Coal Bond Calculation Guidelines 2026

Mining Bureau
Air, Energy, and Mining Division
Montana Department of Environmental Quality

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ACRONYMS

ARM	Administrative Rules of Montana
BCY	Bank Cubic Yards
CMI	Costmine Intelligence
CMI ECC	Costmine Intelligence Equipment Cost Calculator
CPH	Caterpillar Performance Handbook
KSAH	Komatsu Specifications and Application Handbook
LCY	Loose Cubic Yards
MCA	Montana Code Annotated
DEQ	Montana Department of Environmental Quality
MPH	Miles Per Hour
MSUMRA	Montana Strip and Underground Mine Reclamation Act
OSMRE	Office of Surface Mining, Reclamation and Enforcement
PMT	Postmine Topography
TSF	Truck/Shovel Fleet

REVISION HISTORY

Version 1.0 – Initial draft document published 8/21/2025.

Version 1.1 – Revised draft document published 2/23/2026. This version uses the 2025 Costmine Database.

Version 1.2 – Revised draft document published as final revision for 2026. This version includes narrative changes that clarifies the internal application of this guideline. Engineering redesign indirect cost range has additionally been modified.

1 INTRODUCTION

The purpose of this guideline is to provide the Montana Department of Environmental Quality (DEQ) staff with a consistent methodology to determine performance reclamation bonds at regulated coal mines. DEQ is responsible for administrating the Montana Strip and Underground Mine Reclamation Act (MSUMRA) (the Act) (82-4-201 et seq., MCA) and implementation of Administrative Rules of Montana (ARM 17.24.301-1309) adopted under MSUMRA. Pursuant to ARM 17.24.1102, the standard applied by DEQ in determining the amount of performance bond is the estimated cost to DEQ if it had to perform the reclamation, restoration, and abatement work required of an operator or a prospecting permittee under the Act, the rules adopted thereunder, and the permit.

This guideline is written for use by DEQ in determining the bond for Montana coal mines. Mine operators are required to submit supporting information such as cut-fill balances and projected disturbance areas as part of the permit under ARM 17.24.313. These documents are reviewed and approved by DEQ into the permit, but DEQ may use additional information such as the standard industry rates provided in this guideline when determining the appropriate bond amount.

Applicable bonding rules outlined in this guideline apply to the following:

ARM 17.24.305	**Maps**
ARM 17.24.313	**Reclamation Plan**
ARM 17.24.413	**Conditions of Permit**
ARM 17.24.416	**Permit Renewal**
ARM 17.24.1016	**Bond Requirements for Drilling Operations**
ARM 17.24.1101	**Bonding: Definitions**
ARM 17.24.1102	**Bonding: Determination of Bond Amount**
ARM 17.24.1104	**Bonding: Adjustment of Amount of Bond**
ARM 17.24.1111	**Bonding: Bond Release Application Contents**

2 BOND CALCULATION STANDARDIZED COSTS

2.1 EQUIPMENT COSTS

Equipment sizing and classification are based on the assumed utilization by a third-party contractor reclaiming the project site. All equipment utilized in bond calculations should be selected from Appendix Table G-3 unless an operator can appropriately demonstrate, through an engineering analysis, that a deviation is appropriate. No on-site equipment will be permissible for utilization in bond calculations; readily available contractor equipment selection and utilization is assumed in calculations provided within the guideline.

Standardized equipment costs were determined through utilization of Costmine Intelligence's Equipment Cost Calculator for the revision year. This report provides a comprehensive list of capital costs and hourly operating costs associated with mine specific reclamation operations. The rates provided by Costmine Intelligence have been modified to utilize the average Montana diesel fuel price and accepted Montana operator rate found in **Appendix G**. The ownership rates provided have been additionally reduced by 25% to account for potential used equipment utilization along with manufacture discounts when purchasing large heavy equipment; discounts for large mobile equipment, such as trucks, shovels, and loaders, typically range from 5% to 40% (Costmine Intelligence, 2025). The decision of reduced ownership costs and utilization of database capital purchase values is applied by DEQ and is subject to change in-order-to continue alignment with ARM 17.24.1102. The values provided by Costmine are stated to be suitable for preliminary engineering estimates and align with resources necessary for bond determination under ARM 17.24.1102.

Equipment rates published by Costmine are sourced directly from manufacturers, dealers, and mining companies. These rates are generalized and do not include manufacture information to provide protection to third party data sources; the equivalent match of specific equipment listed in Appendix Table G-3 are provided to ease in equipment selection based on a historic understanding and utilization of manufacturer specific equipment.

All production calculations utilize a standard efficiency factor of 0.83, based on a fifty-minute working hour as recommended and referenced by the Komatsu Specifications & Applications Handbook (KSAH) and Caterpillar Performance Handbook (CPH). This efficiency factor is anticipated to be an average of all equipment utilized during reclamation. Additionally, all loading equipment utilize a bucket fill factor of 95% in calculations; this assumption is based on the uniform consistency of spoil material.

2.2 DIESEL PRICING

Diesel pricing is calculated from Montana contracting and bidding resources provided by the Montana Department of Transportation. These values are reported monthly and averaged throughout the year to calculate a yearly average fuel price.

Rates are based on the average Montana diesel fuel price per year provided by the Montana Department of Transportation (https://www.mdt.mt.gov/business/contracting/fuel-prices.aspx). Fuel rates used in equipment pricing can be found in Appendix Table G-1.

2.3 LABOR PRICING

Supervision costs are assumed to be covered by contractor overhead and profit. No additional specific cost will be applied for supervision during reclamation.

Auxiliary support equipment with utilization less than 1.0 are assumed to be servicing work areas with additional equipment during the operating shift. Example: Water truck and blading during a shift could be assigned to a single operator if conditions allow. Operator wage utilized in equipment pricing can be found in Appendix Table G-2.

The accepted operator rate is based on Montana Prevailing Wage Rates for Heavy Construction Services (https://erd.dli.mt.gov/_docs/labor-standards/Prevailing-Wage/Heavy-Final-2025.pdf).

2.4 MINIMUM PERFORMANCE BOND

ARM 17.24.1116(5) requires retaining a performance bond in the amount of not less than $200 per acre until phase IV final bond release has been granted. Therefore, the performance bond must be at least equal to the permit acres multiplied by $200. Since activities within the permit area are all individually bonded and disturbance is required to be bonded prior to its occurrence, bond for additional permit acres through an amendment or incidental boundary change is not required at the time of approval if the overall bond is equal to or greater than the minimum amount. Similarly, a revision for additional disturbance does not require an additional bond at the time of approval if bond is posted for the disturbance prior to its occurrence.

3 DIRECT COSTS

Bond calculation methodology in this guideline aligns with ARM 17.24.1102 and utilizes third-party contractor assumptions for completion of all reclamation activities. These guidelines utilize standard construction industry cost-estimating practices for determining earthmoving, facilities demolition, and revegetation costs which account for most of the bond amount. The direct cost items listed in the bond determination are intended to capture the primary components of reclamation.

DEQ bond calculation steps align with the Office of Surface Mining, Reclamation and Enforcement (OSMRE) guidelines for completing the following steps sequentially:

- Determination of the point of maximum reclamation cost liability for the responsibility period;
- Estimation of direct costs including backfill and grading, drill and blast, facilities demolition, haul road removal, pond and trap removal, scarification and finish grading, and revegetation;
- Adjustment of direct costs for inflation;
- Estimation of indirect reclamation costs including mobilization and demobilization, engineering redesign, contractor profit and overhead, project management, and contingencies; then
- Determination of the total bond amount.

3.1 BACKFILL AND ROUGH GRADING

The bond calculation should include all equipment, procedures, volumes, and costs associated with relocation of all materials; this would be represented by the difference between an updated topography and approved postmine topography (PMT) surface.

Backfill and grading calculations must be based on the difference between the projected disturbance surface for the bond period and an assumed bonding PMT surface. If mine plans are updated or are reported to deviate from the projected disturbance surface, updated bond calculations will be necessary. Bonding PMT surfaces may be different from the life of mine postmine topography surface for permits that have additional mining beyond the bond calculation period. However, the surface must still follow all MSUMRA reclamation requirements.

The surface must be approved through a permit revision and is also subject to an environmental review conducted pursuant to the Montana Environmental Policy Act (MEPA). Permit revisions are classified as major (ARM 17.24.301(66)) or minor (ARM 17.24.301(72)) based on multiple criteria, and revisions that do not meet the major revision criteria are presumed to be minor. Changes to the bonding surface that result in a significant deviation from prior approved surfaces or from the approved PMT, especially beyond the active mine envelope, may result in the need for a major permit revision. Major revisions are classified by changes in the mining or reclamation plan that result in a significant change in the postmining drainage plan, a change in the postmining land use, a significant change in the bonding level, or a change that may affect the reclaimability of the area or the hydrologic balance.

Backfilling and rough grading calculations are typically completed through determination of cut/fill polygons to efficiently balance the projected disturbance topography to the bonding PMT surface.

Operators must submit all elements of these calculations including polygon boundaries, equipment utilized in material movement, volume moved from cut polygon, destination polygon for fill material, cut/fill centroid determination, average grade for each material movement step, haul distances and grades for Truck/Shovel Fleet (TSF) movement, and applicable drill and blast costs for individual polygons.

Dozer push lengths must be limited to 650 feet. As efficiency greatly decreases with excessive dozer push lengths, these material movements should be reclassified from dozer movement to TSF movement.

Appendices A through **D** detail costs associated with accepted equipment through traditional earthmoving methods.

3.2 DRILL AND BLAST

Drill and blast costs associated with fragmentation of bank material must be applied to applicable areas; this typically includes highwall reduction and compacted zones. Site specific blasting costs ($/BCY) can be applied though, if additional drilling is required, contractor quotes may be necessary for specific drilling applications. As earthmoving contractors' availability of drilling equipment may be limited, drill and blast company standard pricing should be utilized.

3.3 FACILITIES

All facilities and structures not approved for retention in postmining land use must be demolished and disposed of per approved permit conditions. This includes but is not limited to:

- Mining related buildings (shops, warehouses, offices, etc.)
- Crushers
- Coal storage bunkers and silos
- Conveyor systems
- Fences
- Foundations
- Power lines
- Rail spurs and embankments
- Utilities
- Bridges
- Equipment and supply storage facilities
- Haul roads or hard-surface roads
- Scoria or shale pits
- Ponds and sediment traps
- Sewage lagoons
- Culverts
- Support facilities (fuel tanks, equipment ready-lines, water tanks, explosive storage tanks)

Specific line-item costs for each demolition step are required in calculating facilities removal. Gordian's RS Means Software offers comprehensive cost estimates for heavy civil construction demolition and is commonly used in facilities removal estimations (https://www.gordian.com/products/rsmeans-data-services/).

When referencing cost estimation data sources, total costs should not include contractor overhead and profits; these costs are regarded as an indirect costs and are added later as a percentage of total direct costs. Salvage value of building materials or abandoned supplies and equipment are not allowed due to volatility in the salvage market. Unless cost references specifically note disposal within the description, additional transportation, landfill disposal, and other costs associated with disposal of demolition debris in an approved solid waste disposal facility must be addressed.

A plan and associated supporting materials for hydrocarbon soil testing and hazardous material removal must be included in facility removal and cost calculations.

Facility demolition specific cost items should include the following (if-applicable):

- Building demolition based on construction of materials (wood, concrete, reinforced concrete, steel, etc.)
- Concrete slab demolition
- Footer demolition
- Column footer demolition
- Retaining wall demolition
- Equipment dismantling
- Conveyor removal
- Gutting costs
- Electrical removal
- Above ground piping and valves
- Well pump removal and abandonment
- Concrete disposal (on or off-site)
- Investigation and testing of hazardous building materials
- Hazardous material removal and disposal

Ripping and grading of haul roads and compacted surfaces with dozers are calculated with associated costs in **Appendix F**.

3.4 SCARIFICATION/FINISH GRADING AND SOIL REDISTRIBUTION

Recontouring, scarification, and drainage finish grading of backfilled areas in preparation for topsoil redistribution must be planned and calculated separately from backfill and grading. Any backfilled or regraded area that does not have Phase I bond release approval should include dozer regrade costs; dozer regrade costs should be included for field tie-in and drainage establishment where motor grader efficiencies would not apply. Costs associated with scarification and finish grading with motor graders are calculated in **Appendix E** and should be applied in soiling calculations. Any heavily compacted

surfaces must be ripped and prepared for soil redistribution; **Appendix F** has associated costs for ripping heavily compacted surfaces with dozers.

Topsoil stockpiles must be tracked and reported by horizon or designated use of the soil and utilized entirely for reclamation activities. Topsoil movement must be reported by topsoil cut location, volume of material relocated, destination of relocated material, haul distances and grades, and equipment utilized. If the stockpiled topsoil on-site will not be sufficient for the complete permitted cover depth, a mitigation plan must be provided and estimated costs for completion of mitigation efforts should also be included in the bond.

3.5 REVEGETATION

Calculations for revegetation should consist of seedbed preparation, soil sampling, soil amendment application, seeding, planting and mulching. Revegetation costs should be applied to the total acres of disturbance. As weather and site conditions will vary and may impact vegetative growth, necessary funds for additional seeding, weed control, monitoring, etc., should be included in bond calculations until all disturbed acres receive approval for Phase II bond release. The costs associated with reseeding and replanting are determined by the specific conditions of the site and historical rates of vegetative failure for the operation being assessed, as well as comparable operations on similar sites. This cost estimate should account for any necessary soil sampling, regrading, and earthmoving expenses involved in evaluating and repairing the site as part of the reseeding and replanting process.

3.6 SUBCATEGORY RECLAMATION COSTS

Additional costs for subcategory items necessary for successful reclamation should be considered such as soil and water sampling, monitoring, site dewatering, drill hole plugging, hazardous waste disposal, and post-mining site management. These topics represent some of the generic costs encountered during bond calculations; each site will encounter permit specific costs which should be captured and calculated based on the operator's best judgement.

