COLORADO
Division of Reclamation, Mining and Safety
Department of Natural Resources

August 27, 2024

Greg Dangler
RMR Aggregates, Inc.
6200 S. Syracuse Way, Suite 450
Greenwood Village, CO 801111

RE: Mid-Continent LST, Permit No. M-1982-121, Proposed SI-4 Reclamation Cost Estimate

Dear Mr. Dangler:

This reclamation cost update was in response to changes made under Technical Revision (TR-6) which was approved on March 29, 2024. It is Division policy to periodically update its costs to ensure that the Financial Warranty adequately reflects the actual current cost of fulfilling the requirements of the approved reclamation plan.

The last surety increase occurred in 2019 with SI-3. Below is a table summarizing input values. Figures that have been changed are in red. This table does not account for price changes resulting from inflation or other RS Means cost changes. Bond calculations are based on a combination of field observations and worst case scenario based on the approved reclamation permit.

*Additional BLM Specific Requirements

Task	Form Used	Description
*01a	Demo	Demo/ Removal of onsite facilities and structures *Per BLM on-site disposal of metal structures is not authorized on Federal Lands. Haul to South Canyon Garfield County Landfill, approx. 8 miles. Demo hrs. = 492 (See attached)
		Removed - Place loose material against highwall/grade benches. Unnecessary with rock bolting
02a	Loader	Transport Fines over Processing benches (New Task). 30'W x 1000' LF x 2 Benches = 60,000 Sq. Ft. = 1.38 ac @ 12" = 2,226 CCY Haul avg 700 LF @ 15% grade

Task	Form Used	Description
02c	Loader	Carry Topsoil to processing benches 1.38 ac @ 6" = 1,113 CCY Haul avg 1300 LF @ 15% grade
02d	Dozer	Spread Transported Topsoil over Processing benches Transported 1,252 LCY, with 50 Ft push
		Removed - Place of backfill against processing bench TR-4 was withdrawn, can't use this figure
03b	Dozer	Finish grading of process bench material 2.75 ac @ 24" = 8,887 CCY Avg. push 150 LF, Ripper 30%
03c	Loader	Trasport topsoil to processing bench 2.75 ac @ 6" = 2,218 CCY Haul avg 1300 LF @ 15% grade
03d	Dozer	Distribute topsoil over processing bench Transported 2,695 LCY, with 50 Ft push
04b	Dozer	Grading of mill bench to 2H: 1V and general blending Est: 60'H x 700 LF of 0.5H: 1V to 2H: 1V = 11,667 CCY Cut/fill, Ripper 30% Prev Est: 10,000 CCY
		Removed - Transport topsoil No carry necessary, push only
04d	Dozer	Spread transported topsoil on Mill Bench 2ac @ 6" = 1,613 CCY, Avg Push distance 175'
05a	Ripper	Rip Upper and Lower access roads 2 ac (3100 LF x 28'W)

Task	Form Used	Description
07b	Mob	Secondary Mobilization of Equipment to site No changes
RB-1	User Provided	Rock Bolting Highwall Safeguarding See attached spreadsheets. Range of cost depending on input source used.
Indirect		10% Contingency required per BLM, DRMS holds 3%, add 7% per BLM 10% Contractor Profit, DRMS requires 10% amount sufficient. 1.5% Contractor Liability Insurance, DRMS requires 2.02% amount sufficient. Performance Bond 1.5% per BLM, DRMS Holds 1.05%, add 0.45% per BLM 10% Contract Administration (engineering bid-prep) per BLM, DRMS requires 4.89%, add 5.11% per BLM 20.58% BLM Contract Administration, not required by DRMS, add 20.58% of reclamation management and/or administration cost for BLM

The Division acknowledges that the need for rock bolting significantly increases the reclamation liabilities for this site. Furthermore, the cost associated with installing these features can vary greatly from one contractor to the next. The Division has done its best to provide a range of the potential costs associated with installing the rock stabilization features. Generally, the Division will take the most conservative estimate. However, given the potential uncertainty associated with this cost the Division would like to afford RMR the opportunity to obtain their own bids for the purpose validating and refining these costs. If RMR would like to use a cost other than the Division proposed maximum they must provide to the Division three separate quotes to perform the rock bolting. Quotes must clearly demonstrate that the work scope is as per the approved TR-6 Geotechnical Plan. Quotes must include total job hours associated with each task to be performed and the equipment used. The Division will then use the average cost of the three bids.

RMR shall provide to the Division the three bids by Friday, October 25, 2024. If no response is received by **Friday, October 25, 2024,** then we will issue the maximum estimate. SI-4 will result in a total required bond amount of **$3,251,767,** which is an increase of **$2,885,588** over the $366,179 currently held.

Please feel free to contact me with any further questions. Amy Yeldell at the Division of Reclamation, Mining and Safety, Rm 215, 1001 E 62nd Ave, Denver CO 80216. Direct contact can be made by phone at 970-210-1272 or via email at amy.yeldell@ state.co.us

Sincerely,

Amy Yeldell
Environmental Protection Specialist

Enclosed: Proposed SI-4 Reclamation Cost Estimate

Ec:
Bobby Wagner, RMR
Russ Means, Program Manager
Travis Marshall, Senior EPS, Grand Junction DRMS
Brittany Cocina, BLM
Valerie Baxter, BLM

COST SUMMARY WORK

Task description: **Proposed SI-4**

Site: **Mid-Continent LST** Permit Action: SI-4 Permit/Job#: M1982121

PROJECT IDENTIFICATION

Task #: ACY State: Colorado Abbreviation: None
Date: 8/23/2024 County: Garfield Filename: M121-ACY
User: ACY

Agency or organization name: DRMS

TASK LIST (DIRECT COSTS)

Task	Description	Form Used	Fleet Size	Task Hours	Cost
01a	Demo/removal of onsite facilities and structures	DEMOLISH	1	492.00	$198,725
02a	Transport Fines over Processing benches	LOADER	2	16.23	$5,108
02b	Spread Transported Fines over Processing benches	DOZER	2	2.02	$1,300
02c	Transport Topsoil over Processing benches	LOADER	2	9.04	$2,846
02d	Spread Transported Topsoil over Processing benches	DOZER	2	0.94	$607
03b	Finish grading of process bench highwall	DOZER	2	23.75	$16,081
03c	Transport topsoil to processing bench	LOADER	2	19.18	$6,035
03d	Distribute topsoil over processing bench	DOZER	2	2.03	$1,306
04b	Grade mill bench to 2H:1V Slope and general blending	DOZER	2	23.20	$15,706
04d	Spread topsoil over mill pad area	DOZER	2	4.13	$2,654
05a	Rip upper and lower access roads	RIPPER	2	1.55	$1,072
06a	Reveg disturbed areas	REVEGE	1	40.00	$59,607
07a	Initial Mobilization	MOBILIZE	1	5.86	$12,735
07b	Secondary Mobilization	MOBILIZE	1	1.93	$762
RB	Rock Bolting - 200 Anchors Min - Max	NA	1	2,707.00	$959,350- $1,896,000
	SUBTOTAL (DC) MIN-MAX:			**3348.86**	**$1,283,894 - $2,220,544**

ROCK BOLTING:

Direct cost vary greatly between input sources, RS Means vs CDOT. As well as engineering estimates vs actual bids received. DRMS has presented the cost range for rock bolting data available to the Division. The Operator is encouraged to obtain a minimum of three bids to complete the rock bolting on site. The Division will take average cost between the bids for bonding purposes.

JOB SUPERINTENDENT HOURS:

50% of all hours except Rock Bolting (641.86 x 50% = 320.93 hrs.)
33% of Rock Bolting (2707 x 33% = 901.43 hrs.)
Simultaneous Operations are anticipated = 1,222.361 hrs.

INDIRECT COSTS

OVERHEAD AND PROFIT:			MIN	MAX
Liability insurance (DC):	2.02%	Total =	$25,935	$44,855
Performance bond (DC):	1.05%	Total =	$13,481	$23,316
*BLM total 1.5% (DC):	0.45%	Total =	$5,778	$9,992
Job superintendent Hrs:	1,133.00	Total =	$89,813	$89,813
Profit (DC):	10.00%	Total =	$128,389	$222,054
		TOTAL O & P =	$257,618	$390,030
		CONTRACT AMOUNT (direct + O & P) =	$1,541,512	$2,610,574

LEGAL - ENGINEERING - PROJECT MANAGEMENT: (added to contract amount)

Financial warranty processing (legal/related costs):	$500	Total =	$500	$500
Engineering work and/or contract/bid preparation (CA):	4.25%	Total =	$65,514	$110,949
Reclamation management and/or administration (CA):	5.41%	Total =	$83,708	$141,232
*BLM total 10% (CA):	4.59%	Total =	$71,021	$119,825
*BLM Indirect Cost of Rec Mgmt (DC) 21% of the 10% profit or 2.1% of DC	2.1%	Total =	$26,962	$46,631
CONTINGENCY (DC):	3.00%	Total =	$38,517	$66,616
*BLM total 10% (DC):	7.00%	Total =	$89,873	$115,438
		TOTAL INDIRECT COST =	$639,735	$1,031,223
		TOTAL BOND AMOUNT (direct + indirect) =	**$1,923,629**	**$3,251,767**

DEMOLITION WORK

Task description: **Demo/removal of onsite facilities and structures**

Site: **Mid-Continent LST** Permit Action: SI-4 Permit/Job#: M1982121

PROJECT IDENTIFICATION

Task #: 01A State: Colorado Abbreviation: None
Date: 8/23/2024 County: Garfield Filename: M121-01a
User: ACY

Agency or organization name: DRMS

UNIT COSTS **Location adjustment: 95.50 %**

Structure or Item Description	Dimensions	Demolition Menu Selection	Quantity	Unit	Unit Cost	Total Cost
Mill Building	30'H x 50'W x 125'L	Plant (3S) demo./off-site disposal in approved landfill - Max. 15 mile haul	187,500.00	CF	$0.88	$164,381.25
Mill slab	50' x 125' x 10"	Pavement, concrete, demolition only, 7 in. to 24 in. thick - Reinforced	192.00	CY	$151.50	$29,088.00
Mill Slab-Hauling	192 CY	Loading and 2 mile haul, no salvage - Machine loading	192.00	CY	$21.15	$4,060.80
Mill Slab-Hauling Additional Mileage	192 CY, 6 Mi	Hauling only, per mile, 12-18 CY truck - 30 mph average speed	64.00	MI	$10.14	$649.05
Mill Slab-Disposal Fee	192 CY	Dump fees - Building construction materials.	192.00	CY	$11.10	$2,131.20
Silo (2x)	30' H x 10' D each	Loading and 2 mile haul, no salvage - Machine loading	175.00	CY	$21.15	$3,701.25
Silo-Hauling Additional Mileage	175 CY, 6 Mi	Hauling only, per mile, 12-18 CY truck - 30 mph average speed	59.00	MI	$10.14	$598.34
Silo-Disposal Fee	175 CY	Dump fees - Building construction materials.	175.00	CY	$11.10	$1,942.50
Scale	30' L x 12' W	Loading and 2 mile haul, no salvage - Machine loading	27.00	CY	$21.15	$571.05
Scale-Hauling Additional Mileage	27 CY, 6 Mi	Hauling only, per mile, 12-18 CY truck - 30 mph average speed	12.00	MI	$10.14	$121.70
Scale-Disposal Fee	27 CY	Dump fees - Building construction materials.	27.00	CY	$11.10	$299.70
Conveyor	40' L x 24" W	Conveyor, demolition, off-site disposal in approved landfill, 15 mile haul	640.00	CF	$0.85	$544.00

Job Hours: **492.00** **Subtotal (unadjusted):** **$208,088.84** **Total Cost (adjusted for location):** **$198,724.84**

Job Demo Hours

Task	Quant	Unit	Min Hrs	Max	Crew
Demo Mill Bldg	187,500	CF	122.47	135.92	B-8
Demo Mill Slab	192	CY	320.06	320.06	B-38
Haul Mill Slab	192	CY	12.67	12.67	B-17
Additional Milage Mill Slab	192	CY	6.34	6.34	B-34B
Disposal Fee			-	-	
Load/Haul Silos	175	CY	11.5	11.5	B-17
Additional Milage Silos	175	CY	5.78	5.78	B-34B
Disposal Fee			-	-	
Load/Haul Scale	27	CY	1.78	1.78	B-17
Additional Milage Scale	27	CY	0.89	0.89	B-34B
Disposal Fee			-	-	
Demo conveyor	640	CF	0.42	0.46	CIRCES 2
Total			**481.91**	**495.4**	

WHEEL LOADER – LOAD AND CARRY WORK

Task description: **Transport Fines over Processing benches**

Site: **Mid-Continent LST** Permit Action: SI-4 Permit/Job#: M1982121

PROJECT IDENTIFICATION

Task #: 02A State: Colorado Abbreviation: None
Date: 8/23/2024 County: Garfield Filename: M121-02a
User: ACY

