Generation Interconnection
Facility Study Report

For

PJM Generation Interconnection Request
Queue Position AA1-138

Earleys – Suffolk 230kV

August / 2016

General

This Facilities Study has been prepared in accordance with the PJM Open Access Transmission Tariff §207, as well as the Facilities Study Agreement between Haslett Solar LLC, (Interconnection Customer (IC)) and PJM Interconnection, LLC (Transmission Provider (TP)). Haslett Solar, LLC, the IC, has proposed a solar generating facility located at Black Mingle Road in Haslett, NC. The installed facilities will have a total capability of 80 MW with 56 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is October 31, 2019. **This study does not imply an Interconnected Transmission Owner (ITO) commitment to this in-service date.**

Point of Interconnection

AA1-138 will interconnect with the ITO transmission system via a new "Haslett" three breaker ring bus switching station that connects on the Earleys – Suffolk 230kV line.

Cost Summary

The AA1-138 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 654,096
Direct Connection Network Upgrades	$5,657,770
Non Direct Connection Network Upgrades	$1,464,247
Allocation for New System Upgrades	$0
Contribution for Previously Identified Upgrades	$0
Total Costs	**$7,776,113**

A. Transmission Owner Facilities Study Summary

1. Description of Project

AA1-138 will interconnect a new 80MW solar facility to be located in Gates County, North Carolina with the ITO transmission system via a new "Haslett" three breaker ring bus switching station that connects on the Earleys - Suffolk 230kV line #246. The requested in-service date for the first phase is October 31, 2019. Attachment Facility and Direct Connection Network upgrade construction is estimated to be 16-18 months from the Effective Date of the Interconnection Service Agreement.

2. Amendments to the System Impact Study data or System Impact Study Results

Stability and Reactive Power Requirements were analyzed as part of the Facilities Study. All fault contingencies tested on the 2018 summer peak case met the recovery criteria. No mitigations were found to be required.

AA1-138 was tested for compliance with NERC, PJM, Transmission Owner and other applicable criteria. 56 contingencies were studied, each with a 20 second simulation time period. For all simulations, the queue project under study along with the rest of the PJM system were required to maintain synchronism and with all states returning to an acceptable new condition following the disturbance.

AA1-138 tripped for two fault contingencies tested on the 2018 summer peak case:

- AA1-138 230 kV POI on Nucor Steel – Earleys circuit (3N02).
- AA1-138 230 kV POI on Suffolk circuit (3N03).

For these faults, the frequency excursion at the AA1-138 terminal bus remained above 60.5 Hz for more than 0.16 seconds and as a result the AA1-138 unit was tripped by an over frequency relay. In accordance with IEEE standard 1547A, the unit tripping was deemed acceptable for this study.

For some contingencies, undamped oscillations were observed in the real, reactive power and terminal voltage plots of AA1-138 only, indicating a potential model tuning issue. Tuning of the model parameters at the time of commissioning is required to ensure damping requirements are satisfied.

3. Interconnection Customer's Submitted Milestone Schedule

- Turn over flat, graded site to ITO for new Haslett switching station 2/28/2019
- Substantial site work completed 4/29/2019
- Delivery of major electrical equipment 8/28/2019
- Backfeed power 10/31/2019

- Commercial Operation
    - Phase one 11/15/2019
    - Phase two 12/31/2019

4. Scope of Customer's Work

IC will build a solar generating facility in Gates County, North Carolina. The generating facility will be comprised of 108 solar arrays. The solar arrays will be connected to 54 x 1.5 MW PowerOne Ultra 1500-TL-OUTD solar inverters. The 27 x 34.5/0.69 kV generator step up (GSU) transformers will connect through four 34.5kV circuit breakers to a 34.5kV bus. The generating facility will be connected to the Point of Interconnection (POI) via a 954 ACSR generator lead to two x 230/34.5/13.8 kV wye grounded wye grounded main collector transformer with a rating of 24/32/40 (OA/F1/F2) MVA.

5. Description of Facilities Included in the Facilities Study

The ITO will connect the proposed generator lead via Attachment Facilities to a new Haslett 230kV ring bus switching station. The Earleys – Nucor Steel – Suffolk 230kV line #246 will looped into and out of the Haslett switching station. There will be transmission line protection and anti-islanding work required at the remote lines terminals in Earleys and Suffolk 230kV substations. As the IC did not provide the location of the generator step-up transformer and an exact site for the proposed ITO "Haslett" switching station some site specific reengineering may be required. The single line is shown in Attachment 1.

