Electrical Distribution System Study

Kennesaw State University

Final Study Report
<u>Revised</u>
December 16, 2011

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Primary Electrical Distribution System Study

Kennesaw State University

REVISED

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INDEX

FOR

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Kennesaw State University

Main Campus

Primary Electrical Distribution System Study

Executive Summary

Future Needs

Future electrical distribution system needs for the KSU main campus must be addressed by looking at the areas of the campus to be impacted by growth and the capability of the service from GPC. In the 2011 Master Plan Update – June 30, 2011 there are two future phases of development. Short term, Phase II, and long term, Phase III. Short term Phase II plans include approximately 811,300 square feet of facilities for campus educational improvements and 1,304,342 square feet of new parking facilities. The long term plan, Phase III adds an additional 1,050,799 square feet of facilities for campus educational improvements and 488,532 square feet of new parking facilities. Proposed usage and square feet for each building has been made available so the load impact for each Phase has been determined using Means Estimating Guide for watts / square foot for typical building usage. The data supporting the load impact is located on Page 13 of this report.

Phase II and Phase III Impact: The existing peak load recorded by Georgia Power Company (GPC) experienced in August of 2011 was 7,782kW. At the service entrance voltage of 12,470 volts, this equates to 360 amps. The full load rating of the GPC 10,000Kva transformer is 463 amps; and the 1000Kcmil GPC service entrance cable is rated at 525 amps. The calculated load increase at the completion of Phase II construction will exceed the full load rating of a single GPC 10,000Kva transformer in the existing GPC Substation by 1,700Kva (79 amps). GPC has two of that size transformer to provide built-in redundancy. This 17% overload would not damage the GPC transformer and could be sustained for an indefinite emergency period, but with any further load increase as development continues to Phase III, a poor situation will continue to worsen. As there is no area for expansion of the existing substation, and full redundancy from GPC is the goal for KSU, a second service entrance from a second substation is the appropriate answer. This new substation should be budgeted and constructed to coincide with Phase II construction and completed before any Phase III construction begins. We will visit feeder loading for Phase II and Phase III later in this discussion.

Recommendations

Electric utility infrastructure improvements to facilitate proposed Phase II and later Phase III construction can be broken into segments to facilitate funding for new construction. Until the approximate size, facility type, and anticipated construction dates all for the proposed new facilities in each Phase are provided, the timing of electric utility infrastructure improvements cannot be determined. Recommendations for individual items are as follows:

- Rebalance the existing feeders and re-establish normally open points. This exercise will balance the load on the individual loops and lower electrical stress on the cable adding to the reliability. See Load Balance Existing Conditions, Sheet 10.
- Replace nine (9) existing transformers to allow for loop feed with dead front construction and 600 amp terminations. See Campus Transformer Analysis Sheet 31.
- Reset existing relays on main switchgear in existing substation for increase in load for Phase II.
- As new Phase II buildings are constructed, connect new transformers to existing campus feeders as shown in the Addition Of Phase II table, Sheet 17 and Drawing E5.3.
- Locate and construct new GPC substation. If the existing substation is mirrored on the GPC side of the new substation at the new location, new campus feeders could be added with new switchgear, duct bank, manholes and cable to intercept existing cable and manholes to form a campus system with loop feeds from the North and South Substations able to handle the expansion into Phase III construction with additional capacity for continued growth. This new substation should be budgeted and constructed to be complete before Phase III campus expansion.
- Provide new feeder MC-3 / MD-3. Connect the new substation to existing #350Kcmil feeders MC-1/MD-1. This is the most heavily loaded feeder. Connection could be made with new manholes and minimum six-way duct bank from the new substation to existing Manhole #52 on Kennesaw State University Road. Cable would continue to Manhole #38 where connection would be made to MC-1/MD-1. See Sheets E5.4 and E5.5 in the drawings.

- Provide new feeders MA-4 / MB-4. Connect the new substation to #4/0 feeder MA-2 / MB-2. This is the next most loaded feeder. Connection could be made in the new
- manholes and six-way duct bank from the new substation to existing Manhole #52 on Kennesaw State University Road. Manhole #52 has the circuit presently looped through it. See Sheets E5.4 and E5.5 in the drawings.
- Provide new feeder MA-3 / MB-3. Connect new substation to #4/0 feeder MA-1/MB-1. This feeder will be impacted most by Phase III construction. New 4-way duct bank will be required to connect the new substation to a manhole in the vicinity of vault V-16 near Manhole #15 where cable can be extended to Manhole#15 to connect or directly to Manhole #22 near the West Parking Deck where connection can be made to MA-1/MB-1. See Sheets E5.4 and E5.5 in the drawings.

Project Cost

Note: Design to be phased to meet available funding and scheduling. Design packages to be prepared as required by KSU.

A.	Replace transformers and Reset Relays	**$457,000.00**
B.	Design Services for Transformer Replacement and Relays	**$45,700.00**
	Subtotal	**$502,700.00**
C.	Provide KSU portion of new substation: Provide new duct bank and cable connecting new substation to existing campus feeders. Substation provided to be complete at end of Phase II construction.	**$1,900,000.00**
D.	Provide GPC portion of new substation with same timing.*	**$273,000.00**
E.	Design Services for new KSU substation and feeders.	**$190,000.00**
	Subtotal	**$2,363,000.00**

*GPC Cost Estimate. Some adjustment required for location. Plus additional $14,000/yr. maintenance

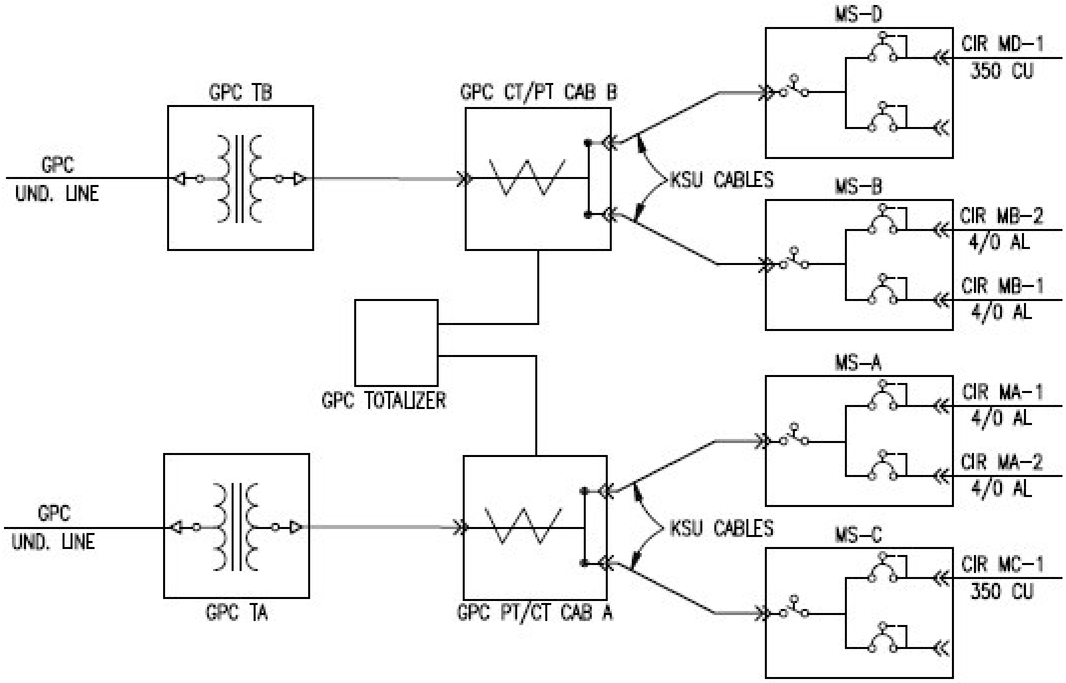
Study Report Segment Analysis

Existing Conditions

Campus – Kennesaw State University is located adjacent to the city limits of Kennesaw, Georgia. The university is comprised of a 384 acre, 51 building Main Campus. The Main Campus has its own electrical distribution system (EDS) metered at the distribution voltage level by Georgia Power. There are also 4 privatized student housing complexes that are separately fed from Georgia Power. The Main Campus EDS system, which includes most of the campus facilities, is the subject of our study.

System - The existing main campus 15Kv rated electrical distribution system is comprised of underground medium voltage (MV) distribution cables installed in concrete encased duct bank, disconnecting switchgear, and transformers serving campus facilities. This 12,470 volt, 3 phase, 4 wire system is fed from a Georgia Power Company (GPC) 24,940 volt feeder from a GPC substation and is metered at 12,470 volts.

GPC Service – (See sketch below) The interface between the campus EDS and Georgia Power Company (GPC) is comprised of two 1,000Kcmil aluminum cable feeders, both rated at 525 amps, each connected to a 10,000Kva, 24,940/12,470 volt transformer. The transformers are designated TA and TB. Two more GPC underground feeders, both the same 1,000Kcmil aluminum, connect these transformers to GPC metering units. Four campus owned, underground feeders connect these metering units to four campus owned, pad-mounted, vacuum interrupter, 600 amp pieces of switchgear. Each vacuum interrupter piece of switchgear has two connections for feeders, both protected by interrupters, and the one input feeder from the metering units.



<u>Campus Feeders</u> - The four pieces of campus owned switchgear are labeled MS-A, MS-B, MS-C and MS-D. Corresponding feeders are MA-1 and MA-2 in switch MS-A; MB-1 and MB-2 in switch MS-B; MC-1 in switch MS-C; and MD-1 in switch MS-D. NOTE: The incoming 15Kv cables from the GPC metering units are campus owned and are the same size as the individual feeders. Therefore, switch loading is limited to the maximum load capabilities of these cables. For MS-A and MS-B this is #4/0 aluminum, concentric neutral, 15kv cable which has a maximum rated ampacity of 230 amps. For MS-C and MS-D this is 350kcmil, copper, tape shield, 15kv cable which has a maximum ampacity of 415 amps. All four campus owned pieces of switchgear have one input feeder from GPC and two output feeders serving the campus. All three internal switches in each piece of switchgear have a 600 amp maximum current rating. The input circuit to each switch from the GPC metering units is a non-supervised load break switch. There is a 600 amp rated vacuum interrupter (circuit breakers) on the output feeders into the campus from each piece of switchgear. Each feeder has relay protection set to a value to protect

the cable, 200 amp for the #4/0 feeders from MS-A and MS-B and 200 amp for the 350kcmil feeders out of MS-C and MS-D.

The outgoing feeders from all four switches enter manhole #29 in the switchyard then enter an eight way 4 inch duct bank to manhole #20 and into the campus. It is critical to note, per the NEC, NFPA 70, cables shall be de-rated as the number of circuits in a duct bank increase above one circuit. As there is six radial circuits in the duct bank from the switchyard, the 4/0 aluminum and the 350Kcmil copper circuits have to be de-rated. This de-rating is caused by the buildup of heat in the duct bank from the number of circuits. This heat buildup could cause the cables to overheat before reaching their maximum, single circuit rating of the cable. Individual feeder loading will be looked at in detail under Feeder Loading below.

Duct Bank and Manholes – A concrete encased duct bank and manhole system provides the path for the cable to the transformers in the campus electrical distribution system. The duct bank system backbone going from manhole to manhole is made up of generally four inch conduits arranged in a rectangle commonly described as 2-way-4", 4-way 4", up to 12-way 4" . A 2-way-4" duct bank typically goes to / from the manhole to the transformer. The main duct bank going through the campus is an 8 way 4". There are forty (40) manholes which are typically 8' X 8' X 7' tall octagonal concrete manholes (two are 10' X 5' X 6' tall) and set with the top set 1' to 3'+ underground. There are also 5 rectangular underground concrete vaults that were located which are used for pull boxes. Many manholes had provisions to power sump pumps which have been removed and are not recommended.

All the duct bank and manholes are in good condition. The cable racking in the manholes for the cable installed in the 80's and 90's is in good condition. Cable racking for newer cable was found to be in good condition. Cable tagging in the manholes was in the same condition as the racking. Splices in the manholes were found to be in good condition. Grounding was in place in all the manholes. Many manholes were found to have moderate water levels, a common condition for the region.

Transformers - The thirty-eight (38) pad-mounted transformers that serve the campus facilities vary in age. Only three (3) are industry standard age that is considered approaching the end of their useful life, depending on their duty cycle and maintenance, of between 25 and 40 years. One (1) of these transformers showed damage caused by aging with significant rust and a minor oil leak. All but seven (7) transformers have internal, under-oil, loop feed switches for use in sectionalizing the circuit. Eight (8) transformers would be required to be replaced if load increase predicted in the future plans required the need for 600 amp bushing wells due to a increase in the circuit conductor. These eight are also those transformers requiring loop feed switches and also include two of the three that are nearing the end of their useful life.

Cable – As mentioned under Campus Feeders above, the existing cables for the feeders is either #4/0 aluminum or 350Kcmil copper. Age of the cable varies. The earliest #4/0 cable was installed in 1993. The last cable installed was the #350Kcmil installed in 2000. The industry standard for primary utility cable is 25 years. Using this as a guide the earliest installed cable should be replaced in 2018.

Existing Feeder Loading - See Sheets 10 and 11. Looking at the worst case #4/0 loop MA-1 / MB-1, per NEC, NFPA 70, Article 310.78, the rating for #4/0 aluminum with six circuits in a duct bank is 150 amps. If it is necessary to operate a loop with the loop closed to the last transformer before the feeder main, it is estimated that the #4/0 loop MA-1 / MB-1 can have between 86 amps to 144 amps (57% to 96% of maximum rating) load current at peak with the connected load as it presently exists (See Addendum #1 attached). This is significantly close to this cables maximum rating. The variance stated is the difference between typical college campus feeder loading and an extrapolated load as a percentage of the actual campus peak loading. Actual loads were measured during the time of the approximate system peak in late

August 2011, when classes resumed and past peaks were recorded by GPC. This recorded data shows that the feeders hit peak on different days and time. Selecting the highest simultaneous time, MA-1 / MB-1 was estimated to have a connected peak at 138 amps. Within the range noted above and below the 150 amp maximum load for the #4/0 cable.

Looking at the higher capacity feeders MC-1 / MD-1, per NEC, NFPA 70, Article 310.77, the rating for #350Kcmil copper with six circuits in a duct bank is 265 amps. If it is necessary to operate this loop with the loop closed to the last transformer before the feeder main, it is estimated that the existing #350Kcmil loop MC-1 / MD-1 could be in worse condition than the #4/0 loops. It is estimated that between 209 amps and 349 amps (79% to 132% of maximum rating) will be experienced at peak load conditions. Again actual loads were measured when classes resumed and during the time of the approximate system peak recorded by GPC in late August 2011. This recorded data shows that the feeders hit peak on the same day and time. MC-1 and MD-1 were recorded and when added, the connected peak was 202 amps. Below the range noted above and below the 265 amp maximum load for the #350Kcmil copper cable.

Another concern of critical importance is the discovery that at the mid-point where the MC-1 and MD-1 circuits are tired together at transformer ST-14, #4/0 cable has been used to connect the two #350Kcmil circuits together in the transformer. This creates a type of fuse between the two circuits. This fuse would be expected to fail if the emergency (short term) capability of #4/0 cable of 271 amps for a maximum of 100 total hours is approached. This issue should be addressed immediately. If MC-1 and MD-1 circuits is switched into the loop configuration for any reason during the summer, an overload could occur and should be monitored.

EXISTING CONDITIONS (PHASE I) **Note: Phase I Construction Completed.**

Final 12/2/11

Revised 12/16/11

Legend

ST-1	BURRUSS	ST-10	TECH. ANNEX	ST-22	VISUAL & COM ARTS	ST-32	CENTRAL PKNG. DK
T-1A	KENNESAW HALL	ST-11	MATH AND STATS.	ST-25	SCIENCE & MATH	ST33A	HEALTH SCIENCE
ST-2	MUSIC	T-12A	OFFICE ANNEX	ST-26	CLENDENIN	ST-33B	HEALTH SCIENCE
T-3	JOE MACK WILSON	T-12B	OFFICE ANNEX	T-27 1P	CAMPUS GREEN	ST-34	THE COMMONS
ST-4	CAMPUS SERVICES	ST-14	STUDENT REC. CNTR.	ST-27	SOCIAL SCIENCE	ST-35	WILLSON ANNEX
ST-5	HUMANITIES	ST-15	STUD. REC. CNTR. AD	ST-28	CONVOCATION CEN	T-36	DATA CENTER
ST-5A	ENGLISH BLDG.	ST-16	CARMICHAEL STU.CN	T-29	EAST PKNG. DECK	T-37	SCIENCE LAB ADD.
ST-6	UNIV.COL./WILNGHM	T-18A IP	ABANDONED	T-29	ROADWAY LTG.	T-38	BALL FIELD
T-7	STURGIS LIBRARY	T-18B 1P	ABANDONED	T-30	WEST PKNG DECK		
ST-8	PILCHER PUB. SVS.	T-19	TENNIS COURTS	T-30 1P	ABANDONED		
ST-9	PUBLIC SAFETY	T-21	JOLLEY LODGE	ST-31	BOBBY BAILEY CTR		

Note: Duplicate numbers found in field. Recommend removing abandoned transformers and eliminating duplcate numbers like T-27, ST-27, (2) T-29's, 1/3P, 1/1P.

Feeder #

MA-1		**MB-1**		**MA-2**		**MB-2**		**MC-1**		**MD-1**	
T-21 1P	75	T-29 1P	75	ST-4	750	T-30 1P	0 (50)	ST-36	1500	ST-31	750
ST-22	500	ST-26	750	T-27 1P	50	T-3	750	ST-27	3750	ST-35	500
ST-5	500	ST-25	1500	T-19	150	ST-2	150	ST-5A	750	ST33A	2000
ST-6	500	T-37	1500	T-1A	2500	ST-1	2500	ST-16	2000	ST-33B	2000
T-7	1500	T-30	150					T-38	500	ST-32	300
ST-8	300	ST-9	300					ST-15	1000	ST-34	1500
ST-11*	500	ST-10	500					ST-14	0 (300)	ST-28	2000
		T-12A 1P	100							T-29	300
		T-12B 1P	100							ST-14*	0 (300)
		18A 1P	0 (167)								
		18B 1P	0 (250)								
Total	3875	Total	4975	Total	3450	Total	3400	Total	9500	Total	9350

Total 34550

Actual August 2010 peak 7,643 kW. @ 12,470 volts = 354 amps GPC 10 Mva tx. = 463 amps FLA @ 12,470V; 1000Kcmil = 525 amps
Actual August 2011 peak 7,782kW. @ 12,470 volts = 360 amps
KSU Campus Utilization Factor: 7,782kW / 34,550kVA = 23%. (Assumed unity PF) **Typical Campus Utilization Factor = 35%**

Revised 12/16/11

LOAD BALANCE OF EXISTING CONDITIONS (PHASE I) **Note: Phase I Construction Completed.**

Final 12/2/11

Revised 12/16/11

Feeder #	MA-1		MB-1		MA-2		MB-2		MC-1		MD-1		
	T-21 1P	75	T-29 1P	75	ST-4	750	T-30 1P	0	ST-36	1500	ST-31	750	
	ST-22	500	ST-26	750	T-27 1P	50	T-3	750	ST-27	3750	ST-35	500	
	ST-5	500	ST-25	1500	T-19	150	ST-2	150	ST-5A	750	ST33A	2000	
	ST-6	500	ST-37	1500	T-1A	2500	*ST-1**	*2500*	ST-16	2000	ST-33B	2000	
	T-7	1500	ST-9	300					T-38	500	ST-32	300	
	ST-8	300	T-30	150					ST-15	1000	ST-34	1500	
	ST-11	500	T-12A 1P	100					ST-14	0	ST-28	2000	
	*ST-10**	*500*	T-12B 1P	100							T-29	300	
			18A 1P	0							ST-14*	0	
			18B 1P	0									**Total**
	Total	4375	Total	4475	Total	3450	Total	3400	Total	9500	Total	9350	34550

ITALIC = MOVE TO BALANCE LOAD

Load Analysis - Existing Conditions

Note: Typical campus style facilities like college campuses, prisons and hospitals with their ouw primary distribution systems have actual loads vs. connected KVA profiles as follows: Individual redial feeders 50% connected KVA; Loops 40% connected KVA; Total Campus 35% connected KVA. KSU Campus has 23% of connected KVA loading @ peak. Reason: Low load parking garages, low / no load 1 phase transformers.

Radial feeders MA-1 and MB-1. #4/0 Al , 100 % Insulation (175 mil) Per NEC Table 310.78 for 6 circuits in a duct bank, 90 degree rated cable, Max rated curent =150 amps. **MA-1** @ 50% connected KVA = 2,188KVA @ 12,470V = **101 amps, 68% of max.**
MB-1 @ 50% connected KVA = 2,238KVA @ 12,470V = **104 amps, 69% of max**.
Actual Recorded Peak MA-1, 59 amps, 8/24/11, 39% of max. - MB-1, 80 amps, 8/25/11, 53% of max.

Radial feeders MA-2 and MB-2. #4/0 Al , 100 % Insulation (175 mil) Per NEC Table 310.78 for 6 circuits in a duct bank, 90 degree rated cable, Max rated curent =150 amps. **MA-2** @ 50% connected KVA = 1,725KVA @ 12,470V = **80 amps, 53% of max.**
MB-2 @ 50% connected KVA = 1,700KVA @ 12,470V = **79 amps, 52% of max.**
Actual Recorded Peak MA-2, 47 amps, 8/25/11, 31% of max. - MB-2, 44 amps, 8/24/11, 29% of max.

Radial feeders MC-1 and MD-1. 350kcmil Copper, 130 % Insulation (220 mil) Per NEC Table 310.77 for 6 circuits in a duct bank, 105 degree rated cable, Max rated curent = 265 amps. **MC-1** @ 50% connected KVA = 4,750KVA @ 12,470V = **220 amps, 83% of max.**
MD-1 @ 50% connected KVA = 4,675KVA @ 12,470V = **216 amps, 82% of max**.
Actual Recorded Peak MC-1, 97 amps, 8/31/11, 37% of max. - MD-1, 105 amps, 8/31/11, 40% of max.

LOAD BALANCE OF EXISTING CONDITIONS (PHASE I) CONT. **Note: Phase I Construction Completed.**

Final 12/2/11
Revised 12/16/11

Looped Circuit MA-1 and MB-1 #4/0 Al , 100 % Insulation (175 mil) Per NEC Table 310.78 for 6 circuits in a duct bank, 90 degree rated cable, Max. rated curent = 150 amps.

MA-1 / MB-1 = 8,850KVA connected. Loop Demand Factor = 40% connected KVA = 3,540KVA @12,470V = **164 amps, 109% of max.**

NOTE: Actual load experienced is 23% of connected KVA. For 23% (actual load %) = 2,036KVA @12,470V= **94 amps, 63% of max.**

This loop had peak recorded @ different days. Recorded combined peak approximately 138 amps, 92% of max.

Looped Circuit MA-2 and MB-2 4/0 Al , 100 % Insulation (175 mil) Per NEC Table 310.78 for 6 circuits in a duct bank, 90 degree rated cable, Max. rated curent = 150 amps.

MA-2 / MB-2 = 6,850KVA connected. Loop Demand Factor = 40% connected KVA = 2,740KVA @12,470V = **128 amps, 85% of max.**

NOTE: Actual load experienced is 23% of connected KVA. For 23% (actual load %) = 1,576KVA @12,470V= **73 amps, 49% of max.**

This loop had peak recorded @ different days. Recorded combined peak approximately 90 amps, 60% of max.

Looped Circuit MC-1 and MD-1 350kcmil Copper, 130 % Insulation (220 mil) Per NEC Table 310.77 for 6 circuits in a duct bank, 105 degree rated cable, Max rated curent = 265 amps.

MC-1 / MD-1 = 18,850KVA connected. Loop Demand Factor = 40% connected KVA = 7,540KVA @12,470V = **349 amps, 132% of max.**

NOTE: Actual load experienced is 23% of connected KVA. For 23% (actual load %) = 4,336KVA @12,470V= **201 amps, 77% of max.**

This loop had peak recorded @ same time frame. Actual Recorded Combined Peak MC-1 / MD-1, 202 amps, 8/31/11, 76% of max.

Analysis of total recorded campus feeders for comparison. Total = 138 + 90 + 202 = 430 amps. Actual = 360 amps

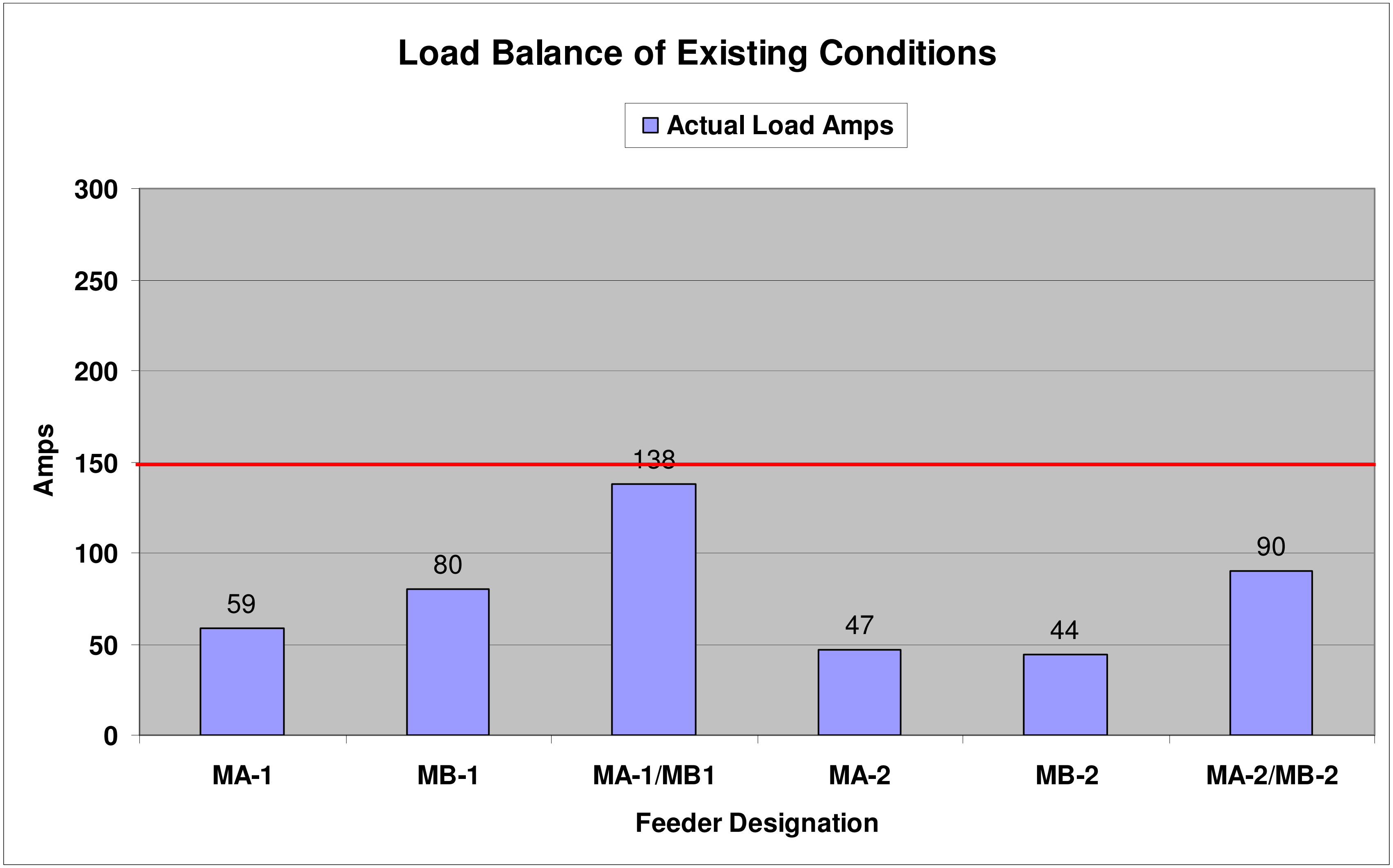
Measured	MS-A = 59 Amps + 47 Amps= 106 Amps (46% of max.)
Loads	MS-B = 80 Amps + 44 Amps= 124 Amps (54% of max.)
Swgr	MS-C = 97 Amps (25% of max.)
(2011Data)	MS-D = 105 Amps (27% of max.)

Calculated	MS-A = 7,825kVA X 40% = 3,130kVA = 145Amps (63% of max.)
Loads	MS-B = 7,875kVA X 40% = 3,150kVA = 148 Amps (63% of max.)
Swgr	MS-C = 9,500kVA X 40% = 3,800kVA = 176 Amps (45% of max.)
	MS-D = 9,350kVA X 40% = 3,740kVA = 173 Amps (44% of max.)

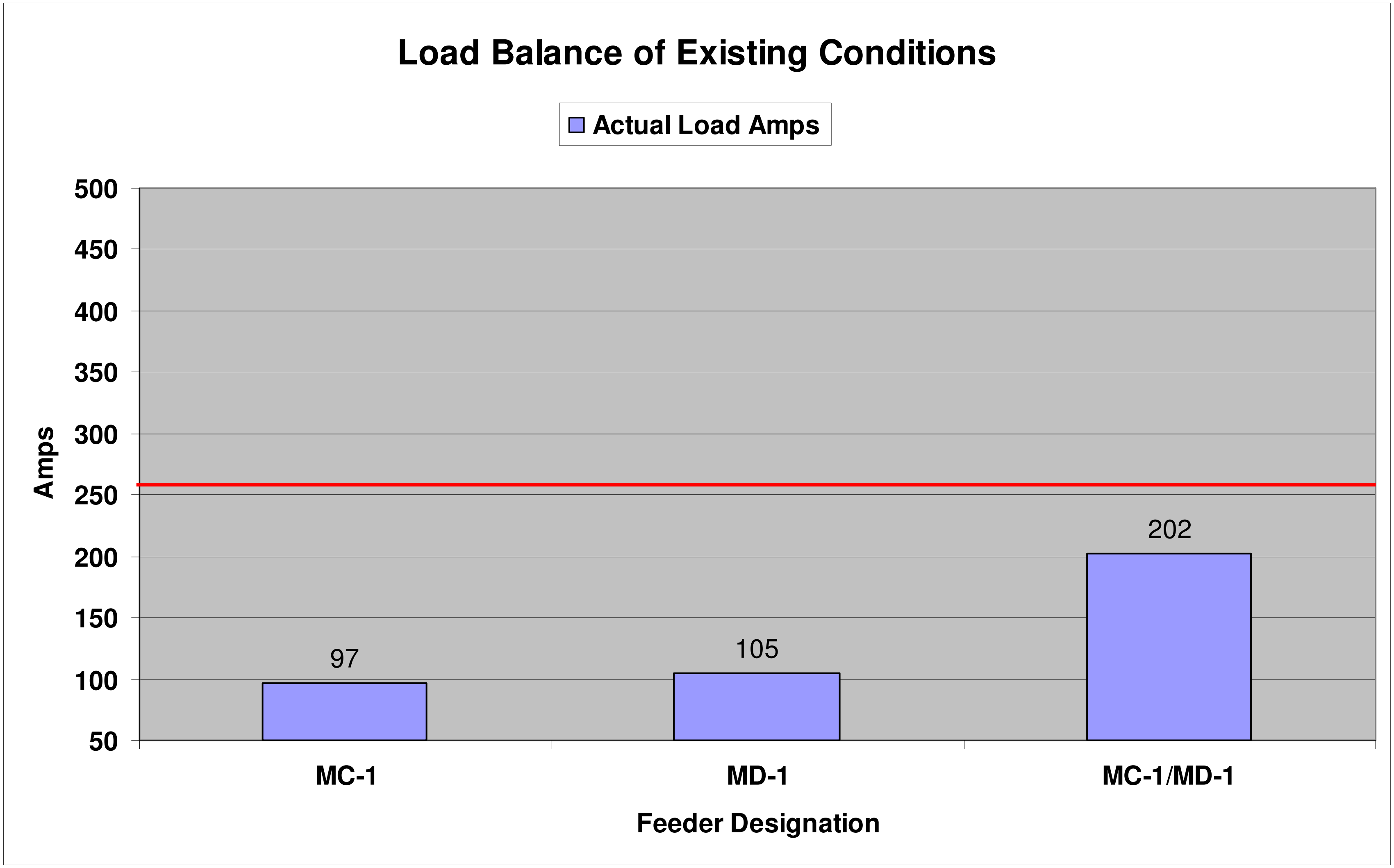
Per NEC Table 310-77, 350kCIL = 390 amps single ckt in duct bank; 245amps with 6 ckts in duct bank; 3 ckts 310 amps.

