A composite image of the solar system. On the left, Earth is shown with a satellite in orbit. The Sun is a large, glowing orange sphere in the center. The Moon is a smaller, grey sphere in the middle. Mars is a reddish-brown sphere to the right of the Moon. Jupiter is a large, striped gas giant in the bottom right. A comet with a long tail is streaking across the sky in the upper right. The background is a dark space filled with stars and a galaxy.

Elements of Regolith Simulant's Cost Structure

Why Rock is NOT Cheap

Doug Rickman
Earth Science Office, Marshall Space Flight Center
March 17, 2009





Cost Elements

Complex Costs

- Development

- Advertising

- Overhead

- Scale, including Weight

Generally Present

- Acquisition

- Shipping

- Storage

- Processing

 - Milling

 - Measurement

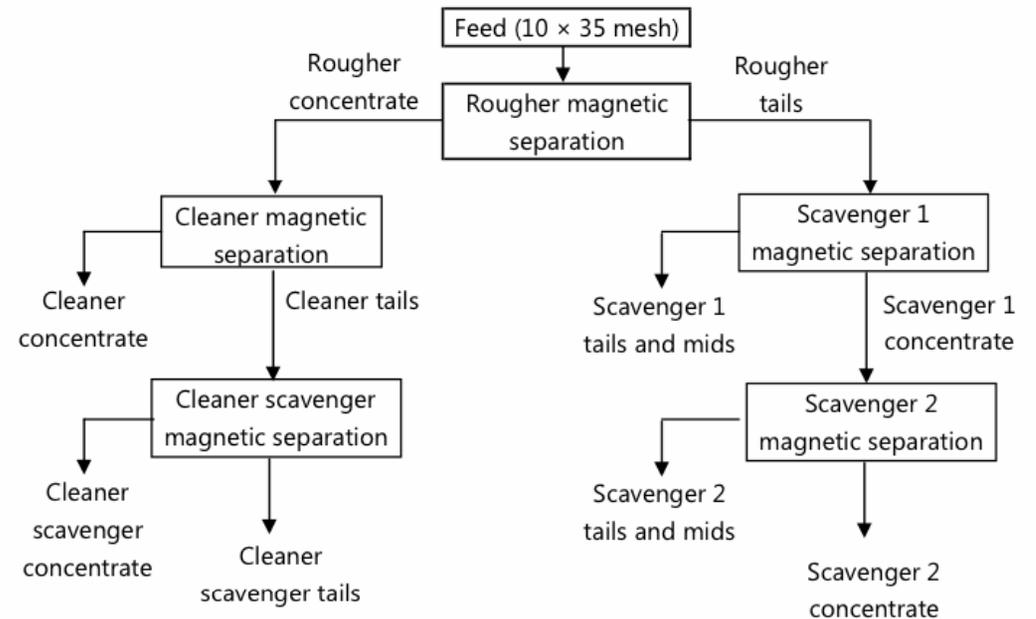
 - Synthesis

- Profit, Risk and Time



Magnetic Separation Circuit

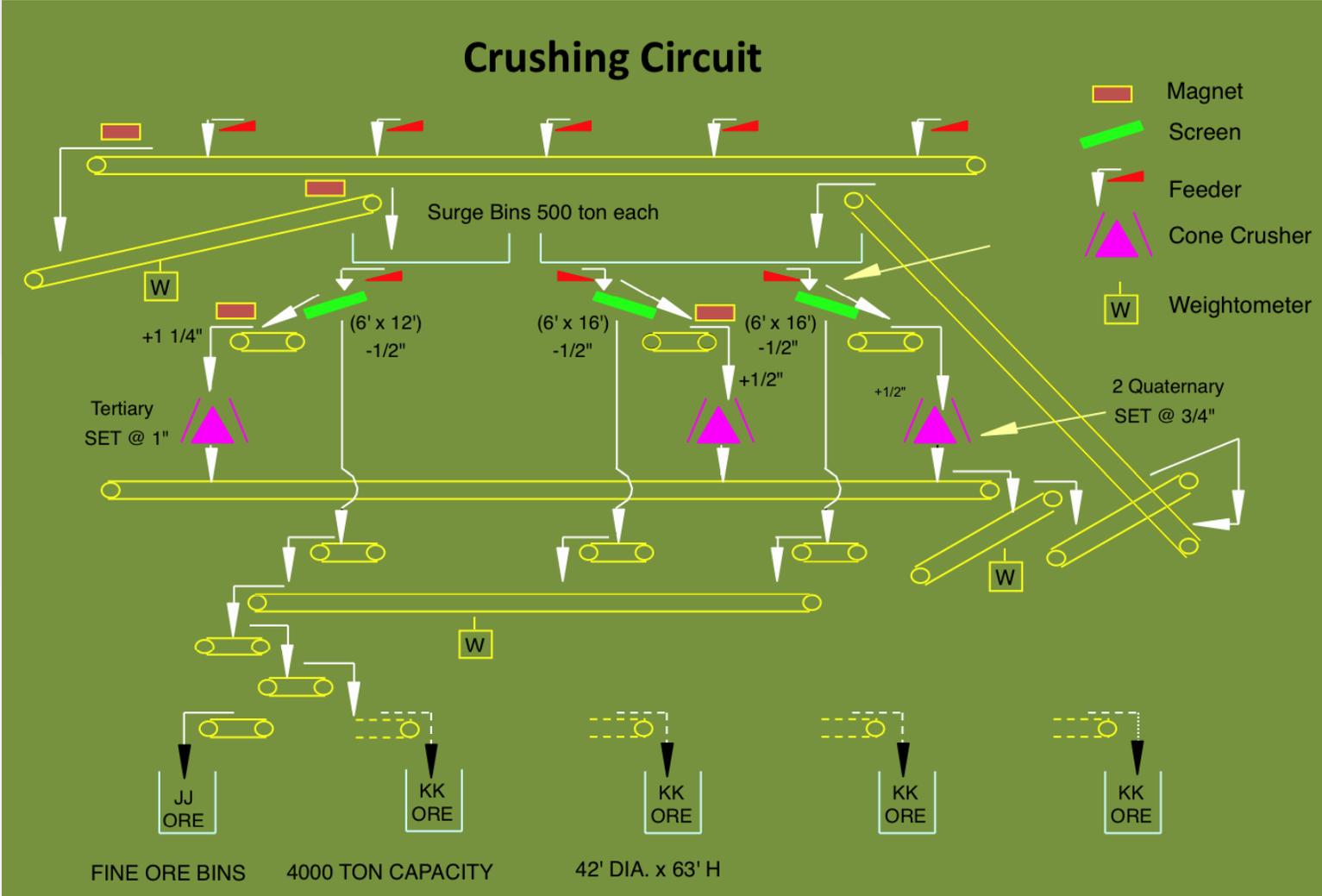
Product	Weight	
	g	%
Cleaner concentrate	803.6	24.5
Cleaner scavenger concentrate	69.4	2.1
Scavenger 2 concentrate	1414.1	43.0
Total Con	2287.1	69.6
Cleaner scavenger tails	63.9	1.9
Scavenger 1 tails and mids	742.8	22.6
Scavenger 2 tails and mids	191.3	5.8
Total Tails	998.0	30.4
Calculated Feed	3285.1	100.0



