2018 Avista Natural Gas IRP

Technical Advisory Committee Meeting
March 29, 2018
Spokane, WA

Agenda

- Introductions & Logistics
- Williams update
- TransCanada update
- Avista's Supply Side Resources
- Distribution
- Renewable Natural Gas
- Power to Gas
- Initial sensitivity results & proposed scenarios

➢ Lunch will be around 12pm

2018 IRP Timeline

- **August 31, 2017** – Work Plan filed with WUTC
- **January through May 2018** – Technical Advisory Committee meetings. Meeting topics will include:
  - **TAC 1: Thursday, January 25, 2018: TAC meeting expectations, review of 2016 IRP acknowledgement letters, customer forecast, and demand-side management (DSM) update.**
  - **TAC 2: Thursday, February 22, 2018: Weather analysis, environmental policies, market dynamics, price forecasts, cost of carbon.**
  - **TAC 3: Thursday, March 29, 2018 : Distribution, supply-side resources overview, overview of the major interstate pipelines, RNG overview and future potential resources.**
  - **TAC 4: Thursday, May 10, 2018:** DSM results, stochastic modeling and supply-side options, final portfolio results, and 2020 Action Items.
- **June 1, 2018 –** Draft of IRP document to TAC
- **June 29, 2018 –** Comments on draft due back to Avista
- **July 2018 –** TAC final review meeting (if necessary)
- **August 31, 2018 –** File finalized IRP document

WE MAKE ENERGY HAPPEN

Avista TAC Meeting #3

March 29, 2018

NYSE: WMB
williams.com

Mastio Survey

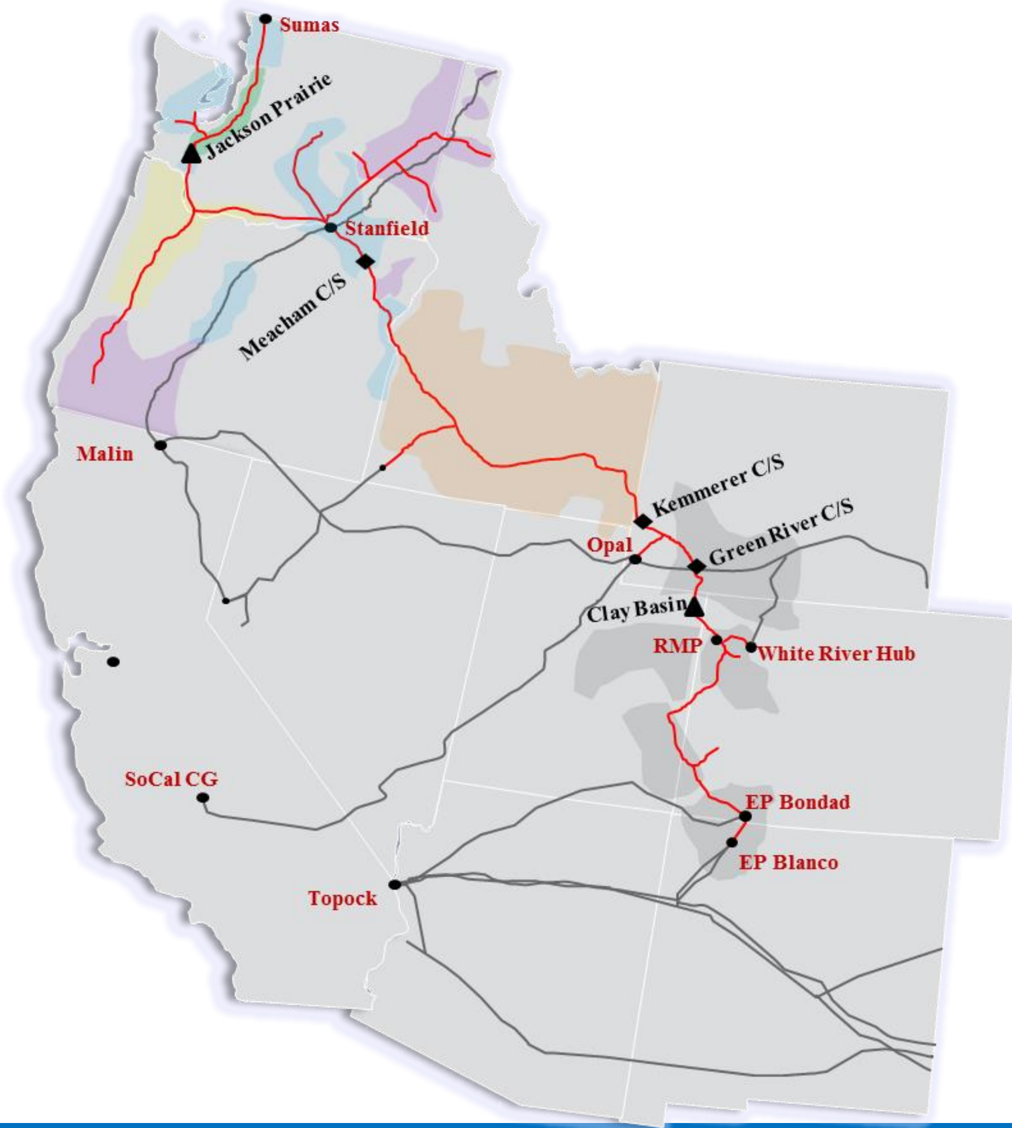
> **Rated No. 2 in the Mega and Major Pipeline categories and No. 3 in the overall Interstate Pipeline category**

> **Northwest was ranked #1 in the following areas:**
- competitive rates
- diverse supply & markets
- likelihood to recommend

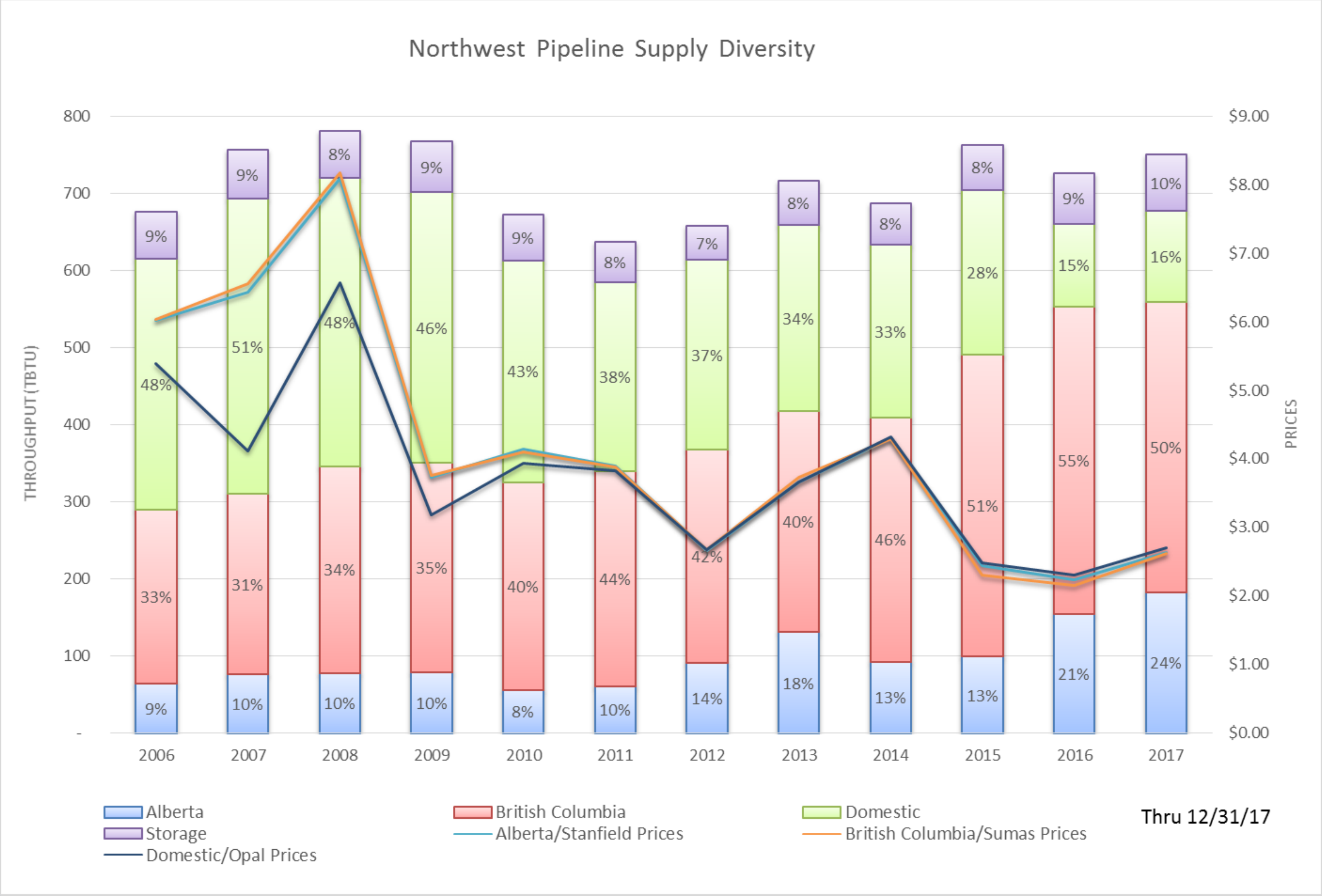
> **Northwest was ranked #2 in the following areas:**
- honest communications
- effectiveness of contract negotiations
- expertise of reps to solve your needs
- value received for the money paid
- flexibility of gas flows
- flexibility of transport options

Northwest System – Strategically Located

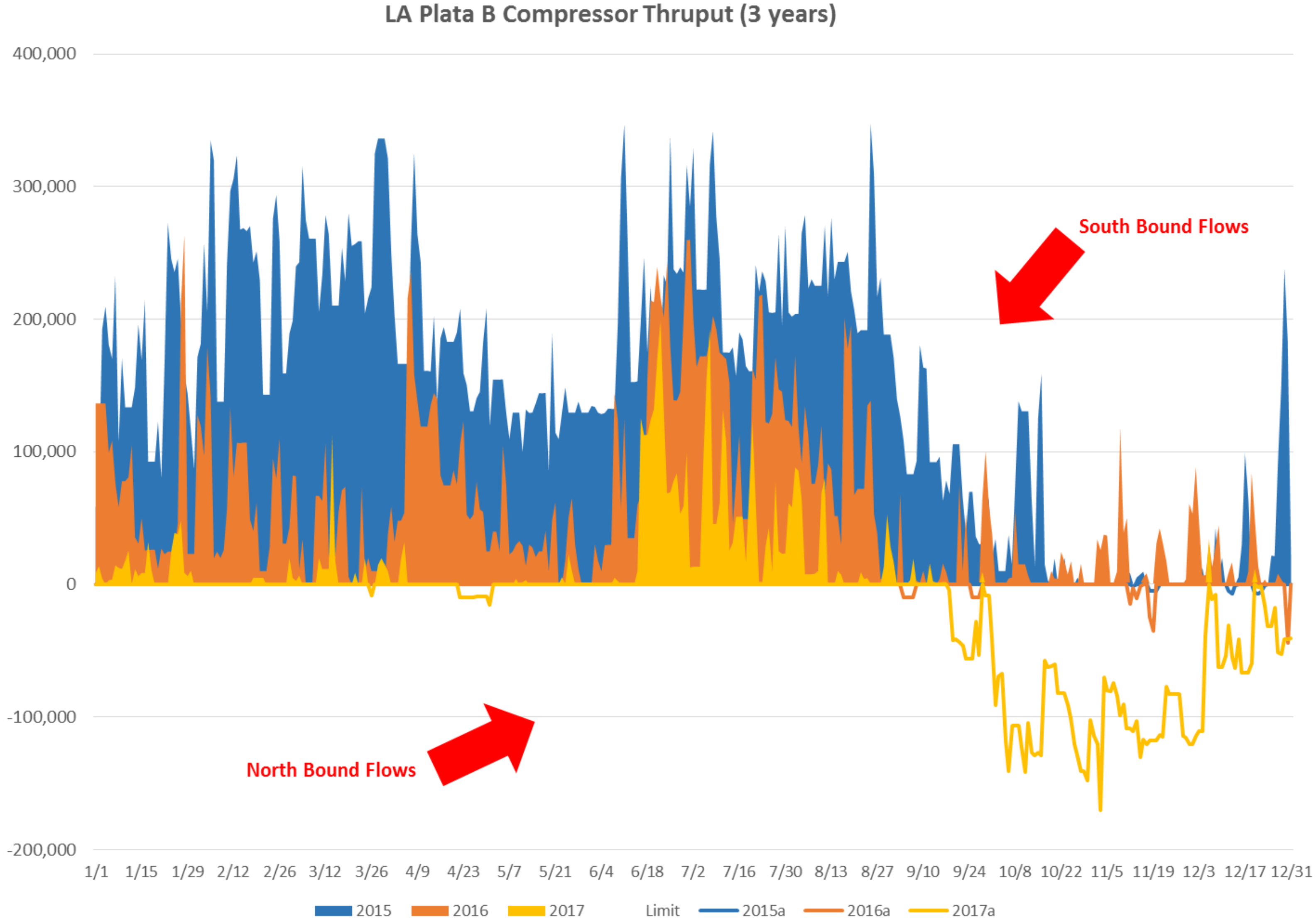
- **Low-cost, primary service provider in the Pacific Northwest**
  - 3,900-mile system with 3.8 Bcf/d peak design capacity
  - ~120 Bcf of access to storage along pipeline, with high injection and deliverability capability in market area
  - Fully Contracted with > 9 year average contract life
- **Bi-directional design**
  - Provides flexibility (Rockies to market and Sumas to market)
  - Cheapest supply drives flow patterns
  - Provides operational efficiencies through displacement
- **Supply and market flexibility**
  - 65 receipt points totaling 11.6 Bcf/d of supply from Rockies, Sumas, WCSB, San Juan, emerging shales
  - 366 delivery points totaling 9.7 Bcf/d of delivery capacity
- **Solution oriented**
  - History of working with our customers both creatively and collaboratively to serve their needs



Supply Diversity

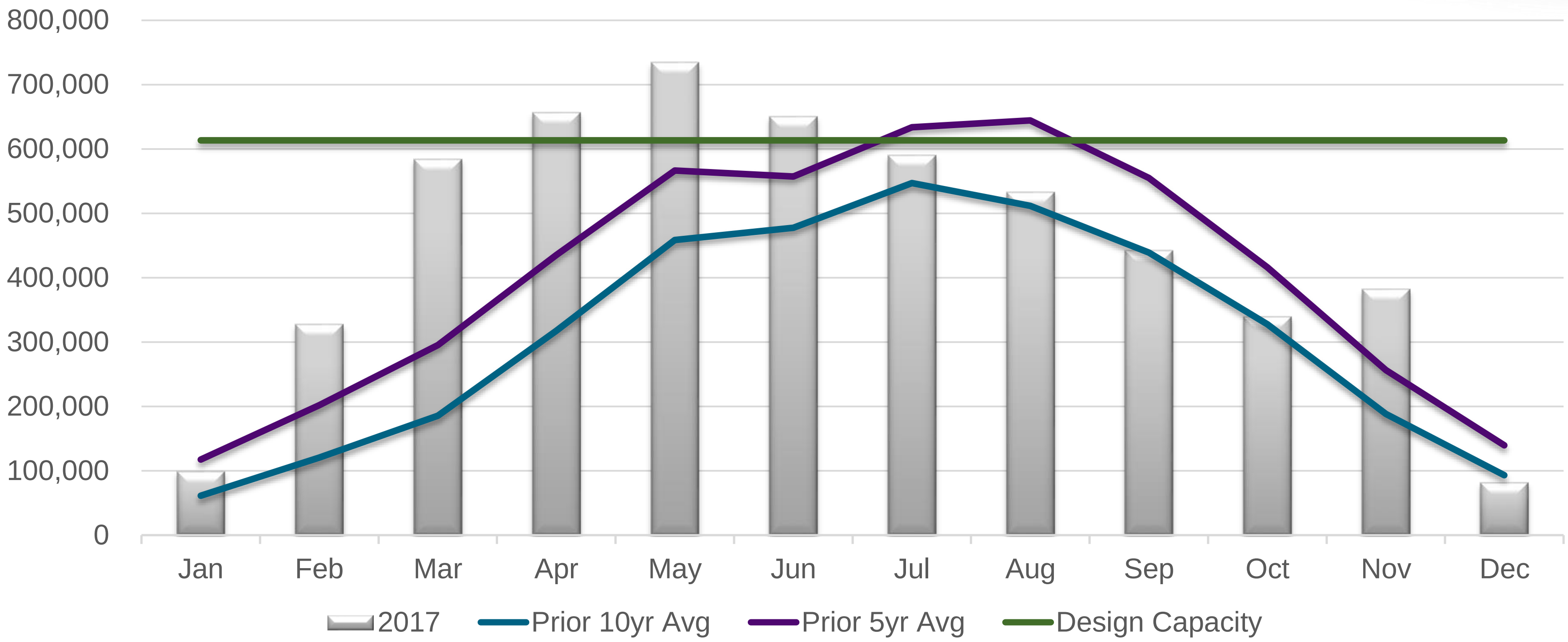


Supply Diversity – South End

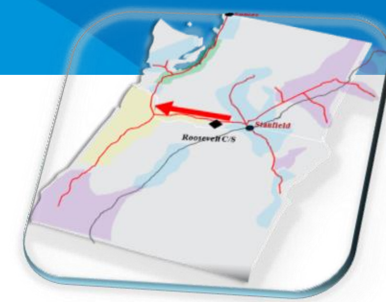


Sumas South Historical

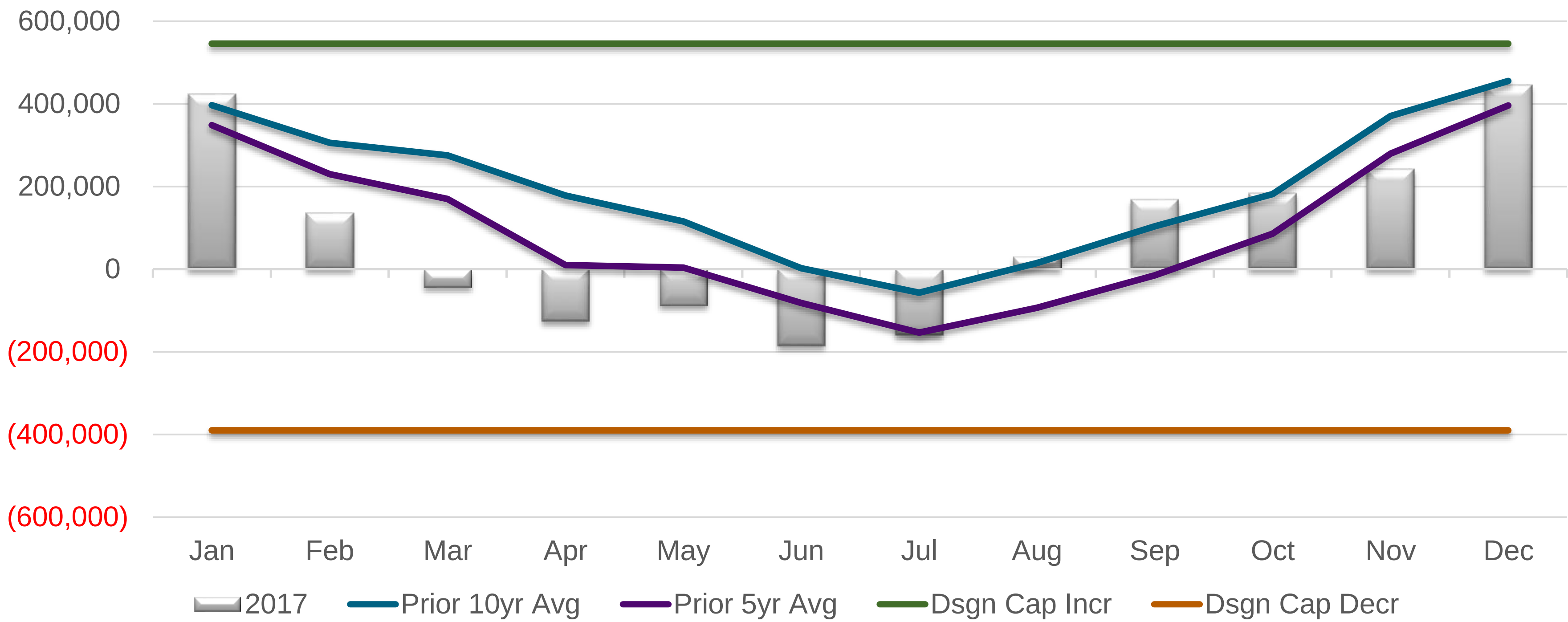
Chehalis Historical (Avg Dth/d)



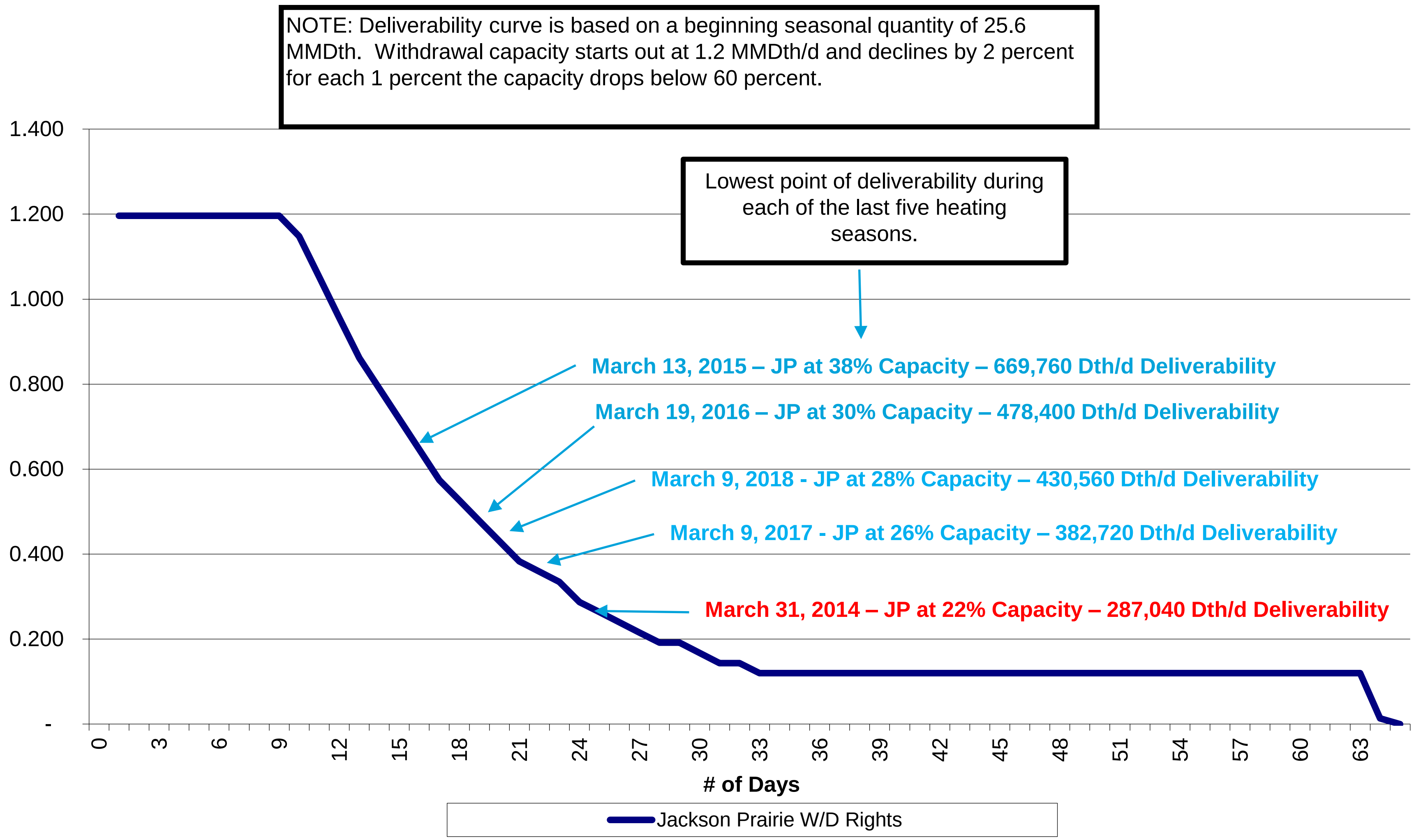
Stanfield West Historical



Roosevelt Historical (Avg Dth/d)

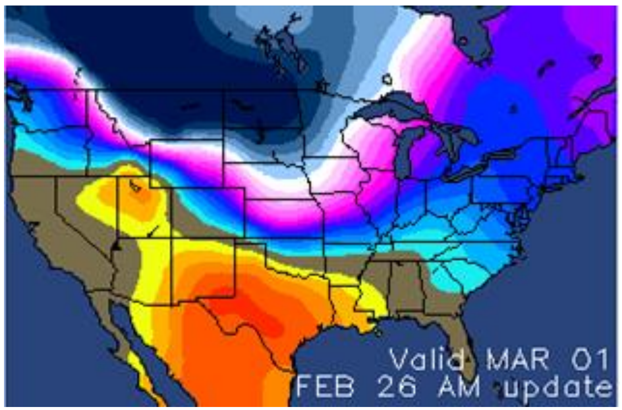


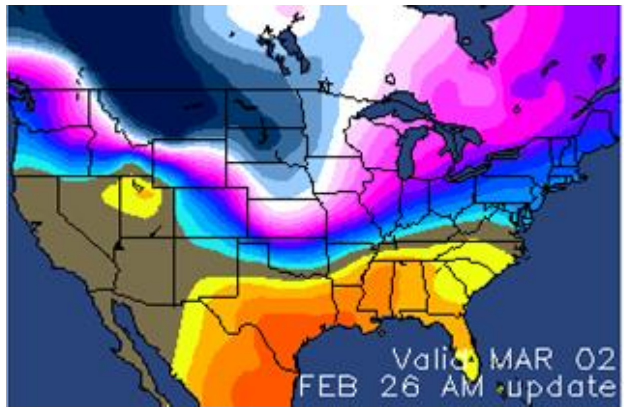
Jackson Prairie Withdrawal Deliverability Curve

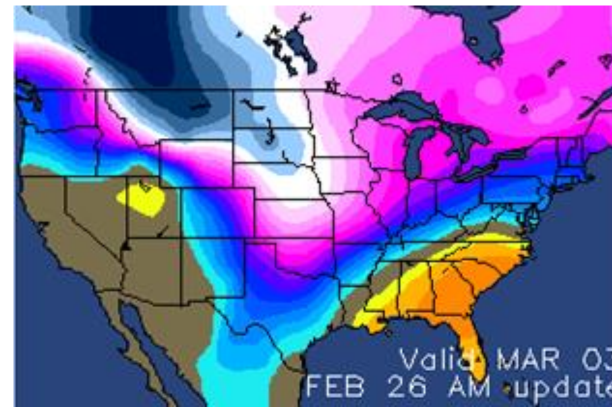


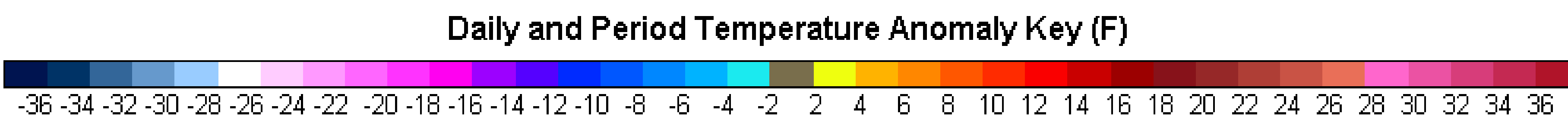
Weather Forecast – February 26, 2014

February 26 forecast for March 1 through 3, 2014









Tariff Rates

Base Tariff Rates

	Effective 12/31/2017	Effective 1/1/2018	Effective 10/1/2018	Comeback Rates Effective 1/1/2023
TF-1 Reservation (Large Customer)	0.41000	0.39294	0.39033	?
TF-1 Volumetric (Large Customer)	0.03000	0.00832	0.00832	?
Small Customer	0.72155	0.69427	0.69427	?

Avista's Net Effective Rate

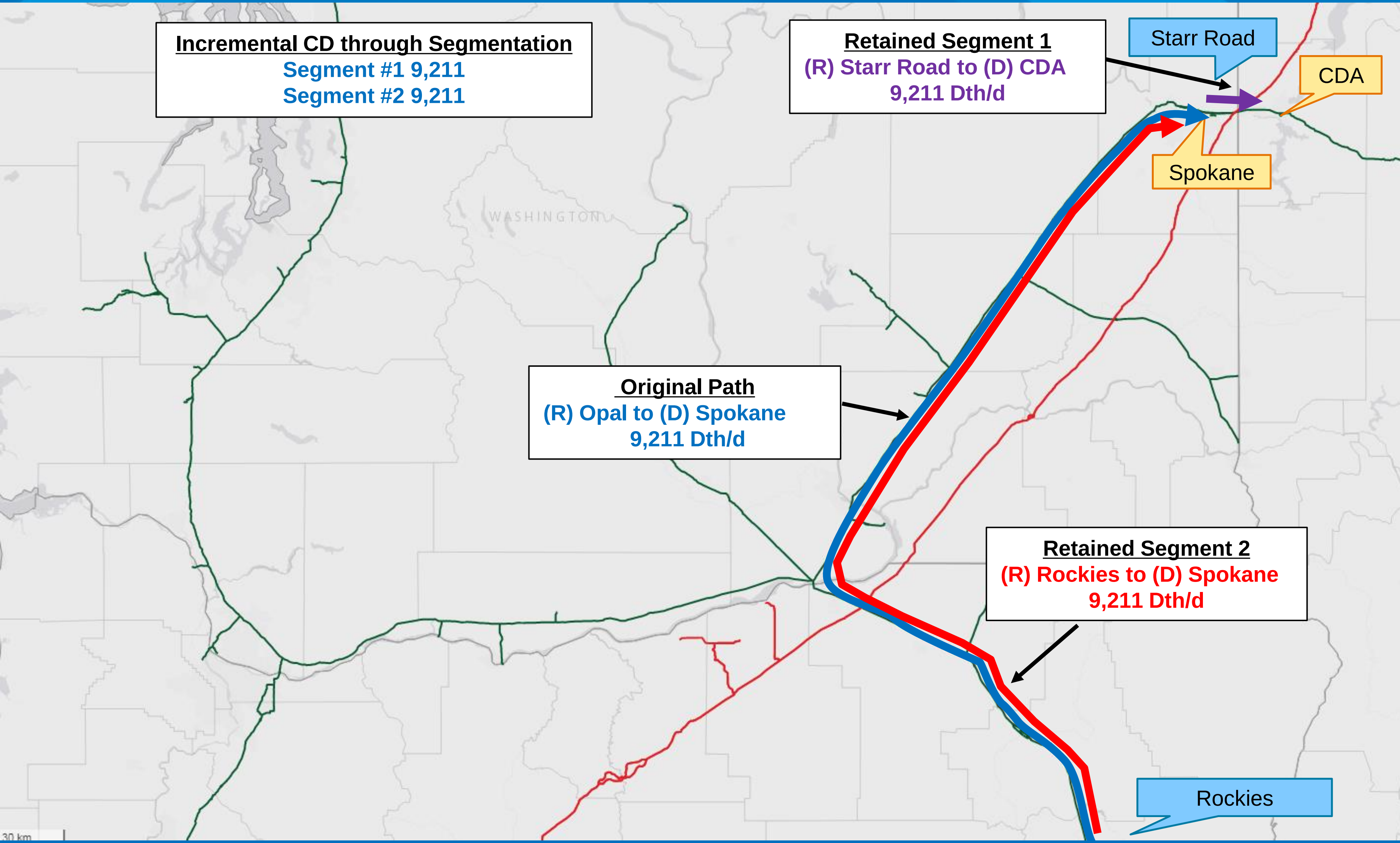
Net Effective Rate

	Contract	Daily Contract Demand	Released Amount	Receipt	Delivery	Rate	Reservation Charge
Base Contract	**Various**	**190,416**				**0.39294**	**$ 27,310,053**
Incremental CD through Segmentations to themselves							
Avista	137286	9,211		Starr Road	Coeur D'Alene	-	$ -
Segmented Releases to Third Parties							
IGI	110203		10,000	Rockies	Idaho	0.39294	$ (1,434,231)
	110192		10,000	Rockies	Meridian/Boise	0.39294	$ (1,434,231)
Clark PUD	140788		2,841	Stanfield	River Road	0.39294	$ (407,465)
	140787		6,709	Stanfield	River Road	0.39294	$ (962,226)
	142230		17,394	Sumas	River Road	0.39294	$ (2,494,701)
Puget Sound	141549		8,056	Sumas	JP Delivery	0.39294	$ (1,155,416)
							$ (7,888,271)
Net Effective Rate		**199,627**				**0.26655**	**$ 19,421,783**

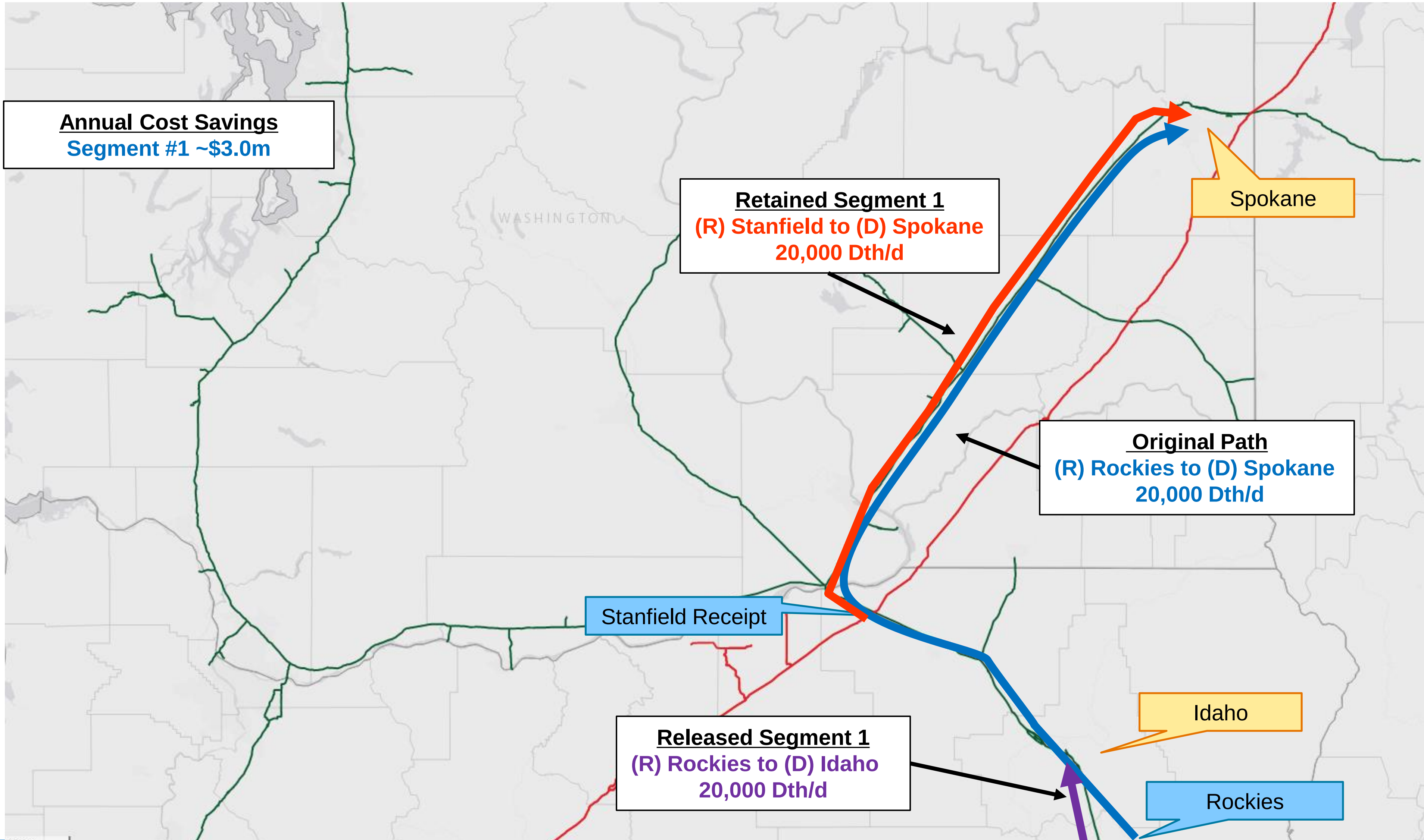
Peak Day Load Effective Rate

	Contract	Daily Contract Demand	Annual Contract Quantity	Receipt	Receipt / Delivery	Daily Rate	Reservation Charge
Avista	100314	91,200	2,906,266	JP Receipt	Various	0.03431	$ 1,141,935
	100315	2,623	94,462	JP Receipt	Various	0.03431	$ 37,147
							$ 1,179,081
Peak Day Effective Rate		**293,450**				**0.19234**	**$ 20,600,864**

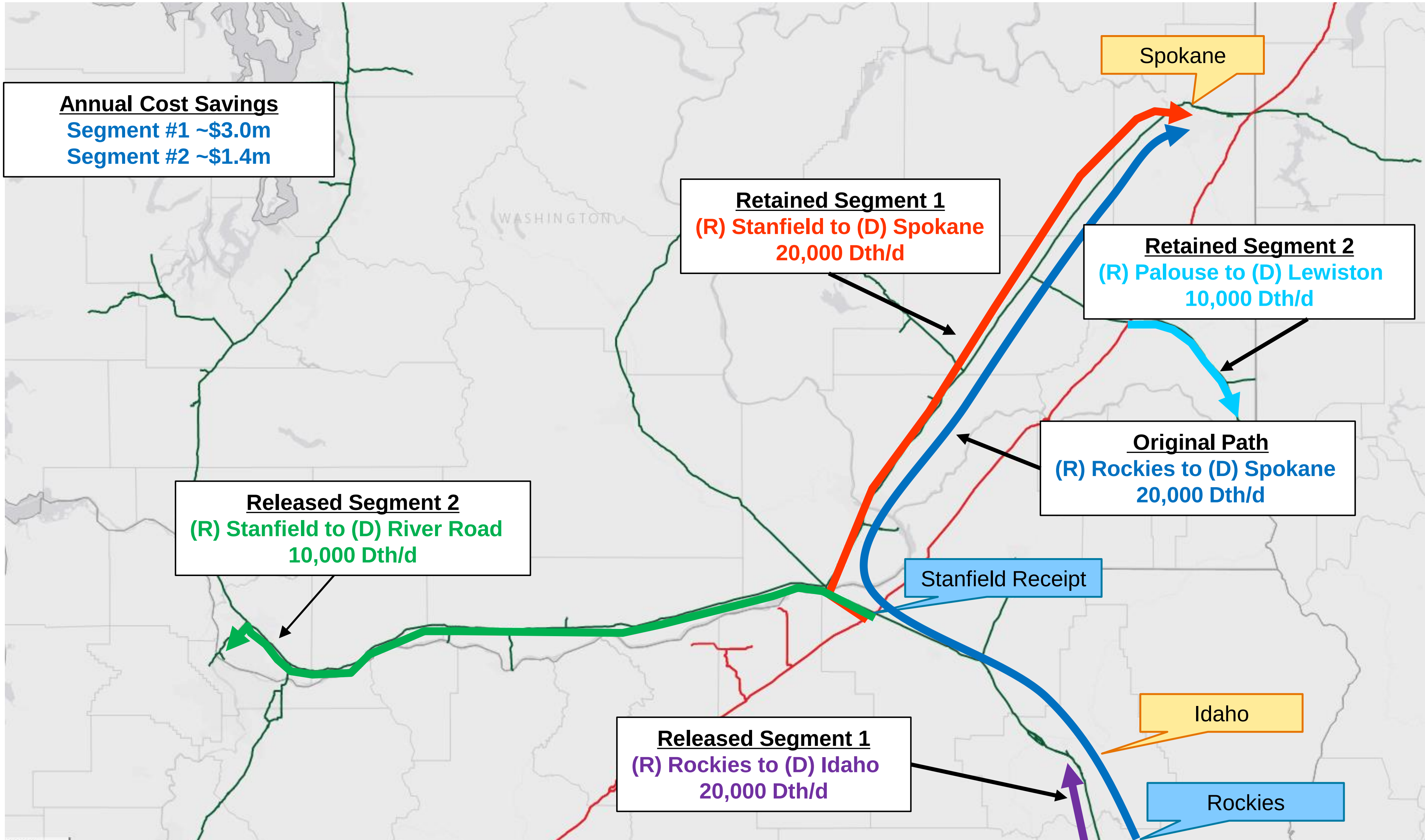
Avista's Segmentation to Themselves



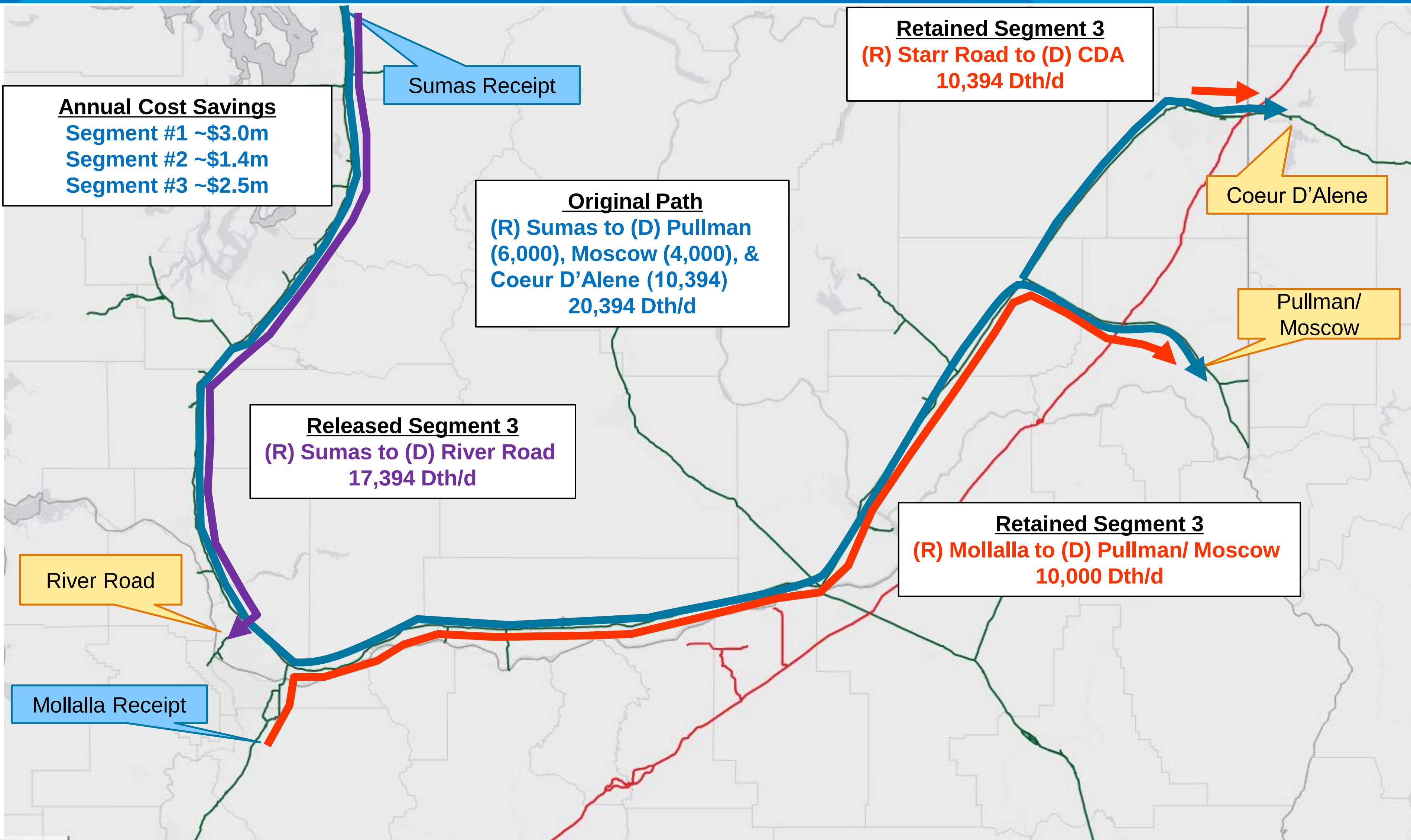
Avista's Segmented Release No. 1



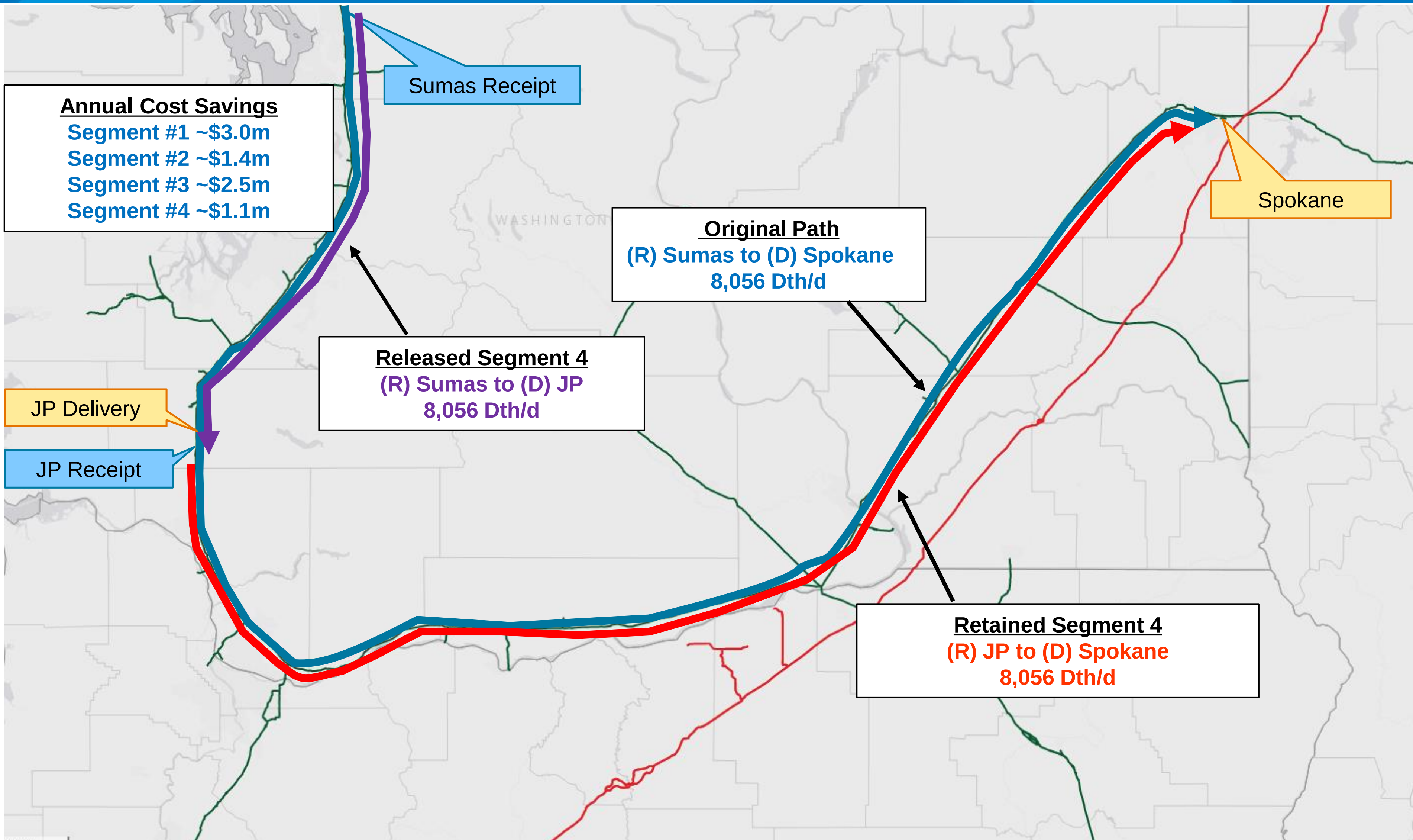
Avista's Segmented Release No. 2



Avista's Segmented Release No. 3



Avista's Segmented Release No. 4



One Williams.
One Mission.

Our Mission

- **Operate safely** in everything we do, every day.
- **Execute** on our commitments exceptionally well.
- **Collaborate** to rapidly deliver our best solutions.
- **Grow** our business, our people and our industry.
- **Improve** our operations and business performance continuously.

Our Vision

Be the premier provider of large-scale infrastructure connecting the growing supply of North American natural gas and natural gas products to growing global demand for clean fuels and feedstocks.

Firm Reliability

- **2014 – 99.9 percent**
- **2015 – 100 percent**
- **2016 – 99.9 percent**
- **2017 – 100 percent**

> **To determine customer impact, firm reliability percentage is calculated on flows prior, during and after posted maintenance**

Reliability and Integrity Programs

> **Integrity Management**
  - In-line Inspections
  - Requalifications
  - Cathodic Protection

> **Geo Hazard**
  - Strain Gauge
  - River Crossing
  - Land Movement

> **Mainline Valve Automation**

Integrity Management Program

- An Integrity Management Program based on an effective framework
  - Prevention, detection and remediation
  - Designed to address safety, reliability and compliance related risks in a comprehensive and systematic way
  - Plan maintenance focused on minimizing customer impacts
- Three major pipeline integrity recurring programs
  - Assessment Program
    - In-Line Inspection (smart pigging)
  - Department of Transportation Requalification Program
  - Cathodic Protection Program

Integrity Management Program (cont.)

Assessments

- In-Line Inspection Program (smart pigging)
  - The preferred assessment method to address most integrity threats
  - Means of complying with the Pipeline Safety Improvement Act (PSIA) of 2002
- Integrity Hydro-test
- Direct Assessments

Integrity Management Program (cont.)

In-Line Inspection (ILI) Program

> **Tools:**
- Gauge plate pig
- Cleaning pig
- Geometry pig (dents, obstructions)
- Magnetic Flux Leakage pig (MFL)

Standard suite of tools

> **Specialty Tools**
- Circumferential/Spiral Magnetic Flux Leakage Pig (CMFL)
- ElectroMagnetic Acoustic Transducer (EMAT)

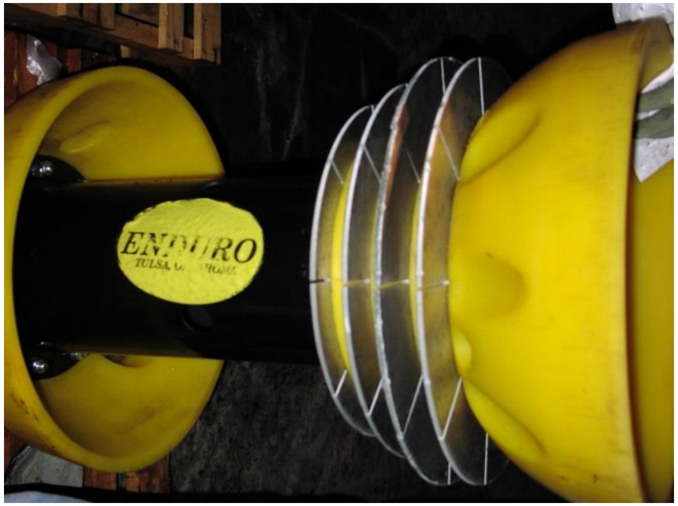
Integrity Management Program (cont.)

In-Line Inspection Program –

Preparing the line for inspection

- **Cleaning pig:**
  - remove liquids and debris from line and prepares line for inspection

- **Gauge Plate Pig:**
  - inspect for obstructions such as severe dents or bends that could stop an instrumented tool



Integrity Management Program (cont.)

In-Line Inspection Program - Standard Instrumented In-line Inspection Tools

Geometry Tool:

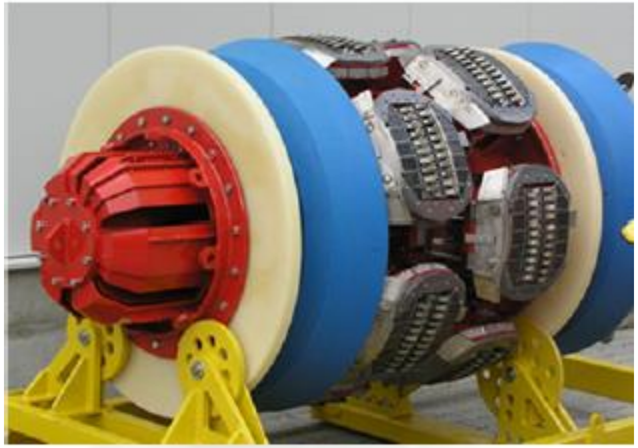
- Locate and size dents, bends, ovality due to construction or third-party damage

> **MFL Tool:**

- inspect for internal/external corrosion or metal loss

Integrity Management Program (cont.)

In-Line Inspection Program - Specialty Tools



> **Circumferential/Spiral Magnetic Flux Leakage Pig (CMFL):**

- Locate and size axially oriented anomalies

> **Electro Magnetic Acoustic Transducer (EMAT) Tool:**

- Locate and size cracking including stress corrosion cracking (SCC)

Benefits of Utilizing ILI Technology for Integrity Assessment

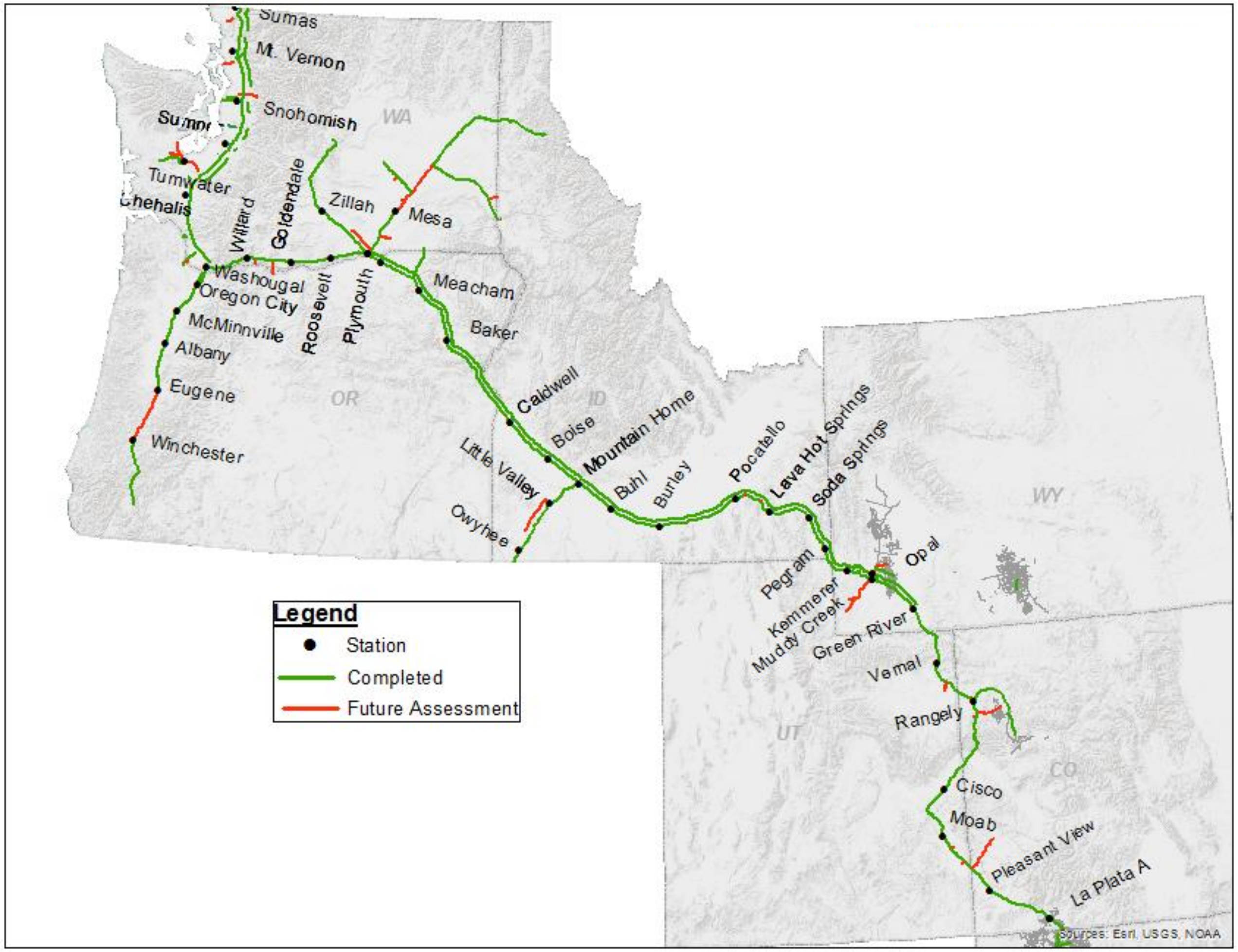
> It can assess for anomalies for the entire length of a pipeline segment vs. just the HCA locations as a hydro test

> The line does not need to be taken out of service to complete the assessment

> It can find features that would not be found in a hydro test,(e.g. pending failures)

> Data can be compared against prior runs to determine if features are growing

Integrity Assessment Program



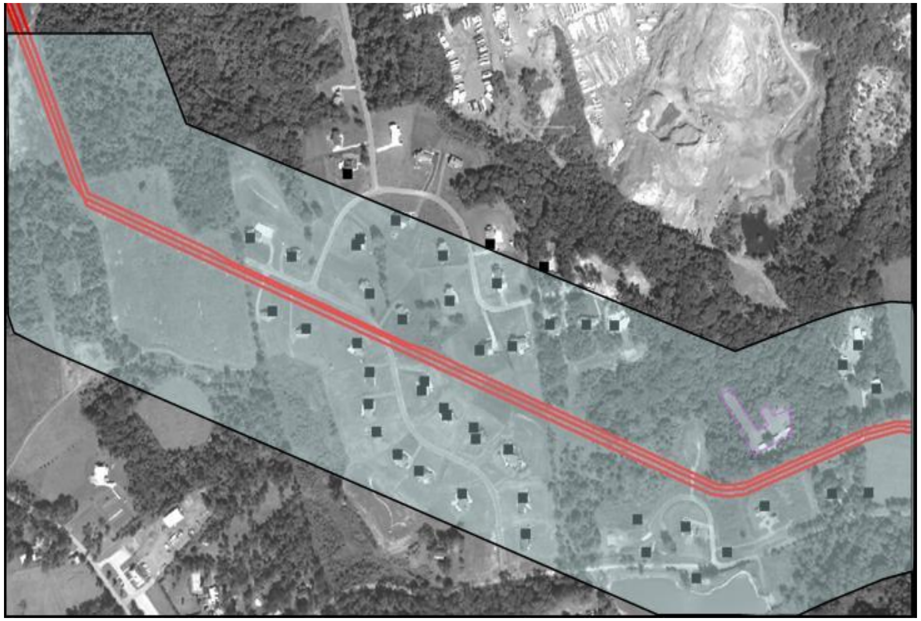
> **Asset integrity**

- 3,201 (83.8%) miles of first time assessment
- 177 (98.6%) miles of High Consequence Area (HCA) first time assessment
  - Reassess HCA's every 7 years

DOT Compliance Program

Department of Transportation Requalification Program

- Class location change based on population density and buildings near pipeline
- If class location changes, then either:
  - Reduce pressure
  - Perform a hydrostatic test
  - Replace pipeline



Cathodic Protection & Recoat Program

> **Purpose**

- Protect the pipeline against corrosion
  - Williams uses impressed current systems to protect against corrosion
    - All current levels are evaluated annually

  - Coating protects against corrosion by providing a physical barrier from the elements as well as making the cathodic protection current more efficient
    - Recoat areas determined primarily by inline inspection run-to-run comparisons

Geologic Hazards Program

- Monitoring pipe strain at strategic locations
- Monitoring land movement in several ways

Strain Gauge

River Crossing

Land Movement

Reliability Programs

Northwest Geotechnical Monitoring

- Strain gauge database
- ILI strain analysis
- Inclinometers
- Aerial surveys
- River crossing monitoring program
- GIS geotechnical hazards database
- LIDAR data

Department of Transportation Mainline Valve Program

- The purpose of the program is to ensure that Northwest Pipeline is in compliance with the Department of Transportation required mainline valve spacing requirements.

> Questions??

