Campus Utility Infrastructure Master Plan Update

Presented to:

Sam Houston State University
Huntsville, Texas

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Executive Summary

This utility infrastructure master plan update was performed for Sam Houston State University – Huntsville in 2017. EEA Consulting Engineers' scope included thermal water systems (chilled and heating water) and the medium-voltage electrical system, and MWM Design Group's scope included domestic water, sanitary sewer, and storm drainage. The intent of this update was to identify and understand the effects of various system modifications that had been implemented since the previous utility master plan in 2012, and to look ahead through the remainder of the existing campus master plan and provide recommendations as needed to ensure continuity of distributed utility service. Major findings of this report are summarized below.

Chilled Water System

The East and West Plants provide chilled water service to much of the campus. Both plants are near their maximum load capacity and lack equipment redundancy. Additional chillers are required at both plants over the course of the remaining master plan to adequately serve existing and new buildings, and provide major equipment redundancy. The new chilled water distribution loop is anticipated to be complete in 2018, and the East and West Plants will be connected by the end of 2017. This will provide added operational flexibility and reliability to the chilled water system.

Heating Water System

The East Plant heating water system has been decommissioned, and modular heating water boilers have been installed at all buildings formerly served by this system. The West Plant's heating water system will be relocated to make room for the additional required chilled water capacity. Any future buildings are to be provided with highly efficient independent heating water boilers.

Electrical System

Currently there is adequate electrical capacity on campus and a high level of redundancy at the building service level exists due to the current loading of the system. An additional pair of medium-voltage circuits are recommended for the master plan update, as well as the reconfiguring of several existing circuits to provide added redundancy at the campus level and decrease the amount of new infrastructure required. Extensive renovations to Manhole #1, or an alternate distribution system out of the main switchgear, are also recommended to improve reliability and resiliency of the campus medium voltage electrical system.

Domestic Water System

Domestic water pressure is an existing issue at several campus buildings. Hydraulic models of the system show that in a peak usage fire demand condition, many of the campus buildings do not have adequate water pressure for operation of plumbing fixtures in 2nd story floors and higher. The primary limitation of the system is the domestic water source pressure available from the City of Huntsville. Depending on the completion of a city bond funded project to increase the upper pressure plane elevation, a combination of booster pumps and/or elevated storage tanks are recommended for comprehensive improvement of campus domestic water pressures.

Sanitary Sewer System

The campus's sanitary sewer system is generally adequately sized for current campus loads as well as future anticipated loads. Several isolated sections of main lines appear overloaded at peak usage conditions, due to either pipe size or low slope. Improvements to these sections are recommended.

Storm Drainage System

The campus's storm drainage conveyance system is adequately sized for both 25-year and 100-year storm events, with only a few exceptions. Improvements to these areas are recommended or are already in planning.

A summary list of the major recommended utility projects (and their current status) is provided below:

Phase I

CHW: Increase West Plant usable capacity (to 2,200 tons) .... To be Completed in 2017
CHW: Piping Chemistry Building to Avenue I .... To be Completed in 2017
CHW: Piping from Avenue I to Bobby K. Marks Drive .... To be Completed in 2017
CHW: Piping from Bowers Blvd. to East Plant .... To be Completed in 2017
CHW: Piping from East Plant to Avenue I (17th Street) .... In Design (Arts Bldg)
CHW: East Plant Capacity Increase (~1,800-ton) .... In Design (Arts Bldg)
CHW: Program Plant and Building Peak Load Tracking Sequences ....
ELEC: Route Circuits #9 & #10 from switchgear building to East Plant .... In Design (Arts Bldg)
ELEC: Manhole #1 Circuit Segregation .... In Design (Arts Bldg)
DW: Install recommended booster pumps and elevated storage tanks .... *(further study required)*
SAN: Improve existing sanitary lines at noted locations ....
STORM: Improve existing storm system at Areas J, N, and A ....

Phase II

CHW: North Residence Hall piping ....
CHW: Install additional 2,500-ton chiller at West Plant ....
HHW: Relocate West Plant HHW System to Thomason Hall ....
ELEC: Redundant electrical feed to HKC and Coliseum ....
ELEC: Migrate existing buildings from overhead electrical to buried ....

Phase III

CHW/ELEC: Indoor Multi-Purpose Facility piping and electrical ....

INTRODUCTION

This utility infrastructure master plan update was performed for Sam Houston State University – Huntsville in 2017. EEA Consulting Engineers' scope included thermal water systems (chilled and heating water) and the medium-voltage electrical system. MWM Design Group's scope included domestic water, sanitary sewer, and storm drainage. The intent of this update was to identify and understand the effects of various system modifications that had been implemented since the previous utility master plan in 2012. Looking ahead through the remainder of the existing campus master plan and providing recommendations to ensure utility service was also a critical scope aspect. Site inspections, reviews of existing documents and automation system data, and meetings with University personnel were performed. The capacity and reliability of the major infrastructure systems were analyzed, and this document catalogs this analysis and the subsequent recommendations.

STATUS OF 2012 CAMPUS MASTER PLAN

The Sam Houston State University Campus Master Plan Update was issued in December 2012 by SmithGroupJJR. This Campus Master Plan was separated in to three Phases for implementation, and included new building construction, existing building expansions, and existing building demolitions. This master plan has largely been followed by the campus. A summary of the major 2012 master plan components, with status and phasing updated per current campus plans, is included below. This updated campus master plan serves as a framework for the requirements of the utility infrastructure master plan.

Completed since the 2012 Master Plan

Student Health and Counseling Center........Completed in 2015........30,100 sq.ft.
(Pirkle) Agricultural Engineering Building........Completed in 2017........57,800 sq. ft.

Phase I

Biology Laboratory Building........To Be Completed in 2018........97,000 sq.ft.
Lowman Student Center Expansion........To Be Completed in 2018........80,000 sq.ft.
Fine Arts and W.A.S.H Complex........To Be Completed in 2019........71,000 sq.ft.
Communications & East Plant Expansion........Modified, In Design (Arts Bldg)
~~Event Center / Press Box~~........No longer part of masterplan

Phase II

Shared Special Instruments Facility.........28,000 sq.ft.
DELTA/CE Building........10,000 sq.ft.
North District Residences (R3)........108,800 sq.ft.
North District Residences (R4-Sorority Hill Repl.)........75,000 sq.ft.
North District Residences (R5)........103,900 sq.ft.
North District Dining........25,000 sq.ft.
Basketball Practice Facility........20,000 sq.ft.
~~Mafrige Field House Expansion~~........No longer part of masterplan

Phase III

~~Demolition of Academic Building III~~	No longer planned for demolition
Demolition of White Hall	
Allied Health Building	60,000 sq.ft.
Indoor Multi-Purpose Facility	125,000 sq.ft.
Academic Building	75,000 sq.ft.
Recreational Sports Complex Expansion	75,000 sq.ft.
Future #1	60,000 sq.ft.
~~Future #2~~	No longer part of masterplan
Piney Woods Hall (South District Residences) ... To Be Completed in 2017	232,830 sq.ft.
General's Market (South District Dining) ... Completed in 2017	23,660 sq.ft.

The table above shows that much of the new construction for Phase 1 has been completed on campus. Phases 2 and 3 also include a significant increase in campus occupied space. The South District Residence and Dining facilities are listed in Phase III despite a completion date of 2017. These buildings will initially be served by dedicated air-cooled chillers, with the intent of loop connection in the distant future.

Recommended utility system improvements were also included in the 2012 campus master plan. These recommendations, along with their status, are included below for reference. Due to variations in the campus master plan, some projects have been modified or are no longer applicable, and are noted as such:

Phase I

CHW: Increase West Plant usable capacity (to 2,200 tons)	To be Completed in 2017
CHW: Connect CHSS chillers to East Plant chilled water loop	No Longer Recommended
CHW: Piping from West Plant to Pirkle Building	Completed in 2016
CHW: Piping from Pirkle Building to Chemistry Building	Completed in 2017
CHW: 17th Street piping to connect East Plant and West Plant	Modified, Completed in 2017
CHW: Piping to Student Health and Counseling Center	Completed in 2016
CHW: East Plant Expansion and Bobby K. Marks Improvements	Modified, In Design (Arts Bldg)
CHW: South campus piping project #1	Modified, To be Completed in 2017
CHW: South campus piping project #2	Modified, To be Completed in 2017
HHW: Relocate West Plant HHW System to Thomason Hall	Shifted to Phase II
ELEC: Manhole #1 Circuit Segregation	In Design (Arts Bldg)

Phase II

CHW: 17th Street east piping project	Shifted to Phase I, In Design (Arts Bldg)
CHW: North Residence Hall piping	
HHW: North Residence Hall piping	No Longer Recommended
ELEC: Redundant electrical feed to HKC and Coliseum	
ELEC: Migrate existing buildings from overhead electrical to buried	

Phase III

CHW/ELEC: Indoor Multi-Purpose Facility piping and electrical	

Most of the utility infrastructure work in the 2012 campus master plan was to be performed in Phase 1. Much of this planned work, particularly the chilled water aspects, has been completed or is in design or construction. It should be noted that analysis of the domestic water system, sanitary sewer system, and storm drain system were not included in the 2012 plan.

CAMPUS CHILLED AND HEATING WATER SYSTEMS

STUDY METHODOLOGY

Capacity Analysis

In creating the 2012 masterplan, extensive data was collected and analyzed for the campus chilled and heating water systems through a combination of field work, discussions with facilities personnel, and examination of existing plant and building construction drawings. The methodology for the masterplan was to understand the existing systems as currently installed, generate software hydraulic models of these systems, and then use the models to identify recommended system improvements to support the campus master plan. Since 2012, much of the Phase I utility infrastructure and new construction projects have been completed or are in design. The focus of this utility infrastructure masterplan update was to bring the 2012 hydraulic models and capacity analysis to present day to identify any new recommended system improvements to support the remaining projects to be completed.

As noted in 2012, one of the primary deficiencies with the campus' distributed thermal utility systems is the lack of metering and monitoring. This remains an issue today as very little data regarding plant generation of chilled and heating water is available, and the data that is available is sometimes suspect due to lack of sensor calibration and maintenance. Therefore, the primary source for peak plant load information, both then and now, was obtained from campus facilities personnel.

Previously, building loads were estimated using automation system data (where available), existing construction drawings, and engineering rules of judgement (sq.ft./ton, buildings use). This data was compiled into a spreadsheet to calculate the overall system diversity, the peak plant load divided by the sum of the building peak loads. The system diversity was used to estimate the building loads at the system peak condition. The building chilled and heating water differential temperatures (dT) were estimated in a similar fashion. The information in this spreadsheet was updated using new square footages for future buildings and the construction drawings of newly completed or in design buildings such as the Student Health and Counseling Center. Due to the timing of this masterplan update effort (late winter / early spring), peak load and dT data were not available through the automation system. Therefore, the system diversities calculated in the 2012 masterplan were assumed to have remained mostly unchanged.

Once the existing system peak loads were updated, a capacity analysis of the systems could be performed. This analysis compared the installed system capacity to load and can be used to determine when increases in system capacity may be needed.

Hydraulic Modeling

For the 2012 masterplan, hydraulic models of the chilled and heating water systems were generated using Pipe-Flo Professional Version 2009©. These models of the distribution piping were created through a combination of existing drawing examination and site work. Actual component pressure drops were entered, and actual pump curves were used. Connected building estimated flowrates were generated in the capacity analysis. After the models were generated, attempts were made to calibrate the models to reflect actual operation of the system. This process was outlined in the 2012 masterplan report.

One limitation of the Pipe-Flo software is that it cannot model heat transfer. With several large chilled water infrastructure projects shifting from design into construction, there was a need to evaluate the insulation effectiveness for the new HDPE distribution piping. Additionally, this functionality was needed to evaluate concerns of the effect of old/poorly insulated steel pipe portions of the existing chilled water distribution system. For this reason, the hydraulic model for the chilled water system was recreated in AFT Fathom Version 9, a software capable of modeling both hydraulics and heat transfer.

The chilled water system was incorporated into one model as plans to keep and connect the West and East Plants are underway. The 2012 Campus Master Plan called to demolish the West Plant and expand the East Plant to serve the entire campus. Due to the timing of this masterplan update (non-peak cooling system) and the lack of peak building chilled water flows in the automation system, data was not available to calibrate the new hydraulic model at full load conditions. Therefore, the new hydraulic model was calibrated against a hydraulic model from the 2012 masterplan, and at off-peak load conditions.

The heating water system hydraulic model was neither updated nor analyzed as part of this masterplan update effort. As recommended in the 2012 masterplan, the campus has moved towards decentralizing the heating water system with more efficient modular heating water boilers installed locally at each building. New buildings to be installed with Phases I through III will not be incorporated into the existing heating water distribution system.

Master Planning

After the 2012 configuration and operation of the campus was updated to present day status, the various analyses were used to identify recommended improvements to the chilled water system in support of the remaining campus master plan projects. The capacity analysis included the construction listed in the phases above. The hydraulic model shows the addition of future master-planned buildings, and the required distribution piping to serve them. Required infrastructure improvements for each phase were identified.

Existing Conditions Assessment and Capacity Analysis

East Plant

Chilled Water System

No significant changes to the chilled water system have occurred at the East Plant since the completion of the 2012 masterplan. Currently providing chilled water to twenty on-campus buildings, the East Plant continues to operate in a constant-volume primary pumping configuration with six chilled water pumps (three of which are dedicated to a single chiller and three to the other two chillers). Three chillers provide 4,200 tons of cooling capacity.

Through discussions with campus facilities personnel, the plant was confirmed to have remained nearly fully utilized at peak cooling load since 2012. If any one chiller or pump should fail, the plant could not support the connected cooling load at these peak conditions. Using the system diversity of 84% and plant dT of 12°F as determined in the 2012 masterplan, individual building diversified loads, dTs, and flows were calculated and are shown in the table below.

	Building	Design			Exist. Bldg. Diversity:		84%
		Load Tons	Flow (gpm)	dT (F)	Load Tons	Flow (gpm)	dT (F)
East Plant	010 - Academic Building IV	255	306	20	215	263	20
	019 - Lowman Student Center	390	520	18	329	447	18
	039 - Academic Building I	266	587	11	225	504	11
	041 - Smith Hutson - New Auditorium	38	45	20	32	39	20
	041 - Smith Hutson - New Building	147	176	20	124	151	20
	041 - Smith Hutson - Old Building	240	577	10	203	496	10
	042 - Newton Gresham Library	558	1,338	10	470	1150	10
	046 - Criminal Justice Center	536	1,400	9	452	1203	9
	047 - Teacher Education Center	233	465	12	196	400	12
	048 - Bernard Johnson Coliseum	306	612	12	258	526	12
	049 - University Theater Center	168	335	12	141	288	12
	052 - Health & Kinesiology Center	379	650	14	320	559	14
	053 - Lee Drain Building	354	850	10	299	731	10
	056 - Music Building	114	195	14	96	168	14
	057 - Ron Mafrige Field House	120	205	14	101	176	14
	168 - White Hall	69	165	10	58	142	10
	242 - Lemit Building	127	138	22	108	119	22
	302 - Recreational Sports	107	160	16	90	138	16
	303 - Counselor Education Center	28	40	17	24	34	17
	315 - Gaertner Performing Arts Center	233	400	14	197	344	14
	East Plant Total	**4,666**	**9,164**	**12**	**3,938**	**7,880**	**12**

Table 1: East Plant Diversified Chilled Water Loads

Plans to add an additional chiller and the associated pumps are currently in design.

Heating Water System

The East Plant no longer provides heating water to any campus buildings. The six existing boilers have been removed and modular boilers have been installed locally at all twelve buildings previously served by the East Plant. Previous plans to expand the cooling capacity of the East Plant were limited to building additions due to the lack of available space. With the heating water system decommissioned, the East Plant will have room for an additional chiller and associated pumps within the existing building footprint. Further investigation into the East Plant space constraints will be needed to determine the amount of cooling capacity that can be added to the East Plant.

West Plant

Chilled Water System

The West Plant currently provides chilled water to seventeen campus buildings. This includes two new buildings, the Student Health and Counseling Center completed in 2015 and the Pirkle Engineering Building completed in 2017. Otherwise, the West Plant has remained largely unchanged since the completion of the 2012 masterplan. The plant continues to operate in a constant-volume primary pumping configuration with a 1,000 and 1,200-ton chiller and two chilled water pumps to provide 2,200 tons of cooling capacity. However, the chillers were originally designed to operate in series to service a 20°F loop dT. With an actual loop dT closer to 8°F, the plant has been limited to operating a single chiller at a time. Also a limiting factor, the existing chilled water pumps do not have adequate pumping head to distribute water effectively to the connected buildings.

The table below shows individual building loads, dTs, and chilled water flows. Most of these were calculated using the system diversity of 47% and plant dT of 8°F as determined in the 2012 masterplan. However, a more conservative system diversity of 73% was applied to the two new buildings.

	Building	Design			New Bldg Diversity: 73% Exist. Bldg. Diversity: 47%		
		Load Tons	Flow (gpm)	dT (F)	Load Tons	Flow (gpm)	dT (F)
West Plant	002 - Austin Hall	63	150	10	29	114	6
	005 - Bobby Marks Admin. Bldg.	90	90	24	42	68	15
	007 - Farrington Building	192	288	16	90	219	10
	008 - Academic Building III	167	400	10	79	304	6
	009 - Estill Building	127	190	16	60	144	10
	011 - Evans Complex - Building A	112	268	10	53	204	6
	011 - Evans Complex - Building B	82	197	10	39	149	6
	012 - Thomason Building	172	516	8	81	392	5
	018 - Margaret Lea Houston	90	217	10	43	165	6
	051 - Dan Rather Communications	192	460	10	90	350	6
	102 - Jackson-Shaver Hall	71	142	12	33	108	7
	103 - Belvin-Buchanan Hall	186	372	12	88	283	7
	104 - Elliott Hall	72	96	18	34	73	11
	271 - Ragsdale Visitor Center	36	50	17	17	38	11
	300 - Chemistry & Forensic Science	310	290	26	262	395	16
	338 - Old Main Market	295	550	13	139	418	8
	360 - SHCC	**133**	**200**	**16**	**97**	**234**	**10**
	368 - Fred Pirkle ETC	**216**	**370**	**14**	**157**	**433**	**9**
	West Plant Total	**2,606**	**4,846**	**13**	**1,432**	**4,090**	**8**

Table 2: West Plant Diversified Chilled Water Loads

The addition of SHCC and Pirkle brought the peak cooling load above the capacity of the larger of the two chillers. To help accommodate these new buildings, both West Plant chillers were operated during the 2016 peak cooling season despite the series piping arrangement. The summer of 2017, the West Plant will undergo the first phase of a capacity expansion. The first phase will modify the current piping configuration to allow both existing chillers to operate in parallel. This will effectively increase the West Plant capacity from 1,200 tons to the full 2,200 tons. Additionally, the existing pumps will be replaced to more effectively circulate water to all seventeen buildings.

Heating Water System

The West Plant provides heating water to six campus buildings: Austin Hall, Bobby K. Marks Admin. Bldg., Evans Complex – Bldg. A and Bldg. B, Thomason Bldg., and Dan Rather Communications. The heating system was installed in 2008 and consists of one high-mass boiler with two pumps. This system is to be moved to make room for the West Plant chilled water capacity expansion. All new campus buildings will have modular boilers installed locally.

CHSS Plant

Chilled Water System

The CHSS (College of Humanities and Social Sciences) building houses a small 800-ton chiller plant that serves the single building. The plant is in a variable-volume primary pumping configuration with two chillers and two chilled water pumps. In the 2012 masterplan, the peak cooling load for CHSS was determined to be 340 tons allowing for approximately 400 tons of spare capacity. A recommendation was made to connect the CHSS chilled water system to the campus loop to provide supplemental cooling to the campus system. However, this recommendation was made as part of a larger master plan for the system, that included demolition of the West Plant and a large expansion of the East Plant.

Currently, there is a 6" CHWS/R connection of the CHSS plant to the campus loop. This connection allows the campus loop to serve CHSS in the event both centrifugal chillers in the building fail. The current piping arrangement does not, however, allow for CHSS to provide chilled water out into the campus loop. An additional chilled water pump, VFD, interconnecting piping, and controls components at CHSS would be required for this to be possible.

However, the West Plant is no longer planned for demolition as renovations to provide an additional 1,000 tons of capacity are currently underway. Additionally, design will begin shortly to increase the capacity of the East Plant by ~1,500 to 1,800 tons. Given the current plans to expand the West Plant and add capacity at the East Plant for a total campus capacity increase of 2,500-2,800 tons, it is not recommended that the required components be installed at CHSS to allow it to provide supplemental chilled water to the main campus loop.

Distribution Piping

Since the 2012 masterplan, the campus completed several key chilled water distribution piping installation projects with the goal of connecting the East and West Plants. New direct buried 24" HDPE piping with Gilsulate insulation was routed from University Avenue and 17th Street down to Avenue I with new 8" and 10" branch piping installed to serve the Lowman Student Center Expansion and Student Health and Counseling Center respectively. New 16" HDPE piping with Gilsulate insulation was installed from the West Plant to the new Pirkle Engineering Building. Currently ongoing is the installation of new 16" HDPE piping from Pirkle to Avenue I. The West and East Plants will be connected in the Fall of 2017 with the installation of 24" HDPE piping from the East Plant to Bowers Boulevard up to Avenue I. A summary view of the piping system is given on sheet M1.0 in Appendix A.

The primary area of concern with the distribution piping in 2012 was the physical condition of the East Plant heating water piping. With the transition to modular boilers located at each building, this distribution piping has been abandoned in place.

Campus Hydraulic Modeling Analysis

Existing Chilled Water System

As mentioned in the section above, the new updated hydraulic model was created in AFT Fathom Version 9. To calibrate the new model, the first step was to re-create the Phase III Pipe-Flo hydraulic model from the 2012 Masterplan in Fathom using identical inputs. Once the Phase III model was complete in Fathom, the output results were compared between the two software products. Small adjustments were made until the updated model results mirrored the 2012 model results. This Fathom hydraulic model served as the calibrated base for the updated existing and all future phase scenarios.

Several additional modifications were made to the Fathom model to reach a present-day condition. Using construction drawings and elements from the existing 2012 West Plant hydraulic model, the Fathom model was updated to reflect the current campus chilled water distribution piping. For the purposes of this study, only the diversified flow condition was modeled in Fathom. This model represents a peak load condition for both plants with the diversified flow values for each building from Tables 1 and 2 shown above.

Two existing condition models, shown in Appendix B, were created to identify issues related to fluid velocity and building differential pressure. The first is the current condition of the campus, before the East and West Plants are connected on the south side of campus and before any West Plant modifications are completed. The second is representative of the condition for Fall of 2017, after the West and East Plants are connected on the south side of campus, the West Plant modifications are completed, and the new Biology Laboratory building is built.

<u>Chilled Water System – Spring 2017 Diversified Flow Model</u>

One main point of interest from this model is the fluid velocity in the piping system. Piping in which the fluid velocity is over 8 ft./sec. is colored pink, as this is nearing the typical design limit of 10 ft./sec. The only real area of concern is the existing return and supply piping at the East Plant. As to be expected with all three chillers in the East Plant fully utilized, the velocity in the 18" East Plant main return pipe exceeds 10ft./sec.

The other point of interest is the buildings in which the software is adding pressure at the representative control valve (building entrance) to achieve the assigned building flowrate. These buildings, identified with a red box on the model, may not be receiving adequate flow from the distribution system. As mentioned in the previous section, the West Plant pumps have insufficient head to distribute chilled water effectively to each building. Therefore, it is not surprising to see many west campus buildings struggling to maintain the diversified flow conditions. However, the same condition is occurring at several east campus buildings as well. This could be due to the fact that the East Plant is fully utilized and is struggling to meet the campus demand.

<u>Chilled Water System – Fall 2017 Diversified Flow Model</u>

In the Fall of 2017, the campus will have completed the chilled water distribution piping projects in south campus, connecting the East and West Plants. The West Plant pumps will have been replaced and the piping modified to allow for parallel operation of both existing chillers. Although the Biology Laboratory building will be connected to the chilled water loop at this time, it will not be occupied or fully-operational. To account for this, the chilled water flowrate at the representative control valve has been reduced to 50% of the peak diversified flowrate (approximately 345 gal./min.).

The supply and return piping at the East Plant continues to be an issue with fluid velocity. However, the West Plant modifications, especially the new pumps, alleviate flow through the East Plant to a degree. The West Plant is limited as well by the 16" main supply and return piping, which should only be expected to support near 5,510 gal./min.

The insufficient pressure issue noted in the previous model is fully remedied by the replacement of the West Plant primary pumps. The new pumps are expected to have a design head of roughly 250 feet, ample to meet the peak diversified demand for chilled water.

Chilled Water System – Piping Insulation

The current campus standard for new direct-buried chilled water distribution piping is to install HDPE with Gilsulate insulation. Design drawings for several current piping projects on campus showed Gilsulate only between the return and supply chilled water piping to mitigate any heat transfer between the two pipes and to save cost associated with a manufacturer's recommended installation of Gilsulate fully surrounding the supply and return pipe. Using calculations published in Chapter 12 of the 2016 ASHRAE Handbook, HVAC Systems and Equipment, it was determined that temperature rise of the chilled water supply due to the surrounding ground (including asphalt pavement top cover) and the neighboring return pipe is only 0.1-0.3°F. Because of this, installation of Gilsulsate between or around new direct-buried HDPE chilled water piping larger than 12" is not recommended. It is still recommended to provide Gilsulate at all valves, flanged connections, and piping 12" in diameter and smaller. Increasing the burial depth of piping where possible will reduce any heat gain to the water that does occur. The ASHRAE calculations are included in Appendix C.

Campus System Efficiency Analysis

Chilled water plant performance is often described in terms of kW/ton. This metric represents the kilowatts of power used to generate each ton of chilled water. Chiller, chilled water pump, cooling tower, and condenser water pump energy are all used for this calculation. This information can be obtained directly through chiller and pump VFD automation system outputs, or through current transducers (CTs) on equipment feeders. If one large piece of switchgear is serving all chilled water equipment (or the entire plant), metering that equipment itself can be a much simpler option. Chilled water tonnage is typically calculated with a flowmeter and supply and return temperature sensors on plant mains, or on individual chillers.

The figure below shows typical operating kW/ton values for chilled water plants, along with a rough categorization of performance. Plant kW/ton values vary depending on system load, equipment staging, and equipment condition, but these numbers can be used as a simple benchmark for plant performance.

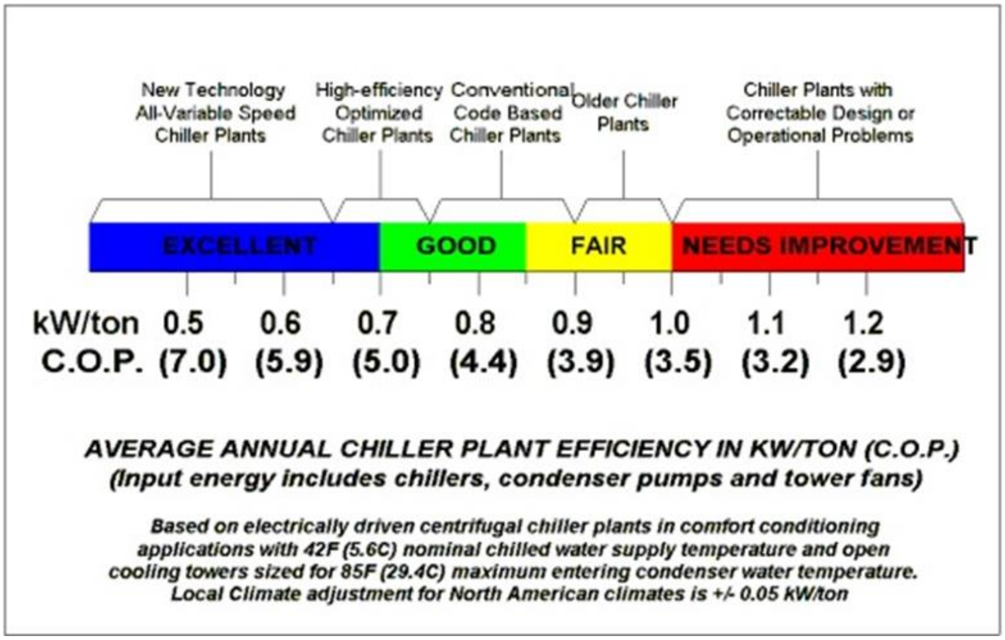


Figure 1: Plant Performance Indexes (www.automatedbuildings.com)

Calculating plant design kW/ton from construction documents can give an indication of how efficiently a plant is operating with respect to its original design. Plant design kW/ton for the East Plants has been calculated and is shown in the table below. Submittal data was used to obtain actual installed values where possible. Plant kW/ton for the West Plant was not calculated, as the upcoming renovations to the plant are expected to significantly alter this value.

	GPM	dT	Tons	BHP	kW	kW/Ton
CH-1	3,600	12	1,800	-	1,053.0	0.585
CH-2	2,780	12	1,390	-	860.4	0.619
CH-3	2,000	12	1,000	-	670.0	0.670
CHWP-1	750	-	-	30.0	22.4	-
CHWP-2	1,500	-	-	60.0	44.7	-
CHWP-3	1,500	-	-	60.0	44.7	-
CHWP-4	1,500	-	-	60.0	44.7	-
CHWP-5	1,500	-	-	46.7	34.8	-
CHWP-6	1,500	-	-	46.7	34.8	-
CT-1	1,500	10	500	30.0	22.4	-
CT-2	1,860	10	620	30.0	22.4	-
CT-3	1,860	10	620	30.0	22.4	-
CT-4	1,860	10	620	30.0	22.4	-
CT-2	7,200	10	2,400	120.0	89.5	-
CWP-1	1,500	-	-	50.0	37.3	-
CWP-2	1,860	-	-	75.0	55.9	-
CWP-3	1,860	-	-	75.0	55.9	-
CWP-4	1,860	-	-	75.0	55.9	-
CWP-5	1,800	-	-	71.4	53.2	-
CWP-6	1,800	-	-	71.4	53.2	-
CWP-7	1,800	-	-	71.4	53.2	-
CWP-8	1,800	-	-	71.4	53.2	-
Total Tons	4,190	Tons				
Total kW	3,407	kW				
Design	**0.81**	kW/ton				

Table 3: East Plant Design kW/ton

Monitoring and trending of the plant kW/ton values, and comparing against the above benchmarks, is recommended as a method to track chilled water system efficiency. Some of the electrical information required for this calculation is currently obtained through the campus automation system. However, the remainder of the information would require additional control monitoring points (in the case of equipment with control panels or VFDs) and possibly additional hardware components (such as CTs). A simpler option may be to use entire plant kW (including lighting, receptacle, and air conditioning loads) for the calculation, with a credit subtracted from the estimated kW value of these miscellaneous loads. Additionally, the chilled water flow measurement at the East Plant is not accurate enough to reliably calculate or trend plant kW/ton.

Based on the available information, the East Plant is anticipated to be operating in the “Good” to “Fair” range shown in the Figure above. While room for improvement does exist, operating in this kW/ton range should be considered generally average to above-average for a higher-education campus of this size and age.

Chiller plant efficiency is a function of many variables, such as system load, system differential temperature, equipment staging, and equipment modulation (speed). While implementing one specific sequence of operation can provide good overall plant efficiency, ideally this sequence can be modified and adjusted to provide the best overall system efficiency, not just chiller or pump efficiency. Central plant optimization programs can be useful tools for this kind of modulation where many variables must be considered. Many options exist for these programs at varying levels of complexity and cost and should be investigated to determine if acceptable implementation paybacks can be achieved.

Existing System Conclusions

The existing distributed thermal utility systems are a significant portion of the campus utility infrastructure and are vital to the daily operation of the campus. Both the generating capacity and distribution capacity must be adequate for proper operation of the system. Even with the West Plant modifications, the generating capacity for campus chilled water is near its limit. Additional campus capacity will be needed to support the buildings to be finished throughout Phase I of the masterplan. Similarly, while several piping improvements have been made and are currently underway such that the general condition and size of the systems' distribution piping is satisfactory, upgrades to the main supply and return piping at both plants will be required for future campus additions.

Campus Utility Master Plan (Mechanical)

The updated master plan for the campus distributed thermal utilities is shown on M2.0 in Appendix A. Master planned buildings are shown shaded by Phase with bold blue lines representing new chilled water piping. The major changes to the distributed thermal utility master plan to note are: completion of the combined chilled water loop in the northeast area of campus, the West Plant to remain, and abandonment of the east campus heating water system. Descriptions of the chilled water and heating water master plans are given below.

Chilled Water System

The table below shows a summary of the campus cooling load increases through the various phases of the master plan. Individual master planned building load estimates were made using sq.ft./ton values and building usage. A total campus diversity of 73% (based on the current East and West Plant diversities) is also shown applied to each building to add to the peak campus load condition. The graph below shows the increase of campus chilled water load over time, per phase.

As can be seen in the table and graph, there is a large increase in campus chilled water capacity required over the course of the campus master plan. To address the increase in capacity, capacity additions at both the East and West Plants are recommended. Much of the recommended distribution system installations from Phase I of the 2012 masterplan will be completed in the Fall of 2017.

Building	Area Sq.Ft.	Cooling Density Sq.Ft./Ton	Cooling Load Tons	Design Flow (gpm)	Design dT (F)	Applied Diversity	Cooling Load Tons	Div. Flow (gpm)
Existing Buildings								
West Plant	666,616		2,600	4,800		54%	1,400	4,100
East Plant	1,474,522		4,700	9,200		83%	3,900	7,900
Total	**2,141,138**		**7,300**	**14,000**		**73%**	**5,300**	**12,000**
Phase I								
355 - Biology Laboratory Building	97,000	153	633	950	16	73%	460	690
XXX - LSC Expansion	80,000	155	517	775	16	73%	375	563
Fine Arts Building / WASH	71,000	200	360	540	16	73%	261	392
New Building Totals			**1,500**	**2,300**			**1,100**	**1,600**
Demolition Totals			**0**	**0**			**0**	**0**
Phase I Campus Totals			**8,800**	**16,300**		**73%**	**6,400**	**13,600**
Phase II								
Shared Special Instruments Facility	28,000	350	80	120	16	73%	58	87
DELTA / Continuing Education	10,000	300	30	45	16	73%	22	33
North Residential (R3)	108,800	350	310	465	16	73%	225	338
North Residential (R4)	75,000	350	210	315	16	73%	152	229
North Residential (R5)	103,900	350	300	450	16	73%	218	327
North Dining Facility	25,000	200	130	195	16	73%	94	142
Basketball Practice Facility	20,000	300	70	105	16	73%	51	76
New Building Totals			**1,100**	**1,700**			**800**	**1,200**
Demolition Totals			**0**	**0**			**0**	**0**
Phase II Campus Totals			**9,900**	**18,000**		**73%**	**7,200**	**14,800**
Phase III								
Allied Health Building	60,000	300	200	300	16	73%	145	218
Indoor Multipurpose Facility	125,000	300	420	630	16	73%	305	457
Academic Building	75,000	300	250	375	16	73%	182	272
Recreation Center Facility Expansion	75,000	300	250	375	16	73%	182	272
Future Building	60,000	300	200	300	16	73%	145	218
373 - Piney Woods Hall	232,822	443	525	1,050	12	73%	381	572
372 - General's Market (Dinning Hall)	23,657	79	300	450	16	73%	218	327
Demo White Hall	-	-	-	-	-	-	-	-
New Building Totals			**2,100**	**3,500**			**1,600**	**2,300**
Demolition Totals			**69**	**165**			**58**	**142**
Phase III Campus Totals			**11,900**	**21,300**		**73%**	**8,700**	**17,000**

Table 4: Master Plan Chilled Water Loads

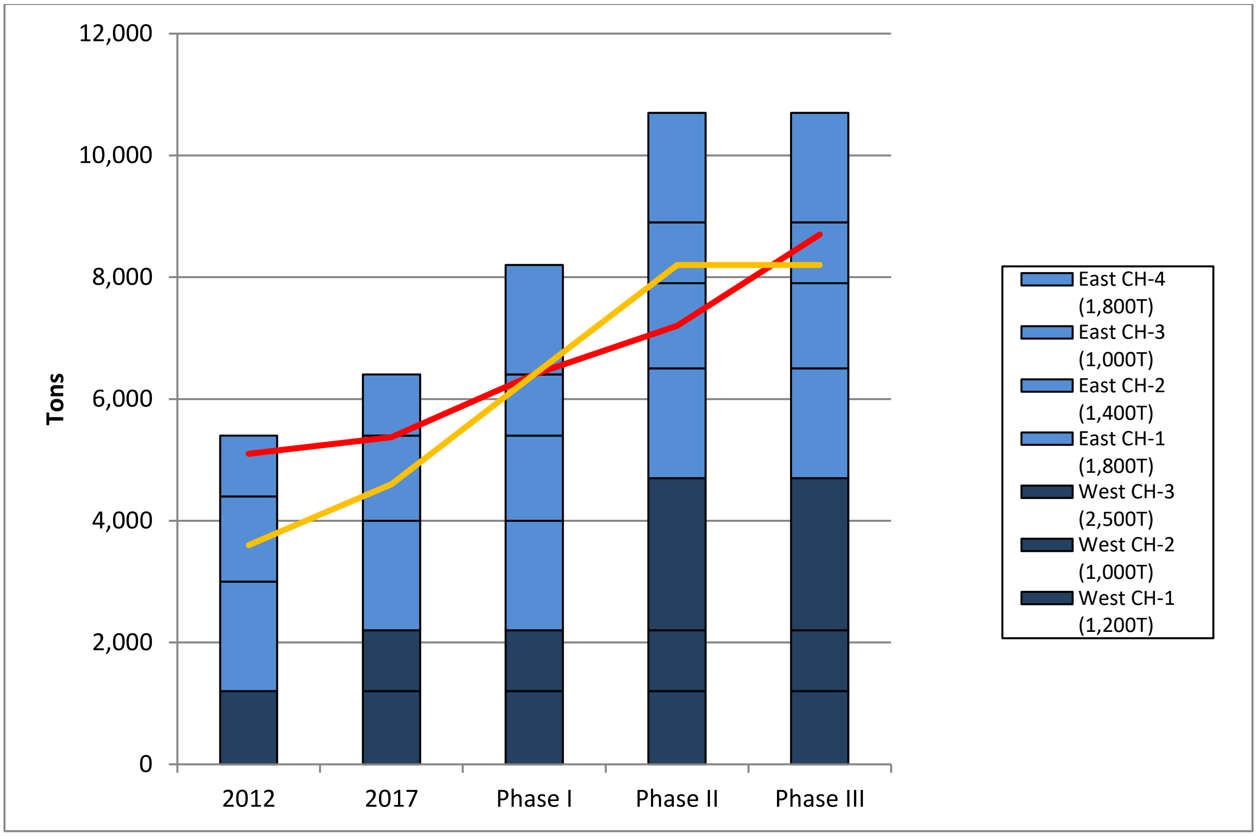


Figure 2: Master Plan Chilled Water Loads

<u>Phase I Recommendations</u>

By the end of Phase I, the East and West Plants will be fully utilized with no spare capacity. If one chiller or pump in either plant was to fail, the campus peak diversified load will not be satisfied. Plans to add an estimated 1,800 tons to the East Plant concurrently with the construction of the new Art Building are presently in design. An additional 1,800-ton chiller would provide the campus with N+1 capacity, meaning if the largest piece of equipment were to fail, the campus peak diversified load could still be satisfied.

At this phase, the only unfinished portion of the new 24" campus chilled water loop is from the East Plant up to Avenue I and 17th Street. The hydraulic model <u>Chilled Water System – Phase I without Loop</u>, shown in Appendix B, represents a peak cooling condition at the end of Phase I without this section of piping installed. All but one East Plant pumps are running at full speed, though it is recommended that the plant be retrofitted for variable volume operation with the addition of the 1,800-ton chiller, and the new West Plant pumps are running at 81%. This section of piping is not required for proper function of the chilled water system. However, connecting the East and West Plants on this side of campus would provide more options serving north campus buildings in the event of a major equipment failure.

The hydraulic model <u>Chilled Water System – Phase I with Loop</u>, shown in Appendix B, represents a peak cooling condition at the end of Phase I with the 24" chilled water loop complete on the north side of campus. A few buildings on the west side of campus still show very low differential pressures (Academic Building I, Evans A, and Farrington). These buildings may need to be retrofitted with tertiary chilled water pumps. This would allow the campus distribution pumps to operate at lower speeds, reducing energy consumption at the plant and avoiding unnecessarily high differential pressures at other buildings. Increasing overall campus chilled water differential temperature would also reduce pumping power across the campus. This will be discussed in the Other Recommendations section.

When the East Plant and West Plant distribution systems are connected, some initial observation and adjustments to the West Plant pump speed and East Plant isolation valve positions may be required to coordinate flow from both plants. The East and West Plants will both be pumping into the same system, and the pumps should be matched hydraulically to the extent possible. Because the East Plant's chilled water pumps will still be constant-volume, the most effective solution for this may be adjustment of the West Plant's chilled water differential pressure setpoint. While the hydraulic models do indicate this balance point (this is the location on the model where flow in the supply and return distribution piping is equalized, or near zero), the actual operating conditions will vary based on campus load conditions and building usage.

Phase II Recommendations

Phase II adds five new buildings to the north end of campus and two new buildings to the south end of campus. The only significant piping project to be completed with this phase is to extend an 8" chilled water supply and return pipe along Avenue J to serve the new residence hall (R5) and north dining. If first cost is an issue for R5 and the north dining hall, another option would be to provide air-cooled chillers or connect these buildings to the Lone Star Hall chilled water system (if that system has enough capacity). Neither of these options would change the overall campus capacity recommendations. Other Phase II buildings are already in proximity to installed chilled water piping and can be connected to piping taps installed for future use. Also, installing the second phase of the West Plant renovations, which include a new 2,500-ton chiller and increased plant piping main sizes, would maintain chiller redundancy for the campus system.

The hydraulic model Chilled Water System – Phase II represents a peak cooling condition at the end of Phase II. In this model, the campus differential temperature has increased slightly again due to new buildings being added at a 16°F design dT. The plant chilled water pumps are shown running at part speed to avoid excess loop differential pressure. Again, tertiary pumps at a few West Plant buildings would allow pump speed and power, and loop differential, to decrease.

Phase III Recommendations

The third phase of campus construction would require no major expansions or additions to the campus thermal distribution system. The largest chilled water infrastructure project would be the piping run to the Indoor Multi-Purpose Facility. The Chilled Water System – Phase III hydraulic model represents the peak cooling condition at the end of the phase. This model is somewhat conservative, as the total campus cooling diversity can be expected to decrease below 70% as more buildings are added to the campus.

Figure 1 above shows the Phase III Campus Diversified Cooling Load rising slightly above the Campus N+1 Capacity. Although the graph does indicate an excess capacity of a single 1,800-ton chiller, the new largest piece of campus equipment is the 2,500-ton chiller at the West Plant. If this piece of equipment were to fail, the chilled water system will be 600-tons short of full redundancy. However, due to the conservative assumption for total campus cooling diversity, this should not be a major concern but should be revisited during Phase II when actual campus peak loads are more established. This increase in capacity could be addressed with replacement of one or both existing chillers at the West Plant.

Heating Water System

The existing West Plant boiler will be removed as part of Phase II of this masterplan. The heating plant can be relocated to the lowest floor of Thomason Hall as was recommended in the 2012 masterplan when the West Plant was to be demolished. Instead of relocating the existing high-mass heating water boiler from the West Plant, the installation of new, high-efficiency condensing modular boilers is recommended. The available space in Thomason Hall has exterior walls for combustion and flue routing, exposed heating water piping for connection to the campus loop, and gas service at the adjacent West Plant.

Other Recommendations

This section contains several recommendations that, while not directly related to the campus utility master plan, would improve the performance and efficiency of the systems.

Improved Plant and Building Monitoring

Reliable measurement and metering of distributed utilities at the generating plants and end-use buildings is essential to efficient system operation and planning. Chilled water flowmeters and temperature sensors have been added at many campus buildings in recent years, although, some buildings are still in need of replacements. Ideally, each building entrance would have the following monitored points for both chilled and heating water (if connected to a distribution loop):

- supply temperature and pressure
- return temperature and pressure
- flowrate
- pump status and speed

Accurate measurement of system operation at the plants is also important. Chiller full load amperage percentage (FLA %), pump status and speed, plant chilled water flowrate, and plant main chilled water supply and return temperature and pressure at a minimum should be monitored and trended. Currently, there are significant discrepancies between measured data points in the plants, or no measured data at all. Accurate data that can be logged, benchmarked, and trended would allow facility personnel to ensure that the systems are operating appropriately and efficiently. These monitoring points should be added to the system with the planned West Plant and East Plant improvements. For chilled water flow measurement, inline or insertion style electromagnetic flowmeters are recommended for their accuracy, turndown, and installation flexibility.

While these building and plant monitoring devices can give instantaneous readings of chilled water consumption and differential temperature, historical tracking of this information would be useful for future planning and load tracking. To do this tracking, control sequences at the East and West Plants and all monitored buildings are recommended:

- When a new maximum chilled water flow, minimum differential temperature, or maximum calculated load is reached at the East Plant or West Plant, the following data points should be collected and logged:
    - Date and Time
    - Plant Data Points (Both Plants)
        - Chiller FLA %
        - Pump VFD Speed
        - Plant Flowrate (gpm)
        - Plant Supply/Return Temperature (°F)
        - Plant Supply/Return Pressure (psi)
    - Building Data Points (All Monitored Buildings)
        - Pump VFD Speed
        - Building Flowrate (gpm)
        - Building Supply/Return Temperature (°F)
        - Building Supply/Return Pressure (psi)
- When a new maximum chilled water flow, minimum differential temperature, or maximum calculated load is reached a monitored building, the following data points should be collected and logged:
    - Pump VFD Speed
    - Building Flowrate (gpm)
    - Building Supply/Return Temperature (°F)
    - Building Supply/Return Pressure (psi)

Identify and Correct East Plant Pressure Drops

As indicated in the East Plant hydraulic models, using current sensor data, there appears to be a significant and unaccounted pressure drop in the return side of the plant's chilled water system. To conserve pump energy and improve plant distribution capacity, it is recommended that this pressure drop be investigated during the capacity addition to the plant in the Arts Complex.

Conversion of East Plant to Variable Volume / Campus dT Improvements

The upcoming renovations at the West Plant will convert that system to variable flow. Significant additional energy savings could be realized by conversion of the East Plant to variable chilled water flow as well. Campus-wide differential temperature improvements at buildings should also be investigated to reduce overall pumping power. Three-way valves at air handlers or building entrances, open bypasses, or improper or un-calibrated control can all contribute to poor building and campus dT. The campus construction standards could also be modified to require that new air handler coils all be sized for 16°F chilled water differential temperature when feasible. Specific buildings where low dT has been observed either through the automation system or by the campus facilities staff are the Criminal Justice Center and the Health and Kinesiology Center. A current retrocommissioning project at the Criminal Justice Center should provide specific recommendations for dT improvements.

Campus Electrical System

Study Methodology

In the 5 years since the 2012 Masterplan, the electrical system looks very similar with a few small changes. The campus electrical system consists of a medium voltage (13,200 Volts) substation building, a medium voltage underground and overhead distribution system, medium voltage switching and voltage step down transformers at each building, and the building loads. Just like the thermal analysis listed in this report, the methodology for the master plan was to gain an understanding of the current system, generate a software model of the system, and then use a combination of the model and hand calculations to develop the recommended system improvements to serve the campus master plan. Data was obtained through conversations with campus personnel, campus provided utility bills, existing drawings, and first-hand observations.

Existing Electrical System

Electrical Load Analysis Capacity

The purpose of an electrical load analysis capacity study is to determine operating electrical demand of the electrical system. This can identify those circuits that have available capacity for future growth.

The campus substation located at the corner of 15th Street and Avenue I provides all of the power for the main campus, with the exception of one building. General's Market is supplied with power from a separate Entergy circuit. Entergy provides an overhead 138kV circuit to the substation via a circuit that runs along 16th Street from the West. The voltage is then stepped down to 13.2kV by an Entergy owned transformer and routed into a building containing medium voltage switchgear near the SW corner of the substation. This substation contains 10-1200A drawout circuit breakers for circuit distribution around the campus. Currently 8 circuits are in use and 2 are reserved for future use. There are four circuit pairs that are routed around the campus. Circuits 1+2, 3+4, 5+6, and 7+8. Each circuit pair is routed along underground conduit ductbanks to provide redundant power to each building. The maximum capacity of each circuit is limited to the ampacity of the cable. Each circuit is routed with 15KV, 133% EPR,90°C, #4/0 AWG cable. According to the 2017 National Electrical Code Table (NEC) 310.60(C)(77), this cable when routed underground in a single conduit is rated for 295A. However, when multiple conductors are routed together, heat dissipation becomes an issue. The heat from conductors start to react with each other and the cables maximum ampacity must be de-rated.

The main area of concern is the first manhole that leaves the substation (Manhole #1). This manhole contains all 8 circuits for the campus. This is where heat dissipation becomes the biggest problem. Because all the conductors are in one area, this is where cable failure is most likely. By using a computer simulation, the maximum ampacity can be determined. EEA utilizes a software program called AmpCalc to analyze the interaction of the conductors with each other and the temperature of each cable. If we specify a maximum temperature, it will return the maximum ampacity that can be applied.

