



# CampusEnergy2021

BRIDGE TO THE FUTURE

Feb. 16-18 | CONNECTING VIRTUALLY

WORKSHOPS | Thermal Distribution: March 2 | Microgrid: March 16



# 20 Years of Using Hydraulic Modeling to Aid in Campus Expansion

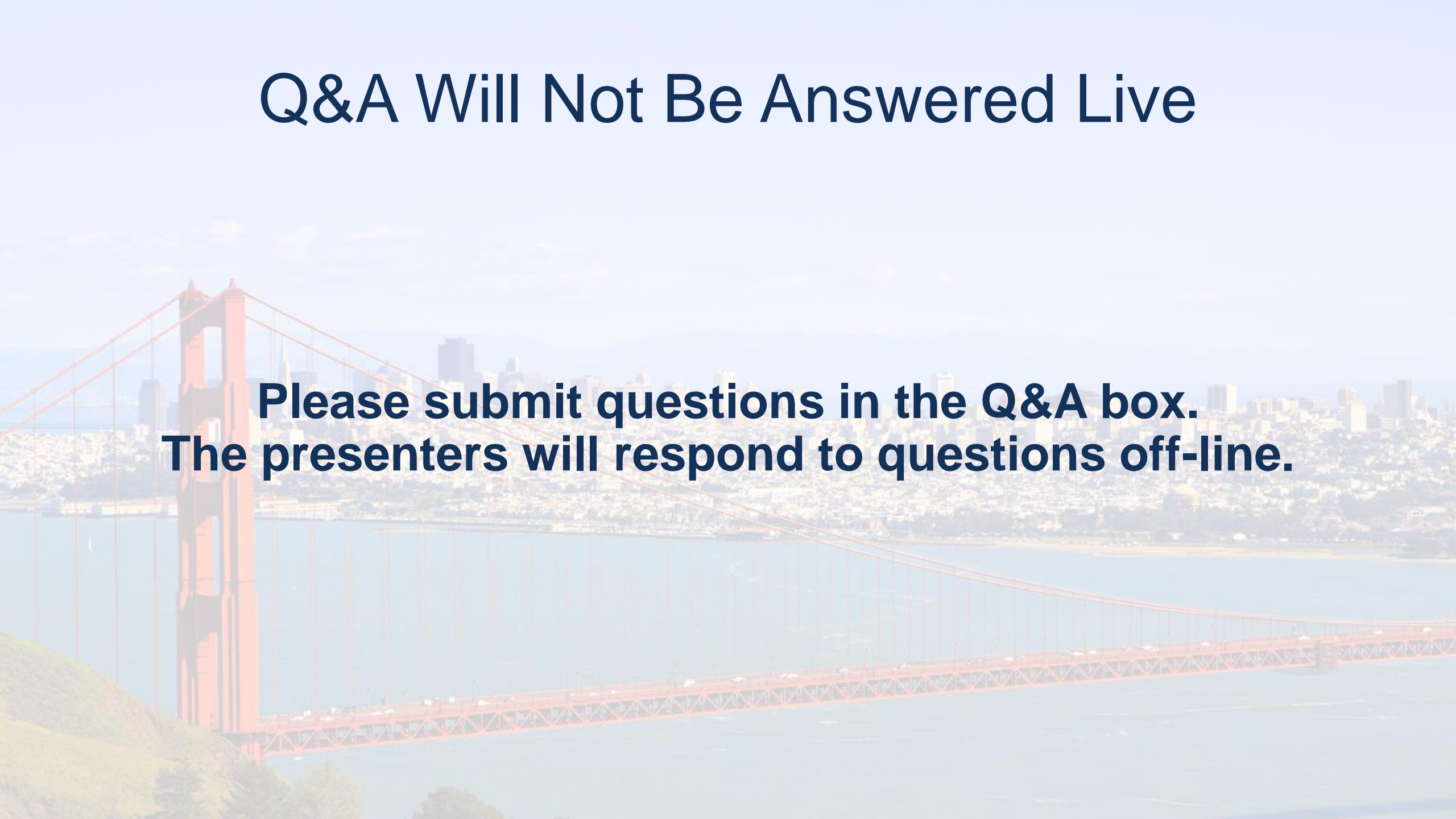
Rob Engle – Auburn University

John Lee – Burns & McDonnell



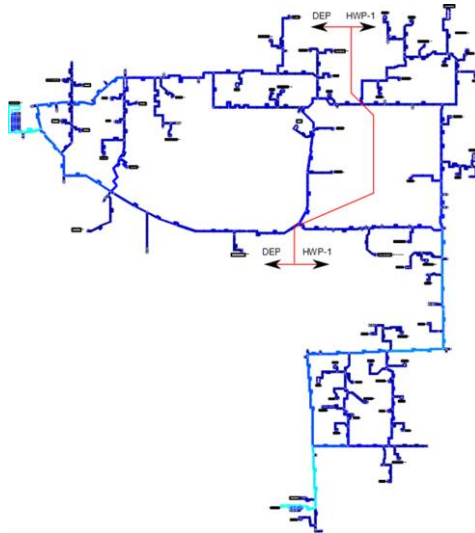
# Q&A Will Not Be Answered Live

**Please submit questions in the Q&A box.  
The presenters will respond to questions off-line.**



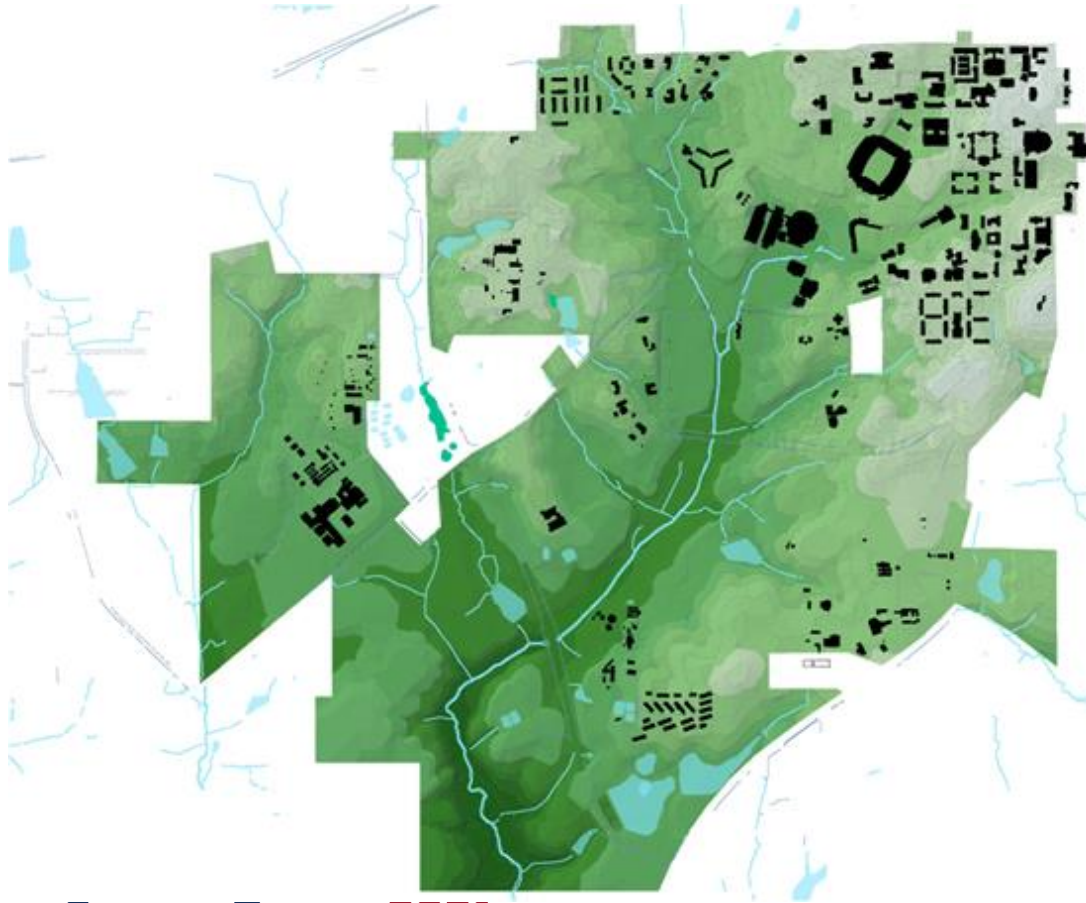
# Agenda

*To provide an overview of the capabilities and importance of using hydraulic modeling as a tool for successful campus expansion*



