University of Alaska Fairbanks Utility Development Plan

Technical Appendices B-D October 25, 2006

GLHN Architects & Engineers, Inc

Design Alaska

Energy Economic & Environmental Consultants

Pacific Consulting

THE UNIVERSITY OF ALASKA FAIRBANKS
2005 UTILITY DEVELOPMENT PLAN

APPENDIX B: TECHNICAL APPENDIX

SECTION 1 – TECHNICAL PRODUCTION EQUIPMENT PERFORMANCE

Existing Systems

ELECTRIC SYSTEM

Equipment	MachineorGroup	Units	Notes	Characteristics
DEG	MinStandby	Percent	Minimum Standby Percent	0.05
DEG	DispatchCapThres	Percent	Dispatch Capacity Threshold	1
DEG	Capacity	LPSteamPerHr	Capacity Units Per Hr	22
DEG	Capacity	kWPerHr	Capacity Units Per Hr	9600
DEG	Efficiency	kWPerGal	Efficiency	12.8
DEG	Efficiency	LPStmPerMlbs	Efficiency	1
PRV	Efficiency	LPSteamPerMlbs	Steam Down Rate # HP Steam = #s LP Steam	1
Turbine3	Capacity	kWPerHr	Capacity Units Per Hr	9600
Turbine3	Capacity	HPSteamPerHr	HP Steam in	138
Turbine3	Capacity	LPStmPerHr	25 # Extraction	78
Turbine3	Capacity	Restraint	% of Capacity Restraint Assumes Linear Relationship	1.0 except Jun, Jul, Aug when equal to 0.71, 0.71, 0.67

STEAM SYSTEM

Equipment	MachineorGroup	Units	Notes	Characteristics
Boiler1	MinStandby	Percent	Minimum Standby Percent	0.2
Boiler1	DispatchCapThres	Percent	Dispatch Capacity Threshold	0.65
Boiler1	Capacity	HPSteamPerHr	Capacity Units Per Hr	45
Boiler1	Efficiency	MlbsPerTonCoal	Based on UAF Historic Data	10.9
Boiler1	Efficiency	MlbsPerMMBtu	=10.9 / (7,800 Btu per lbm *2000 lbs per Ton)*(1351 Btu / Mlb Out/ (1351-178) Btu / Mlb Out)	0.805
Boiler2	MinStandby	Percent	Minimum Standby Percent	0.2
Boiler2	DispatchCapThres	Percent	Dispatch Capacity Threshold	0.65
Boiler2	Capacity	HPSteamPerHr	Capacity Units Per Hr	45
Boiler2	Efficiency	MlbsPerTonCoal	Based on UAF Historic Data	10.9
Boiler2	Efficiency	MlbsPerMMBtu	=10.9 / (7,800 Btu per lbm *2000 lbs per Ton)*(1351 Btu / Mlb Out/ (1351-178) Btu / Mlb Out)	0.805
Boiler3	MinStandby	Percent	Minimum Standby Percent	0.15
Boiler3	DispatchCapThres	Percent	Dispatch Capacity Threshold	1
Boiler3	Capacity	HPSteamPerHr	Capacity Units Per Hr	90
Boiler3	Efficiency	MlbsPerGal	Based on UAF Historic Data	0.0971
Boiler4	MinStandby	Percent	Minimum Standby Percent	0.05
Boiler4	DispatchCapThres	Percent	Dispatch Capacity Threshold	1
Boiler4	Capacity	HPSteamPerHr	Capacity Units Per Hr	90
Boiler4	Efficiency	MlbsPerGal	Based on UAF Historic Data	0.0971
BoilerSA	Efficiency	LpsteamPerGal	78% Efficiency (139,000 Btu / Gal * 78% = 0.10842)	0.10842

CHILLED WATER SYSTEM

Equipment	MachineorGroup	Units	Notes	Characteristics
ChWDES	Efficiency	kWPerTon	Efficiency DES Electric	1
ChWDES	Efficiency	lbsPerTon	Efficiency DES Steam	22
CoolingSA	Efficiency	kWPerTon	Efficiency Stand Alone ChW	1.1

Strategy 1 - New Equipment

STEAM SYSTEM

Equipment	MachineorGroup	Units	Notes	Characteristics
BoilerSA	Efficiency	LpsteamPerGal	78% Efficiency (139,000 Btu / Gal * 78% = 0.10842)	0.10842

CHILLED WATER SYSTEM

Equipment	MachineorGroup	Units	Notes	Characteristics
CoolingSA	Efficiency	kWPerTon	Efficiency Stand Alone ChW	1.1

Strategy 1 - Natural Gas Sub-Option - New Equipment

STEAM SYSTEM

Equipment	MachineorGroup	Units	Notes	Characteristics
BoilerSA	Efficiency	LpsteamPerNG	78% Efficiency (1 Btu / Btu * 78% / 10^6= 0.78)	0.78

CHILLED WATER SYSTEM

Equipment	MachineorGroup	Units	Notes	Characteristics
CoolingSA	Efficiency	kWPerTon	Efficiency Stand Alone ChW	1.1

Strategy 2 - New Equipment

STEAM SYSTEM

Equipment	MachineorGroup	Units	Notes	Characteristics
BoilerWR	MinStandby	Percent	Minimum Standby Percent	0.05
BoilerWR	DispatchCapThres	Percent	Dispatch Capacity Threshold	1
BoilerWR	Capacity	LPSteamPerHr	Capacity Units Per Hr	150
BoilerWR	Efficiency	MlbsPerGal	85% Efficiency (139,000 Btu / Gal * 85% = 0.11815)	0.118

CHILLED WATER SYSTEM

Equipment	MachineorGroup	Units	Notes	Characteristics
CoolingSA	Efficiency	kWPerTon	Efficiency Stand Alone ChW	1.1

Strategy 2 - Natural Gas Sub-Option - New Equipment

STEAM SYSTEM

Equipment	MachineorGroup	Units	Notes	Characteristics
BoilerWR	MinStandby	Percent	Minimum Standby Percent	0.05
BoilerWR	DispatchCapThres	Percent	Dispatch Capacity Threshold	1
BoilerWR	Capacity	LPSteamPerHr	Capacity Units Per Hr	150
BoilerWR	Efficiency	MlbsPerMMBtu	85% Efficiency	0.85

CHILLED WATER SYSTEM

Equipment	MachineorGroup	Units	Notes	Characteristics
CoolingSA	Efficiency	kWPerTon	Efficiency Stand Alone ChW	1.1

Strategy 2 w/Chiller Plant - New Equipment

STEAM SYSTEM

Equipment	MachineorGroup	Units	Notes	Characteristics
BoilerWR	MinStandby	Percent	Minimum Standby Percent	0.05
BoilerWR	DispatchCapThres	Percent	Dispatch Capacity Threshold	1
BoilerWR	Capacity	LPSteamPerHr	Capacity Units Per Hr	150
BoilerWR	Efficiency	MlbsPerGal	85% Efficiency (139,000 Btu / Gal * 85% = 0.11815)	0.118
BoilerWR	Efficiency	MlbsPerMMBtu	85% Efficiency	0.85

Strategy 2 w/Chiller Plant - Natural Gas Sub-Option - New Equipment

STEAM SYSTEM

Equipment	MachineorGroup	Units	Notes	Characteristics
BoilerWR	MinStandby	Percent	Minimum Standby Percent	0.05
BoilerWR	DispatchCapThres	Percent	Dispatch Capacity Threshold	1
BoilerWR	Capacity	LPSteamPerHr	Capacity Units Per Hr	150
BoilerWR	Efficiency	MlbsPerFuel2	85% Efficiency (139,000 Btu / Fuel 2 * 85% = 0.11815)	0.118
BoilerWR	Efficiency	MlbsPerMMBtu	85% Efficiency	0.85

Strategy 3 - New Equipment

ELECTRIC SYSTEM

Equipment	MachineorGroup	Units	Notes	Characteristics
TurbineN	Capacity	kWPerHr	Capacity Units Per Hr	19200
TurbineN	Capacity	HPSteamPerHr	HP Steam in	276
TurbineN	Capacity	LPStmPerHr	25 # Extraction	156

STEAM SYSTEM

Equipment	MachineorGroup	Units	Notes	Characteristics
BoilerC	MinStandby	Percent	Minimum Standby Percent	0.2
BoilerC	DispatchCapThres	Percent	Dispatch Capacity Threshold	0.7
BoilerC	Capacity	HPSteamPerHr	Capacity Units Per Hr	135
BoilerC	Efficiency	MlbsPerTonCoal	Based on GLHN Table and Capacity Percent	10.9
BoilerC	Efficiency	MlbsPerMMBtu	Based on GLHN Table and Capacity Percent	0.805

CHILLED WATER SYSTEM

Equipment	MachineorGroup	Units	Notes	Characteristics
CoolingSA	Efficiency	kWPerTon	Efficiency Stand Alone ChW	1.1

Strategy 3 - Natural Gas Sub-Option - New Equipment

ELECTRIC SYSTEM

Equipment	MachineorGroup	Units	Notes	Characteristics
TurbineN	Capacity	kWPerHr	Capacity Units Per Hr	19200
TurbineN	Capacity	HPSteamPerHr	HP Steam in	276
TurbineN	Capacity	LPStmPerHr	25 # Extraction	156

STEAM SYSTEM

Equipment	MachineorGroup	Units	Notes	Characteristics
BoilerC	MinStandby	Percent	Minimum Standby Percent	0.2
BoilerC	DispatchCapThres	Percent	Dispatch Capacity Threshold	0.7
BoilerC	Capacity	HPSteamPerHr	Capacity Units Per Hr	135
BoilerC	Efficiency	MlbsPerTonCoal	Based on GLHN Table and Capacity Percent	10.9
BoilerC	Efficiency	MlbsPerMMBtu	Based on GLHN Table and Capacity Percent	0.805

CHILLED WATER SYSTEM

Equipment	MachineorGroup	Units	Notes	Characteristics
CoolingSA	Efficiency	kWPerTon	Efficiency Stand Alone ChW	1.1

Strategy 3 w/ 10MW Turbine - New Equipment

ELECTRIC SYSTEM

Equipment	MachineorGroup	Units	Notes	Characteristics
TurbineN	Capacity	kWPerHr	Capacity Units Per Hr	19200
TurbineN	Capacity	HPSteamPerHr	HP Steam in	276
TurbineN	Capacity	LPStmPerHr	25 # Extraction	156

STEAM SYSTEM

Equipment	MachineorGroup	Units	Notes	Characteristics
BoilerC	MinStandby	Percent	Minimum Standby Percent	0.2
BoilerC	DispatchCapThres	Percent	Dispatch Capacity Threshold	0.7
BoilerC	Capacity	HPSteamPerHr	Capacity Units Per Hr	135
BoilerC	Efficiency	MlbsPerTonCoal	Based on GLHN Table and Capacity Percent	10.9
BoilerC	Efficiency	MlbsPerMMBtu	Based on GLHN Table and Capacity Percent	0.805

CHILLED WATER SYSTEM

Equipment	MachineorGroup	Units	Notes	Characteristics
CoolingSA	Efficiency	kWPerTon	Efficiency Stand Alone ChW	1.1

Strategy 3 w/ 10 MW Turbine - Natural Gas Sub-Option - New Equipment

ELECTRIC SYSTEM

Equipment	MachineorGroup	Units	Notes	Characteristics
TurbineN	Capacity	kWPerHr	Capacity Units Per Hr	19200
TurbineN	Capacity	HPSteamPerHr	HP Steam in	276
TurbineN	Capacity	LPStmPerHr	25 # Extraction	156

STEAM SYSTEM

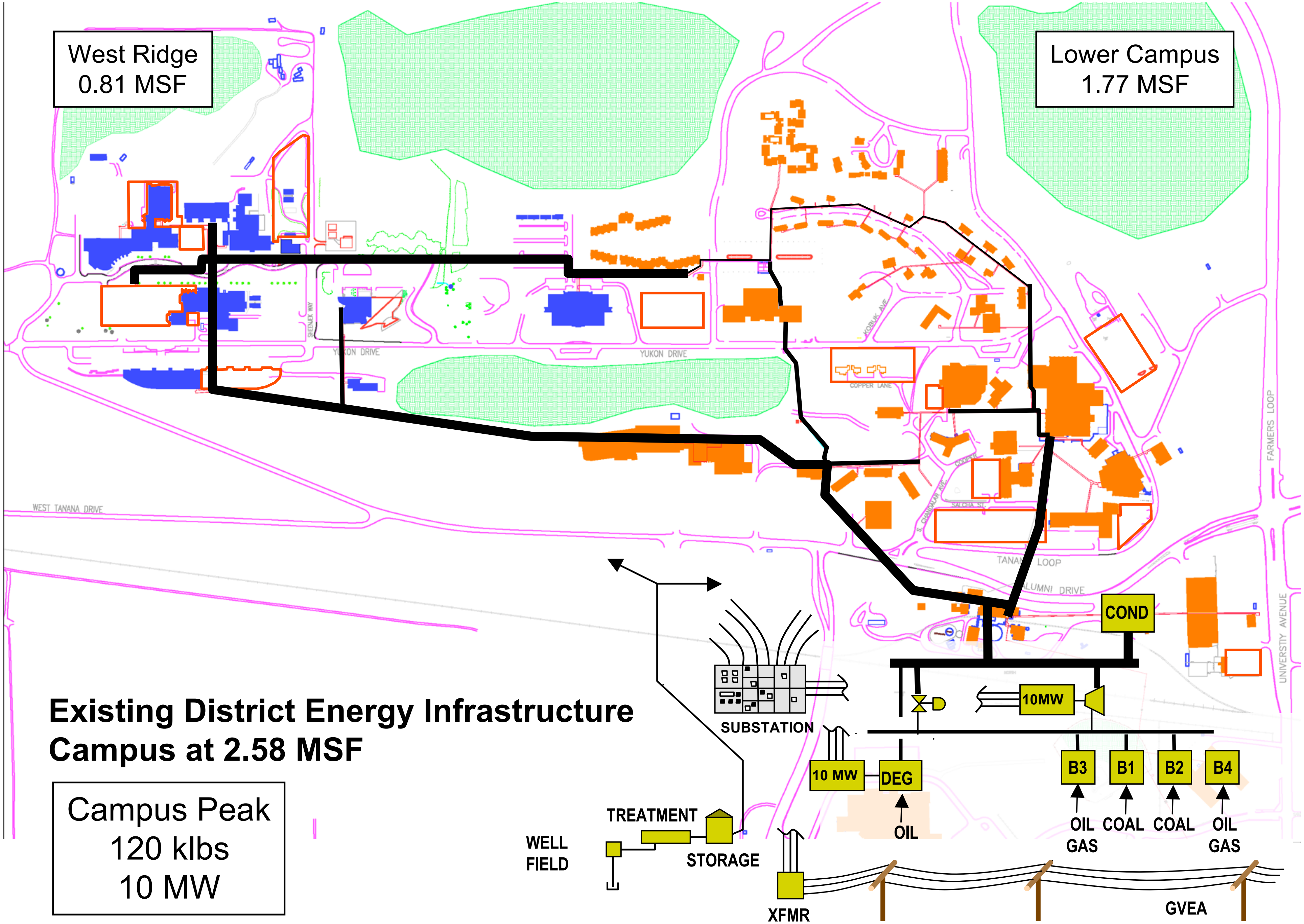
Equipment	MachineorGroup	Units	Notes	Characteristics
BoilerC	MinStandby	Percent	Minimum Standby Percent	0.2
BoilerC	DispatchCapThres	Percent	Dispatch Capacity Threshold	0.7
BoilerC	Capacity	HPSteamPerHr	Capacity Units Per Hr	135
BoilerC	Efficiency	MlbsPerTonCoal	Based on GLHN Table and Capacity Percent	10.9
BoilerC	Efficiency	MlbsPerMMBtu	Based on GLHN Table and Capacity Percent	0.805

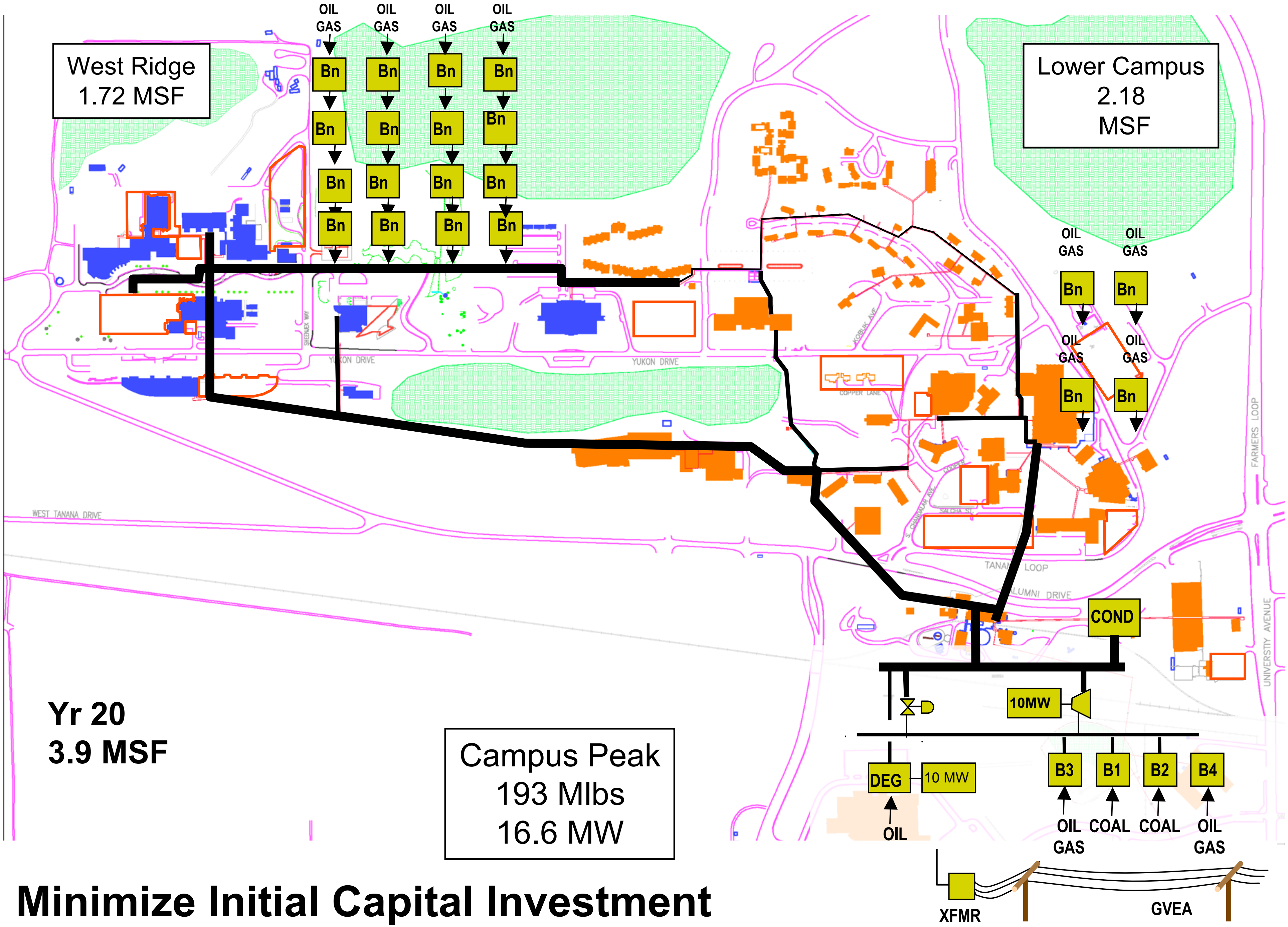
CHILLED WATER SYSTEM

Equipment	MachineorGroup	Units	Notes	Characteristics
CoolingSA	Efficiency	kWPerTon	Efficiency Stand Alone ChW	1.1

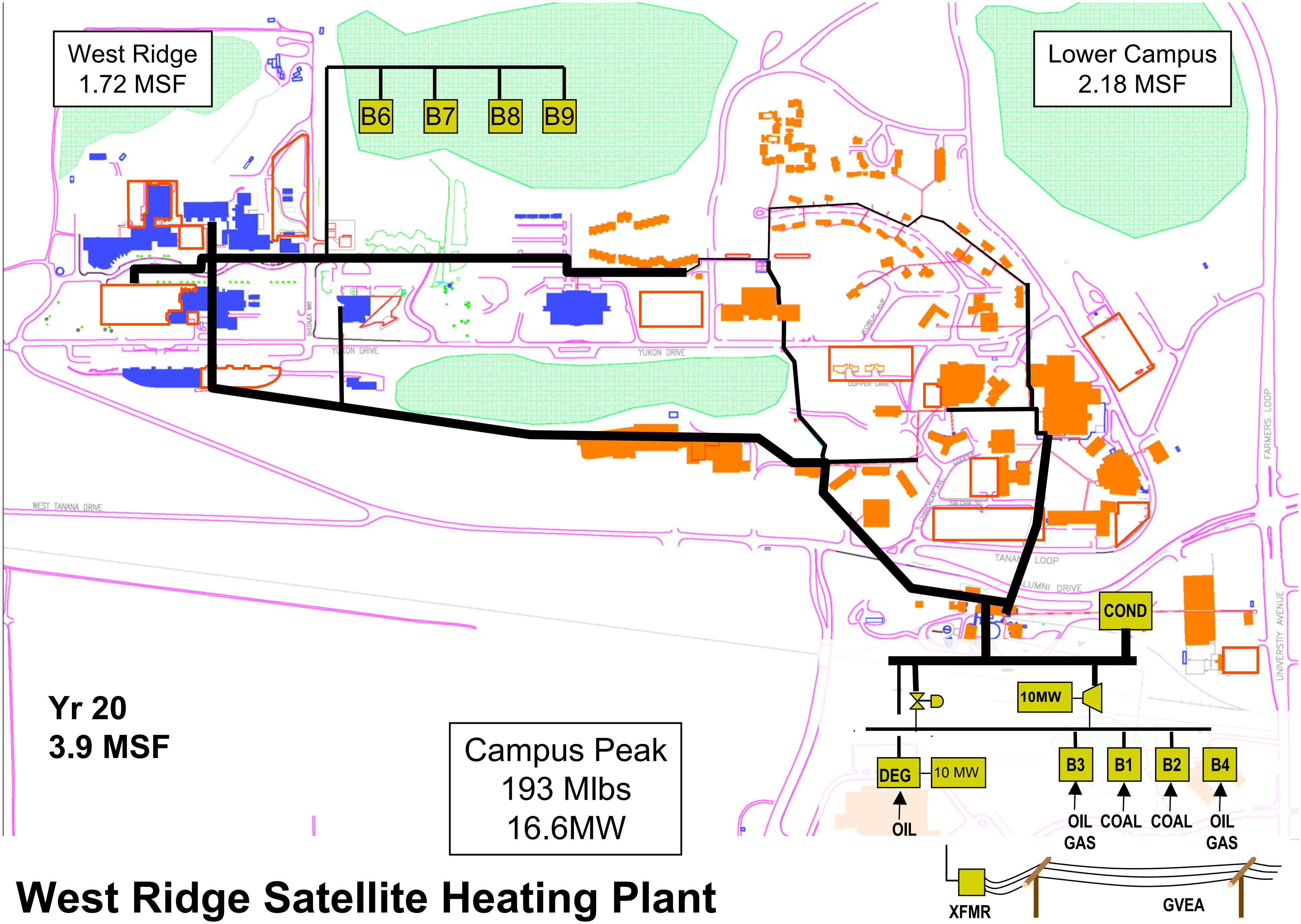
SECTION 2 – UTILITY SERVICE DESIGN MAPS

Existing District Energy Infrastructure Campus at 2.58 MSF

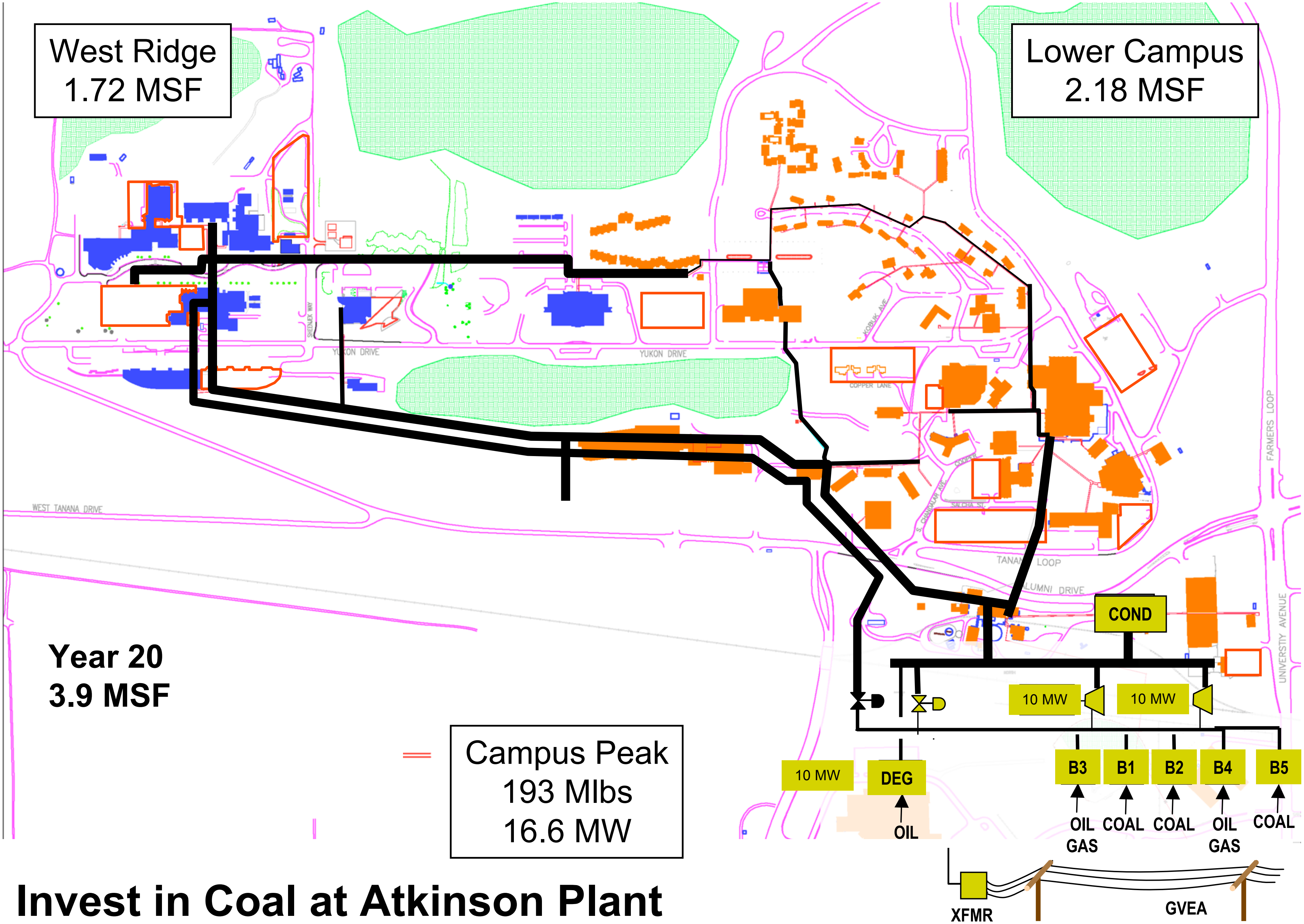




Minimize Initial Capital Investment



West Ridge Satellite Heating Plant



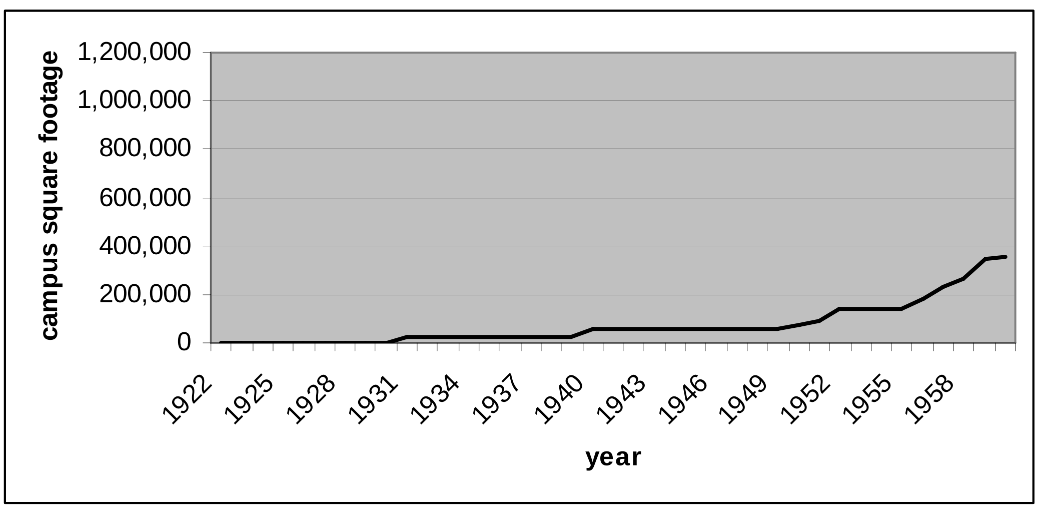
Invest in Coal at Atkinson Plant

APPENDIX C: HISTORY OF UAF'S UTILITIES DEVELOPMENT

Utility Development 1922-1960

Buildings at UAF have been served from a central campus utility system since the inception of the campus. An early campus map posted in Constitution Hall shows a stand alone boiler house that would have provided low pressure steam through a subterranean piping system. A limited campus electric production and distribution system appears to have been in place to provide power, primarily for lighting, to campus buildings.

