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CITY OF GARLAND

Utilization of Tier 4 Generators for Water and Wastewater Facilities | A Case Study

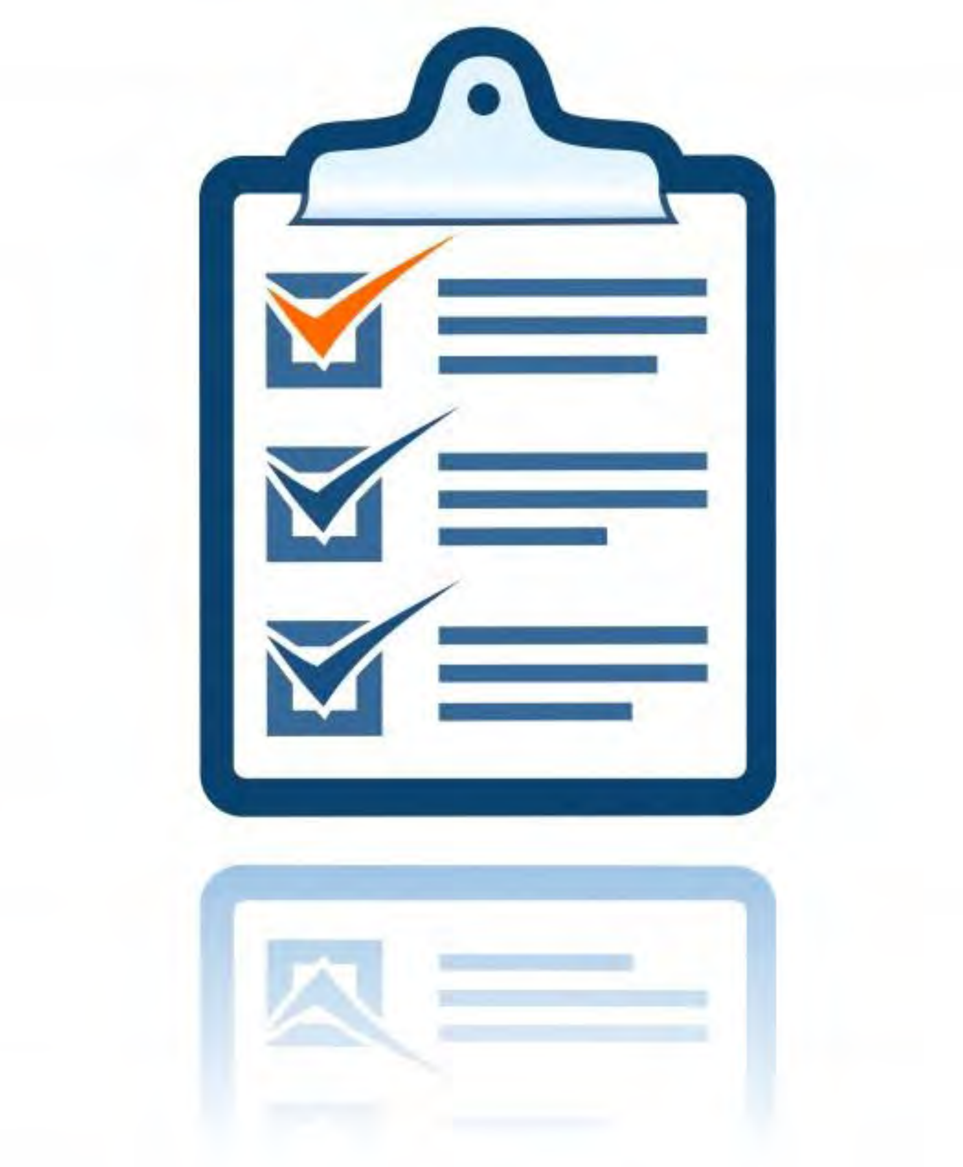
January 28, 2022

GAI Gupta & Associates, Inc

CONSULTING ENGINEERING

Agenda

- Introduction
- EPA Ratings & Technology
- DCWWTP Design Approach
- DCWWTP Design Details
- DCWWTP Tier 4 Design
- Current Construction Phase
- Tier 4 Design Considerations
- Q&A



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Duck Creek Wastewater Treatment Plant

Duck Creek Wastewater Treatment Plant

The Duck Creek Treatment Plant was constructed in 1962 as a physical/chemical treatment Plant. In 1986 the plant was converted to a biological treatment process that treated 30 million gallons per day (MGD). In 2006, it was expanded to a 40 MGD plant.

Duck Creek WWTP is located in Kaufman County next to Sunnyvale Texas

- Permitted by TCEQ for 40 Million Gallons Day (MGD), with a 2hr peak flow of 72 MGD
- Treats West side of Garland, Sunnyvale, Parts of Dallas, Richardson
- Transfers all solids to Rowlett Creek
- Water Reuse permit for flow transfer to Nextera Energy (Forney)

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Duck Creek Wastewater Treatment Plant

Award Winning Plant - Peak Performance Awards from the National Association of Clean Water Agencies (NACWA).

- Gold Peak Performance Awards - 2014, 2015, 2016, 2017
- Platinum Peak Performance Awards – 2018, 2019
- Silver Peak Performance Award - 2020

Other Awards:

- 2018 WEAT Plant of the Year (Category 3)
- 2018 WEF George W Burke Jr. Award
- 2019 TWUA R.B. “Bob” Batchelor Memorial Safety Award
- 2020 WEAT Plant of the Year (Category 3)
- 2021 WEAT Plant of the Year (Category 3)
- 2021 WEF Safety Award

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Typical Generator Design Criteria

- Full load < 80% of generator nameplate rating
- <15% voltage dip
- <5% frequency dip
- Subbase diesel fuel tank
- Sound attenuated enclosure

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EPA Ratings

Tier	Description
Tier 1	Rolled out in 1990, this gave substantial increase in authority and responsibility to the federal government to authorize the issuance of operating permits to stationary sources. It provided the first set of emission standards covering all new non-road mobile diesel engines, regardless of horsepower categories, except those engines used in locomotives and marine vessels.
Tier 2	The phase was adopted in 1998, tightening pollution regulations. It addressed NOx, carbon monoxide, unburned hydrocarbons, and particulate matter emitted. It covered all engine sizes from 2001 to 2005.
Tier 3	Implemented between 2006 and 2008, restricting exhaust emissions for engines with 50 to 75 HP.
Tier 4	Signed on May 11, 2004 with guidelines to phase it in over the period from 2008 to 2015. The new standards require a 90 percent reduction of PM and NOx emissions. The emission reductions are to be achieved using new control technologies like the 2007 to 2010 requirements for highway engines.

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Tier 2 Diesel Generators

- Generator classified as standby emergency only is considered Tier 2.
- Must not run unless the primary source of power is unavailable.
- Can run up to 100 hours annually for testing and maintenance.
- oCannot be utilized for participation of incentive programs.
- Most generator installations are Tier 2 diesel generators

Tier 4 Diesel Generators

- May be utilized for both emergency and non-emergency applications
- Can operate for an unlimited amount of time and be utilized for incentive programs (Note: dependent on Tier 4 classification).
- Designed to limit particulate matter (PM) and nitrogen oxides (NOx)
- o25-40% more expensive than Tier 2 generators
- Requires additional maintenance and design considerations

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Natural Gas Generators

- Meet Tier 4 EPA requirements and can participate in incentive programs
- Natural gas is main fuel source which is cleaner and cheaper than diesel
- Not as robust as diesel generators and may pose a challenge for large loads acceptance
- oLarge footprint and can cost as much as Tier 4 diesel generator
- Requires large gas infrastructure and additional design considerations

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Gas Reciprocating Engines & Turbines

- Option if plant has available natural gas or biosolid gas for use.
- Can accept alternate fuel source (diesel & natural gas).
- Large footprint and requires environmental study during design.
- oStartup process can take up to 10 minutes
- Not recommended for small or medium-sized plants

