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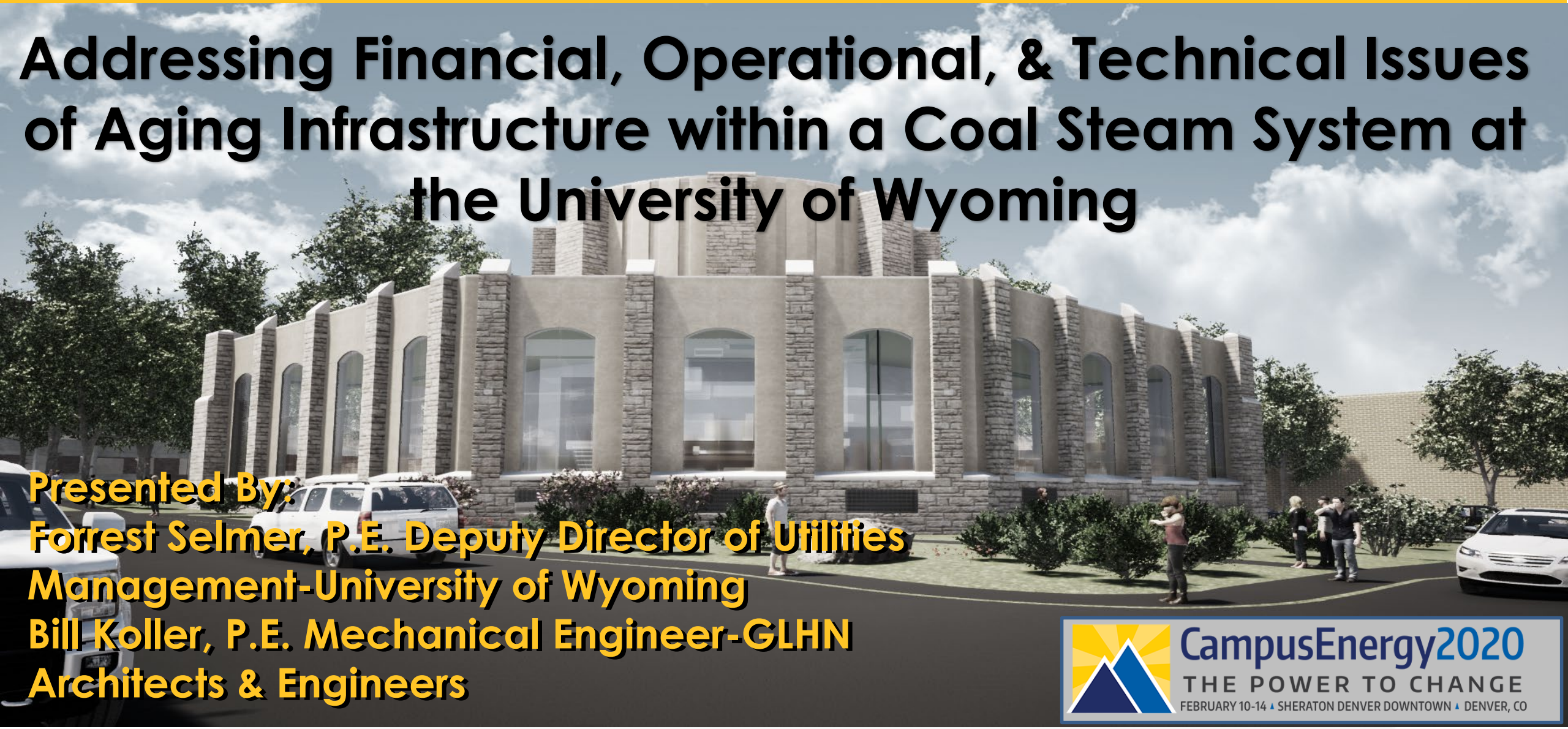
UNIVERSITY OF WYOMING

Addressing Financial, Operational, & Technical Issues of Aging Infrastructure within a Coal Steam System at the University of Wyoming



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CampusEnergy2020
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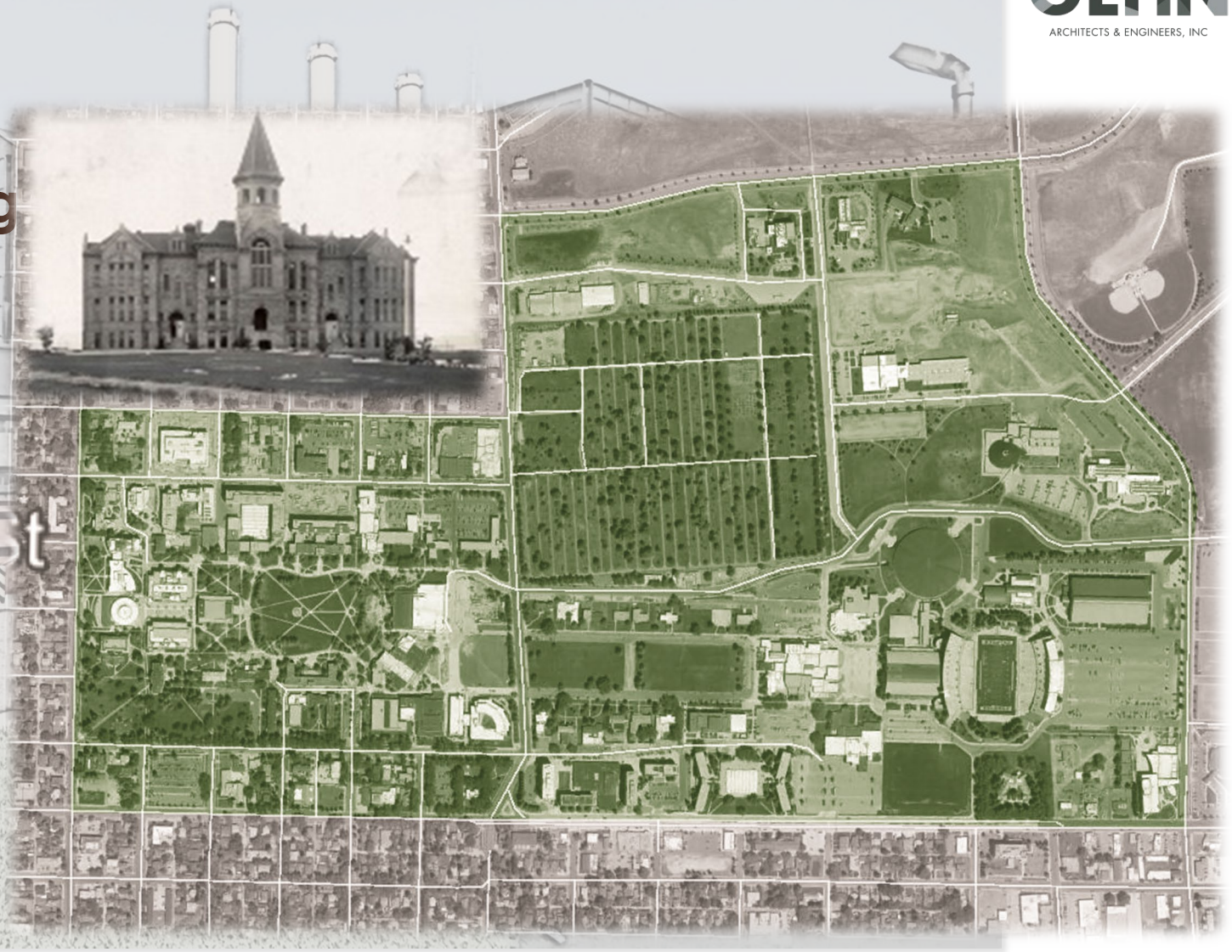
Presentation Objectives