Agency or organization name: DRMS

HOURLY EQUIPMENT COST

Basic Machine: CAT 972H Horsepower: 287
Attachment 1: ROPS Cab Shift Basis: 1 per day
Data Source: (CRG)

Cost Breakdown:

		Utilization %
Ownership Cost/Hour:	$62.43	NA
Operating Cost/Hour:	$57.98	100
Operator Cost/Hour:	$36.85	NA
Total Unit Cost/Hour:	$157.26	
Total Fleet Cost/Hour:	$314.53	

MATERIAL QUANTITIES

Initial volume: 2,226 CCY Swell factor: 1.345
Loose volume: **2,994** LCY

Source of estimated volume: 30'W x 1000' LF x 2 Benches 1.38 ac @ 12"
Source of estimated swell factor: Cat Handbook

HOURLY PRODUCTION

Loader Cycle Time: Unadjusted Basic Cycle Time (load, dump, maneuver): 0.525 minutes

Cycle Time Factors		Factor (min.)	Source
Material:	Bank or broken material 0.04	0.040	(Cat HB)
Stockpile:	No adjustment - factor not applicable 0.00	0.000	(Cat HB)
Truck Ownership:	No adjustment - factor not applicable 0.00	0.000	(Cat HB)
Operation:	Constant operation -0.04	-0.040	(Cat HB)
Dump Target:	Small target 0.04	0.040	(Cat HB)
	Net Cycle Time Adjustment:	0.040	minutes
	Adjusted Basic Cycle Time:	0.565	minutes

Rolling Resistance – Road Conditions

Haul: Rutted dirt, little maintenance, no water, 2" tire penetration 5.0
Return: Rutted dirt, little maintenance, no water, 2" tire penetration 5.0

Haul and Return Time

	Length (feet)	Grade Res. (%)	Rolling Res. (%)	Total Res. (%)	Travel Time (minutes)	Source
Haul Route:	700	9.90	5.00	14.90	1.3484	(Cat HB)
Return Route:	700	-9.90	5.00	-4.90	0.5824	(Cat HB)

Total Travel Time:	1.9308	minutes
Total Cycle Time:	**2.4958**	minutes

Load Bucket Capacity

Rated Capacity:	5.60	LCY (heaped)
Bucket Fill Factor:	0.825	Blasted rock - avg. blasted (75 - 90%) 0.825
Adjusted Capacity:	**4.62**	LCY

Job Condition Correction Factors
Site Altitude: 6800 feet

		Source
Altitude Adj:	1.00	(CAT HB)
Job Efficiency:	0.83	(1 shift/day)
Net Correction:	0.83	multiplier

Unadjusted Hourly Unit Production:	111.07	LCY/Hour
Adjusted Hourly Unit Production:	92.18	LCY/Hour
Adjusted Hourly Fleet Production:	**184.37**	LCY/Hour

JOB TIME AND COST

Fleet size:	2	Loader(s)	Total job time:	**16.24**	Hours
Unit cost:	$1.706	/LCY	Total job cost:	**$5,108**	

BULLDOZER WORK

Task description: **Spread Transported Fines over Processing benches**

Site: **Mid-Continent LST** Permit Action: SI-4 Permit/Job#: M1982121

PROJECT IDENTIFICATION

Task #: 02B State: Colorado Abbreviation: None
Date: 8/23/2024 County: Garfield Filename: M121-02b
User: ACY

Agency or organization name: DRMS

HOURLY EQUIPMENT COST

Basic Machine: Cat D8T - 8SU
Horsepower: 310
Blade Type: Semi-Universal
Attachment: NA
Shift Basis: 1 per day
Data Source: (CRG)

Cost Breakdown:

		Utilization %
Ownership Cost/Hour:	$173.32	NA
Operating Cost/Hour:	$109.71	100
Ripper own. Cost/Hour:	$0.00	NA
Ripper op. Cost/Hour:	$0.00	0
Operator Cost/Hour:	$38.59	NA

Total unit Cost/Hour: $321.62
Total Fleet Cost/Hour: **$643.23**

MATERIAL QUANTITIES

Initial Volume: 2,994
Swell factor: 1.000
Loose volume: **2,994** LCY

Source of estimated volume: Transported Volume
Source of estimated swell factor: Cat Handbook

HOURLY PRODUCTION

Average push distance: 50 feet
Unadjusted hourly production: 1,400.0 LCY/hr

Materials consistency description: Loose stockpile 1.2

Average push gradient: 0 %
Average site altitude: 6,800 feet

Material weight: 2,600 lbs/LCY

Weight description: Limestone - Broken

Job Condition Correction Factor		Source
Operator Skill:	0.750	(AVG.)
Material consistency:	1.200	(CAT HB)
Dozing method:	1.000	(GEN.)
Visibility:	1.000	(AVG.)

Job efficiency:	0.830	(1 SHIFT/DAY)
Spoil pile:	0.800	(FND-RF)
Push gradient:	1.000	(CAT HB)
Altitude:	1.000	(CAT HB)
Material Weight:	0.885	(CAT HB)
Blade type:	1.000	(PAT)

Net correction: 0.5289

Adjusted unit production: 740.46 LCY/hr
Adjusted fleet production: **1480.92** LCY/hr

JOB TIME AND COST

Fleet size: 2 Dozer(s)
Unit cost: $0.434/LCY

Total job time: **2.02** Hours
Total job cost: **$1,300**

WHEEL LOADER – LOAD AND CARRY WORK

Task description: **Transport Topsoil over Processing benches**

Site: **Mid-Continent LST** Permit Action: SI-4 Permit/Job#: M1982121

PROJECT IDENTIFICATION

Task #: 02C State: Colorado Abbreviation: None
Date: 8/23/2024 County: Garfield Filename: M121-02c
User: ACY

Agency or organization name: DRMS

HOURLY EQUIPMENT COST

Basic Machine: CAT 972H Horsepower: 287
Attachment 1: ROPS Cab Shift Basis: 1 per day
Data Source: (CRG)

Cost Breakdown:

		Utilization %
Ownership Cost/Hour:	$62.43	NA
Operating Cost/Hour:	$57.98	100
Operator Cost/Hour:	$36.85	NA
Total Unit Cost/Hour:	$157.26	

Total Fleet Cost/Hour: $314.53

MATERIAL QUANTITIES

Initial volume: 1,113 CCY Swell factor: 1.125
Loose volume: **1,252** LCY

Source of estimated volume: 1.38 ac @ 6”
Source of estimated swell factor: Cat Handbook

HOURLY PRODUCTION

Loader Cycle Time: Unadjusted Basic Cycle Time (load, dump, maneuver): 0.525 minutes

Cycle Time Factors		Factor (min.)	Source
Material:	Mixed material 0.02	0.020	(Cat HB)
Stockpile:	No adjustment - factor not applicable 0.00	0.000	(Cat HB)
Truck Ownership:	No adjustment - factor not applicable 0.00	0.000	(Cat HB)
Operation:	Constant operation -0.04	-0.040	(Cat HB)
Dump Target:	Small target 0.04	0.040	(Cat HB)
	Net Cycle Time Adjustment:	0.020	minutes
	Adjusted Basic Cycle Time:	0.545	minutes

Rolling Resistance – Road Conditions

Haul: Rutted dirt, little maintenance, no water, 2” tire penetration 5.0
Return: Rutted dirt, little maintenance, no water, 2” tire penetration 5.0

Haul and Return Time

	Length (feet)	Grade Res. (%)	Rolling Res. (%)	Total Res. (%)	Travel Time (minutes)	Source
Haul Route:	1300	9.90	5.00	14.90	2.5042	(Cat HB)
Return Route:	1300	-9.90	5.00	-4.90	1.0816	(Cat HB)

Total Travel Time:	3.5858	minutes
Total Cycle Time:	**4.1308**	minutes

Load Bucket Capacity

Rated Capacity:	5.60	LCY (heaped)
Bucket Fill Factor:	1.025	Rock - Earth Mixture (100%-105%) 1.025
Adjusted Capacity:	**5.74**	LCY

Job Condition Correction Factors
Site Altitude: 6800 feet

		Source
Altitude Adj:	1.00	(CAT HB)
Job Efficiency:	0.83	(1 shift/day)
Net Correction:	0.83	multiplier

Unadjusted Hourly Unit Production:	83.37	LCY/Hour
Adjusted Hourly Unit Production:	69.20	LCY/Hour
Adjusted Hourly Fleet Production:	**138.40**	LCY/Hour

JOB TIME AND COST

Fleet size:	2	Loader(s)	Total job time:	**9.05**	Hours
Unit cost:	$2.273	/LCY	Total job cost:	**$2,846**	

BULLDOZER WORK

Task description: **Spread Transported Topsoil over Processing benches**

Site: **Mid-Continent LST** Permit Action: SI-4 Permit/Job#: M1982121

PROJECT IDENTIFICATION

Task #: 02D State: Colorado Abbreviation: None
Date: 8/23/2024 County: Garfield Filename: M121-02d
User: ACY

Agency or organization name: DRMS

HOURLY EQUIPMENT COST

Basic Machine: Cat D8T - 8SU
Horsepower: 310
Blade Type: Semi-Universal
Attachment: NA
Shift Basis: 1 per day
Data Source: (CRG)

Cost Breakdown:

		Utilization %
Ownership Cost/Hour:	$173.32	NA
Operating Cost/Hour:	$109.71	100
Ripper own. Cost/Hour:	$0.00	NA
Ripper op. Cost/Hour:	$0.00	0
Operator Cost/Hour:	$38.59	NA

Total unit Cost/Hour: $321.62
Total Fleet Cost/Hour: **$643.23**

MATERIAL QUANTITIES

Initial Volume: 1,252
Swell factor: 1.000
Loose volume: **1,252** LCY

Source of estimated volume: Transported Volume
Source of estimated swell factor: Cat Handbook

HOURLY PRODUCTION

Average push distance: 50 feet
Unadjusted hourly production: 1,400.0 LCY/hr

Materials consistency description: Loose stockpile 1.2

Average push gradient: 0 %
Average site altitude: 6,800 feet

Material weight: 2,900 lbs/LCY

Weight description: Decomposed rock - 50% Rock, 50% Earth

Job Condition Correction Factor		Source
Operator Skill:	0.750	(AVG.)
Material consistency:	1.200	(CAT HB)
Dozing method:	1.000	(GEN.)
Visibility:	1.000	(AVG.)

Job efficiency:	0.830	(1 SHIFT/DAY)
Spoil pile:	0.800	(FND-RF)
Push gradient:	1.000	(CAT HB)
Altitude:	1.000	(CAT HB)
Material Weight:	0.793	(CAT HB)
Blade type:	1.000	(PAT)

Net correction: 0.4739

Adjusted unit production: 663.46 LCY/hr
Adjusted fleet production: **1326.92** LCY/hr

JOB TIME AND COST

Fleet size: 2 Dozer(s)
Unit cost: $0.485/LCY

Total job time: **0.94** Hours
Total job cost: **$607**

BULLDOZER WORK

Task description: **Finish grading of process bench highwall**

Site: **Mid-Continent LST** Permit Action: SI-4 Permit/Job#: M1982121

PROJECT IDENTIFICATION

Task #: 03B State: Colorado Abbreviation: None
Date: 8/23/2024 County: Garfield Filename: M121-03b
User: ACY

Agency or organization name: DRMS

HOURLY EQUIPMENT COST

Basic Machine: Cat D8T - 8SU
Horsepower: 310
Blade Type: Semi-Universal
Attachment: 3-shank ripper
Shift Basis: 1 per day
Data Source: (CRG)

Cost Breakdown:

		Utilization %
Ownership Cost/Hour:	$173.32	NA
Operating Cost/Hour:	$109.71	100
Ripper own. Cost/Hour:	$14.53	NA
Ripper op. Cost/Hour:	$2.39	30
Operator Cost/Hour:	$38.59	NA

Total unit Cost/Hour: $338.53
Total Fleet Cost/Hour: **$677.06**

MATERIAL QUANTITIES

Initial Volume: 8,887
Swell factor: 1.345
Loose volume: **11,953** LCY

Source of estimated volume: 2.75 Ac @ 24"
Source of estimated swell factor: Cat Handbook

HOURLY PRODUCTION

Average push distance: 150 feet
Unadjusted hourly production: 634.3 LCY/hr

Materials consistency description: Compacted fill or embankment 0.9

Average push gradient: 0 %
Average site altitude: 6,800 feet

Material weight: 2,600 lbs/LCY

Weight description: Limestone - Broken

Job Condition Correction Factor		Source
Operator Skill:	0.750	(AVG.)
Material consistency:	0.900	(CAT HB))
Dozing method:	1.000	(GEN.)
Visibility:	1.000	(AVG.)

