

Cost Estimations

Building Your Confidence Through a Systematic Approach

Edward Winner, PhD

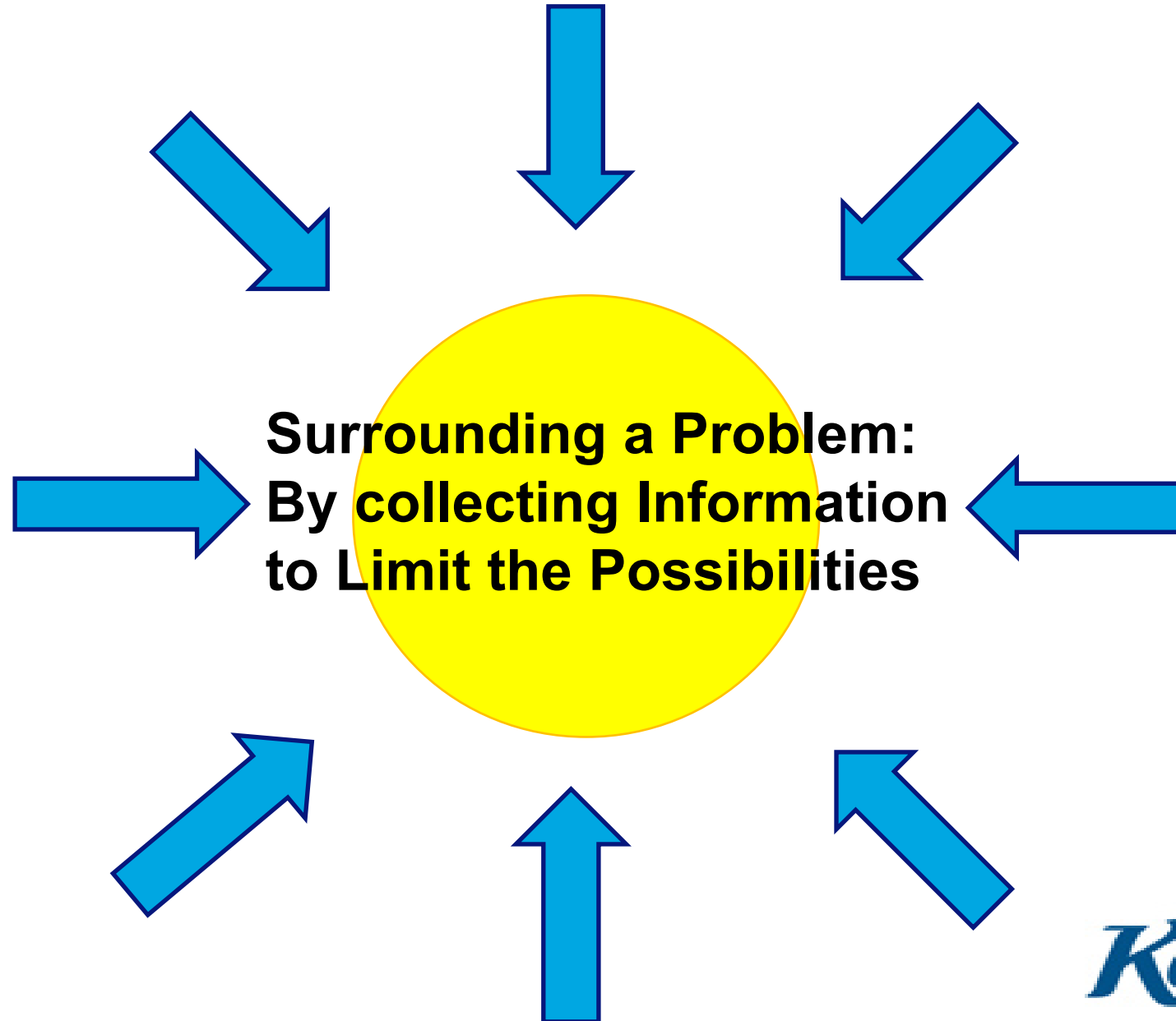
October 2020



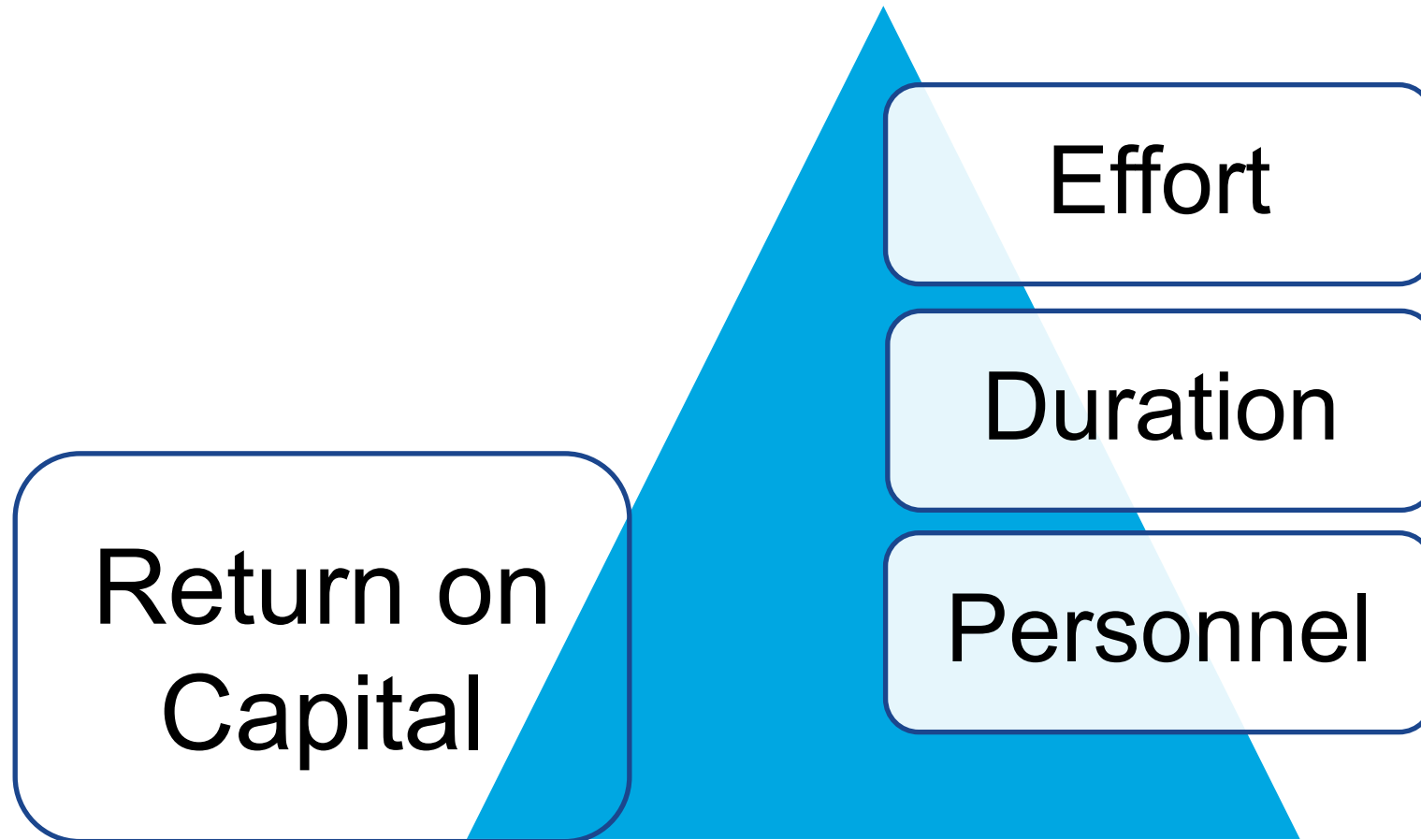
Kentucky
UNBRIDLED SPIRIT™

TM

Cost Estimates

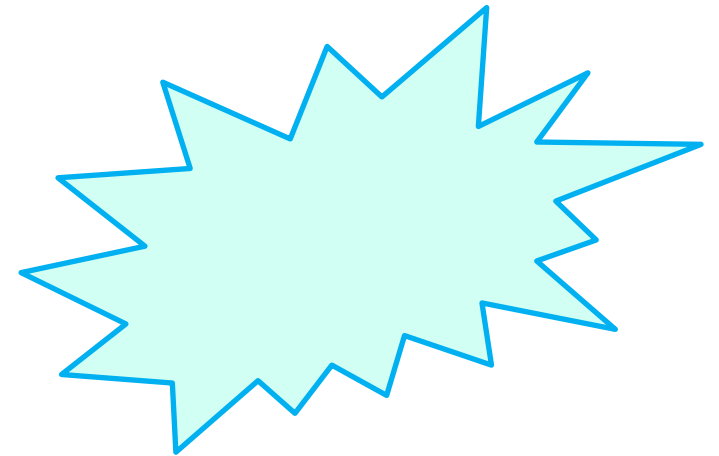


Understanding Core Cost Drivers



Breakdown of Cost Estimation Approaches

- Sum of the Individual Elements in the action (Bottom-up)
- Analysis of Invoices provided by states and contractors (Top-Down)
- Survey of expert judgement (Ask people)
- Cost estimates from published sources
 - e.g. Means Cost Guides*
- Estimate by analogous work
- Cost Estimation Software
 - Remedial Action Cost Engineering Requirements (RACER®) System
 - <https://frtr.gov/ec2/ecracersystem.htm>



Build a Chart to Document Know Information

- **Estimation Information for a specific effort (Tool)**

My Sources

Means Guide: Top-down, Analysis of individual costs

State Invoices: Site based information and matrix calculation

Wes McCall for the Geoprobe and MIP, All State Ford for truck cost in 2018.

Asked some of the state's contractors (In formal)
Survey (Formal via Survey Monkey for Bed Rock wells)

Google where I found the EPA estimate and the CAT cost estimation sheet. Insurance costs

Literature Based: USEPA CLU-IN MIP Cost

- The major costs of operating a MIP system:
- The direct push platform
- MIP operating system, and detectors
- Labor
- Depending upon the equipment used, the cost of a MIP system with crew can range from \$3,000 to \$5,000 per day.

<https://clu-in.org/characterization/technologies/mip.cfm>



Top-down Approach

- Uses personal, institutional, or published knowledge
- Examine cost of individual remedial approaches or entire cleanups
- Scale up or down as necessary to suit needs

(e.g., ICF International et al., 2008; US ACE & US EPA, 2000; US Department of the Interior, 2011).



