

A photograph of a street scene at the University of Pennsylvania. In the foreground, there is a black wrought-iron gate leading to a brick building. The street is lined with more brick buildings, and several cars are driving on the road. The sky is a mix of blue and orange, suggesting dusk or dawn. A dark blue banner is overlaid on the top half of the image, containing the title text.

# University of Pennsylvania Utility Master Plan

PRESENTED BY

Ben Suplick, University of Pennsylvania

Michael Walton, PE, Burns Engineering

Jason Trefz, PE, Trefz Engineering

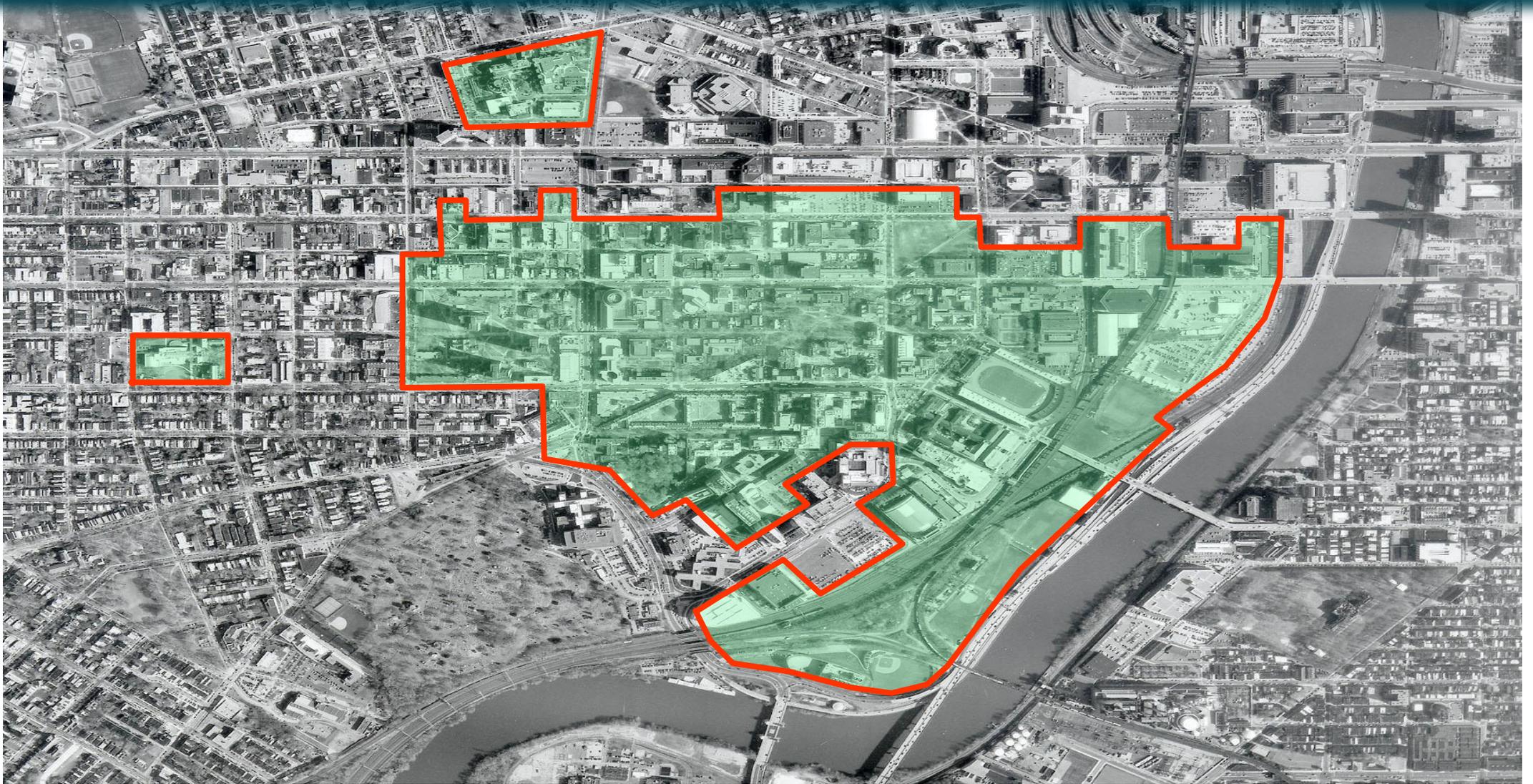
# Agenda/Speakers

- Ben Suplick, University of Pennsylvania
  - University Background & Master Plan
  - Utility Master Plan scope
- Michael Walton, Burns Engineering
  - Overall Master Plan
  - Electric & Steam systems
- Jason Trefz, Trefz Engineering
  - Chilled Water system

## PENN TODAY

- 290 acre West Philadelphia campus
- 14 million square feet in 180 buildings
- 20,000 students / 20,000 faculty and staff
- 12 Undergraduate, Graduate & Professional Schools
- Penn Health System, Morris Arboretum, New Bolton Center, & real estate holdings