- Project Background
- Basics
- Case Study-University of Wyoming
  - Process
  - Analysis
  - Implementation
  - Lessons learned

University of Wyoming

General Campus Statistics

- Founded in 1886
- Located in Laramie Wyoming
- Student Enrollment-9,500 (Laramie) – 14:1 Student/Faculty Ratio
- Buildings on Steam-83 (6.0M sqft)
- Buildings on CHW-30 (1.9M sqft)
- 400 Division 1 Student Athletes



University of Wyoming

Laramie Design Conditions

- 7,200’ Above Sea Level
- Summer 1%
  - 82 DB, 58 WB
  - 80 CDD (65F)
- Winter 1%
  - -3 DB
  - 8,690 HDD (65F)
- Climate Zone 6B

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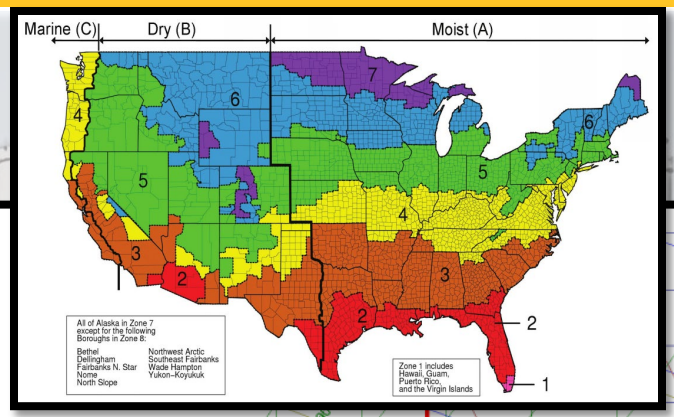

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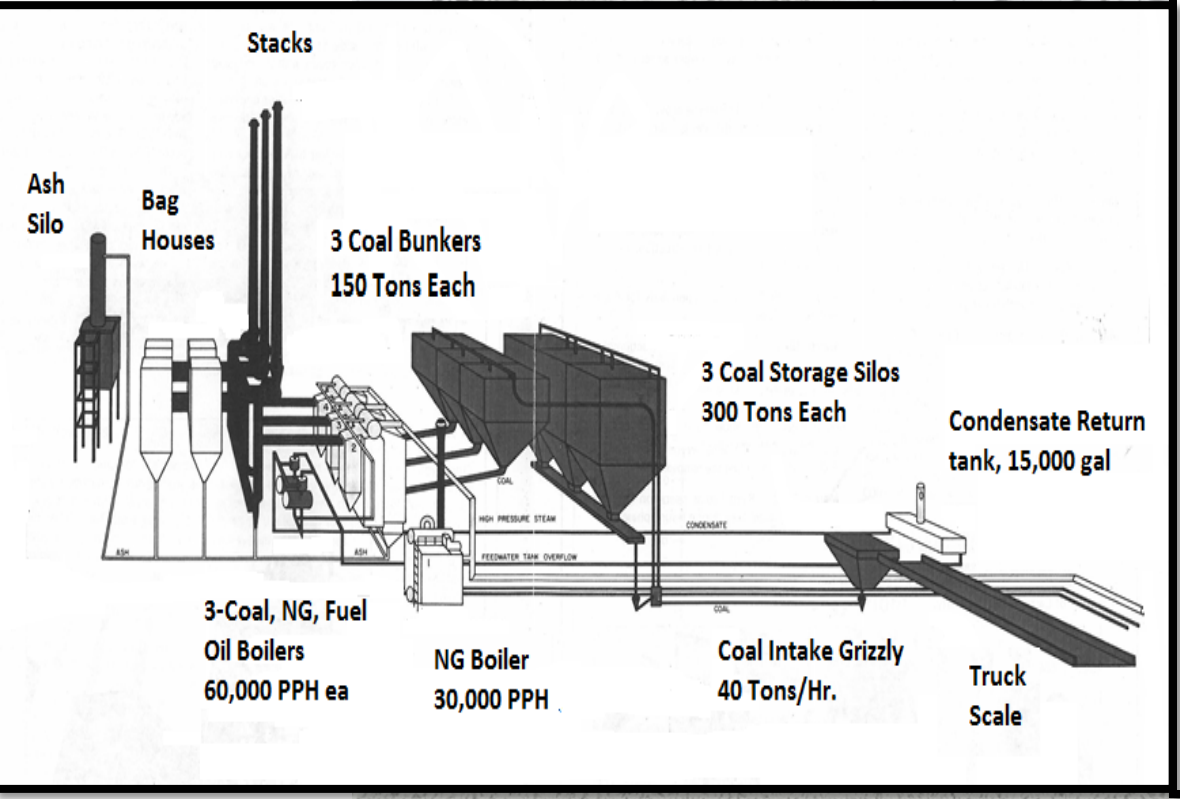
78 DB / 65 WB Temperature Splits

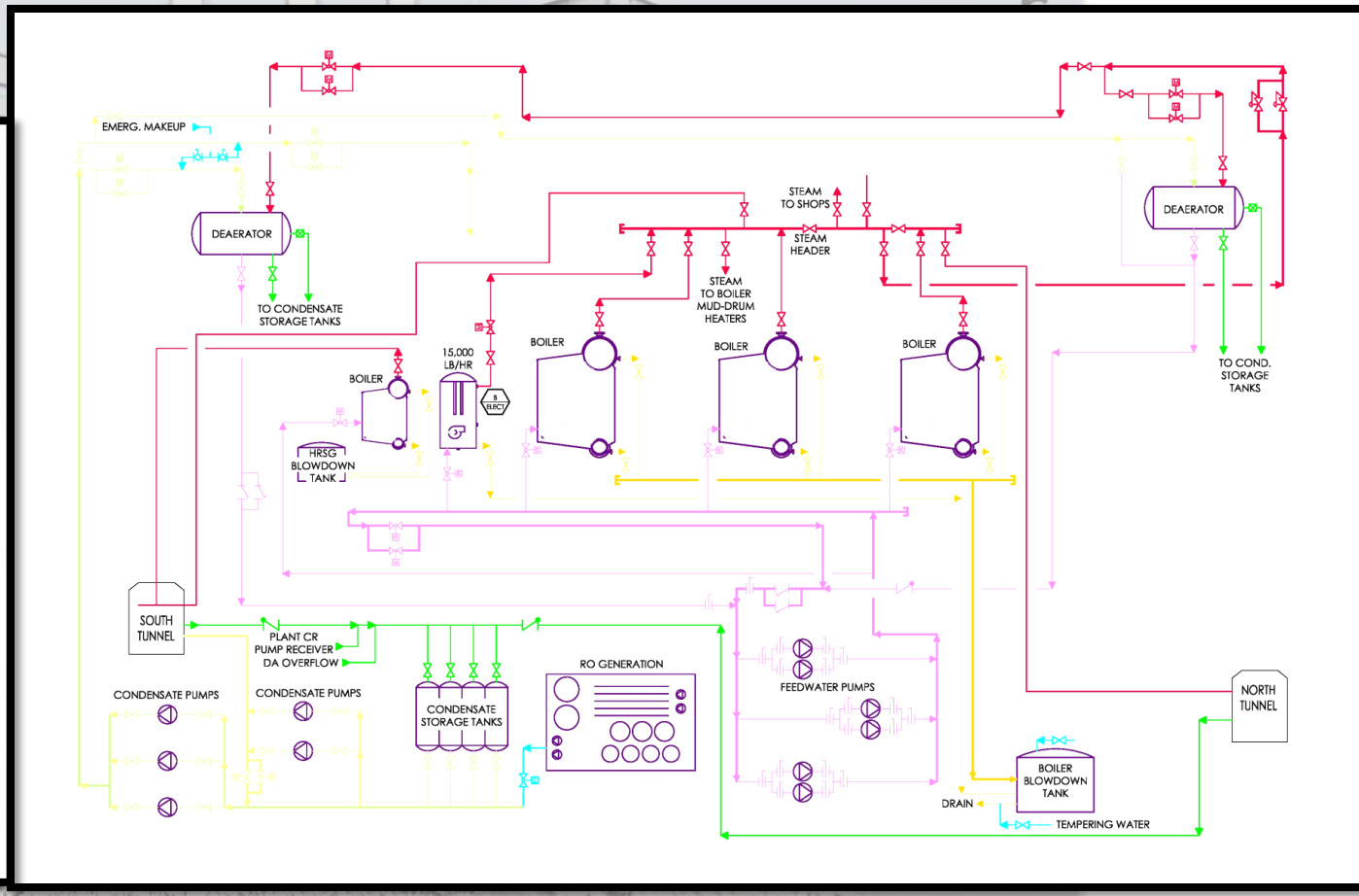
	2007	2008	2009	2010	2011	%
I	0	0	0	0	0	0.0%
II	8361	8515	8542	8455	8389	96.4%
III	399	269	218	305	371	3.6%
IV	0	0	0	0	0	0.0%
Total	8760	8784	8760	8760	8760	100%

