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Austin Energy
Sand Hill Energy Center – Del Valle, Texas
2017 Annual Cathodic Protection Survey

AUSTIN ENERGY®

Prepared for:
Austin Energy, Sand Hill Energy Center
Del Valle, TX
Corrpro Project No.: 340303589
14 February 2018

QUALITY ASSURANCE FORM

Project Identifier 340303589			
Project Name	2017 Cathodic Protection (CP) Survey	Type of Document	Annual Survey
Project Scope of Work			
• Test Cathodic Protection rectifiers for condition and operation. • Perform annual on and instant off survey for all the cathodic protection systems to ensure protective currents are being maintained on underground metallic piping and tanks for Units 1, 2, 3, 4, 5, 6 and 7.			
Referenced Standards for Compliance			
• NACE International Standard Practice SP0169-2013 • NACE International Standard Practice SP0193-2016 • NACE International Standard Practice SP00286-2007 • NACE International Standard Test Method TM0497-2012			
Compliance/Criteria Achieved?	47%	Test procedures documented?	Yes
Recommendations included?	Yes	Data Tables and/or Charts Included?	Yes
Compliant with Scope of Work?	Yes		
Assumptions included in analysis			
• The utilities site plan is electrically continuous. • The CP systems and buried stationary reference cells are functioning properly.			
Corrpro Project Team			
Project Manager – Alwynn Vanburen (avanburen@aegion.com) Corrosion Technician – Jeremy Taylor (jtaylor@aegion.com) Corrosion Engineer – Shalini Dwarakapally (sdwarakapally@aegion.com) Engineering Manager – Nick Judd (njudd@aegion.com)			
Summary of conclusions			
• A total of 9 rectifiers provide 188.5 amps of protective current. • 32 of 68 (47 %) of potential readings gathered on this survey meet the NACE polarized potential criteria.			
Review completed by:	Name	Nick Judd	
	Job Title	Engineering Manager	
	Qualifications	NACE Cathodic Protection Specialist #7987	
	Date	14 February 2018	

REVISION HISTORY

Revision:	Date:	Status:	Approved by:
0	12/18/2017	Generate Report	Shalini Dwarakapally
0	12/19/2017	Peer Review	Alwynn VanBuren
0	02/14/2018	Approved for Final Release	Nick Judd

EXECUTIVE SUMMARY

Corrpro was retained by Austin Energy to provide the cathodic protection (CP) comprehensive performance survey at Sand Hill Energy Center Del Valle, Texas. The survey was completed on November 30, 2017.

- A total of nine (9) rectifiers are providing a total of one hundred and eighty-eight (188) amps of protective current.
- From Unit 1 to 7, 32 of 68 (47%) of potential readings gathered on this survey meet the NACE polarized potential criteria.

Based on the findings from the 2017 annual CP survey, the following actions are recommended:

- Complete the missing potential measurements at Unit 6-7's test stations 13 and 15.
- For Units 1-4, only 6 out of the 26 test points are meeting the NACE polarized potential criteria. 4 of the 6 test points meeting the criteria are associated with the Fence. It is important to note that lines associated with Unit #1, #2, #3 and 4 are not meeting the NACE Criteria.
- Adjust the rectifier settings until the optimal cathodic protection current is achieved. It is recommended that bi-monthly surveys are conducted to ensure the optimal rectifier settings as the adjustments are made.
- Conduct bimonthly rectifier inspections (not to exceed 2.5-month intervals) to ensure continued operation and to establish cathodic protection for data trend analysis.
- Conduct an annual, instant-off cathodic protection survey to record polarized potential measurements.

The Corrpro Project Team includes:

- Project Manager –Alwynn Vanburen avanburen@aegion.com 713-460-6005
- Corrosion Technician – Jeremy Taylor jtaylor@aegion.com 346-237-5611
- Corrosion Engineer – Shalini Dwarakapally sdwarakapally@aegion.com 713-460-6062
- Engineering Supervisor – Nick Judd njudd@aegion.com 713-460-6096

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1. INTRODUCTION

Corrpro was retained by Austin Energy to provide the comprehensive cathodic protection survey report data collected by, a Corrosion Technician, Jeremy Taylor. The survey was completed on November 30, 2017.

This report discusses the data collected, conclusions and provides recommendation for all CP underground metallic piping and tanks for Units 1, 2, 3, 4, 5, 6 and 7.

2. REFERENCED STANDARDS, DEFINITIONS AND ACRONYMS

Standards:

- NACE International Standard Practice SP0169-2013 – "Control of External Corrosion on Underground or Submerged Metallic Piping Systems"
- NACE International Standard Practice SP0193-2016 – "External Cathodic Protection of On-Grade Carbon Steel Storage Tank Bottoms"
- NACE International Standard Practice SP0286-2007 – "Electrical Isolation of Cathodically Protected Pipelines"
- NACE International Standard Test Method TM0497-2012 – "Measurement Techniques Related to Criteria for Cathodic Protection on Underground or Submerged Metallic Piping Systems"

Definitions:

- Native Potential – Pipe-to-soil or structure-to-soil potential recorded before the cathodic protection current is applied
- On Potential – Pipe-to-soil or structure-to-soil potential recorded while the cathodic protection current is being applied
- Instant-Off Potential – Pipe-to-soil or structure-to-soil potential recorded immediately after the cathodic protection current is turned off (polarized potential)

Acronyms:

- CP – Cathodic Protection
- CSE – Copper/Copper Sulfate Reference Electrode
- ICCP – Impressed Current Cathodic Protection
- STP – South Texas Project

3. CRITERIA OF PROTECTION

The following criteria are the basis for the cathodic protection survey presented.

Appropriate cathodic protection levels are determined in accordance with NACE SP0169-2013 and NACE SP0193-2016, which is a standardized set of criteria regarding pipe-to-soil and structure-to-soil potential measurements that evaluate the effectiveness of cathodic protection on metallic piping system. A structure is considered cathodically protected if:

1. Criteria that have been documented through empirical evidence to indicate corrosion control effectiveness on specific piping systems may be used on those piping systems or others with the same characteristics
2. A minimum of 100 mV of cathodic polarization. Either the formation or the decay of polarization must be measured to satisfy this criterion
3. A structure-to-electrolyte potential of -850mV or more negative as measured with respect to a saturated copper/copper sulfate (CSE) reference electrode. This potential may be either a direct measurement of the polarized potential or a current-applied potential. Interpretation of a current-applied measurement requires consideration of the significance of voltage drops in the earth and metallic paths

Appropriate procedures are determined in accordance with NACE SP0286-2007, which is a standardized set of practices regarding isolation of cathodically protected pipelines. These practices dictate that:

1. Pipelines to be cathodically protected must be isolated from other metallic structures unless the CP system has incorporated sufficient current drain for other structures
2. Electrical isolation can minimize or eliminate galvanic corrosion by dissimilar metals in contact with each other
3. A difference in potential of 100mV or greater to CSE can be observed across an isolation kit to confirm isolation. In absence of this an Isolation Kit tester may be used

4. DESCRIPTION OF STRUCTURES

Austin Energy's CP system, at Sand Hill Energy center in Del Valle, TX. The ICCP system with air cooled rectifiers in place are required to protect all underground metallic piping and tanks for Unit 1-4, Unit 5, and Unit 6-7. The utilities site plan general arrangement is shown in Figure 1 below:

Figure 1: Utilities Site Plan General Arrangement

5. DESCRIPTION OF CATHODIC PROTECTION SYSTEMS

The ICCP system consists of 9 rectifiers with deep and distributed anode groundbeds.

- Unit 1 to 4 – Four (4) air-cooled rectifiers with deep anode ground bed.
- Unit 5 – Four (4) air-cooled rectifiers - Rectifier #1 & #2 with distributed groundbed and Rectifier #3 & #4 with deep anode groundbed.
- Unit 6 to 7 – One (1) air-cooled rectifier with deep anode ground bed.