By the early 1960's the campus included approximately 350,000 square feet of academic, housing and administrative space and was on a monotonically increasing trend.



1961 Bechtel Heating Plant Feasibility Study

A 1961 projection that campus enrollment (then just under 1,200 students) would rise to more than 3,200 students by 1971 (a 160% increase over ten years) may have motivated the University to commission the Bechtel Corporation, of San Francisco CA. to perform a "Feasibility Study for a Heating Plant.". The completed report was submitted in 1961 and included the following major elements:

- A derivation of projected peak demand and annual consumption of electrical power and steam; by year over a ten year planning time frame (1961-1971);

- A review of current and projected capacity requirements, including consideration of the dictate for standby equipment to provide reliability under peak load conditions;

- Consideration of alternative fuel sources including oil, coal, and natural gas;

- A NPV analysis of the alternative of a relatively high capital cost boiler plant utilizing relatively inexpensive fuel (coal) versus a less capital intensive plant utilizing more expensive fuel (oil);

- An economic evaluation of the additional capital expenditure to construct a plant in which high pressure steam is used for first electrical generation before distribution to campus for heat (which we now term "combined heat and electric power generation" or "cogeneration") versus a less capital intensive plant that generates only low pressure steam for distribution as heat and the University purchases all of its electric power requirements from the local utility (Golden Valley Electrical Cooperative);

- Technical discussion and presentation of the conceptual general arrangement of the proposed plant and campus steam and electrical power production and distribution systems; and

- Consideration of plant siting issues, and presentation of construction cost estimates and construction phasing issues.

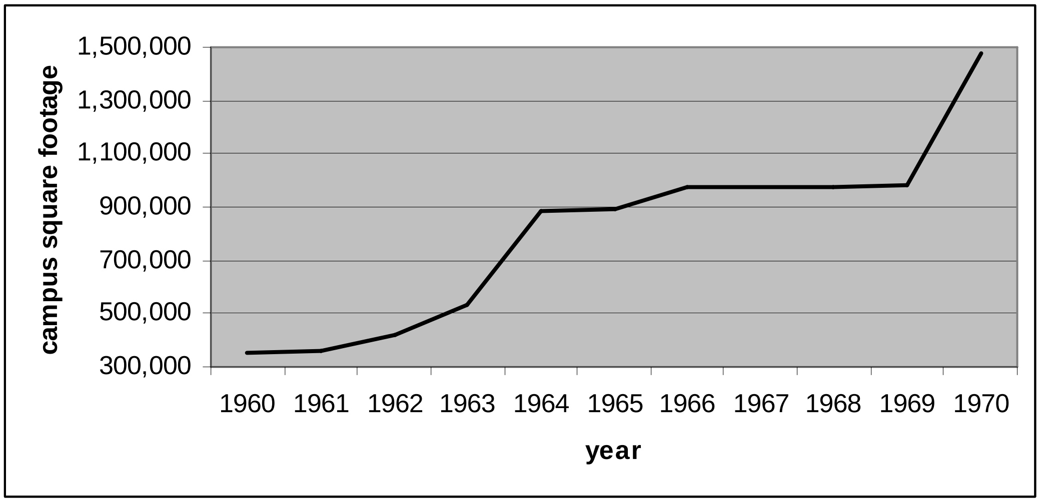
Bechtel's simple NPV analysis demonstrated long term economic advantage to investment in the higher capital cost alternatives and recommended installation of two coal fired units each capable of generating 50,000 lbs/hr of steam at 600 psi, along with installation of two back pressure turbines capable of generating one MW while exhausting 15 psig steam. The cost for this new plant along with associated distribution in utilidors to lower campus and extension of a rail spur was estimated at under $3.5 million.

Implementation of the fundamental recommendations in the 1961 Bechtel Study lead to construction of the central campus utility infrastructure that exists today. Although the plant was not located as recommended, and somewhat larger turbine generators were actually installed (1.5 MW), the general concepts and arrangement of the steam and electrical systems as a coal fired cogeneration system along with much of the original piping, equipment and infrastructure remain in place (and in operation) in the facility known as the Atkinson Plant at the south edge of Lower Campus. Its configuration in the 1964 through 1968 period was as follows:

a. Condensate holding tank, hot well, transfer pumping;
b. Deaerator tank and controls;
c. Feedwater header and pumps (steam drive and electric drive);
d. 50,000 lbs/hr Coal Boiler #1 and #2;
e. Air to air heat exchangers, stacks;
f. Coal grate, vertical coal transport, coal hoppers, scales;
g. Ash silo;
h. Main steam header;
i. Turbines #1 and #2 (1500 kW);
j. Boiler floor control shack;
k. Switchgear room with plant MCC and campus distribution board;
l. Utilidor to LC;

Utility Development 1960-1970

Campus growth in the ten year period 1960 to 1970 was the highest in the history of the UAF campus. Over one million square feet was added in the this period. By 1968, LC footage was approximately 850,000 square feet (SF) and the West Ridge included close to 150,000 SF. Near term building construction plans at that point called for even more additional growth, particularly on the WR. The graph below shows actual building construction during this period, when over 1.2 million square feet were added. Creation of the Atkinson Power Plant was necessary to serve the heating and electrical power loads of the rapidly developing campus.



1968 Kennedy Engineers Utility Study

Sometime in the late 1960s a goal appears to have been set to reach a student enrollment of 8000. By the year 1980, the University of Alaska commissioned an additional study to analyze steam and electrical load and load growth and to provide recommendations for planning further utility development. The Kennedy Engineers' report "Utilities Study" was submitted in 1968 and includes the following scope items:

- A forecast of growth of campus square footage for the years 1968 through 1978;
- A forecast of peak demand and annual consumption of steam and electric power based on campus square footage;
- Recommendations for an addition to the Atkinson plant along with recommendations for the size and type of steam generating unit to be installed therein;
- Study the existing University agreement with the local utility, Golden Valley REA, and evaluate the economics of on-site power generation; make recommendations for improvement of University benefit from power generation;
- Evaluation of current and projected distribution steam line capacity problems and recommendations for improvements
- Evaluation of current electrical distribution system and potential distribution capacity shortfalls due to load growth.

The analysis done by Kennedy Engineers projected overall campus square footage increasing by a factor of 2.35 (from 850,000 SF on LC and 140,000 SF on WR in 1968 to 1,914,000 SF on LC and 447,000 SF on WR by 1978). Kennedy recognized an increase in load density in new construction for both steam (presumably due to higher indoor ventilation rates) and electric demand (possibly associated with more sophisticated requirements for HVAC, lighting and vertical transport). As a result, steam demand was forecast to increase at more that 2.5 times (from 51,000 lbs/hr in 1968 to 126,000 lbs/hr in 1978) and electric demand at just under 3 times over the ten year planning time frame.

The magnitude of the increase in projected peak steam demand triggered a near term need for an additional boiler to satisfy the utility reliability requirement that peak campus load must be met with the largest unit off line. Based on the need for reliability under the peak demand projection, a need for an additional 100,000 lb/hr unit was established. Construction cost estimates for plant extension and installation of a field erected coal boiler versus plant expansion and installation of a packaged fuel oil boiler (with natural gas firing capability) were prepared. The coal option was found to cost on the order of $550,000 more than the fuel oil/natural gas. Operating costs, based on limited peaking duty were similarly prepared for the alternatives. In addition to operation with fuel oil, the analysis included computation of operating cost with natural gas, which, it was speculated, could some day become available in Fairbanks.

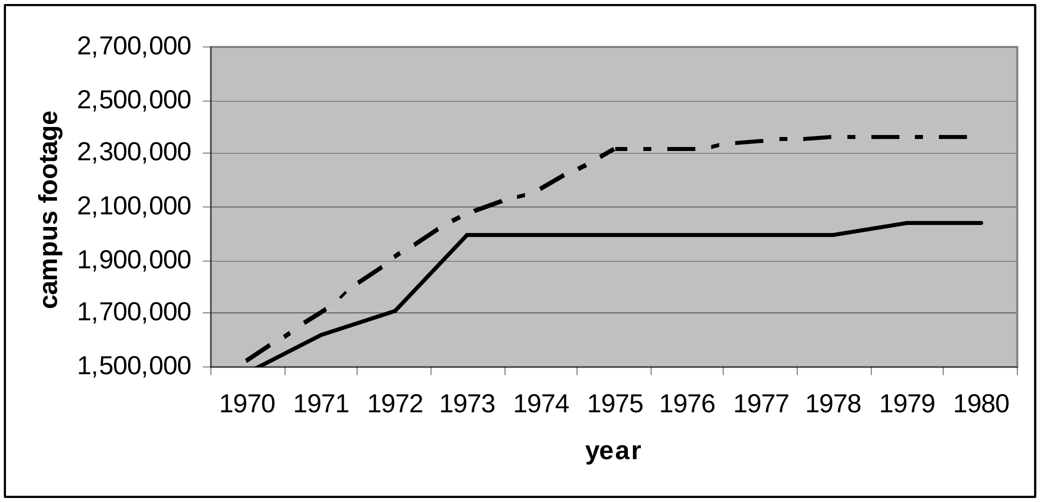
An economic comparison between the high capital cost and low fuel cost of a coal unit alternative against the relatively low capital cost and high fuel cost of an oil unit was provided. Although the NPV analysis was done along the same lines as the earlier Bechtel study and the relative costs of equipment and fuel were of the same magnitude, Kennedy's analysis leads them to the opposite recommendation. Over the ten to twelve year planning horizon in the Kennedy study, Boiler3's function would be primarily as a reliability unit, with relatively few hours of peaking duty under extreme conditions, occurring under increasing frequency toward the end of the twelve year period. In this scenario the payback (in low operating cost) of a higher capital cost coal boiler unit does not occur within the evaluation period—as the unit would operates too few hours to generate sufficient fuel cost savings. This analysis does not recognize the problem that as the campus continues to grow beyond the economic planning time frame, annual hours of operation become increasingly appreciable, and the unit (with an expected service life in excess of forty years) becomes a legacy of inefficiency. Authors of the Kennedy report may have wrestled the long term significance of their recommendation, writing:

> *"Comparison of the excess capital cost of the coal fired installation with the cumulative tabulation of present worth of the excess of oil fuel cost for peaking and standby service indicates equality in approximately 17 years at 1987 for load growth static after 1976 and equality in approximately 12 years for load growth continuing to 1980. The result may be interpreted as follows:*
>
> *A. If the oil fired package installation is selected and:*
>   *a. Natural gas becomes available before 1982 to 1987, assuming actual load growth is within the range forecast herein, a good choice will have been made. The lowest cost will have been achieved and the oil standby unit can become a base load gas unit.*
>   *b. If natural gas does not become available by 1982 to 1987, a poor choice will have been made since continued operation with the more expensive fuel will result in a higher cost than if the more costly coal firing boiling had been installed. If load growth is as forecast and the break even point is reached in 1982 without prospect for natural gas service in the near future, it will be necessary to consider installation of an additional coal fired unit. The oil fired unit would still have use as a standby at reduced level of use"…..*
>
> *…"With the break even point at least 12 years away, most private enterprises would elect to take the gamble offered by the oil fired installation"*

Utility Development 1970-1980

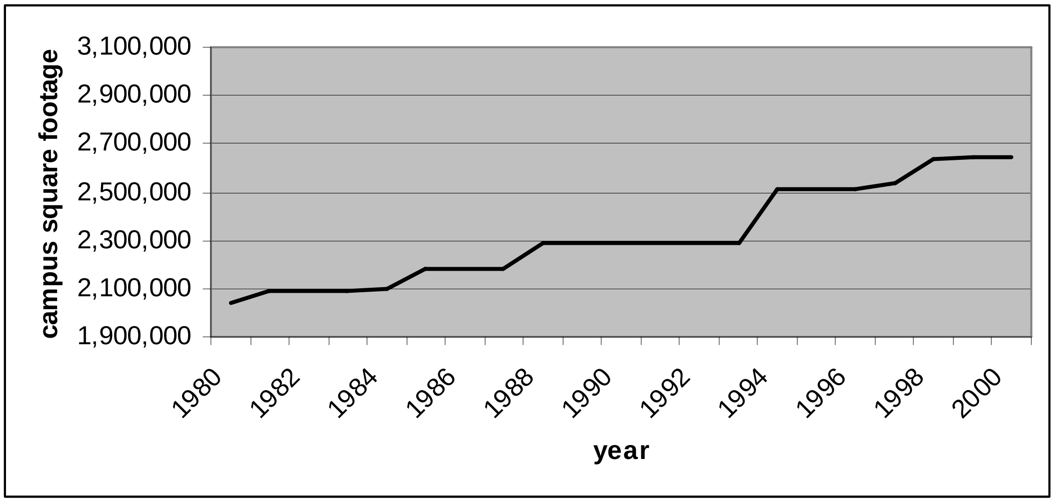
The campus growth used as the basis of the 1968 Kennedy Engineers study did not materialize as projected. The graph below shows actual building growth as a solid line and the Kennedy Study assumptions as a dashed line. The steam and electrical loads associated with campus square footage leveled out between 1973 to1980. This meant that new fuel oil Boiler 3 did, in fact serve as a reliability unit with only limited peaking duty. Plant improvements in the 1970 consisted of:

a. West Building Expansion;
b. 100,000 lb/hr Fuel Oil Boiler 3;
c. Fuel Oil Tank and Pumping Station; and
d. Utilidor to West Ridge.



Utility Development 1980-2000

Campus growth over the next twenty years added another 700,000 SF of heating and power load to the District Energy System. The total campus area of 2.3 MSF, projected in the 1968 Kennedy Engineers study to occur by 1974, actually occurred in 1989—approximately fifteen years later.



As this occurred the peak (and then average) winter campus steam demand exceeded 100,000 lbs/hr and fuel oil Boiler 3 became utilized with increasing frequency to handle base load. By the mid 1980's an additional boiler unit was needed to provide the N+1 redundancy. A study describing economic evaluation of fuel alternatives for Boiler 4 was not uncovered in the research for this report. Presumably, the availability of capital funding at the time was such that the substantial additional first cost of a field erected coal unit could not be considered. A 100,000 lb/hr fuel oil boiler 4 was installed in 1986.

Another result of ongoing campus growth from 1980 through 2000 was increasing electric demand. A larger steam turbine generator, capable of generating as much as 9.6 MW with 140,000 lbs/hr of high pressure steam input was installed in 1981. Additional air cooled condenser capacity to allow high output in summer conditions was added in 1992. By 2000 the campus electric demand again began to exceed turbine generator output, and improvements to the campus interconnection to GVEA to allow a greater level of supplemental power were implemented.

In the late 1990s a federal program to demonstrate coal slurry technology provided much of the funding necessary to install an internal combustion engine generator with heat recovery boiler. Although the coal fuel technology component has not been employed, the unit is fully functional operating with fuel oil. Electric output is approximately 10 MW, with as much as 20,000 lbs/hr of low pressure (25 psig) steam from the heat recovery system. Plant Improvements in 1980-2000 consisted of:

1981: 10 MW Turbine Generator

a. Paralleling Switchgear and Control Systems;
b. Surface condenser using well water; and
c. Air Cooled Condenser #3.

1986: Bag House

a. Bag house 1 and 2

1986: Boiler 4

a. East Building Expansion (including north entrance and admin/office floor);
b. 100,000 #/hr Fuel Oil Boiler #4; and
c. Steam and feedwater header expansion.

1992; Condenser #2

a. Air Cooled Condenser #4.

1999: Diesel Engine Generator

a. DEG building;
b. Diesel Engine with 10 MW Generator;
c. 20,000 lb/hr Heat Recovery Boiler; and
d. Bag House.

2000: WR Utilidor Improvements

THE UNIVERSITY OF ALASKA FAIRBANKS
2005 UTILITY DEVELOPMENT PLAN

APPENDIX D: TECHNICAL DETAIL

TECHNICAL DETAIL

The ***2005 Utility Development Plan*** includes a Capital Renewal Plan and three alternative Utility Development Strategies to address campus growth. Capital costs associated with each of the individual elements are inputs to the economic Model along with annual operating costs derived from efficiency estimates and load assumptions. Technical details and background of the individual elements making up these plans and alternative strategies are provided in the sections that follow.

CAPITAL RENEWAL TECHNICAL DESCRIPTION

A narrative description with associated capital cost estimates of the individual components of the capital renewal program can be found in Financial Appendix - Section A.

STRATEGY ONE - TECHNICAL DESCRIPTION

Strategy 1 is referred to as the “stand alone” Strategy. In order to minimize initial capital construction costs and to avoid a bonding request for development of new or expanded campus infrastructure, building heating and cooling systems would be of the packaged commercial type. Each new building would be provided with a fuel oil or natural gas fired heating water boiler system. Because of the extreme cold temperatures in Fairbanks, prudent engineering practice dictates installation of fully redundant heating systems (i.e., N+1 redundancy) such that full back up of each building’s boilers and heating water auxiliaries exist. Initial construction costs for building boiler plant (not including building heating system) is estimated (based on local experience) at $6/SF, on which a thirty percent (30%) project cost multiplier is applied to arrive at 2005 values.

The useful service life of the equipment installed in a typical boiler plant is estimated at ten years (based on UAF experience). At the end of each ten year period, a repair/replacement/upgrade project costing $4/SF is assumed. This is intended to account for replacing or retubing units, replacing controls, stacks, breeching, etc.

The University's air quality permit will need amendment as individual building boilers become more common. An estimate of costs associated with annual permitting is included in the Strategy analysis. It is assumed that the boiler systems would be specified as "dual fuel," and that fuel oil tanks, piping and transfer pumping equipment would be installed even if natural gas service becomes available. "Dual fuel" capability would provide additional reliability and a hedge against fuel market instability. The capital cost difference between the fuel oil and the natural gas sub-option is the additional cost of a natural gas distribution piping system. A total cost of approximately $14.5 million is expected to install new and replacement units.

The "stand alone" solution assumes installation of air-cooled, electric driven air conditioning equipment in each new building. This cooling solution is consistent with the direction that essentially all construction on the West Ridge has taken. The systems are either Direct Expansion (DX) split systems (with condensers and fans located outside) or air cooled water chillers (with compressors, condensers and fans located outside and a glycol heat transfer solution). Raw construction costs for the refrigeration components of the air conditioning system, based on local experience, are $4/SF. Again, this expense is multiplied by a factor of 1.3 to reflect overall project cost impact. Average efficiency of "stand alone" air-cooled equipment is estimated at 1.1 kW/Ton. The outdoor components of commercial grade air conditioning equipment have been found to suffer from the extreme temperatures in Fairbanks, and history indicates a ten year estimate of useful life is reasonable. Equipment replacement is thought to be slightly less costly than initial installation as much of the equipment support, piping and auxiliaries can remain. An estimate of $3/SF is used. Over the twenty year course of the Model, a total on the order of $7.4 million would be spent on new and replacement stand alone chillers

All new electric demand is assumed to be purchased through the public utility (GVEA) as no new power generation equipment is installed on campus over the planning time frame. The capital renewal program is assumed to be in place and current issues with the electrical power distribution system, the turbine generator, and the air-cooled condenser are addressed. The "stand alone" option does not include estimates for installation of individual building standby generators as the existing 10 MW Diesel Engine Generator (and associated switchgear) would be configured to serve these loads. This may not prove to be an entirely valid assumption, as certain critical electrical users, such as the supercomputer center, are likely to require fully dedicated backup to satisfy the quick response time.

Strategy Two - Technical Description

The second strategy provides a utility infrastructure for the West Ridge with more durability and efficiency than stand alone systems. A new central energy plant, providing lower annual operation and replacement costs, would be constructed on a developed site on the West Ridge and designed for expansion and flexibility.

Campus heat would be provided by a steam plant with equipment of a more institutional class, with the equipment's expected useful service life on the order of twenty-five (25) years. The 15 psig steam boilers would be piped in parallel with the existing utilidor steam system and would operate as a satellite plant, fired on natural gas or fuel oil to supplement the system when the Atkinson turbine exhaust volume is insufficient or when distribution pressure to the West Ridge is inadequate. Two boilers would initially be installed, providing full redundancy. The plant would be designed for relatively simple and economical installation of additional boilers, to be installed as the West Ridge expands. Total estimated project costs for a West Ridge heating plant are on the order of $10 million (significantly less than the "stand alone" option) with much of the expenditure concentrated on initial construction.

As originally conceived, the West Ridge Plant would also house a pair of 1000 ton, single effect absorption chillers and cooling towers with provisions to expand cooling capacity as the campus load increases (see attached drawing). A tremendous benefit of the concept of absorption chilling at a new West Ridge Plant is the summertime combination of beneficial use of Atkinson coal fired steam turbine "waste" heat with the coincident elimination of additional peak electrical demand to run refrigeration compressors. Not only is there a thermodynamic cycle justification for the installation of an absorption chilling plant (resulting in lower annual fuel and power costs), but it also provides significant improvement in annual maintenance and labor over multiple "stand alone" package units. Expected useful life of the absorption equipment would be on the order of twenty to twenty-five years, reducing the planned major maintenance budget.

The life cycle economic model does not support investment in an absorption chiller plant on the WR. The simple reason is that, although peak demand is high, the projected ton-hours of operation (on which the comparative energy and efficiency costs are based) are too low to provide a return on the high investment cost. Implementation of a central chilled water plant involves plant and site development costs, equipment procurement and installation, construction of a distribution piping system, and conversion of existing DX air handling systems to chilled water. Total twenty year project costs for a central absorption chiller plant at WR is estimated a $16 million, roughly twice the "stand alone" cost. Expenses are largely concentrated into the initial plant/distribution/building conversion project. Because the economic prospect of the WR Chiller Plant is poor compared to the "stand alone" option, Strategy 2 is based on a satellite WR heating plant (no individual building boilers) with stand alone building chilling units.

This analysis does not to imply that absorption chilling can never be proven as a viable option on the WR. Installation of absorption chilling as a part of a new and large building construction project with limited distribution requirements, concentrated internal heat loads, and competitive equipment pricing might well pass the life cycle cost test. Future installation of an absorption chiller to serve the supercomputer center warrants consideration.

Electric power to meet anticipated demand of the growing campus would be served by GVEA in a manner identical to Strategy 1. Similarly, it is assumed that the electrical substation, distribution and switchgear projects described in the Capital Renewal section of this report are completed to enable full reliance on the DEG for WR standby power requirements.

STRATEGY THREE - TECHNICAL DESCRIPTION

A third strategy evaluated in the UDP involves expansion of the original cogeneration concept to provide all of the current and projected campus needs for heat and electric power over the next twenty years with coal. The principal advantages of this strategy are the relatively low cost and long-term stability of the fuel source, and the high levels of efficiency, reliability and control that on site generation of primary utilities have historically provided the UAF campus. In its basic form, Strategy 3 includes construction of a 600 psig, 150,000 lbs/hr stoker type steam generator, a 20 MW steam turbine generator with extraction at 125 psig, 75 psig, 15 psig, and a steam exhaust to a new set of condensers. A complete set of coal boiler auxiliaries, such as coal conveying, hopper, ash handling system, piping, plumbing, and electrical are included in the life-cycle cost analysis. Plant expansion on this order will meet projected peak steam and electric power demands of the campus.

The overall Strategy 3 project cost estimate amounts to approximately $85 million. The sources of this cost estimate, which forms a principal input to the economic Model, are described below. An estimate for environmental permitting costs is based on an assumption of annual expenditures over the implementation phase of the project. Direct vendor quotations (including shipping) are used for the primary equipment (boiler, turbine, bag house, condenser, etc.). Auxiliary equipment and systems costs are estimated using in-house engineering judgment and the historical database of HRA, a central Illinois consulting engineering firm with recent relevant experience in design and construction of coal fired power plants of this scale. Costs for site development and primary structures are derived from recent (2001), similar projects in Alaska (Clear AFS and the UAF Clean Coal Project). Contractor overhead and profit are added to the raw equipment and construction costs. A design contingency is applied to the sum of these numbers and a thirty percent (30%) project cost multiplier, intended to cover A/E design, testing, commissioning, UAF project management and construction period contingencies, is applied on top of that total cost.

Although overall this Strategy is more capital intensive than Strategy 1 or Strategy 2, it is possible to implement Strategy 3 in phases. Initiation of environmental compliance and permitting requirements would have to be considered in the early stages of strategy implementation. Initial design of the plant—to tie down site location, footprint, equipment type, general arrangement and overall process flow—would be a necessary part of this early exercise. Once an institutional commitment to expand the cogeneration system at Atkinson Plant is in place, construction of a high pressure steam line to the WR would be a logical step to solving the near term WR pressure deficiency without compromising the output of the existing steam turbine generator. Construction of a new modular ash handling facility, planned for both current (identified under the Capital Renewal program) and future needs, could be accomplished early in the Strategy. Site development, procurement of major equipment, erection of the structures, and installation and commissioning of the turbine generator could be planned for phased implementation.

Improvement of the steam distribution system to the WR is a necessary component of Strategy 3, as all steam will continue to be generated in the Atkinson Plant at the southeast corner of the campus. The dynamics of the concept proposed here are substantiated in the steam model (attached). Existing steam service to WR is accomplished using low pressure (15 psig summer, 25 psig winter) steam from the controlled extraction port of the steam turbine flows out the western side of the plant to the vicinity of Lola Tilly Hall via a 14” line in a section of relatively open utilidor space. At Lola Tilly, the single 14” line splits into two 10” lines routed into the Lathrop Blister. The utilidor is extremely congested in this area. A manifold in the Lathrop Blister ties in an east-west line from the Library, a direct buried line from the upper dorm complex and a second pair of 10” lines routed west to Patty Ice Center. The utilidor, from Lathrop Blister to Patty Ice, is congested. As the utilidor leaves Patty Ice, the two 10” lines combine back into a single 14” line running up the grade to the WR. This long portion of utilidor is relatively large and open.

Under current peak heating load conditions, roughly 37,000 lbs/hr is needed in the vicinity of The Geist Museum on the WR. With this flow rate, the observed steam pressure drop across the piping system is on the order of 15 psig, meaning operation of the controlled extraction port at 25 psig provides 10 psig on the WR - 5 psig under design and too low for satisfactory operation of building heat exchangers. A steam pressure drop calculation model (output attached) yields similar results. When a new 10” line is modeled in parallel to the existing lines from the plant to The Geist Museum, the piping system becomes capable of moving 53,000 lbs/hr at a pressure drop of 10 psig, leaving an acceptable 15 psig on the WR. 53,000 lbs/hr corresponds to an increase in building square footage on the order of 250,000 SF. This magnitude of WR growth is projected within five (5) years.

As peak demand increases further, the new line can be used in a different mode. A 600 to 125 psig regulator on the Atkinson high pressure header would allow the line to flow higher pressure, lower specific volume steam that bypasses the turbine directly to the load on the West Ridge where it would bleed back into the existing low pressure distribution system through a 125 psig to 15 psig regulator set. In this turbine bypass mode, the line could support on the order of 800,000 SF in addition to the 500,000 SF served by the low pressure line at 15 psig. Ultimately, in Strategy 3, a new 20 MW steam turbine is brought on line. This unit would be specified with higher pressure extraction ports so that bypass from the 600 psi header is no longer necessary. A more detailed analysis will be needed to optimize the number and size of these ports. For the purpose of the ***Utility Development Plan*** however, the project cost estimate carries the new line from Atkinson to the WR with its pressure regulating stations, improvements to the existing low pressure steam system to enable the East line to LC to operate at higher pressure (along with PRV stations) and costs to eventually upsize the existing 6” steam line at the north center of the system to allow better loop flow from LC to WR.

The arguments that made installation of “stand alone” air-cooled, electric-driven air conditioning equipment more economically attractive than an absorption chilling facility in Strategy 1 and Strategy 2 remain valid in Strategy 3. The campus’ electrical profile is dual peak, with similar high demand in winter and summer. Installation of absorption chilling equipment would not provide an opportunity to significantly scale back the boiler or turbine capacity. Strategy 3 therefore includes future installation of “stand alone” chilling equipment, subject to the same recommendation that special cases be evaluated individually.

No additional costs for building standby generators are included in Strategy 3. Capital renewal driven improvement of the campus high voltage switchgear and distribution system will allow use of the DEG (or GVEA) electricity as standby in the event of turbine outage. Historically, frequency and extent of outages of the University’s cogeneration system has been significantly better than that of GVEA. On this basis, the electric power reliability of Strategy 3 is postulated to be better than that in Strategy 1 or Strategy 2.

