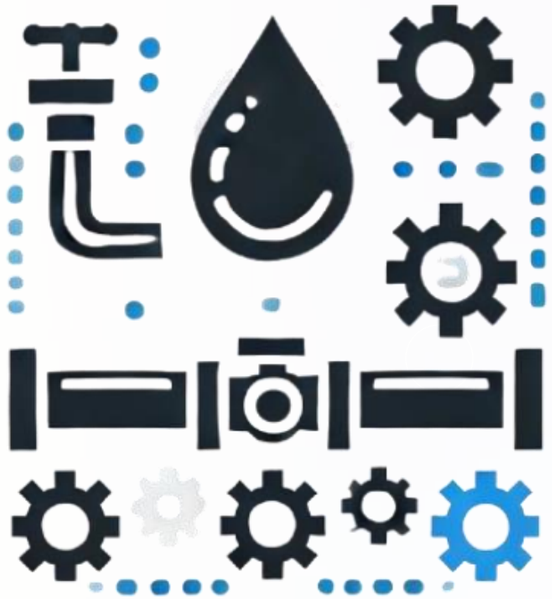
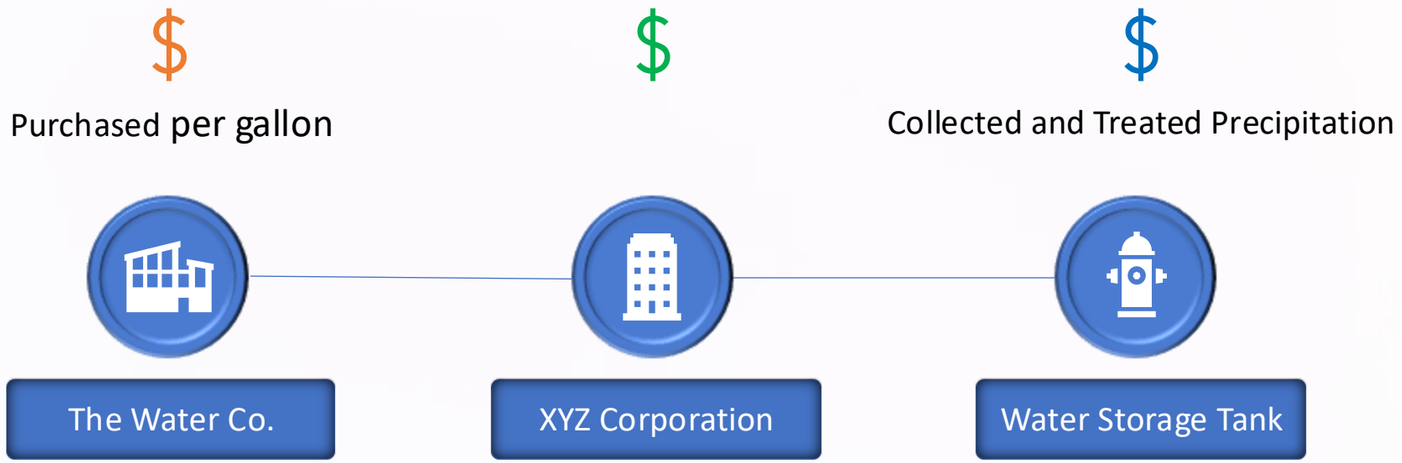
Supply Chain Case Competition
A SAS Approach



Abhishek Bagepalli
Keerthi Anand Sangeetha Rajan
Krithiga Rajan Sangeetha Rajan
Ramya Chowdhary Polineni