1. Campus Growth
2. Infrastructure Growth and Changes
3. Importance of Hydraulic Modeling
4. Considerations After 20 years of Growth and Change

# Campus Growth – Pre 2002



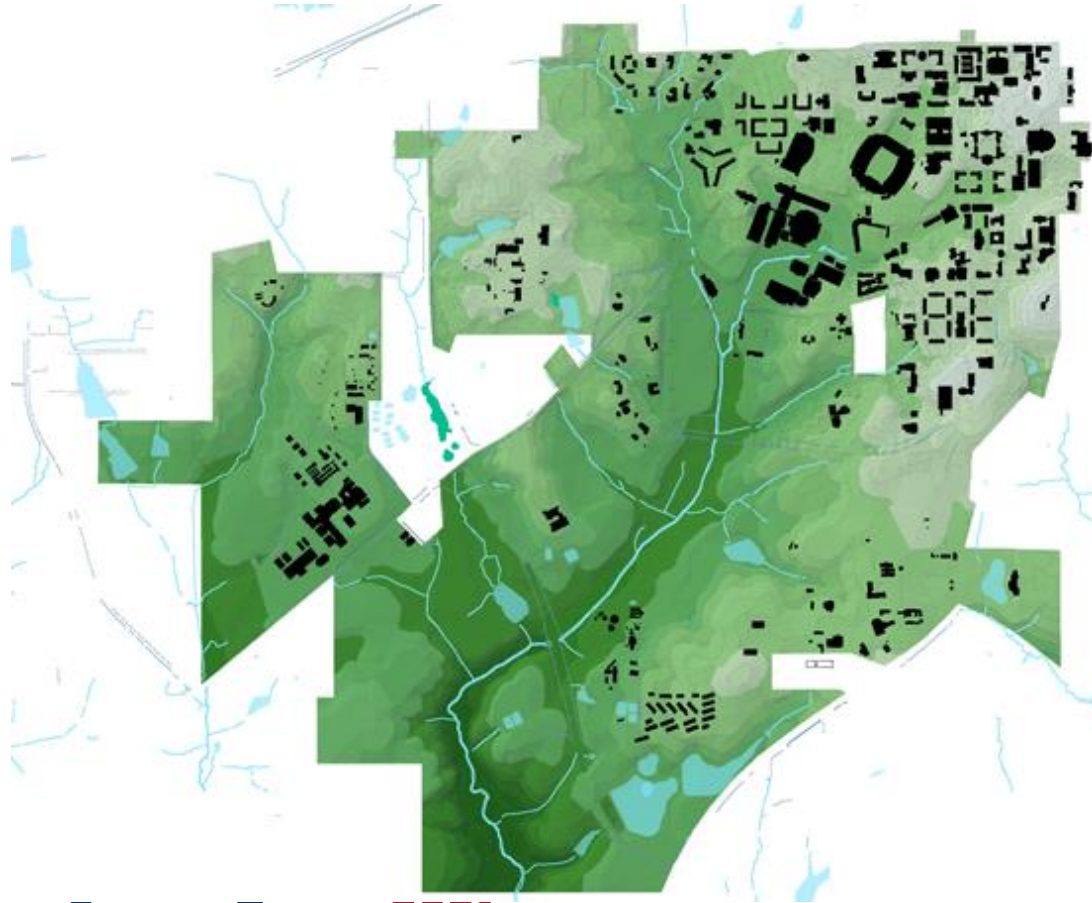
- Occupies ~4.87M gsf (1,870 acre campus)
- Enrollment ~22,000 students
- Main Campus in 2 Identifiable parts
  - Northeast Corner
    - Research and Academic Core
  - South and West area
    - Open space, agriculture, sports and recreation fields



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# Campus Growth – 2002-2010



- Over 3M SF added between 2007 and 2013
  - 26 new facilities added
  - 5 facilities removed

