

Financing Sustainable Water: Effective Rate Modeling in an Uncertain World

AWE Sales Forecasting and Rate Model

Why a New Rate Model?

Typical water rate models assume that future sales are known with certainty, and do not respond to price, weather, the economy, or supply shortages—that is to say, not the world we live in.

- ▶ The **AWE Sales Forecasting and Rate Model** addresses this deficiency:
 - *Customer Consumption Variability*—weather, drought/shortage, or external shock
 - *Demand Response*—Predicting future block sales (volume and revenue) with empirical price elasticity's
 - *Drought Pricing*—Contingency planning for revenue neutrality
 - *Probability Management*—Risk theoretic simulation of revenue risks
 - *Fiscal Sustainability*—Sales forecasting over a 5 Year Time Horizon
 - *Affordability*—Can customers afford water service?



The screenshot shows the title page and overview of the "Sales Forecasting and Rate Model" by the Alliance for Water Efficiency. The document is titled "Sales Forecasting and Rate Model Version 1.0". The overview section states that typical water rate models assume future sales are known with certainty and do not respond to price, weather, or the economy. The AWE Sales Forecasting and Rate Model addresses this deficiency through several key areas: Customer Consumption Variability, Demand Response, Drought Pricing, Probability Management, and Fiscal Sustainability. The model is divided into two modules: the Rate Design Module and the Revenue Simulation Module. The Rate Design Module helps answer questions about the effect of volumetric rates and block rate design on revenue and water use. The Revenue Simulation Module helps answer sales revenue planning questions addressing risk and uncertainty. The document also includes a section on "What Data is Required to Use the Model" and a footer with navigation links.

Alliance for Water Efficiency
Sales Forecasting and Rate Model
Version 1.0

Overview
Typical water rate models assume that future sales are known with certainty, and do not respond to price, weather, the economy, or supply shortages—that is to say, not the world we live in.

The **AWE Sales Forecasting and Rate Model** addresses this deficiency:

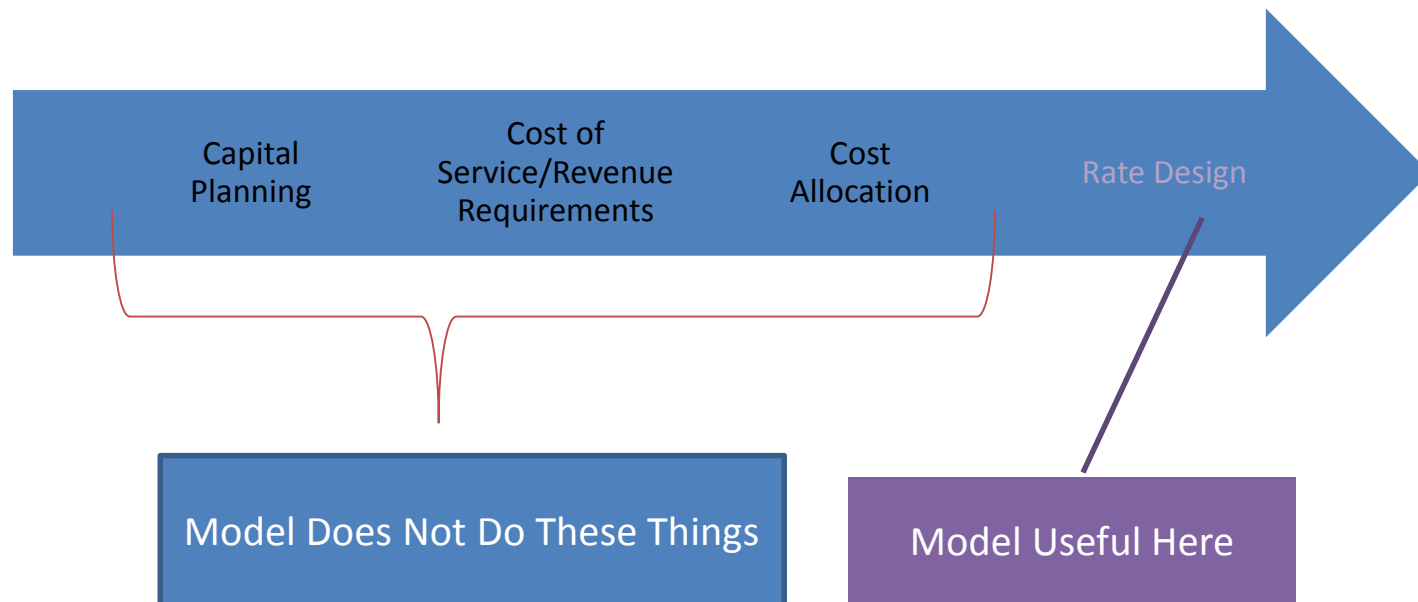
- *Customer Consumption Variability*—weather, drought/shortage, or external shock
- *Demand Response*—Predicting future block sales (volume and revenue) with empirical price elasticities
- *Drought Pricing*—Contingency planning for revenue neutrality
- *Probability Management*—Risk theoretic simulation of revenue risks
- *Fiscal Sustainability*—Sales forecasting over a 5 Year Time Horizon

Model Modules
The model is divided into two modules: the **Rate Design Module** and the **Revenue Simulation Module**. With the **Rate Design Module** you can compare the effect of volumetric rates or proposed new volumetric rates. This module can help you answer questions such as: *What effect would increasing or decreasing volumetric rates have on overall water use to increase or decrease? What block rate design could allow us to preserve our current level of revenue management objectives during water shortages? What proportion of customer bills will increase (or decrease) under our proposed development of effective water rates, and the **Rate Design Module** is designed to help you answer them.* There are other **Model** is not able to answer. These include questions like: *What is the likelihood we will meet our one-year, three-year, five-year sales projections? How likely are we to exceed our current sales projections? What level of confidence can we have that our sales will exceed our current world are unknown. For near-term water sales forecasting the key uncertainties are weather, growth of accounts, and possible revenue.*

Revenue Simulation Module is designed to help answer sales revenue planning questions addressing risk and uncertainty. It is used to simulate future account growth and risk of water use curtailment to simulate your water demands and sales revenues over a five-year period. Using the **Revenue Simulation Module** you can assess how well or poorly your current or proposed rates are likely to perform.

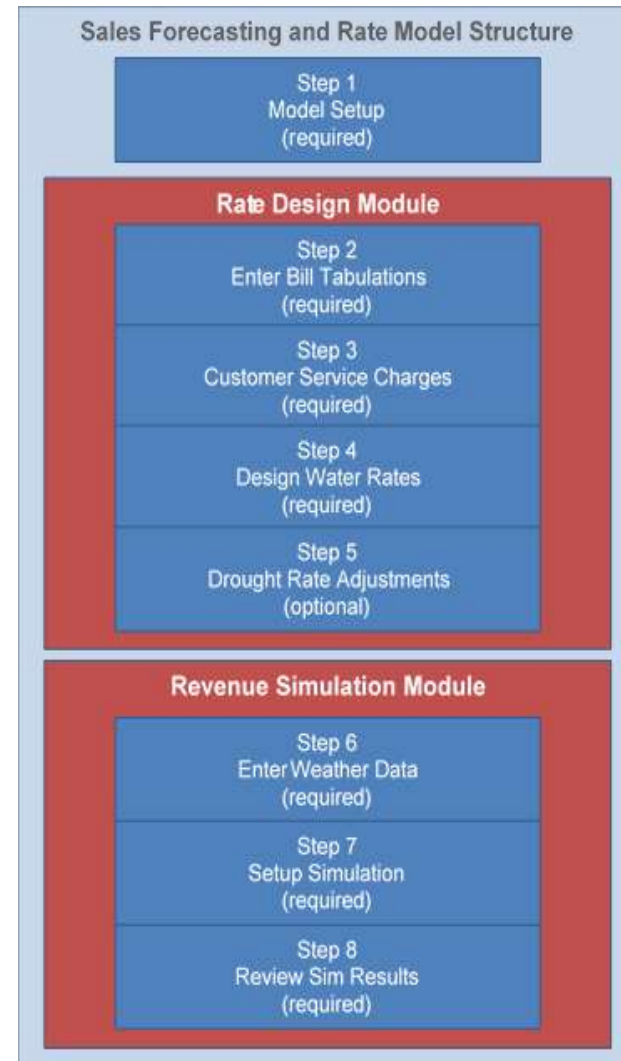
What Data is Required to Use the Model
To use the **Rate Design Module** you need to provide bill tabulations for each of your customer classes. A bill tabulation shows the amount of water used and the amount of revenue generated for each customer class. To use the **Revenue Simulation Module**, in addition to the bill tabulations, you also need to provide the following information: [Water Use Data](#), [Weather Data](#), [Economic Data](#), [Account Growth Data](#), and [Water Use Curtailment Data](#).

