Short-Term Water Demand Forecasting to Optimize Water Supply Operations

Mark Knudson, PE

May 6, 2011

Presentation Overview

- Background
- Supply Challenges & Opportunities
- Development of Demand Forecasting Model
- Use of the Model in 2010
- Conclusions

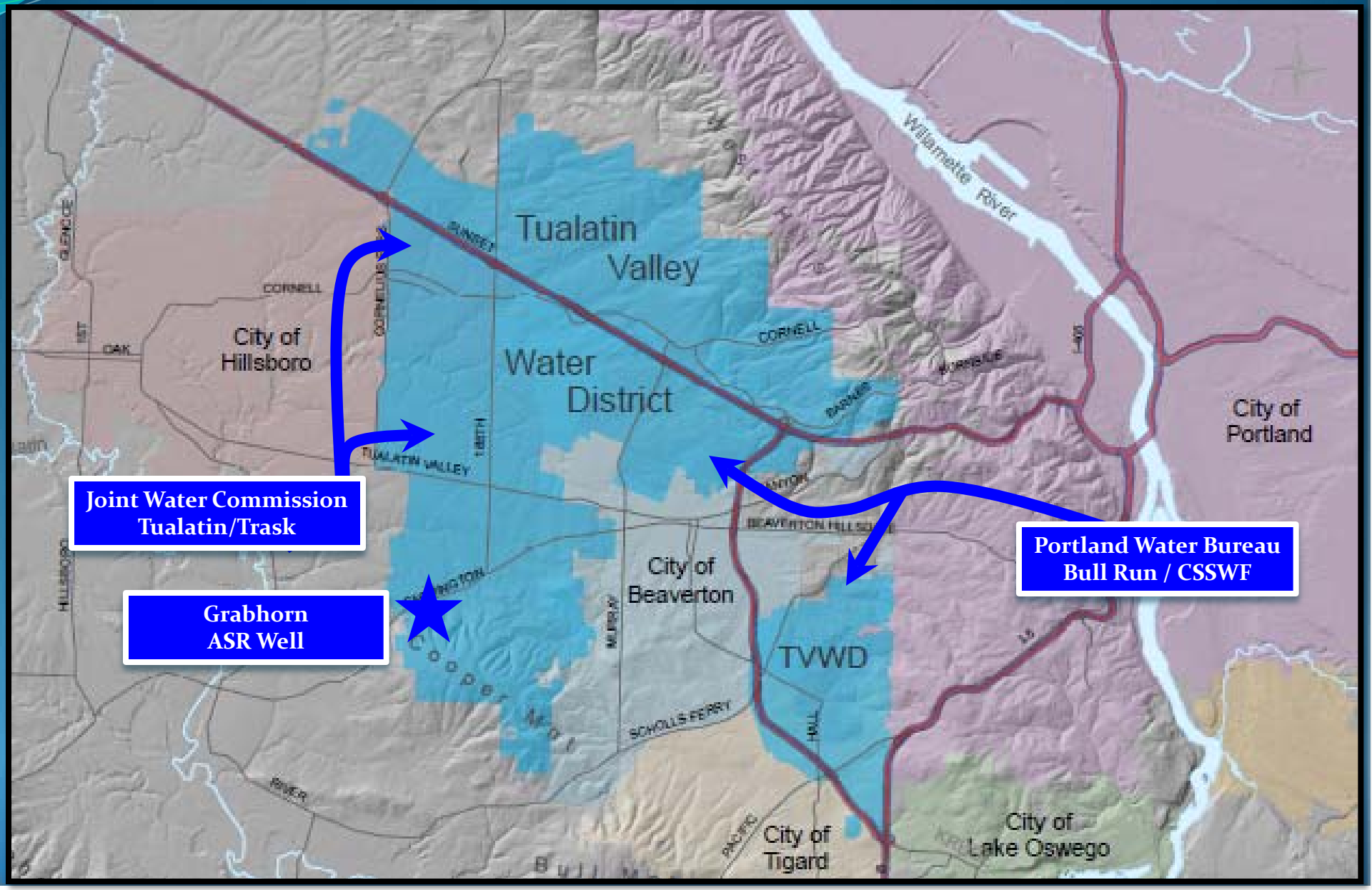
Tualatin Valley Water District

TVWD Overview

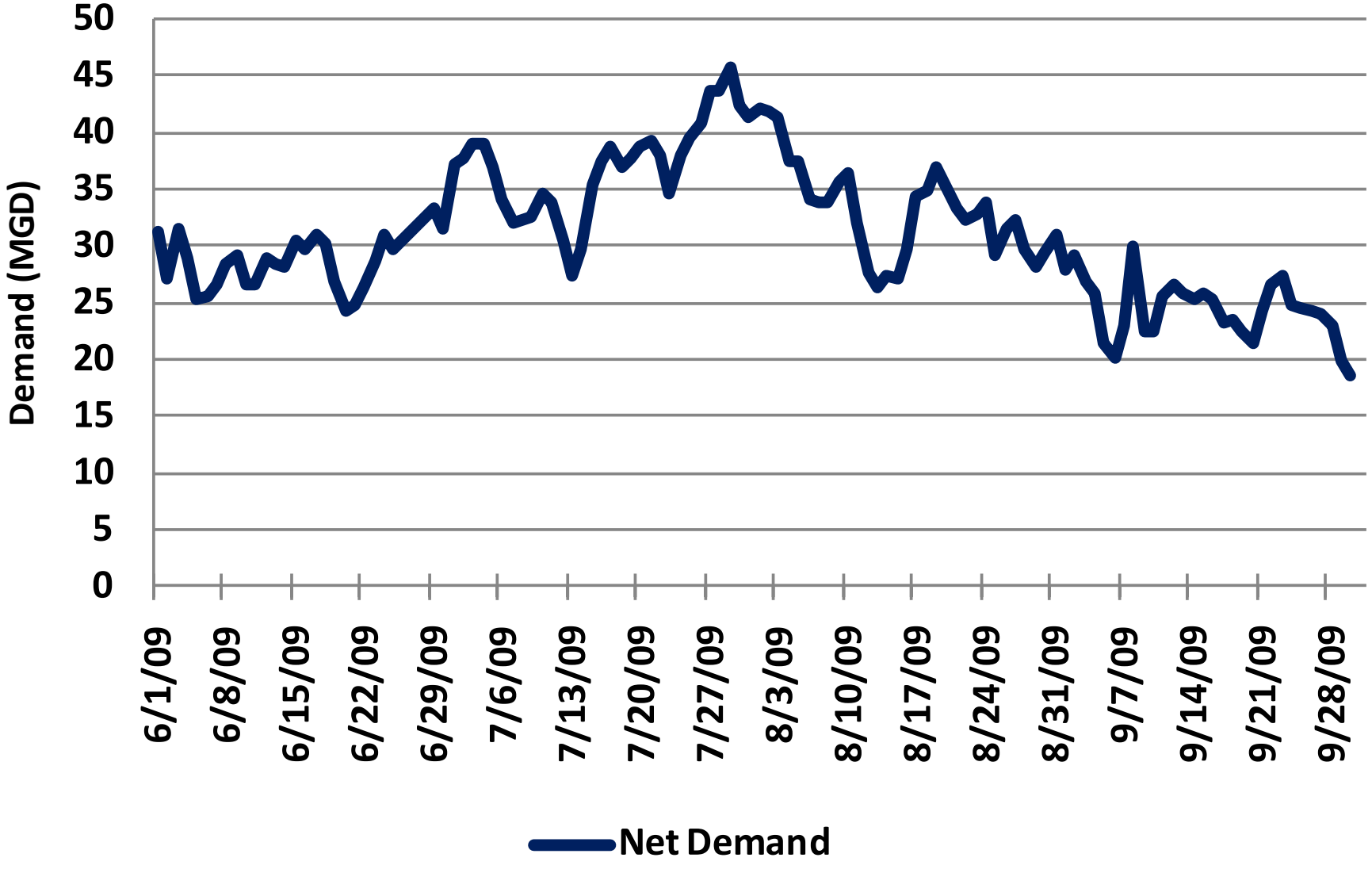
- Service area:
  - Unincorporated areas of Washington County and portions of Cities of Beaverton, Hillsboro and Tigard
  - 200,000 population; second largest water provider in Oregon
  - Mostly residential; key industrial & commercial customers
- Water system:
  - 65 million gallons storage, 24 reservoirs
  - 12 pump stations, 23 pressure zones
  - 760 miles of pipelines
- 2010 Demands:
  - Average day: 21 MGD
  - Max day: 40 MGD
- Sources include JWC, Portland & ASR