TransCanada Supply Update– J. Story

AVISTA – IRP/TAC Meeting

March 29, 2018

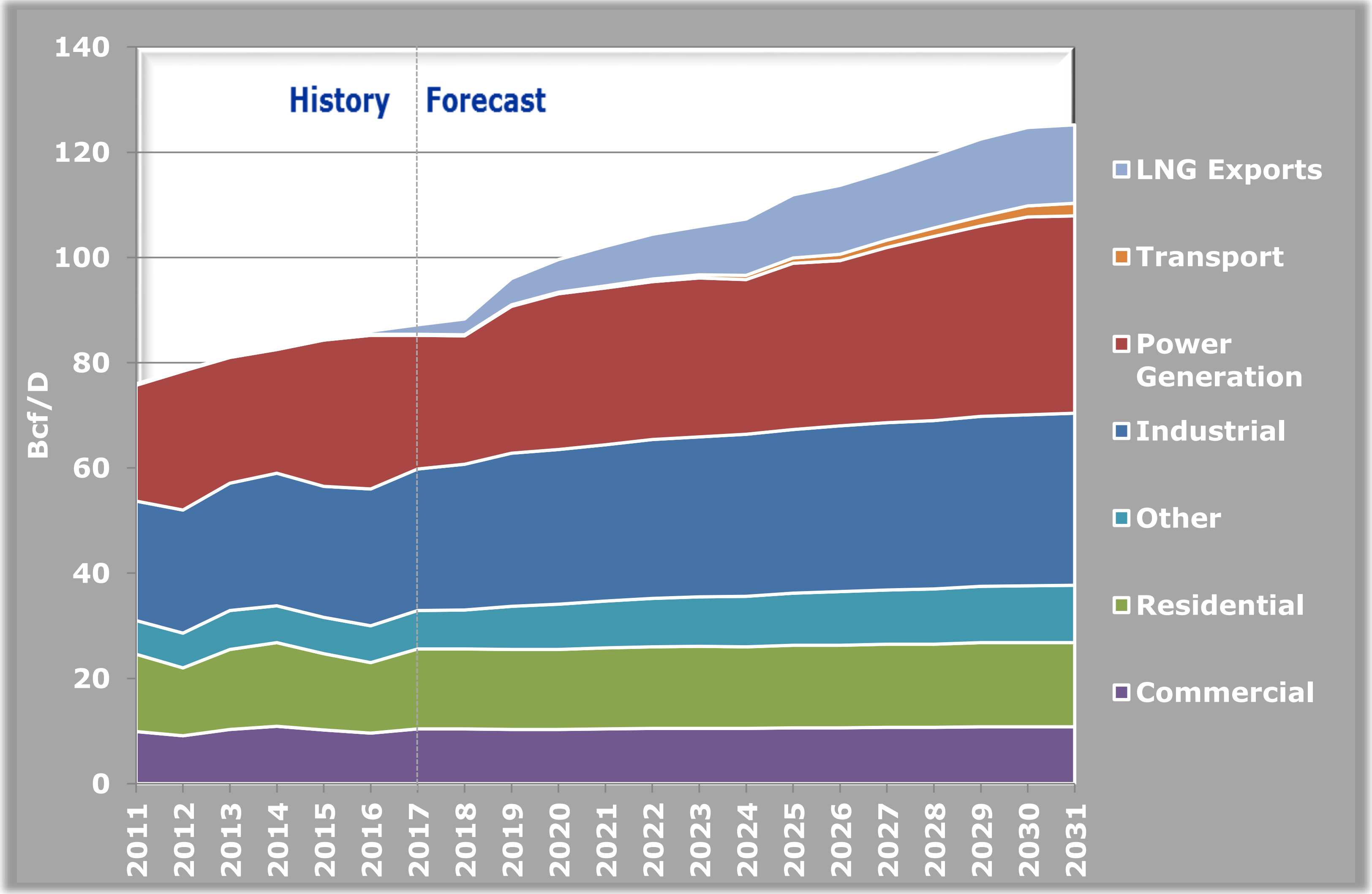
TransCanada
In business to deliver

2017 Supply and Market Outlook

- **North American Supply and Demand**
- **NGTL Expansions**
- **Impact on GTN Supply and Capacity**

38

North American Demand
2017 TransCanada Outlook

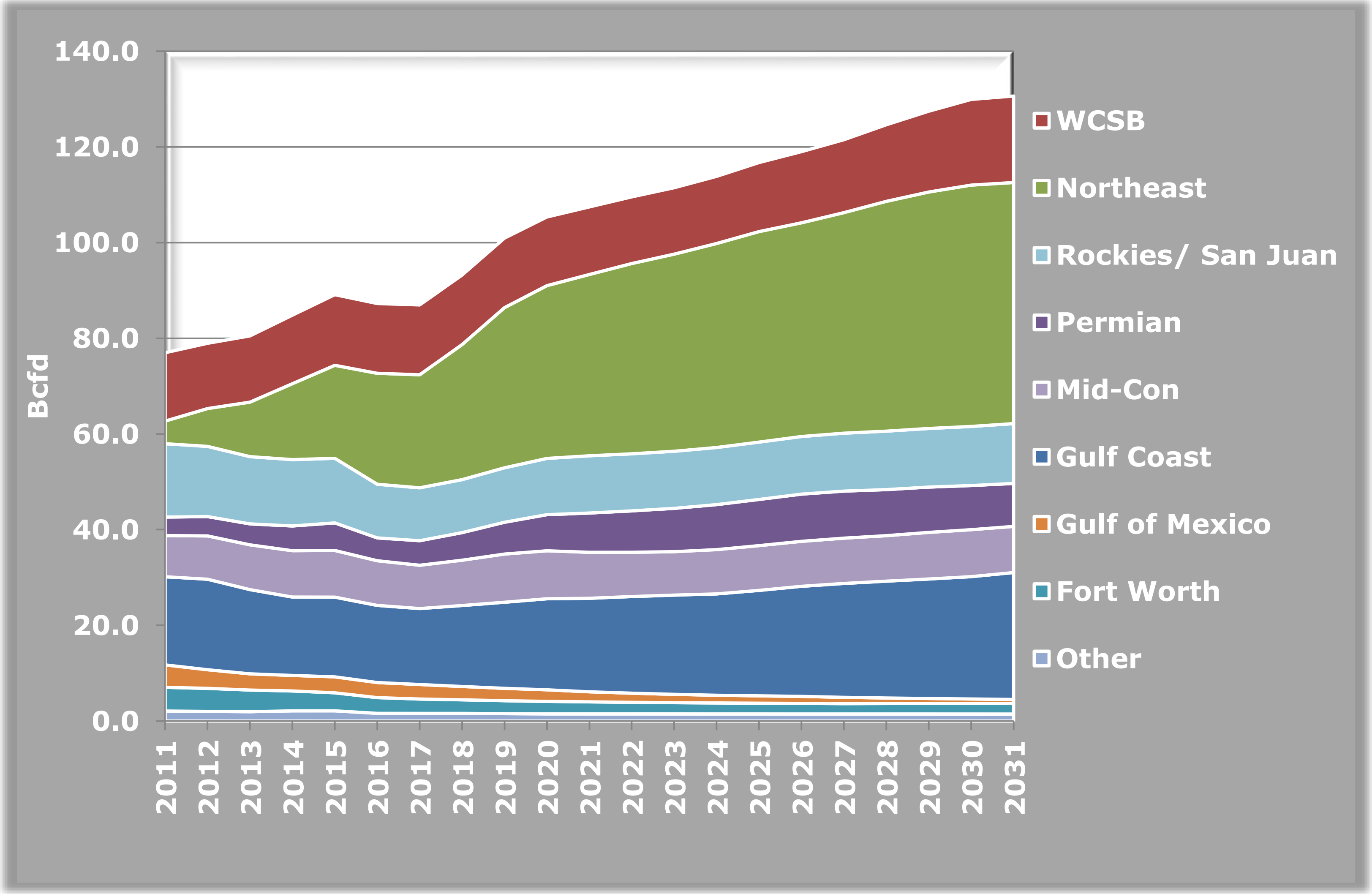


Source: Wood Mackenzie

TransCanada

39

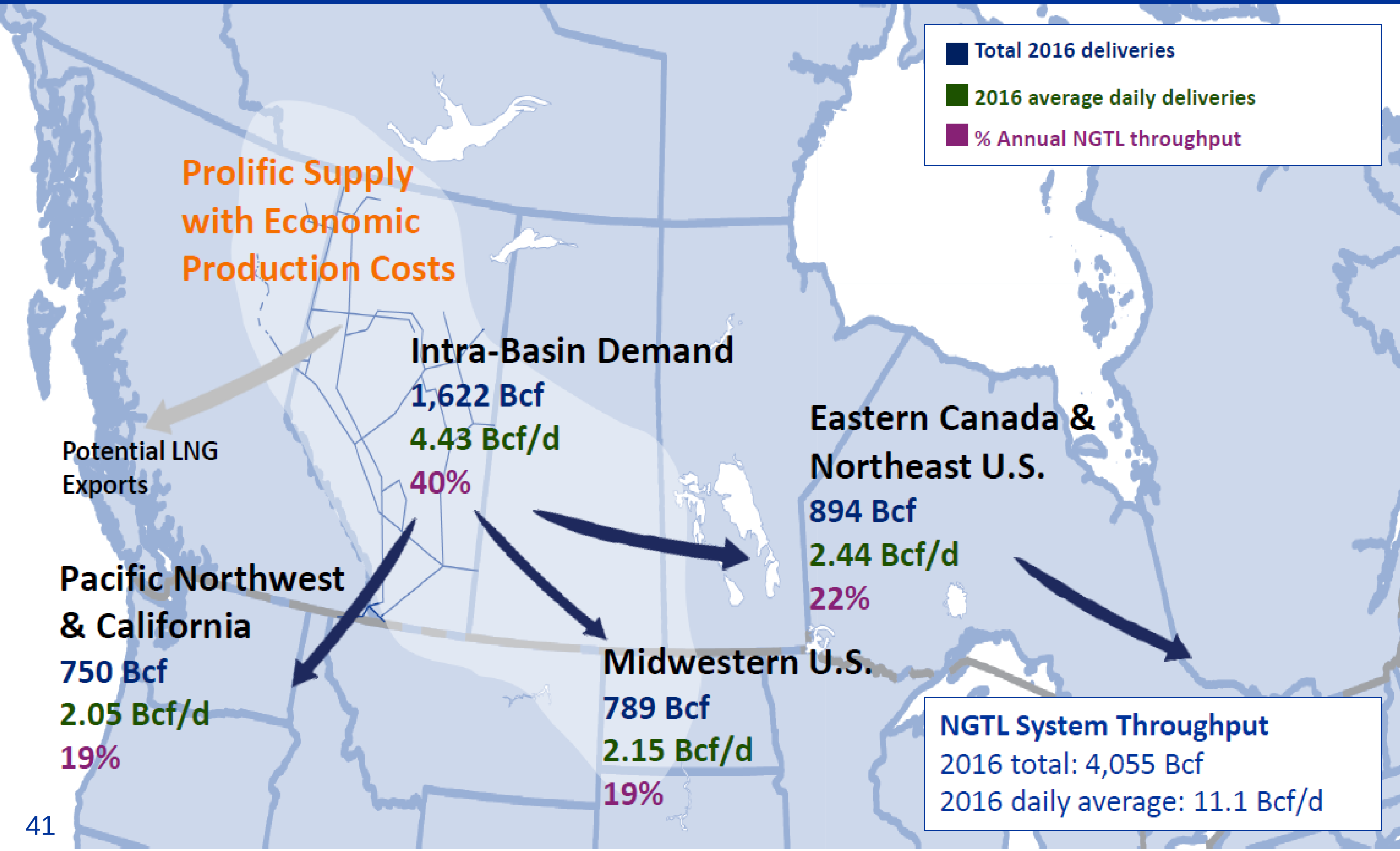
North American Supply
2017 TransCanada Outlook



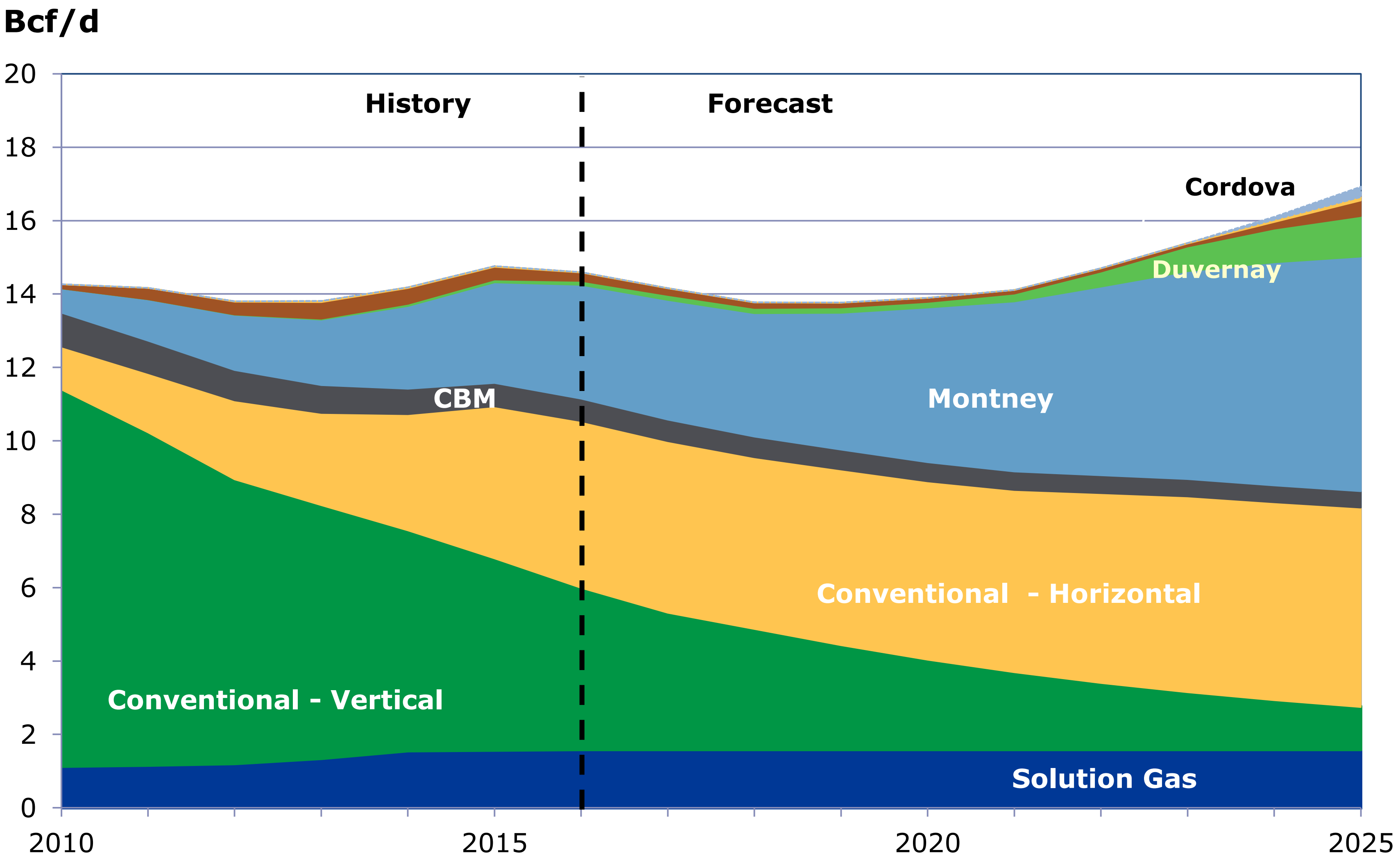
Source: Wood Mackenzie

TransCanada

WCSB Production Seeking Markets

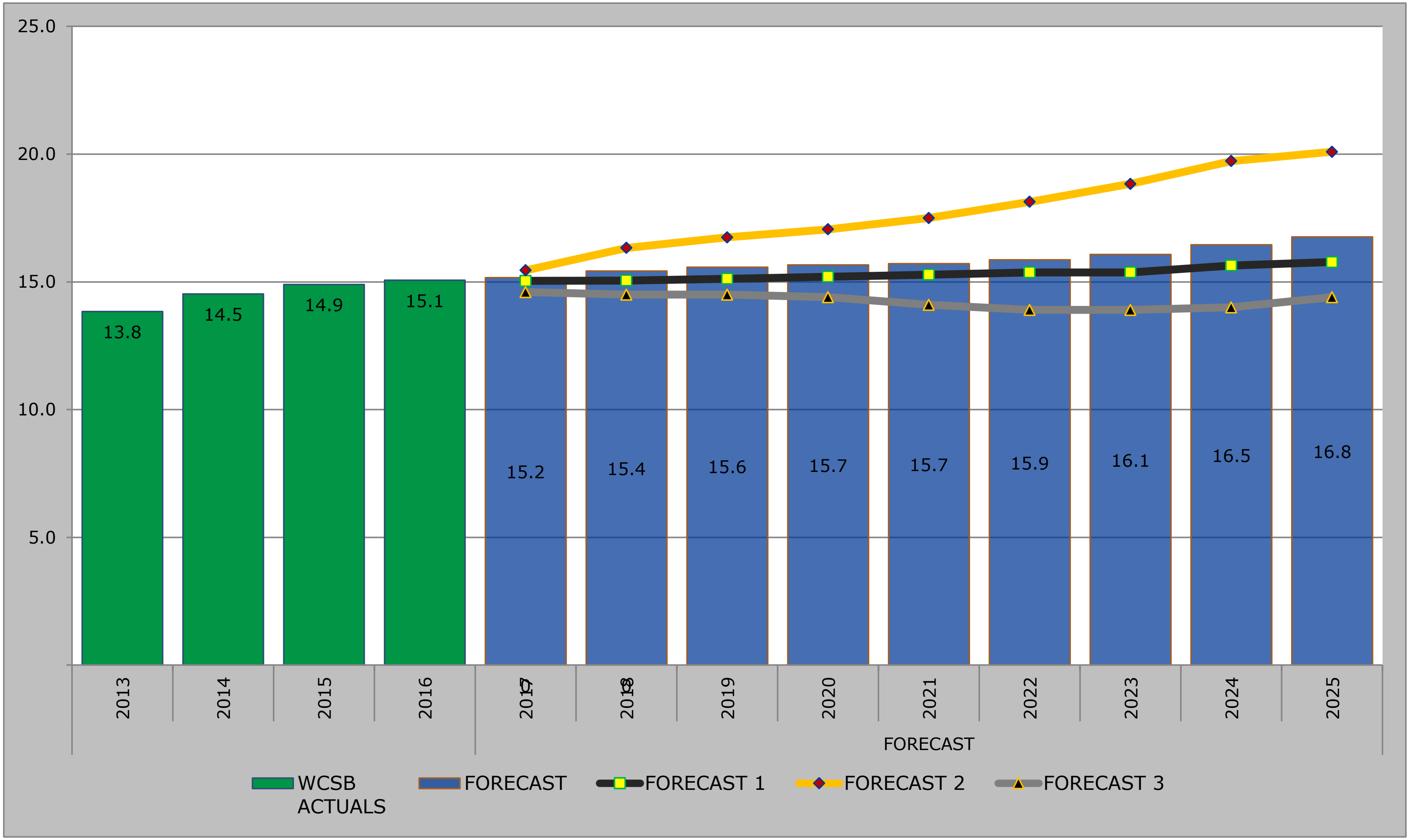


Western Canadian Sedimentary Basin Gas Supply



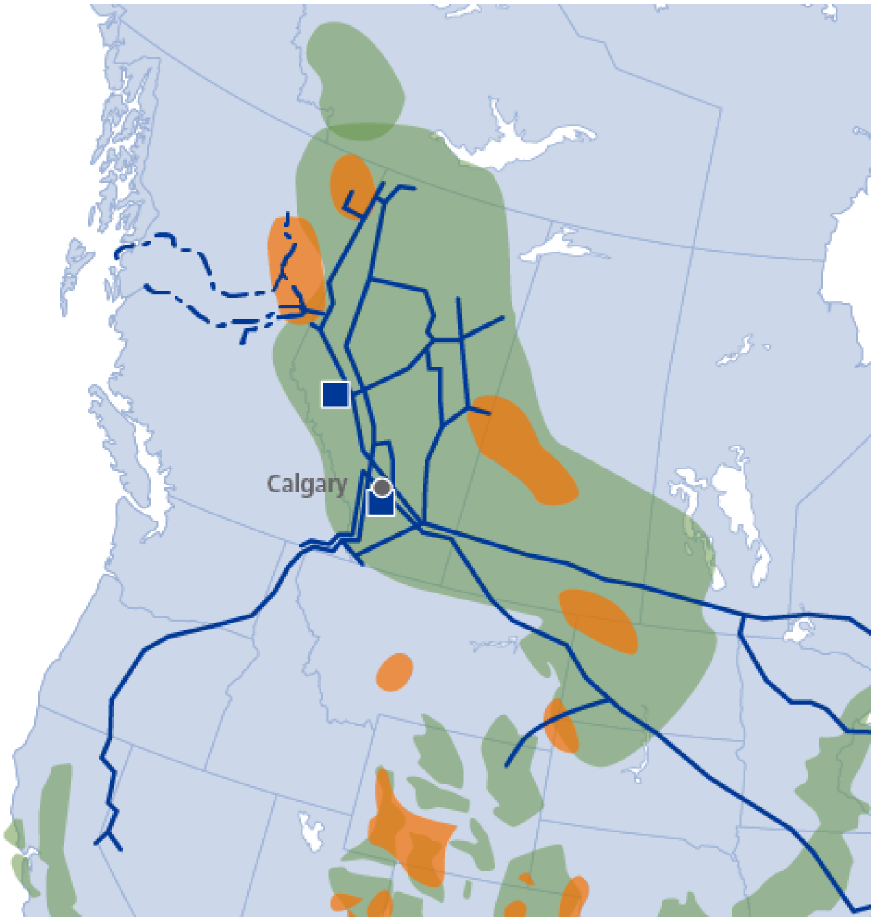
TransCanada

Western Canadian Production (Bcf)



Source: Wood Mackenzie

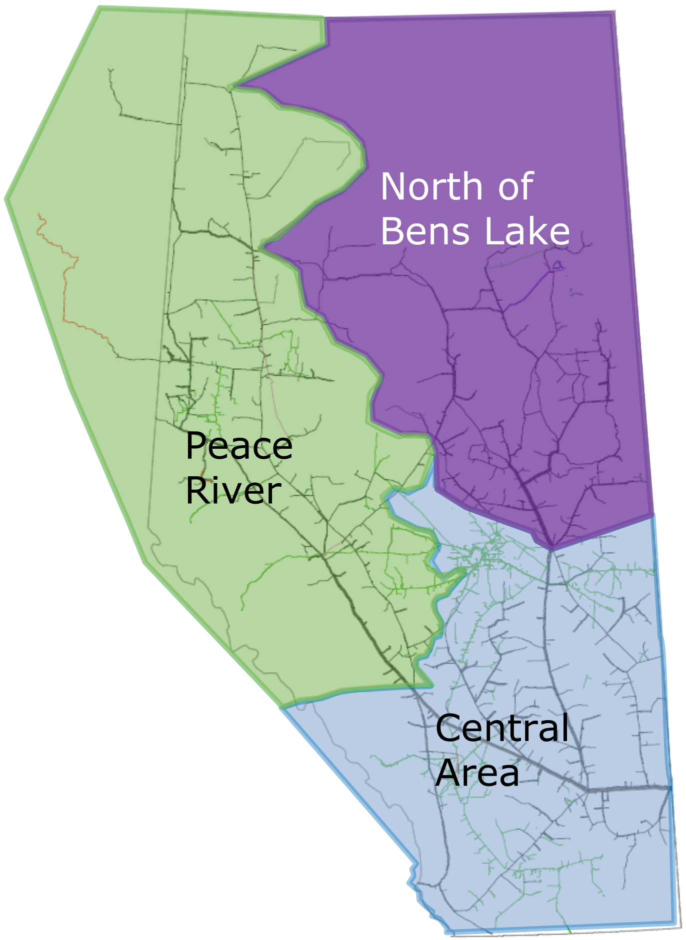
Western Canadian Sedimentary Basin

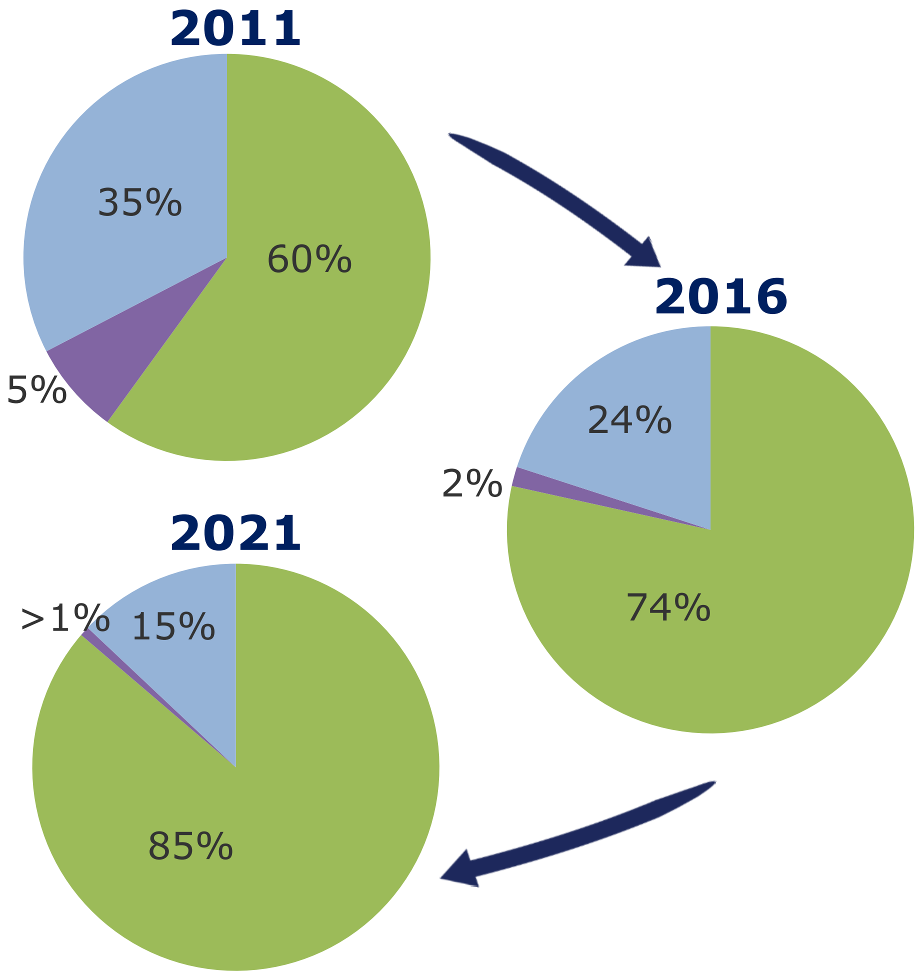


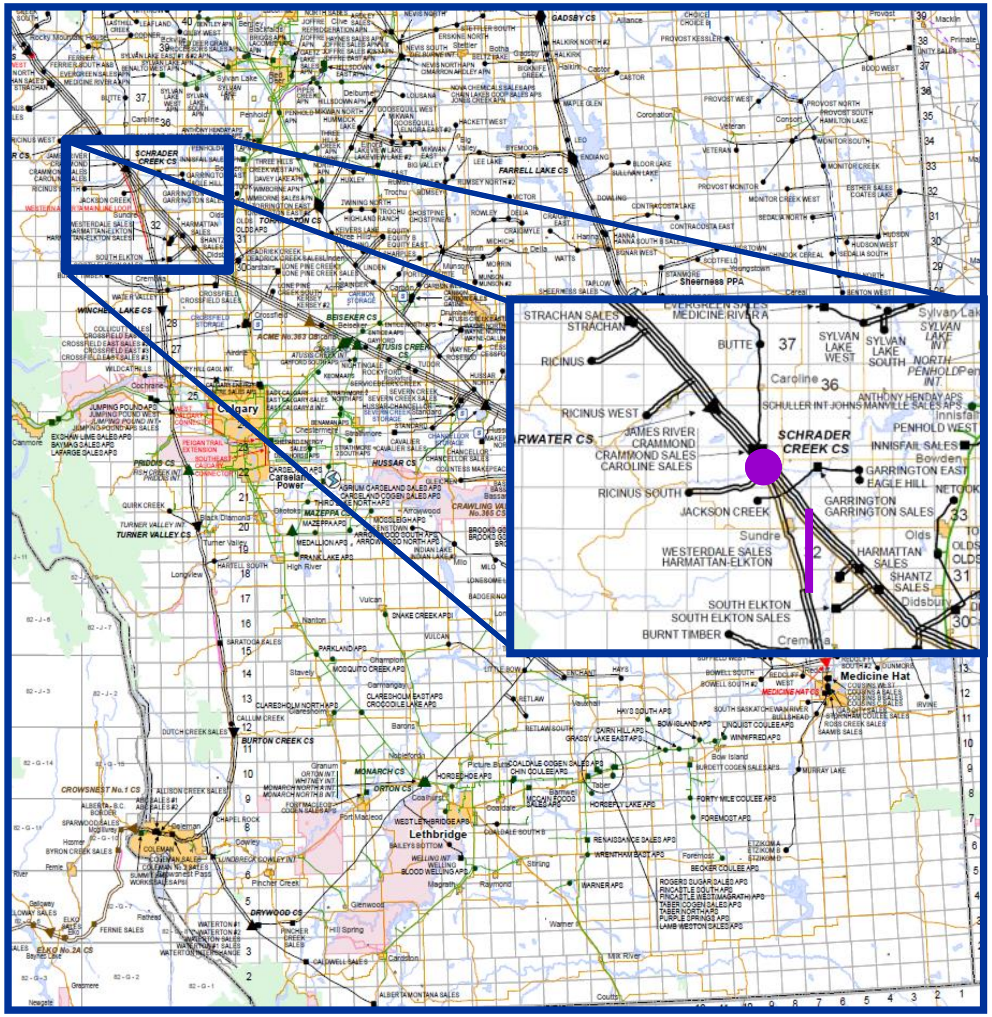
- WCSB:
  - Prolific and competitive resource
  - Economic production in Montney and Deep Basin resources
- NGTL System:
  - Dominant basin position, capturing 75% of WCSB production
  - Strongly connected to substantive supply and intra and ex-basin markets
  - Supply to GTN and Northern Border
  - 400^{+} Bcf of gas storage
  - 50^{+} Bcf/d of NIT trading liquidity

TransCanada

Evolving System Supply Distribution







James River By-Pass

- Open Seasons in 2015
- Onstream June 2016
- Pipeline modification Project
- ~150 TJ/d of capacity
- ABC Border Design Capability: ~2.2 Bcf/d

Sundre Crossover

- Open Seasons in January and June 2016
- Onstream 2018
- ~20km of NPS 42 pipeline loop of WAS Mainline
- ABC Border Design Capability: ~2.45 Bcf/d

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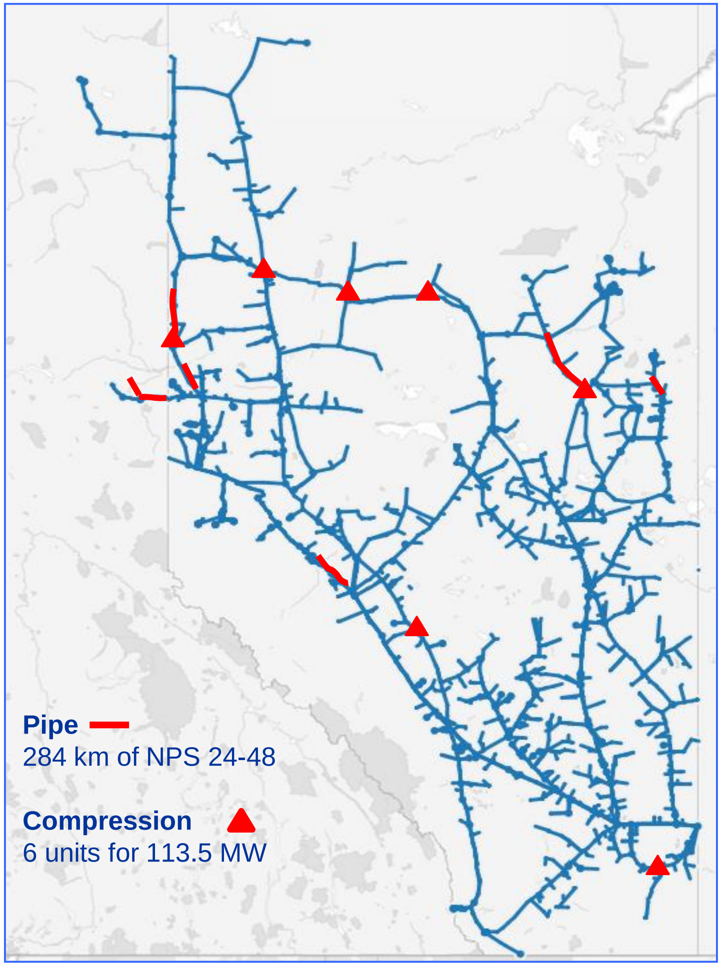
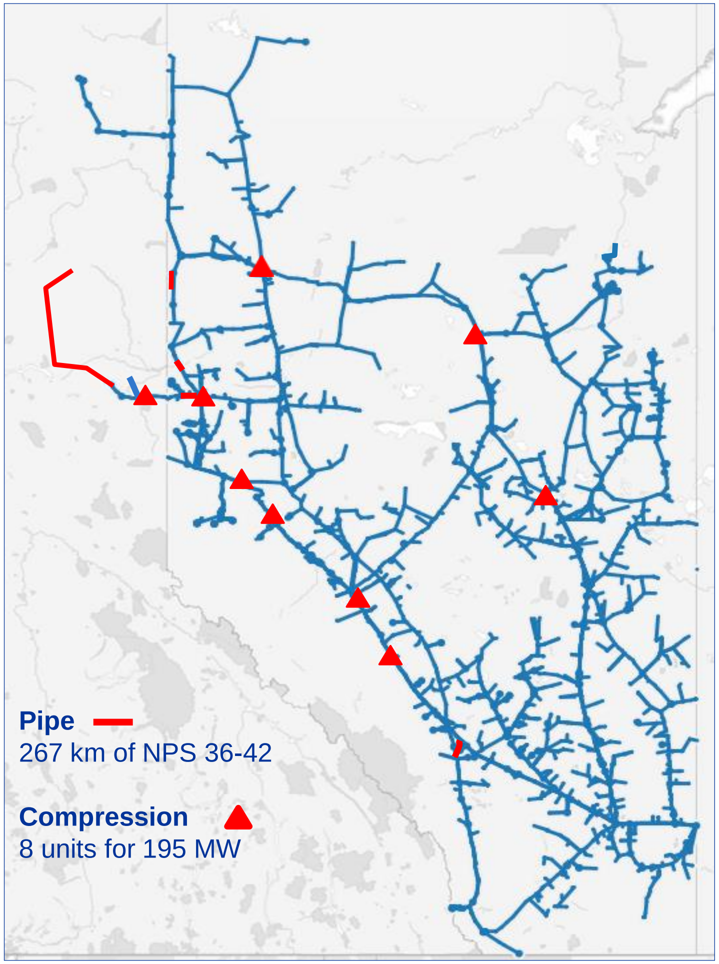
NGTL Mainline Expansions

2017 Expansions



Planned 2017 Facilities

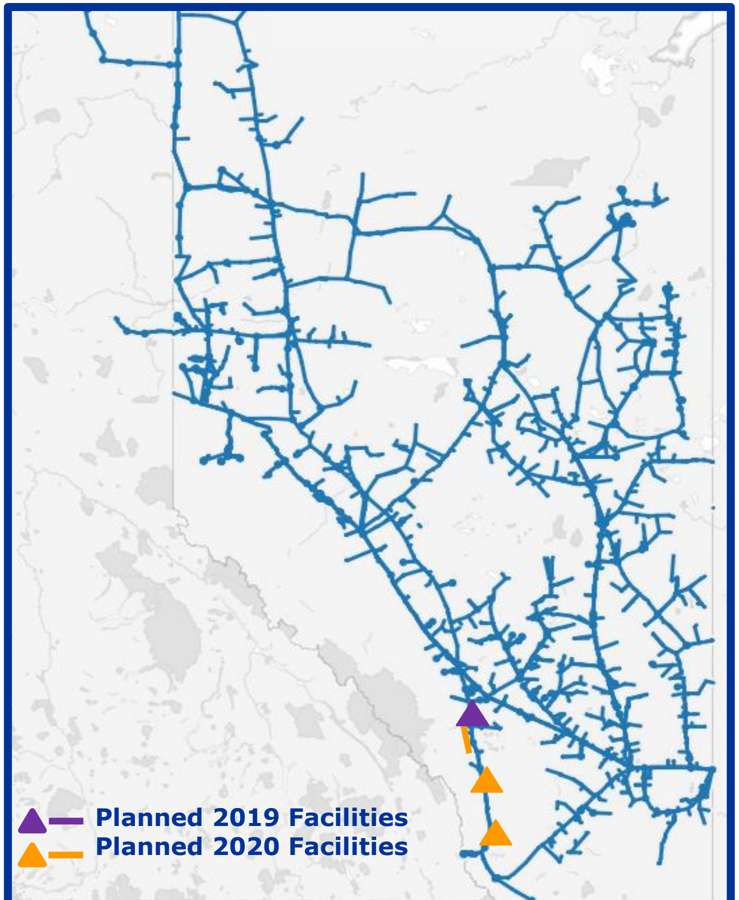
2018-19 Expansions



Planned 2018-19 Facilities

TransCanada

2019/2020 West Path Expansion



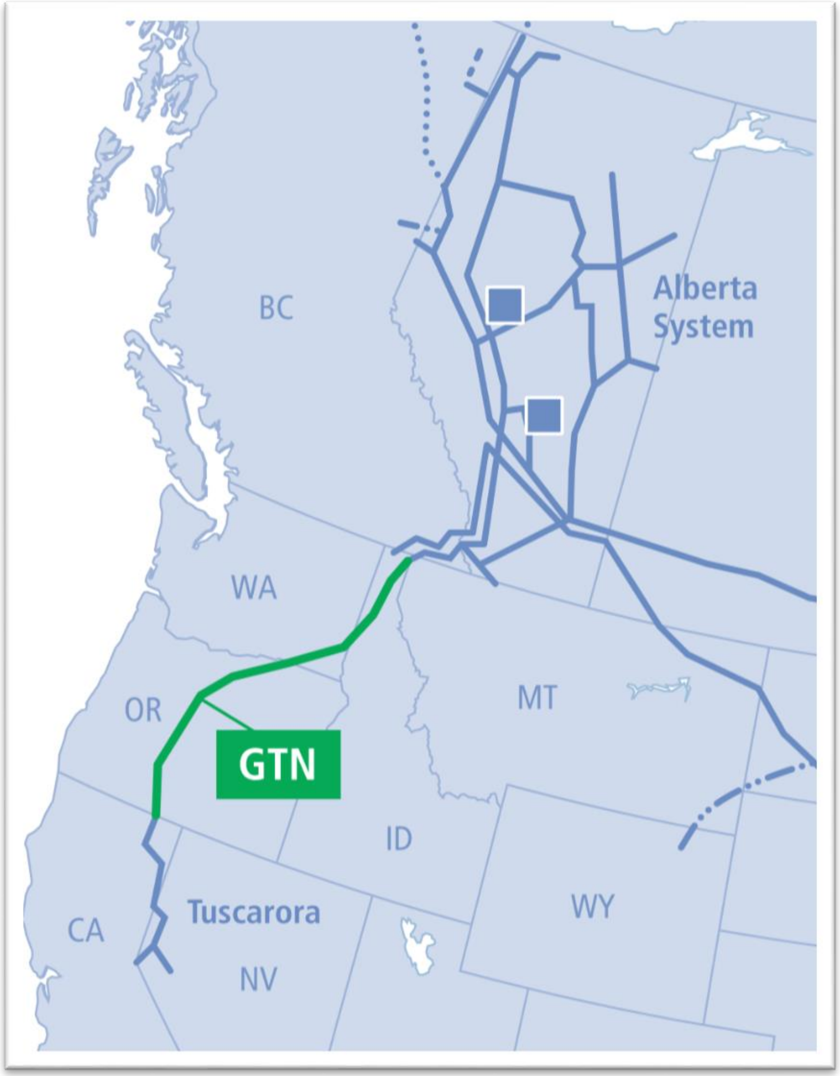
AB-BC Border Expansion Capacity Open Season

Expansion Capacity:	408 TJ/d
Service Commencement Dates:	
Nov 2019	120 TJ/d
Jun 2020	288 TJ/d
Bid Evaluation:	Length of Requested Term
Minimum Term:	8 years
FT-D1 Pricing Discount:	10%
Closing Date:	May 31, 2017

- Full alignment of TransCanada assets serving PacNW and Western states.
- Economic production from the WCSB resources is a good fit for Western US markets

TransCanada

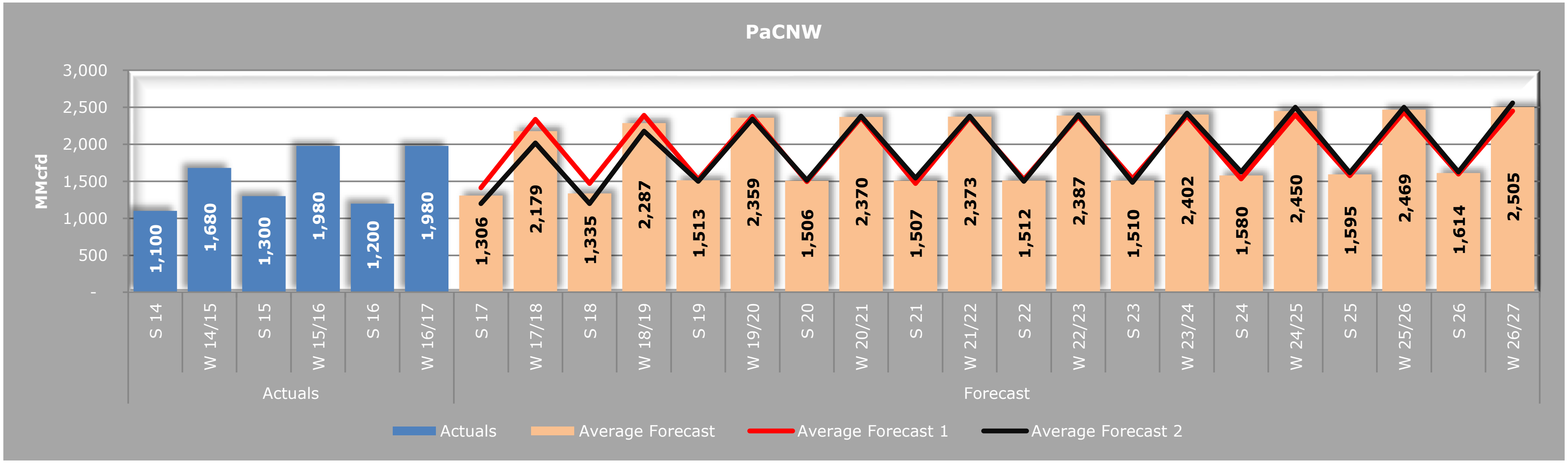
GTN Overview

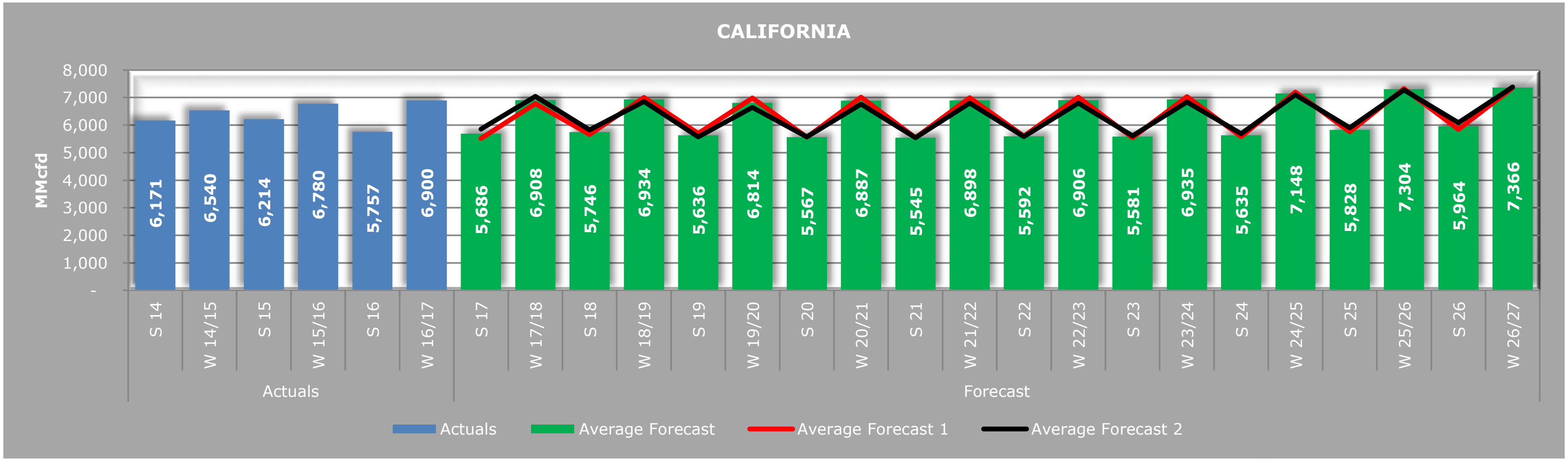


- Positioned to serve markets throughout California, Nevada, and the Pacific Northwest
- Consists of 1,350 miles of pipeline
- Kingsgate best efforts receipt capability of approx. 2.87 Bcfd and throughput capability of approx. 2 Bcfd thru Sta. 14
- Deliveries of up to 1.5 Bcfd to non-California Markets
- Long-term contracts extending out as far as 2039
- Volume throughput continues to be strong and should continue to grow in 2018
- NGTL continues to address the export capability at ABC to bring into alignment with downstream systems

TransCanada

Demand Projections
Pacific Northwest & California





TransCanada

NGTL West Path Expansion Summary

- **James River By-Pass**

  ISD - June 2016

    - 150,000 Gj/d
    - A/BC Border Capability – 2.2 Bcf/d
- **Sundre Crossover**
  - ISD - April 2018
    - 245,000 Gj/d
    - A/BC Border Capability – 2.43 Bcf/d
- **Winchell Unite Addition**
  - ISD – November 2019
    - 120,000 Gj/d
    - Estimated A/BC Border Capability – 2.54 Bcf/d
- **West Path Expansion**
  - ISD – June 2020
    - 288,000 Gj/d
    - Estimated A/BC Border Capability – 2.81 Bcf/d

TransCanada

Impact on Kingsgate Supply

- **Total Available at Kingsgate May Vary Depending upon Foothills Markets and Fuel Usage**

- **Daily Kingsgate Supply Available estimated:**
  - Early 2018 2.33 Bcf/d*
  - November 2019 2.44 Bcf/d*
  - June 2020 2.71 Bcf/d*

*(estimates approx. 100,000dth/d scheduled on FTBC system)

- **Current GTN Kingsgate Receipt Capability:**
  - Best Efforts – 2.87 Bcf/d
  - Capability impacted by seasonal ambient temps and physical flow path

TransCanada

Impact of Kingsgate Supply on GTN

- **Recent GTN Open Seasons to Contract Available Capacity**
  - Open Seasons Process Ran– December 2017 thru January 2018

- **Pre-arranged – Kingsgate to Malin Path**
  - 8 “Packages” totaling approx. 348,610 Dth/d
  - Contract Start Dates of Nov. 2019 and Nov. 2020
  - All contracted long-term
  - All Capacity Awarded to Pre-arranged Entities

- **Remaining Available Capacity – Kingsgate to Malin Path**
  - 139,400 dth/d
  - Effective Date(s) – Any Date April 1, 2018 or Later
  - Unlimited Term
  - All Offered Capacity Awarded

TransCanada

Impact of Kingsgate Supply on GTN

- **Considerable Interest in Additional Kingsgate Sourced GTN Capacity**
  - GTN Exploring Expansion Options
    - "Market Pull" Required
    - Mainline
    - New Pipelines or Laterals – Trail West
  - ROFR Open Season Process
    - Contract Renewals
    - 2023 Contract Cliff
- **GTN Rate Case Update**
  - GTN Full Haul Rate Drops to $0.285 Effective 1/1/2020 thru 12/31/2021
    - Kingsgate to Stanfield - $0.146 Dth/d
    - Kingsgate to Spokane - $0.076 Dth/d
  - "Come Back" Provision Requires New Rates Effective 1/1/2022
    - Rate Case Preparation in 2021
    - Recent Contracting and Facility Upgrades will Impact Rates

TransCanada

NGTL and Foothills Pipelines Update

TransCanada
In business to deliver

Avista - Supply Side Resources

Eric Scott

Manager of Natural Gas Resources

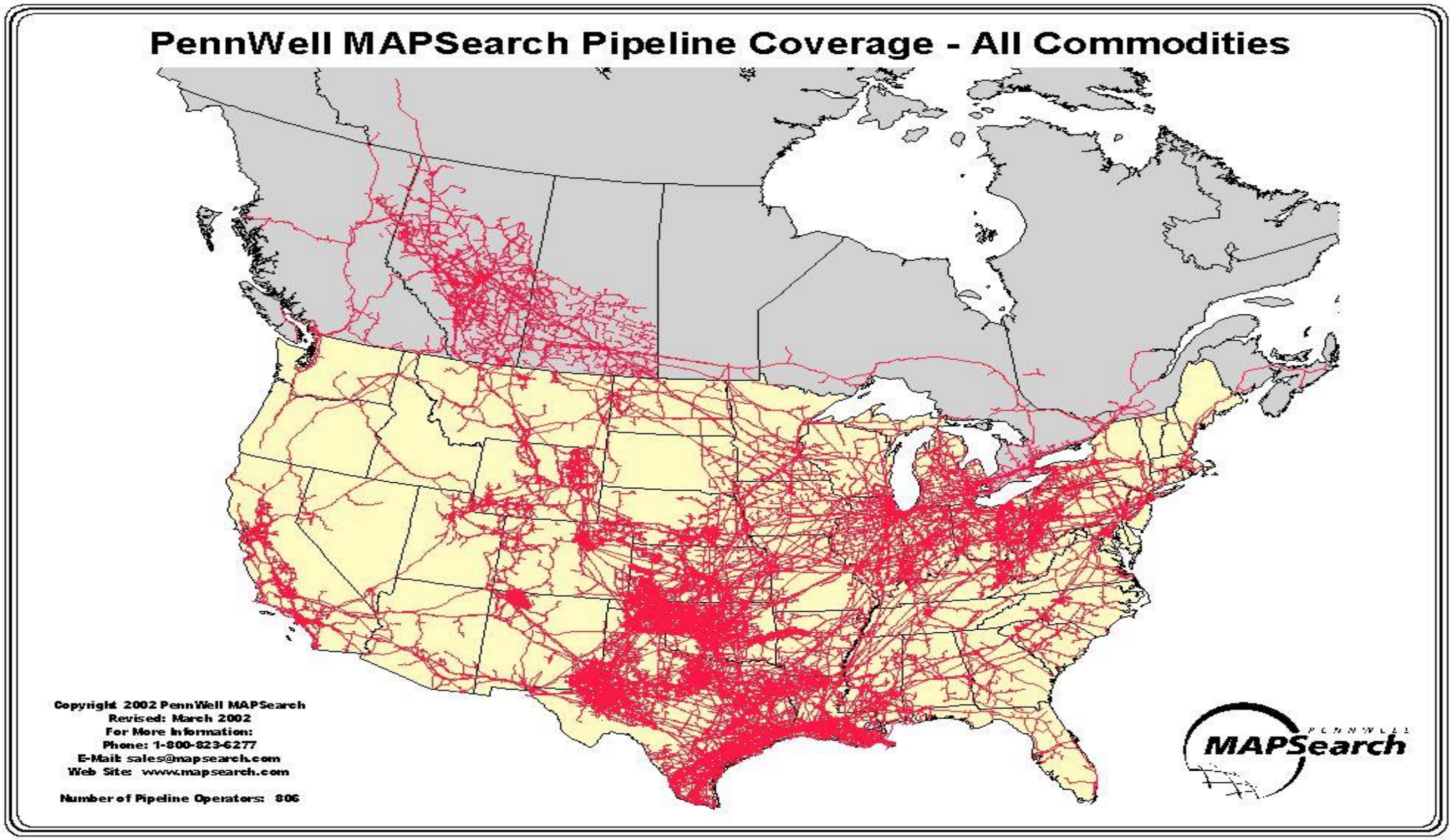
Interstate Pipeline Resources

- The Integrated Resource Plan (IRP) brings together the various components necessary to ensure proper resource planning for reliable service to utility customers.

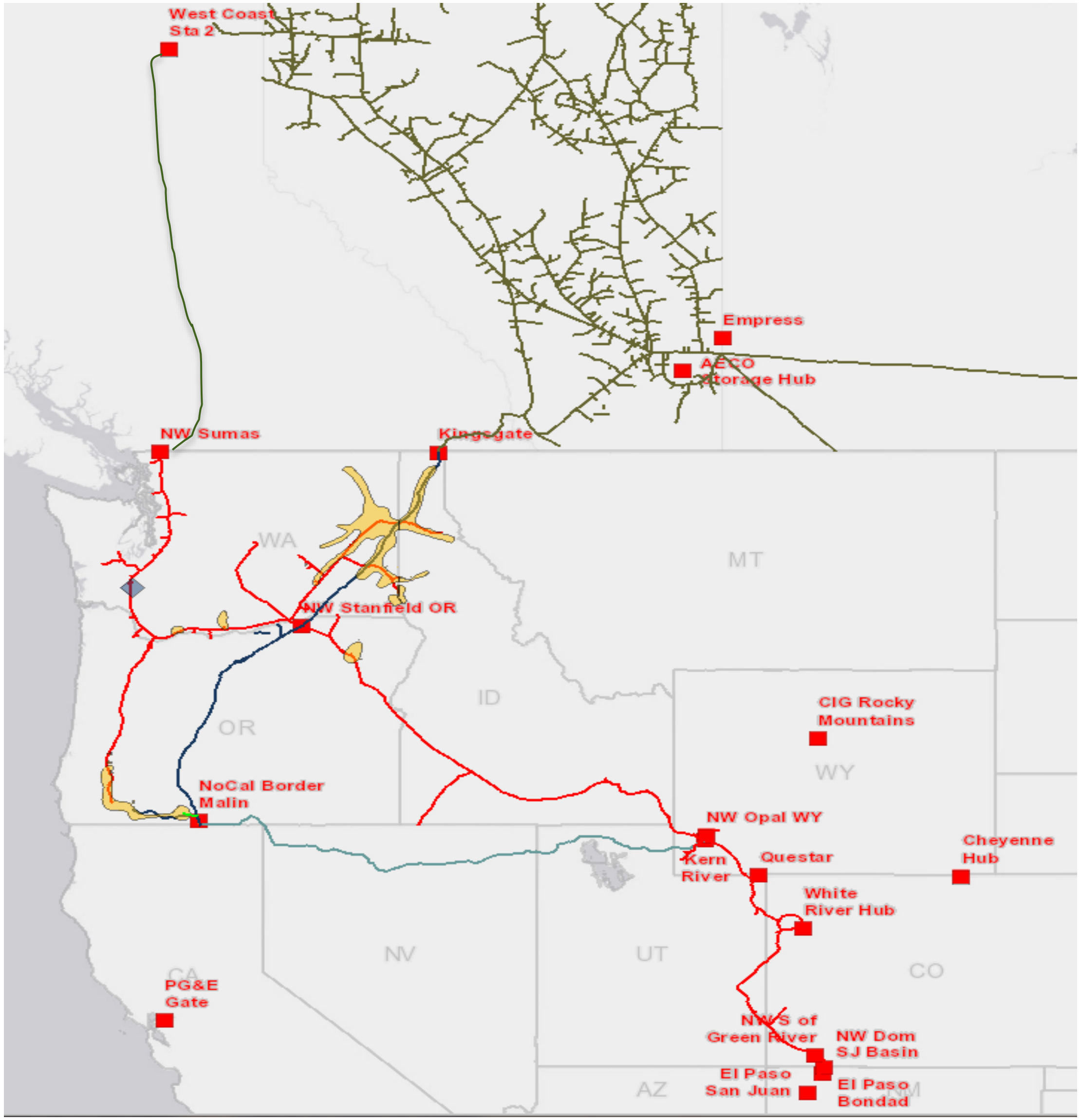
- One of the key components for natural gas service is interstate pipeline transportation. Low prices, firm supply and storage resources are rendered meaningless to a utility customer without the ability to transport the gas reliably during cold weather events.

- Acquiring firm interstate pipeline transportation provides the most reliable delivery of supply.

Pipeline Overview



Pipeline Overview



Avista's Transportation Contract Portfolio

Avista holds firm transportation capacity on 6 interstate pipelines:

Pipeline	Expirations	Base Capacity Dth
Williams NWP	2019 – 2042 (2035)	290,000
Westcoast (Enbridge)	2026	10,000
TransCanada - NGTL	2019-2028	208,000
TransCanada - Foothills	2020-2028	204,000
TransCanada - GTN	2023-2028	240,000 – 321,000 166,000 – 212,000
TransCanada - Tuscarora	2020	200

*Includes Thermal Transport

Contract Provisions - NWP

- Grandfathered Unilateral Evergreen (TF-1, TF-2, SGS-2F)
  - Roll-over 1 year
  - Shipper has sole option to extend or renew
- Standard Unilateral Evergreen
  - Roll-over 1 year
  - 5 year termination provision
- Standard Bilateral Evergreen
  - Either transporter OR shipper may terminate
- Right of First Refusal (ROFR)
  - Provides “last look”

Contract Provisions - GTN

- Unilateral Evergreen
  - Shipper alone may terminate contract
- Bilateral Evergreen
  - Either transporter OR shipper may terminate contract
- Right of First Refusal (ROFR)
  - Provides “last look”

Pipeline Contracting

Simply stated: The right to move (transport) a specified amount of gas from Point A to Point B

Contract Types

- Firm transport
  - Point A to Point B
- Alternate firm
  - Point C to Point D
- Seasonal firm
  - Point A to Point B but only in winter
- Interruptible
  - Maybe it flows, maybe it doesn't

Rate Design

- Postage stamp (NWP)
  - 1 mile or a thousand miles – same price
  - Plus variable
- Mileage (GTN)
  - Fee per mile
  - Plus variable

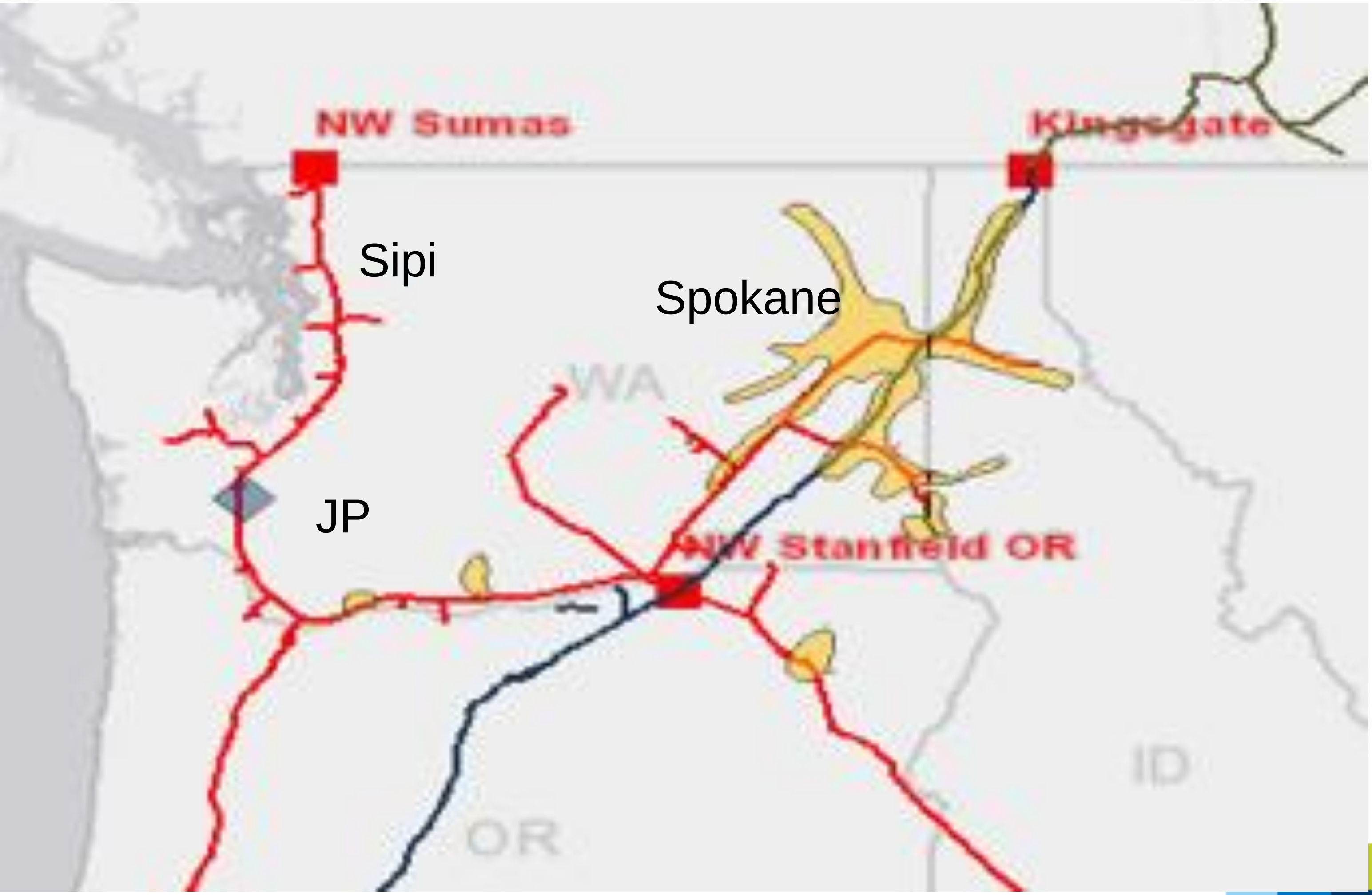
NWP Rate Case Settlement

- New rates in effect January 1, 2018
  - Good through September 30, 2018
- Rates further reduced October 1, 2018 – December 31, 2022
- Mandatory come-back – January 1, 2023
- No stay-out after October 2, 2018

GTN Rate Case Settlement

- New rates in effect January 1, 2016
  - Good through December 31, 2019
- Rates further reduced January 2020 – December 2021
- Mandatory come-back – January 1, 2022
- No stay-out

Pipeline Capacity – Segmented Releases
Example



Effective Rate - #100010

Contract	CD	Rate	Path	Annual $
#100010	19,432 Dth	$0.40	Sumas - Spokane	$2,837,000
Released	(19,432 Dth)	$0.40	Sumas - Spokane	($2,837,000)
#1	19,432 Dth	$0.40	JP - Spokane	$2,837,000
#2	19,432 Dth	-0-	Sumas - JP	-0-
Released	(19,432 Dth)	-0-	Sumas - JP	-0-
#2a	19,432 Dth	-0-	Sumas - Sipi	-0-
#2b	19,432 Dth	-0-	Sipi - JP	-0-
Total	**58,296 Dth**			**$2,837,000**

Northwest Pipeline Tariff Rate: $0.400

Effective rate – segmentation example: $0.133

Capacity Releases

Time	Duration	Rate
Annual	1 year	Full rate
Long-term	1+ year – 31.5 years	Full rate

During 2017, AVA received **$9.6mm** in release “revenue”

Example:

AVA released 35,000 Dths/day at full tariff rate to Clark PUD until 10/31/2025 recapturing over $5.2mm annually all of which goes to customers.