Job efficiency:	0.830	(1 SHIFT/DAY)
Spoil pile:	0.800	(FND-RF)
Push gradient:	1.000	(CAT HB)
Altitude:	1.000	(CAT HB)
Material Weight:	0.885	(CAT HB)
Blade type:	1.000	(PAT)

Net correction: 0.3967

Adjusted unit production: 251.63 LCY/hr
Adjusted fleet production: **503.26** LCY/hr

JOB TIME AND COST

Fleet size: 2 Dozer(s)
Unit cost: $1.345/LCY

Total job time: **23.75** Hours
Total job cost: **$16,081**

WHEEL LOADER – LOAD AND CARRY WORK

Task description: **Transport topsoil to processing bench**

Site: **Mid-Continent LST** Permit Action: SI-4 Permit/Job#: M1982121

PROJECT IDENTIFICATION

Task #: 03C State: Colorado Abbreviation: None
Date: 8/23/2024 County: Garfield Filename: M121-03c
User: ACY

Agency or organization name: DRMS

HOURLY EQUIPMENT COST

Basic Machine: CAT 972H Horsepower: 287
Attachment 1: ROPS Cab Shift Basis: 1 per day
Data Source: (CRG)

Cost Breakdown:

		Utilization %
Ownership Cost/Hour:	$62.43	NA
Operating Cost/Hour:	$57.98	100
Operator Cost/Hour:	$36.85	NA
Total Unit Cost/Hour:	$157.26	
Total Fleet Cost/Hour:	$314.53	

MATERIAL QUANTITIES

Initial volume: 2,218 CCY Swell factor: 1.215
Loose volume: **2,695** LCY

Source of estimated volume: (150’ W x 800’ L) 2.75 ac. @ 6” Thick
Source of estimated swell factor: Cat Handbook

HOURLY PRODUCTION

Loader Cycle Time: Unadjusted Basic Cycle Time (load, dump, maneuver): 0.525 minutes

Cycle Time Factors		Factor (min.)	Source
Material:	Mixed material 0.02	0.020	(Cat HB)
Stockpile:	Dumped by truck 0.02	0.020	(Cat HB)
Truck Ownership:	Common ownership of trucks and loaders -0.04	-0.040	(Cat HB)
Operation:	Constant operation -0.04	-0.040	(Cat HB)
Dump Target:	Nominal target 0.00	0.000	(Cat HB)
	Net Cycle Time Adjustment:	-0.040	minutes
	Adjusted Basic Cycle Time:	0.485	minutes

Rolling Resistance – Road Conditions

Haul: Rutted dirt, little maintenance, no water, 2” tire penetration 5.0
Return: Rutted dirt, little maintenance, no water, 2” tire penetration 5.0

Haul and Return Time

	Length (feet)	Grade Res. (%)	Rolling Res. (%)	Total Res. (%)	Travel Time (minutes)	Source
Haul Route:	1300	9.90	5.00	14.90	2.5042	(Cat HB)
Return Route:	1300	-9.90	5.00	-4.90	1.0816	(Cat HB)

Total Travel Time:	3.5858	minutes
Total Cycle Time:	**4.0708**	minutes

Load Bucket Capacity

Rated Capacity:	5.60	LCY (heaped)
Bucket Fill Factor:	1.025	Rock - Earth Mixture (100%-105%) 1.025
Adjusted Capacity:	**5.74**	LCY

Job Condition Correction Factors
Site Altitude: 6800 feet

		Source
Altitude Adj:	1.00	(CAT HB)
Job Efficiency:	0.83	(1 shift/day)
Net Correction:	0.83	multiplier

Unadjusted Hourly Unit Production:	84.60	LCY/Hour
Adjusted Hourly Unit Production:	70.22	LCY/Hour
Adjusted Hourly Fleet Production:	**140.44**	LCY/Hour

JOB TIME AND COST

Fleet size:	2	Loader(s)	Total job time:	**19.19**	Hours
Unit cost:	$2.240	/LCY	Total job cost:	**$6,035**	

BULLDOZER WORK

Task description: **Distribute topsoil over processing bench**

Site: **Mid-Continent LST** Permit Action: SI-4 Permit/Job#: M1982121

PROJECT IDENTIFICATION

Task #:	03D	State:	Colorado	Abbreviation:	None
Date:	8/23/2024	County:	Garfield	Filename:	M121-03d
User:	ACY				

Agency or organization name: DRMS

HOURLY EQUIPMENT COST

Basic Machine:	Cat D8T - 8SU
Horsepower:	310
Blade Type:	Semi-Universal
Attachment:	NA
Shift Basis:	1 per day
Data Source:	(CRG)

Cost Breakdown:

		Utilization %
Ownership Cost/Hour:	$173.32	NA
Operating Cost/Hour:	$109.71	100
Ripper own. Cost/Hour:	$0.00	NA
Ripper op. Cost/Hour:	$0.00	0
Operator Cost/Hour:	$38.59	NA

Total unit Cost/Hour: $321.62
Total Fleet Cost/Hour: **$643.23**

MATERIAL QUANTITIES

Initial Volume:	2,695
Swell factor:	1.000
Loose volume:	**2,695** LCY

Source of estimated volume: Transported volume
Source of estimated swell factor: Cat Handbook

HOURLY PRODUCTION

Average push distance: 50 feet
Unadjusted hourly production: 1,400.0 LCY/hr

Materials consistency description: Loose stockpile 1.2

Average push gradient: 0 %
Average site altitude: 6,800 feet

Material weight: 2,900 lbs/LCY

Weight description: Decomposed rock - 50% Rock, 50% Earth

Job Condition Correction Factor		Source
Operator Skill:	0.750	(AVG.)
Material consistency:	1.200	(CAT HB)
Dozing method:	1.000	(GEN.)
Visibility:	1.000	(AVG.)

Job efficiency:	0.830	(1 SHIFT/DAY)
Spoil pile:	0.800	(FND-RF)
Push gradient:	1.000	(CAT HB)
Altitude:	1.000	(CAT HB)
Material Weight:	0.793	(CAT HB)
Blade type:	1.000	(PAT)

Net correction: 0.4739

Adjusted unit production: 663.46 LCY/hr
Adjusted fleet production: **1326.92** LCY/hr

JOB TIME AND COST

Fleet size: 2 Dozer(s)
Unit cost: $0.485/LCY

Total job time: **2.03** Hours
Total job cost: **$1,306**

BULLDOZER WORK

Task description: **Grade mill bench to 2H:1V Slope and general blending**

Site: **Mid-Continent LST** Permit Action: SI-4 Permit/Job#: M1982121

PROJECT IDENTIFICATION

Task #: 04B State: Colorado Abbreviation: None
Date: 8/23/2024 County: Garfield Filename: M121-04b
User: ACY

Agency or organization name: DRMS

HOURLY EQUIPMENT COST

Basic Machine: Cat D8T - 8SU
Horsepower: 310
Blade Type: Semi-Universal
Attachment: 3-shank ripper
Shift Basis: 1 per day
Data Source: (CRG)

Cost Breakdown:

		Utilization %
Ownership Cost/Hour:	$173.32	NA
Operating Cost/Hour:	$109.71	100
Ripper own. Cost/Hour:	$14.53	NA
Ripper op. Cost/Hour:	$2.39	30
Operator Cost/Hour:	$38.59	NA

Total unit Cost/Hour: $338.53
Total Fleet Cost/Hour: **$677.06**

MATERIAL QUANTITIES

Initial Volume: 11,667
Swell factor: 1.345
Loose volume: **15,692** LCY

Source of estimated volume: 60'H x 700 LF of 0.5H: 1V to 2H: 1V Cut/fill
Source of estimated swell factor: Cat Handbook

HOURLY PRODUCTION

Average push distance: 100 feet
Unadjusted hourly production: 852.6 LCY/hr

Materials consistency description: Compacted fill or embankment 0.9

Average push gradient: 0 %
Average site altitude: 6,800 feet

Material weight: 2,600 lbs/LCY

Weight description: Limestone - Broken

Job Condition Correction Factor		Source
Operator Skill:	0.750	(AVG.)
Material consistency:	0.900	(CAT HB))
Dozing method:	1.000	(GEN.)
Visibility:	1.000	(AVG.)

Job efficiency:	0.830	(1 SHIFT/DAY)
Spoil pile:	0.800	(FND-RF)
Push gradient:	1.000	(CAT HB)
Altitude:	1.000	(CAT HB)
Material Weight:	0.885	(CAT HB)
Blade type:	1.000	(PAT)

Net correction: 0.3967

Adjusted unit production: 338.23 LCY/hr
Adjusted fleet production: **676.46** LCY/hr

JOB TIME AND COST

Fleet size: 2 Dozer(s)
Unit cost: $1.001/LCY

Total job time: **23.20** Hours
Total job cost: **$15,706**

BULLDOZER WORK

Task description: **Spread topsoil over mill pad area**

Site: **Mid-Continent LST** Permit Action: SI-4 Permit/Job#: M1982121

PROJECT IDENTIFICATION

Task #: 04D State: Colorado Abbreviation: None
Date: 8/23/2024 County: Garfield Filename: M121-04d
User: ACY

Agency or organization name: DRMS

HOURLY EQUIPMENT COST

Basic Machine: Cat D8T - 8SU
Horsepower: 310
Blade Type: Semi-Universal
Attachment: NA
Shift Basis: 1 per day
Data Source: (CRG)

Cost Breakdown:

		Utilization %
Ownership Cost/Hour:	$173.32	NA
Operating Cost/Hour:	$109.71	100
Ripper own. Cost/Hour:	$0.00	NA
Ripper op. Cost/Hour:	$0.00	0
Operator Cost/Hour:	$38.59	NA

Total unit Cost/Hour: $321.62
Total Fleet Cost/Hour: **$643.23**

MATERIAL QUANTITIES

Initial Volume: 1,613
Swell factor: 1.165
Loose volume: **1,879** LCY

Source of estimated volume: 2ac @ 6"
Source of estimated swell factor: Cat Handbook

HOURLY PRODUCTION

Average push distance: 170 feet
Unadjusted hourly production: 576.6 LCY/hr

Materials consistency description: Consolidated stockpile 1.0

Average push gradient: 0 %
Average site altitude: 6,800 feet

Material weight: 2,900 lbs/LCY

Weight description: Decomposed rock - 50% Rock, 50% Earth

Job Condition Correction Factor		Source
Operator Skill:	0.750	(AVG.)
Material consistency:	1.000	(CAT HB)
Dozing method:	1.000	(GEN.)
Visibility:	1.000	(AVG.)

Job efficiency:	0.830	(1 SHIFT/DAY)
Spoil pile:	0.800	(FND-RF)
Push gradient:	1.000	(CAT HB)
Altitude:	1.000	(CAT HB)
Material Weight:	0.793	(CAT HB)
Blade type:	1.000	(PAT)

Net correction: 0.3949

Adjusted unit production: 227.70 LCY/hr
Adjusted fleet production: **455.4** LCY/hr

JOB TIME AND COST

Fleet size: 2 Dozer(s)
Unit cost: $1.412/LCY

Total job time: **4.13** Hours
Total job cost: **$2,654**

BULLDOZER RIPPING WORK

Task description: **Rip upper and lower access roads**

Site: **Mid-Continent LST** Permit Action: SI-4 Permit/Job#: M1982121

PROJECT IDENTIFICATION

Task #: 05A State: Colorado Abbreviation: None
Date: 8/23/2024 County: Garfield Filename: M121-05a
User: ACY

Agency or organization name: DRMS

HOURLY EQUIPMENT COST

Basic Machine: Cat D8T - 8SU Horsepower: 310
Ripper Attachment: 3-Shank Ripper Shift Basis: 1 per day
Data Source: (CRG)

Cost Breakdown:

		Utilization %
Ownership Cost/Hour:	$173.32	NA
Operating Cost/Hour:	$109.71	100
Ripper Ownership Cost/Hour:	$14.53	NA
Ripper Operating Cost/Hour:	$7.95	100
Operator Cost/Hour:	$38.59	NA
Total Unit Cost/Hour:	$344.10	

Total Fleet Cost/Hour: **$688.19**

MATERIAL QUANTITIES

Selected estimating method: Area

Alternate Methods:

Seismic: NA Bank Volume: NA BCY NA
Area: 2.00 acres Rip Depth (ft): 2.00 Volume: 6,453 BCY or CCY

Source of estimated quantity: 3100 LF x 28'W

HOURLY PRODUCTION

Seismic:

Seismic Velocity: NA feet/second

Area:

Average Ripping Depth:	2.56	feet/pass
Average Ripping Width:	7.08	feet/pass
Average Ripping Length:	200.00	feet/pass
Average Dozer Speed:	88.00	feet/minute
Average Maneuver Time:	0.25	minutes/pass
Production per unit area:	0.773	acres/hour