Tualatin Valley Water District

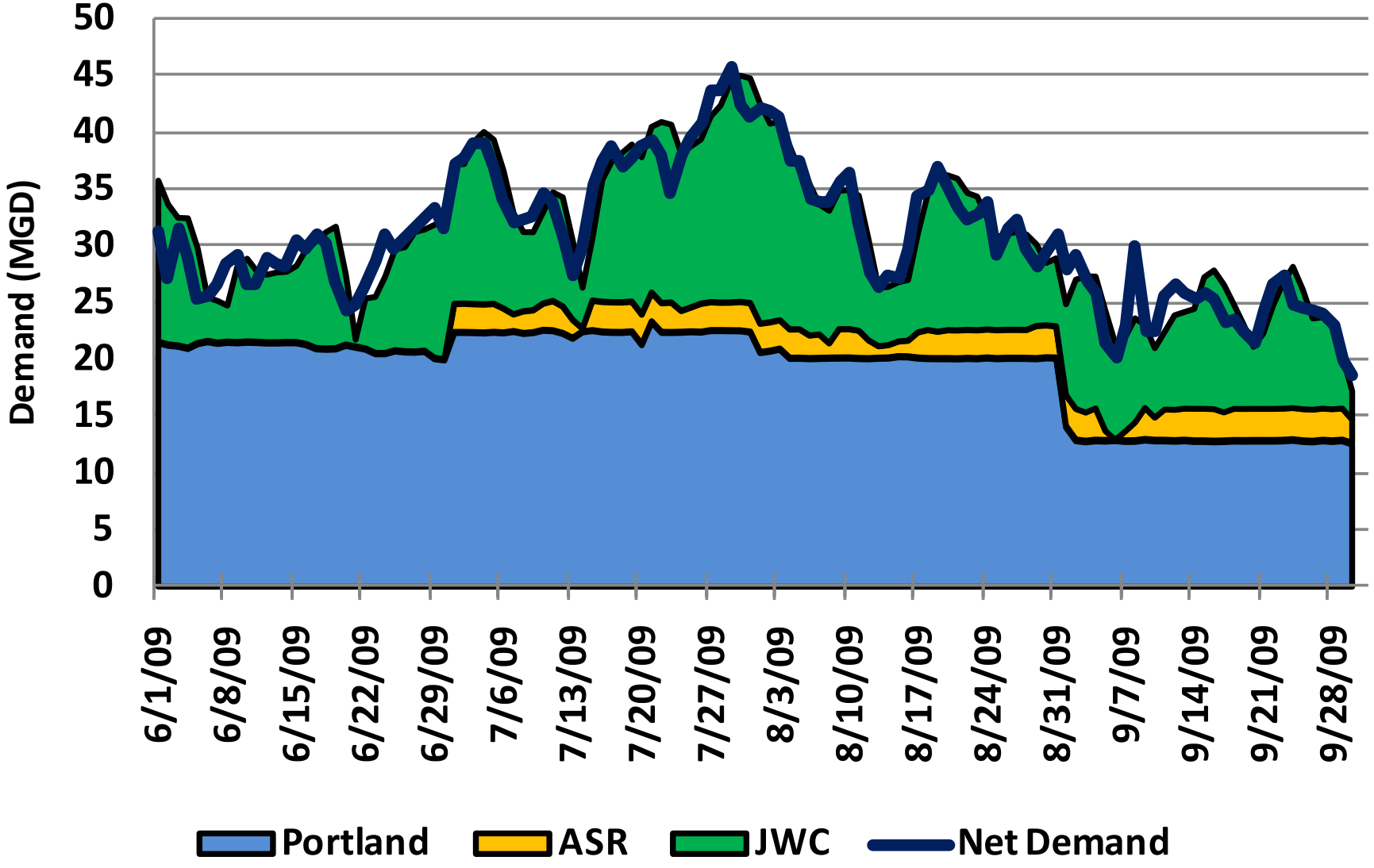
TVWD Service Area



Water Demand - 2009



Water Demand - 2009



Supply Challenges & Opportunities

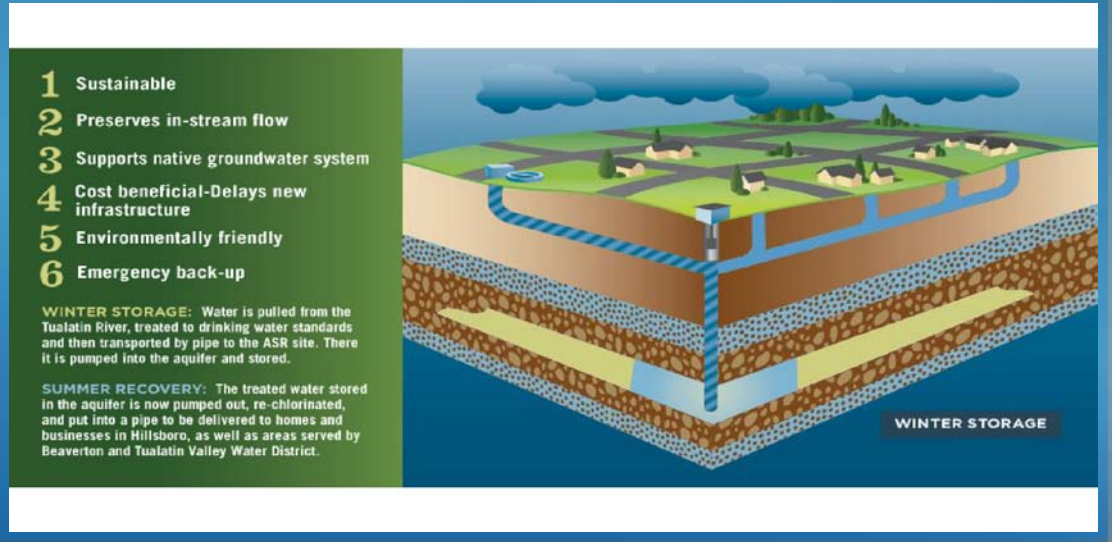
- Portland Water Bureau – Base Supply
  - Supply owned by Portland Water Bureau
  - 10-year agreement between TVWD and PWB
  - Minimum purchase of 13.2 MGD (not negotiable)
  - Peak hydraulic capacity of 42.3 MGD but …
  - Peak 3-day and peak season peaking factors
  - Peak season = July, Aug & Sept
  - 5-year residual impact of “excess peaking factors”
  - Rate:
    - 2010-11: $0.844 / ccf

Supply Challenges & Opportunities

- Joint Water Commission Supply
  - Ownership agreement between TVWD & Cities of Beaverton, Forest Grove & Hillsboro
  - No minimum purchase
  - No flow changes over weekends & holidays
  - Peak capacity limited by ownership
  - TVWD ownership capacity = 12.5 MGD
  - "Excess use" if peak 5-day average > 110% (13.75 MGD)
  - Option to lease capacity but paid for entire year
  - Rates:
    - 2010-11: $0.372 / ccf
    - Cost based on actual use

Supply Challenges & Opportunities

- Aquifer Storage & Recovery (ASR) Supply
  - Owned exclusively by TVWD
  - Injection during winter; recover during summer
  - Recovery capacity ~ 3 MGD * 100 days (300 MG)
  - Minimum production of ~ 1.0 MGD
  - Desire to operate at ~ constant production rate
  - Recharged with JWC water purchased prior winter
  - Production Cost: 2010-11 ~ $0.16 / ccf



Supply Challenges & Opportunities

- Portland Water Bureau – Interruptible Supply
  - Option for “summer interruptible water”
  - Summer interruptible = June + July, Aug & Sept
  - Potentially interrupted if inadequate supply
  - No impact on peaking factors
  - Request for summer interruptible submitted in March
  - Fixed quantity by month (MGD or million gallons)
  - Take or pay
  - Price is 45% of base rate
  - Rate:
    - 2010-11: $0.380 / ccf

2010 Operational Strategy

- Portland Water Bureau - Base
  - Base load with constant demand
  - Limit peak 3-day and peak season peaking factors
- JWC
  - Fluctuate to meet demand as needed
  - Up to TVWD's ownership share but avoid "excess use"
- TVWD Aquifer Storage & Recovery
  - Maintain relatively constant production
  - Ability to "trim" to meet system demand up to 3 MGD
- Portland Water Bureau - Summer Interruptible
  - Fluctuate to meet demand as needed

Tualatin Valley Water District

2010 Operational Strategy

- Portland Water Bureau - Summer Interruptible
  - Identified request for summer interruptible
  - Based on seasonal use in 2008 & 2009

Month	Quantity (MG)
June	10
July	40
August	50
September	25
Total	**125**

  - Need to anticipate use and adjust daily
  - Need to track daily use, report monthly

Tualatin Valley Water District

Water Demand Forecasting Model

- Tool to predict water demand for 2 - 3 days
- Daily planning to optimize source use
- Meet operational goals for each source

Tualatin Valley Water District

Water Demand Forecasting Model

Types of Models

Heuristic	• Experience & judgment • Rules of thumb
Graphical	•Visual representation •Picture
Physical	•Scale replica •Simulation
Mathematical	• Deterministic • Statistical / learning

