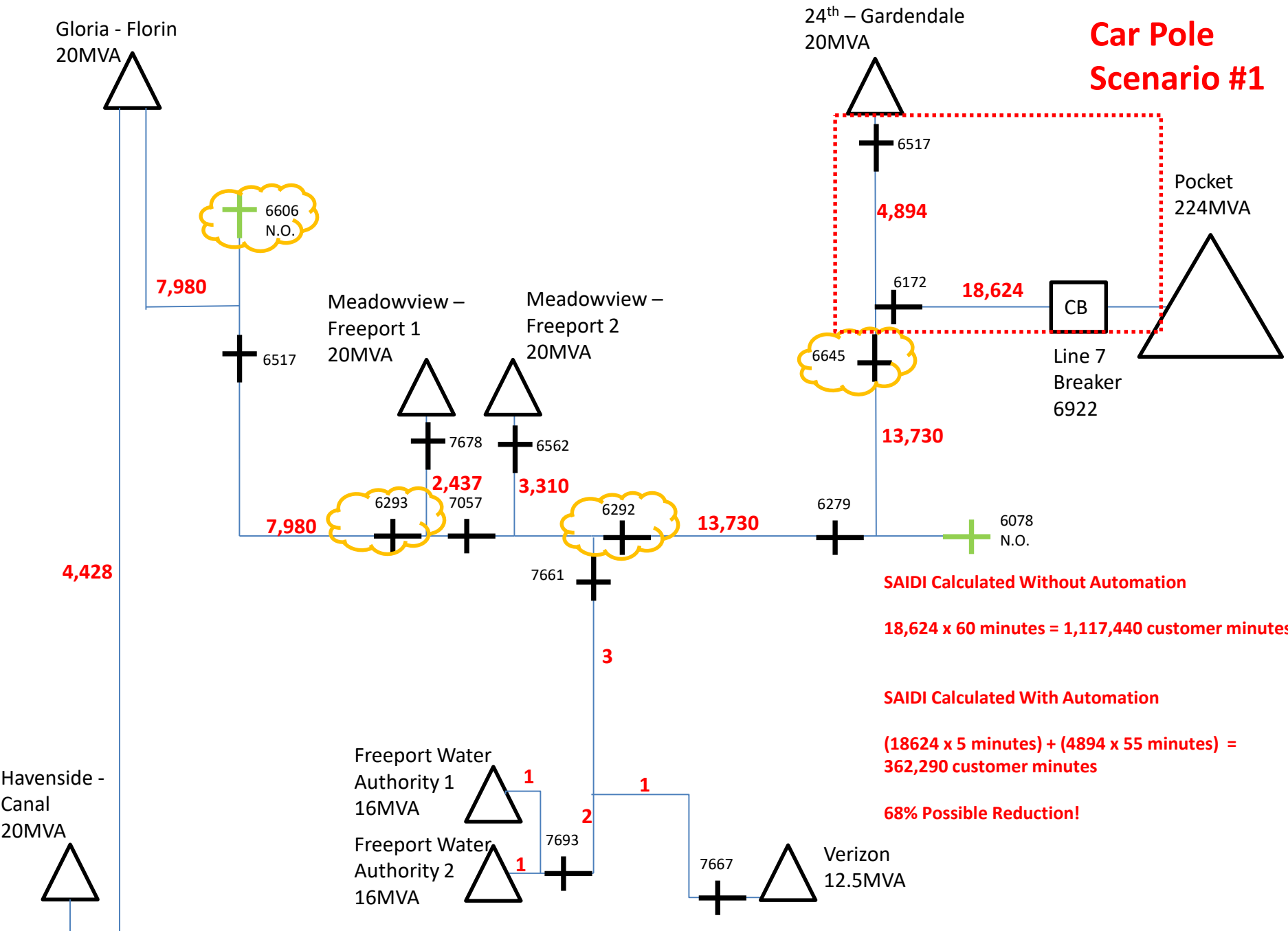


Car Pole Scenario #1



- Sequence of Events:**
- 1.) Breaker 6922 Opens
 - 2.) Switch 6645 does not report seeing fault current
 - 3.) DSO can deduce fault is between 6645 and breaker 6922
 - 4.) DSO remotely opens 6645
 - 5.) DSO remotely closes 6606 returning 13,730 customers to service in approximately 5 minutes
 - 6.) Troubleshooters respond to event and determine if car pole is between 6172 and 6517 or between 6172 and breaker 6922
 - 7.) If between 6172 and breaker 6922, troubleshooter can manually open 6172 and DSO and now remotely close 6645 returning all customers to service.