EQUIPMENT COST SUMMARIES
BY STRAEGY
2005 DOLLARS

University of Alaska Fairbanks
Utility Development Plan
Strategy 1: Stand Alone Project Cost Summary
2005 Dollars
GLHN Architects and Engineers

	Raw Cost Estimate	Construction Cost Estimate 1.43	Project Cost Estimate 1.30
Natural Gas to West Ridge	$ 313,817	$ 450,000	$ 585,000
Add Gas Burners to #3 and #4	$ 357,403	$ 512,500	$ 666,250
Total Extension and Burner Upgrade			$ 1,251,250
Permitting			$ 190,000
Stand Alone Boilers	$ 6,011,483	$ 8,620,210	$ 11,206,273
Replace Stand Alone Boilers	$ 676,144	$ 969,562	$ 1,260,430
Stand Alone Boiler Overhaul			$ 1,811,746
West Ridge Boiler Plant Total			$ 14,468,449
Stand Alone Chillers	$ 2,113,514	$ 3,030,689	$ 3,939,896
Replace & Overhaul Stand Alone Chillers	$ 2,844,490	$ 4,078,878	$ 5,302,541
Overhaul Stand Alone Chillers			$ 646,194
Stand Alone Chiller Total			$ 9,888,631
Total Strategy 1: Stand Alone Heating and Cooling			**$ 25,608,330**

Raw Cost Estimate: Materials, Equipment and Direct Labor: yr 2005 $
Construction Cost Estimate: Raw Cost with Alaska Site Factors and Contractor Overhead and Profit:yr 2005 $
Project Cost Estimate: Construction Cost With A/E Fees, Project Management, Contingencies: yr 2005 $

Refer to Financial Appendix Section B- Production Equipment Capital Cost by Strategy- for
implementation schedules and costs when implemented
overhaul/replacement schedules and costs
Refer to Financial Appendix Section D- Annual Capital Expenditures and Bonding Schedules - for
cummulative capital expenditures over planning time frame

University of Alaska Fairbanks
Utility Development Plan
Strategy 2: West Ridge Plant Project Cost Summary
2005 Dollars
GLHN Architects and Engineers

	Raw Cost Estimate	Construction Cost Estimate 1.43	Project Cost Estimate 1.30
Natural Gas to West Ridge	$ 313,817	$ 450,000	$ 585,000
Utilidor Extension	$ 605,318	$ 868,000	$ 1,128,400
Add Gas Burners to #3 and #4	$ 357,403	$ 512,500	$ 666,250
Total Extension and Burner Upgrade			$ 2,379,650
Permitting			$ 200,000
West Ridge Boiler Plant	$ 3,835,540	$ 5,500,000	$ 7,150,000
West Ridge Additional Boilers	$ 697,371	$ 1,000,000	$ 1,300,000
West Ridge Boiler Overhaul			$ 700,000
West Ridge Boiler Plant Total			$ 9,350,000
West Ridge Chiller Plant	$ 2,022,375	$ 2,900,000	$ 3,770,000
West Ridge Additional Chillers	$ 1,743,427	$ 2,500,000	$ 3,250,000
West Ridge CHW distribution	$ 2,928,958	$ 4,200,000	$ 5,460,000
West Ridge Blg Conversion	$ 1,367,920	$ 1,961,538	$ 2,550,000
West Ridge Plant Overhaul	$ 804,659	$ 1,153,846	$ 1,500,000
West Ridge Chiller Plant Total			$ 16,530,000
Total Strategy 2: West Ridge Heating and Cooling Plant			**$ 28,259,650**

Raw Cost Estimate: Materials, Equipment and Direct Labor: yr 2005 $
Construction Cost Estimate: Raw Cost with Alaska Site Factors and Contractor Overhead and Profit:yr 2005 $
Project Cost Estimate: Construction Cost With A/E Fees, Project Management, Contingencies: yr 2005 $

Refer to Financial Appendix Section B- Production Equipment Capital Cost by Strategy- for implementation schedules and costs when implemented overhaul/replacement schedules and costs
Refer to Financial Appendix Section D- Annual Capital Expenditures and Bonding Schedules - for cummulative capital expenditures over planning time frame

University of Alaska Fairbanks

Utility Development Plan

Strategy 3:150,000lb/hr, 20 MW Project Cost Summary
2005 Dollars
GLHN Architects and Engineers

	Raw Cost Estimate	Construction Cost Estimate 1.43	Project Cost Estimate 1.30
Utilidor/Steam Line Improvements*	$ 5,800,000	$ 8,316,952	$ 10,812,038
Turbine and Auxiliaries	$ 7,500,000	$ 10,754,679	$ 13,981,083
Turbine Module Construction	$ 1,500,000	$ 2,150,935	$ 2,796,216
Turbine Installation	$ 7,500,000	$ 10,754,679	$ 13,981,083
Initial Condensing Surface	$ 2,500,000	$ 3,584,893	$ 4,660,361
Add Condensing Surface	$ 2,500,000	$ 3,584,893	$ 4,660,361
Overhaul Turbine Equipment	$ 509,617	$ 730,769	$ 950,000
Total Line Steam Upgrade and Turbine	$ 27,299,999	$ 39,147,032	**$ 50,891,142**
Permit Application			$ 800,000
Boiler House and Site	$ 3,000,000	$ 4,301,872	$ 5,592,434
Boiler Package Components	$ 10,500,000	$ 15,056,551	$ 19,573,516
Boiler Package Installation	$ 10,500,000	$ 15,056,551	$ 19,573,516
Balance of Plant Components	$ 630,222	$ 903,712	$ 1,174,825
Balance of Plant Installation	$ 630,222	$ 903,711	$ 1,174,824
Stack Components	$ 250,000	$ 358,489	$ 466,036
Stack Installation	$ 500,000	$ 716,978	$ 932,072
Piping Material and Installation	$ 600,000	$ 860,374	$ 1,118,486
Plumbing Material and Installation	$ 250,000	$ 358,489	$ 466,036
Controls Material and Installation	$ 1,000,000	$ 1,433,957	$ 1,864,144
Fuel Handling System	$ 800,000	$ 1,147,166	$ 1,491,316
Ash Handling System	$ 550,000	$ 788,677	$ 1,025,280
Misc Utility Connections	$ 200,000	$ 286,792	$ 372,829
Emission Control	$ 1,666,666	$ 2,389,928	$ 3,106,906
Electrical	$ 1,500,000	$ 2,150,935	$ 2,796,216
Total Boiler Plant and Auxiliaries	$ 32,577,109	$ 46,714,182	**$ 61,528,436**
Total Atkinson Cogeneration Plant	$ 59,877,108	$ 85,861,214	**$ 112,419,578**
Stand Alone Chiller Plants and Overhaul			**$ 9,888,631**
Total Production Capital Cost			**$ 122,308,209**

*final cost estimate for steam line improvements differ from those used in UDP modeling

Raw Cost Estimate:	Materials, Equipment and Direct Labor: yr 2005 $
Construction Cost Estimate:	Raw Cost with Alaska Site Factors and Contractor Overhead and Profit:yr 2005 $
Project Cost Estimate:	Construction Cost With A/E Fees, Project Management, Contingencies: yr 2005 $

Refer to Financial Appendix Section B- Production Equipment Capital Cost by Strategy- for
implementation schedules and costs when implemented
overhaul/replacement schedules and costs
Refer to Financial Appendix Section D- Annual Capital Expenditures and Bonding Schedules - for
cummulative capital expenditures over planning time frame

COST ESTIMATE:

BUDGETARY COST ESTIMATE
150,000 lbs/hr BOILER

PROJECT: University of Alaska Fairbanks	Classification: Budgetary Cost Est	Project Number	05-4030
Location: Fairbanks, AK	Engineer: Henneman Raufeisen and Associates	Date:	7/24/2006
Take Off by:	Quant. by: SJL/TAS Prices by: TAS/SJL	Checked by:	TAS

				Material		Labor		Equipment		
Input Side	Reference	Quantity	Units	Cost	Total	Cost	Total	Cost	Total	Total Cost
Boiler Package										
Coal Fired Stoker Style										
Boiler & Furnace	150,000 lbs / hr	600 PSI / 750 F								
Economizer w/ piping										
Superheater w/ attemperator & piping										
Stoker										
Burner w/ lighters & piping										
Tubular Air Heater										
Steam Coil Air Heater (SCAH)										
Flues & Ducts w/ joints & dampers										
FD / ID Fans w/ motors										
Instrumentation & Controls										
ASME valves										
Selective Non Catalytic Reduction (SNCR)										
Soot Blowers										
Total		1	ea	$10,500,000.00	$10,500,000.00	$10,500,000.00	$10,500,000.00			$21,000,000.00
Output Side										
Turbine Gen-Set										
20MW Steam Turbine										
Generator										
Gear Box										
Controls										
Total		1	ea	$7,500,000.00	$7,500,000.00	$7,500,000.00	$7,500,000.00			$15,000,000.00
Shipping Adder	1.5				$3,750,000.00					
Balance of Plant Equipment										
Boiler Feedwater Pumps		1	ea	$260,000.00	$260,000.00	$260,000.00	$260,000.00			$520,000.00
Dearator		1	ea	$148,000.00	$148,000.00	$148,000.00	$148,000.00			$296,000.00
Water Treatment - Softeners & RO		1	ea	$222,222.00	$222,222.00	$222,222.00	$222,222.00			$444,444.00
Air Cooled Steam Condenser		1	ea	$2,520,000.00	$2,520,000.00	$2,520,000.00	$2,520,000.00			$5,040,000.00
Shipping Adder	1.5				$1,260,000.00					
Stack										
Chimmney / Stack	$ 750,000.00	1	ea	$250,000.00	$250,000.00	$500,000.00	$500,000.00	$0.00	$0.00	$750,000.00
Piping										
LUMP SUM	$ 600,000.00	1	ea	$200,000.00	$200,000.00	$400,000.00	$400,000.00	$0.00	$0.00	$600,000.00
Plumbing										
LUMP SUM	$ 250,000.00	1	ea	$83,333.33	$83,333.33	$166,666.67	$166,666.67	$0.00	$0.00	$250,000.00
Misc Controls										
LUMP SUM	$ 1,000,000.00	1	ea	$333,333.33	$333,333.33	$666,666.67	$666,666.67	$0.00	$0.00	$1,000,000.00
Fuel Handling System										
Coal Belt Style Conveyor	$ 800,000.00	1	ea	$266,666.67	$266,666.67	$533,333.33	$533,333.33	$0.00	$0.00	$800,000.00
Ash Handling System										
LUMP SUM	$ 550,000.00	1	ea	$183,333.33	$183,333.33	$366,666.67	$366,666.67	$0.00	$0.00	$550,000.00
Misc Utility Connections										
LUMP SUM	$ 200,000.00	1	ea	$66,666.67	$66,666.67	$133,333.33	$133,333.33	$0.00	$0.00	$200,000.00
Emission Control										
Fabric Filter Baghouse	$ 833,000.00	1	ea	$833,000.00	$833,000.00	$833,000.00	$833,000.00	$0.00	$0.00	$1,666,000.00
Optional Electrostatic Precipitators	$ 2,600,000.00	0	ea	$2,600,000.00	$0.00	$2,600,000.00	$0.00	$0.00	$0.00	$0.00

Electrical										
LUMP SUM	$ 1,500,000.00	1	ea	$500,000.00	$500,000.00	$1,000,000.00	$1,000,000.00	$0.00	$0.00	$1,500,000.00
Subtotals					**$28,876,555.33**		**$25,749,888.67**		**$0.00**	**$54,626,444.00**
Materials Sales Tax		0.00%			$ -					
Handling Overhead & Profit Mark-up										
Material		10.00%			$ 2,887,655.53				$ -	
Labor		30.00%					$ 7,724,966.60			
Total					**$31,764,210.87**		**$33,474,855.27**		**$0.00**	
City Modifier from Means										
Material Modifier		105.00%			$ 33,352,421.41					
Labor Modifier		100.00%					$ 33,474,855.27		$ -	
Overall Modifier		100.00%								
Labor Productivity Modifier		5.00%					$ 1,287,494.43			
Subtotal					**$ 33,352,421.41**		**$ 34,762,349.70**		**$0.00**	**$68,114,771.11**
General Conditions		15%								$ 10,217,215.67
Total										**$78,331,986.78**

Installation Modifier	1.00
Emissioon Option	1
Filter Baghouse	1
ESP	2

COST ESTIMATE:

BUDGETARY COST ESTIMATE
100,000 lbs/hr BOILER

PROJECT: University of Alaska Fairbanks	Classification: Budgetary Cost Est	Project Number 05-4030
Location: Fairbanks, AK	Engineer: Henneman Raufeisen and Associates	Date: 9/21/2005
Take Off by:	Quant. by: SJL/TAS Prices by: TAS/SJL	Checked by: TAS

	Reference	Quantity	Units	Material Cost	Material Total	Labor Cost	Labor Total	Equipment Cost	Equipment Total	Total Cost
Input Side										
Boiler Package										
Coal Fired Stoker Style										
Boiler & Furnace	100,000 lbs / hr	600 PSI / 750 F								
Economizer w/ piping										
Superheater w/ attemperator & piping										
Stoker										
Burner w/ lighters & piping										
Tubular Air Heater										
Steam Coil Air Heater (SCAH)										
Flues & Ducts w/ joints & dampers										
FD / ID Fans w/ motors										
Instrumentation & Controls										
ASME valves										
Selective Non Catalytic Reduction (SNCR)										
Soot Blowers										
Total		1	ea	$7,870,000.00	$7,870,000.00	$9,050,500.00	$9,050,500.00			$16,920,500.00
Output Side										
Turbine Gen-Set										
10MW Steam Turbine										
Generator										
Gear Box										
Controls										
Total		1	ea	$4,000,000.00	$4,000,000.00	$4,600,000.00	$4,600,000.00			$8,600,000.00
Balance of Plant Equipment										
Boiler Feedwater Pumps		1	ea	$260,000.00	$260,000.00	$299,000.00	$299,000.00			$559,000.00
Dearator		1	ea	$148,000.00	$148,000.00	$170,200.00	$170,200.00			$318,200.00
Water Treatment - Softeners & RO		1	ea	$222,222.00	$222,222.00	$255,555.30	$255,555.30			$477,777.30
Air Cooled Steam Condenser		1	ea	$1,680,000.00	$1,680,000.00	$840,000.00	$840,000.00			$2,520,000.00
										$0.00
Stack										
Chimmney / Stack	$ 625,000.00	1	ea	$208,333.33	$208,333.33	$416,666.67	$416,666.67	$0.00	$0.00	$625,000.00
Piping										
LUMP SUM	$ 400,000.00	1	ea	$133,333.33	$133,333.33	$266,666.67	$266,666.67	$0.00	$0.00	$400,000.00
Plumbing										
LUMP SUM	$ 100,000.00	1	ea	$33,333.33	$33,333.33	$66,666.67	$66,666.67	$0.00	$0.00	$100,000.00
Misc Controls										
LUMP SUM	$ 750,000.00	1	ea	$250,000.00	$250,000.00	$500,000.00	$500,000.00	$0.00	$0.00	$750,000.00
Fuel Handling System										
Coal Belt Style Conveyor	$ 760,000.00	1	ea	$253,333.33	$253,333.33	$506,666.67	$506,666.67	$0.00	$0.00	$760,000.00

PROJECT: University of Alaska Fairbanks		Classification: Budgetary Cost Est						Project Number		05-4030
Location: Fairbanks, AK		Engineer: Henneman Raufeisen and Associates						Date:		9/21/2005
Take Off by:		Quant. by:	SJL/TAS	Prices by:	TAS/SJL			Checked by:	TAS	

	Reference	Quantity	Units	Material Cost	Material Total	Labor Cost	Labor Total	Equipment Cost	Equipment Total	Total Cost
Ash Handling System										
LUMP SUM	$ 350,000.00	1	ea	$116,666.67	$116,666.67	$233,333.33	$233,333.33	$0.00	$0.00	$350,000.00
Misc Utility Connections										
LUMP SUM	$ 150,000.00	1	ea	$50,000.00	$50,000.00	$100,000.00	$100,000.00	$0.00	$0.00	$150,000.00
Emission Control										
Fabric Filter Baghouse	$ 833,000.00	1	ea	$833,000.00	$833,000.00	$957,950.00	$957,950.00	$0.00	$0.00	$1,790,950.00
Optional Electrostatic Precipitators	$ 2,080,000.00	0	ea	$2,080,000.00	$0.00	$2,392,000.00	$0.00	$0.00	$0.00	$0.00
Electrical										
LUMP SUM	$ 1,500,000.00	1	ea	$500,000.00	$500,000.00	$1,000,000.00	$1,000,000.00	$0.00	$0.00	$1,500,000.00
Subtotals					**$16,558,222.00**		**$19,263,205.30**		**$0.00**	**$35,821,427.30**
Materials Sales Tax		0.00%			$ -					
Handling Overhead & Profit Mark-up										
Material		10.00%			$ 1,655,822.20				$ -	
Labor		40.00%					$ 7,705,282.12			
Total					**$18,214,044.20**		**$26,968,487.42**		**$0.00**	
City Modifier from Means										
Material Modifier		105.00%			$ 19,124,746.41					
Labor Modifier		100.00%					$ 26,968,487.42		$ -	
Overall Modifier		100.00%								
Labor Productivity Modifier		5.00%					$ 963,160.27			
Subtotal					**$19,124,746.41**		**$ 27,931,647.69**		**$0.00**	**$47,056,394.10**
Contingency		15%								$ 7,058,459.11
Design Fee		10%								$ 4,705,639.41
Total										**$58,820,492.62**

Installation Modifier	1.15
Emissioon Option	1
Filter Baghouse	1
ESP	2

NARRATIVE:

COAL BOILER PLANT ASSUMPTIONS

Assumptions:

Option One Coal boiler plant construction

Install the following equipment in the new plant. As much as possible we will try to keep the new plant independent of the existing plant.

- Coal boiler either a 50,000#/hr boiler or a 100,000 #/hr boiler. Initially we are to provide pricing on the best fit option which is a stoker type boiler. We will provide qualitative analysis on CFB
- Coal Day bunker 150 ton day bunker will be installed with the boiler
- We will modify existing coal handling equipment. we will provide pricing for a protected horizontal conveyor running across the existing building roof to the roof of the new building.
- Ash handling for the new boiler. We should integrate new and exiting ash handling systems. Provide twice the current capacity → two 13'x13'x13' storage areas with two loading areas side by side. This should provide sufficient time for the ash to cool before it is hauled away.
- Provide new 10 MW turbine, generator, controls and gear. Put Gear above the turbine.
- Provide a new two new 150,000 #/hr DA tanks. This would give the university an opportunity to abandon the existing DA after new construction is complete.
- Utilidor from new to existing plant. The utilidor will consist of high pressure steam, Feedwater, Low pressure steam, Ash lines, Condensate. Building of the new plant would giver the University an opportunity to install that would interconnect the existing and new HPS for the 10 mW turbines. Routing of this tunnel will be difficult. We may need to go below the existing that heads north to the north side of the plant
- Air Cooled Condenser next to plant for the boiler. Could use a hybrid system part air cooled and part surface condenser. Pricing it both ways.
- Install electrical gear in room above Turbine
- Develop full basement for condenser and steam piping from the turbine below.
- An operations room will be installed. It would be great id this was the operations headquarters but this would be redundant with the new facilities that they have developed on the north side of the existing plant.
- There was mention of a ro machine but I am not sure they were

Potential Options within the coal plant options.

- We could use existing feedwater pumps however if we develop a basement it may be a good idea to install new ones in preparation of the replacement of the old ones.
- We could replace the old DA tank and use that. That would have a require a coal system shutdown period. A new da will be require even if a new plant is not developed.

Tentative Coal Plant construction schedule:

Contract Award	0	days	0.00	Weeks
EPA Permit Process	131	days	18.71	Weeks
Preliminary Engineering	43	days	6.14	Weeks
Final Engineering	175	days	25.00	Weeks
Equipment Order	0	days	0.00	Weeks
Site Grading	22	days	3.14	Weeks
Boiler&Turbine Manufacturing	131	days	18.71	Weeks
Turbine Manufacturing	175	days	25.00	Weeks
Foundations	45	days	6.43	Weeks
Building	132	days	18.86	Weeks
Uitilidor /Piping	131	days	18.71	Weeks
Boiler Installation	65	days	9.29	Weeks
Turbine Installation	44	days	6.29	Weeks
Electrical Wiring	133	days	19.00	Weeks
Pre-Commissioning	21	days	3.00	Weeks
Landscaping	22	days	3.14	Weeks
Testing	44	days	6.29	Weeks
Start-Up Prep	43	days	6.14	Weeks
Plant On-Line	0	days	0.00	Weeks
Project Complete	1	days	0.14	Weeks
	1358	days	194	Weeks

We estimate that it will take 2 -1/2 years to complete the project.

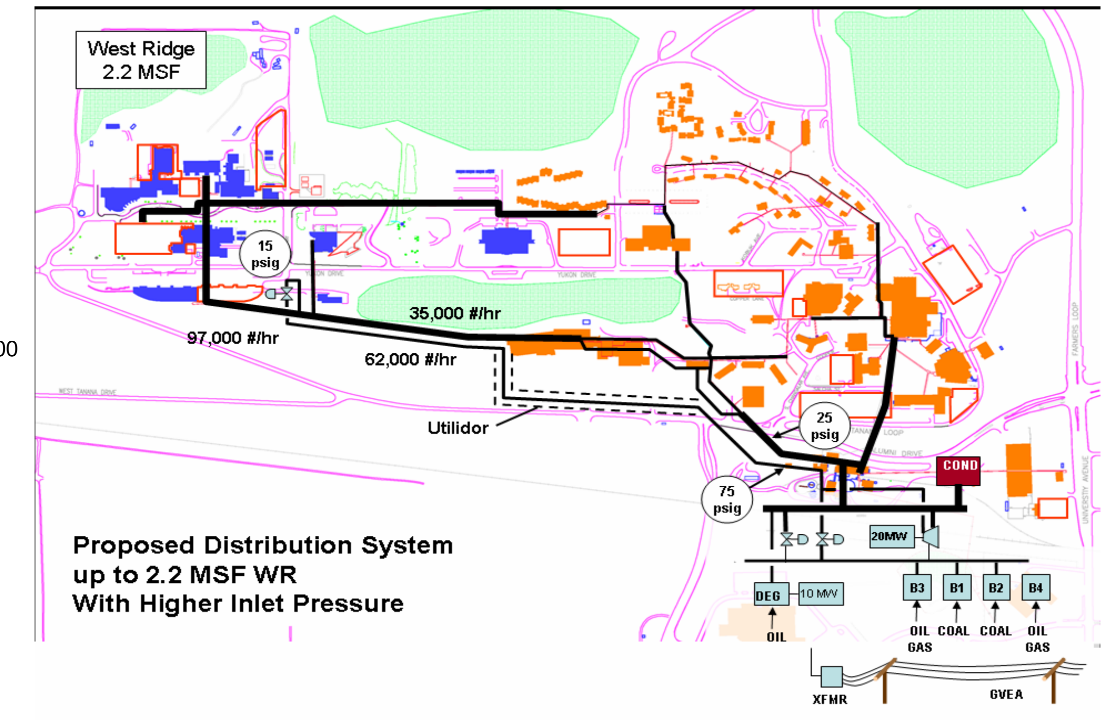
Proposed New Line at 75 psig start pressure

flow split line 1,2	***1***		**Diversity fac**	h	**Start Pressure**							
flow split 2	***1***											
flow split line 3	1		1.00	0.909	75							
Nodes		**MBH**	**MBH***	**Load (Lb/hr)**	**ipe size (in**	**D int. (in.)**	**n. A (in.^2**	**Velocity (ft/s**	**Pressure/10(**	**Distance (ft)**	**D Pressure (psi)**	
Total West Side		56500.00	56500	62156.22								
Atkinson-Lola Tilly	PLNT6-F1	0.00	0	0.00	14	13.12	135.28	0	0.0000	664	0.00	
proposed line 1	PLNT6-F1	56500.00	56500	62156.22	10	10.02	78.85	**14795**	1.4745	664	9.79	
flow split 2		0.00										
												9.79
Lola Tilly-Lathrop Blister	F1-F3	0.00	0	0.00	10	10.02	78.85	0	0.0000	362	0.00	
Lola Tilly-Lathrop Blister		0.00	0	0.00	10	10.02	78.85	0	0.0000	362	0.00	
Lathrop Blister Load		0.00	0	0.00								
Lathrop Blister	F4-K1	0.00	0	0.00	14	13.12	135.28	0	0.0000	200	0.00	
Lathrop Blister-Patty Ice	K1-K4	0.00	0	0.00	10	10.02	78.85	0	0.0000	760	0.00	
Lathrop Blister-Patty Ice	K1-K4	0.00	0	0.00	10	10.02	78.85	0	0.0000	760	0.00	0.00
proposed line 2	F1-K4	56500.00	56500	62156.22	10	10.02	78.85	**14795**	1.4745	1000	14.74	
												14.74
Patty Ice-Geist	K4-K7	0.00	0	0.00	14	13.12	135.28	0	0.0000	2410	0.00	
proposed line 3	K4-K7	56500.00	56500	62156.22	10	10.02	78.85	**14795**	1.4745	2410	35.54	
flow available at Geist				62156.22								35.54

60.07

Pressure @WR 14.93

Sp. Vol.
7.82



Proposed New Line at 75 psig start pressure

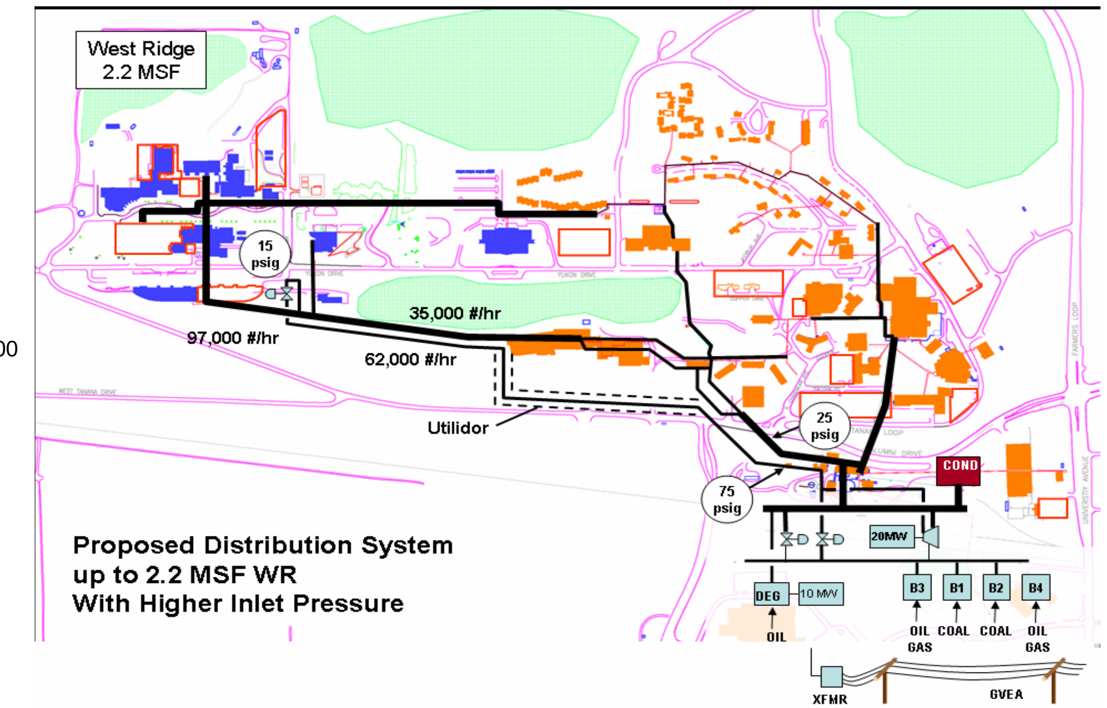
flow split line 1,2	***1***	**Diversity fac**	h	**Start Pressure**
flow split 2	***1***			
flow split line 3	1	1.00	0.909	75

Nodes		MBH	MBH*	Load (Lb/hr)	ipe size (in	D int. (in.)	n. A (in.^2	Velocity (ft/s	Pressure/100	Distance (ft)	D Pressure (psi)	
Total West Side		56500.00	56500	62156.22								
Atkinson-Lola Tilly	PLNT6-F1	0.00	0	0.00	14	13.12	135.28	0	0.0000	664	0.00	
proposed line 1	PLNT6-F1	56500.00	56500	62156.22	10	10.02	78.85	**14795**	1.4745	664	9.79	
flow split 2		0.00										
												9.79
Lola Tilly-Lathrop Blister	F1-F3	0.00	0	0.00	10	10.02	78.85	0	0.0000	362	0.00	
Lola Tilly-Lathrop Blister		0.00	0	0.00	10	10.02	78.85	0	0.0000	362	0.00	
Lathrop Blister Load		0.00	0	0.00								
Lathrop Blister	F4-K1	0.00	0	0.00	14	13.12	135.28	0	0.0000	200	0.00	
Lathrop Blister-Patty Ice	K1-K4	0.00	0	0.00	10	10.02	78.85	0	0.0000	760	0.00	
Lathrop Blister-Patty Ice	K1-K4	0.00	0	0.00	10	10.02	78.85	0	0.0000	760	0.00	0.00
proposed line 2	F1-K4	56500.00	56500	62156.22	10	10.02	78.85	**14795**	1.4745	1000	14.74	
												14.74
Patty Ice-Geist	K4-K7	0.00	0	0.00	14	13.12	135.28	0	0.0000	2410	0.00	
proposed line 3	K4-K7	56500.00	56500	62156.22	10	10.02	78.85	**14795**	1.4745	2410	35.54	
flow available at Geist				62156.22								35.54