Job Condition Correction Factors

Unadjusted Hourly Unit Production: 0.773 Acres/hr

Site Altitude:	6,800	feet
Altitude Adj:	1.00	(CAT HB)
Job Efficiency:	0.83	(1 shift/day)
Net Correction:	0.83	multiplier

Adjusted Hourly Unit Production: 0.64 Acres/hr
Adjusted Hourly Fleet Production: **1.28** Acres/hr

JOB TIME AND COST

Fleet size: 2 Grader(s) Total job time: **1.56** Hours

Unit cost: $536.229 Per acre Total job cost: **$1,072**

REVEGETATION WORK

Task description: **Reveg disturbed areas**

Site: **Mid-Continent LST** Permit Action: SI-4 Permit/Job#: M1982121

PROJECT IDENTIFICATION

Task #: 06A State: Colorado Abbreviation: None
Date: 4/4/2024 County: Garfield Filename: M121-06a
User: ACY

Agency or organization name: DRMS

FERTILIZING

Materials

Description	Units / Acre	Unit	Cost / Unit	Cost /Acre
			$	$
			Total Fertilizer Materials Cost/Acre	**$0.00**

Application

Description	Cost /Acre
	$
Total Fertilizer Application Cost/Acre	**$0.00**

TILLING

Description	Cost /Acre
Disc harrowing, 6" deep (MEANS 32 91 13.23 6100)	$117.61
Total Tilling Cost/Acre	**$117.61**

SEEDING

Seed Mix	Rate – PLS LBS / Acre	Seeds per SQ. FT	Cost /Acre
Indian Ricegrass - Native	10.00	32.37	$172.92
Mountain Brome - Bromar	10.00	16.07	$60.17
Kentucky Bluegrass - Lato	10.00	493.57	$36.90
Milk Vetch, Cicer - Lutana	10.00	33.29	$97.88
Thurber's Fescue	10.00	103.31	$784.88
Western Wheatgrass - Native	10.00	25.25	$90.06
Totals Seed Mix	60.00	703.86	**$1,242.81**

Application

Description	Cost /Acre
Hydro seeding (MEANS 32 92 19.14 0200)	$1,359.07
Total Seed Application Cost/Acre	**$1,359.07**

MULCHING and MISCELLANEOUS

Materials

Description	Units / Acre	Unit	Cost / Unit	Cost /Acre
Herbicide - 2,4D @ 1.0 pt/ac	1.00	ACRE	$4.13	$4.13
Hydromulch tackifier, >15 ac. {Materials Only}	1.00	ACRE	$1,459.26	$1,459.26
Total Mulch Materials Cost/Acre				**$1,463.39**

Application

Description	Cost /Acre
Hydromulching (MEANS 32 92 19.13 1100)	$1,355.20
Weed spray, truck, non-aquatic areas, ann. [DMG]	$27.19
Total Mulch Application Cost/Acre	**$1,382.39**

NURSERY STOCK PLANTING

Common Name	No / Acre	Type and Size	Planting Cost	Fertilizer Pellet Cost	Cost /Acre
Fir, Douglas	44	Tubling, 3 cu. in. container (MEANS)	$1.40	$2.40	$61.60
Oak, Gambel's	50	Bare root seedling, 11-16 inch ht. (MEANS)	$2.62	$0.00	$131.00
Serviceberry	50	Bare root seedling, 11-16 inch ht. (MEANS)	$2.62	$0.00	$131.00
Totals Nursery Stock Cost / Acre					**$323.60**

JOB TIME AND COST

No. of Acres: 8.13 Cost /Acre: $5,888.87
Estimated Failure Rate: 25% Cost /Acre*: $5,771.26
*Selected Replanting Work Items: SEEDING,NURSERY,MULCHING

Initial Job Cost: **$47,876.51**
Reseeding Job Cost: **$11,730.09**
Total Job Cost: **$59,607**
Job Hours: **40.00**

EQUIPMENT MOBILIZATION/DEMOBILIZATION

Task description: **Initial Mobilization**

Site: **Mid-Continent LST** Permit Action: SI-4 Permit/Job#: M1982121

PROJECT IDENTIFICATION

Task #: 07A State: Colorado Abbreviation: None
Date: 8/23/2024 County: Garfield Filename: M121-07a
User: ACY

Agency or organization name: DRMS

EQUIPMENT TRANSPORT RIG COST

Shift basis: 1 per day
Cost Data Source: CRG Data

Truck Tractor Description: GENERIC ON-HIGHWAY TRUCK TRACTOR, 6X4, DIESEL POWERED, 400 HP (2ND HALF, 2006)

Truck Trailer Description: GENERIC FOLDING GOOSENECK, DROP DECK EQUIPMENT TRAILER (25T, 50T, AND 100T)

Cost Breakdown:

Available Rig Capacities	0-25 Tons	26-50 Tons	51+ Tons
Ownership Cost/Hour:	$10.44	$22.18	$23.94
Operating Cost/Hour:	$26.48	$54.55	$55.65
Operator Cost/Hour:	$22.52	$22.52	$22.52
Helper Cost/Hour:	$0.00	$23.53	$23.53
Total Unit Cost/Hour:	$59.44	$122.78	$125.64

NON ROADABLE EQUIPMENT:

Machine Description	Weight/ Unit (TONS)	Owner ship Cost/hr/ unit	Haul Rig Cost/hr/unit	Fleet Size	Haul Trip Cost/hr/ fleet	Return Trip Cost/hr/ fleet	DOT Permit Cost/ fleet
CAT 972H	28.00	$62.43	$122.78	2	$370.42	$245.56	$500.00
Cat D8T - 8SU	53.08	$187.85	$125.64	2	$626.98	$251.28	$500.00
Grove RT650E, 105', 45.4 MT	28.74	$189.03	$122.78	1	$311.81	$122.78	$250.00
CAT 963D	22.29	$83.68	$59.44	1	$143.12	$59.44	$250.00
CAT 450E	9.80	$78.06	$59.44	1	$137.50	$59.44	$250.00
Subtotals:					**$1,589.83**	**$738.50**	**$1,750.00**

ROADABLE EQUIPMENT:

Machine Description	Total Cost/hr/ unit	Fleet Size	Haul Trip Cost/hr/ fleet	Return Trip Cost/hr/ fleet
Generic 12-18 cy, 6x4	$115.19	2	$230.38	$230.38
Flatbed Truck, 6x4, 45K GVW	$103.84	1	$103.84	$103.84
Light Duty Pickup, 4x4, 1 T. Crew	$130.54	2	$261.08	$261.08
Hydroseeder with Tractor	$133.22	1	$133.22	$133.22
Water Tanker, 3,500 Gal.	$75.02	1	$75.02	$75.02
Subtotals:			**$803.54**	**$803.54**

EQUIPMENT HAUL DISTANCE and Time

Nearest Major City or Town within project area region:	GLENWOOD SPRINGS	
Total one-way travel distance:	29.00	miles
Average Travel Speed:	30.00	mph

Total Non-Roadable Mob/Demob Cost * '* two round trips with haul rig:	$11,181.10
Total Roadable Mob/Demob Cost ** ** one round trip, no haul rig:	$1,553.51

Transportation Cycle Time:

	Non-Roadable Equipment	Roadable Equipment
Haul Time (Hours):	0.97	0.97
Return Time (Hours):	0.97	0.97
Loading Time (Hours):	0.50	NA
Unloading Time (Hours):	0.50	NA
Subtotals:	2.93	1.93

JOB TIME AND COST

Total job time:	**5.87**	Hours
Total job cost:	**$12,735**	

EQUIPMENT MOBILIZATION/DEMOBILIZATION

Task description: **Secondary Mobilization**

Site: **Mid-Continent LST** Permit Action: SI-4 Permit/Job#: M1982121

PROJECT IDENTIFICATION

Task #: 07B State: Colorado Abbreviation: None
Date: 8/23/2024 County: Garfield Filename: M121-07b
User: ACY

Agency or organization name: DRMS

EQUIPMENT TRANSPORT RIG COST

Shift basis: 1 per day
Cost Data Source: CRG Data

Truck Tractor Description: GENERIC ON-HIGHWAY TRUCK TRACTOR, 6X4, DIESEL POWERED, 400 HP (2ND HALF, 2006)

Truck Trailer Description: GENERIC FOLDING GOOSENECK, DROP DECK EQUIPMENT TRAILER (25T, 50T, AND 100T)

Cost Breakdown:

Available Rig Capacities	0-25 Tons	26-50 Tons	51+ Tons
Ownership Cost/Hour:	$10.44	$22.18	$23.94
Operating Cost/Hour:	$26.48	$54.55	$55.65
Operator Cost/Hour:	$22.52	$22.52	$22.52
Helper Cost/Hour:	$0.00	$23.53	$23.53
Total Unit Cost/Hour:	$59.44	$122.78	$125.64

NON ROADABLE EQUIPMENT:

Machine Description	Weight/ Unit (TONS)	Owner ship Cost/hr/ unit	Haul Rig Cost/hr/unit	Fleet Size	Haul Trip Cost/hr/ fleet	Return Trip Cost/hr/ fleet	DOT Permit Cost/ fleet
Subtotals:					**$0.00**	**$0.00**	**$0.00**

ROADABLE EQUIPMENT:

Machine Description	Total Cost/hr/ unit	Fleet Size	Haul Trip Cost/hr/ fleet	Return Trip Cost/hr/ fleet
Light Duty Pickup, 4x4, 1 T. Crew	$130.54	2	$261.08	$261.08
Hydroseeder with Tractor	$133.22	1	$133.22	$133.22
Subtotals:			**$394.30**	**$394.30**

EQUIPMENT HAUL DISTANCE and Time

Nearest Major City or Town within project area region:	GLENWOOD SPRINGS	
Total one-way travel distance:	29.00	miles
Average Travel Speed:	30.00	mph
Total Non-Roadable Mob/Demob Cost * '* two round trips with haul rig:	$0.00	
Total Roadable Mob/Demob Cost ** ** one round trip, no haul rig:	$762.31	

Transportation Cycle Time:

	Non-Roadable Equipment	Roadable Equipment
Haul Time (Hours):	0.97	0.97
Return Time (Hours):	0.97	0.97
Loading Time (Hours):	0.50	NA
Unloading Time (Hours):	0.50	NA
Subtotals:	2.93	1.93

JOB TIME AND COST

Total job time: **1.93** Hours

Total job cost: **$762**

Rock Bolting

TR-6 Geo Tech Pg 16 Table 07a and 07b
35' body length with bond length of 18' inside of a 6" diam hole
Spacing 10'x10' over estimated 1,000 LF of highwall = approx. 200 Bolts

		Bare Costs					Production / Job Hrs			
RS Means Heavy Const 2024		**Materials**	**Labor**	**Equipment**	**Total per 10'**	**Total per 35'**	**Crew**	**Daily output (16 hr days)**	**Labor hrs per 10'**	**Labor hrs per 35'**
31 33 13.10 4465	Drill Hole for rock bolt 3-1/2" Diam, 10' long	$ -	$178.00	$ 355.00	$ 533.00	$ 1,865.50	B-56	5.00	3.20	11.20
31 33 13.10 2165	Place Anchor 2" dia. 10 long'	$ 795.00	$ 42.50	$ -	$ 837.50	$ 2,931.25	2-Skwk	24.00	0.67	2.33
				Total per hole		**$ 4,796.75**		**Total per hole**		**13.53**
				Total for 200 Holes		**$ 959,350.00**		**Total for 200 Holes**		**2706.90**

B-56 Crew	1 Laborer
	1 Equip. Oper (light)
	1 Air Track Drill, 4"
	1 Air Compressr, 600 cfm
	1-50' Air hose 3"
Skwk	2- Skilled Workers Avg

CIRCES Assumes 8 Hr work days for crews
200 Holes = 2707 Hrs
= 338.4 Days to complete

Total Cost to Drill and Place Achors for 200 Holes
= $959,350.00

* does not include mobilization to/from site

Rock Bolting - CDOT

Recent cost data provided from CDOT for comperable project

Project # C133A-048								Aug-21	
Contract ID: C23125									
Ground Anchor Project in Sommerest									
Same Hole size and Anchor Strand Design									
				Item Code		Desription		Quanity	
				618-08900		Ground Anchor		4805	LF
Engineers Estimate		Bid #1 (Awared)		Bid #2		Bid #3		Avg Bid	
Unit Price	Amount	Unit Price	Amount	Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
$ 100.00	$ 480,500.00	$ 149.74	$ 719,500.70	$ 123.00	$ 519,015.00	$ 267.00	$ 1,282,935.00	$ 179.91	$ 864,467.55

CDOT cost applied to TR-6 Geo Tech Specs

TR-6 Geo Tech Pg 16 Table 07a and 07b								Quantity	
35' body length with bond length of 18' inside of a 6" diam hole								35 LF	Per Hole
Spacing 10'x10' over estimated 1,000 LF of highwall = approx. 200 Bolts								7000 LF	For 200 Holes
Engineers Estimate		Bid #1 (Awared)		Bid #2		Bid #3		Avg Bid	
Unit Price	Amount	Unit Price	Amount	Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
$ 100.00	$ 700,000.00	$ 149.74	$ 1,048,180.00	$ 123.00	$ 861,000.00	$ 267.00	$ 1,869,000.00	$ 179.91	$ 1,259,370.00

No job hours or production information provided from CDOT. RS Mean Equipment is reasonable, recomnded adding water truck. Will also need cement pump truck for mobilization.

