BLM GAS PIPELINE COST STUDY

During the gas pipeline cost study we encountered four possible routes, all of which were evaluated and compared to minimize the final cost of build.

Scenario #1

Build a pipeline on BLM ground only by heading east through the mountain and then south to the refinery; This route will use 25 miles of pipe and we will incur additional expenses to drill through the mountain, conduct and environmental study and will add three additional months to the project.

Total Cost: $8,250,000 USD

Scenario #2

Build a pipeline on BLM ground only by heading west of the well, then south and finally east of the refinery. This route will use 27 miles of pipe; because it is on BLM ground only no additional cost will be added.

Total Cost: $8,100,000 USD

Scenario #3

Build a pipeline on private ground only, for the shortest distance possible. This route will use 20.6155 miles of pipe; because it is in private land there are additional fees added.

Total Cost: $10,307,764 USD

Scenario #4

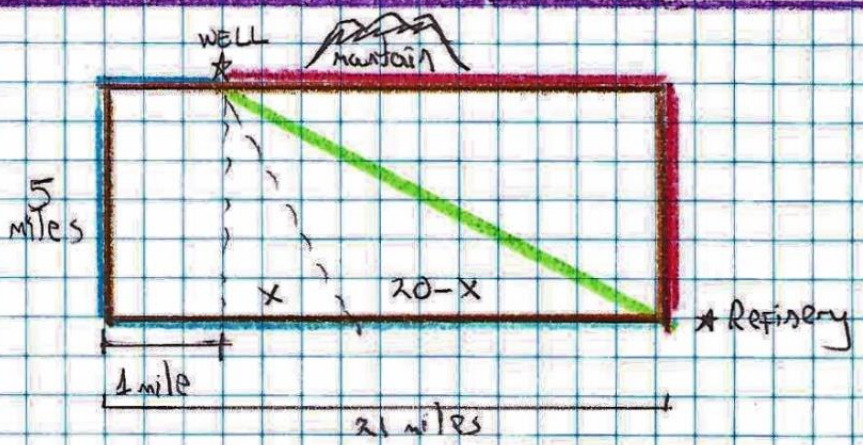
Build a pipeline combining BLM ground with the least amount of private land possible. This route will use 22.5 miles of pipeline; because a section is in private land, there are additional fees added to this part of the pipeline.

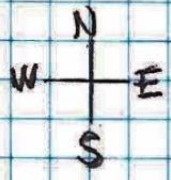
Total cost: $8,000,000 USD

* Calculations for BLM Pipeline:

* Parameters: (cost per mile)

- BLM Ground: $300,000 per mile
- Private Ground: $500,000 per mile ($300,000 pipeline + $200,000 private ground fee)
- Mountain Drilling: $300,000 per mile plus one time cost of $250,000 ($100,000 Environmental study, $150,000 3 additional miles @ 50,000





* Scenarios

(1) (20 mi + 5 mi = 25 miles)

$(25 \times 300{,}000) + (500{,}000) + (100{,}000) + (3 * (50{,}000))$

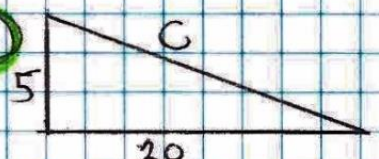
Pipeline | Drilling | study | 3 months

$= \$8{,}250{,}000$

(2) (21 mi + 5 mi + 1 mi) = 27 miles

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

(3)



$a^2 + b^2 = c^2$

$5^2 + 20^2 = c^2$

$\sqrt{25+400} = \sqrt{c^2}$

$20.6155 = c$

$(20.6155 \times 500{,}000) =$

$\$10{,}307{,}764$

4

$\left(500{,}000 \times \sqrt{5^2+x^2}\right) + \left(300{,}000 \cdot (20-x)\right) = F(x)$

Private Ground + BLM ground

$5^2+x^2=c^2$

$\sqrt{5^2+x^2}=\sqrt{c^2}$

$\sqrt{5^2+x^2}=c$

$F'(x) = \left[(500{,}000)(25+x^2)^{1/2}\right] + \left[(300{,}000)(20-x)\right]$

$= \left[(500{,}000)(25+x^2)^{1/2}\right] + \left[(300{,}000)(20-x)\right]$

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

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

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

$\left(\frac{500{,}000x}{\sqrt{25+x^2}} - 300{,}000\right) = 0$

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

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

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

$x^2 = \left(\frac{3\sqrt{25+x^2}}{5}\right)^2$

$x^2 = \frac{9(25+x^2)}{2}$

$x^2 = \frac{9 \cdot 25}{25} + \frac{9x^2}{25}$

$x^2 = 9 + \frac{9x^2}{25}$

$\frac{25x^2}{25} - \frac{9x^2}{25} = 9$

$\frac{16x^2}{25} = 9$

$x^2 = \frac{(9)(25)}{16}$

$\sqrt{x^2} = \sqrt{\frac{225}{16}}$

$x = \frac{15}{4}$ ↔

Second Derivative Test

$\left(\frac{y}{\sqrt{25+x^2}}\right)$

$(x)(25+x^2)^{-1/2}$

$(x)\left(-\frac{1}{2}(\sqrt{25+x})^{3/2}\right)(2x) + \left(\frac{1}{\sqrt{25+x^2}}\right)$

$\frac{-x^2}{(\sqrt{25+x^2})^3} + \frac{1}{\sqrt{25+x^2}}$

$\frac{-\left(\frac{15}{4}\right)^2}{\left(\sqrt{25+\left(\frac{15}{4}\right)^2}\right)^3} + \frac{1}{\sqrt{25+\left(\frac{15}{4}\right)^2}}$