# University of Pennsylvania





# PENN CONNECTS 2.0: VISION 2011-2030



## New Construction

- 1. PENN PRESBYTERIAN HOSPITAL EXPANSION
- 2. RESIDENTIAL DEVELOPMENT AT 3939 AND 4001 CHESTNUT
- 3. 34TH AND CHESTNUT MIXED USE
- 4. GOLKIN HALL
- 5. NEW COLLEGE HOUSE AT HILL SQUARE
- 6. CIRA SOUTH CHESTNUT MIXED USE
- 7. FRANKLIN BUILDING REDEVELOPMENT
- 8. KRISHNA P. SINGH CENTER FOR NANOTECHNOLOGY
- 9. CIRA SOUTH WALNUT MIXED USE
- 10. HAMILTON VILLAGE INFILL COLLEGE HOUSES
- 11. LOT 2 REDEVELOPMENT
- 12. ICE RINK REDEVELOPMENT
- 13. WALNUT SOUTH MIXED USE
- 14. GARAGE 14 REDEVELOPMENT
- 15. STEINBERG HALL - DIETRICH HALL WEST ADDITION
- 16. BARKER TRANSPLANT HOUSE
- 17. 40TH AND PINE RESIDENTIAL DEVELOPMENT
- 18. RICHARDS MEDICAL LABS
- 19. PERELMAN SCHOOL OF MEDICINE EDUCATION FACILITY
- 20. MUSEUM WEST WING
- 21. STEINBERG CONFERENCE CENTER
- 22. VAN PELT LIBRARY SPECIAL COLLECTIONS CENTER
- 23. MEYERSON HALL RENOVATIONS AND ADDITION
- 24. DAVID RITTENHOUSE LABORATORIES
- 25. EVANS BUILDING CLINICS
- 26. 1920 COMMONS
- 27. COLLEGE HALL WEST WING
- 28. EDUCATION COMMONS
- 29. HUTCHINSON GYMNASIUM INFILL AND RENOVATION
- 30. LEVY TENNIS PAVILION
- 31. RYAN HOSPITAL
- 32. VAN PELT LIBRARY
- 33. STEINBERG CONFERENCE CENTER
- 34. VANCE HALL
- 35. COLLEGE HALL WEST WING
- 36. EDUCATION COMMONS
- 37. HUTCHINSON GYMNASIUM INFILL AND RENOVATION
- 38. LEVY TENNIS PAVILION
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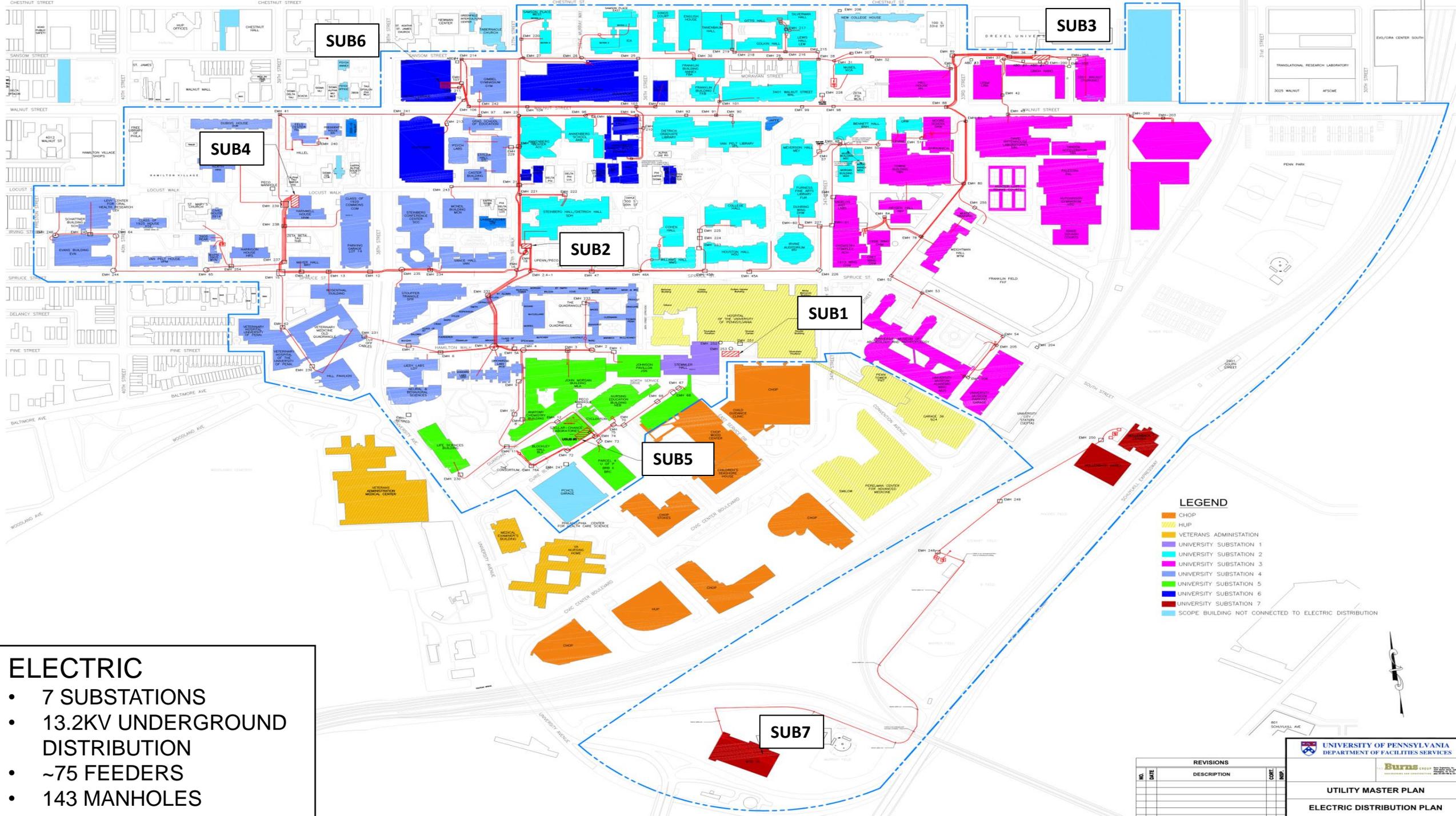
# Penn Central Utilities

