Appendix B

Key Equations and Calculations

Earthwork RCE Calculation Summary

Calculation Documentation

Problem Statement:

Freeport-McMoRan (FMI) utilizes a spreadsheet developed by the New Mexico Mining and Minerals Division (MMD) to estimate the earthwork's closure costs associated with the Little Rock Mine Closure/Closeout Plan (CCP). The spreadsheet calculations are intricate and complex and require careful study to master their structure. Each worksheet groups similar activities, and each line on each worksheet documents one construction step required to complete reclamation. All lines totaled equal the entire earthworks for the CCP. The sheer amount of information in the spreadsheet makes review of the cost estimate difficult for a site as complex as the Little Rock Mine.

Objective:

1. Provide a guide to the earthwork spreadsheets.
2. Note that this calculation set presents the approach, data and assumptions, and calculations and results for developing the unit cost. It is intended to serve as a guide/example even if the actual quantities and/or cost data used in these calculations change due to updates or application to a different Freeport NM Operations mine. The example screenshots shown are from the Tyrone Mine CCP.

Approach:

1. Identify worksheets within the spreadsheet.
2. Provide a general equation or explanation of the calculation performed in each worksheet.
3. Use a graphic of each worksheet to illustrate the equations and augment the explanations pertaining to the specific worksheet.

Results:

The following worksheets are included within the earthwork RCE spreadsheet and covered in this calculation documentation:

Databases:
1. Quantities
2. Activity-Material Codes
3. Unit Rates
4. Equipment

Earthwork Calculations:
1. General
2. Demo
3. Material
4. Earthwork
5. Dozer
6. Road Maint
7. Ripper
8. Excavator
9. Trucks
10. Loader Shovel
11. Scrapers
12. M'grader
13. Earth Sum
14. Revegetation
15. Other
16. Summary
17. Facility Characteristics

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Results:
The following worksheets are included within the earthwork RCE spreadsheet and covered in separate calculation documentations or are self-explanatory:

Equipment Optimization:
1. Truck Optimization

O&M:
1. Full Site Vegetation Maintenance
2. Full Site O&M
3. Full Site O&M Summary

Building Demolition:
1. Building Demo
2. Building Cover
3. Building Vegetation
4. Building Waste
5. Building Summary

Unit Costs:
1. Bench Grading
2. Bench Channel (and Riprap/Gravel)
3. Downdrain
4. Pipeline (6”-8” and 20”-36”)
5. Revegetation
6. Seepage Collection
7. Trestle Demo
8. Berm
9. Substation Demo

Results Cont'd

Sheet 1 – General: A summary of the overall costs (before escalation and discounting for the time-value of money) are included on this sheet along with the applicant's information.

	A	B	C
1			Tyrone Mine
2			Stockpile Spreadsheet Worksheet #1
3	***General Information***		4/29/2019
4			
5	Applicant	Tyrone Mine Company	
6		Tyrone, New Mexico 88065	
7			
8			
9			
10			
11	Disturbed Surface Area (acres)	3,031	
12	*(does not include previously reclaimed areas)*		
13			
14	Type of Operation	Existing/Surface/Copper	
15			
16			
17			
18	*Current value of earthwork and O&M before escalation and discounting*	**$101,470,627**	
19			
20			
21			
22			
23			**Stockpiles, Tailing,**
24			**Reservoirs, Haul Roads**
25			**and Disturbed Areas**

Quantities Sheet: This sheet assigns an item code to a facility and corresponding sub-area code with a description of the facility and sub-area. This sheet provides raw data and factors (such as area, volume, distances, grades, etc.) to be used in calculations within all the other worksheets. Each facility is broken down into sub-areas to account for differing reclamation quantities to more accurately determine the amount of work required for each facility. The Quantities sheet includes 36 columns of hard-wired (hand entered) data associated with each facility. Columns A through H for 1A and 1B Leach, 1C, 2A Leach and 2B Waste, and 3A/3B Stockpiles are shown as an example:

	A	B	C	D	E	F	G	H
1								
2	1	2	3	4	5	6	7	8
3	**Item**	**Facility**	**Sub Area or Destination for Cover Material**	**Description**	**Area (sf)**	**Volume (cy)**	**Push Distance (ft) Berm Length (ft) or Fence Length(ft)**	**Coarse Regrading and Fine Grading (%)**
4	1000	1A and 1B Leach	1A1B-0	Entire Stockpile	11,891,880	1,548,670	-	-
5	1001	1A and 1B Leach	1A1B-1	Top	740,520	79,000	430	1.0%
6	1002	1A and 1B Leach	1A1B-2	Outslopes - Regrade benches from pullback	-	1,329,670	90	-29.0%
7	1003	1A and 1B Leach	1A1B-3	Outslopes - Area outside of pullback	11,151,360	140,000	250	-29.0%
8	1100	1C	1C-0	Top (Haul Road)	740,700	-	-	
9	1200	2A Leach and 2B Waste	2A2B-0	Entire Stockpile	21,213,358	8,203,000	-	-
10	1201	2A Leach and 2B Waste	2A2B-1	Top	1,568,160	143,000	370	1.0%
11	1202	2A Leach and 2B Waste	2A2B-2	Outslopes	19,645,198	8,060,000	470	-29.0%
12	1300	3A / 3B	3A3B-0	Entire Stockpile	19,819,800	5,289,064	-	-
13	1301	3A / 3B	3A3B-1	Top	1,437,480	199,000	560	1.0%
14	1302	3A / 3B	3A3B-2	Outslopes Pullback	-	17,500,000	-	-29.0%
15	1303	3A / 3B	3A3B-3	Outslopes - Regrade benches from pullback	-	1,590,064	90	-29.0%
16	1304	3A / 3B	3A3B-4	Outslopes (total area, volume outside of pullback)	18,382,320	3,500,000	560	-29.0%

For example use only. Values may not match the current spreadsheet.

Results Cont'd

Activity-Material Codes Sheet: This sheet assigns an activity code (column A) to each activity (column B)

	A	B	C
1	**Item**	**Activity**	**Description**
2	-	-	Place holder for item
3	A	Grade	Rough grading original material or fine grading cover material
4	B	Dozer Assist	Dozer is used to assist loader or shovel at cover stockpile or assist scrapers during rough grading
5	C	Load	Cover material is loaded at borrow areas onto haul trucks
6	D	Haul	Haul trucks transport cover material from borrow areas to destination stockpiles
7	E	Rip	Tops of stockpiles are ripped before placing cover to compensate for compaction of soil during rough grading. Stockpiles are also ripped before rough grading with a scraper. Borrow stockpile ripped
8	F	Grade Benches	Benches are graded at stockpiles and tailings after fine grading
9	G	Construct Downdrains	Downdrains are constructed after fine grading and consist of articulated concrete blocks (ACB's)
10	Gb	Construct Downdrain Dissipators	Energy dissipators are specified as part of the downdrains
11	H	Construct Bench Channels w/ Riprap	Bench channels are constructed along benches after bench grading. Construction includes excavation and wasting, riprap production, riprap and filter placement, and final grading.
12	Hb	Construct Bench Channels w/o Riprap	Bench channels are constructed along benches after bench grading. Construction includes excavation and wasting and final grading.
13	I	Construct Top/Outslope Channels	Top and outslope channels are not part of this RCE
14	J	Revegetate	Occurs after final grading and channel construction and includes tractor rental and maintenance, fuel, scarifying, discing, drill seeding, mulching, crimping, seed, and mulch
15	K	Perforate Liner	Reservoir liners are perforated prior to reclamation
16	L	Replace Infrastructure	Replacing infrastructure is not part of this RCE
17	M	Post-Closure O&M	Includes vegetation maintenance for 12 years after reclamation and erosion control, road maintenance, and groundwater monitoring for 100 years after reclamation
18	N	Plug and Abandon Well	Well borehole is backfilled with cement grout
19	O	Replace Well	Includes borehole drilling, casing, and cementing
20	P	Road Maintenance	Dust suppression and road maintenance with water truck and motor grader
21	Q	Construct Haul Road	For shorter hauls etc.
22	R	Construct Berms	Berming for stormwater runoff control
23	S	Fencing	Fencing for pits
24	T	Build Grade Control Walls	Grade control in each drainage of Tailing Launder Line removal
25	U	Vehicle Gates	Limited access at 1-mile intervals around open pits
26	V	Signs Every 500 ft	Warning signs posted every 500 feet around open pits

The same is done by assigning a material code (column A) to differentiate the materials used in the spreadsheet.

	A	B	C
28			
29	**Item**	**Material**	**Description**
30	-	-	Placeholder
31	a	Existing Ground	Existing ground before rough grading
32	b	Cover	Cover material from cover stockpiles, before being placed at destination location
33	c	Rough Graded Material	Exisiting ground after rough grading
34	d	Placed Cover	Cover material after being placed at destination location
35	e	Final Grade	Facility material and cover material after rough grading and fine grading
36	f	Backfill/Stockpile Material	Material used to backfill pit/ponds or stockpile material used in pullback
37			

These codes are used to assign an ID to each task, on the Materials sheet. The codes dictate which earthwork calculation is used for each row of work.

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Results Cont'd

Unit Rates Sheet: This sheet applies the same concept as the Quantities and Activity-Material Codes sheets whereby unit rates for particular activities utilized in the development of costs within the spreadsheet are identified and assigned a unit rate code. The unit rates are used throughout the RCE spreadsheet and are referenced from this sheet.

	A	B	C	D	E	F	G
10	Code	Activity	Base Per Unit Cost	Fuel Per Unit Cost	Units	Source	Reference
11	U1	Fuel	$ 2.34	$ -	gal	-	Diesel fuel cost is estimated by correlating historical local quotes with public data, as agreed upon in November 2018 discussions with the agencies. Fuel cost
12	U2	Revegetation	$ 820.12	$ 3.85	ac	Revegetation Unit Cost Sheet	See unit rates calculations - Cost is based on a calculated unit rate that includes tractor rental and maintenance, fuel, scarifying, discing, drill seeding, mulching,
13	U3	Bench Grading Stockpile	$ 1.35	$ 0.33	ft	Bench Grading Unit Cost Sheet	See unit rates calculations
14	U4	Bench Grading Tailings Pond	$ 1.35	$ 0.33	ft	Bench Grading Unit Cost Sheet	See unit rates calculations
15	U5	Downdrain Construction	$ 374.38	$ -	ft	Downdrain Unit Cost Sheet	See unit rates calculations
16	U6	Downdrain Dissipater	$ 14,556.48	$ -	ea	Downdrain Unit Cost Sheet	See unit rates calculations
17	U7a	Bench Channel Construction w/	$ 6.60	$ 1.39	ft	N/A	See unit rates calculations
18	U7b	Bench Channel Construction w/o	$ 0.41	$ 0.10	ft	N/A	See unit rates calculations
19	U8	Erosion Control	$ 2,923.36	$ 382.26	day	Modified Crew B-13A	Erosion control for O&M - includes 1 foreman, 2 laborers, 1 equipment operator, 2 truck drivers, 1 loader (4 cy), 2 dump trucks (8 cy)
20	U9	Structure Demolition	$ 0.25	$ -	cf	Means Line Item 024116.13 0100	Building demolition, large urban projects, mixture of types, excludes foundation demolition, dump fees
21	U10	Concrete Slab Demolition	$ 0.62	$ -	sf	Means Line Item 024116.17 0400	Building footings and foundations demolition, floors, concrete slab on grade, plain concrete, 6" thick, excludes disposal costs and dump fees
22	U11	Storage Tank Demolition	$ 1,005.97	$ -	ea	Means Line Item 130505.75 0530	Selective Demolition - Storage Tanks, steel tank, single wall, above ground, not including foundations, pumps or piping, 5,000 thru 10,000 gallon
23	U12	Storage Tank Demolition	$ 2,168.93	$ -	ea	Means Line Item 130505.75-0540	Steel tank, single wall, above ground, 15,000 thru 30,000 gallon, selective demolition, excluding foundation, pumps or piping
24	U13	Storage Tank Demolition	$ 3,934.80	$ -	ea	Scaled Means Items	Storage Tanks, steel tank, single wall, above ground, not incl fdn, pumps or piping; scaled for a 45,500 gal tank
25	U14	Power Line Demolition	$ 0.63	$ -	ft	Means Line Item 260505.10 0370	in cost to overhead powerlines.
26	U15	Power Pole Demolition	$ 216.24	$ -	ea	Means Line Item 024113.80 0200	Selective Demolition - wood utility poles 35-45 ft high
27	U16	Pipeline (small HDPE pipe)	$ 2.29	$ -	ft	Means Line Item 024113.38 1700	excludes excavation
28	U17	Pipeline (medium HDPE pipe)	$ 3.82	$ -	ft	Means Line Item 024113.38 1800	excludes excavation
29	U18	Pipeline (large HDPE pipe)	$ 5.72	$ -	ft	Means Line Item 024113.38 1900	excludes excavation
30	U19	Well Plug & Abandon	$ 10.55	$ -	ft	N/A	Layne Christensen Company, 7/31/18 Tyrone estimate is $10,000 mobilization and demobilization plus $5,704.94 (escalated at 2% to $5819.04) for one 1500 ft well
31	U20	Well Replacement	$ 67.76	$ -	ft	N/A	Wilcox Professional Services, 8/2011, est. cost for 5 ½ in bore, $173,500 for 3000 ft total ($57.83/ft). Escalated 2% 2011-2019= $67.76/ft
32	U21	Reinforced Concrete Wall Demolition	$ 199.20	$ -	hr	Means Crew B-12C	Standard Union Crew: 1 equipment operator (crane), 1 laborer, 1 hydraulic excavator, 2 cy, approximately 40 hrs to demo 200 ft reinforced concrete dam.
33	U22	Disc harrow attachment, for tractor	$ 616.33	$ -	month	Means Line Item 015433.20 1500	Equipment rental costs
34	U23	Cast-In-Place Concrete	$ 254.97	$ -	cy	Means Line Item 033053.40 6200	reinforcement
35	U24	Cleanup & Disposal of Wastes Requiring Special Handling	$ 335.20	$ -	ton	Means Line Item 028120.10 1120/1130	Solid pickup; average of minimum and maximum
36	U25	Tranportation of Wastes Requiring Special Handling	$ 4.78	$ -	mile	Means Line Item 028120.10 1260/1270	Transporation to disposal site (Truckload = 80 drums or 25 cy or 18 tons); average of minimum and maximum
37	U26	Road Maintenance	$ 4,945.96	$ 1,240.32	month		water truck
38	U27	Tailing Cover Maintenance	$ 2,144.29	$ 269.57	day	Modified Crew B-13A	1 dump truck (12 ton)
39	U28	Berming	$ 0.06	$ -	ft		per ft. to 0.13 cy/ft; Finish grade volume is 1/3 X 'Excavation Volume' or 0.04 ft/lf; The berm will be made from cover material; only applicable to the types of berms at the reclaimed borrow areas - These berms are only used to move water along an
40	U29	Fencing	$ 23.05	$ -	ft	Means Line Item 323113.20 0800	
41	U30	Vehicle Gates, Pit Perimeters	$ 1,002.88	$ -	ea	Means Line Item 323113.20 5070	Fence, chain link industrial, double swing gates, 6' high, 20' opening, includes excavation, posts & hardware in concrete
42	U31	Signs every 500 ft., pit perimeters	$ 65.19	$ -	ea	Means Line Item 101453.20 0600	Signs, guide and directional signs, reflectorized, 12" x 18", excludes posts
43	U32	Fire Hydrant Demolition	$ 396.73	$ -	ea	Means Line Item 024113.33 0900	Utility removal, hydrants, fire, remove only, excludes hauling
44	U33	Seepage Collection Replacement	$ 133,355.94	$ -	ea	Seepage Collection Unit Cost Sheet	See unit rates calculations
45	U34	Culvert Removal	$ 12.69	$ -	ft	Means Line Item 024113.40 0190	excludes excavation
46	U35	Grade Control Wall	$ 165.59	$ -	cy	Means Line Item 033053.40 3945	deep, unreinforced, includes forms(4 uses), concrete (Portland cement Type I), placing and finishing, excludes reinforcing
47	U36	Steel Trestle Demolition	$ 30,689.10	$ -	ea	Means Line Item 024116.33 0200	Bridge demolition, pedestrian, steel, 50' to 160' long, 8' to 10' wide
48	U37	Sludge Removal	$ 306.69	-	ea	Means Line Item 026510.30 0320	remove sludge, water and remaining product from tank bottom of tank with vacuum truck, 9,000 - 12,000 gallon tank
49	U38	Substation Demo	$ 12,470.55	$ -	ea	Substation Demo Unit Cost	See unit rates calculations

Unit rates are either derived from separate calculations, RSMeans pages, or direct quotes. The unit costs are broken into base per unit cost (column C) and fuel per unit cost (column D) when applicable. If a unit cost is obtained from RSMeans, the Las Cruces, New Mexico, area cost is utilized.

For example use only. Values may not match the current spreadsheet.

Results Cont'd

Equipment Sheet: This sheet assigns a code to the various types of heavy equipment (bulldozers, wheeled loaders, excavators, etc.) used for mine closure activities. It also delineates a multitude of equipment costs and factors as well as labor costs based on the 2019 New Mexico Department of Labor hourly labor rates associated with each piece of equipment.

Equipment Code

Rental & Operating Equipment Costs

See Dozer sheet (Sheet 5) for development of the Productivity Equation

$$Productivity_{normal} = C * (Distance_{Pus}{}^{b})$$

C = Multiplier Constant and b = Exponent Constant

EARTHWORK AND O&M EQUIPMENT

Code (1)	Equipment Description (2)	Equipment Type (3)	Fuel Consumption (gal/hr) (4)	Fuel Cost ($/hr) (5)	Lube Cost ($/hr) (6)	Field Parts ($/hr) (7)	Tire Cost ($/hr) (8)	Ground Engaging Component Cost ($/hr) (9)	Monthly Rental Rate ($/month) (10)	Field Labor Time Cost ($/hr) (11)	Rental Cost (w/o fuel, lube, tires, or field parts) ($/hr)[6] (12)	Lube, Tires, GEC, & Field Parts Adjusted Rental Cost (w/o fuel) ($/hr) (13)	Dozing Production (lcy/hr)[1] Production = C(Avg. dozing distance in ft)[b] C (14)	b (15)
Comb1	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	Combo 1	19.54	$ 45.72	$ 12.72	$ 3.75	$ 13.46	$ 1.16	$ 20,078.37	$ 9.23	$ 114.08	$ 154.40	-	-
Dz1	Cat D11T, U Blade	Dozer	29.75	$ 69.62	$ 26.23	$ 13.89	$ -	$ 12.22	$ 34,408.41	$ 6.60	$ 195.50	$ 254.44	155,881.59	-0.889952
Dz2	Cat D11T CD, U Blade	Dozer[7]	29.75	$ 69.62	$ 26.23	$ 13.89	$ -	$ 12.22	$ 34,408.41	$ 6.60	$ 195.50	$ 254.44	162,758.76	-0.866691
Dz3	Cat D9T, SU Blade	Dozer	14.35	$ 33.58	$ 11.22	$ 5.49	$ -	$ 3.98	$ 30,109.48	$ 6.60	$ 171.08	$ 198.37	52,161.03	-0.845532
Dz4	Cat D6T, SU Blade	Dozer	7.22	$ 16.89	$ 4.83	$ 2.10	$ -	$ 2.10	$ 8,939.42	$ 3.83	$ 50.79	$ 63.65	13,582.45	-0.74851
Dz5	Cat D6T XL, SU Blade	Dozer	7.80	$ 18.25	$ 5.28	$ 2.32	$ -	$ 2.36	$ 9,104.55	$ 3.83	$ 51.73	$ 65.52	13,582.45	-0.74851
Ex1	Cat 319D L	Excavator	5.25	$ 12.29	$ 3.47	$ 1.19	$ -	$ 0.84	$ 7,450.15	$ 4.55	$ 42.33	$ 52.38	-	-
Ld1	Cat 992K	Loader	25.63	$ 59.97	$ 22.35	$ 4.43	$ 35.39	$ 4.99	$ 25,527.98	$ 4.02	$ 145.05	$ 216.23	-	-
Ld2	Cat 988H	Loader	15.20	$ 35.57	$ 11.40	$ 2.11	$ 16.85	$ 1.93	$ 16,272.06	$ 4.02	$ 92.45	$ 128.76	-	-
Ld3	Cat 980H	Loader	10.80	$ 25.27	$ 6.70	$ 1.13	$ 7.69	$ 1.03	$ 10,030.76	$ 4.02	$ 56.99	$ 77.56	-	-
Ld4	Cat 966H	Loader	8.38	$ 19.61	$ 5.33	$ 0.84	$ 5.71	$ 0.75	$ 9,937.50	$ 4.02	$ 56.46	$ 73.11	-	-
Ld5	Cat 993K	Loader	30.40	$ 71.14	$ 26.70	$ 5.32	$ 42.47	$ 4.73	$ 25,527.98	$ 4.02	$ 145.05	$ 228.29	-	-
Mg1	Cat 16M	Motor Grader	9.50	$ 22.23	$ 8.69	$ 3.26	$ 10.13	$ 1.76	$ 11,906.70	$ 2.02	$ 67.65	$ 93.51	-	-
Mg2	Cat 14M	Motor Grader	8.29	$ 19.40	$ 6.57	$ 2.27	$ 7.04	$ 1.16	$ 11,906.70	$ 2.02	$ 67.65	$ 86.71	-	-
Rp1	Cat D11T CD Multi-shank (w/ MSR-359H)	Ripper	29.75	$ 69.62	$ 26.60	$ 14.20	$ -	$ 1.56	$ 36,753.56	$ 8.16	$ 208.83	$ 259.35	-	-
Sc1	Cat 637G	Scraper	38.00	$ 88.92	$ 17.07	$ 6.27	$ 7.57	$ 1.28	$ 25,070.00	$ 12.80	$ 142.44	$ 187.43	-	-
Sc2	Cat 657G	Scraper	42.86	$ 100.29	$ 20.41	$ 7.73	$ 9.34	$ 2.31	$ 25,070.00	$ 12.80	$ 142.44	$ 195.03	-	-
Sh1	Hitachi EX3600-5	Shovel[2]	82.72	$ 193.56	$ 59.15	$ 24.25	$ -	$ 16.56	$ 69,269.00	$ 14.45	$ 393.57	$ 507.98	-	-
Tc1	Deere 7430	Tractor	5.98	$ 13.99	$ 2.84	$ 0.61	$ 2.42	$ -	$ 5,210.05	$ 2.53	$ 29.60	$ 38.00	-	-
Tk1	Komatsu HD-1500 5	Truck[3]	28.12	$ 65.80	$ 19.90	$ 1.79	$ 25.19	$ -	$ 25,211.93	$ 7.47	$ 143.25	$ 197.60	-	-
Tk2	Cat 769D	Truck	9.74	$ 22.79	$ 8.77	$ 1.48	$ 13.72	$ -	$ 14,042.50	$ 4.25	$ 79.79	$ 108.01	-	-
Tk3	Cat 725	Truck	6.02	$ 14.09	$ 5.74	$ 0.94	$ 7.11	$ -	$ 9,849.60	$ 3.36	$ 55.96	$ 73.11	-	-
Tk4	Komatsu 730E	Truck[4]	33.48	$ 78.34	$ 20.49	$ 1.80	$ 21.21	$ -	$ 29,356.98	$ 11.49	$ 166.80	$ 221.79	-	-
Tk5	Cat 777F	Truck	18.76	$ 43.90	$ 19.31	$ 3.03	$ 26.81	$ -	$ 56,160.00	$ 6.38	$ 319.09	$ 374.62	-	-
Tw1	Off-Hwy Water Tanker Truck,6,000-gal.	WaterTruck	11.25	$ 26.33	$ 6.15	$ 1.48	$ 6.42	$ -	$ 8,171.67	$ 7.21	$ 46.43	$ 67.69	-	-
Tw2	Off-Hwy Water Tanker Truck,10,000-gal.	WaterTruck	15.43	$ 36.11	$ 9.04	$ 2.43	$ 10.47	$ -	$ 12,949.87	$ 10.30	$ 73.58	$ 105.82	-	-
X1	2 Deck Screening Plant (5X16, 48X60)	ScreenPlant	4.85	$ 11.35	$ 2.39	$ 1.15	$ 0.40	$ -	$ 5,738.88	$ 4.46	$ 32.61	$ 41.01	-	-
X2	3 Deck Screening Plant (5X16, 48X60)	ScreenPlant	4.85	$ 11.35	$ 2.43	$ 1.24	$ 0.39	$ -	$ 5,994.24	$ 4.62	$ 34.06	$ 42.74	-	-
X3	1 Deck Screening Plant (5X16, 48X60)	ScreenPlant	4.85	$ 11.35	$ 2.37	$ 1.14	$ 0.39	$ -	$ 5,671.66	$ 4.46	$ 32.23	$ 40.59	-	-
X4	3 Deck Screening Plant (5X16, 42X60)	ScreenPlant	4.85	$ 11.35	$ 2.38	$ 1.16	$ 0.37	$ -	$ 5,743.36	$ 4.62	$ 32.63	$ 41.16	-	-

The equipment sheet also contains the production equation coefficients for dozing (columns N-O) and scraper haul travel time coefficients (columns P-AI)

See Trucks sheet (Sheet 9) for development of the Haul Travel Time Equation

Haul Travel Time (min/m)=*A(Eff. Grade %)^4 + B(Eff. Grade %)^3 + C(Eff. Grade %)^2 + D(Eff. Grade %) + E*
where effective grade is the sum of the measured grade and rolling resistance

EARTHWORK AND O&M EQUIPMENT

Haul Travel Time (min/m) = A(Eff. Grade %)^4 + B(Eff. Grade %)^3 + C(Eff. Grade %)^2 + D(Eff. Grade %) + E

Code (1)	Equipment Description (2)	Equipment Type (3)	Loaded Uphill A (16)	B (17)	C (18)	D (19)	E (20)	Empty Uphill A (21)	B (22)	C (23)	D (24)	E (25)	Loaded Downhill A (26)	B (27)	C (28)	D (29)	E (30)	Empty Downhill A (31)	B (32)	C (33)	D (34)	E (35)
Comb1	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	Combo 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dz1	Cat D11T, U Blade	Dozer	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dz2	Cat D11T CD, U Blade	Dozer[7]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dz3	Cat D9T, SU Blade	Dozer	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dz4	Cat D6T, SU Blade	Dozer	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dz5	Cat D6T XL, SU Blade	Dozer	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ex1	Cat 319D L	Excavator	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ld1	Cat 992K	Loader	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ld2	Cat 988H	Loader	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ld3	Cat 980H	Loader	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ld4	Cat 966H	Loader	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ld5	Cat 993K	Loader	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mg1	Cat 16M	Motor Grader	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mg2	Cat 14M	Motor Grader	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rp1	Cat D11T CD Multi-shank (w/ MSR-359H)	Ripper	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sc1	Cat 637G	Scraper	3.2483	-1.9562	0.4337	-0.0026	0.001	0	-0.3247	0.1601	-0.0038	0.0011	0.6464	-0.6147	0.1749	-0.0004	0.0011	0	0	0.0367	0.0018	0.0009
Sc2	Cat 657G	Scraper	0.3036	-0.4512	0.2181	-0.0034	0.0013	0	-0.1016	0.0774	-0.0013	0.0012	0	-0.1612	0.1031	-0.0081	0.0016	0	0.1668	-0.094	0.0207	0.0004
Sh1	Hitachi EX3600-5	Shovel[2]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tc1	Deere 7430	Tractor	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tk1	Komatsu HD-1500 5	Truck[3]	4.494	-2.4571	0.6319	-0.0051	0.0011	0	-0.2561	0.1351	-0.0004	0.001	0	0	0.0856	0.0135	0.0009	0	0	0	0.0143	0.0005
Tk2	Cat 769D	Truck	0.5429	-0.487	0.1823	0.0151	0.0007	0	0.0224	-0.0076	0.0141	0.0007	0	0	-0.0808	0.426	-0.0008	5.6146	-3.6353	0.7823	-0.0535	0.002
Tk3	Cat 725	Truck	0.1363	0.1636	-0.04	0.0342	0.0009	0	-0.024	0.0309	0.0099	0.001	0	2.5262	-0.7562	0.095	-0.002	0	0	0	0.0103	0.0009
Tk4	Komatsu 730E	Truck[4]	7.5599	-2.711	0.4209	0.005	0.0011	0	-0.0689	0.0501	0.0052	0.001	-	-1.1878	0.325	0.0042	0.001	-3.4907	2.4171	-0.55	0.0643	-0.0011
Tk5	Cat 777F	Truck	6.43	-3.2933	0.6548	-0.005	0.0009	0	-0.0197	0.0276	0.011	0.0008	2.147	-1.9812	0.5102	-0.0158	0.0009	0.7651	-0.3831	0.0898	-0.001	0.0008
Tw1	Off-Hwy Water Tanker Truck,6,000-gal.	WaterTruck	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tw2	Off-Hwy Water Tanker Truck,10,000-gal.	WaterTruck	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
X1	2 Deck Screening Plant (5X16, 48X60)	ScreenPlant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
X2	3 Deck Screening Plant (5X16, 48X60)	ScreenPlant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
X3	1 Deck Screening Plant (5X16, 48X60)	ScreenPlant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
X4	3 Deck Screening Plant (5X16, 42X60)	ScreenPlant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

For example use only. Values may not match the current spreadsheet.

Results Cont'd

Equipment Sheet cont'd:

Other equipment specifications listed in the equipment sheet can also be found in the RCE report. It is important to note that each piece of equipment is assigned an operator group by which labor rates are assigned according to the most up to date labor rates from NMDOL.

50	**EARTHWORK AND O&M LABOR**		
51	NMDOL Type A		Rate
52	Operator Group		($/hr)
53	Equipment Operator IV	$	27.41
54	Equipment Operator V	$	27.52
55	Equipment Operator VI	$	27.70
56	Laborer I	$	23.09
57	Laborer II	$	23.84
58	Truck Driver III	$	24.27

Sheet 2 – Demolition: Costs are based on square footage (ex: buildings), linear footage (ex: pipeline or power line length), or lump sum per item (ex: power pole, well casing). The costs are derived from the 2019 R.S. Means Online Heavy Construction cost data or actual on-site experience and bids.

