

Name	Calum [REDACTED]										
Date	4/24/24										
Instructor	Samuel Chukwuemeka										
Project	Water Bill: Residential Rates										
Company	Department of Water Works (https://broadwayva.gov/about/water-and-sewer/)										
Objectives	<p>(1). Calculate the water bill of residents within the town of Broadway, state of Virginia within the different ranges of water usage by using the Arithmetic method.</p> <p>(2.) Write a piecewise function based off the water bill rates.</p> <p>(3.) Recalculate the same water using the piecewise function method.</p>										
Information	<p style="text-align: center;">Broadway Water Rates</p> <table style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="text-align: center;">Gallons</th> <th style="text-align: center;">Water Per 1,000</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">0-3,000</td> <td style="text-align: center;">\$22.40</td> </tr> <tr> <td style="text-align: center;">3,001-100,000</td> <td style="text-align: center;">\$5.34</td> </tr> <tr> <td style="text-align: center;">100,001-400,000</td> <td style="text-align: center;">\$5.44</td> </tr> <tr> <td style="text-align: center;">Above 400,001</td> <td style="text-align: center;">\$6.07</td> </tr> </tbody> </table> <p>gal.</p> <p>Conversions:</p> $\$22.40 \text{ per } 1000 \text{ gallons} = \frac{22.40}{1000} = \0.224 per gallon $\$5.34 \text{ per } 1000 \text{ gallons} = \frac{5.34}{1000} = \$0.00534 \text{ per gallon}$	Gallons	Water Per 1,000	0-3,000	\$22.40	3,001-100,000	\$5.34	100,001-400,000	\$5.44	Above 400,001	\$6.07
Gallons	Water Per 1,000										
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	$\$5.44 \text{ per } 1000 \text{ gallons} = \frac{5.44}{1000} = \$0.00544 \text{ per gallon}$ $\$6.07 \text{ per } 1000 \text{ gallons} = \frac{6.07}{1000} = \$0.00607 \text{ per gallon}$
Numbers to Test	<p>(1.) 0 gallons</p> <p>(2.) 1,000 gallons</p> <p>(3.) 5,000 gallons</p> <p>(4.) 150,000 gallons</p> <p>(5.) 500,000 gallons</p>
Arithmetic Method	<p>I will now calculate the costs for these water consumptions:</p> <p>There are four pieces.</p> <p>(1.) 0 gallons falls in the first piece. $Cost = \\$22.40$</p> <p>(2.) 1000 gallons falls in the first piece. $Cost = 0.224(1000)$ $Cost = \\$224.00$</p> <p>(3.) 5000 gallons falls in the second piece $Cost = 0.224(3000) + 0.00534(5000 - 3000)$ $Cost = 0.224(3000) + 0.00534(2000)$ $Cost = 672 + 10.68$ $Cost = \\$682.68$</p>

(4.) 150000 falls in the third piece.

$$\begin{aligned} \text{Cost} &= 0.224(3000) \\ &+ 0.00534(100000 - 3000) \\ &+ 0.00544(150000 - 100000) \end{aligned}$$

$$\begin{aligned} \text{Cost} &= 0.224(3000) + 0.00534(100000) \\ &\quad + 0.00544(50000) \end{aligned}$$

$$\begin{aligned} \text{Cost} &= 672 + 0.00534(97000) \\ &+ 0.00544(50000) \end{aligned}$$

$$\text{Cost} = 672 + 517.98 + 0.00544(50000)$$

$$\text{Cost} = 672 + 517.98 + 272$$

$$\text{Cost} = \$1461.98$$

(5.) 500000 falls in the fourth piece.

$$\begin{aligned} \text{Cost} &= 0.224(3000) + 0.00534(100000 - 3000) \\ &\quad + 0.00544(400000 - 100000) \\ &\quad + 0.00607(500000 - 400000) \end{aligned}$$

$$\begin{aligned} \text{Cost} &= 0.224(3000) + 0.00534(97000) \\ &\quad + 0.00544(400000 - 100000) \\ &\quad + 0.00607(500000 - 400000) \end{aligned}$$

	$\begin{aligned} \text{Cost} &= 0.224(3000) + 0.00534(97000) \\ &\quad + 0.00544(300000) \\ &\quad + 0.00607(500000 - 400000) \\ \text{Cost} &= 0.224(3000) + 0.00534(97000) \\ &\quad + 0.00544(300000) \\ &\quad + 0.00607(100000) \\ \\ \text{Cost} &= 672 + 0.00534(97000) \\ &\quad + 0.00544(300000) \\ &\quad + 0.00607(100000) \\ \\ \text{Cost} &= 672 + 517.98 + 0.00544(300000) \\ &\quad + 0.00607(100000) \\ \\ \text{Cost} &= 672 + 517.98 + 1632 + 0.00607(100000) \\ \text{Cost} &= 672 + 517.98 + 1632 + 607 \\ \text{Cost} &= \$3428.98 \end{aligned}$
<p>Piecewise Function</p>	<p>Let c = cost of water consumed per gallon in \$ Let g = gallons of water consumed</p> <p>First piece: Cost for $0 \leq g \leq 3000$ is \$0.224 per gallon $c(g) = 0.224g$</p> <p>Second piece: First piece: Cost for $0 \leq g \leq 3000$ is \$0.224 per gallon</p>

