Campus Distributed Utility Master Plan

(Chilled Water, Heating Water, Electrical)

Presented to:

Sam Houston State University
Huntsville, Texas

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EXECUTIVE SUMMARY

A campus master plan update was performed for Sam Houston State University – Huntsville, in 2012. EEA Consulting Engineers served as subconsultant to SmithGroupJJR for the utility infrastructure portion of this master plan update. EEA's role was to analyze the distributed utility systems on campus (chilled water, heating water, and electricity) and determine their capacity and capability to serve the campus throughout the proposed master plan. Where the systems were deemed inadequate, recommendations for infrastructure improvements were made. A summary of these analyses and findings is provided in the master plan update document. This document describes these analyses and findings in greater detail.

The two distributed thermal utility systems on campus (chilled water and hot water) are primarily generated at two main plants (East and West Plants). The water is then distributed to campus primarily through direct-buried piping. Both of the plants are generally in good operating condition, though in need of various general improvements. Much of the campus's distribution piping is also in good condition. However, multiple repairs to the East Plant's chilled water distribution piping have been required over the last decade. In some locations several repairs have been made only feet apart, indicating that entire sections of piping need replacement. The main issue with the distributed thermal utility systems is generating capacity. The chilled water system as currently configured is at capacity with no redundancy, and the heating water system is near its peak capacity. To serve the campus master plan, several improvements to the distributed thermal utility systems are recommended – the main two being construction of an East Plant Expansion, and the addition of a large amount of distribution piping on campus. Eventual demolition of the West Plant is also included in the master plan update, which requires reconfiguring of the thermal utility systems in that area.

Electricity was the other major distributed utility considered in the master plan update. The main campus is provided with electrical power from Entergy, the local service provider. High-voltage (138 kV) electricity is provided at a Main Substation on the north end of campus, where it reduces down to medium-voltage (13.2 kV) for campus distribution. Paired medium-voltage circuits distribute electricity across campus in a manner that allows for redundancy, so long as certain capacity guidelines are followed. 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.

A study on the feasibility of combined heating and power systems for the campus was also performed by Brandt Engineering as part of this utility master plan. The study concluded that this kind of system would provide energy cost savings to the campus, but the capital cost was too high to provide a reasonable payback.

The master plan update is segmented into three main Phases, the first two of which show a large amount of building construction at the north and south ends of campus. Because of the location of this construction and the current capacity of the distributed thermal utility systems, a significant amount of the utility infrastructure projects recommended to support the master plan are required in the first phase. While the current configuration of the campus electrical system does not require substantial upgrades for near-term construction, several projects required for the future are included in earlier Phases to limit rework of surface conditions. Phase 2 also contains several large distribution piping projects. Very few infrastructure improvements are shown to be required in Phase 3. A list of the recommended utility projects to serve the campus master plan update, and to provide the campus with reliable and redundant campus distributed utility systems, is given below. Estimated budget costs are also shown.

Project List

Phase 1

Increase West Plant usable capacity $320,000

Connect CHSS chillers to East Plant chilled water loop $110,000

Extend piping from West Plant to Agricultural Engineering Building $2,280,000

Extend piping from Agricultural Engineering Building to Chemistry Building $230,000

17th Street piping project to connect East Plant and West Plant loops $950,000

Extend Piping to Student Health and Counseling Center $180,000

Communications and East Plant Expansion and Bobby K. Marks Improvements $13,250,000

South campus piping project #1 .... $2,150,000

South campus piping project #2 .... $320,000

Relocate West Plant heating water system to Thomason Hall $1,360,000

Manhole #1 Circuit Segregation .... *(further study required)*

Phase 2

17th Street east piping project $580,000

North Residence Hall piping $380,000

Redundant electrical feed to HKC and Coliseum $80,000

Migrate existing buildings from overhead electrical to buried $1,230,000

Phase 3

Indoor Multi-Purpose Facility piping and electrical $770,000

INTRODUCTION

A campus master plan update was performed for Sam Houston State University – Huntsville in 2012. EEA Consulting Engineers served as subconsultant to SmithGroupJJR for the utility infrastructure portion of this master plan update. EEA's role was to analyze the distributed utility systems on campus (chilled water, heating water, and electricity) and determine their capacity and capability to serve the campus throughout the proposed master plan. System redundancy was also considered an important characteristic in the process. Where the systems were deemed inadequate, recommendations for infrastructure improvements were made. Several methods were used in this study, including field surveys, hydraulic modeling of the chilled and heating water systems, and electrical system software models. A summary of these analyses and findings is provided in the master plan update document. This document describes these analyses and findings in much greater detail.

GENERAL CAMPUS MASTER PLAN

The Sam Houston State University, Campus Master Plant Update, December 2012 document issued by SmithGroupJJR was based on the 2008 Campus Master Plan completed by JJR, LLC. The process and full analysis of the entire update can be found in the update document. The addition of new and demolition of existing building space is of primary importance to this document and to the utility infrastructure component of the master plan in general. The recommendations of the master plan are broken down into three main Phases, each focusing mainly on various parts of the campus. Pertinent building additions per phase, with gross square footages, are listed below:

Phase 1

Agricultural Engineering Building........ 50,000 sq.ft.
Nursing / Biology Building........ 100,000 sq.ft.
Shared Special Instruments Facility........ 28,000 sq.ft.
Lowman Student Center Expansion........ 60,000 sq.ft.
Student Health and Counseling Center........ 28,900 sq.ft.
South District Residences (R1)........ 103,900 sq.ft.
South District Residences (R2)........ 105,000 sq.ft.
South District Dining........ 25,000 sq.ft.
Event Center/Press Box........ 60,000 sq.ft.
Communications & East Plant Expansion........ 15,000 sq.ft.

Phase 2

Fine Arts and W.A.S.H Complex........ 50,000 sq.ft.
North District Residences (R3)........ 108,800 sq.ft.
North District Residences (R5)........ 103,900 sq.ft.
North District Dining........ 25,000 sq.ft.
North District Residences (R4-Sorority Hill Replacement)........ 75,000 sq.ft.
DELTA/CE Building........ 29,000 sq.ft.
Allied Health Building........ 60,000 sq.ft.

Basketball Practice Facility.. 20,000 sq.ft.
Mafrige Field House Expansion.. 20,000 sq.ft.

Phase 3

Indoor Multi-purpose Facility..125,000 sq.ft.
Recreational Sports Complex Expansion.. 70,000 sq.ft.
Academic Building.. 75,000 sq.ft.
Future #1 .... TBD
Future #2 .... TBD

Though several building demolitions are required for the above construction, the master plan update generally shows a significant amount of occupied square footage added to the campus total. With this increase in occupied spaces comes a required increase in electrical and thermal utility requirements. The following sections will describe the processes and results of the various analyses on the campus distributed utility systems.

Campus Chilled and Heating Water Systems

Study Methodology

Capacity Analysis

The campus chilled and heating water systems consist of three main components: the generating plants, distribution piping, and connected buildings. All of these sections were analyzed to create the master plan for the systems. In general, the methodology for the master plan was to gain an understanding of the existing systems as currently installed and operating, generate software hydraulic models of the systems, and then use the models to identify the recommended system improvements to support the campus master plan. The East and West Plant chilled and heating water systems, and the CHSS chilled water system, were included in this process. Several other buildings contain stand-alone heating water systems that 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 site work, discussions with facilities personnel, and examination of existing plant and building construction drawings. Facilities personnel were extremely helpful in this phase and provided valuable information on system configuration and operation.

The next step was to estimate the current loads on the chilled and heating water systems. One of the primary deficiencies with the campus's distributed thermal utility systems is the lack of metering and monitoring. Very little data regarding building use of chilled and heating water is available, and the data that is available is sometimes suspect due to lack of sensor calibration and maintenance. Field surveys of the plants and connected buildings aided in determining peak cooling load, but the schedule for the study did not allow for observation of the peak heating season. Because of this, the primary source for peak plant load information was obtained from campus facilities personnel.

Once the estimated peak plant load for each system was understood, the estimated building loads were calculated, where not available through automation system data. Existing construction drawings for connected buildings were examined. Equipment schedule information, including thermal load, flowrate, entering/leaving temperatures and pressures, was taken from the construction drawings for each piece of equipment using chilled and heating water and was compiled into a spreadsheet. The total cooling and heating capacities of these pieces of equipment were taken to be the peak load of the individual buildings. In some cases, where the construction drawings listed peak building load or the system pump size indicated peak building flowrate, the building estimated peak load was reconciled with these conditions. Other engineering rules of judgment (sq.ft./ton, building use) were also used to identify and revise any suspect calculations. Overall system diversity was calculated from the sum of all building peaks on a system and the estimated peak plant load serving the system. This diversity, applied back on the building peak loads, was used to estimate building loads at the system peak load condition. The equation for system diversity is given below:

System Diversity (%) = Peak Plant Load / Sum of Building Peak Loads

A similar method was used to estimate building chilled and heating water differential temperature (dT), and thus flowrate, when documented data was not available. The plant dT associated with the peak load was again obtained through BAS, log, or interview data. Where building typical dTs were not known, they were estimated based on each building's design dT to the dT of the entire system at peak load. Estimated flowrates for each building were then calculated from the estimated loads and dTs.

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

Hydraulic Modeling

In order to understand the dynamics of the distributed thermal utility systems, hydraulic models of the systems were generated using Pipe-Flo Professional Version 2009©. The software package uses nodal analysis algorithms to determine pressures at various points in relation to the flow demands and pressure sources in the system. The software allows for graphical generation, modification, and analysis of the hydraulic system.

Data models of the distribution piping systems were created through a combination of existing drawing examination and site work. All known major system components in the plants were accounted for in the models. Other components of the distribution systems, such as elbows, tees, and valves, were accounted for where their locations were known. Where sections of piping could not be seen, assumptions were made for pipe lengths and tee, elbow, and valve quantities. The actual pressure drop of components was entered, and actual pump curves were used. Actual component elevations were included where known and estimated where necessary. Connected buildings were modeled as a single coil and control valve, and estimated flowrates generated in the capacity analysis were used for each building.

After the models were generated, attempts were made to calibrate the models to reflect actual operation of the system. More detail on this calibration process is described below. These baseline models were used to examine current system hydraulic limitations.

Master Planning

After the current configuration and operation of the campus was understood, the various analyses could then be used to identify recommended improvements to the chilled and heating water systems in support of the campus master plan. The capacity analysis was expanded to include the construction listed in the phases above. The hydraulic models were modified to show the addition of future master-planned buildings, and also the required distribution piping to serve them. Required infrastructure improvements for each phase were identified, and budgetary cost estimates generated for each project.

Existing Conditions Assessment and Capacity Analysis

East Plant

Chilled Water System

The East Plant currently provides chilled water to twenty campus buildings. The plant is in a constant-volume primary pumping configuration with six chilled water pumps, though three of the pumps are dedicated to one chiller and three to the other two chillers. The plant was constructed in 1974 and underwent capacity expansions and renovations in 1983 and 2004. The plant equipment is generally in good operating condition, though opportunities for improvement in the plant's efficiency do exist. The chillers are all relatively new, with the oldest being installed in 2003.

Three chillers provide a total of 4,200 tons of cooling capacity. The characteristics of the plant's chilled water equipment are shown in the table below.

Equipment	Flow GPM	Head Ft	Motor (HP)	Capacity (Tons)	EWT/LWT (F)	Make / Model
CH-1	4,250	32	-	1,800	52/42	Trane CVHF1720
CH-2	2,500	19.6	-	1,400	57/44	York YKHHJBJ2
CH-3	1,997	13.8	-	1,000	54/42	York YKMQMRH9
CHWP-1	1,500	105	60	-	-	Armstrong Vertical Pump
CHWP-2	1,500	105	60	-	-	Aurora Series 1110
CHWP-3	1,500	105	60	-	-	Aurora Series 1110
CHWP-4	1,500	105	60	-	-	Aurora Series 1110
CHWP-5	1,500	100	60	-	-	B&G 80 SC 8x8x11
CHWP-6	1,500	100	60	-	-	B&G 80 SC 8x8x11

Table 1: East Plant Chilled Water Equipment

The data collection process determined that the peak cooling load on the East Plant chilled water system was at or very nearly 4,200 tons at a 12°F dT, resulting in a total plant flowrate of 8,400 GPM. The sum of the building peaks for the connected buildings was calculated to be 4,977 tons, resulting in a system diversity of 84%. Individual building diversified loads, dTs, and flows were then calculated and are shown in the table below.

Building	Design			Diversity: 84%		
	Load Tons	**Flow** (gpm)	**dT** (F)	**Load** Tons	**Flow** (gpm)	**dT** (F)
010 - Academic Building IV	255	306	20	215	272	19
019 - Lowman Student Center	390	520	18	329	462	17
039 - Academic Building I	266	587	11	225	521	10
041 - Smith Hutson - New Auditorium	38	45	20	32	40	19
041 - Smith Hutson - New Building	147	176	20	124	156	19
041 - Smith Hutson - Old Building	240	577	10	203	513	9
042 - Newton Gresham Library	558	1,338	10	471	1189	9
046 - Criminal Justice Center	536	1,400	9	452	1244	9
047 - Teacher Education Center	233	465	12	196	413	11
048 - Bernard Johnson Coliseum	306	612	12	258	544	11
049 - University Theater Center	168	335	12	141	298	11
050 - Gaertner Performing Arts Center	233	400	14	197	355	13
052 - Health & Kinesiology Center	379	650	14	320	578	13
053 - Lee Drain Building	354	850	10	299	755	9
056 - Music Building	114	195	14	96	173	13
057 - Ron Mafrige Field House	120	205	14	101	182	13
168 - White Hall	69	165	10	58	147	9
242 - Lemit Building	127	138	22	108	123	21
300 - Chemistry & Forensic Science	310	290	26	262	258	24
302 - Recreational Sports	107	160	16	90	142	15
303 - Counselor Education Center	28	40	17	24	36	16
East Plant Total	**4,977**	**9,454**	**13**	**4,200**	**8,400**	**12**

Table 2: East Plant Diversified Chilled Water Loads

The installed capacity and peak load on the plant indicate that there is little or no spare capacity left in the plant in the peak cooling season. Should any one chiller fail the plant could not support the connected cooling load during peak conditions. The same applies for chilled water pump capacity. At peak load, all chilled water pumps are needed to distribute chilled water to the East Plant distribution piping. There is currently no space available in the plant for an additional chiller set.

Heating Water System

The East Plant currently provides heating water to twelve campus buildings. The plant's system consists of five non-condensing modular boilers for heating water generation and one condensing modular boiler for system warm-up. These boilers are a highly efficient method of generating heating water, and combined with the variable flow of the system, create an efficient heating system for the connected buildings overall. The boilers are relatively new and the heating system is generally in good operating condition. However, the buried distribution piping develops frequent leaks. The characteristics of the plant's heating water equipment are shown in the table below.

Equipment	Flow GPM	Head Ft	Motor (HP)	Capacity (MBh out)	EWT/LWT (F)	Make / Model
B-1	112	27	-	1679	160/190	Raypak MVB Model H7-2004
B-2	112	27	-	1679	160/190	Raypak MVB Model H7-2004
B-3	112	27	-	1679	160/190	Raypak MVB Model H7-2005
B-4	112	27	-	1679	160/190	Raypak MVB Model H7-2006
B-5	112	27	-	1679	160/190	Raypak MVB Model H7-2007
B-6	95	25	-	1919	120/160	Raypak Xtherm Model H7-2005
HWP-1	335	110	15	-	-	Vertical Pump
HWP-2	335	110	15	-	-	Vertical Pump
HWP-3	670	110	30	-	-	Aurora Series 1110

Table 3: East Plant Heating Water Equipment

The data collection process determined that the peak load on the East Plant heating water system was approximately 8,350 MBh at a 32°F differential temperature (dT), resulting in a total plant flowrate of 518 GPM. The sum of the building peaks for the connected buildings adds up to be 27,828 MBh, resulting in a system diversity of 30%. This is typical for campus heating systems in Texas. Individual building diversified loads, dTs, and flows were then calculated and are shown in the table below.

Building	Design			Diversity: 30%		
	Load MBh	Flow (gpm)	dT (F)	Load MBh	Flow (gpm)	dT (F)
010 - Academic Building IV	3,480	174	40	1,044	52	40
041 - Smith Hutson - New Auditorium	500	25	40	150	8	40
041 - Smith Hutson - New Building	2,210	130	34	663	39	34
047 - Teacher Education Center	2,050	205	20	615	62	20
048 - Bernard Johnson Coliseum	6,040	302	40	1,812	91	40
049 - University Theater Center	1,700	170	20	510	51	20
052 - Health & Kinesiology Center	3,553	187	38	1,066	56	38
053 - Lee Drain Building	2,205	147	30	662	44	30
056 - Music Building	900	60	30	270	18	30
057 - Ron Mafrige Field House	3,895	205	38	1,169	62	38
168 - White Hall	970	97	20	291	29	20
303 - Counselor Education Center	325	25	26	98	8	26
East Plant Total	**27,828**	**1,727**	**32**	**8,348**	**518**	**32**

Table 4: East Plant Heating Water Loads

The installed capacity and peak load on the plant indicate that there is little or no spare capacity left in the plant during peak heating season. Should any one boiler fail, the plant could not support the connected heating load. Redundancy does exist in the heating water pumps. There is currently space in the plant for significant expansion of the heating water system.

WEST PLANT

Chilled Water System

The West Plant currently provides chilled water to fourteen campus buildings. The plant is in a constant-volume primary pumping configuration but was originally designed for the two installed chillers to be operated in series to service a 20°F loop dT. As the west campus only returns less than a 10°F dT, this is no longer the cooling strategy for the plant. This currently limits the operation of the plant to one chiller at time. The chilled water system was partially renovated in 1996 with the installation of new chillers, but generally the plant is in fair to poor physical and operating condition. The configuration and state of the plant offers several opportunities for capacity and efficiency improvements. Aside from the configuration of the plant limiting chiller capacity, the chilled water pumps do not have adequate pumping head to distribute water effectively to the connected buildings. The pumps barely have enough head (34 ft w.c.) to overcome the pressure drop through the chillers at design flow (27 ft. w.c.).

Equipment	Flow GPM	Head Ft	Motor (HP)	Capacity (Tons)	EWT/LWT (F)	Make / Model
CH-1	2,400	27	-	1,000	54/44	Trane CVHF0910 (1996)
CH-2	2,880	27	-	1,200	54/44	Trane CVHF1280 (1996)
CHWP-1	3,000	34	30	-	-	PACO 1012-9/0, 1200 RPM
CHWP-2	3,000	34	30	-	-	PACO 1012-9/0, 1200 RPM

Table 5: West Plant Chilled Water Equipment

The data collection process determined that the peak cooling load on the West Plant chilled water system was 900 tons at an 8°F dT, resulting in a total plant flowrate of 2,700 GPM. The sum of the building peaks for the connected buildings was calculated to be 1,910 tons, resulting in a system diversity of 47%. Individual building diversified loads, dTs, and flows were then calculated and are shown in the table below.

Building	Design			Diversity: 47%		
	Load Tons	Flow (gpm)	dT (F)	Load Tons	Flow (gpm)	dT (F)
002 - Austin Hall	63	150	10	29	103	7
005 - Bobby Marks Admin. Bldg.	90	90	24	42	62	16
007 - Farrington Building	192	288	16	90	197	11
008 - Academic Building III	167	400	10	79	274	7
009 - Estill Building	127	190	16	60	130	11
011 - Evans Complex - Building A	112	268	10	53	184	7
011 - Evans Complex - Building C	82	197	10	39	135	7
012 - Thomason Building	172	516	8	81	354	6
018 - Margaret Lea Houston	90	217	10	43	149	7
035 - Old Main Market	295	550	13	139	377	9
051 - Dan Rather Communications	192	460	10	90	315	7
102 - Jackson-Shaver Hall	71	142	12	33	97	8
103 - Belvin-Buchanan Hall	186	372	12	88	255	8
104 - Elliott Hall	72	96	18	34	66	12
West Plant Total	**1,910**	**3,936**	**12**	**900**	**2,700**	**8**

Table 6: West Plant Chilled Water Loads

As described above, both the chiller configuration and chilled water pump head are limiting factors for the capacity of the West Plant. However, because only one chiller at a time can be used, this does allow for redundancy in the plant. Operator action is currently required for chiller changeover. There is currently no space in the plant for system expansion.

Heating Water System

The West Plant currently provides heating water to six campus buildings. The plant's system consists of one high-mass hot water boiler and two pumps. The characteristics of the plant's heating water equipment are shown in the table below.

Equipment	Flow GPM	Head Ft	Motor (HP)	Capacity (MBh out)	EWT/LWT (F)	Make / Model
B-1	560	2	-	8369	160/190	Cleaver Brooks Model CB-LE250
HWP-1	400	115	30	-	-	B&G Series 1510-3G
HWP-2	400	115	30	-	-	B&G Series 1510-3G

Table 7: West Plant Heating Water Equipment

The data collection process determined that the peak load on the West Plant heating water system was near 2,880 MBh at a 19°F dT, resulting in a total plant flowrate of 288 GPM. The sum of the building peaks for the connected buildings was calculated to be 5,760 MBh, resulting in a system diversity of 50%. Individual building diversified loads, dTs, and flows were then calculated and are shown in the table below.

Building	Design			Diversity: 50%		
	Load MBh	Flow (gpm)	dT (F)	Load MBh	Flow (gpm)	dT (F)
002 - Austin Hall	350	35	20	175	20	18
005 - Bobby Marks Admin. Bldg.	1,320	66	40	660	37	35
011 - Evans Complex - Building A	1,070	107	20	535	60	18
011 - Evans Complex - Building C	750	75	20	375	42	18
012 - Thomason Building	640	64	20	320	36	18
051 - Dan Rather Communications	1,630	163	20	815	92	18
West Plant Total	**5,760**	**510**	**23**	**2,880**	**288**	**19**

Table 8: West Plant Heating Water Loads

The existing high-mass boiler for the system is oversized, which likely results in inefficient production of heating water. Also, no boiler redundancy is available in the system should the single boiler fail. However, this system was installed in 2008 and appears to be in good operating condition.

CHSS PLANT

Chilled Water System

The CHSS (College of Humanities and Social Sciences) building houses a small chiller plant that serves the single building but also has the potential of being connected to the campus loop. The plant is in a variable-volume primary pumping configuration with two chillers and two chilled water pumps. The building was constructed in 2008 and the equipment is generally in good condition, though some maintenance issues with the chillers have occurred.

The chillers provide a total of 800 tons of cooling capacity. The characteristics of the plant's chilled water equipment are shown in the table below.

Equipment	Flow GPM	Head Ft	Motor (HP)	Capacity (Tons)	EWT/LWT (F)	Make / Model
CH-1	683	13	-	400	56/42	Trane CTV-0018 (2008)
CH-2	683	13	-	400	56/42	Trane CTV-0018 (2008)
CHWP-1	700	90	50	-	-	Taco Model KV/KS6011
CHWP-2	700	90	50	-	-	Taco Model KV/KS6011

Table 9: CHSS Plant Chilled Water Equipment

The data collection process determined that the peak cooling load for the CHSS system was 340 tons at an 18°F dT, resulting in a total building (and plant) flowrate of 453 GPM. This results in a building diversity of 48%. The chilled water system for this building appears to operate efficiently, and the excess chiller and chilled water pump capacity allow for redundancy in the system. There is not space in the plant currently for system expansion.

Distribution Piping

Chilled and heating water from both the East and West Plants is distributed to end-use buildings through an underground piping network. The two distribution systems, however, are not linked together and thus do not allow for any load sharing between plants. The vast majority of this piping is direct buried, though some utility tunnels do exist on the west campus system. Much of the piping was installed from 1970-1990 though some areas of older and newer piping do exist. This information is well documented on the campus's main CAD plan. A summary view of the piping system is given on sheet M1.0 in Appendix A. The original steam distribution piping from the West Plant has been abandoned in the utility tunnels and was replaced with the West Plant heating water system in 2008.

There is also a combination of piping materials present on the campus. Much of the early installations of piping were asbestos-cement, which, while having a predicted life span of 50 years, has been known to have issues earlier, particularly in higher temperature or corrosive applications. Steel piping is also present on some of the campus, again having a life expectancy of 50 years in chilled and heating water applications. One of the more recent installations on campus, from the West Plant to the Old Main Market, used HDPE piping in Gilsulate insulation. This is now the preferred installation for new campus chilled water installations.

The most specific area of concern with the distribution piping is the physical condition of the East Plant heating water piping. This piping system is prone to leaks and some sections have been repaired multiple times. Replacement of entire sections of piping during off-peak seasons may provide for more reliable service than simple patch repairs that only occur when necessary.

Existing Chilled Water Systems

As mentioned in the section above, hydraulic models of the distribution systems were generated to understand the dynamics of system operation. These models can be found in Appendix B of this document.

Chilled Water System – East Plant Calibration Model

The first of these models was used to verify that the hydraulic model of the East Plant system reflected actual operation of the system. Because detailed manual or building automation system log data is not available on the campus, a "snapshot" of field data was used to for validation of the system. A site visit was performed the afternoon of September 11, 2012 and as much BAS and manual gauge data was obtained as possible for the East Plant. BAS data of building operation was also recorded. A comparison of the data recorded is shown below.

	9-11-12, 2PM, FIELD DATA								
	Flow	CHWR-T	CHWS-T	dT	Tons	CHWR-P	CHWS-P	dP	Status
CH-1	ND	51.9	42	9.9	ND	78	69	9	ON
CH-2	ND	51.2	42.3	8.9	ND	84	68	16	ON
CH-3	-	-	-	-	-	-	-	-	OFF
North Main Piping	1550	51.1	40.4	10.7	691	46	64	18	-
South Main Piping	1550	53.9	41.7	12.2	788	49	64	15	-
CHWP-1	ND	-	-	-	-	45	ND	ND	ON
CHWP-2	ND	-	-	-	-	ND	ND	ND	ON
CHWP-3	ND	-	-	-	-	ND	92	ND	ON
CHWP-4	ND	-	-	-	-	30	ND	ND	ON
CHWP-5	ND	-	-	-	-	ND	ND	ND	OFF
CHWP-6	ND	-	-	-	-	ND	ND	ND	OFF

Total plant tons	1,479
Plant average dT	11.5
Total plant GPM	3,100

-	Not applicable
ND	No data available

Table 10: East Plant Model Calibration – Field Data

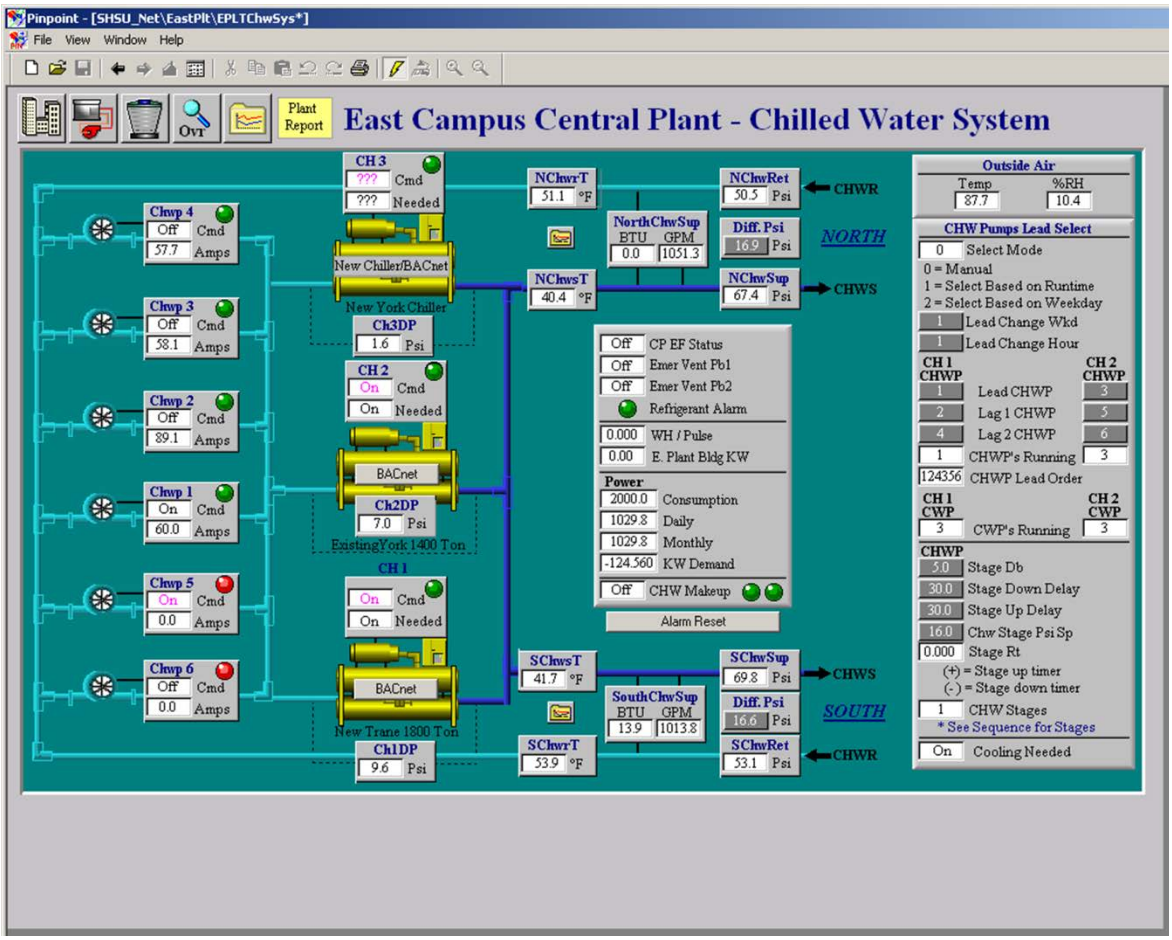


Figure 1: East Plant Model Calibration - BAS Screenshot

	9-11-12, 2PM, BAS DATA								
	Flow	CHWR-T	CHWS-T	dT	Tons	CHWR-P	CHWS-P	dP	Status
CH-1	ND	ND	ND	ND	ND	ND	ND	9.6	ON
CH-2	ND	ND	ND	ND	ND	ND	ND	7	ON
CH-3	ND	ND	ND	ND	ND	ND	ND	1.6	OFF
North Main Piping	1051	51.1	40.4	10.7	469	50.5	67.4	16.9	-
South Main Piping	1014	53.9	41.7	12.2	515	53.1	69.8	16.7	-
CHWP-1	ND	ND	ND	ND	ND	ND	ND	ND	ON
CHWP-2	ND	ND	ND	ND	ND	ND	ND	ND	OFF
CHWP-3	ND	ND	ND	ND	ND	ND	ND	ND	OFF
CHWP-4	ND	ND	ND	ND	ND	ND	ND	ND	OFF
CHWP-5	ND	ND	ND	ND	ND	ND	ND	ND	ON
CHWP-6	ND	ND	ND	ND	ND	ND	ND	ND	OFF

Total plant tons	984
Plant average dT	11.4
Total plant GPM	2,065

-	Not applicable
ND	No data available

Table 11: East Plant Model Calibration – BAS Data

As can be seen from the above two tables and figure, limited data was available for a "snapshot" of system operation at the plants. This data was all taken within half an hour of each other during early afternoon. One particular point of interest is the large discrepancy between flowmeter readings – over 1,000 GPM across both plant main entrances. This large discrepancy also causes the credibility of the other data to be questioned. The same issue is present for building BAS data, as shown in the table below.

Building	CHWS		CHWR		dT	Flow	Calc.	CHWP-1		CHWP-2	
	(F)	(psi)	(F)	(psi)	(F)	(gpm)	Tons	Status	VFD	Status	VFD
010 - Academic Building IV	43.2	ND	51.9	ND	8.7	ND	ND	ON	ND	off	-
019 - Lowman Student Center	43.1	ND	56.2	ND	13.1	ND	ND	ON	ND	off	-
039 - Academic Building I	42.8	ND	56.9	ND	14.1	ND	ND	-	-	-	-
041 - Smith Hutson - New Auditorium	-	-	-	-	-	-	-	-	-	-	-
041 - Smith Hutson - New Building	43.6	ND	60.3	ND	16.7	122.0	85	ON	29	-	-
041 - Smith Hutson - Old Building	44.3	ND	56.6	ND	12.3	ND	ND	ON	20	-	-
042 - Newton Gresham Library	51.5	37.8	57.7	17.6	6.2	ND	ND	ON	36	-	-
046 - Criminal Justice Center	ND	ND	ND	ND	ND	ND	ND	ON	60	-	-
047 - Teacher Education Center	41.7	ND	56.2	ND	14.5	ND	ND	ON	20	-	-
048 - Bernard Johnson Coliseum	41.7	ND	44.7	ND	3.0	ND	ND	-	-	-	-
049 - University Theater Center	42.9	ND	51.6	ND	8.7	ND	ND	ON	20	-	-
050 - Gaertner Performing Arts Center	42.9	55.5	62.1	36.8	19.2	213.0	170	OFF	20	OFF	58
052 - Health & Kinesiology Center	41.5	ND	50.4	ND	8.9	ND	ND	ON	ND	-	-
053 - Lee Drain Building	42.8	ND	52.7	ND	9.9	ND	ND	OFF	20	-	-
056 - Music Building	75.6	ND	50.8	ND	-24.8	ND	ND	ON	60	OFF	60
057 - Ron Mafrige Field House	ND	ND	ND	ND	ND	ND	ND	ON	ND	-	-
168 - White Hall	ND	ND	ND	ND	ND	ND	ND	-	-	-	-
242 - Lemit Building	ND	21.3	54.9	56.4	ND	68.0	ND	ON	60	-	-
300 - Chemistry & Forensic Science	-	-	-	-	-	-	-	-	-	-	-
302 - Recreational Sports	41.5	ND	50.4	ND	8.9	ND	ND	ON	ND	OFF	-
303 - Counselor Education Center	57.4	32.9	58.4	29.9	1.0	0.0	0	ON	60	-	-

-	Not applicable
ND	No data available
###	Questionable data

Table 12: East Plant Model Calibration - Building BAS Data

The model calibration scenario was based on the flowrates shown in the table below, which were generated as an average condition of the field and BAS data obtained. This condition represented a total plant flowrate of 3,000 GPM and total plant load of 1,500 tons at 12°F. Because of the low confidence in some of the building differential temperatures, the previous dT estimates were used and coordinated with field data.

Building	Design			Diversity: 30%		
	Load Tons	**Flow** (gpm)	**dT** (F)	**Load** Tons	**Flow** (gpm)	**dT** (F)
010 - Academic Building IV	255	306	20	75	95	19
019 - Lowman Student Center	390	520	18	115	162	17
039 - Academic Building I	266	587	11	78	182	10
041 - Smith Hutson - New Auditorium	38	45	20	11	14	19
041 - Smith Hutson - New Building	147	176	20	43	54	19
041 - Smith Hutson - Old Building	240	577	10	71	180	9
042 - Newton Gresham Library	558	1,338	10	165	416	9
046 - Criminal Justice Center	536	1,400	9	158	435	9
047 - Teacher Education Center	233	465	12	68	144	11
048 - Bernard Johnson Coliseum	306	612	12	90	190	11
049 - University Theater Center	168	335	12	49	104	11
050 - Gaertner Performing Arts Center	233	400	14	68	123	13
052 - Health & Kinesiology Center	379	650	14	112	202	13
053 - Lee Drain Building	354	850	10	104	264	9
056 - Music Building	114	195	14	34	61	13
057 - Ron Mafrige Field House	120	205	14	35	64	13
168 - White Hall	69	165	10	21	52	9
242 - Lemit Building	127	138	22	38	43	21
300 - Chemistry & Forensic Science	310	290	26	91	90	24
302 - Recreational Sports	107	160	16	32	50	15
303 - Counselor Education Center	28	40	17	9	13	16
	4,977	**9,454**	**-**	**1,500**	**3,000**	**12**

Table 13: East Plant Model Calibration - Model Inputs

The initial run of the model resulted in a much higher plant leaving pressure, and plant differential pressure, than any of the recorded data indicated. Given the similarity between plant dPs obtained from the field data and the BAS data (18 and 15 psi from field data, 17 and 17 psi from BAS data), this data was deemed reasonable.

The make-up pressure on the chilled water pump return header was identified as 50 psi through the field survey, which was represented in the model and resulted in a plant chilled water return pressure of 48-49 psi, which correlated with available data. This possibly indicates that the pressure drop unaccounted for in the model was within the East Plant. BAS and field chiller return and supply pressures indicated that the pressure drop was upstream of them as well. In order to compensate for this discrepancy, an artificial pressure drop of 15 psi was added into the system in the chilled water pump suction header. This is highlighted yellow in the model, and brought the results of the model much closer to the known data points. For example, the plant north and south supply and return pressures are similar to calibration data (though flow varies – likely because of assumed building flowrates). Items such as pressure drop through chillers, and entering and leaving building pressures, were still not able to be reconciled fully because of the very limited data available for calibration. However, a high level of confidence does exist in the generation and calculation of the model, indicating that the model should represent how the system operates under ideal circumstances. Many variances between model results and actual data could point to operational issues in the system that could be rectified. Because of this, future system models used for the master planning process do not account for the additional 15 psi drop. The installation of more calibrated sensors should help to clarify this situation in the future.

It should be noted at this point that not enough data was available for a "snapshot" model to be generated of the West Plant chilled water system. Almost no reliable plant data could be obtained through site survey or the BAS. The model for the West Plant systems were based on a peak load condition using flowrates calculated from the process described in the Study Methodology section above.

Chilled Water System – 2012 Diversified Flow Model

The first model for the East Plant (including additional plant pressure drop) was used to generate the second model, Chilled Water System – 2012 Diversified Flow. This model represents a peak load condition for both plants with the diversified flow values for the buildings. 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, as this is nearing the typical design limit of 10 ft./sec. As can be seen, only a few sections of piping in the East and West Plant distribution systems are nearing their maximum recommended fluid velocity and flowrate through the pipe. This indicates that the majority of the chilled water piping on campus is adequately sized for the current peak loads.

The other point of interest is buildings in which the differential pressure at the representative control valve (building entrance) is below zero. These buildings are highlighted red on the model, and a value less than zero indicates that there may not be adequate flow reaching those buildings. This is particularly true in the West Plant loop, where many buildings do not contain tertiary building pumps and the West Plant pumps have low head. This indicates that the piping is sized appropriately, but the West Plant pumps are undersized.

Chilled Water System – 2012 Non-Diversified Flow Model

This model uses the peak building flowrates to identify which building branch lines may be undersized. All piping with fluid velocities over 10 ft./sec. are colored. Piping in the East and West plants, and on the distribution loops, should be disregarded in this model, because the scenario presented on a campus level would never occur. The focus on this model is the building branch piping, and again, very little color is shown, indicating that all building branch lines are sized adequately, with the exception of the lines serving Thomason.

Existing Heating Water Systems

Heating Water System – 2012 Diversified Flow Model

Because trend or log data was not available for heating during the course of the study, the heating water system models are based on ideal operation of the system and scheduled building loads. This model represents a peak heating day for both the East and West Plants. As can be seen from the model, no piping is colored because the maximum velocity in a pipe is below 7 ft./sec., indicating that all of the piping is adequately sized. The heating water pumps are shown running at speeds required to maintain plant differential pressure based on the variable flow systems. Based on available information obtained during the data collection phase, these models generally represent the conditions present during the heating season on campus.

Heating Water System – 2012 Non-Diversified Flow Model

Like the chilled water non-diversified model, the focus of this model is on branch piping to buildings. Branches serving multiple buildings may also be considered. Piping with fluid velocities over 8 ft./sec. are shaded. As can be seen, nearly all of the heating water piping is sized adequately for this condition.

In the Other Recommendations section of this document, the improvement of plant and building metering and monitoring systems is recommended. Installation of items such as flow meters, temperature sensors, and pressure sensors, along with the trending of this data, would allow for further validation and increased accuracy of these hydraulic models. If improved measurement equipment is installed on campus, we recommend that this calibration process be revisited.

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. The generating capacity for the campus chilled and heating water systems is near its limit. Significant additions to campus building square footage cannot be made without increases in generating capacity. Similarly, while the general condition and size of the systems' distribution piping is adequate, upgrades to these systems will be required for future campus additions.

Campus Utility Master Plan (Mechanical)

The master plan for the campus distributed thermal utilities is shown on M2.0 in Appendix A. Master planned buildings are shown shaded by Phase, bold blue lines represent new chilled water piping, bold red lines represent new heating water piping, and the dashed lines around the piping represent various infrastructure projects required for the master plan. The major components of the distributed thermal utility master plan to note are: a combined east and west chilled water loop, significant additions to south campus chilled water distribution piping, an expanded East Plant, and a demolished West Plant. Descriptions of the chilled water and heating water master plans are given below.

Chilled Water System

The table below shows a summary of campus cooling load increase through the various phases of the master plan. Ideally, all new campus buildings within reasonable proximity to the campus chilled water system should be connected to the system. All master planned buildings that fit that criterion are shown in the table below. Individual master planned building load estimates were made using sq.ft./ton values and building usage. A total campus diversity of 71% (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, an expansion to the East Plant is recommended. To improve the distribution capacity, a large amount of chilled water piping will need to be installed on campus. Given the current status of the plants, and extent of the piping, a majority of this would need to occur in Phase 1.

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	**501,983**		**1,900**	**3,900**		**47%**	**900**	**2,700**
East Plant	**1,538,624**		**5,000**	**9,500**		**84%**	**4,200**	**8,400**
Total	**2,188,029**		**7,600**	**14,200**		**71%**	**5,400**	**11,600**
Phase I								
Agricultural Engineering Builiding	50,000	300	167	250	16	71%	118	178
Nursing / Biology Building	100,000	250	400	600	16	71%	284	426
Shared Specialty Instruments Facility	28,000	350	80	120	16	71%	57	85
Lowman Student Center Expansion	60,000	300	200	300	16	71%	142	213
Student Health and Counseling Center	28,900	300	96	145	16	71%	68	103
South District Residences (R1)	103,900	350	297	445	16	71%	211	316
South District Residences (R2)	105,000	350	300	450	16	71%	213	320
South District Dining	25,000	200	125	188	16	71%	89	133
Communications & Central Plant Exp.	15,000	400	38	56	16	71%	27	40
Demo White Hall	-	-	-	-	-	-	-	-
Demo Academic Building III	-	-	-	-	-	-	-	-
New Building Totals			**1,700**	**2,600**			**1,200**	**1,800**
Demolition Totals			**235**	**565**			**137**	**421**
Phase I Campus Totals			**9,100**	**16,200**		**71%**	**6,500**	**13,000**
Phase II								
Fine Arts	40,000	300	133	200	16	71%	95	142
W.A.S.H.	10,000	300	33	50	16	71%	24	36
DELTA / CE Building	10,000	300	33	50	16	71%	24	36
North District Residences (R3)	108,800	350	311	466	16	71%	221	331
North District Residences (R4)	75,000	350	214	321	16	71%	152	228
North District Residences (R5)	103,900	350	297	445	16	71%	211	316
North District Dining	25,000	200	125	188	16	71%	89	133
Basketball Practice Facility	20,000	300	67	100	16	71%	47	71
Allied Health Building	60,000	300	200	300	16	71%	142	213
New Building Totals			**1,400**	**2,100**			**1,000**	**1,500**
Demolition Totals			**0**	**0**			**0**	**0**
Phase II Campus Totals			**10,500**	**18,300**		**71%**	**7,500**	**14,500**
Phase III								
Indoor Multi-purpose Facility	125,000	300	417	625	16	71%	296	444
Academic Building	75,000	300	250	375	16	71%	178	266
Recreational Sports Complex Exp.	70,000	300	233	350	16	71%	166	249
Future #1	60,000	300	200	300	16	71%	142	213
Future #2	60,000	300	200	300	16	71%	142	213
New Building Totals			**1,300**	**2,000**			**900**	**1,400**
Demolition Totals			**0**	**0**			**0**	**0**
Phase III Campus Totals			**11,800**	**20,300**		**71%**	**8,400**	**15,900**

Table 14: Master Plan Chilled Water Loads

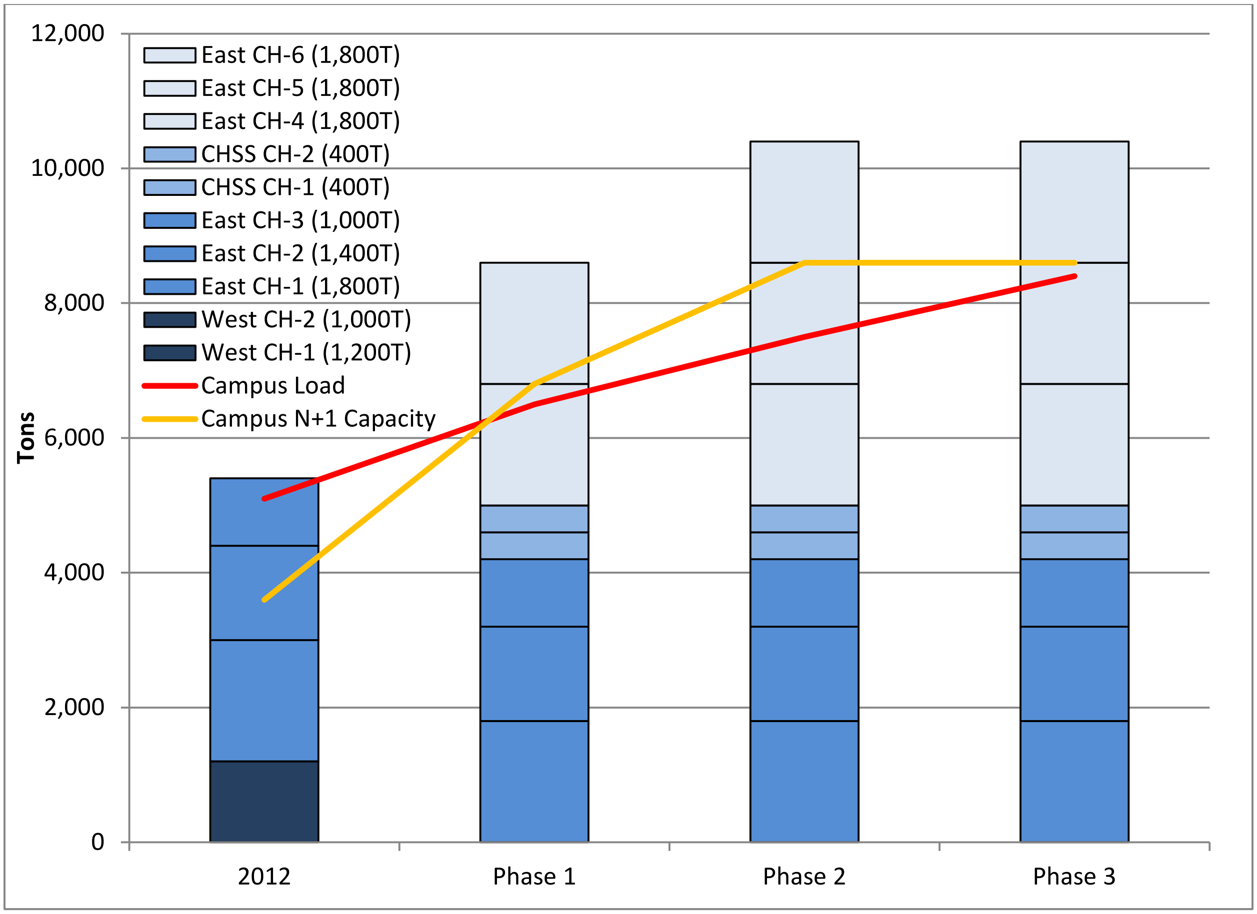


Figure 2: Master Plan Chilled Water Loads by Phase

<u>Phase 1 Recommendations</u>

Both the East and West Plants are currently at capacity and improvements or additions to the systems must be made before any Phase 1 construction is connected to the campus chilled water system. Given the location of the first planned project (the Agricultural Engineering Building) and the spare chiller capacity available in the West Plant after the modifications, it is recommended that modifications be made to the West Plant to allow both chillers to operate at the same time (Project 1.00). Replacement of the chilled water pumps in the plant would also allow for the plant to serve the Agricultural Engineering building, as well as more adequately serve the buildings currently connected to the West Plant loop. Connecting the CHSS chilled water loop to the east campus loop is also recommended to provide supplemental capacity (Project 1.05 on M2.0).

Extension of the chilled water piping from the West Plant to the Agricultural Engineering building site is shown as Project 1.10. Further extension of the piping to connect to the existing Chemistry Building piping is shown as Project 1.15. These recommendations will also provide the first connection between East and West Plant loops. This will allow for several other buildings, such as the Shared Special Instruments Building and Nursing Biology, to be added to the chilled water system as well. No chiller redundancy will be available, but that is also the current situation for both plants.

The second connection between the East and West loops is provided by Project 1.20. This will also create a true campus loop. Extension of chilled water piping to the Student Health Counseling Center is provided by Project 1.25.

To allow for further Phase 1 construction and to provide cooling redundancy on the campus increases to campus chilled water capacity will be required. This major project is represented as 1.30 and involves an expansion to the East Plant and distribution piping project along Bobby K. Marks Drive. This project is essential to the campus utility master plan and will involve a complicated design and construction process. The earlier Phase 1 building additions are dependent on increasing existing plant capacity with aging equipment and reconfiguring the East and West Plant for optimum performance. These improvements will not add any cooling system redundancy to the campus. Part of the overall campus mater plan also involves demolition of the West Plant, which ideally would occur as early as possible. Because of this, Project 1.30 should be a major priority for the general campus master plan.

The proposed piping down Bobby K. Marks is shown parallel to two existing piping paths. The intent is for these existing piping routes to remain in service while the new piping is being installed. This would assist in limiting the service shutdown time required for installation of the new piping.

The proposed design for the East Plant Expansion is a 5,400 ton variable-volume primary plant housing three 1,800 ton chillers. This chiller size matches the largest chiller on campus, which allows for the N+1 redundancy as shown in the capacity graph above.

A separate South Plant was also examined as an option for increasing campus cooling capacity. A South Plant may provide some slight hydraulic benefit over an East Plant, but for several reasons the East Plant presented itself as the better option. First, consolidating chilled water generation to one location allows for a decreased number of operators, and simplified maintenance overall. An acceptable location for an expansion currently exists adjacent to the East Plant, while a location that appears appealing for a South Plant now may not be so in the future. Also, a South Plant would require more extensive electrical distribution to that end of campus, increasing the overall project cost. No opportunity exists for a separate electrical feed into campus on the south side of campus. For all of these reasons, expansion of the East Plant was chosen for the utility master plan.

Project 1.35 would likely occur concurrently with Project 1.30, as it provides the distribution piping necessary for the South District Residence buildings. The project also increases the strength of the connection between East and West Plants on the south end of campus. The final chilled water project for Phase 1 is 1.40, which creates an interconnection between existing east loop piping and the new south distribution piping.

The hydraulic model <u>Chilled Water System – Phase 1</u>, shown in Appendix B, represents a peak cooling condition at the end of Phase 1. The East Plant Expansion has been constructed and the CHSS chillers connected to the main campus loop. The West Plant is no longer in operation. All of the East Plant chillers are running at full speed, though it is recommended that the new plant expansion be built for variable volume operation and the existing East Plant be retrofitted for the same. This will save considerable energy but is not essential to the campus master plan. There are several buildings on the west side of campus that still have low or slightly negative differential pressures. These buildings may need to be retrofitted with tertiary chilled water pumps. This would also allow the campus distribution pumps to operate at lower speed, reducing energy consumption at the plant and also avoiding unnecessarily high differential pressures at buildings close to the plant. Increasing overall campus chilled water differential temperature would also reduce pumping power across the campus. This will be discussed in the Other Recommendations section.

Phase 2 Recommendations

The large amount of utility infrastructure improvements in Phase 1 would allow for the next two Phases of construction to occur with much less cost and impact on the campus. While most of the Phase 1 construction is planned for the south end of campus, Phase 2 focuses on the north end. Project 2.00 would increase the chilled water piping size along 17th street to allow for adequate flow to the North District Residences and Dining. Project 2.05 would then extend piping north to the new residence halls and dining. Other Phase 2 buildings are already in proximity to installed chilled water piping and could be connected to existing taps, though care must be taken to ensure that these taps are installed for future building use during earlier phases of construction. Also, installing the third chiller set in the East Plant Expansion would maintain chiller redundancy for the campus system.

The hydraulic model Chilled Water System – Phase 2 represents a peak cooling condition at the end of Phase 2. 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 3 Recommendations

The third phase of campus construction would require no major expansions or additions to the campus thermal distribution system. The largest infrastructure project would be the piping run to the Indoor Multi-Purpose Facility. The Chilled Water System – Phase 3 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 71% as more buildings are added to the campus.

Distribution Loop Sizing

One major reason for having a distribution "loop" as shown on M2.0 and the hydraulic models is that this configuration allows buildings to be served from multiple directions. This is useful if a section of piping experiences a failure or a shutdown to a section is needed for another reason, such as connection to new branch piping. Main loop isolation valves are a requirement for this and should be a consideration during distribution piping projects. Two "pipe break" locations were identified as worst-case scenarios for the campus chilled water distribution loop. These two scenarios are shown in the hydraulic models Chilled Water System – Phase 3 – North & South Bobby K. Marks Piping Break. If a piping break were to occur in the 30" piping north or south of the East Plant in Bobby K. Marks Drive, chilled water would be forced all the way around the loop, creating the most possible pressure drop for the distribution system. In both cases, both the supply and return lines were modeled as closed.

These two models were both run at the design campus diversity of 71% (8,400 ton load) with the loop distribution piping first sized for design velocities (5-8 ft/s) during normal operation. The distribution system was not able to provide full flow in either model, indicating that the system pressure drop was larger than the available head of the East Plant chilled water pumps. In order to reduce the system pressure drop, the distribution piping was upsized incrementally. Each incremental increase in size allowed more flow throughout the system, however it was discovered that the distribution piping could not feasibly be made large enough to allow full system flow at either worst-case scenario. Because of the existence of 24" piping already in the system and diminishing returns above that size, 24" was selected to be modeled as the loop distribution size.

From this point, the campus diversity was decreased for each failure scenario until the distribution system could provide the full flowrate to the required buildings. The result was that for a piping break south of the East Plant along Bobby K. Marks, 12,285 GPM (or 6,490 tons) could be distributed to the campus. This represents 77% of the design campus diversified load of 8,400 tons. For a piping break north of the East Plant, 11,390 GPM (or 6,018 tons) could be distributed to campus – 72% of the design campus diversified load. These are the two scenarios shown in the hydraulic models.

A Phase 3 design cooling diversity of 71% can be considered conservative, because the percentage can be expected to reduce when additional loads are connected to the system. Also, given the infrequency of peak load on the system and unlikelihood of a worst-scenario failure, the two conditions described above could be considered acceptable risks for the system master plan. However, if the campus were to desire full redundancy in either worst-case piping scenario, the East Plant chilled water pumps could be upsized to provide the head required. The plant expansion's pumps could also be sized to match.

Heating Water System

The table below on the following page shows a summary of campus heating load increase through the various phases of the master plan. Unlike the chilled water system, it is not recommended that new buildings be connected to a distributed heating water system unless they are directly adjacent to existing piping. The efficiency of modular heating water boilers (85-95% efficient) and the climate's short and mild heating season make individual building heating systems a more attractive option than a campus distributed system. In this situation, the cost associated with extended lengths of buried heating water piping does not offset the gain in efficiency and diversity from connecting multiple buildings together. This is especially true when multiple smaller sized boilers are placed in buildings, allowing redundancy within the building itself. Of all new buildings on the campus master plan, only four are recommended to be connected to the existing East Plant system, as shown in the table below. No additional connections to the West Plant heating water system are recommended. Building load estimates were made using Btu/sq.ft. values and building usage. A total campus diversity of 50% (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 East Plant heating water load over time, per phase.

Building	Area Sq.Ft.	Plant	Heating Density Btu/Sq.Ft.	Heating Load MBtu/h	Design Flow (gpm)	Applied Diversity	Heating Load MBtu/h	Div. Flow (gpm)
Existing Buildings								
West Plant	**501,983**	**EAST**		**5,800**	**500**	**50%**	**2,900**	**300**
East Plant	**1,538,624**	**WEST**		**27,800**	**1,700**	**30%**	**8,300**	**500**
Total	**2,188,029**							
Phase I								
Agricultural Engineering Builiding	50,000	LOCAL						
Nursing / Biology Building	100,000	LOCAL						
Shared Specialty Instruments Facility	28,000	LOCAL						
Lowman Student Center Expansion	60,000	LOCAL						
Student Health and Counseling Center	28,900	LOCAL						
South District Residences (R1)	103,900	LOCAL						
South District Residences (R2)	105,000	LOCAL						
South District Dining	25,000	LOCAL						
Communications & Central Plant Exp.	15,000	EAST	25	375	106	50%	188	53
Demo White Hall	-	-	-	-	-	-	-	-
Demo Academic Building III	-	-	-	-	-	-	-	-
New Building Totals				**400**	**100**		**200**	**53**
Demolition Totals				**970**	**97**		**291**	**29**
Phase I Campus Totals		**EAST**		**27,200**	**1,700**	**30%**	**8,200**	**500**
Phase II								
Fine Arts	40,000	LOCAL						
W.A.S.H.	10,000	LOCAL						
DELTA / CE Building	10,000	LOCAL						
North District Residences (R3)	108,800	LOCAL						
North District Residences (R4)	75,000	LOCAL						
North District Residences (R5)	103,900	LOCAL						
North District Dining	25,000	LOCAL						
Basketball Practice Facility	20,000	EAST	35	700	63	50%	350	31
Allied Health Building	60,000	LOCAL						
New Building Totals				**700**	**100**		**400**	**0**
Demolition Totals				**0**	**0**		**0**	**0**
Phase II Campus Totals		**EAST**		**27,900**	**1,800**	**31%**	**8,600**	**500**
Phase III								
Indoor Multi-purpose Facility	125,000	LOCAL						
Academic Building	75,000	EAST	25	1,875	94	50%	938	47
Recreational Sports Complex Exp.	70,000	EAST	25	1,750	88	50%	875	44
Future #1	60,000	LOCAL						
Future #2	60,000	LOCAL						
New Building Totals				**3,600**	**200**		**1,800**	**100**
Demolition Totals				**0**	**0**		**0**	**0**
Phase III Campus Totals		**EAST**		**31,500**	**2,000**	**33%**	**10,400**	**600**

Table 15: Master Plan East Plant Heating Water Loads

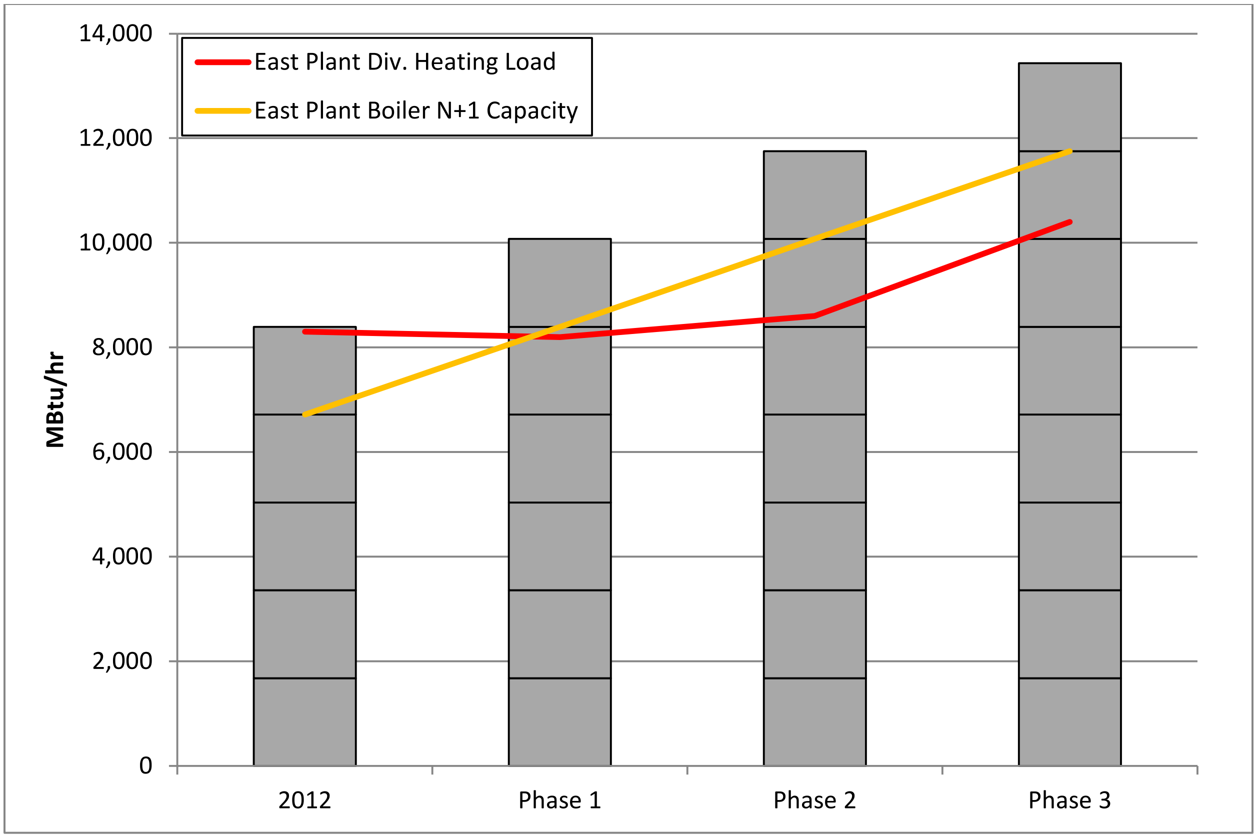


Figure 3: Master Plan East Plant Heating Water Loads by Phase

Although there is a slight net decrease in load in the East Plant heating water system across Phase 1, the addition of two modular boilers sized equal to the existing boilers is recommended to provide boiler redundancy in the plant. Addition of one final boiler in Phase 3 is recommended to maintain redundancy due to added Phase 2 and Phase 3 loads.

Demolition of the West Plant is part of the general campus master plan, so the plant's heating water system must be relocated. The lowest floor of Thomason Hall is an excellent candidate for the new west campus heating water system. 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 the campus loop, and gas service at the adjacent West Plant. The relocation of the heating water system could happen as early as an off-peak season allows.

The Heating Water System – Phase 3 hydraulic model represents a peak heating condition at the end of Phase 3. Both plants are shown with a redundant boiler, and no fluid velocities exceed 8 ft./sec. Both plants are represented as variable flow, allowing loop differential pressures and pump speeds to be as low as possible while still providing adequate flow.