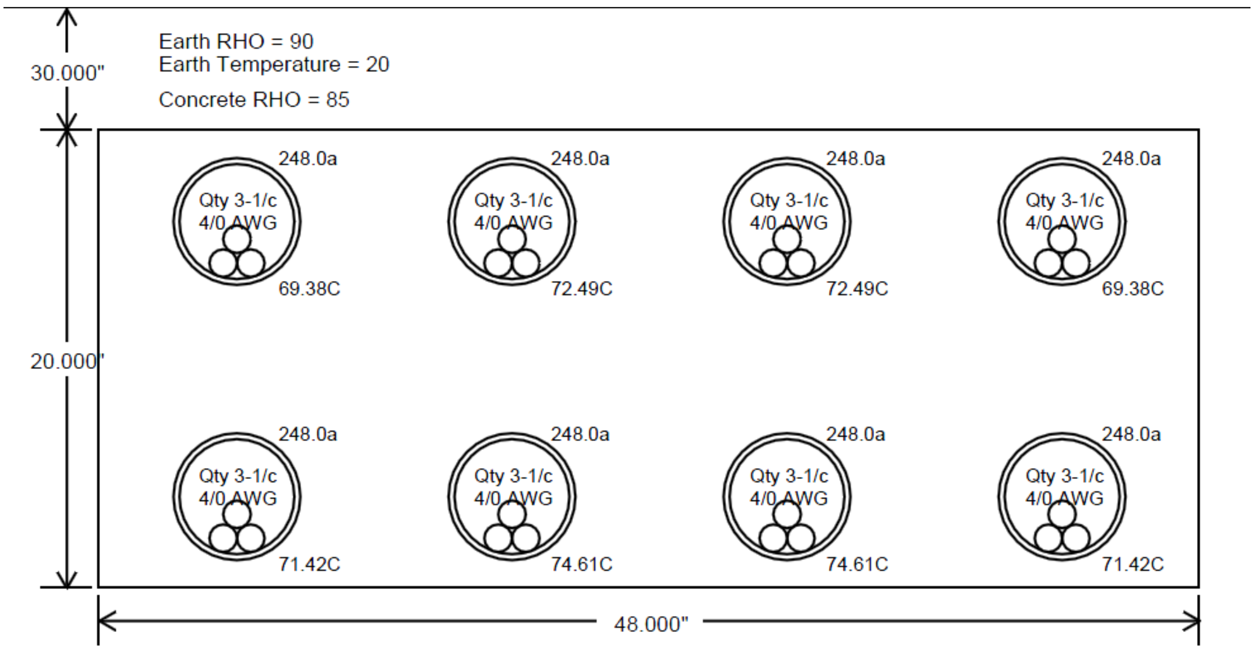


Figure 3: Main Electrical Ductbank from Substation Building

As shown in the figure above, all eight circuits were maintained at 248A. The maximum cable ampacity is 90°C, but for the purposes of this analysis, a safety factor of 15°C is being used to account for unknown cable insulations, cable and ductbank configurations, etc. The middle two conduits on the bottom are the limiting factor in the calculations. Because they are surrounded by other conduits and also furthest from the surface, they have the hardest time dissipating heat. The maximum ampacity of all conductors is 248A. At 13,200V, this equates to a maximum demand of 5670 Kilowatts (5.67Megawatts) per circuit pair. This will be the limiting factor in all the calculations.

To calculate the maximum demand of each circuit pair, it was first determined what buildings were on which circuit. Once an inventory of buildings was determined, meter data was obtained for each building. The meter data shows a maximum demand for each building. This demand is calculated on a month to month basis. It shows the maximum power consumed by the building each month. The meter takes a snapshot of the power consumption every 15 minutes. The snapshot with the highest reading is considered the demand for the month. As you would expect on a month to month basis in Texas, the maximum demand would occur in the summer months when air conditioning is used the most. However, in a chilled water campus setup, the cooling is located outside of the building footprint in a chiller plant. This will result in demands for each building occurring in different periods throughout the year. When analyzing data for each building, the maximum demand sometime occurred in the winter. Because the demands did not all occur at the same time, the summation of all the demands for each circuit pair will give an absolute maximum the circuit could expect to see.

Because the maximum demand for each building did not occur at the same time, a diversity factor should be applied.

For example, when calculating the maximum demand for Circuits 5+6, the peak building demand was totaled regardless of when that peak occurred. This resulted in a total of 6.2MW. However, when taking each month into account, the maximum circuit demand for the circuit pair occurred in August 2016 with 3.5MW. The diversity calculated is ~60%. Data was also used from the main meters at the substation to determine overall demand vs. demand at each building. This calculation resulted in a varied diversity for each circuit pair.

As shown in the table below, the current circuit pair setup is operating well below capacity. The University is in good position to handle the master plan expansions.

Circuit	Maximum MW	Current Load			
		Peak Building MW	Diversity	Peak Circuit Pair kW	Spare
1+2	5.7	5.8	0.7	4.1	28%
3+4	5.7	4.0	0.6	2.5	33%
5+6	5.7	6.2	0.6	3.5	26%
7+8	5.7	1.9	0.6	1.1	80%

Table 5: Existing Circuit Loads

As with any expansion project, timing is critical. The addition of the buildings outlined in the masterplan are sometimes constructed in green space where the load will be directly added to the demand load. Sometimes, buildings are demolished to make room for the new building and there is a net gain realized in the demand.

Electrical Short Circuit and Coordination Study

Along with capacity analysis like mentioned above, another important piece to an electrical study is short circuit coordination. The purpose of a coordination study is to make sure the correct overcurrent protection device opens to clear a fault. The ideal situation is to have the nearest upstream device clear the fault. If a circuit breaker or fuse is not selected properly, a small short inside a building could take out a majority of the campus. Proper coordination is essential to the reliability of the system.

The short circuit study, included in Appendix G, was performed for the electrical distribution system to determine the available fault current that exists at the equipment and devices in the system and compare the results to the equipment Amps Interrupting Capacity (AIC) ratings. The short circuit analysis is critical to determine the energy available for an arc flash. When a bolted fault occurs, the short circuit calculation determines how much energy is available at that particular node. If the rating of the equipment is greater than the calculated energy, it should be able to withstand the fault. If it is less than the calculated range, the equipment could explode and cause serious harm.

It is important to note that the equipment rating is only as good as the lowest rated part of the assembly. A 65,000A rated switchboard with a 10,000A circuit breaker is only rated for 10,000A.

The numbers in Table 6 below were determined based on the lowest equipment rating. In some cases, the equipment rating was not published and was estimated based on equipment construction and is noted in italics.

The electrical system model was created with SKM Dapper Software. Each piece of equipment (cables, fuses, circuit breakers, motors, transformers, etc) shown on the one line diagrams is input as a node into the model. Each node in the system created is analyzed by the software to determine the potential fault current at that node given a zero impedance three phase fault at that location on a balanced linear system with all motors running at full speed. The results are compared with the known AIC rating of the equipment to determine the system capacity to safely clear a worst case fault.

To model the subject electrical distribution system, EEA obtained pertinent information from the facilities electrical department, plan drawings, field investigation, and the one-line diagrams from various renovation projects. Conductor lengths were obtained by measuring the distances on the plans. Conductor sizes were taken from the existing one line diagrams and discussions with campus personnel. Where exact information was not available, every effort was taken to design the model so that it will yield the worst case fault current experienced during a bolted, zero impedance fault between all three phases. Because shorter and larger feeders will yield greater fault current, feeder lengths have been assumed to take the shortest and most direct paths and conductors have been oversized where the sizes are unclear. Entergy provided the maximum available fault current at the main Entergy substation as follows:

- Phase - Phase Fault = 7,291 amps
- Max. Phase - Ground Fault = 8,622 amps
- Three Phase Fault = 8,419 amps

The short circuit calculations were performed based on the assumption that all significant motors shown on the one line are in operation at full speed. Motors that are fed from VFDs are not included prior to performing the short circuit analysis because the fault contribution from these motors will not be transferred through the VFD to the remainder of the system.

Overall, the system is properly selected to handle a short circuit event. There are three distribution panels that are in question, but the withstand rating is not grossly undersized.

- The main circuit breaker for Lemit is rated for 50,000AIC, but has a calculated fault current of 54,884AIC. This circuit breaker resides in the main distribution panel for the CJC and should be replaced to maintain the 65,000AIC rating of the CJC main distribution panel.
- The main circuit breaker for the Music Building is rated for 10,000AIC, but the calculated fault current is listed as 10,608AIC. A quick fix to reduce the fault current would be to install cable limiters on the incoming cables. Cable limiters respond like a fast acting fuse and reduce the available fault current.
- CO-OPS Sorority Hill. The calculated fault current is 10,583AIC with the equipment rating of 10,000AIC.

Sam Houston State University Short Circuit Analysis					
Building	Symetrical Amps Available	Equipment Rating	Building	Symetrical Amps Available	Equipment Rating
8 CO-OPS Sorority Hill	10583	10000	Lemit	56413	50000
AB I	11797	35000	Library	22470	***50000***
AB II (MLH)	8858	***22000***	Lonestar Hall	40061	100000
AB III	20515	***22000***	Lowman Student Center	14346	35000
AB IV	14252	100000	Museum	4752	10000
Administration	8535	10000	Music Building	10663	10000
Belvin/Buchanan Hall	23279	***65000***	Old Main Market	18175	22000
BKV A&B	11381	***22000***	Parking Garage	6648	35000
BKV B(East), C, D (North)	11379	***22000***	Peabody - Austin Hall	10546	***22000***
BKV D(South), E (Clubhouse)	14869	***22000***	Performing Arts Center	17628	65000
BKV F(East), I	11378	***22000***	Pritchett Field	4752	10000
BKV F(West), G, H	15643	***22000***	Pirkle	16201	42000
BKV J & M (Laundry Room)	7919	***22000***	Psyc Services	14716	***22000***
BKV K&L	11378	***22000***	Raven Village "A"	37720	65000
Bowers Stadium	6889	10000	Raven Village "B"	38146	65000
CFS	24234	65000	Raven Village "C"	30470	65000
CHSS	36728	65000	Sam Houston Village	34420	65000
CJC	56413	65000	Sam Houston Village	33477	65000
Coliseum	12722	50000	Old Smith Hutson	13437	***35000***
Dan Rather Communications	32065	***65000***	SHCC	14500	22000
East Plant	22514	***65000***	Smith Huston	15595	65000
Eliott Hall	14550	***22000***	Softball./Baseball Complex	15642	35000
Estill Classroom	8064	65000	South Paw Dining	23307	35000
Estill Dorm	21611	***22000***	Teachers Education Center	14183	***35000***
Evans Complex	8050	65000	Thomason Building	7190	10000
Farrington	7686	10000	UTC	13521	***22000***
HKC	12680	65000	Visitor Center	8050	65000
Jackson Shaver	4752	10000	Walker Ed.	4752	10000
Lee Drain	10079	***35000***	West Plant	25303	***35000***

Table 6: Short circuit results at main panel of each building

Table Notes

Bold Italics Short Circuit Equipment Rating estimated based on equipment construction

Numbers in Orange Short Circuit Equipment Rating that is less than the calculated fault current

The numbers in bold italics indicate equipment that did not have posted equipment ratings and did not have equipment ratings on the design documents, but were estimated based on construction/appearance.

MASTER PLAN

The master plan for the campus electrical system is shown on E2.0 in Appendix A. There are 5 colors shown to indicate different circuit pairs. Master planned buildings are shown shaded by Phase, bold lines represent existing electrical circuits, bold dashed red lines represent new electrical circuits. The major components of the distributed electrical utility master plan to note are: a new Circuit pair (9&10) for the East Plant and its planned expansion and the removal of the 4160V Farrington Switches and its downstream distribution. Descriptions of the electrical plans are given below.

The tables below show the overall summary of the net electrical load increase on each circuit pair at the end of the master plan construction. As shown, there is still available capacity on each circuit at the end of the 20-year master plan. Like mentioned before, the timing of a few of the elements is critical.

CIRCUIT 1+2

As shown in the analysis of Circuit 1+2 below, there is currently about 1,600kW of available capacity (28%). The future plans only call for four additional buildings that are well within the capacity of this circuit pair without moving the East Plant to Circuits 9+10.

Circuit 1 + 2		**Electrical Peak Demand**				
Existing Buildings		**Current kW**	**Future kW**	**sq.ft.**	**W/sq.ft.**	**Peak Demand Month**
BKV A&B		67	67	25,449	3	Jan-16
BKV B(East), C, D (North)		77	77	38,178	2	Nov-15
BKV D(South), E (Clubhouse)		46	46	18,702	2	Oct-15
BKV F(East), I		53	53	25,449	2	Nov-15
BKV F(West), G, H		99	99	42,339	2	Sep-15
BKV J & M (Laundry Room)		36	36	13,192	3	Nov-15
BKV K&L		70	70	29,610	2	Feb-16
Lemit		109	109	38,948	3	Mar-16
Bowers Stadium/Practice Facility		585	585	-	-	Sep-15
CJ Dining		54	54	-	-	Feb-16
CJ Hotel #1		45	45	59,981	1	Oct-16
CJ Hotel #2		116	116	59,981	2	Dec-15
CJC		700	700	140,960	5	Feb-11
CJC Plant		39	39	-	-	Jun-16
Coliseum		926	926	92,587	10	-
HKC		138	138	101,181	1	Nov-11
Performing Arts Center		239	239	101,945	2	Oct-15
Vick		82	82	8,161	10	-
Spivey		82	82	8,161	10	-
Randell		82	82	8,161	10	-
Softball./Baseball Complex		436	436	-	-	Feb-16
Buildings To Be Removed/Relocated	**New Circuit**	**Current kW**	**Future kW**	**sq.ft.**	**W/sq.ft.**	**Date of Removal**
East Plant	9+10	1,742	0	7,002	249	Phase I
Buildings To Be Added		**Current kW**	**Future kW**	**sq.ft.**	**W/sq.ft.**	**Date of Construction**
Bowers Stadium Expansion		0	300	75,000	4	TBD
Multipurpose Indoor Facility		0	250	125,000	2	Phase III
Basketball Practice		0	100	20,000	5	Phase II
Academic Building		0	300	75,000	4	Phase III
Maximum Demand Load (kW)		***5,823***	***5,030***			
Maximum Possible Load (kW)		***5,670***	***5,670***			
Diversity		***70%***	***70%***			
Diversified Load (kW)		***4,076***	***3,521***			
Available Capacity (kW)		***1,594***	***2,149***			
Spare Capacity		***28%***	***38%***			

Table 7: Circuit 1+2 Analysis

Circuit 3+4

Circuit 3+4 serves the middle core of the campus and is then routed to the west side of campus. As shown in the analysis of Circuit 3+4 below, there is about 3,000kW of available capacity (58%). This spare capacity can handle the addition of the Lowman Student Center Expansion, the new parking garage, the DELTA building, and the migration of the 4160V loads around campus from the Farrington Switches to the main distribution. 65% diversity was used on this circuit pair based on current utility bills. More detail about the circuit migration occurs later in this report.

Circuit 3 & 4	Electrical Peak Demand				
Existing Buildings	**Current kW**	**Future kW**	**sq.ft.**	**W/sq.ft.**	**Peak Demand Month**
AB I	359	359	58,265	6	Dec-11
Library	901	901	150,139	6	-
Music Building	296	296	49,375	6	-
Smith Huston	192	192	92,656	2	Dec-10
Teachers Education Center	212	212	79,415	3	Dec-11
Administration	207	207	33,441	6	Jan-11
CHSS	773	773	147,422	5	Feb-11
Coffee House	61	61	-	-	Nov-10
Dan Rather Communications	272	272	45,264	6	-
Food Court	122	122	-	-	Jan-11
Lowman Student Center	664	664	128,081	5	Nov-11
UTC	116	116	41,417	3	Feb-12
Parking Garage	28	28	180,364	0	Mar-11
Sam Houston Village	248	248	128,420	2	Feb-11
Sam Houston Village	291	291	128,420	2	Oct-11
Buildings To Be Added/Relocated	**Current kW**	**Future kW**	**sq.ft.**	**W/sq.ft.**	**Date of Construction**
Student Center Expansion	0	400	80,000	5	0-6 years
New Parking Garage	0	30	-	-	7-12 years
DELTA/CE	0	145	29,000	5	7-12 years
Jackson Shaver	0	65	39,138	2	TBD
Jackson Shaver Mech	0	5	795	6	TBD
Museum	0	69	12,082	0	TBD
Pritchett Field	0	184	-	-	TBD
Maximum Demand Load (kW)	***4,741***	***5,638***			
Maximum Possible Load (kW)	***5,670***	***5,670***			
Diversity	***80%***	***80%***			
Diversified Load (kW)	***3,793***	***4,510***			
Available Capacity (kW)	***1,877***	***1,160***			
Spare Capacity	***33%***	***20%***			

Table 8: Circuit 3+4 Analysis

Circuit 5+6

Circuit 5+6 serves the western part of the main campus and is the focus of the biggest electrical project in the master plan. Buildings built prior to the early 1970s were served from a distribution system of 4,160V. When the main campus was upgraded to 13.2kV, a mini-substation connecting two 13.2kV:4160V transformers were installed to handle this voltage change without any modification to the individual building transformers. This substation is located just east of the Lee-Drain Building. Two 3750kVA transformers step down the voltage from 13.2kV to 4160V for distribution via the Farrington Switches. The set of 8 Farrington Switches provide all the 4160V distribution around the older middle part of campus. Some of this distribution is via overhead lines along Avenue J and 17th Street. Because the switches have reached the end of their useful life and spare parts are hard to obtain in a timely manner, the master plan goal is to remove the Farrington Switches by extending Circuit 7+8 and migrating a majority of the loads to Circuit 7+8 from 5+6. The current spare capacity on Circuit 5+6 is 26% and at the end of the master plan is 25%.

Another benefit of removing the Farrington Switches is the removal of the campus owned overhead distribution. The overhead line that runs parallel to Avenue J and over to 17th Street serves Austin/Peabody, Belvin/Buchanan, Margaret Lea Houston, and Elliott Hall and is routed on poles owned by the University. Once the university owned conductors are removed, steps can be taken with the other utility providers (AT&T, Suddenlink, etc.) to remove the overhead services that are currently feeding the Kats for Christ church and residence life buildings located at 17th St./Avenue J. In addition to these lines, there are overhead lines along University Avenue that can also be removed, but again coordination with the other utility providers will be required because these poles contain communications on them.

Circuit 5&6 - Includes VB1&VB2		Electrical Peak Demand				
Existing Buildings		**Current kW**	**Future kW**	**sq.ft.**	**W/sq.ft.**	**Date**
Raven Village "A"		*254*	*254*	51,498	4	-
Raven Village "B"		*254*	*254*	51,498	4	-
Raven Village "C"		*254*	*254*	51,498	4	-
AB IV		361	361	66,667	5	Jan-12
CFS		196	196	64,102	3	Mar-12
Rec Sports Facility		128	128	31,312	4	Aug-11
Lee Drain		296	296	120,026	2	Nov-10
AB III		65	65	54,876	1	Aug-11
Farrington		51	51	50,947	1	Aug-11
South Paw Dining		207	207	5,815	36	Feb-11
Buildings To Be Removed/Relocated	**New Circuit**	**Current kW**	**Future kW**	**sq.ft.**	**W/sq.ft.**	**Date of Removal**
Adams House	Demo	39	0	8,161	5	0-6 years
Allen House	Demo	29	0	8,161	4	0-6 years
West Plant	Demo	968	0	10,629	91	0-6 years
8 CO-OPS Sorority Hill	Demo	123	0	-	-	7-12 years
Evans Complex	7+8	101	0	47,748	2	TBD
Jackson Shaver	3+4	65	0	39,138	2	TBD
Jackson Shaver Mech	3+4	5	0	795	6	TBD
Museum	3+4	69	0	12,082	6	TBD
Estill Classroom	7+8	235	0	37,107	6	TBD
Estill Parking Lot	7+8	2	0	-	-	TBD
Pritchett Field	3+4	184	0	-	-	TBD
Thomason Building	7+8	112	0	33,423	3	TBD
Visitor Center	7+8	123	0	12,809	6	TBD
Walker Ed. Center	3+4	224	0	22,473	6	TBD
Margaret Lea Houston (AB II)	7+8	67	0	-	-	TBD
Belvin/Café/Buchanan Hall	7+8	364	0	62,277	6	TBD
Elliott Hall	7+8	39	0	34892	1	TBD
Peabody - Austin Hall	7+8	86	0	8262	10	TBD
White Hall	Demo	367	0	85,720	4	TBD
Buildings To Be Added/Relocated		**Current kW**	**Future kW**	**sq.ft.**	**W/sq.ft.**	**Date of Construction**
New Shared Equip. Building		0	100	20,000	5	0-6 years
New Nursing / Biology		0	500	100,000	5	0-6 years
Maximum Demand Load (kW)		***5,270***	***2,667***			
Maximum Possible Load (kW)		***5,670***	***5,670***			
Diversity		***80%***	***80%***			
Diversified Load (kW)		***4,216***	***2,134***			
Available Capacity (kW)		***1,454***	***3,536***			
Spare Capacity		***26%***	***62%***			

Table 9: Circuit 5+6 Analysis

Removal of Farrington Switches

Below is a list of the buildings currently served by the Farrington Switches and the work that must be completed before the building can be migrated to a 13.2kV circuit.

Feeder #	Building	Notes
1	Farrington	2
1	Estill	2
2	Thomason	3
2	Evans	3
2	Visitors Center	3
2	Jackson Shaver	1
2	Museum	1
2	4 West	1
2	Pritchett	1
2	Walker Ed	1
3	SPARE	N/A
4 or 7	West Plant	3
5	Peabody/Austin	2
5	MLHB/ABII	3
5	Sorority Hill	Demolition
8	BAD	N/A

Table 10: Requirements for Removal of Farrington Switches

Notes:

(1) Installation of a single 13.2kV:4.16kV transformer near Jackson Shaver will be necessary for this scope. This will allow the building to be fed from its existing distribution. Downtime will occur when the switchover occurs. This can occur at any time and is not dependent on any future projects.

(2) Existing pad mounted transformer can be reused for new 13.2kV feeder

(3) New 13.2kV primary pad mounted transformer(s) will be required.

(Demolition) Buildings that have been scheduled for demolition

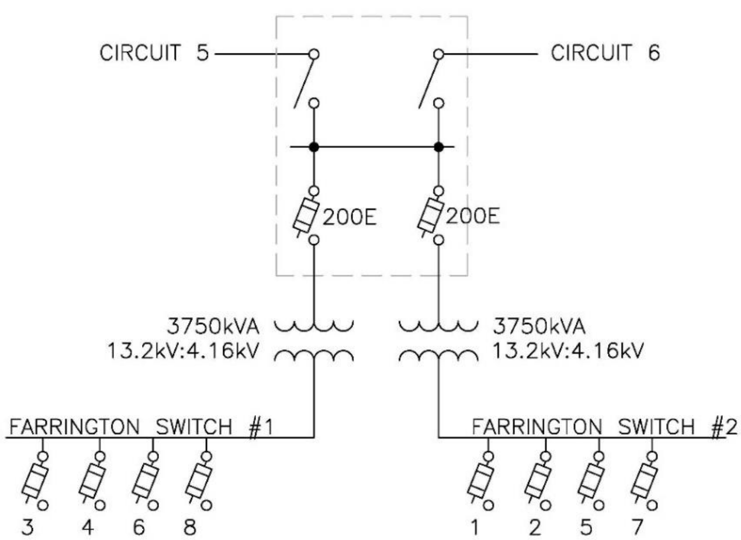


Figure 2: Current Configuration of Farrington Switches

CIRCUIT 7+8

The newest circuit pair is Circuit 7+8 was installed in 2011. It currently serves the north side of campus and includes the Psychological Services Building, Health Center, Estill Dorm, Lonestar Hall, Old Main Market, and the new Student Health and Counseling Center. Belvin-Buchanan Hall and Elliott Hall were identified as candidates to be migrated from the overhead 4160V feeders to Circuit 7+8 in the 2012 Masterplan, which has since been completed. Circuit 8 also has been extended south along University Avenue to the new Pirkle Engineering Building. This extension will allow the buildings along that road to be moved to this circuit in the future with minimal interruptions.

Circuit 7&8	Electrical Peak Demand				
Existing Buildings	**Current kW**	**Future kW**	**sq.ft.**	**W/sq.ft.**	**Date**
Estill Dorm	260	260	54,420	5	Sep-15
Psychological Services	39	39	6,183	6	Sep-11
SHCC	145	145	30,100	5	Jan-16
Lonestar Hall	282	282	87,840	3	Mar-16
Belvin/Café/Buchanan Hall	145	145	62,277	2	Sep-14
Old Main Market	613	613	31,677	19	Oct-15
Elliott Hall	41	41	34,892	1	Oct-14
Pirkle Engineering Building	327	327	54,539	6	-
Buildings To Be Added/Relocated	**Current kW**	**Future kW**	**sq.ft.**	**W/sq.ft.**	**Date of Construction**
New Residential-R3	0	544	108,800	5	Phase II
New Residential-R4	0	375	75,000	5	Phase II
Future Building	0	300	60,000	5	Phase III
Estill Classroom	0	236	37,107	6	TBD
West Plant	0	4,000	10,629	376	Phase I
Evans Complex	0	101	47,748	2	TBD
Thomason Building	0	112	33,423	3	TBD
AB II	0	47	22,931	2	TBD
Visitor Center	0	123	12,809	6	TBD
Maximum Demand Load (kW)	***1,852***	***7,690***			
Maximum Possible Load (kW)	***5,670***	***5,670***			
Diversity	***60%***	***60%***			
Diversified Load (kW)	***1,111***	***4,614***			
Available Capacity (kW)	***4,559***	***1,056***			
Spare Capacity	***80%***	***19%***			

Table 11: Circuit 7+8 Analysis

CIRCUIT 9+10

In order to add the additional 1800 ton chiller to the East Plant for Phase I, Communications, Arts Building and the new residence halls R5 and dining hall on the north end of campus, new Circuits 9+10 will need to be routed from spare cabinets in the switchgear building to the East Plant. This will require a new ductbank from the switchgear building to the East Plant. This ductbank will need to be routed independently, or on top of the existing ductbank if possible, from the other 8 circuits that leave the switchgear building because Manhole #1 does not have any spare conduits available. The routing of the new ductbank is shown on Sheet E2.0 in the Appendix.

Circuit 9&10	Electrical Peak Demand				
Buildings To Be Added/Relocated	Current kW	Future kW	sq.ft.	W/sq.ft.	Date of Construction
East Plant	0	1,742	-	-	Phase I
East Plant Additions	0	1,800	-	-	Phase I
Communications/Art	0	355	71,000	5	Phase I
WASH	0	50	10,000	5	Phase I
New Residential - R5	0	520	103,900	5	Phase II
New North Dining Hall	0	900	25,000	36	Phase II
Maximum Demand Load (kW)	***0***	***5,367***			
Maximum Possible Load (kW)	***11,418***	***11,418***			
Diversity	***100%***	***80%***			
Diversified Load (kW)	***0***	***4,294***			
Available Capacity (kW)	***11,418***	***7,124***			
Spare Capacity	***100%***	***62%***			

Table 12: Circuit 9+10 Analysis

MANHOLE #1 SEGREGATION

A project that is on the high priority list, and currently in design, is to separate even and odd circuits into dedicated manholes. As stated earlier, all conductors leaving the substation building are routed through one manhole. A fault in that manhole by water, animal, etc. can take down a majority of the campus for an extended period of time. By separating Circuits 1,3,5,7 from Circuits 2,4,6,8, this will allow a fault to happen on the odd circuits with some added security to the even circuits. It sounds like a simple approach, but this project could be very complicated and time consuming. Shutdowns will have to take place in order for workers to safely work in the manhole.

Routing a parallel ductbank from ahead of manhole #1 to the substation building for the even circuits will accomplish this. The even and odd circuits after Manhole #1 go in different directions for campus distribution, so interception of the even circuits would need to occur before the split of direction occurs. This would require the removal of the even conductors from the existing ductbank, through Manhole #1, and into the substation building. The existing ductbank ahead of manhole #1 would need to be broken into and the even circuits would be routed through Manhole #1A and to the substation.

Campus Domestic Water System

Existing System Analysis

The campus domestic and fire water system has one primary connection and one emergency connection to the City of Huntsville domestic water system and has a main line with a loop. The system was analyzed to create the master plan. The methodology for the master plan was to gain an understanding of the existing system as currently installed and operating, generate software hydraulic models of the systems, and use the models to identify the recommended system improvements to support the campus master plan. The focus of the evaluation was on domestic and fire service to the buildings served by the campus water system (downstream of the master meter). Several other buildings served directly from the City domestic system were not fully considered in the master plan analysis.

The first step in this process was to obtain as much pertinent information on the systems as possible through a combination of system drawings, discussions with facilities personnel, and examination of construction drawings. Facilities personnel were essential to the accuracy of the existing system by supplementing the information available on construction drawings and system maps.

The campus domestic water system has a significant lack of individual building metering and no metering at a resolution that can be directly applied to a model. Monthly domestic meter data was provided where available but due to the data only being monthly, multiple compounding assumptions would be required to utilize the data. In addition, only 11 buildings are metered. Therefore, the monthly meter data was not directly used to estimate peak demands but was used as a check. Instead, the building square footages were estimated and a factor of one living unit equivalent (LUE), 245 gallons per day for each LUE, converting to gallons per minute, and applying a peaking factor of 4 based on generally accepted ratios for similar building types and Texas Commission on Environmental Quality (TCEQ) requirements. For some locations the calculated peak demand was less than 2.0 gpm. At these locations, a minimum of 2.0 gpm was utilized in the model. In addition, monthly irrigation meter data was provided and utilized with an assumption that the irrigation systems were operated for an average of 60 hours each week. Model defaults values were used for fire flow.

The City of Huntsville has a Bond funded project that is currently under design to increase the upper pressure plane elevation from 597.32’ to 630’ MSL. The modeling described below was performed with the proposed improvements in place except as noted.

Hydraulic Modeling

In order to understand the dynamics of the campus domestic water system, hydraulic models of the system were generated using Bentley’s WaterCAD software. The model calculates the hydraulic characteristics of the system including, but not limited to, pressures at nodes with fire flow parameters applied (model default values), velocities in pipes, and flow direction. The software allows for graphical generation, modification, and analysis of the hydraulic system.

The model of the domestic distribution piping system was created through a combination of provided system maps and additional information provided by Facilities personnel. All known major system components were accounted for in the model. Other components of the distribution systems, such as elbows, tees, and valves, were accounted for where their locations were shown on the system map and hydraulic losses were applied as appropriate in the model to represent these appurtenances. These baseline models were used to examine current system hydraulic limitations, and are shown in Appendix D.

CALCULATED DOMESTIC WATER DEMANDS			
Building	Intersection	Calculated GPM	Assumed GPM
ACADEMIC BUILDING I	North of Bowers Blvd / Avenue I	5.38	
ACADEMIC BUILDING III	19th / Between University Ave and Avenue I	5.96	
ACADEMIC BUILDING IV	19th / Avenue I	5.69	
AUSTIN HALL	South of 17th / Avenue J	1.13	2.00
BASEBALL SOFTBALL PRACTICE FACILITY	Bowers Blvd / Between Montgomery Road and Sycamore Ave	3.27	
BELVIN-BUCHANAN HALL	17th / University Ave	5.18	
BILL BLACKWOOD LEMIT	16TH / Avenue H	2.54	
BOBBY K. MARKS ADMINISTRATION BUILDING	19th / University Ave	2.67	
CHEMISTRY AND FORENSIC SCIENCE	20th / Between Sam Houston Ave and Avenue J	4.96	
CJC-Hotel		3.85	
Coliseum		14.79	
COLLEGE OF HUMANITIES & SOCIAL SCIENCE	North of Bowers Blvd / Avenue I	7.25	
DAN RATHER COMMUNICATIONS BUILDING	South of 17th / Avenue J	3.63	
DON SANDERS STADIUM CONCESSION STAND	Bowers Blvd / Between Montgomery Road and Sycamore Ave	0.98	2.00
EAST CENTRAL PLANT	South of 17th / Avenue H	93.96	
ELEANOR & CHARLES GARRETT TEACHER ED CTR	North of Bowers Blvd / Avenue H	7.07	
ELLIOTT HALL	17th / Avenue J	1.66	2.00
ESTILL BUILDING	19th / University Ave	3.10	
ESTILL HALL	16th / University Ave	4.35	
EVANS COMPLEX	19th / University Ave	3.50	
FARRINGTON BUILDING	19th / University Ave	4.55	
FRED PIRKLE ENGINEERING TECHNOLOGY CENTER	20th / Between Sam Houston Ave and Avenue J	4.96	
GEORGE J. BETO CRIMINAL JUSTICE CTR	17th / Avenue I	14.15	
HKC		14.74	
JAMES & NANCY GAERTNER PER. ARTS CTR	17th / Avenue I	13.62	
JOHN R. RAGSDALE VISITOR & ALUM CTR	19th / University Ave	1.40	2.00
JOHN W. THOMASON BUILDING	19th / University Ave	3.14	
LEE DRAIN ANNEX	19th / University Ave	1.46	2.00
LEE DRAIN BUILDING	19th / Avenue I	7.82	
LSC Food Service		3.70	
LSC South		8.09	
MARGARET LEA HOUSTON	17th / Sam Houston Ave	1.49	2.00
MUSIC BUILDING	South of 17th / Avenue I	5.87	
NEWTON GRESHAM LIBRARY	North of Bowers Blvd / Avenue H	10.69	
Old Main Market		5.17	
PARKING GARAGE	17th / Between Avenue J and Ron Rande	8.02	
PEABODY MEMORIAL LIBRARY	South of 17th / Avenue J	1.00	2.00
Psych Services		2.27	
RANDEL HOUSE	Bowers Blvd / Avenue I	1.07	2.00
RON MAFRIGE FIELD HOUSE	Bowers Blvd / Between Montgomery Road and Sycamore Ave	3.59	
RON RANDLEMAN WEIGHT & FITNESS CTR	Bowers Blvd / Between Montgomery Road and Sycamore Ave	2.39	
SMITH HUTSON BUSINESS BLDG	North of Bowers Blvd / Avenue I	8.76	
SOFTBALL CONCESSIONS CONCOURSE	Bowers Blvd / Between Montgomery Road and Sycamore Ave	0.91	2.00
SORORITY HILL	17th / Between Avenue J and I	6.86	
SPIVEY HOUSE	Bowers Blvd / Avenue I	1.07	2.00
Stadium North		33.96	
Stadium South		33.96	
Student Health & Counseling		4.20	
STUDENT SERVICES ANNEX	16th / Between Avenue J and I	1.75	2.00
TEMPLETON BUILDING	17th / Avenue J	1.49	2.00
UNIVERSITY THEATRE CENTER	South of 17th / Avenue H	5.84	
VICK HOUSE	Bowers Blvd / Avenue I	1.07	2.00
West Plant		93.96	
WHITE HALL	Bowers Blvd / Avenue I	6.29	

Table 13: Assumed Domestic Water Demands

MASTER PLANNING

After the current configuration and operation of the campus was understood, the various analyses could then be used to identify regions with low pressures and recommend improvements to the domestic water system in support of the campus master plan. The analysis was expanded to include the construction listed in the phases discussed at the beginning of this utility master plan modeled as one future phase. The hydraulic models were modified to show the addition of future master-planned buildings and the required distribution piping to serve them. Required infrastructure improvements to correct existing pressure issues and improvements for future improvements were identified for the system to create both an existing model and a future model for the water system.

As requested, the proposed interconnect to the City system at Bowers Boulevard and Avenue J was evaluated under current conditions. Due to the relatively low difference between the ground level elevation of the buildings (approximately 460') and the City's pressure plane elevation (597.32'), the maximum pressure available at ground level is approximately 58 psi. This pressure plane feeds the Campus system and is the primary cause of low pressures at higher elevations around campus. Therefore, regardless of the size of the connection, sufficient pressure cannot be provided at this location by the City's system and installing this proposed separate connection is not recommended.

Based on information provided by the City of Huntsville, the elevation of the pressure plane was increased from 597.32' to 630' for planning purposes in both the existing and proposed models.

The "SHSU Existing System Upper Pressure Plane" model in Appendix D indicates building entry points where water pressures are anticipated to be lower than 60 psi in a peak use scenario with fire demand included. Entry pressures of ~60 psi are required to provide working flush valves, etc. on the second floor of a building. Nodes indicated in red are below 60 psi. As can be seen, many areas fall into this criterion.

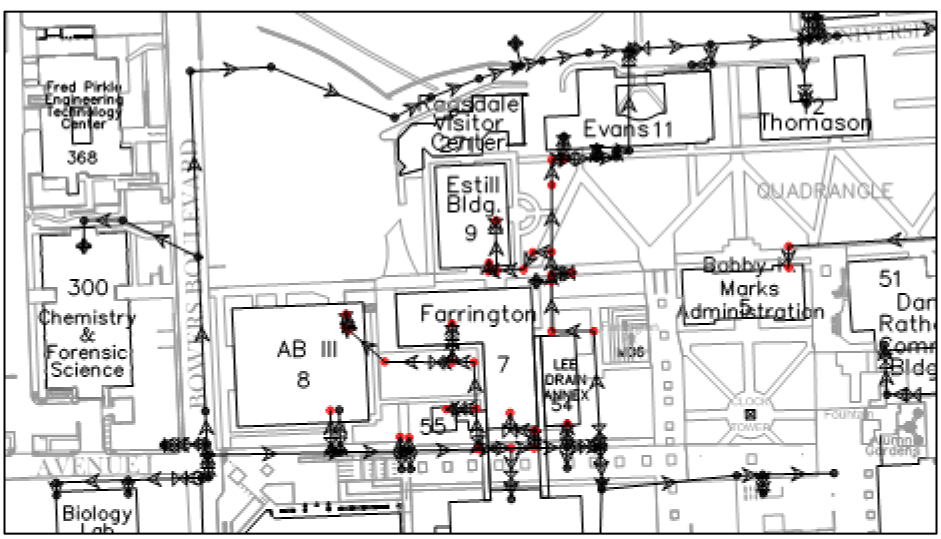


Figure 5: Example Nodes with < 60 psi pressure

Recommendations

The recommendations for the domestic and fire water system are as follows:

- Add tanks or booster pumps at specific locations
- Obtain meter information for future model updates

The pressure issues cannot be easily resolved with a static tank at the same elevation as the City's pressure plane but booster pumps could be utilized to correct the existing pressure issues in the system. Short of boosting the entire campus domestic distribution system at the master meter, the most appropriate approach would be distributing smaller booster pump systems at locations with lower pressures. The following improvement is expected to resolve the pressure issues (with the City's anticipated increase to the pressure plane elevation):

- An increase of 25 feet of head near the Farrington Building

The "SHSU Future System Upper Pressure Plane with Farrington Tank and Pump" model in Appendix D shows the anticipated result of adding this improvement to the current campus domestic water system. As can be seen, 60 psi is available at all locations.

In the event that the City elects to not increase their pressure plane elevation, the following improvements are recommended:

- A relatively small pressure increase of 10 feet of head near the West Plant,
- An increase of 25 feet of head near the Smith Hutson Building,
- A tank at the same elevation as the City's system (597.32') at Farrington, and
- A tank near the Practice Facility building

The "SHSU Future Water System" model in Appendix D shows additional branch lines that will be required to serve the planned future buildings. The recommendations above are also expected to provide adequate pressure at all new buildings.

It should be noted that most of the pipes in the system are relatively old and pressure increases should be evaluated from a pipe condition perspective prior to implementation.

Additional monitoring is recommended prior to the next update to the domestic water distribution system master plan to allow for greater accuracy. Ideally, monitoring that can measure the peak flow throughout the daily use cycle would be obtained by installing temporary meters on each of the service lines (not necessarily at the same time) to measure the flow over time and establish a reliable peak flow. However, any increase in metering, such as more individual building metering, would improve the accuracy of the model.

Campus Sanitary Sewer System

Existing System Analysis

The sanitary collection system serving the campus is part of the City of Huntsville sanitary collection system. Portions of the City's collection system also pass through the campus collection system. The portions of the system within one block of the campus were analyzed to create the master plan. The methodology for the master plan was to gain an understanding of the existing system as currently installed and operating, generate software hydraulic models of the systems, and use the models to identify the recommended system improvements to support the campus master plan. The focus of the evaluation was the portions of the collection system on campus; the portions of the collection system beyond one block of campus were not considered in the master plan analysis.

The first step in this process was to obtain as much pertinent information on the systems as possible through a combination of shapefiles provided by the City of Huntsville, discussions with facilities personnel, and examination of construction drawings. Facilities personnel were essential to the accuracy of the existing system by supplementing the information available on construction drawings and system maps.

Sanitary loading for the system was estimated based on the domestic water system demands with the assumption that domestic water used, excluding irrigation, was equal to the sanitary loading. In addition infiltration and stormwater inflow was added to the loading at a rate of 30,000 gallons per day per mile of pipeline in accordance with standard practices.

Modeling

In order to understand the dynamics of the campus sanitary collection system, a model of the system was generated using Bentley's SewerCAD software. The model calculates the hydraulic characteristics of the system including, but not limited to, the hydraulic grade line (HGL) at manholes, velocities in pipes, and flow direction. The software allows for graphical generation, modification, and analysis of the hydraulic system.

The model of the sanitary collection system was created through a combination of provided system maps and additional information provided by Facilities personnel. All known major system components were accounted for in the model. Components of the collection system, such as manholes and cleanouts, were accounted for where their locations were shown on the system map and hydraulic losses were applied as appropriate in the model to represent these appurtenances. These baseline models were used to examine current system limitations, and are shown in Appendix E.

The "SHSU Existing Wastewater System" model shows the layout of the current campus sanitary sewer system. Pipe sizes are color coded for reference.

MASTER PLANNING

After the current configuration and operation of the campus was understood, the various analyses could then be used to identify regions that are operating above capacity. Causes of inadequate capacity may be due to flat slopes, small pipe sizes, increased loading, or a combination of these factors.

The "SHSU Existing Wastewater System Over Capacity" model shows piping sections highlighted in red that are currently over capacity with anticipated campus loading.

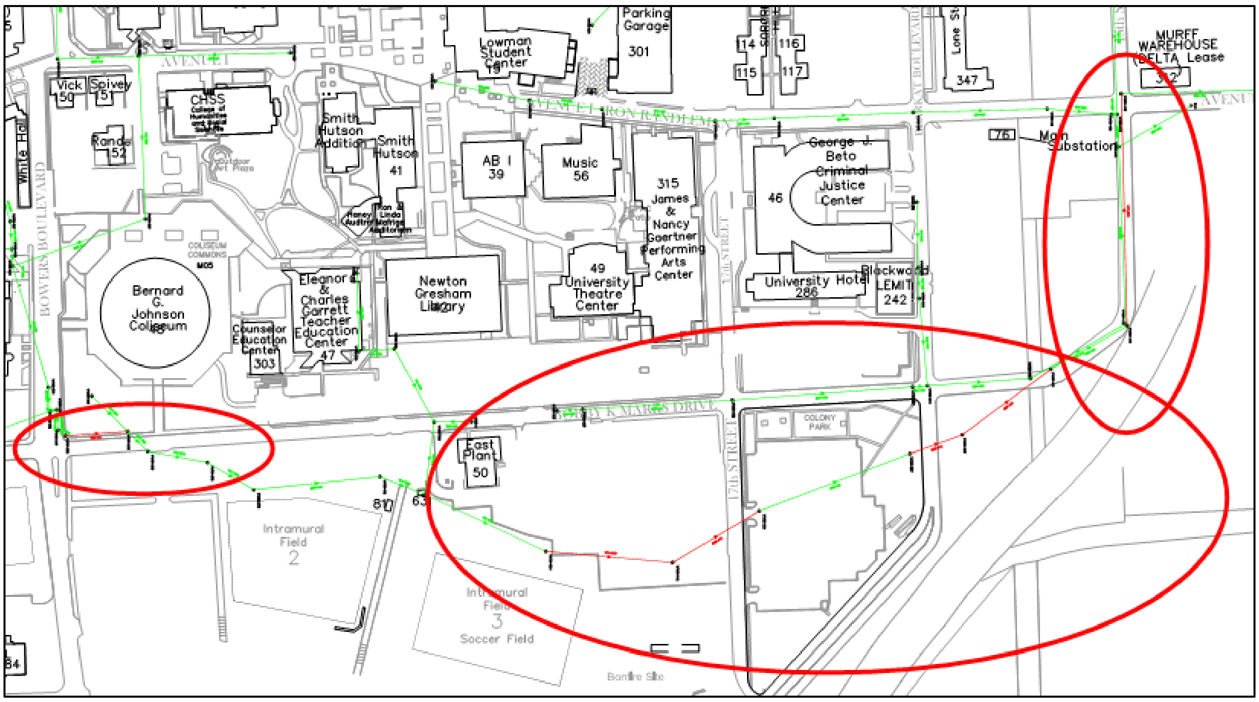


Figure 6: Example sanitary lines over capacity

These results provided the basis for improvement recommendations for the sanitary collection system in support of the campus master plan. The analysis was expanded to include the construction listed in the phases described previously in this utility master plan update as one future phase model (shown in the "SHSU Future Wastewater System Over Capacity" model). The models were modified to show the addition of future master-planned buildings and the required collections piping to serve them to create both an existing model and a future model for the sanitary collection system.

RECOMMENDATIONS

The portions of the collection system that are shown in the figures to be over capacity are typically extremely flat and should be further evaluated for improvements to increase the slope, increase pipe size, or to divert the loading to adjacent portions of the system with excess capacity.

- 6" line near Bearkat Village
- 12" line at Bobby K. Marks Drive and Bowers Blvd.
- 12" line by Intramural Field 3

- 12” line by Bearkat Boulevard and Bobby K. Marks Drive
- 12” line on 15th Street between Avenue I and Bobby K. Marks Drive
- 6” line by Fred Pirkle Engineering Technology Center

CAMPUS STORM DRAIN SYSTEM

EXISTING SYSTEM ANALYSIS

The campus stormwater collection and conveyance system consists of a variety of inlet types including area, curb, and other inlets, and a variety of pipe sizes and shapes. The campus was divided into 14 different major drainage area, identified by letters A through N. In general, each of the 14 systems collects and conveys stormwater to an outfall either in a creek or detention structure which then conveys the stormwater to a creek. The system was analyzed at a relatively high level to create the stormwater master plan. The methodology for the master plan was to gain an understanding of the existing system as currently installed and operating, generate software models of the systems, and use the models to identify the recommended system improvements to support the campus master plan. Evaluation of individual inlets would require a much higher level of detail than required for this master plan. Therefore, the focus of the evaluation was on the stormwater conveyance piping system within the limits of campus.

The first step in this process was to obtain as much pertinent information on the systems as possible through a combination of system drawings, a report from O’Malley Engineers from 2003, discussions with facilities personnel, examination of construction drawings, and site visits. Facilities personnel were essential to the accuracy of the existing system by supplementing the information available on construction drawings and system maps.

HYDROLOGIC MODELING

In order to understand the quantity of stormwater that the campus experiences, hydrologic models of the system were generated using Bentley’s CivilStorm software for 25-year and 100-year design storms. The model calculates the amount of runoff that is anticipated to reach the inlets to be conveyed through the stormwater piping system. The Rational Method was utilized in the model to conservatively calculate stormwater runoff. Sub-drainage areas were delineated for groups of inlets to provide an accurate model of the water entering the system without delineating drainage areas for each individual inlet. The type of surface (paved/unpaved), slope, and other factors were utilized by the model to calculate anticipated peak flows for typical 25-year and 100-year design storm events.

HYDRAULIC MODELING

In order to understand the dynamics of the campus stomwater system, a hydraulic model of the system was generated using Bentley’s CivilStorm software. The model calculates the hydraulic characteristics of the system including, but not limited to, the hydraulic grade line (HGL) at manholes, if manholes are anticipated to overflow, velocities in pipes, and flow direction. The software allows for graphical generation, modification, and analysis of the hydraulic system.

The model of the domestic distribution piping system was created through a combination of provided system maps, the previously referenced O'Malley Engineer's Report from 2003, and additional information provided by Facilities personnel. All known major system components were accounted for in the model. The baseline models were used to examine current system hydraulic limitations, and are shown in Appendix F.

Master Planning

After the current configuration and operation of the campus stormwater system was understood, the various analyses could then be used to identify regions that are operating above capacity. Causes of inadequate capacity may be due to flat slopes, small pipe sizes, or a combination of these factors. These results provided the basis for improvement recommendations for the stormwater collection system in support of the campus master plan. The analysis was expanded to include the construction listed in the phases described previously in this utility master plan update as one future phase model. The models were modified to show the addition of future improvements impacting the campus stormwater system to create both an existing model and a future model for the stormwater collection system.

Recommendations

The recommendations for the campus stormwater system are as follows:

- The main system in Area J has excessive surcharge issues related to geometry and pipe size, particularly at the bottom end of the system. Increasing the 3'X2' box to a 5'X3' box culvert is anticipated to resolve these issues.
- System in Area N has some potential flooding in the ball park/parking areas. Replacing the trapezoidal box section with a box culvert (6'X3') is anticipated to alleviate the flooding.
- System draining to the pond in Area A was found to have surcharge issues. Proceeding with the South Campus Major Storm Drain retrofit is anticipated to alleviate this problem.

CAMPUS UTILITY INFRASTRUCTURE MASTER PLAN SUMMARY

The major recommended projects for the updated campus utility infrastructure are listed below:

Phase I

CHW: Increase West Plant usable capacity (to 2,200 tons) ....To be Completed in 2017

- *Include improved chilled water metering at plant for kW/ton tracking*

CHW: Piping Chemistry Building to Avenue I...To be Completed in 2017

CHW: Piping from Avenue I to Bobby K. Marks Drive..To be Completed in 2017

CHW: Piping from Bowers Blvd. to East Plant..To be Completed in 2017

CHW: Piping from East Plant to Avenue I (17th Street) .... In Design (Arts Bldg)

CHW: East Plant Capacity Increase (~1,800-ton)... In Design (Arts Bldg)

- *Include improved chilled water metering at plant for kW/ton tracking*
- *Include variable-volume chilled water flow conversion*

CHW: Program Plant and Building Peak Load Tracking Sequences...

ELEC: Route Circuits #9 & #10 from switchgear building to East Plant .... In Design (Arts Bldg)

ELEC: Manhole #1 Circuit Segregation.. In Design (Arts Bldg)

DW: Install recommended booster pumps and elevated storage tanks............ *(further study required)*

SAN: Improve existing sanitary lines at noted locations..

STORM: Improve existing storm system at Areas J, N, and A...

Phase II

CHW: North Residence Hall piping ....

CHW: Install additional 2,500-ton chiller at West Plant ....

HHW: Relocate West Plant HHW System to Thomason Hall..

ELEC: Redundant electrical feed to HKC and Coliseum..