Kentucky Summary Data for MIP

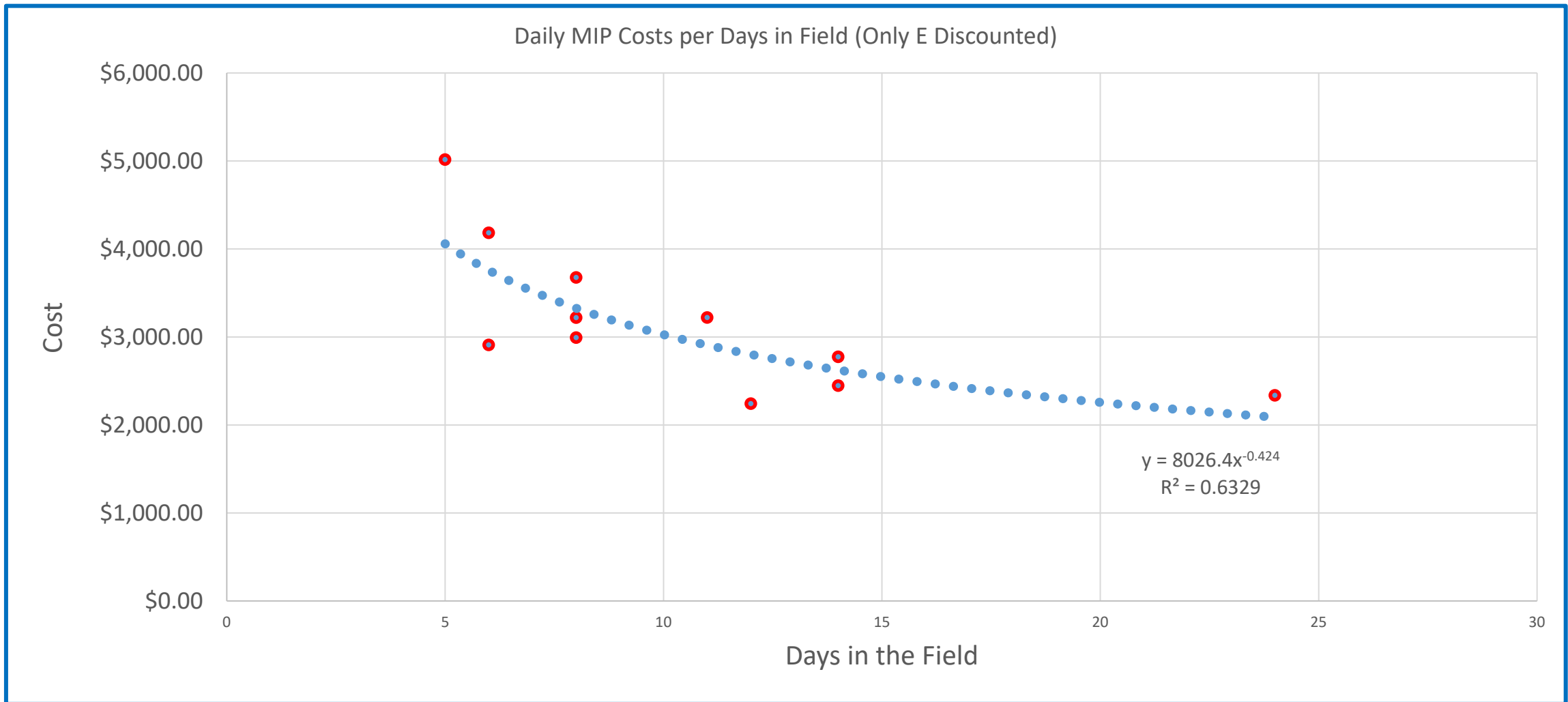
Company	Average all-inclusive cost per day in field	STDEV	Number of Sites
A	\$4,059.35	\$ 350.69	10
B	\$4,608.36	\$ 382.05	6
C	\$4,269.25	\$ 440.32	4
D	\$4,562.25	\$ 150.25*	2
E	\$3,182.74	\$ 799.34	11

Weighted Average of \$3923.00

* Difference between the two invoices



Daily Cost per Days in the Field



Bottom-up Approach

- “Bottom-up,” approach (US ACE & US EPA, 2000), whereby individual cost sub-elements are developed and then summed.
- Unit costs are derived from internal experience, vendor quotes, or commercially available publications (e.g., RSMeans SiteWork & Landscape Cost Data, 2012) and databases, such as the Remedial Action Cost Engineering and Requirements (RACER)™ software (AECOM, 2012).
- Note these costs were developed in 2018! Every item cost is now out of date. The methodology remains sound.