3.6.1 Sampling

Sampling costs should include both initial and ongoing sampling of water quality. Initial sampling before reclamation operations begin may be necessary to track any impacts to water resources during the life of the project. Ongoing sampling may be necessary to track changes throughout reclamation and determine site balance. The costs associated with collecting samples, laboratory analysis and reporting should be included in the bond calculation.

3.6.2 Monitoring

Continuous monitoring is crucial to ensure regulatory compliance and assess any impacts post-mining or during the reclamation process. This may include installation of monitoring wells, sensors and other equipment to measure groundwater levels, determine surface and ground water quality, and monitor for potential contaminants. Costs for equipment, maintenance, and data analysis should be included in bond calculations. ARM 17.24.725(2), 17.24.645(5), and 17.24.646(7) list requirements for monitoring

timeframes; these monitoring requirements apply until final bond release is approved. Justification of applicable acres and their associated monitoring timeframes should be included in bond calculations.

3.6.3 Dewatering

Pit dewatering for highwall reduction or pit backfill reclamation operations may be necessary if conditions require. Costs for pumping, maintenance, and monitoring should be included for dewatering operations. Pit inflow assumptions must be included in calculations; historic data must be utilized, if any exists, for site inflow calculations.

3.6.4 Drilled Holes

Removal and full reclamation of monitoring wells and prospecting holes must be calculated and considered in bond calculations. A list of all prospect drill holes requiring reclamation should include but is not limited to:

- Hole identification
- Total depth
- Acres disturbed
- Equipment utilized in site reclamation
- Seed mix applied to drill pad

DEQ bond rates for prospecting drill holes can be found at the following link.
https://deq.mt.gov/files/Land/CoalUranium/Forms/Prospecting%20Application%20Package.pdf

3.6.5 Hazardous Waste Disposal

Any hazardous waste encountered during reclamation of the site, such as disposal of land farmed material, must be disposed of in compliance with ARM 17.24.507 through ARM 17.24.510. Cost calculations should include the costs typically encountered with waste disposal while aligning with ARM 17.24.507(1)(a) stating, 'Placement, storage, and disposal must ensure that leachate and surface runoff do not degrade surface or ground water, that fires are prevented, and that the area remains stable and suitable for reclamation and revegetation compatible with the natural surroundings.' Ripping and grading of haul roads and compacted surfaces with dozers are calculated with associated costs in **Appendix F**.

3.6.6 Water Replacement

For water supplies that are predicted to be potentially affected by contamination, diminution, or interruption from coal mining (ARM 17.24.648), costs should be included for a permanent replacement water supply of like quality and quantity until final bond release or until DEQ has made a determination that the water supply has not been impacted by mining.

3.6.7 Other Reclamation and Mitigation Costs

DEQ may require additional mitigation costs for specific situations based on the mine plan, permit commitments, and local site conditions. Examples could include but are not limited to bonding for

postmine subsidence impacts to structures, and additional reclamation costs associated with prime farmlands and alluvial valley floors.

3.7 INFLATION ADJUSTMENT

Once direct costs have been calculated, inflation adjustments must be made prior to applying indirect cost percentages. This procedure aligns with OSMRE bonding guidelines to account for anticipated inflationary increases in reclamation costs during the permit term and after permit expiration. Inflation adjustments must be applied based on the length of time between bond recalculations.

The inflation rate to be used will be calculated annually, averaging the previous five (5) years of applicable cost indexes.

To stabilize large or rapid changes in the market and indexes, the inflation rate will be capped with both a minimum **(2.0%)** and maximum rate **(3.5%)**. Similarly, to avoid continual fluctuations in reclamation bond calculations due to varying annual inflation rates, the inflation rate will be placed in one of three categories.

The current inflation rate will be determined by calculating the previous 5-year average change in Consumer Price Index from the U.S. Bureau of Labor Statistics (https://www.bls.gov/cpi/) and assigning the annual inflation range for the given applicable ranges shown below:

5-year average less than 2.0%	=	2.0% Annual Inflation
5-year average between 2.0% – 3.5%	=	2.75% Annual Inflation
5-year average greater than 3.5%	=	3.5% Annual Inflation

The assigned inflation rate is to be applied to the total of direct costs for a reclamation bond, assuming the inflation of construction costs will continue at that rate until either the next comprehensive bond calculation, or the bond is collected and used for reclamation activities, whichever is sooner.

$$\text{Inflation Adjusted Direct Costs} = (\text{Total Direct Cost}) \times (1 + \text{annual inflation rate})^{(\text{number of years})}$$

4 INDIRECT COSTS

Indirect costs are applied as a percentage of the inflated total direct costs to account for any additional expenses DEQ may incur upon bond forfeiture. DEQ indirect cost rates are based on historically acknowledged rates and OSMRE recognized rates (Office of Surface Mining Reclamation and Enforcement, 2020). OSMRE considers their rates acceptable after their review of Federal indirect costs (Office of Surface Mining Reclamation and Enforcement, 2020, Table C1-D Indirect Cost Guidelines). Indirect rates included in bond calculations must align with the values listed below unless an operator can appropriately demonstrate, through an engineering analysis, stamped by a professional engineer, that a deviation is appropriate.

4.1 MOBILIZATION AND DEMOBILIZATION

Costs associated with moving equipment to and from the reclamation site will vary based on the size, type, and number of equipment utilized. If additional steps for reclamation are planned to be completed once the primary equipment fleet has been demobilized (sediment pond removal, additional seeding and weed control, etc.) separate mobilization/demobilization will be necessary and costs will need to be calculated accordingly. As mobilization and demobilization rates are determined by time constraints, special need, presence of non-standard features or conditions impacting mobility, and location, determination of actual rates will vary by permit; operators must provide narrative explaining the basis of cost estimation for this indirect cost.

The DEQ value for mobilization/demobilization is 3.0%; this value is consistent with OSMRE guidelines.

4.2 ENGINEERING REDESIGN

In the event of bond forfeiture, additional planning and redesign may be required as the bond calculation at the time of forfeiture may not reflect actual site conditions. Plans may not be adequately detailed enough to act as contractor plans and specifications; in this event, DEQ would be required to modify the plans for reclamation. OSMRE identifies potential activities necessary for modification as:

- Preparing maps and plans to show the extent of required reclamation;
- Surveying topsoil and overburden stockpiles to determine the amount of material available;
- Analyzing topsoil and overburden stockpiles to determine whether special handling is necessary;
- Evaluating structures to assess the difficulty of demolition and removal;
- Evaluating impoundments and roads to determine any special reclamation needs (such as the presence of toxic materials), the feasibility of leaving those structures in place, and the rehabilitation needed to ensure stability and facilitate the postmining land use;
- Assessing the condition of areas reclaimed by the permittee to determine whether additional work is needed to complete the reclamation plan; and
- Preparing contract documents.

The DEQ value for engineering redesign ranges from 2.0% to 4.0% as shown below in Table 4-2; this value is consistent with the ranges listed in OSMRE's Handbook for Calculation of Reclamation Bond Amounts (Office of Surface Mining Reclamation and Enforcement, 2020, Table C1-D Indirect Cost Guidelines). DEQ may adopt an engineering redesign indirect cost that is lower than the standard value when a coal mine is in the final stages of reclamation and the scope of remaining engineering work has been substantially reduced. In these cases, where no additional engineering services or redesign costs are reasonably anticipated, a reduced indirect cost rate that accurately reflects the remaining reclamation obligation may be applied.

Table 4-2. Engineering Redesign Indirect Cost Range

Direct Cost Total	Percent
Greater than or equal to $100,000,000	2.0%
Less than $100,000,000	4.0%

4.3 CONTRACTOR PROFIT AND OVERHEAD

Contractor profit and overhead are commonly paired under the label "O&P" in civil cost estimating, though project specific rates for contractor overhead must be considered separately from contractor profit rates; overhead rates are project size dependent while contractor profit range is typically based on overall project risk.

The DEQ value for contractor profit is 7.0%. This value aligns with 'normal financial risks' as listed in OSMRE's Handbook for Calculation of Reclamation Bond Amounts (Office of Surface Mining Reclamation and Enforcement, 2020, Table C1-D Indirect Cost Guidelines).

The DEQ value for contractor overhead is 10.0%; this value is consistent with ranges listed in OSMRE's Handbook for Calculation of Reclamation Bond Amounts (Office of Surface Mining Reclamation and Enforcement, 2020, Table C1-D Indirect Cost Guidelines).

4.4 PROJECT MANAGEMENT

This indirect cost value applies to costs associated with hiring a project management firm to inspect and supervise work performed by the reclamation contractor.

The DEQ value for project management is 3.0%; this value is consistent with values listed in OSMRE's Handbook for Calculation of Reclamation Bond Amounts (Office of Surface Mining Reclamation and Enforcement, 2020, Table 1 Project Management Fee).

4.5 CONTINGENCIES

Bond calculations must include a contingency allowance to account for any unanticipated costs; this cost is typically based on unknowns and uncertainty in assumptions utilized in reclamation plans and cost estimates. This cost should not be used to cover any reclamation step or cost where sufficient information is available to determine the associated direct cost.

The DEQ value for contingency is 5.0%; this value is consistent with ranges listed in OSMRE's Handbook for Calculation of Reclamation Bond Amounts (Office of Surface Mining Reclamation and Enforcement, 2020, Table C1-D Indirect Cost Guidelines).

5 ADDITIONAL BONDING GUIDANCE

The following topics are intended to provide DEQ staff with clear standards on the types of submittal documents operators should provide and/or utilize to support their detailed reclamation cost estimate.

5.1 MAPS

The following maps must be submitted to support the detailed reclamation cost estimate. ARM 17.24.305(1)(k),(l), and ARM 17.24.305(3) require that maps submitted for the detailed reclamation cost estimate must be certified in accordance with ARM 17.24.305(2)(a) and prepared by or under the direction of and certified by a qualified licensed professional engineer (ARM 17.24.305(2)(b)). Maps must be provided in a PDF and live file format such as an AutoCAD file. Any derived product such as triangulated surfaces, used in the detailed reclamation cost estimate should also be included.

5.1.1 Projected Disturbance Map

This map should depict the actual and/or projected disturbance topographic conditions at time of the bond calculation until the next bond determination.

5.1.2 PMT Map

This map illustrates the approved postmine topography utilized in cut/fill balances for bond calculations. This map may be different from the life of mine PMT map for permits that have additional mining beyond the bond calculation period. The approved PMT must follow all MSUMRA reclamation requirements and have prior approval by DEQ before utilization in bond calculations.

5.1.3 Cut/Fill Map

This map provides a comparison between the Disturbance Map and the approved PMT Map. It identifies areas where cut or fill is necessary to adjust the projected disturbance topography to the approved PMT Map.

5.1.4 Earthwork Map

The Cut/Fill Map serves as the basis for the creation of the Earthwork Map, which identifies volumetric polygons for dozer, truck/shovel, and scraper overburden material movement. Each cut polygon is paired with an associated fill polygon. The map will delineate polygon centroids, grades and haul routes between polygons. It is required that all centroids include elevation values if haulage grades are used for equipment productivity calculations. The routing of truck and scraper haulage must be realistic and include valid haul roads. The purpose is to determine variables utilized in calculations for dozing and TSF movement.

5.1.5 Topsoil Map

This map should show the planned topsoil replacement activities associated with the bond estimate. This typically includes:

- Topsoil source stockpile
- Final reclamation field polygon
- Haul distance
- Dozer push distance and slope
- Permit specific details (spoil only areas, etc)

5.2 RECLAMATION TIMETABLE

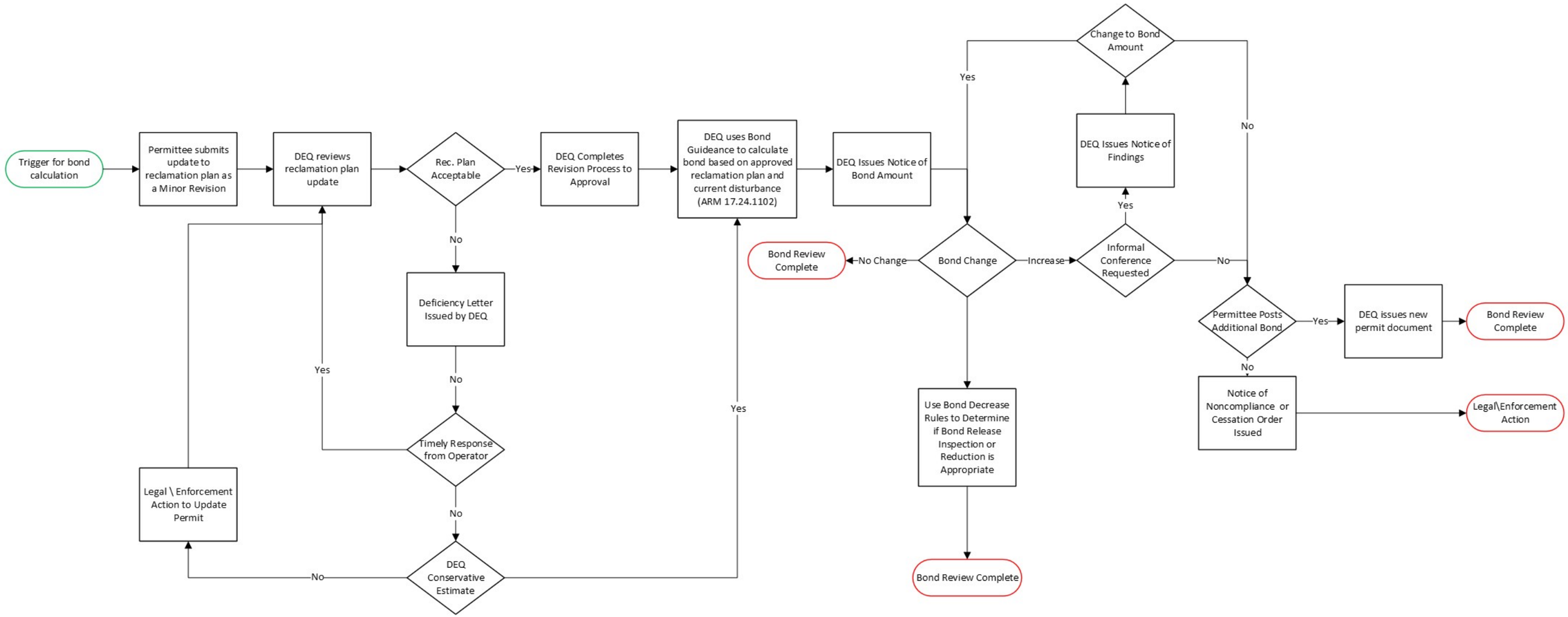
Pursuant to ARM 17.24.313(b), operators should provide 'a detailed timetable for the estimated completion of each major step in the reclamation plan'. An updated reclamation timetable is required with bond calculations because it will be different from the reclamation timetable provided under ARM 17.24.313(b). The timetable will aid in DEQ's understanding of proposed reclamation steps and major developments; in the event of bond forfeiture, this document would represent project scope for reclamation and be sent to contractors in the bid solicitation process. This timetable should represent a general sequencing of reclamation operations. A general reclamation map showing progression of reclamation operations should also be included in the permit revision submittal package.