Per NEC Table 310-78, 4/0 = 230amps single ckt in duct bank; 185 amps with 3 ckts in duct bank; 6 ckts 150 amps.

350KCMIL AL, Jacketed, 1/3 Concentric Neutral = 1.391" Dia, 1.52 Cu. In. X 3 = 4.56 Cu. In. 4" duct = 12.57 Cu. In. Fill = 36% OK.



Red Line indicates maximum allowable cable ampacity per NEC.



Red Line indicates maximum allowable cable ampacity per NEC.

Future Growth

The impact of the additional new facilities proposed for Kennesaw State University in the Phase II and Phase III construction shown in the 2011 Master Plan Update – June 30, 2011 however will add significant load to all the existing feeders and the GPC substation. Alternatives must be considered to address this load growth in a timely manner so that the infrastructure is in place to accommodate this expansion.

Phase II Additions - As shown in the 2011 Master Plan Update – June 30, 2011, Phase II construction is expected to be primarily in the center part of the campus between Campus Loop Road and Marietta Drive. Phase II construction outside this area will be parking decks to the North and South. The existing primary duct bank and cable system is constructed through the center of the campus from North to South. Circuits MA-1 and MB-1 are installed in the Western section of the campus and would be mostly impacted by Phase III construction. Circuits MA-2 and MB-2 plus MC-1 and MD-1 are in the Central and East sections of campus and would be most impacted by Phase II construction. If existing information on spare ducts is accurate, spare ducts are available in all sections of duct bank for at least one additional feeder loop. Spare interrupters are available in switchgear MS-C and MS-D for one new feeder. However, with the existing substation near full load capacity and the feeders at full load capacity by the end of Phase II, this is not an answer to address load growth for Phase III.

Using the information provided in the 2011 Master Plan Update – June 30, 2011, the location, size and type of new campus facility for Phases II and III are provided. Using the Means Estimating Guide for 2010, watts per square foot was assigned to each building by type. This is shown on Sheet 16 of this report. Using the approximate location of the new facilities shown in the 2011 Master Plan Update for Phases II and III, we placed the new facilities on the campus site plan as shown on the drawings Sheets E5.1 and E5.2. Overlaid on these drawings is the campus manhole and duct bank plan. To analyze Phase II impacts, we then connected the new facilities to the available feeders attempting to maintain as close to a balance on the existing feeders as possible without overloading any feeders. The results for Phase II are shown on Sheet 17 of this report. It must be noted that at the completion of all new facilities in Phase II, no individual feeder is expected to be significantly overloaded, as can be seen on Sheets 18, 19, and 20 however, tying the feeders together for maintenance could easily cause overloads which is a poor situation. Also, relays which control the campus feeder breakers will need some adjustment to allow for the higher loading. The addition of a new GPC substation timed to be complete at the completion of Phase II, along with ties to the existing feeder system, would eliminate the loop connection problem and open the door for Phase III expansion.

Phase III Additions As mentioned, using the information provided in the 2011 Master Plan Update, the location, size and type of new campus facility for Phase III were provided and shown on Sheets E5.1 and E5.2 of the drawings. As was done for Phase II, using the Means Estimating Guide for 2010, watts per square foot was assigned to each new building by type. This is shown on Sheet 16 of this report. The proposed Phase III facilities are shown on the drawings Sheets E5.1 and E5.2. We assumed the construction for the new GPC Substation is complete at one of the two proposed locations along with the necessary duct bank and feeder ties as shown on the drawings. We then added the Phase II facilities and made new connections between the new feeders and the existing to create a double redundant system independently fed from either the existing or new substations. The feeders from each substation cannot be directly connected together without compromising feeder relay security so the design is based upon a looped system, with normally open point originating from the same substation. For purposes of this study, the same feeder cable size is used. The feeder one-line drawings, Sheets E5.4 and E5.5, shows the configuration and separation points for each feeder in Phase III. The feeder loading is shown tabulated on Sheet 21 and graphically on Sheets 24 and 25 of this report. Calculations and assumptions are shown on Sheets 22 and 23.

Note: This report is based on information provided by KSU in the 2011 Master Plan Update dated June 30, 2011. As plans and schedules evolve the load tables and assumptions used should be reviewed for applicability.

MASTER PLAN Phase II and Phase III Additions **Note: Phase I Construction Completed.** Final 12/2/11

Revised 12/16/11

Phase II **Additions**

A	Science Lab Addition	74128	sq. ft.	Transformer Installed	1500	kVA
B	Education Classroom Facility	82900	sq. ft.	Load @12.6watts /sq. ft + 67Kw 2 elev.=	1500	kVA
C	Acad. Learning Cntr. & Bus. Add.	200140	sq. ft.	Load @12.6watts /sq. ft + 134Kw 4 elev.=	3000	kVA
E	Student Rec & Activities Cntr.	131738	sq. ft.	Load @10watts /sq. ft.+ 53Kw 2 elev.+ Pools=	1500	kVA
G	South Dining Hall	37875	sq. ft.	Load @10.4watts /sq. ft.=	500	kVA
I	Art Museum	9828	sq. ft.	Load @10.4watts /sq. ft.=	150	kVA
K	Early Learning Center	25000	sq. ft.	Load @11.5watts /sq. ft.=	300	kVA
L	Student Center Expansion	249690	sq. ft.	Load @11.5watts /sq. ft + 134Kw 4 elev.=	3000	kVA
D1	South Campus Parking Deck	313000	sq. ft.	Load @1.5watts /sq. ft.+ 53Kw 2 elev.=	750	kVA
D3	North Deck Expansion	388062	sq. ft.	Load @1.5watts /sq. ft.+ 53Kw 2 elev.=	750	kVA
D4	Town Point Deck	285848	sq. ft.	Load @1.5watts /sq. ft.+ 53Kw 2 elev.=	500	kVA
D5	Campus Parking Deck	317232	sq. ft.	Load @1.5watts /sq. ft.+ 53Kw 2 elev.=	750	kVA
	Total	**2115441**	sq. ft.		**14200**	kVA

Phase III **Additions**

M	Special Collections Bldg.	75000	sq. ft.	Load @10.5watts /sq. ft + 67Kw 2 elev.=	1000	kVA
N	Tech. Classroom & Office Bldg.	273785	sq. ft.	Load @12.6watts /sq. ft + 134Kw 4 elev.=	3000	kVA
O	Research Lab Addition	49140	sq. ft.	Load @12.6watts /sq. ft + 134Kw 4 elev.=	750	kVA
P	Arts / Academic Bldg.	106480	sq. ft.	Load @10.4watts /sq. ft.=	1000	kVA
Q	Allied Health Bldg.	63288	sq. ft.	Load @11.5watts /sq. ft.=	750	kVA
R	Visual Arts Addition	60591	sq. ft.	Load @10.4watts /sq. ft.=	750	kVA
S	Computer Science and Math	81795	sq. ft.	Load @11.5watts /sq. ft.=	1000	kVA
T	Office Bldg.	25510	sq. ft.	Load @12.6watts /sq. ft + 53Kw 2 elev.=	350	kVA
U	Education Addition - Phase II	86720	sq. ft.	Load @12.6watts /sq. ft + 134Kw 4 elev.=	1200	kVA
V	Classroom and Office Bldg.	120490	sq. ft.	Load @8.8watts /sq. ft.+ 53Kw 2 elev.=	1200	kVA
W	Student Center Development	108000	sq. ft.	Load @10.4watts /sq. ft.=	1200	kVA
D6	Southeast Parking Deck	488532	sq. ft.	Load @1.5watts /sq. ft.+ 53Kw 2 elev.=	750	kVA
		1539331	sq. ft.		**12950**	kVA
	Grand Total	**3654772**	sq. ft.		**27150**	kVA

ADDITION OF PHASE II **Note: Phase I Construction Completed.** Final 12/2/11

Revised 12/16/11

MA-1		MB-1		MA-2		MB-2		MC-1		MD-1		
T-21 1P	75	D3	750	ST-4	750	T-30 1P	0	ST-36	1500	ST-31	750	
ST-22	500	T-29 1P	75	T-27 1P	50	T-3	750	ST-27	3750	ST-35	500	
ST-5	500	ST-26	750	T-19	150	I	150	ST-5A	750	ST33A	2000	
ST-6	500	ST-25	1500	D5	750	ST-2	150	ST-16	2000	ST-33B	2000	
T-7	1500	ST-37(A)	1500	T-1A	2500	ST-1	2500	L	3000	ST-32	300	
ST-8	300	D1	750	B	1500	C*	3000	T-38	500	ST-34	1500	
G	500	T-30	150							ST-28	2000	
ST-11	500	T-12A 1P	0							T-29	300	
ST-10	500	T-12B 1P	0							E*	1500	
ST-9*	300	18A 1P	0							ST-15**	1000	
		18B 1P	0							-		
												Total
Total	5175	Total	5475	Total	5700	Total	6550	Total	11500	Total	11850	**46250**

* = N/O Point

** Shift N/O point MC-1 / MD-1 from ST-14 (not in service) to ST-15. Switch so ST-15 on MD-1. Once E is built, shift N/O to there.

New loads for Phase II Phase II additions in green.

A	Science Lab Addition	1500	kVA	
B	Education Classroom Facility	1500	kVA	
C	Acad. Learning Cntr. & Bus. Add.	3000	kVA	
E	Student Rec & Activities	1500	kVA	
G	South Dining Hall	500	kVA	
I	Art Museum	150	kVA	
K	Early Learning Center	300	kVA	GPC?
L	Student Center Expansion	3000	kVA	
D1	South Campus Parking Deck	750	kVA	
D3	North Deck Expansion	750	kVA	
D4	Town Point Deck	500	kVA	GPC?
D5	Campus Parking Deck	750	kVA	

LOAD ANALYSIS - CONDITIONS AFTER PHASE II

Final 12/2/11
Revised 12/16/11

Note: Typical campus style facilities like college campuses, prisons and hospitals with their ouw primary distribution systems have actual loads vs. connected KVA profiles as follows: Individual redial feeders 50% connected KVA; Loops 40% connected KVA; Total Campus 35% connected KVA. KSU has 24% of connected KVA loading @ peak. Reason: Low load parking garages and several low load / no load single phase transformers. Campus peak loading per feeder should be re-checked for closer determination.

Radial feeders MA-1 and MB-1. #4/0 Al , 100 % Insulation (175 mil) Per NEC Table 310.78 for 6 circuits in a duct bank, 90 degree rated cable, Max rated curent =150 amps. **MA-1** @ 50% connected KVA = 2,588KVA @ 12,470V = **120 amps, 80% of max.**
MB-1 @ 50% connected KVA = 2,738KVA @ 12,470V = **127 amps**, **85% of max**.

Radial feeders MA-2 and MB-2. #4/0 Al , 100 % Insulation (175 mil) Per NEC Table 310.78 for 6 circuits in a duct bank, 90 degree rated cable, Max rated curent =150 amps. **MA-2** @ 50% connected KVA =2,850KVA @ 12,470V = **132 amps**, **88% of max**.
MB-2 @ 50% connected KVA = 3,275KVA @ 12,470V = **152amps**, **101% of max.**

Radial feeders MC-1 and MD-1. 350kcmil Copper, 130 % Insulation (220 mil) Per NEC Table 310.77 for 6 circuits in a duct bank, 105 degree rated cable, Max rated curent = 265 amps. **MC-1** @ 50% connected KVA = 5,750KVA @ 12,470V = **266 amps, 100% of max.**
MD-1 @ 50% connected KVA = 5,925KVA @ 12,470V = **274amps**, **104% of max**.

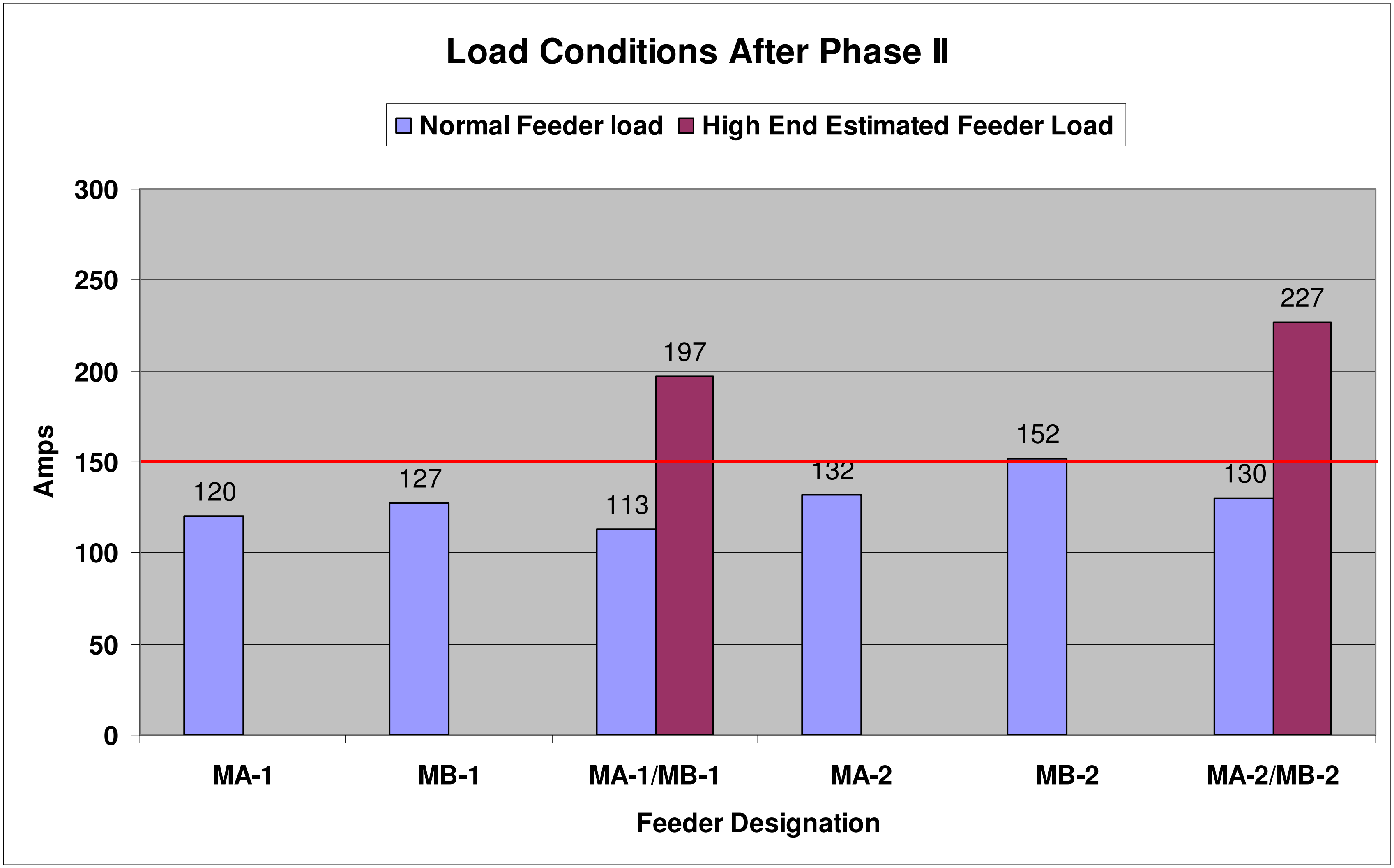
Looped Circuit MA-1 and MB-1 #4/0 Al , 100 % Insulation (175 mil) Per NEC Table 310.78 for 6 circuits in a duct bank, 90 degree rated cable, Max. rated curent = 150 amps. One circuit = 230 amps. Two circuits approx. 205 amps.
MA-1 / MB-1 = 10,650KVA connected. Loop Demand Factor = 40% connected KVA = 4,260KVA @12,470V = **197 amps, 131% of max.**
NOTE: Actual load experienced is 23% of connected KVA. For 23% (actual load %) = 2,450KVA @12,470V= **113 amps, 75% of max.**

Looped Circuit MA-2 and MB-2 4/0 Al , 100 % Insulation (175 mil) Per NEC Table 310.78 for 6 circuits in a duct bank, 90 degree rated cable, Max. rated curent = 150 amps. One circuit = 230 amps. Two circuits approx. 205 amps.
MA-2 / MB-2 =12,250KVA connected. Loop Demand Factor = 40% connected KVA = 4,900KVA @12,470V = **227 amps, 151% of max.**
NOTE: Actual load experienced is 23% of connected KVA. For 23% (actual load %) = 2,818KVA @12,470V= **130 amps, 87% of max.**

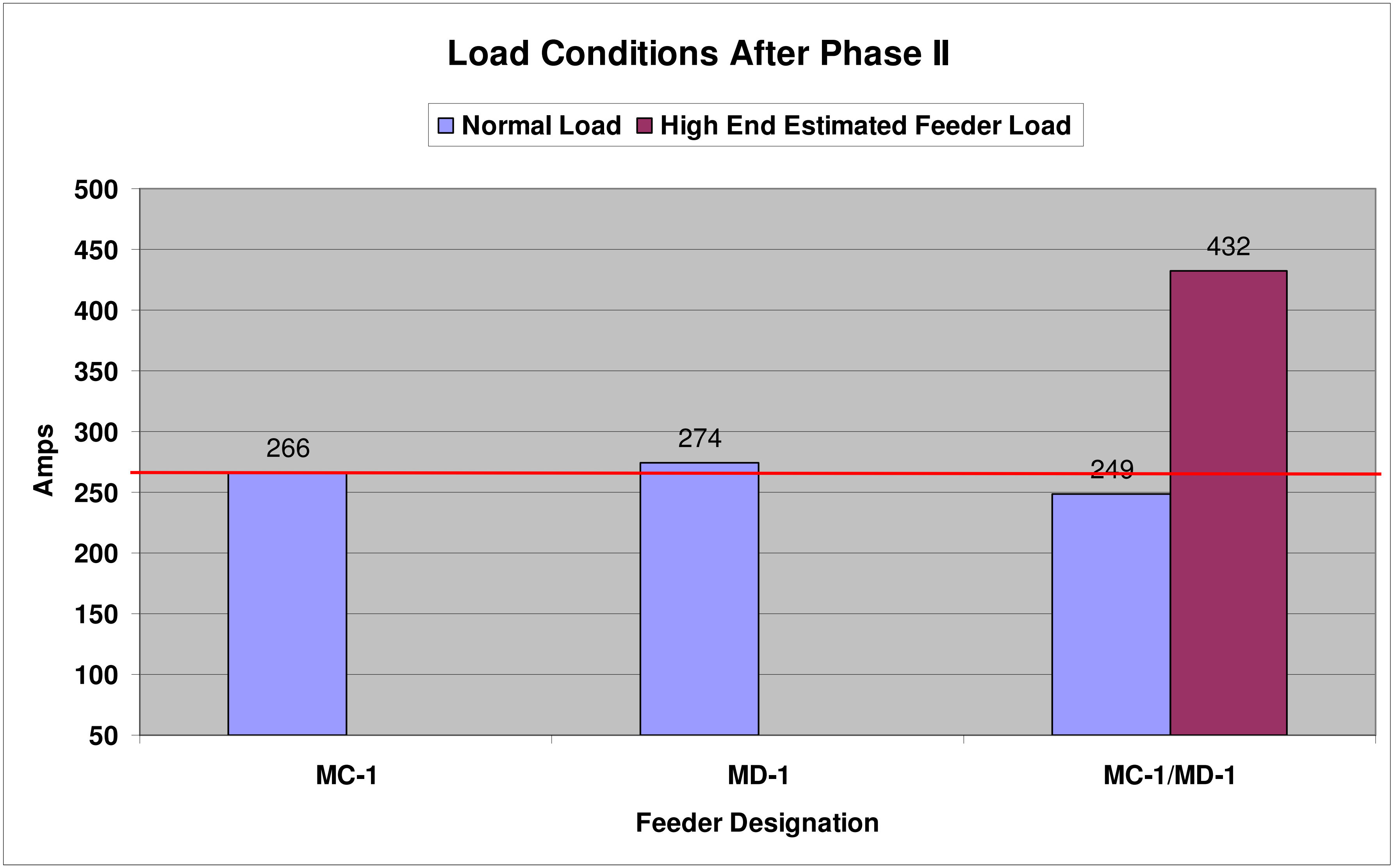
Looped Circuit MC-1 and MD-1 350kcmil Copper, 130 % Insulation (220 mil) Per NEC Table 310.77 for 6 circuits in a duct bank, 105 degree rated cable, Max rated curent = 265 amps.
MC-1 / MD-1 =23,350KVA connected. Loop Demand Factor = 40% connected KVA = 9,340KVA @12,470V = **432amps, 161% of max.**
NOTE: Actual load experienced is 23% of connected KVA. For 23% (actual load %) = 5,604KVA @12,470V= **249 amps, 94% of max.**

Calculated Loads Switchgear

MS-A = 10,875kVA X 40% = 4,350kVA = 201 Amps (88%of max.)
MS-B = 12,025kVA X 40% = 4,810kVA = 223 Amps (97%of max.)
MS-C = 11,500kVA X 40% = 4,600kVA = 213 Amps (55%of max)
MS-D = 11,850kVA X 40% = 4,740kVA = 219 Amps (56%of max)



Red Line indicates maximum allowable cable ampacity per NEC.



Red Line indicates maximum allowable cable ampacity per NEC.

ADDITION OF PHASE III

Phase III Changes: Added new GPC/KSU Substation. New ductbank and cable installed from New Substation to connection w/existing system in three locations. Load seperated between New and Existing Substations by splicing feeders MA-2 to MB-2 and MC-1 to MD-1 in manhole #1. Feeders MA-1 will be spliced to MB-1 in manhole #5.

Phase II additions in green. Phase III additions in blue.

Final 12/2/11
Revised 12/16/11

Existing Substation

Feeder #	MA-1		MB-1		MA-2		MB-2		MC-1		MD-1		
	T-21 1P	75	D3	750	ST-4	750	T-30 1P	50	ST-36	1500	ST-31	750	
	ST-22	500	T	350	T-1A	2500	T-3	750	R	750	ST-35	500	
	ST-5	500	T-29 1P	75			I	150	ST-27	3750	Q	750	
	ST-6(V)	1200	G	500			ST-2(P)	1000	ST-5A	750	ST-32	300	
	T-7	1500	ST-9	300							ST-33B	2000	
	ST-8	300	ST-10	500							ST-33A	2000	
			ST-11	500							ST-34	1500	
			M	1000									**Total**
	Total	4075	Total	3975	Total	3250	Total	1950	Total	6750	Total	7800	27800

* = N/O Point

New Substation

Feeder #	MA-3	NEW	MB-3	NEW	MA-4	NEW	MB-4	NEW	MC-3	NEW	MD-3	NEW	
	D1	750	N	3000	T-27 1P	50	D5	750	D6	750	E	1500	
	O	750	T-30	150	U	1200	S	1000	T-38	500	ST-28	2000	
	ST-37(A)	1500	ST-26	750	B*	1500	T-19	150	ST-15	1000	T-29	300	
	ST-25	1500					T-1A	2500	L	3000	C(Moved)	3000	
									ST-16	2000	W*	1200	**Total**
	Total	4500	Total	3900	Total	2750	Total	4400	Total	7250	Total	8000	30800

* = N/O Point

Phase III	**Additions**						
M	Special Collections Bldg.	1000	kVA	S	Computer Science and Math	1000	kVA
N	Tech. Classroom & Office Bldg.	3000	kVA	T	Office Bldg.	350	kVA
O	Research Lab Addition	750	kVA	U	Education Addition - Phase II	1200	kVA
P	Arts / Academic Bldg.	1000	kVA	V	Classroom and Office Bldg.	1200	kVA
Q	Allied Health Bldg.	750	kVA	W	Student Center Development	1200	kVA
R	Visual Arts Addition	750	kVA	D6	Southeast Parking Deck	750	kVA

LOAD ANALYSIS - CONDITIONS AFTER PHASE III

Final 12/2/11
Revised 12/16/11

Radial feeders MA-1 and MB-1. #4/0 Al , 100 % Insulation (175 mil) Per NEC Table 310.78 for 6 circuits in a duct bank, 90 degree rated cable, Max rated curent =150 amps. **MA-1** @ 50% connected KVA = 2,023KVA @ 12,470V = **94 amps, 63% of max.**
MB-1 @ 50% connected KVA = 1,988KVA @ 12,470V = **92amps, 61% of max.**

Radial feeders MA-3 and MB-3. #4/0 Al , 100 % Insulation (175 mil) Per NEC Table 310.78 for 6 circuits in a duct bank, 90 degree rated cable, Max rated curent =150 amps. **MA-3** @ 50% connected KVA = 2,250KVA @ 12,470V = **104 amps, 69% of max.**
MB-3 @ 50% connected KVA = 1,950KVA @ 12,470V = **90amps, 60% of max.**

Radial feeders MA-2 and MB-2. #4/0 Al , 100 % Insulation (175 mil) Per NEC Table 310.78 for 6 circuits in a duct bank, 90 degree rated cable, Max rated curent =150 amps. **MA-2** @ 50% connected KVA = 1,625KVA @ 12,470V = **75 amps, 50% of max.**
MB-2 @ 50% connected KVA = 975KVA @ 12,470V = **45amps, 30% of max.**

Radial feeders MA-4 and MB-4, #4/0 Al , 100 % Insulation (175 mil) Per NEC Table 310.78 for 6 circuits in a duct bank, 90 degree rated cable, Max rated curent =150 amps. **MA-4** @ 50% connected KVA =1,375KVA @ 12,470V = **64amps, 42% of max.**
MB-4 @ 50% connected KVA = 2,200KVA @ 12,470V = **102 amps, 70% of max.**

Radial feeders MC-1 and MD-1. 350kcmil Copper, 130 % Insulation (220 mil) Per NEC Table 310.77 for 6 circuits in a duct bank, 105 degree rated cable, Max rated curent = 265 amps. **MC-1** @ 50% connected KVA = 3,375KVA @ 12,470V = **156 amps, 59% of max.**
MD-1 @ 50% connected KVA = 3,900KVA @ 12,470V = **181amps, 68% of max.**

Radial feeders MC-3 and MD-3. 350kcmil Copper, 130 % Insulation (220 mil) Per NEC Table 310.77 for 6 circuits in a duct bank, 105 degree rated cable, Max rated curent = 265 amps. **MC-3** @ 50% connected KVA = 3,625KVA @ 12,470V = **168 amps, 63% of max.**
MD-3 @ 50% connected KVA =4,000KVA @ 12,470V = **185 amps, 70% of max.**

LOAD ANALYSIS - CONDITIONS AFTER PHASE III CONT.