6. Total Costs of Transmission Owner Facilities included in Facilities Study

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
Attachment Facilities	$295,785	$254,228	$73,305	$30,778	$654,096
Total Attachment Facilities Cost	$292,785	$254,228	$72,305	$30,778	$654,096
Haslett 230 kV Substation (n5070)	$2,310,629	$2,485,263	$564,318	$297,560	$5,657,770
Loop transmission line #246 into Haslett substation (n5071)	$442,863	$279,929	$190,996	$183,075	$1,096,863
Remote substation protection and communication (n5072)	$236,487	$79,909	$40,679	$10,309	$367,384
Total Network Upgrades	$2,989,979	$2,845,101	$795,993	$490,944	$7,122,017
Total Project Costs	$3,285,764	$3,099,329	$869,298	$521,722	$7,776,113

7. Summary of Milestone Schedules for Completion of Work Included in Facilities Study:

The ITO schedule duration is:

- Engineering 4- 6 months
- Permitting / Real Estate / Outage Request 6 – 8 months
- Construction 8 – 12 months

The estimated time to construct and build the proposed facilities is not based on an exact site for the proposed ITO "Haslett" switching station and assumes typical permitting timelines. Actual permitting requirements required by local zoning conditions may impact this schedule. Total Timeline to Engineer and Construct the proposed facilities is 16-18 months and is based on the ability to obtain outages to construct and test the proposed facilities.

B. Transmission Owner Facilities Study Results

1. Attachment Facilities

The attachment facilities include that portion of the interconnecting switching station which is associated solely with the single feed to the generating facilities. The equipment associated with the Attachment Facilities includes the following. The work required is as follows:

Purchase and install:
1. One (1), 230kV, 3000A Center Break Switch
2. Three (3), 230kV, Metering Accuracy CCVT's
3. Three (3), 230kV,1000:5 Metering Accuracy CT's
4. Tubular bus as required
5. Steel Structures as required
6. Conductor, connectors, conduit, control cable, foundations and grounding material

Purchase and install relay material:
1. One (1), 1109 – 28" Dual SEL-587Z Transmission Bus Panel
2. One (1), 4200 – Bus Differential C.T. M.U. Box
3. One (1), 1421 – Generation/NUG/PJM/IPP Metering Panel
4. One (1), 4524 – Revenue Metering C.T. M.U. Box
5. One (1), 4531 – Generator Interconnect CCVT Potential M.U. Box
6. One (1), 1611 – 28" SEL-451 PMU Panel w/SEL 735/735
7. One (1), Customer Interface Box

2. Transmission Line – Upgrades

Re-arrange Earleys – Nucor Steel – Suffolk 230kV line #246 to loop it into and out of the proposed new "Haslett" switching station (PJM Network Upgrade #n5070).

1. Modify one (1) wood h-frame suspension structures by removing existing wood x-braces and replacing with steel x-braces.
2. Install one (1) 230kV H-frame DOM-Type Suspension structure with pipe pile foundations to provide adequate conductor to bus clearance between structures 125 and the proposed backbone.
3. Install one (1) 230kV SC Steel double dead ended backbone structure (no switches) with pipe pile foundations.
4. Install two (2) Steel Static Poles with pipe pile foundations.
5. Install two (2) spans of 3#6 ALW static wire from proposed backbone to Steel Static Poles and one (1) span between the static poles.
6. Transfer (3) Spans of 2-3#6 ALW static wire and (3) spans of 3-phase 2-545 ACAR conductor to new structures.
7. Install two (2) sets of 3-phase risers to connect to substation tubular bus (tee connections to be provided by Transmission engineering, Risers to be provided by substation engineering).
8. Renumber approximately 128 structures with new line number 2XXX between Haslett and Earleys Substation.

3. New Substation/Switchyard Facilities

Build a three breaker 230 kV "Haslett" switching station (PJM Network Upgrade #n5071).