Example calculation: (10,300 feet of powerline) x ($0.63 per linear foot)=$6,489

	A	B	C	D	E	F	G	H	I
1									Tyrone Mine
2									Stockpile Spreadsheet Worksheet #2
3	***Demolition***								4/29/2019
4									
5	Building Demolition costs are calculated in "1 BuildingDemo", "2 BuildingCover", "3 BuildingVeg", and "4BuildingWaste" and summarized on the last line of this table.								
6									
7									
8									
9									
10	**Item**	**Activity**	**Quantity**	**Unit**	**Unit Cost ($/unit)**	**Direct Item Cost ($)**	**Reference**	**Means Line Item**	**Description**
11	Power line Demolition (3 PLS to 1x1 Pond installed 2012)	-	10,300	ft	$0.63	$6,489	Means	Means Line Item 260505.10 0370	Nonmetallic sheathed cable 3 wire; assume similar enough in cost to overhead power lines.
12	Power pole Demolition (3 PLS to 1x1 Pond installed 2012)	-	36	ea	$216.24	$7,785	Means	Means Line Item 024113.80 0200	wood utility poles 35-45 feet high
13	Power line Demolition (San Salvador Pit)	-	5,222	ft	$0.63	$3,290	Means	Means Line Item 260505.10 0370	Nonmetallic sheathed cable 3 wire; assume similar enough in cost to overhead power lines.
14	Power pole Demolition (San Salvador Pit)	-	17	ea	$216.24	$3,676	Means	Means Line Item 024113.80 0200	wood utility poles 35-45 feet high
15	Power lines to substations or spurs for buildings to be demolished	-	66,200	ft	$0.63	$41,706	Means	Means Line Item 260505.10 0370	Nonmetallic sheathed cable 3 wire; assume similar enough in cost to overhead power lines.
16	Power Poles to substations or spurs for buildings to be demolished	-	135	ea	$216.24	$29,192	Means	Means Line Item 024113.80 0200	wood utility poles 35-45 feet high
17	Telephone Lines around buildings to be demolished	-	1,400	ft	$0.63	$882	Means	Means Line Item 260505.10 0370	Nonmetallic sheathed cable 3 wire; assume similar enough in cost to overhead power lines.
18	Light Poles around to be demolished buildings	-	13	ea	$216.24	$2,811	Means	Means Line Item 024113.80 0200	wood utility poles 35-45 feet high
19	Fire Hydrants Mainly by SXEW	-	14	ea	$396.73	$5,554	Means	Means Line Item 024113.33 0900	Minor Site Demolition; remove fire hydrants
20	Little Rock Dewatering Pipeline Alignment #1 and #2 (Year 34 of Closure)	6"-8" Diameter Plastic	4,940	ft	$1.88	$9,266	-	-	See Pipeline UC
21	Water Treatment Pipelines (Year 99 of Closure)	assume 20-36-inch diameter	74,500	ft	$4.57	$340,282	-	-	See Pipeline UC
22	Sewer Pipelines (Year 6 of Closure)	assume 20-36-inch diameter	1,414	ft	$4.57	$6,459	-	-	See Pipeline UC
23	PLS Pipelines (Year 6 of Closure)	assume 20-36-inch diameter	18,893	ft	$4.57	$86,295	-	-	See Pipeline UC
24	2A East PLS Tank and 2A West PLS Tank (Year 6 of Closure)	Tank Demolition	2	ea	$3,934.80	$7,870	Means	Scaled Means Items	Storage Tanks, steel tank, single wall, above ground, not incl fdn, pumps or piping, 15,000 thru 30,000; scaled for a 45,500 gal tank - assuming 22 ft diameter and 16 ft high
25	1A and 1B PLS Tanks (Year 99 of Closure)	Tank Demolition	2	ea	$3,934.80	$7,870	Means	Scaled Means Items	Storage Tanks, steel tank, single wall, above ground, not incl fdn, pumps or piping, 15,000 thru 30,000 gal; scaled for a 45,500 gal tank - assuming 22 ft diameter and 16 ft high
26	Culverts at Tailing Launder Line	Culvert Removal	22	ea	$12.69	$279	Means	Means Line Item 024113.40 0190	Selective demolition, metal drainage piping, CMP, steel, 48"-60", diameter, excludes
27	Steel Trestle at Tailing Launder Line	Steel Trestle Demo	1	ea	$30,689.10	$30,689	-	-	Bridge demolition, pedestrian, steel, 50' to 160' long, 8' to 10' wide
28	Substation Removal at Mangus Pumphouse	Substation Demo	1	ea	$12,470.55	$0	-	-	See Substation Demo UC
29	Buildings and Associated Facilities	Demolition	See Demo Sheets	-	-	$4,499,228	-	-	-
30									
31					**Total Direct Cost:**	$5,089,622			

For example use only. Values may not match the current spreadsheet.

Results cont'd:

Sheet 3 – <u>Material</u>: No calculations are included on this sheet. Four codes, which can be referenced from the Quantities, Activity-Material Codes, and Equipment or Unit Rates sheets, are entered by hand for each row in Columns A – D. The column labeled ID concatenates the codes. The ID contains the codes for facility location (with sub-area if applicable), work activity, material and equipment used for that particular row of work. This combination determines which equipment production and cost equations are used in the rest of the spreadsheet. The other columns on this sheet then reference the ID to lookup the description from the Activity Material Codes sheet, the source and destination locations from the Quantities sheet, the total haul or push distance and grade from the Quantities sheet, and the equipment (when applicable) from the Equipment sheet.

All activities for the Tyrone RCE are listed on this sheet and carried through the succeeding worksheets of the RCE. The description (F123) lists the activity, top or outslope (if applicable), and the material. The source location (G123) lists the stockpile name (or sub-area) for the location of the activity. If borrow material is involved, it is transported from a borrow stockpile to a destination stockpile (H123). Push or haul distance (I123) is used as part of calculating equipment production on Sheets 5, 9, and 11. Grade (J123 - haul grade or facility slope) is used as part of calculating equipment production on Sheets 5, 9, 11, and 12. Equipment (K123) lists the name of the equipment referenced in the ID. Blank cells indicate that that column is not relevant to a particular activity.

The ID for the example below is 1300-D-b-Tk4. This indicates that a Komatsu 730E truck (Tk4) will be used to haul (D) cover material (b) from the Gila Borrow Area to the 3A/3B (1300). The total haul distance from STS2 to the Raffinate Pond is 11,221 feet, with an average haul grade of 1.3%.

2300-Facility and 23-Sub-area

D-Activity and b-Material

Tk4-Equipment to be used

Tyrone Mine
Stockpile Spreadsheet Worksheet #3
4/29/2019

Material Handling Plan Summary Sheet

All activities for the Tyrone RCE are listed on this sheet and carried through the succeeding worksheets of the RCE. The column labeled ID contains the codes for the facility location, activity, material and equipment used for that particular row of work. The description lists the activity, top or outslope (if applicable), and the material. The source location lists the stockpile name (or sub-area) for the location of the activity. If borrow material is involved, it is transported from a borrow stockpile to a destination stockpile. Blank cells indicate that that column is not relevant to a particular activity.

Notes and Assumptions:

1 - Haul/Push Distance based on 2015 Tyrone RCE Submittal or measured/assumed as shown in documentation
2 - Weighted Average Haul Grades based on 2015 Tyrone RCE Submittal
3 - Grade Factors from 2015 Tyrone RCE Submittal
4 - Cover haul distance for 2A/3B stockpile is volume weighted average of Gila Borrow Area (1/3) & 9AX Stockpile (2/3)

	Item	Activity	Material	Eq	ID	Description	Source Location 1	Destination Location 2	Total Haul/Push Distance (ft)[1]	Grade (%)[2,3]	Equipment
123	1300	D	b	Tk4	1300-D-b-Tk4	Haul-Cover	Gila Borrow Area	3A / 3B	11,221	1.3%	Komatsu 730E
124	1500	D	b	Tk4	1500-D-b-Tk4	Haul-Cover	Gila Borrow Area	5A Overburden	4,750	1.9%	Komatsu 730E
125	2200	D	b	Tk4	2200-D-b-Tk4	Haul-Cover	Leach Stockpile	San Salvador Pit	12,570	1.8%	Komatsu 730E
126	2300	D	b	Tk4	2300-D-b-Tk4	Haul-Cover	Gila Borrow Area	Savanna In-Pit Leach Stockpile	5,730	1.6%	Komatsu 730E
127	1400	D	b	Tk4	1400-D-b-Tk4	Haul-Cover	Gila Borrow Area	4C Leach	17,830	5.0%	Komatsu 730E
128	1800	D	b	Tk4	1800-D-b-Tk4	Haul-Cover	Gila Borrow Area	2C, 4A, 4B, 7B Leach	13,990	3.9%	Komatsu 730E
129	1900	D	b	Tk4	1900-D-b-Tk4	Haul-Cover	Gila Borrow Area	8C	5,730	1.6%	Komatsu 730E
130	1600	D	b	Tk4	1600-D-b-Tk4	Haul-Cover	Gila Borrow Area	6B	10,050	2.0%	Komatsu 730E
131	1700	D	b	Tk4	1700-D-b-Tk4	Haul-Cover	Gila Borrow Area	6C	11,833	2.5%	Komatsu 730E
132	2701	D	b	Tk4	2701-D-b-Tk4	Haul-Cover	Gila Borrow Area	Cntmnt-1	10,811	2.9%	Komatsu 730E
133	3300	D	b	Tk4	3300-D-b-Tk4	Haul-Cover	Gila Borrow Area	Unplanned Disturbance Area	10,811	2.9%	Komatsu 730E
134	2100	D	b	Tk4	2100-D-b-Tk4	Haul-Cover	9AX Stockpile Toe	9AX	6,343	7.7%	Komatsu 730E
135	2600	D	b	Tk2	2600-D-b-Tk2	Haul-Cover	9AX Stockpile	Tailing Launder Line	17,721	-1.8%	Cat 769D
136	2900	D	b	Tk2	2900-D-b-Tk2	Haul-Cover	Tailing Launder Line	Mangus Pumphouse	14,100	-1.8%	Cat 769D

For example use only. Values may not match the current spreadsheet.

Results cont'd:

Sheet 4 – Earthwork: Repeats the ID, Description, Source Location, and Destination Location for each row from the Materials sheet. The acreage (I123), cover depth (J123), swell factor (L123), and loose/stockpile volume (M123) are referenced from the Quantities sheet. The in-place (i.e., bank) volume (K123) is calculated from the loose/stockpile volume by dividing by the swell factor. Swell is assumed to occur when cover material is moved from the borrow stockpile to the haul truck. Material left in place is assumed to have no swell, meaning the bank and loose volumes are equal.

$$Volume_{loose\_cover} = area * depth_{cover}$$

I325*J325/12*43560/27

	E	F	G	H	I	J	K	L	M
1									Tyrone Mine
2									Stockpile Spreadsheet Worksheet #4
3	*Earthwork Quantity Worksheet*								04/29/19
4									
5	**Notes and Assumptions:**								
6	1 - Acres and volumes based on 2015 Tyrone RCE Submittal								
7	2 - Cover Material Swell: The 'Loose Volume' is calculated based on the acreage to be covered, cover depth, and accounts for appropriate swell factor.								
8	3 - No swell factor for Tyrone								
9	4 - Has been agreed upon with State agencies that swell occurs when cover material is moved from source to haul truck but not from the truck to placement on stockpile								
10									
11									
12									
13									
14	ID	Description	Source Location 1	Destination Location 2	Area (ac)[1]	Cover Depth (in)	Bank/Stockpile Volume (bcy)[1,4]	Swell Factor (%)[3]	Loose/Stockpile Volume (lcy)[2]
123	1300-D-b-Tk4	Haul-Cover	Gila Borrow Area	3A / 3B	455.0	36	2,039,074	8%	2,202,200

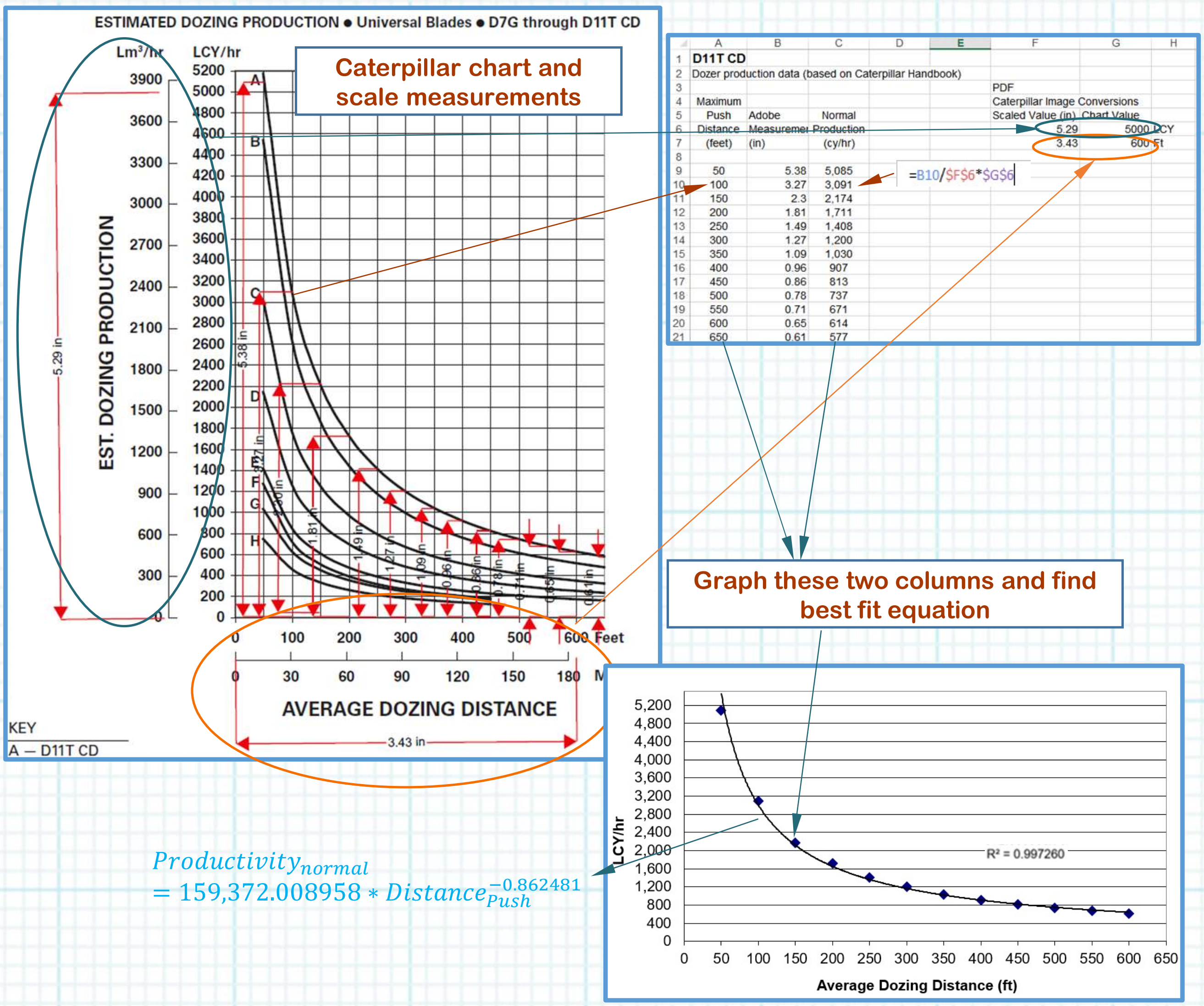
M325/(1+L325)

$$Volume_{bank} = \frac{Volume_{loose}}{(1 + F_{swell})_{bank}}$$

Sheet 5 – Dozer: Dozers are used for rough grading facilities, assisting loaders or shovels at borrow stockpiles, or pushing scrapers for grading facilities. See page 11 of this calculation documentation for a screenshot of the Dozer sheet. Columns E through K repeats ID, activity, locations, equipment from Sheet 3 (Material) and volumes from Sheet 4 (Earthwork). Columns O, P, and Z are the results of the dozer productivity calculations for grading (the multiplier and exponent coefficients C and b, respectively, for the normal productivity equation can be found in columns N and O of the Equipment sheet). Column T is the calculated task time. If the task is for dozer assist of scrapers or loaders/shovels, the dozer task time is equal to the task time of the scraper or loader/shovel, respectively. Columns Q, R, and S are calculated on the scraper and loader sheets and repeated on the dozer sheet. The remaining columns are the input factors that produce the calculation result of bulldozer material handling productivity in cubic yards per hour or acres per hour based on material weight, grade, dozing type, push distance, and operating conditions such as visibility, operator experience, and elevation.

Results cont'd:

Sheet 5 – <u>Dozer cont'd</u>: Input values, power curves and capacities are taken from the 2017 and 2018 Caterpillar (Cat) Performance Handbook (CPH) (Editions 47 and 48) for the specific model dozer. Determining actual productivity starts by calculating the *normal* production factor using a formula derived by curve fit to productivity graphs provided in the CPH for the specific dozer. This is accomplished by scaling values from the figures and using the curve fitting tools within Microsoft Excel:



$$Productivity_{normal} = 159{,}372.008958 * Distance_{Push}^{-0.862481}$$

For example use only. Values may not match the current spreadsheet.

Results cont'd:

Sheet 5 – Dozer cont'd: The *normal* production curves assume a flat surface with a pushed material density of 2,300 lb/cy and a material that is not loose. To account for slope, operator experience, equipment specifications, and other site-specific factors, the CPH modifies the normal production curve by multiplying various factors to obtain the overall productivity:

Productivity and Hours Required for Dozer Use---Earthmoving

Notes and Assumptions:
Uses volumes of outslope sections and dam breaches to calculate productivity
Uses push distances of outslope sections for grading productivity
Uses scraper push cycle time for dozer assist with scraper
Uses loader cycle time for dozer assist with loader at cover stockpiles
Grade Factor = -0.02(Grade %) + 1
May filter on equipement (D14) to show pertinent rows

Number of Dozers per Assist = 1
2 dozers per assist at 3A/3B and San Salvador Pit (manually entered)

ID	Task Description	Source Location 1	Destination Location 2	Equipment	Type of Equipment to Assist (ID)	Type of Equipment to Assist (Name)	Number of Dozers per Assist	Loose /Stockpile Volume (cy)	Area (ac)	Productivity (cy/hr)	Productivity (ac/hr)
1502-A-a-Dz2	Grade-Outslopes-Existing Ground	5A Overburden	-	Cat D11T CD	--	--	--	6,300,000	308	768	-

Tyrone Mine
Stockpile Spreadsheet Worksheet #5
04/29/19

$$Production_{normal} = C * Distance_{Push}^{b}$$

PERFORMANCE FACTORS

Scraper Pusher Cycle Time (min)	Cycles per Scraper per Hr	Loader/ Shovel/ Excavator Cycle Time	Total Task Time (hrs)	Material Factor	Grade Factor	Material Weight (lb/cy)	Production Method/ Blade	Centroid to Centroid Push Distance (ft)	Normal Production (cy/hr)	Effective Blade Width (ft)	Speed (mph)	Operator Factor	Work Hour (min/hr)	Visibility Factor	Elevation Factor	Direct Drive Trans.	Cut to Fill Haul Grade (%)
-	-	-	8,204.8	1.0	1.6	3,300	1.2	540	697	22	3	1.00	50	1.0	1.0	1.0	-29%

$$Productivity(\frac{cy}{hr}) = F_{ma'l} * F_{grade} * F_{prod-metho} * F_{operator} * F_{visibility} * F_{elev} * F_{drive} * \frac{WorkHour}{60min/hr} * \frac{2{,}300\ lb/cy}{Mat'l\ Weight} * Production_{normal}$$

=U39*V39*X39*AC39*AE39*AF39*AG39*(AD39/60)*(2300/W39)*Z39

Sheet 6 – Road Maint: This sheet calculates the time required for a water truck and motor grader to be used for dust suppression and site maintenance during earthwork reclamation. Columns E through I repeats ID, activity, locations, and equipment. The Operational Maintenance Time (Column J) is assumed to be equal to the loader/shovel task time.

Tyrone Mine
Stockpile Spreadsheet Worksheet #6
04/29/19

Productivity and Hours Required for Dust Suppression and Road Maintenance

Notes and Assumptions:
6,000 gal water truck and 14M motor grader for dust suppression and site maintenance (water truck hours and 14M hours tied to loading time for cover material)
May filter on equipement (D14) to show pertinent rows

Sheet to which to tie hrs 10 Loader Shovel
Equipment for hrs Sh1
Equipment for hrs Ld2

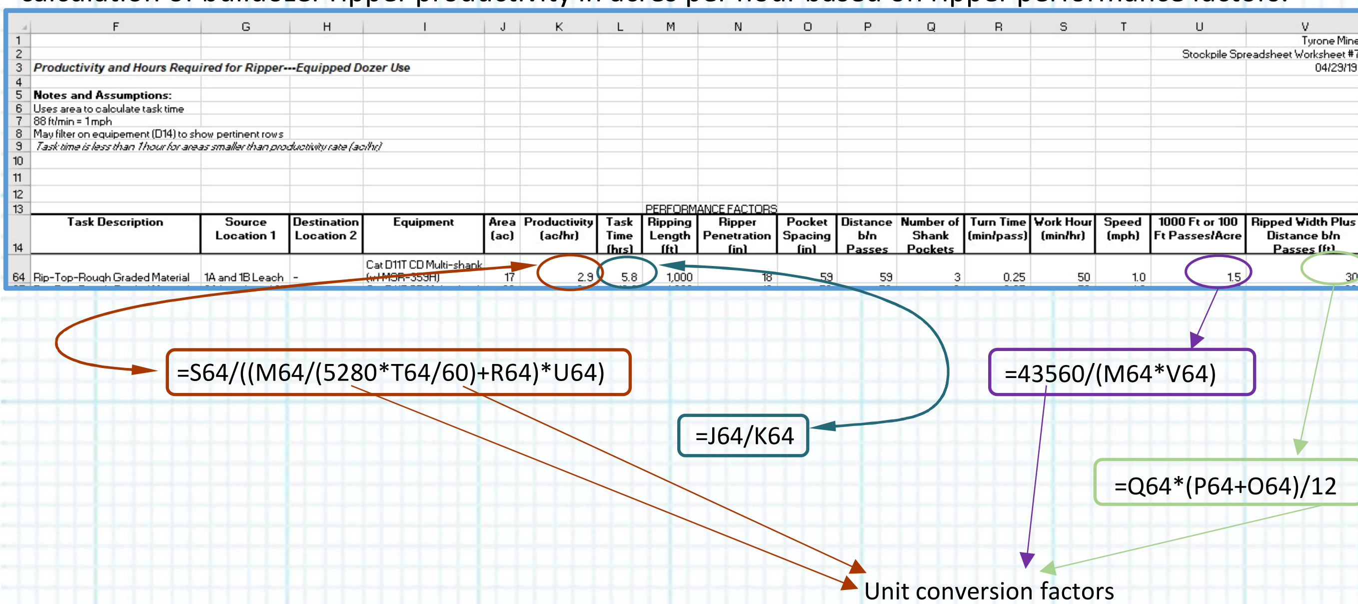
ID	Task Description	Source Location 1	Destination Location 2	Equipment	Operational Maintenance Time
1000-P-b-Comb1	Road Maintenance	Gila Borrow Area	1A and 1B Leach	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	423

Equals loading time on Loader/Shovel sheet

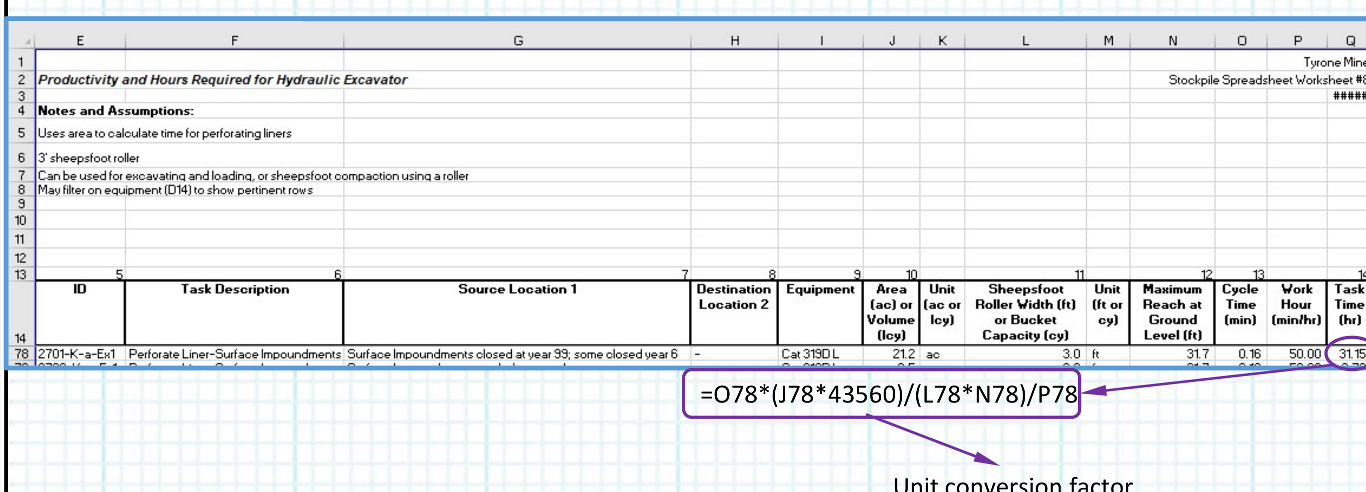
For example use only. Values may not match the current spreadsheet.

Results cont'd:

Sheet 7 – <u>Ripper</u>: Rippers are used after rough grading, before placing cover, at all facilities (or before revegetation at borrow stockpiles) to promote revegetation. Rippers are also used to loosen the existing ground before rough grading with scrapers. Columns E through J repeat the ID, title of the activity, locations, equipment and areas from Sheets 3 & 4. Columns K and L are the results of the dozer ripper productivity calculations. The remaining columns are the inputs that allow the calculation of bulldozer ripper productivity in acres per hour based on ripper performance factors:



Sheet 8 – <u>Excavator</u>: An excavator with a sheepsfoot attachment is used for perforating liners before reclamation of lined impoundments. Columns E through J repeat the ID, title of the activity, locations, equipment and areas from Sheets 3 & 4. Task time (column Q) to complete compacting the entire area is calculated using the inputs from columns J-P, which are referenced from the Equipment sheet.



For example use only. Values may not match the current spreadsheet.

Results cont'd

Sheet 9 – Trucks: Trucks are used to haul cover material from borrow stockpiles to destination facilities. Columns E through J repeat the ID, title of the activity, locations, equipment and volumes from Sheets 3 & 4. Column K sums the truck cycle, which includes the haul time loaded, return time empty, loading time, truck exchange time, and the dump/maneuver time. Column L reports the optimum number of trucks as limited by the number and size of loaders (calculated on the Truck Optimization sheet, as shown in the Equipment Optimization calculation summary). Column M lists the loader or shovel net bucket capacity, referenced from the Shovel sheet. Column O lists the loader or shovel task time, referenced from the Shovel sheet. Columns N and P calculate the overall productivity and time required of the load-haul-dump operations, respectively. Column P calculates the time for the truck to complete that task and compares that time to the loader task time, because the truck will have to idle while the loader/shovel finishes loading if the loader/shovel task time is longer than the truck task time (or vice versa). If the loader task time is longer, the loader task time is listed. If the truck task time is longer, the truck task time is listed.

Productivity and Hours Required for Truck Use

Notes and Assumptions:

Uses haul distance to calculate haul and return time (total task time includes loading, manuevering, dumping, hauling and return time) – moves from cover stockpile to destination stockpile

Volume of cover material based on area of destination

Cycles per truck = the greater of Heaped capacity or Struck capacity divided by Loader's per bucket capacity

1 mph = 88 ft/min

1 m/min = 0.03728227153424 mph

See Truck Optimization optimum number of trucks per loader

Haul Grade (%) assumes postive is uphill while the Effective Haul Grade (%) and Effective Return Grade (%) are postive for downhill and uphill

May filter on equipement (D14) to show pertinent rows

	E	F	G	H	I	J	K	L	M	N	O	P	Q
13	5	6	7	8	9	10	11	12	13	14	15	16	17
14	ID	Task Description	Source Location 1	Destination Location 2	Equipment	Loading Equipment ID	Loose/ Stockpile Volume (cy)	Truck Cycle Time (min)	Optimum Number of Trucks	Loader/Shovel/ Excavator Net Bucket Capacity (cy)	Productivity (cy/hr)	Loader/ Shovel/ Excavator Task Time(hrs)	Truck Task Time (hrs)
123	1300-D-b-Tk4	Haul-Cover	Gila Borrow Area	3A / 3B	Komatsu 730E	Sh1	2,202,200	18.4	8	28.1	3,052.2	705.7	721.5

=SUM(AL123:AP123)

=AQ123*T123*N123*M123/L123

=IF(OR(K123=0,O123=0),0,IF(K123/O123<P123,P123,K123/O123))

Columns R and S are equipment specifications from the CPH. Column T calculates the loader or shovel cycles per truck, based on loader/shovel bucket capacity and truck capacity. The total haul distance (column U) can be divided into three segments (columns V-X) if the route varies greatly in slope. The average grade for each segment is calculated and entered in Columns Y-AA. Columns U through AA are obtained from the Quantities sheet. Column AB is the rolling resistance for the assumed underfooting and tires per the CPH. Columns AC-AE convert segment distances from feet to meters for application of the performance equations from the CPH.

Tyrone Mine
Stockpile Spreadsheet Worksheet #9
04/29/19

PERFORMANCE FACTORS

	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE
13	18	19	20	21	22	23	24	25	26	27	28	29	30	31
14	Struck Capacity (cy)	Heaped Capacity (cy)	Loader/ Shovel Cycles per Truck	Total Haul Distance (ft)	Haul Distance Segment 1 (ft)	Haul Distance Segment 2 (ft)	Haul Distance Segment 3 (ft)	Haul Grade Segment 1 (%)	Haul Grade Segment 2 (%)	Haul Grade Segment 3 (%)	Rolling Resistance (%)	Haul Distance Segment 1 (meters)	Haul Distance Segment 2 (meters)	Haul Distance Segment 3 (meters)
123	101.0	145.0	5.0	11,221	4,411	6,810	-	-7.0%	6.6%	0.0%	2.5%	1,344	2,076	-

=TRUNC(R123/ N123)

=SUM(V123:X123)

For example use only. Values may not match the current spreadsheet.

Results cont'd

Sheet 9 – Trucks cont'd: Columns AF through AK calculate the effective grade of the segment (physical grade plus the rolling resistance). Haul time (column AL) and return time (column AM) are calculated by multiplying travel times (per distance) by haul/return distance. Loading time (column AN) is based on loader/shovel productivity (Sheet 10). Times in columns AO, AP, and AQ are referenced from the Equipment sheet.

=AR123*AC123+AS123*AD123+AE123*AT123

	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ
13	32	33	34	35	36	37	38	39	40	41	42	43
14	Effective Haul Grade Segment 1 (%)	Effective Haul Grade Segment 2 (%)	Effective Haul Grade Segment 3 (%)	Effective Return Grade Segment 1 (%)	Effective Return Grade Segment 2 (%)	Effective Return Grade Segment 3 (%)	Haul Time (min)	Return Time (min)	Loading Time (min)	Truck Exchange Time (min)	Dump/Maneuver Time (min)	Work Hour (min/hr)
123	4.5%	9.1%	2.5%	9.5%	4.1%	2.5%	9.6	4.7	2.25	0.7	1.1	50

=IF(Y123>=$AB123, Y123+$AB123, ABS(Y123+$AB123))

=IF(-Y123>=$AB123, -Y123+$AB123, ABS(-Y123+$AB123))

=AU123*AC123+AV123*AD123+AE123*AW123

Columns AR through AW calculate the travel time (per distance) from a curve fit based on CPH production factors, as explained on the following page. Travel time is dependent on effective grade. If the haul grade is positive (uphill), the loaded or empty uphill travel time is calculated, within the maximum speed of the truck. If the grade is negative (downhill), the loaded or empty downhill travel time is calculated, within the maximum speed of the truck.

