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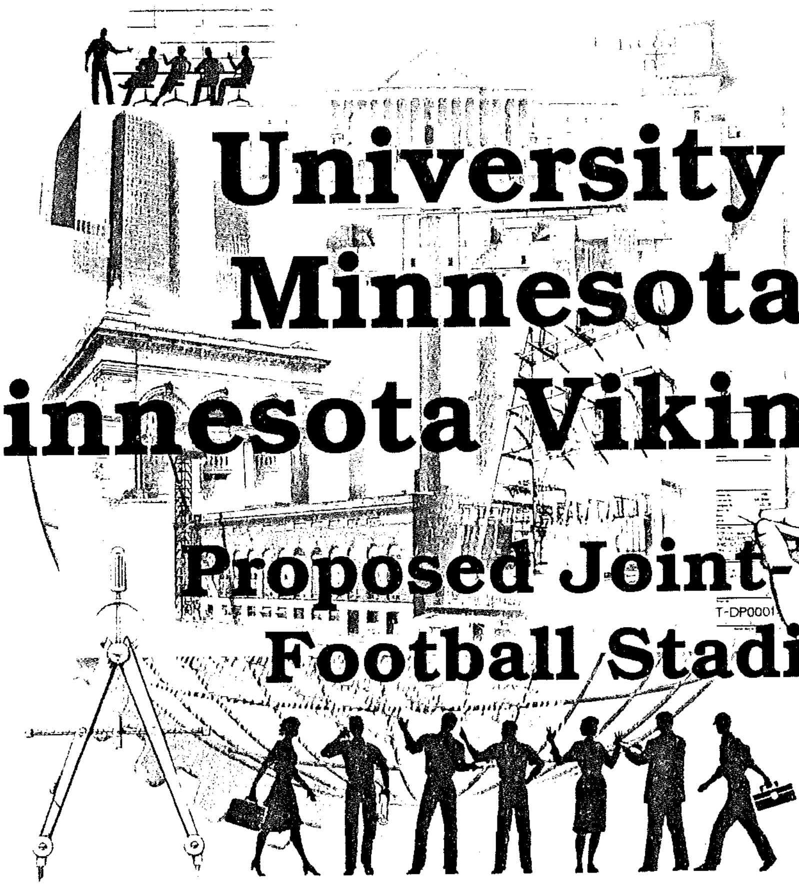
Utility Master Plan Report

For the



University of Minnesota & Minnesota Vikings

Proposed Joint-Use Football Stadium

SEBESTA BLOMBERG
Providing Technical & Business Solutions

Sebesta Blomberg Project No. 2049.00

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Sebesta Blomberg & Associates, Inc.
2381 Rosegate
Roseville, MN 55113
Phone: (651) 634-0775 Fax: (651) 634-7400
Contact: **Tom Kukulski, PE**
E-mail: tkukulski@sebesta.com

Consultant's Report

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UTILITY MASTER PLAN REPORT

Proposed Joint-Use Football Stadium
Minneapolis, Minnesota

Prepared for the:

UNIVERSITY OF MINNESOTA

and the

MINNESOTA VIKINGS

December 5, 2002

Prepared by:

Sebesta Blomberg & Associates, Inc.
2381 Rosegate
Roseville, Minnesota 55113
Phone: (651) 634-0775
Fax: (651) 634-7400
Website: www.sebesta.com

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I. BACKGROUND

A. Basis of Design

The University of Minnesota has established guidelines for providing utility service to University facilities through a process of Utility Master Planning. All new projects, as well as major remodeling efforts, should follow these guidelines to be consistent with a long term utility solution that is in the best interest of the University of Minnesota. Utility planning must parallel the overall Campus Master Planning efforts. When projects are allowed to proceed without adequately addressing utility issues, significant and unexpected costs can and do happen. The primary utilities that are under University control are:

- **Steam**
- **Electric**
- **Chilled Water**
- **Data/Telecom**

The Master Plan for the Steam Utility is to provide this utility on a campus-wide/central basis unless the economics and logistics of the decision will adversely impact the long term, life cycle costs of the project. The central steam utility has been proven to be the most cost effective method of providing reliable steam to the campus. Steam is used for building heat, domestic water heating and some chiller applications. A central steam plant consolidates maintenance functions and allows the use of a variety of fuels for campus steam production. Central steam plants also provide a cost effective way for the University to provide firm capacity – the ability to meet peak demand for steam with the largest boiler unavailable for service. Distributed boilers have been installed in rare occasions where connection to the central system is not feasible. Distributed boilers do not provide the same useful life that central systems provide and require significant additional cost to provide firm capacity. They are also more costly to maintain per unit of production.

Similar to the steam utility, the University Electric Utility was established to provide reliable and economical power to the University facilities. Reliability is enhanced due to the University electrical distribution system configuration as well the fact the University maintains an operations and maintenance staff that can quickly respond problems on the University distribution system. Electrical power is purchased as though there is one electric meter for the campus. Due to the fact campus facilities do not all experience peak electrical demand simultaneously; the single meter billed peak demand is far less than the sum of the campus facilities individual peak electrical demands. This peak load diversity results in lower electrical service costs than would be recognized if each campus facility were served by the retail suppler directly. Another benefit of a central Electric Utility is the ability to interconnect major electrical service entrance points (switch stations) to increase reliability. This also provides a limited amount of centralized standby power due to generation installed at one of the University switch stations.

The Chilled Water Utility Master Plan has taken a slightly different path. By the time a Master Plan was considered in the late 1980's, sufficient infrastructure was already in place that the cost and logistics required to completely centralize the Minneapolis campus long-term chilled water needs was considered impractical. The approach then became one of creating Central Chilled Water Districts, ranging in size from several thousand tons up to 15,000 tons for the current Academic Health Cooling District. A further benefit for district cooling plants was to group facilities of similar cooling characteristics such that firm capacity could be considered for critical districts, chilled water supply temperatures could be uniform across the district, and the cooling seasons would be similar for all users within a district. Central systems have reduced maintenance costs by up to a factor of three over distributed chiller systems. Central systems can save up to 50% in energy consumption and can also be installed for lower overall capital cost than distributed (chiller per building) systems.

The University owns, operates, constructs, and maintains their own data and telecom systems. These systems are routed through out campus in a variety or routing methods. Specific to this project is the existing trunk fiber cable routing through the proposed Stadium site. This cable will have to be relocated prior to proceeding with Stadium site work.

II. Condition Assessment of Impacted University Utilities

A. Facilities and Utilities Currently in District

In order to develop the Stadium area in compliance with the University Utility Master Plan, it is assumed that a Stadium District would be created at some time. The area has historically been referred to as the Athletic District, but the construction of a Stadium would probably change that name. The western portion of the area includes the following buildings that are considered athletic facilities:

- Aquatic Center
- Cooke Hall
- University Recreation Center
- Ridder Arena
- Mariucci Arena
- Williams Arena/Sports Pavilion

Other buildings in the area include research facilities and an office building:

- Center for Magnetic Resonance Research
- Integrated Waste
- Lions Research Building
- McNamara Alumni Center

Based on the buildings listed above, the Athletic/Stadium District would currently be made up of facilities with a total area of over 1.3 million square feet. This does not include Poucher, University Press and Holman that would be demolished when the Stadium is constructed. Several of the buildings in the area around the site are not connected to the University's steam or electric utilities. A Chilled Water District has not been established in the area, forcing buildings to have their own chillers or DX cooling systems. The following discussion of steam, chilled water and electric power is directed at the status, condition and capacity of current University Utilities in the area of the new Stadium site.