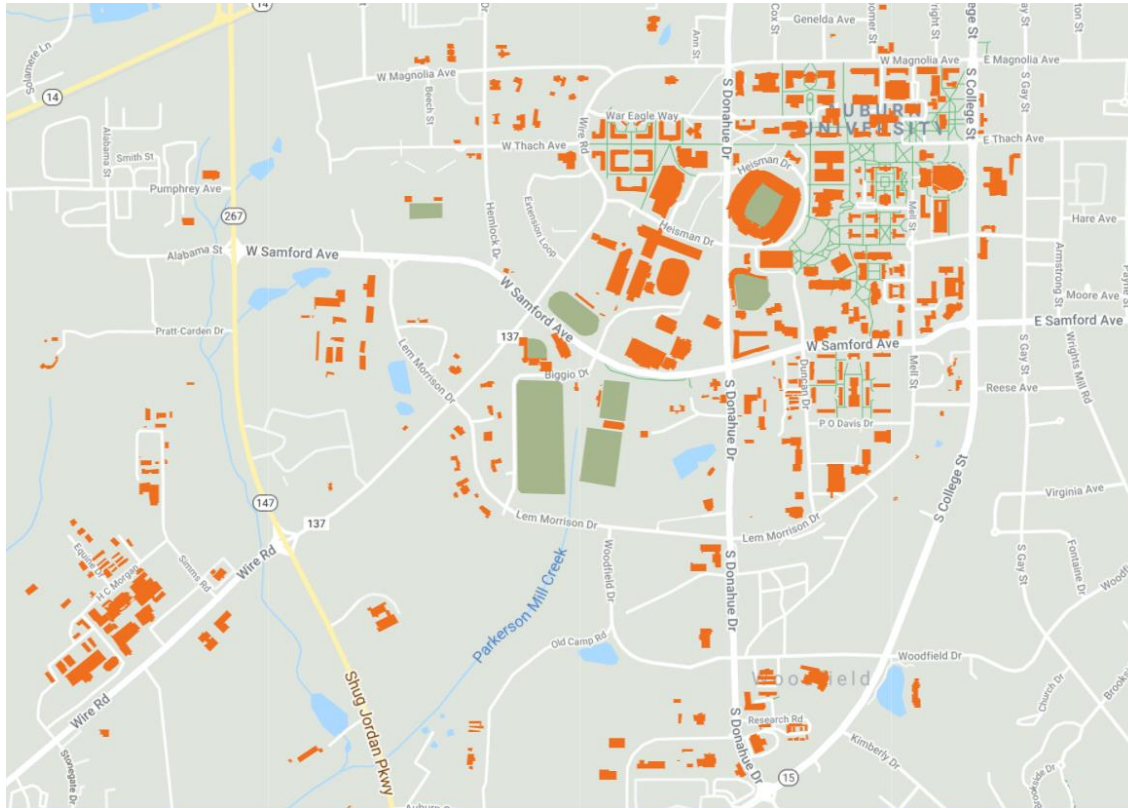


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# Campus Growth - Today



- Enrollment ~30,700 students
- 427 Total Buildings
- GSF: 12M+



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# Campus Growth – Chilled Water System

- 2000

- Peak Load: ~10,500 tons
- Served by 2 central plants
- Total install capacity of 10,500 tons
- 16-year-old system
- Primary/Secondary Pumping w/ constant speed tertiary pumps in buildings

- 2020

- Peak Load: ~15,500 tons
- Served by 3 central plants
- Total install capacity of 23,000 tons
- Primary/Secondary Pumping w/ variable speed tertiary pumps in buildings