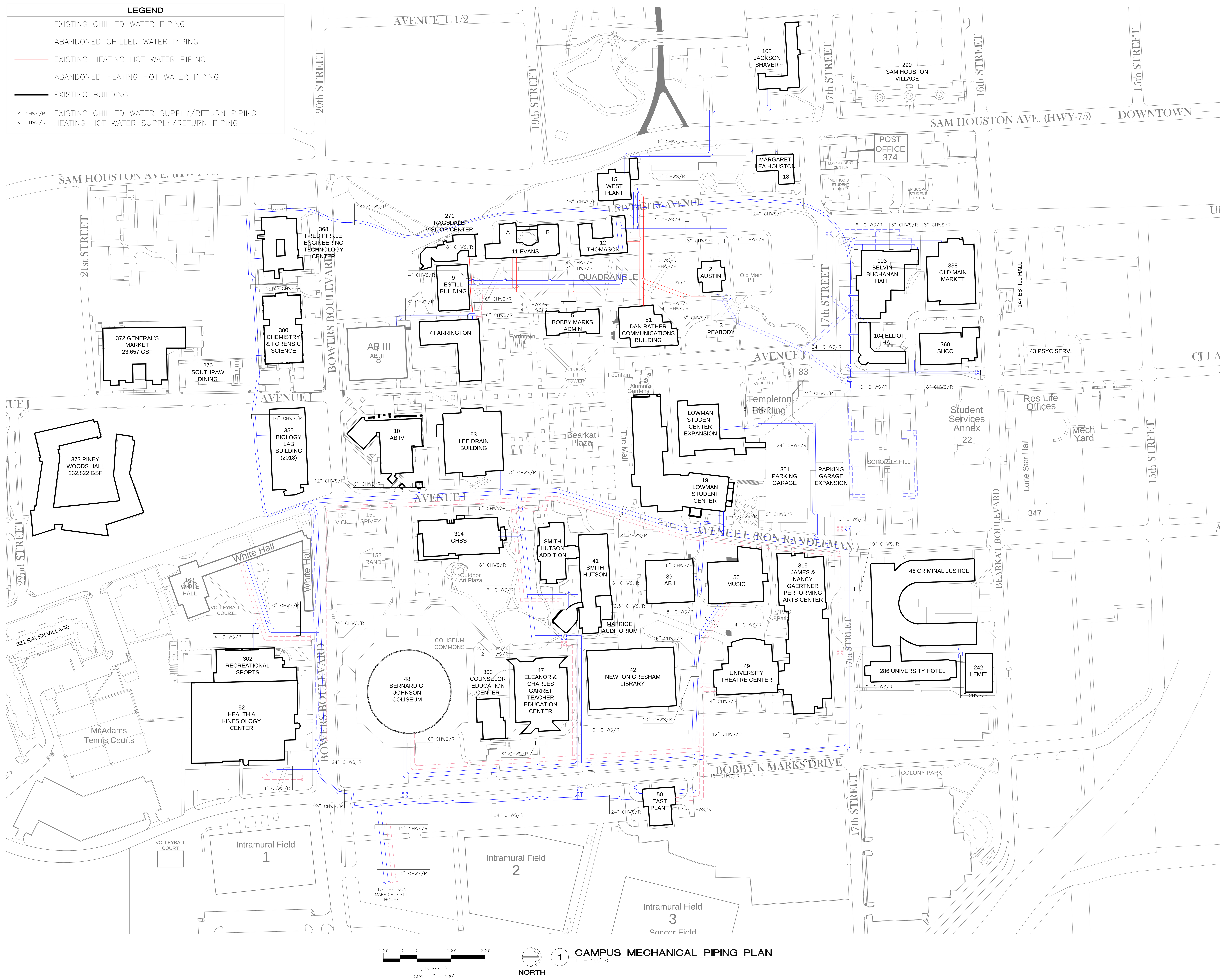
ELEC: Migrate existing buildings from overhead electrical to buried...

Phase III

CHW/ELEC: Indoor Multi-Purpose Facility piping and electrical..

APPENDIX A –CAMPUS THERMAL UTILITY MASTER PLAN DRAWINGS

- M1.0 – Campus Mechanical Piping Plan (2017)
- M2.0 – Campus Mechanical Piping Plan (Future)
- E1.0 – Campus Electrical Plan (2012)
- E2.0 – Proposed Electrical Circuits



REVISIONS

NO	DATE	DESCRIPTION

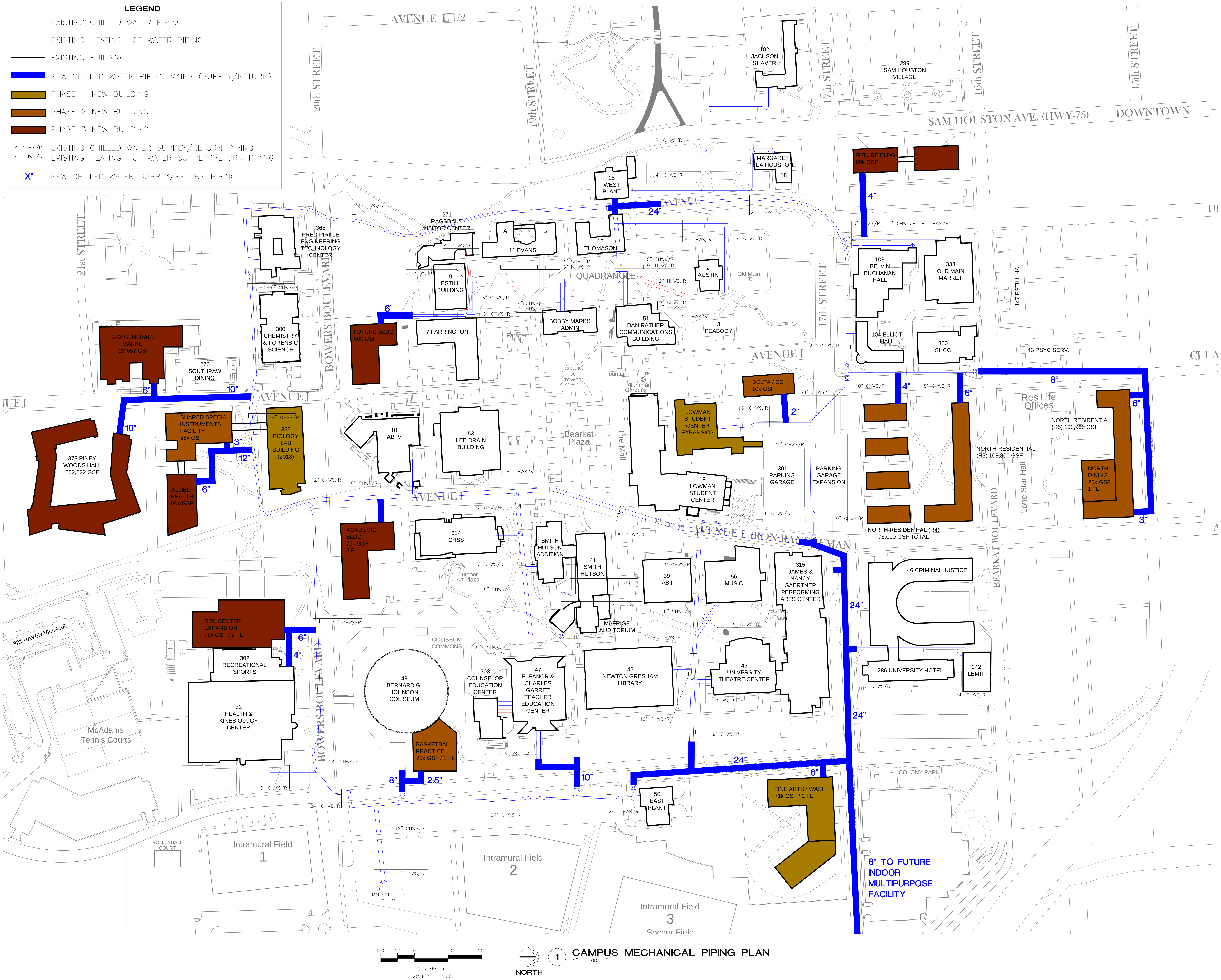
SAM HOUSTON STATE UNIVERSITY
HUNTSVILLE, TEXAS
2017 UTILITY MASTER PLAN UPDATE

EEA CONSULTING ENGINEERS
EEA CONSULTING ENGINEERS
6615 VAUGHT RANCH ROAD, SUITE 200
AUSTIN, TEXAS 78730-2314 USA
512.744.4400 MAIN - 512.744.4444 FAX
FIRM REGISTRATION # F-2497
WWW.EEACE.COM - EEA PROJECT #20160156

TITLE:
CAMPUS MECHANICAL PIPING PLAN (CURRENT)

EEA PROJ: 20160156
DRAWN BY: SG
CHECKED BY: MM
DATE: 05-24-17

SHEET:
M1.0



1 CAMPUS MECHANICAL PIPING PLAN
1" = 100'-0"

NORTH

REVISIONS

NO	DATE	DESCRIPTION

SAM HOUSTON STATE UNIVERSITY
HUNTSVILLE, TEXAS
2017 UTILITY MASTER PLAN UPDATE

EEA CONSULTING ENGINEERS
6615 VAUGHT RANCH ROAD, SUITE 200
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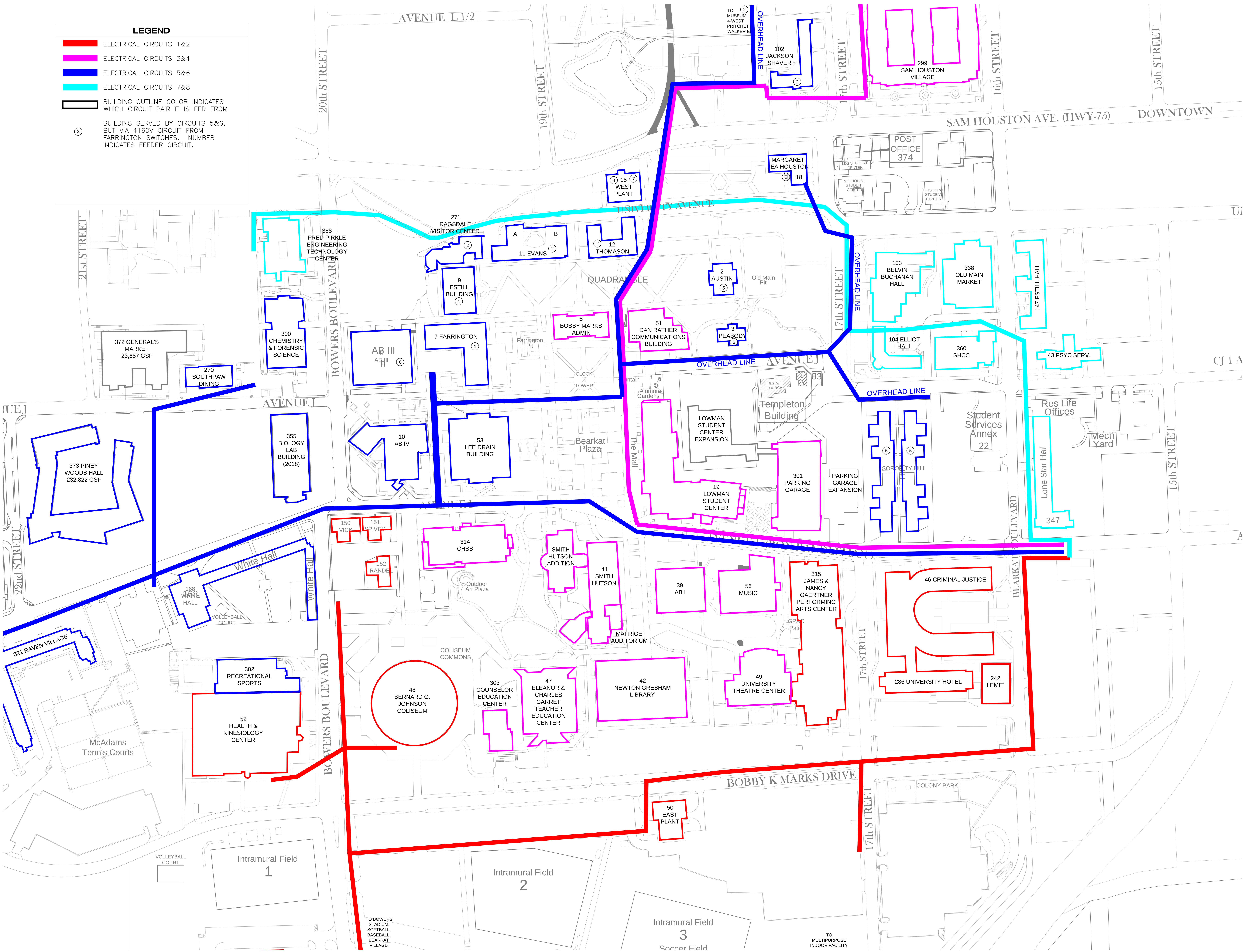
FIRM REGISTRATION # F-2497
WWW.EEACE.COM - EEA PROJECT #20160156

TITLE:
CAMPUS MECHANICAL PIPING PLAN (FUTURE)

EEA PROJ: 20160156
DRAWN BY: SG
CHECKED BY: MM
DATE: 05-24-17

SHEET:
M2.0



100' 50' 0 100' 200'
(IN FEET)
SCALE 1" = 100'

NORTH

1 CAMPUS ELECTRICAL CIRCUIT PLAN
1" = 100'-0"

REVISIONS		
NO	DATE	DESCRIPTION

SAM HOUSTON STATE UNIVERSITY
HUNTSVILLE, TEXAS
2017 UTILITY MASTER PLAN UPDATE

EEA CONSULTING ENGINEERS

EEA CONSULTING ENGINEERS
6615 VAUGHT RANCH ROAD, SUITE 200
AUSTIN, TEXAS 78730-2314 USA
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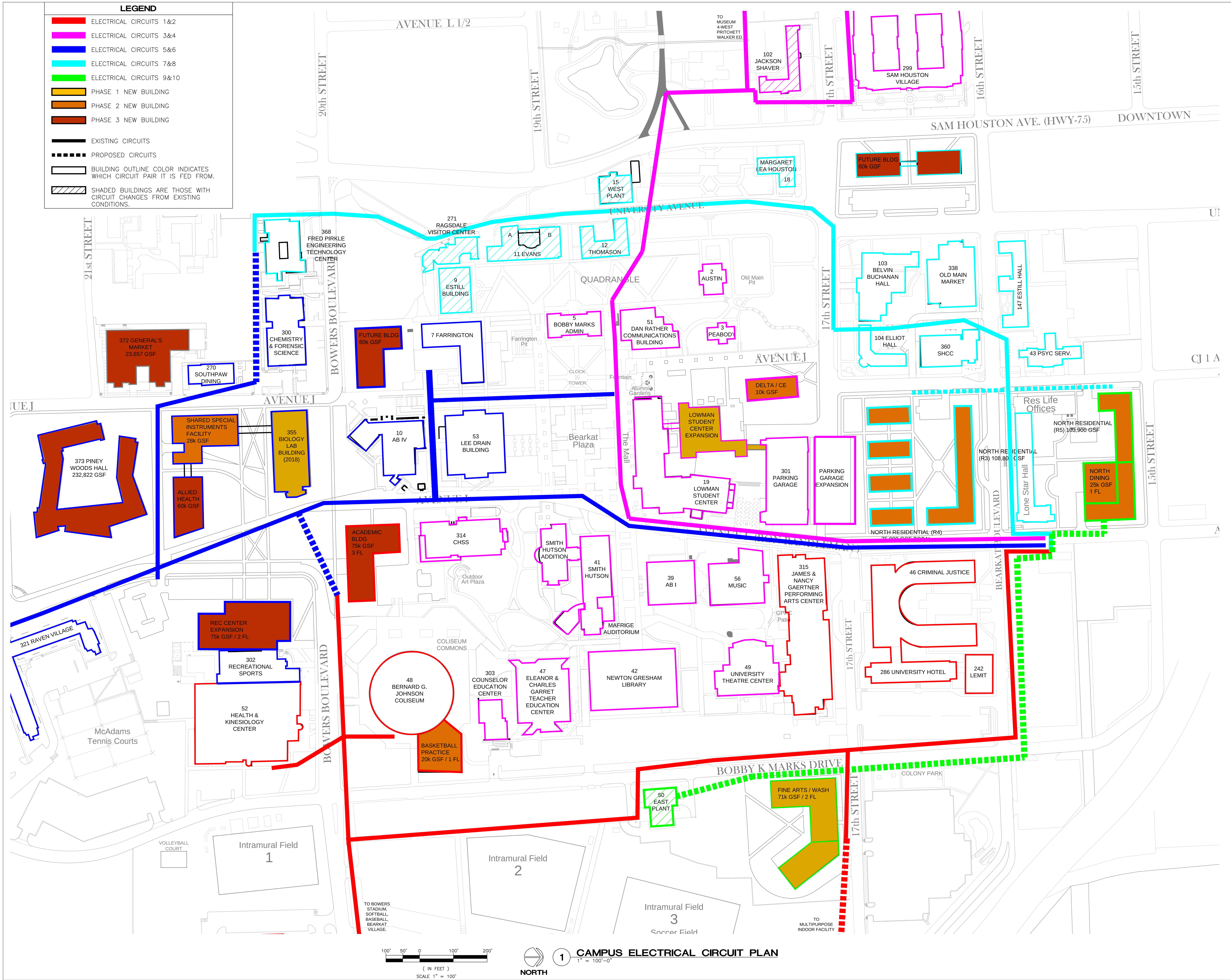
FIRM REGISTRATION # F-2497
WWW.EEACE.COM - EEA PROJECT #20160156

TITLE:
CAMPUS ELECTRICAL CIRCUIT PLAN(CURRENT)

EEA PROJ: 20160156
DRAWN BY: MG
CHECKED BY: DH
DATE: 05-24-17

SHEET:
E1.0



1 **CAMPUS ELECTRICAL CIRCUIT PLAN**
1" = 100'-0"

REVISIONS

NO	DATE	DESCRIPTION

SAM HOUSTON STATE UNIVERSITY
HUNTSVILLE, TEXAS
2017 UTILITY MASTER PLAN UPDATE

EEA CONSULTING ENGINEERS
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512.744.4400 MAIN - 512.744.4444 FAX
FIRM REGISTRATION # F-2497
WWW.EEACE.COM - EEA PROJECT #20160156

TITLE:
CAMPUS ELECTRICAL CIRCUIT PLAN (FUTURE)

EEA PROJ: 20160156
DRAWN BY: MG
CHECKED BY: DH
DATE: 05-24-17

SHEET:
E2.0

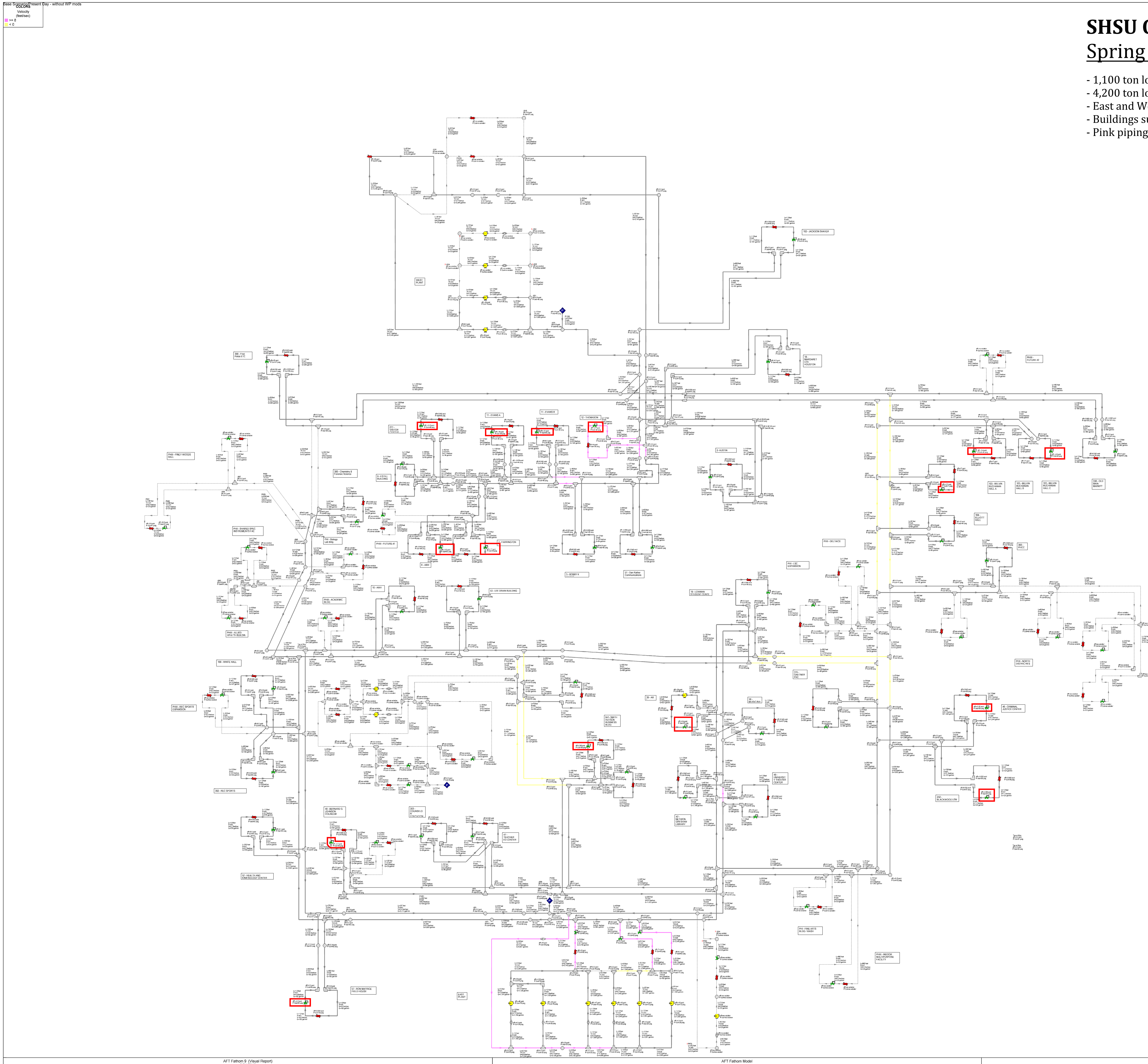
APPENDIX B – CAMPUS THERMAL HYDRAULIC MODELS

- Chilled Water System – Spring 2017 Diversified Flow Model
- Chilled Water System – Fall 2017 Diversified Flow Model
- Chilled Water System – Phase I without Loop Model
- Chilled Water System – Phase I with Loop Model
- Chilled Water System – Phase II Model
- Chilled Water System – Phase III Model

SHSU Chilled Water System

Spring 2017 Diversified Flow Model

- 1,100 ton load at West Plant
- 4,200 ton load at East Plant
- East and West Loops are not yet connected
- Buildings surrounded by red boxes indicate possibly inadequate flow
- Pink piping indicates velocities exceeding 8 ft./sec.



AFT Fathom 9 (Visual Report)
5/24/2017
Page 1 of 1

AFT Fathom Model

Base Scenario/Present Day - with WP mods

COLORS

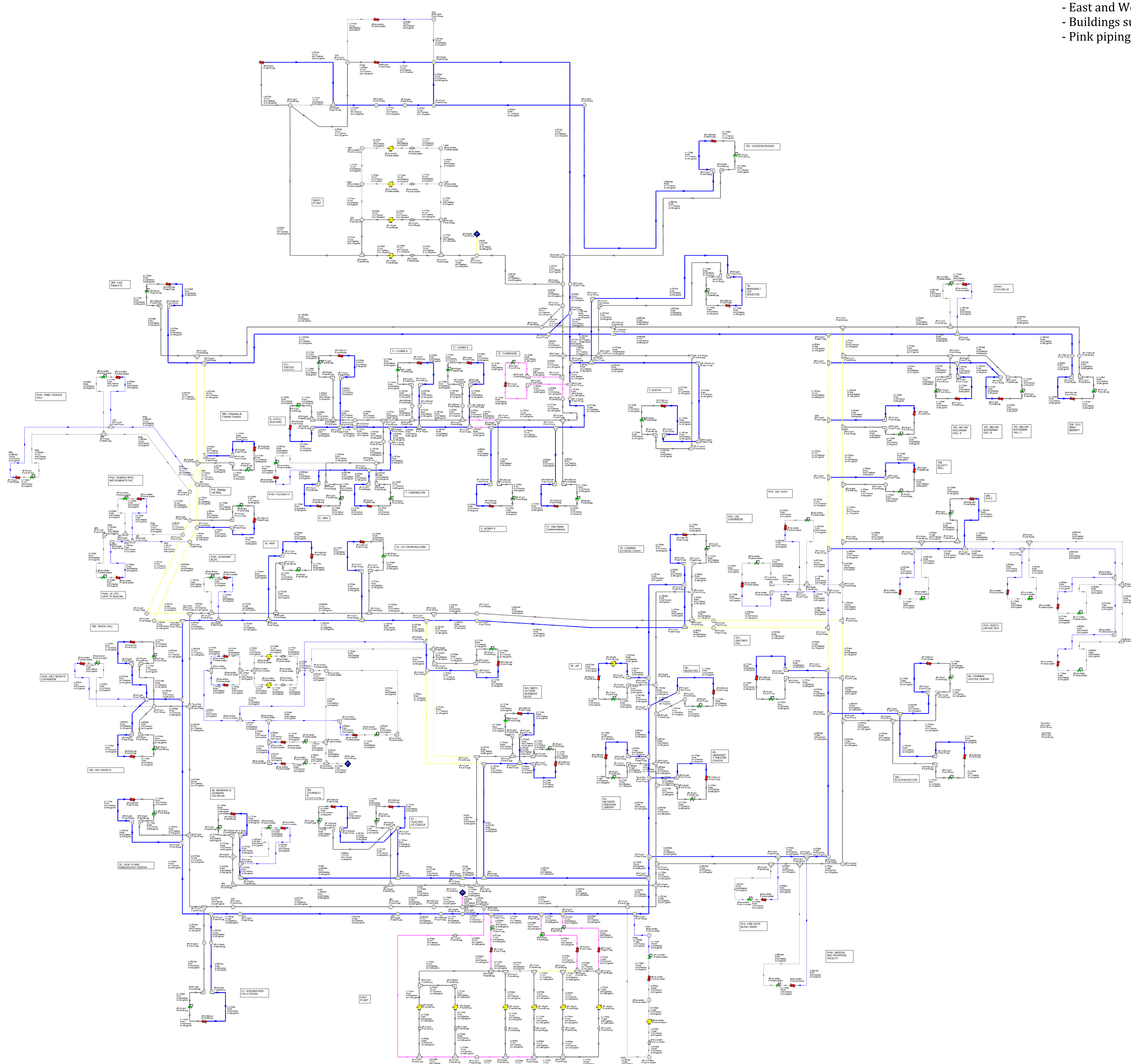
Velocity
(feet/sec)

- >= 8
- < 0

SHSU Chilled Water System

Fall 2017 Diversified Flow Model

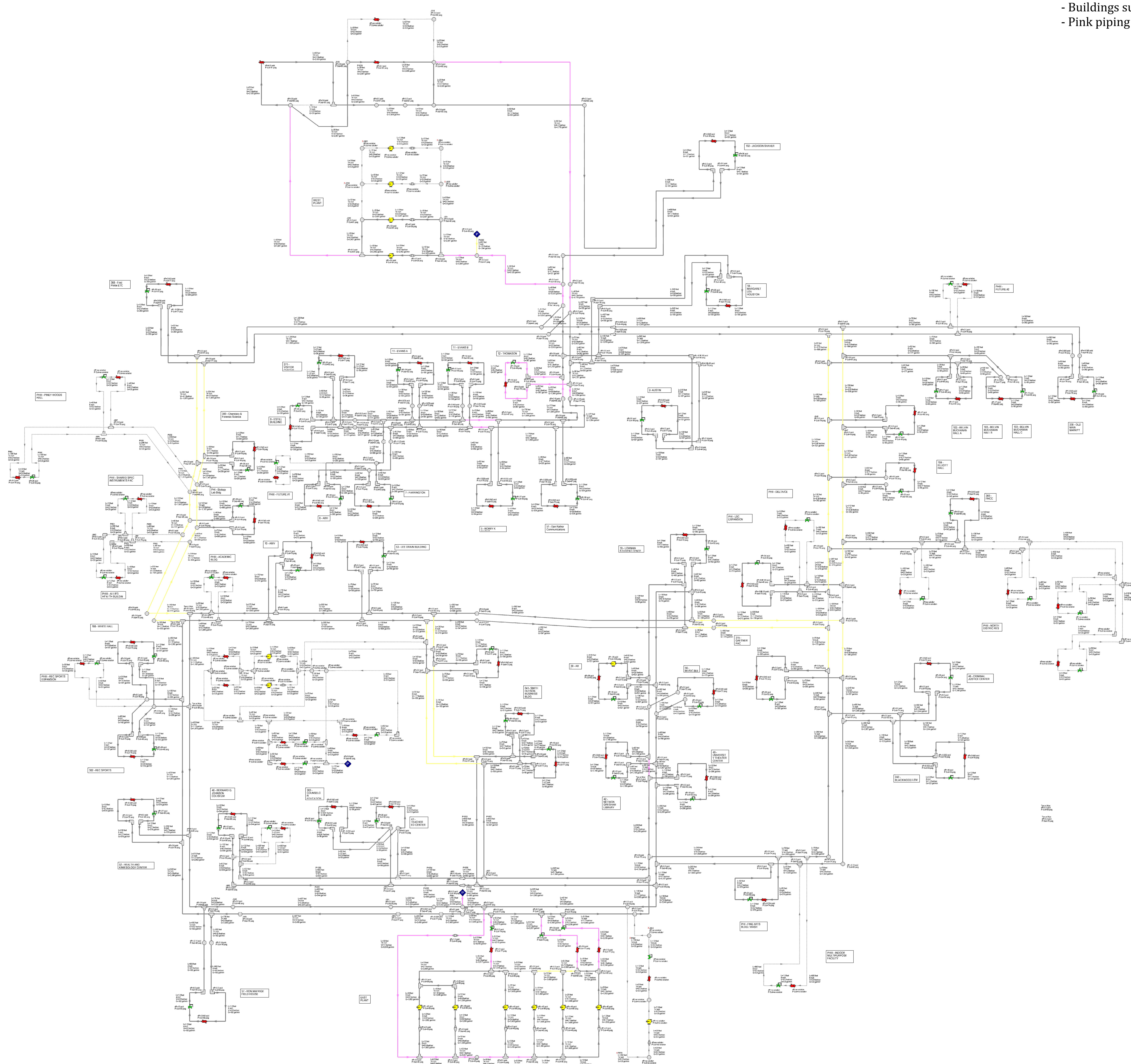
- 1,590 ton load at West Plant
- 4,200 ton load at East Plant
- East and West Loops are connected on the South side of campus
- Buildings surrounded by red boxes indicate possibly inadequate flow
- Pink piping indicates velocities exceeding 8 ft./sec.



SHSU Chilled Water System

Phase I without Loop Flow Model

- 6,400 ton total campus load
- East and West Loops are connected on the South side of campus
- Buildings surrounded by red boxes indicate possibly inadequate flow
- Pink piping indicates velocities exceeding 8 ft./sec.



Base Scenario/PH I - with art 24"

COLORS

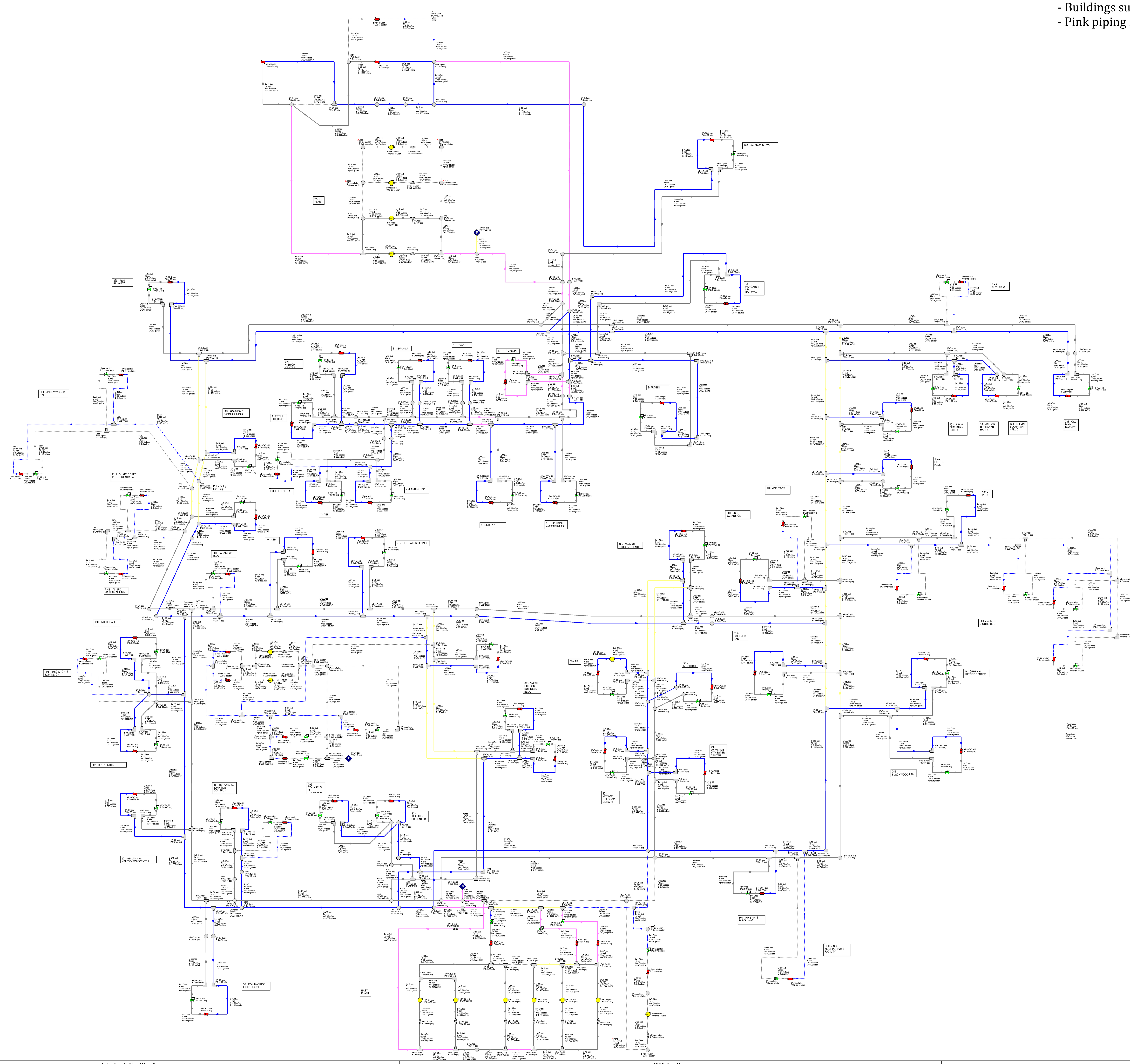
Velocity (feet/sec)

- >= 8
- < 0

SHSU Chilled Water System

Phase I with Loop Flow Model

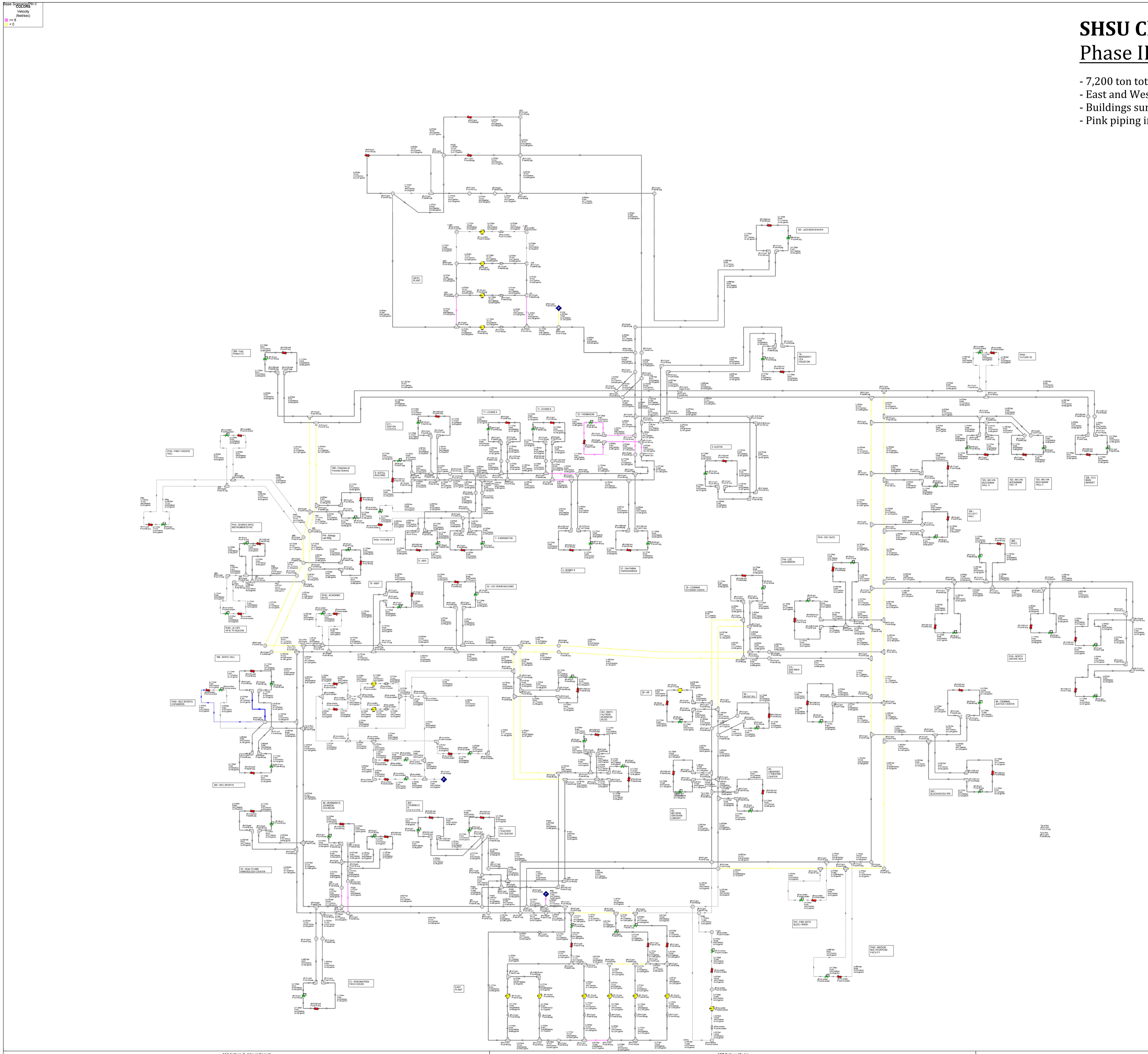
- 6,400 ton total campus load
- East and West Loops are connected on the South and North sides of campus
- Buildings surrounded by red boxes indicate possibly inadequate flow
- Pink piping indicates velocities exceeding 8 ft./sec.



SHSU Chilled Water System

Phase II Flow Model

- 7,200 ton total campus load
- East and West Loops are connected on the South and North sides of campus
- Buildings surrounded by red boxes indicate possibly inadequate flow
- Pink piping indicates velocities exceeding 8 ft./sec.



AFT Fathom 9 (Visual Report)
5/24/2017
Page 1 of 1

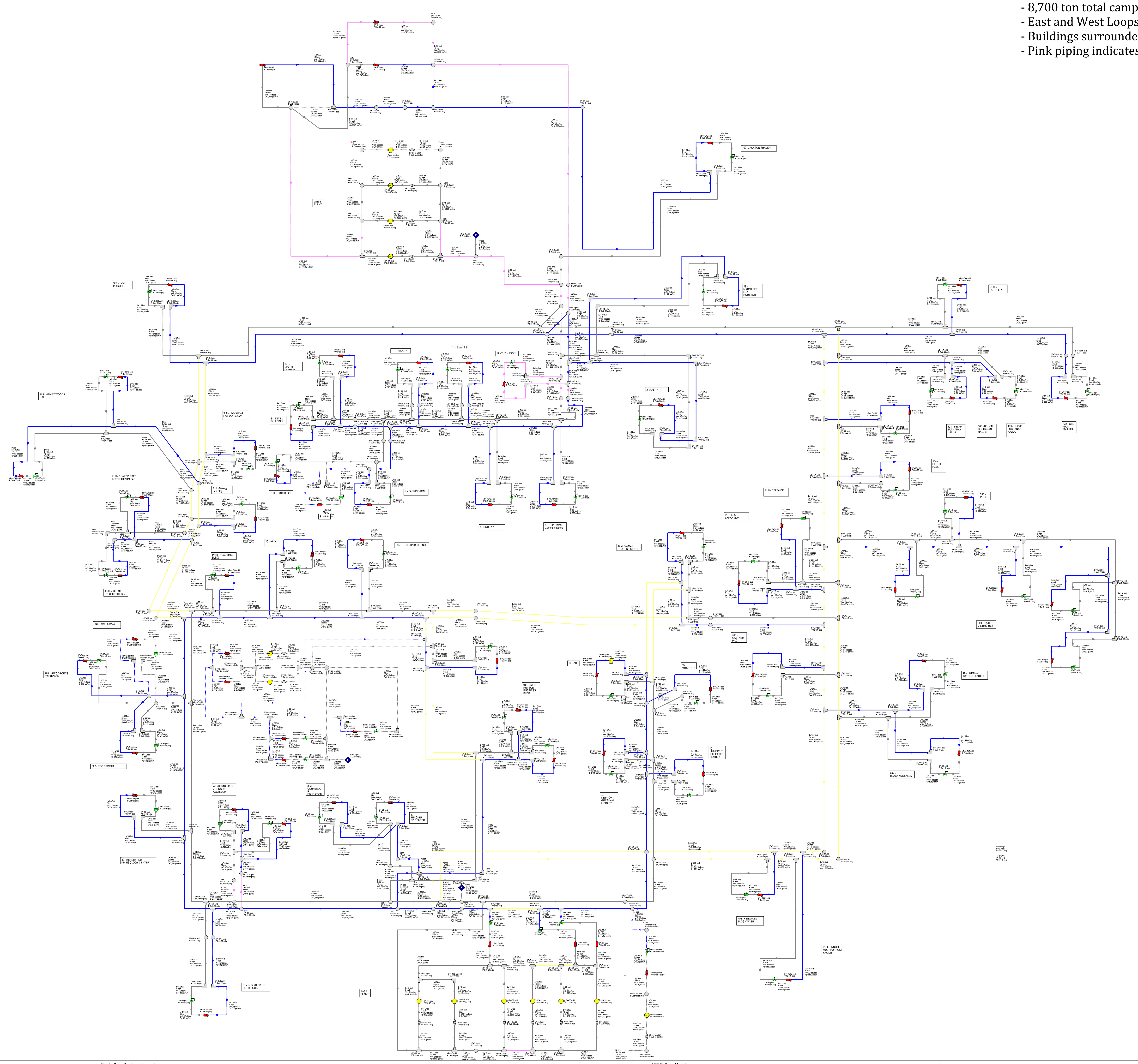
AFT Fathom Model

SHSU Chilled Water System

Phase III Flow Model

- 8,700 ton total campus load
- East and West Loops are connected on the South and North sides of campus
- Buildings surrounded by red boxes indicate possibly inadequate flow
- Pink piping indicates velocities exceeding 8 ft./sec.

