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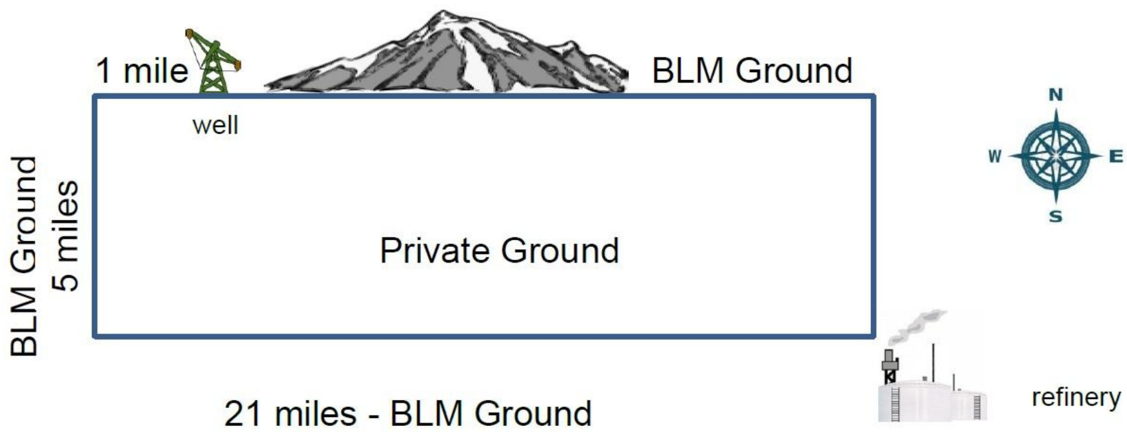
Math 1210

11/2/13

Pipeline Project

Enclosed as requested is the report on the Vernal, Utah pipeline.

a) Determine the cost of running the pipeline strictly on BLM ground with two different scenarios:



i) Heading east through the mountain and then south to the refinery

$Cost = \ 50{,}000\$ * (3) + 100{,}000\$ + 500{,}000\$ + (25) * 300{,}000\$ = 8{,}250{,}000\$$

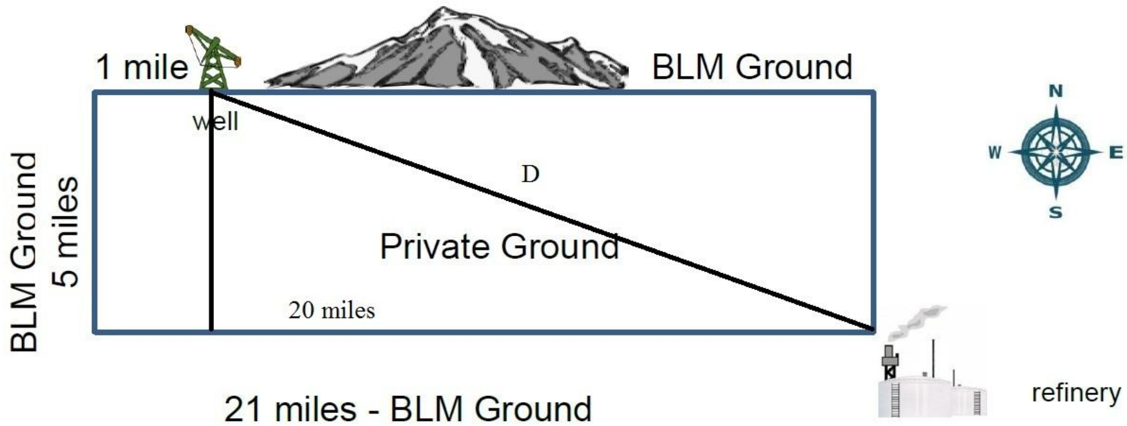
This is 50,000$ every month for three months of delays plus the cost of 100,000$ for the environmental study plus the cost of 500,000$ to drill through the mountain plus the cost of running the pipeline for 25 miles at 300,000$ per mile on BLM land.

ii) Running west, south and then east to the refinery.