WHERE MODEL FITS INTO RATE SETTING PROCESS



Modular Design

- ▶ Rate Design Module
- ▶ Revenue Simulation Module



Model Setup

Step 1: Model Setup

On this worksheet you specify the test year, the units volumes, precipitation, and temperature, seasons, customer classes, and ratio of maximum demand. The model requires these parameters in order to function properly. Therefore this should be the first thing you do if you are using the model on this worksheet. Be sure all sections are completed correctly before moving on to the Rate Design Module.

1. Bill Tabulation Year

The model calculates water sales and sales revenue using the distributions of customer water consumption you enter in Step 2 (Bill Tabulation Year). The model requires consumption data for a recent year. This is called the Bill Tabulation Year. Use the drop-down list below to specify the year for which you want to calculate. Note: The Bill Tabulation Year must be within the last 10 years, and should be a year for which you provide weather data in Step 4, though not necessarily the same year.

Bill Tabulation Year:

2. Model Units

The model needs to know what billing units you use with your water rates. In the U.S., municipal and industrial water use is typically priced per thousand gallons (Thou. Gal.). In countries on the metric system, it is typically priced per kilo liter (kL). Use the drop-down list to select the billing units you use. In Step 6 you will enter historical precipitation and temperature data. Use the drop-down lists to specify units these data are in.

Billing Units: Precipitation Units: Temperature Units:

3. Seasons

The model divides annual water use between Off Peak and Peak seasons. This allows the model to differentiate the change in water use given a rate adjustment (the Peak season is more responsive to rate adjustments than demand in the Off Peak season). It also allows you to specify different water use patterns. Use the drop-down lists to specify the first and last months for the Off Peak season. The model will then determine the months that are in the Peak season. Note: you do not need to specify the months for the Peak season. The model determines this from your specification of the Off Peak season.

Season	From	Thru	No. Months	Season	From	Thru	No. Months
Off Peak:	<input type="text" value="Oct"/>	<input type="text" value="Apr"/>	<input type="text" value="7"/>	Peak:	<input type="text" value="May"/>	<input type="text" value="Sep"/>	<input type="text" value="5"/>

Model Setup

4. Maximum to Minimum Month Production Ratio

The model uses the ratio of maximum to the minimum monthly system production to infer the relative importance of outdoor water use in your service area. Since responsive than indoor use to deviations from normal weather patterns, this is important. Enter the maximum to minimum monthly production ratio in the cell below. Note: It is best to calculate this ratio for several recent years and then enter the average of your results.

Max to Min Monthly Production Ratio:

5. Customer Classes

The model can calculate water use and sales revenue for up to six different customer classes. Use the Number of Customer Classes drop-down list to specify the number you want to model. Enter names for each class in the Class Names table below the drop-down list.

Number of Customer Classes:

Class Names Table

Class 1	Single Family
Class 2	Multi Family
Class 3	CII
Class 4	Landscape
Class 5	Not in use
Class 6	Not in use

6. Median Household Income

The model calculates the change in affordability between your Current and Proposed rates based on the ratio of water cost to median household income. Enter the median household income for your service area and select the Customer Class number you set to your primary residential customer class (e.g. single family customers).

Median household income:

Select the class number you set to your primary residential customer class:

If you have completed this worksheet, go to the Rate Design Module worksheet.

[Go back to Model Overview and Instructions Worksheet](#)

[Go](#)

Rate Design Module

Questions the Rate Design Module Can Address

- ▶ *What effect would increasing the rate in our top tier by 15% have on water demand?*
- ▶ *Will shifting to seasonal rates cause overall water use to increase or decrease?*
- ▶ *What block rate design could allow us to preserve our current level of revenue while reducing overall demand?*
- ▶ *What proportion of customer bills will increase (or decrease) under our proposed rates when compared to our current rates?*
- ▶ *How should we adjust our rates to support our water demand management objectives during water shortages?*

What Rate Designs Can Be Modeled?

▶ Rate Designs

- Uniform
- Seasonal
- Block
- Seasonal Block

▶ Up to 5 blocks

▶ Can vary rates and blocks by customer class

▶ Up to six customer classes

What Data is Needed to Use It?

- ▶ Bill Tabulations from Billing System Data
 - By Class
 - By Season (Off-Peak, Peak)
- ▶ Follows AWWA M1 Bill Tabulation Methodology
- ▶ Allocating Bills to Seasons
 - Easy when bills are rendered monthly
 - Bit harder when bills are rendered bi-monthly or quarterly

Bill Tabulation Screenshot

Step 2: Enter Customer Class Bill Tabulations

On this worksheet, you enter bill tabulations for your Bill Tabulation Year for the customer classes you set up in Step 1. A bill tabulation shows the number of bills may not fall neatly into the seasons you defined in Step 1, creating a seasonal bill tabulation is more challenging than creating an annual bill tabulation. It which this read date corresponds). It will always be the case that consumption will span the two seasons for some bills. In these cases, you will need to have are in the first season, then assign it to the first season). The User Guide provides additional guidance and examples for preparing your bill tabulations. In add using your meter read data.

[Go back to Rate Design Module Worksheet](#)

Usage Bin (Thou. Gal.) From To		Customer Class: Single Family				Customer Class: Multi Family			
		Off Peak Season Oct - Apr		Peak Season May - Sep		Off Peak Season Oct - Apr		Peak Season May - Sep	
		Bills in Bin	Total Use of Bills in Bin (Thou. Gal.)	Bills in Bin	Total Use of Bills in Bin (Thou. Gal.)	Bills in Bin	Total Use of Bills in Bin (Thou. Gal.)	Bills in Bin	Total Use of Bills in Bin (Thou. Gal.)
0	0	1,854	0	700	0	36	0	17	0
1	1	1,781	1,781	601	601	11	11	4	4
2	2	2,073	4,146	631	1,262	12	24	3	6
3	3	3,122	9,366	787	2,361	8	24	5	15
4	4	4,084	16,336	917	3,668	22	88	4	16
5	5	4,974	24,870	1,122	5,610	22	110	9	45
6	6	5,751	34,506	1,150	6,900	20	120	7	42
7	7	6,548	45,836	1,322	9,254	29	203	10	70
8	8	7,080	56,640	1,354	10,832	41	328	6	48
9	9	7,883	70,947	1,385	12,465	49	441	10	90
10	10	8,173	81,730	1,531	15,310	54	540	9	90
11	11	8,333	91,663	1,554	17,094	55	605	10	110
12	12	8,439	101,268	1,588	19,056	45	540	15	180
13	13	8,309	108,017	1,565	20,345	66	858	18	234
14	14	8,377	117,278	1,552	21,728	80	1,120	21	294
15	15	8,082	121,230	1,611	24,165	81	1,215	17	255

Rate Design Table

Block #	Block Switch Point	Rate for Block
Block 1	10	\$2.50
Block 2	20	\$3.00
Block 3		\$3.75
Block 4		\$3.75
Block 5		\$3.75

Rate for first 10 units

Rate for next 10 units

Rate for units in excess of 20

Copy rate in last block to unused blocks

Rate Design Screenshot

Rate Design Tables

Rate Performance Indicators

2. Specify rates for each Customer Class in the tables below.

Use the tables below to specify the Current and Proposed rates for each Customer Class. You can specify uniform, block, seasonal, and seasonal block rates.

Uniform and Uniform Seasonal Designs: Enter the same rate for all five blocks. If you want the uniform rate to vary by season, set a different uniform rate for each season.