60.07

Pressure @WR 14.93

Sp. Vol.
7.82



COST ESTIMATE:

UTILIDOR EXTENSION & STEAM DISTRIBUTION IMPROVMENTS

CONSTRUCTION COST ESTIMATE

Design Alaska

PROJECT: UAF UTILITIES DEVELOPMENT PLAN
LOCATION: FAIRBANKS
PHASE: PHASE II
DESCRIPTION: UTILIDOR EXTENSION & STEAM DISTRIBUTION IMPROVEMENTS

PREPARED BY: DLZ
FOR: UAF

15-Sep-05

DESCRIPTION	QUANTITY	EQUIPMENT		MATERIAL		LABOR						TOTAL		
PLUMBING SUBCONTRACTOR	No. UNITS UNITS	UNIT PRICE	EQUIP COST	UNIT PRICE	MATERIAL COST	HRS/ UNIT	MULT FACT	TOTAL HRS.	LABOR RATE	LABOR COST	UNIT COST	EQUIPMENT MATERIAL & LABOR	MATERIAL SOURCE	LAST DATE
TOTAL DIRECT COST, MATL & LAB.			$0		$4,311,568			10409.9		$601,589		$4,913,156		
FREIGHT	0.0%				$0									
SUBTOTAL			$0		$4,311,568					$601,589		$4,913,156		
CONTRACTORS OVERHEAD	15.0%		$0		$646,735					$90,238				
SUBTOTAL			$0		$4,958,303					$691,827		$5,650,130		
SUBCONTRACTOR TOTALS														
SUB #1............												$0		
SUB #2............												$0		
SUB #3............												$0		
SUBTOTAL												$5,650,130		
CONTRACTORS PROFIT	10.0%											$565,013		
SUBTOTAL												$6,215,143		
CONTINGENCY	10.0%											$621,514		
CONTRACT TOTAL												$6,836,657		
ATKINSON PLANT TO LOLA TILLY COMMONS														
8" STEAM PIPING W/ INSULATION	800 Lin.Ft	$0	$0	$59.98	$47,984	1.03	1	824	$57.79	$47,619	119.5	$95,603	To be verified with AMI	Jan-05
FITTINGS	Allowance		$0		$7,198		1	124	$57.79	$7,143		$14,340		
3" CONDENSATE PIPING W/ INSULATION	800 Lin.Ft	$0	$0	$20.48	$16,384	0.50	1	400	$57.79	$23,116	49.4	$39,500	To be verified with AMI	Jan-05
FITTINGS	Allowance		$0		$2,458		1	60	$57.79	$3,467		$5,925		
LOLA TILLY COMMONS TO WEST OF STUDENT REC														
8" STEAM PIPING W/ INSULATION	1700 Lin.Ft	$0	$0	$59.98	$101,966	1.03	1	1751	$57.79	$101,190	119.5	$203,156	To be verified with AMI	Jan-05
FITTINGS	Allowance		$0		$15,295		1	263	$57.79	$15,179		$30,473		
3" CONDENSATE PIPING W/ INSULATION	1700 Lin.Ft	$0	$0	$20.48	$34,816	0.50	1	850	$57.79	$49,122	49.4	$83,938	To be verified with AMI	Jan-05
FITTINGS	Allowance		$0		$5,222		1	128	$57.79	$7,368		$12,591		
6X6 UTILIDOR	360 Lin.Ft	$0	$0	$2500	$900,000	0.00	1	0	$57.79	$0	2500.0	$900,000	Cost compared to 2004 utilidor extension schedule of values	Jun-04
3X5 UTILIDOR	1120 Lin.Ft	$0	$0	$1670	$1,870,400	0.00	1	0	$57.79	$0	1670.0	$1,870,400	Cost estimated at 2/3 of 6x6 utilidor cost	Jun-04
MANHOLE	1 Each	$0	$0	$50000	$50,000	0.00	1	0	$57.79	$0	50000.0	$50,000	SWAG	Jan-05
WEST OF STUDENT REC TO OTTO GEIST MUSEUM														
8" STEAM PIPING W/ INSULATION	1640 Lin.Ft	$0	$0	$59.98	$98,367	1.03	1	1689	$57.79	$97,619	119.5	$195,986	To be verified with AMI	Jan-05
FITTINGS	Allowance		$0		$14,755		1	253	$57.79	$14,643		$29,398		
3" CONDENSATE PIPING W/ INSULATION	1640 Lin.Ft	$0	$0	$20.48	$33,587	0.50	1	820	$57.79	$47,388	49.4	$80,975	To be verified with AMI	Jan-05
FITTINGS	Allowance		$0		$5,038		1	123	$57.79	$7,108		$12,146		
OTTO GEIST MUSEUM TO WEST RIDGE PLANT														
8" STEAM PIPING W/ INSULATION	1640 Lin.Ft	$0	$0	$59.98	$98,367	1.03	1	1689	$57.79	$97,619	119.5	$195,986	To be verified with AMI	Jan-05
FITTINGS	Allowance		$0		$14,755		1	253	$57.79	$14,643		$29,398		
3" CONDENSATE PIPING W/ INSULATION	1640 Lin.Ft	$0	$0	$20.48	$33,587	0.50	1	820	$57.79	$47,388	49.4	$80,975	To be verified with AMI	Jan-05
FITTINGS	Allowance		$0		$5,038		1	123	$57.79	$7,108		$12,146		
6X6 UTILIDOR	340 Lin.Ft	$0	$0	$2500	$850,000	0.00	1	0	$57.79	$0	2500.0	$850,000	Cost compared to 2004 utilidor extension schedule of values	Jun-04
125#/15# PRV AT WEST RIDGE SITE														
PRV	2 Each	$0	$0	$8435	$16,870	35.00	2	140	$57.79	$8,091	12480.3	$24,961	Cost compared to Clear AFB PRV Steam Heating Station	Sep-05
DESUPERHEATER	2 Each	$0	$0	$8240	$16,480	25.00	2	100	$57.79	$5,779	11129.5	$22,259		
VALVES, PIPING, & ACCESSORIES	1 Each	$0	$0	$73000	$73,000	0.00	2	0	$57.79	$0	73000.0	$73,000		
COLUMN TOTALS:			$0		$4,311,568			10,410		$601,589		$4,913,156		

COST ESTIMATE:

WEST RIDGE CHILLED WATER DISTRIBUTION & EXTENSION

Design Alaska

CONSTRUCTION COST ESTIMATE

PROJECT: UAF UTILITIES DEVELOPMENT PLAN
LOCATION: FAIRBANKS
PHASE: PHASE II
DESCRIPTION: CHILLED WATER DISTRIBUTION & EXTENSION

PREPARED BY: DLZ
FOR: UAF

15-Sep-05

DESCRIPTION	QUANTITY	EQUIPMENT		MATERIAL		LABOR						TOTAL		
PLUMBING SUBCONTRACTOR	No. UNITS UNITS	UNIT PRICE	EQUIP COST	UNIT PRICE	MATERIAL COST	HRS/ UNIT	MULT FACT	TOTAL HRS.	LABOR RATE	LABOR COST	UNIT COST	EQUIPMENT MATERIAL & LABOR	MATERIAL SOURCE	LAST DATE
TOTAL DIRECT COST, MATL & LAB.			$0		$2,701,493			14218.8		$821,706		$3,523,199		
FREIGHT	0.0%				$0									
SUBTOTAL			$0		$2,701,493					$821,706		$3,523,199		
CONTRACTORS OVERHEAD	15.0%		$0		$405,224					$123,256				
SUBTOTAL			$0		$3,106,717					$944,962		$4,051,679		
SUBCONTRACTOR TOTALS														
SUB #1............												$0		
SUB #2............												$0		
SUB #3............												$0		
SUBTOTAL												$4,051,679		
CONTRACTORS PROFIT	10.0%											$405,168		
SUBTOTAL												$4,456,847		
CONTINGENCY	10.0%											$445,685		
CONTRACT TOTAL												$4,902,532		
CHILLED WATER DISTRIBUTION MAINS														
FROM CHILLED WATER PLANT TO UTILIDOR "R"														
18" PIPING W/ INSULATION	150 Lin.Ft	$0	$0	$386.58	$57,987	2.68	1	402	$57.79	$23,232	541.5	$81,219	To be verified with AMI	Jan-05
FITTINGS	Allowance		$0		$8,698		1	60	$57.79	$3,485		$12,183		
FROM PLANT UTILIDOR TO UTILIDOR "K"													To be verified with AMI	Jan-05
16" DIRECT BURIED HDPE PIPING	1780 Lin.Ft	$0	$0	$71.5	$127,270	0.10	1	178	$57.79	$10,287	77.3	$137,557		
FITTINGS	Allowance		$0		$19,091		1	27	$57.79	$1,543		$20,633		
CHILLED WATER DISTRIBUTION BRANCHES														
FROM 16" MAIN TO IRVING BRANCH														
12" PIPING W/ INSULATION	180 Lin.Ft	$0	$0	$121.02	$21,784	1.96	1	353	$57.79	$20,388	234.3	$42,172	To be verified with AMI	Jan-05
FITTINGS	Allowance		$0		$3,268		1	53	$57.79	$3,058		$6,326		
BRANCH TO IRVING														
6" PIPING W/ INSULATION	240 Lin.Ft	$0	$0	$41.94	$10,066	1.12	1	269	$57.79	$15,534	106.7	$25,600	To be verified with AMI	Jan-05
FITTINGS	Allowance		$0		$1,510		1	40	$57.79	$2,330		$3,840		
BRANCH TO O'NEILL														
6" PIPING W/ INSULATION	120 Lin.Ft	$0	$0	$41.94	$5,033	1.12	1	134	$57.79	$7,767	106.7	$12,800	To be verified with AMI	Jan-05
FITTINGS	Allowance		$0		$755		1	20	$57.79	$1,165		$1,920		
FROM IRVING BRANCH TO WRRB BRANCH														
10" PIPING W/ INSULATION	640 Lin.Ft	$0	$0	$94.42	$60,429	1.73	1	1107	$57.79	$63,985	194.4	$124,414	To be verified with AMI	Jan-05
FITTINGS	Allowance		$0		$9,064		1	166	$57.79	$9,598		$18,662		
FROM WRRB BRANCH TO ELVEY BRANCH														
8" PIPING W/ INSULATION	160 Lin.Ft	$0	$0	$59.97	$9,595	1.46	1	234	$57.79	$13,500	144.3	$23,095	To be verified with AMI	Jan-05
FITTINGS	Allowance		$0		$1,439		1	35	$57.79	$2,025		$3,464		
BRANCH TO ELVEY														
8" PIPING W/ INSULATION	160 Lin.Ft	$0	$0	$59.97	$9,595	1.46	1	234	$57.79	$13,500	144.3	$23,095	To be verified with AMI	Jan-05
FITTINGS	Allowance		$0		$1,439		1	35	$57.79	$2,025		$3,464		
BRANCH TO IARC														
6" PIPING W/ INSULATION	830 Lin.Ft	$0	$0	$41.94	$34,810	1.12	1	930	$57.79	$53,722	106.7	$88,532	To be verified with AMI	Jan-05
FITTINGS	Allowance		$0		$5,222		1	139	$57.79	$8,058		$13,280		
BRANCH TO BICS														
6" PIPING W/ INSULATION	1000 Lin.Ft	$0	$0	$41.94	$41,940	1.12	1	1120	$57.79	$64,725	106.7	$106,665	To be verified with AMI	Jan-05
FITTINGS	Allowance		$0		$6,291		1	168	$57.79	$9,709		$16,000		
FROM 16" MAIN TO ARCTIC HEALTH BRANCH														
10" PIPING W/ INSULATION	380 Lin.Ft	$0	$0	$94.42	$35,880	1.73	1	657	$57.79	$37,991	194.4	$73,871	To be verified with AMI	Jan-05
FITTINGS	Allowance		$0		$5,382		1	99	$57.79	$5,699		$11,081		
BRANCH TO ARCTIC HEALTH														
6" PIPING W/ INSULATION	140 Lin.Ft	$0	$0	$41.94	$5,872	1.12	1	157	$57.79	$9,061	106.7	$14,933	To be verified with AMI	Jan-05
FITTINGS	Allowance		$0		$881		1	24	$57.79	$1,359		$2,240		
FROM ARCTIC HEALTH BRANCH TO BUTROVICH SUPERCOMPUTER														
8" PIPING W/ INSULATION	1060 Lin.Ft	$0	$0	$59.97	$63,568	1.46	1	1548	$57.79	$89,436	144.3	$153,004	To be verified with AMI	Jan-05
FITTINGS	Allowance		$0		$9,535		1	232	$57.79	$13,415		$22,951		
BRANCH TO BUTROVICH BUILDING COOLING														
6" PIPING W/ INSULATION	140 Lin.Ft	$0	$0	$41.94	$5,872	1.12	1	157	$57.79	$9,061	106.7	$14,933	To be verified with AMI	Jan-05
FITTINGS	Allowance		$0		$881		1	24	$57.79	$1,359		$2,240		
FROM 16" MAIN TO BIRD BRANCH														
6" PIPING W/ INSULATION	220 Lin.Ft	$0	$0	$41.94	$9,227	1.12	1	246	$57.79	$14,239	106.7	$23,466	To be verified with AMI	Jan-05
FITTINGS	Allowance		$0		$1,384		1	37	$57.79	$2,136		$3,520		
BRANCH TO BIRD														
6" PIPING W/ INSULATION	60 Lin.Ft	$0	$0	$41.94	$2,516	1.12	1	67	$57.79	$3,883	106.7	$6,400	To be verified with AMI	Jan-05
FITTINGS	Allowance		$0		$377		1	10	$57.79	$583		$960		
FROM BIRD BRANCH TO VIROLOGY														
4" PIPING W/ INSULATION	220 Lin.Ft	$0	$0	$21.97	$4,833	0.74	1	163	$57.79	$9,408	64.7	$14,242	To be verified with AMI	Jan-05
FITTINGS	Allowance		$0		$725		1	24	$57.79	$1,411		$2,136		
BRANCH TO MUSEUM														
8" PIPING W/ INSULATION	660 Lin.Ft	$0	$0	$59.97	$39,580	1.46	1	964	$57.79	$55,686	144.3	$95,267	To be verified with AMI	Jan-05
FITTINGS	Allowance		$0		$5,937		1	145	$57.79	$8,353		$14,290		
BRANCH TO NATURAL SCIENCE														
8" PIPING W/ INSULATION	2360 Lin.Ft	$0	$0	$59.97	$141,529	1.46	1	3446	$57.79	$199,121	144.3	$340,650	To be verified with AMI	Jan-05
FITTINGS	Allowance		$0		$21,229		1	517	$57.79	$29,868		$51,098		
CONVERT BUILDING SYSTEM PRICE/TON														

CONSTRUCTION COST ESTIMATE

Design Alaska

PROJECT: UAF UTILITIES DEVELOPMENT PLAN
LOCATION: FAIRBANKS
PHASE: PHASE II
DESCRIPTION: CHILLED WATER DISTRIBUTION & EXTENSION

PREPARED BY: DLZ
FOR: UAF

15-Sep-05

BIRD (CHILLER)	130 Tons	$0	$0	$300	$39,000	0.00	1	0	$57.79	$0	300.0	$39,000	Means Facilities & Maintenance Cost Data	Jan-05
VIROLOGY (NEW CONNECTION)	90 Tons	$0	$0	$100	$9,000	0.00	1	0	$57.79	$0	100.0	$9,000	Means Facilities & Maintenance Cost Data	Jan-05
IRVING 1 (CHILLER)	150 Tons	$0	$0	$300	$45,000	0.00	1	0	$57.79	$0	300.0	$45,000	Means Facilities & Maintenance Cost Data	Jan-05
IRVING 2 (DX)	90 Tons	$0	$0	$2250	$202,500	0.00	1	0	$57.79	$0	2250.0	$202,500	Means Facilities & Maintenance Cost Data	Jan-05
O'NEILL (DX)	260 Tons	$0	$0	$2250	$585,000	0.00	1	0	$57.79	$0	2250.0	$585,000	Means Facilities & Maintenance Cost Data	Jan-05
WRRB (CHILLER)	225 Tons	$0	$0	$300	$67,500	0.00	1	0	$57.79	$0	300.0	$67,500	Means Facilities & Maintenance Cost Data	Jan-05
ELVEY ADDITION (DX)	80 Tons	$0	$0	$2250	$180,000	0.00	1	0	$57.79	$0	2250.0	$180,000	Means Facilities & Maintenance Cost Data	Jan-05
ELVEY (CHILLER)	200 Tons	$0	$0	$300	$60,000	0.00	1	0	$57.79	$0	300.0	$60,000	Means Facilities & Maintenance Cost Data	Jan-05
IARC (CHILLER)	260 Tons	$0	$0	$300	$78,000	0.00	1	0	$57.79	$0	300.0	$78,000	Means Facilities & Maintenance Cost Data	Jan-05
ARCTIC HEALTH (DX)	100 Tons	$0	$0	$2250	$225,000	0.00	1	0	$57.79	$0	2250.0	$225,000	Means Facilities & Maintenance Cost Data	Jan-05
ARCTIC HEALTH (CHILLER)	160 Tons	$0	$0	$300	$48,000	0.00	1	0	$57.79	$0	300.0	$48,000	Means Facilities & Maintenance Cost Data	Jan-05
BUTROVICH (CHILLER)	370 Tons	$0	$0	$300	$111,000	0.00	1	0	$57.79	$0	300.0	$111,000	Means Facilities & Maintenance Cost Data	Jan-05
MUSEUM (CHILLER)	380 Tons	$0	$0	$300	$114,000	0.00	1	0	$57.79	$0	300.0	$114,000	Means Facilities & Maintenance Cost Data	Jan-05
NATURAL SCIENCE (CHILLER)	490 Tons	$0	$0	$300	$147,000	0.00	1	0	$57.79	$0	300.0	$147,000	Means Facilities & Maintenance Cost Data	Jan-05
COLUMN TOTALS:			$0		$2,701,493			14,219		$821,706		$3,523,199		

COST ESTIMATE:

WEST RIDGE CHILLED WATER PLANT

CONSTRUCTION COST ESTIMATE

Design Alaska

PROJECT: UAF UTILITIES DEVELOPMENT PLAN
LOCATION: FAIRBANKS
PHASE: PHASE II
DESCRIPTION: WEST RIDGE CHILLED WATER PLANT

PREPARED BY: DLZ
FOR: UAF

15-Sep-05

DESCRIPTION	QUANTITY	EQUIPMENT		MATERIAL		LABOR						TOTAL		
PLUMBING SUBCONTRACTOR	No. UNITS UNITS	UNIT PRICE	EQUIP COST	UNIT PRICE	MATERIAL COST	HRS/ UNIT	MULT FACT	TOTAL HRS.	LABOR RATE	LABOR COST	UNIT COST	EQUIPMENT MATERIAL & LABOR	MATERIAL SOURCE	LAST DATE
TOTAL DIRECT COST, MATL & LAB.			$0		$3,665,000			.0		$0		$3,665,000		
FREIGHT	0.0%				$0									
SUBTOTAL			$0		$3,665,000					$0		$3,665,000		
CONTRACTORS OVERHEAD	15.0%		$0		$549,750					$0				
SUBTOTAL			$0		$4,214,750					$0		$4,214,750		
SUBCONTRACTOR TOTALS														
SUB #1............												$0		
SUB #2............												$0		
SUB #3............												$0		
SUBTOTAL												$4,214,750		
CONTRACTORS PROFIT	10.0%											$421,475		
SUBTOTAL												$4,636,225		
CONTINGENCY	5.0%											$231,811		
CONTRACT TOTAL												$4,868,036		
CHILLED WATER PLANT														
SITE WORK	1 Each	$0	$0	$316000	$316,000	0.00	1	0	$57.79	$0	316000.0	$316,000	All cost data taken from UAF Utilities Central Chiller Replacement contractor schedule of values. All items multiplied by 2 except chillers, piping, cooling towers, pumps, and misc mech equip. The overhead and profit items were removed from schedule of values to reflect actual costs.	
FOUNDATION WORK	1 Each	$0	$0	$134000	$134,000	0.00	1	0	$57.79	$0	134000.0	$134,000		
STRUCTURAL WORK	1 Each	$0	$0	$948000	$948,000	0.00	1	0	$57.79	$0	948000.0	$948,000		
CHILLERS, PIPING, & COOLING TOWERS	1 Each	$0	$0	$540000	$540,000	0.00	1	0	$57.79	$0	540000.0	$540,000		
PUMPS, PIPING, & MISC MECH EQUIP	1 Each	$0	$0	$287000	$287,000	0.00	1	0	$57.79	$0	287000.0	$287,000		
ELECTRICAL SERVICE	1 Each	$0	$0	$379000	$379,000	0.00	1	0	$57.79	$0	379000.0	$379,000		
BRANCH SERVICE	1 Each	$0	$0	$256000	$256,000	0.00	1	0	$57.79	$0	256000.0	$256,000		
LIGHTING	1 Each	$0	$0	$110000	$110,000	0.00	1	0	$57.79	$0	110000.0	$110,000		
FIRE ALARM	1 Each	$0	$0	$97000	$97,000	0.00	1	0	$57.79	$0	97000.0	$97,000		
CONTROLS	1 Each	$0	$0	$598000	$598,000	0.00	1	0	$57.79	$0	598000.0	$598,000		
COLUMN TOTALS:			$0		$3,665,000			0		$0		$3,665,000		

COST ESTIMATE:

WEST RIDGE STEAM PRODUCTION PLANT

CONSTRUCTION COST ESTIMATE

Design Alaska

PROJECT: UAF UTILITIES DEVELOPMENT PLAN
LOCATION: FAIRBANKS
PHASE: PHASE II
DESCRIPTION: WEST RIDGE STEAM PRODUCTION PLANT

PREPARED BY: DLZ
FOR: UAF

15-Sep-05

DESCRIPTION	QUANTITY		EQUIPMENT		MATERIAL		LABOR						TOTAL		
PLUMBING SUBCONTRACTOR	No. UNITS	UNITS	UNIT PRICE	EQUIP COST	UNIT PRICE	MATERIAL COST	HRS/ UNIT	MULT FACT	TOTAL HRS.	LABOR RATE	LABOR COST	UNIT COST	EQUIPMENT MATERIAL & LABOR	MATERIAL SOURCE	LAST DATE
TOTAL DIRECT COST, MATL & LAB.				$0		$3,895,000			.0		$0		$3,895,000		
FREIGHT	0.0%					$0									
SUBTOTAL				$0		$3,895,000					$0		$3,895,000		
CONTRACTORS OVERHEAD	15.0%			$0		$584,250					$0				
SUBTOTAL				$0		$4,479,250					$0		$4,479,250		
SUBCONTRACTOR TOTALS															
SUB #1............													$0		
SUB #2............													$0		
SUB #3............													$0		
SUBTOTAL													$4,479,250		
CONTRACTORS PROFIT	10.0%												$447,925		
SUBTOTAL													$4,927,175		
CONTINGENCY	15.0%												$739,076		
CONTRACT TOTAL													$5,666,251		
STEAM PRODUCTION PLANT															
SITE WORK	1	Each	$0	$0	$650000	$650,000	0.00	1	0	$57.79	$0	650000.0	$650,000		
FOUNDATIONS AND SLAB	1	Each	$0	$0	$690000	$690,000	0.00	1	0	$57.79	$0	690000.0	$690,000		
STUCTURAL, PLATFORMS, AND STAIRS	1	Each	$0	$0	$1130000	$1,130,000	0.00	1	0	$57.79	$0	1130000.0	$1,130,000	Data compiled from Clear AFB Power Plant Addition that is currently reaching completion, and also the UAF Clean Coal V DEG Power Plant that was completed in 2001. All figures are today's dollars.	
EXTERIOR WALL ASSEMBLY	1	Each	$0	$0	$330000	$330,000	0.00	1	0	$57.79	$0	330000.0	$330,000		
ROOF ASSEMBLY	1	Each	$0	$0	$200000	$200,000	0.00	1	0	$57.79	$0	200000.0	$200,000		
FINISHES	1	Each	$0	$0	$90000	$90,000	0.00	1	0	$57.79	$0	90000.0	$90,000		
EXTERIOR DOORS	1	Each	$0	$0	$40000	$40,000	0.00	1	0	$57.79	$0	40000.0	$40,000		
HVAC, PLUMBING, FIRE PROTECTION, CONTROLS	1	Each	$0	$0	$430000	$430,000	0.00	1	0	$57.79	$0	430000.0	$430,000		
BUILDING ELECTRICAL, LIGHTING, AND FIRE ALARM	1	Each	$0	$0	$310000	$310,000	0.00	1	0	$57.79	$0	310000.0	$310,000		
120 GPM CRP W/ 3000 GAL RECEIVER	1	Each	$0	$0	$25000	$25,000	0.00	2	0	$57.79	$0	25000.0	$25,000	SWAG	
COLUMN TOTALS:				$0		$3,895,000			0		$0		$3,895,000		

NARRATIVE:

UTILIDOR EXTENSION & STEAM DISTRIBUTION IMPROVEMENTS

CHILLED WATER DISTRIBUTION & EXTENSION IMPROVMENTS

WEST RIDGE CHILLED WATER PLANT

WEST RIDGE STEAM PRODUCTION PLANT

STRATEGY 3 IMPLEMENATION SUMMARY

UNIVERSITY OF ALASKA
UTILITITES DEVELOPMENT PLAN
FAIRBANKS, ALASKA

INVESTIGATIVE MECHANICAL NARRATIVE

Utilidor Extension and Steam Distribution Improvements: $6.8 Million

The existing "F" utilidor from approximately Lola Tilly to the Lathrop Blister, and the "K" utilidor from the Lathrop Blister to the mechanical room below Patty Ice Center are congested to a degree that installation of an additional piping is considered impractical. A new utilidor would be constructed to bypass this area, allowing installation of new steam and condensate from Atkinson to the West Ridge. The new utilidor would be installed as a 6' x 6' section of similar construction to the West Ridge Utilidor Extension (completed 2004). Included in the project is new piping in the existing utilidors from Atkinson Plant to Lola Tilly, New piping in existing utilidors from Lola Tilly to the Geist Museum, and a pressure regulation station in the existing vault at the junction of the Geist Museum and the "K" tunnel (point "L" Cost estimates are based on historical construction costs of the West Ridge Utilidor Extension project, current material and labor rate estimates done by American Mechanical Inc, and Means Plumbing Cost Data 2005.

Improvement of the steam distribution system to the West Ridge is a necessary component of Strategy 3 as all steam will continue to be generated in Atkinson at the south east corner of the campus. The dynamics of the concept proposed here are substantiated in the steam model (attached). Existing steam service to West Ridge is accomplished as follows. Low pressure (15 psig summer, 25 psig winter) steam from the controlled extraction port of the steam turbine flows out western side plant to the vicinity of Lola Tilly Hall via a 14" line in a section of relatively open utilidor. At Lola Tilly the single 14" line splits into two 10" lines routed into the Lathrop Blister. The utilidor is extremely congested in this area. A manifold in the Lathrop Blister ties in an east-west line from the Library, a direct buried line from Student Housing and a second pair of 10" lines routed west to Patty Ice. The utilidor from Lathrop Blister to Patty Ice is congested. As the Utilidor leaves Patty Ice the two 10" lines combine back into a single 14" line running up the grade to the West Ridge. This long portion of utilidor is relatively large and open.

