Financing Sustainable Water: Effective Rate Modeling in an Uncertain World

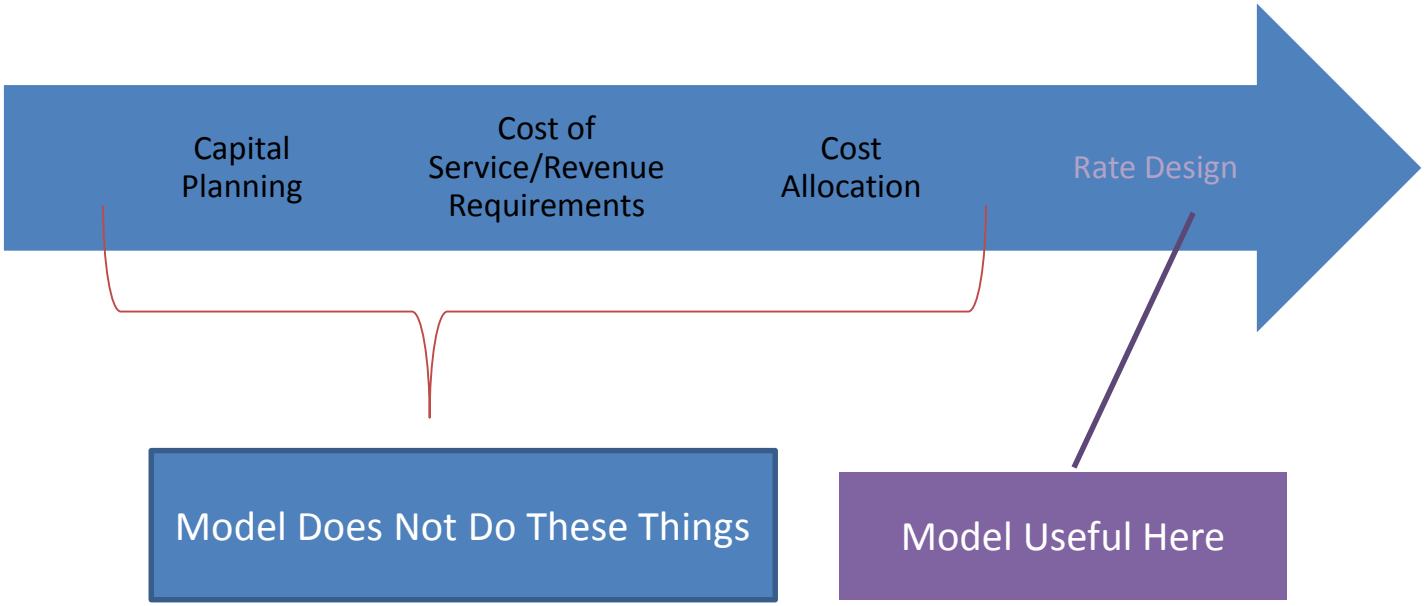
AWE Sales Forecasting and Rate Model

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.

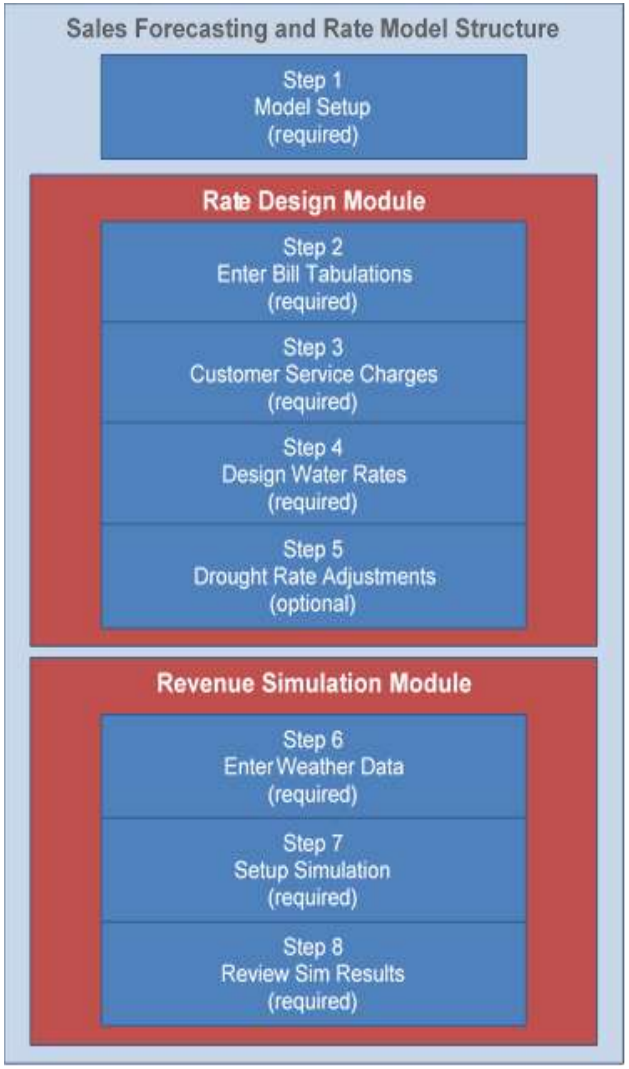
- The **AWE Sales Forecasting and Rate Model** addresses this deficiency:
  - *Customer Consumption Variability*—weather, drought/shortage, or external shock
  - *Demand Response*—Predicting future block sales (volume and revenue) with empirical price elasticity's
  - *Drought Pricing*—Contingency planning 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?

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 max
The model requires these parameters in order to function properly. Therefore this should be the first thing you do if you are using the mod
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 Tabula
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
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

Bill Tabulation Year:	2013

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 price
(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
In Step 6 you will enter historical precipitation and temperature data. Use the drop-down lists to specify units these data are in.