Block and Seasonal Block Designs: Enter the blocks and rates for each block level. You can specify up to 5 blocks. If you want fewer blocks than 5 -- say 3 -- then enter the same rate and block information for Block 4 and Block 5 that you did for Block 3. If you want seasonal block rates, you can specify different blocks and/or rates for each season.

Mixed Designs: You can vary the rate design by Customer Class and season. For example, you can specify a block rate for the single family residential class and uniform rates for all other classes. Or you can specify a uniform rate for one season and a block rate for the other.

Single Family

	Off Peak Season				Peak Season			
	Current Rates		Proposed Rates		Current Rates		Proposed Rates	
	Block (CCF)	Rate (\$/CCF)	Block (CCF)	Rate (\$/CCF)	Block (CCF)	Rate (\$/CCF)	Block (CCF)	Rate (\$/CCF)
Block 1	5	\$3.00	5	\$2.50	5	\$3.00	5	\$3.75
Block 2	10	\$3.00	10	\$2.50	10	\$3.00	10	\$3.75
Block 3	15	\$3.00	15	\$2.50	15	\$3.00	15	\$3.75
Block 4	15	\$3.00	15	\$2.50	15	\$3.00	15	\$3.75
Block 5	15	\$3.00	15	\$2.50	15	\$3.00	15	\$3.75

Save/Load Rates button

Save/Load Rates

Rate Performance by Customer Class

	Annual Sales Volume		
	Current	Proposed	% Change
CCF	9,069,061	8,913,705	-1.7%
	Annual Revenue (Thou. \$)		
	Current	Proposed	% Change
Service	\$12,263	\$12,263	0.0%
Volume	\$27,207	\$27,744	2.0%
Total	\$39,470	\$40,007	1.4%

Impact of Proposed Rates Relative to Current Rates

Annual Sales Volume (% Change)

Annual Service & Volume Revenue (% Change)



Bill Impacts Screenshot

Avg and median bill impacts

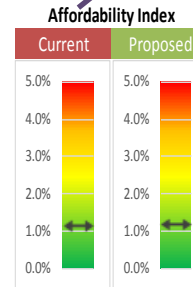
Affordability Indicator

3. Bill impacts of Proposed rates

Under your Proposed rates, the volume charge may go up for some customers and down or stay the same for others. The Bill Impacts Table shows the percentage of bills that will go down, stay the same, or go up -- and by how much. Charts showing the distribution of bill impacts for each customer class are provided on the Bill Impacts worksheet.

% Change in Average and Median Annual Water Service Cost by Customer Class

Customer Class	Average Annual Water Service Cost			Median Annual Water Service Cost		
	Current	Proposed	% Change	Current	Proposed	% Change
Single Family	\$777	\$804	3.4%	\$650	\$672	3.3%
Multi Family	\$4,254	\$4,294	0.9%	\$1,930	\$1,942	0.6%
CII	\$3,323	\$3,382	1.8%	\$1,481	\$1,504	1.5%
Landscape	\$5,599	\$6,007	7.3%	\$2,503	\$2,720	8.7%
Not in use						
Not in use						

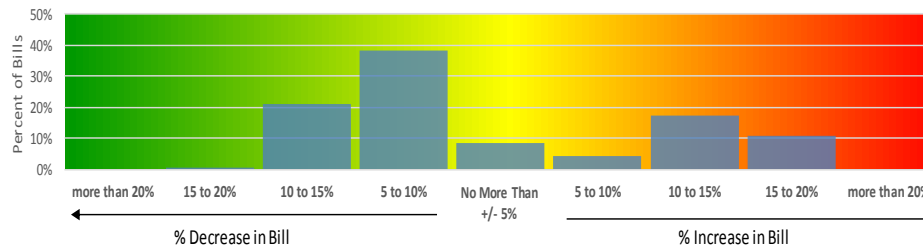


Affordability index equals the median annual water cost for the primary residential customer class divided by median household income.

Bill Impacts Table

Customer Class	% of bills decreasing by				No More Than +/- 5%	% of bills increasing by			
	more than 20%	15 to 20%	10 to 15%	5 to 10%		5 to 10%	10 to 15%	15 to 20%	more than 20%
Single Family	0%	0%	21%	38%	9%	4%	17%	11%	0%
Multi Family	0%	1%	38%	25%	4%	4%	18%	12%	0%
CII	0%	0%	25%	20%	28%	7%	9%	10%	0%
Landscape	0%	0%	26%	12%	33%	2%	6%	20%	0%
Not in use									
Not in use									

Single Family Customer Class Bill Impact Histogram



Bill Impact Histograms

Drought Rates

- ▶ Evaluate rate performance under water use curtailment
- ▶ Up to 4 drought stages can be specified
- ▶ Curtailment levels can vary by customer class
- ▶ User can design rates “by hand”, OR
- ▶ Use built-in calculator to find revenue-neutral rates by drought stage

Specifying Curtailment Levels

Requested curtailment level by stage

1. Specify Curtailment Levels for Drought/Shortage Stages

1. Enter the Customer Class curtailment levels for each stage. If you have fewer than 4 stages, enter the last curtailment level in the unused stages. Stage 0 is the default No Shortage condition. Do not modify the settings for this stage.
2. For each stage, enter the expected compliance rate. The compliance rate can vary by stage. For example, stages with voluntary curtailment may have lower compliance than stages where curtailment is mandatory and enforced. The expected curtailment level for each stage is the product of the stage's curtailment level and the expected compliance rate.

Customer Class	Drought/Shortage Stage Customer Class Curtailment Levels Table					Expected Curtailment				
	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4
Single Family	0%	10%	15%	20%	25%	0%	8%	12%	17%	21%
Multi Family	0%	10%	15%	20%	25%	0%	8%	12%	17%	21%
CII	0%	0%	10%	20%	25%	0%	0%	8%	17%	21%
Landscape	0%	0%	10%	20%	25%	0%	0%	8%	17%	21%
Not in use	0%					0%	0%	0%	0%	0%
Not in use	0%					0%	0%	0%	0%	0%

Enter Expected Compliance %

100%	80%	80%	85%	85%
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Expected compliance rate

Expected curtailment

Designing Drought Rates

Rate Design Tables

Rate Performance Indicators

Drought Stage Selector

2. Rate Performance by Drought/Shortage Stage

The tables in this section hold two sets of rates. Your proposed rates are carried over from Step 3. These rates are used on this worksheet. They are used for calculating the revenue impacts of drought stages. The Stage rates are the rates that would apply for a given drought/shortage stage. To see how your rates would impact annual sales volume and revenue for each Customer Class as well as the rates for each block. You can use trial and error to find rates appropriate to each drought/shortage stage, or you can use Excel's goal-seek or solver functionality to do this. Section 3 provides a calculator that can quickly identify rates for a given drought/shortage stage that are revenue neutral.

Single Family

	Off Peak Season			
	Proposed Rates		Stage 2 Rates	
	Block (CCF)	Rate (\$/CCF)	Block (CCF)	Rate (\$/CCF)
Block 1	5	\$2.50	5	\$2.50
Block 2	10	\$2.50	10	\$2.50
Block 3	15	\$2.50	15	\$2.50
Block 4	15	\$2.50	15	\$2.50
Block 5	15	\$2.50	15	\$2.50

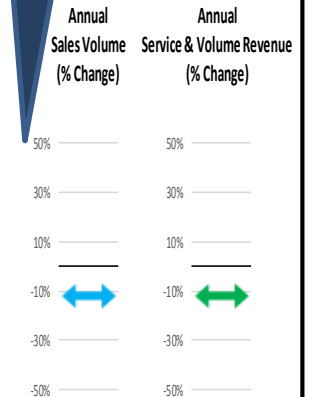
	Peak Season			
	Proposed Rates		Stage 2 Rates	
	Block (CCF)	Rate (\$/CCF)	Block (CCF)	Rate (\$/CCF)
Block 1	5	\$3.75	5	\$3.75
Block 2	10	\$3.75	10	\$3.75
Block 3	15	\$3.75	15	\$3.75
Block 4	15	\$3.75	15	\$3.75
Block 5	15	\$3.75	15	\$3.75