Tualatin Valley Water District

Model Development Process

Data
- Compile Water Supply, Demand Data
- Meteorological Data

Analysis
- Scenario Development
- Regression Analysis

Testing
- Testing Prior Years / Refinement
- Operational Strategy Testing

Interface
- Interface Development / Refinement
- Operator Training

Implement
- Implement Routine Operations
- Verification / Refinement

Tualatin Valley Water District

Model Development – Data Gathering

Tualatin Valley Water District

Model Development – Data Gathering

000
CXUS55 KPQR 011230
CF6HIO
PRELIMINARY LOCAL CLIMATOLOGICAL DATA (WS FORM: F-6)

STATION: HILLSBORO OR
MONTH: JUNE
YEAR: 2010
LATITUDE: 45 32 N
LONGITUDE: 122 57 W

TEMPERATURE IN F:							:PCPN:	SNOW:		WIND			:SUNSHINE:	SKY			:PK WND	
1	2	3	4	5	6A	6B	7	8	9	10	11	12	13	14	15	16	17	18
									12Z	AVG	MX	2MIN						
DY	MAX	MIN	AVG	DEP	HDD	CDD	WTR	SNW	DPTH	SPD	SPD	DIR	MIN	PSBL	S-S	WX	SPD	DR
1	61	48	55	-5	10	0	0.11	M	0	3.5	13	180	M	M	10		16	170
2	63	50	57	-3	8	0	0.35	0.0	0	10.3	21	170	M	M	10	1	24	280
3	59	42	51	-9	14	0	0.26	M	0	2.1	12	220	M	M	7	1	29	330
4	62	47	55	-5	10	0	0.43	M	0	5.0	M	M	M	M	9	18	M	M
5	72	41	57	-3	8	0	0.00	0.0	0	2.7	10	170	M	M	2		14	220
6	63	54	59	-2	6	0	1.44	0.0	0	2.3	8	270	M	M	10	18	10	260
7	69	50	60	-1	5	0	0.00	0.0	0	3.5	9	320	M	M	7		12	320
8	69	46	58	-3	7	0	0.12	M	0	3.8	10	170	M	M	3		M	260
9	63	50	57	-4	8	0	0.17	0.0	0	8.5	21	250	M	M	9	1	29	250
10	60	50	55	-6	10	0	0.22	0.0	0	4.4	15	230	M	M	9	1	20	230
11	62	49	56	-6	9	0	0.00	0.0	0	3.7	13	310	M	M	8		16	310
12	83	44	64	2	1	0	0.00	0.0	0	3.8	12	310	M	M	0	1	15	310
13	70	47	59	-3	6	0	0.00	0.0	0	9.2	20	320	M	M	1		24	320
14	63	42	53	-9	12	0	0.00	0.0	0	6.9	18	310	M	M	5		24	320
15	57	42	50	-12	15	0	0.39	M	0	2.2	16	360	M	M	8	1	23	360
16	60	41	51	-12	14	0	0.00	0.0	0	3.2	14	280	M	M	9	1	16	280
17	62	48	55	-8	10	0	0.01	M	0	3.6	14	300	M	M	10	1	17	310
18	69	44	57	-6	8	0	0.01	M	0	4.7	15	320	M	M	6		17	310
19	65	53	59	-4	6	0	0.01	0.0	0	3.3	13	310	M	M	10		15	310
20	60	52	56	-7	9	0	T	0.0	0	1.3	7	320	M	M	10	18	14	220
21	66	50	58	-5	7	0	0.00	0.0	0	2.1	8	290	M	M	10		9	330
22	75	48	62	-2	3	0	0.00	0.0	0	2.3	9	30	M	M	4		14	20
23	82	54	68	4	0	3	0.00	0.0	0	2.9	21	310	M	M	0		24	310
24	81	49	65	1	0	0	0.00	0.0	0	3.7	13	290	M	M	0		16	330
25	74	53	64	0	1	0	0.00	0.0	0	4.9	12	310	M	M	4		16	60
26	77	49	63	-1	2	0	0.00	0.0	0	1.9	9	30	M	M	4		12	40

Water District

Model Development – Data Gathering

2011 Water Demand Model

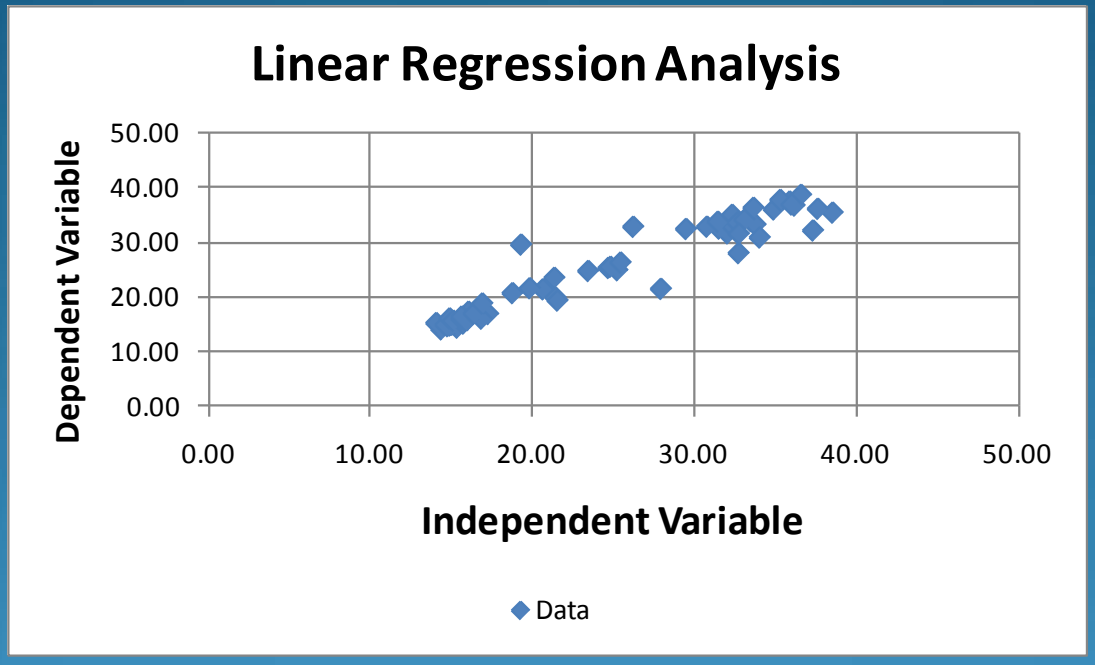
Hillsboro Weather

Date	Month	Year	Net Demand (MG)		Hillsboro High Temp (F)	Hillsboro Precip (in)		Net Demand day-1	High Temp day-1	Precip day-1
6/1/2010	June	2010	14.93		61	0.11		15.07	60	0.11
6/2/2010	June	2010	15.23		63	0.35		14.93	61	0.11
6/3/2010	June	2010	14.46		59	0.26		15.23	63	0.35
6/4/2010	June	2010	14.05		62	0.43		14.46	59	0.26
6/5/2010	June	2010	15.27		72	0.00		14.05	62	0.43
6/6/2010	June	2010	15.02		63	1.44		15.27	72	0.00
6/7/2010	June	2010	14.96		69	0.00		15.02	63	1.44
6/8/2010	June	2010	14.99		69	0.12		14.96	69	0.00
6/9/2010	June	2010	14.54		63	0.17		14.99	69	0.12
6/10/2010	June	2010	14.73		60	0.22		14.54	63	0.17
6/11/2010	June	2010	14.91		62	0.00		14.73	60	0.22
6/12/2010	June	2010	16.11		83	0.00		14.91	62	0.00
6/13/2010	June	2010	17.42		70	0.00		16.11	83	0.00
6/14/2010	June	2010	16.78		63	0.00		17.42	70	0.00
6/15/2010	June	2010	15.88		57	0.00		16.78	63	0.00
6/16/2010	June	2010	15.68		60	0.00		15.88	57	0.00
6/17/2010	June	2010	15.17		62	0.01		15.68	60	0.00
6/18/2010	June	2010	15.66		69	0.01		15.17	62	0.01
6/19/2010	June	2010	15.96		65	0.01		15.66	69	0.01
6/20/2010	June	2010	15.60		60	0.00		15.96	65	0.01
6/21/2010	June	2010	16.29		66	0.00		15.60	60	0.00
6/22/2010	June	2010	16.99		75	0.00		16.29	66	0.00
6/23/2010	June	2010	18.95		82	0.00		16.99	75	0.00
6/24/2010	June	2010	20.87		81	0.00		18.95	82	0.00
6/25/2010	June	2010	21.19		74	0.00		20.87	81	0.00
6/26/2010	June	2010	23.60		77	0.00		21.19	74	0.00
6/27/2010	June	2010	24.78		81	0.00		23.60	77	0.00
6/28/2010	June	2010	25.23		75	0.00		24.78	81	0.00
6/29/2010	June	2010	24.67		68	0.00		25.23	75	0.00
6/30/2010	June	2010	25.62		71	0.00		24.67	68	0.00
7/1/2010	July	2010	26.05		62	0.16		25.62	71	0.00
7/2/2010	July	2010	32.56		64	0.29		26.05	62	0.16

2010 | 2009 | 2008 | 2007 | Previous Day Demand model | Jun-Sept data | June model | July model