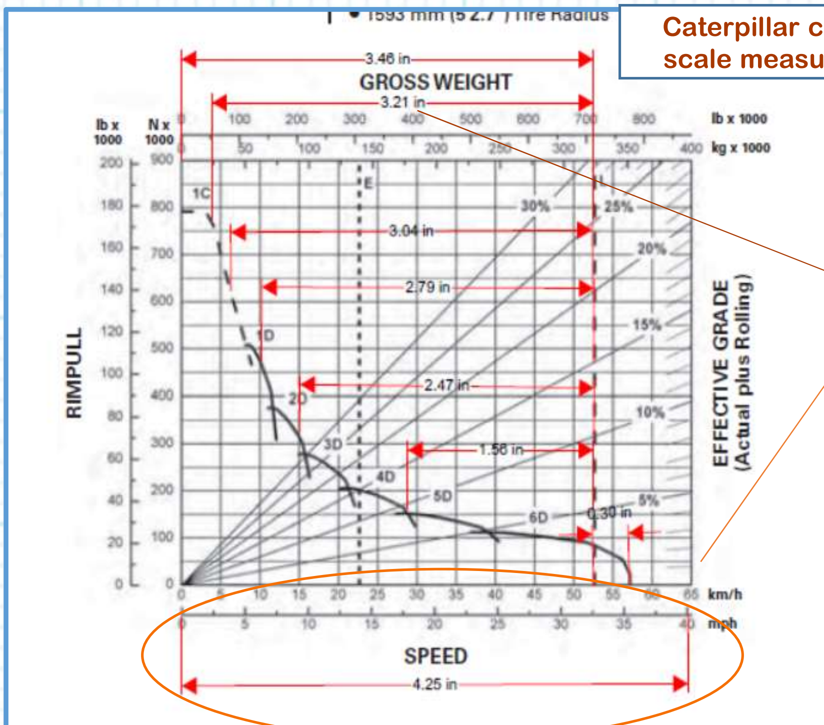
	AR	AS	AT	AU	AV	AW
1						Tyrone Mine
2						Stockpile Spreadsheet Worksheet #9
3						04/29/19
13	44	45	46	47	48	49
14	Travel Time Loaded Segment 1 (min/m)	Travel Time Loaded Segment 2 (min/m)	Travel Time Loaded Segment 3 (min/m)	Travel Time Empty Segment 1 (min/m)	Travel Time Empty Segment 2 (min/m)	Travel Time Empty Segment 3 (min/m)
123	0.00174	0.00352	0.00145	0.00189	0.00105	0.00105

For example use only. Values may not match the current spreadsheet.

Results cont'd

Sheet 9 – Trucks cont'd: Haul times are calculated for the trucks by using rimpull-speed-gradeability curves and retarding curves to create a relationship for travel time vs. effective resistance for travel uphill and downhill, respectively. A formula is derived by curve fit to the rimpull-speed-gradeability curves and retarding curves provided in the CPH for the specific truck. Similar to the dozer productivity curves, this is accomplished by scaling values from the figures and using the curve fitting tools within Microsoft Excel. Input values are taken from the 1998, 2011, 2017 and 2018 Caterpillar (Cat) Performance Handbook (CPH) (Editions 29, 41, 47, and 48) for the specific model truck. The example below shows how travel time is calculated for uphill routes, assuming a loaded truck:

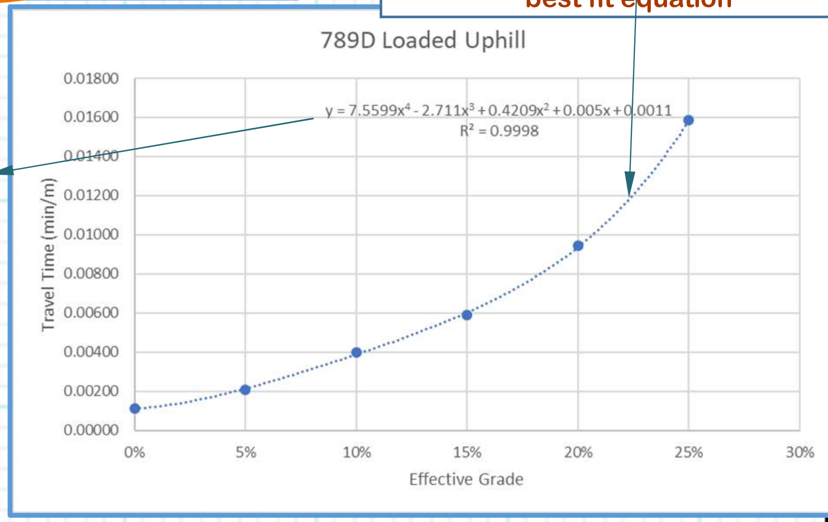
Caterpillar chart and scale measurements



	B	C	D	E	F
1	Loaded Up Hill				
2	Measurement	Speed (mph)			
3	4.25	40			
4	3.46	32.6			
5					
6	Measurement	Speed (mph)	Travel Time (min/m)	Effective Grade	
7	3.21	2.35	0.01585	25%	
8	3.04	3.95	0.00943	20%	
9	2.79	6.31	0.00591	15%	
10	2.47	9.32	0.00400	10%	
11	1.56	17.88	0.00209	5%	
12	0	32.56	0.00114	0%	

Graph these two columns and find best fit equation

Haul Travel Time (min/m)=7.5599(Eff. Grade %)⁴ + -2.711(Eff. Grade %)³ + 0.4209(Eff. Grade %)² + 0.005(Eff. Grade %) + 0.0011



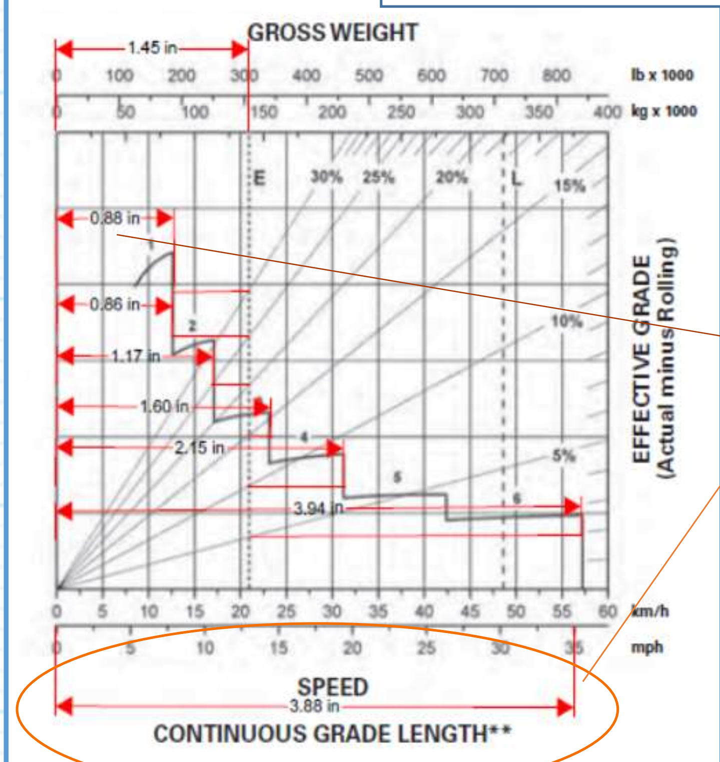
These coefficients are listed for each type of truck in columns P-AI of the Equipment sheet.

For example use only. Values may not match the current spreadsheet.

Results cont'd

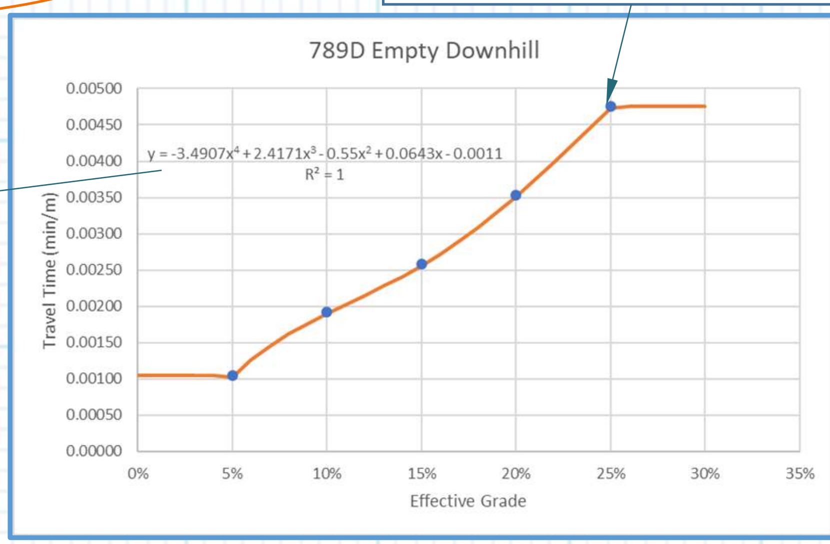
Sheet 9 – Trucks cont'd: The example below shows how travel time is calculated for downhill routes, assuming an empty truck:

Caterpillar chart and scale measurements



	B	C	D	E	F
1					
2	Measurement	Speed (mph)			
3	3.88	35			
4					
5	Measurement	Speed (mph)	Travel Time (min/m)	Effective Grade	
6	0.87	7.85	0.00475	30%	
7	0.87	7.85	0.00475	25%	
8	1.17	10.55	0.00353	20%	
9	1.6	14.43	0.00258	15%	
10	2.15	19.39	0.00192	10%	
11	3.95	35.63	0.00105	5%	
12	3.95	35.63	0.00105	0%	
13					

Graph these two columns and find best fit equation



Haul Travel Time (min/m)= -3.4907(Eff. Grade %)^4 + 2.4171(Eff. Grade %)^3 + 0.0643(Eff. Grade %)^2 + 0.0643(Eff. Grade %) + 0.0011

Fit has been adjusted to only include travel times for effective grades 5%-25%. If statements have been included in truck sheet to make travel time constant if effective grade is above 25% or below 5% for this truck type.

These coefficients are listed for each type of truck in columns P-AI of the Equipment sheet.

For example use only. Values may not match the current spreadsheet.

Results cont'd:

Sheet 10 – <u>Loader Shovel</u>: Loaders or shovels are used to load cover material onto haul trucks at borrow stockpiles. Columns E through I repeat the ID, title of the activity, locations, and equipment from Sheet 3. Column J is the hauling equipment that is loaded by the loader or shovel. Column K is from Sheet 4 and contains the total amount of material to be loaded/moved. Loader/shovel cycle time (column L), net bucket capacity (column P), and work hour (column Q) are from the Equipment sheet. Per Loader/Shovel Productivity (cy/hr) (column M) and Loader/Shovel Task Time (hrs) (column N) are calculated directly. Similar to the truck task time calculation, the maximum of either the loader/shovel task time or the truck task time is used (column O).

	E	F	G	H	I	J	K	L	M	N	O	P	Q
1													Tyrone Mine
2	***Productivity and Hours Required for Front End Loader Use or Hydraulic Shovel Use***												Stockpile Spreadsheet Worksheet #10
3													4/29/2019
4	**Assumptions:**												
5	Uses cover volume to calculate loading time of cover material												
6	May filter on equipement (D14) to show pertinent rows												
7													
8													
9													
10													
11													
12												**PERFORMANCE FACTORS**	
13	5	6	7	8	9	10	11	12	13	14	15	16	17
14	**ID**	**Task Description**	**Source Location 1**	**Destination Location 2**	**Equipment**	**Hauling Equipment ID**	**Loose/Stockpile Volume (cy)**	**Loader/ Shovel Cycle Time (min)**	**Per Loader/Shovel Productivity (cy/hr)**	**Loader/ Shovel Task Time (hrs)**	**Max of Loader/Shovel or Truck Task Time (hrs)**	**Net Bucket Capacity (cy)**	**Work Hour (min/hr)**
99	1000-C-b-Sh1	Load-Cover	Gila Borrow Area	1A and 1B Leach	Hitachi EX3600-5	Tk4	1,321,320	0.45	3,120.6	423.4	423.4	28.1	50

=P99/L99*Q99

=K99/M98

Sheet 11 – <u>Scrapers</u>: No scrapers are used in Tyrone RCE.

For example use only. Values may not match the current spreadsheet.

Results cont'd:

Sheet 12 – M'Grader: Motor graders are used for rough grading tops of stockpiles or for fine grading cover material. Columns E through I repeat the ID, title of the activity, locations, and equipment from Sheet 3. Column J is from Sheet 4 and contains the area of material to be graded. The grade factor (Column M) is calculated based on percent grade. Column K, shaping productivity, is calculated from the speed and effective blade width. Column L is calculated directly. Column N is an assumed material handling factor and Column U is a factor based on operator experience. Columns O-T are based on material properties and equipment information.

Tyrone Mine
Stockpile Spreadsheet Worksheet #12
4/29/2019

Productivity and Hours Required for Motorgrader Use---Grading

Notes and Assumptions:

Productivity (based on area of overall stockpile) = Sq.ft per hour = Speed x (Eff. Blade L -Blade Overlap) x Efficiency (*Cat. Handbook Edition 47* pg 11-27)

Max. safe slope for motor graders is 2:1 (50%), proposed final grade for Tyrone cover grading on stockpiles is 33%, therefore use of graders an option (Cat. Handbook Edition 46 pg 11-30)

Grade Factor = -0.02(Grade %) + 1

May filter on equipement (D14) to show pertinent rows

ID	Task Description	Source Location 1	Destination Location 2	Grading Equipment	Area (ac)	Grading Shaping Productivity (ac/hr)	Task Time (hrs)	Grade Factor	Material Factor	Material Weight (lb/cy)	Production Method/ Blade	Effective Blade Width (ft)	Pass Overlap (ft)	Speed (mph)	Work Hour (min/hr)	Operator Factor
1001-A-a-Mg1	Grade-Top-Existing Ground	1A and 1B Leach	-	Cat 16M	17	3	5.9	1.0	1.0	3,300	1.20	16.00	2.00	2.50	50	1.00

=(T46/60)*N46*(2300/O46)*P46*U46*M46*S46*(Q46-R46)*5280/43560

=IF(K115>0,J115/K115,0)

Unit conversion factors

Soil weight (lb/cy) assumed in CPH

Sheet 13 – EarthSum: This sheet summarizes all of the quantities and production rates on the individual sheets (5, and 7 through 12) and applies costs from Equipment Watch, the New Mexico labor rates table, fuel quotes, etc. Columns E through I repeat the ID, title of the activity, locations, equipment from Sheet 3. Columns J through L list the fuel, rental and maintenance, and labor unit costs from the Equipment sheet for the associated piece of equipment. The number of units of equipment is assumed to be one except for trucks and scrapers, which use an optimum number of units, calculated on the truck and scraper optimization sheets. The time required is taken from each of the equipment sheets (Sheets 5-12). The fuel, rental and maintenance, and labor costs are calculated by multiplying the unit costs by the time required for each task. The total equipment cost (column R) is the sum of the fuel, rental and maintenance, and labor costs. The total production volumes and areas are repeated from Sheet 4.

Summarizes costs for line items involving earthworks

Summary Calculation of Earthmoving Costs

Notes and Assumptions:

Summarizes all earthmoving quantities and co

Productivity (based on area of overall stockpile) = Sq.ft per hour = Speed x (Eff. Blade L -Blade Overlap) x Effici

Max. safe slope for motor graders is 2:1(50%), proposed final grade for Tyrone cover grading on stockpiles is 3

Grade Factor = -0.02(Grade %) + 1

May filter on equipement (D14) to show pertinent rows

ID	Description	Source Location 1	Destination Location 2	Equipment	Fuel Cost ($/hr)	Lube, Tires, GEC, & Field Parts Adjusted Rental Cost (w/o fuel) ($/hr)	Labor Cost ($/hr)
1202-A-a-Dz2	Grade-Outslopes-Existing Ground	2A Leach and 2B Waste	-	Cat D11T CD	$69.62	$254.44	$27.41

For example use only. Values may not match the current spreadsheet.

Results cont'd

Sheet 13 – EarthSum cont'd:

Tyrone Mine
Stockpile Spreadsheet Worksheet #13
04/29/19

5 iency (*Cat Handbook Edition 47* pg 11-27)
6 3%, therefore use of graders an option (Cat. Handbook Edition 46 pg 11-30)

	M	N	O	P	Q	R	S	T
14	Number of Units (Equipment)	Time Req'd (hrs)	Direct Fuel Cost ($)	Direct Lube, Tires, GEC, & Field Parts Adjusted Rental Cost (w/o fuel) (	Direct Labor Cost ($)	Total Equipment Cost ($)	Total Production Volume (CY)	Total Production Area (AC)
36	1	9,386.8	$647,897	$2,368,057	$255,101	$3,271,055	8,060,000	-

=SUM(O15:Q15)

=J15*N15*M15

Sheet 14 – Revegetation: Columns E through I repeat the ID, title of the activity, locations, and areas from Sheets 3 & 4. The calculated unit rates for revegetation (reveg fuel cost and reveg cost without fuel) are multiplied by the corresponding areas to calculate the associated direct revegetation costs for each location. The total revegetation direct cost is then the sum of all direct costs related to each location.

Revegetation Costs

Tyrone Mine
Stockpile Spreadsheet Worksheet #14
04/29/19

Description:
Includes scarifying (ripping), discing, rangeland drill seeding, mulching, crimping, and daily per diem
May filter on equipement (D14) to show pertinent rows

	ID	Description	Source Location 1	Destination Location 2	Area (ac)	Fuel Unit Cost ($/ac)	Reveg w/o Fuel Unit Cost ($/ac)	Fuel Direct Cost ($)	Reveg w/o Fuel Direct Cost ($)
154	1000-J-e-U2	Revegetate-Entire Stockpile-Final Grade	1A and 1B Leach	-	273.0	$ 3.85	$ 820.12	$ 1,051	$ 223,893
155	1100-J-e-U2	Revegetate-Top (Haul Road)-Final Grade	1C	-	17.0	$ 3.85	$ 820.12	$ 65	$ 13,945
156	1200-J-e-U2	Revegetate-Entire Stockpile-Final Grade	2A Leach and 2B Waste	-	487.0	$ 3.85	$ 820.12	$ 1,874	$ 399,392
157	1300-J-e-U2	Revegetate-Entire Stockpile-Final Grade	3A / 3B	-	455.0	$ 3.85	$ 820.12	$ 1,751	$ 373,155
158	1500-J-e-U2	Revegetate-Entire Stockpile-Final Grade	5A Overburden	-	371.0	$ 3.85	$ 820.12	$ 1,428	$ 304,265
159	2200-J-e-U2	Revegetate-Entire Pit-Final Grade	San Salvador Pit	-	115.0	$ 3.85	$ 820.12	$ 443	$ 94,314
160	2300-J-e-U2	Revegetate-Entire Stockpile-Final Grade	Savanna In-Pit Leach Stockpile	-	65.0	$ 3.85	$ 820.12	$ 250	$ 53,308
161	1400-J-e-U2	Revegetate-Entire Stockpile-Final Grade	4C Leach	-	183.0	$ 3.85	$ 820.12	$ 704	$ 150,082
162	1800-J-e-U2	Revegetate-Entire Stockpile-Final Grade	2C, 4A, 4B, 7B Leach	-	375.0	$ 3.85	$ 820.12	$ 1,443	$ 307,545
163	1900-J-e-U2	Revegetate-Sludge Disposal Area-Final Grade	8C	-	47.4	$ 3.85	$ 820.12	$ 182	$ 38,841
164	1600-J-e-U2	Revegetate-Entire Stockpile-Final Grade	6B	-	54.0	$ 3.85	$ 820.12	$ 208	$ 44,286
165	1700-J-e-U2	Revegetate-Entire Stockpile-Final Grade	6C	-	66.0	$ 3.85	$ 820.12	$ 254	$ 54,128
166	2000-J-e-U2	Revegetate-Entire Stockpile-Final Grade	9A Overburden	-	129.0	$ 3.85	$ 820.12	$ 496	$ 105,796
167	2600-J-e-U2	Revegetate-Tailing Launder Line-Final Grade	Tailing Launder Line	-	7.4	$ 3.85	$ 820.12	$ 28	$ 6,072
168	2900-J-e-U2	Revegetate-Mangus Pumphouse-Final Grade	Mangus Pumphouse	-	7.0	$ 3.85	$ 820.12	$ 27	$ 5,741
169	2701-J-e-U2	Revegetate-Surface Impoundments closed at year 99; some closed year 6-	Surface Impoundments closed at year 99; some closed year 6	-	21.2	$ 3.85	$ 820.12	$ 82	$ 17,411
170	2702-J-e-U2	Revegetate-Surface Impoundments graded over at closure-Final Grade	Surface Impoundments graded over at closure	-	0.5	$ 3.85	$ 820.12	$ 2	$ 394
171	3300-J-e-U2	Revegetate-Unplanned Disturbance Area-Final Grade	Unplanned Disturbance Area	-	125.0	$ 3.85	$ 820.12	$ 481	$ 102,515
172	2100-J-e-U2	Revegetate-Entire Stockpile-Final Grade	9AX	-	63.7	$ 3.85	$ 820.12	$ 245	$ 52,242
173	2803-J-e-U2	Revegetate-Revegetation Area-Final Grade	Tailing Repositories Borrow Areas	-	74.7	$ 3.85	$ 820.12	$ 287	$ 61,263
290									
291				TOTAL	####			$ 11,301	$ 2,408,586

=I173*J173

=SUM(M15:M290)

For example use only. Values may not match the current spreadsheet.

TELESTO SOLUTIONS • INCORPORATED

Job No: 200540a	Client: Freeport NM Operations		
Task: Earthwork RCE	Computed By: Taryn Tigges	Date: 4/30/19	
	Checked By: Fred Charles	Date: 4/30/19	

Sheet 15 – Other: This sheet contains the direct costs associated with miscellaneous (other) earthwork tasks. These tasks include grading benches, constructing downdrains, constructing downdrain dissipators, constructing bench channels (including filter and riprap production and placement), replacing infrastructure, plugging and abandoning wells, replacing wells, constructing berms, fencing (including vehicle gates and signs), and building grade control walls. Columns E through H repeat the ID, description, and locations from Sheet 3. Columns I and J document the quantity and unit associated with each quantity for each task (referenced from the Quantities sheet). The unit costs (columns K and L) are referenced from the Unit Cost sheet. The quantity multiplied by the unit costs give the direct costs for each activity. The direct costs are totaled at the bottom of the sheet.

	E	F	G	H	I	J	K	L	M	N
1										Tyrone Mine
2	*Other Reclamation Activity Costs*									Stockpile Spreadsheet Worksheet #15
3										04/29/19
4	**Assumptions:**									
5	1 - Cost to construct drain or channel on re-graded stockpile									
6	2 - The downdrain, ACB, well plug & abandon, and well replacement costs include fuel									
7	May filter on equipement (D14) to show pertinent rows									
8										
9										
10										
11										
12										
13										
14	ID	Description	Source Location 1	Destination Location 2	Quantity	Unit	Fuel Unit Cost ($/unit)	Unit Cost w/o Fuel ($/unit)[1]	Fuel Direct Cost ($)	Direct w/o Fuel Cost ($)
238	1700-G-e-U5	Construct Downdrains-Entire Stockpile-Final Grade	6C	-	550	ft	$ -	$ 374.38	$ -	$ 205,909
239	2000-G-e-U5	Construct Downdrains-Entire Stockpile-Final Grade	9A Overburden	-	2,500	ft	$ -	$ 374.38	$ -	$ 935,951
240	1000-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	1A and 1B Leach	-	4	ea	$ -	$ 14,556.48	$ -	$ 58,226
241	1200-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	2A Leach and 2B Waste	-	5	ea	$ -	$ 14,556.48	$ -	$ 72,782
242	1300-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	3A / 3B	-	4	ea	$ -	$ 14,556.48	$ -	$ 58,226
243	1500-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	5A Overburden	-	2	ea	$ -	$ 14,556.48	$ -	$ 29,113
244	2200-Gb-e-U6	Construct Downdrain Dissipators-Entire Pit-Final Grade	San Salvador Pit	-	1	ea	$ -	$ 14,556.48	$ -	$ 14,556
245	1400-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	4C Leach	-	3	ea	$ -	$ 14,556.48	$ -	$ 43,669
246	1800-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	2C, 4A, 4B, 7B Leach	-	3	ea	$ -	$ 14,556.48	$ -	$ 43,669
247	1600-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	6B	-	1	ea	$ -	$ 14,556.48	$ -	$ 14,556
248	1700-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	6C	-	1	ea	$ -	$ 14,556.48	$ -	$ 14,556
249	2000-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	9A Overburden	-	1	ea	$ -	$ 14,556.48	$ -	$ 14,556
250	1000-H-e-U7a	Construct Bench Channels w/ Riprap-Entire Stockpile-Final Grade	1A and 1B Leach	-	50,013	ft	$ 1.39	$ 6.60	$ 69,277.99	$ 330,108
251	1200-H-e-U7a	Construct Bench Channels w/ Riprap-Entire Stockpile-Final Grade	2A Leach and 2B Waste	-	68,062	ft	$ 1.39	$ 6.60	$ 94,279.45	$ 449,240
252	1300-H-e-U7a	Construct Bench Channels w/ Riprap-Entire Stockpile-Final Grade	3A / 3B	-	65,980	ft	$ 1.39	$ 6.60	$ 91,395.47	$ 435,497
253	1500-H-e-U7a	Construct Bench Channels w/ Riprap-Entire Stockpile-Final Grade	5A Overburden	-	50,330	ft	$ 1.39	$ 6.60	$ 69,717.09	$ 332,200
254	2200-H-e-U7a	Construct Bench Channels w/ Riprap-Entire Pit-Final Grade	San Salvador Pit	-	9,940	ft	$ 1.39	$ 6.60	$ 13,768.88	$ 65,608
255	1400-H-e-U7a	Construct Bench Channels w/ Riprap-Entire Stockpile-Final Grade	4C Leach	-	23,501	ft	$ 1.39	$ 6.60	$ 32,553.57	$ 155,117
256	1800-H-e-U7a	Construct Bench Channels w/ Riprap-Entire Stockpile-Final Grade	2C, 4A, 4B, 7B Leach	-	26,700	ft	$ 1.39	$ 6.60	$ 36,984.83	$ 176,232
257	1700-H-e-U7a	Construct Bench Channels w/ Riprap-Entire Stockpile-Final Grade	6C	-	4,100	ft	$ 1.39	$ 6.60	$ 5,679.32	$ 27,062
258	2000-H-e-U7a	Construct Bench Channels w/ Riprap-Entire Stockpile-Final Grade	9A Overburden	-	25,148	ft	$ 1.39	$ 6.60	$ 34,835.00	$ 165,988
259	2800-Hb-e-U7t	Construct Bench Channels w/o Riprap-Borrow Areas-Final Grade	Tailing Repositories Borrow Areas	-	13,501	ft	$ 0.10	$ 0.41	$ 1,381.33	$ 5,593
260	2800-R-e-U28	Construct Berms-Borrow Areas-Final Grade	Tailing Repositories Borrow Areas	-	3,142	ft	$ -	$ 0.06	$	$ 195
261	2600-T-e-U35	Build Grade Control Walls-Tailing Launder Line-Final Grade	Tailing Launder Line	-	1,002	ft	$ -	$ 165.59	$ -	$ 165,992
283										
284										
285										
286										
287										
288										
289										
290										
291								TOTAL	$ 547,382	$ 19,979,626

=I259*K259

=SUM(M15:M261)

1

For example use only. Values may not match the current spreadsheet.

Results cont'd

Sheet 16 – Sum: This sheet summarizes the direct costs from Sheets 2, 13, 14 and 15. The indirect costs are added as a percentage of the direct costs.

	A	B	C	D	E
1					Tyrone Mine
2					Stockpile Spreadsheet Worksheet #16
3					4/29/2019
4					
5	***Tyrone Mine***				
6	Reclamation Summary Stockpiles, Haul Roads, Reservoirs, and Disturbed Areas				
7					
8				**Current Value**	
9	**DIRECT COSTS**	Facility and Structure Removal		$5,089,622	
10		Earthmoving		$43,140,197	
11		Revegetation		$2,419,888	
12		Other		$20,527,008	
13		**Subtotal, Direct Costs**		**$71,176,714**	
14					
15	**INDIRECT COSTS**	**Subtotal, Indirect Costs**	**30.0%**	**$21,353,014**	
16					
17					
18	**TOTAL COST**			**$92,529,729**	
19		Twelve Year Annual Expenditure		**$7,710,811**	
20					
21					
22	Notes:				
23	Indirect costs are based on 2019 agreement between FMI and agencies				
24	Indirect costs include but are not limited to mobilization and demobilization, engineering redesign fee,				
25	contingencies, contractor profit and overhead, project management fee, and state procurement cost				

- D9: ='2 Demo'!F31
- D10: ='13 EarthSum'!R295
- D11: ='14 Revegetation'!M291+'14 Revegetation'!L291
- D12: ='15 Other'!N291+'15 Other'!M291
- D13: =SUM(D9:D12)
- D15: =C15*D13
- D18: =(D13+D15)
- D19: =D18/12

Total indirect costs of 30% are applied to the capital direct costs based on discussions involving the FA Work Group completed in December 2018 and as agreed in January 2019. The FA Work Group involved representatives of Freeport-McMoRan New Mexico Operations (FNMO), MMD, NMED, and Gila Resources Information Project (GRIP). The indirect costs incorporate Mobilization and Demobilization, Contingencies, Engineering Redesign Fee, Contractor Profit and Overhead, Project Management Fee, and other administrative costs. The RCE report provides further information on the FA Work Group agreement.

For example use only. Values may not match the current spreadsheet.