Select Drought Stage

Rate Performance by Customer Class

	Annual Sales Volume		
	Proposed	Stage 2	% Change
CCF	8,913,705	7,844,060	-12.0%
	Annual Sales Revenue (Thou. \$)		
	Proposed	Stage 2	% Change
Service	\$12,263	\$12,263	0.0%
Volume	\$27,744	\$24,415	-12.0%
Total	\$40,007	\$36,678	-8.3%

Impact of Drought Stage Rates Relative to Proposed Rates



Drought Rate Calculator

3. Calculate Revenue Neutral Rates by Drought Stage

The revenue neutral rates calculator will quickly find a set of rates for a given drought/shortage stage that will generate the same revenue as your Proposed rates under a no shortage condition. There are four steps to using the calculator:

1. Choose the drought/shortage stage you want to calculate rates for.
2. Choose the method for calculating the rates. There are two choices. The first choice is to adjust your Proposed rates so that each customer class generates the same revenue it would have generated under your Proposed rates assuming no use curtailment. This may result in significant differences across classes in the amount by which rates are adjusted. The second choice is to adjust your Proposed rates so that all classes when grouped together are revenue neutral. Rates across classes will be adjusted by the same proportionate amount. Revenue neutrality may not hold for individual classes, but overall revenue will be neutral to the Proposed rates assuming no use curtailment.
3. Complete the Leave or Adjust Rate in Block table below. Choose Leave if you want the rate in the block to be the same as it is for your Proposed rates. Choose Adjust if you want the calculator to adjust this rate. For example, if you only want to adjust the upper block rates, choose Leave for lower blocks and Adjust for upper blocks. If you have fewer than 5 blocks, set the unused blocks to the same setting used for your last block.
4. Make desired adjustments to the block widths for the Stage Rates in the Stage Rates tables above.
5. Click the Find Revenue Neutral Rates button.

Note: The calculator will overwrite the rates that are in the Stage Rates tables above. If you want to preserve these rates, save them as a rate scenario by clicking the Save/Load Rates button before using the calculator.

Choose Drought Stage to Evaluate:

Stage 2 ▼

Choose Method for Calculating Revenue Neutral Rates:

1. Scale rates so that each customer class is revenue neutral ▼

Find Revenue Neutral Rates

Reset Drought Stage Rates to Proposed Rates

Save/Load Rates

Leave or Adjust Rate in Block?

Class	Block 1	Block 2	Block 3	Block 4	Block 5
Single Family	Leave	Adjust	Adjust	Adjust	Adjust
Multi Family	Leave	Adjust	Adjust	Adjust	Adjust
CII	Leave	Adjust	Adjust	Adjust	Adjust
Landscape	Leave	Adjust	Adjust	Adjust	Adjust
Not in use	Leave	Leave	Leave	Leave	Leave
Not in use	Leave	Leave	Leave	Leave	Leave

Limitations of the Rate Design Module

Plans based on average assumptions are wrong on average --
Sam Savage, The Flaw of Averages

- ▶ Results only as good as the **bill tabulation** data
- ▶ Can only evaluate how rates will perform **ON AVERAGE**
- ▶ Does not provide insight into **VARIABILITY** of performance
- ▶ That's where the **Revenue Simulation Module** steps in

Revenue Simulation Module

Questions the Simulation Module Can Address

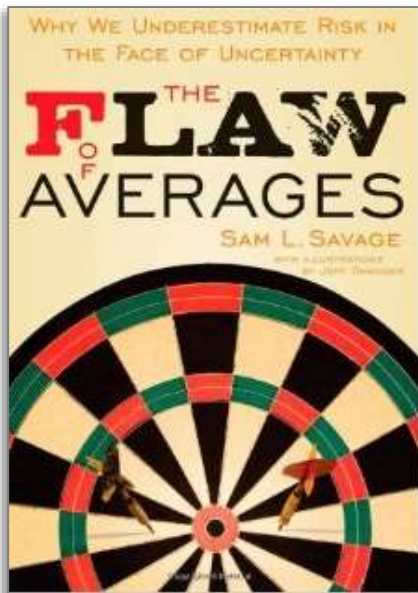
- ▶ *What is the likelihood we will meet our one-year, three-year, five-year revenue targets under our current or proposed rates?*
- ▶ *What is the chance our revenues will turn out more than 15% below our current projections?*
- ▶ *What level of confidence can we have that our sales will exceed our minimum planning estimates?*

Average Outcome vs. Likely Outcomes

Flaw of Averages

- ▶ **Fact 1** – Planning for the future is rife with uncertainties.
- ▶ **Fact 2** - Most people are not happy with Fact 1 and prefer to think of the future in terms of average outcomes.
- ▶ **Fact 3** - The “flaw of averages” states that plans based on average assumptions are, on average, wrong.

-adapted from Savage (2012) Flaw of Averages
www.probabilitymanagement.org



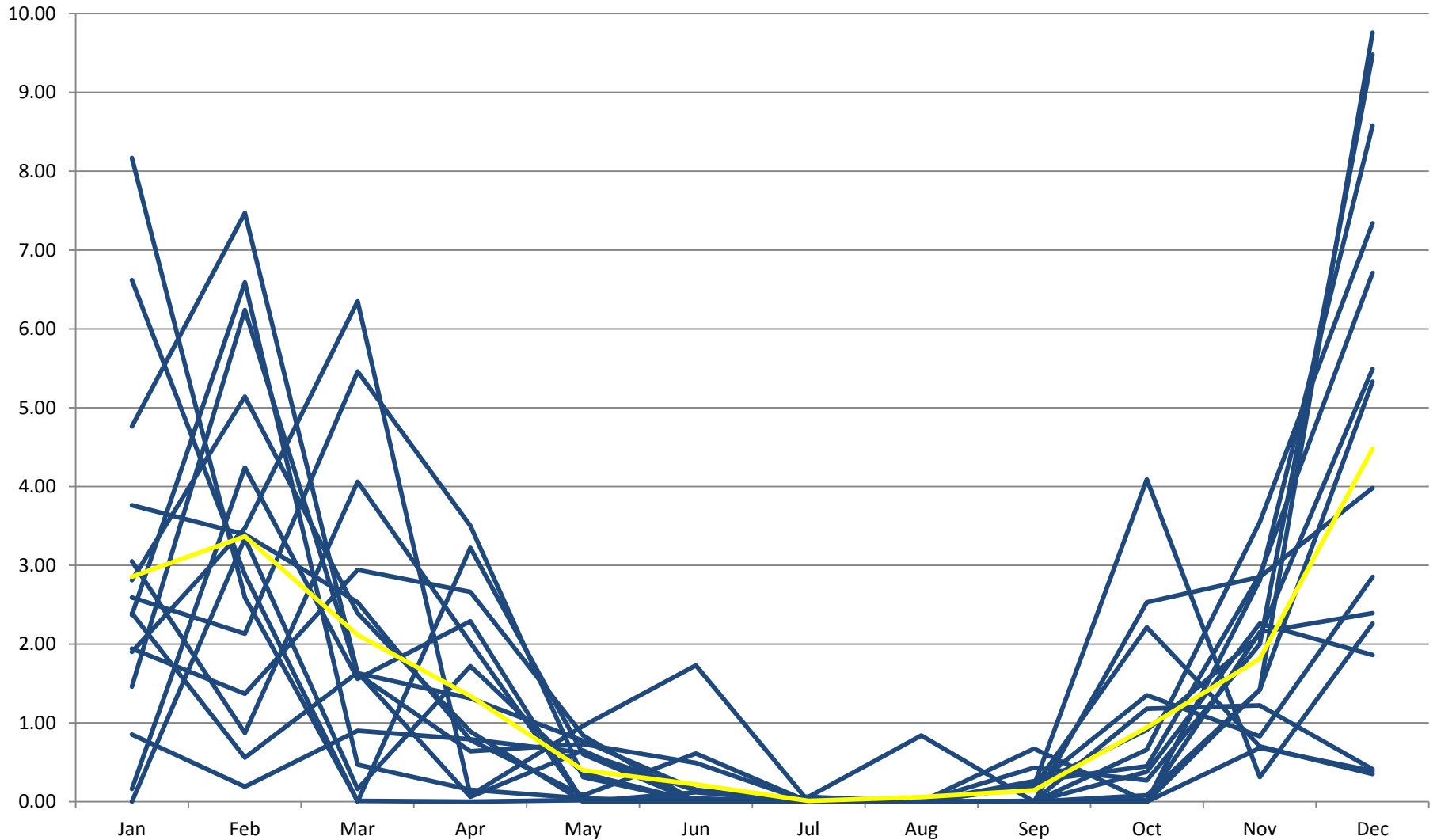
The cyclist is **safe**
on the average
path



On average, the cyclist is **dead**.