The list of the rectifiers providing CP inside the Utilities site plan is provided in Table 1 below:

Table 1: Description of the Cathodic Protection Systems

Rectifier ID.	Serial No.	Operational Status
R-1 Unit 5	1456UO403	Operating
R-2 Unit 5	30776	Operating
R3- Unit 5	153041	Operating
R4-Unit 5	160072	Operating
R1 Unit6-7	92666	Operating
R-1 Unit 1	153722	Operating
R-2 Unit 2	1458UO403	Operating
R-3 Unit 3	1457UO403	Operating
R-4 Unit 4	153721	Operating

6. DATA AND FINDINGS

A total of nine (9) cathodic protection rectifiers were tested and inspected:

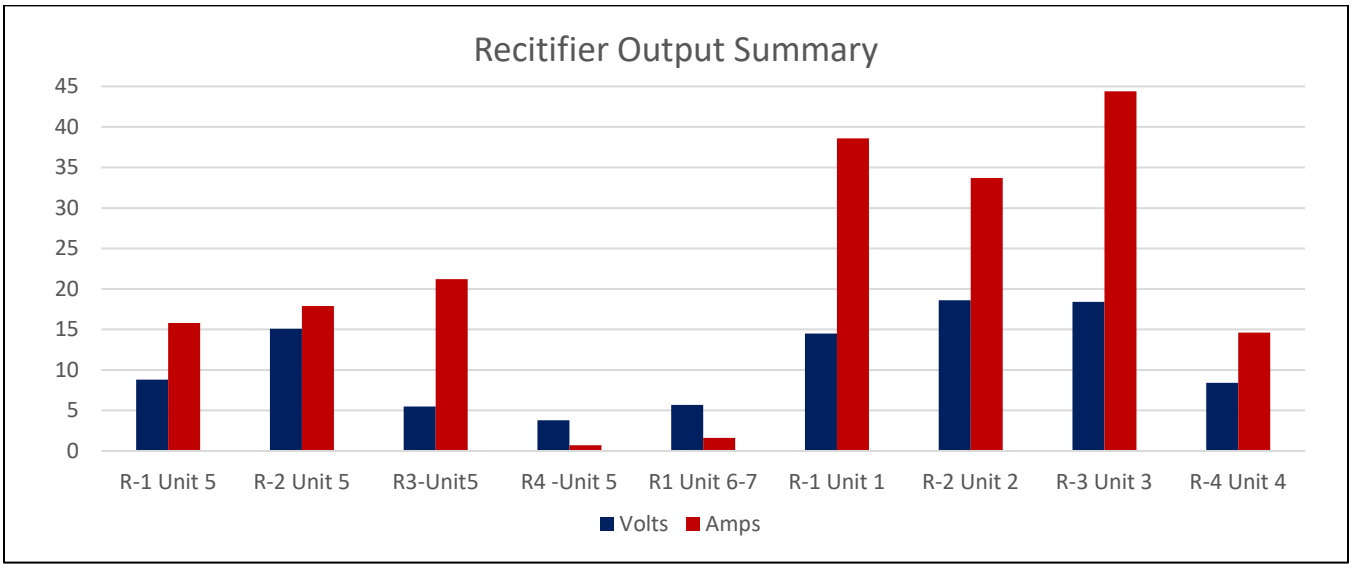
- To assess the operating conditions
- For physical or electrical abnormalities due to damage
- To verify onboard DC meter operation.

The nine (9) rectifiers are providing a total of one hundred and eighty-eight (188) amps of protective current. Below are the key findings from the survey:

- Units 1-4, only 6 out of the 26 test points are meeting the NACE polarized potential criteria. 4 of the 6 test points meeting the criteria are associated with the Fence. It is important to note that lines associated with Unit #1, #2, #3 and 4 are not meeting the NACE Criteria.
- Fuel gas Isolation kit on Unit 1 to 4 is in good condition.

- Unit 5 test stations #27, #33 & #37 are meeting the 100-mV polarized potential but not the -850-mV polarized potential criteria.
- The three ICCP rectifiers – R-1 Unit 1, R-2 Unit 1, R-3 Unit 1 produced a total of 116.7 amps of cathodic protection current.
- The two ICCP rectifiers – R-4 Unit 5, R-1 Unit 6-7 produced a total of 2.3 amps of cathodic protection current.
- Test lead is broken at the Unit 5 Test station #43.
- Unit 6 to 7 test station #13 and #14 missing the potential measurements and the information is inaccessible and non-readable.

The rectifier datasheets are presented in Appendix A, and the rectifier output summary is presented in Figure below:



Potential measurements were taken at sixty-eight (68) test points as required per survey. The accepted criteria follows NACE polarized potential criteria. The polarized potential of more electronegative than -1,200 mV/CSE is considered as over-protection to the structure.

The summary of the potential measurement results is presented in Table 2 below.

Table 2: Summary of Potential Measurements Result

	Survey
Total number of test Points	70
Total number of unavailable potential measurements	2
Total number of potential measurements	68
Total number of potential measurements satisfying NACE criteria	32
Total number of Instant OFF potential measurements less electronegative than -850 mV	36
Percentage of potential measurements satisfying NACE Criteria	47%

The potential measurement datasheet is presented in Appendix B.

7. CONCLUSIONS

Based on evaluation of the rectifier data Corrpro makes the following conclusions:

- A total of nine (9) rectifiers are providing a total of one hundred and eighty-eight (188) amps of protective current to utilities site plan.
- A total 32 of 68 (47%) of potential readings gathered on this survey meet the NACE polarized potential criteria.
- The three ICCP rectifiers – R1 Unit 1, R-2 Unit 1, R-3 Unit 1 produced a total of 116.7 amps of cathodic protection current.
- The two ICCP rectifiers - R4 Unit 5, R-1 Unit 6-7 produced a total of 2.3 amps of cathodic protection current.
- For Units 1-4, only 6 out of the 26 test points are meeting the NACE polarized potential criteria. 4 of the 6 test points meeting the criteria are associated with the Fence. It is important to note that lines associated with Unit #1, #2, #3 and 4 are not meeting the NACE Criteria.

8. RECOMMENDATIONS

Based on the above conclusions Corrpro provides the following recommendations:

- Replace the broken test lead at Unit 5 Test station #43.
- Complete the missing potential measurements at Unit 6-7 test point #13, #15 to provide the complete cathodic protection data for the utilities site plan.
- Adjust the rectifier settings until the optimal cathodic protection current is achieved. It is recommended that bi-monthly surveys are conducted to ensure the optimal rectifier settings as the adjustments are made.

- Continue the annual cathodic protection survey to ensure continuous cathodic protection.

APPENDIX A: CP POWER SOURCE DATA

Cathodic Protection Survey
Rectifier Data Sheet

Appendix B

Rectifier ID	R-1 Unit 5	**Job No.**	34030	**Customer**	Austin Energy	**Date**	11/30/17		
Location	Austin	**Inspector**	Jeremy Tay	**DC Rating**	100	**Volts**	50	**Amps**	
Mfg	Matcor	**Serial No.**	1456UO403	**AC Rating**	230/460	**Volts**	3	**Phase**	
		Type (circle one):	Air						
Shunt Rating	50		50	**Amps**	**Tap Range**	1/5	**Coarse**	1/5	**Fine**

CALIBRATION AND ADJUSTMENT

		DC VOLTS	DC AMPERES	TAP SETTING			
As Found	**Rectifier Meter**	8.8	15.8	**Coarse**	1	**Fine**	2
	Test Meter						
As Left	**Rectifier Meter**	8.8	15.8	**Coarse**	1	**Fine**	2
	Test Meter						

GROUNDBED INSPECTION

Junction Box Condition good **Vent**

ANODE CURRENT OUTPUT (Amps)

1.	2.52	**6.**		**11.**		**16.**	
2.	3.56	**7.**		**12.**		**17.**	
3.	3.64	**8.**		**13.**		**18.**	
4.	3.08	**9.**		**14.**		**19.**	
5.	2.96	**10.**		**15.**		**20.**	
	Total			15.76			

Ground Bed and Anode Details

Anode Type		
Max. Output Rating/Anode		**Amps**
Install Date		
G/B Configuration		
Depth/Length		**Ft.**

RECTIFIER OUTPUT HISTORY

	DC Output					
Taps	**Volts**	**Amps**	**Shunt (mV)**	**Date**	**Reader**	**Comments**

Remarks:

Photo:

Cathodic Protection Survey
Rectifier Data Sheet

Appendix B

Rectifier ID	R-2 Unit 5	**Job No.**	34030	**Customer**	Austin Energy	**Date**	11/30/17		
Location	Austin	**Inspector**	Jeremy Tay	**DC Rating**	90	**Volts**	60	**Amps**	
Mfg	Universal	**Serial No.**	30776	**AC Rating**	115/230	**Volts**	1	**Phase**	
		Type (circle one):	**Air**						
Shunt Rating	50	75	**Amps**	**Tap Range**	1/4	**Coarse**	1/6	**Fine**	

CALIBRATION AND ADJUSTMENT

		DC VOLTS	DC AMPERES	TAP SETTING			
As Found	**Rectifier Meter**	15.1	17.9	**Coarse**	1	**Fine**	4
	Test Meter						
As Left	**Rectifier Meter**	15.1	17.9	**Coarse**	1	**Fine**	4
	Test Meter						

GROUNDBED INSPECTION

Junction Box Condition good **Vent**

ANODE CURRENT OUTPUT (Amps)

1.	5.70	**6.**		**11.**		**16.**		**Ground Bed and Anode Details**	
2.	8.65	**7.**		**12.**		**17.**		**Anode Type**	
3.	3.55	**8.**		**13.**		**18.**		**Max. Output Rating/Anode**	**Amps**
4.		**9.**		**14.**		**19.**		**Install Date**	
5.		**10.**		**15.**		**20.**		**G/B Configuration**	
Total				**17.90**				**Depth/Length**	**Ft.**

RECTIFIER OUTPUT HISTORY

	DC Output					
Taps	**Volts**	**Amps**	**Shunt (mV)**	**Date**	**Reader**	**Comments**

Remarks:

Photo:

Cathodic Protection Survey
Rectifier Data Sheet

Appendix B

Rectifier ID	R-3 Unit 5	**Job No.**	34030	**Customer**	Austin Energy		**Date**	11/30/17	
Location	Austin	**Inspector**	Jeremy Tay	**DC Rating**	30	**Volts**		30	**Amps**
Mfg	Universal	**Serial No.**	153041	**AC Rating**	230/460	**Volts**		3	**Phase**

Type (circle one): Air

Shunt Rating	50	**Volts**	50	**Amps**	**Tap Range**	1/5	**Coarse**	1/6	**Fine**

CALIBRATION AND ADJUSTMENT

		DC VOLTS	DC AMPERES	TAP SETTING			
As Found	**Rectifier Meter**	5.5	21.2	**Coarse**	2	**Fine**	2
	Test Meter						
As Left	**Rectifier Meter**	5.5	21.2	**Coarse**	2	**Fine**	2
	Test Meter						

GROUNDBED INSPECTION

Junction Box Condition good **Vent**

ANODE CURRENT OUTPUT (Amps)

1.		**6.**		**11.**		**16.**		**Ground Bed and Anode Details**	
2.		**7.**		**12.**		**17.**		**Anode Type**	
3.		**8.**		**13.**		**18.**		**Max. Output Rating/Anode**	**Amps**
4.		**9.**		**14.**		**19.**		**Install Date**	
5.		**10.**		**15.**		**20.**		**G/B Configuration**	
Total				**0.00**				**Depth/Length**	**Ft.**

RECTIFIER OUTPUT HISTORY

	DC Output					
Taps	**Volts**	**Amps**	**Shunt (mV)**	**Date**	**Reader**	**Comments**

Remarks:

Photo:

Cathodic Protection Survey
Rectifier Data Sheet

Appendix B

Rectifier ID	R-4 Unit 5	**Job No.**	34030	**Customer**	Austin Energy		**Date**	11/30/17	
Location	Austin	**Inspector**	Jeremy Tay	**DC Rating**	50	**Volts**	50	**Amps**	
Mfg	matcor	**Serial No.**	160072	**AC Rating**	115/230	**Volts**	1	**Phase**	

Type (circle one): Air

Shunt Rating	50	**Volts**	50	**Amps**	**Tap Range**	1/3	**Coarse**	1/6	**Fine**

CALIBRATION AND ADJUSTMENT

		DC VOLTS	DC AMPERES	TAP SETTING			
As Found	**Rectifier Meter**	3.8	0.7	**Coarse**	1	**Fine**	1
	Test Meter						
As Left	**Rectifier Meter**	3.8	0.7	**Coarse**	1	**Fine**	1
	Test Meter						

GROUNDBED INSPECTION

Junction Box Condition good **Vent**

ANODE CURRENT OUTPUT (Amps)

1.		**6.**		**11.**		**16.**		**Ground Bed and Anode Details**	
2.		**7.**		**12.**		**17.**		**Anode Type**	
3.		**8.**		**13.**		**18.**		**Max. Output Rating/Anode**	**Amps**
4.		**9.**		**14.**		**19.**		**Install Date**	
5.		**10.**		**15.**		**20.**		**G/B Configuration**	
Total				**0.00**				**Depth/Length**	**Ft.**

RECTIFIER OUTPUT HISTORY

	DC Output					
Taps	**Volts**	**Amps**	**Shunt (mV)**	**Date**	**Reader**	**Comments**

Remarks:

Photo:

Cathodic Protection Survey
Rectifier Data Sheet

Appendix B

Rectifier ID	R-1 Unit 6-7	**Job No.**	34030	**Customer**	Austin Energy		**Date**	11/30/17	
Location	Austin	**Inspector**	Jeremy Tay	**DC Rating**	20	**Volts**	20	**Amps**	
Mfg	Universal	**Serial No.**	92666	**AC Rating**	115/230	**Volts**	1	**Phase**	

Type (circle one): Air

Shunt Rating	50	**Volts**	25	**Amps**	**Tap Range**	1/3	**Coarse**	1/6	**Fine**

CALIBRATION AND ADJUSTMENT

		DC VOLTS	DC AMPERES	TAP SETTING			
As Found	**Rectifier Meter**	5.7	1.6	**Coarse**	1	**Fine**	4
	Test Meter						
As Left	**Rectifier Meter**	5.7	1.6	**Coarse**	1	**Fine**	4
	Test Meter						

GROUNDBED INSPECTION

Junction Box Condition good **Vent**

ANODE CURRENT OUTPUT (Amps)

1.	0.30	**6.**		**11.**		**16.**	
2.	0.20	**7.**		**12.**		**17.**	
3.	0.30	**8.**		**13.**		**18.**	
4.	0.30	**9.**		**14.**		**19.**	
5.	0.40	**10.**		**15.**		**20.**	
	Total			**1.50**			

Ground Bed and Anode Details

Anode Type		
Max. Output Rating/Anode		**Amps**
Install Date		
G/B Configuration		
Depth/Length		**Ft.**

RECTIFIER OUTPUT HISTORY

	DC Output					
Taps	**Volts**	**Amps**	**Shunt (mV)**	**Date**	**Reader**	**Comments**

Remarks:

Photo:

Cathodic Protection Survey
Rectifier Data Sheet

Appendix B

Rectifier ID	R-1 Unit 1	**Job No.**	34030	**Customer**	Austin Energy		**Date**	11/30/17	
Location	Austin	**Inspector**	Jeremy Tay	**DC Rating**	40	**Volts**		80	**Amps**
Mfg	Matcor	**Serial No.**	153722	**AC Rating**	230/460	**Volts**		3	**Phase**

Type (circle one): Air

Shunt Rating	50	**Volts**	100	**Amps**	**Tap Range**	1/3	**Coarse**	1/6	**Fine**

CALIBRATION AND ADJUSTMENT

		DC VOLTS	DC AMPERES	TAP SETTING			
As Found	**Rectifier Meter**	14.5	38.6	**Coarse**	1	**Fine**	5
	Test Meter						
As Left	**Rectifier Meter**	14.5	38.6	**Coarse**	1	**Fine**	5
	Test Meter						

GROUNDBED INSPECTION

Junction Box Condition | **Vent**

ANODE CURRENT OUTPUT (Amps)

1.		**6.**		**11.**		**16.**		**Ground Bed and Anode Details**	
2.		**7.**		**12.**		**17.**		**Anode Type**	
3.		**8.**		**13.**		**18.**		**Max. Output Rating/Anode**	**Amps**
4.		**9.**		**14.**		**19.**		**Install Date**	
5.		**10.**		**15.**		**20.**		**G/B Configuration**	
Total				0.00				**Depth/Length**	**Ft.**

RECTIFIER OUTPUT HISTORY

	DC Output					
Taps	**Volts**	**Amps**	**Shunt (mV)**	**Date**	**Reader**	**Comments**

Remarks:

Photo:

Cathodic Protection Survey
Rectifier Data Sheet

Appendix B

Rectifier ID	R-2 Unit 2	**Job No.**	34030	**Customer**	Austin Energy		**Date**	11/30/17	
Location	Austin	**Inspector**	Jeremy Tay	**DC Rating**	100	**Volts**	50	**Amps**	
Mfg	Matcor	**Serial No.**	1458Uo403	**AC Rating**	230/460	**Volts**	3	**Phase**	

Type (circle one): Air

Shunt Rating	50	**Volts**	50	**Amps**	**Tap Range**	1/5	**Coarse**	1/5	**Fine**

CALIBRATION AND ADJUSTMENT

		DC VOLTS	DC AMPERES	TAP SETTING			
As Found	**Rectifier Meter**	18.6	33.7	**Coarse**	1	**Fine**	4
	Test Meter						
As Left	**Rectifier Meter**	18.6	33.7	**Coarse**	1	**Fine**	4
	Test Meter						

GROUNDBED INSPECTION

Junction Box Condition | **Vent**

ANODE CURRENT OUTPUT (Amps)

1.	10.08	**6.**		**11.**		**16.**		**Ground Bed and Anode Details**	
2.	0.08	**7.**		**12.**		**17.**		**Anode Type**	
3.	7.60	**8.**		**13.**		**18.**		**Max. Output Rating/Anode**	**Amps**
4.	8.84	**9.**		**14.**		**19.**		**Install Date**	
5.	7.28	**10.**		**15.**		**20.**		**G/B Configuration**	
	Total			**33.88**				**Depth/Length**	**Ft.**

RECTIFIER OUTPUT HISTORY

	DC Output					
Taps	**Volts**	**Amps**	**Shunt (mV)**	**Date**	**Reader**	**Comments**

Remarks:

Photo:

Cathodic Protection Survey
Rectifier Data Sheet

Appendix B

Rectifier ID	R-3 Unit 3	**Job No.**	34030	**Customer**	Austin Energy		**Date**	11/30/17	
Location	Austin	**Inspector**	Jeremy Tay	**DC Rating**	100	**Volts**	50	**Amps**	
Mfg	Matcor	**Serial No.**	1457UO403	**AC Rating**	230/460	**Volts**	3	**Phase**	