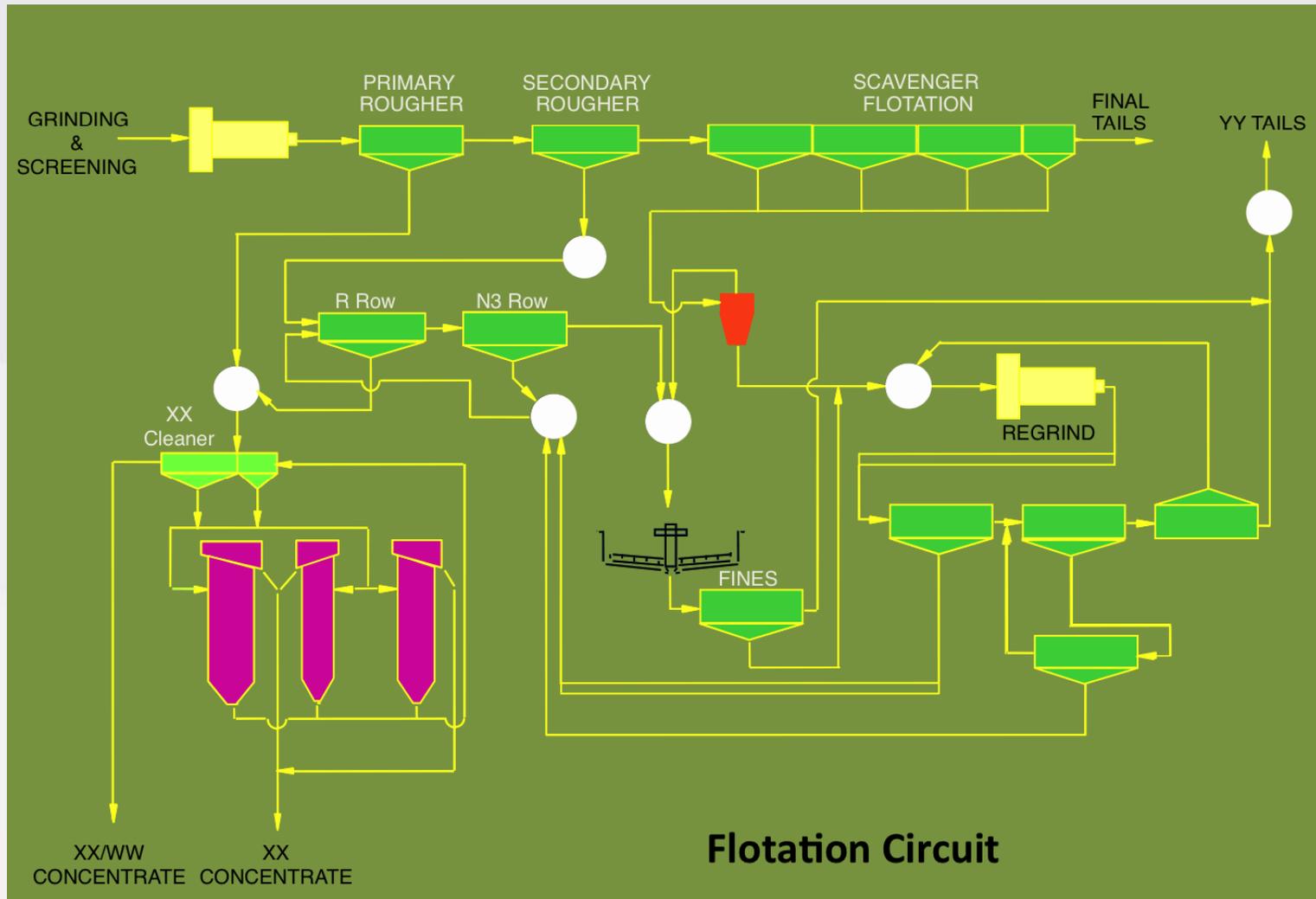
From a report by Hazen Research, Inc. to the USGS.



Crushing Circuit



Flotation Circuit



Jar of NU-LHT

Segregation in simulant due to handling. Note the complex layering which indicates multiple episodes of sorting and probably multiple controlling factors.