Final 12/2/11
Revised 12/16/11

Looped Circuit MA-1 and MB-1 #4/0 Al , 100 % Insulation (175 mil) Per NEC Table 310.78 for 6 circuits in a duct bank, 90 degree rated cable, Max. rated curent = 150 amps. One circuit = 230 amps. Two circuits approx. 205 amps.
MA-1 / MB-1 = 8,050KVA connected. Loop Demand Factor = 40% connected KVA = 2,987KVA @12,470V = **138 amps, 92% of max.**
NOTE: Actual load experienced is 23% of connected KVA. For 23% (actual load %) = 1,852KVA @12,470V= **86 amps, 57% of max.**

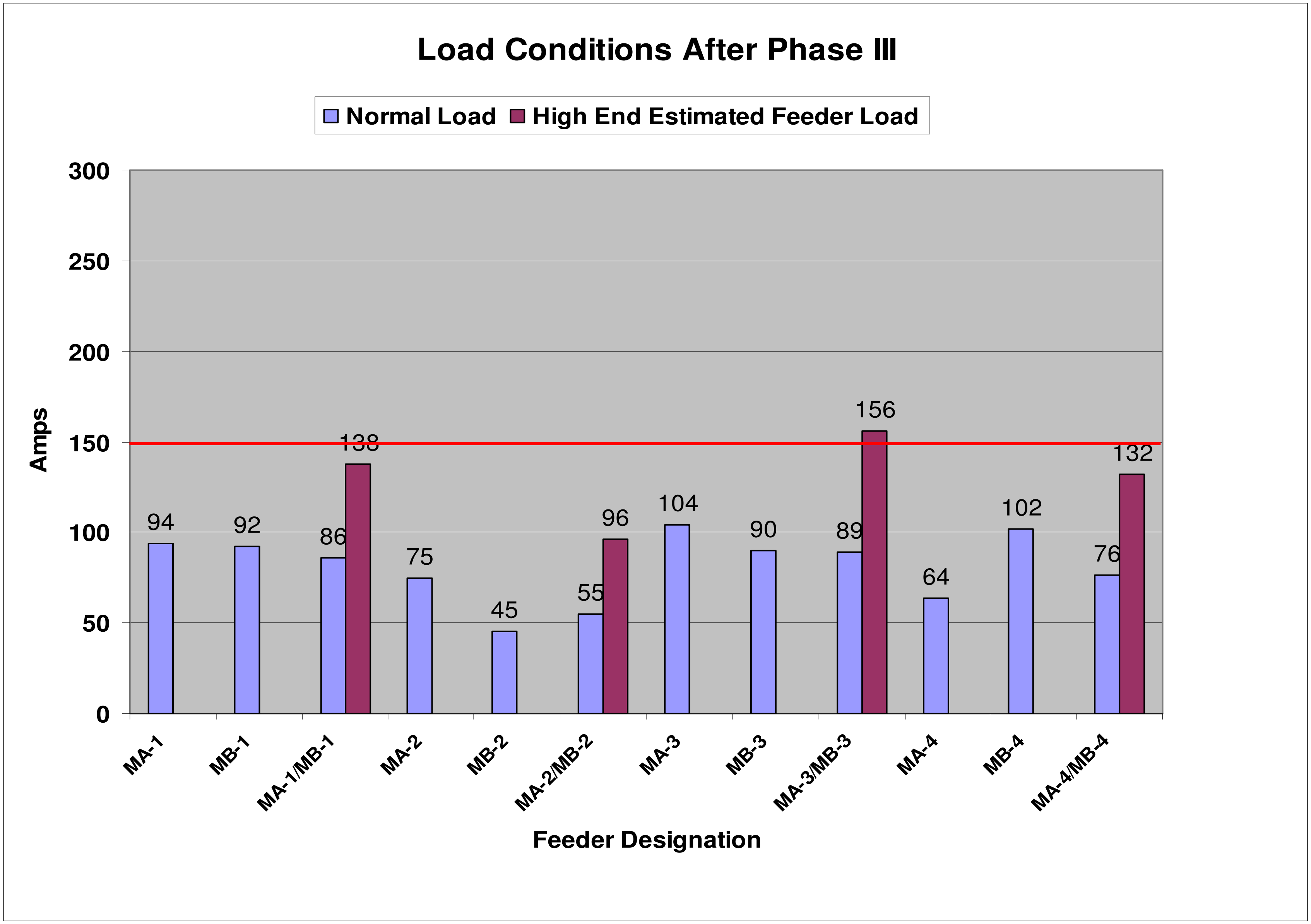
Looped Circuit MA-3 and MB-3 #4/0 Al , 100 % Insulation (175 mil) Per NEC Table 310.78 for 6 circuits in a duct bank, 90 degree rated cable, Max. rated curent = 150 amps. One circuit = 230 amps. Two circuits approx. 205 amps.
MA-3 / MB-3 = 8,400KVA connected. Loop Demand Factor = 40% connected KVA = 3,360KVA @12,470V = **156 amps, 104% of max.**
NOTE: Actual load experienced is 23% of connected KVA. For 23% (actual load %) = 1,932KVA @12,470V= **89 amps, 60% of max.**

Looped Circuit MA-2 and MB-2 4/0 Al , 100 % Insulation (175 mil) Per NEC Table 310.78 for 6 circuits in a duct bank, 90 degree rated cable, Max. rated curent = 150 amps. One circuit = 230 amps. Two circuits approx. 205 amps.
MA-2 / MB-2 =5,200KVA connected. Loop Demand Factor = 40% connected KVA = 2,080KVA @12,470V = **96 amps, 64% of max.**
NOTE: Actual load experienced is 23% of connected KVA. For 23% (actual load %) = 1,196KVA @12,470V= **55 amps, 37% of max.**

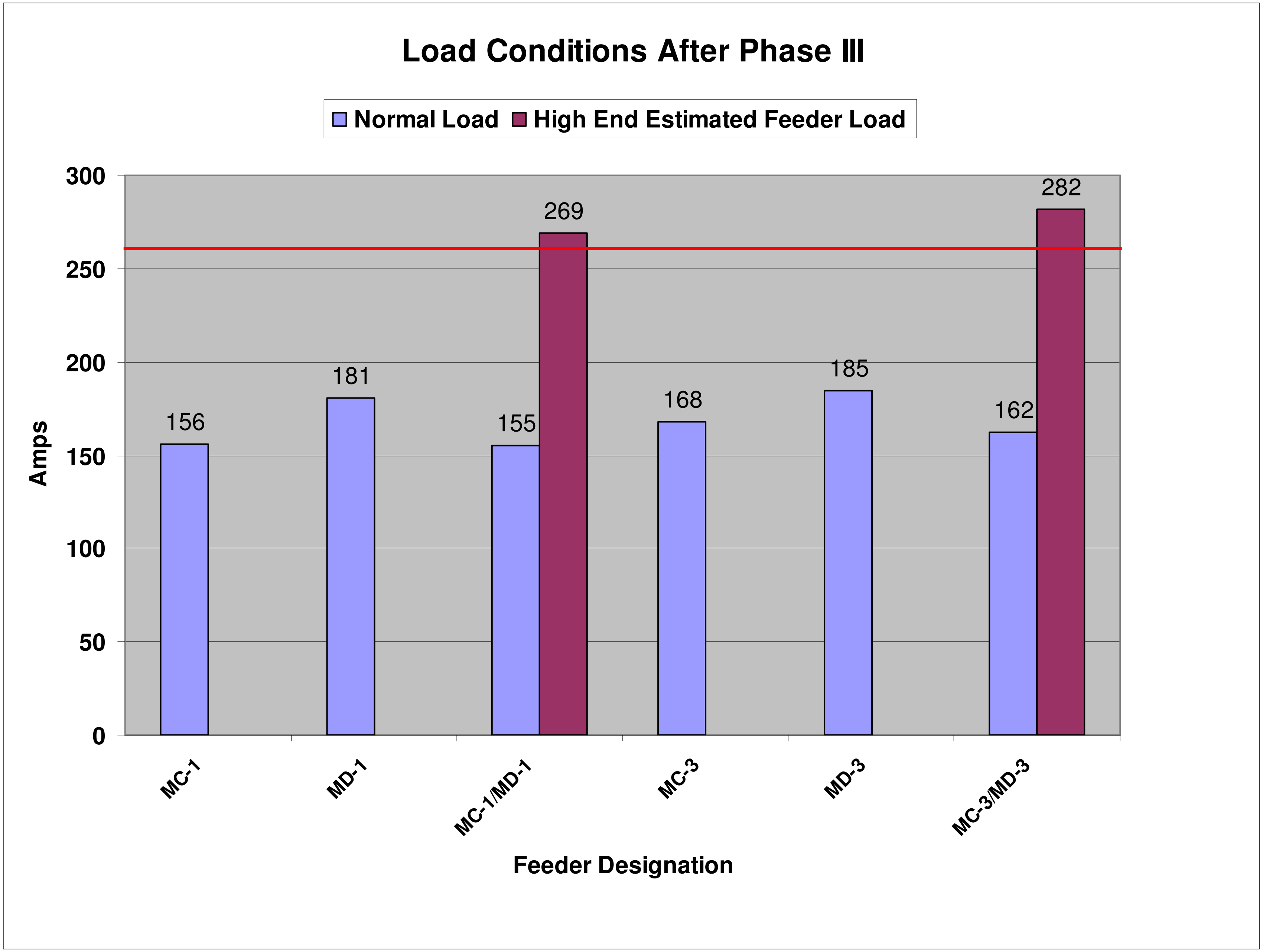
Looped Circuit MA-4 and MB-4 4/0 Al , 100 % Insulation (175 mil) Per NEC Table 310.78 for 6 circuits in a duct bank, 90 degree rated cable, Max. rated curent = 150 amps. One circuit = 230 amps. Two circuits approx. 205 amps.
MA-4 / MB-4 =7,150KVA connected. Loop Demand Factor = 40% connected KVA = 2,860KVA @12,470V = **132 amps, 87% of max.**
NOTE: Actual load experienced is 23% of connected KVA. For 23% (actual load %) = 1,645KVA @12,470V= **76 amps, 51% of max.**

Looped Circuit MC-1 and MD-1 350kcmil Copper, 130 % Insulation (220 mil) Per NEC Table 310.77 for 6 circuits in a duct bank, 105 degree rated cable, Max rated curent = 265 amps.
MC-1 / MD-1 = 14,550KVA connected. Loop Demand Factor = 40% connected KVA = 5,820KVA @12,470V = **269 amps, 101% of max.**
NOTE: Actual load experienced is 23% of connected KVA. For 23% (actual load %) = 3,347KVA @12,470V= **155 amps, 58% of max.**

Looped Circuit MC-3 and MD-3 350kcmil Copper, 130 % Insulation (220 mil) Per NEC Table 310.77 for 6 circuits in a duct bank, 105 degree rated cable, Max rated curent = 265 amps.
MC-3 / MD-3 = 15,250KVA connected. Loop Demand Factor = 40% connected KVA = 6,100KVA @12,470V = **282 amps, 107% of max.**
NOTE: Actual load experienced is 23% of connected KVA. For 23% (actual load %) = 3,508KVA @12,470V= **162 amps, 61% of max.**



Red Line indicates maximum allowable cable ampacity per NEC.



Red Line indicates maximum allowable cable ampacity per NEC.

Survey Findings

A. Electrical Characteristics at Site (at primary meter unless otherwise noted):

1. Operating Supply Voltage: 12,470GY/7200 volts, 3 phase, 4-wire, with grounded neutral.

2. Maximum Fault Current available at site: (Georgia Power Co.)(GPC)

L-L-L	L-L	L-N	PEAK
7,145A	6,188A	7,145A	354A

B. Service Entrance: Service conductors (Owned by GPC): 2 sets: 3#1000 AL, concentric copper neutral, 25Kv cable feeders from connection to GPC substation to two (2) GPC owned 24,940/12,470 volt, 3 phase, 4 wire 10,000Kva transformers. Transformers feed GPC owned metering units with GPC owned cable. KSU owned feeders connect these metering units to the Campus owned switchgear.

The Campus owned switchgear is comprised of four (4) 15kV rated, 600 amp rated, Cooper-Kearney VACpac, SF-6 insulated vacuum interrupter (breaker) pieces of switchgear. Each piece of switchgear has one switchable input feeder from the GPC metering units and two output vacuum interrupter protected feeders into the Campus. The input and output feeders are the same size conductor limiting the vacuum interrupters relay protection to 200 amps for the #4/0 aluminum circuits and 400 amps for the 350Kcmil copper circuits.

C. Campus Feeders: There are three campus loops, “MA”. “MB” and “MC/D”, when configured into a normal operating condition, each will have a normally open point, creating four radial feeds, each protected by a vacuum interrupter. Each loop originates in one of the four pieces of 15Kv rated gear, connected to a vacuum interrupter, and terminates in another piece of 15Kv rated gear’s vacuum interrupter ie: Switch MS-A has feeders MA-1 and MA-2 originating from it, and switch MS-B has feeders MB-1 and MB-2 originating from it. In the field MA-1 connects to MB-1 at its normally open point and MA-2 connect to MB-2 in the same manner. Switchgear MS-C and MS-D have only one feeder originating from them with one open position for future use. These feeders are MC-1 and MD-1. They connect together at a normally open point on campus in the same manner as the other feeders. All campus feeders are installed underground in concrete incased duct bank.

Circuit Designation	Max. Trip Setting Phase/Ground	Trip Setting in Field
MA-1	600A	200/Blocked*
MA-2	600A	200/Blocked*
MB-1	600A	200/Blocked*
MB-2	600A	200/Blocked*
MC-1	600A	200/4000*
MD-1	600A	200/4000*

(*) Designates the continuous / instantaneous trip settings.

D. Circuit Loading

1. No records have been kept on individual circuit loading by the campus.

2. Load calculations noted below are based on connected Kva @ 50% demand for radial, 40% demand for loop, and 35% demand for campus. The percentages used are representative of typical college campus load data. These are conservative values. Actual percent of connected Kva to peak in 2010 was 24%.

3. Maximum Load Current – See Campus Load Analysis Sheets 2 and 3 in Appendix.

Reported Peak 2010 (GPC) 8/10 (At primary Metered Service Point)	354A (24% Conn. Kva)
Reported Peak 2011 (GPC) 8/11 (At primary Metered Service Point)	360A (23% Conn. Kva)

E. Lightning Protection:

1. Distribution aerial type overhead arrester on each circuit phase on overhead portion of incoming GPC overhead feeder.

2. Distribution type 9kV MOV arrester installed in transformers in the field at both ends of the normally open point.

F. Underground Raceway System:

1. Concrete encased 4" duct bank. Number of ducts varies from 8 to 2.

2. Steel reinforced concrete manholes:

   a. 38 Octagonal 8' X 8' X 7' with chimneys and iron covers.
   b. 2 Rectangular 5' X 10' X 6' with chimneys and iron covers.
   c. 6 Rectangular 4' X 4' X 4' with chimneys and iron covers generally used for pullboxes.

G. Cables: (Excluding GPC)

1. Underground: #4/0, type MV-90, 15Kv, single aluminum stranded conductor, crosslinked polyethylene insulated, with concentric (33% X 3 cables = 100%) neutral shield.

2. Underground: 350Kcmil, type MV-105, 15Kv, single copper compact stranded conductor, EPR insulated, with copper tape shield, fully jacketed. #4/0 copper XHHW 600 volt neutral.

H. Cable Terminations:

1. Standard: 15Kv 600A bolted dead-break "T" cable termination to form:

   a. 600A dead end "T"
   b. 600A apparatus connection w/bushing well insert and protective cap.
   c. 600A-600A splice, w/ or w/o 200A tap or 600A tap (in manholes).

2. 15Kv 200A Loadbreak elbow cable terminations. (8 Transformers)

3. 15Kv live front terminations (1 Transformer)

I. Cable Circuit Identification:

1. Some Tags in manholes found to be engraved pot metal, nearly all corroded past legibility.

2. Some Tags in manholes found to be permanent plastic type with hand written or etched in letters.

3. Some newer cable installations in manholes tagged.

4. Most transformers have to / from tags on cable.

5. Primary cables in switchgear, all identified with permanent tags.

6. Tagging found incorrect in some manholes due to system changes.

J. Fireproofing:

1. Original installation: All cable fireproofed in manholes.

2. Newer 350Kcmil “400 amp” circuit: Incorrectly fireproofed with all three phases fireproofed together as one bundle.

K. Pad-mount Transformers:

1. Switching:

   a. 32 three phase transformers and 6 single phase.
   b. 25 three phase with integral loop feed switch.
   c. 7 without integral loop feed switch, none of the single phase transformers have a loop feed switch. Most are radially fed.

2. Of the 38 total transformers only 3 are 30 years old, or older. These are nearing the end of their useful life @ 40 years. Two of the three are three phase. Both would be replaced with the need to replace for having 200 amp bushings and or no loop feed switch.

3. 34,550 total connected Kva.

4. Seven (7) of the three phase transformers are delta-wye connected. The other twenty five (25) three phase transformers are wye-wye connected.

L. The 2005 master plan was updated in 2010, and broken out into short (Phase II) plans for campus expansion and long term (Phase III) expansion plans for the growth of Kennesaw State University. The development of this 2010 plan will point out the need for changes to the main campus electrical distribution system (EDS).

Phase II includes:

1. Four new parking decks plus one parking deck expansion. One additional parking deck is proposed which will be off the main campus and off the campus EDS system. Expansion of the existing duct bank and feeder system will be required to feed three of these new parking decks.

2. Four additions to existing facilities: New 74,128 sq. ft. Science Lab addition, New 131,738 sq. ft. Recreation Center addition; New 200,140 sq. ft. Academic Learning Center & Business addition and New 249,690 sq. ft. Student Center expansion.

3. Addition of three new classroom type facilities: New 82,900 sq. ft. Education Classroom Facility; New 9,828 sq. ft. Art Museum and Classroom facility and a new 25,000 sq. ft. Early Childhood Learning Center.

4. New 37,875 sq. ft. South Dinning Hall.

5. The Addition of the Early Learning Center at the location shown, off campus, will not be included in the EDS system and will be fed from utility sources.

6. Additional Housing (North and South). These are expected to be dormitory Privatization Projects fed by GPC and Not impacting the campus EDS.

Phase III includes:

1. Four additions to existing facilities: New 49,140 sq. ft. Research Lab addition, New 108,000 sq. ft. Student Center Development; New 86,720 sq. ft. Education addition II; and New 60,591 sq. ft. Visual Arts addition.

2. Addition of two new classroom / office facilities: New 273,785 sq. ft. Technology Classroom and Office Facility; and New 120,490 sq. ft. Classroom and Office building.

3. Addition of four new classroom facilities: New 106,480 sq. ft. Arts / Academic Building; New 81,795 sq. ft. Computer Science and Math Building; New 63,288 sq. ft. Allied Health Building.

4. Addition of two new administrative / office buildings: New 25,510 sq. ft. Office Building and New 75,000 sq. ft. Special Collections Building.

5. One additional parking deck is proposed which may be off the main campus and off the campus EDS system. For this study it is included in the campus EDS system.

Conclusion: For Phase II, it is expected all the facilities noted can be served from the existing campus EDS system. As mentioned, Phase III will require a new utility substation be on-line and connected to the existing feeder system to serve Phase III loads.

GSW 7/11/2011
Rev **12/16/2011**

KENNESAW STATE UNIVERSITY
CAMPUS TRANSFORMER ANALYSIS

EXISTING CONDITIONS

Tx.#	Size	Sec. Voltage	Year	Sec. Sw.	HV Bush.
ST-1	2500	480/277	2009	YES	600
T-1A	2500	480/277	1997	NO	200
ST-2	150	120/208	1994	YES	600
T-3	750	480/277	1988	NO	200
ST-4	750	480/277	1999	YES	600
ST-5	500	480/277	1980	YES	200
ST-5A	750	480/277	2004	YES	600
ST-6	500	120/208	1994	YES	600
T-7	1500	480/277	UNK.	NO	200
ST-8	300	120/208	1996	YES	600
ST-9	300	120/208	1996	YES	600
ST-10	500	120/208	1996	YES	600
ST-11	500	120/208	1996	YES	600
T-12A	100	120/240	1973?	NO	200
T-12B	100	120/240	UNK.	NO	200
ST-14	300	120/208	1996	YES	600
ST-15	1000	480/277	2003	YES	600
ST-16	2000	480/277	1996	YES	600
T-18A	167	120/240	1991?	NO	200
T-18B	250	120/240	1992	NO	200

Tx.#	Size	Sec. Voltage	Year	Sec. Sw.	HV Bush.
T-19	150	480/277	1992	NO	200
T-21 1P	75	120/240	UNK	NO	200
ST-22	500	480/277	2000	YES	600
ST-25	1500	480/277	1994	YES	600
ST-26	750	480/277	2001	YES	600
T-27 1P	50	120/240	UNK	NO	200
ST-27	3750	480/277	2006	YES	600
ST-28	2000	480/277	2003	YES	600
T-29	300	480/277	1999?	NO	200
T-29 1P	75	120/240	UNK	NO	200
T-30	300	480/277	2001	NO	200
T-30 1P	50	120/240	UNK	NO	200
ST-31	750	480/277	2006	YES	600
ST-32	300	480/277	2008	YES	600
ST-33A	2000	480/277	2009	YES	600
ST-33B	2000	480/277	2009	YES	600
ST-34	1500	480/277	1989	YES	600
ST-35	500	480/277	2008	YES	600
ST-36	1500	480/277	2010	YES	LF
T-37	500	480/277	2003	NO	200
T-38	1500	480/277	2011	YES?	600?

TRANSFORMERS >30 YEARS = 3 (ST-5, T-7, ~~S~~T-12A)
TRANSFORMERS 20-30 YEARS = 3
TRANSFORMERS < 20 YEARS = 32
TRANSFORMERS REQUIRING LOOP FEED SWITCHES = 7 (Note single phase, non-loop feed excluded) (T-1A, T-3, T-7, T-19, ~~S~~T-29, ~~S~~T-30, ~~S~~T-37)
TRANSFORMERS WITH 200 AMP BUSHING WELLS =8 (Note single phase, non-loop feed excluded) (T-1A, T-3, ST-5, T-7, T-19, ~~S~~T-29, ~~S~~T-30, ~~S~~T-37)
TRANSFORMERS WITH VISABLE DAMAGE = 1 (Note single phase, non-loop feed excluded) (T-7)
LIVE FRONT TRANSFORMERS = 1 (ST-36)

TRANSFORMERS TO BE REPLACED = 9 (LOOP FEED + 200 AMP BUSHING WELLS + LIVE FRONT)

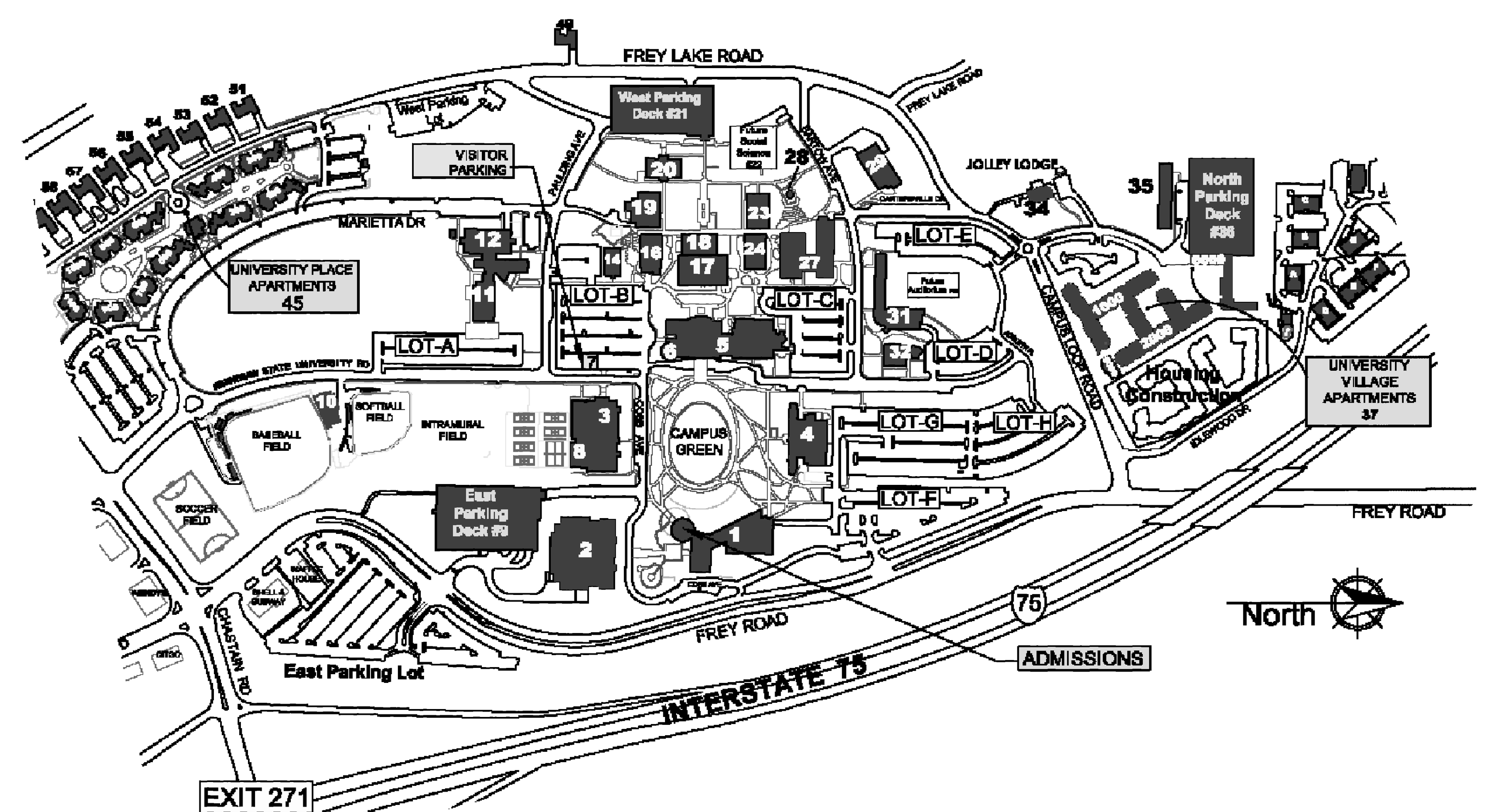
ELECTRICAL DISTRIBUTION SYSTEM STUDY

KENNESAW STATE UNIVERSITY, KENNESAW, GA 30144

INDEX OF DRAWINGS

	DRAWINGS
X1.1	COVER SHEET
E1.1	LEGEND
E1.2	PRIMARY ONE-LINE DIAGRAM – EXISTING CONDITIONS
E3.1	PARTIAL CAMPUS SITE PLAN
E3.2	PARTIAL CAMPUS SITE PLAN
E4.1	EXISTING CONDITIONS IN MANHOLES – 1,2,2A,2B,2C,3,4,5,6,7,8,9 – ELECTRICAL
E4.2	EXISTING CONDITIONS IN MANHOLES – 10,11,12,13,14,15,16,17,18,19,20,21– ELECTRICAL
E4.3	EXISTING CONDITIONS IN MANHOLES – 22,23,24,27,28,29,30,31,32,33,34,35 – ELECTRICAL
E4.4	EXISTING CONDITIONS IN MANHOLES – 37,38,40,41,43,44,45,46,48,52,66 – ELECTRICAL
E5.1	PARTIAL CAMPUS SITE PLAN – MASTER PLAN PHASES II AND III
E5.2	PARTIAL CAMPUS SITE PLAN – MASTER PLAN PHASES II AND III
E5.3	PRIMARY ONE-LINE DIAGRAM – EXISTING CONDITIONS AND PHASE II WORK
E5.4	PRIMARY ONE-LINE DIAGRAM – EXISTING CONDITIONS AND PHASE III WORK
E5.5	PRIMARY ONE-LINE DIAGRAM – EXISTING CONDITIONS AND PHASE III WORK

LOCATION MAP



KENNESAW STATE UNIVERSITY
LOCATION MAP

DATE DECEMBER 2, 2011
DRAWN BY BRADY
CHECKED BY WAUGH
DESIGNED BY PEACOCK

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KENNESAW STATE UNIVERSITY
KENNESAW, GEORGIA

COVER SHEET

SHEET NO.
X1.1
1 OF 14

LEGEND OF SYMBOLS, RISER

MH #3	FOUR-WAY MANHOLE (UNIT NO. 3 SHOWN)
PULL BOX	PULL BOX
1 2	PAD-MOUNT OIL-FILLED TRANSFORMER - LOOP FEED 200A ELBOWS. NO INTERNAL SWITCH
A B	PAD-MOUNT OIL-FILLED TRANSFORMER - LOOP FEED 200A ELBOWS. WITH INTERNAL SELECTOR SWITCHES.
X Y	PAD-MOUNTED, AIR-FILLED, GANG OPERATED SECTIONALIZER SWITCHES, LOOP FEED, STRESS RELIEVED CABLES, LIVE-FRONT.
L.A.	PRIMARY SYSTEM LIGHTNING ARRESTER & GROUND ELECTRODE.
	PRIMARY SYSTEM FUSED DISCONNECT SWITCH.
	PRIMARY SYSTEM DISCONNECT SWITCH.
GOS	GANG-OPERATED PRIMARY SWITCH.
UG	PRIMARY SYSTEM OVERHEAD TO UNDERGROUND DIP (OR UNDERGROUND TO OVERHEAD RISER).

ELECTRICAL LEGEND

CIRCUITS	
	UNDERGROUND DUCT BANK
	ONE DUCT PER WIRE (NONE INDICATES 2-WAY)
GENERAL EQUIPMENT	
◇	MANHOLE
	TRANSFORMER
ABBREVIATIONS	
3ø	THREE PHASE
4W	FOUR WIRE
AC	ALTERNATING CURRENT
AIC	UL LISTED, INTERRUPTING CAPACITY-RMS SYMMETRICAL AMPERES
A, AMP	AMPERES
C, CD.	CONDUIT
KVA	KILOVOLT-AMPERES
KW	KILOWATTS
MAX	MAXIMUM
MIN	MINIMUM
M.B.	MAIN BREAKER
M.L.O.	MAIN LUGS ONLY
RECP.	RECEPTACLE
RM.	ROOM
SWB	SWITCHBOARD
SWG	SWITCHGEAR
UL	UNDERWRITER'S LABORATORY

GEORGIA REGISTERED PROFESSIONAL ENGINEER RANDY B. PEACOCK

DATE	DECEMBER 2, 2011
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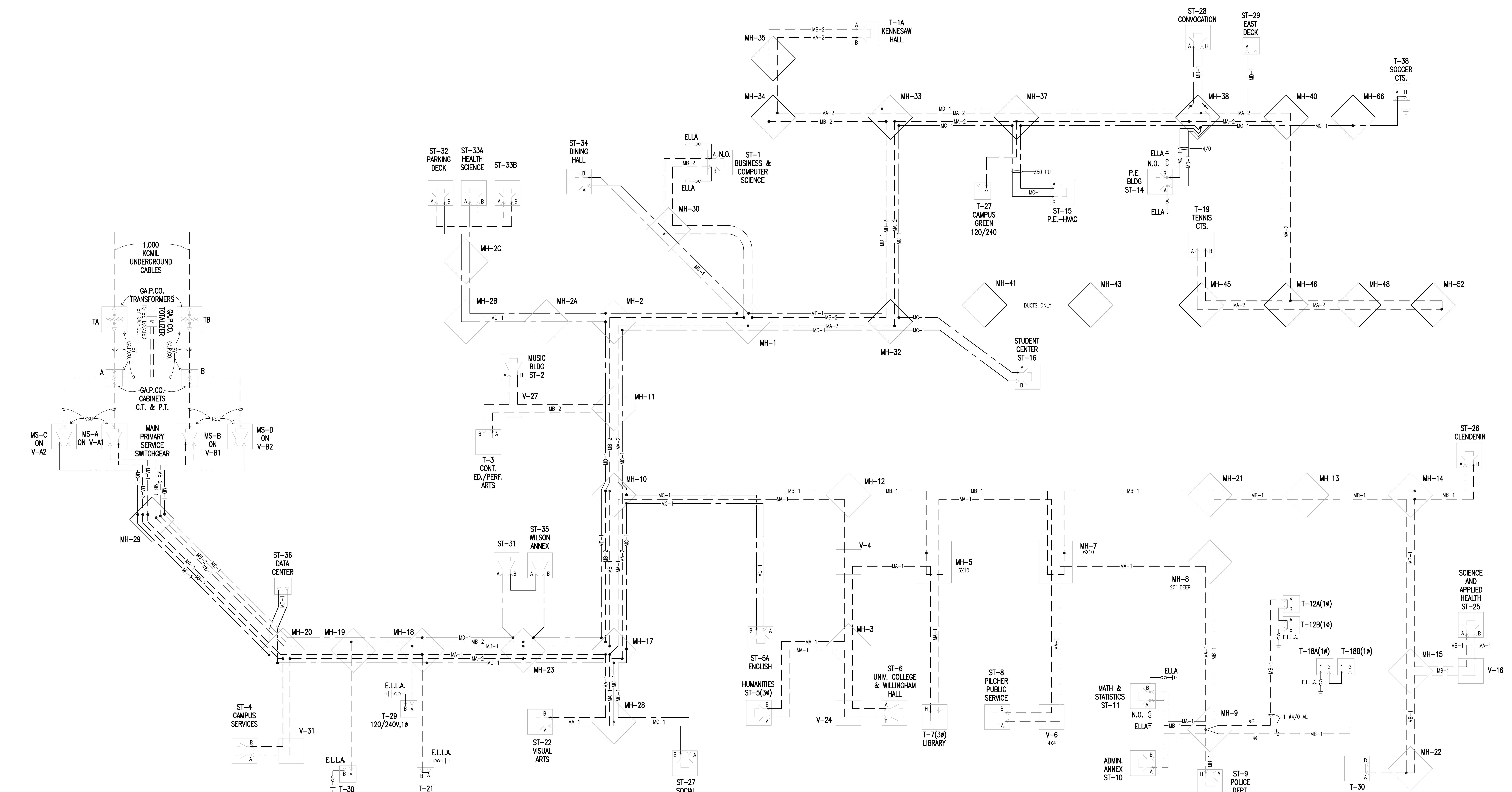
LEGEND
ELECTRICAL

SHEET NO.
E1.1



PRIMARY ONE-LINE DIAGRAM EXISTING CONDITIONS

SCALE: NONE

GENERAL NOTES:
(THIS SHEET ONLY)
A. NORMALLY OPEN POINTS SHOWN ARE RECOMMENDED POINTS TO BALANCE CIRCUIT LOADING. ACTUAL FIELD CONDITIONS MAY VARY.