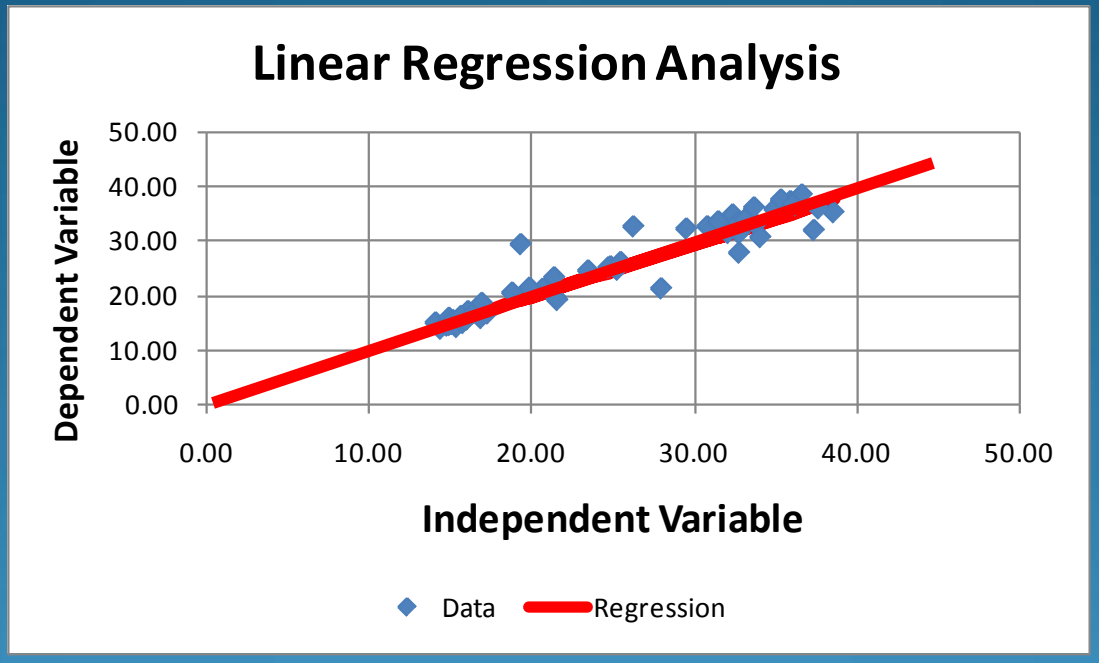
n Valley Water District

Model Development – Data Analysis



Tualatin Valley Water District

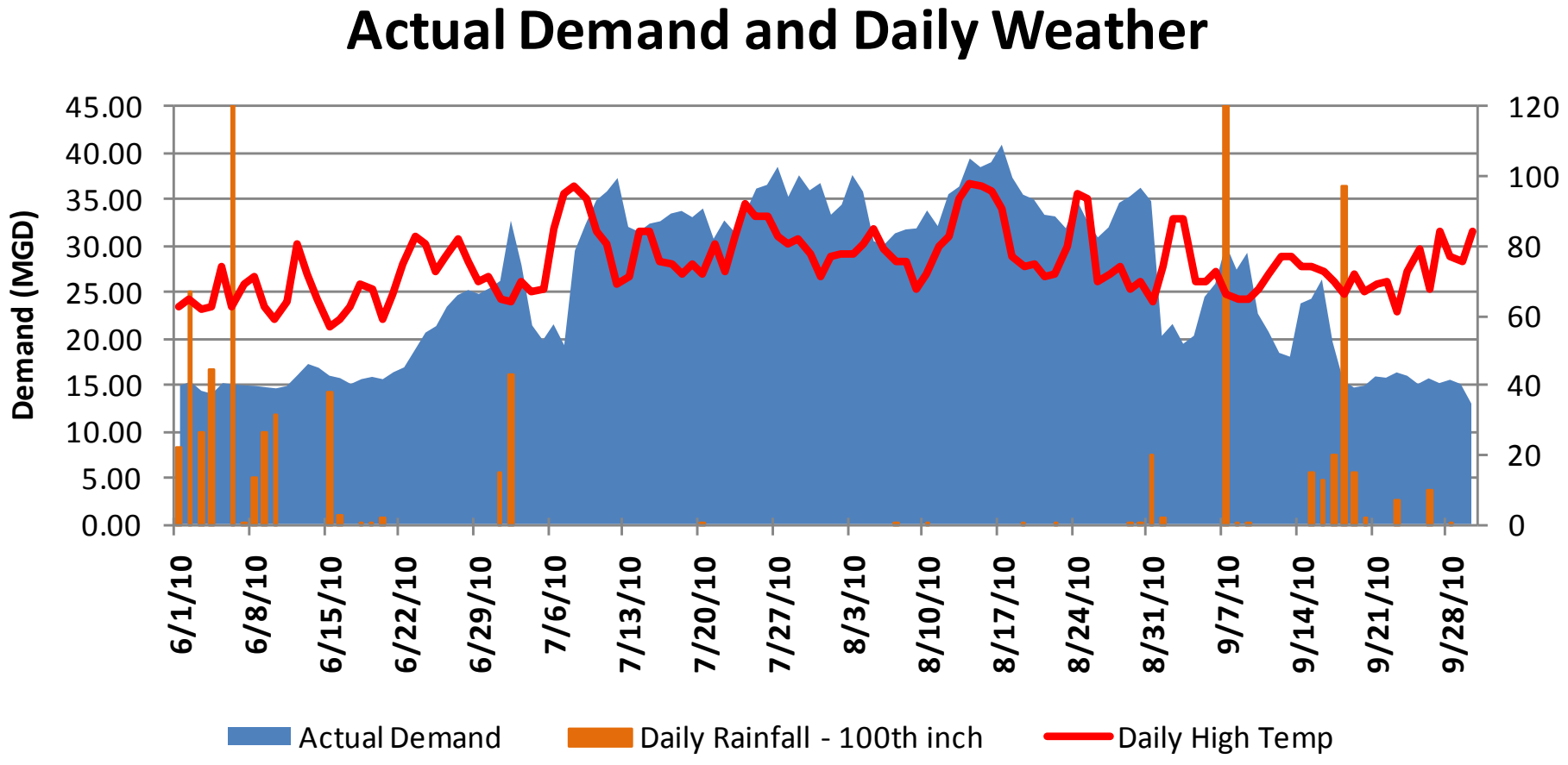
Model Development – Data Analysis



- $Y = mX + b$
  - Y = dependent variable
  - X = independent variable
  - m = coefficient (slope)
  - b = intercept
  - R^2 = residual, "fit"

Tualatin Valley Water District

Model Development – Data Analysis



Tualatin Valley Water District

Model Development – Data Analysis

- Multivariate regression based on …
  - Net water demand for previous day (actual)
  - High temperature for today (forecast)
  - Precipitation for today (forecast)
  - High temperature for yesterday (actual)
  - Precipitation for yesterday (actual)

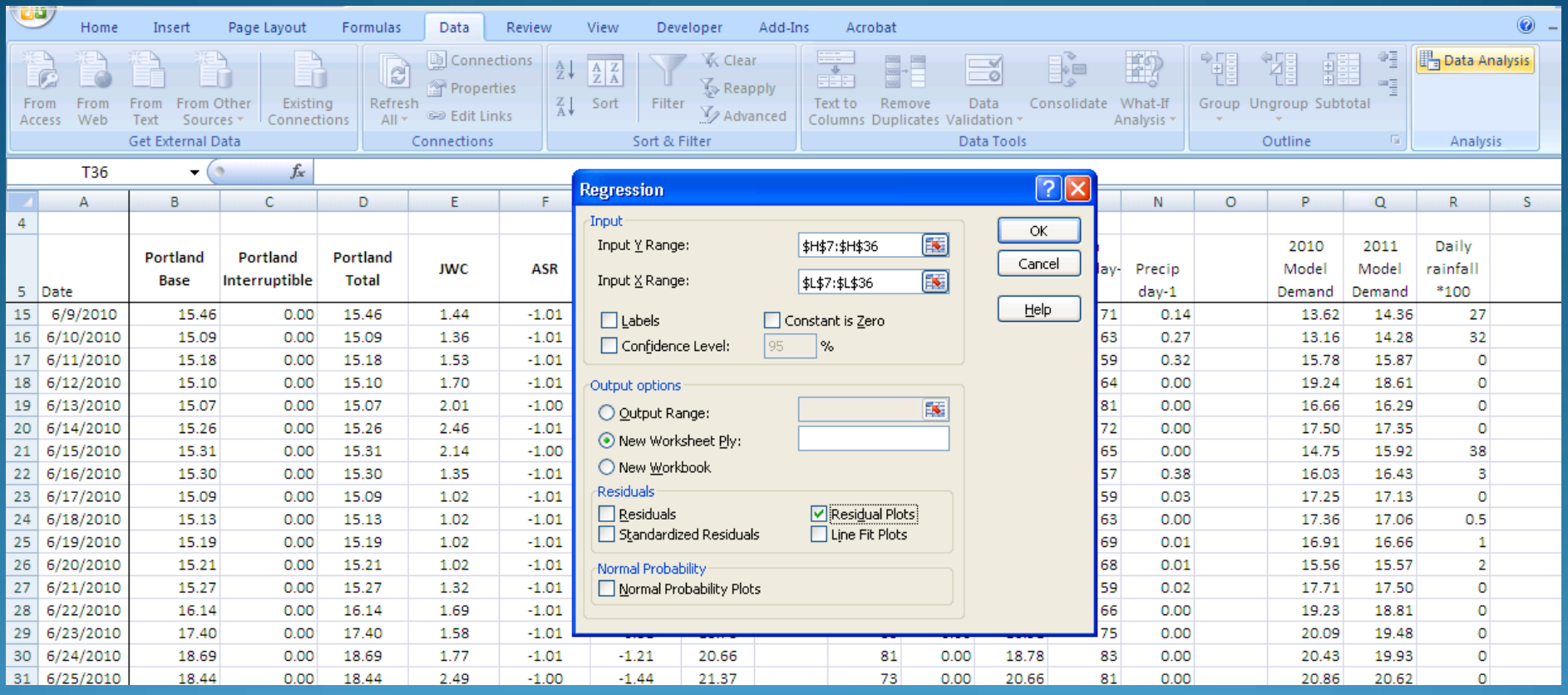
Tualatin Valley Water District

Model Development – Data Analysis

- $Y = b + m_1X_1 + m_2X_2 + m_3X_3 + m_4X_4 + m_5X_5$
  - Y = predicted demand for today (MGD)
  - b = intercept
  - m_1X_1 = yesterday's flow & coefficient
  - m_2X_2 = today's forecast high temp & coefficient
  - m_3X_3 = today's forecast precipitation & coefficient
  - m_4X_4 = yesterday's high temp & coefficient
  - m_5X_5 = yesterday's precipitation & coefficient
- Developed from 2008 & 2009 data
  - June, July, August & September by month

Tualatin Valley Water District

Model Development – Data Analysis



	Date	Portland Base	Portland Interruptible	Portland Total	JWC	ASR								Precip day-1		2010 Model Demand	2011 Model Demand	Daily rainfall *100
15	6/9/2010	15.46	0.00	15.46	1.44	-1.01							71	0.14		13.62	14.36	27
16	6/10/2010	15.09	0.00	15.09	1.36	-1.01							63	0.27		13.16	14.28	32
17	6/11/2010	15.18	0.00	15.18	1.53	-1.01							59	0.32		15.78	15.87	0
18	6/12/2010	15.10	0.00	15.10	1.70	-1.01							64	0.00		19.24	18.61	0
19	6/13/2010	15.07	0.00	15.07	2.01	-1.00							81	0.00		16.66	16.29	0
20	6/14/2010	15.26	0.00	15.26	2.46	-1.01							72	0.00		17.50	17.35	0
21	6/15/2010	15.31	0.00	15.31	2.14	-1.00							65	0.00		14.75	15.92	38
22	6/16/2010	15.30	0.00	15.30	1.35	-1.01							57	0.38		16.03	16.43	3
23	6/17/2010	15.09	0.00	15.09	1.02	-1.01							59	0.03		17.25	17.13	0
24	6/18/2010	15.13	0.00	15.13	1.02	-1.01							63	0.00		17.36	17.06	0.5
25	6/19/2010	15.19	0.00	15.19	1.02	-1.01							69	0.01		16.91	16.66	1
26	6/20/2010	15.21	0.00	15.21	1.02	-1.01							68	0.01		15.56	15.57	2
27	6/21/2010	15.27	0.00	15.27	1.32	-1.01							59	0.02		17.71	17.50	0
28	6/22/2010	16.14	0.00	16.14	1.69	-1.01							66	0.00		19.23	18.81	0
29	6/23/2010	17.40	0.00	17.40	1.58	-1.01							75	0.00		20.09	19.48	0
30	6/24/2010	18.69	0.00	18.69	1.77	-1.01	-1.21	20.66		81	0.00	18.78	83	0.00		20.43	19.93	0
31	6/25/2010	18.44	0.00	18.44	2.49	-1.00	-1.44	21.37		73	0.00	20.66	81	0.00		20.86	20.62	0