$Cost = (27) * 300{,}000\$ = 8{,}100{,}000\$$

This is the cost of running the pipeline 27 miles at 300,000$ per mile on BLM land.

b) Determine the cost of running the pipeline the shortest distance (straight line joining well to refinery across the private ground).

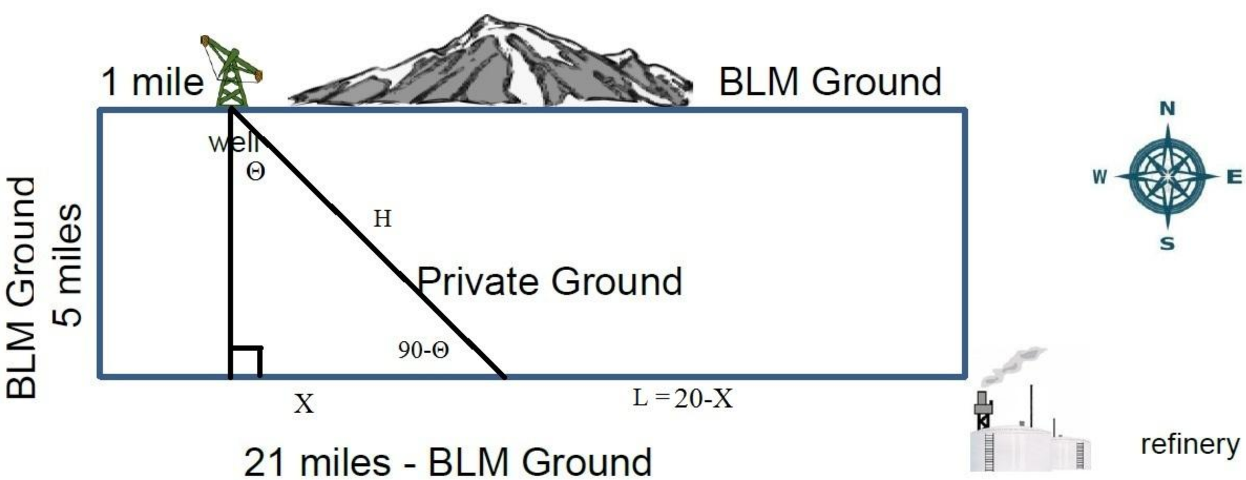


$D = \sqrt{20^2 + 5^2} = 5\sqrt{17} \approx 20.62\ miles$ D is the pipe line

$Cost = 500{,}000\$ * D(5\sqrt{17}) = 2{,}500{,}000\sqrt{17} = 10{,}307{,}764.06\$$

D is the distance from the well to the refinery through private ground. The cost is the distance through the private ground D at 500,000$ for every mile.

c) Determine cost function and the optimal placement to minimize cost then sketch. Draw a graph of the function and label the point of minimum cost.



x = horizontal distance from point across from well to the point where H meets the BLM ground.

H = the distance of the pipe line across the private ground.