B. Steam

The campus central steam system main high-pressure distribution piping currently ends at Cooke Hall with a 6" line. Central steam is provided for all existing buildings listed above within the Athletic/Stadium District except Center for Magnetic Resonance Research, Integrated Waste and Lions Research Building which all have individual building boiler systems. Poucher, University Press and Holman currently require 7200 PPH of central steam but would be demolished with the construction of the Stadium. The existing buildings that will remain connected to the campus central steam system have a combined peak load of approximately 60,000 PPH. This load fully utilizes the capacity of the 6" high-pressure steam service in Cooke Hall. The three buildings not connected to the central system have an estimated combined peak demand of approximately 7000 PPH. The individual boilers installed in these three buildings are relatively new and are in good condition.

C. Chilled Water

All buildings have their own air-cooled chillers or DX systems for cooling since there is no centralized cooling district. Air-cooled equipment typically has a shorter useful life and much higher energy consumption than when compared to a Central Chilled Water Plant. The sum of the peak cooling loads for the buildings listed above is approximately 3400 tons. An estimate of diversified load from these facilities on a Stadium game day would be 2260 tons and 2500 tons on a non-game day. The condition of equipment varies from good to needing replacement.

D. Electric

The area north of Washington Avenue on the East Bank Campus is electrically served from the University 4th Street Switch Station. While the 4th Street Switch Station does have capacity for the proposed Stadium addition, the University electrical distribution system in the vicinity of the proposed Stadium site does not have sufficient capacity. Buildings in the area of the proposed Stadium, Center for Magnetic Resonance Research, Integrated Waste, and Lions Research Building, are currently served directly from Xcel Energy, as the cost of extending University service to these buildings was prohibitive when compared to the economic benefit. Whether these buildings would be connected to the University electrical distribution system if available in the area would be determined by separate economic analyses on a building-by-building basis.

III. Outline of Required Improvements For Each Utility

A. Stadium Utility Requirements

The Facility Planning Group of the Joint Use Football Stadium Predesign Study provided an estimate of utility requirements for the Stadium based on experience with similar facilities. General assumptions used when calculating these requirements included:

- Building will seat 68,500 with a temporary capacity of 72,000 people
- Outside air ventilation air is assumed to be 620,000 cfm
- Space will be kept at an average temperature of 75F
- Ambient design temperature for heating is –15F with building occupied
- Annual heating usage based on the equivalent of 1000 hours of full-load operation
- Annual cooling usage based on the equivalent of 100 hours of full load operation for the entire facility peak load and 600 hours of operation for a 1600 ton load which is that portion of the building which experiences more day to day usage.

Cooling requirements: 8000 tons. To comply with University Standards the Stadium chilled water system would be designed for 40F supply temperature and 58F return temperature. The chilled water plant would be configured with a primary/secondary pumping configuration. Chiller plant assumed to be located within building with cooling towers located outside near the facility.

Heating requirements: 80 million Btu per hour (BTUH) output peak load for heating. For purposes of this Predesign study, we will use a load of 80,000 pounds per hour (PPH) to be consistent with the measure of heating loads in other University facilities and in the Central Steam Plant. The error in using PPH, which understates the heating load, is within the accuracy of this study's level of detail. If connected to the University's central steam system, the building would have a pressure reducing station to provide low pressure steam for steam (15 PSIG) to heat exchangers that produce heating water for the building. Heating water would be pumped through the building to remote air handlers and terminal heating equipment. If gas-fired heating water boilers were utilized, they would typically be located in the building and would require 100 million BTUH input of natural gas.

Domestic Hot Water: Assume 5 million BTUH domestic hot water demand for cooking and laundry. If connected to the University's central steam system, steam to hot water heat exchangers would be used to produce the domestic hot water. Based on providing hot water storage and assuming that there is a reasonable diversity in the usage of steam for building heating and domestic hot water production, there would be little if any increase in peak steam usage from the 80,000 PPH steam requirement for building heat. If the building was heated with internal heating water boilers, separate gas-fired water heaters of 5 million BTUH capacity would be installed, requiring 6.25 million BTUH input of natural gas.

Domestic water: Even though excellent water pressure is anticipated in the area, the initial design will assume that pressure booster pumps will be installed; this will be reviewed during detailed design. Peak domestic water demand at half time is anticipated to be 4000 GPM, with an average flow for the entire game estimated to be about 1200 to 1500 GPM. A 12" water service is anticipated with a 10" meter.

Sanitary sewer: Based on assumed occupancies, two 12" sanitary sewer lines will be needed to serve the building. The preferred layout would have the two lines leaving on opposite sides of the building.

Storm sewer: The preferred storm sewer layout consists of one 21" storm line draining each quadrant of the building, therefore, a total of four (4) 21" storm lines would leave the building to connect to the city storm sewer.

Natural gas: If connected to the University's central steam system, the Stadium gas load is estimated at 5 million BTUH for cooking and laundry. If the building has heated with internal heating water boilers, the gas load is estimated at 105 million BTUH.

Fire protection: Based on anticipated fire protection requirements, the building would be supplied with a 10" fire service to an electric drive 1250 GPM to 1500 GPM fire pump.

Electrical service: With 8000 tons of chillers located within the Stadium, the electrical service would consist of approximately 35 MVA of connected load and a 15 MVA peak load. Service layouts within the facility are assumed to include four major risers plus one service to the chiller plant. If the chiller plant is remote from the Stadium assume the Stadium electrical load will be reduced by 8 MVA.

Emergency Power: It is assumed that emergency power will be required for the facility and that requirements will be satisfied with two (2) 1250 kVA diesel generators dedicated to the Stadium facility. The location is "to be determined" but is typically located outside of the building at most stadiums. Input from the University is needed on this matter when detailed design begins. Permitting of the generators will also be a priority.

Telephone/ Data service: Provisions for serving the building would require the installation of eight (8) 4" conduits for telephone, data, cable, etc.

Smoke control: Based on previous retractable roof stadium design, it is assumed that opening the bowl roof for a fire in the bowl would be acceptable for smoke control. Other spaces will require smoke exhaust fans and make up fans as required.

B. District Utility Requirements

In addition to the existing buildings defined as being assigned to the Stadium District, there are several new and future facilities that must be considered when planning the long term utility requirements of the District. The requirements of the new Stadium itself were defined above. These new facilities are as follows:

- **Joint Use Stadium**
- **Addition to the University Recreation Center**
- **Addition to the Center for Magnetic Resonance Research**
- **Translational Research, addition to Lions Research Building**
- **Structured Parking**
- **Landcare/Warehouse**
- **Future University Development (Office/Laboratory/Classroom)**

Including the Stadium, these new facilities total almost 3.5 million square feet. The anticipated steam load is approximately 150,000 PPH, of which 80,000 PPH is the Stadium. These are all new heating loads, loads that are currently not served by the University's Central Steam Utility or individual stand-alone boilers. As stand-alone boilers in existing facilities reach the end of their useful life, it is assumed that they would be replaced with new boilers or served by a central utility. These existing boilers would add 7000 PPH to the 150,000 PPH new heating load resulting in a new district heating load of approximately 160,000 PPH. The existing buildings in the Stadium District that are currently connected to the University's Central Steam Utility are assumed to remain on that system and are not classified as new heating loads.

We considered the peak cooling loads under two different scenarios – game day and non-game day. The sum of the peak loads of all these facilities is approximately 13,400 tons. Considering diversity of loads on game day (Stadium at its peak load of 8000 tons and the remaining buildings at diversities from 50% to 75%) these facilities would produce a diversified peak load of approximately 11,900 tons. For a non-game day operating scenario, we assumed that the Stadium load would decrease to 1600 tons to handle classrooms, practice facilities, office areas, and other occupied spaces. The diversity of the remaining facilities would increase to 70% – 85%, providing a diversified load of approximately 5,500 tons. When combined with the cooling load from the existing buildings in the Stadium District that would eventually be served by a central chiller plant, the game day peak load requires 14,000 tons of cooling and a non-game day peak load could be satisfied with a central plant capacity of 8000 tons.