Under current peak heating load conditions, roughly 37,000 #/hr is needed in the vicinity of Geist on the West Ridge. With this flow rate the observed steam pressure drop across the piping system is on the order of 15 psig, meaning operation of the controlled extraction port at 25 psig provides 10 psig on the West Ridge- 5 psig under design and too low for satisfactory operation of building heat exchangers. A steam pressure drop calculation model (output attached) yields similar results. When a new 10" line is modeled in parallel to existing from the plant to Geist Museum, the piping system becomes capable of moving 53,000 #/hr at a pressure drop of 10 psig; leaving an acceptable 15 psig on the West Ridge. 53,000 #/hr corresponds to an increase in building square footage on the order of 250,000 SF. This magnitude of West Ridge growth is projected within 5 years. As peak demand increases further, the new line can be used in a different mode. A 600 to 125 psig regulator on the Atkinson high pressure header would allow the line to flow higher pressure, lower specific volume steam that bypasses the turbine direct to the load on the West Ridge where it would bleed back into the existing low pressure distribution system through a 125 psig to 15 psig regulator set. In this turbine bypass mode the line could support on the order of 800,000 SF in addition to the 500,000 SF served by the low pressure line at 15 psig. Ultimately in Strategy 3, a new 20 MW steam turbine is brought on line. This unit would be specified with higher pressure extraction ports so that bypass from the 600 psi header is no longer necessary. A more detailed analysis will be needed to optimize the number and size of these ports. For the purpose of the Utility Development Business Plan however, the project cost estimate carries the new line from Atkinson to the West Ridge with its pressure regulating stations, improvements to the existing low pressure steam system to enable the East line to lower campus to operate at higher pressure (along with PRV stations) and costs to eventually upsize the existing 6" steam line at the north center of the system to allow better loop flow from lower campus to west ridge.

Chilled Water Distribution & Extension Improvements: $4,163,000

For the pricing of chilled water piping, we also used a conservative average of prices relayed to us from American Mechanical Inc., Means Mechanical Cost Data 2004 AND THE West Ridge Utilidor Expansion mentioned in the previous paragraph. The piping prices do not include racks within the utilidor.

For building conversion pricing, we used Means Mechanical Cost Data 2004 to estimate the installation cost of a 100-ton air cooled chiller system. The pricing included the air handler and pumps associated with the chiller. The price to convert a building in Fairbanks from a DX coil to a chilled water system will be similar to the price for installing a new air-cooled chiller system in the lower 48. There will be coil changes in air handlers or plenums, no pumps will be required, there will be some new piping, etc. Ultimately, we decided that it would cost in the neighborhood of $225,000 per 100 tons of cooling to convert the buildings with DX units to chilled water systems.

To add the systems with existing chillers to the proposed chilled water loop, we would need to add piping, three way valves, and accessories and provide programming for the DDC system. We estimate this cost to be in the neighborhood of $30,000 per 100 tones of cooling equipment.

To connect future buildings to the chilled water system, we estimate it would cost about $10,000 per 100 tones of cooling.

West Ridge Chilled Water Plant: $2,861,000

To estimate the construction cost of a new chilled water plant on the West Ridge, we directly compared the new plant to the one currently under construction at the Atkinson Power Plant. The new chilled water plant will be sized to house two 900 ton steam absorption chillers, with additional space for two more units of similar size in the future. Since the new plant on lower campus houses two 900 ton units, then the one at West Ridge would essentially be twice the size. Some of the numbers from the contractor schedule of values could be directly doubled, such as the foundation cost, while others were increased by a percentage depending on the type of system being installed. For instance, the fire protection system cost is mostly in the control panel, so we only added 25% to the cost of the new chilled water plant at West Ridge. For further explanation, see column titled "Material Source" in our mechanical estimate.

West Ridge Steam Production Plant: $5,439,00

To estimate the cost of a steam production plant at the West Ridge, we used our estimate from the BICS Heating Plant Study we created for UAF in 2004 and altered some of the figures. We changed the boilers to two 20,000 #/hr unites and added demineralizer, a condensate receiver, a remote condensate receiver, a combustion air preheater, and three more 10,000 gallon fuel tanks. We increased ventilation fan size and decreased plant lighting, as well as a few other minor modifications.

Proposed Changes: $450,000 Extra

There is a high possibility that natural gas will be available on campus by the time the West Ridge Steam Production Plant is built. If so, the gas line installation from Atkinson Power Plant to the steam production plant will cost about $100 per foot (today's dollars). The gas line could run along the road in from of Patty Center and travel up the hill to the heating plant. The length of run will be about 4500 ft and cost about $450,000.

GLHN ARCHITECTS & ENGINEERS, INC.

OPINION OF PROBABLE CONSTRUCTION COST

BASIS FOR ESTIMATE

- ☒ CODE A (No design completed)
- ☐ CODE B (Preliminary design)
- ☐ CODE C (Finished design)
- ☐ OTHER

COMPUTED BY: HWJ
CHECKED BY: HWJ
DATE 10/09/06

University of Alaska Fairbanks
Utility Development Plant
Utilidor: Atkinson-

PROJECT NO. 0003.00
DEPT. MECHANICAL
SHEET NO.

SUMMARY MECHANICAL	QUANTITY No. UNITS	QUANTITY UNIT MEAS.	MATERIAL PER UNIT	MATERIAL TOTAL	LABOR PER UNIT	LABOR TOTAL	EQUIP PER UNIT	TOTAL COST
Atkinson Plant-steam pipe &ftgs 10"	200	lf	$90	$18,000	$60	$12,000		$ 30,000
Atkinson Plant condensate pipe &ftgs 4'	200	lf	$18	$3,600	$21	$4,200		$ 7,800
Atkinson-Lola Tilly steam pipe & ftgs 10	800	lf	$90	$72,000	$60	$48,000		$ 120,000
Atkinson-Lola Tilly condensate pipe&ftg	800	lf	$18	$14,400	$21	$16,800		$ 31,200
Lola Tilly-Student Rec Utilidor	1700	lf	$1,200	$2,040,000	$1,200	$2,040,000		$ 4,080,000
Lola Tilly-Student Rec Steam pipe & ftg	1700	lf	$90	$153,000	$60	$102,000		$ 255,000
Lola Tilly-Student Rec Cond pipe &^ftgs	1700	lf	$18	$30,600	$21	$35,700		$ 66,300
Student Rec-Geist Steam pipe &ftgs 10	1640	lf	$90	$147,600	$60	$98,400		$ 246,000
Student Rec-Geist Cond pipe & ftgs 10"	1640	lf	$18	$29,520	$21	$34,440		$ 63,960
Geist PRV	1	ls	$20,000	$20,000	$7,500	$12,000		$ 32,000
								$ -
Sub-Total								$ -

Total of Subtotals =	$ 4,932,260
Overhead and Profit =	1,307,049
Total Construction Cost=	$ 6,239,309
Contingency=	623,931
Total Project Cost=	**$ 6,864,000**

*** SUMMARY OF MARKUPS**

Overhead =	15%
Profit =	10%
Contingency=	10%

UAF COAL FIRED COGENERATION PLANT EXPANSION

The central heating, cooling and electric power utility system at the University of Alaska Fairbanks relies on a coal fired cogeneration system. Under Strategy 3 of the Utility Development Plan, the exiting system would be expanded to meet current and future campus loads to reduce reliance on more expensive liquid and gaseous fuels and purchased electric power. An outline of the current cogeneration process at UAF is followed by a narrative description of the proposed process expansion and recommendations for the next steps in developing and the concept and refining the cost estimate.

Coal to Steam

Low sulfur coal is transported by rail from an open pit mine near Healy Ak to Fairbanks, and then by a dedicated rail spur to a coal grate on grade adjacent to the Atkinson Power Plant. Conveyors raise the coal to two hoppers at roof elevation. The coal is gravity fed to the traveling stoker grates in the firebox of the steam generators and ignited. Exhaust gases from the combustion process are routed through combustion air preheaters and bag house filters before discharging up into a vertical flue. Spent ash is dumped from the end of the grate into a vacuum powered ash removal pipe which discharges into an ash silo, and ultimately is trucked off-site. The rate of travel of the stoker grate and geometry of the boiler tubes are designed to combust coal at a rate sufficient to produce 50,000 lbs/hr of 650 psi, 650 F super heated steam. The coal-to-steam energy conversion is on the order of 85% efficient.

Steam Cycle

High pressure superheated steam can be routed to the inlet of a multi-stage turbine. Expansion of up to 120,000 #/hr of steam through the unit drives an electric generator with an electric output as high as 9.6 MW. Steam can be extracted through one of two ports. The medium pressure extraction port at 125 psig, provides approximately 10,000 #/hr for internal plant use (including feedwater heater and deareator). The low pressure port is regulated to maintain the campus distribution steam pressure at 15-25 psig. The flow through this port is a function of campus steam load and varies from a summer time low of 25,000 #/hr to a high of roughly 100,000 #/hr. A sub atmospheric exhaust port releases the steam that is not used for medium pressure or low pressure demand. This ranges from a high value on the order of 90,000 #/hr in the summer time to essentially nothing during peak heating conditions. Exhaust steam is routed to a set of air cooled condensers or a liquid cooled surface condenser where it is returned it to liquid and routed back to the condensate hot well, and mixed with campus distribution steam return. Condensate from the hot well is transferred up to the Deareator then Feedwater pumps and feedwater heater and back into the boilers.

Cogeneration

The thermodynamic process at UAF converts the latent energy contained in coal into high pressure, high temperature steam. As this energy is converted both into motive power to drive the electric generator and the thermal energy to heat the campus, the process is considered to be "co-generation" of heat and electric power. The overall thermodynamic efficiency of this single process is higher than the combined efficiencies of converting fuel energy into electric power and (separately) converting fuel energy into heat. The use of coal as the fuel source makes the overall cogeneration process at UAF remarkably less expensive to operate.

Utility Development Plan Strategy 3

The peak heat and electric power demands on the UAF campus exceed the capacity of the current cogeneration system. Purchase of coal must now be supplemented with purchase of fuel oil (and soon natural gas) to supply additional campus heat, and purchase of electric power from the public utility. The unit costs of these additional purchases (in $/MMBTU, or $/kWh) are substantially higher than the cost of co-generated services. Additional growth of heating and power over the next 20 years increases reliance on, and cost of supplemental utility purchase. Strategy 3 of the Utility Development Plan evaluates expanding the existing cogeneration process.

Proposed Process
Strategy 3a and 3b of the Utility Development Plan evaluated expansion of the current coal fired cogeneration system. A description of the components included in this initial concept follows.

A new stand alone plant structure would be constructed to the west of the existing plant. New subterranean utilidors would connect the plants and provide a route for utility piping. The new structure would house a new boiler of either 100,000#/hr (3a.) or 150,000#/hr (3b.) capacity and a steam turbine generator of either 10 MW (3a.) or 20 MW (3b).

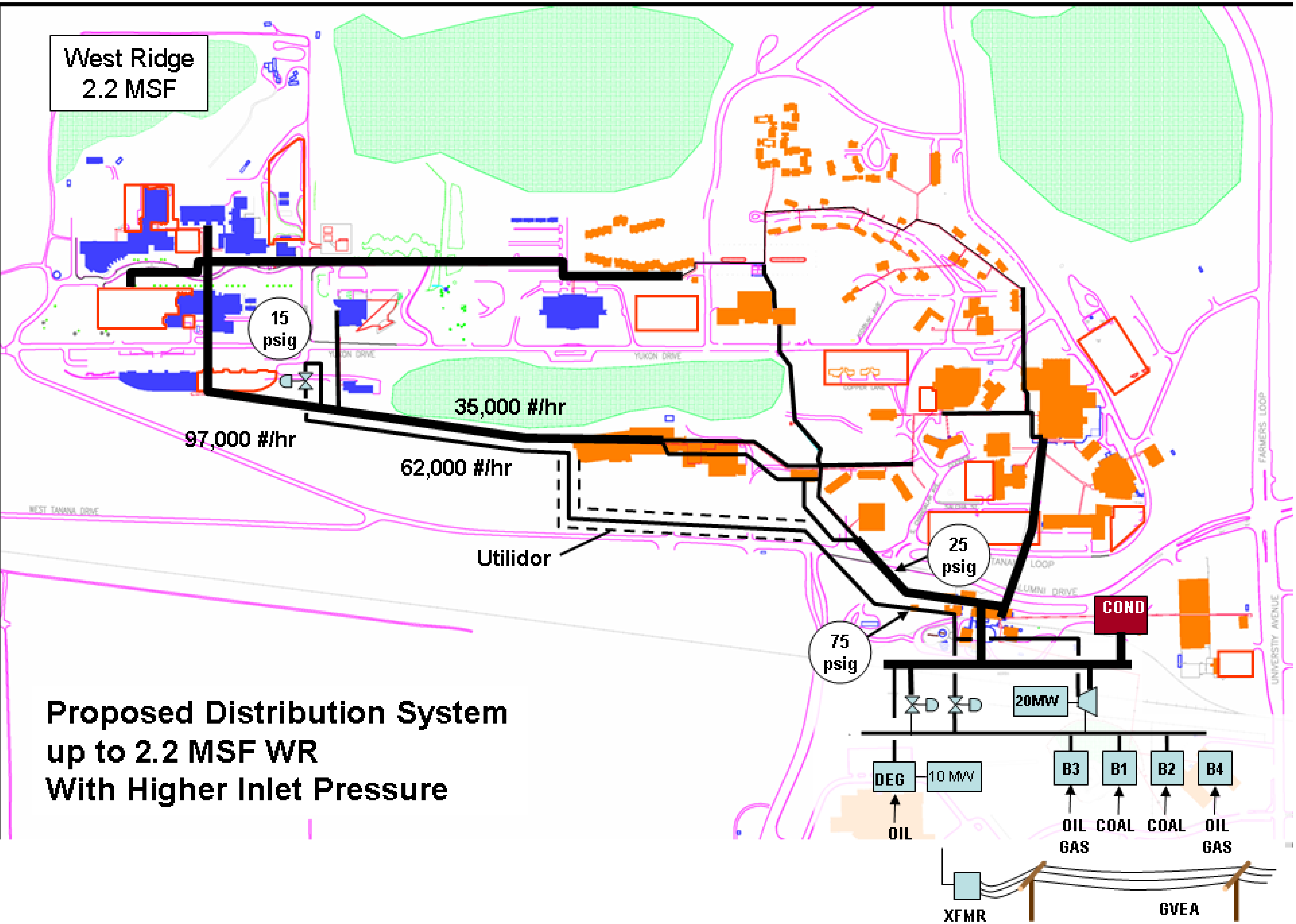
The pressure and temperature rating of boiler unit would match existing coal boilers, allowing parallel operation of a single high pressure header. Stoker grate type boilers were considered as the proposed capacity is considered to be at the low end of fluidized bed boiler technology. The boiler package includes economizer, air heater, flues, fans, soot blowers, instruments and all other auxiliaries to make the unit efficient and safe. Although the boiler "package" would be purchased from a single vendor, it is anticipated that unit would largely be field erected with components shipped to site.

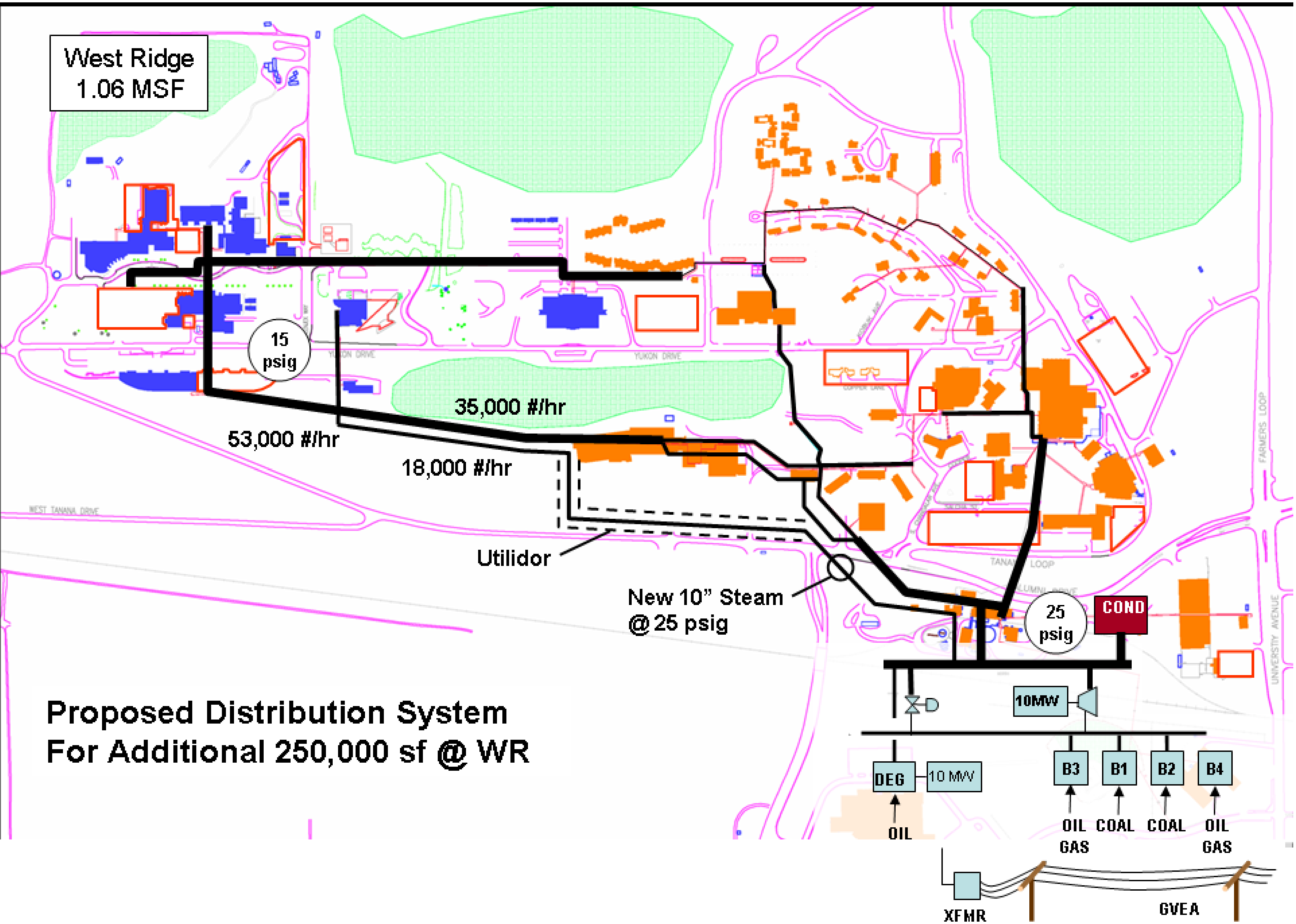
A new steam turbine would be housed in the new plant structure. This unit would be similar to the existing multi-stage extraction turbine, with the exception that an additional port, or ports would be installed to allow medium pressure extraction at high levels. This will solve impending steam line capacity problems as heating loads on the West Ridge increase. This unit will include current technology controls and a new generator. Installation of a larger unit (20 MW) under option 3b has some advantages to simplicity of operation. A new air cooled condenser is included. Because of physical constraints, the new condensers are show to be located adjacent to the new plant, well west of the existing units. If the project were to go forward, consideration could be given to installing an evaporative cooling condenser, for use in summer months for efficient operation when icing and ice fog are not an issue.

Other significant costs factored in the Strategy 3 estimate include new steam system auxiliaries-feedwater pumps, piping, controls, plant auxiliary electrical power, and plumbing. A new coal conveyor is included as is a new bag house, new ash handling system and ash storage silo.

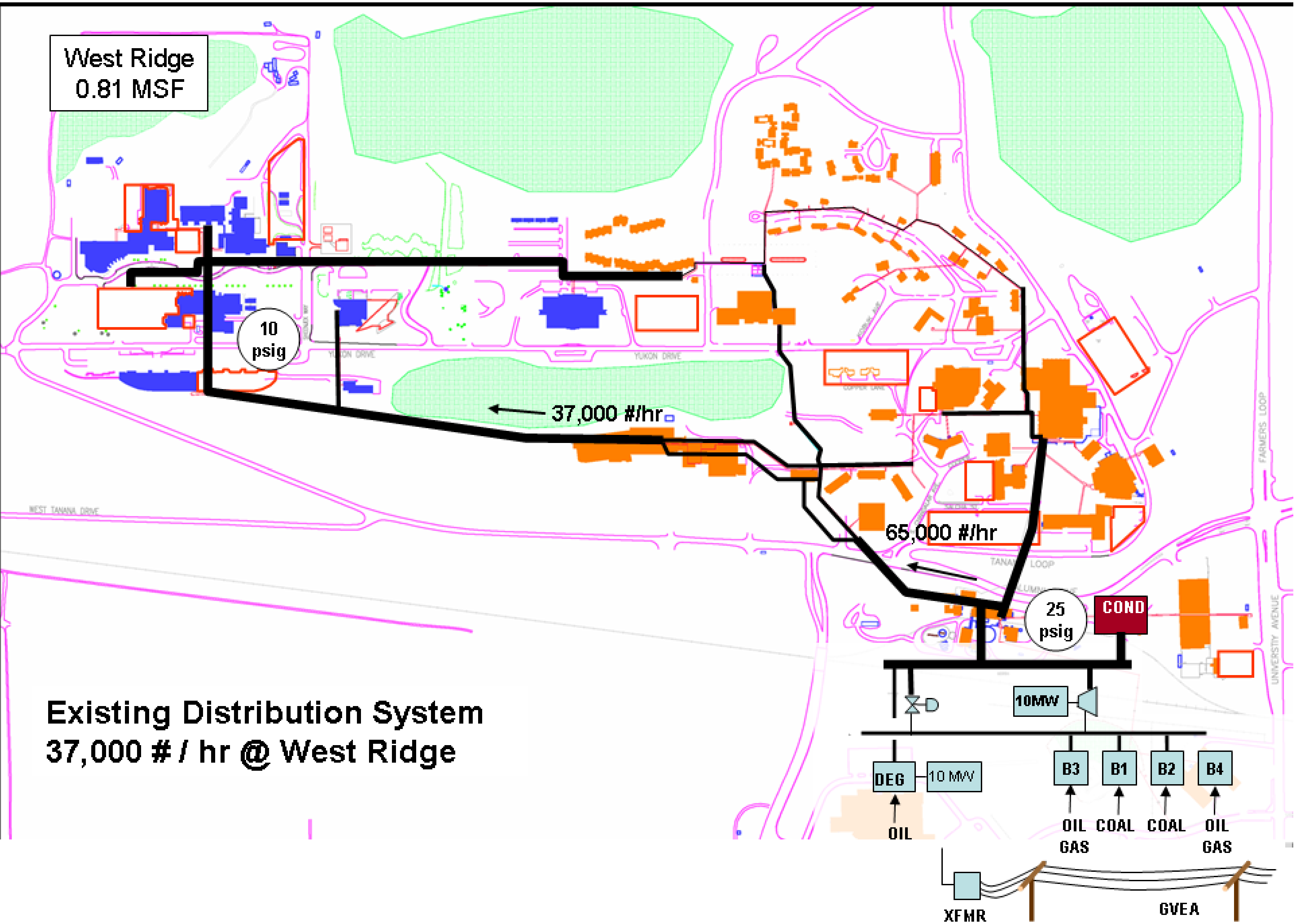
Accuracy of Estimate
The project costs developed for the Utility Development Plan long term economic modeling purposes are of a first order level of accuracy. Competitive bidding is likely to provide lower prices for the major equipment than the budgetary numbers provided by vendors for the UDP. A significant design and construction period contingency factor is included in the estimates, along with handling and project management mark ups factors. The Utility Development Plan cost estimates are intended to err on the side of the conservative so as not to paint an overly optimistic outcome.

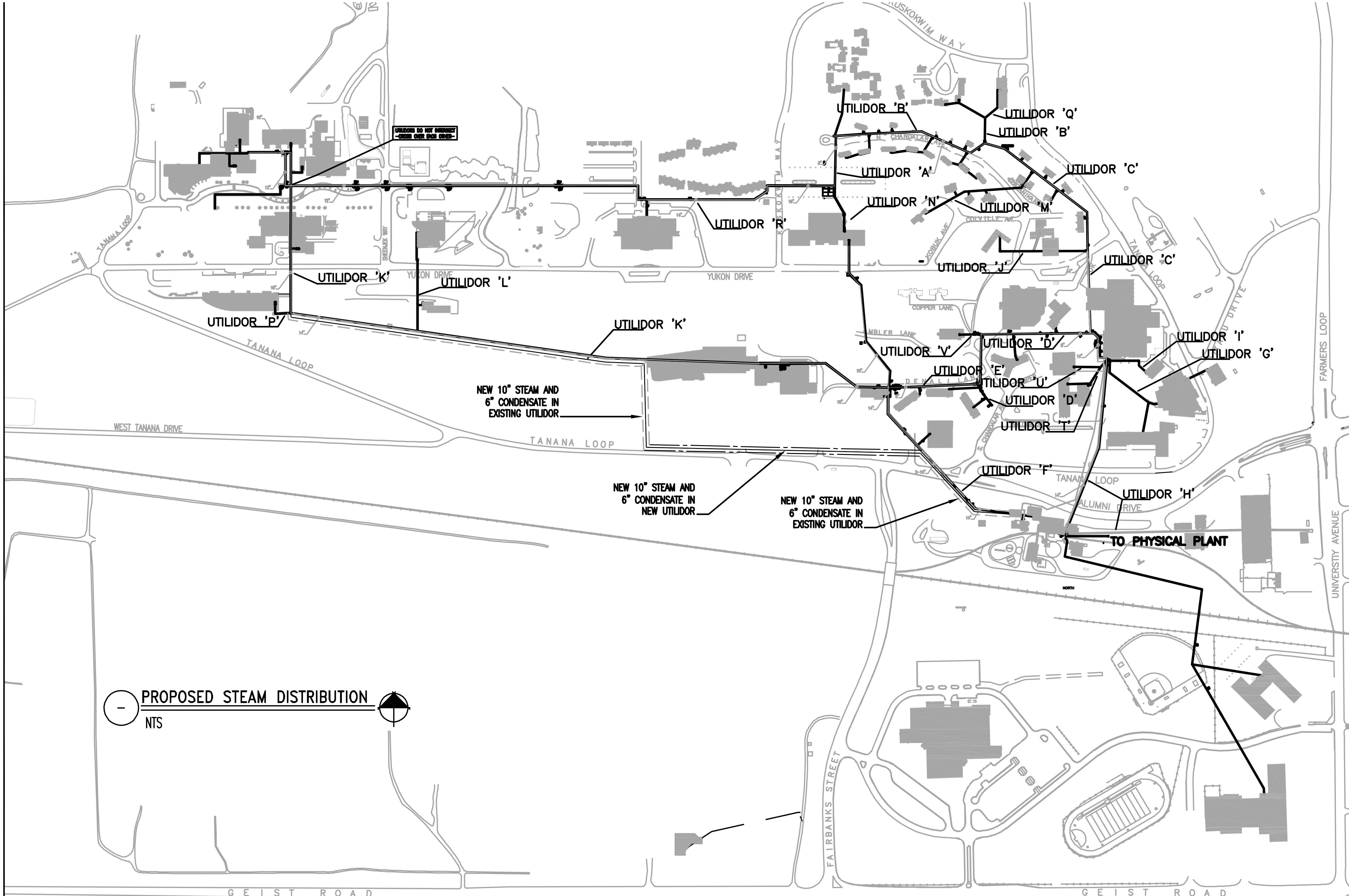
Recommendation of Developing Conceptual Design
An early step in further developing Strategy 3 would be preparation of a more thorough concept design. This would include a site assessment study to identify the most efficient location and layout of the plant. A cohesive and logical site plan showing topology, material haul routes, circulation and clearances to existing facilities would result. A more sophisticated mass flow computation would better tie down cogeneration equipment capacities and enable development of Process Flow, Equipment Schedules, and General Arrangement Diagrams. A well thought out General Arrangement drawing would be the starting point of a conceptual structural diagram that identifies major spans, sections and framing. Conceptual architectural plans of the multi level plant, sample sections, exterior elevations and renderings would follow. A concept design package of this nature would be the basis of a detailed and sound construction cost estimate, perhaps done by a professional estimating firm or construction management organization. Additionally, development of the concept to this level would provide detailed information necessary to advance evaluation of the issues associated with air permitting.