- Own, Operate, Maintain Steam, Electric, & Chilled Water Distribution Systems. Generate Chilled Water.
- 20 Year Energy & Maintenance Agreement with Veolia Energy for the steam system
- HUP relies on UPENN for Steam & Back-up Chilled Water
- Dense Urban Environment with Underground Distribution
- Aging Infrastructure
- Building Energy Reductions
  - Century Bond Program
  - Energy Reduction Funds
  - Sustainability Plan

# Penn Utility Master Plan Scope

Includes University Steam, Chilled Water, and Electric Systems

- Phase A: Document Existing Systems
- Phase B: Develop Plan for Future Growth & Renewal
- Phase C: Analyze and Evaluate Current Chilled Water System
- Phase D: Develop Long Term Objectives and Strategy
- Phase E: Assessment and Preventative Maintenance Plan



SUB6

SUB3

SUB4

SUB2

SUB1

SUB5

SUB7

**LEGEND**

- CHOP
- HUP
- VETERANS ADMINISTRATION
- UNIVERSITY SUBSTATION 1
- UNIVERSITY SUBSTATION 2
- UNIVERSITY SUBSTATION 3
- UNIVERSITY SUBSTATION 4
- UNIVERSITY SUBSTATION 5
- UNIVERSITY SUBSTATION 6
- UNIVERSITY SUBSTATION 7
- SCOPE BUILDING NOT CONNECTED TO ELECTRIC DISTRIBUTION