GEORGIA REGISTERED PROFESSIONAL ENGINEER RANDY B. PEACOCK

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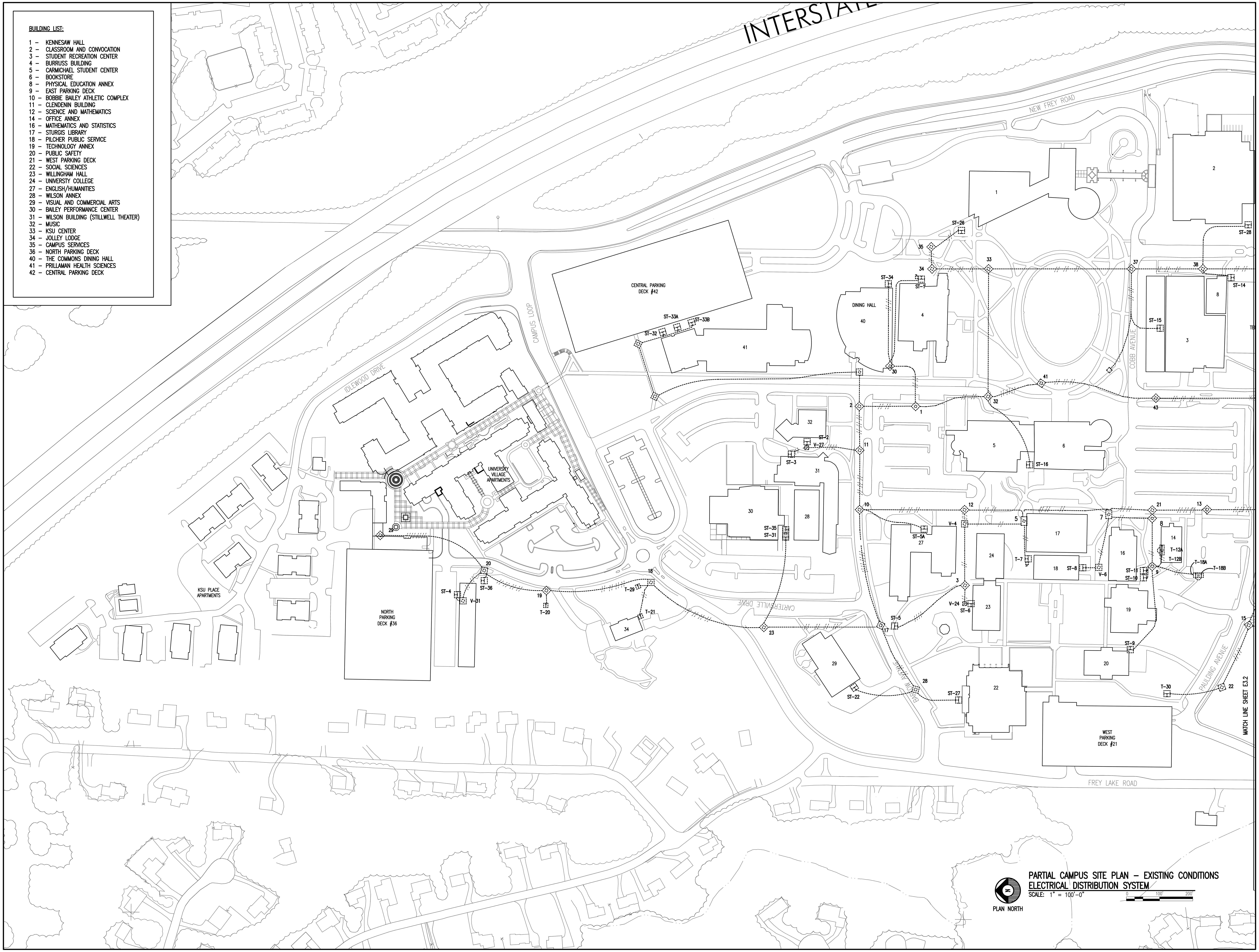
PRIMARY ONE LINE DIAGRAM
EXISTING CONDITIONS

SHEET NO.
E1.2
3 OF 14

BUILDING LIST:

1 – KENNESAW HALL
2 – CLASSROOM AND CONVOCATION
3 – STUDENT RECREATION CENTER
4 – BURRUSS BUILDING
5 – CARMICHAEL STUDENT CENTER
6 – BOOKSTORE
8 – PHYSICAL EDUCATION ANNEX
9 – EAST PARKING DECK
10 – BOBBIE BAILEY ATHLETIC COMPLEX
11 – CLENDENIN BUILDING
12 – SCIENCE AND MATHEMATICS
14 – OFFICE ANNEX
16 – MATHEMATICS AND STATISTICS
17 – STURGIS LIBRARY
18 – PILCHER PUBLIC SERVICE
19 – TECHNOLOGY ANNEX
20 – PUBLIC SAFETY
21 – WEST PARKING DECK
22 – SOCIAL SCIENCES
23 – WILLINGHAM HALL
24 – UNIVERSITY COLLEGE
27 – ENGLISH/HUMANITIES
28 – WILSON ANNEX
29 – VISUAL AND COMMERCIAL ARTS
30 – BAILEY PERFORMANCE CENTER
31 – WILSON BUILDING (STILLWELL THEATER)
32 – MUSIC
33 – KSU CENTER
34 – JOLLEY LODGE
35 – CAMPUS SERVICES
36 – NORTH PARKING DECK
40 – THE COMMONS DINING HALL
41 – PRILLAMAN HEALTH SCIENCES
42 – CENTRAL PARKING DECK



PARTIAL CAMPUS SITE PLAN – EXISTING CONDITIONS
ELECTRICAL DISTRIBUTION SYSTEM
SCALE: 1" = 100'-0"

PLAN NORTH

GEORGIA REGISTERED PROFESSIONAL ENGINEER RANDY B. PEACOCK

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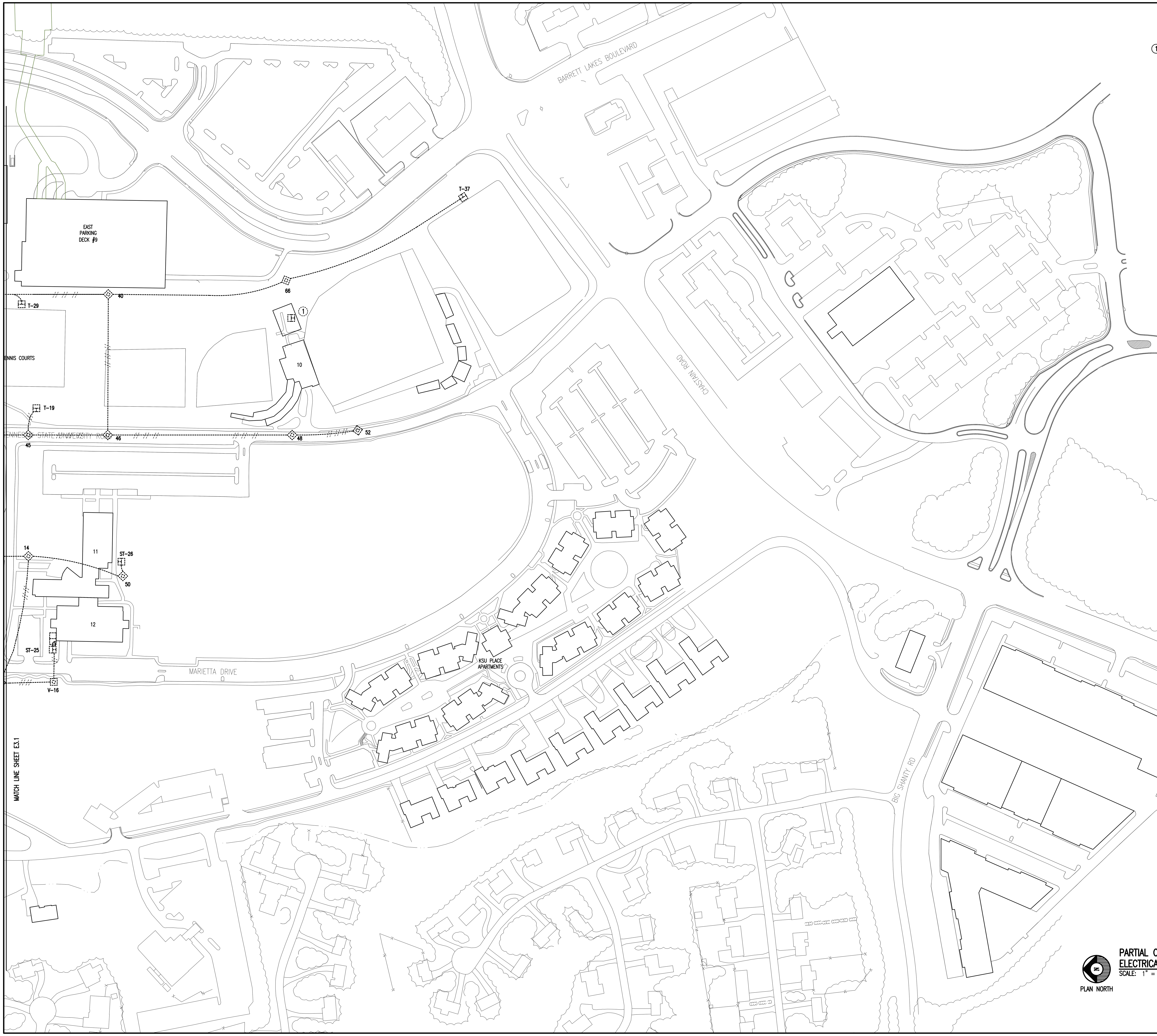
KENNESAW, GEORGIA

PARTIAL CAMPUS SITE PLAN - EXISTING CONDITIONS
ELECTRICAL DISTRIBUTION SYSTEM

SHEET NO.
E3.1
4 OF 14



NOTES:
(THIS SHEET ONLY)

(1) EXISTING TRANSFORMER FED BY GA.P.CO.

BUILDING LIST:

1 – KENNESAW HALL
2 – CLASSROOM AND CONVOCATION
3 – STUDENT RECREATION CENTER
4 – BURRUSS BUILDING
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41 – PRILLAMAN HEALTH SCIENCES
42 – CENTRAL PARKING DECK

PARTIAL CAMPUS SITE PLAN – EXISTING CONDITIONS
ELECTRICAL DISTRIBUTION SYSTEM
SCALE: 1" = 100'-0"
0 100' 200'

GEORGIA REGISTERED PROFESSIONAL ENGINEER NO. 200.. RANDY B. PEACOCK

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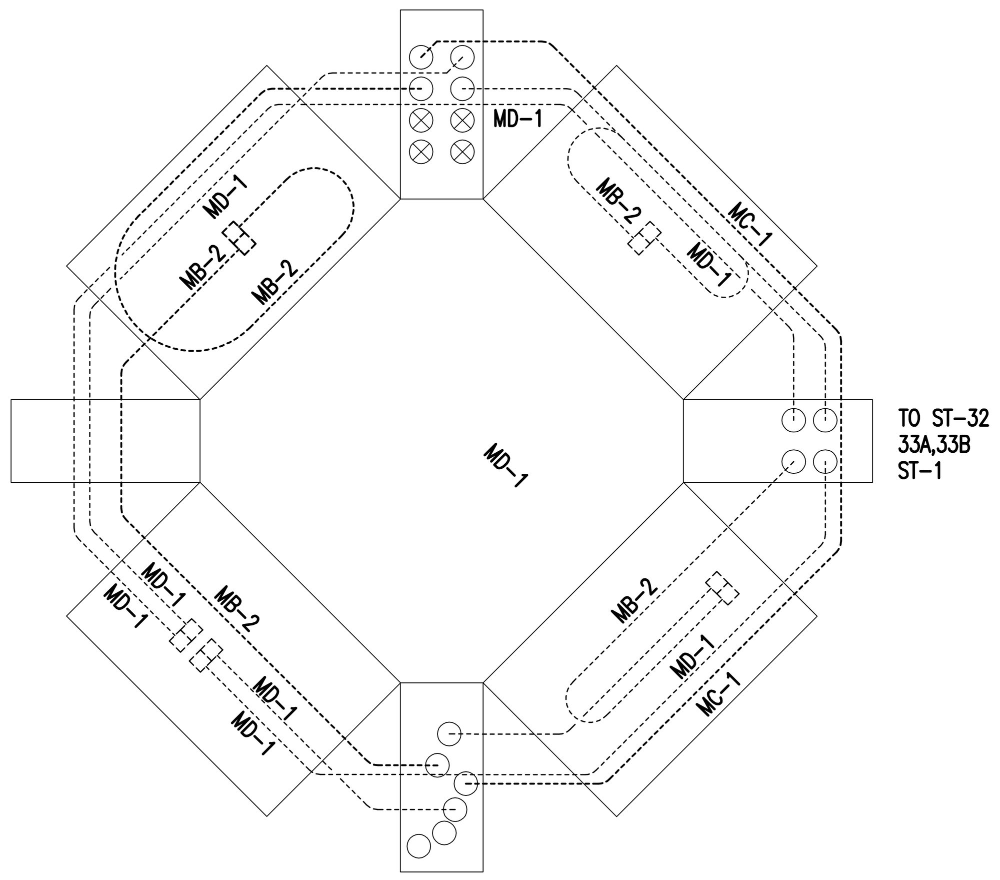
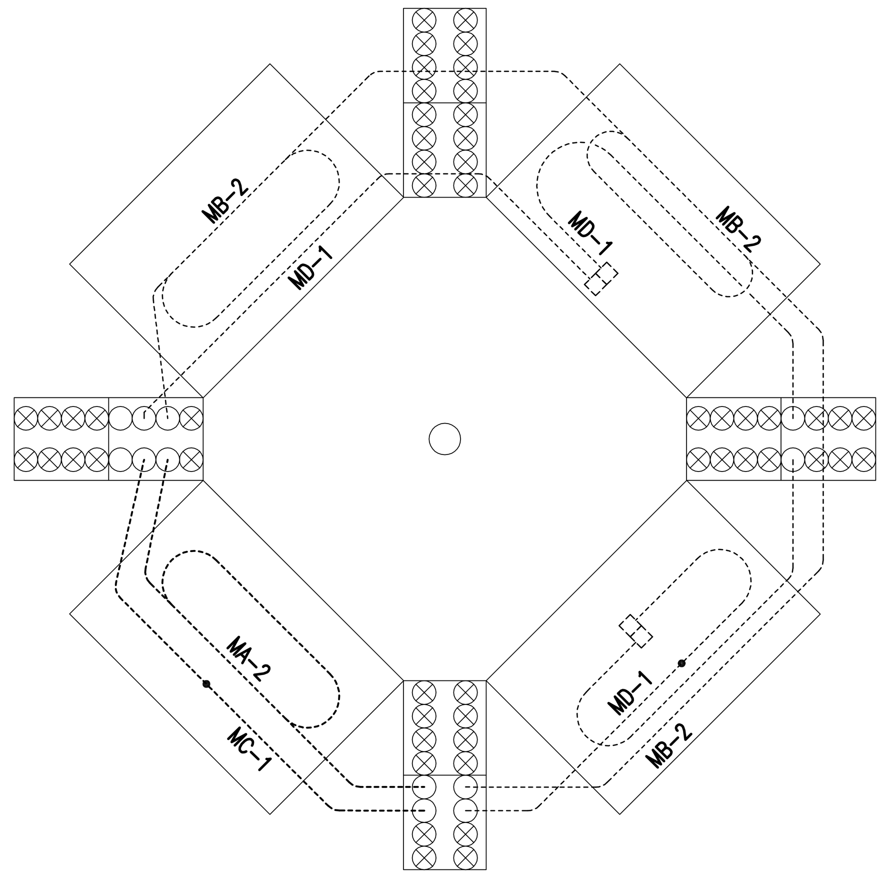
PARTIAL CAMPUS SITE PLAN - EXISTING CONDITIONS
ELECTRICAL DISTRIBUTION SYSTEM

