

LEADING THE WAY **CampusEnergy**2022

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Arizona State University

Presents

How ASU's Utility Master Plan Yielded a Roadmap to Decarbonization

Arizona State University

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Topics

- ASU & Its Campus Utilities
- Goals for Leveraging Future Investments
- Scope of Work
 - Utility Mapping
 - Condition Assessment
 - GIS Database
 - Utility Master Planning
- Results Implementation Plans
- Challenges/Lessons Learned

Arizona State University

- Six Campuses
 - Tempe
 - Polytechnic
 - West
 - Downtown Phoenix
 - Lake Havasu
 - Los Angeles
- 134,500 Students
- 17,674 Faculty
 - 501 Facilities Staff
- 27M GSF Acad./Inst/Res.
- 1M GSF Research



University-Wide Utility Issues

- Decarbonize Campus by 80% in 10 Years
- Unknown utility condition & locations
- Inadequate utility funding
- Poor as-built records = Change orders
- GIS database lacking validation
- Loss of Institutional Knowledge
- Maintenance: Reactive, not Proactive, or Preventative
- Last Master Plan - 11 years old

Tempe Campus Challenges

- 2.2 miles Utility Tunnels – \$300M Asset
 - Aging back to 1940
 - Hazardous work location (Asbestos)
 - High repair cost
 - Structural failures/flooding
 - Steam/condensate/HW distribution long past service life
 - Technology (fiber/copper) – tunnel high failure risk
- Annual monsoon flooding
- Buildings – Good to poor energy usage
- Production plants – carbon based



Polytechnic Campus Challenges

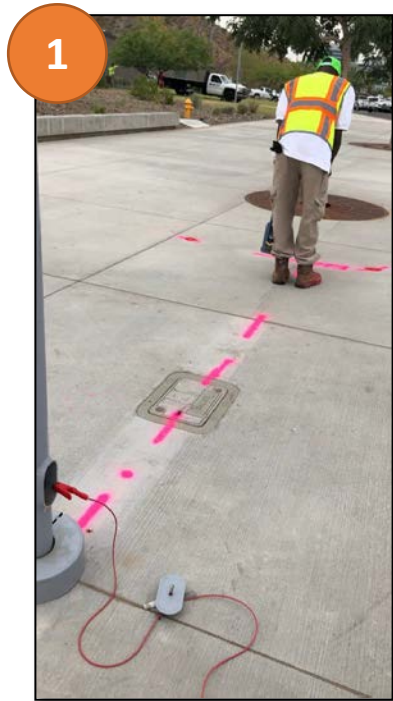
- BRAC Airforce base
- Aging/failing civil utilities
- Inadequate fire water
- Limited central chilled water distribution
- 100+ individual electric meters
- Plan for new College of Advanced Manufacturing



Goal of Leveraging IUMP Investments

- Use infrastructure investments to Decarbonize Campuses
- Accurate utilities location - reduce change of condition claims
- New projects/planning – faster access to utilities information
- Sustainable GIS utility database
- Establish 10 year funding plan
- ASU #1 Innovation – promote as part of IUMP