Business Problem

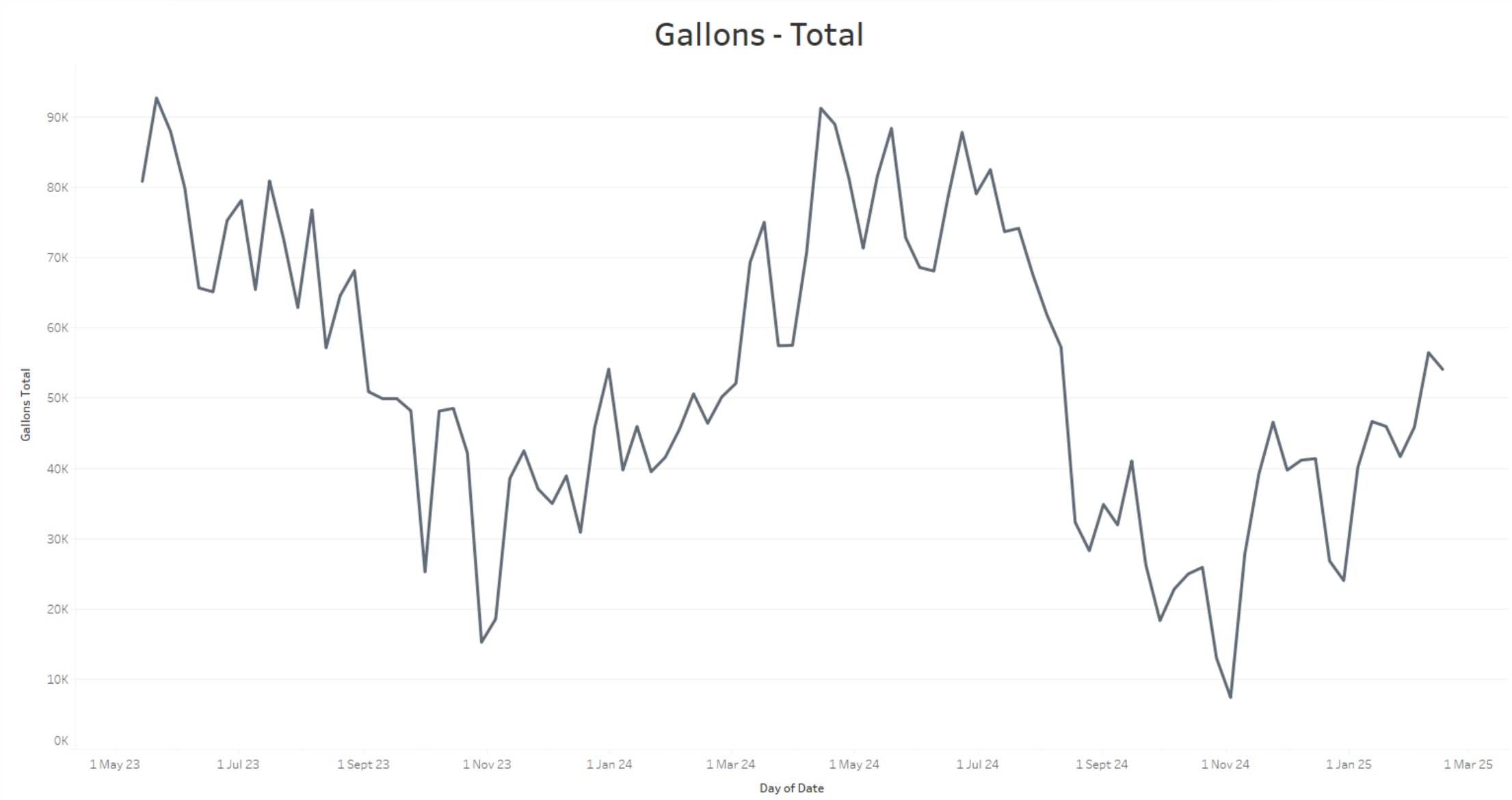


- Contract renewed every 4 weeks
- 10 contract options

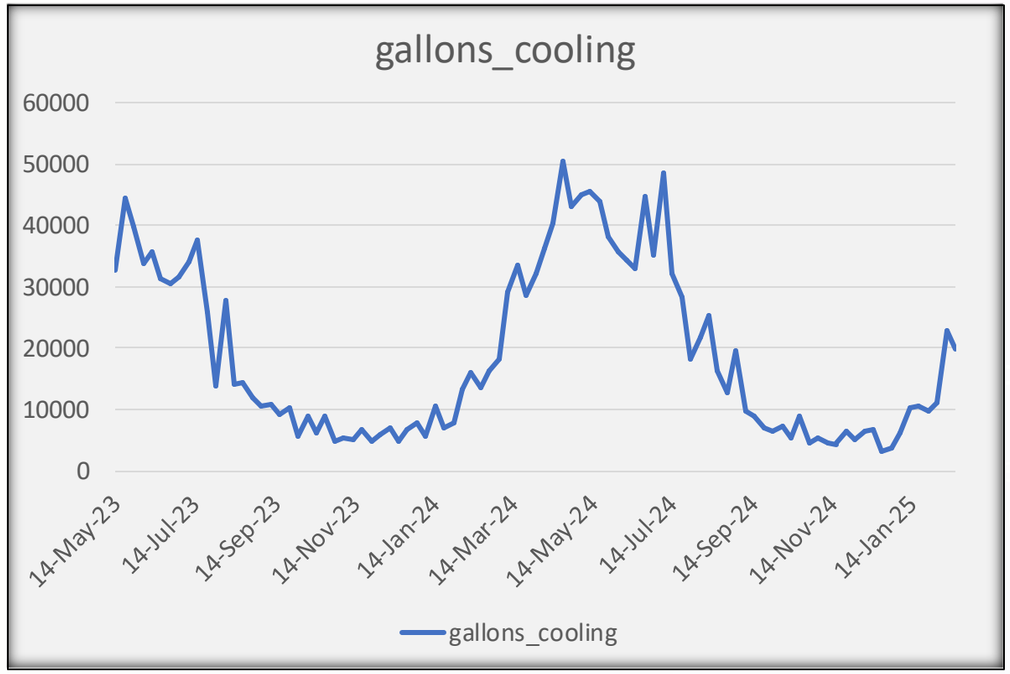
- Must not fall below 30,000 gallons in any given week
- At least 25% renewal water usage
- Higher treatment costs in weeks 1-2 and lower in weeks 3-4