IV. Heating System Analysis

A. Heating System Alternatives

As discussed above, the heating requirement for just the Stadium is 80,000 PPH. Four alternatives were identified to provide this capacity. Two alternatives were compatible with serving only the Stadium. Two alternatives were capable of serving the Stadium initially and then could be expanded to serve the new loads that would develop within the Stadium District. The heating requirement for the Stadium plus these new heating loads within the Stadium District is approximately 160,000 PPH. The four alternatives include:

1. Stand-alone heating water plant within the Stadium – no District connection or service
2. Extend the existing University central steam and condensate system, provide capacity from the existing Southeast Steam Plant
3. New high pressure steam plant near facility to serve Stadium District with an option to configure plant for cogeneration.
4. Geothermal plant for just the Stadium – no District connection or service

B. Discussion of Alternatives

Stand-Alone Heating Water Plant Within The Stadium: This alternative provides no benefit to the remainder of the Stadium District, which is contrary to University Master Planning guidelines. However, it may be argued that several University buildings in the area already have stand-alone systems so a similar approach for the Stadium should be considered as a viable alternative.

The plant would require a firm capacity equal to 80,000 PPH. The plant would supply 200°F heating water to end users within the facility. A potential configuration would be four 25,000 PPH heating water boilers (nominal 800 horsepower boilers), with a smaller 10,000 – 15,000 PPH boiler for low loads (nominal 300 - 400 horsepower).

Any major heating plant located within the Stadium will be challenged to locate and install an adequate stack that is visually acceptable. The final stack dimensions would be determined by dispersion modeling, but with a stadium structure that is approximately 240' high, it would not be unreasonable to expect a requirement for a 260' - 300' tall steel stack costing $500,000 or more. A heating water plant requires fewer components than a steam plant and does operate very efficiently. An estimate for the boilers, pumps, chemical treatment, controls and piping for this configuration is $4.2 million. A separate building would not be required since it is housed within the Stadium; however, we have used an incremental cost of $100/sf to provide and construct 8,000 square feet of appropriate boiler room space at a cost of $800,000. The total cost of this alternative is $5.5 million as shown in the following summary:

Estimate Of Cost Of Stadium Heating Water Plant

Component	Cost
Stack	$500,000
Building space w/ME systems	$800,000
Boilers and auxiliary systems	$4,200,000
Total	**$5,500,000**

The issues for the stand-alone heating water boiler plant vary somewhat from the alternative for a new central high pressure steam plant within the Stadium District. A heating water boiler does not require full-time licensed operators under State law as does the high-pressure steam plant. A single licensed operator is sufficient to meet the State requirements. With a second full-time operator/technician, the annual labor cost is estimated to be $200,000. As with a district steam plant or any major change in the operation or loading of the current central steam plant, a heating water plant would have to be permitted as part of an entire site permit.

To evaluate the merits of the stand-alone heating water plant, capital and operating cost projects were developed. Variable operating costs include energy and a portion of overall maintenance. Based on the 1000 hours of full load operation for the Stadium and 80% boiler efficiency, the Stadium would use 100,000 MMBTU of natural gas annually. Fixed costs include labor, fixed maintenance, interest cost based on the capital cost of the plant and a 25 year depreciation of the plant capital cost. The following table summarized those costs and calculates a unit cost of heating for comparison.

Operating Cost For Stadium Heating Water Plant

Peak Load	Full Load Hours	Annual Load
80,000,000 BTUH	1000 Hours	80,000 MMBTU
	Stadium Plant	**Case Parameters**
Capital Cost	$5,500,000	
Variable Cost		
Fuel	$500,000	$5.00/MMBTU
Maintenance	$60,000	$0.75/MMBTU
Total Variable Cost	$560,000	
Fixed Cost		
Labor	$200,000	
Maintenance	$55,000	1% of Capital Cost/Year
Interest	$302,500	5.5%
Depreciation	$220,000	25 year straight line
Total Fixed Cost	$777,500	
Total Variable & Fixed Cost	$1,337,500	
Unit Cost of Annual Load	$16.72/MMBTU	

Annual variable and fixed costs were estimated to be $1.34 million to provide heat to the facility. The average cost of producing one million BTU's of usable heat to the Stadium with the stand-alone heating water plant is $16.72/MMBTU.

Extend Existing Steam and Condensate System: All steam produced for the campus central steam distribution system is produced at the Southeast Steam Plant. The current peak output from that plant is 450,000 PPH, with a firm capacity of 530,000 PPH. Plant capacity includes two relatively new high pressure steam boilers, each capable of providing 200,000 PPH of 900 PSIG / 900° steam, one boiler is a CFB that can burn coal and other solid fuels and the other is a packaged gas/oil boiler. The plant also has a relatively new 250,00 PPH, 200 PSIG packaged boiler that is fired with gas or oil. Additional older boilers total 130,000 PPH of capacity that are also capable of 200 PSIG operation on gas and oil. Several buildings, especially in the area of the Stadium site, are not connected to the central steam distribution system and have their own boilers as mentioned before.

With the Southeast Steam Plant serving the entire campus, it is able to take advantage of load diversity when considering the impact of additional loads on the central plant. Since the peak Stadium loads would typically occur during periods when the University is NOT at peak, the central plant would not see an 80,000 PPH increase in peak load if it served the Stadium. In fact, the impact on peak load would be a fraction of the 80,000 PPH load and should not immediately trigger the need for additional boiler capacity caused by the Stadium.

Sebesta Blomberg has reviewed the steam distribution system at the University of Minnesota, Twin Cities Campus. The existing high-pressure steam distribution piping system extends from the Southeast steam plant to the old Main Plant and then through the deep tunnel system (approximately 100 feet below grade) throughout the campus. There is a 24" and 16" high-pressure steam line connecting the Southeast Plant with the Main Plant, providing extra capacity for that portion of the overall distribution system. Steam is distributed at 200 PSIG (up from the previous 180 PSIG to increase system capacity). Pressure reducing stations are typically located in the deep tunnels to provide 125 PSIG steam that is routed up vertical shafts and through a shallow tunnel system to the points of connection to the Campus buildings. These 200 PSIG – 125 PSIG stations provide a more stable operating pressure for the buildings due to the extensive network of high-pressure distribution and the resulting pressure variations.

The minimum requirements to extend the existing steam and condensate system to serve just the Stadium would be an extension of the 200 PSIG deep tunnel steam distribution piping and condensate piping to the site. The extension would be capable of handling the 80,000 PPH Stadium load. The single Stadium load would require an 8" – 10" steam line. The closest source of 200 PSIG steam is an 6" line at Cooke Hall, which is already at capacity with existing loads so is not capable of also serving the Stadium. The next closest 200 PSIG line is a 12" steam line at Weaver Densford Hall within the Academic

Health Center. The high-pressure steam line to Academic Health is also heavily loaded and does not have additional capacity.

Sebesta Blomberg had created a computer model of the University of Minnesota's steam distribution system for use in previous projects. It has been used as a tool in planning for supplying steam to current and future buildings on the Minneapolis Campus. There currently are locations within the distribution system where operating pressures are at minimum acceptable levels, especially in the area of the Academic Health Center that includes many critical loads. Taking a conservative approach with load diversity, the 80,000 PPH Stadium load was added to the existing peak campus load model. We have considered two methods of upgrading capacity to supply the Stadium steam load:

- Upsizing the existing 6" line to Cooke Hall to accommodate the new Stadium load plus existing loads. This existing line is installed in a small tunnel that requires that the existing line be removed and replaced with a larger line, it is not feasible to route another parallel high pressure steam line.
- Routing a new 14" line from the Main plant, through existing and new deep tunnels, to the Stadium District to serve the Stadium as well as other District loads. Based on the other costs involved such as deep tunnel excavation, installation of vertical shafts, tunnel power and lights, mobilization, etc., the incremental cost to increase pipe size from 10" to 14" was minimal. This approach is in compliance with the University's master plan for the steam utility since a 14" line will serve the wider Stadium District loads as well as improve the performance of the existing system. The other benefits provided by this approach are described below.