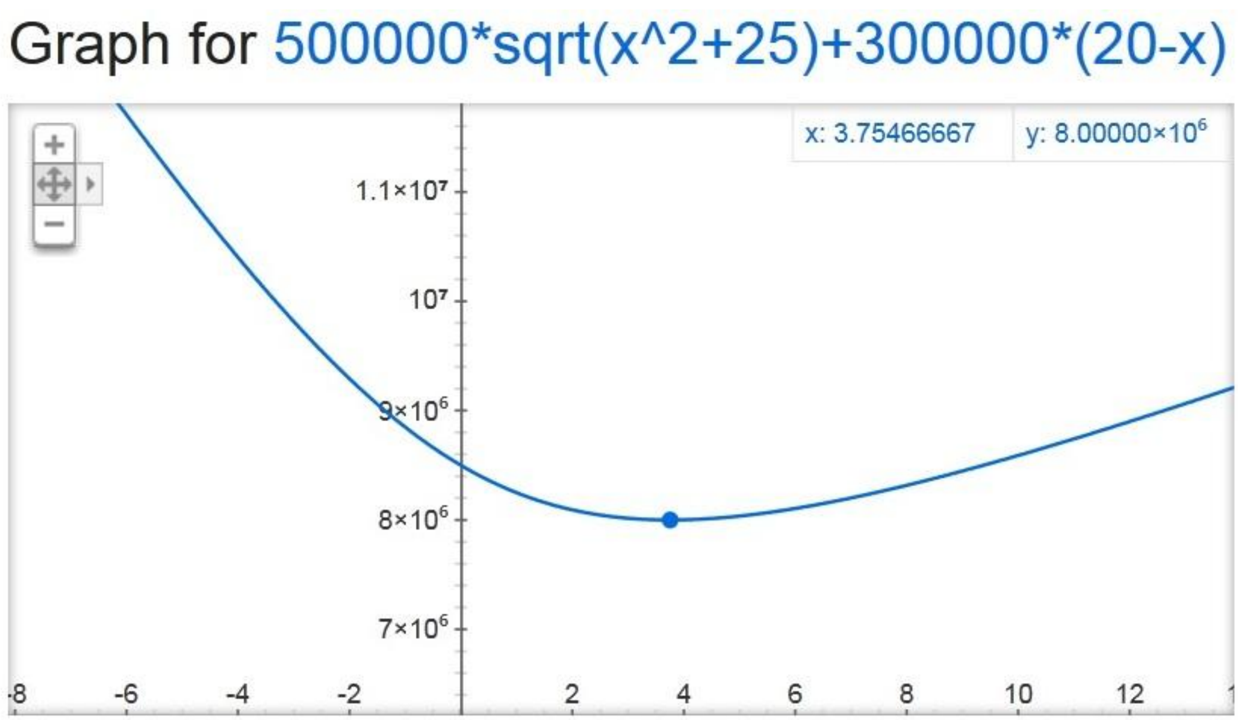
L = the distance of the pipeline from where it connects at the end of H to the refinery.

$H^2 = x^2 + 5^2 \rightarrow H = \sqrt{x^2 + 25} \qquad L = 20 - x$

$C(x) = 500{,}000\$ * H + 300{,}000 * L$

$C(x) = 500{,}000\$ * \left(\sqrt{x^2 + 25}\right) + 300{,}000 * (20 - x)$

This is the cost function, 500,000 dollars for every mile of H plus 300,000 dollars for every mile of L.



$C'(x) = 500{,}000\$ * \left[\frac{1}{2}(x^2 + 25)^{-\frac{1}{2}} * [2x]\right] + 300{,}000\$[-1]$

$C'(x) = 500{,}000\$ * \left[\frac{x}{\sqrt{x^2 + 25}}\right] - 300{,}000\$$

By setting the derivative of the cost function to zero the optimal X can be found to minimize cost.

$500{,}000\$ * \left[\frac{x}{\sqrt{x^2+25}}\right] - 300{,}000\$ = 0 \quad \rightarrow \quad 500{,}000\$ * \left[\frac{x}{\sqrt{x^2+25}}\right] = 300{,}000\$$

$\frac{x}{\sqrt{x^2+25}} = \frac{300{,}000\$}{500{,}000\$} \rightarrow \frac{x}{\sqrt{x^2+25}} = \frac{3}{5} \rightarrow x = \frac{3}{5}\sqrt{x^2 + 25}$

$$\rightarrow x^2 = \frac{9}{25} * (x^2 + 25) \rightarrow x^2 = \frac{9x^2}{25} + 9 \rightarrow \frac{16}{25}x^2 = 9 \rightarrow X^2 = \frac{225}{16}$$

$$\rightarrow x = \frac{15}{4} = 3.75\, miles$$

Since the optimizing x is found to find the minimum cost find H and L with the x value

$$H = \sqrt{\frac{225}{16} + 25} \rightarrow H = \sqrt{\frac{625}{16}} \rightarrow H = \frac{25}{4} = 6.25\, miles$$