Storage – A valuable asset

- Peaking resource
- Improves reliability
- Enables capture of price spreads between time periods
- Enables efficient counter cyclical utilization of transportation (i.e. summer injections)
- May require transportation to service territory
- In-service territory storage offers most flexibility

Avista's Storage Resources

Washington and Idaho
Owned Jackson Prairie

- 7.7 Bcf of Capacity with approximately 346,000 Dth/d of deliverability

Oregon

Owned Jackson Prairie

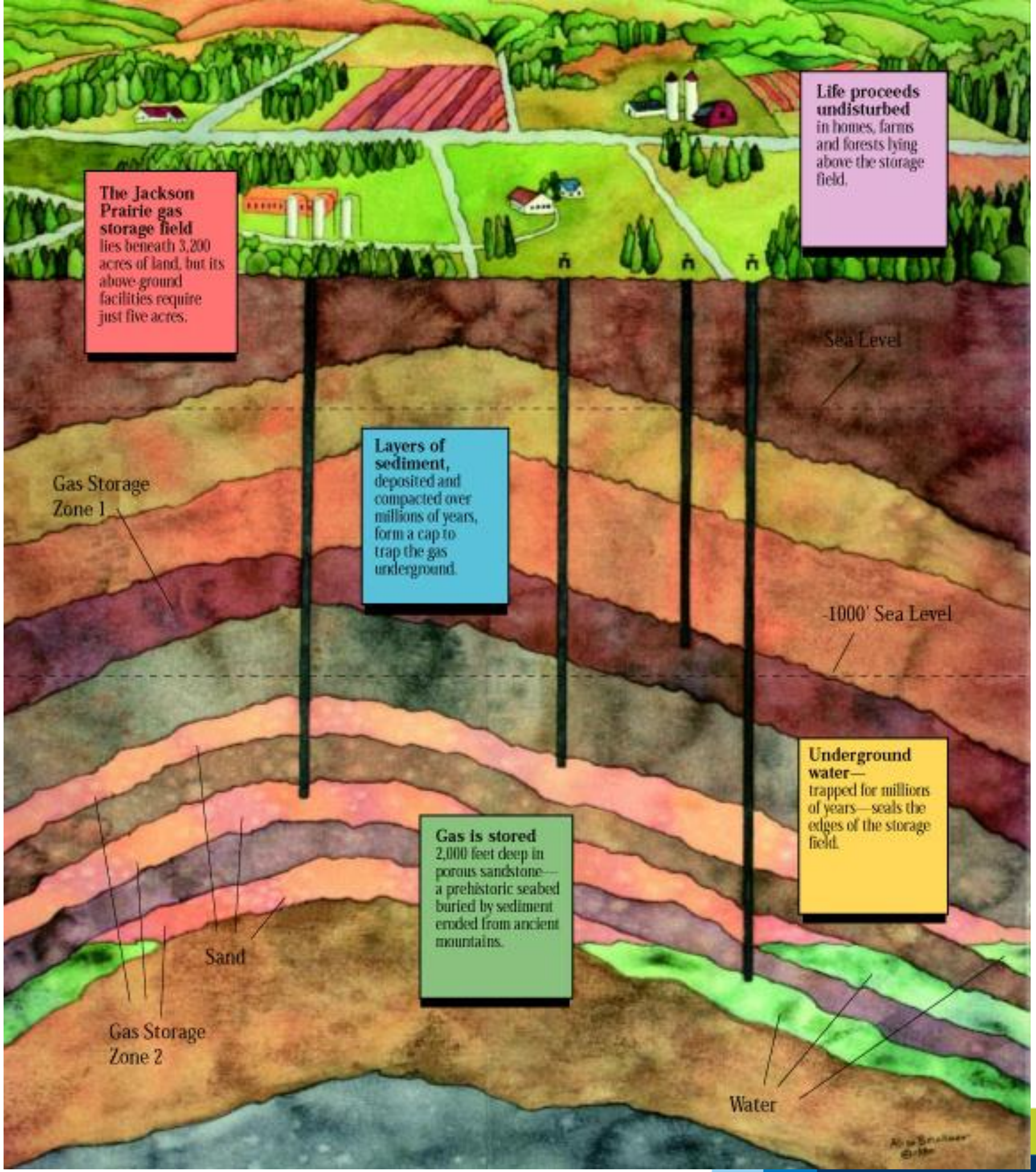
- 823,000 Dth of Capacity with approximately 52,000 Dth/d of deliverability

Leased Jackson Prairie

- 95,565 Dth of Capacity with approximately 2,654 Dth/d of deliverability

The Facility

- Jackson Prairie is a series of deep, underground reservoirs – basically thick, porous sandstone deposits.
- The sand layers lie approximately 1,000 to 3,000 feet below the ground surface.
- Large compressors and pipelines are employed to both inject and withdraw natural gas at 54 wells spread across the 3,200 acre facility.



Jackson Prairie Interesting Energy Comparisons

1.2 Bcf per day (energy equivalent)

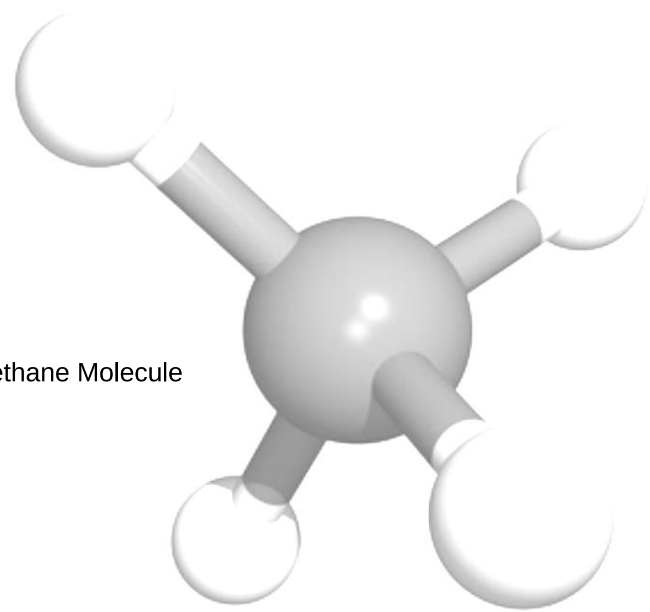
- **10 coal trains with 100 - 50 ton cars each**
- **29 - 500 MW gas-fired power plants**
- **13 Hanford-sized nuclear power plants**
- **2 Grand Coulee-sized hydro plants (biggest in US)**

46 Bcf of stored gas

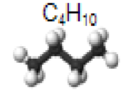
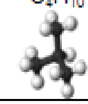
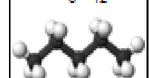
- **12” pipeline 11,000,000 miles long (226,000 miles to the moon)**
- **1,400 Safeco Fields (Baseball Stadiums)**
- **Average flow of the Columbia River for 2 days**
- **Cube - 3,550 feet on a side**

Natural Gas Liquids - Extraction

- Gas from the Western Canadian Sedimentary Basin has many “liquids” that can be extracted and sold
- Nearly **$2,100,000**



Methane Molecule

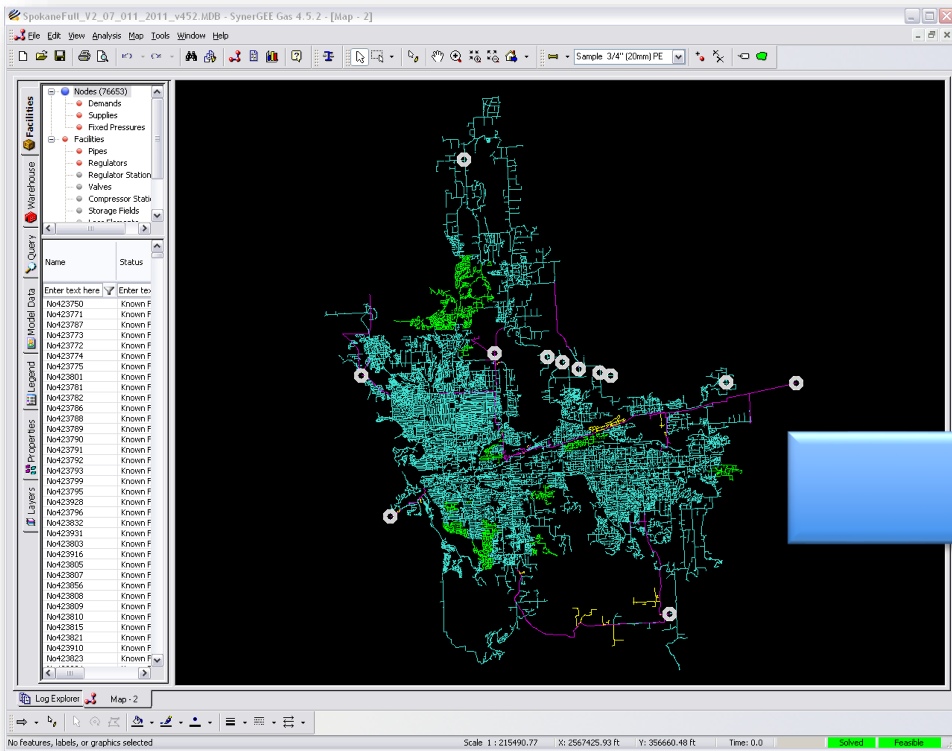
NGL Attribute Summary				eia
Natural Gas Liquid	Chemical Formula	Applications	End Use Products	Primary Sectors
Ethane	C_2H_6 	Ethylene for plastics production; petrochemical feedstock	Plastic bags; plastics; anti-freeze; detergent	Industrial
Propane	C_3H_8 	Residential and commercial heating; cooking fuel; petrochemical feedstock	Home heating; small stoves and barbeques; LPG	Industrial, Residential, Commercial
Butane	C_4H_{10} 	Petrochemical feedstock; blending with propane or gasoline	Synthetic rubber for tires; LPG; lighter fuel	Industrial, Transportation
Isobutane	C_4H_{10} 	Refinery feedstock; petrochemical feedstock	Alkylate for gasoline; aerosols; refrigerant	Industrial
Pentane	C_5H_{12} 	Natural gasoline; blowing agent for polystyrene foam	Gasoline; polystyrene; solvent	Transportation
Pentanes Plus*	Mix of C_5H_{12} and heavier	Blending with vehicle fuel; exported for bitumen production in oil sands	Gasoline; ethanol blends; oil sands production	Transportation

Distribution System Planning

Terrence Browne PE,
Senior Gas Planning Engineer

Mission

- Using technology to plan and design a safe, reliable, and economical distribution system

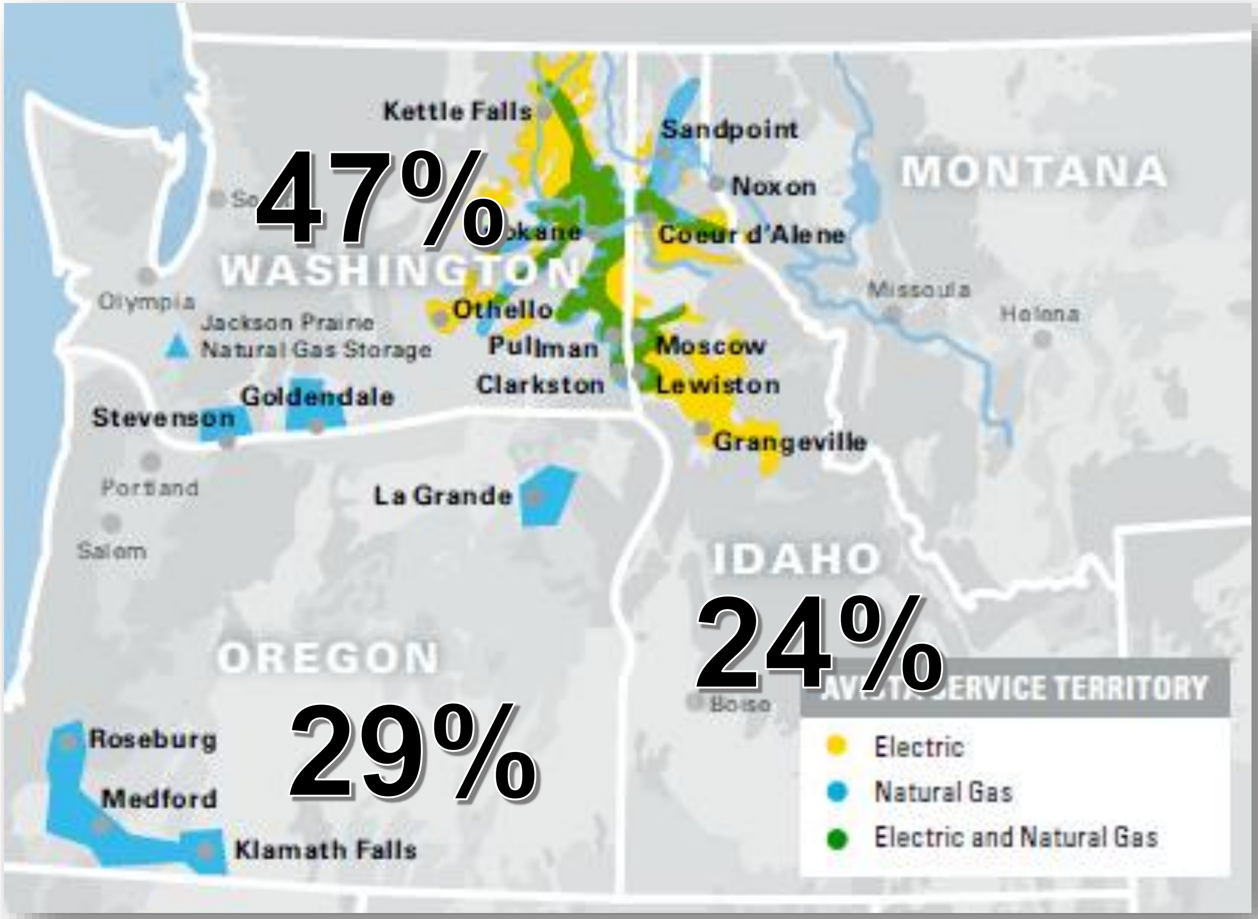


Gas Distribution Planning

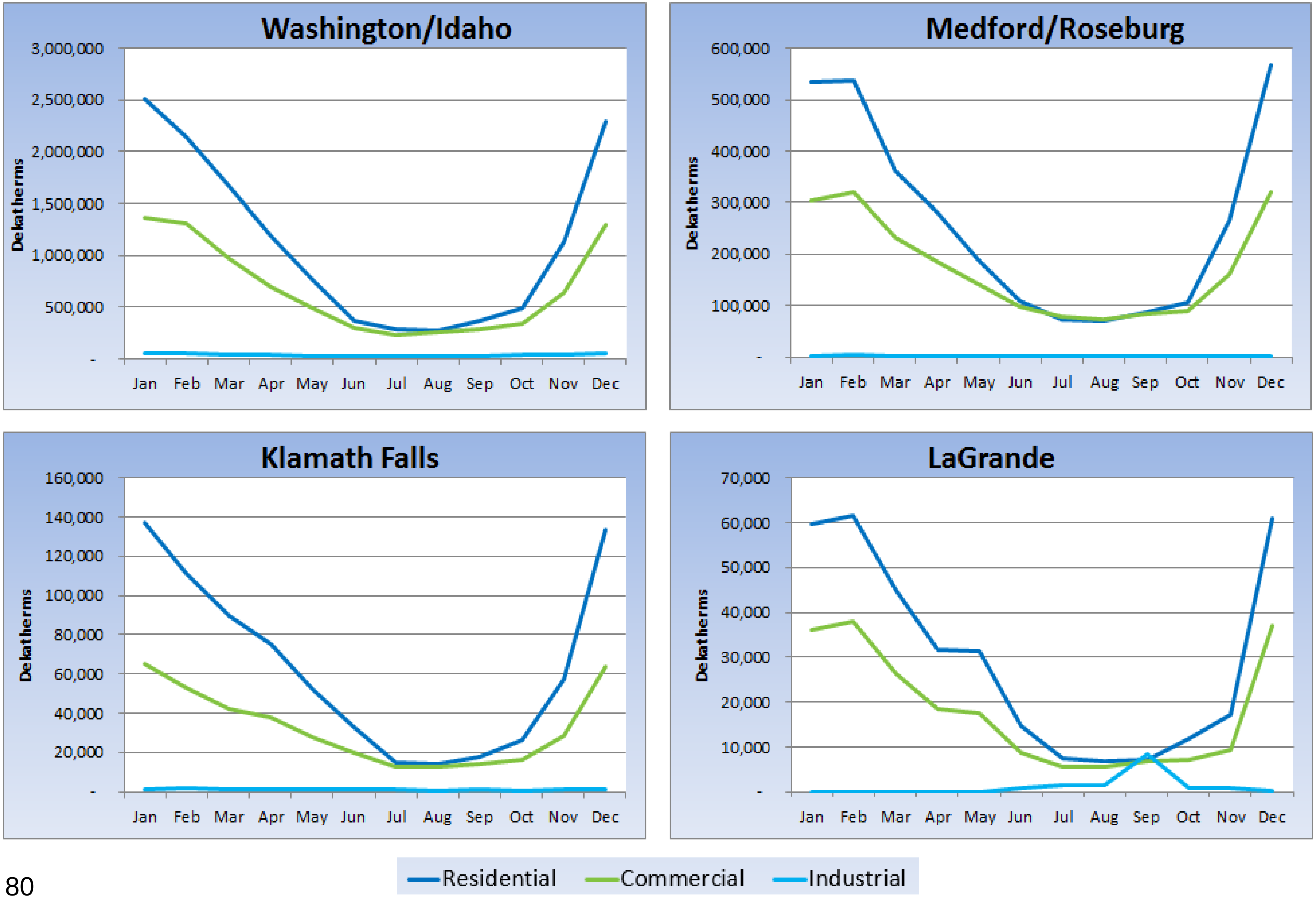
- Service Territory and Customers
- Scope of Gas Distribution Planning
- SynerGi Load Study Tool
- Planning Criteria
- Interpreting Results
- Long-term Planning Objectives
- Historical Temperatures
- Monitoring Our System
- Solutions
- Gate Station Capacity Review
- Project Examples

Service Territory and Customer Overview

- Serves electric and natural gas customers in eastern Washington and northern Idaho, and natural gas customers in southern and eastern Oregon
  - Population of service area 1.5 million
    - 371,000 electric customers
    - 348,000 natural gas customers

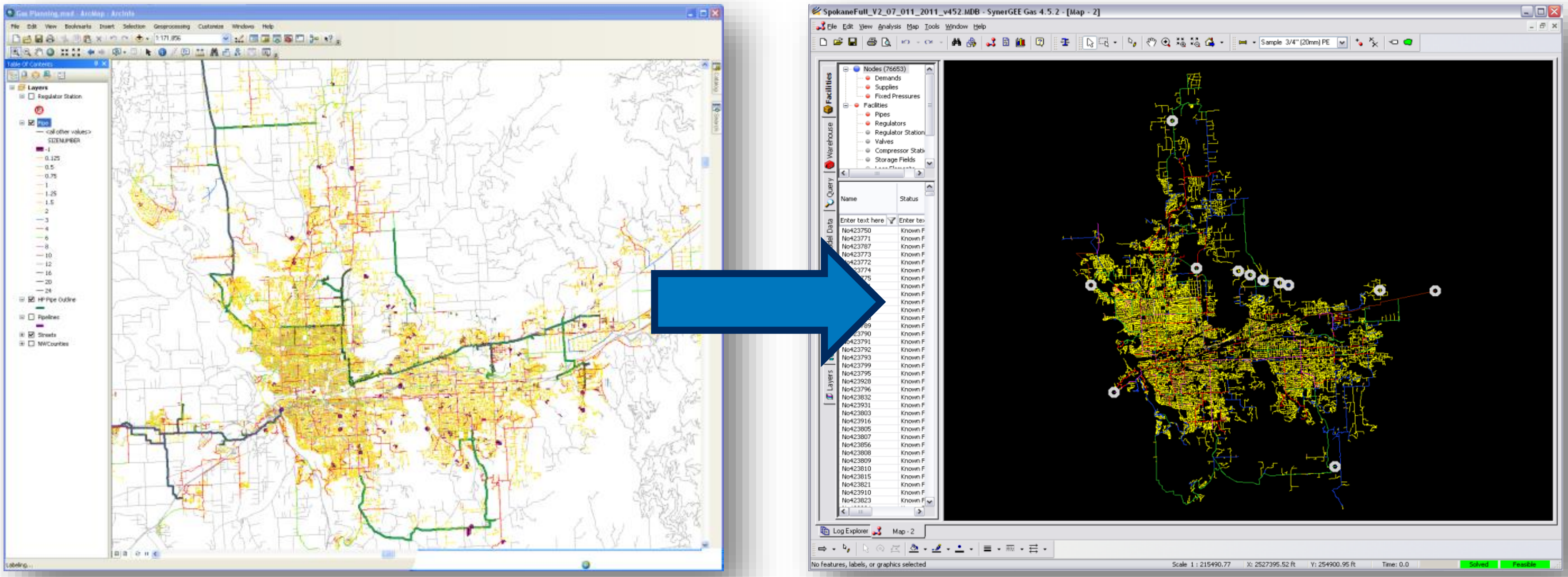


Seasonal Demand Profiles

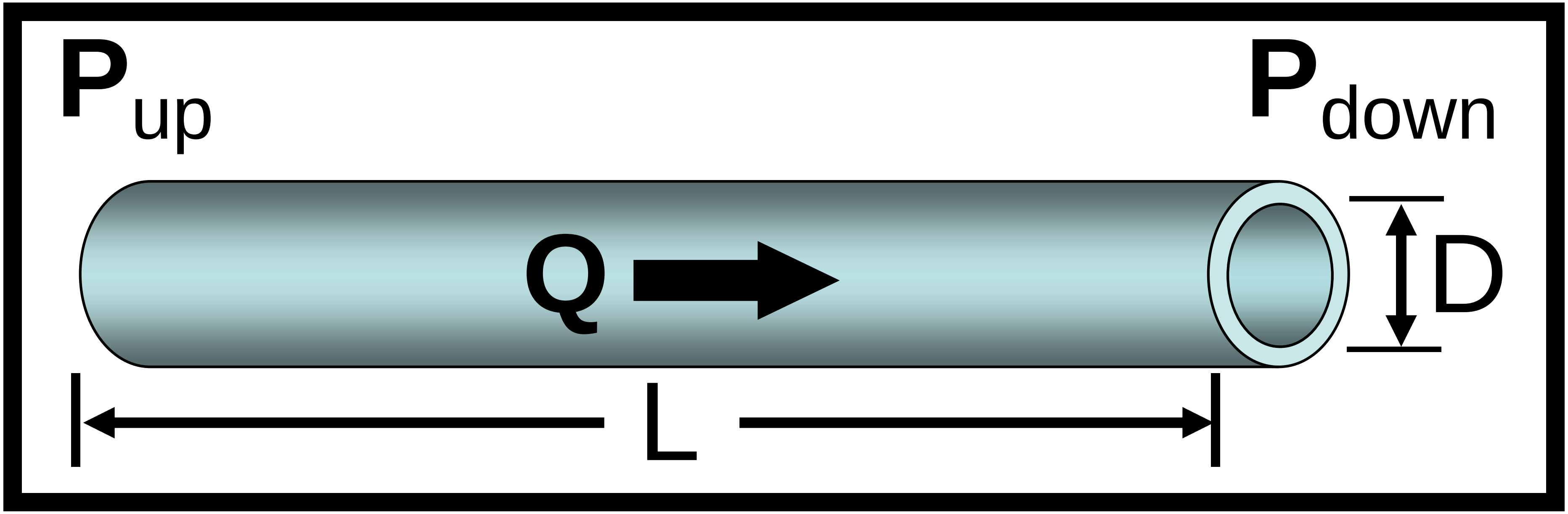


Our Planning Models

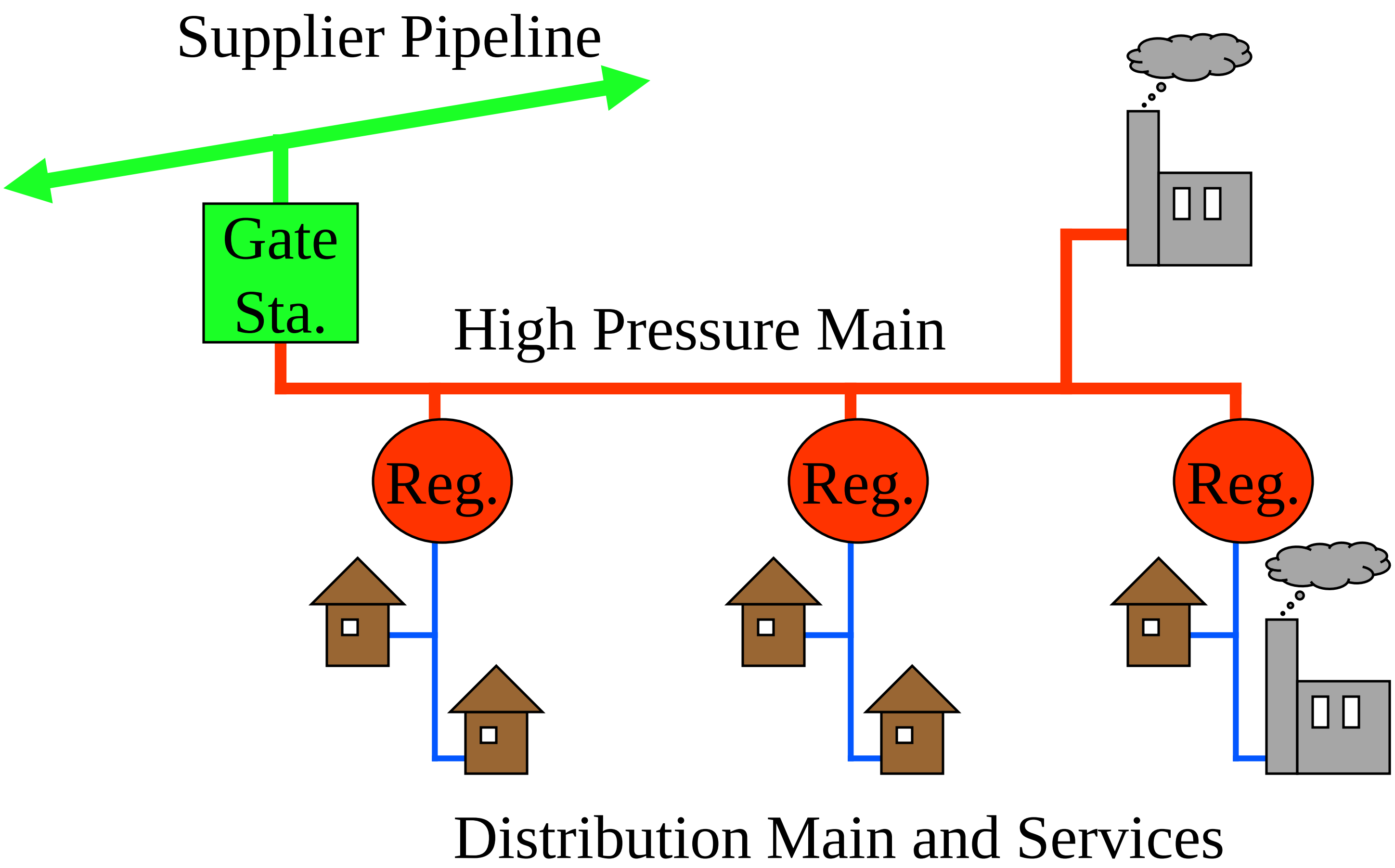
- 122 cities
- 40 load study models



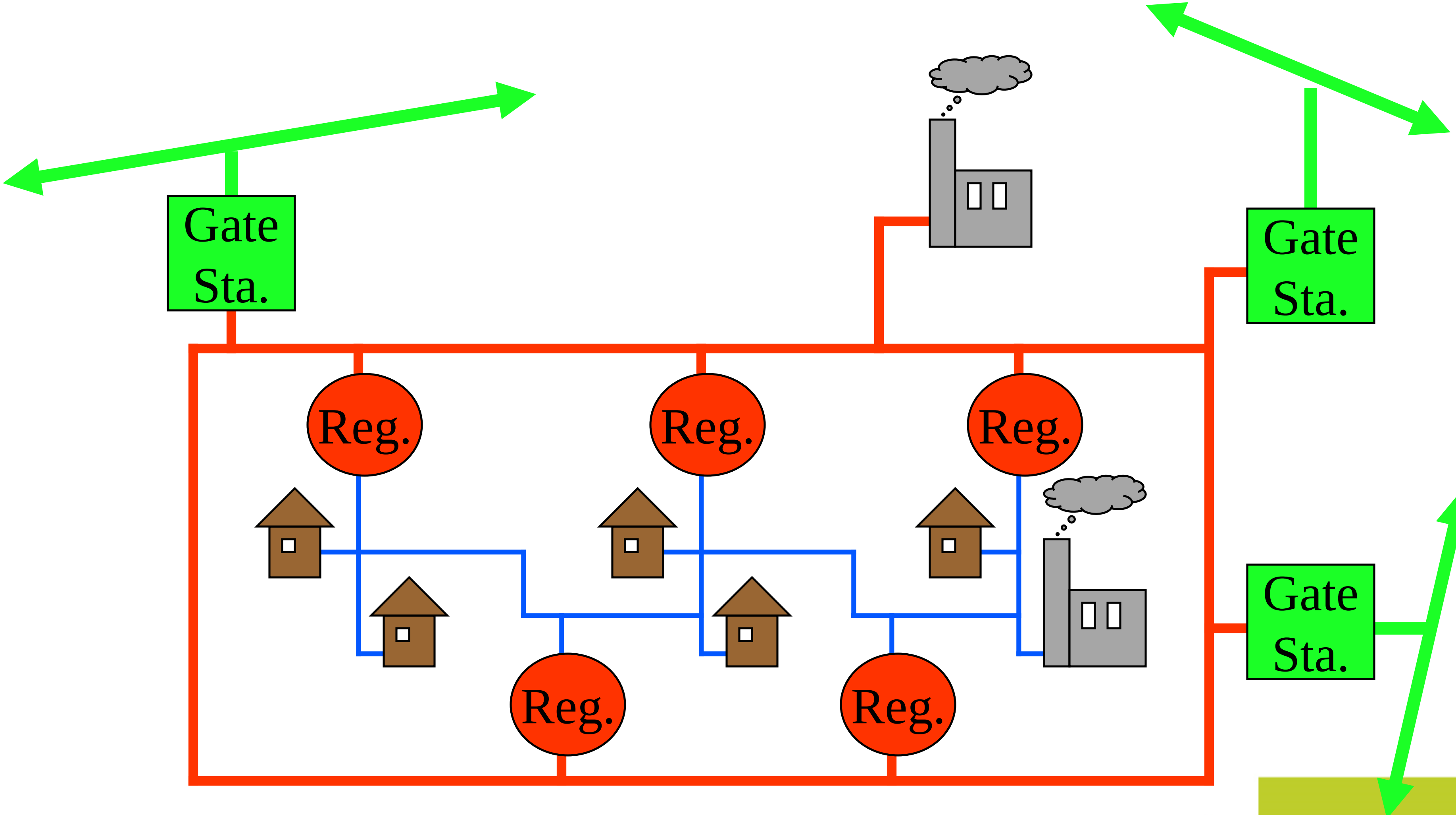
5 Variables for Any Given Pipe



Scope of Gas Distribution Planning

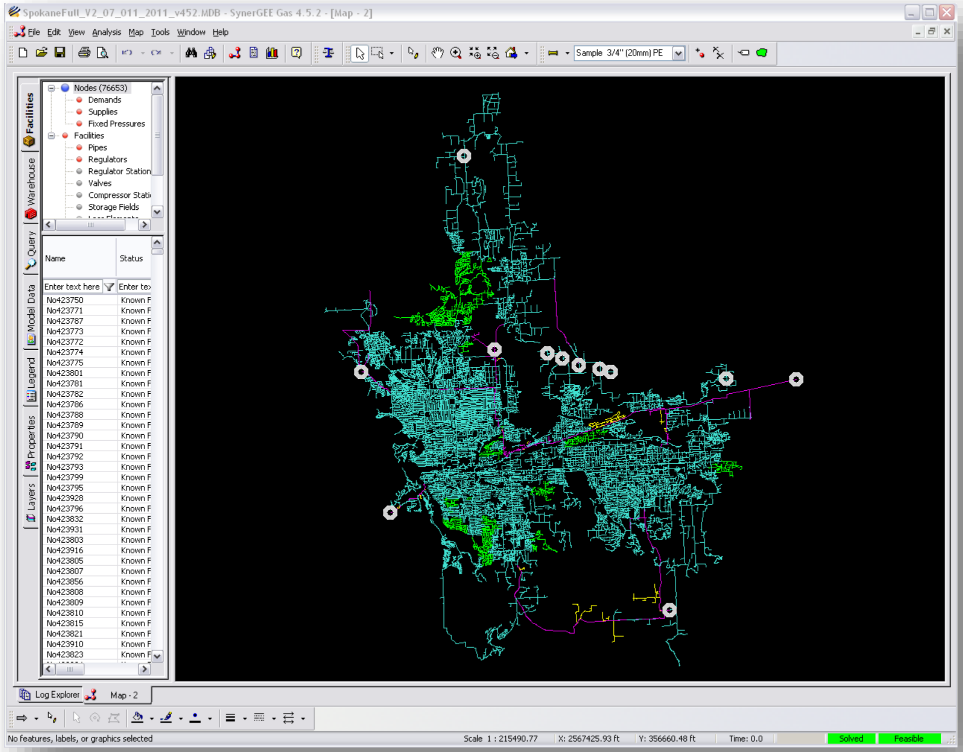


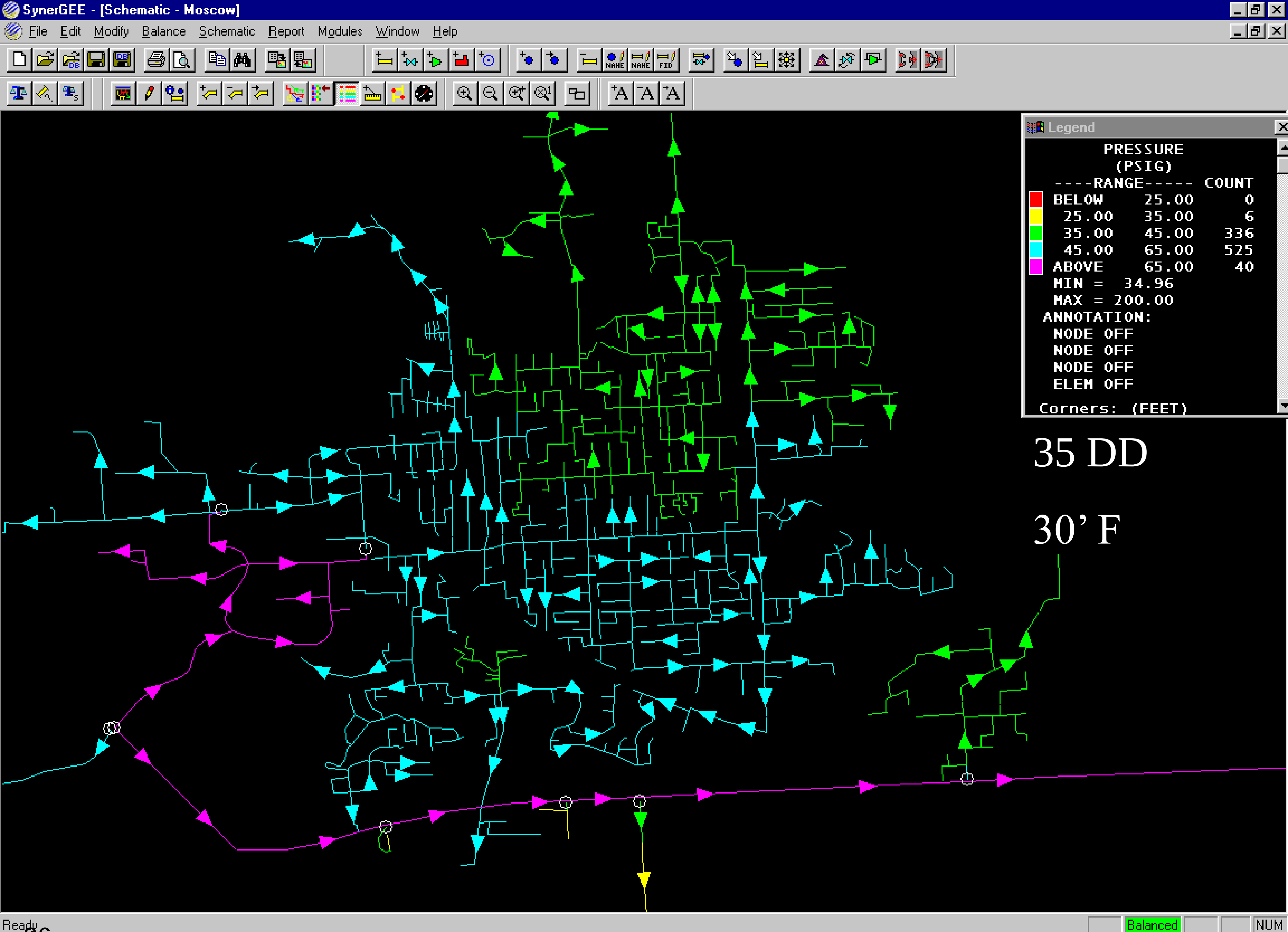
Scope of Gas Distrib. Planning cont.



SynerGi (SynerGEE, Stoner) Load Study

- Simulate distribution behavior
- Identify low pressure areas
- Coordinate reinforcements with expansions
- Measure reliability




SynerGEE - [Schematic - Moscow]
File Edit Modify Balance Schematic Report Modules Window Help
Legend
PRESSURE
(PSIG)
----RANGE----- COUNT
BELOW 25.00 0
25.00 35.00 6
35.00 45.00 336
45.00 65.00 525
ABOVE 65.00 40
MIN = 34.96
MAX = 200.00
ANNOTATION:
NODE OFF
NODE OFF
NODE OFF
ELEM OFF
Corners: (FEET)
35 DD
30' F
Ready
Balanced
NUM

Preparing a Load Study

- Estimating Customer Usage
- Creating a Pipeline Network
- Join Customer Loads to Pipes
- Convert to Load Study

Estimating Customer Usage

- Gathering Data
  - Days of service
  - Degree Days
  - Usage
  - Name, Address, Revenue Class, Rate Schedule…

Estimating Customer Usage cont.

- Degree Days
  - Heating (HDD)
  - Cooling (CDD)
- Temperature - Usage Relationship
  - Load vs. HDD's
  - Base Load (constant)
  - Heat Load (variable)
  - High correlation with residential

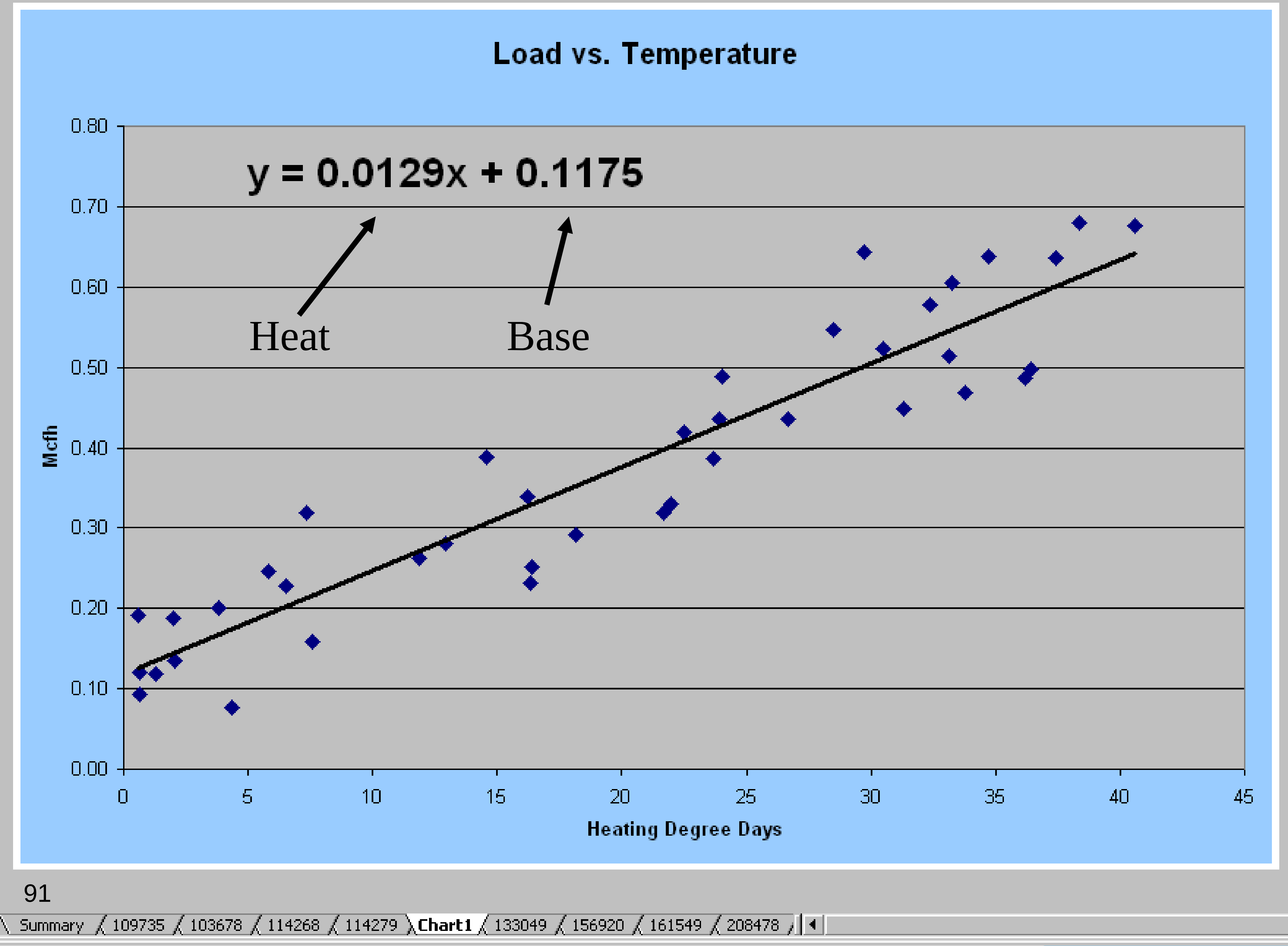
Avg. Daily Temperature ('Fahrenheit)	Heating Degree Days (HDD)	Cooling Degree Days (CDD)
85		20
80		15
75		10
70		5
65	***0***	***0***
60	5	
55	10	
50	15	
45	20	
40	25	
35	30	
30	35	
25	40	
20	45	
15	50	
10	55	
5	60	
4	61	
0	65	
-5	70	
-10	75	
-15	80	
-17	82	

File Edit View Insert Format Tools Data Window Help

K11 =

	A	B	C	D	E	F	G	H	I
	Begin Date	Read Date	RBC	Dys Svc	Deg Dys	Usage	Therm/Day	*DD/day	mcfh/day
	01-23-2002	02-22-2002	RR	30	971	2775	92.5	32.36667	0.58
	12-21-2001	01-23-2002	RR	33	1195	2567	77.78788	36.21212	0.49
	11-20-2001	12-21-2001	RR	31	1028	2547	82.16129	33.16129	0.51
	10-24-2001	11-20-2001	RR	27	586	1379	51.07407	21.7037	0.32
	09-24-2001	10-24-2001	RR	30	491	1208	40.26667	16.36667	0.25
	08-22-2001	09-24-2001	RR	33	67	715	21.66667	2.030303	0.14
	07-24-2001	08-22-2001	RY	29	19	432	14.89655	0.655172	0.09
	06-22-2001	07-24-2001	RR	32	41	611	19.09375	1.28125	0.12
	05-24-2001	06-22-2001	RR	29	219	736	25.37931	7.551724	0.16
	04-23-2001	05-24-2001	RY	31	368	1301	41.96774	11.87097	0.26
	03-23-2001	04-23-2001	RR	31	734	1913	61.70968	23.67742	0.39
	02-22-2001	03-23-2001	RR	29	826	2538	87.51724	28.48276	0.55
	01-24-2001	02-22-2001	RY	29	1113	3153	108.7241	38.37931	0.68
	12-19-2000	01-24-2001	RY	36	1347	3668	101.8889	37.41667	0.64
	11-16-2000	12-19-2000	RY	33	1340	3573	108.2727	40.60606	0.68
	10-18-2000	11-16-2000	RR	29	884	2424	83.58621	30.48276	0.52
	09-20-2000	10-18-2000	RR	28	408	1738	62.07143	14.57143	0.39
	08-22-2000	09-20-2000	RY	29	169	1139	39.27586	5.827586	0.25

Summary / 109735 / 103678 / 114268 / 114279 / Chart1 / **133049** / 156920 / 161549 / 208478

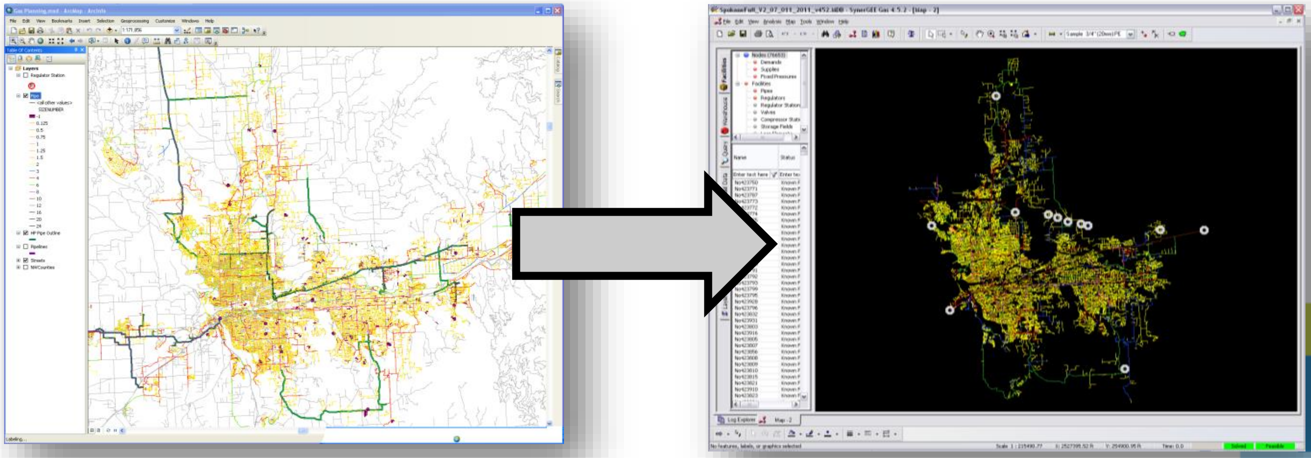

Load vs. Temperature
y = 0.0129x + 0.1175
Heat
Base
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Mcfh
0
5
10
15
20
25
30
35
40
45
Heating Degree Days
Summary
109735
103678
114268
114279
Chart1
133049
156920
161549
208478

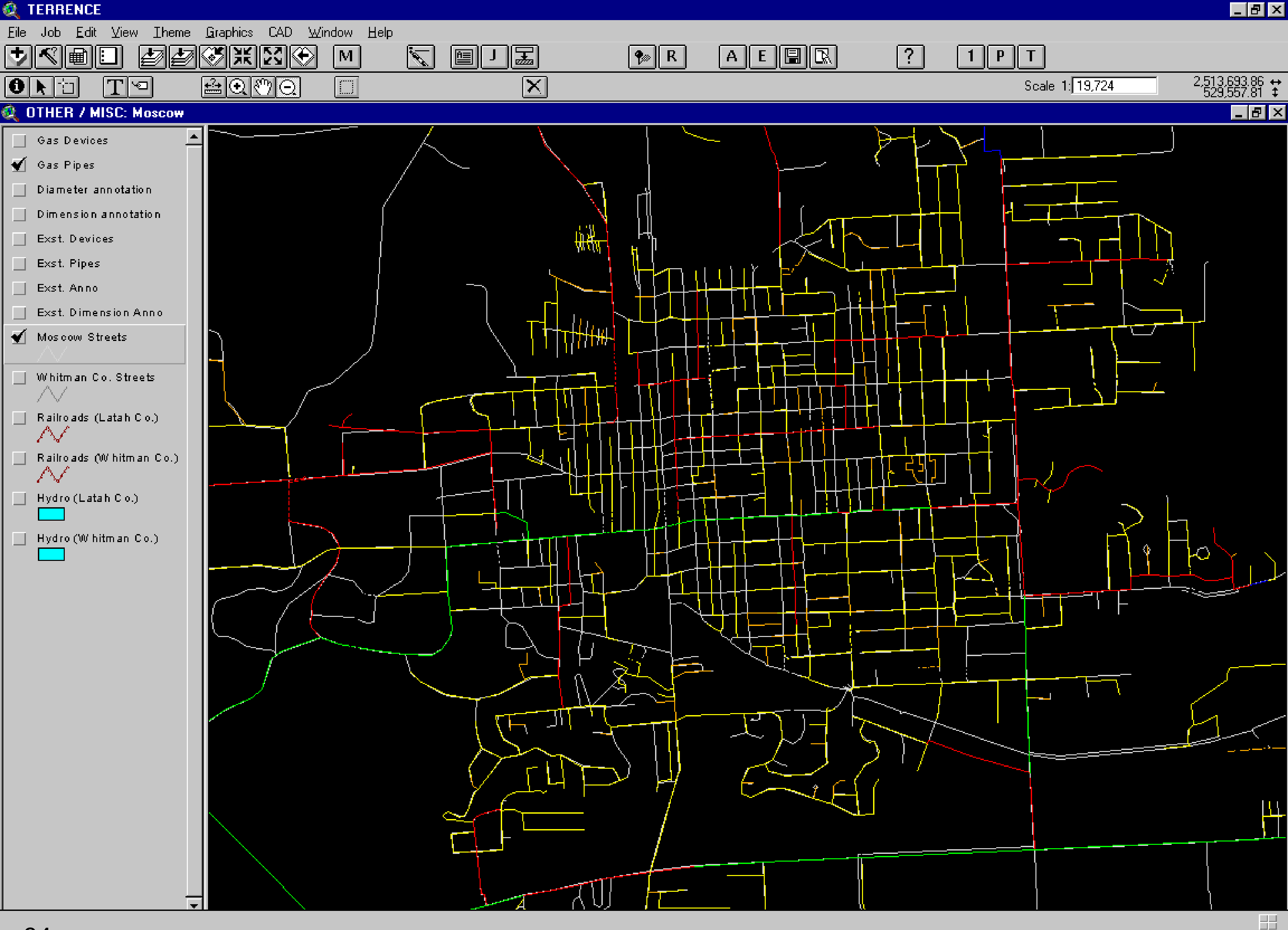
Estimating Customer Usage cont.

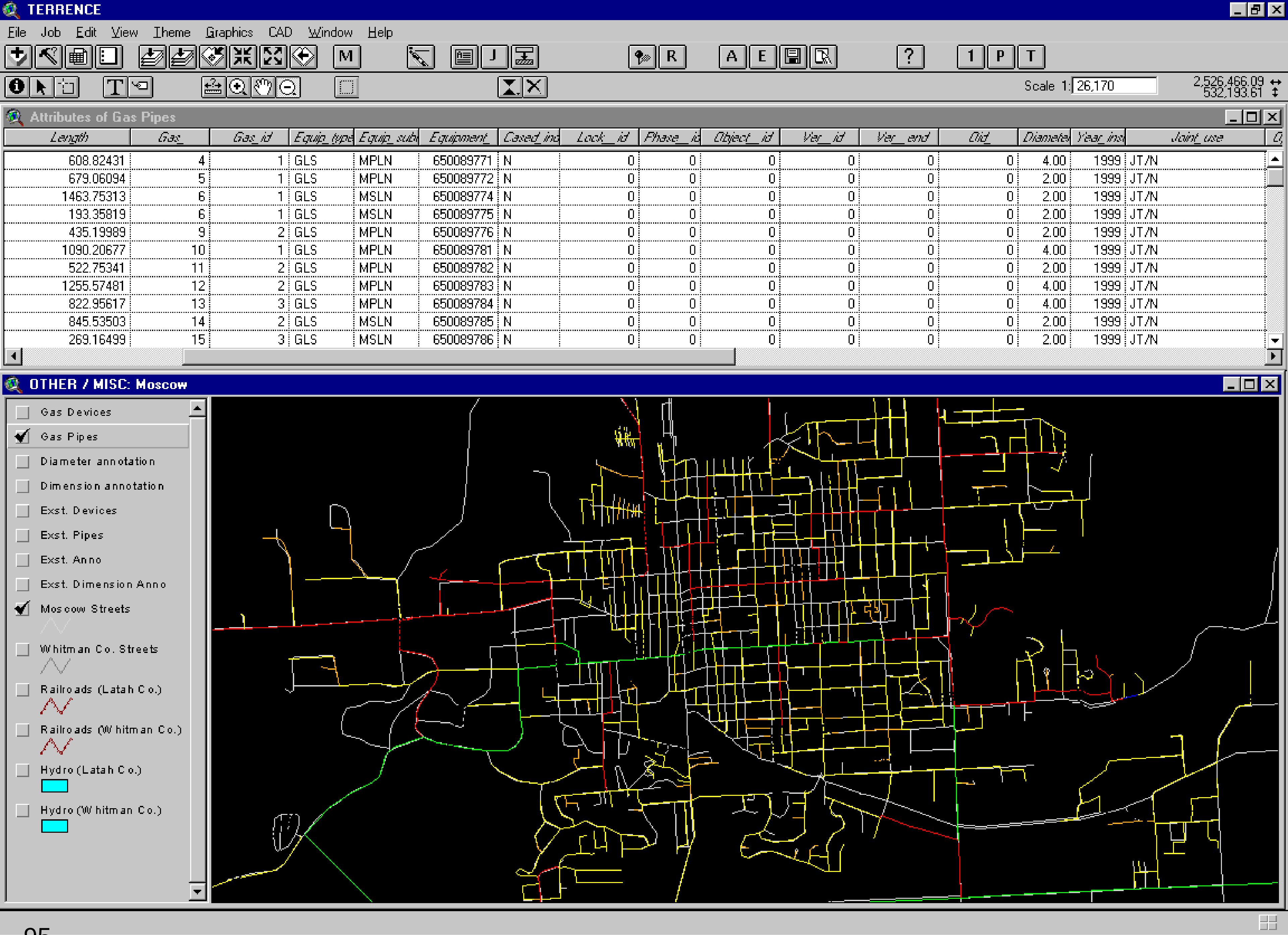
- Peaking Factor
  - Peaking Factor = 6.25% of daily load
  - “Observed ratio” of greatest hourly flow to total daily flow at Gate Stations
- Industrial Customers
  - Model maximum hourly usage per Contractual Agreement
  - Firm Transportation customers only
  - Low Temperature-Usage correlation

Creating a Pipeline Model

- Elements
  - Pipes, regulators, valves
  - Attributes: Length, internal diameter, roughness
- Nodes
  - Sources, usage points, pipe ends
  - Attributes: Flow, pressure



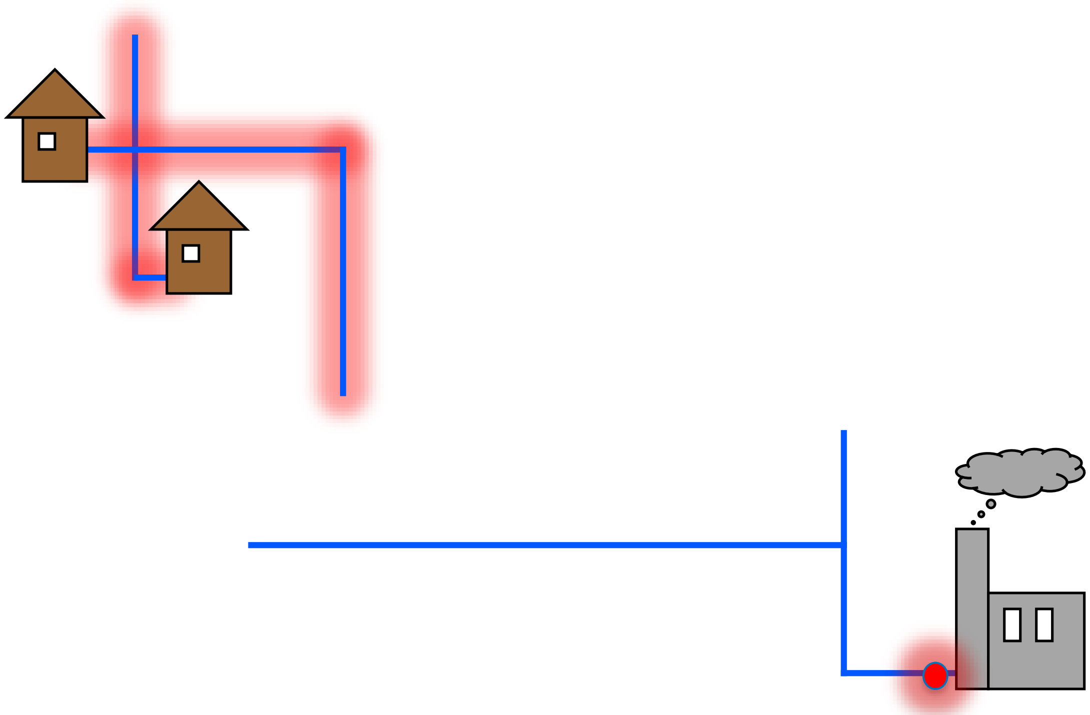

TERRENCE
File Job Edit View Theme Graphics CAD Window Help
M
J
R
A E
?
1 P T
Scale 1: 19,724
2,513,693.86
529,557.81
OTHER / MISC: Moscow
Gas Devices
Gas Pipes
Diameter annotation
Dimension annotation
Exst. Devices
Exst. Pipes
Exst. Anno
Exst. Dimension Anno
Moscow Streets
Whitman Co. Streets
Railroads (Latah Co.)
Railroads (Whitman Co.)
Hydro (Latah Co.)
Hydro (Whitman Co.)