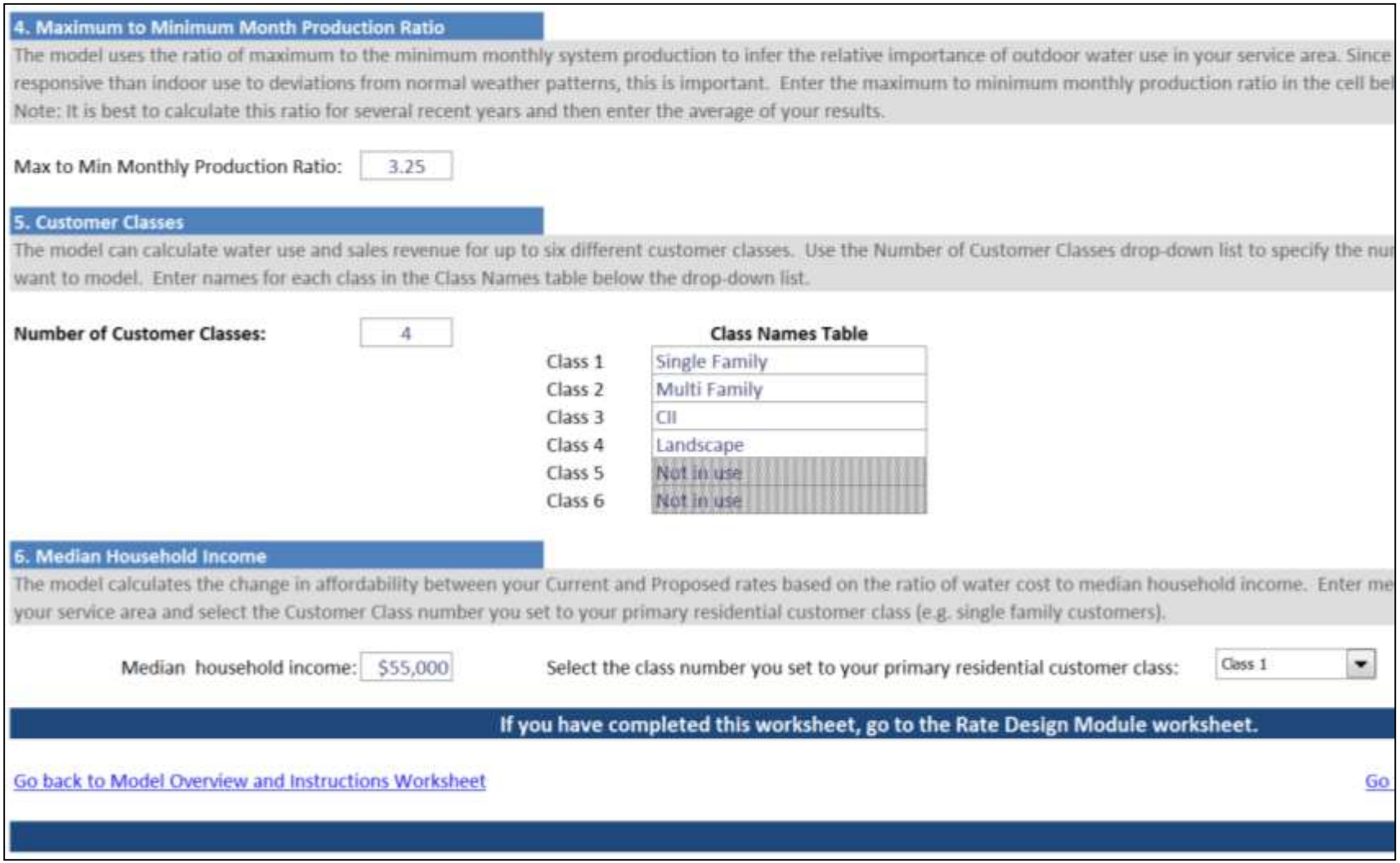
Billing Units:	Thou. Gal.	Precipitation Units:	in	Temperature Units:	F

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 gi
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 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
Note: you do not need to specify the months for the Peak season. The model determines this from your specification of the Off Peak seas

Season	From	Thru	No. Months	Season	From	Thru	No. Months
Off Peak:	Oct	Apr	7	Peak:	May	Sep	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 bel
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: 3.25

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 nu
want to model. Enter names for each class in the Class Names table below the drop-down list.

Number of Customer Classes: 4

	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 me
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: $55,000

Select the class number you set to your primary residential customer class: Class 1

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.)		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	
From	To	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

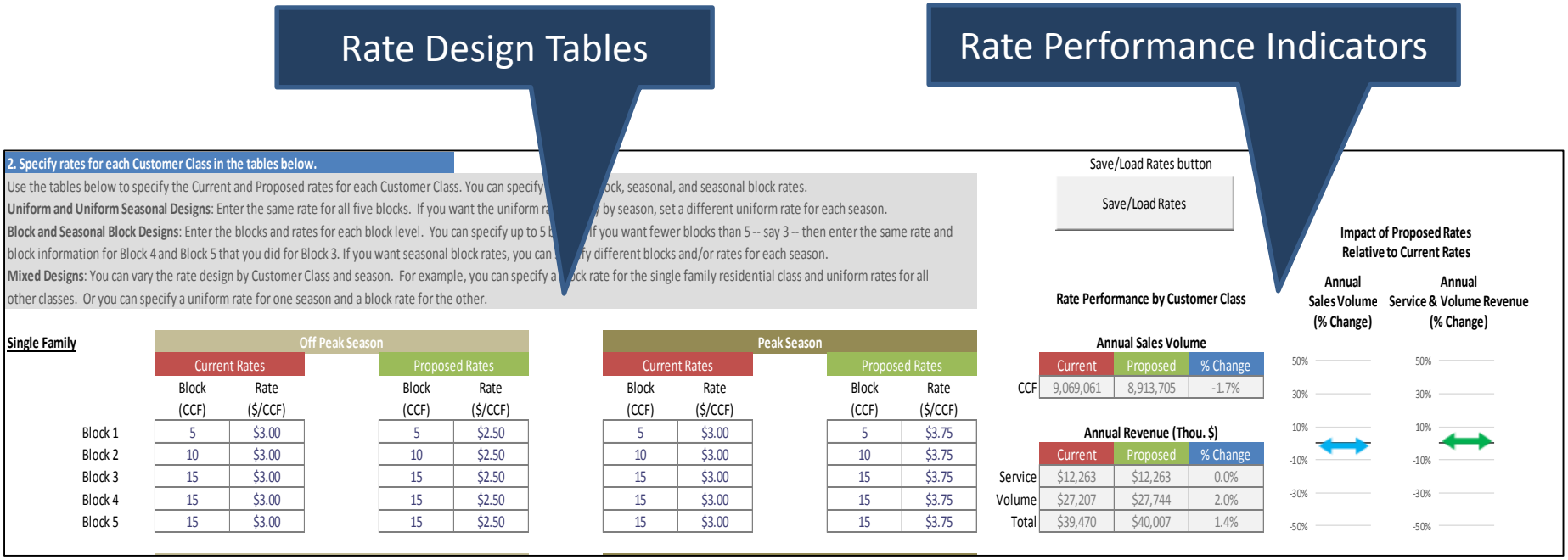
Rate for first 10 units

Rate for next 10 units

Rate for units in excess of 20

Copy rate in last block to unused blocks

Rate Design Screenshot



Bill Impacts Screenshot

Avg and median bill impacts

Affordability Indicator

Bill Impact Histograms

3. Bill impacts of Proposed rates

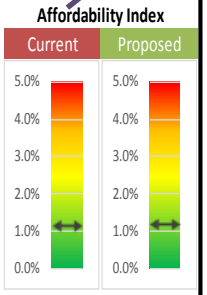
Under your Proposed rates, the volume charge may go up for some customers and down or stay the same for others. The Bill Impacts Table shows the percentage of bills that will go down, stay the same, or go up -- and by how much. Charts showing the distribution of bill impacts for each customer class are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

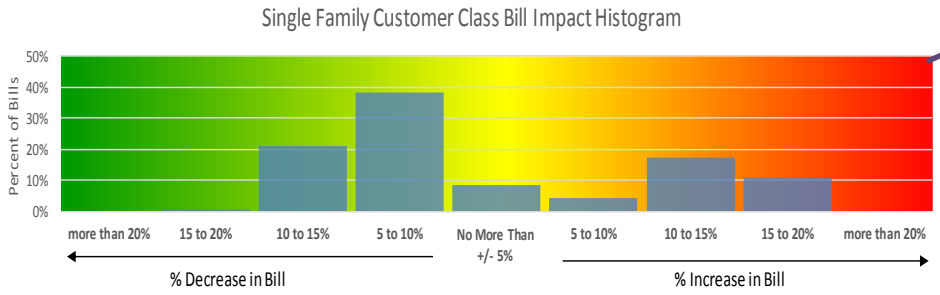
Affordability index equals the median annual water cost for the primary residential customer class divided by median household income.

