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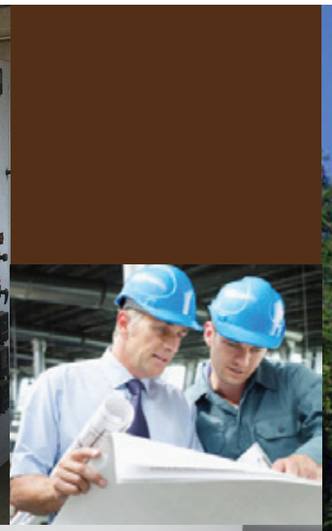
UC RIVERSIDE UNIVERSITY OF CALIFORNIA

University of California, Riverside

East Campus Electrical Distribution System Review



Final Submittal—Issued October 31, 2011

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Background and Scope

The University of California, Riverside is one of 10 universities within the prestigious University of California system, and the only UC located in Inland Southern California. Widely recognized as one of the most ethnically diverse research universities in the nation, UCR's current enrollment is over 20,700 students, with a goal of 25,000 students by 2020. The campus is in the midst of a tremendous growth spurt with new and remodeled facilities coming on-line on a regular basis. The University is located approximately 50 miles east of downtown Los Angeles. Located on nearly 1,200 acres near Box Springs Mountain in Southern California, the park-like campus provides convenient access to the vibrant and growing Inland region. The campus is a living laboratory for the exploration of issues critical to growing communities — air, water, energy, transportation, politics, the arts, history and culture. UCR gives every student the resources to explore, engage, imagine and excel.

The total electrical baseline load for the main campus is approximately 25.5 megawatts. The campus energy usage on an annual basis is approximately 124million kWh.

Perhaps the most visible evidence of UCR's growth is in the physical additions to campus and its continued commitment to providing a modern learning environment for students, faculty and staff. University of California, Riverside will soon be starting construction on the 810 student beds in 932 apartment-style units, which are intended to house graduate students and upper class undergraduates.

The University is composed of approximately 6.8 million gross square foot spread over 1,144 acres. The proposed East Campus Development Plan will provide the campus with improved and expanded facilities and resources over the next twenty plus years. UCR's current enrollment is over 20,700 with a goal of 25,000 students by 2020. A total of approximately 4.5 million square feet is planned to be added to the campus inventory as part of this proposed East Campus Development Plan. To meet these growing needs of the campus, existing electrical system currently serving the campus needs to be evaluated and upgraded as necessary to accommodate the expansion. A campus map showing the proposed facilities that are being added as part of the East Campus Development Plan is enclosed at the end of this chapter. The map also indicates buildings that are being replaced under the Development Plan.

The University owns and maintains its own electrical distribution system which receives 12.47kV and 4.16kV service from Riverside Public Utility (RPU) and distributes power to each building on campus.

UCR has an electric expenditure of nearly $10 million annually.

Objective

P2S Engineering Inc. was contracted by UCR to evaluate the existing electrical distribution system currently serving the East Campus.

The objective of this electrical distribution system review is to evaluate the existing electrical system currently serving the East Campus, consider alternatives for improvements and make cost-effective and specific recommendations as necessary to alter/upgrade/modify the existing electrical infrastructure to support new buildings, major renovations, and building replacements that form part of the proposed East Campus Development Plan.

Methodology

The following methodology was adopted in formulating our East Campus Electrical Distribution System Report.

- A critical aspect in the evaluation of the existing electrical system(s) serving a facility is a detailed and accurate review of the current systems. A detailed review of the existing electrical system was undertaken to include 12.47kV and 4.16kV main switchgears, building substations / transformers and selective manhole / vault inspections. Existing conditions, together with potential problems, were identified and reviewed. The reviewed information was verified through available record drawings and meetings with the campus facilities management staff.
- The system was evaluated for capacity, functionality, reliability, ease of maintenance, age, and its ability to serve the present and future needs of the campus.
- Alterations/upgrade/modifications necessary to support new buildings, major renovations, and building replacements that form part of the proposed University East Campus Development Plan were identified.
- Phasing and costs associated with required electrical upgrades were then developed based on our recommendations.
- Equipment specifications were developed based on discussions with campus personnel in an effort to standardize systems at the campus and also maintain quality of products.

Report Overview

Our following electrical distribution system report provides an analysis of the present electrical systems currently serving the facilities, identifies potential problems associated with each of these systems, defines future requirements, outlines recommended solutions, phasing plans, and costs to implement them. Chapter 2 provides an overview of the existing electrical system currently serving the campus along and its analysis. Chapter 3 provides the methodology adopted in developing the proposed electrical distribution plan, Chapter 4 provides an analysis of future needs to support the future development of the campus as outlined in the East Campus Development Plan. Chapter 5 provides our recommendations to modify/alter/upgrade the existing electrical system to support the proposed facilities planned as part of the as East Campus Development Plan. Chapter 6 provides a phasing and implementation plan. Chapter 7 provides equipment specifications and recommendations and Chapter 8 provides costs by each phase to implement the recommendations provided in our study.

Summary of Our Findings and Recommendations

The following section summarizes our findings and our recommended solution. Estimated cost to upgrade the system is also included following our recommendations.

Findings

- The existing 12.47kV and 4.16kV systems have limited feeder capacities to handle the total load of the proposed facilities identified in the East Campus Development Plan.
- There are limited feeder breakers (space for one additional breaker in each 12kV section) available to serve the demands of additional loads being proposed as part of the East Campus Development Plan.
- The current 67/12.47kV, 26.88MVA and 67/4.16kV, 3.75/5.25MVA transformers owned by the utility company and currently serving the 12.47kV and 4.16kV systems at the campus are not adequately sized to meet the loads of the campus and provide redundancy at the same time if one of the transformer fails during the peak demand period.
- There are limited duct banks available between the west and east side of the campus (currently installed under the freeway) to provide additional 15kV feeders between the 12.47kV switchgear section and the east campus to serve future loads at the campus. A de-rating study of the feeders in duct banks installed underneath the freeway revealed that the current feeders will be de-rated to about 65% of their rated capacity at a load factor of 100%. (See causes of de-rating in Existing Systems Description on page 2.1 of the report.) Provision of additional 15kV duct banks and feeders underneath the freeway will be difficult and cumbersome and will further result in de-rating of the existing/ new 15kV feeders.
- Although majority of the existing facilities have dual 15kV feeds, additional duct banks will need to be provided to provide dual feeders to each of the proposed facilities planned as part of the master plan.
- Standardization of electrical equipment (15kV feeders, 15kV switches) is required to reduce maintenance costs at the campus.

Recommendations

- Add a third utility transformer in the vicinity of the existing 67-12.47kV transformers located at the university substation and provide a new third 12.47kV switchgear section in the vicinity of the existing 12.47kV switchgear to supplement the existing two 12.47kV switchgear sections currently serving the campus and located in the modular building on the west side of the campus. The new utility transformer shall be rated at 67-12.47kV, 26.88MVA and shall serve this new third switchgear section. This increase in capacity will help the campus meet the loads of the future facilities and provide redundancy at the same time if one of the utility transformer or a switchgear section fails during the peak demand period.
- Provide a new three section 15kV switchgear with a main 2000A breaker and (6) 1200A feeder breakers per section with two spare sections. Locate the switchgear on the east side of the freeway near Parking Lot 4 in a block building of approximately 3500sqft. Serve each of the new switchgear sections (three in number) with (3) sets of 15kV, 133% 750kcmil EPR cables from a breaker in each section of the main 12.47kV switchgear section located on the west side of the campus. These new feeders will be routed in existing duct banks currently located underneath the freeway. The provision of this new 15kV switchgear section will provide ease of adding feeders on the east side of the campus as future facilities are added in various phases without having the need to replace the existing switchgear to add additional feeder breaker sections and additional duct banks underneath the freeway to accommodate additional feeders. The provision of this new switchgear section will also alleviate the de-rating affect currently being experienced by cables in duct banks located underneath the freeway.
- Provide new sets of 15kV, 133%, 500kcmil EPR feeders from this new switchgear sections to serve existing and future facilities being added in various phases at the campus. Existing feeders as depicted in Chapter 6 will be used to serve the power needs of facilities in Phase 1. Existing feeders will be intercepted by new feeders from new 15kV switchgear sections to retain service to existing facilities on campus. The existing pathways shown on the plans will need to be evaluated in detail for reuse during the design phase of the project. A combination of existing duct banks, tunnel system and new pathways will be utilized to route new feeders to all facilities on campus as they are added in various phases.
- Provide new 15kV air selector switches for each of the new proposed facilities with dual feeders to each of the these switches to provide a primary selective system at the campus. Each switch will be provided with dual feeders to provide redundancy and a radial feeder originating from the switch will serve the facility.
- All buildings on campus equipped with old oil fused cutouts that have low short circuit availability and could result in failures in event of a short circuit on the 5kV and 12kV system should be replaced with 15kV Air Fused LIS Switches.
- All buildings equipped with leaking SF6 switches shall have their switches replaced with 15kV air based selector switches.

- Provide phased replacement of existing 4.16kV system by providing new substations in each of the buildings listed with 4.16kV service and extending new 12kV service to each of these facilities.
- All equipment (15kV feeders, 15kV switches) shall be provided per our recommendations and specifications provided in Chapter 7 in an effort to standardize and reduce maintenance costs for the campus.
- An arc flash analysis of the electrical system be conducted to verify the available short circuit at each of the substations and label each equipment based on available short circuit current and class of protective clothing required to operate on the system.
- Sub meters are recommended at each building to monitor consumption.

Cost

The following are costs associated with the improvements recommended in our report by each phase to meet the demands of the existing and future facilities planned at the campus. The costs included below are contractor's construction costs and do not include project management fees, design and administrative costs and any other associated construction management costs. A detailed breakdown of costs by each phase and project is included in Chapter 8.

Description	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Total
Provision of new 67-12kV, 26.88MVA utility transformer.		$2,500,000				$2,500,000
Provision of new third section of 15kV switchgear on west side of the campus to serve the new switchgear.		$750,000				$750,000
Provision of new 15kV switchgear on east side of the campus to serve all east facilities on campus.		$2,000,000				$2,000,000
Provision of new 15kV,133%, 750kcmil EPR cables from west switchgear to new east switchgear.		$700,000				$700,000
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	$708,000	$1,770,000	$684,000	$216,000	$540,000	$3,918,000
Conversion of existing 4.16kV substations in existing buildings to a 12kV system.		$1,750,000				$1,750,000
Provision of 15kV, 133%, 500kcmil EPR cables	$1,191,000	$8,070,000	$1,137,000	$324,000	$894,000	$11,616,000
Provision of new 15kV selector switches to served proposed facilities	$630,000	$735,000	$1,085,000	$420,000	$1,435,000	$4,305,000
Demolition of Existing Feeders		$500,000				$500,000
Provision of new manholes	$550,000	$875,000	$475,000	$175,000	$350,000	$2,425,000
Hardscape/Landscape Replacement Costs	$265,000	$197,500	$192,000	$61,500	$178,000	$894,000
Short Circuit and Arc Flash Study	$67,500	$1,706,500	$112,500	$87,500	$150,000	$2,124,000
Subtotal	$3,411,500	$21,554,000	$3,685,500	$1,284,000	$3,547,000	$33,482,000
Design Contingency @10%	$334,400	$1,670,750	$357,300	$119,650	$339,700	$2,821,800
Overhead and Profit@17.3%	$578,512	$2,890,398	$618,129	$206,995	$587,681	$4,881,715
Construction Contingency@10%	$334,400	$1,670,750	$357,300	$119,650	$339,700	$2,821,800
Total Costs	$4,658,812	$27,785,898	$5,018,229	$1,730,295	$4,814,081	$44,007,315

NOTE: THE EXISTING PATHWAYS SHOWN ON THE PLANS WILL NEED TO BE EVALUATED IN DETAIL FOR REUSE DURING THE DESIGN PHASE OF THE PROJECT. A COMBINATION OF EXISTING DUCT BANKS, TUNNEL SYSTEM AND NEW PATHWAYS WILL BE UTILIZED TO ROUTE NEW FEEDERS TO ALL FACILITIES ON CAMPUS.

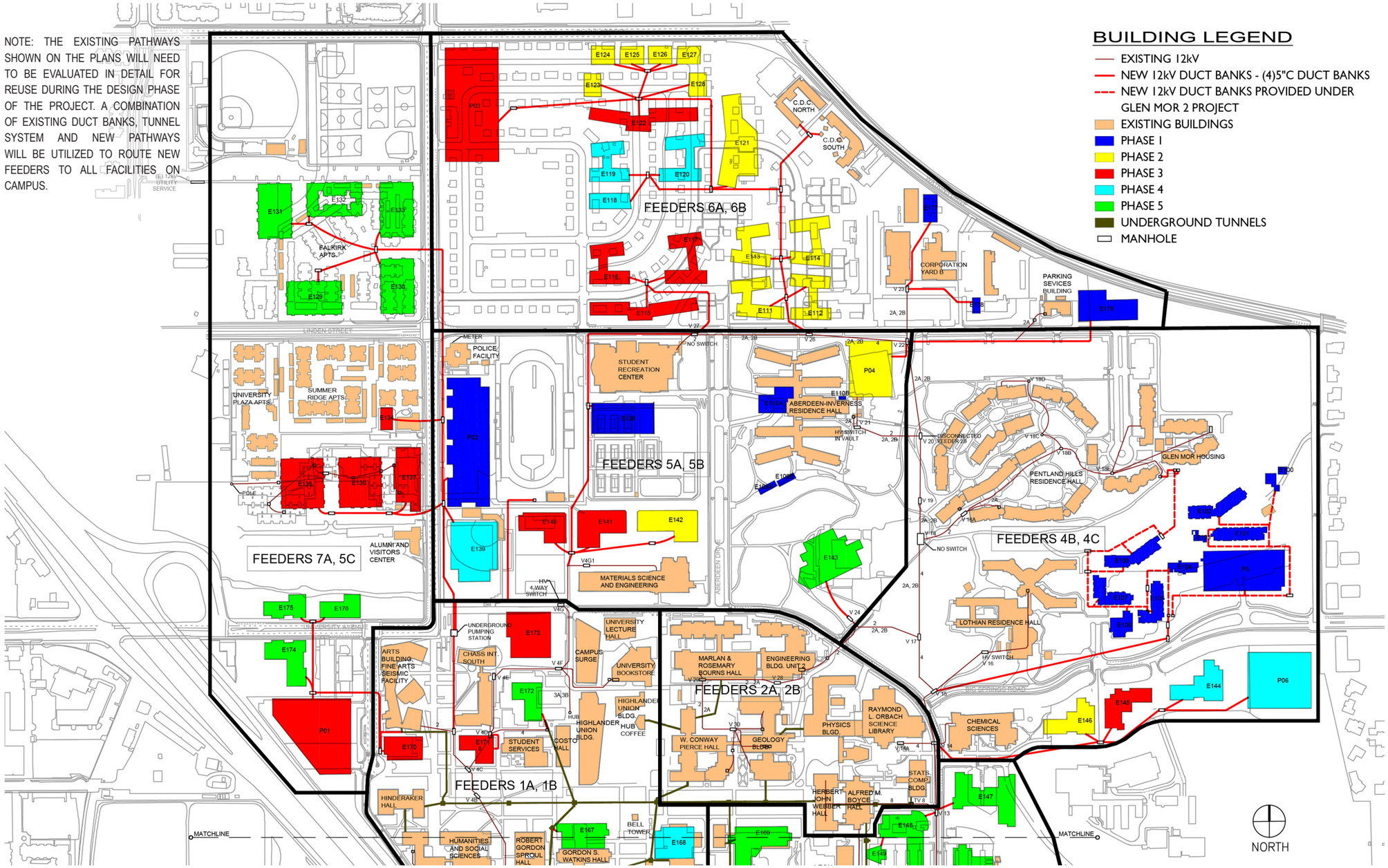

Figure 1.1—East Campus Development Future Buildings–North

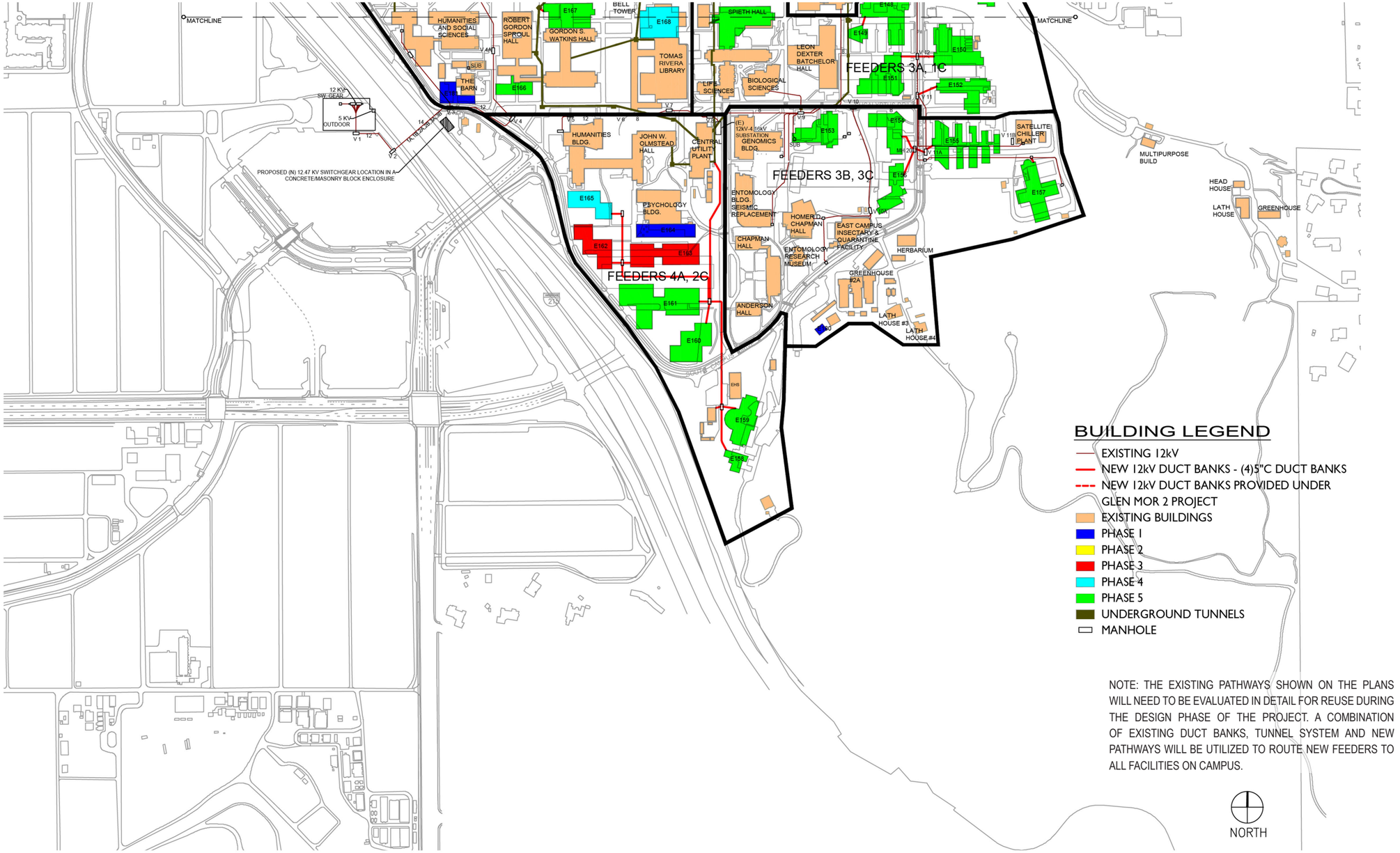

Figure 1.2—East Campus Development Future Buildings–South

Chapter 2—System Description

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Existing System Description

University of California Riverside campus is currently served from two major services derived from Riverside Public Utility Company. Utility circuits '1382' and '1383' serve two 67-12.47kV, 18/26.88MVA transformers that in turn serve double ended 12kV switchgear connected via a tie breaker located in a modular building at the University substation. Utility circuits '84' and '87' serve two 67-4.16kV, 3.75/5.25MVA transformers that in turn serve an indoor and an outdoor 5kV switchgears respectively. These services are located on the west side of the 215 freeway that currently divides the east and west side of the campus. The services are metered at 4.16kV and 12.47kV at each of these switchgears and distribute power to substations in each building on campus through a series of selector switches, manholes and medium voltage duct banks.

Each section of the double ended 12.47kV switchgear comprises of a main 12.47kV 1200A vacuum circuit breaker and four 12.47kV, 600A feeder breakers. Each section is connected via a tie breaker to facilitate the campus to transfer loads between sections in case one of the section or utility transformer is taken down for maintenance or fails during normal business hours. Eight 12.47kV circuits (1A, 1B, 2A, 2B, 3A, 3B, 4A and 4B) originating from the double ended switchgear section traverse through duct banks installed underneath the freeway to serve majority of the buildings on campus.

An analysis of the medium voltage feeders housed in duct banks that currently traverse from the University substation underneath the freeway to serve the east campus facilities revealed that the these conductors will be de-rated to about 65% of their rated capacity at 100% load factor.

The following factors affect the current rating/ capacity of medium voltage conductors:

- Depth of the underground duct banks in which they are housed,
- Number of ducts and their configuration that form part of the duct bank with conductors
- Loading of conductors and
- Soil resistivity

The de-rating of the campus main feeders occurs primarily due to the depth of the underground duct banks, configuration (a total of 12 ducts with medium voltage feeders) and loading of conductors.

Circuits '1A' and '1B' serve 12.47kV-4.16kV, 3/3.36MVA and 5/5.6MVA substations respectively located adjacent to the Central Plant on the east side of the campus. These substations were provided in 1992 to isolate a portion of the buildings loads from the 5kV main switchgear and transfer the same to these substations. 5kV feeders originating from these substations serve existing 4.16kV substations in each of the buildings and also chillers at the central plant.

Circuits '2A', '2B', '3A', '3B' originating from the main 12.47kV switchgear traverse through selector switches, duct banks and manholes to form a primary selective system at the campus and serve majority of the buildings on campus. Circuits '4A' and '4B' supply limited loads at the campus including Satellite Chiller Plant/TES, University Lab building and Recycle Center.

Likewise, each of the 5kV switchgears comprise of a main 5kV circuit breaker and four 600A, 5kV feeder breakers connected via tie line comprising of (6) 500kcmil 5kV conductors. Three 4.16kV feeders (circuits '2', '3' and '4') originate from the indoor 5kV switchgear and traverse through selector switches, ductbanks and manholes to serve buildings on the east side of the campus. Circuit '1' of indoor switchgear has been disconnected. Likewise 4.16kV circuits '6', '7' and '8' originate from the outdoor 5kV switchgear and traverse through selector switches, ductbanks and manholes to serve buildings on the east side of the campus. Circuit '5' has been disconnected. The current configuration allows the campus to switch loads between circuits '2', '6' and '7' through the use of selector switches.

The electrical power distribution system at the campus is comprised of 5kV and 15kV EPR cables. The 15kV cables are sized at 500kcmil and the 5kV cables are sized at 350kcmil.

The feeders traverse through a series of sectionalizing switches housed in individual manholes. The sizes of these switches range from 200A to 600A, 15 KV rated. A few of these switches are equipped with fuses to protect the radial feeds to the building.

In addition, buildings are provided with dual switches to enable the facilities personnel to switch loads between different feeders and to isolate a portion of the existing system for maintenance and expansion. The existing switches are a combination of air and oil fused switches.

The selector switches serve substations/ transformers in individual buildings with either with 12.47kV or 4.16kV primary and 277V/480V or 120/208V secondary voltages.

Majority of the current campus 12.47kV electrical system is a primary selective system formed through a series of selector switches and distribute power to substations in buildings located on the east side of the campus through a series of manholes and medium voltage ductbanks. The primary selective system provides the campus with the ease of isolating faults within the campus distribution system and minimizes power interruptions to the buildings during the event of a particular feeder failure or maintenance on the medium voltage distribution system.

Majority of the current campus 4.16kV electrical system is a primary loop system formed through a series of selector switches and distribute power to substations in buildings located on the east side of the campus through a series of manholes and medium voltage ductbanks. The primary loop system also provides the campus with the ease of isolating faults within the campus distribution system and minimizes power interruptions to the buildings during the event of a particular feeder failure or maintenance on the medium voltage distribution system.

Below is a brief description of each of the above referenced systems for reference:

- Primary loop system with isolating switches at each building.
- Primary selective system with isolating switches at each building.

Primary Loop System

A primary loop system is formed by providing a series of selector switches that enable the main feeders to traverse in and out of the switches. In this system, power is supplied continuously from two sources at the ends of the loop. A radial feeder originating from the selector switches serves each building. A primary loop system enables the system to quickly recover from a single cable fault with no continuous loss of power to utilization equipment.

A second important feature of the loop system is that a section of the cable may be isolated from the loop for repair or maintenance while other parts of the system are still functioning.

TABLE 2.1 ELECTRICAL CONSUMPTION INFORMATION REQUEST ELS-ELM TOTALS FEBRUARY 10 - FEBRUARY 11

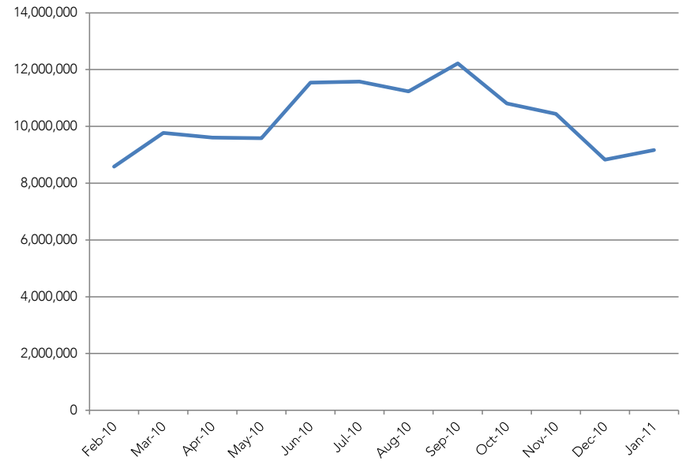
	A—3800 CC		B—State-ELS (LESS Heckman)		C—Recharge-ELN		K.K. 03/14/11	
	Purchase $	KHW/Units	Purchase $	KHW/Units	Purchase $	KHW/Units	Total Purchase $	Total Units
Feb-10	$553,224.68	7,660,800	$26,421.48	211,985	$66,798.46	714,157	$646,444.62	8,586,942
Mar-10	$632,718.96	8,761,600	$40,256.41	249,972	$69,659.00	756,381	$742,634.37	9,767,953
Apr-10	$618,853.64	8,569,600	$78,805.94	245,004	$71,532.36	794,161	$769,191.94	9,608,765
May-10	$614,000.82	8,502,400	$40,595.31	269,782	$73,441.03	809,708	$728,037.16	9,581,890
Jun-10	$752,653.62	10,422,400	$49,238.85	336,206	$69,077.05	783,855	$870,969.52	11,542,461
Jul-10	$742,947.92	10,288,000	$50,102.08	346,419	$78,383.45	941,066	$871,433.45	11,575,485
Aug-10	$702,276.42	9,724,800	$48,598.08	443,629	$92,190.44	1,061,139	$843,064.94	11,229,568
Sep-10	$873,932.75	10,864,000	$53,294.77	375,988	$92,141.11	981,663	$1,019,368.63	12,221,651
Oct-10	$747,540.72	9,292,800	$64,009.53	434,367	$104,621.18	1,079,493	$916,171.43	10,806,660
Nov-10	$749,857.48	9,321,600	$47,575.58	284,281	$81,539.53	838,042	$878,972.59	10,443,923
Dec-10	$619,089.33	7,696,000	$48,139.24	286,672	$81,699.43	846,421	$748,928.00	8,829,093
Jan-11	$662,592.91	8,236,800	$54,171.09	240,182	$69,383.69	688,919	$786,147.69	9,165,901
Total	$8,269,689.25	109,340,800	$601,208.36	3,724,487	$950,466.73	10,295,005	$9,821,364.34	123,360,292

A) 3800 Canyon Crest 12KV 4KV system

B) State ELS (Electric State Funded)

C) Recharge ELN (Electric Non-State Funded) IE: Housing, HUB, Etc

FIGURE 2.1 ELECTRICAL CONSUMPTION TOTALS FEBRUARY 10 - FEBRUARY 11



Primary Selective System

The primary selective system is comprised of two separate feeders that originate from the main switchgear and run to each isolating switch located at each building thereby providing a source of normal and alternate source of power. Upon failure of the normal source, the building is switched to the alternate source. Switching can be either automatic or manual, but there will be an interruption until load is transferred to the alternate source.

Campus Peak Demand and Consumption

A review of campus provided data revealed that the peak demand seen by the campus at each of the 4.16kV and 12.47kV switchgears in MVA is as follows:

- 4.16kV Switchgear – 7MVA
- 12.47kV Switchgear – 18.5MVA

A total of 25.5MVA is the current peak demand of the campus.

The current campus consumption in kWh per year by each month is provided in Table 2.1.

The campus currently has a total electrical consumption of 124 million kWh per year.

Current load readings provided on 12.47kV feeders (1A, 1B, 2A, 2B, 3A, 3B, 4A and 4B) by the campus are documented in Table 2.2 and 2.2A below.

TABLE 2.2
ELECTRICAL LOADS JUNE 8, 2011 10:28 AM

Voltage: 7081		Voltage: 7055	
Circuit	Amperage	Circuit	Amperage
1A	001	1B	168
2A	053	2B	216
3A	072	3B	014
4A	107	4B	022

Breaker Information from Substation

Westinghouse VCP-W

Vacuum Circuit Breakers

W-150VCPW500

Breaker Ampacity 1200 amps

The following Tables 2.3, 2.4, 2.5 and 2.6 provide installed capacities by each system and feeders for each of the building on campus. Installed capacities were taken from existing record drawings and field surveys. Approximate demands of the facilities are calculated at 25% of the installed capacities in absence of available metered data.

TABLE 2.2A
ELECTRICAL DEMAND INFORMATION FURNISHED OCTOBER 4, 2011

Circuit	5:30 pm Amperage	6:10 pm Amperage
1A	002	114
2A	065	065
3A	067	070
4A	002	123
1B	164	230
2B	232	238
3B	030	033
4B	000	025 jumping

TABLE 2.3—EXISTING FACILITIES INSTALLED CAPACITY AND DEMAND BY FEEDERS (12.47 KV SYSTEM)

CAAN	Building Name	Comment	Primary Voltage (kV)	Secondary Voltage (V)	KVA	Impedance	Demand	Feeder(s) Serving the Facility
Feeders 1A, 1B								
P5186	Biological Sciences	A	12	480/277	1,500	5.88	375	Feeder 1A, 1B
P5414	Chemical Sciences		12	480/277	3,000	5.20	750	Feeder 1A, 1B
P5215	Homer D. Chapman Hall		12	208/120	1,500	6.60	375	Feeder 1A, 1B
P5196	Genomics Building		12	480/277	2,500	5.70	625	Feeder 1A, 1B
P5406	School of Medicine Health Science Research Building		12	480/277	1,500	5.60	375	Feeder 1A, 1B
P5406	School of Medicine Health Science Research Building		12	480/277	1,500	5.60	375	Feeder 1A, 1B
P5289	East Campus Insectary and Quarantine Facility		12	480/277	1,000	5.88	250	Feeder 1A, 1B
Total Feeders 1A, 1B - 12.47kV					12,500		3,125	
Feeders 1A, 1B - Central Plant 12.47kV-4.16kV Substation								
P5501	Leon Dexter Bachelor Hall	Basement	4.16	208/120	300	5.75	75	Feeder 1A, 1B
P5501	Leon Dexter Bachelor Hall	SubBasement	4.16	208/120	1,000	6.04	250	Feeder 1A, 1B
P5482	Patrick Boyden Laboratory		4.16	208/120	300		75	Feeder 1A, 1B
P5295	Central Utility Plant	A	4.16	480/277	1,000	5.57	250	Feeder 1A, 1B
P5295	Central Utility Plant	B	4.16	208/120	450	4.50	112.5	Feeder 1A, 1B
P5295	Central Utility Plant	TS-1	4.16	208/120	1,000	6.10	250	Feeder 1A, 1B
P5517	College Building North		4.16	208/120	300	5.00	75	Feeder 1A, 1B
P5507	Custodial & Grounds Building		4.16	208/120	75	2.50	18.75	Feeder 1A, 1B
P5503	Howard Samuel Fawcett Laboratory		4.16	208/120	75	No Name Plate	18.75	Feeder 1A, 1B
P5259	Greenhouse #2A	GH 1 & 2	4.16	208/120	500	4.76	125	Feeder 1A, 1B
P5550	Glasshouse #51	GH 51 & 52	4.16	208/120	300	4.67	75	Feeder 1A, 1B
P5568	Headhouse Botanic Gardens		4.16	240/120V	10		2.5	Feeder 1A, 1B
P5319	Herbarium		4.16	208/120	225		56.25	Feeder 1A, 1B
	This Was Replaced By Theater 12kV	B	4.16	208/120	300		75	Feeder 1A, 1B
P5316	Life Sciences	Unit 1	4.16	208/120	500	4.80	125	Feeder 1A, 1B
P5316	Life Sciences	Unit 2 - A	4.16	208/120	300	5.43	75	Feeder 1A, 1B
P5316	Life Sciences	Unit 2 - B	4.16	208/120	300	5.45	75	Feeder 1A, 1B
P5316	Life Sciences	Unit 2 - C	4.16	208/120	300	5.30	75	Feeder 1A, 1B
P5316	Life Sciences	Unit 2 - D	4.16	480	300	5.47	75	Feeder 1A, 1B
P5316	Life Sciences	Unit 2 - E	4.16	208/120	150	4.04	37.5	Feeder 1A, 1B
P5254	Botanic Gardens Information Center		4.16	240/120	25		6.25	Feeder 1A, 1B
P5476	Trailer Anthropology		4.16	208/120	75	4.25	18.75	Feeder 1A, 1B

TABLE 2.3—EXISTING FACILITIES INSTALLED CAPACITY AND DEMAND BY FEEDERS (12.47 KV SYSTEM)(CONT.)

CAAN	Building Name	Comment	Primary Voltage (kV)	Secondary Voltage (V)	KVA	Impedance	Demand	Feeder(s) Serving the Facility
Site	Temporay Pole Mount - Parking Lot 8		4.16	208/120	75		18.75	Feeder 1A, 1B
P5205	University Office Building		4.16	208/120	500	4.54	125	Feeder 1A, 1B
P5514	Greenhouse #19	GH 18-21	4.16	208/120	300	5.15	75	Feeder 1A, 1B
Total Feeders 1A, 1B – Central Plant 12.47kv-4.16kV Substation					8,660		2,165	
Total					21,160		5,290	
Feeders 2A, 2B								
P5261	Marlan & Rosemary Bourns Hall		12	480/277	4,000	5.52	1000	Feeder 2A
P5272	Parking Services Building		12	208/120	150		37.5	Feeder 2A
P5343	Aberdeen-Inverness Residence Hall	A	12.47	208/120	300	6.23	75	Feeder 2A, 2B
P5343	Aberdeen-Inverness Residence Hall	B	12	208/120	300	6.23	75	Feeder 2A, 2B
P5343	Aberdeen-Inverness Residence Hall	C	12	208/120	300	6.23	75	Feeder 2A, 2B
P5343	Aberdeen-Inverness Residence Hall	C1	12	480	750	6.00	187.5	Feeder 2A, 2B
P5343	Aberdeen-Inverness Residence Hall	D	12	208/120	300	6.23	75	Feeder 2A, 2B
P5343	Aberdeen-Inverness Residence Hall	E	12	208/120	300	6.10	75	Feeder 2A, 2B
P5341	Alfred M. Boyce Hall	A	12	480/277	1,000	6.43	250	Feeder 2A, 2B
P5341	Alfred M. Boyce Hall	B	12	208/120	1,000	6.40	250	Feeder 2A, 2B
P5588	Statistics Computer Building	A	12	480/277	500	5.12	125	Feeder 2A, 2B
P5588	Statistics Computer Building	B	12	208/120	500	5.96	125	Feeder 2A, 2B
P5194	Engineering Building Unit 2		12	480/277	2,000	5.79	500	Feeder 2A, 2B
P5335	Geology Building	A	12	480/277	1,000	5.66	250	Feeder 2A, 2B
P5335	Geology Building	B	12	208/120	500	5.93	125	Feeder 2A, 2B
P5335	Geology Building	Lab	12	480/277	2,000	4.78	500	Feeder 2A, 2B
P5502	Lothian Residence Hall	A - West	12	208/120	500	5.93	125	Feeder 2A, 2B
P5502	Lothian Residence Hall	B	12	480/277	2,000	6.49	500	Feeder 2A, 2B
P5502	Lothian Residence Hall	C	12	480	300	5.87	75	Feeder 2A, 2B
P5502	Lothian Residence Hall	D	12	208/120	300	6.13	75	Feeder 2A, 2B
P5365	Pentland Hills Residence Hall	A	12	480/277	750	5.54	187.5	Feeder 2A, 2B
P5638	Pentland Hills Residence Hall	E	12	480/277	750	5.54	187.5	Feeder 2A, 2B
P5643	Pentland Hills Residence Hall 2	L	12	480/277	750	5.54	187.5	Feeder 2A, 2B
P5646	Pentland Hills Residence Hall 2	O	12	480/277	750	5.54	187.5	Feeder 2A, 2B
P5471	Glen Mor Housing B		12	480/277	150	4.19	37.5	Feeder 2A, 2B
P5508	W. Conway Pierce Hall	Addition	12	480/277	500	5.30	125	Feeder 2A, 2B
P5418	Raymond L. Orbach Science Library		12	480/277	2,500	5.77	625	Feeder 2A, 2B
P5511	Student Recreation Center		12	480/277	2,000	6.23	500	Feeder 2A, 2B
P5342	Herbert John Webber Hall	A	12	480/277	225	5.75	56.25	Feeder 2A, 2B
P5342	Herbert John Webber Hall	B	12	208/120	300	4.42	75	Feeder 2A, 2B

TABLE 2.3—EXISTING FACILITIES INSTALLED CAPACITY AND DEMAND BY FEEDERS (12.47 KV SYSTEM)(CONT.)

CAAN	Building Name	Comment	Primary Voltage (kV)	Secondary Voltage (V)	KVA	Impedance	Demand	Feeder(s) Serving the Facility
P5417	Entomology Buildings Seismic Replacement		12	480/277	2,000	7.73	500	Feeder 2B
P5470	Glen Mor Housing A	A	12	208/120	1,000	5.86	250	Feeder 2B
P5474	Glen Mor Housing E	E	12	208/120	1,000	5.80	250	Feeder 2B
Total					30,675		7,668.75	
Feeders 3A, 3B								
P5224	University Bookstore		12	208/120	300	4.10	75	Feeder 3A, 3B
P5372	Chass Interdisciplinary South		12	480/277	1,500	5.81	375	Feeder 3A, 3B
P5411	Arts Building, Fine Arts Seismic Facility	A	12	208/12	750	5.64	187.5	Feeder 3A, 3B
P5411	Arts Building, Fine Arts Seismic Facility	B	12	208/12	750	5.64	187.5	Feeder 3A, 3B
P5404	Highlander Union Building	A	12	208/120	750	5.63	187.5	Feeder 3A, 3B
P5404	Highlander Union Building	B	12	480/277	1,500	5.62	375	Feeder 3A, 3B
P5307	Humanities & Social Sciences		12	480/277	1,500			Feeder 3A, 3B
P5334	Athletics And Dance Building	Lower	12	208/120	225	5.50	56.25	Feeder 3A, 3B
P5195	Materials Science & Engineering		12	480/277	3,750	5.99	937.5	Feeder 3A, 3B
P5334	Athletics and Dance Building	Upper	12	208/120	300	5.50	75	Feeder 3A, 3B
P5614	Student Support Services Building		12	480/277	750	5.84	187.5	Feeder 3A, 3B
P5380	Campus Surge		12	480/277	750	5.75	187.5	Feeder 3A, 3B
P5498	Humanities Building		12	208/120	500	1.90	125	Feeder 3A, 3B
Total					13,325		2,956.25	
Feeders 4A, 4B								
P5367	Satellite Chiller Plant		12	480/277	2,500	6.00	625	Feeder 4A
P5367	Satellite Chiller Plant	TES Tank 2	12	480/277	225	5.00	56.25	Feeder 4A
P5263	University Laboratory Building		12	208/120	500	5.30	125	Feeder 4A
Site	Recycle Center - University Substation		12	208/120	1,000	5.75	250	Feeder 4B
Total					4,225		1,056.25	
Feeders 1B, 2B								
P5224	Computing and Communications		12	208/120	300	4.10	75	Feeder 3A, 3B
Total					300		75	
Total					69,685		17,046.25	

TABLE 2.4—INSTALLED CAPACITY AND DEMAND BY FACILITIES (12.47 KV SYSTEM)

CAAN	Building Name	Comment	Primary Voltage (kV)	Secondary Voltage (V)	KVA	Impedance	Demand	Feeder(s) Serving the Facility
P5343	Aberdeen-Inverness Residence Hall	A	12.47	208/120	300	6.23	75	Feeder 2A, 2B
P5343	Aberdeen-Inverness Residence Hall	B	12	208/120	300	6.23	75	Feeder 2A, 2B
P5343	Aberdeen-Inverness Residence Hall	C	12	208/120	300	6.23	75	Feeder 2A, 2B
P5343	Aberdeen-Inverness Residence Hall	C1	12	480	750	6.00	187.5	Feeder 2A, 2B
P5343	Aberdeen-Inverness Residence Hall	D	12	208/120	300	6.23	75	Feeder 2A, 2B
P5343	Aberdeen-Inverness Residence Hall	E	12	208/120	300	6.10	75	Feeder 2A, 2B
P5186	Biological Sciences	A	12	480/277	1,500	5.88	375	Feeder 1A, 1B
P5224	University Bookstore		12	208/120	300	4.10	75	Feeder 3A, 3B
P5261	Marlan & Rosemary Bourns Hall		12	480/277	2,000	5.52	500	Feeder 2A
P5341	Alfred M. Boyce Hall	A	12	480/277	1,000	6.43	250	Feeder 2A, 2B
P5341	Alfred M. Boyce Hall	B	12	208/120	1,000	6.40	250	Feeder 2A, 2B
P5372	Chass Interdisciplinary South		12	480/277	1,500	5.81	375	Feeder 3A, 3B
P5414	Chemical Sciences		12	480/277	3,000	5.20	750	Feeder 1A, 1B
P5381	Computing and Communications		12	208/120	300	6.23	75	Feeder 1B, 2B
P5588	Statistics Computer Building	A	12	480/277	500	5.12	125	Feeder 2A, 2B
P5588	Statistics Computer Building	B	12	208/120	500	5.96	125	Feeder 2A, 2B
P5194	Engineering Building Unit 2		12	480/277	2,000	5.79	500	Feeder 2A, 2B
P5417	Entomology Buildings Seismic Replacement		12	480/277	2,000	7.73	500	Feeder 2B
P5215	Homer D. Chapman Hall		12	208/120	1,500	6.60	375	Feeder 1A, 1B
P5411	Arts Building, Fine Arts Seismic Facility	A	12	208/12	750	5.64	187.5	Feeder 3A, 3B
P5411	Arts Building, Fine Arts Seismic Facility	B	12	208/12	750	5.64	187.5	Feeder 3A, 3B
P5196	Genomics Building		12	480/277	2,500	5.70	625	Feeder 1A, 1B
P5335	Geology Building	A	12	480/277	1,000	5.66	250	Feeder 2A, 2B
P5335	Geology Building	B	12	208/120	500	5.93	125	Feeder 2A, 2B
P5335	Geology Building	Lab	12	480/277	2,000	4.78	500	Feeder 2A, 2B
P5406	School Of Medicine Health Science Research Building		12	480/277	1,500	5.60	375	Feeder 1A, 1B
P5406	School Of Medicine Health Science Research Building		12	480/277	1,500	5.60	375	Feeder 1A, 1B
P5404	Highlander Union Building	A	12	208/120	750	5.63	187.5	Feeder 3A, 3B
P5404	Highlander Union Building	B	12	480/277	1,500	5.62	375	Feeder 3A, 3B
P5307	Humanities & Social Sciences		12	480/277	1,500			Feeder 3A, 3B
P5289	East Campus Insectary And Quarantine Facility		12	480/277	1,000	5.88	250	Feeder 1A, 1B

TABLE 2.4—INSTALLED CAPACITY AND DEMAND BY FACILITIES (12.47 KV SYSTEM)(CONT.)

CAAN	Building Name	Comment	Primary Voltage (kV)	Secondary Voltage (V)	KVA	Impedance	Demand	Feeder(s) Serving the Facility
P5502	Lothian Residence Hall	A - West	12	208/120	500	5.93	125	Feeder 2A, 2B
P5502	Lothian Residence Hall	B	12	480/277	2,000	6.49	500	Feeder 2A, 2B
P5502	Lothian Residence Hall	C	12	480	300	5.87	75	Feeder 2A, 2B
P5502	Lothian Residence Hall	D	12	208/120	300	6.13	75	Feeder 2A, 2B
P5334	Athletics And Dance Building	Lower	12	208/120	225	5.50	56.25	Feeder 3A, 3B
P5195	Materials Science & Engineering		12	480/277	3,750	5.99	937.5	Feeder 3A, 3B
P5272	Parking Services Building		12	208/120	150		37.5	Feeder 2A
P5365	Pentland Hills Residence Hall	A	12	480/277	750	5.54	187.5	Feeder 2A, 2B
P5638	Pentland Hills Residence Hall	E	12	480/277	750	5.54	187.5	Feeder 2A, 2B
P5643	Pentland Hills Residence Hall 2	L	12	480/277	750	5.54	187.5	Feeder 2A, 2B
P5646	Pentland Hills Residence Hall 2	O	12	480/277	750	5.54	187.5	Feeder 2A, 2B
P5471	Glen Mor Housing B		12	480/277	150	4.19	37.5	Feeder 2A, 2B
P5508	W. Conway Pierce Hall	Addition	12	480/277	500	5.30	125	Feeder 2A, 2B
Site	Recycle Center - University Substation		12	208/120	1,000	5.75	250	Feeder 4B
P5334	Athletics And Dance Building	Upper	12	208/120	300	5.50	75	Feeder 3A, 3B
P5614	Student Support Services Building		12	480/277	750	5.84	187.5	Feeder 3A, 3B
P5367	Satellite Chiller Plant		12	480/277	2,500	6.00	625	Feeder 4A
P5418	Raymond L. Orbach Science Library		12	480/277	2,500	5.77	625	Feeder 2A, 2B
P5511	Student Recreation Center		12	480/277	2,000	6.23	500	Feeder 2A, 2B
P5380	Campus Surge		12	480/277	750	5.75	187.5	Feeder 3A, 3B
P5367	Satellite Chiller Plant	TES Tank 2	12	480/277	225	5.00	56.25	Feeder 4A
P5498	Humanities Building		12	208/120	500	1.90	125	Feeder 3A, 3B
P5470	Glen Mor Housing A	A	12	208/120	1,000	5.86	250	Feeder 2B
P5474	Glen Mor Housing E	E	12	208/120	1,000	5.80	250	Feeder 2B
P5263	University Laboratory Building		12	208/120	500	5.30	125	Feeder 4A
P5342	Herbert John Webber Hall	A	12	480/277	225	5.75	56.25	Feeder 2A, 2B
P5342	Herbert John Webber Hall	B	12	208/120	300	4.42	75	Feeder 2A, 2B
Total					59,025		14,381.25	

TABLE 2.5—EXISTING FACILITIES INSTALLED CAPACITY AND DEMAND BY FEEDERS (4.16 KV SYSTEM)

CAAN	Building Name	Comment	Primary Voltage (kV)	Secondary Voltage (V)	KVA	Impedance	Demand	Feeder(s) Serving the Facility
P5480	Ivan Hinderaker Hall		4.16	208/120	500	5.25	125	Feeder 3
P5358	The Barn		5	208/120	75		18.75	Feeder 3
P5530	Belltower		5	208/120	75		18.75	Feeder 2, 6 and 7 (Loop System)
P5295	Central Utility Plant	A	5	480/277	1000	5.57	250	Feeder 2,8 (Loop System)
P5295	Central Utility Plant	B	5	208/120	450	4.50	112.5	Feeder 2, 8 (Loop System)
P5295	Central Utility Plant	TS-1	5	208/120	1000	6.10	250	Feeder 2, 8 (Loop System)
P5486	Corporation Yard B		5	208/120	300	4.50	75	Feeder 4
P5278	Greenhouse #10		5	208/120	225		56.25	Feeder 2, 8 (Loop System)
P5483	Greenhouse #17	GH 16 & 17 Pole	5	208/120	75		18.75	Feeder 2, 8 (Loop System)
P5278	Greenhouse #10	GH 6, 7, 8, 9 & 10	5	208/120	225			Feeder 2, 8 (Loop System)
P5481	Greenhouse #14	GH 11, 12, 13, & 14	5	208/120	500			Feeder 2, 8 (Loop System)
P5498	Humanities Building	A	5	208/120	112.5		28.125	Feeder 2, 8 (Loop System)
P5497	John W. Olmsted Hall	A	5	208/120	300		75	Feeder 2, 8 (Loop System)
P5497	John W. Olmsted Hall	B	5	208/120	300		75	Feeder 2, 8 (Loop System)
P5322	Tomas Rivera Library	A (Rm 50)	5	208/120	750	6.45	187.5	Feeder 3
P5322	Tomas Rivera Library	B (Rm 50)	5	480/277	750	5.73	187.5	Feeder 3
P5322	Tomas Rivera Library	C (Rm 6a)	5	208/120	500	6.16	125	Feeder 3
P5322	Tomas Rivera Library	D	5	208/120	225	5.07	56.25	Feeder 3
P5483	Greenhouse #17		5	208/120	112.5	3.60	28.125	Feeder 3
Site	Parking Lot 30 - University Substation		5	480	112.5	4.97	28.125	Feeder 3
P5508	W. Conway Pierce Hall	A (Rm. 100a)	5	208/120	500	5.10	125	Feeder 2,6 and 7 (Loop System)
P5508	W. Conway Pierce Hall	B (Rm. 300a)	5	208/120	750	5.24	187.5	Feeder 2,6 and 7 (Loop System)
P5508	W. Conway Pierce Hall	C (Rm. 300a)	5	208/120	750	5.24	187.5	Feeder 2,6 and 7 (Loop System)

TABLE 2.5—EXISTING FACILITIES INSTALLED CAPACITY AND DEMAND BY FEEDERS (4.16 KV SYSTEM)(CONT.)