The steam model indicates that the 6" line to Cooke Hall would have to be replaced with a pipe sized at approximately 24" in order to meet the Stadium load and still allow it to serve it's existing loads without a significant drop-off in overall campus operating pressures. It is not possible to do this within the confines of the existing tunnel so this approach was ruled out for further consideration.

We then modeled a new 14", 200 PSIG line from the Main Plant to Weaver Densford Hall, to be routed in an existing tunnel with sufficient space for that additional line. The new 14" line would then be extended through a new deep tunnel to Cooke Hall and to a vertical shaft outside the Stadium. A pressure reducing station would be installed at the base of the vertical shaft to provide 125 PSIG steam to serve the Stadium and the Stadium District. After being reduced to 125 PSIG, the line size remained at 14" to provide the 80,000 PPH for the Stadium plus providing capacity for an additional 60,000 PPH of future Stadium District loads. The model included several ties into the current 200 PSIG distribution system that dramatically increased available pressure in that system which in turn provided increased capacity throughout the existing system. The cost of the new 14" line from the Main Plant to the Stadium is $9.2 million. The major components of cost included the steam and condensate piping, the deep tunnel excavation cost with vertical shaft at the Stadium and the miscellaneous components of the system including expansion joints, traps, lighting and power, cross connections to existing system and a condensate pumping system. A breakdown of these costs is as follows:

Estimate Of Cost To Extend Central Steam System

Component	Cost
Steam and condensate piping	$3,400,000
Tunnel excavation subcontract	$4,150,000
Tunnel installation miscellaneous	$1,650,000
Total	**$9,200,000**

Early in the project, a pedestrian tunnel was considered between the McNamara Center and the Stadium. This option has since been eliminated. If a tunnel were installed, there would potentially be approximately a $500,000 savings or more due to reduced tunnel excavation costs since a utility area could be provided in that tunnel.

To evaluate the merits of the extension of the University's existing steam and condensate system, capital and operating cost projections were developed. Annual variable costs were based on the current fuel and maintenance costs from the Southeast plant, fuel costs assumed a 30% coal and 70% natural gas mix. Based on the 1000 hours of full load operation, the Stadium would use consume 80,000 MLB of steam annually with an assumed 1000 MBTU of heating delivered per MLB of steam (approximation used for this study). Fixed costs included labor, fixed maintenance, interest cost based on the capital cost of the project and a 50 year depreciation of the project capital cost of $9.2 million project. The following table summarizes those costs and calculates a unit cost of heating for comparison.

Operating Cost For Extension Of Central Steam System

Peak Load	Full Load Hours	Annual Load
80,000,000 BTUH	1000 Hours	80,000 MMBTU
	Central Steam Extension	**Case Parameters**
Capital Cost	$9,200,000	
Variable Cost		
Fuel	$5344,800	$4.31/MLB
Maintenance	$218,400	$2.73/MLB
Total Variable Cost	$563,200	
Fixed Cost		
Labor	N/A	
Maintenance	$27,600	0.3% of Capital Cost/Year
Interest	$506,000	5.5%
Depreciation	$184,000	50 year straight line
Total Fixed Cost	$717,600	
Total Variable & Fixed Cost	$1,280,800	
Unit Cost of Annual Load	$16.01/MMBTU	

The total annual variable and fixed costs were estimated to be $1.28 million to provide steam to the Stadium. The average cost of producing one million BTU's of usable heat to the Stadium with the extension of the existing system is $16.01/MMBTU. This is a savings of $60,000 annually or an equivalent savings of $0.071/MMBTU.

New High Pressure "District" Steam Plant Near Stadium: Based on input from the Joint Use Stadium Facility Consultant, a heating plant designed to serve just the Stadium would very likely be the heating water hot water system described above. A heating water system, even if additional capacity could be installed, would not benefit other University buildings in the area since they are currently on steam. The alternative of a District Steam Plant was posed for consideration if it was possible to come closer to complying with the University Utility Master Plan guidelines and provide a heating plant that was capable of assisting in the development of the Stadium District as well as enhancing the operation of the current Central Steam Utility.

A facility that could serve the Stadium that was also capable of being a source of steam to replace existing boilers in the area when they are retired, would be designed as a high pressure steam plant of at least 125 PSIG design. Looking further into overall campus needs, the current campus steam distribution system will eventually be unable to deliver steam at adequate pressure to critical campus loads. The ability to back feed 200 PSIG steam into the existing campus distribution system to overcome these limitations would likely drive the decision to construct a 200 PSIG District Plant. Future development of a Stadium District Steam Plant would involve connecting to the 200 PSIG line in the deep tunnel at Cooke Hall, a major pressure reducing station to provide connection with the existing 125 PSIG system in the area, and eventually a high-pressure extension to Academic Health to further backfeed the existing campus system.

Good engineering practice and University Standards would require that this high-pressure district steam plant provide firm capacity. With initial Stadium loads of 80,000 PPH and a total future district load of approximately 160,000 PPH, a firm capacity plant could be configured with three 80,000 PPH boilers and a smaller (say 30,000 PPH) boiler to handle periods of reduced loads. The initial plant would not include the third 80,000 PPH unit but would provide space for it. Due to stack and fuel oil storage requirements, there are advantages to have the steam plant remote from the Stadium on a University site "to be determined". An estimate for the initial plant (a plant building with acceptable appearance, two large and one smaller 200 PSIG boilers, fuel storage, auxiliary systems, personnel space, 125 PSIG distribution piping to Stadium, etc.) is $13 million. Future phases to develop the plant and connect to the University steam system would include more distribution piping, another high pressure boiler, modifications to the existing campus condensate system to return condensate to this plant when exporting steam to campus, tunneling cost, etc. A build-out cost could easily approach $20 million.

Several significant issues exist beyond the technical feasibility of constructing a high-pressure steam district plant. Air quality permitting under the University's site permit would probably be a major permit modification and trigger public hearings, emission control equipment and complying with federal requirements. A plant of this size would require a very large stack, 200 feet high if remote from the Stadium, 260' - 300' high if located near or within the Stadium. By state law, the plant would require full-time operators at an estimated cost of $750,000 annually (6-8 operators). Providing steam to University of Minnesota facilities, especially when the plant ties back into the existing distribution system, would trigger negotiations with Foster Wheeler on their exclusive supply contract with the University.

Along with a much higher capital cost than the stand-alone heating water boiler alternative, the cost of steam produced at this steam plant to provide Stadium heating would also be much higher than either the Stadium heating water plant or the extension of the University's steam system. However, as loads increase, as it becomes a district plant, the cost to produce steam could approach the current University price, but would not result in a cost savings. The high capital and operating cost of this alternative eliminates it from further consideration.

An overview of the potential benefits of cogeneration was requested in the project scope of work. Of all the plant alternatives proposed, the logical configuration would be to integrate cogeneration into this high pressure district plant. Two methods of cogeneration could be considered – generate higher-pressure steam that what is required for district heating and expand it through a backpressure steam turbine generator (similar to what is being done currently at the University's Southeast Steam Plant) or install combustion turbines and recover heat through heat recovery steam generators to meet district steam loads and supplement University steam loads. Both methods of cogeneration demand coincidental heat and power loads at a high load factor to be cost effective. The initial plant, serving just the Stadium, would not have a consistently high steam load so cogeneration would not be cost justified. The final build-out, with connection to campus steam and electric loads may show potential. However, the use of this Stadium cogeneration plant would offset benefits achievable from cogeneration at the Southeast Plant, with the net effect providing unacceptable returns for the additional cost, especially when the higher capital and operating cost of this alternative has been shown. Further consideration of cogeneration is not warranted.

Even though this alternative is not recommended for further consideration, the implications of this type of a facility on air permitting will be discussed later in this report.