REVISION OF SECTION 618
GROUND ANCHORS

Section 618 of the Standard Specifications is hereby deleted for this project and replaced with the following:

DESCRIPTION

618.01 This item of work consists of furnishing all labor, materials, tools, supervision, transportation, installation equipment, shop drawings, and incidentals necessary to install, test, stress, report and complete the permanent grouted ground anchors as shown on the Plans and as specified herein. Permanent grouted ground anchors consist of multi- strand wire tendons installed in grout-filled holes drilled and prestressed into soil and rock. The work shall include, but is not limited to, mobilization, surveying, drilling, inserting, grouting, stressing, load testing, reporting and lock-off of the ground anchors at the appropriate locations.

The Contractor shall select the ground anchor installation means and methods and confirm the estimated rock-grout bond value by testing. The minimum drillhole diameter is shown on the Plans. The Contractor shall be responsiblefor installing ground anchors that will develop the load-carrying capacity indicated on the Plans and the ground anchor load capacities shall be verified by testing and must meet the test acceptance criteria specified herein.

Bidding contractors should be aware that elevated groundwater conditions and movement of the slide mass should be anticipated during parts of the year and accounted for in their bid. Elevated groundwater conditions and movement of the slide mass are likely to occur during parts or all of the months of April, May and June. These conditions may have a negative effect on temporary slope stability, drilling, anchor installation, and anchor grouting. Bidding contractors should plan, schedule, and estimate their work to account for these conditions.

Furnishing and installing pre-cast bearing panels is addressed in Revision to Section 504 Facing (Special). Bench and access ramp construction and final grading is paid as Unclassified Excavation (Complete in Place).

DEFINITIONS

618.02 Definitions. Terms used in this specification are defined as follows:

(a) **Alignment Load:** A nominal minimum load applied to the ground anchor during testing to keep the testing equipment aligned and in the correct position.

(b) **Anchorage:** The combined system of the anchor head, bearing plate, trumpet and corrosion protection that is capable of transmitting the prestressing force from the tendon to the ground surface or supported structure.

(c) **Anchor Grout:** Grout that is injected into the drill hole just before or just after the Contractor installs the tendon. The anchor grout within the bond length transfers the applied tensile force from the tendon to the surrounding soil or rock.

(d) **Bearing Plate:** A steel plate that evenly distributes the ground anchor force to the reaction surface.

(e) **Bond Length:** The length of the grout body that transmits the applied tensile force to the surrounding soil or rock.

(f) **Free Stressing (Unbonded) Length:** The designed length of the tendon that is not bonded to the surrounding ground or grout during stressing, or the portion of the anchor tendon between the stressing anchorage plate and the bond length.

(g) **Ground Anchor:** A system, referred to as a tieback or as an anchor, used to transfer tensile loads to soil or rock. A ground anchor includes all prestressing steel, anchorage devices, grout, coatings and sheathings.

(h) **Liftoff Load:** The load in the tendon determined at any time by completing a liftoff test.

(i) **Liftoff Test:** Procedure to measure the load in a locked-off tendon by reapplying force until initial movement of theanchor head or wedges is measured.

(j) **Lock-Off load:** The tensile force or load in a ground anchor transferred from the jack to the anchorage after testing is complete.

(k) **Maintaining Consistency of Load:** Maintaining the test load within 5 percent of the specified value.

(l) **Maximum Test Load:** The maximum load applied to the ground anchor during testing. The maximum test load is equal to the factored design load (FDL) for load and resistance factor design (LRFD) and to 1.33 times the designload (DL) for allowable stress design (ASD).

(m) **Minimum Tensile Strength (MTS):** The minimum specified tensile breaking load of the prestressing steel as defined by the specified standard.

(n) **Performance Test:** A test to determine whether the anchor has sufficient load carrying capacity, that the free length has actually been established, and that the residual movement of the anchor is within acceptable limits.

(o) **Proof Test:** A test performed to verify anchor capacity and to pre-load the anchor.

(p) **Stressing length:** The portion of the anchor tendon which is free to elongate elastically during the stressing (Stressing length is the free length plus any additional length required for stressing and testing).

(q) **Tendon and Tendon Steel:** An assembly that includes the multi-wire strand prestressing steel, corrosion protection, bond breakers, sheaths, centralizers, and spacers, but specifically excludes the grout and anchorage.

MATERIALS

618.03 General. The Contractor shall not deliver materials to the site until the preconstruction submittals have been reviewed by the Engineer and are found to not require resubmission as outlined in Subsection 618.04 of this Specification.

The designated storage location or locations shall be protected by the Contractor from theft, vandalism, passage of vehicles, and other potential sources of damage to materials delivered to the site.

The Contractor shall protect the materials from the elements by appropriate means. Prestressing steel strands shall be stored and handled in accordance with the manufacturer's recommendations and in such a manner that no damage to the component parts occurs. All steel components shall be protected from the elements at all times.

Cement and additives for grout shall be stored under cover and protected against moisture.

Pre-cast bearing panels or facing shall be in accordance with the Contractor's Shop Drawings required under Revision to Section 504.

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618.04 Tendons. The anchor tendons shown on the plans are high strength steel consisting of single or multiple elements as specified in Subsection 714.01 or compact seven-wire strands conforming to ASTM A 416, "Standard Specification for Low-Relaxation, Seven-Wire Steel Strand for Prestressed Concrete" including the Supplementary Requirement S1 and shall be weldless, low-relaxation grade. They shall have double corrosion protection as shown on the plans and shall be fully encapsulated.

Prestressing steel shall be protected from dirt, rust, or other deleterious substances. Heavy corrosion or pitting is cause for tendon rejection. A light, uniform layer of surface corrosion shall not be cause for rejection. If there is a question about the extent of the corrosion, the Engineer may require the steel to be tested to determine if it still meets the appropriate ASTM specification. If the steel fails to meet the minimum ASTM strengths, the Contractor shall pay all costs associated with the tests and replace the steel at his own expense.

Tendon couplers shall not be used.

618.05 Storage and Handling of Tendons. Tendons shall be handled and stored in such a manner as to avoid damage or corrosion. Damage to the prestressing steel as a result of abrasions, cuts, nicks, welds and weld splatter will be cause for rejection. The prestressing steel shall be protected if welding is to be performed in the vicinity. Ground of welding leads to the prestressing steel is forbidden. Prestressing steel shall be protected from dirt, rust ordeleterious substances. A light coating of rust on the steel is acceptable. If heavy corrosion or pitting is noted, the tendons shall be rejected.

The Contractor shall use care in handling and storing the tendons at the site. Prior to inserting a tendon in the drill hole, the Contractor and the Engineer shall examine the tendon for damage to the prestressing steel, the encapsulationand the bond breaker. If the encapsulation is damaged, it shall be repaired in accordance with the tendon supplier's recommendations. If the bond breaker has been damaged, it can be repaired with ultra-high molecular weight polyethylene. The tape should be spirally wound around the tendon so as to completely seal the damaged area. The pitch of the spiral shall ensure a double thickness at all points.

618.06 Centralizers and spacers. Centralizers and spacers shall be made from plastic which is non-detrimental to the steel and shall support the tendon in the hole and position it to provide at least 0.5 inch of grout cover over the encapsulation. Centralizers and spacers used inside the encapsulation shall position the tendon steel to provide at least 0.2 inch of grout cover between the tendon steel and the inside surface of the encapsulation. Centralizers shall permit grout to flow freely around the tendon and along the drill hole. The Contractor shall provide spacers to separate multiple strands within the bond length.

618.07 Sheath, bond breaker, and encapsulation. The Contractor shall provide plastic tubing or pipe with the following properties:

(a) Resistant to chemical attack from aggressive environments, grout, or corrosion inhibiting compounds.

(b) Resistant to aging by ultraviolet light.

(c) Fabricated from material that is not detrimental to the tendon.

(d) Capable of withstanding abrasion, impact, and bending during handling and installation.

(e) Allow the tendon to elongate during testing and stressing.

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The sheath shall be plastic tubing or pipe, corrugated or smooth. A smooth sheath may also function as a bond breaker. Plastic corrugated sheathing shall have a minimum wall thickness of 0.08 inch and shall be capable of transferring load to the surrounding grout medium. The Contractor shall provide a separate bond breaker with a corrugated sheath.

The bond breaker shall be smooth plastic tubing or pipe that allows the tendon to elongate with minimal friction during testing and stressing.

The Contractor shall provide high density polyethylene corrugated pipe and end caps conforming to AASHTO M 252, Type C, for tendon bond length encapsulation.

Sheath, bond breaker, and encapsulation material is subject to the approval of the Engineer.

618.08 Corrosion inhibiting compound. The Contractor shall provide either grease, wax, or gel with corrosion inhibiting additives that conform with Section 4.6 of Recommendations for Prestressed Rock and Soil Anchors by the Post-Tensioning Institute (2014). The chlorides, nitrates, and sulfides present in the grease shall not exceed the following limits:

Chlorides	10 ppm
Nitrates	10 ppm
Sulfides	10 ppm

The ends of the grease-filled sheath shall be sealed with tape, heat-shrinkable tubes, or other means subject to the approval of the Engineer.

618.09 Heat shrink sleeves and tape. The Contractor shall provide heat shrink sleeves and tape fabricated from radiation cross-linked polyolefin coated with an adhesive sealant.

618.10 Wax tape. The Contractor shall provide petrolatum (wax) tape consisting of synthetic fabric saturated with a stable composition of petrolatum compound (wax) with inert fillers.

618.11 Cement Grout. The Contractor shall provide materials for grout conforming to the following: Portland cement Subsection 701.01

Water shall conform to Subsection 712.01. If fine aggregate is used in the grout mix, the Contractor shall provide natural sand with 100 percent passing the No. 16 sieve (1.18 mm) and no more than 5 percent passing the No. 200 sieve (75 µm).

The Contractor shall provide a pumpable, stable fluid, grout mix that exhibits less than 2 percent bleed in accordance with ASTM C 940. The compressive strength of two-inch cubes, molded, cured, and tested in accordance with ASTM C 942, shall be a minimum of 3,500 psi at the time of stressing the tendon. Admixtures which control bleed, improve flowability, and reduce water content, conforming to ASTM C 494, Types A or F, may be used in the grout subject to the approval of the Engineer. Admixtures, if used, shall be compatible with prestressing steels and mixed inaccordance with the manufacturer's recommendations. Expansive admixtures may only be used for filling sealed encapsulations, trumpets, and anchorage covers. Accelerating admixtures shall not be permitted.

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The Contractor shall provide compressive strength test results of two-inch cubes, molded, cured and tested in accordance with ASTM C 942 for each proposed grout mix design prior to installing the first ground anchor. The Contractor shall also provide three additional compressive strength test results on samples randomly selected during construction by the Engineer. The Contractor shall demonstrate that the grout achieves a 3,500 psi compressive strength at the time of stressing.

618.12 Anchorages. Anchorage components, including anchor heads, wedges, bearing plates, trumpets, anchoragecovers, etc. shall conform to PTI Recommendations for Prestressed Rock and Soil Anchors (PTI DC35.1-14). The anchor heads and wedges shall be from the same supplier.

Trumpets shall be fabricated from steel pipe or steel tubing. Trumpets shall have a minimum wall thickness of 0.20inch (5 mm). The Contractor shall provide a watertight seal between the trumpet and bearing plate by welding the two together.

The Contractor shall furnish anchorage covers that completely cover the anchor head and provide a watertight joint between the cover and the bearing plate. Anchorage covers shall have a minimum thickness of 0.20 inch (5 mm) andbe fabricated from either steel pipe, steel tubing, or steel plate.

Anchorages shall be fabricated from mild steel and shall be capable of developing 100 percent of the guaranteed minimum ultimate tensile strength of the prestressing steel.

CONSTRUCTION REQUIREMENTS

618.13 Pre-construction Submittals. At least 30 working days prior to the start of ground anchor construction, theContractor shall provide three copies of the following preconstruction submittals to the Engineer in accordance withSection 105.02.