CAAN	Building Name	Comment	Primary Voltage (kV)	Secondary Voltage (V)	KVA	Impedance	Demand	Feeder(s) Serving the Facility
P5508	W. Conway Pierce Hall	D (Rm. 418)	5	208/120	750	5.70	187.5	Feeder 2,6 and 7 (Loop System)
P5504	Physics Building	A	5	208/120	300	4.65	75	Feeder 2,6 and 7 (Loop System)
P5504	Physics Building	B	5	208/120	750	6.06	187.5	Feeder 2,6 and 7 (Loop System)
P5504	Physics Building	C	5	480	500	5.25	125	Feeder 2,6 and 7 (Loop System)
P5504	Physics Building	D	5	208/120	300	4.94	75	Feeder 2,6 and 7 (Loop System)
P5504	Physics Building	D	5	480	300	5.13	75	Feeder 2,6 and 7 (Loop System)
P5496	Physical Education Utility Building	Track Stadium	5	480/277	500	4.70	125	Feeder 3
Site	Pumping Station Storm Water - Canyon Crest Underpass	Storm Water	5	208/120	150	3.00	37.5	Feeder 3
Site	Pumping Station Domestic Water - University / Canyon Crest	Domestic Water	5	208/120	1000	5.53	250	Feeder 3
P5523	Robert Gordon Sproul Hall		5	208/120V	500	5.10	125	Feeder 3
P5495	Health Service Building		5	208/120	225	3.75	56.25	Feeder 4
P5354	Gordon S. Watkins Hall		5	208/120V	500	5.00	125	Feeder 3
Total					15,362.5		3,659.375	

TABLE 2.6—EXISTING FACILITIES INSTALLED CAPACITY AND DEMAND OF 12.47 KV - 4.16 KV SYSTEM

CAAN	Building Name	Comment	Primary Voltage (kV)	Secondary Voltage (V)	KVA	Impedance	Demand	Feeder(s) Serving the Facility
P5501	Leon Dexter Bachelor Hall	Basement	4.16	208/120	300	5.75	75	Feeder 1A, 1B
P5501	Leon Dexter Bachelor Hall	SubBasement	4.16	208/120	1000	6.04	250	Feeder 1A, 1B
P5482	Patrick Boyden Laboratory		4.16	208/120	300		75	Feeder 1A, 1B
P5295	Central Utility Plant	A	4.16	480/277	1000	5.57	250	Feeder 1A, 1B
P5295	Central Utility Plant	B	4.16	208/120	450	4.50	112.5	Feeder 1A, 1B
P5295	Central Utility Plant	TS-1	4.16	208/120	1000	6.10	250	Feeder 1A, 1B
P5517	College Building North		4.16	208/120	300	5.00	75	Feeder 1A, 1B
P5507	Custodial & Grounds Building		4.16	208/120	75	2.50	18.75	Feeder 1A, 1B
P5503	Howard Samuel Fawcett Laboratory		4.16	208/120	75	NO NAME PLATE	18.75	Feeder 1A, 1B
P5259	Greenhouse #2A	GH 1 & 2	4.16	208/120	500	4.76	125	Feeder 1A, 1B
P5550	Glasshouse #51	GH 51 & 52	4.16	208/120	300	4.67	75	Feeder 1A, 1B
P5568	Headhouse Botanic Gardens		4.16	240/120V	10		2.5	Feeder 1A, 1B
P5319	Herbarium		4.16	208/120	225		56.25	Feeder 1A, 1B
	This Was Replaced By Theater 12kv	B	4.16	208/120	300		75	Feeder 1A, 1B
P5316	Life Sciences	Unit 1	4.16	208/120	500	4.80	125	Feeder 1A, 1B
P5316	Life Sciences	Unit 2 - A	4.16	208/120	300	5.43	75	Feeder 1A, 1B
P5316	Life Sciences	Unit 2 - B	4.16	208/120	300	5.45	75	Feeder 1A, 1B
P5316	Life Sciences	Unit 2 - C	4.16	208/120	300	5.30	75	Feeder 1A, 1B
P5316	Life Sciences	Unit 2 - D	4.16	480	300	5.47	75	Feeder 1A, 1B
P5316	Life Sciences	Unit 2 - E	4.16	208/120	150	4.04	37.5	Feeder 1A, 1B
P5254	Botanic Gardens Information Center		4.16	240/120	25		6.25	Feeder 1A, 1B
P5476	Trailer Anthropology		4.16	208/120	75	4.25	18.75	Feeder 1A, 1B
Site	Temporary Pole Mount - Parking Lot 8		4.16	208/120	75		18.75	Feeder 1A, 1B
P5205	University Office Building		4.16	208/120	500	4.54	125	Feeder 1A, 1B
P5514	Greenhouse #19	GH 18-21	4.16	208/120	300	5.15	75	Feeder 1A, 1B
Total					8,660		2,165	

System Capacity Evaluation

Based on an evaluation of the current campus 12.47kV and 4.16kV system and an evaluation of the campus peak demand revealed that the campus electrical system is adequately sized to meet the loads of the existing facilities. The current primary selective (12.47kV) and primary loop system (4.16kV) also provides redundancy in case of failure of a switchgear section/feeder or a utility transformer.

System Condition and Assessment

The main 12.47kV switchgear was installed in 1991 and is in fair condition. The main 5kV switchgear on the west side of the campus was installed in 1985 and is at the end of its useful life. The 5kV central plant switchgear was installed in 1991 and is in fair condition. Discussions with the campus revealed that the batteries at the switchgear are old and need to be replaced. The Batteries are a critical component of the medium voltge switchgear and provide required control voltages to accomplish tripping of breakers and provide loss of power indication in event of a power loss.

The electrical power distribution system at the campus is comprised of 5kV and 15kV EPR cables. The 15kV cables are sized at 500kcmil and the 5kV cables are sized at 350kcmil. The 15kV cables are installed in 1991 and are approximately 20 years old. The cables have a useful life of at least fifteen years. The 5kV distribution system was installed in 1985 and is approximately 25years old. The 5kV cables have a useful life of approximately ten years. Discussions with the campus revealed that the campus has seen the following failures in the past on the current electrical distribution system.

- Failure of circuit 2 in vault 9,
- Splice blow up in vault 8,
- 5kV explosion in vault 19 and
- 5kV cable failure on the feed to Bachelor Hall

A review of the load readings provided by the campus for each of the 12.47kV feeders revealed that total load served by feeders '2A' and '2B' equates to 269A. Based on the de-rating experienced by the conductors, 500kcmil conductors are limited to carrying approximately 327A of load. Although these feeders are adequately rated to serve loads individually, they are nearing their capacity to operate in a primary selective configuration and should not be used to serve any future loads on the campus.

The feeders traverse through a series of sectionalizing switches housed in individual manholes. The sizes of these switches range from 200A to 600A, 15 KV rated. A few of these switches are equipped with fuses to protect the radial feeds to the building. Majority of these switches are old and are in need of replacement. The isolation switches enable the facilities personnel to switch loads between different feeders and to isolate a portion of the existing system for maintenance and expansion. A few of the SF6 switches were found to be leaking and need to be replaced. The following are locations of these switches:

- Biological Sciences
- Stream Plant
- Greenhouse 19
- Vault 9 - Circuits '2A' and '2B' serving University Laboratory Building

In addition, buildings are provided with dual switches to enable the facilities personnel to switch loads between different feeders and to isolate a portion of the existing system for maintenance and expansion. The existing switches are a combination of air and oil fused switches. The oil fused switches are old, have limited short circuit interrupting capabilities and need to be replaced.

The following are locations housing the oil fused switches that need to be replaced at the campus:

- Humanities
- Barn
- Ivan Hinderaker Hall
- Bell Tower
- Parking Lot 30
- Howard Samuel Fawcett Laboratory
- Patrick Boyden Laboratory and Life Sciences

Figure 2.1 and 2.2 illustrates the existing 12.47kV and 4.16kV site electrical distribution system. Figures 2.3 and 2.4 provide the existing 4.16kV and 12kV site electrical distribution system showing feeder numbers serving each of the existing facilities on campus. Figures 2.5 and 2.6 provide the existing 4.16kV and 12kV campus single-line diagrams respectively.

Figure 2.1—Existing 4.16kV and 12kV Electrical Site Plan by System–North

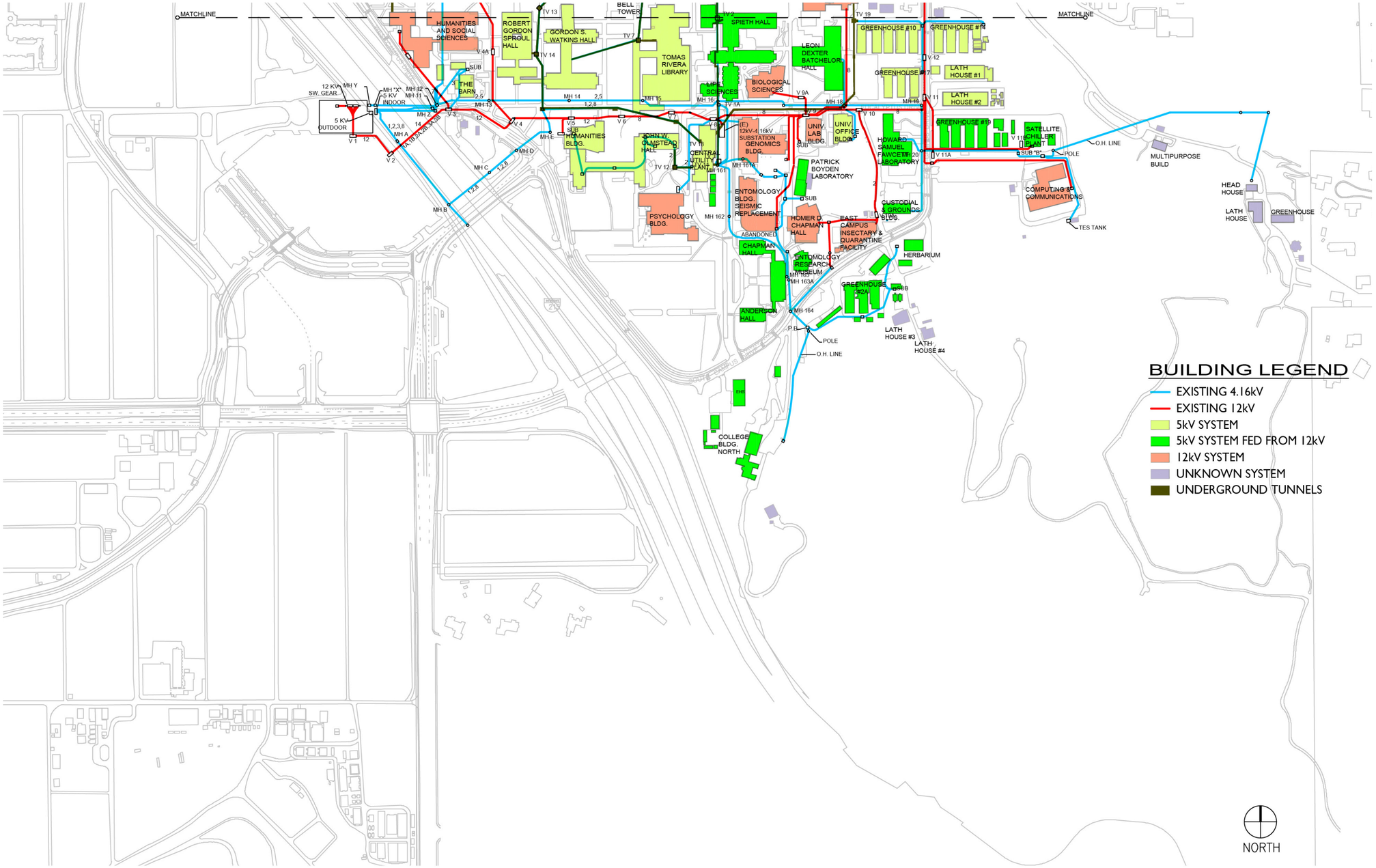


Figure 2.2—Existing 4.16kV and 12kV Electrical Site Plan by System–South

Figure 2.3—Existing 4.16kV and 12kV Electrical Site Plan by System and Feeder–North

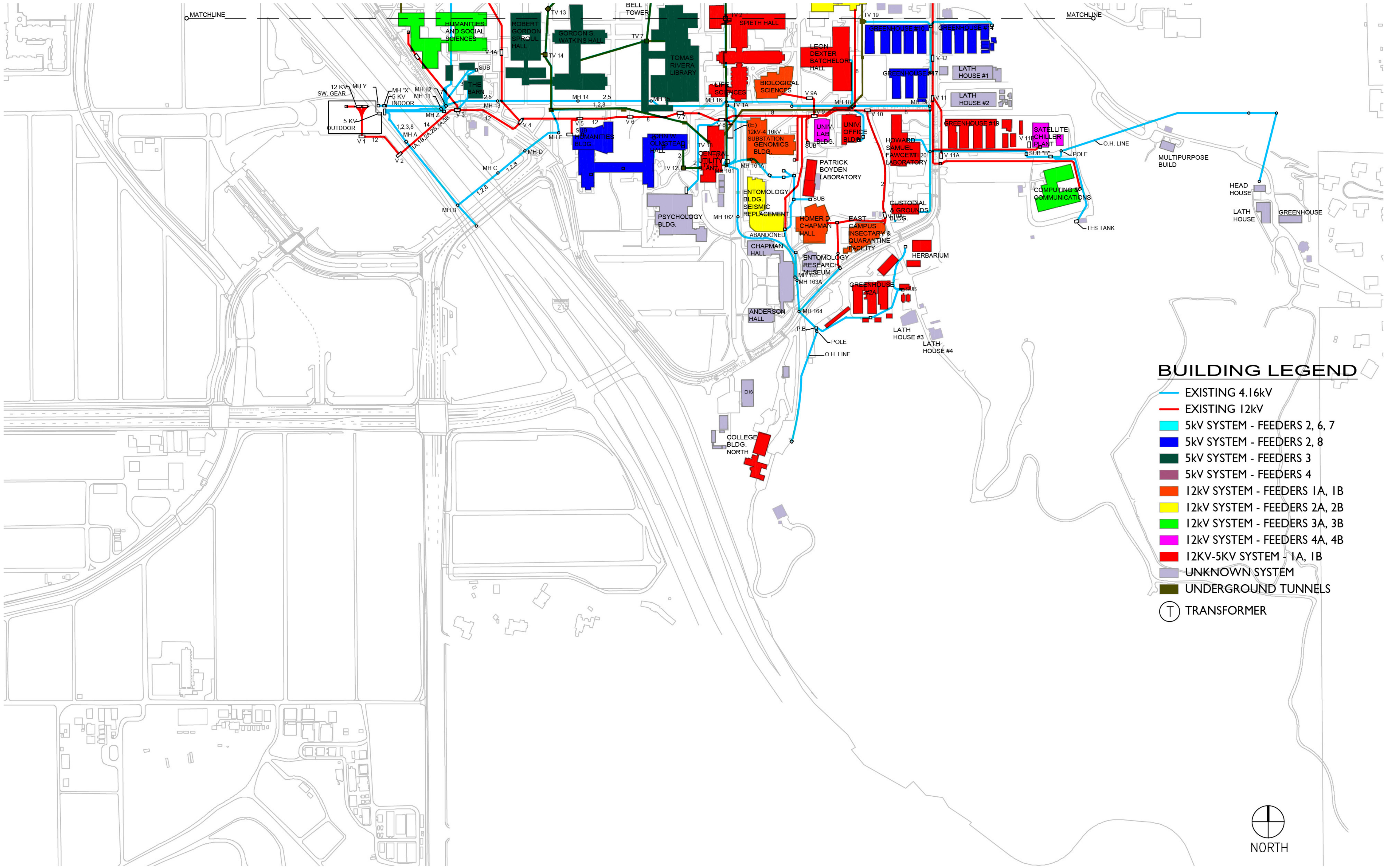


Figure 2.4—Existing 4.16kV and 12kV Electrical Site Plan by System and Feeders–South

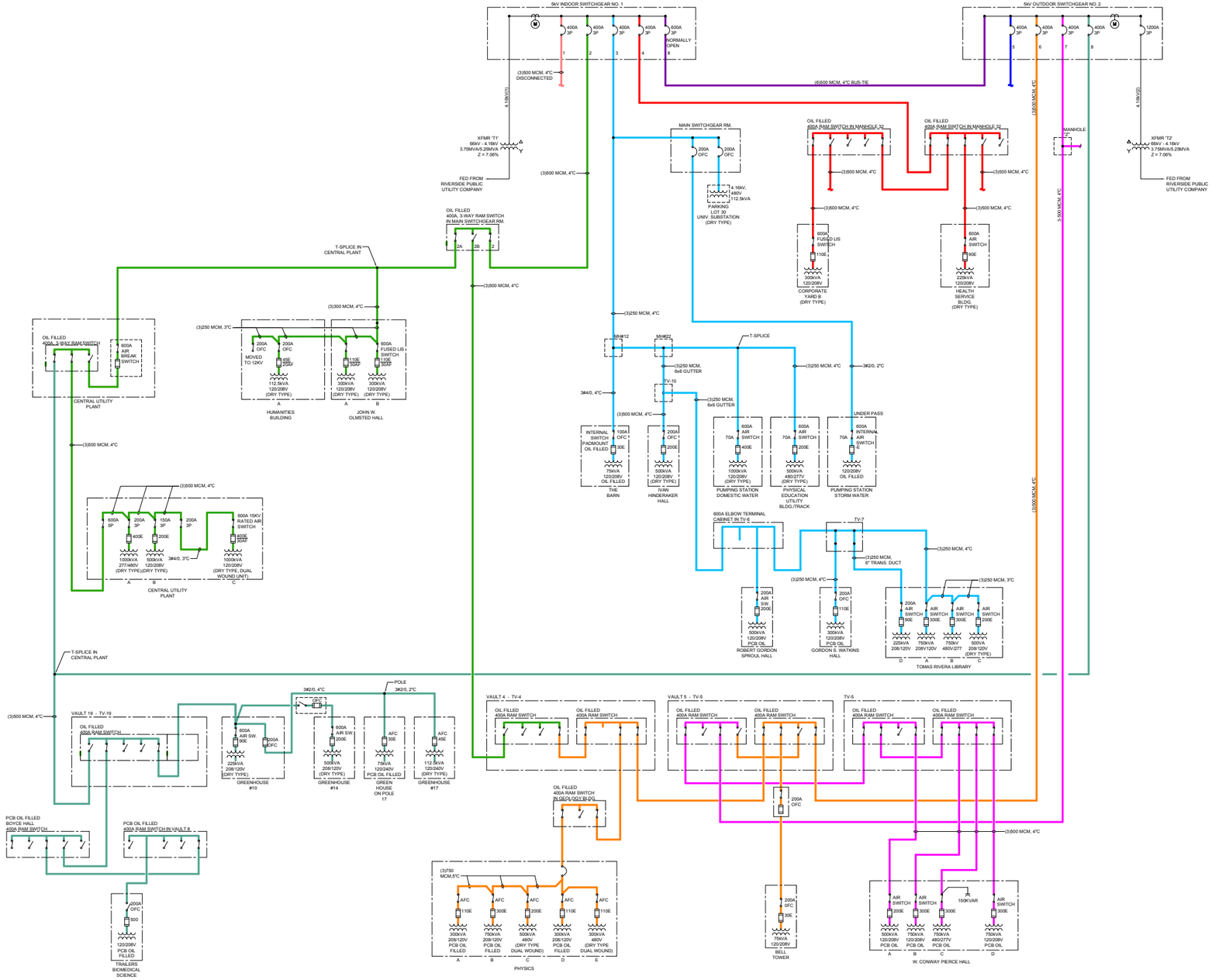


Figure 2.5—Existing 4.16kV Single Line Diagram

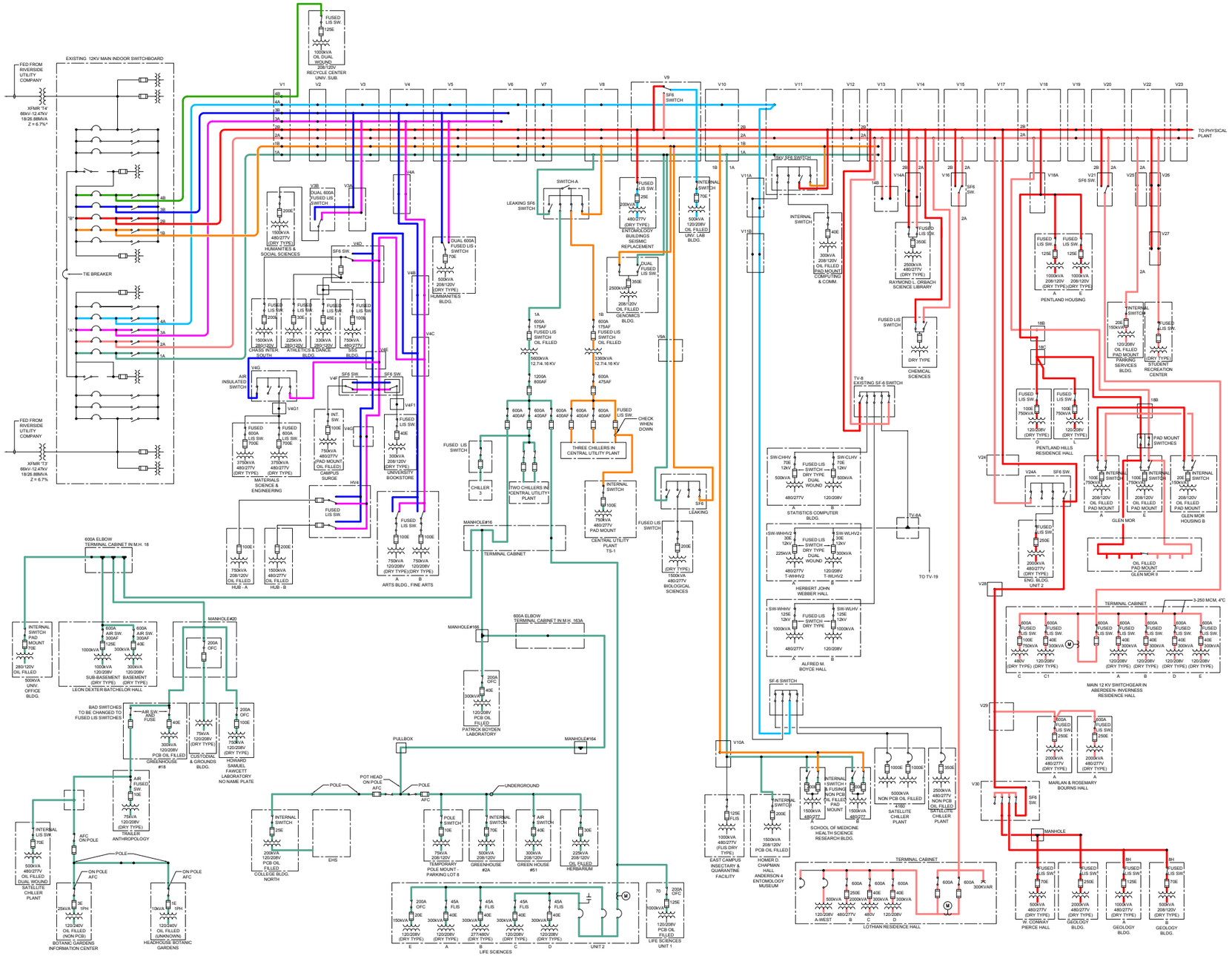


Figure 2.6—Existing 12kV Single Line Diagram

Chapter 3—Methodology

Chapter 3—Methodology

The following methodology was adopted in formulating our electrical utility infrastructure master plan. The methodology presented below outlines the critical tasks that were performed in development of this electrical distribution system report.

- A critical aspect in the evaluation of the existing electrical system serving a facility is a detailed and accurate field investigation of the current system. A detailed survey of the existing electrical system that currently serve the facilities at the University campus was undertaken, and existing conditions, together with potential problems, were identified. The surveyed information was verified through available record drawings and meetings with the campus facilities staff.
- A load flow study of the existing and future loads was developed and existing and proposed capacity requirements were developed. A watts/sqft of proposed facilities was assumed in our load studies. For all existing buildings, existing installed capacities of the substations/transformers were taken and a demand factor was applied to estimate the total loads.
- The Electrical system was then evaluated for capacity, functionality, reliability, redundancy, ease of maintenance, age, and its ability to serve the present and future needs of the campus.
- Alterations/upgrade/modifications necessary to support new buildings, major renovations, and building retrofits that form part of the East Campus Development Plan were identified.
- Recommendations were developed to support new buildings, major renovations, and building retrofits that form part of the proposed East Campus Development Plan were identified.
- An implementation and phasing plan was then developed for each of the recommendations proposed based on phasing schedule provided by the campus for the proposed facilities.
- Costs associated for each of the recommendations proposed by each phase were developed and tabulated.
- Electrical equipment recommendations and specifications were developed to maintain quality and ensure standardization of equipment at the campus.

Chapter 4—Analysis of Future Needs

Chapter 4—Analysis of Future Needs

An analysis of the current 12.47kV and 4.16kV distribution system was conducted to evaluate a) existing spare capacities available in each switchgear/feeders b) the impact of the proposed facilities on the existing electrical distribution system and c) modifications required to support the future build out of the campus. The current electrical distribution was also analyzed for electrical duct-banks/ manholes that will be in conflict with the proposed facilities and will require relocation.

Since the campus operates and maintains the 12.47kV and 4.16kV switchgear and the electrical distribution system, the campus requires an electrical system that must provide (a) Improved system reliability (b) ease of maintenance and isolation of circuits either during a fault or during a regular maintenance without interrupting power to every building on campus (c) be sized to accommodate existing loads and planned future loads resulting from new buildings as well as additions to existing buildings (d) be well coordinated to eliminate nuisance tripping of upstream protective devices (e) have all equipment listed for the short circuit availability at the point of installation and f) provide redundancy in event of a loss or a regular maintenance of either a campus owned medium voltage feeder or utility owned medium voltage transformers.

An evaluation of the East Campus Development Plan revealed that a net additional 4,478,000 square feet of facilities is planned at the campus excluding parking structures. Future building use summary with GSF is provided in Table 4.0. A review of these proposed facilities and their usage revealed that the campus would add an additional demand of approximately 26.8MW to their existing demand of 25.5MW.

A site plan showing the proposed facilities that could be added in various phases is provided at the end of the section.

Table 4.1A depicts projected demand of proposed facilities shown in the east campus development plan update. The demands are calculated based on standard industry watts/ sqft in absence of a design in place for these facilities. A spreadsheet providing standard watts/sqft demand for each of the type of facilities is provided below.

TABLE 4.1—DEMAND PER FACILITIES FUNCTION

Facility Function	Assumed Demand Factor in Watts/Sqft
Housing	4
Institutional Operations	5
Research/Academic Support	5
Administration	5
Academic	5
Athletics/Recreation	5
Student Services	5

TABLE 4.0—FUTURE BUILDING USE SUMMARY WITH GSF

BLDG_Use	GSF New	GSF Demo	Net New
Student Services	264,000	23,362	240,638
Academic/Resarch	2,611,800	119,735	2,492,066
Athletics/Recreation	77,200	69,407	7,793
Housing	2,201,400	607,330	1,594,070
Administration		39,101	-39,101
Academic	125,300	44,648	80,652
Institutional Operations	142,600	40,535	102,065
Total	5,422,300	944,117	4,478,183
Parking Structure	0		0

Phase	GSF New
1-5	545,289
6-10	769,200
11-15	1,226,800
16-20	884,800
Plus 20	1,995,400
	5,421,489

TABLE 4.1A—ANALYSIS OF FUTURE BUILDING LOADS

Ref #	Site ID	Name	GSF	Parking Spaces	Proposed Building Use	Demand in kW	Comments
1	E100	Glen Mor 2 (Bldg N)	4,700	-	Housing	19	
2	E101	Glen Mor 2 (Bldg L)	0	-	Housing	0	
3	E102	Glen Mor 2 (Bldg M)	0	-	Housing	0	
4	E103	Glen Mor 2 (Bldg K)	6,000	-	Housing	24	
5	E104	Glen Mor 2 (Bldg J)	10,800	-	Housing	43	
6	E105	Glen Mor 2 (Bldg I)	0	-	Housing	0	
7	E106	Glen Mor 2 (Bldg H)	8,400	-	Housing	34	
8	E107	Glen Mor 2 (Bldg G)	0	-	Housing	0	
9	E108	Glen Mor 2 (Bldgs F)	338,900	-	Housing	1,356	GSF includes Bldgs F, G, I, L, M
10	E109A	A-I Staff/Faculty 1	4,956	-	Housing	20	
11	E109B	A-I Staff/Faculty 2	0	-	Housing		
12	E110A	A-I Res Dining	19,133	-	Housing	77	A-I Renovation will increase electrical load
12.1	E110B	A-1 Mechanical Equipment	2,100	-	Housing	300	A-1 Final Draft DPP
13	E111	Dundee 1	374,900	-	Housing	1,500	GSF Includes Buildings 2-4
14	E112	Dundee 2	0	-	Housing	0	
15	E113	Dundee 3	0	-	Housing	0	
16	E114	Dundee 4	0	-	Housing	0	
17	E115	Edinburg 1	168,000	-	Housing	672	GSF Includes Building 2
18	E116	Edinburg 2	0	-	Housing	0	
19	E117	Edinburg 3	84,000	-	Housing	336	
20	E118	Café	6,900	-	Housing	28	
21	E119	Lennox 1	168,000	-	Housing	672	GSF Includes Building 2
22	E120	Lennox 2	0	-	Housing	0	
23	E121	Glasgow Dining	96,400	-	Housing	386	
24	E122	Lennox 3	84,000	-	Housing	336	
25	E123	Group Housing 1	90,000	-	Housing	360	GSF Includes Buildings 2-6
26	E124	Group Housing 2	0	-	Housing	0	
27	E125	Group Housing 3	0	-	Housing	0	
28	E126	Group Housing 4	0	-	Housing	0	
29	E127	Group Housing 5	0	-	Housing	0	
30	E128	Group Housing 6	0	-	Housing	0	
31	E129	Falkirk 1	416,800	-	Housing	1,667	GSF Includes Buildings 2-5
32	E130	Falkirk 2	0	-	Housing	0	
33	E131	Falkirk 3	0	-	Housing	0	
34	E132	Falkirk 4	0	-	Housing	0	

TABLE 4.1A—ANALYSIS OF FUTURE BUILDING LOADS (CONT.)

Ref #	Site ID	Name	GSF	Parking Spaces	Proposed Building Use	Demand in kW	Comments
35	E133	Falkirk 5	0	-	Housing	0	
36	E134	Housing Administration	5,700	-	Housing	23	
37	E135	Bannockburn 1	220,000	-	Housing	880	GSF Includes Building 2
38	E136	Bannockburn 2	0	-	Housing	0	
39	E137	Bannockburn Office/Retail	90,900	-	Housing	364	
40	E138	Student Recreation	77,200	-	Athletics/Recreation	386	
41	E139	Performing Arts Center	123,400	-	Academic	617	
42	E140	Academic/Resarch	52,000	-	Academic/Resarch	260	Displaces Soccer Field
43	E141	Engineering IV	113,200	-	Academic/Resarch	566	
44	E142	EBU3	113,500	-	Academic/Resarch	568	GSF is higher than EBU3 program per DPP
45	E143	Health Services	60,700	-	Student Services	304	
46	E144	Academic/Resarch	94,400	-	Academic/Resarch	472	
47	E145	Academic/Resarch	94,400	-	Academic/Resarch	472	
48	E146	Academic/Resarch	94,400	-	Academic/Resarch	472	
49	E147	Academic/Resarch	166,000	-	Academic/Resarch	830	
50	E148	Academic/Resarch	105,600	-	Academic/Resarch	528	Building could displace generator
51	E149	Academic/Resarch	5,300	-	Academic/Resarch	27	
52	E150	Academic/Resarch	123,600	-	Academic/Resarch	618	
53	E151	Academic/Resarch	100,000	-	Academic/Resarch	500	
54	E152	Academic/Resarch	88,800	-	Academic/Resarch	444	
55	E153	Academic/Resarch	88,800	-	Academic/Resarch	444	
56	E154	Academic/Resarch	77,200	-	Academic/Resarch	386	
57	E155	Academic/Resarch	64,300	-	Academic/Resarch	322	
58	E156	Academic/Resarch	66,000	-	Academic/Resarch	330	
59	E157	Replaces C&C	102,400	-	Institutional Operations	512	
60	E158	Included Above	0	-	Academic/Resarch	0	GSF with Site E159
61	E159	Academic/Resarch	47,000	-	Academic/Resarch	235	
62	E160	Academic/Resarch	92,600	-	Academic/Resarch	463	
63	E161	Academic/Resarch	170,800	-	Academic/Resarch	854	
64	E162	Academic/Resarch	82,200	-	Academic/Resarch	411	
65	E163	Academic/Resarch	89,400	-	Academic/Resarch	447	
66	E164	Psychology Phase 2	25,100	-	Academic/Resarch	126	
67	E165	Academic/Resarch	70,400	-	Academic/Resarch	352	
68	E166	Sproul Hall South Addition	60,000	-	Academic/Resarch	300	
69	E167	Watkins North Addition	51,300	-	Academic/Resarch	257	
70	E168	Library Addition	158,300	-	Student Services	792	

TABLE 4.1A—ANALYSIS OF FUTURE BUILDING LOADS (CONT.)

Ref #	Site ID	Name	GSF	Parking Spaces	Proposed Building Use	Demand in kW	Comments
71	E169	Spieth Hall North Addition	66,600	-	Academic/Resarch	333	
72	E170	South of Arts	61,500	-	Academic/Resarch	308	
73	E171	South of CHASS	41,200	-	Academic/Resarch	206	
74	E172	Replace Physical Education	67,000	-	Academic/Resarch	335	
75	E173	Recital Hall/Museum/Gallery	40,300	-	Student Services	202	
76	E174	Academic/Resarch	111,000	-	Academic/Resarch	555	Displaces Reservoir
77	E175	Academic Mixed Use - 3	80,000	-	Academic/Resarch	400	
78	E176	Academic Mixed Use - 4	47,000	-	Academic/Resarch	235	
79	E177	Warehouse (Physical Plant)	4,100	-	Institutional Operations	21	
80	E178	Special Events Building	4,300	-	Institutional Operations	22	
81	E179	EH&S	28,300	-	Institutional Operations	142	
82	E180	Bio-Control Culture Building	1,200	-	Academic/Resarch	6	
	E181	Barn			Student Services		GSF included with sites E181A-E181E
83	E181A	Cottage	0	-	Student Services	0	
84	E181B	Barn Dining/Kitchen	3,800	-	Student Services	19	
85	E181C	Barn Stable	900	-	Student Services	5	
86	E181D	Barn Theater	1,900	-	Academic	10	
87	E181E	KUCR	3,500	-	Institutional Operations	18	No longer KUCR
88		Total	5,421,489			25,209	
89	P01	Parking Structure (Lot 1)		1,200	Parking Structure	125	
90	P02	Parking Structure (Lot 24)		1,250	Parking Structure	125	
91	P03	Parking Structure		1,513	Parking Structure	125	
92	P04	Parking Structure		250	Parking Structure	63	
93	P05	Parking Structure (Glen Mor 2)		596	Parking Structure	83	
94	P06	Parking Structure		853	Parking Structure	83	
		Total		5,662		604	
		Total Added Load				25,444	
		Total Deductive Load (Due to Facilities being demolished)				1,548	
		Total Added Load (Currently on a dedicated RPU Service)				2,565	
		Total Effective Load Added				26,830	

TABLE 4.2—EAST CAMPUS BUILDINGS, EXPANSIONS / PARTIAL REPLACEMENT

			Existing				New		Net New		
Ref #	CAAN	Name	OGSF50	ASF	Raised GSF	Raised ASF	GSF	ASF	GSF	ASF	Sources
E181C	P5271	Barn Stable	1,622	1,400			2,517	1,870	895	470	Barn Project Phases 1 & 2 DPP, pg 25
E181B	P5358	Barn	5,175	4,359			8,964	6,473	3,789	2,114	Barn Project Phases 1 & 2 DPP, pg 24
E181A	P5218	Cottage	1,089	813			Renovate Existing				Barn Project Phases 1 & 2 DPP, pg 23
E181D	P5251	Thtr Wksh	1,651	1,516			3,465	3,013	1,814	1,497	Barn Project Phases 1 & 2 DPP, pg 27
E168	P5322	Rivera Lib	234,429	173,027	40,820	31,816	199,059	128,856	158,239	97,040	Library Facilities Master Plan, pg 16 & 97
E169	P5323	Spieth	102,735	59,822	47,038		113,600		66,562		
E167	P5354	Watkins	63,737	33,861	5,788		57,000		51,212		
Total			410,437	274,799			384,065	140,212	282,511	101,121	

TABLE 4.3—BUILDINGS REMOVED AS PART OF FUTURE EAST CAMPUS DEVELOPMENT

Ref #	CAAN	Name	OGSF50	ASF	Building Use	Demand in kW	Notes	LongName
500	P5001	CC Blain 710	1,340	1,250	Housing	5	-	Canyon Crest Housing 710 & 712 Blaine Street
501	P5002	CC Blain 758	1,608	1,500	Housing	6	-	Canyon Crest Housing 758 & 760 Blaine Street
502	P5003	CC Blain 772	1,340	1,250	Housing	5	-	Canyon Crest Housing 772 & 774 Blaine Street
503	P5004	CC Blain 786	672	620	Housing	3	-	Canyon Crest Housing 786 Blaine Street
504	P5005	CC Blain 798	1,340	1,250	Housing	5	-	Canyon Crest Housing 798 & 800 Blaine Street
505	P5006	CC Blain 818	672	620	Housing	3	-	Canyon Crest Housing 818 Blaine Street
506	P5007	CC Blain 826	1,340	1,250	Housing	5	-	Canyon Crest Housing 826 & 828 Blaine Street
507	P5008	CC Blain 838	672	620	Housing	3	-	Canyon Crest Housing 838 Blaine Street
508	P5009	CC Blain 852	1,340	1,250	Housing	5	-	Canyon Crest Housing 852 & 854 Blaine Street
509	P5010	CC Blain 862	672	620	Housing	3	-	Canyon Crest Housing 862 Blaine Street
510	P5011	CC Blain 876	1,340	1,250	Housing	5	-	Canyon Crest Housing 876 & 878 Blaine Street
511	P5012	CC Blain 890	672	620	Housing	3	-	Canyon Crest Housing 890 Blaine Street
512	P5013	CC Blain 896	1,340	1,250	Housing	5	-	Canyon Crest Housing 896 & 898 Blaine Street
513	P5014	CC Grape 711	1,340	1,250	Housing	5	-	Canyon Crest Housing 711 & 713 Grape Street
514	P5015	CC Grape 725	1,340	1,250	Housing	5	-	Canyon Crest Housing 725 & 727 Grape Street
515	P5016	CC Grape 749	672	620	Housing	3	-	Canyon Crest Housing 749 Grape Street
516	P5017	CC Grape 761	1,340	1,250	Housing	5	-	Canyon Crest Housing 761 & 763 Grape Street
517	P5018	CC Grape 777	672	620	Housing	3	-	Canyon Crest Housing 777 Grape Street
518	P5019	CC Grape 797	1,340	1,250	Housing	5	-	Canyon Crest Housing 797 & 799 Grape Street
519	P5020	CC Grape 801	672	620	Housing	3	-	Canyon Crest Housing 801 Grape Street
520	P5021	CC Grape 813	1,340	1,250	Housing	5	-	Canyon Crest Housing 813 & 815 Grape Street
521	P5022	CC Grape 829	672	620	Housing	3	-	Canyon Crest Housing 829 Grape Street
522	P5023	CC Grape 841	1,340	1,250	Housing	5	-	Canyon Crest Housing 841 & 843 Grape Street

TABLE 4.3—BUILDINGS REMOVED AS PART OF FUTURE EAST CAMPUS DEVELOPMENT (CONT.)

Ref #	CAAN	Name	OGSF50	ASF	Building Use	Demand in kW	Notes	LongName
523	P5024	CC Grape 873	672	620	Housing	3	-	Canyon Crest Housing 873 Grape Street
524	P5025	CC Grape 875	1,340	1,250	Housing	5	-	Canyon Crest Housing 875 & 879 Grape Street
525	P5026	CC Grape 766	672	620	Housing	3	-	Canyon Crest Housing 766 Grape Street
526	P5027	CC Grape 796	1,608	1,500	Housing	6	-	Canyon Crest Housing 796 & 798 Grape Street
527	P5028	CC Grape 802	1,608	1,500	Housing	6	-	Canyon Crest Housing 802 & 804 Grape Street
528	P5029	CC Grape 826	1,608	1,500	Housing	6	-	Canyon Crest Housing 826 & 828 Grape Street
529	P5030	CC Grape 840	1,608	1,500	Housing	6	-	Canyon Crest Housing 840 & 842 Grape Street
530	P5031	CC Grape 860	672	620	Housing	3	-	Canyon Crest Housing 860 Grape Street
531	P5032	CC Grape 870	672	620	Housing	3	-	Canyon Crest Housing 870 Grape Street
532	P5033	CC Cherr 801	1,608	1,500	Housing	6	-	Canyon Crest Housing 801 & 803 Cherry Street
533	P5034	CC Cherr 821	1,608	1,500	Housing	6	-	Canyon Crest Housing 821 & 823 Cherry Street
534	P5035	CC Cherr 841	1,608	1,500	Housing	6	-	Canyon Crest Housing 841 & 843 Cherry Street
535	P5036	CC Cherr 861	672	620	Housing	3	-	Canyon Crest Housing 861 Cherry Street
536	P5037	CC Cherr 871	672	620	Housing	3	-	Canyon Crest Housing 871 Cherry Street
537	P5038	CC Peach 810	672	620	Housing	3	-	Canyon Crest Housing 810 Peach Street
538	P5039	CC Peach 818	1,340	1,250	Housing	5	-	Canyon Crest Housing 818 & 820 Peach Street
539	P5040	CC Peach 848	1,340	1,250	Housing	5	-	Canyon Crest Housing 848 & 850 Peach Street
540	P5041	CC Peach 878	1,340	1,250	Housing	5	-	Canyon Crest Housing 878 & 880 Peach Street
541	P5042	CC Plum 811	672	620	Housing	3	-	Canyon Crest Housing 811 Plum Street
542	P5043	CC Plum 819	1,340	1,250	Housing	5	-	Canyon Crest Housing 819 & 821 Plum Street
543	P5044	CC Plum 849	1,340	1,250	Housing	5	-	Canyon Crest Housing 849 & 851 Plum Street
544	P5045	CC Plum 879	1,340	1,250	Housing	5	-	Canyon Crest Housing 879 & 881 Plum Street
545	P5046	CC Plum 806	1,608	1,500	Housing	6	-	Canyon Crest Housing 806 & 808 Plum Street
546	P5047	CC Plum 818	672	620	Housing	3	-	Canyon Crest Housing 818 Plum Street
547	P5048	CC Plum 822	672	620	Housing	3	-	Canyon Crest Housing 822 Plum Street
548	P5049	CC Plum 850	672	620	Housing	3	-	Canyon Crest Housing 850 Plum Street
549	P5050	CC Plum 860	672	620	Housing	3	-	Canyon Crest Housing 860 Plum Street
550	P5051	CC Plum 870	672	620	Housing	3	-	Canyon Crest Housing 870 Plum Street
551	P5052	CC Plum 880	672	625	Housing	3	-	Canyon Crest Housing 880 Plum Street
552	P5053	CC Plum 890	1,608	1,500	Housing	6	-	Canyon Crest Housing 890 & 892 Plum Street
553	P5054	CC Kent 3401	1,340	1,250	Housing	5	-	Canyon Crest Housing 3401 & 3407 Kentucky Avenue
554	P5055	CC Kent 3419	672	620	Housing	3	-	Canyon Crest Housing 3419 Kentucky Avenue
555	P5056	CC Kent 3433	672	620	Housing	3	-	Canyon Crest Housing 3433 Kentucky Avenue
556	P5058	CC Kent 3459	672	620	Housing	3	-	Canyon Crest Housing 3459 Kentucky Avenue
557	P5059	CC Kent 3461	1,608	1,500	Housing	6	-	Canyon Crest Housing 3461 & 3463 Kentucky Avenue
558	P5060	CC Kent 3479	672	620	Housing	3	-	Canyon Crest Housing 3479 Kentucky Avenue

TABLE 4.3—BUILDINGS REMOVED AS PART OF FUTURE EAST CAMPUS DEVELOPMENT (CONT.)

Ref #	CAAN	Name	OGSF50	ASF	Building Use	Demand in kW	Notes	LongName
559	P5061	CC Kent 3481	672	620	Housing	3	-	Canyon Crest Housing 3481 Kentucky Avenue
560	P5062	CC Kent 3489	672	620	Housing	3	-	Canyon Crest Housing 3489 Kentucky Avenue
561	P5063	CC Kent 3380	1,340	1,250	Housing	5	-	Canyon Crest Housing 3380 & 3382 Kentucky Avenue
562	P5064	CC Kent 3400	672	620	Housing	3	-	Canyon Crest Housing 3400 Kentucky Avenue
563	P5065	CC Kent 3408	672	620	Housing	3	-	Canyon Crest Housing 3408 Kentucky Avenue
564	P5066	CC Kent 3420	672	620	Housing	3	-	Canyon Crest Housing 3420 Kentucky Avenue
565	P5067	CC Kent 3434	672	620	Housing	3	-	Canyon Crest Housing 3434 Kentucky Avenue
566	P5068	CC Kent 3446	672	620	Housing	3	-	Canyon Crest Housing 3446 Kentucky Avenue
567	P5069	CC Kent 3460	1,340	1,250	Housing	5	-	Canyon Crest Housing 3460 & 3462 Kentucky Avenue
568	P5070	CC Kent 3480	1,608	1,500	Housing	6	-	Canyon Crest Housing 3480 & 3488 Kentucky Avenue
569	P5071	CC Flor 3403	672	620	Housing	3	-	Canyon Crest Housing 3403 Florida Avenue
570	P5072	CC Flor 3415	672	620	Housing	3	-	Canyon Crest Housing 3415 Florida Avenue
571	P5073	CC Flor 3429	672	620	Housing	3	-	Canyon Crest Housing 3429 Florida Avenue
572	P5074	CC Flor 3445	672	620	Housing	3	-	Canyon Crest Housing 3445 Florida Avenue
573	P5075	CC Flor 3459	672	620	Housing	3	-	Canyon Crest Housing 3459 Florida Avenue
574	P5076	CC Flor 3475	1,340	1,250	Housing	5	-	Canyon Crest Housing 3475 & 3479 Florida Avenue
575	P5077	CC Flor 3481	1,608	1,500	Housing	6	-	Canyon Crest Housing 3481 & 3489 Florida Avenue
576	P5078	CC Flor 3402	1,608	1,500	Housing	6	-	Canyon Crest Housing 3402 & 3404 Florida Avenue
577	P5079	CC Flor 3408	1,340	1,250	Housing	5	-	Canyon Crest Housing 3408 & 3416 Florida Avenue
578	P5080	CC Flor 3430	1,608	1,500	Housing	6	-	Canyon Crest Housing 3430 & 3432 Florida Avenue
579	P5081	CC Flor 3458	1,340	1,250	Housing	5	-	Canyon Crest Housing 3458 & 3460 Florida Avenue
580	P5082	CC Idah 3323	1,340	1,250	Housing	5	-	Canyon Crest Housing 3323 & 3325 Idaho Avenue
581	P5083	CC Idah 3333	1,608	1,500	Housing	6	-	Canyon Crest Housing 3329 & 3333 Idaho Avenue
582	P5084	CC Idah 3339	1,608	1,500	Housing	6	-	Canyon Crest Housing 3339 & 3341 Idaho Avenue
583	P5085	CC Idah 3359	1,608	1,500	Housing	6	-	Canyon Crest Housing 3359 & 3361 Idaho Avenue
584	P5086	CC Idah 3369	1,608	1,500	Housing	6	-	Canyon Crest Housing 3369 & 3371 Idaho Avenue
585	P5087	CC Idah 3379	1,340	1,250	Housing	5	-	Canyon Crest Housing 3379 & 3381 Idaho Avenue
586	P5088	CC Idah 3397	1,340	1,250	Housing	5	-	Canyon Crest Housing 3397 & 3399 Idaho Avenue
587	P5089	CC Idah 3324	1,340	1,250	Housing	5	-	Canyon Crest Housing 3324 & 3326 Idaho Avenue
588	P5090	CC Idah 3330	672	620	Housing	3	-	Canyon Crest Housing 3330 Idaho Avenue
589	P5091	CC Idah 3334	672	620	Housing	3	-	Canyon Crest Housing 3334 Idaho Avenue
590	P5092	CC Idah 3340	672	620	Housing	3	-	Canyon Crest Housing 3340 Idaho Avenue
591	P5093	CC Idah 3344	672	620	Housing	3	-	Canyon Crest Housing 3344 Idaho Avenue
592	P5094	CC Idah 3360	672	620	Housing	3	-	Canyon Crest Housing 3360 Idaho Avenue
593	P5095	CC Idah 3364	672	620	Housing	3	-	Canyon Crest Housing 3364 Idaho Avenue
594	P5096	CC Idah 3370	672	620	Housing	3	-	Canyon Crest Housing 3370 Idaho Avenue

TABLE 4.3—BUILDINGS REMOVED AS PART OF FUTURE EAST CAMPUS DEVELOPMENT (CONT.)

