HANDBOOK

for

Calculation

of

Reclamation Bond Amounts

Revised October 2020

TABLE OF CONTENTS

PREFACE IV

CHAPTER 1: INTRODUCTION 1

BACKGROUND AND PURPOSE 1

STATUTORY AND REGULATORY REQUIREMENTS 2

ASSUMPTIONS 5

METHODOLOGY 6

DATA SOURCES 6

CHAPTER 2: BOND CALCULATION PROCEDURES 8

STEP 1: DETERMINE POINT OF MAXIMUM RECLAMATION COST LIABILITY 8

STEP 2: ESTIMATE DIRECT RECLAMATION COSTS 9

I. Structure Demolition and Disposal (Worksheet 2) 10

II. Earthmoving (Worksheets 3 Through 13) 11

A. Introduction 11

B. Definitions 11

C. Methods And Discussion 12

D. Materials Handling Plan (Worksheet 3) 13

E. Equipment Productivity and Costs (Worksheets 5 Through 13) 17

III. Revegetation (Worksheet 14) 18

IV. Other Direct Reclamation Costs (Worksheet 15) 18

STEP 3: ADJUST DIRECT COSTS FOR INFLATION 20

I. During A Permit Term 20

A. Adjustment Using 5-Year Permit Term 20

B. Adjustment Using a Schedule 20

II. Bond Release Considerations 21

III. Worst Case Scenario Re-Evaluation 21

STEP 4: ESTIMATE INDIRECT RECLAMATION COSTS 21

I. Mobilization and Demobilization 21

II. Contingency Allowances 22

III. Engineering Redesign Costs 22

IV. Project Management Fee 23
V. Overhead and Profit 23
STEP 5: CALCULATE THE TOTAL PERFORMANCE BOND AMOUNT 24

CHAPTER 3: SPECIAL CONSIDERATIONS FOR CALCULATION OF INCREMENTAL, CUMULATIVE, AND PHASE BONDS 25
INCREMENTAL BONDS 25
CUMULATIVE BONDS 25
PHASE BONDS 26

CHAPTER 4: BOND RELEASE 28
REGULATORY BACKGROUND 28
DISTINCTION BETWEEN BOND ADJUSTMENT AND BOND RELEASE 28
CALCULATION OF ALLOWABLE BOND RELEASE AMOUNTS 29
FINANCIAL CONSIDERATIONS FOR POLLUTIONAL DISCHARGES 29
RELEASE OF BOND POSTED TO GUARANTEE WATER SUPPLY REPLACEMENT OR CORRECTION OF SUBSIDENCE DAMAGE 30

REFERENCES CITED 31

APPENDIX A: BOND CALCULATION WORKSHEETS
BOND AMOUNT COMPUTATION A-1
WORKSHEET 1- Description of The Worst-Case Reclamation Scenario A-2
WORKSHEET 2- Structure Demolition and Disposal Costs A-3
WORKSHEET 3- Material Handling Plan Summary A-4
WORKSHEET 4A- Earthwork Quantity A-5
WORKSHEET 4B- Earthwork Quantity A-6
WORKSHEET 5- Productivity and Hours Required for Dozer Use A-7
WORKSHEET 6- Productivity and Hours Required for Dozer Use- Grading A-8
WORKSHEET 7- Productivity and Hours Required for Ripper-Equipped Dozer Use A-9
WORKSHEET 8- Productivity and Hours Required for Loader Use A-10

WORKSHEET 9- Productivity and Hours Required for Truck Use A-11
WORKSHEET 10- Productivity for Hydraulic Excavator Use A-12
WORKSHEET 11A- Productivity of Push-Pull or Self-Loading Scraper Use A-13
WORKSHEET 11B- Productivity of Dozer Push-Loaded Scraper Use A-14
WORKSHEET 12- Productivity and Hours Required for Motor grader Use A-16
WORKSHEET 13- Summary Calculation of Earthmoving Costs A-17
WORKSHEET 14- Revegetation Costs A-18
WORKSHEET 15- Other Reclamation Activity Costs A-19
WORKSHEET 16- Reclamation Bond Summary Sheet A-20
WORKSHEET 17- Summary Sheet for Determining Amount of Bond to Retain at Phase I Release A-21
WORKSHEET 18- Summary Sheet for Determining Amount of Bond to Retain at Phase II Release A-22

APPENDIX B: EXAMPLES

UNDERGROUND EXAMPLE B1-1
AREA MINING EXAMPLE (COMPLETED BY DRAGLINE) B2-1
HAUL BACK EXAMPLE- CONTOUR B3-1
HAUL BACK EXAMPLE- AREA B4-1
MOUNTAIN TOP REMOVAL EXAMPLE B5-1
PROCESSING PLANT EXAMPLE B6-1

APPENDIX C: OVERHEAD AND PROFIT RATE DETERMINATION

TABLE C1-A: National Construction Benchmarks for Overhead and Profit Reported as Percentage of Revenue C-1
TABLE C1-B: Financial Benchmark Percentages Equivalents with Direct Cost Percentages on Project-Level C-1
TABLE C1-C: Acreage Statistics for Permitted Mine Sites in Federal Programs C-3
TABLE C1-D: Indirect Cost Guidelines C-4

PREFACE

Throughout this document, the OSMRE Handbook for Calculation of Reclamation Bond Amounts will be referred to as "the Handbook." This Handbook establishes a technically sound, consistent methodology to calculate the amount of performance bond required for surface coal mining and reclamation operations under the Surface Mining Control and Reclamation Act of 1977 (SMCRA or the Act) when the Office of Surface Mining Reclamation and Enforcement (OSMRE) is the regulatory authority. OSMRE first adopted the Handbook as policy guidance in 1987, with minor revisions in 1993. A significant update and revision to the Handbook occurred in 2000 in response to management direction and user comments. The current version represents an additional update and revision following nearly 20 years of application in Federal mine permitting and reclamation cost estimation.

Several other Federal agencies, numerous companies in the coal industry, the coal-producing states, and states with non-coal mining use the Handbook as an organized approach to cost estimation. Also, many individuals have attended OSMRE's bonding workshop on cost estimation. Consulting and governmental (state, federal, Tribal) engineers have requested and been provided consultations on the use of this Handbook in order to determine reclamation costs estimates for operations in Canada, Indonesia and Romania.

OSMRE has a standing Bond Calculation Team that is comprised of regional and headquarters staff. Handbook users are encouraged to submit suggested revisions to OSMRE Bond Calculation Team members for consideration in future editions. Members and the OSMRE offices that they represent are:

Josh Rockwell	jrockwell@osmre.gov	Div. of Reg Support, Washington, DC
Mark Gehlhar	mgehlhar@osmre.gov	Div. of Reg Support, Washington, DC
Stefanie Self	sself@osmre.gov	Tech Support, Pittsburgh, PA
Paul Behum	pbehum@osmre.gov	Tech Services Branch, Alton, IL
Stephen Partney	spartney@osmre.gov	Tech Services Branch, Alton, IL
Mathew Hulbert	mhulbert@osmre.gov	Indian Programs Branch, Denver, CO
Karen Jass	kjass@osmre.gov	Indian Programs Branch, Denver, CO
Jeremy Spangler	jspangler@osmre.gov	Indian Programs Branch, Denver, CO

Please consult the directory located on OSMRE's Home Page at http://www.osmre.gov for current contact information.

CHAPTER 1: INTRODUCTION

BACKGROUND AND PURPOSE

Among other requirements, two of the purposes of the Surface Mining Control and Reclamation Act of 1977 (SMCRA or the Act) is to assure that surface coal mining operations are not conducted where reclamation, as required by the Act, is not feasible and to assure that adequate procedures are undertaken to reclaim surface areas as contemporaneously as possible with the surface coal mining operations. 30 U.S.C. § 1202(c) and (e).

This Handbook establishes a reclamation cost calculation methodology for use when OSMRE is the regulatory authority. Since neither SMCRA nor the Federal regulations require adherence to a specific methodology, State regulatory authorities are free to use the Handbook or any other method of bond calculation that results in the establishment of performance bond amounts that meet all regulatory program requirements.

This Handbook applies to all situations involving the calculation or recalculation of reclamation costs when OSMRE is the regulatory authority, including:

- Determination of the amount of bond initially required for permit issuance. See 30 CFR 800.11.
- Determination of the amount of bond required before mining advances into any succeeding increments (under incremental bonding) or operational stages (under cumulative bonding) of the permit area. See 30 CFR 800.11 and 800.14.
- Determination of any adjustment in bond required as a result of a permit revision that alters the calculations or assumptions underlying the reclamation cost estimate for the existing permit and bond. See 30 CFR 800.15.
- Determination of any reduction in the amount of bond that may be approved as a result of a change in the operation plan that reduces the future cost of reclaiming mined land. See 30 CFR 800.15(c).
- Evaluation of bond adequacy at the time of permit renewal. See 30 CFR 774.15(b)(2)(iii) and (c)(1)(v).
- While the minimum requirement to review bond adequacy is during the mid-term review and during significant permit modifications; discretionary evaluation of bond adequacy at any time may be performed. OSMRE may exercise this discretionary bond evaluation based on a reasonable interpretation of 30 CFR 774.15(c)(1)(i), when read in conjunction with 800.15 and 800.40. See also 30 CFR 774.15(c)(1)(v).
- Determination of the amount of bond to be retained at the time of Phase I, II and III bond release. See 30 CFR 800.40(c).
- Determination of the amount of bond that must be posted to guarantee correction of subsidence-related material damage to land, structures or facilities or replacement of water supply damaged by underground mining. See 30 CFR 817.121(c)(5).

- Determination of the amount of bond that must be posted to guarantee treatment if an unanticipated pollutional postmining discharge requiring long-term treatment develops. See OSMRE's March 31, 1997, statement entitled "Policy Goals and Objectives on Correcting, Preventing and Controlling Acid/Toxic Mine Drainage." The bond reviewer should also consider OSMRE's AMDtreat software as the primary data source during the determination of costs associated with long-term treatment of pollutional postmining discharges (https://amd.osmre.gov/).

In addition, if a State regulatory authority uses the Handbook or a variation thereof to calculate bond amounts, OSMRE may use the Handbook to conduct oversight evaluations of bond adequacy, but only after making necessary State specific modifications such as replacement of Davis-Bacon wage rates with whatever rates apply under State law. See generally, 40 U.S.C. §§ 3141 et seq. When conducting oversight, OSMRE may, at its discretion, use State specific technical guidance documents and resources in place of the Handbook as long as it determines such documents and resources are adequate for calculating reclamation cost estimates.

Because the Handbook relies upon standard engineering cost-estimating procedures to develop site-specific costs for each reclamation activity, users must be competent in the subject matter including: knowledge of standard engineering principles, equipment productivity guidebooks, and construction cost reference manuals.

The mention of trade names of commercial equipment and products in this Handbook is for illustrative purposes only and does not constitute endorsement or recommendation by OSMRE.

This Handbook provides guidance at the national level. However, we recognize that there are specific regional and local rates that may differ and in certain circumstances actual costs may be substituted for cost ranges identified in this Handbook. When using actual costs as a substitute, documentation for variances outside of the cost descriptions identified in this manual should be included with the reclamation cost documents. In doing so, accepted engineering practices should be employed.

STATUTORY AND REGULATORY REQUIREMENTS

Section 507(d) of SMCRA (30 U.S.C. § 1257(d)) requires each applicant to submit, as part of the permit application, a reclamation plan in sufficient detail to demonstrate compliance with the reclamation standards of the applicable regulatory program. Section 509(a) of the Act and its implementing regulations at 30 CFR 800.14(b) require that the applicant file a bond in an amount sufficient to cover the cost of reclamation in accordance with the approved plan should the regulatory authority have to perform the reclamation in the event of bond forfeiture.

Under 30 CFR 773.16 and 800.11(a), a permit applicant must file a bond or bonds before the regulatory authority may issue a permit. According to 30 CFR 800.11(b)(1), the bond or bonds must cover either the entire permit area or an identified increment of land within the permit area upon which the operator will initiate and conduct surface coal mining operations during the initial term of the permit. Under 30 CFR 800.11(d)(2), the applicant also has the option of filing a cumulative bond. As provided in 30 CFR 800.11(d) and 30 CFR 800.14, a permit applicant's choice of bonding scheme (entire permit area, incremental, or cumulative) is subject to regulatory authority approval.

Incremental and cumulative bonds are similar in that the permittee or permit applicant initially posts bond for only part of the proposed operation within the permit area. However, under the incremental method, each bond applies only to a specific increment of the permit area, while under the cumulative method each bond applies to the entire permit area even though the permittee may be authorized to disturb only a specified portion of the permit area. Under both the cumulative and the incremental methods, the permit application must identify the amount of bond required for the land to be disturbed by each stage of the operation (when using cumulative bonding) or increment of the permit area (when using incremental bonding). The permittee must file any additional bond or bonds required for each successive stage of the operation or increment of the permit area before beginning that stage of the operation or disturbing that increment of the permit area (30 CFR 800.11(b)(2), (b)(3), (b)(4), and (c)).

Under 30 CFR 800.11(b)(4), independent increments must be of sufficient size and configuration to provide for efficient reclamation operations should bond forfeiture occur.

With certain parameters under 30 CFR 800.13(a)(2), the regulatory authority has the discretion to accept a separate bond or bonds for each phase of reclamation as defined in 30 CFR 800.40(c).

Under 30 CFR 800.14(a), the regulatory authority must determine the amount of the bond based upon:

- The requirements of the approved permit and reclamation plan;
- The probable difficulty of completing reclamation, giving consideration to factors such as topography, geology, hydrology, and revegetation; and
- The applicant's reclamation cost estimate for completing the approved reclamation plan, although the regulatory authority is not limited by the operator’s reclamation cost estimate and may set the value of the reclamation performance bond at its discretion.

Paragraph (b) of 30 CFR 800.14 requires that the bond amount be sufficient to ensure completion of the reclamation plan if the work has to be performed by the regulatory authority in the event of forfeiture. In no case may the bond amount be less than $10,000.

Under 30 CFR 800.15 and section 509(e) of SMCRA, the regulatory authority must re-evaluate bond adequacy and adjust bond amounts as appropriate whenever the permit acreage increases or decreases or the cost of future reclamation changes. However, any bond reduction requested as a result of reclamation work performed must be processed as an application for bond release under 30 CFR 800.40.

A bond adjustment, increase or decrease, as allowed under 30 CFR 800.15 must be justified upon demonstration that the reclamation costs, the basis of the existing bond amount held by OSMRE, have changed requiring an increase or decrease in the amount of bond coverage. A reduction in the amount of bond based on these circumstances will not have undergone a formal bond release in accordance with 30 CFR 800.40. Situations that may qualify as a bond adjustment include deletion of undisturbed acreage from the permit area (with the regulatory authority retaining adequate, calculated funds to ensure the approved reclamation unless deletion of the acreage would not lower the maximum reclamation cost liability for the permit or increment), technological advances that increase or reduce the unit costs of reclamation, changes in the mining plan that result in a more limited operation than originally approved and bonded, or an alteration in the postmining land use that reduces reclamation costs.

Completion of reclamation activities such as backfilling or topsoil replacement does not qualify as a change in the cost of future reclamation. See 48 Fed. Reg. 32944 (July 19, 1983). The permittee must apply for bond release to obtain a bond reduction under these circumstances.

Under 30 CFR 800.15(d), the regulatory authority must conduct a bond adequacy review whenever the approved permit is revised. The regulatory authority must require adjustment of the bond amount to reflect any increase in reclamation costs resulting from the permit revision.

Under section 519(c) of the Act (30 U.S.C. § 1269(c)) and 30 CFR 800.40(c), the regulatory authority may reduce bond amounts in accordance with a phased release schedule as reclamation is completed. However, the amount of bond remaining after each of the first two phases must be sufficient to ensure completion of remaining reclamation obligations, which means that, after conducting the inspection and evaluation required by 30 CFR 800.40(b)(1), the regulatory authority must recalculate reclamation costs to determine how much bond to retain and how much, if any, may be released.

Under 30 CFR 817.121(c)(5), the regulatory authority must require the permittee to obtain additional performance bond to cover the costs of repairing, replacing, or providing compensation for material damage to protected land, structures or facilities when the damage is a result of subsidence caused by underground mining operations. The same requirement applies to subsidence-related material damage to surface lands and to certain drinking, domestic, or residential water supplies adversely impacted by underground mining operations. Both requirements apply only if the permittee fails to correct the damage within a specified time and the damage is not fully covered by the permittee's liability insurance policy.

Finally, OSMRE's March 31, 1997, acid mine drainage policy statement clarifies that the performance bond or an equivalent form of financial assurance must be adequate to ensure completion of the hydrologic reclamation plan approved in the permit. Whenever unanticipated pollutional discharges requiring long- term treatment develop, the regulatory authority must adjust the bond amount (or require equivalent financial assurance) to cover all future costs of monitoring, evaluating, abating, and treating those discharges to the extent necessary to avoid causing material damage to the hydrologic balance.

ASSUMPTIONS

The Handbook's bond calculation methodology assumes that:

- The bond amount will reflect the cost of engaging a third-party contractor to complete the reclamation plan in the event that the state regulatory authority must complete the reclamation. This ensures that the post-mining land use is consistent with the mine permit.
- None of the mining equipment is available for reclamation activities.
- The regulatory authority will use the entirety of the bond to reclaim the site to the approved reclamation plan or reclaim the site in a manner that utilizes the full bond amount.
- The bond amount will reflect the "worst-case scenario;" i.e., the cost of reclaiming the site if the permittee forfeits the bond at the point of maximum reclamation cost liability, under the reclamation and operation plans approved as part of the permit. Calculating the bond amount in this manner should ensure the availability of adequate reclamation funds at all times during the life of the operation.
- The reclamation and operation plans submitted as part of the permit application and any special permit conditions imposed by the regulatory authority will serve as the basis for determining the amount of performance bond required. The regulatory authority will independently calculate reclamation cost estimates. Further, it will consider but not rely upon cost estimates supplied by the permit applicant.
- Reclamation is concurrent and contemporaneous as practicable. Compliance with the approved reclamation and operation plans, permit conditions, and performance standards is always assumed.
- The regulatory authority will routinely reevaluate bond adequacy and require bond adjustments as authorized or mandated by 30 CFR 800.15.
- The bond amount shall not account for credit resulting from the salvage value of building materials or abandoned equipment and supplies.
- The permittee will be in compliance with the approved reclamation and operation plans, permit conditions, and performance standards at all times.
- The regulatory authority will routinely re-evaluate bond adequacy and require bond adjustments as authorized or mandated by 30 CFR 800.15.
- The initial calculation of bond amounts will not include remediation costs for events such as acid mine drainage and landslides that are not anticipated in the approved permit or reclamation plan. Should an unanticipated event occur, the regulatory authority must require a permit revision and adjust the bond amount to include any additional reclamation costs. *See, e.g.* 30 CFR 774.10(b), 774.13(c), and 800.15(d).

METHODOLOGY

The methodology in this Handbook reflects standard construction industry cost-estimating procedures for determining demolition, earthmoving, and revegetation costs, which are the most significant elements of the reclamation cost estimate.

Equipment productivity data, hourly rates and other costs used in the examples in Appendix B are taken from the sources referenced throughout this document. Rounding was applied in preparing the examples as follows:

- Equipment productivity hours are rounded to the nearest hour and
- Total bond amounts are rounded to three significant digits.

DATA SOURCES

There are four major sources of the information needed to calculate reclamation cost estimates:

- The reclamation and operation plans in the permit or permit application;
- Equipment productivity and performance guidebooks;
- Construction unit cost manuals;
- Contract and cost data from State and Federal abandoned mine land and bond forfeiture reclamation programs; the Tennessee Valley Authority; the Natural Resources Conservation Service (formerly the Soil Conservation Service); State, Bureau of Indian Affairs, Bureau of Land Management, Tribal and Federal forestry and wildlife agencies; the Cooperative Extension Service; and the Department of Labor for wage rates. These sources may provide local costs for tasks or materials. Also, State departments of transportation often publish cost estimates for road construction projects and historic cost data which may be representative of mine reclamation costs incurred by a State or Tribe in the event of bond forfeiture and
- Davis-Bacon labor rates shall be consulted for all Federally funded reclamation projects.

The reclamation and operation plans in the permit or permit application provide essential information on the type of mining to be conducted, the sequence of mining and reclamation activities within the permit area, spoil and topsoil handling, haul distances, extent of areas to be disturbed, structures needed during the mining operations, final surface configuration, revegetation standards and techniques, and postmining land use considerations (such as retention of roads, ponds, and other structures).

Equipment productivity and performance guidebooks are extremely useful when estimating earthmoving costs. Most heavy equipment manufacturers publish guidebooks containing performance data. For example, the Caterpillar Performance Handbook includes data on tractors, loaders, scrapers, haulage vehicles, small hydraulic shovels and excavators, in addition to a variety of other information such as estimating methodologies and heavy equipment cost accounting.

To calculate bond amounts, these guidebooks should be used in combination with a comprehensive equipment cost reference guide, such as the https://EquipmentWatch.com. These types of reference manuals, which are updated periodically, provide hourly ownership and non-wage operating costs for a wide range of heavy equipment. Because all contracts awarded by OSMRE to reclaim lands for which it is the regulatory authority are direct Federal contracts, labor costs for equipment operation must reflect Davis-Bacon wage rates as established by the Department of Labor. Any wage rates provided by the Department of Labor, which are used in the reclamation estimate, should be documented to include the date, state, county, construction type and wage number. On Tribal lands, Tribal wages must be reviewed to determine if they are more conservative than local Davis-Bacon wage rates.

The RSMeans Company, Inc., also publishes construction-related cost data (https://www.rsmeansonline.com/ManageAccount/QuickStart). RSMeans guides contain an extensive array of line-item costs for building construction. These reference manuals, which are updated annually, are especially useful for estimating material acquisition costs and the costs of specific reclamation tasks such as structure demolition. Because the Handbook provides for a separate determination of profit and overhead (see Chapter 2 and Worksheet 16), only use "bare cost" data from the reference manuals. Bare costs do not include profit and overhead. Use of Davis-Bacon wage rates should be used and may be found at: https://www.dol.gov/whd/govcontracts/dbra.htm.

Real costs for construction work and materials obtained from local construction contractors may be used. Real costs must be supported with receipts or bid information and must be updated as necessary as part of the regulatory authority’s obligation to periodically review reclamation cost estimates.

CHAPTER 2: BOND CALCULATION PROCEDURES

There are five major steps in the bond calculation process:

- Determine the point of maximum reclamation cost liability;
- Estimate direct reclamation costs such as earthmoving, revegetation, and the removal and demolition of structures not to be retained as part of the postmining land use;
- Adjust direct costs for inflation;
- Estimate indirect reclamation costs, including contractor and equipment mobilization and demobilization charges, contingency allowances, redesign expenses (including surveying, aerial photography, and monitoring in support of this effort), project management fees, overhead cost. Finally, contractor profit is added as a percentage of direct cost similar to, but apart from, the allowances for indirect costs, and
- Calculate the total bond amount.

Appendix A contains worksheets for the orderly completion and documentation of each step. Appendix B provides examples of completed worksheets. Appendix C provides background and justification for the calculation of overhead and profit.

STEP 1: DETERMINE POINT OF MAXIMUM RECLAMATION COST LIABILITY

Since this is the most important step in the cost-estimating procedure, complete Worksheet 1 only after carefully studying the operation and reclamation plans in the permit application.

This point will differ for each operation depending on the nature and complexity of the operation, the number of factors present, and the operation and reclamation plans. Generally, the greatest reclamation cost liability occurs at the point in the permit term at which one or more of the following conditions exist:

- The greatest area of disturbance or the greatest area requiring final grading, topsoil placement, and revegetation.
- The largest volume of material to be backfilled and graded to establish suitable postmining contours and drainages. For multiple-seam mining operations, this is likely the point at which coal extraction from the lowest coal seam is complete, most of the overburden removed to that point has been placed in excess spoil fills, and little or no backfilling has occurred.
- The longest haul distance between spoil or topsoil storage areas and the final placement location.
- The greatest number of on-site structures that would need to be demolished and removed where they do not have a realistic, approved post-mining land use.

- Assume that all sediment ponds and ditches are constructed at full capacity and are to be reclaimed consistent with the permit plan.

- Assume that all haul and access roads have been constructed as planned and are to be reclaimed consistent with the permit plan.

- The point at which refuse piles require the largest amount of cover material.

- Maximum disturbance of areas with special reclamation needs or special materials handling plans, such as sites with prime farmland soils, acidic or toxic materials, difficult topographic situations, or underground mine workings that must be sealed.

- Cost of imported materials such as riprap, mulch, or other engineered products.

- Due to the unavoidable time frame of the bond-forfeiture process, the estimator should assume that the mine pits are flooded to at least the water table elevation and may require dewatering and possibly treatment. This considers only a one-time action during reclamation. It does not include long-term abatement of unanticipated pollution-level drainage.

The worst-case scenario might not be simply be the result of the longest haul distances or longest length of open pit. The longest pit/longest haul distance might not correspond to the worst-case scenario if the corresponding volumes are low. Conversely a shorter pit/shorter haul distance with a very large haul and fill volume might correspond to the worst-case scenario. The estimator may need to determine the worst-case scenario through an iterative approach in order to determine where and when it occurs in consideration of the approved mining and reclamation plan. Review of reclamation cost estimates should be completed by staff who have knowledge and experience with mining and reclamation practices.

As with all engineering estimates, the bond calculation should be supported by documentation of all assumptions, references, and data sources.

STEP 2: ESTIMATE DIRECT RECLAMATION COSTS

Reclamation of most surface coal mining operations includes the following sequence of activities:

- Structure demolition and disposal, including the removal of mining-related buildings and other structures and facilities that are not approved for retention as part of the postmining land use.
- Earthmoving, including backfilling and rough grading, spoil ridge reduction, highwall elimination, final pit elimination, pond and road reclamation, final grading, and topsoil replacement.

- Revegetation.

In addition, other tasks such as sealing mine portals and pumping and treating impounded water may be necessary as part of the reclamation process.

This section describes how to estimate the cost of each of these activities.

I. Structure Demolition and Disposal (Worksheet 2)

With the exception of structures approved for retention as part of the postmining land use, the regulations require the reclamation of all haul and access roads and the removal and disposal of all mining-related buildings, crushers, coal storage bunkers and silos, conveyor systems, fences, foundations, power lines, rail spurs, utilities, storage facilities for equipment and supplies, and other similar structures within the permit area.

For cost estimation purposes, removal of a structure means demolition of the structure. Below-grade foundations and buried utilities may be left in place when compatible with the approved postmining land use.

With respect to the reclamation of roads that are not approved for retention as part of the postmining land use, the structure demolition cost category includes expenses associated with the removal and disposal of bridges and culverts, as well as any road-surfacing materials that are incompatible with the postmining land use or revegetation requirements. Other road reclamation costs such as grading and scarification are more properly included in the earthmoving and revegetation cost categories.

Unless the reclamation plan documents that the pertinent solid waste disposal authority has approved on-site disposal, all structure demolition cost estimates must include transportation expenses, landfill disposal fees, and other costs associated with the disposal of demolition debris in an approved solid waste disposal facility. The approval of the solid waste disposal authority may not be necessary for the disposal of loose road-surfacing materials (shale, gravel, or crushed stone) in the backfill.

Include costs for disposal of abandoned equipment and supplies. Because there is no reasonable means of predicting whether equipment and supplies or other materials with potential resale value will be left on site at the time of bond forfeiture, do not allow credit for the salvage value of building materials or abandoned equipment and supplies.

Use Worksheet 2 and appropriate reference manuals such as the RSMeans guides (https://www.rsmeansonline.com/ManageAccount/QuickStart), or other actual project costs if acceptable by the RA, to calculate the costs required for demolition, removal and disposal of structures.

When using reference manuals, avoid data that incorporates overhead and profit. The Handbook provides a different method for estimating overhead and profit as the Handbook suggests adding overhead and profit as separate, indirect costs. See Worksheet 16 and Table 2 & Table 3 in Chapter 2 Step 4.

II. Earthmoving (Worksheets 3 through 13)

A. Introduction

For most surface mining operations, earthmoving is the major reclamation cost. Necessary earthmoving activities most commonly include backfilling, grading, placement of cover materials (especially on coal refuse disposal sites), and topsoil redistribution. Backfilling consists of the mass transport of spoil to eliminate spoil piles, pits, and highwalls.

Grading commonly includes:

- Removing diversions and siltation structures,
- Reshaping road cut-and-fill slopes,
- Reconstructing stream channels,
- Re-contouring all disturbed areas to restore appropriate drainage patterns and facilitate the postmining land use,
- Preparing the site for topsoil redistribution, and
- Ripping or scarifying the regraded overburden necessary to ensure topsoil adhesion.

To estimate costs for earthmoving activities, complete Worksheets 3 through 13, following the instructions below and the examples in Appendix B. Worksheet 3, the materials handling plan, identifies and describes each type of earthmoving activity needed at the point of anticipated maximum reclamation cost liability. Worksheets 4A and 4B provide two alternatives for calculating the volumes of materials to be handled. Worksheets 5 through 12 provide a means of calculating site-specific equipment productivity data for various types and models of equipment, using the equipment productivity and performance guidebooks listed in Chapter 1.

B. Definitions

Throughout this handbook, especially the appendices, numerous engineering terms are used to identify and describe various correction factors that are necessary for the correct calculation of equipment production. The estimated production calculations are required in the determination of earthmoving costs. Engineering terms, and how they are implemented in earthmoving costs, are best illustrated in the various equipment sub-sections of the 48th edition of the Caterpillar Performance Handbook. Below is a defined list of the engineering terms that are found in this handbook.

Adjustment Factor is used to calculate production estimates by using various correction factors that are measured versus assumed.

Blade Factor is a correction factor used to calculate production and is determined via blade type

Correction Factors include the following: operator factor, material factor, visibility factor and efficiency factor. The value for each of these factors is multiplied to equal the correction factor.

Effective Grade is total resistance expressed as a percent grade.

Efficiency Factor is the amount of time the equipment is actually in a production mode and is a percentage of minutes per hour.

Grade Assistance is a measure of the force that assists machine movement on favorable grades (downhill).

Grade Resistance is a measure of the force that must be overcome to move a machine over unfavorable grades (uphill).

Ground Pressure is a function of tire deflection and tire penetration.

Material Factor is the ratio of volumetric difference between actual material density and assumed.

Operator Factor is used to apply adjustments to production calculations based on the machine operator's experience and ability.

Production is the hourly production of a piece of equipment and is determined by multiplying the maximum production by the correction factor.

Rolling Resistance is the force that resists the motion that the equipment is traveling. It is calculated by multiplying the rolling resistance coefficient for the contact between two specific mediums and the mass of the equipment and the acceleration due to gravity.

Shrinkage is the volumetric loss of loose material once placed and compacted.

Total Resistance is the combined effect of rolling resistance and grade resistance/grade assistance.

Visibility Factor is based on the operator's ability to see depending on atmospheric conditions.

Weight Correction Factor is used to modify production calculations due to differences in actual material density than assumed standard value.

C. Methods and Discussion

Earthmoving is always the largest cost of any reclamation project. When evaluating the "worst case" of an initial or periodic permit, the quantities are calculated by the applicant, and the OSMRE responsibility is to verify whether the quantities are reasonable. In this case, the quantities are speculative, depending on the accuracy of the geological data. OSMRE engineers use accepted engineering practices to check these. In a cessation case, whether by operation abandonment or a “temporary cessation of operations” notice, field work is required to determine the quantities. The use of drones and CAD are common in this case.

Earthmoving calculations should be present on Worksheets 3, 4A and 4B. Additional pages should include information on what data was used to calculate the volumes used in the calculations.

Difficulties and conflicting calculations often occur because there are many different methods available. Some traditional methods are very subjective, so results can vary even when two people use the same method. This is true of methods such as the varied area methods, which can vary based on what locations are used to create the areas – this is especially true in areas where topology is highly varied, such as in the Appalachian coalfields.

Since oversight bonding calculations are based on the permit documents, some of the newer technologies that can be used for more consistent calculations (LiDAR, Remote Sensing, etc.). Those methods are more useful for existing void calculations or reclamation planning.

It is important to document what method is used for the earthmoving estimations in the bonding process. Areas (polygons) with measurements, locations used to create the areas (cross-section lines), reasons for swell factors being used, etc.

For more information on some of the commonly used methods to calculate volumes based on plans, please refer to:
https://www.gxcontractor.com/technology/article/13034514/estimating-earthwork-volumes

D. <u>Materials Handling Plan (Worksheet 3)</u>

Use Worksheet 3 to identify and describe each specific earthmoving activity required as a result of the configuration of the operation at the point of maximum reclamation liability. The determination of equipment needs, productivity, and costs will depend on the information provided on this worksheet. Development of the materials handling plan requires determination of the volume of material to be handled, haul distances and grades, and the types of equipment to be used, as discussed below:

- **<u>Material Volume Estimates</u>**

  Using the reclamation and operation plans in the permit application, compare the pre-reclamation and post-reclamation topography of the site to determine the amount of material that must be handled. Use standard engineering methods to calculate earthmoving volumes. For example, a series of pre-reclamation and post-reclamation cross sections can be used to calculate volumes by the average-end-area method (see Worksheet 4A). Alternatively, use Worksheet 4B to estimate earthmoving needs by calculating the volume of a series of geometric shapes that resemble the difference between pre- and post-reclamation topography. Appendix B contains examples of these two approaches. You may also determine earthmoving volumes using computer programs such as Earthvision by Dynamic Graphics, Inc., Carlson Mining Software Suite, and SEDCAD by Civil Software Design, LLC. This software is available from OSMRE's Technical Information System (TIPS). Document all calculations regardless of the method selected. In many cases, material volume estimates may be obtained from applicant AutoCAD design data. This data can be compiled in a spreadsheet in place of Worksheet 4A and 4B. However, it is suggested that the permit reviewer check this data by either using AutoCAD methods or traditional methods applicable to Worksheets 4A or 4B.

Material volume is defined according to its state in the earthmoving process. The three measures of volume are bank cubic yards (BCY), loose cubic yards (LCY), and compacted cubic yards (CCY). Swell is the increase in volume resulting from a change from bank state to loose state; i.e., the increase in volume caused by excavation. Excavation causes fragmentation, which results in an increase in void spaces.

All excavated materials settle over time, reducing both the void spaces and overall volume. In addition, mechanical compaction results in some immediate volume shrinkage. Hence, the loose volume of material required to backfill an open pit is greater than the pit void space (pit volume) because of the shrinkage and compaction of the loose backfill material that occurs during and after placement in the pit.

One cubic yard of material lying in its undisturbed, geologic state is 1 BCY. One cubic yard of material that has been excavated and has expanded in volume as a result of the fragmentation that occurs during excavation is 1 LCY. One cubic yard of excavated material that has been subsequently compacted during placement is 1 CCY.

Most equipment productivity calculations are based on moving loose volumes of material. Therefore, convert in-place volumes to be moved into loose volumes.

The reclamation and operation plans in the permit application identify the type of overburden materials present within the permit area. Generally, they also specify swell and shrinkage factors for these materials. Verify this information by comparison with swell and shrinkage factors in appropriate equipment guidebooks or other standard engineering reference materials.

Some equipment manuals refer to a load factor, which is the loose density divided by the bank density. Multiply the loose volume of material by the load factor to determine bank volume. This calculation is necessary to estimate productivity and payloads in terms of bank cubic yards (BCY). Use the following equation to determine the swell factor using a load factor:

$$\text{Swell Factor} = (100 \div \text{load factor}) - 100$$

- **Haul Distance Estimates**

Using the reclamation and operation plans in the permit application (including designated haul roads and routes), determine haul distances for each area where backfilling, grading, topsoil replacement, or other earthmoving activities will occur. Identify the approximate centroid (surface expression of the center of mass) of each source material and its destination and determine the centroid-to-centroid distance.

- **Grade Estimates**

Haul grades and surface conditions greatly impact equipment productivity and may limit the type of equipment that can be used. Most equipment productivity and performance guides express these limitations in terms of the total resistance of the haul, which is the sum of the rolling resistance and grade resistance. The guides contain tables that convert rolling resistance to an equivalent percent grade for various types of road and surface conditions.

- **Equipment Selection**

Equipment selection for cost estimation purposes is a two-step process:

First, select the type of equipment (for example, bulldozer or scraper) based on the guidance in this Handbook, information in equipment productivity and performance guides, the reclamation and operation plans in the permit application, and experience.

Second, select the model and size of equipment based on information contained in the materials handling plan (Worksheet 3), the reclamation and operation plans in the permit application, and equipment productivity and performance guides.

For both the first and second steps, complete Worksheets 5 through 12 for several types and models of readily available equipment to determine the most cost-effective equipment type and model or combination of equipment types and models for each earthmoving activity.

When completing Worksheet 13 (earthmoving costs), use an industry publication containing recent cost data for construction equipment to determine hourly equipment ownership costs EquipmentWatch (https://EquipmentWatch.com) is one example of such a publication.

Use regional Davis-Bacon wage rates from the Department of Labor (www.dol.gov/whd/govcontracts/dbra.htm) to determine hourly labor costs (see the examples in Appendix B). In some cases other local costs may be appropriate and can be substituted for the EquipmentWatch (https://EquipmentWatch.com) and Davis-Bacon (www.dol.gov/whd/govcontracts/dbra.htm) rates. The Department of the Interior's Acquisition Regulations (DIAR) require compliance with the Indian Self-Determination and Education Assistance Act (25 U.S.C. 452) when reclamation contracts are let on Indian lands. Thus, local tribal wage rates must be considered when calculating the potential cost of reclamation. For example, when estimating reclamation actions occurring on the Navajo Nation, wage information can be obtained from the Navajo Nation Department of Personnel Management or http://www.dpm.navajo-nsn.gov/classplan.html. Contact the Tribal employment office or regional Bureau of Indian Affairs offices for more information, if necessary. The regulatory authority must use conservative assumptions when completing reclamation cost estimates and must justify and document any substitutions from the local Davis-Bacon wage (www.dol.gov/whd/govcontracts/dbra.htm) rates.

Do not automatically select the equipment listed in the operation and reclamation plans submitted by the applicant. In the event of forfeiture, equipment such as draglines, large shovels and equipment unique to the permittee most likely will not be available to potential contractors. Before calculating earthmoving costs for operations that plan to use this type of equipment, check with several regional earthmoving contractors to determine what equipment may be available. To maintain compliance with Federal procurement requirements, do not base calculations on equipment available to only one contractor.

Equipment needs for typical earthmoving activities are described below:

Spoil Ridge Reduction: Operations that use area mining methods normally rely upon bulldozers to move the tops of the spoil ridges into the valleys between the ridges.

Final Pit / Highwall Elimination: Bulldozers are usually the equipment of choice to fill the last pit with material obtained from adjacent spoil ridges or the area above the highwall (when approved in the permit). When the mining method requires the use of stockpiled overburden, scrapers or a combination of trucks and loaders are typically used to move stockpiled materials to the pit. When trucks and loaders are used, bulldozers spread the material in the pit area. If the pit is to be reconfigured for retention as a permanent impoundment, bulldozers are normally used to reduce the highwall and spoil slopes to acceptable grades.

In some cases, the reclamation plan may not address this reclamation need. For example, the reclamation and operation plans for a mountaintop removal operation would assume complete removal of the top of the mountain, meaning that no highwall elimination would be necessary. However, if a highwall exists at the time of bond forfeiture, we would need to use methods such as ripping or blasting to eliminate the highwall.

Final Grading: Scrapers, bulldozers, and motor graders are commonly used to re-contour backfilled areas, excess spoil disposal structures, and other disturbed areas to facilitate proper drainage and the approved postmining land use and to prepare disturbed areas for topsoil redistribution. In some cases, especially for sites formerly used as roads or support facilities, ripping with bulldozers may be required to reduce compaction in the root zone and provide a slightly rough surface to promote topsoil adhesion.

Topsoil Redistribution: Topsoil redistribution involves the use of scrapers, front-end loaders, trucks, bulldozers, and/or graders. The choice of equipment depends on grade, the haul distance between stockpiles and placement areas, and the volume of material to be moved. Prime farmland requires more attention to equipment selection and material handling to ensure proper soil horizon placement, soil depth, and compaction.

Removal of Diversions and Siltation Structures: Bulldozers are generally adequate to grade out diversions and excavated siltation structures. In some cases, a hydraulic backhoe excavator or small dragline is required to dredge accumulated sediment.

Covering Exposed Coal Mine Waste or Other Acid- or Toxic- Forming Materials: When the reclamation and operation plans require the application of cover material prior to revegetation, the same equipment considerations as those discussed under "Topsoil Redistribution" apply to the transport and distribution of this material. Examples include the covering of coarse coal mine refuse, slurry impoundments and coal stockpile pads. The permit reviewer may have to consider the use of specialized equipment to spread and incorporate alkaline amendments such as agricultural ground limestone prior to cover placement as per the reclamation plan or in accordance to the acid-producing potential of the materials.

E. Equipment Productivity and Costs (Worksheets 5 through 13)

As discussed above, development of the materials handling plan requires a determination of equipment productivity and earthmoving costs. Use Worksheets 5 through 12 to calculate the production of individual pieces of equipment and the hours required for the job. Use Worksheet 13 to calculate earthmoving costs.

Generally, the productivity of a piece of equipment is expressed in cubic yards per hour. Common factors governing equipment productivity are capacity, cycle time, site conditions, and material characteristics.

Reclamation jobs do not operate at 100% efficiency. Complex factors such as operator skill, repairs and adjustments, and personnel and job layout delays are either addressed individually as part of the "Operator Factor" (see Worksheet 5) or combined in an "Efficiency Factor" (see Worksheets 5 through 12). When site-specific data are not available use the information below as guidance.

EFFICIENCY FACTOR

Conditions	Crawler Equipment	Rubber-tired Equipment
Excellent	0.92 55 min/hr	0.83 50 min/hr

Average	0.83 50 min/hr	0.75 45 min/hr
Unfavorable or Night	0.75 45 min/hr	0.67 40 min/hr

To calculate the number of hours that the equipment is needed, apply productivity rates to the amount of material that must be moved. To determine the hourly cost of equipment during the reclamation operation, adjust the components of the hourly costs found within EquipmentWatch (https://EquipmentWatch.com) for the number of shifts, fuel costs, etc., as applicable.

III. Revegetation (Worksheet 14)

Use Worksheet 14 to calculate costs associated with revegetation efforts. The initial revegetation process generally consists of seedbed preparation, including such tasks as soil sampling, application of soil amendments (fertilizer, lime, etc.), seeding, planting, and mulching. Worksheet 14 refers to this as "Initial Seeding." Calculate this cost for all disturbed areas within the worst-case scenario. The reclamation plan will specify the soil condition and species mix. It will also clarify whether irrigation and the planting of trees and shrubs are necessary. Potential sources of cost information for these requirements include the U.S. Department of Agriculture's Cooperative Service Program; agricultural supply firms; agricultural publications; revegetation contractors; landscaping services; Federal, State and Tribal forestry agencies; and State, Federal and Tribal abandoned mine land and bond forfeiture reclamation contracts and programs.

Weather and site conditions may result in complete or partial failure of an initial revegetation effort. The cost estimate must also include reseeding and replanting expenses associated with vegetative failures, including all disturbed lands within the permit area not yet released. This reseeding and replanting cost is based on site conditions and historic vegetative failure rates for the operation being evaluated, or similar operations on similar sites. This reseeding and planting cost estimate must include an allowance for any soil sampling, regrading and earthmoving costs necessary to evaluate and repair the site as part of the reseeding/replanting effort.

Worksheet 14 covers the following aspects of revegetation:

- Initial seeding and planting of the worst-case scenario area.
- Vegetative failure of the worst-case scenario area (i.e., reseeding and replanting needed).
- Vegetative failure for any other unreleased disturbed areas within the permit area (i.e., reseeding and replanting needed).

IV. Other Direct Reclamation Costs (Worksheet 15)

Depending upon site conditions and applicable requirements of the reclamation and operation plans, other necessary reclamation activities may include:

- Pumping and treating impounded waters.
- Use of explosives. See Mountain Top Removal Example for calculation method and this website (https://www.osmre.gov/resources/blasting/ARBlast.shtm) for additional resources.
- Replacing wetlands.
- Sealing underground mine entries and openings.
- Plugging auger holes.
- Sealing monitoring wells and other drilled holes.
- Constructing rock drains.
- Disposing of toxic, hazardous, and other solid (non-coal) waste in accordance with state and Federal laws and local ordinances.
- Maintaining roads during reclamation including grading, surfacing, ditches and culverts, and snow removal.
- Maintaining ponds. Water sampling and monitoring to the extent required to comply with any necessary Federal, State, or local permits.
- Evaluating and rehabilitating structures to be retained as part of the postmining land use (ponds, roads, diversions, etc.).