(a) *Contractor Experience and Qualifications Submittal.* The Contractor shall submit their company's expertise and personnel experience and qualifications for installing ground stabilizing ground anchors. At a minimum, the submittal shall include:

1. A list of project references, verifying the successful completion by the Contractor of installing ground anchors of similar size and length in similar subsurface conditions on at least three separate landslide stabilization projects within the last five years. Include a brief description of each project listed, the location, contract value, scheduled completing date, actual completion date, owner's contact name and current phone number.

2. A list identifying all possible on-site supervisors, engineers, and drill rig operators that may be assigned to the project. The list shall contain a detailed summary of each individual's experience in ground anchor installation for landslide stabilization projects. On-site supervisors shall have a minimum of three years' experience in supervising installation of ground anchors of similar size, length, scope and purpose to those shown on the Plans in similar subsurface conditions to those described in the ground anchor design report/shown on the geology sheets of the Plans. The work experience shall be direct supervision of the on-site ground anchor installation operations. Project management level positions indirectly supervising on-site ground anchor installation operations are not acceptable for this experience requirement.

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3. The Contractor shall assign an engineer to supervise the installation of the ground anchors, completion of ground anchor logs and testing of the ground anchors. The engineer shall be a registered Professional Engineer in Colorado and have a minimum of three years' experience in the design and construction of ground anchors.

4. Drill rig operators shall have a minimum of one year experience installing ground anchors.

5. Confirmation that one or more of the designated site supervisors shall be on site for 100% of the time during which work is being done.

(b) *Ground Anchor Shop Drawing Submittal.* The Contractor shall furnish the ground anchor tendon size, free stressing lengths, anchorage and minimum bond lengths as specified on the Plans. The corrosion protection of the tendons and anchorages shall conform to "Class 1" level protection for all ground anchors in accordance with the Post-Tensioning Institute, 2014 "Recommendations for Prestressed Rock and Soil Anchors."

The corrosion protection of the tendon free stressing length shall be provided by a sheath completely filled with corrosion inhibiting grease. Provisions shall be made to prevent the grease from escaping at the ends of the sheath. The grease shall completely coat the tendon, fill the void between the tendon and the sheath and fill the interstices between the individual wires comprising the seven-wire strands. The Ground Anchor Shop Drawings shall show how the Contractor will provide a transition between the bond length and the free stressing length while maintaining the desired corrosion protection.

The submittal shall conform to Section 105.02 of the Standard Specification and shall include at a minimum:

1. Detailed shop drawing plans of the ground anchors that show the type of tendon (including number of stands), location of centralizers and spacers, bond length and free stressing length, bond breaker in free stressing length, anchorage and trumpet hardware, grout tubes, hole diameter, and angle of installation.

2. Corrosion protection details for anchorages and tendons.

3. Details of the ground anchor connections to the reinforced concrete columns shown on the plans. The reinforced concrete columns, temporary and permanent lagging have been designed and are provided on the plans.

4. Details indicating the design load, test load, the provided post-tensioning force, the jacking force, the transfer force, and the complete details of the anchor and the stressing sequence.

5. Design and calculations sealed by a professional engineer registered in Colorado of the anchorage, including the trumpeted bearing plate dimensions. The calculations shall be completed in accordance with Post-Tensioning Institute (PTI) M 50.2 Anchorage Zone Design.

6. Certificates of compliance for all materials used, including, but not limited to, strand anchors, Portland cement, anchorages and bearing plates, and corrosion protection systems.

7. All shop drawings and other plan details shall be prepared on 11-inch by 17-inch sheets including borders. Each sheet shall have a title block in the lower right-hand corner. Design calculations shall be on 8 ½- inchby 11-inch sheets.

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(c) *Ground Anchor Installation Plan Submittal.* The pullout capacity of a ground anchor depends on many factors inaddition to the soil or rock conditions at the site. The Contractor shall select the drilling method, grout mix, grouting methods (including pressure grouting and/or post grouting methods) and hole diameter appropriate for the soil and rock conditions at the site, so that every ground anchor meets the specified acceptance criteria. At least 30 working days prior to the start of access ramp, bench, or ground anchor construction, the Contractor shall provide a Ground Anchor Installation Plan Submittal to the Engineer in accordance with Section 101 and 105 of the Standard Specifications that shall include the following:

1. Description of excavation sequence and timing for ramps and benches in accordance with Subsection 618.17.

2. A description of the ground anchor installation means and methods, including drilling procedures and equipment, hole diameter, grout mix design and placement method, grouting equipment, and stressing information. Ground conditions will include soil, boulders and bedrock. Drilling for ground anchors may be by any method the Contractor chooses for the particular anchor and ground conditions. However, to facilitate advancing and maintaining the drilled hole in adverse ground conditions, the use of drilled or driven casing is required in the overburden materials.

3. Grout strength test results in accordance with Subsection 618.11 of these specifications. The Contractor shall also submit the methods and materials proposed to fill the annulus over the free stressing length of the ground anchors. Grouting methods and information should include:

   A. Type of mixer

   B. Water/cement ratio

   C. Type of additives, if any

   D. Anticipated grout pressures

   E. Type of cement

   F. Re-grouting equipment, details, and anticipated pressures

4. Detailed plans for the method proposed to be followed for the ground anchor testing. This shall include all necessary drawings and details to clearly describe the method proposed, including details of the test reaction system.

5. Calibration data for each load cell, test jack, pressure gauge, and all other testing equipment to be used for ground anchor testing. The calibration tests shall have been performed by an independent testing laboratory and shall have been performed within 60 calendar days of the date submitted. Testing shall not commence until the Engineer has approved the load cell, test jack, pressure gauge and master pressure gauge calibrations.

6. Method of locating and aligning the drill holes in the field.

7. Methods for storing, handling, and inserting the tendons.

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618.14 Construction Submittals. The Contractor shall submit the following construction submittals within 2 working days of completing the work or, in the case of a ground anchor corrective measure submittal, as directed bythe Engineer.

(a) *Ground Anchor Installation Log Submittal.* The Contractor shall maintain a written log of each ground anchor installation and submit the log to the Engineer. At a minimum the log shall include the following:

1. Ground anchor identifier (No. and Location)
2. Drill operator
3. Date and time of drilling start to finish accounting for all delays and downtime
4. Description of the subsurface materials encountered (soil, bedrock, groundwater)
5. Drill hole diameter
6. Ground anchor length (bonded length plus free stressing [unbonded] length).
7. Date and time of grouting, grout volumes placed in hole, grout pressures,
8. Date, time and volume of each episode of supplemental grouting (top off)

(b) *Grout Strength Test Result Submittal.* The Contractor shall sample and test grout during installation of the ground anchors and submit the results to the Engineer in accordance with Subsection 618.11 of these specifications.

(c) *Ground Anchor Test Report Submittal.* The Contractor shall provide a report that contains the results of each ground anchor test to the Engineer. At a minimum, the report shall include the following:

1. Type of Test (Performance or Proof)
2. Date and Time of Test
3. Person on-site collecting the test data for the Contractor
4. Ground Anchor Identifier (No. and Location)
5. Information from Load test Calibration used to determine applied load on anchor
6. Size and type of Anchor
7. Minimum Tensile Strength of the ground anchor tendon
8. Free-Stressing (Unbonded) Length
9. Bond Length
10. Age of grout and anticipated or actual grout strength based on grout cube test results

11. Completed test results listing measured deflection, applied tensile loads and hold times in accordance with appropriate test schedule

12. Summary of test results showing whether anchor achieved the acceptance criteria or not.

(d) *Ground Anchor Corrective Measure Submittal (if necessary).* In the event that an anchor test does not meet the minimum acceptance criteria, the Contractor shall provide a submittal detailing corrective measures, including replacement or installation of supplemental ground anchors to the Engineer.

(e) *Revised Ground Anchor Installation Plan Submittal (if necessary).* In the event that the Contractor elects to use alternative methods not described in the Ground Anchor Installation Plan, the Contractor shall provide a revised submittal to the Engineer that describes the modified methods prior to implementing the methods.

618.15 Submittal Reviews. The Engineer will formally review the Contractor's preconstruction submittals, including resubmittals, within 20 working days after receipt. The review may result in one of three findings: 1) Reviewed with no exceptions to the submittal; 2) Reviewed with Revisions as noted; or 3) Resubmit, revise as noted. If the Engineer's review requires resubmittal, the Contractor shall complete the adjustments, clarifications, and changes requested by the Engineer. Work shall not start until all of the Contractor's preconstruction submittals have been reviewed by the Engineer and are found to not require resubmission These reviews do not relieve the Contractor of their responsibility for the successful completion of the work.

The Engineer will formally review the Contractor's construction submittals, including resubmittals for completeness and compliance with the specification within 5 working days after receipt. The review may result in one of two findings: 1) Reviewed with no exceptions to the submittal; or 2) Resubmit, revise as noted. If the

Engineer's review requires resubmittal, the Contractor shall complete the adjustments, clarifications, and changes requested by the Engineer. The Engineer may halt the Contractor's work until the Contractor's construction submittals are found to not require resubmission. Reviews of the Contractor's submittals does not relieve the Contractor of their responsibilityfor the successful completion of the work.

618.16 Pre-Construction Conference. A pre-construction conference shall be held at least five working days prior to the Contractor beginning any ground anchor work at the site to discuss subsurface conditions and exploratory boring information, construction procedures, personnel, and equipment to be used, and other elements of the acceptedsubmittals specified in Subsection 618.03 of this Specification. Those attending shall include:

(a) The superintendent, on site supervisors, and other key personnel identified by the Contractor as being in charge of installing, tensioning, and testing the ground anchors.

(b) The Engineer, key inspection personnel, and appropriate representatives of the Owner. If the Contractor's key personnel change, or if the Contractor proposes a revision of the approved submittals, an additional conference may be held at the request of the Engineer before any additional ground anchor construction operations are performed.

618.17 Temporary Slope Stability. The Contractor shall be responsible for maintaining temporary stability of the slopes during construction. Any required shoring shall be at the Contractor's expense. No more than one third of each construction bench may be excavated for anchor installation until the anchors in the previous one third have been locked off. No one third portion of the lower bench may be excavated unless the anchors in the one third portion of the upper bench directly above have been locked off.

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618.18 Drilling. The Contractor shall complete the drilling method, the grouting procedure, and the grouting pressure used for the installation of the ground anchor in accordance with their approved Ground Anchor Installation Plan Submittal. Deviations from the submittal will require providing a Revised Ground Anchor Installation Plan Submittal that includes a description of the deviations to the Engineer for review per Section 618.13.

The Contractor shall drill holes for the ground anchors at the locations indicated on the Plans. A tolerance of +/- 3 degrees in any direction will be permitted on the ground anchor angle, and +/- 12 inches on the location at the point of entry. The ground anchor angles shown on the Plans shall not be changed without written permission from the Engineer.

If water is used in the drilling operation, the Contractor shall be responsible for controlling and disposing of the water in such a manner that is not harmful to the site or adjacent property. Any damage to the site by water or erosion shall be repaired by the Contractor at no cost to the Department. The hole diameter shall be large enough to provide the required grout cover as specified on the plans and to allow the tendon to be inserted without excessive force. The hole shall be drilled to the inclination and alignment specified on the plans within a two-degree tolerance. Holes (casing) shall be thoroughly cleaned of all dust, rock chips, grease or other deleterious material prior to inserting the tendon.

The drill hole shall be located so the longitudinal axis of the drill hole and the longitudinal axis of the planned tendon, as shown on the plans, are parallel. The ground anchor shall not be drilled in a location that requires the tendon to be bent in order to enable the tendon to be connected to the concrete columns.

618.19 Tendon Insertion.

The tendons shall be placed in accordance with working drawings and the recommendations of the tendon manufacturer. The tendon shall be inserted into the drill hole to the desired depth without difficulty. When the tendon cannot be completely inserted, the Contractor shall remove the tendon from the drill hole and clean or re-drill the hole to permitinsertion. Partially inserted tendons shall not be driven or forced into the hole.

Care shall be taken to ensure that the tendon's corrosion-protection is not damaged during handling or installation. The tendon in the bond length shall be installed in such a way as to ensure that it will have uniform grout cover. The bond length of bar or strand shall be cleaned and free of grease prior to installation.

Anchors shall not be used for grounding electric equipment. Welding electrodes shall not be connected to any conductor within two feet of any anchor.

618.20 Grouting The grouting equipment shall produce a grout free of lumps and undispersed cement. A positive displacement grout pump shall be used. The pump shall be equipped with a pressure gauge to monitor grout pressures. The pressure gauge shall be capable of measuring pressures of at least 150 pounds per square inch or twice the actual grout pressures used by the Contractor, whichever is greater. It shall be calibrated to measure increments of not more than 10 psi. The re-grouting pump shall have a capacity of not less than 500 psi. The gauge for the re-grouting pump shall be calibrated to measure increments of not more than 50 psi. The grouting equipment shall be sized to enable the grout to be pumped in one continuous operation. The mixer should be capable of continuously agitating the grout.