Type (circle one): Air

Shunt Rating	50	**Volts**	50	**Amps**	**Tap Range**	1/5	**Coarse**	1/5	**Fine**

CALIBRATION AND ADJUSTMENT

		DC VOLTS	DC AMPERES	TAP SETTING			
As Found	**Rectifier Meter**	18.4	44.4	**Coarse**	1	**Fine**	4
	Test Meter						
As Left	**Rectifier Meter**	18.4	44.4	**Coarse**	1	**Fine**	4
	Test Meter						

GROUNDBED INSPECTION

Junction Box Condition | **Vent**

ANODE CURRENT OUTPUT (Amps)

1.	9.20	**6.**		**11.**		**16.**		**Ground Bed and Anode Details**	
2.	8.40	**7.**		**12.**		**17.**		**Anode Type**	
3.	9.08	**8.**		**13.**		**18.**		**Max. Output Rating/Anode**	**Amps**
4.	7.52	**9.**		**14.**		**19.**		**Install Date**	
5.	7.16	**10.**		**15.**		**20.**		**G/B Configuration**	
	Total			**41.36**				**Depth/Length**	**Ft.**

RECTIFIER OUTPUT HISTORY

	DC Output					
Taps	**Volts**	**Amps**	**Shunt (mV)**	**Date**	**Reader**	**Comments**

Remarks:

Photo:

Cathodic Protection Survey
Rectifier Data Sheet

Appendix B

Rectifier ID	R-4 Unit 4	**Job No.**	34030	**Customer**	Austin Energy		**Date**	11/30/17	
Location	Austin	**Inspector**	Jeremy Tay	**DC Rating**	100	**Volts**	50	**Amps**	
Mfg	Matcor	**Serial No.**	153721	**AC Rating**	230/460	**Volts**	3	**Phase**	

Type (circle one): Air

Shunt Rating	50	**Volts**	50	**Amps**	**Tap Range**	1/3	**Coarse**	1/6	**Fine**

CALIBRATION AND ADJUSTMENT

		DC VOLTS	DC AMPERES	TAP SETTING			
As Found	**Rectifier Meter**	8.4	14.6	**Coarse**	2	**Fine**	3
	Test Meter						
As Left	**Rectifier Meter**	8.4	14.6	**Coarse**	2	**Fine**	3
	Test Meter						

GROUNDBED INSPECTION

Junction Box Condition **Vent**

ANODE CURRENT OUTPUT (Amps)

1.		**6.**		**11.**		**16.**		**Ground Bed and Anode Details**	
2.		**7.**		**12.**		**17.**		**Anode Type**	
3.		**8.**		**13.**		**18.**		**Max. Output Rating/Anode**	**Amps**
4.		**9.**		**14.**		**19.**		**Install Date**	
5.		**10.**		**15.**		**20.**		**G/B Configuration**	
Total				0.00				**Depth/Length**	**Ft.**

RECTIFIER OUTPUT HISTORY

	DC Output					
Taps	**Volts**	**Amps**	**Shunt (mV)**	**Date**	**Reader**	**Comments**

Remarks:

Photo:

APPENDIX B: POTENTIAL MEASUREMENT DATA

Impressed Current CP Form

Appendix A

Job Number	34030	**Date of Survey:**	1-Dec-17
Company:	Austin Energy	**Line/System:**	Power System
Type of Survey:	Annual Survey	**Surveyor:**	Jeremy Taylor

Location	Native/Static (mV)	ON (mV)	Instant OFF (mV)	Shift (Depolarized) (mV)	Latitude	Longitude	Remarks
Unit 1							
Fuel Gas		-534	-400				Iso Kit on -270/ off -250
Supply		-864	-643				
Return		-596	-574				
SS 1"		-533	-507				
Test Station inside unit 1&2		-616	-534				
Unit 2							
Fuel Gas		-515	-483				Iso Kit good on -865/off -833
Supply		-543	-521				
Return		-1011	-977				
SS 1"		-585	-547				
Unit 3							
Fuel Gas		-609	-575				Iso Kit good on-257/off -254
Supply		-615	-573				
Return		-615	-575				
SS 1"		-534	-514				
Test Station inside unit 3&4		-521	-455				
Unit 4							
Fuel Gas		-614	-585				Iso Kit good on -398/ off -396
Supply		-624	-582				
Return		-623	-581				
SS 1"		-578	-546				
3' stainless steel		-678	-532				
12" pipe west of building		-563	-489				
12" inlet and return pipine north of building		-653	-522				
North Fence		-1432	-1112				
West Fence		-1502	-1128				
East Fence		-1428	-1098				
Fence NW of Plant		-1474	-1050				
Power line Ground anchor cable		-1337	-1020				

Impressed Current CP Form

Appendix A

Job Number	34030	**Date of Survey:**	1-Dec-17
Company:	Austin Energy	**Line/System:**	Power System
Type of Survey:	Annual Survey	**Surveyor:**	Jeremy Taylor

Location	Native/Static (mV)	ON (mV)	Instant OFF (mV)	Shift (Depolarized) (mV)	Latitude	Longitude	Remarks
TS1	-832	-2331	-905	73			
TS4		-841	-699				
TS5		-2021	-1046				
TS10	-587	-1329	-631	44			
TS21	-384	-488	-920	536			
TS22	-575	-475	-467	-108			Ref cell is good at test station
TS23	-575	-917	-877	302			Galvanic anode attached
TS24	-660	-1096	-985	325			Galvanic anode attached
TS25	-638	-1315	-1236	598			Galvanic anode attached
TS26	-640	-1156	-923	283			
TS27	-701	-1067	-843	142			
TS28	-757	-1170	-861	104			
TS29	-749	-2388	-1201	452			
TS30	-739	-2170	-1168	429			
TS31	-735	-1339	-1072	337			
TS32	-538	-3035	-1164	626			
TS33	-342	-976	-795	453			
TS34	-575	-1040	-951	376			
TS35		-1098	-950	950			
TS36	-839	-1114	-980	141			
TS37	-309	-842	-745	436			
TS38	-873	-978	-875	2			
TS39	-837	-1102	-1093	256			
TS40	-794	-1310	-1027	233			
TS41	-833	-1640	-1104	271			
TS42	-830	-1632	-1033	203			
TS43	-830	-332	-321	-509			test leads broken
TS44	-893	-1553	-1296	403			