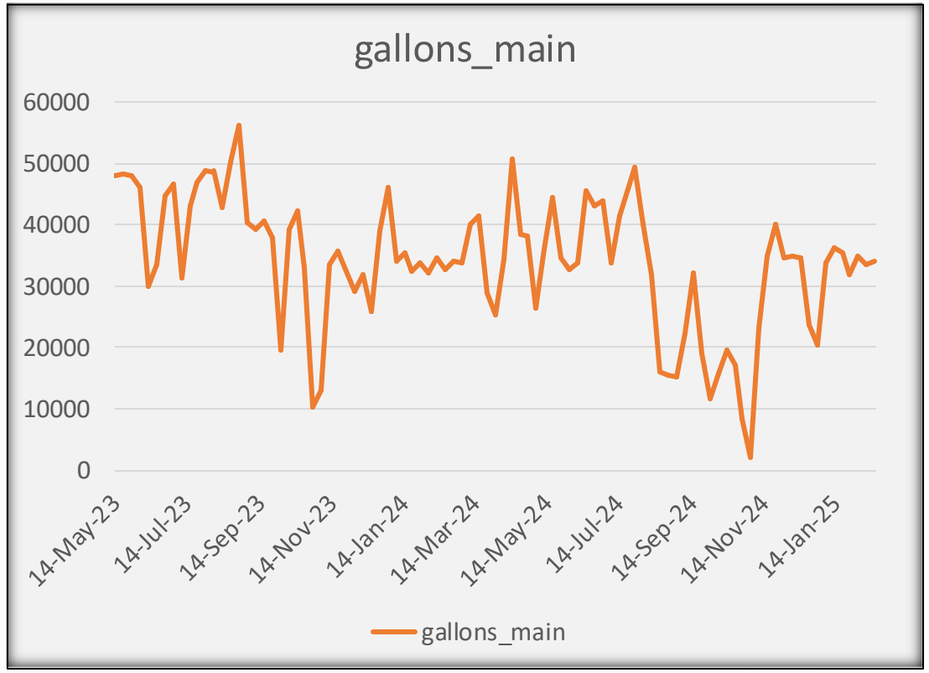
Objective: Find the optimal purchasing and storage usage plan to minimize total cost.

Is the Data Seasonal?