Purchase and install the following:

1. Three (3), 230-kV, 3000A, 50 kA SF-6 Circuit Breakers
2. Six (6), 230-kV, 3000A Center Break Switches
3. Two (2), 230-kV, 3000A, 2-Pole Center Break Switches (for Power Voltage Transformers (PVT))
4. Six (6), 230-kV, CCVT's relay accuracy
5. Two (2), 3000A Wave Trap
6. Two (2), Line Tuners
7. Six (6), 180-kV, 144 kV MCOV Surge Arresters
8. Four (4) 230-kV, 167 kVA Power PT's for Station Service
9. One (1), 24' x 40' Control Enclosure, prewired by Trachte
10. One (1), 135VDC, 577 Ah Batteries with Charger
11. Oil Containment as required for 230kV PVT's.
12. One (1) 230 kV Backbone
13. Two (2) Static Pole
14. Cable Trough as required
15. Tubular bus as required
16. Ground Grid as required
17. Fence as required
18. Steel Structures as required
19. Install two (2) sets of 3-phase risers
20. Conductor, connectors, conduit, control cable, foundations and grounding material

Purchase and install relay material:

1. Three (3), 1510 – 28" Dual SEL-351-7 Transmission Breaker w/ Reclosing Panel
2. Three (3), 4510 - SEL-2411 Breaker Annunciator
3. Two (2), 1320 – 28" Dual SEL-421-5 DCB Line Panel
4. two (2), 1809 – 28" Dual SEL-311L Line Diff. w/ Reclosing Panel
5. Two (2), 4506 – 3 Phase CCVT Potential M.U. Box
6. One (1), 1603 – 28" SEL-451 Islanding Control Scheme Panel
7. Two (2), 4000 – Station Service Potential M.U. Box
8. Two (2), 4018 – 800A Station Service AC Distribution Panel
9. Two (2), 4007 – 225A Outdoor Transmission Yard AC NQOD
10. Two (2), 4019 – 225A Three Phase Throwover Switch
11. One (1), 4153 – Wall Mount Station Battery Monitor
12. One (1), 5612 - SEL-3530 Data Concentrator Panel
13. One (1), 1255 – Station Annunciator Panel
14. One (1), 5021 – SEL-2411 RTU Panel
15. One (1), 5609 – Fiber Optic Management Panel
16. Three (3), 4526_A – Circuit Breaker Fiber Optic M.U. Box
17. One (1), 5202 – 26" APP 601 Digital Fault Recorder
18. One (1), 5603 – Station Network Panel
19. One (1), 4523 – Security Camera Interface Box
20. One (1), 5603 – Station Network Panel
21. One (1), 5611 – Transmission Fiber Patch Panel
22. One (1), Telephone Interface Box

4. Upgrades to Substation / Switchyard Facilities

Remote protection and communication work (PJM Network Upgrade #n5072). ITO protection requirements to reliably interconnect the proposed generating facility with the transmission system determined that work is required at Earleys and Suffolk 230kV substations.

Earleys 230 kV Substation

The queue project requires drawing updates, relay resets, and field support necessary to change the Line 246 destination to the new Haslett Generator Interconnect Substation. It also provides for the installation of an Islanding Transfer Trip scheme to work with the new generator interconnect. This also will require drawing work, relay resets and field support. Install new 3000A Vertically Mounted Wave Trap. This work is estimated to cost $243,589.

Purchase and install substation material:

1. One (1), 3000A, Vertically Mounted, 115-300Hz Wave Trap
2. Install any necessary foundations, structural steel, insulators, grounding, conduit, control cable and connectors as necessary per Dominion Substation Engineering Standards.

Purchase and install relay material:

1. One (1), 1604 – 28" Transmission Transfer Trip Panel

Suffolk 230 kV Substation

The queue project requires drawing updates, relay resets, and field support necessary to restencil the former Line 246 and change the destination to the new Haslett Generator Interconnect

Substation. It also provides for the installation of an Islanding Transfer Trip scheme to work with the new generator interconnect. The scheme is to be installed in existing Islanding Transfer Trip Panel No. 34. This also will require drawing work, relay resets and field support. This work is estimated to cost $123,795.

Purchase and install substation material:

1. One (1), 3000A, Vertically Mounted, 115-300Hz Wave Trap
2. Install any necessary foundations, structural steel, insulators, grounding, conduit, control cable and connectors as necessary per Dominion Substation Engineering Standards.

Purchase and install relay material:

1. One (1), Islanding Transfer Trip Transmitter
2. One (1), SEL-2411 Maintenance Switch

5. Metering & Communications

PJM Requirements

The IC will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Sections 24.1 and 24.2.

ITO Requirements

Metering and SCADA/Communication equipment must meet the requirements outlined in section 3.1.6 Metering and Telecommunications of ITO's Facility Interconnection Connection Requirement NERC Standard FAC-001 which is publically available at www.dom.com.