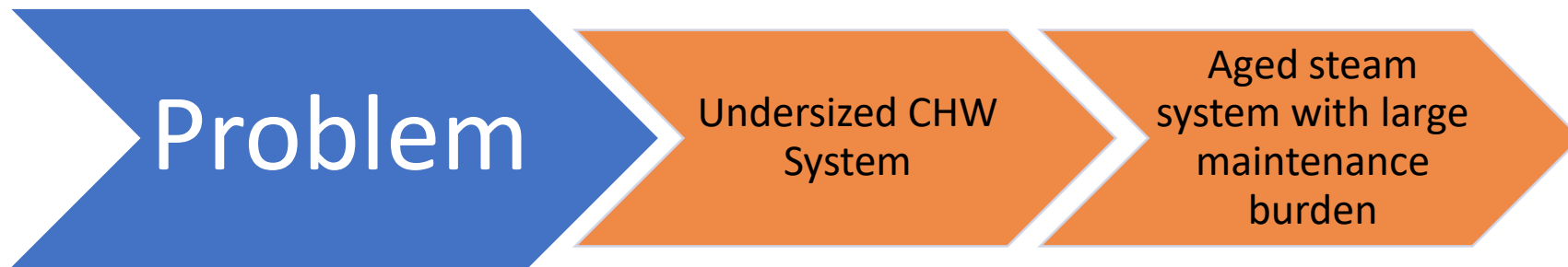
# Campus Growth – Hot Water System

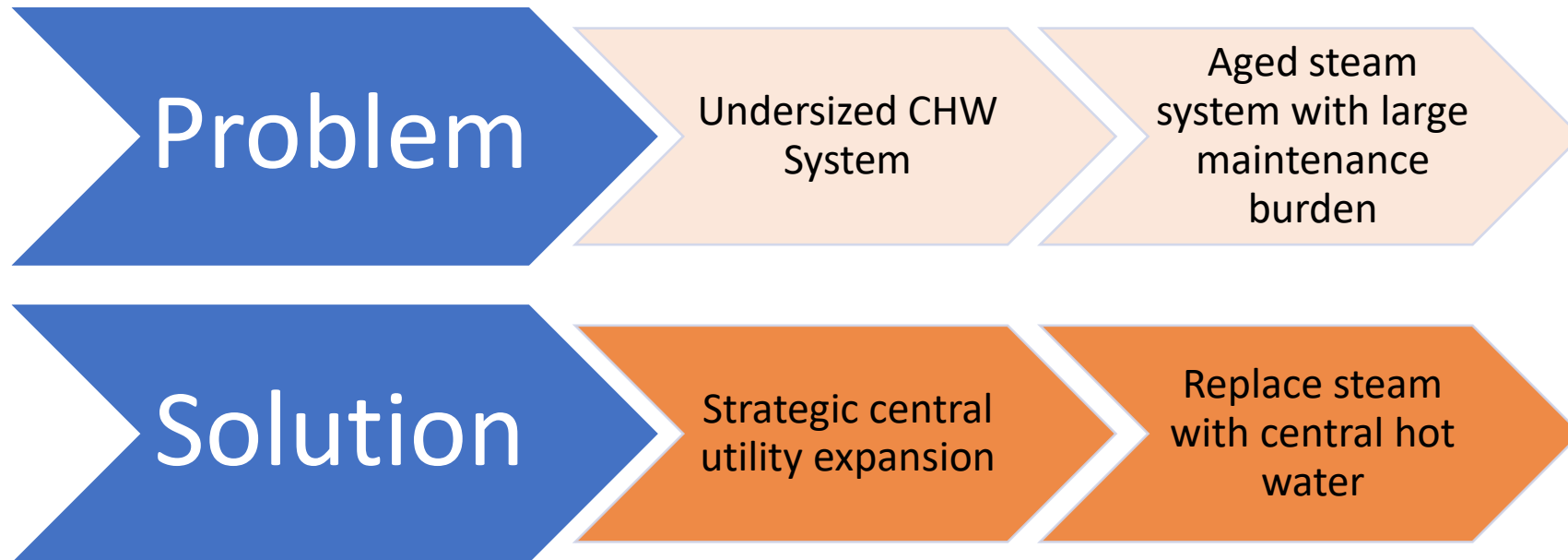
- 2000
  - Steam System
    - Main campus steam loop served by two steam plants. (serves ~1.9MSF)
    - Four additional smaller steam loops.
    - Individual building boilers
  - Most convert steam to hot water in buildings
  - Direct buried steam/condensate distribution
  - Maintenance issues with condensate piping due to contamination from leaking coils
- 2020
  - Central hot water system served by 2 central plants.
  - Decoupled through plate and frame heat exchangers at the buildings
  - Two small steam systems remain in service. Scheduled to be removed and added to hot water system.



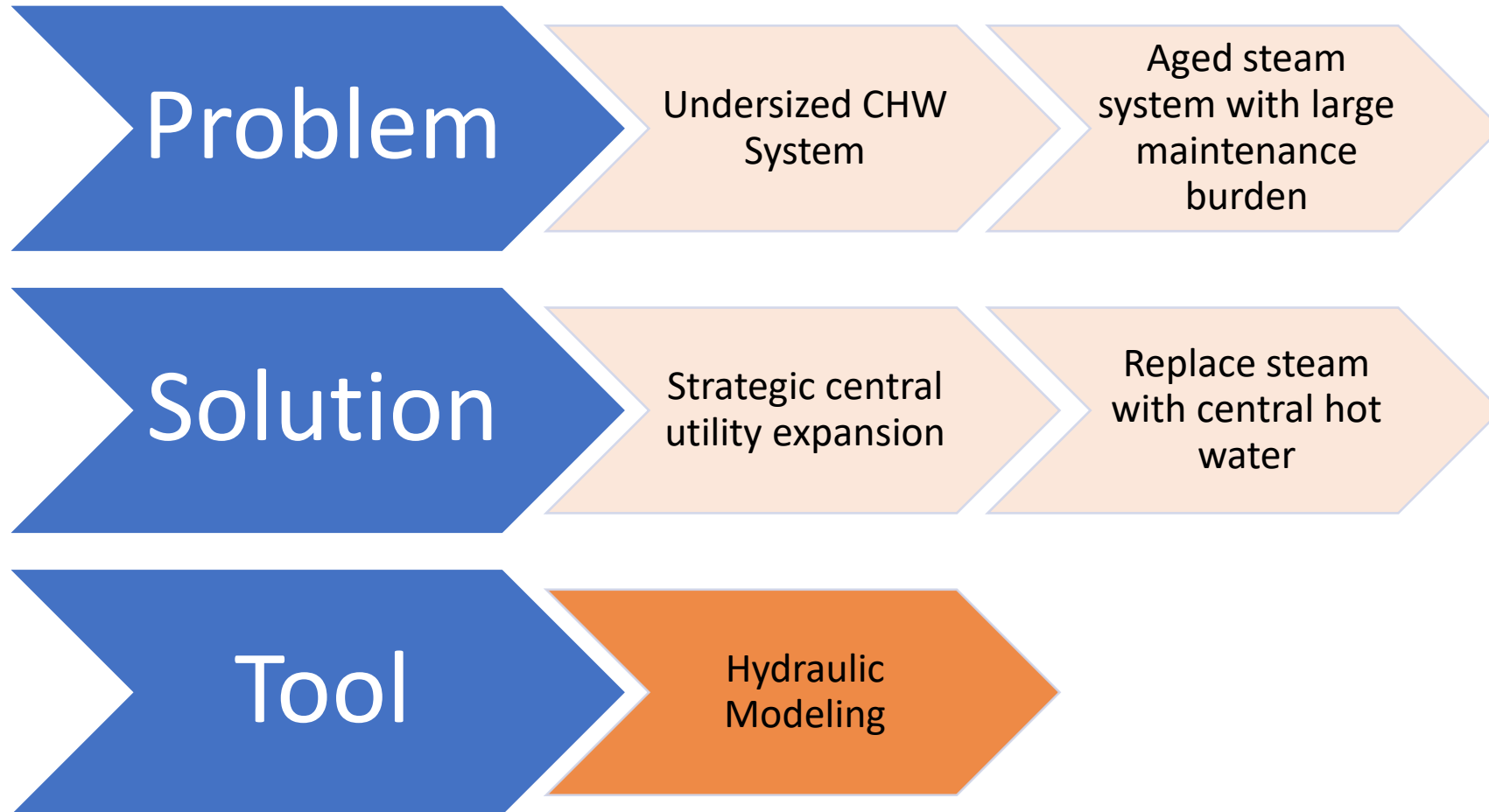
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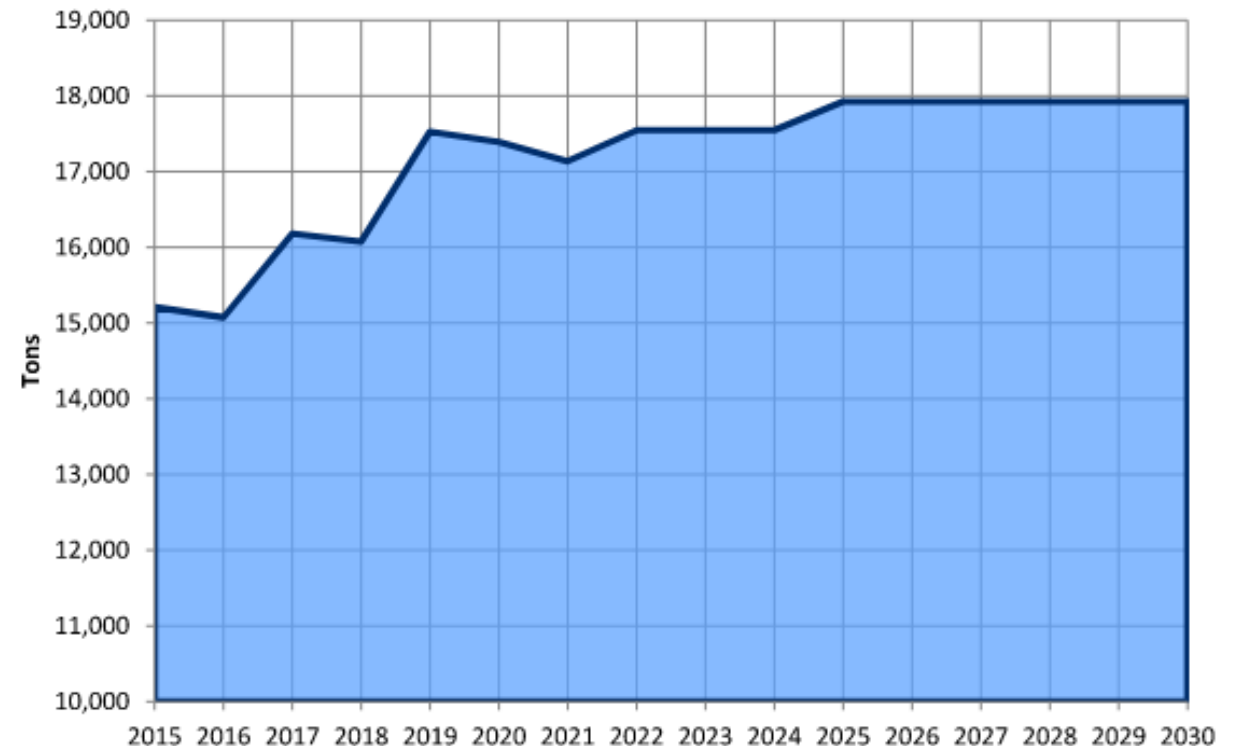