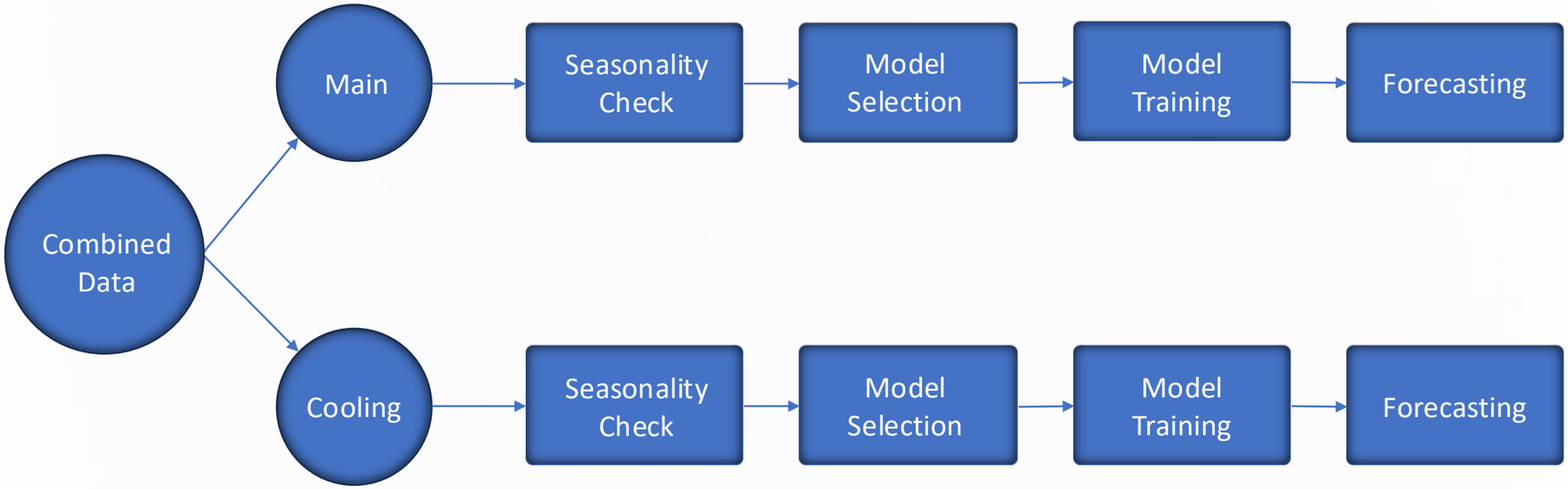
Forecasting Approach



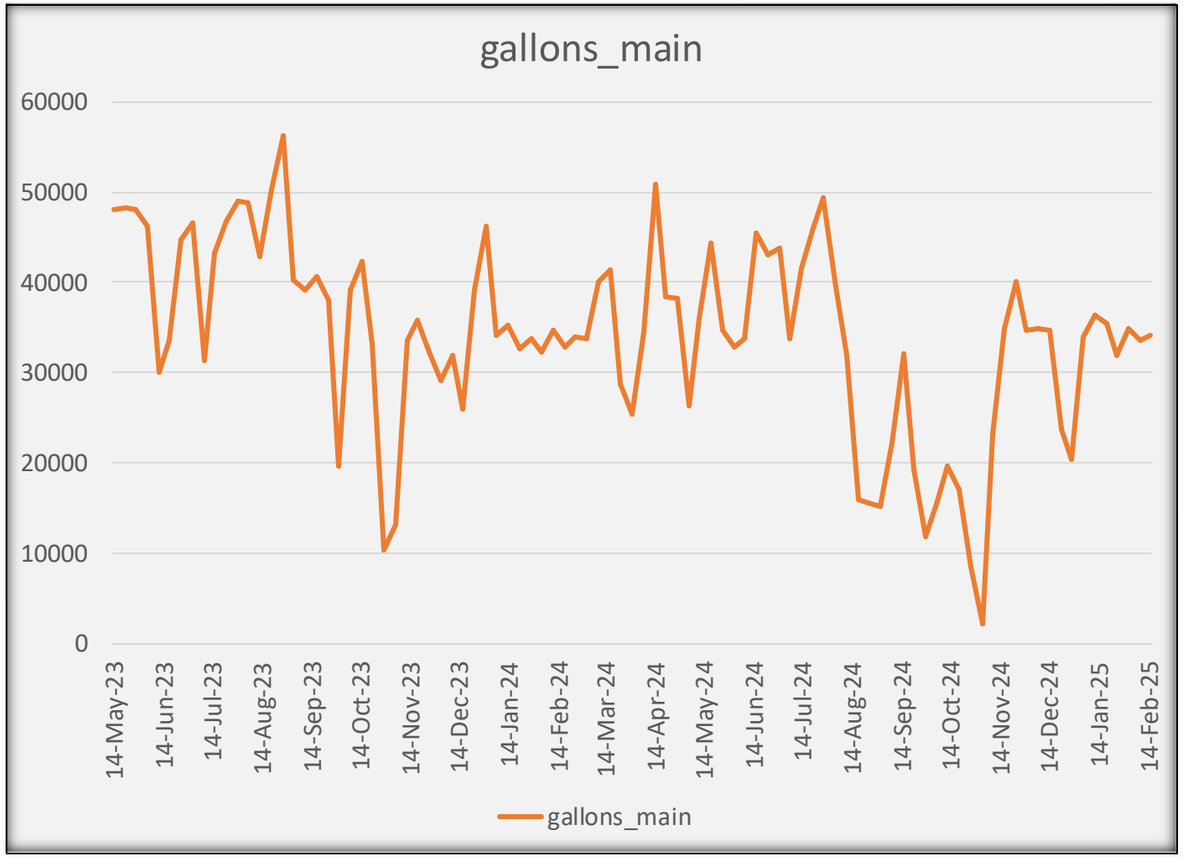


Forecasting Approaches

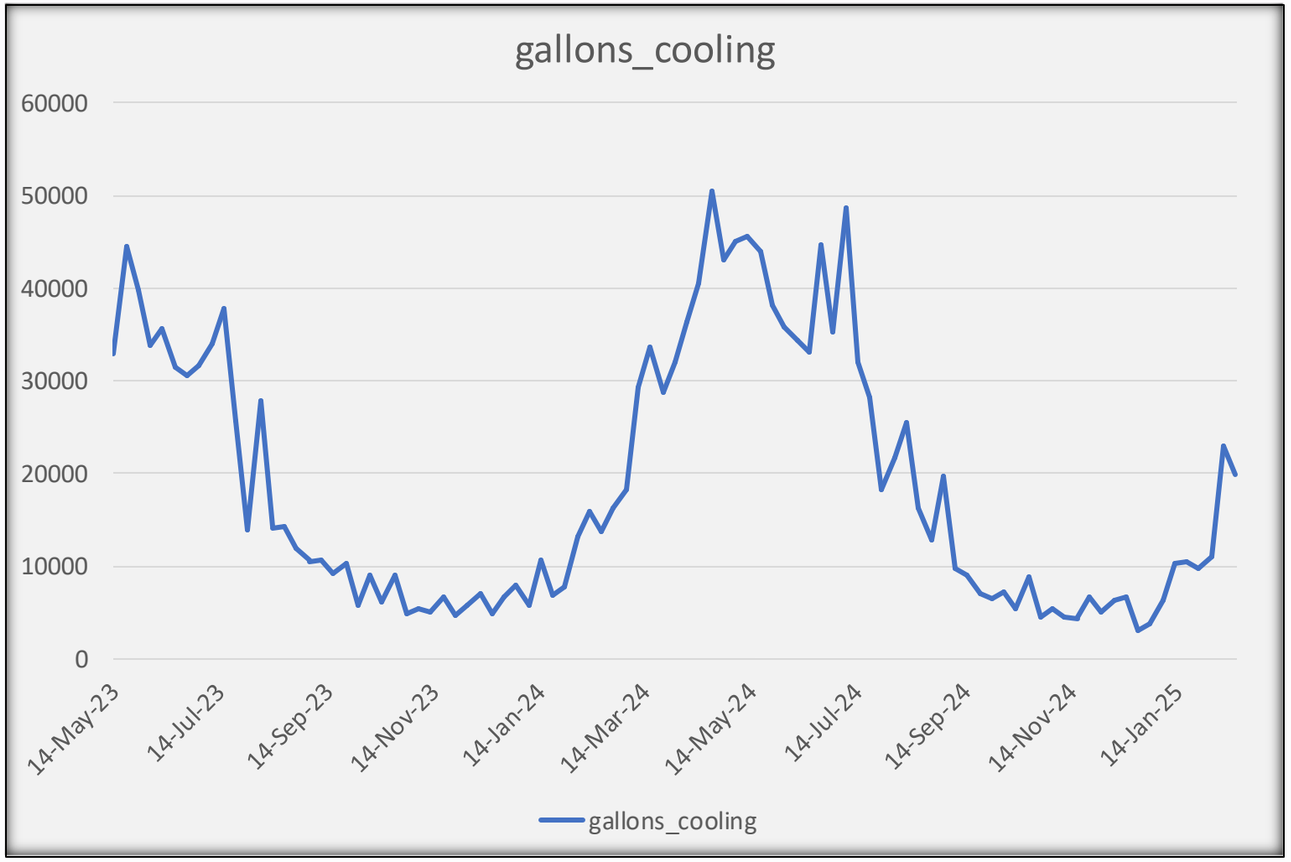
Forecasting Approaches



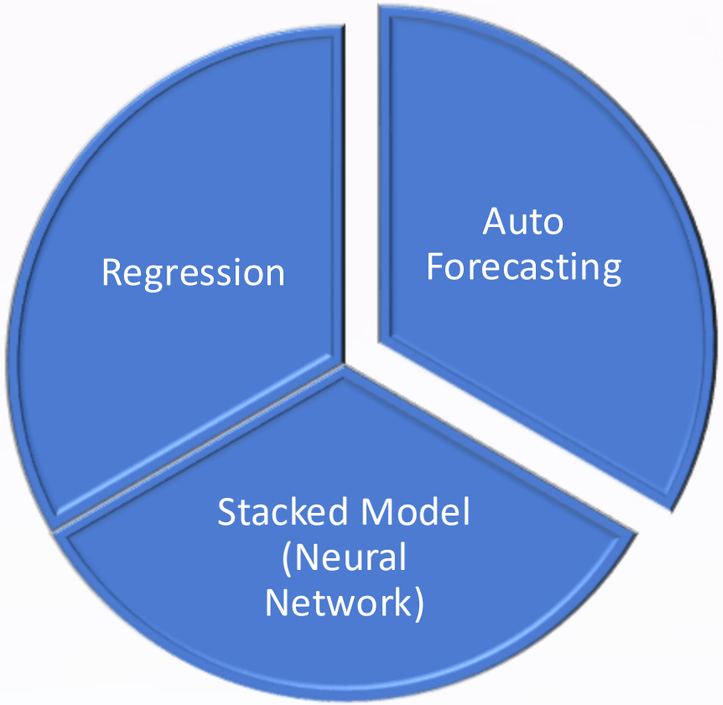
Forecasting Approaches



Forecasting Approaches



Forecasting Models

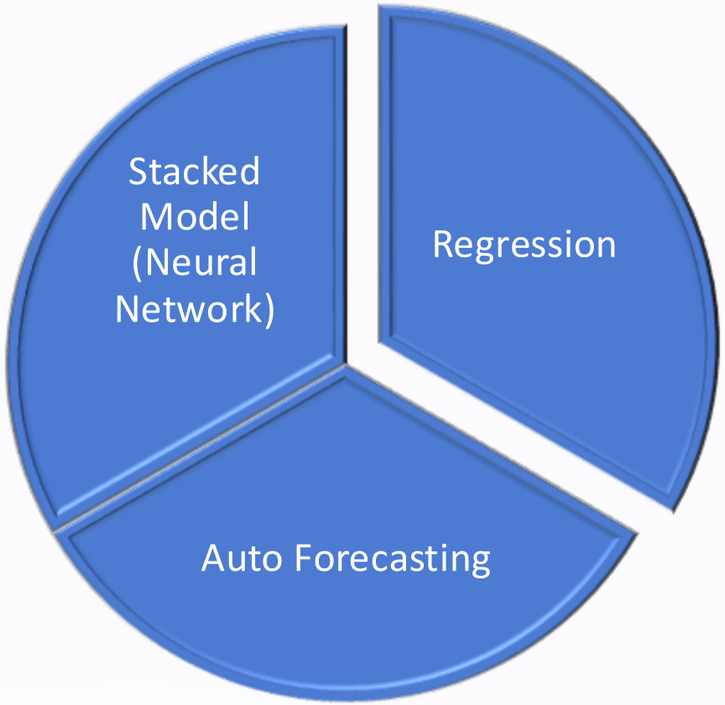