Base Scenario/PH III
COLORS
Velocity
(feet/sec)
>= 8
< 8



AFT Fathom Model

APPENDIX C – INSULATION CALCULATIONS

- Chilled Water Piping Insulation Calculations

HDPE

Heat Gain Calculation w/o Insulation

42 chilled water supply temperature (F)
100 soil temperature (F), assumed
1.25 ks, soil thermal conductivity (Btu/h x ft x F), assumed worst case scenario
0.267 kp, pipe thermal conductivity (Btu/h x ft x F)

Pipe Diameter	Inside Diameter	Outside Diameter	Inside Radius	Outside Radius	Depth (ft)																	
	di	do	ri	ro	2.5						5						6					
(in)	(in)	(in)	(ft)	(ft)	d/ro	Rs	Rp	Rt	q	Btu x 100 ft	d/ro	Rs	Rp	Rt	q	Btu x 100 ft	d/ro	Rs	Rp	Rt	q	Btu x 100 ft
4	3.68	4.50	0.153	0.188	14.333	0.427	0.120	0.547	-105.970	**-10,597**	27.667	0.511	0.120	0.631	-91.909	**-9,191**	33.000	0.533	0.120	0.654	-88.752	**-8,875**
6	5.11	6.25	0.213	0.260	10.600	0.389	0.120	0.509	-113.940	**-11,394**	20.200	0.471	0.120	0.591	-98.115	**-9,812**	24.040	0.493	0.120	0.613	-94.570	**-9,457**
8	7.06	8.63	0.294	0.360	7.952	0.352	0.120	0.472	-122.855	**-12,285**	14.905	0.432	0.120	0.552	-105.056	**-10,506**	17.686	0.454	0.120	0.574	-101.068	**-10,107**
10	8.80	10.75	0.367	0.448	6.581	0.328	0.119	0.448	-129.574	**-12,957**	12.163	0.406	0.119	0.526	-110.305	**-11,030**	14.395	0.428	0.119	0.547	-105.980	**-10,598**
12	10.43	12.75	0.435	0.531	5.706	0.310	0.120	0.430	-134.928	**-13,493**	10.412	0.387	0.120	0.506	-114.526	**-11,453**	12.294	0.408	0.120	0.528	-109.933	**-10,993**
16	13.09	16.00	0.545	0.667	4.750	0.287	0.120	0.406	-142.699	**-14,270**	8.500	0.361	0.120	0.481	-120.697	**-12,070**	10.000	0.381	0.120	0.501	-115.714	**-11,571**
18	14.73	18.00	0.614	0.750	4.333	0.275	0.120	0.395	-146.981	**-14,698**	7.667	0.348	0.120	0.467	-124.129	**-12,413**	9.000	0.368	0.120	0.488	-118.933	**-11,893**
20	16.36	20.00	0.682	0.833	4.000	0.265	0.120	0.385	-150.782	**-15,078**	7.000	0.336	0.120	0.456	-127.217	**-12,722**	8.200	0.356	0.120	0.476	-121.833	**-12,183**
24	19.64	24.00	0.818	1.000	3.500	0.248	0.120	0.367	-157.859	**-15,786**	6.000	0.316	0.120	0.436	-133.014	**-13,301**	7.000	0.336	0.120	0.456	-127.285	**-12,728**

Notes:
1 A negative "q" values indicates heat gain.
2 Equations used in calculation are taken from Chapter 12 of the 2016 ASHRAE Handbook, HVAC Systems and Equipment.
3 d = burial depth to centerline of pipe (ft)
4 Rs = thermal resistance of soil (h x ft x F/Btu)
5 Rp = thermal resistance of HDPE pipe (h x ft x F/Btu)
6 Rt = total thermal resistance (h x ft x F/Btu)
7 q = heat loss or gain per unit length of system (Btu/h x ft)

Heat Gain Calculation w/ Gilsulate

42 chilled water supply temperature (F)
100 soil temperature (F), assumed
0.05 ki, gilsulate thermal conductivity (Btu/h x ft x F)
1.25 ks, soil thermal conductivity (Btu/h x ft x F), assumed worst case scenario
0.267 kp, pipe thermal conductivity (Btu/h x ft x F)
6 amount of gilsulate on each side of pipe (in)

0.53 0.04416667
0.6 0.05
0.65 0.05416667

Nominal Pipe Diameter	Inside Diameter	Outside Diameter	Inside Radius	Outside Radius	Outside Diameter Insulation	Outside Radius Insulation	Depth (ft)																				
	di	do	ri	ro	doi	roi	2.5							5							6						
(in)	(in)	(in)	(ft)	(ft)	(in)	(ft)	d/roi	Rs	Rp	Ri	Rt	q	Btu x 100 ft	d/roi	Rs	Rp	Ri	Rt	q	Btu x 100 ft	d/roi	Rs	Rp	Ri	Rt	q	Btu x 100 ft
4	3.68	4.50	0.153	0.188	18.037	0.752	4.326	0.275	0.120	4.419	4.814	-12.048	**-1,205**	7.653	0.347	0.120	4.419	4.887	-11.869	**-1,187**	8.983	0.368	0.120	4.419	4.907	-11.820	**-1,182**
6	5.11	6.25	0.213	0.260	19.950	0.831	4.007	0.265	0.120	3.694	4.080	-14.217	**-1,422**	7.015	0.336	0.120	3.694	4.151	-13.973	**-1,397**	8.218	0.356	0.120	3.694	4.171	-13.905	**-1,391**
8	7.06	8.63	0.294	0.360	22.552	0.940	3.661	0.253	0.120	3.058	3.431	-16.905	**-1,691**	6.321	0.323	0.120	3.058	3.500	-16.569	**-1,657**	7.385	0.343	0.120	3.058	3.520	-16.476	**-1,648**
10	8.80	10.75	0.367	0.448	24.870	1.036	3.413	0.245	0.119	2.670	3.034	-19.118	**-1,912**	5.825	0.313	0.119	2.670	3.102	-18.698	**-1,870**	6.790	0.332	0.119	2.670	3.121	-18.582	**-1,858**
12	10.43	12.75	0.435	0.531	27.056	1.127	3.218	0.237	0.120	2.395	2.752	-21.077	**-2,108**	5.435	0.304	0.120	2.395	2.819	-20.578	**-2,058**	6.322	0.323	0.120	2.395	2.838	-20.438	**-2,044**
16	13.09	16.00	0.545	0.667	30.609	1.275	2.960	0.226	0.120	2.065	2.411	-24.055	**-2,406**	4.920	0.291	0.120	2.065	2.476	-23.427	**-2,343**	5.705	0.310	0.120	2.065	2.495	-23.250	**-2,325**
18	14.73	18.00	0.614	0.750	32.795	1.366	2.830	0.221	0.120	1.910	2.250	-25.779	**-2,578**	4.659	0.284	0.120	1.910	2.313	-25.071	**-2,507**	5.391	0.303	0.120	1.910	2.332	-24.872	**-2,487**
20	16.36	20.00	0.682	0.833	34.981	1.458	2.715	0.215	0.120	1.780	2.115	-27.424	**-2,742**	4.430	0.278	0.120	1.780	2.177	-26.639	**-2,664**	5.116	0.296	0.120	1.780	2.196	-26.416	**-2,642**
24	19.64	24.00	0.818	1.000	39.354	1.640	2.525	0.206	0.120	1.574	1.900	-30.526	**-3,053**	4.049	0.266	0.120	1.574	1.960	-29.590	**-2,959**	4.659	0.284	0.120	1.574	1.978	-29.322	**-2,932**

Notes:
1 A negative "q" values indicates heat gain.
2 Equations used in calculation are taken from Chapter 12 of the 2016 ASHRAE Handbook, HVAC Systems and Equipment.
3 d = burial depth to centerline of pipe (ft)
4 Rs = thermal resistance of soil (h x ft x F/Btu)
5 Rp = thermal resistance of HDPE pipe (h x ft x F/Btu)
6 Ri = thermal resistance of gilsulate (h x ft x F/Btu)
7 Rt = total thermal resistance (h x ft x F/Btu)
8 q = heat loss or gain per unit length of system (Btu/h x ft)

HDPE

Temperature Rise Calculation w/o Insulation @ 2.5ft deep

Description of Pipe	Length of Pipe (ft)	Pipe Size (in)	CHWS Flow (gpm)	Heat Gain per unit length (q)	Total Heat Gain (Q)	Temperature Rise (T)	% Heat Gain
East Plant to TEC	215	24	5000	157.86	33,940	0.014	0.11%
TEC to Coliseum	440	24	4540	157.86	69,458	0.031	0.25%
Coliseum to Field House	185	24	3980	157.86	29,204	0.015	0.12%
Field House to Health & Kines	200	24	3790	157.86	31,572	0.017	0.14%
Health & Kines to Rec Sports / White Hall	420	24	3200	157.86	66,301	0.041	0.35%
White Hall to Bowers & Ave. I	360	24	2900	157.86	56,829	0.039	0.33%
Ave. I to Biology	430	16	1130	142.70	61,360	0.109	0.91%
Tap to Biology	60	8	865	122.85	7,371	0.017	0.14%
Totals	**2,310**	**-**	**-**	**-**	**356,035**	**0.282**	**1.19%**

Temperature Rise Calculation w/ Gilsulate @ 2.5ft deep

Description of Pipe	Length of Pipe (ft)	Pipe Size (in)	CHWS Flow (gpm)	Heat Gain per unit length (q)	Total Heat Gain (Q)	Temperature Rise (T)	% Heat Gain
East Plant to TEC	215	24	5000	30.53	6,563	0.003	0.02%
TEC to Coliseum	440	24	4540	30.53	13,432	0.006	0.05%
Coliseum to Field House	185	24	3980	30.53	5,647	0.003	0.02%
Field House to Health & Kines	200	24	3790	30.53	6,105	0.003	0.03%
Health & Kines to Rec Sports / White Hall	420	24	3200	30.53	12,821	0.008	0.07%
White Hall to Bowers & Ave. I	360	24	2900	30.53	10,989	0.008	0.06%
Ave. I to Biology	430	16	1130	24.06	10,344	0.018	0.15%
Tap to Biology	60	8	865	16.91	1,014	0.002	0.02%
Totals	**2,310**	**-**	**-**	**-**	**66,916**	**0.051**	**0.22%**

APPENDIX D – CAMPUS DOMESTIC WATER MODELS

- SHSU Existing Water System
- SHSU Existing System Upper Pressure Plane
- SHSU Future System Upper Pressure Plane with Farrington Tank & Pump
- SHSU Future Water System
- SHSU Future System Upper Pressure Plane

NO.	DATE	DESCRIPTION	BY

mwm DesignGroup
305 East Huntland Drive
Suite 200
Austin, Texas 78752
p: 512.453.0767
f: 512.453.1734

TBAE FIRM REGISTRATION NO.: 1452
TBPE FIRM REGISTRATION NO.: F-1416
TBPLS FIRM REGISTRATION NO.: 10065600

SHSU EXISTING WATER SYSTEM

SAM HOUSTON STATE UNIVERSITY
HUNTSVILLE, TEXAS
2017 UTILITY MASTER PLAN UPDATE

PLOTTED: 5/23/2017
JOB NO: 627-02

1 OF 1

File: Y:\627-02_SHSU_MP_Update\CAD\Sheets\Exhibit_SHSU WaterCAD_Existing System.dwg 22x34

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mwm Design Group
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Suite 200
Austin, Texas 78752
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f: 512.453.1734
TBAE FIRM REGISTRATION NO.: 1452
TBPE FIRM REGISTRATION NO.: F-1416
TBPLS FIRM REGISTRATION NO.: 10065600

SHSU EXISTING SYSTEM UPPER PRESSURE PLANE

SAM HOUSTON STATE UNIVERSITY
HUNTSVILLE, TEXAS
2017 UTILITY MASTER PLAN UPDATE

PLOTTED: 6/22/2017
JOB NO: 627-02
1 OF 1

File: Y:\627-02_SHSU_MP_Update\CAD\Sheets\Exhibit_SHSU WaterCAD_Existing System_HPP.dwg 22x34

SHSU FUTURE SYSTEM UPPER PRESSURE PLANE WITH FARRINGTON TANK AND PUMP

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HUNTSVILLE, TEXAS
2017 UTILITY MASTER PLAN UPDATE

PLOTTED: 7/14/2017
JOB NO: 627-02

1 OF 1

NO.	DATE	DESCRIPTION	BY

mwm Design Group
305 East Huntland Drive
Suite 200
Austin, Texas 78752
p: 512.453.0767
f: 512.453.1734
TBAE FIRM REGISTRATION NO.: 1452
TBPE FIRM REGISTRATION NO.: F-1416
TBPLS FIRM REGISTRATION NO.: 10065600

File: Y:\627-02_SHSU_MP_Update\CAD\Sheets\Exhibit_SHSU WaterCAD_Future System_HPP_Tanks.dwg 22x34

NO.	DATE	DESCRIPTION	BY

mwm DesignGroup
305 East Huntland Drive
Suite 200
Austin, Texas 78752
p: 512.453.0767
f: 512.453.1734
TBAE FIRM REGISTRATION NO.: 1452
TBPE FIRM REGISTRATION NO.: F-1416
TBPLS FIRM REGISTRATION NO.: 10065600

0 1"

SHSU FUTURE WATER SYSTEM

SAM HOUSTON STATE UNIVERSITY
HUNTSVILLE, TEXAS
2017 UTILITY MASTER PLAN UPDATE

PLOTTED: 7/14/2017
JOB NO: 627-02

1 OF 1

File: Y:\627-02_SHSU_MP_Update\CAD\Sheets\Exhibit_SHSU WaterCAD_Future System.dwg 22x34

mwm Design Group

305 East Huntland Drive
Suite 200
Austin, Texas 78752
p: 512.453.0767
f: 512.453.1734

TBAE FIRM REGISTRATION NO.: 1452
TBPE FIRM REGISTRATION NO.: F-1416
TBPLS FIRM REGISTRATION NO.: 10065600

NO.	DATE	DESCRIPTION	BY

0 1"

SHSU FUTURE SYSTEM UPPER PRESSURE PLANE

SAM HOUSTON STATE UNIVERSITY
HUNTSVILLE, TEXAS
2017 UTILITY MASTER PLAN UPDATE

PLOTTED: 7/14/2017
JOB NO: 627-02

1 OF 1

File: Y:\627-02_SHSU_MP_Update\CAD\Sheets\Exhibit_SHSU WaterCAD_Future System_HPP.dwg 22x34

APPENDIX E – CAMPUS SANITARY SEWER MODELS

- SHSU Existing Wastewater System
- SHSU Existing Wastewater System Over Capacity
- SHSU Future Wastewater System Over Capacity

NO.	DATE	DESCRIPTION	BY

mwm DesignGroup
305 East Huntland Drive
Suite 200
Austin, Texas 78752
p: 512.453.0767
f: 512.453.1734

TBAE FIRM REGISTRATION NO.: 1452
TBPE FIRM REGISTRATION NO.: F-1416
TBPLS FIRM REGISTRATION NO.: 10065600

0 1"

SHSU EXISTING WASTEWATER SYSTEM

SAM HOUSTON STATE UNIVERSITY
HUNTSVILLE, TEXAS
2017 UTILITY MASTER PLAN UPDATE

PLOTTED: 5/10/2017
JOB NO: 627-02

1 OF 1

File: Y:\627-02_SHSU_MP_Update\CAD\Sheets\Exhibit_SHSU Wastewater_Existing System.dwg 22x34

mwm DesignGroup
305 East Huntland Drive
Suite 200
Austin, Texas 78752
p: 512.453.0767
f: 512.453.1734

TBAE FIRM REGISTRATION NO.: 1452
TBPE FIRM REGISTRATION NO.: F-1416
TBPLS FIRM REGISTRATION NO.: 10065600

NO.	DATE	DESCRIPTION	BY

SHSU EXISTING WASTEWATER SYSTEM OVER CAPACITY

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2017 UTILITY MASTER PLAN UPDATE

PLOTTED: 5/10/2017
JOB NO: 627-02

1 OF 1

File: Y:\627-02_SHSU_MP_Update\CAD\Sheets\Exhibit_SHSU Wastewater_Existing Overcapacity.dwg 22x34

NO.	DATE	DESCRIPTION	BY

mwm DesignGroup
305 East Huntland Drive
Suite 200
Austin, Texas 78752
p: 512.453.0767
f: 512.453.1734

TBAE FIRM REGISTRATION NO.: 1452
TBPE FIRM REGISTRATION NO.: F-1416
TBPLS FIRM REGISTRATION NO.: 10065600

0 1"

SHSU FUTURE WASTEWATER SYSTEM OVER CAPACITY

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HUNTSVILLE, TEXAS
2017 UTILITY MASTER PLAN UPDATE

PLOTTED: 7/14/2017
JOB NO: 627-02

1 OF 1

File: Y:\627-02_SHSU_MP_Update\CAD\Sheets\Exhibit_SHSU Wastewater_Future Overcapacity.dwg 22x34

APPENDIX F – CAMPUS STORM DRAIN MODELS

- SHSU Pipe Sizes Existing Storm System
- SHSU 25-YR Existing Storm System
- SHSU 25-YR Future Storm System
- SHSU 100-YR Existing Storm System
- SHSU 100-YR Future Storm System

NO.	DATE	DESCRIPTION	BY

mwm DesignGroup
305 East Huntland Drive
Suite 200
Austin, Texas 78752
p: 512.453.0767
f: 512.453.1734

TBAE FIRM REGISTRATION NO.: 1452
TBPE FIRM REGISTRATION NO.: F-1416
TBPLS FIRM REGISTRATION NO.: 10065600

0 1"

SHSU PIPE SIZES EXISTING STORM SYSTEM

SAM HOUSTON STATE UNIVERSITY
HUNTSVILLE, TEXAS
2017 UTILITY MASTER PLAN UPDATE

PLOTTED: 7/10/2017
JOB NO: 627-02

1 OF 1

File: Y:\627-02_SHSU_MP_Update\CAD\Exhibits\SHSU Existing Storm_2017.07.10\Exhibit_SHSU Pipe Sizes Existing Storm.dwg 22x34

NO.	DATE	DESCRIPTION	BY

mwm DesignGroup
305 East Huntland Drive
Suite 200
Austin, Texas 78752
p: 512.453.0767
f: 512.453.1734

TBAE FIRM REGISTRATION NO.: 1452
TBPE FIRM REGISTRATION NO.: F-1416
TBPLS FIRM REGISTRATION NO.: 10065600

SHSU 25-YR EXISTING STORM SYSTEM

SAM HOUSTON STATE UNIVERSITY
HUNTSVILLE, TEXAS
2017 UTILITY MASTER PLAN UPDATE

PLOTTED: 7/10/2017
JOB NO: 627-02

1 OF 1

File: Y:\627-02_SHSU_MP_Update\CAD\Exhibits\SHSU Existing Storm_2017.07.10\Exhibit_SHSU 25-YR Existing Storm.dwg 22x34

mwm DesignGroup

305 East Huntland Drive
Suite 200
Austin, Texas 78752
p: 512.453.0767
f: 512.453.1734

TBAE FIRM REGISTRATION NO.: 1452
TBPE FIRM REGISTRATION NO.: F-1416
TBPLS FIRM REGISTRATION NO.: 10065600

NO.	DATE	DESCRIPTION	BY

SHSU 25-YR FUTURE STORM SYSTEM

SAM HOUSTON STATE UNIVERSITY
HUNTSVILLE, TEXAS
2017 UTILITY MASTER PLAN UPDATE

PLOTTED: 7/14/2017
JOB NO: 627-02

1 OF 1

File: Y:\627-02_SHSU_MP_Update\CAD\Exhibits\SHSU Future Storm_2017-07-10\Exhibit_SHSU 25-YR Future Storm.dwg 22x34

NO.	DATE	DESCRIPTION	BY

mwm DesignGroup
305 East Huntland Drive
Suite 200
Austin, Texas 78752
p: 512.453.0767
f: 512.453.1734

TBAE FIRM REGISTRATION NO.: 1452
TBPE FIRM REGISTRATION NO.: F-1416
TBPLS FIRM REGISTRATION NO.: 10065600

0 1"

SHSU 100-YR EXISTING STORM SYSTEM

SAM HOUSTON STATE UNIVERSITY
HUNTSVILLE, TEXAS
2017 UTILITY MASTER PLAN UPDATE

PLOTTED: 7/10/2017
JOB NO: 627-02

1 OF 1

File: Y:\627-02_SHSU_MP_Update\CAD\Exhibits\SHSU Existing Storm_2017.07.10\Exhibit_SHSU 100-YR Existing Storm.dwg 22x34

mwm DesignGroup

305 East Huntland Drive
Suite 200
Austin, Texas 78752
p: 512.453.0767
f: 512.453.1734

TBAE FIRM REGISTRATION NO.: 1452
TBPE FIRM REGISTRATION NO.: F-1416
TBPLS FIRM REGISTRATION NO.: 10065600

NO.	DATE	DESCRIPTION	BY

0 1"

SHSU 100-YR FUTURE STORM SYSTEM

SAM HOUSTON STATE UNIVERSITY
HUNTSVILLE, TEXAS
2017 UTILITY MASTER PLAN UPDATE

PLOTTED: 7/14/2017
JOB NO: 627-02

1 OF 1

File: Y:\627-02_SHSU_MP_Update\CAD\Exhibits\SHSU Future Storm_2017-07-10\Exhibit_SHSU 100-YR Future Storm.dwg 22x34

APPENDIX G – ELECTRICAL SHORT CIRCUIT STUDY

(refer to electronic copy)


UTIL-Primary From Entergy
BUS-Switchgear Building
InitSymRMS 3P 9801.42 A
InitSymRMS SLG 0.00 A
CKT1 MCB
51 RELAY CKT1
CKT2 MCB
51 RELAY CKT2
(1)CBL Substation to MH-2
(2)CBL Substation to MH-2
(1) BUS MH-2
(2) BUS MH-2
InitSymRMS 3P 9463.18 A
InitSymRMS SLG 0.00 A
(1)CBL MH-2 to S&C CJC
(2)CBL MH-2 to S&C CJC
S&C CJC
CJC - S&C Fuse - 80E
CBL-CJC S&C to CJC XFMR
XFMR-CJC
(1)MH-2 to MH-5
(2)MH-2 to MH-5
CKT8 MCB
51 RELAY CKT8
(8)CBL-MH1 to MH49
(8)BUS-MH49
InitSymRMS 3P 9372.17 A
InitSymRMS SLG 0.00 A
(8)CBL-MH49 to S&C LSH
LSH - S&C Fuse 100E
CBL-LSH S&C to XFMR

Aug 22, 2017   13:12:54

SKM POWER*TOOLS FOR WINDOWS
SHORT CIRCUIT ANALYSIS REPORT

ALL PU VALUES ARE EXPRESSED ON A 100 MVA BASE

SWING GENERATORS

BUS NAME	SOURCE NAME	VOLTAGE	ANGLE
BUS-Switchgear	UTIL-Primary F	1.00	0.00

************* P R E - F A U L T   V O L T A G E   P R O F I L E **************

BUS# NAME	BASE VOLTS	PU VOLTS	ANGLE (D)
(1) BUS MH-2	13200.00	1.0000	0.
(1)BUS MH-10	13200.00	1.0000	0.
(1)BUS MH-5	13200.00	1.0000	0.
(1)BUS MH-8	13200.00	1.0000	0.
(2) BUS MH-11	13200.00	1.0000	0.
(2) BUS MH-2	13200.00	1.0000	0.
(2) BUS MH-9	13200.00	1.0000	0.
(2) VSR S&C	13200.00	1.0000	0.
(2)BUS MH-10	13200.00	1.0000	0.
(2)BUS MH-5	13200.00	1.0000	0.
(2)BUS MH-8	13200.00	1.0000	0.
(3) BUS MH-17	13200.00	1.0000	0.
(3) BUS MH-23	13200.00	1.0000	0.
(3) BUS MH-46	13200.00	1.0000	0.
(3) BUS-MH-18	13200.00	1.0000	0.
(3) MH-24	13200.00	1.0000	0.
(3)BUS MH-19	13200.00	1.0000	0.
(3)BUS MH-20	13200.00	1.0000	0.
(3)BUS MH-21	13200.00	1.0000	0.
(3)BUS MH-33	13200.00	1.0000	0.
(3)BUS MH-36	13200.00	1.0000	0.
(3)MUSIC S&C	13200.00	1.0000	0.
(4) BUS MH-17	13200.00	1.0000	0.
(4) BUS MH-23	13200.00	1.0000	0.
(4) BUS MH-46	13200.00	1.0000	0.
(4) BUS-MH-18	13200.00	1.0000	0.
(4) MH-24	13200.00	1.0000	0.
(4) MUSIC S&C	13200.00	1.0000	0.
(4)BUS MH-19	13200.00	1.0000	0.
(4)BUS MH-20	13200.00	1.0000	0.
(4)BUS MH-21	13200.00	1.0000	0.
(4)BUS MH-33	13200.00	1.0000	0.
(4)BUS MH-36	13200.00	1.0000	0.
(5) BUS MH-44	13200.00	1.0000	0.
(5) BUS MH-47	13200.00	1.0000	0.
(5) BUS MH-48	13200.00	1.0000	0.
(5) BUS-MH-25	13200.00	1.0000	0.
(5) BUS-MH-30	13200.00	1.0000	0.
(6) BUS MH-25	13200.00	1.0000	0.
(6) BUS MH-30	13200.00	1.0000	0.
(6) BUS MH-44	13200.00	1.0000	0.
(6) BUS MH-47	13200.00	1.0000	0.
(6) BUS MH-48	13200.00	1.0000	0.
(7)BUS MH-Pirk	13200.00	1.0000	0.

************* P R E - F A U L T   V O L T A G E   P R O F I L E **************

BUS# NAME	BASE VOLTS	PU VOLTS	ANGLE (D)
(7)BUS MH43	13200.00	1.0000	0.
(7)BUS-MH41	13200.00	1.0000	0.
(7)BUS-MH42	13200.00	1.0000	0.
(7)BUS-MH49	13200.00	1.0000	0.
(8)BUS MH43	13200.00	1.0000	0.
(8)BUS-MH41	13200.00	1.0000	0.
(8)BUS-MH42	13200.00	1.0000	0.
(8)BUS-MH49	13200.00	1.0000	0.
(F1) BUS MH31	4160.00	1.0000	-30.
(F2) BUS- MH34	4160.00	1.0000	-30.
(F2)BUS-MH35	4160.00	1.0000	-30.
(F4)BUS- MH34	4160.00	1.0000	-30.
(F5) POLE AT 1	4160.00	1.0000	-30.
(F5) POLE AT B	4160.00	1.0000	-30.
(F5) POLE AT E	4160.00	1.0000	-30.
(F5)MH33	4160.00	1.0000	-30.
(F6)BUS - MH-3	4160.00	1.0000	-30.
AB1 MCB1	480.00	1.0000	-30.
AB3 MDP	208.00	1.0000	-60.
AB4 MDP	480.00	1.0000	-30.
Admin MDP	480.00	1.0000	-30.
BKV A&B	208.00	1.0000	-30.
BKV C&D	208.00	1.0000	-30.
BKV D&E	208.00	1.0000	-30.
BKV Distributi	13200.00	1.0000	0.
BKV-F&I	208.00	1.0000	-30.
BKV-F,G,H	208.00	0.9503	-30.
BKV-J&M	208.00	1.0000	-30.
BKV-K&L	208.00	1.0000	-30.
BUS- (MH34) (F	4160.00	1.0000	-30.
BUS- Farringto	4160.00	1.0000	-30.
BUS-(Bowers,So	13200.00	1.0000	0.
BUS-0954	240.00	1.0000	0.
BUS-Farrington	4160.00	1.0000	-30.
BUS-OH POLE(Vi	480.00	1.0000	-30.
BUS-PEA/AUS WI	208.00	1.0000	-60.
BUS-S&C -(Rave	13200.00	1.0000	0.
BUS-Switchgear	13200.00	1.0000	0.
Baseball MDP	480.00	1.0000	-30.
Belvin MDP	208.00	1.0000	-30.
CFS MDP	480.00	1.0000	-30.
CHSS MDP	480.00	1.0000	-30.
CJC MDP	480.00	1.0000	-30.
Coliseum MDP	480.00	1.0000	-30.