In addition, two other potential cost considerations may arise after permit issuance:

- Under 30 CFR 817.121(c)(5), unless the permittee corrects the subsidence damage within a specified time or has sufficient insurance coverage, the regulatory authority must require the permittee to obtain additional performance bond to cover the cost of (1) correcting subsidence-related material damage to surface lands and protected structures, and (2) replacing certain water supplies adversely impacted by underground mining operations.
- If an unanticipated pollutional discharge requiring long-term treatment develops, the regulatory authority must adjust the bond or require the permittee to post equivalent financial assurance to cover all foreseeable abatement and future treatment costs.

Since there is no established method of estimating costs for most of the activities listed under this heading, use best professional judgement to calculate bond amounts on a case-by-case basis. In some instances, the construction cost reference manuals listed in Chapter 1 may prove useful. Use Worksheet 15 to explain the basis for all cost estimates for these activities.

Use RSMeans guides (https://www.rsmeansonline.com) or obtain estimates from several local contractors to determine the amount of bond required to guarantee repair of subsidence-related damage to surface lands and protected structures. Similarly, use estimates from local drilling and plumbing contractors to estimate the bond amount required to guarantee replacement of damaged water supplies and delivery systems.

The bond reviewer should also consider OSMRE's AMDTreat software as the primary data source during the determination of costs associated with long-term treatment of pollutional postmining discharges (https://amd.osmre.gov/).

STEP 3: ADJUST DIRECT COSTS FOR INFLATION

This step addresses anticipated inflationary increases in reclamation costs during the permit term and after permit expiration, but before final bond release.

I. During a Permit Term

There are two approaches for addressing inflation during a permit term. One approach uses an inflation factor to increase the initial bond amount to reflect inflation for the full permit term. The other approach does not include inflation as an element of the initial bond calculation. Instead, it requires recalculation and adjustment of bond amounts on a fixed schedule (at a minimum during the mid-term permit review process and at permit renewal) to cover any reclamation cost increases due to inflation.

A. Adjustment Using 5-Year Permit Term

To calculate the inflation factor for a 5-year permit term under the first approach, use the formula below and an index such as the Historical Cost Indexes (HCI) from RSMeans (https://www.rsmeansonline.com). We recognize that other cost indexes may be appropriate to use in lieu of the one suggested, but for purposes of this example, we chose the HCI.

> Divide the HCI for July from the most recent month/year by the HCI for July five years earlier, assuming the term of the permit is five years. For example, using the most current year, July 2018, divide the HCI by July 2013.

Example: HCI (July, 2018): 222.9 HCI (July, 2013): 201.2

Inflation factor: 222.9/201.2 = 1.1079 [Enter on Worksheet 16.]

Total inflation (5 years): 10.79%

This percentage can be divided by the number of months, then the monthly rate can be projected forward to cover the months or years of the proposed permit term.

Multiply the Total Direct Costs from Line 5 of Worksheet 16 by the inflation factor to compute the Inflated Total Direct Costs.

B. Adjustment Using a Schedule

Under the bond adjustment schedule approach, we must periodically either recalculate all reclamation cost estimates or use an appropriate inflation factor to adjust the previous reclamation cost estimates to account for inflation since the time of the previous bond calculation. When using this approach, Lines 5 and 6 of Worksheet 16 will be the same. Add a footnote describing the bond adjustment schedule.

Adjustments for inflation also may be considered when permit revisions change the costs of reclamation.

II. Bond Release Considerations

We also must consider inflation when calculating the amount of bond to be retained after Phase I or II bond release. For these calculations, use a base period equal to the minimum revegetation responsibility period under 30 CFR 816/817.116(c), since there is no permit required for reclamation and hence no mid-term permit reviews or permit renewals. See Worksheets 17 and 18. As an alternative, you may establish a periodic bond adjustment schedule during the revegetation responsibility period. The bond would then be adjusted for inflation in accordance with the schedule.

III. Worst Case Scenario Re-evaluation

When reviewing the bond, or bonding increment, for a site, consideration must be given to the actual location of the mining operation in the grand scheme of the operation. For example, if the site has not reached the worst-case scenario, then it may be appropriate to re-evaluate the existing worst-case scenario, given no changes to the reclamation plan have occurred. If the mining operation has moved beyond the worst-case scenario, then prudent review includes evaluating the next worst-case scenario. In many instances, a bond increase is not needed because the existing bond on-hand meets the bonding criteria at 30 CFR 800.14 and 800.15 for the outstanding reclamation remaining for the site. The worst-case scenario should also be re-evaluated if unanticipated events are encountered such as long-term acid mine drainage.

STEP 4: ESTIMATE INDIRECT RECLAMATION COSTS

Use Worksheet 16, standard reference materials, and the procedures set forth below to calculate indirect costs, which include contract preparation costs and other administrative expenses that the regulatory authority would not incur in the absence of forfeiture. Explain any deviations from the standard reference materials in an attachment to the worksheet. Compute indirect costs as a percentage of the inflated direct costs as shown on Worksheet 16, Lines 7 through 11.

I. Mobilization and Demobilization

This category of indirect costs is an allowance for the cost of moving equipment to and from the reclamation site. Costs will vary based on the type and number of equipment to be hauled and the distance to the site.

Consider whether a separate mobilization/demobilization will be necessary to remove sedimentation ponds and associated diversions later and calculate costs accordingly.

Mobilization and demobilization costs are highly variable, dependent on unusual time constraints, a need for special equipment, the presence of non-standard features or conditions that hinder equipment mobility, or a remote location that may require actual cost estimates that could result in the use of a higher percentage. Enter this cost estimate on Line 7 of Worksheet 16.

Explain the basis for the estimate on the worksheet or in an attachment.

II. Contingency Allowances

The bond amount must include a contingency allowance to cover unanticipated costs resulting from unexpected natural events and uncertainties associated with the assumptions that form the basis for the operation and reclamation plans and reclamation cost estimates. This category does not include any activity for which the reclamation and operation plans provide sufficient information to enable calculation as a direct cost. The contingency allowance covers only truly unexpected and unforeseeable events. This contingency allowance is also used to cover any damage that occurs resulting from the delay between site abandonment and forfeiture on-the-ground reclamation work.

Calculate the contingency allowance as a percentage of the total direct costs on Line 8 of Worksheet 16.

III. Engineering Redesign Costs

For various reasons, the reclamation and operation plans in the permit application may not reflect site conditions at the time of bond forfeiture. In addition, they may not be sufficiently detailed to serve as contract plans and specifications. Therefore, in the event of bond forfeiture, the regulatory authority may have to supplement or modify these plans. Necessary activities may include:

- 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.

- Preparing contract documents.

Calculate the engineering redesign costs as a percentage of the total direct costs on Line 9 of Worksheet 16. Explain the cost allowance on Worksheet 16, citing references as needed. Cost references should be contemporary with the project.

IV. Project Management Fee

This fee covers the cost of hiring a project management firm to inspect and supervise the work performed by the reclamation contractor. See Table 1 below. Additional management tasks may include dam inspection (Note: Under certain circumstances where OSMRE is the project manager, this fee may be waived).

Table 1. Project Management Fee

	Percentage of Direct Cost
Project size of site category	
Project Managed by Federal Agency	0
< 90 acres (including other facilities)	6
≥ 90 acres ≤ 700 acres	5
> 700 acres	3

Source: See Appendix C for further details.

V. Overhead and Profit

Because we contract with a third party to perform the actual reclamation work, the bond amount must include an allowance for business overhead and contractor's profit. As noted in Chapter 1 under "Data Sources," all data used to estimate direct reclamation costs in Step 2 of Chapter 2 include only expenses directly related to a specific project, excluding allowance for overhead expenses and contractor's profit.

The total reclamation cost for bond calculation must include nonspecific project costs essential for supporting the overall contractor’s business functions. All construction and reclamation contractors have overhead costs in addition to the direct costs of equipment, labor and materials that we have already calculated in Step 2 of this chapter. Overhead cost, also referred to as general and administrative (G&A) expenses include information technology systems, employee benefits, insurance, building and vehicle leases, asset depreciation, administrative payroll, and executive compensation. These corporate-type costs are considered “fixed” because they typically are pre-determined or planned prior to acceptance of individual projects.

Because reclamation operations differ greatly in size and complexity, overhead cost as a percentage of direct cost vary. Smaller projects typically have disproportionate higher overhead expenses as fixed assets are less efficiently utilized in comparison to larger projects having economies of size advantages generating efficiencies. The average industry overhead rate is 13 percent of direct cost varying from 10 percent to 15 percent depending on size (Table 2).

Table 2. Contractor Overhead

Project size of site category	Percentage of Direct Cost
< 90 acres	15%
≥ 90 acres ≤ 700 acres	13%
> 700 acres	10%

Source: The 2019 CLA Civil Construction Benchmark Report, December 2019. Overhead rate is based on industry average of benchmark percentage of revenue for General and Administrative Expenses. See Appendix C for percentage conversion of revenue percentage basis to direct cost percentage.

Profits are essential to attract needed capital and continuous investment in any industry. Mine reclamation contracting is not sustainable without an expectation of profits accruing to the owners of contracting firms. Thus, profit is a final component part of the total cost of reclamation. Profit rates and risks go hand in hand as owners require a higher rate of return or "risk premium" for riskier projects. The average industry benchmark rate is 7 percent of direct cost (Table 3).

Table 3. Contractor Profit

	Percentage of Direct Cost
Normal financial risks	7%
Elevated risks from site-specific and locality vulnerabilities	8% -10%

Source: The 2019 CLA Civil Construction Benchmark Report, December 2019. Profit rate based on industry average of benchmark percentage of revenue. See Appendix C for further details.

STEP 5: CALCULATE THE TOTAL PERFORMANCE BOND AMOUNT

Add all entries for direct and indirect reclamation costs on Worksheet 16 to determine the amount of bond required.

At the bottom of Worksheet 16, there is a space to record a construction cost index. In the absence of major changes to the reclamation and operation plans, this index allows the inflation factor portion of the bond estimate to be updated periodically without redoing the direct cost calculations needed to establish the initial bond amount. Cost indexes are available from numerous sources including RSMeans (https://www.rsmeansonline.com) and Engineering News Record referenced is the "Construction Cost Index" published monthly in the Engineering News Record (https://www.enr.com/).

CHAPTER 3: SPECIAL CONSIDERATIONS FOR CALCULATION OF INCREMENTAL, CUMULATIVE, AND PHASE BONDS

The bond calculation methodology in Chapter 2 and the assumptions in Chapter 1 presume that the permit applicant will post bond for the entire permit area prior to permit issuance. However, the same methodology and assumptions apply when the applicant elects to post bond on an incremental or cumulative basis, or when the applicant elects to use phase bonds.

INCREMENTAL BONDS

If the applicant selects the incremental method of bonding, use Chapter 2 to estimate reclamation costs and determine the amount of bond required for each increment, rather than for the entire permit area. Because the bond posted for each increment applies only to that increment, treat each increment as a separate mining and reclamation unit with its own maximum reclamation cost liability. When using incremental bonding, the permittee must complete the bond release process prior to applying these funds to a subsequent increment.

Under 30 CFR 800.11(b)(3), the permit applicant must identify both the initial and successive bonding increments, together with the amount of bond proposed to be provided for each increment. However, the regulations do not apply this requirement to the regulatory authority. Instead, they provide only that, at the time of permit application approval, the regulatory authority must calculate the amount of bond required for the initial increment. The regulatory authority must then calculate the required bond amount for each successive increment at the time that the permittee proposes to disturb that increment. See 30 CFR 800.11(d)(3). At its discretion, the regulatory authority may calculate the amount of bond required for each successive increment at the same time that it calculates the amount of bond required for the initial increment.

CUMULATIVE BONDS

If the applicant selects the cumulative method of bonding, use Chapter 2 to estimate reclamation costs and determine the amount of bond required for the initial stage of operations. As with incremental bonding, treat this initial stage of operations as a separate mining and reclamation unit with its own maximum reclamation cost liability. However, legal liability under the bond posted for the initial stage applies to the entire permit area, as do bonds posted for all successive operational stages. Hence, unlike incremental bonding, the reclamation cost estimates and bond calculations for each successive operational stage must include all previously bonded operational stages. See 30 CFR 800.11(d)(2).

For example, a permittee may choose to post bond annually for the term of the permit based on anticipated disturbance during each year of the permit term. Under this scenario, the permittee initially would post a bond in an amount sufficient to cover the maximum reclamation cost liability that would be encountered during the first year of the permit term under the approved reclamation plan. The permittee would then supplement that bond with additional bonds during each of the following years until the amount of bond on file is sufficient to cover the maximum reclamation cost liability for the entire permit area. The annual supplement plus the amount of bond posted for previous years must always be sufficient to cover the maximum reclamation cost liability associated with both the upcoming year and all previous years.

As with incremental bonding, under 30 CFR 800.11(b)(3), a permit applicant proposing to use the cumulative method of bonding must identify both the initial and all successive portions of the permit area for which bond will be posted, together with the amount of bond proposed to be provided for each portion. However, the regulations do not apply this requirement to the regulatory authority. Instead, they provide only that, at the time of permit application approval, the regulatory authority must calculate the amount of bond required for the initial portion. The regulatory authority must then calculate the required bond amount for each successive portion at the time that the permittee proposes to disturb that portion. At its discretion, the regulatory authority may update the amount of bond required for each successive portion at the same time that it calculates the amount of bond required for the initial portion.

In summary, under the cumulative method of bonding, when the permittee proposes to advance beyond the initial operational stages, we must calculate maximum reclamation cost liabilities for both the entire permit area and the portion of the permit area proposed for disturbance. Once the operation reaches the point of maximum reclamation cost liability for the permit area as a whole, we may not need to require any additional bond for subsequent disturbance. Again, during this process, consideration should be made for any unanticipated costs that may be encountered such as long-term acid mine drainage.

PHASE BONDS

Under 30 CFR 800.13(a)(2), the regulatory authority has the discretion to either accept or reject use of the phase bonding method.

When using phase bonding, the permit applicant posts separate bonds for each phase of reclamation as defined in 30 CFR 800.40. The applicant has the choice of posting these bonds for the entire permit area or using either the incremental or cumulative method of bonding. In all cases, the applicant or permittee must post bonds sufficient to cover all reclamation phases for the land to be disturbed prior to initial disturbance. See 30 CFR 800.40(c).

Under 30 CFR 800.13(a)(2), each phase bond must specify in detail the scope of work that it guarantees. This requirement is important because, with a few exceptions, 30 CFR 800.40 does not clearly specify the permitting requirements and performance standards that each phase covers. Furthermore, 30 CFR 800.40 does not establish all liability distinctions. For example, topsoil replacement may be either a Phase I or Phase II activity. Therefore, before we can calculate reclamation cost estimates using the worksheets in Appendix A, the regulatory authority needs to know which of those reclamation activities will be covered by which phase bond.

At a minimum, Phase I bond release requires backfilling, regrading and drainage control in accordance with the approved reclamation plan. 30 CFR 800.40(c)(1). Each Phase II bond must cover topsoil replacement (when not included in Phase I), removal of temporary erosion and sedimentation control structures, and establishment of revegetation. 30 CFR 800.40(c)(2). Phase III has no clearly defined liabilities apart from demonstration of revegetation success and reestablishment of vegetation in the event of failure. 30 CFR 800.40(c)(3). Some instances may allow Phase II and Phase III bonding to be covered with a single release. Therefore, we recommend that Phases II and III be covered by a single bond.

Use the methods in Chapter 2 to estimate the maximum reclamation cost liability and calculate the amount of bond required for each phase of reclamation. The area to which this calculation applies depends upon whether the permittee posts bond for the entire permit area or selects an incremental or cumulative approach.

CHAPTER 4: BOND RELEASE

REGULATORY BACKGROUND

Under section 519(b) of the Act and implementing regulations at 30 CFR 800.40(b)(1), the regulatory authority must, upon receipt of a bond release application, inspect and evaluate the reclamation work, including an assessment of the degree of difficulty in completing any remaining reclamation. This evaluation also must determine whether pollution of surface and ground water is occurring, the probability of future occurrence, and the estimated cost of abating this pollution.

Under Section 519(c)(1) of the Act and implementing regulations at 30 CFR 800.40(c)(1) and section 519(c)(1), the regulatory authority may release up to 60 percent of the bond upon completion of Phase I reclamation, which includes backfilling, regrading, and drainage control. As a practical matter, Phase I bond release includes structure demolition and removal, as necessary. Phase I bond release is discretionary on the part of the regulatory authority, depending upon the results of the evaluation required under 30 CFR 800.40(b)(1) and an evaluation of remaining reclamation costs. Phase I bond release may include topsoil replacement.

Under section 519(c)(2) of the Act and implementing regulations at 30 CFR 800.40(c)(2), for lands other than prime farmland, the regulatory authority may release an additional amount of bond after establishment of revegetation, provided the lands are not contributing suspended solids to streamflow or runoff outside the permit area in excess of State and Federal water quality requirements. Phase II bond release may include topsoil replacement (if not already completed and released in Phase I) and removal of temporary erosion and sedimentation control structures. At this phase, the regulatory authority must retain sufficient bond to cover the cost of having a third party reestablish revegetation during the revegetation responsibility period in accordance with the approved reclamation plan.

For prime farmland, Phase II bond release is contingent upon proof of soil productivity as determined by crop yields equivalent to yields from non-mined lands. For all practical purposes, this results in a combination of Phase II and III bond release.

Finally, under section 519(c) (3) of the Act and 30 CFR 800.40(c) (3), the regulatory authority may release the remainder of the bond once the revegetation responsibility period expires and the permittee meets all reclamation requirements of the permit and approved regulatory program. This action is sometimes referred to as Phase III bond release.

DISTINCTION BETWEEN BOND ADJUSTMENT AND BOND RELEASE

As discussed in Chapter 1, reduction of bond amounts using the bond adjustment provisions of 30 CFR 800.15 is allowable only if the reclamation cost estimates that form the basis and assumptions for the existing bond amount are no longer valid for reasons other than the performance of reclamation work performed under the currently-approved reclamation plan.

CALCULATION OF ALLOWABLE BOND RELEASE AMOUNTS

Upon receipt of a bond release application, the regulatory authority must calculate the cost of completing all remaining reclamation requirements for the entire permit area (or, if the permittee used the incremental bonding method, for the remaining increment). Use Worksheet 17 to calculate remaining reclamation costs when considering Phase I bond release. Use Worksheet 18 to calculate these costs when considering Phase II bond release. Complete Worksheets 1 through 15 as necessary to support these computations.

In all cases, the regulatory authority must retain sufficient funds to complete all remaining reclamation obligations including those identified as a result of the inspection and evaluation conducted under 30 CFR 800.40(b)(1) and adjusting for present and future cost of reclamation if necessary. In addition, at Phase I the regulatory authority may not release more than 60 percent of the total amount of bond posted for the area to which the release application applies. See 30 CFR 800.40(c)(1). Therefore, even when the permittee uses phase bonding, the regulatory authority may not release more than 60 percent of the total amount of bond posted for all phases initiated within the applicable area. Although liability under the Phase I bond is limited to Phase I reclamation activities, we must retain at least 40 percent of the total bond posted for the area until Phase II reclamation has been completed and a Phase II liability release approved.

FINANCIAL CONSIDERATIONS FOR POLLUTIONAL DISCHARGES

If pollutional discharges or other conditions are causing, or may cause without treatment, material damage to the hydrologic balance outside the permit area exist at the time of application for bond release, we must retain a sufficient financial mechanism to cover long-term treatment and remediation costs. Use AMDTreat for guidance on calculating bond amounts for long-term treatment of pollutional discharges. This bond may not be released until treatment is no longer necessary to prevent material damage to the hydrologic balance.

In lieu of retention of existing bond, the permittee may, subject to regulatory authority approval, establish a separate financial guarantee under 30 CFR Part 800 to cover all foreseeable discharge treatment and material damage remediation costs. This is a type of bond to cover one aspect of the operation. As stated above, the bond release for this aspect would not occur until treatment is no longer necessary to prevent material damage to the hydrologic balance, or until another financial mechanism is approved to replace the bond.

Depending on individual circumstances, acceptable financial assurance instruments may include surety bonds, trust funds, pollution liability insurance, general liability insurance, environmental liability insurance, and site liability environmental exposure insurance.

Finally, the permittee has the option of addressing this obligation outside the bonding process and the requirements of 30 CFR Part 800 by entering into an enforceable contract with another party to assume treatment or remediation responsibilities. See the preamble to 30 CFR 700.11(d) (1) (ii) at 53 Fed. Reg. 44362 (Nov. 2, 1988).

RELEASE OF BOND POSTED TO GUARANTEE WATER SUPPLY REPLACEMENT OR CORRECTION OF SUBSIDENCE DAMAGE

Under 30 CFR 817.121(c)(5), in certain situations, the regulatory authority must require the permittee to obtain additional performance bond to cover the costs of repairing, replacing, or providing compensation for material damage to protected structures when the damage is a result of subsidence caused by underground mining operations. The same requirement applies to subsidence-related material damage to surface lands and to certain drinking, domestic, or residential water supplies adversely impacted by underground mining operations.

The preamble to this rule states that the release procedures of 30 CFR 800.40 apply to bond posted under this rule. See 60 Fed. Reg. 16722 (March 31, 1995). However, land, structures, and water supplies covered by this bond generally lie outside the permit area. Hence, there is no revegetation responsibility period and no need for a phased bond release.

Provided all other release criteria and procedural requirements of 30 CFR 800.40 are met, the regulatory authority may release the entire bond amount posted under 30 CFR 817.121(c)(5) once the water supply is replaced, the damage to surface lands or protected structures is repaired, or the owner is compensated for damage to protected structures.

REFERENCES CITED

Office of Surface Mining Reclamation and Enforcement, AMDTreat, https://amd.osmre.gov.

Office of Surface Mining Reclamation and Enforcement, Blasting Material, https://www.osmre.gov/resources/blasting/ARBlast.shtm.

Caterpillar Performance Handbook, Edition 28 through 48, Caterpillar, Inc., Peoria, IL.

EquipmentWatch, https://equipmentwatch.com/, Atlanta, GA.

RSMeans Data Online, www.rsmeansonline.com/ManageAccount/QuickStart, Gordian, Rockland, MA.

Grading and Excavation Contractor Magazine, https://www.gxcontractor.com/technology/article/13034514/estimating-earthwork-volumes, Nashville, TN.

Earthvision, https://www.dgi.com/earthvision/evmain.html, Dynamic Graphics, Inc., Richardson, TX.

Carlson Mining Suite, http://www.carlsonsw.com/, Carlson Software, Carlson Mining Software Suite, Maysville, KY.

SEDCAD, http://mysedcad.com/, Civil Software Design, LLC, Ames, IA.

AutoCAD, www.autodesk.com, AUTODESK, Ashburn, VA.

Navajo Nation wage rates can be found at: http://www.dpm.navajo-nsn.gov/classplan.html

Engineering News Record, www.enr.com, BNP Media, Troy, MI.

Alaska, Mine Closure and Reclamation Cost Estimation Guidelines (Draft), State of Alaska, Department of Natural Resources and Department of Environmental Conservation, April 2015. http://dnr.alaska.gov/mlw/mining/largemine/rcindirects_dowlreport20150407.pdf

BLM, H-3809-1 Surface Management Handbook, Department of Interior Bureau of Land Management, Rel. 3-336, September 2012. https://www.blm.gov/sites/blm.gov/files/H-3809-1.pdf

BLM, BLM Alaska Mining Reclamation Bonding Guide, U.S. Department of Interior, Bureau of Land Management, Alaska State Office, Branch of Energy and Minerals, September 2014. https://www.blm.gov/policy/ak-im-2015-001

CLA Civil Construction Benchmark Report, 2019 https://www.claconnect.com/-

/media/files/white-papers/2019-civil-construction-benchmark-report.pdf?la=en

USDOE, Defense-Related Uranium Mines Cost and Feasibility Topic Report – Final, U.S. Department of Energy LMS/S10859, June 2014. https://www.energy.gov/sites/prod/files/2017/07/f35/S10859_Cost.pdf

USACE/EPA, A Guide to Developing and Documenting Cost Estimates During the Feasibility Study (FS), EPA 540-R-00-002, OSWER 9355.0-75, July 2000. https://semspub.epa.gov/work/HQ/174890.pdf

APPENDIX A: BOND CALCULATION WORKSHEETS

BOND AMOUNT COMPUTATION

Applicant: ______________________________

Permit Number: ______________________________

Increment Number: ______________________________

Permitted Acreage: ______________________________

Increment Acreage: ______________________________

Type of Operation: ______________________________

Location: ______________________________

Prepared by: ______________________________

Date: ______________________________

Total Bond Amount: $_____________________________

WORKSHEET 1- Description of The Worst-Case Reclamation Scenario

Assumptions:

Data Sources:

WORKSHEET 2- Structure Demolition and Disposal Costs

Listing of Structures to be Demolished:

Item	Construction Material	Volume (cubic feet)	Unit Cost Basis ($)	Demolition Cost ($)
			Subtotal	

Other Items to be Demolished (paved roads, conveyors, power poles, railroads, etc.):

Debris Handling and Disposal Costs:

TOTAL DEMOLITION AND DISPOSAL COST = $

Data Sources:

WORKSHEET 3- Material Handling Plan Summary

Listing of All Earthmoving Activities:

Description	Volume (LCY)	Origin	Destination	Haul Distance (ft)	Grade* (%)	Equipment to be used
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10						
* Record Grade Resistance here. Calculate Total Resistance where: Total Resistance = Grade Resistance + Rolling Resistance on the appropriate worksheet						

WORKSHEET 4A- Earthwork Quantity

CROSS-SECTION/ STATION	DISTANCE BETWEEN STATIONS (ft)	END AREA (ft^2)	VOLUME (yd^3)	SWELL (%)	ADJUSTED VOLUME (LCY)
TOTALS					

Data Source:

WORKSHEET 4B- Earthwork Quantity

Data Source:

WORKSHEET 5- Productivity and Hours Required for Dozer Use

Earthmoving Activity:

Characterization of Dozer Used (type, size, etc.):

Description of Dozer Use (origin, destination, grade, haul distance, material, etc.):

Productivity Calculations:

Operating Adjustment Factor = ________ x ________ x ________ x ________ x ________ x
(Operator Factor) (Material Factor) (Efficiency Factor) (Grade Factor) (Weight Correction Factor)

________ x ________ x ________ = ________.
(Production Method/ Blade Factor) (Visibility Factor) (Elevation Factor)

Net Hourly Production = ________ yd^3/hr. x ________ = ________ yd^3/hr.
(Normal Hourly Production) (Operating Adjustment Factor)

Hours Required = ________ yd^3 ÷ ________ yd^3/hr. = ________ hrs.
(volume to be moved) (net hourly production)

Data Sources:

WORKSHEET 6- Productivity and Hours Required for Dozer Use- Grading

Earthmoving Activity:

Characterization of Dozer Used (type, size, etc.):

Description of Dozer Use (% grade, effective blade width, operating speed, etc.):

Productivity Calculations:

Operating Adjustment Factor = ________ X ________ X ________ X ________ X
(Operator factor) (material factor) (efficiency factor) (grade factor)

________ X ____________ X ________ X _________ = ________
(Weight Correction factor) (production method/blade factor) (visibility factor) (elevation factor)

Hourly Production = ________ mi/hr X __________ ft X 5,280 ft/mi X 1 ac/43,560 ft^3 = _______ ac/hr
(Average Speed) (effective blade width)

Net Hourly Production = ________ ac/hr X __________________ = ______________ac/hr
(hourly production) (Operating adjustment factor)

Hours Required = ___________ AC ÷ __________ ac/hr = ____________ hr
(volume to be moved) (net hourly production)

Data Sources:

WORKSHEET 7- Productivity and Hours Required for Ripper-Equipped Dozer Use

Ripping Activity:

Characterization of Dozer and Ripper Use:

Description of Ripping (ripping depth, cut spacing, cut length, and material to be ripped):

Productivity Calculation*:

Cycle Time = (____________ ft. ÷ 88 ft./min) + ______________ min = ________________ min/pass.
cut length [speed] fixed turn time *

Passes/Hour = 60 min/hr. ÷ _____________ min/pass x _________ = _____________ passes/hr.
cycle time efficiency factor

Volume Cut/Pass = (___________ ft. x ___________ ft. x __________ ft.) ÷ 27 cu ft./cu yd.
tool penetration cut spacing cut length

= ___________ BCY/pass.

Hourly Production = ___________ BCY/pass x _________ passes/hr. = ____________ BCY/hr.

Hours Required = ____________ BCY ÷ ____________ BCY/hr. = _____________ hrs.
bank volume to be ripped hourly production

* Calculate separate hauling of ripped material in each lift on Worksheet No. 5, using swell factor to convert from bank to loose cubic yards.

** Fixed turn time is dependent on dozer used. Normally 0.25 min. per turn is used.

Data Sources:

WORKSHEET 8- Productivity and Hours Required for Loader Use

Characterization of Loader Use (type, size, etc.):

Description of Loader Use (origin, destination, grade, haul distance, etc.):

Productivity Calculations:

Cycle time = __________ + __________ + __________ = ________ min

haul time (loaded) | return time (empty) | basic cycle time

Net Bucket Capacity = _____________ yd^3 x _________ = ___________ yd^3

heaped bucket capacity | bucket fill factor

Hourly Production = __________ yd^3 ÷ _________ min x 50 min/hr. (work hour) = __________ yd^3/hr.

net bucket capacity | cycle time

Hours Required = ___________ yd^3 ÷ __________ yd^3/hr. = ______________ hrs.

volume to be moved | hourly production

Date Sources:

WORKSHEET 9- Productivity and Hours Required for Truck Use

Earthmoving Activity:

Characterization of Truck Use (type, size, etc.)

Description of Truck Use (origin, destination, grade, haul distance, capacity, etc.):

Productivity Calculations:

Truck Cycle Time = ________ + ___________ + ______________ + ________________ = __________min
haul time; return time; total loading time*; dump and maneuver time

Number of Trucks Required = ______________ min ÷ _______________ min = ________.
truck cycle time; total loading time*; trucks

Production Rate = ______________ yd^3 x ____________ ÷ __________ min = ___________ yd^3/min
Net truck capacity**; No. of trucks; truck cycle time

Hourly Production =____________ yd^3/min x 50 min/hr. = __________ $yd^3/hr.$
production rate; (work hour)

Hours Required = ___________ yd^3 ÷ ____________ $yd^3/hr.$ =________________ hrs.
volume to be moved; hourly production

Total Loading time = ___________________ min x ___________________ = _______ min
loader cycle time (from Worksheets 8 or 10); No. of loader passes

Number of Loader Passes = ___________ yd^3 ÷ _______________ yd^3 = _____________ passes
truck capacity; Load bucket net capacity; (normally round down and reduce the truck capacity and weight accordingly)

* Normally the average of the heaped and struck capacities.

**Net truck capacity = loader bucket net capacity x No. of loader passes/truck.

Data Sources:

WORKSHEET 10- Productivity for Hydraulic Excavator Use

(Backhoe or Power Shovel)

Earthmoving Activities:

Characterization of the Excavator Used (type, size, etc.):

Description of Excavator Used (loading geometry, materials, etc.):

Productivity Calculations:

Net Bucket Capacity = ____________ yd^3 x ____________ = ____________ yd^3
heaped bucket capacity; fill factor

Hourly Production = ____________ yd^3 x 50 min/hr ¸ ____________ min = ____________ yd^3/hr
net bucket capacity; (work hour); cycle time

Hours Required = ______________ yd^3 X _____________ yd^3/hr = ___________ hrs
volume to be handled; net hourly production

Data Sources:

WORKSHEET 11A- Productivity of Push-Pull or Self-Loading Scraper Use

Earthmoving Activity:

Characterization of Scraper Used (type, capacity, etc.):

Description of Scraper Route:

Productivity Calculations:

Cycle Time = __________ + __________ + __________ + __________ = __________ min

Cycle Time =	load time (push-pull is per pair)	+ loaded trip time	+ maneuver and spread time	+ return trip time	= min (push-pull is per pair)

Hourly Production = __________ yd^3 x __________ min x 50 min/hr = __________ yd^3/hr

capacity* — cycle time — (work hour) — (push-pull is per pair)

Hours Required = __________ yd^3 x __________ yd^3/hr = __________ hrs

volume to be handled — net hourly production

* The average of the <u>heaped</u> and <u>struck</u> capacities; use total for two scrapers for push-pull.

Data Sources:

WORKSHEET 11B- Productivity of Dozer Push-Loaded Scraper Use

Earthmoving Activity:

Characterization of Scraper Used (type, capacity, etc.):

Description of Scraper Route:

List Pusher Tractor(s) Used:

Describe Push Tractor Loading Method (see figure below):

Scraper Productivity Calculations:

Cycle Time = __________ (load time (push-pull is per pair)) + __________ (loaded trip time) + __________ (maneuver and spread time) + __________ (return trip time) = __________ min

Hourly Production = __________ (capacity*) yd^3 x __________ (cycle time) min x 50 min/hr (work hour) = __________ (push-pull is per pair) yd^3/hr

Hours Required = __________ (volume to be handled) yd^3 ÷ __________ (hourly production) yd^3/hr = __________ hrs

* The average of the <u>heaped</u> and <u>struck</u> capacities.

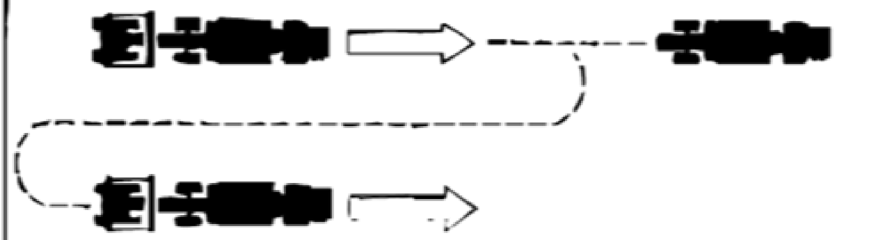
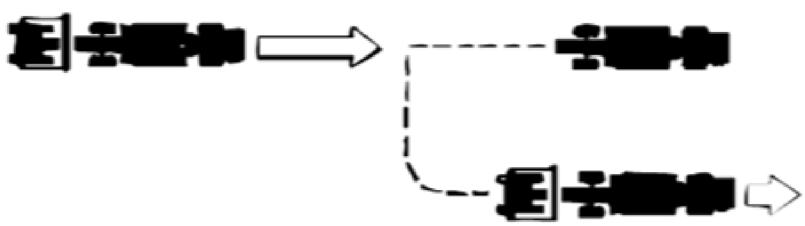
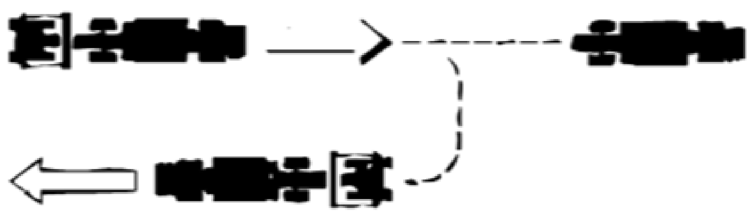
Push Tractor Productivity Calculations:

Pusher Cycle Time = __________ (scraper load time) min x __________ (pusher factor*) = __________ min

Scrapers Per Pusher = __________ (scraper cycle time) min ÷ __________ (pusher cycle time) min = __________ scrapers

Pusher Hours Required = __________ (scraper hours) hrs ÷ __________ (scrapers per pusher) = __________ (round up) hrs

WORKSHEET 11B (Continued): Productivity of Dozer Push-Loaded Scraper Use

PUSHER FACTORS	Single Push	Tandem Push
 A. Back Track Loading	1.5	2.0
 B. Chain Loading	1.3	1.5
 C. Shuttle Loading	1.3	1.5

Data Sources:

WORKSHEET 12- Productivity and Hours Required for Motor grader Use

Earthmoving Activity:

Characterization of Grader Used (type, size capacity, etc.):

Description of Grader Route (push distance, % grade, effective blade width, operating speed, etc.):

Productivity Calculations:

Grading:

Hourly Production = __________ min/hr x _____________ ft x 5280 ft/mi x 1 ac/43560 ft^2 x 50 min/hr.
average speed; effective blade width; (work hour)

= ________ acres/hr

Hours Required = _________ acres ÷ ___________ ac/hr = _____________hr
area to be graded; hourly production

Scarification:

Hourly Production = __________ min/hr x ______________ ft x 5280 ft/mi x 1 ac/43560 ft^2 x 50 min/hr
average speed; effective blade width; (work hour)

= _________ acres/hr

Hours Required = ___________ acres ÷ ___________ ac/hr = _________ hr
area to be scarified; hourly production

Total Hours = _________________

Data Sources:

WORKSHEET 13- Summary Calculation of Earthmoving Costs

Equipment *	Ownership & Operating Cost ($/hr)	Labor Cost ($/hr)	Total Hours Required **	Total Cost *** ($)
			Total Cost =	

* Include all necessary attachments and accessories for each item of equipment. Also, add support equipment such as water wagons, graders, etc. to match total project time as appropriate.

** Account for multiple units in truck and/or scraper teams.

*** To compute Total Cost: Add Ownership & Operation Cost and Labor Cost columns then multiply by Total Hours Required column.

Data Sources:

WORKSHEET 14- Revegetation Costs

Name and Description of Area to be Revegetated:

Description of Revegetation Activities:

Initial Seeding: ______________________

Cost = ____________ acres x ($ ___________ /acre + $ ______________ /acre) = $ ______________.
# of acres to be seeded; $/acre for seed bed preparation; $/acre for seeding, fertilizing, and mulching; cost for seeding

Planting Trees and Shrubs*:

Cost = ____________ acres x ($ ___________ /acre + $ _____________ /acre)= $ ________________.
# of acres for planting; $/acre for planting trees and shrub; costs for herbicide treatment; (cost for planting)

Reseeding:

Cost = ____________ acres x ($ ___________ /acre + $ _____________ /acre) = $ ____________.
# of acres to be reseeded; $/acre for seed bed preparation if needed; $/acre for seeding, fertilizing, and mulching if needed; cost for reseeding

Other Revegetation Activity for this Area:

(soil sampling, rill & gully repair, and other activities; justify, describe and provide cost estimate with documentation; use additional sheets if necessary.)

$ ___________________. (Total of other costs)

Assumptions:

TOTAL REVEGETATION COST FOR THIS AREA = $________________.

Data Sources:

WORKSHEET 15- Other Reclamation Activity Costs

Descriptions of Reclamation Activity:

Assumptions:

Cost Estimate Calculations:

TOTAL = $

Other Documentation or Notes:
(Include additional sheets, maps, calculations, etc., as necessary to document estimate.)

Data Sources:

WORKSHEET 16- Reclamation Bond Summary Sheet

1. Total Facility and Structure Removal Costs	$
2. Total Earthmoving Costs	$
3. Total Revegetation Costs	$
4. Total Other Reclamation Activities Costs	$
5. Total Direct Costs (Sum of Lines 1 through 4)	$
6. Inflated Total Direct Costs (Line 5)*(inflation factor) (Ch. 2 Step 3)	$
7. Mobilization and Demobilization (% of line 6) (1% to 10% of Line 6) (Ch. 2 Step 4)	$
8. Contingencies (% of line 6) (3% to 5% of Line 6) (Ch. 2 Step 4)	$
9. Engineering Redesign Fee (% of line 6) (2.5% to 6% of Line 6) (Ch. 2 Step 4)	$
10. Project Management Fee (% of line 6) (Table 1) (Ch. 2 Step 4)	$
11. Contractor Overhead (% of line 6) (Table 2) (Ch. 2 Step 4)	$
12. Contractor Profit (% of line 6) (Table 3) (Ch. 2 Step 4)	**$**
13. Total Indirect Costs (Sum of Lines 7 through 12)	$
GRAND TOTAL BOND AMOUNT **(Sum of Items 6, 13)**	**$**

WORKSHEET 17- Summary Sheet for Determining Amount of Bond to Retain at Phase I Release

1.	Remaining Structure Removal Costs	$__________
2.	Remaining Earthmoving Costs	$__________
3.	Remaining Revegetation Costs	$__________
4.	Remaining Other Reclamation Activities Costs	$__________
5.	Remaining Total Direct Cost (sum of Lines 1 through 4)	$__________
6.	Remaining Inflated Total Direct Costs (Line 5)*(inflation factor) (Ch. 2 Step 3)	$__________
7.	Mobilization/ Demobilization (_% of Line 6) (1% to 10% of Line 6) (Ch. 2 Step 4)	$__________
8.	Contingencies (%of Line 6) (3% to 5% of Line 6) (Ch. 2 Step 4)	$__________
9.	Engineering Redesign Fee (__ % of Line 6) (2.5% to 6% of Line 6) (Ch. 2 Step 4)	$__________
10.	Project Management Fee (_% of Line 6) (Table 1) (Ch. 2 Step 4)	$__________
11.	Contractor Overhead (__ % of Line 6) (Table 2) (Ch. 2 Step 4)	$__________
12.	Contractor Profit (__ % of Line 6) (Table 3) (Ch. 2 Step 4)	
13.	Total Indirect Costs (sum of Lines 7 through 12)	$__________
14.	AMOUNT OF BOND TO RETAIN AFTER PHASE I RELEASE (sums of Lines 6 and 13)	$__________
15.	Amount of Bond Required at Time of Application for Release (original bond amount as modified by any adjustments)	$__________
16.	Minimum Amount of Bond That Must Be Retained by Law (0.4)*(Line 15)	$__________
17.	AMOUNT OF BOND TO RETAIN AFTER PHASE I RELEASE (enter Line 14 or Line 16, whichever is greater)	$__________
18.	PHASE I RELEASE AMOUNT (subtract Line 17 from Line 15)	$__________

Enter Construction Cost Index (Ch. 2 Step 5)

WORKSHEET 18- Summary Sheet for Determining Amount of Bond to Retain at Phase II Release

1.	Remaining Revegetation Costs	$____________
2.	Remaining Other Reclamation Activities Costs	$____________
3.	Remaining Total Direct Costs (sum of Lines 1 and 2)	$____________
4.	Remaining Inflated Total Direct Costs (Line 3)*(inflation factor) (Ch. 2 Step 3)	$____________
5.	Mobilization/ Demobilization (_% of Line 4) (1% to 10% of Line 4) (Ch. 2 Step 4)	$____________
6.	Contingencies (_% of Line 4) (3% to 5% of Line 4) (Ch. 2 Step 4)	$____________
7.	Engineering Redesign Fee (_% of Line 4) (2.5% to 6% of Line 4) (Ch. 2 Step 4)	$____________
8.	Project Management Fee (_% of Line 4) (Table 1) (Ch. 2 Step 4)	$____________
9.	Contractor Overhead (_ % of Line 4) (Table 2) (Ch. 2 Step 4)	$____________
10.	Contractor Profit (__ % of Line 4) (Table 3) (Ch. 2 Step 4)	$____________
11.	Total Indirect Costs (sum of Lines 5 through 10)	$____________
12.	AMOUNT OF BOND TO RETAIN AFTER PHASE II RELEASE (sums of Lines 4 and 11)	$____________
13.	Amount of Bond Remaining After Phase I Release	$____________
14.	PHASE II RELEASE AMOUNT (subtract Line 12 from Line 13)	$____________

Enter Construction Cost Index (Ch. 2 Step 5)

APPENDIX B: EXAMPLES

BOND AMOUNT COMPUTATION

Applicant:
UNDERGROUND EXAMPLE

Permit Number: Example No. 1 Permitted Acreage: 20

Bonding Scheme (permit area, incremental, cumulative): Permit Area

If Incremental:
Increment Number: _______
Increment Acreage: _______

If Cumulative:
Acres previously authorized for disturbance: _______
New acres proposed for disturbance: _______

Type of Operation: Underground
Location: USA

Prepared by: S. S. Bond
Date: 6/15/2020
Total Bond Amount: $1,238,468

WORKSHEET 1: DESCRIPTION OF THE WORST-CASE RECLAMATION SCENARIO

The worst-case situation for forfeiture would be after all the improvements have been built. This would require the third-party contractor the greatest time and dollars to reclaim.

The mine plan outlines the proposed development sequence for the underground operation, starting with the installation of a sedimentation pond near the lower boundary of the site. Following the installation of the sediment pond, the applicant plans to install all the site culverts, diversion ditches, roads, benches, and topsoil stockpiles. Next, the applicant proposes to install the coal processing equipment. Concurrently, the operator plans to start three underground entries for the manway, materials/conveyor, and ventilation. Each entry will receive corrugated arches for about 50 feet into the mountainside. In addition, a series of highwalls must be constructed to form benches due to the steep slopes of the mountain in this area. These manmade benches provide the needed workspace to access the mine.

Most of these improvements are required for the life of the coal mine. An administration/change facility and a shop/warehouse facility will be constructed during the first 3 years of operations. During the construction period, portable units will house these early facilities.

The following discussion will present the tasks needed to be performed for returning the mine site to the original pre-mining condition. (See Figures B-1 through B-3 at end of worksheets.)