Month	1939 - 2011 (71 Year) Extremes Minimum Dry Bulb	Extremes Maximum Dry Bulb	Means Rain (Inches)
January	-30	66	0.40
February	-34	71	0.40
March	-21	74	0.80
April	-8	83	1.10
May	9	91	1.30
June	25	100	1.20
July	33	100	1.60
August	36	98	1.10
September	8	95	0.90
October	-1	84	0.80
November	-21	75	0.60
December	-28	69	0.40
Yearly	-34	100	10.60

Typical Steam System

Steam Generation and Production System





Coal Conveyance

Plant Processes

Campus Heating Information

Heating System Information

- (3) IBW Coal/NG Fired Nom. 60 Klb/hr Stoker Fed 130 PSIG Steam Boilers
- (1) Keeler NG Fired, Nom. 30 Klb/hr 130 PSIG Steam boiler
- (3) 300 Ton Day Storage Coal Silos
- (3) 150 Ton Coal Bunkers
- Steam Load: 119.6 KPPH max., 11KPPH min.
- Steam Dist. Tunnels ~ 18,500LF
- Steam & Cond. DB piping ~ 25,000LF
- 5:1 Turn Down of IBW's on Coal
- Now Plant is on NG Transport
- NG Used IF Within ~$0.75/MMBTU of Coal

Campus Heating Information

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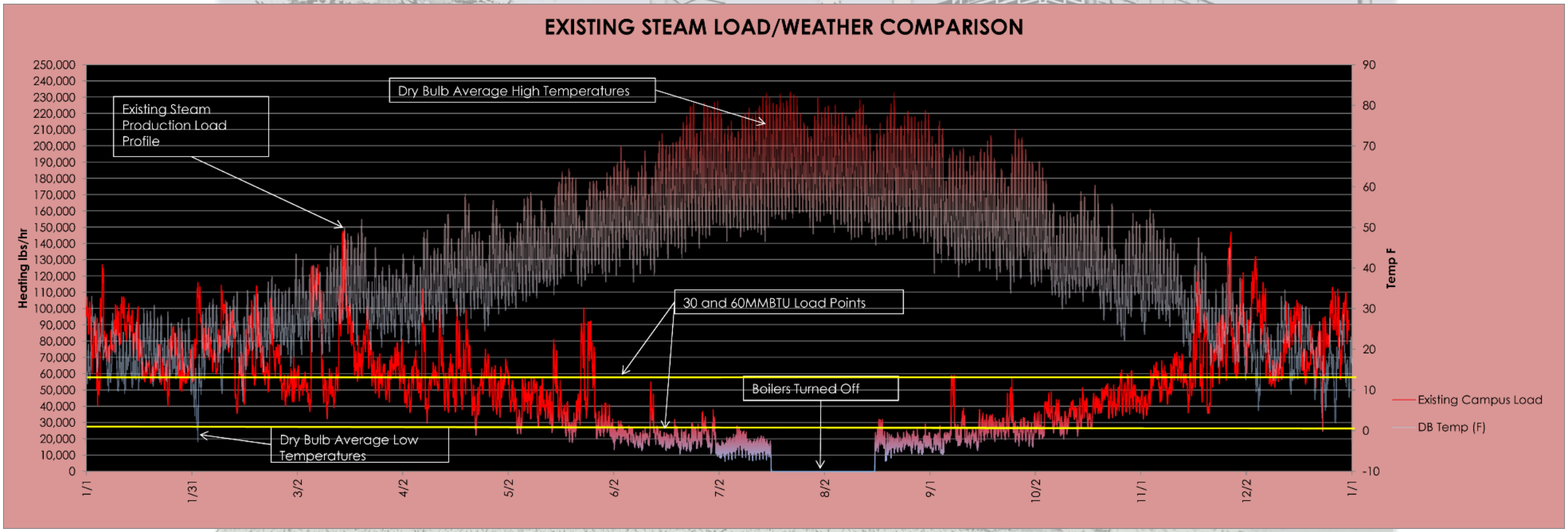
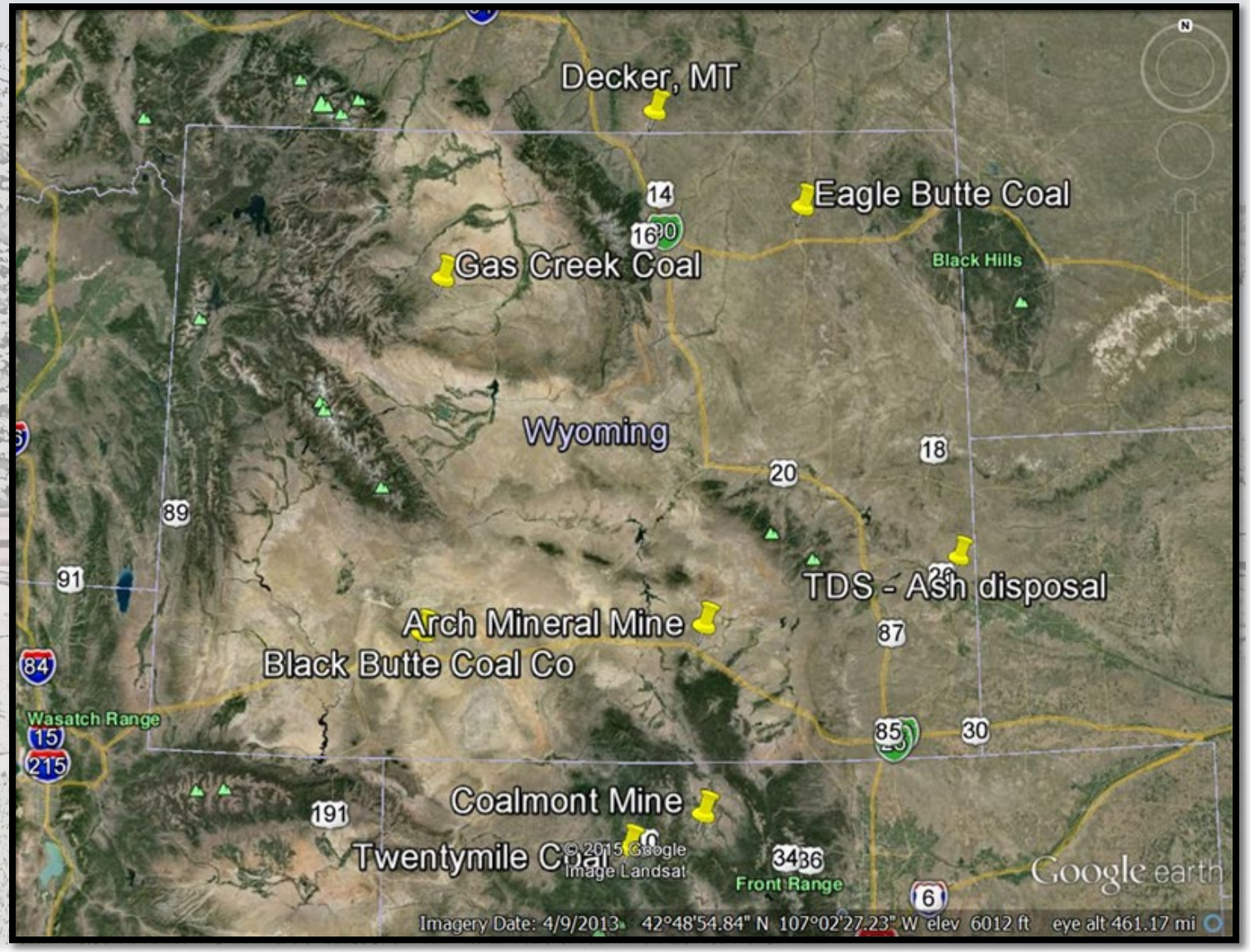
Heating Load Profile