Ref #	CAAN	Name	OGSF50	ASF	Building Use	Demand in kW	Notes	LongName
595	P5097	CC Idah 3374	672	620	Housing	3	-	Canyon Crest Housing 3374 Idaho Avenue
596	P5098	CC Idah 3380	672	620	Housing	3	-	Canyon Crest Housing 3380 Idaho Avenue
597	P5099	CC Idah 3384	672	620	Housing	3	-	Canyon Crest Housing 3384 Idaho Avenue
598	P5100	CC Idah 3388	672	620	Housing	3	-	Canyon Crest Housing 3388 Idaho Avenue
599	P5101	CC Idah 3392	672	620	Housing	3	-	Canyon Crest Housing 3392 Idaho Avenue
600	P5102	CC Idah 3398	672	620	Housing	3	-	Canyon Crest Housing 3398 Idaho Avenue
601	P5103	CC Utah 3315	1,340	1,250	Housing	5	-	Canyon Crest Housing 3315 & 3317 Utah Avenue
602	P5104	CC Utah 3321	1,608	1,500	Housing	6	-	Canyon Crest Housing 3321 & 3323 Utah Avenue
603	P5105	CC Utah 3327	1,608	1,500	Housing	6	-	Canyon Crest Housing 3327 & 3329 Utah Avenue
604	P5106	CC Utah 3333	672	620	Housing	3	-	Canyon Crest Housing 3333 Utah Avenue
605	P5107	CC Utah 3337	672	620	Housing	3	-	Canyon Crest Housing 3337 Utah Avenue
606	P5108	CC Utah 3341	672	620	Housing	3	-	Canyon Crest Housing 3341 Utah Avenue
607	P5109	CC Utah 3351	1,340	1,250	Housing	5	-	Canyon Crest Housing 3351 & 3353 Utah Avenue
608	P5110	CC Utah 3359	672	620	Housing	3	-	Canyon Crest Housing 3359 Utah Avenue
609	P5111	CC Utah 3363	672	620	Housing	3	-	Canyon Crest Housing 3363 Utah Avenue
610	P5112	CC Utah 3367	672	620	Housing	3	-	Canyon Crest Housing 3367 Utah Avenue
611	P5113	CC Utah 3375	672	620	Housing	3	-	Canyon Crest Housing 3375 Utah Avenue
612	P5114	CC Utah 3379	672	620	Housing	3	-	Canyon Crest Housing 3379 Utah Avenue
613	P5115	CC Utah 3385	672	620	Housing	3	-	Canyon Crest Housing 3385 Utah Avenue
614	P5116	CC Utah 3391	672	620	Housing	3	-	Canyon Crest Housing 3391 Utah Avenue
615	P5117	CC Utah 3395	1,340	1,250	Housing	5	-	Canyon Crest Housing 3395 & 3397 Utah Avenue
616	P5118	CC Utah 3304	672	625	Housing	3	-	Canyon Crest Housing 3304 Utah Avenue
617	P5119	CC Utah 3308	672	620	Housing	3	-	Canyon Crest Housing 3308 Utah Avenue
618	P5120	CC Utah 3312	1,608	1,500	Housing	6	-	Canyon Crest Housing 3312 & 3314 Utah Avenue
619	P5121	CC Utah 3318	672	620	Housing	3	-	Canyon Crest Housing 3318 Utah Avenue
620	P5122	CC Utah 3322	1,340	1,250	Housing	5	-	Canyon Crest Housing 3322 & 3324 Utah Avenue
621	P5123	CC Utah 3328	1,340	1,250	Housing	5	-	Canyon Crest Housing 3328 & 3330 Utah Avenue
622	P5124	CC Utah 3334	672	620	Housing	3	-	Canyon Crest Housing 3334 Utah Avenue
623	P5125	CC Utah 3338	672	620	Housing	3	-	Canyon Crest Housing 3338 Utah Avenue
624	P5126	CC Utah 3342	1,340	1,250	Housing	5	-	Canyon Crest Housing 3342 & 3344 Utah Avenue
625	P5127	CC Utah 3346	672	620	Housing	3	-	Canyon Crest Housing 3346 Utah Avenue
626	P5128	CC Utah 3348	672	620	Housing	3	-	Canyon Crest Housing 3348 Utah Avenue
627	P5129	CC Utah 3350	672	620	Housing	3	-	Canyon Crest Housing 3350 Utah Avenue
628	P5130	CC Utah 3352	672	620	Housing	3	-	Canyon Crest Housing 3352 Utah Avenue
629	P5131	CC Utah 3354	1,340	1,250	Housing	5	-	Canyon Crest Housing 3354 & 3356 Utah Avenue
630	P5132	CC Utah 3360	672	620	Housing	3	-	Canyon Crest Housing 3360 Utah Avenue

TABLE 4.3—BUILDINGS REMOVED AS PART OF FUTURE EAST CAMPUS DEVELOPMENT (CONT.)

Ref #	CAAN	Name	OGSF50	ASF	Building Use	Demand in kW	Notes	LongName
631	P5133	CC Utah 3364	672	620	Housing	3	-	Canyon Crest Housing 3364 Utah Avenue
632	P5134	CC Utah 3368	672	620	Housing	3	-	Canyon Crest Housing 3368 Utah
633	P5135	CC Utah 3372	672	620	Housing	3	-	Canyon Crest Housing 3372 Utah
634	P5136	CC Utah 3376	672	620	Housing	3	-	Canyon Crest Housing 3376 Utah
635	P5137	CC Utah 3380	672	620	Housing	3	-	Canyon Crest Housing 3380 Utah
636	P5138	CC Utah 3384	672	620	Housing	3	-	Canyon Crest Housing 3384 Utah
637	P5139	CC Utah 3388	672	620	Housing	3	-	Canyon Crest Housing 3388 Utah
638	P5140	CC Utah 3392	672	620	Housing	3	-	Canyon Crest Housing 3392 Utah
639	P5141	CC Utah 3396	1,340	1,250	Housing	5	-	Canyon Crest Housing 3396 Utah
640	P5142	CC Avoc 3401	1,340	1,250	Housing	5	-	Canyon Crest Housing 3401 & 3403 Avocado Avenue
641	P5143	CC Avoc 3411	1,608	1,500	Housing	6	-	Canyon Crest Housing 3411 & 3413 Avocado Avenue
642	P5144	CC Avoc 3423	1,340	1,250	Housing	5	-	Canyon Crest Housing 3421 & 3423 Avocado Avenue
643	P5145	CC Avoc 3433	672	620	Housing	3	-	Canyon Crest Housing 3433 Avocado Avenue
644	P5146	CC Avoc 3445	672	620	Housing	3	-	Canyon Crest Housing 3445 Avocado Avenue
645	P5147	CC Avoc 3449	1,608	1,500	Housing	6	-	Canyon Crest Housing 3449 & 3451 Avocado Avenue
646	P5148	CC Avoc 3455	672	620	Housing	3	-	Canyon Crest Housing 3455 Avocado Avenue
647	P5149	CC Avoc 3459	1,608	1,500	Housing	6	-	Canyon Crest Housing 3459 & 3461 Avocado Avenue
648	P5150	CC Avoc 3465	1,340	1,250	Housing	5	-	Canyon Crest Housing 3465 & 3467 Avocado Avenue
649	P5151	CC Avoc 3471	1,340	1,250	Housing	5	-	Canyon Crest Housing 3471 & 3473 Avocado Avenue
650	P5152	CC Avoc 3477	1,608	1,500	Housing	6	-	Canyon Crest Housing 3477 & 3479 Avocado Avenue
651	P5153	CC Avoc 3483	1,340	1,250	Housing	5	-	Canyon Crest Housing 3483 & 3485 Avocado Avenue
652	P5154	CC Avoc 3489	1,340	1,250	Housing	5	-	Canyon Crest Housing 3489 & 3491 Avocado Avenue
653	P5155	CC Avoc 3495	1,608	1,500	Housing	6	-	Canyon Crest Housing 3495 & 3497 Avocado Avenue
654	P5156	CC Avoc 3402	1,340	1,250	Housing	5	-	Canyon Crest Housing 3402 & 3404 Avocado Avenue
655	P5157	CC Avoc 3408	672	620	Housing	3	-	Canyon Crest Housing 3408 Avocado Avenue
656	P5158	CC Avoc 3412	1,608	1,500	Housing	6	-	Canyon Crest Housing 3412 & 3414 Avocado Avenue
657	P5159	CC Avoc 3418	672	620	Housing	3	-	Canyon Crest Housing 3418 Avocado Avenue
658	P5160	CC Avoc 3422	1,340	1,250	Housing	5	-	Canyon Crest Housing 3422 & 3424 Avocado Avenue
659	P5161	CC Avoc 3428	1,340	1,250	Housing	5	-	Canyon Crest Housing 3428 & 3430 Avocado Avenue
660	P5162	CC Avoc 3436	1,340	1,250	Housing	5	-	Canyon Crest Housing 3436 & 3438 Avocado Avenue
661	P5163	CC Avoc 3442	1,340	1,250	Housing	5	-	Canyon Crest Housing 3442 & 3444 Avocado Avenue
662	P5164	CC Avoc 3446	672	620	Housing	3	-	Canyon Crest Housing 3446 Avocado Avenue
663	P5165	CC Avoc 3448	1,608	1,500	Housing	6	-	Canyon Crest Housing 3448 & 3450 Avocado Avenue
664	P5166	CC Avoc 3452	672	620	Housing	3	-	Canyon Crest Housing 3452 Avocado Avenue
665	P5167	CC Avoc 3454	1,340	1,250	Housing	5	-	Canyon Crest Housing 3454 & 3456 Avocado Avenue
666	P5168	CC Avoc 3460	1,608	1,500	Housing	6	-	Canyon Crest Housing 3460 & 3462 Avocado Avenue

TABLE 4.3—BUILDINGS REMOVED AS PART OF FUTURE EAST CAMPUS DEVELOPMENT (CONT.)

Ref #	CAAN	Name	OGSF50	ASF	Building Use	Demand in kW	Notes	LongName
667	P5169	CC Avoc 3466	1,340	1,250	Housing	5	-	Canyon Crest Housing 3466 & 3468 Avocado Avenue
668	P5170	CC Avoc 3472	1,340	1,250	Housing	5	-	Canyon Crest Housing 3472 & 3474 Avocado Avenue
669	P5171	CC Avoc 3478	1,608	1,500	Housing	6	-	Canyon Crest Housing 3478 & 3480 Avocado Avenue
670	P5172	CC Avoc 3484	1,340	1,250	Housing	5	-	Canyon Crest Housing 3484 & 3486 Avocado Avenue
671	P5173	CC Avoc 3490	1,340	1,250	Housing	5	-	Canyon Crest Housing 3490 & 3492 Avocado Avenue
672	P5174	CC Avoc 3498	2,481	1,883	Housing	10	-	Canyon Crest Housing 3498 Avocado Avenue
673	P5175	CC LIND 687	1,340	1,250	Housing	5	-	Canyon Crest Housing 687 Linden Street
674	P5176	CC LIND 691	1,352	1,250	Institutional Operations	7	-	Canyon Crest Housing 691 & 693 Linden Street
675	P5177	CC LIND 721	1,340	1,250	Housing	5	-	Canyon Crest Housing 721 & 723 Linden Street
676	P5178	CC LIND 731	1,340	1,250	Housing	5	-	Canyon Crest Housing 731 & 733 Linden Street
677	P5179	CC LIND 741	1,608	1,500	Housing	6	-	Canyon Crest Housing 741 & 743 Linden Street
678	P5180	CC LIND 747	1,608	1,500	Housing	6	-	Canyon Crest Housing 747 & 749 Linden Street
679	P5181	CC LIND 753	1,608	1,500	Housing	6	-	Canyon Crest Housing 753 & 755 Linden Street
680	P5182	CC Flor 3406	905	865	Housing	4	-	Canyon Crest Housing 3406 Florida Avenue
681	P5183	CC Utah 3358	1,548	1,450	Housing	6	-	Canyon Crest Housing 3358 Utah Avenue
682	P5185	CC Kent 3381	4,185	3,306	Housing	17	-	Canyon Crest Housing 3381 Kentuck Avenue
683	P5200	GH09	4,928	4,570	Research/Academic Support	25	-	Greenhouse #9
684	P5205	Univ Off Bldg	20,288	13,150	Administration	101	University Office Building	University Office Building
685	P5210	GH15	5,295	4,918	Research/Academic Support	26	-	Greenhouse #15
686	P5231	Coll Bldg So	8,718	4,984	Administration	44	-	College Building South
687	P5253	Mail	3,095	2,612	Institutional Operations	15	-	Mail Building
688	P5263	Univ Lab Bldg	13,432	8,239	Academic	67	-	University Laboratory Building
689	P5266	T9A	400	384	Research/Academic Support	2	Trailer - unknown use	0
690	P5275	GH06	4,831	4,789	Research/Academic Support	24	-	Greenhouse #6
691	P5276	GH07	5,094	4,707	Research/Academic Support	25	-	Greenhouse #7
692	P5277	GH08	4,665	4,601	Research/Academic Support	23	-	Greenhouse #8
693	P5278	GH10	5,138	4,468	Research/Academic Support	26	-	Greenhouse #10
694	P5279	GH11	4,940	4,474	Research/Academic Support	25	-	Greenhouse #11
695	P5280	GH12	4,919	4,586	Research/Academic Support	25	-	Greenhouse #12
696	P5281	GH13	4,938	4,473	Research/Academic Support	25	-	Greenhouse #13
697	P5282	GH21	4,940	4,693	Research/Academic Support	25	-	Greenhouse #21
698	P5284	GH16	4,886	4,551	Research/Academic Support	24	-	Greenhouse #16
699	P5305	SPI	2,515	1,815	Academic	13	-	Stored Products Insecticide Building
700	P5326	Cobalt 60	480	441	Academic	2	-	Cobalt 60 Building #38
701	P5334	Ath Dance	68,607	41,337	Athletics/Recreation	343	-	Athletics And Dance Building
702	P5348	Whse 2	4,000	3,950	Institutional Operations	20	-	Warehouse #2

TABLE 4.3—BUILDINGS REMOVED AS PART OF FUTURE EAST CAMPUS DEVELOPMENT (CONT.)

Ref #	CAAN	Name	OGSF50	ASF	Building Use	Demand in kW	Notes	LongName
703	P5376	T CNAS	1,377	1,297	Research/Academic Support	7	Two Trailers: T CNAS and T Antro	Trailer CNAS (Surge Trailer)
704	P5381	C&C Center	21,990	16,399	Institutional Operations	110	-	Computing & Communications Center
705	P5382	C&C Carport	540	456	Institutional Operations	3	-	0
706	P5384	Res Val Hall	2,289	1,806	Institutional Operations	11	-	Residence Valencia Hill Drive
707	P5385	T Biomed1	2,160	1,969	Research/Academic Support	11	-	Trailer Biomedical Sciences #1
708	P5387	T Vivaria	1,938	1,426	Research/Academic Support	10	-	Vivaria Trailer
709	P5402	Arab 1	216	200	Research/Academic Support	1	-	Arabidopsis 1
710	P5422	GH5	233	208	Research/Academic Support	1	-	Glasshouse Field 8, Air Pollution
711	P5423	GH4	233	208	Research/Academic Support	1	-	Glasshouse Field 7, Air Pollution
712	P5425	Lath 3	10,234	10,156	Research/Academic Support	51	-	Lathhouse #3
713	P5427	Soil Bldg	557	152	Research/Academic Support	3	-	Soil Facility Building
714	P5476	T Anthrop	1,377	1,252	Research/Academic Support	7	Two Trailers:	Trailer Anthropology (Surge Trailer)
715	P5478	GH AP FL3	318	300	Research/Academic Support	2	-	Glasshouse Field 3, Air Pollution
716	P5479	GH AP FL2	318	300	Research/Academic Support	2	-	Glasshouse Field 2, Air Pollution
717	P5481	GH14	4,623	4,049	Research/Academic Support	23	-	Greenhouse #14
718	P5481	GH14	4,623	4,049	Research/Academic Support	23	-	Greenhouse #14
719	P5482	Boyden Lab	6,434	4,490	Academic	32	-	Patrick Boyden Laboratory
720	P5483	GH17	4,886	4,518	Research/Academic Support	24	-	Greenhouse 17
721	P5495	Health Serv	23,362	14,117	Student Services	117	-	Health Service Building
722	P5503	Fawcett Lab	21,787	14,694	Academic	109	-	Howard Samuel Fawcett Laboratory
723	P5506	Cold BX Roof	1,233	1,104	Research/Academic Support	6	Arabadopsis	0
724	P5507	Cust and Grd	7,269	5,887	Institutional Operations	36	-	Custodial & Grounds Building
725	P5509	T7 AP	1,212	1,008	Research/Academic Support	6	-	Trailer #7 Air Pollution
726	P5513	GH18	4,939	4,535	Research/Academic Support	25	-	Greenhouse #18
727	P5514	GH19	4,902	4,625	Research/Academic Support	25	-	Greenhouse #19
728	P5515	GH20	4,906	4,581	Research/Academic Support	25	-	Greenhouse #20
729	P5517	Coll Bldg No	10,095	6,594	Administration	50	-	College Building North
730	P5533	CC Avoc 3458	2,685	2,500	Housing	11	-	Canyon Crest Housing 3458 Avocado Avenue
731	P5535	Lath B	12,316	11,740	Research/Academic Support	62	-	Lathhouse B
732	P5537	Stu Rec Annx	800	750	Athletics/Recreation	4	-	Student Recreation Annex
733	P5561	T Biomed2	2,160	1,915	Research/Academic Support	11	-	Biomedical Sciences Unit 2 Trailer
734	P5590	Bannock A	17,418	13,528	Housing	70	-	Bannockburn Village Bldg A
735	P5591	Bannock B	3,804	3,120	Housing	15	-	Bannockburn Village Bldg B
736	P5592	Bannock C	4,525	3,855	Housing	18	-	Bannockburn Village Bldg C
737	P5593	Bannock D	6,608	6,115	Housing	26	-	Bannockburn Village Bldg D

TABLE 4.3—BUILDINGS REMOVED AS PART OF FUTURE EAST CAMPUS DEVELOPMENT (CONT.)

Ref #	CAAN	Name	OGSF50	ASF	Building Use	Demand in kW	Notes	LongName
738	P5594	Bannock E	8,686	7,312	Housing	35	-	Bannockburn Village Bldg E
739	P5595	Bannock F	8,694	7,044	Housing	35	-	Bannockburn Village Bldg F
740	P5596	Bannock G	8,624	6,763	Housing	34	-	Bannockburn Village Bldg G
741	P5597	Bannock H	8,596	7,238	Housing	34	-	Bannockburn Village Bldg H
742	P5598	Bannock I	8,596	7,677	Housing	34	-	Bannockburn Village Bldg I
743	P5599	Bannock J	11,733	9,238	Housing	47	-	Bannockburn Village Bldg J
744	P5600	Bannock K	4,235	3,422	Housing	17	-	Bannockburn Village Bldg K
745	P5601	Bannock L	12,636	9,706	Housing	51	-	Bannockburn Village Bldg L
746	P5602	Bannock M	1,929	1,736	Housing	8	-	Bannockburn Village Bldg M
747	P5603	Bannock N	4,272	3,600	Housing	17	-	Bannockburn Village Bldg M
748	P5604	Bannock O	4,272	3,600	Housing	17	-	Bannockburn Village Bldg O
749	P5605	Bannock P	4,328	3,600	Housing	17	-	Bannockburn Village Bldg P
750	P5606	Bannock Q	8,126	6,490	Housing	33	-	Bannockburn Village Bldg Q
751	P5607	Bannock R	8,602	7,200	Housing	34	-	Bannockburn Village Bldg R
752	P5608	Bannock S	17,202	14,400	Housing	69	-	Bannockburn Village Bldg S
753	P5609	Bannock T	8,602	7,200	Housing	34	-	Bannockburn Village Bldg T
754	P5610	Bannock U	12,873	10,800	Housing	51	-	Bannockburn Village Bldg U
755	P5611	Bannock V	17,202	14,400	Housing	69	-	Bannockburn Village Bldg V
756	P5671	Falkirk 1	15,957	13,294	Housing	64	-	Falkirk Apartments 1
757	P5672	Falkirk 2	14,705	12,423	Housing	59	-	Falkirk Apartments 2
758	P5673	Falkirk 3	11,219	9,813	Housing	45	-	Falkirk Apartments 3
759	P5674	Falkirk 4	11,064	9,918	Housing	44	-	Falkirk Apartments 4
760	P5675	Falkirk 5	14,715	12,366	Housing	59	-	Falkirk Apartments 5
761	P5676	Falkirk 6	14,788	12,696	Housing	59	-	Falkirk Apartments 6
762	P5677	Falkirk 7	11,061	9,746	Housing	44	-	Falkirk Apartments 7
763	P5678	Falkirk 8	5,619	4,942	Housing	22	-	Falkirk Apartments 8
764	P5679	Falkirk 9	15,917	13,114	Housing	64	-	Falkirk Apartments 9
765	P5680	Falkirk 10	7,910	6,620	Housing	32	-	Falkirk Apartments 10
766	P5681	Falkirk 11	11,112	9,739	Housing	44	-	Falkirk Apartments 11
767	P5682	Falkirk 12	15,914	13,190	Housing	64	-	Falkirk Apartments 12
768	P5683	Falkirk 13	7,411	6,248	Housing	30	-	Falkirk Apartments 13
769	P5684	Falkirk 14	11,016	4,139	Housing	44	-	Falkirk Apartments 14
770	P5685	Falkirk 15	12,220	6,116	Housing	49	-	Falkirk Apartments 15
771	P5686	Falkirk 16	14,884	5,863	Housing	60	-	Falkirk Apartments 16
772	P5687	Falkirk 17	4,450	2,086	Housing	18	-	Falkirk Apartments 17
773	P5688	Falkirk 18	5,775	2,086	Housing	23	-	Falkirk Apartments 18

TABLE 4.3—BUILDINGS REMOVED AS PART OF FUTURE EAST CAMPUS DEVELOPMENT (CONT.)

Ref #	CAAN	Name	OGSF50	ASF	Building Use	Demand in kW	Notes	LongName
774	P5689	Falkirk 19	6,984	2,499	Housing	28	-	Falkirk Apartments 19
775	P5690	Falkirk LR1	263	263	Housing	1	-	Falkirk Apartments Laundry Room 1
776	P5691	Falkirk LR2	263	263	Housing	1	-	Falkirk Apartments Laundry Room2
777	P5692	Falkirk LR3	263	263	Housing	1	-	Falkirk Apartments Laundry Room 3
778	P5693	Falkirk OFF	601	445	Housing	2	-	Falkirk Apartments Office
779	P5694	Falkirk MOD	336	277	Housing	1	-	Falkirk Apartments Model 3h
	280	Total	944,117	756,434		4,113		
Loads Currently on 12kV/4.16kV System						1,548		
Loads Currently on a Dedicated RPU Service						2,565		

An analysis of the current 12.47kV and 4.16kV system and the additional demand that is being added on to these systems as a result of new facilities being added as part of the master plan revealed the following:

- The existing 12.47kV and 4.16kV systems have limited feeder capacities to handle the total load of the new facilities being added as part of the master plan.
- There are limited feeder breakers (space for one additional breaker in each 12kV section) available to serve the demands of additional loads being proposed as part of the master plan.
- The current 67/12.47kV, 26.88MVA and 67/4.16kV, 3.75/5.25MVA transformers owned by the utility company and currently serving the 12.47kV and 4.16kV systems at the campus are not adequately sized to meet the loads of the campus and provide redundancy at the same time if one of the transformer fails during the peak demand period.
- There are limited duct banks available between the west and east side of the campus (currently installed under the freeway) to provide additional 15kV feeders between the 12.47kV switchgear section and the east campus to serve future loads at the campus. A de-rating study of the feeders in duct banks installed underneath the freeway revealed that the current feeders will be de-rated to about 65% at a load factor of 100%. Provision of additional 15kV duct banks and feeders underneath the freeway will be difficult and cumbersome and will further result in de-rating of the existing/new 15kV feeders.
- Although majority of the existing facilities have dual 15kV feeds, additional duct banks will need to be provided to provide dual feeders to each of the proposed facilities planned as part of the master plan.
- Standardization of electrical equipment (15kV feeders, 15kV switches) is required to reduce maintenance costs at the campus.

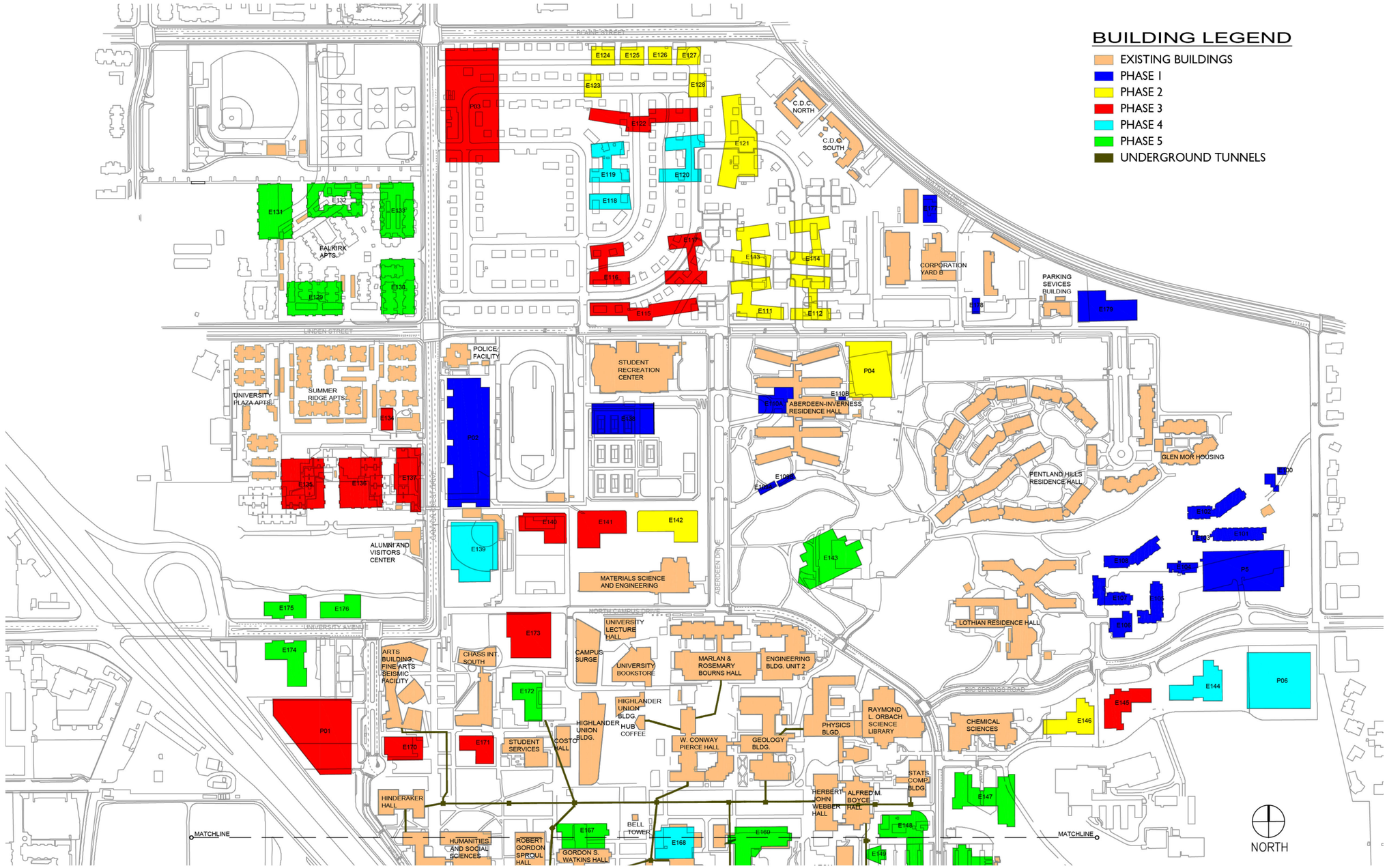


Figure 4.1—East Campus Development Future Buildings–North

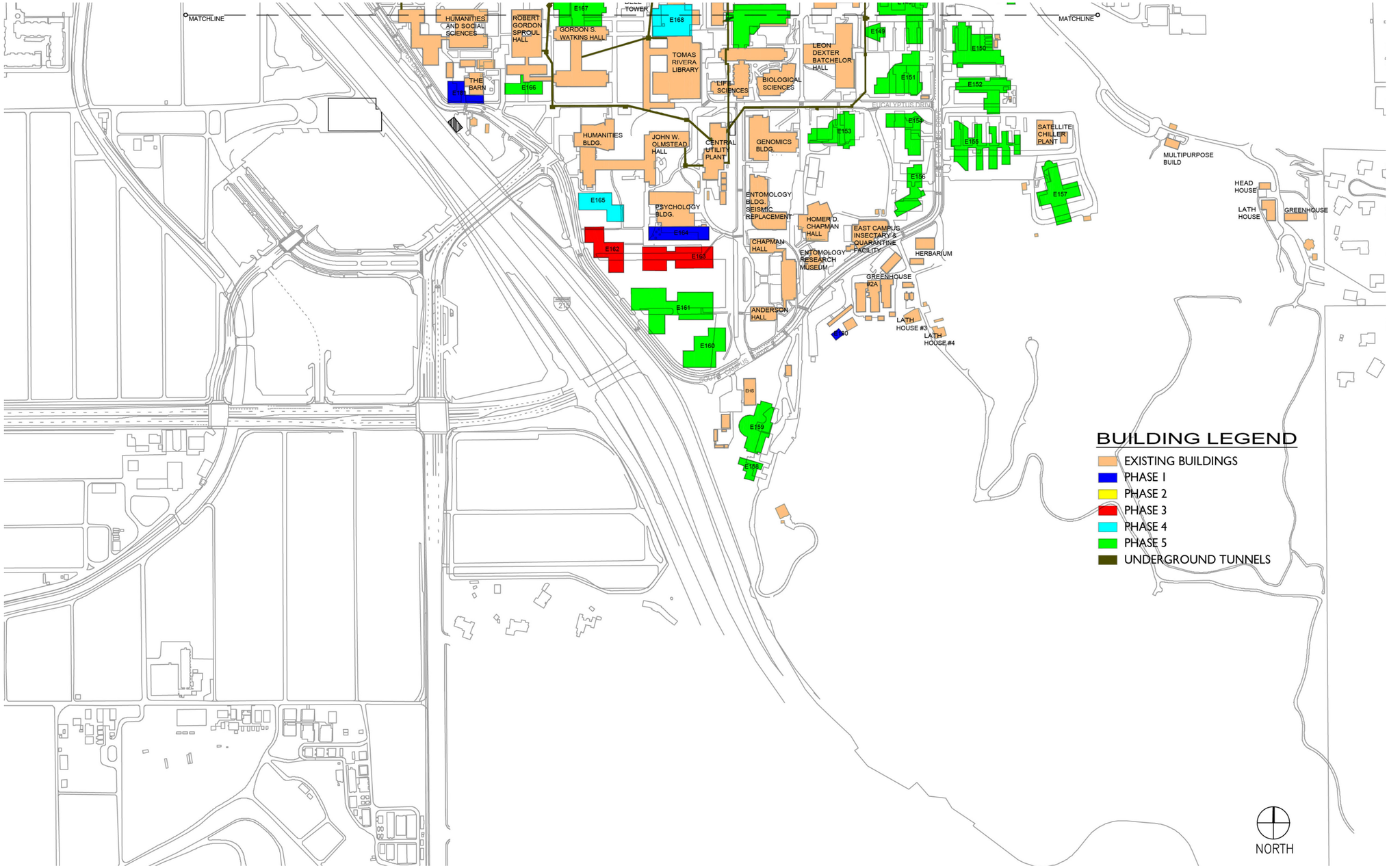


Figure 4.2—East Campus Development Future Buildings–South

Chapter 5—Findings and Recommendations

Chapter 5—Findings and Recommendations

An analysis of the current 12.47kV and 4.16kV system and the projected future demand that is associated with proposed facilities being added as part of the East Campus Development Plan revealed the following:

- The existing 12.47kV and 4.16kV systems have limited feeder capacities to handle the total load of the new facilities being added as part of the development plan.
- There are limited feeder breakers (space for one additional breaker in each 12kV section) available to serve the demands of additional loads being proposed as part of the campus development plan.
- The current 67/12.47kV, 26.88MVA and 67/4.16kV, 3.75/5.25MVA transformers located at the University substation that currently serve the 12.47kV and 4.16kV campus distribution systems are not adequately sized to meet the loads and provide redundancy in the event that the transformer fails during the peak demand period.
- There are limited duct banks available between the west and east side of the campus (currently installed under the freeway) to provide additional 15kV feeders between the 12.47kV switchgear section and the east campus to serve future loads at the campus. A de-rating study of the feeders in duct banks installed underneath the freeway revealed that the current feeders will be de-rated to about 65% at a load factor of 100%. Provision of additional 15kV duct banks and feeders underneath the freeway will be difficult and cumbersome and will further result in de-rating of the existing/new 15kV feeders.
- Although majority of the existing facilities have dual 15kV feeds, additional duct banks will need to be provided to provide dual feeders to each of the proposed facilities planned as part of the east campus development plan.
- Standardization of electrical equipment (15kV feeders, 15kV switches) is required to reduce maintenance costs at the campus.

Based on the analysis of the existing systems and future facilities being added to the campus, following are our recommendations for serving the existing and future facilities as they are being added on in various phases to the existing campus electrical distribution system. These recommendations are geared towards:

(a) Improving system reliability and redundancy

(b) providing ease of maintenance and isolation of circuits either during a fault or during a regular maintenance without interrupting power to every building on campus

(c) to providing adequate capacity of feeders to accommodate existing loads and planned future loads resulting from new buildings addition as well as additions to existing buildings

(d) be well coordinated to eliminate nuisance tripping of upstream protective devices and

(e) having all equipment listed for the short circuit availability at the point of installation.

- Add a third utility transformer in the vicinity of the existing 67-12.47kV transformers located at the university substation, and provide a new third 12.47kV switchgear section in the vicinity of the existing 12.47kV switchgear to supplement the existing two 12.47kV switchgear sections currently serving the campus and located in the modular building on the west side of the campus. The new utility transformer shall be rated at 67-12.47kV, 26.88MVA and shall serve this new third switchgear section. This increase in capacity will help the campus meet the loads of the future facilities and provide redundancy at the same time if one of the utility transformer or a switchgear section fails during the peak demand period.

- Provide a new three section 15kV switchgear with a main 2000A breaker and (6) 1200A feeder breakers per section with two spare sections. Locate the switchgear on the east side of the freeway near Parking Lot 4 in a block building of approximately 3500sqft. Serve each of the new switchgear sections (three in number) with (3) sets of 15kV, 133% 750kcmil EPR cables from a breaker in each section of the main 12.47kV switchgear section located on the west side of the campus. These new feeders will be routed in existing duct banks currently located underneath the freeway. The provision of this new 15kV switchgear section will provide ease of adding feeders on the east side of the campus as future facilities are added in various phases without having the need to replace the existing switchgear to add additional feeder breaker sections and additional duct banks underneath the freeway to accommodate additional feeders. The provision of this new switchgear section will also alleviate the de-rating affect currently being experienced by cables in duct banks located underneath the freeway.

- Provide new sets of 15kV, 133%, 500kcmil EPR feeders from this new switchgear sections to serve existing and future facilities being added in various phases at the campus. Existing feeders as depicted in Chapter 6 will be used to serve the power needs of facilities in Phase 1. Existing feeders will be intercepted by new feeders from new 15kV switchgear sections to retain service to existing facilities on campus. The existing pathways shown on the plans will need to be evaluated in detail for reuse during the design phase of the project. A combination of existing duct banks, tunnel system and new pathways will be utilized to route new feeders to all facilities on campus as they are added in various phases.

- New 15kV air selector switches will be provided for each of the new proposed facilities and dual feeders will be routed to each of the these switches to provide a primary selective system at the campus. Each switch will be provided with dual feeders to provide redundancy and a radial feeder originating from the switch will serve the facility.

- All buildings on campus equipped with old oil fused cutouts that have low short circuit availability and could result in failures in event of a short circuit on the 5kV and 12kV system be replaced with 15kV Fused LIS Switches.

- All buildings on campus equipped with leaking SF6 switches shall be replaced with new air switches.

- Provide phased replacement of existing 4.16kV system by providing new substations in each of the buildings listed with 4.16kV service and extending new 12kV service to each of these facilities.

- All equipment (15kV feeders, 15kV switches) shall be provided per our recommendations and specifications provided in Chapter 7 in an effort to standardize and reduce maintenance costs for the campus.

- An arc flash analysis of the electrical system be conducted to verify the available short circuit at each of the substations and label each equipment based on available short circuit current and class of protective clothing required to operate on the system.

- Sub meters are recommended at each building to monitor consumption.

Proposed single line diagram and a site plan showing allocation of feeder circuits is provided at the end of the section.

Table 5.1 provides a list of facilities being added in each of the phases along with installed capacities, demand and feeder designations is provided below: Phased Implementation of our above recommendations is provided in Chapter 6. Costs associated with each of our phased recommendations are provided in Chapter 8.

TABLE 5.1—ANALYSIS OF FUTURE BUILDING LOADS

Ref #	Site ID	Name	GSF	Parking Spaces	Proposed Building Use	Demand in kW	Feeder Designations	Comments
					Phase 1—2011-2014			
1	E100	Glen Mor 2 (Bldg N)	4,700	-	Housing	19	Feeder 3A, 3B (4B, 4C)	
2	E101	Glen Mor 2 (Bldg L)	0	-	Housing	0	Feeder 3A, 3B (4B, 4C)	
3	E102	Glen Mor 2 (Bldg M)	0	-	Housing	0	Feeder 3A, 3B (4B, 4C)	
4	E103	Glen Mor 2 (Bldg K)	6,000	-	Housing	24	Feeder 3A, 3B (4B, 4C)	
5	E104	Glen Mor 2 (Bldg J)	10,800	-	Housing	43	Feeder 3A, 3B (4B, 4C)	
6	E105	Glen Mor 2 (Bldg I)	0	-	Housing	0	Feeder 3A, 3B (4B, 4C)	
7	E106	Glen Mor 2 (Bldg H)	8,400	-	Housing	34	Feeder 3A, 3B (4B, 4C)	
8	E107	Glen Mor 2 (Bldg G)	0	-	Housing	0	Feeder 3A, 3B (4B, 4C)	
9	E108	Glen Mor 2 (Bldgs F)	338,900	-	Housing	1356	Feeder 3A, 3B (4B, 4C)	GSF includes Bldgs F, G, I, L, M
10	E109A	A-I Staff/Faculty 1	4,956	-	Housing	20	Feeder 3A, 3B (5A, 5B)	
11	E109B	A-I Staff/Faculty 2	-	-	Housing	0	Feeder 3A, 3B (5A, 5B)	
12	E110A	A-1 Res Dining	19,133	-	Housing	77	Feeder 3A, 3B (5A, 5B)	A-I Renovation will increase electrical load
12.1	E110B	A-I Mechanical Equipment	2,100	-	Housing	300	Feeder 3A, 3B (5A, 5B)	A-I Final Draft DPP
40	E138	Student Recreation	77,200	-	Athletics/Recreation	386	Feeder 3A, 3B (5A, 5B)	
66	E164	Psychology Phase 2	25,100	-	Academic/Resarch	126	Feeder 3A, 3B (4A, 2C)	
79	E177	Warehouse (Physical Plant)	4,100	-	Institutional Operations	21	Feeder 3A, 3B (6A, 6B)	
80	E178	Special Events Building	4,300	-	Institutional Operations	22	Feeder 3A, 3B (6A, 6B)	
81	E179	EH&S	28,300	-	Institutional Operations	142	Feeder 3A, 3B (6A, 6B)	
82	E180	Bio-Control Culture Building	1,200	-	Academic/Resarch	6	Feeder 3A, 3B (3B, 3C)	
	E181	Barn	0	-	Student Services	0	Feeder 3A, 3B (1A, 1B)	GSF included with sites E181A-E181E
83	E181A	Cottage	0	-	Student Services	0	Feeder 3A, 3B (1A, 1B)	
84	E181B	Barn Dining/Kitchen	3,800	-	Student Services	19	Feeder 3A, 3B (1A, 1B)	
85	E181C	Barn Stable	900	-	Student Services	5	Feeder 3A, 3B (1A, 1B)	
86	E181D	Barn Theater	1,900	-	Academic	10	Feeder 3A, 3B (1A, 1B)	
87	E181E	KUCR	3,500	-	Institutional Operations	18	Feeder 3A, 3B (1A, 1B)	
	Total					2,623		
Note: Feeders in brackets above indicate proposed feeder deignations that will be used to serve these facilities.								
					Phase 2—2015-2020			
13	E111	Dundee 1	374,900	-	Housing	1500	Feeder 6A, 6B	GSF Includes Buildings 2-4
14	E112	Dundee 2	0	-	Housing	0	Feeder 6A, 6B	
15	E113	Dundee 3	0	-	Housing	0	Feeder 6A, 6B	
16	E114	Dundee 4	0	-	Housing	0	Feeder 6A, 6B	
23	E121	Glasgow Dining	96,400	-	Housing	386	Feeder 6A, 6B	
25	E123	Group Housing 1	90,000	-	Housing	360	Feeder 6A, 6B	GSF Includes Buildings 2-6

TABLE 5.1—ANALYSIS OF FUTURE BUILDING LOADS (CONT.)

Ref #	Site ID	Name	GSF	Parking Spaces	Proposed Building Use	Demand in kW	Feeder Designations	Comments
26	E124	Group Housing 2	0	-	Housing	0	Feeder 6A, 6B	
27	E125	Group Housing 3	0	-	Housing	0	Feeder 6A, 6B	
28	E126	Group Housing 4	0	-	Housing	0	Feeder 6A, 6B	
29	E127	Group Housing 5	0	-	Housing	0	Feeder 6A, 6B	
30	E128	Group Housing 6	0	-	Housing	0	Feeder 6A, 6B	
44	E142	EBU3	113,500	-	Academic/Resarch	568	Feeder 4B, 4C	GSF is higher than EBU3 program per DPP
48	E146	Academic/Resarch	94,400	-	Academic/Resarch	472	Feeder 5A, 5B	
		Total				3,285		
					Phase 3—2021-2025			
17	E115	Edinburg 1	168,000	-	Housing	672	Feeder 6A, 6B	GSF Includes Building 2
18	E116	Edinburg 2	0	-	Housing	0	Feeder 6A, 6B	
19	E117	Edinburg 3	84,000	-	Housing	336	Feeder 6A, 6B	
24	E122	Lennox 3	84,000	-	Housing	336	Feeder 6A, 6B	
36	E134	Housing Administration	5,700	-	Housing	23	Feeder 7A, 5C	
37	E135	Bannockburn 1	220,000	-	Housing	880	Feeder 7A, 5C	GSF Includes Building 2
38	E136	Bannockburn 2	0	-	Housing	0	Feeder 7A, 5C	
39	E137	Bannockburn Office/Retail	90,900	-	Housing	364	Feeder 7A, 5C	
42	E140	Academic/Resarch	52,000	-	Academic/Resarch	260	Feeder 5A, 5B	Displaces Soccer Field
43	E141	Engineering IV	113,200	-	Academic/Resarch	566	Feeder 5A, 5B	
47	E145	Academic/Resarch	94,400	-	Academic/Resarch	472	Feeder 4B, 4C	
64	E162	Academic/Resarch	82,200	-	Academic/Resarch	411	Feeder 4A, 2C	
65	E163	Academic/Resarch	89,400	-	Academic/Resarch	447	Feeder 4A, 2C	
72	E170	South of Arts	61,500	-	Academic/Resarch	308	Feeder 1A, 1B	
73	E171	South of CHASS	41,200	-	Academic/Resarch	206	Feeder 1A, 1B	
75	E173	Recital Hall/Museum/Gallery	40,300	-	Student Services	202	Feeder 1A, 1B	
		Total				5,481		
					Phase 4—2025-2030			
20	E118	Café	6,900	-	Housing	28	Feeder 6A, 6 B	
21	E119	Lennox 1	168,000	-	Housing	672	Feeder 6A, 6 B	GSF Includes Building 2
22	E120	Lennox 2	0	-	Housing	0	Feeder 6A, 6 B	
41	E139	Performing Arts Center	123,400	-	Academic	617	Feeder 5A, 5B	
46	E144	Academic/Resarch	94,400	-	Academic/Resarch	472	Feeder 4B, 4C	
67	E165	Academic/Resarch	70,400	-	Academic/Resarch	352	Feeder 4A, 2C	
70	E168	Library Addition	158,300	-	Student Services	792	Feeder 1A, 1B	
		Total				2,932		

TABLE 5.1—ANALYSIS OF FUTURE BUILDING LOADS (CONT.)

Ref #	Site ID	Name	GSF	Parking Spaces	Proposed Building Use	Demand in kW	Feeder Designations	Comments
					Phase 5—2031+			
31	E129	Falkirk 1	416,800	-	Housing	1667	Feeder 7A, 5C	GSF Includes Buildings 2-5
32	E130	Falkirk 2	0	-	Housing	0	Feeder 7A, 5C	
33	E131	Falkirk 3	0	-	Housing	0	Feeder 7A, 5C	
34	E132	Falkirk 4	0	-	Housing	0	Feeder 7A, 5C	
35	E133	Falkirk 5	0	-	Housing	0	Feeder 7A, 5C	
45	E143	Health Services	60,700	-	Student Services	304	Feeder 5A, 5B	
62	E160	Academic/Resarch	92,600	-	Academic/Resarch	463	Feeder 4A, 2C	
63	E161	Academic/Resarch	170,800	-	Academic/Resarch	854	Feeder 4A, 2C	
49	E147	Academic/Resarch	166,000	-	Academic/Resarch	830	Feeder 3A, 1C	
50	E148	Academic/Resarch	105,600	-	Academic/Resarch	528	Feeder 3A, 1C	Building could displace generator
51	E149	Academic/Resarch	5,300	-	Academic/Resarch	27	Feeder 3A, 1C	
52	E150	Academic/Resarch	123,600	-	Academic/Resarch	618	Feeder 3A, 1C	
53	E151	Academic/Resarch	100,000	-	Academic/Resarch	500	Feeder 3A, 1C	
54	E152	Academic/Resarch	88,800	-	Academic/Resarch	444	Feeder 3A, 1C	
55	E153	Academic/Resarch	88,800	-	Academic/Resarch	444	Feeder 3B, 3C	
56	E154	Academic/Resarch	77,200	-	Academic/Resarch	386	Feeder 3B, 3C	
57	E155	Academic/Resarch	64,300	-	Academic/Resarch	322	Feeder 3B, 3C	
58	E156	Academic/Resarch	66,000	-	Academic/Resarch	330	Feeder 3B, 3C	
59	E157	Replaces C&C	102,400	-	Institutional Operations	512	Feeder 3B, 3C	
60	E158	Included Above	0	-	Academic/Resarch	0	Feeder 4A, 2C	GSF with Site E159
61	E159	Academic/Resarch	47,000	-	Academic/Resarch	235	Feeder 4A, 2C	
68	E166	Sproul Hall South Addition	60,000	-	Academic/Resarch	300	Feeder 1A, 1B	
69	E167	Watkins North Addition	51,300	-	Academic/Resarch	257	Feeder 1A, 1B	
71	E169	Spieth Hall North Addition	66,600	-	Academic/Resarch	333	Feeder 3A, 1C	
74	E172	Replace Physical Education	67,000	-	Academic/Resarch	335	Feeder 1A, 1B	
76	E174	Academic/Resarch	111,000	-	Academic/Resarch	555	Feeder 7A, 5C	Displaces Reservoir
77	E175	Academic Mixed Use - 3	80,000	-	Academic/Resarch	400	Feeder 7A, 5C	
78	E176	Academic Mixed Use - 4	47,000	-	Academic/Resarch	235	Feeder 7A, 5C	
		Total				10,877		

Ref #	Site ID	Name	GSF	Parking Spaces	Proposed Building Use	Demand in kW	Feeder Designations	Comments
90	P02	Parking Structure (Lot 24)		1,250	Parking Structure	125	Feeder 5A, 5B	
93	P05	Parking Structure (Glen Mor 2)		596	Parking Structure	83	Feeder 4B, 4C	
		Total				208		
92	P04	Parking Structure		250	Parking Structure	63	Feeder 5A, 5B	
		Total				63		
89	P01	Parking Structure (Lot 1)		1,200	Parking Structure	125	Feeder 7A, 5C	
91	P03	Parking Structure		1,513	Parking Structure	125	Feeder 6A, 6B	
		Total				250		
94	P06	Parking Structure		853	Parking Structure	83	Feeder 4B, 4C	
		Total				83		
		Total		5,662		604		
		Total Added Load				25,803		
		Total Deductive Load (Due to Facilities being demolished)				1,548		
		Total Added Load (Currently on a dedicated RPU Service)				2,565		
		Total Effective Load Added				26,820		

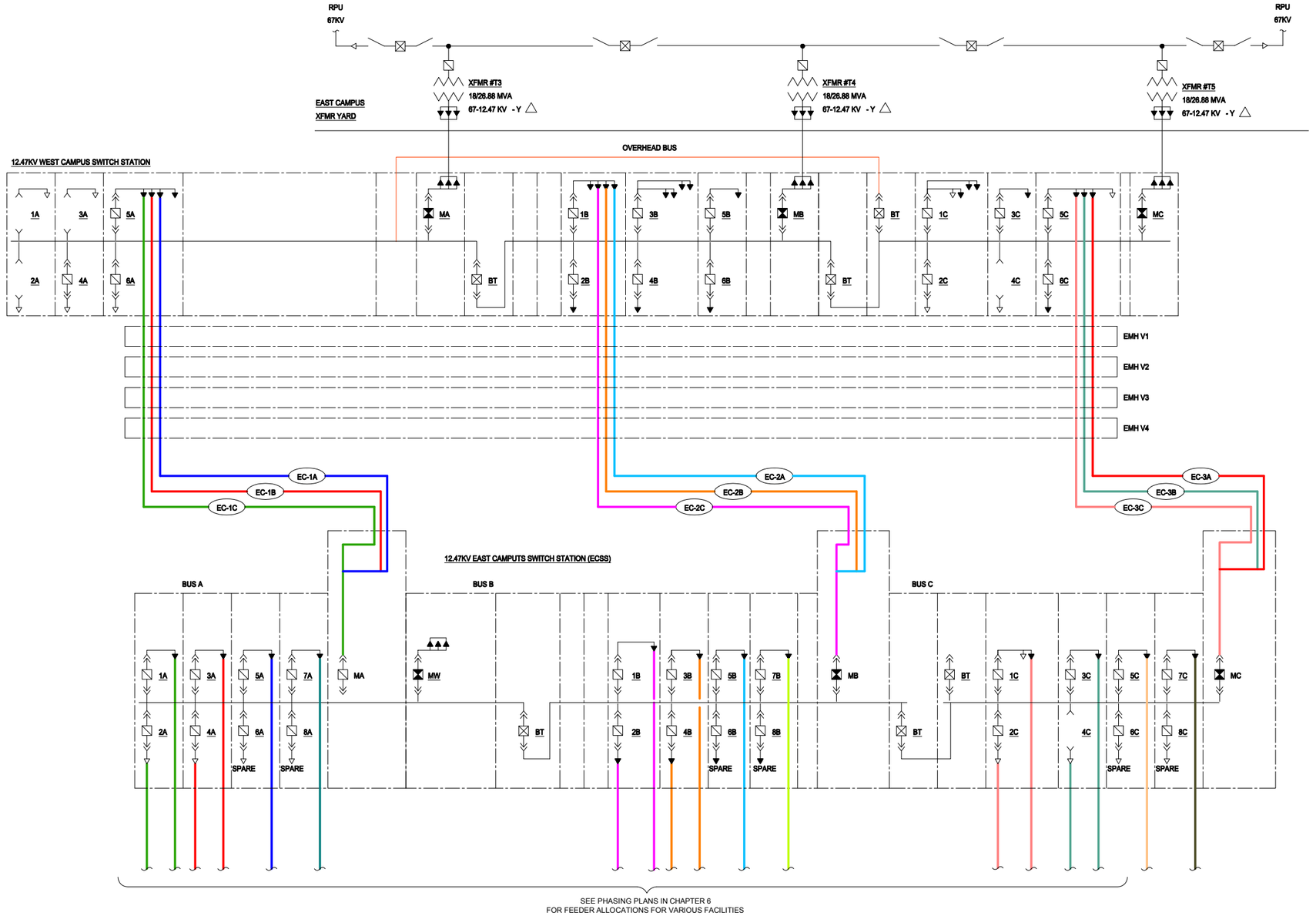


Figure 5.1—Proposed 12kV Single Line Diagram

NOTE: THE EXISTING PATHWAYS SHOWN ON THE PLANS WILL NEED TO BE EVALUATED IN DETAIL FOR REUSE DURING THE DESIGN PHASE OF THE PROJECT. A COMBINATION OF EXISTING DUCT BANKS, TUNNEL SYSTEM AND NEW PATHWAYS WILL BE UTILIZED TO ROUTE NEW FEEDERS TO ALL FACILITIES ON CAMPUS.