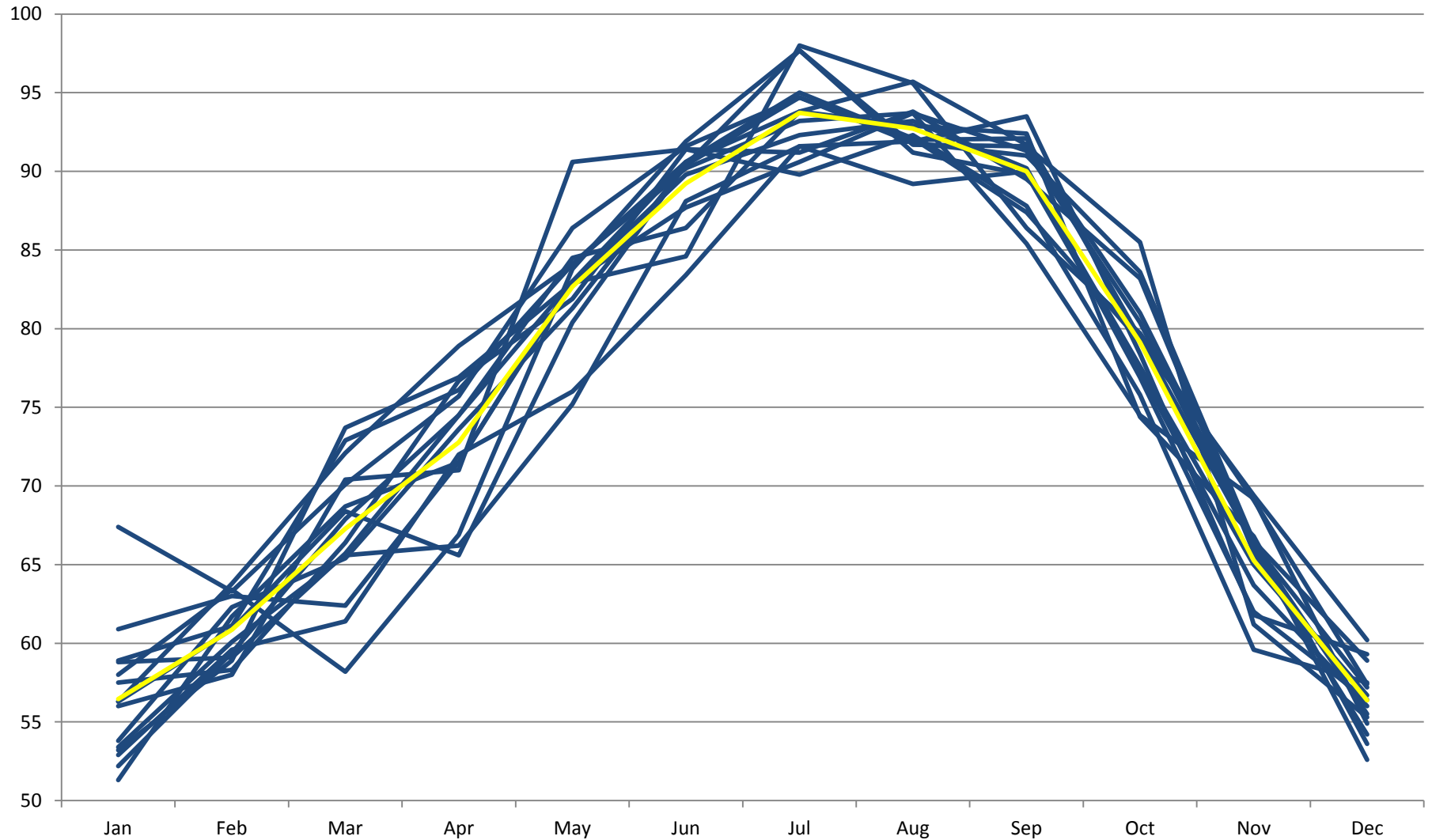
Monthly Precipitation Data 2000-2014

Mean vs. Actual



Temperature Data 2000 – 2014

Mean vs. Actual



Planning for the Future



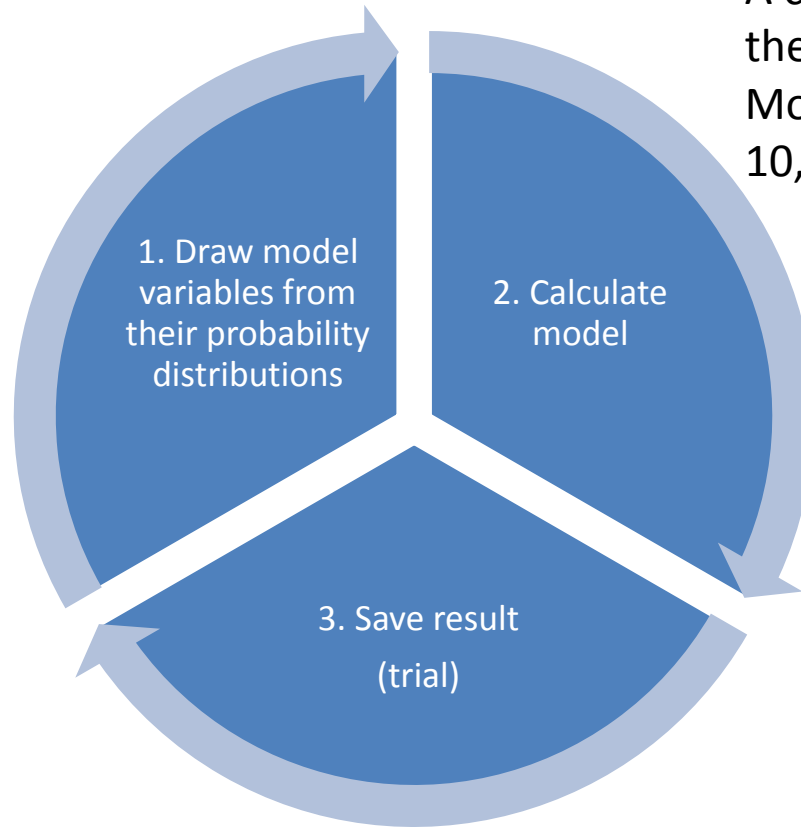
or



How Does It Work?

- ▶ The model focuses on three variables that are key to short-run revenue performance:
 - Weather (historical or synthetic)
 - Growth (projected)
 - Supply disruption/use curtailment (correlated to weather)
- ▶ Two rate designs are simultaneously evaluated:
 - Current rate (reference condition)
 - Proposed rate
- ▶ Monte Carlo Simulation