An updated reclamation timetable is required with the detailed reclamation cost estimate if reclamation timeframes are anticipated to exceed a 2-year as listed in ARM 17.24.501(6)(b): *"Backfilling and grading must be completed within two years after coal removal from each pit has been concluded. For the purpose of this provision, "each pit" means any continuous dragline pass within a particular permit area."* DEQ can approve site-specific reclamation schedules, in conjunction with the necessary bond, for bond calculations in addition to reclamation schedules used during mining operations (ARM 17.24.501(6)). Reclamation schedules supporting bond calculations are necessary for accurate bond calculations and subject to DEQ review and approval.

A Gantt chart with each step in reclamation would be suitable for submittal.

5.3 BOND REVIEW AND APPROVAL

ARM 17.24.313(1)(c) states that the permittee must provide *a detailed estimate of the cost of reclamation of the proposed operations that will be covered by a performance bond with supporting calculations for the estimate.* Site specific information or additional details on equipment usage, local equipment availability, efficiencies, etc. may also be submitted for consideration under the permit revision process, but approval of the information through the revision does not require DEQ to utilize the information in the bond calculation (ARM 17.24.1102(1)).


Trigger for bond calculation
Permittee submits update to reclamation plan as a Minor Revision
DEQ reviews reclamation plan update
Rec. Plan Acceptable
Yes
No
DEQ Completes Revision Process to Approval
DEQ uses Bond Guideance to calculate bond based on approved reclamation plan and current disturbance (ARM 17.24.1102)
DEQ Issues Notice of Bond Amount
Change to Bond Amount
Yes
No
DEQ Issues Notice of Findings
Yes
Bond Review Complete
No Change
Bond Change
Increase
Informal Conference Requested
No
Permittee Posts Additional Bond
Yes
DEQ issues new permit document
Bond Review Complete
No
Notice of Noncompliance or Cessation Order Issued
Legal\Enforcement Action
Deficiency Letter Issued by DEQ
No
Timely Response from Operator
Yes
No
Legal \ Enforcement Action to Update Permit
DEQ Conservative Estimate
No
Yes
Use Bond Decrease Rules to Determine if Bond Release Inspection or Reduction is Appropriate
Bond Review Complete

5.3.1 Document Submittal

DEQ staff should ensure applicants\operators submit all documents pursuant to ARM 17.24.313 including:

- Reclamation plan and narrative
- Reclamation timetable
- Detailed Reclamation Cost Estimate (Excel and PDF format)
- Maps (AutoCAD and PDF format)
    - Disturbance Map
    - PMT Map
    - Cut/Fill Map (created from difference between Disturbance Map and PMT Map)
    - Earthwork Map (including dozer and TSF polygons)
    - Topsoil Map (including all relevant information utilized in calculations)

Any information or data utilized in calculations must be submitted and available for DEQ validation.

Professional Engineer (PE) certification provides an inferred level of training and competency to ensure that the technical aspects of the bond submittal are accurate and true. ARM 17.24.305 requires PE certification for all maps in the permit application which include one or more of the 13 of 26 specific informational categories (e.g. permit boundaries, roads, buildings, facilities, etc.). Maps submitted as part of the supplemental information for detailed reclamation bond estimates and related to the reclamation plan require a PE stamp. Detailed reclamation bond estimates also require detailed technical information and calculations typically performed by engineers with the appropriate education and experience. Supporting documentation and calculations required to demonstrate that the reclamation plan and PMT is achievable are part of the certifying PE's responsibility and form the basis for the detailed reclamation cost estimate.

5.3.2 Notice of Bond

DEQ is responsible for determining if adequate bond is held and notifying the permittee if a change in bond is warranted; approval of a permit revision to include or update supporting reclamation cost estimates under ARM 17.24.313 is separate from the notice of bond under ARM 17.24.1104. The notice of a bond determination has two potential outcomes: 1) adequate bond is held or 2) additional bond is required.

If additional bond is required, DEQ will send a notice to the operator that additional bond is required and include a deadline to post any additional bond. This deadline will be on or before the deadline applicants or operators have included in their permit or the permit renewal date, whichever occurs first. If DEQ determines that the required bond amount is smaller than the bond held amount, the permittee may separately request a bond reduction under the specific requirements of ARM 17.24.1104(3) or the phased bond release process of ARM 17.24.1111 through ARM 17.24.1116. Bond reduction due to backfilling and grading progress must go through the phased bond release process. If DEQ determines additional bond must be posted, an opportunity for an informal conference may be requested by the

operator within 30 days of the notice. This timeline is analogous to the period to request an informal conference under ARM 17.24.403(1)(c). If an informal conference has been requested, a modified deadline to post additional bond may be established by DEQ. To establish the deadline to post bond, DEQ may consider the timing of the informal conference and response timelines established in the informal conference procedure.

5.3.3 Informal Conference & Public Participation

ARM 17.24.1104(1) allows the permittee an opportunity for an informal conference on a bond increase.

> *The amount of the performance bond must be increased, as required by the department, as the acreage in the permit area increases, methods of mining operation change, standards of reclamation change or when the cost of future reclamation, restoration or abatement work increases. The department shall notify the permittee of any proposed bond increase and provide the permittee an opportunity for an informal conference on the proposal. The department shall review each outstanding performance bond at the time that permit reviews are conducted under ARM 17.24.414 through 17.24.416 and reevaluate those performance bonds in accordance with the standards in ARM 17.24.1102.*

The procedure described in ARM 17.24.403(2) through ARM 17.24.403(4) for informal conferences will be used for posting notices, conducting the conference, and notifying participants of any findings or revised bond calculations.

During an informal conference, a permittee may provide oral statements, written statements, or other relevant information from any party to the conference (ARM 17.24.403(1)(d)). At this time, the permittee or any participating member of the public may provide additional information to DEQ on site-specific details that they wish to be considered in the bond calculation beyond the information that may have been provided through a permit revision to the reclamation plan. The information provided at an informal conference could include information related to the values and factors used by DEQ to calculate the bond. An example of site-specific information could include: a request to modify a factor or value based on detailed, specific engineering calculations at a mine site in reclamation; a request to deviate from values adopted in the Coal Bond Calculations Guidelines. Information justifying these requests should be supported by an engineering analysis and certified by a professional engineer. All information presented at the informal conference is a public record and available to all members of the public until final bond release of the permit area (ARM 17.24.403(2)(d)). DEQ will notify all parties within 60 days of an informal conference of any revised bond calculation (ARM 17.24.403(4)). If DEQ determines a modification to the bond determination is necessary as a result of information presented at an informal conference and an increase in bond is necessary, then a permittee may request a subsequent informal conference after DEQ releases a revised bond calculation.

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7 APPENDIX A: MATERIAL RELOCATION WITH 100-TON TRUCK/SHOVEL FLEET

The cost tables listed within Appendix A only apply to relocation of materials; additional costs will be required for grading once material has been hauled to its destination. Additional costs will also need to be applied if drill/blast is required (See **Section 3.2 Drill and Blast**).

All calculation inputs are based on reported values found in the CPH. Travel times were determined by visually interpreting the graphs provided in the CPH Edition 41. The 0% road grade travel times plot line was used to assign travel times on road grades with an average slope less than 0%, as lesser values are not provided.

Costs per LCY should be determined by utilizing the tables below. All tables listed below include a 4.0% rolling resistance in the equivalent grades; add the average road grade and 4.0% rolling resistance to achieve the equivalent grade, then match to the applicable table. **Table A-3** can be used to assist selection of the applicable cost table based on calculated road grade. If bond specific calculated values fall between values reported in the following tables, total costs can be interpolated; this practice must be completed with the tables provided in the subsequent appendix. The following calculations assume that the total cost per hour for equipment includes the operator.

Table A-1. 100-Ton TSF Operating Cost [1]

Equipment	Quantity Used in Fleet	Cost ($/hr)
CAT 992 Loader	1	$385.32
CAT 777 Haul Trucks	TBD	$248.81
12,000 Gal. Water Truck	0.5	$83.05
CAT 16 Grader for Road Maintenance	0.5	$83.17
CAT D10 Dozer for Loader Support	1	$323.90
Total Fleet Cost (Less Trucks)		**$875.45**

[1] Does not include hauling costs; these costs are truck dependent and are calculated in Tables A-4 through A-8

Table A-2. Loader Production Inputs (Caterpillar, 2019)

Operation	**Value**
Loader Capacity (LCY)	18.00
Fill Factor	0.95
Truck Capacity (LCY)	79.00
Passes to Load Truck (round up)	5.00
Truck Spot (min)	0.70
First Pass (min)	0.10
Time/Loader Cycle (min)	0.65
Total Loader Cycle Time (min)	3.40
Operation Efficiency	0.83
Total Loader Productivity (LCY/hr)	**1,157**

Table A-3. 100-Ton TSF Appendix Table Summary (Caterpillar, 2011)

Appendix Table	**Loaded Road Grade**	**Rolling Resistance**	**Loaded Total Grade**	**Empty Total Grade**
A-4	0.0%	4.0%	4.0%	4.0%
A-5	-5.0%	4.0%	-1.0%	9.0%
A-6	-10.0%	4.0%	-6.0%	14.0%
A-7	5.0%	4.0%	9.0%	-1.0%
A-8	10.0%	4.0%	14.0%	-6.0%

Table A-4. 100-Ton TSF Production with 4.0% Loaded Grade and 4.0% Empty Grade.

One-Way Haul Distance (ft)	Load Time (min)	Maneuver Time (min)	Loaded Travel Time (min)	Dump Time (min)	Empty Travel Time (min)	Total Cycle Time (min)	Trips Per Hour	Truck Payload (LCY)	Total Truck Production (LCY/hr)	Loader Production (LCY/hr)	Trucks Required	Total Cost ($/LCY)
500	2.70	0.70	0.25	1.10	0.15	4.90	10.2	79.0	806	1,157	1.4	$1.07
1,000	2.70	0.70	0.56	1.10	0.30	5.36	9.3	79.0	737	1,157	1.6	$1.09
1,500	2.70	0.70	0.85	1.10	0.45	5.80	8.6	79.0	681	1,157	1.7	$1.12
2,000	2.70	0.70	1.13	1.10	0.60	6.23	8.0	79.0	634	1,157	1.8	$1.15
2,500	2.70	0.70	1.41	1.10	0.75	6.66	7.5	79.0	593	1,157	2.0	$1.18
3,000	2.70	0.70	1.69	1.10	0.90	7.09	7.1	79.0	557	1,157	2.1	$1.20
3,500	2.70	0.70	1.98	1.10	1.05	7.53	6.6	79.0	525	1,157	2.2	$1.23
4,000	2.70	0.70	2.26	1.10	1.20	7.96	6.3	79.0	496	1,157	2.3	$1.26
4,500	2.70	0.70	2.54	1.10	1.35	8.39	6.0	79.0	471	1,157	2.5	$1.29
5,000	2.70	0.70	2.82	1.10	1.50	8.82	5.7	79.0	448	1,157	2.6	$1.31
5,500	2.70	0.70	3.10	1.10	1.65	9.25	5.4	79.0	427	1,157	2.7	$1.34
6,000	2.70	0.70	3.39	1.10	1.80	9.69	5.2	79.0	408	1,157	2.8	$1.37
6,500	2.70	0.70	3.67	1.10	1.95	10.12	4.9	79.0	390	1,157	3.0	$1.39
7,000	2.70	0.70	3.95	1.10	2.10	10.55	4.7	79.0	374	1,157	3.1	$1.42

Table A-5. 100-Ton TSF Production with -1.0% Loaded Grade and 9.0% Empty Grade.