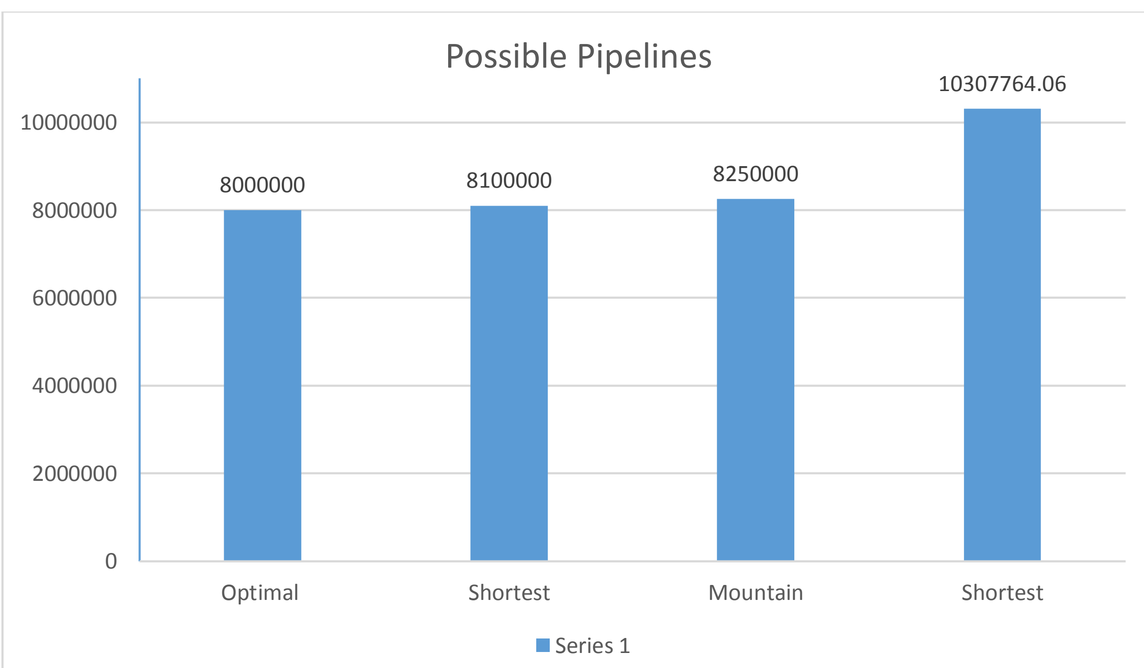
$$L = 20 - \frac{15}{4} = \frac{65}{4} = 16.25\, miles$$

$$\sin(\theta) = \frac{x}{H} \rightarrow \sin(\theta) = \frac{\frac{15}{4}}{\frac{25}{4}} = \frac{3}{5} = .6 \rightarrow \theta = \sin^{-1}(.6) \approx 36.87°$$

$$\theta - 90 \approx 53.13°$$

Then to find minimum cost input the value of x into C(x) or the H and L value.

$C(x) = 500{,}000\$ * (6.25) + 300{,}000 * (16.25) = 8{,}000{,}000\ \$$



I have learned how to take limits of various kinds, I have learned to take derivatives of functions and implicit derivatives, I have learned to graph based on derivatives, and I have learned to take average and instant velocities, optimization based on derivatives among other things. Possible real world applications could be optimizing the speed to drive a long distance for gas mileage, minimizing the amount of wood in a construction project or finding out how fast the water drains out of an AR-15 when it is submerged under water. Calculus is a very useful tool in physics and optimization and finance. While not much calculus is used in computer science it allows me to think logically and understand complex algorithms. When I am trying to create a proof I am exercising the same logical analysis and processes that I need to create a complex regular expression in programs and create algorithms and pseudo code to develop elaborate programs. Overall I think taking calculus and other pure mathematics is essential for the process of software development and engineering.