Tualatin Valley Water District

Model Development – Data Analysis

	A	B	C	D	E	F	G	H	I	J
1	JUNE ONLY - HILLSBORO									
2	SUMMARY OUTPUT									
3										
4	*Regression Statistics*									
5	Multiple R	0.978774								
6	R Square	0.957998								
7	Adjusted R Square	0.956155								
8	Standard Error	1.398318								
9	Observations	120								
10										
11	ANOVA									
12		*df*	*SS*	*MS*	*F*	*gnificance F*				
13	Regression	5	5084.023	1016.805	520.0266	1.06E-76				
14	Residual	114	222.9035	1.955293						
15	Total	119	5306.926							
16										
17		*Coefficients*	*ndard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*	
18	Intercept	-1.3096	1.27616	-1.02621	0.306966	-3.83767	1.218458	-3.83767	1.218458	
19	Hillsboro High Temp (F)	0.170596	0.020796	8.203513	3.95E-13	0.129401	0.211792	0.129401	0.211792	
20	Hillsboro Precip (in)	-2.09158	0.818571	-2.55516	0.011931	-3.71316	-0.47	-3.71316	-0.47	
21	Net Demand day-1	0.904134	0.025847	34.98066	8.58E-63	0.852932	0.955336	0.852932	0.955336	
22	High Temp day-1	-0.11248	0.022633	-4.96992	2.38E-06	-0.15732	-0.06765	-0.15732	-0.06765	
23	Precip day-1	-1.64126	0.814159	-2.0159	0.046162	-3.2541	-0.02842	-3.2541	-0.02842	
24										
25										
26										

ter District

Variable Testing & Model Performance

Variable / Option	Weather Station	r Squared				
		June	July	Aug	Sept	Mean
Previous day's Q	Hillsboro	0.924	0.751	0.747	0.788	0.802
Previous Q & Today high T	Hillsboro	0.925	0.767	0.749	0.795	0.809
Prev Q, T, P and Today T, P	Hillsboro	0.958	0.815	0.873	0.807	0.863
Prev Q, T, P and Today T, P	Portland	0.957	0.822	0.875	0.811	0.866

Tualatin Valley Water District

Variable Testing & Model Performance

Variable / Option	Weather Station	r Squared				
		June	July	Aug	Sept	Mean
Previous day's Q	Hillsboro	**0.924**	0.751	0.747	**0.788**	0.802
Previous Q & Today high T	Hillsboro	0.925	0.767	0.749	0.795	0.809
Prev Q, T, P and Today T, P	Hillsboro	**0.958**	0.815	0.873	**0.807**	0.863
Prev Q, T, P and Today T, P	Portland	0.957	0.822	0.875	0.811	0.866

Observations

- Previous day's net demand adequate to predict June & Sept demands

Tualatin Valley Water District

Variable Testing & Model Performance

Variable / Option	Weather Station	r Squared				
		June	July	Aug	Sept	Mean
Previous day's Q	Hillsboro	0.924	**0.751**	**0.747**	0.788	0.802
Previous Q & Today high T	Hillsboro	0.925	0.767	0.749	0.795	0.809
Prev Q, T, P and Today T, P	Hillsboro	0.958	**0.815**	**0.873**	0.807	0.863
Prev Q, T, P and Today T, P	Portland	0.957	0.822	0.875	0.811	0.866

Observations

- Previous day's net demand adequate to predict June & Sept demands
- Addition of weather data improves performance in July & August

Tualatin Valley Water District

Variable Testing & Model Performance

Variable / Option	Weather Station	r Squared				
		June	July	Aug	Sept	Mean
Previous day's Q	Hillsboro	0.924	0.751	0.747	0.788	0.802
Previous Q & Today high T	Hillsboro	0.925	0.767	0.749	0.795	0.809
Prev Q, T, P and Today T, P	Hillsboro	**0.958**	**0.815**	**0.873**	**0.807**	**0.863**
Prev Q, T, P and Today T, P	Portland	**0.957**	**0.822**	**0.875**	**0.811**	**0.866**

Observations

- Previous day's net demand adequate to predict June & Sept demands
- Addition of weather data improves performance in July & August
- Portland weather data offers marginal improvement over Hillsboro

Tualatin Valley Water District

Variable Testing & Model Performance

Variable / Option	Weather Station	r Squared				
		June	July	Aug	Sept	Mean
Previous day's Q	Hillsboro	0.924	0.751	0.747	0.788	0.802
Previous Q & Today high T	Hillsboro	0.925	0.767	0.749	0.795	0.809
Prev Q, T, P and Today T, P	Hillsboro	0.958	0.815	0.873	0.807	0.863
Prev Q, T, P and Today T, P	Portland	**0.957**	**0.822**	**0.875**	**0.811**	0.866

Observations

- Previous day's net demand adequate to predict June & Sept demands
- Addition of weather data improves performance in July & August
- Portland weather data offers marginal improvement over Hillsboro
- Model captures 81% to 96% of day-to-day variability in demand

Tualatin Valley Water District

Variable Testing & Model Performance

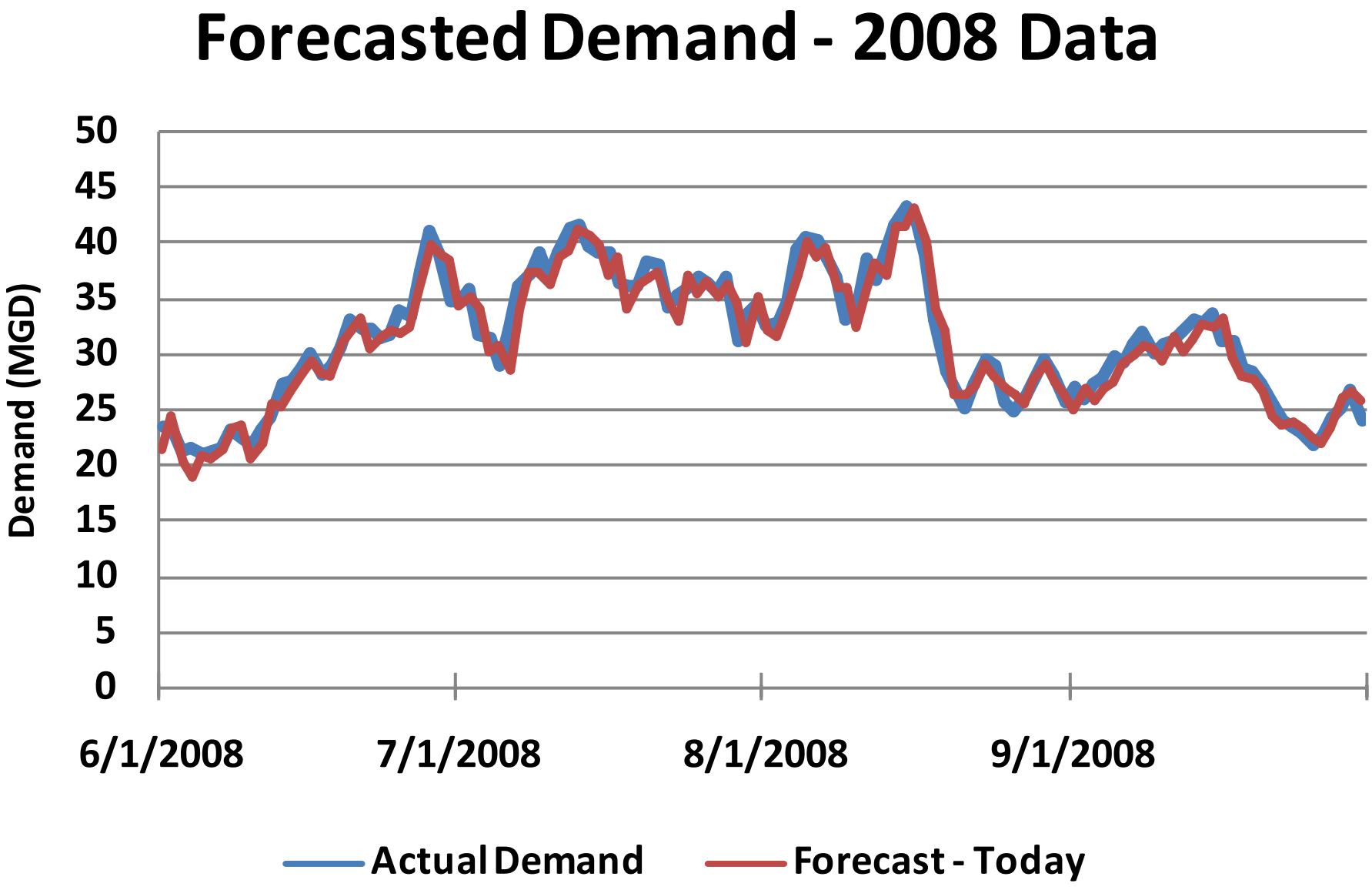
Variable / Option	Weather Station	r Squared				
		June	July	Aug	Sept	Mean
Previous day's Q	Hillsboro	0.924	0.751	0.747	0.788	0.802
Previous Q & Today high T	Hillsboro	0.925	0.767	0.749	0.795	0.809
Prev Q, T, P and Today T, P	Hillsboro	0.958	0.815	0.873	0.807	0.863
Prev Q, T, P and Today T, P	Portland	0.957	0.822	0.875	0.811	**0.866**