A similar exercise was performed for the East Plant heating was system as is described in the "Distribution Loop Sizing" section for chilled water above. A pipe size of 6" was selected for the distribution loop based on design fluid velocities, and in both worst-case conditions, full flow for design diversity can be provided.

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. The primary deficiency with the campus's systems currently is the lack of a thorough monitoring system. There is much data available on individual air handlers within buildings, but very little information on the systems that provide chilled and heating water to these systems.

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. 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.

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 potentially resolve existing hydraulic issues, it is recommended that this pressure drop be investigated by adding more calibrated gauges and sensors into the system.

Conversion of East Plant to Variable Volume / Campus Differential Temperature Improvements

Significant energy savings could be realized by conversion of the East Plant to variable chilled water flow. This may require retrofit of some existing buildings. However, it is recommended that campus-wide differential temperature improvements also be investigated as a means 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.

Replace East Plant Heating Water Piping / Thermal Expansion Models

Several sections of the East Plant heating water system's distribution piping are in poor condition and require frequent repair. Replacement of this piping whenever feasible is recommended. This is reflected on sheet M2.0 in Appendix A, but is not explicitly included as part of the campus utility master plan. The campus prefers that the majority of this work be done section by section when possible, rather than one large project. However, the section of piping along Bobby K. Marks should be installed with Project 1.30 to avoid any future rework. Because future additions to the heating water system are limited, the some of the recommended pipe sizes are smaller than what is currently installed.

Because of the temperatures used in heating water systems, expansion compensation in the form of expansion loops typically required along the piping routes. These expansion loops require significant additional excavation outside of the direct path of the piping. In order to understand the size and impact of these expansion loops, a thermal expansion model of the east heating water distribution system was generated using CAEPipe v6.41 software.

Thermal expansion in buried piping acts fundamentally different than thermal expansion in above ground piping. The soil sets up restraints, which act as virtual anchors, through friction and cohesion when sufficient contact length is possible. In the case of buried pipe, the pipe tries to expand due to temperature change and soil restricts the pipe movement. This restriction in movement falls into two categories: partially restrained or fully restrained.

The frictional force between pipe and soil is equal to the multiplication of normal reaction force (soil pressure) and coefficient of friction. The frictional force will linearly increase along the length of buried pipeline. After certain burial length, the frictional force will be sufficient to counterbalance the thermal expansion force, and beyond that point the pipe material will be fully restrained. When a pipe is fully restrained, there is no displacement during thermal expansion. The soil properties, such as soil cohesion, will determine the length of buried piping required before the pipe becomes fully restrained. For example, loose sand may require 200' of buried piping before it becomes fully restrained, and compacted dirt may only require 100' of buried piping before it becomes fully restrained. The figure below illustrates the concept of fully restrained versus partially restrained.

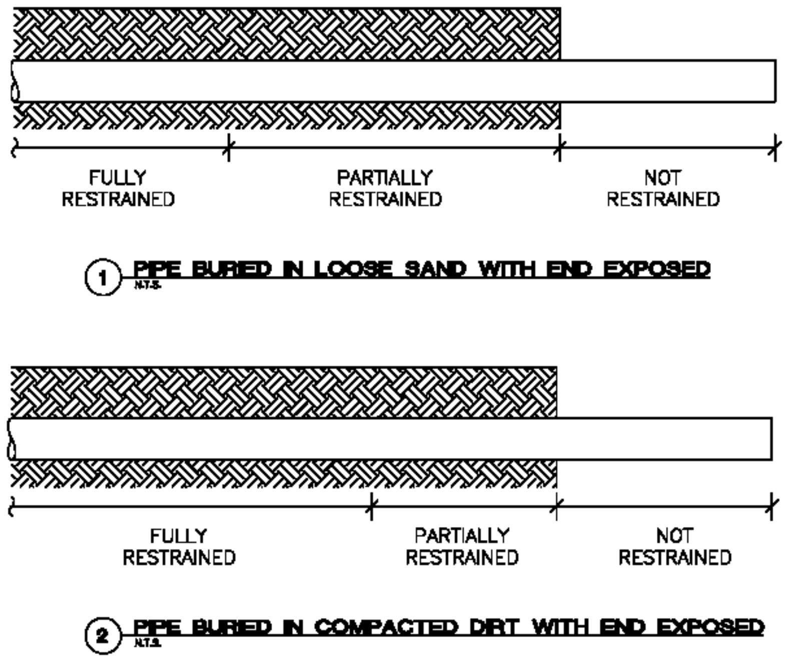


Figure 4: Buried piping with end exposed

The piping will also transition from fully restrained to partially restrained at all elbows and tees. This is presented in the figure below.

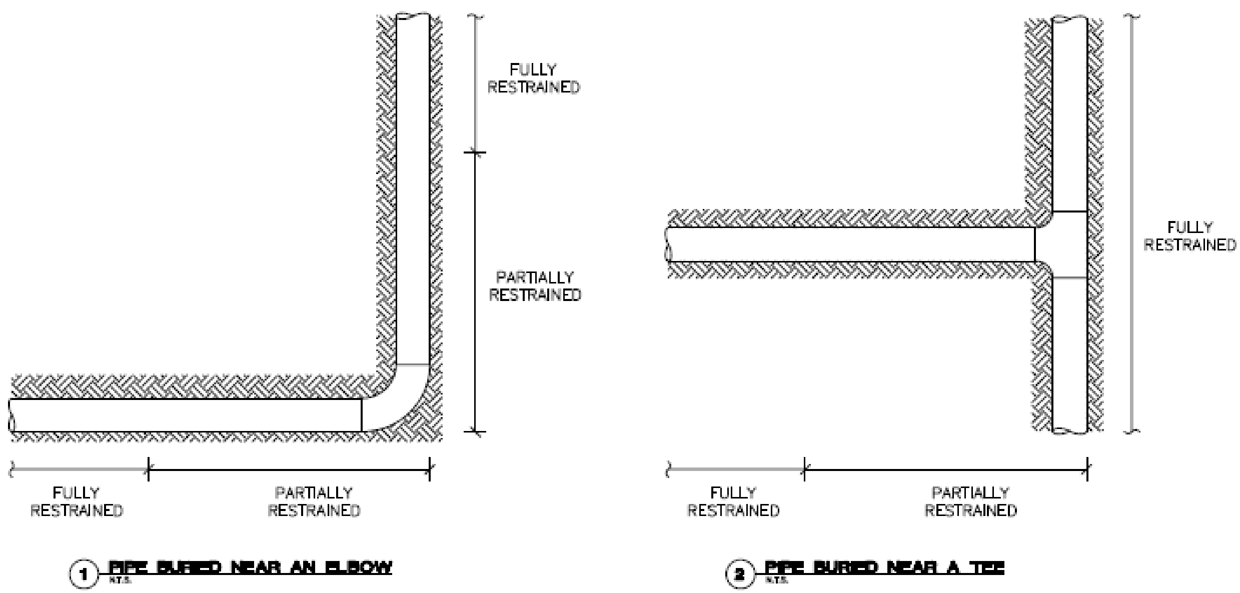


Figure 5: Buried pipe near an elbow or tee

When a pipe is fully restrained, there is no displacement during thermal expansion and all of the stress is transitioned directly to the pipe. When the pipe is not restrained, it is free to move during thermal expansion and will act like a pipe on hangers. There is also a transition region between the not restrained and fully restrained portions of pipe that is called the partially restrained region.

This partially restrained region will move more than the fully restrained region, but less than the not restrained region. The displacement during thermal expansion in the partially restrained region will be a gradient with no displacement beginning at the fully restrained region, then gradually expanding more and more along the pipe as is gets near the not restrained region. The pipe stress will also be a gradient with high pipe stress at the fully restrained region, and then becoming less and less stressed as the pipe transitions to not restrained. This phenomenon is shown in the figure below.

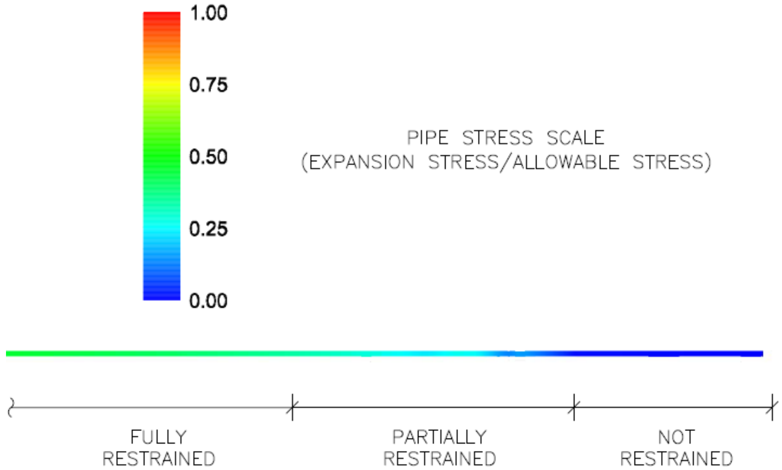


Figure 6: Buried piping with end exposed - stress analysis

This figure shows high pipe stresses at the fully restrained region, and then a pipe stress gradient lowering in pipe stress as the pipe moves into the partially restrained and not restrained regions. The pipe stress is high in the fully restrained region because the pipe cannot move during thermal expansion and all of the stress is transitioned directly to the pipe. The fully restrained region creates virtual anchors that restrain the pipe continuously along the pipe.

The heating water loop on campus delivers heating water at 180°F. 250°F is the approximate temperature threshold where the thermal expansion stress exceeds the allowable stress in the fully restrained region. Since the supply temperature is below approximately 250°F, straight lengths of piping can be allowed to be fully restrained without the thermal expansion stress exceeding allowable pipe stress.

There are three major areas on concern for thermal expansion in the heating water loop. These areas are thermal expansion at tees, thermal expansion at bends, and thermal expansion at anchors. These areas of concern can be corrected by adding additional anchors or expansion loops.

The first area of concern is a typical elbow. There are large elbows in the main piping at all major changes in direction. Under normal operating conditions these elbows will experience high stress during thermal expansion. The pipe stresses on a typical elbow is shown in the figure below.

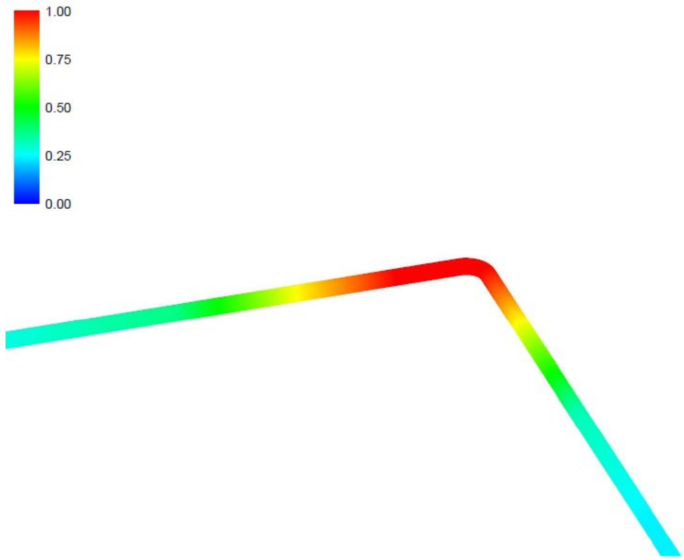


Figure 7: Elbow fitting before adding additional anchors

As shown, there are high stress regions at the elbow. This is because the axial forces from the partially restrained regions are pushing the elbow perpendicularly into the soil from both directions. The pipe is restrained in the axial direction by the soil cohesion, but the soil is not strong enough to hold the pipe at the elbow in the lateral direction. This is illustrated in the figure below.

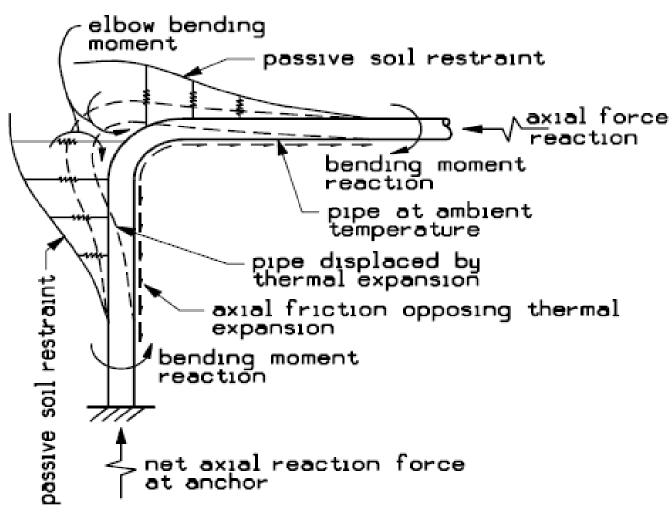


Figure 8: Thermal expansion of an elbow fitting
(Guidelines for the Design of Buried Steel Pipe, ASCE July 2001)

The stress at the elbow can be decreased by adding anchors just before the elbow fitting on both sides, and allowing the elbow to expand inside of a larger elbow fitting. Adding the anchor makes the partially restrained region become fully restrained and stops the thermal expansion movement of the partially restrained region of pipe into the elbow. There will still be a small amount of thermal expansion of the elbow fitting due to the small segments of pipe interior to the anchors.

Because of the small amount of thermal expansion we will put the piping elbow inside of a larger fitting. This detail is shown below.

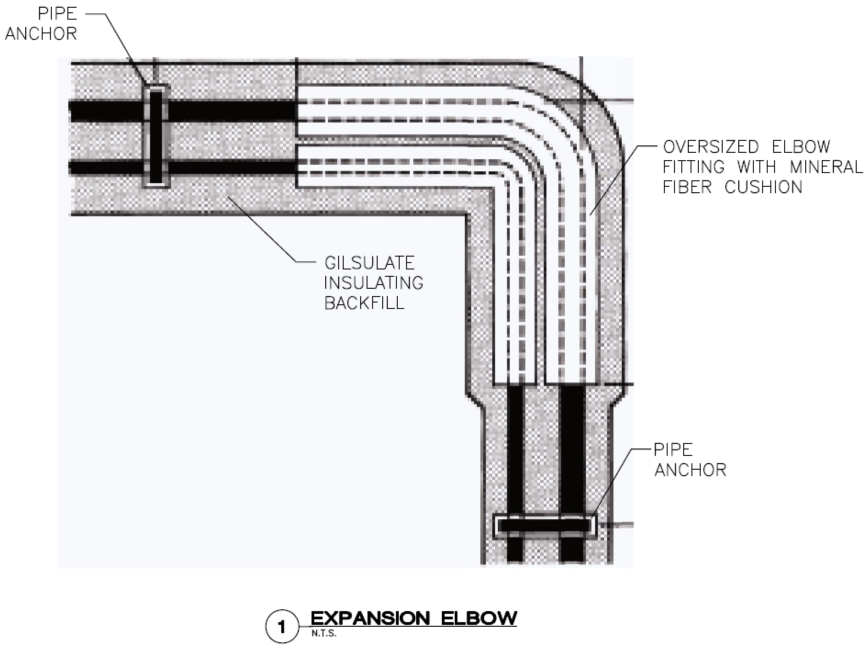


Figure 9: Expansion elbow fitting

The pipe stresses after implementing this correction is shown in the figure below.

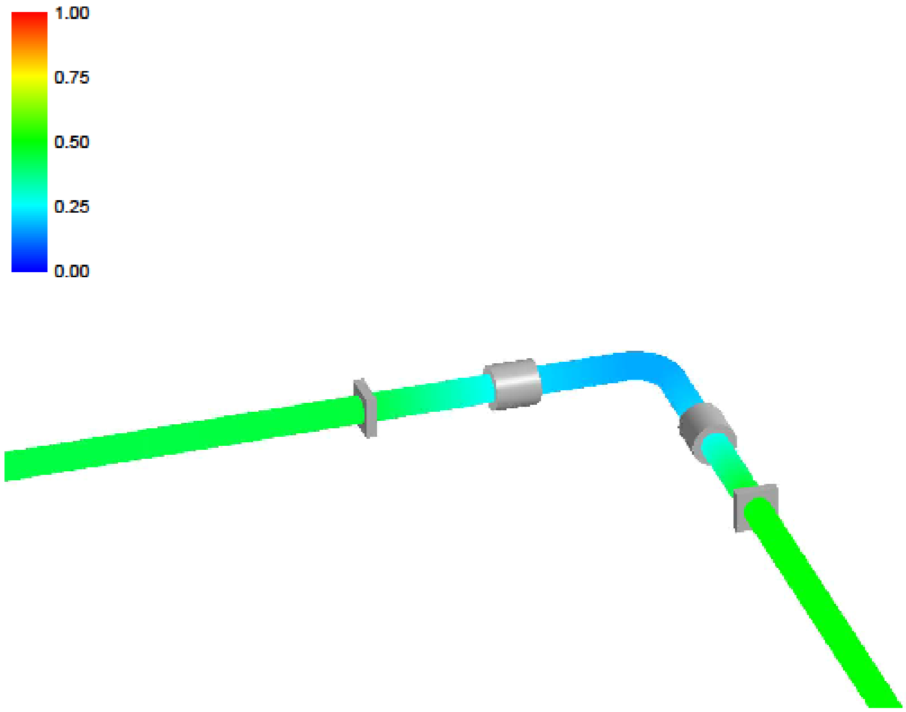


Figure 10: Elbow fitting after adding additional anchors

Piping tees are another area of concern. At all branches from the main heating water loop to each building there will be a tee fitting. Under normal operating conditions these tees will experience high stress during thermal expansion. This is depicted in the figure below.

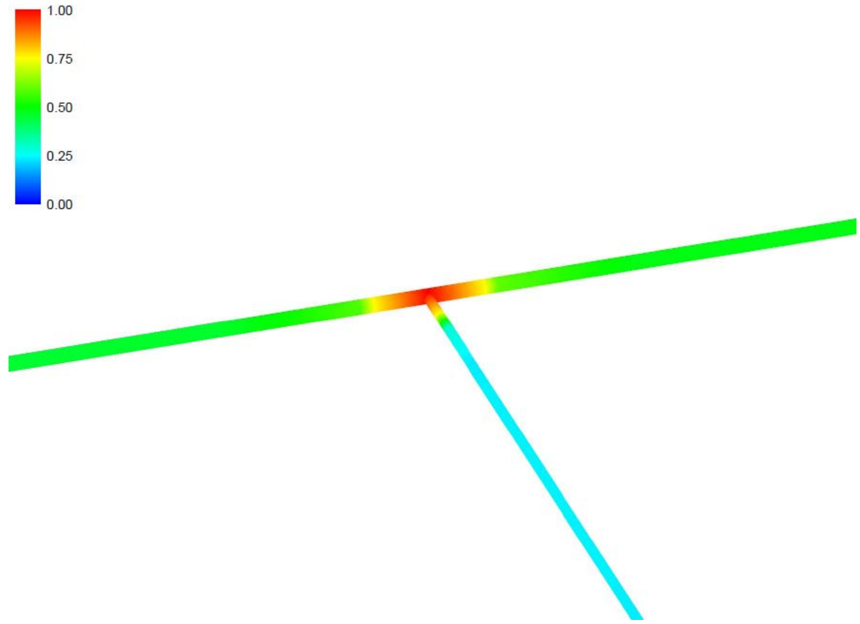


Figure 11: Piping tee before adding additional anchors

There are high stress regions at the tee. This is because the axial force from the branch pipe in the partially restrained region is pushing the main piping perpendicularly into the soil. This stress can be greatly reduced by adding an anchor on the branch piping just before the tee fitting. Adding the anchor makes the partially restrained region become fully restrained and stops the thermal expansion movement of the branch pipe into the main pipe. This correction is shown in the figure below.

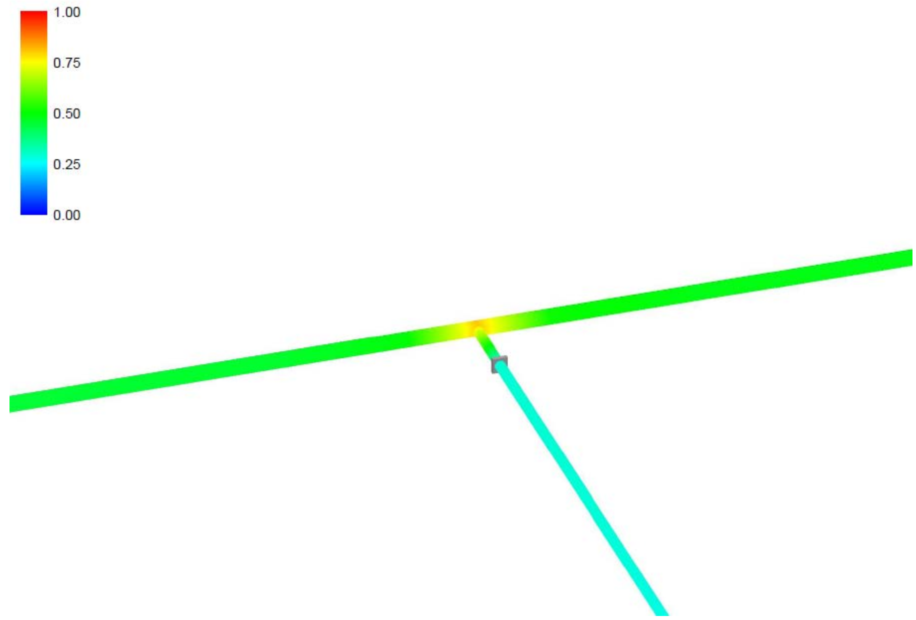


Figure 12: Piping tee after adding additional anchors

Piping anchors are the third area of concern. When the heating water piping enters the ground from a building or central plant, an anchor point is created at the slab penetration because pipe movement is restricted. Additional anchors will also be added in the form of concrete thrust blocks around tees and elbows as demonstrated above. These anchors will need to be sized large enough to hold against the reaction forces of the piping due to thermal expansion. Extremely high reaction forces will require thrust blocks that are so large they become unpractical to build. When this condition occurs, expansion loops can be installed just before the thrust block to greatly reduce the forces on the thrust block. The highest anchor load shown in the thermal expansion model is approximately 110,000 lbs. This load can be compensated for by a thrust block sized to approximately 9'x9'x3'. It will be much more cost effective to install a thrust block in lieu of installing expansion loops in an underground concrete box for all anchors on the campus.

A complete campus map showing all proposed anchor points for the new heating water pipe routing is shown in Appendix E. Anchor force data from the thermal expansion model is also included.

Campus Electrical System

Study Methodology

The campus electrical system consists of a medium voltage (13,200 Volts) substation building, a medium voltage underground 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. 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 the same underground conduit ductbank 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 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 a problem. 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 of the conductors are located 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.

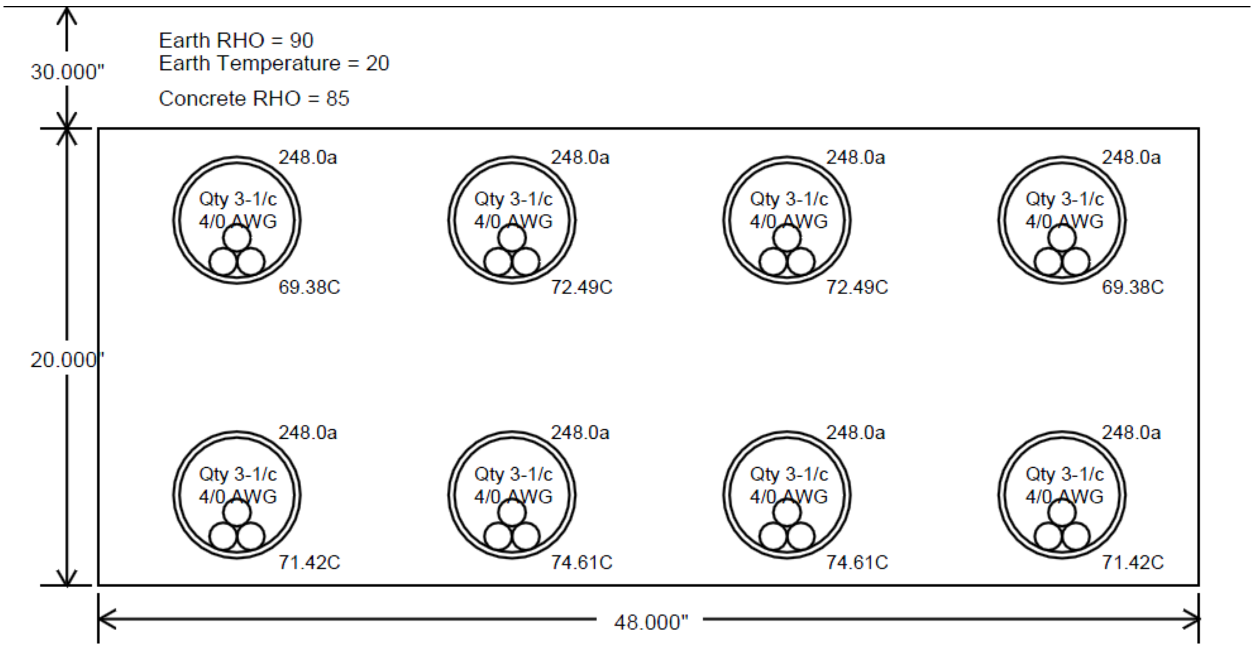


Figure 13: Main Electrical Ductbank from Substation Building

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.

When calculating the maximum demand for Circuits 5+6, the maximum demand of each building was totaled. This resulted in a total of 5.3MW. However, when taking each month into account, the maximum demand for the circuit pair occurred in February 2012 with 4.3MW. The diversity calculated is 80%. This percentage will be used 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 kW	Current Load			
		Peak kW	Diversity	kW	Spare
1+2	5,670	5,588	0.8	4,470	21%
3+4	5,670	4,741	0.8	3,793	33%
5+6	5,670	5,271	0.8	4,216	26%
7+8	5,670	1,405	0.8	1,124	80%

Table 16: 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 is 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 half of the campus. Proper coordination is essential to the reliability of the system.

The short circuit study was performed for the electrical distribution system shown on the one lines included in the appendix 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 the following table 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 inputted 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) or withstand 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 = 7,268 amps

Max. Phase - Ground Fault = 8,523 amps

Three Phase Fault = 8,392 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.

<u>Results</u>

Overall, the system is properly selected to handle a short circuit event. There is one distribution panel that is in question. The main circuit breaker for Lemit is rated for 50,000AIC, but has a calculated fault current of 52,578 AIC. This circuit breaker resides in the main distribution panel for the CJC and should be replaced in order to maintain the 65,000 AIC rating of the CJC main distribution panel.

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.

Sam Houston State University Short Circuit Analysis					
Building	Symetrical Amps Available	Equipment Rating	Building	Symetrical Amps Available	Equipment Rating
8 CO-OPS Sorority Hill	10543	10000	HKC	12602	65000
AB I	11729	35000	Jackson Shaver	4678	10000
AB II (MLH)	9189	***22000***	Lee Drain	10031	***35000***
AB III	20427	***22000***	Lemit	54884	50000
AB IV	14155	100000	Library	22225	***50000***
Adams House	5373	10000	Lonestar Hall	39810	100000
Administration	8499	10000	Lowman Student Center	14246	35000
Allen House	5373	10000	Museum	4678	10000
Belvin/Buchanan Hall	22528	***65000***	Music Building	8885	10000
BKV A&B	11378	***22000***	Old Main Market	18014	22000
BKV B(East), C, D (North)	11376	***22000***	Parking Garage	6627	35000
BKV D(South), E (Clubhouse)	14863	***22000***	Peabody - Austin Hall	10527	***22000***
BKV F(East), I	11375	***22000***	Performing Arts Center	17488	65000
BKV F(West), G, H	15637	***22000***	Pritchett Field	4678	10000
BKV J & M (Laundry Room)	7917	***22000***	Raven Village "A"	37595	65000
BKV K&L	11375	***22000***	Raven Village "B"	38017	65000
Bowers Stadium	5373	10000	Raven Village "C"	30399	65000
CFS	23950	65000	Sam Houston Village	34170	65000
CHSS	36241	65000	Sam Houston Village	33241	65000
CJC	54884	65000	Old Smith Hutson	13408	***35000***
Coliseum	12643	50000	Smith Huston	15476	65000
Dan Rather Communications	31998	***65000***	Softball./Baseball Complex	15523	35000
East Plant	22482	***65000***	South Paw Dining	23277	35000
Eliott Hall	7214	***22000***	Teachers Education Center	14085	***35000***
Estill Classroom	9664	65000	Thomason Building	7170	10000
Estill Dorm	19406	***22000***	UTC	13433	***22000***
Evans Complex	8024	65000	Visitor Center	8024	65000
Farrington	7662	10000	Walker Ed.	4678	10000
Health Center	14236	***22000***	West Plant	25251	***35000***

Table 17: Short circuit results at main panel of each building

Notes

Bold Italics Short Circuit Equipment Rating estimated based on equipment construction

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

Harmonic Analysis Study

The purpose of a harmonic study is to determine where large harmonic distortion occurs within a system. Large harmonic distortion can create unnecessary heat on neutral conductors and negatively impact transformer performance. A pure sine wave has no voltage distortion. Purely resistive loads like incandescent lighting and electric heaters use the sine wave and do not adversely affect the voltage wave. Harmonics are generated by the use of non-linear loads. Any device that accepts an AC sine wave and outputs a wave that is not sinusoidal can create harmonics. Variable speed drives, computer power supplies, fluorescent fixture ballasts, and transformers are just a few of the examples. With modification of the sine wave, harmonics can travel back into the system and have adverse effects on other components of the system. Nuisance tripping of circuit breakers metering errors, increased resistive losses, and increased voltage stress on the main conductors are some of the problems that can occur. With enough distortion, some inputs might be outside prescribed tolerances for proper operations. New VFDs and ballasts do a much better job at not allowing the harmonics to make it back into the system through active and passive filters. An evaluation of the harmonic voltage and current limits to IEEE 519 was done using SKM Power Tools software.

The first step in a harmonic study is to develop a software model from the available data. We have modeled the campus distribution system, the large motors located within each chiller plant, and step down transformers at each building. Fluorescent and high intensity discharge lighting was estimated based on square footage and building use. The results shown in the chart below are the total voltage distortion calculated at each building distribution panel. Further distortion levels can be found in the appendix. The THD % is considered good when below 3% for each building and 5% on the system. Once levels exceed 10% is when corrective actions should take place.

The results yield very little harmonic distortion. The model assumes that all loads are on for a worst case scenario. The field measured levels would more than likely yield lower distortion numbers. Also, as lighting retrofits take place around the campus, the harmonic distortion should improve.

Sam Houston State University Harmonic Load Analysis			
Building	THD %	Building	THD %
8 CO-OPS Sorority Hill	0.97	HKC	2.54
AB I	2.02	Jackson Shaver	0.94
AB II (MLH)	0.96	Lee Drain	3.07
AB III	1.28	Lemit	1.52
AB IV	1.98	Library	2.22
Adams House	1.38	Lonestar Hall	1.45
Administration	1.89	Lowman Student Center	2.64
Allen House	1.38	Museum	0.94
Belvin/Buchanan Hall	0.85	Music Building	1.41
BKV A&B	1.56	Old Main Market	1.57
BKV B(East), C, D (North)	1.72	Parking Garage	1.92
BKV D(South), E (Clubhouse)	1.48	Peabody - Austin Hall	0.96
BKV F(East), I	1.57	Performing Arts Center	4.48
BKV F(West), G, H	1.62	Pritchett Field	0.94
BKV J & M (Laundry Room)	1.52	Raven Village "A"	1.57
BKV K&L	1.61	Raven Village "B"	1.57
Bowers Stadium	1.58	Raven Village "C"	1.57
CFS	1.69	Sam Houston Village #1	2.53
CHSS	3.48	Sam Houston Village #2	2.48
CJC	1.52	Old Smith Hutson	1.56
Coliseum	2.53	Smith Huston	1.76
Dan Rather Communications	1.58	Softball./Baseball Complex	5.72
East Plant	1.40	South Paw Dining	1.46
Eliott Hall	0.96	Teachers Education Center	2.10
Estill Classroom	0.72	Thomason Building	0.69
Estill Dorm	1.32	UTC	1.64
Evans Complex	0.88	Visitor Center	0.80
Farrington	0.96	Walker Ed.	0.94
Health Center	1.40	West Plant	0.96

Table 18: Voltage Harmonic Distortion Levels

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, and the dashed lines around the circuits represent various infrastructure projects required for the master plan. 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 it's downstream distribution. Descriptions of the electrical plans are given below.

The table below shows 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 about 1,200kW of available capacity (21%). This spare capacity can handle the addition of two residence halls, but not the dining facility. The available capacity for the dining facility will be realized once the East Plant is migrated to the new Circuit 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		101	101	25,449	4	Feb-11
BKV B(East), C, D (North)		168	168	38,178	4	Jan-11
BKV D(South), E (Clubhouse)		49	49	18,702	3	Aug-11
BKV F(East), I		106	106	25,449	4	Feb-11
BKV F(West), G, H		152	152	42,339	4	Feb-11
BKV J & M (Laundry Room)		59	59	13,192	4	Feb-11
BKV K&L		125	125	29,610	4	Feb-11
Lemit		155	155	38,948	4	Feb-11
Bowers Stadium		584	584	-	-	Nov-11
CJ Dining		50	50	-	-	Oct-10
CJ Hotel #1		55	55	59,981	1	Nov-11
CJ Hotel #2		111	111	59,981	2	Feb-11
CJC		700	700	140,960	5	Feb-11
CJC Plant		71	71	-	-	Aug-11
Coliseum		463	463	92,587	5	-
HKC		138	138	101,181	1	Nov-11
Performing Arts Center		297	297	101,945	3	Oct-10
Softball./Baseball Complex		461	461	-	-	Mar-12
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	0-6 years
Buildings To Be Added/Relocated		**Current kW**	**Future kW**	**sq.ft.**	**W/sq.ft.**	**Date of Construction**
New Residential-R2		0	525	105,000	4	0-6 years
New Residential-R1		0	520	104,000	4	0-6 years
New South Dining Facility		0	800	25,000	32	0-6 years
Bowers Stadium Expansion		0	300	75,000	4	7-13 years
Multipurpose Indoor Facility		0	250	125,000	2	7-13 years
Rec Center Expansion		0	300	75,000	4	7-13 years
Interdisciplinary Classroom		0	300	75,000	4	7-13 years
Maximum Demand Load (kW)		***5,588***	***6,840***			
Maximum Possible Load (kW)		***5,670***	***5,670***			
Diversity		***80%***	***80%***			
Diversified Load (kW)		***4,470***	***5,472***			
Available Capacity (kW)		***1,200***	***198***			
Spare Capacity		***21%***	***3%***			

Table 199: 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 2,000kW of available capacity (36%). This spare capacity can handle the addition of the Lowman Student Center Expansion, the new parking garage, the DELTA building, and also the migration of the 4160V loads around campus from the Farrington Switches to the main distribution. 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
Dan Rather Communications	272	272	45,264	6	-
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	300	60,000	5	0-6 years
New Parking Garage	0	30	-	-	7-12 years
DELTA/CE	0	145	29,000	5	7-12 years
4 West(Crawford,Baldwin,Mallon,Creager)	0	162	32,362	5	TBD
Jackson Shaver	0	65	39,138	2	TBD
Walker Ed. Center	0	224	22,473	6	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)	***4,558***	***5,740***			
Maximum Possible Load (kW)	***5,670***	***5,670***			
Diversity	***80%***	***80%***			
Diversified Load (kW)	***3,646***	***4,592***			
Available Capacity (kW)	***2,024***	***1,078***			
Spare Capacity	***36%***	***19%***			

Table 20: 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 contacting 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 Lee-Drain. Two 3750kVA transformers step the voltage from 13.2kV to 4160V for distribution via the Farrington Switches. The set of 8 Farrington Switches provide all of the 4160V distribution around the older 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 is routed on poles co-owned by the City of Huntsville and the University. Once the university owned conductors are removed, steps can be taken with the City to remove the overhead conductors that are currently feeding the 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 City 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
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
AB III	Demo	65	0	54,876	1	13+ years
Farrington	7+8	51	0	50,947	1	TBD
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
4 West (Crawford,Baldwin,Creager,Mallon)	3+4	162	0	32,362	5	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
New Residential-R2		0	525	105,000	4	0-6 years
New Residential-R1		0	520	104,000	4	0-6 years
New AG Engineering		0	300	60,000	5	0-6 years
New South Dining Facility		0	800	25,000	32	0-6 years
Allied Health		0	300	60,000	5	7-13 years
Rec Center Expansion		0	300	75,000	4	7-13 years
Maximum Demand Load (kW)		***5,432***	***5,296***			
Maximum Possible Load (kW)		***5,670***	***5,670***			
Diversity		***80%***	***80%***			
Diversified Load (kW)		***4,346***	***4,237***			
Available Capacity (kW)		***1,324***	***1,433***			
Spare Capacity		***23%***	***25%***			

Table 21: 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 Circuit 7+8.

Feeder #	Building	Projects needed	Notes
1	Farrington	2.15, 1.10	3
1	Estill	2.15, 1.10	3
2	Thomason	2.15, 1.10	4
2	Evans	2.15, 1.10	4
2	Vistors Center	2.15, 1.10	4
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	Demolition	
5	Peabody/Austin	2.15	3
5	Belvin/Buchanan	-	2
5	MLHB	2.15	4
5	Elliott	2.15	4
5	Soroity Hill	Demolition	
6	Parkhill	Demolition	
6	Barrett	Demolition	
6	Adams	Demolition	
6	Allen	Demolition	
6	Vick	Demolition	
6	Spivey	Demolition	
6	Randel	Demolition	
8	BAD	N/A	

Table 22: 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) Installation of a single 13.2kV:208V transformer near Belvin/Buchanan will be necessary. This transformer will be fed from the spare cabinet within the Old Main Market medium voltage switch.

(3) Existing pad mounted transformer can be reused for new Circuit 7+8 feeder

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

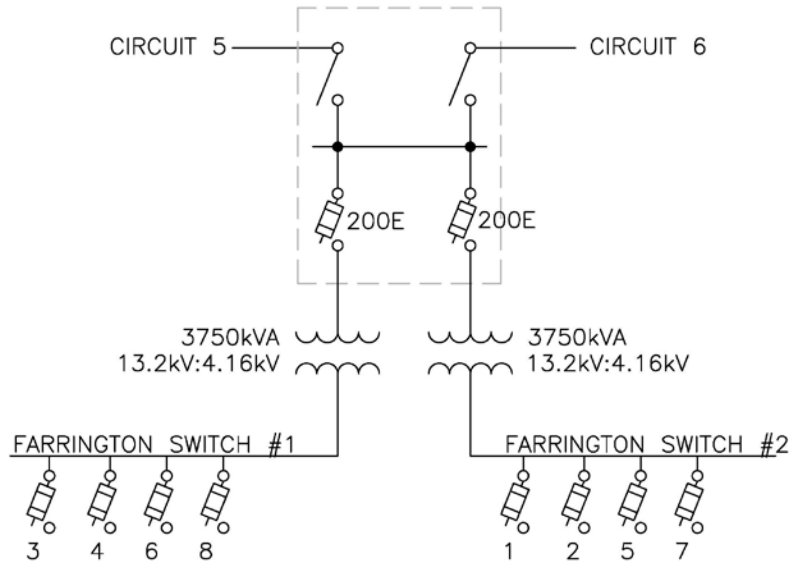


Figure 14: Current Configuration of Farrington Switches

CIRCUIT 7+8

The newest circuit pair is 7+8. It currently serves the north side of campus and includes the Health Center, Estill Dorm, Lonestar Hall, and Old Main Market and was installed in 2011. Circuit 7+8, when extended will be able to handle all of the buildings migrated from the Farrington Switch migration along with the new buildings located on the north side of campus. These include the Residence Halls 3, 4, and 5.

Circuit 7&8	**Electrical Peak Demand**				
Existing Buildings	**Current kW**	**Future kW**	**sq.ft.**	**W/sq.ft.**	**Date**
Estill Dorm	356	356	54,420	7	Feb-11
Health Center	49	49	101,181	0	Sep-11
King Hall #1	138	138	33,654	8	Feb-11
Lonestar Hall	279	279	87,840	3	Aug-11
Old Main Market	583	583	31,677	18	Feb-12
Buildings To Be Added/Relocated	**Current kW**	**Future kW**	**sq.ft.**	**W/sq.ft.**	**Date of Construction**
New Health Center	0	85	17,000	5	0-6 years
New North Dining Hall	0	900	25,000	36	7-12 years
New Residential-R5	0	520	103,900	5	7-12 years
New Residential-R3	0	544	108,800	5	7-12 years
New Residential-R4	0	375	75,000	5	7-12 years
Estill Classroom	0	235	37,107	6	TBD
Estill Parking Lot	0	2	-	-	TBD
Farrington	0	51	50,947	1	TBD
Evans Complex	0	101	47,748	2	TBD
Peabody - Austin Hall	0	86	8262	0	TBD
Elliott Hall	0	39	34,892	1	TBD
Belvin/Café/Buchanan Hall	0	364	62,277	6	TBD
AB II	0	67	-	-	TBD
Visitor Center	0	123	12,809	6	TBD
Maximum Demand Load (kW)	***1,405***	***4,898***			
Maximum Possible Load (kW)	***5,670***	***5,670***			
Diversity	***80%***	***80%***			
Diversified Load (kW)	***1,124***	***3,918***			
Available Capacity (kW)	***4,546***	***1,752***			
Spare Capacity	***80%***	***31%***			

Table 23: Circuit 7+8 Analysis

CIRCUIT 9+10

With the consolidation of the central plants into an East Plant expansion and also to allow capacity for the new residence halls R1 and R2 on the south end of campus, 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 from the other 8 circuits that leave the switchgear building because Manhole #1 does not have any spare conduits available. It is also advised that the conductors for Circuits 9+10 be 500kCM, which will give the circuits about twice as much capacity as the other circuit pairs. With the larger cable, the maximum load is about 11MW. This will give the circuit pair about 25% spare capacity and allow any future buildings beyond this master plan to be connected. 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	-	-	0-6 years
East Plant Expansion	0	6,758	-	-	0-6 years
Communications	0	80	16,000	5	0-6 years
Custodial & Grounds Building	0	40	18,391	2	0-6 years
Maximum Demand Load (kW)	***0***	***8,620***			
Maximum Possible Load (kW)	***11,418***	***11,418***			
Diversity	***100%***	***100%***			
Diversified Load (kW)	***0***	***8,620***			
Available Capacity (kW)	***11,418***	***2,798***			
Spare Capacity	***100%***	***25%***			

Table 24: Circuit 9+10 Analysis

MANHOLE #1 SEGREGATION

A small project that is on the high priority list is trying to place a physical barrier inside Manhole #1. 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 the entire campus for an extended period of time. By separating Circuits 1,3,5,7 from Circuits 2,4,6,8 with a concrete barrier, 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. Also, it is unknown at this time if a barrier can even be placed in the manhole with the current circuit configuration.

If a barrier could not be placed inside the manhole, the alternative would be to route a parallel ductbank from ahead of manhole #1 to the substation building for the even circuits. 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.

Given the complexity of this issue and potential for alternate designs, a cost estimate is not provided in the Project Summary. Further study beyond the scope of this report is recommended if the University selects this project.

COMBINED HEAT AND POWER (CHP) STUDY

A study on the feasibility of a combined heat and power system for the campus was performed by Brandt Engineering as part of this utility master plan. CHP is the simultaneous generation of electric power and useful thermal energy from a single fuel source and could potentially provide electrical redundancy to the campus as well as some energy cost savings. Several options for these technologies were investigated for the campus, but the conclusion of the study is that the capital cost for the CHP equipment would be too high to provide a reasonable payback. If these costs could be subsidized it would make the system more attractive. The full report can be found in Appendix D.

Utility Infrastructure Master Plan Project Summary

A summary of the recommended infrastructure projects for the campus utility master plan are given below, along with project reference numbers and budget costs. More detail on these cost estimates is provided in Appendix C.

Phase 1

1.00	Increase West Plant usable capacity	$320,000
1.05	Connect CHSS chillers to East Plant chilled water loop	$110,000
1.10	Extend piping from West Plant to Agricultural Engineering Building	$2,280,000
1.15	Extend piping from Agricultural Engineering Building to Chemistry Building	$230,000
1.20	17th Street piping project to connect East Plant and West Plant loops	$950,000
1.25	Extend Piping to Student Health and Counseling Center	$180,000
1.30	Communications and East Plant Exp. and Bobby K. Marks Improvements	$13,250,000
1.35	South campus piping project #1	$2,150,000
1.40	South campus piping project #2	$320,000
1.45	Relocate West Plant heating water system to Thomason Hall	$1,360,000
1.50	Manhole #1 Circuit Segregation	*(further study required)*

Phase 2

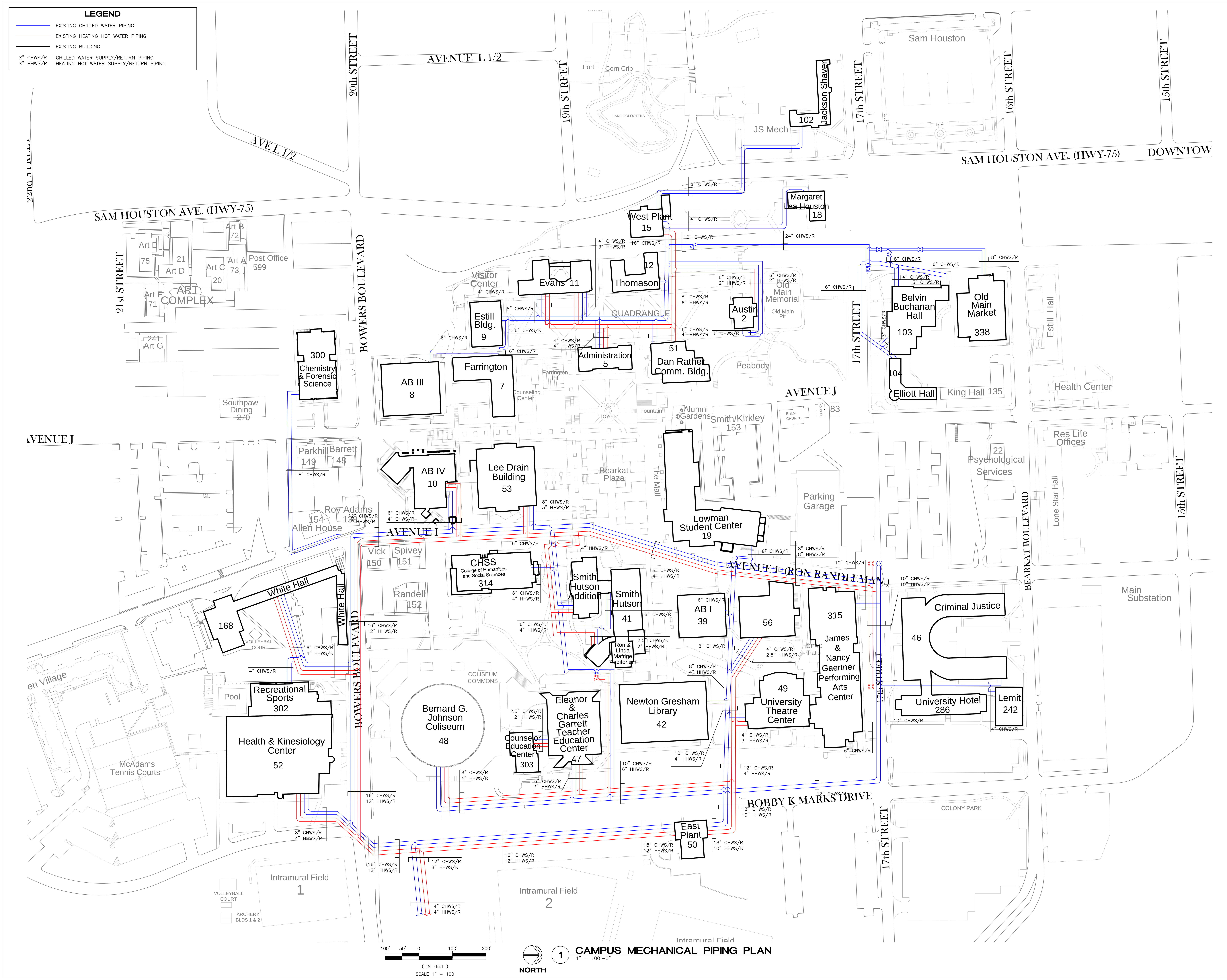
2.00	17th Street east piping project	$580,000
2.05	North Residence Hall piping	$380,000
2.10	Redundant electrical feed to HKC and Coliseum	$80,000
2.15	Migrate existing buildings from overhead electrical to buried	$1,230,000

Phase 3

3.00	Indoor Multi-Purpose Facility piping and electrical	$770,000

APPENDIX A –CAMPUS UTILITY MASTER PLAN DRAWINGS

- M1.0 – Campus Mechanical Piping Plan (2012)
- 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
UTILITY MASTER PLAN

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 #20120049

TITLE:
CAMPUS MECHANICAL PIPING PLAN (2012)

EEA PROJ: 20120049
DRAWN BY: MM
CHECKED BY: TS
DATE: 1-22-13

SHEET:
M1.0

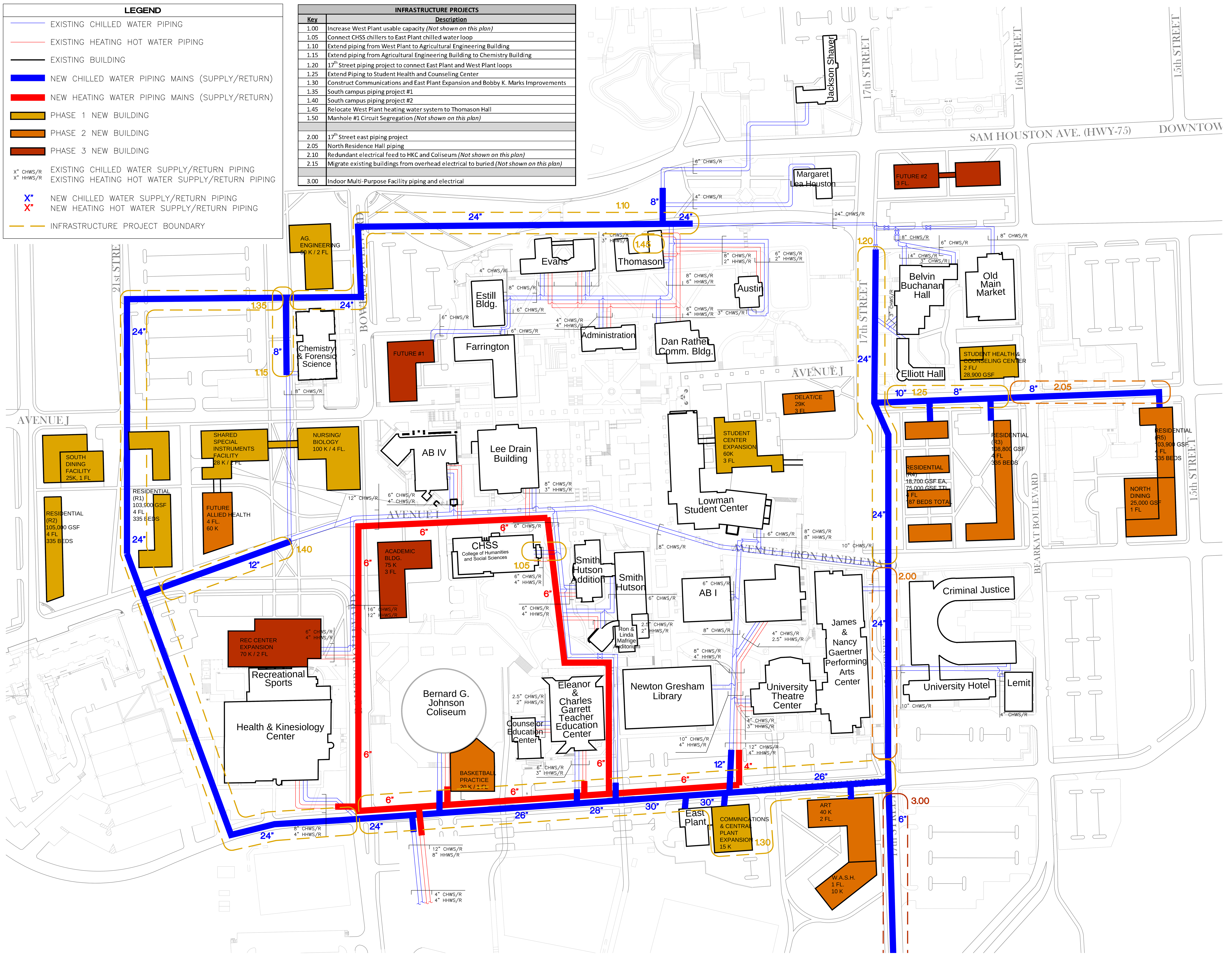
SAM HOUSTON STATE UNIVERSITY
HUNTSVILLE, TEXAS
UTILITY MASTER PLAN

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
- X" CHWS/R — EXISTING CHILLED WATER SUPPLY/RETURN PIPING
- X" HHWS/R — EXISTING HEATING HOT WATER SUPPLY/RETURN PIPING
- X" — NEW CHILLED WATER SUPPLY/RETURN PIPING
- X" — 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



SCALE 1" = 100'
(IN FEET)
NORTH

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

REVISIONS

NO	DATE	DESCRIPTION

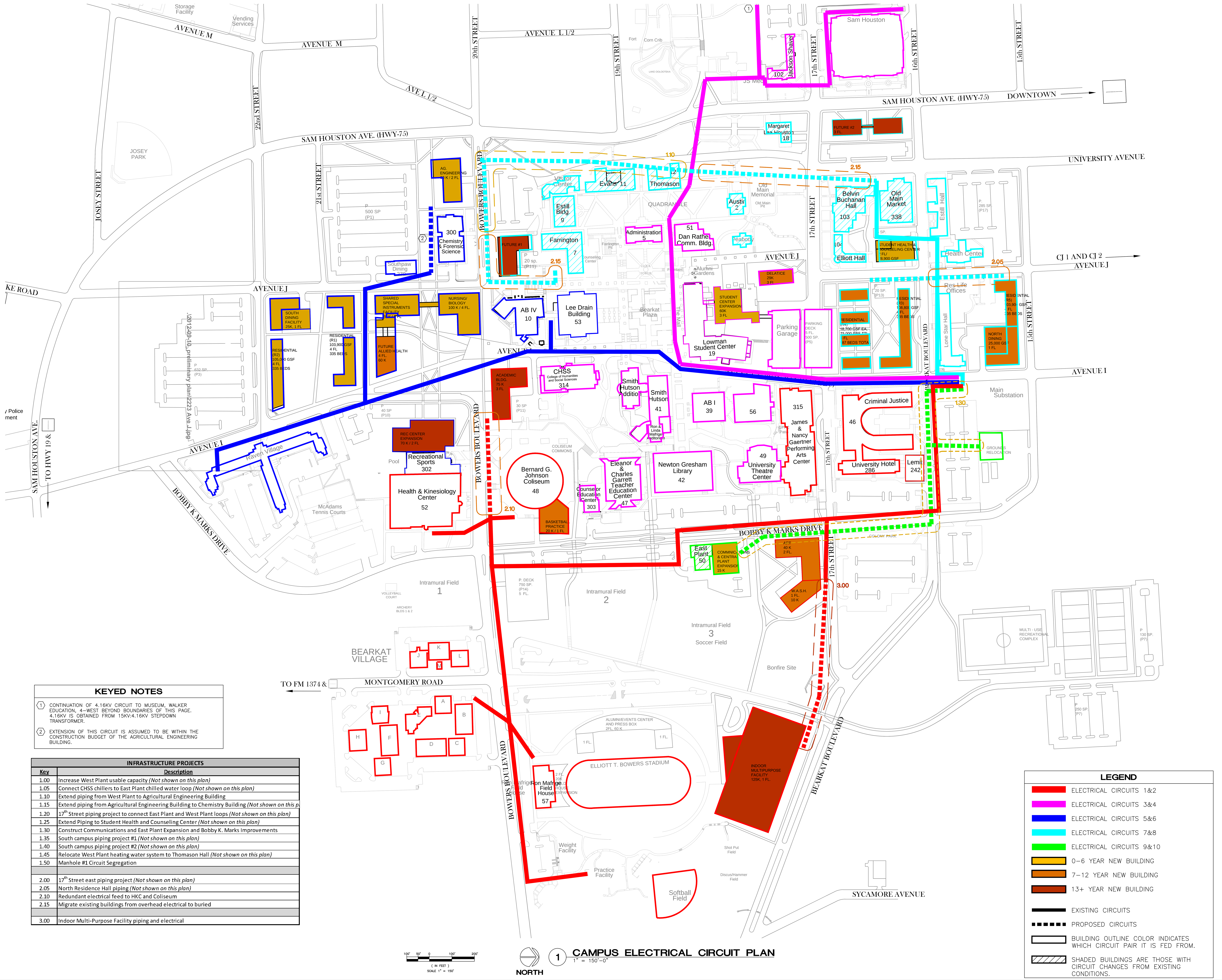
EEA CONSULTING ENGINEERS
6615 VAUGHT RANCH ROAD, SUITE 200
AUSTIN, TEXAS 78730-2314 USA
512.744.4400 MAIN - 512.744.4444 FAX
FIRM REGISTRATION # F-2497
WWW.EEACE.COM - EEA PROJECT # 20120049

TITLE:
CAMPUS MECHANICAL PIPING PLAN (FUTURE)

EEA PROJ: 20120049
DRAWN BY: MM
CHECKED BY: TS
DATE: 1-22-13

SHEET:
M2.0


REVISIONS
NO DATE DESCRIPTION
SAM HOUSTON STATE UNIVERSITY
HUNTSVILLE, TEXAS
UTILITY MASTER PLAN
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 #20120049
TITLE:
CAMPUS ELECTRICAL PLAN (2012)
EEA PROJ: 20120049
DRAWN BY: MG
CHECKED BY: MG
DATE: 1-22-13
SHEET:
E1.0
LEGEND
ELECTRICAL CIRCUITS 1&2
ELECTRICAL CIRCUITS 3&4
ELECTRICAL CIRCUITS 5&6
ELECTRICAL CIRCUITS 7&8
BUILDING OUTLINE COLOR INDICATES WHICH CIRCUIT PAIR IS FED FROM.
1 CAMPUS ELECTRICAL PLAN
1" = 100'-0"
NORTH
SCALE 1" = 100'
(IN FEET)
AVENUE L 1/2
AVE L 1/2
20th STREET
19th STREET
17th STREET
16th STREET
15th STREET
21st STREET
SAM HOUSTON AVE. (HWY-75)
DOWNTOWN
BOWERS BOULEVARD
AVENUE J
BOBBY K MARKS DRIVE
BEARKAT BOULEVARD
Sam Houston
Jackson Shaver 102
Fort
Corn Crib
LAKE OOLOOTEKA
Margaret Lea Houston 18
West Plaza 15
Thomason 12
Evans 11
Visitor Center
Old Main Memorial
Old Main Pit
Austin 2
QUADRANGLE
Belvin Buchanan Hall 103
Old Main Market 338
Estill Hall
Estill Bldg. 9
Farrington 7
Farrington Pit
Counseling Center
Administration 5
51 Dan Rather Comm. Bldg.
Peabody
104
Elliott Hall
King Hall 135
Health Center
Art B 72
Art E 75
21
Art D
Art C 20
Art A 73
Post Office 599
Art F 71
ART COMPLEX
241 Art G
300 Chemistry & Forensic Science
AB III 8
Southpaw Dining 270
CLOCK TOWER
Alumni Gardens
Smith/Kirkley 153
B.S.M. CHURCH
83
Res Life Offices
22 Psychological Services
Parkhill 149
Barrett 148
AB IV 10
Lee Drain Building 53
Bearkat Plaza
The Mall
Parking Garage
Lowman Student Center 19
Lone Star Hall
Roy Adams 138
Allen House 154
Spivey 151
150
CHSS College of Humanities and Social Sciences 314
Smith Hutson Addition
Smith Hutson 41
AB I 39
56
315 James & Nancy Gaertner Performing Arts Center
Criminal Justice
46
Main Substation
White Hall
168
Randel 152
VOLLEYBALL COURT
Village
Ron & Linda Mafrige Auditorium
COLISEUM COMMONS
Pool
Recreational Sports 302
Health & Kinesiology Center 52
Bernard G. Johnson Coliseum 48
Counselor Education Center 303
Eleanor & Charles Garrett Teacher Education Center 47
Newton Gresham Library 42
49 University Theatre Center
University Hotel 286
Lemit 242
McAdams Tennis Courts
East Plant 50
COLONY PARK
Intramural Field 1
Intramural Field 2
Intramural Field
VOLLEYBALL COURT
ARCHERY BLDS 1 & 2



KEYED NOTES

1. CONTINUATION OF 4.16KV CIRCUIT TO MUSEUM, WALKER EDUCATION, 4–WEST BEYOND BOUNDARIES OF THIS PAGE. 4.16KV IS OBTAINED FROM 15KV:4.16KV STEPDOWN TRANSFORMER.
2. EXTENSION OF THIS CIRCUIT IS ASSUMED TO BE WITHIN THE CONSTRUCTION BUDGET OF THE AGRICULTURAL ENGINEERING BUILDING.