Car Pole Scenario #1



SAIDI Calculated Without Automation

18,624 x 60 minutes = 1,117,440 customer minutes

SAIDI Calculated With Automation

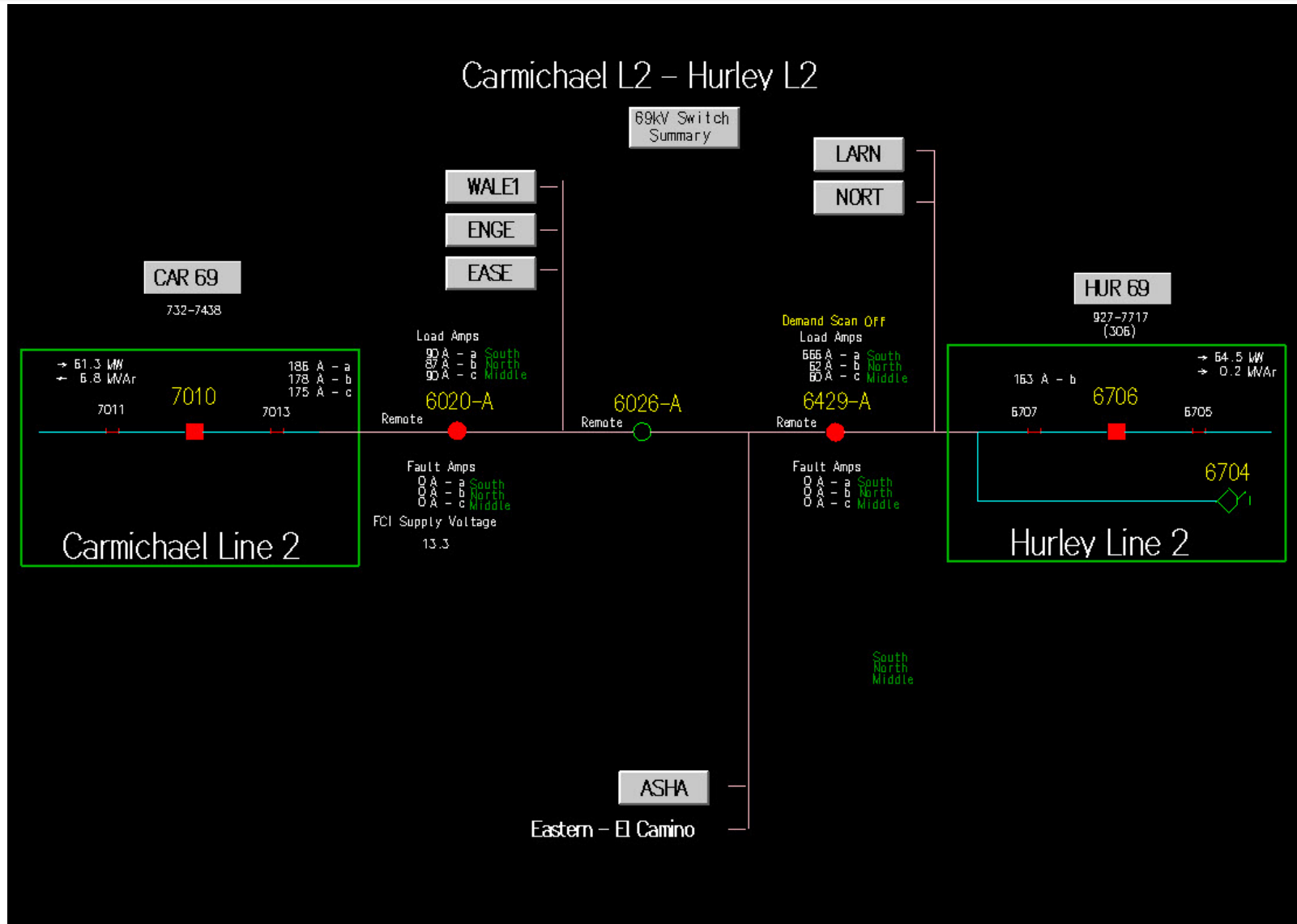
(18624 x 5 minutes) + (4894 x 55 minutes) = 362,290 customer minutes

68% Possible Reduction!