At the IC's expense, the ITO will supply and own at the Point of Interconnection bi-directional revenue metering equipment that will provide the following data:

a. Hourly compensated MWh received from the Customer Facility to the ITO;
b. Hourly compensated MVARh received from the Customer Facility to the ITO;
c. Hourly compensated MWh delivered from the ITO to the Customer Facility; and
d. Hourly compensated MVARh delivered from the ITO to the Customer Facility.

The IC will supply and own metering equipment that will provide Instantaneous net MW and MVar per unit values in accordance with PJM Manuals M-01 and M-14D, and Sections 8.1 through 8.5 of Appendix 2 to the ISA;

The IC will access revenue meter via wireless transceivers or fiber cabling to meter with RS-485 or Ethernet communication port for dial-up reads. IC must provide revenue and real time data to PJM from Interconnection Customer Market Operations Center per "PJM Telemetry Data Exchange Summary" document available at PJM.com.

6. Environmental, Real Estate and Permitting Issues

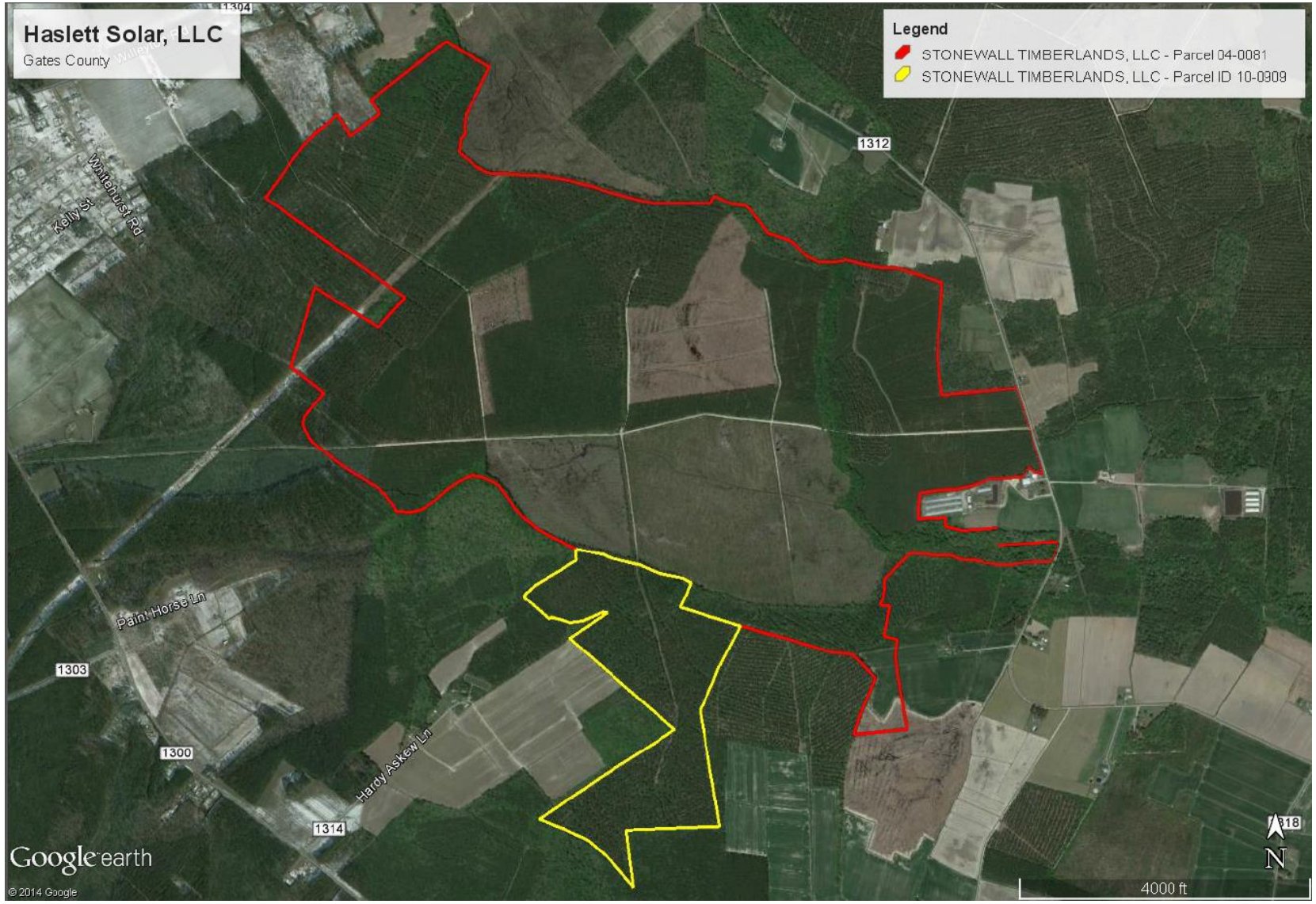
The IC would be responsible for the following expectations in the area of Environmental, Real Estate and Permitting:

- Suitable Access Road from Substation to a North Carolina State Maintained Roadway.