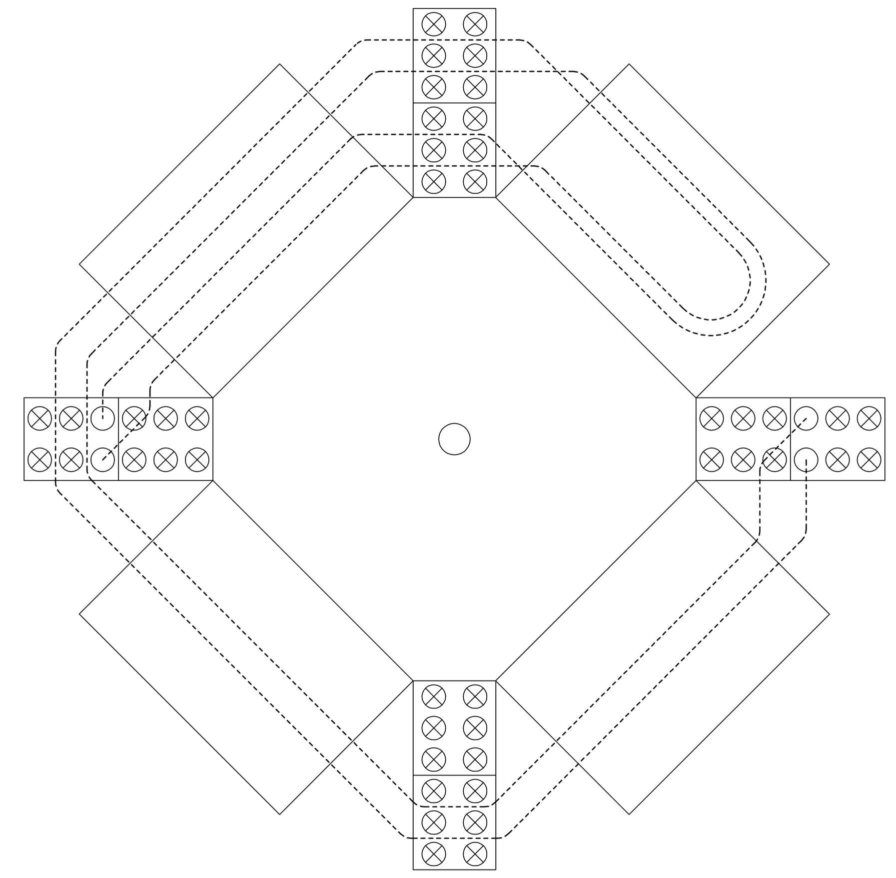
SHEET NO.
E3.2
5 OF 14



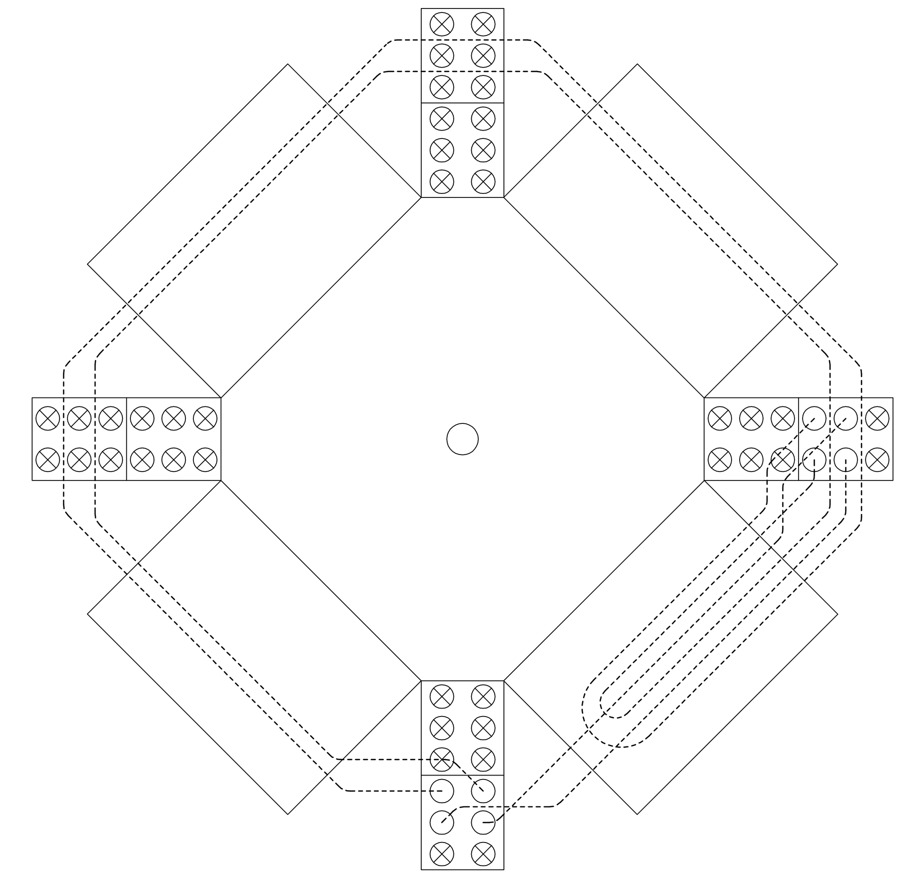
MANHOLE #1
SCALE: NONE



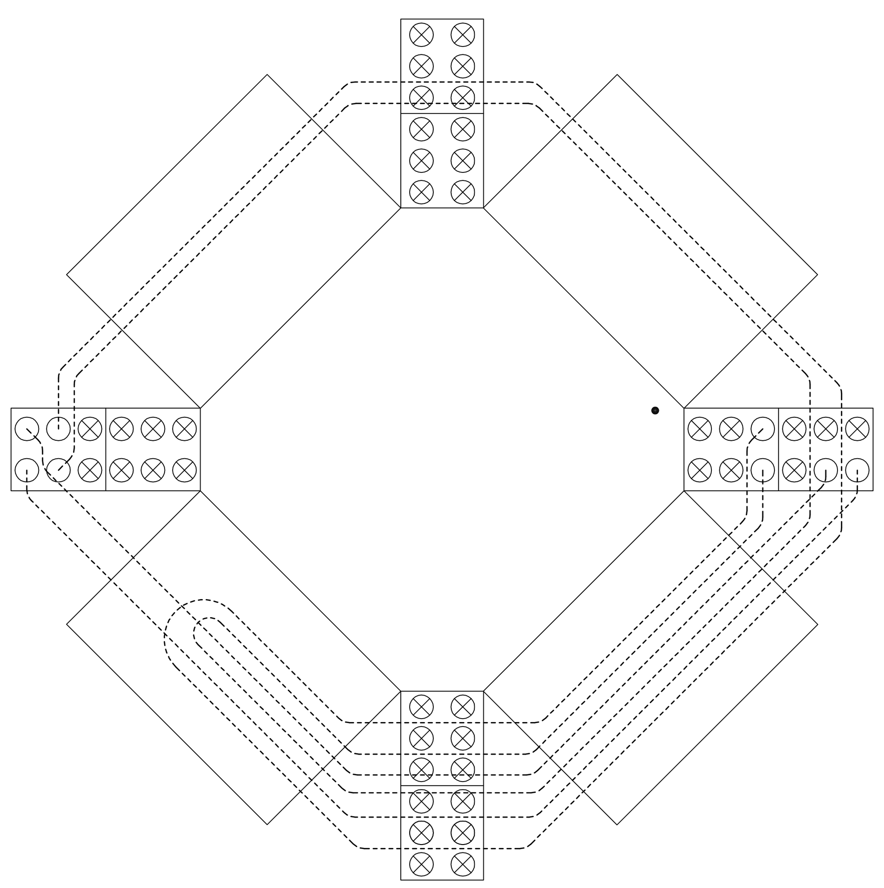
MANHOLE #2
SCALE: NONE



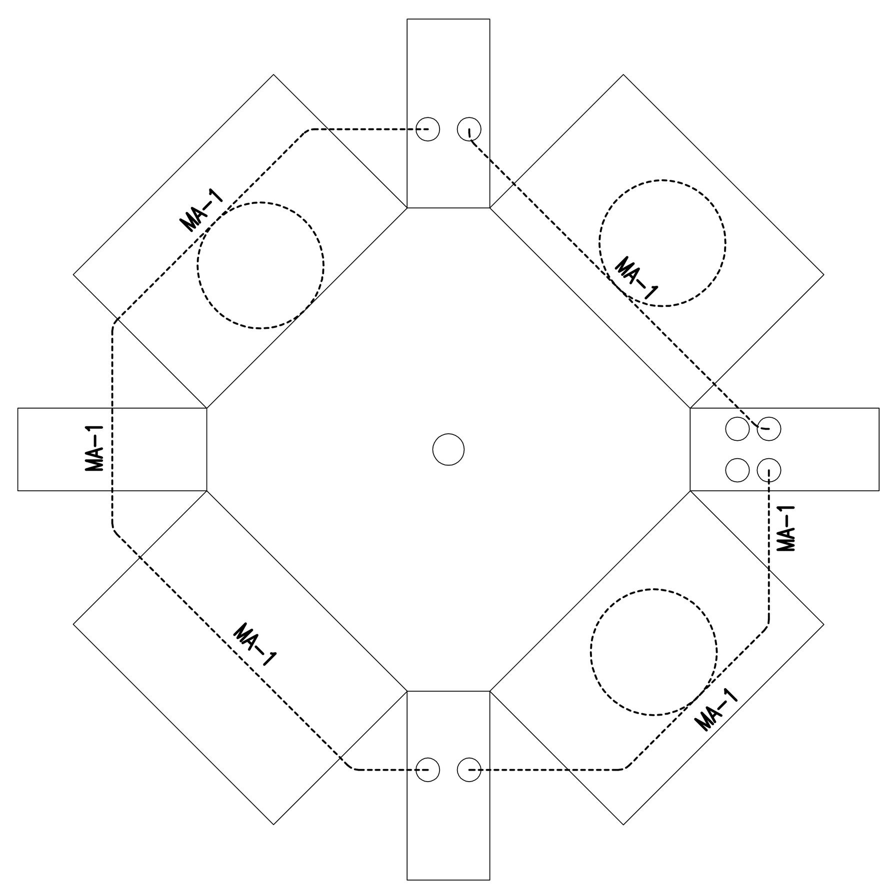
MANHOLE #2A (COMMONS)
SCALE: NONE



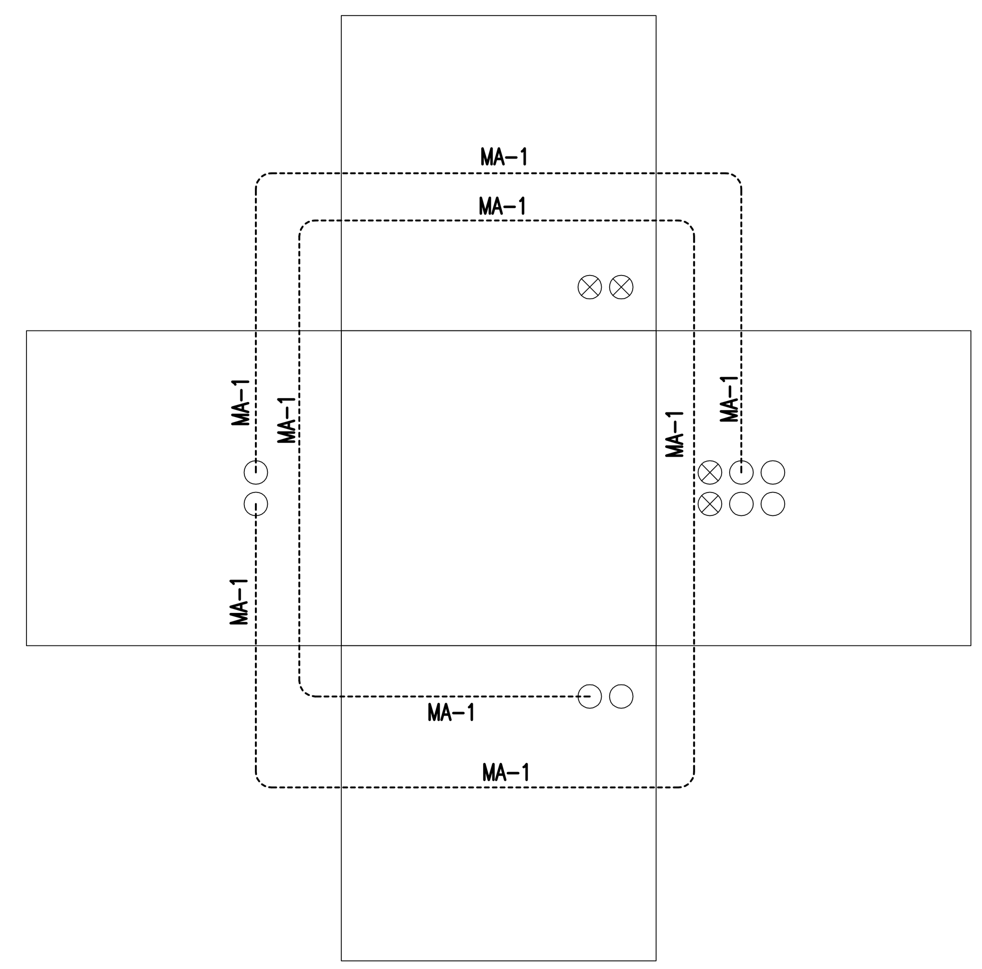
MANHOLE #2B
SCALE: NONE



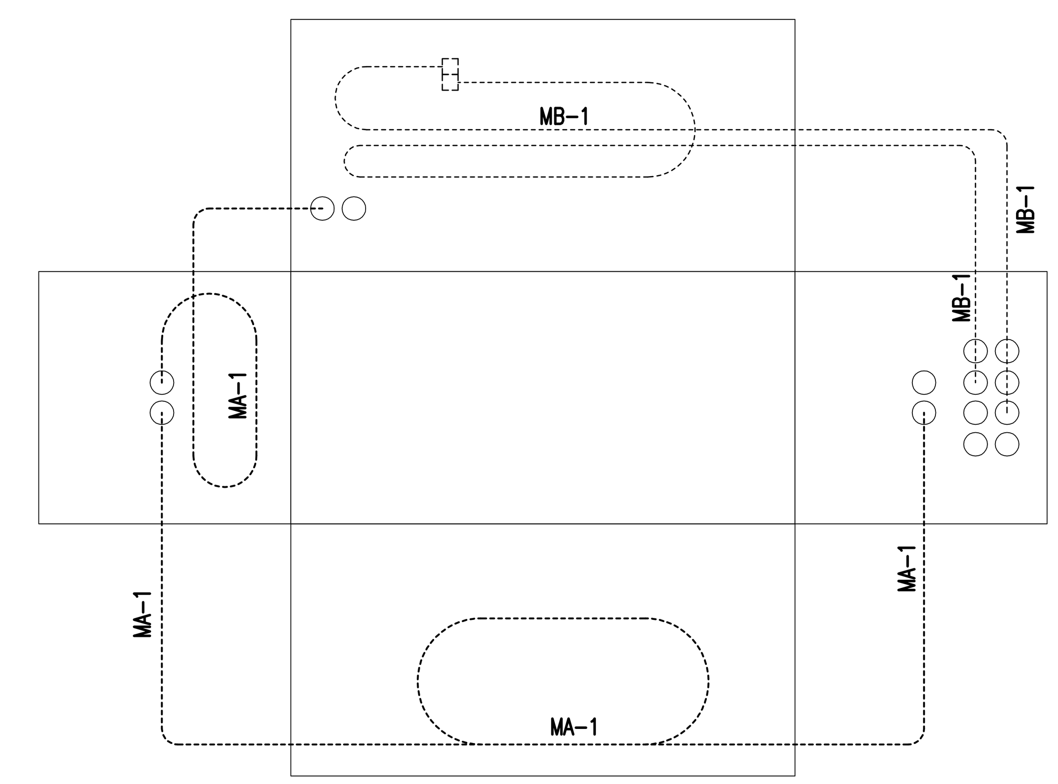
MANHOLE #2C
SCALE: NONE



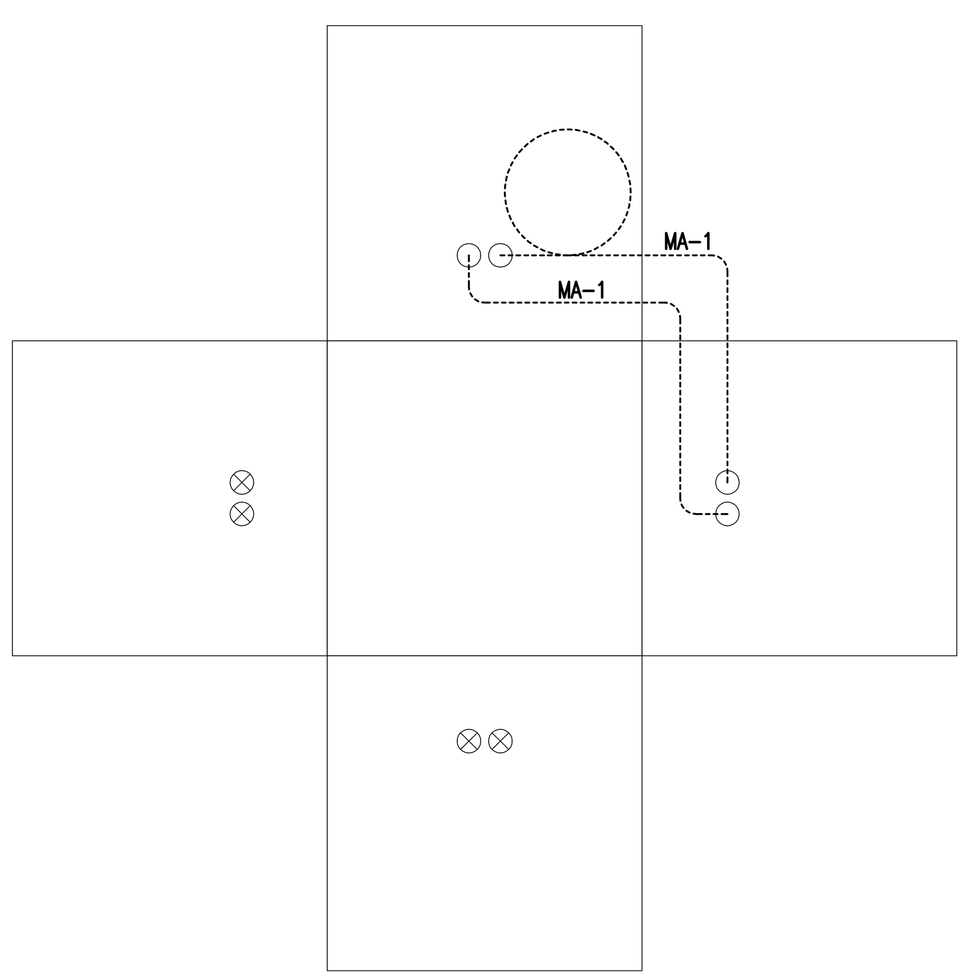
MANHOLE #3
SCALE: NONE



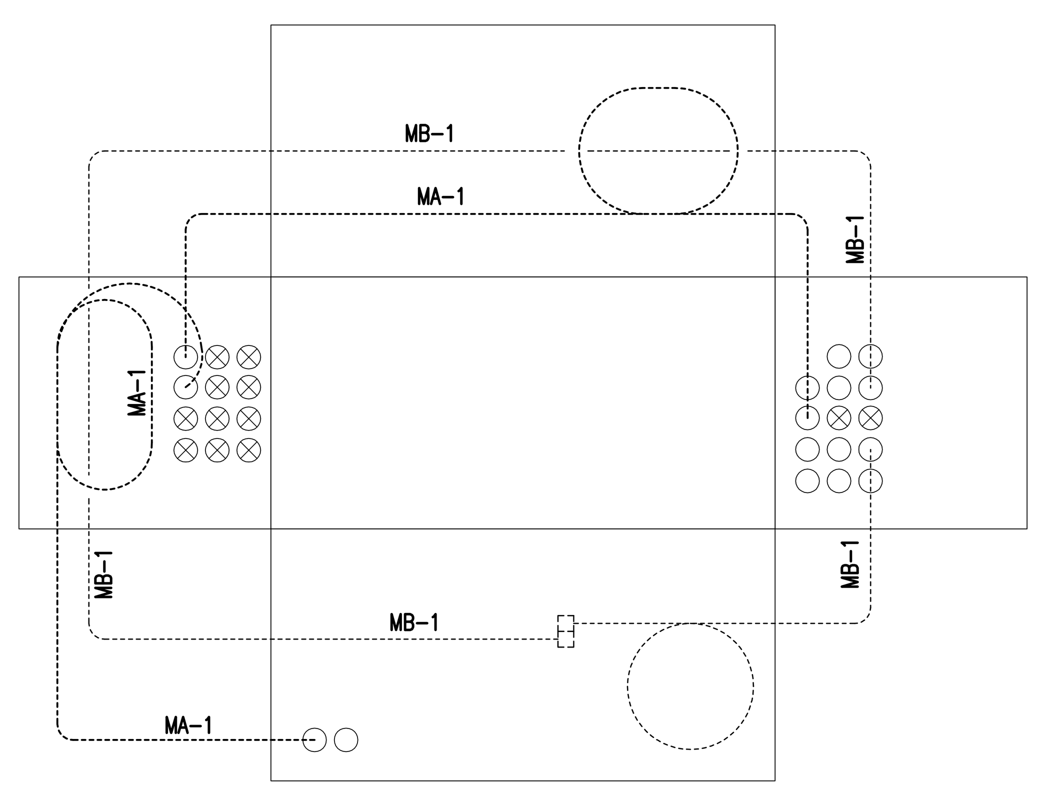
VAULT #4
SCALE: NONE



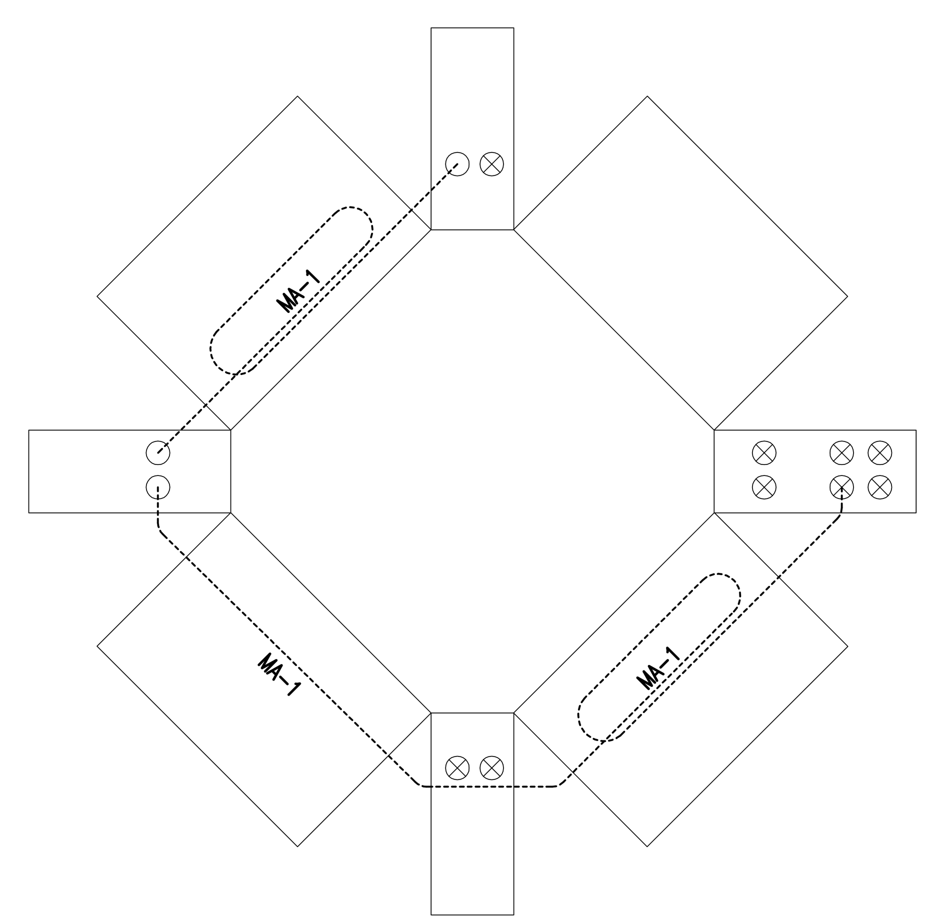
MANHOLE #5
SCALE: NONE



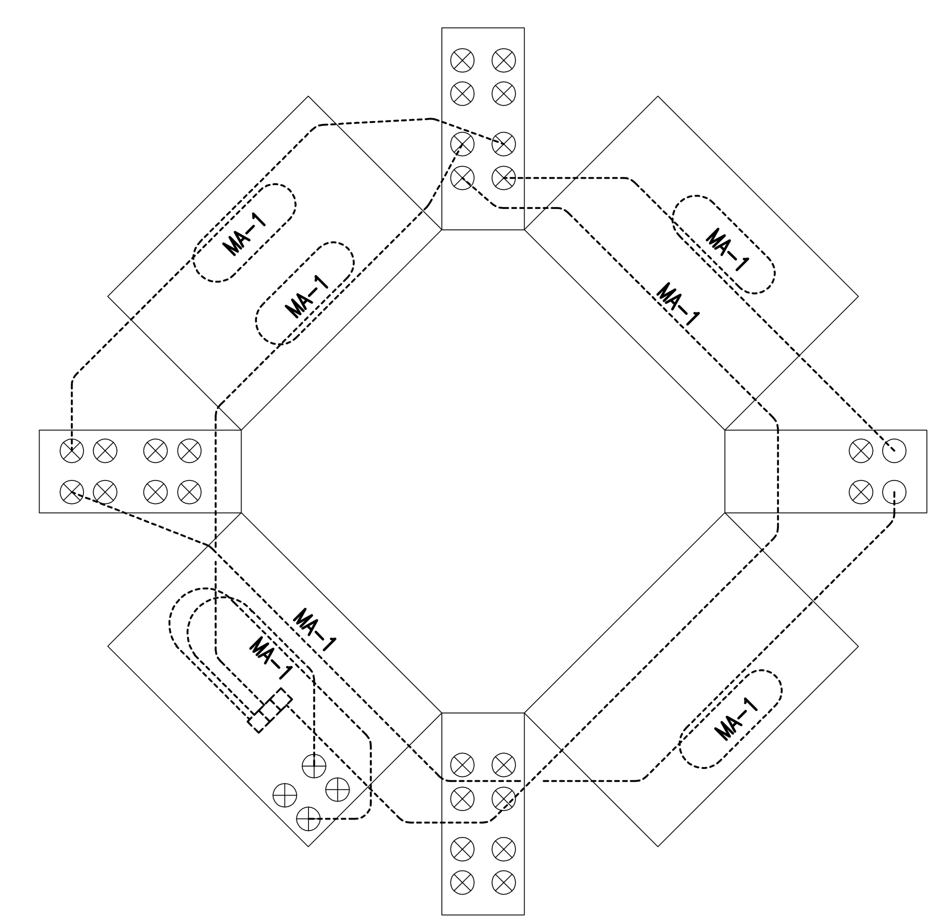
VAULT #6
SCALE: NONE



MANHOLE #7
SCALE: NONE



MANHOLE #8
SCALE: NONE



MANHOLE #9
SCALE: NONE

GEORGIA REGISTERED PROFESSIONAL ENGINEER RANDY B. PEACOCK

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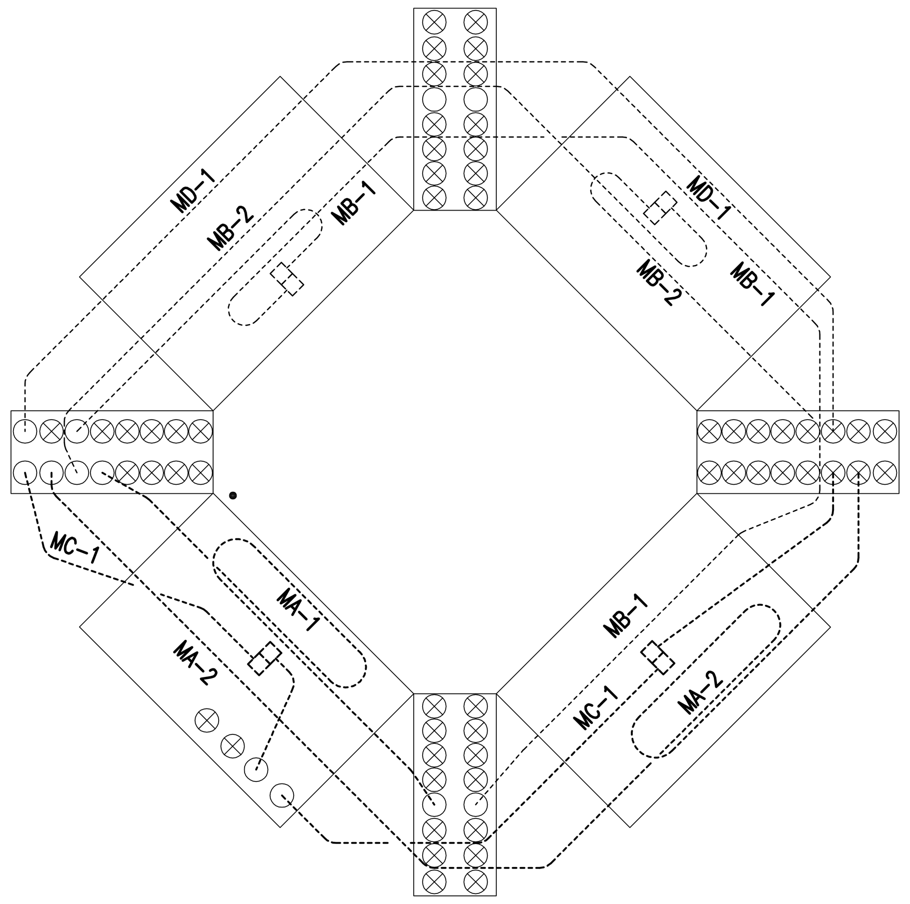
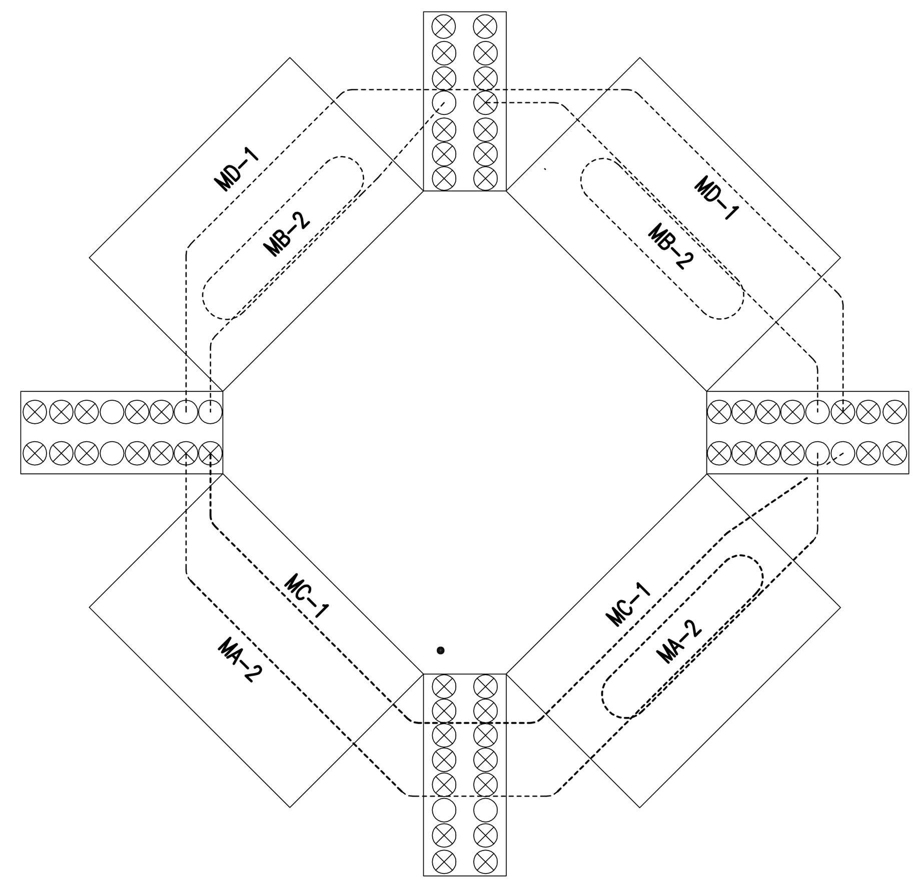
KENNESAW STATE UNIVERSITY
KENNESAW, GEORGIA