West Ridge
2.2 MSF
15 psig
97,000 #/hr
35,000 #/hr
62,000 #/hr
Utilidor
25 psig
75 psig
COND
20MW
DEG
10 MW
B3
B1
B2
B4
OIL
OIL GAS
COAL
COAL
OIL GAS
XFMR
GVEA
YUKON DRIVE
WEST TANANA DRIVE
TANANA LOOP
ALUMNI DRIVE
FARMERS LOOP
UNIVERSITY AVENUE
Proposed Distribution System
up to 2.2 MSF WR
With Higher Inlet Pressure



Proposed Distribution System
For Additional 250,000 sf @ WR


West Ridge
0.81 MSF
10
psig
37,000 #/hr
65,000 #/hr
25
psig
COND
10MW
DEG
10 MW
B3
B1
B2
B4
OIL
OIL
GAS
COAL
COAL
OIL
GAS
XFMR
GVEA
YUKON DRIVE
WEST TANANA DRIVE
TANANA LOOP
FARMERS LOOP
UNIVERSITY AVENUE
Existing Distribution System
37,000 # / hr @ West Ridge



PROPOSED STEAM DISTRIBUTION

NTS

UNIVERSITY OF ALASKA FAIRBANKS

UTILITY DEVELOPMENT BUSINESS PLAN

PROPOSED STEAM DISTRIBUTION

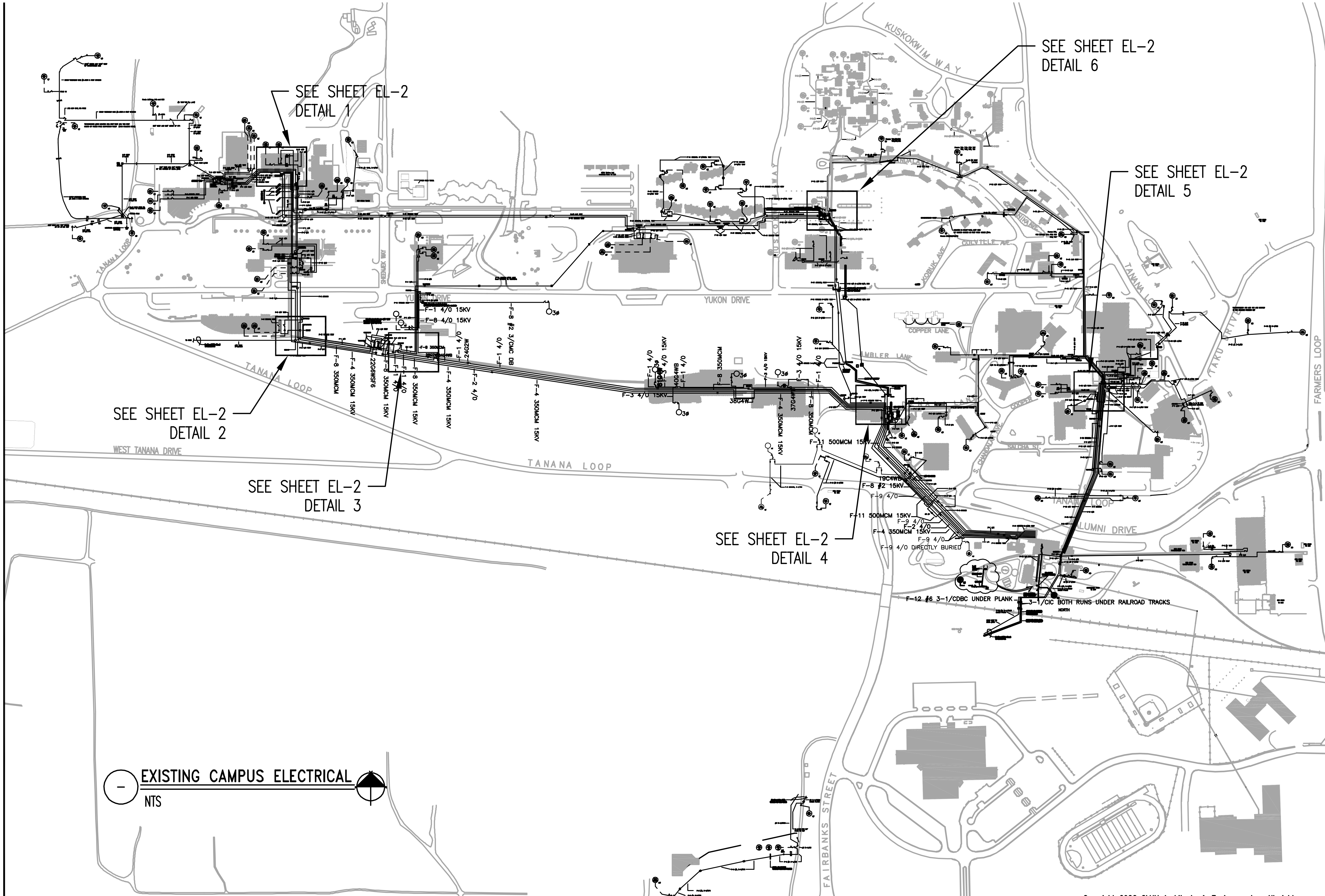
GLHN ARCHITECTS & ENGINEERS, INC.

2939 E. BROADWAY, TUCSON, ARIZONA 85716

PROJ. NO.	0537.00
DESIGNED BY:	HWJ
DRAWN BY:	PMF
CHECKED BY:	HWJ
DATE:	07/24/06
REVISIONS	

ST–1

XREF:
PLOT SCALE =
DATE
FILE



UNIVERSITY OF ALASKA FAIRBANKS

UTILITY DEVELOPMENT BUSINESS PLAN

EXISTING CAMPUS ELECTRICAL

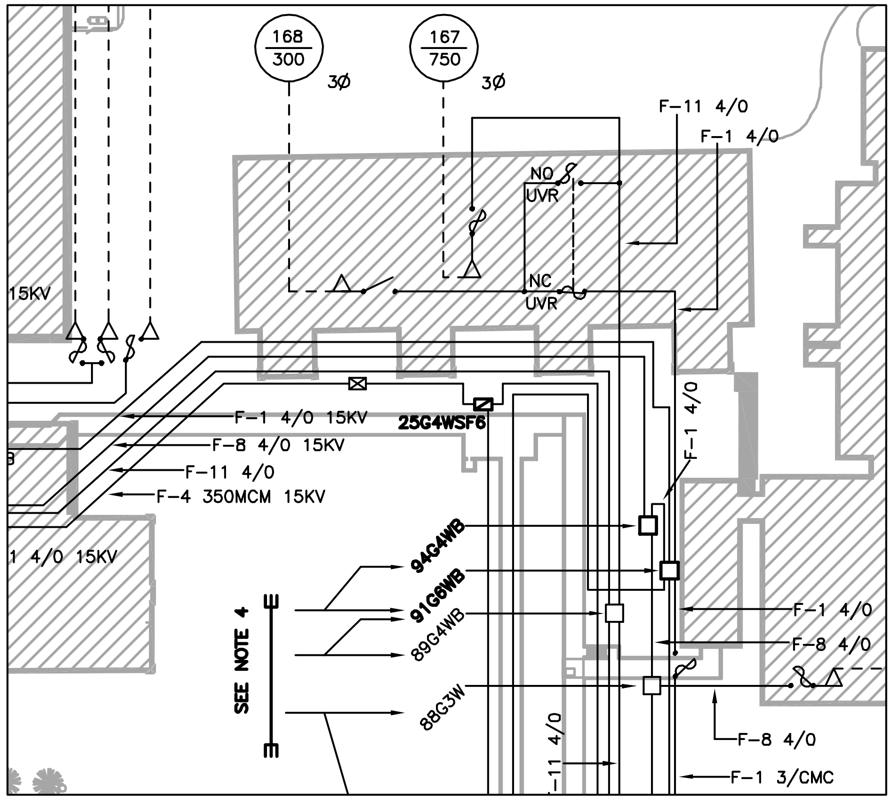
GLHN ARCHITECTS & ENGINEERS, INC.

2939 E. BROADWAY, TUCSON, ARIZONA 85716

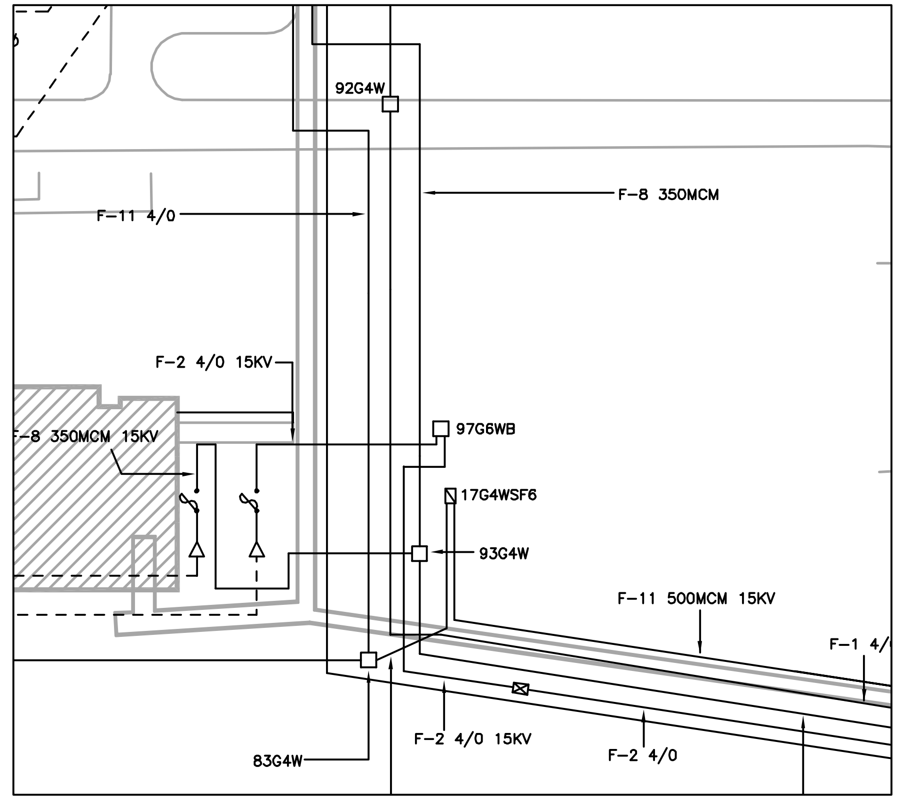
PROJ. NO.	0537.00
DESIGNED BY:	HWJ
DRAWN BY:	PMF
CHECKED BY:	HWJ
DATE:	07/24/06
REVISIONS	

EL-1

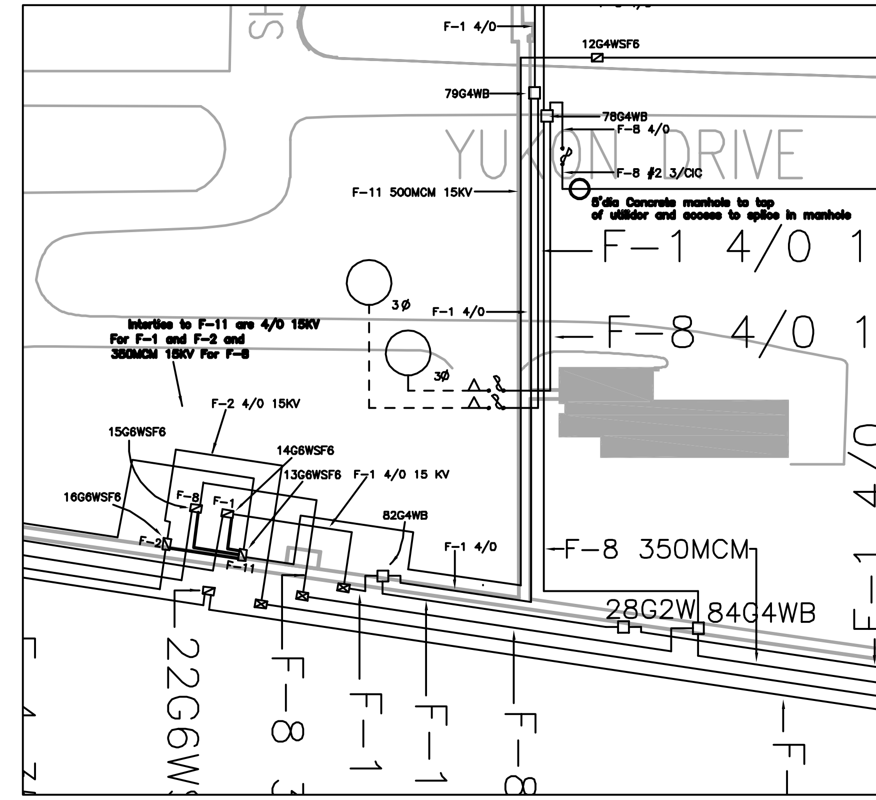
XREF:
PLOT SCALE =
DATE
FILE



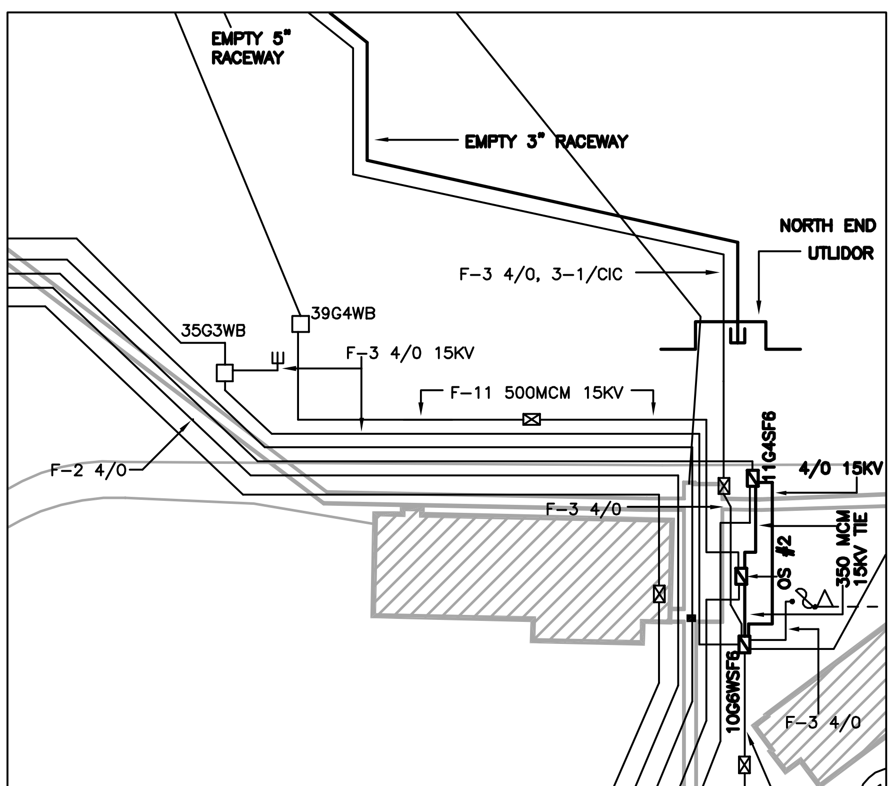
1 ENLARGED VIEW
NTS



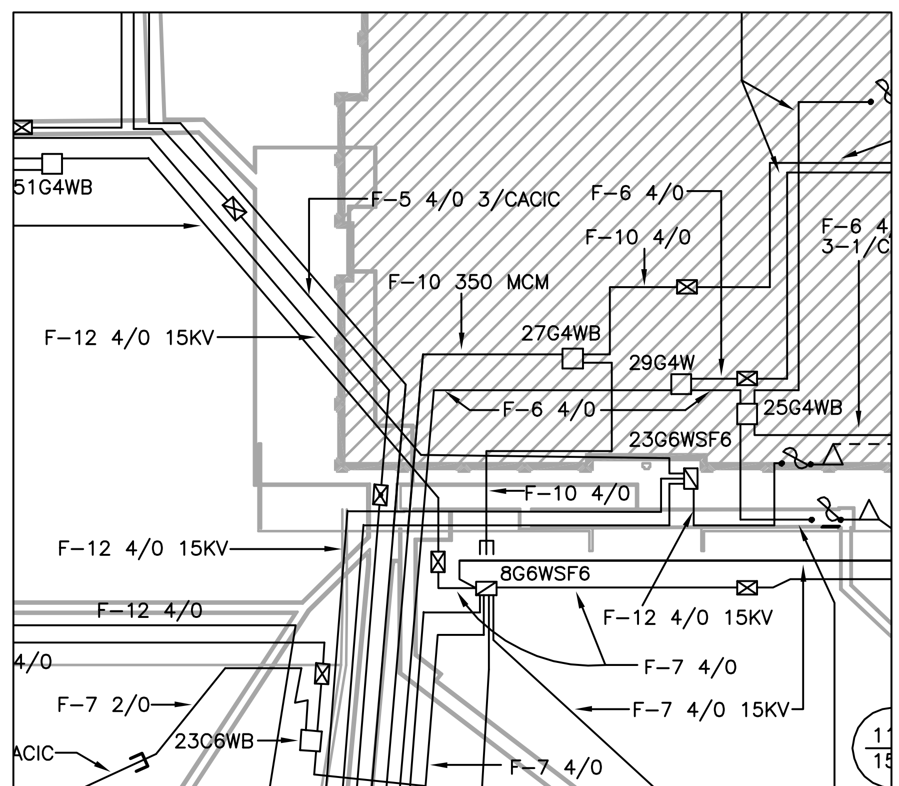
2 ENLARGED VIEW
NTS



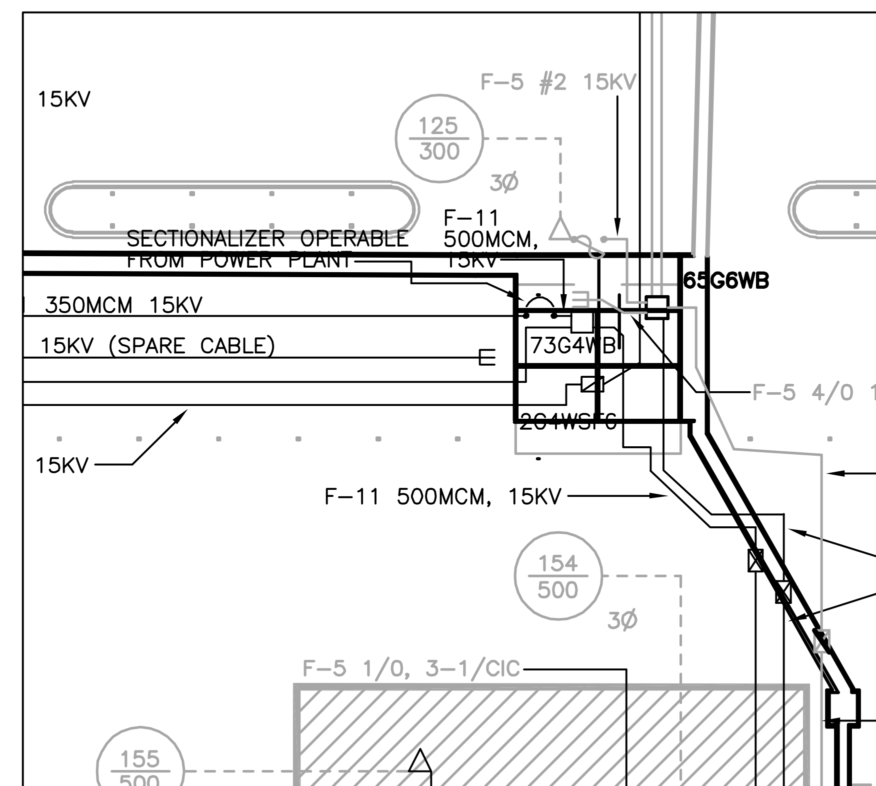
3 ENLARGED VIEW
NTS



4 ENLARGED VIEW
NTS



5 ENLARGED VIEW
NTS



6 ENLARGED VIEW
NTS

UNIVERSITY OF ALASKA FAIRBANKS
UTILITY DEVELOPMENT BUSINESS PLAN
ENLARGED VIEWS

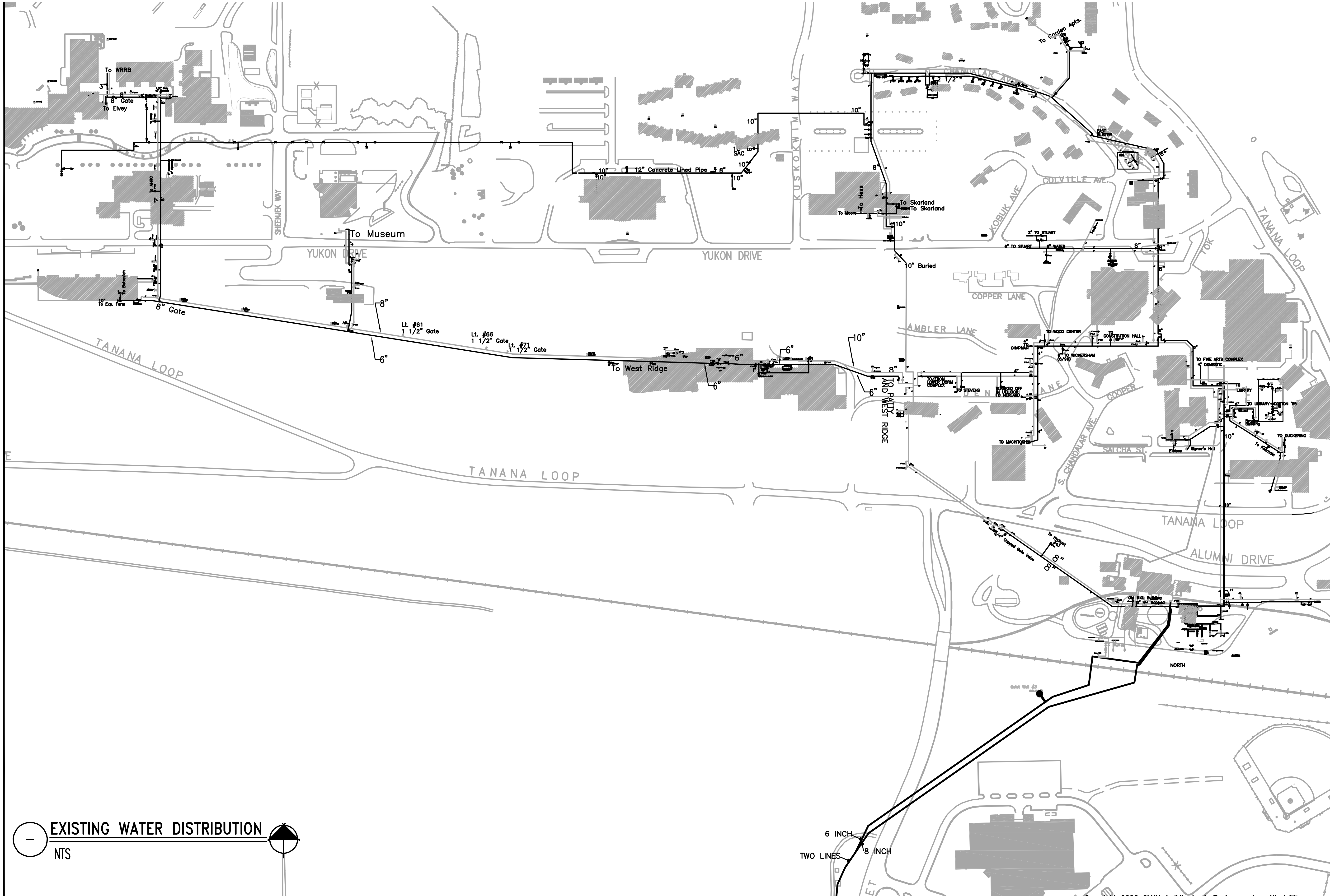
UAF UNIVERSITY OF ALASKA FAIRBANKS

GLHN ARCHITECTS & ENGINEERS, INC.
2939 E. BROADWAY, TUCSON, ARIZONA 85716

PROJ. NO.	0537.00
DESIGNED BY:	HWJ
DRAWN BY:	PMF
CHECKED BY:	HWJ
DATE:	07/24/06
REVISIONS	

EL-2

XREF:
PLOT SCALE =
DATE
FILE



EXISTING WATER DISTRIBUTION

NTS

XREF:
PLOT SCALE =
DATE
FILE

UNIVERSITY OF ALASKA FAIRBANKS

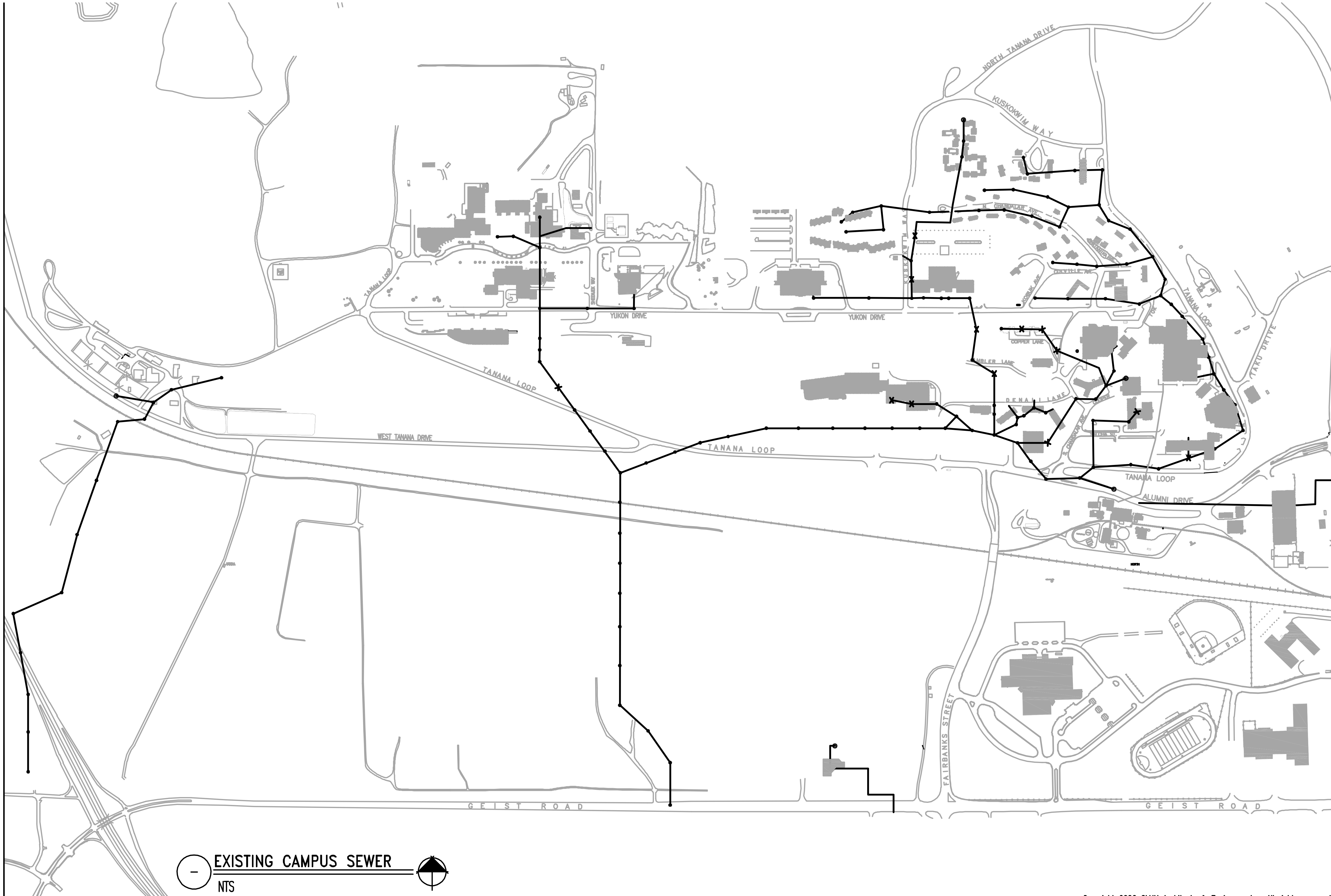
UTILITY DEVELOPMENT BUSINESS PLAN

EXISTING WATER DISTRIBUTION

GLHN
ARCHITECTS & ENGINEERS, INC.
2939 E. BROADWAY, TUCSON, ARIZONA 85716

PROJ. NO.	0537.00
DESIGNED BY:	HWJ
DRAWN BY:	PMF
CHECKED BY:	HWJ
DATE:	07/24/06
REVISIONS	

WA-1



EXISTING CAMPUS SEWER

NTS

UNIVERSITY OF ALASKA FAIRBANKS

UTILITY DEVELOPMENT BUSINESS PLAN

EXISTING CAMPUS SEWER

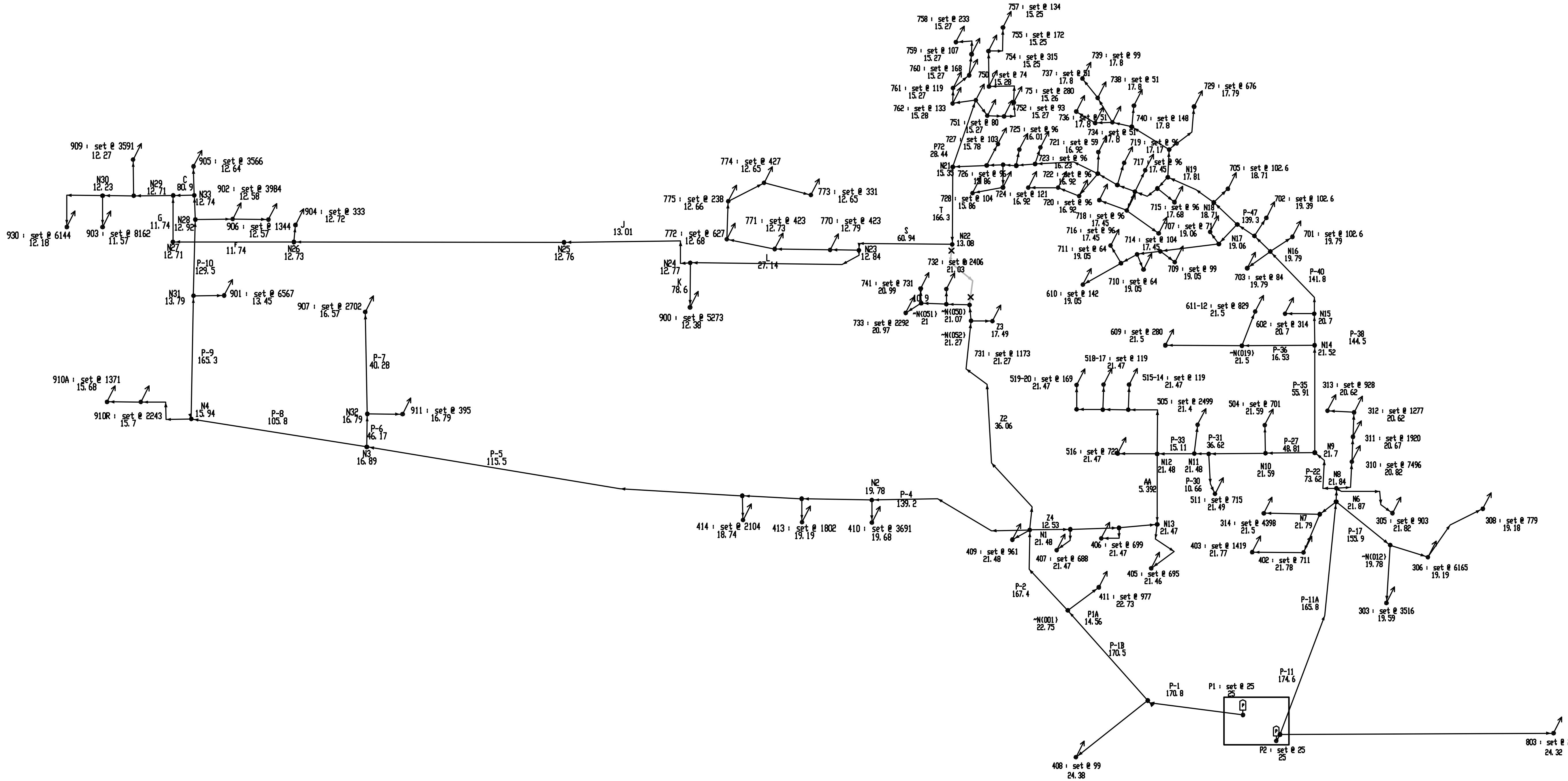
GLHN ARCHITECTS & ENGINEERS, INC.