Observations

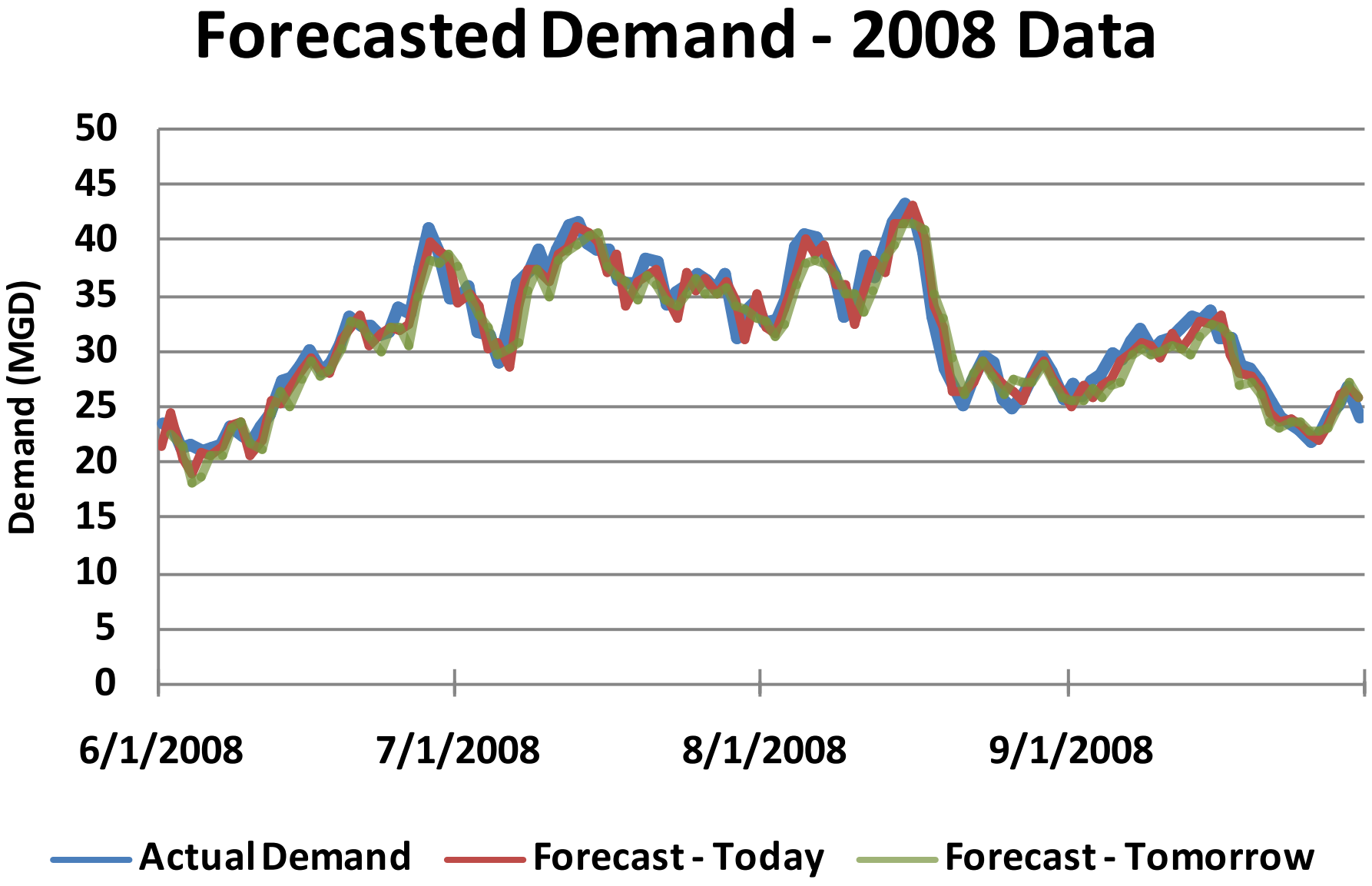
- Previous day's net demand adequate to predict June & Sept demands
- Addition of weather data improves performance in July & August
- Portland weather data offers marginal improvement over Hillsboro
- Model captures 81% to 96% of day-to-day variability in demand
- Model captures 87% of day-to-day variability in demand over summer