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 *(Not shown on this plan)*
1.10	Extend piping from West Plant to Agricultural Engineering Building
1.15	Extend piping from Agricultural Engineering Building to Chemistry Building *(Not shown on this pl*
1.20	17th Street piping project to connect East Plant and West Plant loops *(Not shown on this plan)*
1.25	Extend Piping to Student Health and Counseling Center *(Not shown on this plan)*
1.30	Construct Communications and East Plant Expansion and Bobby K. Marks Improvements
1.35	South campus piping project #1 *(Not shown on this plan)*
1.40	South campus piping project #2 *(Not shown on this plan)*
1.45	Relocate West Plant heating water system to Thomason Hall *(Not shown on this plan)*
1.50	Manhole #1 Circuit Segregation
2.00	17th Street east piping project *(Not shown on this plan)*
2.05	North Residence Hall piping *(Not shown on this plan)*
2.10	Redundant electrical feed to HKC and Coliseum
2.15	Migrate existing buildings from overhead electrical to buried
3.00	Indoor Multi-Purpose Facility piping and electrical

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AUSTIN, TEXAS 78730-2314 USA
512.744.4400 MAIN - 512.744.4444 FAX
FIRM REGISTRATION # F-2497
WWW.EEACE.COM - EEA PROJECT # 20120049

TITLE:
PROPOSED ELECTRICAL CIRCUITS

EEA PROJ: 20120049
DRAWN BY: MG
CHECKED BY: TS
DATE: 1-22-13

SHEET:
E2.0

Appendix B – Campus Hydraulic Models

- Chilled Water System – East Plant Calibration Model
- Chilled Water System – 2012 Diversified Flow Model
- Chilled Water System – 2012 Non-Diversified Flow Model
- Heating Water System – 2012 Diversified Flow Model
- Heating Water System – 2012 Non-Diversified Flow Model
- Chilled Water System – Phase 1 Model
- Chilled Water System – Phase 2 Model
- Chilled Water System – Phase 3 Model
- Chilled Water System – Phase 3 Model – South Bobby K. Marks Piping Break
- Chilled Water System – Phase 3 Model – North Bobby K. Marks Piping Break
- Heating Water System – Phase 3 Model

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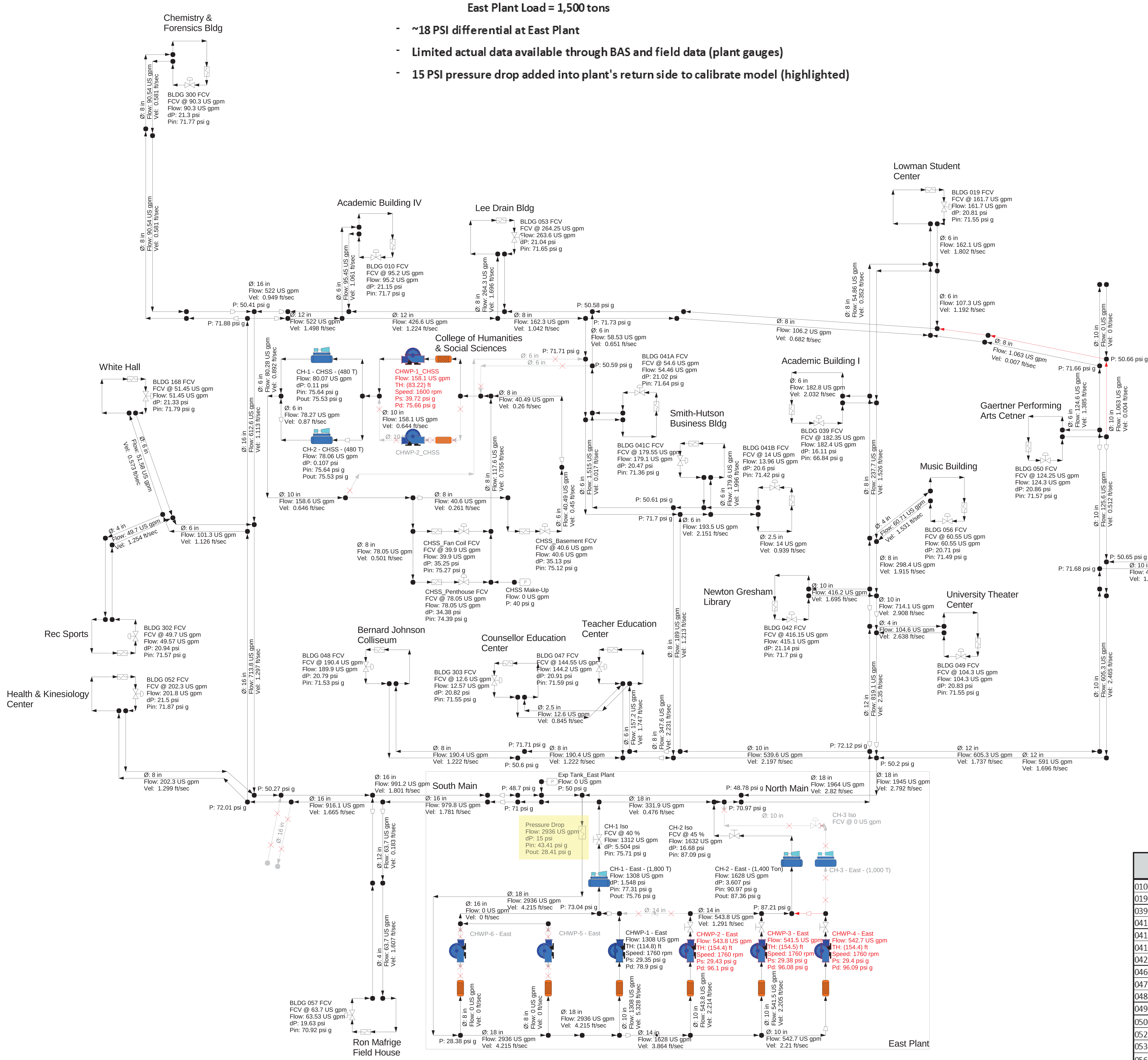
Chilled Water System - East Plant Calibration Model

- Model used to reconcile simulation with actual data of 9/11/12, 2pm
  - East Plant Load = 1,500 tons
- ~18 PSI differential at East Plant
- Limited actual data available through BAS and field data (plant gauges)
- 15 PSI pressure drop added into plant's return side to calibrate model (highlighted)



Building	Design Load (Tons)	Design Flow (gpm)	Design dT (F)	Diversity: 30% Load (Tons)	Diversity: 30% Flow (gpm)	Diversity: 30% dT (F)
010 - Academic Building IV	255	306	20	75	95	19
019 - Lowman Student Center	390	520	18	115	162	17
039 - Academic Building I	266	587	11	78	182	10
041 - Smith Hudson - New Auditorium	38	45	20	11	14	19
041 - Smith Hudson - New Building	147	176	20	43	54	19
041 - Smith Hudson - Old Building	240	577	10	71	180	9
042 - Newton Gresham Library	558	1,338	10	165	416	9
046 - Criminal Justice Center	536	1,400	9	158	435	9
047 - Teacher Education Center	233	465	12	68	144	11
048 - Bernard Johnson Coliseum	306	612	12	90	190	11
049 - University Theater Center	168	335	12	49	104	11
050 - Gaertner Performing Arts Center	233	400	14	68	123	13
052 - Health & Kinesiology Center	379	650	14	112	202	13
053 - Lee Drain Building	354	850	10	104	264	9
056 - Music Building	114	195	14	34	61	13
057 - Ron Mafridge Field House	120	205	14	35	64	13
168 - White Hall	69	165	10	21	52	9
242 - Lemit Building	127	138	22	38	43	21
300 - Chemistry & Forensic Science	310	290	26	91	90	24
302 - Recreational Sports	107	160	16	32	50	15
303 - Counselor Education Center	28	40	17	9	13	16
	4,977	**9,454**	**-**	**1,500**	**3,000**	**12**

9-11-12, 2PM, BAS DATA

	Flow	CHWR-T	CHWS-T	dT	Tons	CHWR-P	CHWS-P	dP	Status
CH-1	ND	ND	ND	ND	ND	ND	ND	9.6	ON
CH-2	ND	ND	ND	ND	ND	ND	ND	7	ON
CH-3	ND	ND	ND	ND	ND	ND	ND	1.6	OFF
North Main	1051	51.1	40.4	10.7	469	50.5	67.4	16.9	-
South Main	1014	53.9	41.7	12.2	515	53.1	69.8	16.7	-
CHWP-1	ND	ND	ND	ND	ND	ND	ND	ND	ON
CHWP-2	ND	ND	ND	ND	ND	ND	ND	ND	OFF
CHWP-3	ND	ND	ND	ND	ND	ND	ND	ND	OFF
CHWP-4	ND	ND	ND	ND	ND	ND	ND	ND	OFF
CHWP-5	ND	ND	ND	ND	ND	ND	ND	ND	ON
CHWP-6	ND	ND	ND	ND	ND	ND	ND	ND	OFF

9-11-12, 2PM, FIELD DATA

	Flow	CHWR-T	CHWS-T	dT	Tons	CHWR-P	CHWS-P	dP	Status
CH-1	ND	51.9	42	9.9	ND	78	69	9	ON
CH-2	ND	51.2	42.3	8.9	ND	84	68	16	ON
CH-3	-	-	-	-	-	-	-	-	OFF
North Main	1550	51.1	40.4	10.7	691	46	64	18	-
South Main	1550	53.9	41.7	12.2	788	49	64	15	-
CHWP-1	ND	-	-	-	-	45	ND	ND	ON
CHWP-2	ND	-	-	-	-	ND	ND	ND	ON
CHWP-3	ND	-	-	-	-	ND	92	ND	ON
CHWP-4	ND	-	-	-	-	30	ND	ND	ON
CHWP-5	ND	-	-	-	-	ND	ND	ND	OFF
CHWP-6	ND	-	-	-	-	ND	ND	ND	OFF

Building	CHWS (F)	CHWS (psi)	CHWR (F)	CHWR (psi)	dT (F)	Flow (gpm)	Calc. Tons	CHWP-1 Status	CHWP-1 VFD	CHWP-2 Status	CHWP-2 VFD
010 - Academic Building IV	43.2	ND	51.9	ND	8.7	ND	ND	ON	ND	off	-
019 - Lowman Student Center	43.1	ND	56.2	ND	13.1	ND	ND	ON	ND	off	-
039 - Academic Building I	42.8	ND	56.9	ND	14.1	ND	ND	-	-	-	-
041 - Smith Hudson - New Auditorium	-	-	-	-	-	-	-	-	-	-	-
041 - Smith Hudson - New Building	43.6	ND	60.3	ND	16.7	122.0	85	ON	29	-	-
041 - Smith Hudson - Old Building	44.3	ND	56.6	ND	12.3	ND	ND	ON	20	-	-
042 - Newton Gresham Library	51.5	37.8	57.7	17.6	6.2	ND	ND	ON	36	-	-
046 - Criminal Justice Center	ND	ND	ND	ND	ND	ND	ND	ON	60	-	-
047 - Teacher Education Center	41.7	ND	56.2	ND	14.5	ND	ND	ON	20	-	-
048 - Bernard Johnson Coliseum	41.7	ND	44.7	ND	3.0	ND	ND	-	-	-	-
049 - University Theater Center	42.9	ND	51.6	ND	8.7	ND	ND	ON	20	-	-
050 - Gaertner Performing Arts Center	42.9	55.5	62.1	36.8	19.2	213.0	170	OFF	20	OFF	58
052 - Health & Kinesiology Center	41.5	ND	50.4	ND	8.9	ND	ND	ON	ND	-	-
053 - Lee Drain Building	42.8	ND	52.7	ND	9.9	ND	ND	OFF	20	-	-
056 - Music Building	75.6	ND	50.8	ND	-24.8	ND	ND	ON	60	OFF	60
057 - Ron Mafridge Field House	ND	ND	ND	ND	ND	ND	ND	ON	ND	-	-
168 - White Hall	ND	ND	ND	ND	ND	ND	ND	-	-	-	-
242 - Lemit Building	ND	21.3	54.9	56.4	ND	68.0	ND	ON	60	-	-
300 - Chemistry & Forensic Science	-	-	-	-	-	-	-	-	-	-	-
302 - Recreational Sports	41.5	ND	50.4	ND	8.9	ND	ND	ON	ND	OFF	-
303 - Counselor Education Center	57.4	32.9	58.4	29.9	1.0	0.0	0	ON	60	-	-

- Not applicable
ND No data available
Questionable data

Lineup: 9-11-12 Calibration | Darcy-Weisbach | PIPE-FLO 2009
System: SHSU CHW MODEL
Date: 10/29/12 10:06 am
Company: EEA
Project: SHSU
by: MM
Flow: US gpm; Pressure: psi g; Size: in; Elevation: ft; Velocity: ft/sec; Length: ft; Volume: gallons

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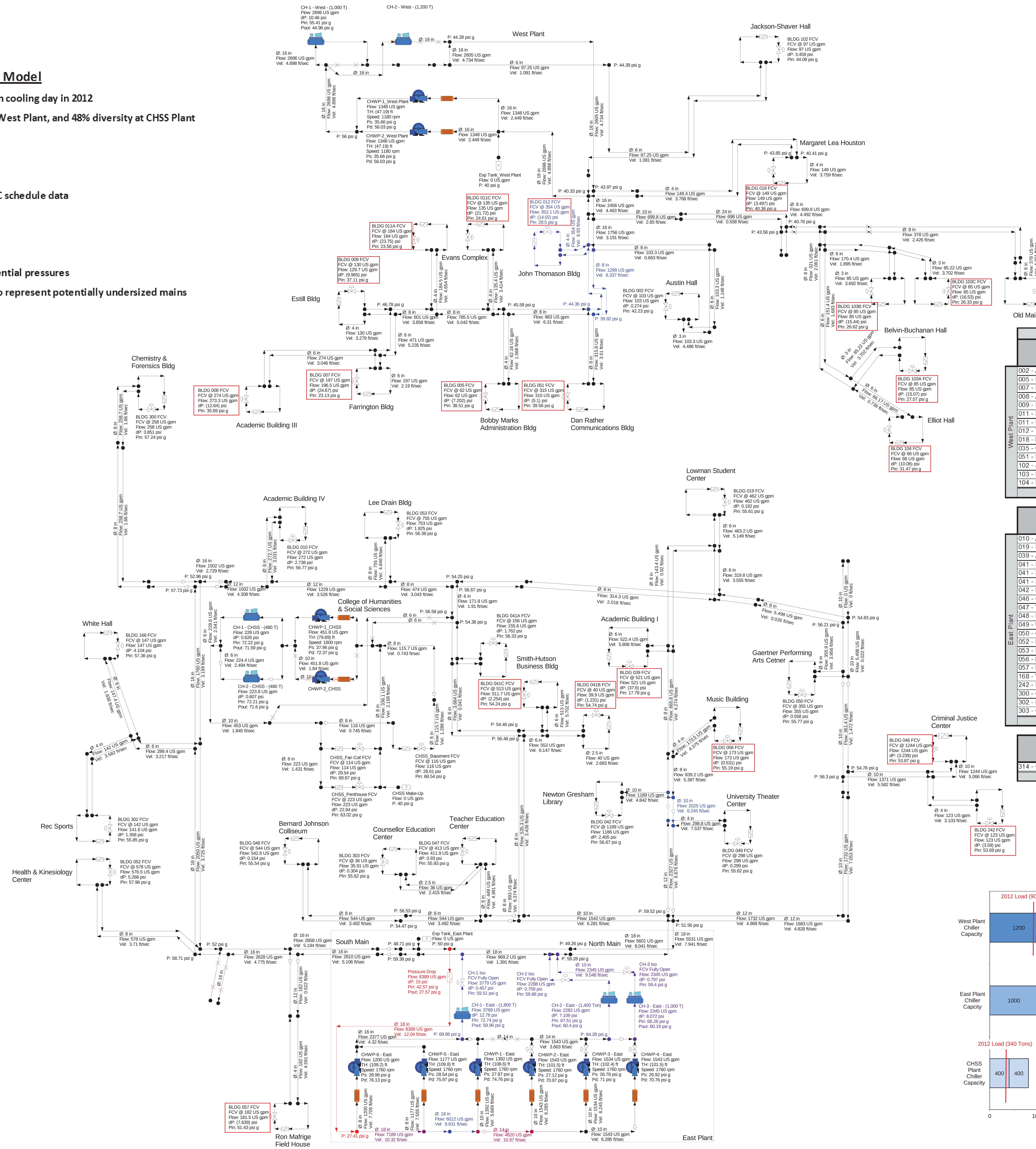
Chilled Water System - 2012 Diversified Flow Model

- Model represents predicted loop conditions on design cooling day in 2012
- Based on 84% diversity at East Plant, 47% diversity at West Plant, and 48% diversity at CHSS Plant
  - East Plant Load = 4,200 tons
  - West Plant Load = 900 tons
  - CHSS Plant Load = 340 tons
- Building loads and dT based on existing building HVAC schedule data
- Constant volume pumping in East and West Plants
- 11 PSI differential pressure at East Plant
- 4 PSI differential pressure at West Plant
- Multiple buildings have negative control valve differential pressures
- Pipes with fluid velocities over 8 ft/s shown in color to represent potentially undersized mains



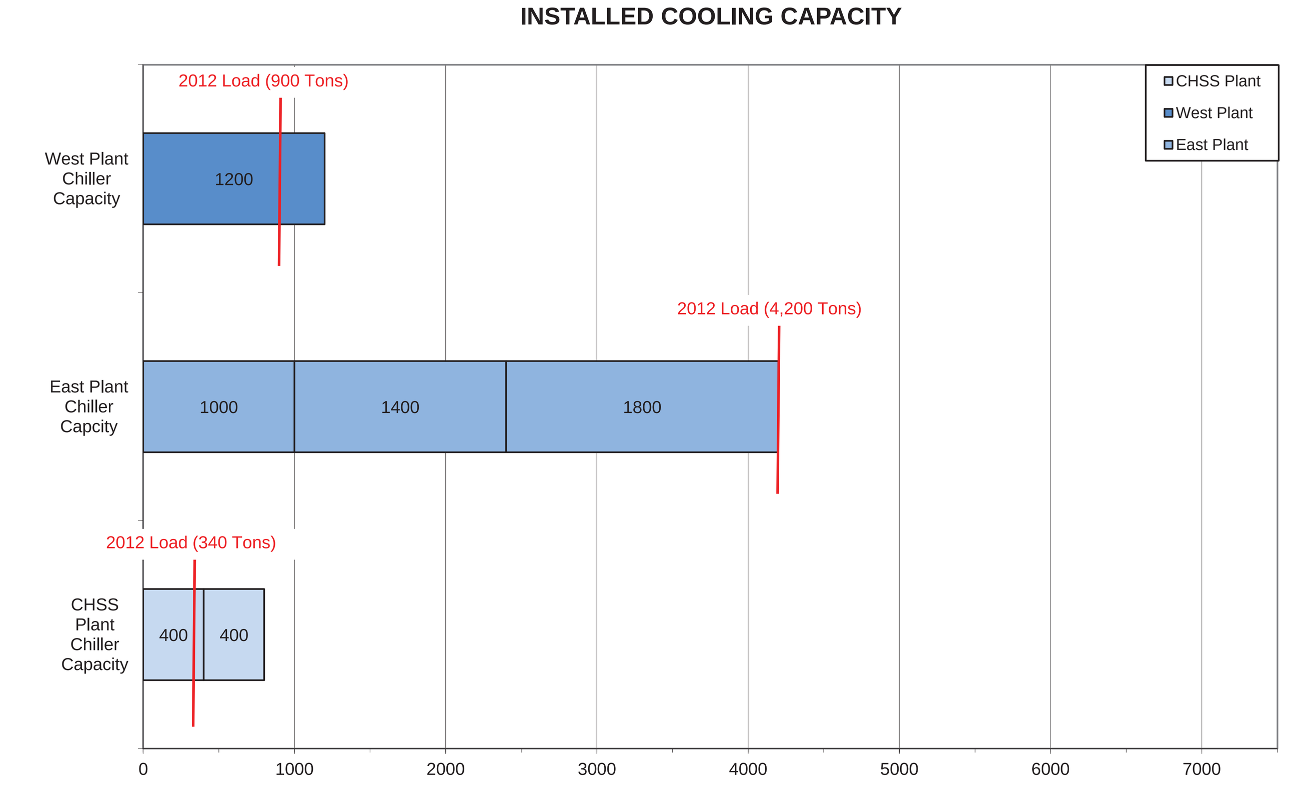
Sam Houston State University - Chilled Water System

	Building	Design Load (Tons)	Design Flow (gpm)	Design dT (F)	Diversity: 47% Load (Tons)	Diversity: 47% Flow (gpm)	Diversity: 47% dT (F)
West Plant	002 - Austin Hall	63	150	10	29	103	7
	005 - Bobby Marks Admin. Bldg.	90	90	24	42	62	16
	007 - Farrington Building	192	288	16	90	197	11
	008 - Academic Building III	167	400	10	79	274	7
	009 - Estill Building	127	190	16	60	130	11
	011 - Evans Complex - Building A	112	268	10	53	184	7
	011 - Evans Complex - Building C	82	197	10	39	135	7
	012 - Thomason Building	172	516	8	81	354	6
	018 - Margaret Lea Houston	90	217	10	43	149	7
	035 - Old Main Market	295	550	13	139	377	9
	051 - Dan Rather Communications	192	460	10	90	315	7
	102 - Jackson-Shaver Hall	71	142	12	33	97	8
	103 - Belvin-Buchanan Hall	186	372	12	88	255	8
	104 - Elliott Hall	72	96	18	34	66	12
	West Plant Total	**1,910**	**3,936**	**12**	**900**	**2,700**	**8**

	Building	Design Load (Tons)	Design Flow (gpm)	Design dT (F)	Diversity: 84% Load (Tons)	Diversity: 84% Flow (gpm)	Diversity: 84% dT (F)
East Plant	010 - Academic Building IV	255	306	20	215	272	19
	019 - Lowman Student Center	390	520	18	329	462	17
	039 - Academic Building I	266	587	11	225	521	10
	041 - Smith Hudson - New Auditorium	38	45	20	32	40	19
	041 - Smith Hudson - New Building	147	176	20	124	156	19
	041 - Smith Hudson - Old Building	240	577	10	203	513	9
	042 - Newton Gresham Library	558	1,338	10	471	1189	9
	046 - Criminal Justice Center	536	1,400	9	452	1244	9
	047 - Teacher Education Center	233	465	12	196	413	11
	048 - Bernard Johnson Coliseum	306	612	12	258	544	11
	049 - University Theater Center	168	335	12	141	298	11
	050 - Gaertner Performing Arts Center	233	400	14	197	355	13
	052 - Health & Kinesiology Center	379	650	14	320	578	13
	053 - Lee Drain Building	354	850	10	299	755	9
	056 - Music Building	114	195	14	96	173	13
	057 - Ron Mafridge Field House	120	205	14	101	182	13
	168 - White Hall	69	165	10	58	147	9
	242 - Lemit Building	127	138	22	108	123	21
	300 - Chemistry & Forensic Science	310	290	26	262	258	24
	302 - Recreational Sports	107	160	16	90	142	15
	303 - Counselor Education Center	28	40	17	24	36	16
	East Plant Total	**4,977**	**9,454**	**13**	**4,200**	**8,400**	**12**

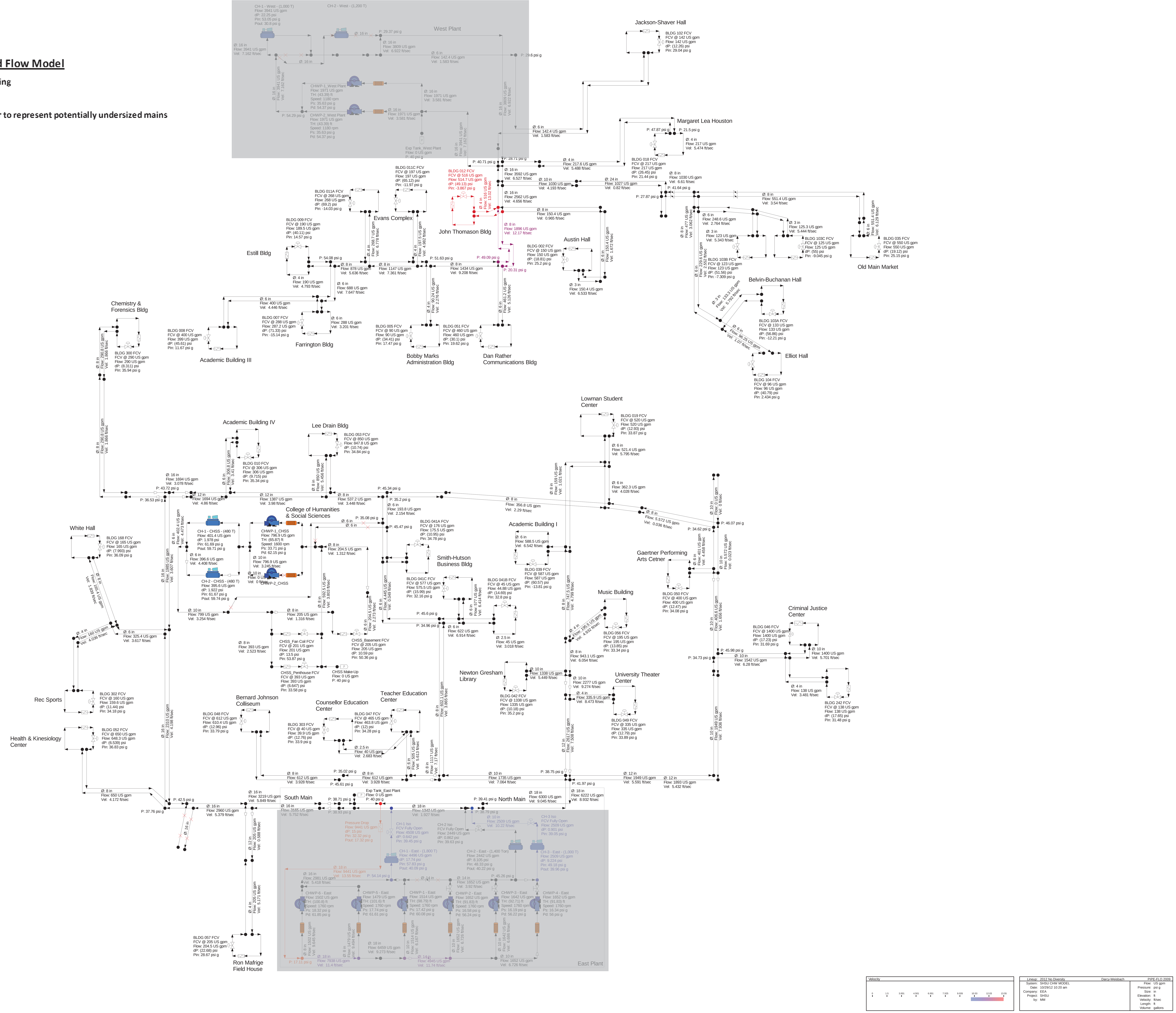
Building	No Diversity Load (Tons)	No Diversity Flow (gpm)	No Diversity dT (F)	Diversity: 48% Load (Tons)	Diversity: 48% Flow (gpm)	Diversity: 48% dT (F)
314 - CHSS	710	799	21	340	453	18
CHSS Plant Total	**710**	**799**	**21**	**340**	**453**	**18**

INSTALLED COOLING CAPACITY



Chilled Water System - 2012 Non-Diversified Flow Model

- Model generated with peak flowrates for each building
- Focus is on building branch piping
- Pipes with fluid velocities over 10 ft/s shown in color to represent potentially undersized mains



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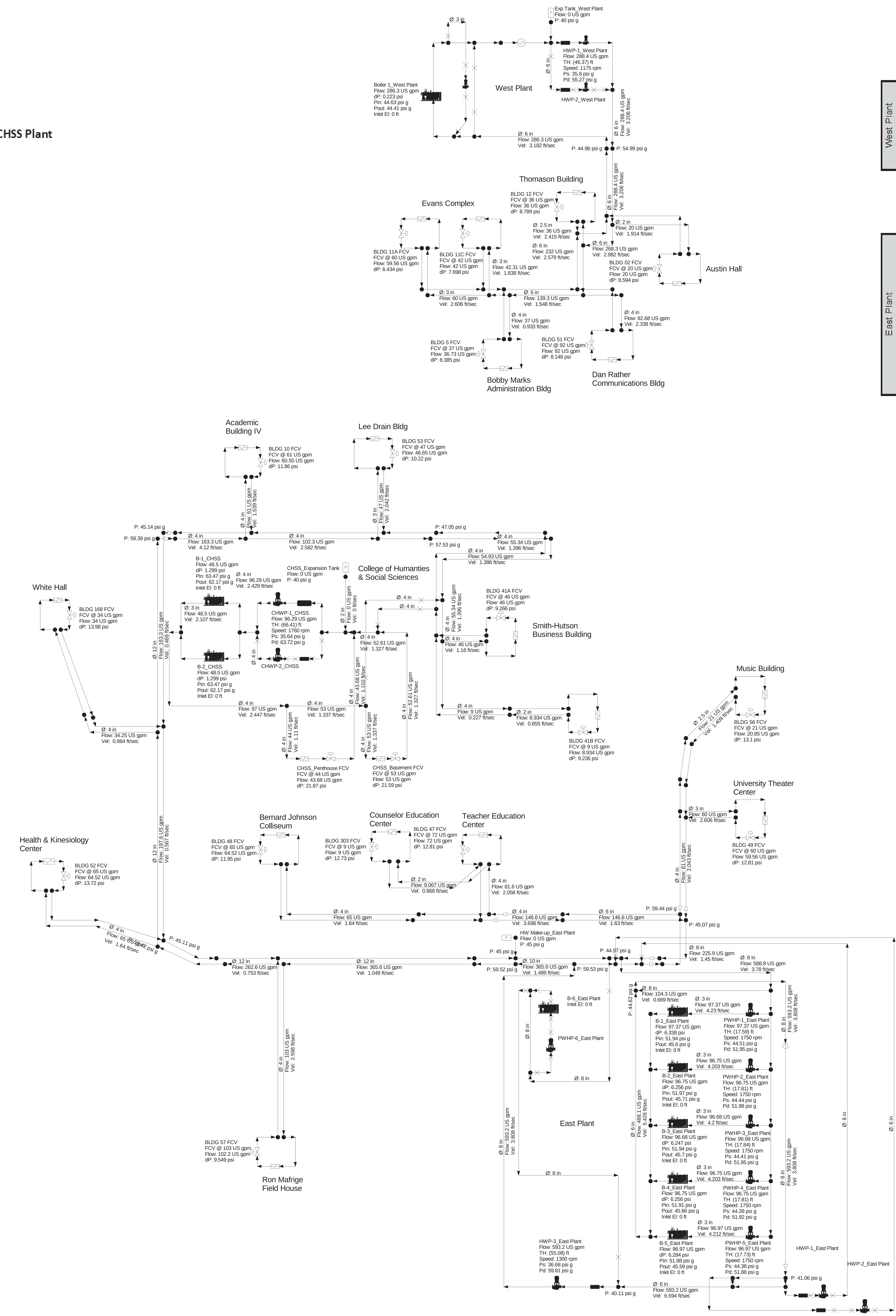
Heating Water System - 2012 Diversified Flow Model

- Model represents predicted loop conditions on design heating day in 2012
- Based on 30% diversity at East Plant, 50% diversity at West Plant, and 50% diversity at CHSS Plant
  - East Plant Load = 8,348 MBh
  - West Plant Load = 2,880 MBh
  - CHSS Plant Load = 1,326 MBh
- Building loads and dT based on existing building HVAC schedule data
- Variable volume pumping in East and West Plants
- No pipes with fluid velocities over 7 ft/sec



Sam Houston State University - Heating Water System

	Building	Design Load MBh	Design Flow (gpm)	Design dT (F)	Diversity: 50% Load MBh	Diversity: 50% Flow (gpm)	Diversity: 50% dT (F)
West Plant	002 - Austin Hall	350	35	20	175	20	18
	005 - Bobby Marks Admin. Bldg.	1,320	66	40	660	37	35
	011 - Evans Complex - Building A	1,070	107	20	535	60	18
	011 - Evans Complex - Building C	750	75	20	375	42	18
	012 - Thomason Building	640	64	20	320	36	18
	051 - Dan Rather Communications	1,630	163	20	815	92	18
	West Plant Total	**5,760**	**510**	**23**	**2,880**	**288**	**19**

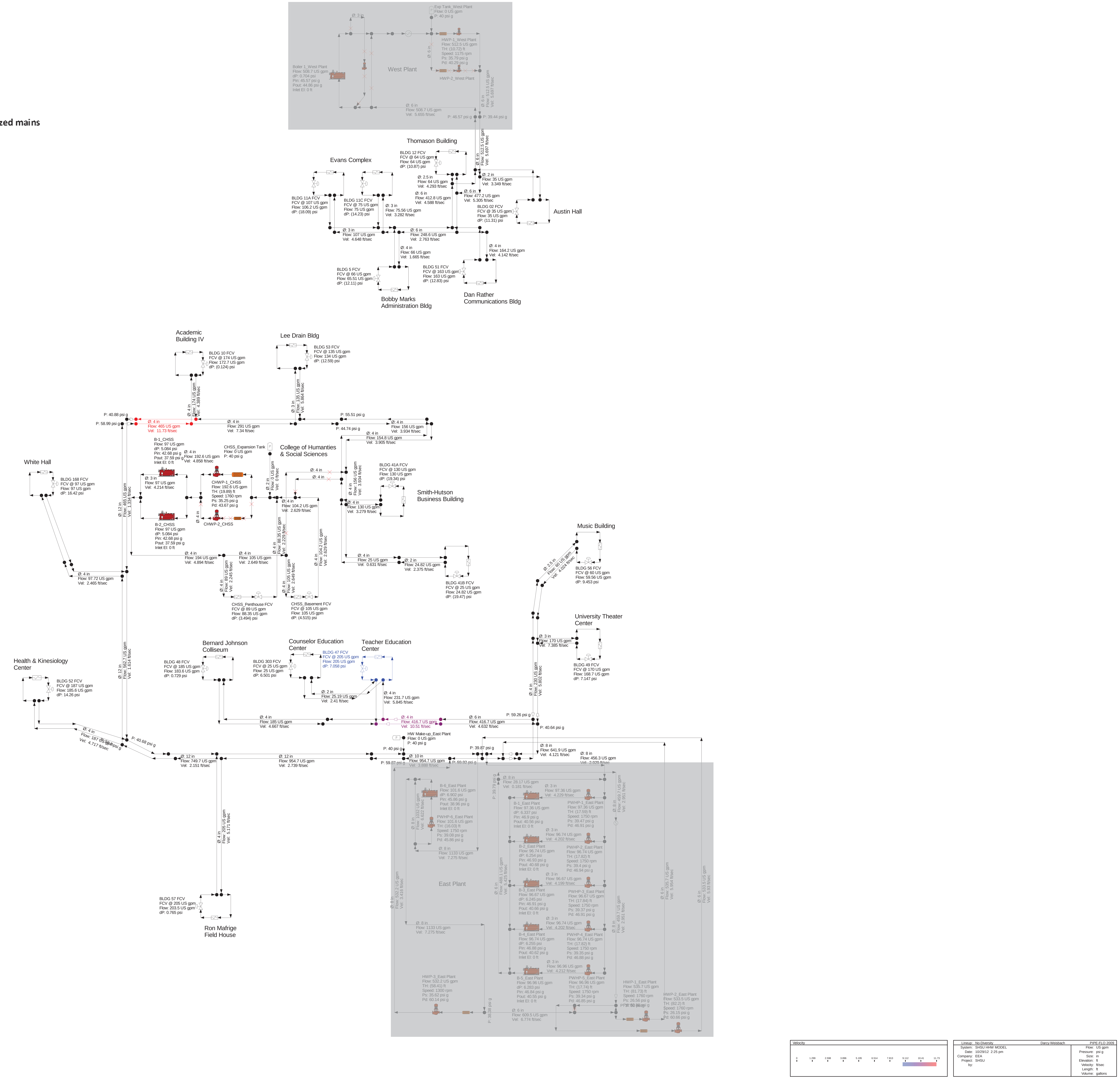
	Building	Design Load MBh	Design Flow (gpm)	Design dT (F)	Diversity: 30% Load MBh	Diversity: 30% Flow (gpm)	Diversity: 30% dT (F)
East Plant	010 - Academic Building IV	3,480	174	40	1,044	52	40
	041 - Smith Hudson - New Auditorium	500	25	40	150	8	40
	041 - Smith Hudson - New Building	2,210	130	34	663	39	34
	047 - Teacher Education Center	2,050	205	20	615	62	20
	048 - Bernard Johnson Coliseum	6,040	302	40	1,812	91	40
	049 - University Theater Center	1,700	170	20	510	51	20
	052 - Health & Kinesiology Center	3,553	187	38	1,066	56	38
	053 - Lee Drain Building	2,205	147	30	662	44	30
	056 - Music Building	900	60	30	270	18	30
	057 - Ron Mafridge Field House	3,895	205	38	1,169	62	38
	168 - White Hall	970	97	20	291	29	20
	303 - Counselor Education Center	325	25	26	98	8	26
	East Plant Total	**27,828**	**1,727**	**32**	**8,348**	**518**	**32**

Building	Design Load MBh	Design Flow (gpm)	Design dT (F)	Diversity: 50% Load MBh	Diversity: 50% Flow (gpm)	Diversity: 50% dT (F)
314 - CHSS	2,652	194	27	1,326	98	27
CHSS Plant Total	**2,652**	**194**	**27**	**1,326**	**98**	**27**

EEA CONSULTING ENGINEERS

Heating Water System - 2012 Non-Diversified Flow Model

- Model generated with peak flowrates for each building
- Focus is on building branch piping
- Pipes with fluid velocities over 8 ft/s shown in color to represent potentially undersized mains



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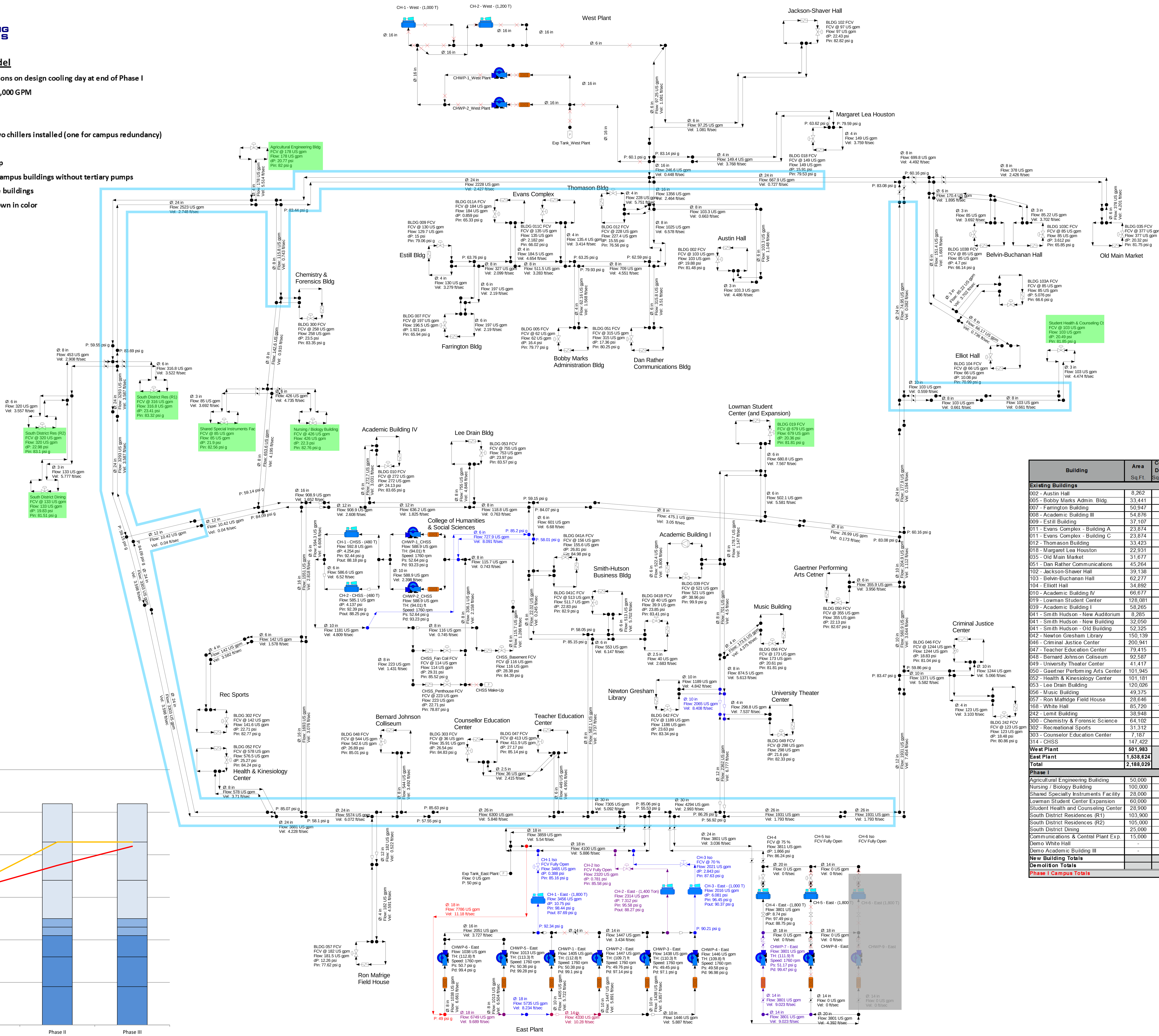
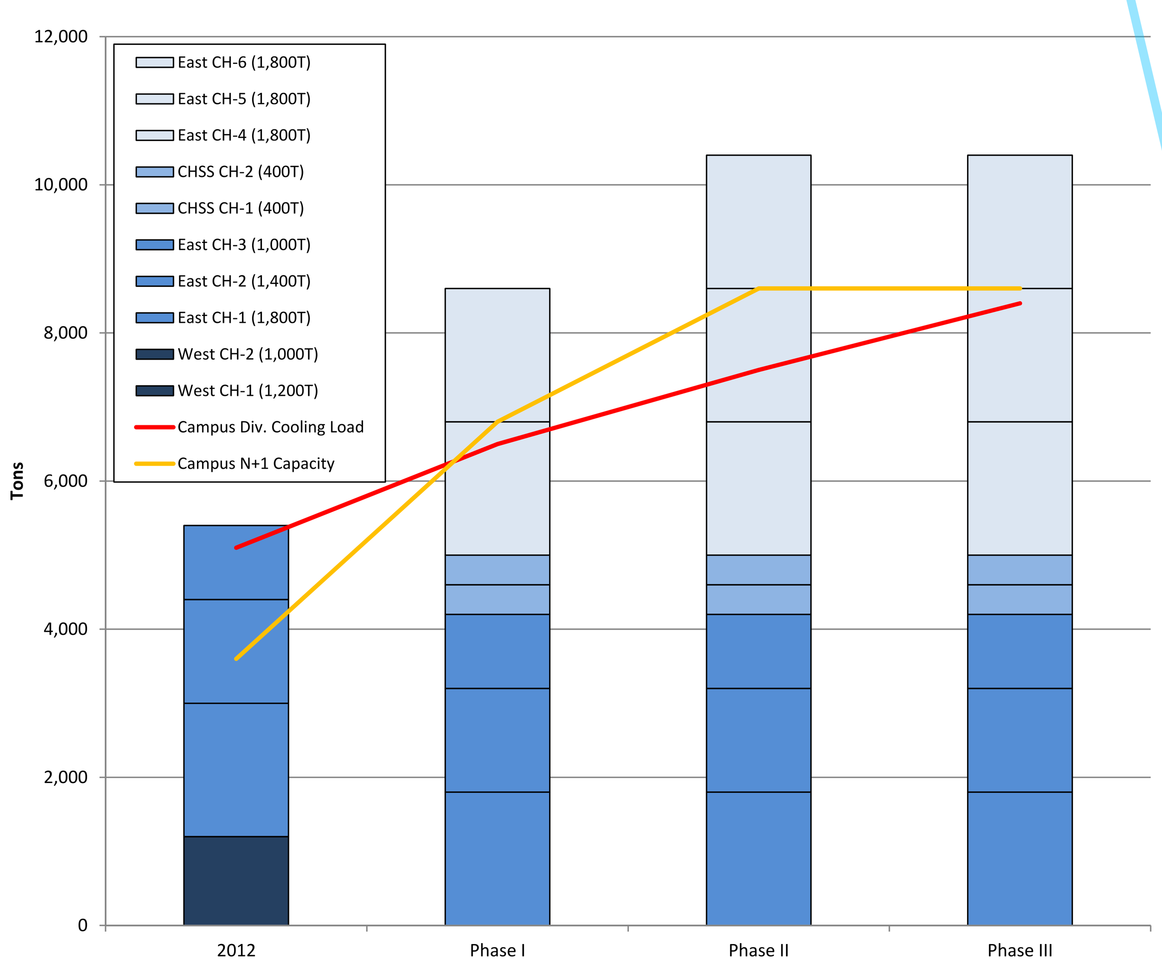
Chilled Water System - Phase I Model

- Model represents predicted loop conditions on design cooling day at end of Phase I
- 6,500 ton total campus load / 12°F dT / 13,000 GPM
- New buildings are highlighted in green
- Piping projects highlighted in blue
- East Plant Expansion constructed with two chillers installed (one for campus redundancy)
- West Plant no longer in use
- CHSS chillers integrated into campus loop
- Some flow issues still apparent at west campus buildings without tertiary pumps
  Teriary pumps may be required for these buildings
- Pipes with fluid velocities over 8 ft/s shown in color





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								
002 - Austin Hall	8,262	130	63	150	10	47%	29	103
005 - Bobby Marks Admin. Bldg.	33,441	370	90	90	24	47%	42	62
007 - Farrington Building	50,947	270	192	288	16	47%	90	197
008 - Academic Building III	54,876	330	167	400	10	47%	79	274
009 - Estill Building	37,107	290	127	190	16	47%	60	130
011 - Evans Complex - Building A	23,874	210	112	268	10	47%	53	184
011 - Evans Complex - Building C	23,874	290	82	197	10	47%	39	135
012 - Thomason Building	33,423	190	172	516	8	47%	81	354
018 - Margaret Lea Houston	22,931	250	90	217	10	47%	43	149
035 - Old Main Market	31,677	110	295	550	13	47%	139	377
051 - Dan Rather Communications	45,264	240	192	460	10	47%	90	315
102 - Jackson-Shaver Hall	39,138	550	71	142	12	47%	33	97
103 - Belvin-Buchanan Hall	62,277	330	186	372	12	47%	88	255
104 - Elliott Hall	34,892	480	72	96	18	47%	34	66
010 - Academic Building IV	66,677	260	255	306	20	84%	215	272
019 - Lowman Student Center	128,081	330	390	520	18	84%	329	462
039 - Academic Building I	58,265	220	266	587	11	84%	225	521
041 - Smith Hudson - New Auditorium	8,285	220	38	45	20	84%	32	40
041 - Smith Hudson - New Building	32,050	220	147	176	20	84%	124	156
041 - Smith Hudson - Old Building	52,325	220	240	577	10	84%	203	513
042 - Newton Gresham Library	150,139	270	558	1,338	10	84%	471	1189
046 - Criminal Justice Center	200,941	380	536	1,400	9	84%	452	1244
047 - Teacher Education Center	79,415	340	233	465	12	84%	196	413
048 - Bernard Johnson Coliseum	92,587	300	306	612	12	84%	258	544
049 - University Theater Center	41,417	250	168	335	12	84%	141	298
050 - Gaertner Performing Arts Center	101,945	440	233	400	14	84%	197	355
052 - Health & Kinesiology Center	101,181	270	379	650	14	84%	320	578
053 - Lee Drain Building	120,026	340	354	850	10	84%	299	755
056 - Music Building	49,375	430	114	195	14	84%	96	173
057 - Ron Mafridge Field House	28,646	240	120	205	14	84%	101	182
168 - White Hall	85,720	1,250	69	165	10	84%	58	147
242 - Lemit Building	38,948	310	127	138	22	84%	108	123
300 - Chemistry & Forensic Science	64,102	210	310	290	26	84%	262	258
302 - Recreational Sports	31,312	290	107	160	16	84%	90	142
303 - Counselor Education Center	7,187	260	28	40	17	84%	24	36
314 - CHSS	147,422	210	710	799	21	48%	340	453
West Plant	**501,983**		**1,900**	**3,900**		**47%**	**900**	**2,700**
East Plant	**1,538,624**		**5,000**	**9,500**		**84%**	**4,200**	**8,400**
Total	**2,188,029**		**7,600**	**14,200**		**71%**	**5,400**	**11,600**
Phase I								
Agricultural Engineering Builiding	50,000	300	167	250	16	71%	118	178
Nursing / Biology Building	100,000	250	400	600	16	71%	284	426
Shared Specialty Instruments Facility	28,000	350	80	120	16	71%	57	85
Lowman Student Center Expansion	60,000	300	200	300	16	71%	142	213
Student Health and Counseling Center	28,900	300	96	145	16	71%	68	103
South District Residences (R1)	103,900	350	297	445	16	71%	211	316
South District Residences (R2)	105,000	350	300	450	16	71%	213	320
South District Dining	25,000	200	125	188	16	71%	89	133
Communications & Central Plant Exp.	15,000	400	38	56	16	71%	27	40
Demo White Hall	-	-	-	-	-	-	-	-
Demo Academic Building III	-	-	-	-	-	-	-	-
New Building Totals			**1,700**	**2,600**			**1,200**	**1,800**
Demolition Totals			**235**	**565**			**137**	**421**
Phase I Campus Totals			**9,100**	**16,200**		**71%**	**6,500**	**13,000**

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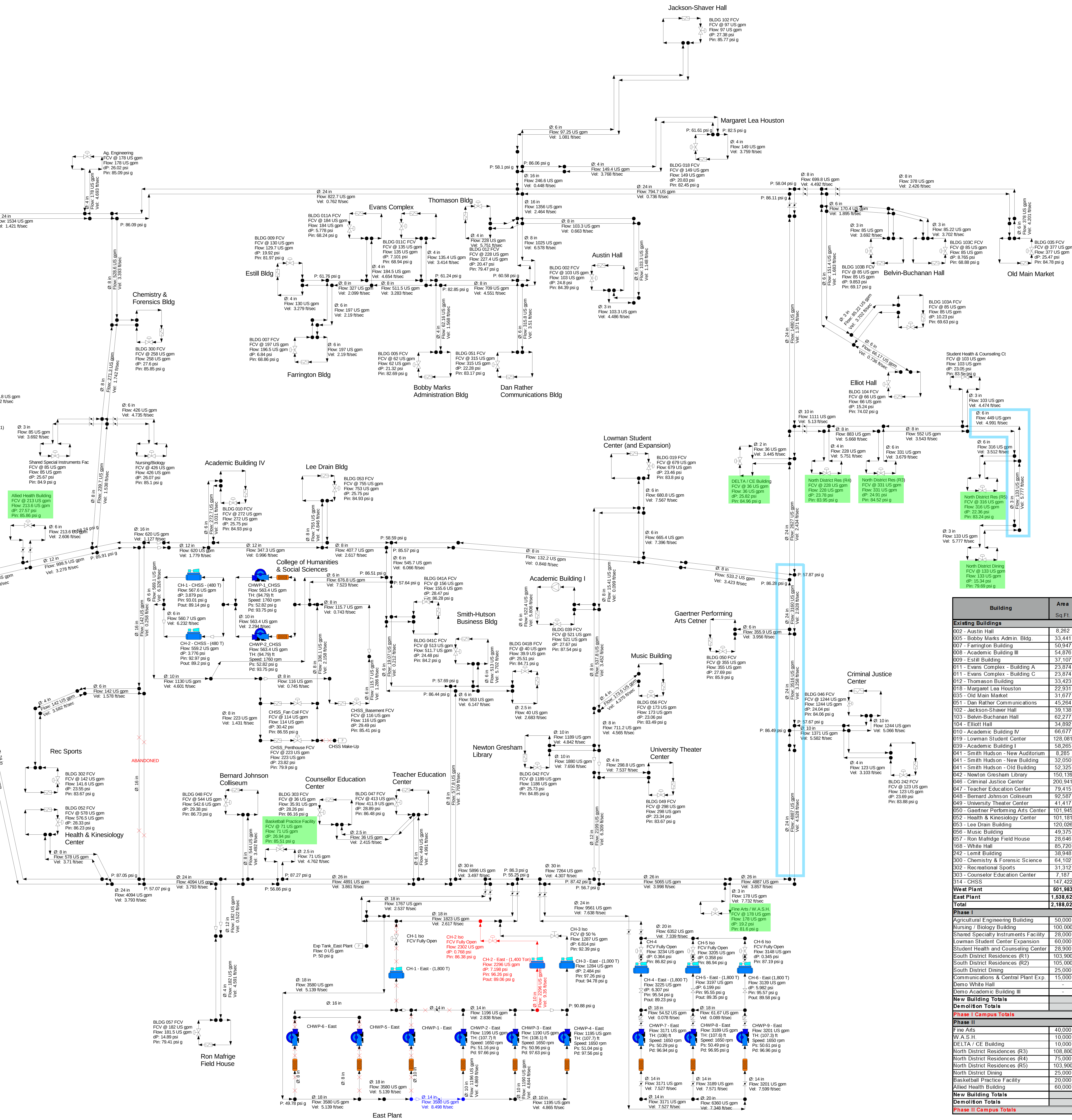
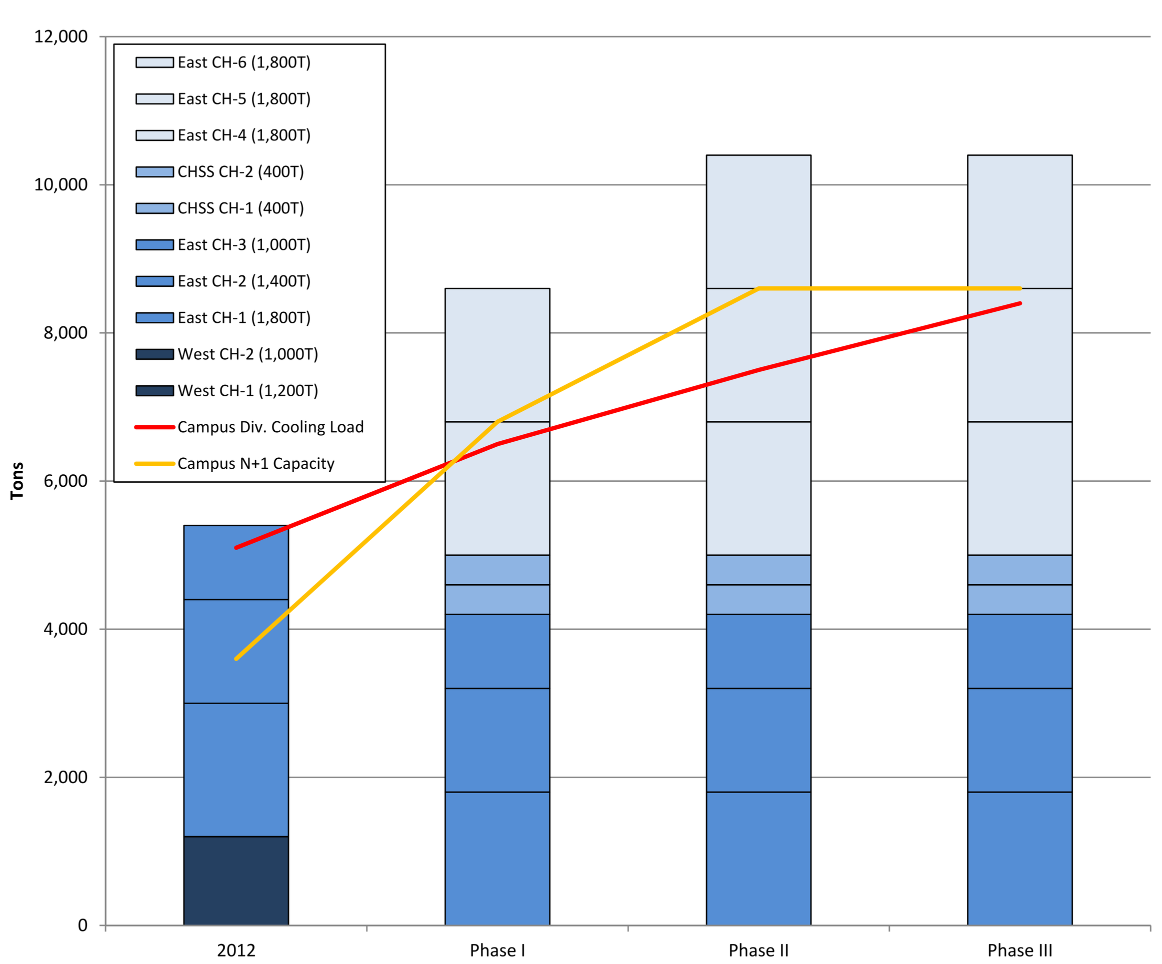
Chilled Water System - Phase 2 Model

- Model represents predicted loop conditions on design cooling day at end of Phase 2
- 7,500 ton total campus load / 12.4°F dT / 14,500 GPM
  All new campus buildings designed around 16°F
- New buildings are highlighted in green
- Piping projects highlighted in blue
- 3rd chiller set installed in East Plant Expansion
- East Plant chilled water pumps running at lower speed
- 31 PSI plant differential pressure
- Some west campus buildings may still need tertiary pumps for peak cooling
- Pipes with fluid velocities over 8 ft/s shown in color





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								
002 - Austin Hall	8,262	130	63	150	10	47%	29	103
005 - Bobby Marks Admin. Bldg.	33,441	370	90	90	24	47%	42	62
007 - Farrington Building	50,947	270	192	288	16	47%	90	197
008 - Academic Building III	54,876	330	167	400	10	47%	79	274
009 - Estill Building	37,107	290	127	190	16	47%	60	130
011 - Evans Complex - Building A	23,874	210	112	268	10	47%	53	184
011 - Evans Complex - Building C	23,874	290	82	197	10	47%	39	135
012 - Thomason Building	33,423	190	172	516	8	47%	81	354
018 - Margaret Lea Houston	22,931	250	90	217	10	47%	43	149
035 - Old Main Market	31,677	110	295	550	13	47%	139	377
051 - Dan Rather Communications	45,264	240	192	460	10	47%	90	315
102 - Jackson-Shaver Hall	39,138	550	71	142	12	47%	33	97
103 - Belvin-Buchanan Hall	62,277	330	186	372	12	47%	88	255
104 - Elliott Hall	34,892	480	72	96	18	47%	34	66
010 - Academic Building IV	66,677	260	255	306	20	84%	215	272
019 - Lowman Student Center	128,081	330	390	520	18	84%	329	462
039 - Academic Building I	58,265	220	266	587	11	84%	225	521
041 - Smith Hudson - New Auditorium	8,285	220	38	45	20	84%	32	40
041 - Smith Hudson - New Building	32,050	220	147	176	20	84%	124	156
041 - Smith Hudson - Old Building	52,325	220	240	577	10	84%	203	513
042 - Newton Gresham Library	150,139	270	558	1,338	10	84%	471	1189
046 - Criminal Justice Center	200,941	380	536	1,400	9	84%	452	1244
047 - Teacher Education Center	79,415	340	233	465	12	84%	196	413
048 - Bernard Johnson Coliseum	92,587	300	306	612	12	84%	258	544
049 - University Theater Center	41,417	250	168	335	12	84%	141	298
050 - Gaertner Performing Arts Center	101,945	440	233	400	14	84%	197	355
052 - Health & Kinesiology Center	101,181	270	379	650	14	84%	320	578
053 - Lee Drain Building	120,026	340	354	850	10	84%	299	755
056 - Music Building	49,375	430	114	195	14	84%	96	173
057 - Ron Mafridge Field House	28,646	240	120	205	14	84%	101	182
168 - White Hall	85,720	1,250	69	165	10	84%	58	147
242 - Lemit Building	38,948	310	127	138	22	84%	108	123
300 - Chemistry & Forensic Science	64,102	210	310	290	26	84%	262	258
302 - Recreational Sports	31,312	290	107	160	16	84%	90	142
303 - Counselor Education Center	7,187	260	28	40	17	84%	24	36
314 - CHSS	147,422	210	710	799	21	48%	340	453
West Plant	**501,983**		**1,900**	**3,900**		**47%**	**900**	**2,700**
East Plant	**1,538,624**		**5,000**	**9,500**		**84%**	**4,200**	**8,400**
Total	**2,188,029**		**7,600**	**14,200**		**71%**	**5,400**	**11,600**
Phase I								
Agricultural Engineering Builiding	50,000	300	167	250	16	71%	118	178
Nursing / Biology Building	100,000	250	400	600	16	71%	284	426
Shared Specialty Instruments Facility	28,000	350	80	120	16	71%	57	85
Lowman Student Center Expansion	60,000	300	200	300	16	71%	142	213
Student Health and Counseling Center	28,900	300	96	145	16	71%	68	103
South District Residences (R1)	103,900	350	297	445	16	71%	211	316
South District Residences (R2)	105,000	350	300	450	16	71%	213	320
South District Dining	25,000	200	125	188	16	71%	89	133
Communications & Central Plant Exp.	15,000	400	38	56	16	71%	27	40
Demo White Hall	-	-	-	-	-	-	-	-
Demo Academic Building III	-	-	-	-	-	-	-	-
New Building Totals			**1,700**	**2,600**			**1,200**	**1,800**
Demolition Totals			**235**	**565**			**137**	**421**
Phase I Campus Totals			**9,100**	**16,200**		**71%**	**6,500**	**13,000**
Phase II								
Fine Arts	40,000	300	133	200	16	71%	95	142
W.A.S.H.	10,000	300	33	50	16	71%	24	36
DELTA / CE Building	10,000	300	33	50	16	71%	24	36
North District Residences (R3)	108,800	350	311	466	16	71%	221	331
North District Residences (R4)	75,000	350	214	321	16	71%	152	228
North District Residences (R5)	103,900	350	297	445	16	71%	211	316
North District Dining	25,000	200	125	188	16	71%	89	133
Basketball Practice Facility	20,000	300	67	100	16	71%	47	71
Allied Health Building	60,000	300	200	300	16	71%	142	213
New Building Totals			**1,400**	**2,100**			**1,000**	**1,500**
Demolition Totals			**0**	**0**			**0**	**0**
Phase II Campus Totals			**10,500**	**18,300**		**71%**	**7,500**	**14,500**

Velocity
0 1.038 2.076 3.114 4.152 5.207 6.245 7.283 8.321 9.375

Lineup:	72% Diversity — Darcy-Weisbach — PIPE-FLO 2009
System:	SHSU CHW MODEL - Phase II
Date:	01/07/13 3:30 pm
Company:	EEA
Project:	SHSU
by:	MM

Flow: US gpm
Pressure: psi g
Size: in
Elevation: ft
Velocity: ft/sec
Length: ft
Volume: gallons