Simulation Process



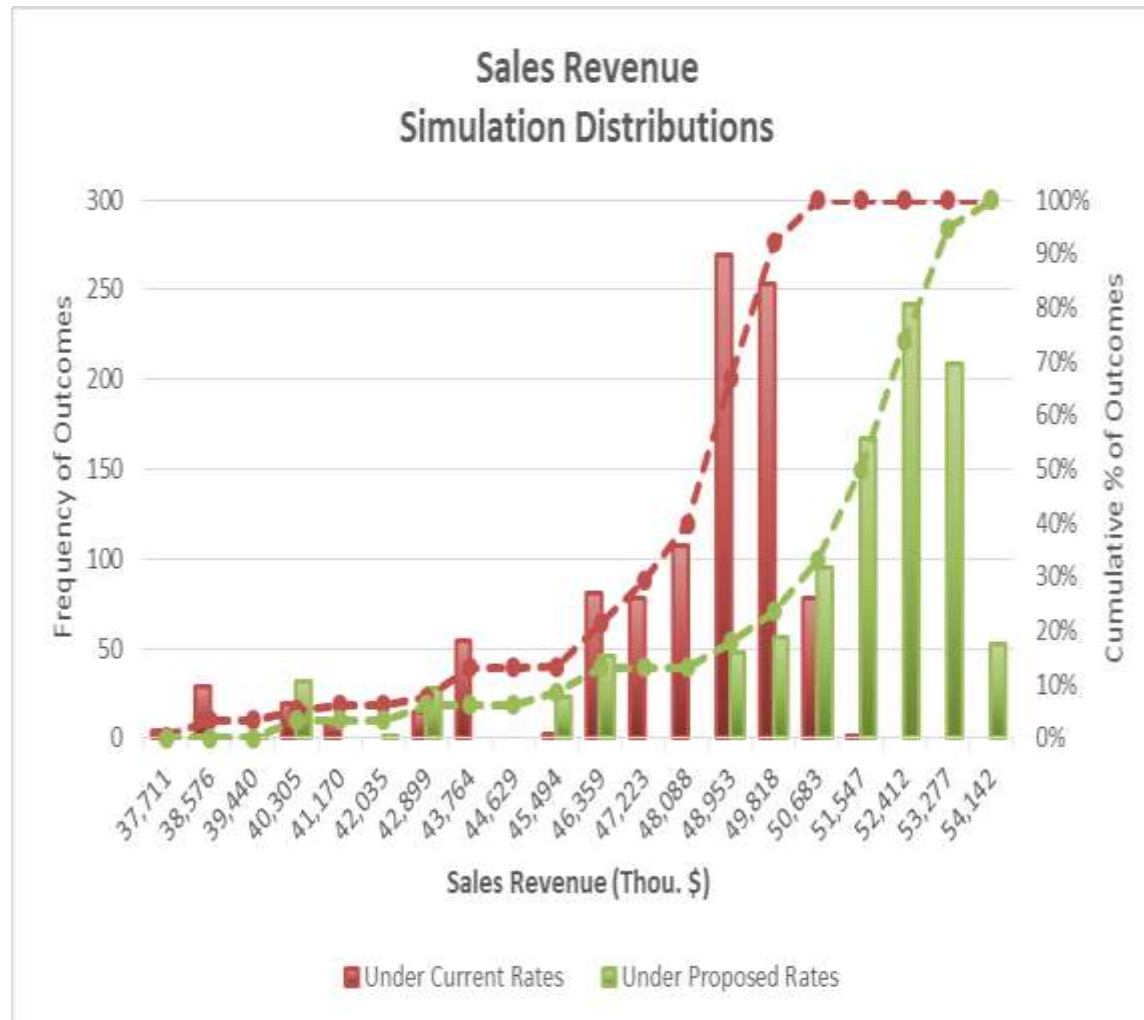
A cycle constitutes 1 trial. In the Revenue Simulation Module, User can simulate 10, 100, 500, or 1000 trials.

Why Simulate?

- ▶ Alternatives to simulation are:
 - Ignore uncertainty (a common strategy)
 - Construct scenarios (also common)
 - Both are problematic
- ▶ Simulation offers:
 - More complete enumeration of possible outcomes
 - Likelihood of particular outcomes



Simulation of Sales Revenue Distribution



Additional Data Needed for Module

▶ Weather

- Monthly Precipitation and Temperature data for Service Area
 - *Historical (up to 90 years), OR*
 - *Synthetic (for example, to simulate impact of climate change)*
- Easy to get historical weather data for service areas – Guidebook recommends several sources for weather data

▶ Customer Class Account Growth

- User specifies Low, Medium, High Account Growth Rates, by Class

Weather Data Screenshot

Step 6: Enter Weather Data to be Used

On this worksheet you enter historical monthly weather data for your service area. You can enter up to a maximum of 90 years of data. It is not required that you provide data for every year. Consult the user guide for information on weather data sources.

[Go back to Revenue Simulation Module Worksheet](#)

Can enter up to 90 yrs. Need at least 15. More is better than less.

1. Set most recent year in your weather data

Enter the most recent year for which you are providing weather data.

Most recent year:

2. Enter Monthly Precipitation Totals (in)

Enter total monthly precipitation in inches for each year of weather data you have for your service area.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012	2.91	1.18	4.17	2.56	0.00	0.04	0.00	0.00	0.00	0.87	4.09	5.83
2011	1.18	4.06	6.26	0.28	0.79	1.93	0.00	0.00	0.00	0.91	1.22	0.08
2010	5.71	2.80	1.93	3.82	1.06	0.00	0.00	0.00	0.00	0.83	1.85	5.71
2009	1.02	6.34	2.36	1.22	0.71	0.00	0.00	0.00	0.16	3.74	0.59	2.40
2008	7.13	1.85	0.12	0.08	0.00	0.00	0.00	0.00	0.04	2.36	1.81	
2007	0.43	3.70	0.24	0.59	0.28	0.00	0.00	0.00	0.12	1.22	0.75	2.40
2006	2.24	1.97	6.26	4.25	1.02	0.00	0.00	0.00	0.00	0.12	1.42	2.95
2005	4.33	3.31	2.60	1.46	1.26	0.28	0.00	0.00	0.00	0.12	0.94	10.04
2004	2.48	5.04	0.91	0.08	0.08	0.00	0.00	0.00	0.08	2.64	2.17	3.90
2003	1.14	0.98	1.46	3.58	0.51	0.00	0.00	0.00	0.00	0.00	1.65	5.94
2002	0.75	1.54	1.89	0.16	1.18	0.00	0.00	0.00	0.00	0.00	2.40	8.66
2001	1.89	5.51	1.10	1.14	0.00	0.12	0.00	0.00	0.12	0.28	3.58	7.01
2000	5.79	8.11	2.01	0.79	1.14	0.08	0.00	0.00	0.04	1.34	0.75	0.39
1999	2.76	5.12	2.48	1.69	0.08	0.00	0.00	0.00	0.00	0.31	2.05	0.51
1998	8.03	12.20	2.09	1.26	2.64	0.00	0.00	0.00	0.16	0.79	3.07	0.67
1997	8.19	0.20	0.24	0.24	0.28	0.20	0.00	0.47	0.00	0.79	5.47	2.56
1996	5.28	5.94	2.44	1.81	1.77	0.00	0.00	0.00	0.00	0.91	2.72	6.89
1995	9.84	0.20	8.62	1.06	1.22	1.18	0.00	0.00	0.00	0.00	0.00	6.77
1994	1.77	3.94	0.20	0.87	1.61	0.00	0.00	0.00	0.00	0.67	5.91	2.48
1993	8.46	4.25	2.13	0.59	0.55	0.39	0.00	0.00	0.00	0.31	2.52	2.36
1992	1.38	5.94	3.11	0.31	0.00	0.28	0.00	0.00	0.00	1.38	0.16	6.02

How your demands may vary in response to weather conditions over the years. It also must be complete across all months for each year. Enter separate rows of the tables. To get reliable

Can modify historical weather for future climate change if desired.

[Go forward to Step 7: Enter Monthly Average Maximum Air Temperature](#)