A Framework to Support Effective Master Planning & Utility Management



**Utility System
Survey &
Mapping**



**Utility Condition
Assessment**



**GIS
Implementation**



**Utility System
Modeling**



**Utility Master
Planning**

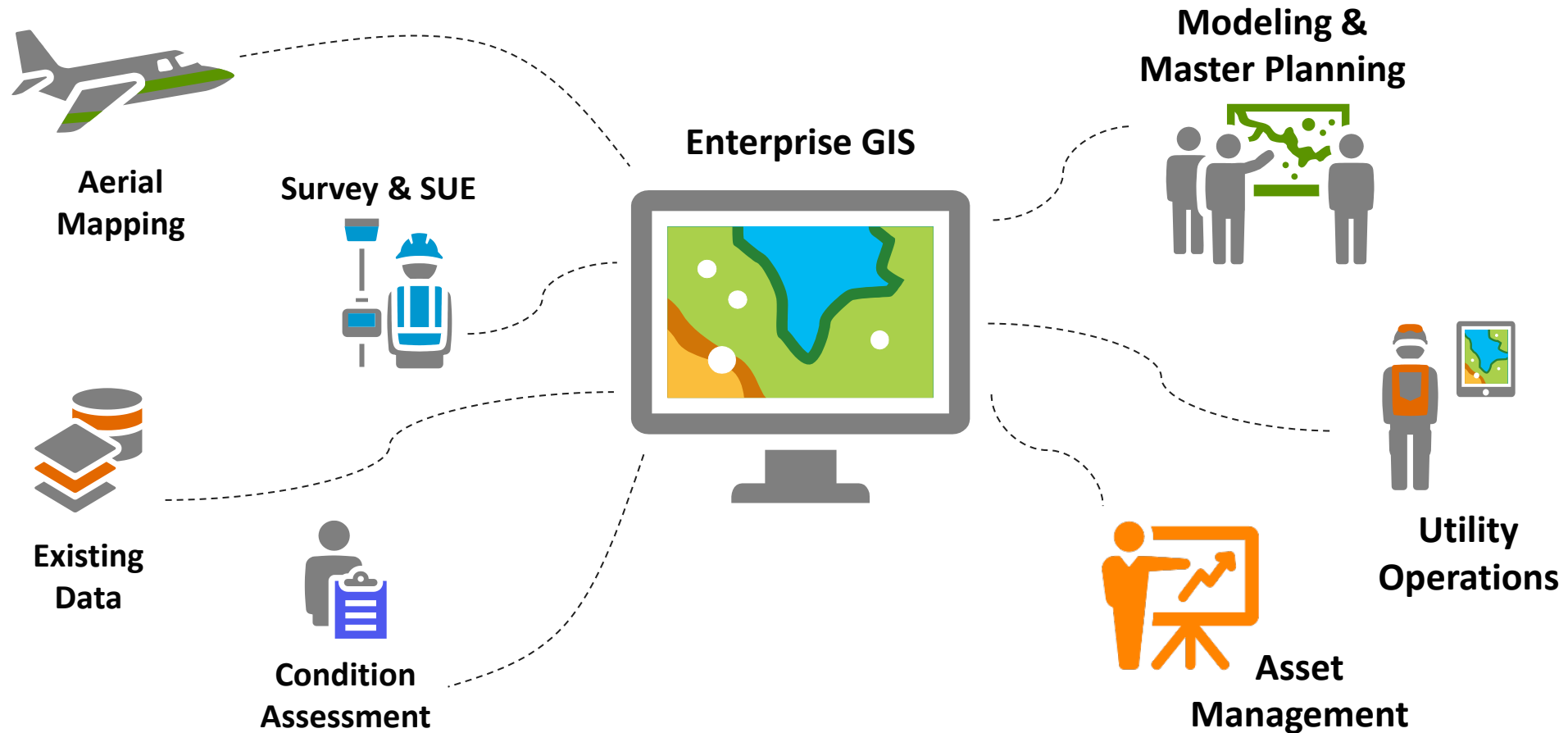
Scope of Work

- Master Plan Utilities: 14

- Electricity
- Chilled water
- Steam
- Condensate
- Domestic hot water
- RO/treated water
- Process gas & chemicals

- Potable water
- Firewater
- Stormwater
- Sanitary sewer
- Natural gas
- Technology – fiber, copper
- Easements