I. Structure Demolition

When returning the site to the postmining land use, most surface mine-related structures and facilities will be removed. This includes all buildings and other manmade items not identified for postmining land use.

Buildings and Facilities

a. A two-story administration building, sized 60’x60’x18’, will be constructed of concrete block on a poured thin, reinforced concrete slab floor. The second floor will be of plywood floor over wood floor joists. The cost of demolition includes the cost of removing the thin slab.

b. One shop building, sized 60’x120’x18’, will be constructed of insulated sheet metal, high enough to accommodate the mine and haul equipment. The 6-inch thick concrete floor is designed of 4,000psi concrete, reinforced with No. 5 rebar @ 12 inches on center, each way. Two reinforced concrete aprons of 60’x50’x6” thick are planned at each end of the building. The demolition size will be: building – 60’x120’x18’; floor – 60’x220’x6” thick.

c. Two explosive magazines are planned. These steel MSHA-approved buildings will be set on a thin concrete slab and must be removed to meet the postmining land use. Two steel buildings: 10'x10'x8' high. The demolition cost includes removal of the slab.

d. Four structures are included for coal primary and secondary processing, storage, and loadout. Each of these structures will be connected with a conveyor belt. This system transmits the coal from the mine to the loadout structure some 1300 feet from the mine mouth. The items that need to be removed are:

- 300' conveyor belt from the mine to the primary processing structure
- Primary processing structure = 35'x40'x60' high
- 480' conveyor belt from primary processing structure to the stacker

  Stacker = 15' diameter x 90'

  15' diameter x 100'
- 290' conveyor from the stacker to the secondary-processing structure
- Secondary-processing structure = 30'x35'x40' high
- 230' conveyor belt from the secondary-processing structure to the loadout structure

  Loadout structure = 20'x20'x60' high

e. The applicant proposes a 2.3-mile powerline to a substation within the mine site. The primary entry lines consist of four wires sized 2/0 and attached to overhead poles spaced at 250 feet.

f. The water supply includes a 20'x30'x8' treatment building constructed of insulated sheet metal on a thin, reinforced concrete slab. The cost of demolition includes the cost of removing the thin slab.

g. The applicant proposes three corrugated metal pipe (CMP) culverts sized to handle the on-site drainage. The various riprap sections can remain as channel protection. The on-site culverts to be removed will be:

- 18" cmp - 132 LF
- 48" cmp - 307 LF
- 84" cmp - 3029 LF
-

II. Earthmoving Activities

During the mine development, the applicant plans to create several benches on the mountainside to create work platforms. Each of these benches will be eliminated when returning the site to the approximate original contour (AOC). Much of the earthwork associated with bench elimination will be by scrapers and bulldozers to create pre-mining slopes. In addition, the bench/stockpile areas, the sedimentation pond, and the diversion ditch area must be backfilled and graded prior to topsoiling and revegetation. The attached mine plan map shows the contours and cross-sections that give the various locations and grades of the proposed development. The earthwork activities will include backfilling and grading the site and preparing the site (ripping) for topsoil placement.

The dugout sedimentation pond includes all appurtenances necessary to make the pond function. The excavated materials will be stockpiled nearby. Removal of all piping and riprap will be necessary prior to backfilling and grading. Most appurtenances can be bull dozed into the pit and covered with backfill. The sediment pond is less than 20 acre-feet in volume and less than 20 feet deep. The sediment pond area covers about I acre in size (32,300 cubic yards).

The applicant plans to rebuild 2 miles of old logging road and about 0.5 miles on the mine site. The half-mile onsite road will be eliminated with the backfilling and grading portion on the reclamation. The mine plan states that 20 percent swell can be expected on the earth material.

III. Topsoil Replacement

The topsoil stockpile is located about 500 feet below the sediment pond. The mine plan requires 6 inches of topsoil removed and stockpiled before mine development could begin. The topsoil stockpile will be adequate to return a depth of 6 inches to the mine area. Topsoil volume is 16,133 cubic yards.

IV. Revegetation

The entire area will need seedbed preparation, fertilization, seeding, and mulching. Local experience indicates a 50 percent failure on the revegetation due to a shorter growing season.

V. Other Reclamation Activities

Three underground entries need to be closed. Each entry has a corrugated arch support that extends about 50 feet into the mine. The ventilation access measures 10 feet in diameter, the material access is 12 feet in diameter, and the manway access is 25 feet on diameter. A masonry wall will be erected to seal the entries prior to the covering with backfill materials.

NOTE: Worksheets 8, 9, 10, 11A, 17 and 18 are not applicable to this example.

Data Source(s):

Underground Example Mine Plan

Caterpillar Performance Handbook, Edition 48

Cost Reference Guide for Construction Equipment, RSMeans

Bureau of Labor Statistics, http://www.bls.gov/oes/current/oes_3710.htm

PA DEP Mine Site Reclamation Bond Rates, 2020

ODNR Performance Security Estimate & Unit Costs

OSM Handbook for Calculation of Reclamation Bond Amounts, Revised 2020

WORKSHEET 2A: STRUCTURE DEMOLITION AND DISPOSAL COSTS

Structures to be demolished:

Item	Construction Material	Volume (cubic feet)	Unit Cost Basis ($)	Demolition Cost ($)
Admin. Building	Masonry Block	64,800	$0.30	$19,440
Shop Building	Metal	129,600	$0.30	$38,880
Explosives Magazine	Metal	1,600	$0.30	$480
Water System Bldg.	Metal	4,800	$0.30	$1,440
Primary Processing	Metal	84,000	$0.30	$25,200
			Subtotal	$85,440

Other items to be demolished (paved roads, conveyors, utility poles, rail spurs, etc.)

Item	Construction Material	Volume or Length	Unit Cost Basis ($)	Demolition Cost ($)
Conveyor System	Metal	1,300	$16.00	$20,800
Power Line, 2.3 miles	4-wire	48,576	$3.00	$145,728
Power Poles, 50	Wood	50	$250.00	$12,500
Shop Slab	Reinforced Concrete	13,200	$7.60	$100,320
			Subtotal	$279,348

Debris handling and disposal costs:

	Quantity	Cost	
Removal of trash and derelict equipment		$4,000.00	$4,000.00

Subtotal = $4,000

TOTAL DEMOLITION AND DISPOSAL = $368,788

Data Sources:

Underground Example Mine Plan
Cost Reference Guide for Construction Equipment, RSMeans

WORKSHEET 2B: STRUCTURE DEMOLITION AND DISPOSAL COSTS

Structures to be demolished:

Item	Construction Material	Volume (cubic feet)	Unit Cost Basis ($)	Demolition Cost ($)
Secondary Processing	Metal	42,000	$0.30	$12,600
Stacker	Concrete	1,600	$0.30	$480
Load Out	Metal	84,000	$0.30	$25,200
			Subtotal	$38,280

Other items to be demolished (paved roads, conveyors, utility poles, rail spurs, etc.)

Item	Construction Material	Volume or Length	Unit Cost Basis ($)	Demolition Cost ($)
18" Culvert	Metal	132	$2.50	$330
48" Culvert	Metal	307	$2.50	$768
84" Culvert	Metal	3,029	$2.50	$7,573
			Subtotal	$8,670

Subtotal = $46,950

TOTAL DEMOLITION AND DISPOSAL = $415,738

Data Sources:

Underground Example Mine Plan
Cost Reference Guide for Construction Equipment, RSMeans

WORKSHEET 3: MATERIAL HANDLING PLAN SUMMARY

Earthmoving Activity	Volume (LCY)	Origin	Destination	Haul Distance (ft)	Grade* (%)	Equipment to Be Used
Site Grading	41,110	Benches	General Contouring	500	10	D9T dozer
Site Grading	20,555	Benches	General Contouring	500	8	D9T dozer
Sedimentation Pond	25,814	Embankment	Pond Area	500	10	Caterpillar 627 with D8 dozer
Sedimentation Pond	12,907	Embankment	Pond Area	500	8	D9T dozer
Topsoil	16,133	Stockpile	Disturbed Area	500	10	D6 dozer
Ripping	64,533		Disturbed Area	500		D7R dozer
Haul Road Maintenance			Disturbed Area	1100		Caterpillar 14G, 6,000 Gallon Water Tanker

*Record grade resistance here. Calculate total resistance on the appropriate worksheet. Total Resistance = Grade Resistance + Rolling Resistance.

Data Sources:

Underground Example Mine Plan

WORKSHEET 4A: EARTHWORK QUANTITY

Cross-Section/Station	Distance Between Stations (ft)	End Area (ft^2)	Volume (yd^3)*	Adjustment Factor (%)**	Adjusted Volume*
0					
	400		7,778	20	9,333
B/D		1,050			
	450		20,833	20	25,000
C/D		1,450			
	400		18,148	20	21,778
D/D		1,000			
	250		4,630	20	5,556
				Subtotal	61,667

*Volume is BCY or LCY as appropriate

** Select adjustment factor based on the state of material being moved.

Data Sources:

Underground Example Mine Plan

WORKSHEET 4B: EARTHWORK QUANTITY

Site Grading
Bench Cut Earthwork Volume = 61,667 LCY (see Worksheet 4A)
Estimate 1/3 moved by scraper and remainder by dozer:
Scraper Volume = 2/3 x 61,667 LCY = 41,111 LCY
Dozer Volume = 61,667 LCY - 41,111 LCY = 20,556 LCY

Sediment Pond Regrade
Embankment Cut Earthwork Volume = 32,267 BCY (from mine plan)
Earthwork Volume = 38,720 LCY (= BCY x 1.2 for 20% swell factor)
Estimate 1/3 moved by scraper and remainder by dozer:
Scraper Volume = 2/3 x 38,720 LCY = 25,814 LCY
Dozer Volume = 38,720 LCY - 25,814 LCY = 12,907 LCY
Disturbed Area =20 acres (from mine plan)

Topsoil Replacement
Cover depth for 20 acres disturbed area = 0.5 ft (from mine plan)
Earthwork Volume = (20 acres x 43,560 ft^2/ac x 0.5 ft) / 27 yd^3/ft^3 = 16,133 LCY

Ripping
Ripping depth for 20 acres disturbed area = 2 ft (from mine plan)
Volume = (20 acres x 43,560 ft^2/ac x 2 ft) / 27 yd^3/ft^3 = 64,533 BCY

Data Source(s): Underground Example Mine Plan

WORKSHEET 5A: PRODUCTIVITY AND HOURS REQUIRED FOR DOZER USE

Earthmoving Activity:
1) Backfill and rough grade sediment pond
2) Rough grade bench site

NOTE: Since these two tasks have similar characteristics in push distance and grade, the yardage is combined, and the total hours required determined. Site located 8,000 feet above sea level.
TOTAL YARDAGE = 20,556 + 12,907 = 33,462 LCY

Characterization of Dozer Used (type, size, etc.):
D9 dozer with Semi-U or SU Blade = 375 cy/hr

Description of Dozer Use (origin, destination, grade, haul distance, material, etc.):
500 LF push distance at 10% effective grade; some material is blasted rock; however, the majority is assumed to be average
Volume (LCY): 33,462 Density (lb/LCY): 2500 Distance (ft): 500 Grade (%): 10

Productivity Calculations:

Operating Adjustment Factor = 0.75 (operator factor) x 0.90 (material factor) x 0.83 (efficiency factor) x 0.75 (grade factor)

x 0.92 (weight correction factor) x 1.0 (production method/blade factor) x 1.00 (visibility factor) x 1.00 (elevation factor) = 0.39

Net Hourly Production = 375 (normal hourly production) LCY/hr x 0.39 (operating adjustment factor) = 146 LCY/hr.

Hours Required = 33,462 (volume to be moved) LCY ÷ 146 (net hourly production) LCY/hr. = 229.9 hrs.
ROUND UP

use 230 Hours

Data Sources:
Underground Example Mine Plan
Caterpillar Performance Handbook, Edition 48

WORKSHEET 5B: PRODUCTIVITY AND HOURS REQUIRED FOR DOZER USE

Earthmoving Activity:
Push tractor to assist loading scrapers

Characterization of Dozer Used (type, size, etc.):
D8 dozer with Semi-U or SU Blade

Description of Dozer Use (origin, destination, grade, haul distance, material, etc.):
Scrapers loaded with Back-track Loading Method. Equipment working at 8,000 ft, msl.

Productivity Calculations:

Operating Adjustment Factor =

Operating Adjustment Factor = ________ x ________ x ________ x ________ x ________ x
Operator Factor, Material Factor, Efficiency Factor, Grade Factor, Weight Correction Factor

________ x ________ x ________ = ________.
Production Method/ Blade Factor, Visibility Factor, Elevation Factor

Net Hourly Production = ________ yd^3/hr. x ________ = ________ yd^3/hr.
Normal Hourly Production, Operating Adjustment Factor

Hours Required = ________ yd^3 ÷ ________ yd^3/hr. = ________ hrs.
volume to be moved, net hourly production
use **117 hrs**

* See Worksheets 11B-1 and 11B-2. (**86hr + 31hr = 117hr**)

Data Sources:
Underground Example Mine Plan
Caterpillar Performance Handbook, Edition 48

WORKSHEET 6A: PRODUCTIVITY AND HOURS REQUIRED FOR DOZER USE - GRADING

Earthmoving Activity:
Final (contour) grading.

Characterization of Dozer Used (type, size, etc.):
D6 dozer with an 11-ft wide Straight or "S" blade (effective width with blade overlap = 10ft)

Description of Dozer Use (origin, destination, grade, haul distance, material, etc.):
Operates along contour at 0% average grade, 8,000ft elevation.
Area (ac.):20 Grade (%):0 Average Speed (mph):3 Effective Blade Width (ft):10 Density (lb/LCY)2300

Productivity Calculations:

Operating Adjustment Factor = 0.75 (operator factor) x 1.00 (material factor) x 0.83 (efficiency factor) x 1.00 (grade factor)

x 1.00 (weight correction factor) x 1.00 (production method/blade factor) x 1.00 (visibility factor) x 1.00 (elevation factor) = 0.63

Hourly Production = 3.0 (average speed) mi/hr. x 10 (effective blade width) ft. x 5,280 ft./mi x 1 ac/43,560 sq. ft.

= 3.6 ac/hr.

Net Hourly Production = 3.6 (hourly production) ac/hr. x 0.63 (operating adjustment factor) = 2.3 ac/hr.

Hours Required = 20 (area to be graded) ac ÷ 2.3 (net hourly production) ac/hr. = 8.8 hrs.
Use **9 hrs**

Data Sources:
Underground Example Mine Plan
Caterpillar Performance Handbook, Edition 48

WORKSHEET 7: PRODUCTIVITY AND HOURS REQUIRED FOR RIPPER-EQUIPPED DOZER USE

Earthmoving Activity:

This unit will be used for ripping the site prior to topsoil placement as well as additional miscellaneous site maintenance activities for the life of the reclamation contract. The ripping activity will involve 20 acres.

Characterization of Dozer and Ripper Use (type, size, etc.):

D7 Dozer	with SU blade and 3 shank adjustable parallelogram ripper; ripper has a 39 inch (3.25 ft) pocket spacing.

Description of Ripping (ripping depth, cut spacing, cut length, and material to be ripped):

Ripping depth = 2 ft

Ripping effective width = 9.75 ft

Productivity Calculations:

Cycle Time = 1000 (cut length (ft)) ÷ 88 ft/min + 0.25 (fixed turn time* (min)) = **11.6 min/pass**

Passes/Hour = 60 min/hr ÷ 11.6 (cycle time (min/pass)) x 0.83 (efficiency factor) = **4.29 passes/hr**

Volume Cut/Pass = 2 (tool penetration (ft)) x 9.75 (cut spacing (ft)) x 1000 (cut length (ft)) ÷ 27 ft^3/yd^3 = **722 BCY/pass**

Hourly Production = 722 (volume cut/pass (BCY/pass)) x 4.29 (passes/hour) = **3096.9 BCY/hr****

Hours Required = 64,533 (volume to be ripped (BCY)) ÷ 3096.9 (hourly production (BCY/hr)) = **20.8 hr**

use **21 hrs**

* Fixed turn time depends upon dozer used. 0.25 min/turn is normal.

** Remember to use the swell factor to convert from bank cubic yards to loose cubic yards when applying these data to Worksheet No. 5.

Calculate separate dozer hauling of ripped material for each lift on that worksheet.

Data Sources:

Underground Example Mine Plan

Caterpillar Performance Handbook, Edition 48

WORKSHEET 11B-1: PRODUCTIVITY OF DOZER PUSH-LOADED SCRAPER USE

Earthmoving Activity:

1) Backfill and rough grade sediment pond

2) Rough grade bench site

NOTE: Since these two tasks have similar characteristics in push distance and grade, the yardage is combined, and the total hours required determined. Site located 8,000 feet above sea level.

TOTAL YARDAGE = 66,925 LCY (from Worksheet 4B)

Characterization of Scraper Use (type, capacity, etc.):

Caterpillar 627F Non-push pull 14 cy (struck) + 20 cy (heaped) = 17 cy avg capacity

Description of Scraper Use (origin, destination, grade, haul distance, capacity etc.):

500 ft haul @ 10 % effective grade 500 ft return @ -4 % effective grade

List Pusher Tractor(s) Used:

D8 dozer will assist the scraper in loading.

Describe Push Tractor Loading Method (see figure on next page):

Back-track loading method with 1 push tractor.

Scraper Productivity Calculations:

Cycle Time =	0.5	**+**	0.55	**+**	0.60	**+**	0.30	**=**	**1.95**	**min**
	load time (min)		loaded trip time (min)		maneuver and spread time (min)		return trip time (min)			
Hourly Production =	17	**x**	60 min	**÷**	1.95	**x**	0.75	**=**	**392**	**LCY/hr**
	capacity* (LCY)		hr		cycle time (min)		efficiency factor			

Hours Required =	59,209	÷	392	=	**171**	**hr**
	volume to be handled (LCY)		hourly production (LCY/hr)			

Pusher Productivity Calculations:

Cycle Time =	0.5	**x**	1.50	**=**	**0.75**	**min**
	scraper load time (min)		pusher factor			
Scrapers/Pusher=	1.95	÷	0.75	**=**	**2.6**	**scrapers/pusher**
	scraper cycle time (min)		pusher cycle time (min)			(use 2)
Pusher Hours Required =	171	÷	2	=	86	**hr**
	scraper hours (hrs)		scrapers per pusher		(round up)	

* The average of the struck and heaped capacities: use total for two scrapers for push-pull.

Data Sources:

Underground Example Mine Plan

Caterpillar Performance Handbook, Edition 48

WORKSHEET 11B-2: PRODUCTIVITY OF DOZER PUSH-LOADED SCRAPER USE

Earthmoving Activity:

Haul and spread topsoil 16,133 CY (from Worksheet 4B)

Characterization of Scraper Use (type, capacity, etc.):

Caterpillar 627F Non-push pull 14 cy (struck) + 20 cy (heaped) = 17 cy avg capacity

Description of Scraper Use (origin, destination, grade, haul distance, capacity etc.):

1100 ft haul @ 10 % effective grade 1100 ft return @ -4 % effective grade

List Pusher Tractor(s) Used:

D8 dozer will assist the scraper in loading.

Describe Push Tractor Loading Method (see figure on next page):

Back-track loading method with 1 push tractor.

Scraper Productivity Calculations:

Cycle Time = 0.5 (load time (min)) + 1.25 (loaded trip time (min)) + 0.60 (maneuver and spread time (min)) + 0.50 (return trip time (min)) = **2.85 min**

Hourly Production = 17 (capacity* (LCY)) x 60 min (hr) ÷ 2.85 (cycle time (min)) x 0.75 (efficiency factor) = **268 LCY/hr**

Hours Required = 16,133 (volume to be handled (LCY)) ÷ 268 (hourly production (LCY/hr)) = **60 hr**

Pusher Productivity Calculations:

Cycle Time = 0.5 (scraper load time (min)) x 1.50 (pusher factor) = **0.75 min**

Scrapers/Pusher= 2.85 (scraper cycle time (min)) ÷ 0.75 (pusher cycle time (min)) = 3.8 **scrapers/pusher** (use 2)

Pusher Hours Required = 60 (scraper hours (hrs)) ÷ 2 (scrapers per pusher) = 31 (round up) **hr**

* The average of the <u>struck</u> and <u>heaped</u> capacities: use total for two scrapers for push-pull.
** Using two scrapers to match Worksheet 11B-1: mobilization of more than 2 scrapers is not justified for this small task.

Data Sources:

Underground Example Mine Plan
Caterpillar Performance Handbook, Edition 48

WORKSHEET 12: PRODUCTIVITY AND HOURS REQUIRED FOR MOTOR GRADER USE

Earthmoving Activity:
The motor grader will be used for maintaining haul roads, to assist in final grading prior to topsoil placement, final grading of topsoil prior to seeding, clean-up, and maintenance work around the site. The moto rgrader, along with the dozer/ripper will be used for the life of the reclamation contract (131 hours). This unit will be working at 8,000 ft, msl.

Characterization of Grader Used (type, capacity, etc.):
14G 215 horsepower, equipped with EROPS and scarifier

Description of Loader Use (origin, destination, grade, haul distance, etc.):
Haul topsoil from storage to disturbed areas. Haul and return distance are both 650 ft over +5% effective grade

Productivity Calculations:

Hourly Production =	________	**x**	________	**x**	5,280 ft	**x**	1 acre	**x**	0.83	**=**	______	**ac/hr**
	average speed (mi/hr)		effective blade width (ft)		mile		43,560 ft^2		efficiency factor			

Hours Required =	________________	**÷**	________________	**=**		**hr**
	area to be graded (ac)		hourly production (ac/hr)			

Scarification

Hourly Production =	________	**x**	________	**x**	5,280 ft	**x**	1 acre	**x**	0.83	**=**	______	**ac/hr**
	average speed (mi/hr)		scarifier width (ft)		mile		43,560 ft^2		efficiency factor			

Hours Required =	________________	**÷**	________________	**=**	____	**hr**
	area to be scarified (ac)		hourly production (ac/hr)			
Hours Required =	________________	**+**	________________	**=**	231	**hr**
	grading hours required (hr)		scarification hours required (hr)			

*Motor grader is to be used for the project life of the reclamation contract (see Worksheet 13)

Data Sources:
Underground Example Mine Plan
Caterpillar Performance Handbook, Edition 48

WORKSHEET 13: SUMMARY CALCULATION OF EARTHMOVING COSTS

Equipment *	Ownership & Operating Cost ($/hr)	Labor Cost ($/hr)	Total Hours Required **	Total Cost *** ($)
627F Non-push-pull	93.92	136.74	231	$53,212.56
D6 dozer	44.46	49.76	9	$847.98
D7 dozer	64.38	69.56	231	$30,899.55
D8 dozer	78.26	85.97	117	$19,214.91
D9 dozer	118.37	123.78	230	$55,694.50
14G	55.02	44.92	231	$23,055.86
6000 Gallon Water Truck	88	32	231	$27,720
			Grand Total of Earthmoving	**$210,645.36**

* Be sure to include all necessary attachments and accessories for each item of equipment. Also, add support equipment such as water wagons and graders to match total project time as appropriate.

** Account for multiple units in truck and/or scraper teams

*** Calculate the total cost for each item of equipment by adding the second and third columns (the ownership and operation and labor costs) and then multiplying that number by the fourth column (the total hours required).

Data Sources:

Underground Example Mine Plan
Caterpillar Performance Handbook, Edition 48
Cost Reference Guide for Construction Equipment, RSMeans
Bureau of Labor Statistics, http://www.bls.gov/oes/current/oes_3710.htm
OSM Handbook for Calculation of Reclamation Bond Amounts, Revised 2020

WORKSHEET 14: REVEGETATION COSTS

Name and Description of Area to Be Revegetated:

Total area disturbed to be revegetated.

Description of Revegetation Activities:

Revegetate 20.0 ac with a pasture seed mix

Revegetation cost = $1,830.00 /ac (from 2020 PA DEP Standard Bond Rate Guidelines)

Cost Calculation for Individual Revegetation Activities:

Initial Seeding

area to be seeded (ac)		seedbed preparation costs ($/ac)		seeding, fertilizing, and mulching costs ($/ac)		
20.0	**x (**	500	+	$1,830.00	**) =**	**$46,600**

Reseeding *

area anticipated to need reseeding (ac)		seedbed preparation costs ($/ac)		seeding, fertilizing, and mulching costs ($/ac)		
10.0	**x (**	500	+	$1,830.00	**) =**	**$23,300**

Other Necessary Revegetation Activities

(Examples of other activities that may be necessary include soil sampling, irrigation, and rill and gully repair. Describe each activity and provide a cost estimate with documentation. Use additional worksheets if necessary.)

TOTAL REVEGETATION COST = $69,900

*Generally, the proportion of the area initially seeded and planted that is anticipated to need reseeding or replanting is determined on the basis of historic failure rates for similar sites and conditions. The same principle applies to determining the extent of seedbed preparation and soil amendments that may be needed as part of any reseeding or replanting effort. If anticipated failure rates vary within the area proposed for disturbance, use a separate worksheet for the area subject to each failure rate.

Assumptions:

Assume 50% failure for second seeding.

Data Sources:

Underground Example Mine Plan
PA DEP Mine Site Reclamation Bond Rates, 2020

WORKSHEET 15: OTHER RECLAMATION ACTIVITY COSTS

(Includes subsidence damage repair costs, water supply replacement costs, and funds required to support long-term treatment of unanticipated acid or ferruginous mine drainage.)

Description of Reclamation, Repair or Pollution Abatement Activity:

Sealing three mine entries; ventilation, manway and material.

The sealing will be as follows:

1) Each entryway will be pneumatically filled for 50 feet and
2) A masonry wall will be installed at the entrance

Assumptions:

	Backfill		Masonry Wall	
1) Ventilation	1,964		39	
2) Manway	12,272		245	
3) Materials	2,827		57	
Totals:	17,063	ft^3	341	ft^2

Cost Estimate Calculations:

Pneumatically filled materials	17,063	ft^3	**x**	$4.22	per ft^3	**=**	$72,044
Masonry walls	341	ft^2	**x**	$16.50	per ft^2	**=**	$5,627

TOTAL COSTS = $77,670

Other Documentation or Notes:

(Include additional sheets, maps, calculations, etc., as necessary to document estimate.)

Data Sources:

Underground Example Mine Plan
PA DEP Mine Site Reclamation Bond Rates, 2020

WORKSHEET 16: RECLAMATION BOND SUMMARY SHEET

1. Total Facility and Structure Removal Costs		$415,738	
2. Total Earthmoving Costs		$210,645	
3. Total Revegetation Costs		$69,900	
4. Total Other Reclamation Activities Costs		$77,670	
5. Total Direct Costs (Sum of Lines 1 through 4)		$773,954	
6. Inflated Total Direct Costs (Line 6 times inflation factor*) (Ch. 2 Step 3)			**$897,441**
7. Mobilization and Demobilization (Ch. 2 Step 4)	5% of line 6	$44,241.38	
8. Contingencies Allowance (Ch. 2 Step 4)	4% of line 6	$35,897.64	
9. Engineering Redesign Cost (Ch. 2 Step 4)	4% of line 6	$35,897.64	
10. Project Management Fee (Ch. 2 Step 4)	5% of line 6	$44,872.05	
11. Contractor Overhead (Ch. 2 Step 4)	13.0% of line 6	$116,667.32	
12. Total Indirect Costs			**$278,207**
13. Contractor Profit (Ch. 2 Step 4)	7.0% of line 6		**$62,821**
14. GRAND TOTAL BOND AMOUNT (Sum of Items 6, 12 & 13)			**$1,238,468**

Data Source(s):

Underground Example Mine Plan
Caterpillar Performance Handbook, Edition 48
Cost Reference Guide for Construction Equipment, RSMeans
Bureau of Labor Statistics, http://www.bls.gov/oes/current/oes_3710.htm
PA DEP Mine Site Reclamation Bond Rates, 2020
ODNR Performance Security Estimate & Unit Costs
OSM Handbook for Calculation of Reclamation Bond Amounts, Revised 2020

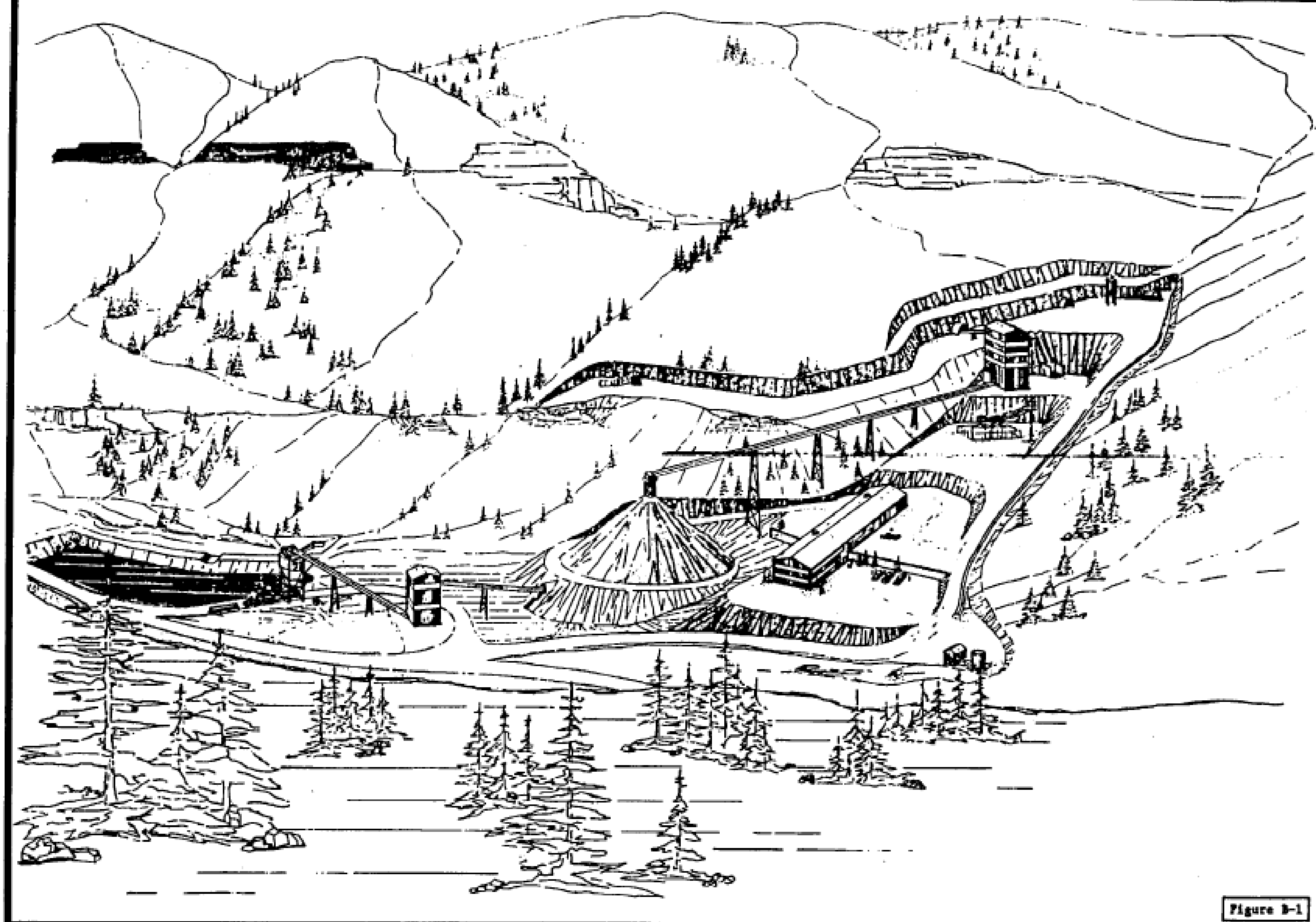


Figure B-1

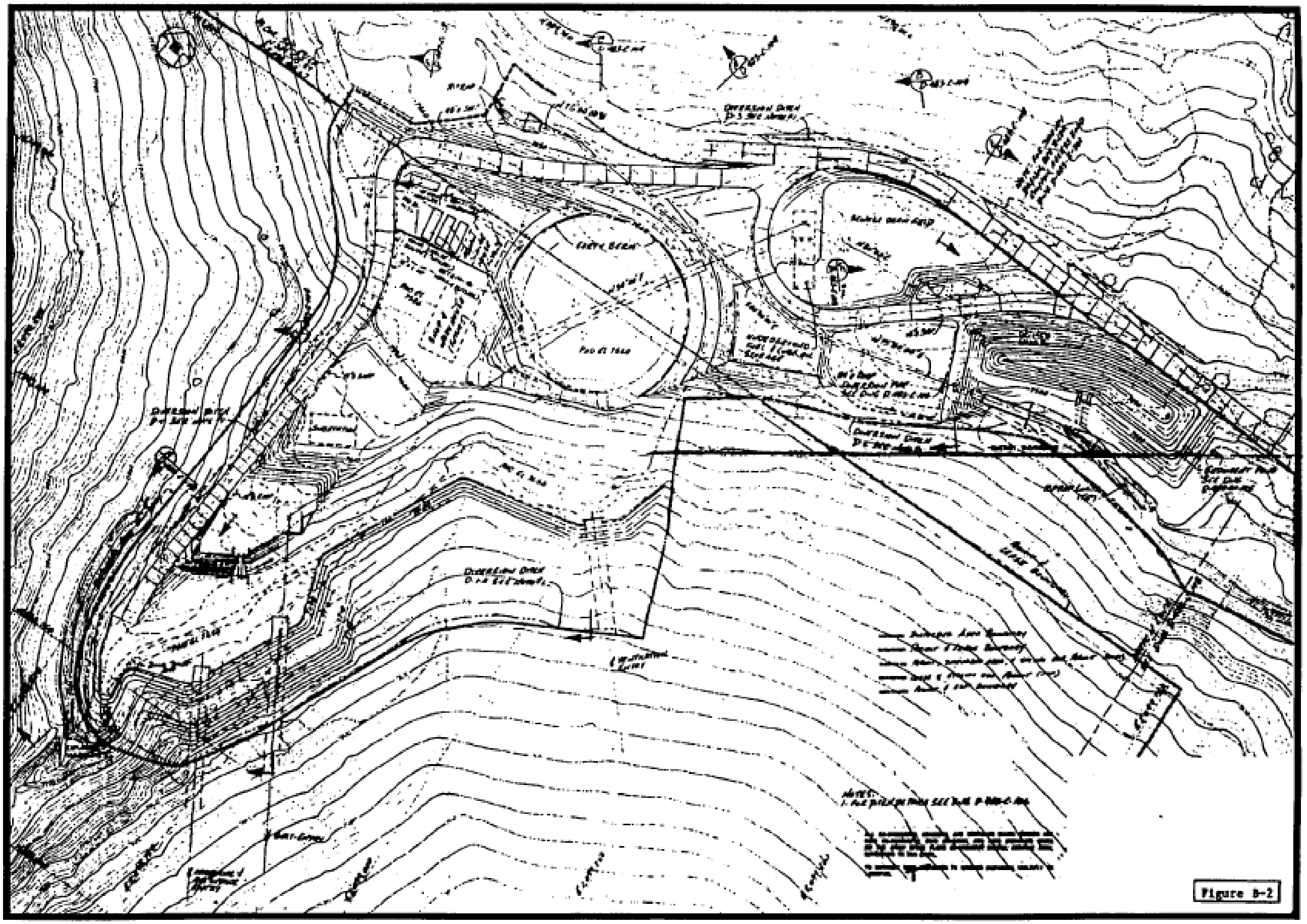


Figure b-2

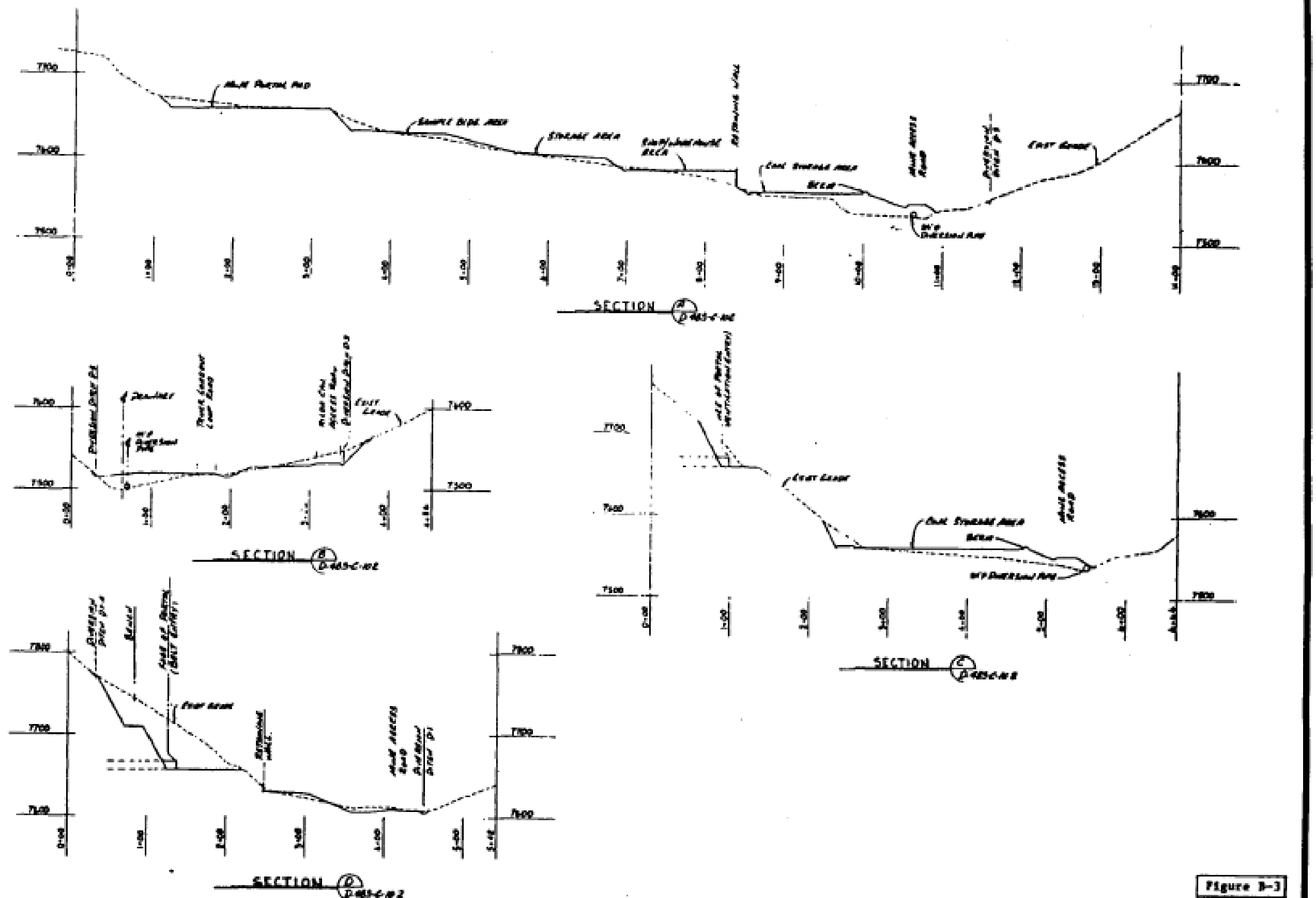


Figure B-3

BOND AMOUNT COMPUTATION

Applicant:
AREA MINING EXAMPLE (COMPLETED BY DRAGLINE)

Permit Number: EX-2   Permitted Acreage: 115.1 Acres

Bonding Scheme (permit area, incremental, cumulative): Whole Permit Area

If Incremental:

Increment Number: N/A

Increment Acreage: N/A

If Cumulative:

Acres previously authorized for disturbance: N/A

New acres proposed for disturbance: N/A

Type of Operation: Area-Mine with spoil piles and an open pit

Location: Midwestern U.S.

Prepared by: Big Boy Bond

Date: 12/31/2019

Total Bond Amount: $1,419,064

WORKSHEET 1: DESCRIPTION OF THE WORST-CASE RECLAMATION SCENARIO

Reclamation requires the following tasks:

The reclamation and operation plans outline the following mining sequence for this Area Mine operation. Mining begins at the southern end of the property and progresses northward. Six inches of topsoil and the initial box cut material will be stockpiled separately near the southern end of the permit boundary and outside the buffer zone of an adjacent creek located along the southern and eastern edge of the permit boundary. The operations plan identifies 71 acres of Prime Farmland soils that must be salvaged. The mine is located in Crawford County, Kansas.

The worst-case scenario will occur with the following disturbance:

1. The greatest disturbance of Prime Farmland.
2. The largest pit.
3. The greatest exposure of non-vegetated land.

From inspection, the worst-case scenario was determined as occurring about midway through the mining operation when one of the longest pits is through Prime Farmland, four spoil ridges exist behind the active pit, and no revegetation has been completed. See Figure B-4 at the end of the worksheets for more information.

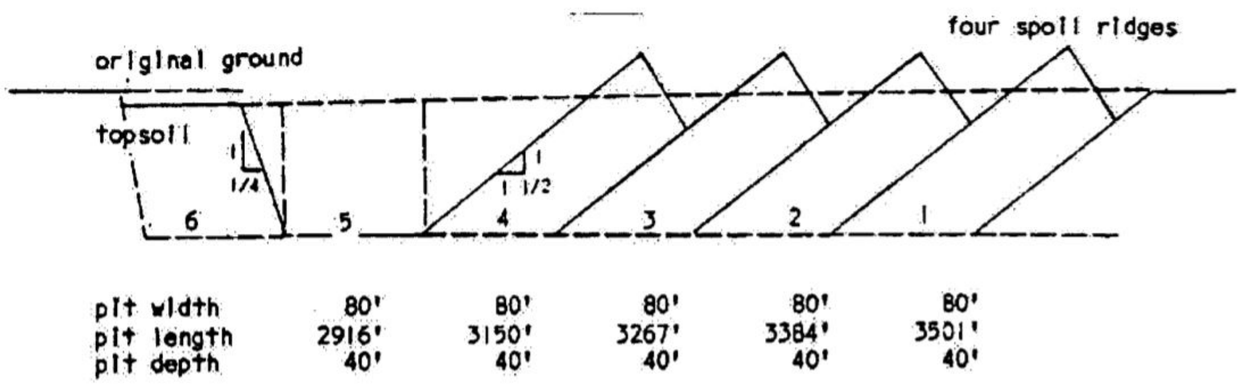
Assuming this worst-case scenario, the following reclamation tasks must be completed:

1. Structure Demolition: There are no facilities. One haul road and five ponds will remain as part of the post-mining land use.
2. Earthmoving Activities: One mine pit was open at the time of forfeiture that will need to be backfilled and rough graded. The accompanying cross section indicates that about a 40-foot-deep pit exists. The mine plan indicates that the highwall will maintain a ¼ Horizontal to 1.0 Vertical slope (¼H: 1.0V) and the spoil ridge side will maintain a 1.5H: 1V slope. See the attached sketch.
3. Topsoil Replacement: It is assumed that the next pit to be mined has had all topsoil removed. All areas behind the open pit form the start of mining need topsoil replaced followed by revegetation. The Prime Farmland areas will receive 48 inches of topsoil and subsoil and the non-Prime Farmland areas will receive six inches of topsoil. These areas will be at final grade once the topsoil is placed.
4. Revegetation: The revegetation worst-case scenario would be if mining started in the fall of the year, as scheduled, with no revegetation having occurred within the permit boundary. The total area requiring revegetation is 40.5 acres, including seedbed preparation, fertilization, seeding, and mulching. Assume a native cereal crop for the seed mixture.

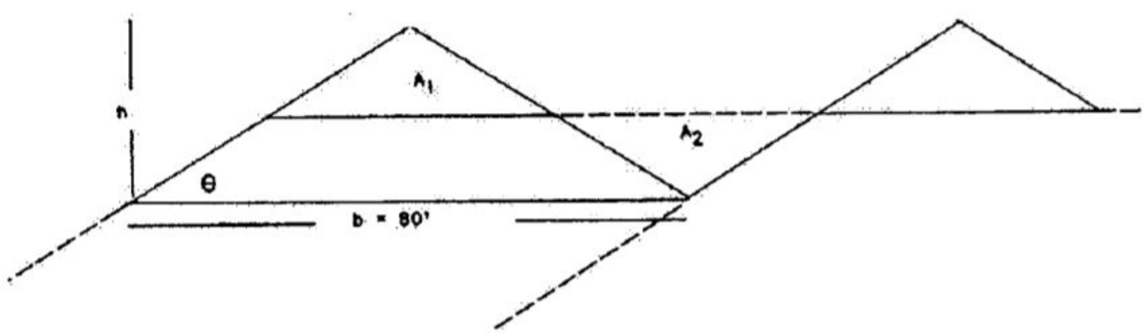
Note: Worksheets 2, 6, 8, 9, 10, 11A, 15, 17 and 18 are not applicable to this example.

Worksheet 1 (continued)
Description of the Worst-Case Reclamation Scenario.