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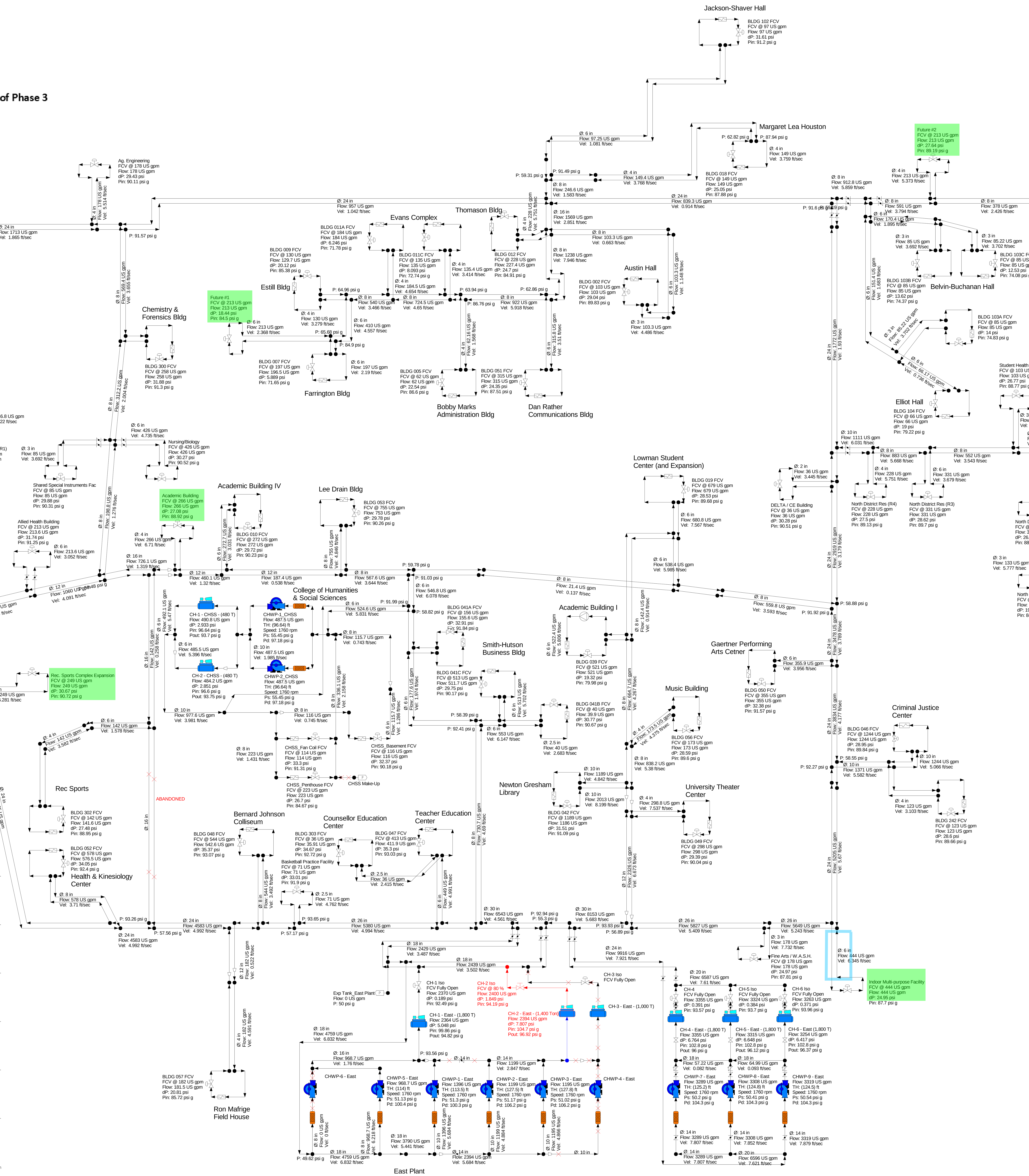
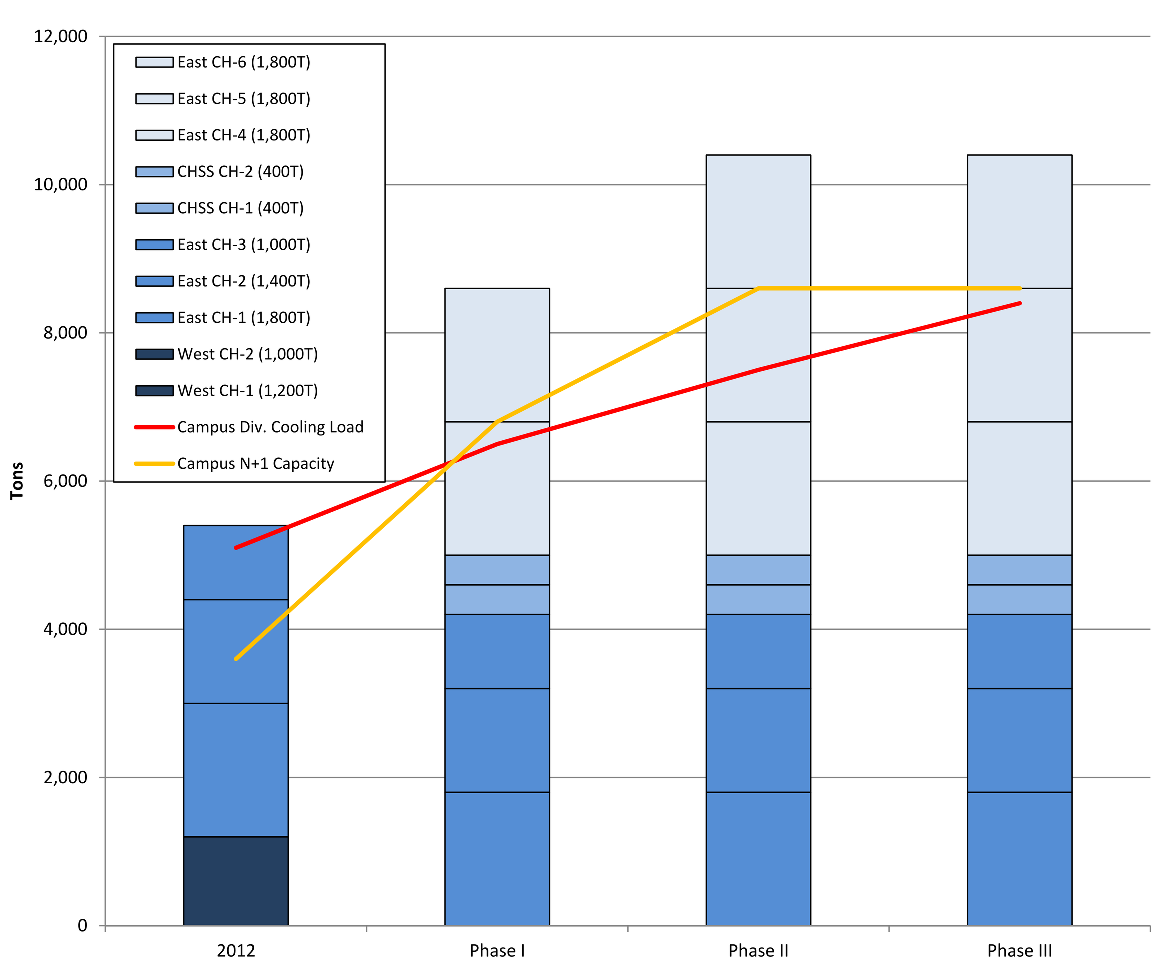
Chilled Water System - Phase 3 Model

- Model represents predicted loop conditions on design cooling day at end of Phase 3
- 8,400 ton total campus load / 12.7°F dT / 15,900 GPM
  All new campus buildings designed around 16°F
- New buildings are highlighted in green
- Piping projects highlighted in blue
- 3rd chiller set installed in East Plant Expansion
- East Plant chilled water pumps running at full speed
- 38 PSI plant differential pressure
- Some west campus buildings may still need tertiary pumps for peak cooling
- Campus differential temperature improvements recommended to reduce flow and campus pressure
- Pipes with fluid velocities over 8 ft/s shown in color





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								
002 - Austin Hall	8,262	130	63	150	10	47%	29	103
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007 - Farrington Building	50,947	270	192	288	16	47%	90	197
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009 - Estill Building	37,107	290	127	190	16	47%	60	130
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051 - Dan Rather Communications	45,264	240	192	460	10	47%	90	315
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103 - Belvin-Buchanan Hall	62,277	330	186	372	12	47%	88	255
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039 - Academic Building I	58,265	220	266	587	11	84%	225	521
041 - Smith Hudson - New Auditorium	8,285	220	38	45	20	84%	32	40
041 - Smith Hudson - New Building	32,050	220	147	176	20	84%	124	156
041 - Smith Hudson - Old Building	52,325	220	240	577	10	84%	203	513
042 - Newton Gresham Library	150,139	270	558	1,338	10	84%	471	1189
046 - Criminal Justice Center	200,941	380	536	1,400	9	84%	452	1244
047 - Teacher Education Center	79,415	340	233	465	12	84%	196	413
048 - Bernard Johnson Coliseum	92,587	300	306	612	12	84%	258	544
049 - University Theater Center	41,417	250	168	335	12	84%	141	298
050 - Gaertner Performing Arts Center	101,945	440	233	400	14	84%	197	355
052 - Health & Kinesiology Center	101,181	270	379	650	14	84%	320	578
053 - Lee Drain Building	120,026	340	354	850	10	84%	299	755
056 - Music Building	49,375	430	114	195	14	84%	96	173
057 - Ron Mafridge Field House	28,646	240	120	205	14	84%	101	182
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303 - Counselor Education Center	7,187	260	28	40	17	84%	24	36
314 - CHSS	147,422	210	710	799	21	48%	340	453
West Plant	**501,983**		**1,900**	**3,900**		**47%**	**900**	**2,700**
East Plant	**1,538,624**		**5,000**	**9,500**		**84%**	**4,200**	**8,400**
Total	**2,188,029**		**7,600**	**14,200**		**71%**	**5,400**	**11,600**
Phase I								
Agricultural Engineering Builiding	50,000	300	167	250	16	71%	118	178
Nursing / Biology Building	100,000	250	400	600	16	71%	284	426
Shared Specialty Instruments Facility	28,000	350	80	120	16	71%	57	85
Lowman Student Center Expansion	60,000	300	200	300	16	71%	142	213
Student Health and Counseling Center	28,900	300	96	145	16	71%	68	103
South District Residences (R1)	103,900	350	297	445	16	71%	211	316
South District Residences (R2)	105,000	350	300	450	16	71%	213	320
South District Dining	25,000	200	125	188	16	71%	89	133
Communications & Central Plant Exp.	15,000	400	38	56	16	71%	27	40
Demo White Hall	-	-	-	-	-	-	-	-
Demo Academic Building III	-	-	-	-	-	-	-	-
New Building Totals			**1,700**	**2,600**			**1,200**	**1,800**
Demolition Totals			**235**	**565**			**137**	**421**
Phase I Campus Totals			**9,100**	**16,200**		**71%**	**6,500**	**13,000**
Phase II								
Fine Arts	40,000	300	133	200	16	71%	95	142
W.A.S.H.	10,000	300	33	50	16	71%	24	36
DELTA / CE Building	10,000	300	33	50	16	71%	24	36
North District Residences (R3)	108,800	350	311	466	16	71%	221	331
North District Residences (R4)	75,000	350	214	321	16	71%	152	228
North District Residences (R5)	103,900	350	297	445	16	71%	211	316
North District Dining	25,000	200	125	188	16	71%	89	133
Basketball Practice Facility	20,000	300	67	100	16	71%	47	71
Allied Health Building	60,000	300	200	300	16	71%	142	213
New Building Totals			**1,400**	**2,100**			**1,000**	**1,500**
Demolition Totals			**0**	**0**			**0**	**0**
Phase II Campus Totals			**10,500**	**18,300**		**71%**	**7,500**	**14,500**
Phase III								
Indoor Multi-purpose Facility	125,000	300	417	625	16	71%	296	444
Academic Building	75,000	300	250	375	16	71%	178	266
Recreational Sports Complex Exp.	70,000	300	233	350	16	71%	166	249
Future #1	60,000	300	200	300	16	71%	142	213
Future #2	60,000	300	200	300	16	71%	142	213
New Building Totals			**1,300**	**2,000**			**900**	**1,400**
Demolition Totals			**0**	**0**			**0**	**0**
Phase III Campus Totals			**11,800**	**20,300**		**71%**	**8,400**	**15,900**

Velocity

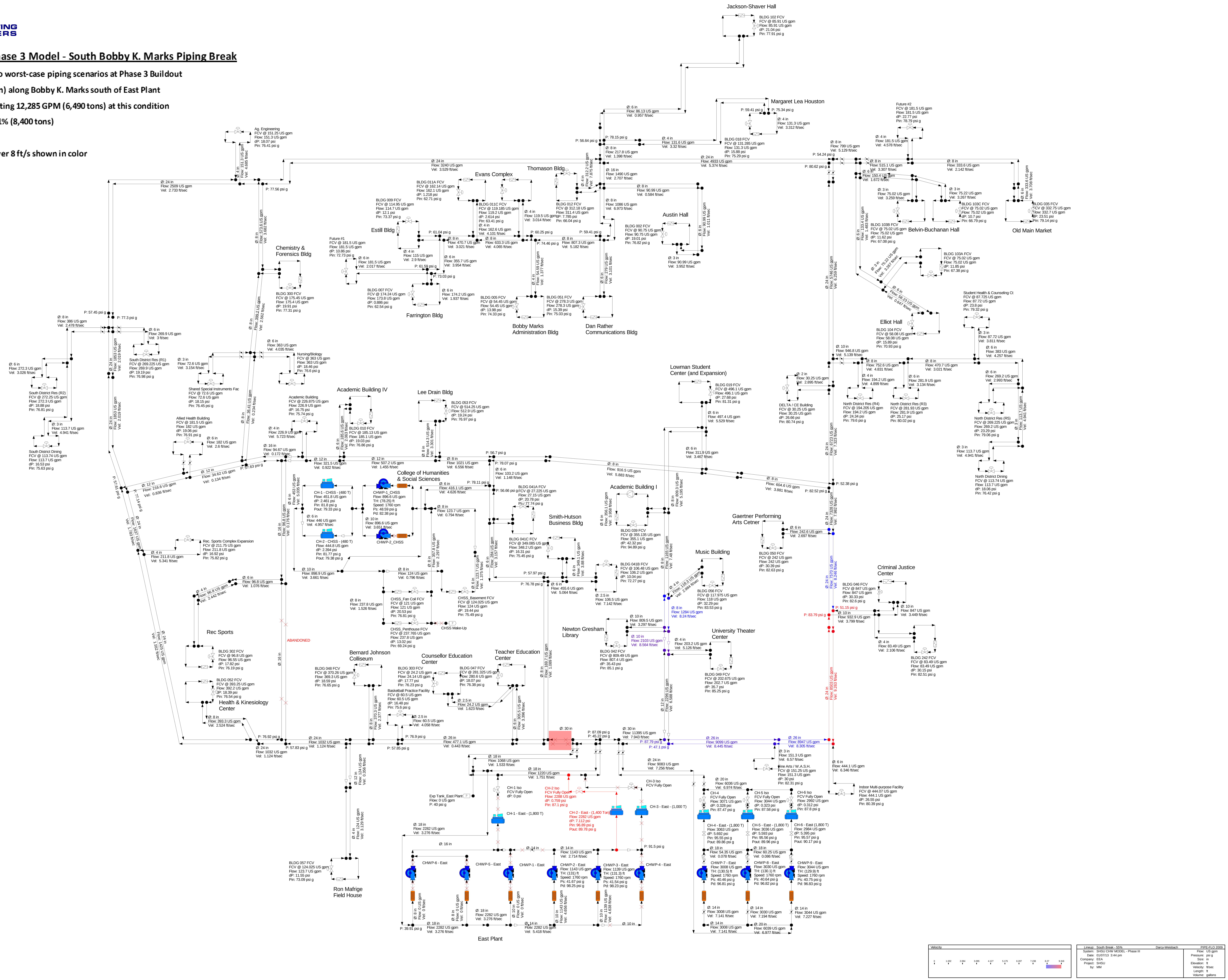
2.165 3.247 4.33 5.429 6.512 7.594 8.677 9.776

Lineup: 71% Diversity — Darcy-Weisbach — PIPE-FLO 2009
System: SHSU CHW MODEL - Phase III
Date: 01/09/13 2:49 pm
Company: EEA
Project: SHSU
by: MM

Flow: US gpm
Pressure: psi g
Size: in
Elevation: ft
Velocity: ft/sec
Length: ft
Volume: gallons

Chilled Water System - Phase 3 Model - South Bobby K. Marks Piping Break

- Model represents one of two worst-case piping scenarios at Phase 3 Buildout
- Piping break (supply & return) along Bobby K. Marks south of East Plant
- System is capable of distributing 12,285 GPM (6,490 tons) at this condition
- Design campus diversity is 71% (8,400 tons)
- Piping break highlighted red
- Pipes with fluid velocities over 8 ft/s shown in color



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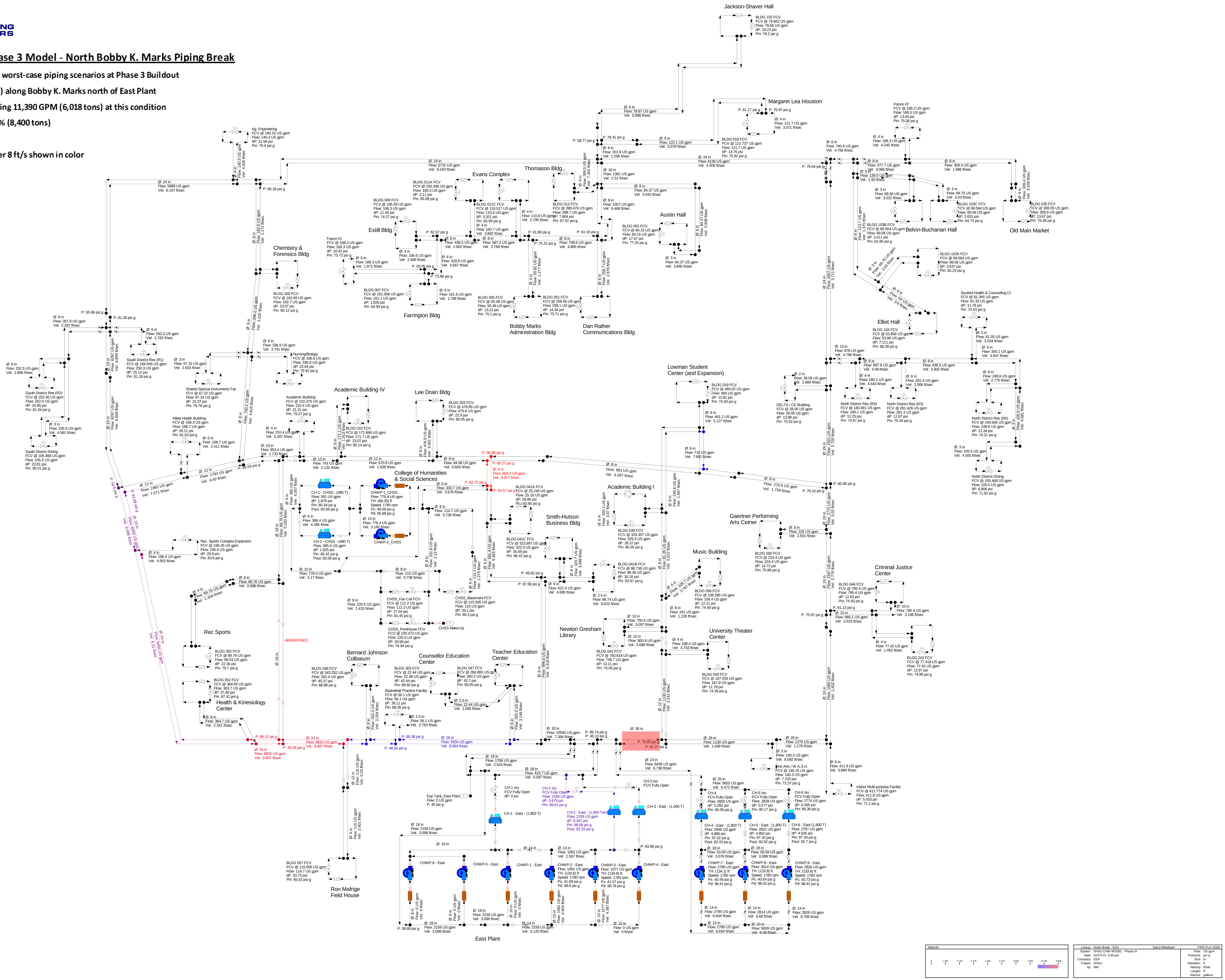
Chilled Water System - Phase 3 Model - North Bobby K. Marks Piping Break

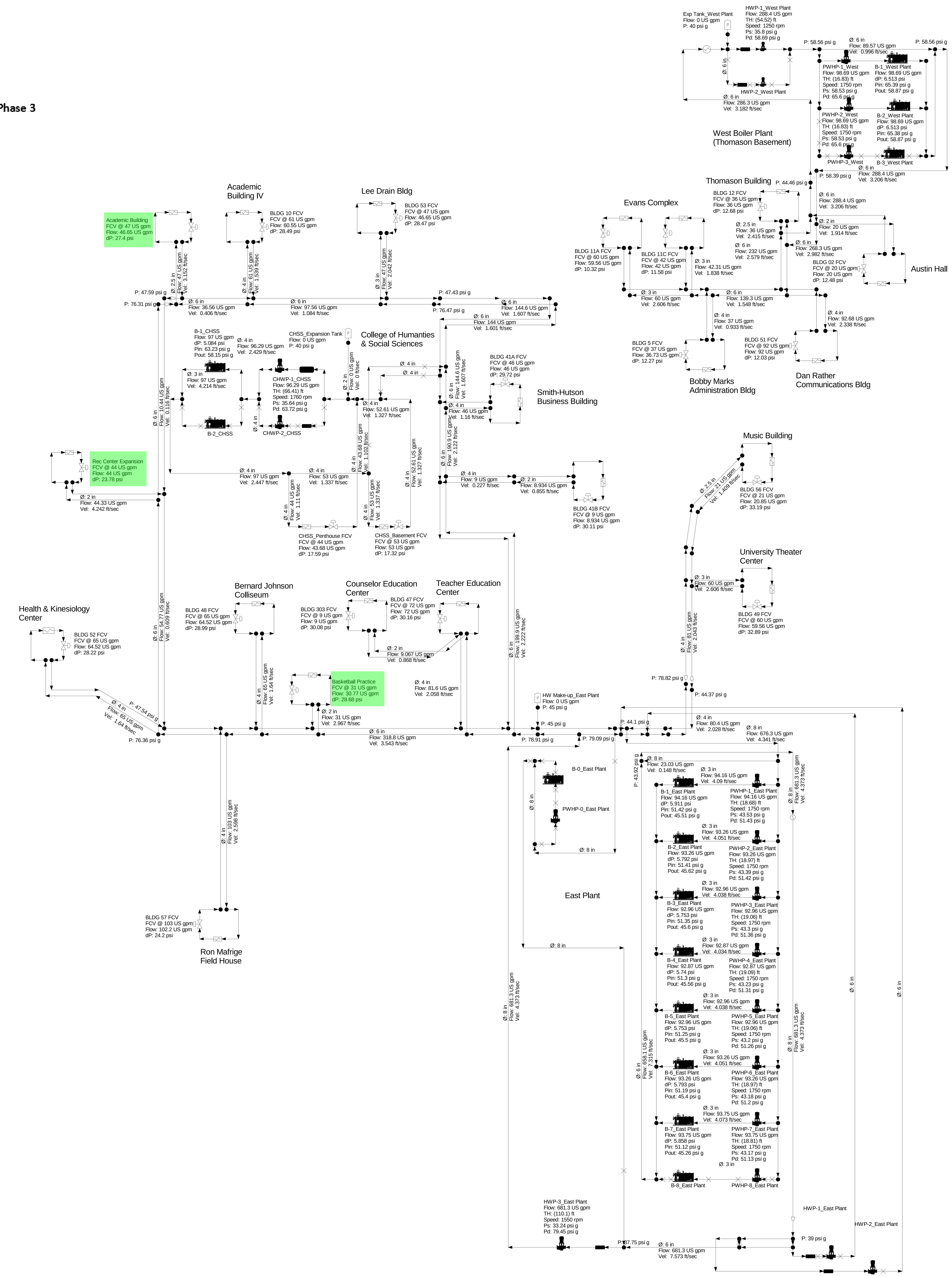
- Model represents one of two worst-case piping scenarios at Phase 3 Buildout
- Piping break (supply & return) along Bobby K. Marks north of East Plant
- System is capable of distributing 11,390 GPM (6,018 tons) at this condition
- Design campus diversity is 71% (8,400 tons)
- Piping break highlighted red
- Pipes with fluid velocities over 8 ft/s shown in color

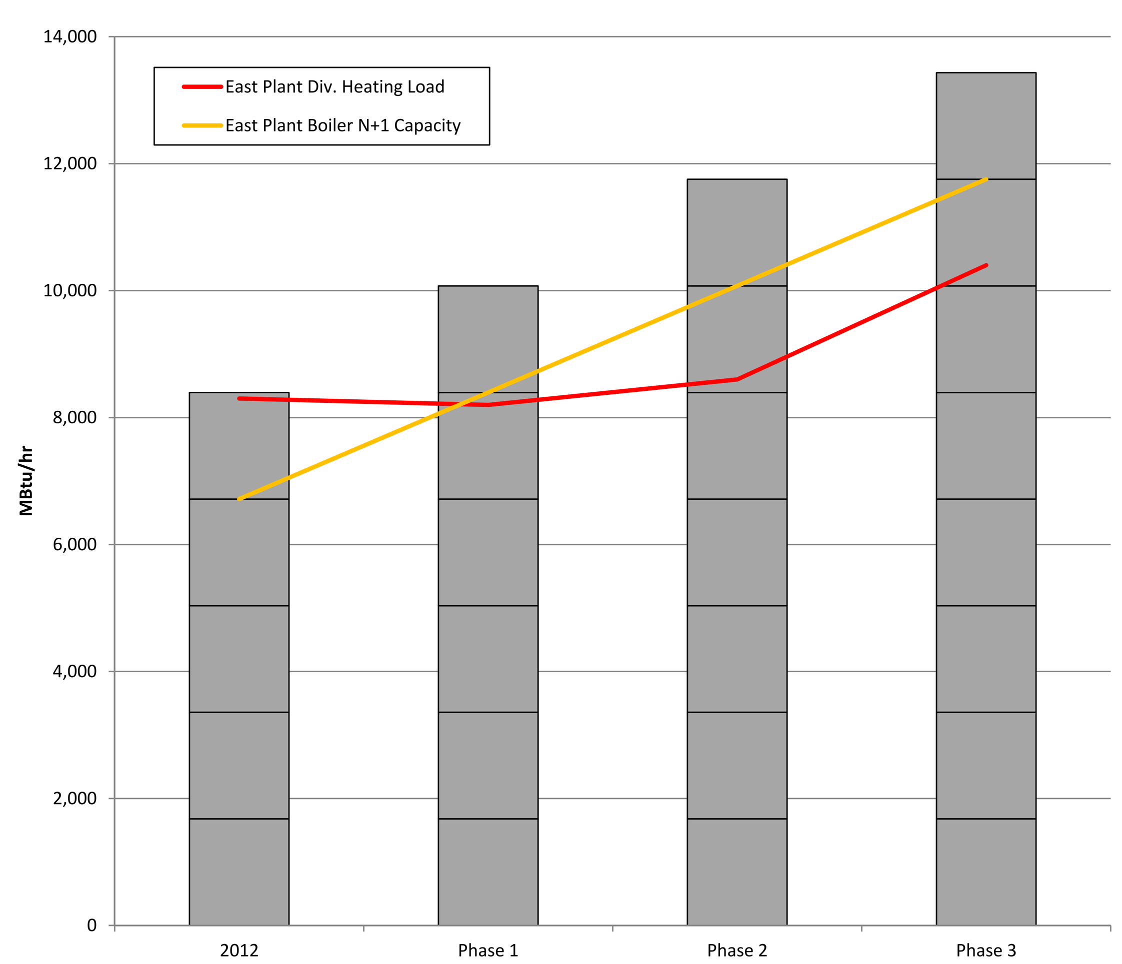


EEA CONSULTING ENGINEERS

Heating Water System - Phase 3 Model

- Model represents predicted loop conditions on design heating day at end of Phase 3
- 2,900 MBh West Plant Load
- 11,800 MBH East Plant Load
- New buildings are highlighted in green
- West Plant relocated to Thomason Hall basement
- 3 additional boilers added to East Plant
- Both plants variable volume flow
  - West Plant pump at 1,250 RPM to maintain 10 psi at buildings
  - East Plant pump at 1,550 RPM to maintain 10 psi at buildings
- No piping with fluid velocities over 8 ft./sec.





Building	Area Sq.Ft.	Plant	Heating Density Btu/Sq.Ft.	Heating Load MBtu/h	Design Flow (gpm)	Applied Diversity	Heating Load MBtu/h	Div. Flow (gpm)
Existing Buildings								
West Plant	**501,983**	**EAST**		**5,800**	**500**	**50%**	**2,900**	**300**
East Plant	**1,538,624**	**WEST**		**27,800**	**1,700**	**30%**	**8,300**	**500**
Total	**2,188,029**							
Phase I								
Agricultural Engineering Builiding	50,000	LOCAL						
Nursing / Biology Building	100,000	LOCAL						
Shared Specialty Instruments Facility	28,000	LOCAL						
Lowman Student Center Expansion	60,000	LOCAL						
Student Health and Counseling Center	28,900	LOCAL						
South District Residences (R1)	103,900	LOCAL						
South District Residences (R2)	105,000	LOCAL						
South District Dining	25,000	LOCAL						
Communications & Central Plant Exp.	15,000	EAST	25	375	106	50%	188	53
Demo White Hall	-	-	-	-	-	-	-	-
Demo Academic Building III	-	-	-	-	-	-	-	-
New Building Totals				**400**	**100**		**200**	**53**
Demolition Totals				**970**	**97**		**291**	**29**
Phase I Campus Totals		**EAST**		**27,200**	**1,700**	**30%**	**8,200**	**500**
Phase II								
Fine Arts	40,000	LOCAL						
W.A.S.H.	10,000	LOCAL						
DELTA / CE Building	10,000	LOCAL						
North District Residences (R3)	108,800	LOCAL						
North District Residences (R4)	75,000	LOCAL						
North District Residences (R5)	103,900	LOCAL						
North District Dining	25,000	LOCAL						
Basketball Practice Facility	20,000	EAST	35	700	63	50%	350	31
Allied Health Building	60,000	LOCAL						
New Building Totals				**700**	**100**		**400**	**0**
Demolition Totals				**0**	**0**		**0**	**0**
Phase II Campus Totals		**EAST**		**27,900**	**1,800**	**31%**	**8,600**	**500**
Phase III								
Indoor Multi-purpose Facility	125,000	LOCAL						
Academic Building	75,000	EAST	25	1,875	94	50%	938	47
Recreational Sports Complex Exp.	70,000	EAST	25	1,750	88	50%	875	44
Future #1	60,000	LOCAL						
Future #2	60,000	LOCAL						
New Building Totals				**3,600**	**200**		**1,800**	**100**
Demolition Totals				**0**	**0**		**0**	**0**
Phase III Campus Totals		**EAST**		**31,500**	**2,000**	**33%**	**10,400**	**600**

Lineup:	Diversity	Darcy-Weisbach	PIPE-FLO 2009
System:	SHSU HHW MODEL - Phase III	Flow:	US gpm
Date:	01/08/13 8:58 am	Pressure:	psi g
Company:	EEA	Size:	in
Project:	SHSU	Elevation:	ft
by:		Velocity:	ft/sec
		Length:	ft
		Volume:	gallons

Appendix C – Project Cost Estimates

SHSU Master Plan Infrastructure Cost Estimates

1.00	**Increase West Plant usable capacity**	$320,000
1.05	**Connect CHSS chillers to East Plant chilled water loop**	$110,000
1.10	**Extend Piping frorm West Plant to Ag Engineering and Extend Circuits 7&8**	$2,280,000
1.15	**Extend piping from Agricultural Engineering Building to Chemistry Building**	$230,000
1.20	**17th Street piping project to connect East Plant and West Plant loops**	$950,000
1.25	**Extending piping to Student Health and Counceling Center**	$180,000
1.30	**Communications and East Plant Expansion and Bobby K. Marks Improvements**	$13,250,000
1.35	**South campus piping project #1**	$2,150,000
1.40	**South campus piping project #2**	$320,000
1.45	**Relocate West Plant heating water system to Thomason Hall**	$1,360,000
2.00	**17th Street east piping project**	$580,000
2.05	**North Residence Hall piping**	$380,000
2.10	**Provide redundant electrical feed to HKC and Colesium**	$80,000
2.15	**Migrate existing buildings from overhead electrical to buried**	$1,230,000
3.00	**Indoor Multi-Purpose Facility piping and electrical**	$770,000
	Total	**$24,190,000**

1.00 Increase West Plant usable capacity

	Qty	Unit	$/unit	Total
New 16" steel piping, insulation & hangers	20	lf	$350	$7,000
New 16" actuated butterfly valves	2	ea	$5,000	$10,000
New 3,600 gpm @ 100' CHW pumps	2	ea	$75,000	$150,000
New elect service for pumps incl VFDs	2	ea	$20,000	$40,000
New dP sensors	2	ea	$4,000	$8,000
Subtotal				$215,000
General Conditions			6%	$12,900
OH&P			15%	$32,250
Engineering			10%	$21,500
Contingency			20%	$43,000
Total				**$320,000**

1.05 Connect CHSS chillers to East Plant chilled water loop

	Qty	Unit	$/unit	Total
New 8" piping	100	lf	$250	$25,000
New 800 gpm @ 40' CHW pump	1	ea	$25,000	$25,000
New elect service for pump incl VFDs	1	ea	$4,000	$4,000
New elect service for pumps incl motors	2	ea	$5,000	$10,000
New impellers	2	ea	$2,000	$4,000
New dP sensors	2	ea	$4,000	$8,000
Subtotal				$76,000
General Conditions			6%	$4,560
OH&P			15%	$11,400
Engineering			10%	$7,600
Contingency			20%	$15,200
Total				**$110,000**

1.10 Extend Piping frorm West Plant to Ag Engineering and Extend Circuits 7&8

	Qty	Unit	$/unit	Total
New 24" CHWS&R piping	1300	lf	$700	$910,000
New 15kv, #4/0 buried elect circuits (2 circuits)	2400	lf	$250	$600,000
Subtotal				$1,510,000
General Conditions			6%	$90,600
OH&P			15%	$226,500
Engineering			10%	$151,000
Contingency			20%	$302,000
Total				**$2,280,000**

1.15	Extend piping from Agricultural Engineering Building to Chemistry Building				
		Qty	Unit	$/unit	Total
	New 8" CHWS&R piping	200	lf	$500	$100,000
	New (4) 4" underground elect ductbank w/#4/0	200	lf	$250	$50,000
	Subtotal				$150,000
	General Conditions			6%	$9,000
	OH&P			15%	$22,500
	Engineering			10%	$15,000
	Contingency			20%	$30,000
	Total				**$230,000**

1.20	17th Street piping project to connect East Plant and West Plant loops				
		Qty	Unit	$/unit	Total
	New 24" CHWS&R piping	900	lf	$700	$630,000
	Subtotal				$630,000
	General Conditions			6%	$37,800
	OH&P			15%	$94,500
	Engineering			10%	$63,000
	Contingency			20%	$126,000
	Total				**$950,000**

1.25	Extending piping to Student Health and Counceling Center				
		Qty	Unit	$/unit	Total
	New 10" HDPE CHWS&R piping	150	lf	$500	$75,000
	New 8" HDPE CHWS&R piping	100	lf	$450	$45,000
	Subtotal				$120,000
	General Conditions			6%	$7,200
	OH&P			15%	$18,000
	Engineering			10%	$12,000
	Contingency			20%	$24,000
	Total				**$180,000**

1.30 Communications and East Plant Expansion and Bobby K. Marks Improvements	Qty	Unit	$/unit	Total
New Central Plant Bldg	10000	sq.ft.	$200	$2,000,000
1800 ton chillers (initial build)	2	ea	$700,000	$1,400,000
MEP Systems	5400	tons	$250	$1,350,000
Cooling Towers	3600	tons	$150	$540,000
New 30" CHWS&R piping	430	lf	$1,000	$430,000
New 28" CHWS&R piping	100	lf	$850	$85,000
New 26" CHWS&R piping	700	lf	$850	$595,000
New 24" CHWS&R piping	150	lf	$700	$105,000
New 12" CHWS&R piping	300	lf	$600	$180,000
New 6" HHWS&R piping	900	lf	$400	$360,000
Piping Interconnections to existing	20	ea	$20,000	$400,000
New (4)-6" conduit ductbank w/ (2) 15kv	1400	lf	$200	$280,000
New (2)-6" ductbank to grounds bldg.	250	lf	$200	$50,000
New pad mounted switchgear & 480v xfmr	1	ea	$1,000,000	$1,000,000
(2) 4" future communication lines from plant to dorms				
Subtotal				$8,775,000
General Conditions			6%	$526,500
OH&P			15%	$1,316,250
Engineering			10%	$877,500
Contingency			20%	$1,755,000
Total				**$13,250,000**

1.35 South campus piping project #1	Qty	Unit	$/unit	Total
New 24" CHWS&R piping	2030	lf	$700	$1,421,000
Subtotal				$1,421,000
General Conditions			6%	$85,260
OH&P			15%	$213,150
Engineering			10%	$142,100
Contingency			20%	$284,200
Total				**$2,150,000**

1.40 South campus piping project #2	Qty	Unit	$/unit	Total
New 12" CHWS&R Piping	380	lf	$550	$209,000
Subtotal				$209,000
General Conditions			6%	$12,540
OH&P			15%	$31,350
Engineering			10%	$20,900
Contingency			20%	$41,800
Total				**$320,000**

1.45 Relocate West Plant heating water system to Thomason Hall

	Qty	Unit	$/unit	Total
Install (3) new 2MMbtuh boilers, pumps, gas, etc	3	boilers	$300,000	$900,000
Buried 6" HWS&R	0	lf	$400	$0
Subtotal				$900,000
General Conditions			6%	$54,000
OH&P			15%	$135,000
Engineering			10%	$90,000
Contingency			20%	$180,000
Total				**$1,360,000**

2.00 17th Street east piping project

	Qty	Unit	$/unit	Total
New 24" CHWS&R piping	550	lf	$700	$385,000
Subtotal				$385,000
General Conditions			6%	$23,100
OH&P			15%	$57,750
Engineering			10%	$38,500
Contingency			20%	$77,000
Total				**$580,000**

2.05 North Residence Hall piping

	Qty	Unit	$/unit	Total
New 6" CHWS&R piping	420	lf	$400	$168,000
Extend circuits 7 & 8 in new ductbank	420	lf	$200	$84,000
Subtotal				$252,000
General Conditions			6%	$15,120
OH&P			15%	$37,800
Engineering			10%	$25,200
Contingency			20%	$50,400
Total				**$380,000**

2.10 Provide redundant electrical feed to HKC and Colesium	Qty	Unit	$/unit	Total
New 15kV, #4/0 conductors - 3ea. @1200'	3600	lf	$15	$54,000
Subtotal				$54,000
General Conditions			6%	$3,240
OH&P			15%	$8,100
Engineering			10%	$5,400
Contingency			20%	$10,800
Total				**$80,000**

2.15 Migrate existing buildings from overhead electrical to buried	Qty	Unit	$/unit	Total
New 15kV, #4/0 conductors	1000	lf	$250	$250,000
New 15kV Switch	8	ea	$40,000	$320,000
New pad mounted transformer	7	ea	$30,000	$210,000
Demo existing overhead	1	ea	$25,000	$25,000
Demo Farrington Swtiches	1	ea	$10,000	$10,000
Subtotal				$815,000
General Conditions			6%	$48,900
OH&P			15%	$122,250
Engineering			10%	$81,500
Contingency			20%	$163,000
Total				**$1,230,000**

Note: This is a multiple phase project that can be done a few buildings at a time once Project 1.10 is complete.

3.00 Indoor Multi-Purpose Facility piping and electrical	Qty	Unit	$/unit	Total
New 6" CHWS&R piping	850	lf	$400	$340,000
Extend circuits 7 & 8 in new ductbank	850	lf	$200	$170,000
Subtotal				$510,000
General Conditions			6%	$30,600
OH&P			15%	$76,500
Engineering			10%	$51,000
Contingency			20%	$102,000
Total				**$770,000**

APPENDIX D – COMBINED HEAT & POWER FEASIBILITY STUDY

SAM HOUSTON STATE UNIVERSITY COMBINED HEAT AND POWER STUDY

As part of a comprehensive master planning effort for Sam Houston State University (SHSU), the Brandt Companies studied the potential benefits of introducing a Combined Heat and Power (CHP) system to optimize utility production for the campus.

CHP is the simultaneous generation of electric power and useful thermal energy from the combustion of a single fuel source. Fuel is combusted in a prime mover which drives an electric generator to produce power. The hot exhaust leaving the prime mover then passes through a heat recovery device where the energy is extracted to produce steam or hot water. The steam or hot water can then be delivered directly to end-users to meet heating demands, it can be used to drive cooling equipment to produce chilled water, or it can be passed through a steam turbine generator (STG) to produce still more electricity. In some cases, the steam or hot water can be divided to simultaneously produce heating, cooling and additional power.

Campus Utility Usage

The University imports electric power and natural gas to provide utilities for its buildings. Some power and gas is consumed in utility plants on campus to generate chilled water and heating hot water to cool and heat the buildings. Peak power consumption is about 11,500 kW, with a base load (typical minimum) of about 6,000 kW. Peak hot water heating load on campus is about 10,000 mbtu/hr, but could grow if more buildings were connected to the central loop. The heating load dips significantly in the summer months as would be expected for a campus located in Texas.

Figure 1 - Historical SHSU Power Consumption Profile

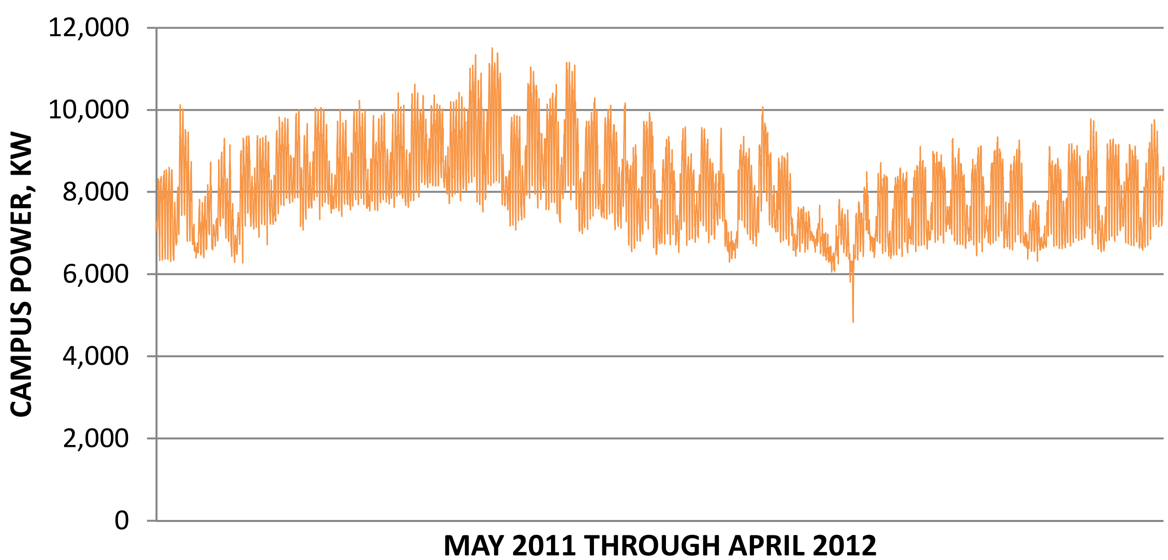


Figure 2 - Connected Chilled Water Consumption Profile (Modeled)

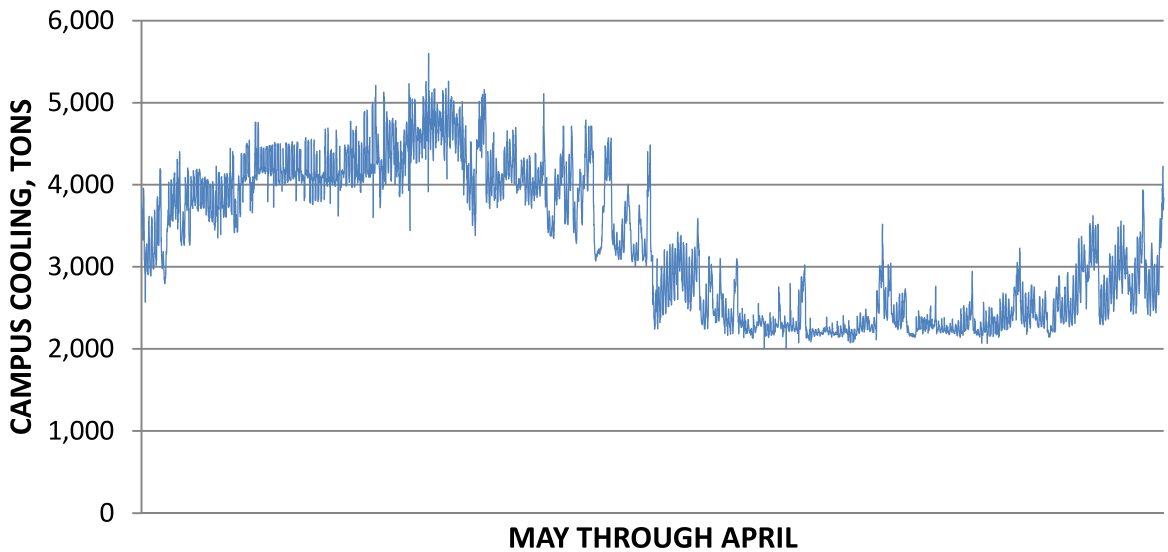
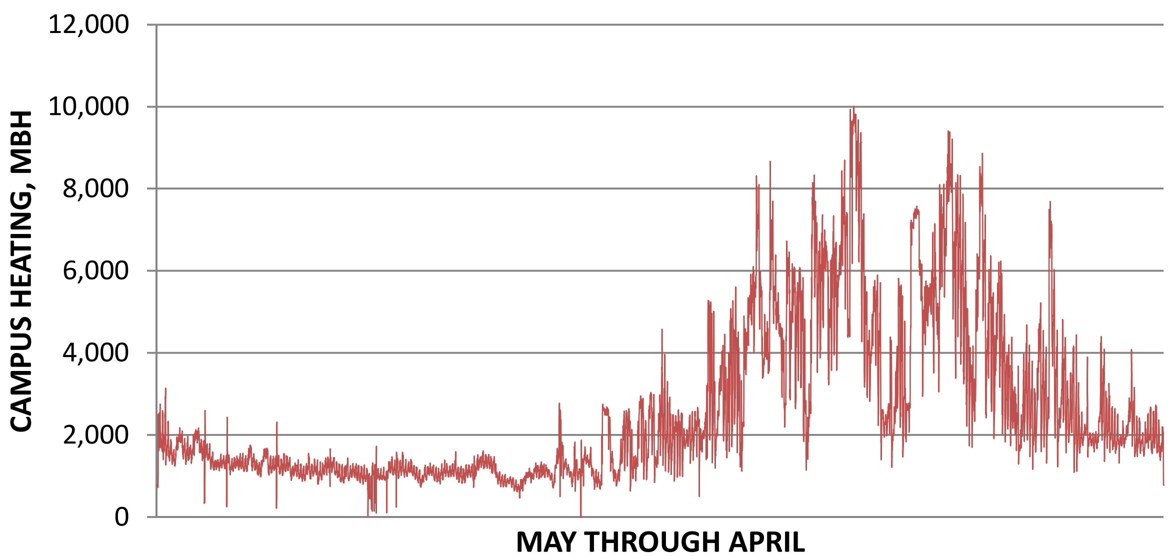


Figure 3 - Connected Heating Hot Water Consumption Profile (Modeled)



Prime Mover Technologies

For the purposes of this study, two prime mover technologies were analyzed for use: Combustion Turbine Generators (CTGs) and Reciprocating Engine Generators (REGs). Each prime mover will combust natural gas fuel and either technology will be paired with heat recovery systems that produce steam.

The units selected for the study were chosen based on the following criteria:

- Capacity for power production

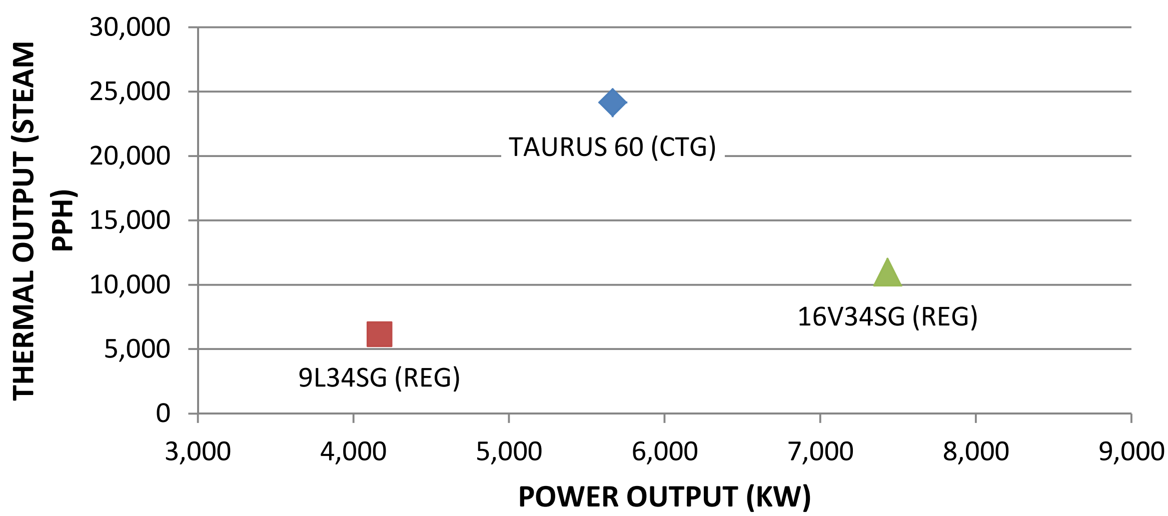
- Capacity for thermal production
- Power production efficiency
- Turn-down capabilities
- Market share (knowledge-base, parts availability)
- Reliability

Prime mover models studied:

- Wartsila 9L34SG REG; 4,100 kW
- Wartsila 16V34SG REG; 7,400 kW
- Solar Taurus 60 CTG; 5,700 kW

Relative to REGs, CTGs typically are less efficient at producing electricity and thereby have the capacity to produce more thermal utilities (steam or hot water) per unit of power. Figures 1 and 2 (below) show the performance differences between the prime movers studied.

Figure 4 - Power to Thermal Output Comparison of Prime Movers



The most favorable CHP technology is largely dependent upon the load profile for the district being served. If the ratio of power consumed to thermal energy consumed is relatively high, REGs generally provide a better match. This appears to be the case for SHSU based on historic power consumption and thermal loading predicted by the models developed as part of this study.

Another advantage of REGs over CTGs is that ambient air temperature does not affect power production very much. The power output of CTGs is greatly diminished with high temperature inlet air, and this is generally not desirable because power is often most valuable and in greatest demand when outdoor temperatures are at their highest.

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Figure 5 - Simple-cycle Power Generating Efficiency Comparison of Prime Movers

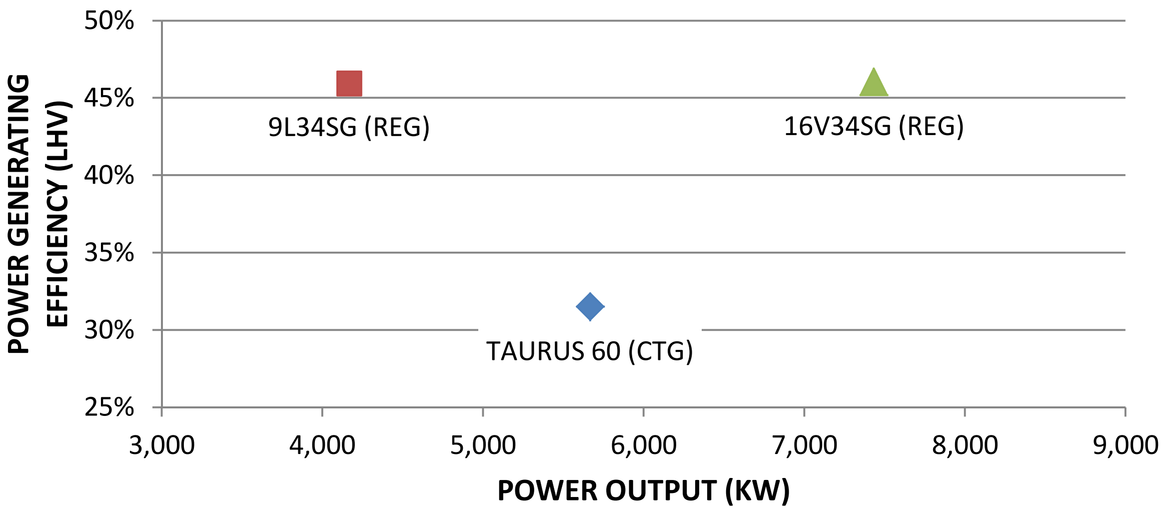


Figure 2 indicates that the REG options exhibit better simple-cycle (power-only production) efficiency than the CTG option.

Results of Analysis

Currently, SHSU imports power from the local utility (Entergy) under the Large Industrial Power Service (LIPS) tariff. This power is fed to the buildings directly and is used to drive the utility plants which generate chilled water for building HVAC. Natural gas is imported and used to produce hot water to heat some of the buildings. This mode of operation will be referred to as Business As Usual (BAU) and will be the version of operation to which all CHP modes are compared.

Five CHP configurations were studied for SHSU:

Option A

This Option utilizes a Wartsila 9L34SG REG. Hot water to support the campus load will be generated via the engine's heat rejection (radiator) system. Steam produced via the exhaust energy will be used to drive a steam turbine-driven centrifugal chiller to produce cooling.

Option B

This Option also utilizes a Wartsila 9L34SG REG. Hot water to support the campus load will be generated via the engine's heat rejection system. Steam produced via the exhaust energy will be used to drive a condensing steam turbine generator to produce additional electricity. This electricity can be used to drive motor-driven centrifugal chillers to produce cooling or can be distributed to other campus electric loads.

Option C

This Option utilizes a Wartsila 16V34SG REG. Hot water to support the campus load will be generated via the engine's heat rejection system. Steam produced via the exhaust energy will be used to drive a steam turbine-driven centrifugal chiller to produce cooling.

Option D

This Option also utilizes a Wartsila 16V34SG REG. Hot water to support the campus load will be generated via the engine's heat rejection system. Steam produced via the exhaust energy will be used to drive a condensing steam turbine generator to produce additional electricity. This power can drive motor-driven centrifugal chillers to produce cooling or can be distributed to other campus electric loads.

Option E

This Option utilizes a Solar Taurus 60 CTG. Steam produced via the exhaust energy will be converted to hot water to meet campus heating loads and will be used to drive a condensing steam turbine generator to produce additional electricity which can drive motor driven centrifugal chillers to produce cooling or be distributed to other campus electric loads.

Table 1 contains the projected economic performance for an optimized dispatch of each of the CHP alternatives investigated in this study.

Table 1 – Economic Performance of CHP Alternatives

Option	Brief Description	Implementation Cost	25-Year NPV Energy Cost Savings	25 Year NPV Life Cycle Cost Savings†
A	4.1 MW engine w/ steam chiller	$20.0M	$10.6M	-$20.3M
B	4.1 MW engine w/ steam turbine generator	$18.1M	$7.8M	-$21.0M
C	7.4 MW engine w/ steam chiller	$22.3M	$14.8M	-$18.4M
D	7.4 MW engine w/ steam turbine generator	$21.9M	$10.9M	-$21.8M
E	5.7 MW combustion turbine w/ steam turbine generator	$22.0M	-$0.5M	-$37.9M
† Life cycle savings when compared to business as usual at a 4.5% discount rate				

As can be seen by the results above, despite the availability of energy cost savings due to efficiency improvements, none of the CHP options generate enough savings to overcome the implementation costs of the project.

The current all-in cost of imported power from Entergy is about 4.5¢/kWh. This is relatively inexpensive when compared to the cost of producing power locally with small-scale equipment fired with natural gas. Baseline natural gas is valued at $4.071/mmbtu (including transport). The relatively low cost of power is the primary obstacle to the economic viability of Combined Heat and Power for Sam Houston State University at this time.

Cost Sensitivity

Sensitivity analyses were performed to evaluate the impact of potential market changes on the economic performance of the options studied. Variables such as natural gas cost, imported electricity cost, capital cost, and escalation factors were adjusted to evaluate financial performance of the CHP plant evaluated in this study. The goal of a sensitivity analysis is to determine which factors play the biggest role in the financial model and to see what conditions (if any) would cause the recommendations to change.

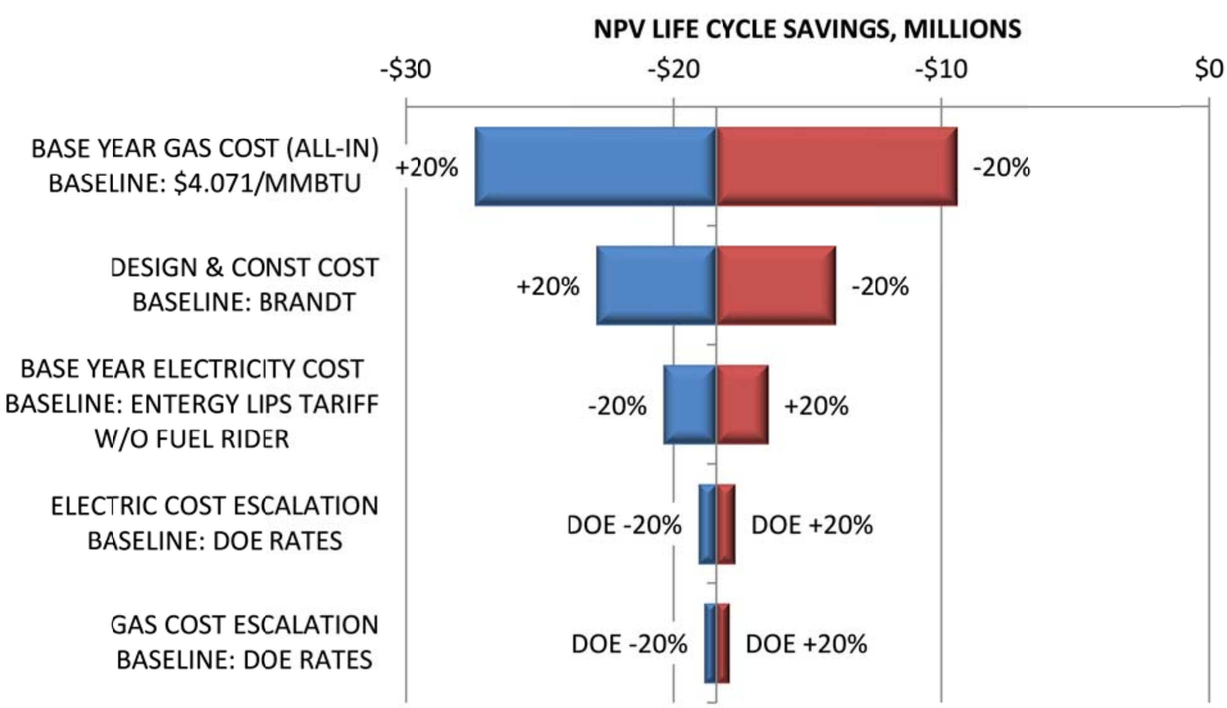
Sensitivity adjustments:

- Increasing baseline natural gas cost by 20%
- Decreasing baseline natural gas cost by 20%
- Increasing baseline electricity cost by 20%
- Decreasing baseline electricity cost by 20%
- Increasing the capital cost of the CHP plant by 20%
- Decreasing the capital cost of the CHP plant by 20%
- Increasing the escalation rate for natural gas by 20% (over DOE projections)
- Decreasing the escalation rate for natural gas by 20% (below DOE projections)
- Increasing the escalation rate for electricity by 20% (over DOE projections)
- Decreasing the escalation rate for electricity by 20% (below DOE projections)

In all but one case, Option C outperformed all the other options economically. The only case where it failed to outperform the others was when the initial cost of natural gas grew by 20%. In this case, the smaller engine scenarios performed better.

Figure 6 illustrates results of the LCC savings (losses) of Option C when compared to the BAU case:

Figure 6 - Option C Lifecycle Savings Sensitivity Chart



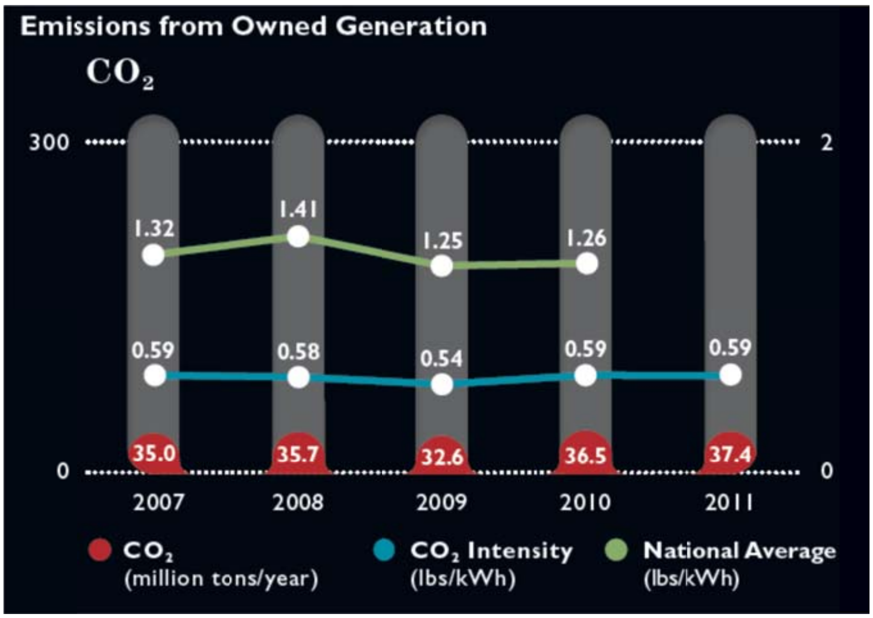
The results of the sensitivity analysis show that the CHP plant will not yield life cycle savings over the BAU case for any of the scenarios described above. Of the variables analyzed, the cost of natural gas impacts the financial performance of the project the most. The cheaper fuel becomes, the better the CHP facility will perform. The only unexpected result in this analysis was that a drop in natural gas escalation rates actually hurt the CHP option more than the BAU. This is because the analysis assumes that the fuel rider on the Entergy electric tariff is tied directly to the cost of gas. In effect, a reduction in gas escalation over time helps both the CHP and BAU scenarios, but the BAU benefits slightly more from the reduction.