Coal Supply

Coal Fuel Issues

- Stoker Grade
- Trucking Cost
- NG Costs
- Increased Regs
- Coal Quality
- Ash Disposal
- Reliability of supplier
- Increased
- Operational Costs



Campus Distribution

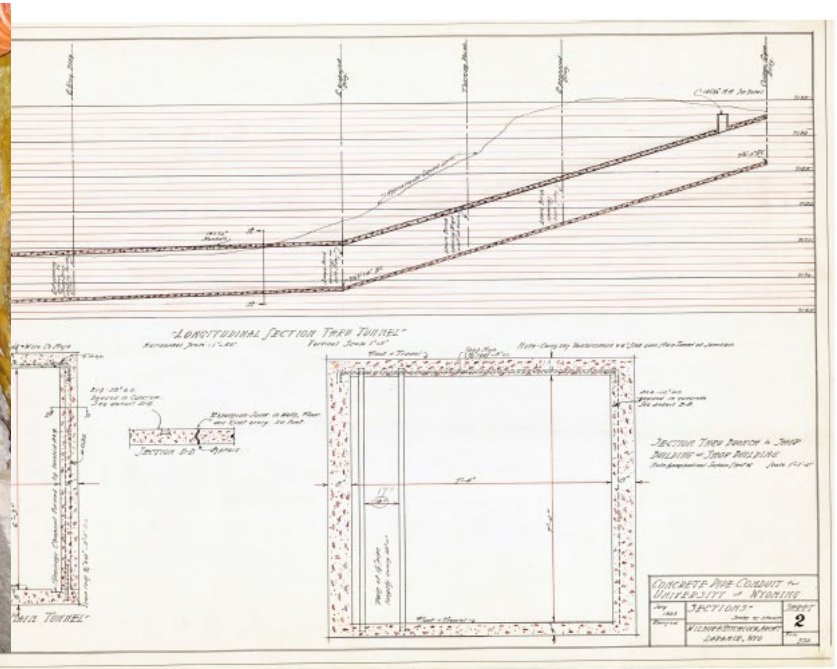
Steam Distribution Issues

- 18,500 LF of Tunnels
- ~99,000 LF St + Cond Piping
- Thermal losses in System = 12% reduction in generation capacity, ~$700K cost & a system efficiency of ~53%.
- Continuous Maintenance (4 week shut down, $350-$400K/yr.)
- Steam to HW Conversion

Campus Distribution

Steam Distribution Issues

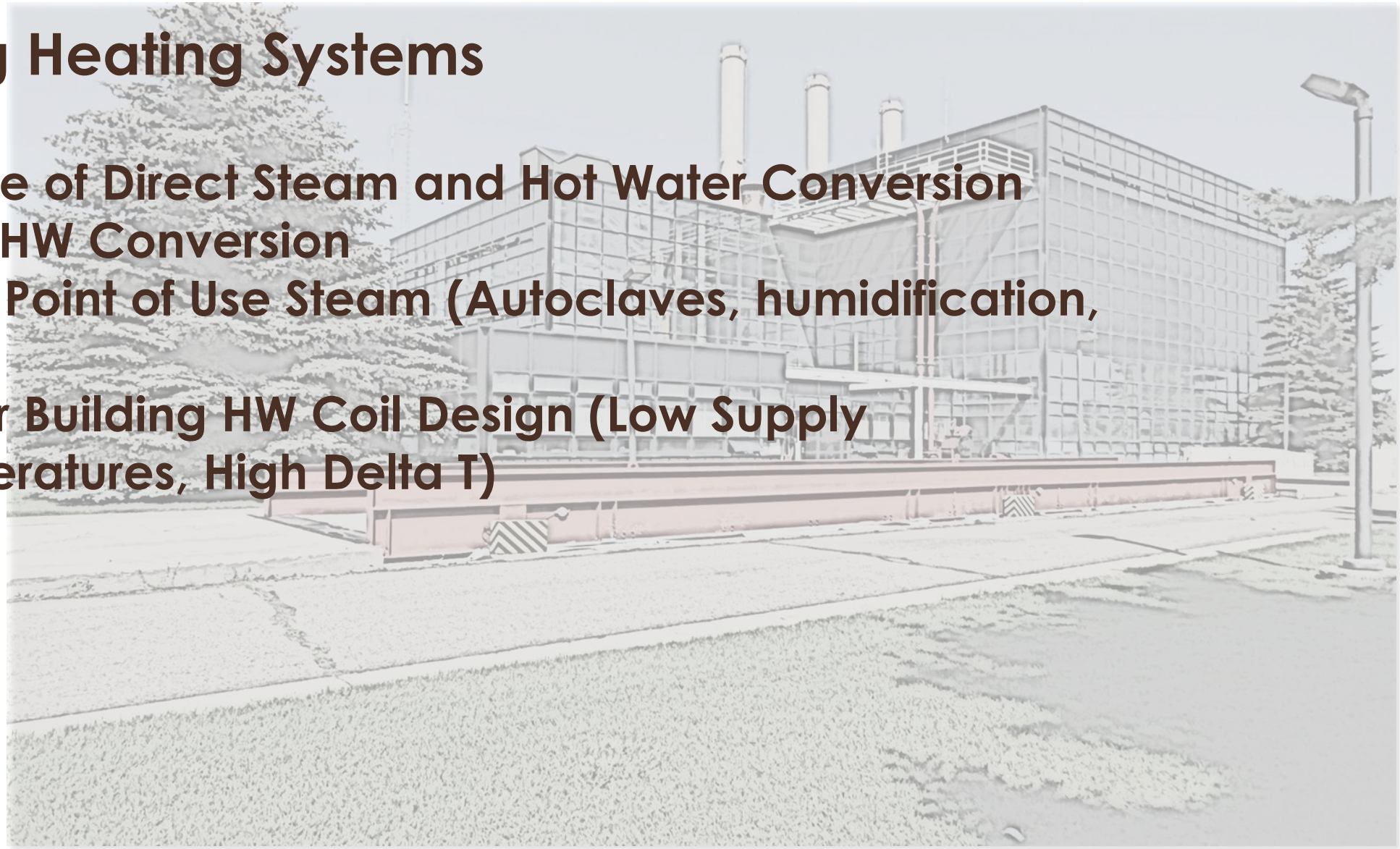
- Tunnel Structural, Asbestos & Egress Issues



Campus Heating

Building Heating Systems

- Mixture of Direct Steam and Hot Water Conversion
- Local HW Conversion
- Some Point of Use Steam (Autoclaves, humidification, etc.)
- Newer Building HW Coil Design (Low Supply Temperatures, High Delta T)