************* P R E - F A U L T   V O L T A G E   P R O F I L E **************

BUS# NAME	BASE VOLTS	PU VOLTS	ANGLE (D)
Comm/Admin Dis	13200.00	1.0000	0.
Communications	208.00	1.0000	-30.
E & PS Transfo	208.00	1.0000	-30.
EP EQ1 MDP	480.00	1.0000	-30.
EP EQ2 MDP	480.00	1.0000	-30.
ESTILL MDP	480.00	1.0000	-60.
East Plant Dis	13200.00	1.0000	0.
Elliott MDP	208.00	1.0000	-30.
Estill Dorm MD	208.00	1.0000	-30.
Evans MDP	480.00	1.0000	-60.
Evans/VisCen M	480.00	1.0000	-60.
FARR MDP	480.00	1.0000	-60.
Field House MD	480.00	1.0000	-30.
Garage MDP	480.00	1.0000	-30.
HKC MDP	480.00	1.0000	-30.
LIB MDP	480.00	1.0000	-30.
LSC MDP	480.00	1.0000	-30.
Lee Drain MDP	480.00	1.0000	-30.
Lonestar Hall	480.00	1.0000	-30.
MLH MDP	208.00	1.0000	-60.
Music Bldg. MD	480.00	1.0000	-30.
OMM MDP	480.00	1.0000	-30.
Old Smith Huts	480.00	1.0000	-30.
PAC MDP	480.00	1.0000	-30.
Pirkle MDP	480.00	1.0000	0.
Psyc Services	208.00	1.0000	-30.
RAVEN MDP	208.00	1.0000	-30.
RVA MDP	208.00	1.0000	-30.
RVB MDP	208.00	1.0000	-30.
SH MDP	480.00	1.0000	-30.
SHCC MDP	240.00	1.0000	0.
SHV Distributi	13200.00	1.0000	0.
SHV#1 MDP	208.00	1.0000	-30.
SHV#2 MDP	208.00	1.0000	-30.
Sorority	480.00	1.0000	0.
SouthPaw MDP	208.00	1.0000	-30.
TEC MDP	480.00	1.0000	-30.
Thomason MDP	480.00	1.0000	-60.
UTC MDP	480.00	1.0000	-30.
VisCen MDP	480.00	1.0000	-60.
West Plant MDP	480.00	1.0000	-60.
XFMR-WEST PLAN	4160.00	1.0000	-30.

```
***************** F A U L T   A N A L Y S I S   R E P O R T ****************

              FAULT TYPE: 3PH
              MODEL INDUCTION MOTOR CONTRIBUTION: YES
              MODEL TRANSFORMER TAPS: YES
              MODEL TRANSFORMER PHASE SHIFT: YES
==============================================================================


 (1) BUS MH-2   VOLTAGE BASE LL:              13200.0 (VOLTS)
              INI. SYM. RMS FAULT CURRENT:   9530.2 /  -81. ( AMPS/DEG )
              THEVENIN EQUIVALENT IMPEDANCE:    0.073 +j   0.453 (PU)
              THEVENIN IMPEDANCE X/R RATIO:     6.188

               ASYM    RMS   INTERRUPTING AMPS
              1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                 12515.1      9692.9      9551.7      9530.5      9530.2

              INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                      AT TIME =     0.5 CYCLES
              ---PHASE A---       ---PHASE B---       ---PHASE C---
              0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

              INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                      AT TIME =     0.5 CYCLES
              ---PHASE A---       ---PHASE B---       ---PHASE C---
               9530.2 / -80.8     9530.2 / 159.2     9530.2 /  39.2

 (1) BUS MH-2   ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                  FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                        ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-Switchgear  13200.0  0.0489 / -49.  0.0489 /-169.  0.0489 /  71.
   (1)BUS MH-5     13200.0  0.0105 / -44.  0.0105 /-164.  0.0105 /  76.
   BUS-0731        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (1) BUS MH-2   ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-Switchgear (1) BUS MH-2   (1)CBL Substat 13200.   8546.7/ -81.   8546.7/ 159.   8546.7/  39.
(1) BUS MH-2   (1)BUS MH-5    (1)MH-2 to MH- 13200.    984.1/  97.    984.1/ -23.    984.1/-143.
(1) BUS MH-2   BUS-0731       (1)CBL MH-2 to 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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```
 (1)BUS MH-10   VOLTAGE BASE LL:              13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   7628.5 /  -71. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.184 +j   0.543 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     2.957

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    8491.0      7630.0      7628.5      7628.5      7628.5

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 7628.5 / -71.3     7628.5 / 168.7      7628.5 /  48.7

 (1)BUS MH-10   ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (1)BUS MH-8     13200.0  0.1306 / -33.  0.1306 /-153.  0.1306 /  87.
   BUS-0681        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0682        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (1)BUS MH-10   ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(1)BUS MH-8    (1)BUS MH-10   (1) CBL MH-8 t 13200.   7628.5/ -71.   7628.5/ 169.   7628.5/  49.
(1)BUS MH-10   BUS-0681       (1) CBL MH-10  13200.      0.0/   0.      0.0/   0.      0.0/   0.
(1)BUS MH-10   BUS-0682       (1) CBL MH10 t 13200.      0.0/   0.      0.0/   0.      0.0/   0.

-----------------------------------------------------------------------------------------------
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 (1)BUS MH-5    VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8977.1 /  -78. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.102 +j   0.477 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     4.688

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   11080.9      9019.2      8980.0      8977.1      8977.1

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8977.1 / -78.0     8977.1 / 162.0      8977.1 /  42.0

 (1)BUS MH-5    ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (1) BUS MH-2    13200.0  0.0855 / -39.  0.0855 /-159.  0.0855 /  81.
   (1)BUS MH-8     13200.0  0.0090 / -45.  0.0090 /-165.  0.0090 /  75.
   BUS-0728        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (1)BUS MH-5    ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(1) BUS MH-2   (1)BUS MH-5    (1)MH-2 to MH- 13200.   7990.2/ -77.   7990.2/ 163.   7990.2/  43.
(1)BUS MH-5    (1)BUS MH-8    (1)CBL MH-5 to 13200.    991.5/  97.    991.5/ -23.    991.5/-143.
(1)BUS MH-5    BUS-0728       (1)CBL MH-5 to 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (1)BUS MH-8    VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8542.5 /  -76. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.125 +j   0.496 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     3.969

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   10146.2      8557.7      8543.2      8542.5      8542.5

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8542.5 / -75.9     8542.5 / 164.1      8542.5 /  44.1

 (1)BUS MH-8    ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (1)BUS MH-5     13200.0  0.0687 / -36.  0.0687 /-156.  0.0687 /  84.
   (1)BUS MH-10    13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0694        13200.0  0.0005 / -45.  0.0005 /-165.  0.0005 /  75.
   (1)BUS MH-8    ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                                FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                               BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(1)BUS MH-5    (1)BUS MH-8    (1)CBL MH-5 to 13200.   7554.8/ -75.   7554.8/ 165.   7554.8/  45.
(1)BUS MH-8    (1)BUS MH-10   (1) CBL MH-8 t 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(1)BUS MH-8    BUS-0694       (1) CBL MH-8 t 13200.    997.9/  96.    997.9/ -24.    997.9/-144.

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 (2) BUS MH-11  VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   7555.5 /  -71. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.191 +j   0.546 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     2.853

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    8349.1      7556.7      7555.6      7555.5      7555.5

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 7555.5 / -70.7     7555.5 / 169.3      7555.5 /  49.3

 (2) BUS MH-11  ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (2) BUS MH-9    13200.0  0.0251 / -32.  0.0251 /-152.  0.0251 /  88.
   BUS-0720        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0722        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (2) VSR S&C     13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (2) BUS MH-11  ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                             FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                            BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(2) BUS MH-9   (2) BUS MH-11  (2) MH-9 to MH 13200.   7555.5/ -71.   7555.5/ 169.   7555.5/  49.
(2) BUS MH-11  BUS-0720       CBL-Coliseum S 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(2) BUS MH-11  BUS-0722       CBL-HKC S&C to 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(2) BUS MH-11  (2) VSR S&C    CBL-MH-9 to VS 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (2) BUS MH-2   VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   9463.2 /  -80. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.078 +j   0.456 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     5.871

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   12287.1      9593.2      9478.6      9463.4      9463.2

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 9463.2 / -80.3     9463.2 / 159.7      9463.2 /  39.7

 (2) BUS MH-2   ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-Switchgear  13200.0  0.0541 / -49.  0.0541 /-169.  0.0541 /  71.
   (2)BUS MH-5     13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0734        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (2) BUS MH-2   ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-Switchgear (2) BUS MH-2   (2)CBL Substat 13200.   9463.2/ -80.   9463.2/ 160.   9463.2/  40.
(2) BUS MH-2   (2)BUS MH-5    (2)MH-2 to MH- 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(2) BUS MH-2   BUS-0734       (2)CBL MH-2 to 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (2) BUS MH-9   VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   7718.6 /  -71. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.180 +j   0.537 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     2.983

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    8606.5      7720.3      7718.7      7718.6      7718.6

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 7718.6 / -71.5     7718.6 / 168.5      7718.6 /  48.5

 (2) BUS MH-9   ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (2)BUS MH-8     13200.0  0.0785 / -33.  0.0785 /-153.  0.0785 /  87.
   (2)BUS MH-10    13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (2) BUS MH-11   13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (2) BUS MH-9   ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(2)BUS MH-8    (2) BUS MH-9   (2) CBL MH-8 t 13200.   7718.6/ -71.   7718.6/ 169.   7718.6/  49.
(2) BUS MH-9   (2)BUS MH-10   (2) CBL MH-9 t 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(2) BUS MH-9   (2) BUS MH-11  (2) MH-9 to MH 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (2) VSR S&C    VOLTAGE BASE LL:                13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   7340.8 /  -70. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.207 +j   0.559 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     2.698

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    8024.3      7341.5      7340.8      7340.8      7340.8

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 7340.8 / -69.7     7340.8 / 170.3      7340.8 /  50.3

 (2) VSR S&C    ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (2) BUS MH-11   13200.0  0.0334 / -31.  0.0334 /-151.  0.0334 /  89.
   BUS-0723        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (2) VSR S&C    ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(2) BUS MH-11  (2) VSR S&C    CBL-MH-9 to VS 13200.   7340.8/ -70.   7340.8/ 170.   7340.8/  50.
(2) VSR S&C    BUS-0723       CBL-HKC S&C to 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (2)BUS MH-10   VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   6933.5 /  -68. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.239 +j   0.584 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     2.446

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    7445.9      6933.7      6933.5      6933.5      6933.5

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 6933.5 / -67.8     6933.5 / 172.2      6933.5 /  52.2

 (2)BUS MH-10   ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (2) BUS MH-9    13200.0  0.1187 / -29.  0.1187 /-149.  0.1187 /  91.
   BUS-0680        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0684        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (2)BUS MH-10   ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(2) BUS MH-9   (2)BUS MH-10   (2) CBL MH-9 t 13200.   6933.5/ -68.   6933.5/ 172.   6933.5/  52.
(2)BUS MH-10   BUS-0680       (2) CBL MH-10  13200.      0.0/   0.      0.0/   0.      0.0/   0.
(2)BUS MH-10   BUS-0684       (2) CBL-MH10 t 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (2)BUS MH-5    VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8781.7 /  -77. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.114 +j   0.485 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     4.244

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   10593.1      8805.2      8782.9      8781.7      8781.7

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8781.7 / -76.7     8781.7 / 163.3      8781.7 /  43.3

 (2)BUS MH-5    ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (2) BUS MH-2    13200.0  0.0940 / -38.  0.0940 /-158.  0.0940 /  82.
   (2)BUS MH-8     13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0729        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (2)BUS MH-5    ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(2) BUS MH-2   (2)BUS MH-5    (2)MH-2 to MH- 13200.   8781.7/ -77.   8781.7/ 163.   8781.7/  43.
(2)BUS MH-5    (2)BUS MH-8    (2)CBL MH-5 to 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(2)BUS MH-5    BUS-0729       (2)CBL MH-5 to 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (2)BUS MH-8    VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8254.2 /  -74. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.145 +j   0.510 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     3.506

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    9530.6      8260.5      8254.4      8254.2      8254.2

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8254.2 / -74.1     8254.2 / 165.9      8254.2 /  45.9

 (2)BUS MH-8    ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (2)BUS MH-5     13200.0  0.0751 / -36.  0.0751 /-156.  0.0751 /  84.
   (2) BUS MH-9    13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0695        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (2)BUS MH-8    ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(2)BUS MH-5    (2)BUS MH-8    (2)CBL MH-5 to 13200.   8254.2/ -74.   8254.2/ 166.   8254.2/  46.
(2)BUS MH-8    (2) BUS MH-9   (2) CBL MH-8 t 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(2)BUS MH-8    BUS-0695       (2) CBL MH-8 t 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (3) BUS MH-17  VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   9100.2 /  -79. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.092 +j   0.472 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     5.102

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   11452.4      9166.0      9105.8      9100.3      9100.2

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 9100.2 / -78.9     9100.2 / 161.1      9100.2 /  41.1

 (3) BUS MH-17  ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-Switchgear  13200.0  0.0983 / -40.  0.0983 /-160.  0.0983 /  80.
   (3) BUS-MH-18   13200.0  0.0008 / -45.  0.0008 /-165.  0.0008 /  75.
   (3) BUS MH-17  ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-Switchgear (3) BUS MH-17  (3)CBL Substat 13200.   8922.0/ -79.   8922.0/ 161.   8922.0/  41.
(3) BUS MH-17  (3) BUS-MH-18  (3) CBL-MH-17  13200.    178.8/  96.    178.8/ -24.    178.8/-144.

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 (3) BUS MH-23  VOLTAGE BASE LL:               13200.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   8178.2 /  -74. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    0.146 +j   0.514 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     3.523

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   9453.1      8184.7      8178.4      8178.2      8178.2

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
                8178.2 / -74.2     8178.2 / 165.8      8178.2 /  45.8

 (3) BUS MH-23  ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   (3)BUS MH-20    13200.0  0.0481 / -36.  0.0481 /-156.  0.0481 /  84.
   BUS-0746        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (3) BUS MH-23  ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(3)BUS MH-20   (3) BUS MH-23  (3) CBL MH-20  13200.   8178.2/ -74.   8178.2/ 166.   8178.2/  46.
(3) BUS MH-23  BUS-0746       (3)CBL MH-23 t 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (3) BUS MH-46  VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   7135.9 /  -69. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.219 +j   0.573 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     2.615

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    7754.8      7136.4      7135.9      7135.9      7135.9

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 7135.9 / -69.1     7135.9 / 170.9      7135.9 /  50.9

 (3) BUS MH-46  ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (3)BUS MH-33    13200.0  0.1527 / -31.  0.1527 /-151.  0.1527 /  89.
   BUS-0767        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (3) BUS MH-46  ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(3)BUS MH-33   (3) BUS MH-46  (3)CBL MH-33 t 13200.   7135.9/ -69.   7135.9/ 171.   7135.9/  51.
(3) BUS MH-46  BUS-0767       (3)CBL MH-46 t 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (3) BUS-MH-18  VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8844.9 /  -78. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.106 +j   0.483 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     4.536

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   10834.8      8879.5      8847.0      8844.9      8844.9

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8844.9 / -77.6     8844.8 / 162.4      8844.9 /  42.4

 (3) BUS-MH-18  ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (3) BUS MH-17   13200.0  0.0371 / -39.  0.0371 /-159.  0.0371 /  81.
   (3)BUS MH-19    13200.0  0.0004 / -45.  0.0004 /-165.  0.0004 /  75.
   (3)MUSIC S&C    13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0965        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (3) BUS-MH-18  ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(3) BUS MH-17  (3) BUS-MH-18  (3) CBL-MH-17  13200.   8667.0/ -77.   8666.9/ 163.   8666.9/  43.
(3) BUS-MH-18  (3)BUS MH-19   (3) CBL-MH-18  13200.    178.9/  96.    178.9/ -24.    178.9/-144.
(3) BUS-MH-18  (3)MUSIC S&C   (3)CBL MH-18 T 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(3) BUS-MH-18  BUS-0965       (3)CBL-MH-18 t 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (3) MH-24      VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8276.9 /  -75. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.140 +j   0.510 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     3.650

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    9643.8      8285.4      8277.2      8276.9      8276.9

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8276.9 / -74.7     8276.9 / 165.3      8276.9 /  45.3

 (3) MH-24      ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (3)BUS MH-19    13200.0  0.0650 / -36.  0.0650 /-156.  0.0650 /  84.
   BUS-0751        13200.0  0.0004 / -45.  0.0004 /-165.  0.0004 /  75.
   (3) MH-24      ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(3)BUS MH-19   (3) MH-24      (3) MH-19 to M 13200.   8100.0/ -74.   8100.0/ 166.   8100.0/  46.
(3) MH-24      BUS-0751       (3)CBL MH-24 t 13200.    179.2/  96.    179.2/ -24.    179.2/-144.

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 (3)BUS MH-19   VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8720.8 /  -77. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.113 +j   0.489 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     4.306

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   10554.8      8746.2      8722.2      8720.8      8720.8

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8720.8 / -76.9     8720.8 / 163.1      8720.8 /  43.1

 (3)BUS MH-19   ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (3)BUS MH-36    13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (3) MH-24       13200.0  0.0014 / -45.  0.0014 /-165.  0.0014 /  75.
   (3)BUS MH-20    13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0795        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0805        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (3) BUS-MH-18   13200.0  0.0183 / -38.  0.0183 /-158.  0.0183 /  82.
   (3)BUS MH-19   ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(3)BUS MH-19   (3)BUS MH-36   (3) Mh-19 to M 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(3)BUS MH-19   (3) MH-24      (3) MH-19 to M 13200.    179.0/  96.    179.0/ -24.    179.0/-144.
(3)BUS MH-19   (3)BUS MH-20   (3) MH-19 to M 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(3)BUS MH-19   BUS-0795       (3)CBL MH-19 T 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(3)BUS MH-19   BUS-0805       (3)CBL MH-19 T 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(3) BUS-MH-18  (3)BUS MH-19   (3) CBL-MH-18  13200.   8543.1/ -77.   8543.1/ 163.   8543.1/  43.

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 (3)BUS MH-20   VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8507.6 /  -76. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.126 +j   0.498 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     3.959

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   10098.8      8522.5      8508.2      8507.6      8507.6

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8507.6 / -75.8     8507.6 / 164.2      8507.6 /  44.2

 (3)BUS MH-20   ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (3)BUS MH-19    13200.0  0.0310 / -37.  0.0310 /-157.  0.0310 /  83.
   (3) BUS MH-23   13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (3)BUS MH-21    13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0743        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (3)BUS MH-20   ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(3)BUS MH-19   (3)BUS MH-20   (3) MH-19 to M 13200.   8507.6/ -76.   8507.6/ 164.   8507.6/  44.
(3)BUS MH-20   (3) BUS MH-23  (3) CBL MH-20  13200.      0.0/   0.      0.0/   0.      0.0/   0.
(3)BUS MH-20   (3)BUS MH-21   (3)CBL MH-20 t 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(3)BUS MH-20   BUS-0743       (3)CBL MH-20 t 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (3)BUS MH-21   VOLTAGE BASE LL:                13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8260.3 /  -75. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.141 +j   0.510 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     3.622

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    9607.8      8268.3      8260.5      8260.3      8260.3

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8260.3 / -74.6     8260.3 / 165.4      8260.3 /  45.4

 (3)BUS MH-21   ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (3)BUS MH-20    13200.0  0.0362 / -36.  0.0362 /-156.  0.0362 /  84.
   BUS-0740        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (3)BUS MH-21   ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(3)BUS MH-20   (3)BUS MH-21   (3)CBL MH-20 t 13200.   8260.3/ -75.   8260.3/ 165.   8260.3/  45.
(3)BUS MH-21   BUS-0740       (3)CBL MH-21 t 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (3)BUS MH-33   VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8184.0 /  -74. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.146 +j   0.514 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     3.530

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    9463.9      8190.7      8184.2      8184.0      8184.0

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8184.0 / -74.2     8184.0 / 165.8      8184.0 /  45.8

 (3)BUS MH-33   ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (3)BUS MH-36    13200.0  0.0482 / -36.  0.0482 /-156.  0.0482 /  84.
   (3) BUS MH-46   13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0774        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (3)BUS MH-33   ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(3)BUS MH-36   (3)BUS MH-33   (3)CBL MH-36 t 13200.   8184.0/ -74.   8184.0/ 166.   8184.0/  46.
(3)BUS MH-33   (3) BUS MH-46  (3)CBL MH-33 t 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(3)BUS MH-33   BUS-0774       (3)CBL MH-33 t 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (3)BUS MH-36   VOLTAGE BASE LL:                13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8513.8 /  -76. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.126 +j   0.498 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     3.968

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   10111.5      8528.9      8514.4      8513.8      8513.8

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8513.8 / -75.9     8513.8 / 164.1      8513.8 /  44.1

 (3)BUS MH-36   ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (3)BUS MH-19    13200.0  0.0301 / -37.  0.0301 /-157.  0.0301 /  83.
   (3)BUS MH-33    13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (3)BUS MH-36   ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(3)BUS MH-19   (3)BUS MH-36   (3) Mh-19 to M 13200.   8513.8/ -76.   8513.8/ 164.   8513.8/  44.
(3)BUS MH-36   (3)BUS MH-33   (3)CBL MH-36 t 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (3)MUSIC S&C   VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8678.1 /  -76. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.118 +j   0.490 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     4.148

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   10412.5      8698.3      8679.1      8678.1      8678.1

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8678.1 / -76.4     8678.1 / 163.6      8678.1 /  43.6

 (3)MUSIC S&C   ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0789        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0790        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (3) BUS-MH-18   13200.0  0.0271 / -45.  0.0271 /-165.  0.0271 /  75.
   (3)MUSIC S&C   ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(3)MUSIC S&C   BUS-0789      (3)CBL S&C MUS 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(3)MUSIC S&C   BUS-0790      MUSIC S&C      13200.      0.0/   0.      0.0/   0.      0.0/   0.
(3) BUS-MH-18  (3)MUSIC S&C  (3)CBL MH-18 T 13200.   8678.1/ -76.   8678.1/ 164.   8678.1/  44.

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 (4) BUS MH-17  VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   9075.1 /  -79. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.094 +j   0.473 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     5.033

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   11385.4      9136.4      9080.2      9075.1      9075.1

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 9075.1 / -78.8     9075.1 / 161.2      9075.1 /  41.2

 (4) BUS MH-17  ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-Switchgear  13200.0  0.1000 / -40.  0.1000 /-160.  0.1000 /  80.
   BUS-0797        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (4) BUS-MH-18   13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (4) BUS MH-17  ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-Switchgear (4) BUS MH-17  (4)CBL Substat 13200.   9075.1/ -79.   9075.1/ 161.   9075.1/  41.
(4) BUS MH-17  BUS-0797       Parking Garage 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(4) BUS MH-17  (4) BUS-MH-18  (4) CBL-MH-17  13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (4) BUS MH-23  VOLTAGE BASE LL:               13200.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   8183.5 /  -74. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    0.150 +j   0.513 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     3.426

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   9400.7      8188.8      8183.6      8183.5      8183.5

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
                8183.5 / -73.7     8183.5 / 166.3      8183.5 /  46.3

 (4) BUS MH-23  ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   (4)BUS MH-20    13200.0  0.0468 / -43.  0.0468 /-163.  0.0468 /  77.
   BUS-0754        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (4) BUS MH-23  ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(4)BUS MH-20   (4) BUS MH-23  (4) CBL MH-20  13200.   8183.5/ -74.   8183.5/ 166.   8183.5/  46.
(4) BUS MH-23  BUS-0754       (4)CBL MH-23 t 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (4) BUS MH-46  VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   7107.7 /  -69. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.221 +j   0.574 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     2.594

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    7712.6      7108.1      7107.7      7107.7      7107.7

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 7107.7 / -68.9     7107.7 / 171.1      7107.7 /  51.1

 (4) BUS MH-46  ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (4)BUS MH-33    13200.0  0.1521 / -30.  0.1521 /-150.  0.1521 /  90.
   BUS-0768        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (4) BUS MH-46  ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(4)BUS MH-33   (4) BUS MH-46  (4)CBL MH-33 t 13200.   7107.7/ -69.   7107.7/ 171.   7107.7/  51.
(4) BUS MH-46  BUS-0768       (4)CBL MH-46 t 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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(4) BUS-MH-18  VOLTAGE BASE LL:              13200.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   8811.1 /  -77. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    0.109 +j   0.484 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     4.462

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                  10752.2      8842.6      8813.0      8811.1      8811.1

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
                8811.1 / -77.4     8811.1 / 162.6      8811.1 /  42.6

(4) BUS-MH-18  ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
  (4) BUS MH-17   13200.0  0.0377 / -39.  0.0377 /-159.  0.0377 /  81.
  (4)BUS MH-19    13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
  (4) MUSIC S&C   13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
  BUS-0966        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
  (4) BUS-MH-18  ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(4) BUS MH-17  (4) BUS-MH-18  (4) CBL-MH-17  13200.   8811.1/ -77.   8811.1/ 163.   8811.1/  43.
(4) BUS-MH-18  (4)BUS MH-19   (4) CBL-MH-18  13200.      0.0/   0.      0.0/   0.      0.0/   0.
(4) BUS-MH-18  (4) MUSIC S&C  (4)CBL MH-18 T 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(4) BUS-MH-18  BUS-0966       (4)CBL-MH-18 t 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (4) MH-24      VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8225.1 /  -74. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.143 +j   0.512 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     3.572

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    9537.1      8232.3      8225.3      8225.1      8225.1

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8225.1 / -74.4     8225.1 / 165.6      8225.1 /  45.6

 (4) MH-24      ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (4)BUS MH-19    13200.0  0.0660 / -36.  0.0660 /-156.  0.0660 /  84.
   BUS-0758        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (4) MH-24      ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                             FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                            BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(4)BUS MH-19   (4) MH-24      (4) MH-19 to M 13200.   8225.1/ -74.   8225.1/ 166.   8225.1/  46.
(4) MH-24      BUS-0758       (4)CBL MH-24 t 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (4) MUSIC S&C  VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8645.0 /  -76. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.120 +j   0.491 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     4.087

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   10337.7      8663.5      8645.9      8645.0      8645.0

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8645.0 / -76.3     8645.0 / 163.7      8645.0 /  43.7

 (4) MUSIC S&C  ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0788        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (4) BUS-MH-18   13200.0  0.0270 / -45.  0.0270 /-165.  0.0270 /  75.
   (4) MUSIC S&C  ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(4) MUSIC S&C  BUS-0788       (4)CBL S&C MUS 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(4) BUS-MH-18  (4) MUSIC S&C  (4)CBL MH-18 T 13200.   8645.0/ -76.   8645.0/ 164.   8645.0/  44.

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 (4)BUS MH-19   VOLTAGE BASE LL:                13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8683.0 /  -77. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.116 +j   0.490 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     4.230

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   10465.9      8705.8      8684.1      8683.0      8683.0

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8683.0 / -76.7     8683.0 / 163.3      8683.0 /  43.3

 (4)BUS MH-19   ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (4)BUS MH-36    13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (4) MH-24       13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (4)BUS MH-20    13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0800        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0806        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (4) BUS-MH-18   13200.0  0.0186 / -38.  0.0186 /-158.  0.0186 /  82.
   (4)BUS MH-19   ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(4)BUS MH-19   (4)BUS MH-36   CBL-0181       13200.      0.0/   0.      0.0/   0.      0.0/   0.
(4)BUS MH-19   (4) MH-24      (4) MH-19 to M 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(4)BUS MH-19   (4)BUS MH-20   (4) MH-19 to M 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(4)BUS MH-19   BUS-0800       (4)CBL MH-19 T 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(4)BUS MH-19   BUS-0806       (4)CBL MH-19 T 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(4) BUS-MH-18  (4)BUS MH-19   (4) CBL-MH-18  13200.  8683.0/ -77.  8683.0/ 163.  8683.0/  43.

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 (4)BUS MH-20   VOLTAGE BASE LL:                13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8471.0 /  -76. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.128 +j   0.500 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     3.897

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   10018.9      8484.4      8471.5      8471.0      8471.0

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8471.0 / -75.6     8471.0 / 164.4      8471.0 /  44.4

 (4)BUS MH-20   ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (4)BUS MH-19    13200.0  0.0308 / -37.  0.0308 /-157.  0.0308 /  83.
   (4) BUS MH-23   13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (4)BUS MH-21    13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0752        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (4)BUS MH-20   ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(4)BUS MH-19   (4)BUS MH-20   (4) MH-19 to M 13200.   8471.0/ -76.   8471.0/ 164.   8471.0/  44.
(4)BUS MH-20   (4) BUS MH-23  (4) CBL MH-20  13200.      0.0/   0.      0.0/   0.      0.0/   0.
(4)BUS MH-20   (4)BUS MH-21   (4)CBL MH-20 t 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(4)BUS MH-20   BUS-0752       (4)CBL MH-20 t 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (4)BUS MH-21   VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8225.1 /  -74. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.143 +j   0.512 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     3.572

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    9537.1      8232.3      8225.3      8225.1      8225.1

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8225.1 / -74.4     8225.1 / 165.6      8225.1 /  45.6

 (4)BUS MH-21   ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (4)BUS MH-20    13200.0  0.0361 / -36.  0.0361 /-156.  0.0361 /  84.
   BUS-0741        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (4)BUS MH-21   ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(4)BUS MH-20   (4)BUS MH-21   (4)CBL MH-20 t 13200.   8225.1/ -74.   8225.1/ 166.   8225.1/  46.
(4)BUS MH-21   BUS-0741       (4)CBL MH-21 t 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (4)BUS MH-33   VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8149.3 /  -74. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.148 +j   0.516 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     3.483

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    9395.7      8155.3      8149.5      8149.3      8149.3

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8149.3 / -74.0     8149.3 / 166.0      8149.3 /  46.0

 (4)BUS MH-33   ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (4)BUS MH-36    13200.0  0.0480 / -35.  0.0480 /-155.  0.0480 /  85.
   (4) BUS MH-46   13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0775        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (4)BUS MH-33   ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                                 FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                                BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(4)BUS MH-36   (4)BUS MH-33   (4)CBL MH-36 t 13200.   8149.3/ -74.   8149.3/ 166.   8149.3/  46.
(4)BUS MH-33   (4) BUS MH-46  (4)CBL MH-33 t 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(4)BUS MH-33   BUS-0775       (4)CBL MH-33 t 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (4)BUS MH-36   VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8477.1 /  -76. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.128 +j   0.500 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     3.906

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   10031.3      8490.7      8477.7      8477.1      8477.1

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8477.1 / -75.6     8477.1 / 164.4      8477.1 /  44.4

 (4)BUS MH-36   ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (4)BUS MH-19    13200.0  0.0299 / -37.  0.0299 /-157.  0.0299 /  83.
   (4)BUS MH-33    13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (4)BUS MH-36   ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                                FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                               BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(4)BUS MH-19   (4)BUS MH-36   CBL-0181       13200.   8477.1/ -76.   8477.1/ 164.   8477.1/  44.
(4)BUS MH-36   (4)BUS MH-33   (4)CBL MH-36 t 13200.       0.0/   0.       0.0/   0.       0.0/   0.

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 (5) BUS MH-44  VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8602.1 /  -75. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.135 +j   0.490 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     3.636

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   10014.1      8610.7      8602.4      8602.2      8602.2

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8602.1 / -74.6     8602.1 / 165.4      8602.1 /  45.4

 (5) BUS MH-44  ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (5) BUS-MH-25   13200.0  0.0001 / -36.  0.0001 /-156.  0.0001 /  84.
   BUS-0836        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0838        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (5) BUS MH-44  ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(5) BUS-MH-25  (5) BUS MH-44  (5) CBL MH-25  13200.   8602.2/ -75.   8602.1/ 165.   8602.1/  45.
(5) BUS MH-44  BUS-0836       (5) CBL-MH-44  13200.      0.0/   0.      0.0/   0.      0.0/   0.
(5) BUS MH-44  BUS-0838       (5) CBL-MH-44  13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (5) BUS MH-47  VOLTAGE BASE LL:              13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   7713.6 /  -69. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.201 +j   0.530 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     2.638

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    8396.3      7714.2      7713.6      7713.6      7713.6

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 7713.6 / -69.2     7713.6 / 170.8      7713.6 /  50.8

 (5) BUS MH-47  ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (5) BUS-MH-25   13200.0  0.1363 / -38.  0.1363 /-158.  0.1363 /  82.
   (5) BUS MH-48   13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0825        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (5) BUS MH-47  ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                                FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                               BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(5) BUS-MH-25  (5) BUS MH-47  (5) CBL MH-25  13200.   7713.6/ -69.   7713.6/ 171.   7713.6/  51.
(5) BUS MH-47  (5) BUS MH-48  (5) CBL-MH-47  13200.      0.0/   0.      0.0/   0.      0.0/   0.
(5) BUS MH-47  BUS-0825       (5) CBL-MH-47  13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (5) BUS MH-48  VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   7468.4 /  -68. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.218 +j   0.544 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     2.496

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    8048.5      7468.8      7468.4      7468.4      7468.4

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 7468.4 / -68.2     7468.4 / 171.8      7468.4 /  51.8

 (5) BUS MH-48  ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (5) BUS MH-47   13200.0  0.0368 / -30.  0.0368 /-150.  0.0368 /  90.
   BUS-0823        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (5) BUS MH-48  ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(5) BUS MH-47  (5) BUS MH-48  (5) CBL-MH-47  13200.   7468.4/ -68.   7468.4/ 172.   7468.4/  52.
(5) BUS MH-48  BUS-0823       (5) CBL-MH-48  13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (5) BUS-MH-25  VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8602.8 /  -75. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.135 +j   0.490 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     3.636

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   10015.3      8611.4      8603.1      8602.8      8602.8

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8602.8 / -74.6     8602.8 / 165.4      8602.8 /  45.4

 (5) BUS-MH-25  ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-Switchgear  13200.0  0.1807 / -43.  0.1807 /-163.  0.1807 /  77.
   (5) BUS-MH-30   13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (5) BUS MH-44   13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (5) BUS MH-47   13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0852        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (5) BUS-MH-25  =============== INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ===============
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-Switchgear (5) BUS-MH-25  CBL-0044       13200.   8602.8/ -75.   8602.8/ 165.   8602.8/  45.
(5) BUS-MH-25  (5) BUS-MH-30  (5) MH-25 to M 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(5) BUS-MH-25  (5) BUS MH-44  (5) CBL MH-25  13200.      0.0/   0.      0.0/   0.      0.0/   0.
(5) BUS-MH-25  (5) BUS MH-47  (5) CBL MH-25  13200.      0.0/   0.      0.0/   0.      0.0/   0.
(5) BUS-MH-25  BUS-0852       (5) CBL-MH-25  13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (5) BUS-MH-30  VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8453.5 /  -74. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.145 +j   0.497 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     3.417

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    9705.2      8458.9      8453.6      8453.5      8453.5

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8453.5 / -73.7     8453.5 / 166.3      8453.5 /  46.3

 (5) BUS-MH-30  ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (5) BUS-MH-25   13200.0  0.0237 / -43.  0.0237 /-163.  0.0237 /  77.
   (5) BUS-MH-30  ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(5) BUS-MH-25  (5) BUS-MH-30  (5) MH-25 to M 13200.   8453.5/ -74.   8453.5/ 166.   8453.5/  46.

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 (6) BUS MH-25  VOLTAGE BASE LL:              13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8501.1 /  -76. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.127 +j   0.499 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     3.941

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   10080.8      8515.6      8501.7      8501.1      8501.1

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8501.1 / -75.8     8501.1 / 164.2      8501.1 /  44.2

 (6) BUS MH-25  ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-Switchgear  13200.0  0.1789 / -37.  0.1789 /-157.  0.1789 /  83.
   (6) BUS MH-30   13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (6) BUS MH-44   13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (6) BUS MH-47   13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0851        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0853        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0854        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (6) BUS MH-25  ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-Switchgear (6) BUS MH-25  CBL-0004       13200.   8277.0/ -76.   8277.0/ 164.   8277.0/  44.
(6) BUS MH-25  (6) BUS MH-30  (6) MH-25 to M 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(6) BUS MH-25  (6) BUS MH-44  (6) CBL MH-25  13200.      0.0/   0.      0.0/   0.      0.0/   0.
(6) BUS MH-25  (6) BUS MH-47  (6)CBL MH-25 t 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(6) BUS MH-25  BUS-0851       (6) CBL-MH-25  13200.      0.0/   0.      0.0/   0.      0.0/   0.
(6) BUS MH-25  BUS-0853       VB1 S&C        13200.    224.5/ 101.    224.5/ -19.    224.5/-139.
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(6) BUS MH-25 ================ FIRST BRANCH SYSTEM BRANCH FLOWS (AMPS) ================

(6) BUS MH-25	BUS-0854	VB2 S&C	13200.	0.0/ 0.	0.0/ 0.	0.0/ 0.

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 (6) BUS MH-30  VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8358.0 /  -75. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.137 +j   0.505 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     3.686

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    9759.9      8367.1      8358.3      8358.0      8358.0

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8358.0 / -74.8     8358.0 / 165.2      8358.0 /  45.2

 (6) BUS MH-30  ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0815        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (6) BUS MH-25   13200.0  0.0235 / -44.  0.0235 /-164.  0.0235 /  76.
   (6) BUS MH-30  ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                                FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                               BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(6) BUS MH-30  BUS-0815       AB4 S&C Switch 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(6) BUS MH-25  (6) BUS MH-30  (6) MH-25 to M 13200.   8358.0/ -75.   8358.0/ 165.   8358.0/  45.

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 (6) BUS MH-44  VOLTAGE BASE LL:                13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8500.5 /  -76. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.127 +j   0.499 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     3.940

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   10079.5      8514.9      8501.1      8500.5      8500.5

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8500.5 / -75.8     8500.5 / 164.2      8500.5 /  44.2

 (6) BUS MH-44  ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0837        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (6) BUS MH-25   13200.0  0.0001 / -37.  0.0001 /-157.  0.0001 /  83.
   (6) BUS MH-44  ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(6) BUS MH-44  BUS-0837       (6) CBL-MH-44  13200.      0.0/   0.      0.0/   0.      0.0/   0.
(6) BUS MH-25  (6) BUS MH-44  (6) CBL MH-25  13200.   8500.5/ -76.   8500.5/ 164.   8500.5/  44.

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 (6) BUS MH-47  VOLTAGE BASE LL:                13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   7644.9 /  -70. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.193 +j   0.539 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     2.796

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    8414.2      7645.9      7644.9      7644.9      7644.9

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 7644.9 / -70.3     7644.9 / 169.7      7644.9 /  49.7

 (6) BUS MH-47  ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (6) BUS MH-48   13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0826        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (6) BUS MH-25   13200.0  0.1351 / -39.  0.1351 /-159.  0.1351 /  81.
   (6) BUS MH-47  ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(6) BUS MH-47  (6) BUS MH-48  (6) CBL MH-47  13200.      0.0/   0.      0.0/   0.      0.0/   0.
(6) BUS MH-47  BUS-0826       (6) CBL-MH-47  13200.      0.0/   0.      0.0/   0.      0.0/   0.
(6) BUS MH-25  (6) BUS MH-47  (6)CBL MH-25 t 13200.   7644.9/ -70.   7644.9/ 170.   7644.9/  50.

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 (6) BUS MH-48  VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   7406.6 /  -69. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.210 +j   0.552 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     2.635

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    8060.2      7407.1      7406.6      7406.6      7406.6

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 7406.6 / -69.2     7406.6 / 170.8      7406.6 /  50.8

 (6) BUS MH-48  ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (6) BUS MH-47   13200.0  0.0365 / -31.  0.0365 /-151.  0.0365 /  89.
   BUS-0824        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (6) BUS MH-48  ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(6) BUS MH-47  (6) BUS MH-48  (6) CBL MH-47  13200.   7406.6/ -69.   7406.6/ 171.   7406.6/  51.
(6) BUS MH-48  BUS-0824       (6) CBL-MH-48  13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (7)BUS MH-Pirk VOLTAGE BASE LL:               13200.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   7530.8 /  -70. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    0.199 +j   0.546 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     2.746

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   8259.5      7531.6      7530.8      7530.8      7530.8

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
                7530.8 / -70.0     7530.8 / 170.0      7530.8 /  50.0

 (7)BUS MH-Pirk ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   (7)BUS MH43     13200.0  0.1934 / -31.  0.1934 /-151.  0.1934 /  89.
   BUS-0962        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (7)BUS MH-Pirk ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(7)BUS MH43    (7)BUS MH-Pirk (7)CBL MH43 to 13200.   7530.8/ -70.   7530.8/ 170.   7530.8/  50.
(7)BUS MH-Pirk BUS-0962       (7)CBL MH43 to 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (7)BUS MH43    VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8953.6 /  -77. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.111 +j   0.476 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     4.291

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   10827.8      8979.1      8955.0      8953.6      8953.6

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8953.6 / -76.9     8953.6 / 163.1      8953.6 /  43.1

 (7)BUS MH43    ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0665        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (7)BUS-MH42     13200.0  0.0130 / -46.  0.0130 /-166.  0.0130 /  74.
   (7)BUS MH-Pirk  13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (7)BUS MH43    ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                                 FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                                BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(7)BUS MH43    BUS-0665       (8)CBL-MH43 to 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(7)BUS-MH42    (7)BUS MH43    (7)CBL MH42 to 13200.   8953.6/ -77.   8953.6/ 163.   8953.6/  43.
(7)BUS MH43    (7)BUS MH-Pirk (7)CBL MH43 to 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (7)BUS-MH41    VOLTAGE BASE LL:                 13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   9058.9 /  -78. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.104 +j   0.472 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     4.539

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   11098.8      9094.5      9061.1      9058.9      9058.9

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 9058.9 / -77.6     9058.9 / 162.4      9058.9 /  42.4

 (7)BUS-MH41    ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (7)BUS-MH49     13200.0  0.0184 / -46.  0.0184 /-166.  0.0184 /  74.
   BUS-0661        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (7)BUS-MH42     13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (7)BUS-MH41    ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                                 FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                                BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(7)BUS-MH49    (7)BUS-MH41    (7)CBL MH49 to 13200.   9058.9/ -78.   9058.9/ 162.   9058.9/  42.
(7)BUS-MH41    BUS-0661       (8)CBL-MH41 to 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(7)BUS-MH41    (7)BUS-MH42    (7)CBL MH41 to 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (7)BUS-MH42    VOLTAGE BASE LL:                13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   9035.4 /  -77. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.105 +j   0.472 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     4.481

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   11037.1      9068.5      9037.4      9035.4      9035.4

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 9035.4 / -77.4     9035.4 / 162.6      9035.4 /  42.6

 (7)BUS-MH42    ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (7)BUS-MH41     13200.0  0.0038 / -46.  0.0038 /-166.  0.0038 /  74.
   (7)BUS MH43     13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0663        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (7)BUS-MH42    ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                                FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                               BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(7)BUS-MH41    (7)BUS-MH42    (7)CBL MH41 to 13200.   9035.4/ -77.   9035.4/ 163.   9035.4/  43.
(7)BUS-MH42    (7)BUS MH43    (7)CBL MH42 to 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(7)BUS-MH42    BUS-0663       (7)CBL-MH42 to 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (7)BUS-MH49    VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   9174.2 /  -78. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.096 +j   0.467 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     4.849

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   11412.4      9225.6      9178.1      9174.3      9174.2

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 9174.2 / -78.3     9174.2 / 161.7      9174.2 /  41.7

 (7)BUS-MH49    ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-Switchgear  13200.0  0.0982 / -47.  0.0982 /-167.  0.0982 /  73.
   (7)BUS-MH41     13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0673        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (7)BUS-MH49    ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                                FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                               BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-Switchgear (7)BUS-MH49    (7)CBL-MH1 to  13200.   9174.2/ -78.   9174.2/ 162.   9174.2/  42.
(7)BUS-MH49    (7)BUS-MH41    (7)CBL MH49 to 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(7)BUS-MH49    BUS-0673       (7)CBL-MH49 to 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (8)BUS MH43    VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   9147.5 /  -78. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.098 +j   0.468 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     4.774

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   11338.1      9194.7      9150.9      9147.5      9147.5

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 9147.5 / -78.2     9147.5 / 161.8      9147.5 /  41.8

 (8)BUS MH43    ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0666        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (8)BUS-MH42     13200.0  0.0133 / -47.  0.0133 /-167.  0.0133 /  73.
   (8)BUS MH43    ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(8)BUS MH43    BUS-0666       (7)CBL-MH43 to 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(8)BUS-MH42    (8)BUS MH43    (8)CBL MH42 to 13200.   9147.5/ -78.   9147.5/ 162.   9147.5/  42.

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 (8)BUS-MH41    VOLTAGE BASE LL:              13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   9254.8 /  -79. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.091 +j   0.464 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     5.094

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   11642.8      9321.2      9260.5      9254.9      9254.8

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 9254.8 / -78.9     9254.8 / 161.1      9254.8 /  41.1

 (8)BUS-MH41    ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (8)BUS-MH49     13200.0  0.0188 / -48.  0.0188 /-168.  0.0188 /  72.
   BUS-0662        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (8)BUS-MH42     13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (8)BUS-MH41    ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                           FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                          BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(8)BUS-MH49    (8)BUS-MH41    (8)CBL MH 49 T 13200.   9254.8/ -79.   9254.8/ 161.   9254.8/  41.
(8)BUS-MH41    BUS-0662       (7)CBL-MH41 to 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(8)BUS-MH41    (8)BUS-MH42    (8)CBL MH41 to 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (8)BUS-MH42    VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   9230.9 /  -79. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.093 +j   0.465 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     5.019

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   11573.3      9292.4      9235.9      9230.9      9230.9

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 9230.9 / -78.7     9230.9 / 161.3      9230.9 /  41.3

 (8)BUS-MH42    ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (8)BUS-MH41     13200.0  0.0038 / -48.  0.0038 /-168.  0.0038 /  72.
   (8)BUS MH43     13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0664        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (8)BUS-MH42    ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                                FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                               BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(8)BUS-MH41    (8)BUS-MH42    (8)CBL MH41 to 13200.   9230.9/ -79.   9230.9/ 161.   9230.9/  41.
(8)BUS-MH42    (8)BUS MH43    (8)CBL MH42 to 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(8)BUS-MH42    BUS-0664       (8)CBL-MH42 to 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (8)BUS-MH49    VOLTAGE BASE LL:              13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   9372.2 /  -80. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.083 +j   0.459 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     5.503

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   11996.6      9469.0      9382.1      9372.3      9372.2

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 9372.2 / -79.7     9372.2 / 160.3      9372.2 /  40.3

 (8)BUS-MH49    ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-Switchgear  13200.0  0.0682 / -49.  0.0682 /-169.  0.0682 /  71.
   (8)BUS-MH41     13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0652        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (8)BUS-MH49    ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-Switchgear (8)BUS-MH49    (8)CBL-MH1 to  13200.   9372.2/ -80.   9372.2/ 160.   9372.2/  40.
(8)BUS-MH49    (8)BUS-MH41    (8)CBL MH 49 T 13200.      0.0/   0.      0.0/   0.      0.0/   0.
(8)BUS-MH49    BUS-0652       (8)CBL-MH49 to 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 (F1) BUS MH31  VOLTAGE BASE LL:                4160.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   5540.1 / -110. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.420 +j   2.470 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     5.884

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    7196.8      5617.0      5549.3      5540.3      5540.1

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 5540.1 /-110.4     5540.1 / 129.6      5540.1 /   9.6

 (F1) BUS MH31  ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS- Farringto   4160.0  0.0188 / -72.  0.0188 / 168.  0.0188 /  48.
   BUS-0894         4160.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0897         4160.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (F1) BUS MH31  ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS- Farringto (F1) BUS MH31  (F1)CBL FS1 TO  4160.   5540.1/-110.   5540.1/ 130.   5540.1/  10.
(F1) BUS MH31  BUS-0894       (F1)CBL MH31 T  4160.      0.0/   0.      0.0/   0.      0.0/   0.
(F1) BUS MH31  BUS-0897       (F1)CBL MH31 T  4160.      0.0/   0.      0.0/   0.      0.0/   0.

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 (F2) BUS- MH34 VOLTAGE BASE LL:                4160.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   4750.7 / -104. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    0.793 +j   2.812 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     3.543

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   5498.4      4754.7      4750.8      4750.7      4750.7

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
                4750.7 /-104.2     4750.7 / 135.8      4750.7 /  15.8

 (F2) BUS- MH34 ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS- Farringto   4160.0  0.1895 / -62.  0.1895 / 178.  0.1895 /  58.
   (F2)BUS-MH35     4160.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0890         4160.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0892         4160.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (F2) BUS- MH34 ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS- Farringto (F2) BUS- MH34 (F2)CBL FS2 TO  4160.   4750.7/-104.   4750.7/ 136.   4750.7/  16.
(F2) BUS- MH34 (F2)BUS-MH35   (F2) CBL MH34   4160.      0.0/   0.      0.0/   0.      0.0/   0.
(F2) BUS- MH34 BUS-0890       (F2) CBL MH34   4160.      0.0/   0.      0.0/   0.      0.0/   0.
(F2) BUS- MH34 BUS-0892       (F2) MH34 TO E  4160.      0.0/   0.      0.0/   0.      0.0/   0.

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 (F2)BUS-MH35   VOLTAGE BASE LL:                4160.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   4327.6 / -101. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    1.063 +j   3.026 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     2.848

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    4780.3      4328.2      4327.6      4327.6      4327.6

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 4327.6 /-100.6     4327.6 / 139.4      4327.6 /  19.4

 (F2)BUS-MH35   ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (F2) BUS- MH34   4160.0  0.1073 / -62.  0.1073 / 178.  0.1073 /  58.
   BUS-0117         4160.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0126         4160.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0142         4160.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0145         4160.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0147         4160.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (F2)BUS-MH35   ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(F2) BUS- MH34 (F2)BUS-MH35   (F2) CBL MH34   4160.   4327.6/-101.   4327.6/ 139.   4327.6/  19.
(F2)BUS-MH35   BUS-0117       CBL-0079        4160.      0.0/   0.      0.0/   0.      0.0/   0.
(F2)BUS-MH35   BUS-0126       CBL-0080        4160.      0.0/   0.      0.0/   0.      0.0/   0.
(F2)BUS-MH35   BUS-0142       CBL-0081        4160.      0.0/   0.      0.0/   0.      0.0/   0.
(F2)BUS-MH35   BUS-0145       CBL-0082        4160.      0.0/   0.      0.0/   0.      0.0/   0.
(F2)BUS-MH35   BUS-0147       CBL-0083        4160.      0.0/   0.      0.0/   0.      0.0/   0.

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 (F4)BUS- MH34  VOLTAGE BASE LL:                4160.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   5669.5 / -104. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.668 +j   2.355 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     3.523

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    6553.4      5674.0      5669.6      5669.5      5669.5

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 5669.5 /-104.2     5669.5 / 135.8      5669.5 /  15.8

 (F4)BUS- MH34  ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-Farrington   4160.0  0.1818 / -71.  0.1818 / 169.  0.1818 /  49.
   BUS-0635         4160.0  0.0013 / -79.  0.0013 / 161.  0.0013 /  41.
   (F4)BUS- MH34  ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-Farrington (F4)BUS- MH34  (F4)CBL-FS4 TO  4160.   4866.5/-103.   4866.5/ 137.   4866.5/  17.
(F4)BUS- MH34  BUS-0635       (F4)CBL MH34 T  4160.    808.1/  70.    808.1/ -50.    808.1/-170.

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 (F5) POLE AT 1 VOLTAGE BASE LL:                4160.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   4942.8 /  -99. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    1.002 +j   2.623 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     2.618

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   5372.7      4943.2      4942.8      4942.8      4942.8

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
                4942.8 / -99.1     4942.8 / 140.9      4942.8 /  20.9

 (F5) POLE AT 1 ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   (F5)MH33        4160.0  0.0676 / -83.  0.0676 / 157.  0.0676 /  37.
   (F5) POLE AT B   4160.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (F5) POLE AT E   4160.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (F5) POLE AT 1 ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(F5) POLE AT 1 (F5)MH33       (F5) OH M33 TO  4160.   4942.8/  81.   4942.8/ -39.   4942.8/-159.
(F5) POLE AT B (F5) POLE AT 1 (F5) OH 17/J T  4160.      0.0/   0.      0.0/   0.      0.0/   0.
(F5) POLE AT E (F5) POLE AT 1 (F5) OH 17/J T  4160.      0.0/   0.      0.0/   0.      0.0/   0.

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 (F5) POLE AT B VOLTAGE BASE LL:                4160.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   4741.8 /  -96. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    1.184 +j   2.677 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     2.261

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   5027.8      4741.9      4741.8      4741.8      4741.8

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
                4741.8 / -96.1     4741.8 / 143.9      4741.8 /  23.9

 (F5) POLE AT B ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   (F5) POLE AT 1   4160.0  0.0648 / -80.  0.0648 / 160.  0.0648 /  40.
   BUS-0887         4160.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (F5) POLE AT B ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(F5) POLE AT B (F5) POLE AT 1 (F5) OH 17/J T  4160.   4741.8/  84.   4741.8/ -36.   4741.8/-156.
BUS-0887       (F5) POLE AT B (F5) OH BB TO   4160.      0.0/   0.      0.0/   0.      0.0/   0.

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 (F5) POLE AT E VOLTAGE BASE LL:               4160.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   4741.8 /  -96. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    1.184 +j   2.677 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     2.261

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   5027.8      4741.9      4741.8      4741.8      4741.8

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
                4741.8 / -96.1     4741.8 / 143.9      4741.8 /  23.9

 (F5) POLE AT E ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   (F5) POLE AT 1   4160.0  0.0648 / -80.  0.0648 / 160.  0.0648 /  40.
   BUS-0886         4160.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (F5) POLE AT E ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
(F5) POLE AT E (F5) POLE AT 1 (F5) OH 17/J T  4160.   4741.8/  84.   4741.8/ -36.   4741.8/-156.
BUS-0886       (F5) POLE AT E (F5) OH ELL TO  4160.      0.0/   0.      0.0/   0.      0.0/   0.

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 (F5)MH33       VOLTAGE BASE LL:                 4160.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   5146.1 / -102. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.820 +j   2.569 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     3.134

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    5798.1      5147.8      5146.2      5146.1      5146.1

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 5146.1 /-102.3     5146.1 / 137.7      5146.1 /  17.7

 (F5)MH33       ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS- Farringto   4160.0  0.1689 / -86.  0.1689 / 154.  0.1689 /  34.
   BUS-0150         4160.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (F5) POLE AT 1   4160.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (F5)MH33       ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                                 FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                                BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS- Farringto (F5)MH33       (F5)CBL FS5 TO  4160.   5146.1/-102.   5146.1/ 138.   5146.1/  18.
(F5)MH33       BUS-0150       CBL POLE TO AU  4160.      0.0/   0.      0.0/   0.      0.0/   0.
(F5) POLE AT 1 (F5)MH33       (F5) OH M33 TO  4160.      0.0/   0.      0.0/   0.      0.0/   0.

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 (F6)BUS - MH-3 VOLTAGE BASE LL:               4160.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   6223.4 / -109. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    0.420 +j   2.190 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     5.219

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   7872.1      6273.6      6227.9      6223.4      6223.4

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
                6223.4 /-109.2     6223.4 / 130.8      6223.4 /  10.8

 (F6)BUS - MH-3 ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-Farrington   4160.0  0.0370 / -78.  0.0370 / 162.  0.0370 /  42.
   BUS-0861         4160.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (F6)BUS - MH-3 ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-Farrington (F6)BUS - MH-3 (F6)CBL - FS6   4160.   6223.4/-109.   6223.4/ 131.   6223.4/  11.
(F6)BUS - MH-3 BUS-0861       (F6) CBL MH-37  4160.      0.0/   0.      0.0/   0.      0.0/   0.

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 AB1 MCB1       VOLTAGE BASE LL:                 480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  11806.7 / -106. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    2.378 +j   9.906 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     4.165

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   14180.3     11834.9     11808.0     11806.7     11806.7

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                11806.7 /-106.5    11806.7 / 133.5     11806.7 /  13.5

 AB1 MCB1       ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0786          480.0  0.1174 / -49.  0.1174 /-169.  0.1174 /  71.
   AB1 MCB1       ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                                 FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                                BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0786       AB1 MCB1       CBL-AB1 XFMR t   480.  11806.7/-106.  11806.7/ 134.  11806.7/  14.

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 AB3 MDP       VOLTAGE BASE LL:                 208.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:  20965.5 / -134. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    3.648 +j  12.727 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     3.488

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                  24180.4     20981.0     20965.9     20965.5     20965.5

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               20965.5 /-134.0    20965.5 / 106.0     20965.5 / -14.0

 AB3 MDP       ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0865         208.0  0.2025 / -81.  0.2025 / 159.  0.2025 /  39.
   AB3 MDP       ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0865       AB3 MDP       CBL-AB3 CFMR t   208.  20965.5/-134.  20965.5/ 106.  20965.5/ -14.

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 AB4 MDP       VOLTAGE BASE LL:                480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:  14252.0 / -102. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    2.644 +j   8.015 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     3.032

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                  15945.5     14255.6     14252.1     14252.0     14252.0

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               14252.0 /-101.7    14252.0 / 138.3     14252.0 /  18.3

 AB4 MDP       ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0817         480.0  0.2097 / -63.  0.2097 / 177.  0.2097 /  57.
   AB4 MDP       ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0817       AB4 MDP       CBL-AB4 XFMR t   480.  14252.0/-102.  14252.0/ 138.  14252.0/  18.

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 Admin MDP      VOLTAGE BASE LL:                 480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8534.9 / -106. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    3.409 +j  13.674 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     4.012

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   10162.1      8551.1      8535.6      8534.9      8534.9

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8534.9 /-106.0     8534.9 / 134.0      8534.9 /  14.0

 Admin MDP      ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0601          480.0  0.0640 / -58.  0.0640 /-178.  0.0640 /  62.
   Admin MDP      ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0601       Admin MDP      CBL-Admin XFMR   480.   8534.9/-106.   8534.9/ 134.   8534.9/  14.

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 BKV A&B        VOLTAGE BASE LL:                 208.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  11381.3 /  -31. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:   24.382 +j   0.555 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     0.023

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   11381.3     11381.3     11381.3     11381.3     11381.3

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                11381.3 / -31.3    11381.3 /-151.3     11381.3 /  88.7

 BKV A&B        ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0577        13200.0  0.9916 /  -1.  0.9916 /-121.  0.9916 / 119.
   BKV A&B        ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0577       BKV A&B        XFMR-BKV A&B     208.  11381.3/ -31.  11381.3/-151.  11381.3/  89.

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```
 BKV C&D       VOLTAGE BASE LL:                208.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:  11378.7 /  -31. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:   24.388 +j   0.559 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     0.023

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                  11378.7     11378.7     11378.7     11378.7     11378.7

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               11378.7 / -31.3    11378.6 /-151.3     11378.7 /  88.7

 BKV C&D       ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0578       13200.0  0.9914 /  -1.  0.9914 /-121.  0.9914 / 119.
   BKV C&D       ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                            FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                           BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0578       BKV C&D       XFMR-BKV C&D     208.  11378.7/ -31.  11378.6/-151.  11378.7/  89.

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```
 BKV D&E        VOLTAGE BASE LL:                 208.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  14868.9 /  -32. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:   18.660 +j   0.559 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     0.030

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   14868.9     14868.9     14868.9     14868.9     14868.9

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                14868.9 / -31.7    14868.9 /-151.7     14868.9 /  88.3

 BKV D&E        ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0579        13200.0  0.9886 /  -2.  0.9886 /-122.  0.9886 / 118.
   BKV D&E        ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                           FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                           BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0579      BKV D&E       XFMR-BKV D&E     208.  14868.9/ -32.  14868.9/-152.  14868.9/  88.

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 BKV Distributi VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   7471.3 /  -71. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.195 +j   0.552 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     2.833

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    8244.5      7472.3      7471.3      7471.3      7471.3

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 7471.3 / -70.6     7471.3 / 169.4      7471.3 /  49.4

 BKV Distributi ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0577        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0578        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0579        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0580        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0581        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0582        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0583        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0677        13200.0  0.0004 / -32.  0.0004 /-152.  0.0004 /  88.
   BKV Distributi ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                                     FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                                    BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BKV Distributi BUS-0577        CBL-BKV S&C to 13200.      0.0/   0.      0.0/   0.      0.0/   0.
BKV Distributi BUS-0578        CBL-BKV S&C to 13200.      0.0/   0.      0.0/   0.      0.0/   0.
BKV Distributi BUS-0579        CBL-BKV S&C to 13200.      0.0/   0.      0.0/   0.      0.0/   0.
BKV Distributi BUS-0580        CBL-BKV S&C to 13200.      0.0/   0.      0.0/   0.      0.0/   0.
BKV Distributi BUS-0581        CBL-BKV S&C to 13200.      0.0/   0.      0.0/   0.      0.0/   0.
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BKV Distributi ================ FIRST BRANCH SYSTEM BRANCH FLOWS (AMPS) ================

BKV Distributi	BUS-0582	CBL-BKV S&C to 13200.	0.0/ 0.	0.0/ 0.	0.0/ 0.
BKV Distributi	BUS-0583	CBL-BKV S&C to 13200.	0.0/ 0.	0.0/ 0.	0.0/ 0.
BUS-0677	BKV Distributi	CBL-S&C to BKV 13200.	7471.3/ -71.	7471.3/ 169.	7471.3/ 49.

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 BKV-F&I        VOLTAGE BASE LL:                208.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  11377.8 /  -31. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:   24.390 +j   0.561 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     0.023

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   11377.8     11377.8     11377.8     11377.8     11377.8

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                11377.8 / -31.3    11377.8 /-151.3     11377.8 /  88.7

 BKV-F&I        ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0580        13200.0  0.9913 /  -1.  0.9913 /-121.  0.9913 / 119.
   BKV-F&I        ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                             FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                            BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0580       BKV-F&I       XFMR-BKV-F&I     208.  11377.8/ -31.  11377.8/-151.  11377.8/  89.

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 BKV-F,G,H      VOLTAGE BASE LL:                 208.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  15643.4 /  -32. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:   16.854 +j   0.508 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     0.030

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   15643.4     15643.4     15643.4     15643.4     15643.4

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                15643.4 / -31.7    15643.4 /-151.7     15643.4 /  88.3

 BKV-F,G,H      ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0581        13200.0  0.9884 /  -2.  0.9884 /-122.  0.9884 / 118.
   BKV-F,G,H      ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                                 FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                                BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0581       BKV-F,G,H      XFMR-BKV FGH     208.  15643.4/ -32.  15643.4/-152.  15643.4/  88.

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```
 BKV-J&M        VOLTAGE BASE LL:                208.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   7918.5 /  -31. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:   35.049 +j   0.561 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     0.016

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    7918.5      7918.5      7918.5      7918.5      7918.5

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 7918.5 / -30.9     7918.5 /-150.9      7918.5 /  89.1

 BKV-J&M        ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0582       13200.0  0.9940 /  -1.  0.9940 /-121.  0.9940 / 119.
   BKV-J&M        ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0582       BKV-J&M       XFMR-BKV J&M     208.   7918.5/ -31.   7918.5/-151.   7918.5/  89.

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 BKV-K&L        VOLTAGE BASE LL:                 208.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  11378.1 /  -31. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:   24.389 +j   0.560 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     0.023

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   11378.1     11378.1     11378.1     11378.1     11378.1

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                11378.1 / -31.3    11378.1 /-151.3     11378.1 /  88.7

 BKV-K&L        ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0583       13200.0  0.9913 /  -1.  0.9913 /-121.  0.9913 / 119.
   BKV-K&L        ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0583      BKV-K&L        XFMR-BKV K&L     208.  11378.1/ -31.  11378.1/-151.  11378.1/  89.

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 BUS- (MH34) (F VOLTAGE BASE LL:                4160.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   4890.4 / -103. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    0.822 +j   2.716 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     3.305

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   5573.5      4892.9      4890.5      4890.4      4890.4

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
                4890.4 /-103.2     4890.4 / 136.8      4890.4 /  16.8

 BUS- (MH34) (F ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS- Farringto   4160.0  0.1827 / -71.  0.1827 / 169.  0.1827 /  49.
   BUS- (MH34) (F ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS- Farringto BUS- (MH34) (F (F7)CBL-FS7 TO  4160.   4890.4/-103.   4890.4/ 137.   4890.4/  17.

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 BUS- Farringto VOLTAGE BASE LL:                4160.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   5618.4 / -111. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    0.383 +j   2.440 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     6.374

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   7424.6      5726.3      5633.6      5618.7      5618.4

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
                5618.4 /-111.1     5618.4 / 128.9      5618.4 /   8.9

 BUS- Farringto ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   (F1) BUS MH31    4160.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (F2) BUS- MH34   4160.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS- (MH34) (F   4160.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0857         4160.0  0.0477 / -73.  0.0477 / 167.  0.0477 /  47.
   (F5)MH33         4160.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS- Farringto ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS- Farringto (F1) BUS MH31  (F1)CBL FS1 TO  4160.      0.0/   0.      0.0/   0.      0.0/   0.
BUS- Farringto (F2) BUS- MH34 (F2)CBL FS2 TO  4160.      0.0/   0.      0.0/   0.      0.0/   0.
BUS- Farringto BUS- (MH34) (F (F7)CBL-FS7 TO  4160.      0.0/   0.      0.0/   0.      0.0/   0.
BUS-0857       BUS- Farringto CBL-VB2 XFMR T  4160.   5618.4/-111.   5618.4/ 129.   5618.4/   9.
BUS- Farringto (F5)MH33       (F5)CBL FS5 TO  4160.      0.0/   0.      0.0/   0.      0.0/   0.

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 BUS-(Bowers,So VOLTAGE BASE LL:               13200.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   6888.7 /  -68. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    0.242 +j   0.587 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     2.421

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   7384.9      6888.9      6888.7      6888.7      6888.7

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
                6888.7 / -67.6     6888.7 / 172.4      6888.7 /  52.4

 BUS-(Bowers,So ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0684       13200.0  0.0000 / -23.  0.0000 /-143.  0.0000 /  97.
   BUS-0686       13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0688       13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-(Bowers,So ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0684       BUS-(Bowers,So S&C Bowers & B 13200.   6888.7/ -68.   6888.7/ 172.   6888.7/  52.
BUS-(Bowers,So BUS-0686       CBL FH S&C to  13200.      0.0/   0.      0.0/   0.      0.0/   0.
BUS-(Bowers,So BUS-0688       CBL BB S&C to  13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 BUS-0954       VOLTAGE BASE LL:                 240.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  26038.1 /  -79. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    1.748 +j   9.072 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     5.189

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   32893.1     26242.4     26056.3     26038.2     26038.1

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                26038.1 / -79.1    26038.1 / 160.9     26038.1 /  40.9

 BUS-0954       ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0658        13200.0  0.9474 /   0.  0.9474 /-120.  0.9474 / 120.
   SHCC MDP          240.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0954       ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                                 FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                                BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0658       BUS-0954       XFMR-SHCC      13200.    473.4/ -79.    473.4/ 161.    473.4/  41.
BUS-0954       SHCC MDP       CBL-XFMR to SH   240.      0.0/   0.      0.0/   0.      0.0/   0.

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 BUS-Farrington VOLTAGE BASE LL:                 4160.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   6378.7 / -111. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    0.349 +j   2.148 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     6.151

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   8365.8      6485.0      6392.5      6378.9      6378.7

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
                6378.7 /-110.8     6378.7 / 129.2      6378.7 /   9.2

 BUS-Farrington ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   (F6)BUS - MH-3   4160.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (F4)BUS- MH34    4160.0  0.0296 / -77.  0.0296 / 163.  0.0296 /  43.
   BUS-0624         4160.0  0.0474 / -73.  0.0474 / 167.  0.0474 /  47.
   BUS-Farrington ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-Farrington (F6)BUS - MH-3 (F6)CBL - FS6   4160.      0.0/   0.      0.0/   0.      0.0/   0.
BUS-Farrington (F4)BUS- MH34  (F4)CBL-FS4 TO  4160.    791.9/  71.    791.9/ -49.    791.9/-169.
BUS-0624       BUS-Farrington CBL-VB1 XFMR T  4160.   5587.3/-111.   5587.3/ 129.   5587.3/   9.

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 BUS-OH POLE(Vi VOLTAGE BASE LL:                 480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   5434.1 / -107. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    5.117 +j  21.535 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     4.208

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   6542.1      5447.9      5434.8      5434.1      5434.1

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
                5434.1 /-106.6     5434.1 / 133.4      5434.1 /  13.4

 BUS-OH POLE(Vi ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0873         480.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0876         480.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0877         480.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0727         480.0  0.0971 / -53.  0.0971 /-173.  0.0971 /  67.
   BUS-OH POLE(Vi ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-OH POLE(Vi BUS-0873      CBL-VICK XFMR    480.      0.0/   0.      0.0/   0.      0.0/   0.
BUS-OH POLE(Vi BUS-0876      CBL-RAND XFMR    480.      0.0/   0.      0.0/   0.      0.0/   0.
BUS-OH POLE(Vi BUS-0877      CBL-SPIV XFMR    480.      0.0/   0.      0.0/   0.      0.0/   0.
BUS-0727       BUS-OH POLE(Vi CBL-VSR XFMR t   480.   5434.1/-107.   5434.1/ 133.   5434.1/  13.

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BUS-PEA/AUS WI VOLTAGE BASE LL:                208.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:  10431.5 / -132. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    8.152 +j  25.329 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     3.107

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                  11731.3     10434.7     10431.6     10431.5     10431.5

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               10431.5 /-132.2    10431.5 / 107.8     10431.5 / -12.2

BUS-PEA/AUS WI ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
  BUS-0151          208.0  0.0991 / -82.  0.0991 / 158.  0.0991 /  38.
  BUS-PEA/AUS WI ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0151       BUS-PEA/AUS WI CBL AUS XFMR T   208.  10431.5/-132.  10431.5/ 108.  10431.5/ -12.

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 BUS-S&C -(Rave VOLTAGE BASE LL:               13200.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   7632.0 /  -69. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    0.206 +j   0.535 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     2.589

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   8278.9      7632.5      7632.0      7632.0      7632.0

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
                7632.0 / -68.9     7632.0 / 171.1      7632.0 /  51.1

 BUS-S&C -(Rave ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0411       13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0825       13200.0  0.0000 / -24.  0.0000 /-144.  0.0000 /  96.
   BUS-0827       13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-S&C -(Rave ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-S&C -(Rave BUS-0411       CBL-RVA S&C to 13200.      0.0/   0.      0.0/   0.      0.0/   0.
BUS-0825       BUS-S&C -(Rave Raven Village  13200.   7632.0/ -69.   7632.0/ 171.   7632.0/  51.
BUS-S&C -(Rave BUS-0827       CBL-RVB S&C to 13200.      0.0/   0.      0.0/   0.      0.0/   0.

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 BUS-Switchgear VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   9801.4 /  -83. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.056 +j   0.443 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     7.876

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   13512.8     10196.6      9882.9      9804.8      9801.5

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 9801.4 / -82.8     9801.4 / 157.2      9801.4 /  37.2

 BUS-Switchgear ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   (2) BUS MH-2    13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (1) BUS MH-2    13200.0  0.0056 / -51.  0.0056 /-171.  0.0056 /  69.
   (4) BUS MH-17   13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (3) BUS MH-17   13200.0  0.0020 / -45.  0.0020 /-165.  0.0020 /  75.
   (8)BUS-MH49     13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (7)BUS-MH49     13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (5) BUS-MH-25   13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   (6) BUS MH-25   13200.0  0.0048 / -41.  0.0048 /-161.  0.0048 /  79.
   BUS-Switchgear ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
UTIL-Primary F BUS-Switchgear                13200.   8419.0/ -83.   8419.0/ 157.   8419.0/  37.
BUS-Switchgear (2) BUS MH-2   (2)CBL Substat 13200.      0.0/   0.      0.0/   0.      0.0/   0.
BUS-Switchgear (1) BUS MH-2   (1)CBL Substat 13200.    980.6/  97.    980.6/ -23.    980.6/-143.
BUS-Switchgear (4) BUS MH-17  (4)CBL Substat 13200.      0.0/   0.      0.0/   0.      0.0/   0.
BUS-Switchgear (3) BUS MH-17  (3)CBL Substat 13200.    178.6/  96.    178.6/ -24.    178.6/-144.
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BUS-Switchgear ================ FIRST BRANCH SYSTEM BRANCH FLOWS (AMPS) ================

BUS-Switchgear	(8)BUS-MH49	(8)CBL-MH1 to	13200.	0.0/ 0.	0.0/ 0.	0.0/ 0.
BUS-Switchgear	(7)BUS-MH49	(7)CBL-MH1 to	13200.	0.0/ 0.	0.0/ 0.	0.0/ 0.
BUS-Switchgear	(5) BUS-MH-25	CBL-0044	13200.	0.0/ 0.	0.0/ 0.	0.0/ 0.
BUS-Switchgear	(6) BUS MH-25	CBL-0004	13200.	223.7/ 101.	223.7/ -19.	223.7/-139.

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 Baseball MDP   VOLTAGE BASE LL:                  480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  15642.1 / -108. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    1.547 +j   7.532 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     4.870

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   19477.5     15731.7     15648.9     15642.2     15642.1

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                15642.1 /-108.4    15642.1 / 131.6     15642.1 /  11.6

 Baseball MDP   ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0690          480.0  0.0196 / -60.  0.0196 /-180.  0.0196 /  60.
   Baseball MDP   ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0690       Baseball MDP   CBL-BB XFMR to   480.  15642.1/-108.  15642.1/ 132.  15642.1/  12.

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 Belvin MDP     VOLTAGE BASE LL:                  208.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  23279.1 /  -37. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:   11.844 +j   1.372 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     0.116

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   23279.1     23279.1     23279.1     23279.1     23279.1

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                23279.1 / -36.6    23279.1 /-156.6     23279.1 /  83.4

 Belvin MDP     ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   E & PS Transfo    208.0  0.1008 /  12.  0.1008 /-108.  0.1008 / 132.
   Belvin MDP     ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                                 FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                                BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
E & PS Transfo Belvin MDP     CBL XFMR TO BB   208.  23279.1/ -37.  23279.1/-157.  23279.1/  83.

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 CFS MDP       VOLTAGE BASE LL:                480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:  24233.5 / -109. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    0.920 +j   4.877 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     5.301

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                  30762.1     24444.2     24253.3     24233.7     24233.5

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               24233.5 /-109.3    24233.5 / 130.7     24233.5 /  10.7

 CFS MDP       ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0834         480.0  0.0577 / -52.  0.0577 /-172.  0.0577 /  68.
   CFS MDP       ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                                FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                               BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0834       CFS MDP       CBL-CFS XFMR t   480.  24233.5/-109.  24233.5/ 131.  24233.5/  11.

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 CHSS MDP       VOLTAGE BASE LL:                 480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  36728.0 / -110. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.549 +j   3.229 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     5.876

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   47697.0     37234.4     36788.0     36728.9     36728.0

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                36728.0 /-110.3    36728.0 / 129.7     36728.0 /   9.7

 CHSS MDP       ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0757          480.0  0.0437 / -61.  0.0437 / 179.  0.0437 /  59.
   BUS-0903          480.0  0.0707 / -75.  0.0707 / 165.  0.0707 /  45.
   BUS-0904          480.0  0.0707 / -75.  0.0707 / 165.  0.0707 /  45.
   CHSS MDP       ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                           FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                          BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
CHSS CH-2      CHSS MDP                      480.   2853.0/-114.   2853.0/ 126.   2853.0/   6.
CHSS CH-1      CHSS MDP                      480.   2853.0/-114.   2853.0/ 126.   2853.0/   6.
BUS-0757       CHSS MDP      CBL CHSS XFMR   480.  31038.1/-110.  31038.0/ 130.  31038.0/  10.
CHSS MDP       BUS-0903      CHSSCHWP1       480.       0.0/   0.       0.0/   0.       0.0/   0.
CHSS MDP       BUS-0904      CHSSCHWP2       480.       0.0/   0.       0.0/   0.       0.0/   0.

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CJC MDP       VOLTAGE BASE LL:                   480.0 (VOLTS)
              INI. SYM. RMS FAULT CURRENT:  56413.3 / -112. ( AMPS/DEG )
              THEVENIN EQUIVALENT IMPEDANCE:    0.287 +j   2.113 (PU)
              THEVENIN IMPEDANCE X/R RATIO:     7.367

               ASYM    RMS   INTERRUPTING AMPS
              1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                 76779.5     58244.7     56750.3     56424.4     56413.3

              INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                      AT TIME =     0.5 CYCLES
              ---PHASE A---       ---PHASE B---       ---PHASE C---
              0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

              INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                      AT TIME =     0.5 CYCLES
              ---PHASE A---       ---PHASE B---       ---PHASE C---
              56413.3 /-112.3    56413.2 / 127.7     56413.3 /   7.7

CJC MDP       ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                  FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                        ---PHASE A---     ---PHASE B---     ---PHASE C---
  BUS-0739         480.0  0.0464 / -62.  0.0464 / 178.  0.0464 /  58.
  CJC MDP       ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0739      CJC MDP       CBL-CJC XFMR t   480.  56413.3/-112.  56413.2/ 128.  56413.3/   8.

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 Coliseum MDP   VOLTAGE BASE LL:                 480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  12721.6 / -107. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    2.146 +j   9.208 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     4.290

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   15384.0     12757.9     12723.5     12721.6     12721.6

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                12721.6 /-106.9    12721.6 / 133.1     12721.6 /  13.1

 Coliseum MDP   ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0721         480.0  0.0710 / -53.  0.0710 /-173.  0.0710 /  67.
   Coliseum MDP   ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                                FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                               BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0721      Coliseum MDP   CBL-Col. XFMR    480.  12721.6/-107.  12721.6/ 133.  12721.6/  13.

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 Comm/Admin Dis VOLTAGE BASE LL:               13200.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   8133.8 /  -74. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    0.149 +j   0.517 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     3.467

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                  9368.0      8139.6      8134.0      8133.8      8133.8

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
                8133.8 / -73.9     8133.8 / 166.1      8133.8 /  46.1

 Comm/Admin Dis ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0329        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0330        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0776        13200.0  0.0005 / -25.  0.0005 /-145.  0.0005 /  95.
   Comm/Admin Dis ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
Comm/Admin Dis BUS-0329      CBL-Dist to Ad 13200.      0.0/   0.      0.0/   0.      0.0/   0.
Comm/Admin Dis BUS-0330      CBL-Dist to Co 13200.      0.0/   0.      0.0/   0.      0.0/   0.
BUS-0776       Comm/Admin Dis CBL-Admin/Comm 13200.  8133.8/ -74.  8133.8/ 166.  8133.8/  46.

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 Communications VOLTAGE BASE LL:                 208.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  32064.8 /  -40. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    8.518 +j   1.545 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     0.181

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   32064.8     32064.8     32064.8     32064.8     32064.8

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                32064.8 / -40.3    32064.8 /-160.3     32064.8 /  79.7

 Communications ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0597          208.0  0.1586 /   8.  0.1586 /-112.  0.1586 / 128.
   Communications ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0597       Communications CBL-Comm XFMR    208.  32064.8/ -40.  32064.8/-160.  32064.8/  80.

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 E & PS Transfo VOLTAGE BASE LL:                   208.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  25103.3 /  -32. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:   11.047 +j   0.473 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     0.043

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   25103.3     25103.3     25103.3     25103.3     25103.3

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                25103.3 / -32.5    25103.3 /-152.5     25103.3 /  87.5

 E & PS Transfo ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   Belvin MDP        208.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0656        13200.0  0.9895 /  -2.  0.9895 /-122.  0.9895 / 118.
   Estill Dorm MD    208.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   Psyc Services     208.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   Elliott MDP       208.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   E & PS Transfo =============== INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ===============
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
E & PS Transfo Belvin MDP     CBL XFMR TO BB   208.      0.0/   0.      0.0/   0.      0.0/   0.
BUS-0656       E & PS Transfo XFMR-Estill &    208.  25103.3/ -32.  25103.3/-152.  25103.3/  88.
E & PS Transfo Estill Dorm MD CBL-XFMR to Es   208.      0.0/   0.      0.0/   0.      0.0/   0.
E & PS Transfo Psyc Services  CBL-XFMR to PS   208.      0.0/   0.      0.0/   0.      0.0/   0.
E & PS Transfo Elliott MDP    CBL XFMR TO EL   208.      0.0/   0.      0.0/   0.      0.0/   0.

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 EP EQ1 MDP     VOLTAGE BASE LL:                 480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  22514.3 /  -39. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    5.284 +j   0.791 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     0.150

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   22514.3     22514.3     22514.3     22514.3     22514.3

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                22514.3 / -38.5    22514.3 /-158.5     22514.3 /  81.5

 EP EQ1 MDP     ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0702        13200.0  0.9718 /  -5.  0.9718 /-125.  0.9718 / 115.
   EP EQ1 MDP     ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
EP-CHWP1-4     EP EQ1 MDP                       480.   1277.0/-114.   1277.0/ 126.   1277.0/   6.
BUS-0702       EP EQ1 MDP    XFMR-EP Equip  13200.    808.5/  -5.    808.5/-125.    808.5/ 115.

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 EP EQ2 MDP     VOLTAGE BASE LL:                 480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  22432.4 /  -39. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    5.303 +j   0.793 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     0.150

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   22432.4     22432.4     22432.4     22432.4     22432.4

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                22432.4 / -38.5    22432.4 /-158.5     22432.4 /  81.5

 EP EQ2 MDP     ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0701        13200.0  0.9719 /  -5.  0.9719 /-125.  0.9719 / 115.
   EP EQ2 MDP     ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
EP-CHWP1-3     EP EQ2 MDP                        480.   1277.0/-114.   1277.0/ 126.   1277.0/   6.
BUS-0701       EP EQ2 MDP     XFMR-EP Equip  13200.    805.6/  -5.    805.6/-125.    805.6/ 115.

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 ESTILL MDP     VOLTAGE BASE LL:                  480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   7908.9 / -137. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    3.506 +j  14.799 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     4.221

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    9528.3      7929.4      7910.0      7908.9      7908.9

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 7908.9 /-136.7     7908.9 / 103.3      7908.9 / -16.7

 ESTILL MDP     ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0898         480.0  0.0297 / -88.  0.0297 / 152.  0.0297 /  32.
   ESTILL MDP     ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                                 FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                                BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0898       ESTILL MDP     CBL ESTILL XFM   480.   7908.9/-137.   7908.9/ 103.   7908.9/ -17.

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 East Plant Dis VOLTAGE BASE LL:               13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8515.4 /  -76. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.127 +j   0.498 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     3.932

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   10092.2      8529.6      8516.0      8515.4      8515.4

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8515.4 / -75.7     8515.4 / 164.3      8515.4 /  44.3

 East Plant Dis ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0696       13200.0  0.0004 / -36.  0.0004 /-156.  0.0004 /  84.
   BUS-0697       13200.0  0.0002 / -56.  0.0002 /-176.  0.0002 /  64.
   BUS-0698       13200.0  0.0002 / -45.  0.0002 /-165.  0.0002 /  75.
   BUS-0700       13200.0  0.0001 / -45.  0.0001 /-165.  0.0001 /  75.
   BUS-0701       13200.0  0.0000 / -43.  0.0000 /-163.  0.0000 /  77.
   BUS-0702       13200.0  0.0000 / -43.  0.0000 /-163.  0.0000 /  77.
   East Plant Dis ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0696       East Plant Dis CBL-S&C to Eas 13200.   7527.6/ -75.   7527.6/ 165.   7527.6/  45.
East Plant Dis BUS-0697       CBL-East Plant 13200.    307.0/  96.    307.0/ -24.    307.0/-144.
East Plant Dis BUS-0698       CBL-East Plant 13200.    366.2/  96.    366.2/ -24.    366.2/-144.
East Plant Dis BUS-0700       CBL-East Plant 13200.    233.0/  96.    233.0/ -24.    233.0/-144.
East Plant Dis BUS-0701       CBL-East Plant 13200.     46.1/  99.     46.1/ -21.     46.1/-141.
East Plant Dis BUS-0702       CBL-East Plant 13200.     46.1/  99.     46.1/ -21.     46.1/-141.

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 Elliott MDP    VOLTAGE BASE LL:                 208.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  14549.9 /  -45. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:   18.444 +j   4.876 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     0.264

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   14549.9     14549.9     14549.9     14549.9     14549.9

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                14549.9 / -44.8    14549.9 /-164.8     14549.9 /  75.2

 Elliott MDP    ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   E & PS Transfo    208.0  0.4512 / -14.  0.4512 /-134.  0.4512 / 106.
   Elliott MDP    ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
E & PS Transfo Elliott MDP    CBL XFMR TO EL   208.  14549.9/ -45.  14549.9/-165.  14549.9/  75.

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 Estill Dorm MD VOLTAGE BASE LL:                 208.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:  21610.8 /  -40. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:   12.642 +j   2.270 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     0.180

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                  21610.8     21610.8     21610.8     21610.8     21610.8

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               21610.8 / -40.2    21610.8 /-160.2     21610.8 /  79.8

 Estill Dorm MD ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   E & PS Transfo    208.0  0.1871 /   8.  0.1871 /-112.  0.1871 / 128.
   Estill Dorm MD ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
E & PS Transfo Estill Dorm MD CBL-XFMR to Es   208.  21610.8/ -40.  21610.8/-160.  21610.8/  80.

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 Evans MDP      VOLTAGE BASE LL:                 480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   7896.0 / -135. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    4.048 +j  14.686 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     3.628

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    9187.7      7903.7      7896.2      7896.0      7896.0

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 7896.0 /-134.6     7896.0 / 105.4      7896.0 / -14.6

 Evans MDP      ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0675          480.0  0.0488 / -85.  0.0488 / 155.  0.0488 /  35.
   Evans MDP      ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0675       Evans MDP      CBL-To Evans M   480.   7896.0/-135.   7896.0/ 105.   7896.0/ -15.

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 Evans/VisCen M VOLTAGE BASE LL:                 480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   8654.8 / -137. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    3.091 +j  13.550 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     4.384

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                  10518.7      8682.8      8656.4      8654.8      8654.8

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
                8654.8 /-137.2     8654.8 / 102.8      8654.8 / -17.2

 Evans/VisCen M ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0674         480.0  0.0087 / -89.  0.0087 / 151.  0.0087 /  31.
   BUS-0675         480.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0678         480.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   Evans/VisCen M =============== INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0674       Evans/VisCen M CBL E/VC XFMR    480.   8654.8/-137.   8654.8/ 103.   8654.8/ -17.
Evans/VisCen M BUS-0675       CBL-To Evans M   480.      0.0/   0.      0.0/   0.      0.0/   0.
Evans/VisCen M BUS-0678       CBL-To VisCen    480.      0.0/   0.      0.0/   0.      0.0/   0.

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 FARR MDP      VOLTAGE BASE LL:                480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   7544.9 / -136. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    3.966 +j  15.441 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     3.893

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   8921.7      7556.8      7545.4      7544.9      7544.9

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
                7544.9 /-135.6     7544.9 / 104.4      7544.9 / -15.6

 FARR MDP      ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0895         480.0  0.0632 / -82.  0.0632 / 158.  0.0632 /  38.
   FARR MDP      ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0895       FARR MDP      CBL-FARR XFMR    480.   7544.9/-136.   7544.9/ 104.   7544.9/ -16.

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 Field House MD VOLTAGE BASE LL:                 480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:  20050.8 /  -36. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    5.960 +j   0.678 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     0.114

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                  20050.8     20050.8     20050.8     20050.8     20050.8

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               20050.8 / -36.5    20050.8 /-156.5     20050.8 /  83.5

 Field House MD ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0685          480.0  0.0188 /  12.  0.0188 /-108.  0.0188 / 132.
   Field House MD ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0685       Field House MD CBL-FH XFMR to   480.  20050.8/ -36.  20050.8/-156.  20050.8/  84.

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 Garage MDP     VOLTAGE BASE LL:                480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   6648.2 / -103. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    5.270 +j  17.308 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     3.284

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    7566.2      6651.3      6648.2      6648.2      6648.2

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 6648.2 /-103.1     6648.2 / 136.9      6648.2 /  16.9

 Garage MDP     ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0799          480.0  0.0978 / -65.  0.0978 / 175.  0.0978 /  55.
   Garage MDP     ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0799       Garage MDP     CBL-Garage XFM   480.   6648.2/-103.   6648.2/ 137.   6648.2/  17.

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 HKC MDP       VOLTAGE BASE LL:                 480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:  12680.2 / -105. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    2.435 +j   9.168 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     3.765

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                  14879.4     12696.2     12680.7     12680.2     12680.2

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               12680.2 /-105.1    12680.2 / 134.9     12680.2 /  14.9

 HKC MDP       ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0726         480.0  0.0708 / -52.  0.0708 /-172.  0.0708 /  68.
   HKC MDP       ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0726       HKC MDP       CBL-HKC SW to    480.  12680.2/-105.  12680.2/ 135.  12680.2/  15.

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 LIB MDP       VOLTAGE BASE LL:                480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:  22469.8 / -110. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    0.929 +j   5.272 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     5.673

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                  28956.9     22735.9     22499.0     22470.2     22469.8

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               22469.8 /-110.0    22469.8 / 130.0     22469.8 /  10.0

 LIB MDP       ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0749         480.0  0.0225 / -62.  0.0225 / 178.  0.0225 /  58.
   LIB MDP       ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0749      LIB MDP       CBL LIB XFMR t   480.  22469.8/-110.  22469.8/ 130.  22469.8/  10.

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 LSC MDP        VOLTAGE BASE LL:                 480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  14388.9 / -107. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    1.911 +j   8.138 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     4.258

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   17369.7     14428.2     14391.0     14388.9     14388.9

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                14388.9 /-106.8    14388.9 / 133.2     14388.9 /  13.2

 LSC MDP        ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0781          480.0  0.1430 / -49.  0.1430 /-169.  0.1430 /  71.
   LSC MDP        ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                                FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                               BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0781       LSC MDP       CBL-LSC XFMR t   480.  14388.9/-107.  14388.9/ 133.  14388.9/  13.

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 Lee Drain MDP  VOLTAGE BASE LL:                 480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  10079.4 / -103. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    3.517 +j  11.403 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     3.243

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   11439.4     10083.7     10079.5     10079.4     10079.4

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                10079.4 /-102.9    10079.4 / 137.1     10079.4 /  17.1

 Lee Drain MDP  ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0848          480.0  0.1483 / -64.  0.1483 / 176.  0.1483 /  56.
   Lee Drain MDP  ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0848       Lee Drain MDP  CBL-LD XFMR to   480.  10079.4/-103.  10079.4/ 137.  10079.4/  17.

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 Lonestar Hall  VOLTAGE BASE LL:                 480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  40060.7 /  -41. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    2.951 +j   0.554 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     0.188

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   40060.7     40060.7     40060.7     40060.7     40060.7

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                40060.7 / -40.6    40060.7 /-160.6     40060.7 /  79.4

 Lonestar Hall  ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0671          480.0  0.0387 /  13.  0.0387 /-107.  0.0387 / 133.
   Lonestar Hall  ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0671       Lonestar Hall  CBL-Lonestar X   480.  40060.7/ -41.  40060.7/-161.  40060.7/  79.

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 MLH MDP        VOLTAGE BASE LL:                208.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8780.6 / -123. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:   14.366 +j  28.159 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     1.960

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    9129.6      8780.6      8780.6      8780.6      8780.6

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 8780.6 /-123.0     8780.6 / 117.0      8780.6 /  -3.0

 MLH MDP        ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0161          208.0  0.2613 / -95.  0.2613 / 145.  0.2613 /  25.
   MLH MDP        ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0161       MLH MDP        CBL XFMR MLH T   208.   8780.6/-123.   8780.6/ 117.   8780.6/  -3.

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 Music Bldg. MD VOLTAGE BASE LL:                 480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:  10671.1 / -104. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    3.174 +j  10.816 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     3.407

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                  12243.3     10677.8     10671.3     10671.1     10671.1

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               10671.1 /-103.6    10671.1 / 136.4     10671.1 /  16.4

 Music Bldg. MD ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0794         480.0  0.0801 / -55.  0.0801 /-175.  0.0801 /  65.
   Music Bldg. MD ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0794       Music Bldg. MD CBL-MUSIC XFMR   480.  10671.1/-104.  10671.1/ 136.  10671.1/  16.

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 OMM MDP        VOLTAGE BASE LL:                480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  18174.7 / -108. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    1.362 +j   6.476 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     4.756

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   22507.8     18266.6     18181.2     18174.7     18174.7

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                18174.7 /-108.1    18174.7 / 131.9     18174.7 /  11.9

 OMM MDP        ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0672          480.0  0.0638 / -56.  0.0638 /-176.  0.0638 /  64.
   OMM MDP        ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                                 FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                                BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0672       OMM MDP         CBL-XFMR OMM t   480.  18174.7/-108.  18174.7/ 132.  18174.7/  12.

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 Old Smith Huts VOLTAGE BASE LL:                 480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:  13436.9 /  -42. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    8.761 +j   1.839 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     0.210

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                  13436.9     13436.9     13436.9     13436.9     13436.9

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               13436.9 / -41.9    13436.8 /-161.9     13436.9 /  78.1

 Old Smith Huts ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0809         480.0  0.2016 /   7.  0.2016 /-113.  0.2016 / 127.
   Old Smith Huts ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0809      Old Smith Huts CBL-S.H.Add XF   480.  13436.9/ -42.  13436.8/-162.  13436.9/  78.

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 PAC MDP        VOLTAGE BASE LL:                480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  17627.7 /  -89. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    3.472 +j   5.874 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     1.692

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   18052.4     17627.7     17627.7     17627.7     17627.7

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                17627.7 / -89.4    17627.7 / 150.6     17627.7 /  30.6

 PAC MDP        ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0733          480.0  0.4547 / -62.  0.4547 / 178.  0.4547 /  58.
   PAC MDP        ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0733       PAC MDP       CBL-PAC XFMR t   480.  17627.7/ -89.  17627.7/ 151.  17627.7/  31.

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 Pirkle MDP     VOLTAGE BASE LL:                 480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  16201.1 /  -78. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    1.527 +j   7.266 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     4.759

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   20066.3     16283.3     16207.0     16201.2     16201.1

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                16201.1 / -78.1    16201.1 / 161.9     16201.1 /  41.9

 Pirkle MDP     ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0957          480.0  0.0427 / -26.  0.0427 /-146.  0.0427 /  94.
   Pirkle MDP     ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0957      Pirkle MDP     CBL-XFMR Pirkl   480.  16201.1/ -78.  16201.1/ 162.  16201.1/  42.

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 Psyc Services  VOLTAGE BASE LL:                 208.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  14716.2 /  -43. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:   18.363 +j   4.310 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     0.235

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   14716.2     14716.2     14716.2     14716.2     14716.2

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                14716.2 / -43.2    14716.2 /-163.2     14716.2 /  76.8

 Psyc Services  ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   E & PS Transfo    208.0  0.4380 / -16.  0.4380 /-136.  0.4380 / 104.
   Psyc Services  ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                                 FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                                BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
 E & PS Transfo Psyc Services  CBL-XFMR to PS   208.  14716.2/ -43.  14716.2/-163.  14716.2/  77.

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 RAVEN MDP      VOLTAGE BASE LL:                 208.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  30470.2 /  -44. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    8.856 +j   2.135 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     0.241

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   30470.2     30470.2     30470.2     30470.2     30470.2

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                30470.2 / -43.6    30470.2 /-163.6     30470.2 /  76.4

 RAVEN MDP      ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0822          208.0  0.2175 /  10.  0.2175 /-110.  0.2175 / 130.
   RAVEN MDP      ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0822       RAVEN MDP      CBL-RV C XFMR    208.  30470.2/ -44.  30470.2/-164.  30470.2/  76.

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 RVA MDP        VOLTAGE BASE LL:                  208.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  37720.3 /  -47. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    7.046 +j   2.122 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     0.301

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   37720.3     37720.3     37720.3     37720.3     37720.3

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                37720.3 / -46.8    37720.3 /-166.8     37720.3 /  73.2

 RVA MDP        ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0829          208.0  0.2692 /   6.  0.2692 /-114.  0.2692 / 126.
   RVA MDP        ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                                 FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                                BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0829       RVA MDP       CBL-RV A XFMR    208.  37720.3/ -47.  37720.3/-167.  37720.3/  73.

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```