**ELECTRIC**

- 7 SUBSTATIONS
- 13.2KV UNDERGROUND DISTRIBUTION
- ~75 FEEDERS
- 143 MANHOLES

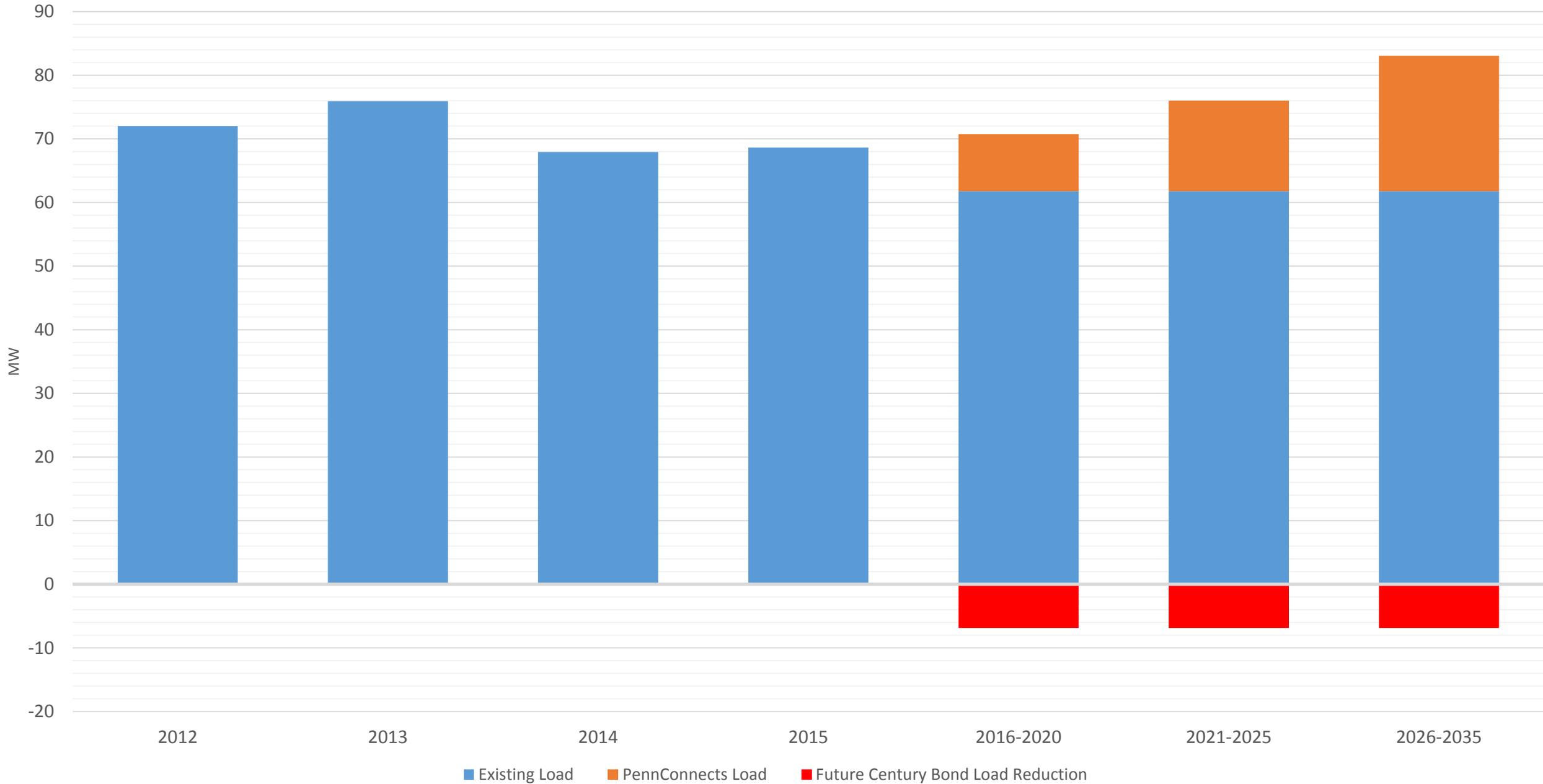
REVISIONS			
NO.	DATE	DESCRIPTION	BY

UNIVERSITY OF PENNSYLVANIA  
DEPARTMENT OF FACILITIES SERVICES

**Burns**  
CONSTRUCTION CONSULTANTS

UTILITY MASTER PLAN  
ELECTRIC DISTRIBUTION PLAN

# Projected Campus Electric Demand

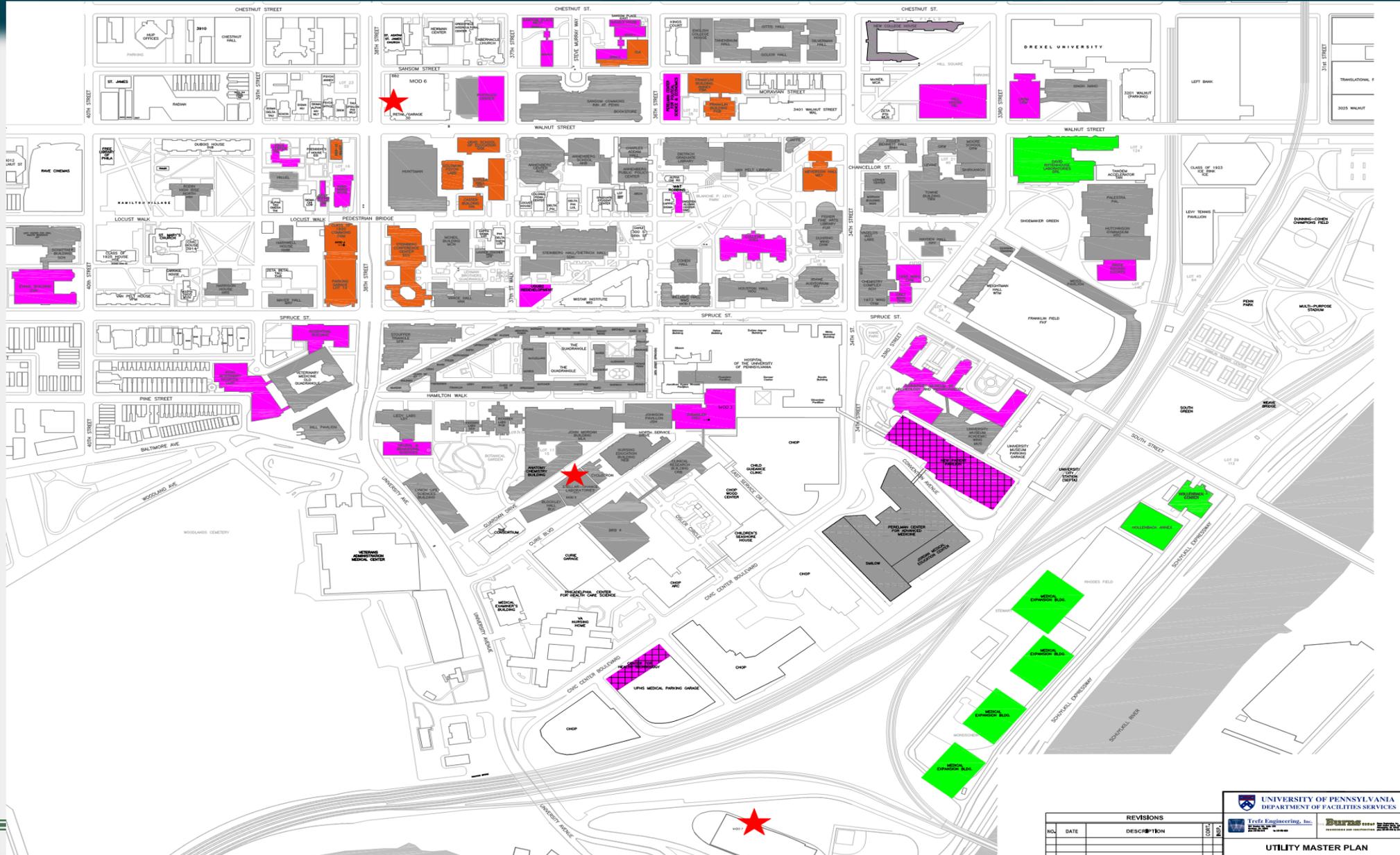


# Electrical Recommendations

- Replace Substation 2 & 4
  - Resilience & Renewal
- Replace 11 building unit substations in 1-5 yrs
- Replace 18 building unit substations in 6-10 yrs
- Continue Feeder replacement Program
- Performed arc flash hazard analysis

# BUILDING MASTER PLAN

DRAWING LEGEND	
BUILDINGS	
	EXISTING CHW BUILDINGS
	NOT OWNED BY PENN
	PHASE 1 (2016-2020)
	PHASE 2 (2021-2025)
	PHASE 3 (2026-2035)



## CHILLED WATER

- 3 CHILLER PLANTS
- 54,000 TONS CAPACITY
- 22,000 TON HRS THERMAL STORAGE
- 16.5 MILES OF UNDERGROUND DUCTILE IRON CEMENT LINED PIPE

REVISIONS			
NO.	DATE	DESCRIPTION	DATE

UNIVERSITY OF PENNSYLVANIA  
DEPARTMENT OF FACILITIES SERVICES

Trefz Engineering, Inc.