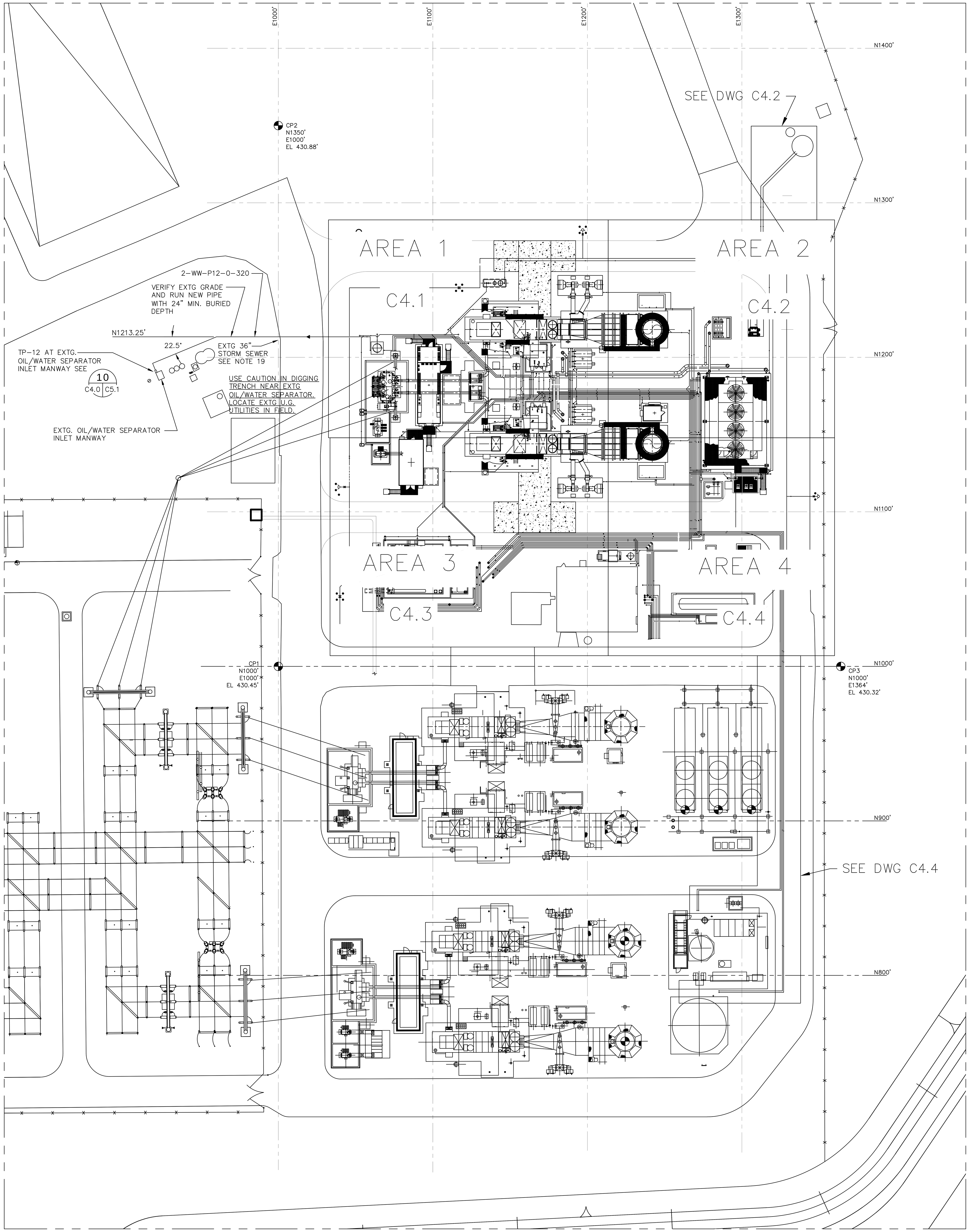
Impressed Current CP Form

Appendix A

Job Number	34030	**Date of Survey:**	1-Dec-17
Company:	Austin Energy	**Line/System:**	Power System
Type of Survey:	Annual Survey	**Surveyor:**	Jeremy Taylor

Location	Native/Static (mV)	ON (mV)	Instant OFF (mV)	Shift (Depolarized) (mV)	Note	Longitude	Remarks
TP1		-1550	-843				Galvanic test station on Fire water .1 on .01 shunt
TP2		-1355	-1053				Galvanic test station on Fire water .1 on .01 shunt
TP3		-943	-522				
TP4		-1083	-612				
TP5		-1268	-846				Galvanic test station on Fire water .7 on .01 shunt
TP6		-1525	-910				Galvanic test station on Fire water . 5 on .01 shun
TP7		-961	-488				
TP8		-1230	-678				
TP9		-1079	-643				
TP10		-1516	-1037				Galvanic test station on Fire water .1 on .01 shunt
TP11		-1840	-1037				No shunt anode diret attached
TP12		-1432	-909				Galvanic test station on Fire water .2 on .01 shunt
TP13							Inacessable
TP14		-990	-550				
TP15							Non Readable
TP16		-841	-699				

APPENDIX C: SITE WIDE MAPS



UNDERGROUND UTILITIES SITE PLAN AND KEY PLAN

SCALE: 1"=30'-0"

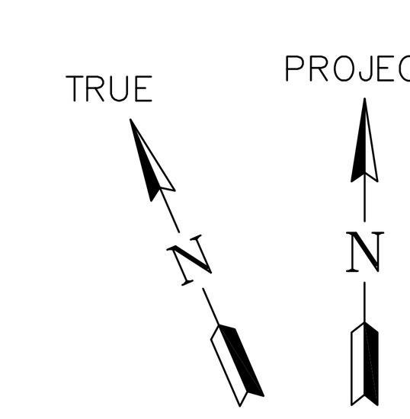
NOTES:

1. EXISTING UNDERGROUND FEATURES AND NEW UNDERGROUND FEATURES BY OTHERS ARE SHOWN BASED ON THE BEST AVAILABLE INFORMATION. CONTRACTOR SHALL VERIFY IN FIELD ALL PERTINENT DIMENSIONS AND EXISTING CONDITIONS PRIOR TO EXCAVATION OR FABRICATION OF NEW WORK.
2. UNDERGROUND PIPING SHALL BE RUN LEVEL OR UNIFORMALLY SLOPED BETWEEN SUCCESSIVE INVERT OR BOTTOM OF PIPE ELEVATIONS SHOWN.
3. UNLESS INDICATED OTHERWISE BY INVERT ELEVATIONS SHOWN, SLOPE ALL GRAVITY DRAINS AT MIN. 1/8" PER FOOT IN THE DIRECTION OF FLOW.
4. UNLESS OTHERWISE NOTED, ALL DRAIN (ED & WWD) STUB-UPS SHALL BE SIZED AS SHOWN ON THE PLAN DRAWINGS AND TERMINATED WITH A DRAIN FUNNEL AT RIM ELEVATION AS SHOWN. FOR TYPICAL DRAIN FUNNEL DETAIL SEE 7 C4.0 | C5.1
5. ALL METALLIC PROCESS PIPING (EXCEPT CAST IRON GRAVITY DRAIN PIPING), EQUIPMENT, MATERIALS, ETC. INSTALLED UNDERGROUND SHALL BE CATHODICALLY PROTECTED. FOR REQUIREMENTS SEE SPECIFICATIONS.
6. MINIMUM COVER ABOVE ALL UNDERGROUND PIPING EXCEPT FIRE SERVICE PIPING SHALL BE 24" UNLESS OTHERWISE SHOWN. MINIMUM COVER ABOVE FIRE SERVICE PIPING SHALL BE 30" EXCEPT UNDER ROADWAYS IT SHALL BE 36" UNLESS OTHERWISE SHOWN.
7. UNLESS OTHERWISE SHOWN, TERMINATE ALL UNDERGROUND PIPE STUB-UPS AT THE ELEVATIONS SHOWN ABOVE FINAL GRADE OR CONCRETE WITH FLANGED ENDS OF THE TYPE SPECIFIED FOR THE SERVICE.
8. FOR TYPICAL CLEAN OUT DETAIL SEE 6 C4.0 | C5.1
9. FOR TYPICAL FIRE HYDRANT DETAIL SEE 1 C4.0 | C5.1
10. FOR TYPICAL POST INDICATING VALVE DETAIL SEE 3 C4.0 | C5.1
11. PROVIDE GUARD POSTS AT ALL FIRE HYDRANT AND POST INDICATING VALVE LOCATIONS. FOR TYPICAL GUARD POST DETAIL SEE 2 C4.0 | C5.1
12. UNLESS OTHERWISE SHOWN AS ABOVEGROUND, INSIDE OF VAULTS OR STUB-UPS, ALL PIPING IS UNDERGROUND.
13. PROVIDE TRACER WIRE ALONG ALL BURIED NONMETALLIC PIPING PER THE SPECIFICATIONS.
14. FOR EXCAVATION AND BACK FILLING FOR UNDERGROUND PIPING REFER TO SPECIFICATIONS SECTION 02200, "EARTHWORK".
15. COORDINATE THE INSTALLATION OF THE UNDERGROUND UTILITIES WITH THE ELECTRICAL DUCT BANKS AND THE STRUCTURAL FOUNDATIONS. EXCEPT WHERE SPECIFICALLY NOTED AND SHOWN ON THE UNDERGROUND UTILITY PLAN DRAWINGS, ALL UNDERGROUND PIPING IS RUN ABOVE THE ELECTRICAL DUCT BANKS. REFER TO THE ELECTRICAL DRAWINGS FOR THE SPECIFIC TOP AND BOTTOM ELEVATIONS OF THE ELECTRICAL DUCT BANKS.
16. PROVIDE SHORING AND SHEETING IN TRENCH EXCAVATIONS AS REQUIRED TO PREVENT INJURY TO PERSONS AND DAMAGE TO STRUCTURES PER ALL APPLICABLE OSHA AND LOCAL CODES.
17. FOR TYPICAL DRAIN VALVE BOX DETAIL SEE 8 C4.0 | C5.1
18. FITTINGS IN HDPE PIPING SYSTEMS SHALL BE STANDARD FABRICATED OR MOLDED FITTINGS OR CUSTOM FABRICATED AS REQUIRED WHERE NECESSARY FOR THE PIPING SYSTEMS TO CONFORM TO CONSTRICTED OR LIMITED SPACED AREAS IN THE INSTALLATION.
19. FIELD VERIFY LOCATION AND DEPTH OF EXTG. UNDERGROUND PIPING AND MAKE NECESSARY ADJUSTMENTS TO NEW PIPING DEPTH AS REQUIRED TO CLEAR ANY POSSIBLE OBSTRUCTION.