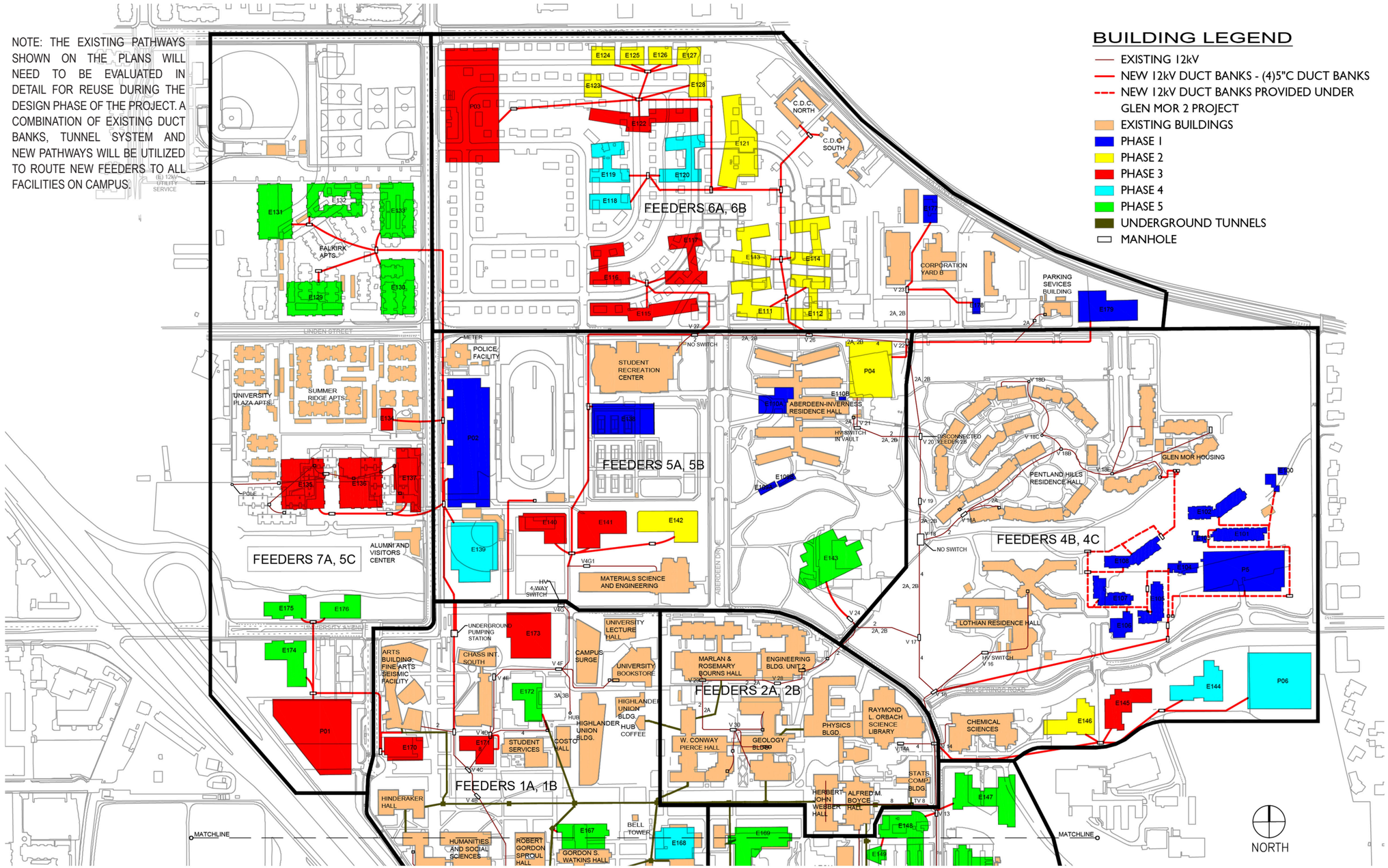


Figure 5.2—Proposed Electrical Site Plan–North

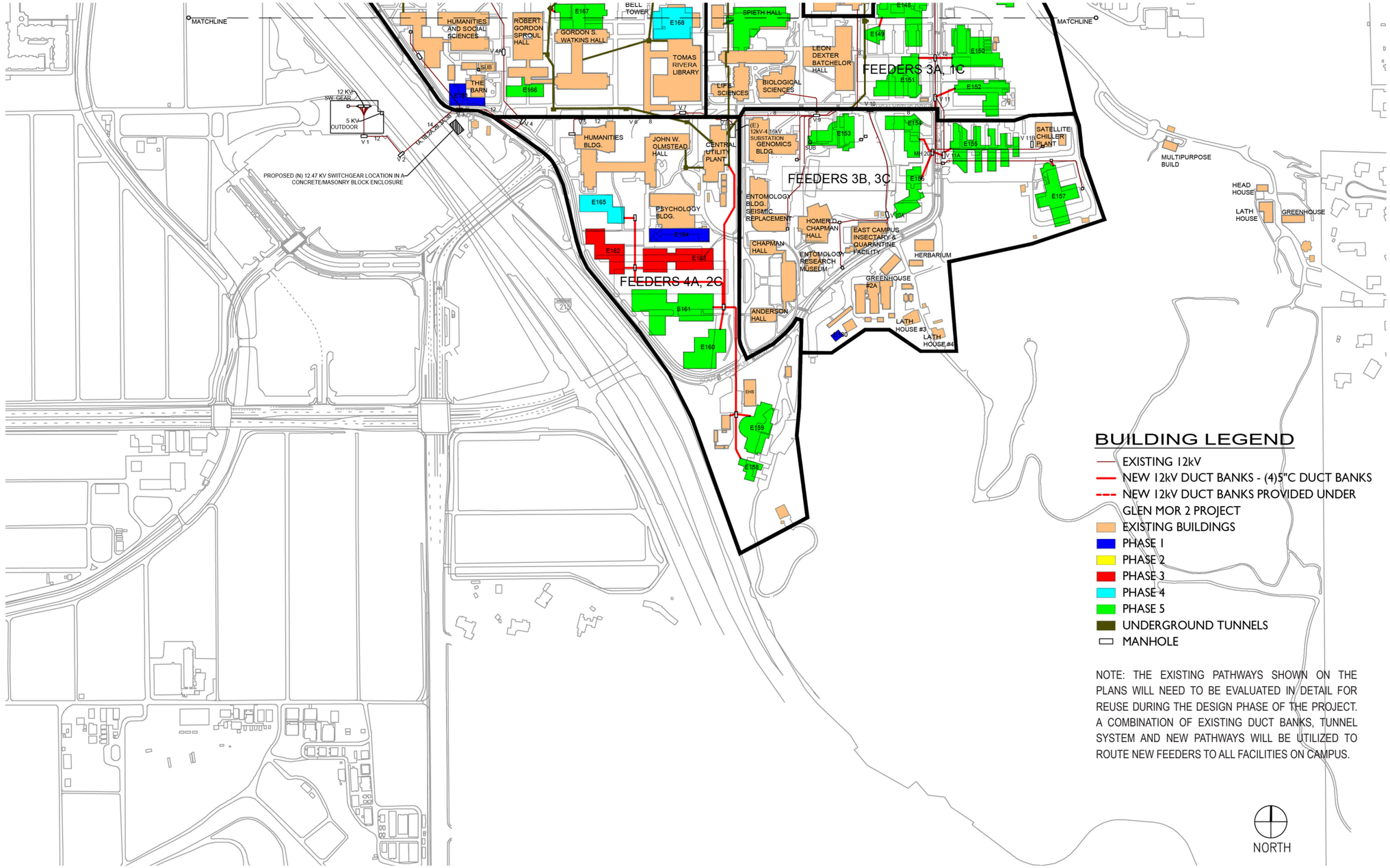


Figure 5.3—Proposed Electrical Site Plan–South

NOTE: THE EXISTING PATHWAYS SHOWN ON THE PLANS WILL NEED TO BE EVALUATED IN DETAIL FOR REUSE DURING THE DESIGN PHASE OF THE PROJECT. A COMBINATION OF EXISTING DUCT BANKS, TUNNEL SYSTEM AND NEW PATHWAYS WILL BE UTILIZED TO ROUTE NEW FEEDERS TO ALL FACILITIES ON CAMPUS.

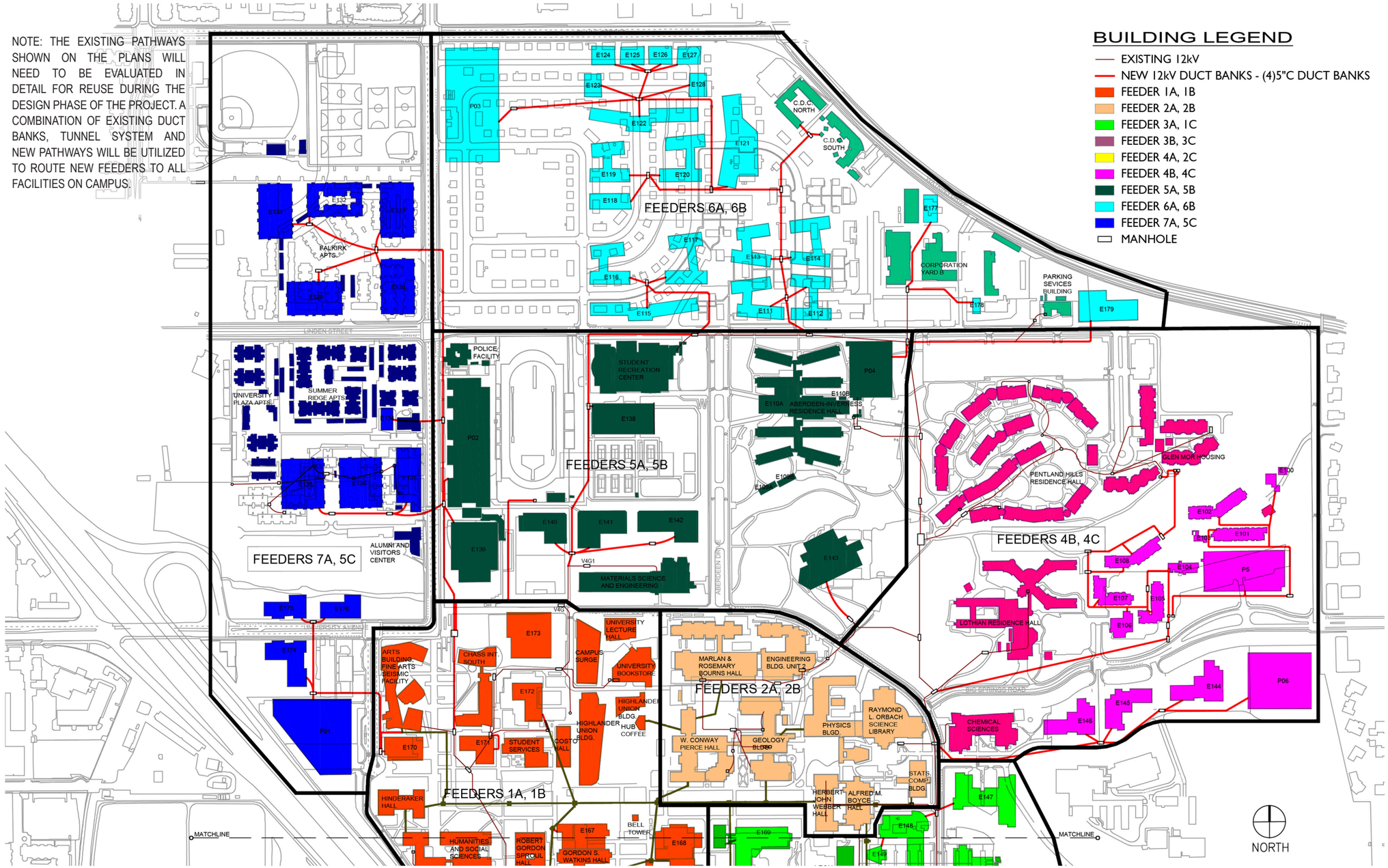


Figure 5.4—Medium Voltage Feeders Allocation Site Plan–North

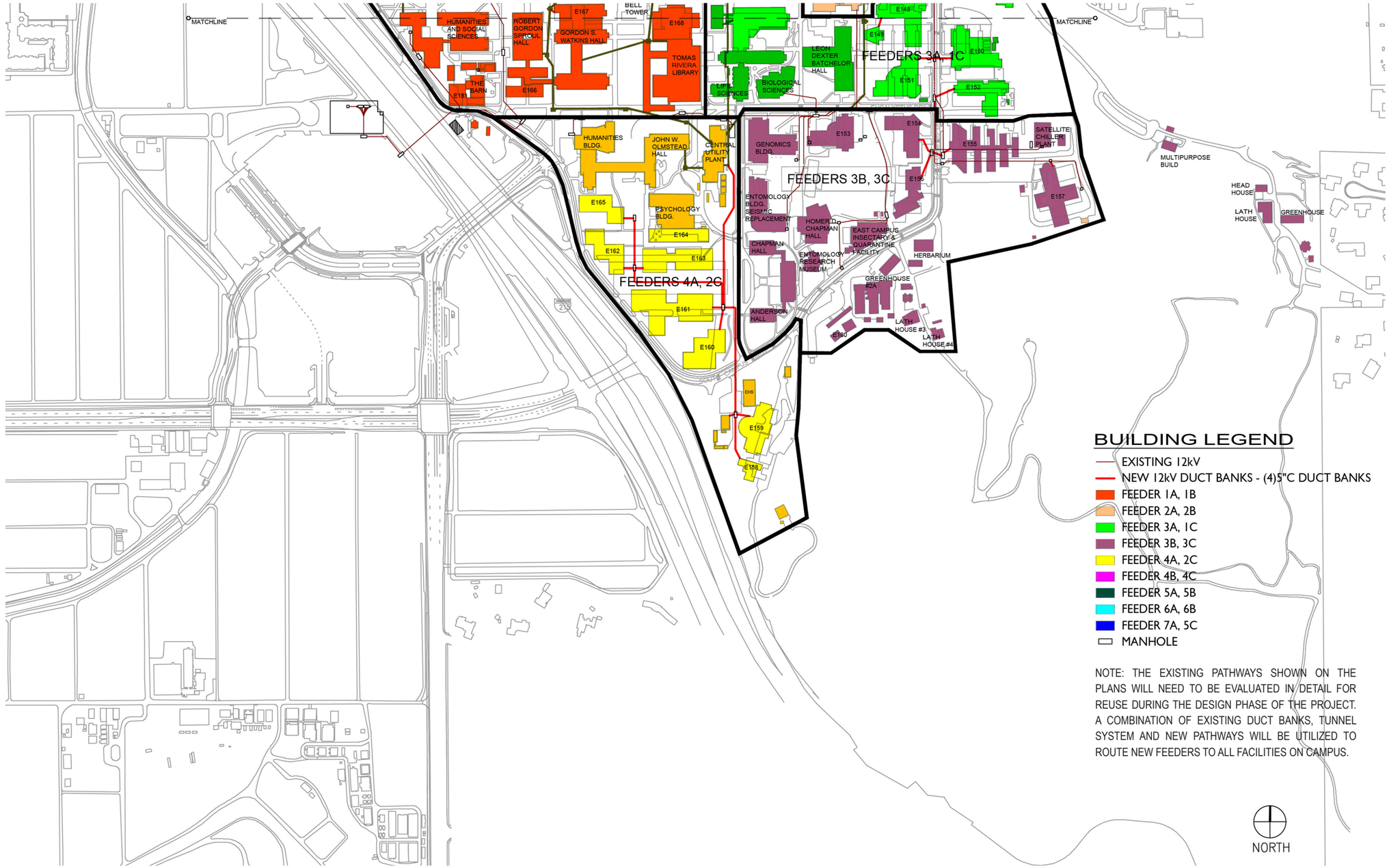


Figure 5.5—Medium Voltage Feeders Allocation Site Plan–South

Chapter 6—Implementation and Phasing Plan

Chapter 6—Implementation and Phasing Plan

An analysis of the future loads/demands being added to the campus as a result of new facilities being added on in each phase was undertaken and it's impact to the existing electrical system was evaluated. The following is a phasing and implementation plan for the proposed improvements recommended in our report to meet the demands of the existing and future facilities planned at the campus for each phase. The total additional demand being added to the campus as a result of new facilities by each phase is also provided below: A site plan showing various facilities being added in various phases is provided at the end of the section.

Phase 1—2011-2014

Table 6.1 provides facilities that are provided in phase I along with their connected loads and demands. An evaluation of the connected loads and demands of these facilities revealed that although the existing switchgear/feeders can support the power demand of these facilities, existing dual feeders '2A' and '2B' will not be able to provide redundancy in event of a failure of one of the feeders or if one of the switchgear sections is taken down for maintenance. The following are our proposed recommendations to be implemented in this phase of the development plan:

- Based on a review of the feeders demand data forwarded to us and a review of the current distribution system, we recommend the following to prevent feeders '2A' and '2B' from further being loaded:
    - Route new duct banks and extend existing feeders '3A' and '3B' from vault V4G to V27.
    - Connect these feeders to feeders '2A' and '2B' in vault 27.
    - Disconnect and isolate feeders '2A' and '2B' between vault V18 and vault V15 and transfer following loads to feeders '3A' and '3B':
        - Student Recreation Center, Parking Services, Aberdeen Residences, Pentland Residences and Existing Glen Mor Housing.
- Route new duct banks and extend feeders '2A' and '2B' from vault V15 travelling east to serve the new Glen Mor Housing 2 instead of serving the same from north vault V18E.
- The above arrangement will help the campus free up loads on feeders '2A' and '2B', prevent any further load being added on to feeders '1A' and '1B' and spread load across feeders '3A' and '3B' which currently are lightly loaded compared to the rest of the feeders. The new duct banks being recommended will also be consistent with our master plan recommendations and will be reused in the future to route the new feeders.
- A spreadsheet providing distribution of loads on feeders 2A and 2B and 3A and 3B is provided in table 6.1A.
- An alternative option will be to provide dedicated new feeders '5A' and '5B' from existing University substation to serve the housing loads. Existing pathways can be used to route these feeders to vault V18 to transfer the existing Lothian Residence Hall, Pentland Residences and Glen Mor Housing loads along with the new Glen Mor 2 loads to these feeders. These will help in reducing loads on feeders '2A' and '2B'.
- Provide new 5" electrical duct banks with 15kV, 3#500kcmil Cu. 133% EPR cables duct banks and medium voltage feeders and associated manholes to extend existing feeders as depicted in Phase 1 Site Plan provided at the end of the section to serve rest of the facilities in this phase.
- Provide new 15kV selector switches consistent with equipment specifications contained in Chapter 7 to serve the proposed facilities and provide a primary selective system. Radial feeders originating from these selector switches will serve substations in each of the facilities. These selector switches will provide ease of isolation of loop faults as well as provide a means of isolating building substations. These switches will be served from the nearest manhole located close to the proposed facility as shown in our proposed phase 1 site plan proposed at the end of the section.
- Balance loads on existing feeders '1A' and '1B,' '2A' and '2B' and '3A' and '3B' as proposed in the demand Table 6.1 below. Feeder designations that will be used to serve proposed facilities provided in this phase of the development plan are also provided in Table 6.1 below.
- Replace existing oil fused cut outs in Humanities, Barn, Ivan Hinderaker Hall, Bell Tower, Parking Lot 30, Howard Samuel Fawcett Laboratory, and Patrick Boyden Laboratory and Life Sciences buildings with 15kV fused LIS switches to improve short circuit withstand capabilities.
- Replace existing 15kV leaking SF6 switches serving Biological Sciences, Steam Plant, Greenhouse 19 and at Vault 9 – Circuits '2A' and '2B' serving University Laboratory building with 15kV Air Switches.
- Conduct a short circuit and arc flash study of the new electrical distribution system and substations provided in facilities as provided as part of the this phase.

TABLE 6.1—PHASE 1: ANALYSIS OF FUTURE LOADS / FEEDERS

Ref #	Site ID	Name	GSF	Parking Spaces	Proposed Building Use	Demand in kW	Feeder Designations	Comments
1	E100	Glen Mor 2 (Bldg N)	4,700	-	Housing	19	Feeder 3A, 3B (4B, 4C)	
2	E101	Glen Mor 2 (Bldg L)	0	-	Housing	0	Feeder 3A, 3B (4B, 4C)	
3	E102	Glen Mor 2 (Bldg M)	0	-	Housing	0	Feeder 3A, 3B (4B, 4C)	
4	E103	Glen Mor 2 (Bldg K)	6,000	-	Housing	24	Feeder 3A, 3B (4B, 4C)	
5	E104	Glen Mor 2 (Bldg J)	10,800	-	Housing	43	Feeder 3A, 3B (4B, 4C)	
6	E105	Glen Mor 2 (Bldg I)	0	-	Housing	0	Feeder 3A, 3B (4B, 4C)	
7	E106	Glen Mor 2 (Bldg H)	8,400	-	Housing	34	Feeder 3A, 3B (4B, 4C)	
8	E107	Glen Mor 2 (Bldg G)	0	-	Housing	0	Feeder 3A, 3B (4B, 4C)	
9	E108	Glen Mor 2 (Bldgs F)	338,900	-	Housing	1,356	Feeder 3A, 3B (4B, 4C)	GSF includes Bldgs F, G, I, L, M
10	E109A	A-I Staff/Faculty 1	4,956	-	Housing	20	Feeder 3A, 3B (5A, 5B)	
11	E109B	A-I Staff/Faculty 2	-	-	Housing	0	Feeder 3A, 3B (5A, 5B)	
12	E110A	A-I Res. Dining	19,133	-	Housing	77	Feeder 3A, 3B (5A, 5B)	A-I Renovation will increase electrical load
12.1	E110B	A-I Mechanical Equipment	2,100	-	Housing	300	Feeder 3A, 3B (5A, 5B)	A-I Final Draft DPP
40	E138	Student Recreation	77,200	-	Athletics/Recreation	386	Feeder 3A, 3B (5A, 5B)	
66	E164	Psychology Phase 2	25,100	-	Academic/Resarch	126	Feeder 3A, 3B (4A, 2C)	
79	E177	Warehouse (Physical Plant)	4,100	-	Institutional Operations	21	Feeder 3A, 3B (6A, 6B)	
80	E178	Special Events Building	4,300	-	Institutional Operations	22	Feeder 3A, 3B (6A, 6B)	
81	E179	EH&S	28,300	-	Institutional Operations	142	Feeder 3A, 3B (6A, 6B)	
82	E180	Bio-Control Culture Building	1,200	-	Academic/Resarch	6	Feeder 3A, 3B (3B, 3C)	
	E181	Barn	0	-	Student Services	0	Feeder 3A, 3B (1A, 1B)	GSF included with sites E181A-E181E
83	E181A	Cottage	0	-	Student Services	0	Feeder 3A, 3B (1A, 1B)	
84	E181B	Barn Dining/Kitchen	3,800	-	Student Services	19	Feeder 3A, 3B (1A, 1B)	
85	E181C	Barn Stable	900	-	Student Services	5	Feeder 3A, 3B (1A, 1B)	
86	E181D	Barn Theater	1,900	-	Academic	10	Feeder 3A, 3B (1A, 1B)	
87	E181E	KUCR	3,500	-	Institutional Operations	18	Feeder 3A, 3B (1A, 1B)	No longer KUCR
Total			545,289			2,623		
90	P02	Parking Structure (Lot 24)		1,250	Parking Structure	125	Feeder 3A, 3B	A section of Parking Structure ground floors are envisioned to support mixed-use development (retail, campus offices, etc).
93	P05	Parking Structure (Glen Mor 2)		596	Parking Structure	83	Feeder 1A, 1B	
Total				1,846		208		
Total Added Load						2,831		

Note: Feeders in brackets indicate proposed feeder designations that will be used to serve these proposed facilities in Phase 2.

TABLE 6.1A—PHASE 1: FACILITIES INSTALLED CAPACITIES AND DEMAND BY FEEDERS (12.47KV SYSTEM) 2A, 2B AND 3A, 3B

CAAN	Updated Building Name	Comment	Primary Voltage (kV)	Secondary Voltage (V)	KVA	Impedance	Demand	Current in A	Proposed Feeder(s) Serving the Facility
			Feeders 2A, 2B						
P5261	Marlan & Rosemary Bourns Hall		12	480/277	4,000	5.52	1000	46	Feeder 2A, 2B
P5341	Alfred M. Boyce Hall	A	12	480/277	1,000	6.43	250	12	Feeder 2A, 2B
P5341	Alfred M. Boyce Hall	B	12	208/120	1,000	6.40	250	12	Feeder 2A, 2B
P5588	Statistics Computer Building	A	12	480/277	500	5.12	125	6	Feeder 2A, 2B
P5588	Statistics Computer Building	B	12	208/120	500	5.96	125	6	Feeder 2A, 2B
P5194	Engineering Building Unit 2		12	480/277	2,000	5.79	500	23	Feeder 2A, 2B
P5335	Geology Building	A	12	480/277	1,000	5.66	250	12	Feeder 2A, 2B
P5335	Geology Building	B	12	208/120	500	5.93	125	6	Feeder 2A, 2B
P5335	Geology Building	Lab	12	480/277	2,000	4.78	500	23	Feeder 2A, 2B
P5502	Lothian Residence Hall	A - West	12	208/120	500	5.93	125	6	Feeder 2A, 2B
P5502	Lothian Residence Hall	B	12	480/277	2,000	6.49	500	23	Feeder 2A, 2B
P5502	Lothian Residence Hall	C	12	480	300	5.87	75	3	Feeder 2A, 2B
P5502	Lothian Residence Hall	D	12	208/120	300	6.13	75	3	Feeder 2A, 2B
P5508	W. Conway Pierce Hall	Addition	12	480/277	500	5.30	125	6	Feeder 2A, 2B
P5418	Raymond L. Orbach Science Library		12	480/277	2,500	5.77	625	29	Feeder 2A, 2B
P5342	Herbert John Webber Hall	A	12	480/277	225	5.75	56.25	3	Feeder 2A, 2B
P5342	Herbert John Webber Hall	B	12	208/120	300	4.42	75	3	Feeder 2A, 2B
P5417	Entomology Buildings Seismic Replacement		12	480/277	2,000	7.73	500	23	Feeder 2A, 2B
E100-E110B	Glen Mor 2		12	480/277	3,000	7.73	1000	46	Feeder 2A, 2B
	Total				24,125		6281.25	291	

TABLE 6.1A—PHASE 1: FACILITIES INSTALLED CAPACITIES AND DEMAND BY FEEDERS (12.47KV SYSTEM) 2A, 2B AND 3A, 3B (CONT.)

CAAN		Updated Building Name	Comment	Primary Voltage (kV)	Secondary Voltage (V)	KVA	Impedance	Demand	Current in A	Proposed Feeder(s) Serving the Facility
Feeders 3A, 3B										
P5224		University Bookstore		12	208/120	300	4.10	75	3	Feeder 3A, 3B
P5372		Chass Interdisciplinary South		12	480/277	1,500	5.81	375	17	Feeder 3A, 3B
P5411		Arts Building, Fine Arts Seismic Facility	A	12	208/12	750	5.64	187.5	9	Feeder 3A, 3B
P5411		Arts Building, Fine Arts Seismic Facility	B	12	208/12	750	5.64	187.5	9	Feeder 3A, 3B
P5404		Highlander Union Building	A	12	208/120	750	5.63	187.5	9	Feeder 3A, 3B
P5404		Highlander Union Building	B	12	480/277	1,500	5.62	375	17	Feeder 3A, 3B
P5307		Humanities & Social Sciences		12	480/277	1,500	5.62	375	17	Feeder 3A, 3B
P5195		Materials Science & Engineering		12	480/277	3,750	5.99	937.5	43	Feeder 3A, 3B
P5614		Student Support Services Building		12	480/277	750	5.84	187.5	9	Feeder 3A, 3B
P5380		Campus Surge		12	480/277	750	5.75	187.5	9	Feeder 3A, 3B
P5498		Humanities Building		12	208/120	500	1.90	125	6	Feeder 3A, 3B
P5511		Student Recreation Center		12	480/277	2,000	6.23	500	23	Feeder 3A, 3B
P5365		Pentland Hills Residence Hall	A	12	480/277	750	5.54	187.5	9	Feeder 3A, 3B
P5638		Pentland Hills Residence Hall	E	12	480/277	750	5.54	187.5	9	Feeder 3A, 3B
P5643		Pentland Hills Residence Hall 2	L	12	480/277	750	5.54	187.5	9	Feeder 3A, 3B
P5646		Pentland Hills Residence Hall 2	O	12	480/277	750	5.54	187.5	9	Feeder 3A, 3B
P5471	X	Glen Mor Housing B		12	480/277	150	4.19	37.5	2	Feeder 3A, 3B
P5470		Glen Mor Housing A	A	12	208/120	1,000	5.86	250	12	Feeder 3A, 3B
P5474		Glen Mor Housing E	E	12	208/120	1,000	5.80	250	12	Feeder 3A, 3B
P5272		Parking Services Building		12	208/120	150		37.5	2	Feeder 3A, 3B
P5343		Aberdeen-Inverness Residence Hall	A	12.47	208/120	300	6.23	75	3	Feeder 3A, 3B
P5343		Aberdeen-Inverness Residence Hall	B	12	208/120	300	6.23	75	3	Feeder 3A, 3B
P5343		Aberdeen-Inverness Residence Hall	C	12	208/120	300	6.23	75	3	Feeder 3A, 3B
P5343		Aberdeen-Inverness Residence Hall	C1	12	480	750	6.00	187.5	9	Feeder 3A, 3B
P5343		Aberdeen-Inverness Residence Hall	D	12	208/120	300	6.23	75	3	Feeder 3A, 3B
P5343		Aberdeen-Inverness Residence Hall	E	12	208/120	300	6.10	75	3	Feeder 3A, 3B
E138		Student Recreation	77,200	12	480/277	750	-	386	18	Feeder 3A, 3B
E164		Psychology Phase 2	25,100	12	208/120	300	-	126	6	Feeder 2A, 2B
Total						23,400		6,099.5	282	

NOTE: THE EXISTING PATHWAYS SHOWN ON THE PLANS WILL NEED TO BE EVALUATED IN DETAIL FOR REUSE DURING THE DESIGN PHASE OF THE PROJECT. A COMBINATION OF EXISTING DUCT BANKS, TUNNEL SYSTEM AND NEW PATHWAYS WILL BE UTILIZED TO ROUTE NEW FEEDERS TO ALL FACILITIES ON CAMPUS.

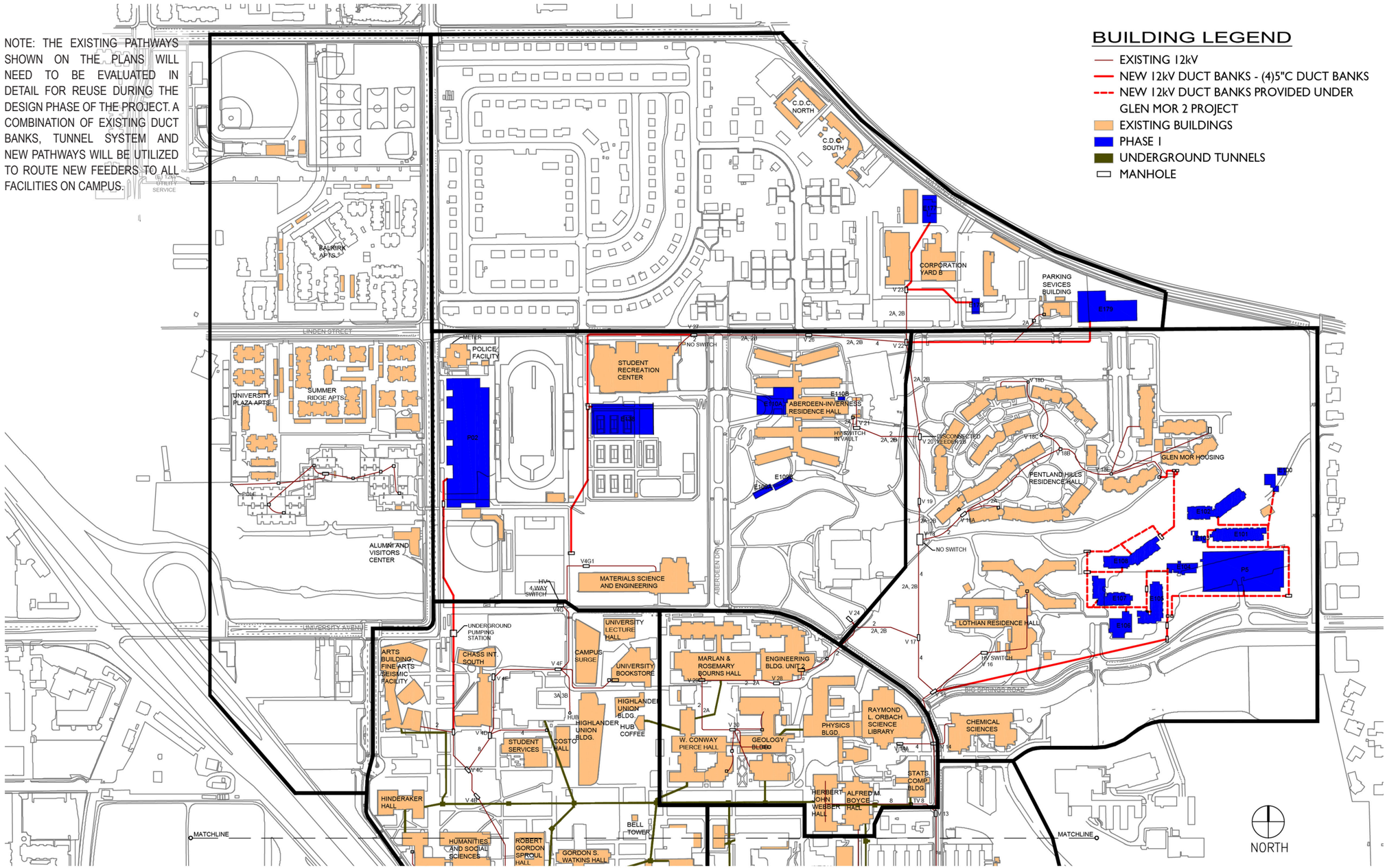


Figure 6.1—Phase 1 Buildings Electrical Site Plan–North

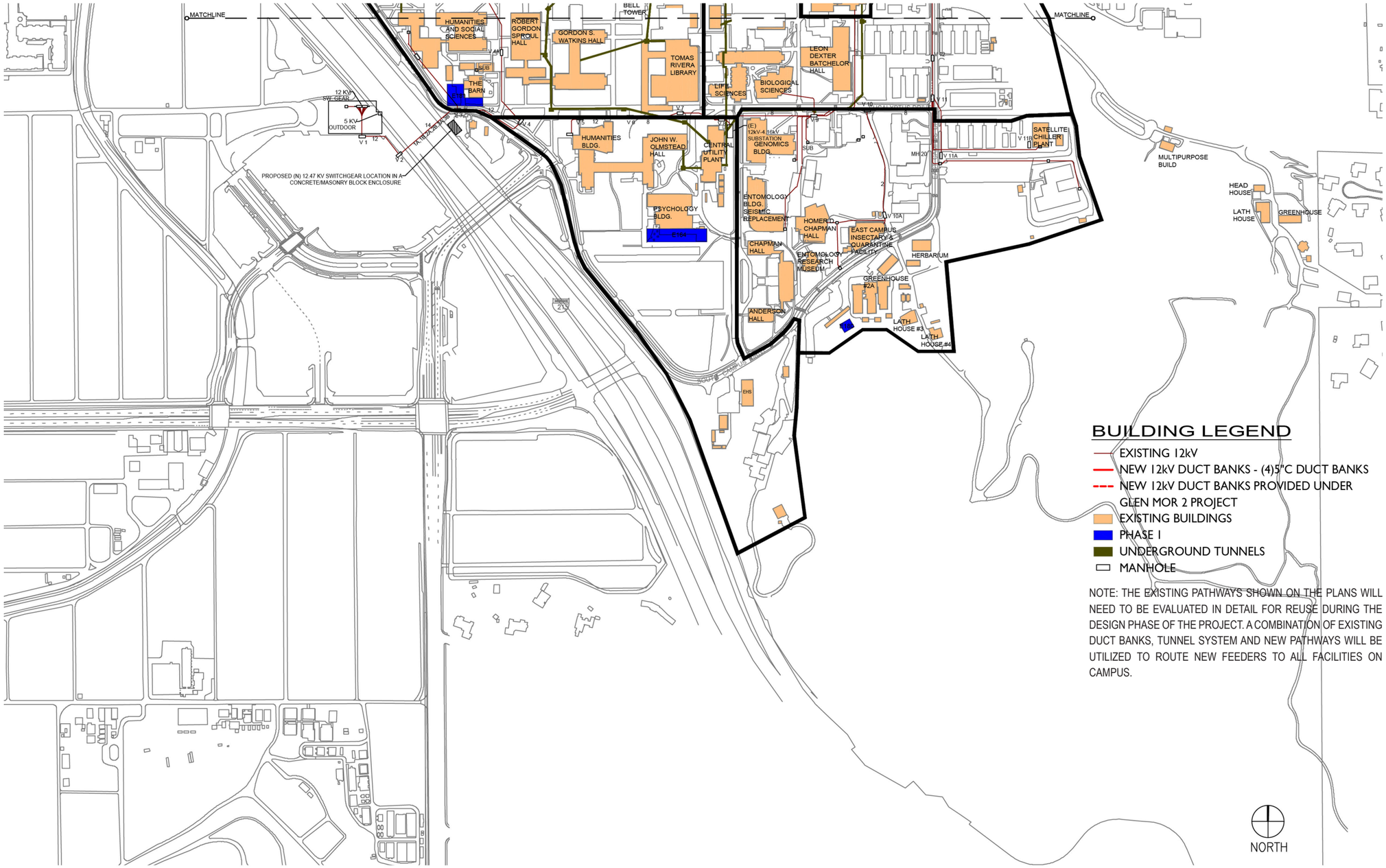


Figure 6.2—Phase 1 Buildings Electrical Site Plan–South

Phase 2—2015-2020

Table 6.2 provides facilities that are provided in phase 2 along with their connected loads and demands. An evaluation of the connected loads and demands of these facilities revealed that new 15kV switchgear and new ductbanks/ feeders will be required to support the power demand of these facilities. The following are our proposed recommendations to be implemented in this phase of the development plan:

- Add a third utility transformer in the vicinity of the existing 67-12.47kV transformers located at the university substation, and provide a new third 12.47kV switchgear section in the vicinity of the existing 12.47 switchgear to supplement the existing two 12.47kV switchgear sections currently serving the campus and located in the modular building on the west side of the campus. The new utility transformer shall be rated at 67-12.47kV, 26.88MVA and shall serve this new third switchgear section. This increase in capacity will help the campus meet the loads of the future facilities and provide redundancy at the same time if one of the utility transformer or a switchgear section fails during the peak demand period.
- Provide a new three section 15kV switchgear with a main 2000A breaker and (6) 1200A feeder breakers per section with two spare sections. Locate the switchgear on the east side of the freeway near Parking Lot 4 in a block building of approximately 3500sqft. Serve each of the new switchgear sections (three in number) with (3) sets of 15kV, 133% 750kcmil EPR cables from a breaker in each section of the main 12.47kV switchgear section located on the west side of the campus. These new feeders will be routed in existing duct banks currently located underneath the freeway. The provision of this new 15kV switchgear section will provide ease of adding feeders on the east side of the campus as future facilities are added in various phases without having the need to replace the existing switchgear to add additional feeder breaker sections and additional duct banks underneath the freeway to accommodate additional feeders. The provision of this new switchgear section will also alleviate the de-rating affect currently being experienced by cables in duct banks located underneath the freeway.
- Provide new feeders as shown in Table 6.2 to serve proposed facilities being provided in this phase of the development plan. Provide new 5” electrical duct banks with 15kV, 3#500kcmil Cu. 133% EPR cables duct banks and medium voltage feeders and associated manholes to extend these feeders as depicted in phase 2 site plan provided at the end of the section. Existing tunnel system and conduit duct banks will be evaluated in detail during the design phase and will supplement the proposed ductbanks to route new feeders. Feeder designations that will be used to serve existing and proposed facilities provided in this phase of the development plan are also provided in Table 6.3 below.
- Provide new 15kV selector switches consistent with equipment specifications contained in Chapter 7 to serve the proposed facilities and provide a primary selective system. Radial feeders originating from these selector switches will serve substations in each of the facilities. These selector switches will provide ease of isolation of loop faults as well as provide a means of isolating building substations. These switches will be served from the nearest manhole located close to the proposed facility as shown in our proposed phase 1 site plan proposed at the end of the section.
- Convert existing 4.16kV substations in existing facilities referenced in Table 2.5 to a 12.47kV system and extend 12.47kV service to each of the proposed facilities as depicted in the phase 2 site plan provided at the end of the section.
- Conduct a short circuit and arc flash study of the new electrical distribution system and substations provided in facilities as provided as part of the this phase.

TABLE 6.2—PHASE 2: ANALYSIS OF FUTURE LOADS / FEEDERS

Ref #	Site ID	Name	GSF	Parking Spaces	Proposed Building Use	Demand in kW	Feeder Designations	Comments
13	E111	Dundee 1	374,900	-	Housing	1,500	Feeder 6A, 6B	GSF Includes Buildings 2-4
14	E112	Dundee 2	0	-	Housing	0	Feeder 6A, 6B	
15	E113	Dundee 3	0	-	Housing	0	Feeder 6A, 6B	
16	E114	Dundee 4	0	-	Housing	0	Feeder 6A, 6B	
23	E121	Glasgow Dining	96,400	-	Housing	386	Feeder 6A, 6B	
25	E123	Group Housing 1	90,000	-	Housing	360	Feeder 6A, 6B	GSF Includes Buildings 2-6
26	E124	Group Housing 2	0	-	Housing	0	Feeder 6A, 6B	
27	E125	Group Housing 3	0	-	Housing	0	Feeder 6A, 6B	
28	E126	Group Housing 4	0	-	Housing	0	Feeder 6A, 6B	
29	E127	Group Housing 5	0	-	Housing	0	Feeder 6A, 6B	
30	E128	Group Housing 6	0	-	Housing	0	Feeder 6A, 6B	
44	E142	EBU3	113,500	-	Academic/Resarch	568	Feeder 4B, 4C	GSF is higher than EBU3 program per DPP
48	E146	Academic/Resarch	94,400	-	Academic/Resarch	472	Feeder 5A, 5B	
Total			769,200			3,285		
92	P04	Parking Structure		250	Parking Structure	63	Feeder 5A, 5B	
Total				250		63		
Total Added Load						3,347		
Total Deductive Load (Due to Facilities being demolished)						1,548		
Total Effective Load Added						1,799		

TABLE 6.3—EXISTING FACILITIES INSTALLED CAPACITIES AND DEMAND BY EXISTING AND PROPOSED FEEDERS (12.47 KV SYSTEM)

CAAN	Building Name	Comment	Primary Voltage (kV)	Secondary Voltage (V)	KVA	Impedance	Demand	Existing Feeder(s) Serving the Facility	Proposed Feeder(s) Serving the Facility
Feeders 1A, 1B									
P5186	Biological Sciences	A	12	480/277	1,500	5.88	375	Feeder 1A, 1B	Feeder 3A, 1C
P5414	Chemical Sciences		12	480/277	3,000	5.20	750	Feeder 1A, 1B	Feeder 4B, 4C
P5215	Homer D. Chapman Hall		12	208/120	1,500	6.60	375	Feeder 1A, 1B	Feeder 3B, 3C
P5196	Genomics Building		12	480/277	2,500	5.70	625	Feeder 1A, 1B	Feeder 3B, 3C
P5289	East Campus Insectary and Quarantine Facility		12	480/277	1,000	5.88	250	Feeder 1A, 1B	Feeder 3B, 3C
Total Feeders 1A, 1B - 12.47kV kVA / Demand					9,500		2,375		
Feeders 1A, 1B - Central Plant 12.47kV-4.16kV Substation									
P5501	Leon Dexter Batchelor Hall	Basement	4.16	208/120	300	5.75	75	Feeder 1A, 1B	Feeder 3A, 1C
P5501	Leon Dexter Batchelor Hall	SubBasement	4.16	208/120	1,000	6.04	250	Feeder 1A, 1B	Feeder 3A, 1C
P5295	Central Utility Plant	A	4.16	480/277	1,000	5.57	250	Feeder 1A, 1B	Feeder 4A, 2C
P5295	Central Utility Plant	B	4.16	208/120	450	4.50	112.5	Feeder 1A, 1B	Feeder 4A, 2C
P5295	Central Utility Plant	TS-1	4.16	208/120	1,000	6.10	250	Feeder 1A, 1B	Feeder 4A, 2C
P5259	Greenhouse #2A	GH 1 & 2	4.16	208/120	500	4.76	125	Feeder 1A, 1B	Feeder 3B, 3C
P5319	Herbarium		4.16	208/120	225		56.25	Feeder 1A, 1B	Feeder 3B, 3C
P5316	Life Sciences	Unit 1	4.16	208/120	500	4.80	125	Feeder 1A, 1B	Feeder 3A, 1C
P5316	Life Sciences	Unit 2 - A	4.16	208/120	300	5.43	75	Feeder 1A, 1B	Feeder 3A, 1C
P5316	Life Sciences	Unit 2 - B	4.16	208/120	300	5.45	75	Feeder 1A, 1B	Feeder 3A, 1C
P5316	Life Sciences	Unit 2 - C	4.16	208/120	300	5.30	75	Feeder 1A, 1B	Feeder 3A, 1C
P5316	Life Sciences	Unit 2 - D	4.16	480	300	5.47	75	Feeder 1A, 1B	Feeder 3A, 1C
P5316	Life Sciences	Unit 2 - E	4.16	208/120	150	4.04	37.5	Feeder 1A, 1B	Feeder 3A, 1C
P5254	Botanic Gardens Information Center		4.16	240/120	25		6.25	Feeder 1A, 1B	Feeder 3B, 3C
P5476	Trailer Anthropology		4.16	208/120	75	4.25	18.75	Feeder 1A, 1B	Feeder 3B, 3C
Site	Temporary Pole Mount - Parking Lot 8		4.16	208/120	75		18.75	Feeder 1A, 1B	Feeder 3B, 3C
Total Feeders 1A, 1B - Central Plant 12.47kV-4.16kV Substation					6,500		1,625		
Total kVA Demand					16,000		4,000		

TABLE 6.3—EXISTING FACILITIES INSTALLED CAPACITIES AND DEMAND BY EXISTING AND PROPOSED FEEDERS (12.47 KV SYSTEM) (CONT.)