A Framework to Support Effective Master Planning & Utility Management



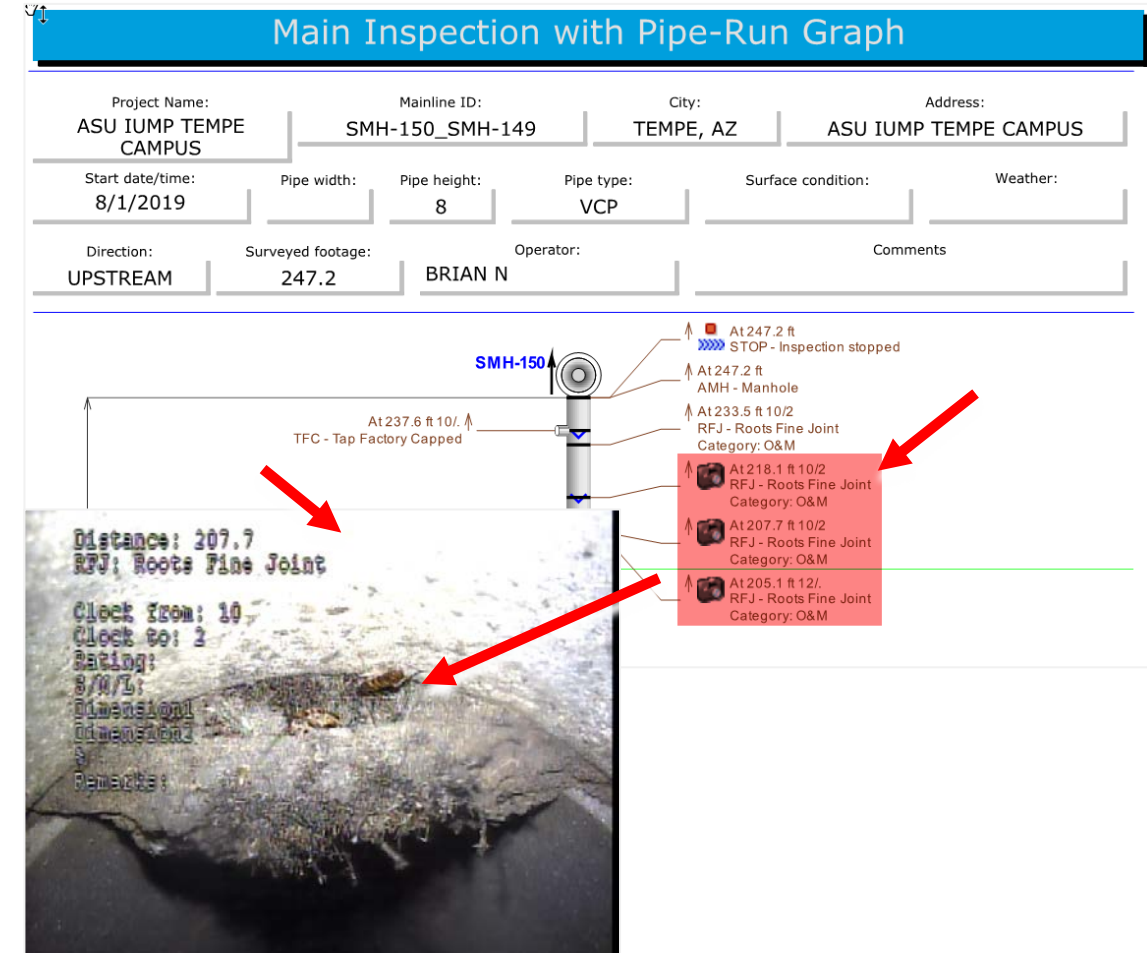
Condition Assessment – Energy Utilities

- Production: Central Plant Utility Asset Inspections
- Distribution: Thermal/Energy System Inspection
 - Maintenance History/PM Program
 - Tunnel & Manhole Inspections
- Building Connections/Conversions
- Telecommunication/IT Inspection
 - Fiber/Copper/Switching/Data/Voice
- Building Fire Inspections



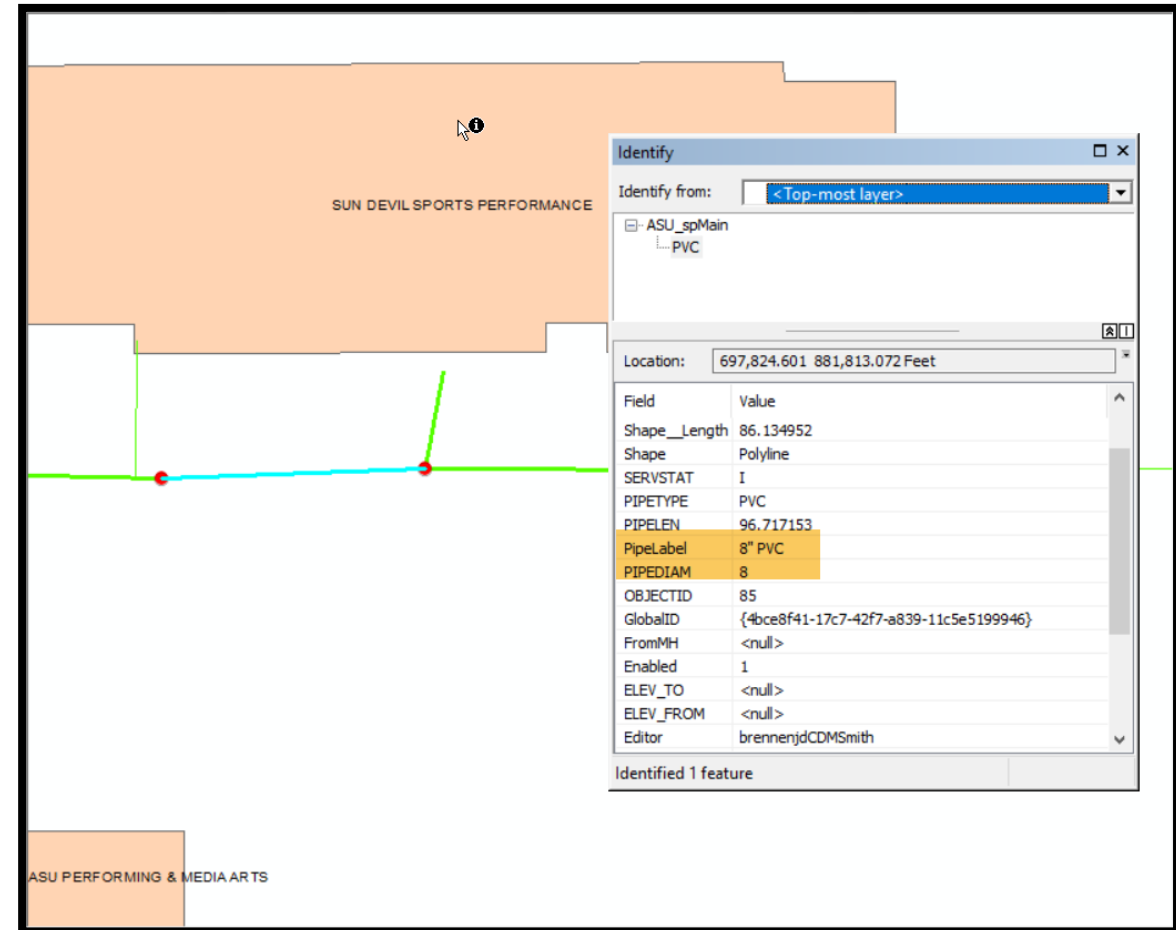
Condition Assessment - Wet Utilities

- Water, Wastewater, & Stormwater Asset Inventory
- Infrastructure Condition Evaluation
- Identification of Pipe Defects
- Determine Amount of Debris
- Sustainability – Plan for Rehabilitation and Replacement Needs
- Budgets for Repairs