Additional Benefits

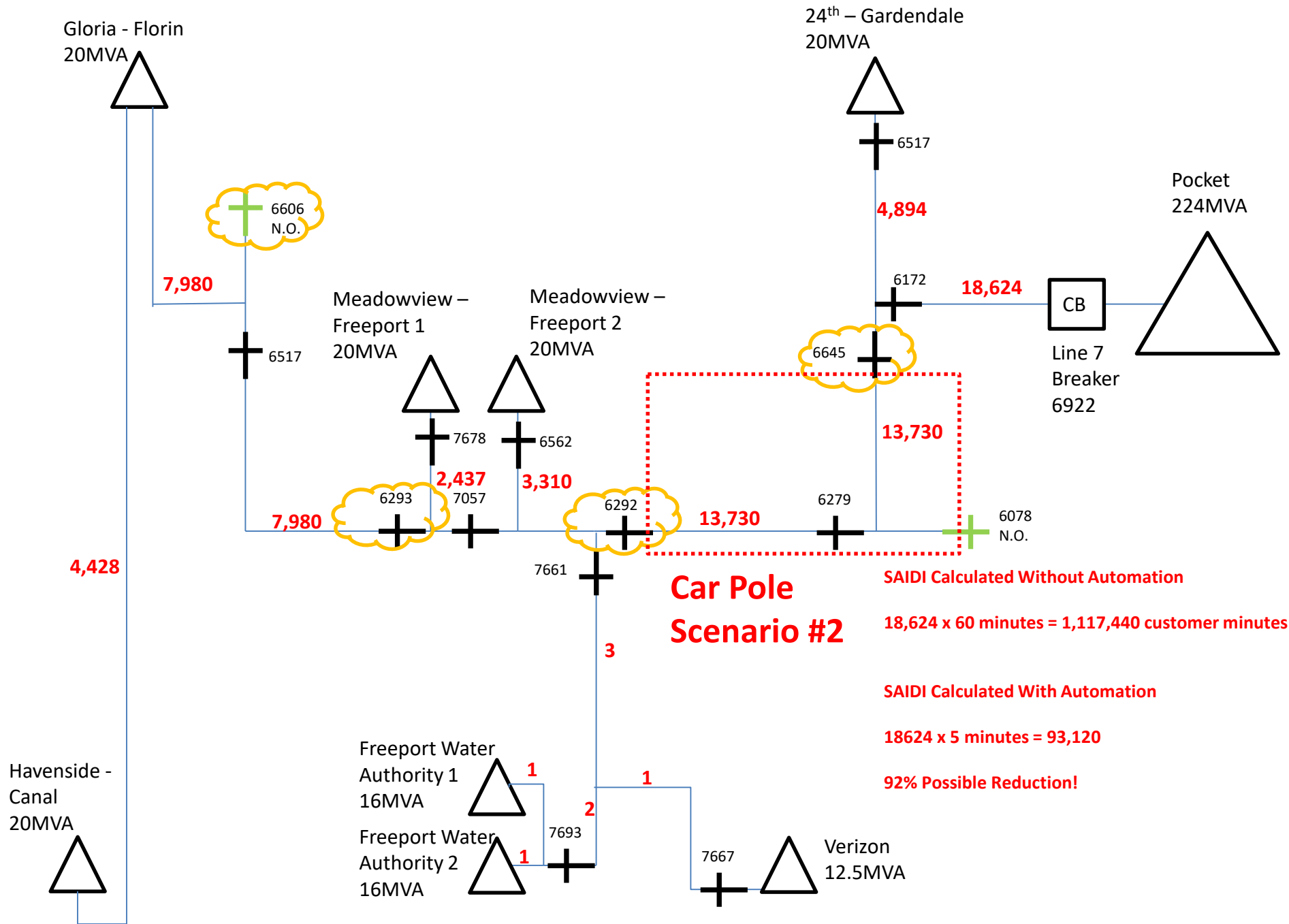
- Switch automation eliminates requirement for field personnel to manually open/close devices to isolate fault/break circuit parallels, etc.
- Visibility of fault location allows for faster troubleshooter response time to pinpoint fault location, identify issue, and make scene safe for public (car-pole, wire down, etc)

Questions?