UNDERGROUND UTILITIES LEGEND:

ACW	AUXILLIARY COOLING WATER
AG	ABOVE GROUND
BF	BLIND FLANGE
BOD	BOTTOM OF DUCT ELEVATION
BOP	BOTTOM OF PIPE ELEVATION
C	CONDENSATE
CHW	CHILLED WATER
CO	CLEANOUT
CW	COOLING WATER (EXTG. PLANT)
DI	DEMINERALIZED WATER
ECC	ECCENTRIC
ED	EQUIPMENT DRAIN
(E)	EXISTING
EL	ELEVATION
EW	EACH WAY
FOB	FLAT ON BOTTOM
FOF	FACE OF FLANGE
FS	FIRE SERVICE
IA	INSTRUMENT AIR
INV	INVERT ELEVATION
HDPE	HIGH DENSITY POLYETHYLENE
(N)	NEW
NG	NATURAL GAS
NH3	AMMONIA
N.T.S.	NOT TO SCALE
O.D.	OUTSIDE DIAMETER
PA	PLANT AIR
PIV	POST INDICATING VALVE
PW	POTABLE WATER
RED	REDUCER
RIM	DRAIN FUNNEL RIM ELEVATION
RW	RAW WATER
SS	SANITARY SEWER
TOC	TOP OF CONCRETE ELEVATION
TOD	TOP OF DUCT ELEVATION
TOP	TOP OF PIPE ELEVATION
TYP.	TYPICAL
UG	UNDERGROUND
U.O.N.	UNLESS OTHERWISE NOTED
WWD	WATER WASH DRAIN (GRAVITY)
WW	WATER WASH DRAIN (PUMPED)

FEATURES BY OTHER DISCIPLINES OR N.I.C.
NEW PIPING AND RELATED FEATURES
SERVICE TIE-IN POINT
EQUIPMENT DRAIN STUB-UP WITH DRAIN FUNNEL
PROCESS PIPING STUB UP – SIZE 4" AND BELOW
PROCESS PIPING STUB UP – SIZE 6" AND ABOVE
CO — CLEAN OUT
HYD. — FIRE HYDRANT
GUARD POST (BOLLARD)
GATE VALVE
(REF) — DATA MUST BE VERIFIED IN FIELD
E7970' — COORDINATE DIMENSION
DRAIN VALVE BOX



STATE OF TEXAS
JAY KENNETH JOHNSON
93099
LICENSED PROFESSIONAL ENGINEER

GRAPHIC SCALE

1" = 30'-0" 0' 10' 20' 30' 60' 90'

SYMBOL	DATE	REVISION DESCRIPTION	DRAWN	APP'D
2	5-7-10	AS BUILT	SK	JKJ
1	6-26-09	REMOVED HOLD & REVISED AS NOTED	JJB	RS
0	5-26-09	ISSUED FOR CONSTRUCTION	JJB	RS

PB Power
A Parsons Brinckerhoff Company
303 SECOND STREET, SUITE 700 NORTH, SAN FRANCISCO, CALIFORNIA 94107

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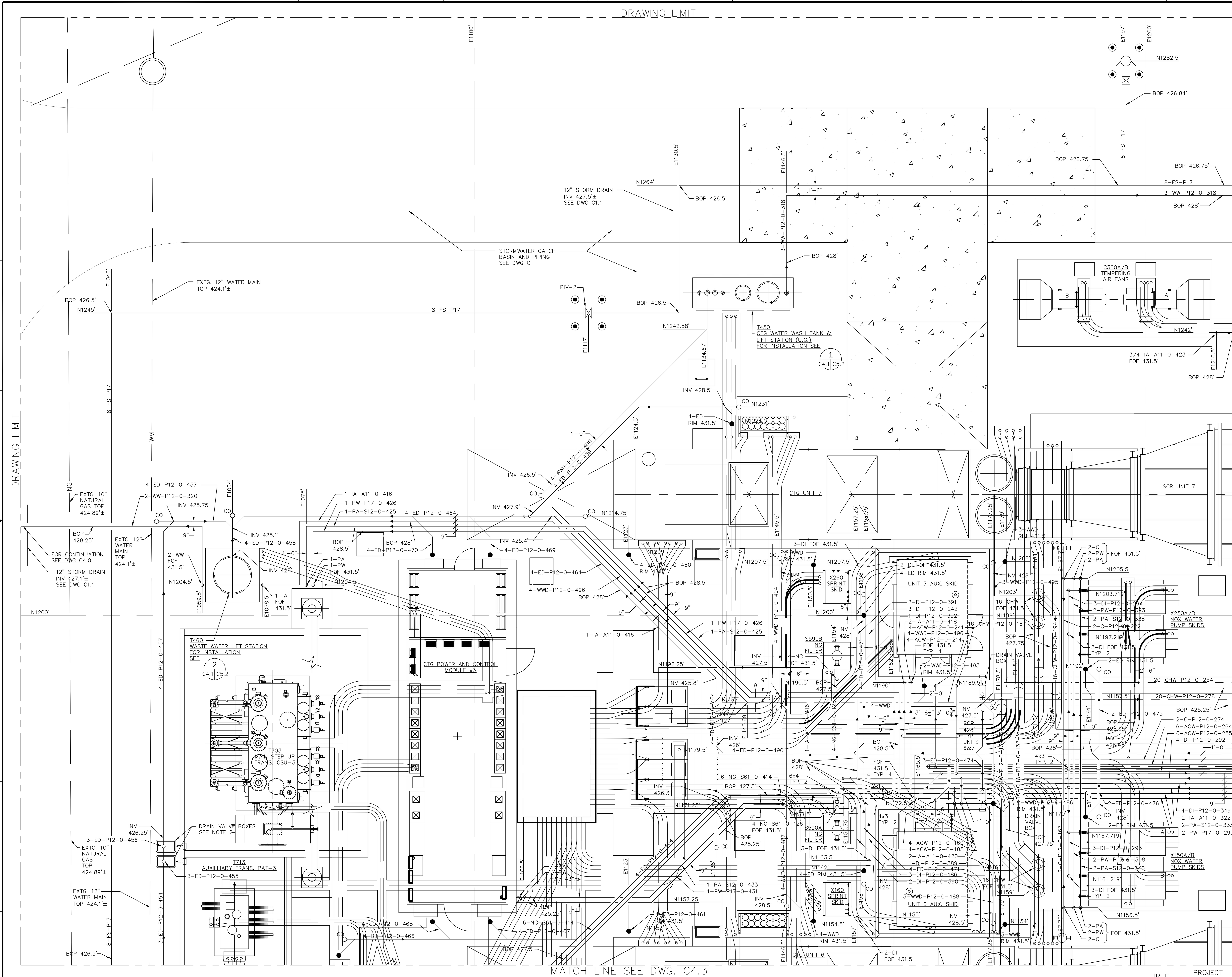
AUSTIN ENERGY®

SAND HILL ENERGY CENTER 100MW EXPANSION PROJECT
AUSTIN, TEXAS

UNDERGROUND UTILITIES SITE PLAN
KEY PLAN, LEGEND AND NOTES

DR. JJB
DES. JJB
CHK. GW
APPROVED DATE
PRINCIPAL IN CHARGE DATE
DRAWING NO. C4.0
REV 2
SHEET OF

H:\gen_draft\sand hill\unit 6 & 7 common\parson brinckerhoff pb_power\Civil\Underground Utilities and Site Work PBP\C4.0.dwg
Date 6-30-15 05:19pm Tuesday Plotted by: dukese
X-SHEC



UNDERGROUND UTILITIES PLAN - AREA 1

SCALE: 3/16"=1'-0"

GRAPHIC SCALE

3/16" = 1'-0" 0 1 2 4 6 8 10 12 14 16

TRUE PROJECT N

NOTES:

1. FOR UNDERGROUND UTILITIES NOTES AND LEGEND SEE DRAWING C4.0 .
2. DRAIN VALVE BOX THESE LOCATIONS SHALL BE INSTALLED SIMILAR TO THE DRAIN VALVE BOX DETAIL ON DWG. C5.1 EXCEPT THAT IT SHALL BE A CHRSTY MODEL B36 WITH MATCHING REQUIRED ACCESSORIES TO PROVIDE ACCESS TO DRAIN VALVE AT GREATER DEPTH. ALTERNATE TO TWO B36 BOXES, ONE LARGER BOX MAY BE PROVIDED TO GIVE THE REQUIRED ACCESS TO THE VALVE.

STATE OF TEXAS — JAY KENNETH JOHNSON — 93099 — LICENSED PROFESSIONAL ENGINEER

SYMBOL	DATE	REVISION DESCRIPTION	DRAWN	APP'D
4	5-7-10	AS BUILT	SK	JKJ
3	8-3-09	REVISED AS NOTED	JJB	RS
2	7-16-09	REVISED AS NOTED & REMOVED HOLD	JJB	RS
1	6-26-09	REVISED AS NOTED	JJB	RS
0	5-26-09	ISSUED FOR CONSTRUCTION	JJB	RS