General Sketch of Operations



Typical Spoil Pile Profile



WORKSHEET 3: MATERIAL HANDLING PLAN SUMMARY

Earthmoving Activity	Volume (LCY)	Origin	Destination	Haul Distance (ft.)	Grade * (%)	Equipment To Be Used
Backfill and Grading	568,836	Box Cut	Excess Spoil Area	1,900 average	4	637E Scraper with D9R Push Assist
Rough Grading	132,922	Spoil Ridges	Spoil Ridge Valleys	100 average	3	D9R-SU
Topsoil	15,972	Stockpile	Disturbed Areas	1,000 average	4	637E Scraper with D9R Push Assist
Subsoil (Prime Farmland Soils)	116,886	Stockpile	Disturbed Areas	1,000 average	4	637E Scraper with D9R Push Assist
Topsoil (Prime Farmland Soils)	16,698	Stockpile	Disturbed Areas	1,000 average	4	637E Scraper with D9R Push Assist
Ripping	131,000	Disturbed Area	Disturbed Areas	N/A	0	D7R-SU Dozer with 3-shank ripper
Scarification	40.5 Acres	Disturbed Area	Disturbed Areas	N/A	0	14H Grader
Final Grading	40.5 Acres	Disturbed Area	Disturbed Areas	N/A	0	14H Grader

Record grade resistance here.
Scraper and dozer work concurrently.
Total Resistance = Grade Resistance + Rolling Resistance.

Data Sources: Permit Application Package Mining and Reclamation Plan

WORKSHEET 4A: EARTHWORK QUANTITY

Cross-section/ station	Distance Between Stations (ft)	End Area (SF)	Volume (CY)	Adjustment Factor (%)	Adjusted Volume (CY)
East End of Pit		4,580			
	2,916		494,640	15%	568,836
West End of Pit		4,580			
Totals			**494,640**		**568,836**

*Select the adjustment factor based on the state of the material to be moved.
Cubic Feet converted to Cubic Yards (CY)

Data Source: Permit Application Package Mining and Reclamation Plan

WORKSHEET 4B: EARTHWORK QUANTITY

Pit Backfill Volume

End Areas of Pit – assume symmetry

1. 0.5 x 10’ x 40’ = 200 ft^2
2. 80’ x 40’ = 3,200 ft^2
3. 0.5 x 40’ x 59’ = 1,180 ft^2

Sum = 4,580 ft^2

Spoil Ridge Volume

$A_1 = A_2$
A_1 = ¼ the area of the total spoil pile
$A_1 = (¼)(½)(b)(h)$
$h = ½(\tan Θ)(b)^2$
$A_1 = (1/16)(\tan Θ)(b)^2$
$Θ = 34°$
$B = 80’$
A_1 = 269.8 ft^2 (area is per lineal foot of spoil pile length)

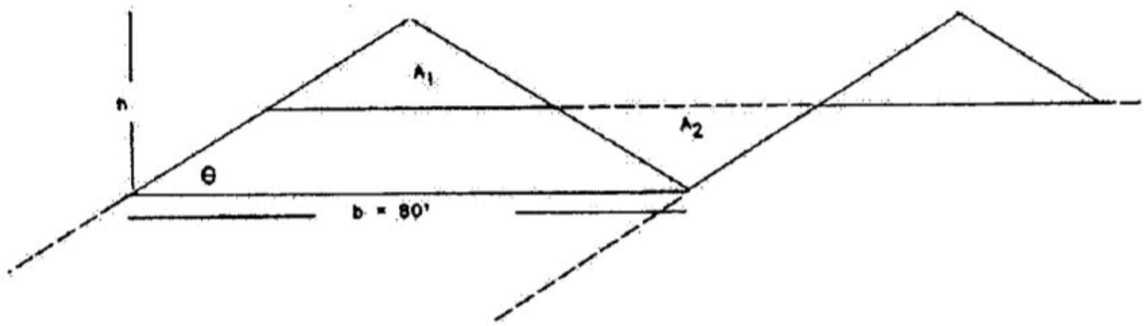
units are in feet and decimal degrees

Ridge 1: 269.8 ft^2 per lineal foot x 3,150 feet long / 27 ft^3/cy = 31,477 compact cubic yards (ccy)
Ridge 2: 269.8 ft^2 per lineal foot x 3,267 feet long / 27 ft^3/cy = 32,646 compact cubic yards
Ridge 3: 269.8 ft^2 per lineal foot x 3,384 feet long / 27 ft^3/cy = 33,815 compact cubic yards
Ridge 4: 269.8 ft^2 per lineal foot x 3,501 feet long / 27 ft^3/cy = 34,984 compact cubic yards

Total volume in spoil piles 1, 2, 3 and 4 = 132,922 ccy

Data Source: Permit Application Package Mining and Reclamation Plan

WORKSHEET 4B (Continued): EARTHWORK QUANTITY



Volume of Material to be Ripped

40.6 acres x 43,560 acres/ft^2 x 2-foot-deep ripping / 27 ft^3/cy = 131,003 cubic yards (cy)

Topsoil Volume

Non-Prime Farmland
19.8 acres to receive 6 inches of topsoil

19.8 acres / 43,560 acres/ft^2 x 0.5 ft / 27 ft^3/cy = 15,972 cy

Prime Farmland
20.7 acres to receive 48 inches of topsoil

Topsoil
20.7 acres / 43,560 acres/ft^2 x 0.5 ft / 27 ft^3/cy = 16,698 cy

Subsoil
20.7 acres / 43,560 acres/ft^2 x 3.5 ft / 27 ft^3/cy = 116,886 cy

Data Sources:
Permit Application Package
Caterpillar Performance Handbook, Edition 46.

WORKSHEET 5A: PRODUCTIVITY AND HOURS REQUIRED FOR DOZER USE

Earthmoving Activity: Spoil ridge reduction.

Characterization of Dozer Used (type, size, etc.): D9T – "Semi-U" or SU Blade

Description of Dozer Use (origin, destination, grade, haul distance, material, etc.):
Spoil ridge peaks graded into spoil ridge valleys
100-foot push at a 3% effective grade; material is a uniform mixture of earth and blasted limestone and shale rock.

Correct for weight of spoil material. See Weights of Materials Table in the Caterpillar reference for the relevant material.

Weight Correction Factor: $\dfrac{2{,}300}{(2{,}700 + 2{,}600 + 2{,}100) / 3} = 0.932$

Productivity Calculations:

Operating Adjustment Factor = 0.75 (operator factor) x 0.80 (material factor) x 0.83 (efficiency factor) x 0.95 (grade factor)

x 0.932 (weight correction factor) x 1.0 (production method/blade factor) x 1.00 (visibility factor) x 1.00 (elevation factor) = 0.44

Net Hourly Production = 1,250 (normal hourly production) LCY/hr x 0.44 (operating adjustment factor) = 553 LCY/hr.

Hours Required = 132,922 (volume to be moved) LCY ÷ 553 (net hourly production) LCY/hr. = 240.2 hrs. ROUND UP to 241 Hours

Data Sources:
Permit Application Package
Caterpillar Performance Handbook, Edition 46.

<u>WORKSHEET 5B: PRODUCTIVITY AND HOURS REQUIRED FOR DOZER USE</u>

<u>Earthmoving Activity</u>: Regrade Ditches

<u>Characterization of Dozer Used (type, size, etc.)</u>: D7R – SU

<u>Description of Dozer Use (origin, destination, grade, haul distance, material, etc.)</u>:

<u>Productivity Calculations</u>:

Operating Adjustment Factor = _________ x _________ x _________ x _________
operator factor, material factor, efficiency factor, grade factor

x _________ x _________ x _________ x _________ = _________
weight correction factor, production method/blade factor, visibility factor, elevation factor

Net Hourly Production = _________ LCY/hr x _________ = _________LCY/hr.
normal hourly production, operating adjustment factor

Hours Required = _________ LCY ÷ _________ LCY/hr. = 496 hrs.
volume to be moved, net hourly production

Use: 496 hours to match Dozer Assist on Scraper.

<u>Data Sources</u>:
Permit Application Package
Caterpillar Performance Handbook, Edition 46.

WORKSHEET 7: PRODUCTIVITY AND HOURS REQUIRED FOR RIPPER-EQUIPPED DOZER USE

Ripping Activity: Ripping the 40.6 acre site prior to placement of topsoil and subsoils. Assume 1,330 foot by 1,330 foot area.

Characterization of Dozer and Ripper Use:
D7R w/ SU blade and 3-shank adjustable parallelogram ripper; ripper as a 39 inch (3.25 foot) pocket spacing.

Description of Ripping (ripping depth, cut spacing, cut length, and material to be ripped):
Sandstone and shale ripping to a depth of 2 feet. Ripping width = 9.75 feet. (3.25 feet x 3 rippers)

Productivity Calculation:

Cycle Time = (1,330 [cut length] ft. ÷ 88 ft./min) [speed] + 0.25 [fixed turn time *] min = 15.36 min/pass.

Passes/Hour = 60 min/hr. ÷ 15.36 [cycle time] min/pass x 0.83 [efficiency factor] = 3.25 passes/hr.

Volume Cut/Pass = (2.0 [tool penetration] ft. x 9.75 [cut spacing] ft. x 1,330 [cut length] ft.) ÷ 27 cu ft./cu yd.

= 961 BCY/pass.

Hourly Production = 961 BCY/pass x 3.25 passes/hr. = 3,126.1 BCY/hr.

Hours Required = 131,003 [bank volume to be ripped] BCY ÷ 3,126.1 [hourly production] BCY/hr. = 41.9 hrs.

The D7R dozer is to be used for miscellaneous site work during the life of the project. **Use 496 hours** consistent with Worksheet 13.

* Fixed turn time depends upon dozer used. 0.25 min/turn is normal.
** Remember to use the swell factor to convert from bank cubic yards to loose cubic yards when applying these data to Worksheet No. 5. Calculate separate dozer hauling of ripped material for each lift on that worksheet.

Data Sources:
Permit Application Package
Caterpillar Performance Handbook, Edition 46

WORKSHEET 11B-1: PRODUCTIVITY OF DOZER PUSH-LOADED SCRAPER USE

Earthmoving Activity: Backfill and Grade final pit areas

Characterization of Scraper Used (type, capacity, etc.):
CAT 637K Push-Load. 24cy struck capacity, 34 cy heaped. Use an average of 29 cy capacity.

Description of Scraper Use (origin, destination, grade, haul distance, capacity, etc.):
Haul Distance = 1,900 LF; 4% effective grade haul; 1,900 LF return 0% effective grade
Haul = 27 MPH X 88 FPM/MPH = 2,376 FPM 1,900 LF/2,376 FPM = 0.80 minutes.
Return = 34 MPH X 88 FPM/MPH = 2,992 FPM 1,900 LF/2,992 FPM = 0.64 minutes.

Describe Push Tractor Loading Method (see figure on next page):
D9R dozer will assist the scraper in loading; back-track loading method with a single-push tractor.

Scraper Productivity Calculations:

Cycle Time = 0.6 min. (load time) + 0.80 min. (loaded trip time) + 0.6 min. (maneuver and spread time) + 0.64 min. (return trip time) = 2.63 min.

Hourly Production = 29 (capacity *) LCY x 60 min./hr. ÷ 2.63 min. (cycle time) X 0.75 (efficiency factor) = 495.3 LCY/hr.

Hours Required = 568,836 LCY (volume to be handled) ÷ 495.3 LCY/hr. (hourly production) = 1,148.4 hrs.

Push Tractor Productivity Calculations:

Pusher Cycle Time = 0.6 min (scraper load time) x 1.5 (pusher factor) = 0.9 min.

Scrapers/Pusher = 2.63 min. (scraper cycle time) ÷ 0.9 min. (pusher cycle time) = 2.93 scrapers. USE 3 SCRAPERS

Pusher Hours Required = 1,148.4 hrs. (scraper hours) ÷ 3 (scrapers per pusher) = 383 hrs. (round up)

* Use the average of the heaped and struck capacities.

Data Sources:
Permit Application Package
Caterpillar Performance Handbook, Edition 46.

WORKSHEET 11B-2: PRODUCTIVITY OF DOZER PUSH-LOADED SCRAPER USE

Earthmoving Activity: Replacing 42 inches (3.5 feet) of prime farmland and subsoils over 20.7 acres.

Characterization of Scraper Used (type, capacity, etc.):
CAT 637K Push-Load. 24cy struck capacity, 34 cy heaped. Use an average of 29 cy capacity.

Description of Scraper Use (origin, destination, grade, haul distance, capacity, etc.):
Haul Distance = 1,000 LF haul, 4% effective grade; 1,000 LF return at 0% grade.
Haul = 27 MPH X 88 FPM/MPH = 2,376 FPM   1,000 LF/2,376 FPM = 0.42 minutes.
Return = 34 MPH X 88 FPM/MPH = 2,992 FPM   1,000 LF/2,992 FPM = 0.33 minutes.

Describe Push Tractor Loading Method (see figure on next page):
D9R dozer will assist the scraper in loading. Back-track loading method with a single push dozer.

Scraper Productivity Calculations:

Cycle Time = 0.6 min. (load time) + 0.42 min. (loaded trip time) + 0.6 min. (maneuver and spread time) + 0.33 min. (return trip time) = 1.96 min.

Hourly Production = 29 (capacity *) LCY x 60 min./hr. ÷ 1.96 (cycle time) min. X 0.75 (efficiency factor) = 667.5 LCY/hr.

Hours Required = 116,886 (volume to be handled) LCY ÷ 667.5 (hourly production) LCY/hr. = 175.1 hrs.

Push Tractor Productivity Calculations:

Pusher Cycle Time = 0.6 (scraper load time) min x 1.5 (pusher factor) = 0.9 min.

Scrapers/Pusher = 1.96 (scraper cycle time) min. ÷ 0.9 (pusher cycle time) min. = 2.2 scrapers (Use 2 scrapers)

Pusher Hours Required = 175.1 (scraper hours) hrs. ÷ 2 (scrapers per pusher) = 88 hrs. (round up)

* Use the average of the heaped and struck capacities.

Data Sources:
Permit Application Package
Caterpillar Performance Handbook, Edition 46.

WORKSHEET 11B-3: PRODUCTIVITY OF DOZER PUSH-LOADED SCRAPER USE

Earthmoving Activity: Replacing 6 inches of topsoil over 40.5 acres (19.8 acres on non-prime and 20.7 acres of prime farmland.)

Characterization of Scraper Used (type, capacity, etc.):
CAT 637K Push-Load. 24cy struck capacity, 34 cy heaped. Use an average of 29 cy capacity.

Description of Scraper Use (origin, destination, grade, haul distance, capacity, etc.):
Haul Distance = 1,000 LF haul, 4% effective grade; 1,000 LF return at 0% grade.
Haul = 27 MPH X 88 FPM/MPH = 2,376 FPM   1,000 LF/2,376 FPM = 0.42 minutes.
Return = 34 MPH X 88 FPM/MPH = 2,992 FPM   1,000 LF/2,992 FPM = 0.33 minutes.

Describe Push Tractor Loading Method (see figure on next page):
D9R dozer will assist the scraper in loading. Back-track loading method with a single push dozer.

Scraper Productivity Calculations:

Cycle Time = 0.6 min. (load time) + 0.42 min. (loaded trip time) + 0.6 min. (maneuver and spread time) + 0.33 min. (return trip time) = 1.96 min.

Hourly Production = 29 LCY (capacity *) x 60 min./hr. ÷ 1.96 min. (cycle time) X 0.75 (efficiency factor) = 667.5 LCY/hr.

Hours Required = 32,670 LCY (volume to be handled) ÷ 667.5 LCY/hr. (hourly production) = 48.9 hrs.

Push Tractor Productivity Calculations:

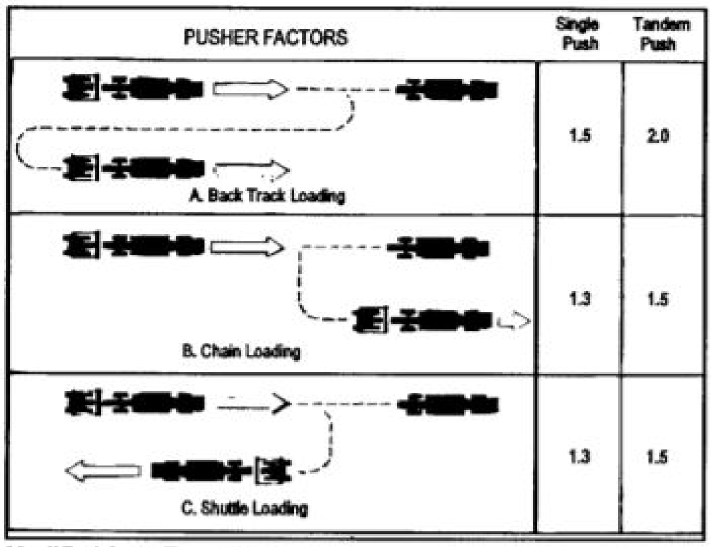
Pusher Cycle Time = 0.6 min (scraper load time) x 1.5 (pusher factor) = 0.9 min.

Scrapers/Pusher = 1.96 min. (scraper cycle time) ÷ 0.9 min. (pusher cycle time) = 2.2 scrapers (Use 2 scrapers)

Pusher Hours Required = 48.9 hrs. (scraper hours) ÷ 2 (scrapers per pusher) = 25 hrs. (round up)

* Use the average of the heaped and struck capacities.

WORKSHEET 11B-1 (CONTINUED): PRODUCTIVITY OF DOZER PUSH-LOADED SCRAPER USE



Modified from Terex,1981

Data Source(s): Illustration from "Production and Cost Estimating of Material Movement and Earthmoving Equipment," TEREX AMERICAS, Tulsa, OK 74107, (918) 445-5802. See disclaimer in Appendix A, *Worksheet 11B.*

Data Sources:
Permit Application Package
Caterpillar Performance Handbook, Edition 46.
TEREX Americas, by reference.

WORKSHEET 12: PRODUCTIVITY AND HOURS REQUIRED FOR MOTOR GRADER USE

Earthmoving Activity: Road maintenance, final grading, Life-of-Mine maintenance work. The motor grader and D7R dozer will be used for the entire duration of reclamation activities.

Characterization of Grader Used (type, size capacity, etc.):
Grader Model: 14H with EROPS and scarifier

Description of Grader Route (push distance, grade, effective blade width, operating speed, etc.):
N/A

Productivity Calculations: Life-of-Mine maintenance work

Grading

Hourly Production = _________ mi. /hr. x ________________ ft. x 5,280 ft./mi. x 1 ac/43,560 sq. ft.
average speed effective blade width

x ____________ = N/A ac/hr.
efficiency factor

Hours Required = _________________ acres ÷ _______________ ac./hr. = _____________ hrs.
area to be graded hourly production (match to scraper fleet)

Scarification

Hourly Production = _________ mi./hr. x _________ ft. x 5,280 ft./mi. x 1 ac/43,560 sq. ft.
average speed scarifier width

x ___________ = _______ ac./hr.
efficiency factor

Hours Required = __________ acres ÷ ___________ ac./hr. = ______ hrs.
area to be scarified hourly production

Total Hours Required

Total Hours = __________________ + __________________ = 496 hrs.
grading hours required scarification hours required

The Motor Grader is to be used for Life of Mine site maintenance. Use 496 hours.

Data Sources:
Permit Application Package
Caterpillar Performance Handbook, Edition 46

WORKSHEET 13: Summary Calculation of Earthmoving Costs

Equipment *	Ownership and Operation Cost ($/hr)	Labor Cost ($/hr)	Total Hours Required **	Number of Equipment	Total Cost *** ($)
637K Scraper (Backfill and Grade)	317.24	$15.68	383	3	$382,525.08
637K Scraper (Prime Farmland)	317.24	$15.68	88	2	$58,593.92
637K Scraper (Topsoil)	317.24	$15.68	25	2	$16,646.00
D7R-SU Dozer	133.94	$16.75	496	1	$74,742.24
D9R-SU Dozer	242.16	$16.75	241	1	$62,397.31
14H Grader	112.51	$15.90	496	1	$63,691.36
6,000 Gallon Water Truck	140	$15.90	496	1	$77,326.40
D9R-SU Dozer - Scraper Push Assist	242.16	$15.68	496	1	$127,888.64
				Grand Total	**$863,810.95**

* Support Equipment such as water trucks, road maintenance and support vehicles match total project time, as appropriate.

** Total project time is found by adding the duration of scraper hours.

*** To compute Total Costs: Add Ownership & Operation Cost and Labor Cost columns then multiply by Total Hours Required Column.

Data Sources:
Cost Reference Guide for Construction Equipment, 2019 edition.
Bureau of Labor Statistics, http://www.bls.gov/oes/current/oes_3710.htm.
Davis Bacon Determination” KS20200037

WORKSHEET 14: REVEGETATION COSTS

Name and Description of Area To Be Revegetated:
The area consists of Prime Farmland and open non-Prime Farmlands. Both areas will be vegetated in the same manner. Alfalfa will be the cover crop.

Description of Revegetation Activities:
Revegetate: 40.5 acres with a pasture seed mix; scarification by Cat 14H motor grader (cost accounted for under motor grader Life-of-Mine duration).

Cost Calculation for Individual Revegetation Activities:

Initial Seeding

___40.5___ ac x ($___0**___/ac + $___777___/ac) = $___31,469___.
area to be seeded; seedbed preparation costs; seeding, fertilizing & mulching costs

Planting Trees and Shrubs

______ ac x ($______/ac + $______/ac) = $______.
area to be planted; planting costs; herbicide treatment costs

Reseeding *

___40.5___ ac x ___0.3___ x $___777___/ac = $___9,441___.
area anticipated to need reseeding; Failure Rate ratio; seeding, fertilizing & mulching costs

Replanting Trees and Shrubs *

______ ac x ($______/ac + $___0___/ac) = $______.
area anticipated to need replanting; planting costs; herbicide treatment costs

Other Necessary Revegetation Activities
(Examples of other activities that may be necessary include soil sampling, irrigation, and rill and gully repair. Describe each activity and provide a cost estimate with documentation. Use additional worksheets if necessary.)

TOTAL REVEGETATION COST = $___40,909___.

* Generally, the proportion of the area initially seeded and planted that is anticipated needing reseeding or replanting is determined based on historic failure rates for similar sites and conditions. The same principle applies to determining the extent of seedbed preparation and soil amendments that may be needed as part of any reseeding or replanting effort. If anticipated failure rates vary within the area proposed for disturbance, use a separate worksheet for the area subject to each failure rate.

Data Sources:
Permit Application Package and NRCS.

WORKSHEET 16: RECLAMATION BOND SUMMARY SHEET

1.	Total Facility and Structure Removal Costs	$ 0
2.	Total Earthmoving Costs	$866,528
3.	Total Revegetation Costs	$40,909
4.	Total Other Reclamation Activities Costs	$0
5.	Subtotal: Total Direct Costs (sum of Items 1 through 4)	$907,437
6.	Inflated Direct Cost = Item 5: $907,437 X 13.32% = (Total Direct Costs)(Inflation Factor*) (Ch. 2 Step 3)	$1,028,308
7.	Mobilization and Demobilization (at 5 % of Item 6) (Ch. 2 Step 4)	$51,415
8.	Contingencies Allowance (at 3 % of Item 6) (Ch. 2 Step 4)	$30,849
9.	Engineering Redesign Cost (at 5 % of Item 6) (Ch. 2 Step 4)	$51,415
10.	Project Management Fee (at 5 % of Item 6) (Ch. 2 Step 4)	$51,415
11.	Contractor Overhead (at 13 % of Item 6) (Ch. 2 Step 4)	$133,680
12.	Subtotal: Total Indirect Costs (sum of Items 7 through 11)	$318,774
13.	Contractor Profit (at 7 % of Item 6) (Ch. 2 Step 4)	$71,981
14.	GRAND TOTAL BOND AMOUNT (sum of Items 6, 12 & 13)	$1,419,064

Enter Current Inflation Information: RSMeans Historic Cost Indexes table 2014 to 2019

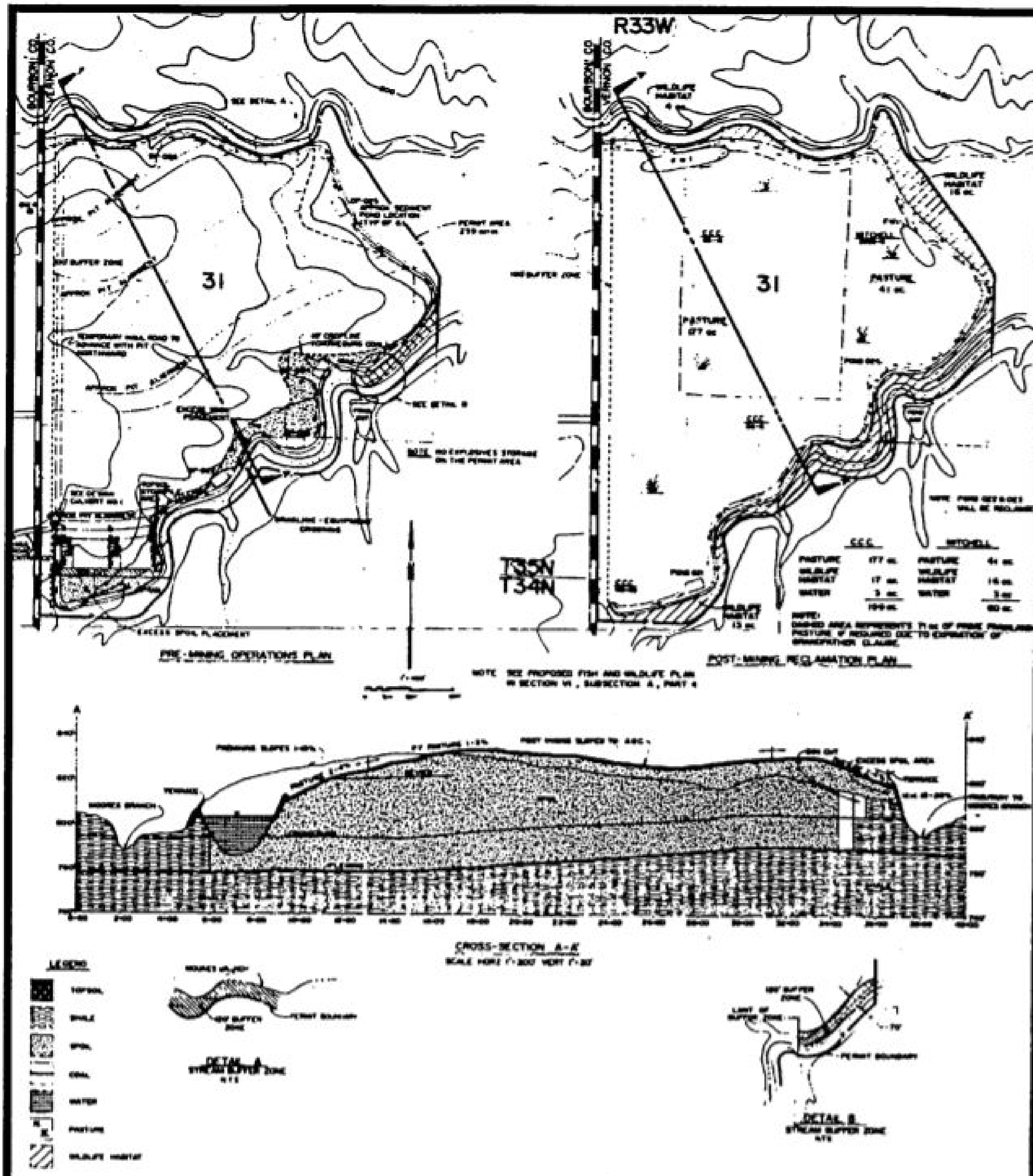

R33W
31
31
T35N
T34N
PRE-MINING OPERATIONS PLAN
POST-MINING RECLAMATION PLAN
CROSS-SECTION A-A'
LEGEND
TOPSOIL
SHALE
SPOIL
COAL
WATER
PASTURE
WILDLIFE HABITAT
DETAIL A
STREAM BUFFER ZONE
DETAIL B
STREAM BUFFER ZONE

Figure B-4

BOND AMOUNT COMPUTATION

Applicant:

HAUL BACK EXAMPLE- CONTOUR

Permit Number: Example No. 3 Permitted Acreage: 160.0

Bonding Scheme (Permit Area, Incremental, Cumulative): Permit Area

If Incremental:
Increment Number: _______
Increment Acreage: _______

If Cumulative:
Acres Previously Authorized for Disturbance: _______
New Acres Proposed for Disturbance: _______

Type of Operation: Contour-type surface (truck and loader)

Location: U.S.A.
Prepared by: S. H. Partney
Date 6/3/2020
Total Bond Amount $ 523,608

WORKSHEET 1: DESCRIPTION OF THE WORST-CASE RECLAMATION SCENARIO

The mining sequence for this haul back operation begins with Pit #l and progresses through Pit #66 (see Worksheet 4B). The topsoil from the box cut and the box-cut material will be stored separately in the four stockpiles located near Pits #4, #10, and #13. From inspection, the worst-case reclamation scenario will occur while Pit #21 is being mined due to the pit size and distance from these stockpiles. At this time, all additional stockpiles would not exist.

1. Structure Demolition

The mine plan Indicates that the office is located at the southern end of the permit area. This facility is mobile therefore it would not be demolished. The office and coal pad area combined take up about 0.5 acres. There are no other structures located on the permit area.

2. Earthmoving Activities

The worst-case reclamation scenario assumes that Pit #21 is completely mined. However, the haul back mining sequence, once in full operation, is conducted such that spoil is hauled immediately behind the active coal mining face and placed within the previous mined-out area. Therefore, it is assumed that 50 percent of Pit #21 and 50 percent of Pit #22 requires backfilling. The total volume contained in both stockpiles, plus 20 percent swell, and the volume of the haul-road surfacing is enough to fill the remaining open pit.

The main haul road is located along the western edge of the permit area, runs for 7000 feet and is 30 feet wide. The mine plan states that the haul road will be constructed out of crushed rock obtained from the initial box cut (Cut 1). The crushed rock will be 34 inches thick for the entire haul road length. This material will be removed and disposed of in the open pit by using the same equipment as used to move the spoil from the stockpiles to the open pit.

The mine plan indicates about a 30-foot overburden depth. The highwall is assumed to have a 1/4:1 slope and the spoil side is assumed to have a 2:1 slope based on field observation (see Worksheet No. 4). Because the mining operation uses scrapers, backfilling and rough grading is already accomplished. Therefore, Pits #17 through #22 require final grading prior to topsoil replacement.

Reclamation of the coal pad/office area will require that contaminated material be removed to a depth of 10 inches. This material will be disposed of in the open pit.

All existing ponds and the containment berm will be left as part of the approved postmining land use.

3. Topsoil Replacement

The mine plan indicates that 10 inches of topsoil will be salvaged. The topsoil from Pit #22 is assumed to have been removed and placed over Pit #16. The stockpiled topsoil will be used to cover Pits #17 through #22, the haul road, and the office/coal pad area. The topsoiled areas will then be final graded. The topsoil stockpile located on the west side of Pit# 5 will be referred to as TSW on the worksheets and the topsoil stockpile located on the east side of Pit %10 will be referred to as TSE on the worksheets.

Data Sources: Mine plan

WORKSHEET 2: STRUCTURE DEMOLITION AND DISPOSAL COSTS

Listing of Structures to be Demolished:

Item	Construction Material	Volume (cubic yards)	Unit Cost Basis ($)	Demolition Cost ($)
None*				
			Subtotal	

Other Items to be Demolished (paved roads, conveyors, power poles, railroads, etc.):

*Remove office trailer, 50' X 10' (9' height); same price as installation fee = $1,440

Cost is based on "demolition of small buildings, steel, including 20-mile haul" from RSMeans at $0.32/CF

Subtotal Cost = $ 1,440** .

Debris Handling and Disposal Costs:

** Demolition includes disposal with up to 20 mi. haul.

TOTAL DEMOLITION AND DISPOSAL COST = $ 1,440 .

Data Sources:
Means Site Work and Landscape Cost Data, 2019
Mine plan.

WORKSHEET 3: MATERIAL HANDLING PLAN SUMMARY

Listing of All Earthmoving Activities:

Earthmoving Activity	Volume (LCY)	Origin	Destination	Haul Distance (ft)	Grade (%)	Equipment To be Used
1. Fill open pit	60,315	West Overburden Stockpile	Pit #22	1,600 200	3 10	988F Loader w/ 769D trucks
2. Fill open pit	60,315	East Overburden Stockpile	Pit #22	800 200	3 10	988F Loader w/ 769D trucks
3. Fill open pit	22,037	Haul Road Area	Pit #22	1,800 200	3 10	988F Loader w/ 769D trucks
4. Remove AFM from Office Area	672	Coal Pad/area	Pit #22	3,200 200	3 10	988F Loader w/ 769D trucks
5. Rough Grading	30,326	Disturbed Area	Disturbed Area	100	3	D8R-SU Dozer
6. Ripping of Backfill, Haul Road, and Office Areas	70,758	Disturbed Area	Disturbed Area		0	D8R-SU Dozer w/ 3-shank ripper
7. Contour Grading of Backfill, Haul Road, and Office Areas	16.2 Acres	Disturbed Area	Disturbed Area		0	14G grader
8. Scarification and Final Grading	26.1 Acres	Disturbed Area	Disturbed Area		0	14G grader
9. Replace Topsoil In pits #17-22 area	14,626	Topsoil Stockpiles	East and West Disturbed Area	750	4	627F Scraper w/ D8R-S push tractor
10. Replace Topsoil Over Office and Haul Road	7,149	West Topsoil Stockpile	Disturbed Area	2,100	4	627F Scraper w/ D8R-S push tractor

Record grade resistance here. Calculate Total Resistance = Grade Resistance + Rolling Resistance on the appropriate worksheet.
** Scraper and dozer works concurrently.

WORKSHEET 4A: EARTHWORK QUANTITY

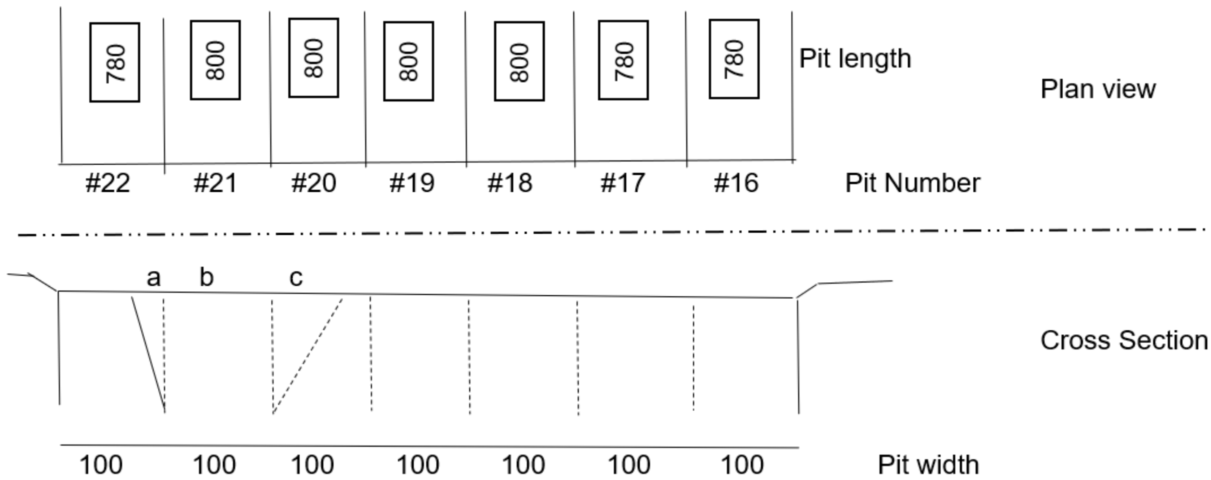
CROSS-SECTION/ STATION	DISTANCE BETWEEN STATIONS (ft)	END AREA (ft^2)	VOLUME (yd^3)	SWELL (%) *	ADJUSTED VOLUME (LCY)
east end of pit		4,012.5			
	800		118,889	1.2	142,667
west end of pit		4,012.5			
TOTALS			118,889		142,667

* Select swell adjustment factor based on the state of the material to be moved.

Data Source: Mine plan

WORKSHEET 4B: EARTHWORK QUANTITY

Earthmoving Volume Area Calculations



<u>Backfilling of Pits #21 and 22 - 50%</u>

Area a:	0.5 x 30' x 7.5'	=	112.5 ft^2
Area b:	30' x 100'	=	3,000 ft^2
Area c:	0.5 x 30' x 60'	=	900 ft^2
		=	4,012.5 ft^*

Backfill Volume (Calculations on Worksheet 4A) = 142,667 LCY

<u>Haul Road Haul Material:</u>

Total haul road volume = 22,088 LCY
The volume and haul distance (from centroid to centroid) for the northern half of the haul road = 12,622 LCY @ 2,200'; for the southern half = 9,466 LCY @ 1700'. The total average haul distance = 2,000'.

Spoil Ridge Volume = Pit Backfill Volume – Haul

Haul Back Volume = Backfill Volume - Haul Road Volume
= 142,887 - 22,089 = 120,578 CY
A dozer is needed to spread and rough grade this backfill material. Assume that 25% of the material is graded

<u>WORKSHEET 4B (Continued): Earthwork Quantity</u>

(3% average grade) = 142,667 LCY x 0.25 = 10,722 LCY

<u>Office Area, and Coal Pad Area Cleanup</u>

Office & Coal
Pad Area: 0.5 acres x 43,560 SF/acre
x 0.83' thick ÷ 27 CF/CY = 673 CY

The total average haul distance = 3,400'.

<u>Topsoil Replacement - Pits #17 through #22, Haul Road, Office Area, and Coal Pad</u>

Pits #17 through #22:	6 pits x 100' wide x 793' long x 0.83' thick ÷ 27 CF/CY	= 14,679 CY
Haul Road:	7,000' long x 30' wide x 0.83' thick ÷ 27 CF/CY	= 6,479 CY
Office & Coal Pad :	0.5 acres x 43,560 SF/acre x 0.83' thick ÷ 27 CF/CY	= 673 CY .
	Total	21,831 CY

<u>Topsoil Volume</u>

Topsoil Haul Distance:

Assume that the total topsoil volume is evenly distributed between the two stockpiles. Therefore,

West Topsoil Stockpile (TSW) = 10,915 CY
East Topsoil Stockpile (TSE) = 10,915 CY

The 7,151 CY of topsoil required for the haul road and office/coal pad area will come from TSW. The remaining 3,764 CY topsoil in TSW and the topsoil In TSE will be placed over Pits #17- #22. The total average haul distance for TSW is 2,100'. The total average haul distance for remaining TSW and TSE Is 750'.

<u>WORKSHEET 4B (Continued): Earthwork Quantity</u>

<u>Final Grading/Scarification Area - Pits #11 through #22, Haul Road, Office Area, and Coal Pad</u>

A planimeter* was used to determine the area of Pits #11 through #22.

Pits #11 - #22	20.8 acres
Haul Road	4.8 acres
Office & Coal Pad Area	<u>0.5 acres</u>
	26.1 acres

*A planimeter is a mechanical device for measuring area of irregular shapes

Data Source: Mine Plan

WORKSHEET 5A: PRODUCTIVITY AND HOURS REQUIRED FOR DOZER USE

Earthmoving Activity:
Spoil Rough Grading for Pits 17 - 22

Characterization of Dozer Used (type, size, etc.):
D8R dozer with "Semi-U or SU" Blade

Description of Dozer Use (origin, destination, grade, haul distance, material, etc.):
100 ft. push @ + 3% effective grade; material is a mixture of earth, blasted sandstone and shale rock

Productivity Calculations:

Operating Adjustment Factor = 0.75 (Operator Factor) x 0.80 (Material Factor) x 0.84 (Efficiency Factor) x 0.95 (Grade Factor) x 0.94* (Weight Correction Factor) x 1.0 (Production Method/ Blade Factor) x 1.0 (Visibility Factor) x 1.0 (Elevation Factor) = 0.449 .

Net Hourly Production = 870 LCY/hr. (Normal Hourly Production) x 0.449 (Operating Adjustment Factor) = 391.1 LCY/hr.

Hours Required = 30,326 yd^3 (volume to be moved) ÷ 391.1 LCY/hr. (net hourly production) = 77.5 ** hrs.

* $\frac{2,300}{(2,700 + 2,550 + 2,100) / 3} = \frac{2,300}{2,466.7} =$ 0.94 hrs.

** Use 301 total hours. Assume D8R-SU is available as support equipment during project life; see Worksheet 13.

Data Sources: Caterpillar Performance Handbook, Edition 40

WORKSHEET 5B: PRODUCTIVITY AND HOURS REQUIRED FOR DOZER USE

Earthmoving Activity:
Push tractor to assist loading scrapers.

Characterization of Dozer Used (type, size, etc.):
D8N dozer with a "S" Blade

Description of Dozer Use (origin, destination, grade, haul distance, material, etc.):
Scrapers loaded with Back-track Loading Method

Productivity Calculations:

Operating Adjustment Factor = ________ x ________ x ________ x ________ x ________________ x
(Operator Factor) (Material Factor) (Efficiency Factor) (Grade Factor) (Weight Correction Factor)

________________ x ________ x __________ = __________.
(Production Method/ Blade Factor) (Visibility Factor) (Elevation Factor)

Net Hourly Production = ____________ LCY/hr. x ____________________ = __________ LCY/hr.
(Normal Hourly Production) (Operating Adjustment Factor)

Hours Required = 30,326 LCY ÷ 391.1 LCY/hr. = 301 ** hrs.
(volume to be moved) (net hourly production)

* Match to Scraper Fleet Hours (see Worksheets 11B-1 and 11B-2)

Data Sources: Caterpillar Performance Handbook, Edition 40

WORKSHEET 7A: PRODUCTIVITY AND HOURS REQUIRED FOR RIPPER-EQUIPPED DOZER USE

Ripping Activity:
This unit will be used for ripping Pits # 16 through 22 prior to topsoil placement.

Characterization of Dozer and Ripper Use:
D8R w/ SU blade and 3-shank adjustable parallelogram ripper; ripper has a 43 inch (3.58-foot) pocket spacing

Description of Ripping (ripping depth, cut spacing, cut length, and material to be ripped):
Ripping depth = 2.7 feet; Cut length = 793'
Ripping effective width = 43"/12"per foot x 3 = 10.75 feet
Volume = 6 pits x 100' wide x 2.7' deep x 793' long / 27 CY/CF= 47,580 BCY

Productivity Calculation*:

Cycle time = (793 ft ÷ 88 fpm) + 0.3 min = 9.3 min/pass
(cut length) [speed] (fixed turn time**)

Passes/hour = 60 min/hr ÷ 9.3 min/pass x 0.83 = 5.38 passes/hr.
(cycle time) (efficiency factor)

Volume cut per pass = (2.7 ft x 10.75 ft x 793 ft) ÷ 27 ft^3/yd^3
(tool penetration) (cut spacing) (cut length)

= 852.5 BCY/pass

Hourly Production = 852.5 BCY/pass x 5.38 passes/hr. = 4,586.3 BCY/hr.

Hours Required = 47,580 BCY ÷ 4,586.3 BCY/hr. = 10.4 hrs.***
(bank volume to be ripped) (hourly production***)

* Calculate separate dozer hauling of ripped material in each lift on Worksheet No. 5, using swell factor to convert from bank to loose cubic yards.

** Fixed turn time is dependent on dozer used. Normally 0.25 min. per turn is used.

*** This D8R bulldozer is also to be for rough grading of the backfill area (see Worksheets 5A, 7A,7B and 7C)

Data Sources: Caterpillar Performance Handbook, Edition 40

WORKSHEET 7B: PRODUCTIVITY AND HOURS REQUIRED FOR RIPPER-EQUIPPED DOZER USE

Ripping Activity:
Rip the 30' wide haul road prior to topsoil placement.

Characterization of Dozer and Ripper Use:
D8R w/ SU blade and 3-shank adjustable parallelogram ripper; ripper has a 43 inch (3.58-foot) pocket spacing.

Description of Ripping (ripping depth, cut spacing, cut length, and material to be ripped):
Ripping depth = 2.7'　　　　　Length = 7,000'
Ripping effective width = 43"/12"per foot X 3 = 10.75'
Volume = 7,000' x 30' wide x 2.7' deep /27 CY/CF= 21,000 cy

Productivity Calculation*:

Cycle time = (7,000 ft [cut length] ÷ 88 fpm [speed]) + 0.3 [fixed turn time**] min = 79.8 min/pass

Passes/hour = 60 min/hr ÷ 79.8 [cycle time] min/pass x 0.83 [efficiency factor] = 0.63 passes/hr.

Volume cut per pass = (2.7 ft [tool penetration] x 10.75 ft [cut spacing] x 7,000 ft [cut length]) ÷ 27 ft^3/yd^3

= 7,525 BCY/pass

Hourly Production = 7,525 BCY/pass x 0.63 passes/hr. = 4,740.8 BCY/hr.