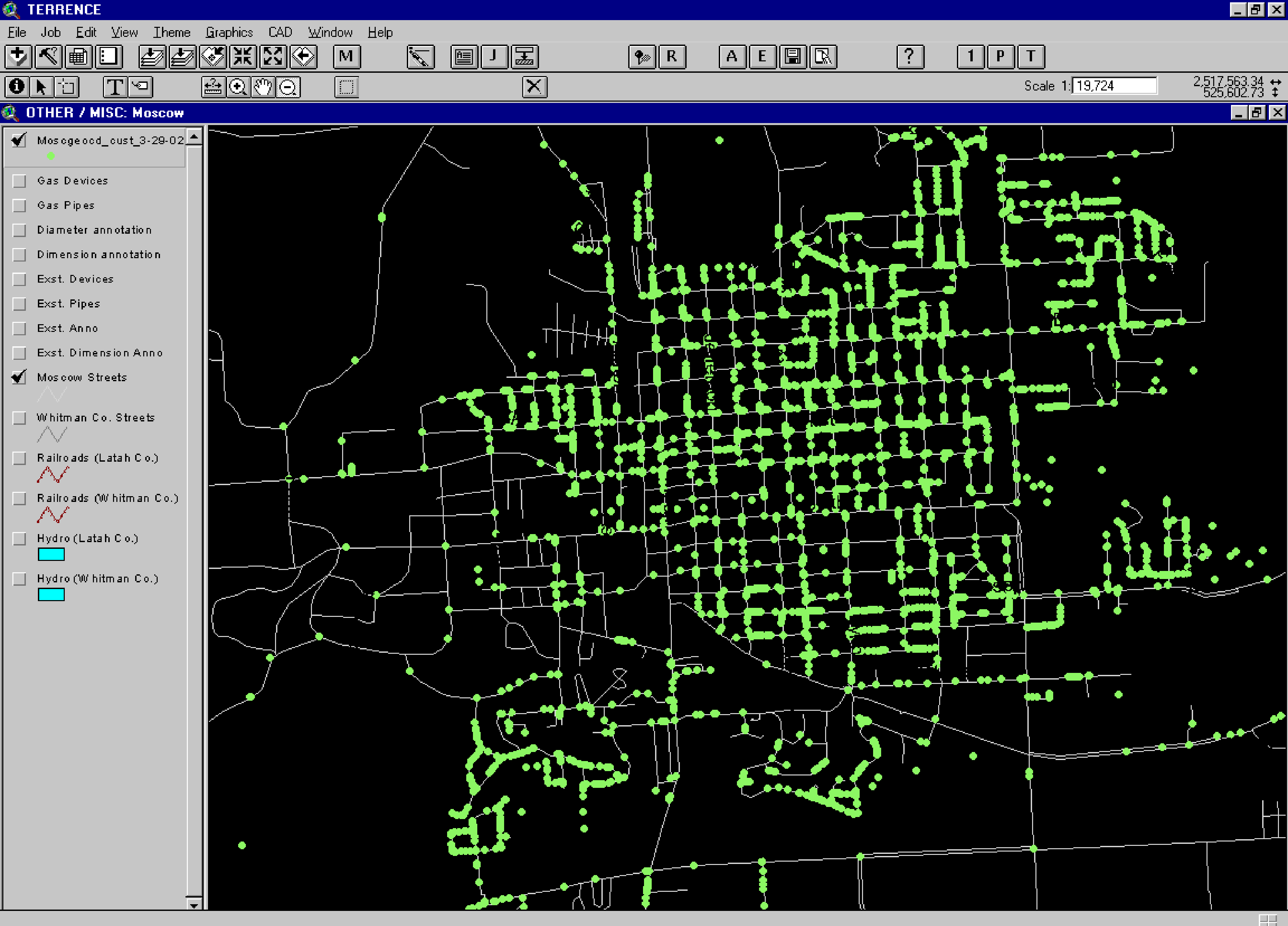


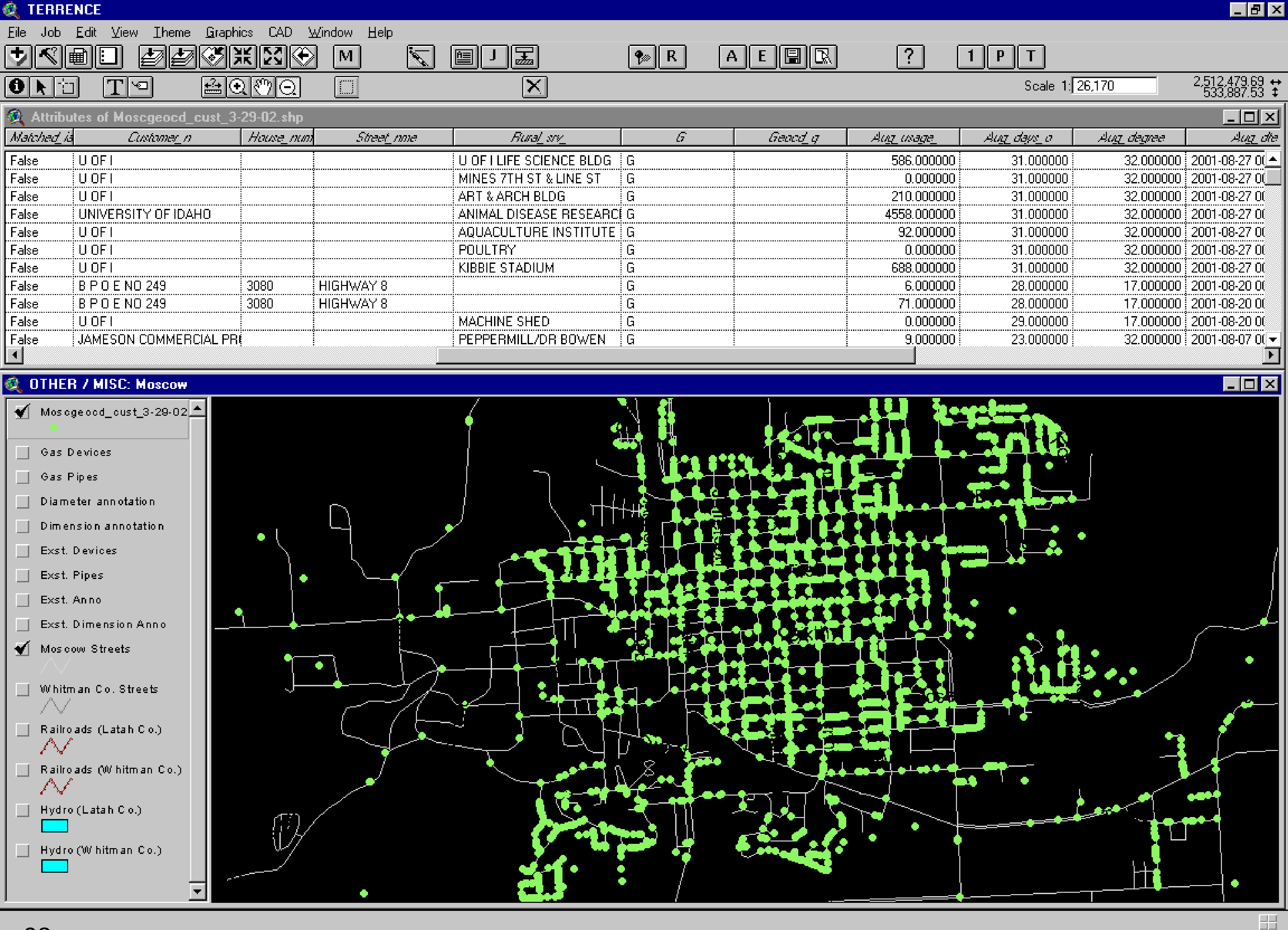
Length	Gas_	Gas_id	Equip_type	Equip_sub	Equipment_	Cased_ind	Lock_id	Phase_id	Object_id	Ver_id	Ver_end	Oid	Diamete	Year_ins	Joint_use
608.82431	4	1	GLS	MPLN	650089771	N	0	0	0	0	0	0	4.00	1999	JT/N
679.06094	5	1	GLS	MPLN	650089772	N	0	0	0	0	0	0	2.00	1999	JT/N
1463.75313	6	1	GLS	MSLN	650089774	N	0	0	0	0	0	0	2.00	1999	JT/N
193.35819	6	1	GLS	MSLN	650089775	N	0	0	0	0	0	0	2.00	1999	JT/N
435.19989	9	2	GLS	MPLN	650089776	N	0	0	0	0	0	0	2.00	1999	JT/N
1090.20677	10	1	GLS	MPLN	650089781	N	0	0	0	0	0	0	4.00	1999	JT/N
522.75341	11	2	GLS	MPLN	650089782	N	0	0	0	0	0	0	2.00	1999	JT/N
1255.57481	12	2	GLS	MPLN	650089783	N	0	0	0	0	0	0	4.00	1999	JT/N
822.95617	13	3	GLS	MPLN	650089784	N	0	0	0	0	0	0	4.00	1999	JT/N
845.53503	14	2	GLS	MSLN	650089785	N	0	0	0	0	0	0	2.00	1999	JT/N
269.16499	15	3	GLS	MSLN	650089786	N	0	0	0	0	0	0	2.00	1999	JT/N

Join Customer Loads to a Model

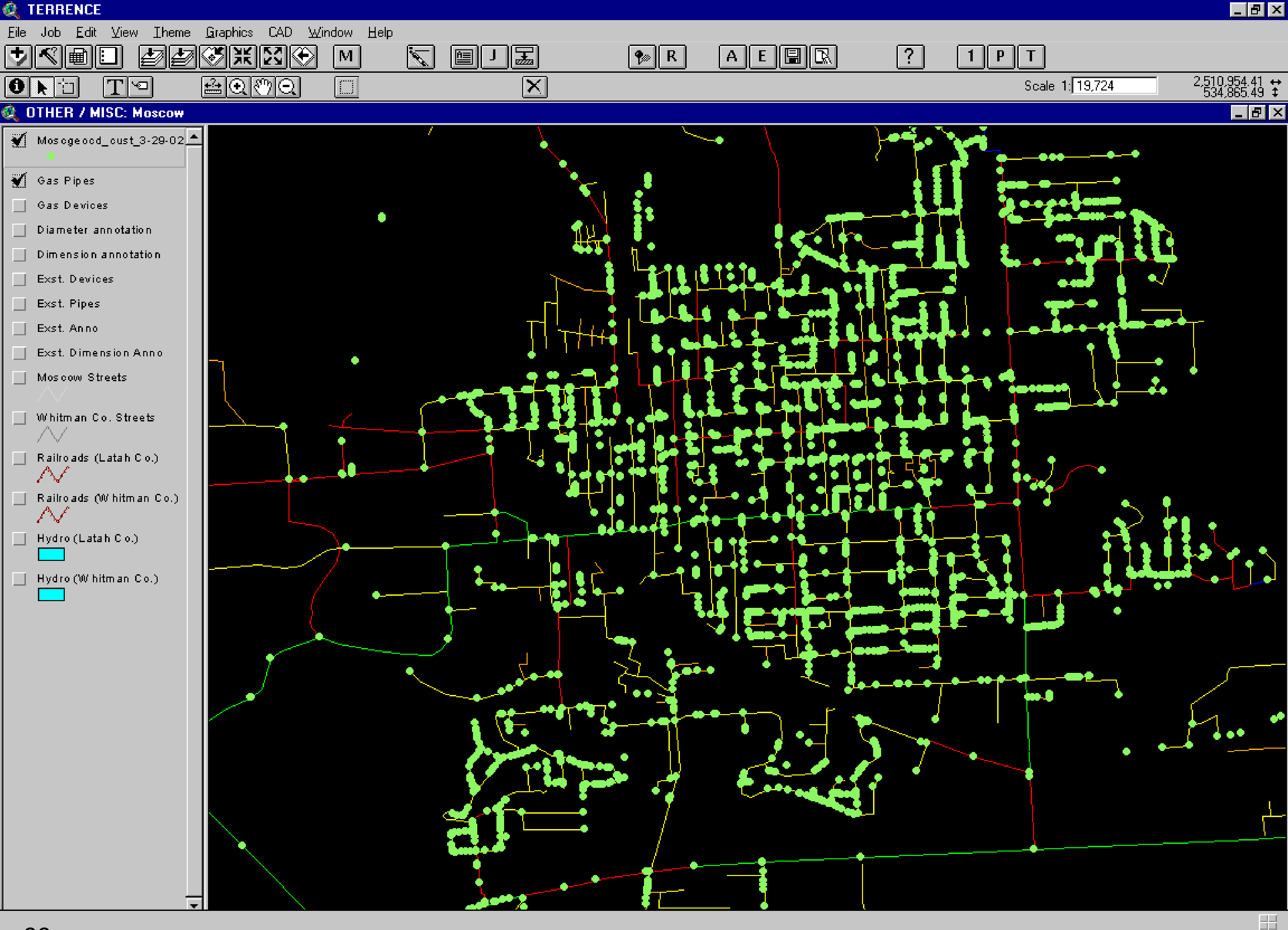
- Residential and commercial loads are assigned to ***pipes***
- Industrial or other large loads are assigned to ***nodes***

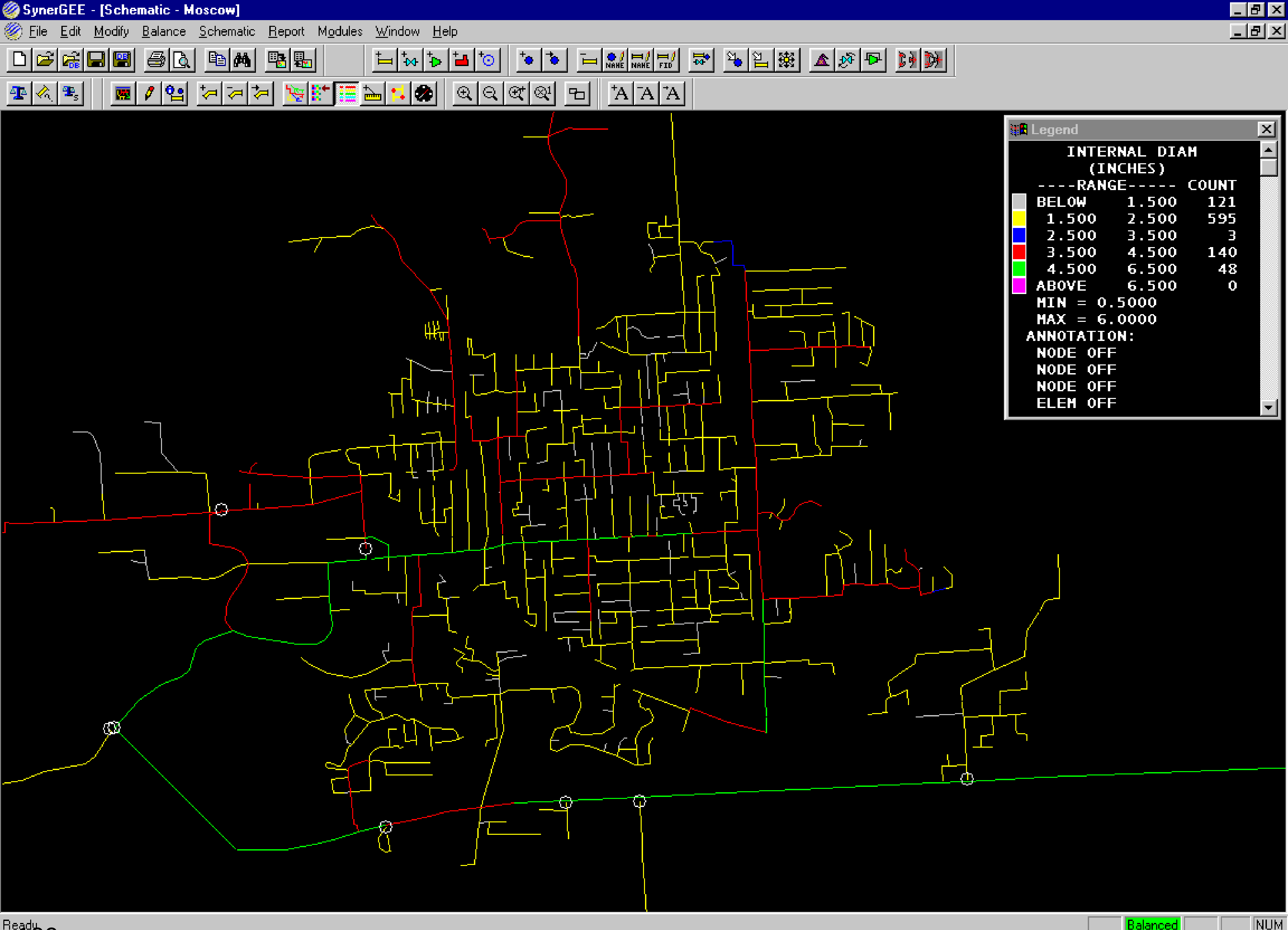



TERRENCE
File
Job
Edit
View
Theme
Graphics
CAD
Window
Help
Scale 1: 19,724
2,517,563.34
525,602.73
OTHER / MISC: Moscow
Moscgeocd_cust_3-29-02
Gas Devices
Gas Pipes
Diameter annotation
Dimension annotation
Exst. Devices
Exst. Pipes
Exst. Anno
Exst. Dimension Anno
Moscow Streets
Whitman Co. Streets
Railroads (Latah Co.)
Railroads (Whitman Co.)
Hydro (Latah Co.)
Hydro (Whitman Co.)



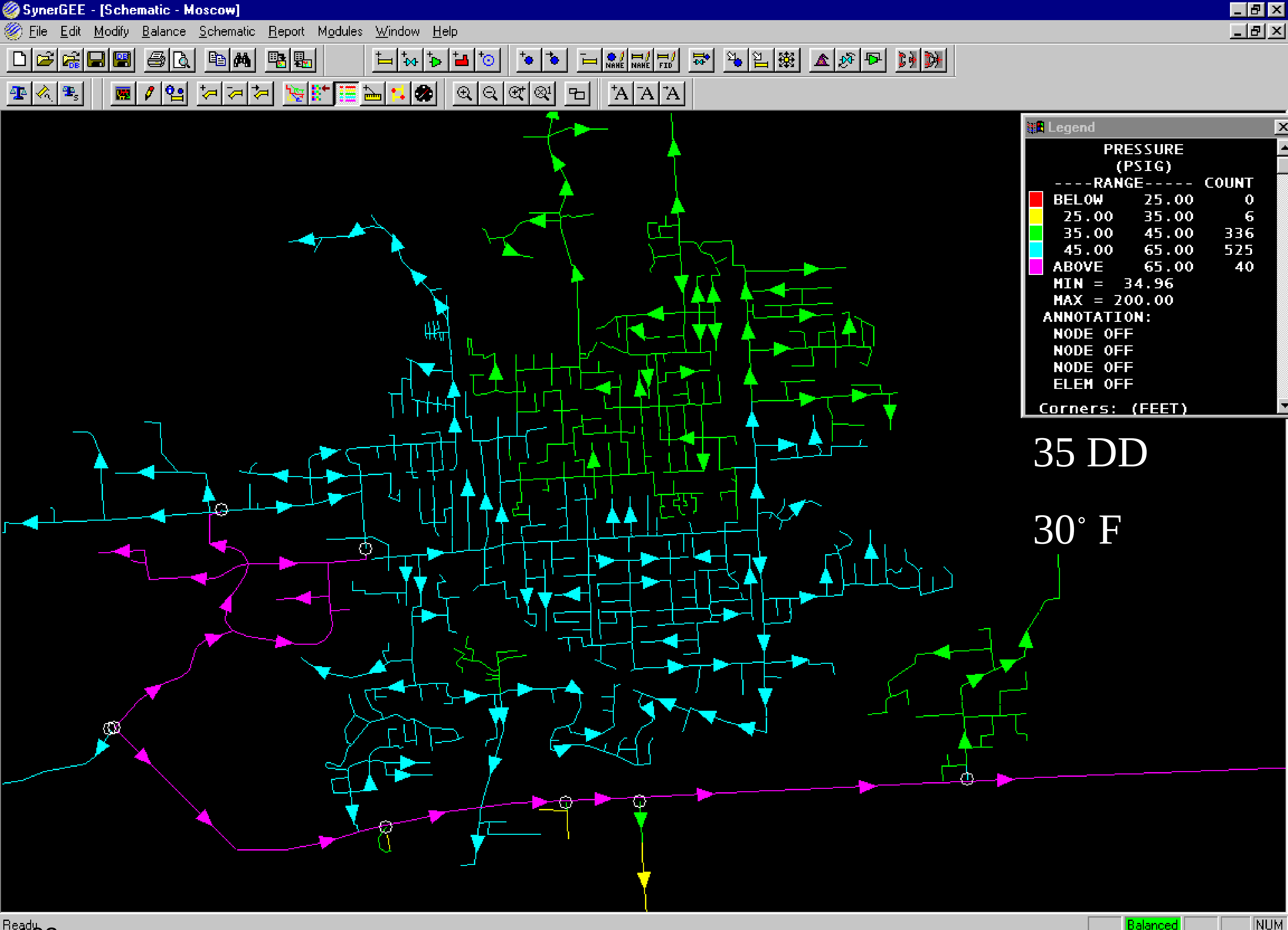
Matched_id	Customer_n	House_num	Street_nme	Rural_srv_	G	Geocd_q	Avg_usage_	Avg_days_o	Avg_degree	Avg_dte
False	U OF I			U OF I LIFE SCIENCE BLDG	G		586.000000	31.000000	32.000000	2001-08-27 0
False	U OF I			MINES 7TH ST & LINE ST	G		0.000000	31.000000	32.000000	2001-08-27 0
False	U OF I			ART & ARCH BLDG	G		210.000000	31.000000	32.000000	2001-08-27 0
False	UNIVERSITY OF IDAHO			ANIMAL DISEASE RESEARC	G		4558.000000	31.000000	32.000000	2001-08-27 0
False	U OF I			AQUACULTURE INSTITUTE	G		92.000000	31.000000	32.000000	2001-08-27 0
False	U OF I			POULTRY	G		0.000000	31.000000	32.000000	2001-08-27 0
False	U OF I			KIBBIE STADIUM	G		688.000000	31.000000	32.000000	2001-08-27 0
False	B P O E NO 249	3080	HIGHWAY 8		G		6.000000	28.000000	17.000000	2001-08-20 0
False	B P O E NO 249	3080	HIGHWAY 8		G		71.000000	28.000000	17.000000	2001-08-20 0
False	U OF I			MACHINE SHED	G		0.000000	29.000000	17.000000	2001-08-20 0
False	JAMESON COMMERCIAL PR			PEPPERMILL/DR BOWEN	G		9.000000	23.000000	32.000000	2001-08-07 0


TERRENCE
File Job Edit View Theme Graphics CAD Window Help
Scale 1: 19,724
2,510,954.41
534,865.49
OTHER / MISC: Moscow
Moscgeocd_cust_3-29-02
Gas Pipes
Gas Devices
Diameter annotation
Dimension annotation
Exst. Devices
Exst. Pipes
Exst. Anno
Exst. Dimension Anno
Moscow Streets
Whitman Co. Streets
Railroads (Latah Co.)
Railroads (Whitman Co.)
Hydro (Latah Co.)
Hydro (Whitman Co.)


SynerGEE - [Schematic - Moscow]
File Edit Modify Balance Schematic Report Modules Window Help
Legend
INTERNAL DIAM
(INCHES)
----RANGE----- COUNT
BELOW 1.500 121
1.500 2.500 595
2.500 3.500 3
3.500 4.500 140
4.500 6.500 48
ABOVE 6.500 0
MIN = 0.5000
MAX = 6.0000
ANNOTATION:
NODE OFF
NODE OFF
NODE OFF
ELEM OFF
Ready
Balanced
NUM

Balancing Model

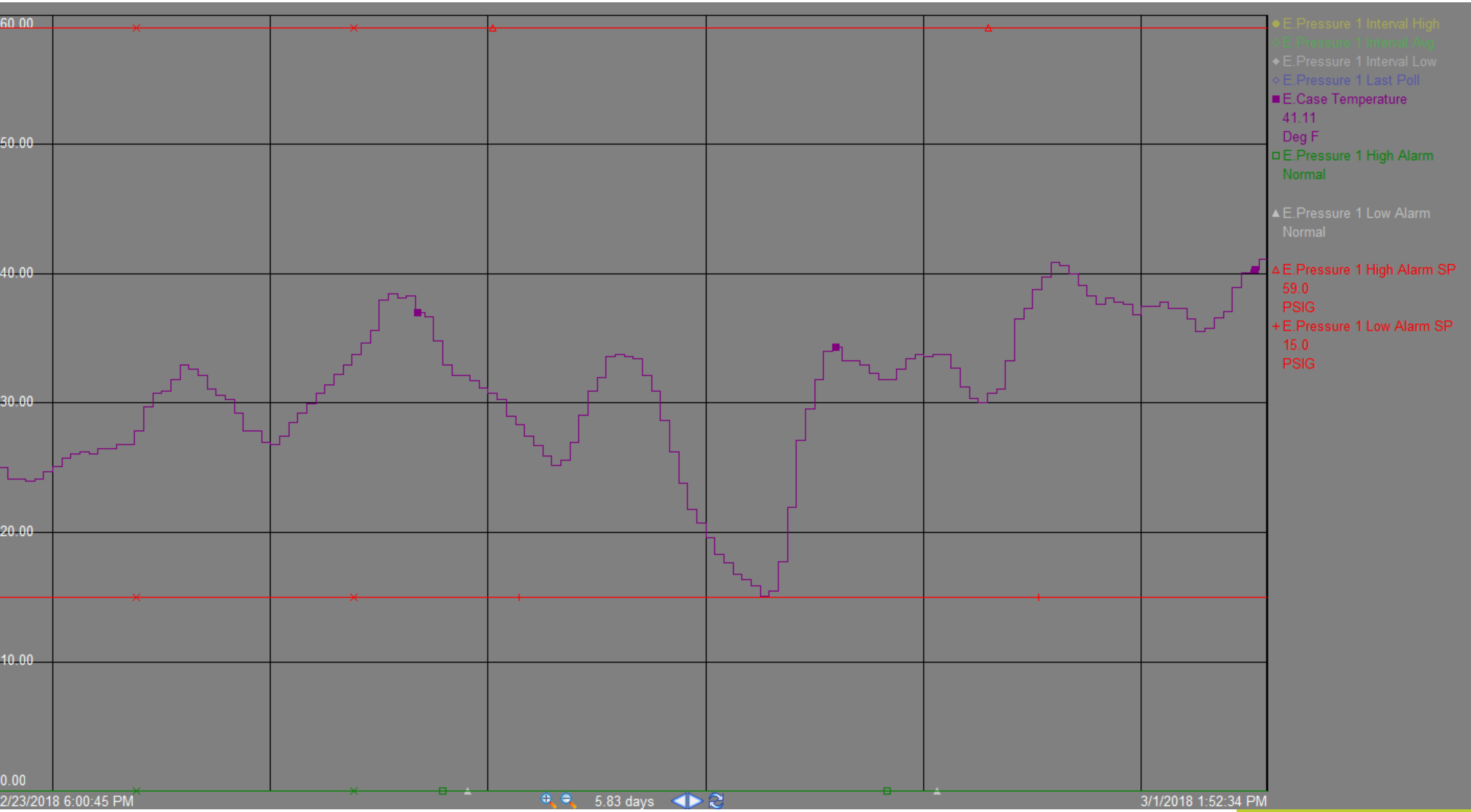
- Simulate system for any temperature
  - HDD’s
- Solve for pressure at all nodes


SynerGEE - [Schematic - Moscow]
File Edit Modify Balance Schematic Report Modules Window Help
Legend
PRESSURE
(PSIG)
----RANGE----- COUNT
BELOW 25.00 0
25.00 35.00 6
35.00 45.00 336
45.00 65.00 525
ABOVE 65.00 40
MIN = 34.96
MAX = 200.00
ANNOTATION:
NODE OFF
NODE OFF
NODE OFF
ELEM OFF
Corners: (FEET)
35 DD
30° F
Ready
Balanced
NUM

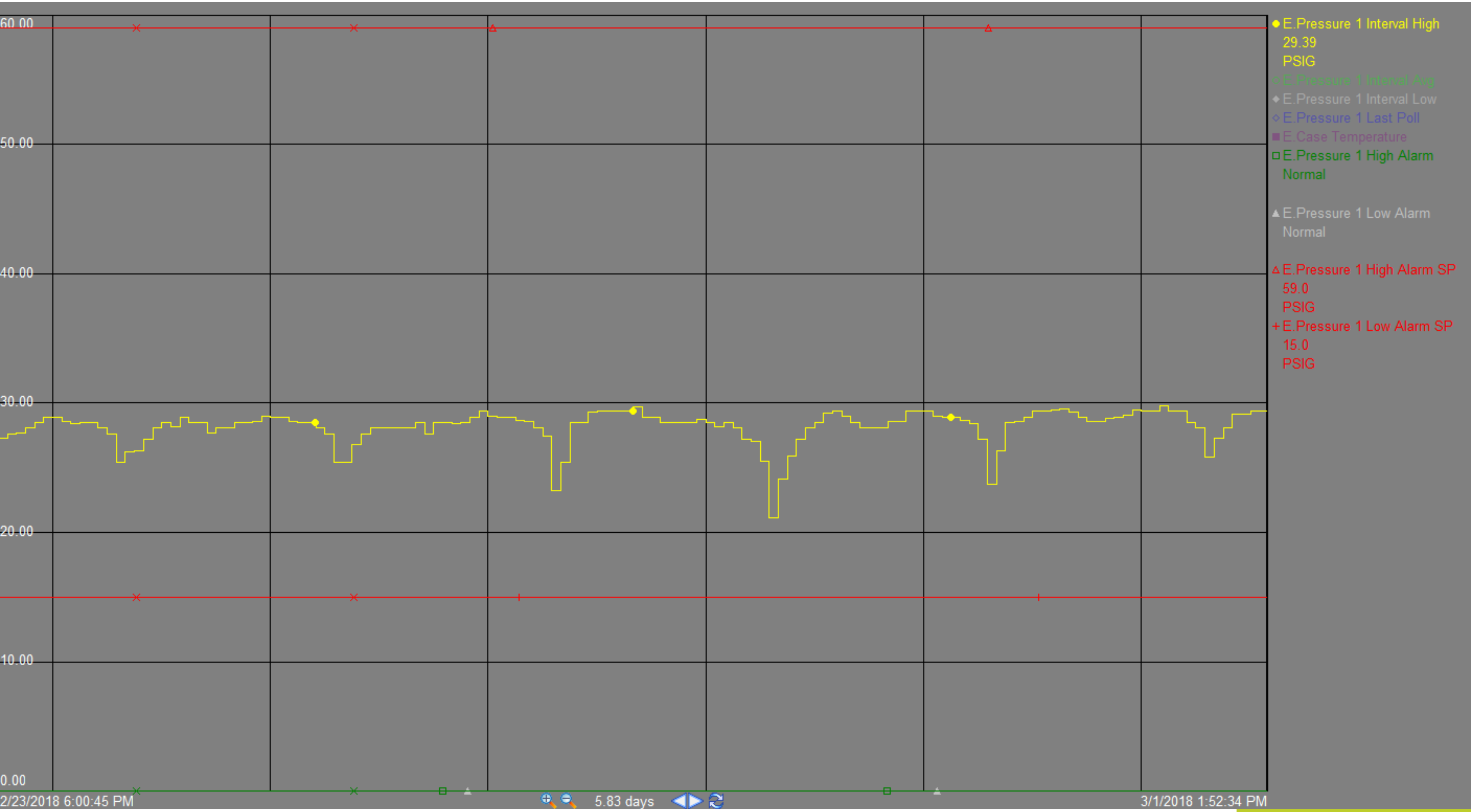
Validating Model

AVISTA

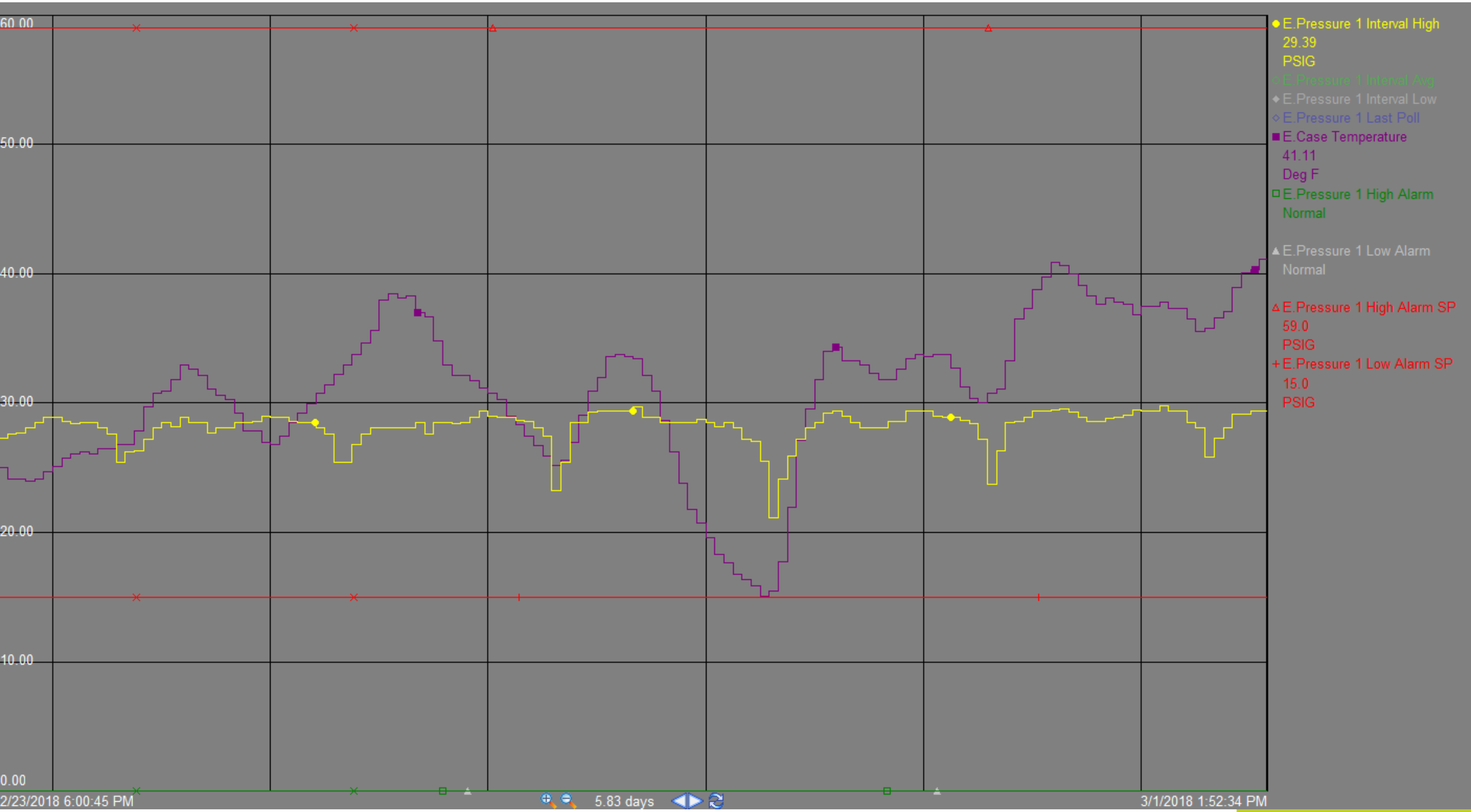
Validating Model cont.



Validating Model cont.



Validating Model cont.



Validating Model cont.

- Simulate recorded condition
- Electronic Pressure Recorders
  - Do calculated results match *field* data?
- Gate Station Telemetry
  - Do calculated results match *source* data?
- Possible Errors
  - Missing pipe
  - Source pressure changed
  - Industrial loads

Planning Criteria

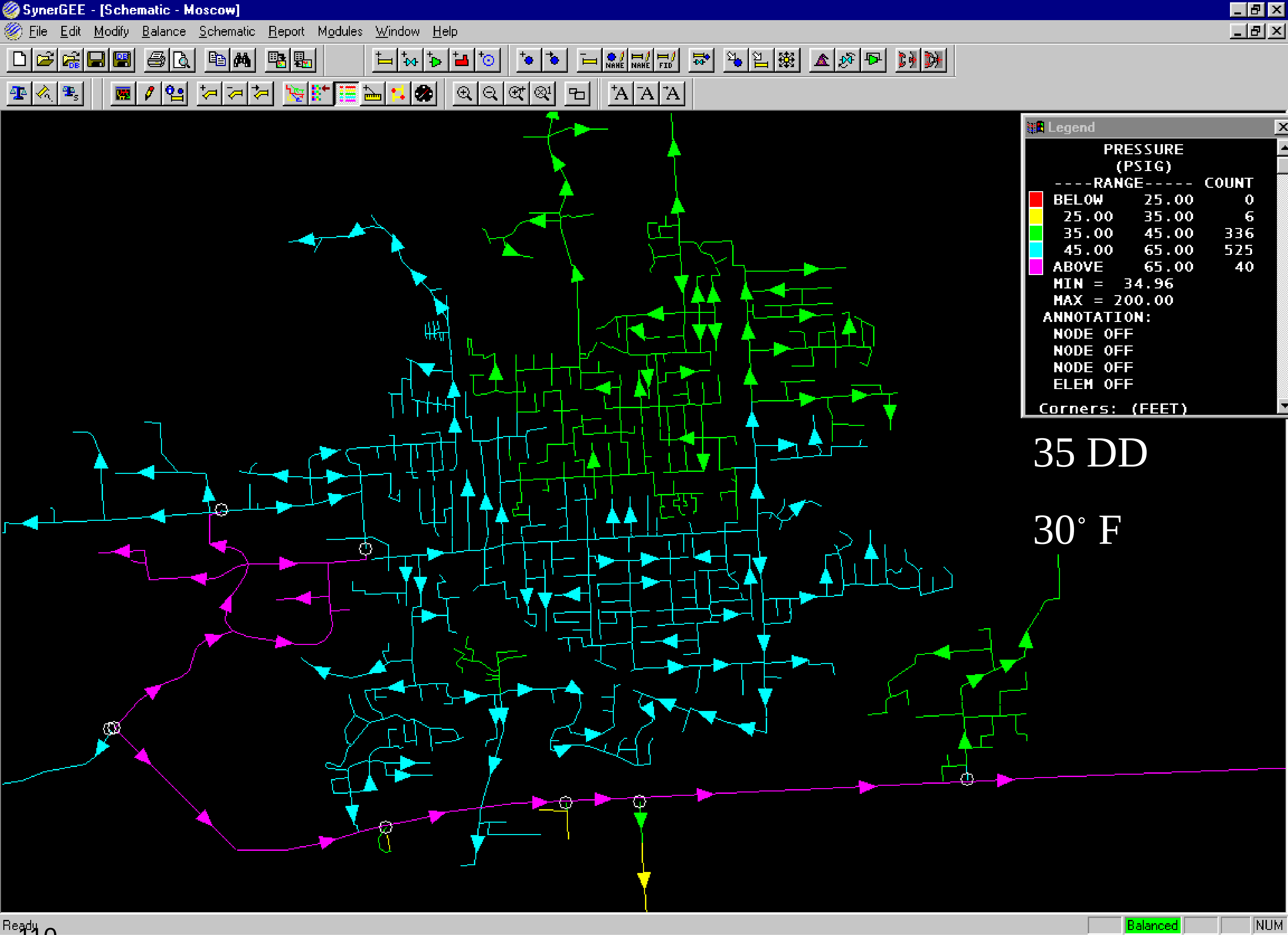
- Reliability during design HDD
  - Spokane 82 HDD
  - Medford 61 HDD
  - Klamath Falls 72 HDD
  - La Grande 74 HDD
  - Roseburg 55 HDD

- Maintain minimum of 15 psig in system at all times
  - 5 psig in lower MAOP areas

Planning Criteria

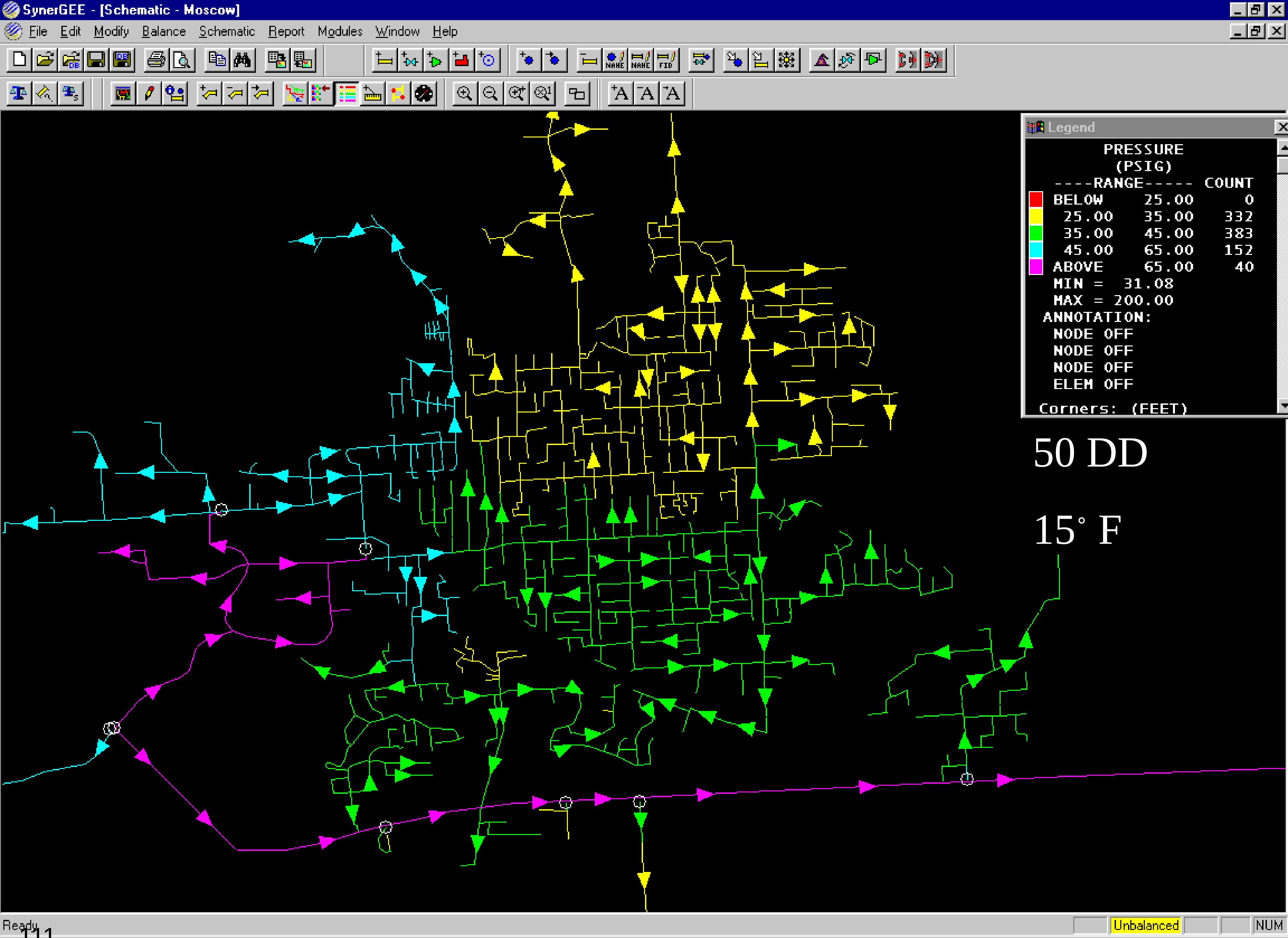
- Reliability during design HDD
  - Spokane **82 HDD** *(avg. daily temp. -17' F)*
  - Medford **61 HDD** *(avg. daily temp. 4' F)*
  - Klamath Falls **72 HDD** *(avg. daily temp. -7' F)*
  - La Grande **74 HDD** *(avg. daily temp. -9' F)*
  - Roseburg **55 HDD** *(avg. daily temp. 10' F)*

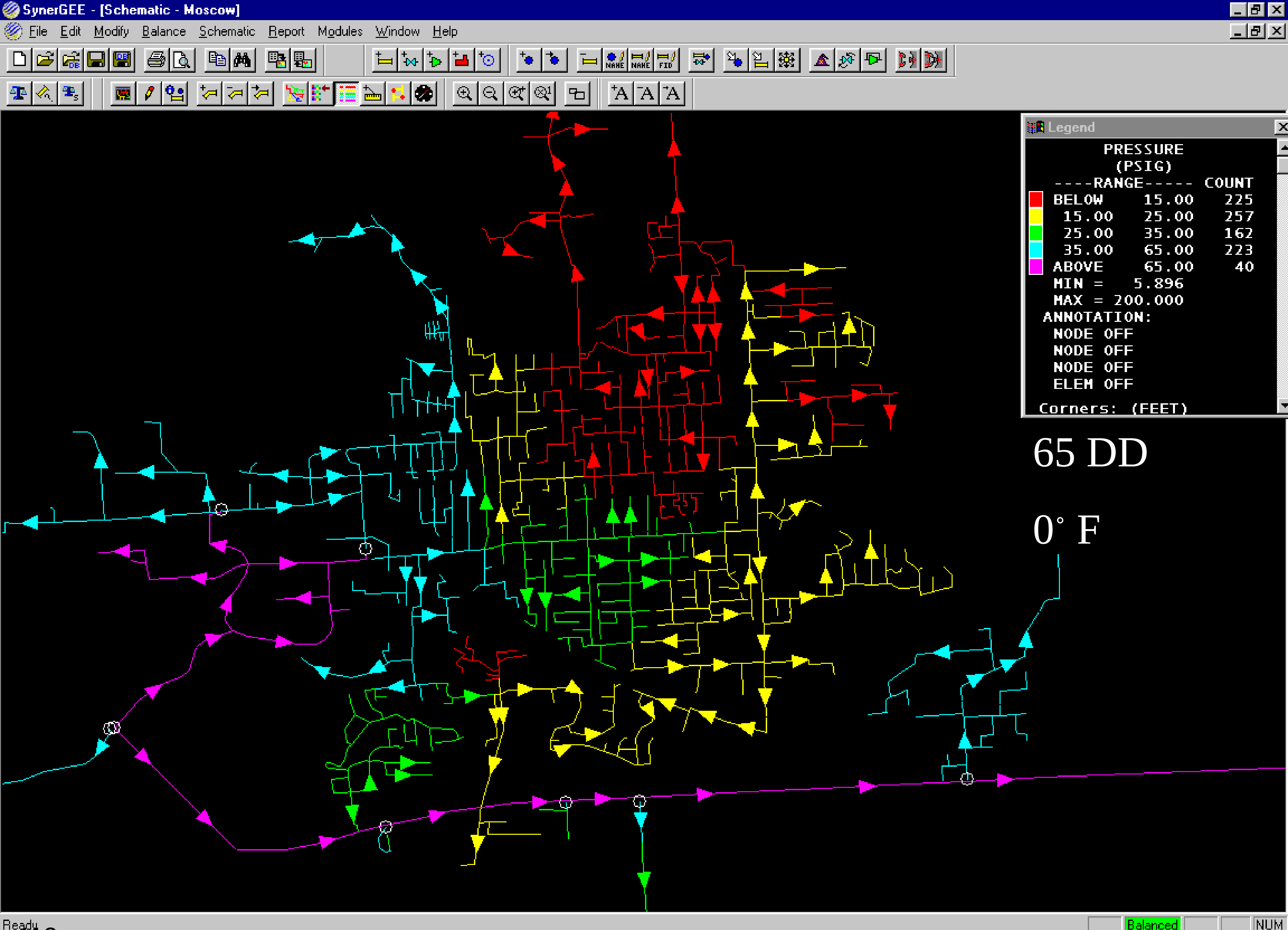
- Maintain minimum of 15 psig in system at all times
  - 5 psig in lower MAOP areas


SynerGEE - [Schematic - Moscow]
File Edit Modify Balance Schematic Report Modules Window Help
Legend
PRESSURE
(PSIG)
----RANGE----- COUNT
BELOW 25.00 0
25.00 35.00 6
35.00 45.00 336
45.00 65.00 525
ABOVE 65.00 40
MIN = 34.96
MAX = 200.00
ANNOTATION:
NODE OFF
NODE OFF
NODE OFF
ELEM OFF
Corners: (FEET)
Ready
Balanced
NUM

35 DD

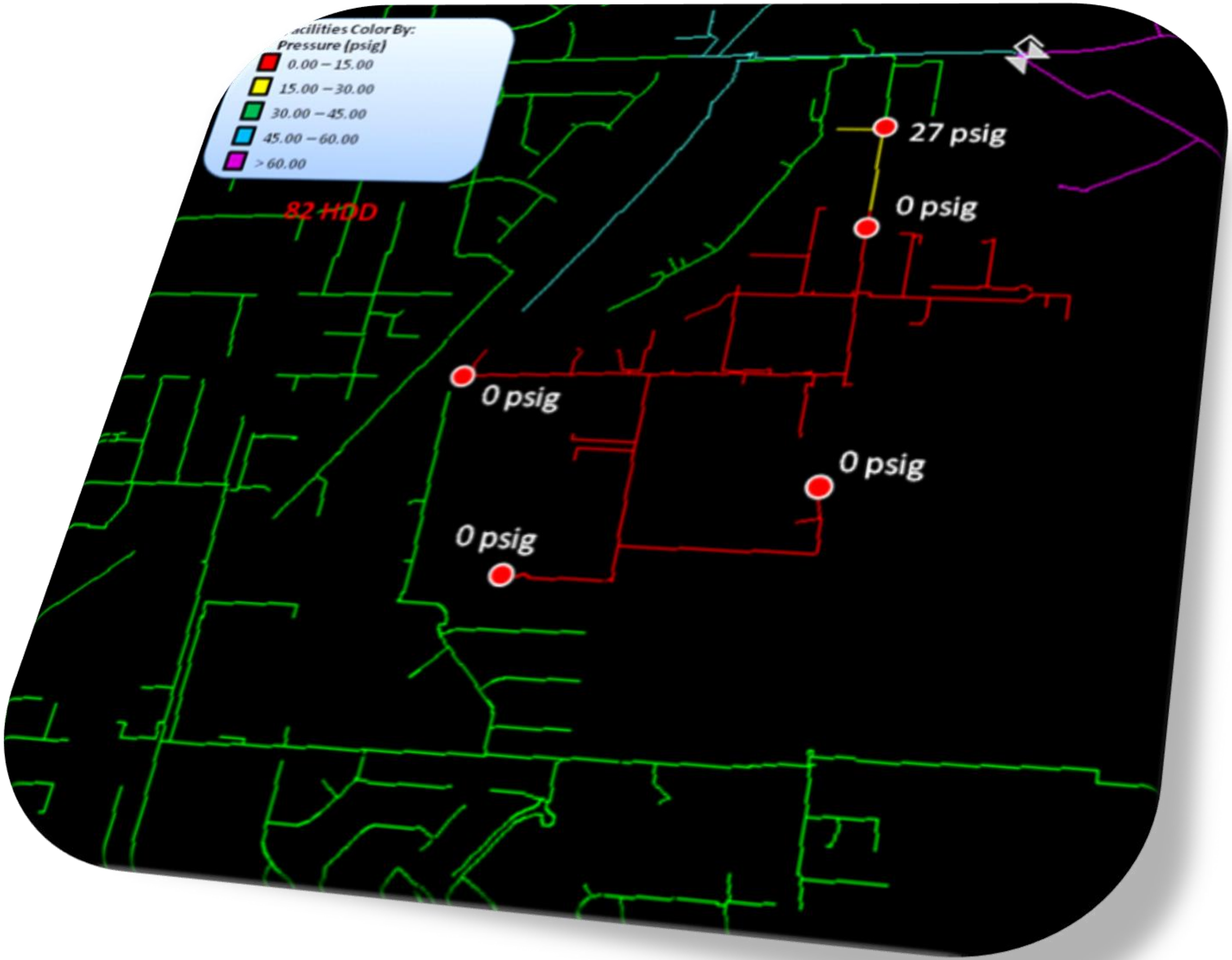
30° F

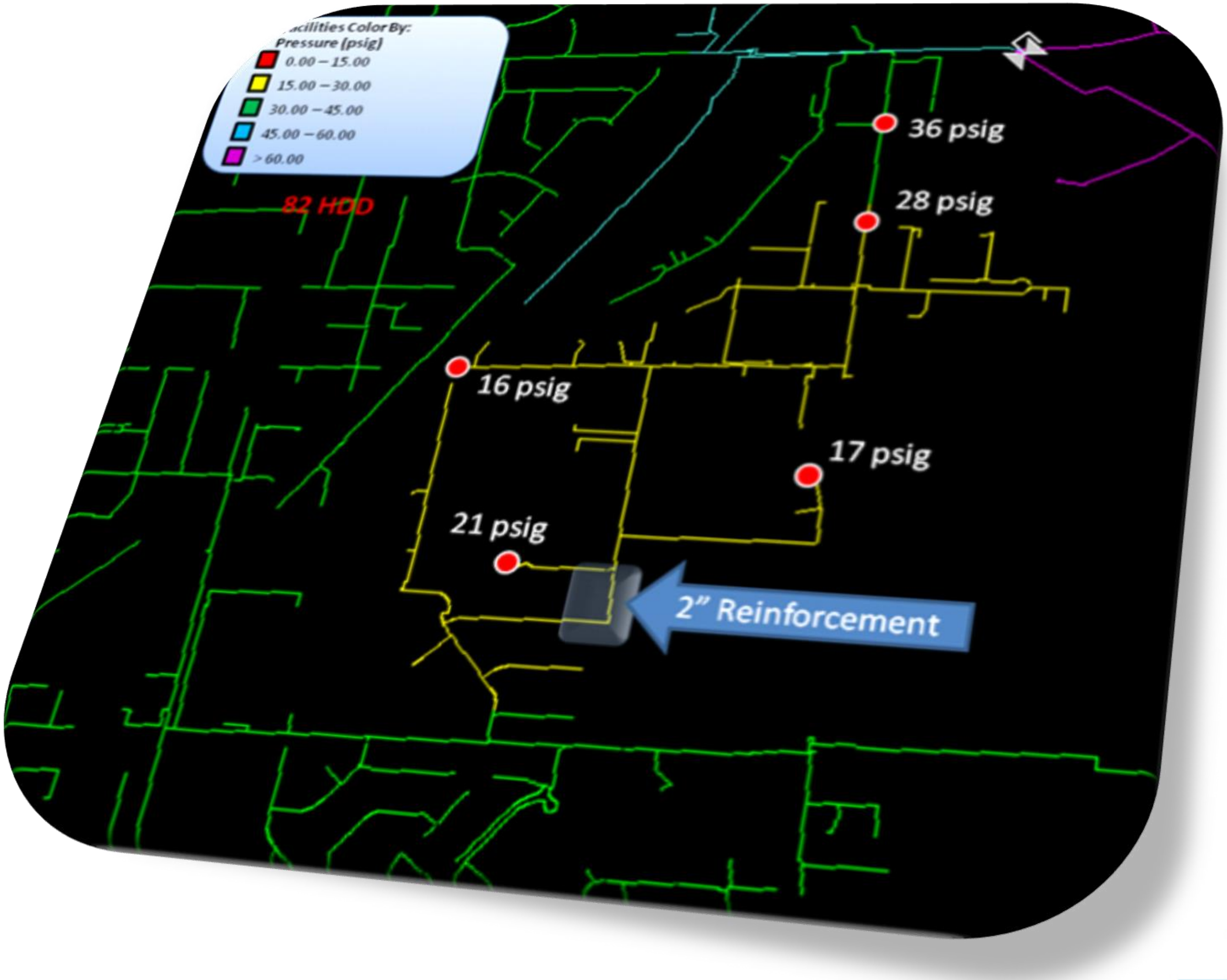

SynerGEE - [Schematic - Moscow]
File Edit Modify Balance Schematic Report Modules Window Help
Legend
PRESSURE
(PSIG)
----RANGE----- COUNT
BELOW 25.00 0
25.00 35.00 332
35.00 45.00 383
45.00 65.00 152
ABOVE 65.00 40
MIN = 31.08
MAX = 200.00
ANNOTATION:
NODE OFF
NODE OFF
NODE OFF
ELEM OFF
Corners: (FEET)
50 DD
15° F
Ready
Unbalanced
NUM

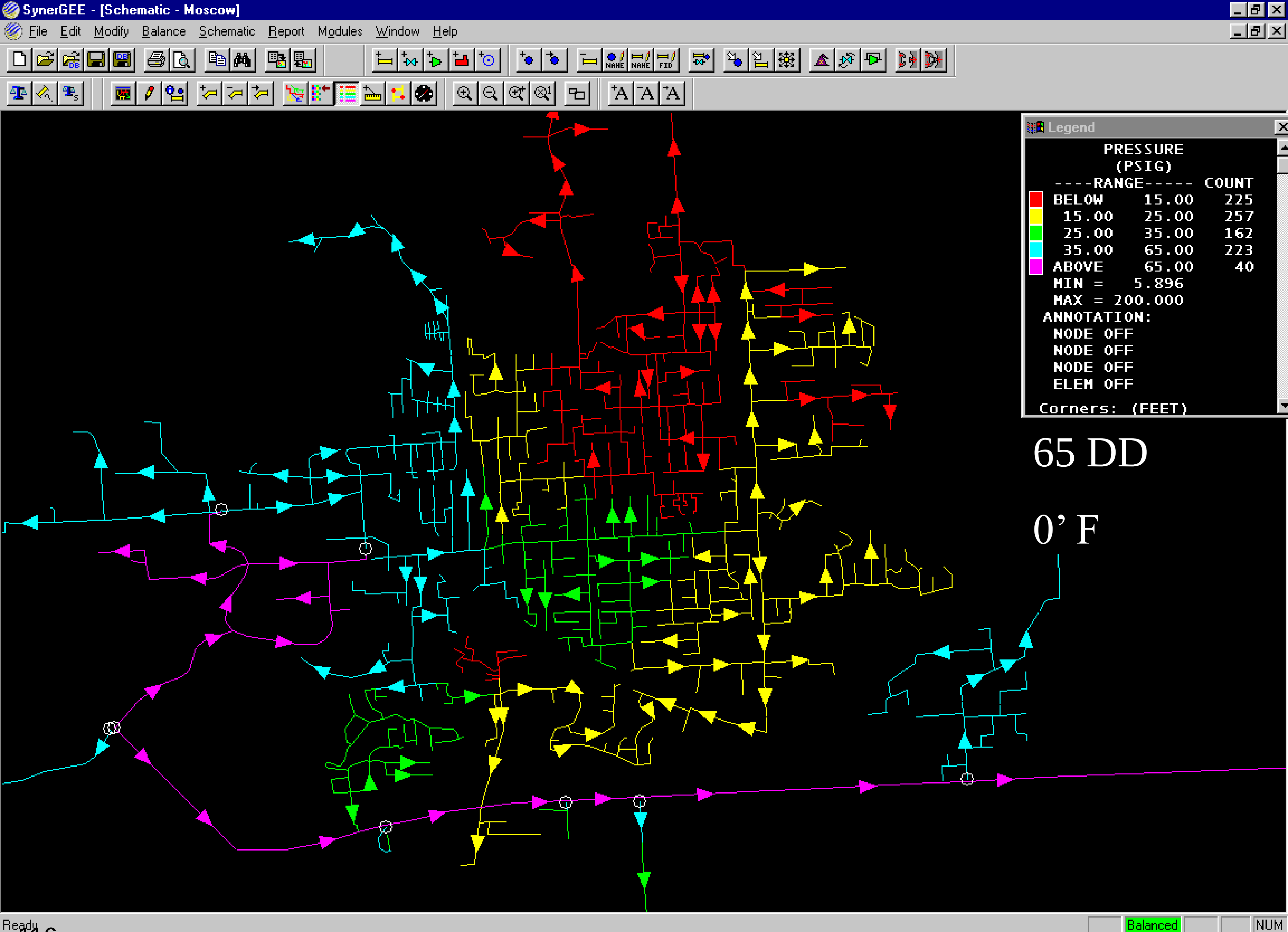

SynerGEE - [Schematic - Moscow]
File Edit Modify Balance Schematic Report Modules Window Help
Legend
PRESSURE
(PSIG)
----RANGE----- COUNT
BELOW 15.00 225
15.00 25.00 257
25.00 35.00 162
35.00 65.00 223
ABOVE 65.00 40
MIN = 5.896
MAX = 200.000
ANNOTATION:
NODE OFF
NODE OFF
NODE OFF
ELEM OFF
Corners: (FEET)
65 DD
0° F
Ready
Balanced
NUM

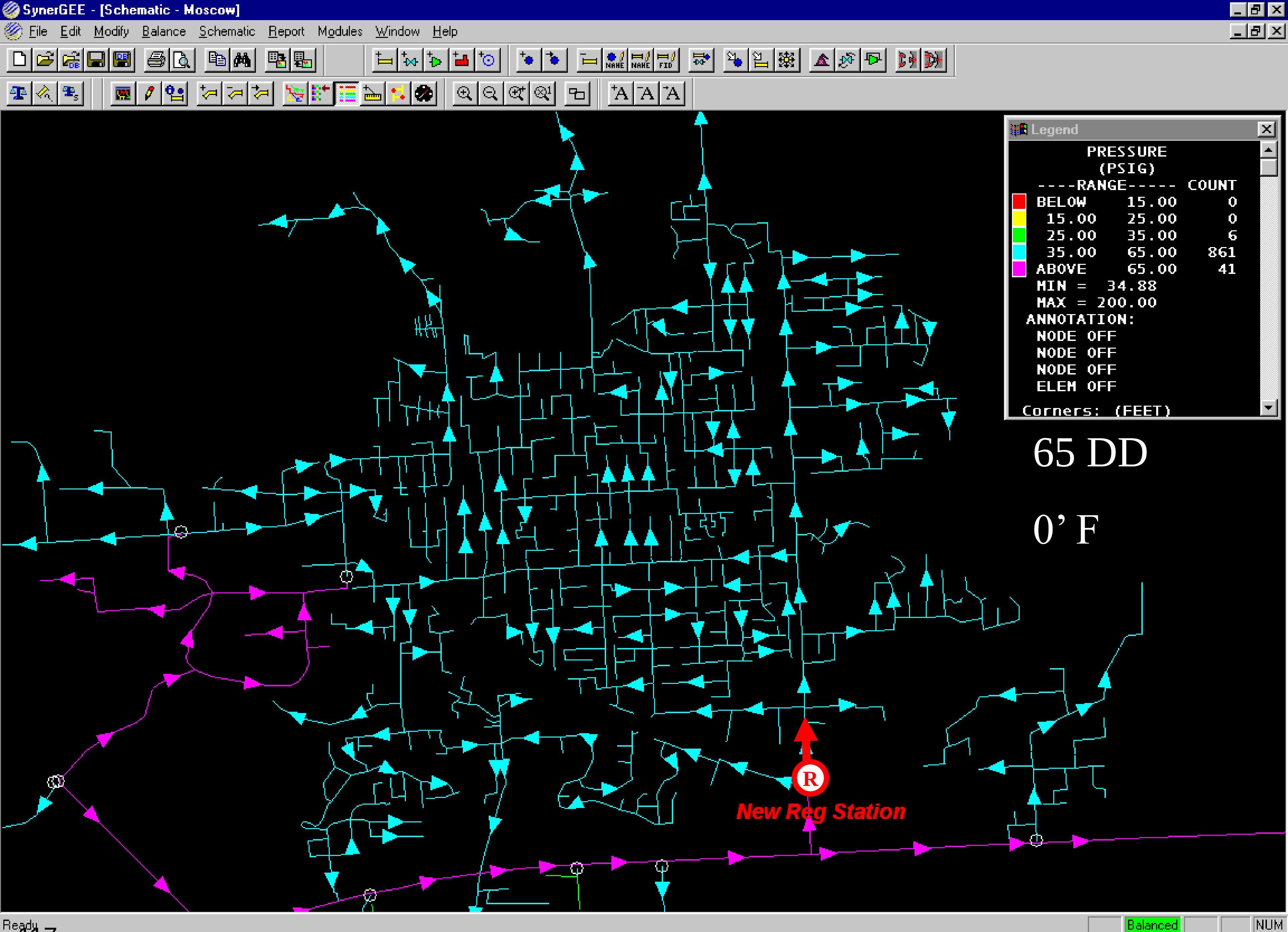
Interpreting Results

- Identify Low Pressure Areas
  - Number of feeds
  - Proximity to source
- Looking for Most Economical Solution
  - Length (minimize)
  - Construction obstacles (minimize)
  - Customer growth (maximize)

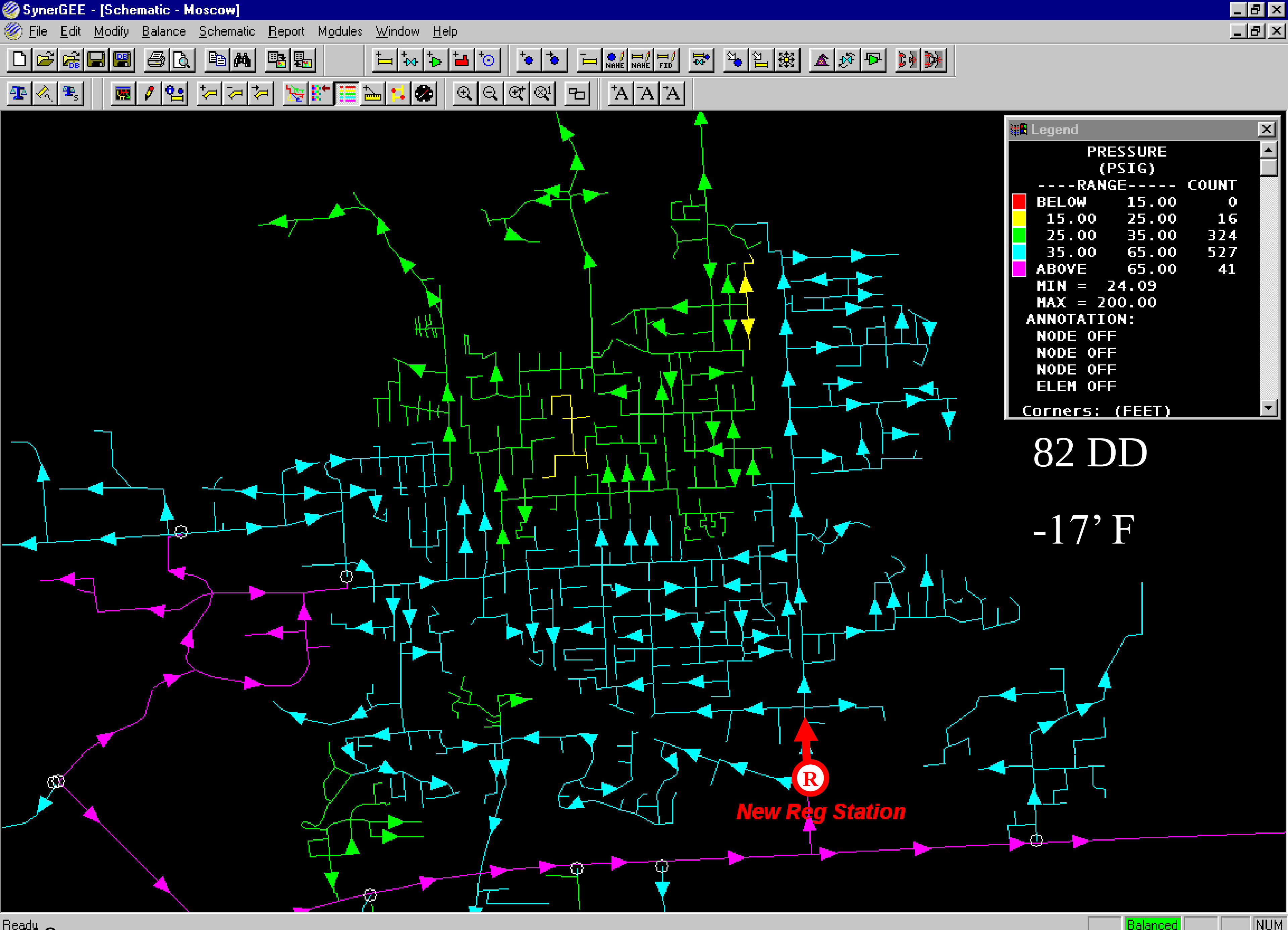

acilities Color By:
Pressure (psig)
0.00 – 15.00
15.00 – 30.00
30.00 – 45.00
45.00 – 60.00
> 60.00
82 HDD
27 psig
0 psig
0 psig
0 psig
0 psig