Geothermal: This alternative was brought up because continuous dewatering of the site is a possibility. Dewatering would provide a constant source of 55° water at some unknown flow rate. Geothermal is not an appropriate technology for a project this size and especially not for heating. Electrically driven compressors (heat pumps) cannot produce heating water much in excess of 110°, which is not acceptable for heating this facility. If the need for dewatering would go away due to a fluctuating water table, the system would no longer function and a traditional system would be needed immediately. There is too much risk and too many unknowns involved for the University to consider a geothermal plant.

Conclusion

The extension of the campus steam and condensate system provides a lower overall annual fixed and variable cost and a system that provides more value to the University of Minnesota. If both scenarios provided the same quality of service and benefits to the Stadium and University, the higher capital cost may be hard to justify with only a $60,000 per year savings. However, there are several other important considerations that have to be weighed. The largest component of variable plant operating cost is fuel. With the benefits provided by fuel flexibility, the long term trend would greatly favor the central plant. The central plant steam also provides maintenance and labor savings versus a stand-alone plant, since that workforce and expertise currently exists at the Southeast Steam Plant. Considering the impact to the overall University operation and conformance with the Steam Utility Master Plan, the extension of the central system could be considered a project requirement. It will provide significant long-term benefits to the entire campus and make future capacity available at a fraction of the cost of stand-alone facilities. It will result in lower overall unit steam costs for the University as well as lower operating cost (versus having to install and operate individual boilers in future buildings).

From a Stadium project standpoint the major implications, other that strictly capital cost, include the timelines and the visual impact on the Stadium. A stand-alone heating water plant could potentially cause delays to negotiate an air quality permit, taking from 3 months to 1½ years. A heating plant at the Stadium would require that a substantial stack be installed. The Minnesota Pollution Control Agency would probably require air dispersion modeling of the site and would dictate the final height of the stack. It may be a real challenge to make a 300' tall stack fit into the architecture of the facility. Somewhat offsetting the higher cost of connection to the central steam and condensate system is freeing up of approximately 8,000 square feet of space to another use.

Even with an incremental cost over the stand-alone heating water boilers at the Stadium of $3.7 million ($5.5 million versus $9.2 million), the extension of the campus steam and condensate system to serve the Stadium District is recommended. It provides much more flexibility as well as being an enhancement to long-term University needs and the Steam Utility Master Plan. Once installed, the cost of connecting future facilities in the Stadium District can be accomplished at a fraction of the cost of additional stand-alone boilers. The extension of the central steam system provides improvements to the existing system and upgrades the steam service to all campus users. A permit modification to an existing central plant should not be a significant issue. The direction given to the design team was to provide a utility solution that was in the best interest of the University of Minnesota and this approach provides that type of solution.

V. Central Chilled Water Plant Analysis

A. Cooling System Discussions

The configuration and location of the chilled water plant really does not have any viable alternatives to consider other than location. It has been assumed that space would be provided within the Stadium for the first phase of plant construction, which will be to serve the Stadium. The Stadium load was projected to be 8,000 tons. The chillers will be electric centrifugal type, building on nominal modules of 2000 tons. Two smaller chillers of 1000 tons each would probably be included to handle periods of low loads. The projected future Stadium District cooling load would require that a central chilled water plant be capable of expanding to 14,000 tons.

The use of high-pressure steam absorbers was not be considered for this plant due to the higher capital and operating cost. If the plant were base loaded, and served by the main campus steam system, there would be cogeneration and steam load benefits to consider. Since peak Stadium cooling loads happen very seldom, these steam system benefits would not be experienced. As the plant is built out to serve the district, the issue could be revisited.

Potential locations for cooling towers have been reviewed. The options to utilize a "spray pond" or to create an architectural tower constructed of concrete were considered and dismissed due to cost and operational issues. The preferred configuration is to provide modular factory assembled towers that can be added as capacity is installed. Concerns that have to be addressed when locating towers include noise, plume, tower recirculation and drift. Towers that are installed on or near the Stadium, but lower than the roof elevation, would have performance and recirculation issues as well as concerns about controlling drift. The preferred location for the towers is on the roof of the parking structure to the east of the Stadium. Prevailing south to southwest winds during the summer would not cause moisture and treatment chemicals to drift on the Stadium or people. The tower performance would not be impacted by winds swirling around the

Stadium. This would make the preferred location of the chiller plant near the southeast portion of the Stadium to minimize piping costs.

Based on previous chilled water plant projects at the University of Minnesota, the estimated cost of the initial 8000 ton chiller plant is approximately $16 million, or roughly $2000 per installed ton. This includes electrical capacity, building space (again at $100/sf as with the heating water boiler space, but for 15,000 square feet), provisions for future capacity additions, water treatment, controls, pumps, etc.

Estimate Of Cost For Stadium Chilled Water Plant

Component	Cost
Chillers	$4,000,000
Remote cooling towers	$2,400,000
Instrumentation, control, comm.	$1,200,000
Pumps, piping, auxiliaries, misc.	$4,800,000
Electrical service	$2,000,000
Building space w/ME systems	$1,600,000
Total	**$16,000,000**

Incremental future capacity would be added for about $1600 per ton providing a build-out to 14,000 tons for an additional $9.6 million. A chilled water distribution system would also have to be installed to serve the district at some time in the future, estimated at $3 - $4 million as the plant was built out. Chillers and distribution costs are not included in current project costs.

A chilled water plant would be structured under the University's Chilled Water Utility District plan if it is connected to a distribution loop. The Stadium plant would not initially be part of a loop but would be configured for that service. Since portions of the loop will be constructed within a few years of startup or sooner, the plant is considered part of a Chilled Water Utility District. Due to the cyclical nature of the Stadium's cooling load, the initial cost of providing cooling (cost per ton-hour) will be very high, approximately $1.19/ton-hour. This is primarily due to charges for interest and depreciation on the $16 million plant capital cost. Other major costs include energy and maintenance as shown below:

Chilled Water Plant Operating Costs

Peak Load	Full Load Hours	Annual Cooling
8,000 Tons	100 Hours	800,000 Ton-Hrs
Non-Gameday Load		
1,600 Tons	600 Hours	960,000 Ton-Hrs
		1,760,000 Ton-Hrs
Annual Energy Usage:	@ .80 KWH Ton-Hr =	1,408,000 KWH
	Stadium CHW Plant	**Case Parameters**
Capital Cost	$16,000,000	
Variable Cost		
Electricity	$105,600	$0.075/KWH
Maintenance	$200,000	$25.00/Ton
Total Variable Cost	$305,600	
Fixed Cost		
Labor	$100,000	1 FTE
Maintenance	$160,000	1% of Capital Cost/Year
Interest	$880,000	5.5%
Depreciation	$640,000	25 year straight line
Total Fixed Cost	$1,78,000	
Total Variable & Fixed Cost	$2,085,600	
Unit Cost of Annual Load	$1.19/Ton-Hr	

*Annual energy usage based on .80 KWH/Ton-Hr (chiller plus auxiliaries)
**Electric costs based on time used and is not equal to campus annual average costs

Total annual variable and fixed charges result in an annual cooling cost for the Stadium of approximately $2.1 million. The combination of a significant initial plant cost with high peak loads but a relatively small amount of cooling produced (very low load factor) makes economical operation very difficult. As the Cooling District grows by serving more consistent loads in the area, the cost of cooling will be reduced.

VI. Electric Power

A. Electrical Power Requirements

The following identifies electrical power distribution requirements for the proposed Stadium:

- Service Voltage: 13.8kV
- Stadium Requirement: 15MVA peak load. The chiller plant load portion of this peak load is estimated to be 8MVA.
- Future district development electrical requirements are estimated to be 11MVA for the potential additions identified.

B. Evaluate Sources of Power

Two alternatives for supplying electric service to the Stadium site were evaluated. These alternatives are:

1. Extend electrical service from the U of M 4th Street Switch Station (Campus Substation Building #160)
2. Direct service from Xcel Energy.