UTILITY MASTER PLAN

# CHW PRODUCTION CAPACITY ASSESSMENT

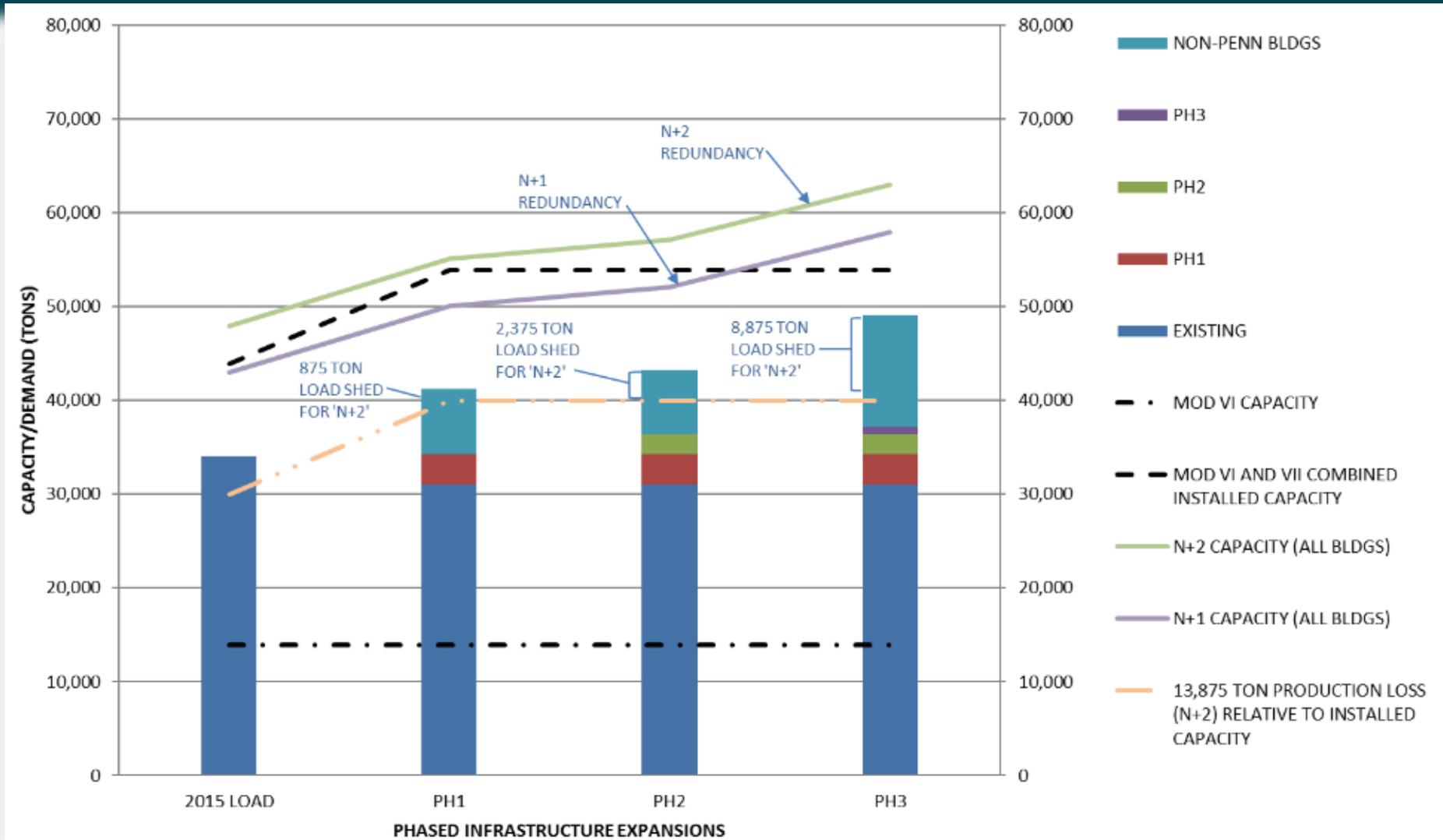
CHW PRODUCTION CAPACITY ASSESSMENT (TONS)				
CONDITION	CURRENT	PH 1	PH 2	PH 3
2016 INSTALLED CAPACITY	54,000	54,000	54,000	54,000
DEMAND FORECAST	34,000	41,000	42,500	49,000
NET	20,000	13,000	11,500	5,000
REDUNDANCY	N+3	N+1	N+1	0
N+1 LOAD SHED	0	0	0	3,875
N+2 LOAD SHED	0	875	2,375	8,875

REDUNDANCY FACTORS	
N+1	8,875
N+2	13,875
N+3	18,875

- N+1 WITH LOAD SHED OPERATIONS
  - ADD 5,000 TONS FOR PHASE 3
- N+2 WITH NO LOAD SHED OPERATIONS
  - ADD 5,000 TONS FOR PHASE 2 AND PHASE 3