One-Way Haul Distance (ft)	Load Time (min)	Maneuver Time (min)	Loaded Travel Time (min)	Dump Time (min)	Empty Travel Time (min)	Total Cycle Time (min)	Trips Per Hour	Truck Payload (LCY)	Total Truck Production (LCY/hr)	Loader Production (LCY/hr)	Trucks Required	Total Cost ($/LCY)
500	2.70	0.70	0.14	1.10	0.28	4.92	10.2	79.0	803	1,157	1.4	$1.07
1,000	2.70	0.70	0.28	1.10	0.58	5.36	9.3	79.0	737	1,157	1.6	$1.09
1,500	2.70	0.70	0.42	1.10	0.83	5.75	8.7	79.0	687	1,157	1.7	$1.12
2,000	2.70	0.70	0.56	1.10	1.10	6.16	8.1	79.0	641	1,157	1.8	$1.14
2,500	2.70	0.70	0.70	1.10	1.40	6.60	7.6	79.0	598	1,157	1.9	$1.17
3,000	2.70	0.70	0.87	1.10	1.66	7.03	7.1	79.0	562	1,157	2.1	$1.20
3,500	2.70	0.70	0.98	1.10	1.91	7.39	6.8	79.0	535	1,157	2.2	$1.22
4,000	2.70	0.70	1.11	1.10	2.21	7.82	6.4	79.0	505	1,157	2.3	$1.25
4,500	2.70	0.70	1.25	1.10	2.50	8.25	6.1	79.0	479	1,157	2.4	$1.28
5,000	2.70	0.70	1.39	1.10	2.80	8.69	5.8	79.0	455	1,157	2.5	$1.30
5,500	2.70	0.70	1.53	1.10	3.08	9.11	5.5	79.0	434	1,157	2.7	$1.33
6,000	2.70	0.70	1.67	1.10	3.30	9.47	5.3	79.0	417	1,157	2.8	$1.35
6,500	2.70	0.70	1.81	1.10	3.61	9.92	5.0	79.0	398	1,157	2.9	$1.38
7,000	2.70	0.70	1.95	1.10	3.85	10.30	4.9	79.0	383	1,157	3.0	$1.41

Table A-6. 100-Ton TSF Production with -6.0% Loaded Grade and 14.0% Empty Grade.

One-Way Haul Distance (ft)	Load Time (min)	Maneuver Time (min)	Loaded Travel Time (min)	Dump Time (min)	Empty Travel Time (min)	Total Cycle Time (min)	Trips Per Hour	Truck Payload (LCY)	Total Truck Production (LCY/hr)	Loader Production (LCY/hr)	Trucks Required	Total Cost ($/LCY)
500	2.70	0.70	0.14	1.10	0.44	5.08	9.8	79.0	778	1,157	1.5	$1.08
1,000	2.70	0.70	0.28	1.10	0.87	5.65	8.8	79.0	699	1,157	1.7	$1.11
1,500	2.70	0.70	0.42	1.10	1.31	6.23	8.0	79.0	634	1,157	1.8	$1.15
2,000	2.70	0.70	0.56	1.10	1.74	6.80	7.4	79.0	581	1,157	2.0	$1.18
2,500	2.70	0.70	0.70	1.10	2.18	7.38	6.8	79.0	535	1,157	2.2	$1.22
3,000	2.70	0.70	0.87	1.10	2.61	7.98	6.3	79.0	495	1,157	2.3	$1.26
3,500	2.70	0.70	0.98	1.10	3.05	8.53	5.9	79.0	463	1,157	2.5	$1.29
4,000	2.70	0.70	1.11	1.10	3.35	8.96	5.6	79.0	441	1,157	2.6	$1.32
4,500	2.70	0.70	1.25	1.10	3.92	9.67	5.2	79.0	408	1,157	2.8	$1.37
5,000	2.70	0.70	1.39	1.10	4.36	10.25	4.9	79.0	385	1,157	3.0	$1.40
5,500	2.70	0.70	1.53	1.10	4.79	10.82	4.6	79.0	365	1,157	3.2	$1.44
6,000	2.70	0.70	1.67	1.10	5.23	11.40	4.4	79.0	346	1,157	3.3	$1.47
6,500	2.70	0.70	1.81	1.10	5.66	11.97	4.2	79.0	330	1,157	3.5	$1.51
7,000	2.70	0.70	1.95	1.10	6.10	12.55	4.0	79.0	315	1,157	3.7	$1.55

Table A-7. 100-Ton TSF Production with 9.0% Loaded Grade and -1.0% Empty Grade.

One-Way Haul Distance (ft)	Load Time (min)	Maneuver Time (min)	Loaded Travel Time (min)	Dump Time (min)	Empty Travel Time (min)	Total Cycle Time (min)	Trips Per Hour	Truck Payload (LCY)	Total Truck Production (LCY/hr)	Loader Production (LCY/hr)	Trucks Required	Total Cost ($/LCY)
500	2.70	0.70	0.62	1.10	0.14	5.26	9.5	79.0	751	1,157	1.5	$1.09
1,000	2.70	0.70	1.24	1.10	0.29	6.03	8.3	79.0	655	1,157	1.8	$1.14
1,500	2.70	0.70	1.86	1.10	0.43	6.79	7.4	79.0	582	1,157	2.0	$1.18
2,000	2.70	0.70	2.49	1.10	0.57	7.56	6.6	79.0	522	1,157	2.2	$1.23
2,500	2.70	0.70	3.11	1.10	0.71	8.32	6.0	79.0	475	1,157	2.4	$1.28
3,000	2.70	0.70	3.73	1.10	0.86	9.09	5.5	79.0	435	1,157	2.7	$1.33
3,500	2.70	0.70	4.35	1.10	1.00	9.85	5.1	79.0	401	1,157	2.9	$1.38
4,000	2.70	0.70	4.97	1.10	1.14	10.61	4.7	79.0	372	1,157	3.1	$1.42
4,500	2.70	0.70	5.59	1.10	1.29	11.38	4.4	79.0	347	1,157	3.3	$1.47
5,000	2.70	0.70	6.21	1.10	1.43	12.14	4.1	79.0	325	1,157	3.6	$1.52
5,500	2.70	0.70	6.84	1.10	1.57	12.91	3.9	79.0	306	1,157	3.8	$1.57
6,000	2.70	0.70	7.46	1.10	1.71	13.67	3.7	79.0	289	1,157	4.0	$1.62
6,500	2.70	0.70	8.08	1.10	1.86	14.44	3.5	79.0	274	1,157	4.2	$1.67
7,000	2.70	0.70	8.70	1.10	2.00	15.20	3.3	79.0	260	1,157	4.5	$1.71

Table A-8. 100-Ton TSF Production with 14.0% Loaded Grade and -6.0% Empty Grade.

One-Way Haul Distance (ft)	Load Time (min)	Maneuver Time (min)	Loaded Travel Time (min)	Dump Time (min)	Empty Travel Time (min)	Total Cycle Time (min)	Trips Per Hour	Truck Payload (LCY)	Total Truck Production (LCY/hr)	Loader Production (LCY/hr)	Trucks Required	Total Cost ($/LCY)
500	2.70	0.70	0.99	1.10	0.14	5.63	8.9	79.0	702	1,157	1.6	$1.11
1,000	2.70	0.70	1.98	1.10	0.29	6.77	7.4	79.0	583	1,157	2.0	$1.18
1,500	2.70	0.70	2.97	1.10	0.43	7.90	6.3	79.0	500	1,157	2.3	$1.25
2,000	2.70	0.70	3.96	1.10	0.57	9.03	5.5	79.0	437	1,157	2.6	$1.33
2,500	2.70	0.70	4.95	1.10	0.71	10.16	4.9	79.0	389	1,157	3.0	$1.40
3,000	2.70	0.70	5.94	1.10	0.86	11.30	4.4	79.0	350	1,157	3.3	$1.47
3,500	2.70	0.70	6.93	1.10	1.00	12.43	4.0	79.0	318	1,157	3.6	$1.54
4,000	2.70	0.70	7.91	1.10	1.14	13.55	3.7	79.0	292	1,157	4.0	$1.61
4,500	2.70	0.70	8.96	1.10	1.29	14.75	3.4	79.0	268	1,157	4.3	$1.69
5,000	2.70	0.70	9.89	1.10	1.43	15.82	3.2	79.0	250	1,157	4.6	$1.75
5,500	2.70	0.70	10.88	1.10	1.57	16.95	2.9	79.0	233	1,157	5.0	$1.82
6,000	2.70	0.70	11.87	1.10	1.71	18.08	2.8	79.0	218	1,157	5.3	$1.90
6,500	2.70	0.70	12.86	1.10	1.86	19.22	2.6	79.0	206	1,157	5.6	$1.97
7,000	2.70	0.70	13.85	1.10	2.00	20.35	2.5	79.0	194	1,157	6.0	$2.04

8 APPENDIX B: MATERIAL RELOCATION COSTS WITH 200/250-TON TRUCK/SHOVEL FLEETS

The cost tables listed within Appendix B only apply to relocation of materials; additional costs should be included for grading once material has been hauled to its destination. Additional costs should also be included if drill/blast is required (See **Section 3.2 Drill and Blast**).

All calculation inputs are based on reported values found in the KSAH. Travel times were determined by calculating the total resistance and required rimpull, then utilizing graphs provided in the KSAH to determine the average travel speed. A maximum travel speed of 30 MPH was assigned to align with safety standards typically implemented by mine operators and contract mining companies.

Determine cost per LCY by utilizing the tables below. All tables listed below include a 4.0% rolling resistance in the equivalent grades; add the average road grade and 4.0% rolling resistance to achieve the equivalent grade, then match to the applicable table. **Table B-5** can be used to assist selection of the applicable cost table based on calculated road grade. If bond specific calculated values fall between values reported in the following tables, total costs can be interpolated; this practice must be completed with the tables provided in the subsequent appendix. The following calculations assume that the total cost per hour for equipment includes the operator.

Table B-1: 200-Ton TSF Operating Cost [2]

Equipment	Quantity Used in Fleet	Cost ($/hr)
PC5500 Shovel	1	$1,889.59
730E Haul Trucks	TBD	$439.13
12,000 Gal. Water Truck	0.5	$83.05
CAT 16 Grader for Road Maintenance	1	$166.35
CAT D10 Dozer for Shovel Support	1	$323.90
Total Fleet Cost (Less Trucks)		**$2,462.88**

Table B-2: 200-Ton TSF Production Inputs (Komatsu, 2019)

Operation	Value
Shovel Capacity (LCY)	38.00
Fill Factor	0.95
Truck Capacity (LCY)	145.00
Passes to Load Truck (round up)	4.00
Truck Spot (min)	0.30
First Pass (min)	0.10
Time/Shovel Cycle (min)	0.59
Total Shovel Cycle Time (min)	2.17
Operation Efficiency	0.83
Total Shovel Productivity (LCY/hr)	**3,328**

[2] Does not include hauling costs. Hauling costs are truck dependent and are calculated in Tables B-4 through B-8

Table B-3: 250-Ton TSF Operating Cost [3]

Equipment	Quantity Used in Fleet	Cost ($/hr)
PC5500 Shovel	1	$1,889.59
830E Haul Trucks	TBD	$556.70
12,000 Gal. Water Truck	0.5	$83.05
CAT 16 Grader for Road Maintenance	1	$166.35
CAT D10 Dozer for Shovel Support	1	$323.90
Total Fleet Cost (Less Trucks)		**$2,462.88**

Table B-4: 250-Ton TSF Production Inputs (Komatsu, 2019)

Operation	Value
Shovel Capacity (LCY)	38.00
Fill Factor	0.95
Truck Capacity (LCY)	207.00
Passes to Load Truck (round up)	6.00
Truck Spot (min)	0.30
First Pass (min)	0.10
Time/Shovel Cycle (min)	0.59
Total Shovel Cycle Time (min)	3.35
Operation Efficiency	0.83
Total Shovel Productivity (LCY/hr)	**3,077**

[3] Does not include hauling costs. Hauling costs are truck dependent and are calculated in Tables B-9 through B-13

Table B-5. 200/250-Ton TSF Appendix Table Summary (Komatsu, 2019) [4]

Appendix Table	Loaded Road Grade	Rolling Resistance	Loaded Total Grade	Empty Total Grade
B-6, B-11	0.0%	4.0%	4.0%	4.0%
B-7, B-12	-5.0%	4.0%	-1.0%	9.0%
B-8, B-13	-10.0%	4.0%	-6.0%	14.0%
B-9, B-14	5.0%	4.0%	9.0%	-1.0%
B-10, B-15	10.0%	4.0%	14.0%	-6.0%

[4] Maximum speed in calculations is limited to 30 MPH

Table B-6. 200-Ton TSF Production with 4.0% Loaded Grade and 4.0% Empty Grade.

One-Way Haul Distance (ft)	Load Time (min)	Maneuver Time (min)	Loaded Travel Time (min)	Dump Time (min)	Empty Travel Time (min)	Total Cycle Time (min)	Trips Per Hour	Truck Payload (LCY)	Total Truck Production (LCY/hr)	Shovel Production (LCY/hr)	Trucks Required	Total Cost ($/LCY)
500	1.87	0.80	0.27	1.20	0.19	4.33	11.5	145.0	1,673	3,328	2.0	$1.00
1,000	1.87	0.80	0.55	1.20	0.38	4.80	10.4	145.0	1,511	3,328	2.2	$1.03
1,500	1.87	0.80	0.82	1.20	0.57	5.26	9.5	145.0	1,378	3,328	2.4	$1.06
2,000	1.87	0.80	1.10	1.20	0.76	5.73	8.7	145.0	1,266	3,328	2.6	$1.09
2,500	1.87	0.80	1.37	1.20	0.95	6.19	8.1	145.0	1,171	3,328	2.8	$1.12
3,000	1.87	0.80	1.65	1.20	1.14	6.65	7.5	145.0	1,090	3,328	3.1	$1.14
3,500	1.87	0.80	1.92	1.20	1.33	7.12	7.0	145.0	1,019	3,328	3.3	$1.17
4,000	1.87	0.80	2.20	1.20	1.52	7.58	6.6	145.0	956	3,328	3.5	$1.20
4,500	1.87	0.80	2.47	1.20	1.70	8.04	6.2	145.0	901	3,328	3.7	$1.23
5,000	1.87	0.80	2.74	1.20	1.89	8.51	5.9	145.0	852	3,328	3.9	$1.26
5,500	1.87	0.80	3.02	1.20	2.08	8.97	5.6	145.0	808	3,328	4.1	$1.28
6,000	1.87	0.80	3.29	1.20	2.27	9.44	5.3	145.0	768	3,328	4.3	$1.31
6,500	1.87	0.80	3.57	1.20	2.46	9.90	5.1	145.0	732	3,328	4.5	$1.34
7,000	1.87	0.80	3.84	1.20	2.65	10.36	4.8	145.0	700	3,328	4.8	$1.37

Table B-7. 200-Ton TSF Production with -1.0% Loaded Grade and 9.0% Empty Grade.