Service from the University electrical distribution system will provide lower electrical energy rates than would be available with direct service from Xcel Energy. The reason for this difference is due to the electrical demand charge component of the electric bill. If the Stadium receives electrical power from the University electrical system, the total billed demand of the campus and the Stadium will be less than the sum of the individual peak demands of the campus and Stadium. This is due to the fact the Stadium peak demand, during game days on weekends, is non-coincidental with the campus peak demand (weekdays). If the Stadium were to receive electrical service direct from Xcel Energy, it will have its own meter and will incur a separate peak demand charge each month.

The University campus monthly peak demand occurs on weekdays, which sets the electrical demand component of the electric bill each month. Weekend electrical demand for the past year was compared to the corresponding monthly peak electrical demand. The conclusion is that campus weekend demand is at minimum 6,000 kilowatts (kW) less than the campus peak monthly demand for any month of the year. Some months the difference is much greater. The months of February and March have the least differential while the peak electrical demand months of summer have the greatest differential.

Since the monthly Xcel Energy electric bill demand component is based on the peak electrical demand incurred in the month, the 6,000 kW figure represents the amount of weekend load that could be added to the University system "demand free". That is, the monthly peak electrical demand will not be increased if up to 6,000kW of weekend electrical demand is added.

In order to estimate the electrical demand impact and demand costs or savings of the proposed Stadium, the following assumptions were made:

- 5,600 kW Stadium electrical demand. 30% of this demand will occur on non-game days. Net 3,920 kW game day (weekend) demand addition
- 6,400 kW chiller plant electrical demand. 20% of chiller plant demand will be incurred on non-game days. Net 5,120 kW game day (weekend) chiller plant demand addition
- 6 months, August through January, when game days will occur.
- 2 months when game day air conditioning is required. These two months occur during the Xcel rate schedule summer demand months. Total demand load during these months is estimated to be 9,040kW (3,920 kW + 5,120 kW)

These assumptions are used in the following example to illustrate the potential electrical demand costs on weekend game days.

Game Day Demand Savings

	No. Of Game Day Months Applicable	Demand Charge per kW	Game Day Demand kW	Annual Demand Charge
Summer Month Demand	2	$8.31	9,040	$150,250
Non Summer Month Demand	4	$5.66	3,920	$88,750
Example Total Annual Potential Savings				**$239,000**

This example illustrates the potential electrical operating savings due to demand diversity that could be recognized by serving new facilities from the University electrical distribution system rather than direct from Xcel Energy.

U of M 4th Street Switch Station and Distribution System Condition:

The Stadium and associated chiller plant represent weekend or off peak electrical load. The Stadium electrical peak loading will be non coincidental with peak campus loading. Therefore the existing service supply capacity to the 4th Street Switch station will be adequate for the proposed Stadium development.

The existing University electrical feeders in the vicinity of the proposed Stadium site do not have capacity for the proposed Stadium development. Similarly, the existing underground electrical duct bank which contains the electrical distribution feeders in the vicinity of the proposed Stadium site is filled; additional distribution feeders cannot be added to it.

The University Electrical distribution system will require upgrade and additions totaling approximately $1.5 million in order to adequately serve the proposed Stadium development. Specific University electrical distribution system upgrades required to provide electrical service to the proposed Stadium development include:

1. Approximately 2500 feet of 6-barrel, 5" reinforced concrete encased underground duct bank. The duct bank will be extended from the existing 4th St. Switch Station cable vaults to the Stadium site. Routing will be generally under sidewalks. Either

4th or 5th Street will be the route to the site. One electrical manhole will be required every block to accommodate duct bank elevation transitions required to miss other utilities and for acceptable pulling tensions. The estimated cost of the duct bank extension is approximately $800k.

2. Electrical service distribution feeders. These electrical feeders will be routed in the proposed underground duct bank and will have a capacity of 6.9MVA each. Three feeders are required to meet the projected Stadium load of 13MVA and to provide redundancy for maintenance and emergency switching operations. The estimated cost of these electrical feeders is $363k.

3. 4th Street Switch Station additions. Provisions exist in the 4th Street Switch Station to accommodate equipment additions for the three additional electrical distribution feeders.. These additions include 3 – 15kV metal clad circuit breakers to existing metal clad switchgear ($30k ea), 3 – 15kV air core field assembled reactors ($35k ea), 15kV circuitry between breakers and reactors, equipment installation and testing ($100k). The total estimated cost of the required equipment additions at the 4th Street Switch Station is $295k.

Service Direct From Xcel Energy

Two feeders will be required to serve the projected Stadium and cooling electrical loads. At the time of this study, Xcel Energy has indicated there is available capacity on one electrical feed in the proposed Stadium area. A second feed would be constructed from the Xcel electrical substation immediately north and across the railroad tracks from the proposed Stadium site. The estimated cost for electrical service extension to the proposed Stadium direct form Xcel Energy was quoted at $500,000. There is the caveat that the Xcel existing feeder capacity must still be available at time of Stadium construction in order for this estimate to be valid. This option needs to be re-evaluated at the time of Stadium design and construction.

C. Recommendation

Although direct service from Xcel Energy appears to have a lower first cost, the uncertainty that the needed electrical capacity will be available at the quoted cost at time of Stadium construction in the future is a concern. Also, the potential for operating savings (electrical demand) is not present with direct service from Xcel Energy. Simple pay back due to electrical demand savings available if the Stadium is served from the University electrical distribution system appears to be less than six years. For these reasons the recommendation is to extend electrical service from the University electrical distribution system.

An additional benefit of this recommendation is that University electrical distribution facilities will be extended into an area of campus that previously was electrically served only from Xcel Energy. Existing University buildings in the Stadium area presently served from Xcel Energy, Center for Magnetic Resonance Research, Integrated Waste, and Lions Research Building, as well as future planned developments will be able to be electrically served from the University system. Having all University facilities originate at one service point rather than several service points provides the economic benefit of demand diversity in that all facilities do not peak at the same time.

D. Emergency Power Requirements

The proposed Stadium will require its own emergency power system and will be part of the Stadium development. The University does not have emergency power generators in the area that could be used for the proposed Stadium. The University does have two 2,000kW generators connected to the 4th Street Switch Station for switching, maintenance, and disaster recovery purposes. However, these generators cannot be used as the source of emergency power for the Stadium as emergency power distribution infrastructure meeting electrical code requirements does not exist.

E. Data /Telecom

The proposed Stadium site will require the relocation of a major trunk fiber data and telecommunications cable. The University owns and maintains this cable and will be responsible for relocating it. The cost estimated by the University for relocation of the data and telecommunications cable is $780,000.

VII. Non-University Utilities

A. Discussion of Non-University Utilities

Domestic water: The City of Minneapolis has a number of large water main pipes around the site area that provide domestic water to the site. Current water pressure and flow to the area from hydrant tests taken at the corner of 4th Street S.E. and 23rd Avenue S.E. were 81 PSI static with 70 PSI residual pressure on a flow rate of 2784 GPM. There is currently a 48-inch diameter water main within the existing Oak Street S.E. road alignment a 16-inch main extending East from Oak along University Avenue S.E. and a 12-inch main extending East from Oak along 6th Street S.E. The 12-inch main within 6th Street S.E. is a dead end main and should be looped to the 12 inch main on the East side of the site within 23rd Avenue S.E. Based on the assumed half time flow of 4000 GPM, more than one connection point is recommended to the City of Minneapolis system and may require a booster pump to maintain pressure and flow during peak demand. Average flow is anticipated for a game to be about 1200 to 1500 GPM. Water service is assumed to be 12" with a 10" meter.

Sanitary sewer: There is currently a 52-inch sanitary sewer pipe within the 96-inch storm sewer pipe in the Oak Street right-of-way on the West side of the site that has capacity available to serve this project. We have assumed two 12-inch sanitary sewer lines leaving the building, with both of them connecting to the existing 52-inch sanitary main within Oak Street. The depth of sanitary sewer main is around 14 feet. There are no other large capacity mains in the area that could serve this site.