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Incentive Programs

Export To Grid

Market Participation

4CP

Coincidental Peak

LR

Load Resource

ERS

Emergency Response Service

Duck Creek Wastewater Treatment Plant Standby Generator Project

Owner

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Prime Consultant

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Sub Consultant

JQ Infrastructure

DCWWTP Generator Design Approach

Determine Goal: Provide Backup Power to Entire Plant

Evaluate Existing Conditions

Determine Flow/ Treatment Requirements
- Critical Loads
- Partial Plant Backup

Determine Electrical Power Requirements

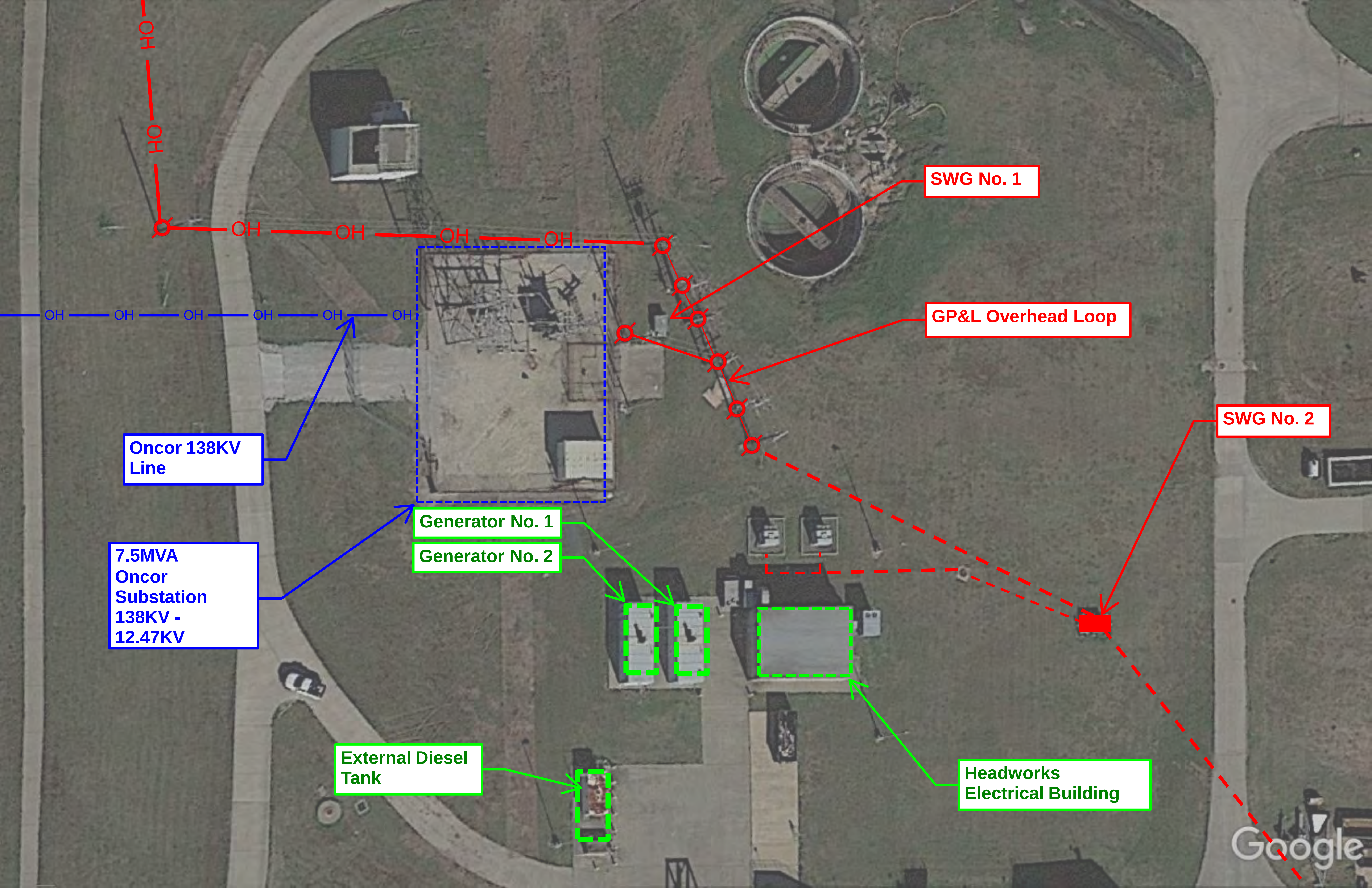
Evaluate Backup Options and Locations
- Utilize Existing Generators
- Distributed Approach
- Backup Plant Loop

Evaluate and Identify Generator Sizes and Rating

Evaluate Generator Technology
- External Vs. Sub-base fuel tank
- Tier 2 Vs. Tier 4

Cost Benefit Analysis
- Cost Analysis
- Advantage and Disadvantage

Service: Oncor Electric Delivery
Plant Distribution: Overhead Loop
Distribution Voltage: 12.47 kV
Backup Capabilities: 2-1750 kW, 480 V Generators
Plant Voltage: 480V
Operations Building
GP&L Overhead Loop
7.5MVA Oncor Substation 138KV - 12.47KV
Oncor 138KV Line
SWG No. 2
Headworks Electrical Building & Generators
Headworks
EQ Basin
OH
Google



SWG No. 1
GP&L Overhead Loop
SWG No. 2
Oncor 138KV Line
7.5MVA Oncor Substation 138KV - 12.47KV
Generator No. 1
Generator No. 2
External Diesel Tank
Headworks Electrical Building
OH

Points of Responsibility

Oncor Electric Delivery → **Garland Power and Light** → **Duck Creek WWTP**

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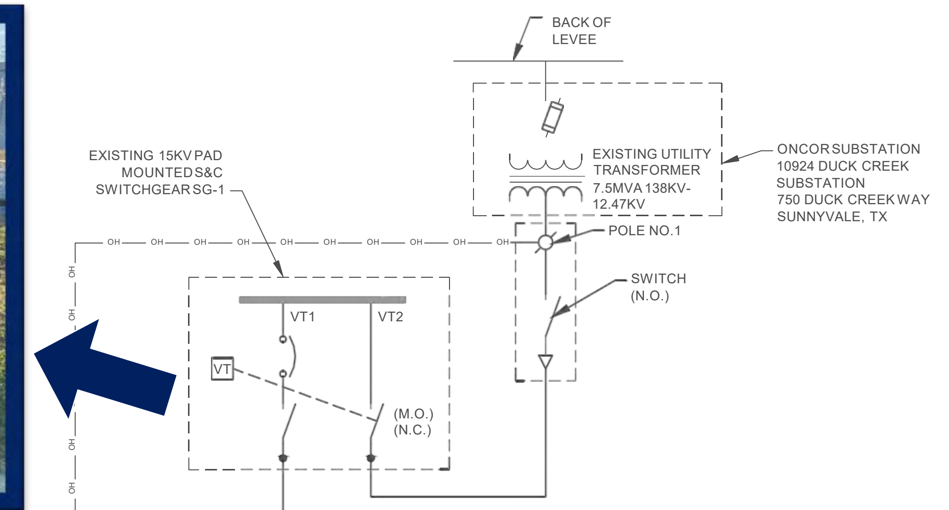
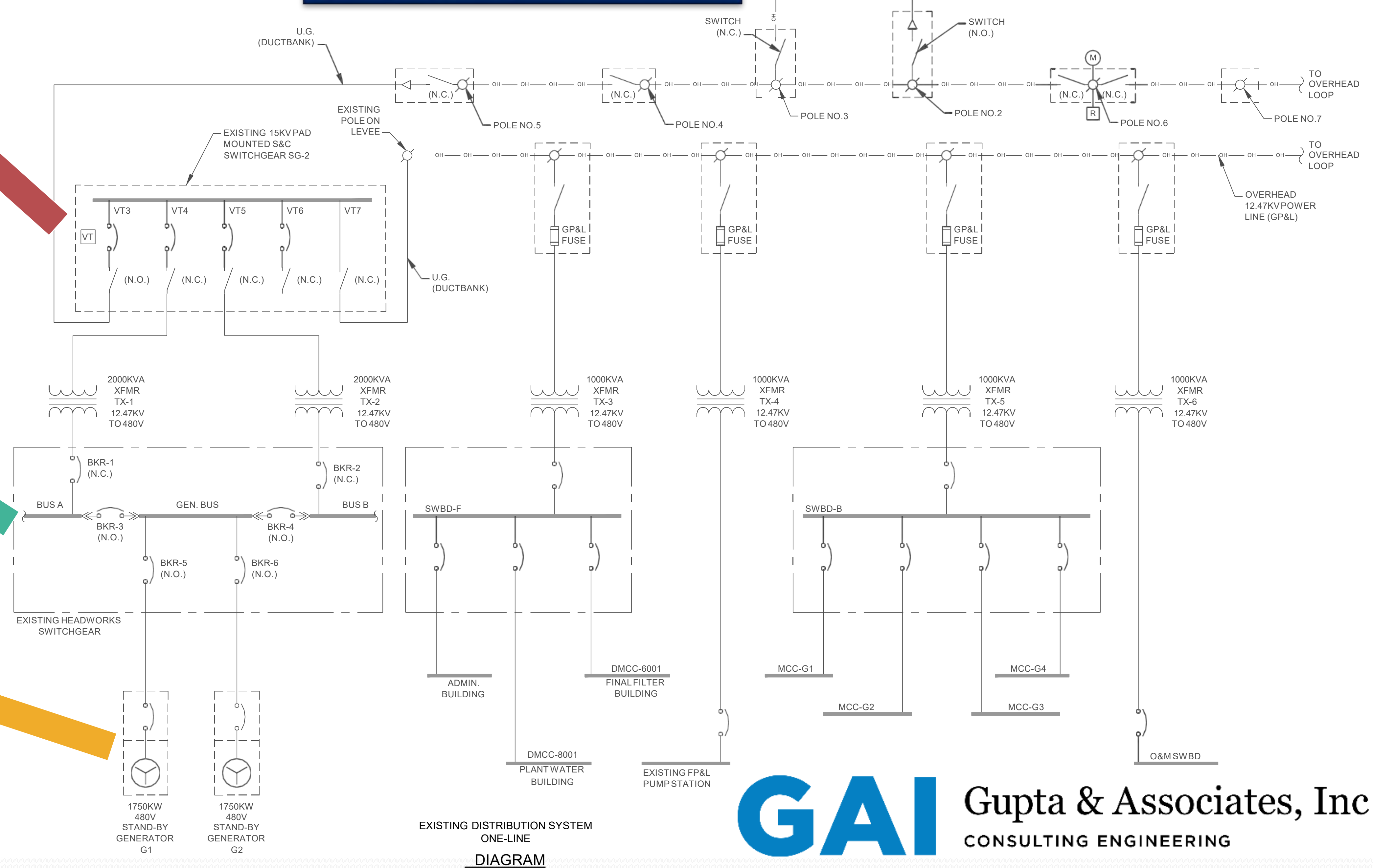
Existing Distribution