As with all feasibility exercises, this analysis should be revisited if economic factors which impact financial performance change beyond the ranges analyzed herein.

Environmental Impacts

Ordinarily the implementation of combined heat and power will dramatically improve the greenhouse gas footprint of the owning entity. In this case, with Entergy's average carbon content per unit of power being as low as it is, none of the proposed CHP alternatives are able to yield a net reduction in carbon emissions.

Figure 7 - Entergy Emissions (courtesy Entergy Corporation 2011 Sustainability Report)



Entergy is able to achieve these low carbon emission rates because a significant portion of the energy they deliver is generated via nuclear and renewable sources. These sources contribute no carbon (CO_2) emissions to the atmosphere.

The proposed CHP units will outperform nearly all of the fossil fuel burning assets in the Entergy portfolio because less CO_2 is released during the combustion of natural gas than during oil or coal combustion. The CHPs will outperform most other natural gas fired assets due to superior efficiency of operation.

If CHP were implemented, carbon emission reductions would occur on the days when the other fossil-fuel fired plants are dispatched, which would be when the weather is hot and the grid requires more power than can be met by those cleaner alternatives.

Enhanced Power Reliability

Having a power generating asset would help to insulate the University from grid power interruptions. If configured properly, the power generating asset can continue to operate after the grid signal is lost. This would require an advanced control system to accomplish island operation and load shedding (as necessary) in such an event. This system would also need to be capable of synchronizing output to the grid when operating in parallel.

The prime mover can also be dispatched even if it was not operating when the grid power is lost so long as appropriate controls and blackstart capabilities are included in the design.

These benefits are especially valuable in the event of an emergency condition such as a major weather event which may cause the general population the need to seek shelter for a long period of time. This also has a great deal of value for institutions of higher education that conduct long-term research projects for which power reliability is critical. It is possible for a power generation project like this to be subsidized for these reasons if stand-alone economics are not sufficient to justify implementation.

Conclusions

While energy cost savings are available with these CHP systems, the capital cost and increased maintenance costs associated with the systems appear to be too great to yield positive economics over a 25-year term for SHSU at this time.

If the University is interested in investing in the CHP resource for the reliability benefits that it brings, then Option C would be recommended based on best financial benefit. It also is only about 2.3 million more to implement when compared to Option A but gains the University 80% more power capacity.

Under the current combination of economic conditions, it appears that it would take an initial capital subsidy of $18.4M to make Option C breakeven over a 25 year period.

LIFE CYCLE COMPARISON INPUTS

BASELINE

Business as usual operation of SHSU Utilities (conventional electric driven cooling, gas fired hot water, and imported power)

CAPITAL INVESTMENT COSTS

	YEAR	AMOUNT	INFLATED AMT	TERM	APR	ANNUAL COST
1						
2						
3						
4						
5						

OPERATIONS & MAINTENANCE COSTS

ANNUALLY RECURRING COSTS

ITEM	DESCRIPTION	USAGE SCHEDULE	ANNUAL COST
1			
2			
3			
4			
5			
		TOTAL ANNUAL COSTS:	$0

OPERATING CHARACTERISTICS

ITEM	DESCRIPTION	VALUE
1	Natural Gas Cost Escalation Schedule	A
2	2013 Natural Gas Consumption (MMBTU)	28,053
3	Electricity Cost Escalation Schedule	A
4	2013 Electricity Non-Fuel Cost	$1,163,384
5	2013 Electricity Fuel Adjustment Cost	$2,343,690

Life Cycle Cost:	$82,399,761
Life Cycle Cost Savings:	N/A

OPTION A

Addition of 4.1 MW reciprocating engine to produce power and thermal energy (cogeneration). Thermal energy is used to offset boiler operation and to generate some chilled water.

CAPITAL INVESTMENT COSTS

	YEAR	AMOUNT	INFLATED AMT	TERM	APR	ANNUAL COST
1	1	$19,997,004	$19,997,004	25	4.5%	$1,348,579
2	1	$0	$0	25	4.5%	$0
3						
4						
5						

OPERATIONS & MAINTENANCE COSTS

ANNUALLY RECURRING COSTS

ITEM	DESCRIPTION	USAGE SCHEDULE	ANNUAL COST
1	CHP Plant Staffing	A	$200,000
2	Prime Mover Maintenance	A	$299,592
3	Steam Chiller Maintenance	A	$25,000
4			
5			
		TOTAL ANNUAL COSTS:	$524,592

OPERATING CHARACTERISTICS

ITEM	DESCRIPTION	VALUE
1	Natural Gas Cost Escalation Schedule	A
2	2013 Natural Gas Consumption (MMBTU)	298,283
3	Electricity Cost Escalation Schedule	A
4	2013 Electricity Non-Fuel Cost	$844,235
5	2013 Electricity Fuel Adjustment Cost	$1,074,828

Life Cycle Cost:	$102,681,524
Life Cycle Cost Savings:	-$20,281,764

OPTION B

Addition of 4.1 MW reciprocating engine and steam turbine generator to produce power and thermal energy (cogeneration). Thermal energy is used to offset boiler operation.

CAPITAL INVESTMENT COSTS

	YEAR	AMOUNT	INFLATED AMT	TERM	APR	ANNUAL COST
1	1	$18,104,377	$18,104,377	25	4.5%	$1,220,942
2	1	$0	$0	25	4.5%	$0
3						
4						
5						

OPERATIONS & MAINTENANCE COSTS

ANNUALLY RECURRING COSTS

ITEM	DESCRIPTION	USAGE SCHEDULE	ANNUAL COST
1	CHP Plant Staffing	A	$200,000
2	Prime Mover Maintenance	A	$299,592
3	STG Maintenance	A	$18,000
4			
5			
		TOTAL ANNUAL COSTS:	$517,592

OPERATING CHARACTERISTICS

ITEM	DESCRIPTION	VALUE
1	Natural Gas Cost Escalation Schedule	A
2	2013 Natural Gas Consumption (MMBTU)	298,248
3	Electricity Cost Escalation Schedule	A
4	2013 Electricity Non-Fuel Cost	$863,617
5	2013 Electricity Fuel Adjustment Cost	$1,176,441

Life Cycle Cost:	$103,448,044
Life Cycle Cost Savings:	-$21,048,283

OPTION C

Addition of 7.4 MW reciprocating engine to produce power and thermal energy (cogeneration). Thermal energy is used to offset boiler operation and to generate some chilled water.

CAPITAL INVESTMENT COSTS

	YEAR	AMOUNT	INFLATED AMT	TERM	APR	ANNUAL COST
1	1	$22,325,048	$22,325,048	25	4.5%	$1,505,580
2	1	$0	$0	25	4.5%	$0
3						
4						
5						

OPERATIONS & MAINTENANCE COSTS

ANNUALLY RECURRING COSTS

ITEM	DESCRIPTION	USAGE SCHEDULE	ANNUAL COST
1	CHP Plant Staffing	A	$200,000
2	Prime Mover Maintenance	A	$299,592
3	Steam Chiller Maintenance	A	$25,000
4			
5			
		TOTAL ANNUAL COSTS:	$524,592

OPERATING CHARACTERISTICS

ITEM	DESCRIPTION	VALUE
1	Natural Gas Cost Escalation Schedule	A
2	2013 Natural Gas Consumption (MMBTU)	495,563
3	Electricity Cost Escalation Schedule	A
4	2013 Electricity Non-Fuel Cost	$688,447
5	2013 Electricity Fuel Adjustment Cost	$231,854

Life Cycle Cost:	$100,821,220
Life Cycle Cost Savings:	-$18,421,460

OPTION D

Addition of 7.4 MW reciprocating engine and steam turbine generator to produce power and thermal energy (cogeneration). Thermal energy is used to offset boiler operation.

CAPITAL INVESTMENT COSTS

	YEAR	AMOUNT	INFLATED AMT	TERM	APR	ANNUAL COST
1	1	$21,891,521	$21,891,521	25	4.5%	$1,476,343
2	1	$0	$0	25	4.5%	$0
3						
4						
5						

OPERATIONS & MAINTENANCE COSTS

ANNUALLY RECURRING COSTS

ITEM	DESCRIPTION	USAGE SCHEDULE	ANNUAL COST
1	CHP Plant Staffing	A	$200,000
2	Prime Mover Maintenance	A	$299,592
3	STG Maintenance	A	$18,000
4			
5			
		TOTAL ANNUAL COSTS:	$517,592

OPERATING CHARACTERISTICS

ITEM	DESCRIPTION	VALUE
1	Natural Gas Cost Escalation Schedule	A
2	2013 Natural Gas Consumption (MMBTU)	512,622
3	Electricity Cost Escalation Schedule	A
4	2013 Electricity Non-Fuel Cost	$704,903
5	2013 Electricity Fuel Adjustment Cost	$315,144

Life Cycle Cost:	$104,199,010
Life Cycle Cost Savings:	-$21,799,249

OPTION E

Addition of 5.7 MW combustion turbine and steam turbine generator to produce power and thermal energy (cogeneration). Thermal energy is used to offset boiler operation.

CAPITAL INVESTMENT COSTS

	YEAR	AMOUNT	INFLATED AMT	TERM	APR	ANNUAL COST
1	1	$21,958,087	$21,958,087	25	4.5%	$1,480,832
2	1	$0	$0	25	4.5%	$0
3						
4						
5						

OPERATIONS & MAINTENANCE COSTS

ANNUALLY RECURRING COSTS

ITEM	DESCRIPTION	USAGE SCHEDULE	ANNUAL COST
1	CHP Plant Staffing	A	$300,000
2	Prime Mover Maintenance	A	$420,000
3	STG Maintenance	A	$18,000
4			
5			
		TOTAL ANNUAL COSTS:	$738,000

OPERATING CHARACTERISTICS

ITEM	DESCRIPTION	VALUE
1	Natural Gas Cost Escalation Schedule	A
2	2013 Natural Gas Consumption (MMBTU)	549,480
3	Electricity Cost Escalation Schedule	A
4	2013 Electricity Non-Fuel Cost	$759,572
5	2013 Electricity Fuel Adjustment Cost	$599,060

Life Cycle Cost:	$120,264,761
Life Cycle Cost Savings:	-$37,865,000

LIFE CYCLE COMPARISON CONSTANTS

STANDARD ASSUMPTIONS FOR ALL MODELS	
First Year of Study	2014
Length of Study (Years)	25
General Inflation Rate	3.0%
Discount Rate	4.5%
O&M Escalation Rate	3.0%
Capital Cost Adjustment	+0.0%

BASELINE FACTORS	2013 VALUE	ADJUSTMENT	MODEL VALUE	
NATURAL GAS RATE	$3.471	+0.0%	$3.471	/MMBTU
NATURAL GAS XPORT RATE	$0.600	+0.0%	$0.600	/MMBTU
NATURAL GAS BASIS DIFFERENTI	$0.000	+0.0%	$0.000	/MMBTU
ALL-IN NATURAL GAS RATE	$4.071	+0.0%	$4.071	/MMBTU
ELECTICITY INITIAL RATE ADJ		+0.0%	$0.000	/KWH

ENERGY ESCALATION RATE

	+0.0%	+0.0%	INCREASE
	+0.0%	+0.0%	ADDER

YEAR	ADJUSTED NG	ADJUSTED ELE	DOE NG	DOE ELE
2014	4.30%	2.65%	4.30%	2.65%
2015	4.16%	3.70%	4.16%	3.70%
2016	0.31%	2.51%	0.31%	2.51%
2017	2.34%	1.23%	2.34%	1.23%
2018	2.05%	2.56%	2.05%	2.56%
2019	4.16%	2.17%	4.16%	2.17%
2020	4.69%	2.98%	4.69%	2.98%
2021	5.83%	3.86%	5.83%	3.86%
2022	6.50%	3.56%	6.50%	3.56%
2023	5.56%	4.10%	5.56%	4.10%
2024	4.26%	3.61%	4.26%	3.61%
2025	4.82%	2.48%	4.82%	2.48%
2026	4.33%	3.18%	4.33%	3.18%
2027	4.69%	3.83%	4.69%	3.83%
2028	3.48%	2.84%	3.48%	2.84%
2029	4.36%	2.37%	4.36%	2.37%
2030	4.15%	3.34%	4.15%	3.34%
2031	4.18%	4.16%	4.18%	4.16%
2032	4.70%	3.75%	4.70%	3.75%
2033	3.71%	2.71%	3.71%	2.71%
2034	7.61%	4.44%	7.61%	4.44%
2035	6.45%	4.28%	6.45%	4.28%
2036	3.58%	2.42%	3.58%	2.42%
2037	3.58%	2.42%	3.58%	2.42%
2038	3.58%	2.42%	3.58%	2.42%

SCHEDULE OF USAGE INDICES

Usage indices model growth or reductions in consumption over the course of the study. These are user-defined.

YEAR	A	B	C	D	E	F
2014	100%	10%	100%	100%	100%	0%
2015	100%	20%	90%	100%	100%	0%
2016	100%	30%	80%	100%	100%	0%
2017	100%	40%	70%	100%	100%	0%
2018	100%	50%	60%	100%	100%	0%
2019	100%	60%	50%	100%	100%	0%
2020	100%	70%	40%	100%	100%	0%
2021	100%	80%	30%	100%	100%	0%
2022	100%	90%	20%	100%	100%	0%
2023	100%	100%	10%	100%	100%	0%
2024	100%	100%	0%	100%	100%	0%
2025	100%	100%	0%	100%	100%	0%
2026	100%	100%	0%	100%	100%	0%
2027	100%	100%	0%	100%	100%	0%
2028	100%	100%	0%	100%	100%	0%
2029	100%	100%	0%	100%	100%	0%
2030	100%	100%	0%	100%	100%	0%
2031	100%	100%	0%	100%	100%	0%
2032	100%	100%	0%	100%	100%	0%
2033	100%	100%	0%	100%	100%	0%
2034	100%	100%	0%	100%	100%	0%
2035	100%	100%	0%	100%	100%	0%
2036	100%	100%	0%	100%	100%	0%
2037	100%	100%	0%	100%	100%	0%
2038	100%	100%	0%	100%	100%	0%

	BASELINE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	TOTALS
BASELINE																											
CAPITAL INVESTMENT COSTS																											
Discounted Annual Cost		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
O&M - ANNUALLY RECURRING COSTS																											
Discounted Annual Cost		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
NATURAL GAS COSTS																											
Natural Gas Usage Schedule	A	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Natural Gas Cost	$114,205	$119,118	$124,068	$124,457	$127,372	$129,977	$135,378	$141,721	$149,978	$159,724	$168,606	$175,781	$184,249	$192,230	$201,241	$208,254	$217,341	$226,352	$235,814	$246,889	$256,052	$275,541	$293,314	$303,817	$314,696	$325,965	
Discounted Annual Cost		$113,988	$113,613	$109,061	$106,809	$104,300	$103,957	$104,141	$105,462	$107,479	$108,570	$108,316	$108,645	$108,470	$108,665	$107,609	$107,468	$107,104	$106,777	$106,977	$106,170	$109,331	$111,372	$110,392	$109,421	$108,458	$2,702,557
ELECTRICITY COSTS																											
Electricity Usage Schedule	A	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Electricity Non-Fuel Cost	$1,163,384	$1,194,164	$1,238,394	$1,269,461	$1,285,050	$1,317,964	$1,346,592	$1,386,678	$1,440,162	$1,491,439	$1,552,572	$1,608,678	$1,648,505	$1,700,943	$1,766,118	$1,816,289	$1,859,319	$1,921,501	$2,001,469	$2,076,560	$2,132,811	$2,227,574	$2,322,980	$2,379,203	$2,436,786	$2,495,763	
Electricity Fuel Adjustment Cost	$2,343,690	$2,444,512	$2,546,102	$2,554,084	$2,613,898	$2,667,369	$2,778,213	$2,908,383	$3,077,816	$3,277,837	$3,460,096	$3,607,356	$3,781,117	$3,944,918	$4,129,835	$4,273,752	$4,460,234	$4,645,150	$4,839,340	$5,066,610	$5,254,655	$5,654,600	$6,019,346	$6,234,884	$6,458,139	$6,689,389	
Discounted Annual Cost		$3,481,987	$3,465,576	$3,350,559	$3,269,508	$3,198,035	$3,167,420	$3,156,133	$3,176,975	$3,209,267	$3,227,796	$3,214,114	$3,201,652	$3,185,799	$3,183,655	$3,146,849	$3,124,825	$3,107,184	$3,097,521	$3,095,148	$3,063,160	$3,127,548	$3,167,589	$3,129,929	$3,092,796	$3,056,181	$79,697,204
TOTAL ANNUAL NPV COST		$3,595,975	$3,579,188	$3,459,621	$3,376,317	$3,302,335	$3,271,376	$3,260,274	$3,282,437	$3,316,746	$3,336,365	$3,322,430	$3,310,297	$3,294,269	$3,292,320	$3,254,458	$3,232,293	$3,214,288	$3,204,297	$3,202,125	$3,169,330	$3,236,879	$3,278,960	$3,240,321	$3,202,217	$3,164,639	$82,399,761
CUMULATIVE NPV TOTAL		$3,595,975	$7,175,163	$10,634,784	$14,011,100	$17,313,436	$20,584,812	$23,845,086	$27,127,523	$30,444,270	$33,780,635	$37,103,065	$40,413,362	$43,707,631	$46,999,951	$50,254,409	$53,486,702	$56,700,990	$59,905,288	$63,107,413	$66,276,743	$69,513,622	$72,792,582	$76,032,904	$79,235,121	$82,399,761	
NON-DISCOUNTED ANNUAL COST		$3,757,794	$3,908,563	$3,948,002	$4,026,320	$4,115,311	$4,260,183	$4,436,782	$4,667,956	$4,929,001	$5,181,273	$5,391,816	$5,613,871	$5,838,091	$6,097,195	$6,298,295	$6,536,894	$6,793,002	$7,076,623	$7,390,058	$7,643,518	$8,157,715	$8,635,641	$8,917,904	$9,209,621	$9,511,116	
NON-DISCOUNTED ANNUAL SAVINGS		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	SIR: N/A
OPTION A																											
CAPITAL INVESTMENT COSTS																											
Project Cost	$1,348,579	$1,348,579	$1,348,579	$1,348,579	$1,348,579	$1,348,579	$1,348,579	$1,348,579	$1,348,579	$1,348,579	$1,348,579	$1,348,579	$1,348,579	$1,348,579	$1,348,579	$1,348,579	$1,348,579	$1,348,579	$1,348,579	$1,348,579	$1,348,579	$1,348,579	$1,348,579	$1,348,579	$1,348,579	$1,348,579	
Rebate	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Discounted Annual Cost		$1,290,506	$1,234,934	$1,181,755	$1,130,866	$1,082,168	$1,035,568	$990,974	$948,300	$907,464	$868,387	$830,992	$795,208	$760,965	$728,196	$696,838	$666,831	$638,116	$610,637	$584,341	$559,178	$535,099	$512,056	$490,006	$468,905	$448,713	$19,997,004
O&M - ANNUALLY RECURRING COSTS																											
CHP Plant Staffing O&M Schedule	A	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
CHP Plant Staffing	$200,000	$206,000	$212,180	$218,545	$225,102	$231,855	$238,810	$245,975	$253,354	$260,955	$268,783	$276,847	$285,152	$293,707	$302,518	$311,593	$320,941	$330,570	$340,487	$350,701	$361,222	$372,059	$383,221	$394,717	$406,559	$418,756	
Prime Mover Maintenance O&M Schedule	A	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Prime Mover Maintenance	$299,592	$308,580	$317,837	$327,372	$337,193	$347,309	$357,729	$368,460	$379,514	$390,900	$402,627	$414,705	$427,147	$439,961	$453,160	$466,755	$480,757	$495,180	$510,035	$525,336	$541,096	$557,329	$574,049	$591,271	$609,009	$627,279	
Steam Chiller Maintenance O&M Schedule	A	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Steam Chiller Maintenance	$25,000	$25,750	$26,523	$27,318	$28,138	$28,982	$29,851	$30,747	$31,669	$32,619	$33,598	$34,606	$35,644	$36,713	$37,815	$38,949	$40,118	$41,321	$42,561	$43,838	$45,153	$46,507	$47,903	$49,340	$50,820	$52,344	
Discounted Annual Cost		$517,062	$509,640	$502,325	$495,114	$488,007	$481,002	$474,098	$467,293	$460,585	$453,974	$447,458	$441,035	$434,704	$428,464	$422,314	$416,252	$410,277	$404,388	$398,584	$392,862	$387,223	$381,665	$376,186	$370,787	$365,464	$10,926,765
NATURAL GAS COSTS																											
Natural Gas Usage Schedule	A	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Natural Gas Cost	$1,214,312	$1,266,550	$1,319,185	$1,323,321	$1,354,312	$1,382,016	$1,439,446	$1,506,890	$1,594,677	$1,698,312	$1,792,744	$1,869,042	$1,959,071	$2,043,939	$2,139,749	$2,214,315	$2,310,935	$2,406,743	$2,507,357	$2,625,110	$2,722,540	$2,929,759	$3,118,741	$3,230,416	$3,346,089	$3,465,904	
Discounted Annual Cost		$1,212,009	$1,208,017	$1,159,622	$1,135,674	$1,109,000	$1,105,345	$1,107,306	$1,121,353	$1,142,802	$1,154,397	$1,151,701	$1,155,193	$1,153,337	$1,155,406	$1,144,182	$1,142,686	$1,138,814	$1,135,332	$1,137,465	$1,128,882	$1,162,492	$1,184,189	$1,173,772	$1,163,447	$1,153,212	$28,735,635
ELECTRICITY COSTS																											
Electricity Usage Schedule	A	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Electricity Non-Fuel Cost	$844,235	$866,571	$898,667	$921,211	$932,524	$956,409	$977,183	$1,006,272	$1,045,085	$1,082,294	$1,126,657	$1,167,372	$1,196,273	$1,234,325	$1,281,621	$1,318,029	$1,349,255	$1,394,378	$1,452,409	$1,506,900	$1,547,720	$1,616,487	$1,685,720	$1,726,520	$1,768,306	$1,811,104	
Electricity Fuel Adjustment Cost	$1,074,828	$1,121,066	$1,167,655	$1,171,316	$1,198,747	$1,223,269	$1,274,103	$1,333,800	$1,411,502	$1,503,233	$1,586,818	$1,654,352	$1,734,040	$1,809,160	$1,893,964	$1,959,965	$2,045,486	$2,130,290	$2,219,347	$2,323,574	$2,409,812	$2,593,229	$2,760,504	$2,859,350	$2,961,736	$3,067,789	
Discounted Annual Cost		$1,902,045	$1,892,193	$1,833,675	$1,787,202	$1,749,085	$1,728,753	$1,719,551	$1,727,436	$1,739,813	$1,747,282	$1,738,743	$1,727,900	$1,717,352	$1,714,730	$1,693,807	$1,678,595	$1,667,790	$1,662,572	$1,659,751	$1,640,962	$1,670,362	$1,688,235	$1,666,276	$1,644,652	$1,623,357	$43,022,120
TOTAL ANNUAL NPV COST		$4,921,622	$4,844,784	$4,677,376	$4,548,856	$4,428,261	$4,350,668	$4,291,929	$4,264,382	$4,250,664	$4,224,040	$4,168,894	$4,119,336	$4,066,358	$4,026,796	$3,957,141	$3,904,365	$3,854,997	$3,812,929	$3,780,141	$3,721,885	$3,755,176	$3,766,145	$3,706,241	$3,647,791	$3,590,747	$102,681,524
CUMULATIVE NPV TOTAL		$4,921,622	$9,766,406	$14,443,782	$18,992,638	$23,420,899	$27,771,567	$32,063,496	$36,327,878	$40,578,543	$44,802,583	$48,971,477	$53,090,813	$57,157,171	$61,183,968	$65,141,108	$69,045,473	$72,900,469	$76,713,399	$80,493,540	$84,215,424	$87,970,600	$91,736,746	$95,442,987	$99,090,778	$102,681,524	
NON-DISCOUNTED ANNUAL COST		$5,143,095	$5,290,626	$5,337,663	$5,424,595	$5,518,419	$5,665,701	$5,840,723	$6,064,380	$6,316,892	$6,559,805	$6,765,503	$6,985,905	$7,206,384	$7,457,405	$7,658,185	$7,896,070	$8,147,061	$8,420,773	$8,724,037	$8,976,122	$9,463,949	$9,918,716	$10,200,191	$10,491,097	$10,791,754	$10,642,006
NON-DISCOUNTED ANNUAL SAVINGS		-$1,385,301	-$1,382,062	-$1,389,661	-$1,398,275	-$1,403,108	-$1,405,518	-$1,403,941	-$1,396,424	-$1,387,891	-$1,378,532	-$1,373,687	-$1,372,035	-$1,368,293	-$1,360,211	-$1,359,889	-$1,359,177	-$1,354,058	-$1,344,150	-$1,333,979	-$1,332,604	-$1,306,234	-$1,283,075	-$1,282,288	-$1,281,476	-$1,280,637	0.0

OPTION B

	BASELINE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CAPITAL INVESTMENT COSTS													
Project Cost	$1,220,942	$1,220,942	$1,220,942	$1,220,942	$1,220,942	$1,220,942	$1,220,942	$1,220,942	$1,220,942	$1,220,942	$1,220,942	$1,220,942	$1,220,942
Rebate	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Discounted Annual Cost		$1,168,365	$1,118,053	$1,069,907	$1,023,834	$979,746	$937,556	$897,183	$858,548	$821,577	$786,198	$752,343	$719,945
O&M - ANNUALLY RECURRING COSTS													
CHP Plant Staffing O&M Schedule	A	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
CHP Plant Staffing	$200,000	$206,000	$212,180	$218,545	$225,102	$231,855	$238,810	$245,975	$253,354	$260,955	$268,783	$276,847	$285,152
Prime Mover Maintenance O&M Schedule	A	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Prime Mover Maintenance	$299,592	$308,580	$317,837	$327,372	$337,193	$347,309	$357,729	$368,460	$379,514	$390,900	$402,627	$414,705	$427,147
STG Maintenance O&M Schedule	A	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
STG Maintenance	$18,000	$18,540	$19,096	$19,669	$20,259	$20,867	$21,493	$22,138	$22,802	$23,486	$24,190	$24,916	$25,664
Discounted Annual Cost		$510,162	$502,840	$495,622	$488,508	$481,495	$474,584	$467,772	$461,057	$454,439	$447,916	$441,487	$435,150
NATURAL GAS COSTS													
Natural Gas Usage Schedule	A	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Natural Gas Cost	$1,214,167	$1,266,399	$1,319,029	$1,323,164	$1,354,151	$1,381,852	$1,439,276	$1,506,711	$1,594,487	$1,698,110	$1,792,531	$1,868,820	$1,958,838
Discounted Annual Cost		$1,211,865	$1,207,874	$1,159,484	$1,135,539	$1,108,869	$1,105,214	$1,107,174	$1,121,220	$1,142,666	$1,154,260	$1,151,565	$1,155,056
ELECTRICITY COSTS													
Electricity Usage Schedule	A	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Electricity Non-Fuel Cost	$863,617	$886,466	$919,299	$942,361	$953,934	$978,367	$999,618	$1,029,375	$1,069,078	$1,107,142	$1,152,523	$1,194,173	$1,223,738
Electricity Fuel Adjustment Cost	$1,176,441	$1,227,050	$1,278,044	$1,282,051	$1,312,076	$1,338,916	$1,394,555	$1,459,895	$1,544,944	$1,645,347	$1,736,834	$1,810,753	$1,897,974
Discounted Annual Cost		$2,022,503	$2,012,173	$1,949,245	$1,900,188	$1,859,506	$1,838,475	$1,829,187	$1,838,142	$1,852,163	$1,860,537	$1,851,632	$1,840,761
TOTAL ANNUAL NPV COST		$4,912,896	$4,840,939	$4,674,258	$4,548,069	$4,429,616	$4,355,829	$4,301,316	$4,278,967	$4,270,845	$4,248,912	$4,197,026	$4,150,912
CUMULATIVE NPV TOTAL		$4,912,896	$9,753,836	$14,428,094	$18,976,162	$23,405,778	$27,761,607	$32,062,922	$36,341,890	$40,612,734	$44,861,646	$49,058,672	$53,209,584
NON-DISCOUNTED ANNUAL COST		$5,133,977	$5,286,427	$5,334,105	$5,423,656	$5,520,107	$5,672,422	$5,853,496	$6,085,122	$6,346,882	$6,598,430	$6,811,156	$7,039,454
NON-DISCOUNTED ANNUAL SAVINGS		-$1,376,183	-$1,377,864	-$1,386,103	-$1,397,336	-$1,404,797	-$1,412,239	-$1,416,714	-$1,417,166	-$1,417,881	-$1,417,157	-$1,419,340	-$1,425,584

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	TOTALS
CAPITAL INVESTMENT COSTS														
Project Cost	$1,220,942	$1,220,942	$1,220,942	$1,220,942	$1,220,942	$1,220,942	$1,220,942	$1,220,942	$1,220,942	$1,220,942	$1,220,942	$1,220,942	$1,220,942	
Rebate	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Discounted Annual Cost	$688,943	$659,275	$630,885	$603,718	$577,721	$552,843	$529,036	$506,255	$484,454	$463,593	$443,629	$424,526	$406,245	$18,104,377
O&M - ANNUALLY RECURRING COSTS														
CHP Plant Staffing O&M Schedule	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
CHP Plant Staffing	$293,707	$302,518	$311,593	$320,941	$330,570	$340,487	$350,701	$361,222	$372,059	$383,221	$394,717	$406,559	$418,756	
Prime Mover Maintenance O&M Schedule	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Prime Mover Maintenance	$439,961	$453,160	$466,755	$480,757	$495,180	$510,035	$525,336	$541,096	$557,329	$574,049	$591,271	$609,009	$627,279	
STG Maintenance O&M Schedule	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
STG Maintenance	$26,434	$27,227	$28,043	$28,885	$29,751	$30,644	$31,563	$32,510	$33,485	$34,490	$35,525	$36,590	$37,688	
Discounted Annual Cost	$428,904	$422,747	$416,679	$410,698	$404,803	$398,992	$393,265	$387,620	$382,056	$376,572	$371,167	$365,839	$360,588	$10,780,962
NATURAL GAS COSTS														
Natural Gas Usage Schedule	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Natural Gas Cost	$2,043,696	$2,139,495	$2,214,052	$2,310,660	$2,406,458	$2,507,059	$2,624,798	$2,722,216	$2,929,411	$3,118,371	$3,230,032	$3,345,691	$3,465,492	
Discounted Annual Cost	$1,153,200	$1,155,269	$1,144,046	$1,142,551	$1,138,679	$1,135,197	$1,137,330	$1,128,748	$1,162,353	$1,184,048	$1,173,632	$1,163,308	$1,153,075	$28,732,222
ELECTRICITY COSTS														
Electricity Usage Schedule	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Electricity Non-Fuel Cost	$1,262,664	$1,311,046	$1,348,289	$1,380,232	$1,426,391	$1,485,754	$1,541,496	$1,583,253	$1,653,599	$1,724,422	$1,766,158	$1,808,904	$1,852,684	
Electricity Fuel Adjustment Cost	$1,980,196	$2,073,017	$2,145,258	$2,238,864	$2,331,685	$2,429,161	$2,543,242	$2,637,633	$2,838,390	$3,021,478	$3,129,670	$3,241,736	$3,357,814	
Discounted Annual Cost	$1,829,854	$1,827,302	$1,805,187	$1,789,532	$1,778,233	$1,772,675	$1,769,924	$1,750,160	$1,782,365	$1,802,023	$1,778,900	$1,756,125	$1,733,692	$45,830,483
TOTAL ANNUAL NPV COST	$4,100,900	$4,064,594	$3,996,797	$3,946,499	$3,899,435	$3,859,707	$3,829,555	$3,772,783	$3,811,229	$3,826,236	$3,767,328	$3,709,798	$3,653,600	$103,448,044
CUMULATIVE NPV TOTAL	$57,310,484	$61,375,078	$65,371,875	$69,318,374	$73,217,809	$77,077,516	$80,907,071	$84,679,854	$88,491,082	$92,317,318	$96,084,646	$99,794,444	$103,448,044	
NON-DISCOUNTED ANNUAL COST	$7,267,599	$7,527,403	$7,734,932	$7,981,281	$8,240,976	$8,524,081	$8,838,078	$9,098,873	$9,605,216	$10,076,973	$10,368,314	$10,669,430	$10,980,654	$7,837,056
NON-DISCOUNTED ANNUAL SAVINGS	-$1,429,508	-$1,430,209	-$1,436,637	-$1,444,387	-$1,447,974	-$1,447,458	-$1,448,020	-$1,455,355	-$1,447,501	-$1,441,332	-$1,450,410	-$1,459,809	-$1,469,538	-0.2

OPTION C

	BASELINE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CAPITAL INVESTMENT COSTS													
Project Cost	$1,505,580	$1,505,580	$1,505,580	$1,505,580	$1,505,580	$1,505,580	$1,505,580	$1,505,580	$1,505,580	$1,505,580	$1,505,580	$1,505,580	$1,505,580
Rebate	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Discounted Annual Cost		$1,440,746	$1,378,704	$1,319,334	$1,262,521	$1,208,154	$1,156,128	$1,106,343	$1,058,701	$1,013,111	$969,484	$927,736	$887,786
O&M - ANNUALLY RECURRING COSTS													
CHP Plant Staffing O&M Schedule	A	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
CHP Plant Staffing	$200,000	$206,000	$212,180	$218,545	$225,102	$231,855	$238,810	$245,975	$253,354	$260,955	$268,783	$276,847	$285,152
Prime Mover Maintenance O&M Schedule	A	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Prime Mover Maintenance	$299,592	$308,580	$317,837	$327,372	$337,193	$347,309	$357,729	$368,460	$379,514	$390,900	$402,627	$414,705	$427,147
Steam Chiller Maintenance O&M Schedule	A	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Steam Chiller Maintenance	$25,000	$25,750	$26,523	$27,318	$28,138	$28,982	$29,851	$30,747	$31,669	$32,619	$33,598	$34,606	$35,644
Discounted Annual Cost		$517,062	$509,640	$502,325	$495,114	$488,007	$481,002	$474,098	$467,293	$460,585	$453,974	$447,458	$441,035
NATURAL GAS COSTS													
Natural Gas Usage Schedule	A	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Natural Gas Cost	$2,017,438	$2,104,226	$2,191,674	$2,198,545	$2,250,033	$2,296,060	$2,391,474	$2,503,524	$2,649,371	$2,821,549	$2,978,436	$3,105,197	$3,254,770
Discounted Annual Cost		$2,013,613	$2,006,981	$1,926,577	$1,886,790	$1,842,476	$1,836,402	$1,839,660	$1,862,998	$1,898,633	$1,917,898	$1,913,418	$1,919,220
ELECTRICITY COSTS													
Electricity Usage Schedule	A	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Electricity Non-Fuel Cost	$688,447	$706,661	$732,835	$751,219	$760,445	$779,922	$796,863	$820,584	$852,234	$882,577	$918,754	$951,956	$975,523
Electricity Fuel Adjustment Cost	$231,854	$241,828	$251,878	$252,668	$258,585	$263,875	$274,840	$287,718	$304,479	$324,267	$342,297	$356,865	$374,055
Discounted Annual Cost		$907,646	$901,731	$879,703	$854,519	$837,596	$822,956	$814,412	$813,384	$812,091	$812,025	$806,494	$795,797
TOTAL ANNUAL NPV COST		$4,879,067	$4,797,057	$4,627,939	$4,498,944	$4,376,233	$4,296,489	$4,234,513	$4,202,376	$4,184,420	$4,153,381	$4,095,106	$4,043,838
CUMULATIVE NPV TOTAL		$4,879,067	$9,676,123	$14,304,063	$18,803,007	$23,179,240	$27,475,729	$31,710,242	$35,912,618	$40,097,037	$44,250,419	$48,345,525	$52,389,363
NON-DISCOUNTED ANNUAL COST		$5,098,625	$5,238,506	$5,281,248	$5,365,075	$5,453,582	$5,595,146	$5,762,587	$5,976,201	$6,218,446	$6,450,074	$6,645,755	$6,857,870
NON-DISCOUNTED ANNUAL SAVINGS		-$1,340,831	-$1,329,943	-$1,333,246	-$1,338,755	-$1,338,272	-$1,334,963	-$1,325,805	-$1,308,245	-$1,289,445	-$1,268,801	-$1,253,939	-$1,243,999

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	TOTALS
CAPITAL INVESTMENT COSTS														
Project Cost	$1,505,580	$1,505,580	$1,505,580	$1,505,580	$1,505,580	$1,505,580	$1,505,580	$1,505,580	$1,505,580	$1,505,580	$1,505,580	$1,505,580	$1,505,580	
Rebate	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Discounted Annual Cost	$849,556	$812,972	$777,964	$744,463	$712,405	$681,727	$652,370	$624,278	$597,395	$571,670	$547,053	$523,495	$500,952	$22,325,048
O&M - ANNUALLY RECURRING COSTS														
CHP Plant Staffing O&M Schedule	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
CHP Plant Staffing	$293,707	$302,518	$311,593	$320,941	$330,570	$340,487	$350,701	$361,222	$372,059	$383,221	$394,717	$406,559	$418,756	
Prime Mover Maintenance O&M Schedule	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Prime Mover Maintenance	$439,961	$453,160	$466,755	$480,757	$495,180	$510,035	$525,336	$541,096	$557,329	$574,049	$591,271	$609,009	$627,279	
Steam Chiller Maintenance O&M Schedule	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Steam Chiller Maintenance	$36,713	$37,815	$38,949	$40,118	$41,321	$42,561	$43,838	$45,153	$46,507	$47,903	$49,340	$50,820	$52,344	
Discounted Annual Cost	$434,704	$428,464	$422,314	$416,252	$410,277	$404,388	$398,584	$392,862	$387,223	$381,665	$376,186	$370,787	$365,464	$10,926,765
NATURAL GAS COSTS														
Natural Gas Usage Schedule	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Natural Gas Cost	$3,395,768	$3,554,945	$3,678,828	$3,839,350	$3,998,526	$4,165,683	$4,361,316	$4,523,185	$4,867,456	$5,181,428	$5,366,962	$5,559,139	$5,758,198	
Discounted Annual Cost	$1,916,136	$1,919,574	$1,900,925	$1,898,441	$1,892,008	$1,886,223	$1,889,766	$1,875,506	$1,931,345	$1,967,393	$1,950,086	$1,932,932	$1,915,929	$47,740,931
ELECTRICITY COSTS														
Electricity Usage Schedule	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Electricity Non-Fuel Cost	$1,006,554	$1,045,122	$1,074,812	$1,100,275	$1,137,072	$1,184,394	$1,228,830	$1,262,117	$1,318,195	$1,374,653	$1,407,923	$1,441,999	$1,476,899	
Electricity Fuel Adjustment Cost	$390,259	$408,552	$422,790	$441,238	$459,531	$478,742	$501,225	$519,827	$559,393	$595,476	$616,799	$638,885	$661,761	
Discounted Annual Cost	$788,182	$784,945	$773,841	$762,231	$755,475	$753,068	$749,636	$738,871	$745,003	$748,060	$735,683	$723,530	$711,598	$19,828,476
TOTAL ANNUAL NPV COST	$3,988,578	$3,945,955	$3,875,045	$3,821,387	$3,770,165	$3,725,407	$3,690,356	$3,631,517	$3,660,967	$3,668,787	$3,609,008	$3,550,744	$3,493,943	$100,821,220
CUMULATIVE NPV TOTAL	$56,377,941	$60,323,896	$64,198,941	$68,020,328	$71,790,492	$75,515,899	$79,206,255	$82,837,772	$86,498,738	$90,167,525	$93,776,533	$97,327,277	$100,821,220	
NON-DISCOUNTED ANNUAL COST	$7,068,542	$7,307,692	$7,499,306	$7,728,259	$7,967,779	$8,227,481	$8,516,826	$8,758,180	$9,226,519	$9,662,308	$9,932,590	$10,211,989	$10,500,817	$14,830,354
NON-DISCOUNTED ANNUAL SAVINGS	-$1,230,451	-$1,210,497	-$1,201,011	-$1,191,365	-$1,174,776	-$1,150,858	-$1,126,768	-$1,114,663	-$1,068,804	-$1,026,668	-$1,014,687	-$1,002,368	-$989,700	0.2

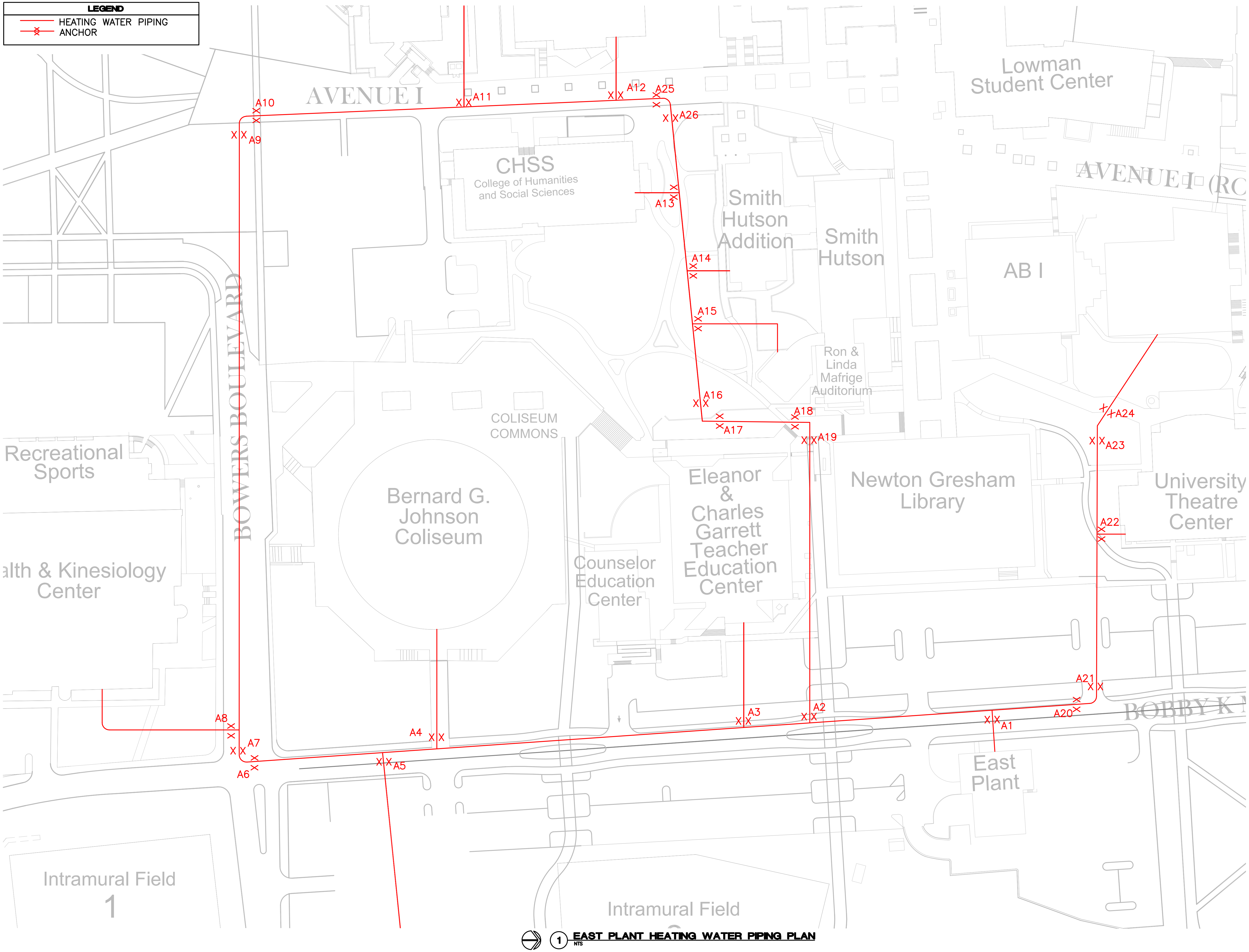
OPTION D

	BASELINE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	TOTALS
CAPITAL INVESTMENT COSTS																											
Project Cost	$1,476,343	$1,476,343	$1,476,343	$1,476,343	$1,476,343	$1,476,343	$1,476,343	$1,476,343	$1,476,343	$1,476,343	$1,476,343	$1,476,343	$1,476,343	$1,476,343	$1,476,343	$1,476,343	$1,476,343	$1,476,343	$1,476,343	$1,476,343	$1,476,343	$1,476,343	$1,476,343	$1,476,343	$1,476,343	$1,476,343	
Rebate	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Discounted Annual Cost		$1,412,768	$1,351,931	$1,293,714	$1,238,004	$1,184,693	$1,133,677	$1,084,859	$1,038,142	$993,438	$950,658	$909,721	$870,546	$833,058	$797,185	$762,857	$730,006	$698,571	$668,489	$639,702	$612,155	$585,794	$560,569	$536,429	$513,330	$491,224	$21,891,521
O&M - ANNUALLY RECURRING COSTS																											
CHP Plant Staffing O&M Schedule	A	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
CHP Plant Staffing	$200,000	$206,000	$212,180	$218,545	$225,102	$231,855	$238,810	$245,975	$253,354	$260,955	$268,783	$276,847	$285,152	$293,707	$302,518	$311,593	$320,941	$330,570	$340,487	$350,701	$361,222	$372,059	$383,221	$394,717	$406,559	$418,756	
Prime Mover Maintenance O&M Schedule	A	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Prime Mover Maintenance	$299,592	$308,580	$317,837	$327,372	$337,193	$347,309	$357,729	$368,460	$379,514	$390,900	$402,627	$414,705	$427,147	$439,961	$453,160	$466,755	$480,757	$495,180	$510,035	$525,336	$541,096	$557,329	$574,049	$591,271	$609,009	$627,279	
STG Maintenance O&M Schedule	A	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
STG Maintenance	$18,000	$18,540	$19,096	$19,669	$20,259	$20,867	$21,493	$22,138	$22,802	$23,486	$24,190	$24,916	$25,664	$26,434	$27,227	$28,043	$28,885	$29,751	$30,644	$31,563	$32,510	$33,485	$34,490	$35,525	$36,590	$37,688	
Discounted Annual Cost		$510,162	$502,840	$495,622	$488,508	$481,495	$474,584	$467,772	$461,057	$454,439	$447,916	$441,487	$435,150	$428,904	$422,747	$416,679	$410,698	$404,803	$398,992	$393,265	$387,620	$382,056	$376,572	$371,167	$365,839	$360,588	$10,780,962
NATURAL GAS COSTS																											
Natural Gas Usage Schedule	A	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Natural Gas Cost	$2,086,882	$2,176,657	$2,267,115	$2,274,223	$2,327,483	$2,375,095	$2,473,793	$2,589,700	$2,740,567	$2,918,671	$3,080,959	$3,212,084	$3,366,805	$3,512,657	$3,677,312	$3,805,460	$3,971,508	$4,136,162	$4,309,074	$4,511,441	$4,678,881	$5,035,002	$5,359,782	$5,551,702	$5,750,495	$5,956,405	
Discounted Annual Cost		$2,082,925	$2,076,065	$1,992,894	$1,951,737	$1,905,897	$1,899,615	$1,902,985	$1,927,126	$1,963,987	$1,983,915	$1,979,282	$1,985,283	$1,982,093	$1,985,649	$1,966,359	$1,963,789	$1,957,134	$1,951,150	$1,954,815	$1,940,065	$1,997,826	$2,035,114	$2,017,212	$1,999,467	$1,981,878	$49,384,262
ELECTRICITY COSTS																											
Electricity Usage Schedule	A	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Electricity Non-Fuel Cost	$704,903	$723,553	$750,352	$769,176	$778,621	$798,564	$815,910	$840,198	$872,605	$903,674	$940,715	$974,710	$998,841	$1,030,614	$1,070,104	$1,100,503	$1,126,575	$1,164,251	$1,212,705	$1,258,203	$1,292,286	$1,349,704	$1,407,511	$1,441,577	$1,476,467	$1,512,201	
Electricity Fuel Adjustment Cost	$315,144	$328,701	$342,361	$343,435	$351,477	$358,667	$373,572	$391,075	$413,858	$440,754	$465,261	$485,063	$508,427	$530,453	$555,318	$574,669	$599,745	$624,609	$650,721	$681,281	$706,566	$760,345	$809,390	$838,373	$868,393	$899,488	
Discounted Annual Cost		$1,006,941	$1,000,630	$974,977	$947,657	$928,622	$913,398	$904,775	$904,622	$904,671	$905,347	$899,510	$888,782	$880,866	$877,684	$865,596	$853,612	$846,447	$843,760	$840,382	$828,810	$837,241	$841,759	$828,420	$815,316	$802,443	$22,142,266
TOTAL ANNUAL NPV COST		$5,012,797	$4,931,466	$4,757,206	$4,625,906	$4,500,707	$4,421,274	$4,360,390	$4,330,948	$4,316,535	$4,287,836	$4,230,000	$4,179,761	$4,124,920	$4,083,265	$4,011,490	$3,958,105	$3,906,954	$3,862,391	$3,828,164	$3,768,649	$3,802,917	$3,814,014	$3,753,228	$3,693,951	$3,636,133	$104,199,010
CUMULATIVE NPV TOTAL		$5,012,797	$9,944,263	$14,701,470	$19,327,376	$23,828,083	$28,249,358	$32,609,748	$36,940,696	$41,257,231	$45,545,067	$49,775,067	$53,954,828	$58,079,748	$62,163,013	$66,174,503	$70,132,608	$74,039,563	$77,901,953	$81,730,117	$85,498,767	$89,301,684	$93,115,698	$96,868,926	$100,562,877	$104,199,010	
NON-DISCOUNTED ANNUAL COST		$5,238,373	$5,385,284	$5,428,763	$5,516,479	$5,608,700	$5,757,649	$5,933,889	$6,159,043	$6,414,782	$6,658,879	$6,864,668	$7,088,379	$7,310,168	$7,561,981	$7,763,367	$8,004,754	$8,256,867	$8,530,008	$8,834,868	$9,088,905	$9,584,268	$10,044,786	$10,329,507	$10,623,855	$10,928,160	$10,873,233
NON-DISCOUNTED ANNUAL SAVINGS		-$1,480,580	-$1,476,721	-$1,480,761	-$1,490,159	-$1,493,390	-$1,497,466	-$1,497,107	-$1,491,087	-$1,485,782	-$1,477,605	-$1,472,851	-$1,474,508	-$1,472,077	-$1,464,787	-$1,465,071	-$1,467,860	-$1,463,864	-$1,453,385	-$1,444,810	-$1,445,387	-$1,426,553	-$1,409,145	-$1,411,603	-$1,414,234	-$1,417,043	0.0

OPTION E

	BASELINE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	TOTALS
CAPITAL INVESTMENT COSTS																											
Project Cost	$1,480,832	$1,480,832	$1,480,832	$1,480,832	$1,480,832	$1,480,832	$1,480,832	$1,480,832	$1,480,832	$1,480,832	$1,480,832	$1,480,832	$1,480,832	$1,480,832	$1,480,832	$1,480,832	$1,480,832	$1,480,832	$1,480,832	$1,480,832	$1,480,832	$1,480,832	$1,480,832	$1,480,832	$1,480,832	$1,480,832	
Rebate	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Discounted Annual Cost		$1,417,064	$1,356,042	$1,297,648	$1,241,769	$1,188,295	$1,137,125	$1,088,158	$1,041,299	$996,458	$953,549	$912,487	$873,193	$835,592	$799,609	$765,176	$732,226	$700,695	$670,521	$641,647	$614,016	$587,576	$562,273	$538,061	$514,890	$492,718	$21,958,087
O&M - ANNUALLY RECURRING COSTS																											
CHP Plant Staffing O&M Schedule	A	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
CHP Plant Staffing	$300,000	$309,000	$318,270	$327,818	$337,653	$347,782	$358,216	$368,962	$380,031	$391,432	$403,175	$415,270	$427,728	$440,560	$453,777	$467,390	$481,412	$495,854	$510,730	$526,052	$541,833	$558,088	$574,831	$592,076	$609,838	$628,133	
Prime Mover Maintenance O&M Schedule	A	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Prime Mover Maintenance	$420,000	$432,600	$445,578	$458,945	$472,714	$486,895	$501,502	$516,547	$532,043	$548,005	$564,445	$581,378	$598,820	$616,784	$635,288	$654,346	$673,977	$694,196	$715,022	$736,473	$758,567	$781,324	$804,763	$828,906	$853,774	$879,387	
STG Maintenance O&M Schedule	A	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
STG Maintenance	$18,000	$18,540	$19,096	$19,669	$20,259	$20,867	$21,493	$22,138	$22,802	$23,486	$24,190	$24,916	$25,664	$26,434	$27,227	$28,043	$28,885	$29,751	$30,644	$31,563	$32,510	$33,485	$34,490	$35,525	$36,590	$37,688	
Discounted Annual Cost		$727,407	$716,965	$706,674	$696,530	$686,532	$676,678	$666,965	$657,391	$647,955	$638,654	$629,487	$620,451	$611,545	$602,767	$594,115	$585,587	$577,181	$568,896	$560,730	$552,682	$544,748	$536,929	$529,222	$521,625	$514,138	$15,371,856
NATURAL GAS COSTS																											
Natural Gas Usage Schedule	A	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Natural Gas Cost	$2,236,932	$2,333,162	$2,430,124	$2,437,743	$2,494,832	$2,545,867	$2,651,662	$2,775,903	$2,937,618	$3,128,528	$3,302,485	$3,443,037	$3,608,883	$3,765,222	$3,941,717	$4,079,078	$4,257,065	$4,433,558	$4,618,902	$4,835,820	$5,015,299	$5,397,026	$5,745,158	$5,950,878	$6,163,964	$6,384,680	
Discounted Annual Cost		$2,232,691	$2,225,337	$2,136,186	$2,092,070	$2,042,934	$2,036,200	$2,039,812	$2,065,689	$2,105,200	$2,126,561	$2,121,595	$2,128,028	$2,124,608	$2,128,420	$2,107,743	$2,104,988	$2,097,855	$2,091,441	$2,095,369	$2,079,558	$2,141,472	$2,181,442	$2,162,252	$2,143,232	$2,124,378	$52,935,062
ELECTRICITY COSTS																											
Electricity Usage Schedule	A	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Electricity Non-Fuel Cost	$759,572	$779,667	$808,545	$828,829	$839,007	$860,496	$879,187	$905,359	$940,279	$973,758	$1,013,671	$1,050,303	$1,076,306	$1,110,542	$1,153,095	$1,185,852	$1,213,946	$1,254,544	$1,306,755	$1,355,782	$1,392,508	$1,454,379	$1,516,670	$1,553,377	$1,590,973	$1,629,479	
Electricity Fuel Adjustment Cost	$599,060	$624,831	$650,798	$652,838	$668,127	$681,794	$710,127	$743,399	$786,707	$837,833	$884,420	$922,060	$966,475	$1,008,343	$1,055,609	$1,092,395	$1,140,060	$1,187,326	$1,236,962	$1,295,053	$1,343,119	$1,445,347	$1,538,578	$1,593,671	$1,650,736	$1,709,845	
Discounted Annual Cost		$1,344,017	$1,336,364	$1,298,379	$1,263,824	$1,237,613	$1,220,427	$1,211,554	$1,214,391	$1,219,028	$1,222,233	$1,215,368	$1,204,554	$1,195,627	$1,192,640	$1,177,217	$1,163,984	$1,155,435	$1,151,796	$1,148,612	$1,134,308	$1,150,575	$1,160,080	$1,143,480	$1,127,154	$1,111,095	$29,999,756
TOTAL ANNUAL NPV COST		$5,721,179	$5,634,709	$5,438,887	$5,294,193	$5,155,374	$5,070,430	$5,006,489	$4,978,771	$4,968,641	$4,940,998	$4,878,937	$4,826,226	$4,767,372	$4,723,436	$4,644,250	$4,586,785	$4,531,166	$4,482,655	$4,446,359	$4,380,564	$4,424,371	$4,440,724	$4,373,015	$4,306,901	$4,242,330	$120,264,761
CUMULATIVE NPV TOTAL		$5,721,179	$11,355,888	$16,794,775	$22,088,968	$27,244,342	$32,314,772	$37,321,261	$42,300,032	$47,268,673	$52,209,671	$57,088,607	$61,914,833	$66,682,205	$71,405,641	$76,049,891	$80,636,676	$85,167,843	$89,650,497	$94,096,856	$98,477,420	$102,901,791	$107,342,515	$111,715,530	$116,022,431	$120,264,761	
NON-DISCOUNTED ANNUAL COST		$5,978,632	$6,153,243	$6,206,674	$6,313,424	$6,424,535	$6,603,018	$6,813,140	$7,080,313	$7,383,874	$7,673,218	$7,917,797	$8,184,707	$8,448,717	$8,747,544	$8,987,936	$9,276,177	$9,576,062	$9,899,847	$10,261,575	$10,564,668	$11,150,482	$11,695,322	$12,035,264	$12,386,707	$12,750,044	-$535,057
NON-DISCOUNTED ANNUAL SAVINGS		-$2,220,838	-$2,244,679	-$2,258,672	-$2,287,103	-$2,309,224	-$2,342,835	-$2,376,358	-$2,412,356	-$2,454,873	-$2,491,945	-$2,525,981	-$2,570,836	-$2,610,627	-$2,650,349	-$2,689,641	-$2,739,283	-$2,783,060	-$2,823,224	-$2,871,517	-$2,921,151	-$2,992,767	-$3,059,681	-$3,117,361	-$3,177,086	-$3,238,927	-0.7

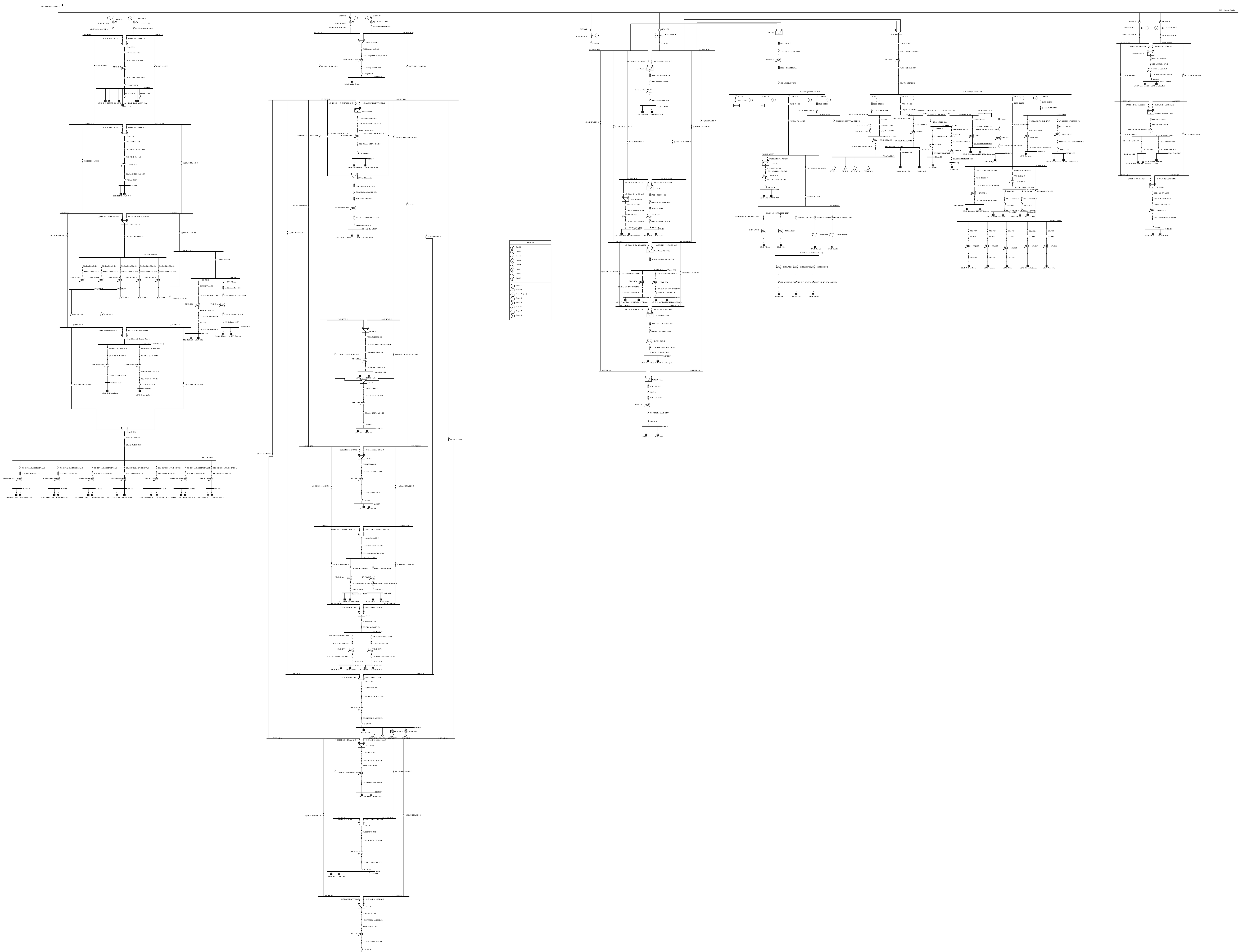
APPENDIX E – THERMAL EXPANSION MODEL RESULTS



1 EAST PLANT HEATING WATER PIPING PLAN
NTS

Anchor	Load (lb)
A1	90,200
A2	102,600
A3	34,200
A4	34,200
A5	53,000
A6	105,500
A7	105,500
A8	38,700
A9	105,500
A10	105,500
A11	45,400
A12	34,200
A13	53,000
A14	53,000
A15	11,700
A16	105,500
A17	105,500
A18	105,500
A19	105,500
A20	61,100
A21	55,300
A22	35,000
A23	42,800
A24	30,500
A25	105,500
A26	105,500