Facilities Color By:
Pressure (psig)
0.00 – 15.00
15.00 – 30.00
30.00 – 45.00
45.00 – 60.00
> 60.00
82 HDD
36 psig
28 psig
16 psig
17 psig
21 psig
2" Reinforcement


SynerGEE - [Schematic - Moscow]
File Edit Modify Balance Schematic Report Modules Window Help
Legend
PRESSURE
(PSIG)
----RANGE----- COUNT
BELOW 15.00 225
15.00 25.00 257
25.00 35.00 162
35.00 65.00 223
ABOVE 65.00 40
MIN = 5.896
MAX = 200.000
ANNOTATION:
NODE OFF
NODE OFF
NODE OFF
ELEM OFF
Corners: (FEET)
65 DD
0' F
Ready
Balanced
NUM



SynerGEE - [Schematic - Moscow]
File Edit Modify Balance Schematic Report Modules Window Help
Legend
PRESSURE
(PSIG)
----RANGE----- COUNT
BELOW 15.00 0
15.00 25.00 0
25.00 35.00 6
35.00 65.00 861
ABOVE 65.00 41
MIN = 34.88
MAX = 200.00
ANNOTATION:
NODE OFF
NODE OFF
NODE OFF
ELEM OFF
Corners: (FEET)
65 DD
0' F
R
New Reg Station
Ready
Balanced
NUM


SynerGEE - [Schematic - Moscow]
File Edit Modify Balance Schematic Report Modules Window Help
Legend
PRESSURE
(PSIG)
----RANGE----- COUNT
BELOW 15.00 0
15.00 25.00 16
25.00 35.00 324
35.00 65.00 527
ABOVE 65.00 41
MIN = 24.09
MAX = 200.00
ANNOTATION:
NODE OFF
NODE OFF
NODE OFF
ELEM OFF
Corners: (FEET)
82 DD
-17' F
R
New Reg Station
Ready
Balanced
NUM

Long-term Planning Objectives

- Future Growth/Expansion
- Design Day Conditions
- Facilitate Customer Installation Targets

Historical Temperatures

Historical Temperatures

- Spokane **82 HDD**
  - *11/23/10: 64 HDD "Artic Blast"*
- La Grande **74 HDD**
- Medford **61 HDD**
- Roseburg **55 HDD**
- Klamath Falls **72 HDD**

Historical Temperatures

- Spokane **82 HDD**
  - *11/23/10: 64 HDD "Artic Blast"*
  - *12/6/13 and 12/8/13: 58 HDD "Polar Vortex"*
- Medford **61 HDD**
  - *12/8/13: 52 HDD "Polar Vortex"*
- Klamath Falls **72 HDD**
  - *12/8/13: 72 HDD "Polar Vortex"*
- La Grande **74 HDD**
  - *12/8/13: 65 HDD "Polar Vortex"*
- Roseburg **55 HDD**
  - *12/8/13: 44 HDD"Polar Vortex"*

Historical Temperatures

- Spokane **82 HDD**
  - *11/23/10: 64 HDD "Artic Blast"*
  - *12/6/13 and 12/8/13: 58 HDD "Polar Vortex"*
  - *1/1/16: 55 HDD*
- Medford **61 HDD**
  - *12/8/13: 52 HDD "Polar Vortex"*
- Klamath Falls **72 HDD**
  - *12/8/13: 72 HDD "Polar Vortex"*
  - *1/2/16: 62 HDD*
- La Grande **74 HDD**
  - *12/8/13: 65 HDD "Polar Vortex"*
- Roseburg **55 HDD**
  - *12/8/13: 44 HDD"Polar Vortex"*

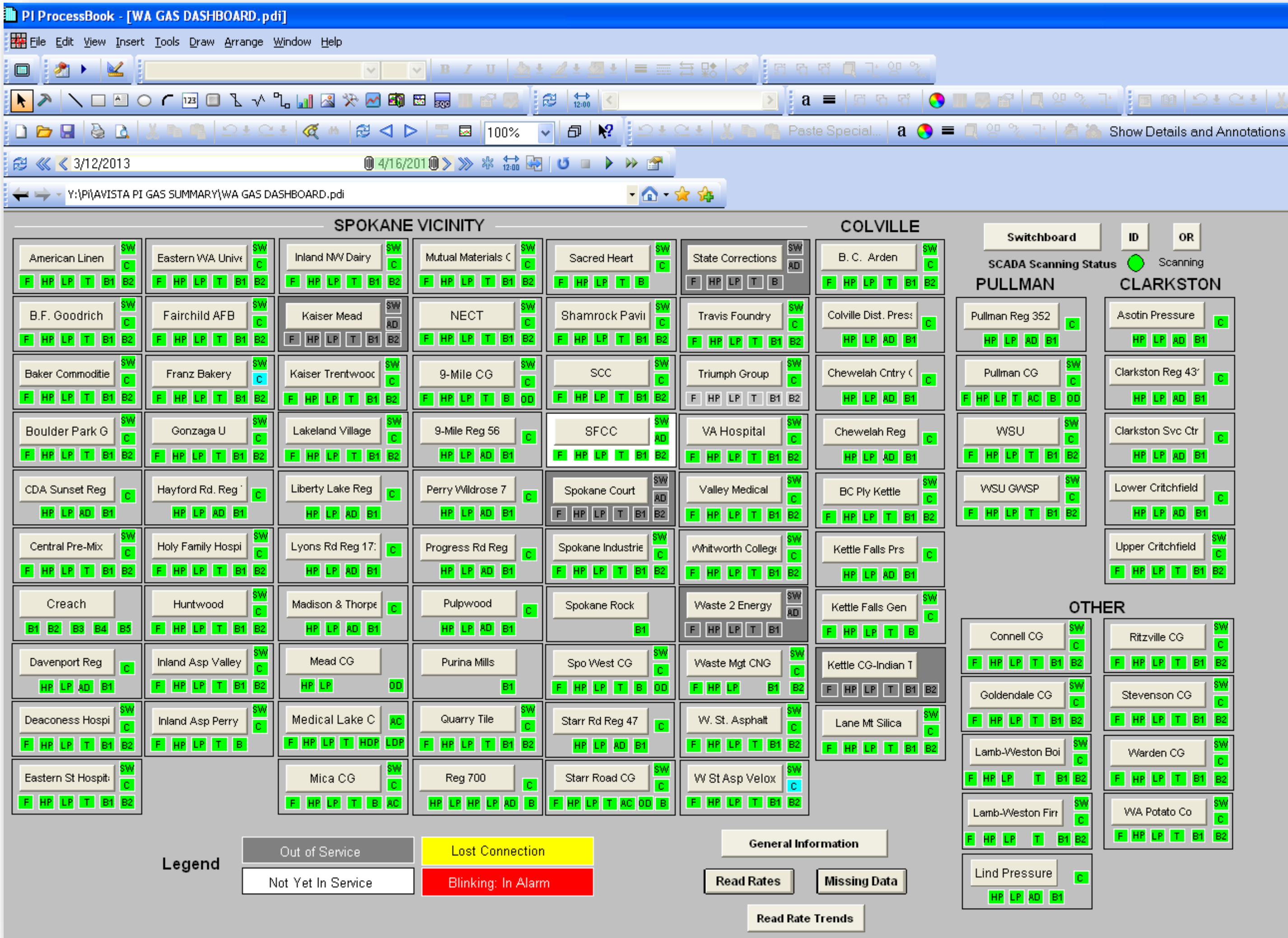
Historical Temperatures

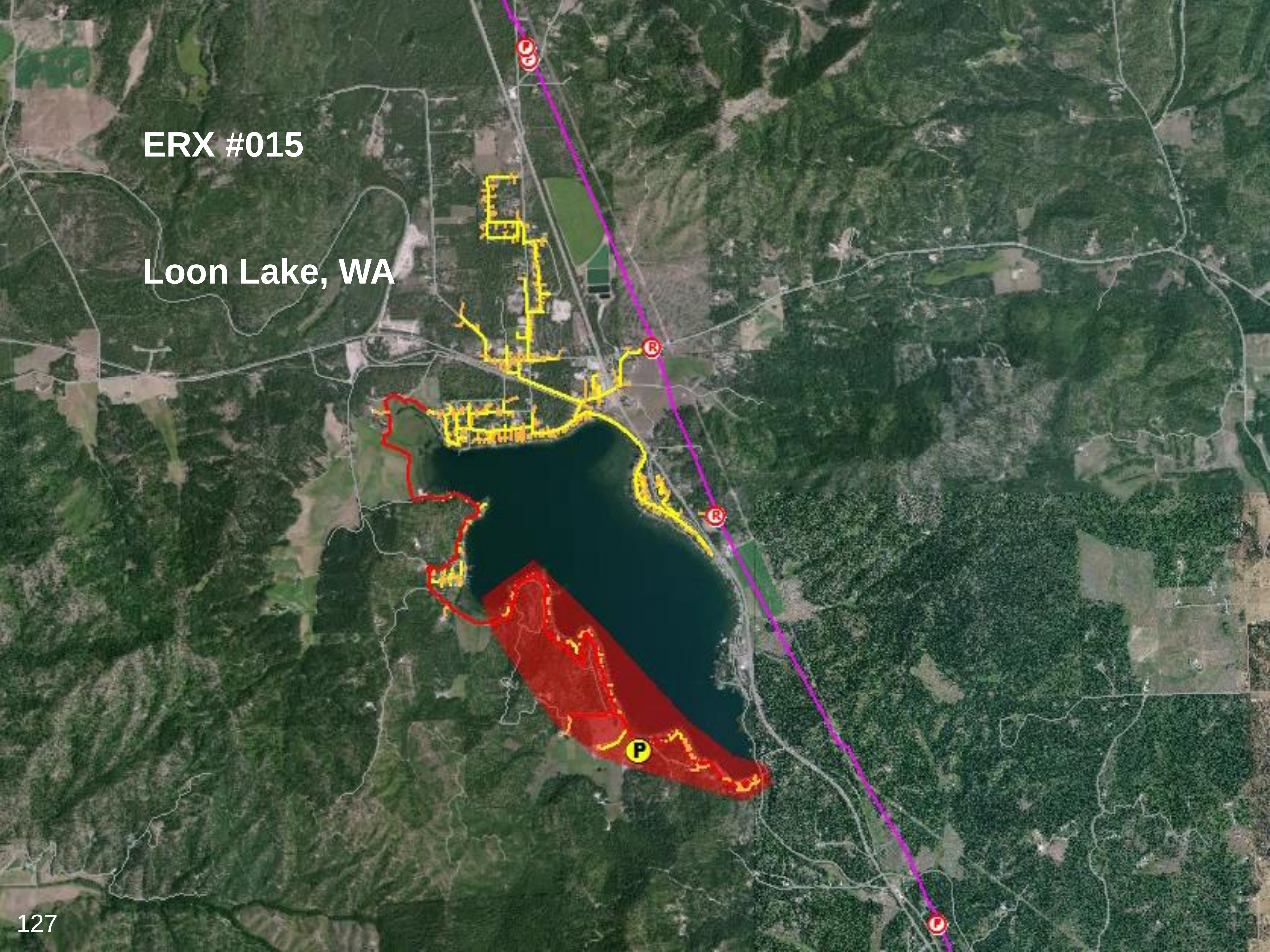
- Spokane **82 HDD**
  - *11/23/10: 64 HDD "Artic Blast"*
  - *12/6/13 and 12/8/13: 58 HDD "Polar Vortex"*
  - *1/1/16: 55 HDD*
  - *1/5/17: 59 HDD*
- Medford **61 HDD**
  - *12/8/13: 52 HDD "Polar Vortex"*
  - *1/5/17: 42 HDD*
- Klamath Falls **72 HDD**
  - *12/8/13: 72 HDD "Polar Vortex"*
  - *1/2/16: 62 HDD*
  - *1/5/17: 71 HDD*
- La Grande **74 HDD**
  - *12/8/13: 65 HDD "Polar Vortex"*
  - *1/5/17: 65 HDD*
- Roseburg **55 HDD**
  - *12/8/13: 44 HDD"Polar Vortex"*
  - *1/5/17: 38 HDD*

Monitoring Our System

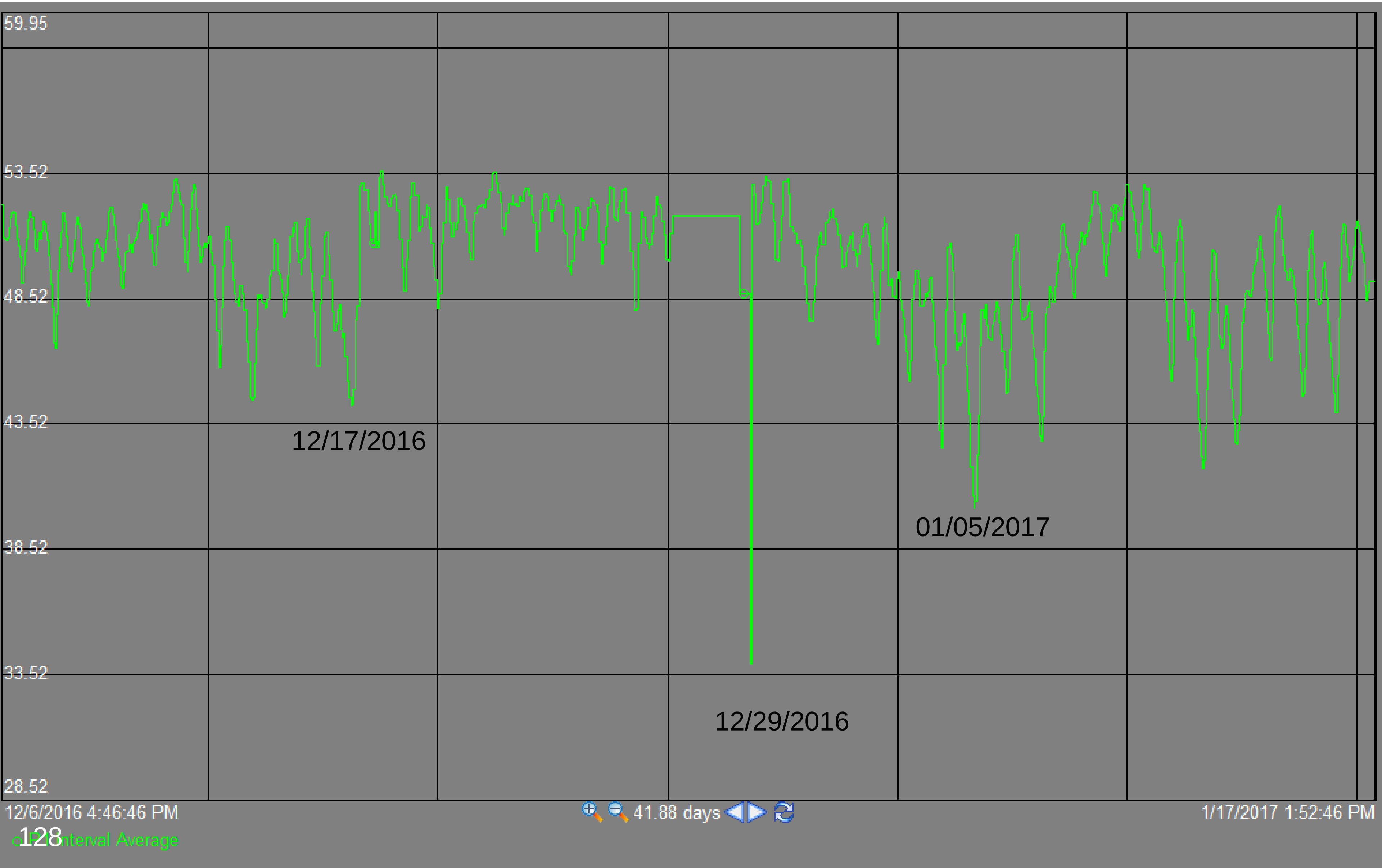
- Electronic Pressure Recorders
  - Daily Feedback
  - Real time if necessary
- Validates our Load Studies

Real-time Pressure & Flow Monitoring



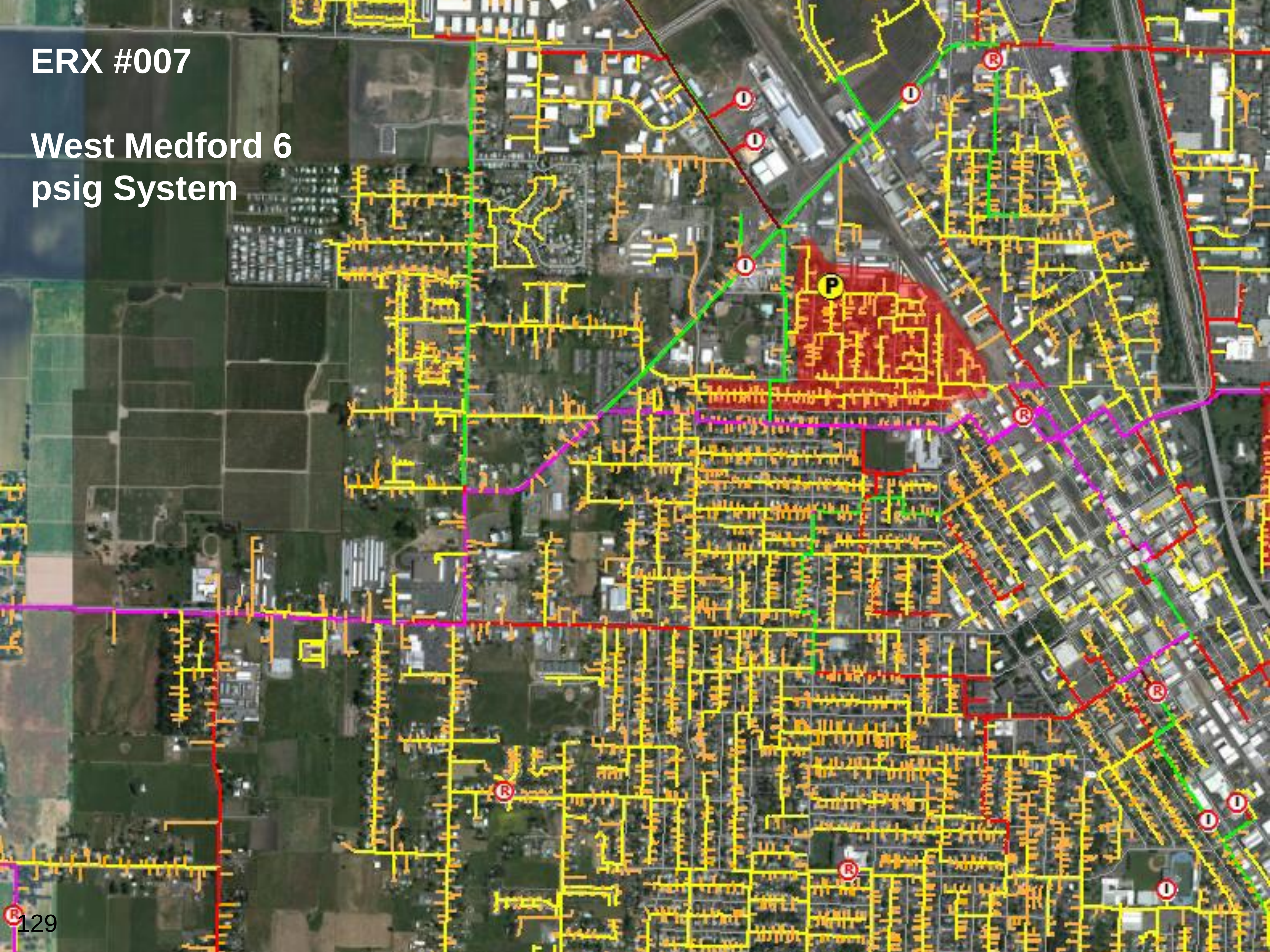

ERX #015
Loon Lake, WA

ERX #015: Loon Lake, WA

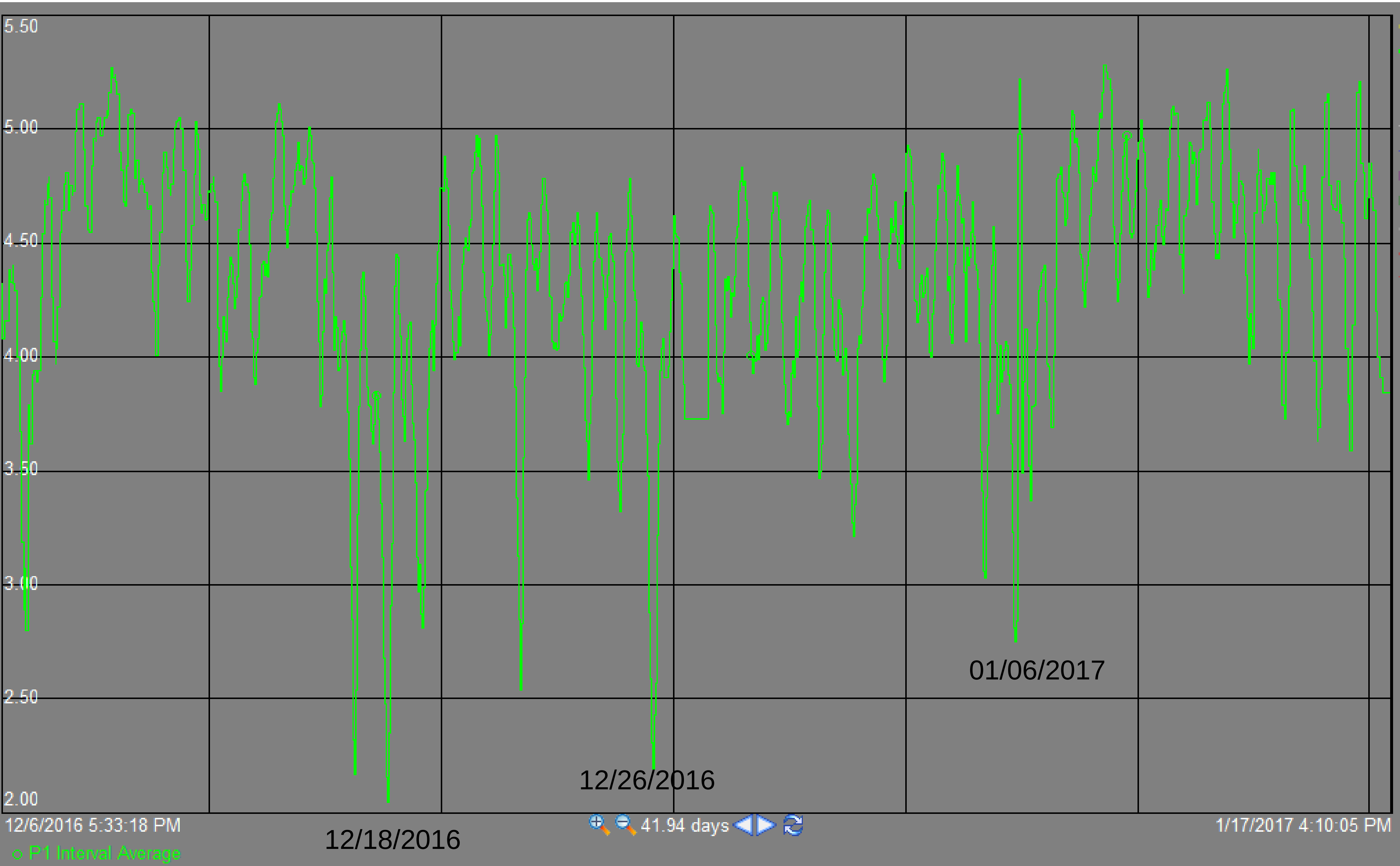


ERX #007

West Medford 6 psig System



ERX #007: West Medford 6 psig System, OR

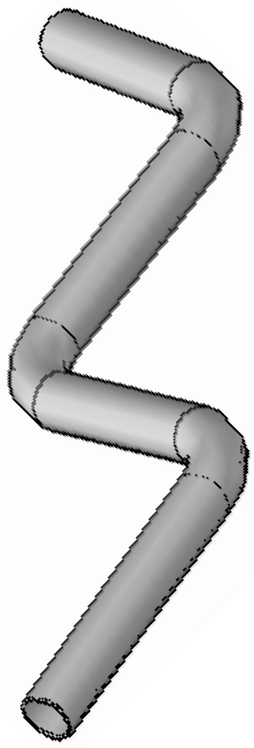


Solutions: short-term

AVISTA

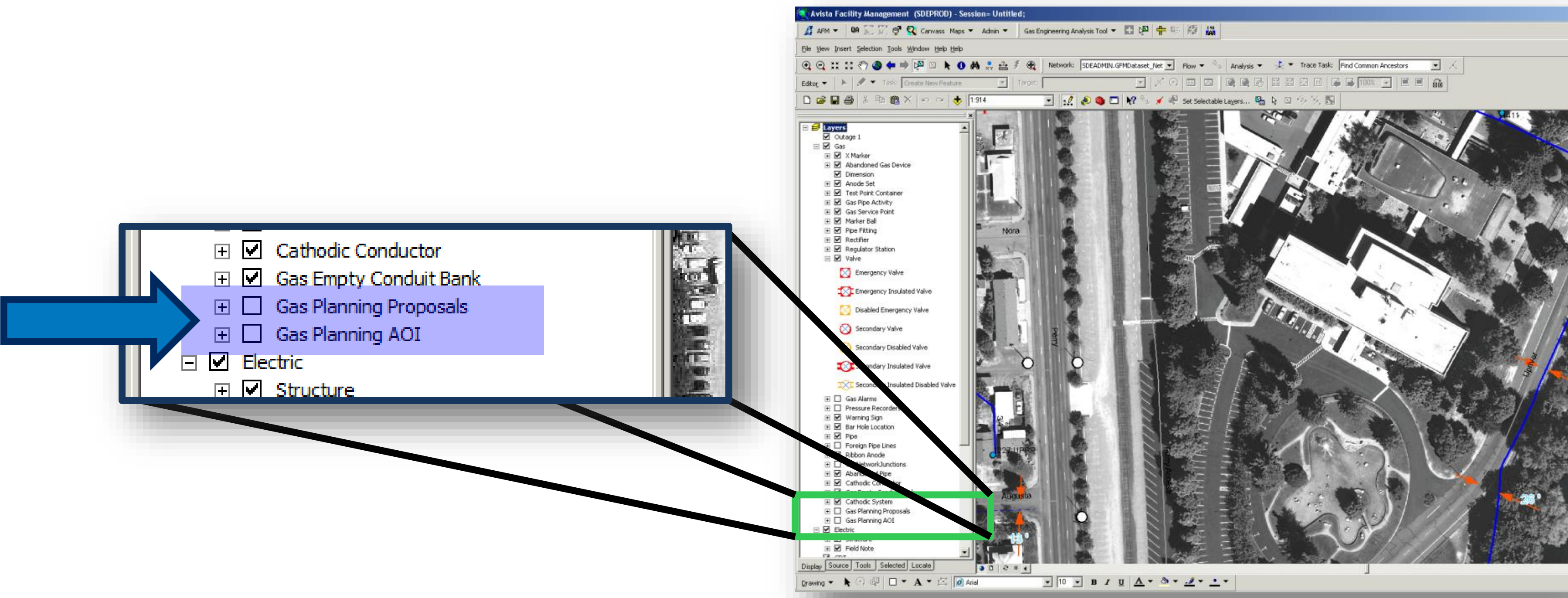
Solutions: long-term

State	Feet of pipe
Idaho	37,800
Oregon	62,300
Washington	121,100

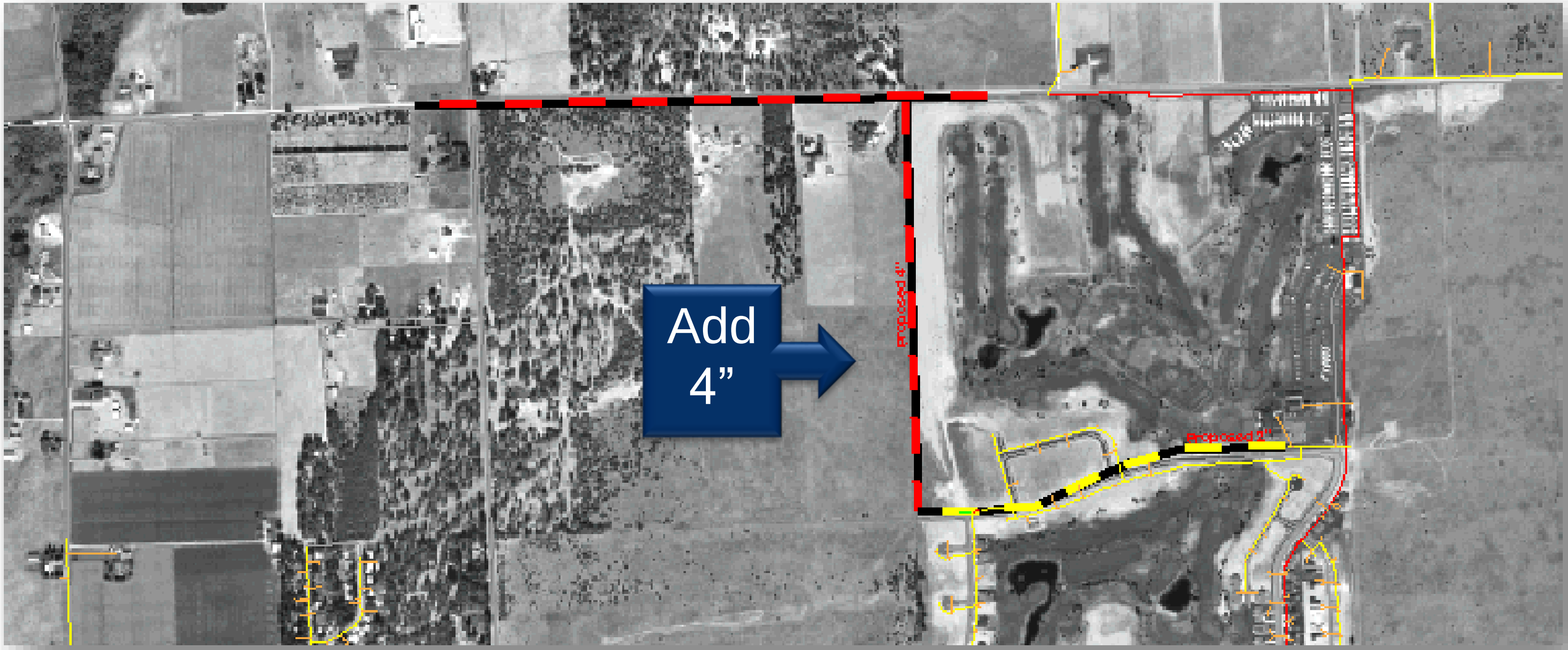


Gas Planning Layers

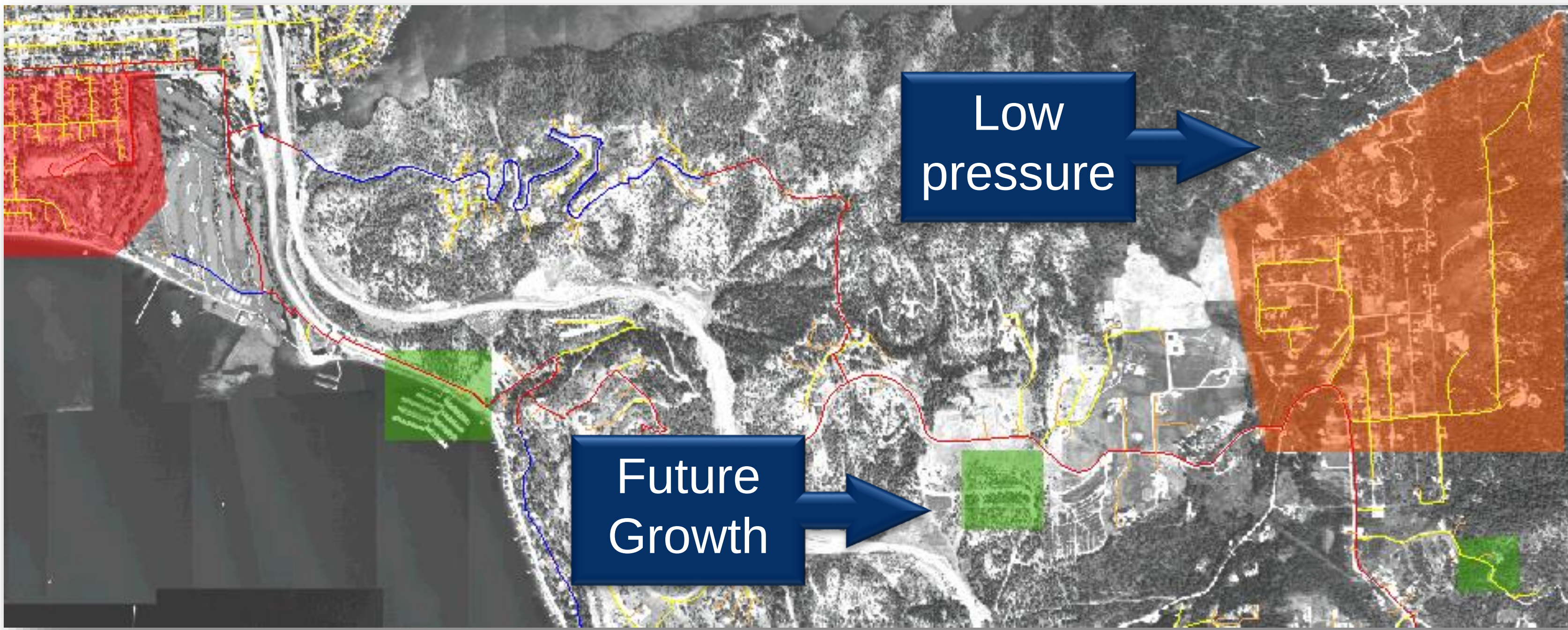
- Gas Planning Proposals
- Gas Planning AOI

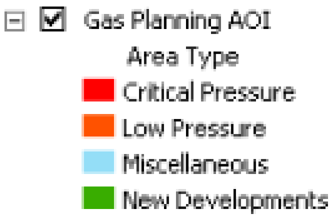


Gas Planning Proposals

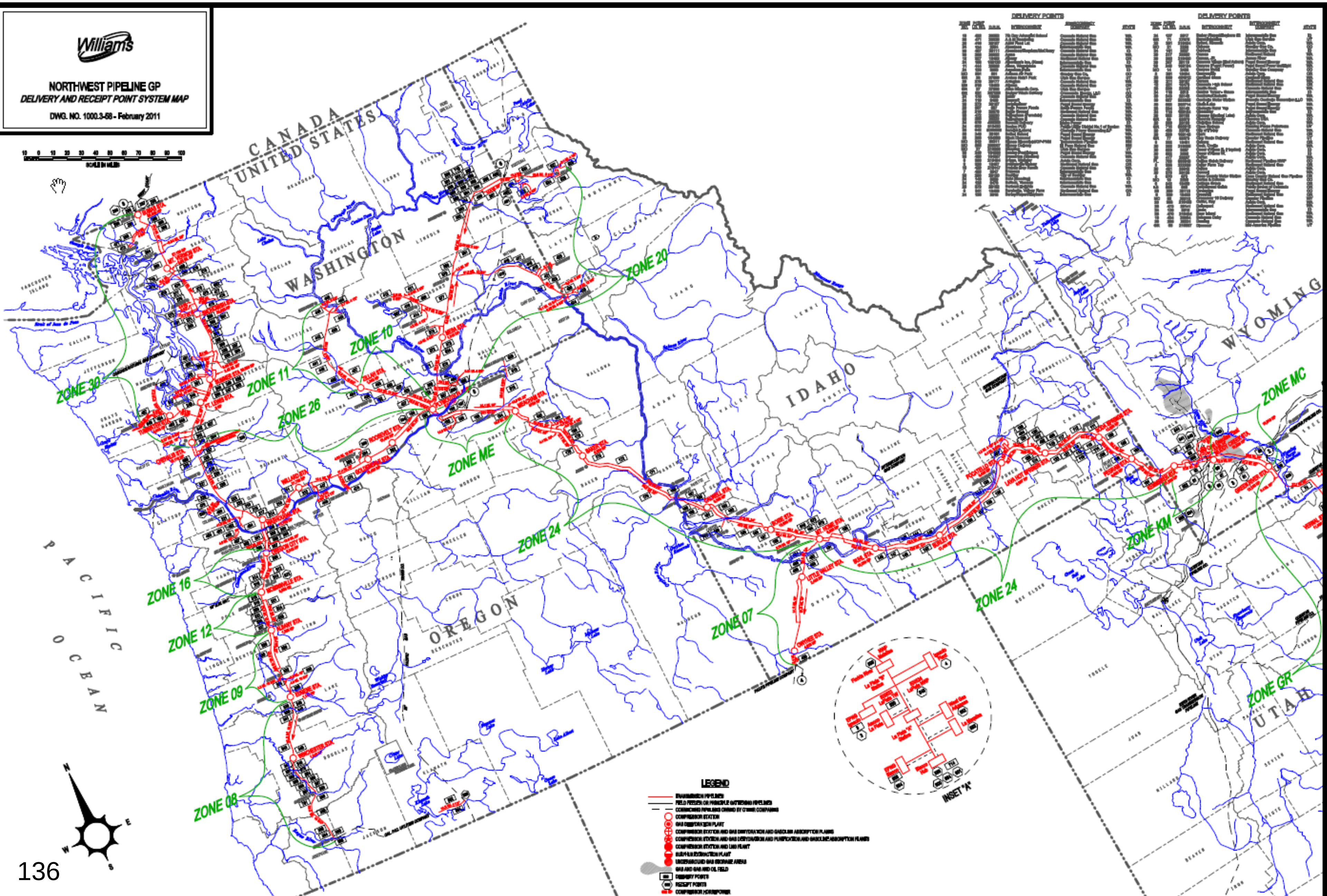


Gas Planning AOI

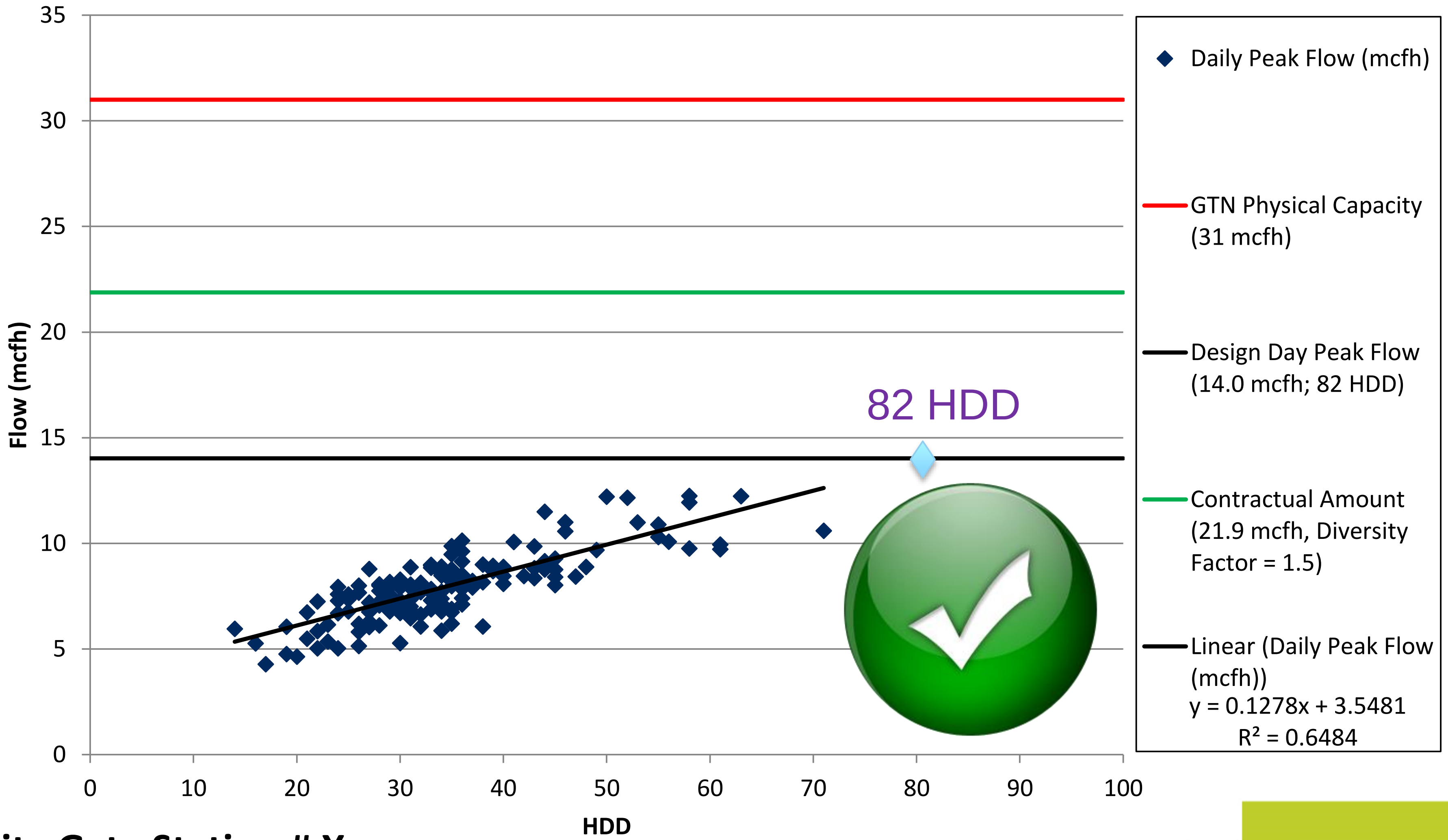




Gate Station Capacity Review

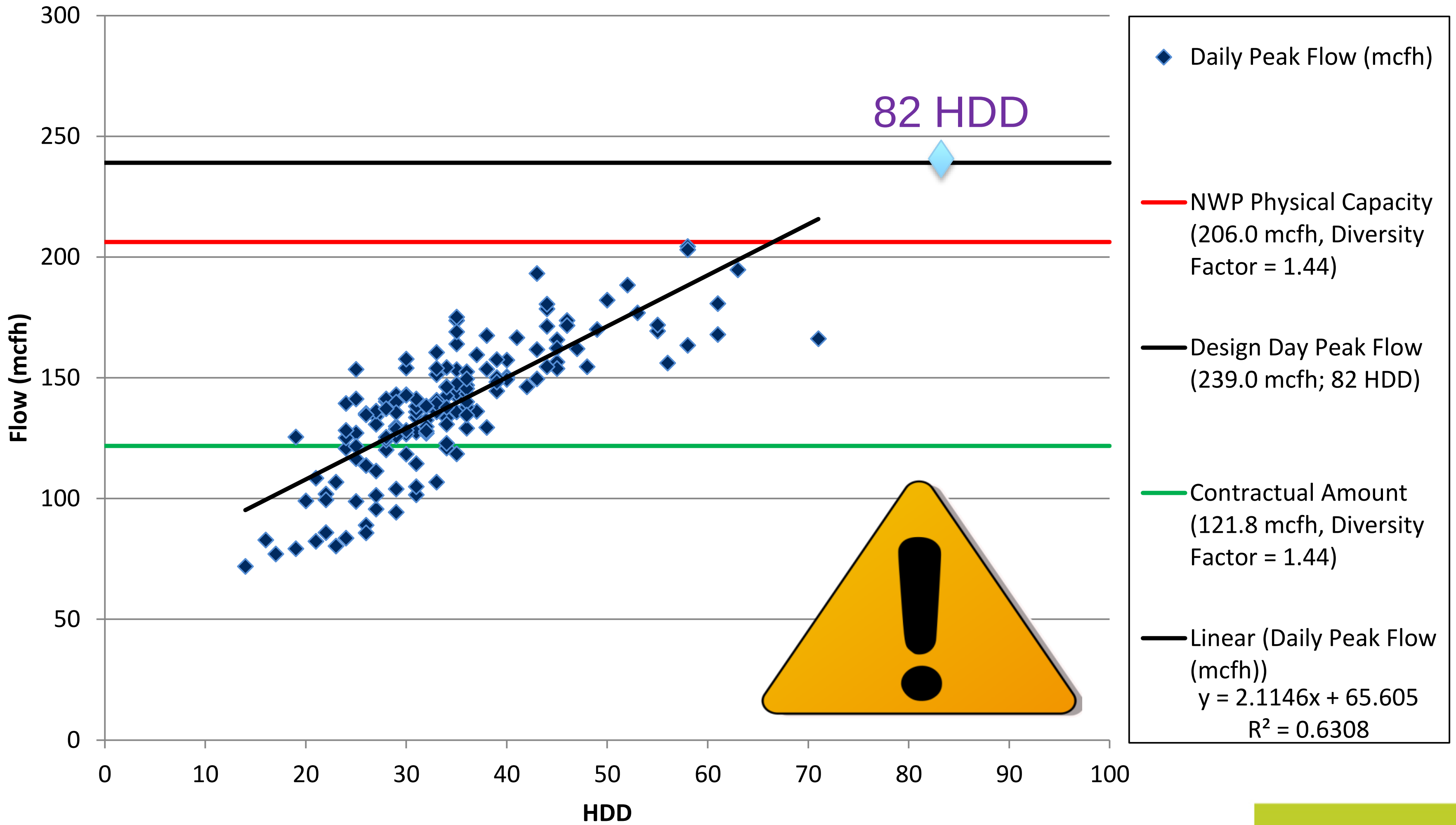


Gate Station Capacity Review (example)



City Gate Station # X

Gate Station Capacity Review (example)

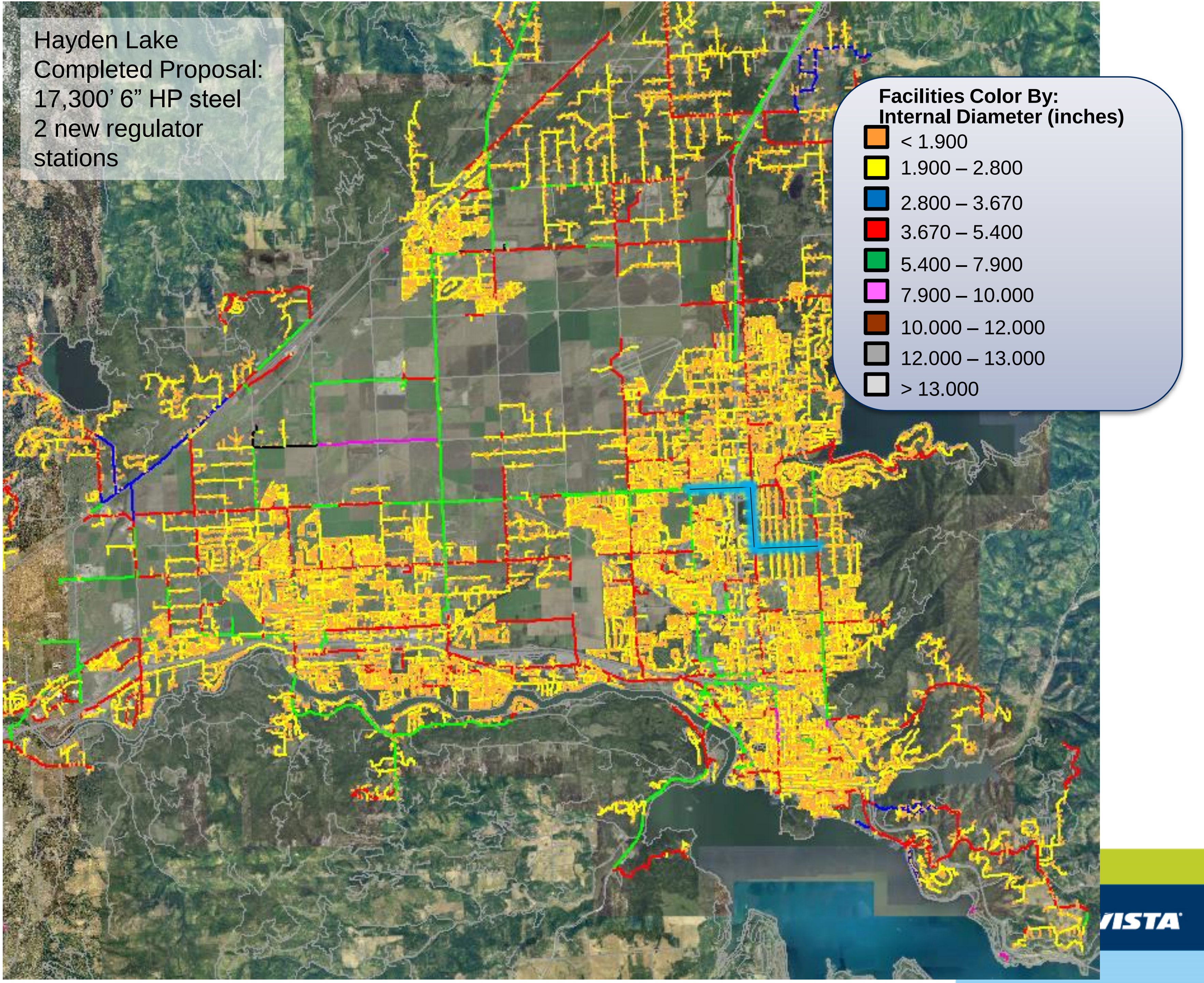


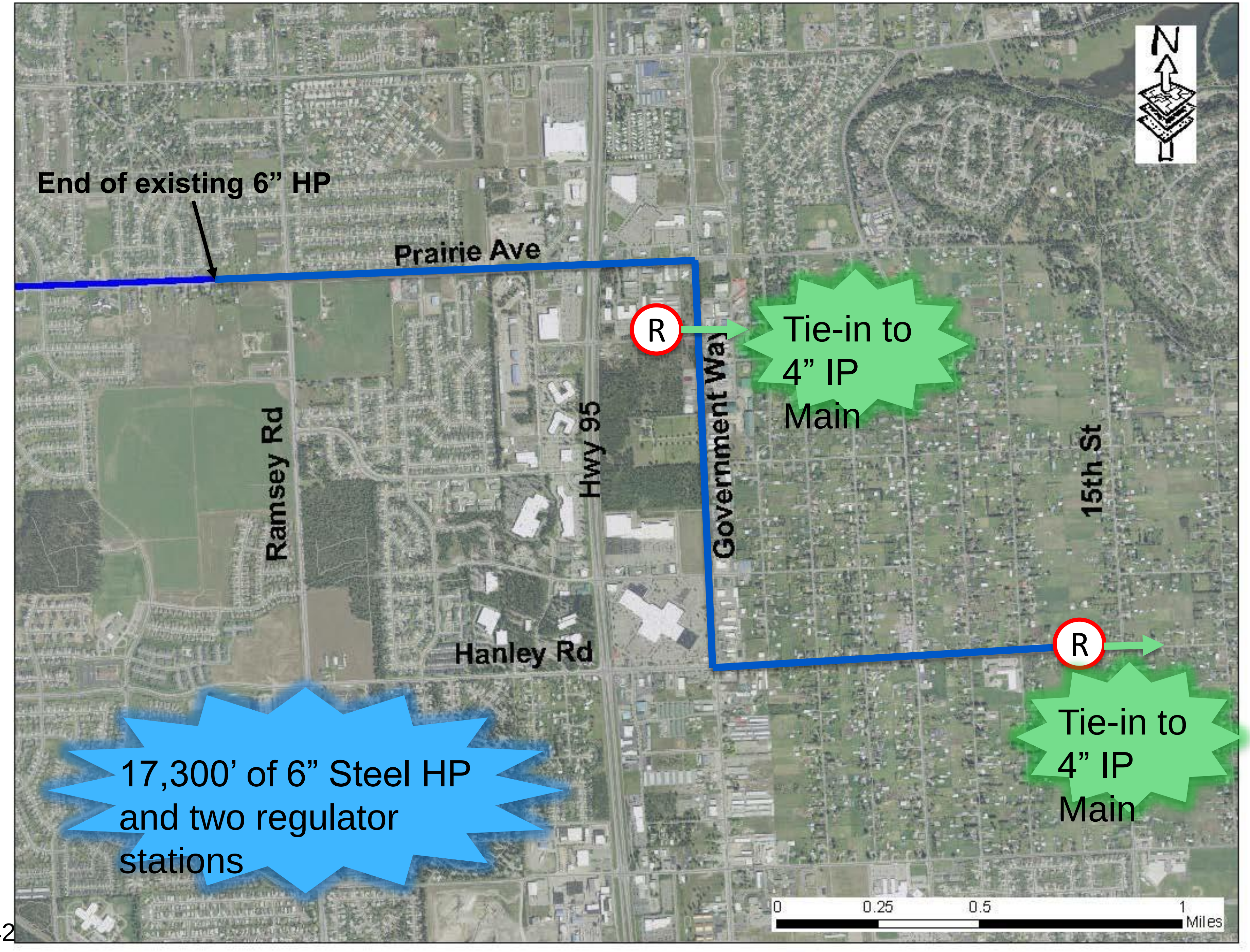
City Gate Station # Y

Current Projects and Examples

Hayden Lake HighPressure Reinforcement

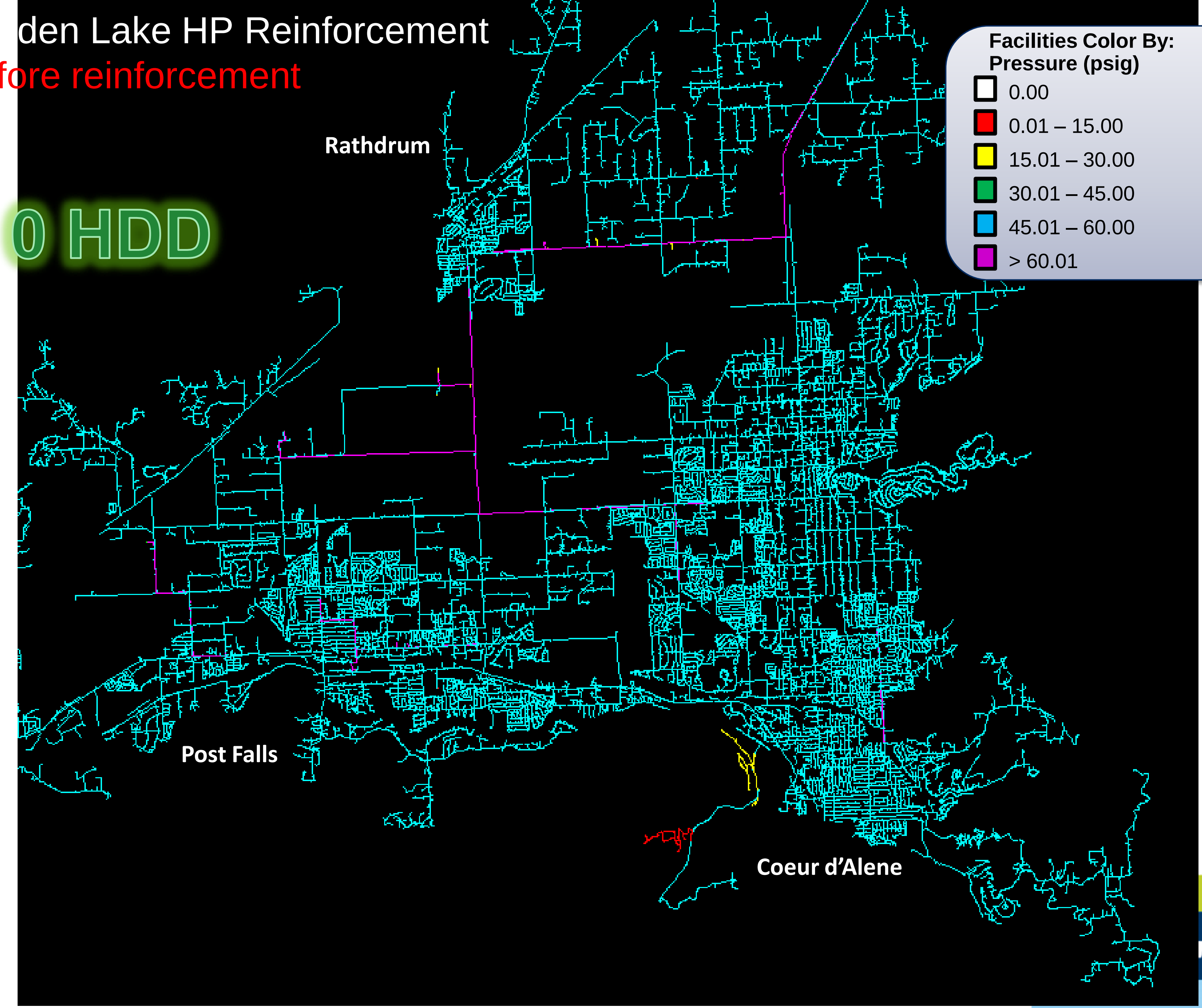
Coeur d'Alene, ID


Hayden Lake
Completed Proposal:
17,300’ 6” HP steel
2 new regulator
stations
Facilities Color By:
Internal Diameter (inches)
< 1.900
1.900 – 2.800
2.800 – 3.670
3.670 – 5.400
5.400 – 7.900
7.900 – 10.000
10.000 – 12.000
12.000 – 13.000
> 13.000


End of existing 6” HP
Prairie Ave
R
Tie-in to 4” IP Main
Ramsey Rd
Hwy 95
Government Way
15th St
Hanley Rd
R
Tie-in to 4” IP Main
17,300’ of 6” Steel HP and two regulator stations
0 0.25 0.5 1 Miles
N