Hours Required = 21,000* BCY [bank volume to be ripped] ÷ 4,740.8 BCY/hr. [hourly production***] = 4.4 hrs.***

* Calculate separate dozer hauling of ripped material in each lift on Worksheet No. 5, using swell factor to convert from bank to loose cubic yards.
** Fixed turn time is dependent on dozer used. Normally 0.25 min. per turn is used.
*** This D8R bulldozer is also to be for rough grading of the backfill area (see Worksheets 5A, 7A,7B and 7C)

Data Sources: Caterpillar Performance Handbook, Edition 40

WORKSHEET 7C: PRODUCTIVITY AND HOURS REQUIRED FOR RIPPER-EQUIPPED DOZER USE

Ripping Activity:
Rip the office/coal pad area prior to topsoil placement.

Characterization of Dozer and Ripper Use:
D8R w/ SU blade and 3-shank adjustable parallelogram ripper; ripper has a 43 inch (3.58-foot) pocket spacing

Description of Ripping (ripping depth, cut spacing, cut length, and material to be ripped):

Ripping depth = 2.7'
Ripping effective width = 43"/12"per foot X 3 = 10.75'
Volume = 21,780 sf x 2.7' deep /27 CY/CF = 2,178 cy

Length = 148'
Area = 21,780 SF (0.5 ac.)

Productivity Calculation*:

Cycle time = (148 ft ÷ 88 fpm) + 0.3 min = 1.98 min/pass
(cut length) (speed) (fixed turn time**)

Passes/hour = 60 min/hr ÷ 1.98 min/pass x 0.83 = 25.23 passes/hr.
(cycle time) (efficiency factor)

Volume cut per pass = (2.7 ft x 10.75 ft x 148 ft) ÷ 27 ft^3/yd^3
(tool penetration) (cut spacing) (cut length)

= 159.1 BCY/pass

Hourly Production = 159.1 BCY/pass x 25.23 passes/hr. = 4,014.1 BCY/hr.

Hours Required = 2,100* BCY ÷ 4,014.1 BCY/hr. = 0.5 hrs.***
(bank volume to be ripped) (hourly production***)

Use a total of 271.2 hrs.***

* Calculate separate dozer hauling of ripped material in each lift on Worksheet No. 5, using swell factor to convert from bank to loose cubic yards.

** Fixed turn time is dependent on dozer used. Normally 0.25 min. per turn is used.

*** This D8R bulldozer is also to be for rough grading of the backfill area (see Worksheets 5A, 7A,7B and 7C) for a total of 125.1 hrs.; Use 271.2 total hours for added use as support equipment (see Worksheet 13.)

Data Sources: Caterpillar Performance Handbook, Edition 40

WORKSHEET 8A: PRODUCTIVITY AND HOURS REQUIRED FOR LOADER USE

Earthmoving Activity:

1. Load haul truck with spoil from overburden stockpile, west (OSW)
2. Load haul truck with spoil from overburden stockpile, east (OSE)

Characterization of Loader Use (type, size, etc.):

988F, Spade-edge 8.0 CY rock bucket, 11.5' dump height clearance

Description of Loader Use (origin, destination, grade, haul distance, etc.):

Loading 35 ton trucks from stockpile with minimum haul.

Productivity Calculations:

Cycle time = 0 (haul time (loaded)) + 0 (return time (empty)) + 0.575 (basic cycle time) = 0.575 min

Net Bucket Capacity = 8.0 (heaped bucket capacity) LCY x 0.8 (bucket fill factor) = 6.4 LCY

Hourly Production = 6.4 (net bucket capacity) LCY ÷ 0.575 (cycle time) min x 50 min/hr. (work hour) = 556.52 LCY/hr.

Hours Required = 1. 60,289 / 2. 60,289 (volume to be moved) LCY ÷ 556.52 (hourly production) LCY/hr. = 1. - 108.3 / 2. - 108.3 hrs.

Data Sources: Caterpillar Performance Handbook, Edition 28

WORKSHEET 8B: PRODUCTIVITY AND HOURS REQUIRED FOR LOADER USE

Earthmoving Activity:
Excavate and load road base material.

Characterization of Loader Use (type, size, etc.):
988F, 8.0 CY spade-edge rock bucket

Description of Loader Use (origin, destination, grade, haul distance, etc.):
Approximately 50' haul at 4% effective grade

Productivity Calculations:

Cycle time = 0.15 (haul time (loaded)) + 0.135 (return time (empty)) + 0.575 (basic cycle time) = 0. 86 min

Net Bucket Capacity = 8.0 (heaped bucket capacity) LCY x 0.9 (bucket fill factor) = 7.2 LCY

Hourly Production = 7.2 (net bucket capacity) LCY ÷ 0.86 (cycle time) min x 50 min/hr. (work hour) = 418.6 LCY/hr.

Hours Required = 22,088 (volume to be moved) LCY ÷ 418.6 (hourly production) LCY/hr. = 52.8 hrs.

Data Sources: Caterpillar Performance Handbook, Edition 28

WORKSHEET 8C: PRODUCTIVITY AND HOURS REQUIRED FOR LOADER USE

Earthmoving Activity:
Office and coal pad area waste cleanup: Remove 10 inches of contaminated material and place in final pit

Characterization of Loader Use (type, size, etc.):
988F with 8.0 CY spade-edge rock bucket, 11.5' dump height

Description of Loader Use (origin, destination, grade, haul distance, etc.):
Approximately 50' haul and loading of 35 ton trucks.

Productivity Calculations:

Cycle time = 0.15 (haul time (loaded)) + 0.135 (return time (empty)) + 0.575 (basic cycle time) = 0. 86 min

Net Bucket Capacity = 8.0 (heaped bucket capacity) LCY x 0.9 (bucket fill factor) = 7.2 LCY

Hourly Production = 7.2 (net bucket capacity) LCY ÷ 0.86 (cycle time) min x 50 min/hr. (work hour) = 418.6 LCY/hr.

Hours Required = 672 (volume to be moved) LCY ÷ 418.6 (hourly production) LCY/hr. = 1.8 hrs.

Data Sources: Caterpillar Performance Handbook, Edition 28

WORKSHEET 9A: PRODUCTIVITY AND HOURS REQUIRED FOR TRUCK USE

Earthmoving Activity:
Haul spoil from Overburden Stockpile West (OSW) to open pit.

Characterization of Truck Use (type, size, etc.)
Caterpillar 769D, (21.6 + 31.7) / 2 = 26.7 CY capacity (average of struck and heaped)

Description of Truck Use (origin, destination, grade, haul distance, capacity, etc.):
Haul distance and grade from OSW to open pit.
Haul: 1,600' @ 3% effective grade plus 200' @ 10% effective grade;
Return: 1,600' @ 3% effective grade plus 200' @ (-) 7% effective grade

Productivity Calculations:

Truck Cycle Time = 0.7 (haul time) + 0.2 (return time) + 0.45 + 0.1*** (total loading time*) + 2.3** + 2.0 (dump and maneuver time) = 5.75 min

Number of Trucks Required = 5.75 (truck cycle time) min ÷ 2.3 (total loading time*) min = 2.5 (trucks).

Production Rate = 25. 6 (truck capacity**) LCY x 3 (No. of trucks) ÷ 5.75 (truck cycle time) min = 13.36 LCY/min

Hourly Production = 13.36 (production rate) LCY/min x 50 min/hr. (work hour) = 667.8 LCY/hr.

Hours Required = 60,289 (volume to be moved) LCY ÷ 667.8 (hourly production) LCY/hr. = 90.3 hrs.

Match to Loader 108.3 hrs.

* Number of Loader Passes = 26.7 (truck capacity) LCY ÷ 6.4 (Load bucket net capacity) LCY = 4.16 passes (normally round down and reduce the truck capacity and weight accordingly)

** Total Loading time = 0.575 (loader cycle time (from Worksheets 8 or 10)) min x 4 (No. of loader passes) = 2.3 min

Net Truck capacity = 6.4 CY * 4 passes = 26.7 CY

*** 200' / (25 MPH x 88FPM/1 MPH) = 0.09 min. → use 0.1).

Data Sources: Caterpillar Performance Handbook, Edition 29

WORKSHEET 9B: PRODUCTIVITY AND HOURS REQUIRED FOR TRUCK USE

Earthmoving Activity:
Haul spoil from Overburden Stockpile East (OSE) to open pit.

Characterization of Truck Use (type, size, etc.)
769D, (21.6 + 31.7) /2 = 26.7 CY capacity (average of heaped and struck)

Description of Truck Use (origin, destination, grade, haul distance, capacity, etc.):
Haul distance and grade from OSE to open pit.
Haul: 800' @ 3% effective grade plus 200' @ 10% grade
Return: 800' @ 3% effective grade plus 200' @ (-)7% grade

Productivity Calculations:

Truck Cycle Time = 0.4 (haul time) + 0.2 (return time) + 0.3 + 0.1*** (total loading time**) + 2.3 + 2.0 (dump and maneuver time) = 5.3 min

Number of Trucks Required = 5.3 min (truck cycle time) ÷ 2.3 min (total loading time*) = 2.3 trucks

Production Rate = 25.6 LCY (Net truck capacity**) x 3 (No. of trucks) ÷ 5.3 min (truck cycle Time) = 14.5 LCY/min

Hourly Production = 14.5 LCY/min (production rate) x 50 min/hr. (work hour) = 724.5 LCY/hr.

Hours Required = 60,289 LCY (volume to be moved) ÷ 724.5 LCY/hr. (hourly production) = 83.2 hrs.
Match to Loader 108.3 hrs.

* Number of Loader Passes = 26.7 CY (truck capacity) ÷ 6.4 CY (Load bucket net capacity) = 4.16 passes (normally round down and reduce the truck capacity and weight accordingly)

** Total Loading time = 0.575 min (loader cycle time (from Worksheets 8 or 10)) x 4 (No. of loader passes) = 2.3 min

Net Truck capacity = 6.4 CY x 4 passes = 26.7 CY

*** 200' / (25 MPH x 88FPM/1 MPH) = 0.09 min. → use 0.1).

Data Sources: Caterpillar Performance Handbook, Edition 29

WORKSHEET 9C: PRODUCTIVITY AND HOURS REQUIRED FOR TRUCK USE

Earthmoving Activity:
Haul road base material to open pit.

Characterization of Truck Use (type, size, etc.):
Caterpillar 769D, (21.6 + 31.7) /2 = 26.7 CY average capacity (average of struck and heaped).

Description of Truck Use (origin, destination, grade, haul distance, capacity, etc.):
1800' @ 3% effective grade and 200' haul @ 10% effective grade
1800'@ 3% effective grade and 200' haul@ (-)7% effective grade

Productivity Calculations:

Truck Cycle Time = 0.8 (haul time) + 0.2 (return time) + 0.3 + 0.1*** (loading time**) + 2.3 + 2 (dump and maneuver time) = 5.70 min

No. of Trucks Required = 5.7 min (truck cycle time) 2.3 min (loading time) = 2.5 trucks

Production Rate = 28.8 LCY (Net truck capacity**) x 2 (no. of trucks) ÷ 5.7 min (truck cycle time) = 10.1 LCY/min

Hourly Production = 10.1 (production rate) LCY/min x 50 min/hr. (work hour) = 505.3 LCY/hr.

Hours Required = 22,037 LCY (volume to be moved) + 505.3 LCY/hr. (hourly production) = 43.6**** hr.
Match to Loader 52.8 hrs.

* Number of Loader Passes = 26.7 CY (truck capacity) ÷ 7.2 CY (Load bucket capacity) = 3.7 passes (normally round down and reduce the truck capacity)

** Total Loading time = 0.575 min (loader cycle time (from Worksheets 8 or 10)) x 4 (No. of loader passes) = 2.3 min

Net Truck capacity = 7.2 CY x 4 passes = 28.8 CY

*** 200' / (25 MPH x 88FPM/1 MPH) = 0.09 min. → use 0.1).

**** Use 2 trucks for 52.8 hours each to match loader production rate, see Worksheets 8B, 8C and 9D.

Data Sources: Caterpillar Performance Handbook, Edition 29

WORKSHEET 9D: PRODUCTIVITY AND HOURS REQUIRED FOR TRUCK USE

Earthmoving Activity:
Haul office area/coal pad waste material to open pit for burial.

Characterization of Truck Use (type, size, etc.):
769C, 26.8 cy bucket capacity (21.6 + 31.7) /2 = 26.7 CY average capacity (ave. of struck and heaped)

Description of Truck Use (origin, destination, grade, haul distance, capacity, etc.):
Haul: 3,200' at 3% effective grade and 200' @ I0% effective grade.
Return: 3,200' at 3% effective grade and 200' @ (-)7% effective grade.

Productivity Calculations:

Truck cycle Time = 1.35 + 0.2 (haul time) + 0.9 + 0.1 (return time) + 2.3 (total loading time*) + 2.0 (dump and maneuver time) = 6.85 min

Number of Trucks Required = 6.85 min (truck cycle time) ÷ 2.3 min (total loading time**) = 3 (trucks)

Production Rate = 28.8 LCY (Net truck capacity***) x 2 (No. of trucks****) ÷ 6.85 min (truck cycle time) = 8.41 LCY/min

Hourly Production = 8.41 (production rate) LCY/min x 50 min/hr. (work hour) = 420.44 LCY/hr.

Hours Required = 672 LCY (volume to be moved) ÷ 420.44 LCY/hr. (hourly production) = 1.6 hrs. Match to Loader 1.8 hrs.

* No. of Loader Passes/truck = 26.7 LCY (truck capacity) ÷ 7.2 LCY (Load bucket net capacity) = 3.7 passes (round down and reduce the truck capacity)

**Loading time/truck = 0.575 min (loader cycle time) x 4 (No. of loader passes (from Worksheets 8 or 10)) = 2.3 min

***Net Truck Capacity = 7.2 CY x 4 = 28.8 CY

**** Use 2 trucks for 47.3 hours each to match loader production rate, see Worksheets 8B, 8C and 9D.

Data Sources: Caterpillar Performance Handbook, Edition 29

WORKSHEET 11B-1: PRODUCTIVITY OF DOZER PUSH-LOADED SCRAPER USE

Earthmoving Activity:
Replacing topsoil over Pits #17 - #22.

Characterization of Scraper Used (type, capacity, etc.):
Cat 627F Non-push pull 14 CY (struck) + 20 CY (heaped) = (14 CY + 20 CY)/2 = 17 CY avg. capacity

Description of Scraper Route:
750' haul @ 4% effective grade; 750' return @ 4% effective grade

List Pusher Tractor(s) Used:
D8N-S blade push dozer will assist the scraper in loading.

Describe Push Tractor Loading Method:
Back-track loading method with 1 push tractor

Scraper Productivity Calculations:

Cycle Time = 0.5 (load time (push-pull/ pair)) + 0.5 (loaded trip time) + 0.6 (maneuver and spread time) + 0. 4 (return trip time) = 2.0 min (push-pull/ pair)

Hourly Production = 17 LCY (capacity*) x 50 min/hr. (work hour) ÷ 2.0 min (cycle time) = 425.0 LCY/hr.

Hours Required = 14,679 LCY (volume to be handled) ÷ 425.0 LCY/hr. (hourly production) = 34.5 hrs.

Push Tractor Productivity Calculations:

Pusher Cycle Time = 0.5 min (scraper load time) x 1.5 (pusher factor) = 0.75 min

Scrapers Per Pusher = 2.0 min (scraper cycle time) ÷ 0.75 min (pusher cycle time) = 2.667 min (round down)

Pusher Hours Required = 34.5 hrs. (scraper hours) ÷ 3 (scrapers per pusher) = 11.5 hrs. (round up)

* The average of the heaped and struck capacities.

Data Sources: Caterpillar Performance Handbook, Edition 28

WORKSHEET 11B-2: PRODUCTIVITY OF DOZER PUSH-LOADED SCRAPER USE

Earthmoving Activity:
Replacing topsoil over office area and haul road.

Characterization of Scraper Used (type, capacity, etc.):
Cat 627F Non-push pull 14 CY (struck) + 20 CY (heaped) = (14 CY + 20 CY)/2 = 17 CY avg. capacity

Description of Scraper Route:
2,100' haul @ 4% effective grade; 2,100' return @ 4% effective grade

List Pusher Tractor(s) Used:
D8N-S blade dozer will assist the scraper in loading.

Describe Push Tractor Loading Method (see figure below):
Back-track loading method with 1 push tractor

Scraper Productivity Calculations:

Cycle Time = 0.5 (load time (push-pull/ pair)) + 1.1 (loaded trip time) + 0.6 (maneuver and spread time) + 0.8 (return trip time) = 3.0 min (push-pull/ pair)

Hourly Production = 17 (capacity*) LCY x 50 min/hr. (work hour) ÷ 3.0 (cycle time) min = 283.3 LCY/hr.

Hours Required = 7,151 (volume to be handled) LCY ÷ 283.3 (hourly production) LCY/hr. = 25.2 hrs.

Push Tractor Productivity Calculations:

Pusher Cycle Time = 0.5 (scraper load time) min x 1.5 (pusher factor) = .75 min

Scrapers Per Pusher = 3.0 (scraper cycle time) min ÷ 0.75 (pusher cycle time) min = 4.0 (Use 3 to match Worksheet 11B-1)

Pusher Hours Required = 25.2 (scraper hours) hrs. ÷ 3 (scrapers per pusher) = 8.4 hrs. (round up) (Use 20 hrs. Total)

* The average of the heaped and struck capacities.

Data Sources: Caterpillar Performance Handbook, Edition 2

WORKSHEET 12: PRODUCTIVITY AND HOURS REQUIRED FOR MOTOR GRADER USE

Earthmoving Activity:
Final grade ripped area prior to placing topsoil.

Characterization of Grader Used (type, size capacity, etc.):
Caterpillar 14G, 215 horsepower, equipped with EROPS and scarifier

Description of Grader Route (push distance, % grade, effective blade width, operating speed, etc.):

Pit area (#17 - G22)	10.9 acres
Haul road area	4.8 acres
Coal pad/office area	0.5 acres
TOTAL AREA	**16.2 acres**

Productivity Calculations:

Grading:

Production = 2.8 mph (average speed) x 9 ft (effective blade width) x 5,280 ft/mi x 1 ac/43,560 ft^2 x 0.83 min/hr. (work hour factor) = 2.55 acres/hr.

Hours Required = 16.2 acres (area to be graded) ÷ 2.55 ac/hr. (hourly production) = 6.35 hr.

Scarification:

Hourly Production = 2.8 mph (average speed) x 11.1 ft (Scarifier width *) x 5,280 ft/mi x 1 ac/43,560 ft^2 x 0.83 min/hr. (work hour factor) = 3.12 acres/hr.

Hours Required = 16.2 acres (area to be scarified) ÷ 3.12 ac/hr. (hourly production) = 5.2 hr.

Total Hours = 11.6 (use 271.2 hrs.**)
*7 shanks X (19" spacing / 12in./ft.) = 11.1 ft.

**Motor grader is assumed to be onsite while all earthmoving tasks are being conducted. Therefore, it used for the life of the reclamation contract (see Worksheet No. 13)

Data Sources: Caterpillar Performance Handbook, Edition 28

WORKSHEET 13: SUMMARY CALCULATION OF EARTHMOVING COSTS

Equipment *	Ownership & Operating Cost ($/hr.)	Labor Cost ($/hr.)	Total Hours Required **	Total Cost *** ($)
627F Scraper	208.55	32.00	20.0	$ 4,811
627F Scraper	208.55	32.00	20.0	$ 4,811
627F Scraper	208.55	32.00	20.0	$ 4,811
D8N-S Push Tractor	148.39	32.00	20.0	$ 3,608
988F Loader	160.73	32.00	271.2	$ 52,268
D8R-SU Dozer w/ 3 shank ripper	157.02	32.00	271.2	$ 51,262
14G Grader	93.46	32.00	271.2	$ 34,025
6,000 gal. Water Tanker	88.00	32.00	271.2	$ 32,544
769D Truck	142.82	32.00	271.2	$ 47,411
769D Truck	142.82	32.00	271.2	$ 47,411
769D Truck	142.82	32.00	218.4	$ 38,181
				321,143

* Add support equipment such as water wagons, graders, etc. to match total project time as needed. Equipment and Accessory Identification: Support equipment = D8R-SU 3-shank,14G and 6,000 gal. Water Tanker

** Total project time = total truck and loader team time = [108.3 + 108.3 + 52.8 + 1.8] = 271.2 hrs.; 2 trucks are used for 271.2 hrs.; one truck is used for 218.4 hrs.

*** Account for multiple units in truck and/or scraper teams.

Data Sources: EquipmentWatch, 2019 edition

WORKSHEET 14: REVEGETATION COSTS

Name and Description of Area to be Revegetated:
Pits #11 - #22 = 20.8 Ac, Haul road = 4.8 Ac, Coal pad/office area = 0.5 Ac; TOTAL = 26.1 Ac.

Description of Revegetation Activities:
No special revegetation activities required. Seedbed preparation has already taken place. The local SCS of face provided an average revegetation cost of $450/Ac.

Initial Seeding:

Cost = 26.1 acres x ($ ** /acre + $ 450 /acre) = $ 11,745
(# of acres to be seeded) ($/acre for seed bed preparation) ($/acre for seeding, fertilizing, and mulching) (cost for seeding)

Planting Trees and Shrubs:

Cost =_____ acres x ($______ /acre + $__________ /acre) = $ $ 0.00
(# of acres for planting) ($/acre for planting (costs for herbicide trees and shrub) (cost for planting) treatment)

Reseeding:

Cost = 26.1* acres x ($______ /acre + $ 450 /acre) = $ 11,745
(# of acres to be reseeded*) ($/acre for seed bed preparation if needed) $/acre for seeding, fertilizing, and mulching if needed) (cost for reseeding)

Other Revegetation Activity for this Area:
(soil sampling, rill & gully repair, and other activities; justify, describe and provide cost estimate with documentation; use additional sheets if necessary.)
$______
(Total of other costs)

Assumptions: ** Scarifying is to be accomplished by motor grader, see Worksheet No. 12.

TOTAL REVEGETATION COST FOR THIS AREA = $ 23,490

* Reseeding area is the total area disturbed or to be disturbed which has not received Phase III bond release.

Data Sources: Mine plan and the state SCS

WORKSHEET 16: RECLAMATION BOND SUMMARY SHEET

1. Total Facility and Structure Removal Costs $ 1,440

2. Total Earthmoving Costs $ 321,143

3. Total Revegetation Costs $ 23,490

4. Total Other Reclamation Activities Costs

5. Subtotal: Total Direct Costs (sum of Items 1 through 4) $ 346,073

6. Inflated Direct Cost = Item 5 $ 346,073 X 1.0 = $ 346,073
(Total Direct Costs) (Inflation Factor*) (Ch. 2 Step 3)

7. Mobilization and Demobilization (at 7 % of Item 6) $ 24,225
(1% to 10% of Item 6) (Ch. 2 Step 4)
Explanation: All equipment can be mobilized complete using standard haulers.

8. Contingencies (at 5 % of Item 6) $ 17,304
(3% to 5% of Item 6) (Ch. 2 Step 4)
Explanation: This is a relatively small job, therefore the maximum value is used.

9. Engineering Redesign Fee (at 7.3 % of Item 6) $ 25,263
Explanation: Minor changes from the approved plan are necessary due to differences In actual spoil vs projected and the need to remove haul roads. A relatively high percentage Is used because of project size. (Ch. 2 Step 4)

10. Contractor Profit (at 12 % of Item 6) $ 41,528
Explanation: Profit is relatively high due to the small size (Ch. 2 Step 4).

11. Contractor Overhead (at 15 % of Item 6) $ 51,911
Explanation: Overhead is 15%, since project size is between 90 and 700 acres per Table 2. (Ch. 2 Step 4)

12. Reclamation Management Fee (at 5 % of Item 6) $ 17,304
Explanation: A manager is recommended for the project (Ch. 2 Step 4)

13. Subtotal: Total Indirect Costs (sum of Items 7 through 12) $ 177,535

14. GRAND TOTAL BOND AMOUNT $ 523,608
(sum of Items 7 and 13)

* This calculation does not reflect an inflation factor because the purpose of the calculation is to determine if the posted bond is sufficient for the current conditions.

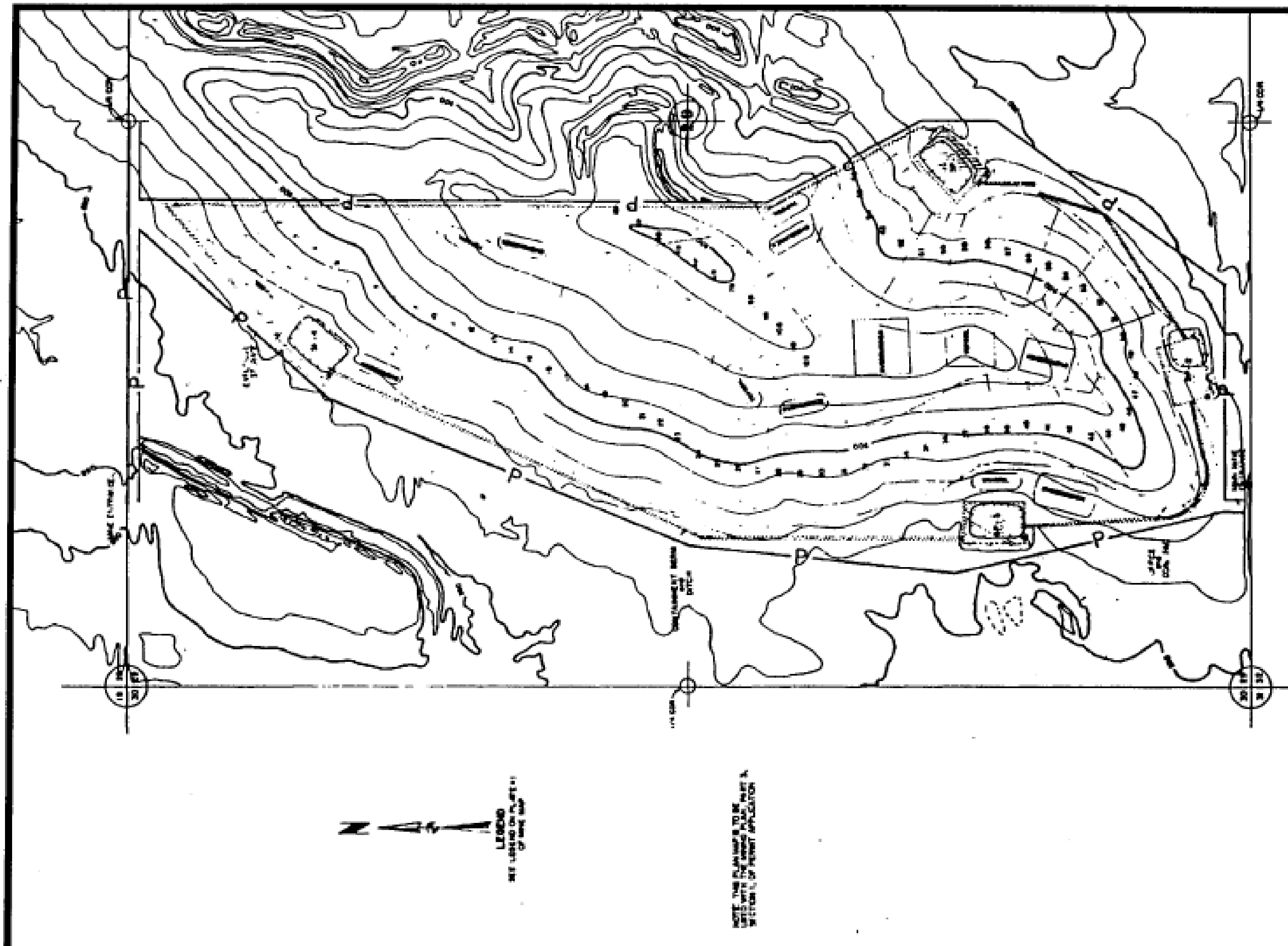


PLATE # 7

Figure B-5

BOND AMOUNT COMPUTATION

Applicant:

HAUL BACK EXAMPLE- AREA

Permit Number: P-123   Permitted Acreage: 623

Bonding Scheme (permit area, incremental, cumulative):   permit area

If Incremental:
  Increment Number: _____
  Increment Acreage: _____

If Cumulative:
  Acres previously authorized for disturbance: _______
  New acres proposed for disturbance: _______

Type of Operation:	Area-Type, Truck and Shovel Haulback Surface Mine
Location:	Midwestern U.S.
Prepared by:	P.T. Bond
Date:	9/24/2020
Total Bond Amount:	$ 2,266,703

WORKSHEET 1: DESCRIPTION OF THE WORST-CASE RECLAMATION SCENARIO

Reclamation requires the following tasks:
This mine typifies a mid-sized operation in the North Central U.S. Mining begins in the SE corner of the mining area with the box cut shown on Worksheet 4B-3. The operation then progresses in a general northwest direction gradually re-orienting the pit toward the planned final pit location immediately southeast of a county road. The worst case occurs wherever there is:

1) the greatest disturbance of prime farmland,
2) the largest open pit,
3) stream reconstruction is required, and
4) the largest acreage of revegetation.

This location is in the northwestern part of the mining area where two seams are being extracted (No. 5 and No. 6). At this point, the pit will be about 1,600 ft. long; overburden is 32 ft. of loess overlying 11 ft. of bedrock above the 4-foot-thick No. 6 seam. The interburden here averages 24 ft. above the 4.5-foot-thick No.5 seam to yield a highwall of 81.5 ft. bedrock material is primarily shale. Re-grading the highwall and spoil stockpile from 1.5:1 to 3:1 to a depth of 4 ft. below the design pool elevation (490 ft.) is required to create the final pit impoundment.

Although a significant amount of the rooting media is to be replaced as prime farmland soils the vegetation is to be re-established as a grassland cover crop with tree planting along a reconstructed stream channel.

Assumptions:
Backfilling requirements are minimal due to the contemporaneous haulback mining technique and the plan for a final pit impoundment. Backfill material will be derived from:

1) the box cut stockpile
2) removal of acid-forming material (AFM) in the coal stockpile pad,
3) material excavated from two haul roads, and
4) sediment from a permanent impoundment near the coal stockpile (AFM).

Ripping is required prior to scraper excavation of the coal stockpile and haul roads. Deep ripping is also required on all prime soil replacement areas to remove compaction.

Worksheets 4B-2 and 4B-3 are the applicable mine operation and reclamation plan maps, respectively (Data Source: Permit P-123).

Data Sources:
Permit: P-123.
Caterpillar Performance Handbook, Edition 48.
OSM Handbook for Calculation of Reclamation Bond Amounts, Revised 2020.

WORKSHEET 2: STRUCTURE DEMOLITION AND DISPOSAL COSTS

Structures to be Demolished:

Item	Construction Material	Volume (cubic feet)	Unit Cost Basis ($)	Demolition Cost ($)
Cost Subtotal				

Other items to be demolished (paved roads, conveyors, utility poles, rail spurs, etc.):

Remove two trailers @ $500.00 each.

Cost Subtotal = $ 1,000

Debris Handling and Disposal Costs:

Removal of trash and derelict equipment, Lump Sum

Miscellaneous scrap equipment removal = $4,000.
Cost Subtotal = $ 4,000

TOTAL DEMOLITION AND DISPOSAL COST = $ 5,000

Data Sources:
Permit P-123

WORKSHEET 3A: MATERIAL HANDLING PLAN SUMMARY

Earthmoving Activity	Volume (LCY)	Origin	Destination	Haul Distance (ft.)	Grade* (%)	Equipment To Be Used
Highwall, backfill regrade (5A)	54,953	Top of Bench	Bottom of bench	66	-20	D9T-SU
Rip haul roads (7A)	8,320	Roadway	Roadway	300' pass	0	D10T-SU-MS*
LHD* roadbed material (11B-1)	30,720	Roadway	Backfill bench	2,900	0	637K NPP*
Rip facilities/coal stockpile (7B)	38,720	Facilities/coal stockpile area	Facilities/coal stockpile area	300' pass	0	D10T-SU-MS*
LHD facilities/coal stockpile (11B2)	46,464	Facilities/coal stockpile area	Backfill bench	4,700	5	637K NPP**
Cleanout Sed. Pond 002 (8A/9A)	3,525	Sed. Pond 002	Backfill bench	4,700	5	980K/740C
LHD* stockpile backfill (8B/9B)	20,690	Boxcut Spoil Area	Backfill bench	6,400	5	980K/740C
Regrade ditches (5B)	22,289	Ditch area	Ditch	50	-10	D7R-SU LGP**
Rough grading (5C)	35,409	Pre-strip area	Pre-strip area	50	-10	D7R-SU LGP**
Final grading (6A)	237.53 ac.	Reclaimed area	Reclaimed area	300' pass	0	D7R-SU LGP**
Replace prime soils (11B-3)	1,447,354	Prime soil stockpiles	Final pit area	1,400	0	637K NPP**
Replace non-prime soils (11B-4)	65,334	Non-prime soil stockpiles	Facilities area/roads	600	0	637K NPP**
Rip prime area (7C)	753,830	Mine Re-soil area	Mine Re-soil area	300' pass	0	D10T-SU-MS**

** NPP = non-push pull variant, LGP = low-ground pressure variant, MS = multi-shank ripper.

Data Sources: Permit P-123,

Caterpillar Performance Handbook, Edition 48.

WORKSHEET 3B: MATERIAL HANDLING PLAN SUMMARY

Earthmoving Activity	Volume (LCY)	Origin	Destination	Haul Distance (ft.)	Grade* (%)	Equipment To Be Used
Re-construct Stream (5D)	33,754	Stream bed area	Stream Area	50	-10	D7R-SU LGP**
Re-construct Stream (11B-5)	168,786	Stream bed area	Final pit area	1,600	10	637K NPP**
Maintain Haul Roads (12A)	NA	Roadways	Roadways	Match to fleet	--	14M w/scarifier
Support 980 Loader (5E)	3,525	Pond 002	Pond 002 area	100	20	D7R LGP**
Support 980 Loader (5F)	170,987	Stockpile	Stockpile	50	-20	D10T SU
Scraper push tractor (5G)	NA	Cut areas	Cut areas	Match to fleet	--	D10T S
Maintain Haul Roads (13)	NA	Roadways	Roadways	Match to fleet	--	2,500 Gal/ On Highway Water Tanker

* Record grade resistance here. Calculate total resistance on applicable equipment worksheets. Total Resistance = Grade Resistance + Rolling Resistance.

** NPP = non-push pull variant, LGP = low-ground pressure variant.

Data Sources: Permit P-123
Caterpillar Performance Handbook, Edition 48.

WORKSHEET 4A: EARTHWORK QUANTITY

Cross-Section/ Station	Distance Between Stations (ft.)	End Area (ft^2)	Volume (BCY)	Adjust-ment Factor * (%)	Adjusted Volume (LCY)
S. H.W. Backfill Area		363			
	3,400		45,711	20	**54,853**
N. H.W. Backfill Area		363			
E. HR 1 Excavation Area		108			
	1,600		6,400	20	7,680
W. HR 1 Excavation Area		108			
E. HR 2 Excavation Area		108			
	4,800		19,200	20	23,040
W. HR 2 Excavation Area		108			
E. Spoil Stockpile		1,603			
	2,400		142,489	20	**170,987**
W. Spoil Stockpile		1,603			
S. Spoil Bench Backfill		7,658			
	866		245,623	10	270,186
N. Spoil Bench Backfill		7,658			
Stream Channel Area A		680			
	7,477		146,771	15	**168,786**
Stream Channel Area B		380			
Diversion Ditch Area A		208.5			
	7,375		**56,951**	**10**	**62,647**
Diversion Ditch Area B		208.5			
TOTALS					

* See material volume estimate discussion in the Handbook; the average end area method is used here.

Note: See Worksheet 4B-3 for applicable drawings.

Data Source: Permit P-123

WORKSHEET 4B-1: EARTHWORK QUANTITY

Fill Open Pit:

Misc. Earthwork	Volume	Volume	Swell (%)	LCY
Pond 002 Sediment	1.9 Ac.-Ft	3,065 CF	15 %	3,525

	Cross-section area	Length	Volume	Swell	LCY
Diversion Ditch Grading	68 SF X	7,375 Ft	18,574 BCY	20 %	**22,289**

Coal Processing Area (CPA):	Area	Depth	Volume	Volume	Swell (%)	LCY
Coal Stock. Pre-AFM Removal	2.4 Ac	3.0 Ft	7.2 Ac.-Ft	11,616 BCY	20 %	13,939
Facilites Area Pre-AFM Removal	16.8 Ac	1.0 Ft	16.8 Ac.-Ft	27,104 BCY	20 %	32,525
Total	19.2		Ripping Total =	**38,720** BCY		**46,464**
Ripping of CPA and roadways*:	Area	Depth	Volume	Volume	Swell (%)	BCY
Roadway Volume:	8.3 Ac	2.0 Ft	16.6 Ac.-Ft	26,781 BCY		
Total Ripping Volume:	27.5 Ac	2.0 Ft	55 Ac.-Ft	**88,733** BCY		

Rough grade Pre-strip Areas:	Area	Depth	Volume	Volume	Swell (%)	LCY
Grading Volume:	18.29 Ac	1.0 Ft	18.29 Ac.-Ft	29,508 BCY	20 %	**35,409**

Soil Volumes (top-and sub-soil) - Prime:

	Area	Depth	Volume	Volume	Swell (%)	LCY
Soil Volume (Haul) =	186.9 Ac	4.0 Ft	747.6 Ac.-Ft	1,206,128 BCY	20 %	**1,447,354**
Ripping Volume	186.9 Ac	2.5 Ft	467.25 Ac.-Ft	**753,830** BCY		

Soil Volumes (top-and sub-soil) - Non-Prim

	Area	Depth	Volume	Volume	Swell (%)	LCY
Soil Volume (non-prime)	50.62 Ac	0.667 Ft	33.764 Ac.-Ft	54,472 BCY	20 %	**65,366**
Ripping Volume	50.62 Ac	2.0 Ft	101.24 Ac.-Ft	**163,334** BCY		

* Ripping Roadways 2' to remove Compaction, Second ripping of CPA Area to prepare for resoiling and vegetation.

Roadway Rip Tot. = 25,600 BCY
Roadway Haul Total = 30,720 LCY

Spoil Balance

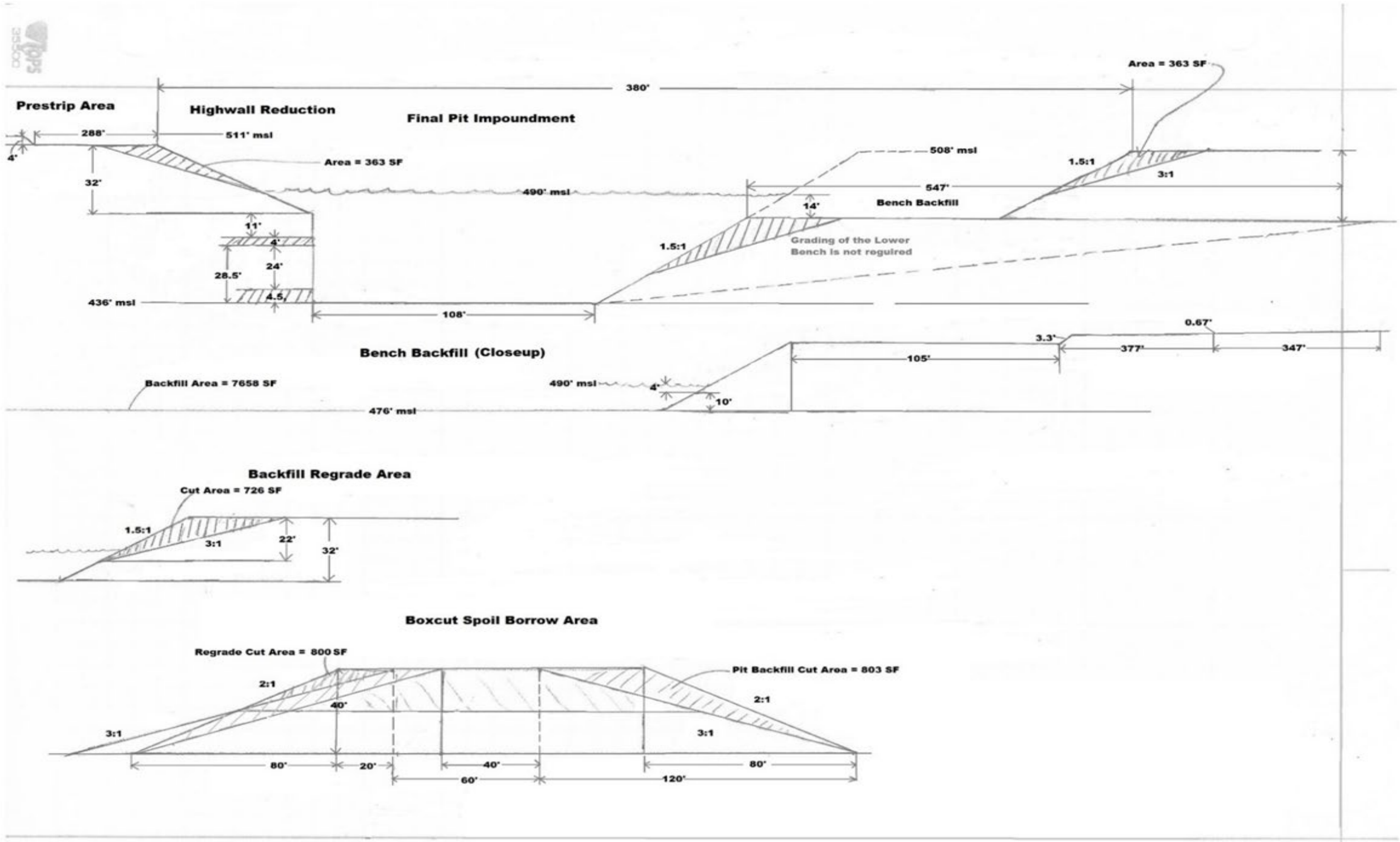
Backfill Needed:	**270,186 CY**
Stream Reconstruct.	**-168,786 CY**
AFM	**-46,464 CY**
Pond 002 Sediment	**-3,525 CY**
Road Base Material	**-30,720 CY**
Remainder (Box cut Spoil)	**20,690 CY**

Note: See Worksheet 4B-3 for applicable drawings.