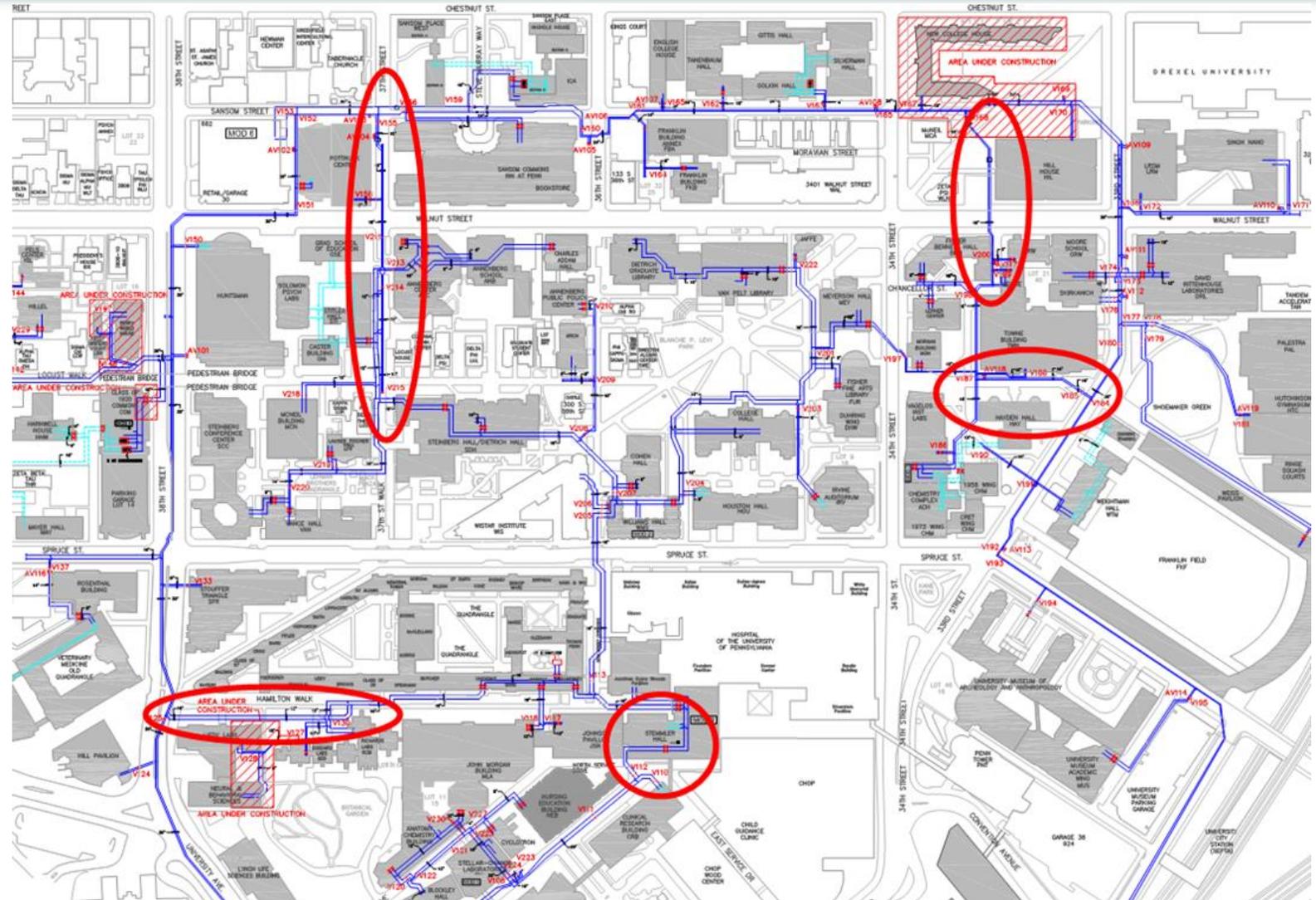
# PRODUCTION CAPACITY ASSESSMENT



# CHW DISTRIBUTION CAPACITY ASSESSMENT

## DISTRIBUTION RESTRICTIONS

- 37<sup>TH</sup> ST
- HILL HOUSE
- TOWNE BLDG
- STEMMLER BLDG
- HAMILTON WALK

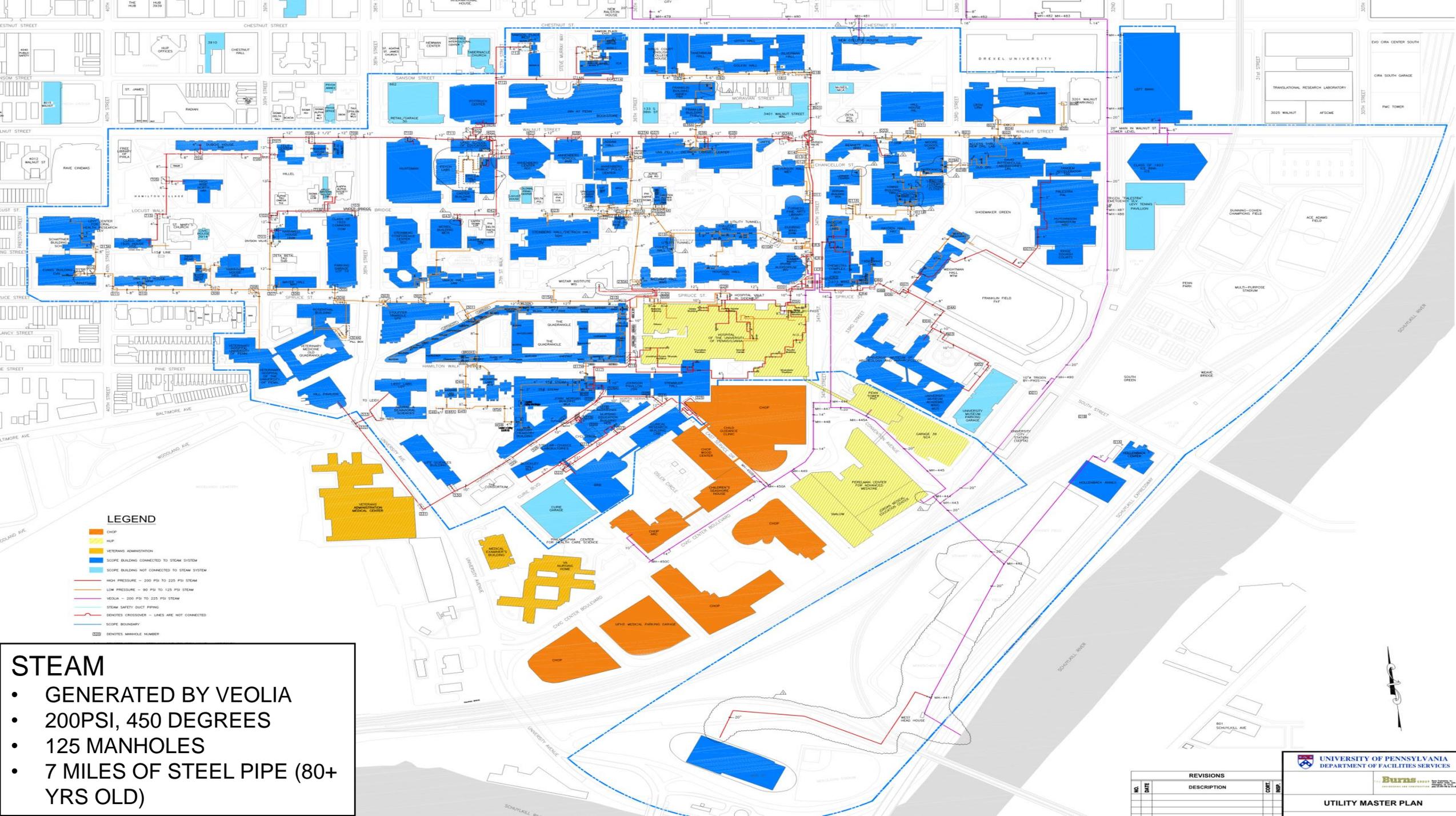




# Other Chilled Water Recommendations

- Building Primary/Secondary Interface
  - Update early generation interfaces to current standard
    - Add Instrumentation (DPT, TT, etc)
    - Add Pri/Sec Bridge
    - Add Flow Meters