O&M

Operations and Maintenance Costs

- Coal Systems Require Continuous 24/7 Support
- Steam Systems Require a High Level of Maintenance
  4 week shutdown
  ~$400K/yr. being spent on Shut Downs
  $6.7M spent on CEP Repairs Since 2007
- Coal & Ash Conveying
  are High Wear Systems
- Stoker Boilers are Dinosaurs
- PRV Maintenance Cost
- Costly Repair Parts Costs
- Lack of Coal Boiler
  Technician Expertise

Thermodynamics

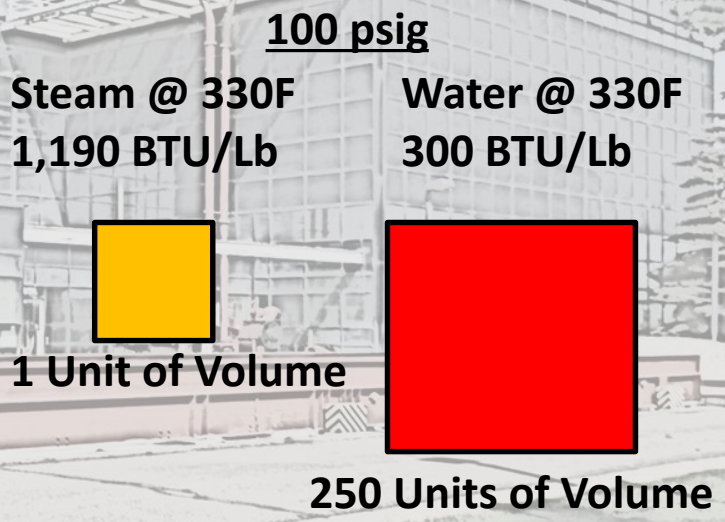
Typical Steam Generation and Production System

Pros

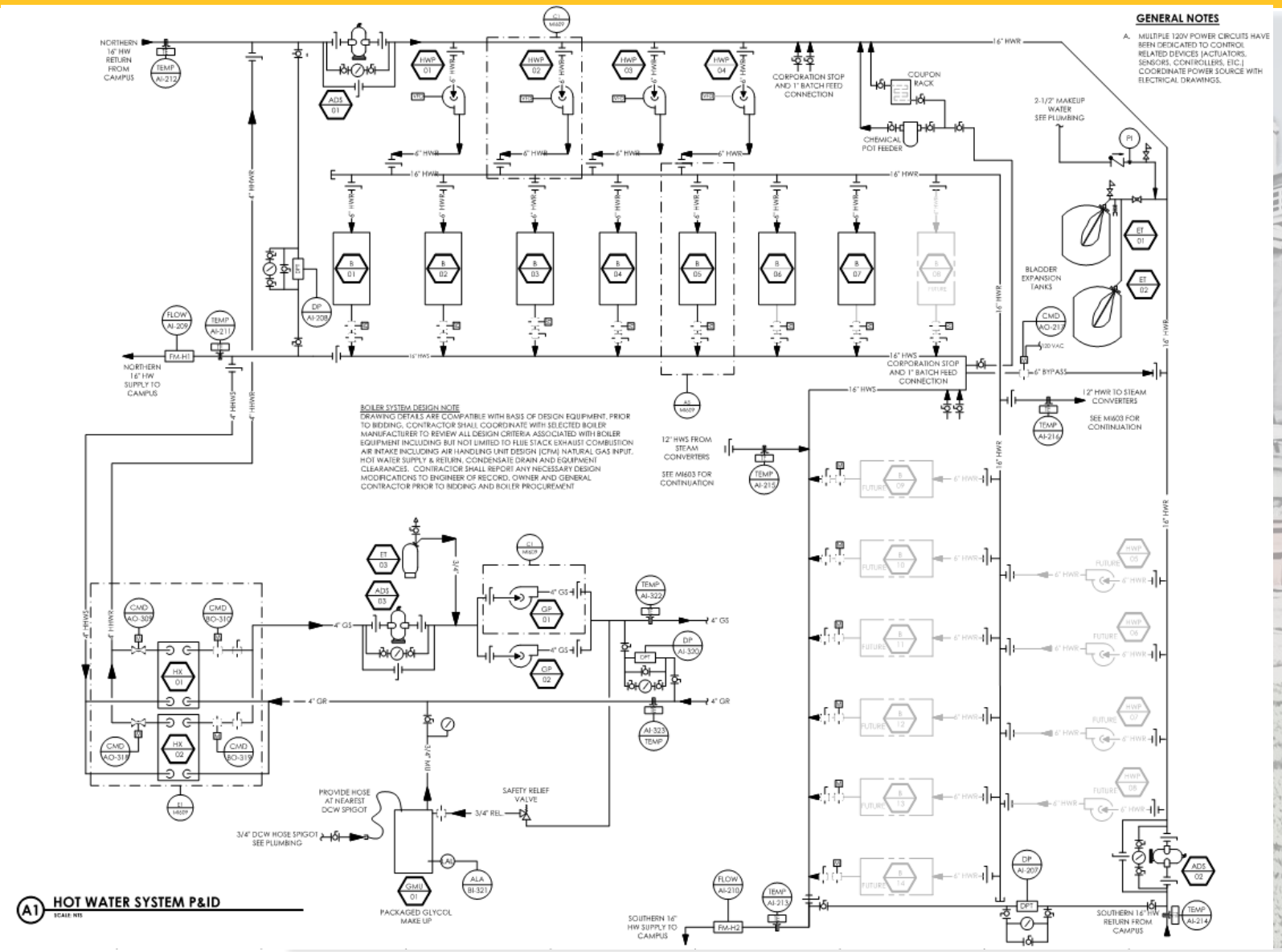
- High Energy Density
- Low Changes in Temperature
- Existing Infrastructure (UW)

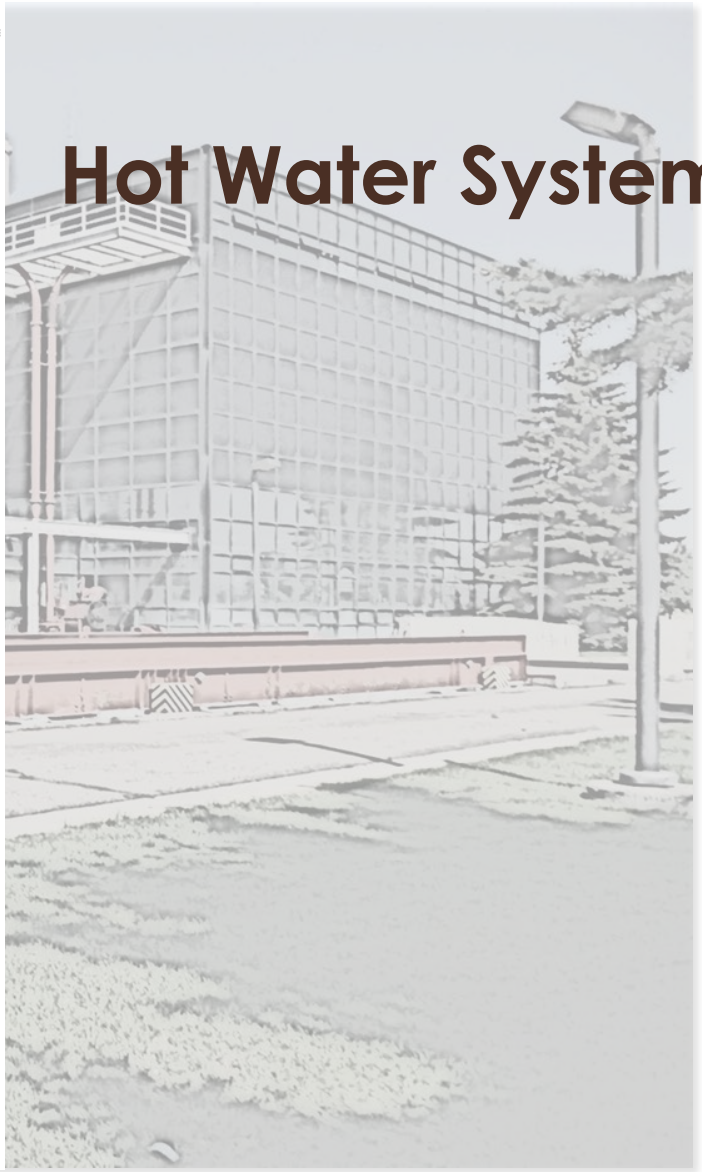
Cons

- Many Components
- Harsh Environment
- Energy Lost (heat and mass)
- High Repair Costs
- Gravity Return Required (or the need for pumps)
- Potential for Water Hammer
- Low System Efficiency