Why Auto Forecasting?

Model Generation
- ESM
- ARIMAX
- UCM

Model Selection
- No holdout samples

Forecasting Models



Why Regression?

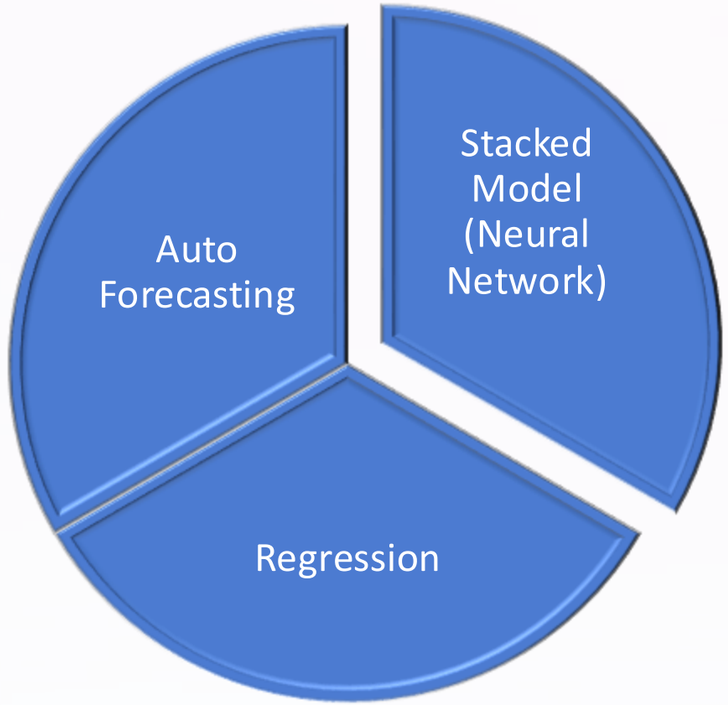
Feature Extraction

- Observation index
- Observation index squared and cubed
- Seasonal dummy variables

Model Selection

- No holdout samples

Forecasting Models



Why Stacked Model ?