```
 RVB MDP       VOLTAGE BASE LL:                208.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:  38145.9 /  -47. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    6.960 +j   2.122 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     0.305

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                  38145.9     38145.9     38145.9     38145.9     38145.9

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               38145.9 / -47.0    38145.8 /-167.0     38145.8 /  73.0

 RVB MDP       ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0831         208.0  0.2723 /   6.  0.2723 /-114.  0.2723 / 126.
   RVB MDP       ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0831      RVB MDP       CBL-RV A XFMR    208.  38145.9/ -47.  38145.8/-167.  38145.8/  73.

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```
SH MDP        VOLTAGE BASE LL:                  480.0 (VOLTS)
              INI. SYM. RMS FAULT CURRENT:  15594.6 / -108. ( AMPS/DEG )
              THEVENIN EQUIVALENT IMPEDANCE:    1.668 +j   7.531 (PU)
              THEVENIN IMPEDANCE X/R RATIO:     4.515

               ASYM    RMS   INTERRUPTING AMPS
              1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                 19082.8     15654.1     15598.3     15594.6     15594.6

              INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                      AT TIME =     0.5 CYCLES
              ---PHASE A---       ---PHASE B---       ---PHASE C---
              0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

              INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                      AT TIME =     0.5 CYCLES
              ---PHASE A---       ---PHASE B---       ---PHASE C---
              15594.6 /-107.5    15594.6 / 132.5     15594.6 /  12.5

SH MDP        ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                  FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                        ---PHASE A---     ---PHASE B---     ---PHASE C---
  BUS-0803         480.0  0.0780 / -59.  0.0780 /-179.  0.0780 /  61.
  SH MDP        ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                           FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                          BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0803      SH MDP      CBL-S.Hutson X   480.  15594.6/-108.  15594.6/ 132.  15594.6/  12.

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```
 SHCC MDP       VOLTAGE BASE LL:                 240.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  22321.8 /  -75. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    2.777 +j  10.413 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     3.750

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   26168.7     22349.2     22322.8     22321.8     22321.8

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                22321.8 / -75.1    22321.8 / 164.9     22321.8 /  44.9

 SHCC MDP       ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0954          240.0  0.1568 / -23.  0.1568 /-143.  0.1568 /  97.
   SHCC MDP       ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0954       SHCC MDP       CBL-XFMR to SH   240.  22321.8/ -75.  22321.8/ 165.  22321.8/  45.

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 SHV Distributi VOLTAGE BASE LL:              13200.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   7093.6 /  -69. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    0.222 +j   0.575 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     2.585

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    7692.5      7094.0      7093.6      7093.6      7093.6

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 7093.6 / -68.9     7093.6 / 171.1     7093.6 /  51.1

 SHV Distributi ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0602        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0603        13200.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0769        13200.0  0.0008 / -30.  0.0008 /-150.  0.0008 /  90.
   SHV Distributi =============== INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
SHV Distributi BUS-0602       CBL-SHV Dist t 13200.      0.0/   0.      0.0/   0.      0.0/   0.
SHV Distributi BUS-0603       CBL-SHV Dist t 13200.      0.0/   0.      0.0/   0.      0.0/   0.
BUS-0769       SHV Distributi CBL SHV S&C to 13200.   7093.6/ -69.   7093.6/ 171.   7093.6/  51.

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```

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 SHV#1 MDP     VOLTAGE BASE LL:                208.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:  34420.1 / -106. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    2.002 +j   7.812 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     3.902

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                  40721.8     34474.9     34422.3     34420.1     34420.1

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               34420.1 /-105.6    34420.1 / 134.4     34420.1 /  14.4

 SHV#1 MDP     ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0770         208.0  0.1192 / -57.  0.1192 /-177.  0.1192 /  63.
   SHV#1 MDP     ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0770       SHV#1 MDP     CBL SHV1 XFMR    208.  34420.1/-106.  34420.1/ 134.  34420.1/  14.

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 SHV#2 MDP      VOLTAGE BASE LL:                 208.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  33476.8 / -105. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    2.174 +j   8.001 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     3.681

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   39080.3     33513.0     33478.0     33476.8     33476.8

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                33476.8 /-104.8    33476.8 / 135.2     33476.8 /  15.2

 SHV#2 MDP      ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0771          208.0  0.1449 / -56.  0.1449 /-176.  0.1449 /  64.
   SHV#2 MDP      ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                                 FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                                BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0771       SHV#2 MDP      CBL SHV1 XFMR    208.  33476.8/-105.  33476.8/ 135.  33476.8/  15.

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 Sorority       VOLTAGE BASE LL:                480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  10340.4 /  -59. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    6.068 +j   9.924 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     1.635

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   10559.9     10340.4     10340.4     10340.4     10340.4

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                10340.4 / -58.6    10340.4 /-178.6     10340.4 /  61.4

 Sorority       ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0155          480.0  0.2510 / -41.  0.2510 /-161.  0.2510 /  79.
   Sorority       ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                                 FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                                BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0155       Sorority       CBL SOR XFMR T   480.  10340.4/ -59.  10340.4/-179.  10340.4/  61.

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 SouthPaw MDP   VOLTAGE BASE LL:                 208.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  23306.7 /  -38. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:   11.806 +j   1.568 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     0.133

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   23306.7     23306.7     23306.7     23306.7     23306.7

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                23306.7 / -37.6    23306.7 /-157.6     23306.7 /  82.4

 SouthPaw MDP   ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0842          208.0  0.1068 /  20.  0.1068 /-100.  0.1068 / 140.
   SouthPaw MDP   ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0842       SouthPaw MDP   CBL-SP XFMR to   208.  23306.7/ -38.  23306.7/-158.  23306.7/  82.

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 TEC MDP        VOLTAGE BASE LL:                 480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  14182.9 / -108. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    1.703 +j   8.308 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     4.878

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   17666.7     14264.7     14189.1     14182.9     14182.9

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                14182.9 /-108.4    14182.9 / 131.6     14182.9 /  11.6

 TEC MDP        ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0753          480.0  0.0142 / -60.  0.0142 / 180.  0.0142 /  60.
   TEC MDP        ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                                 FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                                BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0753       TEC MDP        CBL TEC XFMR t   480.  14182.9/-108.  14182.9/ 132.  14182.9/  12.

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 Thomason MDP   VOLTAGE BASE LL:                  480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   7067.0 / -135. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    4.539 +j  16.404 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     3.614

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    8215.9      7073.7      7067.2      7067.0      7067.0

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 7067.0 /-134.5     7067.0 / 105.5      7067.0 / -14.5

 Thomason MDP   ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0639          480.0  0.0530 / -86.  0.0530 / 154.  0.0530 /  34.
   Thomason MDP   ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0639       Thomason MDP   CBL-THO XFMR T   480.   7067.0/-135.   7067.0/ 105.   7067.0/ -15.

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 UTC MDP        VOLTAGE BASE LL:                480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:  13521.4 / -107. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    2.017 +j   8.664 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     4.294

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   16354.9     13560.2     13523.5     13521.4     13521.4

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                13521.4 /-106.9    13521.4 / 133.1     13521.4 /  13.1

 UTC MDP        ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0745          480.0  0.0676 / -58.  0.0676 /-178.  0.0676 /  62.
   UTC MDP        ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                                 FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                                BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0745       UTC MDP        CBL UTC XFMR t   480.  13521.4/-107.  13521.4/ 133.  13521.4/  13.

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 VisCen MDP     VOLTAGE BASE LL:                480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   7896.0 / -135. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    4.048 +j  14.686 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     3.628

                 ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                    9187.7      7903.7      7896.2      7896.0      7896.0

                INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

                INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---       ---PHASE B---       ---PHASE C---
                 7896.0 /-134.6     7896.0 / 105.4      7896.0 / -14.6

 VisCen MDP     ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                    FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                          ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0678          480.0  0.0488 / -85.  0.0488 / 155.  0.0488 /  35.
   VisCen MDP     ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                               FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                              BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0678      VisCen MDP     CBL-To VisCen    480.   7896.0/-135.   7896.0/ 105.   7896.0/ -15.

-----------------------------------------------------------------------------------------------
```

```
 West Plant MDP VOLTAGE BASE LL:                480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:  25302.9 / -141. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    0.736 +j   4.696 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     6.381

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                  33445.3     25791.0     25371.6     25304.2     25302.9

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               25302.9 /-141.1    25302.9 /  98.9     25302.9 / -21.1

 West Plant MDP ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0878          480.0  0.0342 / -83.  0.0342 / 157.  0.0342 /  37.
   West Plant MDP ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                                FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                               BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
WP CHWP-2      West Plant MDP                 480.    212.8/-144.    212.8/  96.    212.8/ -24.
WP CHWP-1      West Plant MDP                 480.    212.8/-144.    212.8/  96.    212.8/ -24.
WP CH-2        West Plant MDP                 480.   7608.0/-144.   7608.0/  96.   7608.0/ -24.
WP CH-1        West Plant MDP                 480.   7608.0/-144.   7608.0/  96.   7608.0/ -24.
BUS-0878       West Plant MDP CBL W.PLANT XF  480.   9724.8/-136.   9724.8/ 104.   9724.8/ -16.

--------------------------------------------------------------------------------------------------
```

```
 XFMR-WEST PLAN VOLTAGE BASE LL:               4160.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   5638.3 / -104. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    0.682 +j   2.365 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     3.467

                ASYM    RMS   INTERRUPTING AMPS
               1/2 CYCLES    2 CYCLES    3 CYCLES    5 CYCLES    8 CYCLES
                   6494.2      5642.3      5638.4      5638.3      5638.3

               INI. SYM. RMS FAULTED BUS VOLTAGES ( PU / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
               0.0000 /    0.0     0.0000 /    0.0     0.0000 /    0.0

               INI.    RMS   FAULTED CURRENT ( AMPS / DEG )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
                5638.3 /-103.9     5638.3 / 136.1      5638.3 /  16.1

 XFMR-WEST PLAN ==== INI. SYM. RMS SYSTEM BUS VOLTAGES ( PU / DEG ) =======
                   FIRST BUS FROM FAULT    AT TIME =     0.5 CYCLES
                         ---PHASE A---     ---PHASE B---     ---PHASE C---
   BUS-0634        4160.0  0.0000 /   0.  0.0000 /   0.  0.0000 /   0.
   BUS-0635        4160.0  0.0005 / -15.  0.0005 /-135.  0.0005 / 105.
   BUS-0878         480.0  0.5316 / -62.  0.5316 / 178.  0.5316 /  58.
   XFMR-WEST PLAN ================ INI.    RMS   SYSTEM BRANCH FLOWS ( AMPS ) ================
                              FIRST BRANCH FROM FAULT AT TIME =     0.5 CYCLES
                             BRANCH NAME   VBASE LL  -PHASE A-     -PHASE B-     -PHASE C-
BUS-0634       XFMR-WEST PLAN (F7)CBL W. PLA  4160.      0.0/   0.      0.0/   0.      0.0/   0.
BUS-0635       XFMR-WEST PLAN (F4)CBL W.PLAN  4160.   4835.1/-103.   4835.1/ 137.   4835.1/  17.
XFMR-WEST PLAN BUS-0878       XFMR-W.PLANT    4160.    808.9/  70.    808.9/ -50.    808.9/-170.

***********************************************************************************************
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***************** F A U L T   A N A L Y S I S   S U M M A R Y ***************

BUS NAME	VOLTAGE L-L	AVAILABLE FAULT CURRENT 3 PHASE	X/R	LINE/GRND	X/R
(1) BUS MH-2	13200.	9530.2	6.2		
(1)BUS MH-10	13200.	7628.5	3.0		
(1)BUS MH-5	13200.	8977.1	4.7		
(1)BUS MH-8	13200.	8542.5	4.0		
(2) BUS MH-11	13200.	7555.5	2.9		
(2) BUS MH-2	13200.	9463.2	5.9		
(2) BUS MH-9	13200.	7718.6	3.0		
(2) VSR S&C	13200.	7340.8	2.7		
(2)BUS MH-10	13200.	6933.5	2.4		
(2)BUS MH-5	13200.	8781.7	4.2		
(2)BUS MH-8	13200.	8254.2	3.5		
(3) BUS MH-17	13200.	9100.2	5.1		
(3) BUS MH-23	13200.	8178.2	3.5		
(3) BUS MH-46	13200.	7135.9	2.6		
(3) BUS-MH-18	13200.	8844.9	4.5		
(3) MH-24	13200.	8276.9	3.6		
(3)BUS MH-19	13200.	8720.8	4.3		
(3)BUS MH-20	13200.	8507.6	4.0		
(3)BUS MH-21	13200.	8260.3	3.6		
(3)BUS MH-33	13200.	8184.0	3.5		
(3)BUS MH-36	13200.	8513.8	4.0		
(3)MUSIC S&C	13200.	8678.1	4.1		
(4) BUS MH-17	13200.	9075.1	5.0		
(4) BUS MH-23	13200.	8183.5	3.4		
(4) BUS MH-46	13200.	7107.7	2.6		
(4) BUS-MH-18	13200.	8811.1	4.5		
(4) MH-24	13200.	8225.1	3.6		
(4) MUSIC S&C	13200.	8645.0	4.1		
(4)BUS MH-19	13200.	8683.0	4.2		
(4)BUS MH-20	13200.	8471.0	3.9		
(4)BUS MH-21	13200.	8225.1	3.6		
(4)BUS MH-33	13200.	8149.3	3.5		
(4)BUS MH-36	13200.	8477.1	3.9		
(5) BUS MH-44	13200.	8602.1	3.6		
(5) BUS MH-47	13200.	7713.6	2.6		
(5) BUS MH-48	13200.	7468.4	2.5		

****************** F A U L T   A N A L Y S I S   S U M M A R Y ****************

BUS NAME	VOLTAGE L-L	AVAILABLE FAULT CURRENT 3 PHASE	X/R	LINE/GRND	X/R
(5) BUS-MH-25	13200.	8602.8	3.6		
(5) BUS-MH-30	13200.	8453.5	3.4		
(6) BUS MH-25	13200.	8501.1	3.9		
(6) BUS MH-30	13200.	8358.0	3.7		
(6) BUS MH-44	13200.	8500.5	3.9		
(6) BUS MH-47	13200.	7644.9	2.8		
(6) BUS MH-48	13200.	7406.6	2.6		
(7)BUS MH-Pirk	13200.	7530.8	2.7		
(7)BUS MH43	13200.	8953.6	4.3		
(7)BUS-MH41	13200.	9058.9	4.5		
(7)BUS-MH42	13200.	9035.4	4.5		
(7)BUS-MH49	13200.	9174.2	4.8		
(8)BUS MH43	13200.	9147.5	4.8		
(8)BUS-MH41	13200.	9254.8	5.1		
(8)BUS-MH42	13200.	9230.9	5.0		
(8)BUS-MH49	13200.	9372.2	5.5		
(F1) BUS MH31	4160.	5540.1	5.9		
(F2) BUS- MH34	4160.	4750.7	3.5		
(F2)BUS-MH35	4160.	4327.6	2.8		
(F4)BUS- MH34	4160.	5669.5	3.5		
(F5) POLE AT 1	4160.	4942.8	2.6		
(F5) POLE AT B	4160.	4741.8	2.3		
(F5) POLE AT E	4160.	4741.8	2.3		
(F5)MH33	4160.	5146.1	3.1		
(F6)BUS - MH-3	4160.	6223.4	5.2		
AB1 MCB1	480.	11806.7	4.2		
AB3 MDP	208.	20965.5	3.5		
AB4 MDP	480.	14252.0	3.0		
Admin MDP	480.	8534.9	4.0		
BKV A&B	208.	11381.3	0.0		
BKV C&D	208.	11378.7	0.0		
BKV D&E	208.	14868.9	0.0		
BKV Distributi	13200.	7471.3	2.8		
BKV-F&I	208.	11377.8	0.0		
BKV-F,G,H	208.	15643.4	0.0		
BKV-J&M	208.	7918.5	0.0		
BKV-K&L	208.	11378.1	0.0		
BUS- (MH34) (F	4160.	4890.4	3.3		
BUS- Farringto	4160.	5618.4	6.4		
BUS-(Bowers,So	13200.	6888.7	2.4		

***************** F A U L T   A N A L Y S I S   S U M M A R Y ***************

BUS NAME	VOLTAGE L-L	AVAILABLE FAULT CURRENT 3 PHASE	X/R	LINE/GRND	X/R
BUS-0954	240.	26038.1	5.2		
BUS-Farrington	4160.	6378.7	6.2		
BUS-OH POLE(Vi	480.	5434.1	4.2		
BUS-PEA/AUS WI	208.	10431.5	3.1		
BUS-S&C -(Rave	13200.	7632.0	2.6		
BUS-Switchgear	13200.	9801.4	7.9		
Baseball MDP	480.	15642.1	4.9		
Belvin MDP	208.	23279.1	0.1		
CFS MDP	480.	24233.5	5.3		
CHSS MDP	480.	36728.0	5.9		
CJC MDP	480.	56413.3	7.4		
Coliseum MDP	480.	12721.6	4.3		
Comm/Admin Dis	13200.	8133.8	3.5		
Communications	208.	32064.8	0.2		
E & PS Transfo	208.	25103.3	0.0		
EP EQ1 MDP	480.	22514.3	0.1		
EP EQ2 MDP	480.	22432.5	0.1		
ESTILL MDP	480.	7908.9	4.2		
East Plant Dis	13200.	8515.4	3.9		
Elliott MDP	208.	14549.9	0.3		
Estill Dorm MD	208.	21610.8	0.2		
Evans MDP	480.	7896.0	3.6		
Evans/VisCen M	480.	8654.8	4.4		
FARR MDP	480.	7544.9	3.9		
Field House MD	480.	20050.8	0.1		
Garage MDP	480.	6648.2	3.3		
HKC MDP	480.	12680.2	3.8		
LIB MDP	480.	22469.8	5.7		
LSC MDP	480.	14388.9	4.3		
Lee Drain MDP	480.	10079.4	3.2		
Lonestar Hall	480.	40060.7	0.2		
MLH MDP	208.	8780.6	2.0		
Music Bldg. MD	480.	10671.1	3.4		
OMM MDP	480.	18174.7	4.8		
Old Smith Huts	480.	13436.9	0.2		
PAC MDP	480.	17627.7	1.7		
Pirkle MDP	480.	16201.1	4.8		
Psyc Services	208.	14716.2	0.2		
RAVEN MDP	208.	30470.2	0.2		
RVA MDP	208.	37720.3	0.3		

***************** F A U L T   A N A L Y S I S   S U M M A R Y ***************

BUS NAME	VOLTAGE L-L	AVAILABLE FAULT CURRENT 3 PHASE	X/R	LINE/GRND	X/R
RVB MDP	208.	38145.9	0.3		
SH MDP	480.	15594.6	4.5		
SHCC MDP	240.	22321.8	3.7		
SHV Distributi	13200.	7093.6	2.6		
SHV#1 MDP	208.	34420.1	3.9		
SHV#2 MDP	208.	33476.8	3.7		
Sorority	480.	10340.4	1.6		
SouthPaw MDP	208.	23306.7	0.1		
TEC MDP	480.	14182.9	4.9		
Thomason MDP	480.	7067.0	3.6		
UTC MDP	480.	13521.4	4.3		
VisCen MDP	480.	7896.0	3.6		
West Plant MDP	480.	25302.9	6.4		
XFMR-WEST PLAN	4160.	5638.3	3.5		

*********************** FAULT ANALYSIS REPORT COMPLETED ***********************

APPENDIX H – FINAL PRESENTATION SLIDES

(refer to electronic copy)

SAM HOUSTON STATE UNIVERSITY

UTILITY INFRASTRUCTURE MASTER PLAN

FINAL PRESENTATION

AUGUST 9, 2017

Utility Master Planning Team

- **EEA Consulting Engineers** (Austin, TX)
  - *Chilled Water*
  - *Heating Water*
  - *Medium Voltage Electrical*

- **MWM Design Group** (Austin, TX)
  - *Domestic Water*
  - *Sanitary Sewer*
  - *Storm Drain*

Agenda

Introduction – Purpose and Scope

Status of 2012 Campus Master Plan Utility Components

Chilled and Heating Water Systems

Medium Voltage Electrical System

Domestic Water System

Sanitary Sewer System

Storm Drain System

Campus Utility Infrastructure Master Plan Summary

Purpose and Scope

Purpose

Utility Master Plan

"A consolidated approach to utility generation, distribution, and consumption, documented in a format that is repeatable, referenceable, and adaptable."

- Document and analyze existing systems
  - Generating capacity
  - Distribution capacity
  - System reliability / redundancy / resiliency
- Identify problem areas
  - Capacity deficiencies
  - Distribution deficiencies
  - Single points of failure
- Provide recommendations
  - Capacity goals
  - Distribution efficiency and effectiveness
  - Improve system stability

Status of 2012 Campus Master Plan Utility Components

2012 Campus Master Plan (SmithGroupJJR)

Completed since the 2012 Master Plan

Student Health and Counseling Center
(Pirkle) Agricultural Engineering Building
Piney Woods Hall (South District Residences)
General's Market (South District Dining)

Phase I

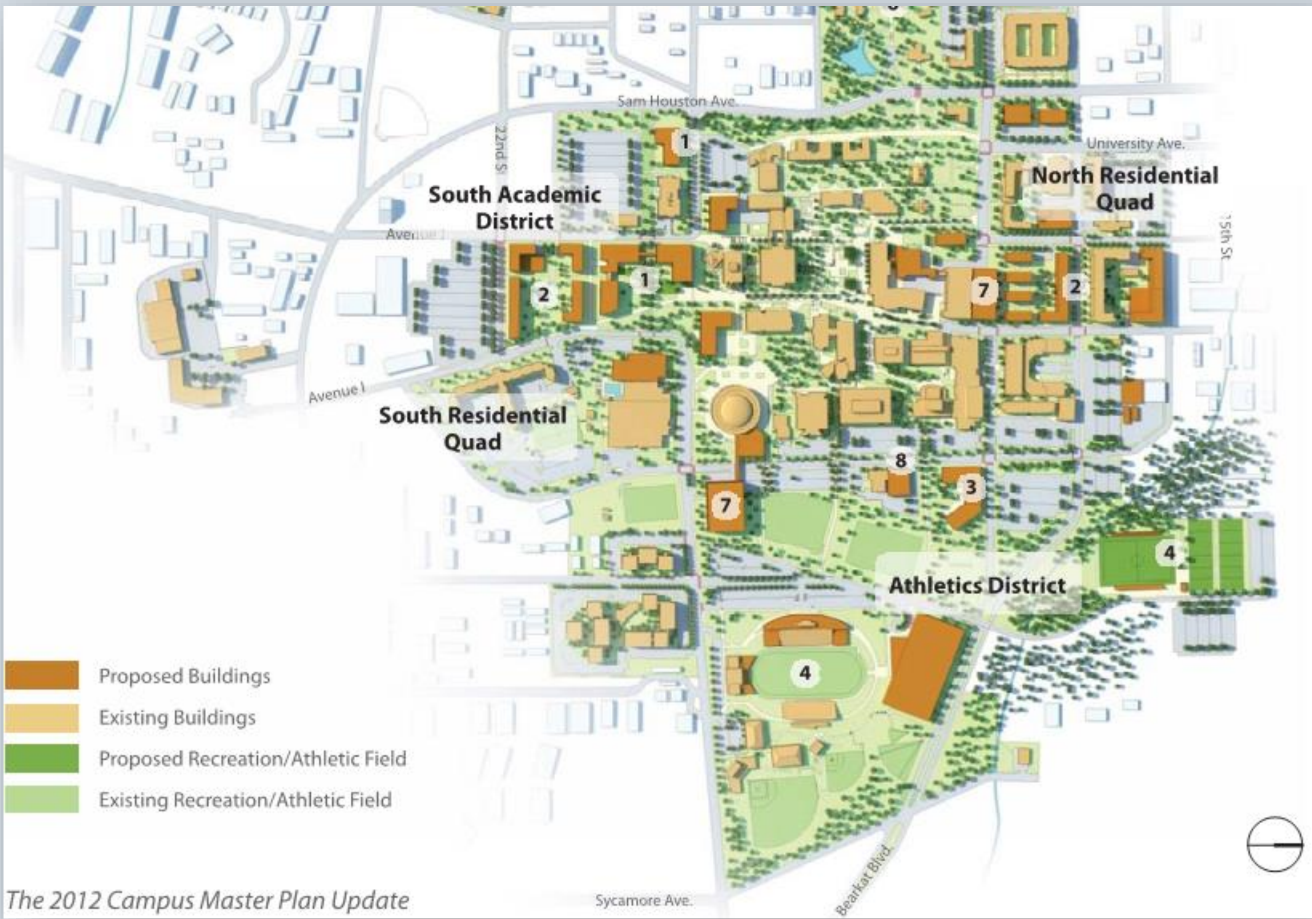
Biology Laboratory Building
Lowman Student Center Expansion
Fine Arts and W.A.S.H Complex
Communications & East Plant Expansion
~~Event Center / Press Box~~

Phase II

Shared Special Instruments Facility
DELTA/CE Building.
North District Res. (R3)
North District Res. (R4).
North District Res. (R5)
North District Dining
Basketball Practice Facility.
~~Mafrige Field House Expansion~~

Phase III

~~Demolition of Academic Building III~~
Demolition of White Hall
Allied Health Building
Indoor Multi-Purpose Facility
Academic Building
Rec. Sports Complex Expansion
Future #1
~~Future #2~~



The 2012 Campus Master Plan Update

2012 Campus Master Plan (SmithGroupJJR)

<u>Completed since the 2012 Master Plan</u>

CHW: Increase West Plant usable capacity (to 2,200 tons)
CHW: Piping from West Plant to Pirkle Building
CHW: Piping from Pirkle Building to Chemistry Building
CHW: 17th Street piping to connect East Plant and West Plant
CHW: Piping to Student Health and Counseling Center

<u>Phase I</u>

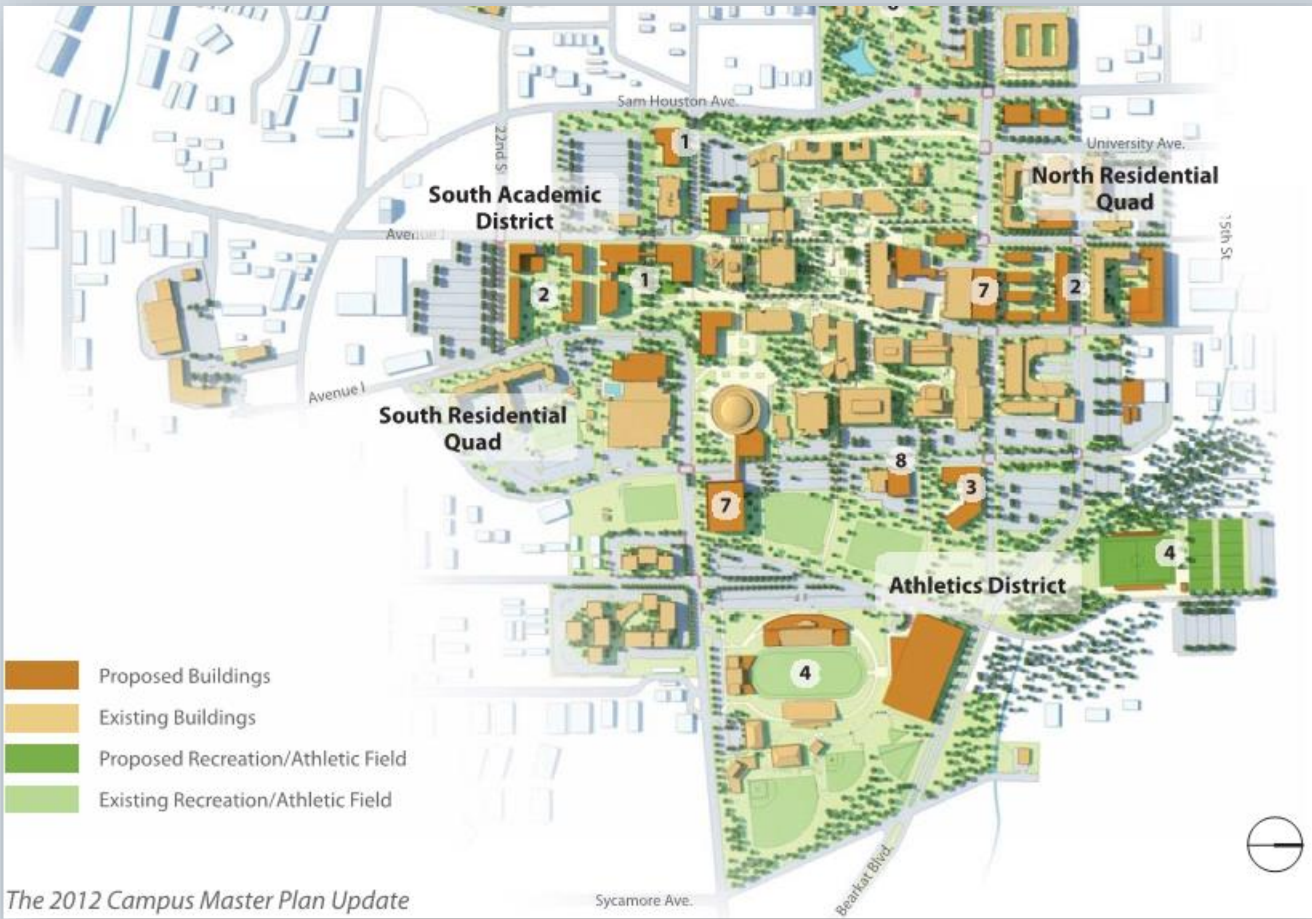
~~CHW: Connect CHSS chillers to East Plant chilled water loop~~
CHW: East Plant Expansion and Bobby K. Marks Improvements
CHW: South campus piping project #1
CHW: South campus piping project #2
HHW: Relocate West Plant HHW System to Thomason Hall
ELEC: Manhole #1 Circuit Segregation

<u>Phase II</u>

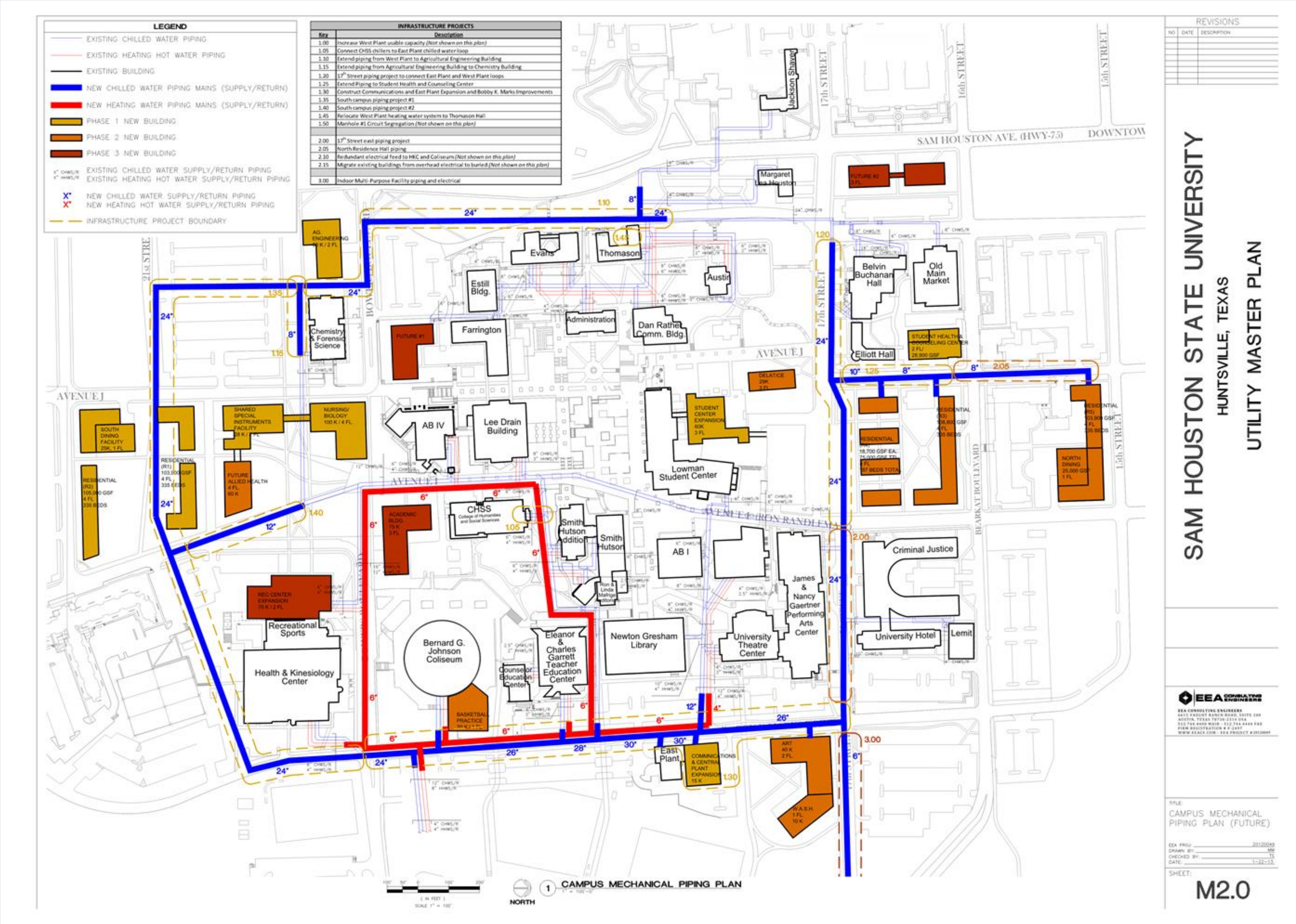
CHW: 17th Street east piping project
CHW: North Residence Hall piping
~~HHW: North Residence Hall piping~~
ELEC: Redundant electrical feed to HKC and Coliseum
ELEC: Migrate existing buildings from overhead electrical to buried