Data Source: Permit P-123

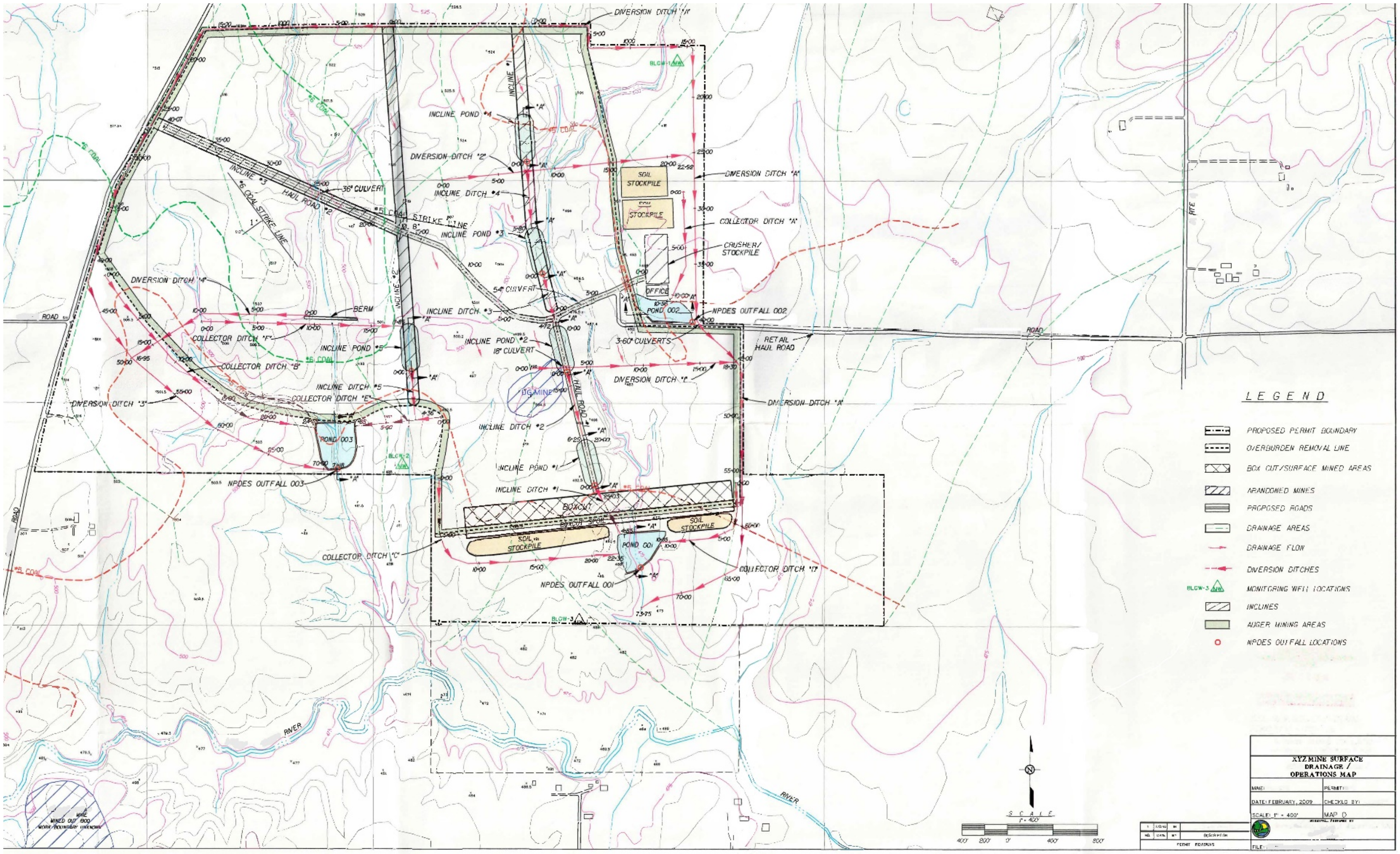
WORKSHEET 4B-2: EARTHWORK QUANTITY

In reference to Worksheet 4A and 4B-1

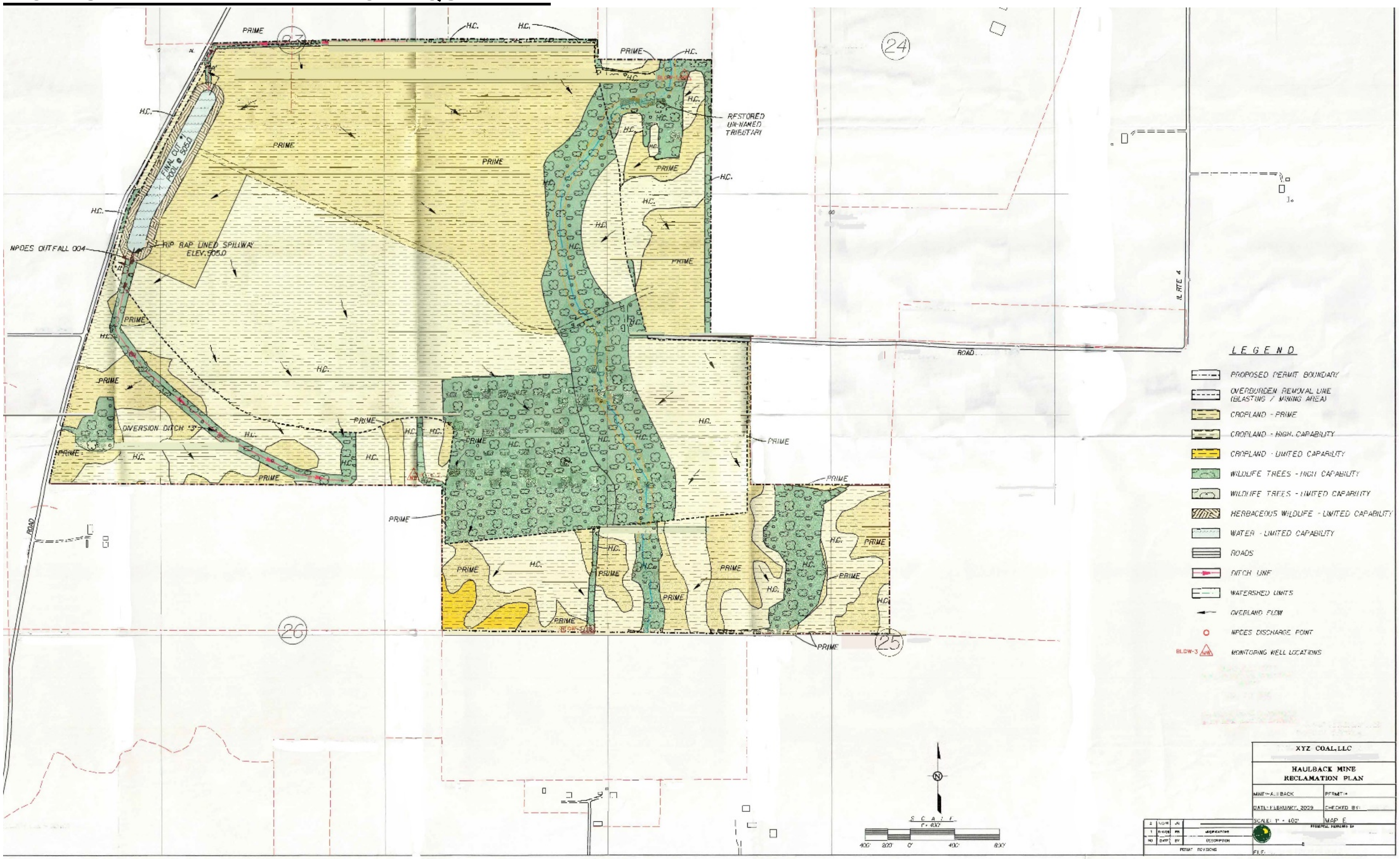


<u>Data Source</u>: Permit P-123

WORKSHEET 4B-3 - EARTHWORK QUANTITY



WORKSHEET 4B-4 - EARTHWORK QUANTITY



WORKSHEET 5A: PRODUCTIVITY AND HOURS REQUIRED FOR DOZER USE

Earthmoving Activity:
Regrade HW and Spoil Bench to 3:1 to 4 ft. below the final cut lake's pool level (505 ft.)

Characterization of Dozer Used (type, size, etc.):
D9T – SU

Description of Dozer Use (origin, destination, grade, haul distance, material, etc.):

Volume (LCY):	Density (lb./LCY):	Distance (ft.):	Grade (%):
54,953	2,100	66	-20

Productivity Calculations:

Operating Adjustment Factor = 0.75 (operator factor) x 0.80 (material factor) x 0.83 (efficiency factor) x 1.40 (grade factor)

x 2,300/2,100 (weight correction factor) x 1.10 (production method/blade factor) x 1.00 (visibility factor) x 1.00 (elevation factor) = 0.84.

Net Hourly Production = 1,300 (normal hourly production) LCY/hr. x 0.84 (operating adjustment factor) = 1,096 LCY/hr.

Hours Required = 54,953 (volume to be moved) LCY ÷ 1,096 (net hourly production) LCY/hr. = 50.1 hrs.

Use: 51 hrs.

Data Sources:
Permit P-123
Caterpillar Performance Handbook, Edition 48.

WORKSHEET 5B: PRODUCTIVITY AND HOURS REQUIRED FOR DOZER USE

Earthmoving Activity:
Regrade Ditches

Characterization of Dozer Used (type, size, etc.):
D7R – SU LGP

Description of Dozer Use (origin, destination, grade, haul distance, material, etc.):

Volume (LCY):	Density (lb./LCY):	Distance (ft.):	Grade (%):
22,289	2,300	50	-10

Productivity Calculations:

Operating Adjustment Factor = 0.75 (operator factor) x 0.80 (material factor) x 0.83 (efficiency factor) x 1.20 (grade factor)

x 2,300/2,300 (weight correction factor) x 1.00 (production method/blade factor) x 1.00 (visibility factor) x 1.00 (elevation factor) = 0.60 .

Net Hourly Production = 850 (normal hourly production) LCY/hr. x 0.60 (operating adjustment factor) = 510 LCY/hr.

Hours Required = 22,289 (volume to be moved) LCY ÷ 510 (net hourly production) LCY/hr. = 43.7 hrs.

Use: 44 hrs.

Data Sources:
Permit P-123
Caterpillar Performance Handbook, Edition 48

WORKSHEET 5C: PRODUCTIVITY AND HOURS REQUIRED FOR DOZER USE

Earthmoving Activity:
Regrade Pre-strip Area

Characterization of Dozer Used (type, size, etc.):
D7R – SU LGP

Description of Dozer Use (origin, destination, grade, haul distance, material, etc.):

Volume (LCY):	Density (lb./LCY):	Distance (ft.):	Grade (%):
35,408	2,300	50	-10

Productivity Calculations:

Operating Adjustment Factor = 0.75 (operator factor) x 0.80 (material factor) x 0.83 (efficiency factor) x 1.20 (grade factor)

x 2,300/2,300 (weight correction factor) x 1.00 (production method/blade factor) x 1.00 (visibility factor) x 1.00 (elevation factor) = 0.60.

Net Hourly Production = 850 (normal hourly production) LCY/hr. x 0.60 (operating adjustment factor) = 510 LCY/hr.

Hours Required = 35,408 (volume to be moved) LCY ÷ 510 (net hourly production) LCY/hr. = 69.4 hrs.

Use: 70 hrs.

Data Sources:
Permit P-123
Caterpillar Performance Handbook, Edition 48

WORKSHEET 5D: PRODUCTIVITY AND HOURS REQUIRED FOR DOZER USE

Earthmoving Activity:
Excavate Reconstructed Stream Channel

Characterization of Dozer Used (type, size, etc.):
D7R – SU LGP

Description of Dozer Use (origin, destination, grade, haul distance, material, etc.):

Volume (LCY):	Density (lb./LCY):	Distance (ft.):	Grade (%):
33,754*	2,300	50	-10

Productivity Calculations:

Operating Adjustment Factor = 0.75 (operator factor) x 0.80 (material factor) x 0.83 (efficiency factor) x 1.20 (grade factor)

x 2,300/2,300 (weight correction factor) x 1.00 (production method/blade factor) x 1.00 (visibility factor) x 1.00 (elevation factor) = 0.60 .

Net Hourly Production = 1,050 (normal hourly production) LCY/hr. x 0.60 (operating adjustment factor) = 510 LCY/hr.

Hours Required = 33,754 (volume to be moved) LCY ÷ 510 (net hourly production) LCY/hr. = 66.2 hrs.

Use: 67 hrs.

*This is a support dozer--20% of material hauled by scrapers during stream reconstruction rehandled by D7R dozer,

Data Sources:
Permit P-123
Caterpillar Performance Handbook, Edition 48

WORKSHEET 5E: PRODUCTIVITY AND HOURS REQUIRED FOR DOZER USE

Earthmoving Activity:
Support to loader at Pond 002; excavate sediment and stack for dewatering at pond perimeter.

Characterization of Dozer Used (type, size, etc.):
D7R-SU LGP

Description of Dozer Use (origin, destination, grade, haul distance, material, etc.):

Volume (LCY):	Density (lb./LCY):	Distance (ft.):	Grade (%):
3,525	2300	100	20

Productivity Calculations:

Operating Adjustment Factor = 0.75 (operator factor) x 0.80 (material factor) x 0.83 (efficiency factor) x 0.60 (grade factor)

x 2300/2300 (weight correction factor) x 1.0 (production method/blade factor) x 1.00 (visibility factor) x 1.00 (elevation factor) = 0.30.

Net Hourly Production = 525 (normal hourly production) LCY/hr. x 0.30 (operating adjustment factor) = 158 LCY/hr.

Hours Required = 3,525 (volume to be moved) LCY ÷ 158 (net hourly production) LCY/hr. = 22.4 hrs.

Use: 23 hrs.

Data Sources:
Permit P-123
Caterpillar Performance Handbook, Edition 48

WORKSHEET 5F: PRODUCTIVITY AND HOURS REQUIRED FOR DOZER USE

Earthmoving Activity:
Regrade slope of Box cut Spoil Stockpile and support (trap) to loader.

Characterization of Dozer Used (type, size, etc.):
D9T - SU

Description of Dozer Use (origin, destination, grade, haul distance, material, etc.):

Volume (LCY):	Density (lb./LCY):	Distance (ft.):	Grade (%):
170,986	2,300	100	-20

Productivity Calculations:

Operating Adjustment Factor = 0.75 (operator factor) x 0.80 (material factor) x 0.83 (efficiency factor) x 1.40 (grade factor)

x 2300/2300 (weight correction factor) x 1.10 (production method/blade factor) x 1.00 (visibility factor) x 1.00 (elevation factor) = 0.77.

Net Hourly Production = 1,100 (normal hourly production) LCY/hr. x 0.77 (operating adjustment factor) = 847 LCY/hr.

Hours Required = 170,986 (volume to be moved) LCY ÷ 847 (net hourly production) LCY/hr. = 201.9 hrs.

Use: 202 hrs.

Data Sources:
Permit P-123
Caterpillar Performance Handbook, Edition 48

WORKSHEET 5G: PRODUCTIVITY AND HOURS REQUIRED FOR DOZER USE

Earthmoving Activity:
Serve as push tractor for 627K scrapers match (time calculations on scraper worksheets).

Characterization of Dozer Used (type, size, etc.):
D9T - SU

Description of Dozer Use (origin, destination, grade, haul distance, material, etc.):
Volume (LCY): Density (lb./LCY): Distance (ft.): Grade (%):

Match to total scraper team hours; for one task two push tractors support six scrapers.

Productivity Calculations:

Operating Adjustment Factor = 0.75 (operator factor) x 0.80 (material factor) x 0.83 (efficiency factor) x 1.00 (grade factor)

x 2,300/2,300 (weight correction factor) x 1.00 (production method/blade factor) x 1.00 (visibility factor) x 1.00 (elevation factor) = N/A

Net Hourly Production = ______ LCY/hr. (normal hourly production) x ______ (operating adjustment factor) = ______ LCY/hr.

Hours Required = ______ LCY (volume to be moved) ÷ ______ LCY/hr (net hourly production) = ______ hrs.

Use: 641 hrs.

Data Sources:
Permit P-123
Caterpillar Performance Handbook, Edition 48

WORKSHEET 6: PRODUCTIVITY AND HOURS REQUIRED FOR DOZER USE--GRADING

Earthmoving Activity:
Final Grading of Reclaimed Area

Characterization of Dozer Used (type, size, etc.):
Dozer Grading Model: D7R-SU

Description of Dozer Use (% grade, effective blade width, operating speed, etc.):
Area (ac.): 237.5 Grade (%): 0 Average Speed (MPH): 4 Effective Blade Width (Ft): 14.9
Density (lb./LCY): 2,300

Productivity Calculations:

Operating Adjustment Factor = 0.75 (operator factor) x 0.80 (material factor) x 0.83 (efficiency factor) x 1.00 (grade factor)

x 1.00 (weight correction factor) x 1.00 (production method/blade factor) x 1.00 (visibility factor) x 1.00 (elevation factor) = 0.50

Hourly Production = 4.0 (average speed) mi/hr. x 14.9 (effective blade width) ft. x 5,280 ft./mi x 1 ac/43,560 sq. ft.

= 7.2 ac/hr.

Net Hourly Production = 7.2 (hourly production) ac/hr. x 0.5 (operating adjustment factor) = 3.6 ac/hr.

Hours Required = 237.5 (area to be graded) ac ÷ 3.6 (net hourly production) ac/hr. = 65.8 hrs.

Use: 66 hrs.

Data Sources:
Permit P-123
Caterpillar Performance Handbook, Edition 48

WORKSHEET 7A: PRODUCTIVITY AND HOURS REQUIRED FOR RIPPER-EQUIPPED DOZER USE

Ripping Activity:
Rip haul roads to remove compaction prior to excavation

Characterization of Dozer and Ripper Use:
Dozer with Ripper: D10T-SU MS (3-shanks)

Description of Ripping (ripping depth, cut spacing, cut length, and material to be ripped):
BCY: 25,600 Cut Spacing (ft.): 12.75 Cut Length (ft.): 300 Tool Penetration (ft.): 2.0

Productivity Calculation:

Cycle Time = (300 ft. ÷ 88 ft./min) + 0.25 min = 3.7 min/pass.
cut length speed fixed turn time *

Passes/Hour = 60 min/hr. ÷ 3.7 min/pass x 0.83 = 13.66 passes/hr.
cycle time efficiency factor

Volume Cut/Pass = (2.0 ft. x 12.75 ft. x 300 ft.) □ 27 cu ft./cu yd.
tool penetration cut spacing cut length

= 283 BCY/pass.

Hourly Production = 283 BCY/pass x 13.66 passes/hr. = 3,871.6 BCY/hr. **

Hours Required = 25,600 BCY ÷ 3,871.6 BCY/hr. = 6.6 hrs. **
bank volume to be ripped hourly production Use: 7 hrs.

* *Fixed turn time depends upon dozer used. 0.25 min/turn is normal.*

** *Remember to use the swell factor to convert from bank cubic yards to loose cubic yards when applying these data to Worksheet No. 5. Calculate separate dozer hauling of ripped material for each lift on that worksheet.*

Data Sources:
Permit P-123
N 48Caterpillar Performance Handbook, Edition 48

WORKSHEET 7B: PRODUCTIVITY AND HOURS REQUIRED FOR RIPPER-EQUIPPED DOZER USE

Ripping Activity:
Rip haul roads to remove compaction prior to excavation

Characterization of Dozer and Ripper Use:
Dozer with Ripper: D10T-SU MS (3-shanks)

Description of Ripping (ripping depth, cut spacing, cut length, and material to be ripped):

BCY: 38,720   Cut Spacing (ft.): 12.75   Cut Length (ft.): 300   tool penetration (ft.): 2.0

Productivity Calculation:

Cycle Time = (300 ft. ÷ 88 ft./min.) + 0.25 min. = 3.7 min/pass.
(cut length) ([speed]) (fixed turn time *)

Passes/Hour = 60 min/hr. ÷ 3.7 min./pass x 0.83 = 13.66 passes/hr.
(cycle time) (efficiency factor)

Volume Cut/Pass = (2.0 ft. x 12.75 ft. x 300 ft.) ÷ 27 cu ft./cu yd.
(tool penetration) (cut spacing) (cut length)

= 283 BCY/pass.

Hourly Production = 283 BCY/pass x 13.66 passes/hr. = 3871.6 BCY/hr. **

Hours Required = 38,720 BCY ÷ 3871.6 BCY/hr. = 10.0 hrs. **
(bank volume to be ripped) (hourly production) Use: 11 hr.

* *Fixed turn time depends upon dozer used. 0.25 min/turn is normal.*

** *Remember to use the swell factor to convert from bank cubic yards to loose cubic yards when applying these data to Worksheet No. 5. Calculate separate dozer hauling of ripped material for each lift on that worksheet.*

Data Sources:
Permit P-123
Caterpillar Performance Handbook, Edition 48

WORKSHEET 7C: PRODUCTIVITY AND HOURS REQUIRED FOR RIPPER-EQUIPPED DOZER USE

Ripping Activity:
Rip Prime Topsoil Replacement Areas to remove compaction

Characterization of Dozer and Ripper Use:
Dozer with Ripper: D10T-SU MS (3-shanks)

Description of Ripping (ripping depth, cut spacing, cut length, and material to be ripped):
BCY: **753,830** Cut Spacing (ft.): **12.75** Cut Length (ft.): **300** tool penetration (ft.): **2.5**

Productivity Calculation:

Cycle Time = (300 ft. ÷ 88 ft. /min) + 0.25 min = 3.7 min/pass.
(cut length) [speed] (fixed turn time *)

Passes/Hour = 60 min/hr. ÷ 3.7 min/pass x 0.83 = 13.66 passes/hr.
(cycle time) (efficiency factor)

Volume Cut/Pass = (2.5 ft. x 12.75 ft. x 300 ft.) □ 27 cu ft./cu yd.
(tool penetration) (cut spacing) (cut length)

= 354 BCY/pass.

Hourly Production = 354 BCY/pass x 13.66 passes/hr. = 4,839.5 BCY/hr. **

Hours Required = 753,830 BCY ÷ 4,839.5 BCY/hr. = 155.8 hrs. **
(bank volume to be ripped) (hourly production) Use: 156 hrs.

* *Fixed turn time depends upon dozer used. 0.25 min/turn is normal.*

** *Remember to use the swell factor to convert from bank cubic yards to loose cubic yards when applying these data to Worksheet No. 5. Calculate separate dozer hauling of ripped material for each lift on that worksheet.*

Data Sources:
Permit P-123
Caterpillar Performance Handbook, Edition 48

WORKSHEET 7D: PRODUCTIVITY AND HOURS REQUIRED FOR RIPPER-EQUIPPED DOZER USE

Ripping Activity:
Rip Non-Prime Topsoil Replacement Areas to remove compaction

Characterization of Dozer and Ripper Use:
Dozer with Ripper: D10T-SU MS (3-shanks)

Description of Ripping (ripping depth, cut spacing, cut length, and material to be ripped):
BCY: **163,334** Cut Spacing (ft.): **12.75** Cut Length (ft.): **300** tool penetration (ft.): **2.5**

Productivity Calculation:

Cycle Time = (300 ft. ÷ 88 ft. /min) + 0.25 min = 3.7 min/pass.
(300 = cut length; 88 ft./min = [speed]; 0.25 = fixed turn time *)

Passes/Hour = 60 min/hr. ÷ 3.7 min/pass x 0.83 = 13.66 passes/hr.
(3.7 = cycle time; 0.83 = efficiency factor)

Volume Cut/Pass = (2.5 ft. x 12.75 ft. x 300 ft.) □ 27 cu ft./cu yd.
(2.5 = tool penetration; 12.75 = cut spacing; 300 = cut length)

= 354 BCY/pass.

Hourly Production = 354 BCY/pass x 13.66 passes/hr. = 4,839.5 BCY/hr. **

Hours Required = 163,334 BCY ÷ 4,839.5 BCY/hr. = 33.4 hrs. **
(163,334 = bank volume to be ripped; 4,839.5 = hourly production)

Use: 34 hrs.

* *Fixed turn time depends upon dozer used. 0.25 min/turn is normal.*

** *Remember to use the swell factor to convert from bank cubic yards to loose cubic yards when applying these data to Worksheet No. 5. Calculate separate dozer hauling of ripped material for each lift on that worksheet.*

Data Sources:
Permit P-123
Caterpillar Performance Handbook, Edition 48

WORKSHEET 8A: PRODUCTIVITY AND HOURS REQUIRED FOR LOADER USE

Earthmoving Activity:
Cleanout Pond 002 of AFM

Characterization of Loader Use (type, size, etc.):
Loader Model: Cat 980-K Heaped 7.06 CY, struck 6.54 CY, (avg. = 6.8 CY), dump clearance = 10.67 ft.

Description of Loader Use (origin, destination, grade, haul distance, etc.):
Load sediment/coal fines piled by LGP dozer and dried, load 40-ton ADT trucks.

Quantity:
3,525 CY

Productivity Calculations:

Cycle time = 0 min (haul time (loaded)) + 0 min (return time (empty)) + 0.55 min (basic cycle time) = 0.55 min.

Net Bucket Capacity = 6.8 LCY (heaped bucket capacity) x 0.90 (bucket fill factor *) = 6.12 LCY.

Hourly Production = 6.12 LCY (net bucket capacity) ÷ 0.55 min (cycle time) x 0.83 (efficiency factor) x 60 min/hr. = 556 LCY/hr.

Hours Required = 3,525 LCY (volume to be moved) ÷ 556 LCY/hr. (hourly production) = 6.3 hrs.
Use: 7 hrs.

** See loader section of equipment manual.*

Data Sources:
Permit P-123
Caterpillar Performance Handbook, Edition 48.

WORKSHEET 8B: PRODUCTIVITY AND HOURS REQUIRED FOR LOADER USE

Earthmoving Activity:
Load mine bench backfill at box cut spoil stockpile;

Characterization of Loader Use (type, size, etc.):
Loader Model: Cat 980-K Heaped 7.06 CY, struck 6.54 CY, (avg. = 6.8 CY), dump clearance = 10.67 ft.

Description of Loader Use (origin, destination, grade, haul distance, etc.):
Load weathered spoil/loess trapped by dozer, load 40-ton ADT trucks.

Quantity:
20,690 CY

Productivity Calculations:

Cycle time = 0 (haul time (loaded)) min + 0 (return time (empty)) min. + 0.55 (basic cycle time) min. = 0.55 min.

Net Bucket Capacity = 6.8 (heaped bucket capacity) LCY x 0.90 (bucket fill factor *) = 6.12 LCY.

Hourly Production = 6.12 (net bucket capacity) LCY ÷ 0.55 (cycle time) min x 0.83 (efficiency factor) x 60 min/hr. = 556 LCY/hr.

Hours Required = 20,690 (volume to be moved) LCY ÷ 556 (hourly production) LCY/hr. = 37.2 hrs.

Use: 38.0 hrs.

* See loader section of equipment manual.

Data Sources:
Permit P-123
Caterpillar Performance Handbook, Edition 48.

WORKSHEET 9A: PRODUCTIVITY AND HOURS REQUIRED FOR TRUCK USE

Earthmoving Activity: Haul dried sediment/coal fines from Pond 002 to final cut

Characterization of Truck Use (type, size, etc.):
Truck Model: 740C ADT Struck = 23.5 CY, Heaped = 30.1 CY, Avg. = 26.8 CY,
Load height = 9.8 ft.

Description of Truck Use (origin, destination, grade, haul distance, capacity, etc.):
40-ton ADT trucks. Density (lb./LCY): 2,300; Distance (ft.): 4,700; Grade (%): 5; Rolling resistance (%): 5%

Quantity:
3,525 CY   Total Resistance (%): 10%

Productivity Calculations:

No. Loader Passes/Truck = 26.8 LCY (truck capacity *) ÷ 6.12 LCY (loader bucket net capacity) = 4.38 passes. (round down to nearest whole number; reduces net truck capacity and weight accordingly, in calculations below)

Loading Time/Truck = 0.55 min. (loader cycle time (from *Worksheet 8* or *10*)) x 4.0 (no. loader passes/truck) = 2.20 min.

Truck Cycle Time = 2.7 min. (haul time) + 1.59 min. (return time) + 2.20 min. (loading time) + 1.8 min (dump and maneuver time) = 8.26 min.

No. Trucks Required = 8.26 min. (truck cycle time) ÷ 2.20 min. (total loading time) = 3.75 trucks.

Production Rate = 24.48 LCY (net truck capacity **) x 4 (no. trucks) ÷ 8.26 min. (truck cycle time) = 11.9 LCY/min.

Hourly Production = 11.9 (production rate) LCY/min x 60 min/hr. x 0.83 (efficiency factor) = 592.7 LCY/hr.

Hours Required = 3,525 LCY (volume to be moved) ÷ 592.7 LCY/hr. (hourly production) = 6.0 hr.

Use whichever is higher from Worksheets 8 & 9 = 7.0 hrs.

* *Use the average of the heaped and struck capacities.*
** *Net truck capacity = loader bucket net capacity x no. loader passes/truck.*

Data Sources:
Permit P-123
Caterpillar Performance Handbook, Edition 48.

WORKSHEET 9B: PRODUCTIVITY AND HOURS REQUIRED FOR TRUCK USE

Earthmoving Activity: Haul dried sediment/coal fines from Pond 002 to final cut

Characterization of Truck Use (type, size, etc.):
Truck Model: 740C ADT Struck = 23.5 CY, Heaped = 30.1 CY, Avg. = 26.8 CY,
Load height = 9.8 ft.

Description of Truck Use (origin, destination, grade, haul distance, capacity, etc.):
40-ton ADT trucks. Density (lb./LCY): 2,300; Distance (ft.): 4,700; Grade (%): 5; Rolling resistance (%): 5%

Quantity:
20,690 CY Total Resistance (%): 10%

Productivity Calculations:

No. Loader Passes/Truck = 26.8 (truck capacity *) LCY ÷ 6.12 (loader bucket net capacity) LCY = 4.38 passes. (round down to nearest whole number; reduces net truck number; capacity and weight accordingly, in calculations below)

Loading Time/Truck = 0.55 (loader cycle time (from *Worksheet 8* or *10*)) min. x 4.0 (no. loader passes/truck) = 2.20 min.

Truck Cycle Time = 2.7 (haul time) min. + 1.59 (return time) min. + 2.20 (loading time) min. + 1.8 (dump and maneuver time) min = 8.26 min.

No. Trucks Required = 8.26 (truck cycle time) min. ÷ 2.20 (total loading time) min. = 3.75 trucks.

Production Rate = 24.48 (net truck capacity **) LCY x 4 (no. trucks) ÷ 8.26 (truck cycle time) min. = 11.9 LCY/min.

Hourly Production = 11.9 (production rate) LCY/min x 60 min/hr. x 0.83 (efficiency factor) = 592.7 LCY/hr.

Hours Required = 20,690 (volume to be moved) LCY ÷ 592.7 (hourly production) LCY/hr. = 35.0 hr.

Use whichever is higher from Worksheets 8 & 9 = 85.0 hrs.

* *Use the average of the* *__heaped__* *and* *__struck__* *capacities.*
** *Net truck capacity = loader bucket net capacity x no. loader passes/truck.*

Data Sources:
Permit P-123
Caterpillar Performance Handbook, Edition 48.

WORKSHEET 11B-1: PRODUCTIVITY OF DOZER PUSH-LOADED SCRAPER USE

Earthmoving Activity: LHD road base material (pre-ripped)

Characterization of Scraper Used (type, capacity, etc.).
List Pusher Tractor(s) Used:
Scraper Model: 637K NPP (Non-Push-Pull) with one D10T-S
D10T Push Tractor with Cushion Blade

Description of Scraper Use (origin, destination, grade, haul distance, capacity, etc.):
Haul Distance = 2900 LF; 5% Roll Resistance; Rock (ripped); 41 CY struck, 50 CY heaped, avg. = 45.5 CY; 33.5 MPH = max. speed.
Haul = 20 MPH X 88 FPM/MPH = 1,760 FPM   2,900 LF/1,760 FPM = **1.65 minutes.**
Return = 33.5 MPH X 88 FPM/MPH = 2,948 FPM   2,900 LF/2,948 FPM = **0.98 mins.**

Describe Push Tractor Loading Method (see figure on next page):
Volume Hauled = **30,720** LCY   Back-Track Loading Method: push factor = **1.5**

Scraper Productivity Calculations:

Cycle Time = 0.5 min. + 1.65 min. + 0.60 min. + 0.98 min. = 3.73 min.
(0.5 = load time (push-pull is per pair); 1.65 = loaded trip time; 0.60 = maneuver and spread time; 0.98 = return trip time)

Hourly Production = 45.5 LCY x 60 min./hr. ÷ 3.73 min. X 0.83 = 609.7 LCY/hr.
(45.5 = capacity *; 3.73 = cycle time; 0.83 = efficiency factor)

Hours Required = 30,700 LCY ÷ 609.7 LCY/hr. = 50.38 hrs.
(30,700 = volume to be handled; 609.7 = hourly production)
Use 13 hrs. for a fleet of 4

Push Tractor Productivity Calculations:

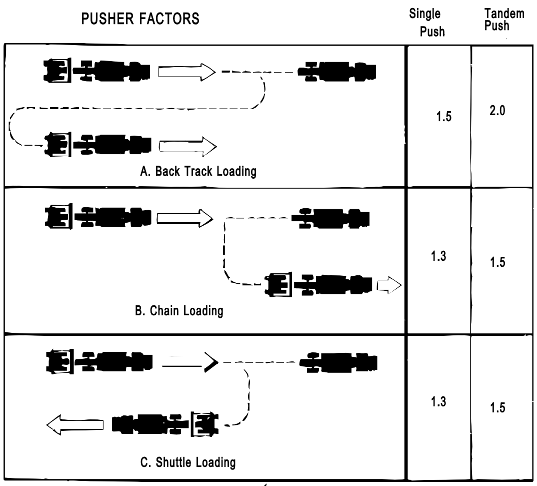
Pusher Cycle Time = 0.5 min x 1.5 = 0.75 min.
(0.5 = scraper load time; 1.5 = pusher factor)

Scrapers/Pusher = 3.73 min. ÷ 0.75 min. = 4.98 scrapers.
(3.73 = scraper cycle time; 0.75 = pusher cycle time)

Pusher Hours Required = 50.38 hrs. ÷ 4 = 13 hrs.
(50.38 = scraper hours; 4 = scrapers per pusher (round up))

* Use the average of the heaped and struck capacities.

WORKSHEET 11B1— (CONTINUED) PRODUCTIVITY OF DOZER PUSH-LOADED SCRAPER USE



Back-track loading with a single push tractor used for all scraper production tasks (Worksheets 11B-1 though 11B-5)

<u>Data Sources</u>:
Permit
Caterpillar Performance Handbook, Edition 48.

<u>WORKSHEET 11B-2: PRODUCTIVITY OF DOZER PUSH-LOADED SCRAPER USE</u>

<u>Earthmoving Activity</u>:
LHD facility area and coal stockpile AFM (pre-ripped)

<u>Characterization of Scraper Used (type, capacity, etc.)</u>:
<u>List Pusher Tractor(s) Used</u>:
Scraper Model: 637K NPP (Non-Push-Pull) with one D10T-S
D10T Push Tractor with Cushion Blade

<u>Description of Scraper Use (origin, destination, grade, haul distance, capacity, etc.)</u>:
Haul Distance = 4,700 LF; 5% Roll Resistance; Rock (ripped); 41 CY struck, 50 CY heaped, avg. = 45.5 CY; 33.5 MPH = max. speed.
Haul = 20 MPH X 88 FPM/MPH = 1,760 FPM 4,700 LF/1,760 FPM = **2.67 minutes.**
Return = 30 MPH X 88 FPM/MPH = 2,640 FPM 4,700 LF/2,640 FPM = **1.78 minutes.**

<u>Describe Push Tractor Loading Method (see figure on next page)</u>:
Volume Hauled = **46,464** LCY Back-Track Loading Method: push factor = **1.5**

<u>Scraper Productivity Calculations:</u>

Cycle Time =	0.5	min. +	2.67	min. +	0.60	min. +	1.78	min. =	5.55	min.
	load time (push-pull is per pair)		loaded trip time		maneuver and spread time		return trip time			

Hourly Production =	45.5	LCY x 60 min./hr. ÷	5.55	min. X	0.83	=	409.9	LCY/hr.
	capacity *		cycle time		efficiency factor			

Hours Required =	46,464	LCY ÷	409.9	LCY/hr. =	113.37	hrs.
	volume to be handled		hourly production		Use 19 hrs. for a fleet of 6	

<u>Push Tractor Productivity Calculations</u>:

Pusher Cycle Time =	0.5	min x	1.5	=	0.75	min.
	scraper load time		pusher factor			

Scrapers/Pusher =	5.55	min. ÷	0.75	min. =	7.40	scrapers.
	scraper cycle time		pusher cycle time			

Pusher Hours Required =	113.37	hrs. ÷	6	=	19	hrs.
	scraper hours		scrapers (round up) per pusher			

* Use the average of the <u>heaped</u> and <u>struck</u> capacities.

WORKSHEET 11B-3: PRODUCTIVITY OF DOZER PUSH-LOADED SCRAPER USE

Earthmoving Activity:
LHD soils (prime) from stockpiles to mining disturbance areas.

Characterization of Scraper Used (type, capacity, etc.):
List Pusher Tractor(s) Used:
Scraper Model: 637K NPP (Non-Push-Pull) with one D10T-S
D10T Push Tractor with Cushion Blade

Description of Scraper Use (origin, destination, grade, haul distance, capacity, etc.):
Haul Distance = 1,400 LF; 5% Roll Resistance; Rock (ripped); 41 CY struck, 50 CY heaped, avg. = 45.5 CY; 33.5 MPH = max. speed.
Haul = 20 MPH X 88 FPM/MPH = 1,760 FPM 1400 LF/1,760 FPM = **0.80 minutes.**
Return = 30 MPH X 88 FPM/MPH = 2,640 FPM 1400 LF/2,640FPM = **0.53 minutes.**

Describe Push Tractor Loading Method (see figure on next page):
Volume Hauled = **1,346,095** LCY Back-Track Loading Method: push factor = **1.5**

Scraper Productivity Calculations:

Cycle Time = 0.5 min. + 0.80 min. + 0.60 min. + 0.53 min. = 2.43 min.
(load time (push-pull is per pair) + loaded trip time + maneuver and spread time + return trip time)

Hourly Production = 45.5 LCY x 60 min. /hr. ÷ 2.43 min. X 0.83 = 937.9 LCY/hr.
(capacity * ; cycle time; efficiency factor)

Hours Required = 1,447,354 LCY ÷ 937.9 LCY/hr. = 1,543.3 hrs.
(volume to be handled; hourly production) Use 257 hrs. for a fleet of 6

Push Tractor Productivity Calculations:

Pusher Cycle Time = 0.5 min x 1.5 = 0.75 min.
(scraper load time; pusher factor)

Scrapers/Pusher = 2.43 min. ÷ 0.75 min. = 3.23 scrapers.
(scraper cycle time; pusher cycle time)

Pusher Hours Required = 1,435.3 hrs. ÷ 3 = 515 hrs.
(scraper hours; scrapers (round up) per pusher)

Use 2 tractors for 257 hrs. each to match mobilized fleet of 6 scrapers.

* Use the average of the heaped and struck capacities.

WORKSHEET 11B-4: PRODUCTIVITY OF DOZER PUSH-LOADED SCRAPER USE

Earthmoving Activity:
LHD soils (non-prime) from stockpiles to facility area and former coal stockpile area.

Characterization of Scraper Used (type, capacity, etc.):
List Pusher Tractor(s) Used:
Scraper Model: 637K NPP (Non-Push-Pull) with one D10T-S
D10T Push Tractor with Cushion Blade

Description of Scraper Use (origin, destination, grade, haul distance, capacity, etc.):
Haul Distance = 1,400 LF; 5% Roll Resistance; Rock (ripped); 41 CY struck, 50 CY heaped, avg. = 45.5 CY; 33.5 MPH = max. speed.
Haul = 20 MPH X 88 FPM/MPH = 1,760 FPM 1,400 LF/1,760 FPM = **0.34 minutes.**
Return = 30 MPH X 88 FPM/MPH = 2,640 FPM 1,400 LF/1,760 FPM = **0.23 minutes.**

Describe Push Tractor Loading Method (see figure on next page):
Volume Hauled = **65,334** LCY Back-Track Loading Method: push factor = **1.5**

Scraper Productivity Calculations:

Cycle Time = 0.5 min. + 0.34 min. + 0.60 min. + 0.23 min. = 1.67 min.

load time (push-pull is per pair)	loaded trip time	maneuver and spread time	return trip time	

Hourly Production = 45.5 LCY x 60 min./hr. ÷ 1.67 min. X 0.83 = 1,363.8 LCY/hr.
(45.5 = capacity *; 1.67 = cycle time; 0.83 = efficiency factor)

Hours Required = 65,334 LCY ÷ 1,363.8 LCY/hr. = 47.91 hrs.
(65,334 = volume to be handled; 1,363.8 = hourly production)
Use 24 hrs. for a fleet of 2

Push Tractor Productivity Calculations:

Pusher Cycle Time = 0.5 min x 1.50 = 0.75 min.
(0.5 = scraper load time; 1.50 = pusher factor)

Scrapers/Pusher = 3.73 min. ÷ 0.75 min. = 2.22 scrapers.
(3.73 = scraper cycle time; 0.75 = pusher cycle time)

Pusher Hours Required = 47.91 hrs. ÷ 2 = 24 hrs.
(47.91 = scraper hours; 2 = scrapers per pusher; 24 = (round up))

Use 1 to match mobilized fleet size

* Use the average of the heaped and struck capacities.

WORKSHEET 11B-5: PRODUCTIVITY OF DOZER PUSH-LOADED SCRAPER USE

Earthmoving Activity:
LHD spoil and earth from the stream reconstruction channel area to the final cut area.

Characterization of Scraper Used (type, capacity, etc.):
List Pusher Tractor(s) Used:
Scraper Model: 637K NPP (Non-Push-Pull) with one D10T-S
D10T Push Tractor with Cushion Blade

Description of Scraper Use (origin, destination, grade, haul distance, capacity, etc.):
Haul Distance = 1,400 LF; 5% Roll Resistance; Rock (ripped); 41 CY struck, 50 CY heaped, avg. = 45.5 CY; 33.5 MPH = max. speed.
Haul = 20 MPH X 88 FPM/MPH = 1,760 FPM 1,800 LF/1,760 FPM = **1.02 minutes.**
Return = 30 MPH X 88 FPM/MPH = 2,640 FPM 1,800 LF/2640 FPM = **0.68 minutes.**

Describe Push Tractor Loading Method (see figure on next page):
Volume Hauled = **168,786** LCY Back-Track Loading Method: push factor = **1.5**

Scraper Productivity Calculations:

Cycle Time = 0.5 min. + 1.65 min. + 0.60 min. + 0.98 min. = 2.80 min.
(0.5 = load time (push-pull is per pair); 1.65 = loaded trip time; 0.60 = maneuver and spread time; 0.98 = return trip time)

Hourly Production = 45.5 LCY x 60 min./hr. ÷ 2.80 min. X 0.83 = 811.2 LCY/hr.
(45.5 = capacity *; 2.80 = cycle time; 0.83 = efficiency factor)

Hours Required = 168,786 LCY ÷ 811.2 LCY/hr. = 208.1 hrs.
(168,786 = volume to be handled; 811.2 = hourly production)
Use 70 hrs. for a fleet of 3

Push Tractor Productivity Calculations:

Pusher Cycle Time = 0.5 min x 1.5 = 0.75 min.
(0.5 = scraper load time; 1.5 = pusher factor)

Scrapers/Pusher = 2.80 min. ÷ 0.75 min. = 3.74 scrapers.
(2.80 = scraper cycle time; 0.75 = pusher cycle time)

Pusher Hours Required = 208.1 hrs. ÷ 3 = 70 hrs.
(208.1 = scraper hours; 3 = scrapers (round up) per pusher)

* Use the average of the heaped and struck capacities.

WORKSHEET 12: PRODUCTIVITY AND HOURS REQUIRED FOR MOTOR GRADER USE

Earthmoving Activity:
Road maintenance and scarification of reclamation area

Characterization of Grader Used (type, size capacity, etc.):
Grader Model: 14M3 with scarifier   Max. 3rd gear speed = 5.3MPH   Scarifier width/pass = 9.7 ft.

Description of Grader Route (push distance, grade, effective blade width, operating speed, etc.):
Scarification along topographic contour (0% grade).

Productivity Calculations: Road Grading

Grading

Hourly Production = 5.3 (average speed) mi. /hr. x ____ (effective blade width) ft. x 5,280 ft./mi. x 1 ac/43,560 sq. ft.

x 0.83 (efficiency factor) = N/A ac/hr.

Hours Required = ____ (area to be graded) acres ÷ ____ (hourly production) ac./hr. = 428 hrs.

(match to scraper fleet)

Scarification

Hourly Production = 5.3 (average speed) mi./hr. x 9.70 (scarifier width) ft. x 5,280 ft./mi. x 1 ac/43,560 sq. ft.

x 0.83 (efficiency factor) = 5.19 ac./hr.

Hours Required = 237.5 (area to be scarified) acres ÷ 5.19 (hourly production) ac./hr. = 45.74 hrs.

Total Hours Required

Total Hours = 427.66 (grading hours required) + 45.74 (scarification hours required) = 474.0 hrs.

Data Sources:
Permit ID
Caterpillar Performance Handbook, Edition 48

WORKSHEET 13: SUMMARY CALCULATION OF EARTHMOVING COSTS

Equipment *	Ownership & Operation Cost ($/hr.)	Labor Cost ($/hr.)	Total Hours Required **	Total Cost *** ($)
Grading Dozer: D9T-SU	$210.42	$41.37	253	$63,702.87
Grading Dozer: D7R-SU	$128.47	$41.37	270	$45,856.80
Ripper: D10T-SU MS (3 shank)	$277.50	$41.37	208	$66,324.96
Loader Model: 980K	$130.35	$52.80	45	$8,241.75
Truck Model: 740C ADT	$130.87	$35.70	180	$29,982.60
Scraper Model: 637K NPP	$317.24	$52.25	1,965	$726,020.94
Dozer Push Tractor: D10-S	$254.39	$41.37	641	$189,582.16
Grader Model: 14M3	$68.59	$69.99	474	$65,686.92
2,500 Gal. **Water Tanker**	$127.70	$35.70	428	$69,686.52
			Grand Total of Earthmoving Costs:	$1,265,085.52

* Be sure to include all necessary attachments and accessories for each item of equipment. Also, add support equipment such as water wagons and graders to match total project time as appropriate.

** Account for multiple units in truck and/or scraper teams.

*** Calculate the Total Cost for each item of equipment by adding the second and third columns (the ownership and operation and labor costs) and then multiplying that number by the fourth column (the total hours required).

Data Sources:
Cost Reference Guide for Construction Equipment, 2019 edition.
Bureau of Labor Statistics, http://www.bls.gov/oes/current/oes_3710.htm.

WORKSHEET 14: REVEGETATION COSTS

Name and Description of Area To Be Revegetated:
Revegetate all disturbed areas to pasture except for a band of woodlands along the reconstructed stream channel. Planting of a cover crop only as the RA will not be required to meet productivity.

Description of Revegetation Activities:
Revegetate: 239.8 acres with a pasture seed mix; scarification by Cat 14M3 (cost in earthwork section).