3. Enter Monthly Average Maximum Air Temperature (degrees F)

Enter the monthly average daily maximum air temperature in degrees Fahrenheit for each year of weather data you have for your service area. Be sure you are entering average daily **maximum** air temperature and not average daily air temperature.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012	61.0	63.0	63.0	70.6	78.6	82.9	85.9	87.3	83.4	75.7	65.8	56.9
2011	56.2	60.5	62.7	69.0	72.4	79.2	84.3	84.5	86.4	76.5	62.8	60.0
2010	55.1	60.8	65.3	66.1	72.5	82.6	84.1	83.3	85.2	74.9	64.7	57.2
2009	60.4	59.1	65.4	70.6	78.6	80.4	86.6	87.1	88.0	73.3	65.7	54.6
2008	53.7	60.8	66.5	71.6	77.7	85.3	86.7	88.5	85.1	78.1	66.9	54.7
2007	58.2	60.8	70.5	72.2	77.7	83.9	86.1	87.0	80.8	72.9	67.4	55.9
2006	58.5	63.2	59.3	66.0	77.8	84.9	91.8	83.9	83.0	74.0	64.2	57.9
2005	52.7	61.3	67.0	68.8	74.9	78.7	89.7	87.2	80.1	75.6	67.8	58.8
2004	55.1	59.7	74.0	75.0	77.9	83.2	85.9	87.0	86.7	73.1	62.2	56.8
2003	59.2	61.5	67.6	64.9	76.6	83.3	91.1	86.3	86.6	81.5	61.7	56.6
2002	55.0	63.0	64.6	69.5	76.1	84.0	87.5	86.1	86.1	76.2	66.9	58.1
2001	57.0	59.2	69.1	67.9	85.9	87.2	84.0	86.4	82.1	78.7	65.9	55.7
2000	58.8	60.0	66.5	72.9	76.9	84.5	82.5	86.1	84.3	73.1	61.0	59.3
1999	55.3	58.5	60.8	69.1	73.0	80.7	83.2	83.3	82.8	79.3	66.4	61.2
1998	56.3	57.6	64.9	67.5	67.3	76.5	85.4	88.9	82.6	73.8	62.3	55.3
1997	56.0	63.4	69.9	73.1	82.6	83.0	86.5	84.6	86.1	75.2	65.5	56.5
1996	57.9	62.1	67.1	72.9	77.5	84.3	89.5	88.9	82.1	75.5	65.1	59.0
1995	57.1	61.3	62.2	68.3	71.7	79.9	86.2	87.7	83.8	79.2	71.2	59.9
1994	58.2	58.4	68.4	70.9	74.1	83.4	84.4	87.0	82.4	75.3	58.0	53.0
1993	54.8	58.7	67.2	69.9	75.8	84.6	85.7	86.6	84.1	76.8	65.3	55.0
1992	52.8	63.7	65.7	74.8	81.9	80.8	85.7	88.8	84.9	79.1	66.6	54.2

Calculation of Weather Effects

- ▶ Based on **CUWCC GPCD Weather Normalization Methodology and Empirical Model**
- ▶ Accounts for
 - Seasonal Shape of Demand
 - Relative Importance of (weather sensitive) Outdoor Use
- ▶ Monthly effects formed into weighted-average seasonal effect
- ▶ Weighting accounts for:
 - Monthly contribution to total seasonal use
 - Strength of monthly weather effect on total seasonal use
- ▶ Weather effect coefficients can be modified by user

Uncertain Account Growth

- ▶ Can simulate with or without growth uncertainty
 - No Growth
 - Certain Growth
 - Uncertain Growth
- ▶ If Uncertain Growth, then Low, Medium, High Growth Rates transformed into probability distribution
 - Normal
 - Triangular
 - Uniform
- ▶ User specifies which distribution to use

Water Use Curtailments

▶ Three Choices

- Exclude from simulation
- Associate with historical weather (preferred method)
- Specify likelihood

Associate Drought Stage with Historical Weather

Preferred Method

3. Enter Monthly Average Maximum Air Temperature (degrees F)

Enter the monthly average daily maximum air temperature in degrees Fahrenheit for each year of weather data you have for your service area. Be sure you are entering average daily **maximum** air temperature and not average daily air temperature.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012	61.0	63.0	63.0	70.6	78.6	82.9	85.9	87.3	83.4	75.7	65.8	56.9
2011	56.2	60.5	62.7	69.0	72.4	79.2	84.3	84.5	86.4	76.5	62.8	60.0
2010	55.1	60.8	65.3	66.1	72.5	82.6	84.1	83.3	85.2	74.9	64.7	57.2
2009	60.4	59.1	65.4	70.6	78.6	80.4	86.6	87.1	88.0	73.3	65.7	54.6
2008	53.7	60.8	66.5	71.6	77.7	85.3	86.7	88.5	85.1	78.1	66.9	54.7
2007	58.2	60.8	70.5	72.2	77.7	83.9	86.1	87.0	80.8	72.9	67.4	55.9
2006	58.5	63.2	59.3	66.0	77.8	84.9	91.8	83.9	83.0	74.0	64.2	57.9
2005	52.7	61.3	67.0	68.8	74.9	78.7	89.7	87.2	80.1	75.6	67.8	58.8
2004	55.1	59.7	74.0	75.0	77.9	83.2	85.9	87.0	86.7	73.1	62.2	56.8
2003	59.2	61.5	67.6	64.9	76.6	83.3	91.1	86.3	86.6	81.5	61.7	56.6
2002	55.0	63.0	64.6	69.5	76.1	84.0	87.5	86.1	86.1	76.2	66.9	58.1
2001	57.0	59.2	69.1	67.9	85.9	87.2	84.0	86.4	82.1	78.7	65.9	55.7
2000	58.8	60.0	66.5	72.9	76.9	84.5	82.5	86.1	84.3	73.1	61.0	59.3
1999	55.3	58.5	60.8	69.1	73.0	80.7	83.2	83.3	82.8	79.3	66.4	61.2
1998	56.3	57.6	64.9	67.5	67.3	76.5	85.4	88.9	82.6	73.8	62.3	55.3
1997	56.0	63.4	69.9	73.1	82.6	83.0	86.5	84.6	86.1	75.2	65.5	56.5
1996	57.9	62.1	67.1	72.9	77.5	84.3	89.5	88.9	82.1	75.5	65.1	59.0
1995	57.1	61.3	62.2	68.3	71.7	79.9	86.2	87.7	83.8	79.2	71.2	59.9
1994	58.2	58.4	68.4	70.9	74.1	83.4	84.4	87.0	82.4	75.3	58.0	53.0
1993	54.8	58.7	67.2	69.9	75.8	84.6	85.7	86.6	84.1	76.8	65.3	55.0
1992	52.8	63.7	65.7	74.8	81.9	80.8	85.7	88.8	84.9	79.1	66.6	54.2
1991	57.8	65.3	59.6	68.5	72.7	77.9	85.1	82.0	84.4	80.6	67.6	57.1
1990	57.0	57.8	65.4	73.3	74.6	81.8	85.8	84.7	83.3	79.2	65.9	53.9
1989	55.6	56.8	63.4	73.5	75.6	80.5	86.4	83.1	79.0	74.5	67.2	57.0
1988	56.2	66.0	70.1	70.9	74.6	81.3	89.2	84.5	83.1	75.7	62.6	57.1
1987	55.2	62.1	64.8	76.2	78.8	81.5	80.9	83.9	82.6	77.7	63.6	55.2

4. Enter Drought Shortage Stage

(Optional) For each hydrologic year you can select what drought/shortage stage would have applied given your current system supplies and customer demands. You can then have the model use this information when it simulates water sales. This is explained further in Step 5 Setup Simulation.

Stage	Index
Stage 0	0
Stage 0	0
Stage 0	0
Stage 2	2
Stage 0	0
Stage 0	0
Stage 0	0
Stage 0	0
Stage 0	0
Stage 0	0
Stage 1	1
Stage 0	0
Stage 0	0
Stage 0	0
Stage 0	0
Stage 0	0
Stage 0	0
Stage 0	0
Stage 0	0
Stage 0	0
Stage 0	0
Stage 4	4
Stage 3	3
Stage 2	2
Stage 1	1
Stage 0	0

Drought Stage association table

Specify Drought Stage Likelihood

Secondary Method

Choose Method for Simulating Impact of Droughts/Shortages on Sales Volumes and Revenues:

Use Stage Probabilities Table ▼

Drought Stage Probabilities Table

Drought Stage	Likelihood of Occurrence	Cumulative Probability
Stage 0	90.00%	90.00%
Stage 1	5.00%	95.00%
Stage 2	2.50%	97.50%
Stage 3	1.50%	99.00%
Stage 4	1.00%	100.00%
	100.00%	

Table Instructions: For each stage, enter the likelihood of occurrence. For example, if historically your system has had no water use curtailments in 90% of years, you would enter 90% for Stage 0. The remaining 10% would then be distributed across the other stages according to the likelihood of each stage's occurrence. The sum of the occurrence likelihoods must sum to 100%.

User specifies probability of occurrence

Simulation Outputs

Summary Statistics

1. Simulation Summary Statistics

Summary statistics for the simulation are provided in the following tables. The average value shows the central tendency while the standard deviation indicates the degree of variability. The minimum and maximum values define the range of outcomes.