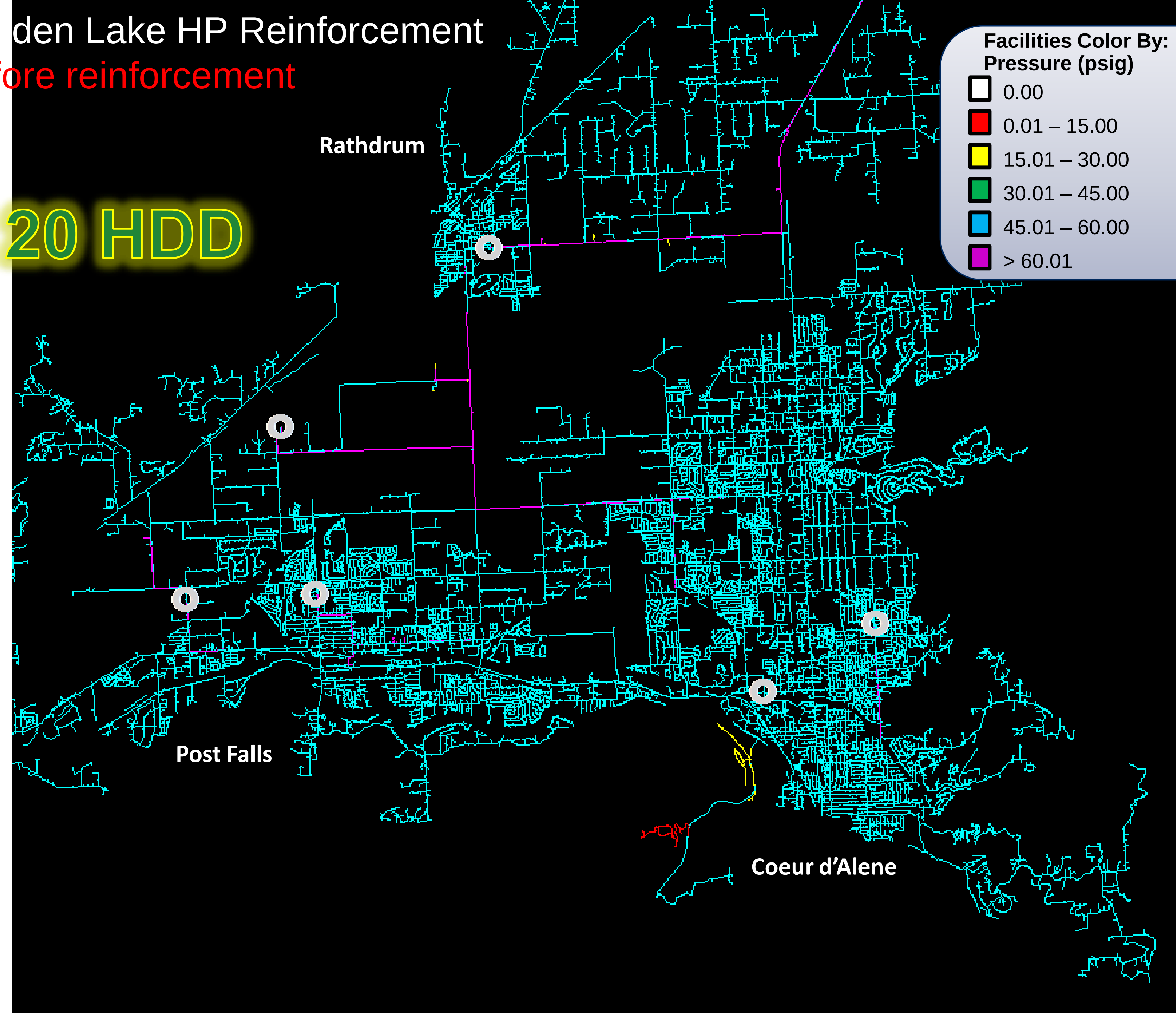
den Lake HP Reinforcement

Before reinforcement



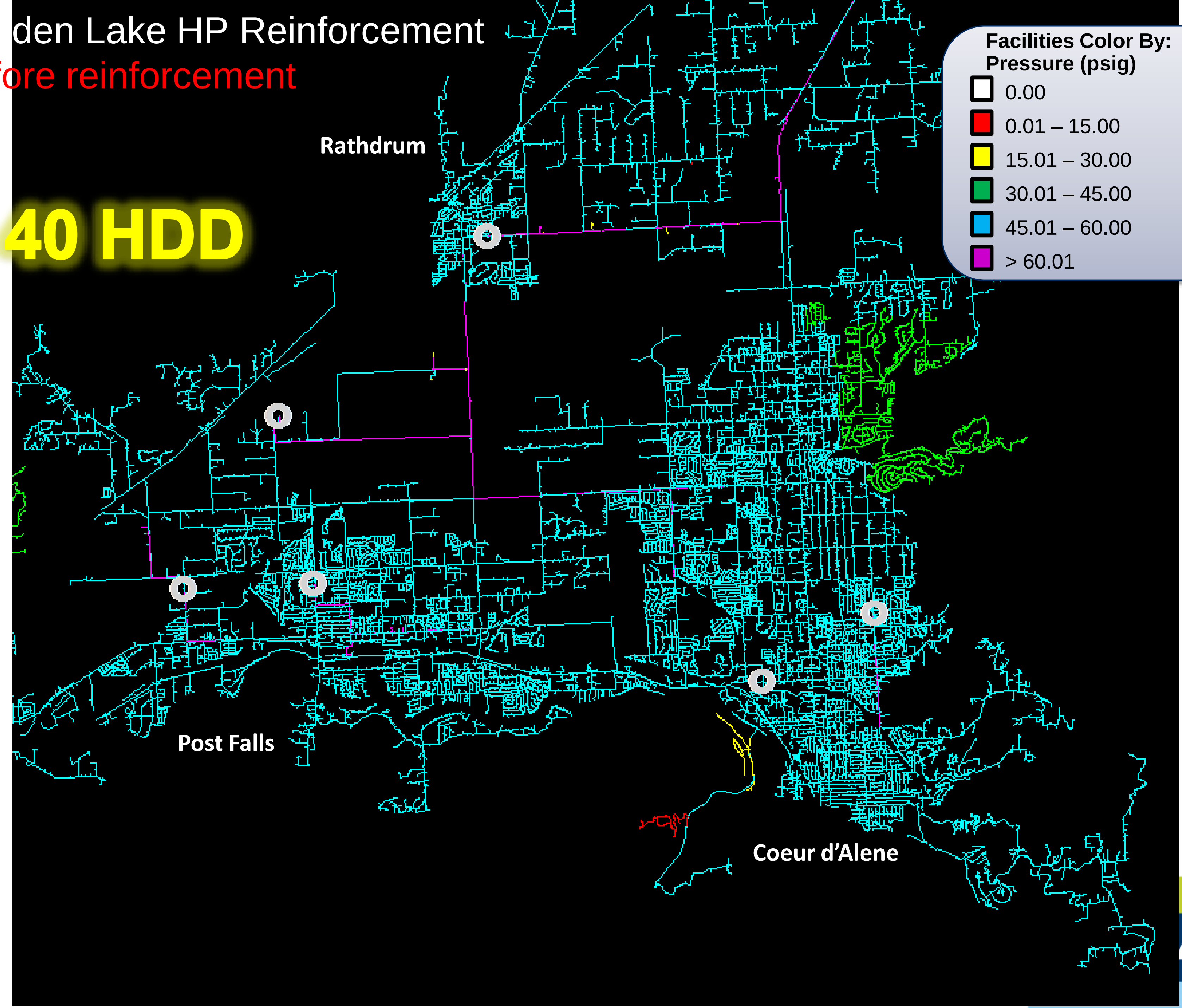
den Lake HP Reinforcement

Before reinforcement



den Lake HP Reinforcement

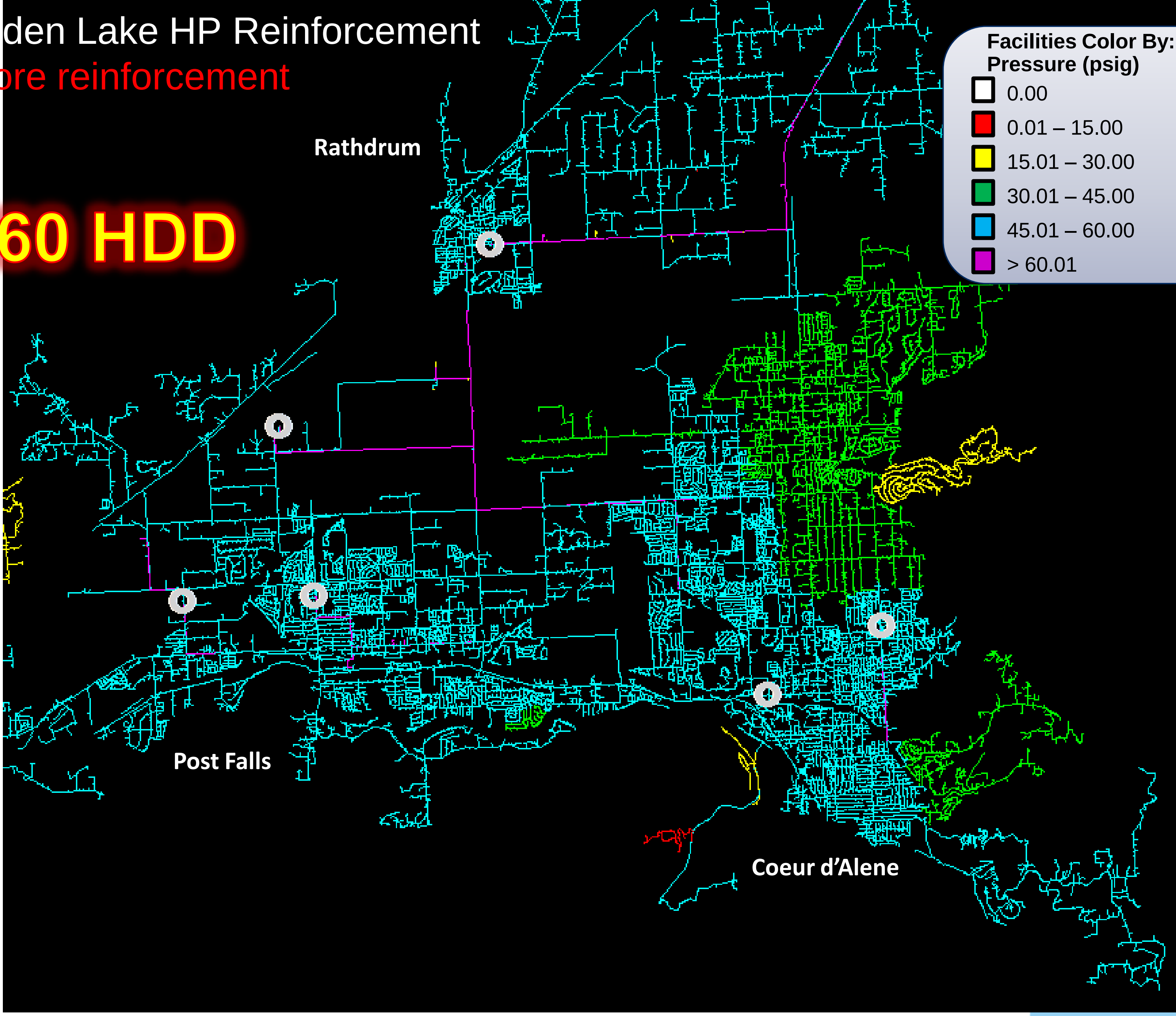
Before reinforcement



VISTA

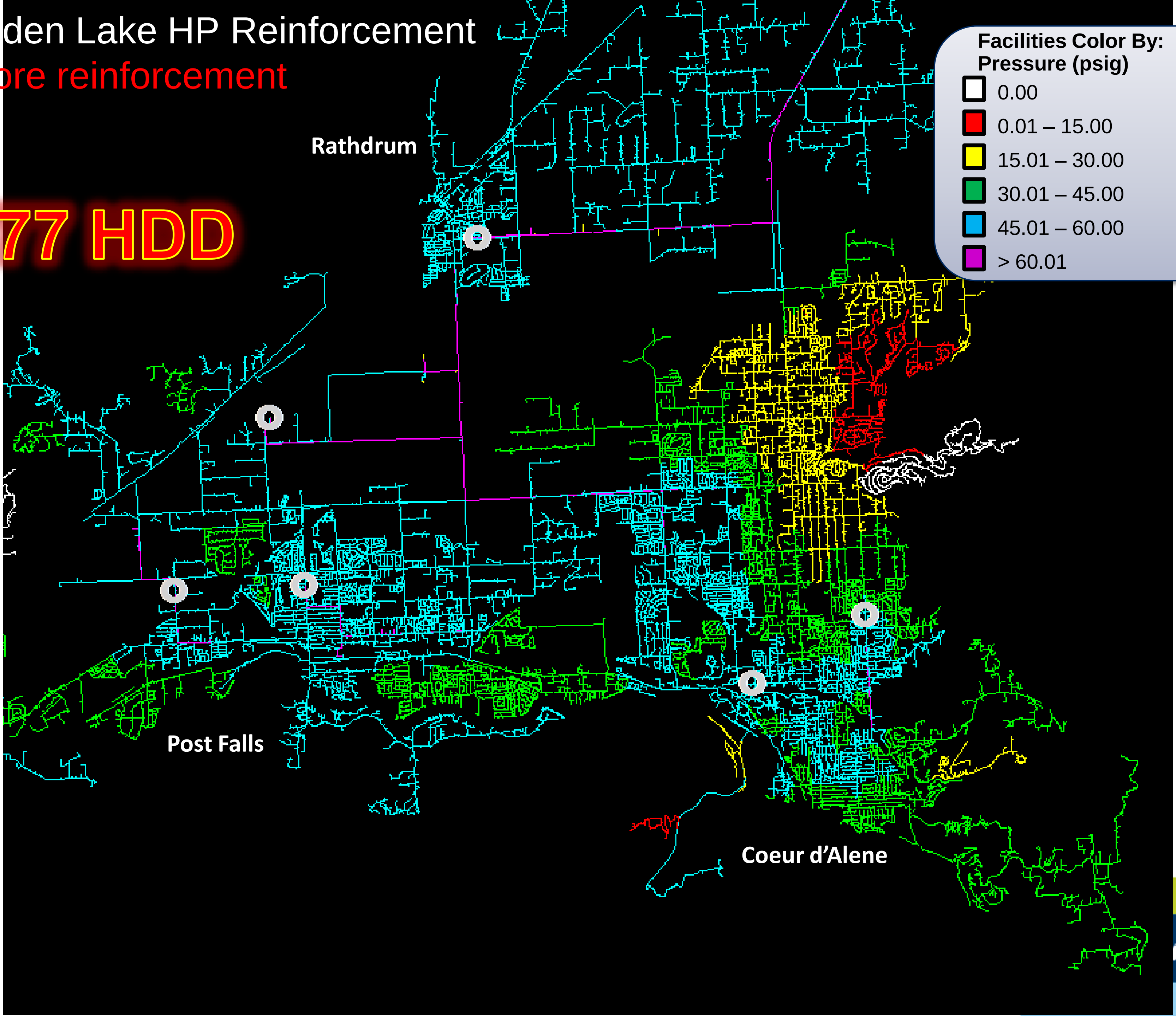
den Lake HP Reinforcement

Before reinforcement



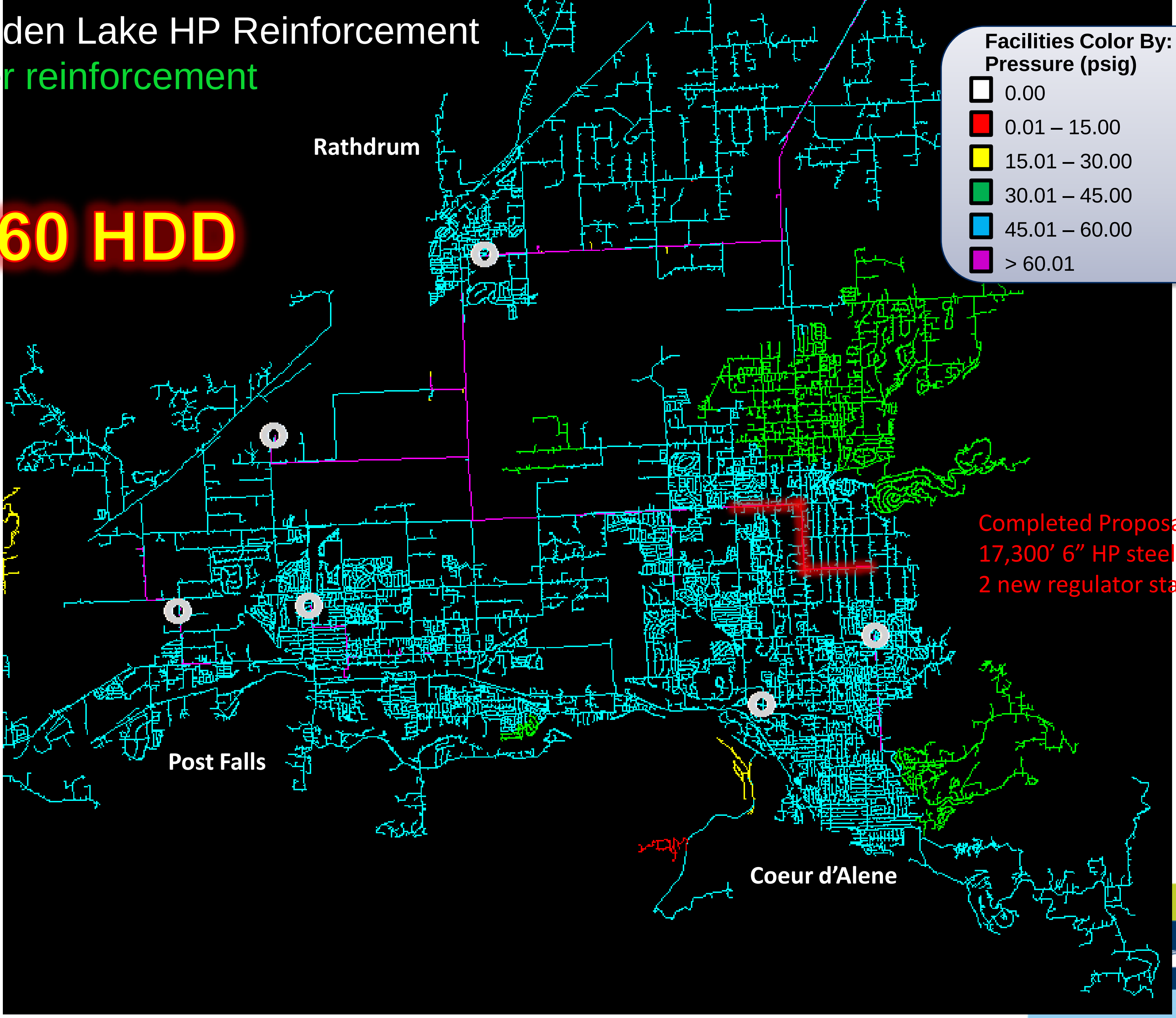
den Lake HP Reinforcement

Before reinforcement



den Lake HP Reinforcement

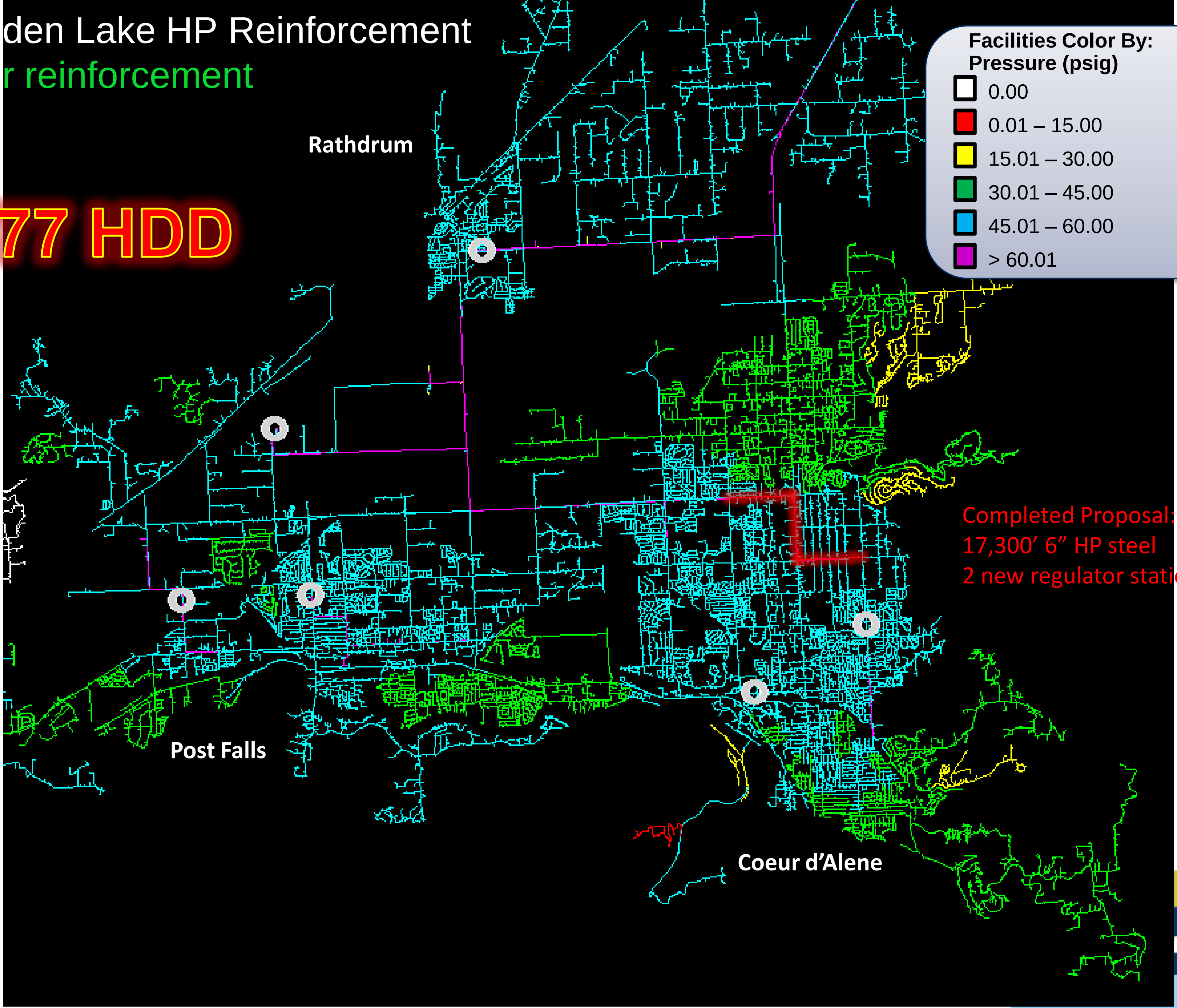
After reinforcement



den Lake HP Reinforcement

After reinforcement

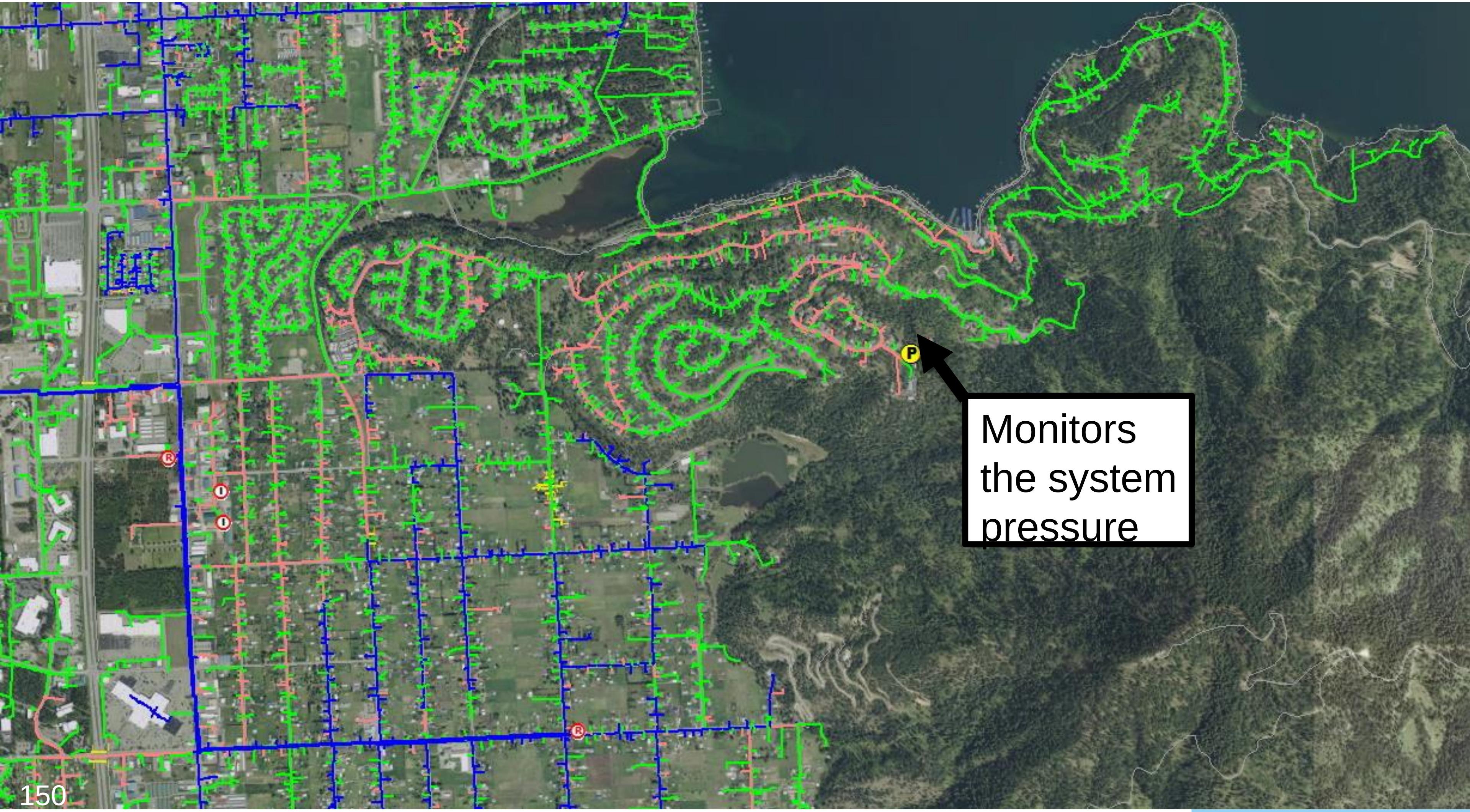
77 HDD



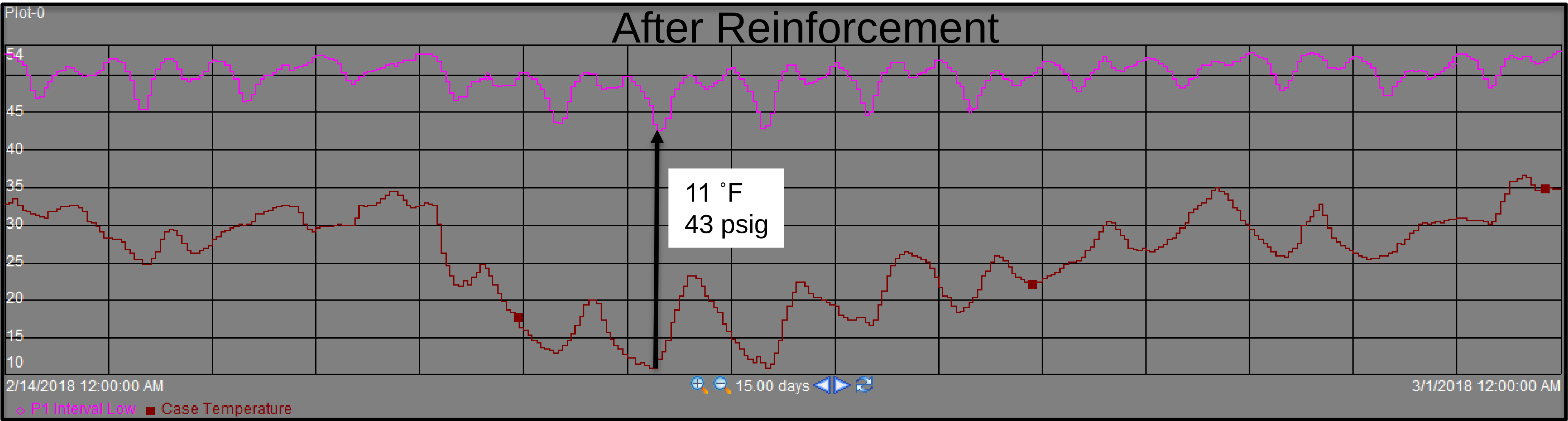
Completed Proposal:
17,300' 6" HP steel
2 new regulator stations

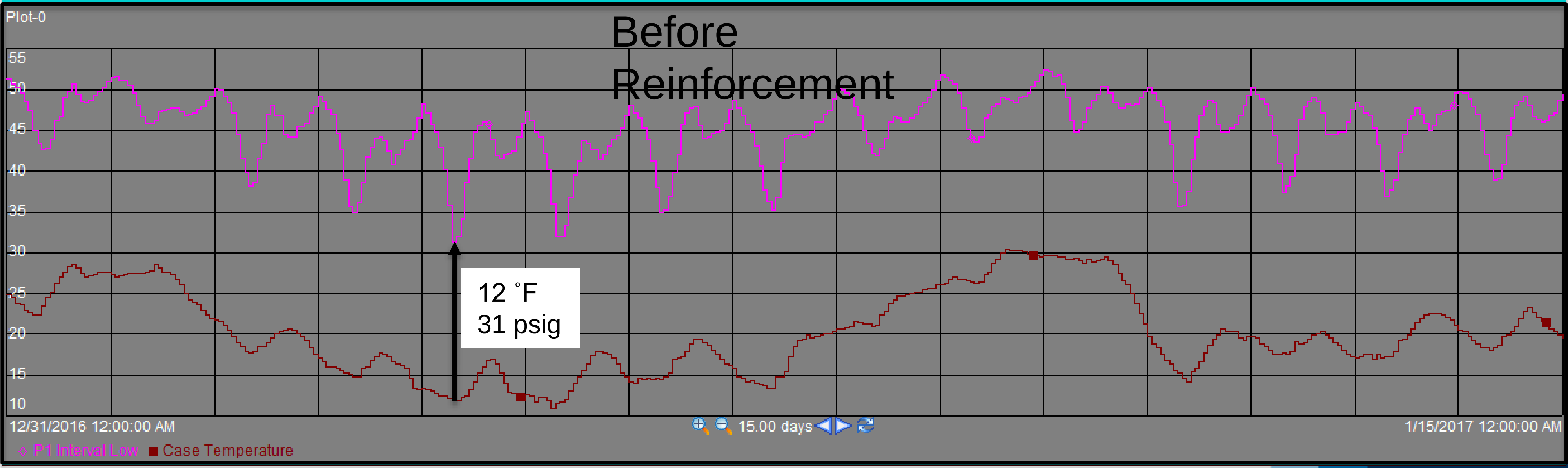
ISTA

Portable Pressure Monitor



Hayden Lake Pressures Before & After

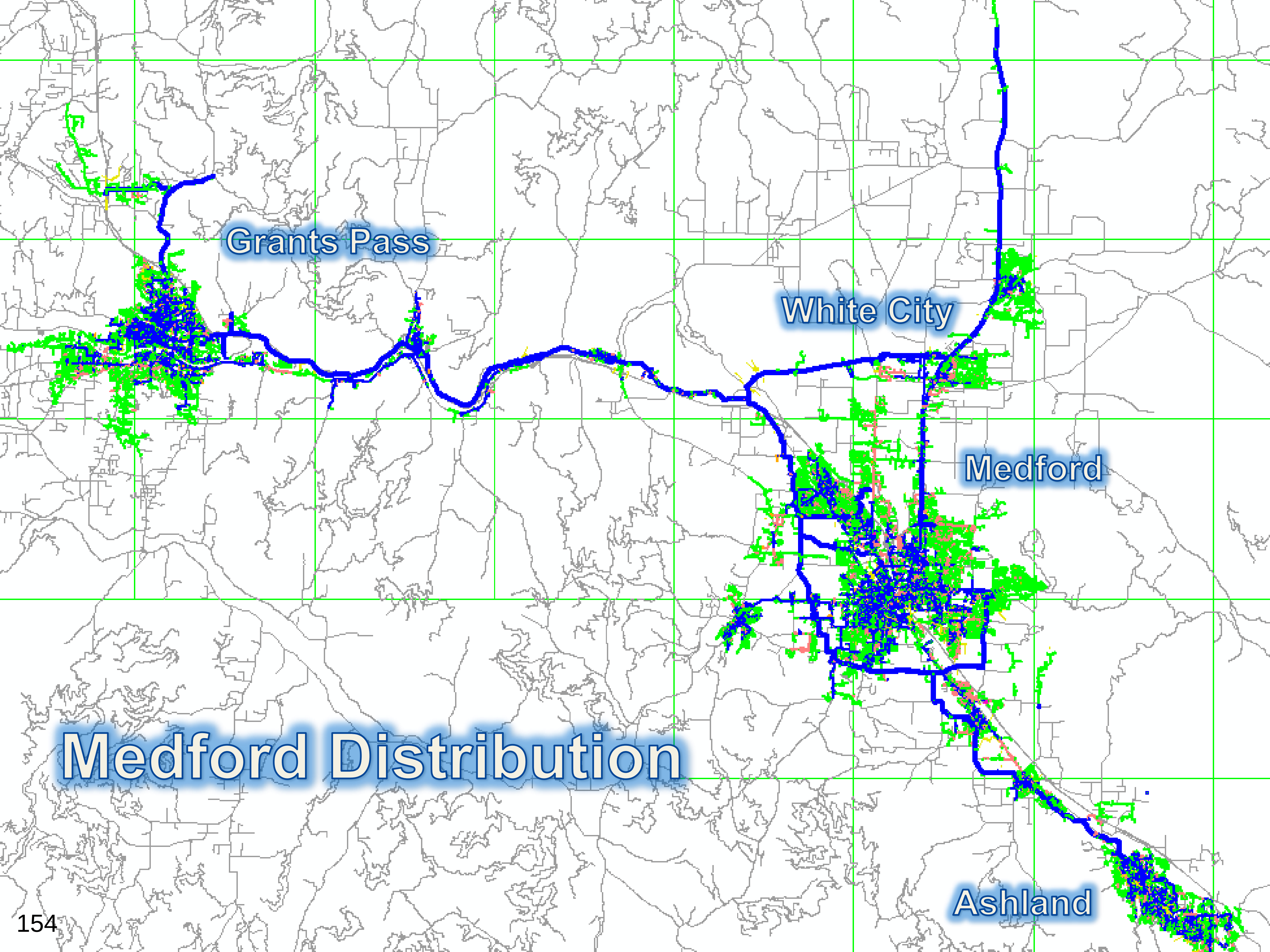




Hayden Lake H.P. Reinforcement

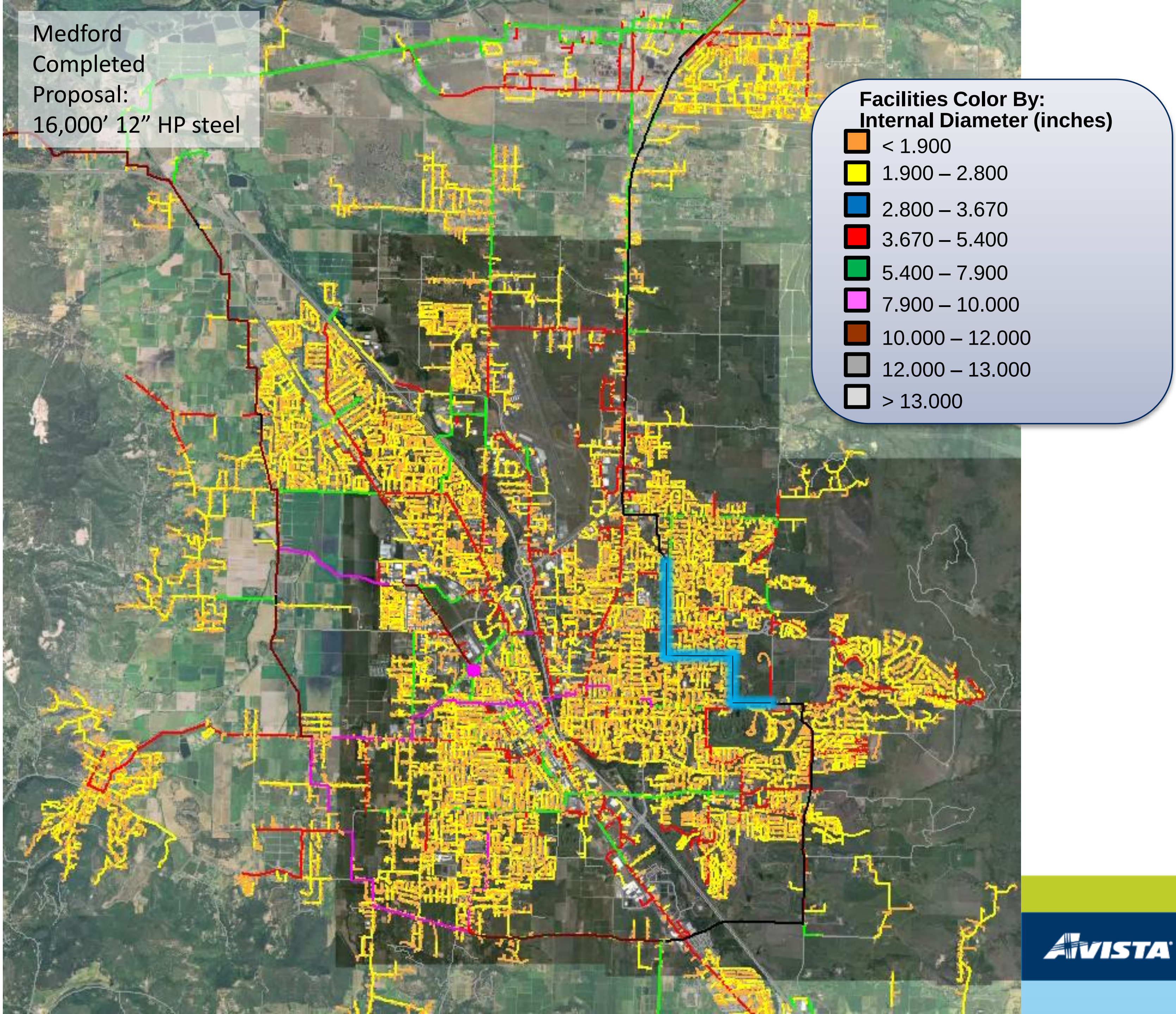
East Medford H.P. Reinforcement

Medford, OR



Grants Pass
White City
Medford
Ashland
Medford Distribution

Medford
Completed
Proposal:
16,000' 12" HP steel

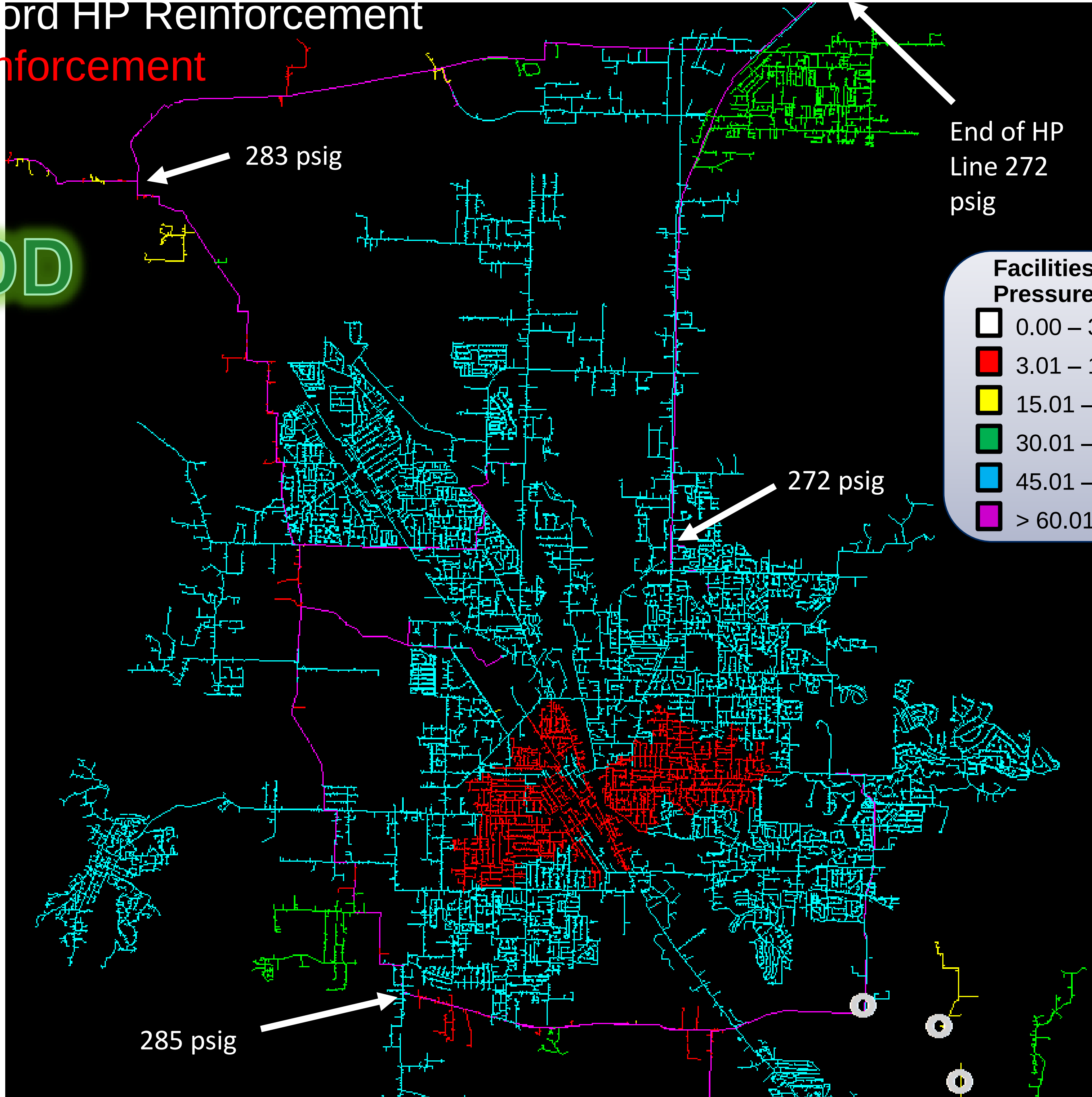


AVISTA

ord HP Reinforcement

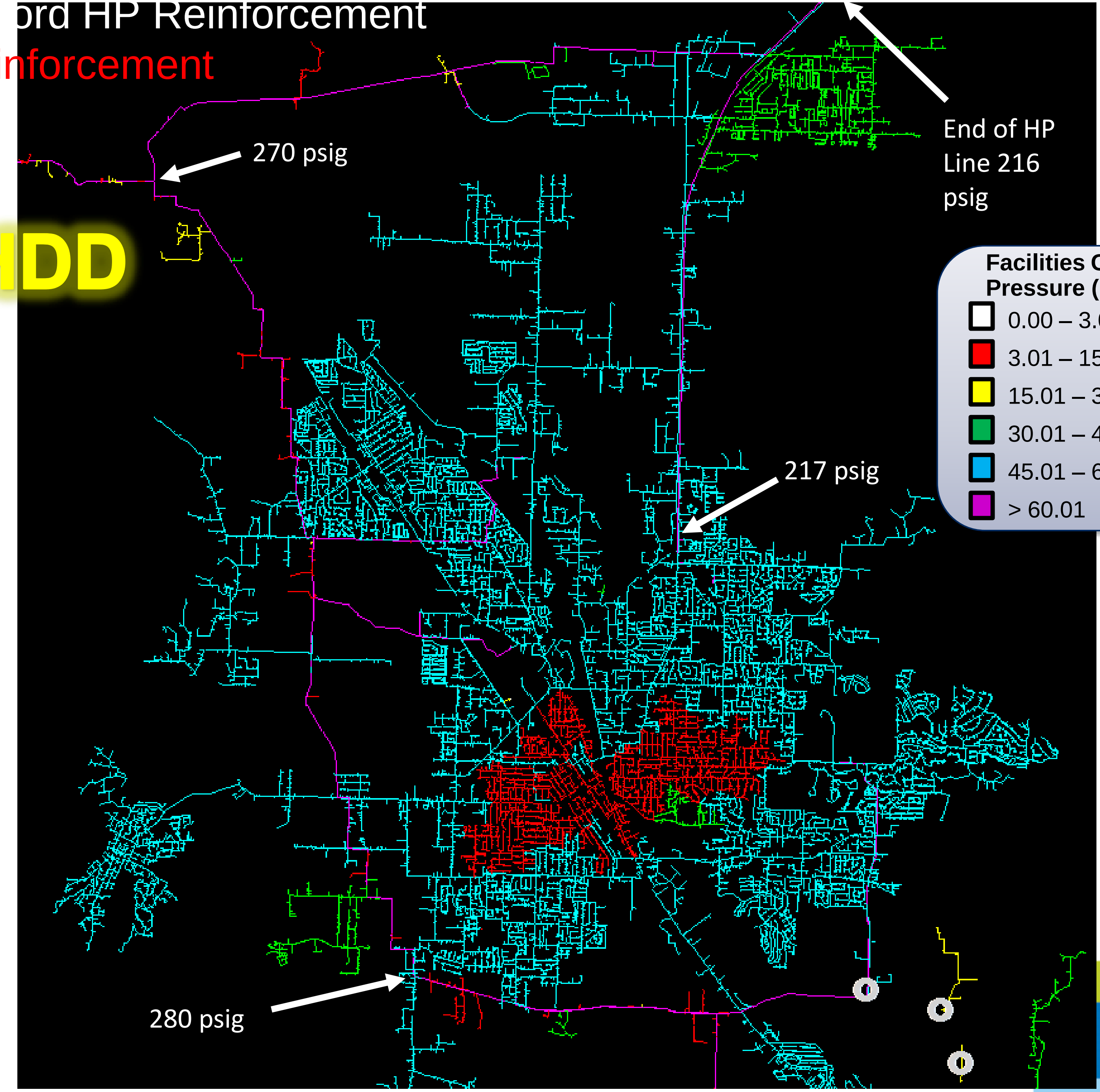
Before reinforcement

0 HDD



ord HP Reinforcement

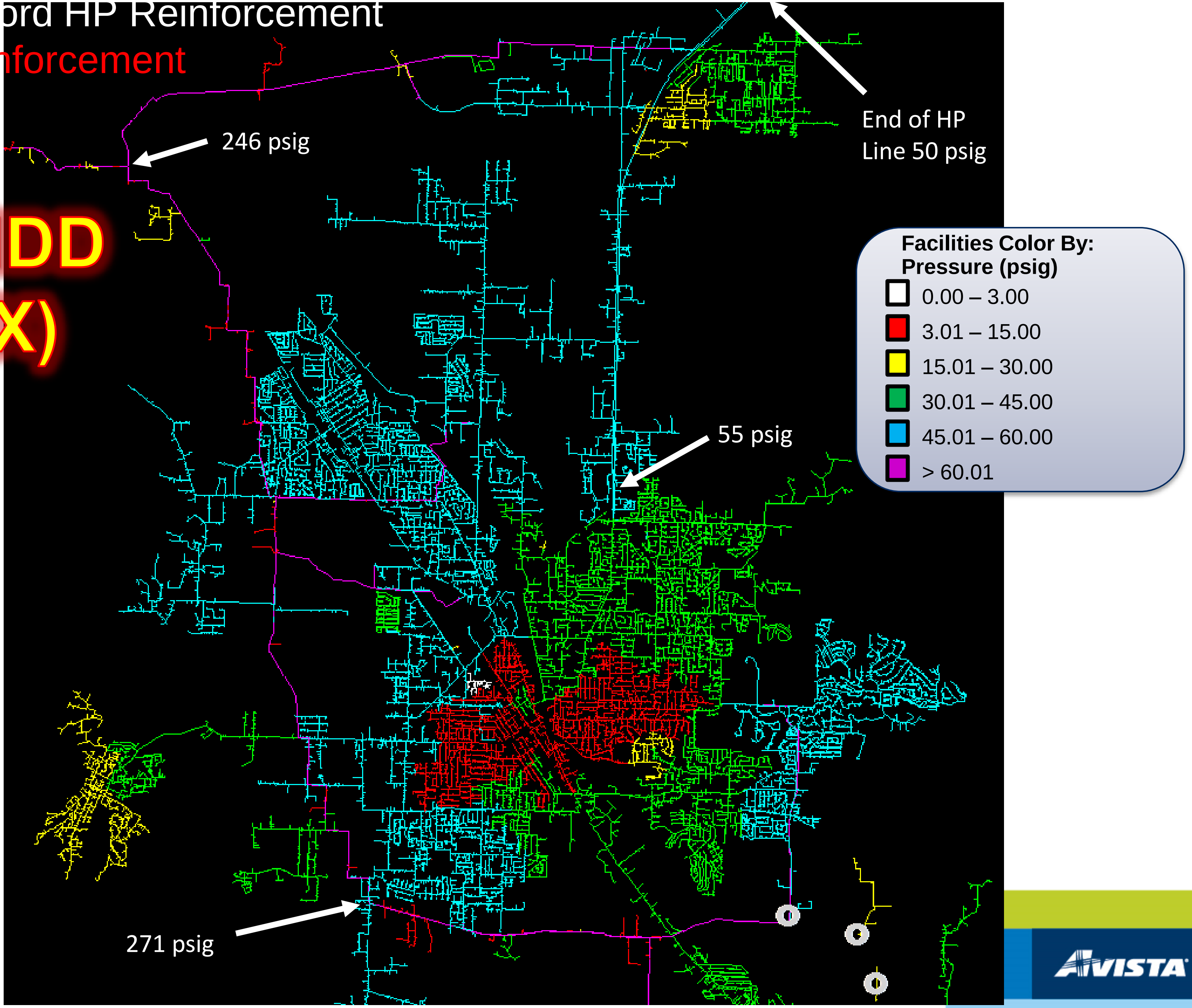
Before reinforcement



ord HP Reinforcement

Before reinforcement

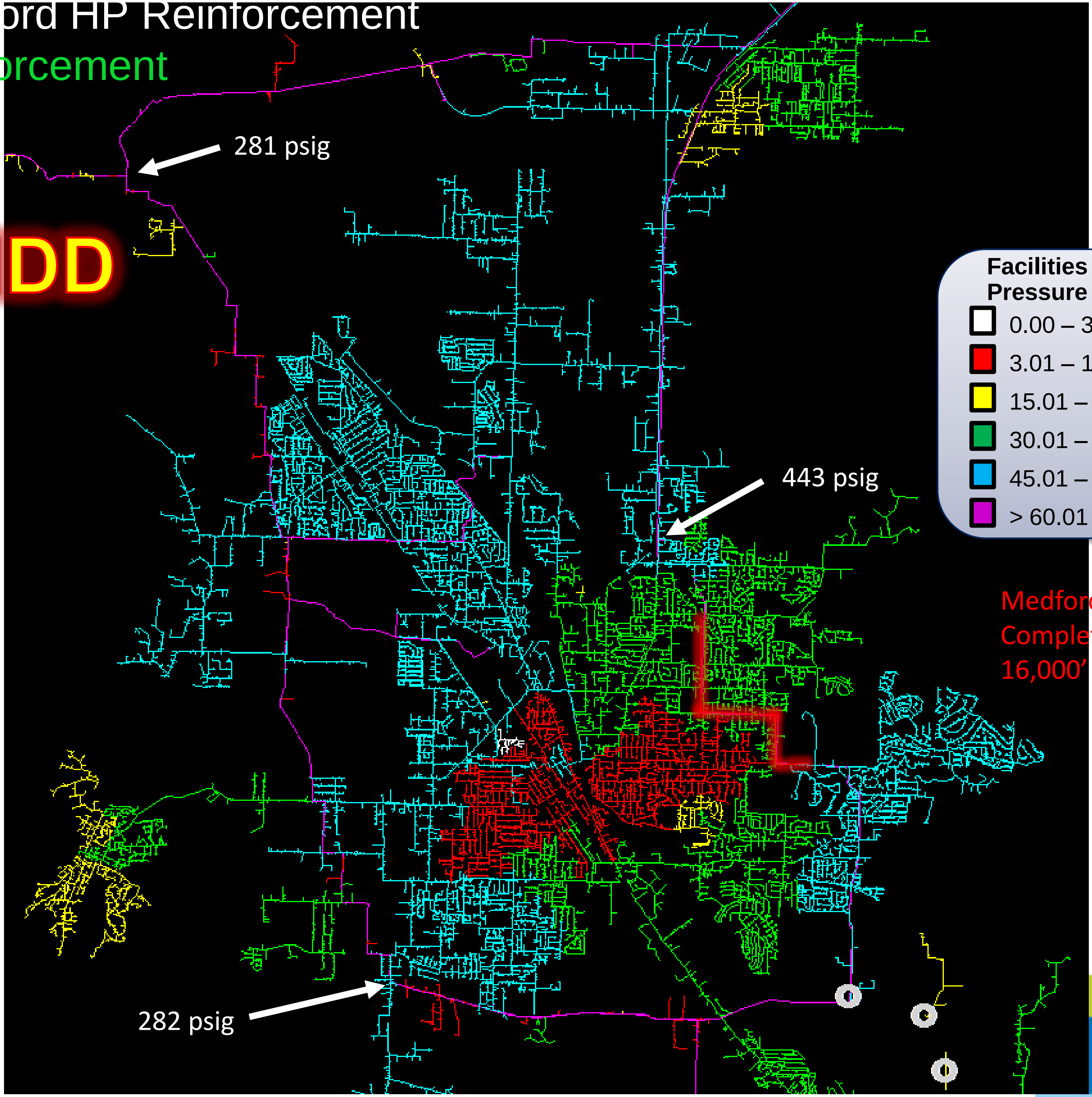
40 HDD (MAX)



ord HP Reinforcement

After reinforcement

40 HDD



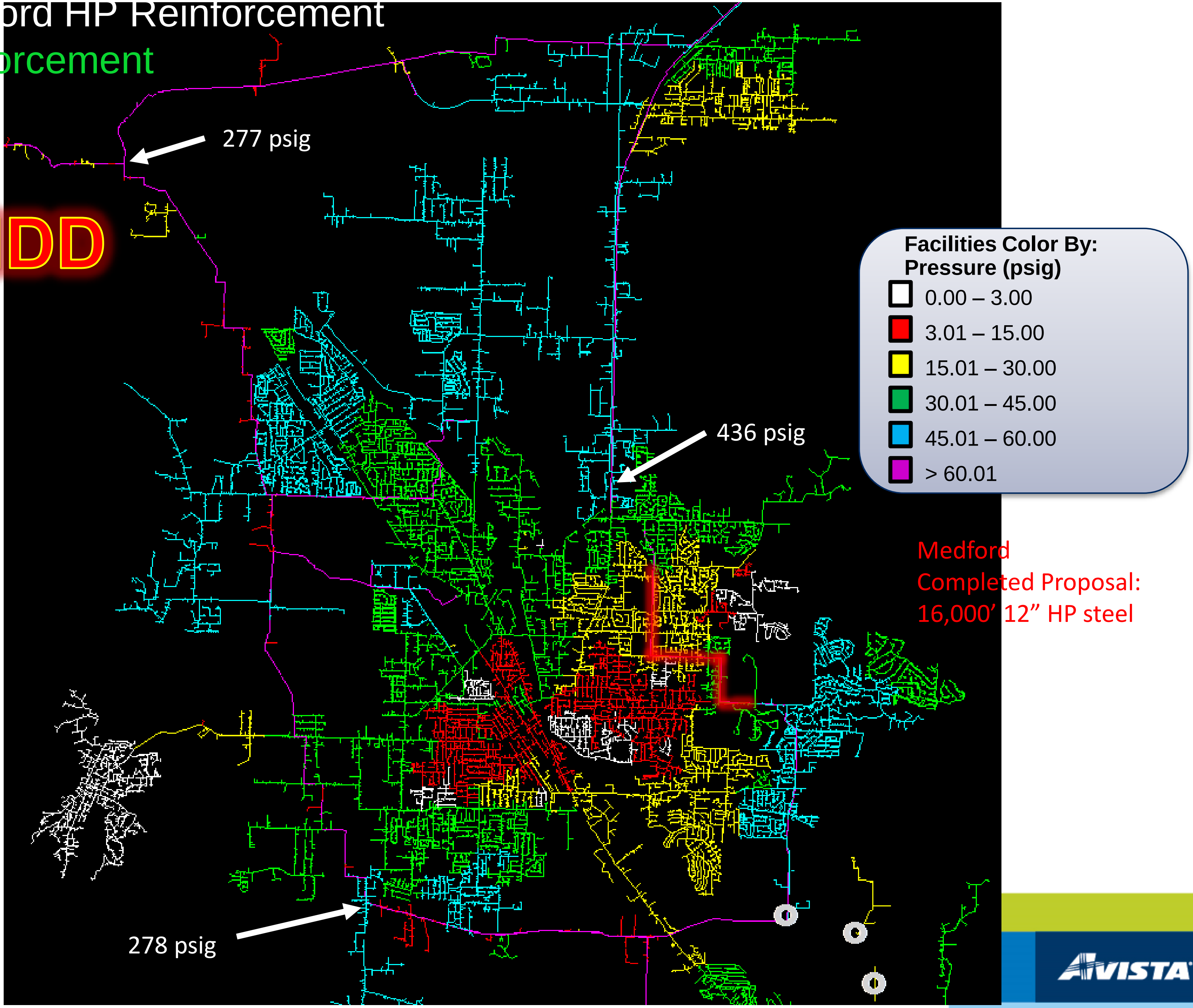
Medford
Completed Proposal:
16,000' 12" HP steel

AVISTA

ord HP Reinforcement

After reinforcement

61 HDD

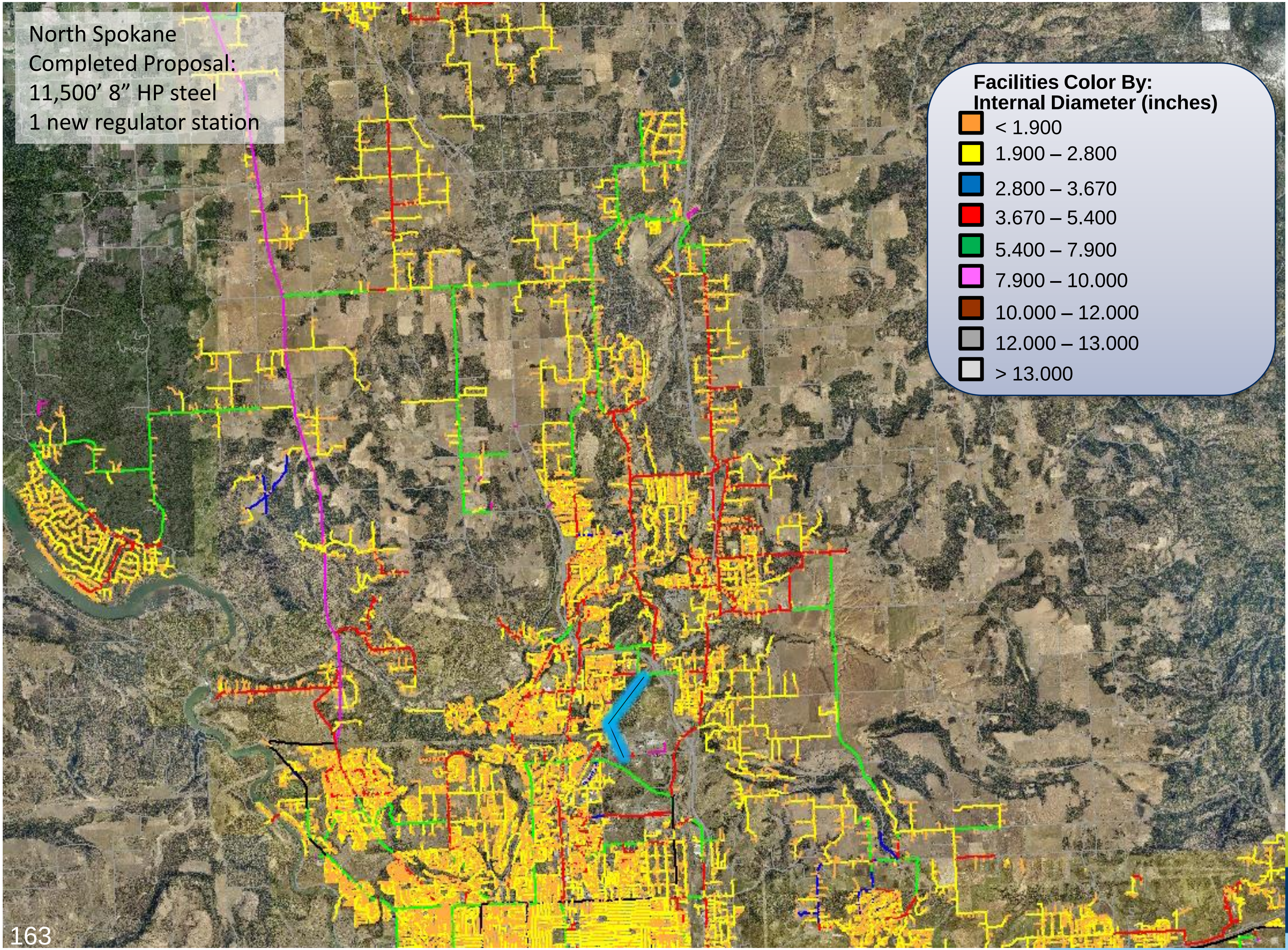


Medford
Completed Proposal:
16,000’ 12” HP steel

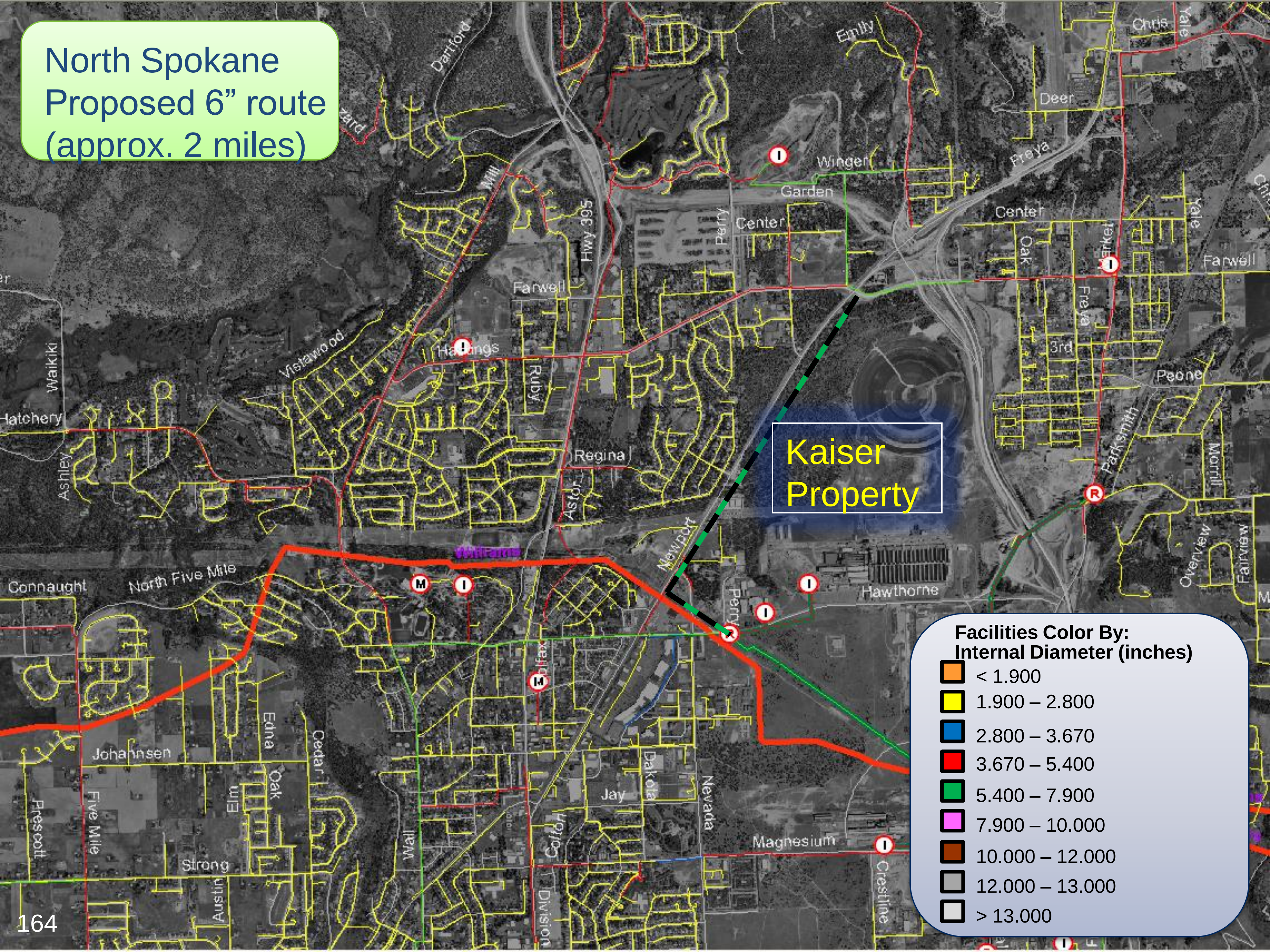
East Medford H.P. Reinforcement

North Spokane H.P. Reinforcement

Spokane, WA

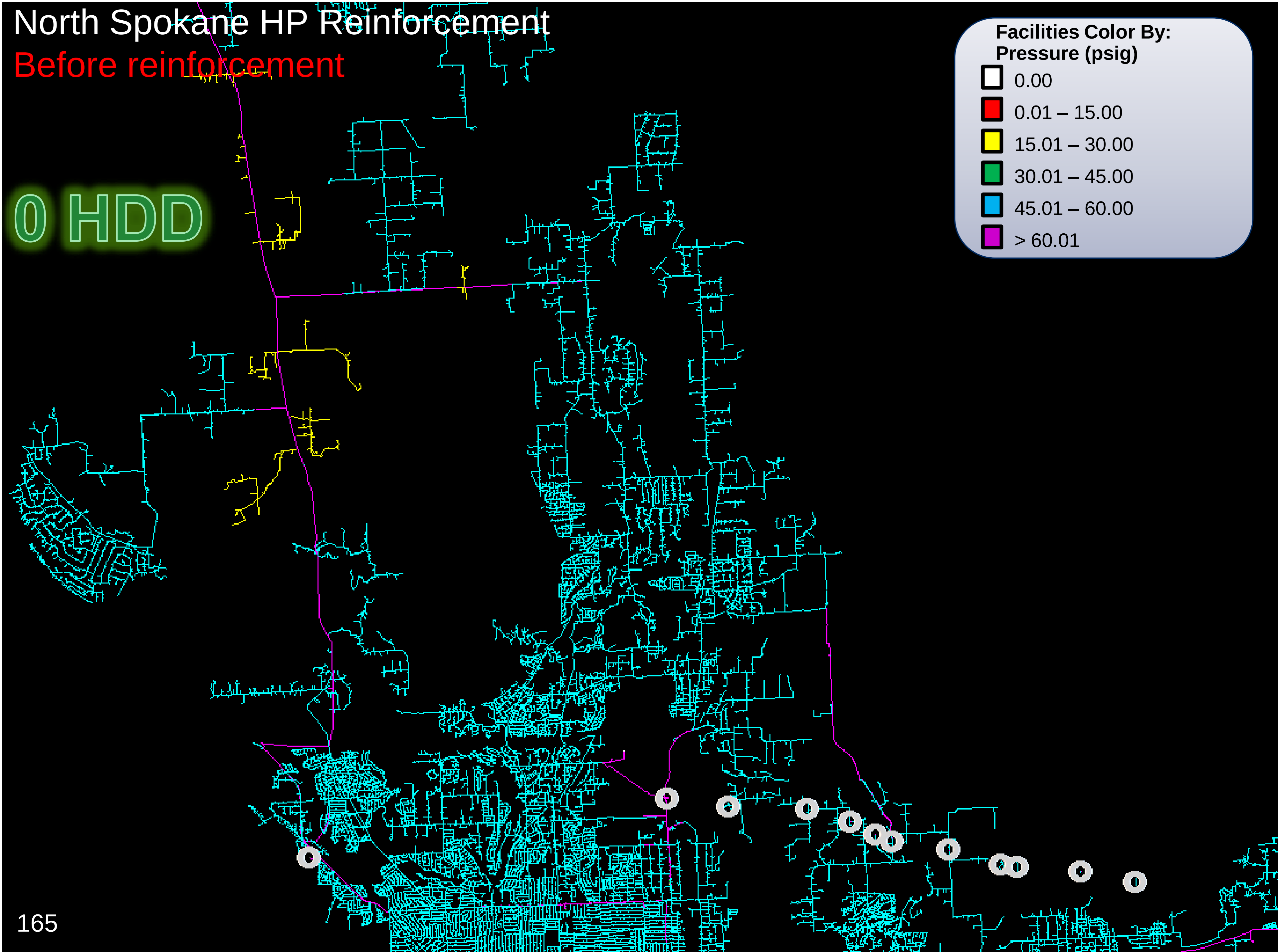

North Spokane
Completed Proposal:
11,500' 8" HP steel
1 new regulator station
Facilities Color By:
Internal Diameter (inches)
< 1.900
1.900 – 2.800
2.800 – 3.670
3.670 – 5.400
5.400 – 7.900
7.900 – 10.000
10.000 – 12.000
12.000 – 13.000
> 13.000