Reforestation: 52.6 acres

Cost Calculation for Individual Revegetation Activities:

Initial Seeding

239.8 ac x ($ 0** /ac + $ 1,127 /ac) = $ 270,255 .
area to be seeded | seedbed preparation costs | seeding, fertilizing & mulching costs

Planting Trees and Shrubs

52.6 ac x ($ 200/ac*$2.69/ea. /ac + $ 0 /ac) = $ 28,299 .
area to be planted | planting costs | herbicide treatment costs

Reseeding *

239.8 ac x ($ 0** /ac + $ 225 /ac) = $ 53,955 .
area anticipated to need reseeding | seedbed preparation costs | seeding, fertilizing & mulching costs

Replanting Trees and Shrubs *

52.6 ac x ($ 269 /ac + $ 0 /ac) = $ 14,149 .
area anticipated to need replanting | planting costs | herbicide treatment costs

Other Necessary Revegetation Activities

(Examples of other activities that may be necessary include soil sampling, irrigation, and rill and gully repair. Describe each activity and provide a cost estimate with documentation. Use additional worksheets if necessary.)

TOTAL REVEGETATION COST = $ 366,658.

* *Generally, the proportion of the area initially seeded and planted that is anticipated needing reseeding or replanting is determined based on historic failure rates for similar sites and conditions. The same principle applies to determining the extent of seedbed preparation and soil amendments that may be needed as part of any reseeding or replanting effort. If anticipated failure rates vary within the area proposed for disturbance, use a separate worksheet for the area subject to each failure rate.*

WORKSHEET 14 (Continued): REVEGETATION COSTS

Assumptions:
$1,127.00 per acre includes seed mix, 2T/ac. mulch, 3T/ac. lime, 50 lb./ac. nitrogen, 100 lb./ac. phosphorous, and 100 lb./ac. potassium. Second seeding at $225 per acre based on a 20% failure rate. Assume 50% failure for tree replanting ($538/ac. x 0.5 = $269/ac.).

Data Sources: Permit P-123
Per acre cost obtained from consultation with AML programs in coal mining states.

WORKSHEET 15: OTHER RECLAMATION ACTIVITY COSTS

(Includes subsidence damage repair costs, water supply replacement costs, and funds required to support long-term treatment of unanticipated acid or ferruginous mine drainage.)

Description of Reclamation, Repair or Pollution Abatement Activity:

Plug 3 monitoring wells @ 75 ft. avg. depth = 225 LF X $20.00/LF = $4,500.

Assumptions:

Volume of water to be treated and pumped = nil

Cost Estimate Calculations:

TOTAL COSTS = $ 4,500.00 .

Other Documentation or Notes:

(Include additional sheets, maps, calculations, etc., as necessary to document estimate.)

Data Sources:
Permit P-123

Cost obtained from consultation with AML programs in surrounding states.

WORKSHEET 16: RECLAMATION BOND SUMMARY SHEET

1.	Total Facility and Structure Removal Costs	$ 5,000
2.	Total Earthmoving Costs	$1,265,086
3.	Total Revegetation Costs	$366,698
4.	Total Other Reclamation Activities Costs	$4,500
5.	Subtotal: Total Direct Costs (sum of Items 1 through 4)	$1,641,284
6.	Inflated Direct Cost = Item 5 X 0% = (Total Direct Costs) (Inflation Factor*) (Ch. 2 Step 3)	$1,641,284
7.	Mobilization and Demobilization (at 5 % of Item 6) (Ch. 2 Step 4)	$82,641
8.	Contingencies Allowance (at 3 % of Item 6) (Ch. 2 Step 4)	$49,239
9.	Engineering Redesign Cost (at 5 % of Item 6) (Ch. 2 Step 4)	$82,641
10.	Project Management Fee (at 5 % of Item 6) (Ch. 2 Step 4)	$82,641
11.	Contractor Overhead (at 13 % of Item 6) (Ch. 2 Step 4)	$213,367
12.	Subtotal: Total Indirect Costs (sum of Items 7 through 11)	$510,529
13.	Contractor Profit (at 7 % of Item 6) (Ch. 2 Step 4)	$114,890
14.	GRAND TOTAL BOND AMOUNT (sum of Items 6, 12 & 13)	$2,266,703

Enter Current Construction Cost Index (Ch. 2 Step 5) 1.0 .

BOND AMOUNT COMPUTATION

Applicant:
MOUNTAIN TOP REMOVAL EXAMPLE

Permit Number: Example No. 4 Permitted Acreage: 175

Bonding Scheme (permit area, incremental, cumulative): Permit Area

If Incremental:
Increment Number: _______
Increment Acreage: _______

If Cumulative:
Acres previously authorized for disturbance: _______
New acres proposed for disturbance: _______

Type of Operation: Mountain Top Removal
Location: USA

Prepared by: S. S. Bond
Date: 5/14/2020
Total Bond Amount: $1,444,550

WORKSHEET 1: DESCRIPTION OF THE WORST-CASE RECLAMATION SCENARIO

This is a 175-acre mountain-top-removal site from which six seams of coal will be removed (see Figures B-6 through B-9 at end of worksheets). The spoil will be stored both in temporary and permanent storage. Spoil material is composed of 90% sandstone and 10% shale. The permanent storage will be in two durable rock valley fills neither of which encroaches on streams. The temporary spoil storage will be adjacent to the working face of the highwall. The spoil above the 2,975 ft elevation will be stored in the valley fills while the spoil below elevation 2,975 ft will be temporarily stored, as shown on attached drawings, and graded over the disturbed mine area for positive drainage.

The worst-case reclamation scenario occurs when the mining of the lower seams (A & B) just begins. At this point, approximately 1,400 ft of highwall is exposed above the B through E seams. It is assumed that all work activities on both hollow fills are current except for spreading topsoil and revegetation. Hollow fills are approximately one-half their designed capacity at this point.

The following sections discuss the reclamation plan for the worst-case scenario.

1. Structure Removal

   No buildings are planned for the site; however, three 40-ft storage trailers will need to be removed.

2. Earthmoving Activities

   The first step of the earthmoving activities is backfilling of the open highwall. Approximately 1,400 ft of highwall length is exposed at the D-seam level. This highwall will be eliminated by blasting a portion of it to an acceptable grade and pushing the blast material and the stored spoil to reclaim the highwall. Spoil is stored adjacent to the base of the exposed highwall. Prior to topsoil redistribution, the spoil storage areas adjacent to the highwall must be graded to final contours.

   For the road areas, the main road will be permanent. The access road to the ponds will be removed when the ponds are removed.

   Ponds are to be removed by grading the pond berms to original drainage contours.

3. Topsoil Replacement and Revegetation

   Topsoil will be redistributed by loaders and trucks and will be graded by dozers. It is assumed that 140 acres will require topsoil redistribution. This includes the mined area and hollow fills. A 6-inch depth amounts to 112,933 cubic yards of topsoil requiring replacement. It is assumed that the topsoil will need to be hauled 650 feet up a 5% grade to the mined area and 600 ft down a 5% grade to the hollow fills. Assume that the trucks will spread 50% of the topsoil in dumping and the remaining 50% is spread by dozers.

The areas that require revegetation and topsoil redistribution are listed below.

Area	Revegetation	Topsoil Redistribution
Mining	58.2 acres	58.2 Acres
Hollow Fill A	37.8 acres	37.8 acres
Hollow Fill B	35.6 acres	35.6 acres
Basins	4.6 acres	4.6 acres
Basin Access Road	1.3 acres	1.3 acres
Explosive Area	2.5 acres	2.5 acres
	140 acres	140 acres

It is assumed that all areas will be revegetated using the same type of seed mix recommended in the mining plan and no tree planting will be conducted.

4. Other Reclamation Activities
    a. Ponds will need to be maintained and pumped prior to removal.
    b. The haul road is permanent and will need to be maintained until reclamation is complete.
    c. Drilling and blasting the high wall to an acceptable grade is required.

NOTE: Worksheets 4A, 7, 11A, 11B, 12, 17 and 18 are not applicable to this example.

Data Source(s):

Mountain Top Removal Example Mine Plan
Caterpillar Performance Handbook, Edition 48
Cost Reference Guide for Construction Equipment, RSMeans
Bureau of Labor Statistics, http://www.bls.gov/oes/current/oes_3710.htm
PA DEP Mine Site Reclamation Bond Rates, 2020
ODNR Performance Security Estimate & Unit Costs
OSM Handbook for Calculation of Reclamation Bond Amounts, Revised 2020

WORKSHEET 2: STRUCTURE DEMOLITION AND DISPOSAL COSTS

Structures to be demolished:

Item	Construction Material	Volume (cubic feet)	Unit Cost Basis ($)	Demolition Cost ($)
			Subtotal	$-

Other items to be demolished (paved roads, conveyors, utility poles, rail spurs, etc.)

Item	Construction Material	Length (Linear Foot)	Unit Cost Basis ($)	Demolition Cost ($)
			Subtotal	$-

Debris handling and disposal costs:

		Quantity	Cost	
Remove 40 foot storage trailers (3)		3	$2,000.00	$6,000.00
Removal of trash and derelict equipment			$4,000.00	$4,000.00
* Demolition includes disposal with up to 20 mile haul ** Cost breakdown from Mine Plan				
			Subtotal =	$10,000
			TOTAL DEMOLITION AND DISPOSAL =	$10,000

Data Sources:

Mountain Top Removal Example Mine Plan
Cost Reference Guide for Construction Equipment, RSMeans

WORKSHEET 3: MATERIAL HANDLING PLAN SUMMARY

Earthmoving Activity	Volume (LCY)	Origin	Destination	Haul Distance (ft)	Grade* (%)	Equipment To Be Used
Grade Spoil, $^1/_2$ blasted rock, into pit	39,638	Highwall	Highwall	140	-30	D9T dozer
Grade spoil from temporary storage highwall	63,519	Storage	Highwall	100	30	D9T dozer
Grade temporary spoil storage area	18,563	Storage	Storage Area	100	0	D9T dozer
Load topsoil	53,724	Storage	Trucks			992K
Haul topsoil	53,724	Storage	Mined Area	650	5	777G
Load topsoil	59,209	Storage	Trucks			992K
Haul topsoil	59,209	Storage	A, B Hollow Fill	600	-5	777G
Spread topsoil	56,467	Site	Disturbed Area	100	15	D9T dozer
Remove ponds	11,500	Berm	Pond	100	0	D9T dozer
Remove pond access roads	1,407	Fill Areas	Cut Areas	100	-5	D9T dozer
Final grading	140	acres			30	D9T dozer

*Record grade resistance here. Calculate total resistance on the appropriate worksheet. Total Resistance = Grade Resistance + Rolling Resistance.

WORKSHEET 4B: EARTHWORK QUANTITY

1. Grade blasted material. Assume ½ of the material is casted in blasting.
   Material Volume = ½ ((½ x 58' x 32.95' x 1400') ÷ 27 ft^3/yd^3) = 24,774 yd^3 x 1.60 swell factor = 39,638 yd^3

2. Grade spoil peaks in temporary storage to highwall at lower seams. (See Figure B-8 at end of worksheets.)
   Material Volume = (2 levels x ½ (35' x 35') x 1400') ÷ 27 ft^3/yd^3 = 24,774 yd^3 = 63,519 yd^3

3. Grade temporary spoil pile left after highwall backfilled.
   Material Volume = (1' (Depth) x 358' (Area) x 1400') ÷ 27 ft^3/yd^3) = 18,563 yd^3

4. Load and haul topsoil.
   Material Volume (Hollow Fills A & B) = (73.4 ac x 43,560 ft^2/acre x 0.5 ft) ÷ 27 ft^3/yd^3 = 59,209 yd^3

   Material Volume (Mining, Basins, Ponds, etc.) = (66 ac x 43,560 ft^2/acre x 0.5 ft) ÷ 27 ft^3/yd^3 = 53,724 yd^3

5. Spread topsoil. Assume ½ of topsoil is spread by trucks; ½ by dozers.
   Material Volume = 112,933 yd^3 ÷ 27 = 56,467 yd^3

6. Pond removal. Remove ponds by grading to original contours.

Pond	Volume (ac-ft)	Area (ft^2)
021	6.8	35,625
022	11.9	63,000
023	6.8	35,625
024	3.3	21,000
Totals	28.8 ac-ft	155,250 ft^2

Estimate Volume as a 2 ft depth over pond area.
   Material Volume = (155,250 ft^2 x 2') ÷ 27 ft^3/yd^3 = 11,500 yd^3

7. Pond access road removal.
   Material Volume = ((3,800' x 10' x 1') ÷ 27 ft^3/yd^3) = 1,407 yd^3

Data Source(s): Mountain Top Removal Example Mine Plan

WORKSHEET 5A: PRODUCTIVITY AND HOURS REQUIRED FOR DOZER USE

Earthmoving Activity:

Grade spoil, 1/2 blasted rock, into open pit.

Characterization of Dozer Used (type, size, etc.):

D9 dozer with Semi-U or SU Blade = 1300 cy/hr

Description of Dozer Use (origin, destination, grade, haul distance, material, etc.):

The dozer is used to push 1/2 of blasted rock into the open pit. The material will be pushed 140 feet down -30% effective grade

Volume (LCY): 39,638 Density (lb/LCY): 2550 Distance (ft): 140 Grade (%): -30

Productivity Calculations:

Operating Adjustment Factor = 0.75 (Operator Factor) x 0.70 (Material Factor) x 0.83 (Efficiency Factor) x 1.6 (Grade Factor) x 0.90 (Weight Correction Factor) x 1.0 (Production Method/ Blade Factor) x 1.0 (Visibility Factor) x 1.0 (Elevation Factor) = 0.63 .

Net Hourly Production = 825 LCY/hr. (Normal Hourly Production) x 0.63 (Operating Adjustment Factor) = 521 LCY/hr.

Hours Required = 39.638 LCY (volume to be moved) ÷ 521 LCY/hr. (net hourly production) = 76.1 ** hrs.

use 77 hrs.

* Weight Factor = 2,300 lb/yd3 ÷ 2,550 lb/yd3 = 0.90

** Normal dozing with straight and U-blades use 1.00

Data Sources:

Mountain Top Removal Example Mine Plan

Caterpillar Performance Handbook, Edition 48

WORKSHEET 5B: PRODUCTIVITY AND HOURS REQUIRED FOR DOZER USE

Earthmoving Activity:

Grade spoil from temporary storage to open pit

Characterization of Dozer Used (type, size, etc.):

D9 dozer with Semi-U or SU Blade

Description of Dozer Use (origin, destination, grade, haul distance, material, etc.):

The dozer is used to push spoil 100 feet up a +30% effective grade

Productivity Calculations:

Operating Adjustment Factor = 0.75 (Operator Factor) x 0.70 (Material Factor) x 0.83 (Efficiency Factor) x .30 (Grade Factor) x 0.90 (Weight Correction Factor) x 1.0 (Production Method/ Blade Factor) x 1.0 (Visibility Factor) x 1.0 (Elevation Factor) = 0.12 .

Net Hourly Production = 1100 (Normal Hourly Production) LCY/hr. x 0.12 (Operating Adjustment Factor) = 129 LCY/hr.

Hours Required = 63.519 (volume to be moved) LCY ÷ 129 (net hourly production) LCY/hr. = 490.8 ** hrs.

use 491 hrs.

* Weight Factor = 2,300 lb/yd3 ÷ 2,550 lb/yd3 = 0.90

** Normal dozing with straight and U-blades use 1.00

Data Sources:

Mountain Top Removal Example Mine Plan

Caterpillar Performance Handbook, Edition 48

WORKSHEET 5C: PRODUCTIVITY AND HOURS REQUIRED FOR DOZER USE

Earthmoving Activity:
Grade temporary spoil storage area to final reclaimed contours

Characterization of Dozer Used (type, size, etc.):
D9 dozer with Semi-U or SU Blade

Description of Dozer Use (origin, destination, grade, haul distance, material, etc.):
The dozer is used to grade spoil by pushing 100 feet at a 0% effective grade

Productivity Calculations:

Operating Adjustment Factor =

0.75	x	0.70	x	0.83	x	1.00	x	0.90	x
operator factor		material factor		efficiency factor		grade factor		weight correction factor	
		1.00	x	1.00	x	1.00	=	**0.39**	
		production method/ blade factor		visibility factor		elevation factor			

Net Hourly Production =

1100	x	0.39	=	**431**	**LCY/hr**
normal hourly production (LCY/hr)		operating adjustment factor			

Hours Required =

18,563	/	431	=	43.0 hrs
volume to be moved (LCY)		net hourly production (LCY/hr)		Use **44 hrs**

* Weight Factor = 2,300 lb/yd3 ÷ 2,550 lb/yd3 = 0.90
** Normal dozing with straight and U-blades use 1.00

Data Sources:
Mountain Top Removal Example Mine Plan
Caterpillar Performance Handbook, Edition 48

WORKSHEET 5D: PRODUCTIVITY AND HOURS REQUIRED FOR DOZER USE

Earthmoving Activity:

Spread topsoil.

Characterization of Dozer Used (type, size, etc.):

D9 dozer with Semi-U or SU Blade

Description of Dozer Use (origin, destination, grade, haul distance, material, etc.):

The dozer is used to spread topsoil 100 feet at a +15% effective grade

Productivity Calculations:

Operating Adjustment Factor =

0.75 (operator factor) x 1.20 (material factor) x 0.83 (efficiency factor) x 0.70 (grade factor) x 0.90 (weight correction factor) x 1.00 (production method/ blade factor) x 1.00 (visibility factor) x 1.00 (elevation factor) = **0.47**

Net Hourly Production =

1100 (normal hourly production (LCY/hr)) x 0.47 (operating adjustment factor) = **518** **LCY/hr**

Hours Required =

56,467 (volume to be moved (LCY)) ÷ 518 (net hourly production (LCY/hr)) = 109.1hrs

Use **110 hrs**

* Weight Factor = 2,300 lb/yd3 ÷ 2,550 lb/yd3 = 0.90

** Normal dozing with straight and U-blades use 1.00

Data Sources:

Mountain Top Removal Example Mine Plan

Caterpillar Performance Handbook, Edition 48

WORKSHEET 5E: PRODUCTIVITY AND HOURS REQUIRED FOR DOZER USE

Earthmoving Activity:
Remove ponds by grading each berm to original contours.

Characterization of Dozer Used (type, size, etc.):
D9 dozer with Semi-U or SU Blade

Description of Dozer Use (origin, destination, grade, haul distance, material, etc.):
Dozer will push pond berm 100 ft to original drainage contours over mostly flat (0%) grades.

Productivity Calculations:

Operating Adjustment Factor =

0.75	x	0.90	X	0.83	x	1.60	x	0.90	x
operator factor		material factor		efficiency factor		grade factor		weight correction factor	
		1.00	x	1.00	x	1.00	=	**0.50**	
		production method/ blade factor		visibility factor		elevation factor			

Net Hourly Production =

1100	x	0.50	=	**555**	**LCY/hr**
normal hourly production (LCY/hr)		operating adjustment factor			

Hours Required =

11,500	÷	555	=	20.7 hrs	
volume to be moved (LCY)		net hourly production (LCY/hr)			use **21 hrs**

* Weight Factor = 2,300 lb/yd3 ÷ 2,550 lb/yd3 = 0.90
** Normal dozing with straight and U-blades use 1.00

Data Sources:
Mountain Top Removal Example Mine Plan
Caterpillar Performance Handbook, Edition 48

WORKSHEET 5F: PRODUCTIVITY AND HOURS REQUIRED FOR DOZER USE

Earthmoving Activity:

Remove access road to ponds.

Characterization of Dozer Used (type, size, etc.):

D9 dozer with Semi-U or SU Blade

Description of Dozer Use (origin, destination, grade, haul distance, material, etc.):

Dozer used to grade road and ditches to original contours. Push distance, 100 ft at a -5% effective grade.

Productivity Calculations:

Operating Adjustment Factor =

0.75 operator factor	**x**	0.90 material factor	**x**	0.83 efficiency factor	**x**	1.10 grade factor	**x**	0.90 weight correction factor	**x**	
		1.00 production method/ blade factor	**x**	1.00 visibility factor	**x**	1.00 elevation factor	**=**	**0.55**		

Net Hourly Production =

1100 normal hourly production (LCY/hr)	**x**	0.55 operating adjustment factor	**=**	**610**	**LCY/hr**

Hours Required =

1,407 volume to be moved (LCY)	÷	610 net hourly production (LCY/hr)	**=**	2.3 hrs	use **3 hrs**

Total Dozer Hours from all Worksheets 5A - 5F = 746

* Weight Factor = 2,300 lb/yd3 ÷ 2,550 lb/yd3 = 0.90
** Normal dozing with straight and U-blades use 1.00

Data Sources:

Mountain Top Removal Example Mine Plan
Caterpillar Performance Handbook, Edition 48

WORKSHEET 6A: PRODUCTIVITY AND HOURS REQUIRED FOR DOZER USE - GRADING

Earthmoving Activity:
Final (contour) grading.

Characterization of Dozer Used (type, size, etc.):
D6 dozer with an 11-ft wide Straight or "S" blade (effective width with blade overlap)

Description of Dozer Use (origin, destination, grade, haul distance, material, etc.):
1) Grading backfilled spoil on 98.9 acres of steeper slopes at 30% grade but backtracking upslope for net 0%.
2) Contour grading of backfill and disturbed areas on 45.1 acres at 0% grade.
Area (ac.):144.0Grade (%):0 Average Speed (mph):3 Effective Blade Width (ft):10 Density (lb/LCY)2300

Productivity Calculations:

Operating Adjustment Factor =

0.75	x	0.90	x	0.83	x	1.00	x	1.00	x
operator factor		material factor		efficiency factor		grade factor		weight correction factor	

1.00	x	1.00	x	1.00	=	**0.63**
production method/ blade factor		visibility factor		elevation factor		

Hourly Production =

3	x	10	x	1	x	43,560 sq ft/mile	=	**3.6 ac/hr**
average speed (mph)		effective blade width (ft)						

Net Hourly Production =

1100	x	0.55	=	**2.3 ac/hr**
hourly production (ac/hr)		operating adjustment factor		

Hours Required =

144	÷	2.3	=	63.4 hrs
Area to be graded (ac)		net hourly production (ac/hr)		use **64 hrs**

* Weight Factor = 2,300 lb/yd3 ÷ 2,550 lb/yd3 = 0.90
** Normal dozing with straight and U-blades use 1.00

Data Sources:
Mountain Top Removal Example Mine Plan
Caterpillar Performance Handbook, Edition 48

WORKSHEET 8A: PRODUCTIVITY AND HOURS REQUIRED FOR LOADER USE

Earthmoving Activity:

Load topsoil on trucks to be hauled to mined areas.

Characterization of Loader Use (type, size, etc.):

992K with Large Standard Spade-edge, 16 CY rock bucket, 15.7 ft dump clearance
heaped capacity = 16CY

Description of Loader Use (origin, destination, grade, haul distance, etc.):

Load topsoil in storage area.

Productivity Calculations:

Cycle Time = 0 (haul time loaded (min)) + 0 (return time empty (min)) + 0.7 (basic cycle time (min)) = **0.7 min**

Net Bucket Capacity = 16.00 (heaped bucket capacity (LCY)) x 0.9 (bucket fill factor*) = **14.4 LCY**

Hourly Production = 14.4 (net bucket capacity (LCY)) ÷ 0.7 (cycle time (min)) x 0.75 (efficiency factor) x 60 min (hr) = **926 LCY/hr**

Hours Required = 53,724 (volume to be moved (LCY)) ÷ 926 (net hourly production (LCY/hr)) = **58.0 hr**

* See loader section of equipment manual.

Data Sources:

Mountain Top Removal Example Mine Plan
Caterpillar Performance Handbook, Edition 48

WORKSHEET 8B: PRODUCTIVITY AND HOURS REQUIRED FOR LOADER USE

Earthmoving Activity:
Load topsoil on trucks to be hauled to mined areas.

Characterization of Loader Use (type, size, etc.):
992K with Large Standard Spade-edge, 16 CY rock bucket, 15.7 ft dump clearance
heaped capacity = 16 CY

Description of Loader Use (origin, destination, grade, haul distance, etc.):
Load topsoil in storage area.

Productivity Calculations:

Cycle Time =	0 haul time loaded (min)	+	0 return time empty (min)	+	0.7 basic cycle time (min)			=	**0.7**	**min**
Net Bucket Capacity =	16.00 heaped bucket capacity (LCY)	x	0.9 bucket fill factor*					=	**14.4**	**LCY**
Hourly Production =	14.4 net bucket capacity (LCY)	÷	0.7 cycle time (min)	x	0.75 efficiency factor	x	60 min hr	=	**926**	**LCY/ hr**
Hours Required =	59,209 volume to be moved (LCY)	÷	926 net hourly production (LCY/hr)					=	**64.0**	**hr**

Total Loader Hours from Worksheets 8A & 8B = 122

* See loader section of equipment manual.

Data Sources:
Mountain Top Removal Example Mine Plan
Caterpillar Performance Handbook, Edition 48

WORKSHEET 9A: PRODUCTIVITY AND HOURS REQUIRED FOR TRUCK USE

Characterization of Loader Use (type, size, etc.):
777G, Struck capacity = 54.6 CY, heaped capacity = 78.6 CY, 66.6 avg capacity

Description of Loader Use (origin, destination, grade, haul distance, etc.):
Haul topsoil from storage to disturbed areas. Haul and return distance are both 650 ft over +5% effective grade

Productivity Calculations:

No. Loader Passes/Truck = 66.6 truck capacity* (LCY) ÷ 16 loader bucket net capacity (LCY) **=** 4 passes (round down to the nearest whole number; reduce net truck capacity and weight accordingly in calculations below)

Net Truck Capacity = 16 loader bucket net capacity (LCY) ÷ 4 no. loader passes/truck = 64 LCY

Loading Time/Truck = 0.7 loader cycle time (min) (From WS 8) x 4 number of loader passes/ truck = 2.8 min

Truck Cycle Time = 0.46 haul time (min) **+** 0.28 return time (min) **+** 2.8 loading time (min) + 2 dump and maneuver time (min) = 5.54 min

No. Trucks Required = 5.54 truck cycle time (min) ÷ 2.8 total loading time (min) **=** 2 trucks (round down to the nearest whole number; reduce net truck capacity and weight accordingly in calculations below)

Production Rate = 64 net truck capacity ** **x** 2.00 number of trucks **÷** 5.54 truck cycle time (min) = 23.1 LCY/min

Hourly Production = 23.1 production rate (LCY/min) **x** 60 min hr x 0.75 efficiency factor = 1039.7 LCY/hr

Hours Required = 53,724 volume to be moved (LCY) **÷** 1039.7 hourly production (LCY/hr) = 51.7 hr

*Use the average of the heaped and struck capacities.
**Net truck capacity = loader bucket net capacity x no. loader passes/truck.

650 ft ÷ (15 MPH x 88 FPM/MPH) = 0.46
650 ft ÷ (25 MPH x 88 FPM/MPH) = 0.28

Data Sources:
Mountain Top Removal Example Mine Plan
Caterpillar Performance Handbook, Edition 48

WORKSHEET 9B: PRODUCTIVITY AND HOURS REQUIRED FOR TRUCK USE

Characterization of Loader Use (type, size, etc.):

777G, Struck capacity = 54.6 CY heaped capacity = 78.6 CY, 66.6 avg capacity

Description of Loader Use (origin, destination, grade, haul distance, etc.):

Haul topsoil from storage to disturbed areas. Haul distance is 600 ft over -5% effective grade; return is 600 ft at 0% effective grade.

Productivity Calculations:

No. Loader Passes/Truck = 66.6 (truck capacity* (LCY)) ÷ 16 (loader bucket net capacity (LCY)) **= 4 passes** (round down to the nearest whole number; reduce net truck capacity and weight accordingly in calculations below)

Net Truck Capacity = 16 (loader bucket net capacity (LCY)) ÷ 4 (no. loader passes/truck) **= 64 LCY**

Loading Time/Truck = 0.7 (loader cycle time (min) (From WS 8)) x 4 (number of loader passes/ truck) **= 2.8 min**

Truck Cycle Time = 0.46 (haul time (min)) + 0.28 (return time (min)) + 2.8 (loading time (min)) + 2 (dump and maneuver time (min)) **= 5.54 min**

No. Trucks Required = 5.54 (truck cycle time (min)) ÷ 2.8 (total loading time (min)) **= 2 trucks** (round down to the nearest whole number; reduce net truck capacity and weight accordingly in calculations below)

Production Rate = 64 (net truck capacity **) x 2.00 (number of trucks) ÷ 5.54 (truck cycle time (min)) **= 23.1 LCY/min**

Hourly Production = 23.1 (production rate (LCY/min)) x 60 min/hr x 0.75 (efficiency factor) **= 1040 LCY/hr**

Hours Required = 53,724 (volume to be moved (LCY)) ÷ 1040 (hourly production (LCY/hr)) **= 56.9 hr**

*Use the average of the heaped and struck capacities.

**Net truck capacity = loader bucket net capacity x no. loader passes/truck.

650 ft ÷ (15 MPH x 88 FPM/MPH) = 0.46

650 ft ÷ (25 MPH x 88 FPM/MPH) = 0.28

Data Sources:

Mountain Top Removal Example Mine Plan

Caterpillar Performance Handbook, Edition 48

WORKSHEET 13: SUMMARY CALCULATION OF EARTHMOVING COSTS

Equipment *	Ownership & Operating Cost ($/hr)	Labor Cost ($/hr)	Total Hours Required **	Total Cost *** ($)
992K	181.85	189.69	122	$45,326.22
D6 dozer	44.46	49.76	64	$6,030.08
D9 dozer	118.37	123.78	746	$180,643.90
777G	87.4	93.89	321	$58,118.54
777G	87.4	93.89	160	$29,059.27
6000 Gallon Water Truck	88	32	122	$14,639.46
		Grand Total of Earthmoving		**$ $304,758.20**

* Be sure to include all necessary attachments and accessories for each item of equipment. Also, add support equipment such as water wagons and graders to match total project time as appropriate.

** Account for multiple units in truck and/or scraper teams

*** Calculate the total cost for each item of equipment by adding the second and third columns (the ownership and operation and labor costs) and then multiplying that number by the fourth column (the total hours required).

Data Sources:

Mountain Top Removal Example Mine Plan
Caterpillar Performance Handbook, Edition 48
Cost Reference Guide for Construction Equipment, RSMeans
Bureau of Labor Statistics, http://www.bls.gov/oes/current/oes_3710.htm
OSM Handbook for Calculation of Reclamation Bond Amounts, Revised 2020

WORKSHEET 14: REVEGETATION COSTS

Name and Description of Area To Be Revegetated:
All disturbed acreage requires seeding; no tree planting.
Description of Revegetation Activities:
Hydroseeding will be used because of steep slope conditions
Revegetate 140.0 ac with a pasture seed mix
(from 2020 PA DEP Standard Bond Rate
Revegetation cost = $1,830.00 /ac Guidelines)
Cost Calculation for Individual Revegetation Activities:

Initial Seeding

140.0	**x (**	500	+	$1,830.00	**) =**	**$326,200**
area to be seeded (ac)		seedbed preparation costs ($/ac)		seeding, fertilizing, and mulching costs ($/ac)		

Reseeding *

70.0	**x (**	500	+	$1,830.00	**) =**	**$163,100**
area anticipated to need reseeding (ac)		seedbed preparation costs ($/ac)		seeding, fertilizing, and mulching costs ($/ac)		

Other Necessary Revegetation Activities
(Examples of other activities that may be necessary include soil sampling, irrigation, and rill and gully repair. Describe each activity and provide a cost estimate with documentation. Use additional worksheets if necessary.)

TOTAL REVEGETATION COST = $489,300

*Generally, the proportion of the area initially seeded and planted that is anticipated to need reseeding or replanting is determined on the basis of historic failure rates for similar sites and conditions. The same principle applies to determining the extent of seedbed preparation and soil amendments that may be needed as part of any reseeding or replanting effort. If anticipated failure rates vary within the area proposed for disturbance, use a separate worksheet for the area subject to each failure rate.

Assumptions:

Assume 25% failure for second seeding.

Data Sources:

Mountain Top Removal Example Mine Plan

PA DEP Mine Site Reclamation Bond Rates, 2020

WORKSHEET 15A: OTHER RECLAMATION ACTIVITY COSTS

POND MAINTENANCE DURING RECLAMATION

(Includes subsidence damage repair costs, water supply replacement costs, and funds required to support long-term treatment of unanticipated acid or ferruginous mine drainage.)

Description of Reclamation, Repair or Pollution Abatement Activity:

Maintenance, pumping and treatment of ponds.

Assumptions:

Volume: 28.8 acre-feet

Cost Estimate Calculations:

28.8	acre-feet	x	43,560	ft^2/ac	x	$0.20	/10 ft^3	= $25,091

TOTAL COSTS = $25,091

Other Documentation or Notes:

(Include additional sheets, maps, calculations, etc., as necessary to document estimate.)

Data Sources:

Mountain Top Removal Example Mine Plan

PA DEP Mine Site Reclamation Bond Rates, 2020

WORKSHEET 15B: OTHER RECLAMATION ACTIVITY COSTS

HAUL ROAD MAINTENANCE DURING RECLAMATION

(Includes subsidence damage repair costs, water supply replacement costs, and funds required to support long-term treatment of unanticipated acid or ferruginous mine drainage.)

Description of Reclamation, Repair or Pollution Abatement Activity:
Haul road maintenance during reclamation.

Assumptions:

Haul Road 3.5 acres

Cost Estimate Calculations:

3.5 acre x $600 /acre = $2,100

TOTAL COSTS = $2,100

Other Documentation or Notes:

(Include additional sheets, maps, calculations, etc., as necessary to document estimate.)

Data Sources:

Mountain Top Removal Example Mine Plan
PA DEP Mine Site Reclamation Bond Rates, 2020

WORKSHEET 15C: OTHER RECLAMATION ACTIVITY COSTS

BLASTING COSTS FOR HIGHWALL REMOVAL

(Includes subsidence damage repair costs, water supply replacement costs, and funds required to support long-term treatment of unanticipated acid or ferruginous mine drainage.)

Description of Reclamation, Repair or Pollution Abatement Activity:

Drilling and blasting of 1400 linear feet of highwall
Most reclamation projects will use either a 3.5-inch top-hammer drill or a 6-inch rotary drill for highwall reduction.

Assumptions:

The optimum burden and spacing is based on the drill hole size and can be determined using the "Blast Design Rules of Thumb" worksheet as described on the AR Blast website referenced below.
For a 3.5-inch hole, 9' by 9' burden and spacing results in a powder factor of 0.96 lbs/yd3 which is appropriate for a SS/SH overburden. (Obtained from the "Blast Design Rules of Thumb" worksheet.

ANFO (density 0.85 g/cc) is the primary charge with a booster and detonator in each hole.

Quantities – See Worksheet 15D

Drilling ($/lin ft) =	3.5" hole $2.5: 6" hole $1.25	
Explosives Down Hole Cost $/lb)=	ANFO $0.4: Emulsion $0.55 (wet holes)	
Blaster Cost =	$80	per hour
Blasting Crew Cost	$60	per hour

Downhole costs include blasting crew costs

Cost Estimate Calculations:

Drilling 3.5"	16,380	linear ft	x	$2.50	per ft	$40,950
ANFO	41,028	lbs	x	$0.40	per lb	$16,411
Detonators	936	units	x	$10.00	unit	$9,360
Boosters	936	units	x	$5.00	unit	$4,680
Leadlines/connectors	10	units	x	$9.00	unit	$90
Blast crew (included above)						

TOTAL COSTS = $71,491

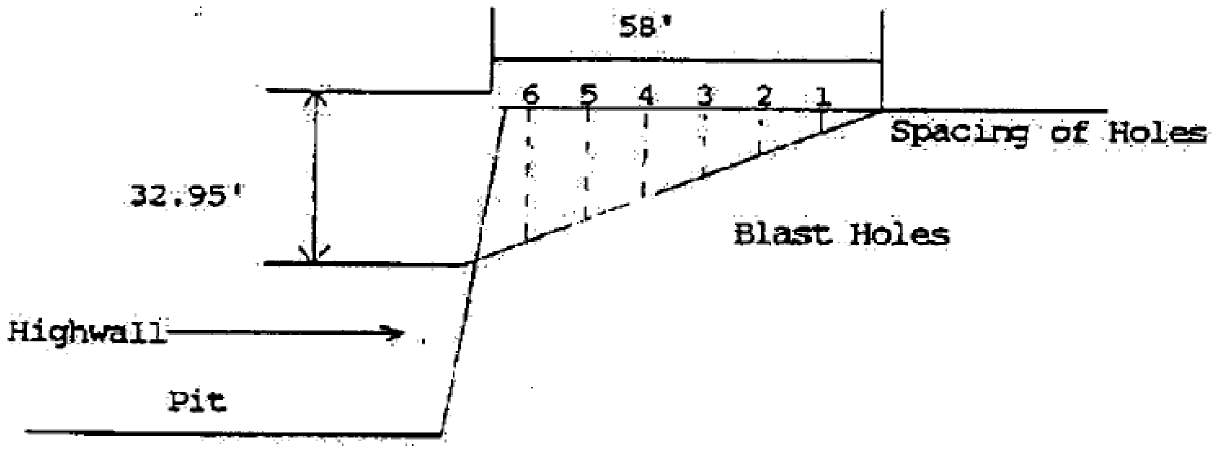
Other Documentation or Notes:

Use of the OSMRE AR BLAST WEBSITE Worksheet "Blast Design Rules of Thumb" to determine blast design using a typical blast hole drill of 3.5" :
https://www.osmre.gov/resources/blasting/arblast.shtm

Data Sources:

Mountain Top Removal Example Mine Plan
OSM Blast Design Rules of Thumb
Blasting contractor cost discussions.

WORKSHEET 15D: OTHER RECLAMATION ACTIVITY COSTS



Drill Hole 3.5" 15x15	1	2	3	4	5	6	Total
Distance to Highwall Face (ft)	54	45	36	27	18	9	
Drill Hole Depth (ft)	5	10	15	20	25	30	105

105 ft/row × 156 rows = **16,380 lin ft drilling**

936 holes – requiring detonators to boosters = 936

Data Sources:

Mountain Top Removal Example Mine Plan
OSM Blast Design Rules of Thumb
Blasting contractor cost discussions.

WORKSHEET 15E: OTHER RECLAMATION ACTIVITY COSTS TOTAL

(Includes subsidence damage repair costs, water supply replacement costs, and funds required to support long-term treatment of unanticipated acid or ferruginous mine drainage.)

Description of Reclamation, Repair or Pollution Abatement Activity:

Pond treatment and maintenance during reclamation activities	$ 25,090.56
Haul road maintenance during reclamation activities	$ 2,100.00
Blasting costs to remove remaining highwall	$ 71,491

Cost Estimate Calculations:

TOTAL COSTS = $98,682

Other Documentation or Notes:

(Include additional sheets, maps, calculations, etc., as necessary to document estimate.)

Data Sources:

Mountain Top Removal Example Mine Plan
OSM Blast Design Rules of Thumb
Blasting contractor cost discussions.