CAAN	Building Name	Comment	Primary Voltage (kV)	Secondary Voltage (V)	KVA	Impedance	Demand	Existing Feeder(s) Serving the Facility	Proposed Feeder(s) Serving the Facility
Feeders 2A, 2B									
P5261	Marlan & Rosemary Bourns Hall		12	480/277	4,000	5.52	1,000	Feeder 2A	Feeder 2A, 2B
P5272	Parking Services Building		12	208/120	150		37.5	Feeder 3A	Feeder 6A, 6B
P5343	Aberdeen-Inverness Residence Hall	A	12.47	208/120	300	6.23	75	Feeder 3A, 3B	Feeder 5A, 5B
P5343	Aberdeen-Inverness Residence Hall	B	12	208/120	300	6.23	75	Feeder 3A, 3B	Feeder 5A, 5B
P5343	Aberdeen-Inverness Residence Hall	C	12	208/120	300	6.23	75	Feeder 3A, 3B	Feeder 5A, 5B
P5343	Aberdeen-Inverness Residence Hall	C1	12	480	750	6.00	187.5	Feeder 3A, 3B	Feeder 5A, 5B
P5343	Aberdeen-Inverness Residence Hall	D	12	208/120	300	6.23	75	Feeder 3A, 3B	Feeder 5A, 5B
P5343	Aberdeen-Inverness Residence Hall	E	12	208/120	300	6.10	75	Feeder 3A, 3B	Feeder 5A, 5B
P5341	Alfred M. Boyce Hall	A	12	480/277	1,000	6.43	250	Feeder 2A, 2B	Feeder 2A, 2B
P5341	Alfred M. Boyce Hall	B	12	208/120	1,000	6.40	250	Feeder 2A, 2B	Feeder 2A, 2B
P5588	Statistics Computer Building	A	12	480/277	500	5.12	125	Feeder 2A, 2B	Feeder 2A, 2B
P5588	Statistics Computer Building	B	12	208/120	500	5.96	125	Feeder 2A, 2B	Feeder 2A, 2B
P5194	Engineering Building Unit 2		12	480/277	2,000	5.79	500	Feeder 2A, 2B	Feeder 2A, 2B
P5335	Geology Building	A	12	480/277	1,000	5.66	250	Feeder 2A, 2B	Feeder 2A, 2B
P5335	Geology Building	B	12	208/120	500	5.93	125	Feeder 2A, 2B	Feeder 2A, 2B
P5335	Geology Building	Lab	12	480/277	2,000	4.78	500	Feeder 2A, 2B	Feeder 2A, 2B
P5502	Lothian Residence Hall	A - West	12	208/120	500	5.93	125	Feeder 2A, 2B	Feeder 4B, 4C
P5502	Lothian Residence Hall	B	12	480/277	2,000	6.49	500	Feeder 2A, 2B	Feeder 4B, 4C
P5502	Lothian Residence Hall	C	12	480	300	5.87	75	Feeder 2A, 2B	Feeder 4B, 4C
P5502	Lothian Residence Hall	D	12	208/120	300	6.13	75	Feeder 2A, 2B	Feeder 4B, 4C
P5365	Pentland Hills Residence Hall	A	12	480/277	750	5.54	187.5	Feeder 3A, 3B	Feeder 4B, 4C
P5638	Pentland Hills Residence Hall	E	12	480/277	750	5.54	187.5	Feeder 3A, 3B	Feeder 4B, 4C
P5643	Pentland Hills Residence Hall 2	L	12	480/277	750	5.54	187.5	Feeder 3A, 3B	Feeder 4B, 4C
P5646	Pentland Hills Residence Hall 2	O	12	480/277	750	5.54	187.5	Feeder 3A, 3B	Feeder 4B, 4C
P5471	Glen Mor Housing B		12	480/277	150	4.19	37.5	Feeder 3A, 3B	Feeder 4B, 4C
P5508	W. Conway Pierce Hall	Addition	12	480/277	500	5.30	125	Feeder 2A, 2B	Feeder 2A, 2B
P5418	Raymond L. Orbach Science Library		12	480/277	2,500	5.77	625	Feeder 2A, 2B	Feeder 2A, 2B
P5511	Student Recreation Center		12	480/277	2,000	6.23	500	Feeder 3A, 3B	Feeder 5A,5B

TABLE 6.3—EXISTING FACILITIES INSTALLED CAPACITIES AND DEMAND BY EXISTING AND PROPOSED FEEDERS (12.47 KV SYSTEM) (CONT.)

CAAN	Building Name	Comment	Primary Voltage (kV)	Secondary Voltage (V)	KVA	Impedance	Demand	Existing Feeder(s) Serving the Facility	Proposed Feeder(s) Serving the Facility
P5342	Herbert John Webber Hall	A	12	480/277	225	5.75	56.25	Feeder 2A, 2B	Feeder 2A, 2B
P5342	Herbert John Webber Hall	B	12	208/120	300	4.42	75	Feeder 2A, 2B	Feeder 2A, 2B
P5417	Entomology Buildings Seismic Replacement		12	480/277	2,000	7.73	500	Feeder 2B	Feeder 3B, 3C
P5470	Glen Mor Housing A	A	12	208/120	1,000	5.86	250	Feeder 3A, 3B	Feeder 4B, 4C
P5474	Glen Mor Housing E	E	12	208/120	1,000	5.80	250	Feeder 3A, 3B	Feeder 4B, 4C
Total	kVA / Demand				30,675		7668.75		
Feeders 3A, 3B									
P5224	University Bookstore		12	208/120	300	4.10	75	Feeder 3A, 3B	Feeder 1A, 1B
P5372	Chass Interdisciplinary South		12	480/277	1,500	5.81	375	Feeder 3A, 3B	Feeder 1A, 1B
P5411	Arts Building, Fine Arts Seismic Facility	A	12	208/12	750	5.64	187.5	Feeder 3A, 3B	Feeder 1A, 1B
P5411	Arts Building, Fine Arts Seismic Facility	B	12	208/12	750	5.64	187.5	Feeder 3A, 3B	Feeder 1A, 1B
P5404	Highlander Union Building	A	12	208/120	750	5.63	187.5	Feeder 3A, 3B	Feeder 1A, 1B
P5404	Highlander Union Building	B	12	480/277	1,500	5.62	375	Feeder 3A, 3B	Feeder 1A, 1B
P5307	Humanities & Social Sciences		12	480/277	1,500			Feeder 3A, 3B	Feeder 1A, 1B
P5195	Materials Science & Engineering		12	480/277	3,750	5.99	937.5	Feeder 3A, 3B	Feeder 5A, 5B
P5614	Student Support Services Building		12	480/277	750	5.84	187.5	Feeder 3A, 3B	Feeder 1A, 1B
P5380	Campus Surge		12	480/277	750	5.75	187.5	Feeder 3A, 3B	Feeder 1A, 1B
P5498	Humanities Building		12	208/120	500	1.90	125	Feeder 3A, 3B	Feeder 4A, 2C
Total	kVA / Demand				12,800		2825		
Feeders 4A, 4B									
P5367	Satellite Chiller Plant		12	480/277	2,500	6.00	625	Feeder 4A	Feeder 3B, 3C
P5367	Satellite Chiller Plant	TES Tank 2	12	480/277	225	5.00	56.25	Feeder 4A	Feeder 3B, 3C
Site	Recycle Center - University Substation		12	208/120	1,000	5.75	250	Feeder 4B	Feeder 4B
Total	kVA / Demand				3,725		931.25		
Total	kVA / Demand				63,200		15,425		

TABLE 6.4—EXISTING FACILITIES INSTALLED CAPACITIES AND DEMAND BY EXISTING AND PROPOSED FEEDERS (4.16 KV SYSTEM)

CAAN	Building Name	Comment	Primary Voltage (kV)	Secondary Voltage (V)	KVA	Impedance	Demand	Existing Feeder(s) Serving the Facility	Proposed Feeder(s) Serving the Facility
P5480	Ivan Hinderaker Hall		4.16	208/120	500	5.25	125	Feeder 3	Feeder 1A, 1B
P5358	The Barn		5	208/120	75		18.75	Feeder 3	Feeder 1A, 1B
P5530	Bell Tower		5	208/120	75		18.75	Feeder 2, 6 and 7 (Loop System)	Feeder 1A, 1B
P5295	Central Utility Plant	A	5	480/277	1,000	5.57	250	Feeder 2, 8 (Loop System)	Feeder 4A, 2C
P5295	Central Utility Plant	B	5	208/120	450	4.50	112.5	Feeder 2, 8 (Loop System)	Feeder 4A, 2C
P5295	Central Utility Plant	TS-1	5	208/120	1,000	6.10	250	Feeder 2, 8 (Loop System)	Feeder 4A, 2C
P5486	Corporation Yard B		5	208/120	300	4.50	75	Feeder 4	Feeder 4
P5498	Humanities Building	A	5	208/120	113		28.125	Feeder 2, 8 (Loop System)	Feeder 4A, 2C
P5497	John W. Olmsted Hall	A	5	208/120	300		75	Feeder 2, 8 (Loop System)	Feeder 4A, 2C
P5497	John W. Olmsted Hall	B	5	208/120	300		75	Feeder 2, 8 (Loop System)	Feeder 4A, 2C
P5322	Tomas Rivera Library	A (Rm 50)	5	208/120	750	6.45	187.5	Feeder 3	Feeder 1A, 1B
P5322	Tomas Rivera Library	B (Rm 50)	5	480/277	750	5.73	187.5	Feeder 3	Feeder 1A, 1B
P5322	Tomas Rivera Library	C (Rm 6a)	5	208/120	500	6.16	125	Feeder 3	Feeder 1A, 1B
P5322	Tomas Rivera Library	D	5	208/120	225	5.07	56.25	Feeder 3	Feeder 1A, 1B
Site	Parking Lot 30 - University Substation		5	480	113	4.97	28.125	Feeder 3	Feeder 3
P5508	W. Conway Pierce Hall	A (Rm. 100a)	5	208/120	500	5.10	125	Feeder 2, 6 and 7 (Loop System)	Feeder 2A, 2B
P5508	W. Conway Pierce Hall	B (Rm. 300a)	5	208/120	750	5.24	187.5	Feeder 2, 6 and 7 (Loop System)	Feeder 2A, 2B
P5508	W. Conway Pierce Hall	C (Rm. 300a)	5	208/120	750	5.24	187.5	Feeder 2, 6 and 7 (Loop System)	Feeder 2A, 2B
P5508	W. Conway Pierce Hall	D (Rm. 418)	5	208/120	750	5.70	187.5	Feeder 2, 6 and 7 (Loop System)	Feeder 2A, 2B
P5504	Physics Building	A	5	208/120	300	4.65	75	Feeder 2, 6 and 7 (Loop System)	Feeder 2A, 2B
P5504	Physics Building	B	5	208/120	750	6.06	187.5	Feeder 2, 6 and 7 (Loop System)	Feeder 2A, 2B

TABLE 6.4—EXISTING FACILITIES INSTALLED CAPACITIES AND DEMAND BY EXISTING AND PROPOSED FEEDERS (4.16 KV SYSTEM) (CONT.)

CAAN	Building Name	Comment	Primary Voltage (kV)	Secondary Voltage (V)	KVA	Impedance	Demand	Existing Feeder(s) Serving the Facility	Proposed Feeder(s) Serving the Facility
P5504	Physics Building	C	5	480	500	5.25	125	Feeder 2, 6 and 7 (Loop System)	Feeder 2A, 2B
P5504	Physics Building	D	5	208/120	300	4.94	75	Feeder 2, 6 and 7 (Loop System)	Feeder 2A, 2B
P5504	Physics Building	D	5	480	300	5.13	75	Feeder 2, 6 and 7 (Loop System)	Feeder 2A, 2B
P5496	Physical Education Utility Building	Track Stadium	5	480/277	500	4.70	125	Feeder 3	Feeder 5A, 5B
Site	Pumping Station Storm Water - Canyon Crest Underpass	Storm Water	5	208/120	150	3.00	37.5	Feeder 3	Feeder 3
SITE	Pumping Station Domestic Water - University / Canyon Crest	Domestic Water	5	208/120	1,000	5.53	250	Feeder 3	Feeder 3
P5523	Robert Gordon Sproul Hall		5	208/120V	500	5.10	125	Feeder 3	Feeder 1A, 1B
P5354	Gordon S. Watkins Hall		5	208/120V	500	5.00	125	Feeder 3	Feeder 1A, 1B
Total	kVA / Demand				14,000		3,500		

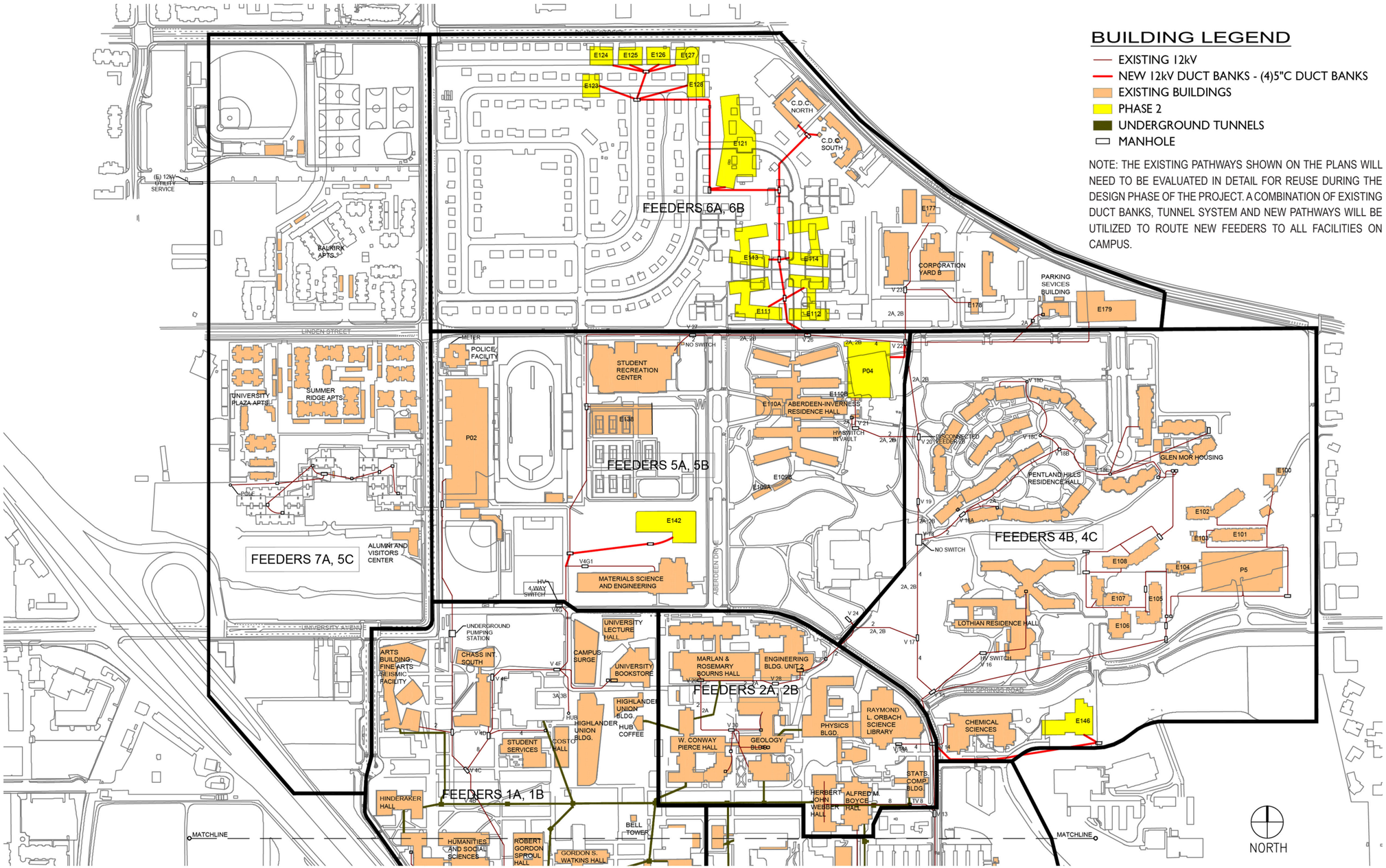


Figure 6.3—Phase 2 Buildings Electrical Site Plan–North

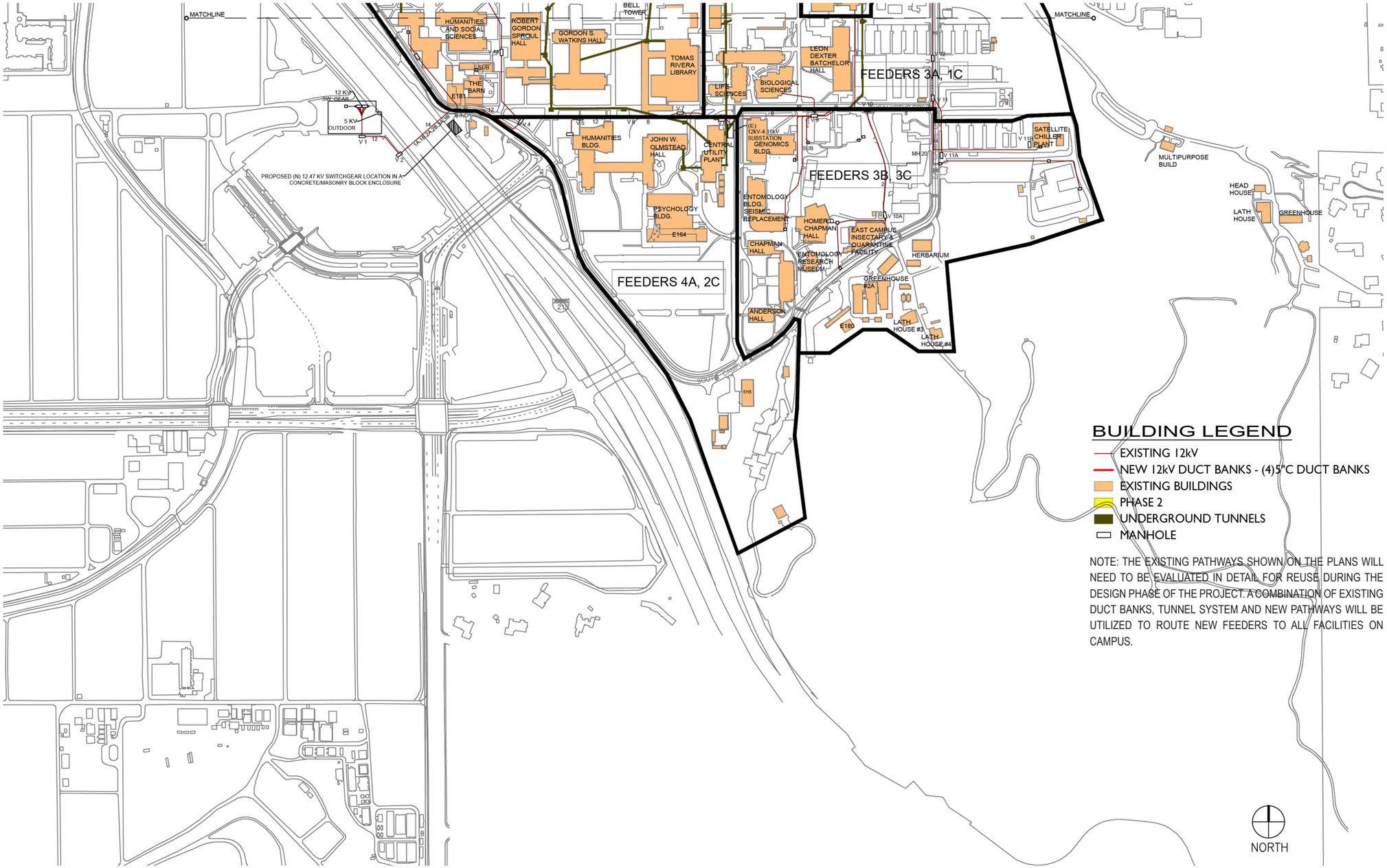


Figure 6.4—Phase 2 Buildings Electrical Site Plan–South

Phase 3—2021-2025

Table 6.3 provides facilities that are provided in phase 3 along with their connected loads and demands. An evaluation of the connected loads and demands of these facilities revealed that the new duct banks/feeders will need to be provided to support the power demand of these facilities. The following are our proposed recommendations to be implemented in this phase of the development plan:

- Extend new feeders as shown in Table 6.5 to serve proposed facilities being provided in this phase of the development plan. Provide new 5" electrical duct banks with 15kV, 3#500kcmil Cu. 133% EPR cables duct banks and medium voltage feeders and associated manholes to extend these feeders as depicted in phase 3 site plan provided at the end of the section. Feeder designations that will be used to serve proposed facilities provided in this phase of the development plan are also provided in table 6.5 below.
- Provide new 15kV selector switches consistent with equipment specifications contained in Chapter 7 to serve the proposed facilities and provide a primary selective system. Radial feeders originating from these selector switches will serve substations in each of the facilities. These selector switches will provide ease of isolation of loop faults as well as provide a means of isolating building substations. These switches will be served from the nearest manhole located close to the proposed facility as shown in our proposed phase 1 site plan proposed at the end of the section.
- Conduct a short circuit and arc flash study of the new electrical distribution system and substations provided in facilities as provided as part of the this phase.

TABLE 6.5—PHASE 3: ANALYSIS OF FUTURE LOADS / FEEDERS

Ref #	Site ID	Name	GSF	Parking Spaces	Proposed Building Use	Demand in kW	Feeder Designations	Comments
17	E115	Edinburg 1	168,000	-	Housing	672	Feeder 6A, 6B	GSF Includes Building 2
18	E116	Edinburg 2	0	-	Housing	0	Feeder 6A, 6B	
19	E117	Edinburg 3	84,000	-	Housing	336	Feeder 6A, 6B	
24	E122	Lennox 3	84,000	-	Housing	336	Feeder 6A, 6B	
36	E134	Housing Administration	5,700	-	Housing	23	Feeder 7A, 5C	
37	E135	Bannockburn 1	220,000	-	Housing	880	Feeder 7A, 5C	GSF Includes Building 2
38	E136	Bannockburn 2	0	-	Housing	0	Feeder 7A, 5C	
39	E137	Bannockburn Office/Retail	90,900	-	Housing	364	Feeder 7A, 5C	
42	E140	Academic/Resarch	52,000	-	Academic/Resarch	260	Feeder 5A, 5B	Displaces Soccer Field
43	E141	Engineering IV	113,200	-	Academic/Resarch	566	Feeder 5A, 5B	
47	E145	Academic/Resarch	94,400	-	Academic/Resarch	472	Feeder 4B, 4C	
64	E162	Academic/Resarch	82,200	-	Academic/Resarch	411	Feeder 4A, 2C	
65	E163	Academic/Resarch	89,400	-	Academic/Resarch	447	Feeder 4A, 2C	
72	E170	South of Arts	61,500	-	Academic/Resarch	308	Feeder 1A, 1B	
73	E171	South of CHASS	41,200	-	Academic/Resarch	206	Feeder 1A, 1B	
75	E173	Recital Hall/Museum/Gallery	40,300	-	Student Services	202	Feeder 1A, 1B	
Total			1,226,800			5,481		
89	P01	Parking Structure (Lot 1)		1,200	Parking Structure	125	Feeder 7A, 5C	
91	P03	Parking Structure		1,513	Parking Structure	125	Feeder 6A, 6B	
Total				2,713		250		
Total Added Load in kW						5,731		
Total Deductive Load (Due to Facilities being demolished)						1,548		
Total Effective Load Added						4,183		

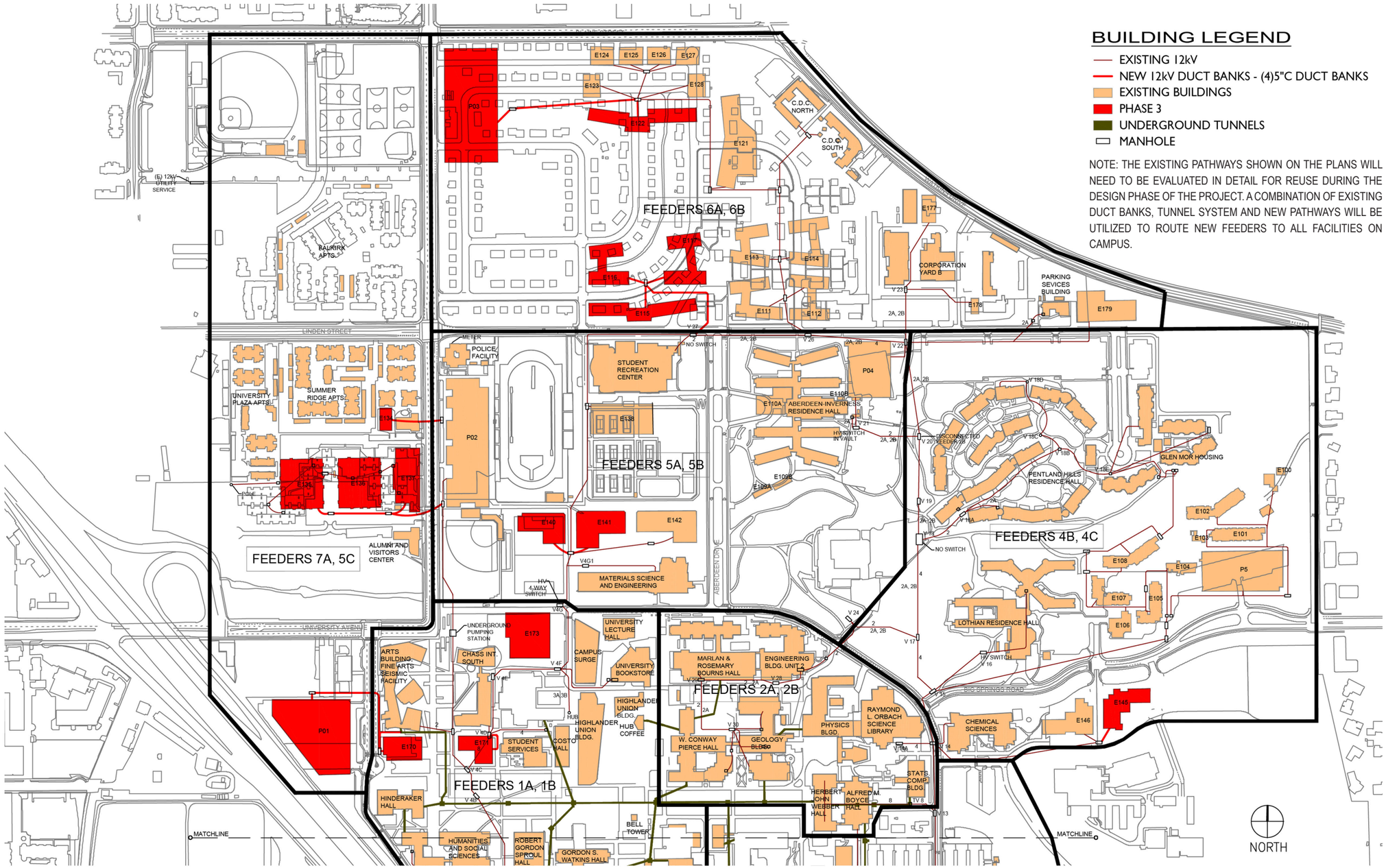


Figure 6.5—Phase 3 Buildings Electrical Site Plan–North

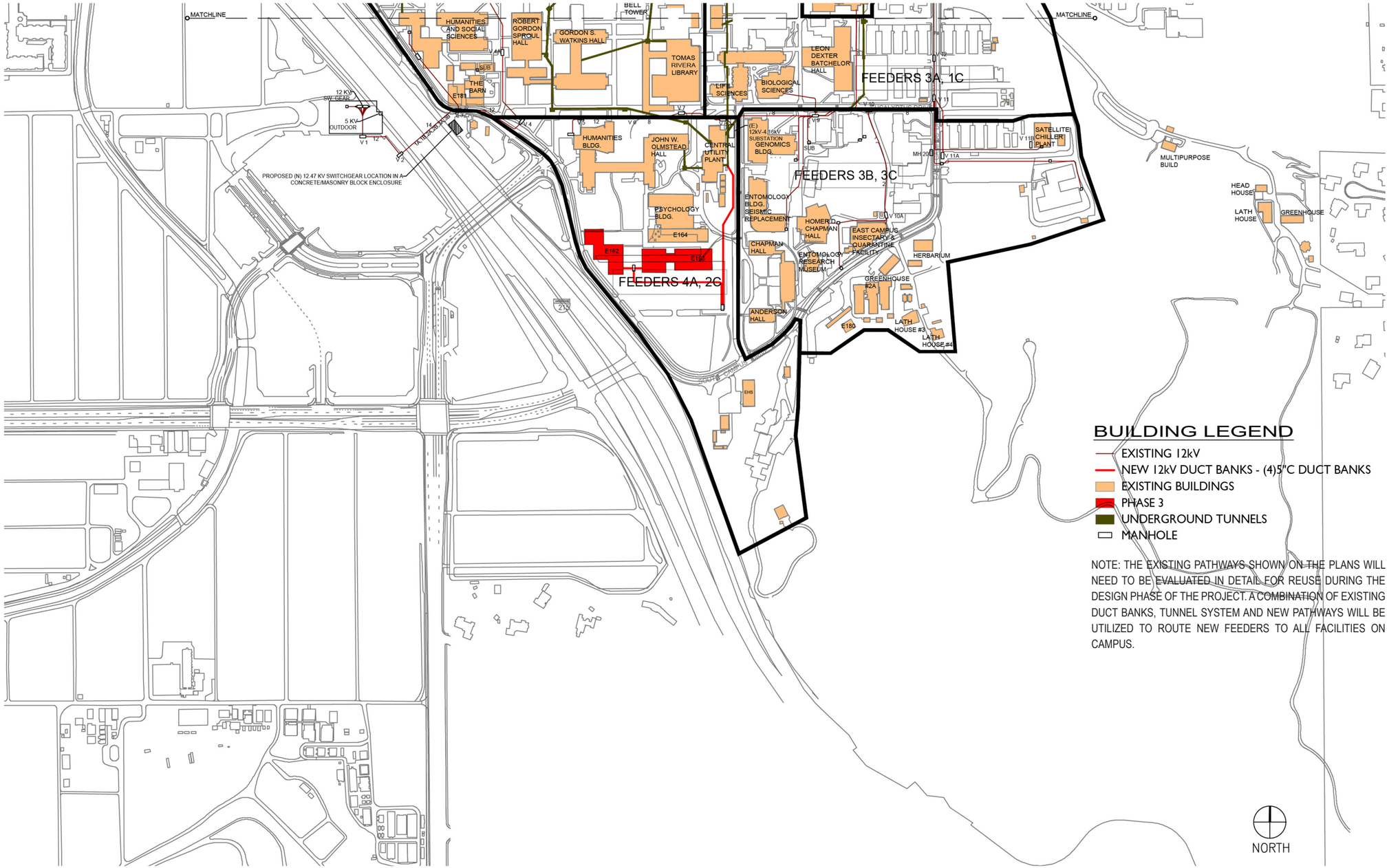


Figure 6.6—Phase 3 Buildings Electrical Site Plan–South

Phase 4—2025-2030

Table 6.6 provides facilities that are provided in phase 4 along with their connected loads and demands. An evaluation of the connected loads and demands of these facilities revealed that the new duct banks/feeders will need to be provided to support the power demand of these facilities. The following are our proposed recommendations to be implemented in this phase of the development plan:

- Extend new feeders as shown in Table 6.6 to serve proposed facilities being provided in this phase of the development plan. Provide new 5" electrical duct banks with 15kV, 3#500kcmil Cu. 133% EPR cables duct banks and medium voltage feeders and associated manholes to extend these feeders as depicted in phase 4 site plan provided at the end of the section. Feeder designations that will be used to serve proposed facilities provided in this phase of the development plan are also provided in table 6.6 below.
- Provide new 15kV selector switches consistent with equipment specifications contained in Chapter 7 to serve the proposed facilities and provide a primary selective system. Radial feeders originating from these selector switches will serve substations in each of the facilities. These selector switches will provide ease of isolation of loop faults as well as provide a means of isolating building substations. These switches will be served from the nearest manhole located close to the proposed facility as shown in our proposed phase 1 site plan proposed at the end of the section.
- Conduct a short circuit and arc flash study of the new electrical distribution system and substations provided in facilities as provided as part of the this phase.

TABLE 6.6—PHASE 4: ANALYSIS OF FUTURE LOADS / FEEDERS

Ref #	Site ID	Name	GSF	Parking Spaces	Proposed Building Use	Demand in kW	Feeder Designations	Comments
20	E118	Café	6,900	-	Housing	28	Feeder 6A, 6 B	
21	E119	Lennox 1	168,000	-	Housing	672	Feeder 6A, 6 B	GSF Includes Building 2
22	E120	Lennox 2	0	-	Housing	0	Feeder 6A, 6 B	
41	E139	Performing Arts Center	123,400	-	Academic	617	Feeder 5A, 5B	
46	E144	Academic/Resarch	94,400	-	Academic/Resarch	472	Feeder 4B, 4C	
67	E165	Academic/Resarch	70,400	-	Academic/Resarch	352	Feeder 4A, 2C	
70	E168	Library Addition	158,300	-	Student Services	792	Feeder 1A, 1B	
Total			884,800			4,250		
94	P06	Parking Structure		853	Parking Structure	83	Feeder 4B, 4C	
Total				853		83		
Total Added Load						4,333		
Total Deductive Load (Due to Facilities being demolished)						1,548		
Total Effective Load Added						2,785		

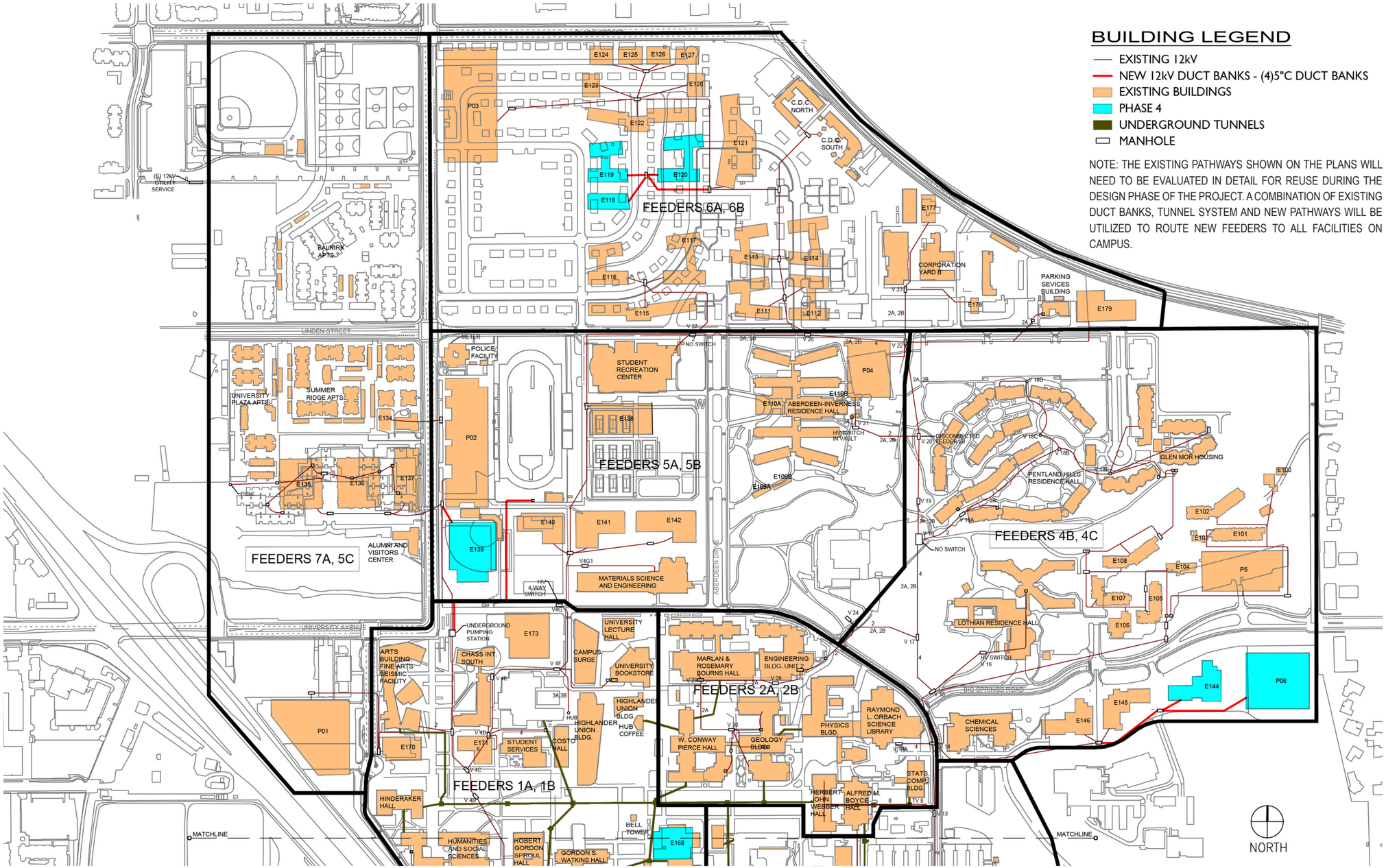


Figure 6.7—Phase 4 Buildings Electrical Site Plan–North

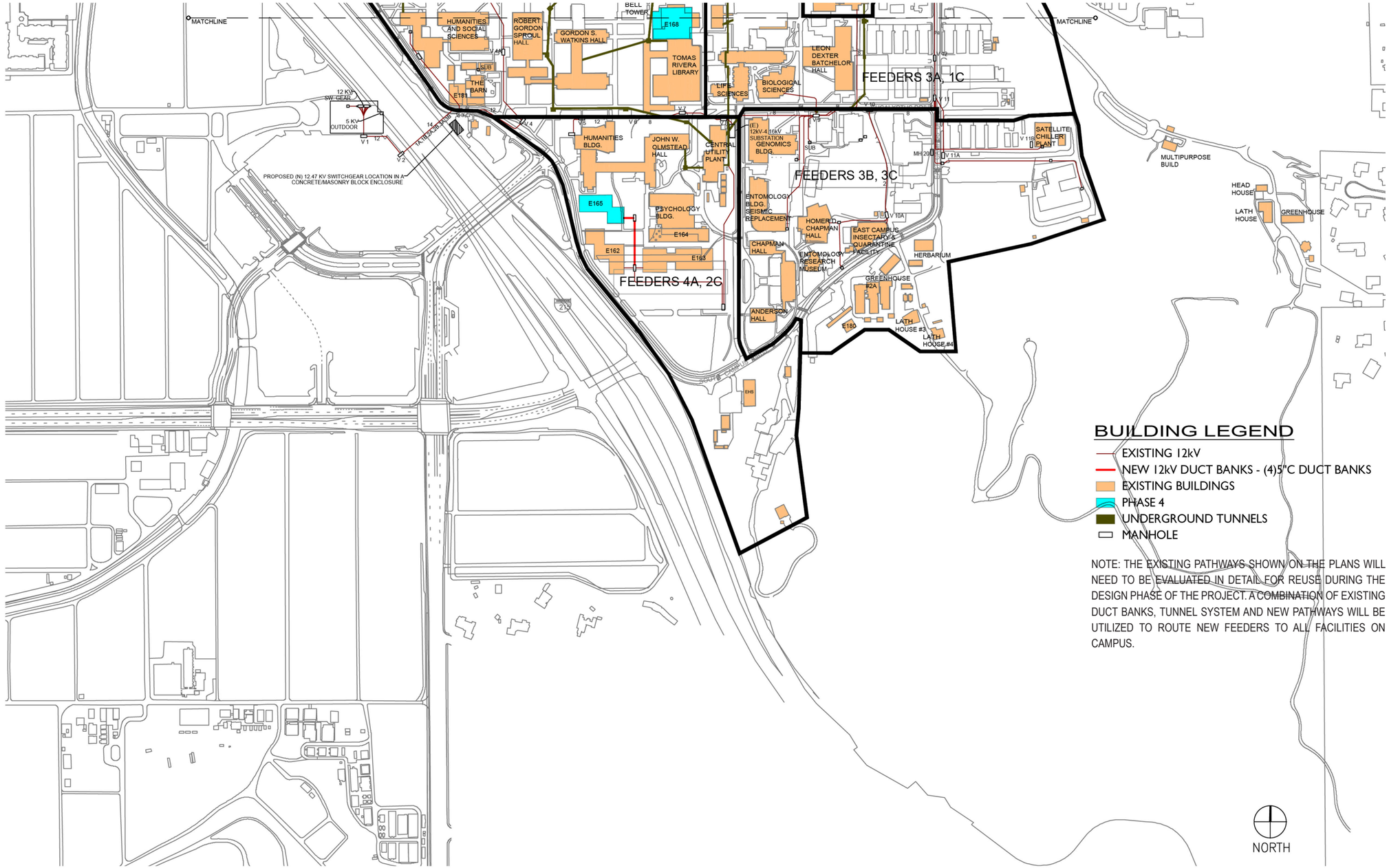


Figure 6.8—Phase 4 Buildings Electrical Site Plan–South

Phase 5—2031+

Table 6.7 provides facilities that are provided in phase 5 along with their connected loads and demands. An evaluation of the connected loads and demands of these facilities revealed that the new duct banks/feeders will need to be provided to support the power demand of these facilities. The following are our proposed recommendations to be implemented in this phase of the development plan:

- Extend new feeders as shown in Table 6.7 to serve proposed facilities being provided in this phase of the development plan. Provide new 5" electrical duct banks with 15kV, 3#500kcmil Cu. 133% EPR cables duct banks and medium voltage feeders and associated manholes to extend these feeders as depicted in phase 5 site plan provided at the end of the section. Feeder designations that will be used to serve proposed facilities provided in this phase of the development plan are also provided in table 6.7 below.
- Provide new 15kV selector switches consistent with equipment specifications contained in Chapter 7 to serve the proposed facilities and provide a primary selective system. Radial feeders originating from these selector switches will serve substations in each of the facilities. These selector switches will provide ease of isolation of loop faults as well as provide a means of isolating building substations. These switches will be served from the nearest manhole located close to the proposed facility as shown in our proposed phase 1 site plan proposed at the end of the section.
- Conduct a short circuit and arc flash study of the new electrical distribution system and substations provided in facilities as provided as part of the this phase.

TABLE 6.7—PHASE 5: ANALYSIS OF FUTURE LOADS / FEEDERS

Ref #	Site ID	Name	GSF	Parking Spaces	Proposed Building Use	Demand in kW	Feeder Designations	Comments
31	E129	Falkirk 1	416,800	-	Housing	1667	Feeder 7A, 5C	GSF Includes Buildings 2-5
32	E130	Falkirk 2	0	-	Housing	0	Feeder 7A, 5C	
33	E131	Falkirk 3	0	-	Housing	0	Feeder 7A, 5C	
34	E132	Falkirk 4	0	-	Housing	0	Feeder 7A, 5C	
35	E133	Falkirk 5	0	-	Housing	0	Feeder 7A, 5C	
45	E143	Health Services	60,700	-	Student Services	304	Feeder 5A, 5B	
62	E160	Academic/Resarch	92,600	-	Academic/Resarch	463	Feeder 4A, 2C	
63	E161	Academic/Resarch	170,800	-	Academic/Resarch	854	Feeder 4A, 2C	
49	E147	Academic/Resarch	166,000	-	Academic/Resarch	830	Feeder 3A, 1C	
50	E148	Academic/Resarch	105,600	-	Academic/Resarch	528	Feeder 3A, 1C	Building could displace generator
51	E149	Academic/Resarch	5,300	-	Academic/Resarch	27	Feeder 3A, 1C	
52	E150	Academic/Resarch	123,600	-	Academic/Resarch	618	Feeder 3A, 1C	
53	E151	Academic/Resarch	100,000	-	Academic/Resarch	500	Feeder 3A, 1C	
54	E152	Academic/Resarch	88,800	-	Academic/Resarch	444	Feeder 3A, 1C	
55	E153	Academic/Resarch	88,800	-	Academic/Resarch	444	Feeder 3B, 3C	
56	E154	Academic/Resarch	77,200	-	Academic/Resarch	386	Feeder 3B, 3C	
57	E155	Academic/Resarch	64,300	-	Academic/Resarch	322	Feeder 3B, 3C	
58	E156	Academic/Resarch	66,000	-	Academic/Resarch	330	Feeder 3B, 3C	
59	E157	Replaces C&C	102,400	-	Institutional Operations	512	Feeder 3B, 3C	
60	E158	Included Above	0	-	Academic/Resarch	0	Feeder 4A, 2C	GSF with Site E159
61	E159	Academic/Resarch	47,000	-	Academic/Resarch	235	Feeder 4A, 2C	
68	E166	Sproul Hall South Addition	60,000	-	Academic/Resarch	300	Feeder 1A, 1B	
69	E167	Watkins North Addition	51,300	-	Academic/Resarch	257	Feeder 1A, 1B	
71	E169	Spieth Hall North Addition	66,600	-	Academic/Resarch	333	Feeder 3A, 1C	
74	E172	Replace Physical Education	67,000	-	Academic/Resarch	335	Feeder 1A, 1B	
76	E174	Academic/Resarch	111,000	-	Academic/Resarch	555	Feeder 7A, 5C	Displaces Reservoir
77	E175	Academic Mixed Use - 3	80,000	-	Academic/Resarch	400	Feeder 7A, 5C	
78	E176	Academic Mixed Use - 4	47,000	-	Academic/Resarch	235	Feeder 7A, 5C	
Total			2,258,800			10,877		
Total Deductive Load (Due to Facilities being demolished)						1,548		
Total Effective Load Added						9,329		

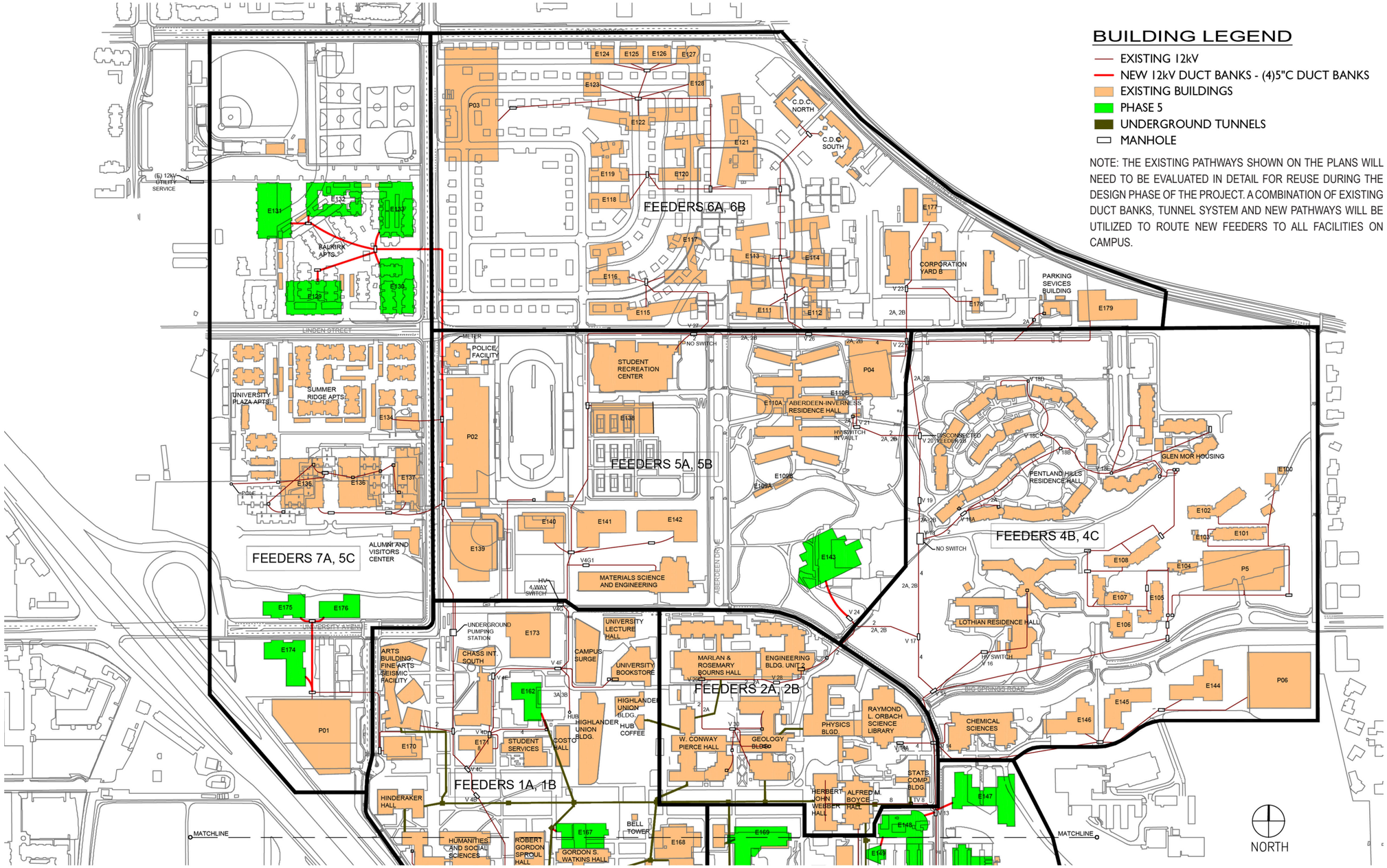


Figure 6.9—Phase 5 Buildings Electrical Site Plan–North

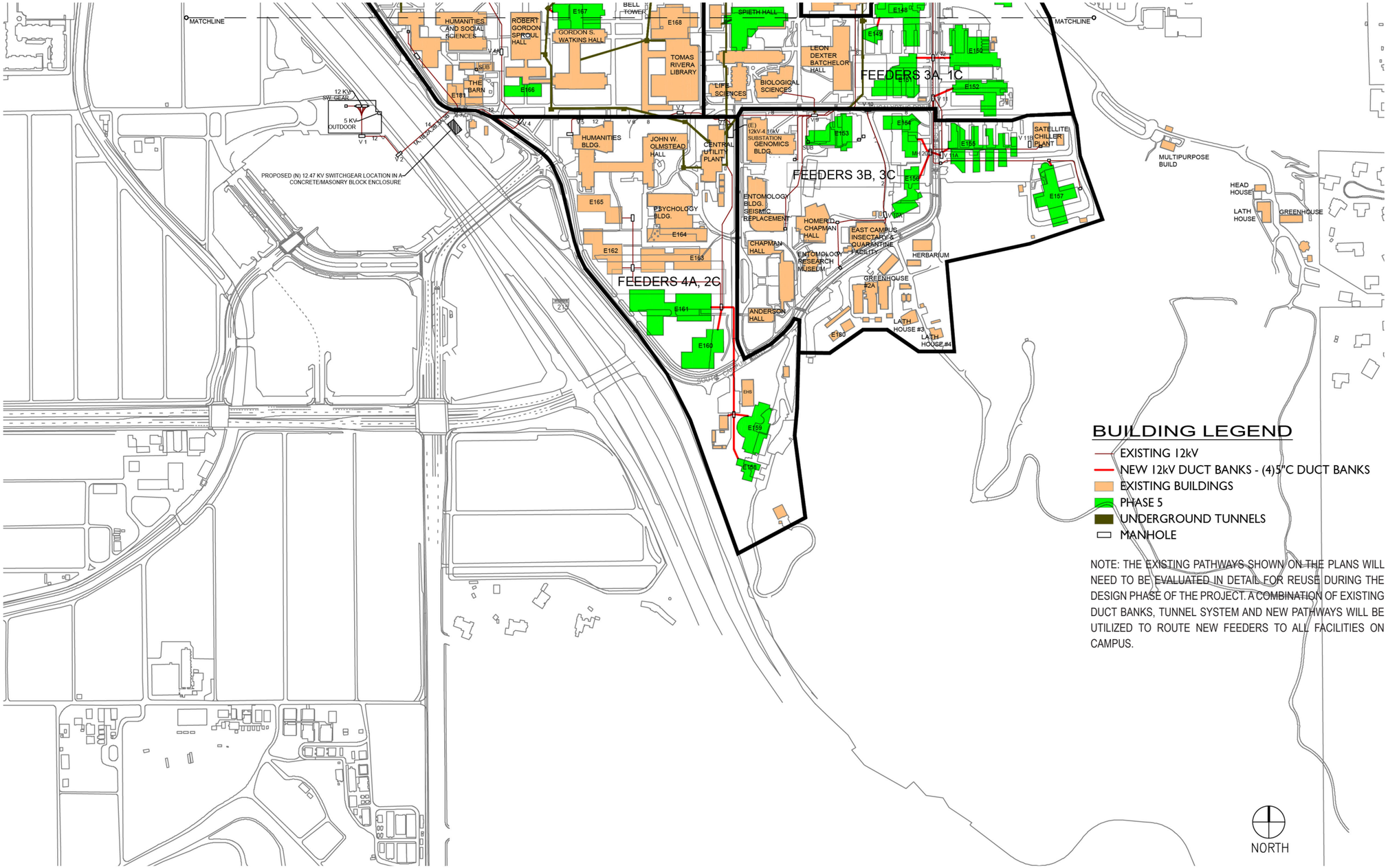


Figure 6.10—Phase 5 Buildings Electrical Site Plan–South

Chapter 7—Electrical Equipment Recommendations and Specifications

Chapter 7—Electrical Equipment Recommendations and Specifications

The following are our recommendations and specifications for proposed electrical equipment to be used in the proposed improvements of the electrical infrastructure to serve the existing and future facilities planned at the campus. The specifications provided below are for 15kV medium voltage cables, 15kV selector switches and underground electrical work. These specifications are provided in an effort to a) maintain quality of equipment being installed at the campus for supporting existing and future facilities, b) standardizing equipment at the campus to reduce maintenance costs, and c) to ensure future projects use the same as reference in specifying these materials to maintain consistency of electrical materials at the campus.