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Job No: 200540a | Client: Freeport NM Operations |

Task: Earthwork RCE | Computed By: Taryn Tigges | Date: 4/30/19

Checked By: Fred Charles | Date: 4/30/19

Results cont'd:

Sheets 17-Facility Characteristics- This sheet summarizes direct and indirect cost for each facility in the Tyrone RCE spreadsheet. The first four facilities listed on this sheet are shown below:

	A	B	C	D	E	F
1						
2						
3	**Facility Characteristics**					
4	Facilities are categorized in this listing to meet the MMD reporting					
5	requirement					
6			1000	1100	1200	1300
7		**Facility**	**1A and 1B Leach**	**1C**	**2A Leach and 2B Waste**	**3A / 3B**
8						
9		**Reclaimed Acres[6]**	273.00	17.00	486.99	455.00
10						
11		**Item**	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**
12	Direct Costs	Cover Material Excav, Haul, Grade[1]	$1,262,102	$95,723	$3,231,529	$3,105,876
13		Pullback or Backfill	$0	$0	$0	$13,577,409
14		Top/Outslope Adjustment Grading[2]	$164,600	$0	$3,277,233	$1,659,024
15		Scarify, Seed & Mulch, Reveg[3]	$224,943	$14,011	$401,266	$374,906
16		Channels & Benches[4]	$1,928,349	$0	$3,709,623	$2,966,998
17		Demolition	$0	$0	$0	$0
18		Other[5]	$0	$0	$0	$0
19		**Capital Cost Totals**	**$3,579,994**	**$109,734**	**$10,619,651**	**$21,684,211**
20		**Capital Cost/Acre**	**$13,114**	**$6,453**	**$21,807**	**$47,658**
21						
22	Indirect Costs	Cover Material Excav, Haul, Grade1	$378,631	$28,717	$969,459	$931,763
23		Pullback or Backfill	$0	$0	$0	$4,073,223
24		Top/Outslope Adjustment Grading[2]	$49,380	$0	$983,170	$497,707
25		Scarify, Seed & Mulch, Reveg[3]	$67,483	$4,203	$120,380	$112,472
26		Channels & Benches[4]	$578,505	$0	$1,112,887	$890,099
27		Demolition	$0	$0	$0	$0
28		Other[5]	$0	$0	$0	$0
29		**Indirect Cost Totals**	**$1,073,998**	**$32,920**	**$3,185,895**	**$6,505,263**
30		**Indirect Cost/Acre**	**$3,934**	**$1,936**	**$6,542**	**$14,297**
31						
32						
33						
34		**Total Cost**	**$4,653,992**	**$142,654**	**$13,805,546**	**$28,189,475**
35		Total Cost Cover	$1,640,733	$124,440	$4,200,988	$4,037,638
36		Pullback or Backfill	$0	$0	$0	$17,650,631
37		Total Cost Top/Outslope Adjustment	$213,980	$0	$4,260,403	$2,156,731
38		Total Cost Earthwork	$1,854,712	$124,440	$8,461,391	$23,845,001
39		Capital Cost Re-Veg	$292,426	$18,214	$521,645	$487,377
40		Capital Cost Other[5]	$0	$0	$0	$0
41						
42		**Total Cost/Acre**	**$17,048**	**$8,389**	**$28,349**	**$61,955**
43		Total Cost/Acre Cover	**$6,010**	**$7,318**	**$8,626**	**$8,874**
44		Pullback or Backfill	**$0**	**$0**	**$0**	**$38,793**
45		Total Cost/Acre Top/Outslope Adjustment	**$784**	**$0**	**$8,748**	**$4,740**
46		Total Cost/Acre Earthwork	**$6,794**	**$7,318**	**$17,375**	**$52,407**
47		Capital Cost/Acre Re-Veg	**$1,071**	**$1,071**	**$1,071**	**$1,071**
48		Capital Cost/Acre Other[5]	**$0**	**$0**	**$0**	**$0**
49						

The Direct and Indirect Costs are each broken down into the following sections: Cover Material, Pullback or Backfill, Top/Outslope Adjustment Grading, Revegetation, Channels & Benches, Demolition, and Other. Demolition is not divided by location but is given as a total.

For example use only. Values may not match the current spreadsheet.

Results cont'd:

Remaining Sheets: The remaining sheets and data supporting the earthwork calculations described in this calculation documentation are described in the following calculation summaries:

- Equipment Optimization
- O&M
- Building Demo
- Bench Grading Unit Cost
- Bench Channel Unit Cost (and Riprap/Gravel Unit Cost)
- Downdrain Unit Cost
- Pipeline Unit Cost
- Revegetation Unit Cost
- Fuel Unit Cost

Fuel Cost

Job No: 200544a-001-02	Client: Freeport NM Operations	Page 1 of 4
Task: Fuel Cost	Computed By: Fred Charles	Date: 2/19/2019
	Checked By: Taryn Tigges	Date: 2/19/2019

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Calculation Documentation

Problem Statement:

Freeport-McMoRan (FMI) utilizes fuel price information as part of earthwork closure cost estimation associated with the Little Rock Mine Closure/Closeout Plan (CCP). A reliable estimate of the local 2021 fuel price is needed, based on local and national data for past years.

Objective:

1. Develop an equation to predict the estimated 2021 local fuel price for use in estimating earthwork closure costs at FMI's mining operations in Grant County, NM.

Approach:

1. Identify existing data used for the calculation.
2. Correlate local and national data for fuel price, paired by year.
3. Estimate 2021 fuel price for use in the earthwork closure costs.

Data and Assumptions:

1. Data used for the calculations are shown below (1995-2018 as example) and include (a) U.S. No. 2 Diesel Retail Prices (annual national) and (b) FMI quotes (for specific dates within a year) for the local Silver City area. All prices are in $/gallon.

Fuel Price Data

Data 1: U.S. No 2 Diesel Retail Prices (Dollars per Gallon)

Date	U.S. No 2 Diesel Retail Prices[1]
1995	1.109
1996	1.235
1997	1.198
1998	1.044
1999	1.121
2000	1.491
2001	1.401
2002	1.319
2003	1.509
2004	1.81
2005	2.402
2006	2.705
2007	2.885
2008	3.803
2009	2.467
2010	2.992
2011	3.84
2012	3.968
2013	3.922
2014	3.825
2015	2.707
2016	2.304
2017	2.65
2018	3.178

Date	U.S. No 2 Diesel Retail Prices[1]
Jan 2019	2.98

FMI Fuel Quotes[2]

Site	Date	Dyed, low-sulfur diesel	Notes
Continental	1/21/2005	$1.40	Tom Shelley - quote from fuel broker
Chino & Tyrone	5/9/2007	$2.41	Porter Oil Quote (7500 gal capacity)
Continental	1/23/2009	$1.80	Porter Oil Quote (7500 gal capacity)
Tyrone (Little Rock)	1/14/2010	$2.49	Porter Oil Quote (7500 gal capacity)
Tyrone	7/7/2012	$3.13	Western Refining Oil
Continental	6/18/2014	$3.22	Western Refining Oil
Chino (North Lampbright)	11/5/2015	$1.74	Western Refining Oil
Chino	5/20/2016	$1.66	Western Refining Oil
Tyrone (Little Rock)	4/24/2017	$1.90	Western Refining Oil
Continental	3/12/2018	$2.75	Griffin Propane
Chino	10/10/2018	$2.75	Griffin Propane

1. U.S. Energy Information Administration
http://tonto.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMD_EPD2D_PTE_NUS_DPG&f=M
2. Quotes obtained from Freeport-McMoRan (FMI)

For example use only. Values may not match the current spreadsheet.

Data and Assumptions (continued):

2. The local FMI fuel quotes and annual national retail fuel (U.S. No. 2) prices are assumed to trend similarly – if the national prices increase the local prices also increase.
3. A correlation between national and local fuel prices is assumed to be a reasonable predictor of local fuel prices for any time period (e.g., annual, monthly, etc).

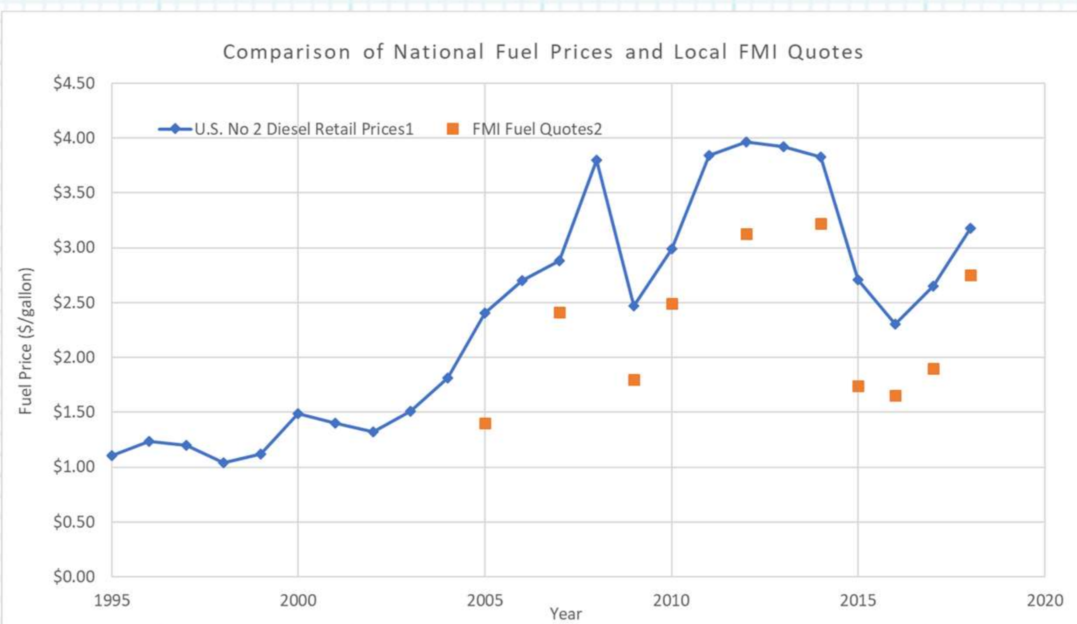
Calculations and Results:

1. The annual national retail fuel prices (U.S. Energy Information Administration) dataset is tabulated and plotted for comparison with the available annual local FMI fuel quotes (note that quotes are not available for blank years).

Year	U.S. No 2 Diesel Retail Prices[1]	FMI Fuel Quotes[2]
1995	1.109	
1996	1.235	
1997	1.198	
1998	1.044	
1999	1.121	
2000	1.491	
2001	1.401	
2002	1.319	
2003	1.509	
2004	1.81	
2005	2.402	$1.40
2006	2.705	

Year	U.S. No 2 Diesel Retail Prices[1]	FMI Fuel Quotes[2]
2007	2.885	$2.41
2008	3.803	
2009	2.467	$1.80
2010	2.992	$2.49
2011	3.84	
2012	3.968	$3.13
2013	3.922	
2014	3.825	$3.22
2015	2.707	$1.74
2016	2.304	$1.66
2017	2.65	$1.90
2018	3.178	$2.75

1. U.S. Energy Information Administration
http://tonto.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMD_EPD2D_PTE_NUS_DPG&f=M
2. Quotes obtained from Freeport-McMoRan (FMI)



For example use only. Values may not match the current spreadsheet.

Calculations and Results (continued):

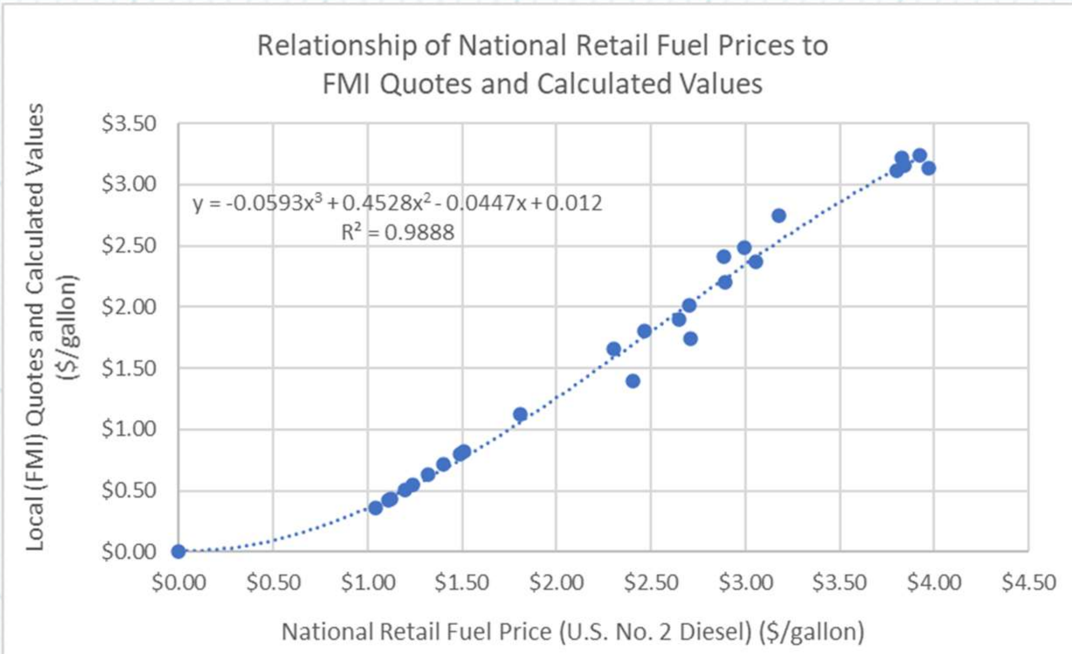
2. The annual national fuel retail prices are ranked from lowest to highest, and corresponding local FMI fuel quotes are listed for matching years in which they are available. (see Col. A and B, below)
3. The difference between the national fuel retail prices and FMI fuel quotes is calculated for each pairing. Note that FMI fuel quotes are all lower than the corresponding national fuel retail prices. The differences for all pairs are averaged. (Col. C)
4. For each year without an FMI quote, the average difference ($0.69) is subtracted from the national fuel retail prices. This results in a calculated FMI value for each unpaired data year. (Col. D)
5. The available FMI fuel quotes and calculated FMI values are combined into one column for a full listing of calculated FMI values and FMI quotes. (Col. E)
6. The annual national fuel retail prices (Col. A) are plotted vs FMI calculated values and quotes (Col. E), and a correlation is developed with national fuel prices as the independent variable and FMI values and quotes as the dependent (i.e., estimated) variable. (see Col. F and graph below)

A	B	C	D	E	F
U.S. No. 2 Diesel Retail Prices[1]	FMI Fuel Quotes[2]	Difference Between Retail Prices and FMI Quotes	Calculated FMI Values Based on Average Difference	Calculated FMI Values and Quotes	y = -0.0617x3 + 0.4659x2 - 0.0611x + 0.0148
$0.00				*$0.00*	$0.01
$1.11			$0.42	*$0.42*	$0.44
$1.24			$0.55	*$0.55*	$0.53
$1.20			$0.51	*$0.51*	$0.50
$1.04			$0.36	*$0.36*	$0.39
$1.12			$0.43	*$0.43*	$0.44
$1.49			$0.80	*$0.80*	$0.75
$1.40			$0.71	*$0.71*	$0.67
$1.32			$0.63	*$0.63*	$0.60
$1.51			$0.82	*$0.82*	$0.77
$1.81			$1.12	*$1.12*	$1.06
$2.40	$1.40	$1.00		$1.40	$1.70
$2.71			$2.02	*$2.02*	$2.04
$2.89	$2.41	$0.47		$2.41	$2.23
$3.80			$3.11	*$3.11*	$3.13
$2.47	$1.80	$0.67		$1.80	$1.77
$2.99	$2.49	$0.50		$2.49	$2.35
$3.84			$3.15	*$3.15*	$3.16
$3.97	$3.13	$0.84		$3.13	$3.25
$3.92			$3.23	*$3.23*	$3.22
$3.83	$3.22	$0.61		$3.22	$3.14
$2.71	$1.74	$0.97		$1.74	$2.04
$2.30	$1.66	$0.65		$1.66	$1.59
$2.65	$1.90	$0.75		$1.90	$1.98
$3.18	$2.75	$0.43		$2.75	$2.89
	Average	$0.69			

1. U.S. Energy Information Administration
http://tonto.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMD_EPD2D_PTE_NUS_DPG&f=M
2. Quotes obtained from Freeport-McMoRan (FMI)

For example use only. Values may not match the current spreadsheet.

Calculations and Results (continued):



7. The prediction equation (and coefficient of determination, R^2) is shown in the above graph where x = national retail fuel price ($/gallon) and y = predicted local fuel price ($/gallon).
8. Based on this equation, and a national retail fuel price in December of 2020 of $2.59, the predicted local FMI fuel price for U.S. No. 2 diesel (December) is

$$Local\ fuel\ price = (-0.0593)(2.59)^3 + (0.4528)(2.59)^2 - (0.0447)(2.59) + 0.012 = \$1.90/gallon$$

Summary and Conclusions:

1. National and local (FMI) fuel price data were used to develop a strongly-correlated (R^2 = 0.9888) prediction equation by which local FMI fuel prices can be predicted from national fuel price data. Note that the relationship developed in this analysis applies only to FMI operations in the Silver City (Grant County), NM area.
2. The following prediction equation developed in these calculations can be used to predict the estimated December 2020 local fuel price for use in earthwork closure costs:

$$Local\ fuel\ price = -0.0593x^3 + 0.4528x^2 - 0.0447x + 0.012$$

where x = national retail fuel price ($/gallon) and y = predicted local fuel price ($/gallon)

For example use only. Values may not match the current spreadsheet.

Bench Grading Unit Cost

Calculation Documentation

Problem Statement:

Freeport-McMoRan (FMI) utilizes unit cost information for bench grading on side slopes of stockpiles and tailing ponds as part of earthwork closure cost estimation associated with the Little Rock Mine Closure/Closeout Plan (CCP). The unit costs need to account for the earthwork process and site-specific conditions, equipment productivity, equipment rental rates, and associated equipment maintenance, fuel costs, and labor rates.

This calculation set presents a summary of the approach and results for estimating the unit cost for bench grading. Detailed information is presented in the earthwork reclamation cost estimate (RCE) spreadsheet file.

This calculation set is intended to serve as a guide/example even if the actual quantities and/or cost data used in these calculations change due to updates or application to a different Freeport NM Operations mine.

Objective:

1. Develop a bench grading unit cost ($/ft) for stockpile side slopes and tailing pond side slopes for use in estimating earthwork closure costs at FMI's mining operations in Grant County, NM. Account for equipment and fuel costs in the estimate.

Approach:

1. The data, assumptions, calculations, and results for the bench grading unit cost estimate are presented within the Tyrone earthwork RCE spreadsheet file in a sheet (tab) named "Bench Grading_UC".
2. The approach for estimating bench grading unit costs is as follows:
   - Compile data and assumptions used in the calculations. Data obtained from the CCP or Scope of Work include:
     - Material factors
     - Grade factors
     - Soil weight
     - Production method/blade factors
     - Centroid to centroid push distance
     - Operator factor
     - Work hour
     - Visibility factor
     - Elevation factor
     - Transmission factor
     - Number of passes to finish grade
     - Speed
     - Volume

For example use only. Values may not match the current spreadsheet.

Approach:

- Equipment costs are referenced from the Equipment Sheet
- Estimate the unit cost for bench grading on sides slopes of the stockpiles and tailing ponds. The unit cost for bench grading operations is calculated based on two construction steps: excavate and final grade.
  - Productivity in cy/hr is calculated for excavation using the following equation:

$$Productivity\ (cy/hr) = Normal\ Production\ (cy/hr) * Operator * Material * \frac{Work\ Hour\ (min/hr)}{60\ (min/hr)} * Grade\ Factor * \frac{2300\ (lbs/cy)}{Material\ Weight\ (lbs/cy)} * Prod.\ Method * Visibility * Elev. * Drive\ Trans.$$

  - Productivity in hrs/ft is calculated for finish grade by using the following equation:

$$Productivity\ (hrs/ft) = \left(Operator * Material * Grade\ Factor * \frac{Work\ Hour\ (min/hr)}{60\ (min/hr)} * \frac{2300\ \left(\frac{lbs}{cy}\right)}{Material\ Weight\ \left(\frac{lbs}{cy}\right)} * Prod.\ Method * Visibility * Elev. * Drive\ Trans. * Speed\ (mi/hr) * 5280\ (ft/mi) * \frac{1}{\#\ Passes} \right)^{-1}$$

For example use only. Values may not match the current spreadsheet.

Results:

1. The results of the bench grading unit cost calculations are shown below (some of the final results may vary from what is shown). These results are used in the overall earthwork RCE.

Bench Grading Unit Cost

Bench Grading - Stockpiles					
Task Description	Equipment	Bench Equipment Cost ($/ft)	Bench Fuel Cost ($/ft)		
Excavate	Cat D11T CD	$1.43	$0.35		
Finish Grade	Cat D6T XL, SU Blade	$0.09	$0.02		
		$1.52	$0.37	**$1.89**	**Total**

Bench Grading -Tailings					
Task Description	Equipment	Bench Equipment Cost ($/ft)	Bench Fuel Cost ($/ft)		
Excavate	Cat D11T CD	$1.43	$0.35		
Finish Grade	Cat D6T XL, SU Blade	$0.09	$0.02		
		$1.52	$0.37	**$1.89**	**Total**

For example use only. Values may not match the current spreadsheet.

Bench Channel Unit Cost

Calculation Documentation

Problem Statement:

Freeport-McMoRan (FMI) utilizes bench channel unit cost information as part of earthwork closure cost estimation associated with the Little Rock Mine Closure/Closeout Plan (CCP). The unit cost for bench channel construction (including production and placement of riprap and filter material) needs to account for the earthwork process and site-specific conditions, equipment productivity, equipment rental rates, and associated equipment maintenance, fuel costs, and labor rates.

Objectives:

1. Develop a bench channel unit cost ($/ft) for use in estimating earthwork closure costs at FMI's mining operations in Grant County, NM.
2. Note that this calculation set presents the approach, data and assumptions, and calculations and results for developing the unit cost. It is intended to serve as a guide/example even if the actual quantities and/or cost data used in these calculations change due to updates or application to a different Freeport NM Operations mine.

Approach:

1. The data, assumptions, calculations, and results for the bench channel unit cost estimate are presented within the Tyrone earthwork RCE spreadsheet file in sheets (tabs) named "Bench Channel_UC" and "Riprap_Gravel_UC".
2. The approach for the calculations is as follows:
   - Estimate the unit cost for each of the five following bench channel construction steps:
     - Earthwork excavate and waste
     - Load and transfer riprap and filter
     - Haul riprap and filter
     - Place riprap and filter
     - Finish grade channel and riprap
   - Estimate the cost to produce riprap and filter where these materials are obtained.
   - Combine equipment and fuel costs for the bench channel operations and riprap and filter production for a total bench channel unit cost.

For example use only. Values may not match the current spreadsheet.

Data and Assumptions:

1. Bench channel cross-section data and earthwork quantities are defined in the reclamation design, with additional calculations presented below in Calculations and Results. Basic channel dimensions are shown in Table 1.

Table 1

BENCH CHANNELS		
Dimensions:		
Left Side Slope:	3.00	H:1V
Left Side Slope:	2.50	H:1V
Depth:	2.00	ft
Left Side Slope Length:	3.61	
Right Side Slope Length:	3.20	
Bottom Width:	5.00	ft
Left Anchor	0.00	ft
Right Anchor	0.00	ft
Perimeter:	11.81	ft
Excavation Area:	21.00	sf
Filter Area[1] (cross-sectional)	5.90	sf or cf/ft [2]
Riprap Area (cross-sectional)	11.81	sf or cf/ft

1. Bench cross width* 6" filter thickness
2. Volume (cy) =Area(sf)*Length(ft)/27

2. Equipment and fuel cost information used for bench channel unit cost calculations is developed in the Equipment sheet of the separate Earthwork RCE spreadsheet (summary) calculation set.
3. Equipment rates from Equipment Watch include overhaul labor, parts, and time, and are corrected for a 50-minute work hour.
4. Other equipment parameters used in the calculations are assigned based on previous use at other FMI New Mexico operations.
5. The work day is set at 8 hours/day, 50 minutes/hour.
6. The following assumptions/data inputs apply to riprap and filter production:
   - For riprap and filter production, the primary plant is fed directly by two 769D haul trucks, 300 to 400 yd haul.
   - 400 tons input/hr (per Rusty McCauley, equipment peak production is 900 tons/hr).
   - 30% - 60% waste depending on smallest rip rap size used. (per Rusty McCauley, consistent w/ McCain Springs waste rate of 43% - 1" minus).
   - 3650 lb/cy (Caterpillar Performance Handbook p. 27-4, consistent with 1.8 tons/cy riprap unit weight).

Data and Assumptions (continued):

7. Key assumptions/data inputs for riprap and filter production equipment and labor are shown in Table 2.

Table 2

Equipment & Labor	Rate ($/hr)	Comment
One 988H Loader with Operator (bucket = 8.3 cy)	$ 156.46	Used to load stockpiled material to 769D trucks and 777 haul trucks
Three 769D haul trucks with drivers (22 cy, 36 ton payload each)	$ 396.83	Option: Two used to directly feed primary screening plant, one used to move material from end of conveyor
One 1 Deck Portable Screening Plant w/ 5x16 screen & 48"x60' conveyor + 1 Operator	$ 63.68	Primary screening plant, grizzly used to split oversized, 6" - 12" and 6" minus (2 conveyers) One operator required in tower to run screening plant
		One operator required in tower to run screening plant
One 3 Deck Portable Screening Plant w/ 5x16 screen & 42"x60' conveyor + 1 Operator	$ 64.25	Fed with 6" minus, Produce 6" - 6", 1.5" - 3", 3/8" - 1.5", 3/8 minus One operator required in tower to run screening plant
Two Cat 980H Loaders with Operator (bucket = 7.5 cy)	$ 210.53	Used move material to conveyors or load trucks
Zero Cat 992K Loaders with Operator (bucket = 16 cy)	$ -	Unused loader option
One Cat 966H Loader with Operator (bucket = 5.5 cy)	$ 100.81	Used to move material from end of conveyors & load trucks
One Water Truck with Driver (10,000 gal)	$ 91.96	Dust suppression
One Foreman	$ 23.84	

For example use only. Values may not match the current spreadsheet.

Calculations and Results:

The unit costs for each of the five following bench channel construction steps are developed:

- Earthwork excavate and waste
- Load and transfer riprap and filter
- Haul riprap and filter
- Place riprap and filter
- Finish grade channel and riprap

1. Excavate and waste (earthwork) operations comprise the first construction step (shown in "Bench Channel_UC" sheet). The unit cost is calculated based on both operations using a Cat D11T CD, U Blade dozer. Table 3 (split into 3 segments due to many columns) shows the progression of the calculations to estimate the cost for these operations. This table is followed by the calculations (or assigned parameters) for the "Excavate" row.

Table 3

	B	C	D	E	F	G	H	I	J
5		Task Description	Equipment	Volume (cy/ft)	Productivity (cy/hr)	Material Factor[2]	Grade Factor[2]	Material Weight[2] (lb/cy)	Production Method/ Blade Factor[2]
6	Bench Channels	Excavate	Cat D11T CD, U Blade	0.78	1123	1.20	1.0	2900	1.00
7	Bench Channels	Waste	Cat D11T CD, U Blade	0.78	1001	1.20	1.0	2900	1.00

	B	C	K	L	M	N	O	P	Q
5		Task Description	Centroid to Centroid Push Distance[2] (feet)	Normal Production (cy/hr)	Operator Factor[2]	Work Hour[2] (min/hr)	Visibility Factor[2]	Elevation Factor[2]	Transmission Factor[2]
6	Bench Channels	Excavate	175	1851	0.75	50	1.00	1.00	1.00
7	Bench Channels	Waste	200	1649	0.75	50	1.00	1.00	1.00

	B	C	R	S	T	U	V	W	X	Y
5		Task Description	Productivity (hrs/ft)	Fuel Cost ($/hr)	Equipment Cost ($/hr)	Operator Cost (IV) ($/hr)	Dozer Cost ($/hr)	Bench Equipment Cost ($/ft)	Bench Fuel Cost ($/ft)	Total $/ft
6	Bench Channels	Excavate	0.0007	69.62	254.44	27.41	281.85	0.20	0.05	
7	Bench Channels	Waste	0.0008	69.62	254.44	27.41	281.85	0.22	0.05	
8								0.41	0.10	$ 0.52

The following parameters used in the calculations are based on previous use at other FMI New Mexico operations – also see Equipment sheet in the separate Earthwork RCE (summary) spreadsheet calculation set: Material Factor (Col. G), Grade Factor (Col. H), Material Weight (Col. I), Production Method/Blade Factor (Col. J), Centroid to Centroid Push Distance (Col. K), Operator Factor (Col. M), Work Hour (Col. N), Visibility Factor (Col. O), Elevation Factor (Col. P), and Transmission Factor (Col. Q).

Calculations and Results (continued):

1. Excavate and waste (earthwork) calculations (continued)

$$Volume(Col.E) = \frac{(Excav\ Area, sf\ [Bench\ channel, Table\ 1])}{(27\ cf/cy)} = \frac{21.00\ sf}{27\ cf/cy} = 0.78\ cy/ft$$

$$Productivity(Col.F) = \text{Col.}\,L\ x\ M\ x\ G\ x \left(\frac{N}{60}\right) x\ H\ x \left(\frac{2300}{I}\right) x\ J\ x\ O\ x\ P\ x\ Q =$$

$$1851\frac{cy}{hr}\ x\ 0.75\ x\ 1.20\ x \left(\frac{50\ min/hr}{60\ min}\right) x\ 1.0\ x \frac{2300\ lb/cy}{2900\ lb/cy}\ x\ 1.00\ x\ 1.00\ x\ 1.00\ x\ 1.00 =$$

1123 cy/hr

$Normal\ Production\ (Col.L){:}\ If\ Centroid\ to\ Centroid\ Push\ Distance\ is\ not\ 0,$
$then, for\ the\ equipment\ used, look\ up\ the\ production\ curve\ fit\ parameters\ C\ and\ b$
$for\ equation{:}\ C\ x\ (Average\ dozing\ distance\ [ft])^b = 162{,}758.76\ x\ (175\ ft)^{-0.86691} =$
1851 cy/hr

$$Productivity(Col.R) = \frac{\left(Volume, \frac{cy}{ft}[Col.E]\right)}{\left(Productivity, \frac{cy}{hr}[Col.F]\right)}$$ = (0.78 cy/ft)/(1123 cy/hr) =

0.00069 hr/ft (or 0.0007 hr/ft)

$Fuel\ Cost\ (Col.S), Equipment\ Cost(Col.T), and\ Operator\ (IV)\ Cost\ (Col.U)\ are\ from$
$Equipment\ cost\ calcs\ (presented\ in\ the\ Earthwork\ RCE\ spreadsheet\ calculation\ set).$

Dozer Cost (Col. V)$= \frac{\$254.44}{hr}(equipment) + \frac{\$27.41}{hr}(operator) = \frac{\$281.85}{hr}$

$Bench\ equipment\ cost\ (Col.W) =$
$\left(Dozer\ cost, \frac{\$}{hr}[Col.V]\right) x \left(Productivity, \frac{hr}{ft}[Col.R]\right)$ = ($281.85/hr) x (0.00069 hr/ft) =
$0.20/ft

Bench Fuel Cost (Col. X) =
$\left(Fuel\ cost, \frac{\$}{hr}[Col.S]\right) x \left(Productivity, \frac{hr}{ft}[Col.R]\right)$ = ($69.62/hr) x (0.00069 hr/ft) =
$0.05/ft

The total unit cost for the earthwork (excavate and waste) = $0.52/ft

Calculations and Results (continued):

2. Load riprap and filter, and transfer for placing, unit cost is calculated based on the following separate operations (see "Riprap_Gravel_UC" sheet): load riprap, load filter, transfer riprap for placing, and transfer filter for placing. A Cat 992K is used for these operations. Table 4 (split into 2 segments due to many columns) shows the progression of the calculations to estimate the cost for these operations. This table is followed by the calculations (or assigned parameters) for the "Load Riprap" row.