<u>Phase III</u>

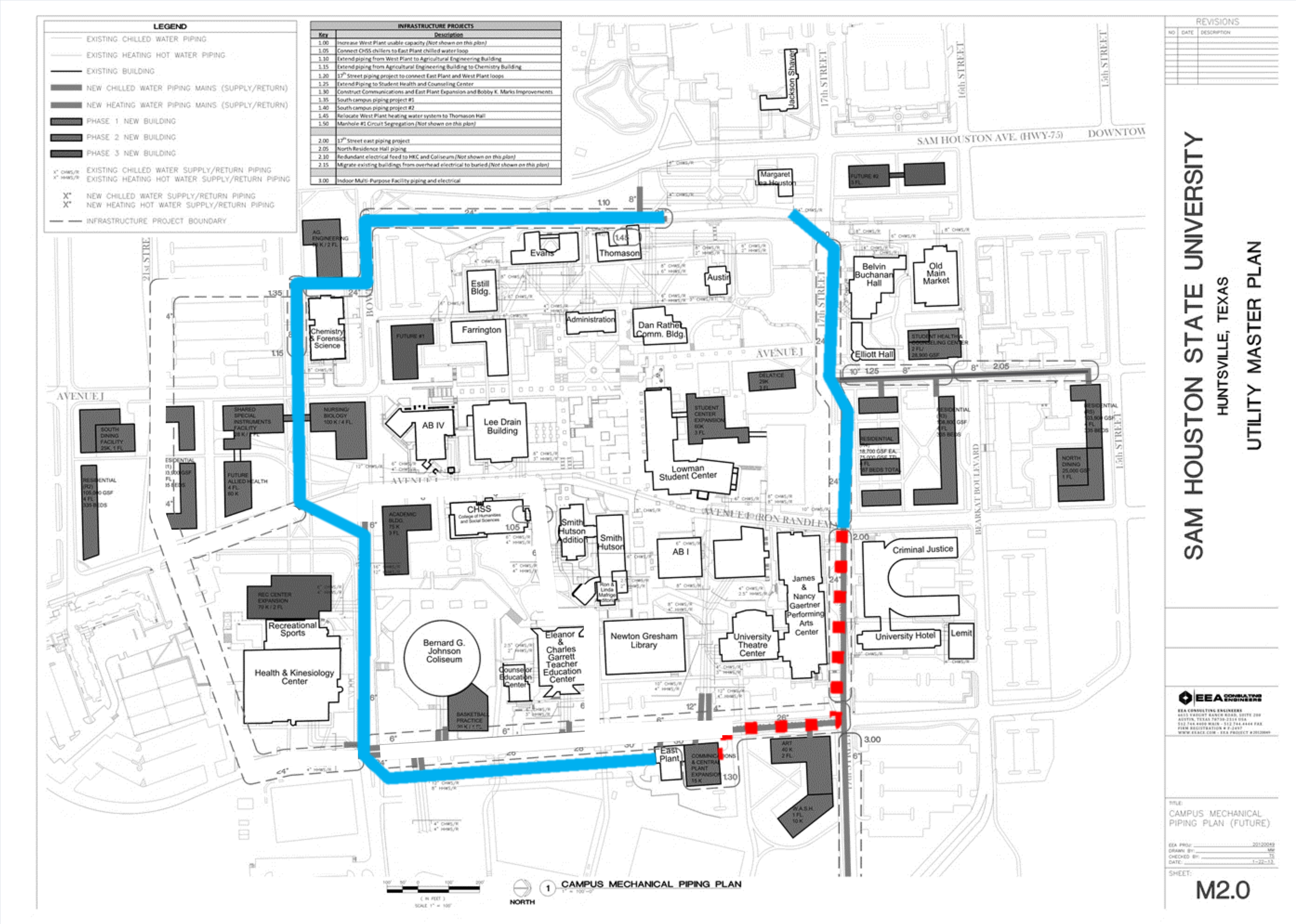
CHW/ELEC: Indoor Multi-Purpose Facility piping and electrical



Chilled Water System

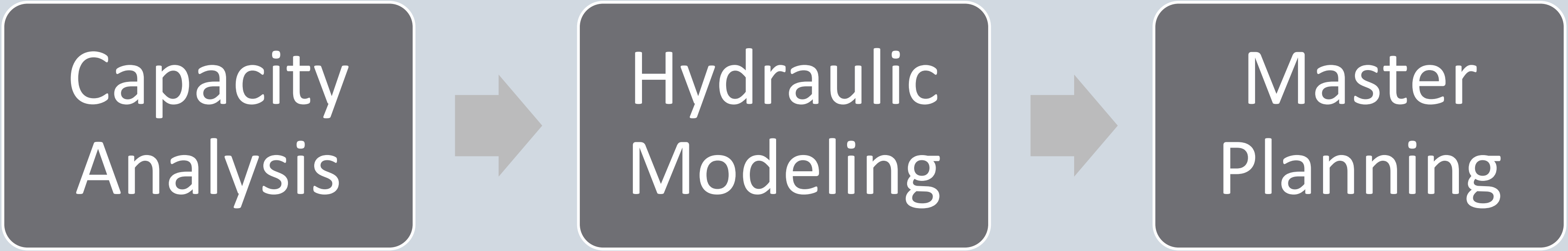


LEGEND
EXISTING CHILLED WATER PIPING
EXISTING HEATING HOT WATER PIPING
EXISTING BUILDING
NEW CHILLED WATER PIPING MAINS (SUPPLY/RETURN)
NEW HEATING WATER PIPING MAINS (SUPPLY/RETURN)
PHASE 1 NEW BUILDING
PHASE 2 NEW BUILDING
PHASE 3 NEW BUILDING
EXISTING CHILLED WATER SUPPLY/RETURN PIPING
EXISTING HEATING HOT WATER SUPPLY/RETURN PIPING
NEW CHILLED WATER SUPPLY/RETURN PIPING
NEW HEATING HOT WATER SUPPLY/RETURN PIPING
INFRASTRUCTURE PROJECT BOUNDARY
INFRASTRUCTURE PROJECTS
Key
Description
1.00 Increase West Plant usable capacity (Not shown on this plan)
1.05 Connect CHSS chillers to East Plant chilled water loop
1.10 Extend piping from West Plant to Agricultural Engineering Building
1.15 Extend piping from Agricultural Engineering Building to Chemistry Building
1.20 17th Street piping project to connect East Plant and West Plant loops
1.25 Extend Piping to Student Health and Counseling Center
1.30 Construct Communications and East Plant Expansion and Bobby K. Marks Improvements
1.35 South campus piping project #1
1.40 South campus piping project #2
1.45 Relocate West Plant heating water system to Thomason Hall
1.50 Manhole #1 Circuit Segregation (Not shown on this plan)
2.00 17th Street east piping project
2.05 North Residence Hall piping
2.10 Redundant electrical feed to HKC and Coliseum (Not shown on this plan)
2.15 Migrate existing buildings from overhead electrical to buried (Not shown on this plan)
3.00 Indoor Multi-Purpose Facility piping and electrical
SAM HOUSTON AVE. (HWY-75)
AVENUE I
AVENUE J
Evans
Thomason
Austin
Estill Bldg.
Administration
Dan Rather Comm. Bldg.
Farrington
Chemistry & Forensic Science
Belvin Buchanan Hall
Old Main Market
Elliott Hall
AB IV
Lee Drain Building
Lowman Student Center
CHSS
Smith Hutson
AB I
Criminal Justice
James & Nancy Gaertner Performing Arts Center
University Hotel
Lemit
Recreational Sports
Health & Kinesiology Center
Bernard G. Johnson Coliseum
Eleanor & Charles Garrett Teacher Education Center
Newton Gresham Library
University Theatre Center
East Plant
Margaret Lea Houston
Jackson Shaver
CAMPUS MECHANICAL PIPING PLAN
NORTH
REVISIONS
SAM HOUSTON STATE UNIVERSITY
HUNTSVILLE, TEXAS
UTILITY MASTER PLAN
EEA CONSULTING ENGINEERS
CAMPUS MECHANICAL PIPING PLAN (FUTURE)
M2.0



INFRASTRUCTURE PROJECTS	
Key	Description
1.00	Increase West Plant usable capacity *(Not shown on this plan)*
1.05	Connect CHSS chillers to East Plant chilled water loop
1.10	Extend piping from West Plant to Agricultural Engineering Building
1.15	Extend piping from Agricultural Engineering Building to Chemistry Building
1.20	17th Street piping project to connect East Plant and West Plant loops
1.25	Extend Piping to Student Health and Counseling Center
1.30	Construct Communications and East Plant Expansion and Bobby K. Marks Improvements
1.35	South campus piping project #1
1.40	South campus piping project #2
1.45	Relocate West Plant heating water system to Thomason Hall
1.50	Manhole #1 Circuit Segregation *(Not shown on this plan)*
2.00	17th Street east piping project
2.05	North Residence Hall piping
2.10	Redundant electrical feed to HKC and Coliseum *(Not shown on this plan)*
2.15	Migrate existing buildings from overhead electrical to buried *(Not shown on this plan)*
3.00	Indoor Multi-Purpose Facility piping and electrical

Study Methodology



Chilled Water Capacity Analysis

- **East Plant**
  - No significant changes since 2012 masterplan
  - Serves 20 campus buildings
  - 4,200-ton cooling capacity (available)
  - 4,000-ton peak load (*95%* utilized)

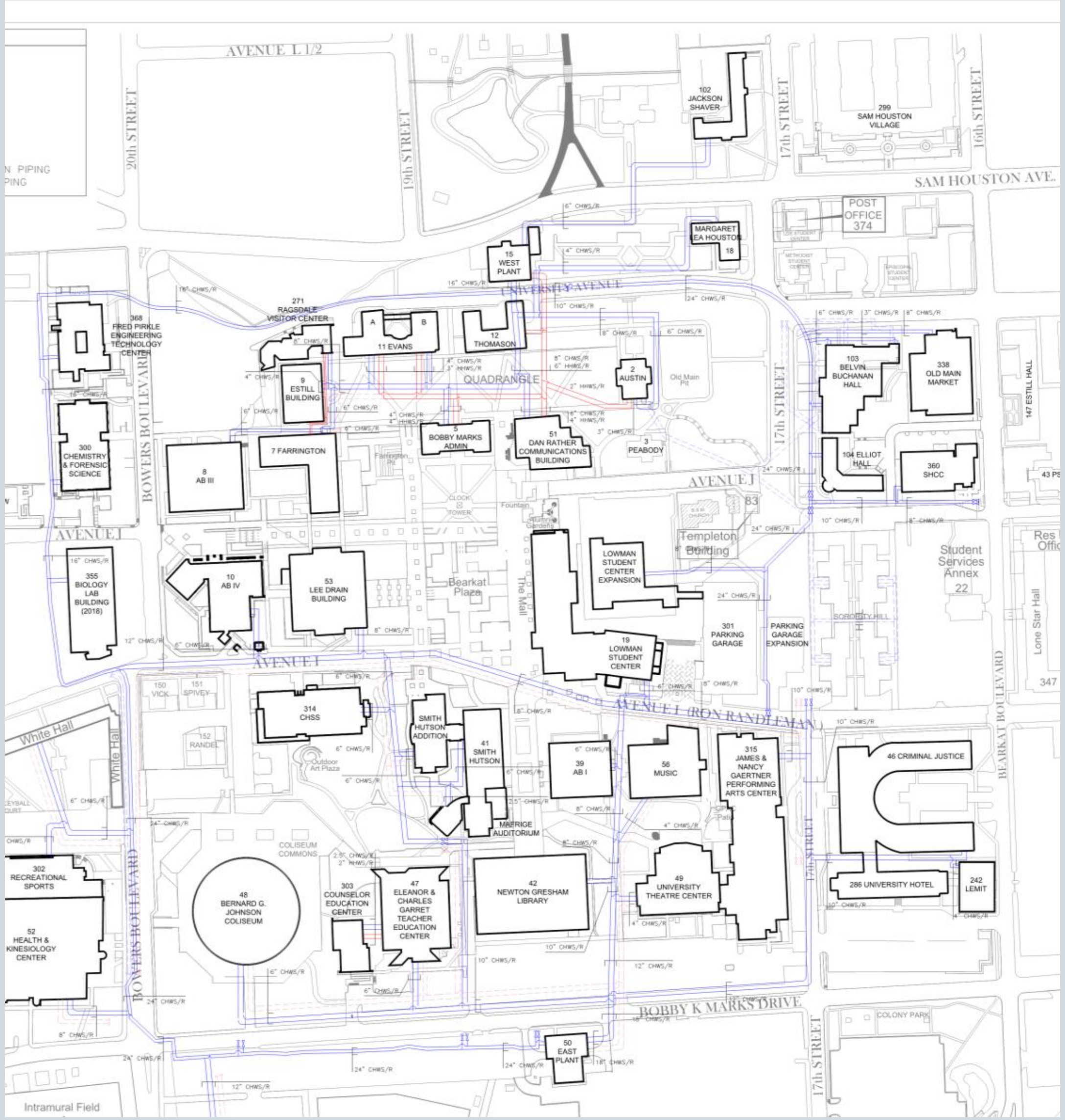
- **West Plant**
  - Efficiency and capacity improvements made to plant since 2012 masterplan
  - Serves 17 campus buildings
  - 2,200-ton cooling capacity (available)
  - 2,200-ton peak load (*100%* utilized)

Chilled Water Capacity Analysis

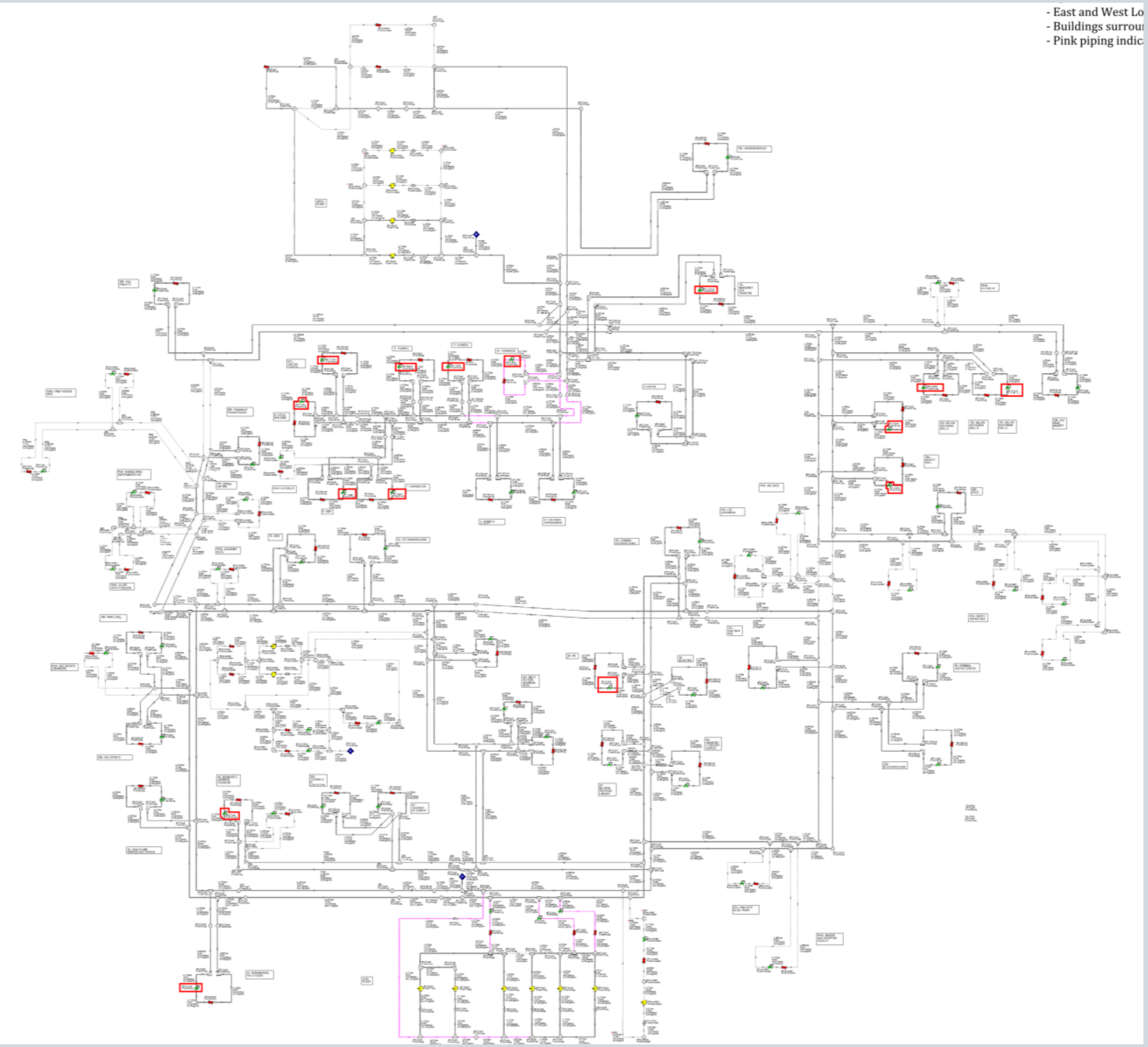
- **CHSS Plant**
  - No significant changes since 2012 masterplan
  - Serves only the CHSS building
  - 800-ton cooling capacity (available)
  - 340-ton peak load (*43%* utilized)
  - Tie-in to campus loop no longer recommended (West Plant to remain)
- **Campus Distribution Piping**
  - Significant improvements, large additions since 2012 masterplan
  - New 18”-24” main lines improve distribution capacity, efficiency, reliability
  - Connection of West and East Plants will further increase reliability

Hydraulic Modeling Analysis

- Hydraulic model: software simulation of the physical installation and operation of a hydronic system (chilled water / heating water).
- Process:
  - Understand existing installed conditions
  - Document or estimate building peak load / flowrate
  - Build software model
  - Calibrate software model to actual operational data
  - Use calibrated hydraulic model to:
    - ***Analyze existing system for issues or vulnerabilities***
    - ***Plan for future growth scenarios***
    - ***Test operational / shutdown scenarios***



Campus Chilled Water Piping



Hydraulic Model of Chilled Water Piping

Hydraulic Modeling Analysis

- **Spring 2017 Chilled Water Model**
  - "Present Day" scenario
  - Nearly all of campus distribution piping is adequately sized
  - *Plants are not able to meet flow requirements to some buildings at peak load*
- **Fall 2017 Chilled Water Model**
  - East and West Plant piping connection has been completed
  - West Plant pumps modified to provide more pumping capacity
  - Biology Building connected to loop but at partial load
  - *Plants are able to provide full flow to more buildings at peak load*

System Efficiency Analysis (kW/ton)

- **Chilled Water System Efficiency**
  - Described in terms of kW/ton (power used per cooling performed)
    - < 0.7 kW/ton = excellent
    - 0.7 – 1.0 kW/ton = good to fair
    - > 1.0 kW/ton = improvement needed
- **East Plant**
  - Existing Design = 0.8 kW/ton
  - Improved flow measurement devices are recommended to calculate and track kW/ton
- **West Plant**
  - Existing design not analyzed due to improvements in progress
  - After plant improvements, kW/ton should be monitored

System Efficiency Analysis **(dT)**

- **Chilled Water Differential Temperature**
  - Difference between chilled water supply and return temperatures
    - > 12°F = excellent
    - 8 – 12°F = good to fair
    - < 8°F = improvement needed
  - Directly impacts amount of water pumped & amount of energy consumed
    - Building design = 16°F dT, 500 gallons/minute
    - Actual operation = 8°F dT, 1000 gallons/minute
  - Poor dT will significantly *<u>increase power consumed</u>* and *<u>reduce capacity</u>* at plants
  - Must be fixed at *<u>connected buildings</u>*, not at plants
    - Coil cleaning and HVAC replacements
    - Retro- and re-commissioning
    - Automation system trending
    - *Proper instrumentation must be in place*

System Efficiency Analysis (dT)

- **East Plant**
  - Existing Design = 12°F dT
  - Average current operation = 12°F dT
- **West Plant**
  - Existing Design = 13°F dT
  - Average current operation = 8°F dT

- East Plant differential temperatures are good (with only isolated poor performing buildings).
- West Plant building (older HVAC) perform poorer. Regular monitoring and troubleshooting is recommended.

CHW Master Plan (Load)

- 2017 Load: 5,300 tons
- Phase 1 Load: 6,400 tons
- Phase 2 Load: 7,200 tons
- Phase 3 Load: 8,700 tons

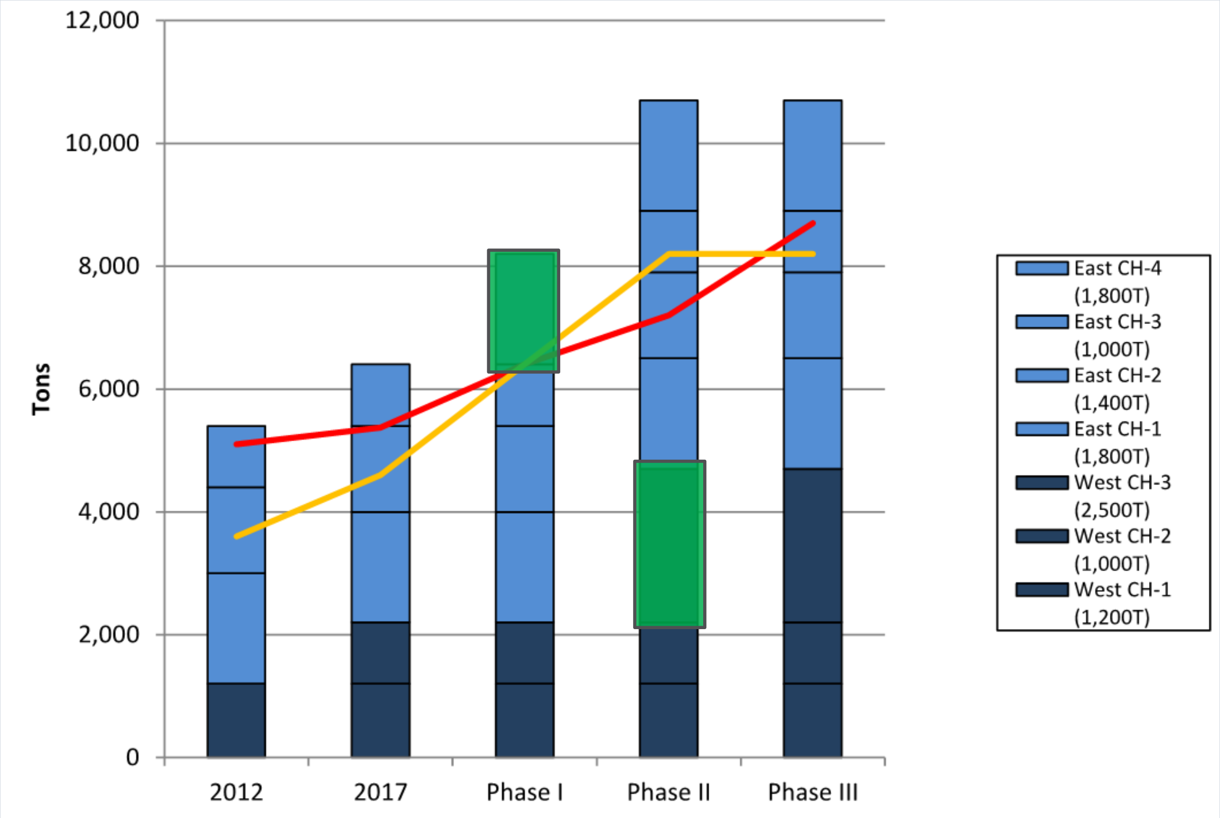
Building	Area Sq.Ft.	Cooling Density Sq.Ft./Ton	Cooling Load Tons	Design Flow (gpm)	Design dT (F)	Applied Diversity	Cooling Load Tons	Div. Flow (gpm)
Existing Buildings								
West Plant	666,616		2,600	4,800		54%	1,400	4,100
East Plant	1,474,522		4,700	9,200		83%	3,900	7,900
Total	**2,141,138**		**7,300**	**14,000**		**73%**	**5,300**	**12,000**
Phase I								
355 - Biology Laboratory Building	97,000	153	633	950	16	73%	460	690
XXX - LSC Expansion	80,000	155	517	775	16	73%	375	563
Fine Arts Building / WASH	71,000	200	360	540	16	73%	261	392
New Building Totals			**1,500**	**2,300**			**1,100**	**1,600**
Demolition Totals			**0**	**0**			**0**	**0**
Phase I Campus Totals			**8,800**	**16,300**		**73%**	**6,400**	**13,600**
Phase II								
Shared Special Instruments Facility	28,000	350	80	120	16	73%	58	87
DELTA / Continuing Education	10,000	300	30	45	16	73%	22	33
North Residential (R3)	108,800	350	310	465	16	73%	225	338
North Residential (R4)	75,000	350	210	315	16	73%	152	229
North Residential (R5)	103,900	350	300	450	16	73%	218	327
North Dining Facility	25,000	200	130	195	16	73%	94	142
Basketball Practice Facility	20,000	300	70	105	16	73%	51	76
New Building Totals			**1,100**	**1,700**			**800**	**1,200**
Demolition Totals			**0**	**0**			**0**	**0**
Phase II Campus Totals			**9,900**	**18,000**		**73%**	**7,200**	**14,800**
Phase III								
Allied Health Building	60,000	300	200	300	16	73%	145	218
Indoor Multipurpose Facility	125,000	300	420	630	16	73%	305	457
Academic Building	75,000	300	250	375	16	73%	182	272
Recreation Center Facility Expansion	75,000	300	250	375	16	73%	182	272
Future Building	60,000	300	200	300	16	73%	145	218
373 - Piney Woods Hall	232,822	443	525	1,050	12	73%	381	572
372 - General's Market (Dinning Hall)	23,657	79	300	450	16	73%	218	327
Demo White Hall	-	-	-	-	-	-	-	-
New Building Totals			**2,100**	**3,500**			**1,600**	**2,300**
Demolition Totals			**69**	**165**			**58**	**142**
Phase III Campus Totals			**11,900**	**21,300**		**73%**	**8,700**	**17,000**

CHW Master Plan (Capacity)

<u>2017 Capacity</u>

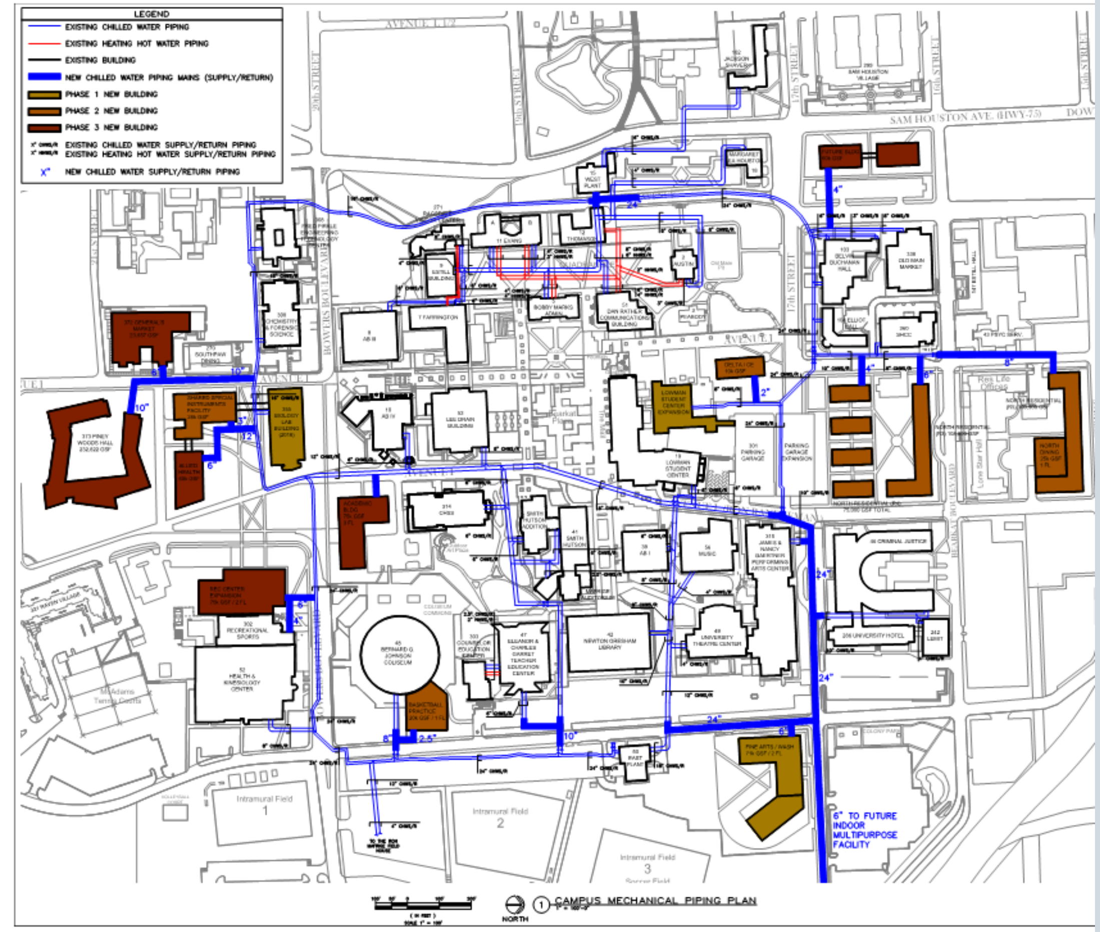
- East Plant: 4,200 ton capacity
- West Plant: 2,200 ton capacity
- Total Capacity: 6,400 ton capacity
- ***Firm Capacity: 4,600 ton capacity***

- 2017 Load: **5,300 tons**
- Phase 1 Load: **6,400 tons**
- Phase 2 Load: **7,200 tons**
- Phase 3 Load: **8,700 tons**



CHW Master Plan (Distribution)

- **Phase 1**
  - East and West Plant loops connected on north and south side of campus
  - All campus buildings adequately served
  - *Complete 24” north loop allows for two East/West Plant backfeeds*
- **Phase 2**
  - Third chiller added at West Plant for system N+1 capacity
  - North campus branch piping (residences) added
  - *All buildings served adequately*
- **Phase 3**
  - All planned buildings connected
  - All piping completed
  - *All buildings served adequately, pipes adequately sized*



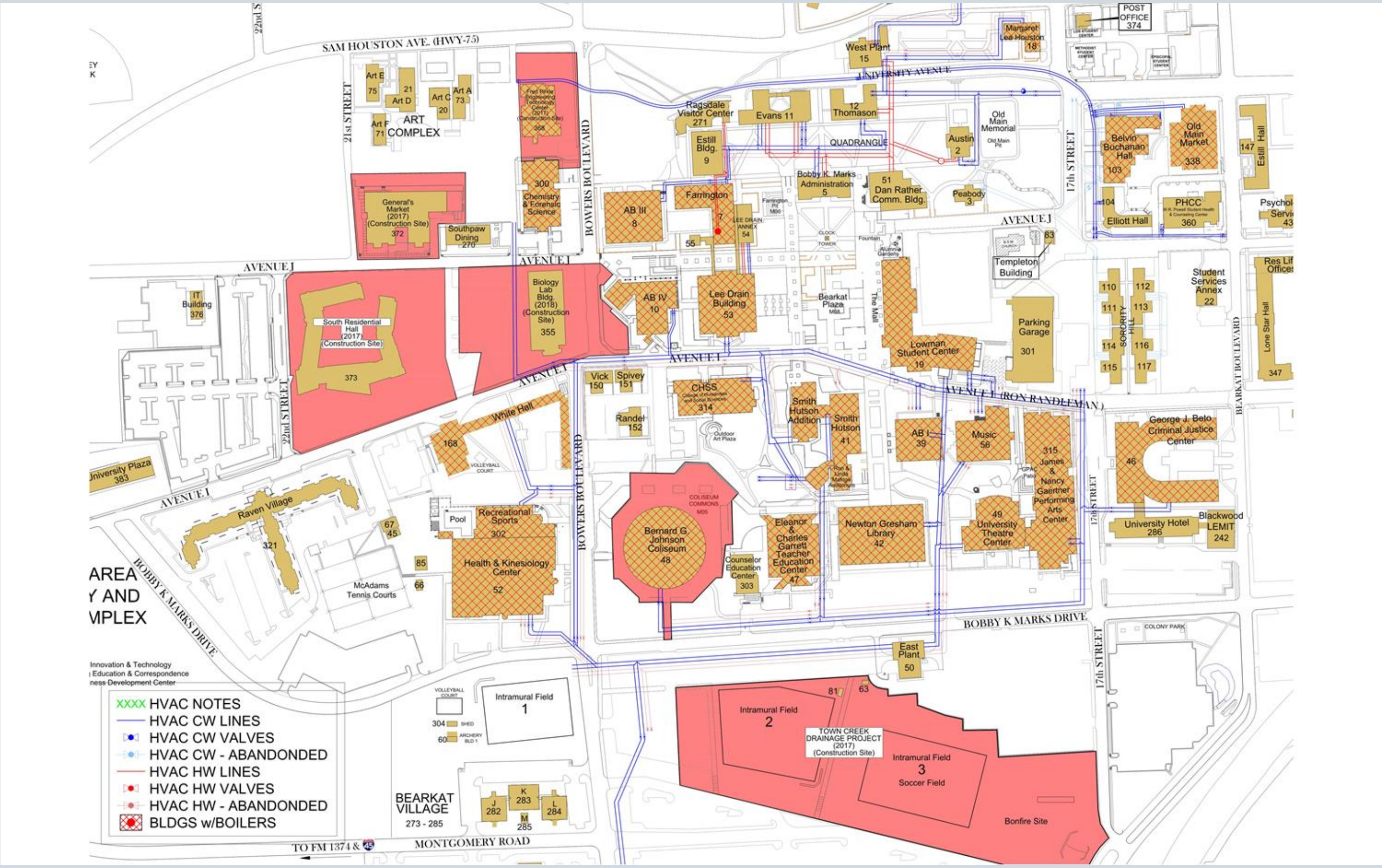
CHW Master Plan (Summary)

- **Phase 1**
  - Increase West Plant usable capacity (to 2,200 tons) *- to be completed in 2017*
  - Install Piping from Chemistry Building to Ave. I *- to be completed in 2017*
  - Install Piping from Ave. I to Bobby K. Marks *- to be completed in 2017*
  - Install Piping from East Plant to Ave I. *- to be completed in 2017*
  - Increase East Plant capacity (~1,800 tons) *- in design (Arts Building)*
    - Improve chilled water metering at plant for kW/ton tracking
    - Include variable-volume flow conversion
  - Monitor building and plant flowrate and load to improve model accuracy
- **Phase 2**
  - Install piping to North Residence Hall
  - Increase West Plant capacity (~2,500 tons)
- **Phase 3**
  - Install piping to Multi-Purpose Facility

Heating Water System

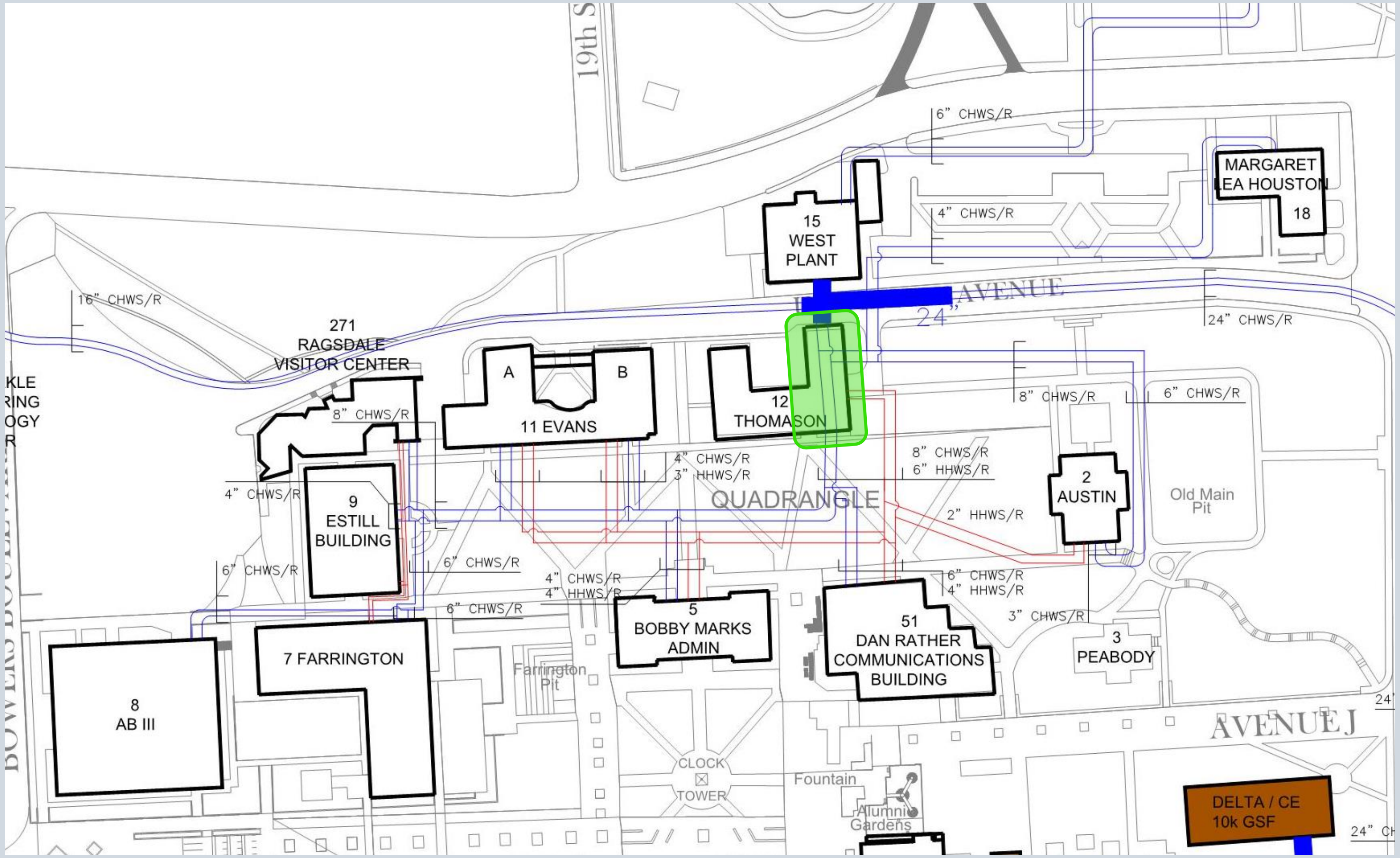
Heating Water System Status

- **<u>East Plant</u> - *decommissioned***
  - Six existing boilers have been removed
  - Modular boilers installed locally at all (12) buildings previously served
- **<u>West Plant</u>**
  - Provides heating water to 6 campus buildings
    - Austin Hall
    - Bobby K. Marks Admin.
    - Evans Complex A
    - Evans Complex B
    - Thomason
    - Dan Rather Communications



Heating Water System Masterplan

- **East Plant** - ***decommissioned***
  - Continue to install modular boilers locally at all new buildings
- **West Plant**
  - Remove existing high-mass heating water boiler
  - Install new, high-efficiency condensing modular boilers at Thomason Hall
    - Available space in the lowest floor of Thomason Hall with exterior walls for combustion / flue routing
    - Exposed heating water piping for connection to the loop
    - Gas service nearby at the West Plant



Medium Voltage Electrical System

Medium Voltage Capacity Analysis

- **Distribution System Summary (Existing Conditions)**
  - All buildings on campus (with a few exceptions) are fed from a primary redundant circuit pair. Circuits 1+2, 3+4, 5+6, or 7+8.
  - On each circuit pair, building load is evenly split (i.e. Circuit 1 and Circuit 2 share the load). If one circuit were to be lost, the other circuit could handle the full load.
  - All circuits are operating well below maximum capacity with at least 25% spare on each circuit pair.
  - SHSU Electrical Department has done a good job making sure the electrical system is capable of campus expansion with redundant circuits.

Medium Voltage Capacity Analysis

- **Software Modeling (Future Conditions)**
  - Software utilized to determine correct coordination of overcurrent protection devices (breakers).
    - *Campus system is designed to properly handle a fault event, with several isolated recommendations.*

  - Software utilized to determine maximum allowable ampacity in campus cabling due to conduit size, feeder size, and heat dissipation.

Circuit	Current Spare Capacity	Phase III Spare Capacity
1+ 2	28%	38%
3 + 4	33%	20%
5 + 6	26%	62%
7 + 8	80%	19%
9 + 10 (new)	-	63%

Medium Voltage Capacity Analysis

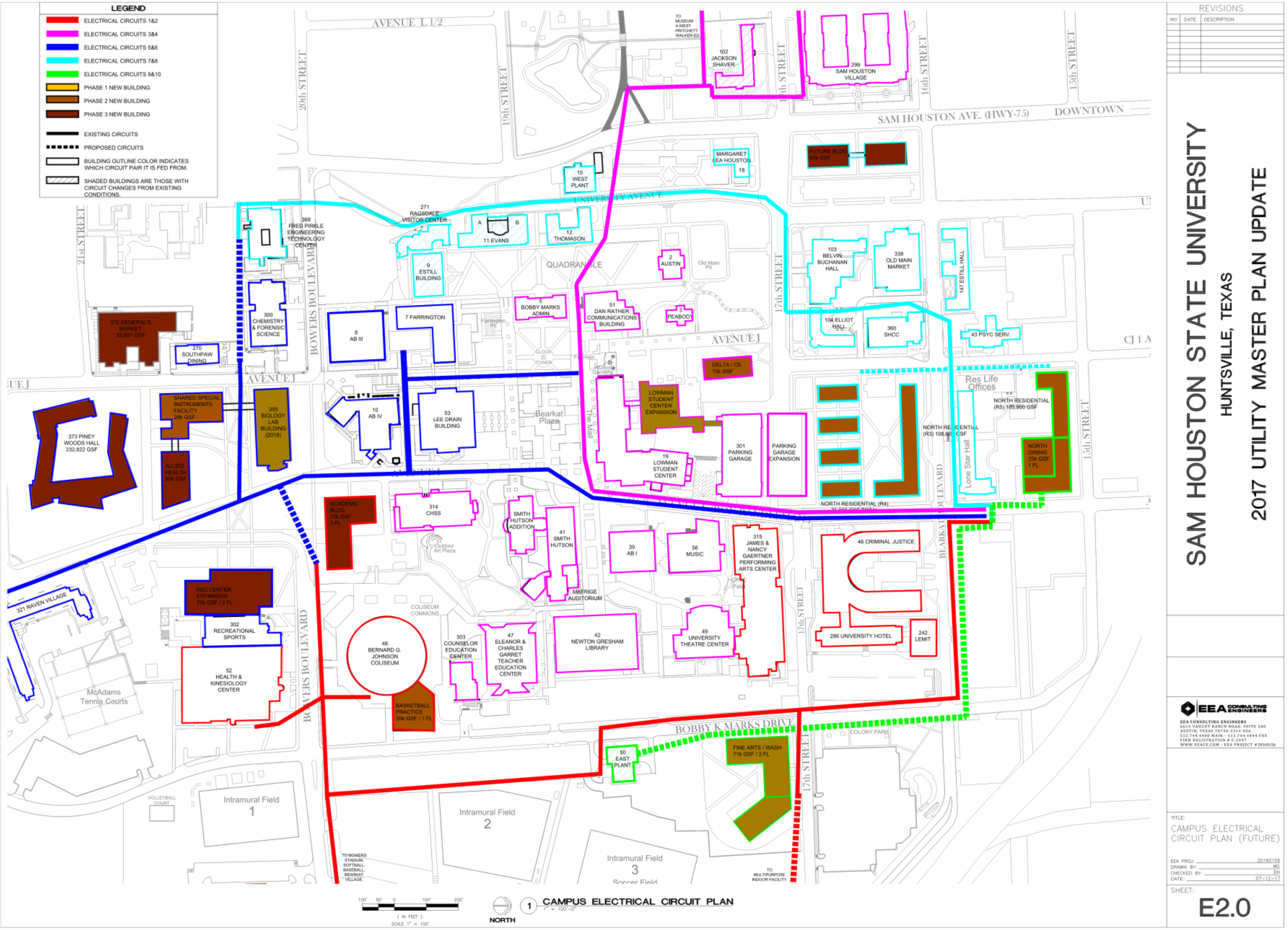
- **Distribution Limitations**
  - Circuit pairs are run in parallel through same manholes around campus. If a manhole is compromised (fault, etc.) it could disrupt power to both circuit pairs.

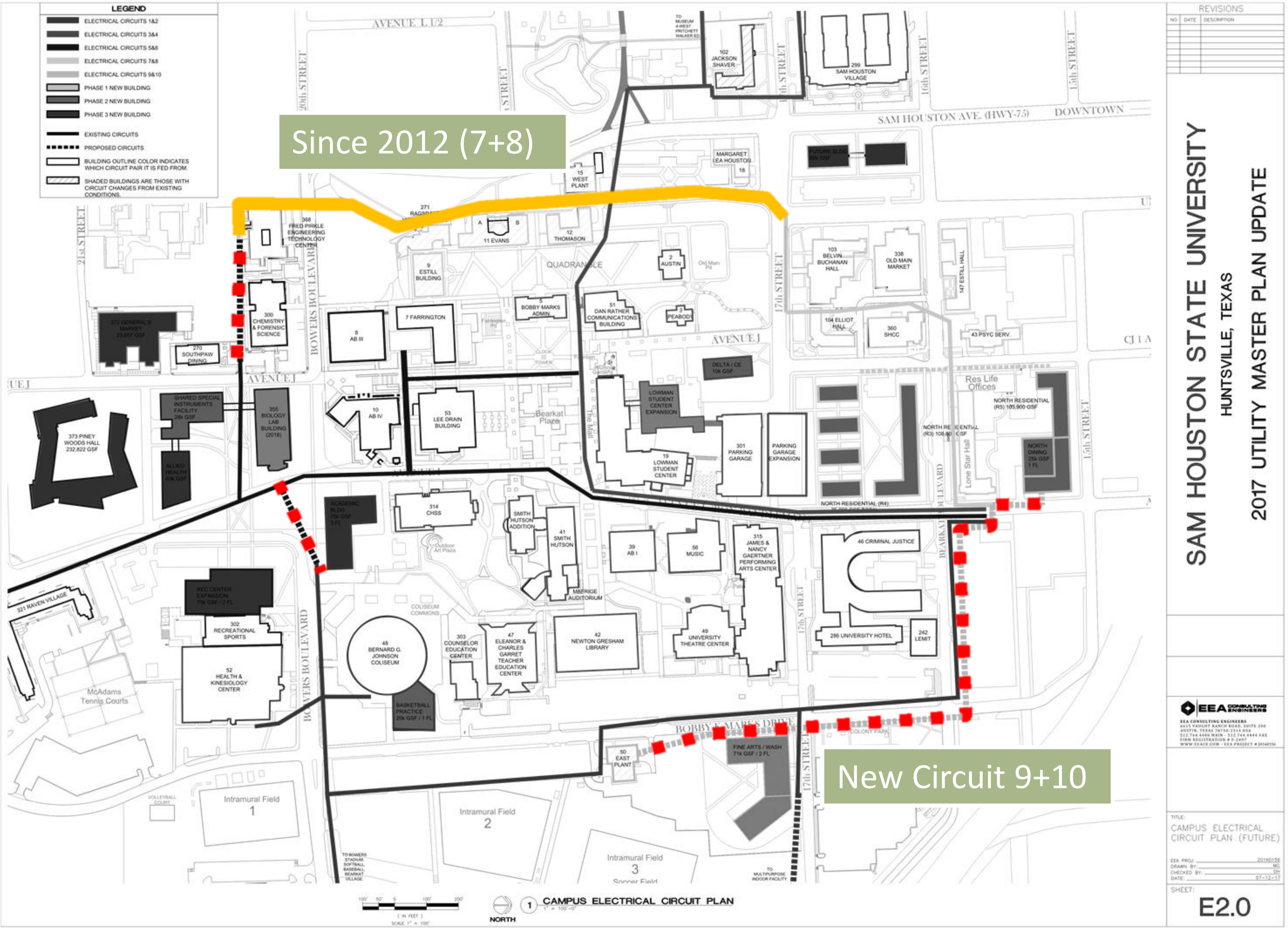
  - SHSU has identified this limitation and have planned projects to complete electrical loops (1+2 with 5+6, and 3+4 with 7+8). This will allow any circuit to be "back-fed" if necessary.

  - **<u>Manhole #1</u>**

All circuit pairs are routed through Manhole #1. A project is planned to separate the odd circuits and even circuits into different manholes. This reduces the downtime if a fault happened in Manhole #1.

This design is taking place with the Arts Building project.