North Spokane Proposed 6” route (approx. 2 miles)



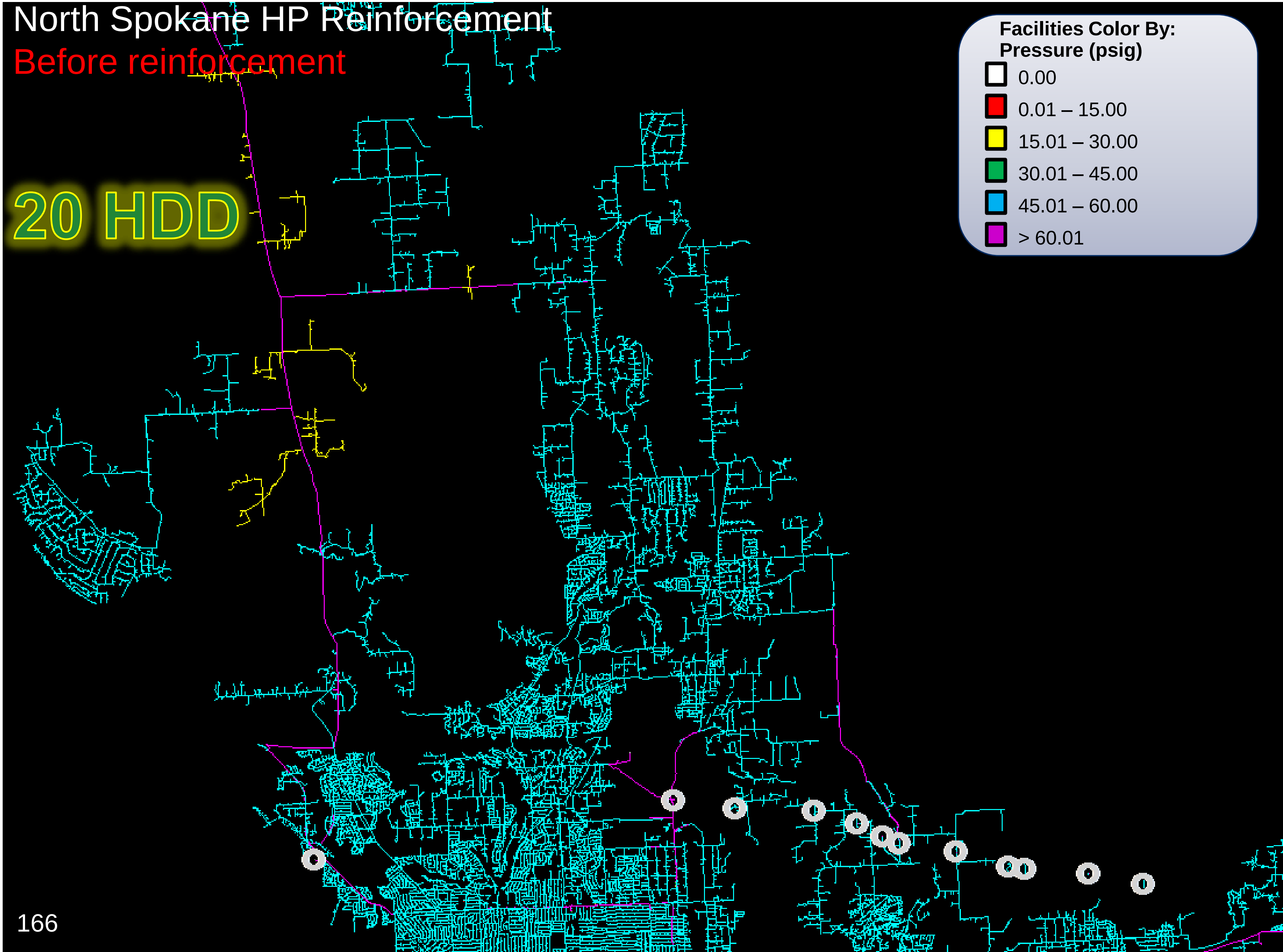
North Spokane HP Reinforcement

Before reinforcement



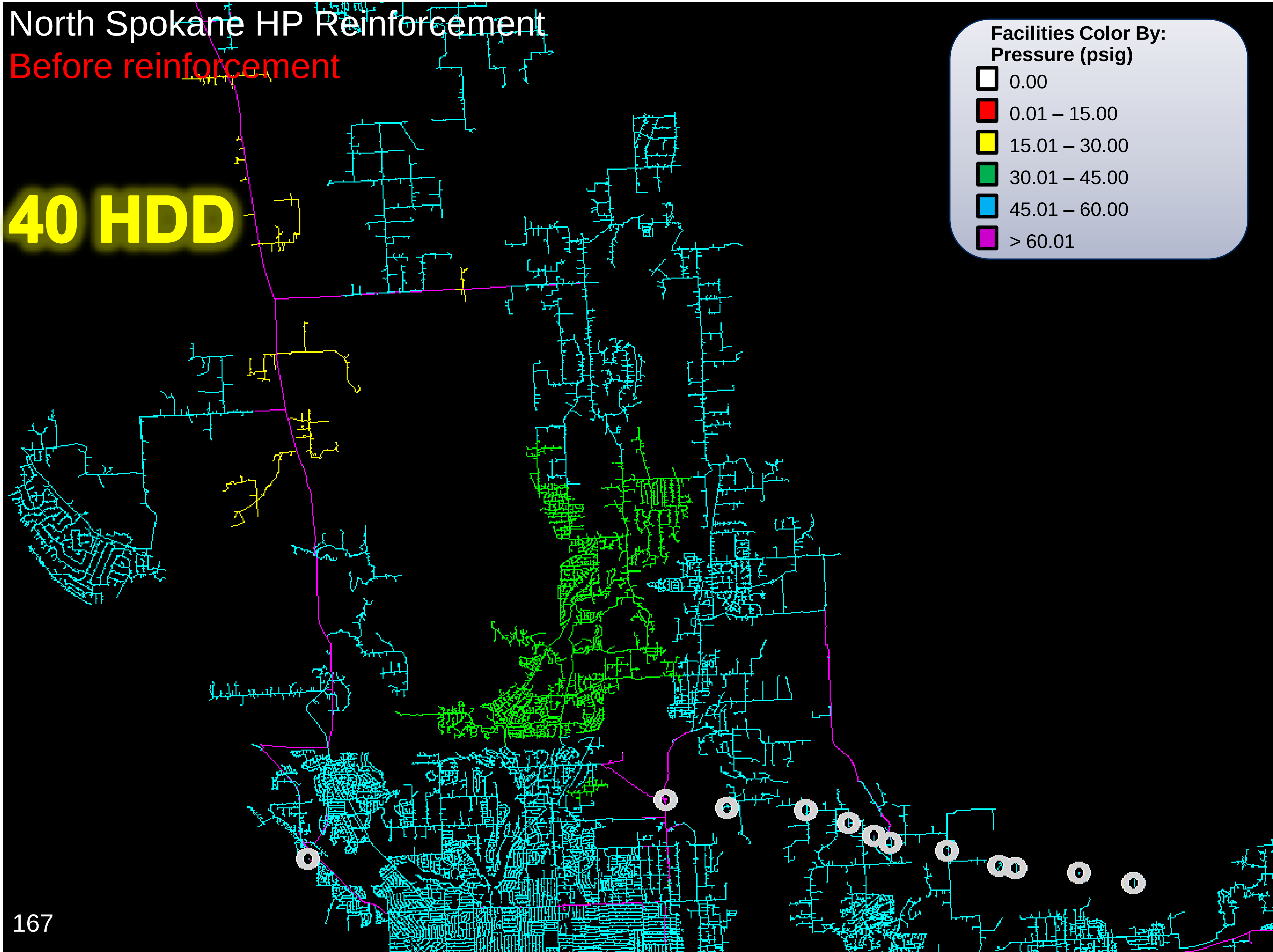
North Spokane HP Reinforcement

Before reinforcement



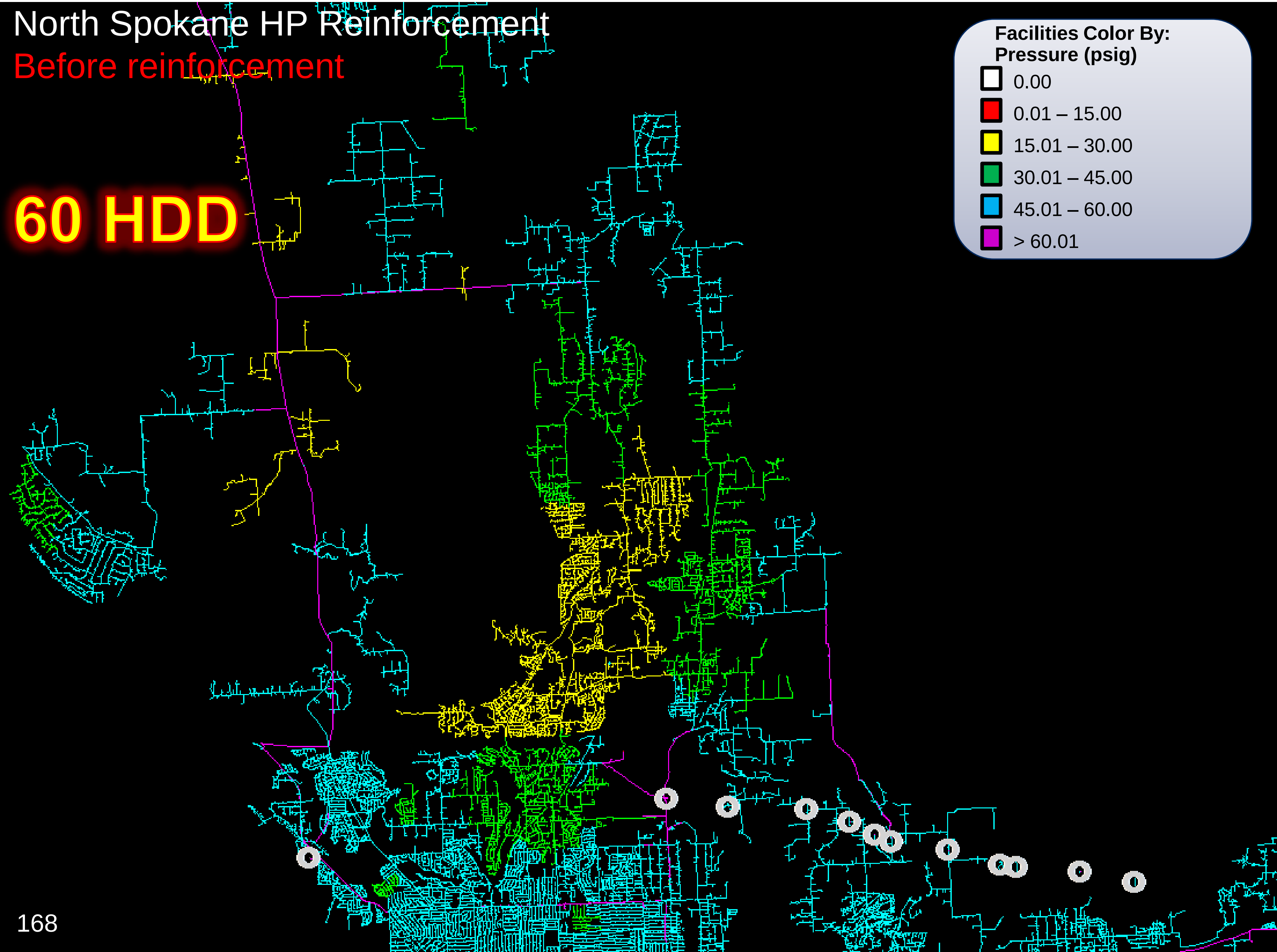
North Spokane HP Reinforcement

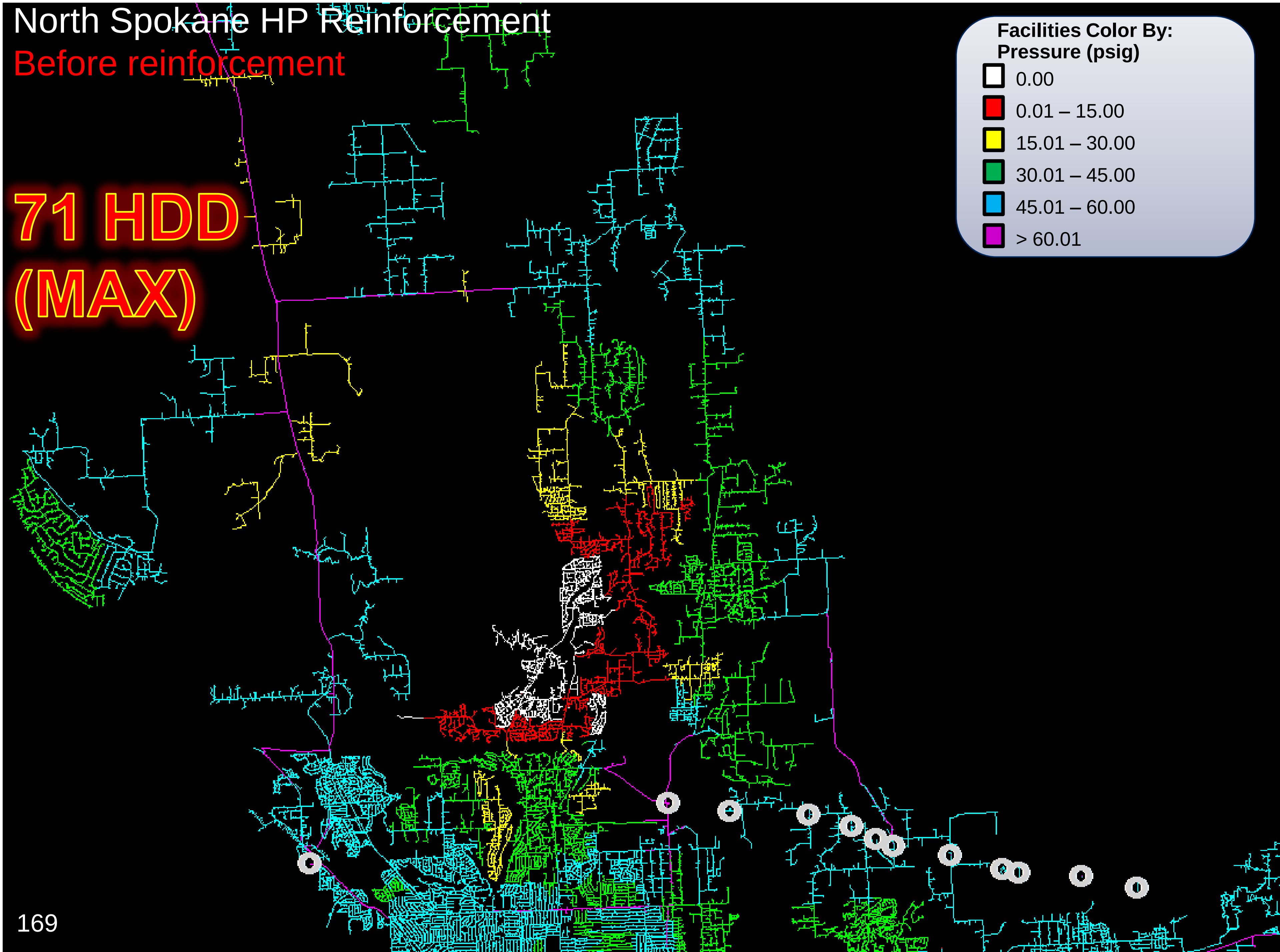
Before reinforcement



North Spokane HP Reinforcement

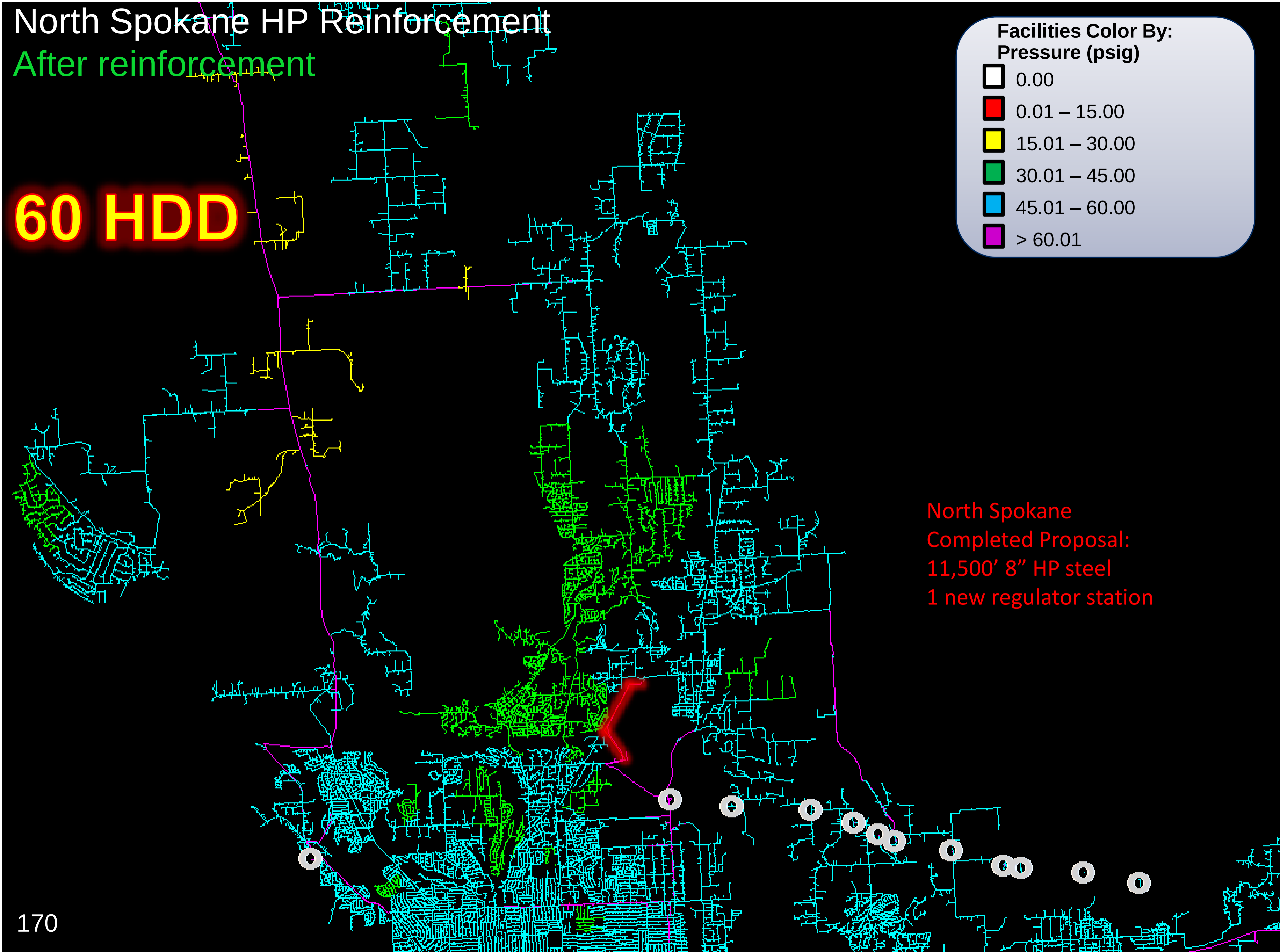
Before reinforcement




North Spokane HP Reinforcement
Before reinforcement
71 HDD
(MAX)
Facilities Color By:
Pressure (psig)
0.00
0.01 – 15.00
15.01 – 30.00
30.01 – 45.00
45.01 – 60.00
> 60.01

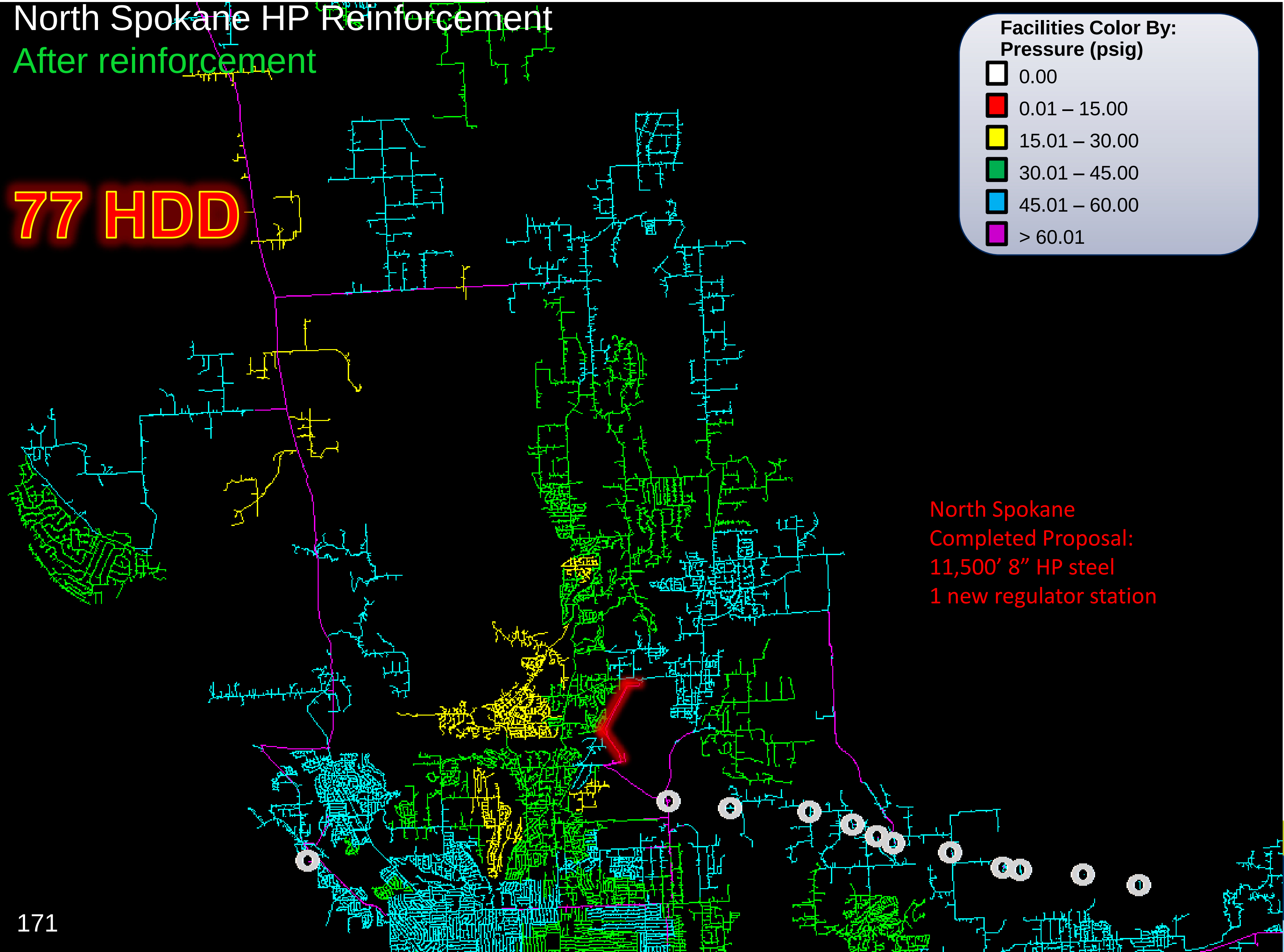
North Spokane HP Reinforcement

After reinforcement



North Spokane HP Reinforcement

After reinforcement



North Spokane H.P. Reinforcement

Questions and Discussion

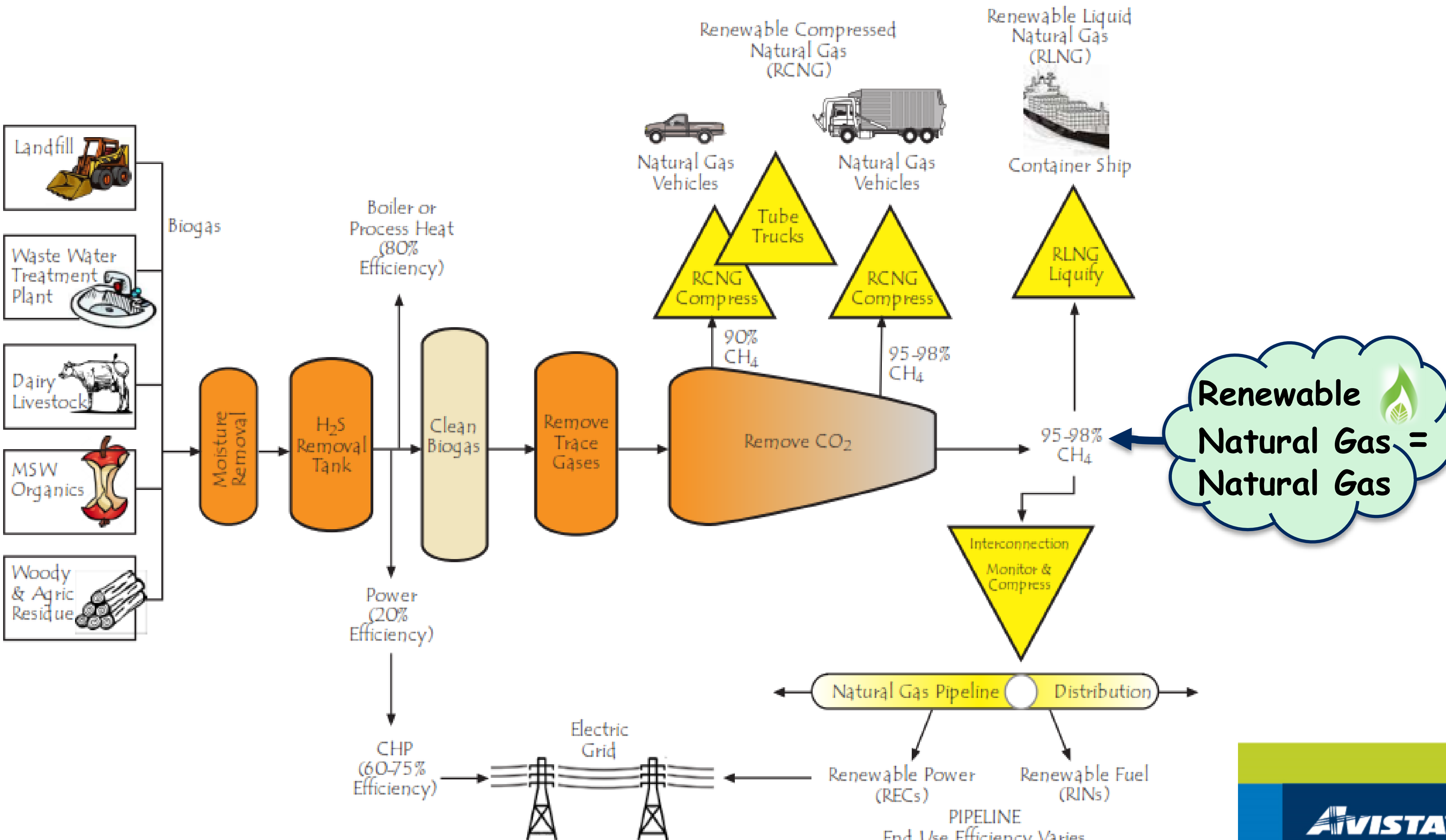
Mission

Using technology to plan and design a safe, reliable, and economical distribution system

Renewable Natural Gas

Jody Morehouse
Director of Natural Gas

What is Renewable Natural Gas (RNG)?

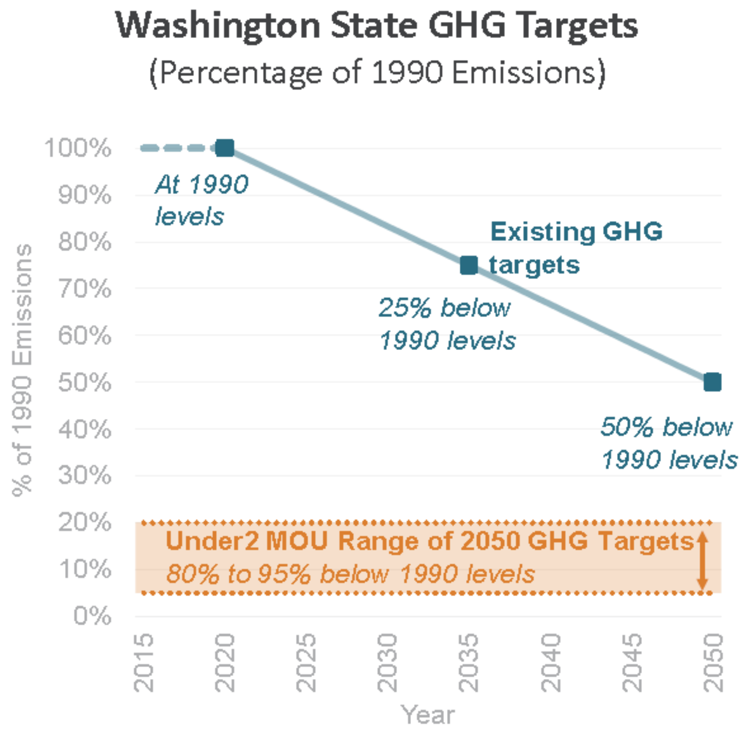


Why does RNG matter?

Carbon (CO_2) Emission Reduction

- Carbon reduction
  - LDC pathway to reduce emissions through “de-carbonized” gas stream
  - Can provide customers a new energy choice
  - Gives communities another means in meeting ambitious climate change commitments

- Renewable Fuel Standard (RFS) & Low Carbon Fuel Standards (LCFS)
  - Significant value for RNG in transportation sector in CA and OR



Source: State of Washington Deep Decarbonization Pathways Project 12/16/2016

Other Benefits of RNG

Other

- Reduces waste remediation costs
- Reduces odors, water & air pollution, pathogens originating from waste streams
- Creates local jobs and generates revenue for cities and businesses
- New local sources for gas supply

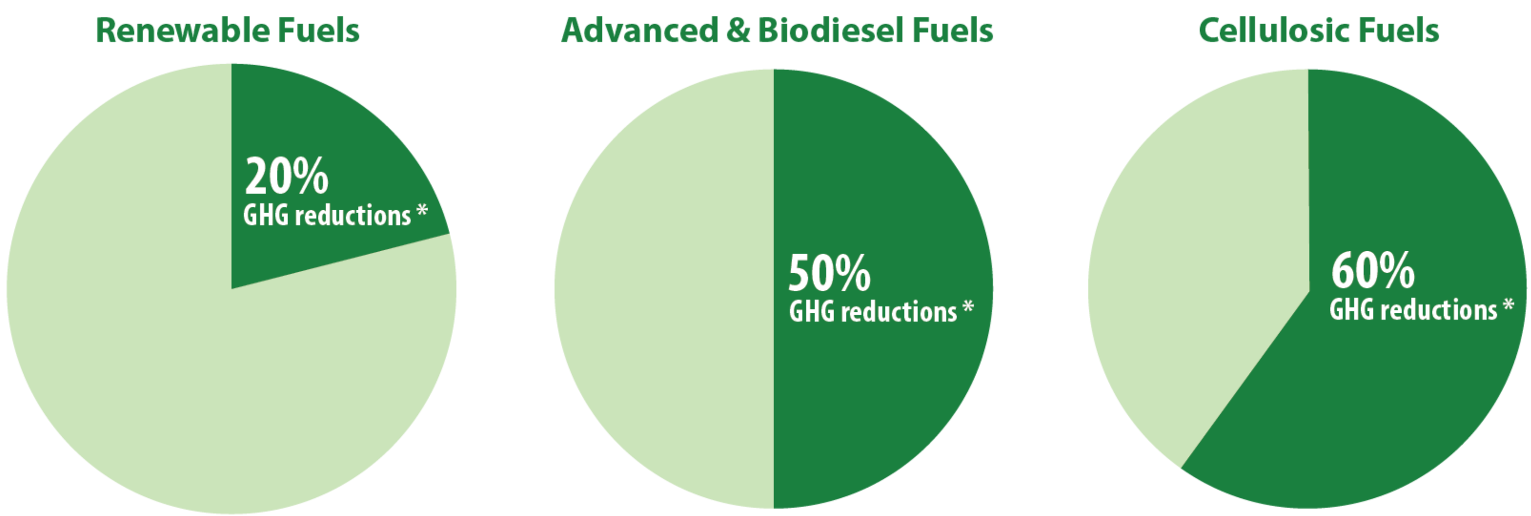
"It reminds me of the Mr. Fusion Home Energy Reactor in the movie Back to the Future"
Dan Kirschner, NWGA Executive Director, on WA HB 2580 RNG Bill

Federal Renewable Fuel Standard Program

- Mandates renewable fuel to replace % of petroleum-based transportation fuel

Lifecycle Greenhouse Gas (GHG) Emissions

GHG emissions must take into account direct and significant indirect emissions, including land use change.



* compared to a 2005 petroleum baseline

**D6

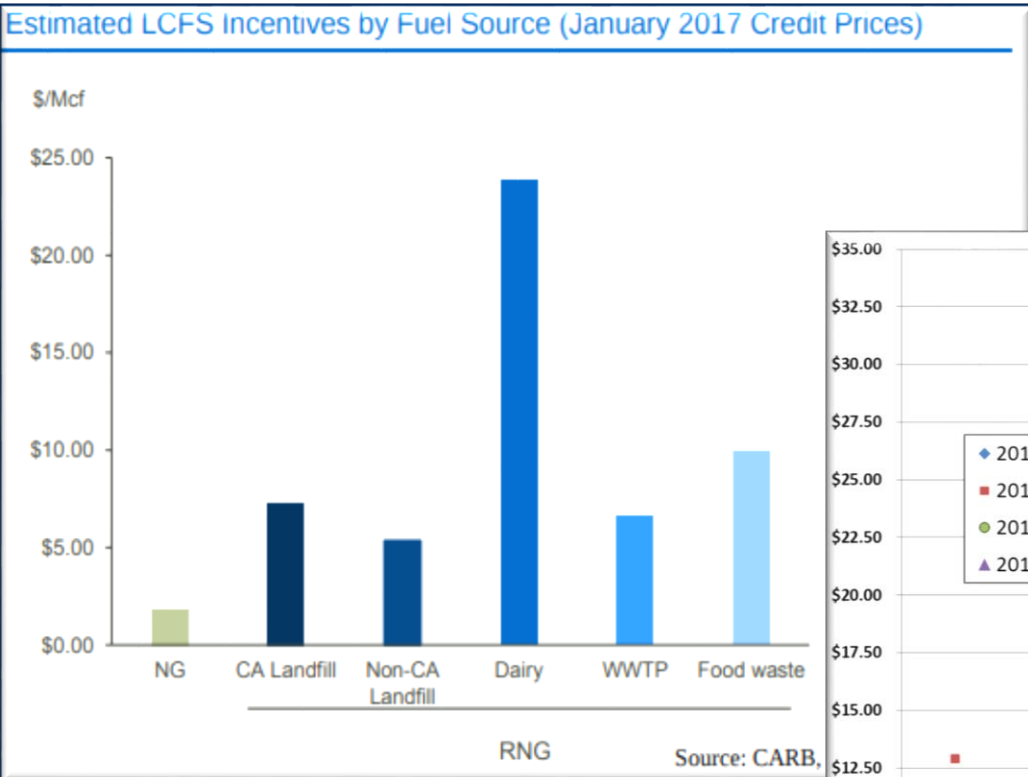
**D4-D5

**D3

**D-codes are an approximation; actual code determined by EPA formula

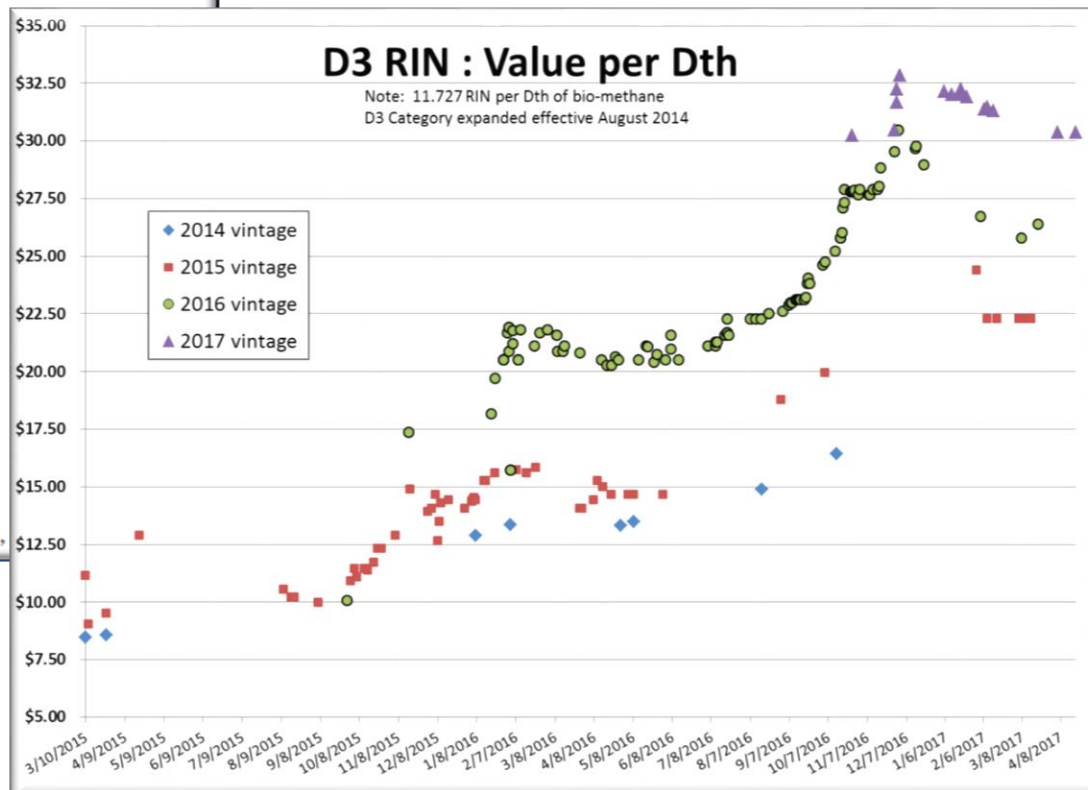
Source: EIA

RFS and LCFS Effect on RNG Value



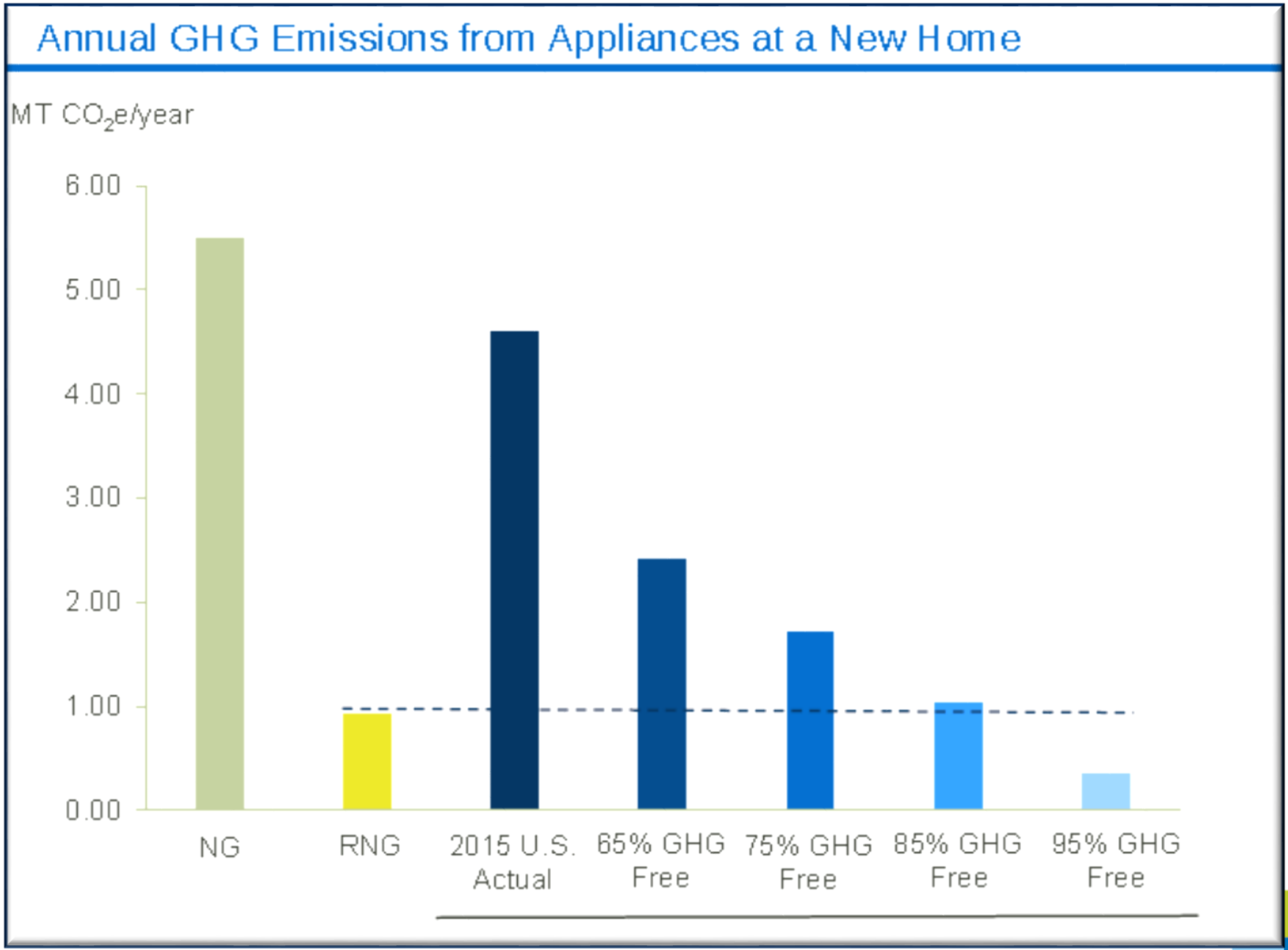
Source: CARB

RIN = renewable identification number



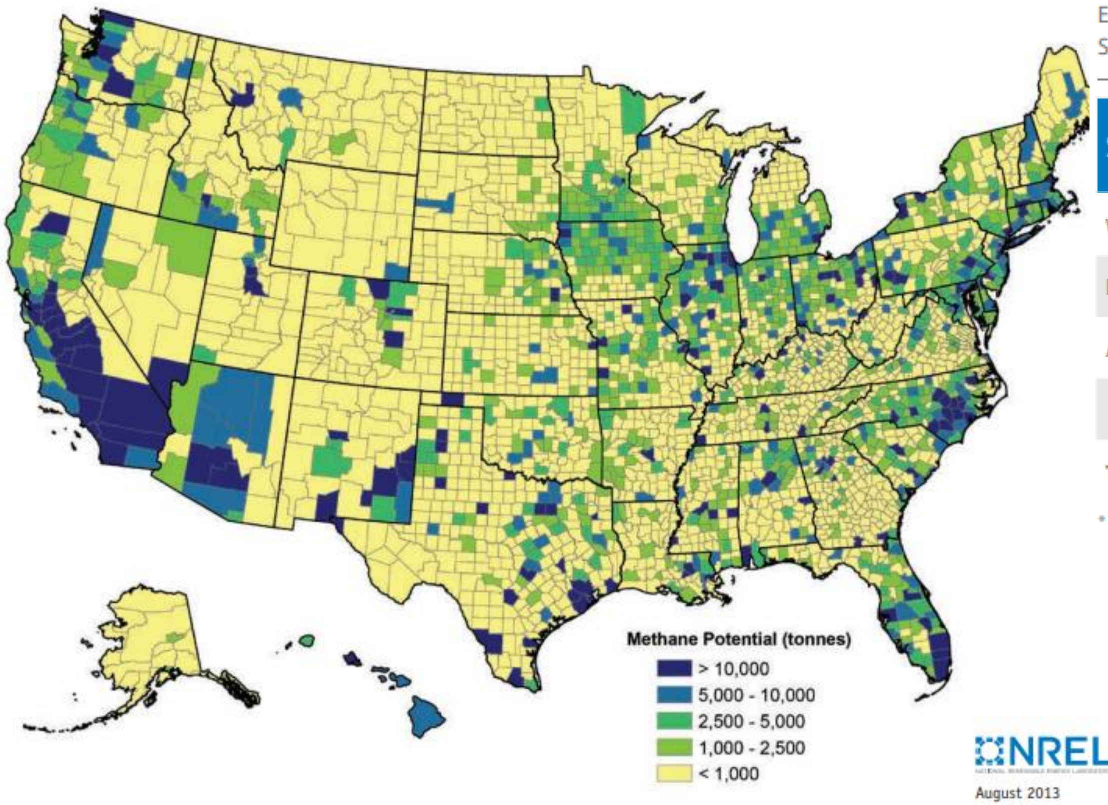
Source: EPA

GHG CO_2 Reductions



Source: AGA, MJB&A analysis

Potential RNG Production



Estimated methane generation potential for select biogas sources by county

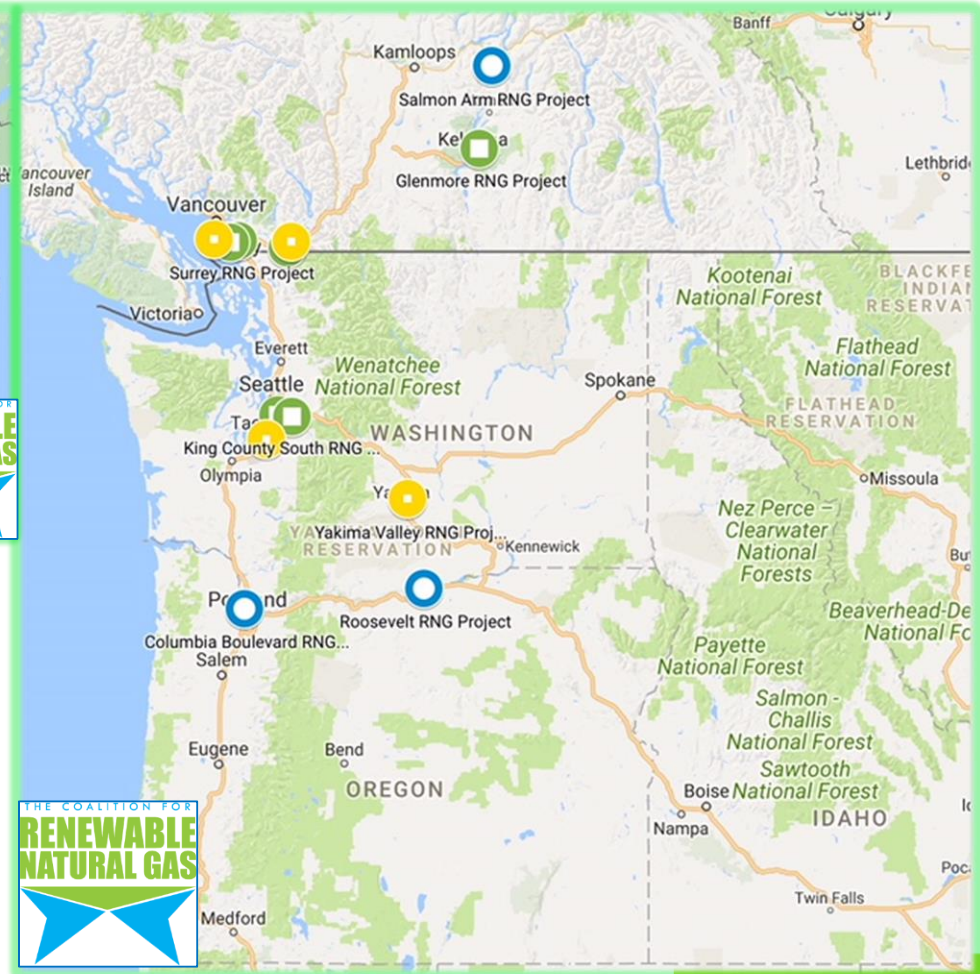
Estimated Methane Generation Potential for Select Biogas Sources in the United States

Source	Methane Potential (tonnes/yr)
Wastewater	2,339,339
Landfills*	2,454,974
Animal manure	1,905,253
IIC organic waste	1,157,883
Total	**7,857,449**

* Includes candidate landfills only as defined by the EPA's Landfill Methane Outreach Program

About 420 Bcf

RNG Projects in North America



- Approx. 120 RNG projects in North America
- 13 of these are located in the Pacific Northwest

Oregon SB 344 DOE RNG Update

As a means toward feasible **reductions in greenhouse gas emissions**, committee to provide recommendations to ODOE regarding:

- Development of an inventory of RNG resources
- Characterization of the opportunities
- Identify barriers to production and utilization
- Policies to promote RNG and remove barriers
- Report due by September 2018

Washington SB 2580 RNG Bill

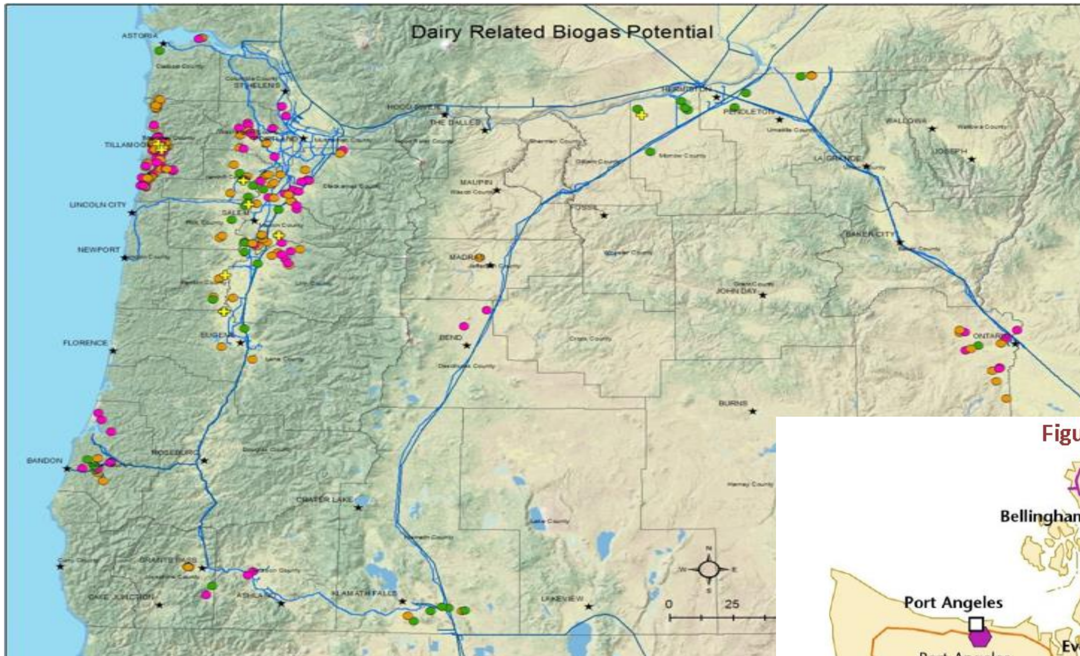
- Requires the Washington State University Extension Energy Program and the Department of Commerce, in consultation with the Utilities and Transportation Commission, to submit recommendations on how to promote the sustainable development of RNG to the Governor and the Legislature by September 1, 2018

  “Governor Inslee and Department of Commerce were pleased to request this bill, which received near unanimous, bipartisan support from the Legislature,” said Peter Moulton, Energy Policy Section Manager, Washington Department of Commerce.

- Requires the Department of Commerce, in consultation with natural gas utilities and other state agencies, to explore the development of voluntary gas quality standards for the injection of RNG into the state’s natural gas pipeline systems

- Reinstate and expand incentives in order to stimulate investment in biogas capture and conditioning, compression, nutrient recovery, and use of RNG for heating, electricity generation and transportation fuel

Oregon and Washington RNG Studies



Source: ODOE RNG Feb. 22, 2018 Presentation

Oregon and Washington RNG Production Potential Info Coming Soon

Figure 4. Washington Landfills and Major Natural Gas Pipelines

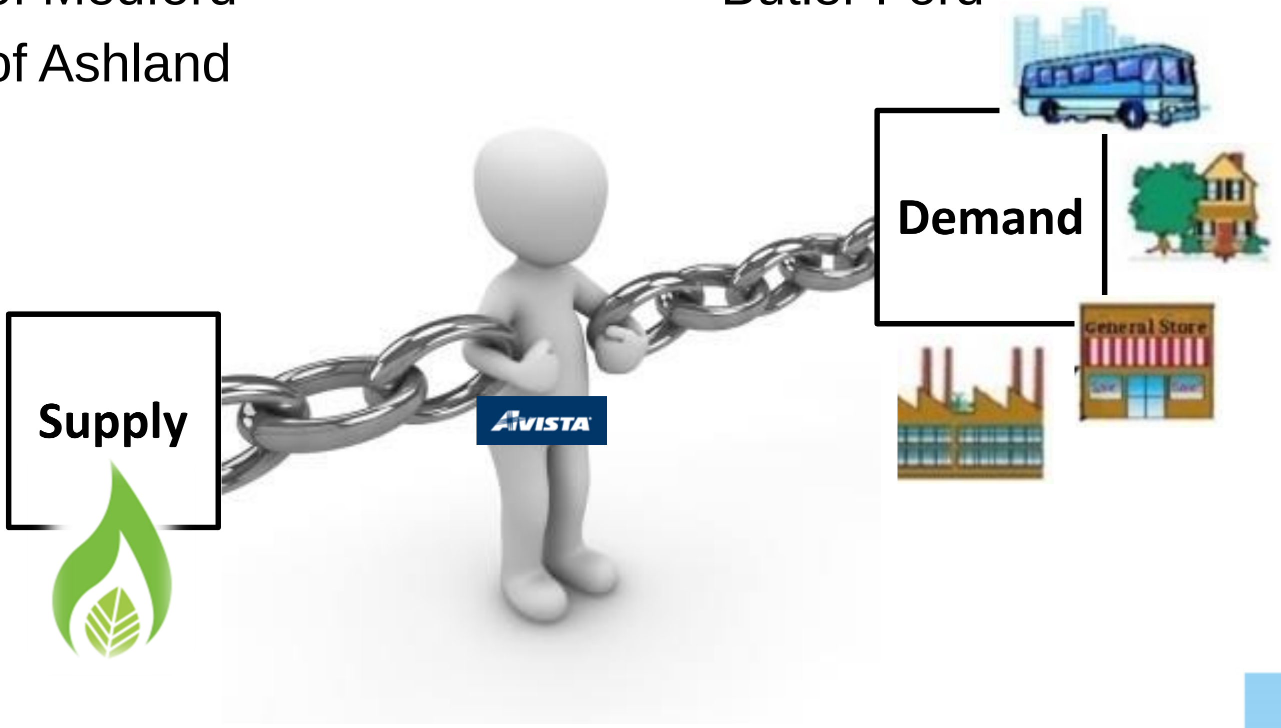
Source: Washington State Department of Ecology, 2015.
Solid Waste in Washington State: 24th Annual Status Report

Regional RNG Policies

- California SB 1383: Goal to reduce the economic uncertainty associated with RNG. Requires LDCs to interconnect at least five dairy projects to the natural gas pipeline system by January 1, 2018.
  - Allows LDCs to recover the costs associated with projects
- British Columbia Green House Gas Reduction Regulation
  - Allows for 5% RNG on LDC system
  - Allows LDCs to invest and recover costs associated with projects

Are Avista customers interested in RNG?

- Rogue Disposal
- Rogue Valley Transit
- Southern Oregon University
- City of Medford
- City of Ashland
- US Postal Service
- United Parcel Service
- DSU Peterbilt
- Butler Ford



Source: Interest expressed through Rogue Valley Clean Cities Coalition per Dry Creek Landfill

What are the challenges & barriers?