Table 4

	B	C	D	E	F	G	H	I	J
4	Earthwork								
5	Loading per cy								
6	Task Description	Equipment		Load, Dump, Maneuver Time (min)	Work Time (min)	Loads/ hr	Net Bucket (cy/load)	Production Rate (cy/hr)	Fuel Use Gal per Hour
7	Load riprap	Cat 992K		0.65	50	76.92	14.00	1076.92	25.63
8	Load filter	Cat 992K		0.65	50	76.92	14.00	1076.92	25.63
9	Transfer riprap for placing	Cat 992K		0.65	50	76.92	14.00	1076.92	25.63
10	Transfer filter for placing	Cat 992K		0.65	50	76.92	14.00	1076.92	25.63

	B	K	L	M	N	O	P	Q
4	Earthwork							
5	Loading per cy							
6	Task Description	Fuel Cost ($/hr)	Equipment Cost ($/hr)	Operator Cost ($/hr)	Loader+Oper Cost ($/hr)	Load+Op Cost ($/cy)	Fuel Cost ($/cy)	Total Cost ($/cy)
7	Load riprap	59.97	216.23	27.70	243.93	0.23	0.06	0.28
8	Load filter	59.97	216.23	27.70	243.93	0.23	0.06	0.28
9	Transfer riprap for placing	59.97	216.23	27.70	243.93	0.23	0.06	0.28
10	Transfer filter for placing	59.97	216.23	27.70	243.93	0.23	0.06	0.28

The following parameters used in the calculations are developed in the Equipment sheet as described for the separate Earthwork RCE (summary) spreadsheet calculation set: Load, Dump, Maneuver Time (min) (Col. E); Net Bucket (cy/load) (Col. H); Fuel Use Gal per Hour (Col. J); Fuel Cost ($/hr) (Col. K); Equipment Cost ($/hr) (Col. L); and Operator Cost ($/hr) (Col. M).

Calculations and Results (continued):

2. Load/transfer riprap and filter (continued)

Work Time (Col. F) = 50 min per hour

Loads/hr (Col. G) = (Col. F)/(Col. E) = 50/0.65 = 76.92 loads/hr

Production Rate (cy/hr) (Col. I) = (Col. H) x (Col. G) = 14.00 x 76.92 = 1076.92 cy/hr

Loader + Operator Cost/hr (Col. N) = Equipment Cost (Col. L) + Operator Cost (Col. M) = $216.23/hr + $27.70/hr = $243.93/hr

Loader + Operator Cost/cy (Col. O) = [Loader Cost, $/hr (Col. N)]/[Production Rate, cy/hr (Col. I)] = ($243.93/hr)/(1076.92 cy/hr) = $0.23/cy

Fuel Cost/cy (Col. P) = [Fuel Cost/hr (Col. K)]/[Production Rate, cy/hr (Col. I)] = ($59.97/hr)/(1076.92 cy/hr) = $0.06/cy

The total unit cost for the loading and transferring (for placing) riprap and filter = total for equipment + total for fuel = $0.23/ft + $0.06/ft = $0.28/ft (difference due to rounding)

Calculations and Results (continued):

3. <u>Haul riprap and filter</u> unit cost is calculated based on the following separate operations (see "Riprap_Gravel_UC" sheet): haul riprap and haul filter. A Komatsu 730E is used for these operations. Table 5 (split into 3 segments due to many columns) shows the progression of the calculations to estimate the cost for these operations. This table is followed by the calculations (or assigned parameters) for the "Haul Riprap" row.

Table 5

	B	C	D	E	F	G	H	I	J
12									
13	Hauling								
14	Task Description	Equipment		Exchange Time (min)	Delivery Travel Time[1] (min)	Unload and Maneuver Time (min)	Return Travel Time[1] (min)	Load Time (min)	Total Time (min)
15	Haul riprap from source to site	Komatsu 730E		0.70	8.62	1.10	3.47	6.73	20.62
16	Haul filter from source to site	Komatsu 730E		0.70	8.62	1.10	3.47	6.73	20.62

	B	K	L	M	N	O	P
12							
13	Hauling						
14	Task Description	Work Time (min)	Loads/ hr	Heaped Capacity (cy/load)	Production Rate (cy/hr)	Fuel Use Gal per Hour	Fuel Cost ($/hr)
15	Haul riprap from source to site	50	2.42	145	352	33.48	78.34
16	Haul filter from source to site	50	2.42	145	352	33.48	78.34

	B	Q	R	S	T	U	V
12							
13	Hauling						
14	Task Description	Equipment Cost ($/hr)	Operator Cost ($/hr)	Truck+Op Cost ($/hr)	Truck + Op Cost ($/cy)	Fuel Cost ($/cy)	Total Cost ($/cy)
15	Haul riprap from source to site	221.79	24.27	246.06	0.70	0.22	0.92
16	Haul filter from source to site	221.79	24.27	246.06	0.70	0.22	0.92

The following parameters used in the calculations are developed in the Equipment sheet as described for the separate Earthwork RCE (summary) spreadsheet calculation set: Exchange Time (min) (Col. E); Unload and Maneuver Time (min) (Col. G); Heaped Capacity (cy/load) (Col. M); Fuel Use Gal per Hour (Col. O); Fuel Cost ($/hr) (Col. P); Equipment Cost ($/hr) (Col. Q); and Operator Cost ($/hr) (Col. R).

Delivery Travel Time (Col. F) and Return Travel Time (Col. H) are based on site-wide average borrow haul time.

Calculations and Results (continued):

3. Haul riprap and filter (continued)

Load Time (Col. I)
= Dump, Maneuver Time (Col. E in load/transfer riprap)
x [Heaped Capacity, cy/load (Col. M)]/[Net Bucket, cy/load (Col. H in load/transfer riprap)]
= 0.65 min x (145 cy/load)/(14.00 cy/load) = 6.73 min

Total Time (Col. J) = Exchange Time (Col. E) + Delivery Travel Time (Col. F) + Unload and Maneuver Time (Col. G) + Return Travel Time (Col. H) + Load Time (Col. I)
= 0.70 + 8.62 + 1.10 + 3.47 + 6.73 = 20.62 min

Work Time (Col. K) = 50 min per hour

Loads/hr (Col. L) = [Work Time (Col. K)]/[Total Time (Col. J)] = 50/20.62 = 2.42 loads/hr

Production Rate, cy/hr (Col. N) = [Heaped Capacity, cy/load (Col. M)] x [Loads/hr (Col. L)]
= (145 cy/load) x (2.42 loads/hr) = 352 cy/hr

Truck + Operator Cost/hr (Col. S) = Equipment Cost (Col. Q) + Operator Cost (Col. R)
= $221.79/hr + $24.27/hr = $246.06/hr

Truck + Operator Cost/cy (Col. T) = [Truck + Operator Cost, $/hr (Col. S)]/[Production Rate, cy/hr (Col. N)] = ($246.06/hr)/(352 cy/hr) = $0.70/cy

Fuel Cost/cy (Col. U) = [Fuel Cost/hr (Col. P)]/[Production Rate, cy/hr (Col. N)]
= ($78.34/hr)/(352 cy/hr) = $0.22/cy

The total unit cost for the hauling riprap and filter = total for equipment + total for fuel = $0.70/ft + $0.22/ft = $0.92/ft

Calculations and Results (continued):

4. Place riprap and filter unit cost is calculated based on the following separate operations (see "Riprap_Gravel_UC" sheet): place riprap and place filter. A Cat 725 is used for these operations. The sequence of calculations for the place riprap and filter unit cost is the same as for haul riprap and filter (from source to site) calculations, above. Inputs to the calculations for placing riprap and filter are generally the same except that Cat 725 operating parameters and costs are used. Delivery and return travel times are calculated based on the haul distance and the Haul Travel Time polynomial equation (see Equipment sheet) that calculates minutes/meter based on effective grade.

Table 6 (split into 3 segments due to many columns) shows the progression of the calculations to estimate the cost for these operations.

Table 6

	B	C	D	E	F	G	H	I
19	Placing							
20	Task Description	Equipment	Distance	Grade	Exchange Time (min)	Delivery Travel Time (min)	Unload and Maneuver Time (min)	Return Travel Time (min)
21	Place riprap	Cat 725	400.00	-30%	0.70	3.25	1.10	0.74
22	Place filter	Cat 725	400.00	-30%	0.70	3.25	1.10	0.74

	B	J	K	L	M	N	O	P
19	Placing							
20	Task Description	Load Time (min)	Total Time (min)	Work Time (min)	Loads/ hr	Heaped Capacity (cy/load)	Production Rate (cy/hr)	Fuel Use Gal per Hour
21	Place riprap	0.87	6.67	50	7.50	19	141.01	6.02
22	Place filter	0.87	6.67	50	7.50	19	141.01	6.02

	B	Q	R	S	T	U	V	W
19	Placing							
20	Task Description	Fuel Cost ($/hr)	Equipment Cost ($/hr)	Operator Cost ($/hr)	Truck + Op Cost ($/hr)	Truck+Op Cost ($/cy)	Fuel Cost ($/cy)	Total Cost ($/cy)
21	Place riprap	14.09	73.11	24.27	97.38	0.69	0.10	0.79
22	Place filter	14.09	73.11	24.27	97.38	0.69	0.10	0.79
23								

Calculations and Results (continued):

5. Finish grade unit cost is calculated based on the following separate operations (see "Riprap_Gravel_UC" sheet): finish grade channel and finish grade riprap. A Cat D6T, SU Blade is used for these operations. The sequence of calculations for the finish grade unit cost is the same as for the first operation for bench channel construction – earthwork (excavate and waste) (see those calculations, above, for details). Inputs to the finish grade channel and finish grade riprap calculations are generally the same with the following exceptions:
   - Cat D6T, SU Blade operating parameters and costs are used.
   - Material Factor (Col. E) and Material Weight (Col. G) for riprap are used, which are different than for the excavate and waste, and channel grading, materials.

   Table 7 (split into 3 segments due to many columns) shows the progression of the calculations to estimate the cost for these operations.

   Table 7

	B	C	D	E	F	G	H	I
24								
25	Grading							
26	Task Description	Equipment	Productivity (cy/hr)	Material Factor	Grade Factor	Soil Weight (lb/cy)	Production Method/Blade Factor	Centroid to Centroid Push Distance (ft)
27	Finish grade -filter	Cat D6T, SU Blade	304.38	1.0	1.02	3500	1.0	50
28	Finish grade - Riprap	Cat D6T, SU Blade	230.34	0.8	1.02	3700	1.0	50

	B	J	K	L	M	N	O
24							
25	Grading						
26	Task Description	Normal Production (cy/hr)	Operator Factor	Work Time (min)	Visibility Factor[2]	Elevation Factor	Transmission Factor
27	Finish grade -filter	727	1	50	1	1.00	1.00
28	Finish grade - Riprap	727	1	50	1	1.00	1.00

	B	P	Q	R	S	T	U	V
24								
25	Grading							
26	Task Description	Fuel Cost ($/hr)	Equipment Cost ($/hr)	Operator Cost (IV) ($/hr)	Dozer + Op Cost ($/hr)	Dozer + Op Cost ($/cy)	Fuel Cost ($/cy)	Total Cost ($/cy)
27	Finish grade -filter	16.8948	63.65	27.41	91.06	0.30	0.06	0.35
28	Finish grade - Riprap	16.8948	63.65	27.41	91.06	0.40	0.07	0.47

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Job No: 200540A | Client: Freeport NM Operations |

Task: Bench Channel Unit Cost (including riprap/filter material) | Computed By: Fred Charles | Date: 4/29/2019

Checked By: Taryn Tigges | Date: 4/30/2019

Calculations and Results (continued):

6. Riprap and filter production costs (where the material source is located) are estimated according to Table 8, with a summary of the calculations provided after Table 8.

Table 8

	B	C	D	E	F	G	H	I
36	Equipment	Equipment Cost	Fuel Cost	# Equipment	Operator	# Operator	Total Equipment Cost	Total Fuel Cost
37		($/hr)	($/hr)		($/hr)		($/hr)	($/hr)
38	Cat 988H	$ 128.76	$ 35.57	1	$ 27.70	1	$ 156.46	$ 35.57
39	Cat 769D	$ 108.01	$ 22.79	3	$ 24.27	3	$ 396.83	$ 68.37
40	1 Deck Screening Plant (5X16, 48X60)	$ 40.59	$ 11.35	1	$ 23.09	1	$ 63.68	$ 11.35
41	3 Deck Screening Plant (5X16, 42X60)	$ 41.16	$ 11.35	1	$ 23.09	1	$ 64.25	$ 11.35
42	Cat 980H	$ 77.56	$ 25.27	2	$ 27.70	2	$ 210.53	$ 50.54
43	Cat 992K	$ 216.23	$ 59.97	0	$ 27.70	0	$ -	$ -
44	Cat 966H	$ 73.11	$ 19.61	1	$ 27.70	1	$ 100.81	$ 19.61
45	Off-Hwy Water Tanker Truck,6,000-gal.	$ 67.69	$ 26.33	1	$ 24.27	1	$ 91.96	$ 26.33
46	Supervisor	$ -	-	0	$ 23.84	1	$ 23.84	$ -
47								
48					Direct Cost	Equipment	Fuel	
49						$ 1,108	$ 223	$/hr
50						8	8	hr/work day
51						$ 8,867	$ 1,785	$/day
52								
53					Production			
54						400	tons input/hr (total)	
55						0.30	% waste	
56						0.70	% rip rap and gravel/filter	
57						280	tons produced/hr (net)	
58						560,000	lb/hr	
59						3,650	lb/cy	
60						153	cy/hr	
61						8	hr/day (net (60 min/hr))	
62						1,227	cy/day net production	
63								
64					Production	$ 7.22	$ 1.45	$/cy
65					Filter Delivery and placement	$ 2.14	$ 0.49	$/cy
66					Rip Rap Delivery and placement	$ 2.24	$ 0.51	$/cy
67								

For example use only. Values may not match the current spreadsheet.

Calculations and Results (continued):

6. Riprap and filter production calculations (continued):

For each type of equipment used, the costs calculated (see Earthwork RCE spreadsheet calculation set) are tabulated in Table 8, including Equipment Cost (Col. C), Fuel Cost (Col. D), and Operator Cost (Col. F).

The number of pieces of equipment (Col. E) and number of operators (Col. G) are assigned based on the logistical requirements for production. Pieces of equipment match the number of operators, except for addition of a Supervisor.

Total equipment cost (Col. H) is calculated as follows, with an example calculation shown for the Cat 988H:

$$Total\ Equipment\ Cost, \$/hr = \{(Equip\ Cost\ [Col.C])\ x\ (\#\ Equipment\ [Col.E])\} + \{(Operator\ Cost\ [Col.F])\ x\ (\#\ Operator\ [Col.G])\} = \{(\$128.76)x(1)\} + \{(\$27.70)x(1)\} = \$156.46/hr$$

Total fuel cost (Col. I) is calculated as follows, with an example calculation shown for the Cat 988H:

$$Total\ Fuel\ Cost, \$/hr = \{(Fuel\ Cost\ [Col.D])\ x\ (\#\ Equipment\ [Col.E])\} = \{(\$35.57)x(1)\} = \$35.57/hr$$

The daily cost is calculated for all equipment by summing the total equipment cost (Cell G56) and total fuel cost (Cell H56), as follows:

$$Daily\ Total\ Equipment\ Cost, \frac{\$}{day} = \left(Sum\ for\ all\ equipment, \frac{\$}{hr}\right) x \left(8\frac{hr}{day}\right) = \left(\frac{\$1,108}{hr}\right) x \left(8\frac{hr}{day}\right) = \frac{\$8,867}{day}$$

$$Daily\ Total\ Fuel\ Cost, \frac{\$}{day} = \left(Sum\ for\ all\ fuel, \frac{\$}{hr}\right) x \left(8\frac{hr}{day}\right) = \left(\frac{\$223}{hr}\right) x \left(8\frac{hr}{day}\right) = \frac{\$1,785}{day}$$

For example use only. Values may not match the current spreadsheet.

Calculations and Results (continued):

6. Riprap and filter production calculations (continued):

Next, the production calculations are summarized (see Rows 54-62 in Table 8). Daily net production is calculated via the following sequence:

- 400 tons input/hr (total) – see production assumptions
- 30% waste – see production assumptions
- 70 % riprap and gravel/filter = 100 minus % waste
- 280 tons produced/hr (net) = (400 tons input/hr) x (70%)
- 560,000 lb/hr = (280 tons) x (2,000 lb/ton)
- 3,650 lb/cy – see production assumptions
- 153 cy/hr = (560,000 lb/hr)/(3,650 lb/cy)
- 8 hr/day (net [60 min/hr]) – see production assumptions
- 1,227 cy/day net production = (153 cy/hr) x (8 hr/day)

The total cost for production (see Row 64 in Table 8) is calculated separately for equipment and fuel as follows:

- Equipment portion of the cost = ($8,867/day)/(1,227 cy/day) = $7.22/cy
- Fuel portion of the cost = ($1,785/day)/(1,227 cy/day) = $1.45/cy
- This yields a total cost of $8.67/cy

Summary and Conclusions:

These calculations achieve the objective to develop an estimated bench channel unit cost for the earthwork RCE, as summarized below for production of filter and riprap, and delivery and placement of filter and riprap.

The cost for production of filter and riprap $7.22/cy (equipment + operator) + $1.45/cy (fuel) = $8.68/cy (difference due to rounding).

The cost for filter delivery and placement is the sum of the calculations presented above, for loading, hauling, placing, and final grading, for a total of $2.14/cy (equipment + operator) + $0.49/cy (fuel) = $2.63/cy

Similarly, the cost for riprap delivery and placement is the sum of the calculations above, for a total of $2.24/cy (equipment + operator) + $0.51/cy (fuel) = $2.75/cy

The total cost ($/ft) for bench channel construction, including the initial earthwork (excavate and waste) along with riprap placed at 0.44 cy/ft and filter placed at 0.22 cy/ft, for combined equipment/operator and fuel costs, is:

$0.52/ft (excavate and waste) + $2.47/ft (filter) + $5.00/ft (riprap) = $7.99/ft

Downdrain/ Dissipater Unit Cost

Calculation Documentation

Problem Statement:

Freeport-McMoRan (FMI) utilizes downdrain/dissipater unit cost information as part of earthwork closure cost estimation associated with the Little Rock Mine Closure/Closeout Plan (CCP). Downdrains are constructed on regraded side slopes of rock stockpiles to convey runoff. Dissipaters are constructed as needed at the bottom end (downslope) of specific downdrains to dissipate the energy of the downdrain runoff flow. The unit cost needs to account for excavation/preparation of the subgrade, material and placement costs to install articulated concrete blocks (ACBs) in the downdrains and dissipaters, and installation of a concrete cutoff wall at the downslope end of each dissipater.

Objective:

1. Develop unit costs for downdrains ($/ft) and dissipaters ($/each) for use in estimating earthwork closure costs at FMI's mining operations in Grant County, NM.
2. Note that this calculation set presents the approach, data and assumptions, and calculations and results for developing the unit cost. It is intended to serve as a guide/example even if the actual quantities and/or cost data used in these calculations change due to updates or application to a different Freeport NM Operations mine.

Approach:

1. The data, assumptions, calculations, and results for the downdrain/dissipater unit cost estimate are presented within the Tyrone earthwork RCE spreadsheet file.
2. The approach for the calculations is as follows:
   - Identify locations and lengths required for downdrains. Use reclamation design drawings and quantities.
   - Identify excavation equipment and estimate cost to complete the rough grade where the downdrains and dissipaters will be constructed. Use equipment cost information and calculations as also developed for other earthwork operations in the overall earthwork cost estimate.
   - Estimate cost to finish grade and place ACBs in downdrains and dissipaters. Use available unit costs from Contech Engineered Solutions (Contech ES), the manufacturer and installer of ACBs in the area.
   - Estimate cost to install cast-in-place concrete cutoff wall at downslope end of dissipaters. Use online RS Means data.

For example use only. Values may not match the current spreadsheet.

Data and Assumptions (continued):

1. Attachment A presents the following key quantity data used to develop unit costs (note that Attachment A also includes the calculations and results presented in this calculation set):
   - Downdrain base excavation area = 52 square feet/foot of length (sf/ft)
   - Downdrain ACB area coverage = 31 sf/ft
   - Dissipater area (middle [Area 2]) = 320 sf
   - Dissipater area (each side [Area 1 = Area 3]) = 253 sf
   - Cutoff wall concrete volume (each dissipater) = 14 cubic yards
2. Unit cost data from Contech ES (February 2019, see Attachment A) include the following:
   - Material costs for ACBs (includes non-woven geotextile and microgrid/geogrid) are as follows:
     - $7.42/sf (Block Class 40T, for the channel of each downdrain and both side areas of each dissipater)
     - $10.65/sf (Block Class 70T, for the center area of each dissipater)
   - Installation cost is $4.63/sf, which covers the following installation process for both sizes of ACBs: off-load the truck and place delivered ACBs in temporary storage area, fine grade base/subgrade soils, compact soils to 90% Standard Proctor (D698), place and secure filter fabric (non-woven geotextile), place 4- to 6-inch drainage layer overlaid by geogrid, place ACBs in final configuration, grout seams, and backfill ACBs with crushed stone. The installation cost includes crushed stone.
3. Cost data from RS Means for installation of a concrete cutoff wall at the downslope end of each dissipater are presented in Attachment A. The online RS Means cost is $254.97/cubic yard.

Calculations and Results:

1. The estimated cost to excavate the rough grade (where the downdrains will be constructed) is developed in the same manner as excavation costs prepared for bench channel unit costs. Therefore, see the bench channel unit cost calculation set for details. The downdrain rough grade cost = $0.83/ft.
2. The estimated cost to install ACBs in downdrains includes the finish grade and subsequent placement of ACBs. This estimated cost is developed from the Contech ES quotes (as listed above in Data and Assumptions), as follows:
   - Downdrain material cost for 40T ACBs is $7.42/sf
   - Downdrain installation cost for 40T ACBs is $4.63/sf
   - The cost per ft of downdrain ($/ft) = ($7.42/sf + $4.63/sf) x (31 sf/ft) = $12.05/sf x 31 sf/ft = $373.55/ft

$$\boldsymbol{Total\ downdrain\ installation\ cost\ (after\ rough\ grading) = \$373.55/ft}$$

1

For example use only. Values may not match the current spreadsheet.

Calculations and Results (continued):

3. Similarly, the estimated cost to install ACBs in dissipaters includes the finish grade and subsequent placement of ACBs. This estimated cost is developed from the Contech ES quotes (as listed above in Data and Assumptions), as follows:

   - Dissipater material cost for 40T ACBs is $7.42/sf
   - Dissipater material cost for 70T ACBs is $10.65/sf
   - Dissipater installation cost for 40T and 70T ACBs is $4.63/sf
   - For each dissipater, 40T ACBs cover 506 sf and 70T ACBs cover 320 sf
   - The cost for the 40T part of each downdrain ($/each) =
     ($7.42/sf + $4.63/sf) x (506 sf) = $12.05/sf x 506 sf = $6,097.30/each
   - The cost for the 70T part of each downdrain ($/each) =
     ($10.65/sf + $4.63/sf) x (320 sf) = $15.28/sf x 320 sf = $4,889.60/each
   - The total cost for ACBs in each dissipater = $6,097.30 + $4,889.60 = $10,986.90

4. The estimated cost for installing a cast-in-place concrete cutoff wall at the downslope end of each dissipater is based on on-line cost data from RS Means and the required concrete volume:

   - Cast-in-place concrete cutoff wall (RS Means) cost = $254.97/cubic yard
   - Each dissipater requires cutoff wall concrete volume of 14 cubic yard
   - The total cost for cutoff wall installation at each dissipater =
     ($254.97/cubic yard) x (14 cubic yard) = $3,569.58

$$\boldsymbol{Total\ dissipater\ installation\ cost\ (after\ rough\ grading) =}$$

$10,986.90 + $3,569.58 = $14,556.48

Summary and Conclusions:

1. Unit costs for installing downdrains ($/ft) and dissipaters ($/each) were developed for use in estimating earthwork closure costs at FMI's mining operations in Grant County, NM. Note that the estimated unit cost developed in this analysis applies only to FMI operations in the Silver City (Grant County), NM area.
2. Downdrain cost = $0.83/ft (rough grading) + $373.55/ft (after rough grading) = **$374.38/ft**
3. Dissipater cost **=** $10,986.90/each (rough grading is included in downdrain cost) + $3,569.58/each (cutoff wall) = **$14,556.48/each**

Downdrain Unit Cost

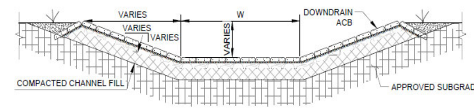
Rough Grade

Task Description	Equipment	Productivity (cy/hr)	Material Factor	Grade Factor	Soil Weight (lb/cy)	Production Method/Blade Factor	Centroid to Centroid Push Distance (ft)	Normal Production (cy/hr)	Operator Factor	Work Hour (min/hr)	Visibility Factor	Elevation Factor	Transmission Factor	Volume (cy/ft)	Productivity (hrs/ft)	Fuel Cost ($/hr)	Equipment Cost ($/hr)	Operator Cost (IV) ($/hr)	Dozer Cost ($/hr)	Equipment w/o Fuel Cost ($/ft)	Fuel Cost ($/ft)	Total Excavation Cost ($/ft)
Excavate	Cat D11T CD	1731	1.2	1.6	2900	1.0	175	1851	0.75	50	1.0	1.0	1.0	1.9	0.0011	$69.62	$254.44	$27.41	$281.85	$0.31	$0.08	$0.39
Waste	Cat D11T CD	1542	1.2	1.6	2900	1.0	200	1649	0.75	50	1.0	1.0	1.0	1.9	0.0012	$69.62	$254.44	$27.41	$281.85	$0.35	$0.09	$0.44
								.												$0.67	$0.16	$0.83

Finish Grade & Place ACB

	Area (sf/ft)	Unit Cost ($/sf)	$/ft
Downdrain ACBs			
40T[1]	31	$7.42	$230.02
Installation[1]	31	$4.63	$143.53
		ACB Cost/ft	**$373.55**

Total Downdrain Cost ($/ft)	**$374.38**



N.T.S. AU 022A TYPICAL DOWNDRAIN SECTION

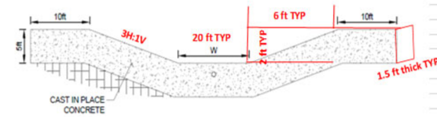
Place ACB

Dissipater ACBs	Area (sf)	Unit Cost ($/sf)	$/sf
70T[1]	320	$10.65	$3,408.00
Installation[1]	320	$4.63	$1,481.60
40T[1]	506	$7.42	$3,754.52
Installation[1]	506	$4.63	$2,342.78
		ACB Cost per Dissipater	**$10,986.90**

Install Cutoff Wall

Cutoff Wall (cast in place concrete)	cubic yard	$/cubic yard	$/dissipater[2]
RSMeans (2019)	14	$ 254.97	**$3,569.58**

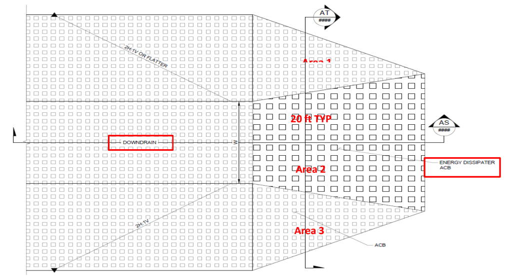
Total Dissipator Cost ($/each)	**$14,556.48**



N.T.S. AX 022A TYPICAL CUTTOFF WALL SECTION

DOWNDRAIN Dimensions:		
Left Side Slope:	3	H:1V
Left Side Slope:	3	H:1V
Depth:	2	ft
Perimeter:	31	ft
Excavation Area:	52	sf
ACB Area:	31	sf

DISSIPATERS	ACB				Cutoff Wall[3]		
	Surface Area 1	Surface Area 2	Surface Area 3	Total	Cross-Sectional Area	Thickness	Volume
	(sf)	(sf)	(sf)	(sf)	(sf)	(ft)	(cy)
	253	320	253	825	260	1.5	14



N.T.S. 8 022A TYPICAL TOE ENERGY DISSIPATOR PLAN DETAIL

1. Quote from Contech ES 2018; Downdrain ACB installation includes fine grade base/subgrade soils (assuming subgrade at + 0.5 ft); equipment is D6 LGP dozer with Power Angle Tilt Blade (PAT) and GPS Blade Control
2. One cutoff wall per dissipator
3. Typical flow depth is 2'; concrete depth is 5' (diagram is not drawn to scale); concrete thickness is 1.5'

Fred Charles

From: Fawcett, Clayton <CFawcett@conteches.com>
Sent: Tuesday, February 5, 2019 9:25 AM
To: Fred Charles
Subject: RE: confirm or update costs for ACBs (reply requested by end of day Monday Feb 4, if possible)

Fred,

Hello and good morning. I hope this message finds you doing well. I made it back in to the office this morning and saw your e-mails.

Material and installation costs we discussed in September are still good. Please feel free to use those to complete your estimate.

Regarding your questions:

1. Yes, installation costs are the same for both downchutes and dissipator basins.
2. Yes, installation cost does include crushed stone infill (purchase and install)

Regarding your follow up e-mail with questions pertaining to cut-off walls.

1. Cut-off walls are not always required, however they are a good idea. The use of cut-off walls has increased in the last five years and as such, they are now recommended for inclusion at dissipator basins.
2. Material and installation costs for the installation of a cut-off wall are not included in the costs previously discussed and should be added.

I hope this information helps. Feel free to contact me directly with any additional questions.

Regards,

Clayton Fawcett PE (co)
Armortec Area Manager - West

CONTECH Engineered Solutions
970-290-2971 (cell)
cfawcett@conteches.com

From: Fred Charles [mailto:fcharles@telesto-inc.com]
Sent: Sunday, February 3, 2019 3:28 PM
To: Fawcett, Clayton <CFawcett@conteches.com>
Subject: confirm or update costs for ACBs (reply requested by end of day Monday Feb 4, if possible)

Hi Clayton. This email is a follow up to our email correspondence in September 2018 regarding material and installation costs for articulated concrete blocks (ACBs) used for downdrains at Chino. We've been using the cost info you passed along to me at that time. Now, I need you to confirm those costs or update them. We will use this information in a reclamation cost estimate (financial assurance for closure bonding) which we are currently finalizing for Chino and other mines in that area.

Costs

As we had discussed, the material costs for ACBs (includes non-woven geotextile and microgrid/geogrid) are as follows:

- $7.42/square foot (Block Class 40T, for the channel of each downdrain)

- $10.65/square foot (Block Class 70T, for the dissipation basin at bottom of each downdrain)

Also, you quoted $4.63/square foot for installation costs, which covers the following installation process: off-load the truck and place delivered ACBs in temporary storage area, fine grade base/subgrade soils, compact soils to 90% Standard Proctor (D698), place and secure filter fabric (non-woven geotextile), place 4-6" drainage layer overlaid by geogrid, place ACBs in final configuration, grout seams, and backfill ACBs with crushed stone.

2 questions
In addition to you confirming or updating the material and installation costs, I have two questions: (1) Is the installation cost ($4.63/square foot) the same for both channel downdrains and dissipation basins? (2) Does the installation or material cost include the crushed stone used to backfill the ACBs?

Please create a new email to me with updated unit costs or reply to this email to confirm what I show is still correct. I will present what you provide for documentation in the cost estimate we submit to the state agencies.

Thanks,

Fred Charles, Ph.D., P.E. Senior Engineer
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Truck and Scraper Optimization

Calculation Documentation

Problem Statement:
Freeport-McMoRan's (FMI's) Chino Mines Company utilizes truck optimization information to develop the most efficient proportions of equipment as part of earthwork closure cost estimation associated with the Little Rock Mine Closure/Closeout Plan (CCP). Optimization needs to account for the time required and associated costs for truck loading and hauling operations.