Storm sewer: There is a 96-inch storm line within the Oak Street S.E. road right-of-way located on the West side of the site available along with a 72-inch main a few blocks to the East of the site within 25th Avenue S.E. road right-of-way. Both have capacity available according to the City of Minneapolis to serve this site. We have assumed the preferred storm sewer layout will consist of one 21" storm line draining a quadrant of the building. The City of Minneapolis has implemented a storm water management program as part of its compliance with the Phase II NPDES Storm Water Permitting. As a result of those guidelines, we have assumed a storm water detention pond for storm water treatment placed on the site to treat runoff before it enters into the City of Minneapolis system. The size of the pond will be dictated by what the City will allow to not be treated by the pond. Typically, roofs are not treated since, in theory, they do not pick up any nutrient loading before entering the storm sewer system. However, other surface areas would be required to be drained through a pond for treatment. The current site condition is generally hard surface parking lots, so there would probably not be an increase in runoff from the new site and it has the potential to reduce the runoff with proposed green areas around the Stadium.

Natural gas: There is existing natural gas lines available around the site with a 12-inch main located within Oak Street S.E., University Avenue S.E., and 23rd Avenue S.E. with a pressure of 90 PSI. If a central steam is used, assume the Stadium gas load requirement will be 5 million BTUH for cooking and laundry. If the building has a stand-alone heating plant, assume the gas load will be 105 million BTUH.

Fire protection: The City of Minneapolis has a number of large water main pipes around the site area that provide domestic water to the site. Current water pressure and flow to the area from hydrant tests taken at the corner of 4th Street S.E. and 23rd Avenue S.E. were 81 PSI static with 70 PSI residual pressure on a flow rate of 2784 GPM. There is currently a 48-inch diameter water main within the existing Oak Street S.E. road alignment a 16-inch main extending East from Oak along University Avenue S.E. and a 12-inch main extending East from Oak along 6th Street S.E. The 12-inch main within 6th Street S.E. is a dead end main and should be looped to the 12 inch main on the East side of the site within 23rd Avenue S.E. We have assumed the building will be supplied with a 10" fire service connected to an electric drive 1250 GPM to 1500 GPM fire pump to serve the Stadium fire demands.

B. Summary of Findings for Non-University Utilities

Domestic Water, Natural Gas, Sanitary Sewer and Storm Sewer are available and of adequate size for the Stadium. The requirement for storm water detention can be located on the site for storm water treatment. If Oak Street is relocated, a major relocation of utilities may be required. The magnitude of that cost is thought to be $3.5 million. One option that could be explored is to leave the Oak Street utilities in place within easements granted to the utility owners and relocate only the street. This would assume that the utility owners would agree to an easement over their utilities. Surface access would need to be maintained for repair and replacement of existing utilities in the future. Conversations with CenterPoint Energy and City of Minneapolis Right-Of-Way indicate a willingness to consider the easement alternative, leaving their utilities with the existing Oak Street right-of-way. The project team has indicated a preference for that option as well.

The following is a summary of the costs to serve the Stadium from Non-University utilities:

Estimate Of Cost For Non-University Stadium Utilities

Component	Cost
Domestic Water	$80,000
Sanitary Sewer	$60,000
Storm Sewer	$190,000
Natural Gas	$20,000
Total	**$350,000**

VIII. Regulatory and Permitting Issues

A. Air Permitting

The University of Minnesota has three alternatives to provide steam to the Stadium; steam from the existing SE Plant, an on-site dedicated steam plant, or a stand alone steam/power plant serving the Stadium as well as other campus needs in the area. Each of these alternatives requires some level of air permitting to proceed. The alternatives and their air permitting requirements are discussed in the paragraphs that follow.

B. Steam Provided by Existing Steam Plant

The University can provide steam to the Stadium without modifying its existing air permit as long as the remaining steam capacity is sufficient to satisfy the Stadium's demand. The University will need to determine that the available capacity has not already been dedicated to another future development project. If the University would have to add additional boiler capacity to its steam plant to provide the capacity, the existing operating permit would require amending through the permit application process.

C. Stand-alone Heating Water Plant Within Stadium

The University of Minnesota Campus (which encompasses two steam plants and miscellaneous stand alone boilers and generators) is considered one facility per the USEPA definition of facility. The University (as one facility) is considered a major source subject to federal New Source Review (NSR) Prevention of Significant Deterioration (PSD) permitting requirements. Because of the NSR major source designation, any modification that increases air emissions above the significant emission rates (SERs) is subject to PSD permitting requirements. PSD review is triggered for each pollutant that exceeds the pollutant specific SER threshold. Permitting requirements include application of Best Available Control Technology (BACT), demonstration of compliance with ambient air quality standards, and review of additional impacts. The SER thresholds for the criteria pollutants are presented in the following table:

SER THRESHOLDS

Pollutant	SER Threshold (tons/year)
NO_x	40
SO_x	40
VOC	40
PM/PM_{10}	25/15
CO	100

Preliminary review of the heating requirements indicates that four 25 MMTUH and one 15 MMBTUH boilers will be required to satisfy the Stadium demand. One of the 25 MMBTUH boilers will be used for backup purposes. The boilers will operate on natural gas with no designated backup fuel at this time. The table below, Potential Annual Emissions Compared to NSR PSD Major Permit Modification Thresholds, presents the potential emissions for two scenarios; 1 - all both boilers operating 8760 hours a year and 2 - all the boilers minus the backup boiler operating 8760 hours a year. Both operating scenarios (all boilers vs. no backup boiler) are compared to the SER thresholds in the table. If the University would want to limit operation of boilers to designate one as backup only, this type of operational limitation would have to be accomplished as a federally enforceable permit condition. In other words, worst-case potential emissions would be all the boilers operating simultaneously, full-time, unless there is a physical operation limitation or a federal enforceable permit condition, which prevents such operation. Emissions were calculated based on USEPA AP42 emission factors taken from Tables 1.4-1 and 1.4-2 for natural gas combustion.

Potential Annual Emissions Compared to NSR PSD Major Permit Modification Thresholds (SER Thresholds)

Emission Unit	NO_x (tons/year)	SO_x (tons/year)	VOC (tons/year)	PM/PM_{10} (tons/year)	CO (tons/year)
All Boilers	47.98	0.29	2.64	3.65/3.65	40.29
All Boilers Minus Backup	37.55	0.23	2.07	2.85/2.85	31.54
SER Threshold	40	40	40	25/15	100

Based on the emission calculations, only NO_x emissions for the "all boilers operating scenario" would be above the SER threshold. It is important to point out that these emission rates are based on available AP42 emission factors which are generally conservative (overestimate emissions), vendor specific emission rates may be lower than what is represented by AP42. Even if vendor based emission rates for NO_x are above the SER, NO_x control options such as low NO_x burners coupled with operational restrictions would likely be sufficient to lower potential NO_x emission to below the SER threshold. Based on these assumptions, it is not likely that the installation of stand-alone boilers will trigger federal PSD permitting.

In addition to federal permitting programs, the Minnesota Pollution Control Agency (MPCA) has different types of permit modifications (minor, moderate or major), each with a different level of required input and review. The type of permit modification triggered would depend on whether a Title I condition was required or if the potential hourly emission rates were above certain thresholds. A Title I condition would be a permit limitation that is required in order to avoid federal NSR permitting requirements. Based on the potential emission estimates, the University would have to accept a limitation on NO_x emissions in order to avoid triggering PSD permitting. A limit taken to avoid PSD permitting is considered a Title I condition and requires a major permit modification to become federally enforceable.

If the boiler plant is part of the Stadium and dedicated only to the Stadium, no construction can begin until the air permit for the boilers is received. Permits can take as little as 3 months and up to 1.5 years to receive, depending on the project, type of permit modification triggered, and backlog at the MPCA.