GIS Sanitary and Stormwater Information Before

- ⚠ Limited Data Available
- ⚠ Manholes and Cleanouts Not Identified
- ⚠ Building Services not Mapped
- ⚠ No Elevation and Invert Information
- ⚠ Limited or no information on condition of mains and laterals
- ⚠ Defects and Failing Pipes Not Known



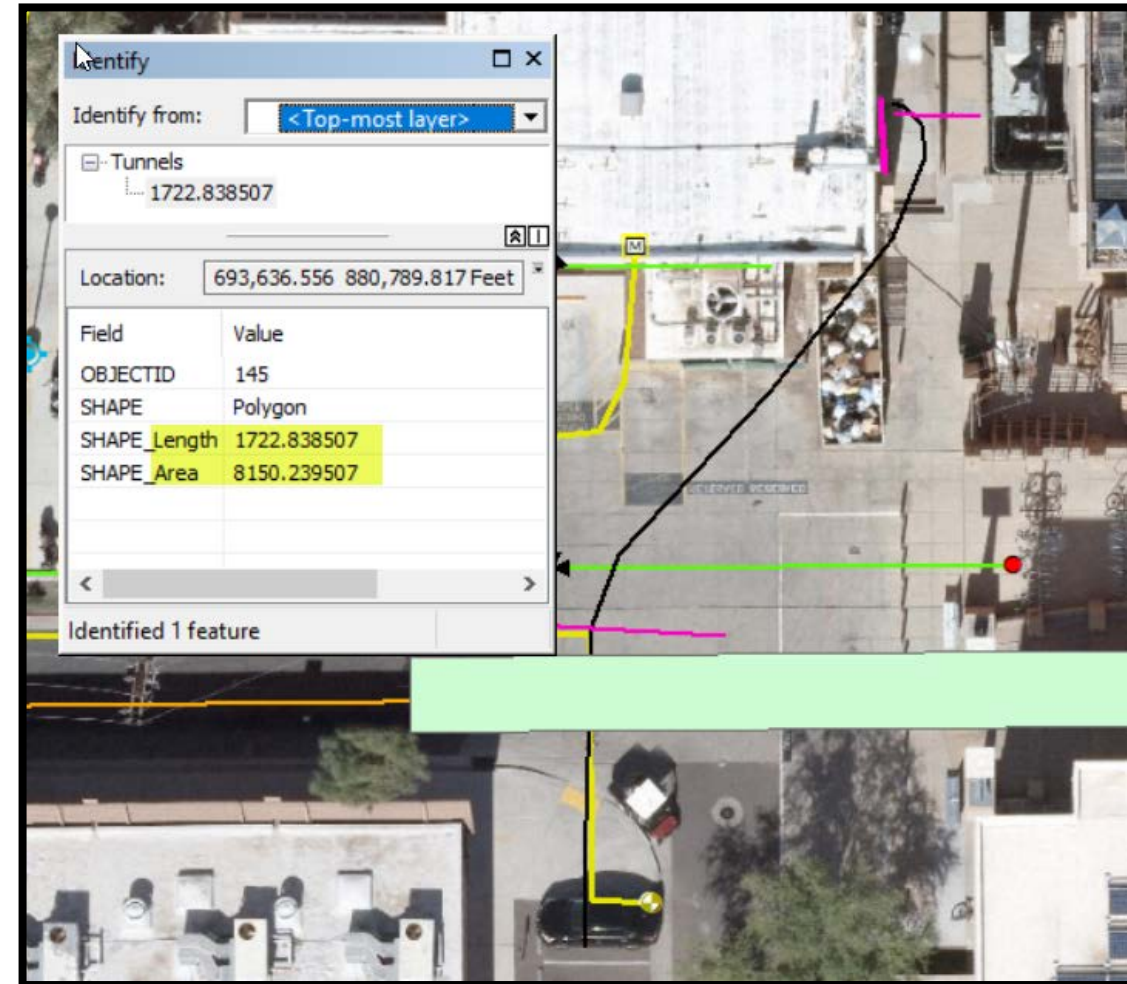
GIS Sanitary and Stormwater Information After

- ✓ ASU Assets Accurately Mapped
- ✓ Detailed Attributes Collected
- ✓ CCTV Inspection of ASU owned Sewer/Storm
- ✓ Building Connections Located
- ✓ Pipe Defects Mapped
- ✓ Pipes Rated with Industry Standard Rankings
- ✓ Repair and Rehabilitation Planned Budgets