15kV Medium Voltage Cables

General Requirements

The cable shall be copper, 15 KV rated EPR insulation jacketed, shielded. Aluminum cable will not be accepted.

Standards

A. ICEA S-93-639 & ICEA S-97-682

B. AEIC CS8

C. UL 1072

D. IEEE

E. ASTM

F. NEMA

G. Material and installation shall meet or exceed the above referenced standards.

Quality Assurance

A. The manufacturer shall have a minimum of ten (10) years of experience in manufacturing medium voltage EPR power cables and shall submit a certified copy of its AEIC CS 8 qualification.

B. American made cable has been acceptable to the University. If non-domestic equipment is submitted, notice is hereby given that extensive testing shall be required to ensure quality and conformance to the specifications. All of the testing procedures and results shall be satisfactory to the University and witnessed by the University's Representative. The contractor shall bear all costs for testing and shall be responsible for all costs associated with travel, lodging, etc. for the University's Representative to witness the tests at the testing facility. The Contractor shall reimburse the University's Representative at $1,200 per man-day or part thereof for the time required to witness the testing. The Contractor shall issue a deductive change order for the above costs.

C. Testing: Provide the services of a qualified testing laboratory to perform the specified field tests. Notify the University's Representative 14 days in advance of performance of Work requiring testing.

D. Manufacturer shall have ISO - 9001 Certification.

E. The cable manufacturer shall compound the insulation in its own facility using a closed system to insure maximum cleanliness. All ingredients shall be mixed and screened through a fine mesh screen pack. Materials shall be stored in a Class 10,000 clean room.

Submittals

A. Shop Drawings:

B. Complete data sheet for cable construction, shielding, insulation material, thickness of insulation and jacket cable stranding and voltage rating, total amount of order in feet, including manufacturer's AEIC CS 8 qualifications.

C. Manufacturer's ISO certification.

D. Certified test reports for:

1. Sample test on insulation: physical properties, voids, contaminants, hot creep
2. Factory test for insulation resistance, partial discharge, AC withstand.
3. Certified Factory Test Report including the results of the test plus cable identification, factory order number, cable length and all cable specifications. No cable shall be installed in any duct or conduit until related test report has been accepted by the University's Representative.
4. Field Test Report.
5. Qualifications of "Cable Splicers": Submit a certification for the approval of the University's Representative containing the names and the qualifications of persons recommended to perform the splicing and termination of medium voltage cables approved for installation.
6. Factory Tests: A complete test shall be done on each length of cable at the factory in accordance with ICEA S-93-639, and UL-1072. In addition a corona test shall be done per AEIC CS8-00, Section E. Furnish six (6) certified copies of the test report complete with X-Y recording showing the corona test results for review and approval.
7. Cable Sample: Furnish a two (2) feet sample of actual cable to be used on this project. Sample shall be submitted to the University's Representative for review (14) days prior to shipment of cable by the manufacturer.

E. Testing Agency Qualification Documents.

Material Specifications

Medium Voltage Cables

A. General:

1. 15 KV ungrounded, shielded, single copper conductor, UL listed Type MV 133% rated, with ethylene-propylene (EPR) insulation, jacketed. Manufactured within one year of installation.

2. Suitable for installation in conduit, subject to alternately wet and dry conditions

3. To operate satisfactorily, both electrically and mechanically, at conductor temperatures not exceeding 105 Deg. C continuous for normal loading; 130 Deg. C for emergency loading, 250 Deg. C for short circuit loading assuming a short circuit duration of two seconds. Emergency overload operation may occur for periods up to 1500 hours during the lifetime of the cable.

4. Cable to meet the specifications and the minimum requirements of the latest revisions of ICEA and AEIC Standards.

5. All future cable replacements shall be 15 kV, 133% EPR cable insulation.

B. Conductors: Soft, annealed copper, concentric compact Class B stranded per ASTM B-8.

C. Strand Shielding: Thermoset EPR based material or a semi- conducting polymer extruded over the conductors with thermal characteristics equal to or better than those of the insulation; chemically compatible with the conductor and the cable insulation; firmly and continuously bonded to the overlaying insulation; easily removable from the conductors; not less than 12 mils (8-4/0), 16 mils (250-500), 20 mils (750-1000). Compatibility of material shall be demonstrated by laboratory test results.

D. Insulation: High quality, ethylene-propylene base, thermosetting compound of high dielectric strength with heat, moisture, ozone, and corona resistant properties, homogenous, solid, and applied with good workmanship. Insulation thickness shall be 220 mils minimum average, and 210 mils minimum at any point; meet or exceed the latest editions of Standards ICEA S-93-639, AEIC CS-8 for 133% insulation level. EPR insulation compound shall contain no polyethylene.

E. Semi-Conducting Shield: Insulated conductor to have a suitable layer of semi-conducting, extruded, thermosetting, polymer insulation shielding applied directly over the insulation; 60 mils maximum thickness; 24 mils minimum thickness; impervious to sunlight, the elements and acid or alkaline soils.

F. Shielding Tape: Uncoated copper tape, helically applied over insulation .005 inch thick with minimum 25% overlap.

G. Jacket: 80 mil, minimum average thickness polyvinyl chloride jacket extruded over the shielding tape; smooth, of uniform composition and free of holes, cracks and imperfections; longitudinal shrinkage relative to the insulation less than five percent.

H. Construction: Strand shielding insulation and semi-conducting insulation shield shall be applied in a true triple extrusion or dual tandem extrusion process.

I. Identification: Provide durable lifetime identification printed, embossed, or engraved on outer surface of the jacket including manufacturer's name, year of manufacture, place of manufacture, conductor type and size, insulation thickness in mils, and the rated voltage, all on 3 foot center maximum spacing.

J. Sealing: Seal ends of cable with mastic material and tight fitting plastic end cap to prevent entrance of moisture.

K. Manufacturers: Okonite, General Cable, Kerite, or equal.

L. Cable shall be triplexed as noted on drawings at the factory, with all 3 phases custom cut to length and twisted on to a common reel prior to delivery to job site.

Cable Terminators

A. Conductor terminations on 15KV switchgear shall be 25 kV porcelain type slip-on terminators manufactured by G&W Electric Company, or equal (no known equal).

Modular Connectors

A. Manufacturers: 3M, Elastimold, Cooper

B. Description: 600 ampere fully shielded, submersible type separable insulated connection "T-Bolt" system rated for continuous operation at 25 KV for single-conductor shielded power cables. The system components shall be designed according to the specifications listed in ANSI/IEEE Standard 386-1985 for 25 KV, 600 amp dead-break interfaces. The system shall be made up of specific kits designed for splicing, tapping (adding-on) dead-ending, and 600 amp equipment connecting. Each kit shall contain all the components necessary for its intended application. The connector cable sizing adapter and shield adapter, shall be contained in a separate adapter kit. The system shall be capable of making dead-end, 2 way, 3-way or multiple tap splices, and of making connections to 25 KV 600 amp apparatus bushings.

C. Provide neon voltage indicators attached to each splice connector test point above ground only. The indicator shall provide a flashing signal when the connector is energized. The indicator shall be replaceable type by "Hot Stick" method".

In-Line Cable Splices

A. Manufacturers: Raychem, Elastimold

B. Description:

1. Raychem – Type HVS heat shrinkable, rated 5-35 kV

2. Elastimold – Type PCJ cable joint, 25 kV rated

Arc and Fireproofing Tape

A. Manufacturers:

1. Bishop Model 43A

2. 3M Model 7700, or equal

Execution

Preparation

A. Use swab to clean conduits and ducts before pulling cables.

Installation

A. Install cable and accessories in accordance with manufacturer's instructions by qualified high volt electrician.

B. Avoid abrasion and other damage to cables during installation.

C. Use suitable lubricants and pulling equipment.

D. Do not exceed cable pulling tensions and bending radius.

E. Ground cable shield at each termination and splice. Conductor shield continuity must be maintained at all splices.

F. Install cables in manholes such that cables have sufficient slack for addition of minimum one set of T-bolt splices. Coordinate exact requirement with University's Representative prior to rough-in.

G. Arrange cable in manholes to avoid interference with duct entrances and future splicing.

H. Fireproof cables in manholes and cable vault using fireproofing tape in half-lapped wrapping. Extend fireproofing one inch into duct.

I. Spiral wrap fireproofing tape with glass tape 3M number 27 or equal (no known equal).

J. Keep splices to a minimum unless otherwise indicated. Pull cable in two directions from central manhole wherever possible.

L. Single conductor cables in gutters or wireways, or racks in vaults, shall have the three conductors or each circuit bound together with plastic cable ties at point not over three feet apart.

M. Manufacturer's instruction shall be followed for installation of terminations, splices and modular connectors.

Field Tests

A. Testing of cables shall be performed by an independent testing agency at the Contractor's expense. The testing agency shall have a minimum of 5 years experience. Each person engaged in the testing procedures shall also meet the experience requirements. Provide to University's Representative, documentation, including references, of the testing agency's, and agency's personnel experience for approval.

B. Perform DC high potential test of each conductor in accordance with the latest NETA standards.

C. Connect untested conductors in circuit to ground during test.

D. Apply test voltage in at least eight equal increments to maximum test voltage.

E. Record leakage current at each increment, allowing for charging current decay.

F. Hold maximum test voltage for fifteen minutes. Record current at 30 seconds and every 60 seconds thereafter. Plot results on X-Y axis.

G. Each insulated conductor provided under this section of the Specification shall be tested in accordance with AEIC CS8

H. Cable splices and terminations shall be tested as an assembly.

I. All existing cable shall be megger tested at 15kV. Do not hi-pot existing cables. Submit megger test results to UCR Representative for approval prior to termination and re-energizing.

Protection

A. Protect installed cables from entrance of moisture. Provide heat shrink caps per Cable Manufacturer's recommendations for cables to be energized later on.

Underground Electrical Work

General Requirements

Section Includes

A. Conduit/Duct (all types)

B. Precast Manholes

C. Sealing Material for Precast Manholes

D. Manhole Frames and Covers

Submittals

The following information shall be submitted for approval:

A. Product Data: Provide for:

1. Conduit/Duct (all types)
2. Precast Manholes
3. Sealing Material for Precast Manholes
4. Manhole Frames and Covers

B. Shop drawings: Provide for:

1. Precast Manholes: Indicate dimensions, reinforcement, size and locations of openings, and accessory locations for precast manholes.

C. Certificates:

1. Material and Equipment: Provide manufacturer's statement certifying that the product supplied meets or exceeds contract requirements.

a. Precast manhole and accessories.

Project Record Documetns

A. Accurately record actual locations of exact routing of ductbank in both plan and profile views.

B. Accurately record actual locations of each manhole.

Material Specifications

Materials and Equipment

All materials and equipment shall be new and of high quality to give long life and reliable operation. All equipment shall be modern in design and shall not have been in prior service except as required by factory tests. Materials and equipment shall conform to the respective specifications and standards and to the specifications herein. Electrical ratings shall be as indicated.

Conduit

A. Rigid Metal Conduit: UL 6, hot-dip galvanized, threaded type.

B. Rigid Plastic Conduit: NEMA TC2; Schedule 40 PVC.

C. Rigid Plastic Conduit: NEMA TC2; Schedule 80 PVC.

Plastic Duct

A. Plastic Utilities Duct: NEMA TC 8; PVC Type EB.

Fittings and Outlet Boxes

A. Metal Fittings and Outlet Boxes: UL 514A and 514B. Fittings and boxes for use with steel conduit, rigid or flexible shall be cast-metal with gasketed closures.

B. PVC Fittings and Conduit Bodies: NEMA TC3.

C. Plastic Utility Duct Fittings: NEMA TC 9.

Power Wire and Cables

A. Wire and Cable Conductor Sizes: Wire and cable conductor sizes are designated by American Wire Gauge (AWG) or Thousands of Circular Mils (kcmil). Conductors shall be copper. Insulated conductors shall bear the date of manufacture imprinted on the wire insulation with other identification. Wire and cable manufactured more than 6 months before delivery to the job site shall not be used. Provide conductor identification within each enclosure where a tap, a splice or a termination is made.

B. 600 Volt Wires and Cables: UL 44, ICEA S-66-524, NEMA WC-7. Conductors shall be stranded copper per ASTM B-3 or B-8. Insulation shall be type THHN unless otherwise noted.

Connectors and Terminals

A. Wire Connectors and Terminals for use with Copper Conductors: UL 486A.

B. Insulated Wire Connectors for Underground Conductor: UL 486C.

C. Grounding conductors shall be 600V insulated conductor with green jacket. All conduits shall have properly sized ground per current codes installed with undergrounded feeders.

D. High voltage connectors shall be rated for their application and use.

Pull WirePull wire shall be nylon having a minimum tensile strength of 200 lbs in each empty duct. Minimum 48 inches of slack shall be left at each end of pull wires. Rod and clean all existing ducts to be used. Plug spares for future use.

Cable Supports

Provide a means of supporting all cables running through electrical manholes. This shall be in the form of vertical channels cinch anchored to the manhole wall. A cantilevered support fastened to the channels shall be used to support the cable and splices. Cable racks, including rack arms and insulators, shall be adequate to accommodate the cable. A porcelain clamp shall be used to insulate and protect cables from supports. All cables smaller than 0.75" diameter shall be provided with some supplementary means of support such as cable tray or conduit. All exposed metal parts and fasteners shall be fabricated of stainless steel or double hot-dip galvanized steel.

Precast Concrete Manholes

A. Precast concrete manholes, risers and tops shall conform to ASTM C 478, except that the spacing of manhole steps or ladder rungs shall not exceed 16 inches and shall be per detailed on the drawings. Precast units shall be the product of a manufacturer regularly engaged in the manufacture of precast concrete manholes. Manholes shall be the type noted on the drawings and shall be constructed in accordance with the applicable details as indicated. Top, walls, and bottom shall consist of reinforced concrete constructed in modular sections with tongue-and-groove joints. Walls and bottom shall be of monolithic concrete construction. Covers shall fit the frames without undue play. Steel and iron shall be formed to shape and size with sharp lines and angles. Castings shall be free from warp and blow holes that may impair their strength or appearance. Exposed metal shall have a smooth finish and sharp lines. Provide all necessary lugs, rabbets, and brackets.

B. Reinforcing: AASHTO Classification H-20.

C. Duct Entry Provisions: Windows with plastic duct terminators and diaphragms. Duct entrances and windows shall be located near the corners of structures to facilitate cable racking.

D. Cable Pulling Irons: Use galvanized rod and hardware. A pulling-in iron shall be installed in the wall opposite each duct line entrance. Set pulling-in irons and other built-in items in place before depositing concrete. Provide watertight seal.

E. Cable Rack Inserts: Minimum load rating of 800 pounds.

F. Ladder: Steel, with top hook to engage manhole step in riser casting. Provide one ladder for each manhole.

G. Sump Covers: ASTM A48; Class 30B gray cast iron.

H. Riser Casting: 6 inch, with manhole step cast into frame.

I. Frames and Covers: ASTM A48; Class 30B gray cast iron, 30 inch size, machine finished with flat bearing surfaces. The word "ELECTRIC" shall be cast in the top face of all power manhole covers. In addition, manhole identification (i.e. "EMH 1-1") shall be welded on cover.

Grounding

Shall conform to UL 467 and requirements of Section 16170.

Execution

Installation

Underground cable installation shall conform to NFPA 70, Cal. P.U.C. G.O.128, and all other state and local codes.

Concrete

Concrete for electrical requirements shall be at least 3000 psi concrete with one-inch maximum aggregate, unless otherwise noted.

Underground Duct with Concrete Encasement

Construct underground duct lines of individual conduits encased in concrete. Concrete encased conduit shall be of polyvinyl chloride, Type EB-35. Do not mix the kind of conduit used in any one duct bank. Ducts shall not be smaller than 5 inches in diameter, unless otherwise indicated. The concrete encasement surrounding the bank shall be rectangular in cross-section and shall provide at least 3 inches of concrete cover for ducts. Separate conduits by a minimum concrete thickness of 3 inches, except separate power conduits from telephone conduits by a minimum concrete thickness of 3 inches. Elbows and risers shall be rigid steel.

A. Duct Line: Duct lines shall have a continuous slope downward toward manholes and away from buildings with a pitch of not less than 4 inches in 100 feet. Except at conduit risers, changes in direction of runs exceeding a total of 10 degrees, either vertical or horizontal, shall be accomplished by long sweep bends having a minimum radius of curvature of 25 feet. Sweep bends may be made up of one or more curved or straight sections or combinations thereof. Manufactured bends shall have a minimum radius of 36 inches for ducts of 3 inches in diameter and larger.

1. Join nonmetallic duct using adhesive as recommended by manufacturer. Wipe nonmetallic duct dry and clean before joining. Apply full even coat of adhesive to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.
2. Use suitable separators or chairs of high impact polystyrene installed not greater than 4 feet on center.
3. The joints of the conduits shall be staggered by rows and layers so as to provide a duct line having the maximum strength.
4. During construction, partially completed duct lines shall be protected from the entrance of debris such as mud, sand and dirt by means of suitable conduit plugs.
5. All electrical equipment and distribution systems must be protected from water run-off.

B. Conduit Termination to Manholes: Conduits shall terminate in end-bells at right angles with the wall, where duct lines enter manholes. As each section of a duct line is completed from manhole to manhole, a testing mandrel not less than 12 inches long with a diameter 1/4 inch less than the size of the conduit shall be drawn through each conduit, after which a brush having the diameter of the duct, and having stiff bristles shall be drawn through until the conduit is clear of all particles of earth, sand, of gravel; conduit plugs shall then be immediately installed.

C. Concrete Envelope: Securely anchor duct to prevent movement during concrete placement. The top of the concrete envelope shall not be less than 18 inches below grade, except that under roads and pavement it shall not be less than 24 inches below grade, unless otherwise indicated on drawings. Concrete for encasement of conduit shall be at least 3000 psi concrete, with ten pounds of red oxide added for color. Excavated material shall be removed from the site on the same day as excavation. Backfill shall be a two sack slurry.

D. Underground Warning Tape: Identifying tapes shall be buried in all utility line trenches. Place one tape above the centerline of each duct bank. Refer to Section 16195.

Precase Manholes

Provide precast manholes complete with all accessories, sumps, drain facilities, and strengths as required. Identify each casting by having the manufacturers name and address cast into an interior face or permanently attached thereto. Rate the complete assembly, including neck, collar, frame, and cover for AASHTO Class H20 wheel loading. Submit manufacturer's certificate of compliance with requirements.

A. Install and seal precast sections in accordance with manufacturer's instructions. Install manholes plumb. Use precast neck and shaft sections to bring manhole cover to finished elevation.

B. Attach cable racks to inserts after manhole installation is complete.

C. Install drains in manholes and connect to 4 inch pipe terminating in crushed gravel bed. Evaluate each manhole location and provide necessary drainage as necessary to prevent water ingress.

D. Ground Rods: In each electric manhole, at a convenient point close to the wall, a 3/4-inch by 10-foot stainless steel ground rod shall be driven into the earth so that the approximately 4 inches of the ground rod will extend above the manhole floor.

E. Manhole Grounding: Ground rods installed in electrical manholes shall be properly connected to the cable shielding, metallic sheath, and armor at each cable joint or splice by means of No. 6 AWG or equivalent braided tinned copper wire. Ground rods shall be protected with a double wrapping of pressure-sensitive plastic tape for a distance of 2 inches above and 6 inches below concrete penetrations. Ground wires shall be neatly and firmly attached to manhole and the amount of exposed bare wire shall be held to a minimum.

Grounding

Grounding shall be in accordance with ANSI C2. All ground wire shall be copper.

15kV Selector Switches

General Requirements

The pad-mounted gear shall be in accordance with the single-line diagram, and shall conform to the following specification.

The pad-mounted gear shall consist of a single self-supporting enclosure, containing interrupter switches and power fuses with the necessary accessory components, all completely factory-assembled and operationally checked. The interrupter switches and fuses shall be enclosed within an inner grounded steel compartment for electrical isolation and for protection from contamination. Switch terminals shall be equipped with bushings rated 600 amperes continuous, and fuse terminals and bus terminals shall be equipped with bushing wells rated 600 amperes continuous to provide for elbow connection. Bushings and bushing wells shall be mounted on the walls of the inner compartment and shall extend into termination compartments. A termination compartment shall be provided for each three-phase switch, each three-phase set of fuses, and each three-phase set of bus terminals.

SELECTION OF 60-HERTZ RATING

Nominal Voltage, kV		14.4
Maximum Voltage, kV		17.0●
BIL Voltage, kV		95
Short-Circuit■	Peak Withstand Current, Amperes, Peak	36 400●□♦
	One-Second Short-Time Withstand Current, Amperes, RMS, Symmetrical	14 000●□♦
	MVA, Three-Phase Symmetrical, at Rated Nominal Voltage	350●□♦
Main Bus	Continuous Current, Amperes	600
	Peak Withstand Current, Amperes, Peak	65 000★
	One-Second Short-Time Withstand Current, Amperes, RMS, Symmetrical	25 000★
Three-Pole Interrupter Switches	Continuous Current, Amperes	600
	Load Dropping Current, Amperes	600
	Peak Withstand Current, Amperes, Peak	65 000
	One-Second Short-Time Withstand Current, Amperes, RMS, Symmetrical	14 000
	Three-Time Duty-Cycle Fault-Closing Current, Amperes, Peak	36 400
Fuses	Maximum Current, Amperes	200, 200E, or 200K

■ Short-circuit rating of complete pad-mounted gear may be limited by ratings of bushing inserts, elbows, T-bodies, fuses, and cables used.

★★14.4-kV gear, when furnished with switches only (and no fuses), has the following ratings:

● 17.5 kV maximum voltage;

65,000 amperes, peak, short-circuit peak withstand current;

25,000 amperes, RMS, symmetrical, short-circuit one-second short-time withstand current; 620 MVA, three-phase symmetrical, at rated nominal voltage.

□ 14.4-kV gear, when furnished with fuses utilizing refill-unit-and-holder construction, has the following ratings:

32,500 amperes, peak, short-circuit peak withstand current;

12,500 amperes, RMS, symmetrical, short-circuit one-second short-time withstand current;

310 MVA, three-phase symmetrical, at rated nominal voltage.

♦ 14.4-kV gear, when furnished with current-limiting fuses having a rated maximum interrupting current of at least of 25,000 amperes, RMS, symmetrical, and limiting the instantaneous peak let-through current to less than 36,000 amperes, has the following ratings:

65,000 amperes, peak, short-circuit peak withstand current;

25,000 amperes, RMS, symmetrical, short-circuit one-second short-time withstand current;

620 MVA, three-phase symmetrical, at rated nominal voltage.

★ Applicable to four-compartment models. Two-compartment models have the following ratings:

36,400 amperes, peak, short-circuit peak withstand current;

14,000 amperes, RMS, symmetrical, short-circuit one-second short-time withstand current.

Certification of Ratings

(a) The manufacturer of the pad-mounted gear shall be completely and solely responsible for the performance of the basic switch and fuse components as well as the complete integrated assembly as rated.

(b) The manufacturer shall furnish, upon request, certification of ratings of the basic switch and fuse components and/or the integrated pad-mounted gear assembly consisting of the switch and fuse components in combination with the enclosure.

Compliance with Standards and Codes

The pad-mounted gear shall conform to or exceed the applicable requirements of the following standards and codes:

(a) All portions of ANSI C57.12.28, covering enclosure integrity for pad-mounted equipment.

(b) Article 710.21(e) in the National Electrical Code, which specifies that the interrupter switches in combination with power fuses shall safely withstand the effects of closing, carrying, and interrupting all possible currents up to the assigned maximum short-circuit rating.

(c) All portions of ANSI, IEEE, and NEMA standards applicable to the basic switch and fuse components.

The following optional feature should be specified as required:

(d) UL Listing.

Enclosure Design

To ensure a completely coordinated design, the pad-mounted gear shall be constructed in accordance with the minimum construction specifications of the fuse and/or switch manufacturer to provide adequate electrical clearances.

(b) In establishing the requirements for the enclosure design, consideration shall be given to all relevant factors such as controlled access, tamper resistance, corrosion resistance, and resistance to entry of foliage, animals, and airborne contaminants.

Material Specifications

Manufacturers

Acceptable Manufacturers: S&C – Model # PME-X, Alternative manufacturers – Federal Pacific, Maulton

Insulators

The interrupter-switch and fuse-mounting insulators shall be of a cycloaliphatic epoxy resin system with characteristics and restrictions as follows:

(a) Operating experience of at least 25 years under similar conditions.

(b) Adequate leakage distance established by test per IEC Publication 507, "Artificial Pollution Test on High Voltage Insulators to be Used on AC Systems."

(c) Adequate strength for short-circuit stress established by test.

(d) Conformance with applicable ANSI standards.

(e) Homogeneity of the cycloaliphatic epoxy resin throughout each insulator to provide maximum resistance to power arcs. Ablation due to high temperatures from power arcs shall continuously expose more material of the same composition and properties so that no change in mechanical or electrical characteristics takes place because of arc-induced ablation. Furthermore, any surface damage to insulators during installation or maintenance of the pad-mounted gear shall expose material of the same composition and properties so that insulators with minor surface damage need not be replaced.

High Voltage Bus

(a) Bus and interconnections shall consist of copper bar of 56% IACS conductivity.

(b) Bus and interconnections shall withstand the stresses associated with short-circuit currents up through the maximum rating of the pad-mounted gear.

(c) Bolted aluminum-to-aluminum connections shall be made with a suitable number of galvanized steel bolts, with two Belleville spring washers per bolt, one under the bolt head and one under the nut. Bolts shall be tightened to 50 foot-pounds torque.

(d) Before installation of the bus, all electrical contact surfaces shall first be prepared by machine-abrading to remove any aluminum-oxide film. Immediately after this operation, the electrical contact surfaces shall be coated with a uniform coating of an oxide inhibitor and sealant.

(e) Tie bus, where furnished, shall consist of continuous, one-piece sections of aluminum bar with no intermediate splices. Flexible braid or cable shall not be used.

Provisions for Grounding

(a) A ground-connection pad shall be provided in each termination compartment of the pad-mounted gear.

(b) The ground-connection pad shall be constructed of no less than 3/8 in.-thick steel. It shall be nickel plated and welded to the enclosure, and shall have a short-circuit rating equal to that of the pad-mounted gear.

(c) Ground-connection pads shall be coated with a uniform coating of an oxide inhibitor and sealant prior to shipment.

(d) A copper rod, connected to the ground-connection pad, shall be provided in each termination compartment for switches and bus. The rod shall have a diameter no less than 3/8-in. and extend across the full width of the compartment to allow convenient grounding of cable concentric neutrals and accessories, and shall have a short-circuit rating equal to that of the pad-mounted gear.

(e) Continuous copper ground bus shall be provided across the full width of each termination compartment for fuses. For each fuse mounting, there shall be a ground ring made of 3/8 in.-diameter copper rod bolted to the ground bus and placed to allow convenient grounding of cable concentric neutrals and accessories. Ground rings and bus shall have a short-circuit rating equal to that of the pad-mounted gear.

Bushings and Bush Well

(a) Bushings and bushing wells shall conform to ANSI/IEEE Standard 386.

(b) Bushings and bushing wells shall be of a cycloaliphatic epoxy resin system with characteristics and restrictions as follows:

(1) Operating experience of at least 15 years under similar conditions.

(2) Adequate leakage distance for in-air application established by test per IEC Publication 507, "Artificial Pollution Test on High Voltage Insulators to be Used on AC Systems."

(3) Adequate strength for short-circuit stress established by test.

(4) Conformance with applicable ANSI standards.

(5) Homogeneity of the cycloaliphatic epoxy resin throughout each bushing or bushing well to provide maximum resistance to power arcs. Ablation due to high temperatures from power arcs shall continuously expose more material of the same composition and properties so that no change in mechanical or electrical characteristics takes place because of arc-induced ablation.

(c) Bushings and bushing wells shall be mounted in such a way that the semiconductive coating is solidly grounded to the enclosure.

(d) Bushings rated 600 amperes continuous shall have a removable threaded stud so that the bushings are compatible with all 600-ampere elbow systems—those requiring a threaded stud as well as those that do not.

Termination Compartments

(a) Termination compartments for switches shall have bushings, and termination compartments for fuses shall have bushing wells to permit connection of elbows. The bushings and bushing wells shall be mounted on the interior walls at a minimum height of 33 inches above the enclosure base.

(b) Termination compartments for bus shall have bushing wells to permit connection of elbows. The bushing wells shall be mounted on the interior walls at a minimum height of 25 inches above the enclosure base.

(c) Termination compartments for bushings rated 600 amperes continuous shall be of an adequate depth to accommodate two 600-ampere elbows mounted piggyback, encapsulated surge arresters or grounding elbows mounted on 600-ampere elbows having 200-ampere interfaces, or other similar accessory combinations without the need for an enclosure extension.

(d) Termination compartments for bushing wells rated 200 amperes continuous shall be of an adequate depth to accommodate 200-ampere elbows mounted on portable feedthrus or standoff insulators, or other similar accessory combinations without the need for an enclosure extension.

(e) Termination compartments shall be provided with one parking stand for each bushing or bushing well. The parking stand shall be located immediately adjacent to the associated bushing or bushing well and shall accommodate standard feedthrus and standoff insulators, and other similar accessories.

(f) Each termination compartment for a switch shall be equipped with a viewing window to allow visual inspection of interrupter switch blades to allow positive verification of switch position.

(g) Each termination compartment for a set of fuses shall be equipped with a set of viewing windows to allow visual inspection of blown-fuse indicators.

Enclosure

(a) The pad-mounted gear enclosure shall be of unitized monocoque (not structural-frame-and-bolted-sheet) construction to maximize strength, minimize weight, and inhibit corrosion.

(b) The basic material shall be 11-gauge hot-rolled, pickled and oiled steel sheet.

(c) All structural joints and butt joints shall be welded, and the external seams shall be ground flush and smooth. The gas-metal-arc welding process shall be employed to eliminate alkaline residues and to minimize distortion and spatter.

(d) To guard against unauthorized or inadvertent entry, enclosure construction shall not utilize any externally accessible hardware.

(e) The base shall consist of continuous 90-degree flanges, turned inward and welded at the corners, for bolting to the concrete pad.

(f) The door openings shall have 90-degree flanges, facing outward, that shall provide strength and rigidity as well as deep overlapping between doors and door openings to guard against water entry.

(g) Gasketing between the roof and the enclosure shall guard against entry of water and airborne contaminants and shall discourage tampering or insertion of foreign objects.

(h) An internal steel-enclosed compartment shall encase the interrupter switches and fuses for electrical isolation and protection from contamination. The compartment shall have a galvanized steel sheet floor to exclude foliage and animals. The floor shall have screened drain vents to allow drainage if the enclosure is flooded. The top of this compartment shall be gasketed to provide sealing with the enclosure roof.

(i) Insulating barriers of NEMA GPO3-grade fiberglass-reinforced polyester shall be provided for each interrupter switch where required to achieve BIL ratings. Additional insulating barriers of the same material shall isolate the tie bus (where furnished).

(j) Full-length steel barriers shall separate adjoining termination compartments.

(k) Lifting tabs shall be removable. Sockets for the lifting-tab bolts shall be blind-tapped. A resilient material shall be placed between the lifting tabs and the enclosure to help prevent corrosion by protecting the finish against scratching by the tabs. To further preclude corrosion, this material shall be closed-cell to prevent moisture from being absorbed and held between the tabs and the enclosure in the event that lifting tabs are not removed.

(l) The enclosure shall be provided with an instruction manual holder.

Doors

(a) Doors shall be constructed of 11-gauge hot-rolled, pickled and oiled steel sheet.

(b) Door-edge flanges shall overlap with door-opening flanges to discourage tampering or insertion of foreign objects.

(c) Doors shall have a minimum of two extruded-aluminum hinges with stainless-steel hinge pins, and interlocking extruded-aluminum hinge supports for the full length of the door to provide strength, security, and corrosion resistance. Mounting hardware shall be stainless steel or zinc-nickel-plated steel, and shall not be externally accessible to guard against tampering.

(d) Doors shall be hinged at the sides to swing open with minimum effort. Doors hinged at the top requiring significant effort to lift open shall not be allowed.

(e) In consideration of controlled access and tamper resistance, each door (or set of double doors) shall be equipped with an automatic three-point latching mechanism.

(1) The latching mechanism shall be spring-loaded, and shall latch automatically when the door is closed. All latch points shall latch at the same time to preclude partial latching.

(2) A pentahead socket wrench or tool shall be required to actuate the mechanism to unlatch the door and, in the same motion, recharge the spring for the next closing operation.

(3) The latching mechanism shall have provisions for padlocking that incorporate a means to protect the padlock shackle from tampering and that shall be coordinated with the latches such that:

(i) It shall not be possible to unlatch the mechanism until the padlock is removed, and

(ii) It shall not be possible to insert the padlock until the mechanism is completely latched closed.

(f) Doors providing access to solid-material power fuses shall have provisions to store spare fuse units or refill units.

(g) Each door shall be provided with a zinc-nickel-plated steel door holder located above the door opening. The holder shall be hidden from view when the door is closed, and it shall not be possible for the holder to swing inside the enclosure.

Roof

(a) The roof shall be constructed of 11-gauge hot-rolled, pickled and oiled steel sheet.

(b) A heavy coat of insulating "no-drip" compound shall be applied to the inside surface of the center roof section to minimize condensation of the moisture thereon.

(c) Roof sections over termination compartments shall be liftable and hinged to allow room for cable pulling during installation. Each roof section shall require minimal effort to open and close and shall have a retainer to hold it in the open position.

(d) A mechanical interlock shall be provided to ensure that the roof sections over the termination compartments are closed and secured before allowing full engagement of the door latching mechanism described in Section 3.02(e).

(e) Roof sections over high-voltage compartments shall be bolted to the enclosure with no exposed fasteners.

Finish

(a) Full coverage at joints and blind areas shall be achieved by processing enclosures independently of components such as doors and roofs before assembly into the unitized structures.

(b) All exterior seams shall be filled and sanded smooth for neat appearance.

(c) To remove oils and dirt, to form a chemically and anodically neutral conversion coating to improve the finish-to-metal bond, and to retard underfilm propagation of corrosion, all surfaces shall undergo a thorough pretreatment process comprised of a fully automated system of cleaning, rinsing, phosphatizing, sealing, drying, and cooling before any protective coatings are applied. By utilizing an automated pretreatment process, the enclosure shall receive a highly consistent thorough treatment, eliminating fluctuations in reaction time, reaction temperature, and chemical concentrations.

(d) After pretreatment, protective coatings shall be applied that shall help resist corrosion and protect the steel enclosure. To establish the capability to resist corrosion and protect the enclosure, representative test specimens coated by the enclosure manufacturer's finishing system shall satisfactorily pass the following tests:

(1) 4000 hours of exposure to salt-spray testing per ASTM B 117 with:

(i) Underfilm corrosion not to extend more than 1/32 in. from the scribe, as evaluated per ASTM D 1645, Procedure A, Method 2 (scraping); and

(ii) Loss of adhesion from bare metal not to extend more than 1/8 in. from the scribe.

(2) 1000 hours of humidity testing per ASTM D 4585 using the Cleveland Condensing Type Humidity Cabinet, with no blistering as evaluated per ASTM D 714.

(3) 500 hours of accelerated weathering testing per ASTM G 53 using lamp UVB-313, with no chalking as evaluated per ASTM D 659, and no more than 10% reduction of gloss as evaluated per ASTM D 523.

(4) Crosshatch-adhesion testing per ASTM D 3359 Method B, with no loss of finish.

(5) 160-inch-pound impact, followed by adhesion testing per ASTM D 2794, with no chipping or cracking.

(6) 3000 cycles of abrasion testing per ASTM 4060, with no penetration to the substrate.

Certified test abstracts substantiating the above capabilities shall be furnished upon request.

(e) After the finishing system has been properly applied and cured, welds along the enclosure bottom flange shall be coated with a wax-based anticorrosion moisture barrier to give these areas added corrosion resistance.

(f) A resilient closed-cell material, such as PVC gasket, shall be applied to the entire underside of the enclosure bottom flange to protect the finish on this surface from scratching during handling and installation. This material shall isolate the bottom flange from the alkalinity of a concrete foundation to help protect against corrosive attack.

(g) After the enclosure is completely assembled and the components (switches, fuses, bus, etc.) are installed, the finish shall be inspected for scuffs and scratches. Blemishes shall be touched up by hand to restore the protective integrity of the finish.

(h) The finish shall be olive green, Munsell 7GY3.29/1.5.

The following optional feature should be specified as required:

(i) The finish shall be outdoor light gray, satisfying the requirements of ANSI Standard Z55.1 for No. 70.

To guard against corrosion, all hardware (including door fittings, fasteners, etc.), all operating-mechanism parts, and other parts subject to abrasive action from mechanical motion shall be of either nonferrous materials, or galvanized or zinc-nickel-plated ferrous materials. Cadmium-plated ferrous parts shall not be used.

Basic Components

Interruptor Switches

(a) Interrupter switches shall be enclosed in an inner steel compartment and shall be provided with bushings rated 600 amperes continuous to permit connection of elbows external to the switch compartment.

(b) Interrupter switches shall have a three-time duty-cycle fault-closing rating equal to or exceeding the short-circuit rating of the pad-mounted gear. These ratings define the ability to close the interrupter switch three times against a three-phase fault with asymmetrical current in at least one phase equal to the rated value, with the switch remaining operable and able to carry and interrupt rated current. Tests substantiating these ratings shall be performed at maximum voltage with current applied for at least 10 cycles. Certified test abstracts establishing such ratings shall be furnished upon request.

(c) Interrupter switches shall be operated by means of an externally accessible 3/4-in. hex switch-operating hub. The switch-operating hub shall be located within a recessed stainless-steel pocket mounted on the side of the pad-mounted gear enclosure and shall accommodate a 3/4-in. deep-socket wrench or a 3/4-in. shallow-socket wrench with extension. The switch-operating-hub pocket shall include a padlockable stainless-steel access cover that shall incorporate a hood to protect the padlock shackle from tampering. Stops shall be provided on the switch-operating hub to prevent overtravel and thereby guard against damage to the interrupter switch quick-make quick-break mechanism. Labels to indicate switch position shall be provided in the switch-operating-hub pocket.

(d) Each interrupter switch shall be provided with a folding switch-operating handle. The switch-operating handle shall be secured to the inside of the switch-operating-hub pocket by a brass chain. The folded handle shall be stored behind the closed switch-operating-hub access cover.

(e) Interrupter switches shall utilize a quick-make quick-break mechanism installed by the switch manufacturer. The quick-make quick-break mechanism shall be integrally mounted on the switch frame, and shall swiftly and positively open and close the interrupter switch independent of the switch-operating-hub speed.

(f) Each interrupter switch shall be completely assembled and adjusted by the switch manufacturer on a single rigid mounting frame. The frame shall be of welded steel construction such that the frame intercepts the leakage path which parallels the open gap of the interrupter switch to positively isolate the load circuit when the interrupter switch is in the open position.

(g) Interrupter switch contacts shall be backed up by stainless-steel springs to provide constant high contact pressure.

(h) Interrupter switches shall be provided with a single blade per phase for circuit closing, including fault closing, continuous current carrying, and circuit interrupting. Spring-loaded auxiliary blades shall not be permitted. Interrupter switch blade supports shall be permanently molded in place in a unified insulated shaft constructed of the same cycloaliphatic epoxy resin as the insulators.

(i) Circuit interruption shall be accomplished by use of an interrupter which is positively and inherently sequenced with the blade position. It shall not be possible for the blade and interrupter to get out of sequence. Circuit interruption shall take place completely within the interrupter, with no external arc or flame. Any exhaust shall be vented in a controlled manner through a deionizing vent.

(j) Key interlocks shall be provided to prevent paralleling the two source interrupter switches.

(k) Key interlocks shall be provided to guard against opening the door(s) of fuse-termination compartment(s) unless all switches are locked open.

(l) Mounting provisions shall be provided to accommodate one three-phase fault indicator with three single-phase sensors in each switch-termination compartment.

(m) Interrupter switch bushings rated 600 amperes continuous shall be provided without studs.

Fuses

(a) Solid-Material Power Fuses

(1) Solid-material power fuses shall utilize refill-unit-and-holder or fuse-unit-and-end-fitting construction. The refill unit or fuse unit shall be readily replaceable and low in cost.

(2) Fusible elements shall be nonaging and nondamageable so it is unnecessary to replace unblown companion fuses following a fuse operation.

(3) Fusible elements for refill units or fuse units, rated 10 amperes or larger, shall be helically coiled to avoid mechanical damage due to stresses from current surges.

(4) Fusible elements that carry continuous current shall be supported in air to help prevent damage from current surges.

(5) Refill units and fuse units shall have a single fusible element to eliminate the possibility of unequal current sharing in parallel current paths.

(6) Solid-material power fuses shall have melting time-current characteristics that are permanently accurate to within a maximum total tolerance of 10% in terms of current. Time-current characteristics shall be available which permit coordination with source-side and load-side protective relays, automatic circuit reclosers, and other fuses.

(7) Solid-material power fuses shall be capable of detecting and interrupting all faults, whether large, medium, or small (down to minimum melting current); under all realistic conditions of circuitry; and with line-to-line or line-to-ground voltage across the fuse. They shall be capable of handling the full range of transient recovery voltage severity associated with these faults.

(8) All arcing accompanying solid-material power fuse operation shall be contained within the fuse, and all arc products and gases evolved shall be effectively contained within the exhaust control device during fuse operation.

(9) Solid-material power fuses shall be equipped with a blown-fuse indicator that shall provide visible evidence of fuse operation while installed in the fuse mounting.

(b) Electronic Power Fuses

(1) Electronic power fuses shall utilize an expendable interrupting module and a reusable control module.

(i) The interrupting module shall consist of a main-current section and a fault-interrupting section. These sections shall be arranged coaxially and contained within the same housing.

(ii) The main-current section shall carry current under normal operating conditions.

(iii) The fault-interrupting section shall operate only under fault conditions. It shall not carry current continuously and shall not determine the minimum operating time-current characteristic curve shape.

(iv) The current-limiting-section fusible element shall not be subject to damage due to current surges.

(v) All arcing accompanying operation of the electronic power fuse shall be contained within the interrupting module and fuse operation shall be silent, without any exhaust.

(vi) The control module shall continuously monitor the line current through an electronic sensing circuit.

(vii) The electronic components shall be located within a cylindrical cast-aluminum housing that shall serve as both a path for continuous current and as a shield to protect the electronic components against interference from external electric fields.

(iix) To prevent damage to the control-module circuits by surges (such as due to lightning or inrush currents), the control module shall be free of external control wiring and connections to ground, and shall incorporate a device that acts as a buffer to isolate the electronic components at a level of current well below their surge-withstand capability.

(ix) The control module shall be factory-sealed to assure a dry, contaminant-free environment for the electronic components.

(x) The control module shall be self-powered with the capability to supply power for operating the sensing logic circuits and to actuate the interrupting module when a fault occurs.

(xi) The control module shall include one or more integrally mounted current transformers to provide both the sensing signal and the control power.

(xii) The current transformer used to provide control power shall be designed to act as a buffer against surges in the line by saturating at a level of current well below the surge-withstand capability of the electronic components.

(xiii) No leads (including coaxial leads) between the current transformers and the electronic components shall be exposed.

(2) To ensure the integrity of the electrical connection between the interrupting and control modules is independent of the mechanical force with which the modules are joined, the connection shall be through a louvered ring-type sliding contact.

(3) Electronic power fuses shall be equipped with a blown-fuse indicator that shall provide visible evidence of fuse operation while installed in the fuse mounting.

(4) It shall not be necessary to replace unblown companion interrupting modules following operation of an electronic power fuse.

(5) Electronic power fuses shall have time-current characteristics that are permanently accurate. Time-current characteristics shall be available which permit coordination with source-side and load-side protective relays, automatic circuit reclosers, and other fuses.

(6) Mountings for electronic power fuses shall also accommodate current-limiting fuses.

(c) Fuse mountings shall be enclosed in an inner steel compartment and shall be provided with bushing wells rated 200 amperes continuous for elbow connection.

(1) Each fuse mounting shall be an integral part of a fuse handling mechanism that does not allow access to the fuse until the elbow for that fuse has been disconnected. To access a fuse it shall be necessary to:

(i) Disconnect the elbow for that fuse and move it to the appropriate parking stand.

(ii) Actuate a mechanical interlock to unlock the fuse-access panel. It shall not be possible to disengage this interlock before the elbow is moved.

(iii) Unlatch and then pivot the fuse-access panel to electrically isolate the fuse so that it can be removed from the fuse mounting with a shotgun stick.

(2) The opening into the component compartment shall be covered by the fuse-access panel in both the open and closed positions to help prevent inadvertent access to high voltage.

(3) To protect the fuse-handling mechanism from corrosion, all mechanism parts shall be painted or made of corrosion-resistant materials, or otherwise be protected from corrosion. All latches and pivots shall be stainless steel or zinc-nickel-plated steel with nylon or plastic bushings.

(4) Cable guides shall be provided in each termination compartment for a set of fuses, to prevent cables from interfering with rotation of the fuse-access panel.

(d) A fuse-storage feature shall be provided in (one, two) source interrupter-switch compartment(s). Each fuse-storage feature shall provide space for storing three spare fuse holders or fuse units with end fittings for solid-material power fuses, or two spare electronic power fuse holders.

Labeling

Hazard Alerting Signs

(a) All external doors shall be provided with "Warning—Keep Out—Hazardous Voltage Inside—Can Shock, Burn, or Cause Death" signs.

(b) The inside of each door shall be provided with a "Danger—Hazardous Voltage—Failure to Follow These Instructions Will Likely Cause Shock, Burns, or Death" sign. The text shall further indicate that operating personnel must know and obey the employer's work rules, know the hazards involved, and use proper protective equipment and tools to work on this equipment.