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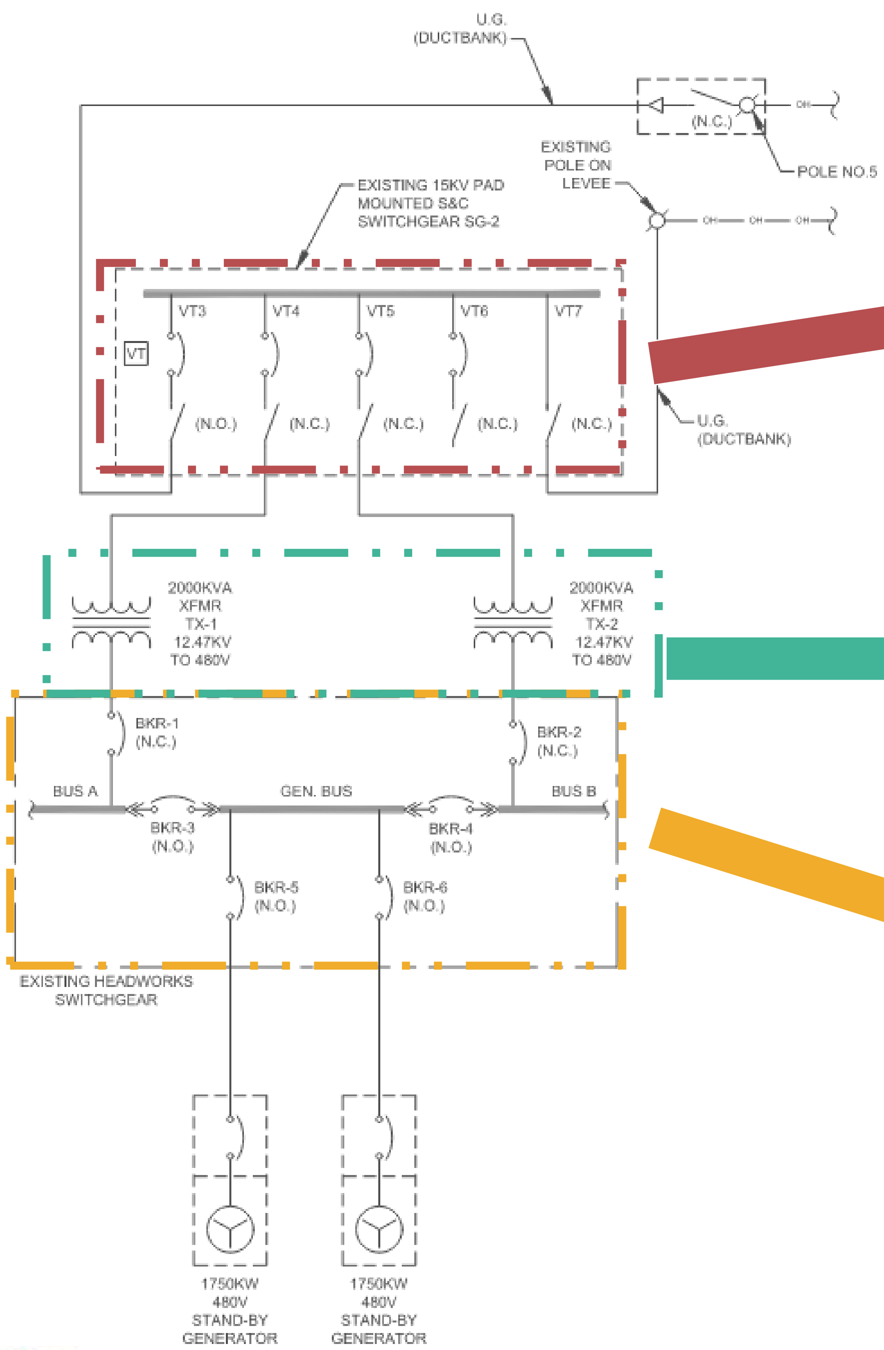
Minimum Loads Required

- As required per TCEQ 217
- Minimum required to keep permit
- Peak flows diverted to EQ Basin
- Miscellaneous & future loads

Process	Total kW
Raw Water & Headworks	744
Activated Sludge System	310
Chlorine Disinfection System	120
Final Lift Pumps	217
Odor Control System	274
Future UV & Miscellaneous	275
Plant Total	**1,940**

Backup Option 1 - Utilize Existing Generators



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Backup Option 1 - Utilize Existing Generators

- Advantages
  - Utilize infrastructure already in place
- Disadvantages
  - Extensive controls required
  - GP&L transformers undersized for full generator capacity
  - Not recommended to utilize step-down transformers for step-up applications