APPENDIX F – ELECTRICAL ONE-LINE



APPENDIX G – SHORT CIRCUIT REPORT

Project: SamHoustonUniver

DAPPER Fault Contribution Complete Report

Comprehensive Short Circuit Study Settings

Three Phase Fault	Yes	**Faulted Bus**	All Buses
Single Line to Ground	No	**Bus Voltages**	First Bus From Fault
Line to Line Fault	No	**Branch Currents**	First Branch From Fault
Line to Line to Ground	No	**Phase or Sequence**	Report phase quantities
Motor Contribution	Yes	**Fault Current Calculation**	Initial Symmetrical RMS (with 1/2 Cycle Asym)
Transformer Tap	Yes	**Asym Fault Current at Time**	0.50 **Cycles**
Xformer Phase Shift	Yes		

				-------------Initial Symmetrical Amps-----------				----------------Asymmetrical Amps----------------				---Init Sym Neutral Amps---	
Bus Name	---------Contributions---------			**3 Phase**	**SLG**	**LLG**	**LL**	**3 Phase**	**SLG**	**LLG**	**LL**	**SLG**	**LLG**
(1) BUS MH-2				**8,446**	**0**	**0**	**0**	**11,161**	**0**	**0**	**0**		
	(1)CBL MH-2 to S&C CJC	CABLE	In	0	0	0	0	0	0	0	0		
	(1)MH-2 to MH-5	CABLE	In	984	0	0	0	1,300	0	0	0		
	(1)CBL Substation to MH-2	CABLE	In	7,462	0	0	0	9,861	0	0	0		
(1)BUS MH-10				**6,950**	**0**	**0**	**0**	**7,853**	**0**	**0**	**0**		
	) CBL MH10 to Bowers S&C	CABLE	In	0	0	0	0	0	0	0	0		
	(1) CBL MH-10 to S&C BKV	CABLE	In	0	0	0	0	0	0	0	0		
	(1) CBL MH-8 to MH-10	CABLE	In	6,950	0	0	0	7,853	0	0	0		
(1)BUS MH-5				**8,025**	**0**	**0**	**0**	**10,034**	**0**	**0**	**0**		
	(1)CBL MH-5 to S&C PAC	CABLE	In	0	0	0	0	0	0	0	0		
	(1)CBL MH-5 to MH-8	CABLE	In	991	0	0	0	1,240	0	0	0		
	(1)MH-2 to MH-5	CABLE	In	7,037	0	0	0	8,799	0	0	0		
(1)BUS MH-8				**7,690**	**0**	**0**	**0**	**9,278**	**0**	**0**	**0**		
	(1) CBL MH-8 to MH-10	CABLE	In	0	0	0	0	0	0	0	0		
	CBL MH-8 to S&C East Plant	CABLE	In	998	0	0	0	1,204	0	0	0		

				------------Initial Symmetrical Amps-----------				---------------Asymmetrical Amps---------------				---Init Sym Neutral Amps---	
Bus Name	**---------Contributions---------**			**3 Phase**	**SLG**	**LLG**	**LL**	**3 Phase**	**SLG**	**LLG**	**LL**	**SLG**	**LLG**
	(1)CBL MH-5 to MH-8	CABLE	In	6,701	0	0	0	8,084	0	0	0		
(2) BUS MH-11				**6,865**	**0**	**0**	**0**	**7,685**	**0**	**0**	**0**		
	L-HKC S&C to HKC XFMR	CABLE	In	0	0	0	0	0	0	0	0		
	Coliseum S&C to Col. XFMR	CABLE	In	0	0	0	0	0	0	0	0		
	(2) MH-9 to MH-11	CABLE	In	6,865	0	0	0	7,685	0	0	0		
(2) BUS MH-2				**8,386**	**0**	**0**	**0**	**10,955**	**0**	**0**	**0**		
	(2)CBL MH-2 to S&C CJC	CABLE	In	0	0	0	0	0	0	0	0		
	(2)MH-2 to MH-5	CABLE	In	0	0	0	0	0	0	0	0		
	(2)CBL Substation to MH-2	CABLE	In	8,386	0	0	0	10,955	0	0	0		
(2) BUS MH-9				**6,998**	**0**	**0**	**0**	**7,906**	**0**	**0**	**0**		
	(2) CBL MH-9 to MH-10	CABLE	In	0	0	0	0	0	0	0	0		
	(2) MH-9 to MH-11	CABLE	In	0	0	0	0	0	0	0	0		
	(2) CBL MH-8 to MH-9	CABLE	In	6,998	0	0	0	7,906	0	0	0		
(2)BUS MH-10				**6,354**	**0**	**0**	**0**	**6,902**	**0**	**0**	**0**		
	(2) CBL MH-10 to S&C BKV	CABLE	In	0	0	0	0	0	0	0	0		
	) CBL-MH10 to Bowers S&C	CABLE	In	0	0	0	0	0	0	0	0		
	(2) CBL MH-9 to MH-10	CABLE	In	6,354	0	0	0	6,902	0	0	0		
(2)BUS MH-5				**7,850**	**0**	**0**	**0**	**9,580**	**0**	**0**	**0**		
	(2)CBL MH-5 to S&C PAC	CABLE	In	0	0	0	0	0	0	0	0		
	(2)CBL MH-5 to MH-8	CABLE	In	0	0	0	0	0	0	0	0		
	(2)MH-2 to MH-5	CABLE	In	7,850	0	0	0	9,580	0	0	0		
(2)BUS MH-8				**7,430**	**0**	**0**	**0**	**8,693**	**0**	**0**	**0**		
	CBL MH-8 to S&C East Plant	CABLE	In	0	0	0	0	0	0	0	0		
	(2) CBL MH-8 to MH-9	CABLE	In	0	0	0	0	0	0	0	0		
	(2)CBL MH-5 to MH-8	CABLE	In	7,430	0	0	0	8,693	0	0	0		
(3) BUS MH-17				**8,104**	**0**	**0**	**0**	**10,291**	**0**	**0**	**0**		
	Parking Garage S&C		In	0	0	0	0	0	0	0	0		
	(3) CBL-MH-17 to MH-19	CABLE	In	179	0	0	0	227	0	0	0		
	(3)CBL Substation to MH-17	CABLE	In	7,925	0	0	0	10,065	0	0	0		
(3) BUS MH-23				**7,372**	**0**	**0**	**0**	**8,636**	**0**	**0**	**0**		
	(3)CBL MH-23 to TEC S&C	CABLE	In	0	0	0	0	0	0	0	0		
	(3) CBL MH-20 to MH-23	CABLE	In	7,372	0	0	0	8,636	0	0	0		
(3) BUS MH-46				**6,523**	**0**	**0**	**0**	**7,177**	**0**	**0**	**0**		
	(3)CBL MH-46 to SHV S&C	CABLE	In	0	0	0	0	0	0	0	0		
	(3)CBL MH-33 to MH-46	CABLE	In	6,523	0	0	0	7,177	0	0	0		
(3) MH-24				**7,453**	**0**	**0**	**0**	**8,800**	**0**	**0**	**0**		

Bus Name	---------Contributions---------			-------------Initial Symmetrical Amps----------- 3 Phase	SLG	LLG	LL	----------------Asymmetrical Amps---------------- 3 Phase	SLG	LLG	LL	---Init Sym Neutral Amps--- SLG	LLG
	(3)CBL MH-24 to CHSS	CABLE	In	179	0	0	0	212	0	0	0		
	(3) MH-19 to MH-24	CABLE	In	7,275	0	0	0	8,591	0	0	0		
(3)BUS MH-19				**7,805**	**0**	**0**	**0**	**9,558**	**0**	**0**	**0**		
	(3) Mh-19 to MH-36	CABLE	In	0	0	0	0	0	0	0	0		
	L MH-19 TO S.H.ADD S&C	CABLE	In	0	0	0	0	0	0	0	0		
	(3) MH-19 to MH-20	CABLE	In	0	0	0	0	0	0	0	0		
	BL MH-19 TO MUSIC S&C	CABLE	In	0	0	0	0	0	0	0	0		
	MH-19 TO S.HUTSON S&C	CABLE	In	0	0	0	0	0	0	0	0		
	(3) MH-19 to MH-24	CABLE	In	179	0	0	0	219	0	0	0		
	(3) CBL-MH-17 to MH-19	CABLE	In	7,627	0	0	0	9,341	0	0	0		
(3)BUS MH-20				**7,635**	**0**	**0**	**0**	**9,179**	**0**	**0**	**0**		
	(3) CBL MH-20 to MH-23	CABLE	In	0	0	0	0	0	0	0	0		
	(3)CBL MH-20 to MH-21	CABLE	In	0	0	0	0	0	0	0	0		
	CBL MH-20 to Library S&C	CABLE	In	0	0	0	0	0	0	0	0		
	(3) MH-19 to MH-20	CABLE	In	7,635	0	0	0	9,179	0	0	0		
(3)BUS MH-21				**7,438**	**0**	**0**	**0**	**8,766**	**0**	**0**	**0**		
	(3)CBL MH-21 to UTC S&C	CABLE	In	0	0	0	0	0	0	0	0		
	(3)CBL MH-20 to MH-21	CABLE	In	7,438	0	0	0	8,766	0	0	0		
(3)BUS MH-33				**7,376**	**0**	**0**	**0**	**8,645**	**0**	**0**	**0**		
	MH-33 to Admin/Comm S&C	CABLE	In	0	0	0	0	0	0	0	0		
	(3)CBL MH-33 to MH-46	CABLE	In	0	0	0	0	0	0	0	0		
	(3)CBL MH-36 to MH-33	CABLE	In	7,376	0	0	0	8,645	0	0	0		
(3)BUS MH-36				**7,640**	**0**	**0**	**0**	**9,190**	**0**	**0**	**0**		
	(3)CBL-MH-36 to LSC S&C	CABLE	In	0	0	0	0	0	0	0	0		
	(3)CBL MH-36 to MH-33	CABLE	In	0	0	0	0	0	0	0	0		
	(3) Mh-19 to MH-36	CABLE	In	7,640	0	0	0	9,190	0	0	0		
(3)MUSIC S&C				**7,658**	**0**	**0**	**0**	**9,186**	**0**	**0**	**0**		
	S&C MUSIC TO S&C AB1	CABLE	In	0	0	0	0	0	0	0	0		
	MUSIC S&C		In	0	0	0	0	0	0	0	0		
	BL MH-19 TO MUSIC S&C	CABLE	In	7,658	0	0	0	9,186	0	0	0		
(4) BUS MH-17				**8,081**	**0**	**0**	**0**	**10,230**	**0**	**0**	**0**		
	(4) CBL-MH-17 to MH-19	CABLE	In	0	0	0	0	0	0	0	0		
	Parking Garage S&C		In	8,081	0	0	0	10,229	0	0	0		
	(4)CBL Substation to MH-17	CABLE	In	8,081	0	0	0	10,230	0	0	0		
(4) BUS MH-23				**7,373**	**0**	**0**	**0**	**8,583**	**0**	**0**	**0**		
	(4)CBL MH-23 to TEC S&C	CABLE	In	0	0	0	0	0	0	0	0		

Bus Name	---------Contributions---------			-------------Initial Symmetrical Amps----------- 3 Phase	SLG	LLG	LL	----------------Asymmetrical Amps---------------- 3 Phase	SLG	LLG	LL	---Init Sym Neutral Amps--- SLG	LLG
	(4) CBL MH-20 to MH-23	CABLE	In	7,373	0	0	0	8,583	0	0	0		
(4) BUS MH-46				**6,497**	**0**	**0**	**0**	**7,135**	**0**	**0**	**0**		
	(4)CBL MH-46 to SHV S&C	CABLE	In	0	0	0	0	0	0	0	0		
	(4)CBL MH-33 to MH-46	CABLE	In	6,497	0	0	0	7,135	0	0	0		
(4) MH-24				**7,406**	**0**	**0**	**0**	**8,699**	**0**	**0**	**0**		
	(4)CBL MH-24 to CHSS	CABLE	In	0	0	0	0	0	0	0	0		
	(4) MH-19 to MH-24	CABLE	In	7,406	0	0	0	8,699	0	0	0		
(4) MUSIC S&C				**7,625**	**0**	**0**	**0**	**9,111**	**0**	**0**	**0**		
	L S&C MUSIC TO S&C AB1	CABLE	In	0	0	0	0	0	0	0	0		
	CBL MH-19 TO MUSIC S&C	CABLE	In	7,625	0	0	0	9,111	0	0	0		
	MUSIC S&C		In	7,658	0	0	0	9,186	0	0	0		
(4)BUS MH-19				**7,771**	**0**	**0**	**0**	**9,476**	**0**	**0**	**0**		
	CBL MH-19 TO MUSIC S&C	CABLE	In	0	0	0	0	0	0	0	0		
	(4) MH-19 to MH-24	CABLE	In	0	0	0	0	0	0	0	0		
	(4) MH-19 to MH-20	CABLE	In	0	0	0	0	0	0	0	0		
	L MH-19 TO S.H.ADD S&C	CABLE	In	0	0	0	0	0	0	0	0		
	MH-19 TO S.HUTSON S&C	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-0181	CABLE	In	0	0	0	0	0	0	0	0		
	(4) CBL-MH-17 to MH-19	CABLE	In	7,771	0	0	0	9,476	0	0	0		
(4)BUS MH-20				**7,602**	**0**	**0**	**0**	**9,104**	**0**	**0**	**0**		
	(4)CBL MH-20 to MH-21	CABLE	In	0	0	0	0	0	0	0	0		
	)CBL MH-20 to Library S&C	CABLE	In	0	0	0	0	0	0	0	0		
	(4) CBL MH-20 to MH-23	CABLE	In	0	0	0	0	0	0	0	0		
	(4) MH-19 to MH-20	CABLE	In	7,602	0	0	0	9,104	0	0	0		
(4)BUS MH-21				**7,406**	**0**	**0**	**0**	**8,699**	**0**	**0**	**0**		
	(4)CBL MH-21 to UTC S&C	CABLE	In	0	0	0	0	0	0	0	0		
	(4)CBL MH-20 to MH-21	CABLE	In	7,406	0	0	0	8,699	0	0	0		
(4)BUS MH-33				**7,345**	**0**	**0**	**0**	**8,580**	**0**	**0**	**0**		
	MH-33 to Admin/Comm S&C	CABLE	In	0	0	0	0	0	0	0	0		
	(4)CBL MH-33 to MH-46	CABLE	In	0	0	0	0	0	0	0	0		
	(4)CBL MH-36 to MH-33	CABLE	In	7,345	0	0	0	8,580	0	0	0		
(4)BUS MH-36				**7,607**	**0**	**0**	**0**	**9,114**	**0**	**0**	**0**		
	(4)CBL-MH-36 to LSC S&C	CABLE	In	0	0	0	0	0	0	0	0		
	(4)CBL MH-36 to MH-33	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-0181	CABLE	In	7,607	0	0	0	9,114	0	0	0		
(5) BUS MH-44				**7,710**	**0**	**0**	**0**	**9,096**	**0**	**0**	**0**		

Bus Name	---------Contributions---------			-------------Initial Symmetrical Amps-----------				----------------Asymmetrical Amps----------------				---Init Sym Neutral Amps---	
				3 Phase	SLG	LLG	LL	3 Phase	SLG	LLG	LL	SLG	LLG
	(5) CBL-MH-44 to CFS S&C	CABLE	In	0	0	0	0	0	0	0	0		
	5) CBL-MH-44 to CFS S&C0	CABLE	In	0	0	0	0	0	0	0	0		
	(5) CBL MH-25 MH-44	CABLE	In	7,710	0	0	0	9,096	0	0	0		
(5) BUS MH-47				**6,999**	**0**	**0**	**0**	**7,718**	**0**	**0**	**0**		
	CBL-MH-47 to RVA&B S&C	CABLE	In	0	0	0	0	0	0	0	0		
	(5) CBL-MH-47 to MH-48	CABLE	In	0	0	0	0	0	0	0	0		
	(5) CBL MH-25 to MH-47	CABLE	In	6,999	0	0	0	7,718	0	0	0		
(5) BUS MH-48				**6,799**	**0**	**0**	**0**	**7,419**	**0**	**0**	**0**		
	(5) CBL-MH-48 to RVC S&C	CABLE	In	0	0	0	0	0	0	0	0		
	(5) CBL-MH-47 to MH-48	CABLE	In	6,799	0	0	0	7,419	0	0	0		
(5) BUS-MH-25				**7,710**	**0**	**0**	**0**	**9,097**	**0**	**0**	**0**		
	(5) CBL MH-25 to MH-47	CABLE	In	0	0	0	0	0	0	0	0		
	(5) MH-25 to MH-30	CABLE	In	0	0	0	0	0	0	0	0		
	(5) CBL-MH-25 to LD S&C	CABLE	In	0	0	0	0	0	0	0	0		
	(5) CBL MH-25 MH-44	CABLE	In	0	0	0	0	0	0	0	0		
	VB1 S&C		In	0	0	0	0	0	0	0	0		
	VB2 S&C		In	224	0	0	0	270	0	0	0		
	CBL-0044	CABLE	In	7,710	0	0	0	9,097	0	0	0		
(5) BUS-MH-30				**7,592**	**0**	**0**	**0**	**8,836**	**0**	**0**	**0**		
	AB4 S&C Switch		In	0	0	0	0	0	0	0	0		
	(5) MH-25 to MH-30	CABLE	In	7,592	0	0	0	8,836	0	0	0		
(6) BUS MH-25				**7,633**	**0**	**0**	**0**	**9,168**	**0**	**0**	**0**		
	(6)CBL MH-25 to MH-47	CABLE	In	0	0	0	0	0	0	0	0		
	(6) MH-25 to MH-30	CABLE	In	0	0	0	0	0	0	0	0		
	(6) CBL-MH-25 to LD S&C	CABLE	In	0	0	0	0	0	0	0	0		
	(6) CBL MH-25 to MH-44	CABLE	In	0	0	0	0	0	0	0	0		
	VB2 S&C		In	7,408	0	0	0	8,899	0	0	0		
	CBL-0004	CABLE	In	7,409	0	0	0	8,899	0	0	0		
	VB1 S&C		In	7,633	0	0	0	9,168	0	0	0		
(6) BUS MH-30				**7,519**	**0**	**0**	**0**	**8,898**	**0**	**0**	**0**		
	AB4 S&C Switch		In	7,519	0	0	0	8,898	0	0	0		
	(6) MH-25 to MH-30	CABLE	In	7,519	0	0	0	8,898	0	0	0		
(6) BUS MH-44				**7,632**	**0**	**0**	**0**	**9,167**	**0**	**0**	**0**		
	(6) CBL-MH-44 to CFS S&C	CABLE	In	0	0	0	0	0	0	0	0		
	(6) CBL MH-25 to MH-44	CABLE	In	7,632	0	0	0	9,167	0	0	0		
(6) BUS MH-47				**6,945**	**0**	**0**	**0**	**7,747**	**0**	**0**	**0**		

Bus Name	---------Contributions---------			-------------Initial Symmetrical Amps-----------				----------------Asymmetrical Amps----------------				---Init Sym Neutral Amps---	
				3 Phase	SLG	LLG	LL	3 Phase	SLG	LLG	LL	SLG	LLG
	(6) CBL MH-47 to MH-48	CABLE	In	0	0	0	0	0	0	0	0		
	ΞBL-MH-47 to RVA&B S&C	CABLE	In	0	0	0	0	0	0	0	0		
	(6)CBL MH-25 to MH-47	CABLE	In	6,945	0	0	0	7,747	0	0	0		
(6) BUS MH-48				**6,750**	**0**	**0**	**0**	**7,441**	**0**	**0**	**0**		
	(6) CBL-MH-48 to RVC S&C	CABLE	In	0	0	0	0	0	0	0	0		
	(6) CBL MH-47 to MH-48	CABLE	In	6,750	0	0	0	7,441	0	0	0		
(7)BUS MH43				**7,987**	**0**	**0**	**0**	**9,772**	**0**	**0**	**0**		
	(8)CBL-MH43 to S&C OMM	CABLE	In	0	0	0	0	0	0	0	0		
	(7)CBL MH41 to MH43	CABLE	In	7,987	0	0	0	9,772	0	0	0		
(7)BUS-MH41				**8,070**	**0**	**0**	**0**	**9,995**	**0**	**0**	**0**		
	(7)CBL MH41 to MH43	CABLE	In	0	0	0	0	0	0	0	0		
	8)CBL-MH41 to S&C E&HC	CABLE	In	0	0	0	0	0	0	0	0		
	(7)CBL MH49 to MH41	CABLE	In	8,070	0	0	0	9,995	0	0	0		
(7)BUS-MH49				**8,160**	**0**	**0**	**0**	**10,251**	**0**	**0**	**0**		
	(7)CBL MH49 to MH41	CABLE	In	0	0	0	0	0	0	0	0		
	(7)CBL-MH49 to S&C LSH	CABLE	In	0	0	0	0	0	0	0	0		
	(7)CBL-MH1 to MH49	CABLE	In	8,160	0	0	0	10,251	0	0	0		
(8)BUS MH43				**8,139**	**0**	**0**	**0**	**10,190**	**0**	**0**	**0**		
	(7)CBL-MH43 to S&C OMM	CABLE	In	0	0	0	0	0	0	0	0		
	(8)CBL MH41 to MH43	CABLE	In	8,139	0	0	0	10,190	0	0	0		
(8)BUS-MH41				**8,223**	**0**	**0**	**0**	**10,437**	**0**	**0**	**0**		
	(8)CBL MH41 to MH43	CABLE	In	0	0	0	0	0	0	0	0		
	7)CBL-MH41 to S&C E&HC	CABLE	In	0	0	0	0	0	0	0	0		
	(8)CBL MH 49 TO MH41	CABLE	In	8,223	0	0	0	10,437	0	0	0		
(8)BUS-MH49				**8,315**	**0**	**0**	**0**	**10,723**	**0**	**0**	**0**		
	(8)CBL MH 49 TO MH41	CABLE	In	0	0	0	0	0	0	0	0		
	(8)CBL-MH49 to S&C LSH	CABLE	In	0	0	0	0	0	0	0	0		
	(8)CBL-MH1 to MH49	CABLE	In	8,315	0	0	0	10,723	0	0	0		
(F1) BUS MH31				**6,145**	**0**	**0**	**0**	**7,917**	**0**	**0**	**0**		
	)CBL MH31 TO ESTILL SW	CABLE	In	0	0	0	0	0	0	0	0		
	ΞBL MH31 TO FARR XFMR	CABLE	In	0	0	0	0	0	0	0	0		
	(F1)CBL FS1 TO MH31	CABLE	In	6,145	0	0	0	7,917	0	0	0		
(F2) BUS- MH34				**5,182**	**0**	**0**	**0**	**5,923**	**0**	**0**	**0**		
	(F2) CBL MH34 TO M35	CABLE	In	0	0	0	0	0	0	0	0		
	(F2) MH34 TO E/VC S&C	CABLE	In	0	0	0	0	0	0	0	0		
	CBL MH34 TO THO XFMR	CABLE	In	0	0	0	0	0	0	0	0		

Bus Name	---------Contributions---------			-------------Initial Symmetrical Amps-----------				----------------Asymmetrical Amps----------------				---Init Sym Neutral Amps---	
				3 Phase	SLG	LLG	LL	3 Phase	SLG	LLG	LL	SLG	LLG
	(F2)CBL FS2 TO MH34	CABLE	In	5,182	0	0	0	5,923	0	0	0		
(F2)BUS-MH35				**4,678**	**0**	**0**	**0**	**5,109**	**0**	**0**	**0**		
	CBL-0079	CABLE	Out										
	CBL-0080	CABLE	Out										
	CBL-0081	CABLE	Out										
	CBL-0082	CABLE	Out										
	CBL-0083	CABLE	Out										
	(F2) CBL MH34 TO M35	CABLE	In	4,678	0	0	0	5,109	0	0	0		
(F4)BUS- MH34				**4,792**	**0**	**0**	**0**	**5,477**	**0**	**0**	**0**		
	MH34 TO W.PLANT XFMR	CABLE	In	0	0	0	0	0	0	0	0		
	(F4)CBL-FS4 TO MH34	CABLE	In	4,792	0	0	0	5,477	0	0	0		
(F5) POLE AT 17TH, AVE J.				**5,401**	**0**	**0**	**0**	**5,798**	**0**	**0**	**0**		
	(F5) OH 17/J TO BB	CABLE	In	0	0	0	0	0	0	0	0		
	(F5) OH 17/J TO ELL	CABLE	In	0	0	0	0	0	0	0	0		
	(F5) OH M33 TO 17/J POLE	CABLE	In	5,401	0	0	0	5,798	0	0	0		
(F5) POLE AT BB				**5,155**	**0**	**0**	**0**	**5,408**	**0**	**0**	**0**		
	(F5) OH BB TO MLH	CABLE	In	0	0	0	0	0	0	0	0		
	BL BB FUSE TO BB XFMR	CABLE	In	0	0	0	0	0	0	0	0		
	(F5) OH 17/J TO BB	CABLE	In	5,155	0	0	0	5,408	0	0	0		
(F5) POLE AT ELLIOT				**5,155**	**0**	**0**	**0**	**5,408**	**0**	**0**	**0**		
	(F5) OH ELL TO SOR	CABLE	In	0	0	0	0	0	0	0	0		
	L ELL POLE TO ELL XFMR	CABLE	In	0	0	0	0	0	0	0	0		
	(F5) OH 17/J TO ELL	CABLE	In	5,155	0	0	0	5,408	0	0	0		
(F5)MH33				**5,653**	**0**	**0**	**0**	**6,281**	**0**	**0**	**0**		
	CBL POLE TO AUS XFMR	CABLE	In	0	0	0	0	0	0	0	0		
	(F5) OH M33 TO 17/J POLE	CABLE	In	0	0	0	0	0	0	0	0		
	(F5)CBL FS5 TO MH33	CABLE	In	5,653	0	0	0	6,281	0	0	0		
(F6)BUS - MH-37				**5,373**	**0**	**0**	**0**	**6,882**	**0**	**0**	**0**		
	(F6) CBL - MH-37 to MH-38	CABLE	In	0	0	0	0	0	0	0	0		
	F6) CBL MH-37 to AB3 S&C	CABLE	In	0	0	0	0	0	0	0	0		
	(F6)CBL - FS6 to MH37	CABLE	In	5,373	0	0	0	6,882	0	0	0		
AB1 MCB1				**11,729**	**0**	**0**	**0**	**14,086**	**0**	**0**	**0**		
	BL-AB1 XFMR to AB1 MDP	CABLE	In	11,729	0	0	0	14,086	0	0	0		
AB3 MDP				**20,427**	**0**	**0**	**0**	**23,644**	**0**	**0**	**0**		
	BL-AB3 CFMR to AB3 MDP	CABLE	In	20,427	0	0	0	23,644	0	0	0		
AB4 MDP				**14,155**	**0**	**0**	**0**	**15,852**	**0**	**0**	**0**		

Bus Name	---------Contributions---------			-------------Initial Symmetrical Amps-----------				----------------Asymmetrical Amps----------------				---Init Sym Neutral Amps---	
				3 Phase	SLG	LLG	LL	3 Phase	SLG	LLG	LL	SLG	LLG
	BL-AB4 XFMR to AB4 MDP	CABLE	In	14,155	0	0	0	15,852	0	0	0		
Admin MDP				**8,499**	**0**	**0**	**0**	**10,125**	**0**	**0**	**0**		
	Admin XFMR to Admin MCB	CABLE	In	8,499	0	0	0	10,125	0	0	0		
Baseball MDP				**15,523**	**0**	**0**	**0**	**19,341**	**0**	**0**	**0**		
	CBL-BB XFMR to BB MDP0	CABLE	In	15,523	0	0	0	19,341	0	0	0		
Belvin MDP				**22,528**	**0**	**0**	**0**	**25,563**	**0**	**0**	**0**		
	CBL BB XFMR TO BB MDP	CABLE	In	22,528	0	0	0	25,563	0	0	0		
BKV A&B				**11,378**	**0**	**0**	**0**	**11,378**	**0**	**0**	**0**		
	XFMR-BKV A&B	2W-XFMR	In	11,378	0	0	0	11,378	0	0	0		
BKV C&D				**11,376**	**0**	**0**	**0**	**11,376**	**0**	**0**	**0**		
	XFMR-BKV C&D	2W-XFMR	In	11,375	0	0	0	11,376	0	0	0		
BKV D&E				**14,863**	**0**	**0**	**0**	**14,863**	**0**	**0**	**0**		
	XFMR-BKV D&E	2W-XFMR	In	14,863	0	0	0	14,863	0	0	0		
BKV Distribution				**6,821**	**0**	**0**	**0**	**7,638**	**0**	**0**	**0**		
	KV S&C to XFMR BKV FGH	CABLE	In	0	0	0	0	0	0	0	0		
	KV S&C to XFMR BKV F&I	CABLE	In	0	0	0	0	0	0	0	0		
	KV S&C to XFMR BKV C&D	CABLE	In	0	0	0	0	0	0	0	0		
	KV S&C to XFMR BKV K&L	CABLE	In	0	0	0	0	0	0	0	0		
	KV S&C to XFMR BKV D&E	CABLE	In	0	0	0	0	0	0	0	0		
	KV S&C to XFMR BKV J&M	CABLE	In	0	0	0	0	0	0	0	0		
	KV S&C to XFMR BKV A&B	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-S&C to BKV DIST	CABLE	In	6,821	0	0	0	7,638	0	0	0		
BKV-F&I				**11,375**	**0**	**0**	**0**	**11,375**	**0**	**0**	**0**		
	XFMR-BKV-F&I	2W-XFMR	In	11,375	0	0	0	11,375	0	0	0		
BKV-F,G,H				**15,637**	**0**	**0**	**0**	**15,637**	**0**	**0**	**0**		
	XFMR-BKV FGH	2W-XFMR	In	15,637	0	0	0	15,638	0	0	0		
BKV-J&M				**7,917**	**0**	**0**	**0**	**7,917**	**0**	**0**	**0**		
	XFMR-BKV J&M	2W-XFMR	In	7,917	0	0	0	7,917	0	0	0		
BKV-K&L				**11,375**	**0**	**0**	**0**	**11,375**	**0**	**0**	**0**		
	XFMR-BKV K&L	2W-XFMR	In	11,375	0	0	0	11,375	0	0	0		
BUS - MH-38				**5,186**	**0**	**0**	**0**	**6,406**	**0**	**0**	**0**		
	(F6) MH-38 to BARR XFMR	CABLE	In	0	0	0	0	0	0	0	0		
	(F6) MH-38 to PARK XFMR	CABLE	In	0	0	0	0	0	0	0	0		
	I-MH-38 TO ADAMS XFMR	CABLE	In	0	0	0	0	0	0	0	0		
	H-MH-38 TO ALLEN XFMR	CABLE	In	0	0	0	0	0	0	0	0		
	(F6)OH POLE X TO POLE Y	CABLE	In	0	0	0	0	0	0	0	0		

Bus Name	---------Contributions---------			-------------Initial Symmetrical Amps----------- 3 Phase	SLG	LLG	LL	----------------Asymmetrical Amps---------------- 3 Phase	SLG	LLG	LL	---Init Sym Neutral Amps--- SLG	LLG
(F6) CBL - MH-37 to MH-38	CABLE	In		5,186	0	0	0	6,406	0	0	0		
BUS- (MH34) (F7, WestPlant				**5,567**	**0**	**0**	**0**	**6,454**	**0**	**0**	**0**		
CBL-0092	CABLE	In		808	0	0	0	937	0	0	0		
(F7)CBL-FS7 TO MH34	CABLE	In		4,764	0	0	0	5,523	0	0	0		
BUS- Farrington Switches VE				**6,242**	**0**	**0**	**0**	**8,193**	**0**	**0**	**0**		
(F1)CBL FS1 TO MH31	CABLE	In		0	0	0	0	0	0	0	0		
(F2)CBL FS2 TO MH34	CABLE	In		0	0	0	0	0	0	0	0		
(F5)CBL FS5 TO MH33	CABLE	In		0	0	0	0	0	0	0	0		
(F7)CBL-FS7 TO MH34	CABLE	In		792	0	0	0	1,039	0	0	0		
CBL-VB2 XFMR TO FS	CABLE	In		5,450	0	0	0	7,154	0	0	0		
BUS-(Bowers,Softball/Baseba				**6,316**	**0**	**0**	**0**	**6,849**	**0**	**0**	**0**		
CBL FH S&C to FH XFMR	CABLE	In		0	0	0	0	0	0	0	0		
CBL BB S&C to BB XFMR	CABLE	In		0	0	0	0	0	0	0	0		
BUS-0109				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
I-MH-38 TO ADAMS XFMR	CABLE	In		0	0	0	0	0	0	0	0		
XMFR-ADAMS	2W-XFMR	In		0	0	0	0	0	0	0	0		
BUS-0110				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
XMFR-ADAMS	2W-XFMR	In		0	0	0	0	0	0	0	0		
BUS-0112				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
XFMR-ALLEN	2W-XFMR	In		0	0	0	0	0	0	0	0		
BUS-0114				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
XFMR-BARR	2W-XFMR	In		0	0	0	0	0	0	0	0		
BUS-0116				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
XFMR-PARKHILL	2W-XFMR	In		0	0	0	0	0	0	0	0		
BUS-0117				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
CBL-0079	CABLE	Out											
XF2-0076	2W-XFMR	In		0	0	0	0	0	0	0	0		
BUS-0125				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
CBL-0310	CABLE	In		0	0	0	0	0	0	0	0		
XF2-0076	2W-XFMR	In		0	0	0	0	0	0	0	0		
BUS-0126				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
CBL-0080	CABLE	Out											
XF2-0077	2W-XFMR	In		0	0	0	0	0	0	0	0		
BUS-0139				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
CBL-0311	CABLE	In		0	0	0	0	0	0	0	0		
XF2-0077	2W-XFMR	In		0	0	0	0	0	0	0	0		

Bus Name	---------Contributions---------			-------------Initial Symmetrical Amps----------- 3 Phase	SLG	LLG	LL	----------------Asymmetrical Amps---------------- 3 Phase	SLG	LLG	LL	---Init Sym Neutral Amps--- SLG	LLG
BUS-0142				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
	CBL-0081	CABLE	Out										
	XF2-0078	2W-XFMR	In	0	0	0	0	0	0	0	0		
BUS-0144				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
	CBL-0312	CABLE	In	0	0	0	0	0	0	0	0		
	XF2-0078	2W-XFMR	In	0	0	0	0	0	0	0	0		
BUS-0145				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
	CBL-0082	CABLE	Out										
	XF2-0079	2W-XFMR	In	0	0	0	0	0	0	0	0		
BUS-0146				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
	XF2-0079	2W-XFMR	In	0	0	0	0	0	0	0	0		
BUS-0147				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
	CBL-0083	CABLE	Out										
	XF2-0080	2W-XFMR	In	0	0	0	0	0	0	0	0		
BUS-0148				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
	XF2-0080	2W-XFMR	In	0	0	0	0	0	0	0	0		
BUS-0150				**5,195**	**0**	**0**	**0**	**5,468**	**0**	**0**	**0**		
	XFMR AUS	2W-XFMR	In	0	0	0	0	0	0	0	0		
	CBL POLE TO AUS XFMR	CABLE	In	5,195	0	0	0	5,468	0	0	0		
BUS-0151				**11,592**	**0**	**0**	**0**	**13,456**	**0**	**0**	**0**		
	CBL AUS XFMR TO WIRE	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR AUS	2W-XFMR	In	11,592	0	0	0	13,456	0	0	0		
BUS-0153				**24,699**	**0**	**0**	**0**	**29,103**	**0**	**0**	**0**		
	CBL BB XFMR TO BB MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR BB	2W-XFMR	In	24,699	0	0	0	29,103	0	0	0		
BUS-0155				**12,841**	**0**	**0**	**0**	**14,029**	**0**	**0**	**0**		
	L SOR XFMR TO SOR MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR SOR	2W-XFMR	In	12,841	0	0	0	14,029	0	0	0		
BUS-0161				**11,067**	**0**	**0**	**0**	**12,715**	**0**	**0**	**0**		
	XFMR MLH TO MLH MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR MLH	2W-XFMR	In	11,067	0	0	0	12,715	0	0	0		
BUS-0329				**7,309**	**0**	**0**	**0**	**8,512**	**0**	**0**	**0**		
	XF2-Admin0	2W-XFMR	In	0	0	0	0	0	0	0	0		
	CBL-Dist to Admin XFMR	CABLE	In	7,309	0	0	0	8,512	0	0	0		
BUS-0330				**7,309**	**0**	**0**	**0**	**8,512**	**0**	**0**	**0**		
	XFMR-Comm	2W-XFMR	In	0	0	0	0	0	0	0	0		

Bus Name	---------Contributions---------			-------------Initial Symmetrical Amps-----------				----------------Asymmetrical Amps----------------				---Init Sym Neutral Amps---	
				3 Phase	SLG	LLG	LL	3 Phase	SLG	LLG	LL	SLG	LLG
	CBL-Dist to Comm XFMR	CABLE	In	7,309	0	0	0	8,512	0	0	0		
BUS-0411				**6,910**	**0**	**0**	**0**	**7,584**	**0**	**0**	**0**		
	XFMR-RVA	2W-XFMR	In	0	0	0	0	0	0	0	0		
	3L-RVA S&C to RVA XFMR	CABLE	In	6,910	0	0	0	7,584	0	0	0		
BUS-0413				**6,715**	**0**	**0**	**0**	**7,296**	**0**	**0**	**0**		
	RAVEN C XFMR	2W-XFMR	In	0	0	0	0	0	0	0	0		
	L-RV C S&C to RV C XFMR	CABLE	In	6,715	0	0	0	7,296	0	0	0		
BUS-0485				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
	CBL-0310	CABLE	In	0	0	0	0	0	0	0	0		
BUS-0486				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
	CBL-0311	CABLE	In	0	0	0	0	0	0	0	0		
BUS-0487				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
	CBL-0312	CABLE	In	0	0	0	0	0	0	0	0		
BUS-0577				**6,780**	**0**	**0**	**0**	**7,571**	**0**	**0**	**0**		
	XFMR-BKV A&B	2W-XFMR	In	0	0	0	0	0	0	0	0		
	KV S&C to XFMR BKV A&B	CABLE	In	6,780	0	0	0	7,571	0	0	0		
BUS-0578				**6,719**	**0**	**0**	**0**	**7,472**	**0**	**0**	**0**		
	XFMR-BKV C&D	2W-XFMR	In	0	0	0	0	0	0	0	0		
	KV S&C to XFMR BKV C&D	CABLE	In	6,719	0	0	0	7,472	0	0	0		
BUS-0579				**6,719**	**0**	**0**	**0**	**7,472**	**0**	**0**	**0**		
	XFMR-BKV D&E	2W-XFMR	In	0	0	0	0	0	0	0	0		
	KV S&C to XFMR BKV D&E	CABLE	In	6,719	0	0	0	7,472	0	0	0		
BUS-0580				**6,698**	**0**	**0**	**0**	**7,440**	**0**	**0**	**0**		
	XFMR-BKV-F&I	2W-XFMR	In	0	0	0	0	0	0	0	0		
	KV S&C to XFMR BKV F&I	CABLE	In	6,698	0	0	0	7,440	0	0	0		
BUS-0581				**6,678**	**0**	**0**	**0**	**7,408**	**0**	**0**	**0**		
	XFMR-BKV FGH	2W-XFMR	In	0	0	0	0	0	0	0	0		
	KV S&C to XFMR BKV FGH	CABLE	In	6,678	0	0	0	7,408	0	0	0		
BUS-0582				**6,698**	**0**	**0**	**0**	**7,440**	**0**	**0**	**0**		
	XFMR-BKV J&M	2W-XFMR	In	0	0	0	0	0	0	0	0		
	KV S&C to XFMR BKV J&M	CABLE	In	6,698	0	0	0	7,440	0	0	0		
BUS-0583				**6,706**	**0**	**0**	**0**	**7,453**	**0**	**0**	**0**		
	XFMR-BKV K&L	2W-XFMR	In	0	0	0	0	0	0	0	0		
	KV S&C to XFMR BKV K&L	CABLE	In	6,706	0	0	0	7,453	0	0	0		
BUS-0597				**36,352**	**0**	**0**	**0**	**36,352**	**0**	**0**	**0**		
	Comm XFMR to Comm MDP	CABLE	In	0	0	0	0	0	0	0	0		

Bus Name	---------Contributions---------			-------------Initial Symmetrical Amps----------- 3 Phase	SLG	LLG	LL	----------------Asymmetrical Amps---------------- 3 Phase	SLG	LLG	LL	---Init Sym Neutral Amps--- SLG	LLG
	XFMR-Comm	2W-XFMR	In	36,352	0	0	0	36,352	0	0	0		
BUS-0601				**9,004**	**0**	**0**	**0**	**11,085**	**0**	**0**	**0**		
	dmin XFMR to Admin MCB	CABLE	In	0	0	0	0	0	0	0	0		
	XF2-Admin0	2W-XFMR	In	9,004	0	0	0	11,085	0	0	0		
BUS-0602				**6,481**	**0**	**0**	**0**	**7,112**	**0**	**0**	**0**		
	XFMR SHV1	2W-XFMR	In	0	0	0	0	0	0	0	0		
	3L-SHV Dist to SHV1 XFMR	CABLE	In	6,481	0	0	0	7,112	0	0	0		
BUS-0603				**6,353**	**0**	**0**	**0**	**6,922**	**0**	**0**	**0**		
	XFMR SHV2	2W-XFMR	In	0	0	0	0	0	0	0	0		
	3L-SHV Dist to SHV2 XFMR	CABLE	In	6,353	0	0	0	6,922	0	0	0		
BUS-0624				**5,679**	**0**	**0**	**0**	**7,879**	**0**	**0**	**0**		
	CBL-VB1 XFMR TO FS	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR - VB1	2W-XFMR	In	5,679	0	0	0	7,879	0	0	0		
BUS-0625				**5,058**	**0**	**0**	**0**	**5,271**	**0**	**0**	**0**		
	XFMR BB	2W-XFMR	In	0	0	0	0	0	0	0	0		
	BL BB FUSE TO BB XFMR	CABLE	In	5,058	0	0	0	5,271	0	0	0		
BUS-0626				**4,510**	**0**	**0**	**0**	**4,586**	**0**	**0**	**0**		
	XFMR SOR	2W-XFMR	In	0	0	0	0	0	0	0	0		
	CBL SOR POLE TO XFMR	CABLE	In	4,510	0	0	0	4,586	0	0	0		
BUS-0628				**4,690**	**0**	**0**	**0**	**4,806**	**0**	**0**	**0**		
	XFMR MLH	2W-XFMR	In	0	0	0	0	0	0	0	0		
	MLH FUSE TO MLH XFMR	CABLE	In	4,690	0	0	0	4,806	0	0	0		
BUS-0634				**5,539**	**0**	**0**	**0**	**6,399**	**0**	**0**	**0**		
	(F7)CBL W. PLANT	CABLE	In	809	0	0	0	934	0	0	0		
	CBL-0092	CABLE	In	4,736	0	0	0	5,471	0	0	0		
BUS-0635				**5,534**	**0**	**0**	**0**	**6,393**	**0**	**0**	**0**		
	MH34 TO W.PLANT XFMR	CABLE	In	0	0	0	0	0	0	0	0		
	(F4)CBL W.PLANT	CABLE	In	5,534	0	0	0	6,393	0	0	0		
BUS-0639				**7,532**	**0**	**0**	**0**	**8,940**	**0**	**0**	**0**		
	-THO XFMR TO THO MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR THO	2W-XFMR	In	7,532	0	0	0	8,940	0	0	0		
BUS-0647				**8,818**	**0**	**0**	**0**	**9,745**	**0**	**0**	**0**		
	3L ELL XFMR TO ELL MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XF2-0086	2W-XFMR	In	8,818	0	0	0	9,745	0	0	0		
BUS-0651				**8,287**	**0**	**0**	**0**	**10,646**	**0**	**0**	**0**		
	CBL-LSH S&C to XFMR	CABLE	In	0	0	0	0	0	0	0	0		

Bus Name	---------Contributions---------			-------------Initial Symmetrical Amps----------- 3 Phase	SLG	LLG	LL	----------------Asymmetrical Amps---------------- 3 Phase	SLG	LLG	LL	---Init Sym Neutral Amps--- SLG	LLG
BUS-0652				**8,288**	**0**	**0**	**0**	**10,647**	**0**	**0**	**0**		
	S&C Lone Star Hall		In	8,287	0	0	0	10,646	0	0	0		
	(8)CBL-MH49 to S&C LSH	CABLE	In	8,288	0	0	0	10,647	0	0	0		
BUS-0653				**8,285**	**0**	**0**	**0**	**10,639**	**0**	**0**	**0**		
	XFMR-Lone Star Hall	2W-XFMR	In	0	0	0	0	0	0	0	0		
	CBL-LSH S&C to XFMR	CABLE	In	8,285	0	0	0	10,639	0	0	0		
BUS-0655				**8,043**	**0**	**0**	**0**	**9,930**	**0**	**0**	**0**		
	CBL-EHC S&C to XFMR	CABLE	In	0	0	0	0	0	0	0	0		
BUS-0656				**8,040**	**0**	**0**	**0**	**9,924**	**0**	**0**	**0**		
	XFMR-Estill & Health Center	2W-XFMR	In	0	0	0	0	0	0	0	0		
	CBL-EHC S&C to XFMR	CABLE	In	8,040	0	0	0	9,924	0	0	0		
BUS-0661				**8,043**	**0**	**0**	**0**	**9,930**	**0**	**0**	**0**		
	S&C Estill and Health Center		In	0	0	0	0	0	0	0	0		
	8)CBL-MH41 to S&C E&HC	CABLE	In	8,043	0	0	0	9,930	0	0	0		
BUS-0662				**8,196**	**0**	**0**	**0**	**10,366**	**0**	**0**	**0**		
	S&C Estill and Health Center		In	8,043	0	0	0	9,930	0	0	0		
	7)CBL-MH41 to S&C E&HC	CABLE	In	8,196	0	0	0	10,366	0	0	0		
BUS-0665				**7,960**	**0**	**0**	**0**	**9,711**	**0**	**0**	**0**		
	S&C OMM		In	0	0	0	0	0	0	0	0		
	(8)CBL-MH43 to S&C OMM	CABLE	In	7,960	0	0	0	9,711	0	0	0		
BUS-0666				**8,112**	**0**	**0**	**0**	**10,123**	**0**	**0**	**0**		
	S&C OMM		In	7,960	0	0	0	9,711	0	0	0		
	(7)CBL-MH43 to S&C OMM	CABLE	In	8,112	0	0	0	10,123	0	0	0		
BUS-0667				**7,960**	**0**	**0**	**0**	**9,711**	**0**	**0**	**0**		
	CBL-OMM S&C to XFMR	CABLE	In	0	0	0	0	0	0	0	0		
BUS-0669				**7,958**	**0**	**0**	**0**	**9,705**	**0**	**0**	**0**		
	XFMR-OMM	2W-XFMR	In	0	0	0	0	0	0	0	0		
	CBL-OMM S&C to XFMR	CABLE	In	7,958	0	0	0	9,705	0	0	0		
BUS-0671				**40,979**	**0**	**0**	**0**	**40,979**	**0**	**0**	**0**		
	CBL-Lonestar XFMR to MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR-Lone Star Hall	2W-XFMR	In	40,978	0	0	0	40,979	0	0	0		
BUS-0672				**19,095**	**0**	**0**	**0**	**24,513**	**0**	**0**	**0**		
	-XFMR OMM to OMM MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR-OMM	2W-XFMR	In	19,095	0	0	0	24,513	0	0	0		
BUS-0673				**8,133**	**0**	**0**	**0**	**10,182**	**0**	**0**	**0**		
	S&C Lone Star Hall		In	0	0	0	0	0	0	0	0		

Bus Name	---------Contributions---------			-------------Initial Symmetrical Amps-----------				----------------Asymmetrical Amps----------------				---Init Sym Neutral Amps---	
				3 Phase	SLG	LLG	LL	3 Phase	SLG	LLG	LL	SLG	LLG
	(7)CBL-MH49 to S&C LSH	CABLE	In	8,133	0	0	0	10,182	0	0	0		
BUS-0674				**8,879**	**0**	**0**	**0**	**10,817**	**0**	**0**	**0**		
	E/VC XFMR TO E/VC MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR E/VC	2W-XFMR	In	8,879	0	0	0	10,817	0	0	0		
BUS-0675				**8,401**	**0**	**0**	**0**	**9,948**	**0**	**0**	**0**		
	CBL-To Evans MDP	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-To Evans MCB	CABLE	In	8,401	0	0	0	9,948	0	0	0		
BUS-0676				**5,130**	**0**	**0**	**0**	**5,380**	**0**	**0**	**0**		
	XF2-0086	2W-XFMR	In	0	0	0	0	0	0	0	0		
	L ELL POLE TO ELL XFMR	CABLE	In	5,130	0	0	0	5,380	0	0	0		
BUS-0677				**6,824**	**0**	**0**	**0**	**7,642**	**0**	**0**	**0**		
	CBL-S&C to BKV DIST	CABLE	In	0	0	0	0	0	0	0	0		
BUS-0678				**8,401**	**0**	**0**	**0**	**9,948**	**0**	**0**	**0**		
	CBL-To VisCen MDP	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-To VisCen MCB	CABLE	In	8,401	0	0	0	9,948	0	0	0		
BUS-0680				**6,244**	**0**	**0**	**0**	**6,746**	**0**	**0**	**0**		
	(2) CBL MH-10 to S&C BKV	CABLE	In	6,244	0	0	0	6,746	0	0	0		
	S&C - BKV		In	6,824	0	0	0	7,642	0	0	0		
BUS-0681				**6,824**	**0**	**0**	**0**	**7,642**	**0**	**0**	**0**		
	S&C - BKV		In	0	0	0	0	0	0	0	0		
	(1) CBL MH-10 to S&C BKV	CABLE	In	6,824	0	0	0	7,642	0	0	0		
BUS-0682				**6,908**	**0**	**0**	**0**	**7,781**	**0**	**0**	**0**		
	Bowers & Baseball Complex		In	0	0	0	0	0	0	0	0		
	) CBL MH10 to Bowers S&C	CABLE	In	6,908	0	0	0	7,781	0	0	0		
BUS-0684				**6,317**	**0**	**0**	**0**	**6,849**	**0**	**0**	**0**		
	Bowers & Baseball Complex		In	6,316	0	0	0	6,849	0	0	0		
	) CBL-MH10 to Bowers S&C	CABLE	In	6,317	0	0	0	6,849	0	0	0		
BUS-0685				**20,286**	**0**	**0**	**0**	**20,286**	**0**	**0**	**0**		
	CBL-FH XFMR to FH MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR-Field House	2W-XFMR	In	20,286	0	0	0	20,287	0	0	0		
BUS-0686				**6,225**	**0**	**0**	**0**	**6,720**	**0**	**0**	**0**		
	XFMR-Field House	2W-XFMR	In	0	0	0	0	0	0	0	0		
	CBL FH S&C to FH XFMR	CABLE	In	6,225	0	0	0	6,720	0	0	0		
BUS-0688				**6,225**	**0**	**0**	**0**	**6,720**	**0**	**0**	**0**		
	XFMR-Soft/Baseball	2W-XFMR	In	0	0	0	0	0	0	0	0		
	CBL BB S&C to BB XFMR	CABLE	In	6,225	0	0	0	6,720	0	0	0		

				-------------Initial Symmetrical Amps-----------				----------------Asymmetrical Amps----------------				---Init Sym Neutral Amps---	
Bus Name	---------Contributions---------			**3 Phase**	**SLG**	**LLG**	**LL**	**3 Phase**	**SLG**	**LLG**	**LL**	**SLG**	**LLG**
BUS-0690				**15,787**	**0**	**0**	**0**	**19,903**	**0**	**0**	**0**		
	CBL-BB XFMR to BB MDP0	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR-Soft/Baseball	2W-XFMR	In	15,787	0	0	0	19,903	0	0	0		
BUS-0694				**7,671**	**0**	**0**	**0**	**9,238**	**0**	**0**	**0**		
	S&C - East Plant		In	998	0	0	0	1,202	0	0	0		
	CBL MH-8 to S&C East Plant	CABLE	In	6,682	0	0	0	8,046	0	0	0		
BUS-0695				**7,406**	**0**	**0**	**0**	**8,646**	**0**	**0**	**0**		
	S&C - East Plant		In	6,681	0	0	0	8,046	0	0	0		
	CBL MH-8 to S&C East Plant	CABLE	In	7,406	0	0	0	8,646	0	0	0		
BUS-0696				**7,671**	**0**	**0**	**0**	**9,237**	**0**	**0**	**0**		
	CBL-S&C to East Plant Dist.	CABLE	In	998	0	0	0	1,202	0	0	0		
BUS-0697				**7,642**	**0**	**0**	**0**	**9,164**	**0**	**0**	**0**		
	XFMR-EP Chiller 2	2W-XFMR	In	307	0	0	0	368	0	0	0		
	CBL-East Plant Chiller #2	CABLE	In	7,338	0	0	0	8,799	0	0	0		
BUS-0698				**7,647**	**0**	**0**	**0**	**9,185**	**0**	**0**	**0**		
	XFMR-EP Chiller 1	2W-XFMR	In	366	0	0	0	440	0	0	0		
	CBL-East Plant Chiller #1	CABLE	In	7,284	0	0	0	8,749	0	0	0		
BUS-0700				**7,646**	**0**	**0**	**0**	**9,183**	**0**	**0**	**0**		
	XFMR-EP Chiller 3	2W-XFMR	In	233	0	0	0	280	0	0	0		
	CBL-East Plant Chiller #3	CABLE	In	7,415	0	0	0	8,906	0	0	0		
BUS-0701				**7,645**	**0**	**0**	**0**	**9,181**	**0**	**0**	**0**		
	XFMR-EP Equip 2	2W-XFMR	In	46	0	0	0	55	0	0	0		
	CBL-East Plant Equip #2	CABLE	In	7,599	0	0	0	9,125	0	0	0		
BUS-0702				**7,645**	**0**	**0**	**0**	**9,181**	**0**	**0**	**0**		
	XFMR-EP Equip 1	2W-XFMR	In	46	0	0	0	55	0	0	0		
	CBL-East Plant Equip #1	CABLE	In	7,599	0	0	0	9,125	0	0	0		
BUS-0720				**6,790**	**0**	**0**	**0**	**7,563**	**0**	**0**	**0**		
	XFMR-Coliseum	2W-XFMR	In	0	0	0	0	0	0	0	0		
	Coliseum S&C to Col. XFMR	CABLE	In	6,790	0	0	0	7,563	0	0	0		
BUS-0721				**13,512**	**0**	**0**	**0**	**16,906**	**0**	**0**	**0**		
	CBL-Col. XFMR to Col. MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR-Coliseum	2W-XFMR	In	13,512	0	0	0	16,906	0	0	0		
BUS-0722				**6,790**	**0**	**0**	**0**	**7,563**	**0**	**0**	**0**		
	XFMR-HKC	2W-XFMR	In	0	0	0	0	0	0	0	0		
	BL-HKC S&C to HKC XFMR	CABLE	In	6,790	0	0	0	7,563	0	0	0		
BUS-0725				**14,471**	**0**	**0**	**0**	**18,091**	**0**	**0**	**0**		

Bus Name	---------Contributions---------			-------------Initial Symmetrical Amps----------- 3 Phase	SLG	LLG	LL	----------------Asymmetrical Amps---------------- 3 Phase	SLG	LLG	LL	---Init Sym Neutral Amps--- SLG	LLG
	:BL-HKC XFMR to HKC SW	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR-HKC	2W-XFMR	In	14,471	0	0	0	18,091	0	0	0		
BUS-0726				**13,478**	**0**	**0**	**0**	**16,265**	**0**	**0**	**0**		
	CBL-HKC SW to HKC MDP	CABLE	In	0	0	0	0	0	0	0	0		
	:BL-HKC XFMR to HKC SW	CABLE	In	13,478	0	0	0	16,265	0	0	0		
BUS-0728				**7,920**	**0**	**0**	**0**	**9,780**	**0**	**0**	**0**		
	S&C PAC		In	0	0	0	0	0	0	0	0		
	(1)CBL MH-5 to S&C PAC	CABLE	In	7,920	0	0	0	9,780	0	0	0		
BUS-0729				**7,748**	**0**	**0**	**0**	**9,352**	**0**	**0**	**0**		
	S&C PAC		In	7,748	0	0	0	9,351	0	0	0		
	(2)CBL MH-5 to S&C PAC	CABLE	In	7,748	0	0	0	9,352	0	0	0		
BUS-0730				**7,748**	**0**	**0**	**0**	**9,351**	**0**	**0**	**0**		
	BL-PAC S&C to PAC XFMR	CABLE	In	0	0	0	0	0	0	0	0		
BUS-0731				**8,334**	**0**	**0**	**0**	**10,836**	**0**	**0**	**0**		
	S&C CJC		In	0	0	0	0	0	0	0	0		
	(1)CBL MH-2 to S&C CJC	CABLE	In	8,334	0	0	0	10,836	0	0	0		
BUS-0732				**7,746**	**0**	**0**	**0**	**9,346**	**0**	**0**	**0**		
	XFMR-PAC	2W-XFMR	In	0	0	0	0	0	0	0	0		
	BL-PAC S&C to PAC XFMR	CABLE	In	7,746	0	0	0	9,346	0	0	0		
BUS-0733				**26,428**	**0**	**0**	**0**	**34,642**	**0**	**0**	**0**		
	3L-PAC XFMR to PAC MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR-PAC	2W-XFMR	In	26,428	0	0	0	34,642	0	0	0		
BUS-0734				**8,275**	**0**	**0**	**0**	**10,644**	**0**	**0**	**0**		
	S&C CJC		In	8,275	0	0	0	10,643	0	0	0		
	(2)CBL MH-2 to S&C CJC	CABLE	In	8,275	0	0	0	10,644	0	0	0		
BUS-0735				**8,275**	**0**	**0**	**0**	**10,643**	**0**	**0**	**0**		
	:BL-CJC S&C to CJC XFMR	CABLE	In	0	0	0	0	0	0	0	0		
BUS-0738				**8,272**	**0**	**0**	**0**	**10,635**	**0**	**0**	**0**		
	XFMR-CJC	2W-XFMR	In	0	0	0	0	0	0	0	0		
	:BL-CJC S&C to CJC XFMR	CABLE	In	8,272	0	0	0	10,635	0	0	0		
BUS-0739				**57,044**	**0**	**0**	**0**	**80,710**	**0**	**0**	**0**		
	:BL-CJC XFMR to CJC MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR-CJC	2W-XFMR	In	57,044	0	0	0	80,710	0	0	0		
BUS-0740				**7,332**	**0**	**0**	**0**	**8,558**	**0**	**0**	**0**		
	S&C UTC		In	0	0	0	0	0	0	0	0		
	(3)CBL MH-21 to UTC S&C	CABLE	In	7,332	0	0	0	8,558	0	0	0		

Bus Name	---------Contributions---------			-------------Initial Symmetrical Amps----------- 3 Phase	SLG	LLG	LL	----------------Asymmetrical Amps---------------- 3 Phase	SLG	LLG	LL	---Init Sym Neutral Amps--- SLG	LLG
BUS-0741				**7,301**	**0**	**0**	**0**	**8,495**	**0**	**0**	**0**		
	(4)CBL MH-21 to UTC S&C	CABLE	In	7,301	0	0	0	8,495	0	0	0		
	S&C UTC		In	7,332	0	0	0	8,558	0	0	0		
BUS-0742				**7,332**	**0**	**0**	**0**	**8,558**	**0**	**0**	**0**		
	BL UTC S&C to UTC XFMR	CABLE	In	0	0	0	0	0	0	0	0		
BUS-0743				**7,526**	**0**	**0**	**0**	**8,947**	**0**	**0**	**0**		
	S&C Library		In	0	0	0	0	0	0	0	0		
	)CBL MH-20 to Library S&C	CABLE	In	7,526	0	0	0	8,947	0	0	0		
BUS-0744				**7,330**	**0**	**0**	**0**	**8,554**	**0**	**0**	**0**		
	XFMR UTC	2W-XFMR	In	0	0	0	0	0	0	0	0		
	BL UTC S&C to UTC XFMR	CABLE	In	7,330	0	0	0	8,554	0	0	0		
BUS-0745				**14,267**	**0**	**0**	**0**	**17,944**	**0**	**0**	**0**		
	3L UTC XFMR to UTC MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR UTC	2W-XFMR	In	14,267	0	0	0	17,944	0	0	0		
BUS-0746				**7,268**	**0**	**0**	**0**	**8,435**	**0**	**0**	**0**		
	S&C TEC		In	0	0	0	0	0	0	0	0		
	(3)CBL MH-23 to TEC S&C	CABLE	In	7,268	0	0	0	8,435	0	0	0		
BUS-0747				**7,526**	**0**	**0**	**0**	**8,947**	**0**	**0**	**0**		
	:BL LIB. S&C to LIB. XFMR	CABLE	In	0	0	0	0	0	0	0	0		
BUS-0748				**7,523**	**0**	**0**	**0**	**8,942**	**0**	**0**	**0**		
	XFMR Library	2W-XFMR	In	0	0	0	0	0	0	0	0		
	:BL LIB. S&C to LIB. XFMR	CABLE	In	7,523	0	0	0	8,942	0	0	0		
BUS-0749				**22,652**	**0**	**0**	**0**	**29,673**	**0**	**0**	**0**		
	CBL LIB XFMR to LIB MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR Library	2W-XFMR	In	22,652	0	0	0	29,673	0	0	0		
BUS-0750				**7,267**	**0**	**0**	**0**	**8,435**	**0**	**0**	**0**		
	:BL LIB. S&C to TEC XFMR	CABLE	In	0	0	0	0	0	0	0	0		
BUS-0751				**7,351**	**0**	**0**	**0**	**8,600**	**0**	**0**	**0**		
	S&C CHSS		In	179	0	0	0	210	0	0	0		
	(3)CBL MH-24 to CHSS	CABLE	In	7,174	0	0	0	8,393	0	0	0		
BUS-0752				**7,494**	**0**	**0**	**0**	**8,876**	**0**	**0**	**0**		
	)CBL MH-20 to Library S&C	CABLE	In	7,494	0	0	0	8,876	0	0	0		
	S&C Library		In	7,526	0	0	0	8,947	0	0	0		
BUS-0753				**14,259**	**0**	**0**	**0**	**17,923**	**0**	**0**	**0**		
	BL TEC XFMR to TEC MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR TEC	2W-XFMR	In	14,259	0	0	0	17,923	0	0	0		