EXISTING CONDITIONS IN MANHOLES
1,2,2A,2B,2C,3,4,5,6,7,8,9 - ELECTRICAL

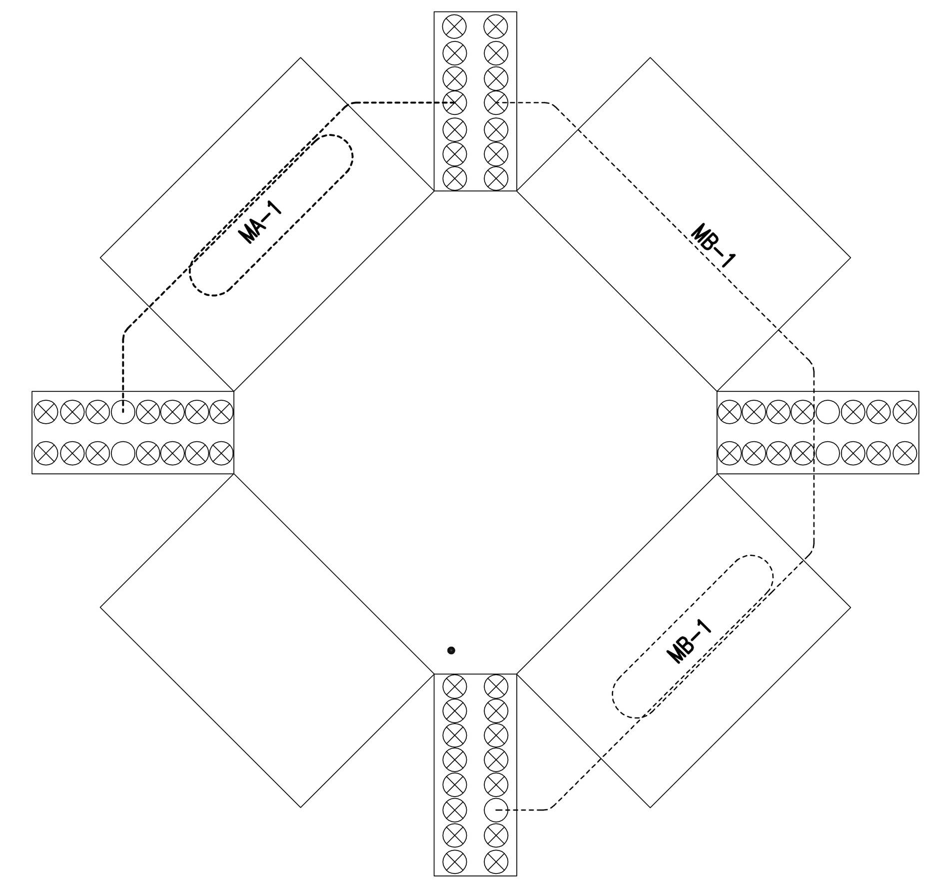
SHEET NO.
E4.1
6 OF 14



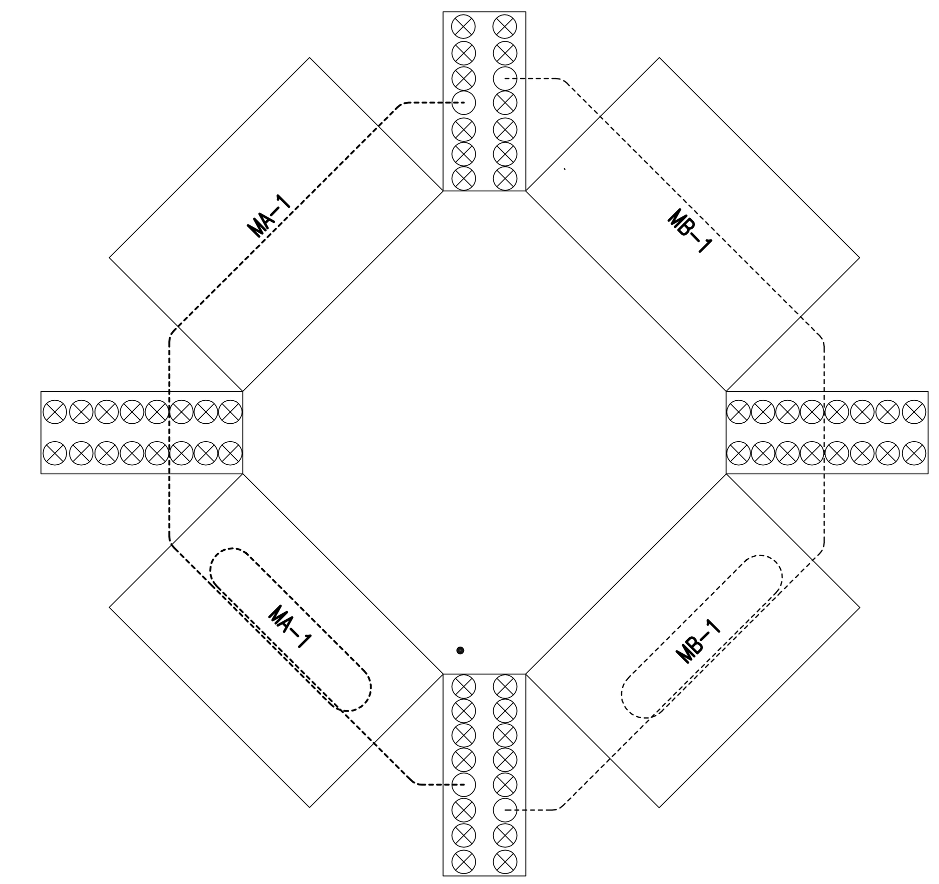
MANHOLE #10
SCALE: NONE



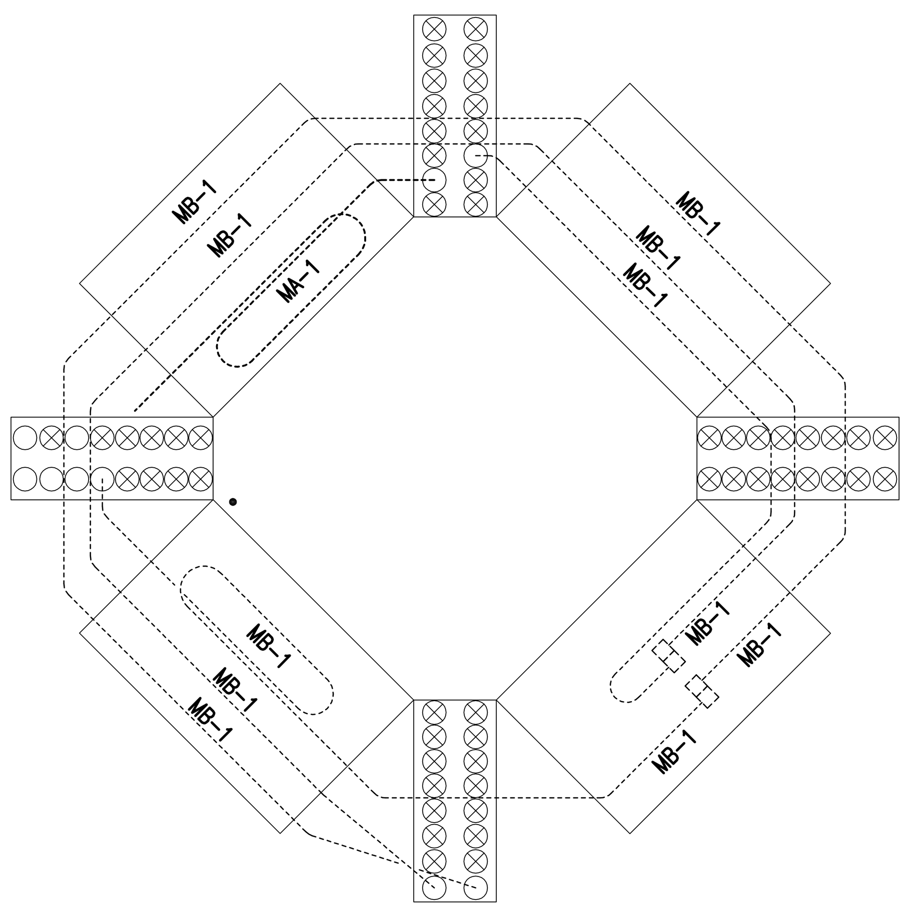
MANHOLE #11
SCALE: NONE



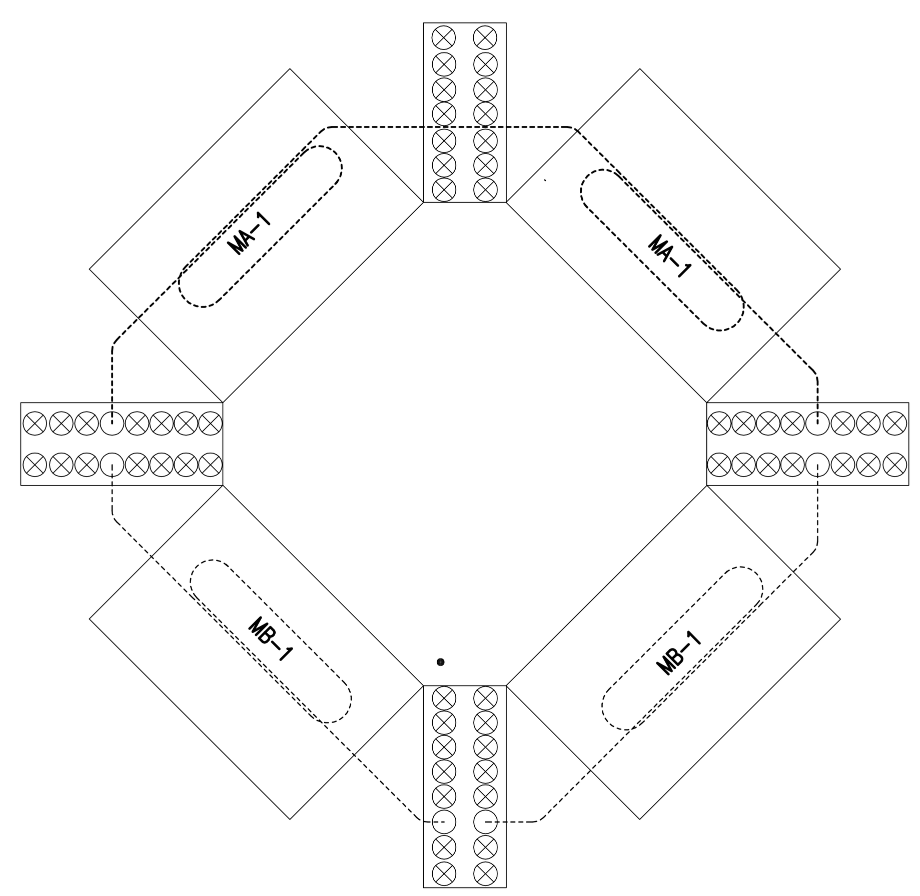
MANHOLE #12
SCALE: NONE



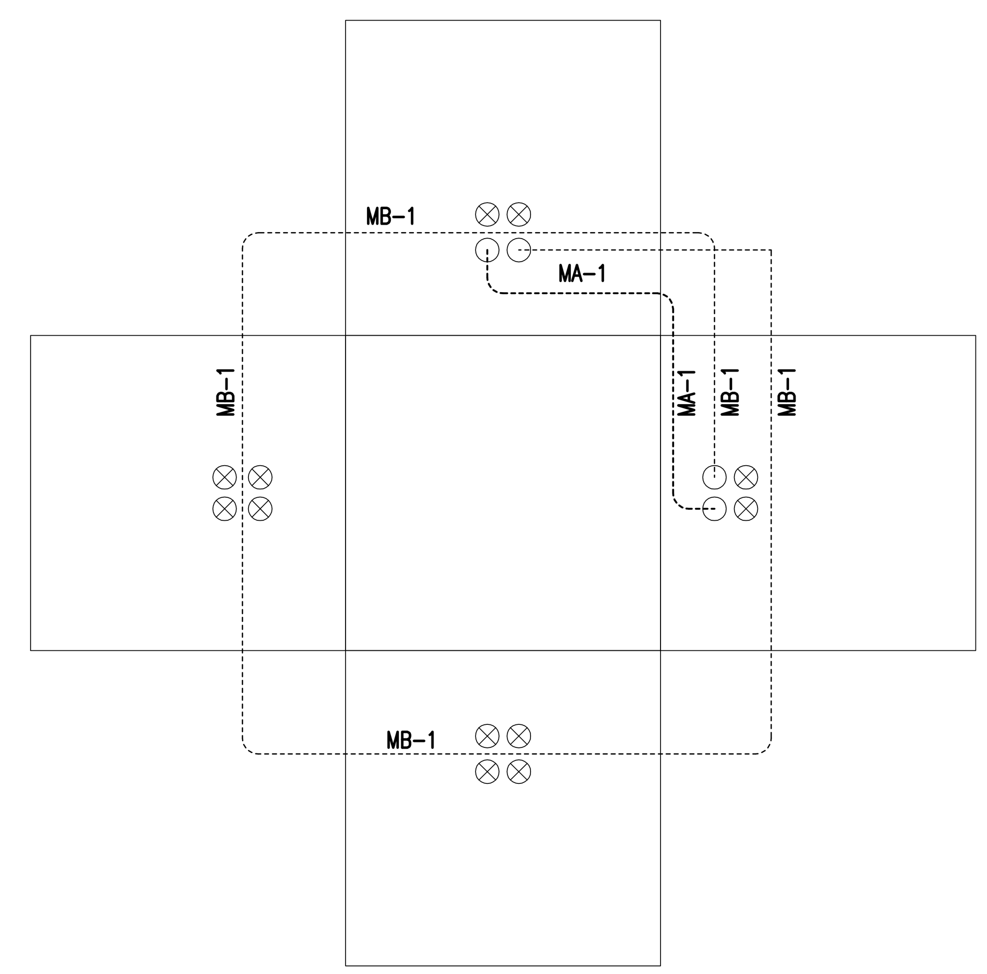
MANHOLE #13
SCALE: NONE



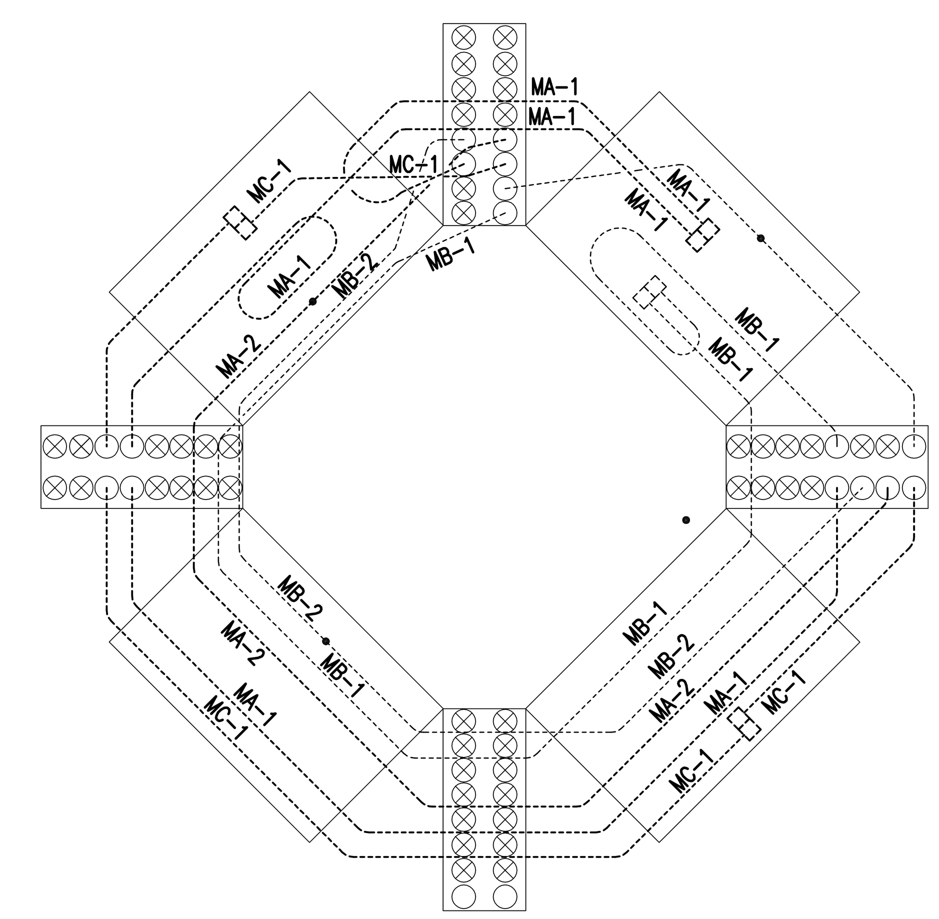
MANHOLE #14
SCALE: NONE



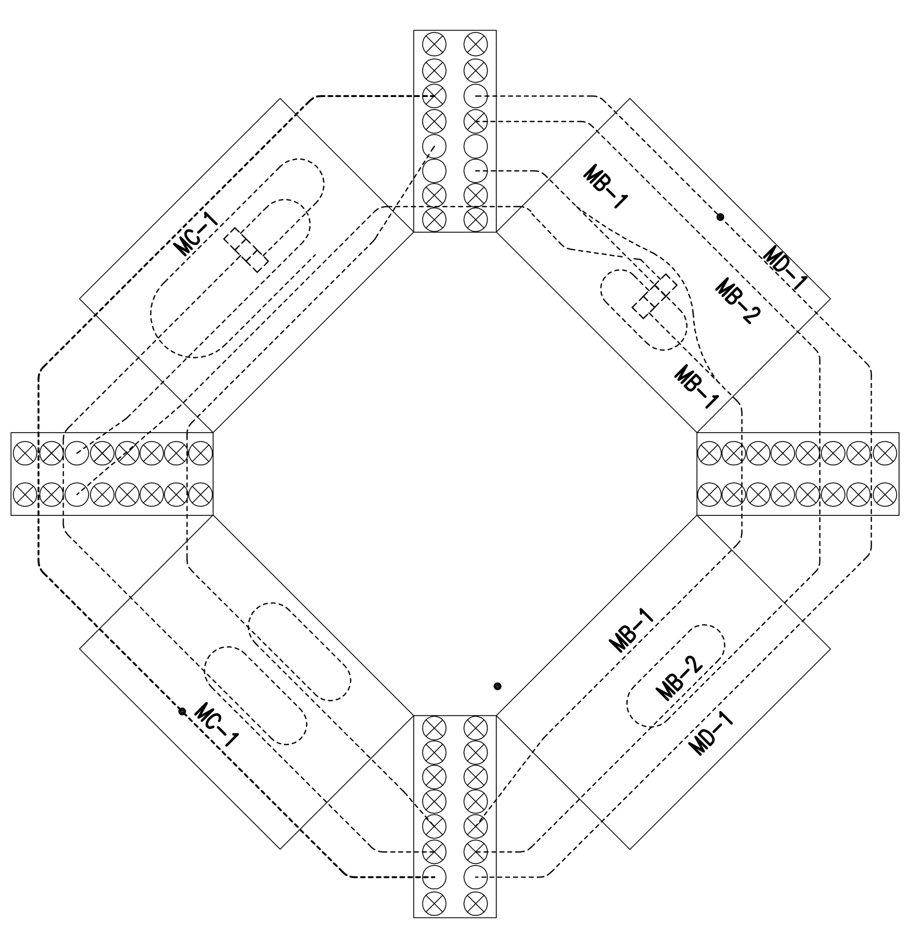
MANHOLE #15
SCALE: NONE



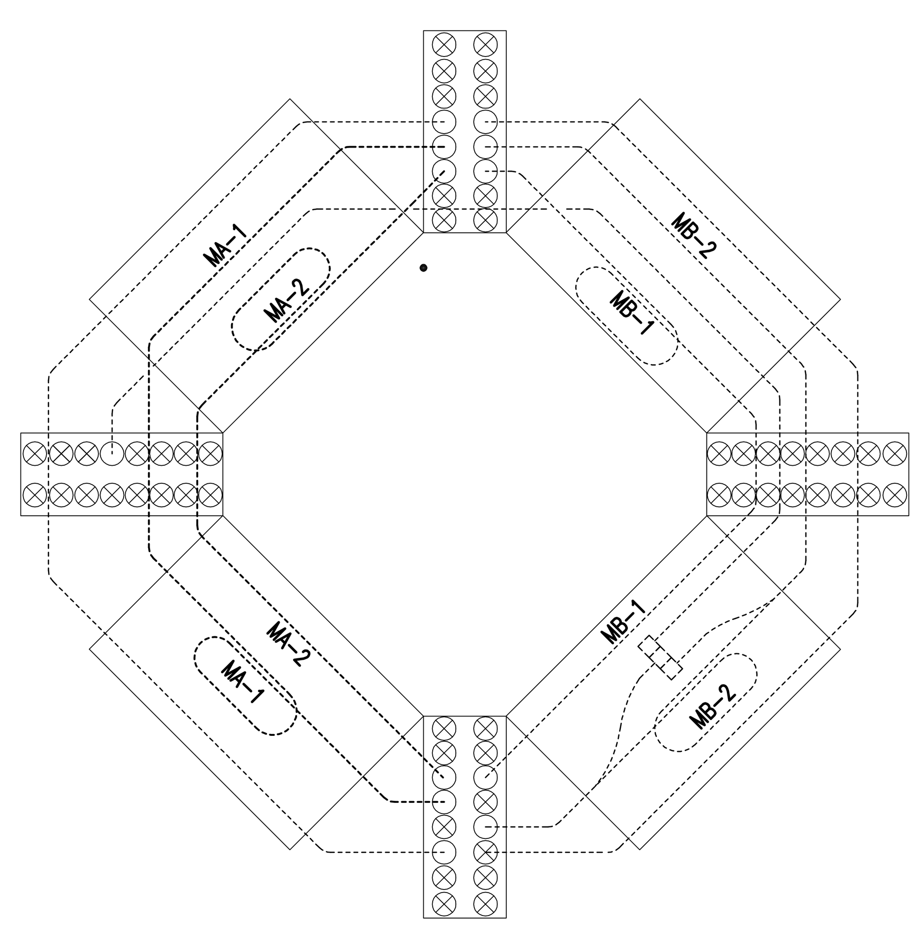
VAULT #16
SCALE: NONE



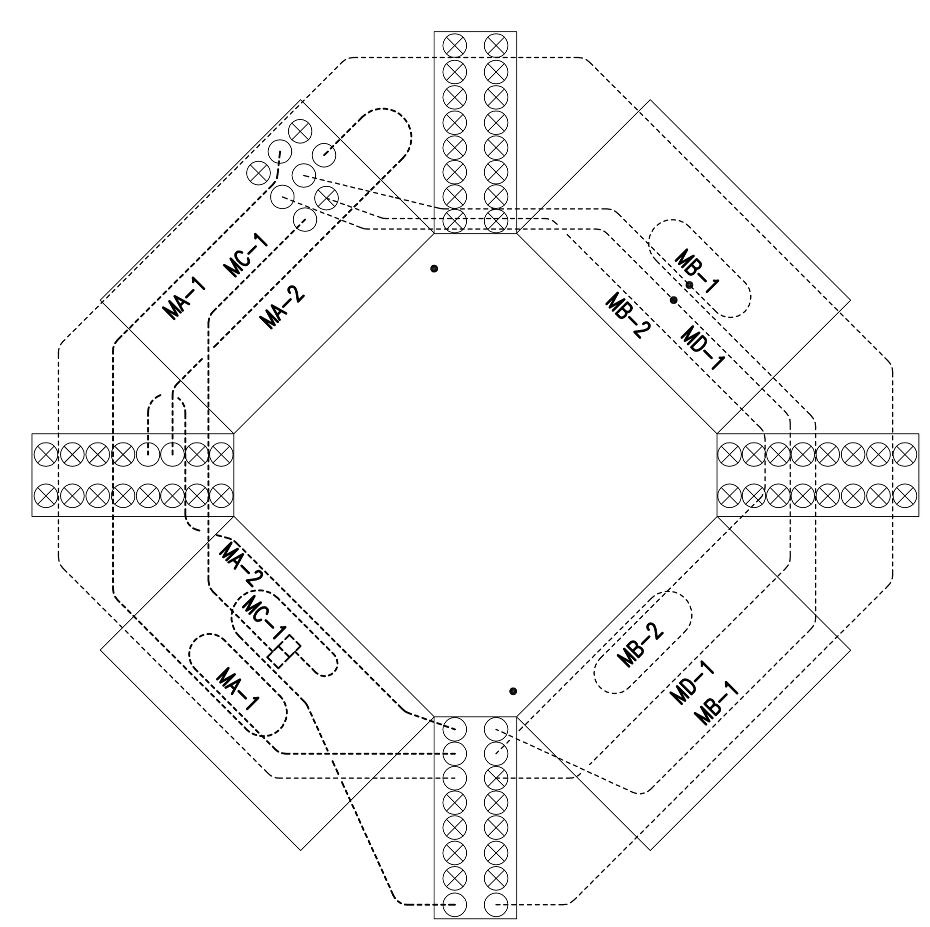
MANHOLE #17
SCALE: NONE



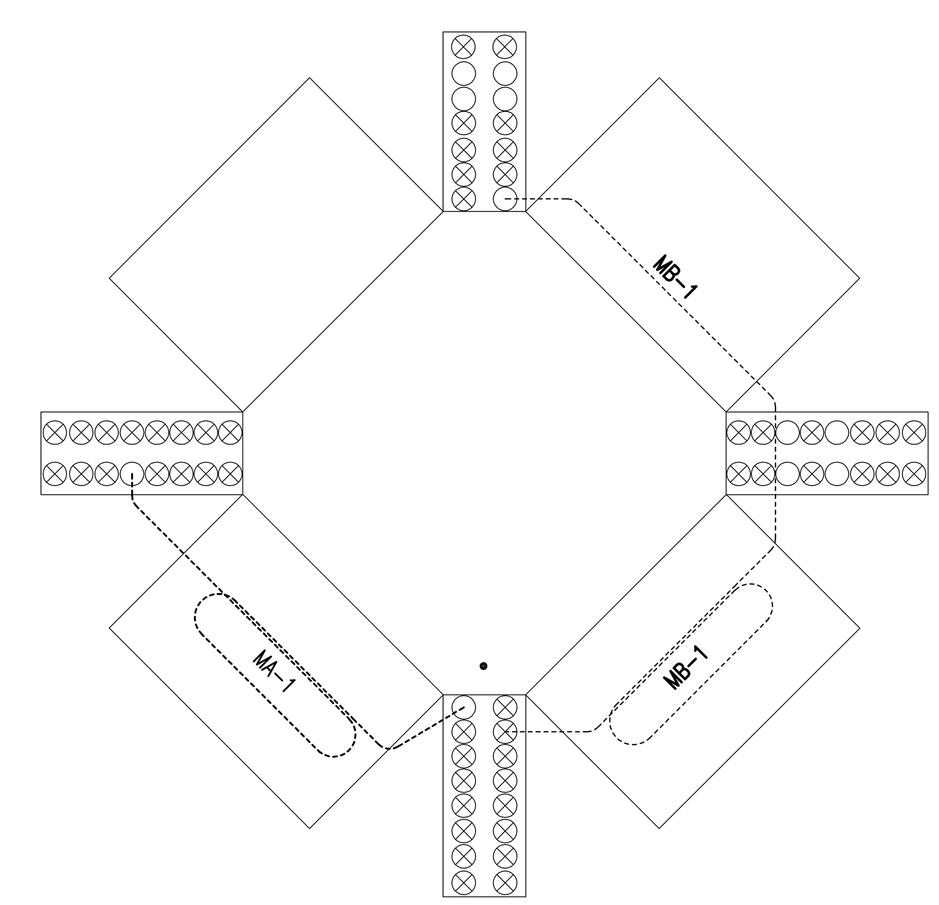
MANHOLE #18
SCALE: NONE



MANHOLE #19
SCALE: NONE



MANHOLE #20
SCALE: NONE



MANHOLE #21
SCALE: NONE

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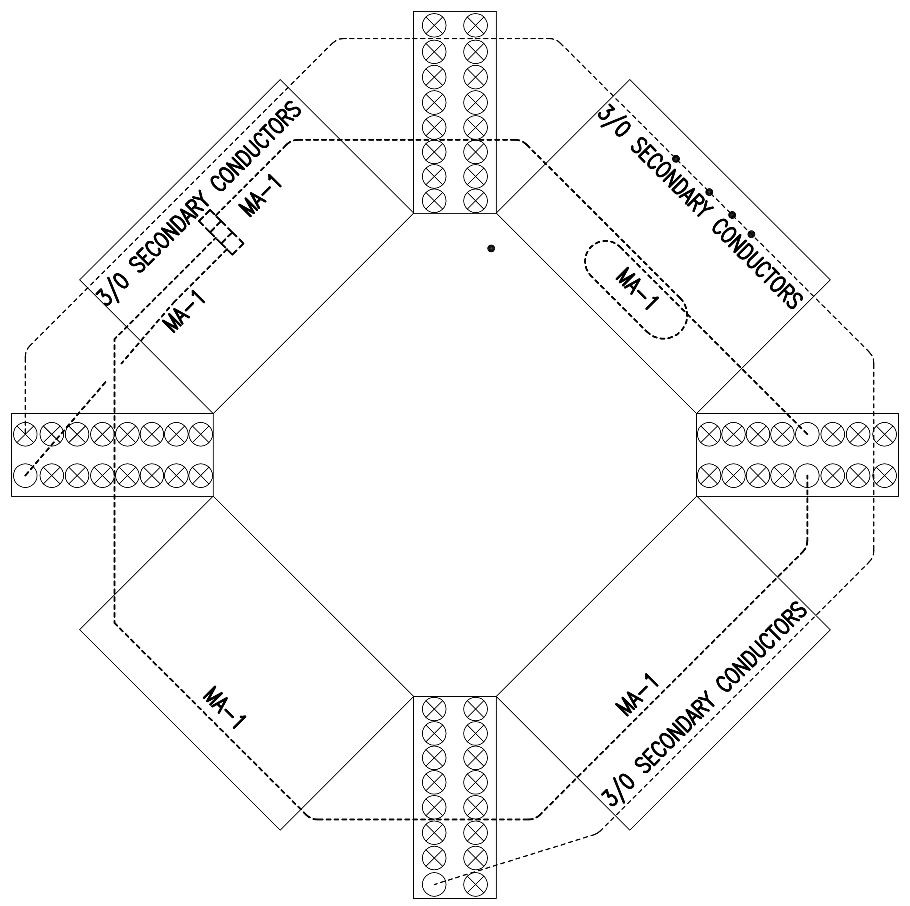
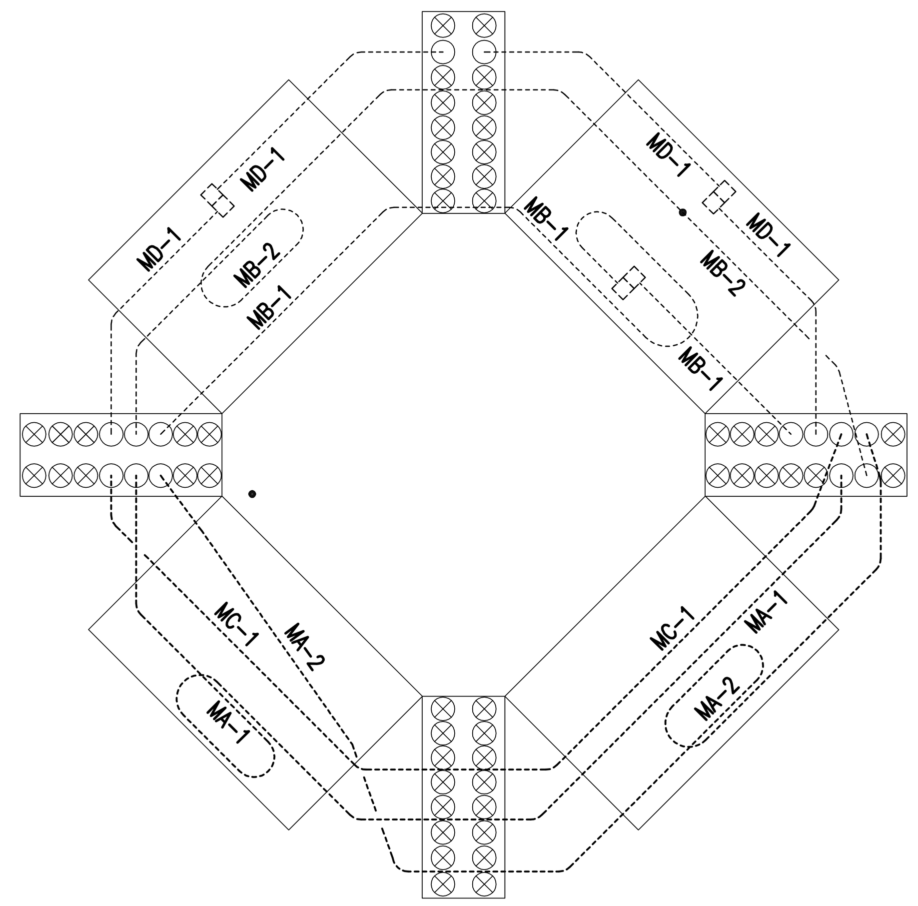
KENNESAW, GEORGIA