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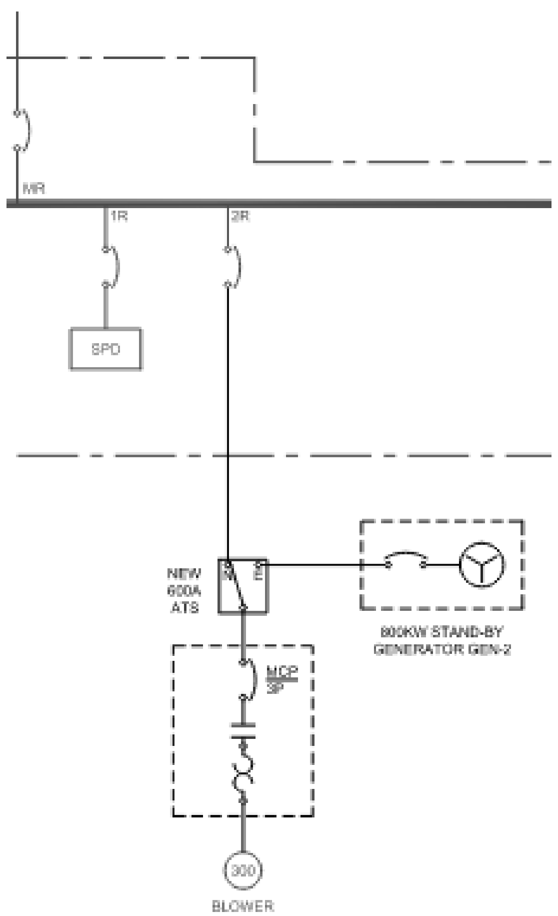
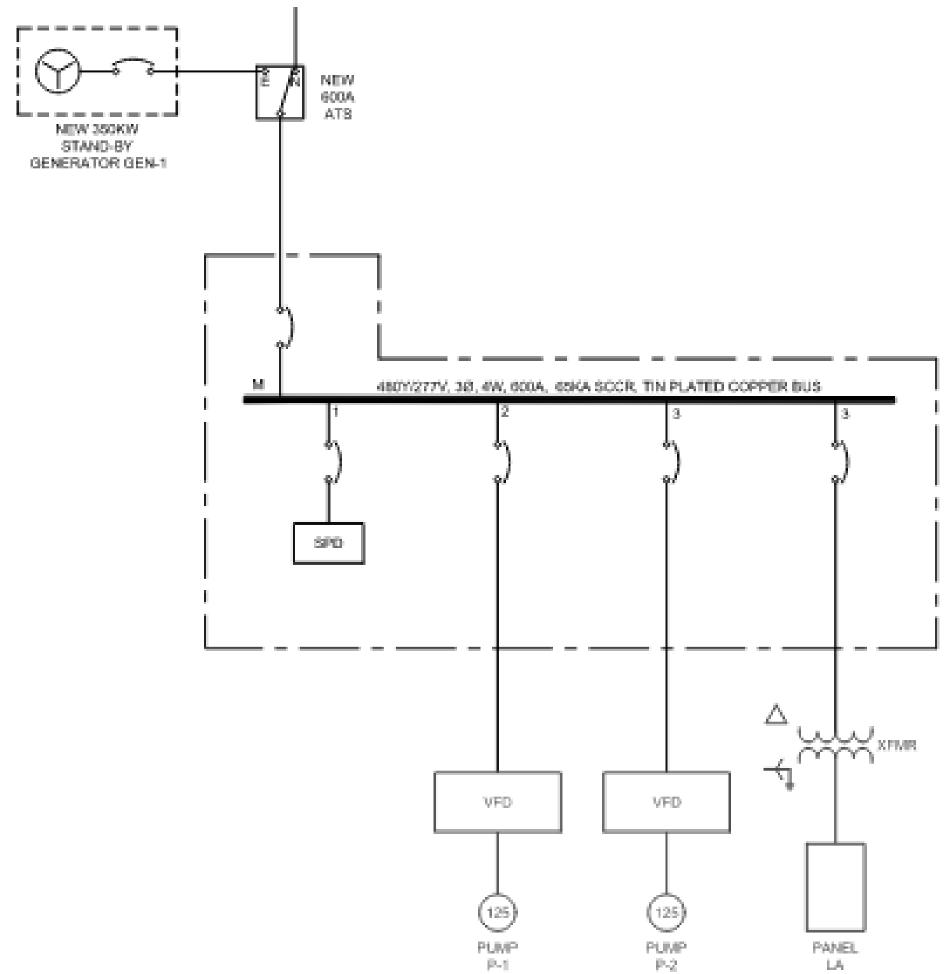
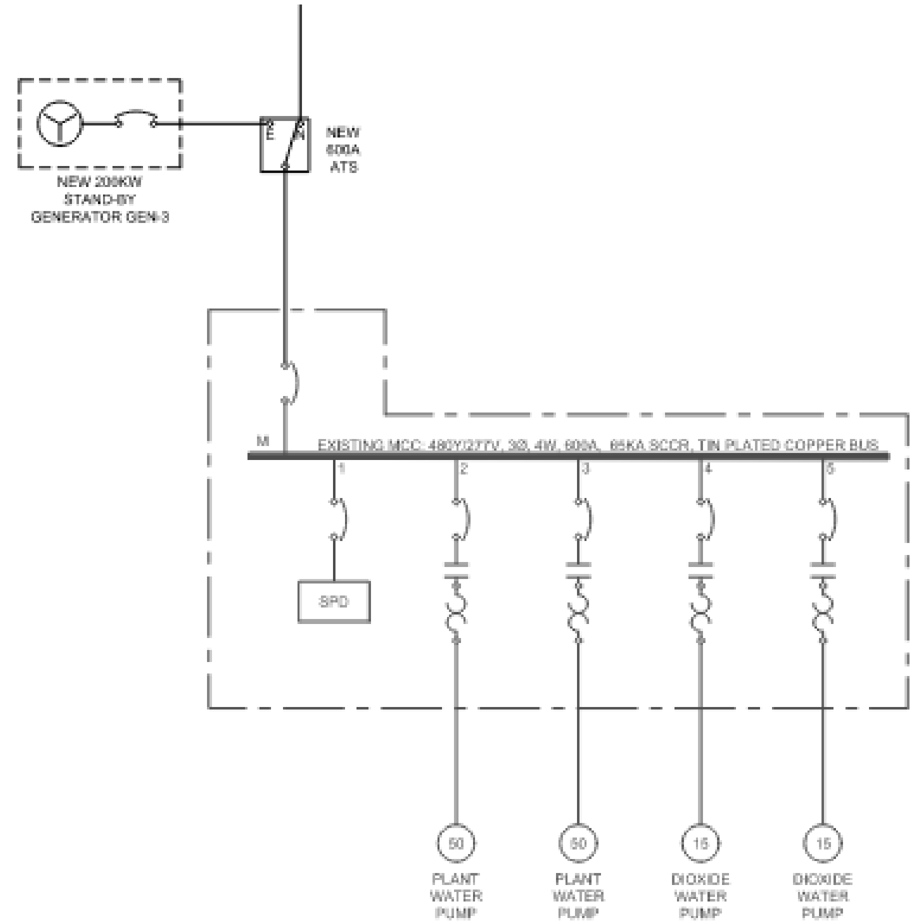
Backup Option 2 - Distributed Approach



Blower Building



Lift Station



Chemical Facility

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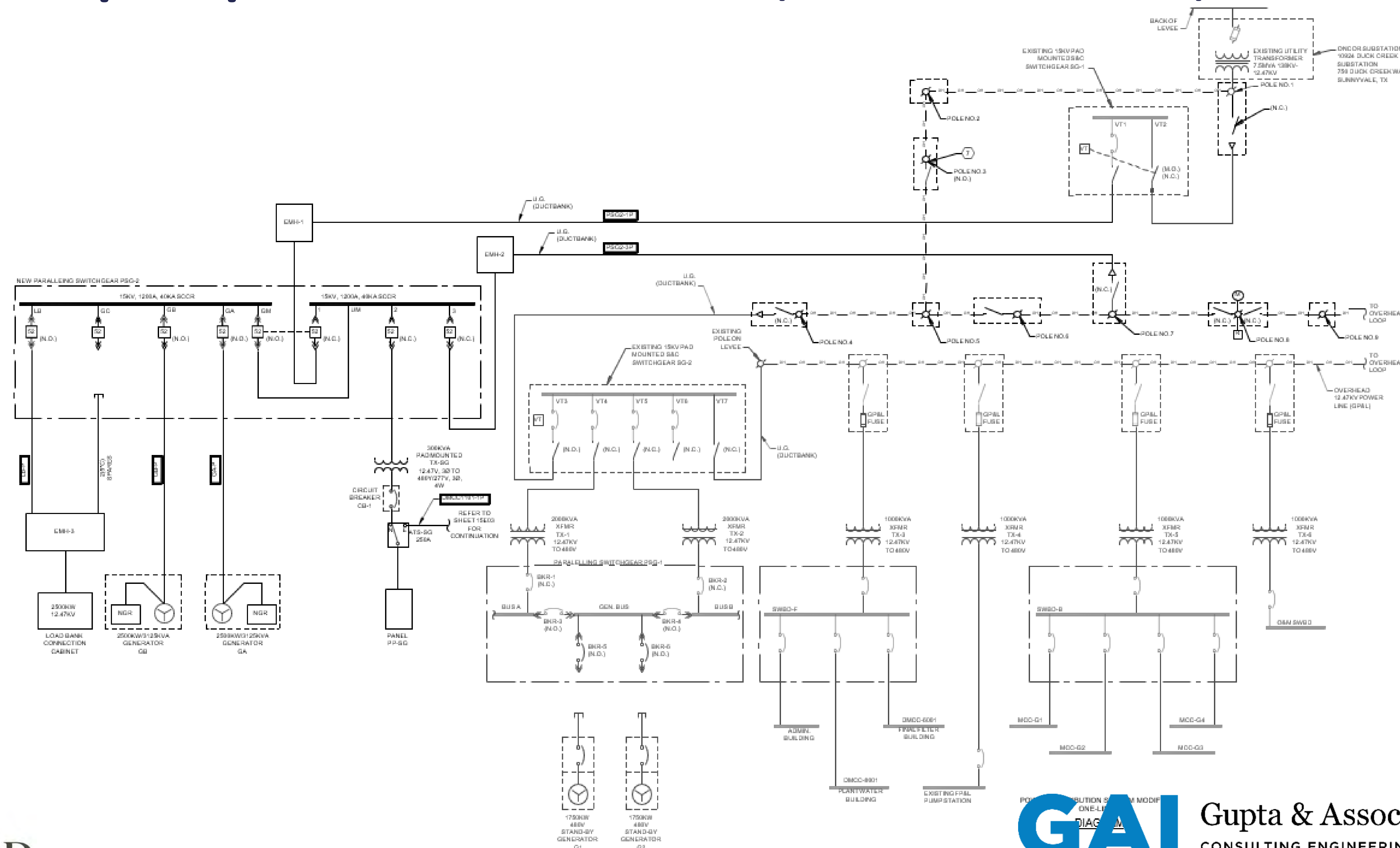
Backup Option 2 - Distributed Approach

- Disadvantages
  - Cost prohibitive at the Blower Facility
  - Multiple points of connections required
  - Limited redundancy and flexibility
  - Operation and maintenance considerations

Backup Option 3 - Backup Plant Loop



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Backup Option 3 - Backup Plant Loop