Hot Water System





Hot Water System

Hydronic Systems

Typical HW Generation and Production System

Pros

- Lower Temperature Operation
- System Efficiency
- Number of System Components
- Less of a Hazard over Steam
- Closed System
- Less potential for System Heat Loss
- Overall lower Installed and Operational Costs

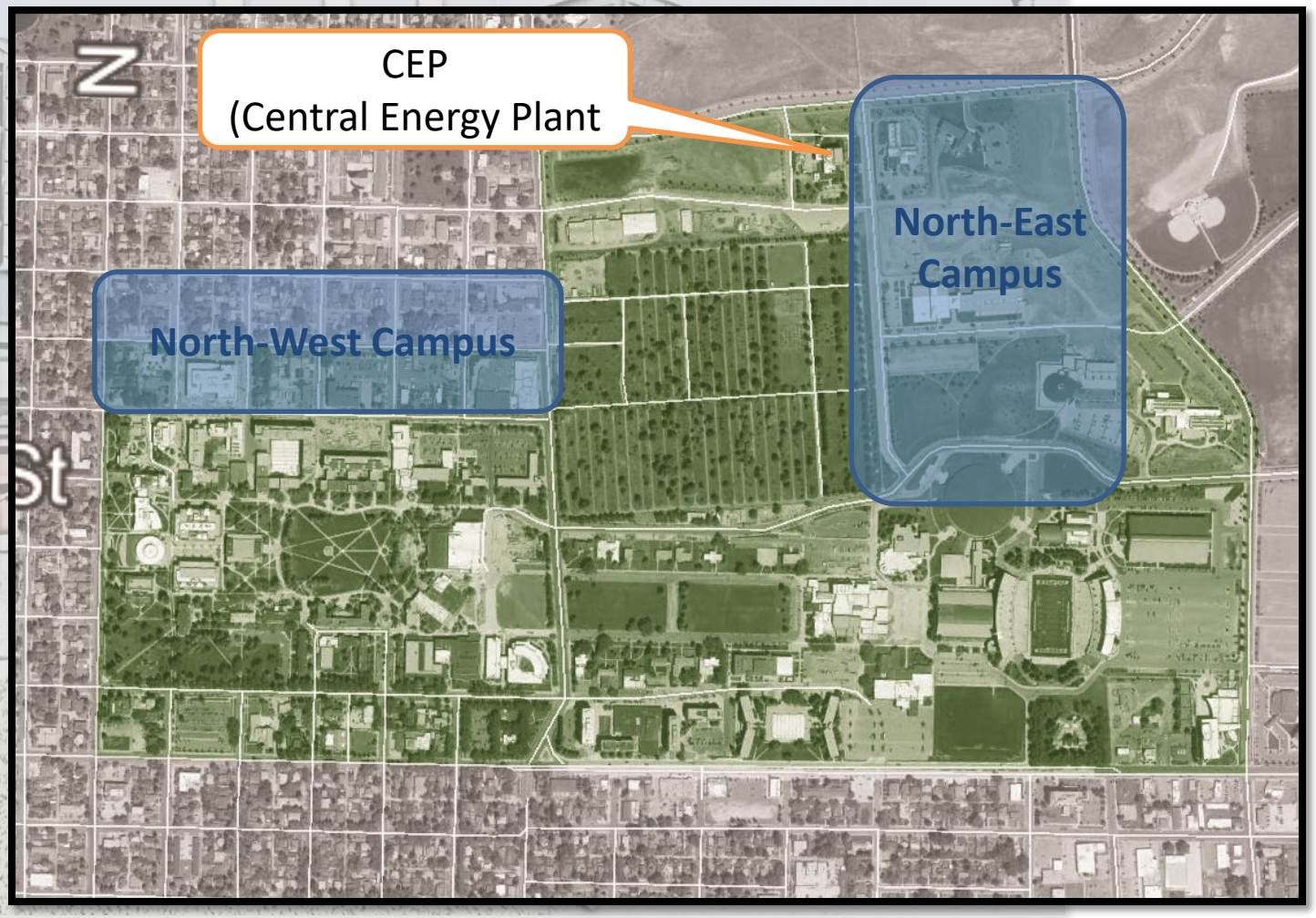
Cons

- Larger Piping
- Distribution Pumps
- Flat Plate HX's at each service

Capacity vs Load Growth

Projected Major Growth Areas

- North-West Campus-Project Focus
- North-East Campus