EXISTING CONDITIONS IN MANHOLES
10,11,15,13,14,15,16,17,18,19,20,21 - ELECTRICAL

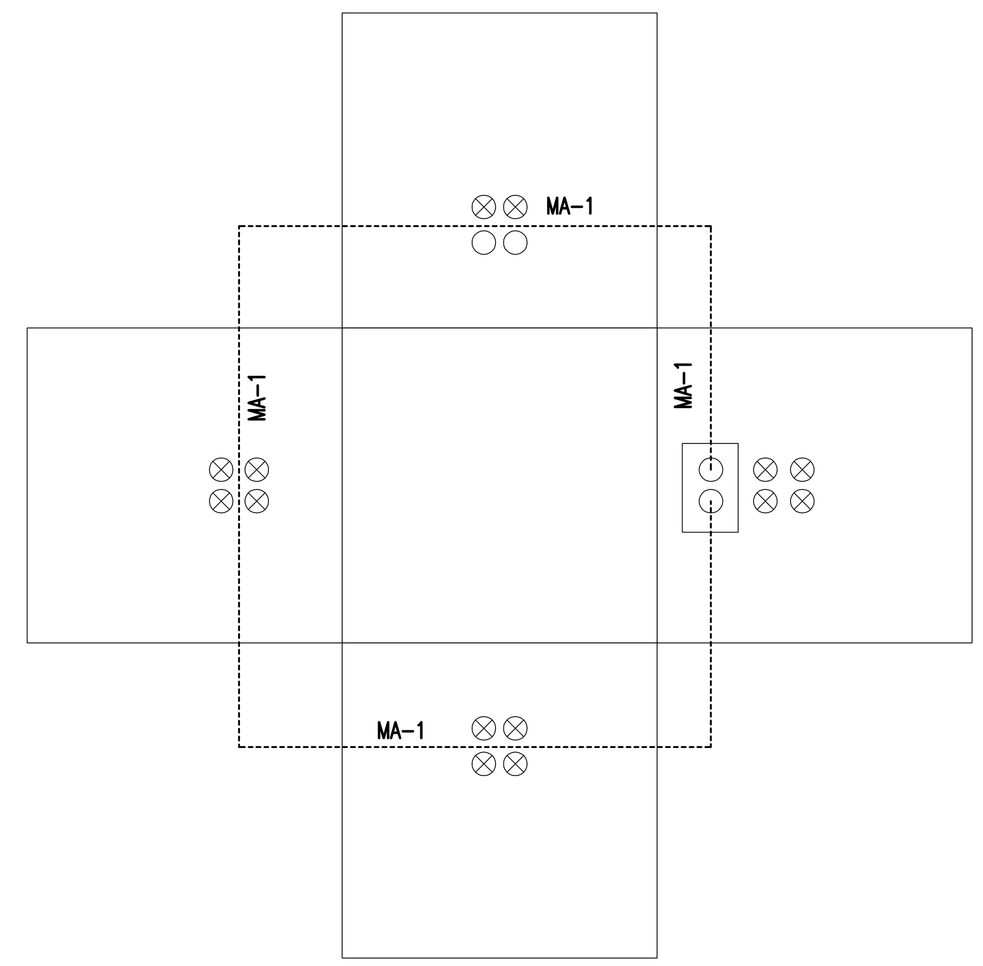
SHEET NO.
E4.2
7 OF 14



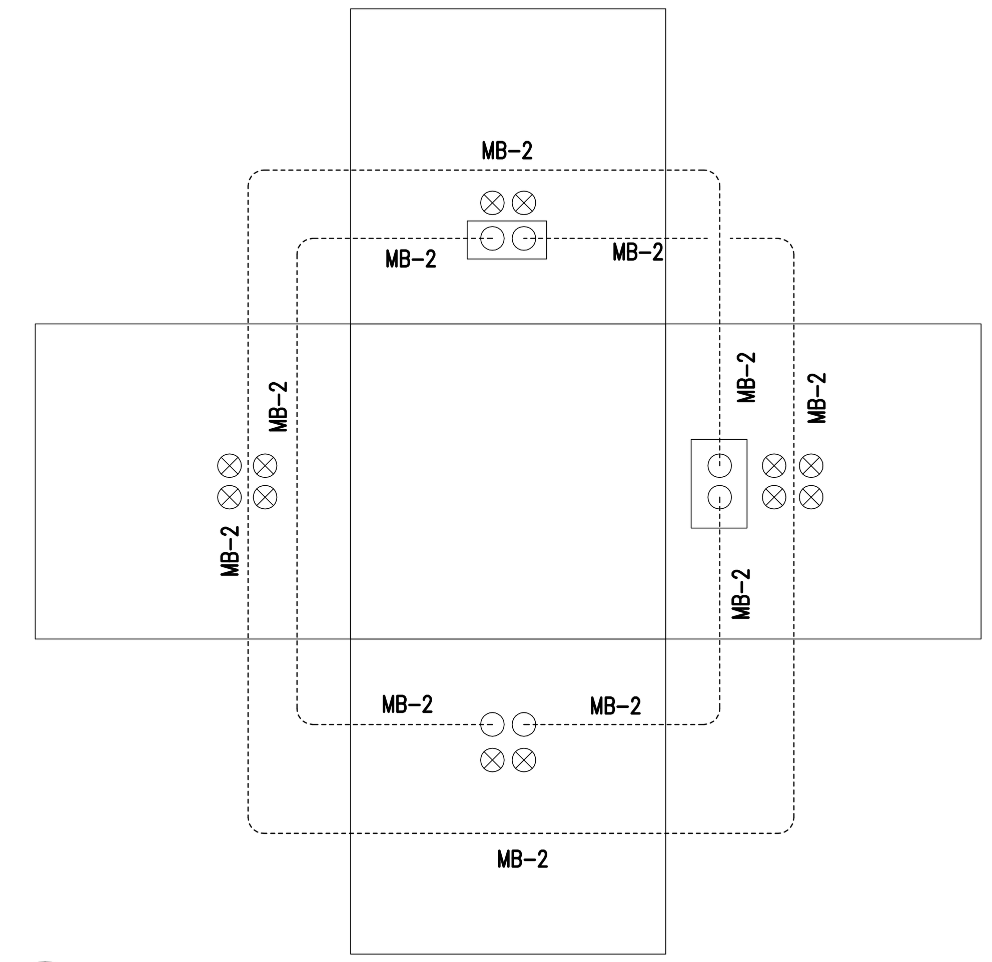
MANHOLE #22
SCALE: NONE



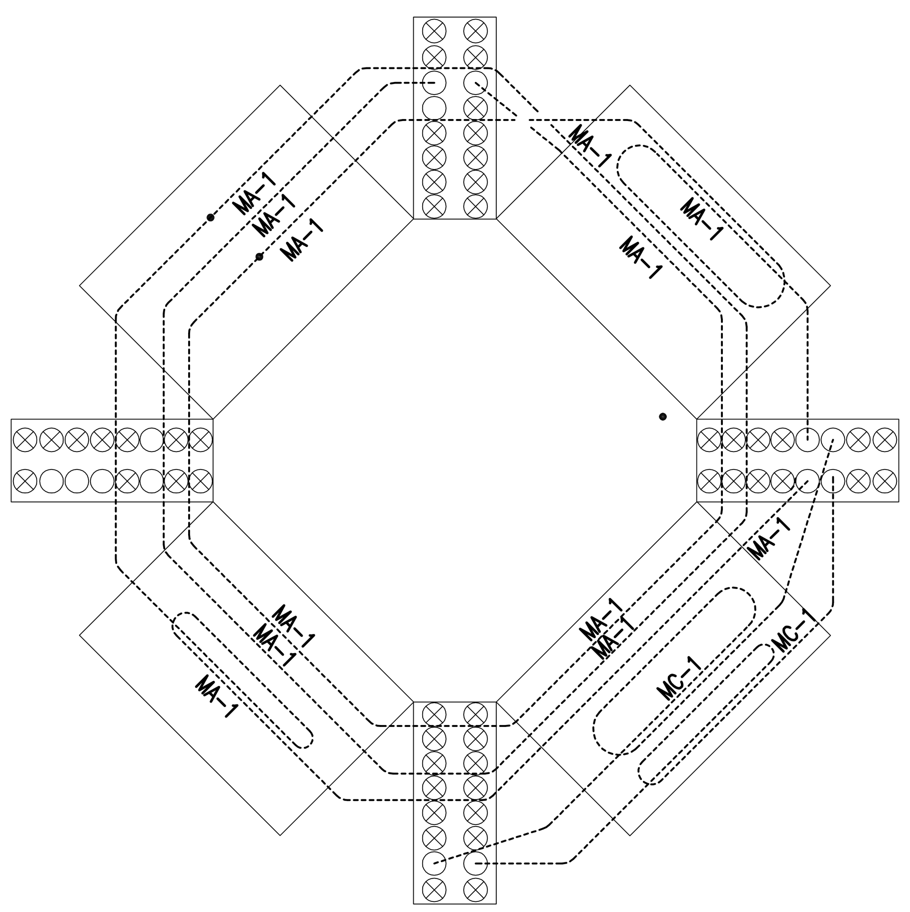
MANHOLE #23
SCALE: NONE



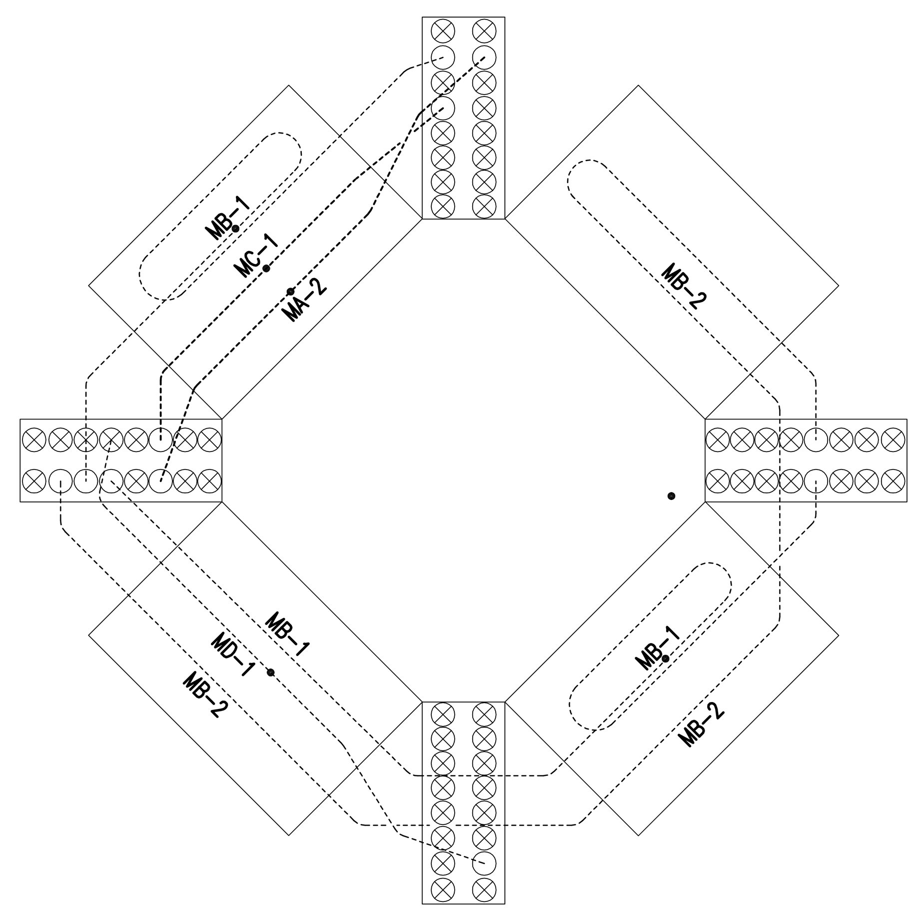
VAULT #24
SCALE: NONE



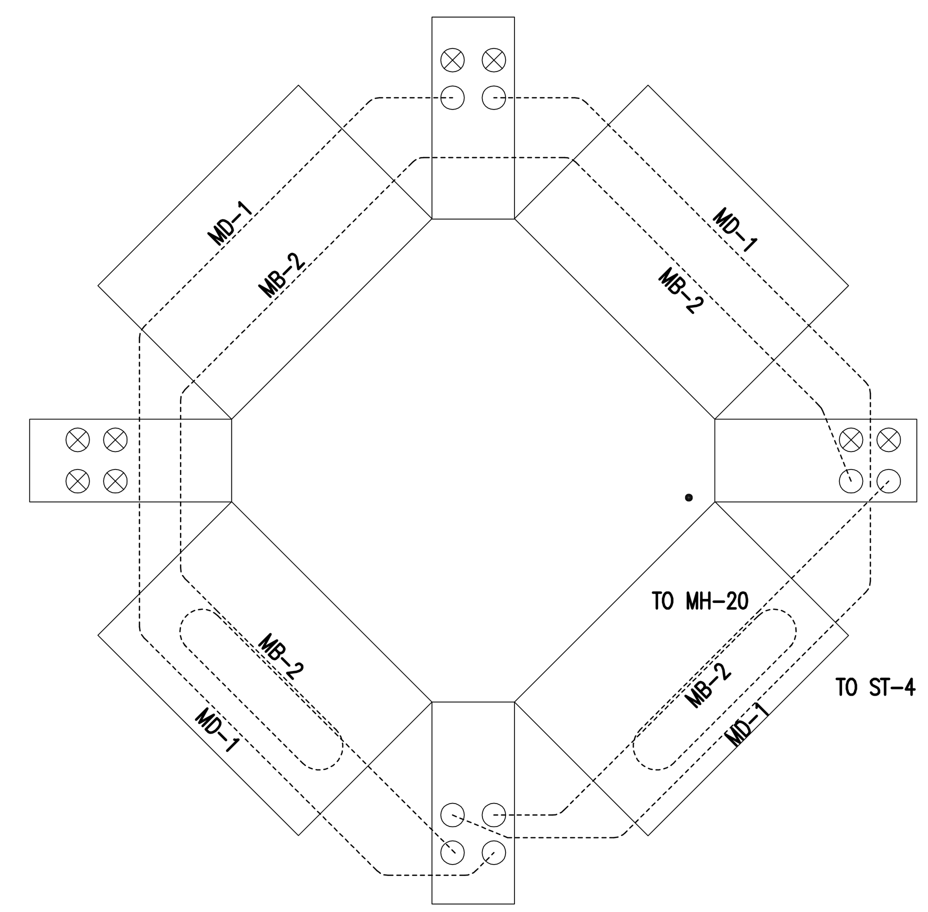
VAULT #27
SCALE: NONE



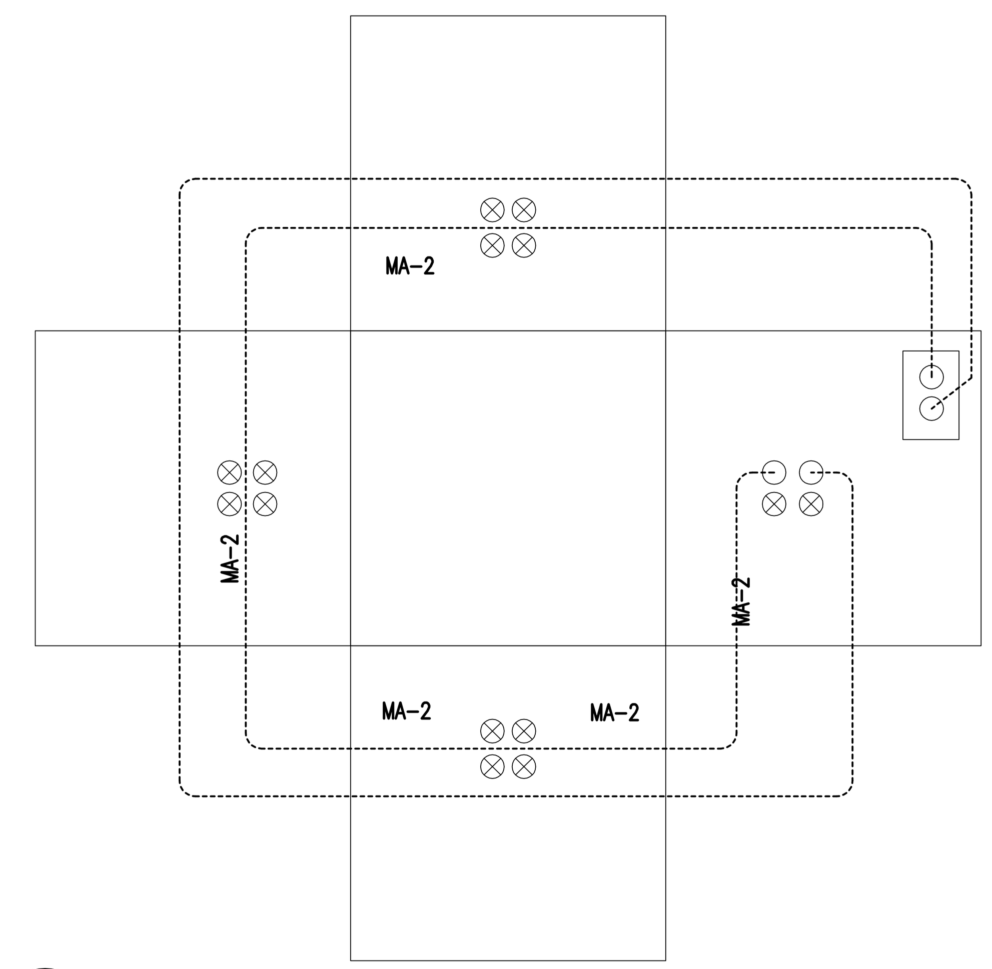
MANHOLE #28
SCALE: NONE



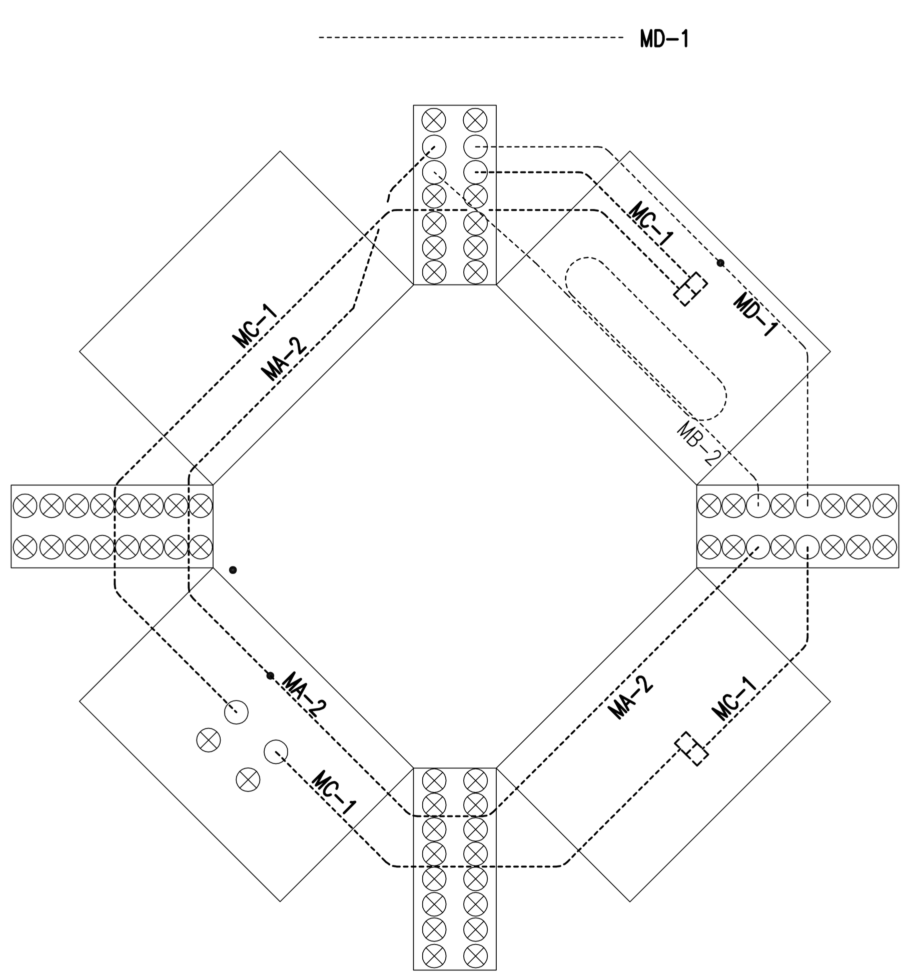
MANHOLE #29
SCALE: NONE



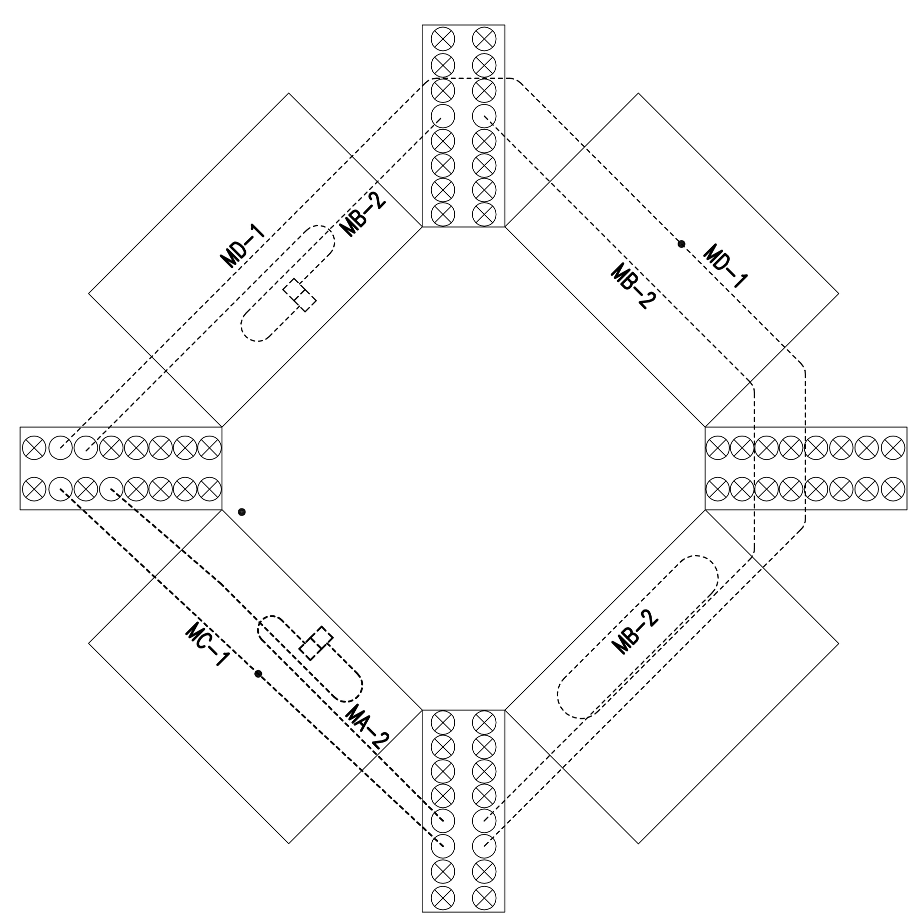
MANHOLE #30
SCALE: NONE



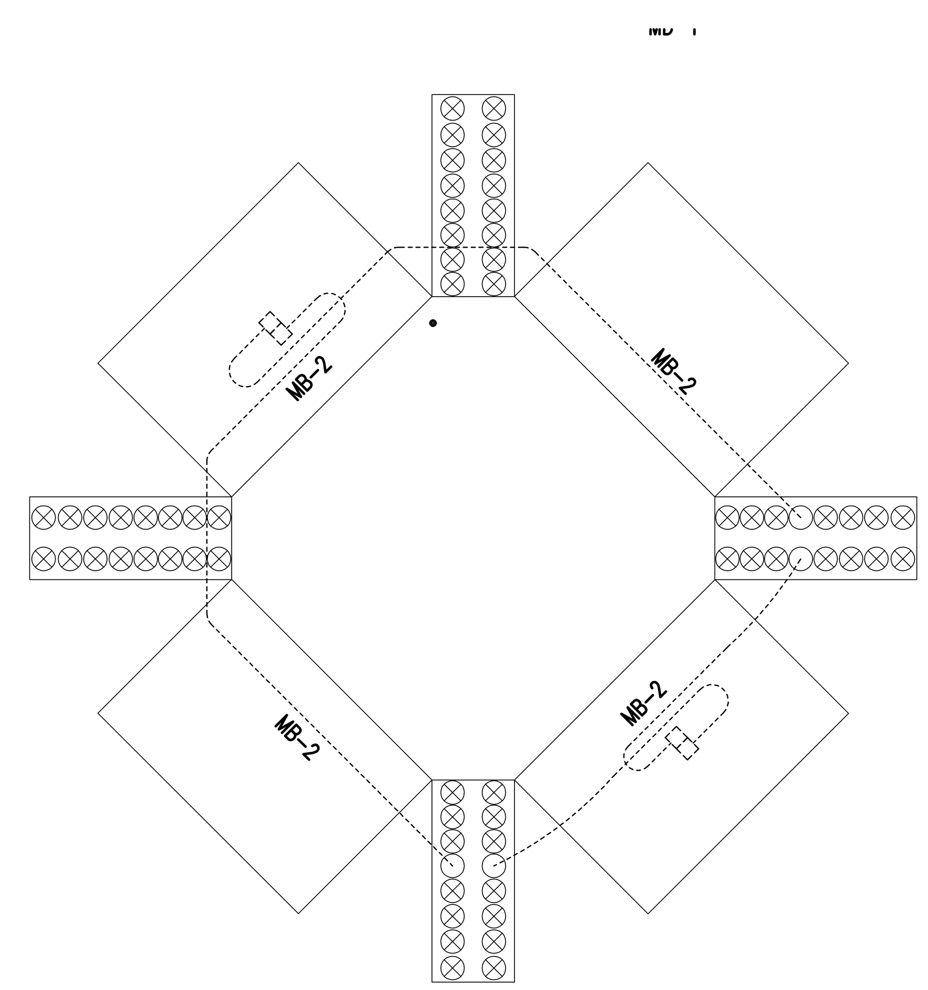
VAULT #31
SCALE: NONE



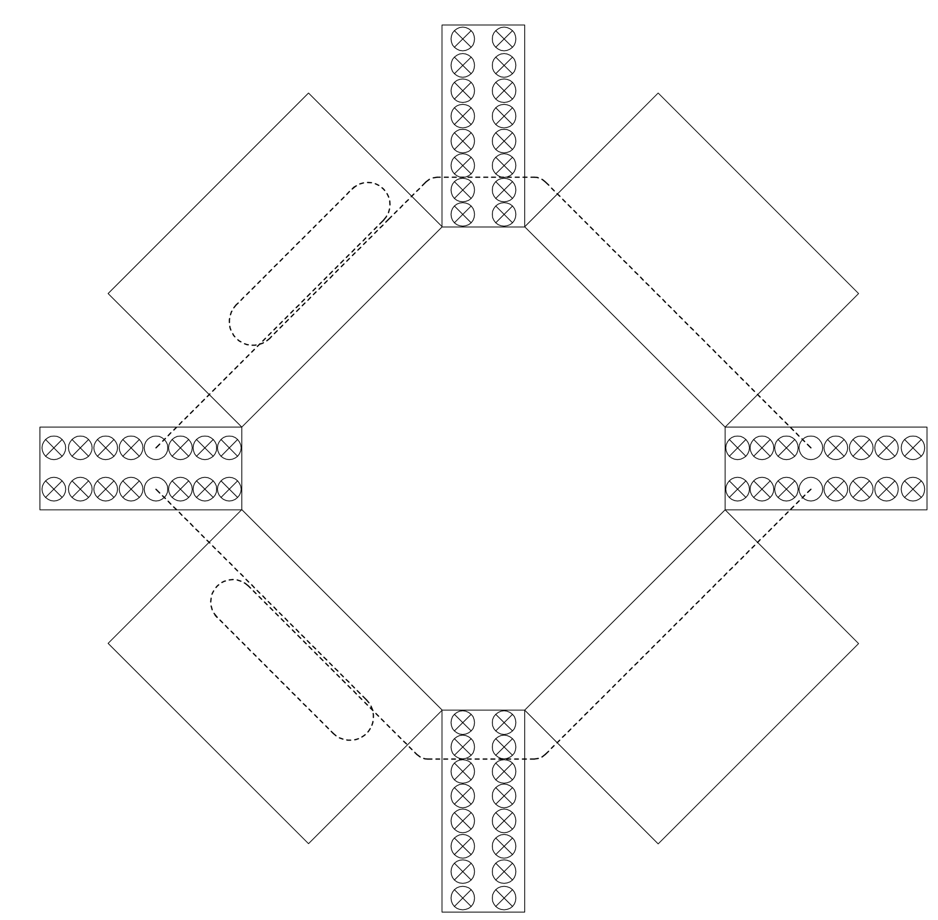
MANHOLE #32
SCALE: NONE



MANHOLE #33
SCALE: NONE



MANHOLE #34
SCALE: NONE



MANHOLE #35
SCALE: NONE

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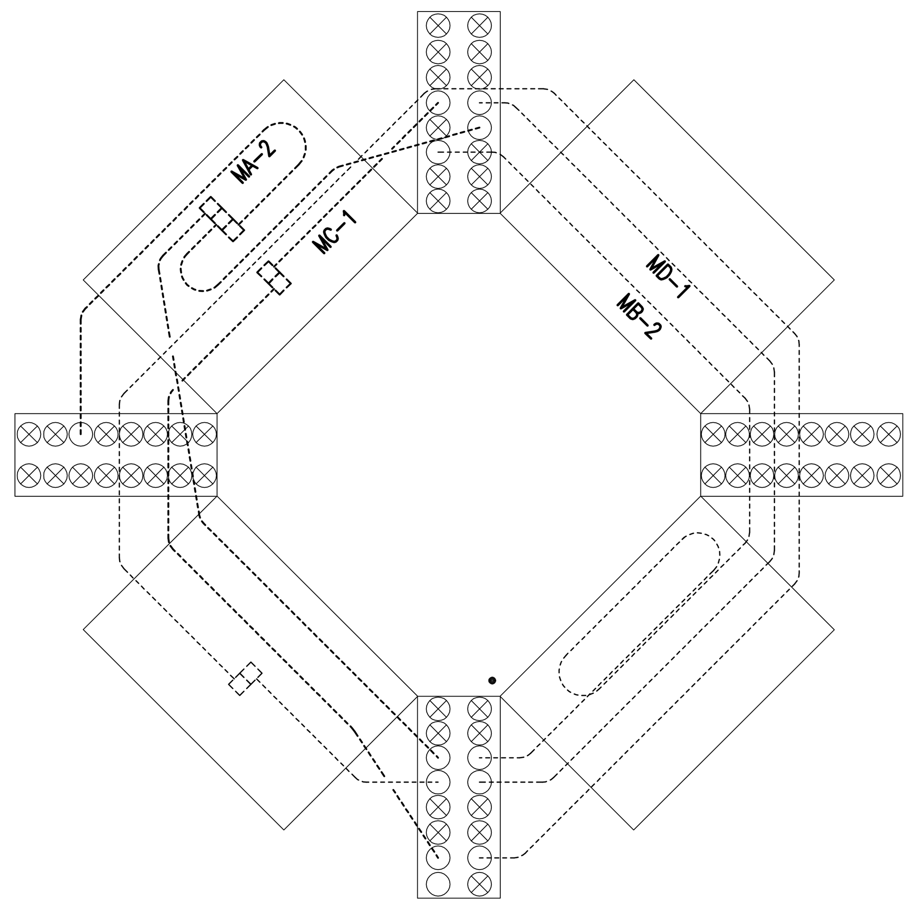
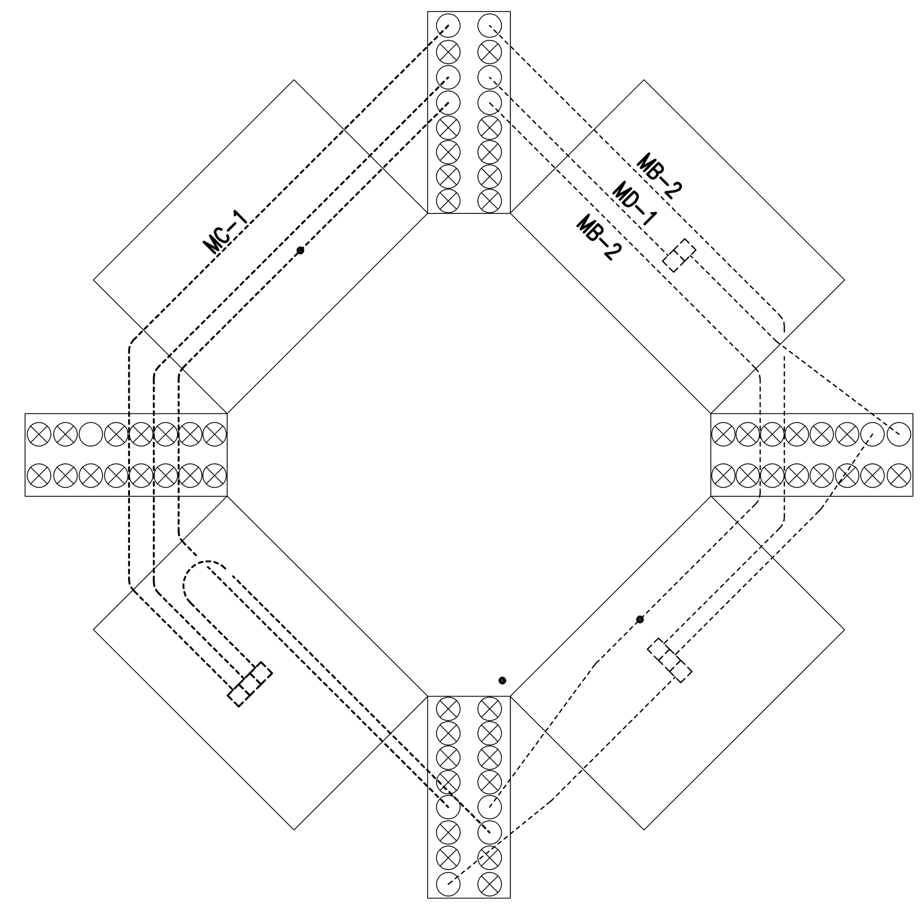
EXISTING CONDITIONS IN MANHOLES
22,23,24,27,28,29,30,31,32,33,34,35 - ELECTRICAL