Bus Name	---------Contributions---------			-------------Initial Symmetrical Amps-----------				----------------Asymmetrical Amps----------------				---Init Sym Neutral Amps---	
				3 Phase	SLG	LLG	LL	3 Phase	SLG	LLG	LL	SLG	LLG
BUS-0754				**7,268**	**0**	**0**	**0**	**8,386**	**0**	**0**	**0**		
	(4)CBL MH-23 to TEC S&C	CABLE	In	7,268	0	0	0	8,386	0	0	0		
	S&C TEC		In	7,267	0	0	0	8,435	0	0	0		
BUS-0755				**7,351**	**0**	**0**	**0**	**8,600**	**0**	**0**	**0**		
	CHSS S&C to CHSS XFMR	CABLE	In	179	0	0	0	210	0	0	0		
BUS-0757				**37,369**	**0**	**0**	**0**	**49,823**	**0**	**0**	**0**		
	CHSS XFMR to CHSS MDP	CABLE	In	5,668	0	0	0	7,556	0	0	0		
	XFMR CHSS	2W-XFMR	In	31,709	0	0	0	42,275	0	0	0		
BUS-0758				**7,301**	**0**	**0**	**0**	**8,495**	**0**	**0**	**0**		
	S&C CHSS		In	7,174	0	0	0	8,393	0	0	0		
	(4)CBL MH-24 to CHSS	CABLE	In	7,301	0	0	0	8,495	0	0	0		
BUS-0759				**7,265**	**0**	**0**	**0**	**8,430**	**0**	**0**	**0**		
	XFMR TEC	2W-XFMR	In	0	0	0	0	0	0	0	0		
	BL LIB. S&C to TEC XFMR	CABLE	In	7,265	0	0	0	8,430	0	0	0		
BUS-0766				**7,349**	**0**	**0**	**0**	**8,596**	**0**	**0**	**0**		
	XFMR CHSS	2W-XFMR	In	179	0	0	0	210	0	0	0		
	CHSS S&C to CHSS XFMR	CABLE	In	7,172	0	0	0	8,389	0	0	0		
BUS-0767				**6,516**	**0**	**0**	**0**	**7,165**	**0**	**0**	**0**		
	S&C SHV		In	0	0	0	0	0	0	0	0		
	(3)CBL MH-46 to SHV S&C	CABLE	In	6,516	0	0	0	7,165	0	0	0		
BUS-0768				**6,489**	**0**	**0**	**0**	**7,124**	**0**	**0**	**0**		
	S&C SHV		In	6,489	0	0	0	7,124	0	0	0		
	(4)CBL MH-46 to SHV S&C	CABLE	In	6,489	0	0	0	7,124	0	0	0		
BUS-0769				**6,489**	**0**	**0**	**0**	**7,124**	**0**	**0**	**0**		
	CBL SHV S&C to SHV Dist	CABLE	In	0	0	0	0	0	0	0	0		
BUS-0770				**38,116**	**0**	**0**	**0**	**48,204**	**0**	**0**	**0**		
	SHV1 XFMR to SHV1 MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR SHV1	2W-XFMR	In	38,116	0	0	0	48,204	0	0	0		
BUS-0771				**38,053**	**0**	**0**	**0**	**48,041**	**0**	**0**	**0**		
	SHV1 XFMR to SHV1 MDP0	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR SHV2	2W-XFMR	In	38,053	0	0	0	48,041	0	0	0		
BUS-0774				**7,367**	**0**	**0**	**0**	**8,626**	**0**	**0**	**0**		
	Admin/Comm S&C		In	0	0	0	0	0	0	0	0		
	MH-33 to Admin/Comm S&C	CABLE	In	7,367	0	0	0	8,626	0	0	0		
BUS-0775				**7,336**	**0**	**0**	**0**	**8,562**	**0**	**0**	**0**		
	Admin/Comm S&C		In	7,335	0	0	0	8,562	0	0	0		

Bus Name	---------Contributions---------			-------------Initial Symmetrical Amps----------- 3 Phase	SLG	LLG	LL	---------------Asymmetrical Amps--------------- 3 Phase	SLG	LLG	LL	---Init Sym Neutral Amps--- SLG	LLG
MH-33 to Admin/Comm S&C	CABLE	In		7,336	0	0	0	8,562	0	0	0		
BUS-0776				**7,335**	**0**	**0**	**0**	**8,562**	**0**	**0**	**0**		
;L-Admin/Comm S&C to Dist	CABLE	In		0	0	0	0	0	0	0	0		
BUS-0777				**7,543**	**0**	**0**	**0**	**8,982**	**0**	**0**	**0**		
LSC S&C		In		0	0	0	0	0	0	0	0		
(3)CBL-MH-36 to LSC S&C	CABLE	In		7,543	0	0	0	8,982	0	0	0		
BUS-0778				**7,510**	**0**	**0**	**0**	**8,911**	**0**	**0**	**0**		
LSC S&C		In		7,510	0	0	0	8,910	0	0	0		
(4)CBL-MH-36 to LSC S&C	CABLE	In		7,510	0	0	0	8,911	0	0	0		
BUS-0779				**7,510**	**0**	**0**	**0**	**8,910**	**0**	**0**	**0**		
:BL-LSC S&C to LSC XFMR	CABLE	In		0	0	0	0	0	0	0	0		
BUS-0780				**7,508**	**0**	**0**	**0**	**8,905**	**0**	**0**	**0**		
XFMR-LSC	2W-XFMR	In		0	0	0	0	0	0	0	0		
:BL-LSC S&C to LSC XFMR	CABLE	In		7,508	0	0	0	8,905	0	0	0		
BUS-0781				**16,426**	**0**	**0**	**0**	**21,038**	**0**	**0**	**0**		
BL-LSC XFMR to LSC MDP	CABLE	In		0	0	0	0	0	0	0	0		
XFMR-LSC	2W-XFMR	In		16,426	0	0	0	21,038	0	0	0		
BUS-0784				**7,374**	**0**	**0**	**0**	**8,605**	**0**	**0**	**0**		
BL-AB1 S&C to AB1 XFMR	CABLE	In		0	0	0	0	0	0	0	0		
BUS-0785				**7,372**	**0**	**0**	**0**	**8,601**	**0**	**0**	**0**		
XFMR-AB1	2W-XFMR	In		0	0	0	0	0	0	0	0		
BL-AB1 S&C to AB1 XFMR	CABLE	In		7,372	0	0	0	8,601	0	0	0		
BUS-0786				**13,173**	**0**	**0**	**0**	**16,576**	**0**	**0**	**0**		
BL-AB1 XFMR to AB1 MDP	CABLE	In		0	0	0	0	0	0	0	0		
XFMR-AB1	2W-XFMR	In		13,173	0	0	0	16,576	0	0	0		
BUS-0788				**7,375**	**0**	**0**	**0**	**8,605**	**0**	**0**	**0**		
AB1 S&C		In		7,374	0	0	0	8,605	0	0	0		
_ S&C MUSIC TO S&C AB1	CABLE	In		7,375	0	0	0	8,605	0	0	0		
BUS-0789				**7,406**	**0**	**0**	**0**	**8,671**	**0**	**0**	**0**		
AB1 S&C		In		0	0	0	0	0	0	0	0		
_ S&C MUSIC TO S&C AB1	CABLE	In		7,406	0	0	0	8,671	0	0	0		
BUS-0790				**7,658**	**0**	**0**	**0**	**9,186**	**0**	**0**	**0**		
ISIC S&C TO MUSIC XFMR	CABLE	In		0	0	0	0	0	0	0	0		
BUS-0793				**7,655**	**0**	**0**	**0**	**9,180**	**0**	**0**	**0**		
XFMR-Music	2W-XFMR	In		0	0	0	0	0	0	0	0		
ISIC S&C TO MUSIC XFMR	CABLE	In		7,655	0	0	0	9,180	0	0	0		

Bus Name	---------Contributions---------			-------------Initial Symmetrical Amps----------- 3 Phase	SLG	LLG	LL	----------------Asymmetrical Amps---------------- 3 Phase	SLG	LLG	LL	---Init Sym Neutral Amps--- SLG	LLG
BUS-0794				**9,438**	**0**	**0**	**0**	**11,637**	**0**	**0**	**0**		
	CBL-MUSIC XFMR to MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR-Music	2W-XFMR	In	9,438	0	0	0	11,637	0	0	0		
BUS-0795				**7,795**	**0**	**0**	**0**	**9,535**	**0**	**0**	**0**		
	S&C SmithHutson		In	0	0	0	0	0	0	0	0		
	MH-19 TO S.HUTSON S&C	CABLE	In	7,795	0	0	0	9,535	0	0	0		
BUS-0797				**8,081**	**0**	**0**	**0**	**10,229**	**0**	**0**	**0**		
	Garage S&C to Garage XFMR	CABLE	In	0	0	0	0	0	0	0	0		
BUS-0798				**8,079**	**0**	**0**	**0**	**10,223**	**0**	**0**	**0**		
	XFMR-Parking Garage	2W-XFMR	In	0	0	0	0	0	0	0	0		
	Garage S&C to Garage XFMR	CABLE	In	8,079	0	0	0	10,223	0	0	0		
BUS-0799				**7,192**	**0**	**0**	**0**	**8,644**	**0**	**0**	**0**		
	CBL-Garage XFMR to MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR-Parking Garage	2W-XFMR	In	7,192	0	0	0	8,644	0	0	0		
BUS-0800				**7,761**	**0**	**0**	**0**	**9,453**	**0**	**0**	**0**		
	MH-19 TO S.HUTSON S&C	CABLE	In	7,761	0	0	0	9,453	0	0	0		
	S&C SmithHutson		In	7,795	0	0	0	9,535	0	0	0		
BUS-0801				**7,795**	**0**	**0**	**0**	**9,535**	**0**	**0**	**0**		
	S.Hutson S&C to S.H. XFMR	CABLE	In	0	0	0	0	0	0	0	0		
BUS-0802				**7,793**	**0**	**0**	**0**	**9,529**	**0**	**0**	**0**		
	XF2-Smith Hutson	2W-XFMR	In	0	0	0	0	0	0	0	0		
	S.Hutson S&C to S.H. XFMR	CABLE	In	7,793	0	0	0	9,529	0	0	0		
BUS-0803				**16,585**	**0**	**0**	**0**	**21,309**	**0**	**0**	**0**		
	-S.Hutson XFMR to SH MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XF2-Smith Hutson	2W-XFMR	In	16,585	0	0	0	21,309	0	0	0		
BUS-0804				**7,795**	**0**	**0**	**0**	**9,535**	**0**	**0**	**0**		
	-S.H. OldS&C to S.H. XFMR	CABLE	In	0	0	0	0	0	0	0	0		
BUS-0805				**7,795**	**0**	**0**	**0**	**9,535**	**0**	**0**	**0**		
	S&C SmithHutson Old		In	0	0	0	0	0	0	0	0		
	L MH-19 TO S.H.ADD S&C	CABLE	In	7,795	0	0	0	9,535	0	0	0		
BUS-0806				**7,761**	**0**	**0**	**0**	**9,453**	**0**	**0**	**0**		
	L MH-19 TO S.H.ADD S&C	CABLE	In	7,761	0	0	0	9,453	0	0	0		
	S&C SmithHutson Old		In	7,795	0	0	0	9,535	0	0	0		
BUS-0808				**7,793**	**0**	**0**	**0**	**9,529**	**0**	**0**	**0**		
	XF2-Old Smith Hutson	2W-XFMR	In	0	0	0	0	0	0	0	0		
	-S.H. OldS&C to S.H. XFMR	CABLE	In	7,793	0	0	0	9,529	0	0	0		

Bus Name	---------Contributions---------			-------------Initial Symmetrical Amps-----------				----------------Asymmetrical Amps----------------				---Init Sym Neutral Amps---	
				3 Phase	SLG	LLG	LL	3 Phase	SLG	LLG	LL	SLG	LLG
BUS-0809				**15,848**	**0**	**0**	**0**	**15,848**	**0**	**0**	**0**		
	.Add XFMRto S.H.Add MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XF2-Old Smith Hutson	2W-XFMR	In	15,848	0	0	0	15,848	0	0	0		
BUS-0815				**7,519**	**0**	**0**	**0**	**8,898**	**0**	**0**	**0**		
	CBL-0174	CABLE	In	0	0	0	0	0	0	0	0		
BUS-0816				**7,516**	**0**	**0**	**0**	**8,893**	**0**	**0**	**0**		
	XFMR AB4	2W-XFMR	In	0	0	0	0	0	0	0	0		
	CBL-0174	CABLE	In	7,516	0	0	0	8,893	0	0	0		
BUS-0817				**16,977**	**0**	**0**	**0**	**21,733**	**0**	**0**	**0**		
	BL-AB4 XFMR to AB4 MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR AB4	2W-XFMR	In	16,977	0	0	0	21,733	0	0	0		
BUS-0820				**6,736**	**0**	**0**	**0**	**7,326**	**0**	**0**	**0**		
	L-RV C S&C to RV C XFMR	CABLE	In	0	0	0	0	0	0	0	0		
BUS-0822				**36,051**	**0**	**0**	**0**	**36,051**	**0**	**0**	**0**		
	-RV C XFMR TO RV C MDP	CABLE	In	0	0	0	0	0	0	0	0		
	RAVEN C XFMR	2W-XFMR	In	36,050	0	0	0	36,051	0	0	0		
BUS-0823				**6,736**	**0**	**0**	**0**	**7,327**	**0**	**0**	**0**		
	Raven Village C S&C		In	0	0	0	0	0	0	0	0		
	(5) CBL-MH-48 to RVC S&C	CABLE	In	6,736	0	0	0	7,327	0	0	0		
BUS-0824				**6,689**	**0**	**0**	**0**	**7,347**	**0**	**0**	**0**		
	Raven Village C S&C		In	6,736	0	0	0	7,326	0	0	0		
	(6) CBL-MH-48 to RVC S&C	CABLE	In	6,689	0	0	0	7,347	0	0	0		
BUS-0825				**6,932**	**0**	**0**	**0**	**7,618**	**0**	**0**	**0**		
	Raven Village A&B S&C		In	0	0	0	0	0	0	0	0		
	CBL-MH-47 to RVA&B S&C	CABLE	In	6,932	0	0	0	7,618	0	0	0		
BUS-0826				**6,881**	**0**	**0**	**0**	**7,644**	**0**	**0**	**0**		
	Raven Village A&B S&C		In	6,932	0	0	0	7,617	0	0	0		
	CBL-MH-47 to RVA&B S&C	CABLE	In	6,881	0	0	0	7,644	0	0	0		
BUS-0827				**6,910**	**0**	**0**	**0**	**7,584**	**0**	**0**	**0**		
	XFMR-RVB	2W-XFMR	In	0	0	0	0	0	0	0	0		
	BL-RVB S&C to RVB XFMR	CABLE	In	6,910	0	0	0	7,584	0	0	0		
BUS-0829				**47,079**	**0**	**0**	**0**	**47,079**	**0**	**0**	**0**		
	RV A XFMR TO RV A MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR-RVA	2W-XFMR	In	47,079	0	0	0	47,080	0	0	0		
BUS-0831				**47,771**	**0**	**0**	**0**	**47,771**	**0**	**0**	**0**		
	V A XFMR TO RV A MDP0	CABLE	In	0	0	0	0	0	0	0	0		

Bus Name	---------Contributions---------			-------------Initial Symmetrical Amps-----------				----------------Asymmetrical Amps----------------				---Init Sym Neutral Amps---	
				3 Phase	SLG	LLG	LL	3 Phase	SLG	LLG	LL	SLG	LLG
	XFMR-RVB	2W-XFMR	In	47,770	0	0	0	47,771	0	0	0		
BUS-0832				**7,559**	**0**	**0**	**0**	**9,011**	**0**	**0**	**0**		
	3L - CFS S&C to CFS XFMR	CABLE	In	0	0	0	0	0	0	0	0		
BUS-0833				**7,538**	**0**	**0**	**0**	**8,962**	**0**	**0**	**0**		
	XFMR-CFS	2W-XFMR	In	0	0	0	0	0	0	0	0		
	3L - CFS S&C to CFS XFMR	CABLE	In	7,538	0	0	0	8,962	0	0	0		
BUS-0834				**25,282**	**0**	**0**	**0**	**33,068**	**0**	**0**	**0**		
	BL-CFS XFMR to CFS MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR-CFS	2W-XFMR	In	25,282	0	0	0	33,068	0	0	0		
BUS-0836				**7,634**	**0**	**0**	**0**	**8,945**	**0**	**0**	**0**		
	CFS S&C		In	0	0	0	0	0	0	0	0		
	(5) CBL-MH-44 to CFS S&C	CABLE	In	7,634	0	0	0	8,945	0	0	0		
BUS-0837				**7,559**	**0**	**0**	**0**	**9,011**	**0**	**0**	**0**		
	CFS S&C		In	7,559	0	0	0	9,011	0	0	0		
	(6) CBL-MH-44 to CFS S&C	CABLE	In	7,559	0	0	0	9,011	0	0	0		
BUS-0838				**7,634**	**0**	**0**	**0**	**8,945**	**0**	**0**	**0**		
	South Paw S&C1		In	0	0	0	0	0	0	0	0		
	5) CBL-MH-44 to CFS S&C0	CABLE	In	7,634	0	0	0	8,945	0	0	0		
BUS-0839				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
	South Paw S&C1		In	7,634	0	0	0	8,945	0	0	0		
BUS-0840				**7,634**	**0**	**0**	**0**	**8,945**	**0**	**0**	**0**		
	CBL - SP S&C to SP XFMR	CABLE	In	0	0	0	0	0	0	0	0		
BUS-0841				**7,612**	**0**	**0**	**0**	**8,897**	**0**	**0**	**0**		
	XFMR-South Paw	2W-XFMR	In	0	0	0	0	0	0	0	0		
	CBL - SP S&C to SP XFMR	CABLE	In	7,612	0	0	0	8,897	0	0	0		
BUS-0842				**24,911**	**0**	**0**	**0**	**24,911**	**0**	**0**	**0**		
	CBL-SP XFMR to SP MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR-South Paw	2W-XFMR	In	24,911	0	0	0	24,911	0	0	0		
BUS-0844				**7,559**	**0**	**0**	**0**	**9,012**	**0**	**0**	**0**		
	CBL LD S&C to LD XFMR	CABLE	In	0	0	0	0	0	0	0	0		
BUS-0847				**7,557**	**0**	**0**	**0**	**9,007**	**0**	**0**	**0**		
	XFMR-Lee Drain	2W-XFMR	In	0	0	0	0	0	0	0	0		
	CBL LD S&C to LD XFMR	CABLE	In	7,557	0	0	0	9,007	0	0	0		
BUS-0848				**11,371**	**0**	**0**	**0**	**14,140**	**0**	**0**	**0**		
	CBL-LD XFMR to LD MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR-Lee Drain	2W-XFMR	In	11,371	0	0	0	14,140	0	0	0		

Bus Name	---------Contributions---------			-------------Initial Symmetrical Amps-----------				----------------Asymmetrical Amps----------------				---Init Sym Neutral Amps---	
				3 Phase	SLG	LLG	LL	3 Phase	SLG	LLG	LL	SLG	LLG
BUS-0851				**7,560**	**0**	**0**	**0**	**9,012**	**0**	**0**	**0**		
	Lee Drain S&C		In	7,559	0	0	0	9,012	0	0	0		
	(6) CBL-MH-25 to LD S&C	CABLE	In	7,560	0	0	0	9,012	0	0	0		
BUS-0852				**7,634**	**0**	**0**	**0**	**8,946**	**0**	**0**	**0**		
	Lee Drain S&C		In	0	0	0	0	0	0	0	0		
	(5) CBL-MH-25 to LD S&C	CABLE	In	7,634	0	0	0	8,946	0	0	0		
BUS-0853				**7,633**	**0**	**0**	**0**	**9,168**	**0**	**0**	**0**		
	BL-VB1 S&C to VB1 XFMR	CABLE	In	0	0	0	0	0	0	0	0		
BUS-0854				**7,633**	**0**	**0**	**0**	**9,168**	**0**	**0**	**0**		
	BL-VB2 S&C to VB2 XFMR	CABLE	In	224	0	0	0	270	0	0	0		
BUS-0855				**7,623**	**0**	**0**	**0**	**9,147**	**0**	**0**	**0**		
	XFMR - VB1	2W-XFMR	In	0	0	0	0	0	0	0	0		
	BL-VB1 S&C to VB1 XFMR	CABLE	In	7,623	0	0	0	9,147	0	0	0		
BUS-0856				**7,623**	**0**	**0**	**0**	**9,148**	**0**	**0**	**0**		
	XFMR - VB2	2W-XFMR	In	225	0	0	0	269	0	0	0		
	BL-VB2 S&C to VB2 XFMR	CABLE	In	7,399	0	0	0	8,879	0	0	0		
BUS-0857				**6,426**	**0**	**0**	**0**	**8,776**	**0**	**0**	**0**		
	CBL-VB2 XFMR TO FS	CABLE	In	788	0	0	0	1,076	0	0	0		
	XFMR - VB2	2W-XFMR	In	5,640	0	0	0	7,703	0	0	0		
BUS-0861				**5,342**	**0**	**0**	**0**	**6,786**	**0**	**0**	**0**		
	AB3 S&C		In	5,342	0	0	0	6,786	0	0	0		
	F6) CBL MH-37 to AB3 S&C	CABLE	In	5,342	0	0	0	6,786	0	0	0		
BUS-0862				**5,342**	**0**	**0**	**0**	**6,786**	**0**	**0**	**0**		
	3L - AB3 S&C to AB3 XFMR	CABLE	In	0	0	0	0	0	0	0	0		
BUS-0863				**5,309**	**0**	**0**	**0**	**6,691**	**0**	**0**	**0**		
	XFMR-AB3	2W-XFMR	In	0	0	0	0	0	0	0	0		
	3L - AB3 S&C to AB3 XFMR	CABLE	In	5,309	0	0	0	6,691	0	0	0		
BUS-0865				**24,958**	**0**	**0**	**0**	**31,564**	**0**	**0**	**0**		
	BL-AB3 CFMR to AB3 MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR-AB3	2W-XFMR	In	24,958	0	0	0	31,564	0	0	0		
BUS-0869				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
	(F6) MH-38 to PARK XFMR	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR-PARKHILL	2W-XFMR	In	0	0	0	0	0	0	0	0		
BUS-0870				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
	(F6) MH-38 to BARR XFMR	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR-BARR	2W-XFMR	In	0	0	0	0	0	0	0	0		

				-------------Initial Symmetrical Amps-----------				----------------Asymmetrical Amps----------------				---Init Sym Neutral Amps---	
Bus Name	---------Contributions---------			**3 Phase**	**SLG**	**LLG**	**LL**	**3 Phase**	**SLG**	**LLG**	**LL**	**SLG**	**LLG**
BUS-0871				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
	H-MH-38 TO ALLEN XFMR	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR-ALLEN	2W-XFMR	In	0	0	0	0	0	0	0	0		
BUS-0872				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
	VICK XFMR TO VICK MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR-VICK	2W-XFMR	In	0	0	0	0	0	0	0	0		
BUS-0873				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
	VICK XFMR TO VICK MDP	CABLE	In	0	0	0	0	0	0	0	0		
BUS-0874				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
	-SPIV XFMR TO SPIV MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR-SPIVEY	2W-XFMR	In	0	0	0	0	0	0	0	0		
BUS-0875				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
	AND XFMR TO RAND MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR-RANDEL	2W-XFMR	In	0	0	0	0	0	0	0	0		
BUS-0876				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
	AND XFMR TO RAND MDP	CABLE	In	0	0	0	0	0	0	0	0		
BUS-0877				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
	-SPIV XFMR TO SPIV MDP	CABLE	In	0	0	0	0	0	0	0	0		
BUS-0878				**24,889**	**0**	**0**	**0**	**32,316**	**0**	**0**	**0**		
	XFMR-W.PLANT	2W-XFMR	In	9,987	0	0	0	12,967	0	0	0		
	W.PLANT XFMR TO MDP	CABLE	In	14,934	0	0	0	19,391	0	0	0		
BUS-0886				**4,917**	**0**	**0**	**0**	**5,081**	**0**	**0**	**0**		
	CBL SOR POLE TO XFMR	CABLE	In	0	0	0	0	0	0	0	0		
	(F5) OH ELL TO SOR	CABLE	In	4,917	0	0	0	5,081	0	0	0		
BUS-0887				**4,764**	**0**	**0**	**0**	**4,888**	**0**	**0**	**0**		
	MLH FUSE TO MLH XFMR	CABLE	In	0	0	0	0	0	0	0	0		
	(F5) OH BB TO MLH	CABLE	In	4,764	0	0	0	4,888	0	0	0		
BUS-0890				**5,150**	**0**	**0**	**0**	**5,859**	**0**	**0**	**0**		
	L THO S&C TO THO XFMR	CABLE	In	0	0	0	0	0	0	0	0		
	CBL MH34 TO THO XFMR	CABLE	In	5,150	0	0	0	5,859	0	0	0		
BUS-0891				**5,117**	**0**	**0**	**0**	**5,797**	**0**	**0**	**0**		
	XFMR THO	2W-XFMR	In	0	0	0	0	0	0	0	0		
	L THO S&C TO THO XFMR	CABLE	In	5,117	0	0	0	5,797	0	0	0		
BUS-0892				**4,720**	**0**	**0**	**0**	**5,195**	**0**	**0**	**0**		
	XFMR E/VC	2W-XFMR	In	0	0	0	0	0	0	0	0		
	(F2) MH34 TO E/VC S&C	CABLE	In	4,720	0	0	0	5,195	0	0	0		

Bus Name	---------Contributions---------			Initial Symmetrical Amps 3 Phase	Initial Symmetrical Amps SLG	Initial Symmetrical Amps LLG	Initial Symmetrical Amps LL	Asymmetrical Amps 3 Phase	Asymmetrical Amps SLG	Asymmetrical Amps LLG	Asymmetrical Amps LL	Init Sym Neutral Amps SLG	Init Sym Neutral Amps LLG
BUS-0894				**6,104**	**0**	**0**	**0**	**7,789**	**0**	**0**	**0**		
	XFMR FARR	2W-XFMR	In	0	0	0	0	0	0	0	0		
	BL MH31 TO FARR XFMR	CABLE	In	6,104	0	0	0	7,789	0	0	0		
BUS-0895				**8,144**	**0**	**0**	**0**	**9,858**	**0**	**0**	**0**		
	ARR XFMR TO FARR MDP	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR FARR	2W-XFMR	In	8,144	0	0	0	9,858	0	0	0		
BUS-0897				**5,608**	**0**	**0**	**0**	**6,523**	**0**	**0**	**0**		
	XFMR ESTILL	2W-XFMR	In	0	0	0	0	0	0	0	0		
	)CBL MH31 TO ESTILL SW	CABLE	In	5,608	0	0	0	6,523	0	0	0		
BUS-0898				**8,257**	**0**	**0**	**0**	**10,082**	**0**	**0**	**0**		
	LL XFMR TO ESTILL MCB	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR ESTILL	2W-XFMR	In	8,257	0	0	0	10,082	0	0	0		
BUS-0903				**36,594**	**0**	**0**	**0**	**47,619**	**0**	**0**	**0**		
	CHSS CHWP-1	IND-MTR	In	355	0	0	0	461	0	0	0		
	CHSSCHWP1		In	36,241	0	0	0	47,158	0	0	0		
BUS-0904				**36,594**	**0**	**0**	**0**	**47,619**	**0**	**0**	**0**		
	CHSS CHWP-2	IND-MTR	In	355	0	0	0	461	0	0	0		
	CHSSCHWP2		In	36,241	0	0	0	47,158	0	0	0		
BUS-0922				**4,788**	**0**	**0**	**0**	**6,434**	**0**	**0**	**0**		
	EP-CH 3	IND-MTR	In	878	0	0	0	1,179	0	0	0		
	XFMR-EP Chiller 3	2W-XFMR	In	3,911	0	0	0	5,256	0	0	0		
BUS-0923				**5,139**	**0**	**0**	**0**	**6,931**	**0**	**0**	**0**		
	EP-CH 2	IND-MTR	In	1,229	0	0	0	1,657	0	0	0		
	XFMR-EP Chiller 2	2W-XFMR	In	3,911	0	0	0	5,276	0	0	0		
BUS-0924				**5,271**	**0**	**0**	**0**	**7,151**	**0**	**0**	**0**		
	EP-CH 1	IND-MTR	In	1,580	0	0	0	2,143	0	0	0		
	XFMR-EP Chiller 1	2W-XFMR	In	3,693	0	0	0	5,010	0	0	0		
BUS-Farrington Switches - V				**5,488**	**0**	**0**	**0**	**7,259**	**0**	**0**	**0**		
	(F6)CBL - FS6 to MH37	CABLE	In	0	0	0	0	0	0	0	0		
	(F4)CBL-FS4 TO MH34	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-VB1 XFMR TO FS	CABLE	In	5,488	0	0	0	7,259	0	0	0		
BUS-OH POLE(VickSpivey,				**4,886**	**0**	**0**	**0**	**5,510**	**0**	**0**	**0**		
	XFMR-RANDEL	2W-XFMR	In	0	0	0	0	0	0	0	0		
	XFMR-SPIVEY	2W-XFMR	In	0	0	0	0	0	0	0	0		
	XFMR-VICK	2W-XFMR	In	0	0	0	0	0	0	0	0		
	F6)OH POLE X TO POLE Y	CABLE	In	4,886	0	0	0	5,510	0	0	0		

				Initial Symmetrical Amps				Asymmetrical Amps				Init Sym Neutral Amps	
Bus Name	Contributions			3 Phase	SLG	LLG	LL	3 Phase	SLG	LLG	LL	SLG	LLG
BUS-PEA/AUS WIREWAY				**10,527**	**0**	**0**	**0**	**11,823**	**0**	**0**	**0**		
	CBL AUS XFMR TO WIRE	CABLE	In	10,527	0	0	0	11,823	0	0	0		
BUS-S&C -(Raven Village A				**6,932**	**0**	**0**	**0**	**7,617**	**0**	**0**	**0**		
	L-RVA S&C to RVA XFMR	CABLE	In	0	0	0	0	0	0	0	0		
	L-RVB S&C to RVB XFMR	CABLE	In	0	0	0	0	0	0	0	0		
BUS-Switchgear Building				**8,650**	**0**	**0**	**0**	**11,921**	**0**	**0**	**0**		
	CBL-0044	CABLE	In	0	0	0	0	0	0	0	0		
	(7)CBL-MH1 to MH49	CABLE	In	0	0	0	0	0	0	0	0		
	(8)CBL-MH1 to MH49	CABLE	In	0	0	0	0	0	0	0	0		
	(2)CBL Substation to MH-2	CABLE	In	0	0	0	0	0	0	0	0		
	(4)CBL Substation to MH-17	CABLE	In	0	0	0	0	0	0	0	0		
	(3)CBL Substation to MH-17	CABLE	In	179	0	0	0	246	0	0	0		
	CBL-0004	CABLE	In	224	0	0	0	308	0	0	0		
	(1)CBL Substation to MH-2	CABLE	In	980	0	0	0	1,351	0	0	0		
	UTIL-Primary From Entergy	UTILITY	In	7,268	0	0	0	10,016	0	0	0		
CFS MDP				**23,950**	**0**	**0**	**0**	**30,430**	**0**	**0**	**0**		
	BL-CFS XFMR to CFS MDP	CABLE	In	23,950	0	0	0	30,430	0	0	0		
CHSS MDP				**36,241**	**0**	**0**	**0**	**47,117**	**0**	**0**	**0**		
	CHSSCHWP1		In	0	0	0	0	0	0	0	0		
	CHSSCHWP2		In	0	0	0	0	0	0	0	0		
	CHSS CH-1	IND-MTR	In	2,852	0	0	0	3,708	0	0	0		
	CHSS CH-2	IND-MTR	In	2,852	0	0	0	3,708	0	0	0		
	CHSS XFMR to CHSS MDP	CABLE	In	30,552	0	0	0	39,721	0	0	0		
CJC MDP				**54,884**	**0**	**0**	**0**	**74,718**	**0**	**0**	**0**		
	BL-CJC XFMR to CJC MDP	CABLE	In	54,884	0	0	0	74,718	0	0	0		
Coliseum MDP				**12,643**	**0**	**0**	**0**	**15,298**	**0**	**0**	**0**		
	BL-Col. XFMR to Col. MDP	CABLE	In	12,643	0	0	0	15,298	0	0	0		
Comm/Admin Dist				**7,332**	**0**	**0**	**0**	**8,556**	**0**	**0**	**0**		
	CBL-Dist to Comm XFMR	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-Dist to Admin XFMR	CABLE	In	0	0	0	0	0	0	0	0		
	L-Admin/Comm S&C to Dist	CABLE	In	7,332	0	0	0	8,556	0	0	0		
Communications MDP				**31,998**	**0**	**0**	**0**	**31,998**	**0**	**0**	**0**		
	Comm XFMR to Comm MDP	CABLE	In	31,998	0	0	0	31,998	0	0	0		
E & HC Transformer Second				**21,736**	**0**	**0**	**0**	**21,736**	**0**	**0**	**0**		
	CBL-XFMR to HC MDP	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-XFMR to Estill MDP	CABLE	In	0	0	0	0	0	0	0	0		

				Initial Symmetrical Amps				Asymmetrical Amps				Init Sym Neutral Amps	
Bus Name	Contributions			3 Phase	SLG	LLG	LL	3 Phase	SLG	LLG	LL	SLG	LLG
	XFMR-Estill & Health Center	2W-XFMR	In	21,736	0	0	0	21,736	0	0	0		
East Plant Distribution				**7,669**	**0**	**0**	**0**	**9,233**	**0**	**0**	**0**		
	CBL-East Plant Equip #2	CABLE	In	46	0	0	0	55	0	0	0		
	CBL-East Plant Equip #1	CABLE	In	46	0	0	0	55	0	0	0		
	CBL-East Plant Chiller #3	CABLE	In	233	0	0	0	280	0	0	0		
	CBL-East Plant Chiller #2	CABLE	In	307	0	0	0	370	0	0	0		
	CBL-East Plant Chiller #1	CABLE	In	366	0	0	0	441	0	0	0		
	CBL-S&C to East Plant Dist.	CABLE	In	6,680	0	0	0	8,042	0	0	0		
Elliott MDP				**7,214**	**0**	**0**	**0**	**7,480**	**0**	**0**	**0**		
	L ELL XFMR TO ELL MDP	CABLE	In	7,214	0	0	0	7,480	0	0	0		
EP EQ1 MDP				**22,482**	**0**	**0**	**0**	**22,482**	**0**	**0**	**0**		
	EP-CHWP1-4	IND-MTR	In	1,277	0	0	0	1,277	0	0	0		
	XFMR-EP Equip 1	2W-XFMR	In	22,190	0	0	0	22,190	0	0	0		
EP EQ2 MDP				**22,401**	**0**	**0**	**0**	**22,401**	**0**	**0**	**0**		
	EP-CHWP1-3	IND-MTR	In	1,277	0	0	0	1,277	0	0	0		
	XFMR-EP Equip 2	2W-XFMR	In	22,109	0	0	0	22,109	0	0	0		
Estill Dorm MDP				**19,406**	**0**	**0**	**0**	**19,406**	**0**	**0**	**0**		
	CBL-XFMR to Estill MDP	CABLE	In	19,406	0	0	0	19,406	0	0	0		
ESTILL MDP				**8,038**	**0**	**0**	**0**	**9,664**	**0**	**0**	**0**		
	LL XFMR TO ESTILL MCB	CABLE	In	8,038	0	0	0	9,664	0	0	0		
Evans MDP				**8,024**	**0**	**0**	**0**	**9,316**	**0**	**0**	**0**		
	CBL-To Evans MDP	CABLE	In	8,024	0	0	0	9,316	0	0	0		
Evans/VisCen MDP				**8,810**	**0**	**0**	**0**	**10,684**	**0**	**0**	**0**		
	CBL-To Evans MCB	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-To VisCen MCB	CABLE	In	0	0	0	0	0	0	0	0		
	E/VC XFMR TO E/VC MDP	CABLE	In	8,810	0	0	0	10,684	0	0	0		
FARR MDP				**7,662**	**0**	**0**	**0**	**9,042**	**0**	**0**	**0**		
	ARR XFMR TO FARR MDP	CABLE	In	7,662	0	0	0	9,042	0	0	0		
Field House MDP				**20,002**	**0**	**0**	**0**	**20,002**	**0**	**0**	**0**		
	CBL-FH XFMR to FH MDP	CABLE	In	20,002	0	0	0	20,003	0	0	0		
Garage MDP				**6,627**	**0**	**0**	**0**	**7,545**	**0**	**0**	**0**		
	CBL-Garage XFMR to MDP	CABLE	In	6,627	0	0	0	7,545	0	0	0		
Health Center MDP				**14,236**	**0**	**0**	**0**	**14,236**	**0**	**0**	**0**		
	CBL-XFMR to HC MDP	CABLE	In	14,236	0	0	0	14,236	0	0	0		
HKC MDP				**12,602**	**0**	**0**	**0**	**14,799**	**0**	**0**	**0**		
	CBL-HKC SW to HKC MDP	CABLE	In	12,602	0	0	0	14,799	0	0	0		

Bus Name	---------Contributions---------			-------------Initial Symmetrical Amps----------- 3 Phase	SLG	LLG	LL	----------------Asymmetrical Amps---------------- 3 Phase	SLG	LLG	LL	---Init Sym Neutral Amps--- SLG	LLG
Lee Drain MDP				**10,031**	**0**	**0**	**0**	**11,392**	**0**	**0**	**0**		
	CBL-LD XFMR to LD MDP	CABLE	In	10,031	0	0	0	11,392	0	0	0		
LIB MDP				**22,225**	**0**	**0**	**0**	**28,661**	**0**	**0**	**0**		
	CBL LIB XFMR to LIB MDP	CABLE	In	22,225	0	0	0	28,661	0	0	0		
Lonestar Hall MDP				**39,810**	**0**	**0**	**0**	**39,810**	**0**	**0**	**0**		
	CBL-Lonestar XFMR to MDP	CABLE	In	39,810	0	0	0	39,811	0	0	0		
LSC MDP				**14,246**	**0**	**0**	**0**	**17,168**	**0**	**0**	**0**		
	BL-LSC XFMR to LSC MDP	CABLE	In	14,246	0	0	0	17,168	0	0	0		
MLH MDP				**8,845**	**0**	**0**	**0**	**9,189**	**0**	**0**	**0**		
	XFMR MLH TO MLH MDP	CABLE	In	8,845	0	0	0	9,189	0	0	0		
Music Bldg. MDP				**8,885**	**0**	**0**	**0**	**10,583**	**0**	**0**	**0**		
	CBL-MUSIC XFMR to MDP	CABLE	In	8,885	0	0	0	10,583	0	0	0		
Old Smith Hutson MDP				**13,408**	**0**	**0**	**0**	**13,408**	**0**	**0**	**0**		
	.Add XFMRto S.H.Add MDP	CABLE	In	13,408	0	0	0	13,408	0	0	0		
OMM MDP				**18,014**	**0**	**0**	**0**	**22,326**	**0**	**0**	**0**		
	-XFMR OMM to OMM MDP	CABLE	In	18,014	0	0	0	22,326	0	0	0		
PAC MDP				**17,488**	**0**	**0**	**0**	**17,921**	**0**	**0**	**0**		
	BL-PAC XFMR to PAC MDP	CABLE	In	17,488	0	0	0	17,921	0	0	0		
RAVEN MDP				**30,399**	**0**	**0**	**0**	**30,399**	**0**	**0**	**0**		
	RV C XFMR TO RV C MDP	CABLE	In	30,399	0	0	0	30,399	0	0	0		
RVA MDP				**37,595**	**0**	**0**	**0**	**37,595**	**0**	**0**	**0**		
	RV A XFMR TO RV A MDP	CABLE	In	37,595	0	0	0	37,596	0	0	0		
RVB MDP				**38,017**	**0**	**0**	**0**	**38,017**	**0**	**0**	**0**		
	V A XFMR TO RV A MDP0	CABLE	In	38,017	0	0	0	38,017	0	0	0		
SH MDP				**15,476**	**0**	**0**	**0**	**18,953**	**0**	**0**	**0**		
	-S.Hutson XFMR to SH MDP	CABLE	In	15,476	0	0	0	18,953	0	0	0		
SHV Distribution				**6,485**	**0**	**0**	**0**	**7,118**	**0**	**0**	**0**		
	BL-SHV Dist to SHV2 XFMR	CABLE	In	0	0	0	0	0	0	0	0		
	BL-SHV Dist to SHV1 XFMR	CABLE	In	0	0	0	0	0	0	0	0		
	CBL SHV S&C to SHV Dist	CABLE	In	6,485	0	0	0	7,118	0	0	0		
SHV#1 MDP				**34,170**	**0**	**0**	**0**	**40,461**	**0**	**0**	**0**		
	SHV1 XFMR to SHV1 MDP	CABLE	In	34,170	0	0	0	40,461	0	0	0		
SHV#2 MDP				**33,241**	**0**	**0**	**0**	**38,839**	**0**	**0**	**0**		
	SHV1 XFMR to SHV1 MDP0	CABLE	In	33,241	0	0	0	38,839	0	0	0		
Sorority				**10,543**	**0**	**0**	**0**	**10,749**	**0**	**0**	**0**		
	L SOR XFMR TO SOR MDP	CABLE	In	10,543	0	0	0	10,749	0	0	0		

Bus Name	---------Contributions---------			-------------Initial Symmetrical Amps-----------				----------------Asymmetrical Amps----------------				---Init Sym Neutral Amps---	
				3 Phase	SLG	LLG	LL	3 Phase	SLG	LLG	LL	SLG	LLG
SouthPaw MDP				**23,277**	**0**	**0**	**0**	**23,277**	**0**	**0**	**0**		
	CBL-SP XFMR to SP MDP	CABLE	In	23,277	0	0	0	23,277	0	0	0		
TEC MDP				**14,085**	**0**	**0**	**0**	**17,556**	**0**	**0**	**0**		
	BL TEC XFMR to TEC MDP	CABLE	In	14,085	0	0	0	17,556	0	0	0		
Thomason MDP				**7,170**	**0**	**0**	**0**	**8,318**	**0**	**0**	**0**		
	-THO XFMR TO THO MDP	CABLE	In	7,170	0	0	0	8,318	0	0	0		
UTC MDP				**13,433**	**0**	**0**	**0**	**16,259**	**0**	**0**	**0**		
	3L UTC XFMR to UTC MDP	CABLE	In	13,433	0	0	0	16,259	0	0	0		
VisCen MDP				**8,024**	**0**	**0**	**0**	**9,316**	**0**	**0**	**0**		
	CBL-To VisCen MDP	CABLE	In	8,024	0	0	0	9,316	0	0	0		
West Plant MDP				**25,251**	**0**	**0**	**0**	**33,395**	**0**	**0**	**0**		
	WP CHWP-1	IND-MTR	In	213	0	0	0	281	0	0	0		
	WP CHWP-2	IND-MTR	In	213	0	0	0	281	0	0	0		
	WP CH-1	IND-MTR	In	7,606	0	0	0	10,059	0	0	0		
	WP CH-2	IND-MTR	In	7,606	0	0	0	10,059	0	0	0		
	W.PLANT XFMR TO MDP	CABLE	In	9,676	0	0	0	12,797	0	0	0		
XFMR-WEST PLANT				**5,537**	**0**	**0**	**0**	**6,396**	**0**	**0**	**0**		
	(F4)CBL W.PLANT	CABLE	In	0	0	0	0	0	0	0	0		
	XFMR-W.PLANT	2W-XFMR	In	809	0	0	0	934	0	0	0		
	(F7)CBL W. PLANT	CABLE	In	4,734	0	0	0	5,468	0	0	0		

APPENDIX H – HARMONIC ANALYSIS REPORT

Project: SamHoustonUniver

HI_WAVE Report

Buses

Bus Name	Bus Voltage	THD%	RMS (V)	TIF
(1) BUS MH-2	13,200	1.40	11,758.45	3.74
(1)BUS MH-10	13,200	1.41	11,681.69	3.76
(1)BUS MH-5	13,200	1.40	11,724.23	3.74
(1)BUS MH-8	13,200	1.40	11,695.13	3.74
(2) BUS MH-11	13,200	1.53	11,718.44	4.07
(2) BUS MH-2	13,200	1.42	11,763.96	3.79
(2) BUS MH-9	13,200	1.53	11,720.13	4.07
(2)BUS MH-10	13,200	1.58	11,705.05	4.20
(2)BUS MH-5	13,200	1.46	11,746.92	3.89
(2)BUS MH-8	13,200	1.49	11,734.28	3.97
(3) BUS MH-17	13,200	1.42	11,754.25	3.80
(3) BUS MH-23	13,200	1.44	11,736.41	3.84
(3) BUS MH-46	13,200	1.44	11,741.27	3.84
(3) MH-24	13,200	1.44	11,736.42	3.86
(3)BUS MH-19	13,200	1.44	11,741.21	3.83
(3)BUS MH-20	13,200	1.44	11,737.43	3.84
(3)BUS MH-21	13,200	1.44	11,737.02	3.84
(3)BUS MH-33	13,200	1.44	11,741.24	3.83
(3)BUS MH-36	13,200	1.44	11,741.22	3.83
(3)MUSIC S&C	13,200	1.44	11,740.32	3.83
(4) BUS MH-17	13,200	1.42	11,757.40	3.79
(4) BUS MH-23	13,200	1.43	11,746.36	3.81
(4) BUS MH-46	13,200	1.45	11,726.83	3.88
(4) MH-24	13,200	1.43	11,746.36	3.81
(4) MUSIC S&C	13,200	1.43	11,745.29	3.81
(4)BUS MH-19	13,200	1.43	11,746.35	3.81
(4)BUS MH-20	13,200	1.43	11,746.36	3.81
(4)BUS MH-21	13,200	1.43	11,746.36	3.81
(4)BUS MH-33	13,200	1.44	11,736.36	3.84

Buses

Bus Name	Bus Voltage	THD%	RMS (V)	TIF
(4)BUS MH-36	13,200	1.43	11,741.33	3.82
(5) BUS MH-44	13,200	1.41	11,759.77	3.76
(5) BUS MH-47	13,200	1.41	11,748.61	3.77
(5) BUS MH-48	13,200	1.41	11,747.57	3.77
(5) BUS-MH-25	13,200	1.41	11,759.77	3.76
(5) BUS-MH-30	13,200	1.41	11,759.77	3.76
(6) BUS MH-25	13,200	1.41	11,710.96	3.76
(6) BUS MH-30	13,200	1.41	11,710.10	3.76
(6) BUS MH-44	13,200	1.41	11,710.95	3.76
(6) BUS MH-47	13,200	1.41	11,710.99	3.76
(6) BUS MH-48	13,200	1.41	11,710.99	3.76
(7)BUS MH43	13,200	1.40	11,764.99	3.74
(7)BUS-MH41	13,200	1.40	11,765.90	3.74
(7)BUS-MH49	13,200	1.40	11,767.61	3.74
(8)BUS MH43	13,200	1.40	11,774.97	3.75
(8)BUS-MH41	13,200	1.40	11,774.97	3.75
(8)BUS-MH49	13,200	1.40	11,774.97	3.75
(F1) BUS MH31	4,160	0.97	3,466.40	2.67
(F2) BUS- MH34	4,160	0.94	3,455.25	2.60
(F2)BUS-MH35	4,160	0.94	3,455.25	2.60
(F4)BUS- MH34	4,160	1.38	3,665.38	3.70
(F5) POLE AT 17TH, AVE	4,160	0.96	3,441.59	2.66
(F5) POLE AT BB	4,160	0.96	3,436.58	2.66
(F5) POLE AT ELLIOT	4,160	0.96	3,439.75	2.66
(F5)MH33	4,160	0.97	3,448.45	2.67
(F6)BUS - MH-37	4,160	1.38	3,663.87	3.70
AB1 MCB1	480	2.02	407.96	5.16
AB3 MDP	208	1.28	181.46	3.42
AB4 MDP	480	1.98	409.11	5.03

Buses

Bus Name	Bus Voltage	THD%	RMS (V)	TIF
Admin MDP	480	1.89	411.40	4.90
Baseball MDP	480	5.72	408.99	13.07
Belvin MDP	208	0.85	162.48	1.70
BKV A&B	208	1.56	178.05	4.10
BKV C&D	208	1.72	173.76	4.43
BKV D&E	208	1.48	173.91	3.95
BKV Distribution	13,200	1.41	11,679.12	3.77
BKV-F&I	208	1.57	177.73	4.11
BKV-F,G,H	208	1.62	168.30	4.22
BKV-J&M	208	1.52	179.12	4.01
BKV-K&L	208	1.61	176.54	4.21
BUS - MH-38	4,160	1.38	3,662.10	3.70
BUS- (MH34) (F7, WestPla	4,160	0.96	3,434.25	2.65
BUS- Farrington Switches V	4,160	0.97	3,467.27	2.67
BUS-(Bowers,Softball/Base	13,200	1.58	11,704.10	4.21
BUS-0109	4,160	1.38	3,661.80	3.70
BUS-0110	480	1.38	419.76	3.69
BUS-0112	480	1.38	420.36	3.69
BUS-0114	480	1.38	419.93	3.69
BUS-0116	480	1.38	420.07	3.69
BUS-0117	4,160	0.00	0.00	0.00
BUS-0125	208	0.00	0.00	0.00
BUS-0126	4,160	0.00	0.00	0.00
BUS-0139	240	0.00	0.00	0.00
BUS-0142	4,160	0.00	0.00	0.00
BUS-0144	480	0.00	0.00	0.00
BUS-0145	4,160	0.00	0.00	0.00
BUS-0146	480	0.00	0.00	0.00
BUS-0147	4,160	0.00	0.00	0.00

Buses

Bus Name	Bus Voltage	THD%	RMS (V)	TIF
BUS-0148	480	0.00	0.00	0.00
BUS-0150	4,160	0.97	3,446.65	2.67
BUS-0151	208	0.96	167.66	2.65
BUS-0153	208	0.73	163.91	1.71
BUS-0155	480	0.96	391.89	2.66
BUS-0161	208	0.96	167.95	2.65
BUS-0329	13,200	1.44	11,736.15	3.84
BUS-0330	13,200	1.44	11,736.12	3.84
BUS-0411	13,200	1.41	11,747.82	3.77
BUS-0413	13,200	1.41	11,747.11	3.77
BUS-0485	208	0.00	0.00	0.00
BUS-0486	240	0.00	0.00	0.00
BUS-0487	480	0.00	0.00	0.00
BUS-0577	13,200	1.41	11,679.03	3.77
BUS-0578	13,200	1.41	11,678.73	3.77
BUS-0579	13,200	1.41	11,678.62	3.77
BUS-0580	13,200	1.41	11,678.83	3.77
BUS-0581	13,200	1.41	11,678.64	3.77
BUS-0582	13,200	1.41	11,678.96	3.77
BUS-0583	13,200	1.41	11,678.80	3.77
BUS-0597	208	1.52	180.02	4.03
BUS-0601	480	1.86	412.68	4.84
BUS-0602	13,200	1.45	11,726.66	3.88
BUS-0603	13,200	1.45	11,725.78	3.88
BUS-0624	4,160	1.38	3,667.54	3.70
BUS-0625	4,160	0.96	3,434.88	2.66
BUS-0626	4,160	0.97	3,435.78	2.67
BUS-0628	4,160	0.96	3,435.08	2.66

Buses

Bus Name	Bus Voltage	THD%	RMS (V)	TIF
BUS-0634	4,160	0.96	3,432.80	2.65
BUS-0635	4,160	0.96	3,432.73	2.65
BUS-0639	480	0.67	390.10	1.71
BUS-0647	208	0.96	168.99	2.65
BUS-0651	13,200	1.40	11,774.84	3.75
BUS-0652	13,200	1.40	11,774.84	3.75
BUS-0653	13,200	1.40	11,774.83	3.75
BUS-0655	13,200	1.40	11,765.71	3.74
BUS-0656	13,200	1.40	11,765.70	3.74
BUS-0661	13,200	1.40	11,765.72	3.74
BUS-0662	13,200	1.40	11,774.97	3.75
BUS-0665	13,200	1.40	11,764.72	3.74
BUS-0666	13,200	1.40	11,774.97	3.75
BUS-0667	13,200	1.40	11,764.72	3.74
BUS-0669	13,200	1.40	11,764.70	3.74
BUS-0671	480	1.44	423.91	3.84
BUS-0672	480	1.56	410.26	4.12
BUS-0673	13,200	1.40	11,767.61	3.74
BUS-0674	480	0.75	384.74	1.56
BUS-0675	480	0.82	384.00	1.57
BUS-0676	4,160	0.96	3,439.71	2.66
BUS-0677	13,200	1.41	11,679.16	3.77
BUS-0678	480	0.78	383.88	1.56
BUS-0680	13,200	1.58	11,705.05	4.20
BUS-0681	13,200	1.41	11,679.16	3.77
BUS-0682	13,200	1.41	11,681.69	3.76
BUS-0684	13,200	1.58	11,704.11	4.21
BUS-0685	480	2.81	406.77	6.48

Buses

Bus Name	Bus Voltage	THD%	RMS (V)	TIF
BUS-0686	13,200	1.58	11,702.78	4.22
BUS-0688	13,200	1.58	11,703.06	4.22
BUS-0690	480	5.60	409.45	12.91
BUS-0694	13,200	1.40	11,693.83	3.74
BUS-0695	13,200	1.49	11,734.28	3.97
BUS-0696	13,200	1.40	11,693.82	3.74
BUS-0697	13,200	1.40	11,693.14	3.74
BUS-0698	13,200	1.40	11,693.19	3.74
BUS-0700	13,200	1.40	11,693.41	3.74
BUS-0701	13,200	1.40	11,693.65	3.74
BUS-0702	13,200	1.40	11,693.65	3.74
BUS-0720	13,200	1.53	11,717.67	4.07
BUS-0721	480	2.43	405.45	6.13
BUS-0722	13,200	1.53	11,718.22	4.07
BUS-0725	480	2.36	420.78	6.03
BUS-0726	480	2.45	420.18	6.18
BUS-0728	13,200	1.40	11,724.23	3.74
BUS-0729	13,200	1.46	11,746.49	3.89
BUS-0730	13,200	1.46	11,746.49	3.89
BUS-0731	13,200	1.40	11,758.45	3.74
BUS-0732	13,200	1.46	11,746.47	3.89
BUS-0733	480	4.33	422.66	4.52
BUS-0734	13,200	1.42	11,762.69	3.79
BUS-0735	13,200	1.42	11,762.69	3.79
BUS-0738	13,200	1.42	11,762.65	3.79
BUS-0739	480	1.50	425.53	3.90
BUS-0740	13,200	1.44	11,736.79	3.84
BUS-0741	13,200	1.43	11,746.36	3.81

Buses

Bus Name	Bus Voltage	THD%	RMS (V)	TIF
BUS-0742	13,200	1.44	11,736.79	3.84
BUS-0743	13,200	1.44	11,735.58	3.84
BUS-0744	13,200	1.44	11,736.79	3.84
BUS-0745	480	1.62	422.23	4.30
BUS-0746	13,200	1.44	11,735.99	3.85
BUS-0747	13,200	1.44	11,735.57	3.84
BUS-0748	13,200	1.44	11,735.53	3.84
BUS-0749	480	2.20	404.57	5.57
BUS-0750	13,200	1.44	11,735.99	3.85
BUS-0751	13,200	1.45	11,734.98	3.86
BUS-0752	13,200	1.43	11,746.36	3.81
BUS-0753	480	2.09	418.32	5.37
BUS-0754	13,200	1.43	11,746.36	3.81
BUS-0755	13,200	1.45	11,734.98	3.86
BUS-0757	480	3.39	415.59	8.74
BUS-0758	13,200	1.43	11,746.36	3.81
BUS-0759	13,200	1.44	11,735.98	3.85
BUS-0766	13,200	1.45	11,734.95	3.86
BUS-0767	13,200	1.44	11,741.27	3.84
BUS-0768	13,200	1.45	11,726.73	3.88
BUS-0769	13,200	1.45	11,726.73	3.88
BUS-0770	208	2.37	181.21	6.01
BUS-0771	208	2.37	180.54	6.01
BUS-0774	13,200	1.44	11,741.24	3.83
BUS-0775	13,200	1.44	11,736.27	3.84
BUS-0776	13,200	1.44	11,736.27	3.84
BUS-0777	13,200	1.44	11,741.22	3.83
BUS-0778	13,200	1.43	11,740.09	3.82

Buses

Bus Name	Bus Voltage	THD%	RMS (V)	TIF
BUS-0779	13,200	1.43	11,740.09	3.82
BUS-0780	13,200	1.43	11,740.06	3.82
BUS-0781	480	2.39	402.63	5.96
BUS-0784	13,200	1.43	11,743.59	3.81
BUS-0785	13,200	1.43	11,743.58	3.81
BUS-0786	480	1.93	410.78	5.00
BUS-0788	13,200	1.43	11,743.59	3.81
BUS-0789	13,200	1.44	11,740.32	3.83
BUS-0790	13,200	1.44	11,740.32	3.83
BUS-0793	13,200	1.44	11,740.31	3.83
BUS-0794	480	1.41	410.29	3.77
BUS-0795	13,200	1.44	11,741.19	3.83
BUS-0797	13,200	1.42	11,757.40	3.79
BUS-0798	13,200	1.42	11,757.40	3.79
BUS-0799	480	1.88	425.20	4.90
BUS-0800	13,200	1.43	11,746.35	3.81
BUS-0801	13,200	1.44	11,741.19	3.83
BUS-0802	13,200	1.44	11,741.19	3.83
BUS-0803	480	1.73	423.98	4.57
BUS-0804	13,200	1.44	11,741.19	3.83
BUS-0805	13,200	1.44	11,741.19	3.83
BUS-0806	13,200	1.43	11,746.35	3.81
BUS-0808	13,200	1.44	11,741.19	3.83
BUS-0809	480	1.49	423.29	3.95
BUS-0815	13,200	1.41	11,710.10	3.76
BUS-0816	13,200	1.41	11,710.08	3.76
BUS-0817	480	1.85	413.61	4.81
BUS-0820	13,200	1.41	11,747.22	3.77

Buses

Bus Name	Bus Voltage	THD%	RMS (V)	TIF
BUS-0822	208	1.44	180.51	3.85
BUS-0823	13,200	1.41	11,747.22	3.77
BUS-0824	13,200	1.41	11,710.99	3.76
BUS-0825	13,200	1.41	11,747.93	3.77
BUS-0826	13,200	1.41	11,710.99	3.76
BUS-0827	13,200	1.41	11,747.82	3.77
BUS-0829	208	1.47	181.66	3.91
BUS-0831	208	1.47	181.71	3.91
BUS-0832	13,200	1.41	11,710.69	3.76
BUS-0833	13,200	1.41	11,710.61	3.76
BUS-0834	480	1.67	421.84	4.41
BUS-0836	13,200	1.41	11,759.77	3.76
BUS-0837	13,200	1.41	11,710.69	3.76
BUS-0838	13,200	1.41	11,759.49	3.76
BUS-0839	13,200	0.00	0.00	0.00
BUS-0840	13,200	1.41	11,759.49	3.76
BUS-0841	13,200	1.41	11,759.40	3.76
BUS-0842	208	1.45	179.74	3.88
BUS-0844	13,200	1.41	11,710.55	3.76
BUS-0847	13,200	1.41	11,710.54	3.76
BUS-0848	480	2.78	410.02	6.83
BUS-0851	13,200	1.41	11,710.55	3.76
BUS-0852	13,200	1.41	11,759.77	3.76
BUS-0853	13,200	1.41	11,710.95	3.76
BUS-0854	13,200	1.41	11,710.95	3.76
BUS-0855	13,200	1.41	11,710.90	3.76
BUS-0856	13,200	1.41	11,710.50	3.76
BUS-0857	4,160	0.98	3,484.89	2.70

Buses

Bus Name	Bus Voltage	THD%	RMS (V)	TIF
BUS-0861	4,160	1.38	3,663.79	3.70
BUS-0862	4,160	1.38	3,663.79	3.70
BUS-0863	4,160	1.38	3,663.70	3.70
BUS-0865	208	1.30	181.96	3.48
BUS-0869	4,160	1.38	3,662.05	3.70
BUS-0870	4,160	1.38	3,662.05	3.70
BUS-0871	4,160	1.38	3,661.88	3.70
BUS-0872	480	1.38	419.85	3.69
BUS-0873	480	1.38	419.31	3.69
BUS-0874	480	1.37	414.30	3.67
BUS-0875	480	1.38	419.83	3.69
BUS-0876	480	1.38	419.29	3.69
BUS-0877	480	1.37	413.75	3.67
BUS-0878	480	0.53	341.93	1.51
BUS-0886	4,160	0.97	3,438.35	2.67
BUS-0887	4,160	0.96	3,435.29	2.66
BUS-0890	4,160	0.94	3,455.08	2.59
BUS-0891	4,160	0.94	3,454.92	2.59
BUS-0892	4,160	0.93	3,450.85	2.57
BUS-0894	4,160	0.97	3,466.32	2.67
BUS-0895	480	0.96	396.38	2.66
BUS-0897	4,160	0.96	3,461.66	2.66
BUS-0898	480	0.71	383.02	1.79
BUS-0903	480	3.01	480.22	7.75
BUS-0904	480	3.01	480.22	7.75
BUS-0922	4,160	1.21	3,603.52	3.23
BUS-0923	4,160	1.14	3,571.55	3.07
BUS-0924	4,160	1.07	3,529.97	2.89

Buses

Bus Name	Bus Voltage	THD%	RMS (V)	TIF
BUS-Farrington Switches - `	4,160	1.38	3,665.38	3.70
BUS-OH POLE(VickSpivey	4,160	1.38	3,660.24	3.70
BUS-PEA/AUS WIREWAY	208	0.96	166.94	2.65
BUS-S&C -(Raven Village .	13,200	1.41	11,747.93	3.77
BUS-Switchgear Building	13,200	1.40	11,776.62	3.74
CFS MDP	480	1.69	421.48	4.45
CHSS MDP	480	3.48	414.78	8.96
CJC MDP	480	1.52	425.11	3.91
Coliseum MDP	480	2.53	403.32	6.28
Comm/Admin Dist	13,200	1.44	11,736.25	3.84
Communications MDP	208	1.58	178.92	4.16
E & HC Transformer Secon	240	1.40	200.88	3.75
East Plant Distribution	13,200	1.40	11,693.70	3.74
Elliott MDP	208	0.96	167.92	2.66
EP EQ1 MDP	480	1.41	422.01	3.76
EP EQ2 MDP	480	1.41	422.00	3.76
Estill Dorm MDP	240	1.32	198.59	3.55
ESTILL MDP	480	0.72	382.24	1.77
Evans MDP	480	0.88	383.45	1.58
Evans/VisCen MDP	480	0.76	384.55	1.56
FARR MDP	480	0.96	396.02	2.66
Field House MDP	480	2.87	406.32	6.61
Garage MDP	480	1.92	424.87	4.98
Health Center MDP	240	1.40	199.80	3.76
HKC MDP	480	2.54	419.58	6.33
Lee Drain MDP	480	3.07	406.34	7.23
LIB MDP	480	2.22	403.82	5.61
Lonestar Hall MDP	480	1.45	423.70	3.86