Objectives:

1. Develop optimization calculations to determine the most efficient number of trucks (2 to 9 and a calculated maximum) per loader or shovel for loading cover material at borrow stockpiles.
2. Note that this calculation set presents the approach and calculations and results for optimizing equipment for earthwork. It is intended to serve as a guide/example even if the actual quantities and/or cost data used in these calculations change due to updates or application to a different Freeport NM Operations mine.

Approach:

1. The data, calculations, and results for the optimization calculations are presented within the Tyrone earthwork RCE spreadsheet file in sheet (tab) named "18 Truck Optimization".
2. Truck optimization is calculated for each cover material source and destination based on
   - The truck cycle time for 1 roundtrip between a cover material source and destination and the maximum number of trucks per loader/shovel.
   - For X number of trucks (2 to 9 and a calculated maximum), the productivity, task time, cost of using X trucks per loader, the optimum number of trucks per loader/shovel, and the maximum number of trucks per loader/shovel.

For example use only. Values may not match the current spreadsheet.

Calculations and Results:

1. The truck optimization calculations are set up as shown in Table 1, which is a snapshot of a row of data/calculations in the “18 Truck Optimization” sheet. Table 1 is shown in 6 parts due to the many columns in the spreadsheet. Key calculation steps are listed after Table 1, with referencing to the Column identifier in Table 1 (and the spreadsheet).

Table 1

	E	F	G	H	I	J	K	L
13								
14	ID	Task Description	Source Location 1	Destination Location 2	Equipment	Work Hour (min/hr)	Loader/Shovel Cycles per Truck	Loader/Shovel Cycle Time (min)
299	1200-D-b-Tk4	Haul-Cover	Upper South	West Stockpile	Komatsu 730E	50	5	0.45

	M	N	O	P	Q	R	S	T	U
13									
14	Loader/Shovel Time Per Truck (min)	Truck Cycle Time Per Truck (min)	Trucks Per Loader/ Shovel	Loader/ Shovel Type	Loader/ Shovel Cost ($/hr)	Loader Net Bucket Capacity (cy)	Haul Volume (cy)	Max Trucks Round Up	Max Trucks Round Down
299	2.25	22.7	10.1	Sh1	$ 535.68	27.4	3,031,924	3,317	3,016

	V	W	X	Y	Z	AA	AB	AC
13	Productivity for X Trucks (cy/hr)							
14	9	8	7	6	5	4	3	2
299	2,714	2,412	2,111	1,809	1,508	1,206	905	603

	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM
13	Task Time for X Trucks (hr)									
14	Max Trucks Round Up	Max Trucks Round Down	9	8	7	6	5	4	3	2
299	914.0	1,005.4	1,117.2	1,256.8	1,436.4	1,675.7	2,010.9	2,513.6	3,351.5	5,027.2

	AN	AO	AP	AQ	AR	AS	AT	AU
13							Cost of Using X Trucks per Loader ($	
14	Loader/ Shovel Task Time (hr)	Truck Cost ($/hr)	Max Trucks Round Up	Max Trucks Round Down	9	8	7	6
299	995.9	$ 246.06	$ 3,229,021	$ 3,012,613	$ 3,072,458	$ 3,147,264	$ 3,243,442	$ 3,371,681

	AV	AW	AX	AY	AZ	BA	BB
13	$)						
14	5	4	3	2	Lowest Cost ($)	Optimum Number of Trucks Per Loader/ Shovel	Optimum Number of Trucks Per Loader/ Shovel Within Max
299	$ 3,551,215	$ 3,820,515	$ 4,269,350	$ 5,167,019	$ 3,012,613	10	10

For example use only. Values may not match the current spreadsheet.

Calculations and Results:

1. Truck optimization (continued)

- Calculate the number of loader/shovel (or referred to as loader) cycles to load a truck and the loading time required per truck (Columns K, L, and M) – this calculation uses data from the "9 Trucks" and "10 Shovel" sheets.

Loader Time Per Truck (Col. M) =
[Loader Cycles per Truck (Col. K)] x [Loader Cycle Time, min (Col. L)]
= (5 cycles/truck) x (0.45 min/cycle) = 2.25 min/truck

- Using the truck cycle time for 1 roundtrip between a cover material source and destination (data from the "9 Trucks" sheet), calculate the maximum number of trucks per loader/shovel.

Max Number Trucks Per Loader (Col. O) = [Truck Cycle Time, min (Col. N)]/[Loader Time, min/truck (Col. M)]
= (22.7 min)/(2.25 loader min/truck) = 10.1 trucks/loader

- Calculate the productivity (cy/hr) for X number of trucks (2 to 9 and a calculated maximum).

For X=6 trucks, Productivity, cy/hr (Col. Y) =
(X) x Work Hour, min/hr (Col. J) x Loader Cycles/Truck (Col. K) x [Loader Net Bucket Capacity, cy (Col. R)]/[Truck Cycle Time Per Truck, min (Col. N)]
= [6 x (50 min/hr) x (5 loader cycles/truck) x (27.4 cy/loader cycle)]/(22.7 min/truck cycle) = 1,809 cy/hr

- Using the productivity and total volume of cover material to be hauled, calculate the task time for X trucks (2 to 9).

For X=6 trucks, Task Time, hr (Col. AI) =
[Haul Volume, cy (Col. S)]/[Productivity, cy/hr (Col. Y)]
= (3,031,924 cy)/(1,809 cy/hr) = 1,676 hr

For example use only. Values may not match the current spreadsheet.

Calculations and Results (continued):

1. Truck optimization (continued):

- Calculate the cost of using X trucks per loader (2 to 9 and a calculated maximum) using data for loader/shovel task time in "9 Trucks" (for each cover material source and destination), loader/shovel cost ($/hr), truck cost ($/hr), and task time for the number of trucks.

For X=6 trucks, Cost of Using X Trucks per Loader, $ (Col. AU) =
[Max of Task Time for Trucks (Col AI) or Loader/Shovel Task Time (Col. AN)] x
{(Loader Cost, $/hr (Col. Q) + [(X) x (Truck Cost, $/hr (Col. AO)]}
= (1,675.7 hr) x {($535.68/hr + [6 x $246.06/hr]} = $3,371,681

- The optimum number of trucks per loader is the lowest cost number of trucks per loader/shovel. This optimum number is compared with the maximum number of trucks per loader/shovel, to ensure the optimum number is within the maximum.

For this row of data, the optimum number of trucks per loader = 10, which is the same within the max.

Building Demolition Cost

Calculation Documentation

Problem Statement:
Freeport-McMoRan (FMI) utilizes cost information for demolition of buildings (including storage tanks) as part of earthwork closure cost estimation associated with the Little Rock Mine Closure/Closeout Plan (CCP). The demolition costs need to account for site-specific conditions including building dimensions and footprint areas which are used with available construction/earthwork unit rates to estimate the demolition cost.

This calculation set presents a summary of the approach and results for estimating the building demolition cost. Detailed information is presented in the Tyrone earthwork reclamation cost estimate (RCE) spreadsheet file.

This calculation set is intended to serve as a guide/example even if the actual quantities and/or cost data used in these calculations change due to updates or application to a different Freeport NM Operations mine.

Objective:

1. Develop a cost estimate for demolition of buildings (including storage tanks) for use in estimating earthwork closure costs at FMI's mining operations in Grant County, NM.

Approach:

1. The data, assumptions, calculations, and results for the building demolition cost estimate are presented within the Tyrone earthwork RCE spreadsheet file in a series of sheets (tabs) that address building demolition, cover placement, revegetation, and removal/disposal of building waste materials requiring special handling. An additional tab presents a summary of the costs.
2. The approach for estimating building demolition costs is as follows:
   - Compile building and storage tank dimension/footprint area data and assumptions used in the calculations.
   - Estimate the cost for demolition to account for volume of structural materials, volume of cover material placement, area of revegetation, and tonnage of waste requiring special handling.

For example use only. Values may not match the current spreadsheet.

Results:

1. The results of the building demolition cost calculations are summarized below (some of the final results may vary from what is shown). These results are used in the overall earthwork RCE.
2. The indirect costs are set at 30% of direct costs, based on an agreement between FMI and the agencies in January 2019. Indirect costs include but are not limited to mobilization and demobilization, contingencies, engineering redesign fees, contractor profit and overhead, project management, administrative expenses, etc.

DRAFT Facility Demolition Summary

			Current Value
DIRECT COSTS	Facility and Structure Removal		$666,916
	Cover		$24,132
	Ripping & Revegetation		$2,061
	Hazardouse Waste Removal		$2,534,217
	Subtotal, Direct Costs		**$3,227,325**
INDIRECT COSTS[1]	**Subtotal, Indirect Costs**	**30.0%**	**$968,198**
TOTAL COST			**$4,195,523**

For example use only. Values may not match the current spreadsheet.

Pipeline Demolition Unit Cost

TELESTO SOLUTIONS • INCORPORATED

Job No: 200540a

Client: Freeport NM Operations

Task: Pipeline Demolition Unit Cost

Computed By: Fred Charles Date: 3/14/2019

Checked By: Taryn Tigges Date: 3/14/2019

Calculation Documentation

Problem Statement:

Freeport-McMoRan (FMI) utilizes unit cost information for pipeline demolition as part of earthwork closure cost estimation associated with the Little Rock Mine Closure/Closeout Plan (CCP). The unit costs need to account for site-specific conditions and pipeline information which are used with available construction/earthwork unit rates to estimate the pipeline demolition cost.

This calculation set presents a summary of the approach and results for estimating the unit cost for pipeline demolition (remove sludge/water, place cover). Detailed information is presented in the earthwork reclamation cost estimate (RCE) spreadsheet file.

This calculation set is intended to serve as a guide/example even if the actual quantities and/or cost data used in these calculations change due to updates or application to a different Freeport NM Operations mine.

Objective:

1. Develop a pipeline demolition unit cost ($/ft) for use in estimating earthwork closure costs at FMI's mining operations in Grant County, NM.

Approach:

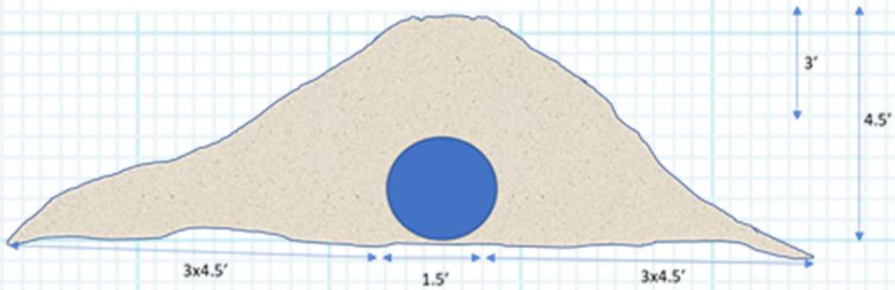
1. The data, assumptions, calculations, and results for the pipeline demolition unit cost estimate are presented within the Tyrone earthwork RCE spreadsheet fil in sheets (tabs) named "6"-8" Pipeline_UC", "18" Pipeline_UC", and 20"-36" Pipeline UC".
2. The approach for estimating the pipeline demolition unit cost is as follows:
   - Compile pipeline data and assumptions used in the calculations.
   - Identify a unit rate for pipeline sludge/water removal from available construction/earthwork data. For the required sludge/water removal, use a similar operation for storage tank sludge/water removal from R.S. Means Online to develop a pipeline cost ($/ft).
   - Estimate the volume of cover (cubic yard [cy]) required and cost to excavate, haul, and grade the cover material over the pipeline areas. Calculate a site-wide average unit cost ($/cy) to excavate, haul, and grade cover material.
   - Based on an assumed cover volume per foot of pipeline, calculate a weighted cost ($/ft) for all pipeline areas.

For example use only. Values may not match the current spreadsheet.

Approach:

- For the calculation shown below for an 18” pipe, 65 sf of cover per foot of pipeline is assumed based on 3 ft of cover over the pipeline with 3:1 side slopes:

$$3 \cdot 4.5\ ft \cdot 4.5\ ft + 3\ ft \cdot 1.5\ ft = 2.417\ \frac{yd^3}{ft}$$



- Calculate the total unit cost by adding the unit rate for sludge/water removal and the site-wide average cost to excavate, haul, and grade cover.

Results:

1. The results of the pipeline demolition unit cost calculations are shown below (some of the final results may vary from what is shown). These results are used in the overall earthwork RCE.
   - The total unit cost for 18” pipeline demolition is $3.12/ft. Results for the other sizes are shown in the earthwork RCE spreadsheet..
   - The total unit cost for 18” pipeline demotion is the sum of the unit rate for removing sludge/water ($0.13/ft) and the calculated unit cost to cover the pipeline areas ($2.99/ft).

Revegetation Unit Cost

Calculation Documentation

Problem Statement:
Freeport-McMoRan (FMI) utilizes revegetation unit cost information as part of earthwork closure cost estimation associated with the Little Rock Mine Closure/Closeout Plan (CCP). The unit cost for revegetation needs to account for equipment rental rates and associated maintenance, fuel costs, and labor rates.

Objectives:

1. Develop a revegetation unit cost ($/acre) for use in estimating earthwork closure costs at FMI's mining operations in Grant County, NM.
2. Note that this calculation set presents the approach, data and assumptions, and calculations and results for developing the unit cost. It is intended to serve as a guide/example even if the actual quantities and/or cost data used in these calculations change due to updates or application to a different Freeport NM Operations mine.

Approach:

1. The data, assumptions, calculations, and results for the revegetation unit cost estimate are presented within the Tyrone earthwork RCE spreadsheet file.
2. The approach for the calculations is as follows:
   - Identify equipment types for scarifying, discing, drill seeding, mulching, crimping.
   - Obtain equipment information from EquipmentWatch (EQW) and RS Means, labor rates from NMDOL; revegetation material costs (seed, mulch) from FMI and/or their supplier; and the current fuel price from fuel cost calculations.
   - Determine the equipment traveling distance and time to cover 1 acre.
   - For each of the key operations, estimate the operating cost ($/hour).
   - Combine all operations and material costs, calculate the total unit cost.

Data and Assumptions:

1. Rental and operating cost information is accessed online from EQW for tractor (Deere 7340), ripper, and mulcher, and from RS Means for disc harrow (see Attachment A). Monthly rental rates are converted to hourly rates assuming 176 hours/month.
2. Equipment information is not available in EQW nor RS Means for drill seeding and crimping. Therefore, the drill seeder cost is assumed to be an average of the mulcher and disc (complexity is between the two, thus an average is assumed), and the crimper rental cost is assumed to be equal to the disc harrow (similar type of equipment).
3. Costs are included in the ripper and disc harrow (and drill seeder and crimper) to account for the ground engaging component (GEC) of these implements. The GEC cost for the ripper is applied to each of these other implements.
4. Local fuel price is developed from fuel cost calculations also prepared for earthwork closure cost estimates – the estimated 2019 fuel price is $2.34/gallon.
5. Revegetation material costs are from a quote by Rocky Mountain Reclamation, based on typical sources for seed and mulch (see Attachment A). The cost for seed is $210/acre and for mulch is $245/ton which, at 2 tons/acre, is $490/acre.

For example use only. Values may not match the current spreadsheet.

Data and Assumptions (continued):

6. Labor rates are from NMDOL (see Attachment A).
7. Equipment typical net coverage (width) is set at 12 feet, and equipment travel speed is set at 3 miles/hour (mph) for a 60-minute hour.

Calculations and Results:

1. The Deere 7340 tractor data, along with labor and fuel costs, are tabulated in the following table:

	B	C	D	E
5	**Tractor used for each operation is Deere 7430**	**Cost**	**Unit**	**Information or Calculation**
6	EQW base rate for tractor rental	$ 5,210.05	$ per month	EQW for Deere 7430
7	EQW base rate for tractor rental	$ 29.60	$ per hour	= ($/month)/176
8	EQW field labor rate per hour of operation	$ 2.53	$ per hour	EQW for Deere 7430, which includes mechanic's wage of $23.09 (NMDOL, 2019)
9	EQW lube material cost	$ 2.84	$ per hour	EQW for Deere 7430
10	EQW field parts cost	$ 0.61	$ per hour	EQW for Deere 7430
11	EQW tire material cost	$ 2.42	$ per hour	EQW for Deere 7430
12	EQW fuel burn rate	5.98	gallons per hour	EQW for Deere 7430
13	Local fuel cost	$ 2.34	$ per gallon	Local quote
14	Fuel cost	$ 13.99	$ per hour	= (EQW fuel burn rate) x (local fuel cost)
15	NM Department of labor equipment operator rate	$ 24.27	$ per hour	NM Department of Labor (NMDOL)
16	**Total tractor cost**	**$ 76.27**	**$ per hour**	**Sum of $ per hour costs shown in boxes**

Data in Rows 6 and 8-12 are from EQW, data in Row 8 also incorporates an NMDOL labor rate in the EQW cost, Row 13 is the estimated local fuel cost of $2.34/gallon, and Row 15 shows an NMDOL labor rate. Costs in other rows (7, 14, and 16) are calculated as follows:

$$EQW\ base\ rate\ for\ tractor\ rental = (\$5{,}210.05/\text{month})/(176\ \text{hours/month}) = \$29.60/\text{hour}$$

$$Fuel\ cost = (\text{EQW burn rate})\ \text{x}\ (\text{local fuel cost}) = (5.98\ \text{gallons/hour})\ \text{x}\ (\$2.34/\text{gallon}) = \$13.99/\text{hour}$$

$$Total\ tractor\ cost = \text{sum of rows } 7, 8, 9, 10, 11, 14, 15 =$$
$$29.60 + 2.53 + 2.84 + 0.61 + 2.42 + 13.99 + 24.27 = \$76.27/\text{hour}$$

2. Based on an equipment typical net width of 12 feet, and equipment net travel speed of 2.5 mph (3 mph x 50/60 to adjust for a 50-minute hour), each operation will travel a distance of 3,630 feet to cover 1 acre, and will require 0.275 hour to travel this distance (see calc steps in the table below). The resulting fuel cost is $3.85/acre.

	B	C	D	E
18	**Tractor coverage/rate of operation, fuel cost per acre**			
19	Tractor/equipment net width	12	feet	Assigned as a typical net width of coverage for each pass
20	Tractor/equipment travel speed	2.5	miles per hour	Assigned as approximate average speed of equipment (3 mph for 50 min/hr)
21	For 1 acre, total traveling distance	3630	feet per acre	= (43560 sf/ac)/(net width)
22	Time of travel over 1 acre	0.275	hour per acre	= [(traveling distance feet/acre)/(5280 ft/mile)]/(travel speed)
23	**Fuel cost per acre**	**$ 3.85**	**$ per acre**	**Already included in total tractor cost... Fuel cost/acre = (fuel cost/hour) x (travel time hour/acre)**

For example use only. Values may not match the current spreadsheet.

TELESTO SOLUTIONS • INCORPORATED	Job No: 200540A	Client: Freeport NM Operations	Page 3 of 4
	Task: Revegetation Unit Cost	Computed By: Fred Charles	Date: 2/21/2019
		Checked By: Taryn Tigges	Date: 3/14/2019

Calculations and Results (continued):

3. Operating costs for each of the 5 revegetation operations are calculated as shown in the following table. Calculation equations are also noted in the table. Note the total cost for each operation includes fuel.

	B	C	D	E
25	**Operation**			
26	*Scarifying*			
27	Base rate for ripper rental	$ 898.90	per month	EQW Ripper, Miscellaneous MSR-189H, to 260 HP
28	Base rate for ripper rental	$ 5.11	$ per hour	= ($/month)/176
29	Lube labor rate per hour of operation	$ 0.57	$ per hour	EQW for ripper, incl mechanic's wage $23.09 (NMDOL, 2019)
30	Lube material cost	$ 0.15	$ per hour	EQW for ripper
31	Field parts cost	$ 0.16	$ per hour	EQW for ripper
32	Ground Engaging Component cost	$ 0.78	$ per hour	EQW for ripper
33	**Total cost with tractor+operator included**	**$ 83.03**	**per hour**	
35	*Discing*			
36	Disc harrow attachment, for tractor	$ 616.33	per month	RS Means 01 54 33 20 1500
37	Disc harrow attachment, for tractor	$ 3.50	per hour	= ($/month)/176
38	Ground Engaging Component (GEC) cost	$ 0.78	$ per hour	Assume similar to GEC cost for ripper (EQW)
39	**Total cost with tractor+operator included**	**$ 80.55**	**per hour**	
41	*Drill seeding (assume similar to discing)*			
42	Disc harrow attachment, for tractor	$ 616.33	per month	RS Means 01 54 33 20 1500
43	Disc harrow attachment, for tractor	$ 3.50	per hour	= ($/month)/176
44	Ground Engaging Component cost	$ 0.78	$ per hour	Assume similar to GEC cost for ripper (EQW)
45	**Total cost with tractor+operator included**	**$ 80.55**	**per hour**	
47	*Mulching*			
48	Mulcher, diesel powered, trailer mounted	$ 2,167.95	per month	EQW for trailer mounted mulcher (Finn B260)
49	Mulcher, diesel powered, trailer mounted	$ 12.32	per hour	= ($/month)/176
50	Lube labor rate per hour of operation	$ 1.25	$ per hour	EQW for trailer mounted mulcher (Finn B260), incl mechanic's wage $23.09 (NMDOL, 2019)
51	Lube material cost	$ 1.60	$ per hour	EQW for trailer mounted mulcher (Finn B260)
52	Field parts cost	$ 0.15	$ per hour	EQW for trailer mounted mulcher (Finn B260)
53	Tire material cost	$ 0.60	$ per hour	EQW for trailer mounted mulcher (Finn B260)
54	Fuel burn rate	4.13	gallons per hour	EQW for trailer mounted mulcher (Finn B260)
55	Local fuel cost	$ 2.34	$ per gallon	Local quote
56	Fuel cost	$ 9.66	$ per hour	= (EQW fuel burn rate) x (local fuel cost)
57	NM Department of labor equipment operator rate	$ 24.27	$ per hour	NM Department of Labor (NMDOL)
58	**Total cost with tractor+operator included**	**$ 126.12**	**per hour**	
60	*Crimping (assume similar to discing)*			
61	Disc harrow attachment, for tractor	$ 616.33	per month	RS Means 01 54 33 20 1500
62	Disc harrow attachment, for tractor	$ 3.50	per hour	= ($/month)/176
63	Ground Engaging Component cost	$ 0.78	$ per hour	Assume similar to GEC cost for ripper (EQW)
64	**Total cost with tractor+operator included**	**$ 80.55**	**per hour**	
65	Summary for operations			

For example use only. Values may not match the current spreadsheet.

Calculations and Results (continued):

5. The hourly operating cost for each operation (includes fuel) is summed for a total cost of \$450.79/hour. The cost for each operations is as follows:
    - Scarifying = \$83.03/hour
    - Discing = \$80.55/hour
    - Drill seeding = \$80.55/hour
    - Mulching = \$126.12/hour
    - Crimping = \$80.55/hour

6. The total combined equipment operating cost with fuel (\$/acre) is then calculated based on the operating cost per hour and the time of travel over 1 acre, as follows:

$$Total\ combined\ operating\ cost = \left(\frac{\$450.79}{hour}\right) x \left(0.275\frac{hour}{acre}\right) = \$123.97/acre$$

7. Seed and mulch costs are added to the total combined operating cost (\$/acre) to calculate the total revegetation unit cost as follows:
    - Total combined operating cost = \$123.97/acre
    - Seed = \$210/acre
    - Mulch = \$490/acre

Total revegetation unit cost = Total combined operating cost + Seed + Mulch = \$123.97/acre + \$210/acre + \$490/acre = \$823.97/acre (\$824/acre)

Summary and Conclusions:

1. A revegetation unit cost was developed for use in estimating earthwork closure costs at FMI's mining operations in Grant County, NM. Note that the estimated unit cost developed in this analysis applies only to FMI operations in the Silver City (Grant County), NM area.
2. The total revegetation unit cost is \$824/acre.

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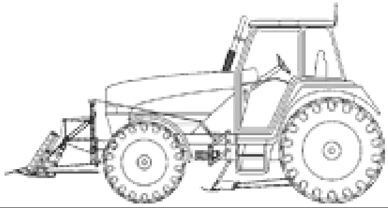
All prices shown in US$

Adjustments for MANDYLILLA27 in All Saved Models

January 17, 2019

Deere 7430 (disc. 2011)
Wheel Tractors

Size Class:
125 to 174 hp
Weight:
N/A



Configuration for 7430 (disc. 2011)

Power Mode **Diesel**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	$12.48/hr	$11.70/hr	-6.3%
Cost of Facilities Capital (CFC)	$3.12/hr	$2.43/hr	-22.1%
Overhead	$4.42/hr	$3.35/hr	-24.2%
Overhaul Labor	$6.46/hr	$1.92/hr	-70.3%
Overhaul Parts	$5.55/hr	$4.20/hr	-24.3%
Total Hourly Ownership Cost:	**$32.03/hr**	**$23.60/hr**	**-26.3%**

User Defined Adjustments: Annual Use Hours (1,030hrs -> 1,359hrs) Sales Tax (5.1% -> 0%)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	$8.51/hr	$2.53/hr	-70.3%
Field Parts	$4.86/hr	$0.61/hr	-87.4%
Ground Engaging Component (GEC)	$0.00/hr	-	-
Tire	$2.42/hr	-	-
Electrical/Fuel	$19.54/hr	$5.98/hr	-69.4%
Lube	$2.84/hr	-	-
Total Operating Ownership Cost:	**$38.17/hr**	**$14.38/hr**	**-62.3%**

User Defined Adjustments: Annual Field Repair Parts Cost ($4,174.20 -> $0.20) Diesel Cost (3.27 -> 1) Mechanics Wage ($58.84 -> $23.09)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	$32.03/hr	$23.60/hr	-26.3%
Hourly Operating Costs	$38.17/hr	$14.38/hr	-62.3%
Total Hourly Cost	**$70.20**	**$37.98/hr**	**-45.9%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	$20.02/hr	$17.48/hr	-12.7%
Idle	$51.57/hr	$29.58/hr	-42.6%

Revised Date: 1st Half 2019

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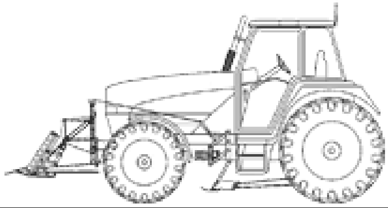
All prices shown in US$

Adjustments for MANDYLILLA27 in All Saved Models

January 17, 2019

Deere 7430 (disc. 2011)
Wheel Tractors

Size Class:
125 to 174 hp
Weight:
N/A



Configuration for 7430 (disc. 2011)

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	Weekly	Daily
Published Rates	$3,891.00	$1,303.00	$463.00
Adjustments			
Region (New Mexico: 134%)	$1,319.05	$441.72	$156.96
User Defined			
Rental Rates (100%)	-	-	-
Total:	**$5,210.05**	**$1,744.72**	**$619.96**

Date Last Updated: Oct 01, 2018

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EquipmentWatch

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All prices shown in US$

Custom Cost Evaluator

February 21, 2019

Miscellaneous MSR-189H
Crawler Tractor Multi-Shank Rippers

Size Class:
To 260 HP
Weight:
3,557 lbs.

Model Image

Configuration for MSR-189H

Engine Horsepower	**130 - 189**	Number of Shanks	**3**
Ripper Type	**Parallelogram**		

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	$2.64/hr	$2.50/hr	-5.3%
Cost of Facilities Capital (CFC)	$0.38/hr	$0.31/hr	-18.4%
Overhead	$0.66/hr	$0.52/hr	-21.2%
Overhaul Labor	$1.10/hr	$0.34/hr	-69.1%
Overhaul Parts	$0.95/hr	$0.75/hr	-21.1%
Total Hourly Ownership Cost:	**$5.73/hr**	**$4.42/hr**	**-22.9%**

User Defined Adjustments: Annual Use Hours (1,285hrs -> 1,629hrs) Sales Tax (5.1% -> 0%)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	$1.83/hr	$0.57/hr	-68.9%
Field Parts	$1.18/hr	$0.16/hr	-86.4%
Ground Engaging Component (GEC)	$0.99/hr	$0.78/hr	-21.2%
Tire	$0.00/hr	-	-
Electrical/Fuel	$0.00/hr	-	-
Lube	$0.15/hr	-	-
Total Operating Ownership Cost:	**$4.15/hr**	**$1.66/hr**	**-60%**

User Defined Adjustments: Annual Field Repair Parts Cost ($1,268.18 -> $0.18) Mechanics Wage ($58.84 -> $23.09)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	$5.73/hr	$4.42/hr	-22.9%
Hourly Operating Costs	$4.15/hr	$1.66/hr	-60%
Total Hourly Cost	**$9.88**	**$6.08/hr**	**-38.5%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	$3.68/hr	$3.33/hr	-9.5%
Idle	$5.73/hr	$4.42/hr	-22.9%

Revised Date: 1st Half 2019

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EquipmentWatch

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All prices shown in US$

Rental Rate Blue Book®

February 21, 2019

Miscellaneous MSR-189H
Crawler Tractor Multi-Shank Rippers

Size Class:
To 260 HP
Weight:
3,557 lbs.

Model Image

Configuration for MSR-189H

Engine Horsepower	**130 - 189**	Number of Shanks	**3**
Ripper Type	**Parallelogram**		

Blue Book Rates

** FHWA Rate is equal to the monthly ownership cost divided by 176 plus the hourly estimated operating cost.

	Ownership Costs				Estimated Operating Costs	FHWA Rate**
	Monthly	**Weekly**	**Daily**	**Hourly**	**Hourly**	**Hourly**
Published Rates	$1,010.00	$285.00	$71.00	$11.00	$4.15	$9.89
Adjustments						
Region (Las Cruces, New Mexico: 89%)	($111.10)	($31.35)	($7.81)	($1.21)		
Model Year (2019: 100%)	-	-	-	-		
Adjusted Hourly Ownership Cost (100%)	-	-	-	-		
Hourly Operating Cost (100%)					-	
Total:	**$898.90**	**$253.65**	**$63.19**	**$9.79**	**$4.15**	**$9.26**

Non-Active Use Rates

Non-Active Use Rates	**Hourly**
Standby Rate	$3.52
Idling Rate	$5.11

Rate Element Allocation

Element	**Percentage**	**Value**
Depreciation (ownership)	50%	$505.00/mo
Overhaul (ownership)	31%	$313.10/mo
CFC (ownership)	7%	$70.70/mo
Indirect (ownership)	12%	$121.20/mo

Fuel cost data is not available for these rates.

Revised Date: 1st Half 2019

These are the most accurate rates for the selected Revision Date(s). However, due to more frequent online updates, these rates may not match Rental Rate Blue Book Print. Visit the Cost Recovery Product Guide on our Help page for more information.

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All prices shown in US$

Custom Cost Evaluator

February 21, 2019

Finn B260
Trailer Mounted Mulchers

Size Class:
51 HP & Over
Weight:
4,880 lbs.