# Hydraulic Modeling at Auburn

- AFT Fathom
- Flow Model of complete distribution network
- Inputs:
  - Distribution Pumps
  - Distribution Pipe
    - length/size/material
    - elevation
    - Isolation Valves
  - Building Data
    - Connection (pump/HEX/CV)

# Hydraulic Modeling at Auburn

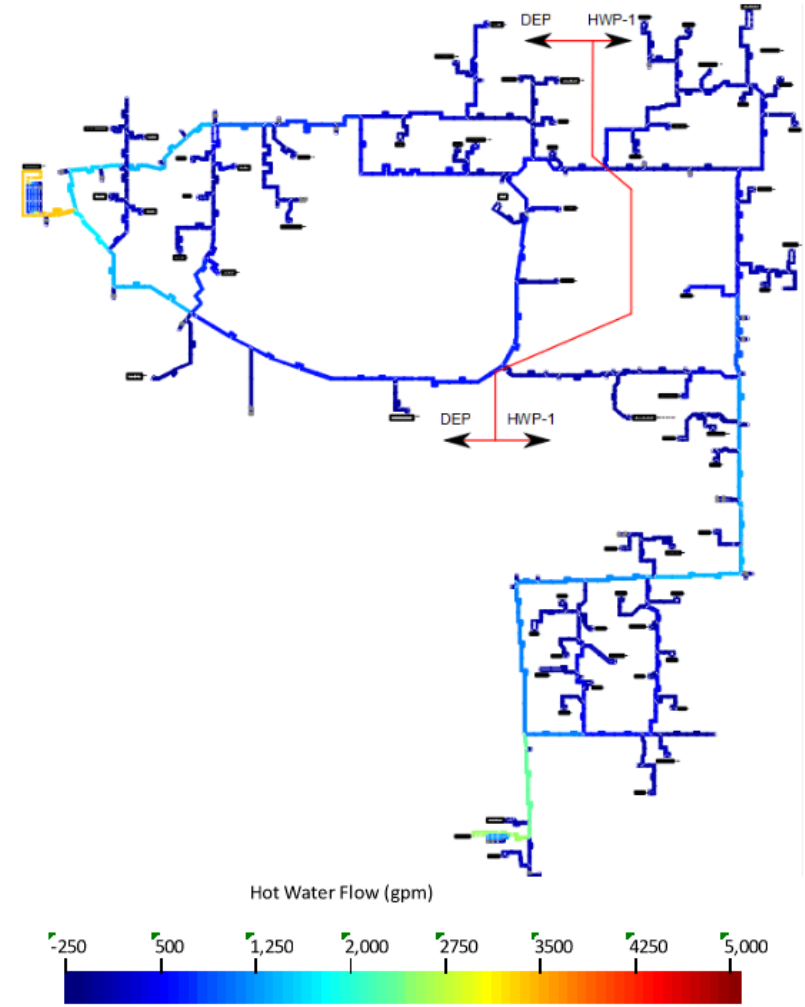
- Initial modeling used for expansion decisions and central plant placement.
- New model developed in 2012