  - Recommission control interface sequences
  - Calibrate instrumentation
- Plant Upgrades
  - Mod VI Controls





**LEGEND**

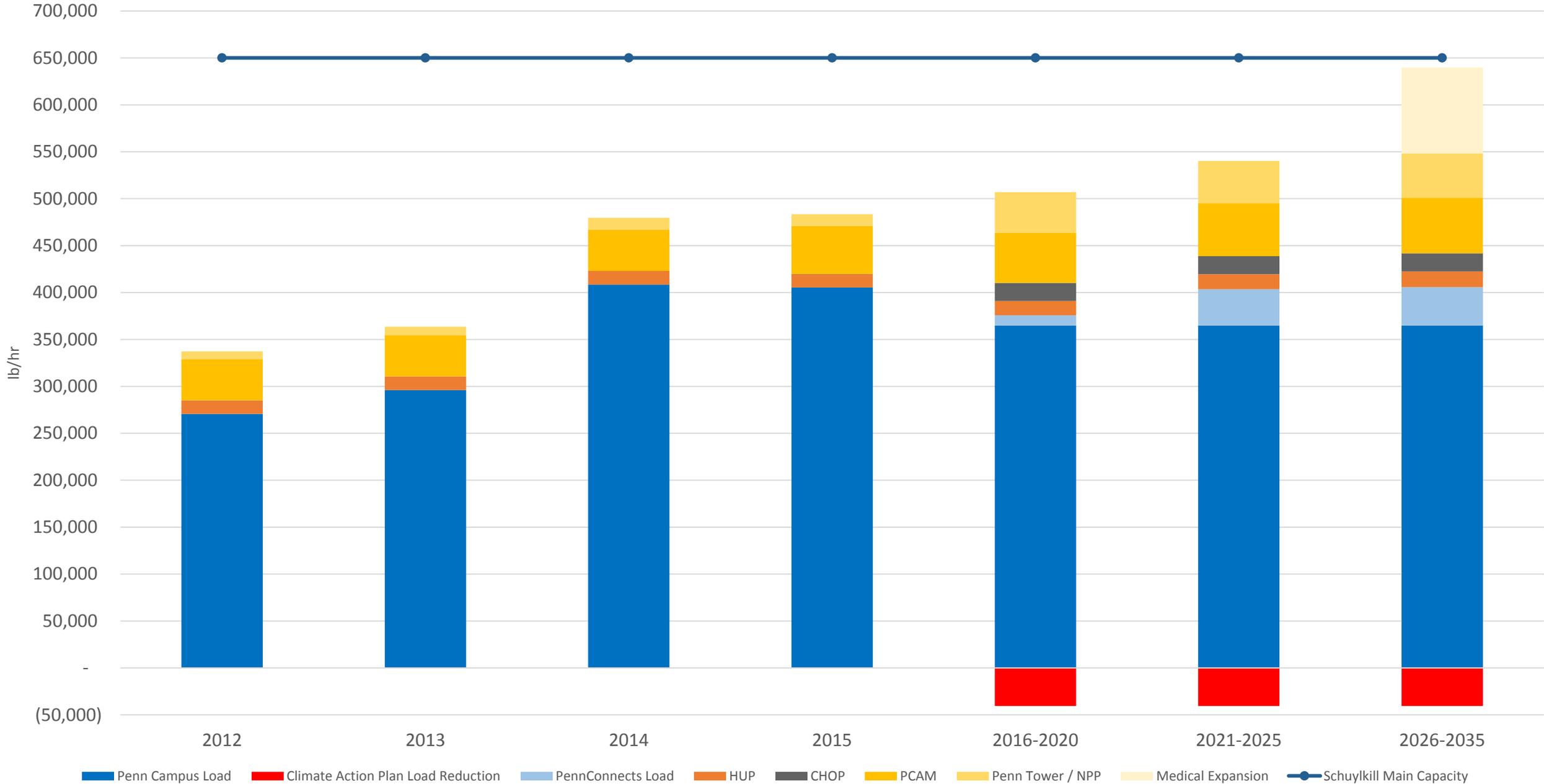
- CHOP
- HUP
- VETERANS ADMINISTRATION
- SCOPE BUILDING CONNECTED TO STEAM SYSTEM
- SCOPE BUILDING NOT CONNECTED TO STEAM SYSTEM
- HIGH PRESSURE - 200 PSI TO 225 PSI STEAM
- LOW PRESSURE - 80 PSI TO 125 PSI STEAM
- MEDIUM - 200 PSI TO 225 PSI STEAM
- STEAM SAFETY DUCT PIPING
- DENOTES CROSSOVER - LINES ARE NOT CONNECTED
- SCOPE BOUNDARY
- DENOTES MANHOLE NUMBER