LEGEND
ELECTRICAL CIRCUITS 1&2
ELECTRICAL CIRCUITS 3&4
ELECTRICAL CIRCUITS 5&6
ELECTRICAL CIRCUITS 7&8
ELECTRICAL CIRCUITS 9&10
PHASE 1 NEW BUILDING
PHASE 2 NEW BUILDING
PHASE 3 NEW BUILDING
EXISTING CIRCUITS
PROPOSED CIRCUITS
BUILDING OUTLINE COLOR INDICATES WHICH CIRCUIT PAIR IT IS FED FROM.
SHADED BUILDINGS ARE THOSE WITH CIRCUIT CHANGES FROM EXISTING CONDITIONS.
AVENUE L 1/2
SAM HOUSTON AVE. (HWY-75)
DOWNTOWN
UNIVERSITY AVENUE
QUADRANGLE
AVENUE J
BOWERS BOULEVARD
BOBBY K MARKS DRIVE
17th STREET
15th STREET
20th STREET
21st STREET
19th STREET
299 SAM HOUSTON VILLAGE
102 JACKSON SHAVER
MARGARET LEA HOUSTON
15 WEST PLANT
271 RAGSDALE VISITOR CENTER
368 FRED PIRKLE ENGINEERING TECHNOLOGY CENTER
11 EVANS
12 THOMASON
2 AUSTIN
9 ESTILL BUILDING
103 BELVIN BUCHANAN HALL
338 OLD MAIN MARKET
147 ESTILL HALL
300 CHEMISTRY & FORENSIC SCIENCE
8 AB III
7 FARRINGTON
5 BOBBY MARKS ADMIN
51 DAN RATHER COMMUNICATIONS BUILDING
3 PEABODY
104 ELLIOT HALL
360 SHCC
43 PSYC SERV.
372 GENERAL'S MARKET 23,657 GSF
270 SOUTHPAW DINING
DELTA / CE 10k GSF
LOWMAN STUDENT CENTER EXPANSION
Res Life Offices
NORTH RESIDENTIAL (R5) 103,900 GSF
SHARED SPECIAL INSTRUMENTS FACILITY 28k GSF
355 BIOLOGY LAB BUILDING (2018)
373 PINEY WOODS HALL 232,822 GSF
10 AB IV
53 LEE DRAIN BUILDING
Bearkat Plaza
19 LOWMAN STUDENT CENTER
301 PARKING GARAGE
PARKING GARAGE EXPANSION
NORTH DINING 25k GSF 1 FL
ALLIED HEALTH 60k GSF
ACADEMIC BLDG 75k GSF 3 FL
314 CHSS
SMITH HUTSON ADDITION
41 SMITH HUTSON
39 AB I
56 MUSIC
315 JAMES & NANCY GAERTNER PERFORMING ARTS CENTER
46 CRIMINAL JUSTICE
321 RAVEN VILLAGE
REC CENTER EXPANSION 75k GSF / 2 FL
302 RECREATIONAL SPORTS
MARRIGE AUDITORIUM
COLISEUM COMMONS
48 BERNARD G. JOHNSON COLISEUM
303 COUNSELOR EDUCATION CENTER
47 ELEANOR & CHARLES GARRETT TEACHER EDUCATION CENTER
42 NEWTON GRESHAM LIBRARY
49 UNIVERSITY THEATRE CENTER
286 UNIVERSITY HOTEL
242 LEMIT
52 HEALTH & KINESIOLOGY CENTER
McAdams Tennis Courts
BASKETBALL PRACTICE 20k GSF / 1 FL
50 EAST PLANT
FINE ARTS / WASH 71k GSF / 2 FL
COLONY PARK
Intramural Field 1
Intramural Field 2
Intramural Field 3
TO BOWERS STADIUM, SOFTBALL, BASEBALL, BEARKAT VILLAGE
TO MULTIPURPOSE INDOOR FACILITY
NORTH
1 CAMPUS ELECTRICAL CIRCUIT PLAN
REVISIONS
SAM HOUSTON STATE UNIVERSITY
HUNTSVILLE, TEXAS
2017 UTILITY MASTER PLAN UPDATE
EEA CONSULTING ENGINEERS
TITLE: CAMPUS ELECTRICAL CIRCUIT PLAN (FUTURE)
SHEET: E2.0

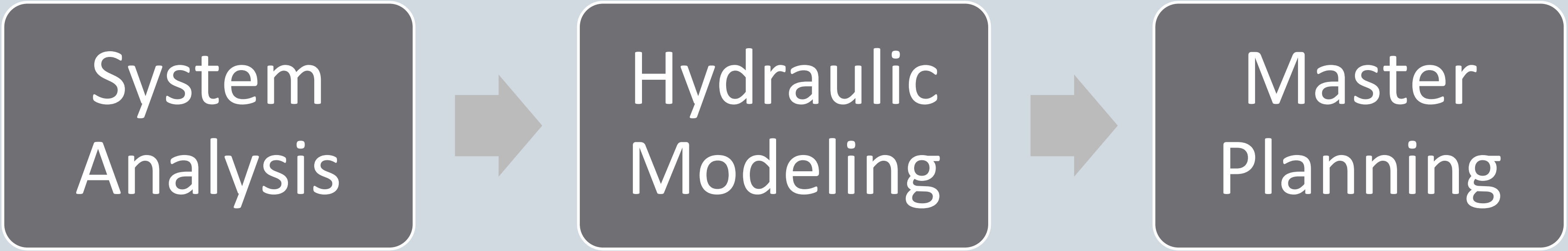

Since 2012 (7+8)
New Circuit 9+10
LEGEND
ELECTRICAL CIRCUITS 1&2
ELECTRICAL CIRCUITS 3&4
ELECTRICAL CIRCUITS 5&6
ELECTRICAL CIRCUITS 7&8
ELECTRICAL CIRCUITS 9&10
PHASE 1 NEW BUILDING
PHASE 2 NEW BUILDING
PHASE 3 NEW BUILDING
EXISTING CIRCUITS
PROPOSED CIRCUITS
SAM HOUSTON STATE UNIVERSITY
HUNTSVILLE, TEXAS
2017 UTILITY MASTER PLAN UPDATE
REVISIONS
CAMPUS ELECTRICAL CIRCUIT PLAN
NORTH
CAMPUS ELECTRICAL CIRCUIT PLAN (FUTURE)
SHEET:
E2.0

MV Electrical Master Plan (Summary)

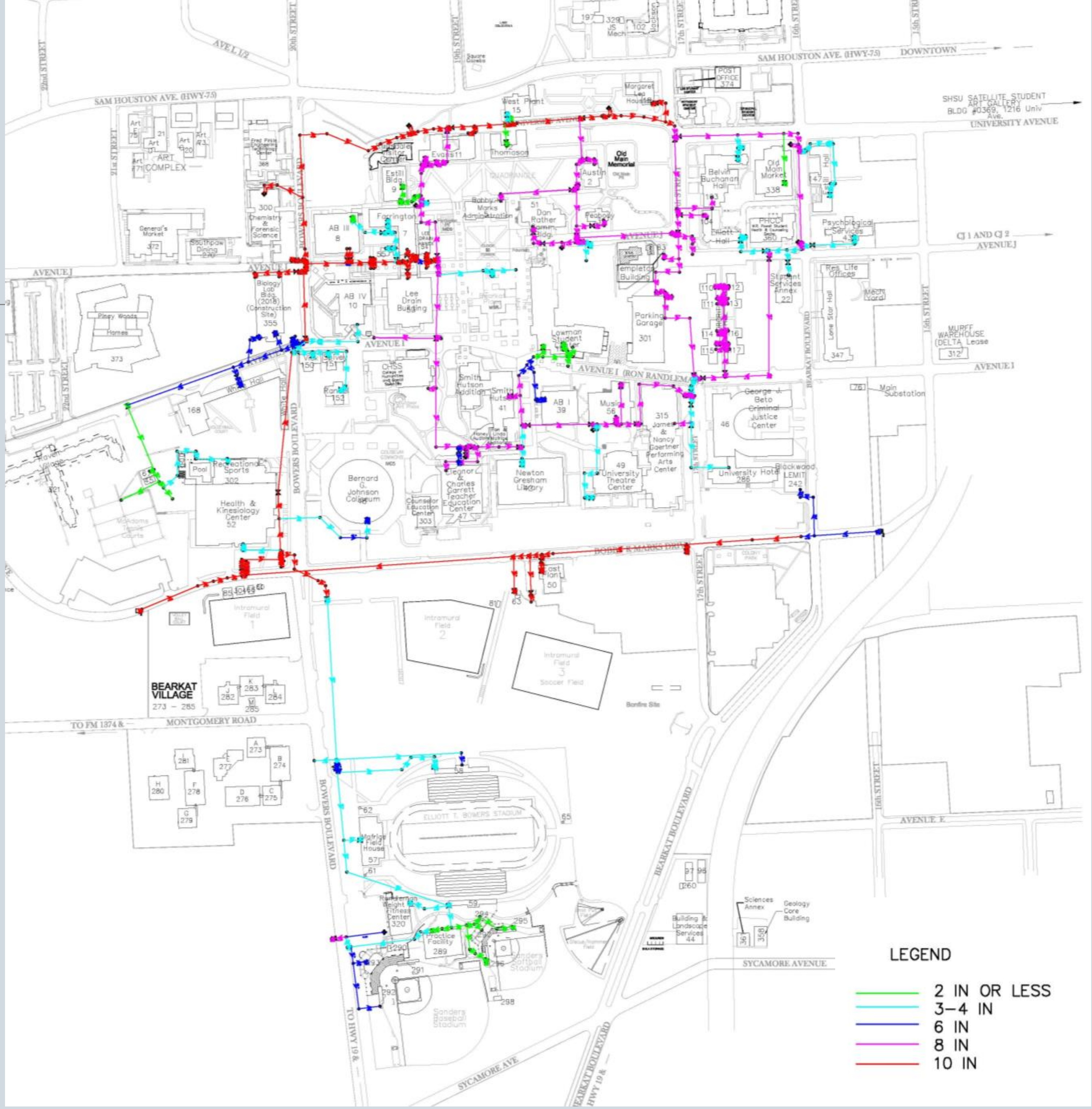
- **<u>Phase 1</u>**
  - Route Circuits #9 & #10 from switchgear building to East Plant *- in design (Arts Building)*
  - Manhole #1 Circuit Separation *- in design (Arts Building)*
  - MV branch extensions to buildings
- **<u>Phase 2</u>**
  - Redundant electrical feed to HKC and Coliseum
  - Migrate existing buildings from overhead electrical services to buried
  - MV branch extensions to buildings
- **<u>Phase 3</u>**
  - Install ductbank to Multi-Purpose Facility
  - MV branch extensions to buildings

Domestic Water System

Study Methodology



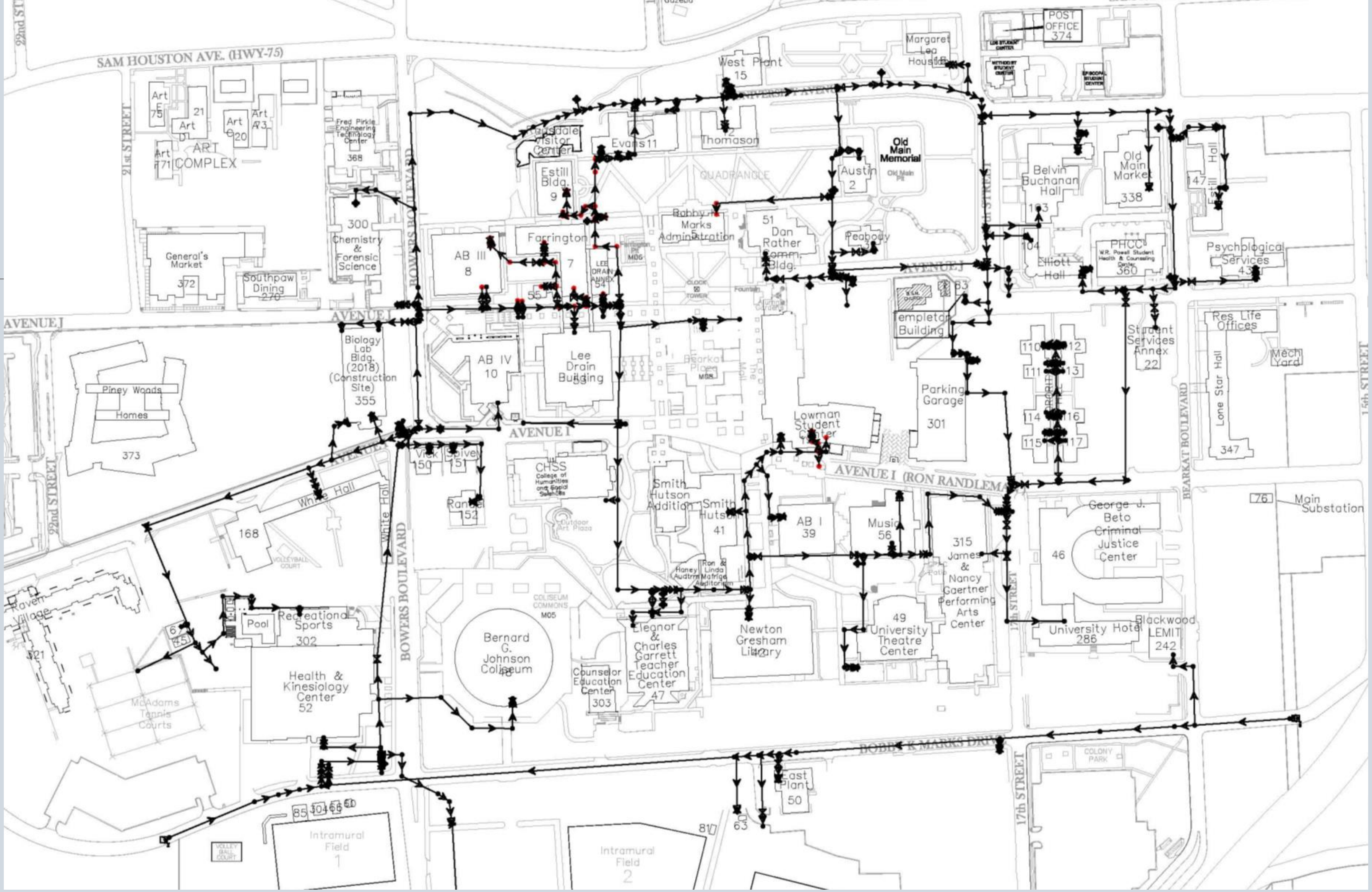
Existing Domestic System



Hydraulic Modeling Analysis

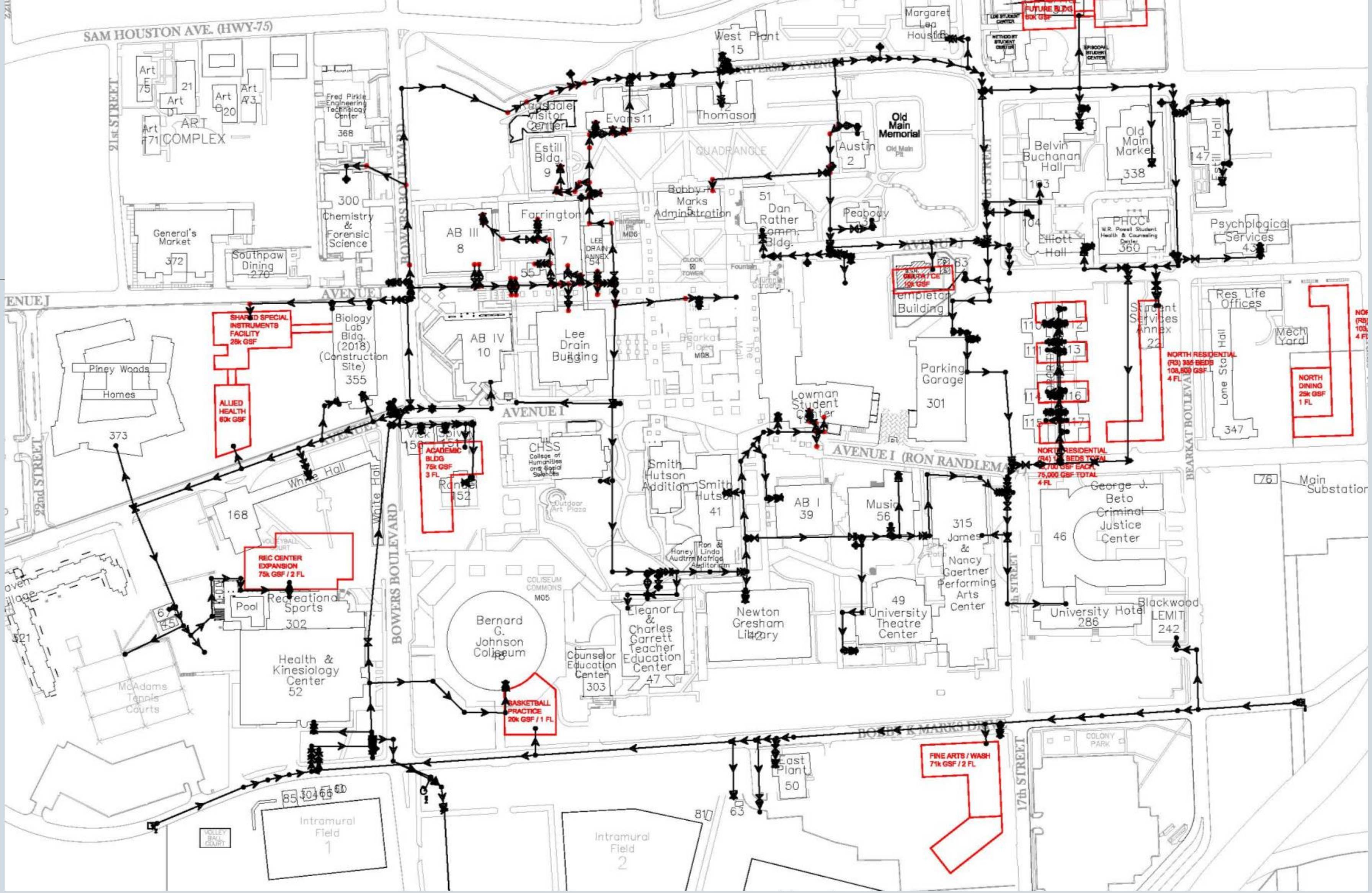
- No current water model – started from scratch
- Industry Standard Bentley WaterCAD
- Modeled Campus Loop/System
- Created using system maps and input from Facilities personnel
- Obtained limited meter data and used to check standard demand estimates
  - Included irrigation demands from meters provided
- Modeled both Existing and Future Systems
- Evaluated Based on 60psi minimum (able to get to 2nd story of buildings)
- Included City's proposed pressure plane increase (597.32' up to 630')

Existing Domestic System



- Pressures <60 psi shown in red
  - Generally at high point in system

Future Domestic System



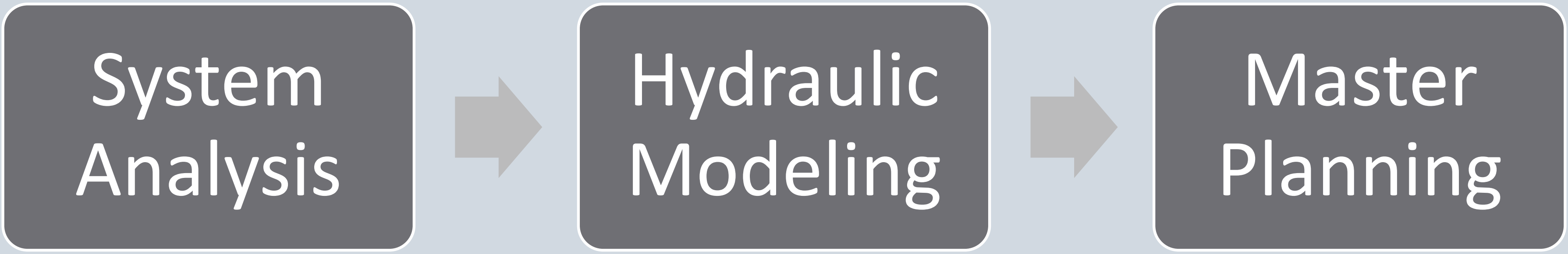
- Pressures <60 psi shown in red
  - Generally at high point in system

Domestic Water Master Plan (Recommendations)

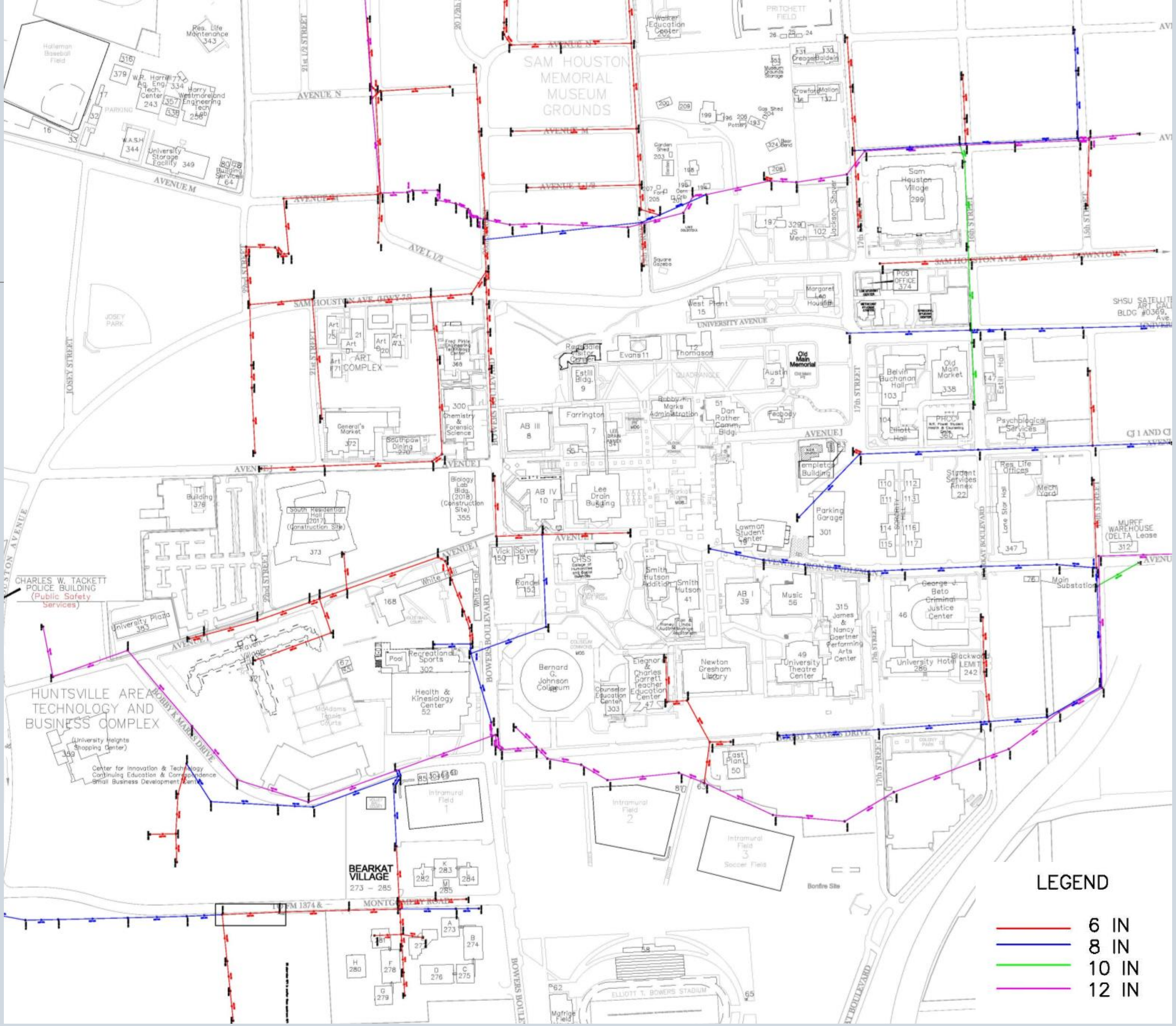
- Booster Pump/Tank near Farrington (approx. 25’ head)
- Encourage City to follow-through with planned pressure plane increase
- Additional Monitoring - flowmeters

Sanitary Sewer System

Study Methodology



Existing Sanitary Sewer System



Hydraulic Modeling Analysis

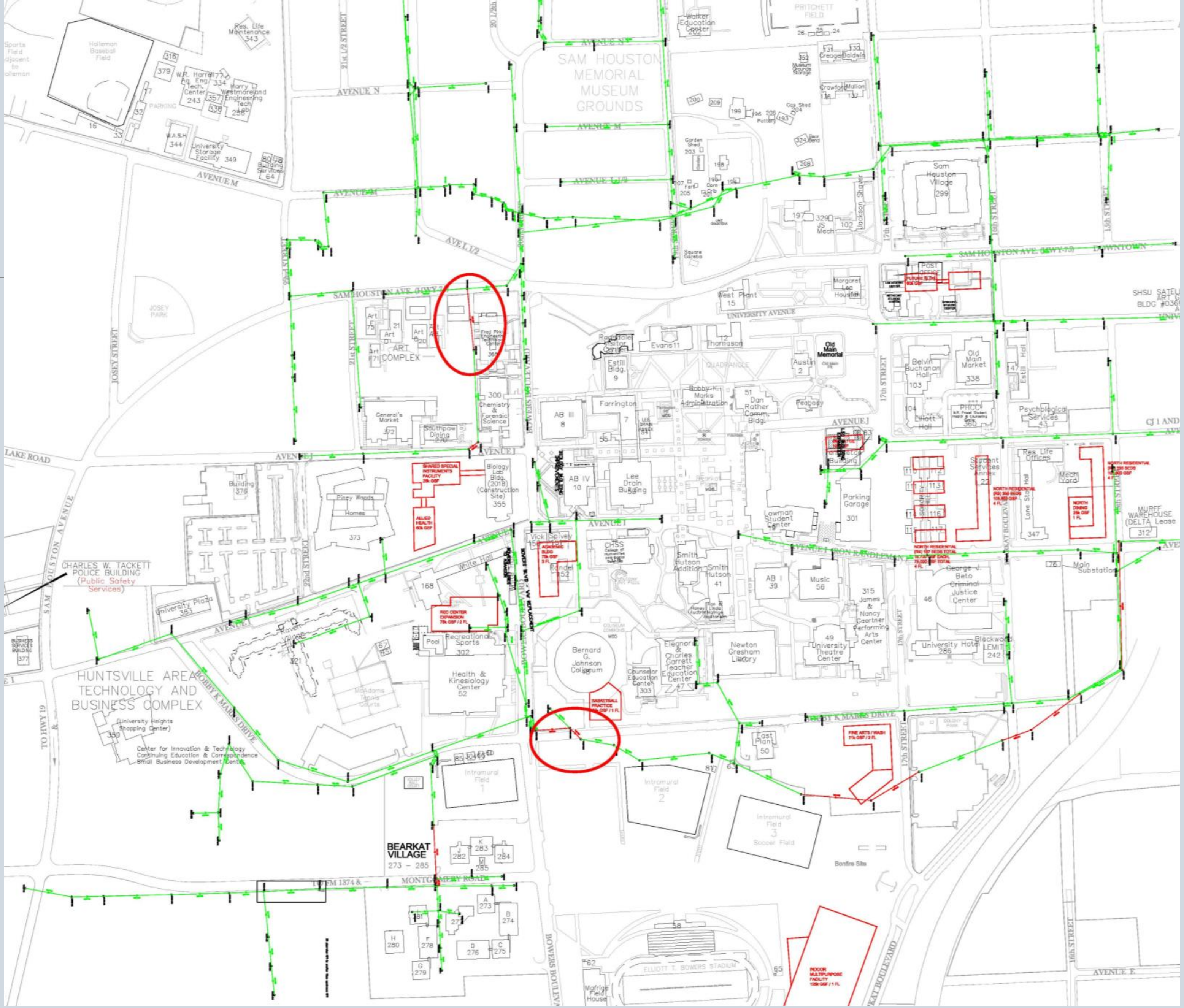
- No current sanitary sewer model – started from scratch
- Industry Standard Bentley SewerCAD
- System passes through campus
  - Modeled portion within campus + one block outside
- Created using system maps and input from Facilities personnel
- Assumed loading matches domestic demands
- Modeled both Existing and Future Systems
- Evaluated Based on capacity (pipe >85% full)

Existing Sanitary Sewer System

- Over capacity

Future Sanitary Sewer System

- Over capacity

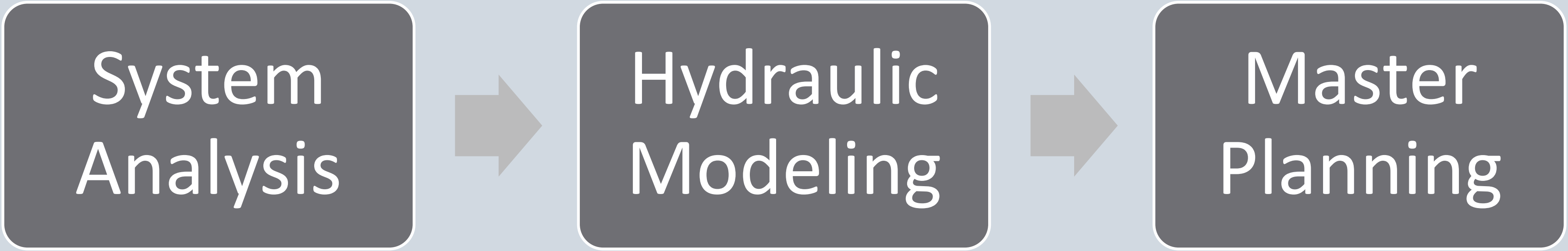


Sanitary Sewer Master Plan (Recommendations)

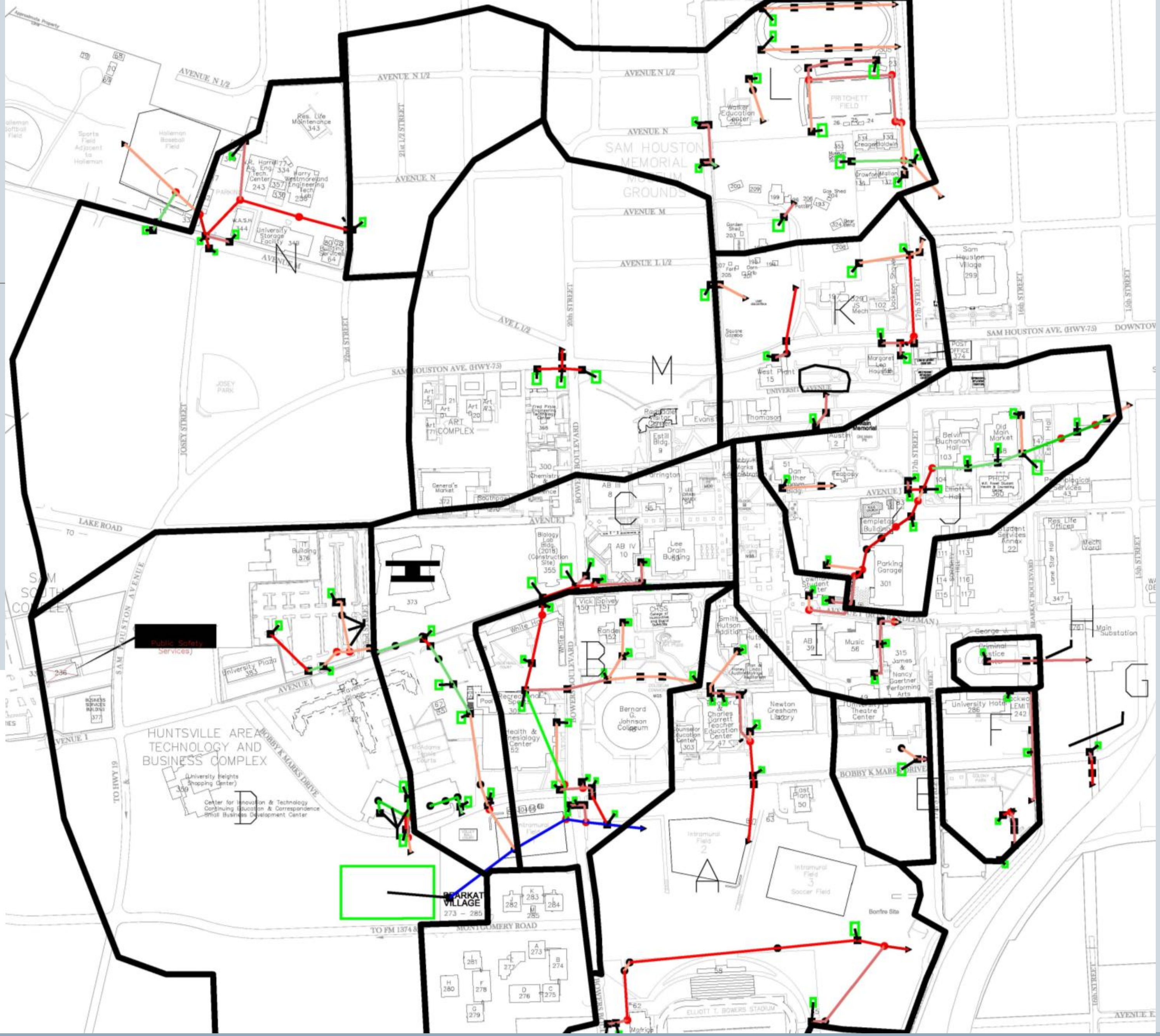
- Sections shown to be over capacity are typically extremely flat
  - Increase slope,
  - Increase pipe size,
  - Divert loading to adjacent systems
  - Need detailed evaluation for each section

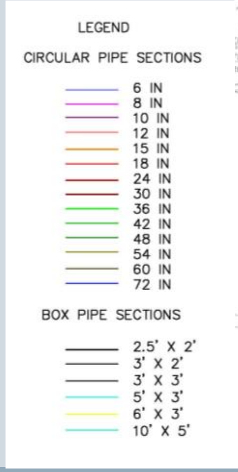
Storm Drain System

Study Methodology



Existing Storm Sewer System



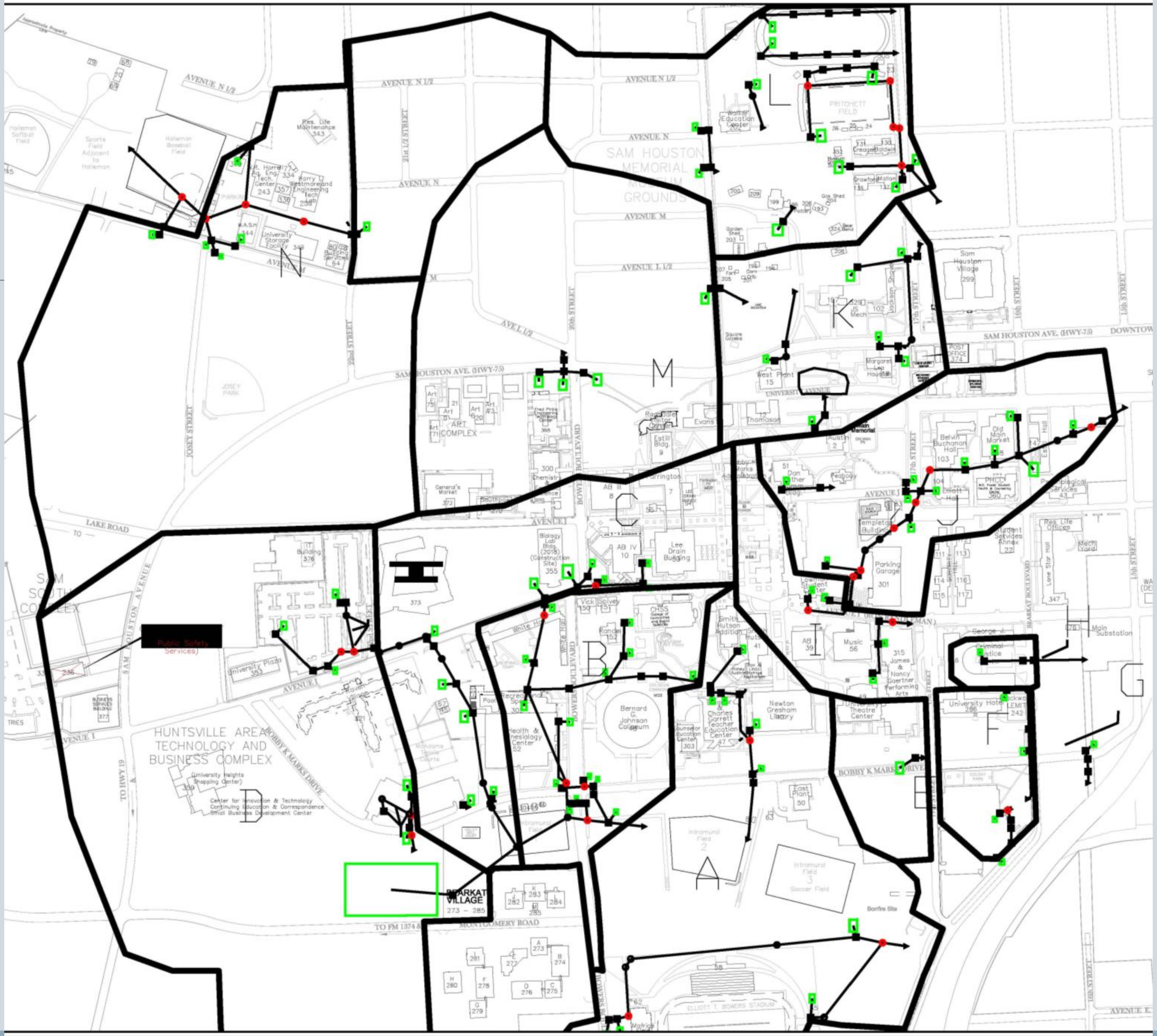


H&H Modeling Analysis

- No current storm sewer model – started from scratch
- Industry Standard Bentley CivilStorm
- Modeled Campus System
- Created using system maps and input from Facilities personnel
  - Heavy reliance on Report created by O'Malley Engineers in December 2003
- 14 Major drainage areas – many more minor drainage areas
- Modeled both Existing and Future Systems
- Evaluated based on whether manholes overflow

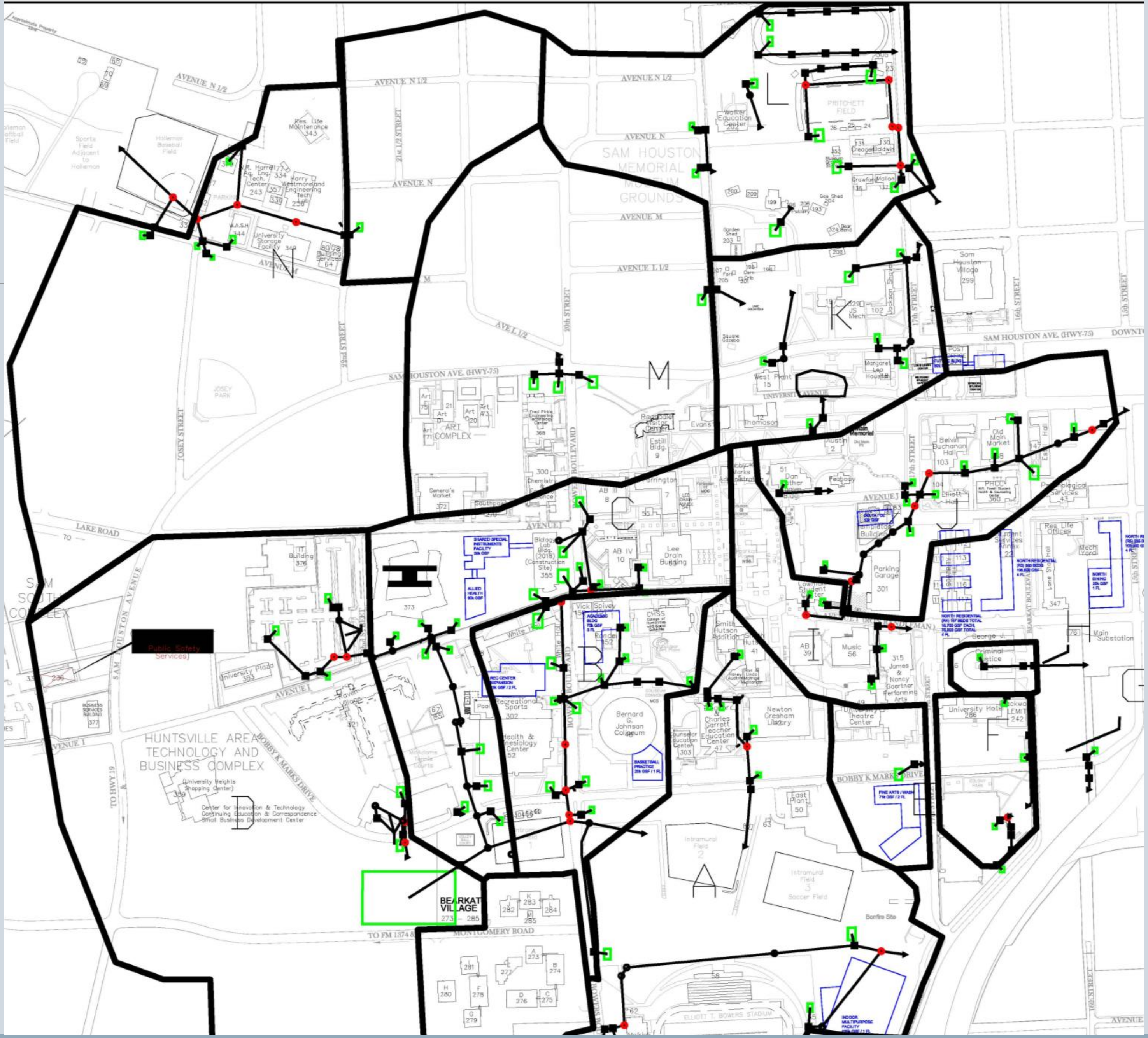
Existing Storm Sewer System – 25yr

- Overflowing



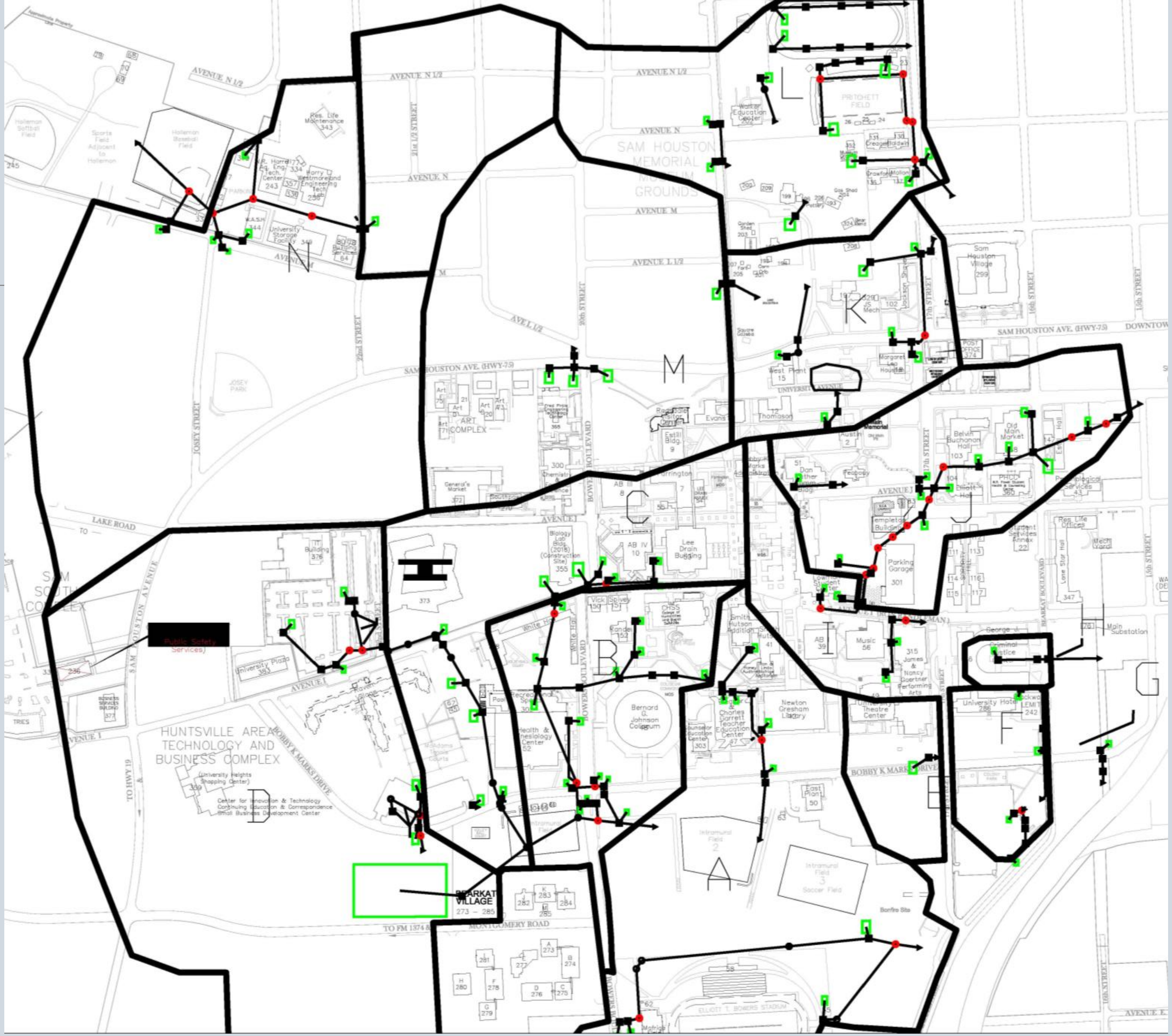
Future Storm Sewer System – 25yr

- Overflowing



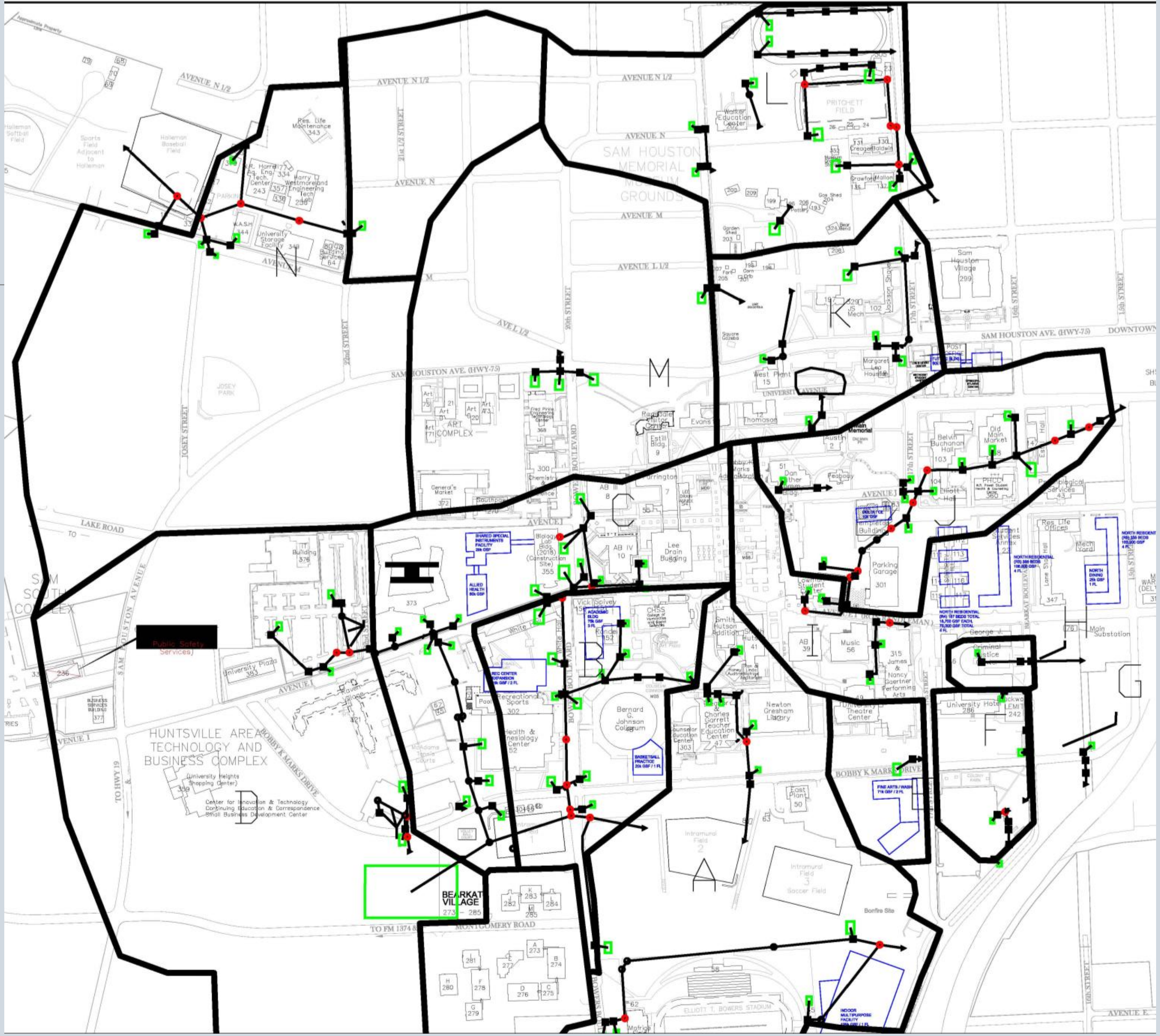
Existing Storm Sewer System – 100yr

- Overflowing



Future Storm Sewer System – 100yr

- Overflowing



Storm Sewer Master Plan (Recommendations)

- Area J - excessive surcharge issues related to geometry and pipe size
  - Increasing the 3'X2' box to a 5'X3' box culvert is anticipated to resolve these issues.
- Area N has some potential flooding in the ball park/parking areas.
  - Replacing the trapezoidal box section with a box culvert (6'X3') is anticipated to alleviate the flooding.
- Pond in Area A was found to have surcharge issues.
  - Proceeding with the South Campus Major Storm Drain retrofit is anticipated to alleviate this problem.

Campus Utility Infrastructure Master Plan Summary

Utility Infrastructure Master Plan
Major Projects

Phase I	Project Status
CHW: Increase West Plant usable capacity (to 2,200 tons)	*To be Completed in 2017*
• *Include improved chilled water metering at plant for kW/ton tracking*	
CHW: Piping Chemistry Building to Avenue I	*To be Completed in 2017*
CHW: Piping from Avenue I to Bobby K. Marks Drive	*To be Completed in 2017*
CHW: Piping from Bowers Blvd. to East Plant.	*To be Completed in 2017*
CHW: Piping from East Plant to Avenue I (17th Street)	*In Design (Arts Bldg)*
CHW: East Plant Capacity Increase (~1,800-ton)	*In Design (Arts Bldg)*
• *Include improved chilled water metering at plant for kW/ton tracking*	
• *Include variable-volume chilled water flow conversion*	
CHW: Program Plant and Building Peak Load Tracking Sequences	-----
ELEC: Route Circuits #9 & #10 from switchgear building to East Plant	*In Design (Arts Bldg)*
ELEC: Manhole #1 Circuit Segregation	*In Design (Arts Bldg)*
DW: Install recommended booster pumps and elevated storage tanks	***(further study required)***
SAN: Improve existing sanitary lines at noted locations	-----
STORM: Improve existing storm system at Areas J, N, and A	-----

Phase II

CHW: North Residence Hall piping

CHW: Install additional 2,500-ton chiller at West Plant

HHW: Relocate West Plant HHW System to Thomason Hall

ELEC: Redundant electrical feed to HKC and Coliseum

ELEC: Migrate existing buildings from overhead electrical to buried

Phase III

CHW/ELEC: Indoor Multi-Purpose Facility piping and electrical

Q & A