Affordability Index



Bill Impacts Table

Customer Class	% of bills decreasing by				No More Than	% of bills increasing by			
	more than 20%	15 to 20%	10 to 15%	5 to 10%	+/- 5%	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									



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

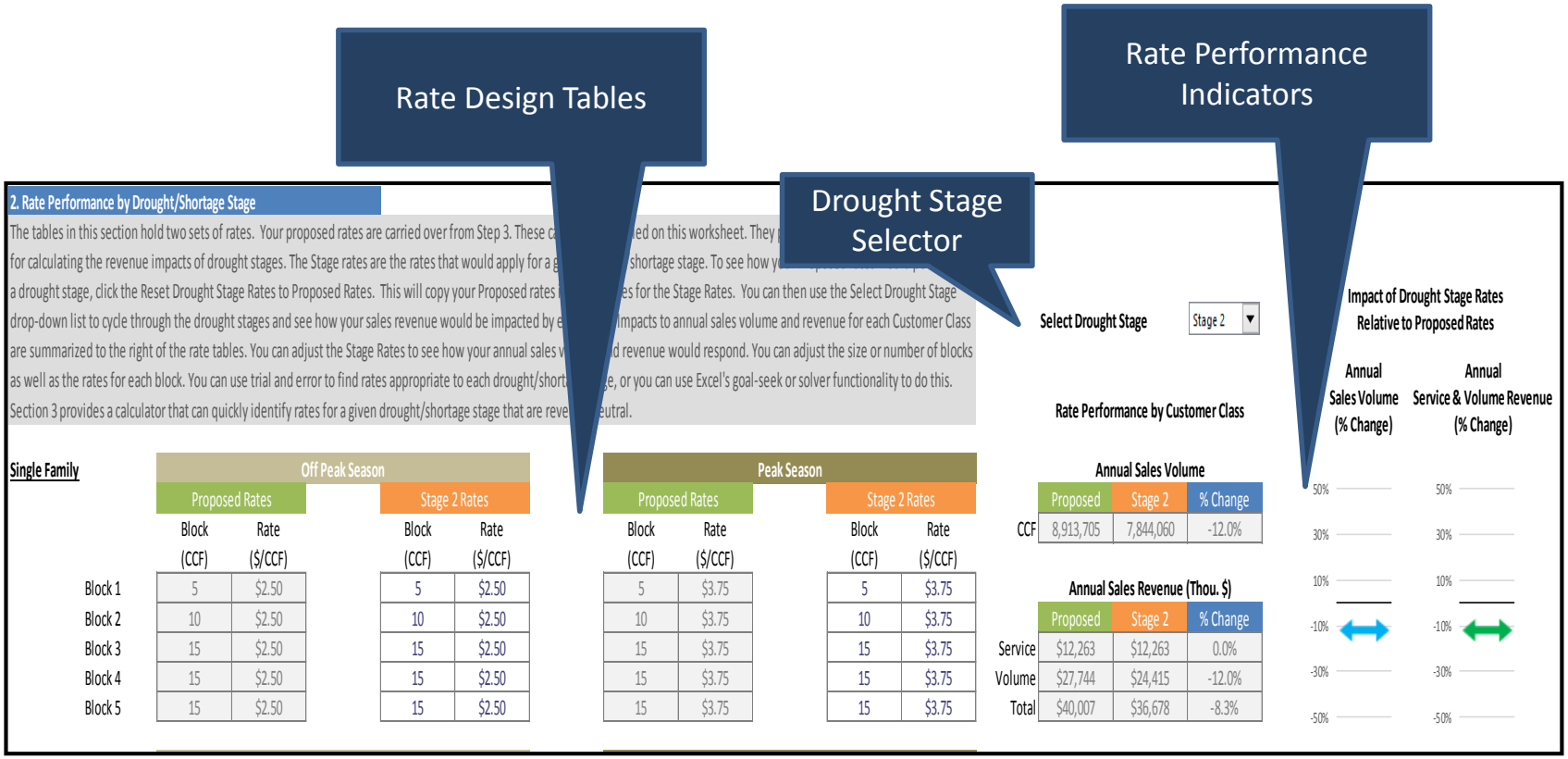
1. Enter the Customer Class curtailment levels for each stage. If you have fewer than 4 stag… last curtailment level in the unused stages. Stage 0 is the default No Shortage condition. Do not modify the settings for this stage.
2. For each stage, enter the expected compliance rate. The compliance rate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

	Drought/Shortage Stage Customer Class Curtailment L… s Table					Expected Curtailment				
Customer Class	**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%					

Expected compliance rate

Expected curtailment

Designing Drought 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

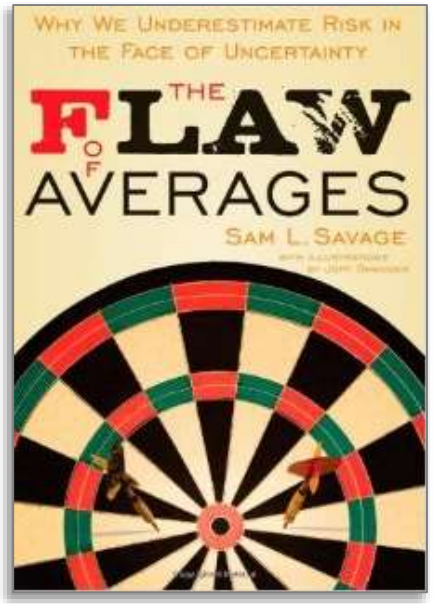
- *What is the likelihood we will meet our one-year, three-year, five-year revenue targets under our current or proposed rates?*
- *What is the chance our revenues will turn out more than 15% below our current projections?*
- *What level of confidence can we have that our sales will exceed our minimum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