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The grout shall be injected from the lowest point of the drill hole. The grout may be pumped through grout tubes, casing, hollow-stem augers or drill rods. The grout can be placed before or after insertion of the tendon. The quantity of the grout and the grout pressures shall be recorded. The grout pressures and grout takes shall be controlled to prevent excessive heave in soils or fracturing of rock formations. The Contractor shall schedule casing extraction and grouting such that caving of the hole prior to grouting does not occur.

The grout above the top of the bond length may be placed at the same time as the bond length grout, but it shall not be placed under pressure. The grout at the top of the drill hole shall not contact the back of the structure or the bottom of the trumpet before testing the ground anchors.

The grouting equipment shall be sized to enable the anchor to be grouted in one continuous operation. Neat cement grouts shall be screened to remove lumps. The maximum size of the screen openings shall be 0.250 inches. Mixing and storage times shall not cause excessive temperature build-up in the grout. The mixer shall be capable of continuously agitating the grout.

Field placement of grout in the annulus between the sheath and tendon shall be according to the following requirements. Prior to placing the grout, the tendon and sheathing shall be at a temperature of at least 40 degrees F but not more than 90 degrees F. At the time of placing the grout, the grout shall have a temperature of at least 50 degrees F but not more than 90 degrees F. If the air temperature is below 35 degrees F, exposed portions of the anchors shall be protected against freezing immediately after the grout is placed for at least 6 days (4 days for high early strength cement) after placement of the grout. These requirements shall be met any time the outside air temperature is expected to drop below 35 degrees F.

Upon completion of the grouting, the grout tube may remain in the hole, but it shall be filled with grout. After grouting, the tendon shall not be tested for a minimum of 3 days or until the grout has attained the minimum grout strength required at the time of stressing, whichever is greater.

618.21 Installation and Corrosion Protection of the Trumpet and Anchorage. The corrosion protection surrounding the free stressing length of the tendon shall extend up beyond the bottom seal of the trumpet or 1 foot into the trumpet if no trumpet seal is provided. If the protection does not extend beyond the seal or sufficiently far enough into the trumpet, the Contractor shall extend the corrosion protection or lengthen the trumpet.

The corrosion protection surrounding the free stressing length of the tendon shall not contact the bearing plate or the anchor head during testing and stressing. If the protection is too long, the Contractor shall trim the corrosion protection to prevent contact.

The bearing plate and anchor head shall be placed so the axis of the tendon is perpendicular to the bearing plate within ± 3 degrees and the axis of the tendon shall pass through the center of the bearing plate.

If grout protected tendons or fusion-bonded epoxy encapsulations are used, the bearing plate, anchor head, and trumpet shall be electrically isolated from the surrounding concrete or any metallic element embedded in the structure.

The most critical area to protect from corrosion is in the vicinity of the trumpet and anchorage. Trumpets shall be completely filled with grout or corrosion inhibiting grease after the ground anchor has been tested and locked-off. Trumpet grease can be placed anytime during construction. Trumpet grout shall be placed after the ground anchor has been tested. The Contractor shall demonstrate to the Engineer that the procedures selected by the Contractor for placement of either grease or grout will produce a completely filled trumpet.

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All anchorages permanently exposed to the atmosphere shall be covered with a corrosion inhibiting grease-filled orgrout-filled cover. The Contractor shall demonstrate to the Engineer that the procedures selected by the Contractorfor placement of either grease or grout will produce a completely filled cover.

Anchorage devices shall be capable of developing 100 percent of the minimum ultimate tensile strength of the prestressing steel tendon.

The bearing plates shall be sized so the bending stresses in the plate do not exceed the yield strength of the steel when a load equal to 100 percent of the minimum ultimate tensile strength of the tendon is applied.

The trumpet shall have an inside diameter equal to or larger than the hole in the bearing plate. The trumpet shall be long enough to accommodate movements of the structure during testing and stressing. For strand tendons with encapsulation over the free stressing length, the trumpet shall be long enough to enable the tendon to make a transition from the diameter of the tendon in the free stressing length to the diameter of the tendon at the anchor head without damaging the encapsulation. Trumpets filled with corrosion-inhibiting grease shall have a permanent Buna-N rubber or approved equal seal provided between the trumpet and the tendon free stressing length corrosion protection.

Trumpets filled with grout shall have a temporary seal provided between the trumpet and the tendon free stressing length, corrosion protection, or the trumpet shall overlap the tendon free stressing length corrosion protection.

618.22 Ground Anchor Testing and Acceptance. The Contractor shall test each ground anchor to demonstrate that it meets the specified acceptance criteria. The compressive strength of the concrete used by the Contractor to design of the anchorages and bearing plates shall be achieved prior to tensioning of the ground anchor tendons. The Engineer shall choose up to 5% of the total anchors identified on the plans be performance tested. Proof tests shall be completed on all ground anchors that are not subject to performance testing. The Contractor shall complete a performance test as the first test. During the hold periods for all types of tests, a constant load shall be maintained by adjusting the jack pressure as necessary. The jack pressure shall not be allowed to drop more than 50 psi during a hold period. Anchor movement shall be measured and recorded to the nearest 0.001 inch.

Regripping strands or creating wedge bite marks on the strand below the anchor head shall be avoided. When analyzing displacement measurements, the effect of seating losses from the wedges shall be considered.

(a) *Testing Equipment.* The testing equipment shall consist of the following:

1. A minimum of two dial gauges capable of measuring to 0.001 inches shall be used to measure the ground anchor movement and shall be supported on a fixed reference independent of the ground anchor structure. The dial gauges shall have a minimum travel at least equal to the theoretical elastic elongation of the unbonded length plus the bond length at the maximum test load plus any anticipated length need to accommodate deformation of the soil below the reaction system.

2. A hydraulic jack and pump shall be used to apply the test load. The jack and a calibrated pressure gauge shall be used to measure the applied load. The jack and pressure gauge shall be calibrated by an independent firm as a unit. The calibration shall have been performed within 6 months of the date submitted. Testing cannot commence until the Engineer has approved the calibration submittals. The pressure gauge shall be graduated in 100 psi increments or less. The ram travel of the jack shall not be less than the theoretical elastic elongation of the total anchor length at the maximum test load. The hydraulic pump shall be capable of applying each load increment in less than 60 seconds.

3. A calibrated reference pressure gauge shall also be kept at the site. The reference gauge shall be calibrated with the test jack and pressure gauge.

4. The Contractor shall provide an electrical resistance load cell and readout with machined platens placed on both ends of the load cell when performing a creep test.

5. The stressing equipment shall be placed over the ground anchor tendon in such a manner that the jack, bearing plates, load cells, and stressing anchorage are axially aligned with the tendon and the tendon is centered within the equipment.

(b) *Testing Equipment Setup.* The hydraulic jack, load cell (for extended creep tests), and other necessary items (such as bar extensions, stressing anchorages, and jack chair) shall be positioned over the anchor tendon and parallel to its axis. The alignment load shall be applied to hold the jack in place.

The displacement gage shall be set after applying the alignment load. The displacement gage shall be supported on a tripod or other support device that is independent of the ground anchor and the structure. The displacement gage shall be positioned so that its axis is parallel to the axis of the anchor tendon within 5 degrees. The stem ofthe displacement gage shall be checked to confirm it is free to move over its entire measurement range.

(c) *Proof Test.* A proof test shall be performed by incrementally loading and unloading the ground anchor accordingto the following schedule:

PROOF TEST LOAD SCHEDULE

Load Increment Relative to Design Load (DL)	Hold Period (minutes)	Time for Displacement Reading (minutes)
AL (0.05 DL)	---	Initial Reading
0.25 DL	*	*
0.50 DL	*	*
0.75 DL	*	*
1.00 DL	*	*
1.20 DL	*	*
1.33 DL	10	1, 2, 3, 4, 5, 6, 10
1.33 DL	(60)	(20, 30, 40, 50, 60)[1]
0.50 DL	*	*
AL (0.10 DL)	---	1

* Hold load just long enough to read displacement, but not longer than one minute
[1] If the amount of movement between the 1 minute and 10 minute displacement readings exceeds 0.04 inch, then hold the load for 60 minutes and take additional displacement readings at the times shown in parentheses.
AL = Alignment Load DL = Design Load (shown on the plans)

(d) *Performance Test.* A performance test shall be performed by incrementally loading and unloading the ground anchoraccording to the following schedule:

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PERFORMANCE LOAD TEST SCHEDULE

Load Cycle	Load Increment Relative to Design Load (DL)	Hold Period (minutes)	Time for Displacement, Load Cell and Strain Gauge Readings (minutes)
1	AL (0.10 DL)	---	Initial Reading
	0.25 DL	*	*
2	AL (0.10 DL)	---	1
	0.25 DL	*	*
	0.50 DL	*	*
3	AL (0.10 DL)	---	1
	0.25 DL	*	*
	0.50 DL	*	*
	0.75 DL	*	*
4	AL (0.10 DL)	---	1
	0.25 DL	*	*
	0.50 DL	*	*
	0.75 DL	*	*
	1.00 DL	*	*
5	AL (0.10 DL)	---	1
	0.25 DL	*	*
	0.50 DL	*	*
	0.75 DL	*	*
	1.00 DL	*	*
	1.20 DL	*	*
6	AL (0.10 DL)	---	1
	0.25 DL	*	*
	0.50 DL	*	*
	0.75 DL	*	*
	1.00 DL	*	*
	1.20 DL	*	*
	1.33 DL	10	1, 2, 3, 4, 5, 6, 10
		(60)[1]	(20, 30, 40, 50, 60)[1]
	AL (0.10 DL)	---	1

* Hold load just long enough to read displacement, but not longer than one minute
[1] If the amount of movement between the 1 minute and 10 minute displacement readings exceeds 0.04 inch, then hold the load for 60 minutes and take additional displacement readings at the times shown in parentheses.
AL = Alignment Load DL = Design Load (shown on the plans)

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(e) Acceptance Criteria for Ground Anchors.

1. Creep. A performance- or proof-tested ground anchor with a 10 minute load hold is acceptable if the ground anchor carries the maximum test load with less than 0.04 inches of movement between 1 minute and 10 minutes. A performance- or proof-tested ground anchor with a 60 minute load hold is acceptable if the ground anchor carries the maximum test load with a creep rate that does not exceed 0.08 inches of movement between 6 and 60 minutes.

2. Minimum Movement. The elastic movement at the maximum test load is equal to or greater than 80 percent ofthe theoretical elastic elongation of the free stressing length.

3. Maximum Movement. The elastic movement at the maximum test load is equal to or less than the sum of 100 percent of the theoretical elastic elongation of the free stressing length and 50 percent of the bond length.

(f) Ground Anchors Not Meeting Acceptance Criteria. When a ground anchor does not meet the acceptance criteria outlined above, the Contractor shall correct the problem with the Engineer's approval and at no additional expense to the Department. The corrections may include, but are not limited to, post-grouting the anchor, replacing the unacceptable ground anchor, reducing the ground anchor design load and installing additional ground anchors in a secondary ground anchor location, changing installation methods, or increasing anchor total length, anchor bond length, or anchor hole diameter.

The Contractor shall submit the proposed corrective plan to the Engineer in writing before beginning corrective work in accordance with Section 618.14.

(g) Permanent Ground Anchor Lock-Off. After successful testing of a ground anchor is complete, the Contractor shall adjust the load on the ground anchor to the specified lock-off load shown on the plans, but not less than the minimum seating load which is 50 percent of the minimum ultimate tensile strength of the strand tendons. The load shall be increased as necessary to compensate for seating losses and the load shall be transferred from the jack to the anchorage device. Before removing the jack, the Contractor shall perform a lift-off test to confirm the load in the anchor tendon. The lift-off test shall be performed by re-applying load to the anchor tendon until the wedge plate lifts off the bearing plate or the wedges lift. The lift-off reading shall be within 5 percent of the specified lock-off load. If the lift-off reading is more than 5 percent below the specified lock-off load, the lock- off load shall be increased by lifting the anchor head and placing shims under the anchor head. If the lift-off reading is more than 5 percent above the specified lock-off load, the Contractor shall notify the Engineer and adjust the procedures to ensure this does not occur on subsequent ground anchors.

Only after the Engineer has completed the review of the construction submittals and found that they do not require resubmittal shall the Contractor cut off excess tendon steel and leave at least 0.5 inch extending above the wedges or anchor nut and completely fill the trumpet with grout. Cutting shall be done according to the tendon manufacturer's recommendations and as approved by the Engineer. Care shall be taken not to damage the tendon anchor. The tendon shall not be cut using a torch or other device which in the opinion of the Engineer might affect the strength of the tendon at the anchorage. The exposed end, including anchor plate, shall be coated with epoxy paint prior to the grouting.