One-Way Haul Distance (ft)	Load Time (min)	Maneuver Time (min)	Loaded Travel Time (min)	Dump Time (min)	Empty Travel Time (min)	Total Cycle Time (min)	Trips Per Hour	Truck Payload (LCY)	Total Truck Production (LCY/hr)	Loader Production (LCY/hr)	Trucks Required	Total Cost ($/LCY)
500	1.87	0.80	0.19	1.20	0.27	4.33	11.5	145.0	1,673	3,328	2.0	$1.00
1,000	1.87	0.80	0.38	1.20	0.55	4.80	10.4	145.0	1,511	3,328	2.2	$1.03
1,500	1.87	0.80	0.57	1.20	0.82	5.26	9.5	145.0	1,378	3,328	2.4	$1.06
2,000	1.87	0.80	0.76	1.20	1.10	5.73	8.7	145.0	1,266	3,328	2.6	$1.09
2,500	1.87	0.80	0.95	1.20	1.37	6.19	8.1	145.0	1,171	3,328	2.8	$1.12
3,000	1.87	0.80	1.14	1.20	1.65	6.65	7.5	145.0	1,090	3,328	3.1	$1.14
3,500	1.87	0.80	1.33	1.20	1.92	7.12	7.0	145.0	1,019	3,328	3.3	$1.17
4,000	1.87	0.80	1.52	1.20	2.20	7.58	6.6	145.0	956	3,328	3.5	$1.20
4,500	1.87	0.80	1.70	1.20	2.47	8.04	6.2	145.0	901	3,328	3.7	$1.23
5,000	1.87	0.80	1.89	1.20	2.74	8.51	5.9	145.0	852	3,328	3.9	$1.26
5,500	1.87	0.80	2.08	1.20	3.02	8.97	5.6	145.0	808	3,328	4.1	$1.28
6,000	1.87	0.80	2.27	1.20	3.29	9.44	5.3	145.0	768	3,328	4.3	$1.31
6,500	1.87	0.80	2.46	1.20	3.57	9.90	5.1	145.0	732	3,328	4.5	$1.34
7,000	1.87	0.80	2.65	1.20	3.84	10.36	4.8	145.0	700	3,328	4.8	$1.37

Table B-8. 200-Ton TSF Production with -6.0% Loaded Grade and 14.0% Empty Grade.

One-Way Haul Distance (ft)	Load Time (min)	Maneuver Time (min)	Loaded Travel Time (min)	Dump Time (min)	Empty Travel Time (min)	Total Cycle Time (min)	Trips Per Hour	Truck Payload (LCY)	Total Truck Production (LCY/hr)	Loader Production (LCY/hr)	Trucks Required	Total Cost ($/LCY)
500	1.87	0.80	0.19	1.20	0.44	4.50	11.1	145.0	1,612	3,328	2.1	$1.01
1,000	1.87	0.80	0.38	1.20	0.87	5.12	9.8	145.0	1,415	3,328	2.4	$1.05
1,500	1.87	0.80	0.57	1.20	1.31	5.75	8.7	145.0	1,261	3,328	2.6	$1.09
2,000	1.87	0.80	0.76	1.20	1.75	6.38	7.8	145.0	1,137	3,328	2.9	$1.13
2,500	1.87	0.80	0.95	1.20	2.19	7.00	7.1	145.0	1,035	3,328	3.2	$1.16
3,000	1.87	0.80	1.14	1.20	2.62	7.63	6.6	145.0	950	3,328	3.5	$1.20
3,500	1.87	0.80	1.33	1.20	3.06	8.26	6.1	145.0	878	3,328	3.8	$1.24
4,000	1.87	0.80	1.52	1.20	3.50	8.88	5.6	145.0	816	3,328	4.1	$1.28
4,500	1.87	0.80	1.70	1.20	3.93	9.51	5.3	145.0	763	3,328	4.4	$1.32
5,000	1.87	0.80	1.89	1.20	4.37	10.13	4.9	145.0	715	3,328	4.7	$1.35
5,500	1.87	0.80	2.08	1.20	4.81	10.76	4.6	145.0	674	3,328	4.9	$1.39
6,000	1.87	0.80	2.27	1.20	5.24	11.39	4.4	145.0	637	3,328	5.2	$1.43
6,500	1.87	0.80	2.46	1.20	5.68	12.01	4.2	145.0	603	3,328	5.5	$1.47
7,000	1.87	0.80	2.65	1.20	6.12	12.64	4.0	145.0	574	3,328	5.8	$1.51

Table B-9. 200-Ton TSF Production with 9.0% Loaded Grade and -1.0% Empty Grade.

One-Way Haul Distance (ft)	Load Time (min)	Maneuver Time (min)	Loaded Travel Time (min)	Dump Time (min)	Empty Travel Time (min)	Total Cycle Time (min)	Trips Per Hour	Truck Payload (LCY)	Total Truck Production (LCY/hr)	Loader Production (LCY/hr)	Trucks Required	Total Cost ($/LCY)
500	1.87	0.80	0.62	1.20	0.19	4.68	10.7	145.0	1,550	3,328	2.1	$1.02
1,000	1.87	0.80	1.24	1.20	0.38	5.48	9.1	145.0	1,322	3,328	2.5	$1.07
1,500	1.87	0.80	1.85	1.20	0.57	6.29	7.9	145.0	1,152	3,328	2.9	$1.12
2,000	1.87	0.80	2.47	1.20	0.76	7.10	7.0	145.0	1,021	3,328	3.3	$1.17
2,500	1.87	0.80	3.09	1.20	0.95	7.90	6.3	145.0	917	3,328	3.6	$1.22
3,000	1.87	0.80	3.71	1.20	1.14	8.71	5.7	145.0	832	3,328	4.0	$1.27
3,500	1.87	0.80	4.32	1.20	1.33	9.52	5.3	145.0	762	3,328	4.4	$1.32
4,000	1.87	0.80	4.94	1.20	1.52	10.33	4.8	145.0	702	3,328	4.7	$1.37
4,500	1.87	0.80	5.56	1.20	1.70	11.13	4.5	145.0	651	3,328	5.1	$1.41
5,000	1.87	0.80	6.18	1.20	1.89	11.94	4.2	145.0	607	3,328	5.5	$1.46
5,500	1.87	0.80	6.79	1.20	2.08	12.75	3.9	145.0	569	3,328	5.9	$1.51
6,000	1.87	0.80	7.41	1.20	2.27	13.55	3.7	145.0	535	3,328	6.2	$1.56
6,500	1.87	0.80	8.03	1.20	2.46	14.36	3.5	145.0	505	3,328	6.6	$1.61
7,000	1.87	0.80	8.65	1.20	2.65	15.17	3.3	145.0	478	3,328	7.0	$1.66

Table B-10. 200-Ton TSF Production with 14.0% Loaded Grade and -6.0% Empty Grade.

One-Way Haul Distance (ft)	Load Time (min)	Maneuver Time (min)	Loaded Travel Time (min)	Dump Time (min)	Empty Travel Time (min)	Total Cycle Time (min)	Trips Per Hour	Truck Payload (LCY)	Total Truck Production (LCY/hr)	Loader Production (LCY/hr)	Trucks Required	Total Cost ($/LCY)
500	1.87	0.80	0.96	1.20	0.19	5.02	10.0	145.0	1,444	3,328	2.3	$1.04
1,000	1.87	0.80	1.93	1.20	0.38	6.17	8.1	145.0	1,174	3,328	2.8	$1.11
1,500	1.87	0.80	2.89	1.20	0.57	7.33	6.8	145.0	989	3,328	3.4	$1.18
2,000	1.87	0.80	3.85	1.20	0.76	8.48	5.9	145.0	855	3,328	3.9	$1.25
2,500	1.87	0.80	4.82	1.20	0.95	9.63	5.2	145.0	753	3,328	4.4	$1.32
3,000	1.87	0.80	5.78	1.20	1.14	10.78	4.6	145.0	672	3,328	4.9	$1.39
3,500	1.87	0.80	6.74	1.20	1.33	11.94	4.2	145.0	607	3,328	5.5	$1.46
4,000	1.87	0.80	7.70	1.20	1.52	13.09	3.8	145.0	554	3,328	6.0	$1.53
4,500	1.87	0.80	8.67	1.20	1.70	14.24	3.5	145.0	509	3,328	6.5	$1.60
5,000	1.87	0.80	9.63	1.20	1.89	15.39	3.2	145.0	471	3,328	7.1	$1.67
5,500	1.87	0.80	10.59	1.20	2.08	16.55	3.0	145.0	438	3,328	7.6	$1.74
6,000	1.87	0.80	11.56	1.20	2.27	17.70	2.8	145.0	410	3,328	8.1	$1.81
6,500	1.87	0.80	12.52	1.20	2.46	18.85	2.7	145.0	385	3,328	8.7	$1.88
7,000	1.87	0.80	13.48	1.20	2.65	20.00	2.5	145.0	362	3,328	9.2	$1.95

Table B-11. 250-Ton TSF Production with 4.0% Loaded Grade and 4.0% Empty Grade.

One-Way Haul Distance (ft)	Load Time (min)	Maneuver Time (min)	Loaded Travel Time (min)	Dump Time (min)	Empty Travel Time (min)	Total Cycle Time (min)	Trips Per Hour	Truck Payload (LCY)	Total Truck Production (LCY/hr)	Shovel Production (LCY/hr)	Trucks Required	Total Cost ($/LCY)
500	3.05	0.80	0.26	1.20	0.19	5.50	9.1	207.0	1,882	3,077	1.6	$1.10
1,000	3.05	0.80	0.52	1.20	0.38	5.95	8.4	207.0	1,739	3,077	1.8	$1.12
1,500	3.05	0.80	0.78	1.20	0.57	6.40	7.8	207.0	1,617	3,077	1.9	$1.14
2,000	3.05	0.80	1.04	1.20	0.76	6.85	7.3	207.0	1,511	3,077	2.0	$1.17
2,500	3.05	0.80	1.30	1.20	0.95	7.30	6.8	207.0	1,418	3,077	2.2	$1.19
3,000	3.05	0.80	1.56	1.20	1.14	7.75	6.5	207.0	1,335	3,077	2.3	$1.22
3,500	3.05	0.80	1.82	1.20	1.33	8.20	6.1	207.0	1,262	3,077	2.4	$1.24
4,000	3.05	0.80	2.09	1.20	1.52	8.65	5.8	207.0	1,197	3,077	2.6	$1.27
4,500	3.05	0.80	2.35	1.20	1.70	9.10	5.5	207.0	1,137	3,077	2.7	$1.29
5,000	3.05	0.80	2.61	1.20	1.89	9.55	5.2	207.0	1,084	3,077	2.8	$1.31
5,500	3.05	0.80	2.87	1.20	2.08	10.00	5.0	207.0	1,035	3,077	3.0	$1.34
6,000	3.05	0.80	3.13	1.20	2.27	10.45	4.8	207.0	990	3,077	3.1	$1.36
6,500	3.05	0.80	3.39	1.20	2.46	10.90	4.6	207.0	950	3,077	3.2	$1.39
7,000	3.05	0.80	3.65	1.20	2.65	11.35	4.4	207.0	912	3,077	3.4	$1.41

Table B-12. 250-Ton TSF Production with -1.0% Loaded Grade and 9.0% Empty Grade.

One-Way Haul Distance (ft)	Load Time (min)	Maneuver Time (min)	Loaded Travel Time (min)	Dump Time (min)	Empty Travel Time (min)	Total Cycle Time (min)	Trips Per Hour	Truck Payload (LCY)	Total Truck Production (LCY/hr)	Loader Production (LCY/hr)	Trucks Required	Total Cost ($/LCY)
500	3.05	0.80	0.19	1.20	0.26	5.50	9.1	207.0	1,882	3,077	1.6	$1.10
1,000	3.05	0.80	0.38	1.20	0.52	5.95	8.4	207.0	1,739	3,077	1.8	$1.12
1,500	3.05	0.80	0.57	1.20	0.78	6.40	7.8	207.0	1,617	3,077	1.9	$1.14
2,000	3.05	0.80	0.76	1.20	1.04	6.85	7.3	207.0	1,511	3,077	2.0	$1.17
2,500	3.05	0.80	0.95	1.20	1.30	7.30	6.8	207.0	1,418	3,077	2.2	$1.19
3,000	3.05	0.80	1.14	1.20	1.56	7.75	6.5	207.0	1,335	3,077	2.3	$1.22
3,500	3.05	0.80	1.33	1.20	1.82	8.20	6.1	207.0	1,262	3,077	2.4	$1.24
4,000	3.05	0.80	1.52	1.20	2.09	8.65	5.8	207.0	1,197	3,077	2.6	$1.27
4,500	3.05	0.80	1.70	1.20	2.35	9.10	5.5	207.0	1,137	3,077	2.7	$1.29
5,000	3.05	0.80	1.89	1.20	2.61	9.55	5.2	207.0	1,084	3,077	2.8	$1.31
5,500	3.05	0.80	2.08	1.20	2.87	10.00	5.0	207.0	1,035	3,077	3.0	$1.34
6,000	3.05	0.80	2.27	1.20	3.13	10.45	4.8	207.0	990	3,077	3.1	$1.36
6,500	3.05	0.80	2.46	1.20	3.39	10.90	4.6	207.0	950	3,077	3.2	$1.39
7,000	3.05	0.80	2.65	1.20	3.65	11.35	4.4	207.0	912	3,077	3.4	$1.41

Table B-13. 250-Ton TSF Production with -6.0% Loaded Grade and 14.0% Empty Grade.