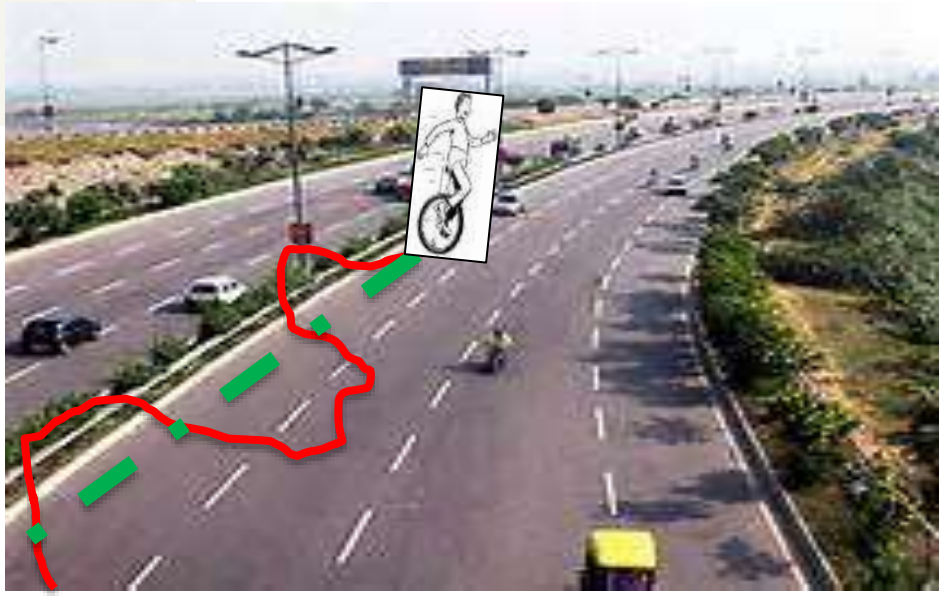
Average Outcome vs. Likely Outcomes

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.probabilitymanagment.org

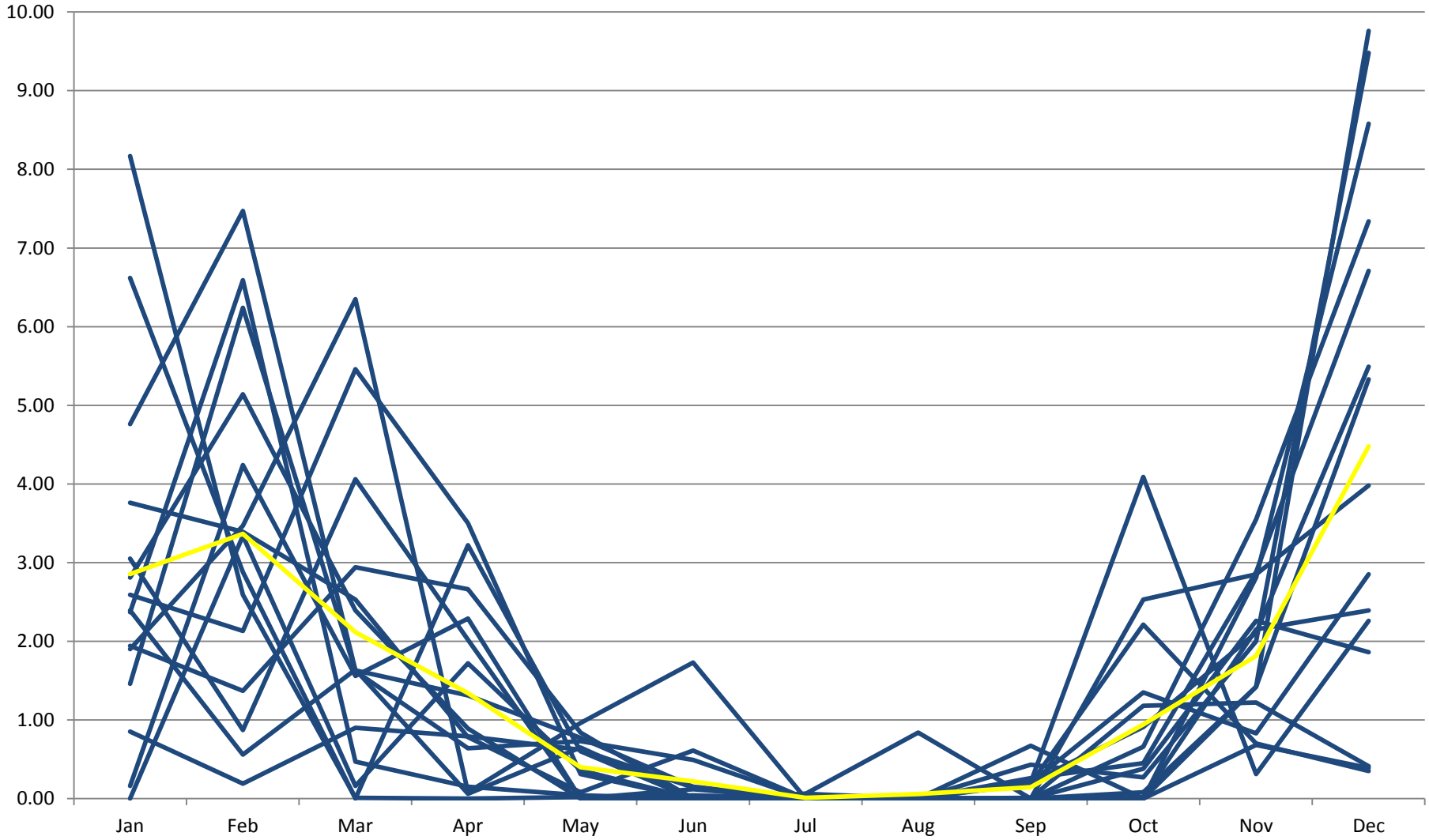




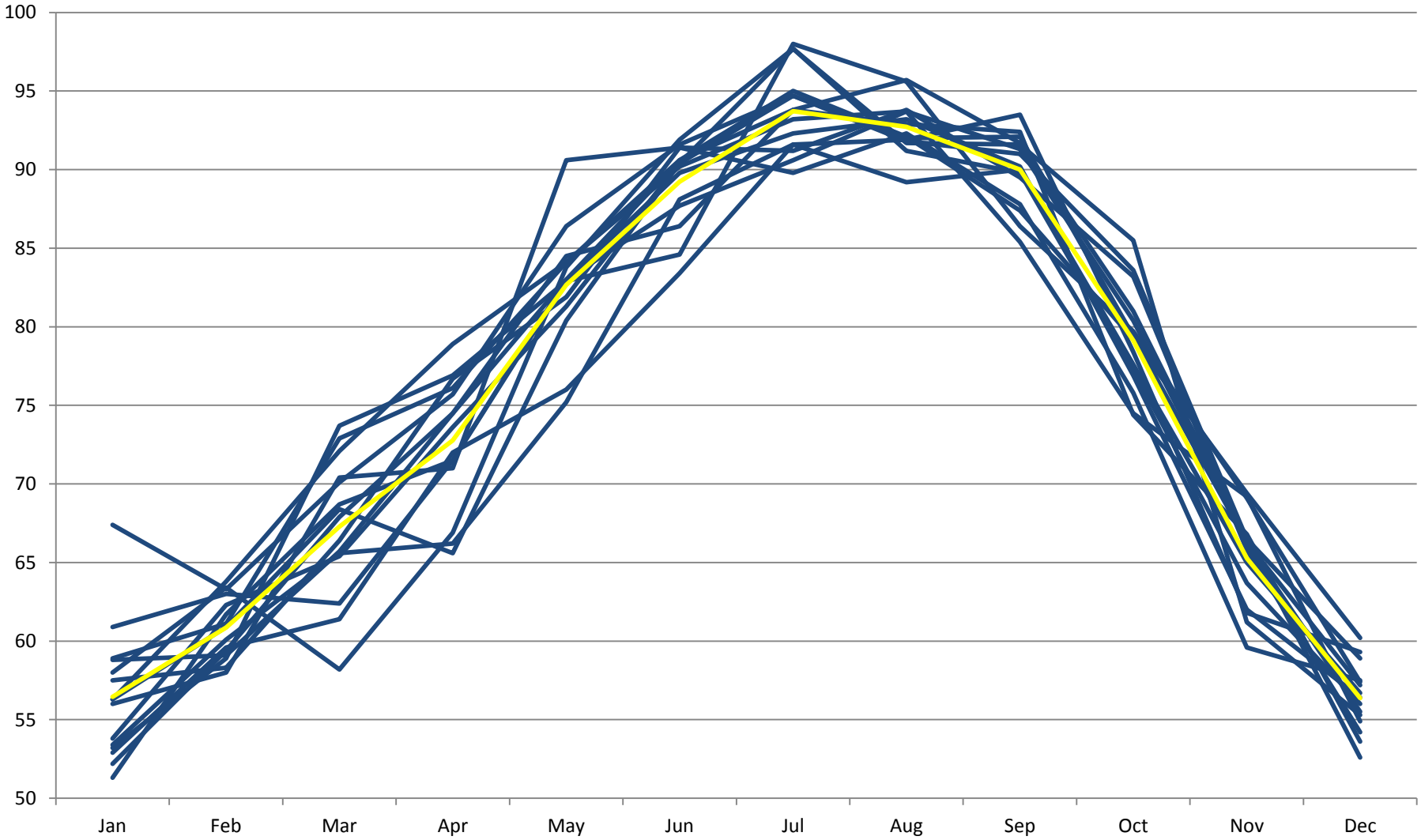
The cyclist is **safe** on the average path