2939 E. BROADWAY, TUCSON, ARIZONA 85716

PROJ. NO.	0537.00
DESIGNED BY:	HWJ
DRAWN BY:	PMF
CHECKED BY:	HWJ
DATE:	07/24/06
REVISIONS	

SW-1

XREF:
PLOT SCALE =
DATE
FILE



System:	UAF	PIPE-FLO 2005	01/18/06 11:16 am
Lineup:	Lineup(1)	Pipes:	ft/sec
Company:	GLHN Architects & Engineers, INC	Nodes:	psi g
Project:		Pumps:	ft
by:		Components:	psi
		Controls:	psi
		Level:	ft

XREF:
PLOT SCALE =
DATE
FILE

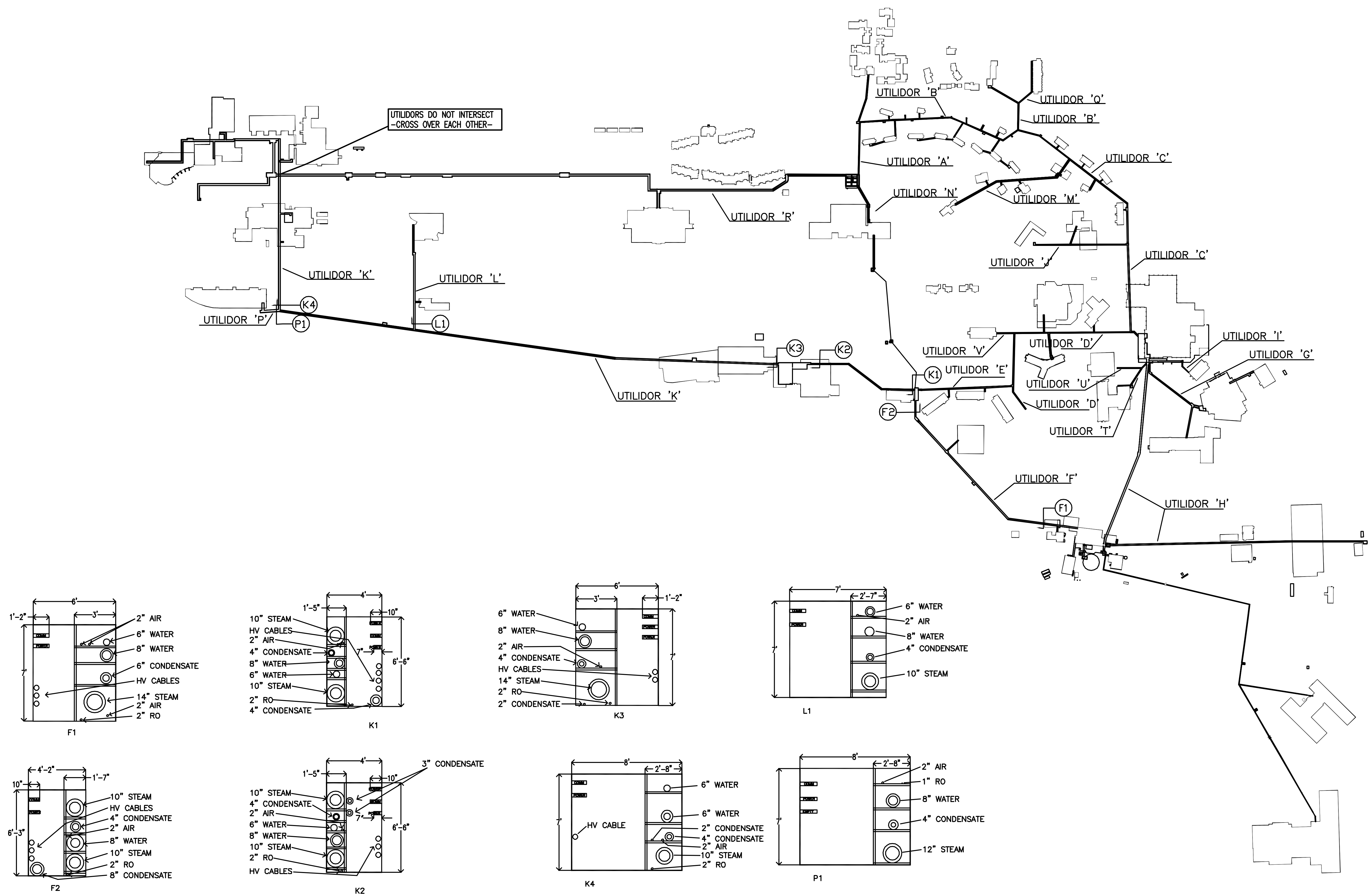
UNIVERSITY OF ALASKA FAIRBANKS
UTILITY DEVELOPMENT BUSINESS PLAN
UAF EXISTING STEAM NODE NETWORK

UNIVERSITY OF ALASKA FAIRBANKS

GLHN
ARCHITECTS & ENGINEERS, INC.
2939 E. BROADWAY, TUCSON, ARIZONA 85716

PROJ. NO.	0537.00
DESIGNED BY:	HWJ
DRAWN BY:	MEM
CHECKED BY:	HWJ
DATE:	07/24/06
REVISIONS	

MSK-1



XREF:
PLOT SCALE =
DATE
FILE

UNIVERSITY OF ALASKA FAIRBANKS
UTILITY DEVELOPMENT BUSINESS PLAN
EXISTING UTILIDOR LAYOUT AND CROSS SECTION

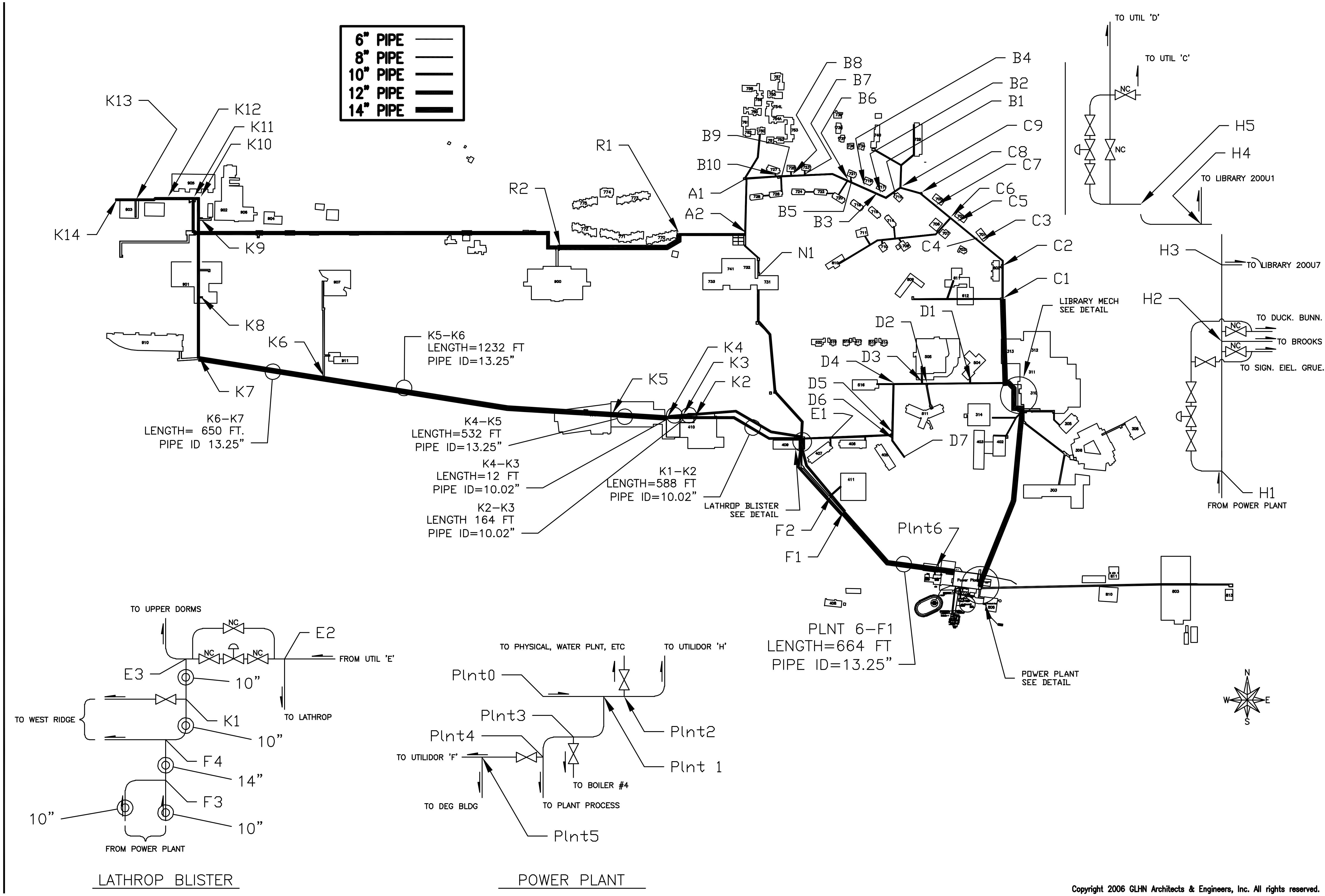
UNIVERSITY OF ALASKA FAIRBANKS

GLHN ARCHITECTS & ENGINEERS, INC.
2939 E. BROADWAY, TUCSON, ARIZONA 85716 (520)881-4546

PROJ. NO.	0537.00
DESIGNED BY:	HWJ
DRAWN BY:	MEM
CHECKED BY:	HWJ
DATE:	07/24/06
REVISIONS	

MSK-2

UAF CAMPUS DISTRIBUTION STEAM NETWORK
-LOCATION OF NETWORK NODES-



UNIVERSITY OF ALASKA FAIRBANKS

UTILITY DEVELOPMENT BUSINESS PLAN

UAF EXISTING CAMPUS STEAM DISTRIBUTION

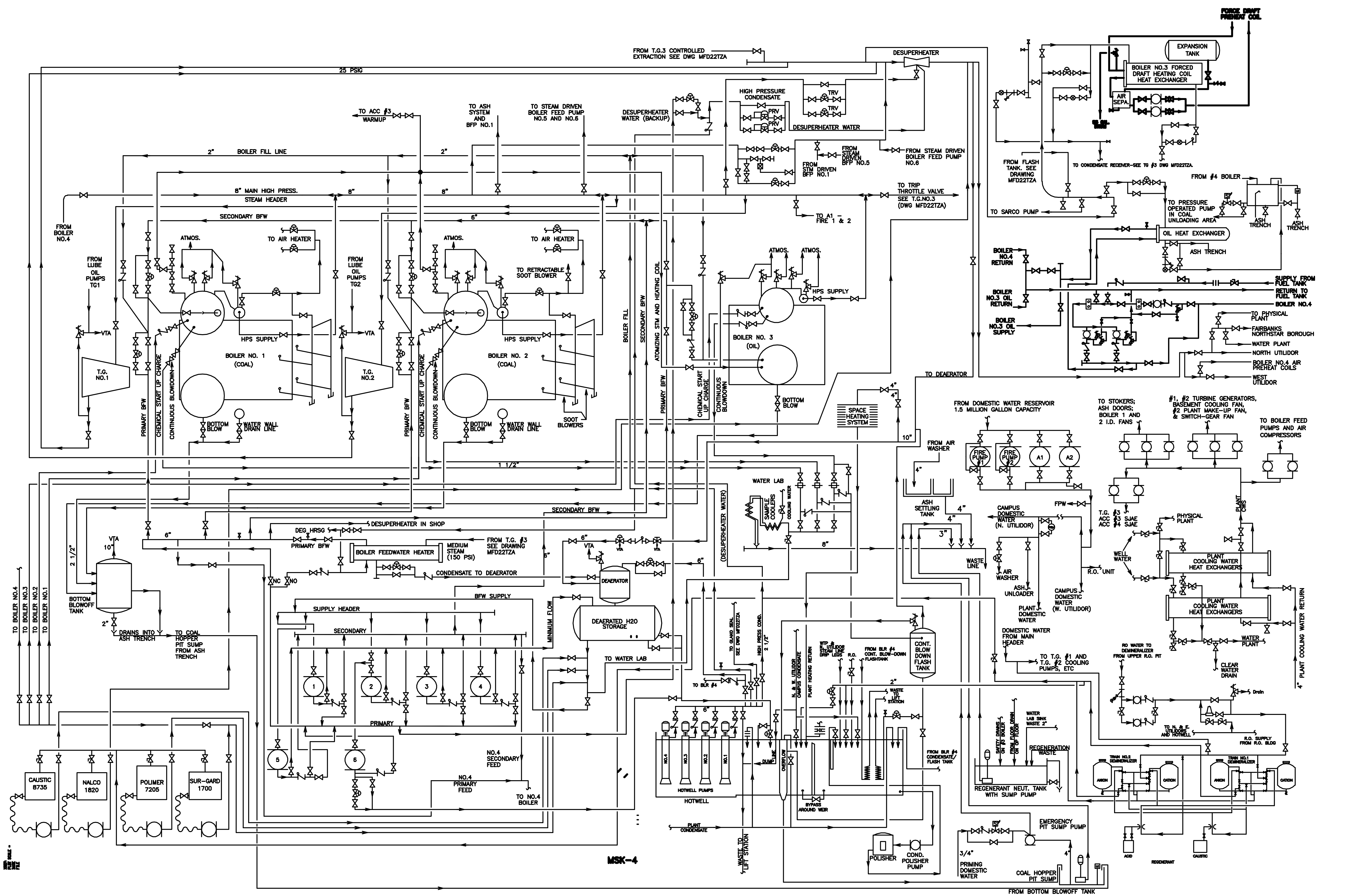
GLHN ARCHITECTS & ENGINEERS, INC.

2939 E. BROADWAY, TUCSON, ARIZONA 85716

PROJ. NO.	0537.00
DESIGNED BY:	HWJ
DRAWN BY:	MEM
CHECKED BY:	HWJ
DATE:	07/24/06
REVISIONS	

MSK-3

XREF:
PLOT SCALE =
DATE
FILE



UNIVERSITY OF ALASKA FAIRBANKS

UTILITY DEVELOPMENT BUSINESS PLAN

EXISTING PIPING AND INSTRUMENTATION DIAGRAM

UNIVERSITY OF ALASKA FAIRBANKS

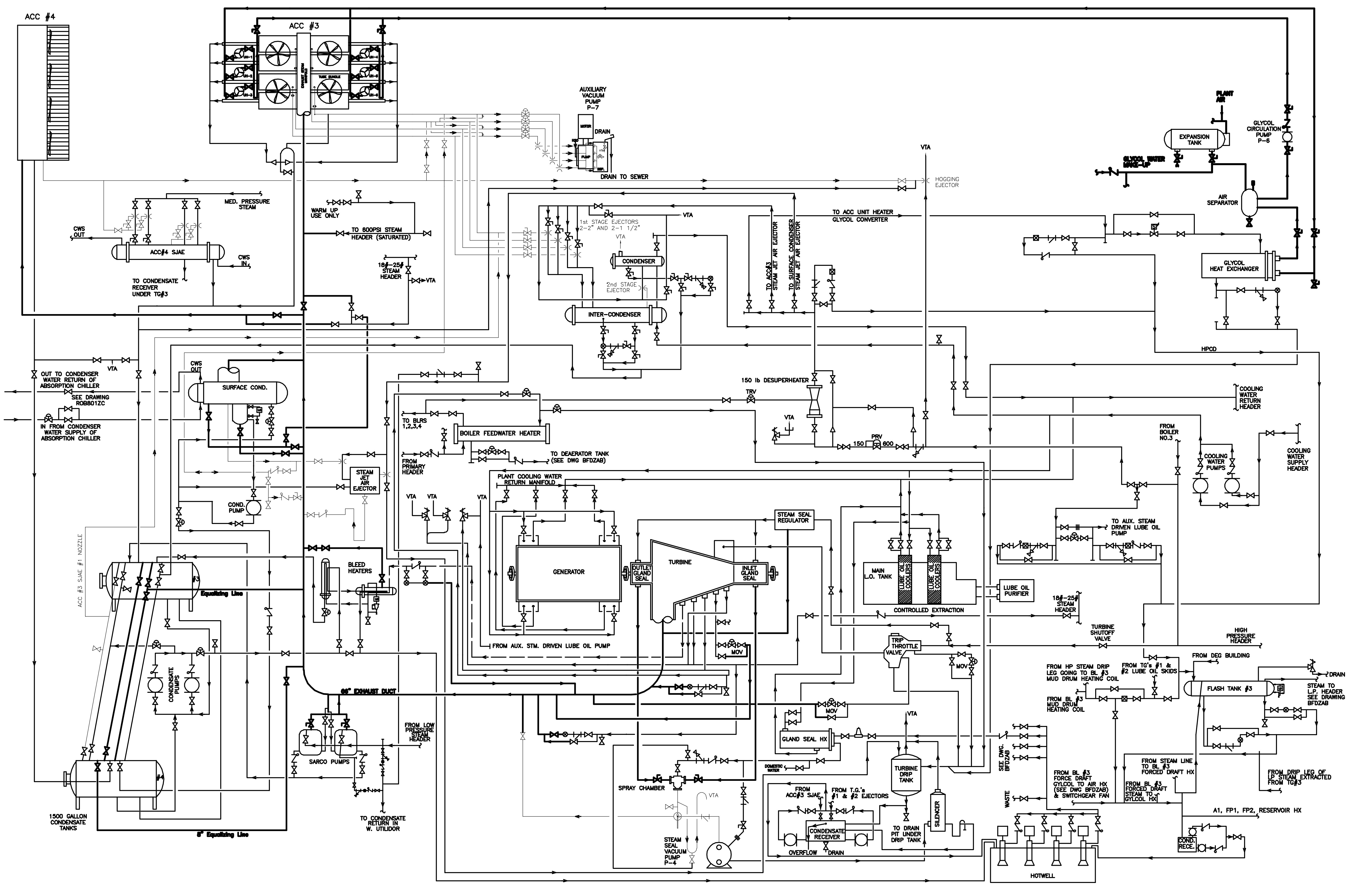
GLHN ARCHITECTS & ENGINEERS, INC.

2939 E. BROADWAY, TUCSON, ARIZONA 85716 (520)881-4546

PROJ. NO.	0537.00
DESIGNED BY:	HMJ
DRAWN BY:	MEM
CHECKED BY:	HMJ
DATE:	07/24/06
REVISIONS	

MSK-4

XREF:
PLOT SCALE =
DATE
FILE



UNIVERSITY OF ALASKA FAIRBANKS

UTILITY DEVELOPMENT BUSINESS PLAN

EXISTING PIPING AN INSTRUMENTATION DIAGRAM

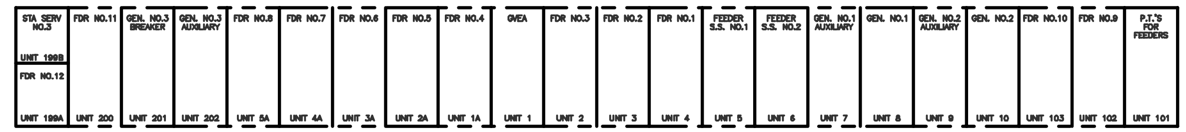
GLHN ARCHITECTS & ENGINEERS, INC.

2939 E. BROADWAY, TUCSON, ARIZONA 85716

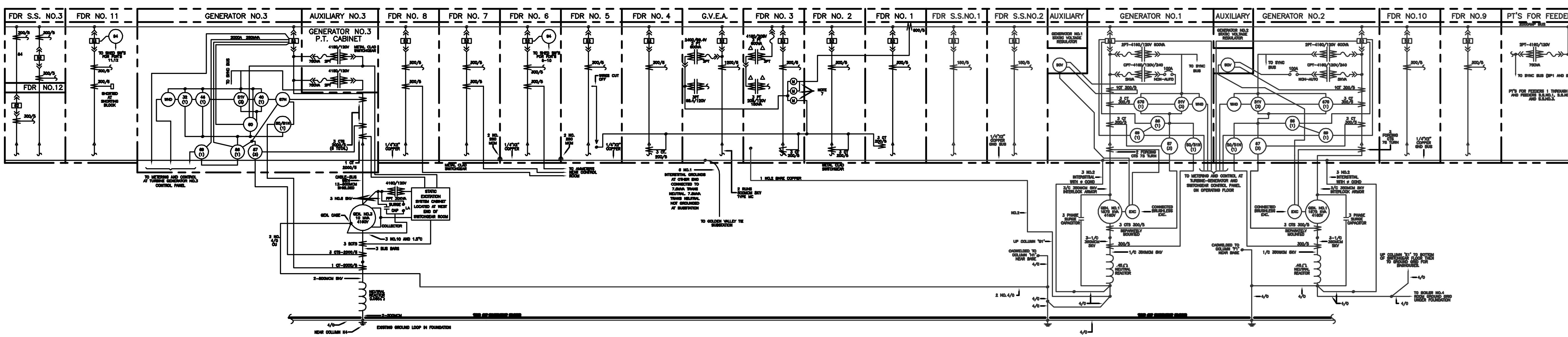
PROJ. NO.	0537.00
DESIGNED BY:	HMJ
DRAWN BY:	MEM
CHECKED BY:	HMJ
DATE:	07/24/06
REVISIONS	

MSK-5

XREF:
PLOT SCALE =
DATE
FILE



NORTH ELEVATION OF UAF POWER PLANT 4160V SWITCHGEAR (FRONT VIEW)
(NO SCALE)



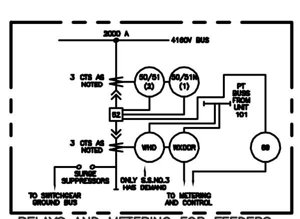
4160V ELECTRICAL ONE LINE DIAGRAM FOR UAF POWER PLANT
(NO SCALE)

NOTES :

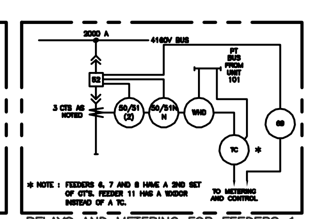
1) THE 4160V DISTRIBUTION HAS A SHED SYSTEM. EACH NUMBERED FEEDER (1 THROUGH 12) CAN BE SELECTED TO SHED OR HOLD WHEN THE G.V.E.A. BREAKER TRIPS. FEEDERS MAY ALSO BE SELECTED TO SHED FOR LOW FREQUENCY CONDITION WHICH IS MONITORED BY THE L&N RECORDER. THE L&N RECORDER HAS A SHED OUTPUT FOR FREQUENCIES OF 57.6, 59.4 AND 59.2 HERTZ. SHED SWITCHES ARE AT THE CONTROL ROOM.
2) WHEN TURBINE GENERATOR NO.1 AND TURBINE GENERATOR NO.2 ARE PARALLELED WITH TURBINE GENERATOR NO.3 AND/OR G.V.E.A., LARGE 3RD HARMONIC CURRENTS FLOW IN THE T.G.1 AND T.G.2 NEUTRALS DUE TO THESE CURRENTS. TAP SETTING AT THE 51N FOR T.G.1 AND T.G.2 IS 2.5.
3) THE DIRECTIONAL FEATURE OF THE DIRECTIONAL OVER-CURRENT RELAY 67 FOR THE G.V.E.A. TIE IS JUMPERED OUT. THE G.V.E.A. TIE DOES NOT HAVE INSTANTANEOUS OVER-CURRENT PROTECTION, AND DOES NOT HAVE ANY OTHER OVER-CURRENT PROTECTION BETWEEN TRANSFORMER AND THE SWITCHGEAR BUS.
4) ALL 4160V BREAKERS SHOWN ARE RATED 250MVA AND 1200 AMPS UNLESS OTHERWISE NOTED. BUS BRACING MATCHES BREAKER RATING.
5) 4160V BUS IS RATED FOR 2000 AMPS. SEE TABLE FOR VARIATIONS IN BUS BAR DIMENSIONS AND MATERIAL.
6) PT'S ON FEEDER NO.3 ARE DISCONNECTED AT SECONDARY OF 208/120V PT'S. THEY USED TO BE THE PT BUS FOR FEEDERS BUT WERE REPLACED BY PT'S IN UNIT 101.
7) THE CT'S RATED 200:5 ON FEEDERS 2, 3, AND 4 ARE NO LONGER USED. THERE ARE ALSO 3 CT'S 200:5 PHYSICALLY LOCATED IN FEEDER NO.1; HOWEVER THEY HAVE NO CABLE PASSING THROUGH THEM. THERE ARE 3 METERS IN FEEDER NO.3 CABINET THAT ARE NO LONGER USED.
8) FEEDER NO.1 HAS 3 CT'S RATED 600:5 WHICH ARE INSTALLED ON THE 2000 AMP BUS, THEY ARE CONNECTED TO A NO LONGER USED NET GENERATION METER.
9) TO FIND PT RATINGS AT 55°C, MULTIPLY BY 2/3. WORST CASE AMBIENT IS APPROXIMATELY 35°C. MULTIPLY RATINGS ON DRAWING BY .93 TO GET ACTUAL RATING AT 35°C.
10) METERING DEVICES ARE ONLY USED IN TWO OF THE THREE PHASES. A BALANCED THREE PHASE LOAD IS ASSUMED ALTHOUGH THE LOADS ARE NOT TRULY BALANCED.
11) CABLE BUS CONDUCTORS FOR GENERATOR NO.3 ARE SHIELDED WITH SHIELDS CONNECTED TO THE CABLE BUS ENCLOSURE AT THE GENERATOR END. THE SHIELDS ARE CONNECTED TO THE SWITCHGEAR GROUND BUS AT THE SWITCHGEAR END.
12) THE SWITCHGEAR GROUND BUS IS 1/4"X2" COPPER RUNNING THE ENTIRE LENGTH OF THE SWITCHGEAR LINEUP, UNLESS OTHERWISE NOTED.
13) ALL CONDUCTORS ARE COPPER.