Tualatin Valley Water District

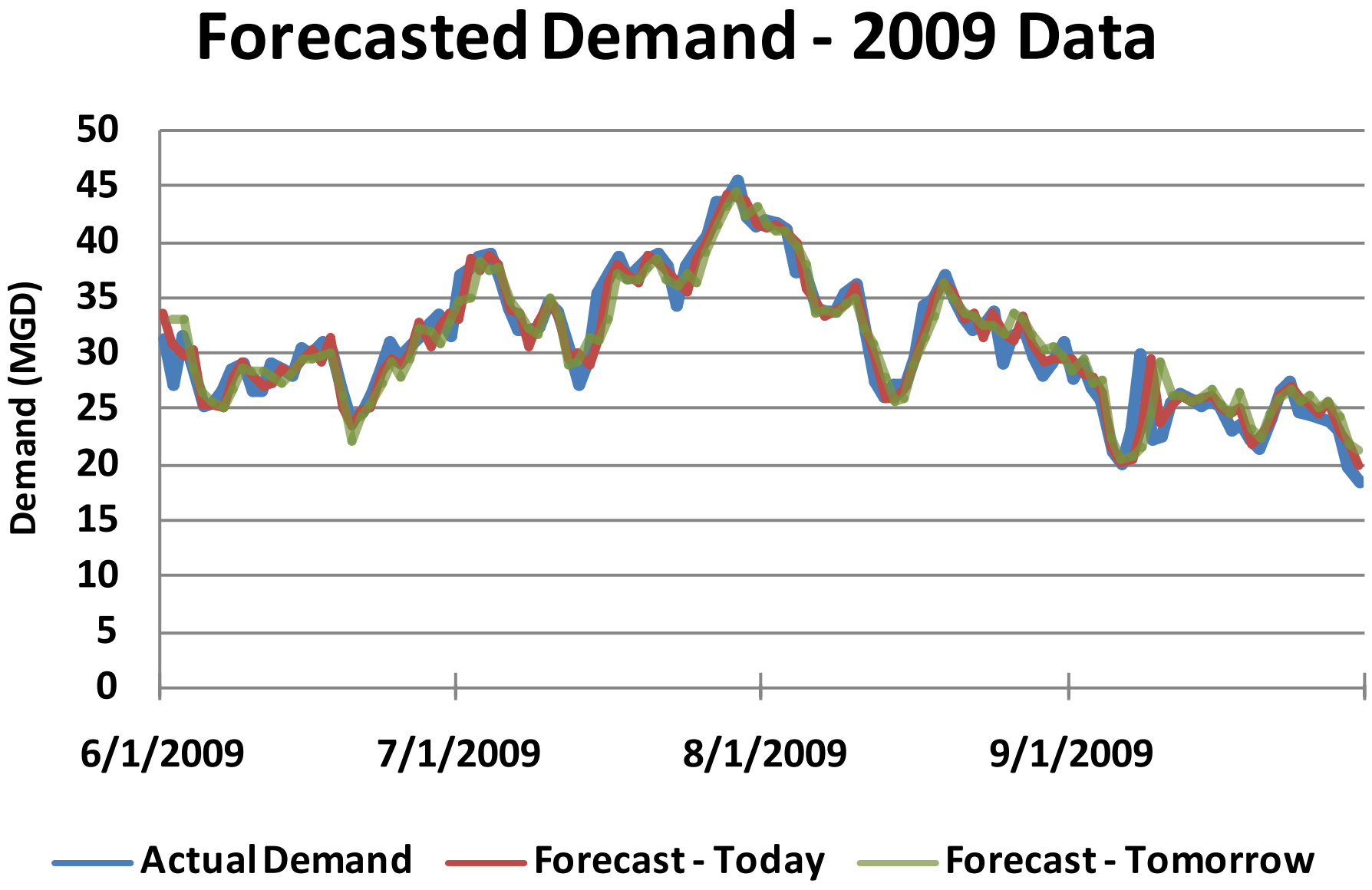
Model Testing



Model Testing

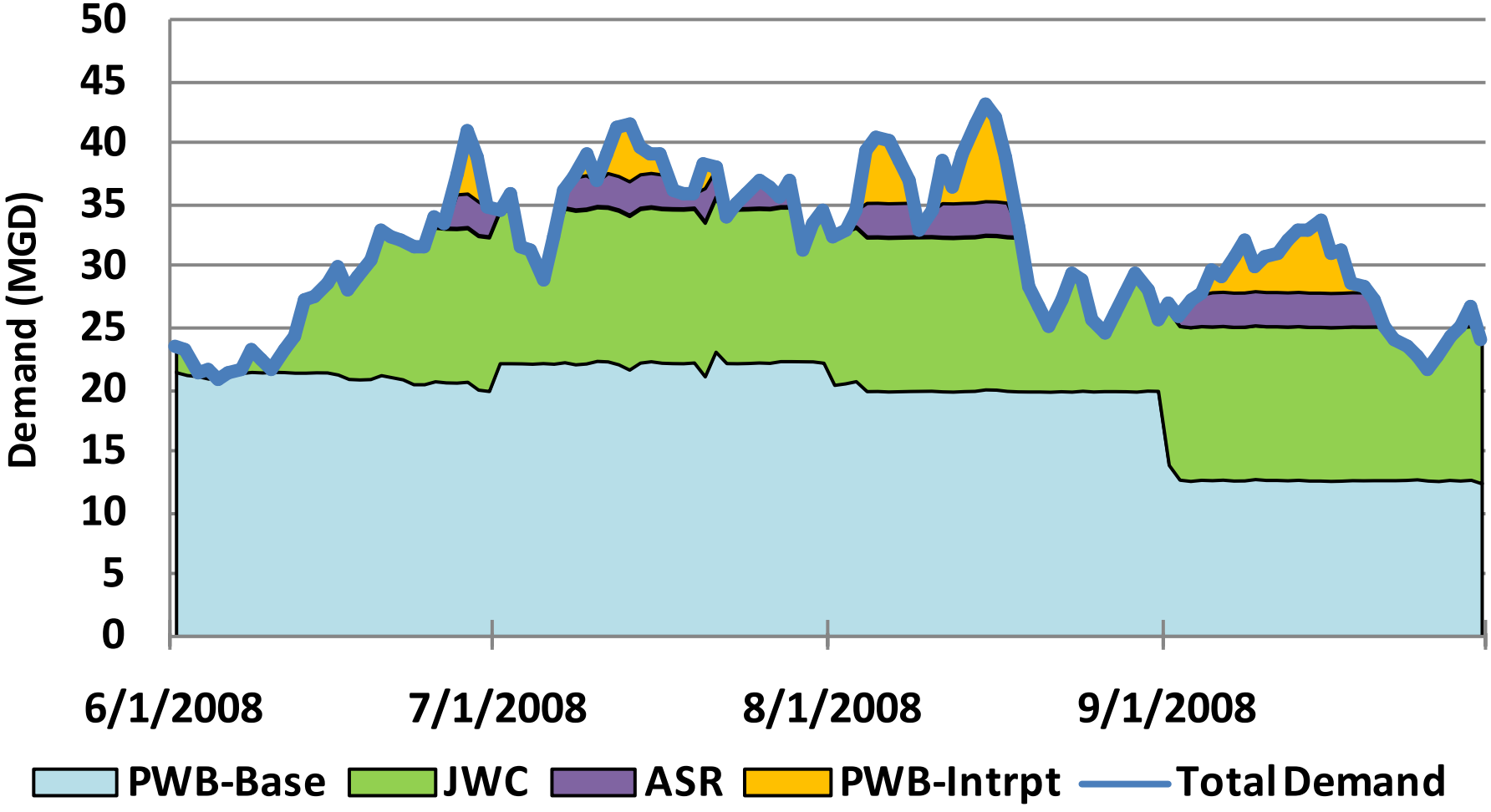


Model Testing



Operational Plan Development

Possible 2010 Operation - 2008 Data



Operator Interface

Tualatin Valley Water District

TVWD Water Demand Forecasting Tool

Version 3.3

PRINT WORKSHEET EACH DAY

Yellow - Entered by Operator
Blue - Calculated by Tool

Step 1 - Enter Data:

Comments / Notes

Today		Enter Today's Date - mm/dd/yyyy:	4/23/2010
Yesterday	Thursday, April 22, 2010	Yesterday's Actual Net Demand - MG:	14.23
		Yesterday's Actual High Temp - degrees F:	54
		Yesterday's Actual Rainfall - inches:	0.03
Today	Friday, April 23, 2010	Today's Forecast High Temp - degrees F:	52
		Today's Forecast Rainfall - inches:	0.48
Tomorrow	Saturday, April 24, 2010	Desired Increase (+) or Decrease (-) in Storage - MG:	3.20
		Tomorrow's Forecast High Temp at PDX - degrees F:	49
		Tomorrow's Forecast Rainfall at PDX - inches:	0.06
Second Day	Sunday, April 25, 2010	Second Day's Forecast High Temp at PDX - degrees F:	53
		Second Day's Forecast Rainfall at PDX - inches:	0.00

From Daily Water Report - incl

Weather Data

Enter decreases in storage wit

Step 2 - Water Demand Forecast Results:

Tomorrow	Saturday, April 24, 2010	Tomorrow's Forecast Net Demand - MG:	11.18
		Tomorrow's Desired Change in Storage:	3.20
		Tomorrow's Forecast Total Demand - MG (including storage):	14.38
Second Day	Sunday, April 25, 2010	Second Day's Forecast Net Demand - MG:	12.55

Operator Interface

AccuWeather.com for Portland, OR GO

Home | Forecast | Radar & Maps | News & Video | Severe Weather | Social

Currently | Weekend | Extended Forecast | Month

< April 2011 | View: | May | 2011

	High	Low	Precip (in)	Snow (in)	Forecast
Sun 5/1/2011	67°	38°	0.00	0.0	
Mon 5/2/2011	61°	48°	trace	0.0	
Tue 5/3/2011	60°	45°	0.03	0.0	
Wed 5/4/2011	70°	41°	0.00	0.0	
Thu 5/5/2011	60°	47°	0.05	0.0	
Fri 5/6/2011	**61°**	48°	0.17	0	Mostly cloudy, showers around
Sat 5/7/2011	**56°**	45°	0.27	0	Occasional rain and drizzle

Operator Interface

AccuWeather.com for Portland, OR GO

Home | Forecast | Radar & Maps | News & Video | Severe Weather | Social

Currently | High Temp | kend | Precip | ed Forecast | Month

< April 2011 | View: | May | 2011

	High	Low	Precip (in)	Snow (in)	Forecast
Sun 5/1/2011	67°	38°	0.00	0.0	
Mon 5/2/2011	61°	48°	trace	0.0	
Tue 5/3/2011	60°	45°	0.03	0.0	
Wed 5/4/2011	70°	41°	0.00	0.0	
Thu 5/5/2011	60°	47°	0.05	0.0	
Fri 5/6/2011	**61°**	48°	0.17	0	Mostly cloudy, showers around
Sat 5/7/2011	**56°**	45°	0.27	0	Occasional rain and drizzle

Yesterday (actual)

Today & Tomorrow (forecast)

trict

Operator Interface

Tualatin Valley Water District

TVWD Water Demand Forecasting Tool

Version 3.3

PRINT WORKSHEET EACH DAY

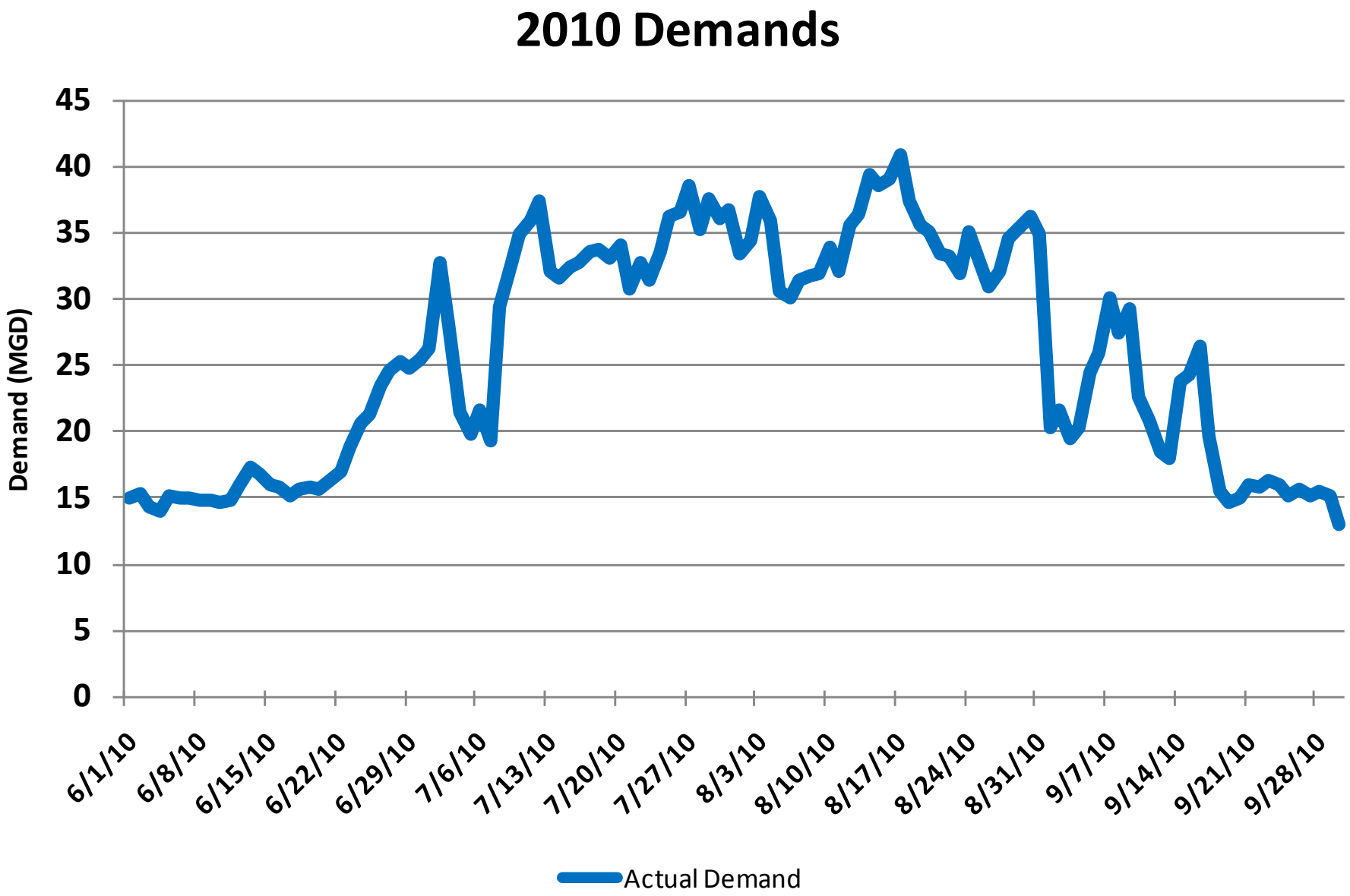
Yellow - Entered by Operator
Blue - Calculated by Tool

Step 3 - Plan Water Supply Flows:

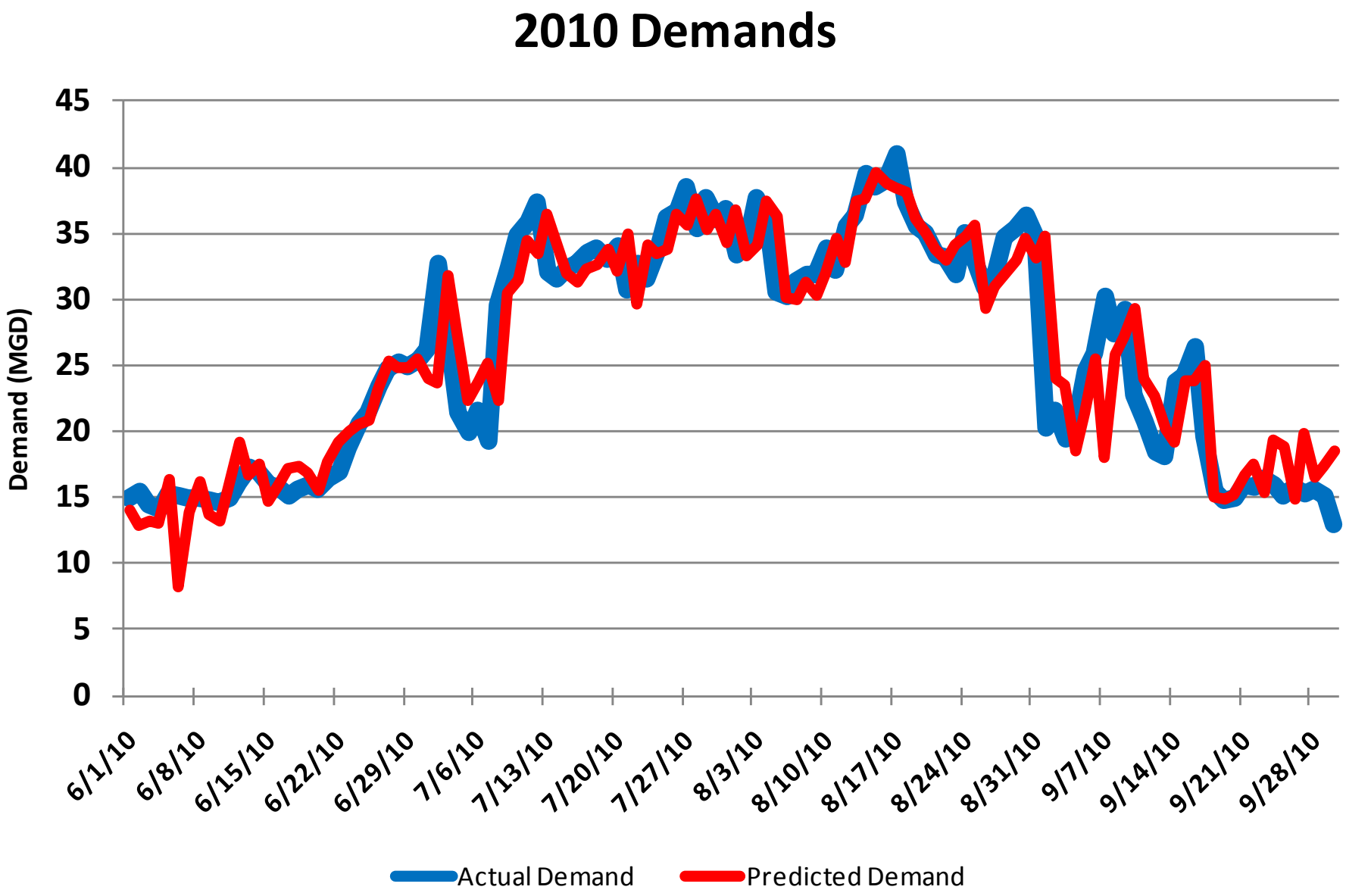
Tomorrow	Saturday, April 24, 2010	Portland Base Supply - MG	10.75	OKAY
		JWC Total - MG	5.30	OKAY
		ASR Total - MG (enter recharge as negative number)	-1.73	OKAY
		Portland Interruptible Supply - MG	0.00	OKAY
		Total Planned Supply - MG	14.32	OKAY
Second Day	Sunday, April 25, 2010	Portland Base Supply - MG	10.75	OKAY
		JWC Total - MG	3.50	OKAY
		ASR Total - MG (enter recharge as negative number)	-1.73	OKAY
		Portland Interruptible Supply - MG	0.00	OKAY
		Total Planned Supply - MG	12.52	OKAY
TWO DAY AVERAGE	Average of Tomorrow and the Second Day	Portland Base Supply - MG	10.75	
		JWC Total - MG	4.40	Use this value when ordering .
		ASR Total - MG (recharge is negative number)	-1.73	
		Portland Interruptible Supply - MG	0.00	
		Total Planned Supply - MG	13.42	

Tualatin Valley Water District

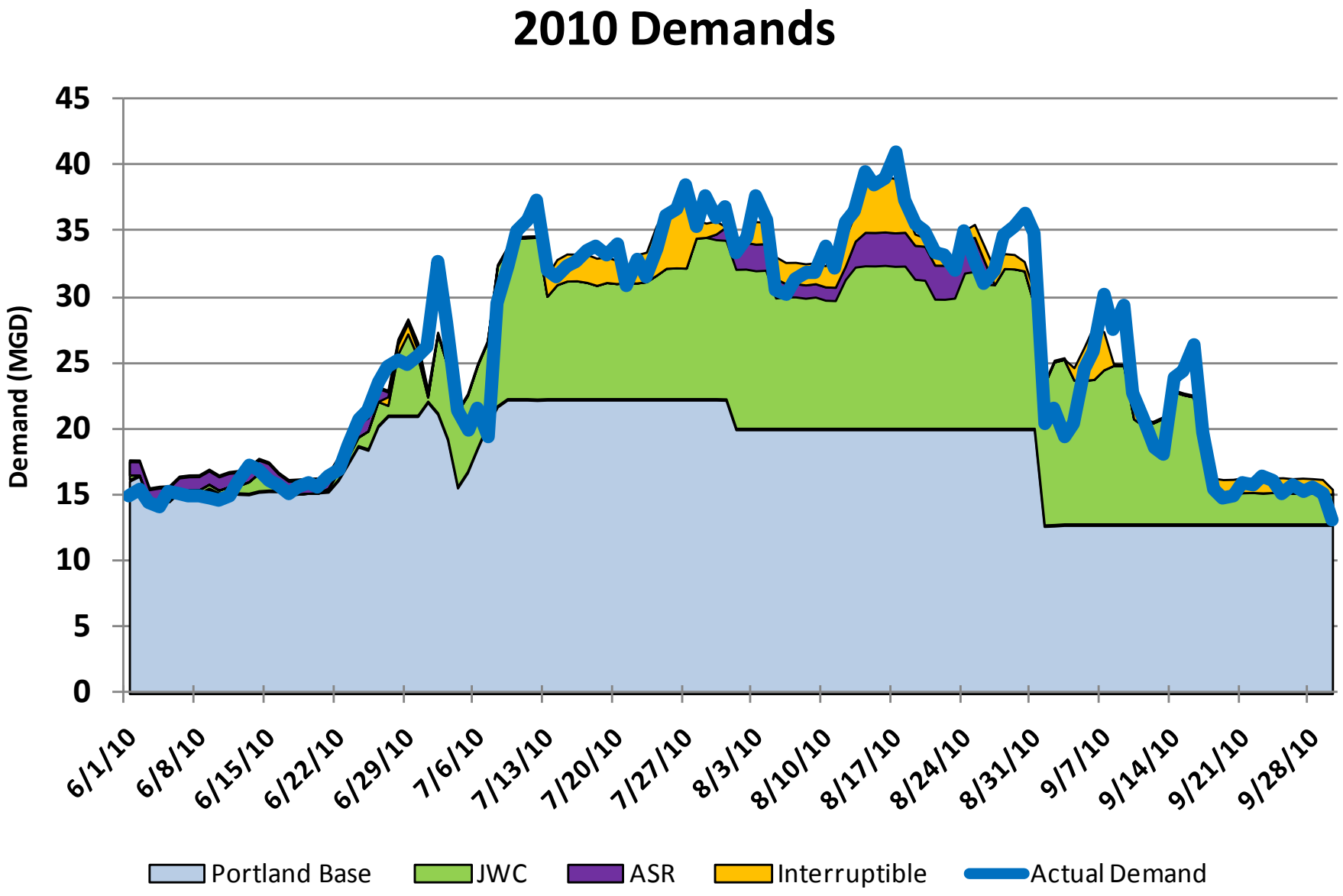
2010 Model Performance



2010 Model Performance



2010 Model Performance



Summer 2010 Operational Performance

Factor	Target	Result	Target Hit?
WATER DEMANDS			
Total Summer Water Demand (MG)	3,727	3,230	No
Portland Minimum Purchase (MG)	2,322	2,163	Almost
Interruptible Water Utilization (MG)	125	120	Almost
JWC Utilization (MG)	1,000	895	No
ASR Utilization (MG)	280	52	No
OPERATIONAL CONTROL			
Portland Peak Season PF	< 1.69	1.39	Yes
Portland Peak 3-Day PF	< 2.25	1.69	Yes
JWC Peak Day Demand (MGD)	< 12.5	12.48	Yes

Tualatin Valley Water District

Summer 2010 Operational Performance

Operator Observations

- “The model took the guesswork out of daily supply planning – especially over weekends.”
- “It helped us accurately anticipate big demand changes when the weather changed.”
- “It was so accurate that we didn’t get enough turnover of the distribution storage reservoirs.”
- “Can we use this to reduce our peaking factors even more next year?”
- “It’s easy to use – even Ron figured it out.”

Tualatin Valley Water District

Conclusions

- TVWD's need to manage four supplies presents unusual challenges and opportunities
- Addition of "Summer Interruptible" in 2010 necessitated new approach to managing supplies
- Accurate short-term demand forecasting is possible using available data and simple tools
- Use of the short-term water demand model:
  - Established consistent demand planning procedures
  - Improved performance to meet operational targets
  - Resulted in lower peaking factors, leading to …
  - Reduced costs of purchased water

Tualatin Valley Water District

Tualatin Valley Water District