One-Way Haul Distance (ft)	Load Time (min)	Maneuver Time (min)	Loaded Travel Time (min)	Dump Time (min)	Empty Travel Time (min)	Total Cycle Time (min)	Trips Per Hour	Truck Payload (LCY)	Total Truck Production (LCY/hr)	Loader Production (LCY/hr)	Trucks Required	Total Cost ($/LCY)
500	3.05	0.80	0.25	1.20	0.38	5.68	8.8	207.0	1,822	3,077	1.7	$1.11
1,000	3.05	0.80	0.51	1.20	0.75	6.31	7.9	207.0	1,640	3,077	1.9	$1.14
1,500	3.05	0.80	0.76	1.20	1.13	6.94	7.2	207.0	1,491	3,077	2.1	$1.17
2,000	3.05	0.80	1.02	1.20	1.51	7.57	6.6	207.0	1,366	3,077	2.3	$1.21
2,500	3.05	0.80	1.27	1.20	1.88	8.21	6.1	207.0	1,261	3,077	2.4	$1.24
3,000	3.05	0.80	1.53	1.20	2.26	8.84	5.7	207.0	1,171	3,077	2.6	$1.28
3,500	3.05	0.80	1.78	1.20	2.63	9.47	5.3	207.0	1,093	3,077	2.8	$1.31
4,000	3.05	0.80	2.04	1.20	3.01	10.10	5.0	207.0	1,025	3,077	3.0	$1.34
4,500	3.05	0.80	2.29	1.20	3.39	10.73	4.7	207.0	965	3,077	3.2	$1.38
5,000	3.05	0.80	2.55	1.20	3.76	11.36	4.4	207.0	911	3,077	3.4	$1.41
5,500	3.05	0.80	2.80	1.20	4.14	11.99	4.2	207.0	863	3,077	3.6	$1.45
6,000	3.05	0.80	3.06	1.20	4.52	12.62	4.0	207.0	820	3,077	3.8	$1.48
6,500	3.05	0.80	3.31	1.20	4.89	13.25	3.8	207.0	781	3,077	3.9	$1.51
7,000	3.05	0.80	3.57	1.20	5.27	13.88	3.6	207.0	745	3,077	4.1	$1.55

Table B-14. 250-Ton TSF Production with 9.0% Loaded Grade and -1.0% Empty Grade.

One-Way Haul Distance (ft)	Load Time (min)	Maneuver Time (min)	Loaded Travel Time (min)	Dump Time (min)	Empty Travel Time (min)	Total Cycle Time (min)	Trips Per Hour	Truck Payload (LCY)	Total Truck Production (LCY/hr)	Loader Production (LCY/hr)	Trucks Required	Total Cost ($/LCY)
500	3.05	0.80	0.57	1.20	0.19	5.81	8.6	207.0	1,782	3,077	1.7	$1.11
1,000	3.05	0.80	1.14	1.20	0.38	6.57	7.6	207.0	1,577	3,077	2.0	$1.15
1,500	3.05	0.80	1.70	1.20	0.57	7.32	6.8	207.0	1,413	3,077	2.2	$1.19
2,000	3.05	0.80	2.27	1.20	0.76	8.08	6.2	207.0	1,281	3,077	2.4	$1.23
2,500	3.05	0.80	2.84	1.20	0.95	8.84	5.7	207.0	1,171	3,077	2.6	$1.28
3,000	3.05	0.80	3.41	1.20	1.14	9.60	5.2	207.0	1,079	3,077	2.9	$1.32
3,500	3.05	0.80	3.98	1.20	1.33	10.35	4.8	207.0	1,000	3,077	3.1	$1.36
4,000	3.05	0.80	4.55	1.20	1.52	11.11	4.5	207.0	932	3,077	3.3	$1.40
4,500	3.05	0.80	5.11	1.20	1.70	11.87	4.2	207.0	872	3,077	3.5	$1.44
5,000	3.05	0.80	5.68	1.20	1.89	12.63	4.0	207.0	820	3,077	3.8	$1.48
5,500	3.05	0.80	6.25	1.20	2.08	13.38	3.7	207.0	773	3,077	4.0	$1.52
6,000	3.05	0.80	6.82	1.20	2.27	14.14	3.5	207.0	732	3,077	4.2	$1.56
6,500	3.05	0.80	7.39	1.20	2.46	14.90	3.4	207.0	695	3,077	4.4	$1.60
7,000	3.05	0.80	7.95	1.20	2.65	15.66	3.2	207.0	661	3,077	4.7	$1.64

Table B-15. 250-Ton TSF Production with 14.0% Loaded Grade and -6.0% Empty Grade.

One-Way Haul Distance (ft)	Load Time (min)	Maneuver Time (min)	Loaded Travel Time (min)	Dump Time (min)	Empty Travel Time (min)	Total Cycle Time (min)	Trips Per Hour	Truck Payload (LCY)	Total Truck Production (LCY/hr)	Loader Production (LCY/hr)	Trucks Required	Total Cost ($/LCY)
500	3.05	0.80	0.92	1.20	0.26	6.23	8.0	207.0	1,662	3,077	1.9	$1.14
1,000	3.05	0.80	1.83	1.20	0.52	7.40	6.8	207.0	1,398	3,077	2.2	$1.20
1,500	3.05	0.80	2.75	1.20	0.78	8.58	5.8	207.0	1,206	3,077	2.6	$1.26
2,000	3.05	0.80	3.67	1.20	1.04	9.76	5.1	207.0	1,061	3,077	2.9	$1.33
2,500	3.05	0.80	4.58	1.20	1.30	10.94	4.6	207.0	946	3,077	3.3	$1.39
3,000	3.05	0.80	5.50	1.20	1.56	12.11	4.1	207.0	855	3,077	3.6	$1.45
3,500	3.05	0.80	6.41	1.20	1.82	13.29	3.8	207.0	779	3,077	4.0	$1.52
4,000	3.05	0.80	7.33	1.20	2.09	14.47	3.5	207.0	715	3,077	4.3	$1.58
4,500	3.05	0.80	8.25	1.20	2.35	15.64	3.2	207.0	662	3,077	4.7	$1.64
5,000	3.05	0.80	9.16	1.20	2.61	16.82	3.0	207.0	615	3,077	5.0	$1.71
5,500	3.05	0.80	10.08	1.20	2.87	18.00	2.8	207.0	575	3,077	5.4	$1.77
6,000	3.05	0.80	11.00	1.20	3.13	19.17	2.6	207.0	540	3,077	5.7	$1.83
6,500	3.05	0.80	11.91	1.20	3.39	20.35	2.5	207.0	509	3,077	6.1	$1.90
7,000	3.05	0.80	12.83	1.20	3.65	21.53	2.3	207.0	481	3,077	6.4	$1.96

9 APPENDIX C: MATERIAL RELOCATION COSTS WITH SCRAPER FLEET

As scrapers require a uniform material type and contractors do not typically have this equipment in their fleets, a suitable regrade plan from the permittee should be provided to DEQ for consideration; specific applications should be and a determination made on the appropriateness of scrapper use.

The cost tables listed within Appendix C only apply to relocation of materials; additional costs will be required for grading once material has been hauled to its destination. Additional costs should also be included if drill/blast is required (See **Section 3.2 Drill and Blast**).

Travel times were calculated with equipment specific performance charts listed in the CPH (Edition 41). The 500 ft haul distance travel times were visually obtained from graphs, while 1,000 ft through 7,000 ft haul distance travel times were calculated utilizing a trend line between data points on graphs for each associated total road grade. The 0% road grade travel times plot line was used to assign travel times on road grades with an average slope less than 0%, as lesser values are not provided.

Determine cost per LCY by utilizing the tables below. All tables listed below include a 4.0% rolling resistance in the equivalent grades; add the average road grade and 4.0% rolling resistance to achieve the equivalent grade, then match to the applicable table. **Table C-2** can be used to assist selection of the applicable cost table based on calculated road grade. If bond specific calculated values fall between values reported in the following tables, total costs can be interpolated; this practice should be completed with the tables provided in the subsequent appendix. The following calculations assume that the total cost per hour for equipment includes the operator.

Table C-1: Scraper Fleet Operating Cost

Equipment	Quantity Used in Fleet	Cost ($/hr)
CAT 657 Scrapers	1	$342.36
12,000 Gal. Water Truck	0.25	$41.53
CAT 16 Grader for Road Maintenance	0.25	$41.59
CAT D10 Dozer for Scraper Support	0.25	$80.97
Total Fleet Cost Per Scraper		**$506.45**

Table C-2: Scraper Fleet Appendix Table Summary (Caterpillar, 2011)

Appendix Table	Loaded Road Grade	Rolling Resistance	Loaded Total Grade	Empty Total Grade
C-3	0.0%	4.0%	4.0%	4.0%
C-4	-5.0%	4.0%	-1.0%	9.0%
C-5	-10.0%	4.0%	-6.0%	14.0%
C-6	5.0%	4.0%	9.0%	-1.0%
C-7	10.0%	4.0%	14.0%	-6.0%

Table C-3. Scraper Production with 4.0% Loaded Grade and 4.0% Empty Grade.

One-Way Haul Distance (ft)	Load Time (min)	Loaded Travel Time (min)	Maneuver & Spread Time (min)	Empty Travel Time (min)	Total Cycle Time (min)	Trips Per Hour	Scraper Payload (LCY)	Efficiency Factor (50 min/hr)	Scraper Production (LCY/hr)	Total Cost ($/LCY)
500	1.10	0.38	0.60	0.31	2.39	25.1	44.0	0.83	917	$0.55
1,000	1.10	0.63	0.60	0.50	2.83	21.2	44.0	0.83	774	$0.65
1,500	1.10	0.85	0.60	0.68	3.22	18.6	44.0	0.83	680	$0.75
2,000	1.10	1.06	0.60	0.85	3.62	16.6	44.0	0.83	606	$0.84
2,500	1.10	1.28	0.60	1.03	4.01	15.0	44.0	0.83	546	$0.93
3,000	1.10	1.50	0.60	1.21	4.40	13.6	44.0	0.83	498	$1.02
3,500	1.10	1.71	0.60	1.38	4.80	12.5	44.0	0.83	457	$1.11
4,000	1.10	1.93	0.60	1.56	5.19	11.6	44.0	0.83	422	$1.20
4,500	1.10	2.15	0.60	1.74	5.58	10.7	44.0	0.83	392	$1.29
5,000	1.10	2.36	0.60	1.91	5.98	10.0	44.0	0.83	367	$1.38
5,500	1.10	2.58	0.60	2.09	6.37	9.4	44.0	0.83	344	$1.47
6,000	1.10	2.80	0.60	2.27	6.76	8.9	44.0	0.83	324	$1.56
6,500	1.10	3.01	0.60	2.44	7.16	8.4	44.0	0.83	306	$1.65
7,000	1.10	3.23	0.60	2.62	7.55	7.9	44.0	0.83	290	$1.75

Table C-4. Scraper Production with -1.0% Loaded Grade and 9.0% Empty Grade.

One-Way Haul Distance (ft)	Load Time (min)	Loaded Travel Time (min)	Maneuver & Spread Time (min)	Empty Travel Time (min)	Total Cycle Time (min)	Trips Per Hour	Scraper Payload (LCY)	Efficiency Factor (50 min/hr)	Scraper Production (LCY/hr)	Total Cost ($/LCY)
500	1.10	0.28	0.60	0.35	2.33	25.8	44.0	0.83	940	$0.54
1,000	1.10	0.50	0.60	0.68	2.88	20.8	44.0	0.83	761	$0.67
1,500	1.10	0.67	0.60	0.98	3.35	17.9	44.0	0.83	654	$0.77
2,000	1.10	0.83	0.60	1.28	3.82	15.7	44.0	0.83	574	$0.88
2,500	1.10	1.00	0.60	1.58	4.28	14.0	44.0	0.83	511	$0.99
3,000	1.10	1.17	0.60	1.89	4.75	12.6	44.0	0.83	461	$1.10
3,500	1.10	1.33	0.60	2.19	5.22	11.5	44.0	0.83	420	$1.21
4,000	1.10	1.50	0.60	2.49	5.69	10.5	44.0	0.83	385	$1.32
4,500	1.10	1.67	0.60	2.79	6.16	9.7	44.0	0.83	356	$1.42
5,000	1.10	1.83	0.60	3.09	6.63	9.1	44.0	0.83	331	$1.53
5,500	1.10	2.00	0.60	3.39	7.09	8.5	44.0	0.83	309	$1.64
6,000	1.10	2.17	0.60	3.70	7.56	7.9	44.0	0.83	290	$1.75
6,500	1.10	2.33	0.60	4.00	8.03	7.5	44.0	0.83	273	$1.86
7,000	1.10	2.50	0.60	4.30	8.50	7.1	44.0	0.83	258	$1.96

Table C-5. Scraper Production with -6.0% Loaded Grade and 14.0% Empty Grade.

One-Way Haul Distance (ft)	Load Time (min)	Loaded Travel Time (min)	Maneuver & Spread Time (min)	Empty Travel Time (min)	Total Cycle Time (min)	Trips Per Hour	Scraper Payload (LCY)	Efficiency Factor (50 min/hr)	Scraper Production (LCY/hr)	Total Cost ($/LCY)
500	1.10	0.28	0.60	0.50	2.48	24.2	44.0	0.83	884	$0.57
1,000	1.10	0.50	0.60	0.96	3.16	19.0	44.0	0.83	693	$0.73
1,500	1.10	0.67	0.60	1.41	3.78	15.9	44.0	0.83	580	$0.87
2,000	1.10	0.83	0.60	1.87	4.40	13.6	44.0	0.83	498	$1.02
2,500	1.10	1.00	0.60	2.32	5.02	11.9	44.0	0.83	436	$1.16
3,000	1.10	1.17	0.60	2.78	5.64	10.6	44.0	0.83	388	$1.30
3,500	1.10	1.33	0.60	3.23	6.26	9.6	44.0	0.83	350	$1.45
4,000	1.10	1.50	0.60	3.69	6.89	8.7	44.0	0.83	318	$1.59
4,500	1.10	1.67	0.60	4.14	7.51	8.0	44.0	0.83	292	$1.73
5,000	1.10	1.83	0.60	4.59	8.13	7.4	44.0	0.83	270	$1.88
5,500	1.10	2.00	0.60	5.05	8.75	6.9	44.0	0.83	250	$2.02
6,000	1.10	2.17	0.60	5.50	9.37	6.4	44.0	0.83	234	$2.17
6,500	1.10	2.33	0.60	5.96	9.99	6.0	44.0	0.83	219	$2.31
7,000	1.10	2.50	0.60	6.41	10.61	5.7	44.0	0.83	207	$2.45

Table C-6. Scraper Production with 9.0% Loaded Grade and -1.0% Empty Grade.