LEGEND

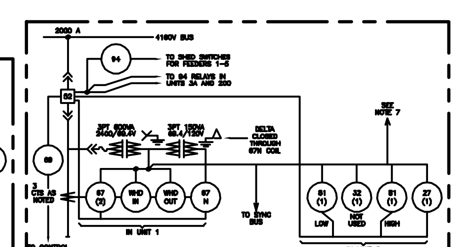
- 52 — DRAW OUT AIR BREAK OR VACUUM BREAK POWER CIRCUIT BREAKER. ANSI/IEEE DEVICE NO.52. ONLY FDR 12 AND FDR S.S.3 HAVE VACUUM BREAK.
- POTENTIAL TRANSFORMER (PT) OR CONTROL POWER TRANSFORMER (CPT). VA FOR PT'S GIVEN AT 30°C.
- PLUG-IN OR DRAW-OUT CONNECTION
- FUSE
- VA — VOLT-AMPERES
- WHD — WATT HOUR METER WITH DEMAND
- 51 (3) — ANSI/IEEE DEVICE NO.51, QUANTITY OF DEVICES IN PARENTHESIS. AN "N" IN THE CIRCLE MEANS A DEVICE USED FOR GROUND/NEUTRAL CURRENT DETECTION.
- AM — AMMETER
- TC — THERMO CONVERTER
- FDR — FEEDER
- S.S.NO.1 — STATION SERVICE NUMBER ONE
- WXDCR — WATT TRANSDUCER
- M — METER
- CURRENT TRANSFORMER
- LA LIGHTNING ARRESTOR



RELAYS AND METERING FOR FEEDERS NO.12 AND STATION SERVICE NO.3
(NO SCALE)



RELAYS AND METERING FOR FEEDERS 1 THROUGH 11, S.S.NO.1 AND S.S.NO.2
(NO SCALE)



RELAYS AND METERING FOR G.V.E.A. TIE
(NO SCALE)

UNIT #	DESIGNATION	PURCH YEAR	BUS, BARS	PT'S / PT CONNECTION	PT RATIO	GE REQ NO.	GE SUM NO.	GE SHOP ORDER NO.	GE CUSTOMER ORDER NO.	REMARKS
1	GVEA TIE	1963	5/8" X 6" AL	3 OF 600VA, 3 OF 150VA	35:1 TO 0.578	471-96442	PHILADELPHIA 0172A2602	E90862	GESCO FOR GRASLE 7741-54140-D	81 LOW, 27, AND 32 ADDED 1966 81 HIGH ADDED 1983 P.O. 72246 BRKR CHANGED FROM 150MVA TO 250MVA 1980 SUM 0287A9406
1A	FEEDER 4	1963	5/8" X 6" AL	FROM UNIT 101		471-59038	PHILADELPHIA 0172A6058	E91739	GESCO FOR UAF 7741-55462-D	BREAKER CHANGED FROM 150MVA TO 250MVA 1980 SUM 0287A9406
2	FEEDER 3	1963	5/8" X 6" AL	FROM UNIT 101	SPARE PT'S IN CUBICLE	471-96442	PHILADELPHIA 0172A2602	E90862	GESCO FOR GRASLE 7741-54140-D	BREAKER CHANGED FROM 150MVA TO 250MVA 1980 SUM 0287A9406
2A	FEEDER 5	1963	5/8" X 6" AL	FROM UNIT 101		471-59038	PHILADELPHIA 0172A6058	E91739	GESCO FOR UAF 7741-55462-D	BREAKER CHANGED FROM 150MVA TO 250MVA 1980 SUM 0287A9406
3	FEEDER 2	1963	5/8" X 6" AL	FROM UNIT 101		471-96442	PHILADELPHIA 0172A2602	E90862	GESCO FOR GRASLE 7741-54140-D	BREAKER CHANGED FROM 150MVA TO 250MVA 1980 SUM 0287A9406
4	FEEDER 1	1963	5/8" X 6" AL	FROM UNIT 101		471-96442	PHILADELPHIA 0172A2602	E90862	GESCO FOR GRASLE 7741-54140-D	BREAKER CHANGED FROM 150MVA TO 250MVA 1980 SUM 0287A9406
4A	FEEDER 7	1970	5/8" X 6" AL	FROM UNIT 101		438-12134	PHILADELPHIA 0224A6933	950229	GESCO FOR UAF 7731-5794-D	
5	STA. SERV. 1	1963	5/8" X 6" AL	FROM UNIT 101		471-96442	PHILADELPHIA 0172A2602	E90862	GESCO FOR GRASLE 7741-54140-D	BREAKER CHANGED FROM 150MVA TO 250MVA 1980 SUM 0287A9406
5A	FEEDER 8	1970	5/8" X 6" AL	FROM UNIT 101		438-12134	PHILADELPHIA 0224A6933	950229	GESCO FOR UAF 7731-5794-D	
6	STA. SERV. 2	1963	5/8" X 6" AL	FROM UNIT 101		471-96442	PHILADELPHIA 0172A2602	E90862	GESCO FOR GRASLE 7741-54140-D	BREAKER CHANGED FROM 150MVA TO 250MVA 1980 SUM 0287A9406
7	GEN. 1 AUX.	1963	5/8" X 6" AL	FROM UNIT 101		471-96442	PHILADELPHIA 0172A2602	E90862	GESCO FOR GRASLE 7741-54140-D	
8	GEN. 1	1963	5/8" X 6" AL	2 OF 600VA	35:1	471-96442	PHILADELPHIA 0172A2602	E90862	GESCO FOR GRASLE 7741-54140-D	BREAKER CHANGED FROM 150MVA TO 250MVA 1980 SUM 0287A9406
9	GEN. 2 AUX.	1963	5/8" X 6" AL	FROM UNIT 101		471-96442	PHILADELPHIA 0172A2602	E90862	GESCO FOR GRASLE 7741-54140-D	
10	GEN. 2	1963	5/8" X 6" AL	2 OF 600VA	35:1	471-96442	PHILADELPHIA 0172A2602	E90862	GESCO FOR GRASLE 7741-54140-D	BREAKER CHANGED FROM 150MVA TO 250MVA 1980 SUM 0287A9406
3A	FEEDER 6	1969	1/2" X 6" CU SILVER PLATED	FROM UNIT 101		N/A	N/A	N/A	N/A	UNITED POWER AND CONTROL SYSTEMS - DWG'S AT UAF, P.O. J13731
199A	FEEDER 12	1984	1/2" X 6" CU SILVER PLATED	FROM UNIT 101		N/A	N/A	N/A	N/A	G.C.I. SYSTEMS MANUFACTURERS JOB NO.1160 FOR UAF CUSTOMER ORDER NO.103649, PROJ SPEC PVM-883-90707R
199B	STA. SERV. 3	1984	1/2" X 6" CU SILVER PLATED	FROM UNIT 101		N/A	N/A	N/A	N/A	SAME AS FEEDER NO.12, UAF P.O. 103649 FOR FDR 12 AND STATION SERVICE NO.3
101	PT'S FOR FDRS	1973	3/8" X 6" CU SILVER PLATED	2 OF 750VA	35:1	438-89077	PHILADELPHIA 0228A6836	942015	GESCO FOR UAF 7731-0064160	RELOCATED TO WEST END OF SWITCHGEAR LINE UP IN 1981
102	FEEDER 9	1973	3/8" X 6" CU SILVER PLATED	FROM UNIT 101		438-89077	PHILADELPHIA 0228A6836	942015	GESCO FOR UAF 7731-0064160	RELOCATED TO WEST END OF SWITCHGEAR LINE UP IN 1981
103	FEEDER 10	1973	3/8" X 6" CU SILVER PLATED	FROM UNIT 101		438-89077	PHILADELPHIA 0228A6836	942015	GESCO FOR UAF 7731-0064160	RELOCATED TO WEST END OF SWITCHGEAR LINE UP IN 1981
200	FEEDER 11	1981	3/8" X 6" CU SILVER PLATED	FROM UNIT 101		892-90337	BURLINGTON, IOWA 0303A8154	942657	GESCO FOR UAF	
201	TURB. GEN. 3	1980	1/2" X 6" CU SILVER PLATED	FROM AUX. CABINET		438-50118	BURLINGTON, IOWA 0295A5559	942600	F-40551	
202	TURB. GEN. 3 AUX.	1980	1/2" X 6" CU SILVER PLATED	2 OF 750VA, 2 OF 750VA	35:1, 35:1	438-50118	BURLINGTON, IOWA 0295A5559	942600	F-40551	

NOTE: As Of 06/04/90 G.E. Has Not Been Able To Find Summary No. 0295A5559 And It May Be Lost.

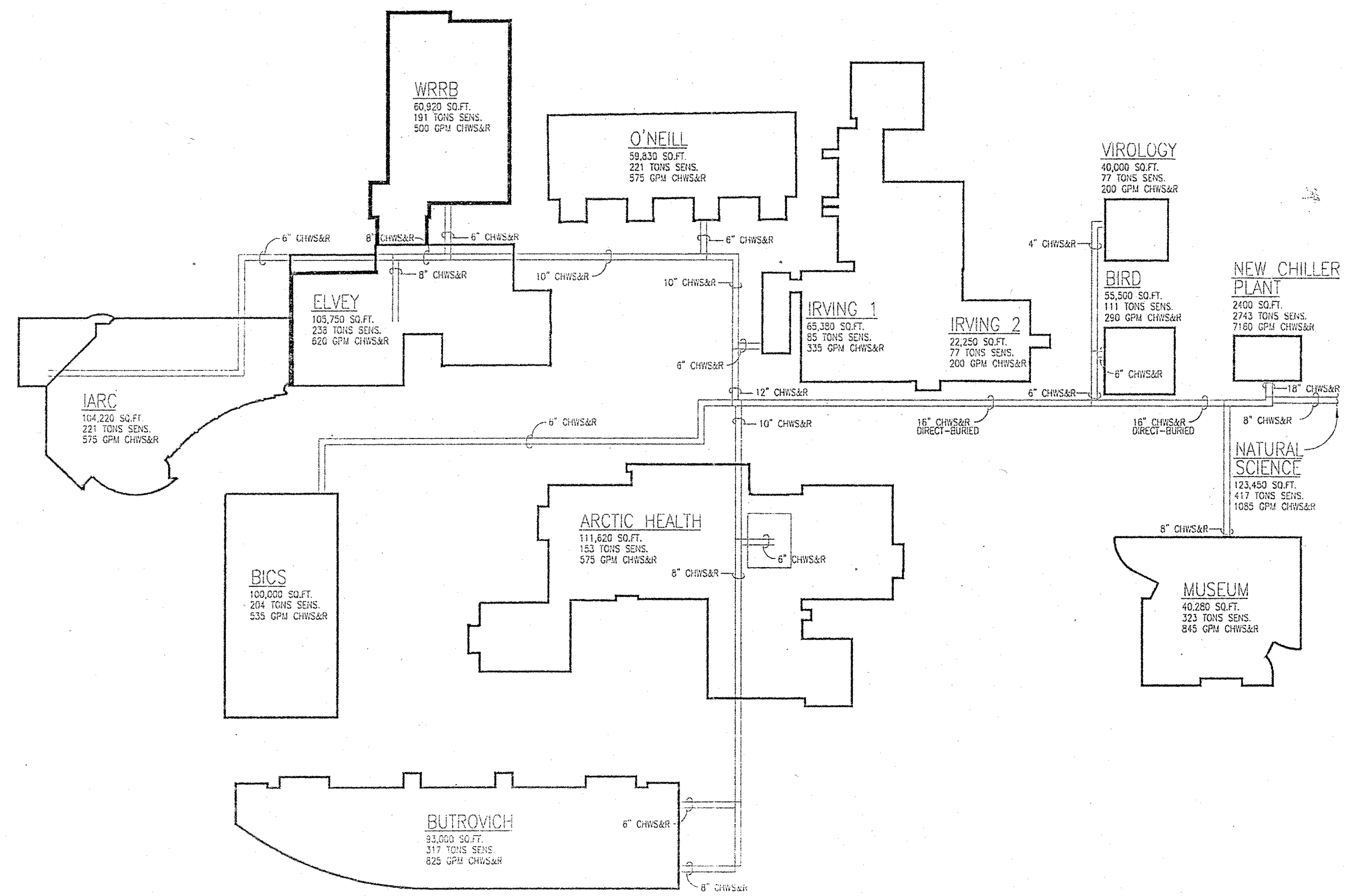
UNIVERSITY OF ALASKA FAIRBANKS
UTILITY DEVELOPMENT BUSINESS PLAN
EXISTING ELECTRICAL ONE-LINE DIAGRAM

GLHN ARCHITECTS & ENGINEERS, INC.
2939 E. BROADWAY, TUCSON, ARIZONA 85716

PROJ. NO. 0537.00
DESIGNED BY: HWJ
DRAWN BY: MEM
CHECKED BY: HWJ
DATE: 07/24/06
REVISIONS

MSK-6

XREF:
PLOT SCALE =
DATE
FILE



UNIVERSITY OF ALASKA FAIRBANKS

UTILITY DEVELOPMENT BUSINESS PLAN

PROPOSED WEST RIDGE

CHILLED WATER PIPING DIAGRAM

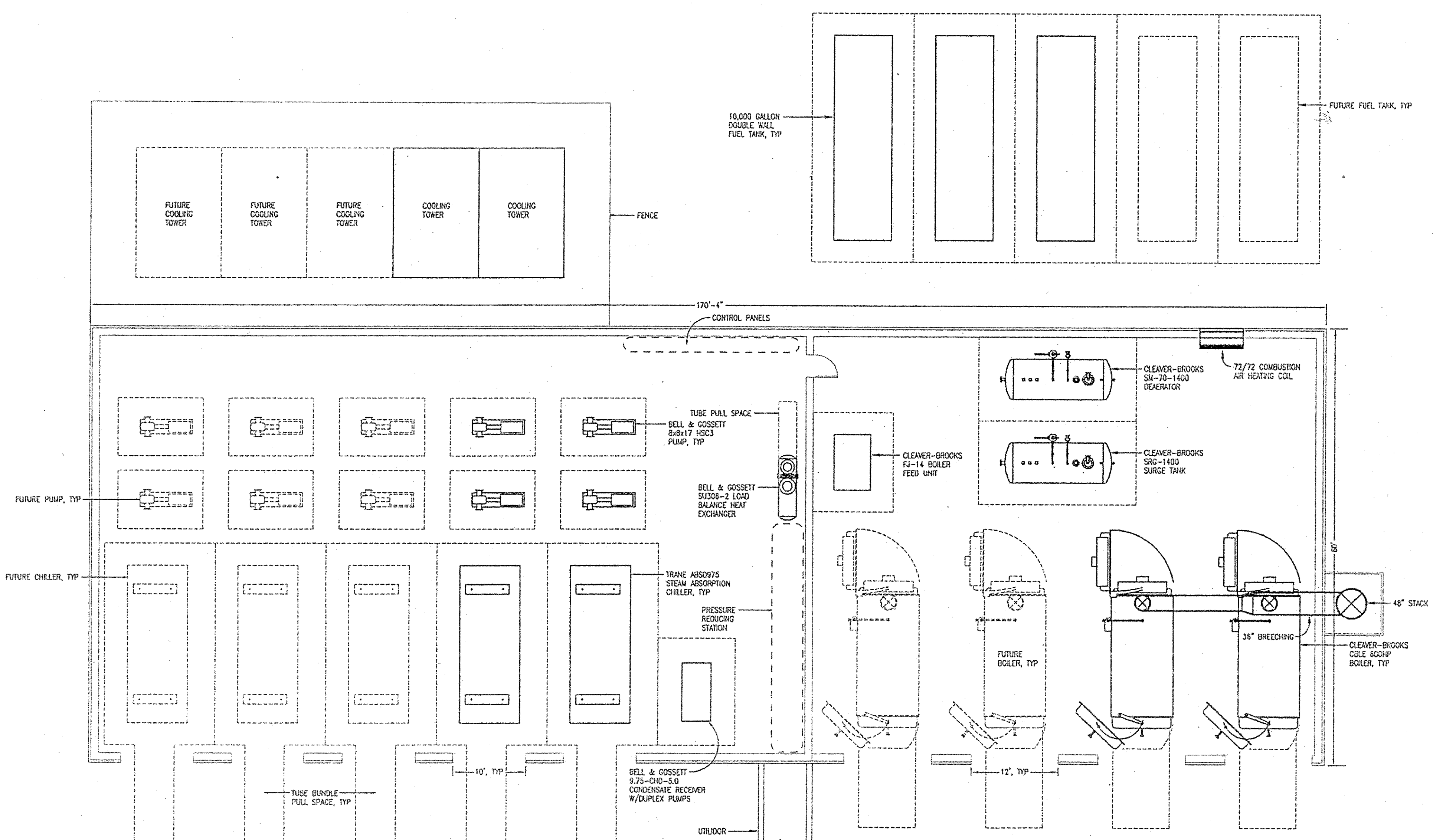
UNIVERSITY OF ALASKA FAIRBANKS

GLHN
ARCHITECTS & ENGINEERS, INC.
2939 E. BROADWAY, TUCSON, ARIZONA 85716 (520)881-4546

PROJ. NO.	0537.00
DESIGNED BY:	HWJ
DRAWN BY:	PMF
CHECKED BY:	HWJ
DATE:	07/24/06
REVISIONS	

MSK-7

XREF:
PLOT SCALE =
DATE
FILE



XREF:
PLOT SCALE =
DATE
FILE

UNIVERSITY OF ALASKA FAIRBANKS
UTILITY DEVELOPMENT BUSINESS PLAN

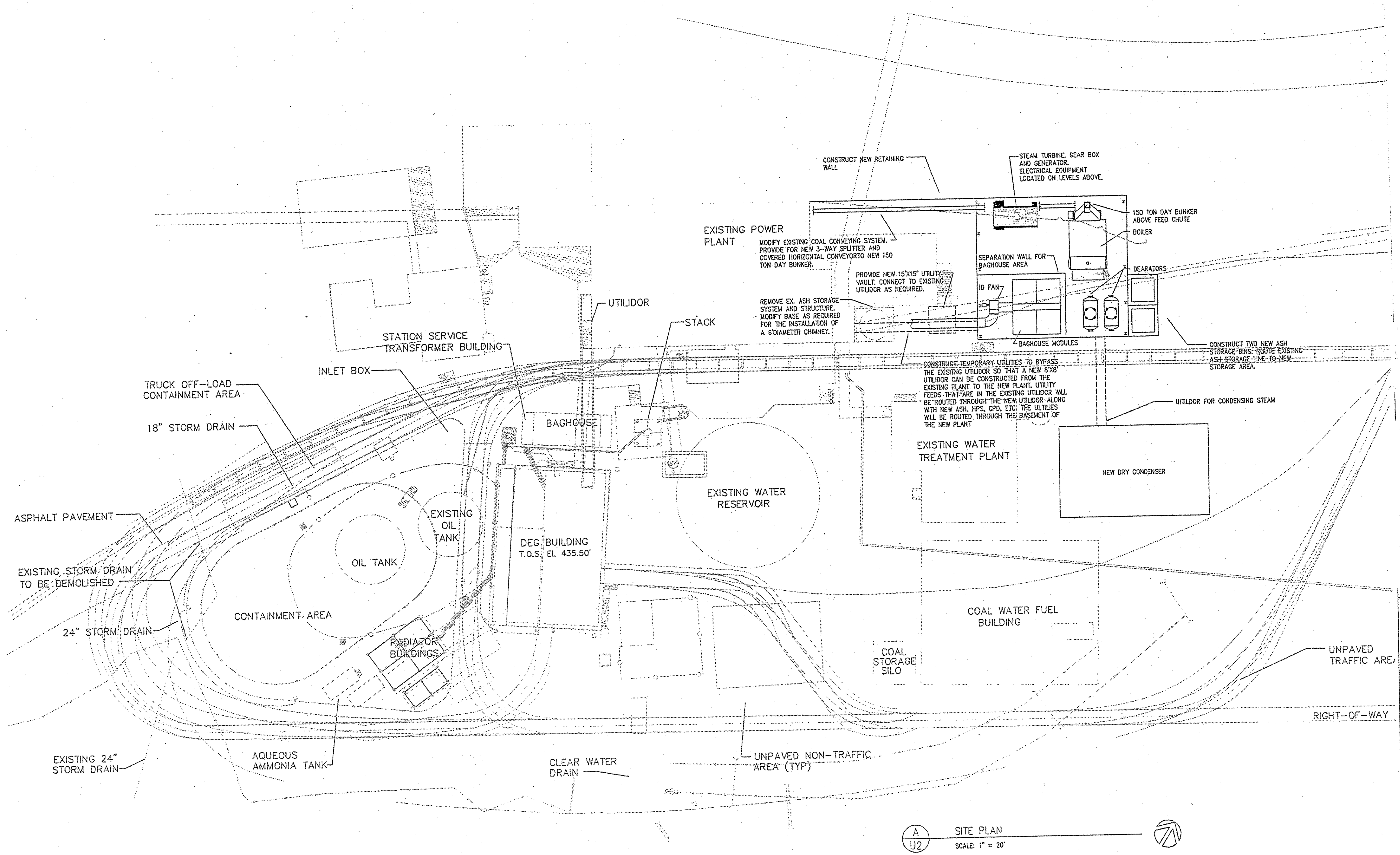
PROPOSED CHILLER AND STEAM
PRODUCTION PLANT LAYOUT

UNIVERSITY OF ALASKA FAIRBANKS

GLHN
ARCHITECTS & ENGINEERS, INC.
2939 E. BROADWAY, TUCSON, ARIZONA 85716 (520)881-4546

PROJ. NO. 0537.00
DESIGNED BY: HWJ
DRAWN BY: PWF
CHECKED BY: HWJ
DATE: 07/24/06
REVISIONS

MSK-8



A U2 SITE PLAN
SCALE: 1" = 20'

UNIVERSITY OF ALASKA FAIRBANKS
UTILITY DEVELOPMENT BUSINESS PLAN
BLOCK DIAGRAM OF PROPSED BOILER PLANT ON EXISTING SITE PLAN

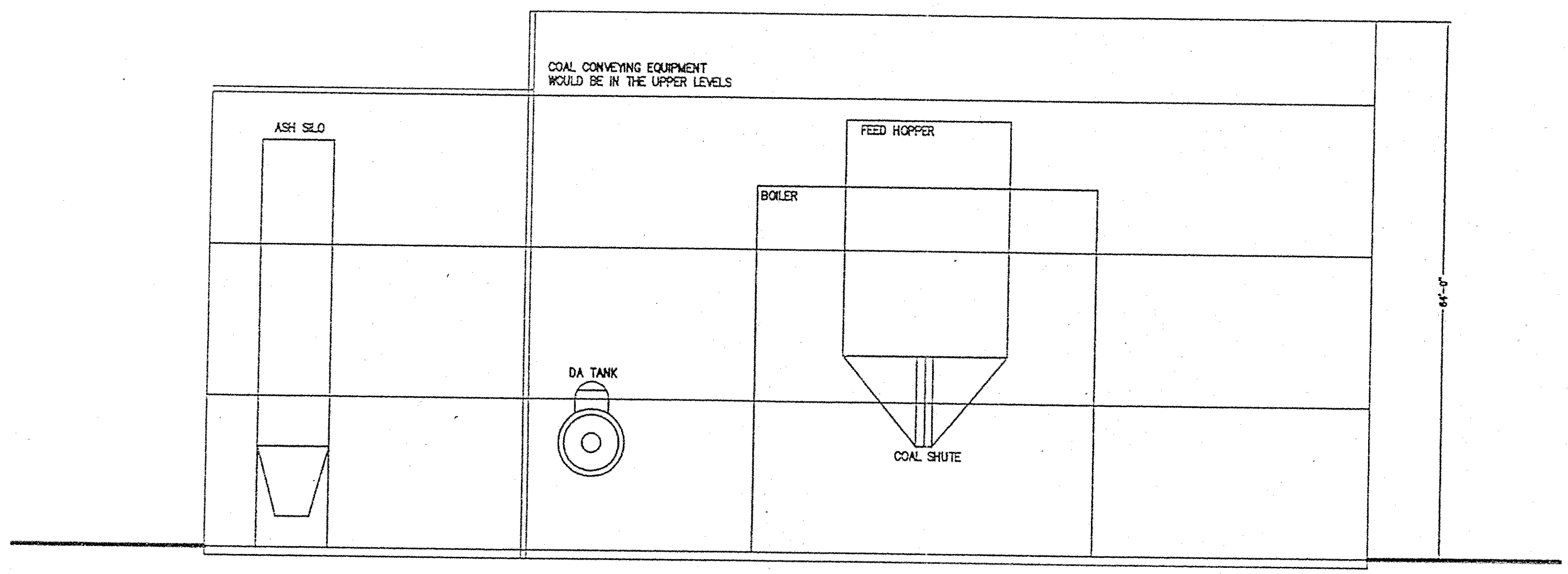
UNIVERSITY OF ALASKA FAIRBANKS

GLHN ARCHITECTS & ENGINEERS, INC.
2939 E. BROADWAY, TUCSON, ARIZONA 85716 (520)881-4546

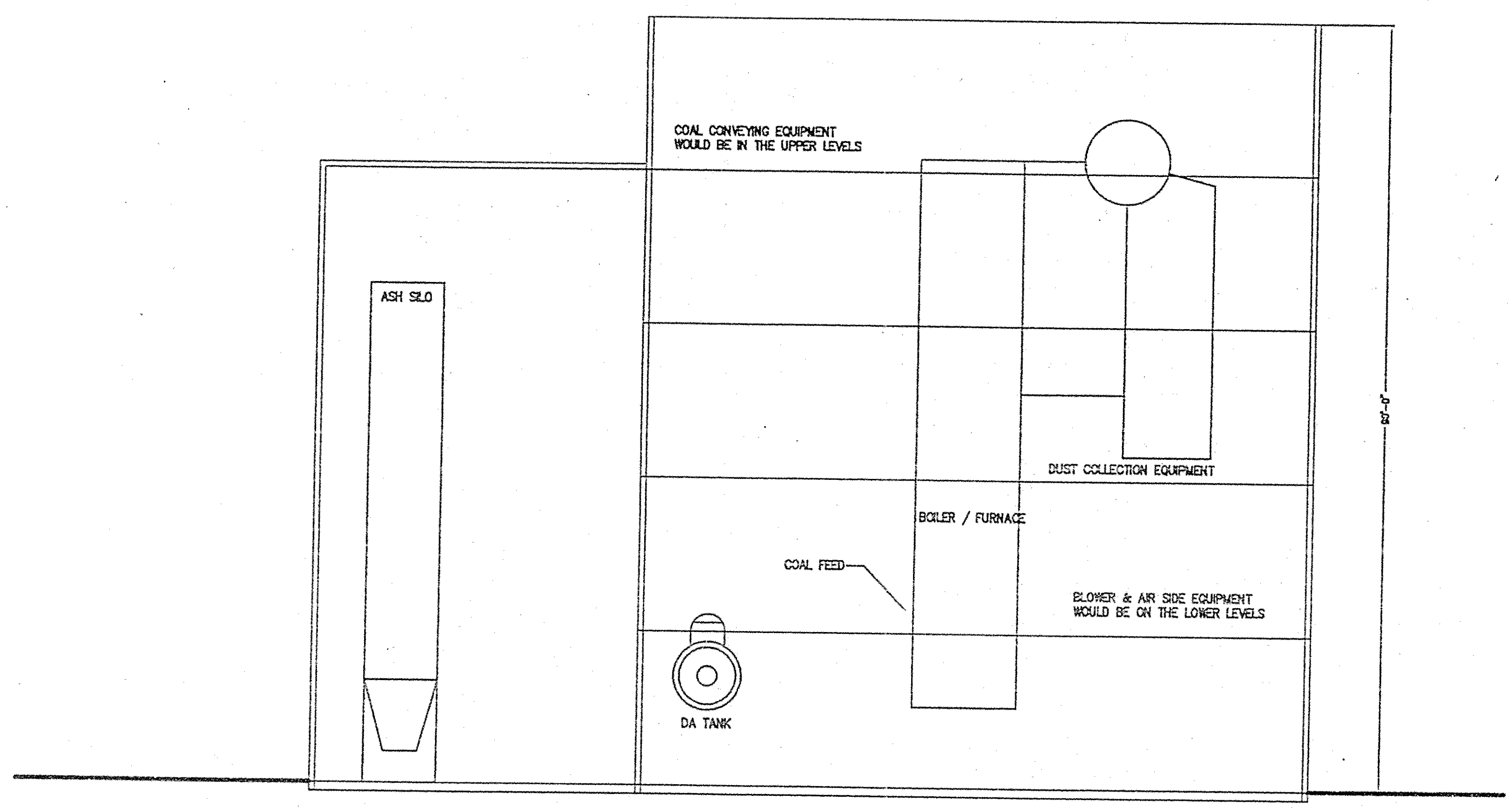
PROJ. NO.	0537.00
DESIGNED BY:	HWJ
DRAWN BY:	PMF
CHECKED BY:	HWJ
DATE:	07/24/06
REVISIONS	

MSK-9

XREF:
PLOT SCALE =
DATE
FILE



STOKER STYLE BOILER PLANT PROFILE PLAN



FLUIDIZED BED BOILER PLANT PROFILE PLAN

UNIVERSITY OF ALASKA FAIRBANKS
UTILITY DEVELOPMENT BUSINESS PLAN

STOKER STYLE BOILER PLANT PROFILE PLAN
AND FLUIDIZED BED BOILER PLANT PROFILE PLAN

UNIVERSITY OF ALASKA FAIRBANKS

GLHN
ARCHITECTS & ENGINEERS, INC.
2930 E. BROADWAY, TUCSON, ARIZONA 85716 (520)881-4546

PROJ. NO. 0537.00
DESIGNED BY: HWJ
DRAWN BY: PMF
CHECKED BY: HWJ
DATE: 07/24/06
REVISIONS

MSK-10

XREF:
PLOT SCALE =
DATE
FILE