- Advantages
  - Provides flexibility to provide backup power to any load
  - Robust design
  - Future growth
- Disadvantages
  - More expensive solution

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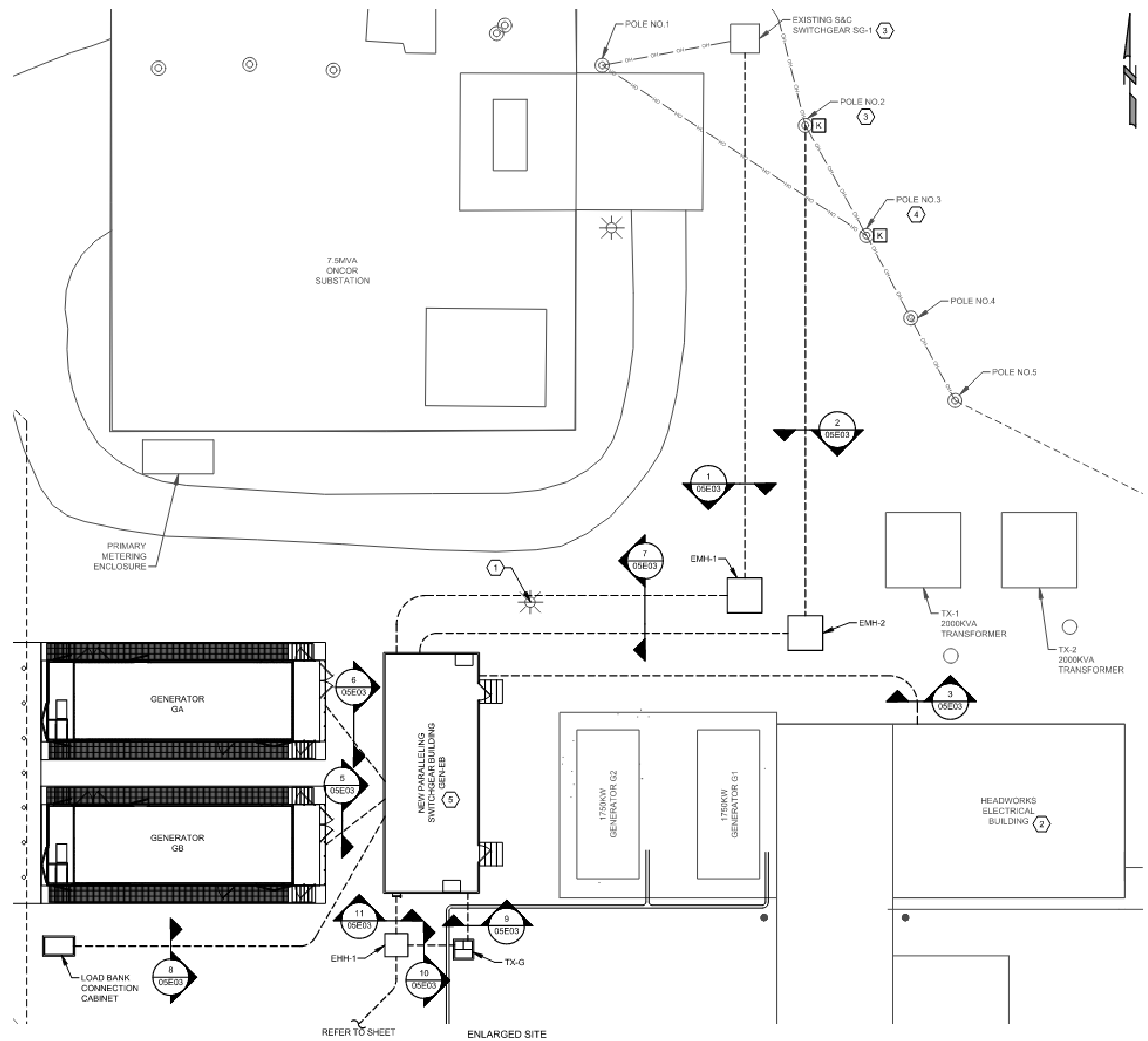
Design Details

- Demolition
  - Demolish wires and conduits from PSG-1 to existing generators.
  - Decommission existing generators.
- New Equipment
  - New 12.47 kV, paralleling switchgear PSG-2
  - 2-1,500 kW, 12.47 kV, Tier 2 Generators.
  - Sub-Base fuel tanks.
- Modifications
  - Modifications to PSG-1
  - Modify pad-mounted SG-1 to provide added protection.
  - GP&L to modify their lines for enhanced switching and operations.



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Change of Course: Tier 4 Generators

- At 90% planning stage of Tier 2 generators, course correction to Tier 4.
- Plan for future participation of demand response programs
- Upgrade from Tier 2 to Tier 4 generators
- Necessitates re-evaluation of plant loads

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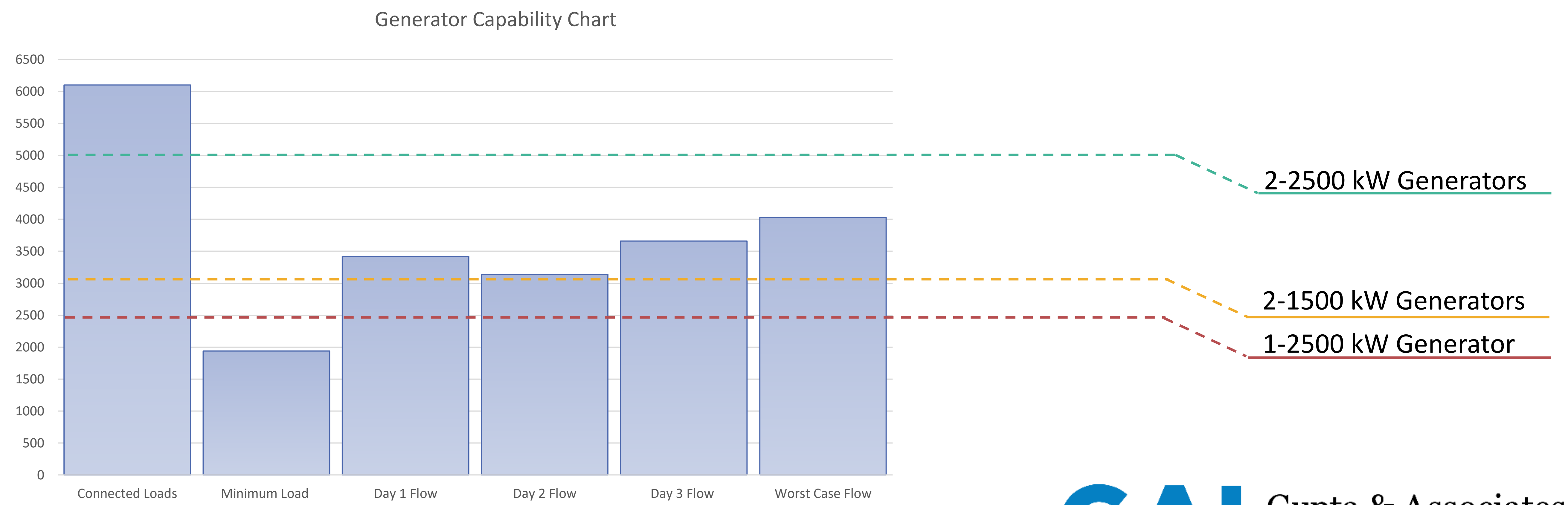
Reevaluate Plant Flows

Scenarios	Total kW	2-1500 kW	2-2000 kW	2-2250 kW	2-2500 kW
Total Connected Loads	6,100	203%	153%	136%	122%
Minimum Load Required	1,940	65%	48%	43%	38%
Day 1 Flow (Sunny Day, 98)	3,420	114%	86%	76%	68%
Day 2 Flow (Rain Event)	3,140	105%	78%	70%	63%
Day 3 Flow (Rain Event)	3,660	122%	92%	81%	73%
Worst Case Flow	4,030	134%	101%	89%	81%