Model Image

Configuration for B260

Power Mode	**Diesel**	Horsepower	**115**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	$5.80/hr	$5.45/hr	-6%
Cost of Facilities Capital (CFC)	$0.88/hr	$0.69/hr	-21.6%
Overhead	$1.18/hr	$0.90/hr	-23.7%
Overhaul Labor	$3.36/hr	$1.00/hr	-70.2%
Overhaul Parts	$2.54/hr	$1.92/hr	-24.4%
Total Hourly Ownership Cost:	**$13.76/hr**	**$9.96/hr**	**-27.6%**

User Defined Adjustments: Annual Use Hours (1,050hrs -> 1,388hrs) Sales Tax (5.1% -> 0%)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	$4.20/hr	$1.25/hr	-70.2%
Field Parts	$1.47/hr	$0.15/hr	-89.8%
Ground Engaging Component (GEC)	$0.00/hr	-	-
Tire	$0.60/hr	-	-
Electrical/Fuel	$13.50/hr	$4.13/hr	-69.4%
Lube	$1.60/hr	-	-
Total Operating Ownership Cost:	**$21.37/hr**	**$7.73/hr**	**-63.8%**

User Defined Adjustments: Annual Field Repair Parts Cost ($1,342.66 -> $0.66) Diesel Cost (3.27 -> 1) Mechanics Wage ($58.84 -> $23.09)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	$13.76/hr	$9.96/hr	-27.6%
Hourly Operating Costs	$21.37/hr	$7.73/hr	-63.8%
Total Hourly Cost	**$35.13**	**$17.69/hr**	**-49.6%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	$7.86/hr	$7.04/hr	-10.4%
Idle	$27.26/hr	$14.09/hr	-48.3%

Revised Date: 1st Half 2019

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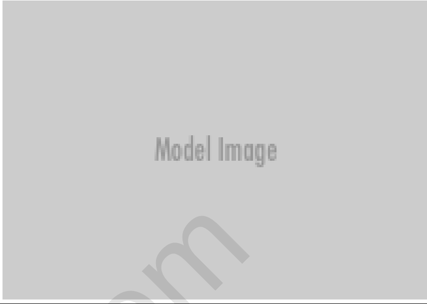
All prices shown in US$

Rental Rate Blue Book®

February 21, 2019

Finn B260
Trailer Mounted Mulchers

Size Class:
51 HP & Over
Weight:
4,880 lbs.



Configuration for B260

Power Mode	**Diesel**	Horsepower	**115**

Blue Book Rates

** FHWA Rate is equal to the monthly ownership cost divided by 176 plus the hourly estimated operating cost.

	Ownership Costs				Estimated Operating Costs	FHWA Rate**
	Monthly	**Weekly**	**Daily**	**Hourly**	**Hourly**	**Hourly**
Published Rates	$2,425.00	$680.00	$170.00	$26.00	$21.35	$35.13
Adjustments						
Region (Las Cruces, New Mexico: 89.4%)	($257.05)	($72.08)	($18.02)	($2.76)		
Model Year (2019: 100%)	-	-	-	-		
Adjusted Hourly Ownership Cost (100%)	-	-	-	-		
Hourly Operating Cost (100%)					-	
Total:	**$2,167.95**	**$607.92**	**$151.98**	**$23.24**	**$21.35**	**$33.67**

Non-Active Use Rates

	Hourly
Standby Rate	$6.16
Idling Rate	$25.82

Rate Element Allocation

Element	**Percentage**	**Value**
Depreciation (ownership)	37%	$897.25/mo
Overhaul (ownership)	50%	$1,212.50/mo
CFC (ownership)	6%	$145.50/mo
Indirect (ownership)	7%	$169.75/mo
Fuel (operating) @ 3.27	63%	$13.50/hr

Revised Date: 1st Half 2019

These are the most accurate rates for the selected Revision Date(s). However, due to more frequent online updates, these rates may not match Rental Rate Blue Book Print. Visit the Cost Recovery Product Guide on our Help page for more information.

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RS Means Online Data
Accessed February 13, 2019

Revegetation

Line Number	Description	Unit	Material	Labor	Equipment	Total	Data Release	CCI Location
015433201500	Rent disc harrow attchment for tractor, Excl. Hourly Oper. Cost.	Month	$ -	$ -	$ 616.33	$ 616.33	Year 2019	NEW MEXICO / LAS CRUCES (880)

Labor Rates

NMDOL Type A Operator Group	Base rate	Fringe rate	Apprenticeship	Total 2019 Rate ($/hr)
Equipment Operator IV	20.87	5.94	0.6	$ 27.41
Equipment Operator V	20.98	5.94	0.6	$ 27.52
Equipment Operator VI	21.16	5.94	0.6	$ 27.70
Laborer I	16.86	5.63	0.6	$ 23.09
Laborer II	17.61	5.63	0.6	$ 23.84
Truck Driver III	16.15	7.52	0.60	$ 24.27

Labor rates based on NM Department of Labor Type H (Heavy Engineering) 2019 labor rates. Rates include base hourly wage, fringe benefit, and apprenticeship contribution rates.

https://www.dws.state.nm.us/Portals/0/DM/LaborRelations/Prevailing_Wage_Poster_H_2019_final.pdf

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FREEPORT MCMORAN – NEW MEXICO MINING OPERATIONS

PRICE ESTIMATES FOR REVEGETATION SERVICES FOR BUDGETING ESTIMATES

Table 1 –Freeport McMoRan, New Mexico Mining Operations – Price Estimates for Revegetation Services for Budgeting Estimates, prepared April, 2018.

	REVEGETATION OPERATION	ESTIMATED QUANTITY	UNITS	COST/UNIT ($)	TOTAL COST
I.	**OPERATIONS:**				
1	**SCARIFYING**	500	Acres	$30.00	$15,000.00
2	**DISCING**	500	Acres	$20.00	$10,000.00
3	**DRILL SEEDING (special Rangeland Drill)**	500	Acres	$80.00	$40,000.00
4	**MULCHING**	500	Acres	$148.00	$74,000.00
5	**CRIMPING**	500	Acres	$55.00	$27,500.00
6	**DAILY PER DIEM, ETC.**	50	Days	$385.00	$19,250.00
7	**MOBILIZATION**	1	Each	$13,500.00	$13,500.00
	Subtotal				**$199,250.00**
II.	**MATERIALS:**				
1	**SEED** at 8.9 PLS/acre	500	Acres	$210.00	$105,000.00
2	**HAY MULCH** - nox. weed free, native	1000	Tons	$245.00	$245,000.00
	Subtotal				**$350,000.00**
	TOTAL ESTIMATED REVEGETATION COST BEFORE TAX				**$549,250.00**
	Add New Mexico Gross Receipts Tax	5.9375	%		**$32,611.72**
	ESTIMATED REVEGETATION COST PER ACRE:			**$1,163.72**	
	TOTAL ESTIMATED REVEGETATION COST				**$581,861.72**

Estimate prepared by Ron Schreibeis, Rocky Mountain Reclamation, for use for Budgeting Estimates.

O&M Costs

TELESTO SOLUTIONS • INCORPORATED	Job No: 200540a	Client: Freeport NM Operations	
	Task: O&M Costs	Computed By: Fred Charles	Date: 4/29/2019
		Checked By: Taryn Tigges	Date: 4/30/2019

Calculation Documentation

Problem Statement:
Freeport-McMoRan (FMI) utilizes cost information for operations and maintenance (O&M) as part of earthwork closure cost estimation associated with the Little Rock Mine Closure/Closeout Plan (CCP). The O&M costs need to account for vegetation maintenance costs for a 12-year period after completion of initial revegetation activities in each area, along with ongoing erosion control, road maintenance, and groundwater monitoring for a 100-year period. Tailing cover maintenance for areas reclaimed in the past will take place for the first 7 years of closure reclamation.

This calculation set presents a summary of the approach and results for estimating O&M costs. Detailed information is presented in the earthwork reclamation cost estimate (RCE) spreadsheet file.

This calculation set is intended to serve as a guide/example even if the actual cost data used in these calculations change due to updates or application to a different Freeport NM Operations mine.

Objective:

1. Develop the estimated O&M costs for vegetation maintenance for a 12-year period after completion of initial revegetation activities in each area, along with ongoing erosion control, road maintenance, and groundwater monitoring activities for a 100-year period. Also, develop tailing cover maintenance costs for previously reclaimed areas for the first 7 years of closure reclamation. The O&M costs are used as part of the earthwork RCE for FMI's mining operations in Grant County, NM.

Approach:

1. The data, assumptions, calculations, and results for the O&M cost estimate are presented within the Tyrone earthwork RCE spreadsheet file. Also, a summary of results is presented in the spreadsheet file.
2. The approach for estimating vegetation maintenance O&M costs is as follows:
   - For each facility (stockpile, tailing pond, reservoirs, etc), the total area is listed, along with approximate year of reclamation start, vegetation maintenance start, and vegetation maintenance complete. A 2% loss per year (i.e., 2% of vegetation fails each year) for 12 years is assumed to estimate the acreage requiring vegetation maintenance for each year.
   - Revegetation unit costs (equipment and fuel) are applied to the loss of acreage for each year to calculate the vegetation maintenance cost for each facility.

For example use only. Values may not match the current spreadsheet.

Approach (continued):

3. The approach for estimating erosion control, road maintenance, tailings cover maintenance, and groundwater monitoring ("Other") O&M costs is as follows:
   - For erosion control and road maintenance
     - Determine base costs ($/day) for equipment and fuel base. Also, estimate the number of days/yr for erosion control and road maintenance for three periods: Years 0-19, 20-39, and 40-99.
     - Calculate the annual equipment and fuel costs, based on days/yr, for the same three periods.
   - For tailing cover maintenance
     - Use erosion control equipment with reduced truck requirement and, therefore, reduced base cost. Assume 10 days/yr for Years 0-6, after which tailing cover maintenance is not required.
   - For groundwater monitoring
     - Determine base costs ($/day) for equipment and aqueous chemistry (lab analytical), and days/yr for groundwater monitoring for three periods: Years 0-19, 20-39, and 40-99.
     - Calculate the annual equipment and annual aqueous chemistry costs, based on days/yr, for the same three periods.
   - For these "Other" O&M activities
     - While reclamation is ongoing, adjust the O&M costs accordingly based on the proportion of reclamation completed as of each year. The full annual cost applies when reclamation is complete.
     - For years after reclamation is complete, assign the O&M costs for each year based on the annual costs calculated for Years 0-19, 20-39, and 40-99.

Results:

1. The vegetation maintenance and "Other" O&M costs are summed for all years, as shown in the summary table below (some of the final results may vary from what is shown). These results are used in the overall earthwork RCE.
2. The indirect costs are set at 17.5% of direct costs, based on an agreement between FMI and the agencies in January 2019. Indirect costs include but are not limited to mobilization and demobilization, contingencies, engineering redesign fees, contractor profit and overhead, project management, administrative expenses, etc.

DRAFT Operations and Maintenance Summary			
			Current Value
DIRECT COSTS	Facility and Structure Removal		$0
	Earthmoving		$0
	Vegetation		$1,328,888
	Other		$6,202,825
	Subtotal, Direct Costs		**$7,531,713**
INDIRECT COSTS[1]	**Subtotal, Indirect Costs**	**17.5%**	**$1,318,050**
TOTAL COST			**$8,849,763**

1

For example use only. Values may not match the current spreadsheet.

Stormwater Conveyance Channels

Calculation Documentation

Problem Statement:

Freeport-McMoRan (FMI) utilizes a spreadsheet developed by the New Mexico Mining and Minerals Division (MMD) to estimate the earthwork's closure costs associated with the Closure/Closeout Plans (CCPs) for various New Mexico operations. Part of the CCP involves design and unit cost of channels to direct stormwater from stockpiles. Channel sizes are unknown and needed for estimating closure costs and complying with regulations.

Objectives:

1. Estimate the runoff potential for each contributing watershed to the reclamation channels under the 100-year, 24-hour storm event (i.e., design storm)
2. Verify that the channels created by typical cross sections can convey the design storm
3. Recommend areas of channel protection (riprap) and size based on a conceptual design

Approach:

1. Utilize NOAA Frequency precipitation website to determine the most current 100-yr, 24-hr storm event
2. Use the SCS TR-55 method to estimate total runoff from each basin and the peak flow to each conveyance channel or runoff scenario (stockpile top with no channel, top channels, bench channels, and downdrains)
3. Determine the "worst case" scenario/channels with the highest peak flows to determine the standard channel size needed for the entire site
4. Estimate the peak velocity and if > 5 fps, then size riprap using the US Army Corps (USACE) technique

Data and Assumptions:

1. SCS Curve number of 80 and Manning's n=0.13 for disturbed mine areas (utilized throughout Freeport's mines as agreed to in various agency documents)
2. Assume peak flows from each drainage basin occur simultaneously
3. Manning's n for Articulate Concrete Block (ACB) is 0.025 (Contech)
4. Manning's n for riprap is 0.033 (Chow)
5. Analyze the basins that will produce the largest peak flow for riprap and ACB requirement.
6. NOAA Frequency precipitation 100-yr, 24-hr storm event depth is 3.74 inches.

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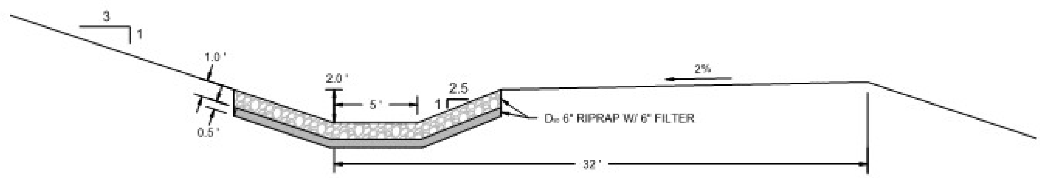
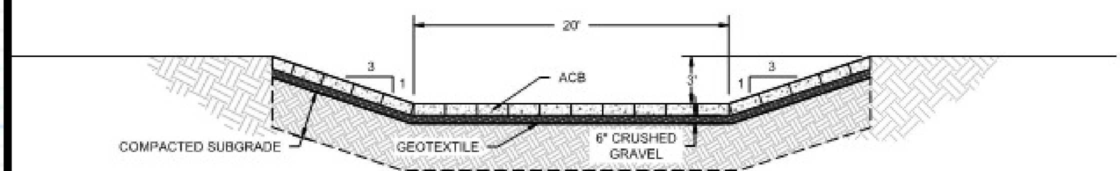
Data and Assumptions: ***Calculation Documentation***

7. Bench channels are dimensioned as follows:

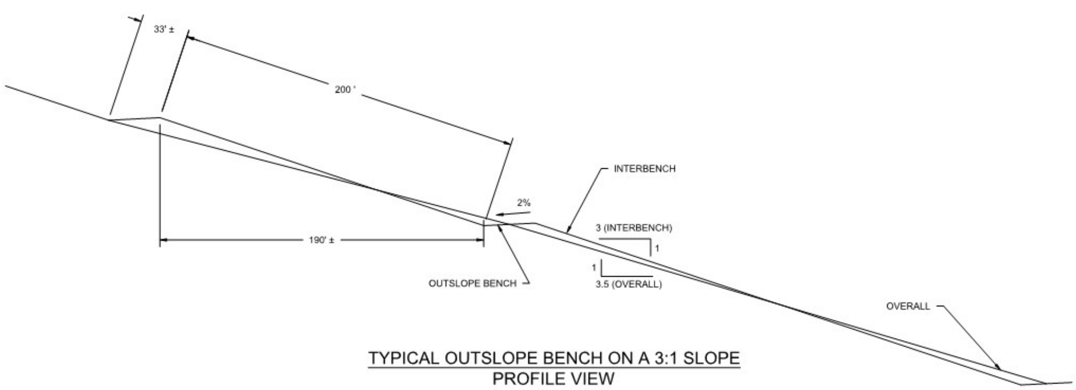


TYPICAL BENCH CHANNEL CROSS SECTION
SECTION VIEW

8. Downdrains are dimensioned as follows:



TYPICAL DOWNDRAIN
SECTION VIEW



TYPICAL OUTSLOPE BENCH ON A 3:1 SLOPE
PROFILE VIEW

9. When used, top channels have historically had a base width between 5-10 ft and varying side slopes.
10. Typical channel dimensions should be verified for each project site.

Calculation Documentation

Data and Assumptions:

11. Calculate total and peak runoff using SCS TR-55. Add together the travel times for sheet flow and shallow concentrated flow, where applicable. Use a minimum Tc of 0.1 hr.

Equations for sheet flow:

SCS runoff curve number method

The SCS Runoff Curve Number (CN) method is described in detail in NEH-4 (SCS 1985). The SCS runoff equation is

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S} \qquad \text{[eq. 2-1]}$$

where

- Q = runoff (in)
- P = rainfall (in)
- S = potential maximum retention after runoff begins (in) and
- I_a = initial abstraction (in)

Initial abstraction (I_a) is all losses before runoff begins. It includes water retained in surface depressions, water intercepted by vegetation, evaporation, and infiltration. I_a is highly variable but generally is correlated with soil and cover parameters. Through studies of many small agricultural watersheds, I_a was found to be approximated by the following empirical equation:

$$I_a = 0.2S \qquad \text{[eq. 2-2]}$$

By removing I_a as an independent parameter, this approximation allows use of a combination of S and P to produce a unique runoff amount. Substituting equation 2-2 into equation 2-1 gives:

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)} \qquad \text{[eq. 2-3]}$$

S is related to the soil and cover conditions of the watershed through the CN. CN has a range of 0 to 100, and S is related to CN by:

$$S = \frac{1000}{CN} - 10 \qquad \text{[eq. 2-4]}$$

Figure 2-1 and table 2-1 solve equations 2-3 and 2-4 for a range of CN's and rainfall.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overtop and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}} \qquad \text{[eq. 3-3]}$$

where:

- T_t = travel time (hr),
- n = Manning's roughness coefficient (table 3-1)
- L = flow length (ft)
- P_2 = 2-year, 24-hour rainfall (in)
- s = slope of hydraulic grade line (land slope, ft/ft)

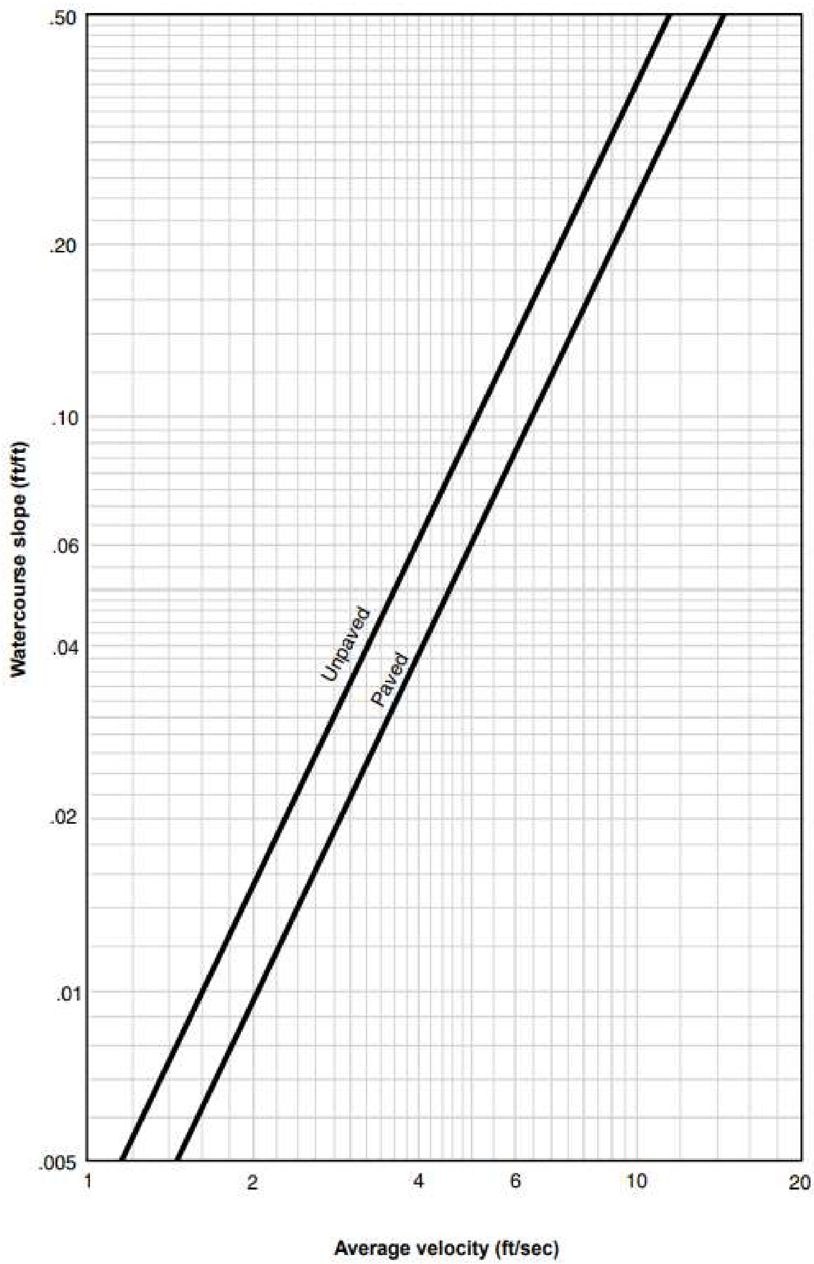
Calculation Documentation

Data and Assumptions:

Shallow concentrated flow =10^(0.5*LOG10(slope)+1.2)

(or use Figure 3-1):

Figure 3-1 Average velocities for estimating travel time for shallow concentrated flow



3–2 (210-VI-TR-55, Second Ed., June 1986)

Calculation Documentation

Data and Assumptions:

To calculate channel velocity and depth, use manning's equation:

Manning's equation is:

$$V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n} \quad \text{[eq. 3-4]}$$

where:

- V = average velocity (ft/s)
- r = hydraulic radius (ft) and is equal to a/p_w
  - a = cross sectional flow area (ft^2)
  - p_w = wetted perimeter (ft)
- s = slope of the hydraulic grade line (channel slope, ft/ft)
- n = Manning's roughness coefficient for open channel flow.

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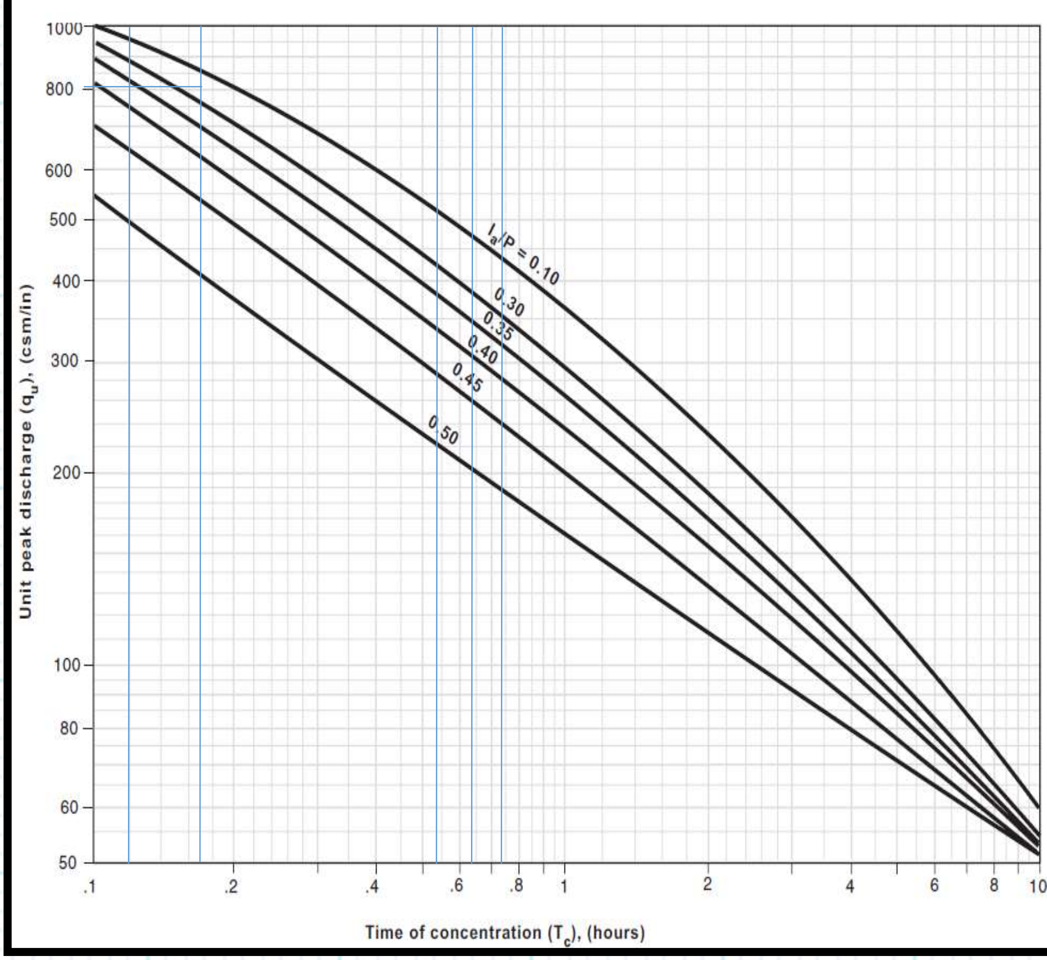
Calculation Documentation

Data and Assumptions:

12. Use the total calculated Tc with graphical peak flow method to determine unit and peak flow rates:

Exhibit 4-II Unit peal discharge (q_u) for NRCS (SCS) type II rainfall distribution



$$q_p = q_u A_m Q F_p$$ [eq

where:

q_p = peak discharge (cfs)
q_u = unit peak discharge (csm/in)
A_m = drainage area (mi^2)
Q = runoff (in)
F_p = pond and swamp adjustment factor

Table 4-2 Adjustment factor (F_p) for pond and swamp areas that are spread throughout the watershed

Percentage of pond and swamp areas	F_p
0	1.00
0.2	0.97
1.0	0.87
3.0	0.75
5.0	0.72

Calculation Documentation

Calculations and Results:

1. The TR-55 method is shown as an example to determine peak discharge from the top of a stockpile to a 1% top channel (see: YYYYMMDD_TR-55_Channel_Sizing.xlsx):

	A	B	C	
1				
2		1% Top Channel		
3				
4	L =	1,000	ft	From CAD, the longest (straight line) flow path to the channel
5				
6	A =	0.0230	ac	=B4/43560 (based on one unit length of channel)
7		3.59E-05	mi^2	=B6/640
8				**TIME OF TRAVEL (MANNING'S FORMULA) FOR SHEET FLOW, TR55:**
9	n =	0.13		See assumptions
10	L(<300) =	300	ft	Based on topography and <300 ft
11	P2 =	1.83	in	=B41
12	S =	0.01		From CAD
13				
14	Tt =	36.73	min	=0.007*((B9*B10))^0.8/(B11^0.5*B12^0.4)*60 (from TR-55)
15				
16				**TIME OF TRAVEL FOR SHALLOW CONCENTRATED FLOW, TR55:**
17	L =	700	ft	=B4-B10
18	v =	1.58	ft/s	=10^(0.5*LOG10(B12)+1.2) (from TR-55)
19				
20	Tt =	7.36	min	=B17/B18/60
21				
22	Tc =	44.09	min	=B20+B14
23		0.73484	hr	
35				**SCS CURVE NUMBER METHO:D**
36	P =	3.74	in	=From NOAA
37	Ia =	0.50	in	=0.2*B40
38	CN =	80		Assumed
39				
40	S =	2.50	in	=1000/Q38-10
41	Q =	1.83	in	=(B36-B37)^2/(B36-B37+B40)
42		0.003499	ac-ft	=B41/12*B6
43		ac-ft		
44				**GRAPHICAL PEAK DISCHARGE METHOD:**
45	Ia/P =	0.13		=B37/B36
46				
47	Qu =	417	csm/in	From TR-55 Chart
48	Am =	3.59E-05	mi²	=B7
49	Q =	1.83	in	=B41
50	Fp =	1.00		
51				
52	Qp =	2.73E-02	cfs	=B47*B48*B49*B50

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Calculation Documentation

Calculations and Results (con'd)

1. (con'd) Multiply Qp (cell B52) by the channel length to compute total peak flow from the top channel. Multiple channel lengths are shown in column A (starting in row 57):

	A	B	C
1			
2		1% Top Channel	
3			
4	L =	1,000	ft
5			
6	A =	0.0230	ac
7		3.59E-05	mi^2
8			
9	n =	0.13	
10	L(<300) =	300	ft
11	P2 =	1.83	in
12	S =	0.01	
13			
14	Tt =	36.73	min
15			
16			
17	L =	700	ft
18	v =	1.58	ft/s
19			
20	Tt =	7.36	min
21			
22	Tc =	44.09	min
23		0.73484	hr
35			
36	P =	3.74	in
37	Ia =	0.50	in
38	CN =	80	
39			
40	S =	2.50	in
41	Q =	1.83	in
42		0.003499	ac-ft
43		ac-ft	
44			
45	Ia/P =	0.13	
46			
47	Qu =	417	csm/in
48	Am =	3.59E-05	mi^2
49	Q =	1.83	in
50	Fp =	1.00	
51			
52	Qp =	2.73E-02	cfs

	A	B
57	Ditch Length	
58	100	6.55
59	200	13.10
60	400	26.20
61	800	52.40
62	1000	65.51
63	1500	98.26
64	1600	104.81
65	3200	209.62

Calculation Documentation

Calculations and Results (con'd)

2. The TR-55 method is shown as an example to determine peak discharge from the top of a stockpile to a bench channel (see: YYYYMMDD_TR-55_Channel_Sizing.xlsx):

	A	B	C
1			
2	3:1 Outslope Bench Channel		
3	TOTAL WATERSHED LENGTH		
4	L =	200	ft
5	TOTAL WATERSHED AREA		
6	A =	0.0046	ac
7		7.17401E-06	mi^2
8	**TIME OF TRAVEL (MANNING'S FORMULA) FC**		
9	n =	0.13	
10	L(<300) =	200	ft
11	P2 =	1.83	in
12	S =	0.333333333	
13			
14	Tt =	6.53	min
15			
16	**TIME OF TRAVEL FOR SHALLOW CONCENTI**		
17	L =	0	ft
18	v =	9.15	ft/s
19			
20	Tt =	0.00	min
21			
22	Tc =	6.53	min
23		0.108851936	hr
35	**SCS CURVE NUMBER METHOD**		
36	P =	3.74	in
37	Ia =	0.50	in
38	CN =	80	
39			
40	S =	2.50	in
41	Q =	1.83	in
42		0.000699744	ac-ft
43	**GRAPHICAL PEAK DISCHARGE METHOD**		
44			
45	Ia/P =	0.13	
46			
47	Qu =	973	csm/in
48	Am =	7.17E-06	mi²
49	Q =	1.83	in
50	Fp =	1.00	
51			
52	Qp =	0.01	cfs

Use the same equations shown on page 7 for a top channel.

Multiply Qp (cell B52) by bench channel length to compute total peak flow to each bench channel. Multiple channel lengths are shown in column A:

	A	B
69	Ditch Length	Flow (cfs)
70	1260	**16.08**
71	1010	12.89
72	1140	14.55
73	340	4.34
74	215	2.74
75	280	3.57
76	405	5.17
77	405	5.17
78	470	6.00
79	400	5.11

The longest bench channel has the contributing area and largest peak flow, which can be used for capacity and erosion calculations.