Questions?





Gloria - Florin
20MVA

24th - Gardendale
20MVA

6606
N.O.

7,980

Meadowview -
Freeport 1
20MVA

Meadowview -
Freeport 2
20MVA

Pocket
224MVA

6517

6517

4,894

6172

18,624

CB

Line 7
Breaker
6922

6645

13,730

7678

6562

7,980

6293

2,437
7057

3,310

6292

13,730

6279

6078
N.O.

4,428

7661

3

**Car Pole
Scenario #2**

SAIDI Calculated Without Automation

18,624 x 60 minutes = 1,117,440 customer minutes

SAIDI Calculated With Automation

1,862 x 5 minutes = 93,120

92% Possible Reduction!

Freeport Water
Authority 1
16MVA

1

Freeport Water
Authority 2
16MVA

1

2

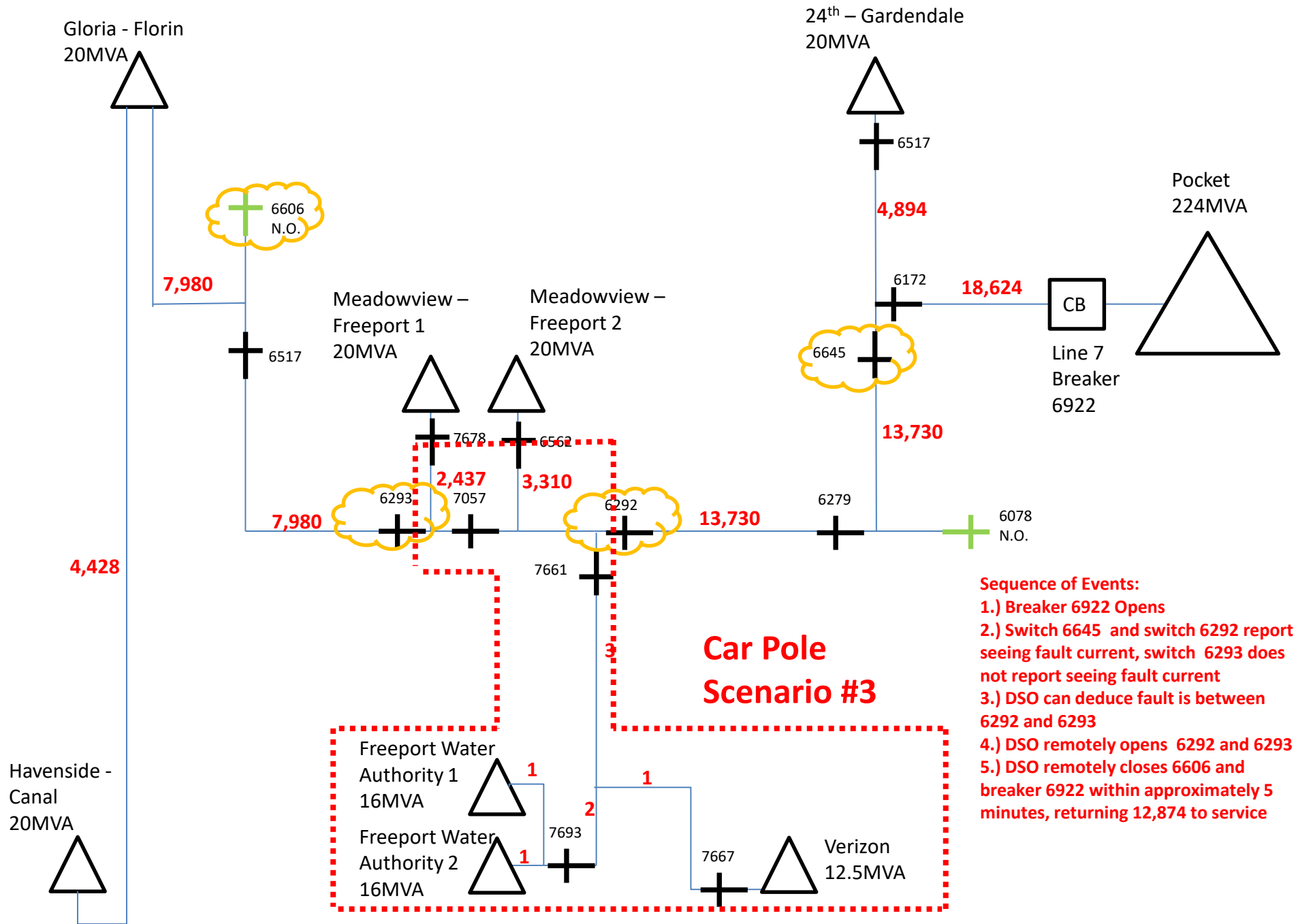
1

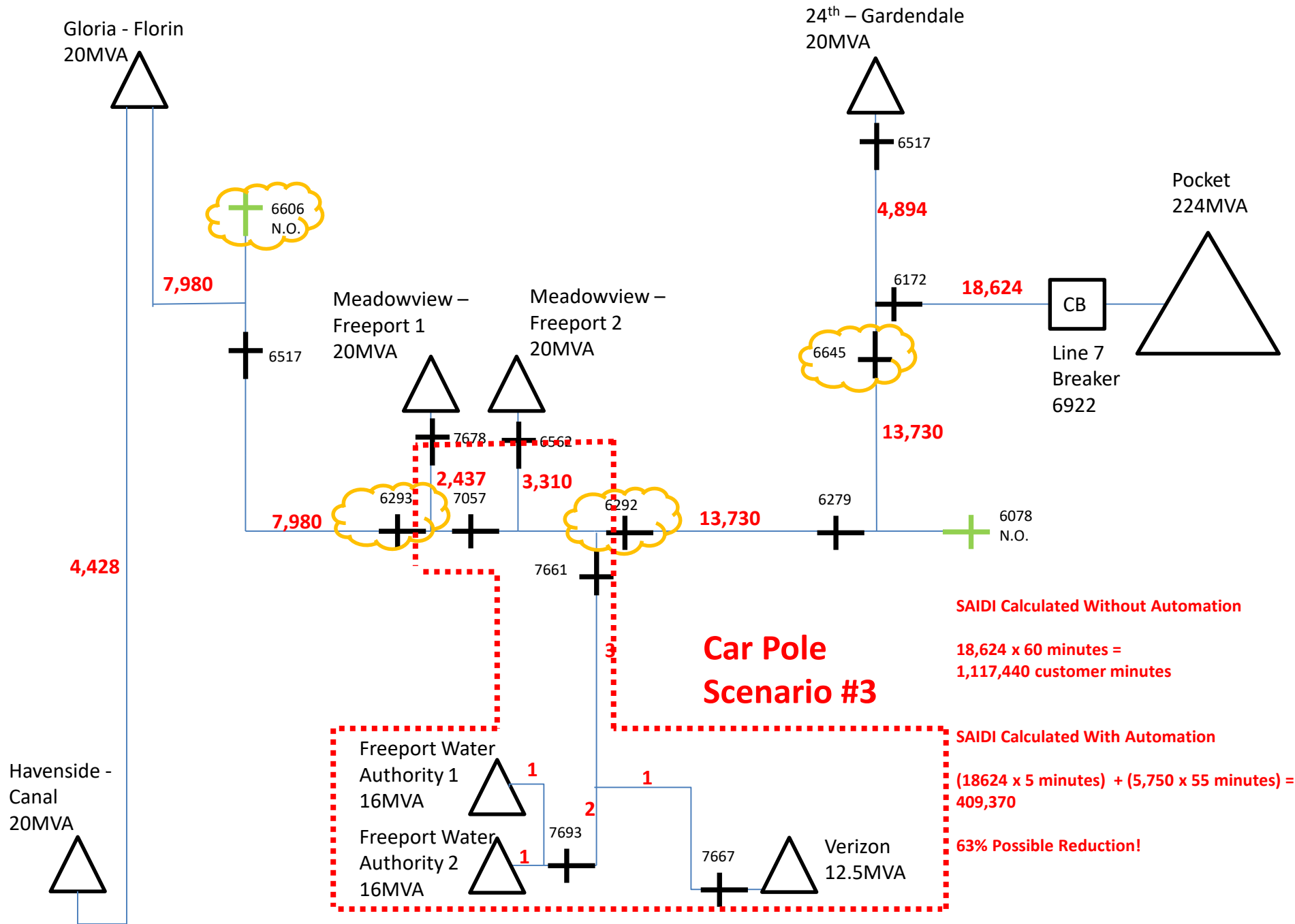