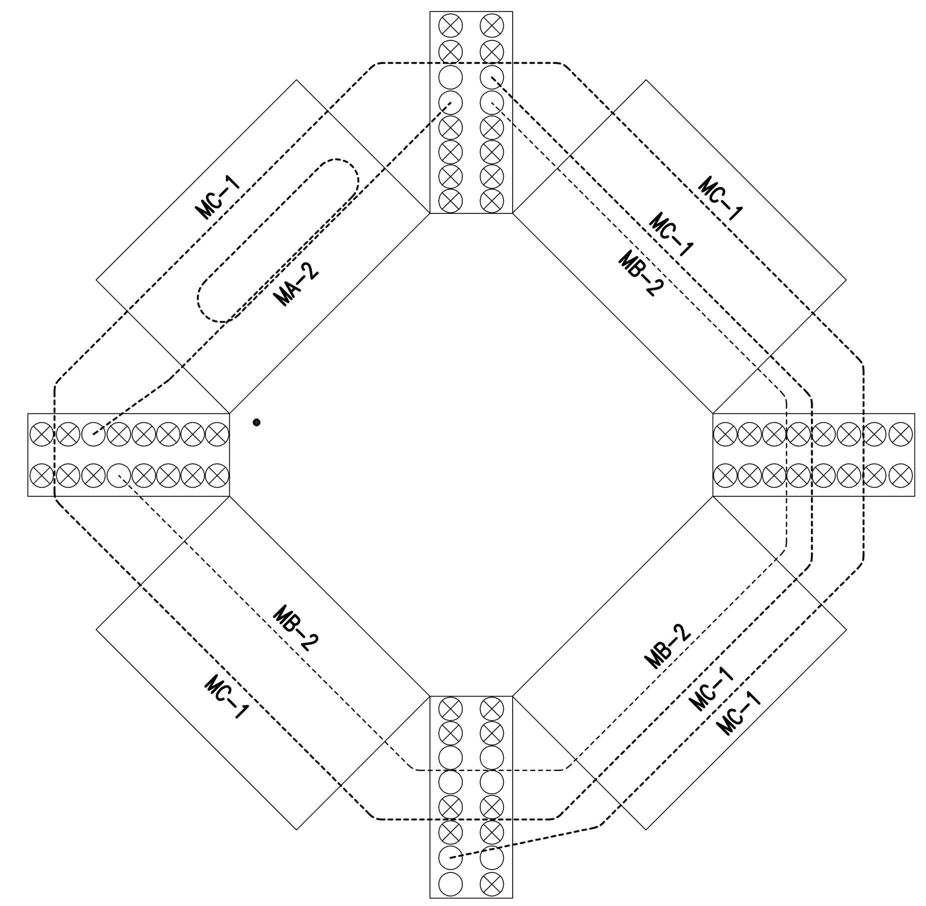
SHEET NO.
E4.3
8 OF 14



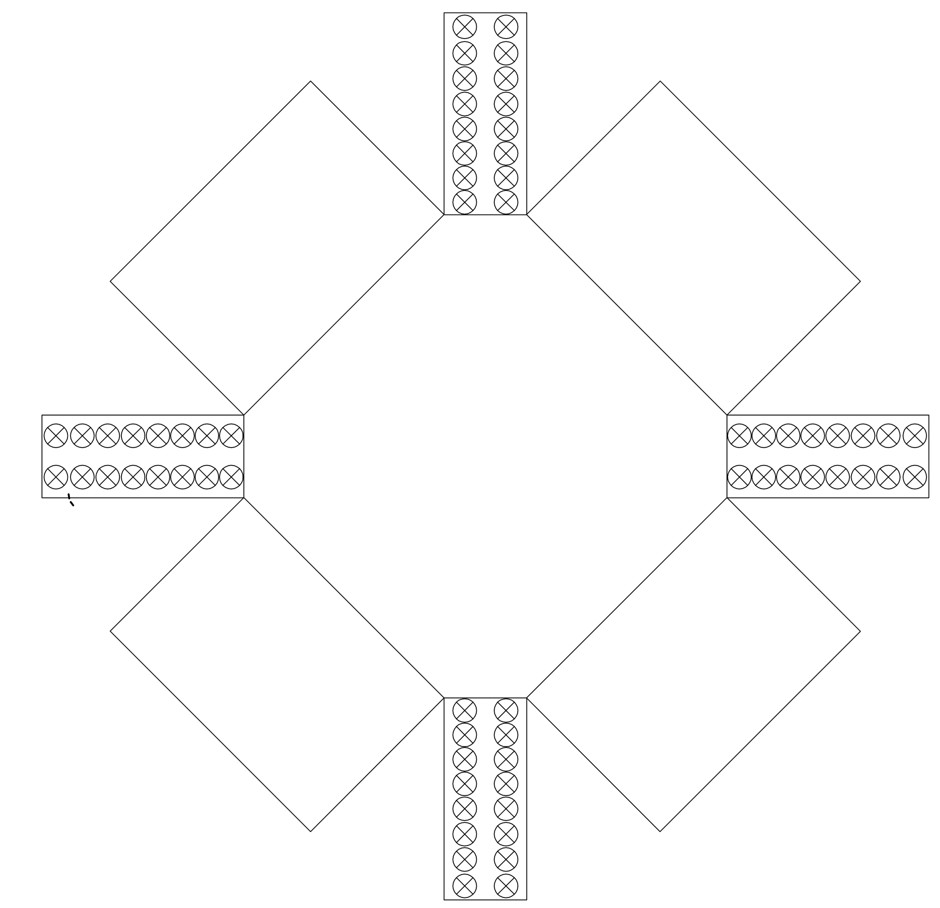
MANHOLE #37
SCALE: NONE



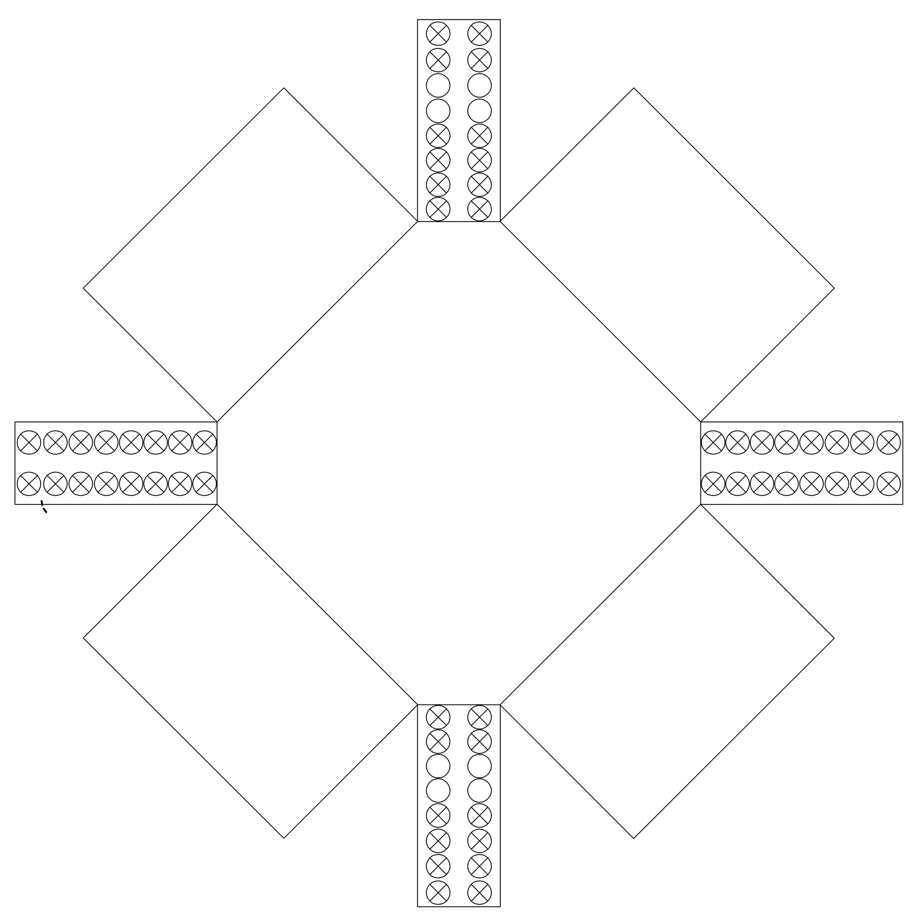
MANHOLE #38
SCALE: NONE



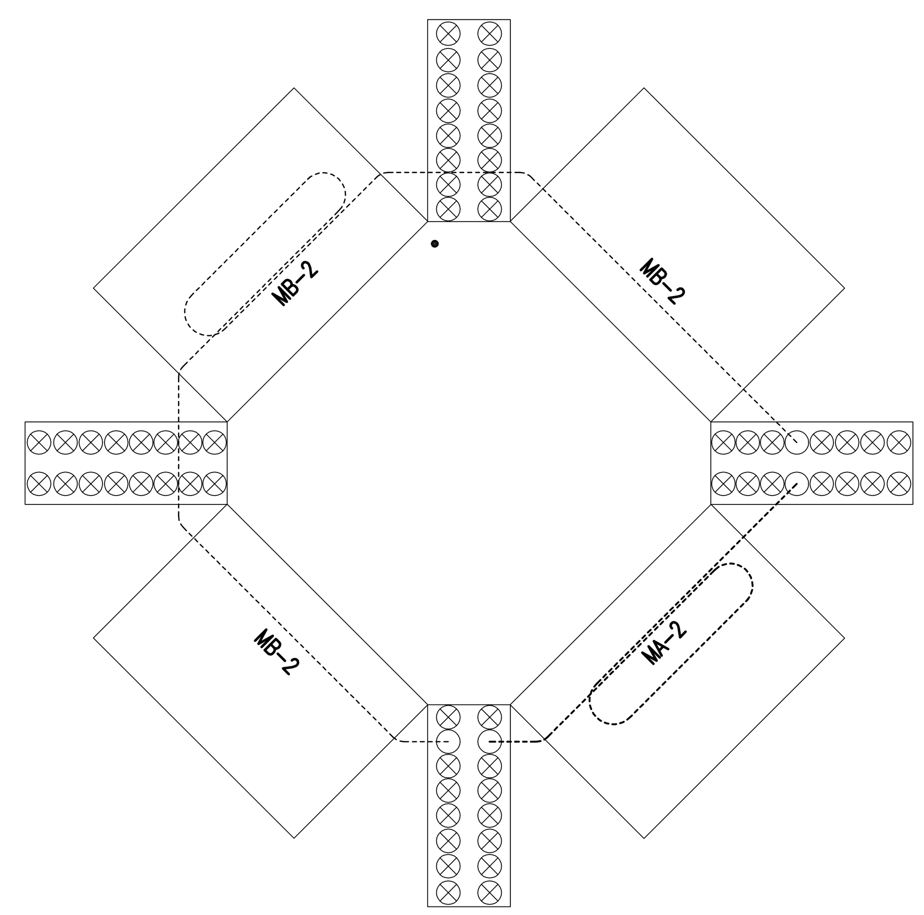
MANHOLE #40
SCALE: NONE



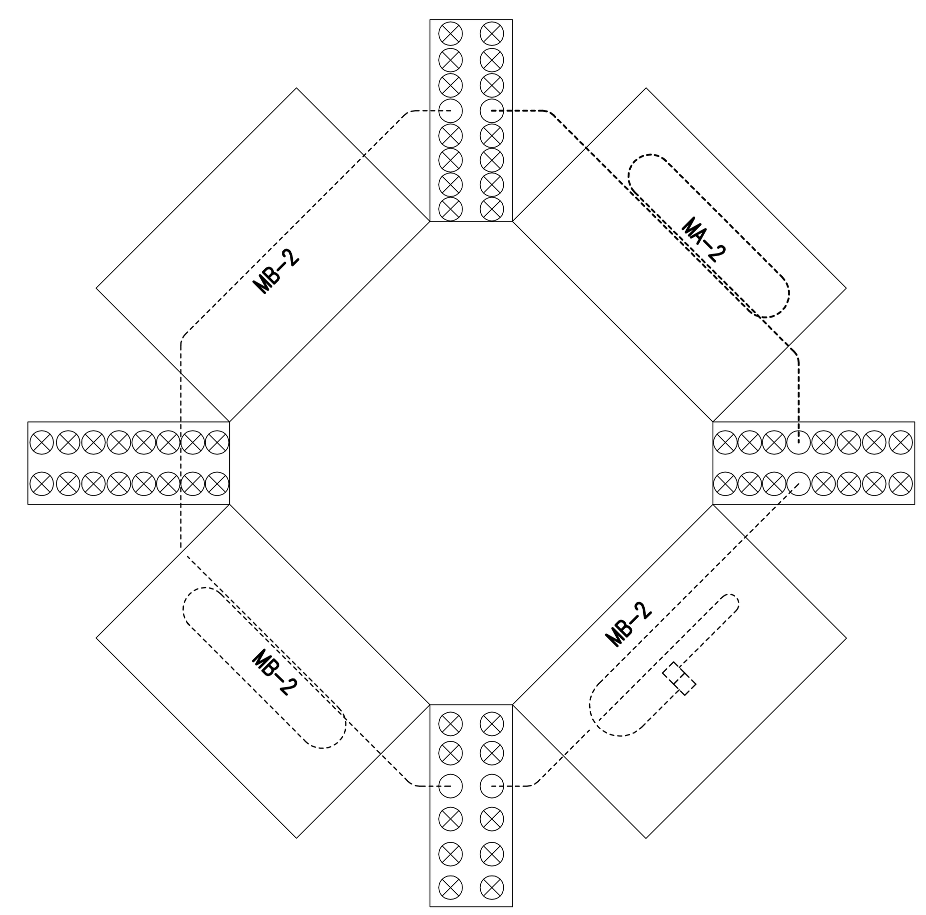
MANHOLE #41
SCALE: NONE



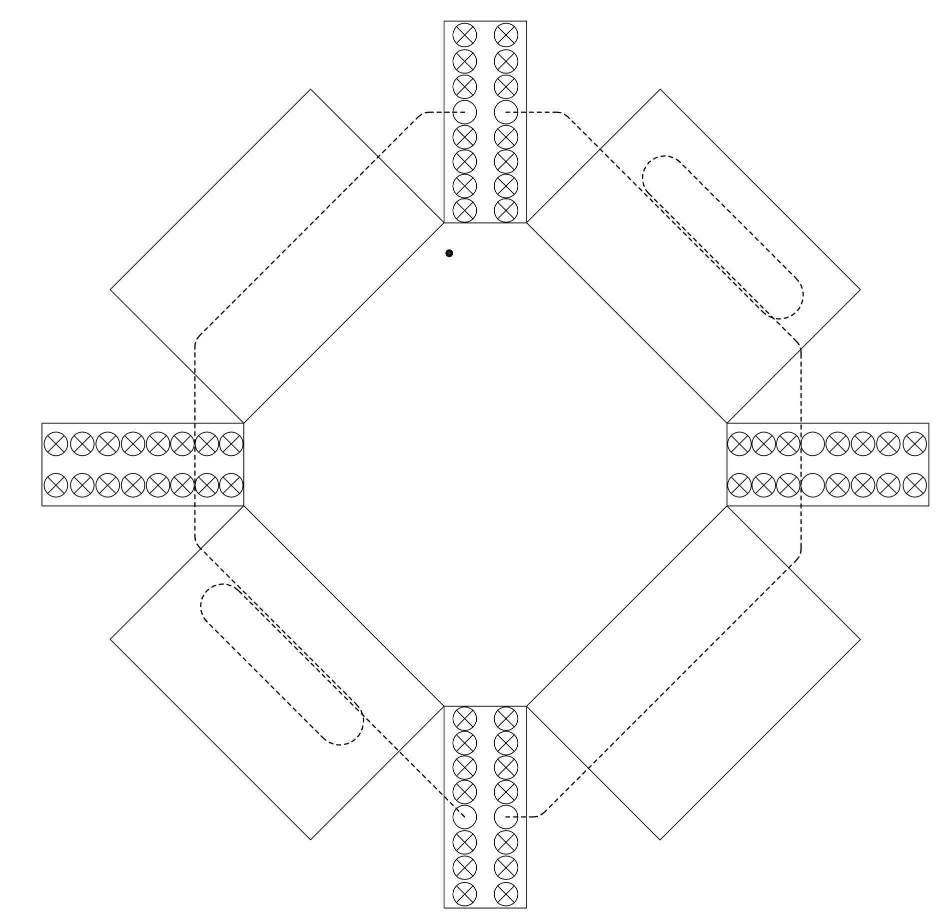
MANHOLE #43
SCALE: NONE



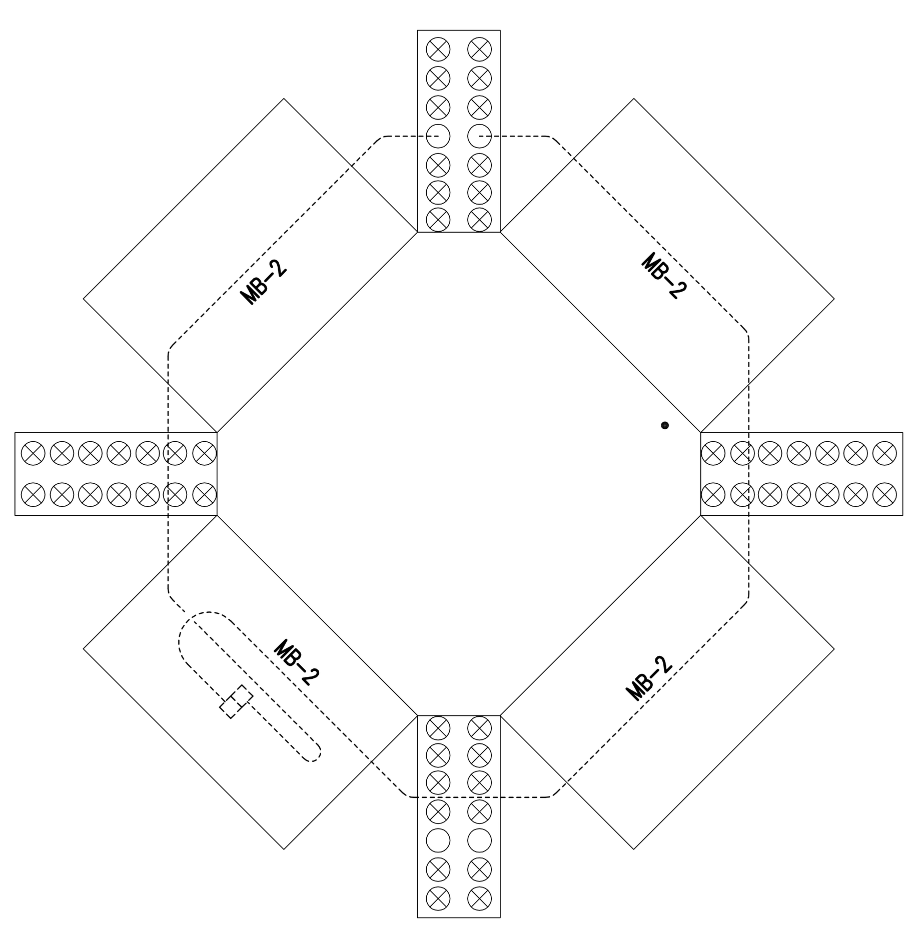
MANHOLE #45
SCALE: NONE



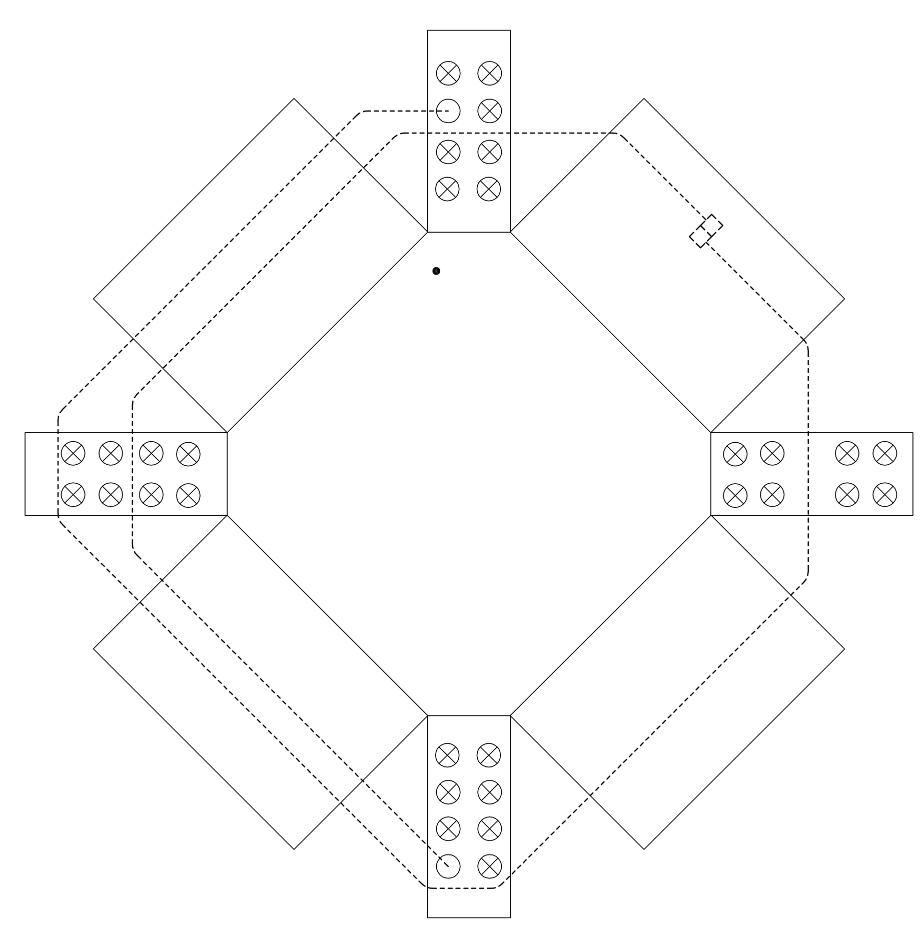
MANHOLE #46
SCALE: NONE



MANHOLE #48
SCALE: NONE



MANHOLE #52
SCALE: NONE



MANHOLE #66
SCALE: NONE

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EXISTING CONDITIONS IN MANHOLES
37,38,40,41,43,45,46,48,52,66 - ELECTRICAL

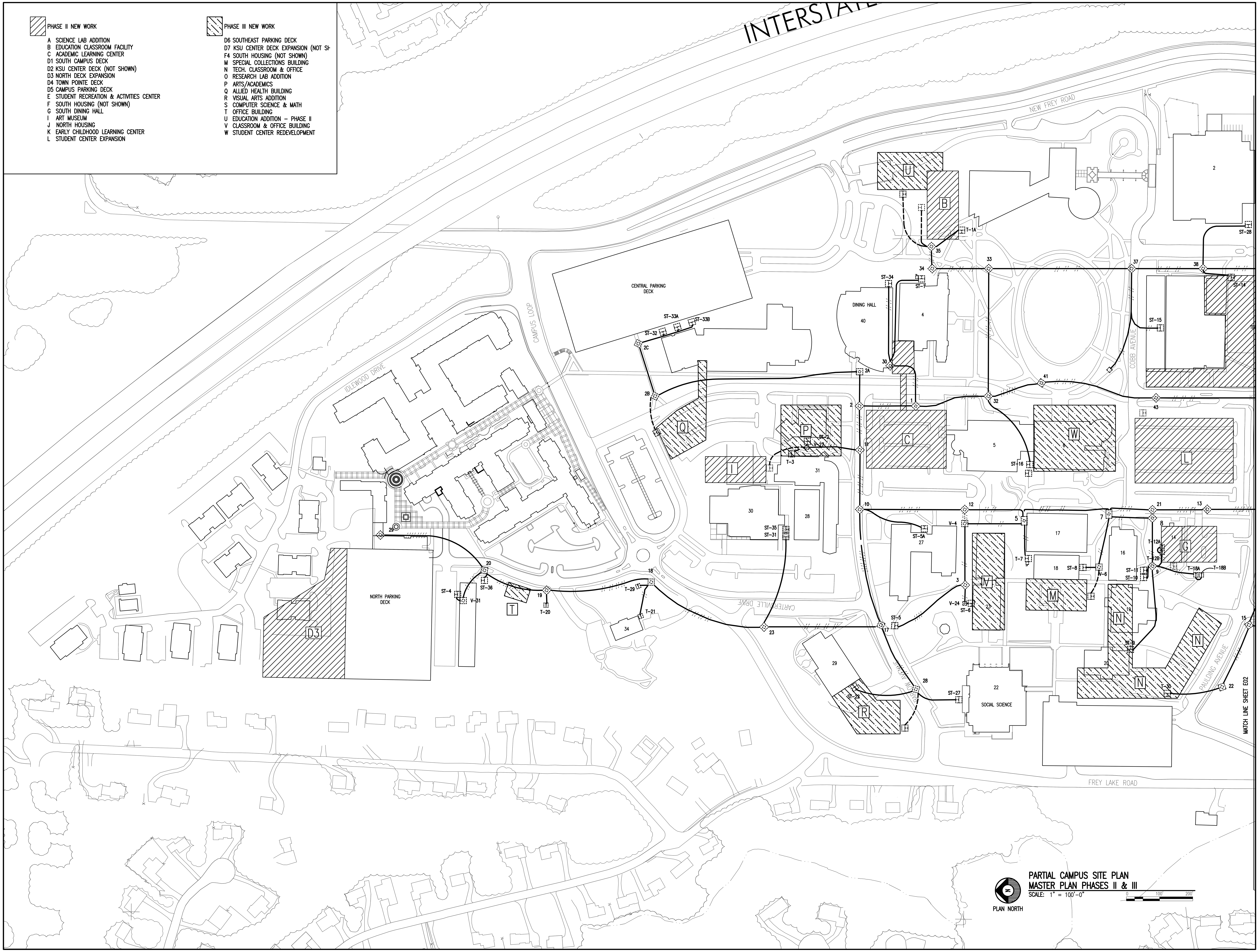
SHEET NO.
E4.4
9 OF 14

PHASE II NEW WORK

A SCIENCE LAB ADDITION
B EDUCATION CLASSROOM FACILITY
C ACADEMIC LEARNING CENTER
D1 SOUTH CAMPUS DECK
D2 KSU CENTER DECK (NOT SHOWN)
D3 NORTH DECK EXPANSION
D4 TOWN POINTE DECK
D5 CAMPUS PARKING DECK
E STUDENT RECREATION & ACTIVITIES CENTER
F SOUTH HOUSING (NOT SHOWN)
G SOUTH DINING HALL
I ART MUSEUM
J NORTH HOUSING
K EARLY CHILDHOOD LEARNING CENTER
L STUDENT CENTER EXPANSION

PHASE III NEW WORK

D6 SOUTHEAST PARKING DECK
D7 KSU CENTER DECK EXPANSION (NOT SH
F4 SOUTH HOUSING (NOT SHOWN)
M SPECIAL COLLECTIONS BUILDING
N TECH. CLASSROOM & OFFICE
O RESEARCH LAB ADDITION
P ARTS/ACADEMICS
Q ALLIED HEALTH BUILDING
R VISUAL ARTS ADDITION
S COMPUTER SCIENCE & MATH
T OFFICE BUILDING
U EDUCATION ADDITION – PHASE II
V CLASSROOM & OFFICE BUILDING
W STUDENT CENTER REDEVELOPMENT



PARTIAL CAMPUS SITE PLAN
MASTER PLAN PHASES II & III
SCALE: 1" = 100'-0"
PLAN NORTH

GEORGIA REGISTERED PROFESSIONAL ENGINEER RANDY B. PEACOCK

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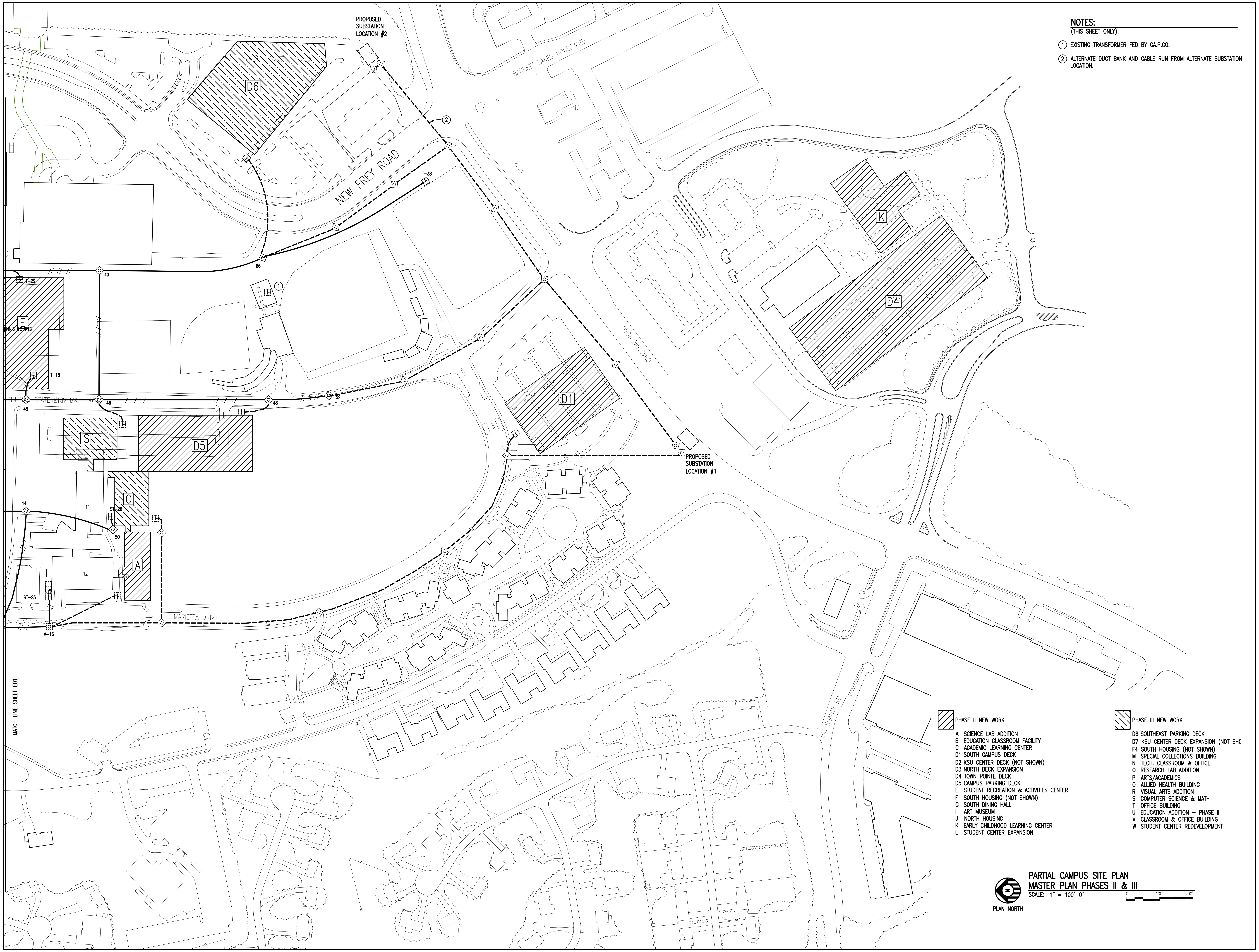
PARTIAL CAMPUS SITE PLAN
MASTER PLAN PHASES II & III

SHEET NO.
E5.1
10 OF 14



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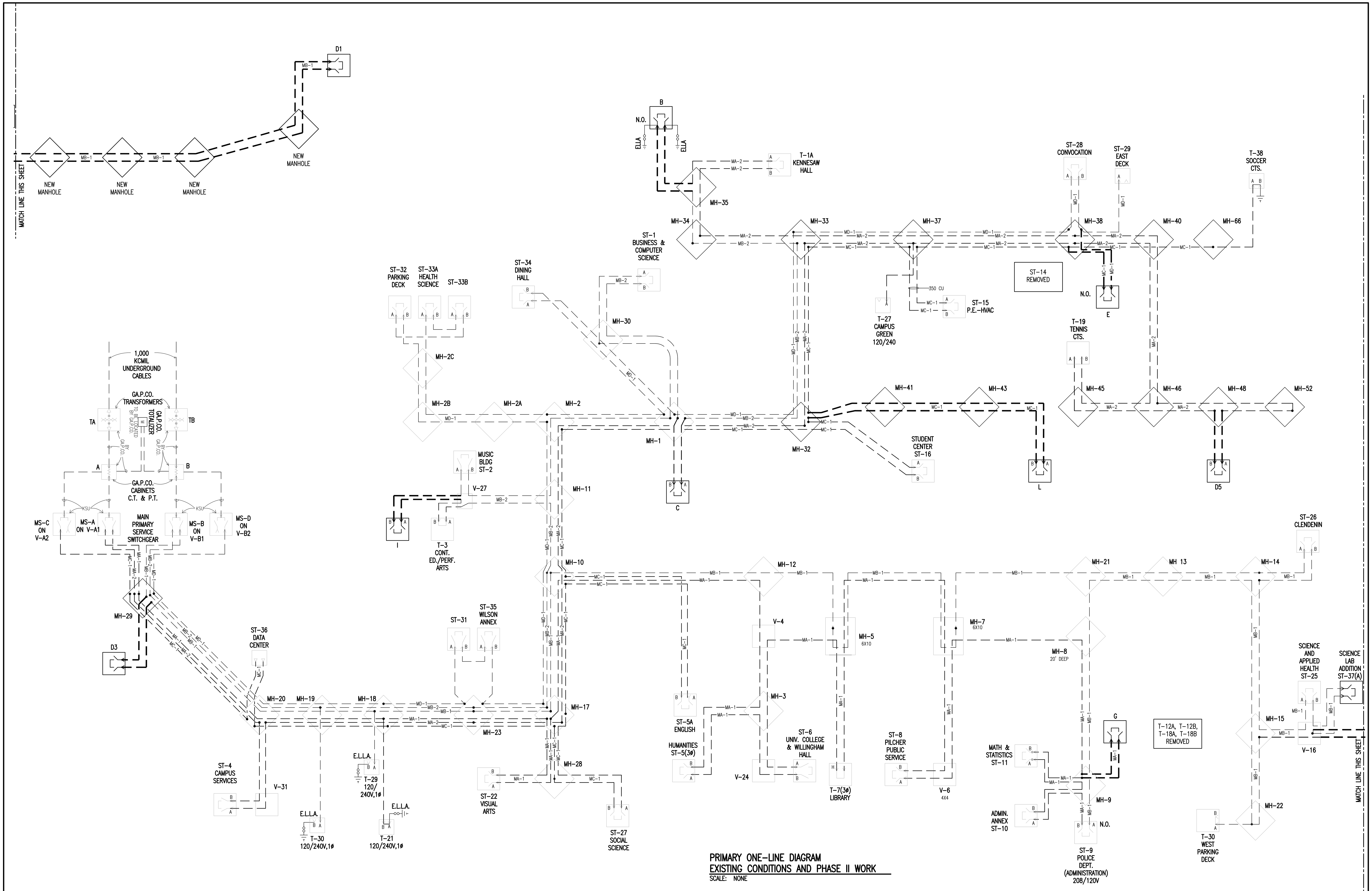
PARTIAL CAMPUS SITE PLAN
MASTER PLAN PHASES II & III

SHEET NO.
E5.2



PRIMARY ONE-LINE DIAGRAM
EXISTING CONDITIONS AND PHASE II WORK
SCALE: NONE

GENERAL NOTES:
(THIS SHEET ONLY)

A. NORMALLY OPEN POINTS SHOWN ARE RECOMMENDED POINTS TO BALANCE CIRCUIT LOADING. ACTUAL FIELD CONDITIONS MAY VARY.

B. CONNECTIONS SHOWN TO EXISTING TRANSFORMERS DO NOT INCLUDE TRANSFORMER REPLACEMENT RECOMMENDED IN THE STUDY.

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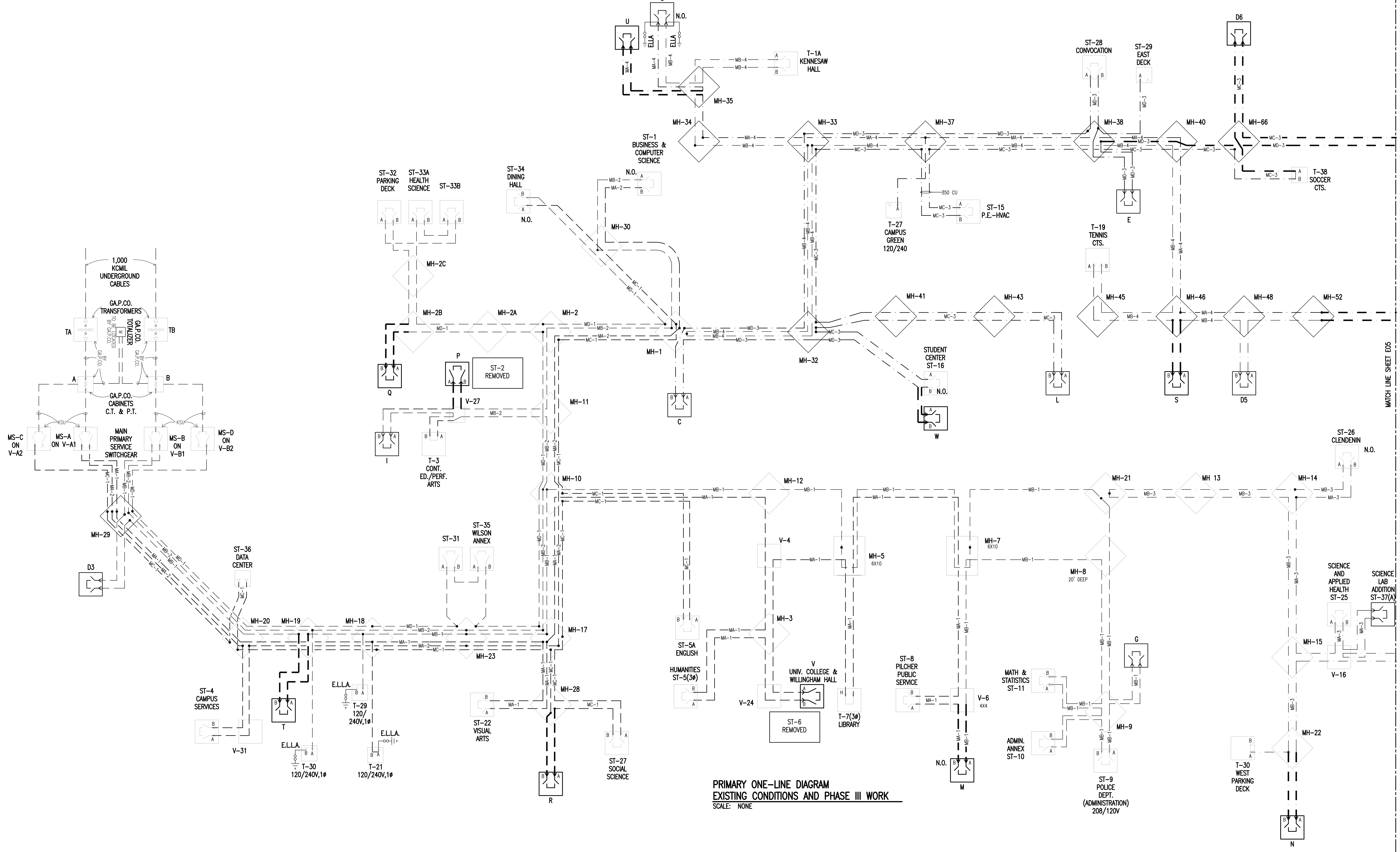
PRIMARY ONE LINE DIAGRAM
EXISTING CONDITIONS AND PHASE II WORK

SHEET NO.
E5.3

GENERAL NOTES:
(THIS SHEET ONLY)

A. NORMALLY OPEN POINTS SHOWN ARE RECOMMENDED POINTS TO BALANCE CIRCUIT LOADING. ACTUAL FIELD CONDITIONS MAY VARY.

B. CONNECTIONS SHOWN TO EXISTING TRANSFORMERS DO NOT INCLUDE TRANSFORMER REPLACEMENT RECOMMENDED IN THE STUDY.



PRIMARY ONE-LINE DIAGRAM
EXISTING CONDITIONS AND PHASE III WORK
SCALE: NONE

GEORGIA REGISTERED PROFESSIONAL ENGINEER RANDY B. PEACOCK

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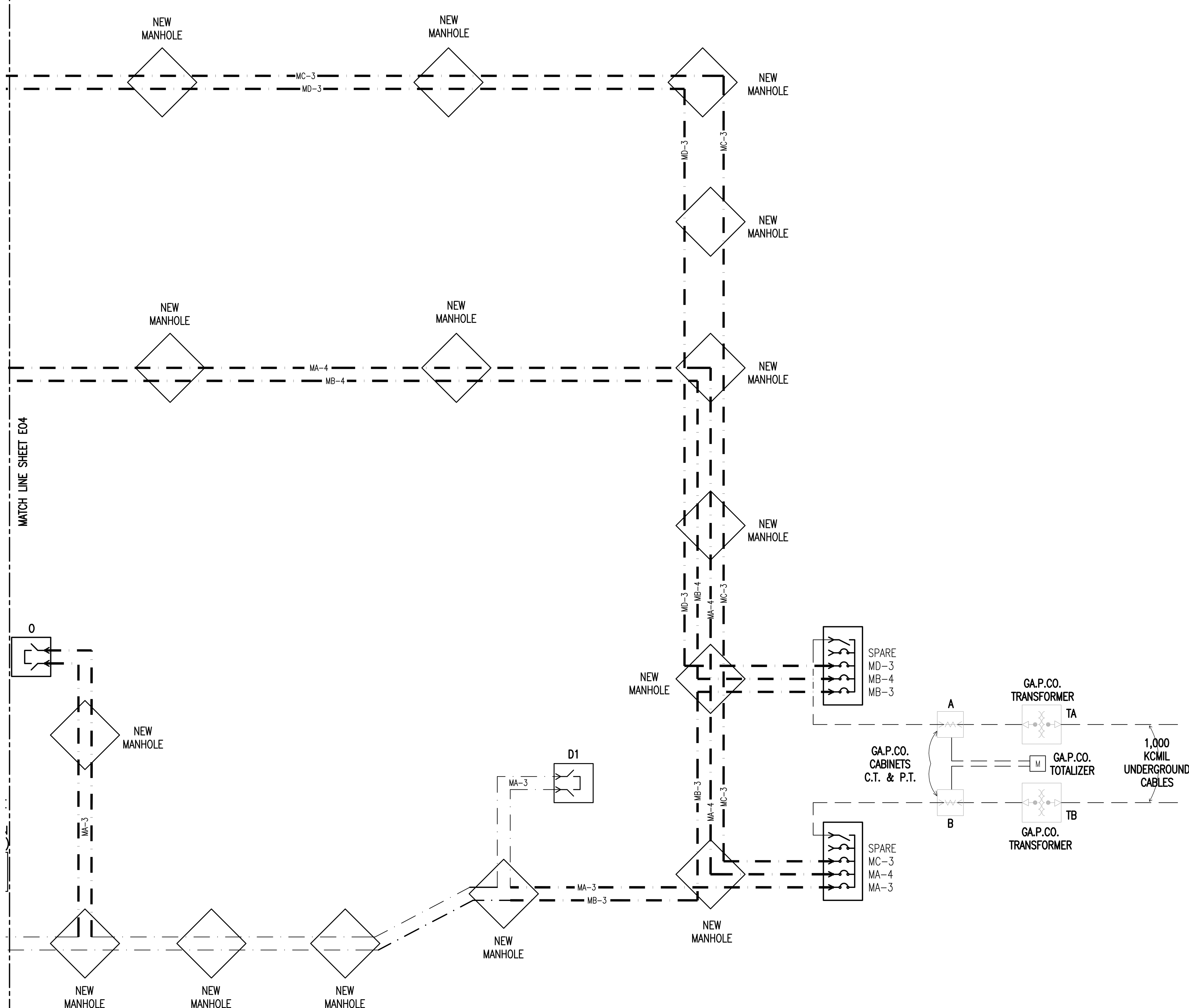
PRIMARY ONE LINE DIAGRAM
EXISTING CONDITIONS AND PHASE III WORK

SHEET NO.
E5.4

GENERAL NOTES:
(THIS SHEET ONLY)

A. NORMALLY OPEN POINTS SHOWN ARE RECOMMENDED POINTS TO BALANCE CIRCUIT LOADING. ACTUAL FIELD CONDITIONS MAY VARY.

B. CONNECTIONS SHOWN TO EXISTING TRANSFORMERS DO NOT INCLUDE TRANSFORMER REPLACEMENT RECOMMENDED IN THE STUDY.



PRIMARY ONE-LINE DIAGRAM
EXISTING CONDITIONS AND PHASE III WORK
SCALE: NONE

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PRIMARY ONE LINE DIAGRAM
EXISTING CONDITIONS AND PHASE III WORK

SHEET NO.
E5.5