----- Results based on 1000 simulation trials -----

Under Current Rates

Sales Volume (CCF)

	Year 1	Year 2	Year 3	Year 4	Year 5
Avg	15,391,247	15,496,019	15,635,586	15,697,702	15,861,245
St Dev	841,193	894,240	880,139	935,512	900,860
Min	12,254,361	12,309,867	12,375,362	12,440,635	12,474,137
Max	16,200,382	16,344,414	16,520,316	16,657,595	16,843,932

Sales Revenue (Thou. \$)

	Year 1	Year 2	Year 3	Year 4	Year 5
Avg	\$69,966	\$70,430	\$70,999	\$71,338	\$71,981
St Dev	\$2,524	\$2,682	\$2,645	\$2,809	\$2,706
Min	\$60,555	\$60,814	\$61,121	\$61,426	\$61,581
Max	\$72,393	\$73,011	\$73,767	\$74,356	\$75,157

Under Proposed Rates

Sales Volume (CCF)

	Year 1	Year 2	Year 3	Year 4	Year 5
Avg	15,155,448	15,259,211	15,397,276	15,457,801	15,619,683
St Dev	829,223	880,884	867,799	922,020	888,074
Min	12,070,660	12,125,441	12,190,075	12,254,491	12,287,565
Max	15,964,343	16,106,516	16,280,144	16,415,657	16,599,589

Sales Revenue (Thou. \$)

	Year 1	Year 2	Year 3	Year 4	Year 5
Avg	\$70,634	\$71,096	\$71,664	\$72,016	\$72,657
St Dev	\$2,551	\$2,719	\$2,670	\$2,842	\$2,735
Min	\$61,031	\$61,292	\$61,600	\$61,908	\$62,063
Max	\$72,994	\$73,573	\$74,308	\$75,010	\$75,705

Simulation Distributions

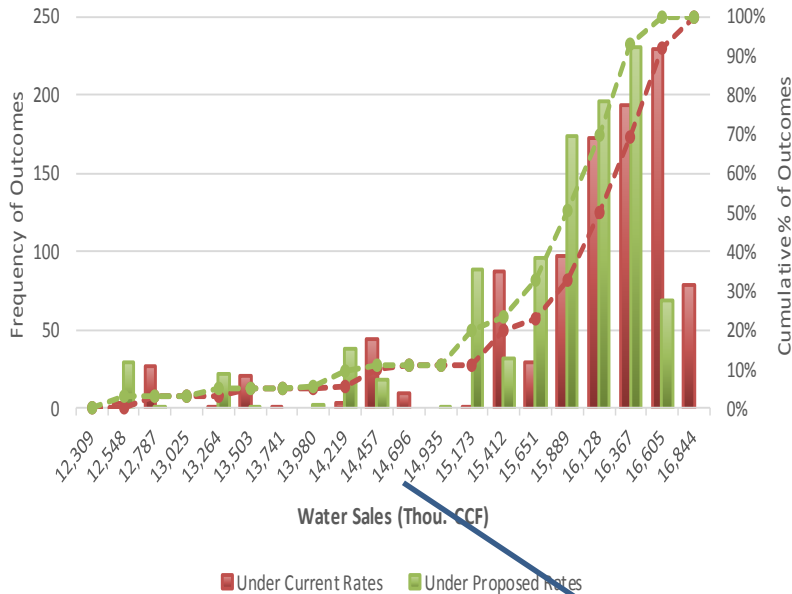
2. Sales Volume and Revenue Distributions

The charts below show the frequency and cumulative distributions for simulated sales volume and revenue. The cumulative distributions (the dashed lines in the charts) show the likelihood of sales volume or revenue being above or below the corresponding value on the x-axis. The frequency distributions (the bars) show the likelihood that sales volume or revenue will fall between the value indicated on the x-axis and the value to its left.

Use the drop-down to choose the forecast year to display:

User selects forecast year

Annual Sales Volume Simulation Distributions



Water Sales

Annual Service Charge and Sales Revenue Simulation Distributions



Annual Revenue

Confidence Intervals

3. Sales Volume and Revenue Confidence Intervals

A 95% confidence interval indicates the range of values such that 95% of all simulation outcomes fall within this interval. Similarly, for a 90% confidence interval, 90% of all simulation outcomes would fall within the interval. More generally, for an x% interval, x% of all simulation outcomes would fall within the interval. This means the probability that the outcome variable will take on a value in the indicated range is x%. The charts below show confidence intervals (by year) for sales volume and revenue under your Current and Proposed rates. You can use the drop-down list to select the desired confidence level for the intervals. As you select higher levels of confidence you will note the intervals widen to accommodate the broader range of potential outcomes.

Use drop-down to select confidence level for sales volume and revenue confidence intervals:

User selects level of confidence for interval (50-95%)



Exceedence Probabilities

4. Determine Sales Revenue Exceedence Probability

The sales revenue exceedence probability gives the probability that sales revenue will equal or exceed a target revenue. Use the Target Cells below to see the likelihood of meeting or exceeding a revenue target under your Current and Proposed rates.

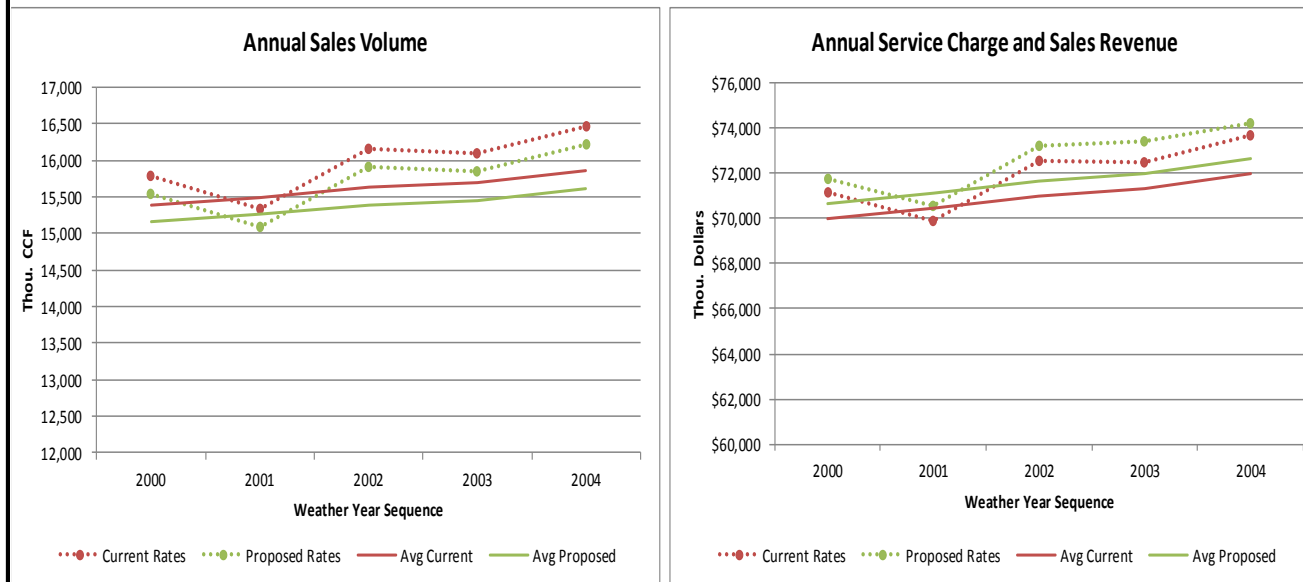


Dynamic Step-Through Charts

5. Step Through the Simulation Trials

You can use the slider bar below the charts to step through each trial of the simulation. The charts display the simulated sales volume and revenue for each forecast year along with the averages across all the trials. The x-axis labels will show the weather year sequence used in the trial. Click the Animate Simulation button to cycle through all the simulations dynamically. If you want to see even more detail, you can access all the simulation output on the Simulation Output worksheet.

Simulation Trial #: 1



Click the Animate Simulation Button to cycle through all the simulation trials dynamically

Animate Simulation

Dynamic charts let user step through each simulation trial

You can type a trial # in the box below to see the results for a specific trial

Simulation Trial Number:

Demo

► Model includes built-in demonstration data and exercises:

- Model setup
- Bill tabulation
- Setting service charges
- Designing volume rates
- Drought rate adjustments
- Simulation