Model Generation
- 1 hidden layer
- 16-32 neurons
- ReLU activation function

Model Selection
- No holdout samples

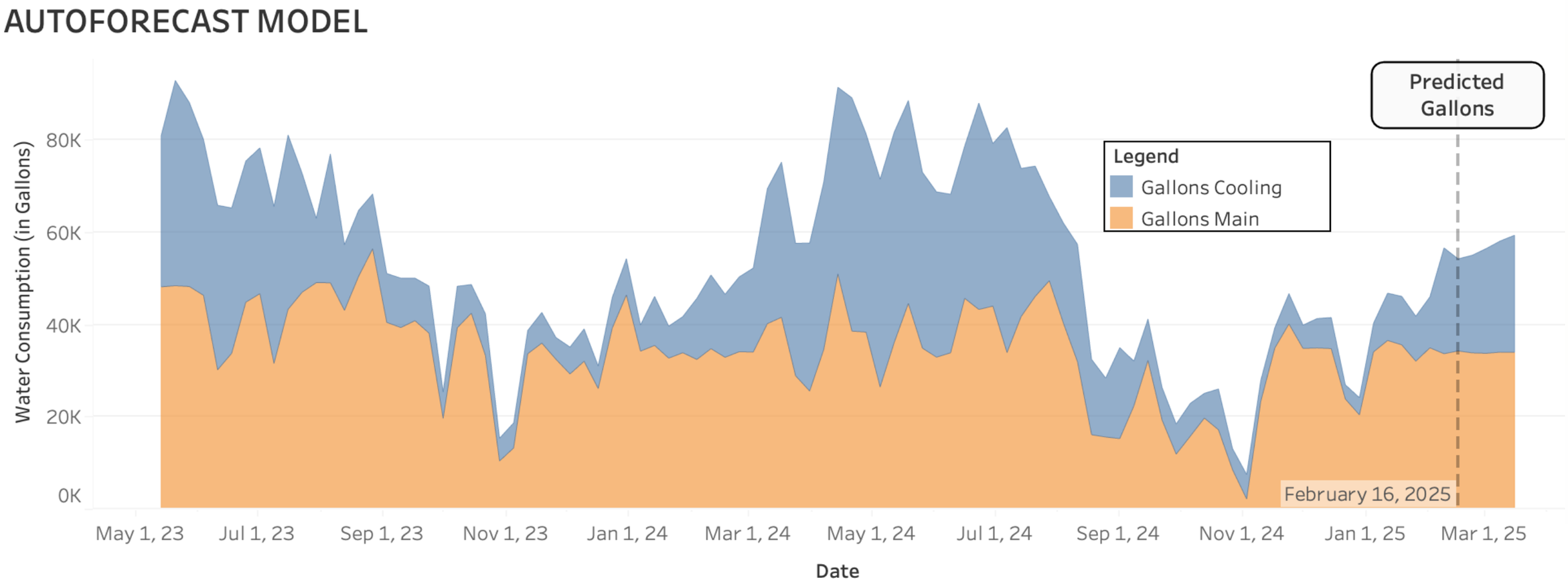
Forecasting in SAS Model Studio

1.Two-Step Forecasting
model generates the initial forecasts.
2.Residual
model are

Champion	Model Name	WMAE	↑ WMAPE	WMASE
★	Stacked Model (NN + TS)	734.1024	2.5232	0.1142
	Panel Series Neural Network	734.1024	2.5232	0.1142
	Regression for Time Series	3,836.4822	14.1614	0.5968
	Non-seasonal Model	5,855.1871	25.0351	0.9109
	Auto-forecasting	5,855.1871	25.0351	0.9109