One-Way Haul Distance (ft)	Load Time (min)	Loaded Travel Time (min)	Maneuver & Spread Time (min)	Empty Travel Time (min)	Total Cycle Time (min)	Trips Per Hour	Scraper Payload (LCY)	Efficiency Factor (50 min/hr)	Scraper Production (LCY/hr)	Total Cost ($/LCY)
500	1.10	0.56	0.60	0.28	2.54	23.6	44.0	0.83	863	$0.59
1,000	1.10	1.20	0.60	0.48	3.38	17.8	44.0	0.83	648	$0.78
1,500	1.10	1.65	0.60	0.64	3.99	15.0	44.0	0.83	549	$0.92
2,000	1.10	2.10	0.60	0.81	4.61	13.0	44.0	0.83	476	$1.06
2,500	1.10	2.55	0.60	0.97	5.22	11.5	44.0	0.83	420	$1.21
3,000	1.10	3.00	0.60	1.13	5.83	10.3	44.0	0.83	376	$1.35
3,500	1.10	3.45	0.60	1.29	6.44	9.3	44.0	0.83	340	$1.49
4,000	1.10	3.90	0.60	1.46	7.06	8.5	44.0	0.83	311	$1.63
4,500	1.10	4.35	0.60	1.62	7.67	7.8	44.0	0.83	286	$1.77
5,000	1.10	4.80	0.60	1.78	8.28	7.2	44.0	0.83	265	$1.91
5,500	1.10	5.25	0.60	1.94	8.89	6.7	44.0	0.83	246	$2.06
6,000	1.10	5.70	0.60	2.11	9.51	6.3	44.0	0.83	231	$2.20
6,500	1.10	6.15	0.60	2.27	10.12	5.9	44.0	0.83	217	$2.34
7,000	1.10	6.60	0.60	2.43	10.73	5.6	44.0	0.83	204	$2.48

Table C-7. Scraper Production with 14.0% Loaded Grade and -6.0% Empty Grade.

One-Way Haul Distance (ft)	Load Time (min)	Loaded Travel Time (min)	Maneuver & Spread Time (min)	Empty Travel Time (min)	Total Cycle Time (min)	Trips Per Hour	Scraper Payload (LCY)	Efficiency Factor (50 min/hr)	Scraper Production (LCY/hr)	Total Cost ($/LCY)
500	1.10	0.76	0.60	0.28	2.74	21.9	44.0	0.83	800	$0.63
1,000	1.10	1.54	0.60	0.48	3.72	16.1	44.0	0.83	589	$0.86
1,500	1.10	2.27	0.60	0.64	4.62	13.0	44.0	0.83	475	$1.07
2,000	1.10	3.01	0.60	0.81	5.51	10.9	44.0	0.83	397	$1.27
2,500	1.10	3.74	0.60	0.97	6.41	9.4	44.0	0.83	342	$1.48
3,000	1.10	4.48	0.60	1.13	7.31	8.2	44.0	0.83	300	$1.69
3,500	1.10	5.21	0.60	1.29	8.20	7.3	44.0	0.83	267	$1.90
4,000	1.10	5.95	0.60	1.46	9.10	6.6	44.0	0.83	241	$2.10
4,500	1.10	6.68	0.60	1.62	10.00	6.0	44.0	0.83	219	$2.31
5,000	1.10	7.41	0.60	1.78	10.89	5.5	44.0	0.83	201	$2.52
5,500	1.10	8.15	0.60	1.94	11.79	5.1	44.0	0.83	186	$2.73
6,000	1.10	8.88	0.60	2.11	12.69	4.7	44.0	0.83	173	$2.93
6,500	1.10	9.62	0.60	2.27	13.58	4.4	44.0	0.83	161	$3.14
7,000	1.10	10.35	0.60	2.43	14.48	4.1	44.0	0.83	151	$3.35

10 APPENDIX D: MATERIAL BACKFILL AND GRADING WITH DOZERS

The cost tables listed within Appendix D apply to backfilling and grading costs associated with dozing. Materials in this appendix are assumed to be unconsolidated; additional costs should be added if drill/blast is required (See **Section 3.2 Drill and Blast**).

Production rates and modifying factors were sourced from the CPH (Edition 49). Universal blades were assumed on all equipment when calculating production rates. Graphs provided in the CPH were visually interpreted to determine unadjusted production rates, these rates are then multiplied by the modifying factors to determine a modified production rate. As Costmine database rates do not account for sub-model variations of dozers, D11CD production rates were not used in cost calculations; CPH reported values for D11 dozers with universal blades were utilized. Spoil density for Material Density modifying factor was assumed at 2,850 lb/LCY; this correction factor is detailed on pages 19-58 and 19-63 in the CAT Handbook.

Determine cost per LCY by utilizing the tables below. If bond specific calculated values fall between values reported in the following tables, total costs can be interpolated; this practice should be completed with the tables provided in the subsequent appendix. The following calculations assume that the total cost per hour for equipment includes the operator.

Table D-1: Dozer Grading Modifying Factors (Caterpillar, 2019)[5]

Operator	Material	Material Density	Visibility	Efficiency	Slot Dozing
0.88	1.20	0.81	0.90	0.83	1.20

Table D-2: Dozer Slope Modifying Factors (Caterpillar, 2019)

Grade (%)						
-30	**-20**	**-10**	**0**	**10**	**20**	**30**
1.59	1.41	1.21	1.00	0.79	0.55	0.28

[5] Slot dozing modifying factor is only applied to D10/D11 equivalent dozer production

Table D-3: Material Movement with CAT D8 Dozer

Push Distance (ft)	Unadjusted Production Rate (LCY/hr)	Modified Production Rate (LCY/hr)	Costs ($/LCY)	Modified Production Rate (LCY/hr)	Costs ($/LCY)	Modified Production Rate (LCY/hr)	Costs ($/LCY)	Modified Production Rate (LCY/hr)	Costs ($/LCY)	Modified Production Rate (LCY/hr)	Costs ($/LCY)	Modified Production Rate (LCY/hr)	Costs ($/LCY)	Modified Production Rate (LCY/hr)	Costs ($/LCY)
Grade:		**-30%**		**-20%**		**-10%**		**0%**		**10%**		**20%**		**30%**	
50	1,400	1,417	$0.14	1,257	$0.16	1,078	$0.19	891	$0.22	704	$0.28	490	$0.41	250	$0.80
100	850	860	$0.23	763	$0.26	655	$0.31	541	$0.37	427	$0.47	298	$0.67	152	$1.32
150	600	607	$0.33	539	$0.37	462	$0.43	382	$0.52	302	$0.66	210	$0.95	107	$1.87
200	475	481	$0.42	426	$0.47	366	$0.55	302	$0.66	239	$0.84	166	$1.20	85	$2.37
250	400	405	$0.49	359	$0.56	308	$0.65	255	$0.79	201	$1.00	140	$1.43	71	$2.81
300	325	329	$0.61	292	$0.69	250	$0.80	207	$0.97	163	$1.23	114	$1.76	58	$3.46
350	300	304	$0.66	269	$0.74	231	$0.87	191	$1.05	151	$1.33	105	$1.91	53	$3.75
400	250	253	$0.79	224	$0.89	193	$1.04	159	$1.26	126	$1.59	88	$2.29	45	$4.50
450	235	238	$0.84	211	$0.95	181	$1.11	150	$1.34	118	$1.69	82	$2.43	42	$4.78
500	200	202	$0.99	180	$1.12	154	$1.30	127	$1.57	101	$1.99	70	$2.86	36	$5.62
550	190	192	$1.04	171	$1.17	146	$1.37	121	$1.66	96	$2.10	67	$3.01	34	$5.91
600	170	172	$1.16	153	$1.31	131	$1.53	108	$1.85	85	$2.34	60	$3.37	30	$6.61
650	155	157	$1.28	139	$1.44	119	$1.68	99	$2.03	78	$2.57	54	$3.69	28	$7.25

Table D-4: Material Movement with CAT D9 Dozer

Push Distance (ft)	Unadjusted Production Rate (LCY/hr)	Modified Production Rate (LCY/hr)	Costs ($/LCY)	Modified Production Rate (LCY/hr)	Costs ($/LCY)	Modified Production Rate (LCY/hr)	Costs ($/LCY)	Modified Production Rate (LCY/hr)	Costs ($/LCY)	Modified Production Rate (LCY/hr)	Costs ($/LCY)	Modified Production Rate (LCY/hr)	Costs ($/LCY)	Modified Production Rate (LCY/hr)	Costs ($/LCY)
Grade:		**-30%**		**-20%**		**-10%**		**0%**		**10%**		**20%**		**30%**	
50	2,150	2,176	$0.12	1,930	$0.14	1,656	$0.16	1,369	$0.19	1,081	$0.25	753	$0.35	383	$0.69
100	1,275	1,291	$0.21	1,144	$0.23	982	$0.27	812	$0.33	641	$0.42	446	$0.60	227	$1.17
150	900	911	$0.29	808	$0.33	693	$0.38	573	$0.46	453	$0.59	315	$0.84	160	$1.66
200	700	709	$0.38	628	$0.42	539	$0.49	446	$0.60	352	$0.76	245	$1.09	125	$2.13
250	575	582	$0.46	516	$0.52	443	$0.60	366	$0.73	289	$0.92	201	$1.32	102	$2.60
300	490	496	$0.54	440	$0.61	377	$0.71	312	$0.85	246	$1.08	172	$1.55	87	$3.05
350	425	430	$0.62	381	$0.70	327	$0.81	271	$0.98	214	$1.25	149	$1.79	76	$3.51
400	375	380	$0.70	337	$0.79	289	$0.92	239	$1.12	189	$1.41	131	$2.03	67	$3.98
450	340	344	$0.77	305	$0.87	262	$1.02	216	$1.23	171	$1.56	119	$2.24	61	$4.39
500	300	304	$0.88	269	$0.99	231	$1.15	191	$1.39	151	$1.76	105	$2.53	53	$4.98
550	275	278	$0.96	247	$1.08	212	$1.26	175	$1.52	138	$1.92	96	$2.76	49	$5.43
600	250	253	$1.05	224	$1.19	193	$1.38	159	$1.67	126	$2.12	88	$3.04	45	$5.97
650	235	238	$1.12	211	$1.26	181	$1.47	150	$1.78	118	$2.25	82	$3.24	42	$6.35

Table D-5: Material Movement with CAT D10 Dozer

Push Distance (ft)	Unadjusted Production Rate (LCY/hr)	Modified Production Rate (LCY/hr)	Costs ($/LCY)	Modified Production Rate (LCY/hr)	Costs ($/LCY)	Modified Production Rate (LCY/hr)	Costs ($/LCY)	Modified Production Rate (LCY/hr)	Costs ($/LCY)	Modified Production Rate (LCY/hr)	Costs ($/LCY)	Modified Production Rate (LCY/hr)	Costs ($/LCY)	Modified Production Rate (LCY/hr)	Costs ($/LCY)
Grade:		**-30%**		**-20%**		**-10%**		**0%**		**10%**		**20%**		**30%**	
50	3,000	3,644	$0.09	3,231	$0.10	2,773	$0.12	2,292	$0.14	1,810	$0.18	1,260	$0.26	642	$0.50
100	1,800	2,186	$0.15	1,939	$0.17	1,664	$0.19	1,375	$0.24	1,086	$0.30	756	$0.43	385	$0.84
150	1,250	1,518	$0.21	1,346	$0.24	1,155	$0.28	955	$0.34	754	$0.43	525	$0.62	267	$1.21
200	950	1,154	$0.28	1,023	$0.32	878	$0.37	726	$0.45	573	$0.56	399	$0.81	203	$1.59
250	800	972	$0.33	862	$0.38	739	$0.44	611	$0.53	483	$0.67	336	$0.96	171	$1.89
300	675	820	$0.40	727	$0.45	624	$0.52	516	$0.63	407	$0.80	284	$1.14	144	$2.24
350	590	717	$0.45	636	$0.51	545	$0.59	451	$0.72	356	$0.91	248	$1.31	126	$2.57
400	510	619	$0.52	549	$0.59	471	$0.69	390	$0.83	308	$1.05	214	$1.51	109	$2.97
450	450	547	$0.59	485	$0.67	416	$0.78	344	$0.94	272	$1.19	189	$1.71	96	$3.37
500	425	516	$0.63	458	$0.71	393	$0.82	325	$1.00	256	$1.26	179	$1.81	91	$3.56
550	375	455	$0.71	404	$0.80	347	$0.93	286	$1.13	226	$1.43	158	$2.06	80	$4.04
600	350	425	$0.76	377	$0.86	324	$1.00	267	$1.21	211	$1.53	147	$2.20	75	$4.33
650	320	389	$0.83	345	$0.94	296	$1.10	244	$1.32	193	$1.68	134	$2.41	68	$4.73

