## **Case Study**

### Introduction

Building T is the corporate headquarters of the XYZ Corporation. The water used in Building T comes from two sources. The first source is through The Water Co., where, like other businesses in the area, the XYZ Corporations has a contract with The Water Co. to provide water at a contracted price per gallon.

The second source is through XYZ’s own Water Storage Tank. Precipitation is collected, treated, stored, and used to supply water to Building T, and there is a per-gallon cost associated with this process.

XYZ Corporation has hired your team of consultants to provide solutions to optimize water allocation at Building T.

### Objective 1 - Forecasting

The **waterplustempin.sas7bdat** data set contains over three and a half years of historical weekly gallon usage data from Building T.

The gallons used in Building T each week are broken down into two categories: Cooling and Main. The Cooling category represents the gallons used to regulate the temperature in the building. The Main category represents the gallons used by the employees. Together, Cooling and Main make up the total amount of gallons used per week in Building T. There is no difference in the quality of water between the two categories.

The date range begins on the week of January 1, 2022, and runs through the end of the week beginning February 16, 2025. There may be partial or missing data as well as anomalies associated with idiosyncratic and/or recurring, holiday events. Since water usage can be impacted by precipitation and ambient, outdoor temperatures, local weather variables should be considered in the process of modeling water usage.

XYZ Corporation needs ***total*** weekly water demand forecasts through the end of 2025. These forecasts will be used as parameters in an optimization model to be developed in Objective 2.

For Objective 1, provide details on your forecasting analysis:

1. Describe your assessment and preparation of the timeseries data for modeling.
2. Your modeling process should follow a champion-challenger framework that includes at least three model types.
   1. Provide details on the types of forecast models you considered.
   2. Describe your model selection process. Include details on relevant criteria and best practices followed.
   3. Explain the model and forecast. For example, provide details on estimated relationships in the model, review periods of abnormally high or low water usage. Provide a description of components of variation in the data that are captured by your forecast model.
3. How many total gallons of water is Building T expected to use per week through the end of 2025?

### Objective 2 - Optimization

Contracts between the XYZ Corporation and The Water Co. are renewed every four weeks. The current four weeks has concluded, and XYZ Corporation has received ten contract proposals from The Water Co. to supply water for the next four-week period.

The *first contract* (i.e., Tier 1) from The Water Co. will supply water at 25 cents ($0.25) per gallon with a minimum of 10,000 gallons purchased per week.

The *second contract* (i.e., Tier 2) will supply water at 20 cents ($0.20) per gallon with a minimum of 15,000 gallons purchased per week.

The *third contract* (i.e., Tier 3) will supply water at 18 cents ($0.18) per gallon with a minimum of 20,000 gallons purchased per week.

The *fourth contract* (i.e., Tier 4) will supply water at 16 cents ($0.16) per gallon with a minimum of 25,000 gallons purchased per week.

The *fifth contract* (i.e., Tier 5) will supply water at 14 cents ($0.14) per gallon with a minimum of 30,000 gallons purchased per week.

The *sixth contract* (i.e., Tier 6) will supply water at 13 cents ($0.13) per gallon with a minimum of 35,000 gallons purchased per week.

The *seventh contract* (i.e., Tier 7) will supply water at 12 cents ($0.12) per gallon with a minimum of 40,000 gallons purchased per week.

The *eighth contract* (i.e., Tier 8) will supply water at 11 cents ($0.11) per gallon with a minimum of 45,000 gallons purchased per week.

The *ninth contract* (i.e., Tier 9) will supply water at 10 cents ($0.10) per gallon with a minimum of 50,000 gallons purchased per week.

The *tenth contract* (i.e., Tier 10) will supply water at 16 cents ($0.07) per gallon with a minimum of 100,000 gallons purchased per week.

None of the ten contract tiers do not have a capped amount, meaning XYZ Corporation can purchase as many gallons as needed from The Water Co. at or above the minimum gallon threshold at the contracted price.