A.						B.		
MIP and supporting equipment purchase and operation costs for the life of the tool			Estimated Costs	Includes Debt Servicing Costs	Per Annual	Cost Category Total	Percent of total costs	Percent costs for category
<p>This estimate is intended to replicate what a potential provider would have to consider prior to purchasing the equipment and thus the base cost of operation necessary to support the tool in the field. Data analysis and reporting costs are highly variable and individualizes; therefore, those costs must be considered separately. All variable costs associated with mobilization, staff per diem, health and safety plans, utility location survey etc. are excluded. Confirmational sampling of soil or water samples is not included. Overhead associated with equipment storage and administrative staff are not included.</p>						<p>These values are per category. For example, it will cost about 42K per year to own and operate a push rig assuming that the tool is working about 100 days/year.</p>		
Item						a.	b.	c.
Geoprobe A7822DT 60 ft of rod			\$135,000.00	7% for 5 years	\$33,000.00			
Annual Maintenance Costs			\$1,500.00		\$1,500.00			
Insurance on Geoprobe					\$900.00			
Fuel for Geoprobe at 12 gallons/day * Days operated					\$4,680.00	\$41,030.00	14.6%	
Fuel 8 to 14 gallons a day	12	\$3.90						
Trailer 10,000 pound			\$4,000.00	7% for 5 years	\$950.00			
Insurance for trailer					\$250.00			
Annual Maintenance Costs					\$1,000.00	\$2,200.00	0.8%	
Truck sufficient to transport Geoprobe 5% interest			\$40,000.00	7% for 5 years	\$9,500.00			
Annual Maintenance Costs			\$480.00		\$690.00			
Insurance			\$1,850.00		\$1,850.00	\$12,040.00	4%	19.7%
MIP Equipment with 3 Standard Detectors			\$86,000.00	7% for 5 years	\$20,400.00			
Annual Maintenance Costs			\$3,200.00		\$3,200.00			
Computer, Software, Connections			\$2,400.00		\$2,400.00			
Repairs and maintenance					\$700.00	\$26,700.00	9.5%	
Van for MIP controller and detectors			\$35,000.00	7% for 5 years	\$8,300.00			
Annual Maintenance Costs			\$480.00		\$600.00			
Insurance			\$1,000.00		\$1,000.00	\$9,900.00	3.5%	13.0%
Other tools shovels, wrenches, etc. intial purchase costs \$1500.00 and replacement			\$1,500.00		\$300.00	\$300.00	0.1%	
General Liability Insurance					\$10,000.00	\$10,000.00	3.6%	3.7%
Geologist/Chemist 75K plus 1/3 Benefits			\$100,000.00		\$100,000.00			
Driller 60K plus 1/3 Benefits			\$80,000.00		\$80,000.00	\$180,000.00	64.0%	64.0%
Sum					\$281,220.00		100%	100%

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- 7% for 5 years = 168,000.00 / 5 years = \$33,600.00 per year
- Annual maintenance costs from Wes McCall of Geoprobe
- Insurance costs from
- Daily fuel costs from Wes McCall of Geoprobe
- Diesel fuel costs in 2018
- Annual cost of a push rig estimated at \$41,640.00
- Constitutes approximately 15% of the cost of operating

Cost by Analogous Item

- Cat track loader

<https://www.holtcat.com/Documents/PDFs/2012PerformanceHandbook/Owning%20&%20Operating%20Costs%20-%20Sec%2020.pdf>



- Both the loader and the direct-push rig have steel frames, diesel motors of similar size, and hydraulics.
- Loaders have high resale value and a broad target market, so you have to consider residual value.
- The loader has less maintenance but the maintenance items are more expensive, so in the early years of ownership them two pieces of equipment are similar.
- If we compare the purchase costs, financing, and maintenance the costs are dead-on. Both cost about \$35.00 per hour not including fuel or operator.
- I recognize that I cheated in my analogy in that I picked two items that are similarity made, cost the same, have parallel maintenance needs, and would be analogously financed. **But that's the point!**

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Insurance			\$1,850.00		\$1,850.00	\$12,040.00	4%	19.7%	