- California RNG market ($30/Dth v. $2/Dth)
  - Vehicle emission incentives shut-out other potential end users
  - RIN market is volatile
  - No forward pricing for RNG RINs in carbon market
  - RFS future beyond 2022 uncertain
  - Vehicle market may be approaching saturation in CA
  - Too expensive for LDCs to purchase; LDCs could produce RNG cheaper

- Financing for producers challenging
  - Future RNG value unknown
  - Producer/LDC partnerships for product

- Policies for LDC cost recovery or purchase of not least cost fuel source

Next Steps for RNG

- Model various RNG scenarios for 2018 IRP
- Participate in ODOE SB 344 Advisory Council
- Support efforts with WSU and WA SB 2580
- Evaluate customer interest in RNG products
- Evaluate potential RNG projects in Avista service territory

Power to Gas

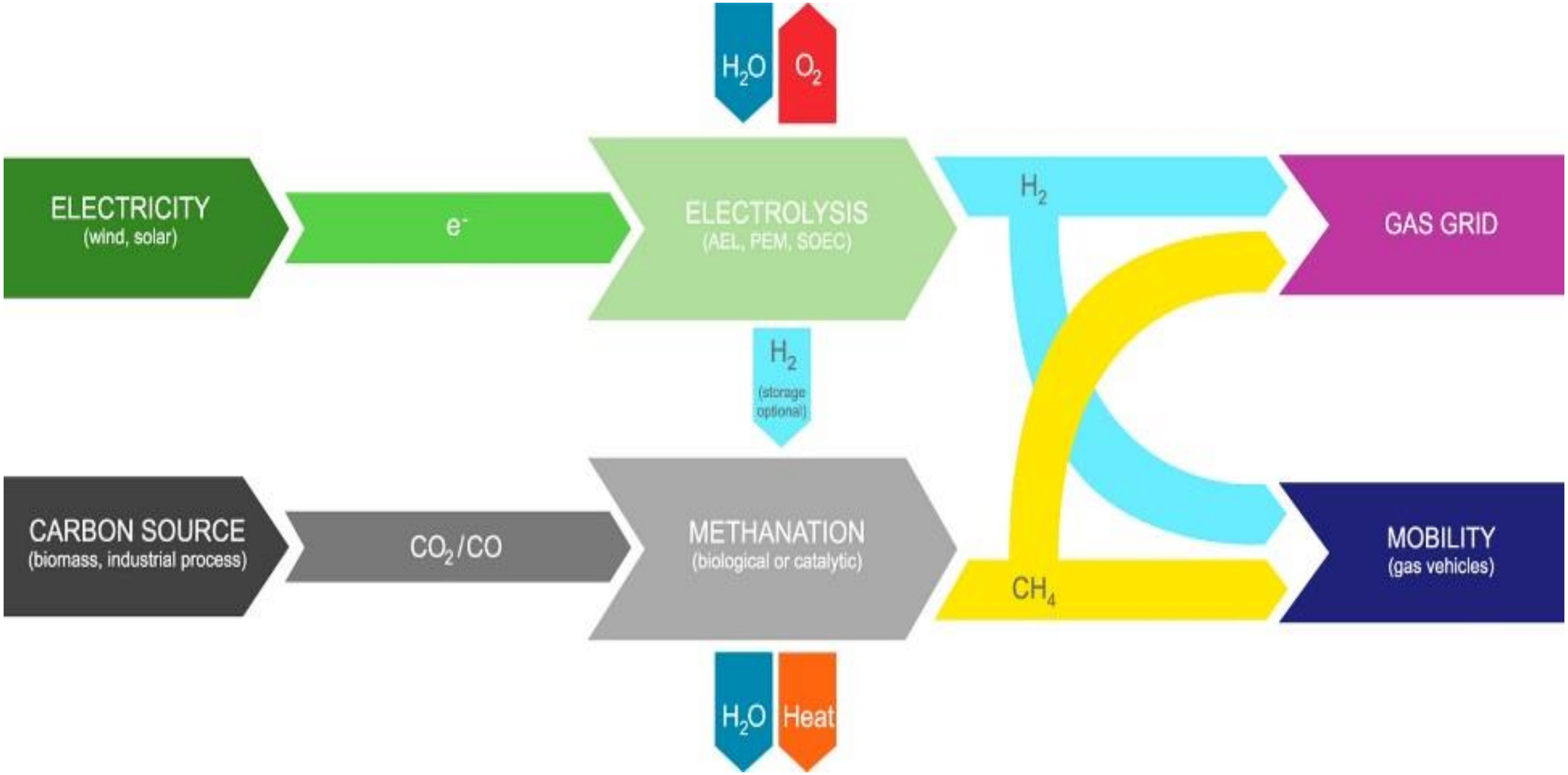
Tom Pardee
Manager of Natural Gas Planning

Power to Gas

- Power to Gas (PtG) is a process using power to separate water into hydrogen and oxygen
- Both hydrogen and methane can be stored, as a % of gas, in the existing gas grid or used in the mobility sector (blend up to 20%)
- PtG can help to balance excess power from intermittent sources like wind and solar
- PtG can decarbonize the direct use of natural gas
- PtG economics will advance as more renewables are added and the technology matures
- Short term and seasonal energy storage
- Stored in the existing gas pipeline

https://youtu.be/lQWIubQyaao

PtG Process



Source: http://www.europeanpowertogas.com/about/power-to-gas

Hydrogen

- The energy factor of H2 Low Heating Value (LHV) is roughly equivalent to a gallon of gasoline or 114,000btu
  - This equates to 8.78 kg of $H2_{LHV}$ per Dth
- Most H2 is currently made from reforming natural gas
- The US Department of Energy expects that over the long term the production of hydrogen will be increased with production from renewables

Water Electrolysis for PtG

- Water electrolysis is a mature and well understood technology with 3 different types of electrolysis technologies in these PtG processes
  - Alkaline electrolysis (AEL)
    - Most mature and well understood technology
    - Best when coupled with an intermittent power supply
  - Polymer electrolyte membrane (PEM)
    - Fast cold start with a high purity of H2
    - Limited Life expectancy
  - Solid oxide electrolysis (SOEC)
    - High electrical efficiency
    - Currently not as stable when paired with intermittent power supply

PtG Comparison

Benefits

- Cleans up the grid using excess power
- Stores the energy for future use
- Hydrogen is relatively safe as if it is released it quickly dilutes into a non-flammable concentration

Obstacles

- High cost (currently) when compared to energy in a Dth combined with current prices of natural gas
- Hydrogen can only be stored in the pipeline as a % of gas though this is primarily cause by end-use restrictive conditions
  - Risks increase significantly if over 50% mix
- Hydrogen is lighter than air and diffuses rapidly (3.8x faster than natural gas) making it more difficult to contain

Cost Status and Targets: Dispensed H_2

Targets

Early Market Target

$7/kg

$4/kg

Ultimate Target

Cost Status

(untaxed)

Low-Volume
early markets using NG

$16/kg to $10/kg

High-Volume*

$7.5/kg to $5/kg

*high-volume projections assume economies of scale

LOW-VOLUME

- Early market status based on low-cost H_2 from NG (<$2/kg) plus delivery & dispensing
- R&D innovations are essential to reduce H_2 delivery & dispensing costs

HIGH-VOLUME

- Projected status based on large-scale deployments of a portfolio of H_2 production, delivery & dispensing options
- R&D of diverse, sustainable hydrogen production pathways remains vital

Continued R&D is needed to reduce H_2 production & delivery costs

Next Steps

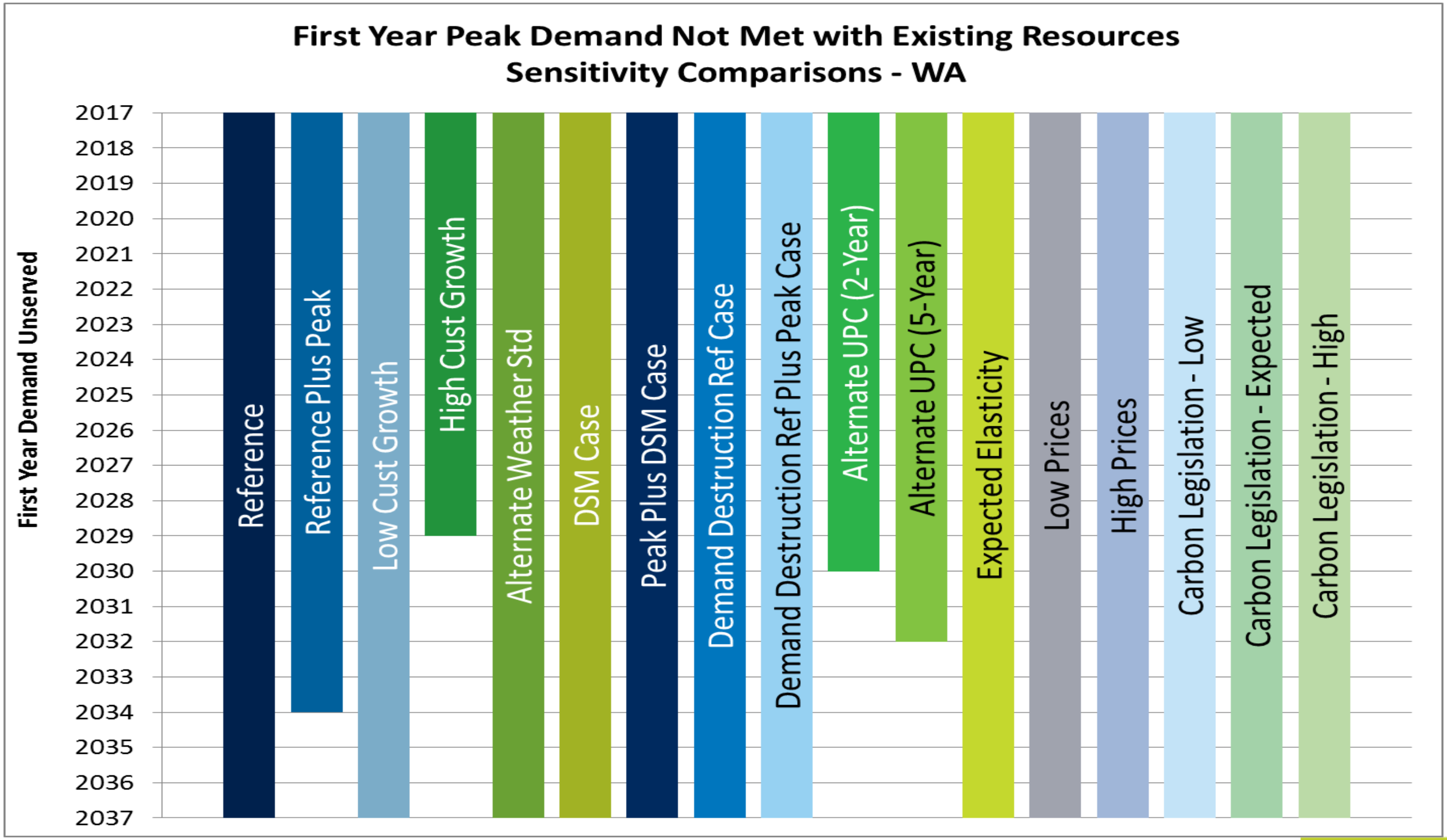
- Model at an estimated rate of $4 per kg of H2 based on DOE technical target by 2020
  - This is the untaxed cost of hydrogen produced, delivered, and dispensed to the vehicle
    - It does not include off-board cooling or regeneration of chemical hydrogen storage materials
  - Source: https://www.energy.gov/eere/fuelcells/doe-technical-targets-onboard-hydrogen-storage-light-duty-vehicles

- Look for a consultant or ways to more accurately estimate the cost of H2 in Avista's territory

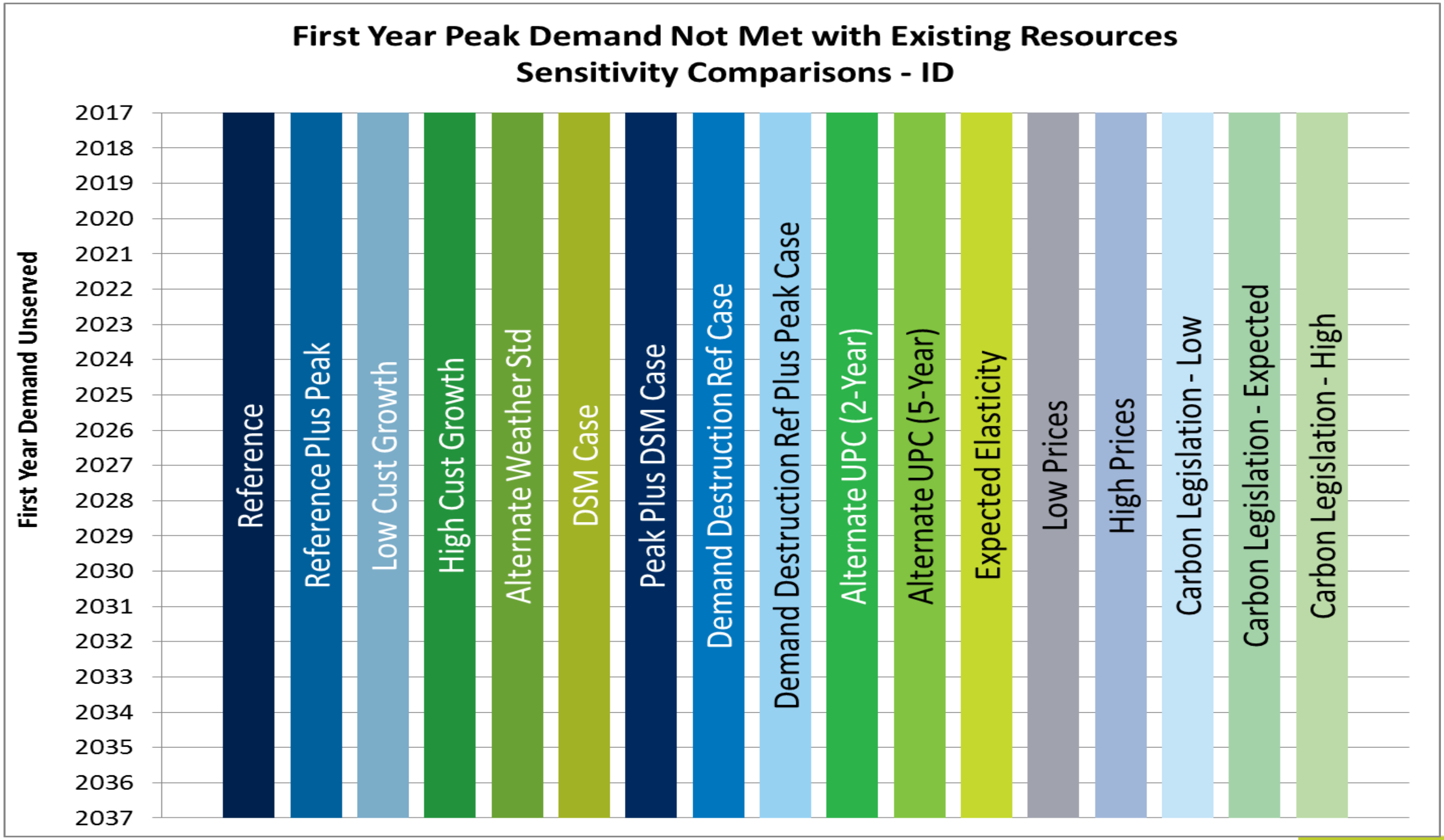
Initial Results and Proposed Scenarios

Kaylene Schultz
Natural Gas Analyst

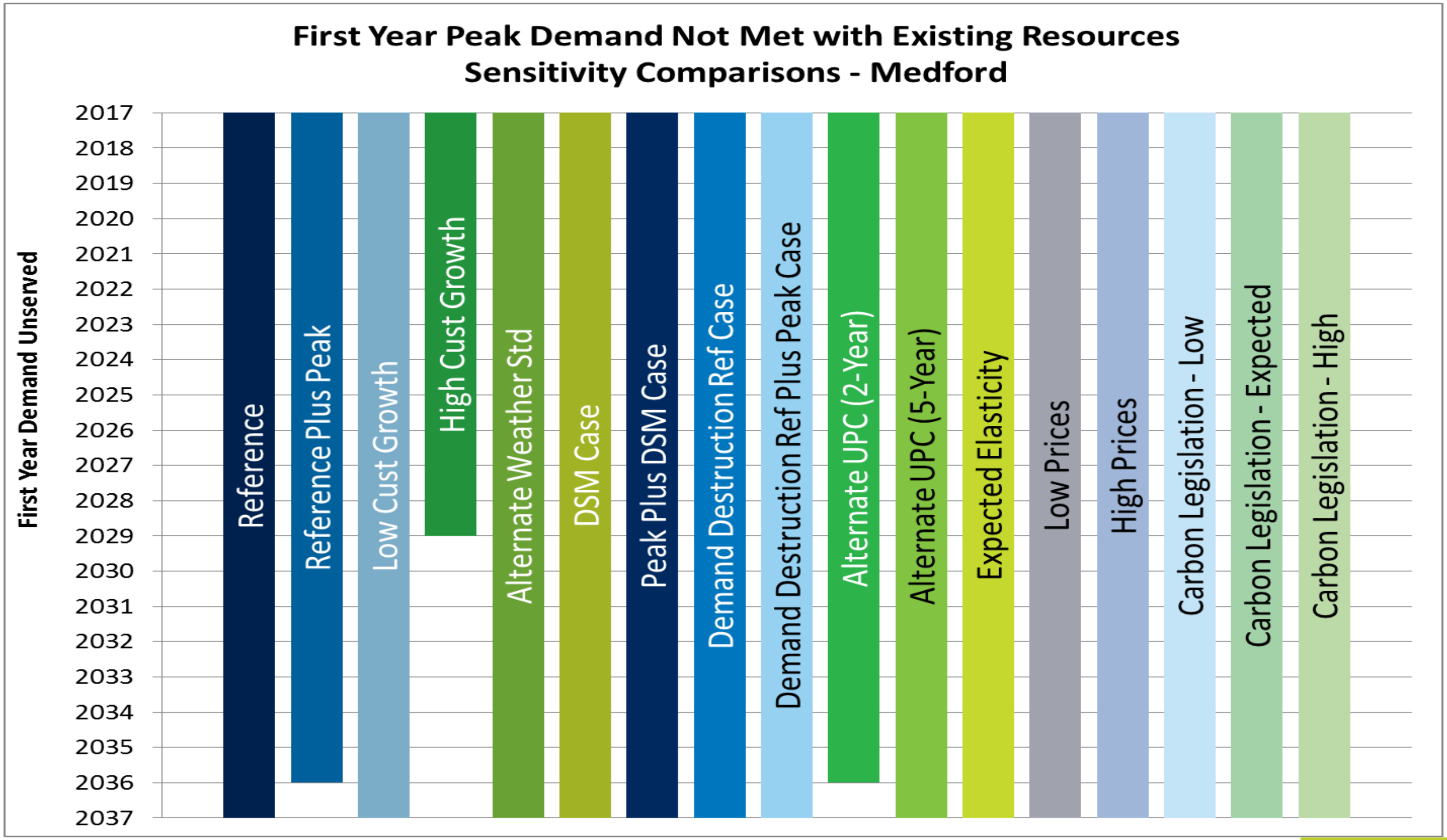
First Year Peak Demand Unserved Washington



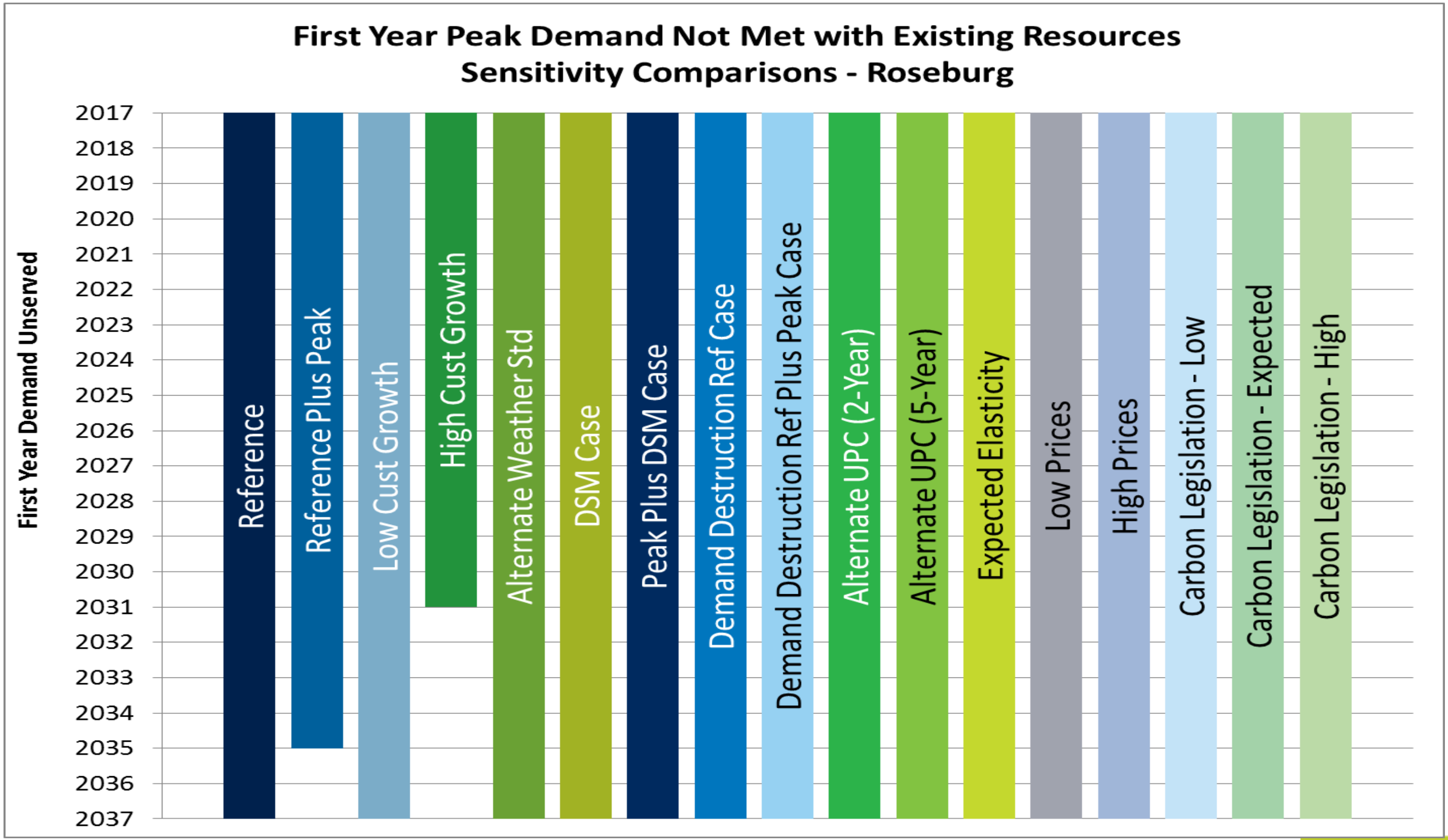
First Year Peak Demand Unserved Idaho



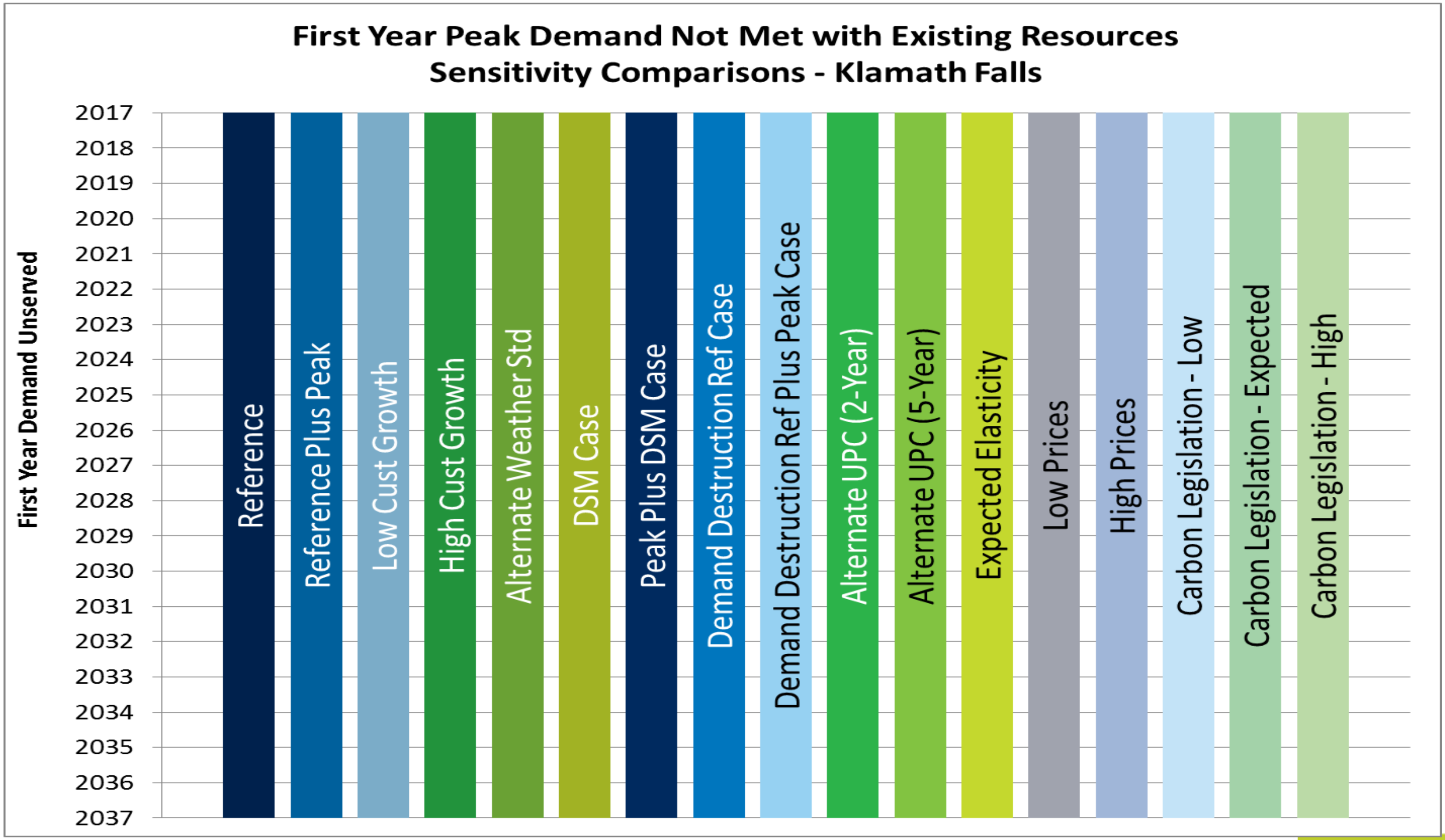
First Year Peak Demand Unserved Medford



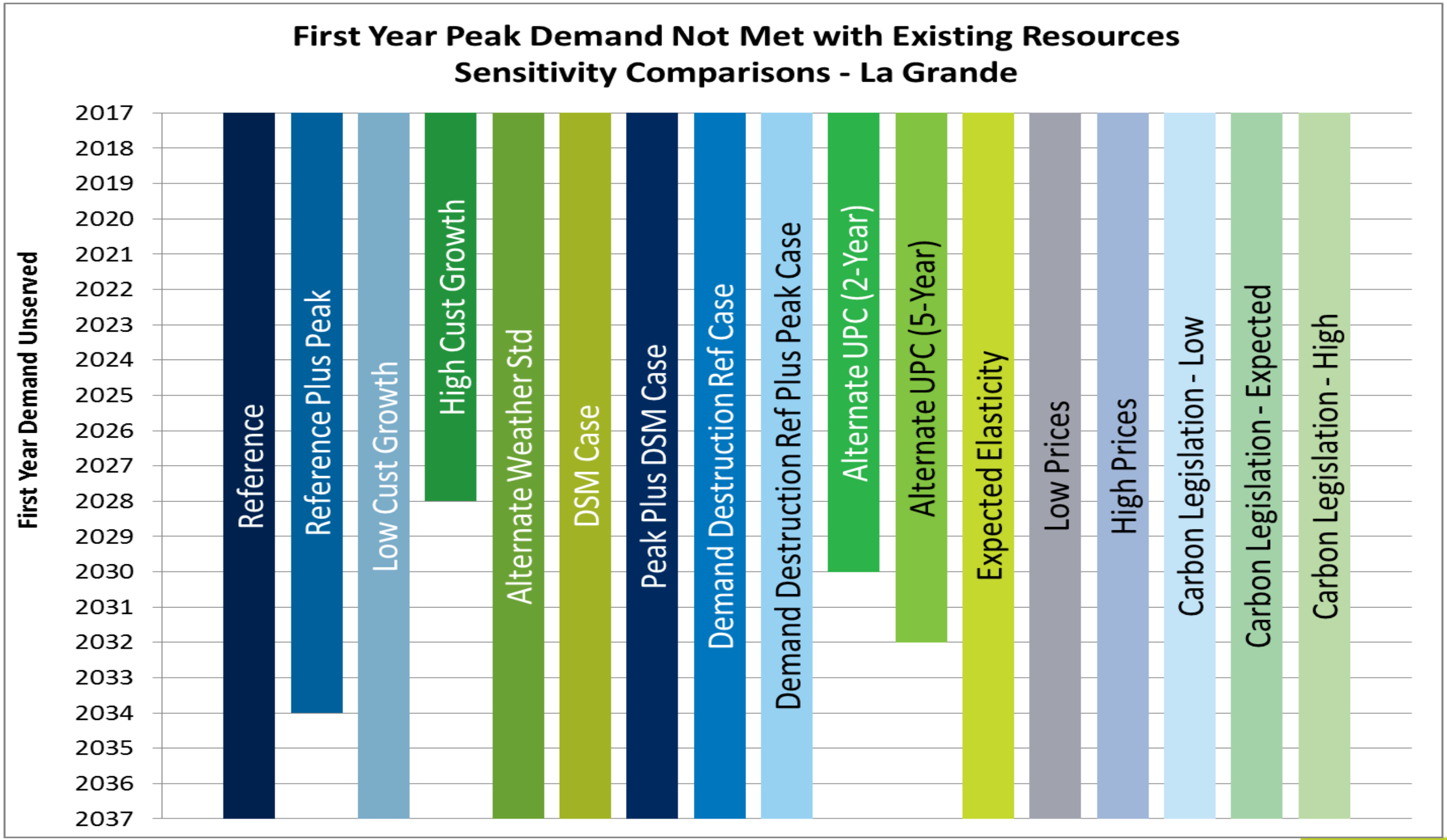
First Year Peak Demand Unserved Roseburg

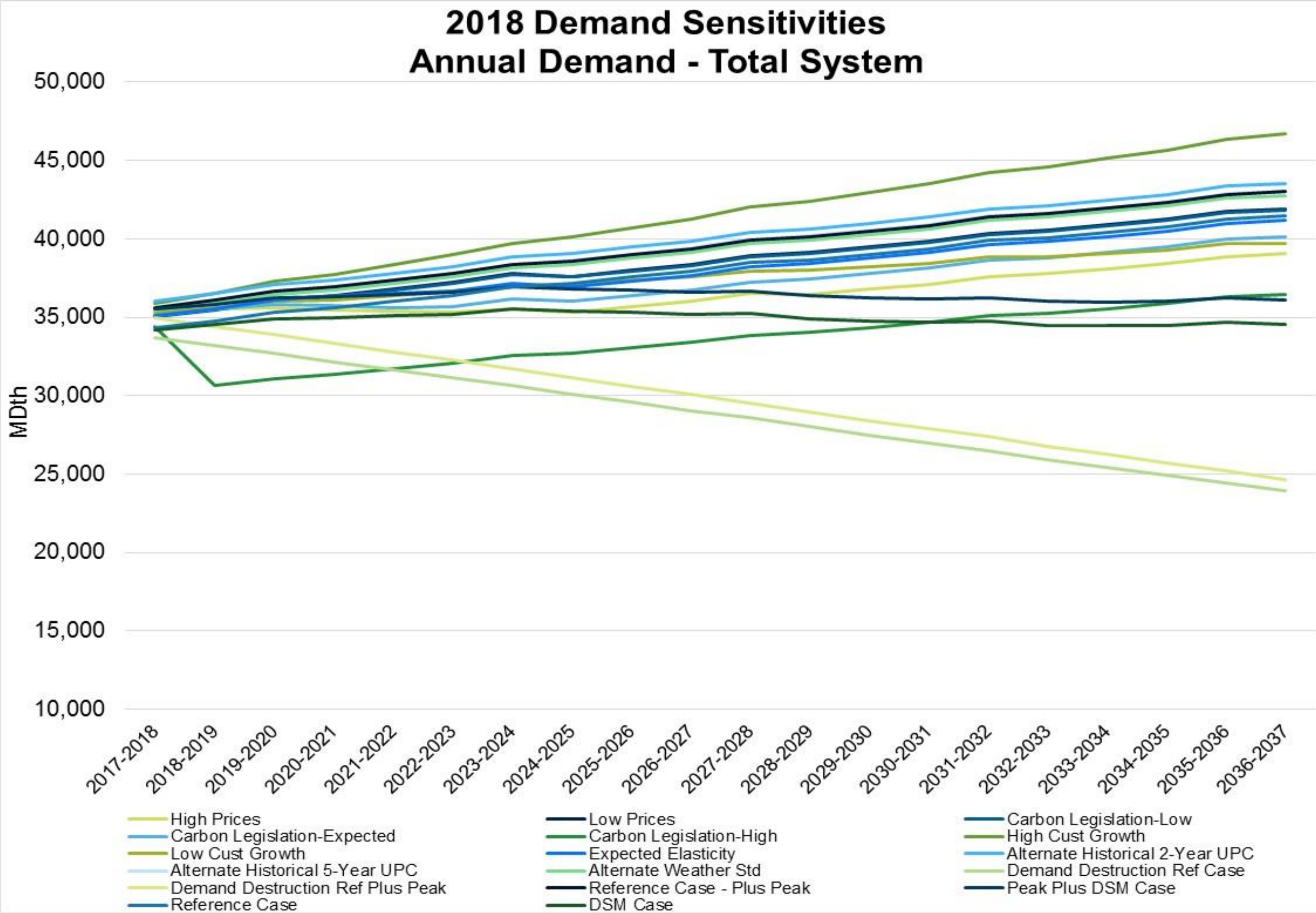


First Year Peak Demand Unserved Klamath Falls

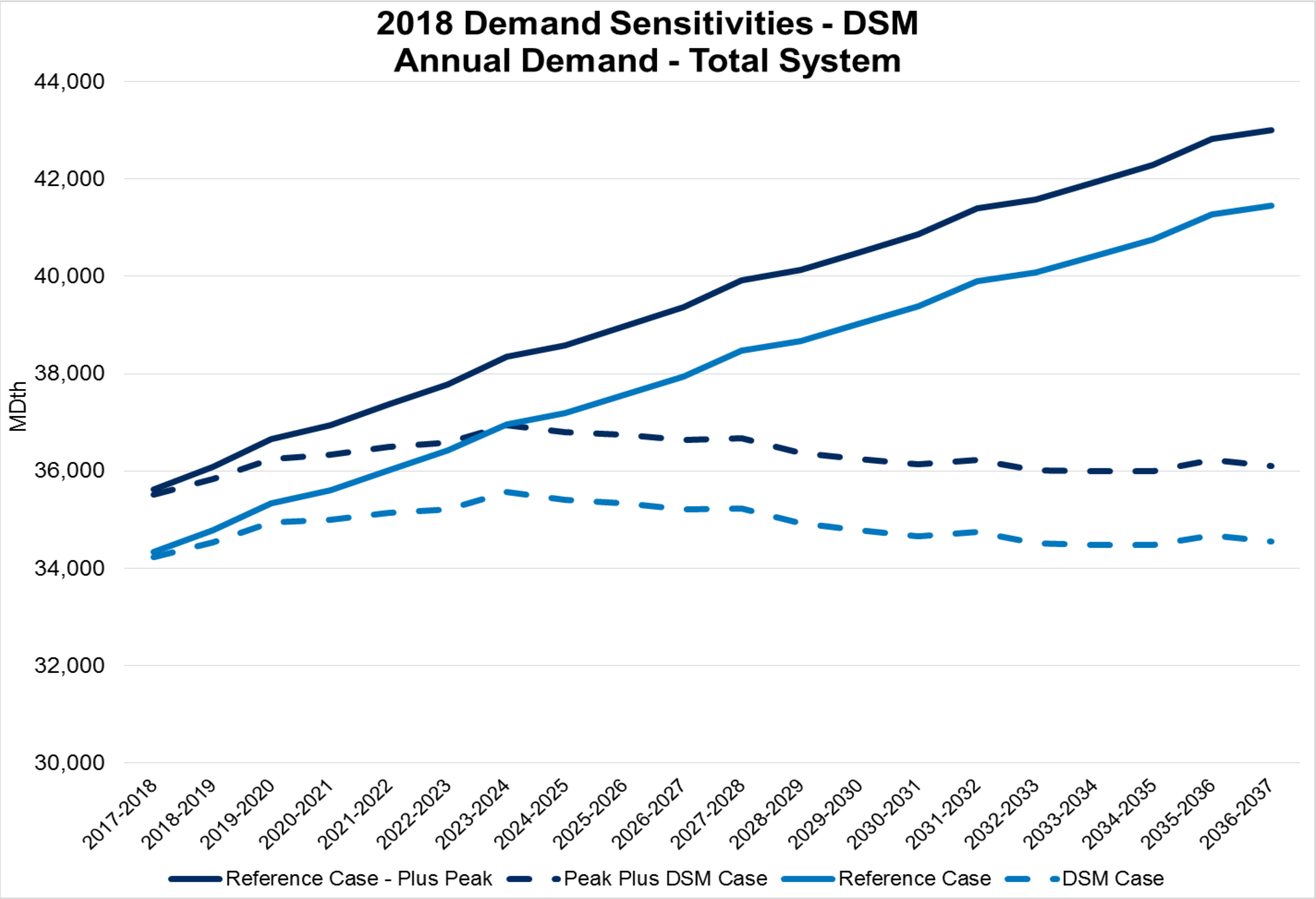


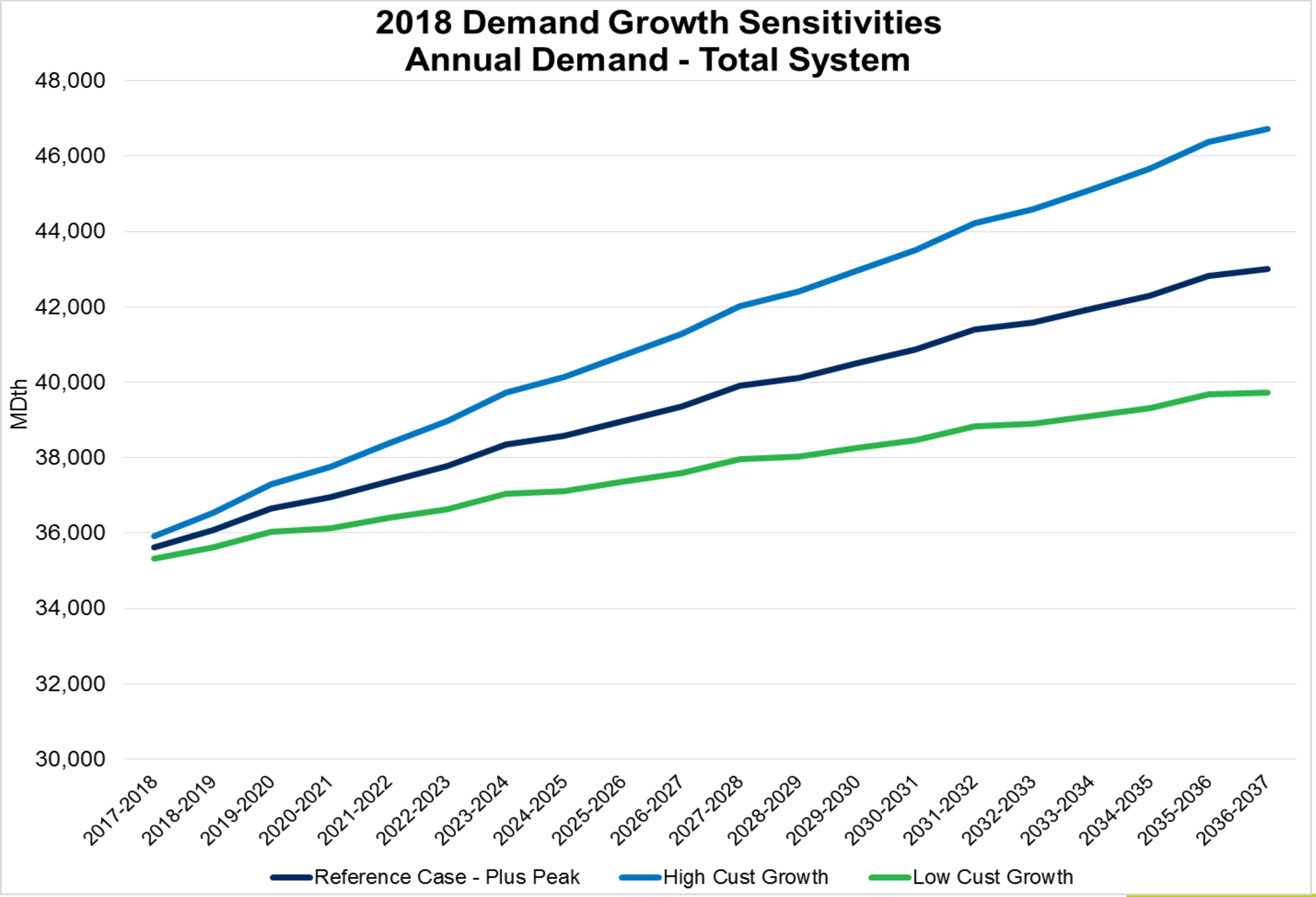
First Year Peak Demand Unserved La Grande





2018 Demand Sensitivities
Annual Demand - Total System
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
MDth
2017-2018
2018-2019
2019-2020
2020-2021
2021-2022
2022-2023
2023-2024
2024-2025
2025-2026
2026-2027
2027-2028
2028-2029
2029-2030
2030-2031
2031-2032
2032-2033
2033-2034
2034-2035
2035-2036
2036-2037
High Prices
Low Prices
Carbon Legislation-Low
Carbon Legislation-Expected
Carbon Legislation-High
High Cust Growth
Low Cust Growth
Expected Elasticity
Alternate Historical 2-Year UPC
Alternate Historical 5-Year UPC
Alternate Weather Std
Demand Destruction Ref Case
Demand Destruction Ref Plus Peak
Reference Case - Plus Peak
Peak Plus DSM Case
Reference Case
DSM Case


2018 Demand Sensitivities - DSM
Annual Demand - Total System
44,000
42,000
40,000
38,000
36,000
34,000
32,000
30,000
MDth
2017-2018
2018-2019
2019-2020
2020-2021
2021-2022
2022-2023
2023-2024
2024-2025
2025-2026
2026-2027
2027-2028
2028-2029
2029-2030
2030-2031
2031-2032
2032-2033
2033-2034
2034-2035
2035-2036
2036-2037
Reference Case - Plus Peak
Peak Plus DSM Case
Reference Case
DSM Case


2018 Demand Growth Sensitivities
Annual Demand - Total System
MDth
48,000
46,000
44,000
42,000
40,000
38,000
36,000
34,000
32,000
30,000
2017-2018
2018-2019
2019-2020
2020-2021
2021-2022
2022-2023
2023-2024
2024-2025
2025-2026
2026-2027
2027-2028
2028-2029
2029-2030
2030-2031
2031-2032
2032-2033
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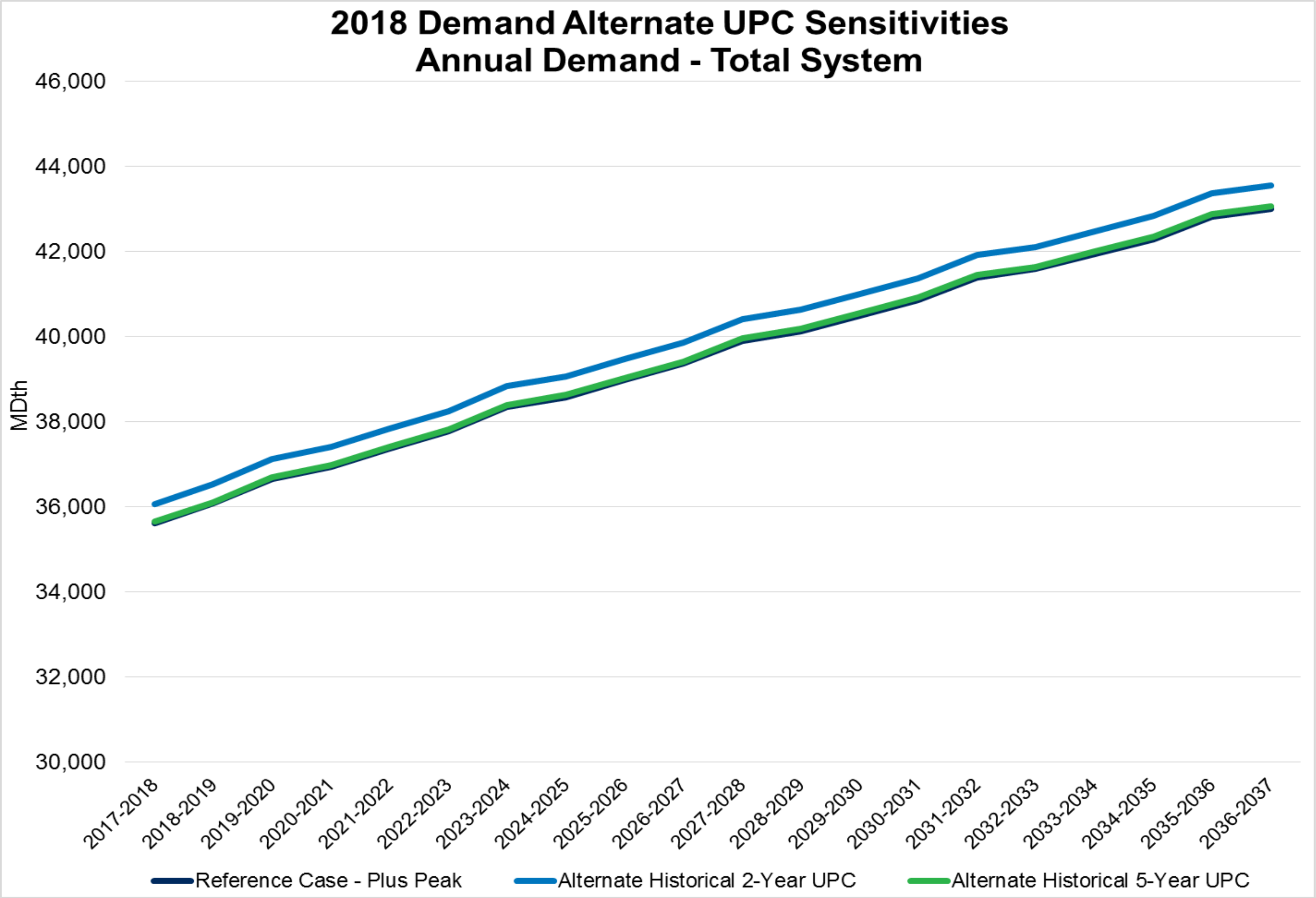
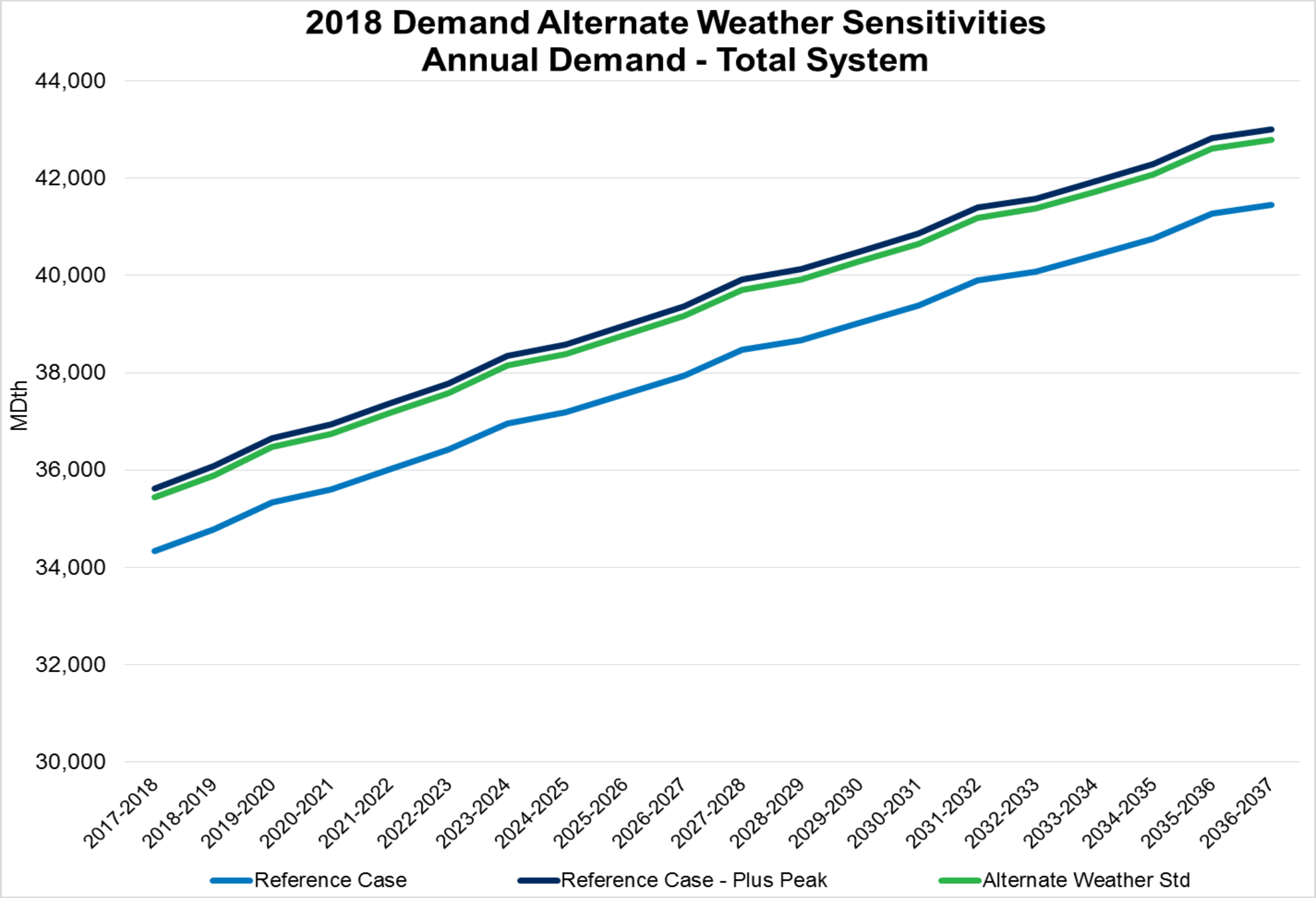
2036-2037
Reference Case - Plus Peak
High Cust Growth
Low Cust Growth


2018 Demand Alternate UPC Sensitivities
Annual Demand - Total System
46,000
44,000
42,000
40,000
38,000
36,000
34,000
32,000
30,000
MDth
2017-2018
2018-2019
2019-2020
2020-2021
2021-2022
2022-2023
2023-2024
2024-2025
2025-2026
2026-2027
2027-2028
2028-2029
2029-2030
2030-2031
2031-2032
2032-2033
2033-2034
2034-2035
2035-2036
2036-2037
Reference Case - Plus Peak
Alternate Historical 2-Year UPC
Alternate Historical 5-Year UPC



2018 Demand Alternate Weather Sensitivities
Annual Demand - Total System
MDth
44,000
42,000
40,000
38,000
36,000
34,000
32,000
30,000
2017-2018
2018-2019
2019-2020
2020-2021
2021-2022
2022-2023
2023-2024
2024-2025
2025-2026
2026-2027
2027-2028
2028-2029
2029-2030
2030-2031
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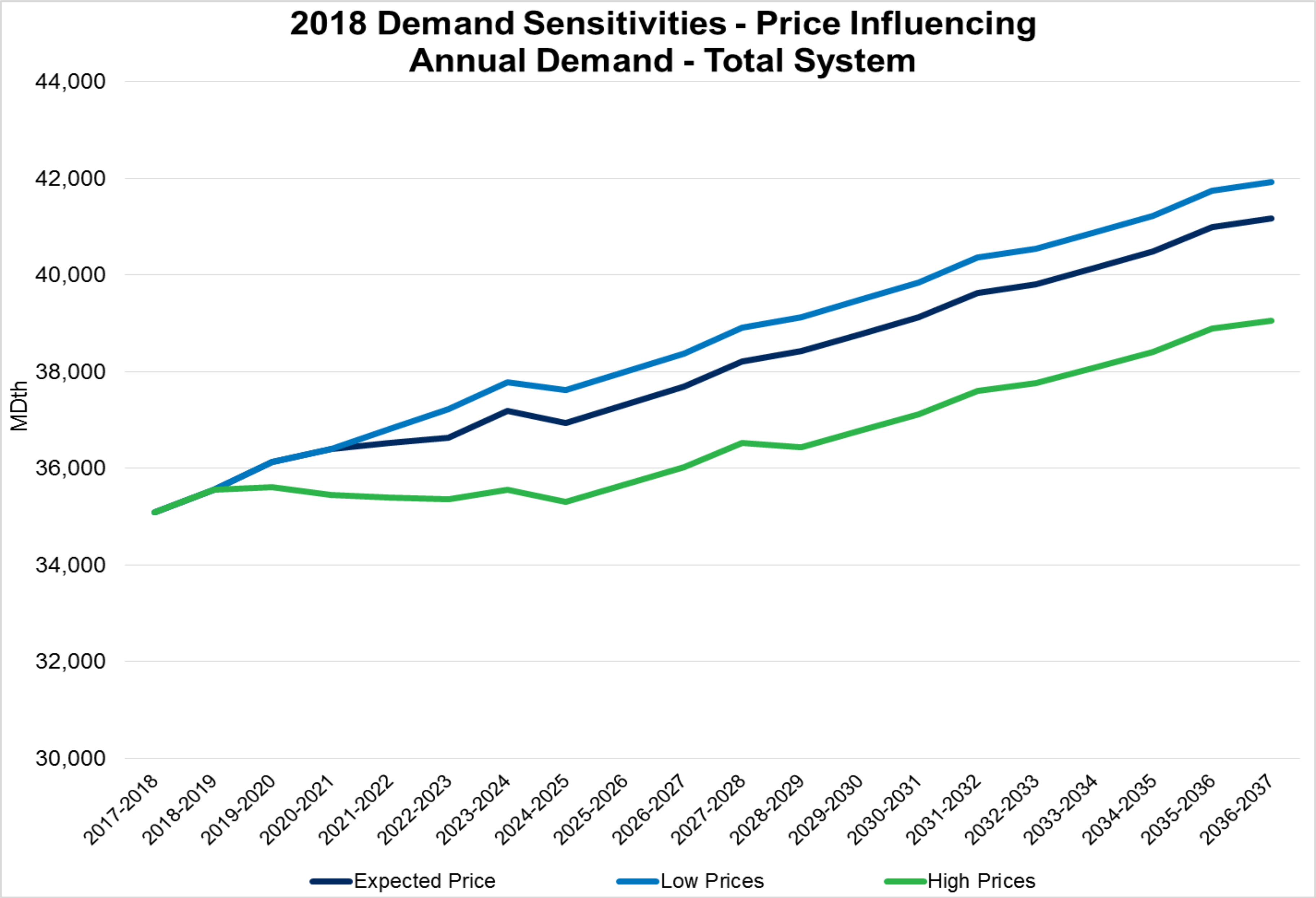
2036-2037
Reference Case
Reference Case - Plus Peak
Alternate Weather Std


2018 Demand Sensitivities - Price Influencing
Annual Demand - Total System
44,000
42,000
40,000
38,000
36,000
34,000
32,000
30,000
MDth
2017-2018
2018-2019
2019-2020
2020-2021
2021-2022
2022-2023
2023-2024
2024-2025
2025-2026
2026-2027
2027-2028
2028-2029
2029-2030
2030-2031
2031-2032
2032-2033
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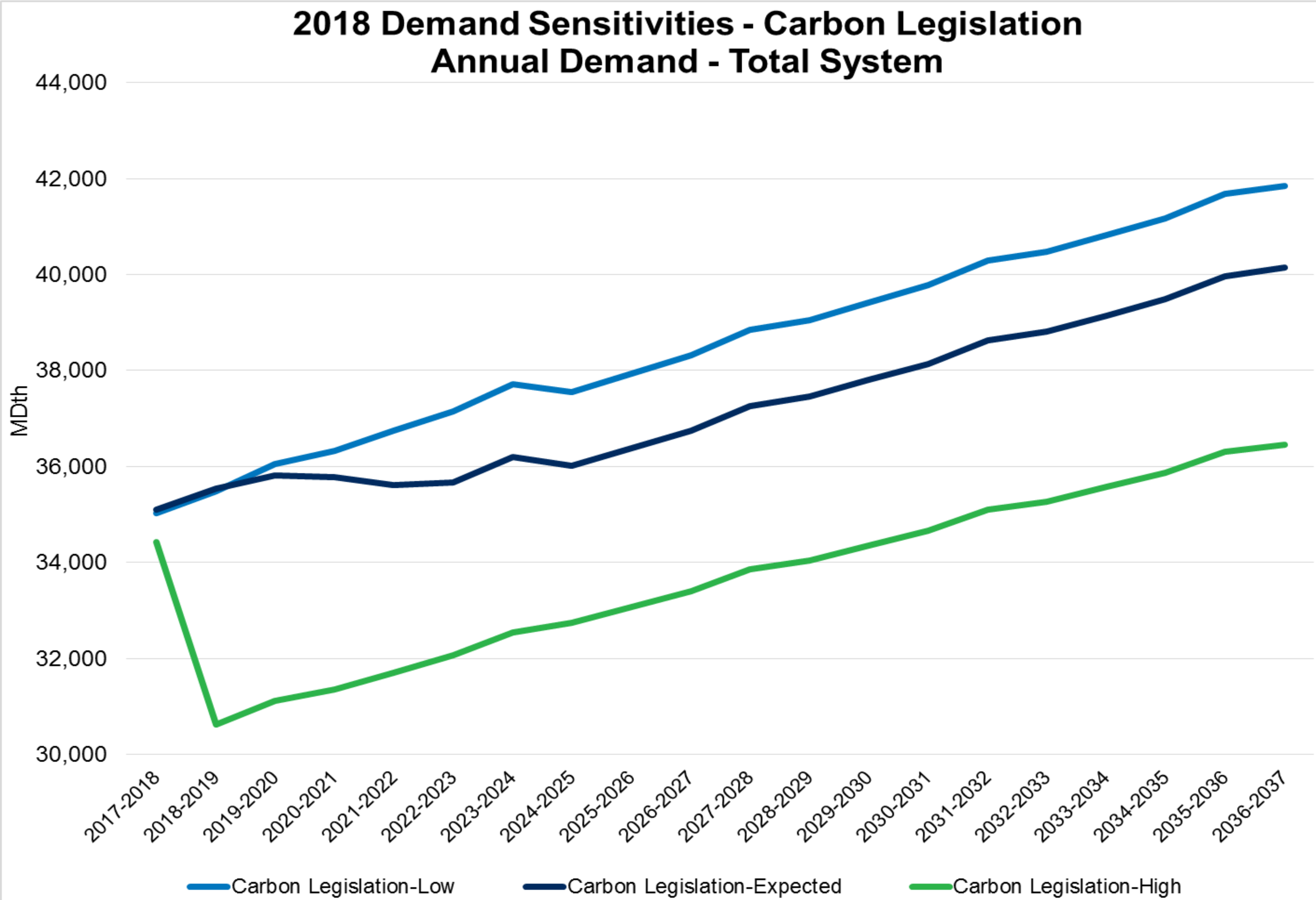
2036-2037
Expected Price
Low Prices
High Prices


2018 Demand Sensitivities - Carbon Legislation
Annual Demand - Total System
44,000
42,000
40,000
38,000
36,000
34,000
32,000
30,000
MDth
2017-2018
2018-2019
2019-2020
2020-2021
2021-2022
2022-2023
2023-2024
2024-2025
2025-2026
2026-2027
2027-2028
2028-2029
2029-2030
2030-2031
2031-2032
2032-2033
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2036-2037
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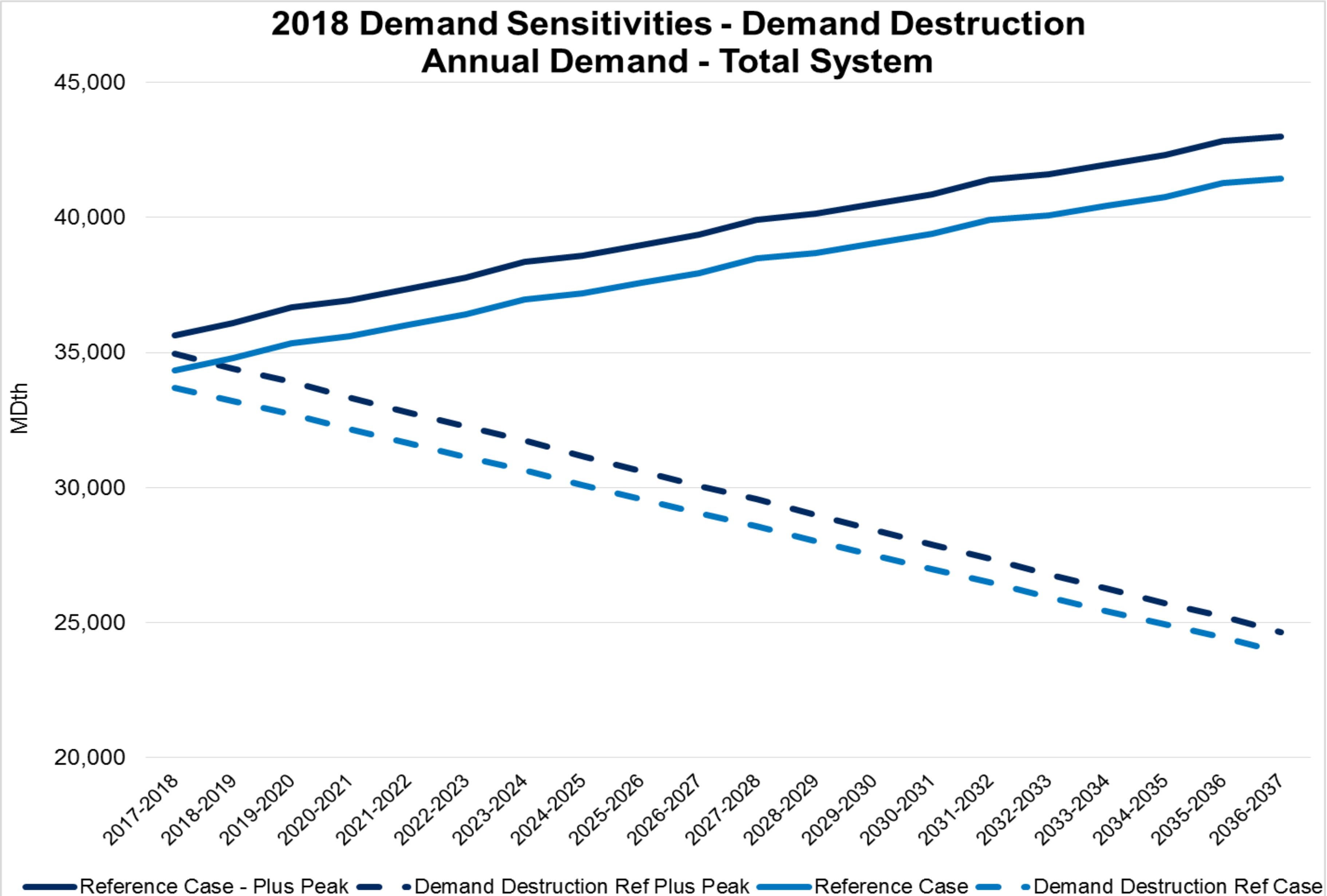
Carbon Legislation-Expected
Carbon Legislation-High



*Assumes average yearly reduction starting in 2018 to achieve 2050 target of 80% below 1990 emissions

2018 Proposed Scenarios

Proposed Scenarios INPUT ASSUMPTIONS	Expected Case	Cold Day 20yr Weather Std	Average Case	Low Growth & High Prices	Demand Destruction	High Growth & Low Prices
Customer Growth Rate	Reference Case Cust Growth Rates			Low Growth Rate	Reference Case minus	High Growth Rate
Use per Customer	3 yr Flat + Price Elasticity					3 yr Flat + Price Elasticity+CNG / NGV
Demand Side Management	Yes					
Weather Planning Standard	Historical Coldest Day	Coldest in 20 years	20 year average	Historical Coldest Day		
Prices Price curve	Expected			High	Low	
Carbon Legislation ($/Metric Ton)	\$10-\$30 WA \$17.86-\$51.58 OR \$0 ID					None

2018 IRP Timeline

- **August 31, 2017** – Work Plan filed with WUTC
- **January through May 2018** – Technical Advisory Committee meetings. Meeting topics will include:
  - **TAC 1: Thursday, January 25, 2018: TAC meeting expectations, review of 2016 IRP acknowledgement letters, customer forecast, and demand-side management (DSM) update.**
  - **TAC 2: Thursday, February 22, 2018: Weather analysis, environmental policies, market dynamics, price forecasts, cost of carbon.**
  - **TAC 3: Thursday, March 29, 2018 : Distribution, supply-side resources overview, overview of the major interstate pipelines, RNG overview and future potential resources.**
  - **TAC 4: Thursday, May 10, 2018: DSM results, stochastic modeling and supply-side options, final portfolio results, and 2020 Action Items.**
- **June 1, 2018 –** Draft of IRP document to TAC
- **June 29, 2018 –** Comments on draft due back to Avista
- **July 2018 –** TAC final review meeting (if necessary)
- **August 31, 2018 –** File finalized IRP document

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Questions?