# Hydraulic Modeling at Auburn

- GIS Information
- Graphically accurate
  - Troubleshooting
  - Discussions

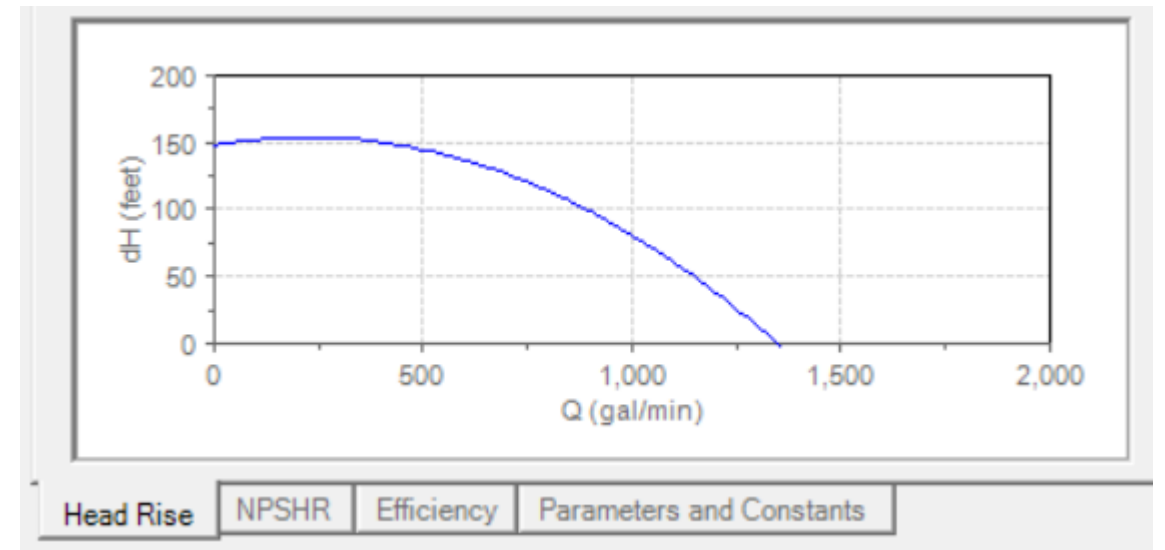


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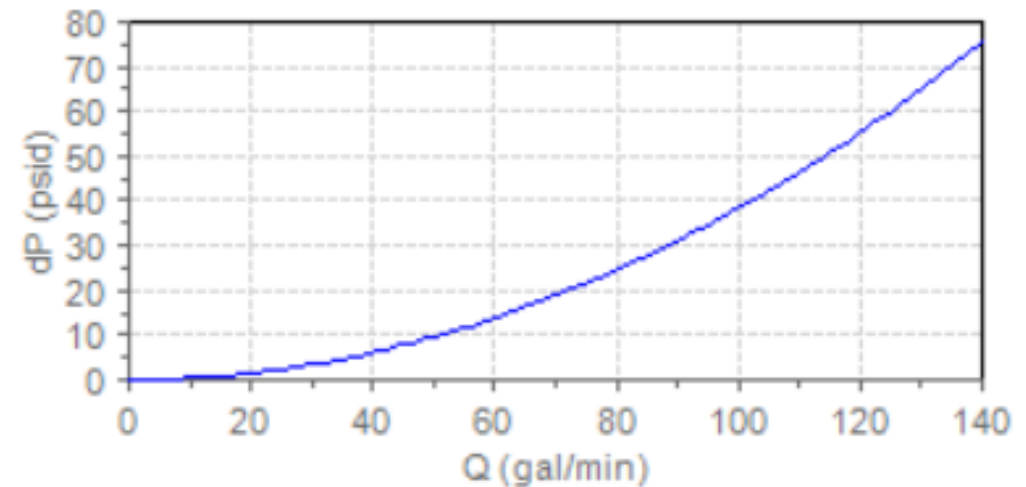
# Hydraulic Modeling at Auburn

- Central Distribution Equipment
  - Modeled developed on design data
    - Pump Curves
      - Variable Speed Pumps
      - Operations (Lead/Lag)
    - Control Valves
    - Equipment flow constraints



# Hydraulic Modeling at Auburn

- Building Data
  - Design Data Used
    - Control Valve Flow Parameters
    - Heat Exchangers Pressure Drop
    - Pumps
  - Design Loads



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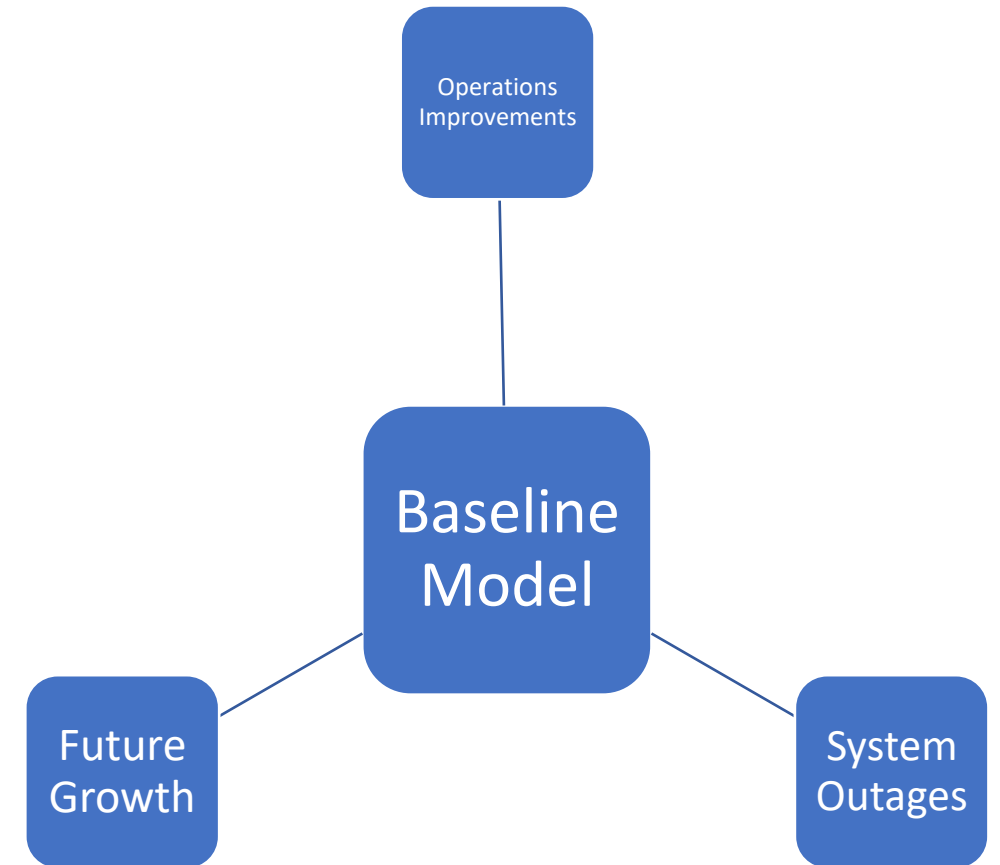
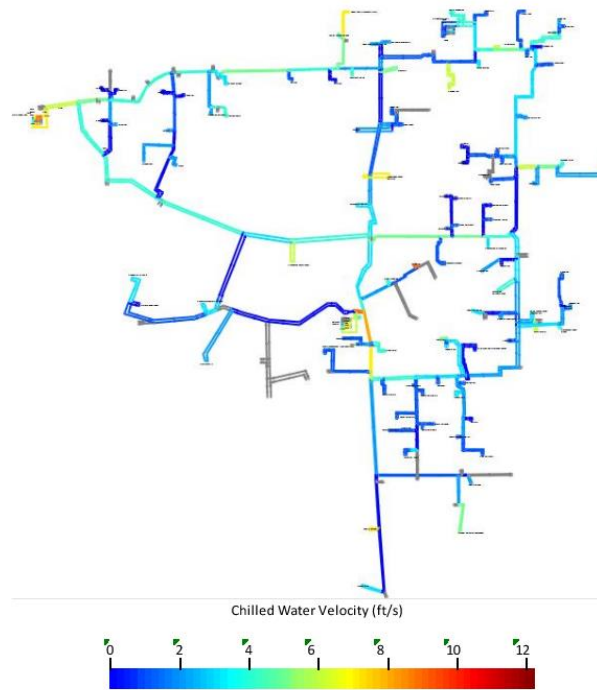
- Base Model Developed
  - Model Calibration
    - Trended Data (flow, pressure)
      - Central Plants
      - Buildings
        - Established Load Diversity
  - Iterative Process
  - Load Point Sensitivity
    - Max/Min/Average