GIS Tunnel Information Before

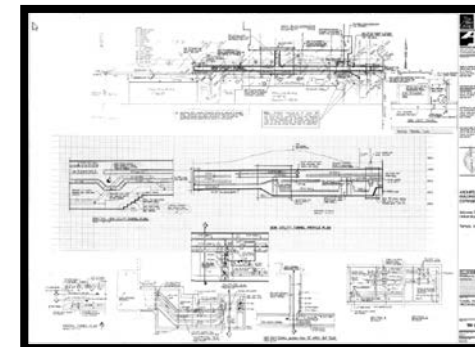
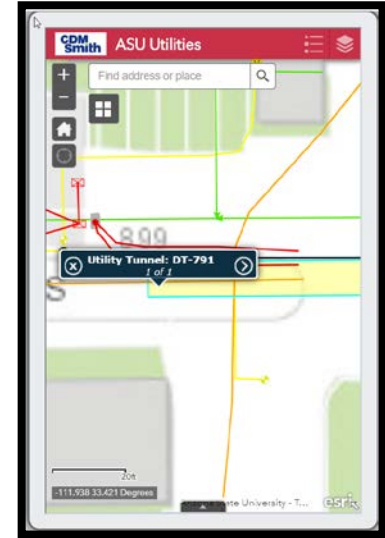
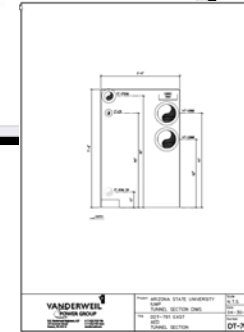
- ! Massive reference drawing search
- ! Unknown Utilities in Tunnel
- ! Limited Tunnel Data in GIS
- ! No Tunnel Entry Locations in GIS
- ! No Tunnel AutoCAD Elevation
- ! No Organized Tunnel Photos
- ! Tunnel Utility Conditions Unknown
- ! No Location of Failures
- ! No Plan for Repair of Tunnel Utilities



GIS Tunnel Information

After

- ✓ Drawings & All Data Organized by Tunnel
- ✓ Detailed Tunnel Mapping
- ✓ Extensive Tunnel Attribute Information Collected
- ✓ Tunnel Inspections Integrated with GIS
- ✓ Tunnel Entrances Mapped in GIS
- ✓ Tunnel Photos accessible through GIS
- ✓ Tunnel schematics accessible through GIS
- ✓ Utility deficiencies linked with assets
- ✓ Critical Emergency Response Assets Identified and Mapped

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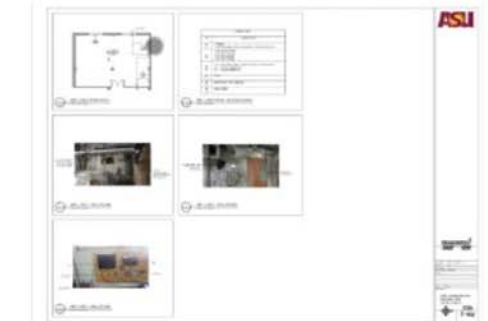
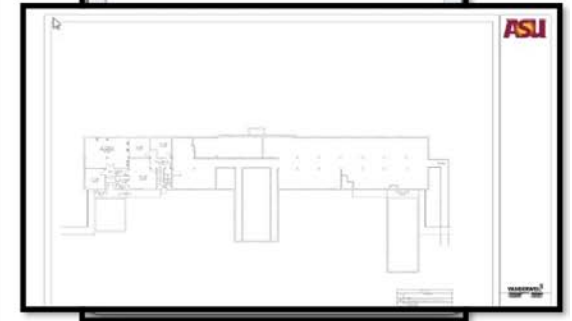
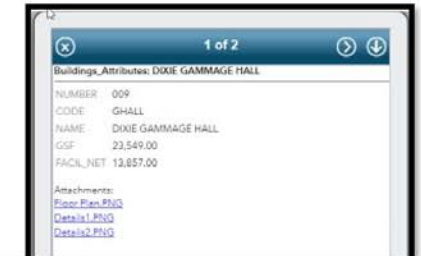
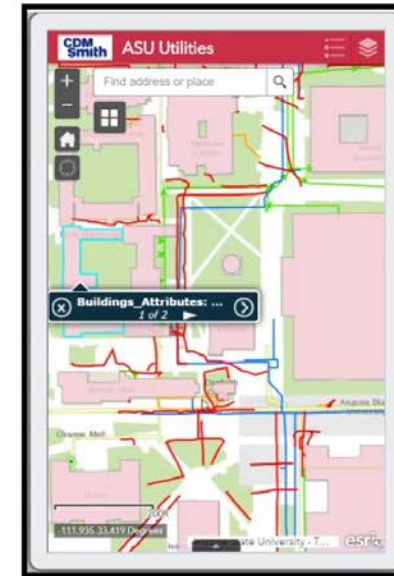
GIS Building Technology

Before








No Content in GIS

After

- ✓ Panel Elevations and Room Locations
- ✓ Improved Access
- ✓ All Telecom and Fiber Numbered
- ✓ From/To Wiring Diagrams
- ✓ Data Easily Accessed Through GIS
- ✓ Inspections of All Telecom Connectivity
- ✓ Photo Record for All Hardware