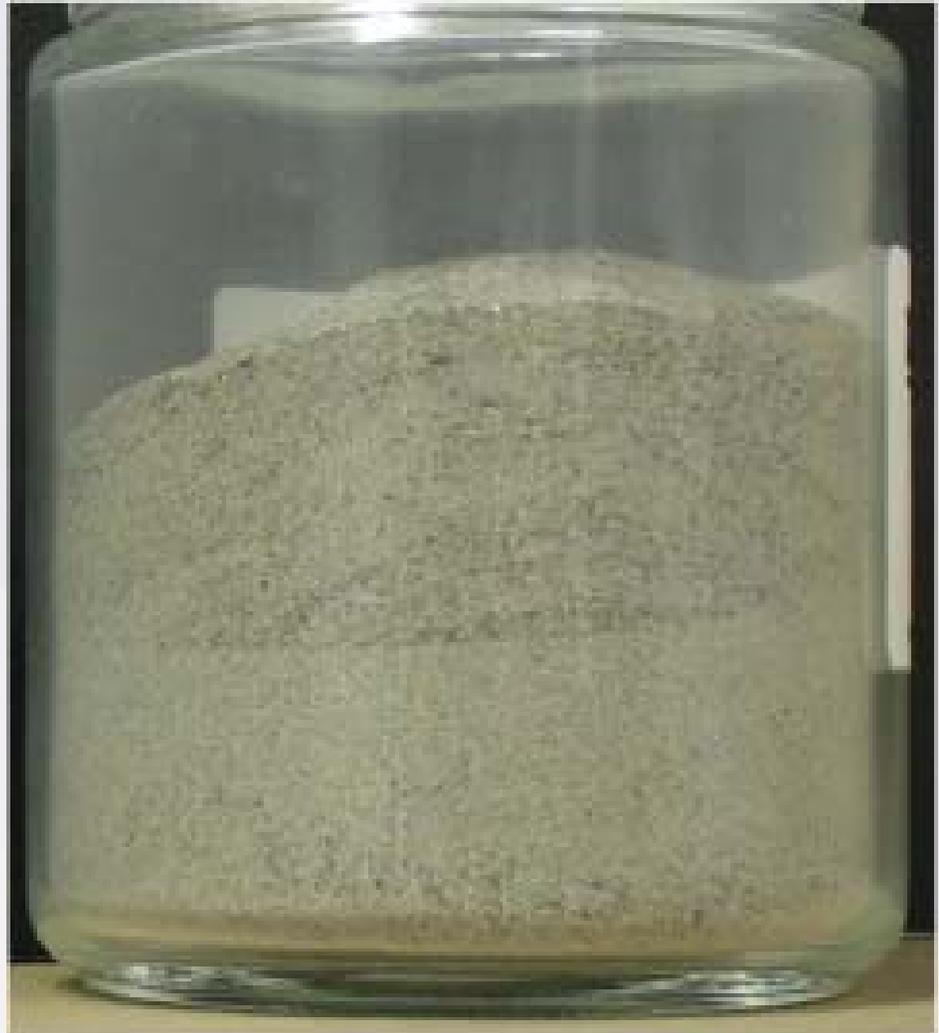


Photo from report by Intellection



Simple Cost Example, part 1

The requirement is to make a test area 100' x 100' filled 3 feet deep using whatever is locally used as road fill.

Conversion factors and handy approximations

$$1 \text{ ft}^3 = 0.0283\text{m}^3 = 28,300\text{cm}^3$$

$$1 \text{ lb} = 0.45 \text{ kg}$$

The regolith weighs approximately 1.6 g/cm^3

Simulant weight/volume

$$45.3 \text{ kg/ft}^3 = 100 \text{ lb/ft}^3$$

$$1 \text{ m}^3 = 1,600 \text{ kg}$$



Simple Cost Example, part 2

Local bulk rock for road fill is ~\$10/ton (English).
Haul cost for local material is ~ \$10/ton (English)

Volume	- 30,000 ft ³
Weight per volume	- 100 lb/ ft ³
Unit conversion	- 2000 lb/ton
Cost per ton	- \$20/ton
Total weight	- 1,500 tons
Final cost	- \$30,000

Notes:

Road fill is not sized and is very coarse.

The cost of distributing the rock once it is dumped is not included.