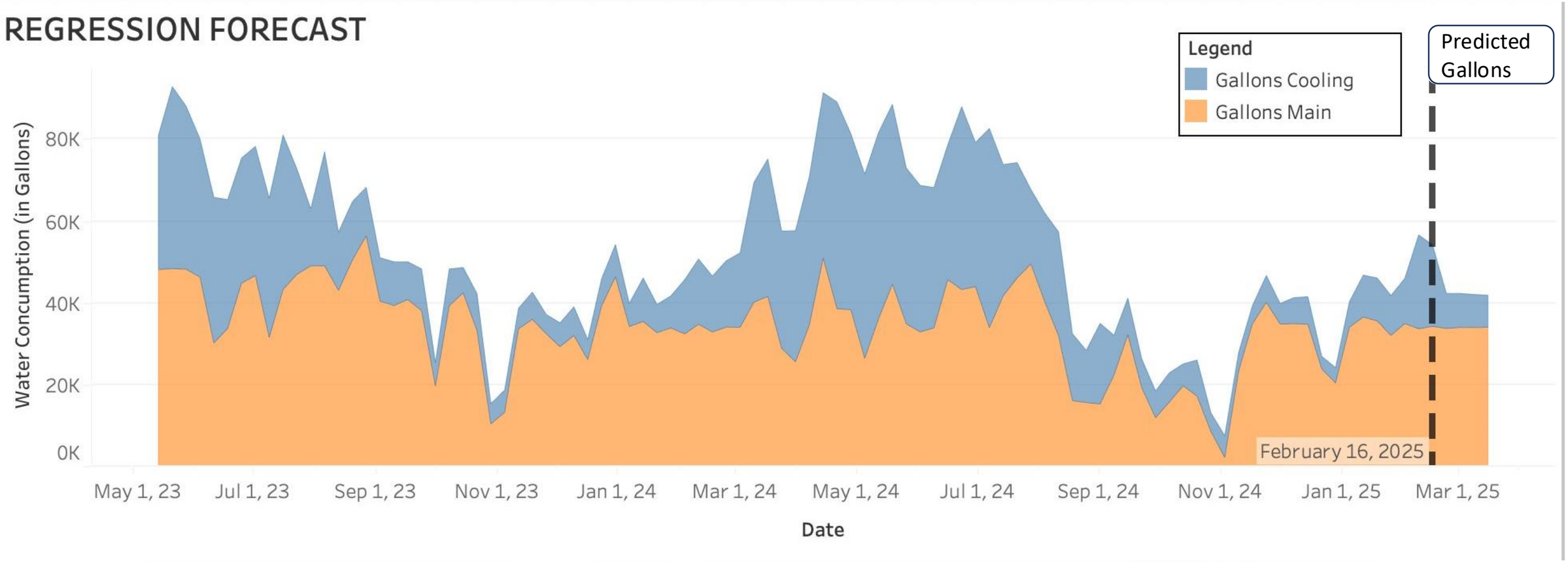
Forecasted Values

Date	Gallons Cooling	Gallons Main
Feb 23 2025	21,155	33,716
Mar 02 2025	22,712	33,622
Mar 09 2025	24,107	33,873
Mar 16 2025	25,355	33,843



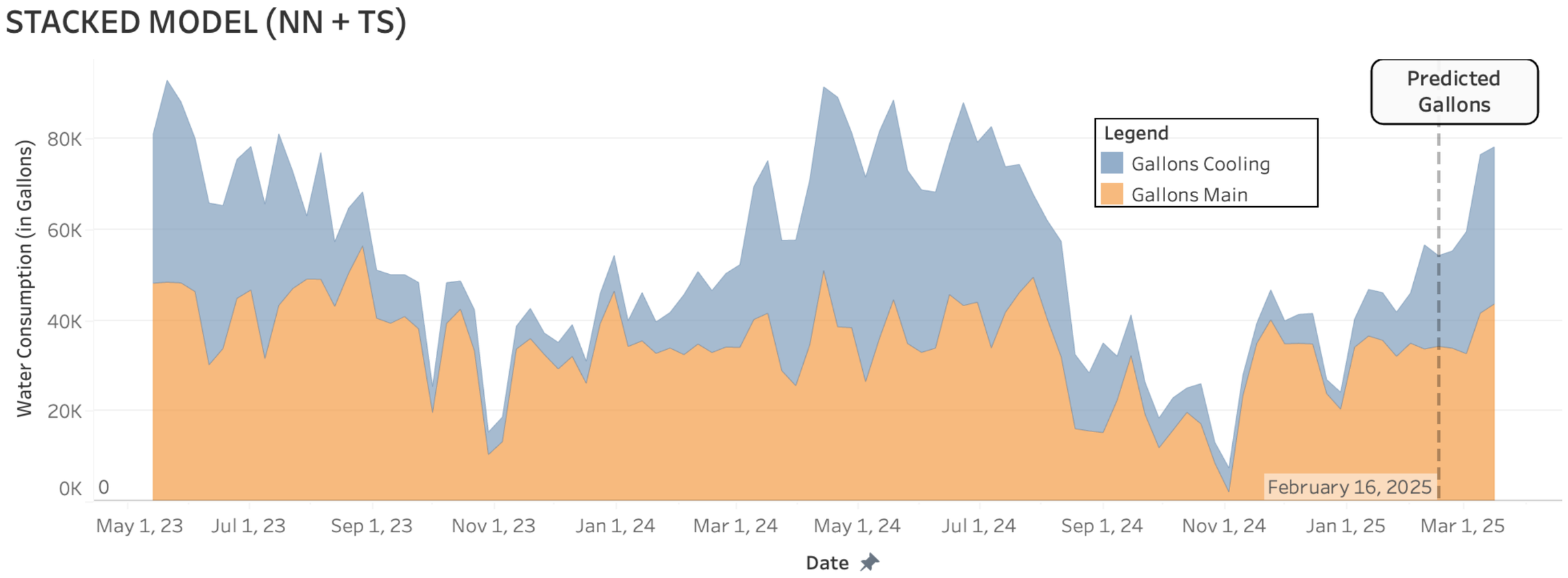
Forecasted Values

Date	Gallons Cooling	Gallons Main
Feb 23 2025	8,548	33,622
Mar 02 2025	8,315	33,873
Mar 09 2025	8,081	33,843
Mar 16 2025	7,847	33,913



Forecasted Values

Date	Gallons Cooling	Gallons Main
Feb 23 2025	21,431	33,709
Mar 02 2025	26,868	32,503
Mar 09 2025	34,902	41,444
Mar 16 2025	34,588	43,452



Forecasted Values

Date	Gallons Total
Feb 23 2025	55,140
Mar 02 2025	59,371
Mar 09 2025	76,346
Mar 16 2025	78,040

Optimization Model

The OPTMODEL Procedure

Problem Summary	
Objective Sense	Minimization
Objective Function	Total_Cost
Objective Type	Linear
Number of Variables	98
Bounded Above	0
Bounded Below	48
Bounded Below and Above	50
Free	0
Fixed	0
Binary	50
Integer	0
Number of Constraints	133
Linear LE (<=)	40
Linear EQ (=)	44
Linear GE (>=)	49
Linear Range	0
Constraint Coefficients	309

Solution Summary	
Solver	MILP
Algorithm	Branch and Cut
Objective Function	Total_Cost
Solution Status	Optimal
Objective Value	30591.695
Relative Gap	0
Absolute Gap	0
Primal Infeasibility	0
Bound Infeasibility	0
Integer Infeasibility	0
Best Bound	30591.695
Nodes	1
Solutions Found	2
Iterations	16
Presolve Time	0.00
Solution Time	0.00

Why MILP?