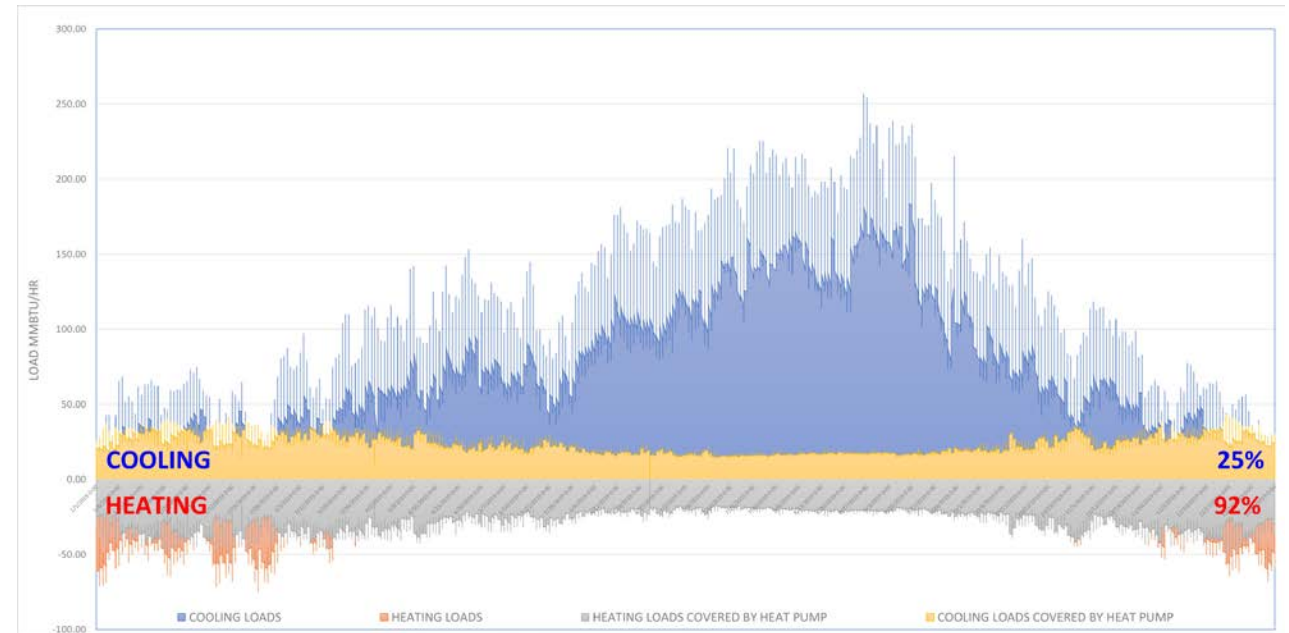


Benefits to Facilities Management

-  “Utility” Master Plan Ensures Utilities Meet Needs of Growing Campus
-  Facilities Management & CIP Savings
-  Capture Institutional Knowledge (Before Staff Retirement)
-  Comprehensive Asset Inventory to Support Lifecycle Asset Management
-  More Effective Utility Operations and Emergency Response
-  Streamlined Capital Planning & Project Planning
-  Tools to Support Scenario Development, “Future-Proof”, CO2 Reduction

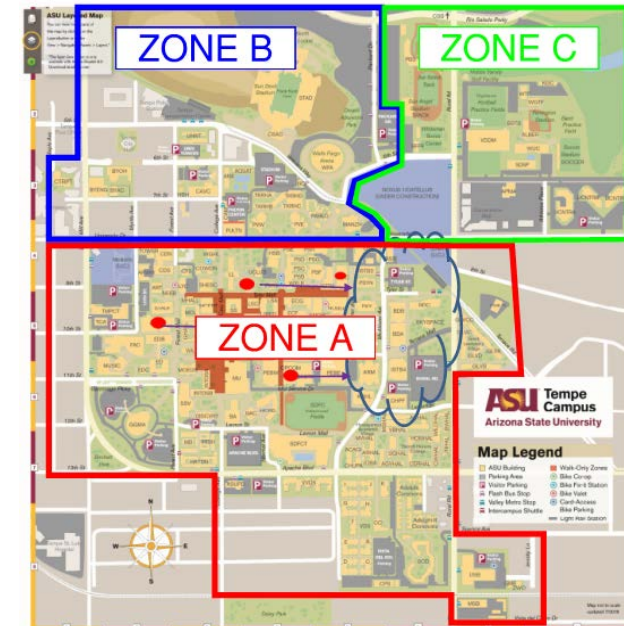
Decarbonization Roadmap –Tempe Campus

- Steam to hot water conversion
 - Heat Recovery Chillers
 - Heat Pumps
 - Electric Boilers as Backup
 - Phasing Plan