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AUSTIN, TEXAS

UNDERGROUND UTILITIES PLAN – AREA 1

DR. JJB	APPROVED	DATE	DRAWING NO.	REV
DES. JJB			C4.1	4
CHK. GW	PRINCIPAL IN CHARGE	DATE	SHEET	OF

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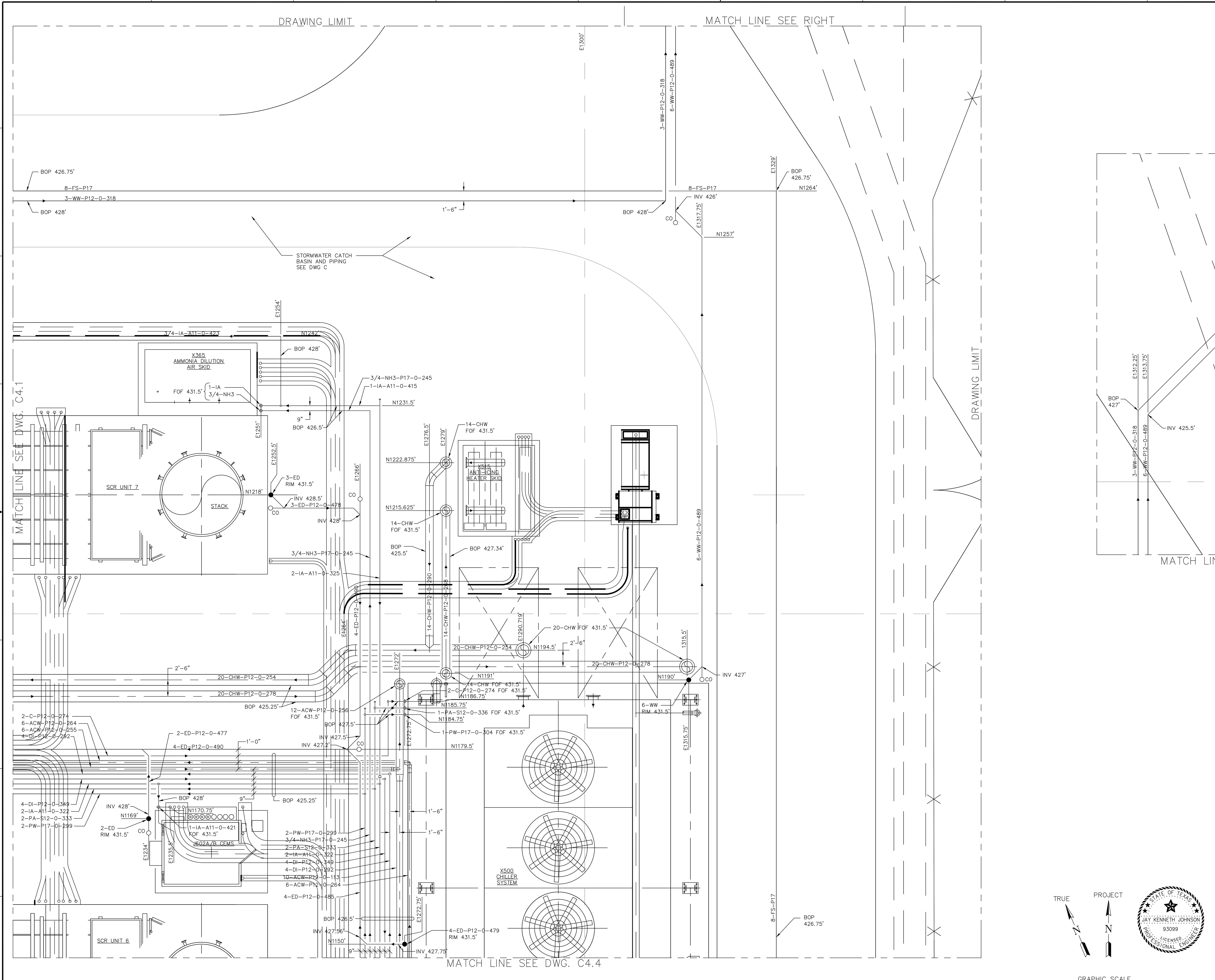

UNDERGROUND UTILITIES PLAN - AREA 2
SCALE: 3/16"=1'-0"

GRAPHIC SCALE
3/16" = 1'-0"   0 1 2 4 6 8 10 12 14 16

NOTES:

1. FOR UNDERGROUND UTILITIES NOTES AND LEGEND SEE DRAWING C4.0 .

SYMBOL	DATE	REVISION DESCRIPTION	DRAWN	APP'D
6	5-7-10	AS BUILT	SK	JKJ
5	8-26-09	REVISED AS NOTED	JJB	RS
4	7-27-09	REVISED AS NOTED, REMOVED HOLD	JJB	RS
3	7-16-09	REVISED AS NOTED, REMOVED HOLD	JJB	RS
2	7-1-09	REVISED AS NOTED	JJB	RS
1	6-26-09	REMOVED HOLD & REVISED AS NOTED	JJB	RS
0	5-26-09	ISSUED FOR CONSTRUCTION	JJB	RS

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UNDERGROUND UTILITIES PLAN – AREA 2

DR. JJB | DES. JJB | CHK. GW | APPROVED | DATE | PRINCIPAL IN CHARGE | DATE | DRAWING NO. C4.2 | REV 6 | SHEET | OF

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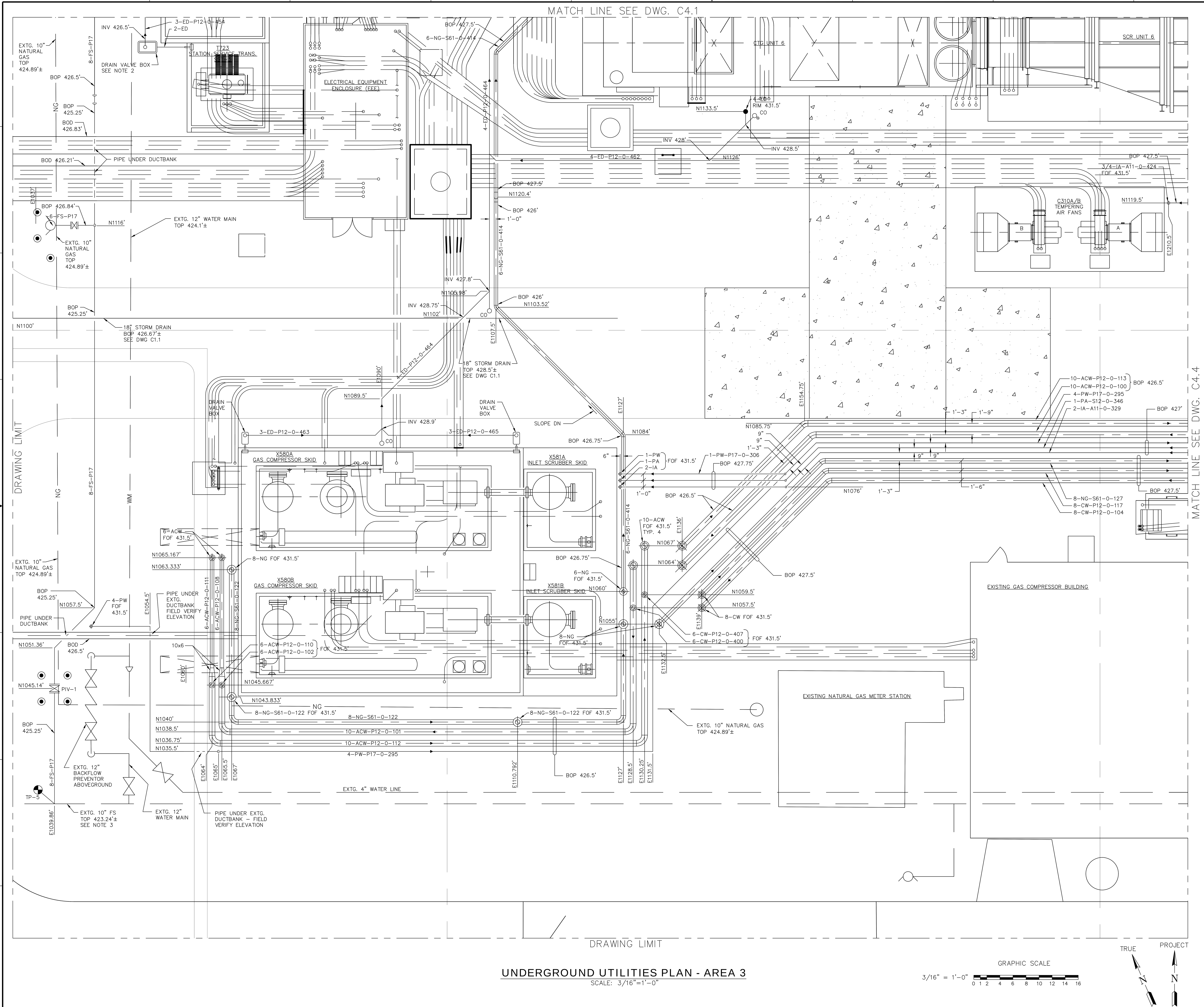

UNDERGROUND UTILITIES PLAN - AREA 3

SCALE: 3/16"=1'-0"

GRAPHIC SCALE

3/16" = 1'-0"   0 1 2 4 6 8 10 12 14 16

NOTES:

1. FOR UNDERGROUND UTILITIES NOTES AND LEGEND SEE DRAWING C4.0 .
2. DRAIN VALVE BOX THIS LOCATIONS SHALL BE INSTALLED SIMILAR TO THE DRAIN VALVE BOX DETAIL ON DWG. C5.1 EXCEPT THAT IT SHALL BE A CHRSTY MODEL B36 WITH MATCHING REQUIRED ACCESSORIES TO PROVIDE ACCESS TO DRAIN VALVE AT GREATER DEPTH.
3. FIELD VERIFY LOCATION AND DEPTH OF EXTG. UNDERGROUND PIPING AND MAKE NECESSARY ADJUSTMENTS TO NEW PIPING DEPTH AS REQUIRED TO CLEAR ANY POSSIBLE OBSTRUCTION.