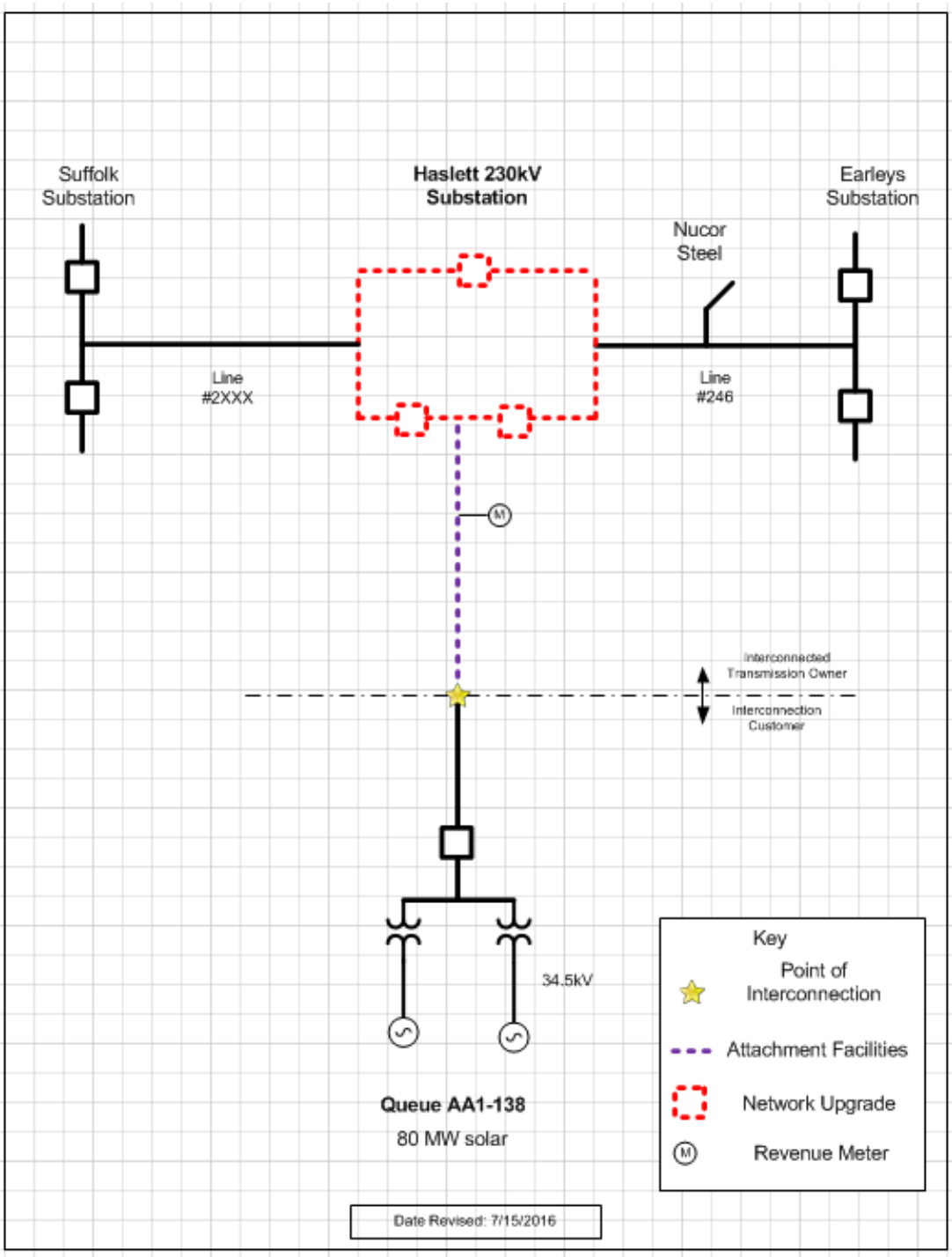
- Any additional land needed for Storm Water Management, Landscaping, and Wetlands/Wetlands Mitigation.
- Conditional Use Permit for Substation.
- Any other Land/Permitting requirements required by the Substation.
- ITO would prefer to own the Substation in fee simple but would accept a perpetual easement.