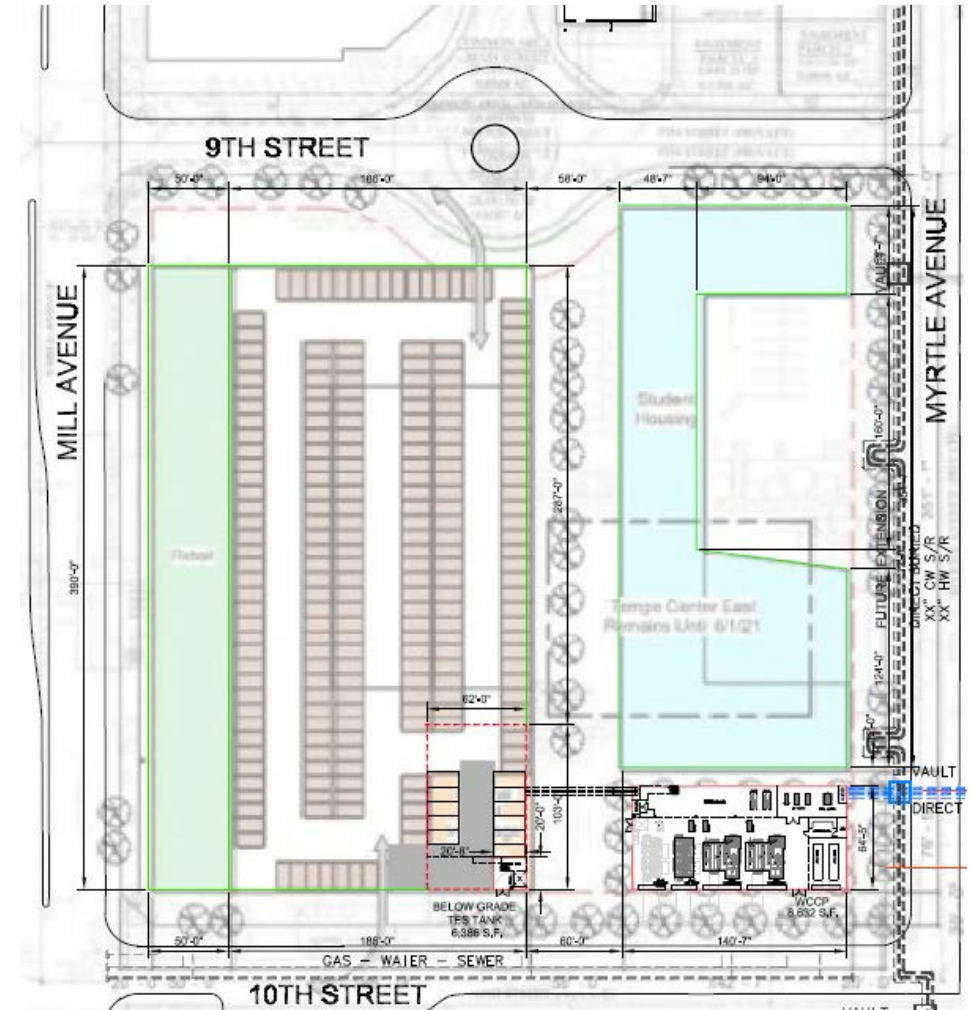
Decarbonization Roadmap –Tempe Campus

- Technology “co-location” with hot water distribution
 - Eliminate the mess in tunnels



Decarbonization Roadmap – Tempe Campus

- WCCP – Heating/Cooling
 - Electrification – New Substation
 - Compliant chillers and heat pumps
 - E-boilers – Backup
 - TES



Decarbonization Roadmap – Tempe Campus

- Existing CHP Plant
 - 18MW Combined-Cycle
 - Options in year 10:
 - Fuel Switch to H2
 - Convert to simple cycle – standby
 - Unplug and Replace E-Gen/BESS
 - Expand Cooling – Heat Pumps
 - BESS
 - Hot Water Storage