Table D-6: Material Movement with CAT D11 Dozer

Push Distance (ft)	Unadjusted Production Rate (LCY/hr)	Modified Production Rate (LCY/hr)	Costs ($/LCY)	Modified Production Rate (LCY/hr)	Costs ($/LCY)	Modified Production Rate (LCY/hr)	Costs ($/LCY)	Modified Production Rate (LCY/hr)	Costs ($/LCY)	Modified Production Rate (LCY/hr)	Costs ($/LCY)	Modified Production Rate (LCY/hr)	Costs ($/LCY)	Modified Production Rate (LCY/hr)	Costs ($/LCY)
Grade:		**-30%**		**-20%**		**-10%**		**0%**		**10%**		**20%**		**30%**	
50	5,500	6,680	$0.07	5,924	$0.08	5,084	$0.09	4,202	$0.11	3,319	$0.13	2,311	$0.19	1,176	$0.38
100	3,175	3,856	$0.12	3,420	$0.13	2,935	$0.15	2,425	$0.18	1,916	$0.23	1,334	$0.33	679	$0.66
150	2,350	2,854	$0.16	2,531	$0.18	2,172	$0.21	1,795	$0.25	1,418	$0.31	987	$0.45	503	$0.89
200	1,800	2,186	$0.20	1,939	$0.23	1,664	$0.27	1,375	$0.32	1,086	$0.41	756	$0.59	385	$1.16
250	1,460	1,773	$0.25	1,573	$0.28	1,350	$0.33	1,115	$0.40	881	$0.51	613	$0.73	312	$1.43
300	1,250	1,518	$0.29	1,346	$0.33	1,155	$0.39	955	$0.47	754	$0.59	525	$0.85	267	$1.67
350	1,100	1,336	$0.33	1,185	$0.38	1,017	$0.44	840	$0.53	664	$0.67	462	$0.97	235	$1.90
400	975	1,184	$0.38	1,050	$0.42	901	$0.49	745	$0.60	588	$0.76	410	$1.09	209	$2.14
450	850	1,032	$0.43	916	$0.49	786	$0.57	649	$0.69	513	$0.87	357	$1.25	182	$2.45
500	775	941	$0.47	835	$0.53	716	$0.62	592	$0.75	468	$0.95	326	$1.37	166	$2.69
550	725	881	$0.51	781	$0.57	670	$0.67	554	$0.81	438	$1.02	305	$1.46	155	$2.88
600	650	790	$0.56	700	$0.64	601	$0.74	497	$0.90	392	$1.14	273	$1.63	139	$3.21
650	600	729	$0.61	646	$0.69	555	$0.80	458	$0.97	362	$1.23	252	$1.77	128	$3.48

11 APPENDIX E: SCARIFICATION AND FINISH GRADING

The cost tables listed within Appendix E apply to the costs associated with scarification and finish grading of spoil and soil materials. **Table E-5** should be utilized for cut/fill areas requiring final dozer grading for tie-ins and drainage establishment; this will be required for any disturbance areas not approved for Phase I bond release. The following calculations assume that the total cost per hour for equipment includes the operator.

Table E-1: Scarification with CAT 16 Grader

Operation	Value	Unit	Data Source
CAT 16 Grader Total Cost	$166.35	$/hr	CMI Equipment Cost Calculator 2025
Effective Ripping Width	9.75	ft	CPH 49
Scarifying Pass Overlap	2.0	ft	CPH 49
Scarification Ripping Speed	2.5	mph	CPH 49
Feet Per Mile	5,280	ft/mile	
Square Feet Per Acre	43,560	sqft	
Operating Efficiency	0.83		CPH 49
Effective Grading Production	**1.95**	**acres/hr**	
CAT 16 Scarification Total Cost	**$85.34**	**$/acre**	

Table E-2: Scarification with CAT 24 Grader

Operation	Value	Unit	Data Source
CAT 24 Grader Total Cost	$371.85	$/hr	CMI Equipment Cost Calculator 2025
Effective Ripping Width	12.83	ft	CPH 49
Scarifying Pass Overlap	2.0	ft	CPH 49
Scarification Ripping Speed	2.5	mph	CPH 49
Feet Per Mile	5,280	ft/mile	
Square Feet Per Acre	43,560	sqft	
Operating Efficiency	0.83		CPH 49
Effective Grading Production	**2.72**	**acres/hr**	
CAT 24 Scarification Total Cost	**$136.47**	**$/acre**	

Table E-3: Soil Finish Grading with CAT 16 Grader

Operation	Value	Unit	Data Source
CAT 16 Grader Total Cost	$166.35	$/hr	CMI Equipment Cost Calculator 2025
Effective Blade Width (20°)	15.04	ft	CPH 49
Grading Pass Overlap	2.0	ft	CPH 49
Finish Grading Speed	2.5	mph	CPH 49
Feet Per Mile	5,280	ft/mile	
Square Feet Per Acre	43,560	sqft	
Operating Efficiency	0.83		CPH 49
Effective Grading Production	**3.28**	**acres/hr**	
CAT 16 Finish Grading Total Cost	**$50.72**	**$/acre**	

Table E-4: Soil Finish Grading with CAT 24 Grader

Operation	Value	Unit	Data Source
CAT 24 Grader Total Cost	$371.85	$/hr	CMI Equipment Cost Calculator 2025
Effective Blade Width (20°)	22.55	ft	CPH 49
Grading Pass Overlap	2.0	ft	CPH 49
Finish Grading Speed	2.5	mph	CPH 49
Feet Per Mile	5,280	ft/mile	
Square Feet Per Acre	43,560	sqft	
Operating Efficiency	0.83		CPH 49
Effective Grading Production	**5.17**	**acres/hr**	
CAT 24 Finish Grading Total Cost	**$71.94**	**$/acre**	

Table E-5: Phase I CAT D10 Grading

Operation	Value	Unit	Data Source
CAT D10 Dozer Cost	$323.90	$/hr	CMI Equipment Cost Calculator 2025
Effective Blade Width (Universal)	17.25	ft	CPH 49
Grading Pass Overlap	2.0	ft	CPH 49
Grading Speed	2.5	mph	CPH 49
Feet Per Mile	5,280	ft/mile	
Square Feet Per Acre	43,560	sqft	
Operating Efficiency	0.83		CPH 49
Effective Grading Production	**3.84**	**acres/hr**	
CAT D10 Finish Grading Total Cost	**$84.44**	**$/acre**	

12 APPENDIX F: DOZER RIPPING

The cost tables listed within Appendix F apply to the costs associated with ripping and soil preparation with dozers; this would apply to all haul roads, railroad beds, facilities, and heavily compacted surfaces. The following calculations assume that the total cost per hour for equipment includes the operator.

Table F-1: Ripping with CAT D10 Dozer Single-Shank

Operation	Value	Unit	Data Source
CAT D10 Dozer Total Cost	$323.90	$/hr	CMI Equipment Cost Calculator 2025
Effective Ripping Width - Single-Shank	4.79	ft	CPH 49, half multi-shank width
Ripping Pass Overlap	0.0	ft	CPH 49
Dozer Ripping Speed	1.0	mph	CPH 49
Feet Per Mile	5,280	ft/mile	
Square Feet Per Acre	43,560	sqft	
Operating Efficiency	0.75		CPH 49, 45 mins/hr
Effective Ripping Production	**0.44**	**acres/hr**	
CAT D10 Ripping Total Cost	**$743.56**	**$/acre**	

Table F-2: Ripping with CAT D10 Dozer Multi-Shank

Operation	Value	Unit	Data Source
CAT D10 Dozer Total Cost	$323.90	$/hr	CMI Equipment Cost Calculator 2025
Effective Ripping Width - Multi-Shank	11.50	ft	CPH 49, 120% of multi-shank width
Ripping Pass Overlap	0.0	ft	CPH 49
Dozer Ripping Speed	1.0	mph	CPH 49
Feet Per Mile	5,280	ft/mile	
Square Feet Per Acre	43,560	sqft	
Operating Efficiency	0.75		CPH 49, 45 mins/hr
Effective Ripping Production	**1.05**	**acres/hr**	
CAT D10 Ripping Total Cost	**$309.82**	**$/acre**	

Table F-3: Ripping with CAT D11 Dozer Single-Shank

Operation	Value	Unit	Data Source
CAT D11 Dozer Total Cost	$446.02	$/hr	CMI Equipment Cost Calculator 2025
Effective Ripping Width - Single-Shank	5.46	ft	CPH 49, half multi-shank width
Ripping Pass Overlap	0.0	ft	CPH 49
Dozer Ripping Speed	1.0	mph	CPH 49
Feet Per Mile	5,280	ft/mile	
Square Feet Per Acre	43,560	sqft	
Operating Efficiency	0.75		CPH 49, 45 mins/hr
Effective Ripping Production	**0.50**	**acres/hr**	
CAT D11 Ripping Total Cost	**$898.84**	**$/acre**	

Table F-4: Ripping with CAT D11 Dozer Multi-Shank

Operation	Value	Unit	Data Source
CAT D11 Dozer Total Cost	$446.02	$/hr	CMI Equipment Cost Calculator 2025
Effective Ripping Width - Multi-Shank	13.10	ft	CPH 49, 120% of multi-shank width
Ripping Pass Overlap	0.0	ft	CPH 49
Dozer Ripping Speed	1.0	mph	CPH 49
Feet Per Mile	5,280	ft/mile	
Square Feet Per Acre	43,560	sqft	
Operating Efficiency	0.75		CPH 49, 45 mins/hr
Effective Ripping Production	**1.19**	**acres/hr**	
CAT D11 Ripping Total Cost	**$374.52**	**$/acre**	

13 APPENDIX G: STANDARDIZED EQUIPMENT COSTS AND INPUTS

Table G-1: Montana Diesel Fuel Pricing (Yearly Average)

Fuel Type	2022	2023	2024	2025	2026	5-Year Average
Ultra Low Sulfur Diesel	$2.50	$3.96	$3.29	$2.68	$2.54	**$2.99**

Table G-2: Montana Prevailing Wage ($/hr)

Title	Wage	Benefit	Total
Construction Equipment Op, Group 3 (2025)	$38.00	$16.35	**$54.35**

Table G-3: Standardized Equipment Costs ($/hr without operator)

Equipment Type	Equipment Description	Equivalent Match	Hourly Ownership Cost	Hourly Operating Cost	Total Hourly Cost (Ownership and Operating)	Data Source
Dozer	13.0 ft (4.0 m) blade width, 354 hp	CAT D8	$55.00	$90.96	**$145.96**	CMI ECC 2025 (25% Ownership Cost Reduction)
Dozer	15.0 ft (4.6 m) blade width, 574 hp	CAT D9	$77.90	$133.95	**$211.85**	CMI ECC 2025 (25% Ownership Cost Reduction)
Dozer	16.2 ft (4.9 m) blade width, 600 hp	CAT D10	$109.24	$160.31	**$269.55**	CMI ECC 2025 (25% Ownership Cost Reduction)
Dozer	21.0 ft (6.4 m) blade width, 850 hp	CAT D11	$167.02	$224.65	**$391.67**	CMI ECC 2025 (25% Ownership Cost Reduction)
Rubber Tire Dozer	17.75 ft (5.4 m) blade width, 680 hp	CAT 844	$50.81	$215.90	**$266.71**	CMI ECC 2025 (25% Ownership Cost Reduction)
Blade	16 ft (4.9m) blade width, 300 hp	CAT 16	$39.85	$72.15	**$112.00**	CMI ECC 2025 (25% Ownership Cost Reduction)
Blade	24 ft (7.3 m) blade width, 533 hp	CAT 24	$131.51	$185.99	**$317.50**	CMI ECC 2025 (25% Ownership Cost Reduction)
Scraper	44 cu yd (33.6 cu m), 26.0 in (66.0 cm) cut depth, 564 hp	CAT 657	$103.40	$184.61	**$288.01**	CMI ECC 2025 (25% Ownership Cost Reduction)
On-Highway Truck	20 ft (6.1 m) dump body, Class 8	10-12 CY	$5.81	$56.70	**$62.51**	CMI ECC 2025 (25% Ownership Cost Reduction)
Haul Truck	41.0 st (37.3 mt), 30.0 cu yd (22.9 cu m), articulated mechanical drive, 441 hp	CAT 745	$18.02	$59.17	**$77.19**	CMI ECC 2025 (25% Ownership Cost Reduction)
Haul Truck	105 st (95.0 mt), 79 cu yd (60.4 cu m), mechanical drive, 1,200 hp	CAT 777	$38.87	$155.59	**$194.46**	CMI ECC 2025 (25% Ownership Cost Reduction)
Haul Truck	205 st (186 mt), 145 cu yd (111 cu m), electric drive, 2,000 hp	KOMATSU 730E	$84.48	$300.30	**$384.78**	CMI ECC 2025 (25% Ownership Cost Reduction)
Haul Truck	250 st (227 mt), 207 cu yd (158 cu m), electric drive, 2,500 hp	KOMATSU 830E	$116.28	$386.07	**$502.35**	CMI ECC 2025 (25% Ownership Cost Reduction)
Water Truck	55 ton rigid frame chassis, 12,000 gal tank, 550 hp	12,000 gal WT	$26.84	$84.91	**$111.75**	CMI ECC 2025 (25% Ownership Cost Reduction)
Loader	7.5 cu yd (5.7 cu m) bucket, 10 ft 6 in (3.2 m) dump height	CAT 980	$33.48	$84.54	**$118.02**	CMI ECC 2025 (25% Ownership Cost Reduction)
Loader	17.0 cu yd (13 cu m) bucket, 14 ft 8 in (4.5 m) dump height	CAT 992	$121.13	$209.84	**$330.97**	CMI ECC 2025 (25% Ownership Cost Reduction)
Backhoe Loader	0.44 cu yd (0.34 cu m) bucket size, 98 hp	CAT 430	$12.53	$31.88	**$44.41**	CMI ECC 2025 (25% Ownership Cost Reduction)
Excavator	2.98 cu yd (2.3 cu m) bucket size, 367 hp	CAT 340	$42.07	$75.56	**$117.63**	CMI ECC 2025 (25% Ownership Cost Reduction)
Hydraulic Shovel	38.0 cu yd (29.0 cu m) bucket capacity, 43.0 ft (13.1 m) dump height	KOMATSU PC5500	$777.10	$1,058.14	**$1,835.24**	CMI ECC 2025 (25% Ownership Cost Reduction)
Pickup Truck	1 ton, automatic, crew cab, heavy duty	F350 Diesel Crew	$1.68	$27.16	**$28.84**	CMI ECC 2025 (25% Ownership Cost Reduction)