The expected substation fence line (NOT INCLUDING Storm Water Management) is 304’ x 185’.

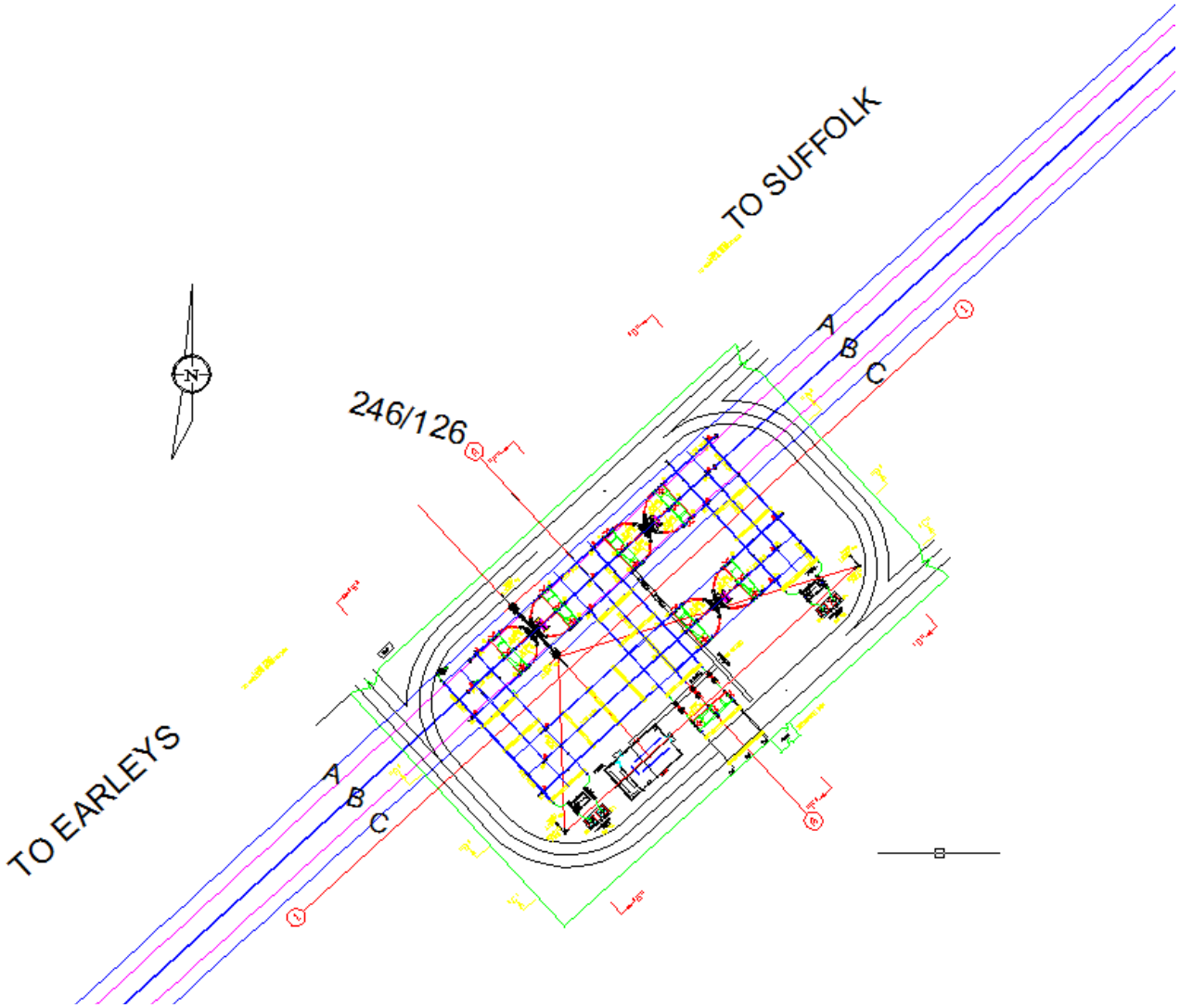
Attachment 1.
Generation Site



Attachment 2.
Single Line



Attachment 3.
Site Plan



Attachment 4.
Transmission Line Profile