Trailer

- 7% for 5 years = $\$4800 / 5 \text{ years} = \960.00 per year
- Annual maintenance costs estimated at $\$1,000.00$
- Insurance costs from enquiry
- Constitutes approximately $> 1\%$ of the cost of operating a MIP

Truck

- 7% for 5 years = $\$4800 / 5 \text{ years} = \960.00 per year
- Annual maintenance costs estimated at $\$1,000.00$
- Insurance costs from enquiry
- Constitutes approximately 4% of the cost of operating a MIP

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Van for MIP controller and detectors				\$35,000.00	7% for 5 years	\$8,300.00			
Annual Maintenance Costs				\$480.00		\$600.00			
Insurance				\$1,000.00		\$1,000.00	\$9,900.00	3.6%	13.2%

The MIP Controller and Detectors are the only items that are unfamiliar to most people. Basic Costs for the MIP was supplied by Geoprobe.

Still all we need to know are the following:

- Cost of the item plus financing
- Maintenance
- Insurance

The van is only need to house and transport the MIP controller and detector

Theme for the “Objects”

- The object’s cost
- Its maintenance (Software is maintenance.)
- Its insurance
- Interest on money borrowed
 - Assume that capital equipment is financed through a standard business loan.
 - Assume that the capital equipment is repurchased when the loan is paid off and the value of vehicles is negligible.
 - Assume at the end of the loan period the equipment has no significant value for specialized equipment.
 - For common use equipment, e.g. Track loader, subtract five-year value from ownership costs for residual value.

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Sum						\$281,220.00		100%	100%

- Associated tools and supplies are a relatively small percentage of costs.
- General liability insurance tends to be about the same cost assuming similar safety records.
- Personnel drive costs! In the bottom-up estimate personnel accounts for 65% of the costs.
- The Bureau of Labor Statistics collects data on a per state basis and by job title. The information does not cover all job titles for all cities. Sometime substitution job titles may be employed. A degree of judgment will allow one to select similar job duties and salaries. <https://www.bls.gov/ooh/life-physical-and-social-science/environmental-scientists-and-specialists.htm#tab-8> U.S. Bureau of Labor Statistics accessed on 11/16/2018.

Some Uncertainties

- Fuel costs are variable. We don't know the miles traveled. Miles traveled varies by part of the country and national reach of the company.
 - As the size and weight of the item increases fuel goes from being negligible to significant.
- Taxes on property, etc. vary by state and business practices.
- Residual equipment values $(281,220 - 54,000/5) \div 100 = \$2,704.20$
 - A \$108.00 difference
- Business motivation may supersede costs concerns, e.g., the price difference between companies A and E.
- An item that is proprietary and is not subject to competition may step outside of item costs, maintenance, insurance, etc. paradigm.



Our Estimate

- As an estimate minimal costs are above \$281,220.00 year.
- At 100 days per year = \$2,812.00 per day
- Adding an extra helper at 50K raises the price to \$3,478.70
- Area Cost Factors

e.g., ACFs can be downloaded through the
USACE Cost Engineering Branch website at

<http://www.hq.usace.army.mil/cemp/e/es/pax/321/321.pdf>

$KY \text{ to Ca} = \$3,478.70 \times 1.255 = \$4,365.77$



What about profits?

- What about profits?

Gross profits and net profits and other measures may be accessed at:

New York University http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/margin.html accessed on November 19, 2018.

- Best fits categories for the work are engineering and construction, and oilfield services.
- Gross margins in the two industries are 11.15% and 13.05% respectively. Net profits, which we don't need for our purpose, are usually between 2 to 5%.



Hay, We've got to make some money!