$(-0.0570) + (0.16)$

$= 0.1024$

Positive value so graph is concave UP. It proves $\frac{15}{4}$ is a minimum value

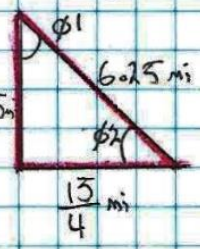
$F(x) = \left[(500{,}000)\left(\sqrt{5^2+x^2}\right)\right] + \left[(300{,}000)(20-x)\right]$

$= \left[(500{,}000)\left(\sqrt{5^2+\left(\frac{15}{4}\right)^2}\right)\right] + \left[(300{,}000)\left(20-\frac{15}{4}\right)\right]$

$3{,}125{,}000 + 4{,}875{,}000$

$= \$8{,}000{,}000$

Angles for the Proposed pipeline



$a^2 + b^2 = c^2$

$5^2 + \left(\frac{15}{4}\right)^2 = c^2$

$\sqrt{25+\frac{225}{16}} = \sqrt{c^2}$

$6.25 = c$

$\cos\phi_1 = \frac{5}{6.25}$

$\cos^{-1}(\phi_1) = \cos^{-1}\left(\frac{5}{6.25}\right)$

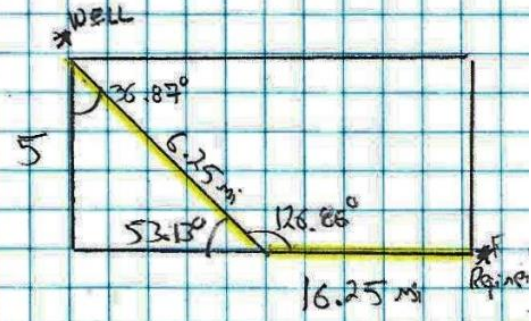
$\phi_1 = 36.8699°$

$180 = 36.8699 + 90 + \phi_2$

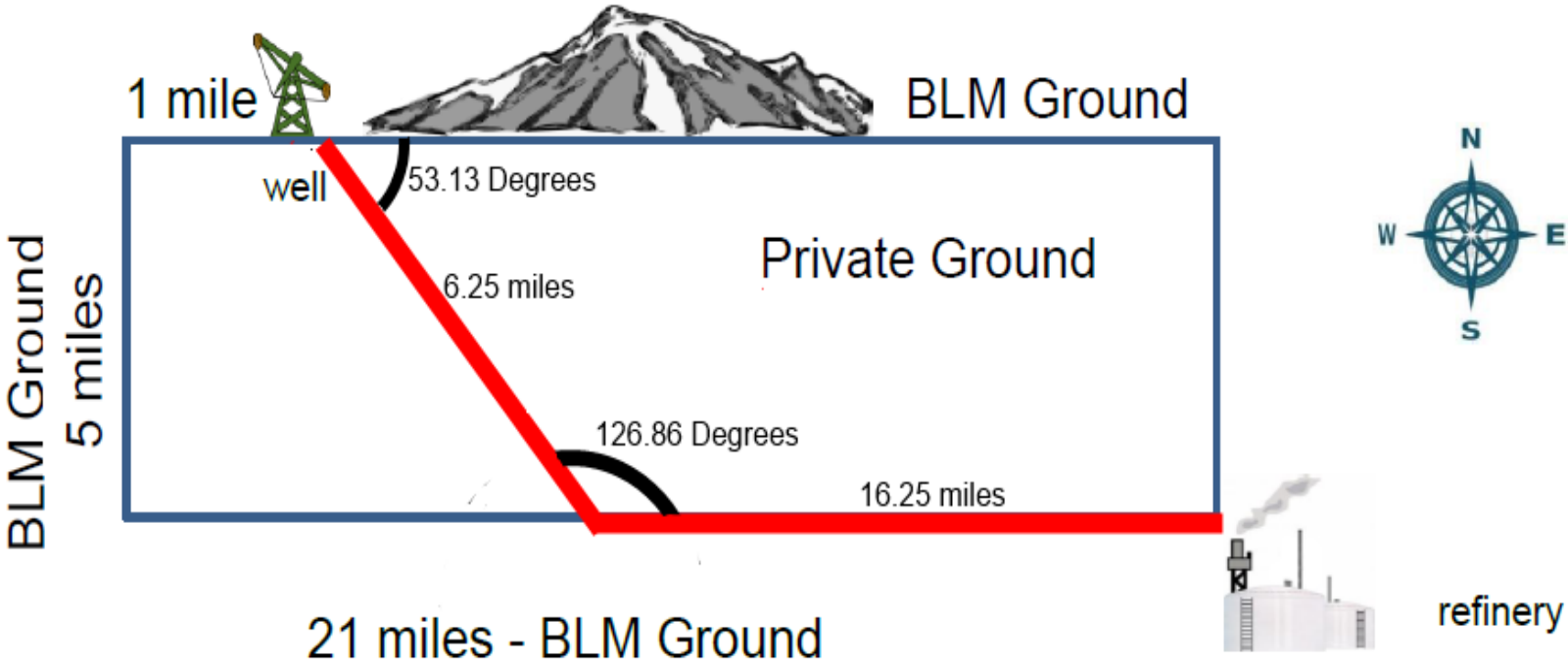
$180 - 36.8699 - 90 = \phi_2$

$53.1301° = \phi_2$

Final Dimensions



FINAL LAYOUT FOR BLM GAS PIPELINE



OPTIMIZATION GRAPH