7693

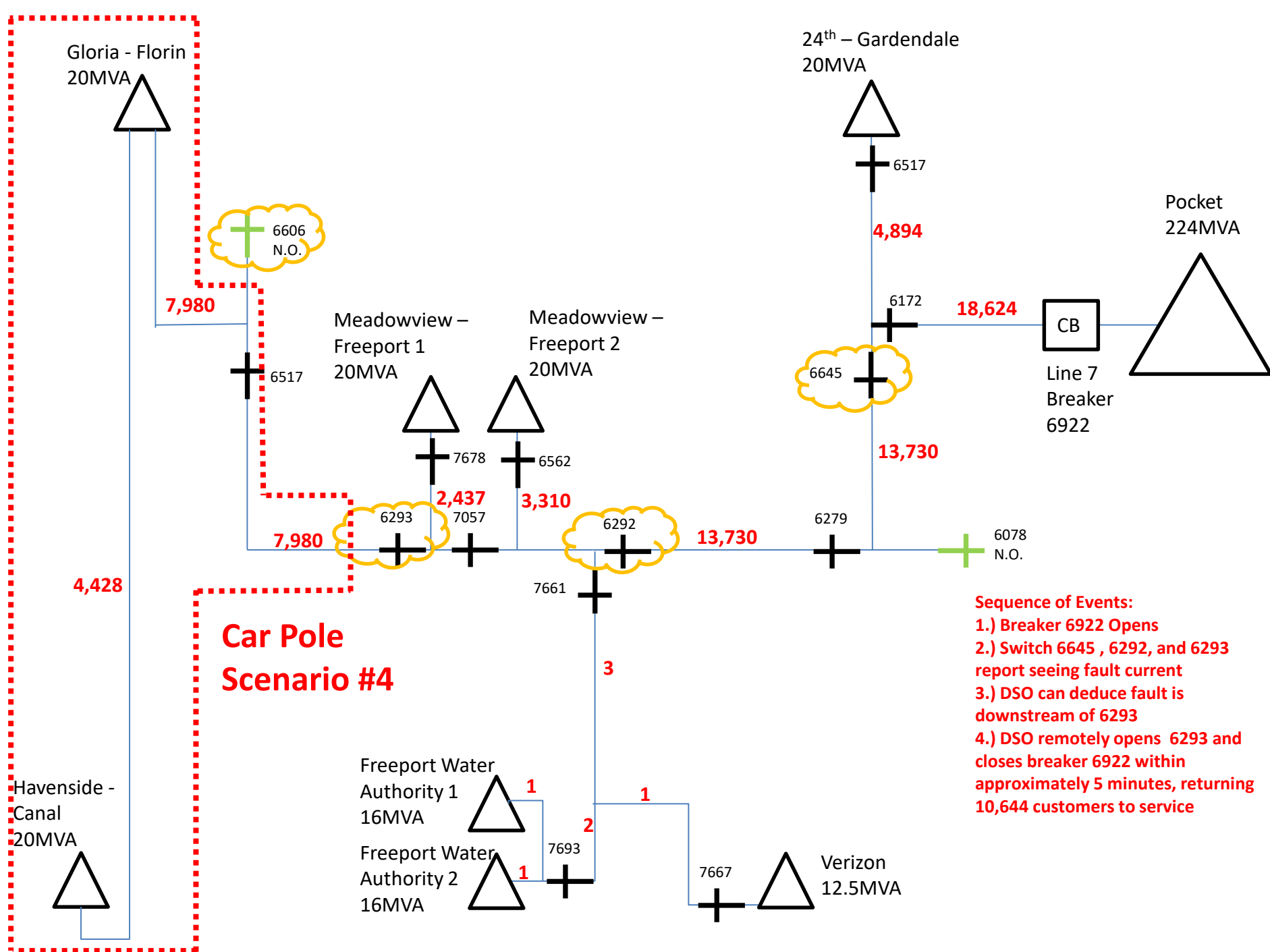
7667

Verizon
12.5MVA

Havenside -
Canal
20MVA

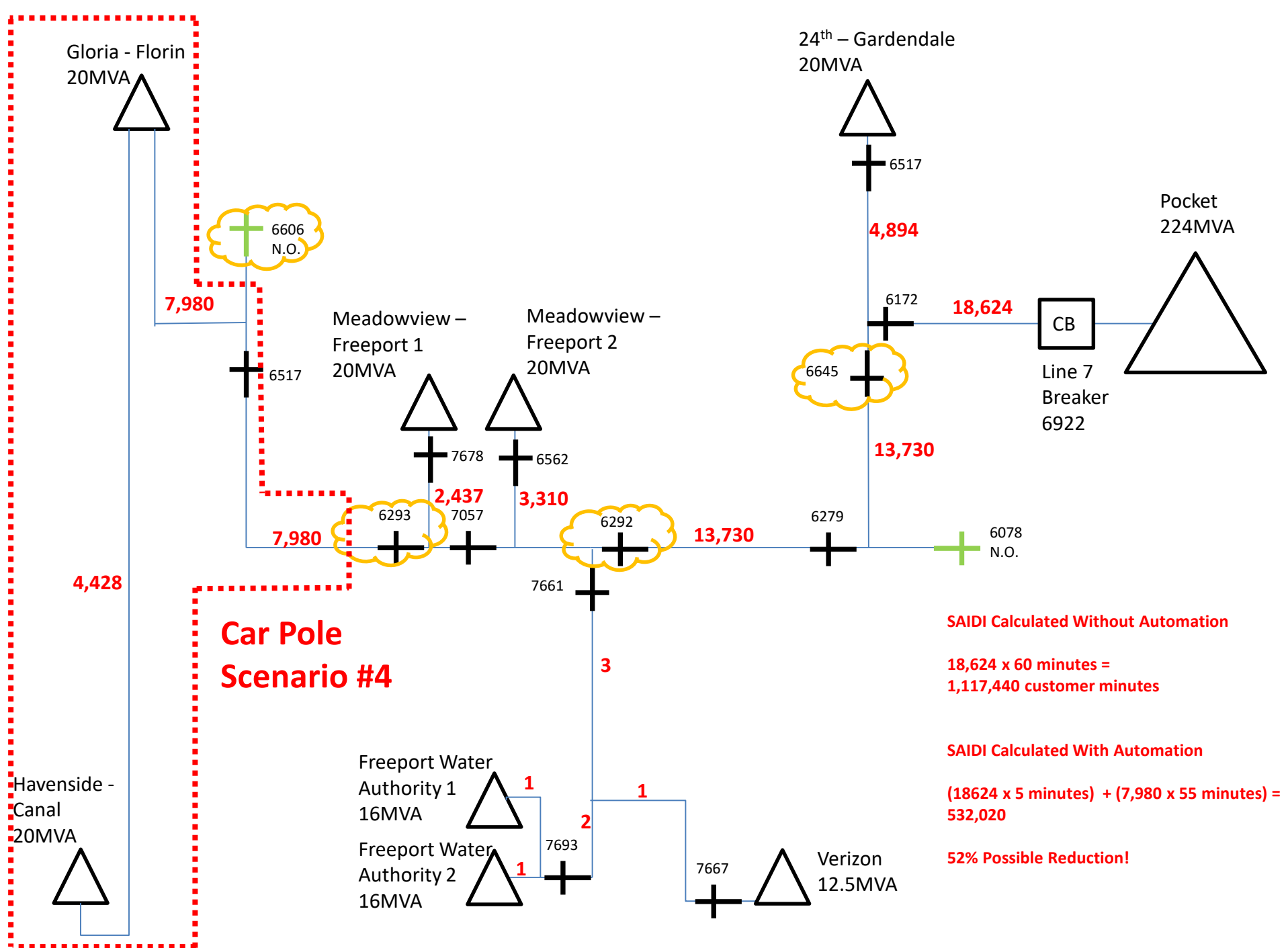






Car Pole Scenario #4

- Sequence of Events:**
- 1.) Breaker 6922 Opens
 - 2.) Switch 6645 , 6292, and 6293 report seeing fault current
 - 3.) DSO can deduce fault is downstream of 6293
 - 4.) DSO remotely opens 6293 and closes breaker 6922 within approximately 5 minutes, returning 10,644 customers to service



Car Pole Scenario #4

SAIDI Calculated Without Automation

18,624 x 60 minutes =
1,117,440 customer minutes

SAIDI Calculated With Automation

(18624 x 5 minutes) + (7,980 x 55 minutes) =
532,020

52% Possible Reduction!