D. Stadium District Steam Plant

A separate power plant (cogeneration facility) with the ability to not only provide steam and electricity to the Stadium but also neighboring University buildings, is another option being explored. This option would be faced with some of the same issues as installing boilers to only serve the Stadium. That is, construction of a cogeneration facility will require the University to modify their existing air permit. It is likely this option would be considered a major modification and may, even with pollution control equipment, trigger federal air permitting requirements. Permitting a new cogeneration facility could take 6 months to 1.5 years if, or if not, federal permitting is triggered. The time frame could be longer if controversial fuels are proposed such as coal. One positive schedule point concerning a cogeneration facility is that construction could begin on the Stadium without first obtaining an air permit for the cogeneration facility.

E. Emergency Generators

Another item that needs to be considered is the emergency generators for the Stadium. In Minnesota, facilities that have major source permits are required to modify their permits in order to install emergency generators if the generators have hourly emissions over certain thresholds. Based on the anticipated size of the generators to be installed (two at 1200 kVA each), the University will be required to modify their existing air permit to include the generators. The permit application for the generators includes the requirement to perform a Screen Model analysis to show that the emissions from the proposed generator will not exceed ambient air quality standards at ground level. The requirement to demonstrate compliance with ambient air quality standards will likely dictate the location and the height of the stack for the generators.

F. Environmental Assessment Requirements

Certain projects with the "potential for significant environmental effects" require an Environmental Impact Statement (EIS) for governmental approval of the project. The EIS identifies likely environmental impacts associated with the project and ways to limit or avoid the impacts. The process is implemented by rules adopted by the Environmental Quality Board (EQB). The EQB's role in the EIS process is as an advisor or monitor for the preparation of the EIS.

The capacity of a planned sports/recreation facility determines whether a mandatory EIS is required for development of the facility. A facility with a peak attendance greater then 20,000 triggers a mandatory EIS. Based on the proposed size of the Joint-Use (U of M /Vikings) Stadium, the Stadium would trigger a mandatory EIS.

An EIS is prepared by a Responsible Governmental Unit (RGU). The RGU is pre-established for various mandatory EIS categories, including a sports/recreation facility.

The established RGU for a sports/recreation facility is identified as the local governmental unit. The U of M is proposing to be the RGU for the Joint-Use Stadium.

There are four basic steps to preparing an EIS and they include:

- EIS Scoping documents. These include a Scoping EAW (project information and potentially significant environmental impacts), a Draft Scoping Decision Document (preliminary EIS intended scope), and a Final Scoping Decision Document (official "blueprint" for the EIS and basis for the work plan/costs for the EIS).
- Preparation of the Draft EIS, based on the scoping documents.
- Public review/comment on the Draft EIS and preparation of the Final EIS.
- Determination of "adequacy" of the EIS.

The EIS Scoping Document component of the process provides the basic information (potentially significant and relevant issues) to determine the level of effort for completing the EIS. Items to be addressed in the EIS Scoping Document include:

- Project components
- Required permits/approval time frames
- Land and water uses and waste issues
- Traffic
- Emissions
- Location to nearby resources (natural, historical, architectural)
- Visual impacts/compatibility with plans
- Infrastructure/public services issues
- Cumulative impact

The components and the timeframe to complete the EIS, vary depending on the type of project and the level of effort assigned to each specific area. The EIS process includes specific public notices, comment periods, and public meetings, and typically can involve a 1 ½ to 2-year period.

IX. Summary of Recommendations

A. Estimates of Probable Cost

Heating System: Accomplished by extending the existing University Central Steam System through the installation of new steam and condensate piping within a new deep tunnel to provide the 80,000 PPH of steam needed for facility heating.

Cost estimated at $9.2 million

Cooling System: Installation of 8000 ton central plant within the Stadium footprint utilizing electric chillers and cooling towers located on an adjacent parking structure.

Cost estimated at $16 million

Electric System: Installation of University electric utility infrastructure from 4th Street Switch Station to proposed Stadium site.

Cost estimated at $1.5 million

Data/Telecom System: Relocation of existing trunk cables through proposed Stadium site.

Cost estimated at $780,000

Non-University Utilities: Installation of domestic water, storm sewer, sanitary sewer and natural gas to connect to existing utility mains.

Cost estimated at $350,000

Total Cost: Provide utility service to Stadium is estimated at $27.83 million

X. Key/Relevant Findings

1. A critical overall perspective on this project is that the Stadium is part of a larger Stadium District and that utilities for the Stadium are also a part of the overall University Utility Plan. The Stadium is not a stand-alone facility; no University facility of this magnitude is ever really stand-alone. The financial implications of decisions that are made in the "best interest of the University" will have to be weighed.

2. The Memorandum of Understanding is critical to determining the cost allocation to the project versus total utility project costs. MOU may impact location of equipment (chilled water plant that serves District as well as Stadium). MOU also has to deal with concerns for using capacity (steam plant, electric switch station) that may be already committed to future University Program requirements. What project or what entity will pay for the next boiler at the Southeast Plant or the upgrade of 4^{th} Street Switch Station that will be triggered, to a large degree, by the construction of the Stadium?

3. Project schedule will be impacted by Air Quality Permitting and Stadium EAW/EIS process.

4. **Chilled Water Utility** – Only real concern is the relatively high cost of providing the cooling capacity for this type of facility. Provide a central plant to serve the district with the initial load being the Stadium. Location can be within the Stadium unless the MOU would lead to another location. Plant to be expandable to serve the needs of the future Stadium District.

5. **Electric** – There are two choices for electrical service: 1) extend service from the University 4th St Switch Station or 2) extend service direct from Xcel Energy. Option 1 is recommended although at a capital cost premium ($1.5MM vs. $500,000). The estimate for option 2 provided by Xcel Energy is based on service capacity that is available today; there is no guaranty that this capacity will be available, or the estimate will still be valid, several years from now when the stadium is constructed. Option 1 also provides a lower life cycle cost benefit.

   An issue that needs to be addressed by the University is the allocation of service and distribution capacity from the University 4th Street Switch Station for the Stadium project. There is finite service and distribution capacity available before significant investment must be made for future projects. Are future projects to bear the cost of these upgrades or does each project carry an assessment for these future upgrades?

6. **Steam** – A stand-alone heating water boiler for just the Stadium is lowest capital cost ($5.5 million) but does nothing to enhance the University's Steam Utility, does nothing for existing or future buildings in the area, requires significant air permitting, adds maintenance cost, and would require a large stack at the Stadium. Extending the University's steam system to serve the Stadium and the District has a higher capital cost ($9.2 million) but provides benefits to the University's Steam Utility, is the easiest to permit, provides Stadium heating at a lower cost, and provides heating with no visual impact on the site. It does use up most of the current available capacity at the Southeast Steam Plant, which raises concerns for the cost of installing additional capacity in the near future. The alternative for a new steam plant for the District that feeds back into the Campus distribution was not cost effective.

7. **Permit** - The University can provide steam to the Stadium using the available capacity from the SE plant without modifying its existing air permit as long as the remaining steam capacity is sufficient to satisfy the Stadium's demand. However the University will need to determine that the available capacity has not already been dedicated to another future development project. If the University would have to add additional boiler capacity to its steam plant to provide the needed capacity, the existing operating permit would require amending through the permit application process.

   A standalone boiler dedicated to the Stadium would require modification of the University's existing air permit.

   Emergency generators for the Stadium will require the University to modify the existing permit. In addition, the University will have to demonstrate that operation of the generators will not exceed ambient air quality standards at ground level.

8. **Non-University Utilities** - If Oak Street is relocated, a major relocation of utilities may be required. The magnitude of that cost is estimated to be $3.5 million. Leaving the current utilities in the existing Oak Street right-of-way would avoid the relocation cost but requires that those utilities remain accessible.