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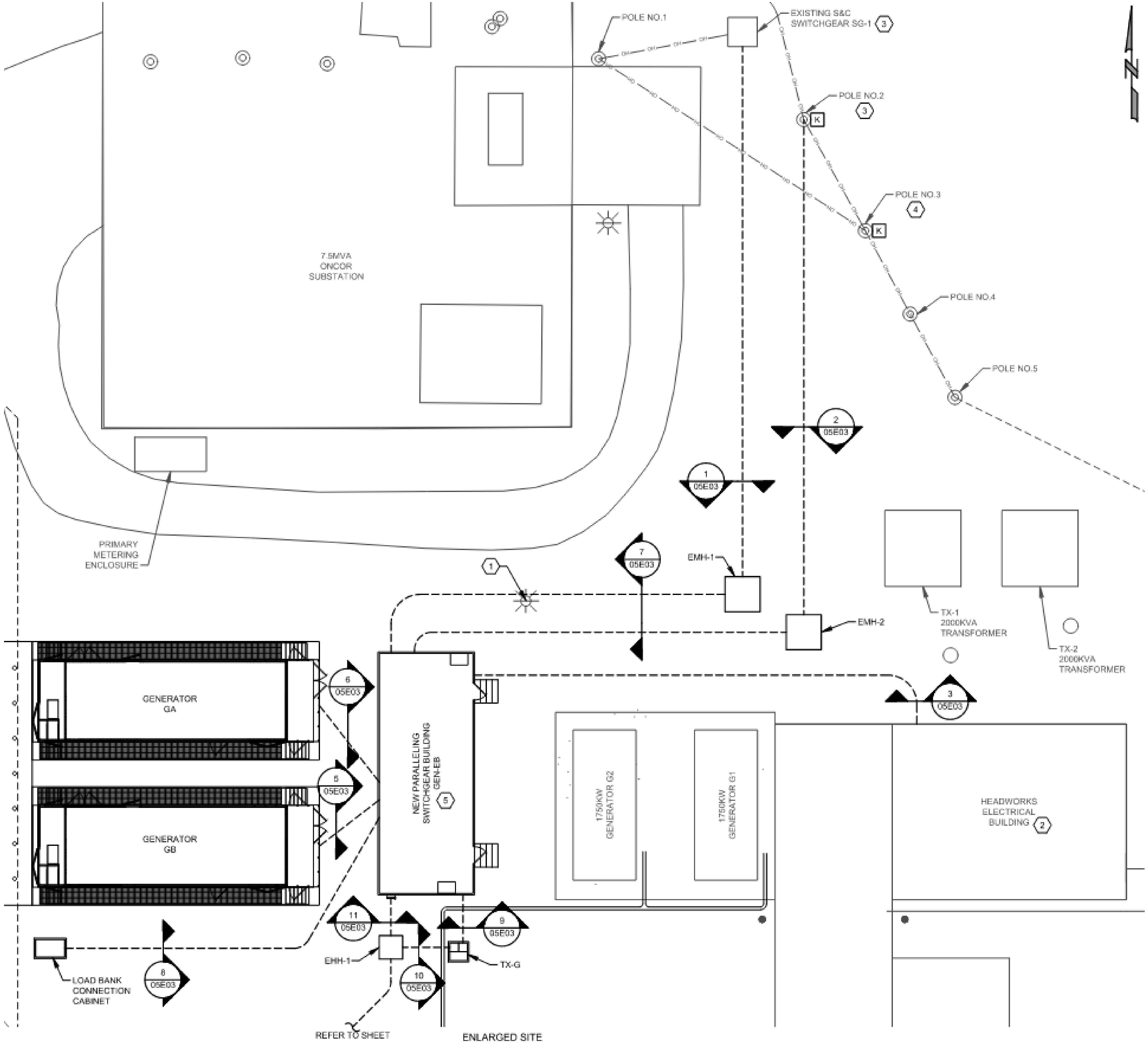
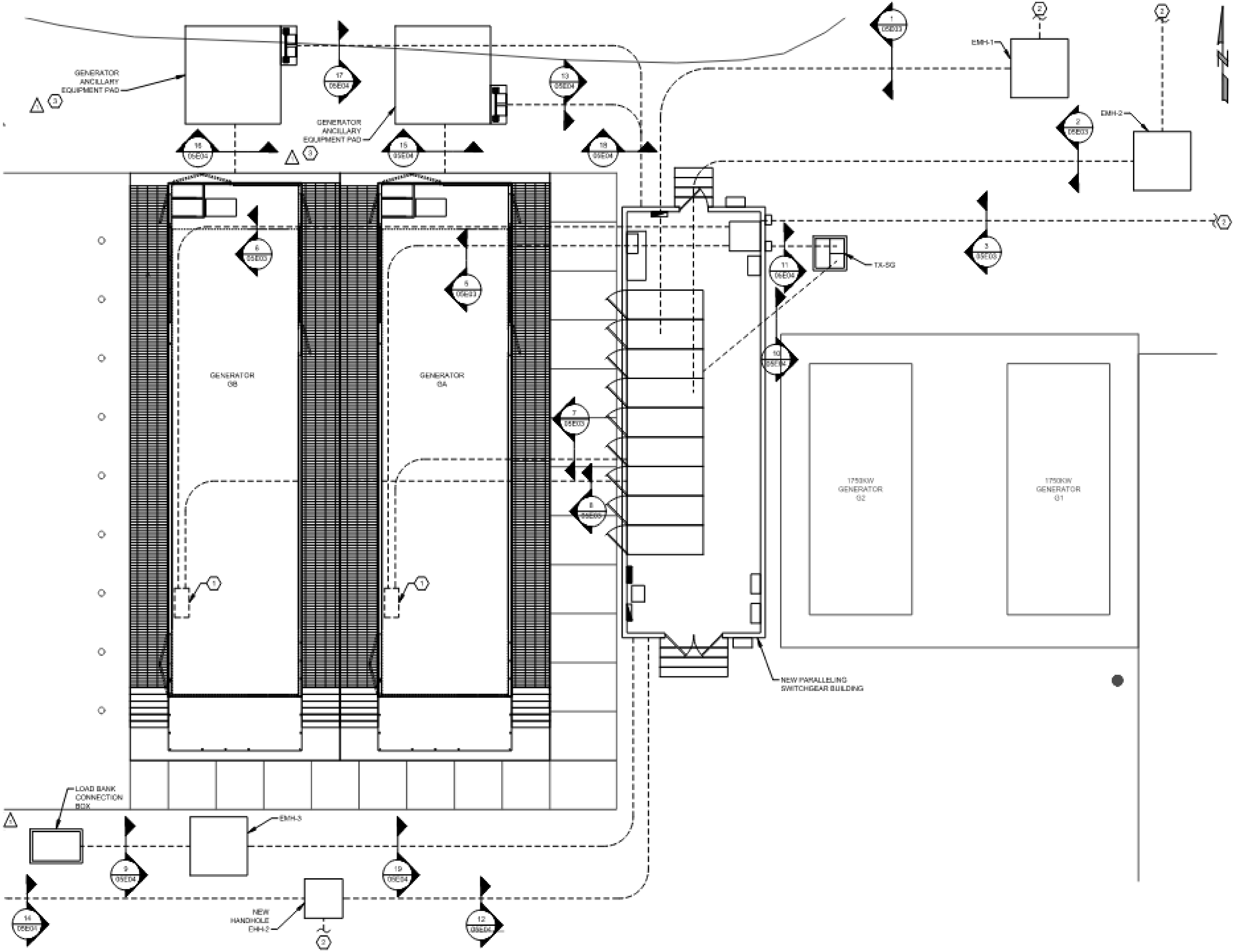
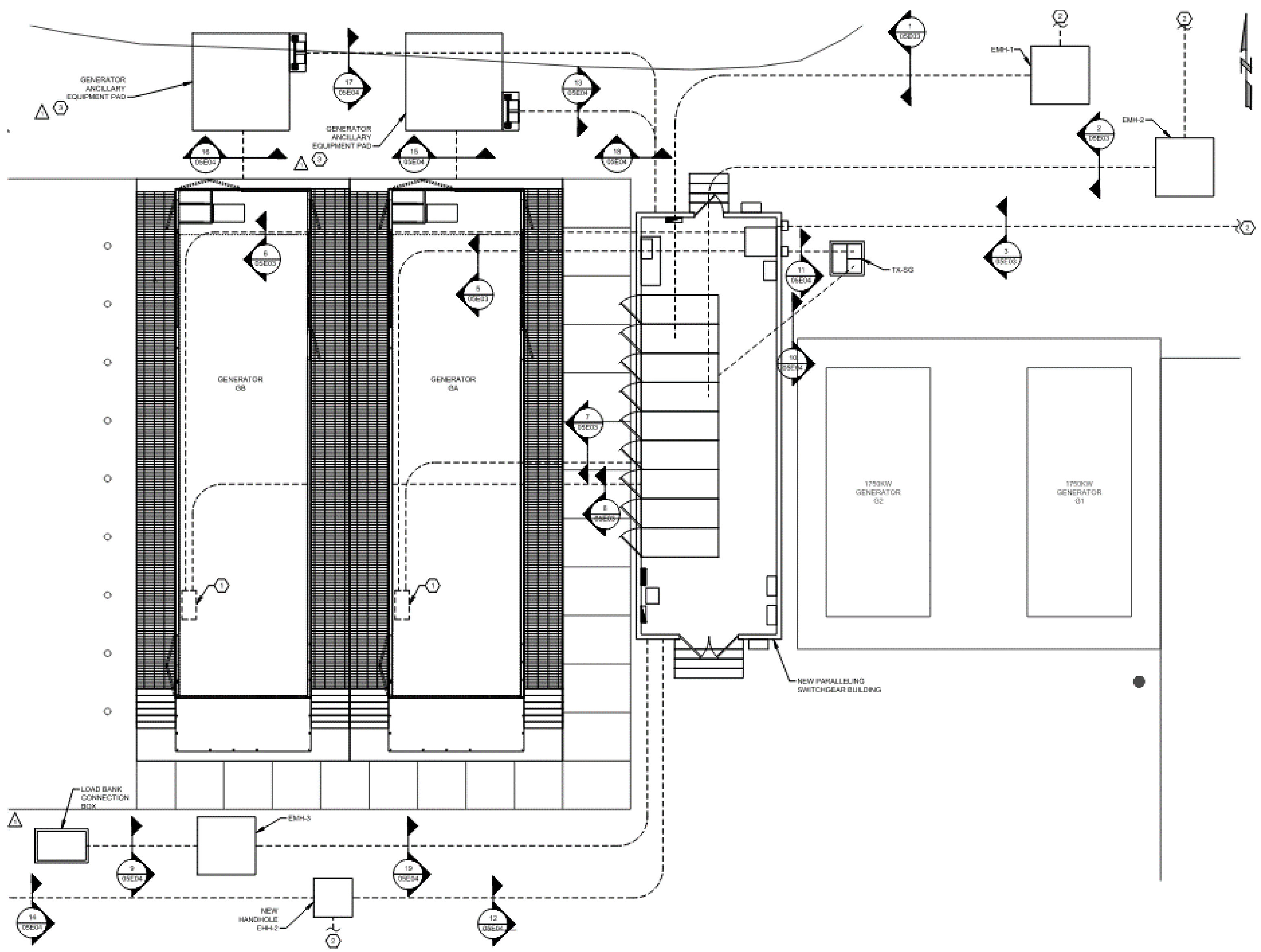