Adequate precautions shall be taken to prevent grout from freezing. For permanent anchors that require an anchorage cover, the Contractor shall ensure the cover fits over the anchor head and seals against the bearing plate. The Contractor shall completely fill the cover with grout.

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METHOD OF MEASUREMENT

618.23 Permanent ground anchors that are installed, tested, and accepted will be measured by the linear foot as indicated on the plans, from the front of the wedge plate to the bottom of the ground anchor tendons. The stressing length or portion of the tendons extending past the front of the wedge plate shall not be included in the measurement for payment. Additional permanent ground anchors installed by the Contractor in secondary ground anchor locations to achieve the acceptance criteria shall be considered corrective measures and will not be measured for payment.

BASIS OF PAYMENT

618.24 The unit price of a permanent ground anchor shall be full compensation for all materials and labor necessary to complete the permanent ground anchor including hauling and disposal of drill cuttings; furnishing and installing the multi-strand ground anchor tendon with Class I corrosion protection; furnishing and installing the anchorage end hardware including the bearing plate with trumpet and anchorage heads with wedge grips and end caps; furnishing and placing grout throughgrout tubes; placement and removal of temporary drill casing; all costs associated with proof testing and performance testing; costs of all submittals, test reports and engineering; and for furnishing all tools, labor, equipment, materials and incidentals necessary to complete the work.

The accepted quantities will be paid for at the unit price bid for the pay items listed below:

Pay Item	Pay Unit
Ground Anchor	Linear Foot

Excavation shall be paid for as UNCLASSIFIED EXCAVATION (COMPLETE IN PLACE) in accordance with Section 203. Pre-cast concrete panels shall be paid for as FACING (SPECIAL) in accordance with Revision of Section 504.

Additional compensation will not be paid for the portions of a permanent ground anchor that are extended due to the Contractor’s method of operation, as determined by the Engineer.

GENERAL NOTES

1. ALL MATERIAL AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF THESE GENERAL NOTES, THE SPECIAL PROVISIONS, AND CDOT STANDARD SPECIFICATIONS AND DETAILS.
2. TIEBACK GROUND ANCHORS WERE DESIGNED IN GENERAL ACCORDANCE WITH PROCEDURES CONTAINED IN THE FHWA "GEOTECHNICAL ENGINEERING CIRCULAR NO. 4: GROUND ANCHORS AND ANCHORED SYSTEMS", 1999 EDITION, PUBLICATION NO. FHWA-IF-99-015.
3. ALL ANCHOR LENGTHS AND STRAND SIZES SHALL BE IN ACCORDANCE WITH THE PLANS. FREE LENGTHS REPRESENT ENGINEER'S ESTIMATE TO BEDROCK CONTACT BASED ON AVAILABLE GEOTECHNICAL DATA AND IS CONSIDERED APPROXIMATE.
5. GROUND CONDITIONS AT THE SITE ARE VARIABLE. BEDROCK ENCOUNTERED IN THE SLOPE IS EXPECTED TO VARY IN LITHOLOGY, HARDNESS, AND DRILLABILITY.
6. CONTRACTOR SHALL PROVIDE SAFE WORKING CONDITIONS FROM POTENTIAL ROCKFALL AND MAINTAINING STABLE SLOPES ABOVE AND BELOW THE TIEBACK GROUND ANCHORS.
7. CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFYING THE LOCATION AND DEPTH OF ALL EXISTING UTILITIES AS NECESSARY TO ENSURE THE UTILITIES WILL NOT BE IMPACTED BY CONSTRUCTION ACTIVITIES.
8. PROOF, PERFORMANCE, AND VERIFICATION TESTS SHALL BE CONDUCTED IN ACCORDANCE WITH THE REQUIREMENTS CONTAINED IN THE SPECIAL PROVISIONS.

GROUND ANCHOR DESIGN REQUIREMENTS

1. THE FOLLOWING GEOTECHNICAL PARAMETERS WERE USED FOR THE GROUND ANCHOR DESIGN DESCRIBED IN THESE DRAWINGS:

Material	Loading Condition	Unit Weight (pcf) Dry	Unit Weight (pcf) Saturated	Friction Angle (deg)	Cohesion, c (psf)	Unconfined Compressive Strength, S (psi)
Failure Surface Material1	Static	117	117	18.5	0	--
	Seismic					
Fill Material	Static	108	123	30	375	--
	Seismic				300	--
Native Material	Static	117	133	22	500	--
	Seismic				400	--
Native Material (Saturated)	Static	118	130	22	21	--
	Seismic				17	--
Bedrock	Static	160	160	--	--	10,000
	Seismic					

2. THE FOLLOWING FACTORS OF SAFETY WERE USED:

- LONG-TERM GLOBAL STABILITY: FACTOR OF SAFETY (FOS) ≥ 1.3
- SHORT-TERM PSUEDOSTATIC STABILITY: FOS ≥ 1.0
- ROCK/GROUT BOND STRESS: FOS ≥ 3.0
- STEEL STRAND STRESS: ALLOWABLE DESIGN LOAD ≤ 0.6 X SMTS (SPECIFIED MINIMUM TENSILE STRENGTH)

3. DESIGN REQUIREMENTS
   - MAXIMUM ULTIMATE BOND STRESS = 116 PSI
   - ASSUMED ALLOWABLE ROCK/GROUT BOND STRESS = 38.5 PSI
   - ASSUMED HOLE DIAMETER IN BOND ZONE = 7 IN.
   - DUE TO VARIABILITY IN THE AMOUNT OF WEATHERING AND ROCK STRENGTH OF DEPOSITION LAYERS IN THE BEDROCK, THE MINIMUM BOND LENGTH SHALL BE 35 FEET.
   - DESIGN LOAD FOR THE ANCHORS OF 210 KIPS EACH AND A MAXIMUM TEST LOAD OF 280 K.
   - ANCHOR INCLINATION 30 DEGREES BELOW HORIZONTAL.
   - CLASS I CORROSION PROTECTION REQUIRED (PERMANENT ANCHORS; GEC NO. 4, SABATINI ET AL., 1999).
   - REINFORCED, PRECAST CONCRETE BEARING PANELS WITH APPROXIMATELY 8-FOOT LENGTH AND WIDTH (SQUARE) SHALL BE DESIGNED AND SEALED BY AN EXPERIENCED STRUCTURAL ENGINEER LICENSED IN THE STATE OF COLORADO.

CONSTRUCTION PROCEDURES

1. GROUND ANCHOR PAY LENGTHS TO BE MEASURED FROM THE FRONT OF THE WEDGE PLATE TO THE BOTTOM OF THE ANCHOR TENDON. CONTRACTOR SHALL CALCULATE AND ADD ADDITIONAL TENDON STRESSING LENGTH.
2. THE WALL SHALL BE CONSTRUCTED FROM THE TOP DOWN.
3. THE CONTRACTOR IS RESPONSIBLE FOR TEMPORARY SLOPE STABILITY DURING CONSTRUCTION. SEE PROJECT SPECIAL PROVISIONS FOR REQUIREMENTS RELATED TO CONSTRUCTION SEQUENCING.
4. NO MORE THAN ONE THIRD OF THE ANCHORS ON ANY ROW SHALL BE UN-STRESSED AT ANY TIME.
5. CONSTRUCTION BENCHES AND ACCESS ROADS SHALL BE SLOPED BACK INTO THE HILLSIDE SO AS TO DIVERT STORMWATER RUNOFF AWAY FROM THE OUTER SLOPE IN ACCORDANCE WITH THE EROSION CONTROL PLAN TO BE SUBMITTED BY THE CONTRACTOR. THE CONTRACTOR SHALL ENSURE POSITIVE DRAINAGE TO AVOID PONDING ON THE BENCHES.
6. SOIL EXCAVATED TO CONSTRUCT THE ACCESS ROADS AND CONSTRUCTION BENCHES MAY BE HAULED AND STOCKPILED NEARBY TO BE USED AS BACKFILL UPON COMPLETION OF THE GROUND ANCHOR INSTALLATIONS.

GROUND ANCHOR QUANTITIES

ITEM NO.	PAY ITEM	UNIT	QUANTITY	AS CONSTR.
201-00001	CLEARING AND GRUBBING	ACRE	2.6	
203-00010	UNCLASSIFIED EXCAVATION (COMPLETE IN PLACE)	CY	5,500	
504-04440	FACING (SPECIAL)	SF	4,100	
605-01030	3 INCH HORIZONTAL DRAIN	LF	1,300	
605-84000	SUBSURFACE DRAIN OUTLET	LF	500	
605-84100	SUBSURFACE DRAIN OUTLET STRUCTURE	EA	22	
618-08900	GROUND ANCHOR	LF	4,805	

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Print Date: 2021-06-21
File Name: 1533175C004.dwg
Horiz. Scale: N/A Vert. Scale: N/A
Unit Information Unit Leader Initials NEJ

GOLDER
7245 W. ALASKA DR. SUITE 200
LAKEWOOD, COLORADO, 80226
+1 (303) 980-0540

Sheet Revisions

Date:	Comments	Init.

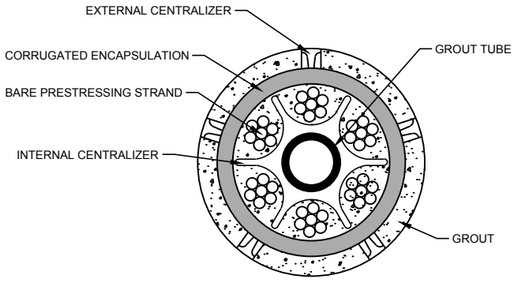
Colorado Department of Transportation
2424 N. TOWNSEND AVENUE
MONTROSE, COLORADO 81401
PHONE: 970-683-6420
FAX: 970-249-6018
REGION 3 RMS

As Constructed
No Revisions:
Revised:
Void:

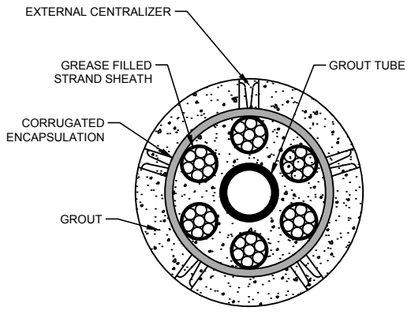
GROUND ANCHOR
GENERAL INFORMATION

Designer: ALB
Detailer: AMD
Sheet Subset: GEO
Structure Numbers
Subset Sheets: 1 of 18

Project No./Code
C 133A-048
23125
Sheet Number 14



SCALE N.T.S. A 26 BOND LENGTH SECTION



SCALE N.T.S. B 26 FREE LENGTH SECTION

NOTES

1. ANCHOR DESIGN LOADS ARE 211 KIPS. ANCHORS SHALL BE TESTED TO 280 KIPS. FOR ADDITIONAL ANCHOR DESIGN CRITERIA, REFER TO GEOTECHNICAL REPORT.
2. PROOF TESTING IS REQUIRED ON ALL ANCHORS NOT SUBJECTED TO VERIFICATION TESTING. REFER TO PROJECT SPECIALS FOR TESTING REQUIREMENTS.
3. ANY CHANGES TO THE DESIGN SHALL REQUIRE CONTRACTOR'S ENGINEER TO SUBMIT CALCULATIONS AND DETAILS FOR REVIEW BY PROJECT ENGINEER.
4. CONTRACTOR IS RESPONSIBLE FOR ALL MEANS AND METHODS REQUIRED TO INSTALL ANCHORS CAPABLE OF RESISTING REQUIRED DESIGN LOADS.
5. ALL ANCHORS SHALL HAVE CLASS I CORROSION PROTECTION (FHWA-IF-99-015, 1999).
6. CONTRACTOR RESPONSIBLE FOR DETERMINING THE REQUIRED ADDITIONAL STRESSING LENGTH IN ADDITION TO PAY LENGTH.

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Print Date: 2021-06-30
File Name: 1533175C007.dwg
Horiz. Scale: N/A Vert. Scale: N/A
Unit Information Unit Leader Initials NEJ

GOLDER
7245 W. ALASKA DR. SUITE 200
LAKEWOOD, COLORADO, 80226
+1 (303) 980-0540

Sheet Revisions		
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2424 N. TOWNSEND AVENUE
MONTROSE, COLORADO 81401
PHONE: 970-683-6420
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REGION 3 RMS

As Constructed
No Revisions:
Revised:
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GROUND ANCHOR DETAILS (1 OF 2)

Designer:	ALB	Structure Numbers	
Detailer:	AMD		
Sheet Subset:	GEO	Subset Sheets: 13 of 18	

Project No./Code
C 133A-048
23125
Sheet Number 26