Buses

Bus Name	Bus Voltage	THD%	RMS (V)	TIF
LSC MDP	480	2.64	397.27	6.34
MLH MDP	208	0.96	166.17	2.66
Music Bldg. MDP	480	1.41	408.42	3.77
Old Smith Hutson MDP	480	1.56	422.21	4.11
OMM MDP	480	1.57	408.59	4.15
PAC MDP	480	4.48	417.50	4.75
RAVEN MDP	208	1.44	179.05	3.85
RVA MDP	208	1.57	180.21	4.12
RVB MDP	208	1.57	180.27	4.12
SH MDP	480	1.76	423.62	4.62
SHV Distribution	13,200	1.45	11,726.69	3.88
SHV#1 MDP	208	2.53	180.52	6.27
SHV#2 MDP	208	2.58	179.52	6.33
Sorority	480	0.97	389.37	2.67
SouthPaw MDP	208	1.46	178.99	3.89
TEC MDP	480	2.10	418.15	5.39
Thomason MDP	480	0.69	389.37	1.68
UTC MDP	480	1.64	421.77	4.33
VisCen MDP	480	0.80	383.21	1.57
West Plant MDP	480	0.51	338.88	1.46
XFMR-WEST PLANT	4,160	0.96	3,432.73	2.65

Branches

Component Name	Type	From Bus To Bus	Bus Voltage (V)	THD%	RMS(A)	I T	K	LF Amps	LF Angle
(2)CBL Substation to MH-2	Cable	BUS-Switchgear Building (2) BUS MH-2	13,200	5.81	168	2,420.03	1.08	168	-35
XFMR-BKV A&B	Xformer2	BUS-0577 BKV A&B	13,200	4.96	6	42.97	1.03	6	-42
XFMR-BKV D&E	Xformer2	BUS-0579 BKV D&E	13,200	0.33	14	13.49	1.00	14	-41
XFMR-BKV FGH	Xformer2	BUS-0581 BKV-F,G,H	13,200	5.78	10	74.17	1.04	10	-41
XFMR-BKV J&M	Xformer2	BUS-0582 BKV-J&M	13,200	4.47	4	21.93	1.03	4	-42
XFMR-BKV K&L	Xformer2	BUS-0583 BKV-K&L	13,200	4.80	8	51.82	1.03	8	-41
XFMR-Parking Garage	Xformer2	BUS-0798 BUS-0799	13,200	11.67	2	50.10	1.33	2	-43
XFMR UTC	Xformer2	BUS-0744 BUS-0745	13,200	2.23	7	39.76	1.01	7	-43
XFMR SHV1	Xformer2	BUS-0602 BUS-0770	13,200	5.78	16	223.40	1.08	16	-44
XFMR SHV2	Xformer2	BUS-0603 BUS-0771	13,200	4.84	18	220.99	1.06	18	-44
XFMR-RVA	Xformer2	BUS-0411 BUS-0829	13,200	2.05	16	82.01	1.01	16	-42
XFMR-RVB	Xformer2	BUS-0827 BUS-0831	13,200	2.05	16	81.99	1.01	16	-42
RAVEN C XFMR	Xformer2	BUS-0413 BUS-0822	13,200	0.34	16	15.70	1.00	16	-42
XFMR-South Paw	Xformer2	BUS-0841 BUS-0842	13,200	0.02	13	6.68	1.00	13	-42

XFMR-CFS	Xformer2	BUS-0833 BUS-0834	13,200	3.54	12	107.38	1.03	12	-43
XFMR-OMM	Xformer2	BUS-0669 BUS-0672	13,200	0.32	37	35.62	1.00	37	-45
(F6)CBL - FS6 to MH37	Cable	BUS-Farrington Switches - VB1 (F6)BUS - MH-37	4,160	0.70	61	109.27	1.00	61	-74
XFMR-AB3	Xformer2	BUS-0863 BUS-0865	4,160	2.06	13	66.12	1.01	13	-74
(F6) OH-MH-38 TO ADAMS XFMR	Cable	BUS - MH-38 BUS-0109	4,160	0.34	8	7.46	1.00	8	-74
XMFR-ADAMS	Xformer2	BUS-0109 BUS-0110	4,160	0.34	8	7.46	1.00	8	-74
XFMR-ALLEN	Xformer2	BUS-0871 BUS-0112	4,160	0.34	6	5.55	1.00	6	-73
XFMR-BARR	Xformer2	BUS-0870 BUS-0114	4,160	0.34	7	6.69	1.00	7	-74
XFMR-PARKHILL	Xformer2	BUS-0869 BUS-0116	4,160	0.34	7	6.69	1.00	7	-74
(F6)OH POLE X TO POLE Y	Cable	BUS - MH-38 BUS-OH POLE(VickSpivey,Randel)	4,160	0.33	21	20.02	1.00	21	-74
CBL-VICK XFMR TO VICK MDP	Cable	BUS-0872 BUS-0873	480	0.34	60	58.01	1.00	60	-73
XFMR-VICK	Xformer2	BUS-OH POLE(VickSpivey,Randel) BUS-0872	4,160	0.34	7	6.69	1.00	7	-73
CBL-SPIV XFMR TO SPIV MDP	Cable	BUS-0874 BUS-0877	480	0.32	61	57.47	1.00	61	-74
XFMR-SPIVEY	Xformer2	BUS-OH POLE(VickSpivey,Randel) BUS-0874	4,160	0.32	7	6.63	1.00	7	-74
CBL-RAND XFMR TO RAND MDP	Cable	BUS-0875 BUS-0876	480	0.34	60	58.01	1.00	60	-73
XFMR-RANDEL	Xformer2	BUS-OH POLE(VickSpivey,Randel) BUS-0875	4,160	0.34	7	6.69	1.00	7	-73

XFMR-BKV C&D	Xformer2	BUS-0578 BKV C&D	13,200	4.52	11	66.27	1.03	11	-41
XFMR-BKV-F&I	Xformer2	BUS-0580 BKV-F&I	13,200	4.72	7	42.79	1.03	7	-41
(1)CBL Substation to MH-2	Cable	BUS-Switchgear Building (1) BUS MH-2	13,200	0.57	242	353.54	1.00	242	-44
(1)MH-2 to MH-5	Cable	(1) BUS MH-2 (1)BUS MH-5	13,200	0.58	242	355.85	1.00	242	-44
(2)MH-2 to MH-5	Cable	(2) BUS MH-2 (2)BUS MH-5	13,200	7.82	121	2,346.71	1.15	121	-43
S&C PAC		BUS-0728 BUS-0729	13,200	2.05	15	79.10	1.01	15	-43
CBL-PAC S&C to PAC XFMR	Cable	BUS-0730 BUS-0732	13,200	2.05	15	79.10	1.01	15	-43
XFMR-PAC	Xformer2	BUS-0732 BUS-0733	13,200	2.05	15	79.08	1.01	15	-43
(1)CBL MH-5 to MH-8	Cable	(1)BUS MH-5 (1)BUS MH-8	13,200	0.58	242	359.12	1.00	242	-44
(2)CBL MH-5 to MH-8	Cable	(2)BUS MH-5 (2)BUS MH-8	13,200	8.64	106	2,264.29	1.18	106	-43
XFMR-EP Equip 2	Xformer2	BUS-0701 EP EQ2 MDP	13,200	1.65	7	28.16	1.01	7	-43
XFMR-EP Equip 1	Xformer2	BUS-0702 EP EQ1 MDP	13,200	1.65	7	28.16	1.01	7	-43
XFMR-EP Chiller 3	Xformer2	BUS-0700 BUS-0922	13,200	1.41	41	141.88	1.00	41	-44
XFMR-EP Chiller 2	Xformer2	BUS-0697 BUS-0923	13,200	1.34	57	187.17	1.00	57	-45
XFMR-EP Chiller 1	Xformer2	BUS-0698 BUS-0924	13,200	1.26	72	223.66	1.00	72	-45
S&C Bowers & Baseball Complex		BUS-0682 BUS-0684	13,200	11.52	68	1,918.43	1.32	67	-43

(1) CBL MH-8 to MH-10	Cable	(1)BUS MH-8 (1)BUS MH-10	13,200	1.97	60	294.09	1.01	60	-41
XFMR-Field House	Xformer2	BUS-0686 BUS-0685	13,200	20.62	39	1,109.66	1.54	38	-41
(1) CBL MH-10 to S&C BKV	Cable	(1)BUS MH-10 BUS-0681	13,200	1.93	60	289.32	1.01	60	-41
S&C - BKV		BUS-0681 BUS-0680	13,200	1.93	60	288.49	1.01	60	-41
(2) CBL MH-10 to S&C BKV	Cable	(2)BUS MH-10 BUS-0680	13,200	8.06	0	1.21	1.17	0	84
CBL-S&C to BKV DIST	Cable	BUS-0677 BKV Distribution	13,200	1.93	60	288.47	1.01	60	-41
XFMR-Coliseum	Xformer2	BUS-0720 BUS-0721	13,200	2.10	30	159.14	1.01	30	-45
CBL-PAC XFMR to PAC MDP	Cable	BUS-0733 PAC MDP	480	4.03	424	2,219.07	1.02	424	-73
CBL-East Plant Chiller #1	Cable	East Plant Distribution BUS-0698	13,200	1.25	72	223.52	1.00	72	-45
CBL-East Plant Chiller #2	Cable	East Plant Distribution BUS-0697	13,200	1.34	57	187.04	1.00	57	-45
CBL-East Plant Chiller #3	Cable	East Plant Distribution BUS-0700	13,200	1.41	41	141.73	1.00	41	-44
CBL-East Plant Equip #1	Cable	East Plant Distribution BUS-0702	13,200	1.64	7	28.01	1.01	7	-43
CBL-East Plant Equip #2	Cable	East Plant Distribution BUS-0701	13,200	1.64	7	28.01	1.01	7	-43
(2) CBL MH-8 to MH-9	Cable	(2)BUS MH-8 (2) BUS MH-9	13,200	8.63	106	2,261.51	1.18	106	-43
CBL FH S&C to FH XFMR	Cable	BUS-(Bowers,Softball/Baseball) BUS-0686	13,200	11.69	38	1,093.63	1.33	38	-41
CBL-BKV S&C to XFMR BKV A&B	Cable	BKV Distribution BUS-0577	13,200	2.64	6	42.47	1.02	6	-41

CBL-BKV S&C to XFMR BKV C&D	Cable	BKV Distribution BUS-0578	13,200	2.40	11	65.71	1.01	11	-40
CBL-BKV S&C to XFMR BKV D&E	Cable	BKV Distribution BUS-0579	13,200	0.31	14	12.88	1.00	14	-40
CBL-BKV S&C to XFMR BKV F&I	Cable	BKV Distribution BUS-0580	13,200	2.54	7	42.85	1.02	7	-41
CBL-BKV S&C to XFMR BKV FGH	Cable	BKV Distribution BUS-0581	13,200	3.04	10	73.73	1.02	10	-41
CBL-BKV S&C to XFMR BKV J&M	Cable	BKV Distribution BUS-0582	13,200	2.44	4	22.39	1.01	4	-41
CBL-BKV S&C to XFMR BKV K&L	Cable	BKV Distribution BUS-0583	13,200	2.58	8	51.65	1.02	8	-41
(2) MH-9 to MH-11	Cable	(2) BUS MH-9 (2) BUS MH-11	13,200	3.50	39	337.78	1.03	39	-45
CBL-Coliseum S&C to Col. XFMR	Cable	(2) BUS MH-11 BUS-0720	13,200	2.11	30	159.71	1.01	30	-45
(4)CBL Substation to MH-17	Cable	BUS-Switchgear Building (4) BUS MH-17	13,200	2.80	132	924.61	1.02	132	-44
(3)CBL Substation to MH-17	Cable	BUS-Switchgear Building (3) BUS MH-17	13,200	4.47	154	1,600.56	1.05	154	-44
Parking Garage S&C		(3) BUS MH-17 (4) BUS MH-17	13,200	11.68	2	50.12	1.33	2	-43
CBL-Garage S&C to Garage XFMR	Cable	BUS-0797 BUS-0798	13,200	11.68	2	50.12	1.33	2	-43
CBL-Garage XFMR to MDP	Cable	BUS-0799 Garage MDP	480	20.62	49	1,398.89	1.54	48	-73
(4) CBL-MH-17 to MH-19	Cable	(4) BUS MH-17 (4)BUS MH-19	13,200	2.67	131	872.04	1.02	131	-44
S&C SmithHutson		BUS-0795 BUS-0800	13,200	5.62	6	77.88	1.08	6	-43
CBL-S.Hutson S&C to S.H. XFMR	Cable	BUS-0801 BUS-0802	13,200	5.62	6	77.88	1.08	6	-43

(3) CBL-MH-17 to MH-19	Cable	(3) BUS MH-17 (3)BUS MH-19	13,200	4.46	154	1,597.88	1.05	154	-44
XF2-Smith Hutson	Xformer2	BUS-0802 BUS-0803	13,200	5.62	6	77.86	1.08	6	-43
XF2-Old Smith Hutson	Xformer2	BUS-0808 BUS-0809	13,200	5.65	6	78.46	1.08	6	-43
MUSIC S&C		(3)MUSIC S&C (4) MUSIC S&C	13,200	0.33	19	18.15	1.00	19	-45
CBL MUSIC S&C TO MUSIC XFMR	Cable	BUS-0790 BUS-0793	13,200	0.33	19	18.15	1.00	19	-45
(4)CBL MH-19 TO MUSIC S&C	Cable	(4)BUS MH-19 (4) MUSIC S&C	13,200	1.57	23	90.97	1.01	23	-45
(3)CBL MH-19 TO MUSIC S&C	Cable	(3)BUS MH-19 (3)MUSIC S&C	13,200	0.28	19	15.97	1.00	19	-44
XFMR-Music	Xformer2	BUS-0793 BUS-0794	13,200	0.33	19	18.16	1.00	19	-45
(4)CBL S&C MUSIC TO S&C AB1	Cable	(4) MUSIC S&C BUS-0788	13,200	1.55	23	89.76	1.01	23	-45
(3)CBL S&C MUSIC TO S&C AB1	Cable	(3)MUSIC S&C BUS-0789	13,200	7.34	0	1.98	1.14	0	84
LSC S&C		BUS-0777 BUS-0778	13,200	1.84	44	202.70	1.01	44	-46
CBL-LSC S&C to LSC XFMR	Cable	BUS-0779 BUS-0780	13,200	1.84	44	202.70	1.01	44	-46
CBL-0181	Cable	(4)BUS MH-19 (4)BUS MH-36	13,200	2.87	108	770.29	1.02	108	-44
(3) Mh-19 to MH-36	Cable	(3)BUS MH-19 (3)BUS MH-36	13,200	7.34	0	11.90	1.14	0	84
XFMR-LSC	Xformer2	BUS-0780 BUS-0781	13,200	1.84	44	202.68	1.01	44	-46
CBL-LSC XFMR to LSC MDP	Cable	BUS-0781 LSC MDP	480	3.76	1,208	5,698.61	1.02	1,207	-76

(4) MH-19 to MH-24	Cable	(4)BUS MH-19 (4) MH-24	13,200	7.30	0	3.65	1.14	0	84
(3) MH-19 to MH-24	Cable	(3)BUS MH-19 (3) MH-24	13,200	11.49	46	1,192.43	1.31	45	-44
Admin/Comm S&C		BUS-0774 BUS-0775	13,200	1.56	30	119.21	1.01	30	-43
CBL-Admin/Comm S&C to Dist	Cable	BUS-0776 Comm/Admin Dist	13,200	1.56	30	119.20	1.01	30	-43
(4)CBL MH-36 to MH-33	Cable	(4)BUS MH-36 (4)BUS MH-33	13,200	3.58	64	571.64	1.03	64	-43
(3)CBL MH-36 to MH-33	Cable	(3)BUS MH-36 (3)BUS MH-33	13,200	7.34	0	9.88	1.14	0	84
XFMR-Comm	Xformer2	BUS-0330 BUS-0597	13,200	1.63	17	70.51	1.01	17	-42
CBL-Dist to Admin XFMR	Cable	Comm/Admin Dist BUS-0329	13,200	1.51	13	50.07	1.01	13	-45
XF2-Admin0	Xformer2	BUS-0329 BUS-0601	13,200	1.50	13	49.92	1.01	13	-45
CBL-Dist to Comm XFMR	Cable	Comm/Admin Dist BUS-0330	13,200	1.64	17	70.65	1.01	17	-42
(4) MH-19 to MH-20	Cable	(4)BUS MH-19 (4)BUS MH-20	13,200	7.30	0	7.76	1.14	0	84
(3) MH-19 to MH-20	Cable	(3)BUS MH-19 (3)BUS MH-20	13,200	2.06	79	406.08	1.01	79	-45
(4) CBL MH-20 to MH-23	Cable	(4)BUS MH-20 (4) BUS MH-23	13,200	7.30	0	3.27	1.14	0	84
(3) CBL MH-20 to MH-23	Cable	(3)BUS MH-20 (3) BUS MH-23	13,200	4.15	13	136.27	1.04	13	-44
S&C UTC		BUS-0740 BUS-0741	13,200	2.23	7	39.77	1.01	7	-43
CBL UTC S&C to UTC XFMR	Cable	BUS-0742 BUS-0744	13,200	2.23	7	39.77	1.01	7	-43

(4)CBL MH-20 to MH-21	Cable	(4)BUS MH-20 (4)BUS MH-21	13,200	7.30	0	2.37	1.14	0	84
(3)CBL MH-20 to MH-21	Cable	(3)BUS MH-20 (3)BUS MH-21	13,200	2.34	7	41.70	1.01	7	-43
S&C SHV		BUS-0767 BUS-0768	13,200	5.29	34	445.48	1.07	34	-44
CBL SHV S&C to SHV Dist	Cable	BUS-0769 SHV Distribution	13,200	5.29	34	445.45	1.07	34	-44
(4)CBL MH-33 to MH-46	Cable	(4)BUS MH-33 (4) BUS MH-46	13,200	5.38	34	451.66	1.07	34	-44
(3)CBL MH-33 to MH-46	Cable	(3)BUS MH-33 (3) BUS MH-46	13,200	7.34	0	7.70	1.14	0	84
CBL-SHV Dist to SHV2 XFMR	Cable	SHV Distribution BUS-0603	13,200	4.87	18	222.06	1.06	18	-44
CBL-SHV Dist to SHV1 XFMR	Cable	SHV Distribution BUS-0602	13,200	5.78	16	223.43	1.08	16	-44
(8)CBL-MH1 to MH49	Cable	BUS-Switchgear Building (8)BUS-MH49	13,200	3.53	17	151.84	1.03	17	-42
(7)CBL-MH1 to MH49	Cable	BUS-Switchgear Building (7)BUS-MH49	13,200	0.59	64	99.67	1.00	64	-43
S&C Lone Star Hall		BUS-0673 BUS-0652	13,200	3.42	17	147.69	1.03	17	-42
CBL-LSH S&C to XFMR	Cable	BUS-0651 BUS-0653	13,200	3.42	17	147.69	1.03	17	-42
(8)CBL MH 49 TO MH41	Cable	(8)BUS-MH49 (8)BUS-MH41	13,200	7.17	0	2.01	1.14	0	84
(7)CBL MH49 to MH41	Cable	(7)BUS-MH49 (7)BUS-MH41	13,200	0.61	64	102.55	1.00	64	-43
XFMR-Lone Star Hall	Xformer2	BUS-0653 BUS-0671	13,200	3.42	17	147.67	1.03	17	-42
S&C Estill and Health Center		BUS-0661 BUS-0662	13,200	1.81	27	120.57	1.01	27	-40

CBL-EHC S&C to XFMR	Cable	BUS-0655 BUS-0656	13,200	1.81	27	120.57	1.01	27	-40
XFMR-Estill & Health Center	Xformer2	BUS-0656 E & HC Transformer Secondary	13,200	1.81	27	120.59	1.01	27	-40
CBL-XFMR to Estill MDP	Cable	E & HC Transformer Secondary Estill Dorm MDP	240	2.01	1,294	6,489.55	1.01	1,294	-40
CBL-XFMR to HC MDP	Cable	E & HC Transformer Secondary Health Center MDP	240	0.31	177	160.89	1.00	177	-40
(8)CBL MH41 to MH43	Cable	(8)BUS-MH41 (8)BUS MH43	13,200	7.17	0	0.97	1.14	0	84
(7)CBL MH41 to MH43	Cable	(7)BUS-MH41 (7)BUS MH43	13,200	0.32	37	36.25	1.00	37	-45
CBL LD S&C to LD XFMR	Cable	BUS-0844 BUS-0847	13,200	4.37	19	207.69	1.05	19	-45
CBL-0004	Cable	BUS-Switchgear Building (6) BUS MH-25	13,200	0.21	230	164.33	1.00	230	-48
CBL-0044	Cable	BUS-Switchgear Building (5) BUS-MH-25	13,200	1.09	61	170.99	1.00	61	-41
Lee Drain S&C		BUS-0852 BUS-0851	13,200	4.37	19	207.69	1.05	19	-45
(6) MH-25 to MH-30	Cable	(6) BUS MH-25 (6) BUS MH-30	13,200	1.81	23	105.19	1.01	23	-44
XFMR-Lee Drain	Xformer2	BUS-0847 BUS-0848	13,200	4.37	19	207.68	1.05	19	-45
CBL-LD XFMR to LD MDP	Cable	BUS-0848 Lee Drain MDP	480	8.16	528	5,813.74	1.08	526	-75
(5) MH-25 to MH-30	Cable	(5) BUS-MH-25 (5) BUS-MH-30	13,200	7.19	0	1.18	1.14	0	84
CBL-0174	Cable	BUS-0815 BUS-0816	13,200	1.81	23	105.19	1.01	23	-44
AB4 S&C Switch		(5) BUS-MH-30 (6) BUS MH-30	13,200	1.81	23	105.19	1.01	23	-44

XFMR AB4	Xformer2	BUS-0816 BUS-0817	13,200	1.81	23	105.17	1.01	23	-44
CBL-AB4 XFMR to AB4 MDP	Cable	BUS-0817 AB4 MDP	480	3.63	639	2,954.43	1.02	639	-74
(6) CBL MH-25 to MH-44	Cable	(6) BUS MH-25 (6) BUS MH-44	13,200	3.56	12	107.99	1.03	12	-43
(5) CBL MH-25 MH-44	Cable	(5) BUS-MH-25 (5) BUS MH-44	13,200	0.04	13	6.77	1.00	13	-42
CFS S&C		BUS-0836 BUS-0837	13,200	3.54	12	107.55	1.03	12	-43
CBL - CFS S&C to CFS XFMR	Cable	BUS-0832 BUS-0833	13,200	3.54	12	107.55	1.03	12	-43
Raven Village A&B S&C		BUS-0825 BUS-0826	13,200	2.05	32	164.29	1.01	32	-42
(6)CBL MH-25 to MH-47	Cable	(6) BUS MH-25 (6) BUS MH-47	13,200	1.97	0	2.81	1.01	0	84
(5) CBL MH-25 to MH-47	Cable	(5) BUS-MH-25 (5) BUS MH-47	13,200	1.32	48	160.15	1.00	48	-42
CBL-RVA S&C to RVA XFMR	Cable	BUS-S&C -(Raven Village A & B) BUS-0411	13,200	2.05	16	82.16	1.01	16	-42
Raven Village C S&C		BUS-0823 BUS-0824	13,200	0.34	16	15.57	1.00	16	-42
CBL-RV C S&C to RV C XFMR	Cable	BUS-0820 BUS-0413	13,200	0.34	16	15.70	1.00	16	-42
(6) CBL MH-47 to MH-48	Cable	(6) BUS MH-47 (6) BUS MH-48	13,200	7.19	0	2.25	1.14	0	84
(5) CBL-MH-47 to MH-48	Cable	(5) BUS MH-47 (5) BUS MH-48	13,200	0.30	16	14.12	1.00	16	-42
CBL-VB2 XFMR TO FS	Cable	BUS-0857 BUS- Farrington Switches VB2	4,160	1.27	499	1,575.27	1.00	499	-80
XFMR - VB2	Xformer2	BUS-0856 BUS-0857	13,200	1.27	157	496.26	1.00	157	-50

(F1)CBL FS1 TO MH31	Cable	BUS- Farrington Switches VB2 (F1) BUS MH31	4,160	1.59	62	245.31	1.01	62	-78
XFMR FARR	Xformer2	BUS-0894 BUS-0895	4,160	0.21	11	7.71	1.00	11	-76
XFMR ESTILL	Xformer2	BUS-0897 BUS-0898	4,160	1.89	51	240.68	1.01	51	-78
CBL ESTILL XFMR TO ESTILL MCB	Cable	BUS-0898 ESTILL MDP	480	3.28	444	2,116.12	1.01	444	-108
(F2)CBL FS2 TO MH34	Cable	BUS- Farrington Switches VB2 (F2) BUS- MH34	4,160	3.28	73	589.91	1.03	73	-77
(F2) MH34 TO E/VC S&C	Cable	(F2) BUS- MH34 BUS-0892	4,160	3.18	49	384.00	1.02	49	-78
XFMR E/VC	Xformer2	BUS-0892 BUS-0674	4,160	5.62	49	390.21	1.04	49	-78
(F2) CBL MH34 TO THO XFMR	Cable	(F2) BUS- MH34 BUS-0890	4,160	3.49	24	207.24	1.03	24	-77
XFMR THO	Xformer2	BUS-0891 BUS-0639	4,160	6.10	24	210.40	1.05	24	-77
(F2) CBL MH34 TO M35	Cable	(F2) BUS- MH34 (F2)BUS-MH35	4,160	4.80	0	0.61	1.06	0	51
CBL-0079	Cable	(F2)BUS-MH35 BUS-0117	4,160	0.00	0	0.00	0.00	0	0
XF2-0076	Xformer2	BUS-0117 BUS-0125	4,160	0.00	0	0.00	0.00	0	0
CBL-0080	Cable	(F2)BUS-MH35 BUS-0126	4,160	0.00	0	0.00	0.00	0	0
XF2-0077	Xformer2	BUS-0126 BUS-0139	4,160	0.00	0	0.00	0.00	0	0
CBL-0081	Cable	(F2)BUS-MH35 BUS-0142	4,160	0.00	0	0.00	0.00	0	0
XF2-0078	Xformer2	BUS-0142 BUS-0144	4,160	0.00	0	0.00	0.00	0	0

CBL-0082	Cable	(F2)BUS-MH35 BUS-0145	4,160	0.00	0	0.00	0.00	0	0
XF2-0079	Xformer2	BUS-0145 BUS-0146	4,160	0.00	0	0.00	0.00	0	0
CBL-0083	Cable	(F2)BUS-MH35 BUS-0147	4,160	0.00	0	0.00	0.00	0	0
XF2-0080	Xformer2	BUS-0147 BUS-0148	4,160	0.00	0	0.00	0.00	0	0
CBL-0310	Cable	BUS-0125 BUS-0485	208	0.00	0	0.00	0.00	0	0
CBL-0311	Cable	BUS-0139 BUS-0486	240	0.00	0	0.00	0.00	0	0
CBL-0312	Cable	BUS-0144 BUS-0487	480	0.00	0	0.00	0.00	0	0
XFMR-W.PLANT	Xformer2	XFMR-WEST PLANT BUS-0878	4,160	0.59	217	334.64	1.00	217	-82
(F5)CBL FS5 TO MH33	Cable	BUS- Farrington Switches VB2 (F5)MH33	4,160	1.17	149	435.34	1.00	149	-77
CBL POLE TO AUS XFMR	Cable	(F5)MH33 BUS-0150	4,160	0.20	19	12.97	1.00	19	-77
XFMR AUS	Xformer2	BUS-0150 BUS-0151	4,160	0.20	19	12.97	1.00	19	-77
XFMR BB	Xformer2	BUS-0625 BUS-0153	4,160	3.53	81	409.92	1.02	81	-78
XFMR SOR	Xformer2	BUS-0626 BUS-0155	4,160	0.20	26	18.61	1.00	26	-76
XF2-0086	Xformer2	BUS-0676 BUS-0647	4,160	0.20	8	5.89	1.00	8	-76
XFMR MLH	Xformer2	BUS-0628 BUS-0161	4,160	0.20	15	10.12	1.00	15	-77
(F1)CBL MH31 TO ESTILL SW	Cable	(F1) BUS MH31 BUS-0897	4,160	1.89	51	240.24	1.01	51	-78

CBL AUS XFMR TO WIRE	Cable	BUS-0151 BUS-PEA/AUS WIREWAY	208	0.20	372	259.40	1.00	372	-107
CBL BB XFMR TO BB MDP	Cable	BUS-0153 Belvin MDP	208	3.53	1,618	8,198.31	1.02	1,617	-108
CBL SOR XFMR TO SOR MDP	Cable	BUS-0155 Sorority	480	0.20	228	161.28	1.00	228	-46
CBL ELL XFMR TO ELL MDP	Cable	BUS-0647 Elliott MDP	208	0.20	168	117.89	1.00	168	-46
CBL XFMR MLH TO MLH MDP	Cable	BUS-0161 MLH MDP	208	0.20	291	202.43	1.00	291	-107
(F6) CBL MH-37 to AB3 S&C	Cable	(F6)BUS - MH-37 BUS-0861	4,160	2.05	13	66.03	1.01	13	-74
(F6) CBL - MH-37 to MH-38	Cable	(F6)BUS - MH-37 BUS - MH-38	4,160	0.33	48	46.20	1.00	48	-74
XFMR-CJC	Xformer2	BUS-0738 BUS-0739	13,200	2.05	51	244.34	1.01	51	-16
CBL-0092	Cable	BUS- (MH34) (F7, WestPlant) BUS-0634	4,160	0.59	217	334.60	1.00	217	-82
(F1)CBL MH31 TO FARR XFMR	Cable	(F1) BUS MH31 BUS-0894	4,160	0.21	11	7.68	1.00	11	-76
CBL-Col. XFMR to Col. MDP	Cable	BUS-0721 Coliseum MDP	480	4.22	833	4,470.58	1.02	832	-75
CBL-FH XFMR to FH MDP	Cable	BUS-0685 Field House MDP	480	20.62	1,060	30,515.77	1.54	1,038	-71
CBL-S.Hutson XFMR to SH MDP	Cable	BUS-0803 SH MDP	480	10.19	154	2,176.50	1.13	153	-73
CBL-S.H.Add XFMRto S.H.Add MDP	Cable	BUS-0809 Old Smith Hutson MDP	480	10.20	155	2,193.05	1.14	154	-73
CBL-MUSIC XFMR to MDP	Cable	BUS-0794 Music Bldg. MDP	480	0.33	530	499.54	1.00	530	-75
CBL-Comm XFMR to Comm MDP	Cable	BUS-0597 Communications MDP	208	3.26	1,094	4,569.50	1.01	1,093	-72

CBL-Admin XFMR to Admin MCB	Cable	BUS-0601 Admin MDP	480	3.10	363	1,404.19	1.01	363	-75
CBL UTC XFMR to UTC MDP	Cable	BUS-0745 UTC MDP	480	4.31	197	1,114.87	1.02	197	-73
CBL BB FUSE TO BB XFMR	Cable	(F5) POLE AT BB BUS-0625	4,160	2.01	81	403.86	1.01	81	-78
CBL SOR POLE TO XFMR	Cable	BUS-0886 BUS-0626	4,160	0.20	26	18.61	1.00	26	-76
CBL MLH FUSE TO MLH XFMR	Cable	BUS-0887 BUS-0628	4,160	0.20	15	10.12	1.00	15	-77
(F7)CBL W. PLANT	Cable	BUS-0634 XFMR-WEST PLANT	4,160	0.59	217	334.64	1.00	217	-82
(F4)CBL W.PLANT	Cable	BUS-0635 XFMR-WEST PLANT	4,160	0.00	0	0.00	0.00	0	0
CBL-THO XFMR TO THO MDP	Cable	BUS-0639 Thomason MDP	480	6.10	208	1,823.48	1.05	208	-107
CBL E/VC XFMR TO E/VC MDP	Cable	BUS-0674 Evans/VisCen MDP	480	5.62	422	3,381.79	1.04	422	-108
CBL-To Evans MCB	Cable	Evans/VisCen MDP BUS-0675	480	9.80	191	2,656.02	1.13	190	-108
CBL ELL POLE TO ELL XFMR	Cable	(F5) POLE AT ELLIOT BUS-0676	4,160	0.20	8	5.89	1.00	8	-76
CBL-VB1 XFMR TO FS	Cable	BUS-0624 BUS-Farrington Switches - VB1	4,160	0.69	61	109.08	1.00	61	-74
XFMR - VB1	Xformer2	BUS-0855 BUS-0624	13,200	0.69	19	34.10	1.00	19	-44
(8)CBL-MH49 to S&C LSH	Cable	(8)BUS-MH49 BUS-0652	13,200	3.43	17	147.83	1.03	17	-42
(7)CBL-MH49 to S&C LSH	Cable	(7)BUS-MH49 BUS-0673	13,200	7.16	0	0.18	1.14	0	84
CBL-Lonestar XFMR to MDP	Cable	BUS-0671 Lonestar Hall MDP	480	6.35	478	4,132.23	1.05	477	-72

(8)CBL-MH41 to S&C E&HC	Cable	(7)BUS-MH41 BUS-0661	13,200	1.81	27	120.43	1.01	27	-40
(7)CBL-MH41 to S&C E&HC	Cable	(8)BUS-MH41 BUS-0662	13,200	7.17	0	0.18	1.14	0	84
(8)CBL-MH43 to S&C OMM	Cable	(7)BUS MH43 BUS-0665	13,200	0.32	37	35.75	1.00	37	-45
(7)CBL-MH43 to S&C OMM	Cable	(8)BUS MH43 BUS-0666	13,200	7.17	0	0.18	1.14	0	84
S&C OMM		BUS-0665 BUS-0666	13,200	0.32	37	35.63	1.00	37	-45
CBL-OMM S&C to XFMR	Cable	BUS-0667 BUS-0669	13,200	0.32	37	35.63	1.00	37	-45
CBL-XFMR OMM to OMM MDP	Cable	BUS-0672 OMM MDP	480	0.99	1,030	1,021.03	1.00	1,030	-75
(2) CBL-MH10 to Bowers S&C	Cable	(2)BUS MH-10 BUS-0684	13,200	11.52	68	1,918.76	1.32	67	-43
(1) CBL MH10 to Bowers S&C	Cable	(1)BUS MH-10 BUS-0682	13,200	7.20	0	0.37	1.14	0	84
XFMR-Soft/Baseball	Xformer2	BUS-0688 BUS-0690	13,200	11.67	30	858.09	1.33	30	-45
CBL BB S&C to BB XFMR	Cable	BUS-(Bowers,Softball/Baseball) BUS-0688	13,200	11.69	30	858.92	1.33	30	-45
CBL-BB XFMR to BB MDP0	Cable	BUS-0690 Baseball MDP	480	20.62	832	23,960.52	1.54	815	-75
(2) CBL MH-9 to MH-10	Cable	(2) BUS MH-9 (2)BUS MH-10	13,200	11.56	68	1,919.74	1.33	67	-43
S&C - East Plant		BUS-0694 BUS-0695	13,200	1.34	183	608.26	1.00	183	-45
CBL-S&C to East Plant Dist.	Cable	BUS-0696 East Plant Distribution	13,200	1.34	183	608.28	1.00	183	-45
(1) CBL MH-8 to S&C East Plant	Cable	(1)BUS MH-8 BUS-0694	13,200	1.34	183	608.12	1.00	183	-45

(2) CBL MH-8 to S&C East Plant	Cable	(2)BUS MH-8 BUS-0695	13,200	7.62	0	0.19	1.15	0	84
XFMR-HKC	Xformer2	BUS-0722 BUS-0725	13,200	8.39	9	179.77	1.17	9	-44
CBL-HKC S&C to HKC XFMR	Cable	(2) BUS MH-11 BUS-0722	13,200	8.43	9	180.35	1.17	9	-43
CBL-HKC XFMR to HKC SW	Cable	BUS-0725 BUS-0726	480	15.01	240	5,022.48	1.29	237	-74
CBL-HKC SW to HKC MDP	Cable	BUS-0726 HKC MDP	480	15.01	240	5,022.48	1.29	237	-74
(1)CBL MH-5 to S&C PAC	Cable	(1)BUS MH-5 BUS-0728	13,200	7.16	0	0.73	1.14	0	84
(2)CBL MH-5 to S&C PAC	Cable	(2)BUS MH-5 BUS-0729	13,200	2.07	15	79.71	1.01	15	-43
S&C CJC		BUS-0731 BUS-0734	13,200	2.05	51	244.34	1.01	51	-16
CBL-CJC S&C to CJC XFMR	Cable	BUS-0735 BUS-0738	13,200	2.05	51	244.34	1.01	51	-16
(1)CBL MH-2 to S&C CJC	Cable	(1) BUS MH-2 BUS-0731	13,200	7.16	0	0.74	1.14	0	84
(2)CBL MH-2 to S&C CJC	Cable	(2) BUS MH-2 BUS-0734	13,200	2.05	51	244.38	1.01	51	-16
CBL-CJC XFMR to CJC MDP	Cable	BUS-0739 CJC MDP	480	6.30	1,411	7,174.65	1.04	1,409	-46
(3)CBL MH-21 to UTC S&C	Cable	(3)BUS MH-21 BUS-0740	13,200	2.27	7	40.45	1.01	7	-43
(4)CBL MH-21 to UTC S&C	Cable	(4)BUS MH-21 BUS-0741	13,200	7.30	0	0.84	1.14	0	84
XFMR Library	Xformer2	BUS-0748 BUS-0749	13,200	1.56	59	229.50	1.01	59	-46
S&C Library		BUS-0743 BUS-0752	13,200	1.56	59	229.52	1.01	59	-46

CBL LIB. S&C to LIB. XFMR	Cable	BUS-0747 BUS-0748	13,200	1.56	59	229.52	1.01	59	-46
CBL LIB XFMR to LIB MDP	Cable	BUS-0749 LIB MDP	480	3.24	1,610	6,457.72	1.01	1,609	-76
(3)CBL MH-20 to Library S&C	Cable	(3)BUS MH-20 BUS-0743	13,200	1.57	58	230.18	1.01	58	-46
(4)CBL MH-20 to Library S&C	Cable	(4)BUS MH-20 BUS-0752	13,200	7.30	0	0.84	1.14	0	84
XFMR TEC	Xformer2	BUS-0759 BUS-0753	13,200	7.55	13	136.27	1.07	13	-44
S&C TEC		BUS-0746 BUS-0754	13,200	4.07	13	133.92	1.04	13	-44
CBL LIB. S&C to TEC XFMR	Cable	BUS-0750 BUS-0759	13,200	4.07	13	133.92	1.04	13	-44
CBL TEC XFMR to TEC MDP	Cable	BUS-0753 TEC MDP	480	7.55	365	3,747.43	1.07	364	-74
(3)CBL MH-23 to TEC S&C	Cable	(3) BUS MH-23 BUS-0746	13,200	4.09	13	134.60	1.04	13	-44
(4)CBL MH-23 to TEC S&C	Cable	(4) BUS MH-23 BUS-0754	13,200	7.30	0	0.84	1.14	0	84
XFMR CHSS	Xformer2	BUS-0766 BUS-0757	13,200	11.97	46	1,191.27	1.32	45	-44
S&C CHSS		BUS-0751 BUS-0758	13,200	11.45	46	1,190.34	1.31	45	-44
CBL CHSS S&C to CHSS XFMR	Cable	BUS-0755 BUS-0766	13,200	11.45	46	1,190.34	1.31	45	-44
CBL CHSS XFMR to CHSS MDP	Cable	BUS-0757 CHSS MDP	480	11.97	1,258	32,760.01	1.32	1,249	-74
(3)CBL MH-24 to CHSS	Cable	(3) MH-24 BUS-0751	13,200	11.46	46	1,190.82	1.31	45	-44
(4)CBL MH-24 to CHSS	Cable	(4) MH-24 BUS-0758	13,200	7.30	0	0.84	1.14	0	84

(3)CBL MH-46 to SHV S&C	Cable	(3) BUS MH-46 BUS-0767	13,200	0.00	0	0.00	0.00	0	84
(4)CBL MH-46 to SHV S&C	Cable	(4) BUS MH-46 BUS-0768	13,200	5.29	34	445.55	1.07	34	-44
CBL SHV1 XFMR to SHV1 MDP	Cable	BUS-0770 SHV#1 MDP	208	10.54	993	14,415.57	1.14	988	-74
CBL SHV1 XFMR to SHV1 MDP0	Cable	BUS-0771 SHV#2 MDP	208	8.93	1,171	14,267.77	1.10	1,166	-74
(3)CBL MH-33 to Admin/Comm S&C	Cable	(3)BUS MH-33 BUS-0774	13,200	0.00	0	0.00	0.00	0	84
(4)CBL MH-33 to Admin/Comm S&C	Cable	(4)BUS MH-33 BUS-0775	13,200	1.57	30	119.27	1.01	30	-43
(3)CBL-MH-36 to LSC S&C	Cable	(3)BUS MH-36 BUS-0777	13,200	7.34	0	0.76	1.14	0	84
(4)CBL-MH-36 to LSC S&C	Cable	(4)BUS MH-36 BUS-0778	13,200	1.85	44	203.28	1.01	44	-46
AB1 S&C		BUS-0789 BUS-0788	13,200	1.52	23	88.22	1.01	23	-45
CBL-AB1 S&C to AB1 XFMR	Cable	BUS-0784 BUS-0785	13,200	1.52	23	88.22	1.01	23	-45
XFMR-AB1	Xformer2	BUS-0785 BUS-0786	13,200	1.52	23	88.20	1.01	23	-45
CBL-AB1 XFMR to AB1 MDP	Cable	BUS-0786 AB1 MCB1	480	3.14	636	2,481.37	1.01	635	-75
(3)CBL MH-19 TO S.HUTSON S&C	Cable	(3)BUS MH-19 BUS-0795	13,200	5.63	6	77.93	1.08	6	-43
(4)CBL MH-19 TO S.HUTSON S&C	Cable	(4)BUS MH-19 BUS-0800	13,200	0.00	0	0.00	0.00	0	84
(3)CBL MH-19 TO S.H.ADD S&C	Cable	(3)BUS MH-19 BUS-0805	13,200	5.65	6	78.54	1.08	6	-43
S&C SmithHutson Old		BUS-0805 BUS-0806	13,200	5.65	6	78.48	1.08	6	-43

(4)CBL MH-19 TO S.H.ADD S&C	Cable	(4)BUS MH-19 BUS-0806	13,200	0.00	0	0.00	0.00	0	84
CBL-S.H. OldS&C to S.H. XFMR	Cable	BUS-0804 BUS-0808	13,200	5.65	6	78.48	1.08	6	-43
CBL-To VisCen MCB	Cable	Evans/VisCen MDP BUS-0678	480	2.19	232	731.06	1.01	232	-108
CBL-RV C XFMR TO RV C MDP	Cable	BUS-0822 RAVEN MDP	208	0.34	1,024	996.46	1.00	1,024	-72
(5) CBL-MH-48 to RVC S&C	Cable	(5) BUS MH-48 BUS-0823	13,200	0.33	16	15.20	1.00	16	-42
(6) CBL-MH-48 to RVC S&C	Cable	(6) BUS MH-48 BUS-0824	13,200	7.19	0	0.55	1.14	0	84
(5) CBL-MH-47 to RVA&B S&C	Cable	(5) BUS MH-47 BUS-0825	13,200	2.06	32	164.72	1.01	32	-42
(6) CBL-MH-47 to RVA&B S&C	Cable	(6) BUS MH-47 BUS-0826	13,200	7.19	0	0.55	1.14	0	84
CBL-RVB S&C to RVB XFMR	Cable	BUS-S&C -(Raven Village A & B) BUS-0827	13,200	2.05	16	82.13	1.01	16	-42
CBL-RV A XFMR TO RV A MDP	Cable	BUS-0829 RVA MDP	208	3.98	1,018	5,307.80	1.02	1,017	-72
CBL-RV A XFMR TO RV A MDP0	Cable	BUS-0831 RVB MDP	208	3.98	1,018	5,306.17	1.02	1,017	-72
CBL-CFS XFMR to CFS MDP	Cable	BUS-0834 CFS MDP	480	6.58	336	3,005.30	1.06	336	-73
(5) CBL-MH-44 to CFS S&C	Cable	(5) BUS MH-44 BUS-0836	13,200	7.19	0	0.56	1.14	0	84
(6) CBL-MH-44 to CFS S&C	Cable	(6) BUS MH-44 BUS-0837	13,200	3.56	12	107.99	1.03	12	-43
(5) CBL-MH-44 to CFS S&C0	Cable	(5) BUS MH-44 BUS-0838	13,200	0.03	13	6.70	1.00	13	-42
South Paw S&C1		BUS-0838 BUS-0839	13,200	0.02	13	6.67	1.00	13	-42

CBL - SP S&C to SP XFMR	Cable	BUS-0840 BUS-0841	13,200	0.02	13	6.67	1.00	13	-42
CBL-SP XFMR to SP MDP	Cable	BUS-0842 SouthPaw MDP	208	0.49	839	441.33	1.00	839	-72
(6) CBL-MH-25 to LD S&C	Cable	(6) BUS MH-25 BUS-0851	13,200	4.38	19	208.14	1.05	19	-45
(5) CBL-MH-25 to LD S&C	Cable	(5) BUS-MH-25 BUS-0852	13,200	7.19	0	0.56	1.14	0	84
VB1 S&C		(5) BUS-MH-25 (6) BUS MH-25	13,200	0.69	19	34.05	1.00	19	-44
VB2 S&C		(5) BUS-MH-25 (6) BUS MH-25	13,200	1.27	157	496.21	1.00	157	-50
CBL-VB1 S&C to VB1 XFMR	Cable	BUS-0853 BUS-0855	13,200	0.69	19	34.05	1.00	19	-44
CBL-VB2 S&C to VB2 XFMR	Cable	BUS-0854 BUS-0856	13,200	1.27	157	496.21	1.00	157	-50
CBL - AB3 S&C to AB3 XFMR	Cable	BUS-0862 BUS-0863	4,160	2.06	13	66.08	1.01	13	-74
CBL-AB3 CFMR to AB3 MDP	Cable	BUS-0865 AB3 MDP	208	3.33	259	1,337.97	1.02	259	-104
(F6) MH-38 to PARK XFMR	Cable	BUS - MH-38 BUS-0869	4,160	0.34	7	6.69	1.00	7	-74
(F6) MH-38 to BARR XFMR	Cable	BUS - MH-38 BUS-0870	4,160	0.34	7	6.69	1.00	7	-74
(F6) OH-MH-38 TO ALLEN XFMR	Cable	BUS - MH-38 BUS-0871	4,160	0.34	6	5.55	1.00	6	-73
(F4)CBL-FS4 TO MH34	Cable	BUS-Farrington Switches - VB1 (F4)BUS- MH34	4,160	0.00	0	0.00	0.00	0	0
(F4)CBL MH34 TO W.PLANT XFMR	Cable	(F4)BUS- MH34 BUS-0635	4,160	0.00	0	0.00	0.00	0	0
CBL W.PLANT XFMR TO MDP	Cable	BUS-0878 West Plant MDP	480	0.59	1,877	2,900.19	1.00	1,877	-112

(F7)CBL-FS7 TO MH34	Cable	BUS- Farrington Switches VB2 BUS- (MH34) (F7, WestPlant)	4,160	0.59	217	334.60	1.00	217	-82
(F5) OH M33 TO 17/J POLE	Cable	(F5) POLE AT 17TH, AVE J. (F5)MH33	4,160	1.31	130	426.45	1.00	130	103
(F5) OH 17/J TO BB	Cable	(F5) POLE AT BB (F5) POLE AT 17TH, AVE J.	4,160	1.73	95	410.16	1.01	95	102
(F5) OH 17/J TO ELL	Cable	(F5) POLE AT ELLIOT (F5) POLE AT 17TH, AVE J.	4,160	0.20	35	24.50	1.00	35	104
(F5) OH ELL TO SOR	Cable	BUS-0886 (F5) POLE AT ELLIOT	4,160	0.20	26	18.61	1.00	26	104
(F5) OH BB TO MLH	Cable	BUS-0887 (F5) POLE AT BB	4,160	0.19	15	10.05	1.00	15	103
(F2) CBL THO S&C TO THO XFMR	Cable	BUS-0890 BUS-0891	4,160	3.49	24	207.27	1.03	24	-77
CBL-To Evans MDP	Cable	BUS-0675 Evans MDP	480	9.80	191	2,656.02	1.13	190	-108
CBL-To VisCen MDP	Cable	BUS-0678 VisCen MDP	480	2.19	232	731.06	1.01	232	-108
CBL-FARR XFMR TO FARR MDP	Cable	BUS-0895 FARR MDP	480	0.21	93	66.81	1.00	93	-106
CHSSCHWP1		CHSS MDP BUS-0903	480	101.47	111	18,020.71	13.19	78	-74
CHSSCHWP2		CHSS MDP BUS-0904	480	101.47	111	18,020.71	13.19	78	-74

Motors

Motor Name	Type	Bus Name	Bus Voltage (V)	THD%	RMS (A)	I T	K	LF Amps	LF Angle
CHSS CH-1	Ind Mtr	CHSS MDP	480	3.10	562	3,971.39	1.02	562	-74
CHSS CHWP-1	Ind Mtr	BUS-0903	480	3.59	60	493.78	1.03	60	-37
CHSS CH-2	Ind Mtr	CHSS MDP	480	3.10	562	3,971.39	1.02	562	-74
CHSS CHWP-2	Ind Mtr	BUS-0904	480	3.59	60	493.78	1.03	60	-37
WP CHWP-1	Ind Mtr	West Plant MDP	480	0.30	51	37.34	1.00	51	-112
WP CH-1	Ind Mtr	West Plant MDP	480	0.30	1,832	1,334.71	1.00	1,832	-112
WP CH-2	Ind Mtr	West Plant MDP	480	0.30	1,832	1,334.71	1.00	1,832	-112
WP CHWP-2	Ind Mtr	West Plant MDP	480	0.30	51	37.34	1.00	51	-112
EP-CH 1	Ind Mtr	BUS-0924	4,160	0.90	317	700.50	1.00	317	-75
EP-CH 2	Ind Mtr	BUS-0923	4,160	0.99	243	587.08	1.00	243	-75
EP-CH 3	Ind Mtr	BUS-0922	4,160	1.06	172	445.54	1.00	172	-74
EP-CHWP1-3	Ind Mtr	EP EQ2 MDP	480	1.27	247	768.61	1.00	247	-73
EP-CHWP1-4	Ind Mtr	EP EQ1 MDP	480	1.27	247	768.61	1.00	247	-73

Non-Motor Loads

Load Name	Bus Name	Bus Voltage (V)	THD%	RMS (A)	I T	K	LF Amps	LF Angle
LOAD-BKV A&B	BKV A&B	208	0.37	308	272.06	1.00	308	-72
LOAD-BKV D&E	BKV D&E	208	0.33	203	164.41	1.00	203	-71
LOAD-BKV F,G,H	BKV-F,G,H	208	0.35	472	383.32	1.00	472	-71
LOAD-BKV J&M	BKV-J&M	208	0.36	181	158.06	1.00	181	-72
LOAD-BKV-K&L	BKV-K&L	208	0.38	388	346.63	1.00	388	-71
LOAD-Parking Garage	Garage MDP	480	20.62	49	1,398.89	1.54	48	-73
LOAD-AB 1	AB1 MCB1	480	0.49	533	586.31	1.00	533	-75
LOAD-UTC	UTC MDP	480	0.41	154	151.26	1.00	154	-73
LOAD-SHV #1	SHV#1 MDP	208	0.67	476	664.62	1.00	476	-74
LOAD-Raven Village A	RVA MDP	208	0.38	813	738.88	1.00	813	-72
LOAD-Raven Village B	RVB MDP	208	0.38	813	738.59	1.00	813	-72
LOAD-Raven Village C	RAVEN MDP	208	0.34	818	683.25	1.00	818	-72
LOAD-South Paw	SouthPaw MDP	208	0.34	815	687.10	1.00	815	-72
LOAD-CFS	CFS MDP	480	0.42	226	227.83	1.00	226	-73
LOAD-OMM	OMM MDP	480	0.37	973	860.04	1.00	973	-75
LOAD-Adams	BUS-0110	480	0.34	67	55.23	1.00	67	-74
LOAD-Allen	BUS-0112	480	0.34	50	41.15	1.00	50	-73
LOAD-Barrett	BUS-0114	480	0.34	60	49.59	1.00	60	-74
LOAD-Parkhill	BUS-0116	480	0.34	60	49.61	1.00	60	-74
LOAD-Vick	BUS-0873	480	0.22	90	49.57	1.00	90	-73
LOAD-Spivey	BUS-0877	480	1.#Je+000	0	48.69	25.61	0	0
LOAD-Randel	BUS-0876	480	0.22	90	49.57	1.00	90	-73
LOAD-BKV C&D	BKV C&D	208	0.40	540	491.83	1.00	540	-71
LOAD-BKV F&I	BKV-F&I	208	0.37	329	290.22	1.00	329	-71

LOAD-CJC	CJC MDP	480	1.19	759	2,309.12	1.00	759	-37
LOAD-Lemit	CJC MDP	480	20.62	179	5,148.14	1.54	175	-63
LOAD-Hotel	CJC MDP	480	0.52	75	89.66	1.00	75	-63
LOAD-PAC	PAC MDP	480	1.64	337	379.13	1.00	337	-73
LOAD-Field House/Bowers	Field House MDP	480	20.62	1,060	30,515.77	1.54	1,038	-71
LOAD-Baseball/Softball	Baseball MDP	480	20.62	832	23,960.52	1.54	815	-75
LOAD-Coliseum	Coliseum MDP	480	0.62	653	858.70	1.00	653	-75
LOAD-HKC	HKC MDP	480	0.67	64	91.06	1.00	64	-74
LOAD-Smith Hutson	SH MDP	480	0.45	77	81.13	1.00	77	-73
LOAD-Old Smith Hutson	Old Smith Hutson MDP	480	0.39	77	71.73	1.00	77	-73
LOAD-Music	Music Bldg. MDP	480	0.33	486	388.12	1.00	486	-75
LOAD-LSC	LSC MDP	480	0.65	974	1,255.86	1.00	974	-76
LOAD-COMM.	Communications MDP	208	0.38	912	823.84	1.00	912	-72
LOAD-Admin	Admin MDP	480	0.46	305	324.05	1.00	305	-75
LOAD-Lone Star Hall	Lonestar Hall MDP	480	0.36	327	287.99	1.00	327	-72
LOAD-ESTILL DORM	Estill Dorm MDP	240	0.29	1,098	775.66	1.00	1,098	-40
LOAD-HEALTH CENTER	Health Center MDP	240	0.31	177	134.36	1.00	177	-40
LOAD-Lee Drain	Lee Drain MDP	480	0.80	313	481.18	1.00	313	-75
LOAD-AB 4	AB4 MDP	480	0.49	521	561.63	1.00	520	-74
LOAD-Farrington	FARR MDP	480	0.21	93	48.00	1.00	93	-106
LOAD-Estill Classroom	ESTILL MDP	480	0.19	374	109.31	1.00	374	-108
LOAD-Thomason	Thomason MDP	480	0.19	146	41.58	1.00	146	-107
LOAD-Evans	Evans MDP	480	0.27	100	24.43	1.00	100	-108
LOAD-Jackson Shaver	BUS-0485	208	0.00	0	0.00	0.00	0	0
LOAD-Museum	BUS-0486	240	0.00	0	0.00	0.00	0	0
LOAD-4 West	BUS-0487	480	0.00	0	0.00	0.00	0	0
LOAD-Prichett Field Area	BUS-0146	480	0.00	0	0.00	0.00	0	0
LOAD-Walker Ed.	BUS-0148	480	0.00	0	0.00	0.00	0	0

LOAD-Peabody Hall	BUS-PEA/AUS WIREWAY	208	0.20	186	90.46	1.00	186	-107
LOAD-Belvin/Buchanan	Belvin MDP	208	0.24	1,341	351.35	1.00	1,341	-108
LOAD-Sorrority	Sorority	480	0.20	228	114.09	1.00	228	-46
LOAD-Elliot Hall	Elliott MDP	208	0.20	168	82.91	1.00	168	-46
LOAD-AB2 (MLH)	MLH MDP	208	0.20	291	140.75	1.00	291	-107
LOAD-Austin	BUS-PEA/AUS WIREWAY	208	0.20	186	90.46	1.00	186	-107
LOAD-LIBRARY	LIB MDP	480	0.53	1,341	1,573.54	1.00	1,341	-76
LOAD-TEC	TEC MDP	480	0.53	228	274.97	1.00	228	-74
LOAD-SHV #2	SHV#2 MDP	208	0.68	651	910.10	1.00	651	-74
LOAD-VISCEN	VisCen MDP	480	0.24	207	50.11	1.00	207	-108
LOAD -AB3	AB3 MDP	208	0.31	219	166.10	1.00	219	-104
LIGHTS-CJC	CJC MDP	480	20.62	196	5,631.89	1.54	192	-37
LIGHTS-Lemit	CJC MDP	480	20.62	60	1,730.84	1.54	59	-63
LIGHTS-Hotel	CJC MDP	480	20.62	185	5,325.66	1.54	181	-63
LIGHTS-PAC	PAC MDP	480	20.62	88	2,544.18	1.54	87	-73
LIGHTS-BKV A&B	BKV A&B	208	20.62	103	2,980.30	1.54	101	-72
LIGHTS-BKV C&D	BKV C&D	208	20.62	161	4,641.88	1.54	158	-71
LIGHTS-BKV D&E	BKV D&E	208	0.33	697	563.68	1.00	697	-71
LIGHTS-BKV F&I	BKV-F&I	208	20.62	104	2,985.56	1.54	102	-71
LIGHTS-BKV F,G,H	BKV-F,G,H	208	20.62	184	5,296.79	1.54	180	-71
LIGHTS-BKV J&M	BKV-J&M	208	20.62	53	1,540.49	1.54	52	-72
LIGHTS-BKV-K&L	BKV-K&L	208	20.62	125	3,606.89	1.54	123	-71
LIGHTS-HKC	HKC MDP	480	20.62	177	5,110.37	1.54	174	-74
LIGHTS-Colesium	Coliseum MDP	480	20.62	183	5,263.71	1.54	179	-75
LIGHTS-Smith Hutson	SH MDP	480	20.62	78	2,254.79	1.54	77	-73
LIGHTS-Old Smith Hutson	Old Smith Hutson MDP	480	20.62	79	2,262.25	1.54	77	-73
LIGHTS-Music	Music Bldg. MDP	480	0.33	44	35.28	1.00	44	-75
LIGHTS-AB 1	AB1 MCB1	480	20.62	105	3,017.90	1.54	103	-75

LIGHTS-LSC	LSC MDP	480	20.62	238	6,840.31	1.54	233	-76
LIGHTS-COMM	Communications MDP	208	20.62	185	5,338.50	1.54	182	-72
LIGHTS-Admin	Admin MDP	480	20.62	59	1,702.66	1.54	58	-75
LIGHTS-SHV #1	SHV#1 MDP	208	20.62	523	15,052.92	1.54	512	-74
LIGHTS-SHV #2	SHV#2 MDP	208	20.62	526	15,137.18	1.54	515	-74
LIGHTS-CHSS	CHSS MDP	480	20.62	261	7,525.97	1.54	256	-74
LIGHTS-LIBRARY	LIB MDP	480	20.62	274	7,885.19	1.54	268	-76
LIGHTS-TEC	TEC MDP	480	20.62	139	4,010.45	1.54	136	-74
LIGHTS-UTC	UTC MDP	480	20.62	44	1,258.12	1.54	43	-73
LIGHTS-Lee Drain	Lee Drain MDP	480	20.62	218	6,270.35	1.54	213	-75
LIGHTS-CFS	CFS MDP	480	20.62	112	3,223.03	1.54	110	-73
LIGHTS-South Paw	SouthPaw MDP	208	20.62	25	711.49	1.54	24	-72
LIGHTS-Raven Village A	RVA MDP	208	20.62	209	6,006.74	1.54	204	-72
LIGHTS-Raven Village B	RVB MDP	208	20.62	208	6,004.93	1.54	204	-72
LIGHTS-Raven Village C	RAVEN MDP	208	0.34	206	171.65	1.00	206	-72
LIGHTS-AB 4	AB4 MDP	480	20.62	121	3,476.34	1.54	118	-74
LIGHTS -AB3	AB3 MDP	208	20.62	41	1,169.64	1.54	40	-104
LIGHTS-Thomason	Thomason MDP	480	20.62	62	1,798.71	1.54	61	-107
LIGHTS-Evans	Evans MDP	480	20.62	92	2,656.74	1.54	90	-108
LIGHTS-VISCEN	VisCen MDP	480	20.62	25	719.98	1.54	24	-108
LIGHTS-Belvin/Buchanan	Belvin MDP	208	20.62	281	8,098.50	1.54	275	-108
LIGHTS-Estill Classroom	ESTILL MDP	480	20.62	71	2,054.37	1.54	70	-108
LIGHTS-Lone Star Hall	Lonestar Hall MDP	480	20.62	153	4,408.33	1.54	150	-72
LIGHTS-ESTILL DORM	Estill Dorm MDP	240	11.67	198	5,683.82	1.33	196	-40
LIGHTS-OMM	OMM MDP	480	20.62	58	1,662.32	1.54	57	-75

Sources

Source Name	Type	Bus Name	Bus Voltage (V)	THD%	RMS (A)	I T	K	LF Amps	LF Angle
UTIL-Primary From Entergy	Util.	BUS-Switchgear Building	13,200	1.70	1,066.59	4,457.91	1.01	1,066	-43