POLE NO.1
EXISTING S&C SWITCHGEAR SG-1 3
POLE NO.2 3
K
POLE NO.3 4
K
POLE NO.4
POLE NO.5
7.5MVA ONCOR SUBSTATION
PRIMARY METERING ENCLOSURE
2 05E03
1 05E03
7 05E03
1
EMH-1
EMH-2
TX-1 2000KVA TRANSFORMER
TX-2 2000KVA TRANSFORMER
3 05E03
GENERATOR GA
GENERATOR GB
6 05E03
5 05E03
NEW PARALLELING SWITCHGEAR BUILDING GEN-EB 5
1750KW GENERATOR G2
1750KW GENERATOR G1
HEADWORKS ELECTRICAL BUILDING 2
11 05E03
9 05E03
8 05E03
10 05E03
EHH-1
TX-G
LOAD BANK CONNECTION CABINET
REFER TO SHEET
ENLARGED SITE


GENERATOR ANCILLARY EQUIPMENT PAD
GENERATOR ANCILLARY EQUIPMENT PAD
EMH-1
EMH-2
TX-SG
GENERATOR GB
GENERATOR GA
1750KW GENERATOR G2
1750KW GENERATOR G1
NEW PARALLELING SWITCHGEAR BUILDING
LOAD BANK CONNECTION BOX
EMH-3
NEW HANDHOLE EHH-2

Design Changes



- Increase Generator pad size
- Increase electrical infrastructure
- Concrete pad for ancillary equipment (DEF Tank Enclosure or step-down transformer)
- Additional infrastructure for generator controls
- Provisions for future closed-transition operation with Oncor

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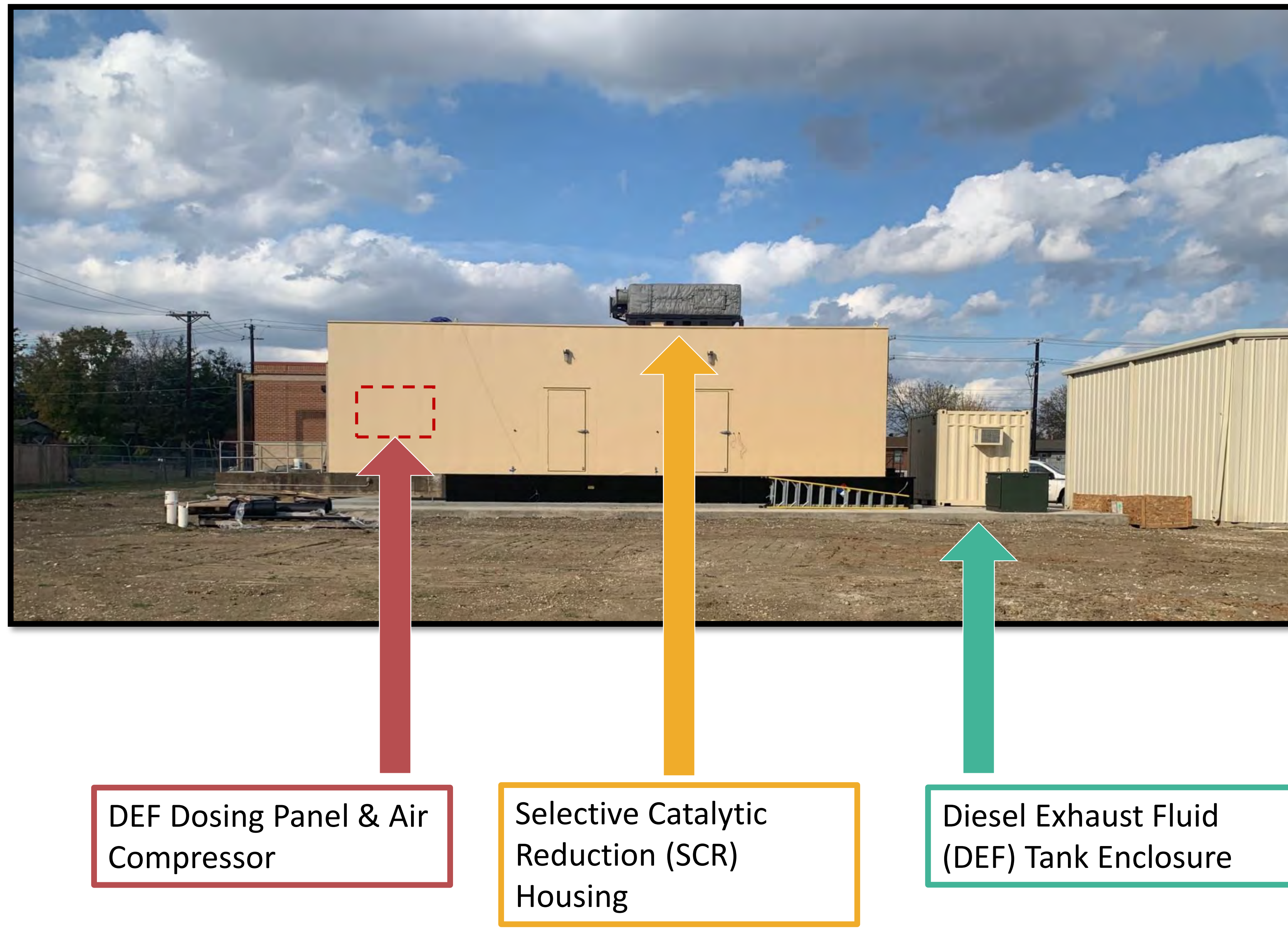
Wallace Pump Station – Tier 4

- 2,000 kW, 2,400 V Tier 4 Generator
- Export power to GP&L grid
- Manufacturer: Holt CAT
- Substantial Completion: Q1, 2022



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DCWWTP Standby Generators Construction Phase

- Progress: 30% Complete
- Substantial Completion: Q3, 2022
- Construction Contract: $7,548,300
- Generator Manufacturer: Cummins
- General Contractor: Gracon Inc.

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Reutilization of Existing Generators

Relocated Generator No. 1

Relocated Generator No.2

Rowlett Creek WWTP Transfer Pump Station

Lavon Pump Station

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Design Considerations - Tier 4 Generators

- Approximately 25-40% more expensive than Tier 2.
- 15-25% larger in footprint than Tier 2.
- Limited Power nodes and different designs by Manufacturers.
- 0A consideration for closed-transition electrical distribution systems.
- Long-Lead Item: Consideration for Pre-selection.

Operational Considerations - Tier 4 Generators

- Incentive Programs – Impact Study & Cost Analysis
- Water facility Vs. wastewater facility
- Not suitable for small applications.
- oDiesel fuel & DEF storage.
- Have stringent maintenance requirements.

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Ongoing Tier 4 Projects

City of Garland

- Wallace Pump Station (Tier 4) (Under Construction)

City of Pflugerville

- Surface Water Treatment Plant (Tier 4) (Under Construction)

North Texas Municipal Water District

- Wylie WTP/RW PS: Evaluating Design for Tier 4 Generators

Many Thanks

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Questions or Comments?