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

Monthly Precipitation Data 2000-2014 Mean vs. Actual



Temperature Data 2000 – 2014
Mean vs. Actual



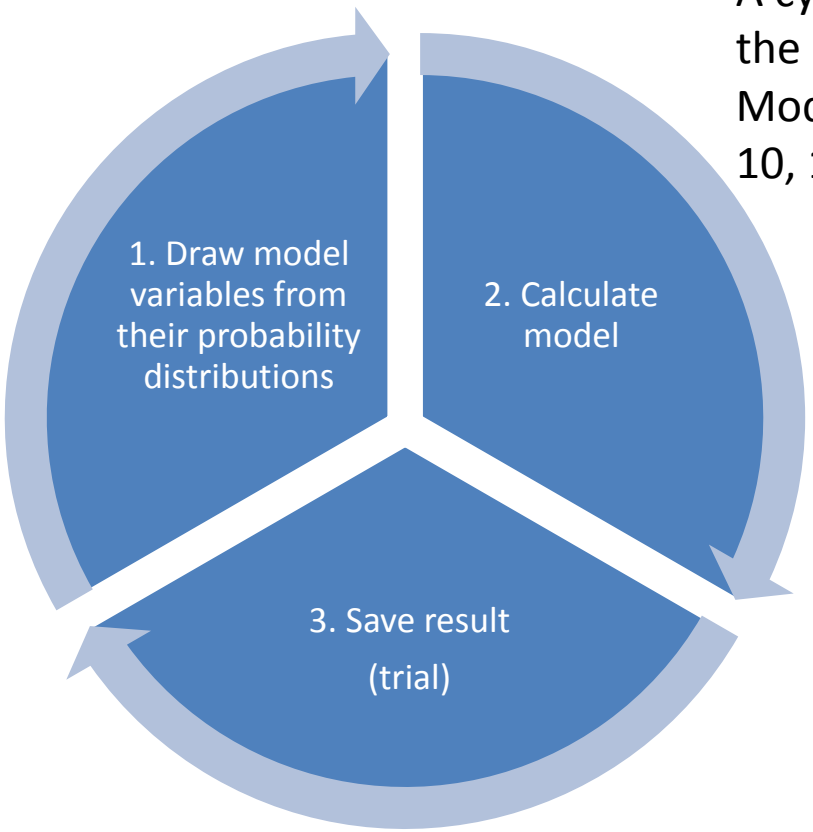
Planning for the Future

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

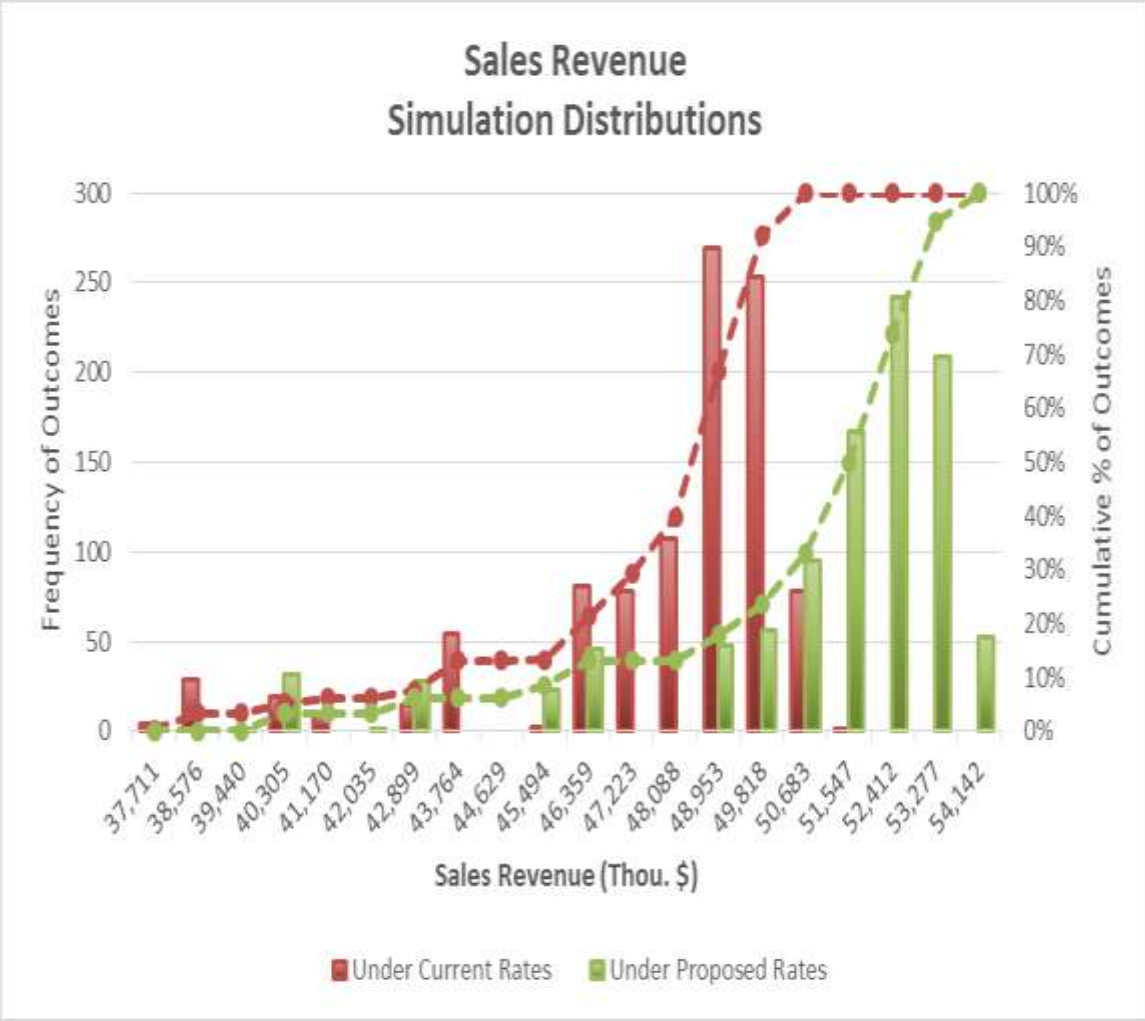


A cycle constitutes 1 trial. In the Revenue Simulation Module, User can simulate 10, 100, 500, or 1000 trials.

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

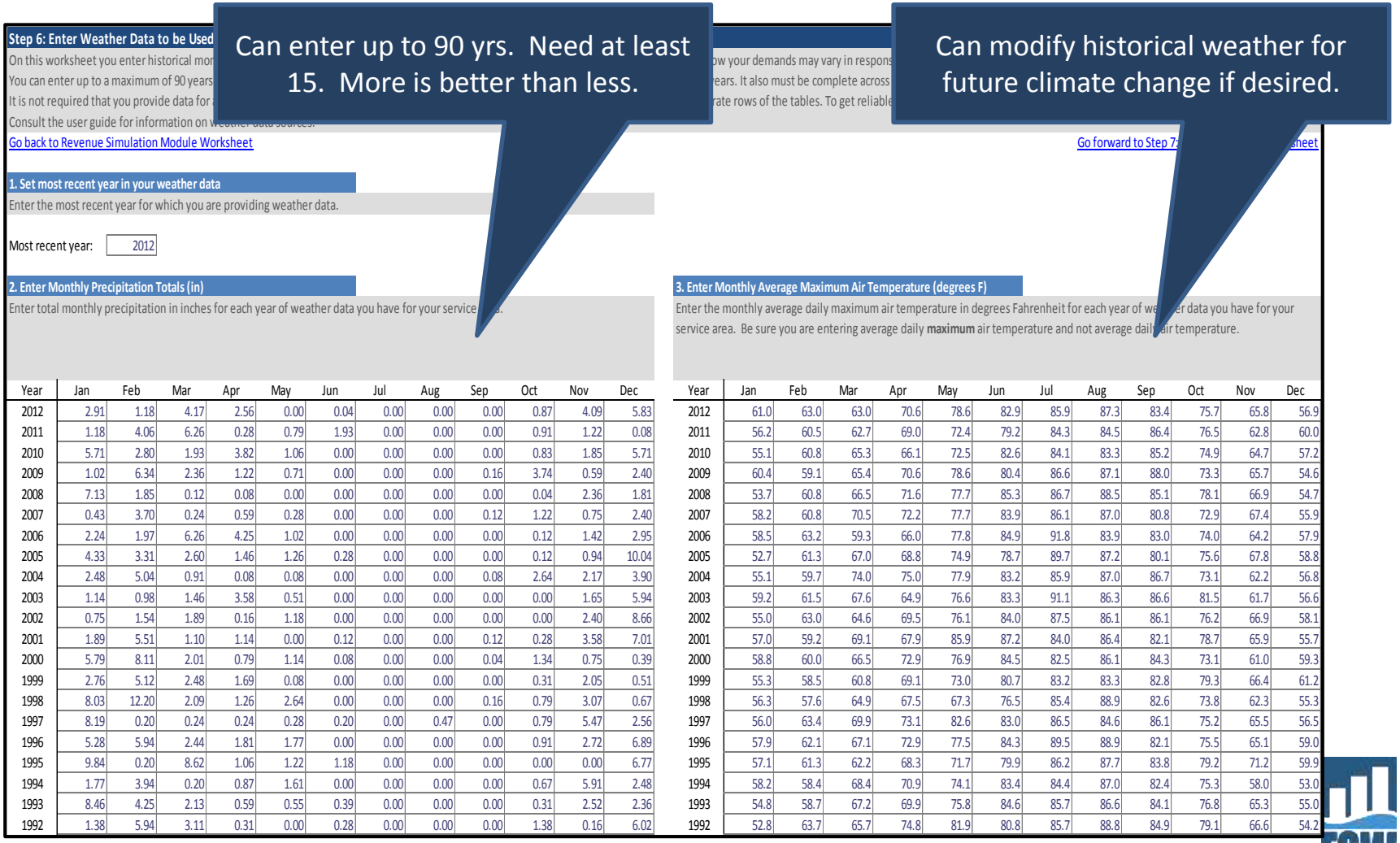
Simulation of Sales Revenue Distribution



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 mor… …ow your demands may vary in respons…
You can enter up to a maximum of 90 years … …ears. It also must be complete across …
It is not required that you provide data for … …rate rows of the tables. To get reliable…
Consult the user guide for information on …

Go back to Revenue Simulation Module Worksheet

Go forward to Step 7: … …sheet

1. Set most recent year in your weather data

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

Most recent year: 2012

2. Enter Monthly Precipitation Totals (in)

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

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	0.00	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