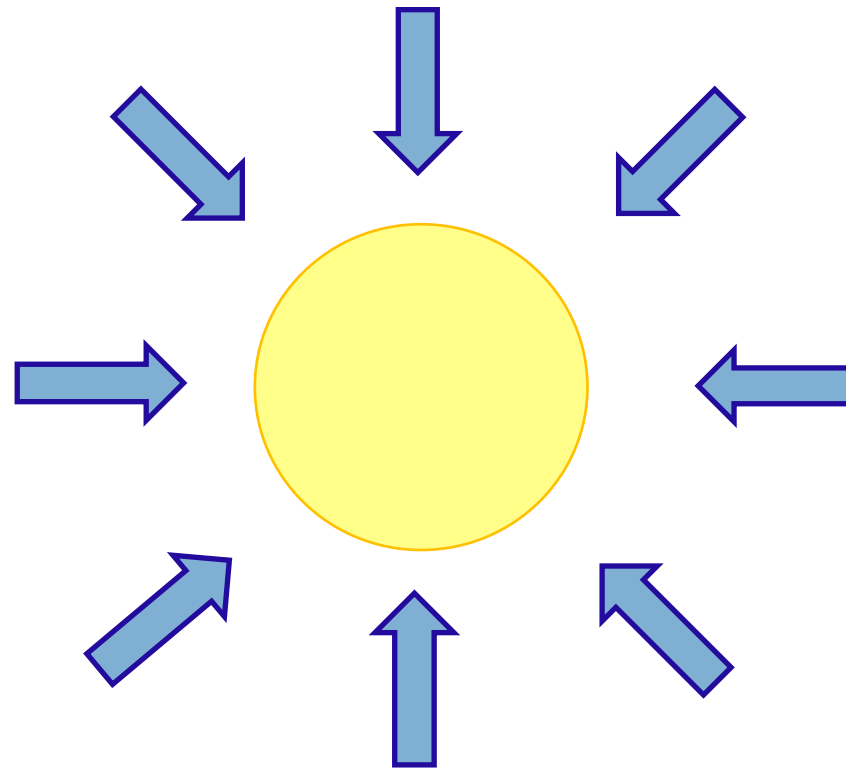
- A range on gross of 8 to 16 (3%) percent for perspective.

Number of working days in the field working for MIP (Mobilization days are not included)			100
Lower percent return (\$3,478.70)	8%	1.08	\$3,757.00
Higher Percent return (\$3,478.70)	16%	1.16	\$4,035.29

Surrounding the Cost Question

Top-down = \$3923.00 day

Literature =
\$3000 to 5000 day



Survey or Expert
Judgement

Bottom-up = \$3700.00 to \$4000.00 day

Sources of Information

Institutionalization of Sustainable Consumption Patterns Based on Shared Use
Ecological Economics, Volume 50, Issues 1–2, 1 September 2004, Pages 135-153

Construction Equipment Management for Engineers, Estimators, and Owners
By Douglas D. Gransberg, Calin M. Popescu
CRC Press June 13, 2006, ISBN 9781420013993

Capital Equipment Acquisition in Heavy Construction
By Doug Clapp,
International Journal of Construction Education and Research Volume 3, 2007 - Issue 3

A Guide to Developing and Documenting Costs Estimates During the Feasibility Study.
EPA 540-R-00-002, July 2000

Guide to Estimating Environmental Costs, Requested by: American Association of State Highway and Transportation Officials (AASHTO) Standing Committee on the Environment Prepared by: ICF International, Venner Consulting, CH2M Hill and the University of Florida, October 2008

[Utilizing the Membrane Interface Probe \(MIP\)](#)

Linn, William.

State Coalition for Remediation of Drycleaners, 2012 Conference, 28 slides.



Inflation

<https://www.usinflationcalculator.com/>

The US Inflation Calculator below measures the buying power of the dollar over time. To use it, just enter any two dates from 1913 to 2020, an amount, and then click 'Calculate'.

Inflation Calculator

If in (enter year)

I purchased an item for \$

then in (enter year)

that same item would cost: **\$3,795.64**

Cumulative rate of inflation: **8.4%**