Buildings	Hot Water Load (MBH)		
	2:00 AM	7:00 AM	2:00 PM
Village View (Student) Dining Hall	1,888	1,747	1,114
Aubie Hall (4C)	1,224	1,478	569
Tiger Hall (6D)	224	488	187
Talon Hall (7E)	173	356	0
Plainsman Hall (8E)	107	300	0
Willow Hall (3B)	458	579	0
Oak Hall (2B)	478	747	707
Magnolia Hall (1A)	587	775	265
Basketball Arena	2,246	3,001	1,237
Petrie Hall	210	163	82
Miller Gorrie Building	0	484	306
Science Center Classroom	107	432	80
Cary Hall	0	0	0
Thach Hall	114	1,238	178
Harbert Civil Engineering	611	652	490
Ramsay Hall	381	440	193
Dunn Hall	96	254	98
Dowell Hall	18	18	4
Boyd Hall	155	194	157
Poultry Science Center	911	1,194	909
Forestry & Wildlife Sci.	991	1,396	509
Medical Clinic	103	1,146	181
<b>Total</b>	<b>11,081</b>	<b>17,083</b>	<b>7,268</b>
*Data from January 19, 2012			
*Daily weather data; 59°F High, 30 °F Low			
*Table Legend			
	High	Medium	Low



# Hydraulic Modeling at Auburn

- Complete Model – Now What?



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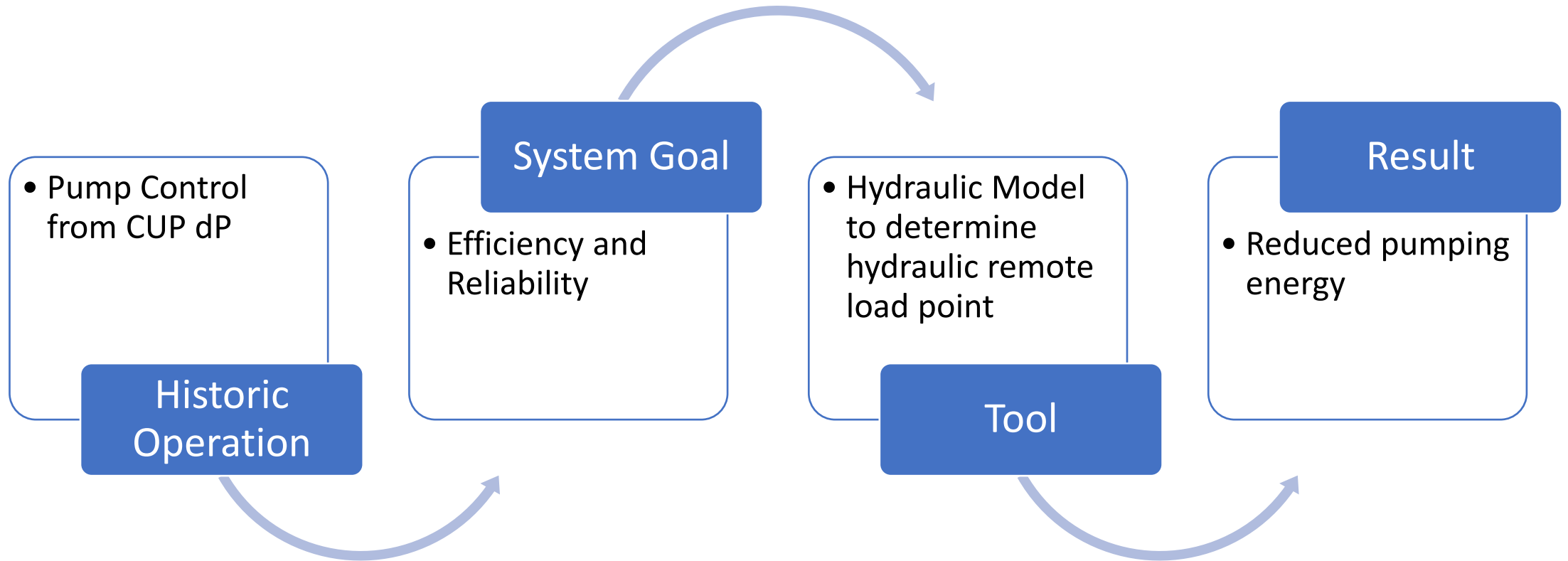


# Hydraulic Modeling at Auburn

## Operations Goal – Reliability and Efficiency

- Prioritization – Equipment Efficiency
- Seasonal Plant Impacts
- Evaluate historical operations