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

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

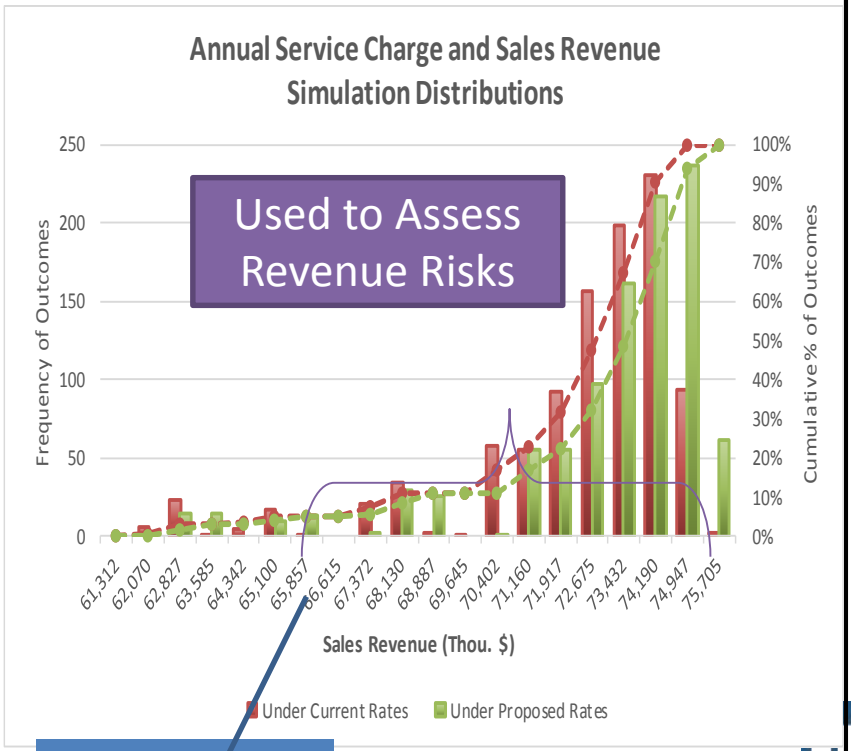
Simulation Distributions

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: 5

User selects forecast year



Used to Assess Revenue Risks

Water Sales

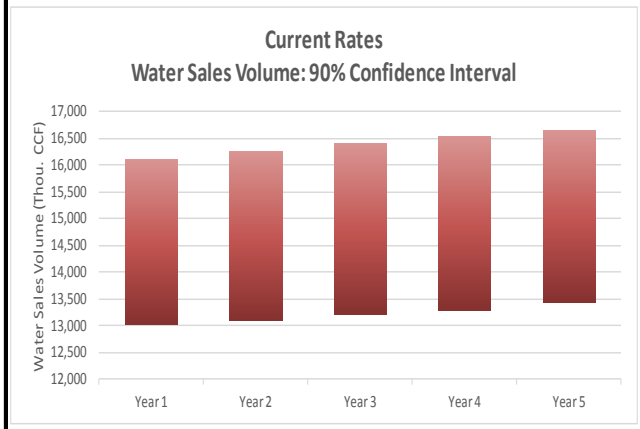
Annual Revenue

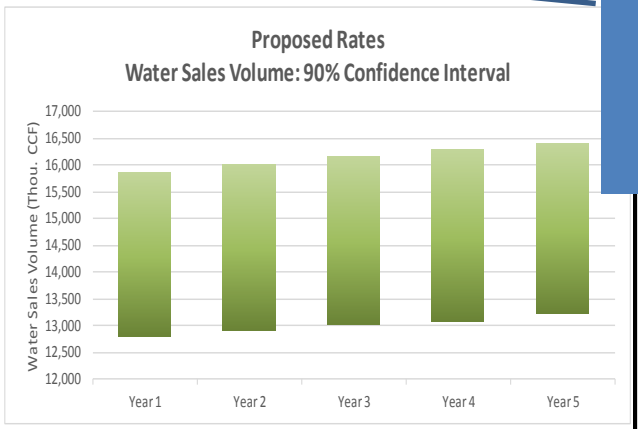
Confidence Intervals

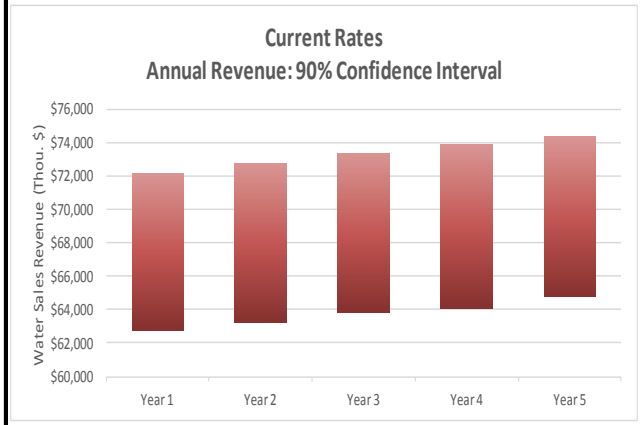
3. Sales Volume and Revenue Confidence Intervals

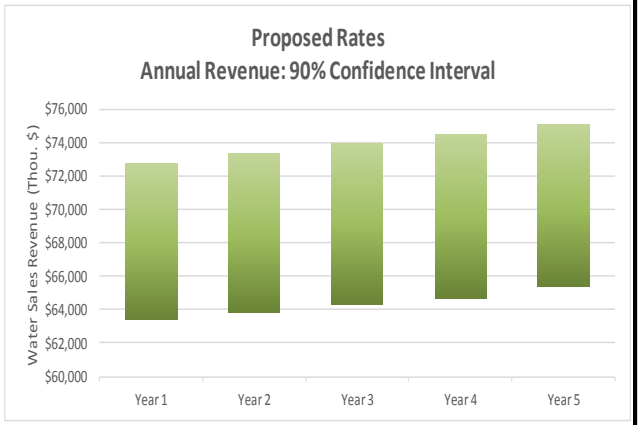
A 95% confidence interval indicates the range of values such that 95% of all simulation outcomes fall within this interval. Similarly, for a 90% confidence interval, 90% of all simulation outcomes would fall within the interval. More generally, for an x% interval, x% of all simulation outcomes would 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: 90%