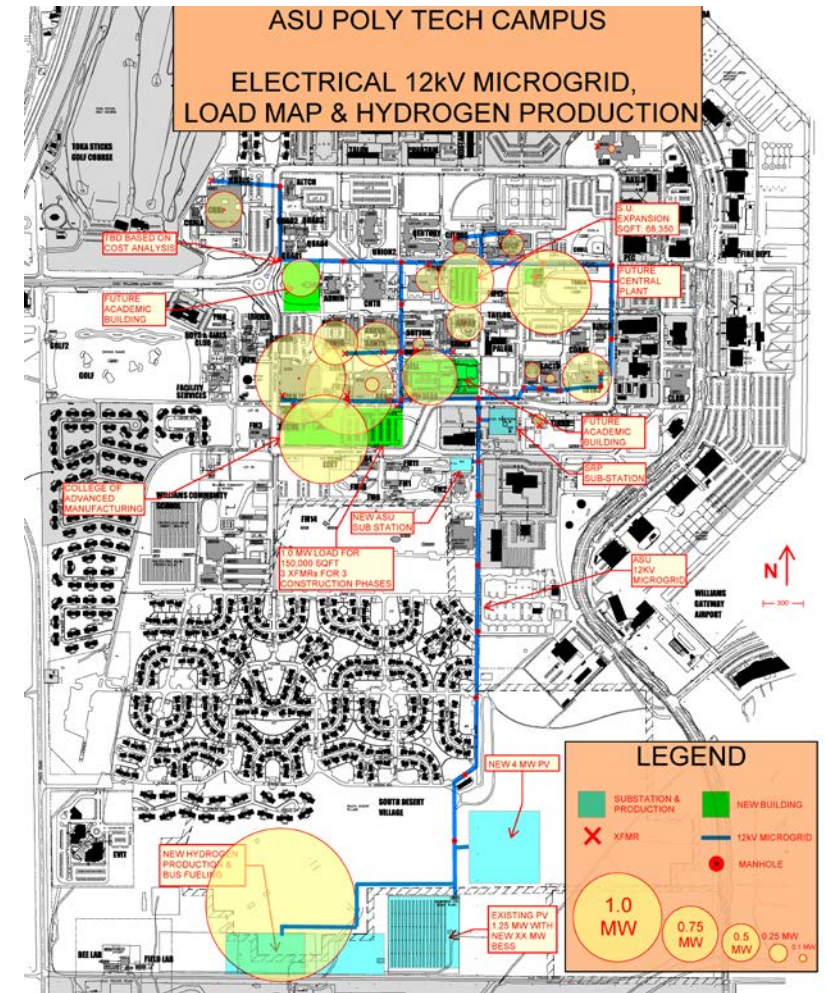
Decarbonization Roadmap – Tempe Campus

- Steam Plant
 - Retire 1940s vintage
 - Retire natural gas stand-by steam boilers
 - Remove (R-134a Refrigerant) non-compliant chillers
 - Repurpose site for marque academic building



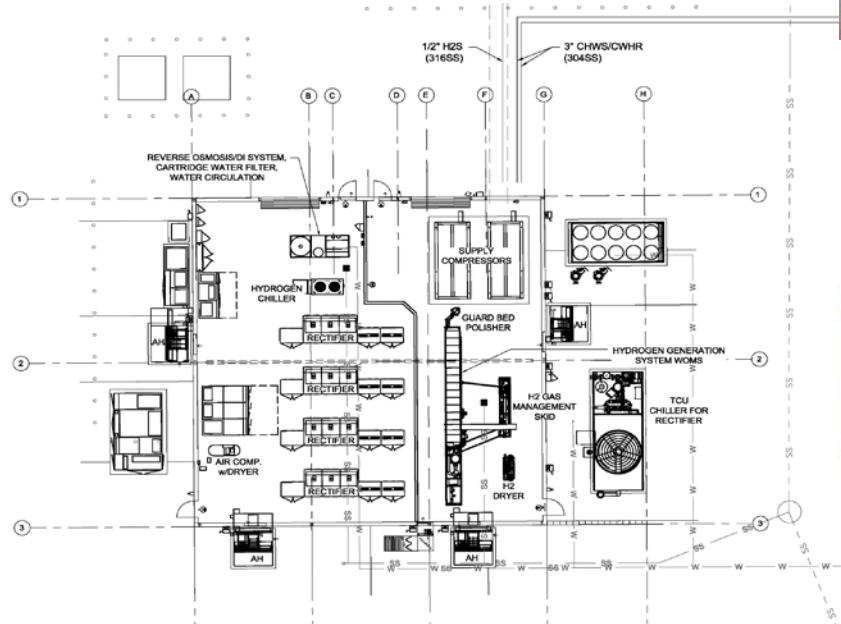
Decarbonization Roadmap – Polytechnic Campus

- Consolidate 30 major building loads
- 12kV microgrid/substation
- PV expansion
 - Existing - 3.5 MW
 - New – 4 MW
- BESS



Intercampus Coach Fleet Conversion

- 25 Coaches: 250 miles/day, 5 day/week
- Total Scope 3 annual CO₂ – 2,400 MT/year
- Zero carbon MT/year savings
- Green H₂ Production On-Campus



Budgets

Tempe Campus

640 acres

- **\$2.5 M** Mapping
- **\$1.3 M** Conditional Assessment
- **\$1.0 M** GIS Database
- **\$1.2 M** Utility Master Plan
- **\$6.0 M** Total

Polytechnic Campus

500 acres

- **\$1.5 M** Mapping
- **\$0.8 M** Conditional Assessment
- **\$0.5 M** GIS Database
- **\$0.7 M** Utility Master Plan
- **\$3.5 M** Total

Utilities Master Plan

11 Year Phased Execution

- **\$80 M** Plants
- **\$150 M** Distribution
- **\$80 M** Building Conversions
- **\$20 M** Technology Distribution
- **\$20 M** Wet Utilities
- **\$350 M** Total (**\$110 M** Decarbonization Premium)

Challenges/Lessons Learned

- SUE Subcontractor Underestimated Scope/Execution Schedule (add 1 year)
- Decarbonization Roadmap Decisions Take Time (6 Months)
- Funding for Staff to Sustain GIS Database Imperative
- Accurate As-Builts/GIS GPS Locating
- Enforcement – Training PMs / Changing State Contracts Take Time
- Met Budget but Added 18 Months



Questions?

Thank you!

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