Second piece: Cost for $3001 \leq g \leq 100000$ is \$0.00534 per gallon

Cost for 3000 gallons = $0.224(3000) = \$672$

$$c(g) = 672 + 0.00534(g - 3000)$$

$$c(g) = 672 + 0.00534g - 16.02$$

$$c(g) = 0.00534g + 655.98$$

Third piece:

First piece: Cost for $0 \leq g \leq 3000$ is \$0.224 per gallon.

Second piece: Cost for $3001 \leq g \leq 100000$ is \$0.00534 per gallon.

Third piece: Cost for $100001 \leq g \leq 400000$ is \$0.00544 per gallon.

Cost for 70000 gallons = $0.00534(70000) = \$37.38$

$$c(g) = 0.224(3000) + 0.00534(100000 - 3000) + 0.00544(g - 100000)$$

$$c(g) = 672 + 0.00534(100000 - 3000) + 0.00544g - 544$$

$$c(g) = 672 + 0.00534(97000) + 0.00544g - 544$$

$$c(g) = 672 + 517.98 + 0.00544g - 544$$

$$c(g) = 0.00544g + 645.98$$

Fourth piece

First piece: Cost for $0 \leq g \leq 3000$ is \$0.224 per gallon.

Second piece: Cost for $3001 \leq g \leq 100000$ is \$0.00534 per gallon.

Third piece: Cost for $100001 \leq g \leq 400000$ is \$0.00544 per gallon.

Forth piece: Cost for $g \geq 400001$ is \$0.00607 per gallon

$$c(g) = 0.224(3000) + 0.00534(100000 - 3000) \\ + 0.00544(400000 - 100000) + 0.00607(g \\ - 400000)$$

$$c(g) = 0.224(3000) + 0.00534(97000) \\ + 0.00544(400000 - 100000) \\ + 0.00607(g - 400000)$$

$$c(g) = 0.224(3000) + 0.00534(97000) \\ + 0.00544(300000) + 0.00607(g - 400000)$$

$$c(g) = 672 + 0.00534(97000) + 0.00544(300000) \\ + 0.00607(g - 400000)$$

$$c(g) = 672 + 517.98 + 0.00544(300000) \\ + 0.00607(g - 400000)$$

$$c(g) = 672 + 517.98 + 1632 + 0.00607(g - 400000)$$

$$c(g) = 672 + 517.98 + 1632 + 0.00607g - 2428$$

$$c(g) = 1189.98 + 1632 + 0.00607g - 2428$$

$$c(g) = 2821.98 + 0.00607g - 2428$$

$$c(g) = 0.00607g + 393.98$$

	$c(g) = \begin{cases} 0.224g; & 0 \leq g \leq 3000 \\ 0.00534g + 655.98; & 3001 \leq g \leq 100000 \\ 0.00544g + 645.98; & 100001 \leq g \leq 400000 \\ 0.00607g + 393.98; & g > 400000 \end{cases}$
<p>Algebraic Method</p>	<p>(1.) For 0 gallons: this is the first piece</p> $c(g) = 0.224g$ $c(0) = 0.224(0)$ $c(0) = \$0.00$ <p>(2.) For 1000 gallons: this is the first piece</p> $c(g) = 0.224g$ $c(1000) = 0.224(1000)$ $c(1000) = \$244.00$ <p>(3.) For 5000 gallons: this is the second piece</p> $c(g) = 0.00534g + 655.98$ $c(5000) = 0.00534(5000) + 655.98$ $c(5000) = 26.7 + 655.98$ $c(5000) = \$682.68$ <p>(4.) For 150000 gallons: this is the third piece</p> $c(g) = 0.00544g + 645.98$ $c(150000) = 0.00544(150000) + 645.98$ $c(150000) = 816 + 645.98$ $c(150000) = \$1461.98$ <p>(5.) For 500000 gallons: this is the fourth piece</p>

	$c(g) = 0.00607g + 393.98$ $c(500000) = 0.00607(500000) + 393.98$ $c(500000) = 3035 + 393.98$ $c(500000) = \$3428.98$
MLA Citations	Chukwuemeka, Samuel D. "Piecewise Functions – Water Bill" <i>Piecewise Functions</i> , https://precalculus.appspot.com/PiecewiseFunctions/piecewise-functions.html#studentProjectWaterBill , Accessed 17, Apr. 2024 "Water and Sewer" <i>Town of Broadway</i> , https://broadwayva.gov/about/water-and-sewer/ Accessed 17, Apr. 2024