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APPENDIX SLIDES

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Emergency Response

- Can get paid even if not called upon
- Payment is incumbent on 3 things: Performance, Availability, and Testing
- Payment for 1MW claimed can be up to $50K
- Must claim every period how much plant can commit to shedding of the grid…for example
  -Summer Months, Plant can shed up to 3MW, since that is the expected load on the grid
  -Winter Months, Plant can shed up to 1MW since that is the expected load on the grid
  - If the plant claims 5MW on Summer, but only had generator Capacity for 3mW, then Plant may still be able to take off 5MW, but only produce 3MW of water

LR – Short Notice Response

- Pays Businesses for being available at short notice
- Payment is dependent on availability, and cost of kW at the time of availability
- Requires outside Control from QSE of Owners electrical system to respond to Grid notice, typically a 10 Minute window
- Equipment required is a switch that opens and closes from utility to generator, and an Underfrequency Relay to protect from system issues.
- If owner does not wish to have this, then they have 10 minutes to react to do switching themselves.

Coincidental Peak (4CP)

- Do not get paid, but rather will experience energy savings
- ERCOT defines peaks within the summer months of June, July, August, September.
- To participate in 4CP, must curtail load at the identified peak. Becoming hard to forecast
- Customers can approach this one of two ways:
  - -Utilize QSE to predict the 4CP and curtail 8 times a month during the summer months for 3 hours
  - -Curtail every day of the summer months for 3 hours a day

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Market Participation – Export to Grid

- Sell Excess generation back into grid
- Payment is dependent on MW exported
- Requires outside Control from QSE of Owners electrical system to respond to Grid notice, typically a 10 Minute window
- Equipment required is a switch that opens and closes from utility to generator, and an Underfrequency Relay to protect from system issues.
- If owner does not wish to have this, then they have 10 minutes to react to do switching themselves.
- Requires extensive coordination with Oncor, Relaying, and more infrastructure.

Standby Emergency Only	Tier 2	Open Transition	• Coordinate to Obtain Primary Metering	• Cost effective solution for backup power to the plant in the short run • Less complexity • Minimal coordination with Oncor	• Will <u>not</u> be able to participate in any incentive programs
ERS Participation & 4CP **ERS 15** **ERS 30**	Tier 4	Closed Transition	• Coordinate to Obtain Primary Metering • Coordinate paralleling configuration with Oncor for 60 seconds to soft load back to grid • Will require formal RFP for QSE services	• Allows Generators to participate in ERS or 4CP response • Revenue stream from ERS even if not called upon • Savings if participating in 4CP	• High upfront cost for Tier 4 technology • Additional complexity for Tier 4 design
LR Participation	Tier 4	Closed Transition	• Coordinate to Obtain Primary Metering • Coordinate paralleling configuration with Oncor for 60 seconds to soft load back to grid • Will require formal RFP for QSE services • Requires an underfrequency relay • Controls for QSE to remotely switch from utility to generator for effective operation	• Allows Generators to participate in LR or 4CP response • Revenue stream from LR even if not called upon • Savings if participating in 4CP	• High upfront cost for Tier 4 technology • Additional complexity for installing relay and controls • Require underfrequency relay • 10 minute response time requires QSE to add controls to remotely switch from utility to generators
Export to Grid*	Tier 4	Closed transition & Parallel to Grid	• Coordinate to Obtain Primary Metering • Will require formal RFP for QSE services • Coordinate paralleling configuration with Oncor for extended period • Will require feasibility study by Oncor • Oncor may need to upgrade their transmission, depending on findings of study • Requires an underfrequency relay • Controls for QSE to remotely switch from utility to generator for effective operation	• Allows Generators to participate in ERS or 4CP response • Revenue stream from ERS even if not called upon • Allows for export of power to grid during winter when consumption is not high (more available capacity)	• High upfront cost for Tier 4 technology • Additional complexity associated with exportation of power • Require underfrequency relay • 10 minute response time requires QSE to add controls to remotely start paralleling • Feasibility study by Oncor is $5K • Oncor may need to upgrade their transmission, cost will be on Owner • May require larger generators to be more lucrative, but higher upfront cost

Cummins Power Generation

Recommended Generator Report - 2750DQLH

Project - GAI - Garland Duck Creek

Comments -

Project Requirements

Frequency, Hz	60.0	**Generators Running in Parallel**	2
Duty	Prime	**Site Altitude, ft(m)**	600(183)
Voltage	12470, Series Wye	**Site Temperature, °C**	40
Phase	3	**Max. Altr Temp Rise, °C**	125
Fuel	Diesel	**Project Voltage Distortion Limit, %**	10
Emissions	EPA, stationary non-emergency application		

Calculated Individual Generator Set Load Running and Peak Requirements

Running kW	1971.7	**Max. Step kW**	780.6 In Step 2	**Cumulative Step kW**	2024.5
Running kVA	2209.9	**Max. Step kVA**	1695.2 In Step 1	**Cumulative Step kVA**	2376.3
Running PF	0.89	**Peak kW**	None	**Cumulative Peak kW**	None
Running NLL kVA	954.4	**Peak kVA**	None	**Cumulative Peak kVA**	None
Alternator kW	2830.62			**Pct Rated Capacity**	78.9

Total System Running Load and Step Load Requirements

Running kW	3943.4	**Max. Step kW**	1561.2	**Running NLL kVA**	1908.8
Running kVA	4419.8	**Max. Step kVA**	3390.4		

Generator Set Configuration

Alternator	HVSI804W	**Engine**	QSK78-G14
BCode	B823	**Fuel**	Diesel
Excitation	PMG	**Displacement, cu in. (Litre)**	4735.0(77.6)
Voltage Range	*	**Cylinders**	18
Number of Leads	6	**Altitude Knee, ft(m)**	1447(441)
Reconnectable	Yes	**Altitude Slope, % per 1000ft(304.8m)**	9
Full Single Phase Output	No	**Temperature Knee, °F(°C)**	104(40)
Increased Motor Starting	No	**Temperature Slope, % per 18°F(10.0°C)**	30
Extended Stack	No	**Emissions**	Tier 4 Final
		Cooling Package	High ambient

*Note: Consult your Cummins Power Generation Distributor for more information.

Set Performance / Load Requirements

Set Performance		Load Requirements	
Running At	78.9% Rated Capacity		
Max. Step Voltage Dip, %	12	**Max. Allowed Step Voltage Dip**	20 in Step 1
Max. Step Frequency Dip, %	2	**Max. Allowed Step Frequency Dip**	10 in Step 1
Peak Voltage Dip, %		**Peak Voltage Dip Limit %**	20.0
Peak Frequency Dip, %		**Peak Frequency Dip Limit %**	10
Site Rated Prime kW/kVA	2500 / 3125	**Running kW**	1971.7
		Running kVA	2209.9
Site Rated Max. SkW	2756	**Effective Step kW**	1798.9
Max. SkVA	11213	**Effective Step kVA**	2376.3
Temp Rise at Full Load, °C	105	**Percent Non-Linear Load**	44.0
Voltage Distortion	7.9	**Voltage Distortion Limit**	10
Site Rated Max Step kW Limit		**Max Step kW**	

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Project Sizing Report

Project Name	Duck Creek 2020	Electricity Supply	60 Hz 12470/7200 V
Customer Name	GAI	Connection	STAR
Region	U.S.	Max. Ambient Temperature	77.0 F
Prepared By	Ronald Tyler	Altitude	500.0 Ft. A.S.L
Modified Date	28-Jul-2020	Humidity	30%

Load Analysis Summary

Max Transient Load Step	1,032.0 SkVA / 317.6 SkW
Peak Transient Load Step	4,111.7 SkVA / 3,751.7 SkW
Final Running Load	4,111.7 kVA / 3,751.7 kW / 0.91 PF
Max Running Non Linear Load	2,138.8 RkVA
Maximum Running Load	4,111.7 kVA / 3,751.7 kW
Selection Criteria	Step 13 Running kW requirements

Generator Set

Generator Set Model	(2) of 3516 C	Nameplate Rating	2,250.0 ekW / 2,812.0 kVA / 0.8 PF
Voltage Regulator and Slope	CDVR 2:1 slope;	Site Output Rating	2,247.9 ekW / 2,809.9 kVA
Feature Code	516DRK9	Rating Type	Prime
Fuel	Diesel	Open / Enclosure	Open
Sizing Methodology	Conventional	UL Listed	No
Capacity Used	83.4%		

Engine

Make/Model	3516 C	Emissions / Certifications	EPA ESE
Aspiration	TA	Governor	ADEM3
Cylinder Configuration	VEE - 16	Aftercooler Type	ATAAC
Speed	1800 RPM	Displacement	4,765 Cubic Inch / 78 Liter