(c) Termination compartments shall be provided with "Danger—Keep Away—Hazardous Voltage—Will Shock, Burn, or Cause Death" signs.

Nameplates, Ratings Labels and Connection Diagrams

(a) The outside of each door (or set of double doors) shall be provided with a nameplate indicating the manufacturer's name, catalog number, model number, date of manufacture, and serial number.

(b) The inside of each door (or set of double doors) shall be provided with a ratings label indicating the following:

(1) Overall pad-mounted gear ratings: nominal voltage, kV; maximum voltage, kV; BIL voltage, kV; power frequency, Hz; short-circuit peak withstand current, amperes, peak; short-circuit one-second short-time withstand current, amperes, RMS, symmetrical; and short-circuit MVA, three-phase symmetrical, at rated nominal voltage.

(2) Main bus ratings: continuous current, amperes; peak withstand current, amperes, peak; and one-second short-time withstand current, amperes, RMS symmetrical.

(3) Switch ratings: continuous current, amperes; load splitting current, amperes; load dropping current, amperes; peak withstand current, amperes, peak; one-second short-time withstand current, amperes, RMS, symmetrical; and three-time duty-cycle fault-closing current, amperes, RMS symmetrical and amperes, peak.

(4) Fuse type and ratings: maximum current, amperes and interrupting current, amperes, RMS, symmetrical.

(c) A three-line connection diagram showing interrupter switches, fuses, and bus along with the manufacturer's model number shall be provided on the inside of each door (or set of double doors), and on the inside of each switch-operating-hub access cover.

Accessories (Specify as required.)

End fittings and fuse unit, holder and refill unit, or interrupting module and control module shall be furnished for each fuse mounting. In addition, one spare fuse unit, refill unit, or interrupting module shall be furnished.

A voltage tester with audio-visual signal capability shall be provided, along with batteries, shotgun clamp-stick adapter, and storage case.

A shotgun clamp stick (6 ft.– 5 1/2 in., 8 ft.– 5 1/2 in.) in length shall be provided complete with canvas storage bag.

Analytical Services

Short Circuit Analysis

(a) A short-circuit analysis shall be provided to determine the currents flowing in the electrical system under faulted conditions. Since expansion of an electrical system can result in increased available short-circuit current, the momentary and interrupting ratings of new and existing equipment on the system shall be checked to determine if the equipment can withstand the short-circuit energy. Fault contributions from utility sources, motors, and generators shall be taken into consideration. If applicable, results of the analysis shall be used to coordinate overcurrent protective devices and prepare an arc-flash hazard analysis of the system.

(b) Data used in the short-circuit analysis shall be presented in tabular format, and shall include the following information:

(1) Equipment identifications.

(2) Equipment ratings.

(3) Protective devices.

(4) Operating voltages.

(5) Calculated short-circuit currents.

(6) X/R ratios.

(c) A single-line diagram model of the system shall be prepared, and shall include the following information:

(1) Identification of each bus.

(2) Voltage at each bus.

(3) Maximum available fault current, in kA symmetrical, on the utility source side of the incoming feeder or first upstream device.

(4) Data for each transformer

(i) Three-phase kVA rating

(ii) Percent impedance

(iii) Temperature rise, 65°C and 55/65°C

(iv) Primary voltage

(v) Primary connection

(vi) Secondary voltage

(vii) Secondary connection

(iix) X/R ratio

(ix) Tap settings and available settings

(d) The manufacturer shall use commercially available PC-based computer software such as Power System Analysis Framework (PSAF—Fault) from CYME International, CYMDIST, and/or SKM Power Tools® for Windows with the PTW Dapper Module to calculate three-phase, phase-to-phase, and phase-to-ground fault currents at relevant locations in the electrical system, in accordance with ANSI Standards C37.010, C37.5, and C37.13. If applicable, an ANSI closing-and-latching duty analysis shall also be performed to calculate the maximum currents following fault inception.

Overcurrent Protective Device Coordination Analysis

(a) An overcurrent protective device coordination analysis to verify that electrical equipment is protected against damage from short-circuit currents. Analysis results shall be used to select appropriately rated protective devices and settings that minimize the impact of short-circuits in the electrical system, by isolating faults as quickly as possible while maintaining power to the rest of the system.

(b) As applicable, the analysis shall take into account pre-load and ambient-temperature adjustments to fuse minimum-melting curves, transformer magnetizing-inrush current, full-load current, hot-load and cold-load pick-up, coordination time intervals for series-connected protective devices, and the type of reclosers and their reclosing sequences. Locked-rotor motor starting curves and thermal and mechanical damage curves shall be plotted with the protective-device time-current characteristic curves, as applicable.

(c) Differing per-unit fault currents on the primary and secondary sides of transformers (attributable to winding connections) shall be taken into consideration in determining the required ratings or settings of the protective devices.

(d) The time separation between series-connected protective devices, including the upstream (source-side) device and largest downstream (load-side) device, shall be graphically illustrated on log-log paper of standard size. The time-current characteristics of each protective device shall be plotted such that all upstream devices shall be clearly depicted on one sheet.

(e) The manufacturer shall furnish coordination curves indicating the required ratings or settings of protective devices to demonstrate, to the extent possible, selective coordination. The following information shall be presented on each coordination curve, as applicable:

(1) Device identifications.

(2) Voltage and current ratios.

(3) Transformer through-fault withstand duration curves.

(4) Minimum-melting, adjusted, and total-clearing fuse curves.

(5) Cable damage curves.

(6) Transformer inrush points.

(7) Maximum available fault current, in kA symmetrical, on the utility source side of the incoming feeder or first upstream device.

(8) Single-line diagram of the feeder branch under study.

(9) A table summarizing the ratings or settings of the protective devices, including:

(i) Device identification.

(ii) Relay current-transformer ratios, and tap, time-dial, and instantaneous-pickup settings.

(iii) Circuit-breaker sensor ratings; long-time, short-time, and instantaneous settings; and time bands.

(iv) Fuse type and rating.

(v) Ground fault pickup and time delay.

(f) The manufacturer shall use commercially available PC-based computer software such as CYMTCC from CYME International and/or SKM Captor to create the time-current characteristic curves for all protective devices on each feeder.

(g) As applicable, a technical evaluation shall be prepared for areas of the electrical system with inadequate overcurrent protective device coordination, with recommendations for improving coordination.

Arc Flash Hazard Analysis

(a) An arc-flash hazard analysis to verify that electrical equipment on the system is "electrically safe" for personnel to work on while energized. An arc flash is a flashover of electric current in air—from one phase conductor to another phase conductor, or from one phase conductor to ground—that can heat the air to 35,000°F. It can vaporize metal and cause severe burns to unprotected workers from direct heat exposure and ignition of improper clothing. And the arc blast resulting from release of the concentrated radiant energy can damage hearing and knock down personnel, causing trauma injuries.

(b) The arc-flash hazard analysis shall include the following:

(1) Identification of equipment locations where an arc-flash hazard analysis is required.

(2) Collection of pertinent data at each equipment location, including:

(i) Transformer kVA ratings, including voltage, current, percent impedance, winding ratio, and X/R ratio, plus wiring connections.

(ii) Protective device ratings, including current, time-current characteristics, settings, and time delays.

(iii) Switchgear data, including conductor phase spacing, type of grounding, and appropriate working distances.

(3) Preparation of a single-line diagram model of the system.

(4) Preparation of a short-circuit study to determine the three-phase bolted fault current at each location.

(5) Preparation of arc-flash calculations in accordance with NFPA 70E and IEEE 1584, including:

(i) Calculation of arc current in accordance with applicable guidelines.

(ii) Determination of protective device total-clearing times based upon the time-current characteristics.

(iii) Calculation of arc-flash incident energy level based on the protective device total-clearing times and appropriate working distance.

(6) Determination of appropriate personal protective equipment in accordance with risk levels defined in NFPA 70E.

(7) Calculation of the arc-flash protection boundary distance.

(8) Documentation of the results of the analysis, including:

(i) Preparation of a written report.

(ii) Preparation of single-line diagrams.

(iii) Preparation of arc-flash hazard labels to be affixed to the equipment.

(9) The manufacturer shall use commercially available PC-based computer software such as the arc-flash module in SKM Power Tools® for Windows to calculate the incident energy category levels, in accordance with IEEE 1584.

Analytical Service Site Visits

(a) The manufacturer shall perform a site walk-down to gather:

(1) Transformer ratings, including voltage, current, power, percent impedance, winding ratio, and X/R ratio, plus wiring connections.

(2) Protective device ratings, including current, time-current characteristics, settings, and time delays.

(3) Switchgear data, including conductor phase spacing, type of grounding, and appropriate working distances.

Chapter 8—Costs

Chapter 8—Costs

The following are costs associated with the improvements recommended in our report by each phase to meet the demands of the existing and future facilities planned at the campus. The costs included below are contractor's construction costs and do not include project management fees, design and administrative costs and any other associated construction management costs.

The costs provided in this section are in current dollars (2011) and assume that work will be done by an electrical contractor. The costs are based upon current material costs obtained from suppliers, labor costs from contractors and from a database of costs maintained by us for similar projects. The costs provided assume that the infrastructure project will provide the main distribution lines and individual projects will connect the building to the main distribution point.

The following table provides a summary of total costs by each phase and the pages following this table provide breakdown of costs by each phase and project.

Description	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Total
Provision of new 67-12kV, 26.88MVA utility transformer.		$2,500,000				$2,500,000
Provision of new third section of 15kV switchgear on west side of the campus to serve the new switchgear.		$750,000				$750,000
Provision of new 15kV switchgear on east side of the campus to serve all east facilities on campus.		$2,000,000				$2,000,000
Provision of new 15kV,133%, 750kcmil EPR cables from west switchgear to new east switchgear.		$700,000				$700,000
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	$708,000	$1,770,000	$684,000	$216,000	$540,000	$3,918,000
Conversion of existing 4.16kV substations in existing buildings to a 12kV system.		$1,750,000				$1,750,000
Provision of 15kV, 133%, 500kcmil EPR cables	$1,191,000	$8,070,000	$1,137,000	$324,000	$894,000	$11,616,000
Provision of new 15kV selector switches to served proposed facilities	$630,000	$735,000	$1,085,000	$420,000	$1,435,000	$4,305,000
Demolition of Existing Feeders		$500,000				$500,000
Provision of new manholes	$550,000	$875,000	$475,000	$175,000	$350,000	$2,425,000
Hardscape/Landscape Replacement Costs	$265,000	$197,500	$192,000	$61,500	$178,000	$894,000
Short Circuit and Arc Flash Study	$67,500	$1,706,500	$112,500	$87,500	$150,000	$2,124,000
Subtotal	$3,411,500	$21,554,000	$3,685,500	$1,284,000	$3,547,000	$33,482,000
Design Contingency @10%	$334,400	$1,670,750	$357,300	$119,650	$339,700	$2,821,800
Overhead and Profit@17.3%	$578,512	$2,890,398	$618,129	$206,995	$587,681	$4,881,715
Construction Contingency@10%	$334,400	$1,670,750	$357,300	$119,650	$339,700	$2,821,800
Total Costs	$4,658,812	$27,785,898	$5,018,229	$1,730,295	$4,814,081	$44,007,315

BREAKDOWN OF COSTS BY PHASES AND PROJECTS

Phase 1—2011-2014

Description	Unit	Qty	Cost/unit	Costs
Vault V15 - Future Vault(s) / E100, E101, E102, E103, E104, E105, E106, E107, E108, P05				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	1,200	$120	$144,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	8,000	$30	$240,000
Provision of new 15kV selector switches to served proposed facilities	No.	6	$35,000.00	$210,000
Provision of new manholes	No.	5	$25,000.00	$125,000
Hardscape/Landscape Replacement Costs	Sqft	3,600	$10	$36,000
Short Circuit and Arc Flash Study	-	L.S.	L.S.	$15,000
Subtotal				$770,000
Design Contingency @10%				$75,500
Overhead and Profit@17.3%				$130,615
Construction Contingency@10%				$75,500
Total Construction Costs With Mark Up				$1,051,615

Description	Unit	Qty	Cost/unit	Costs
E109A, E109B, E110A, E110B				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	100	$120	$0
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	600	$30	$0
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$0
Hardscape/Landscape Replacement Costs	Sqft	500	$10	$0
Short Circuit and Arc Flash Study	-		L.S.	$0
Subtotal				$0
Design Contingency @10%				$0
Overhead and Profit@17.3%				$0
Construction Contingency@10%				$0
Total Construction Costs With Mark Up				$0

NOTE: THE CAMPUS ELECTRICAL DISTRIBUTION EXTENSION COST IS ASSUMED TO BE PART OF THE EXPANSION PROJECT.

Description	Unit	Qty	Cost/unit	Costs
Vault V4G- Future Vault/E138				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	1,500	$120	$180,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	10,000	$30	$300,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Provision of new manholes	No.	6	$25,000.00	$150,000
Hardscape/Landscape Replacement Costs	Sqft	10,000	$10	$100,000
Short Circuit and Arc Flash Study	-		L.S.	$7,500
Subtotal				$807,500
Design Contingency @10%				$80,000
Overhead and Profit@17.3%				$138,400
Construction Contingency@10%				$80,000
Total Construction Costs With Mark Up				$1,105,900

Description	Unit	Qty	Cost/unit	Costs
E164				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	50	$120	$0
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	400	$30	$0
Provision of new 15kV selector switches to served proposed facilities	No.	1	$35,000.00	$0
Hardscape/Landscape Replacement Costs	Sqft	200	$10	$0
Short Circuit and Arc Flash Study	-		L.S.	$0
Subtotal				$0
Design Contingency @10%				$0
Overhead and Profit@17.3%				$0
Construction Contingency@10%				$0
Total Construction Costs With Mark Up				$0

NOTE: THE CAMPUS ELECTRICAL DISTRIBUTION EXTENSION COST IS ASSUMED TO BE PART OF THE EXPANSION PROJECT.

Description	Unit	Qty	Cost/unit	Costs
Vault V23-Facility/E177				
Electrical				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	350	$120	$42,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	2,500	$30	$75,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Provision of new manholes	No.	1	$25,000.00	$25,000
Hardscape/Landscape Replacement Costs	Sqft	1,200	$10	$12,000
Short Circuit and Arc Flash Study	-		L.S.	$7,500
Subtotal				$231,500
Design Contingency @10%				$22,400
Overhead and Profit@17.3%				$38,752
Construction Contingency@10%				$22,400
Total Construction Costs With Mark Up				$315,052

Description	Unit	Qty	Cost/unit	Costs
Vault V23-Facility/E178				
Electrical				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	350	$120	$42,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	2,500	$30	$75,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Provision of new manholes	No.	1	$25,000.00	$25,000
Hardscape/Landscape Replacement Costs	Sqft	1,200	$10	$12,000
Short Circuit and Arc Flash Study	-		L.S.	$7,500
Subtotal				$231,500
Design Contingency @10%				$22,400
Overhead and Profit@17.3%				$38,752
Construction Contingency@10%				$22,400
Total Costs				$315,052

Description	Unit	Qty	Cost/unit	Costs
Vault V22-Facility/E179				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	900	$120	$108,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	6,000	$30	$180,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Provision of new manholes	No.	4	$25,000.00	$100,000
Hardscape/Landscape Replacement Costs	Sqft	3,000	$10	$30,000
Short Circuit and Arc Flash Study	-		L.S.	$7,500
Subtotal				$495,500
Design Contingency @10%				$48,800
Overhead and Profit@17.3%				$84,424
Construction Contingency@10%				$48,800
Total Construction Costs With Mark Up				$677,524

Description	Unit	Qty	Cost/unit	Costs
Vault V3-Facilities/E180, E181, E181A, E181B, E181C, E181D, E181E				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	100	$120	$12,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	700	$30	$21,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Hardscape/Landscape Replacement Costs	Sqft	2,500	$10	$25,000
Short Circuit and Arc Flash Study	-		L.S.	$15,000
Subtotal				$143,000
Design Contingency @10%				$12,800
Overhead and Profit@17.3%				$22,144
Construction Contingency@10%				$12,800
Total Construction Costs With Mark Up				$190,744

Description	Unit	Qty	Cost/unit	Costs
Vault V4C- Future Vault/P02				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	1,500	$120	$180,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	10,000	$30	$300,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Provision of new manholes	No.	5	$25,000.00	$125,000
Hardscape/Landscape Replacement Costs	Sqft	5,000	$10	$50,000
Short Circuit and Arc Flash Study	-		L.S.	$7,500
Subtotal				$732,500
Design Contingency @10%				$72,500
Overhead and Profit@17.3%				$125,425
Construction Contingency@10%				$72,500
Total Construction Costs With Mark Up				$1,002,925
Total Construction Costs With Mark Up—Phase 1				$4,658,812

Phase 1—Alternative Option

Description	Unit	Qty	Cost/unit	Costs
Alternative Option Costs for routing feeders '5A' and '5B'				
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	30,000	$30	$900,000
Short Circuit and Arc Flash Study	-		L.S.	$25,000
Subtotal				$925,000
Design Contingency @10%				$92,500
Overhead and Profit@17.3%				$160,025
Construction Contingency@10%				$92,500
Total Construction Costs With Mark Up				$1,270,025

Phase 2—2015-2020

Description	Unit	Qty	Cost/unit	Costs
New Switchgear East to Main Distribution Point for Facilities				
Provision of new 67-12kV, 26.88MVA utility transformer.	-	L.S.	-	$2,500,000
Provision of new third section of 15kV switchgear on west side of the campus to serve the new switchgear.		L.S.		$750,000
Provision of new 15kV switchgear on east side of the campus to serve all east facilities on campus.		L.S.		$2,000,000
Provision of new 15kV,133%, 750kcmil EPR cables from west switchgear to new east switchgear.	L.F.	20,000	$35.00	$700,000
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	10,000	$120	$1,200,000
Conversion of existing 4.16kV substations in existing buildings to a 12kV system.	No.	35	$50,000.00	$1,750,000
Provision of 15kV, 133%, 500kcmil EPR cables				
Feeders 1A, 1B (New Switchgear to V4 and V7 and to Facilities)	L.F.	10,000	$30.00	$300,000
Feeders 2A, 2B (New Switchgear to V24 and to Facilities)	L.F.	32,000	$30.00	$960,000
Feeders 3A, 1C (New Switchgear to V11/ V12 and to Facilities)	L.F.	22,000	$30.00	$660,000
Feeders 3B, 3C (New Switchgear to V9 and V11A and to Facilities)	L.F.	22,000	$30.00	$660,000
Feeders 4B, 4C (New Switchgear to V14 and V15 and to Facilities)	L.F.	32,000	$30.00	$960,000
Feeders 4A, 2C (New Switchgear to V8 and to Facilities)	L.F.	10,000	$30.00	$300,000
Feeders 5A, 5B (New Switchgear to V4G and V20 to Facilities)	L.F.	45,000	$30.00	$1,350,000
Feeders 6A, 6B (New Switchgear to V22, V26 and V27 and to Facilities)	L.F.	50,000	$30.00	$1,500,000
Feeders 7A, 5C (New Switchgear to Future Vault and to Facilities)	L.F.	15,000	$30.00	$450,000
Demolition of Existing Feeders	L.F.	50,000	$10	$500,000
Provision of new manholes	No.	15	$25,000.00	$375,000
Hardscape/Landscape Replacement Costs	Sqft	10,000	$10	$15,000
Short Circuit and Arc Flash Study				$1,654,000
Subtotal				**$18,584,000**
Design Contingency @10%				$1,404,000
Overhead and Profit@17.3%				$2,428,920
Construction Contingency@10%				$1,404,000
Total Construction Costs With Mark Up				**$23,820,920**

Description	Unit	Qty	Cost/unit	Costs
Vault V26-Future Vaults(s)/E111, E112, E113, E114				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	700	$120	$84,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	5,000	$30	$150,000
Provision of new 15kV selector switches to served proposed facilities	No.	5	$35,000.00	$175,000
Provision of new manholes	No.	3	$25,000.00	$75,000
Hardscape/Landscape Replacement Costs	Sqft	2,500	$10	$25,000
Short Circuit and Arc Flash Study	-	L.S.	L.S.	$15,000
Subtotal				$524,000
Design Contingency @10%				$50,900
Overhead and Profit@17.3%				$88,057
Construction Contingency@10%				$50,900
Total Construction Costs With Mark Up				**$713,857**

Description	Unit	Qty	Cost/unit	Costs
Future Vault (Center of E113-E114) to Facilities/E121, E123, E124, E125, E125, E127, E128				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	2,500	$120	$300,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	16,000	$30	$480,000
Provision of new 15kV selector switches to served proposed facilities	No.	10	$35,000.00	$350,000
Hardscape/Landscape Replacement Costs	Sqft	8,000	$10	$80,000
Provision of new manholes	No.	10	$25,000.00	$250,000
Short Circuit and Arc Flash Study	-		L.S.	$15,000
Subtotal				**$1,475,000**
Design Contingency @10%				$121,000
Overhead and Profit@17.3%				$209,330
Construction Contingency@10%				$121,000
Total Construction Costs With Mark Up				**$1,926,330**

Description	Unit	Qty	Cost/unit	Costs
Future Vault (South of E140-E141) to Facility E142				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	600	$120	$72,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	4,000	$30	$120,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Provision of new manholes	No.	3	$25,000.00	$75,000
Hardscape/Landscape Replacement Costs	Sqft	2,000	$10	$20,000
Short Circuit and Arc Flash Study	-		L.S.	$7,500
Subtotal				$364,500
Design Contingency @10%				$35,700
Overhead and Profit@17.3%				$61,761
Construction Contingency@10%				$35,700
Total Construction Costs With Mark Up				$497,661
Vault V14-Future Vault/E146				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	800	$120	$96,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	5,000	$30	$150,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Provision of new manholes	No.	3	$25,000.00	$75,000
Hardscape/Landscape Replacement Costs	Sqft	5,000	$10	$7,500
Short Circuit and Arc Flash Study	-		L.S.	$7,500
Subtotal				$406,000
Design Contingency @10%				$39,850
Overhead and Profit@17.3%				$68,941
Construction Contingency@10%				$39,850
Total Construction Costs With Mark Up				$554,641

Description	Unit	Qty	Cost/unit	Costs
Vault V22-Facility/P04				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	150	$120	$18,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	1,000	$30	$30,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Provision of new manholes	No.	1	$25,000.00	$25,000
Hardscape/Landscape Replacement Costs	Sqft	5,000	$10	$50,000
Short Circuit and Arc Flash Study	-		L.S.	$7,500
Subtotal				$200,500
Design Contingency @10%				$19,300
Overhead and Profit@17.3%				$33,389
Construction Contingency@10%				$19,300
Total Construction Costs With Mark Up				$272,489
Total Construction Costs With Mark Up—Phase 2				$27,785,898

Phase 3—2021-2025

Description	Unit	Qty	Cost/unit	Costs
V27 to Future Vault to Facilities/E115, E116, E117				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	800	$120	$96,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	5,000	$30	$150,000
Provision of new 15kV selector switches to served proposed facilities	No.	5	$35,000.00	$175,000
Provision of new manholes	No.	3	$25,000.00	$75,000
Hardscape/Landscape Replacement Costs	Sqft	2,500	$10	$25,000
Short Circuit and Arc Flash Study	-	L.S.	L.S.	$15,000
Subtotal				$536,000
Design Contingency @10%				$52,100
Overhead and Profit@17.3%				$90,133
Construction Contingency@10%				$52,100
Total Construction Costs With Mark Up				$730,333
Future Vault (South of E123 and E128) to Facility/E122				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	100	$120	$12,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	700	$30	$21,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Hardscape/Landscape Replacement Costs	Sqft	400	$10	$4,000
Short Circuit and Arc Flash Study	-		L.S.	$7,500
Subtotal				$114,500
Design Contingency @10%				$10,700
Overhead and Profit@17.3%				$18,511
Construction Contingency@10%				$10,700
Total Construction Costs With Mark Up				$154,411

Description	Unit	Qty	Cost/unit	Costs
Future Vault (Northwest of E139) to Facilities/E134, E135, E136, E137				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	1,800	$120	$216,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	12,000	$30	$360,000
Provision of new 15kV selector switches to served proposed facilities	No.	6	$35,000.00	$210,000
Provision of new manholes	No.	4	$25,000.00	$100,000
Hardscape/Landscape Replacement Costs	Sqft	6,000	$10	$60,000
Short Circuit and Arc Flash Study	-		L.S.	$15,000
Subtotal				$961,000
Design Contingency @10%				$94,600
Overhead and Profit@17.3%				$163,658
Construction Contingency@10%				$94,600
Total Construction Costs With Mark Up				$1,313,858
Future Vault (South of E140 and E141) to Facilities/E140, E141				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	200	$120	$24,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	1,400	$30	$42,000
Provision of new 15kV selector switches to served proposed facilities	No.	3	$35,000.00	$105,000
Provision of new manholes	No.	1	$25,000.00	$25,000
Hardscape/Landscape Replacement Costs	Sqft	700	$10	$7,000
Short Circuit and Arc Flash Study	-		L.S.	$15,000
Subtotal				$218,000
Design Contingency @10%				$20,300
Overhead and Profit@17.3%				$35,119
Construction Contingency@10%				$20,300
Total Construction Costs With Mark Up				$293,719

Description	Unit	Qty	Cost/unit	Costs
Future Vault (Southeast of E146) to Facility/ E145				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	100	$120	$12,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	700	$30	$21,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Provision of new manholes	No.	1	$25,000.00	$25,000
Hardscape/Landscape Replacement Costs	Sqft	400	$10	$4,000
Short Circuit and Arc Flash Study	-		L.S.	$7,500
Subtotal				$139,500
Design Contingency @10%				$13,200
Overhead and Profit@17.3%				$22,836
Construction Contingency@10%				$13,200
Total Construction Costs With Mark Up				$188,736

Description	Unit	Qty	Cost/unit	Costs
Vault East of Central Utility Plant to Future Vault to Facility/E162, E163				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	1,200	$120	$144,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	8,000	$30	$240,000
Provision of new 15kV selector switches to served proposed facilities	No.	3	$35,000.00	$105,000
Provision of new manholes	No.	5	$25,000.00	$125,000
Hardscape/Landscape Replacement Costs	Sqft	4,000	$10	$40,000
Short Circuit and Arc Flash Study	-		L.S.	$15,000
Subtotal				$669,000
Design Contingency @10%				$65,400
Overhead and Profit@17.3%				$113,142
Construction Contingency@10%				$65,400
Total Construction Costs With Mark Up				$912,942

Description	Unit	Qty	Cost/unit	Costs
Utility Tunnel North of Facility to Future Vault to Facility/E170				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	100	$120	$12,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	700	$30	$21,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Hardscape/Landscape Replacement Costs	Sqft	400	$10	$4,000
Short Circuit and Arc Flash Study	-		L.S.	$7,500
Subtotal				$114,500
Design Contingency @10%				$10,700
Overhead and Profit@17.3%				$18,511
Construction Contingency@10%				$10,700
Total Construction Costs With Mark Up				$154,411

Description	Unit	Qty	Cost/unit	Costs
Vault V4D to Facility/E171				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	100	$120	$12,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	700	$30	$21,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Hardscape/Landscape Replacement Costs	Sqft	400	$10	$4,000
Short Circuit and Arc Flash Study	-		L.S.	$7,500
Subtotal				$114,500
Design Contingency @10%				$10,700
Overhead and Profit@17.3%				$18,511
Construction Contingency@10%				$10,700
Total Construction Costs With Mark Up				$154,411

Description	Unit	Qty	Cost/unit	Costs
Vault V4F to Facility/E173				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	100	$120	$12,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	700	$30	$21,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Provision of new manholes	No.	1	$25,000.00	$25,000
Hardscape/Landscape Replacement Costs	Sqft	400	$10	$4,000
Short Circuit and Arc Flash Study	-		L.S.	$7,500
Subtotal				$139,500
Design Contingency @10%				$13,200
Overhead and Profit@17.3%				$22,836
Construction Contingency@10%				$13,200
Total Construction Costs With Mark Up				$188,736

Description	Unit	Qty	Cost/unit	Costs
Future Vault (West of E170) to Facility/P01				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	600	$120	$72,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	4,000	$30	$120,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Provision of new manholes	No.	2	$25,000.00	$50,000
Hardscape/Landscape Replacement Costs	Sqft	2,000	$10	$20,000
Short Circuit and Arc Flash Study	-		L.S.	$7,500
Subtotal				$339,500
Design Contingency @10%				$33,200
Overhead and Profit@17.3%				$57,436
Construction Contingency@10%				$33,200
Total Construction Costs With Mark Up				$463,336

Description	Unit	Qty	Cost/unit	Costs
Future Vault (North of E122) to Facility/P03				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	600	$120	$72,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	4,000	$30	$120,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Provision of new manholes	No.	2	$25,000.00	$50,000
Hardscape/Landscape Replacement Costs	Sqft	2,000	$10	$20,000
Short Circuit and Arc Flash Study	-		L.S.	$7,500
Subtotal				$339,500
Design Contingency @10%				$33,200
Overhead and Profit@17.3%				$57,436
Construction Contingency@10%				$33,200
Total Construction Costs With Mark Up				$463,336

Total Construction Costs With Mark Up—Phase 3	$5,018,229

Phase 4—2026-2030

Description	Unit	Qty	Cost/unit	Costs
Future Vault (Southwest of E121) to Facilities/E118, E119, E120				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	600	$120	$72,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	4,000	$30	$120,000
Provision of new 15kV selector switches to served proposed facilities	No.	4	$35,000.00	$140,000
Provision of new manholes	No.	3	$25,000.00	$75,000
Hardscape/Landscape Replacement Costs	Sqft	2,000	$10	$20,000
Short Circuit and Arc Flash Study	-	L.S.	L.S.	$15,000
Subtotal				$442,000
Design Contingency @10%				$42,700
Overhead and Profit@17.3%				$73,871
Construction Contingency@10%				$42,700
Total Construction Costs With Mark Up				$601,271
Future Vault (Southwest of P02) to Facility/E139				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	100	$120	$12,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	700	$30	$21,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Hardscape/Landscape Replacement Costs	Sqft	400	$10	$4,000
Short Circuit and Arc Flash Study	-		L.S.	$7,500
Subtotal				$114,500
Design Contingency @10%				$10,700
Overhead and Profit@17.3%				$18,511
Construction Contingency@10%				$10,700
Total Construction Costs With Mark Up				$154,411

Description	Unit	Qty	Cost/unit	Costs
Future Vault (Southeast of E146) to Facility/E144				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	400	$120	$48,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	3,000	$30	$90,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Provision of new manholes	No.	2	$25,000.00	$50,000
Hardscape/Landscape Replacement Costs	Sqft	1,500	$10	$15,000
Short Circuit and Arc Flash Study	-		L.S.	$7,500
Subtotal				$280,500
Design Contingency @10%				$27,300
Overhead and Profit@17.3%				$47,229
Construction Contingency@10%				$27,300
Total Construction Costs With Mark Up				$382,239
Future Vault (Between E162 and E163) to Facility/E165				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	300	$120	$36,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	100	$30	$3,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Provision of new manholes	No.	1	$25,000.00	$25,000
Hardscape/Landscape Replacement Costs	Sqft	5,000	$10	$7,500
Short Circuit and Arc Flash Study	-		L.S.	$50,000
Subtotal				$191,500
Design Contingency @10%				$14,150
Overhead and Profit@17.3%				$24,480
Construction Contingency@10%				$14,150
Total Construction Costs With Mark Up				$244,280

Description	Unit	Qty	Cost/unit	Costs
Utility Tunnel (West of Facility) to Facility/E168				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	50	$120	$0
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	300	$30	$0
Provision of new 15kV selector switches to served proposed facilities	No.	1	$35,000.00	$0
Hardscape/Landscape Replacement Costs	Sqft	200	$10	$0
Short Circuit and Arc Flash Study	-		L.S.	$0
Subtotal				$0
Design Contingency @10%				$0
Overhead and Profit@17.3%				$0
Construction Contingency@10%				$0
Total Construction Costs With Mark Up				$0

NOTE: THE CAMPUS ELECTRICAL DISTRIBUTION EXTENSION COST IS ASSUMED TO BE PART OF THE EXPANSION PROJECT.

Future Vault (Southeast of E146) to Facility/P06				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	400	$120	$48,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	3,000	$30	$90,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Provision of new manholes	No.	1	$25,000.00	$25,000
Hardscape/Landscape Replacement Costs	Sqft	1,500	$10	$15,000
Short Circuit and Arc Flash Study	-		L.S.	$7,500
Subtotal				$255,500
Design Contingency @10%				$24,800
Overhead and Profit@17.3%				$42,904
Construction Contingency@10%				$24,800
Total Construction Costs With Mark Up				$348,004

Total Construction Costs With Mark Up—Phase 4	$1,730,295

Phase 5—2031+

Description	Unit	Qty	Cost/unit	Costs
Future Vault (West oF P02) to Facilities/E129, E130, E131, E132, E133				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	1,600	$120	$192,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	10,000	$30	$300,000
Provision of new 15kV selector switches to served proposed facilities	No.	7	$35,000.00	$245,000
Provision of new manholes	No.	6	$25,000.00	$150,000
Hardscape/Landscape Replacement Costs	Sqft	5,000	$10	$50,000
Short Circuit and Arc Flash Study	-	L.S.	L.S.	$15,000
Subtotal				$952,000
Design Contingency @10%				$93,700
Overhead and Profit@17.3%				$162,101
Construction Contingency@10%				$93,700
Total Construction Costs With Mark Up				$1,301,501

Vault V24 to Facility/E143				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	200	$120	$24,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	1,400	$30	$42,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Provision of new manholes	No.	1	$25,000.00	$25,000
Hardscape/Landscape Replacement Costs	Sqft	700	$10	$7,000
Short Circuit and Arc Flash Study	-		L.S.	$7,500
Subtotal				$175,500
Design Contingency @10%				$16,800
Overhead and Profit@17.3%				$29,064
Construction Contingency@10%				$16,800
Total Construction Costs With Mark Up				$238,164

Description	Unit	Qty	Cost/unit	Costs
Vault V13 to Facility/E147				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	100	$120	$12,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	700	$30	$21,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Hardscape/Landscape Replacement Costs	Sqft	400	$10	$4,000
Short Circuit and Arc Flash Study	-		L.S.	$7,500
Subtotal				$114,500
Design Contingency @10%				$10,700
Overhead and Profit@17.3%				$18,511
Construction Contingency@10%				$10,700
Total Construction Costs With Mark Up				$154,411

Description	Unit	Qty	Cost/unit	Costs
Vault V13 to Facilities/E148, E149, E151				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	200	$120	$24,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	1,400	$30	$42,000
Provision of new 15kV selector switches to served proposed facilities	No.	4	$35,000.00	$140,000
Provision of new manholes	No.	1	$25,000.00	$25,000
Hardscape/Landscape Replacement Costs	Sqft	700	$10	$7,000
Short Circuit and Arc Flash Study	-		L.S.	$15,000
Subtotal				$253,000
Design Contingency @10%				$23,800
Overhead and Profit@17.3%				$41,174
Construction Contingency@10%				$23,800
Total Construction Costs With Mark Up				$341,774

Description	Unit	Qty	Cost/unit	Costs
Vault V12 to Facility/E150				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	100	$120	$12,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	700	$30	$21,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Hardscape/Landscape Replacement Costs	Sqft	400	$10	$4,000
Short Circuit and Arc Flash Study	-		L.S.	$7,500
Subtotal				$114,500
Design Contingency @10%				$10,700
Overhead and Profit@17.3%				$18,511
Construction Contingency@10%				$10,700
Total Construction Costs With Mark Up				$154,411

Description	Unit	Qty	Cost/unit	Costs
Vault V11 to Facility/E152				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	100	$120	$12,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	700	$30	$21,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Hardscape/Landscape Replacement Costs	Sqft	400	$10	$4,000
Short Circuit and Arc Flash Study	-		L.S.	$7,500
Subtotal				$114,500
Design Contingency @10%				$10,700
Overhead and Profit@17.3%				$18,511
Construction Contingency@10%				$10,700
Total Construction Costs With Mark Up				$154,411

Description	Unit	Qty	Cost/unit	Costs
Vault South West of Facility to Facility/E153				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	100	$120	$12,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	700	$30	$21,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Hardscape/Landscape Replacement Costs	Sqft	400	$10	$4,000
Short Circuit and Arc Flash Study	-		L.S.	$7,500
Subtotal				**$114,500**
Design Contingency @10%				$10,700
Overhead and Profit@17.3%				$18,511
Construction Contingency@10%				$10,700
Total Construction Costs With Mark Up				**$154,411**

Description	Unit	Qty	Cost/unit	Costs
Vault V11A to Facilities/E154, E156				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	300	$120	$36,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	2,000	$30	$60,000
Provision of new 15kV selector switches to served proposed facilities	No.	3	$35,000.00	$105,000
Provision of new manholes	No.	2	$25,000.00	$50,000
Hardscape/Landscape Replacement Costs	Sqft	1,000	$10	$10,000
Short Circuit and Arc Flash Study	-		L.S.	$15,000
Subtotal				**$276,000**
Design Contingency @10%				$26,100
Overhead and Profit@17.3%				$45,153
Construction Contingency@10%				$26,100
Total Construction Costs With Mark Up				**$373,353**

Description	Unit	Qty	Cost/unit	Costs
Vault V11A to Facility/E155				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	100	$120	$12,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	700	$30	$21,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Hardscape/Landscape Replacement Costs	Sqft	400	$10	$4,000
Short Circuit and Arc Flash Study	-		L.S.	$7,500
Subtotal				**$114,500**
Design Contingency @10%				$10,700
Overhead and Profit@17.3%				$18,511
Construction Contingency@10%				$10,700
Total Construction Costs With Mark Up				**$154,411**

Description	Unit	Qty	Cost/unit	Costs
Vault North of Facility to Facility/E157				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	100	$120	$12,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	700	$30	$21,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Hardscape/Landscape Replacement Costs	Sqft	400	$10	$4,000
Short Circuit and Arc Flash Study	-		L.S.	$7,500
Subtotal				**$114,500**
Design Contingency @10%				$10,700
Overhead and Profit@17.3%				$18,511
Construction Contingency@10%				$10,700
Total Construction Costs With Mark Up				**$154,411**

Description	Unit	Qty	Cost/unit	Costs
Future Vault (East of E161) to Facilities/E158, E159				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	800	$120	$96,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	5,000	$30	$150,000
Provision of new 15kV selector switches to served proposed facilities	No.	3	$35,000.00	$105,000
Provision of new manholes	No.	3	$25,000.00	$75,000
Hardscape/Landscape Replacement Costs	Sqft	5,000	$10	$50,000
Short Circuit and Arc Flash Study	-		L.S.	$15,000
Subtotal				$491,000
Design Contingency @10%				$47,600
Overhead and Profit@17.3%				$82,348
Construction Contingency@10%				$47,600
Total Construction Costs With Mark Up				$668,548

Description	Unit	Qty	Cost/unit	Costs
Future Vault (East of E161) to Facilities/E160, E161				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	200	$120	$24,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	1,400	$30	$42,000
Provision of new 15kV selector switches to served proposed facilities	No.	3	$35,000.00	$105,000
Provision of new manholes	No.	1	$25,000.00	$25,000
Hardscape/Landscape Replacement Costs	Sqft	700	$10	$7,000
Short Circuit and Arc Flash Study	-		L.S.	$7,500
Subtotal				$210,500
Design Contingency @10%				$20,300
Overhead and Profit@17.3%				$35,119
Construction Contingency@10%				$20,300
Total Construction Costs With Mark Up				$286,219

Description	Unit	Qty	Cost/unit	Costs
E166				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	100	$120	$0
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	700	$30	$0
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$0
Hardscape/Landscape Replacement Costs	Sqft	400	$10	$0
Short Circuit and Arc Flash Study	-		L.S.	$0
Subtotal				$0
Design Contingency @10%				$0
Overhead and Profit@17.3%				$0
Construction Contingency@10%				$0
Total Construction Costs With Mark Up				$0

NOTE: THE CAMPUS ELECTRICAL DISTRIBUTION EXTENSION COST IS ASSUMED TO BE PART OF THE EXPANSION PROJECT.

Description	Unit	Qty	Cost/unit	Costs
E167				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	100	$120	$0
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	700	$30	$0
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$0
Hardscape/Landscape Replacement Costs	Sqft	400	$10	$0
Short Circuit and Arc Flash Study	-		L.S.	$0
Subtotal				$0
Design Contingency @10%				$0
Overhead and Profit@17.3%				$0
Construction Contingency@10%				$0
Total Construction Costs With Mark Up				$0

NOTE: THE CAMPUS ELECTRICAL DISTRIBUTION EXTENSION COST IS ASSUMED TO BE PART OF THE EXPANSION PROJECT.

Description	Unit	Qty	Cost/unit	Costs
E169				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	100	$120	$0
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	700	$30	$0
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$0
Hardscape/Landscape Replacement Costs	Sqft	400	$10	$0
Short Circuit and Arc Flash Study	-		L.S.	$0
Subtotal				$0
Design Contingency @10%				$0
Overhead and Profit@17.3%				$0
Construction Contingency@10%				$0
Total Construction Costs With Mark Up				$0

NOTE: THE CAMPUS ELECTRICAL DISTRIBUTION EXTENSION COST IS ASSUMED TO BE PART OF THE EXPANSION PROJECT.

Vault North East of Student Services to Facility/E172				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	100	$120	$12,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	700	$30	$21,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Hardscape/Landscape Replacement Costs	Sqft	400	$10	$4,000
Short Circuit and Arc Flash Study	-		L.S.	$7,500
Subtotal				$114,500
Design Contingency @10%				$10,700
Overhead and Profit@17.3%				$18,511
Construction Contingency@10%				$10,700
Total Construction Costs With Mark Up				$154,411

Future Vault (North fo P01) to Facility/E174				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	100	$120	$12,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	700	$30	$21,000
Provision of new 15kV selector switches to served proposed facilities	No.	2	$35,000.00	$70,000
Hardscape/Landscape Replacement Costs	Sqft	400	$10	$4,000
Short Circuit and Arc Flash Study	-		L.S.	$7,500
Subtotal				$114,500
Design Contingency @10%				$10,700
Overhead and Profit@17.3%				$18,511
Construction Contingency@10%				$10,700
Total Construction Costs With Mark Up				$154,411

Future Vault (North of P01) to Facilities/E175, E176				
Provision of new medium voltage conduit duct banks to proposed buildings including trenching and backfill	L.F.	400	$120	$48,000
Provision of 15kV, 133%, 500kcmil EPR cables	L.F.	3,000	$30	$90,000
Provision of new 15kV selector switches to served proposed facilities	No.	3	$35,000.00	$105,000
Hardscape/Landscape Replacement Costs	Sqft	1,500	$10	$15,000
Short Circuit and Arc Flash Study	-		L.S.	$15,000
Subtotal				$273,000
Design Contingency @10%				$25,800
Overhead and Profit@17.3%				$44,634
Construction Contingency@10%				$25,800
Total Construction Costs With Mark Up				$369,234

Total Construction Costs With Mark Up—Phase 5	$4,814,081

Appendix

Meeting Report

Project: UCR Electrical Distribution System Review
Meeting Date: March 9, 2011
Time: 1:00PM
Location: Capital and Facilities Planning Conference Room

Present:

Mike Miller	UC Riverside
George MacMullin	UC Riverside
Kieron Brunelle	UC Riverside
Jon Harvey	UC Riverside
Eric Shuler	UC Riverside
Aravind Batra	P2S Engineering

This meeting report constitutes the official record of events noted, and unless questioned or amended in writing within 14 days, shall stand as written.

ACTION	CODE	SUBJECT

A. SCOPE CONFIRMATION AND ELECT. DISTRIBUTION SYSTEM REVIEW

1.1 Scope of project was revisited and following items were discussed/reviewed:

Review of existing 12kV and 4.16kV electrical distribution system

- *The campus currently has a12kV switchgear and 4.16kV switchgear that exists on the west side of the freeway and distributes power to all buildings on campus located on the east side of the freeway. The 4.16kV switchgear was installed in mid to late 1970's and the 12kV switchgear was installed in 1991-1992. The campus indicated that multiple feeders traverse close to each other under the freeway to serve the east campus resulting in de-rating of the feeders.*
- *A new 12kV-4.16kV substation was installed in 1991-1992 to serve few of the buildings located centrally on the east side of the campus.*
- *Campus preference is to transition to a 12kV system.*
- *The campus has oil fused cutouts in vaults that help isolate buildings and provide over current protection.*
- *The 5kV cables are EPR 133% cables and were provided in 1986.*
- *The 15kV cables are approximately 20years old and were installed in 1990.*
- *A separate 12kV service exists to serve the Capital Planning and Facilities area.*
- *The campus indicated that they had seen failures of circuit 2 in vault 9, splice blow up in vault 8 and 5kV explosion in vault 19. In addition, 5kV cable failure took place on the feed to Bachelor Hall.*
- *The campus indicated that the batteries at the switchgear are old and need to be replaced.*

P2S 1.2 *Project Schedule to deliver the electrical distribution system review report was discussed. P2S indicated that they would provide an updated schedule for campus review and use.*

ACTION	CODE	SUBJECT
P2S	*1.3*	*Campus indicated that all relevant electrical distribution system documents were posted on P2S ftp site. P2S indicated that they would review the same and set up a time to walk the job with the campus electrical staff.*
P2S	*1.4*	*Campus discussed the need to have an accurate as built documentation. P2S indicated that they would walk the campus and identify the various surface features (manholes, switches etc.) to update the electrical site plan. The same was acceptable to the campus. P2S also indicated that currently there are 10manholes that will be investigated as part of the scope of work. These manholes will be selected jointly with P2S. Additional manholes will be surveyed at the rate of $600/manhole based on campus selection and preference.*
P2S	*1.5*	*The campus indicated that the site plans were available in GIS and not in AutoCAD. P2S indicated that the same will be converted into AutoCAD to update the same.*
P2S/Campus	*1.6*	*Campus indicated that they would like to have productive meetings and the same be scheduled once P2S has substantial information to present to the campus. P2S suggested that three meetings be set up, one after existing systems have been analyzed, second after the analysis of the systems has been conducted and the third after to share the proposed recommendations. These meetings will be scheduled by the campus at each milestone after checking schedules of all involved.*

Sincerely,

P2S Engineering, Inc.

Aravind Batra, P.E.,LC, LEED
Principal

Meeting Report

Project: UCR Electrical Distribution System Review
Meeting Date: May 10, 2011
Time: 3:00PM
Location: Capital and Facilities Planning Conference Room

Present:		
	George MacMullin	UC Riverside
	Jon Harvey	UC Riverside
	Eric Shuler	UC Riverside
	Brian Hambleton	UC Riverside
	Aravind Batra	P2S Engineering

This meeting report constitutes the official record of events noted, and unless questioned or amended in writing within 14 days, shall stand as written.

ACTION	CODE	SUBJECT
	1.1	*P2S provided a project update to all in attendance. P2S indicated that they had completed their surveys except for documenting a portion of buildings transformers KVA. The same is in progress and will be completed early next week. The single line diagrams and site plan have been completed with the information gathered to date and the same were shared at the meeting. The same will be updated further as more information is gathered on the existing system.*
UCR	1.2	*P2S requested that it would be beneficial to receive a year of utility bills providing kW and kWh demand for the 12kV system serving the campus.*
P2S	*1.3*	*Campus indicated that the electrical site map shall be updated to cover the north part of the campus up to Blaine Street. The site plan shall also show current electrical system serving the housing units on the south side of Blaine Street.*
P2S	*1.4*	*Campus discussed the need to have selector switches that are free of SF6 gas and are capable of remotely switching over circuits to manage their medium voltage grid system. P2S discussed the options available and indicated that the same will be included in the equipment specification sections of the report.*
P2S	*1.5*	*P2S reviewed the report format with the campus and reviewed the chapters that will form part of our report. The campus indicated that one of the scope items was to provide a contingency plan that can be employed to service a feeder in case service is lost. P2S indicated that the same will be included in the recommendation section of the report.*
P2S/Campus	*1.6*	*UCR noticed that few of the campus existing buildings are not spelled correctly and need to be corrected. It was decided that P2S will send a spreadsheet providing a list of existing buildings to the campus so that the campus can review and correct them. UCR also requested that P2S send an electronic copy of the report format.*
P2S	*1.7*	*P2S discussed the campus plan to have renewable systems at the campus to reduce greenhouse gas emissions consistent with AB32 being adopted by the state. UCR requested that a copy of the same be sent to them for their review.*

ACTION	CODE	SUBJECT
P2S	*1.8*	*P2S discussed the need to have meters at each of the building to monitor energy consumption. Campus shared the existing meters/software being used currently at the campus to monitor the energy consumed in few of the buildings. Campus also indicated that they are open to new technologies available to monitor their energy use at each of the building. P2S indicated that they would provide the same as part of their equipment specifications chapter in the report.*
P2S	*1.9*	*Campus discussed the options of providing substations in each of the buildings. Campus indicated that they would prefer to have separate primary 12kV feeds to 480V and 120/208V substations rather than having 480-120/208V transformers in each of the buildings. P2S indicated that they would address the same in their recommendations chapter of their report.*
	1.10	*Next meeting will be held on May 31st at 3pm.*

Sincerely,

P2S Engineering, Inc.

Aravind Batra, P.E.,LC, LEED
Principal

Meeting Report

Project: UCR Electrical Distribution System Review
Meeting Date: June 7th, 2011
Time: 3:00PM
Location: Capital and Facilities Planning Conference Room

Present:

Mike Miller	UC Riverside
Richard W. Racicot	UC Riverside
George MacMullin	UC Riverside
Kieron Brunelle	UC Riverside
Don Caskey	UC Riverside
Tim Ralston	UC Riverside
Jon Harvey	UC Riverside
Brian Hambleton	UC Riverside
Aravind Batra	P2S Engineering

This meeting report constitutes the official record of events noted, and unless questioned or amended in writing within 14 days, shall stand as written.