**STEAM**

- GENERATED BY VEOLIA
- 200PSI, 450 DEGREES
- 125 MANHOLES
- 7 MILES OF STEEL PIPE (80+ YRS OLD)

REVISIONS			
NO.	DATE	DESCRIPTION	BY

# Projected Campus Steam Demand



# Steam System Recommendations

- Additional Supply Line from Veolia
- Continue Piping Distribution renewal each summer
- Address some steam distribution bottlenecks when new loads come online

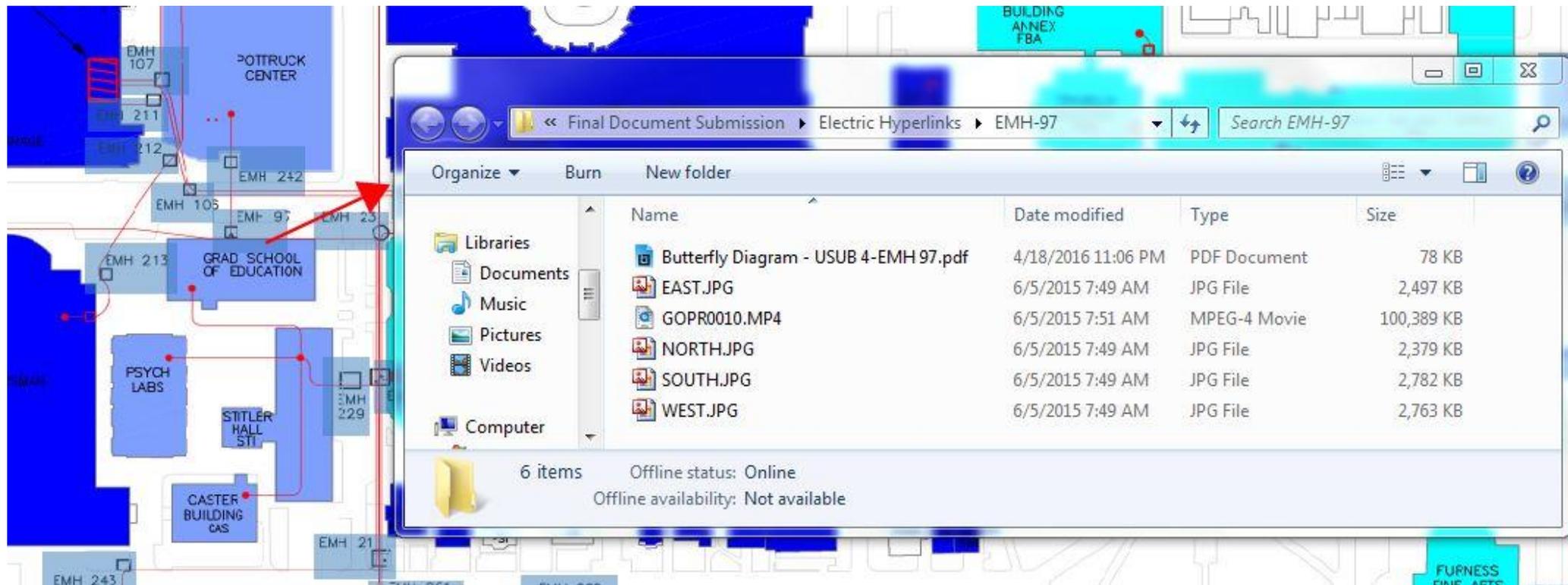


# Utility Master Plan Capital Plan

- Implementation of Recommendations
  - Projects are placed on the 5-year capital plans
  - Campus infrastructure projects funded through utility charges to schools and centers
  - Building specific utility renewals (e.g. switchgear) funded by building owner or through facility renewal funding
  - New buildings' fund extending or connecting utility distribution as part of project budget

# Consolidated Utility Records

- Makes information available in one location
- Access for Design & Construction, Engineering, & Operations



# Questions