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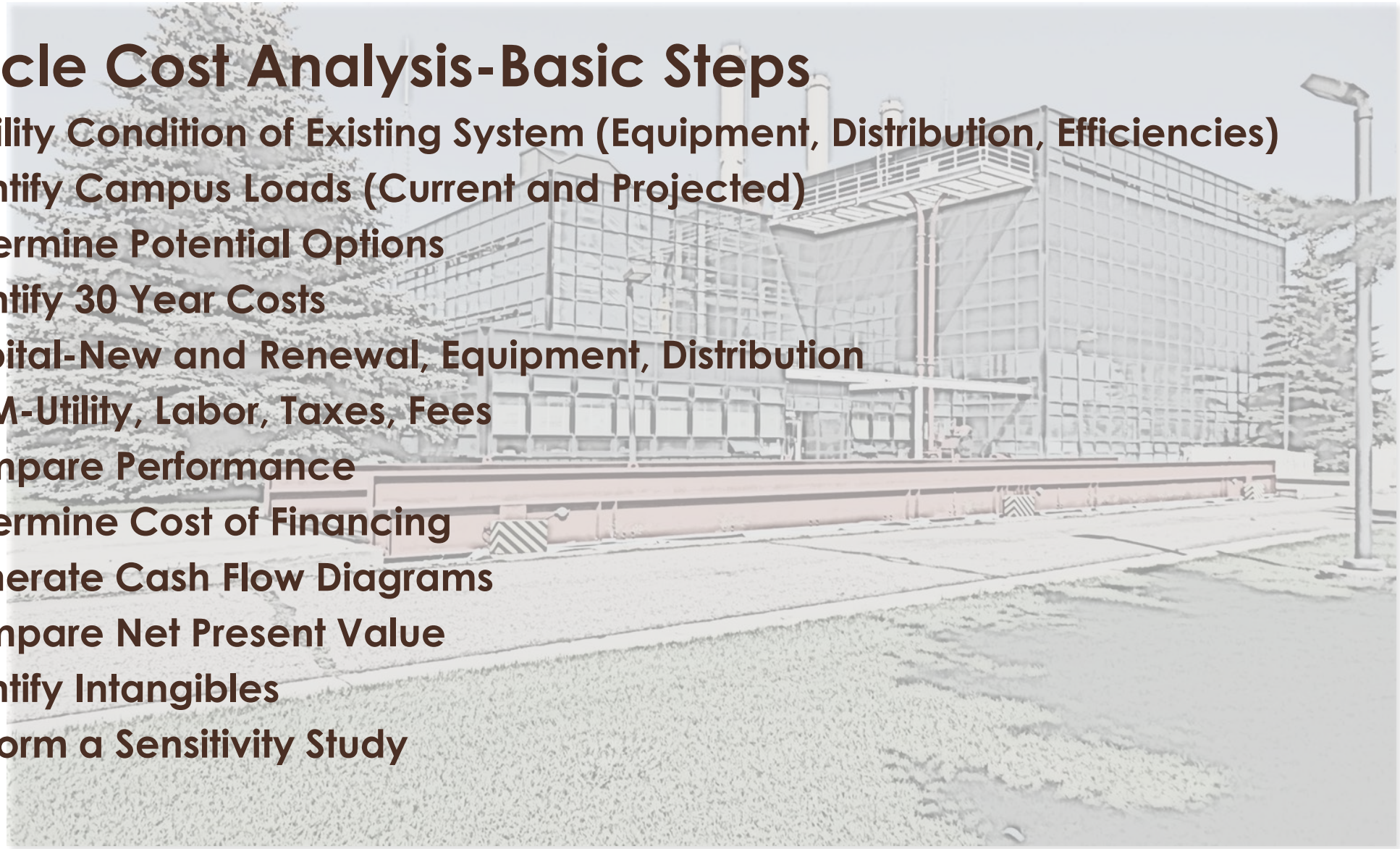
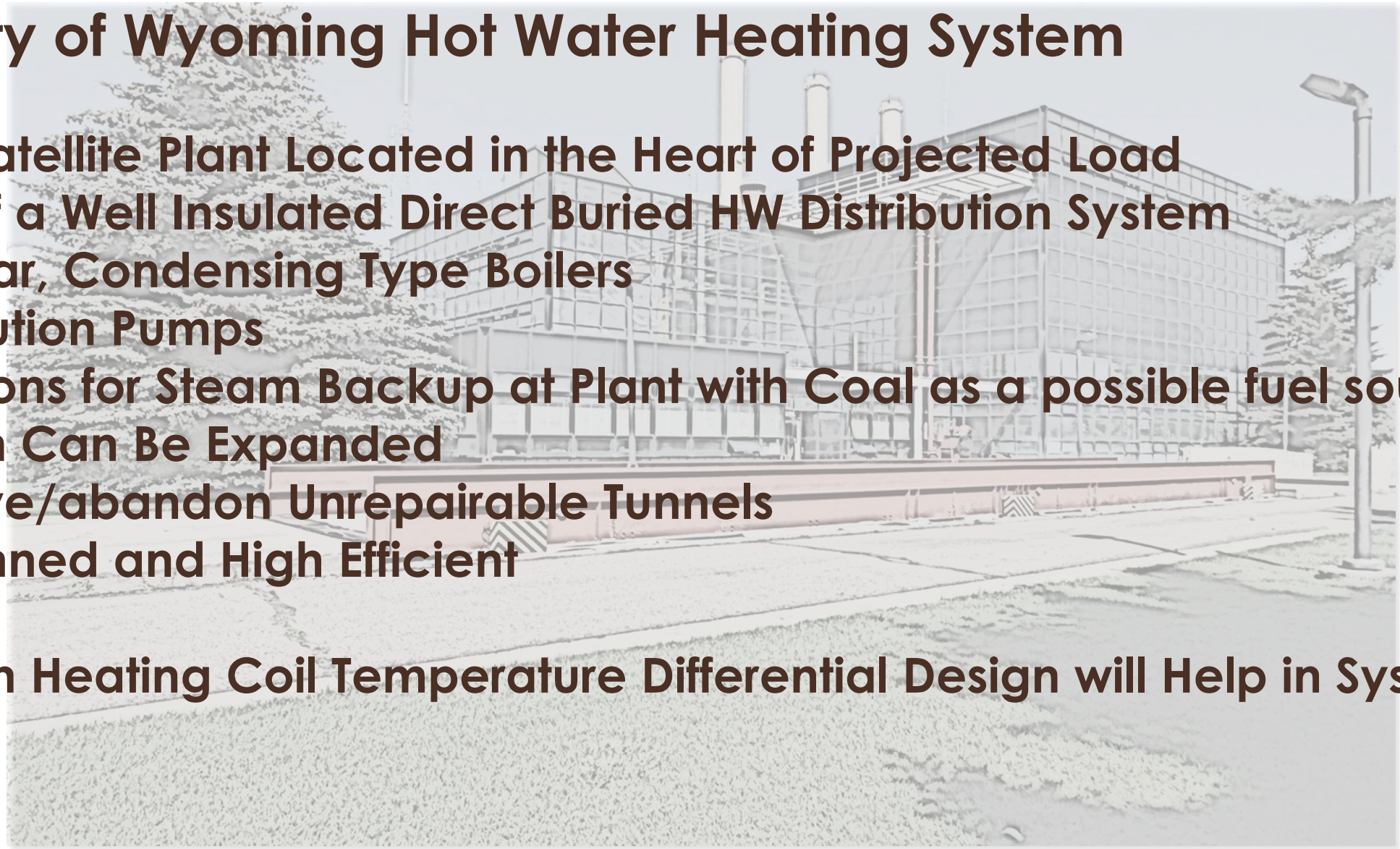
Life Cycle Cost Analysis-Basic Steps

- Facility Condition of Existing System (Equipment, Distribution, Efficiencies)
- Identify Campus Loads (Current and Projected)
- Determine Potential Options
- Identify 30 Year Costs
- Capital-New and Renewal, Equipment, Distribution
- O&M-Utility, Labor, Taxes, Fees
- Compare Performance
- Determine Cost of Financing
- Generate Cash Flow Diagrams
- Compare Net Present Value
- Identify Intangibles
- Perform a Sensitivity Study