ACTION	CODE	SUBJECT
	1.1	*P2S provided a project update to all in attendance. P2S also shared spreadsheets providing connected load and demand on the existing 12.47kV and 4.16kV systems by each feeder currently serving the campus. Spreadsheets providing future facilities loads and demands were also shared with all in attendance. Based on the demands of the existing facilities, it was indicated that 12.47kV feeders 2A, 2B and 1A, 1B are at capacity and should not be used to serve any future facilities if redundancy is to be maintained.*
UCR	1.2	*P2S requested that it would be beneficial to receive maximum load readings on each of the 12.47kV feeders to compare the computed demand to actual demand seen on these feeders.*
	1.3	*P2S presented the option of meeting the demands of future facilities. P2S recommended that the best option of serving the future loads at the campus would be to add a third transformer/12.47kV switchgear section at the existing electrical switchyard located on the west side of the campus and shift the feeders distribution to the east side of the campus. New 3-section 12.47kV switchgear housed in a building of approximately 3000sqft will be provided with main and multiple feeder breakers to distribute power to each of the existing and future facility located on the east side of the campus. This switchgear will be served from the main 12.47kV switchgear currently located on the west side of the campus. Existing ducts currently traversing under the freeway will be used to route feeders to serve the proposed 12.47kV switchgear located on the east side of the campus. This option will not only alleviate the de-rating effect that is currently being experienced with the feeders traversing under the freeway but also avoid the provision of any new duct banks that will need to be added under the freeway to route multiple feeders in the future to feed the new facilities. It was also recommended that the 4.16kV system be replaced with 12.47kV system in a phased manner. The location of the proposed 12.47kV switchgear was discussed and was proposed to be located close to the existing 12kV duct banks/manhole in the general vicinity of the Barn Group. Exact location of the switchgear will be provided by the campus. The campus agreed with the recommended option.*

ACTION	CODE	SUBJECT
P2S	*1.4*	*P2S discussed the need to have a meeting with RPU to confirm the above recommended option and verify the provision of the third transformer/switchgear. UCR indicated that P2S contact the utility company and provide contact person at the utility company to set up the meeting.*
P2S	*1.5*	*P2S requested UCR to provide a phasing schedule for the proposed facilities if the same was available so that the improvements can be phased. UCR indicated that the spreadsheet providing new facilities developed by P2S be sent to enable the campus show phasing for the proposed facilities.*
P2S	*1.6*	*UCR requested that equipment specifications be provided as part of the proposed master plan.*
P2S	*1.7*	*Next meeting scheduled for June 22nd has been cancelled and will be rescheduled by UCR.*

Sincerely,

P2S Engineering, Inc.

Aravind Batra, P.E.,LC, LEED
Principal

Meeting Report

Project: UCR Electrical Distribution System Review
Meeting Date: July 20th, 2011
Time: 10:30AM
Location: Capital and Facilities Planning Conference Room

Present:		
	George MacMullin	UC Riverside
	Kieron Brunelle	UC Riverside
	Jon Harvey	UC Riverside
	Eric Shuler	UC Riverside
	Brian Hambleton	UC Riverside
	Aravind Batra	P2S Engineering

This meeting report constitutes the official record of events noted, and unless questioned or amended in writing within 14 days, shall stand as written.

ACTION	CODE	SUBJECT
	1.1	*P2S distributed the draft master plan report to all in attendance. P2S reviewed the report and indicated that the report comprises of various chapters and provides a description of existing conditions, analysis of future needs, recommendations, phasing and costs for implementing the proposed recommendations in phases.*
	1.2	*P2S reviewed the existing conditions with the campus. P2S indicated that the existing oil fused switches should be replaced as they are at the end of their useful life. P2S also noted that combined load on existing feeders 2A, 2B is nearing the capacity of one feeder and no additional load should be added to these feeders if redundancy needs to be maintained. UCR indicated that there are feeders 1A and 1B that are currently available on the south side can be extended north to pick up the new housing loads. UCR will confirm their locations and provide the same to P2S. UCR also indicated that there are certain gas switches that need to be replaced and should be included in the report. P2S requested the locations of these switches and agreed to include the same in the final report.*
	1.3	*P2S presented the analysis of future needs. A total load of approximately 26.5MVA is being added as a result of proposed facilities being added at the campus. P2S presented the recommendations and indicated that that the best option of serving the future loads at the campus would be to add a third transformer/12.47kV switchgear section at the existing electrical switchyard located on the west side of the campus and shift the feeders distribution to the east side of the campus. New 3-section 12.47kV switchgear housed in a building of approximately 3000sqft will be provided with main and multiple feeder breakers to distribute power to each of the existing and future facility located on the east side of the campus. This switchgear will be served from the main 12.47kV switchgear currently located on the west side of the campus. Existing ducts currently traversing under the freeway will be used to route feeders to serve the proposed 12.47kV switchgear located on the east side of the campus. This option will not only alleviate the de-rating effect that is currently being experienced with the feeders traversing under the freeway but also avoid the provision of any new duct banks that will need to be added*

ACTION	CODE	SUBJECT
		under the freeway to route multiple feeders in the future to feed the new facilities. It was also recommended that the 4.16kV system be replaced with 12.47kV system in a phased manner. The location of the proposed 12.47kV switchgear will be provided by the campus. P2S also indicated that the same will be confirmed with RPU at the meeting next week.
P2S	*1.4*	*P2S reviewed the equipment specifications with the campus. UCR indicated that model numbers of proposed materials be provided as part of the specifications.*
P2S	*1.5*	*P2S reviewed the phasing and associated costs with the campus. UCR requested that breakdown of costs be provided for each phase as part of the final report.*
UCR	*1.6*	*UCR indicated that the draft report will be reviewed by the campus and comments will be provided in two weeks.*
	1.7	*Next meeting is scheduled for July 28th with RPU.*

Sincerely,

P2S Engineering, Inc.

Aravind Batra, P.E.,LC, LEED
Principal

Meeting Report

Project: UCR Electrical Distribution System Review
Meeting Date: July 28th, 2011
Time: 9:45AM
Location: Capital and Facilities Planning Conference Room

Present:

Mike Miller	UC Riverside
George MacMullin	UC Riverside
Kieron Brunelle	UC Riverside
Jon Harvey	UC Riverside
Eric Shuler	UC Riverside
Brian Hambleton	UC Riverside
Jerry McAllister	RPU
David P. Hernandez	RPU
Russ Johnson	RPU
Jeff M.	RPU
Aravind Batra	P2S Engineering

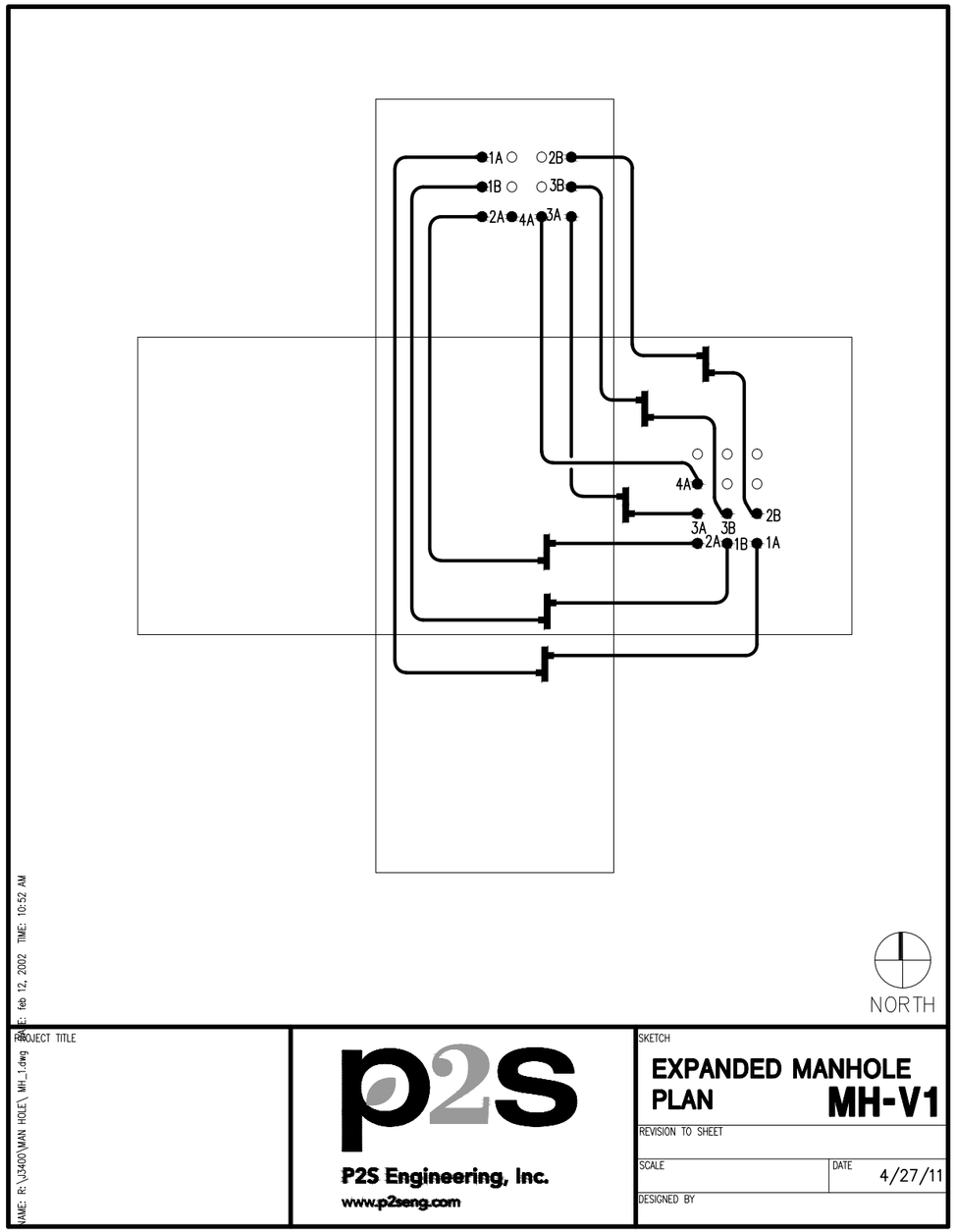
This meeting report constitutes the official record of events noted, and unless questioned or amended in writing within 14 days, shall stand as written.

ACTION	CODE	SUBJECT
	1.1	*P2S provided an overview of the draft electrical distribution study to all in attendance.*
	1.2	*P2S presented their analysis of future needs and indicated that a total load of 26.5MVA is being added as a result of proposed facilities to the existing campus demand of approximately 25.5MVA.*
	1.3	*P2S presented their proposed recommendations and indicated that future loads at the campus would be served by adding a third transformer/12.47kV switchgear section at the existing electrical switchyard located on the west side of the campus and shift the feeders distribution to the east side of the campus. This would provide the campus with the same redundancy as the campus currently has from the RPU end. New 3-section 12.47kV switchgear housed in a building of approximately 3000sqft will be provided with main and multiple feeder breakers to distribute power to each of the existing and future facility located on the east side of the campus. This switchgear will be served from the main 12.47kV switchgear currently located on the west side of the campus. Existing ducts currently traversing under the freeway will be used to route feeders to serve the proposed 12.47kV switchgear located on the east side of the campus. This option will not only alleviate the de-rating effect that is currently being experienced with the feeders traversing under the freeway but also avoid the provision of any new duct banks that will need to be added under the freeway to route multiple feeders in the future to feed the new facilities. It is also recommended that the 4.16kV system be replaced with 12.47kV system in a phased manner. RPU agreed with the proposed recommendations and indicated they do not see any problem with the proposed recommendations.*
		UCR also indicated that it is important to have RPU review the capacity requirements of the west campus as well while considering their capacity requirement for east campus. UCR indicated that the proposed load that will be added on the west campus in the future would be approximately 33MVA. RPU indicated that they have already considered the impact of these loads at their end and propose to provide two separate transformers of approximately 33MVA to meet the loads of the west campus. A new third transformer of approximately 33MVA will be added to meet the additional loads of east campus.
RPU	1.4	*RPU indicated that additional space is needed at the University Substation to support proposed East Campus electrical requirements. A second substation would be needed to accommodate the proposed West Campus loads, and an initial footprint of 140 by 200 feet was proposed. A larger space of 200 ft square was suggested for discussion purposes pending a more detailed review of the actual electrical requirements and potential locations. Previous planning efforts placed the School of Medicine substation at the UCR Support Yard which is close to Chicago Avenue and 12th Street. RPU indicated that they would review the UCR requirements and furnish comments on the concepts to UCR/P2S.*
	1.5	*UCR/P2S reviewed the timeline of implementing the addition of transformer with RPU on the west side of the campus. RPU indicated that they would need approximately 2 ½ years from the date of authorizing them to proceed.*
RPU	1.6	*RPU provided a plan showing the addition of transformer(s) on the west side of the campus for everyone's review. P2S requested that RPU clarify the meter readings currently being recorded both on 4.16kV and 12.47kV system. RPU agreed to furnish the required information.*

Sincerely,

P2S Engineering, Inc.

Aravind Batra, P.E.,LC, LEED
Principal



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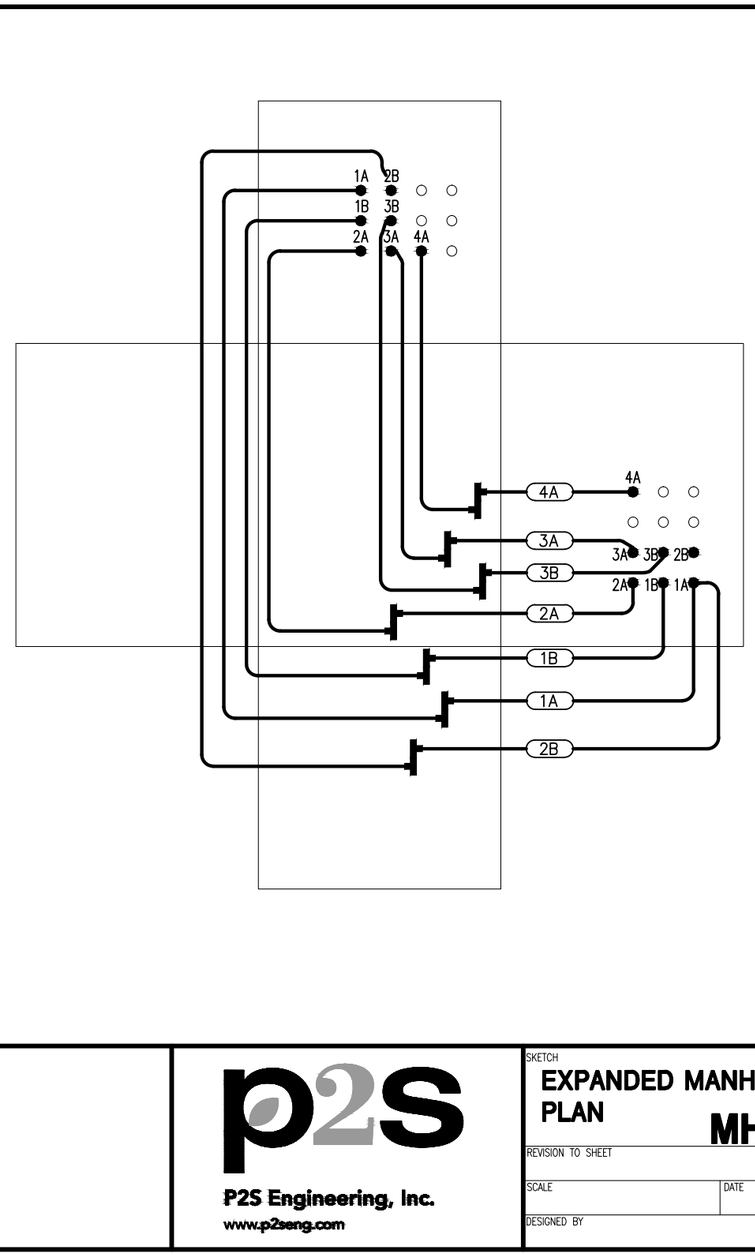
PROJECT TITLE

p2s
P2S Engineering, Inc.
www.p2seng.com

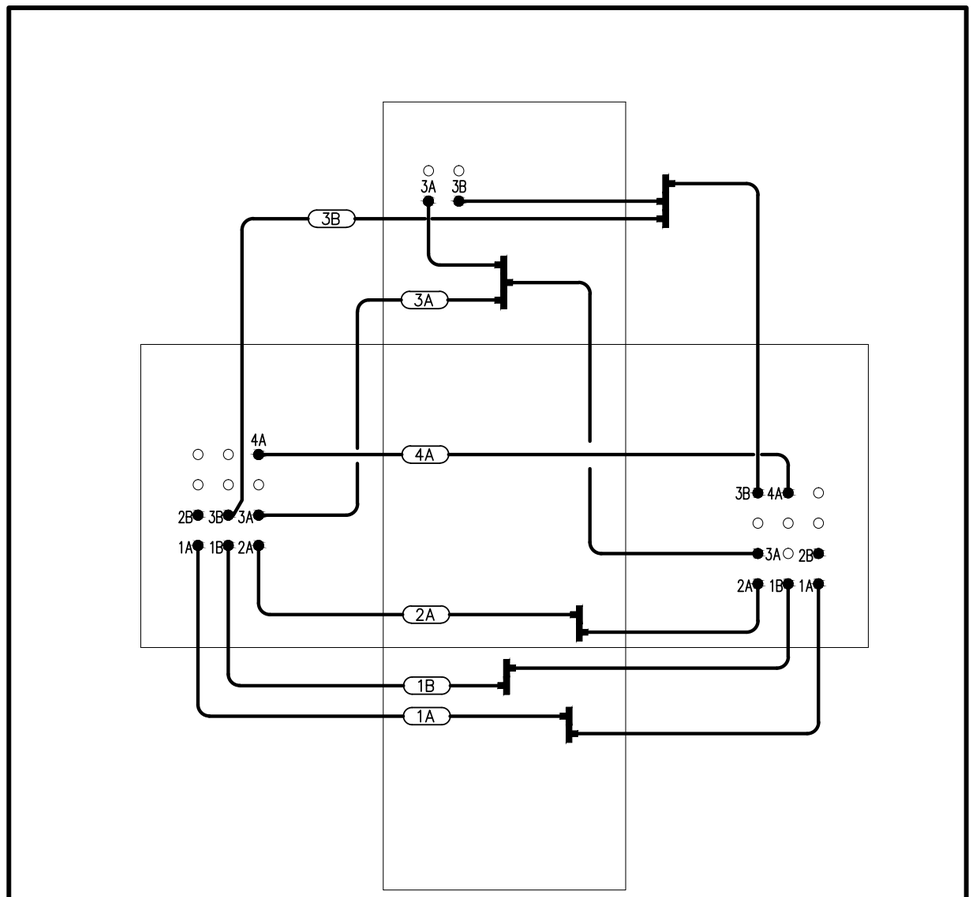
SKETCH
EXPANDED MANHOLE PLAN **MH-V1**
REVISION TO SHEET
SCALE
DATE 4/27/11
DESIGNED BY



PROJECT TITLE

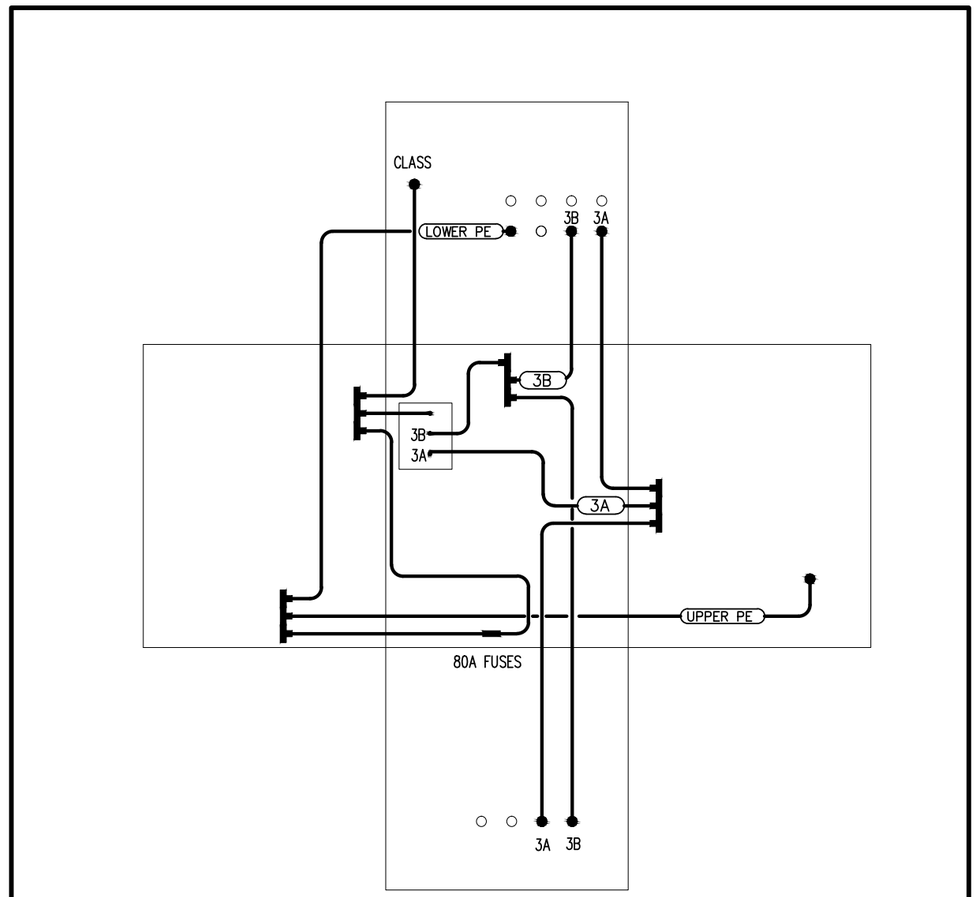
p2s
P2S Engineering, Inc.
www.p2seng.com

SKETCH
EXPANDED MANHOLE PLAN **MH-V2**
REVISION TO SHEET
SCALE
DATE 4/27/11
DESIGNED BY



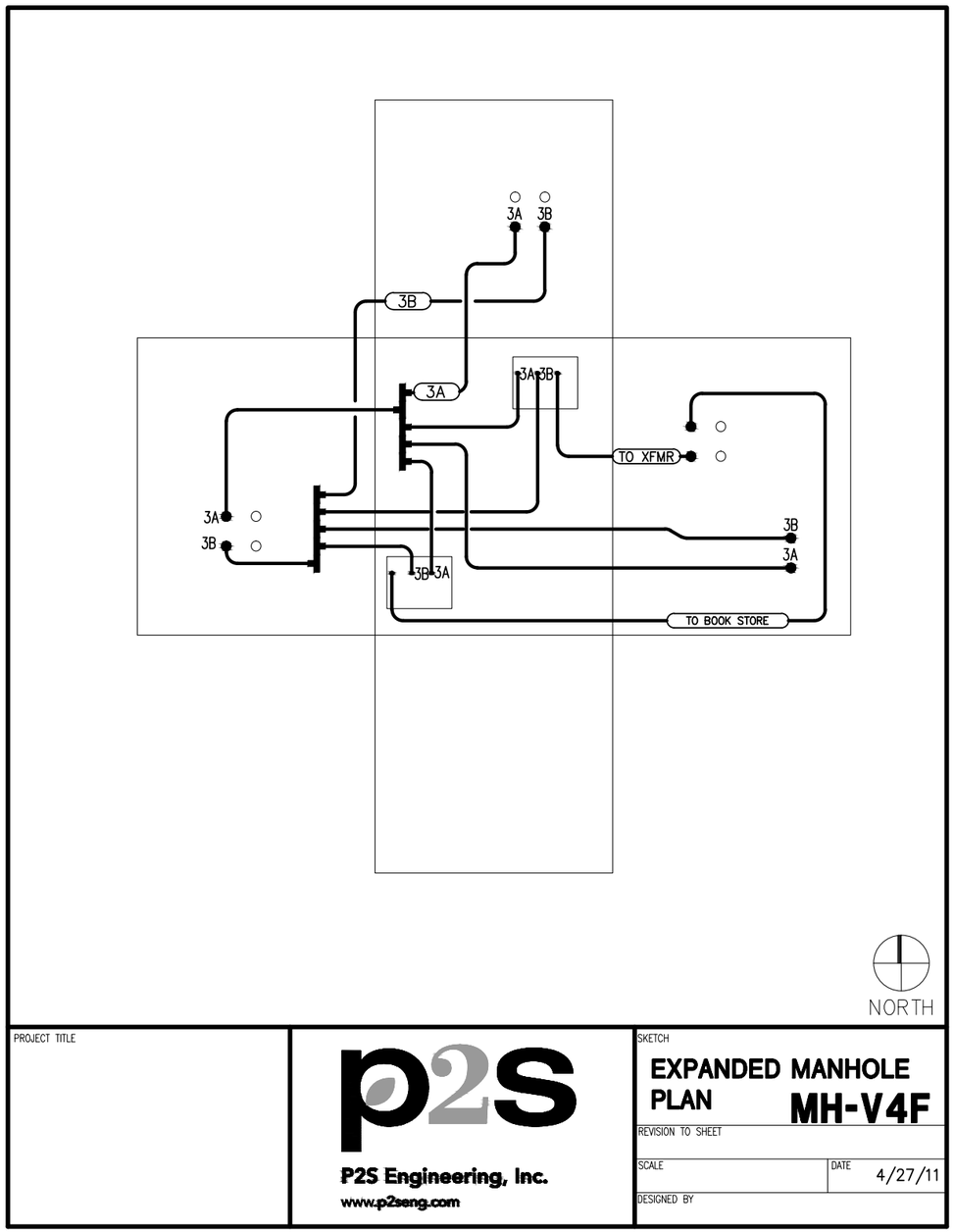
NORTH

PROJECT TITLE	p2s P2S Engineering, Inc. www.p2seng.com	SKETCH EXPANDED MANHOLE PLAN **MH-V3** REVISION TO SHEET SCALE DATE 4/27/11 DESIGNED BY

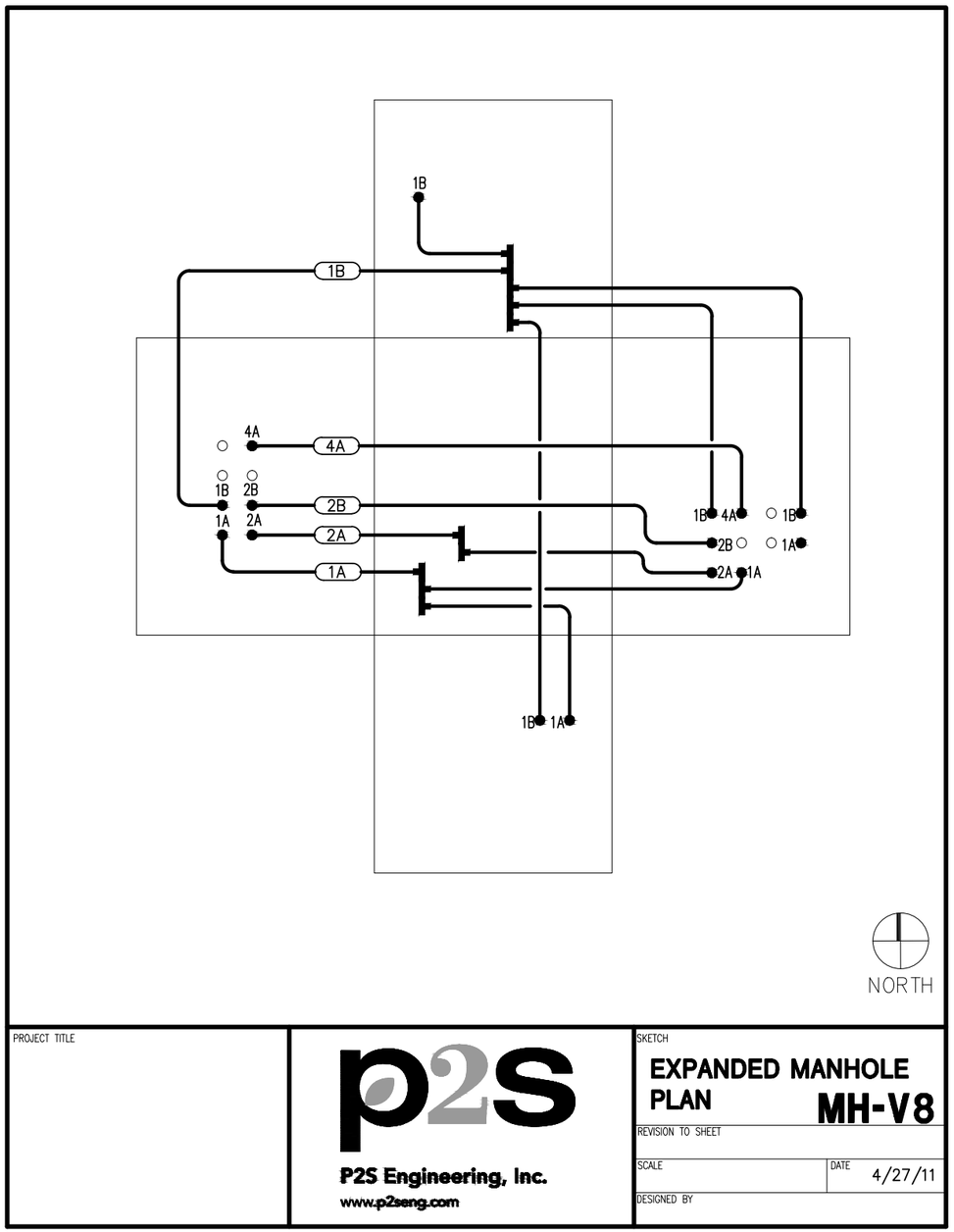


NORTH

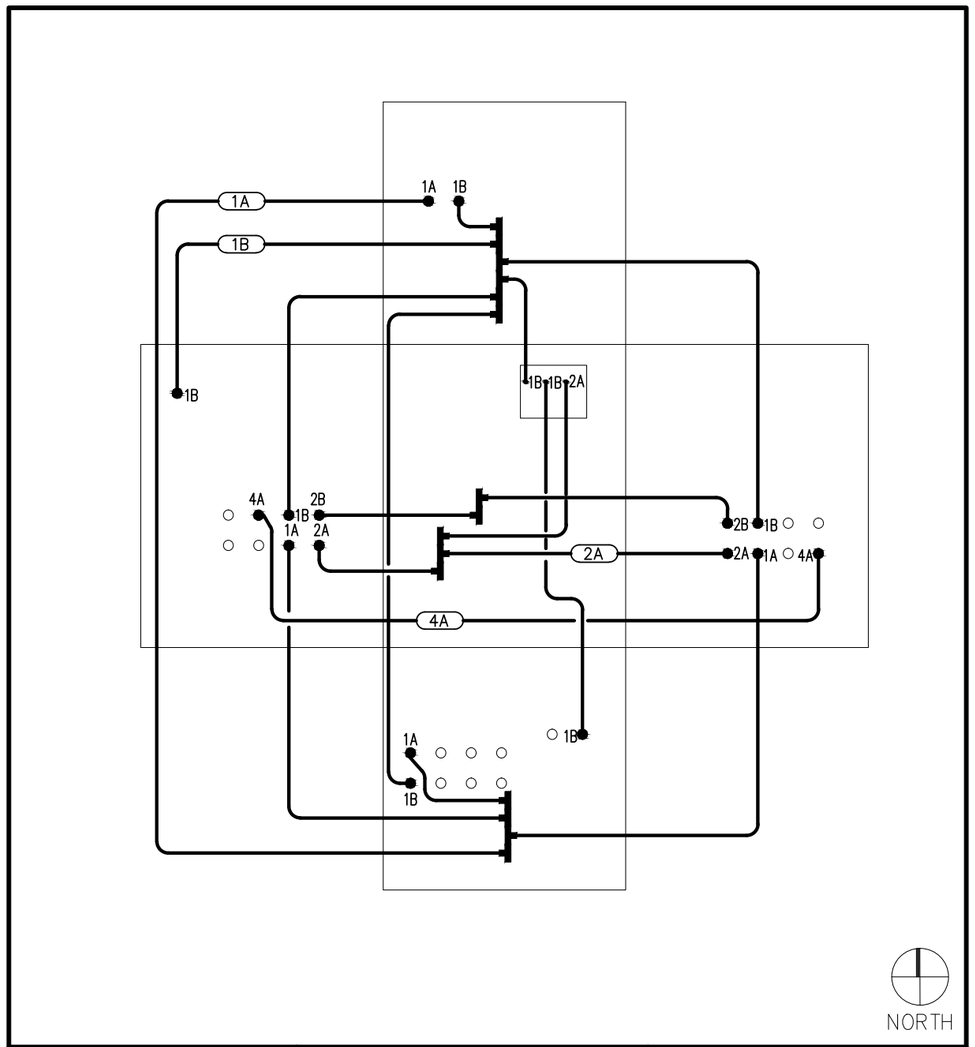
PROJECT TITLE	p2s P2S Engineering, Inc. www.p2seng.com	SKETCH EXPANDED MANHOLE PLAN **MH-V4D** REVISION TO SHEET SCALE DATE 4/27/11 DESIGNED BY



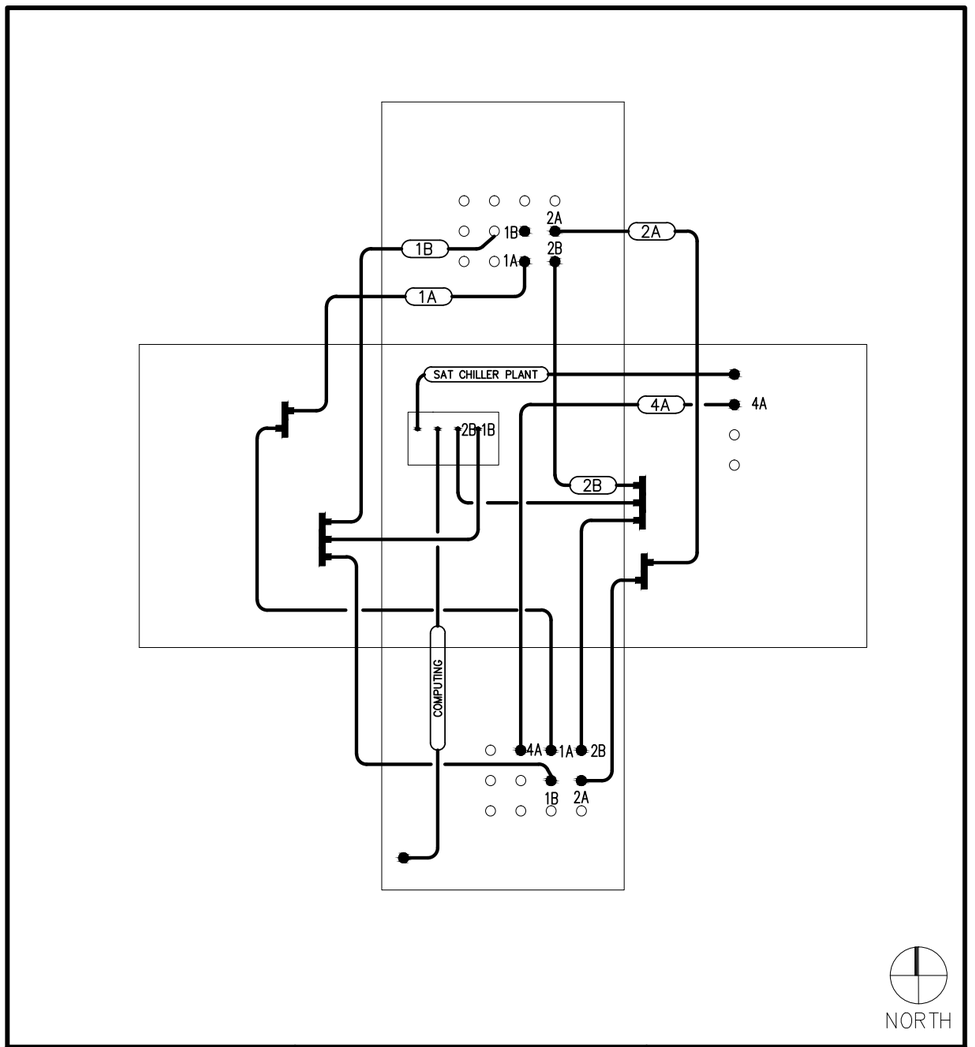
PROJECT TITLE	P2S Engineering, Inc. www.p2seng.com	SKETCH EXPANDED MANHOLE PLAN **MH-V4F** REVISION TO SHEET SCALE DATE 4/27/11 DESIGNED BY



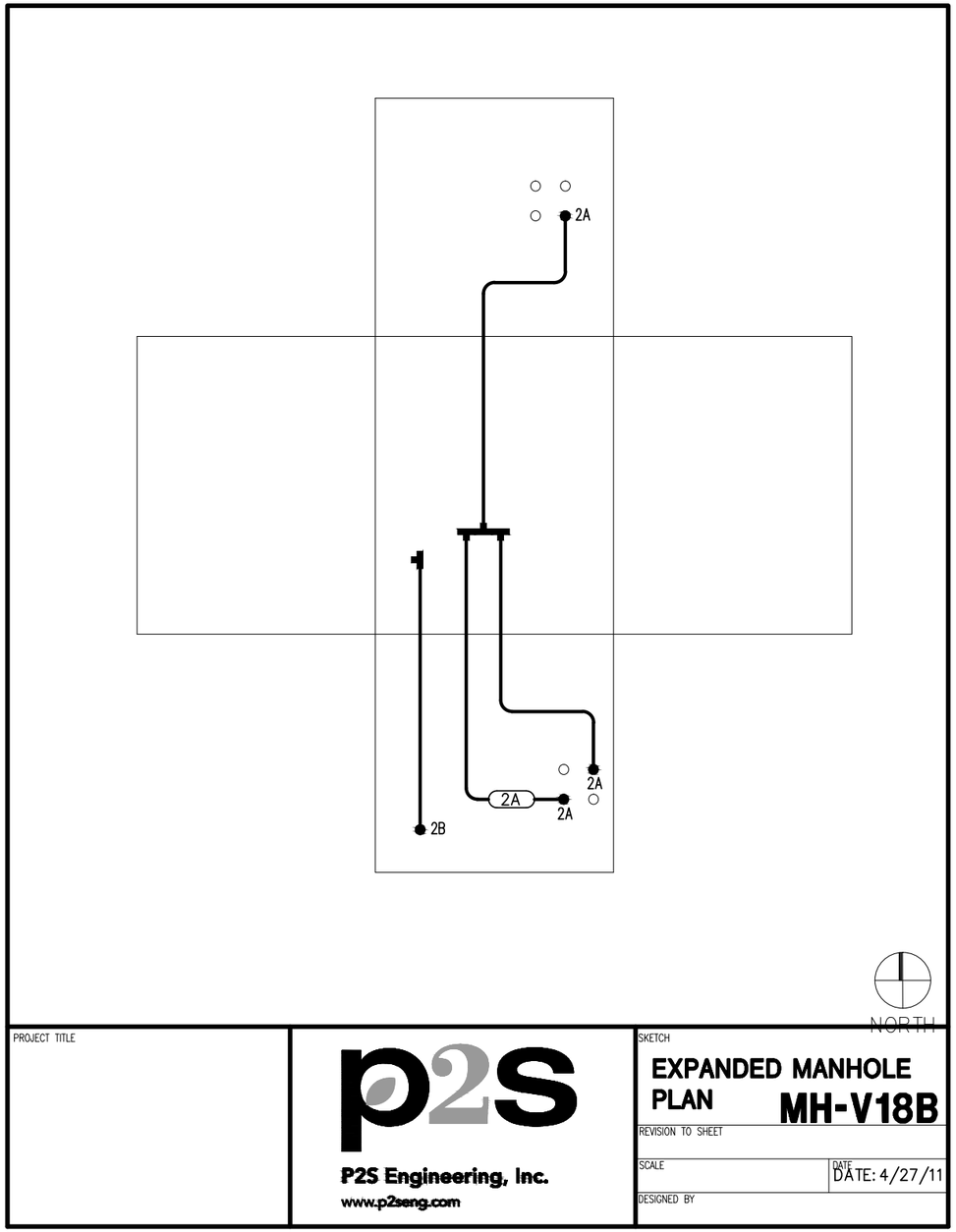
PROJECT TITLE	P2S Engineering, Inc. www.p2seng.com	SKETCH EXPANDED MANHOLE PLAN **MH-V8** REVISION TO SHEET SCALE DATE 4/27/11 DESIGNED BY



PROJECT TITLE	P2S Engineering, Inc. www.p2seng.com	SKETCH EXPANDED MANHOLE PLAN **MH-V9** REVISION TO SHEET SCALE DATE 4–27–11 DESIGNED BY

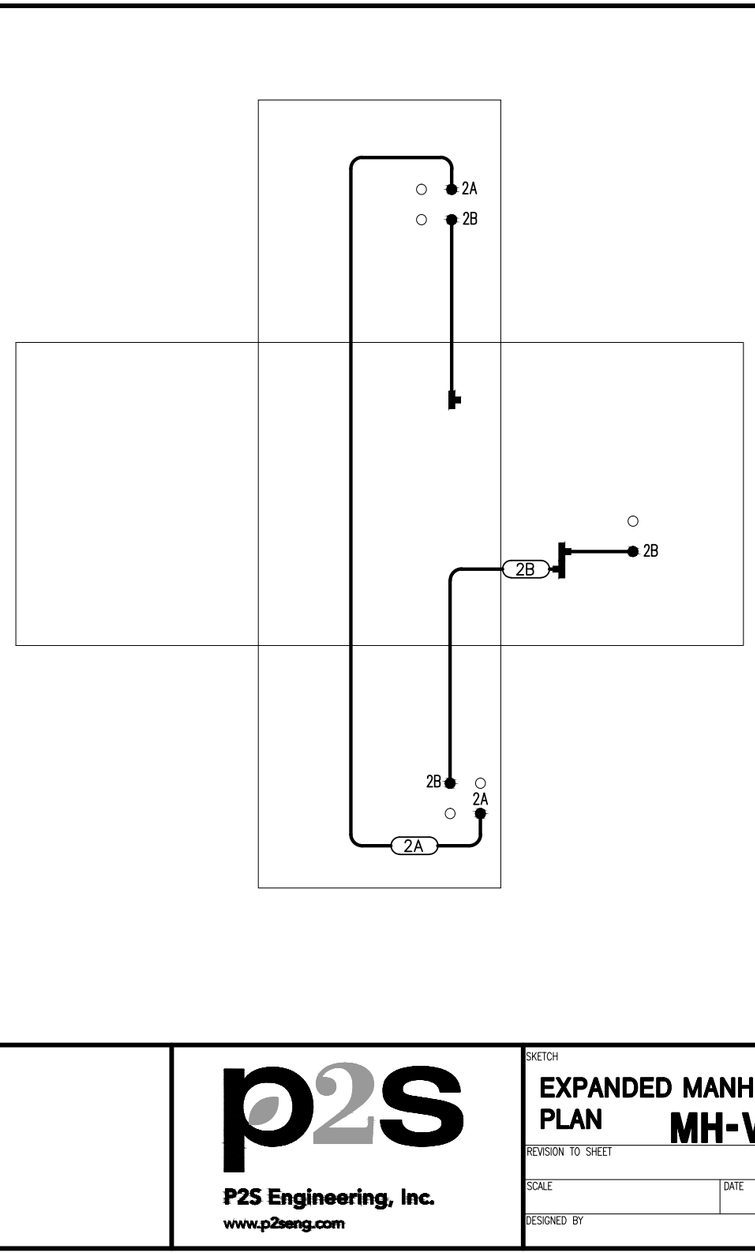


PROJECT TITLE	P2S Engineering, Inc. www.p2seng.com	SKETCH EXPANDED MANHOLE PLAN **MH-V11** REVISION TO SHEET SCALE DATE 4/27/11 DESIGNED BY



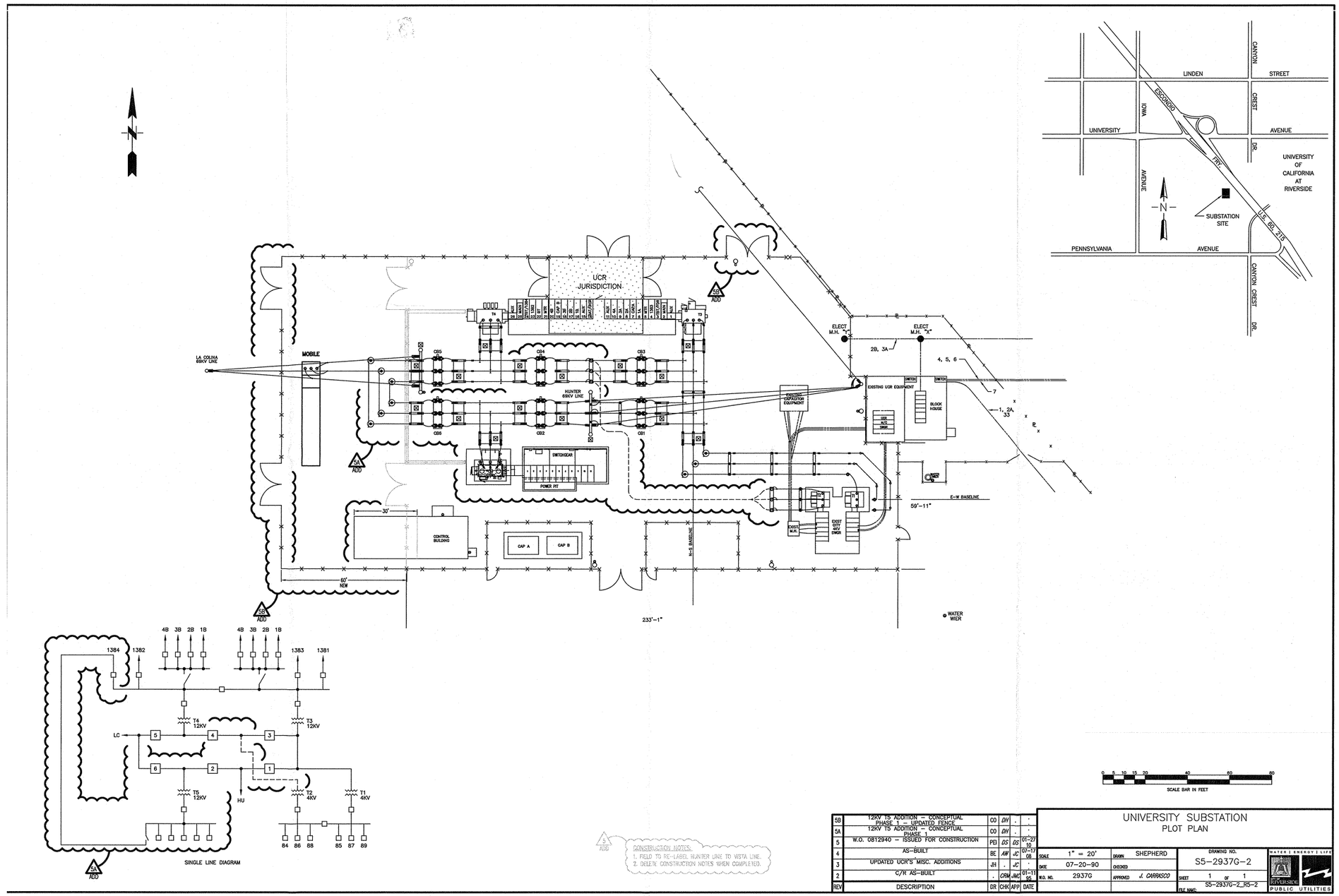
NORTH

PROJECT TITLE	P2S Engineering, Inc. www.p2seng.com	SKETCH EXPANDED MANHOLE PLAN **MH-V18B**
		REVISION TO SHEET
		SCALE / DATE: 4/27/11
		DESIGNED BY



NORTH

PROJECT TITLE	P2S Engineering, Inc. www.p2seng.com	SKETCH EXPANDED MANHOLE PLAN **MH-V18A**
		REVISION TO SHEET
		SCALE / DATE: 4/27/11
		DESIGNED BY



REV	DESCRIPTION	DR	CHK	APP	DATE
5B	12KV TS ADDITION – CONCEPTUAL PHASE 1 – UPDATED FENCE	CO	DH	.	.
5A	12KV TS ADDITION – CONCEPTUAL PHASE 1	CO	DH	.	.
5	W.O. 0812940 – ISSUED FOR CONSTRUCTION	PEI	DS	DS	01-27-10
4	AS-BUILT	BE	AW	JC	07-17-08
3	UPDATED UCR'S MISC. ADDITIONS	JH	.	JC	.
2	C/R AS-BUILT	.	CRW	JMC	01-11-05

UNIVERSITY SUBSTATION
PLOT PLAN

SCALE	1" = 20'	DRAWN	SHEPHERD
DATE	07-20-90	CHECKED	
W.O. NO.	2937G	APPROVED	J. CARRASCO
		DRAWING NO.	S5-2937G-2
		SHEET	1 OF 1
		FILE NAME	S5-2937G-2_R5-2

RIVERSIDE PUBLIC UTILITIES

Participants

Physical Plant

Mike Miller ..... Associate Vice Chancellor, Facilities
Eric Shuler ..... Electrical Supervisor
Brian Hambleton ..... Maintenance Electrician

Capital Programs

Timothy Ralston ..... Associate Vice Chanchellor, Capital Programs
Don Caskey ..... Campus Architect

Capital Resource Management

Kieron Brenelle ..... Executive Director
Jon Harvey ..... Principal Educational Facilities Planner

Architects and Engineers

Richard Raciot ..... Executive Director
George MacMullin ..... Senior Engineer

P2S Engineering

Aravind Batra ..... Principal-in-Charge / Senior Electrical Engineer
Mike Bukowski ..... Senior Electrical Design Engineer