Calculation Documentation

Calculations and Results (Con'd)

3. Downdrains- where conveying to a downdrain, combine flow from top of stockpile with bench channel flows

Ditch Length	Flow (cfs)	CUMULATIVE TOTAL TO DOWNDRAIN (CFS)
1260	16.08	36.77
1010	12.89	49.66
1140	14.55	64.21
340	4.34	68.55
215	2.74	71.30
280	3.57	74.87
405	5.17	80.04
405	5.17	85.21
470	6.00	91.21
400	5.11	96.31

Combined with top flow of 20.69 cfs (→ 36.77)

=36.77+12.89 etc. (→ 49.66)

Total flow to downdrain (→ 96.31)

4. For each channel type (downdrain shown as an example), calculate channel depths and velocities based upon Manning's Formula and verify that typical channel dimensions are adequate for calculated flow:

	A	B	C	D	E	F	G	H	I	J	K	L
1												
2		TRAPEZOIDAL DITCH										
3	NAME	SLOPE	LS	RS	DEPTH	BOTTOM	MANNING	AREA	WETTED	HYD RAD	MANNING	VELOCITY
4			SLOPE	SLOPE	FT	WIDTH	COEFF	FT^2	PER	FT	FLOW	F/S
5			L:H	L:H		FT			FT		CFS	
6						ACB Down Drain						
7	A	0.28571	3	3	0.10	20	0.025	2.03	20.63	0.10	13.78	6.79
8	A	0.28571	3	3	0.20	20	0.025	4.12	21.26	0.19	43.95	10.67
9	A	0.28571	3	3	0.30	20	0.025	6.27	21.90	0.29	86.78	13.84

- B (SLOPE): Slope along ditch
- C (LS SLOPE): Outslope
- D (RS SLOPE): Cross-slope
- E (DEPTH): Depth of flow, iterate this value
- F (BOTTOM WIDTH): 20 ft for downdrain (see page 2)
- G (MANNING COEFF): See assumptions
- H (AREA): =(F9+F9+E9*C9+E9*D9)*E9/2
- I (WETTED PER): =F9+SQRT(E9^2+(E9*C9)^2)+SQRT(E9^2+(E9*D9)^2)
- J (HYD RAD): =H9/I9
- K (MANNING FLOW): =1.49/G9*H9*(J9)^(2/3)*B9^0.5
- L (VELOCITY): =K9/H9

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Calculation Documentation

Calculations and Results (Con'd)

5. For the bench channels (or a channel where riprap is used), check riprap requirement on section with highest velocity and slope (see: YYYYMMDD_Riprap Sizing Spreadsheet.xlsx for use of the USACE method):

Color Key:
Entered by user
Calculated by spreadsheet
Iteratively adjusted by user to calculate riprap size
Calculated results
Flow regieme (supercritical or sub-critical flow)

$d_0 = 0.25 d_{50}$ $d_{15} \cong 0.42 d_{50}$ $d_{100} = 2.00 d_{50}$

Steps to Calculate Riprap Size:
1. User selects and copies the appropriate riprap sizing tab dependant on channel bedslope (s), sideslope (z) and design D50
2. User enters all values in green in "trapezoidal channel hyrdaulics" and the appropriate riprap sizing tab
3. User adjusts design D50 until design D50 is greater than D50 minimum
4. User adjusts h (ft) with solver ad-in until column s = 0 (Design Q - Calculated Q)
5. User repeats steps 3. and 4. until both column R = 0 and design D50 > minimum D50
6. Check that channel freeboard and flow regieme (Froude Number) is adequate

Channel Name	Bedslope (S) (ft/ft)	Design Discharge (Q) (cfs)	Side Slope (z)	Bw (ft)	Channel Depth (ft)	Minimum Riprap Depth (in)	Design Min. Riprap Size (d_0) (in)	Design Min. Riprap Size (d_{15})	Design Max. Riprap Size (d_{100}) (in)	Design d_{50} (in)
Example 1 (S < 2%, z >= 1.5)	0.020	17.0	2.5	5.0	2.0	2.0	0.3	0.4	2.0	1.0
Example 2 (S > 2%, D50 > 6")	0.020	17.0	2.5	5.0	2.0	2.0	0.3	0.4	2.0	1.0
Example 3 (S > 2%, D50 < 6")	0.020	17.0	2.5	5.0	2.0	2.0	0.3	0.4	2.0	1.0

Channel Name	Calculated Min d_{50} (in)	Flow Depth (h) (ft)	Channel Freeboard (ft)	Cross Sect. Area (A) (ft^2)	Wetted Perimeter (Pw) (ft)	Hydraulic Radius (R) (ft)	Calculated Discharge (Q) (cfs)	Design Q - Calculated Q	Design Vel. (ft/s)	Flow Top Width (Tw) (ft)	Channel Top Width (Tw) (ft)	Froude Number
Example 1 (S < 2%, z >= 1.5)	0.3	1.00	1.0	7.5	10.4	0.72	48.6	998.160	2.3	10.00	15.0	0.40
Example 2 (S > 2%, D50 > 6")	1.9	1.00	1.0	7.5	10.4	0.72	51.8	1212.326	2.3	10.00	15.0	0.40
Example 3 (S > 2%, D50 < 6")	1.7	1.00	1.0	7.5	10.4	0.72	51.8	1212.326	2.3	10.00	15.0	0.40

5. For the given downdrain geometry, the Contech 40T ACB system has been verified to be used with a flow rate of 200 cfs and higher. The minimum Factor of Safety with the ACB systems that Freeport has previously established is 1.8. A flow rate of 200 cfs (18.9 ft/s velocity) results in a factor of safety of 2.73. This calculation was obtained from Contech on 1/21/21 and is included as Attachment A. Re-evaluate this calculation with larger flow rates (over 200 cfs) or a different channel geometry.

Discussion and Conclusions:

1. This calculation set is conservative in that it assumes the peak flows occur simultaneously, which is not the case. Larger drainage areas will lag behind the smaller areas.
2. The calculation set met its objectives by estimating, runoff flow rates, verifying that the channels can carry the flow safely, and showing that typical erosion protection is adequate.

Factor of Safety
Hydraulic Analysis

These calculations are an application of the Moment Stability Analysis technique presented in Julien (2010) ar
as illustrated in the NCMA Manual (2010), listed in the References.
The factor of safety method is used in the selection of block sizes for ACB’s for revetments or bed armor.
The following assumes that hydraulic testing has been performed for the block system to quantify a
critical shear stress; the use of Manning's equation conservatively assumes normal depth and critical velocity.

References

1. Julien, Pierre Y. (2010) "Erosion and Sedimentation", 2nd Edition, Cambridge University Press

2. National Concrete Masonry Association (2010), "Design Manual for Articulating Concrete Block (ACB) Revetment Systems", NCMA Publication TR220A.

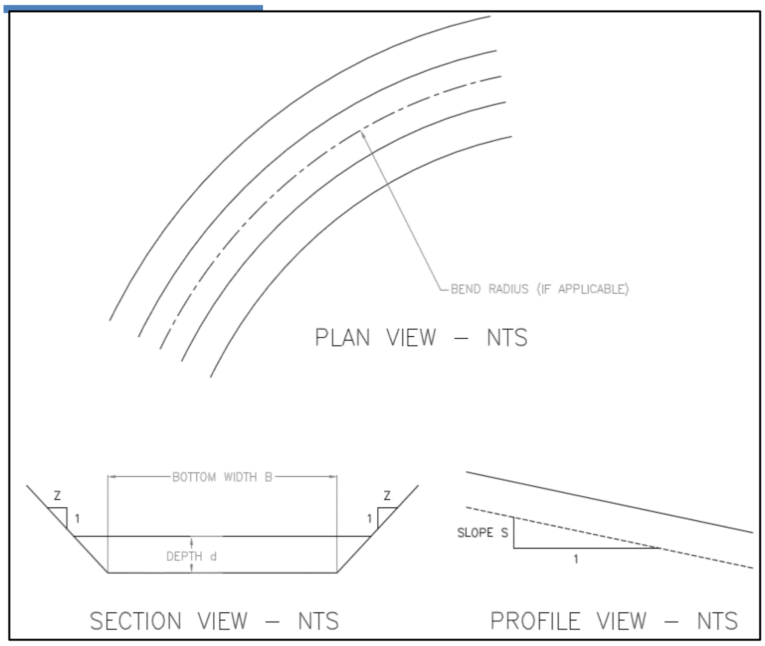
3. USDOT Federal Highway Administration Hydraulic Engineering Circular No. 15, Third Edition (2005) "Design of Roadside Channels with Flexible Linings", National Highway Institute.

4. Cox, A.L. (2010), "Moment Stability Analysis Method for Determining Safety Factors for Articulated Concrete Blocks", Ph.D. Dissertation, Colorado State University

5. ASTM D 7276 & D7277 Testing and Analysis Compliant

Factor of Safety
Hydraulic Analysis

Project Data



Channel Bottom Width, B	20	ft
Bed Slope, S_o	0.285	ft/ft
Friction Slope, S	0.285	ft/ft
Left Side Slope, Z_L	3	(_H:1V)
Right Side Slope, Z_R	3	(_H:1V)
Bend Radius, r	0	ft
Depth of Flow d	0.49	ft

The Depth of Flow is varied iteratively to obtain a given volumetric flow rate.

Top Surface Width ,T	22.96	ft

Other Constants

Unit Weight of Water, γ	62.4	pcf
Unit Wt. of Concrete, Dry-Cast	130	pcf
Sp. Gr. Of Concrete, S_c	2.083	--
Gravitational Constant, g	32.2	ft/s^2

Calculated Channel Geometry Factors

Flow Area, A	10.60	ft^2
Wetted Perimeter, P	23.12	ft
Hydraulic Radius = R_H = A/P =	0.46	ft
Bend Coefficient, K_b	1	--
Froude Number, Fr	4.73	--
Flow Type	Supercritical	

Volumetric Flow Rate, Q 200.00 cfs

The Volumetric Flow Rate is determined using Manning's equation:

$Q = 1.486 / (n * A * R^{2/3} * S^{1/2})$

Velocity, V 18.87 ft/sec

			sin	cos	tan
Largest Side Slope Angle, θ_1	18.435	°	0.316	0.949	0.333
Bed Slope Angle, θ_0	15.908	°	0.274	0.962	0.285

ArmorFlex Block parameters

Class	40-T
SF	2.60

ϑ_1	0.198	ft	A_B	1.1	
ϑ_2	0.725	ft	C_L	0.00834	
ϑ_3	0.396	ft	Weight	58.1	lbs
ϑ_4	0.725	ft	Width	1.292	ft
ϑ_5	0.646		τ_c	25.0	psf
ϑ_6	0.646		ΔZ	0.0	in
ϑ_7	0.971		n	0.025	--
ϑ_8	0.971				

ARMORTEC
Erosion Control Solutions

Factor of Safety
Hydraulic Analysis

Detailed Calculations — REFERENCE

Flow Area, $A = A_L + A_B + A_R$

$A_L = ½ * d^2 * Z_L =$	0.37	ft^2	
$A_B = B * d =$	9.87	ft^2	
$A_R = ½ * d^2 * Z_R =$	0.37	ft^2	
$A =$	10.60	ft^2	

Wetted Perimeter, $P = P_L + P_B + P_R$

$P_L = d * (Z_L^2 +1)^{0.5} =$	1.56	ft	
$P_B = B =$	20	ft	
$P_R = d * (Z_R^2 +1)^{0.5} =$	1.56	ft	
$P =$	23.12	ft	

Volumetric Flow Rate, Q

$Q = 1.486 / n * A * R_H^{2/3} * S^{1/2} =$	200.00	cfs	(Ref. 3 Eqn. 2.1)

Compute Factor of Safety Parameters

Submerged Weight, W_s	$W_s = W * ((S_c - 1) / S_c) =$	30.22	lb	(Ref. 2 Eqn 4.13a)
Applied Shear Stress, τ_o	$\tau_o = \gamma * d * S_o =$	8.78	psf	(Ref. 3 Eqn. 2.4)

Bend Coefficient Calculation

$X = r/B =$ (Constrained to between 1.984 and 10)	1.984	--	
Calculated $K_b = 2.38-0.206(X)+0.0073(X)^2 =$	2.00	--	(Ref. 3 Eqn. 3.7)
Constrained K_b: $1.05 \leq K_b \leq 2$ →	1.00		

(If no bend radius is present, K_b = 1)

(Design Shear Stress)	$\tau_o = K_b \gamma y \sin(\tan^{-1} S_o) =$	8.44	lbs/ft^2	(Ref. 3 Eqn 3.1 & 3.6)

Calculate Cox Parameters

$\beta = \cos^{-1}((b/2)/\vartheta_8) =$	48.31	°	
$\sin\beta =$ 0.747; $\cos\beta =$	0.665		
$W_{SX} = W_S * \sin\theta_0$	8.28	lb	(Ref. 4. Eqn. 7.1)
$\theta_2 = \tan^{-1}(\tan\theta_1 * \cos\theta_0)$	17.774	°	(Ref. 4. Eqn. 7.3)
$W_{SY} = W_S * \cos\theta_0 * \cos\theta_2$	27.68	lb	(Ref. 4. Eqn. 7.2)
$W_{SZ} = W_S * \cos\theta_0 * \sin\theta_2$	8.87	lb	(Ref. 4. Eqn. 7.4)
Applied $F_D = \tau_0 * A_B =$	9.46	lbs	(Ref. 4. Eqn. 7.10)
Applied $F_L = 0.5 * C_{BL} * \rho * A_B * V^2 =$	3.22	lbs	(Ref. 4. Eqn. 7.11)
$F_L' = F_D' = 0.5 \Delta Z b \rho V_{des}^2 =$	0.00	lbs	(Ref. 4. Eqn. 7.12)

$SF_M = (\vartheta_7 * W_{SY})/[(\vartheta_1 * (W_{SX} * \sin\beta + W_{SZ} * \cos\beta)) + (\vartheta_3 * (F_D + F_D') * \sin\beta) + (\vartheta_8 * (F_L + F_L'))] =$ **3.23** (Ref. 4. Eqn. 7.18)

$SF_P = (\vartheta_2 * W_{SY})/[(\vartheta_1 * W_{SX}) + (\vartheta_3 * (F_D + F_D')) + (\vartheta_4 * (F_L + F_L'))] =$ **2.60** (Ref. 4. Eqn. 7.20)

$SF_O = (\vartheta_5 * W_{SY})/[(\vartheta_1 * W_{SZ}) + (\vartheta_6 * (F_L + F_L'))] =$ **4.66** (Ref. 4. Eqn. 7.22)

$SF_{BED} = (\vartheta_2 * W_S * \cos\theta_0)/[(\vartheta_1 * (W_S * \sin\theta_0)) + (\vartheta_3 * (F_D + F_D')) + (\vartheta_4 * (F_L + F_L'))] =$ **2.73** (Ref. 4. Eqn. 7.28)

Factor of Safety
Hydraulic Analysis

Parameters for Factor of Safety Calculations													
Block Class	**Block Area**	ϑ_1	ϑ_2	ϑ_3	ϑ_4	ϑ_5	ϑ_6	ϑ_7	ϑ_8	τ_c **0°**	**Width**	**Weight**	**Lift Coeff. C_L**
	(SF)	**(ft)**	**(ft)**	**(ft)**	**(ft)**	**(ft)**	**(ft)**	**(ft)**	**(ft)**	**(psf)**	**(ft)**	**(lbs)**	
30-S	0.68	0.198	0.542	0.396	0.542	0.483	0.483	0.726	0.726	5.180	0.967	32.89	0.11045
40	1.23	0.198	0.725	0.396	0.725	0.646	0.646	0.971	0.971	11.200	1.292	59.02	0.04563
40-L	1.93	0.198	0.725	0.396	0.725	0.983	0.983	1.222	1.222	19.460	1.967	97.18	0.02455
40-T	1.12	0.198	0.725	0.396	0.725	0.646	0.646	0.971	0.971	25.022	1.292	58.12	0.00834
45	1.49	0.198	0.725	0.396	0.725	0.646	0.646	0.971	0.971	13.530	1.292	71.25	0.04563
45-L	2.31	0.198	0.725	0.396	0.725	0.983	0.983	1.222	1.222	21.860	1.967	109.15	0.02455
45-S	0.83	0.198	0.542	0.396	0.542	0.483	0.483	0.726	0.726	6.170	0.967	39.20	0.11045
50	1.23	0.250	0.725	0.500	0.725	0.646	0.646	0.971	0.971	13.610	1.292	76.29	0.04563
50-L	1.93	0.250	0.725	0.500	0.725	0.983	0.983	1.222	1.222	22.050	1.967	116.02	0.02455
50-S	0.68	0.250	0.542	0.500	0.542	0.483	0.483	0.726	0.726	6.130	0.967	42.03	0.11045
50-T	1.12	0.250	0.725	0.500	0.725	0.646	0.646	0.971	0.971	30.500	1.292	75.39	0.00834
55	1.49	0.250	0.725	0.500	0.725	0.646	0.646	0.971	0.971	16.290	1.292	91.37	0.04563
55-L	2.31	0.250	0.725	0.500	0.725	0.983	0.983	1.222	1.222	26.280	1.967	138.29	0.02455
55-S	0.83	0.250	0.542	0.500	0.542	0.483	0.483	0.726	0.726	7.330	0.967	50.25	0.11045
60	1.23	0.313	0.725	0.625	0.725	0.646	0.646	0.971	0.971	15.490	1.292	93.17	0.04563
60-T	1.12	0.313	0.725	0.625	0.725	0.646	0.646	0.971	0.971	35.200	1.292	93.42	0.00834
70	1.23	0.354	0.725	0.708	0.725	0.646	0.646	0.971	0.971	17.730	1.292	113.90	0.04563
70-L	1.93	0.354	0.725	0.708	0.725	0.983	0.983	1.222	1.222	29.520	1.967	174.46	0.02455
70-T	1.12	0.354	0.725	0.708	0.725	0.646	0.646	0.971	0.971	38.500	1.292	108.96	0.00834
75	1.49	0.313	0.725	0.625	0.725	0.646	0.646	0.971	0.971	18.620	1.292	112.02	0.04563
85	1.49	0.354	0.725	0.708	0.725	0.646	0.646	0.971	0.971	21.100	1.292	135.60	0.04563
85-L	2.31	0.354	0.725	0.708	0.725	0.983	0.983	1.222	1.222	35.060	1.967	207.23	0.02455

	A_B	ϑ_1	ϑ_2	ϑ_3	ϑ_4	ϑ_5	ϑ_6	ϑ_7	ϑ_8	τ_c **0°**	**Width**	**Weight**	**Lift Coeff. C_L**
40-T	1.121	0.198	0.725	0.396	0.725	0.646	0.646	0.971	0.971	25.022	1.292	58.120	0.00834

TELESTO SOLUTIONS • INCORPORATED

Job No: 200540A Client: FMI

Task: NM Operations Stormwater Management Computed By: T. Tigges Date: 1/13/21

Checked By: W. Niccoli Date: 1/12/21

Calculation Documentation

Problem Statement:

Freeport-McMoRan (FMI) utilizes a spreadsheet developed by the New Mexico Mining and Minerals Division (MMD) to estimate the earthwork's closure costs associated with the Closure/Closeout Plans (CCPs) for the Little Rock Mine. Part of the CCP involves design and unit cost of channels to direct stormwater from stockpiles. Channel sizes are unknown and needed for estimating closure costs and complying with regulations.

See the Channel Size Verification calculation documentation for New Mexico operations for detailed calculation steps. This documentation summarizes the results from the calculations specific to the Little Rock Mine.

Objectives:

1. Estimate the runoff potential for each contributing watershed to the reclamation channels under the 100-year, 24-hour storm event (i.e., design storm)
2. Verify that the channels created by typical cross sections can convey the design storm
3. Recommend areas of channel protection (riprap) and size based on a conceptual design

Approach:

1. Use the SCS TR-55 method to estimate total runoff from each basin and the peak flow to each conveyance channel or runoff scenario (stockpile top with no channel, top channels, bench channels, and downdrains)
2. Determine the "worst case" scenario/channels with the highest peak flows to determine the standard channel size needed for the entire site
3. Estimate the peak velocity and if > 5 fps, then size riprap using the US Army Corps technique

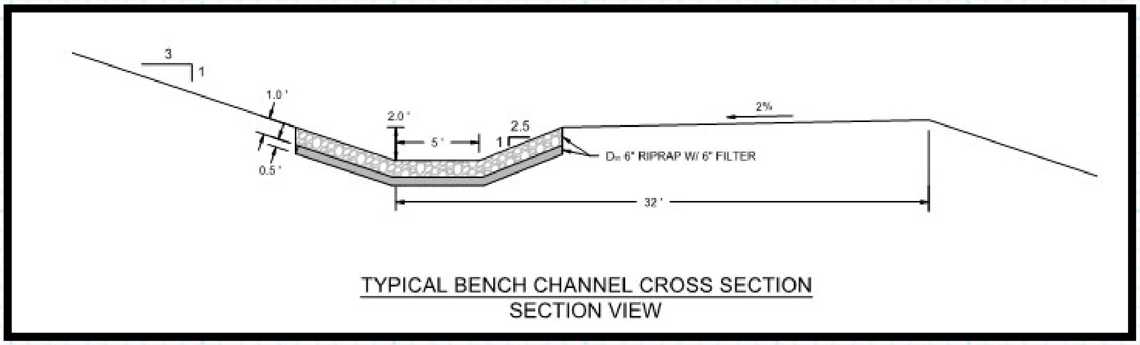
Data and Assumptions:

1. See the Channel Size Verification calculation documentation for New Mexico operations

Job No: 200540A	Client: FMI	Page 2 of 13
Task: NM Operations Stormwater Management	Computed By: T. Tigges	Date: 1/13/21
	Checked By: W. Niccoli	Date: 1/12/21

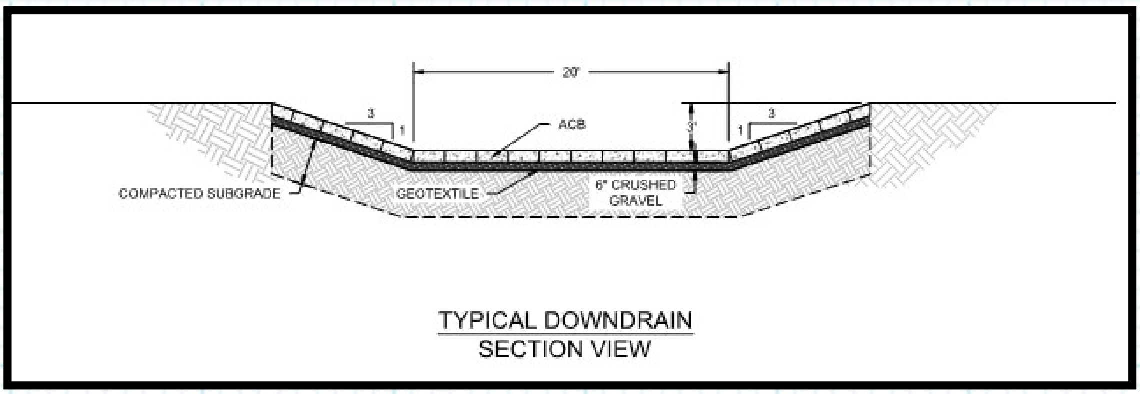
Data and Assumptions: *Calculation Documentation*

2. Bench channels are dimensioned as follows:

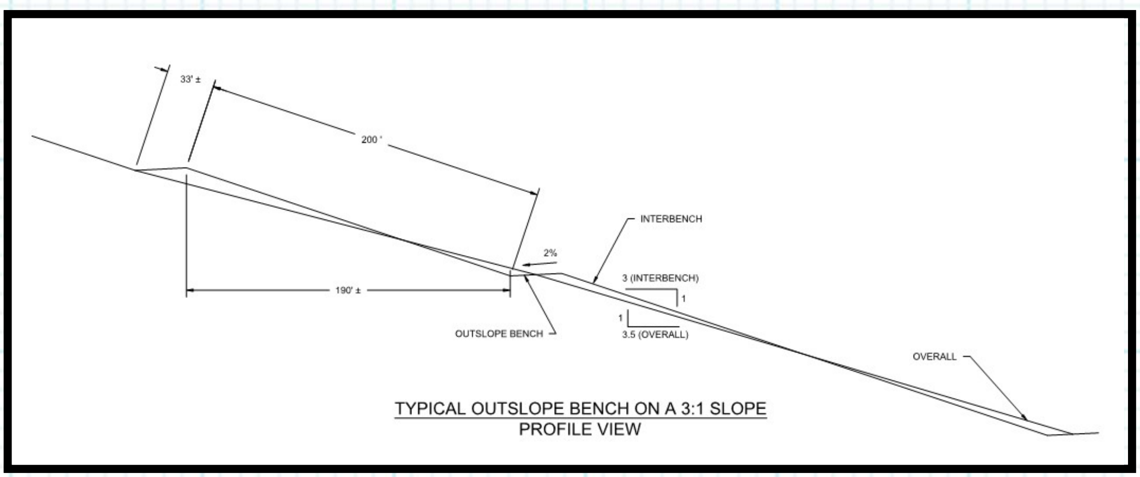


TYPICAL BENCH CHANNEL CROSS SECTION
SECTION VIEW

3. Downdrains are dimensioned as follows:



TYPICAL DOWNDRAIN
SECTION VIEW



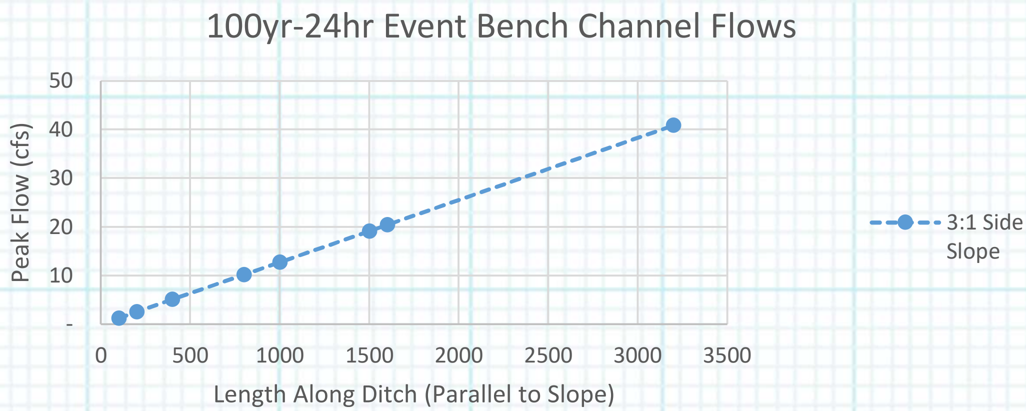
TYPICAL OUTSLOPE BENCH ON A 3:1 SLOPE
PROFILE VIEW

4. No top channels are proposed in the Little Rock Mine CCP.

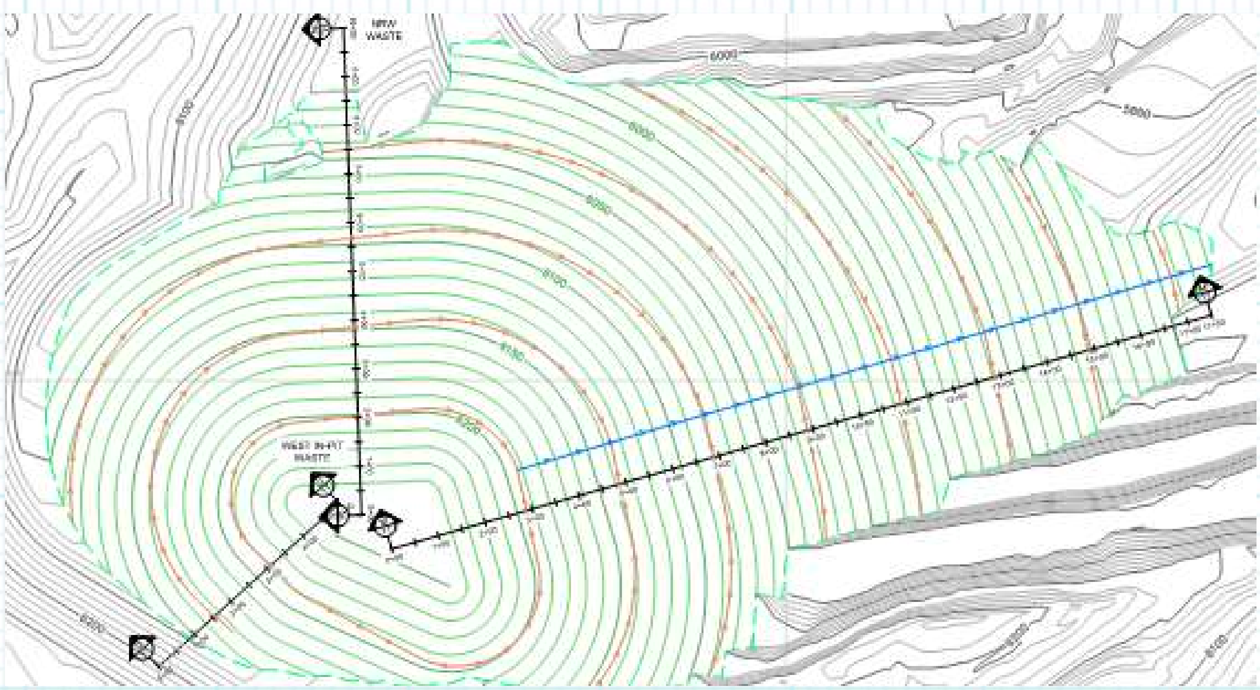
Calculation Documentation

Calculations and Results:

Calculate total and peak runoff using SCS TR-55 (see: YYYYMMDD_TR-55_Channel_Sizing.xlsx). Use the spreadsheet to calculate required channel sizes (bench and downdrain) for the Little Rock Mine CCP. The West In-Pit waste was found to have the largest peak flows for both bench channels and downdrain.



West In-Pit Waste: *("worst case" scenario for Little Rock reclamation channels)*
Longest bench channel = 1824 ft
Maximum bench channel flow = 24 cfs
Bench channel depth = 0.77 ft, velocity = 4.3 fps
Total downdrain flow = 134 cfs
Downdrain depth = 0.39 ft, velocity = 16.9 fps
Because the requirements have been met for the West In-Pit Waste, the other stockpile conveyance channels are also adequate, with smaller ditch lengths and total flow.



Discussion and Conclusions:

1. The bench channels at West In-Pit Waste were found to have velocities less than 5 fps and the typical bench channel capacity was adequate, as well. For future projects, verify riprap size for velocities above 5 ft/s (silt erosive velocity).
2. The downdrain at West In-Pit Waste also met the requirements needed for use of 40T ACB system and typical channel capacity.
3. This calculation set is conservative in that it assumes the peak flows occur simultaneously, which is not the case. Larger drainage areas will lag behind the smaller areas.
4. The calculation set met its objectives by estimating, runoff flow rates, verifying that the channels can carry the flow safely, and showing that typical erosion protection is adequate.