STATE OF TEXAS
JAY KENNETH JOHNSON
93099
LICENSED
PROFESSIONAL ENGINEER

SYMBOL	DATE	REVISION DESCRIPTION	DRAWN	APP'D
6	5-7-10	AS BUILT	SK	JKJ
5	8-26-09	REVISED PER RFI #023	JJB	RS
4	7-29-09	REVISED PER RFI #017	JJB	RS
3	7-17-09	REVISED PER RFI #011	JJB	RS
2	7-16-09	REVISED AS NOTED	JJB	RS
1	6-26-09	REVISED AS NOTED	JJB	RS
0	5-26-09	ISSUED FOR CONSTRUCTION	JJB	RS

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UNDERGROUND UTILITIES PLAN – AREA 3

DR. JJB
DES. JJB
CHK. GW

APPROVED DATE
PRINCIPAL IN CHARGE DATE

DRAWING NO. C4.3
REV 6
SHEET OF

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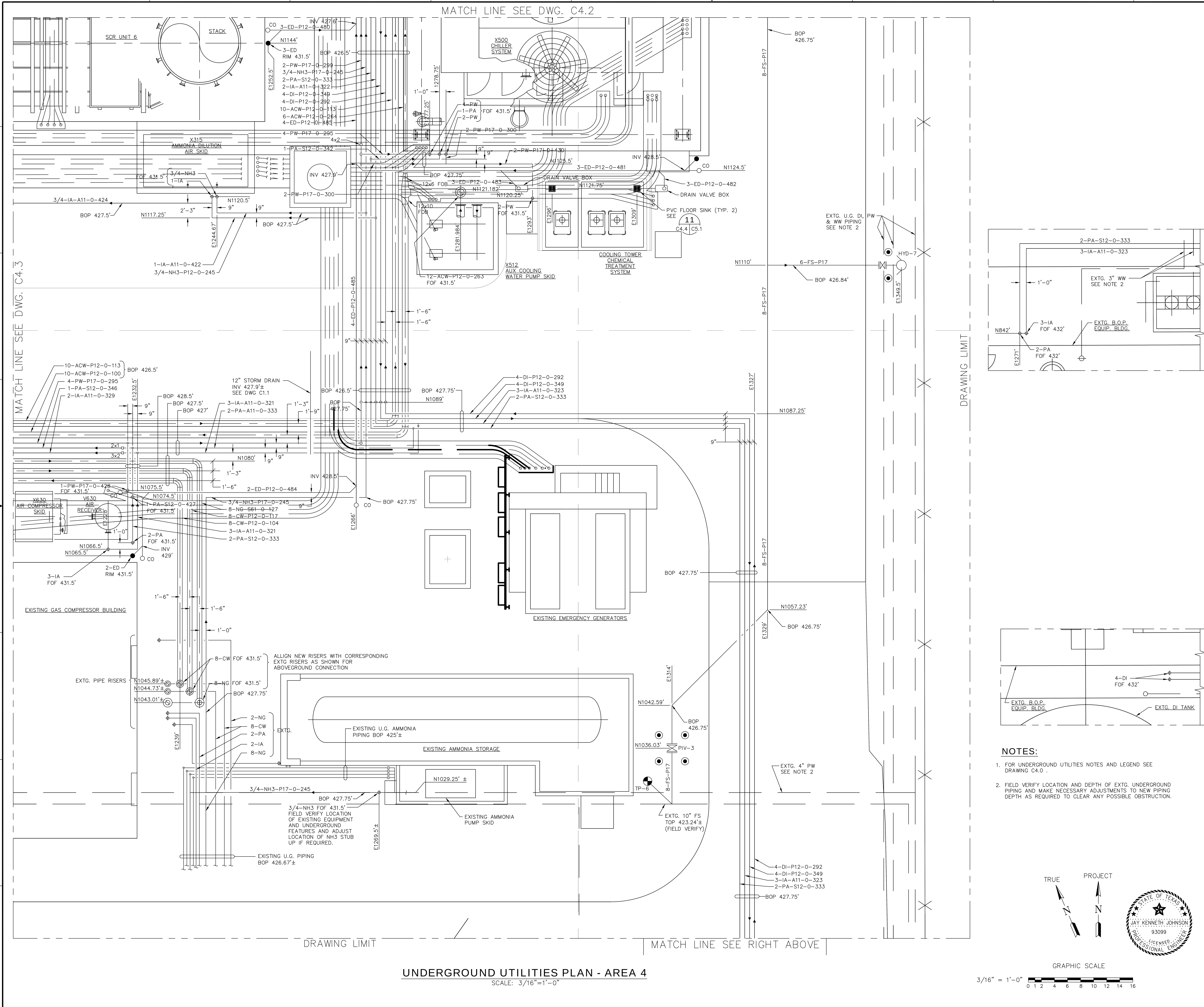

UNDERGROUND UTILITIES PLAN - AREA 4

SCALE: 3/16"=1'-0"

NOTES:

1. FOR UNDERGROUND UTILITIES NOTES AND LEGEND SEE DRAWING C4.0 .
2. FIELD VERIFY LOCATION AND DEPTH OF EXTG. UNDERGROUND PIPING AND MAKE NECESSARY ADJUSTMENTS TO NEW PIPING DEPTH AS REQUIRED TO CLEAR ANY POSSIBLE OBSTRUCTION.

SYMBOL	DATE	REVISION DESCRIPTION	DRAWN	APP'D
6	5-7-10	AS BUILT	SK	JKJ
5	8-26-09	REVISED PER RFI #024	JJB	RS
4	8-5-09	REVISED AS NOTED	JJB	RS
3	7-17-09	REVISED PER RFI #011, DRAIN REMV'D	JJB	RS
2	7-16-09	REVISED AS NOTED & REMOVED HOLD	JJB	RS
1	6-26-09	REVISED AS NOTED	JJB	RS
0	5-26-09	ISSUED FOR CONSTRUCTION	JJB	RS

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AUSTIN, TEXAS

UNDERGROUND UTILITIES PLAN – AREA 4

DR. JJB
DES. JJB
CHK. GW
APPROVED DATE
PRINCIPAL IN CHARGE DATE
DRAWING NO. C4.4
REV 6
SHEET OF

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Date 6-30-15 05:19pm Tuesday Plotted by: dukese

APPENDIX D: TESTING PROCEDURES

The following test procedures were utilized during the cathodic protection evaluation and are in accordance with industry standards.

- Visual Inspection
- Rectifier Electrical Inspection
- Structure-to-Potential Measurements

1. VISUAL INSPECTION

Corrpro performed a visual inspection of CP components (rectifiers, anode junction boxes, etc.) for physical or electrical damage and assessment of condition. This assessment is included in the report.

2. RECTIFIER ELECTRICAL INSPECTION

Assessment of operating condition of the rectifiers, including inspection for physical or electrical damage, verification of meter accuracy and general assessment of the rectifier condition was performed. Generated data and results are included within the appendix of this report. Rectifier voltage and current outputs were recorded using the built-in meters within the unit and verified utilizing a calibrated high impedance digital multi-meter by reading across the individual output lugs and calibrated measuring shunts.

3. STRUCTURE-TO-POTENTIAL MEASUREMENTS

Structure-to-soil potential measurements are used to determine the level of CP being provided to a structure by measuring the potential difference (voltage) between the structure and a reference electrode. A calibrated stationary CSE placed in soil adjacent to the structure is utilized. When the potential difference between the reference electrode and the structure meets one of the NACE recognized criteria, CP has been achieved on the structure in the vicinity of the reference electrode.

3.1. ON-POTENTIAL MEASUREMENTS

The application of CP current to a structure will cause the structure-to-soil potential values to become more negative. Potentials measured with CP current applied to the structure are referred to as on potential measurements. In cathodic protection systems with large current requirement, the on potential measurements can include an IR drop error. This error can cause erroneous results and must be considered when evaluating the potential value. IR consideration was in the form of comparison to previously established IR at each test point location.

3.2. INSTANT OFF-POTENTIAL MEASUREMENTS

The instant-off potential is also known as the polarized potential because the measurement is made immediately upon current interruption. Because there is no externally applied current, the IR-drop error is negligible.

4. TEST EQUIPMENT

Digital Voltmeter

A calibrated high impedance digital multi-feature voltmeter was used for the voltage and amperage output tests. The meter was a multi-scale, 10 MΩ input impedance, accurate to within one percent of full scale, covering the following full-scale ranges: 0-10 and 0-100 millivolts; 0-1, 0-10, 0-100 volts.

Stationary Copper/Copper Sulfate Reference Electrode

A calibrated stationary CSE was utilized for all potential readings on CP system to obtain measurements that most accurately represent the environment along the pipeline system.