Analysis Results

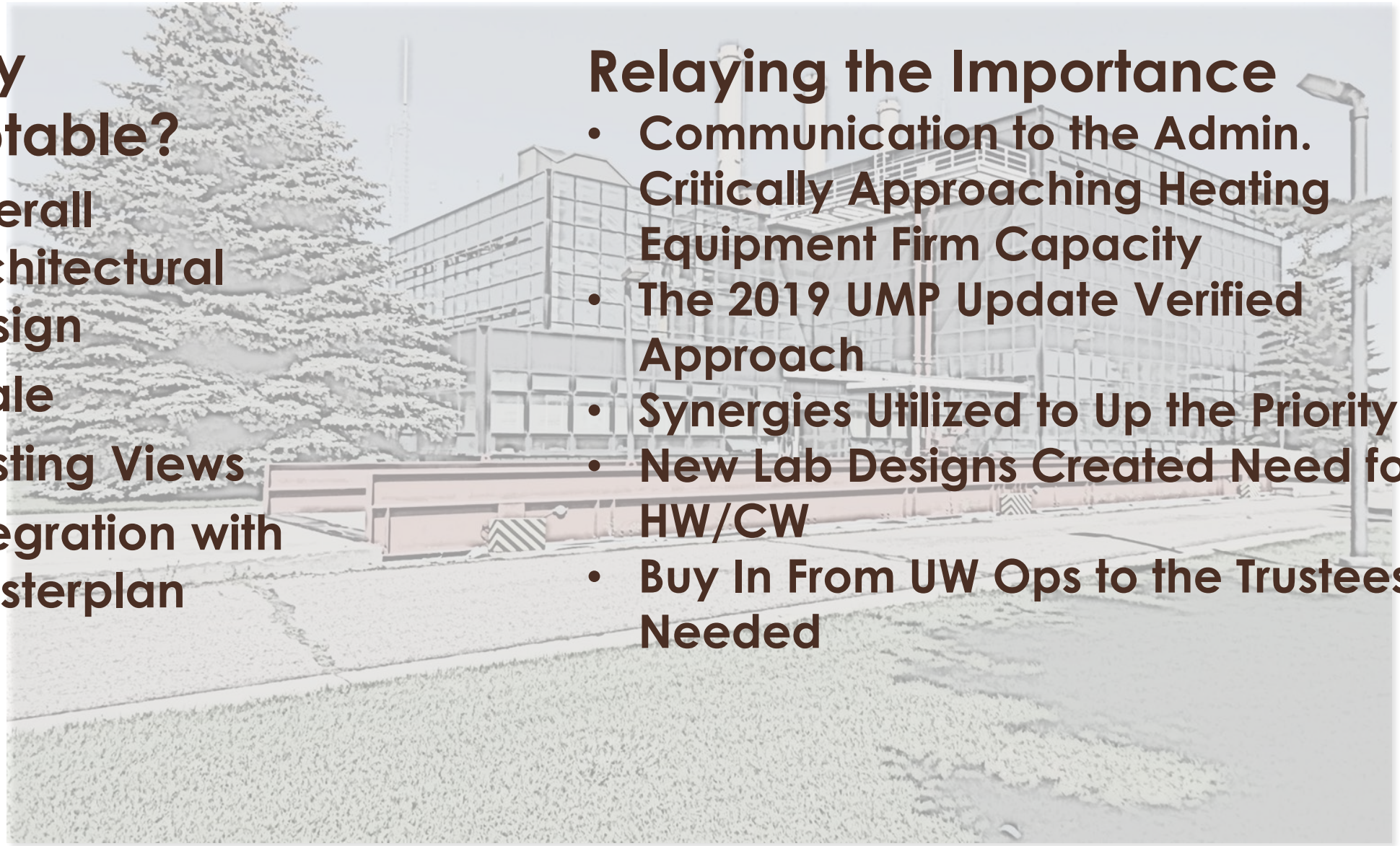
University of Wyoming Hot Water Heating System



- New Satellite Plant Located in the Heart of Projected Load
- Start of a Well Insulated Direct Buried HW Distribution System
- Modular, Condensing Type Boilers
- Distribution Pumps
- Provisions for Steam Backup at Plant with Coal as a possible fuel source
- System Can Be Expanded
- Remove/abandon Unrepairable Tunnels
- Unmanned and High Efficient

Note: High Heating Coil Temperature Differential Design will Help in System Efficiency

Appearance / Financial Decisions



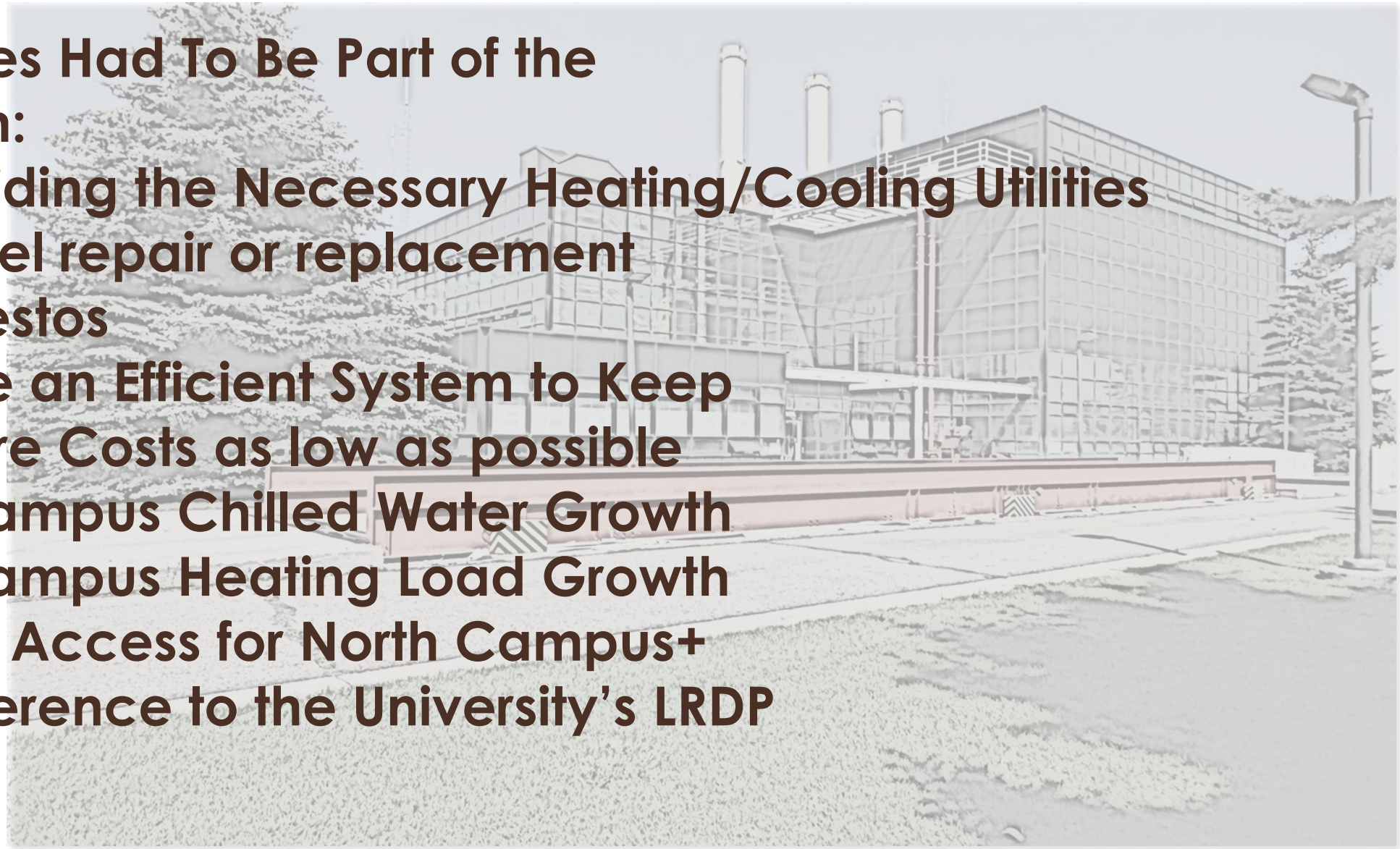
Visually Acceptable?

- Overall Architectural Design
- Scale
- Existing Views
- Integration with Masterplan

Relaying the Importance

- Communication to the Admin. Critically Approaching Heating Equipment Firm Capacity
- The 2019 UMP Update Verified Approach
- Synergies Utilized to Up the Priority
- New Lab Designs Created Need for HW/CW
- Buy In From UW Ops to the Trustees Needed

Appearance / Financial Decisions



All Issues Had To Be Part of the Solution:

- Providing the Necessary Heating/Cooling Utilities
- Tunnel repair or replacement
- Asbestos
- Have an Efficient System to Keep Future Costs as low as possible
- W Campus Chilled Water Growth
- W Campus Heating Load Growth
- ADA Access for North Campus+
- Adherence to the University's LRDP

Appearance

Architectural Design

Contemporary Architecture

Classical Architecture

Appearance

UNIVERSITY OF WYOMING

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Compare Costs and Acceptable Solutions

- 2018 Exterior Design Advisory Committee
  - Architectural Design
  - Location
  - Future Vision of the University

University of Wyoming

Outcome

- Transition to a Natural Gas fired, Hot Water Production/ Distribution System with Steam Backup
- Standardize new Campus Design Requirements & relocated site further to the north
- Phase I Construction complete Spring 2021

Q&A

Thank You!

Open Question Session

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