Currently there are 62,500 gallons in the Water Storage Tank. The CEO of XYZ Corporation insists that the Water Storage Tank must not drop below 30,000 gallons during any week over the next four weeks.

For the next two weeks, the treatment cost from Water Storage is 18 cents ($0.18) per gallon. Due to expected gains in water treatment efficiency, the treatment cost will drop to 10 cents ($0.10) per gallon in weeks three and four.

The amount of water in the Water Storage Tank depends on the gallons remaining in the tank from the prior week, plus the difference between how many gallons of precipitation accumulated in the current week and how many gallons are used to supply Building T from the Water Storage Tank in the current week.

The amount of expected precipitation in that region over the next four weeks has already been estimated. Based on expected precipitation and accumulation methods used by XYZ Corporation, they expect to add 12,000 gallons to the Water Storage Tank in the first week, 18,000 gallons in the second week, 20,000 gallons in the third week, and 22,000 gallons in the fourth week. There is no cap on the amount of water that can be stored at any one time.

XYZ Corporation is also a proud member of the *Elite Environmental Corporate Sustainer Initiative*. The primary environmental sustainability project that granted XYZ Corporation membership into EECSI is their investment in renewable water usage (via the Water Storage Tank). One of the requirements for XYZ to remain a member of EECSI is that at least 25% of all water supplied to Building T each week must come from the Water Storage Tank.

Using your team’s total water demand forecasts from Objective 1, along with the information above, construct an optimization model that minimizes total water cost over the next four weeks by finding the optimal amount of gallons to purchase from The Water Co. and to use from the Water Storage Tank. To ensure demand is satisfied, the sum of these two values must be greater than or equal to forecasted water demand for each week.

Total water cost over the next four weeks equals the sum of (Price\*Quantity bought from The Water Co.) + (Treatment Cost\*Quantity used from the Water Storage Tank) for each week.

For Objective 2, provide answers to the following questions:

1. Which contract tier provides XYZ Corporation with the lowest total water cost over the next four weeks while satisfying the business requirements described above?

Having chosen the contract recommended by your team:

1. How many gallons should XYZ purchase from The Water Co. each week?
2. How many gallons should XYZ use from their Water Storage Tank each week?
3. What is XYZ’s projected total water cost at the end of the next four weeks?
4. What is XYZ’s projected ending Water Storage Tank inventory at the end of each week?
5. How much money will XYZ save by choosing the recommended contract tier over each of the alternative contract tiers?

### Data & Instructions for Getting Started

The **waterplustempin.sas7bdat** data set contains historical weekly water usage broken down by Cooling and Main for Building T. You will use this data set to generate ***total*** water demand forecasts for Building T over the next four weeks.

Once you’ve forecasted ***total*** water demand for the next four weeks, insert those forecasted values into the data step below, replacing the **xxxxx** values for each week. Copy and paste this data step into the programming editor and run it to create the **forecast\_data** data set.

**data** forecast\_data;

input week water\_demand unit\_cost precipitation;

datalines;

1 xxxxx 0.18 12000

2 xxxxx 0.18 18000

3 xxxxx 0.10 20000

4 xxxxx 0.10 22000

;

The **contract\_data** data set contains price and purchase lower bound information for each contract tier. This is an optional data set, however, you may find useful to include in your OPTMODEL program to avoid the need to hard-key specific values. Copy and paste this data step into the programming editor and run it to create the **contract\_data** data set.

**data** contract\_data;

length tier $6.;

input tier $ price purchase\_lb;

datalines;

Tier01 0.25 10000

Tier02 0.20 15000

Tier03 0.18 20000

Tier04 0.16 25000

Tier05 0.14 30000

Tier06 0.13 35000

Tier07 0.12 40000

Tier08 0.11 45000

Tier09 0.10 50000

Tier10 0.07 100000

;

Read these data set(s) into the OPTMODEL procedure to construct your optimization model to answer the case study questions. Other values, such as initial Water Storage Tank inventory, maybe hard keyed directly into your program.