Mixed Integer Linear Programming – some decision variables are continuous and some are Integers

Why Branch and Cut Algorithm?

Hybrid of Branch-and-Bound & Cutting Plane Methods

Branch-and-Bound:

Systematically explores possible values of binary/integer variables

Cutting Plane Methods:

Helps eliminate unnecessary possibilities to speed up the search

Four steps in Branch and cut -

1. Relaxation (Ignore Integer Constraints Initially)
2. Branching (Branch-and-Bound)
3. Cutting Planes (Eliminating Bad Solutions)
4. Pruning (Discarding Unnecessary Paths)

Objective – 2 : Optimization Results

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

Answer – Tier 09

	y									
	Tier01	Tier02	Tier03	Tier04	Tier05	Tier06	Tier07	Tier08	Tier09	Tier10
1	0	0	0	0	0	0	0	0	1	0
2	0	0	0	0	0	0	0	0	1	0
3	0	0	0	0	0	0	0	0	1	0
4	0	0	0	0	0	0	0	0	1	0

2. How much gallons are being purchased from The Water Co. each week?
Answer – 50,000 in first 3 weeks and 58,530 in the final week.

	purchase									
	Tier01	Tier02	Tier03	Tier04	Tier05	Tier06	Tier07	Tier08	Tier09	Tier10
1	0	0	0	0	0	0	0	0	50000	0
2	0	0	0	0	0	0	0	0	50000	0
3	0	0	0	0	0	0	0	0	50000	0
4	0	0	0	0	0	0	0	0	58530	0

3. How many gallons should XYZ use from their Water Storage Tank each week?

[1]	storage_use
1	13785
2	14843
3	26347
4	19510

4. What is XYZ's projected total water cost at the end of the next four weeks?

Answer – $ 30,591.695

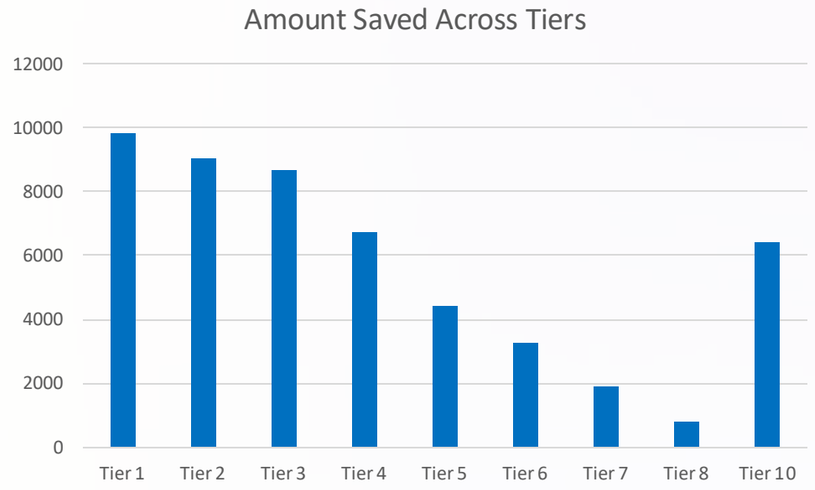
Objective Value	30591.695

5. What is XYZ's projected ending Water Storage Tank inventory at the end of each week?

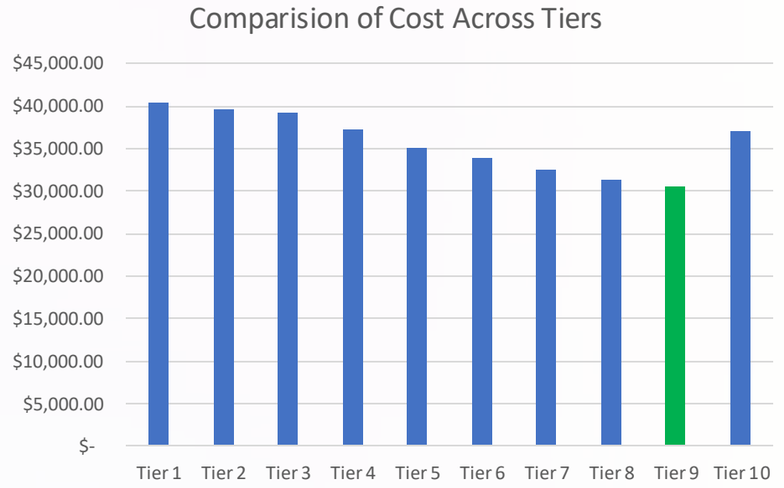
storage_inventory
60715
63872
57525
60015

Objective – 2 : Optimization Results

6. How much money will XYZ save by choosing the recommended contract tier over each of the alternative contract tiers?



Tier List	Amount Saved
Tier 1	9858.985
Tier 2	9058.985
Tier 3	8658.985
Tier 4	6741.32
Tier 5	4423.655
Tier 6	3264.823
Tier 7	1905.99
Tier 8	800
Tier 10	6420.975



THANK YOU