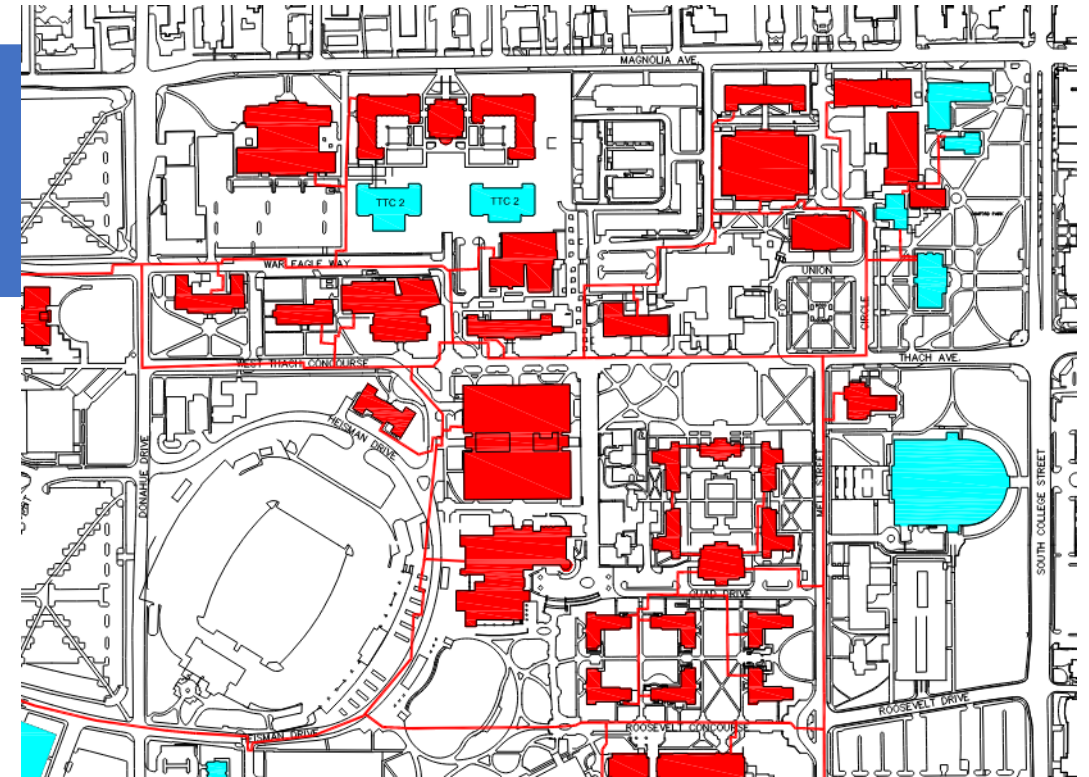
# Hydraulic Modeling at Auburn



# Hydraulic Modeling at Auburn

## System Outage

- Building Impacts
- Operational Adjustments



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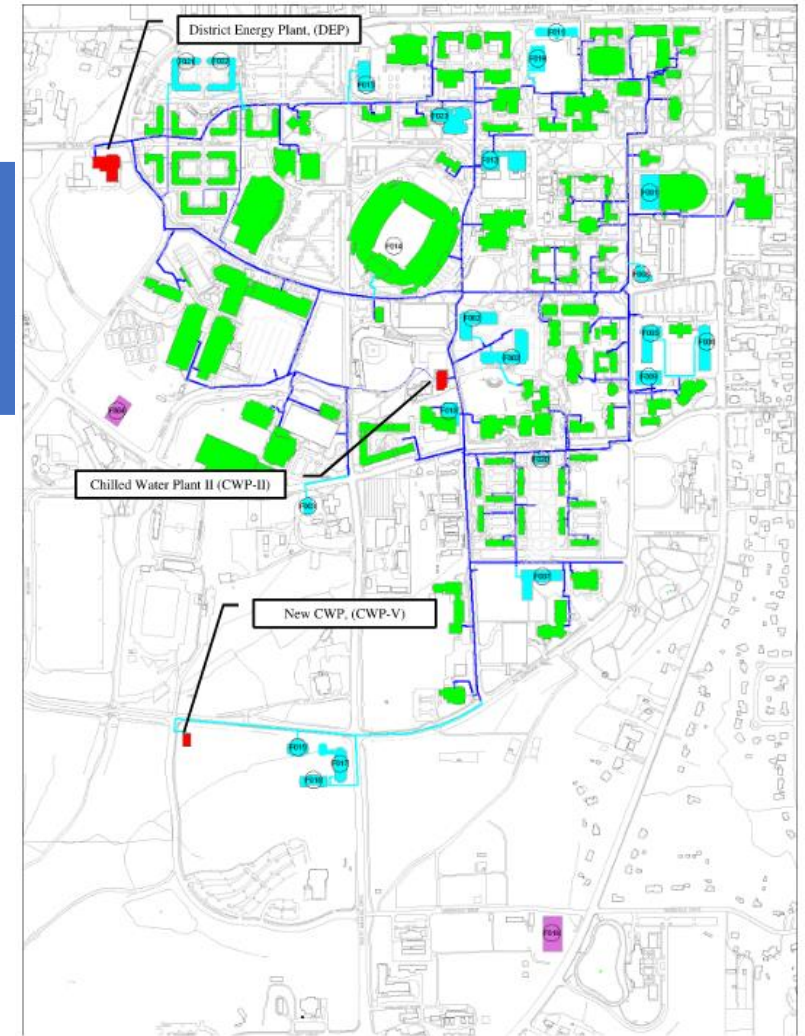




# Hydraulic Modeling at Auburn

## Future Load Growth

- Central Plant Impact
- Distribution Impact



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# Auburn University - 2021

- New 5,000-ton Chilled Water Plant – In Construction
  - Located on the south edge of the campus loop
  - Replacement of Chilled Water Plant 1, located on the North of Campus.
    - Hydraulic modeling confirmed the ability of the new plant and the advantages of this location relative to expansion
    - Variable primary pumping arrangement
    - Room for 2500 tons of future expansion

# Summary → Next Steps

- Hydraulic Modeling has been a valuable tool for planning and decision making at Auburn University.
- Use Flow Model for Operations Improvements
  - Testing in a simulated environment
  - Energy Efficiency Goals

# Questions?



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