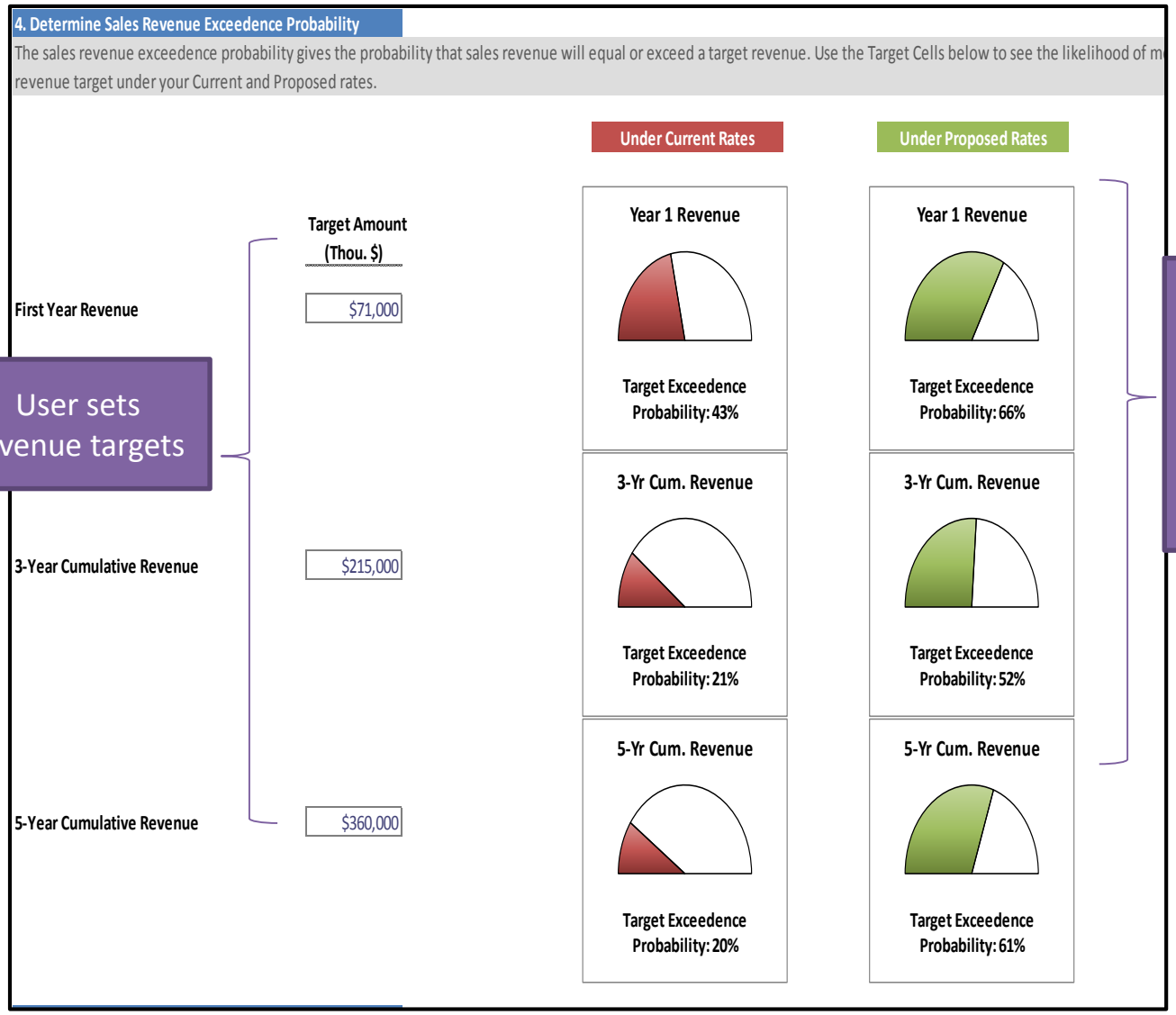






User selects level of confidence for interval (50-95%)

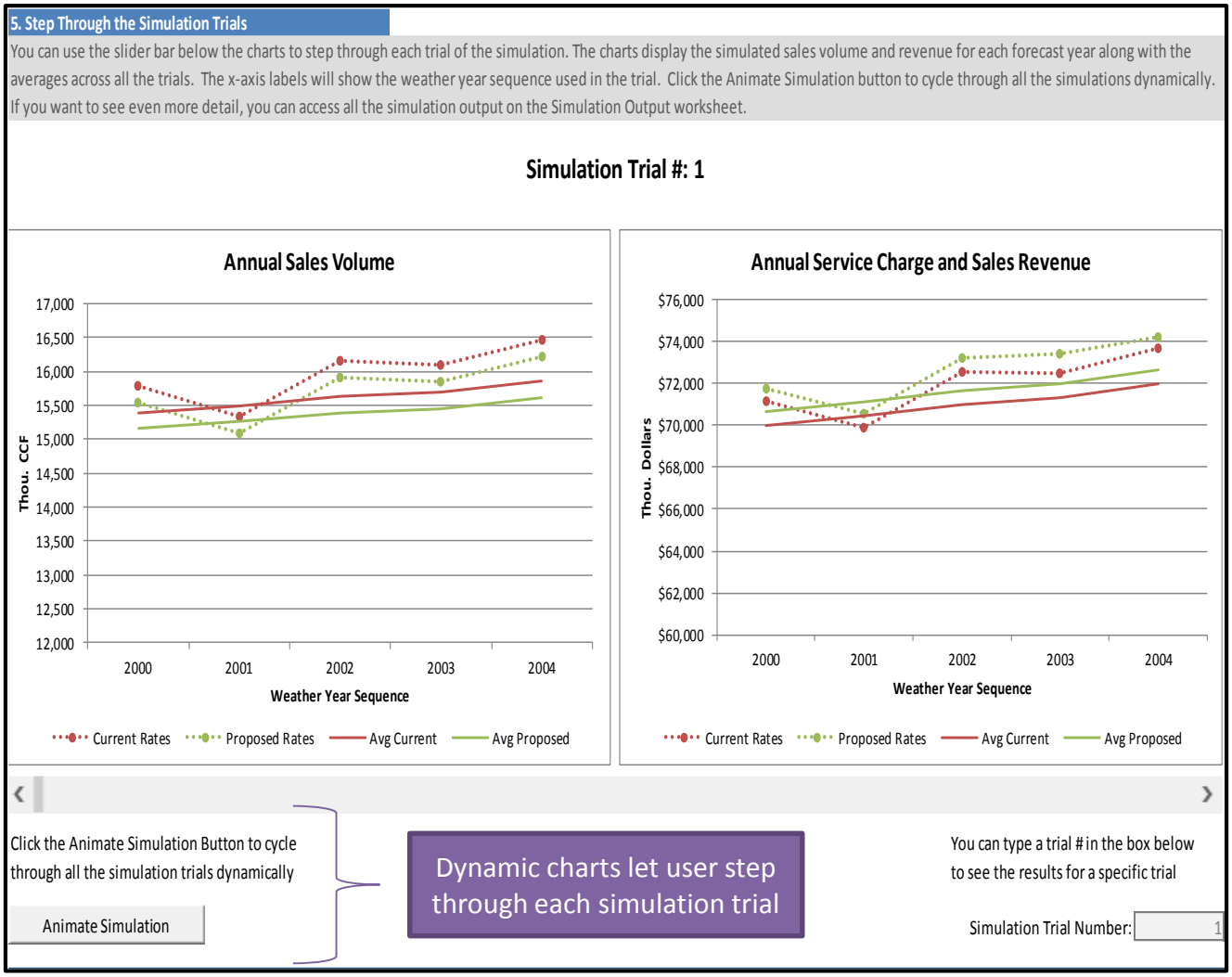
Exceedence Probabilities



User sets revenue targets

Model calculates likelihood of meeting or exceeding target

Dynamic Step-Through Charts



Demo

- Model includes built-in demonstration data and exercises:
  - Model setup
  - Bill tabulation
  - Setting service charges
  - Designing volume rates
  - Drought rate adjustments
  - Simulation