WORKSHEET 16: RECLAMATION BOND SUMMARY SHEET

Total Facility and Structure Removal Costs		$10,000	
Total Earthmoving Costs		$304,758	
Total Revegetation Costs		$489,300	
Total Other Reclamation Activities Costs		$98,682	
Total Direct Costs (Sum of Lines 1 through 4)		$902,740	
Inflated Total Direct Costs (Line 5 times inflation factor*) (Ch. 2 Step 3)			**$1,046,776**
Mobilization and Demobilization (Ch. 2 Step 4)	5% of line 6	$52,338.78	
Contingencies Allowance (Ch. 2 Step 4)	4% of line 6	$41,871.02	
Engineering Redesign Cost (Ch. 2 Step 4)	4% of line 6	$41,871.02	
Project Management Fee (Ch. 2 Step 4)	5% of line 6	$52,338.78	
Contractor Overhead (Ch. 2 Step 4)	13.0% of line 6	$136,080.83	
Total Indirect Costs			**$324,500**
Contractor Profit (Ch. 2 Step 4)	7.0% of line 6		**$73,274**
GRAND TOTAL BOND AMOUNT (Sum of Items 6, 12 & 13)			**$1,444,550**

Data Source(s):

Mountain Top Removal Example Mine Plan
Caterpillar Performance Handbook, Edition 48
Cost Reference Guide for Construction Equipment, RSMeans
Bureau of Labor Statistics, http://www.bls.gov/oes/current/oes_3710.htm
PA DEP Mine Site Reclamation Bond Rates, 2020
ODNR Performance Security Estimate & Unit Costs
OSM Handbook for Calculation of Reclamation Bond Amounts, Revised 2020

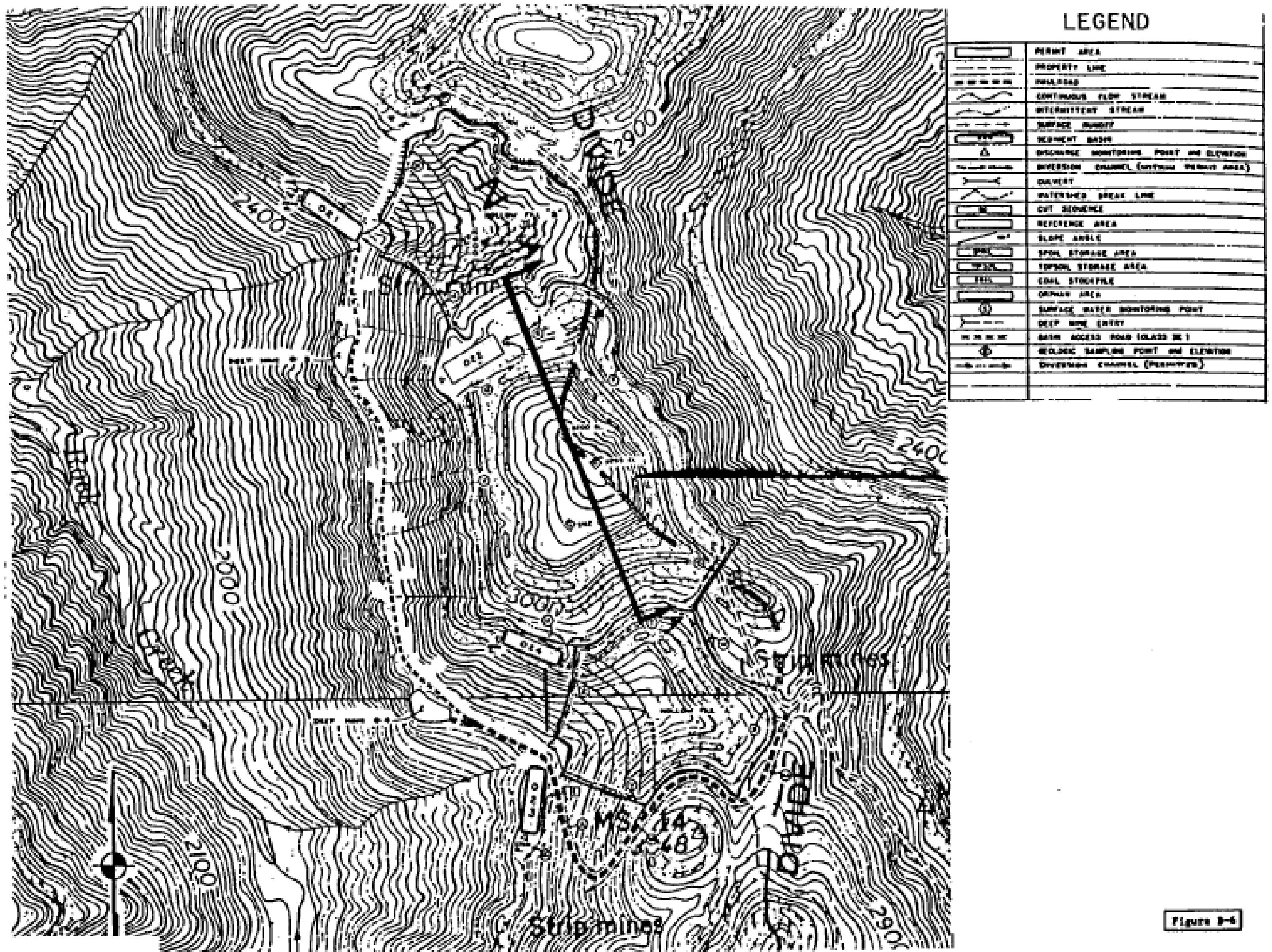

LEGEND
PERMIT AREA
PROPERTY LINE
HAULROAD
CONTINUOUS FLOW STREAM
INTERMITTENT STREAM
SURFACE RUNOFF
SEDIMENT BASIN
DISCHARGE MONITORING POINT AND ELEVATION
DIVERSION CHANNEL (WITHIN PERMIT AREA)
CULVERT
WATERSHED BREAK LINE
CUT SEQUENCE
REFERENCE AREA
SLOPE ANGLE
SPOIL STORAGE AREA
TOPSOIL STORAGE AREA
COAL STOCKPILE
ORPHAN AREA
SURFACE WATER MONITORING POINT
DEEP MINE ENTRY
BASIN ACCESS ROAD (CLASS III)
GEOLOGIC SAMPLING POINT AND ELEVATION
DIVERSION CHANNEL (PERIMETER)
DIVIDE
2900
2400
2000
2100
Strip mines
Rock
Creek
MS-14

Figure 9-6

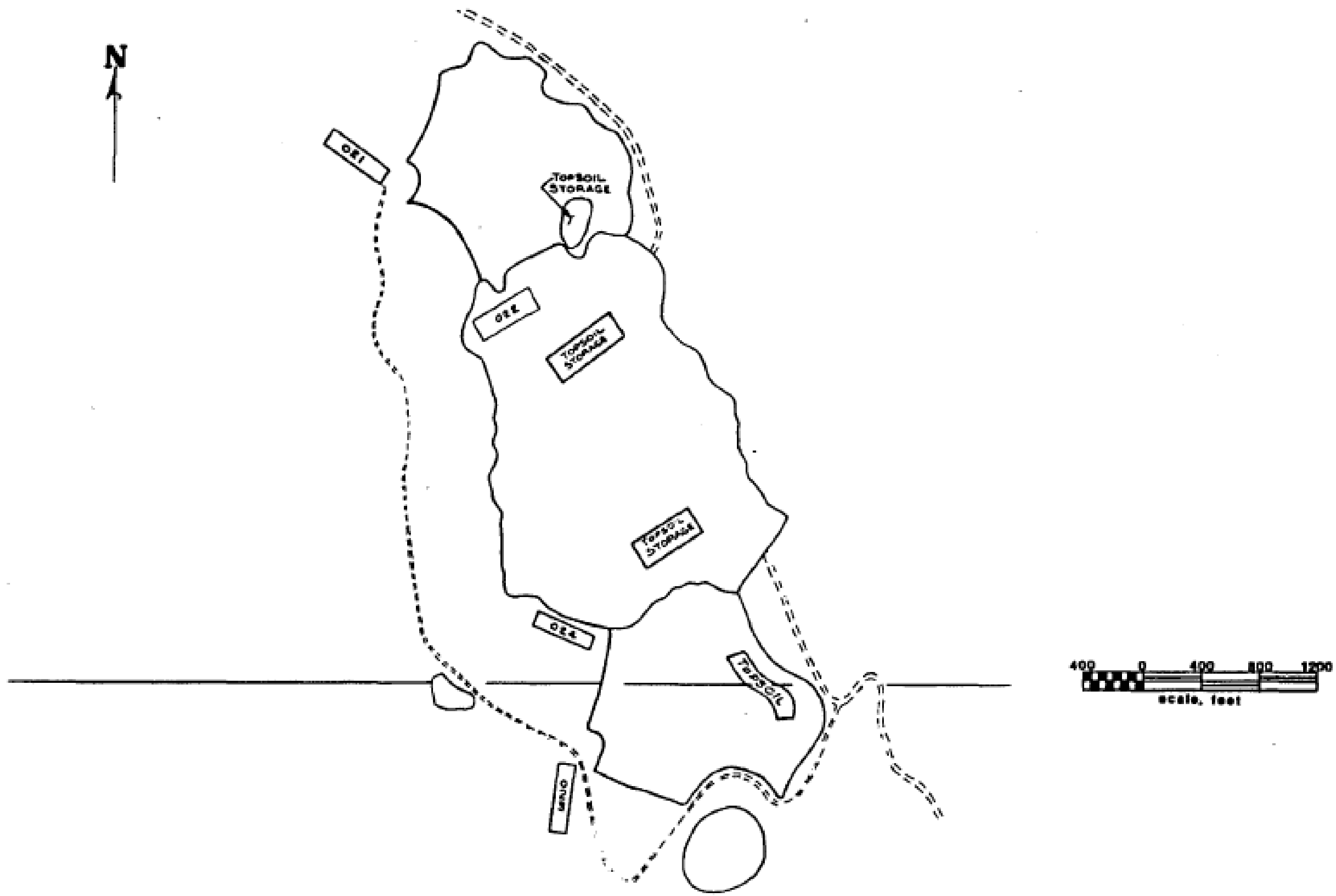
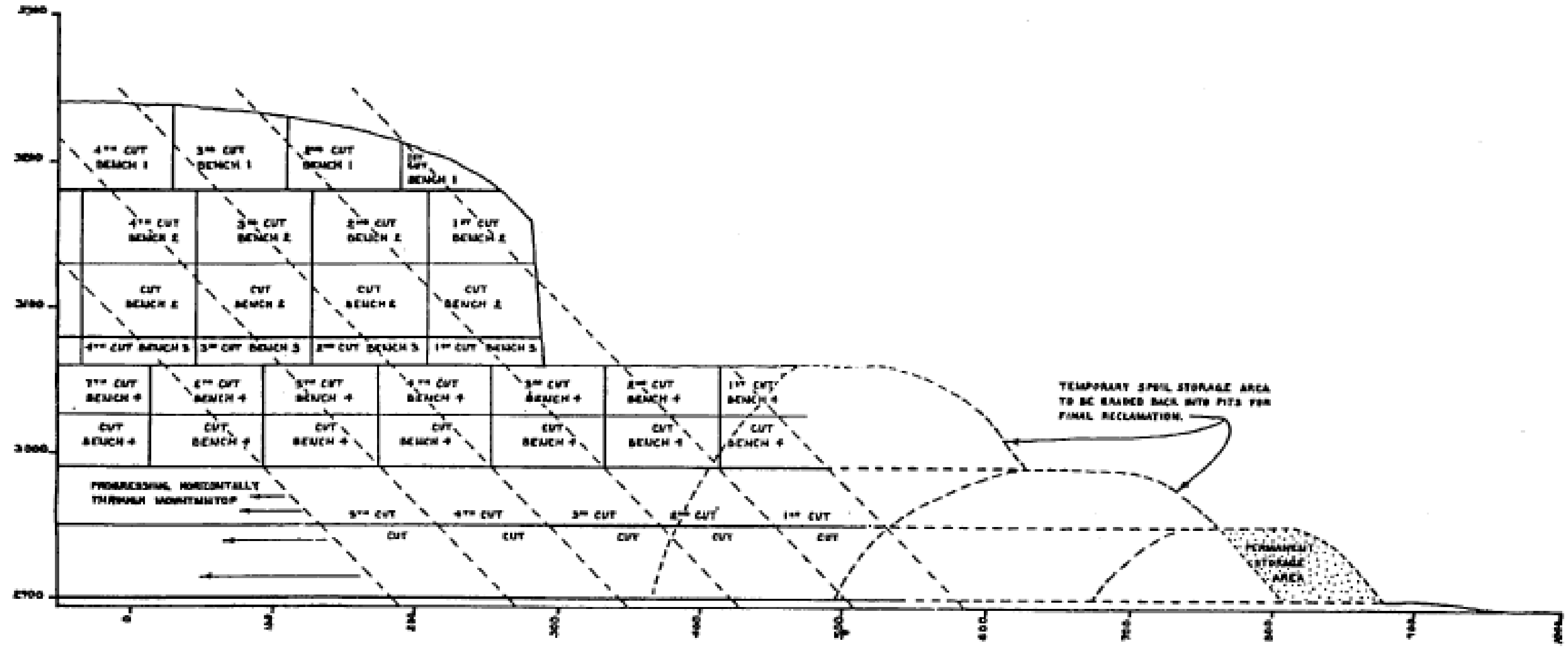
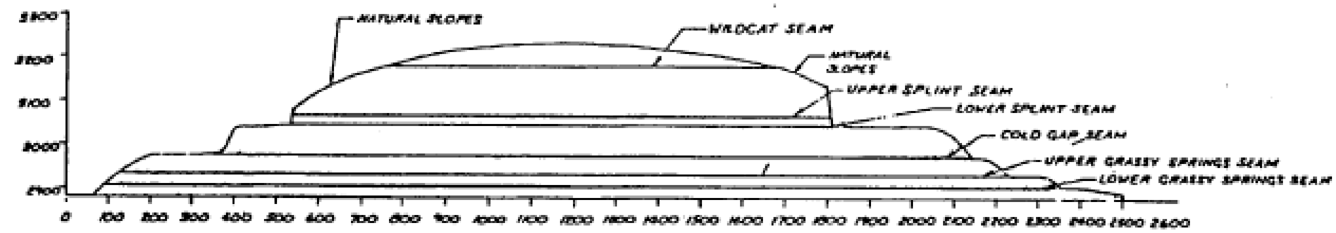

N
ORE 1
ORE 2
ORE 4
TOPSOIL STORAGE
TOPSOIL STORAGE
TOPSOIL STORAGE
TOPSOIL
400 0 400 800 1200
scale, feet

Figure 8-7

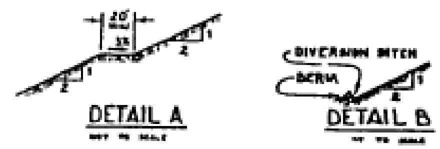


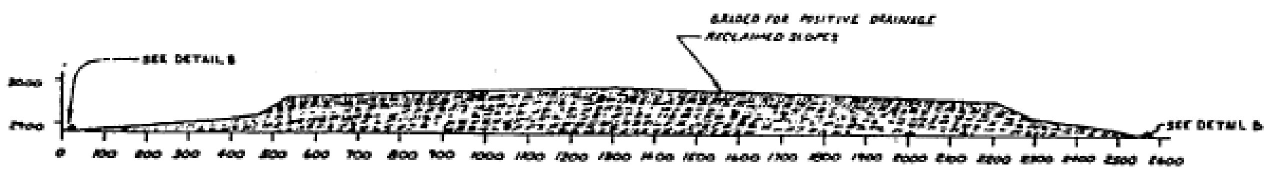
LOCATION & SEQUENCE OF CUTS

Figure B-8



PRE-MINING AREA SECTION "A-A"





POST MINING AREA SECTION "A-A"

Figure 3-9

BOND AMOUNT COMPUTATION

Applicant:
PROCESSING PLANT EXAMPLE

Permit Number: Example No.5 Permitted Acreage: 31.0

Bonding Scheme (permit area, incremental, cumulative): permit area

If Incremental:
Increment Number: __
Increment Acreage: __

If Cumulative:
Acres previously authorized for disturbance: __
New acres proposed for disturbance: __

Type of Operation: Coal Processing with Reclamation
Location: U.S.A. - West Virginia

Prepared by: P.T. Bond
Date: 02/02/2020
Total Bond Amount: $ 396,320.00

WORKSHEET 1 : DESCRIPTION OF THE WORST-CASE RECLAMATION SCENARIO

The coal-processing operation consists of a processing plant, a rail loading facility, and a refuse disposal area. The processing/loading site covers a disturbed area of approximately 9 acres. The refuse disposal site covers approximately 22 acres. (Figures B-1 0 through B-13 pertain to this example and can be found at the end of the worksheets.)

The processing/loading operation consists of a raw coal stockpile, an underground conveyor to the plant, the processing plant, conveyors from the plant to the refuse stockpile and the clean coal silo/stockpile, a scale house/office, scale, and shop building. Surface drainage control structures include diversion ditches, two storage basins that supply water to the plant, and sedimentation pond No. 001. The railroad ties and rail were previously removed.

Reclamation of the area includes removal of all structures from the processing/loading site. Waste coal and contaminated soil will be excavated and transported to the refuse disposal area. The surface of the site will be ripped to loosen and mix the compacted soil prior to seed-bed preparation. The site will be returned to its approximate original contour and vegetated with herbaceous species, achieving a condition capable of supporting an industrial post-mining land use.

Refuse from the processing operation will be transported to the refuse disposal area via a public road, approximately 1.4 miles away. The refuse disposal site is an abandoned surface coal mine from which the spoil will be salvaged, segregated and stored along the perimeter for use as a topsoil substitute to cover the refuse. Refuse will be compacted in lifts, then topsoil substitute will be graded to cover the completed lifts with 4 feet of material. Sedimentation pond No. 002 provides surface drainage control for the refuse disposal site.

The refuse disposal area will be covered with the topsoil substitute and vegetated with species that will stabilize the site and provide wildlife enhancement, achieving an undeveloped post-mining land use.

When it has been determined that vegetation has been successfully established and the surface drainage control structures are no longer required, the storage basins and sedimentation pond No. 001 will be backfilled and eliminated, and the sites vegetated. Sedimentation pond No. 002 will be removed to create a rock-lined channel on that site. The adjacent terrain will be vegetated.

Source(s): Permit Application

WORKSHEET 1 (continued)

DESCRIPTION OF THE WORST-CASE RECLAMATION SCENARIO

1. EARTHMOVING	
Waste coal and contaminated soil:	Soil will be removed to a depth of 6 inches from the footprint below three stockpile areas totaling 1.4 acres. With 15% final swell volume, the total ripped volume is 1,300 cubic yards.
Topsoil Substitute Material:	Material salvaged for final lift area of refuse disposal site: 0.86-acre surface area with depth of 4', plus 15 % final swell volume yields total volume of 6,400 cubic yards.
Storage basins and sediment pond No. 001:	Pond No. 001 embankment contains 5,000 cubic yards. The material excavated from the basins and the berms will be used to fill the basins. Basin No. 1 volume is 313 cubic yards, Basin No. 2 is 333 cubic yards. With 15% final swell volume the total volume is 6,500 cubic yards. Water quality is non-acidic.
Area to be ripped:	Two acres of a 9-acre processing/loading site is vegetated and will not be re-disturbed. The remaining 7 acres will be ripped.
2. REVEGETATION	
Processing/loading site:	Seven acres will require re-vegetation.
Refuse disposal site:	Of this 22-acre site, concurrent reclamation occurred on 17 acres. The remaining 5 acres require vegetation.
3. OTHER RECLAMATION ACTIVITY	
Sediment pond No. 002	Embankment will be graded and eliminated to construct a rock-lined drainage channel. Rocks rimming the embankment will be used for the post-mine channel.
Treating and dewatering basins and ponds:	Volume of water to be removed is total of basins filled at normal pool elevation. Basin No. 1 8,450 ft^3 Basin No. 2 9,000 ft^3 Pond No. 001 214,751 ft^3 Pond No. 002 463,914 ft^3 696,115 ft^3

NOTE: Worksheets 4A or B, 10, 11A or B, 12, 17 and 18 are not applicable to this example.

Data Source(s): Permit Application

WORKSHEET 2: STRUCTURE DEMOLITION AND DISPOSAL COSTS

Structures to be demolished:

Item	Construction Material	Volume (cubic feet)	Unit Cost	Demolition Cost ($)
Plant	Steel beams, metal siding & roofing	50W' X50'H X80'L 200,000	.30	60,000.00
Scale House/Office	Wood frame, steel siding & roofing	20'W X10'H X 28'L 5,600	.30	1,680.00
Scale House/ Office Floor	Concrete	20'W X.5'H X 28'L 280	.91	255.00
Scale	Wood frame, steel siding & roofing	30'W X .5'H X 25'L 375	.30	113.00
Scale Foundation	Concrete	30'W X 2'H X 25L 1500	.91	1,365.00
Shop Building	Wood frame, steel siding & roof	28.5'W X 10'H X 28.5'L 8,123	.30	2,437.00
	Subtotal	215,878 (7,995 cy)		$ 65,850.00

Other items to be demolished (paved roads, conveyors, etc.):

Conveyor Systems: Structural steel supports for elevated units; underground units enclosed in metal pipes; total length of conveyor system is 790 linear feet.

790 LF x 16 / 1 LF = $12,640 Subtotal = $ 12,640.00

Debris Handling and Disposal Costs:

Lump-sum cost to move rubble and gravel into the underground conveyor excavations and removal/disposal of culvert with dozer.

Lump sum = $9,000 Subtotal = $ 9,000.00

Haul Steel and concrete building waste disposal, by truck to local landfill (5 miles)

7,995 cy X $14.70/cy Subtotal =$ 117,527.00

TOTAL DEMOLITION AND DISPOSAL = $ 205,017.00

Data Source(s): Means Heavy Construction Cost Data, 2019; AML data

WORKSHEET 3: MATERIAL HANDLING PLAN SUMMARY

Earthmoving Activity	Volume (LCY)	Origin	Destination	Haul Distance (ft)	Grade* (%)	Equipment To Be Used
1. Excavate coal waste	1,300	Coal stockpile pad	Coal stockpile pad	50	0	D7E-SU w/ 3-shank ripper
2. Load coal waste	1,300	Site	Site	50	0	325F L excavator
3. Haul coal waste	1,300	Site	Site	7,392	0	Over the Road
4. Grade coal waste	1,300	Site	Site	50	0	D7E-SU
5. Rip surface of site; 7 acres					0	D7E-SU W/3-shank ripper
6. Final grading of site; 7 acres					0	D6R-S
7. Grade topsoil substitute	6,400	Site	Site	150	0	D7E-SU W/3-shank ripper
8. Grade and remove pond No. 001 and storage basins	6,500	Embankments	Basins and Pond	100	0	D7E-SU W/3-shank ripper
9. Grade and remove pond No. 002 and construct rock channel						See Worksheet 15
*Record grade resistance (0% grade) here.						

WORKSHEET 5A: PRODUCTIVITY AND HOURS REQUIRED FOR DOZER USE

Earthmoving Activity:
Excavate 6-inch layer of coal waste and contaminated soil from the 1.4 acres stockpile area. Swollen volume of material is 1,300 LCY.

Characterization of Dozer Used (type, size, etc.):
D7E with SU-Blade dozer and 3-shank ripper

Description of Dozer Use (origin, destination, grade, haul distance, material, etc.):
Dozer will excavate and pile material for loading. The average push distance is 50 feet and the effective grade is 0 percent. The material weight is 1,600 lb/LCY.

Productivity Calculations:

Operating Adjustment Factor = 0.75 (Operator Factor) x 0.80 (Material Factor) x 0.83 (Efficiency Factor) x 1.0 (Grade Factor) x 0.74* (Weight Correction Factor) x

1.0** (Production Method/ Blade Factor) x 1.0 (Visibility Factor) x 1.0 (Elevation Factor) = 0.37 .

Net Hourly Production = 700 (Normal Hourly Production) LCY/hr. x 0.37 (Operating Adjustment Factor) = 259 LCY/hr.

Hours Required = 1,300 (volume to be moved) LCY ÷ 259 (net hourly production) LCY/hr. = 5 hrs.

*Weight Factor = $\frac{1{,}600 \text{ lb/LCY}}{2{,}150 \text{ lb/BCY}}$ = 0.74

** Normal dozing with SU blade use 1.00

Data Source(s): Permit application, Caterpillar Performance Handbook Ed. 46

WORKSHEET 5B: PRODUCTIVITY AND HOURS REQUIRED FOR DOZER USE

Earthmoving Activity:
Grade waste/soil at refuse site to blend with contour of fill. Swollen volume of material is 1,300 LCY.

Characterization of Dozer Used (type, size, etc.):
D7E with SU-Blade dozer and 3-shank ripper

Description of Dozer Use (origin, destination, grade, haul distance, material, etc.):
Dozer will excavate and pile material for loading. The average push distance is 50 feet and the effective grade is 0 percent. The material weight is 1,600 lb/LCY.

Productivity Calculations:

Operating Adjustment Factor = 0.75 (Operator Factor) x 1.2 (Material Factor) x 0.83 (Efficiency Factor) x 1.0 (Grade Factor) x 0.74* (Weight Correction Factor) x 1.0** (Production Method/ Blade Factor) x 1.0 (Visibility Factor) x 1.0 (Elevation Factor) = 0.55 .

Net Hourly Production = 925 LCY/hr. (Normal Hourly Production) x 0.55 (Operating Adjustment Factor) = 509 LCY/hr.

Hours Required = 1,300 LCY (volume to be moved) ÷ 509 LCY/hr. (net hourly production) = 3 hrs.

*Weight Factor = $\frac{1{,}600 \text{ lb/LCY}}{2{,}150 \text{ lb/BCY}}$ = 0.74

** Normal dozing with SU blade use 1.00

Data Source(s): Permit application, Caterpillar Performance Handbook Ed. 46

WORKSHEET 5C: PRODUCTIVITY AND HOURS REQUIRED FOR DOZER USE

Earthmoving Activity:
Grade topsoil substitute material to distribute over refuse and achieve final contour. Swollen volume of material is 6,400 LCY.

Characterization of Dozer Used (type, size, etc.):
D7E with SU-Blade dozer and 3-shank ripper

Description of Dozer Use (origin, destination, grade, haul distance, material, etc.):
Dozer will grade material to achieve 4-foot depth over 0.86-acre surface of refuse fill. The average push distance is 150 feet and the effective grade is 0 percent. The material weight is 1,600 lb/LCY.

Productivity Calculations:

Operating Adjustment Factor =	0.75	x	1.2	x	0.83	x	1.0	x	0.74*	x
	Operator Factor		Material Factor		Efficiency Factor		Grade Factor		Weight Correction Factor	

1.0**	x	1.0	x	1.0	=	0.55 .
Production Method/ Blade Factor		Visibility Factor		Elevation Factor		

Net Hourly Production	=	400	LCY/hr. x	0.55	=	220	LCY/hr.
		Normal Hourly Production		Operating Adjustment Factor			

Hours Required	=	6,400	LCY ÷	220	LCY/hr. =	29	hrs.
		volume to be moved		net hourly production			

*Weight Factor = $\frac{\text{1,600 lb/LCY}}{\text{2,150 lb/BCY}}$ = 0.74

** Normal dozing with SU blade use 1.00

Data Source(s): Permit application, Caterpillar Performance Handbook Ed. 46

WORKSHEET 5D: PRODUCTIVITY AND HOURS REQUIRED FOR DOZER USE

Earthmoving Activity:
Grade embankment material to backfill storage basins and pond no. 001. Swollen volume of material is 6,500 LCY.

Characterization of Dozer Used (type, size, etc.):
D7E with SU-Blade dozer and 3-shank ripper

Description of Dozer Use (origin, destination, grade, haul distance, material, etc.):
Dozer will embankment to fill excavations. The average push distance is 100 feet and the effective grade is 0 percent. The material weight is 1,600 lb/LCY.

Productivity Calculations:

Operating Adjustment Factor = 0.75 (Operator Factor) x 1.0 (Material Factor) x 0.83 (Efficiency Factor) x 1.0 (Grade Factor) x 0.74* (Weight Correction Factor) x 1.0** (Production Method/ Blade Factor) x 1.0 (Visibility Factor) x 1.0 (Elevation Factor) = 0.46 .

Net Hourly Production = 580 (Normal Hourly Production) LCY/hr. x 0.46 (Operating Adjustment Factor) = 267 LCY/hr.

Hours Required = 6,500 (volume to be moved) LCY ÷ 267 (net hourly production) LCY/hr. = 24 hrs.

*Weight Factor = $\frac{\text{1,600 lb/LCY}}{\text{2,150 lb/BCY}}$ = 0.74

** Normal dozing with SU blade use 1.00

Data Source(s): Permit application, Caterpillar Performance Handbook Ed. 46

WORKSHEET 6: PRODUCTIVITY AND HOURS REQUIRED FOR DOZER USE - GRADING

Earthmoving Activity:
Final Grading

Characterization of Dozer Used (type, size, etc.):
D6R with 13'8" blade.

Description of Dozer Use (origin, destination, grade, haul distance, material, etc.):
Grading along contour (0% grade) to smooth coal refuse moved by truck and loader team and to eliminate rills and gullies prior to topsoil replacement in loose cubic yards.

Productivity Calculations:

Operating Adjustment Factor = .75 (Operator factor) X 1.0 (material factor) X .83 (efficiency factor) X 1.0 (grade factor) X .74* (weight correction factor) X 1.0 (production method/blade factor) X 1.0 (visibility factor) X 1.0 (elevation factor) = 0.46

Hourly Production = 3.0 (Average Speed) mi/hr X 12 ** (effective blade width) ft X 5,280 ft/mi X 1 ac/43,560 ft^3 = 4 ac/hr

Net Hourly Production = 4 (hourly production) ac/hr X 0.46 (Operating adjustment factor) = 2 ac/hr

Hours Required = 31 (area to be graded) AC ÷ 2 (net hourly production) ac/hr = 16 hr

*Weight Factor = $\frac{1{,}600 \text{ lb/LCY}}{2{,}150 \text{ lb/BCY}}$ = .74

**Effective blade width: 13.75' – 1.5' overlap = 12'

Data Source(s): Permit application, Caterpillar Performance Handbook Ed. 46

WORKSHEET 7: PRODUCTIVITY AND HOURS REQUIRED FOR RIPPER EQUIPPED DOZER USE

Ripping Activity:
Characterization of Dozer and Ripper Use:
D7E with SU-blade and 3 shank parallelogram ripper.

Description of Ripping (ripping depth, cut spacing, and material to be ripped):
Dozer will rip surface area of 7 acres (304,920 ft^2). The average cut length is 200', ripping is about 2.45' deep and 9.75' wide.
(3 ripper shanks with a 3.25' spacing and 3.25' gap between passes. Pass width = 3 X 39"/12"/1' = 9.75')

Productivity Calculations:

Cycle Time = (200 ft [cut length] ÷ 88 ft/min [speed]) + 0.3 [fixed turn time] min = 2.6 min/pass

Passes/Hour = 60 min/hr ÷ 2.6 [cycle time] min/pass X 0.83 [efficiency factor] = 19 passes/hr

Volume Cut/Pass = (2.45 [tool penetration] ft X 9.75 [cut spacing] ft X 200 [cut length] ft) ÷ 27 ft^3/yd^3 = 177 BCY/pass

Hourly Production = 177 BCY/pass X 19 passes/hr = 3,363 BCY/hr

Hours Required = 27,669 [bank volume to be ripped] BCY ÷ 3,398 BCY/hr = 8 hr

Fixed turn time depends on dozer used. 0.3 min/turn is normal.

Data Source(s): Permit application, Caterpillar Performance Handbook Ed. 46

WORKSHEET 8: PRODUCTIVITY AND HOURS REQUIRED FOR EXCAVATOR USE

Earthmoving Activity:
Load excavated waste coal and contaminated soil into 8-ton OTR truck for haul to refuse area. Swollen volume of material is 1,300 cubic yards.

Characterization of Loader Use (type, size, etc.):
Caterpillar 325F L Excavator

Description of Ripping (ripping depth, cut spacing, and material to be ripped):
Excavator will have 2.2 heaped yd bucket to load truck for haul to refuse site.

Productivity Calculations:

Net Bucket Capacity =	2.2	LCY X	0.85*	=	1.87	LCY
	heaped bucket capacity		bucket fill factor			

Hourly Production =	1.87	LCY ÷	0.30	min X	0.83	X 60 min/hr	=	310.42	LCY/hr
			cycle time*		efficiency factor				

Hours Required =	1,300	LCY ÷	310	LCY/hr	=	4.19	hr
	Volume to be moved		hourly production			use 5 hrs	

*See excavator section of equipment manual.

Data Source(s): Permit application, Caterpillar Performance Handbook Ed. 46

WORKSHEET 9: PRODUCTIVITY AND HOURS REQUIRED FOR TRUCK USE

Earthmoving Activity:
Haul waste coal and contaminated soil for haul to refuse disposal site. Swollen volume of material is 1,300 cubic yards.

Characterization of Truck Use (type, size, etc.):
8-ton OTR truck, average capacity

Description of Truck Use (origin, destination, grade, haul distance, capacity, etc.):
Trucks will haul material from processing/loading site to disposal site, a haul distance of 1.4 miles (7,400 ft). The effective grade is 4%; the effective grade for the return is 4%.

Productivity Calculations:

No. Loaders Passes/Truck = 8 (truck capacity) LCY ÷ 1.87 (net capacity) LCY = 4.28 passes

Net Truck Capacity = 1.87 (loader bucket net capacity) LCY X 5 (number loader passes/truck) = 9.35 LCY

Loading Time/Truck = 0.30 (Loader cycle time) min X 5 (number loader passes/truck) = 1.5 min

Truck Cycle Time = 5.61 (haul time) + 3.36 (return time) + 1.5 (total loading time) + 2.0 (dump and maneuver time) = 12.5 min

No. Trucks Required = 12.5 (truck cycle time) min ÷ 1.5 (total loading time) min = 9 trucks

Production Rate = 8 (net truck capacity) LCY X 9 (number trucks) ÷ 12.5 (truck cycle time) min = 5.76 LCY/min

Hourly Production = 5.76 (Production rate) LCY/min X 60 min/hr X 0.75 (efficiency factor) = 259.2 LCY/hr

Hours Required = 1,300 (Volume to be moved) LCY ÷ 259 (hourly production) LCY/hr = 5.02 hr
use 5 hours

*Normally the average of the struck and heaped capacities.

Haul time: 7400 ft/(15 mph X 88 fpm/1 mph) = 5.61 minutes. Return time: 7400 ft/(25 mph X 88 fpm/1 mph) = 3.36 minutes

Data Source(s): Permit application, Caterpillar Performance Handbook Ed. 46

WORKSHEET 13: SUMMARY CALCULATION OF EARTHMOVING COSTS

Equipment*	Ownership & Operation Cost ($/hr)	Labor Cost ($/hr)	Total Hours Required**	Total Cost*** ($)
D7E-SU with ripper (249 hp)	133.94	51.79	69	12,815.37
D6R-2 (180 hp)	96.58	51.79	16	2,373.92
325F L	125.00	54.79	5	898.95
9 OTR 8-ton trucks	60.00	51.79	**45	5030.55
			Grand Total	$ 21,119.00

* Include all necessary attachments and accessories for each item of equipment. Also, add support equipment such as water wagons and graders to match total project time as appropriate.

** Account for multiple units in truck/loader team.

*** To compute Total Cost: Add Ownership & Operation Cost and Labor Cost columns then multiply by Total Hours Required column.

Data Source(s): Caterpillar Performance Handbook Ed. 46, Davis Bacon-Labor Costs, website: excavation.promatcher.com – Morgantown, WV, RSMeans Heavy Construction Cost Date 2019, EquipmentWatch – Nov 2019 and June 2020.

WORKSHEET 14: REVEGETATION COSTS

Name and Description of Area to be Revegetated:
Seven acres of processing/loading site and 5 acres of refuse site.

Description of Revegetation Activities:
Seedbed preparation, liming, seeding and mulching; shrub-planting pattern will cover total area of 1 acre; 50% reseeding failure rate assumed and 20% plant failure assumed.

Cost Calculation for Individual Revegetation Activities:

Initial Seeding

12 ac x ($ 500 /ac + 43.88 /ac) = $ 6527.00
Area to be seeded; seedbed preparation & mulching; seeding, mulching,

Planting Trees and Shrubs

1 ac x ($ 350 /ac) + 300 /ac) = $650.00
Area to be planted; planting; herbicide treatment

Reseeding

12 ac x .50 x ($ 500 /ac + 43.88 /ac) = $ 3,263.00
Area to be seeded; seedbed preparation & mulching; seeding, mulching,

Replanting Trees and Shrubs

1 ac x .20 x ($ 350 /ac) + 300 /ac) =$ 130.00
Area to be planted; failure rate; planting; herbicide treatment

Other Necessary Revegetation Activities

(Examples of other activities that may be necessary include soil sampling, irrigation, and rill and gully repair. Describe each activity and provide a cost estimate with documentation. Use additional worksheets if necessary.

Other Costs: $ 0 .

Total Revegetation Cost: $ 10,570.00

Data Source: AML Contract Data, USDA

WORKSHEET 15: OTHER RECLAMATION ACTIVITY COSTS

(Subsidence damage repair costs, water supply replacement costs, funds required to support long-term treatment of unanticipated or ferruginous mine drainage, etc.)

Description of Reclamation, Repair or Pollution Abatement Activity:
Grade to eliminate embankment of sediment pond No. 002 and construct rock-lined drainage channel using on-site rock. Channel will be 300 feet long.

Assumptions:
Unit cost includes elimination of rock-line embankment. Rock to be used to line final drainage channel.

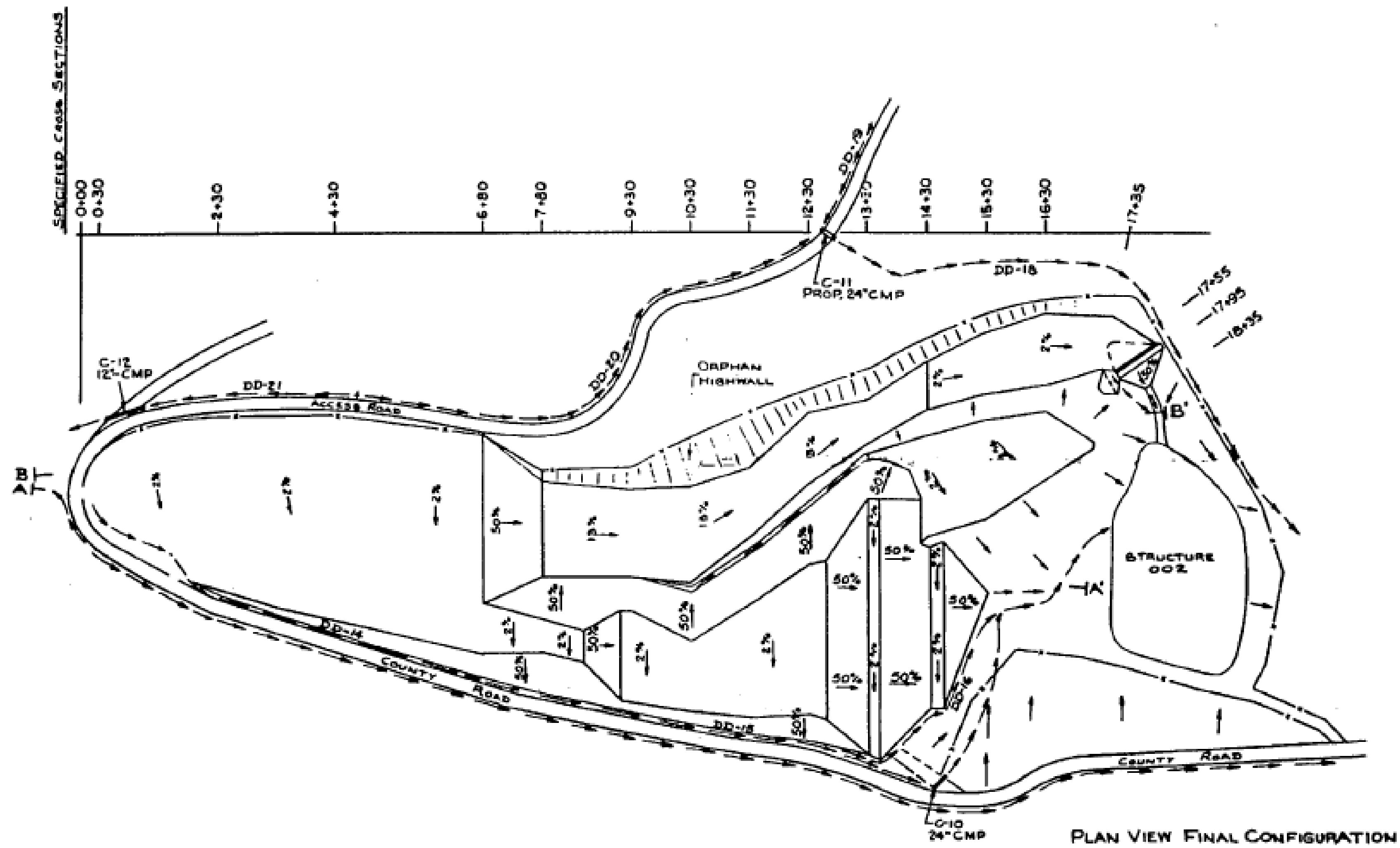
Cost Estimate Calculations:
Dozer D7E use for 40 hours X 185.73/hr = $7,429.20 to remove embankment and create rock-lined post-mine channel.

TOTAL COSTS = $7,429.00

Data source(s): Permit Application, WV Davis-Bacon Wage Rate (Nov 2019), EquipmentWatch (Nov 2019)

WORKSHEET 16- RECLAMATION BOND SUMMARY SHEET

1. Total Facility and Structure Removal Costs	$ 205,017.00
2. Total Earthmoving Costs	$ 21,119.00
3. Total Revegetation Costs	$ 10,570.00
4. Total Other Reclamation Activities Costs	$ 7,429.00
5. Total Direct Costs (Sum of Lines 1 through 4)	$ 244,135.00
6. Inflated Total Direct Costs (Line 5)*(inflation factor) (Ch. 2 Step 3)	$ 283,088.00
7. Mobilization and Demobilization (5% of line 6) (1% to 10% of Line 6) (Ch. 2 Step 4)	$ 14,154.00
8. Contingencies (5% of line 6) (3% to 5% of Line 6) (Ch. 2 Step 4)	$ 14,154.00
9. Engineering Redesign Fee (5% of line 6) (2.5% to 6% of Line 6) (Ch. 2 Step 4)	$ 14,154.00
10. Project Management Fee (5% of line 6) (Table 1) (Ch. 2 Step 4)	$ 14,154.00
11. Contractor Overhead (13% of line 6) (Table 2) (Ch. 2 Step 4)	$ 36,800.00
12. Contractor Profit (7% of line 6) (Table 3) (Ch. 2 Step 4)	$ 19,816.00
13. Total Indirect Costs (Sum of Lines 7 through 12)	$ 113,232.00
GRAND TOTAL BOND AMOUNT **(Sum of Items 6, 13)**	**$ 396,320.00**



Plan View Final Configuration
Refuse Area #1

Figure 3-10

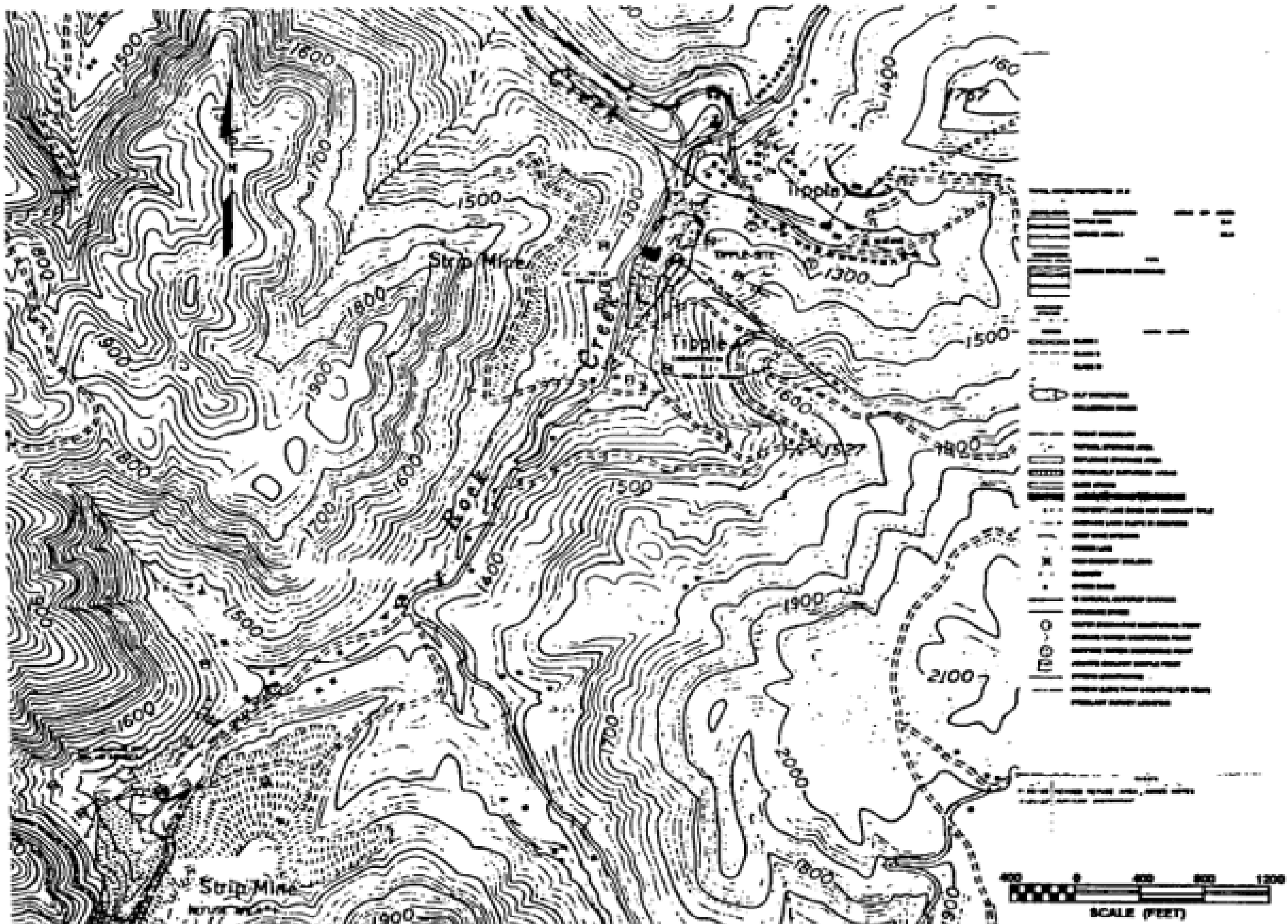
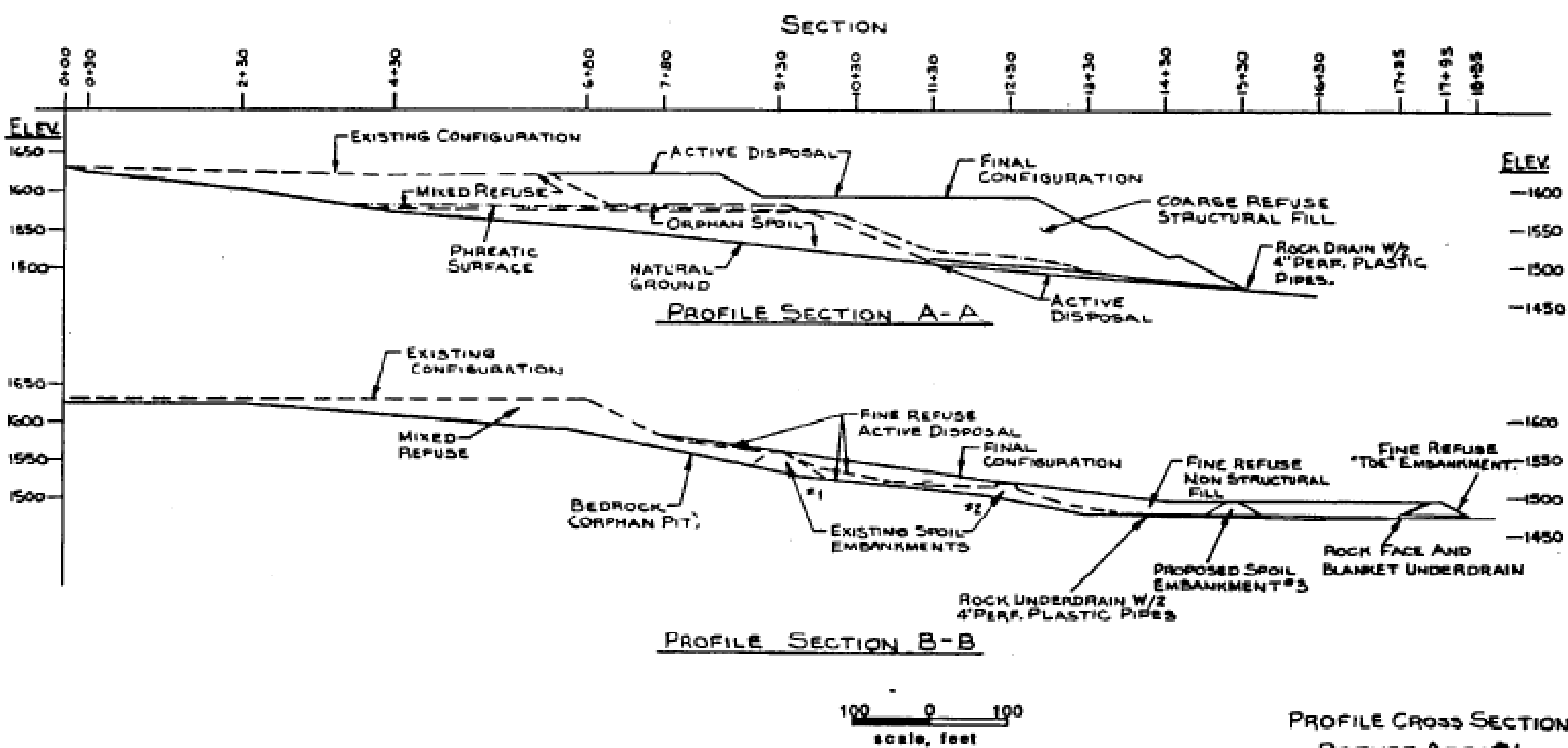
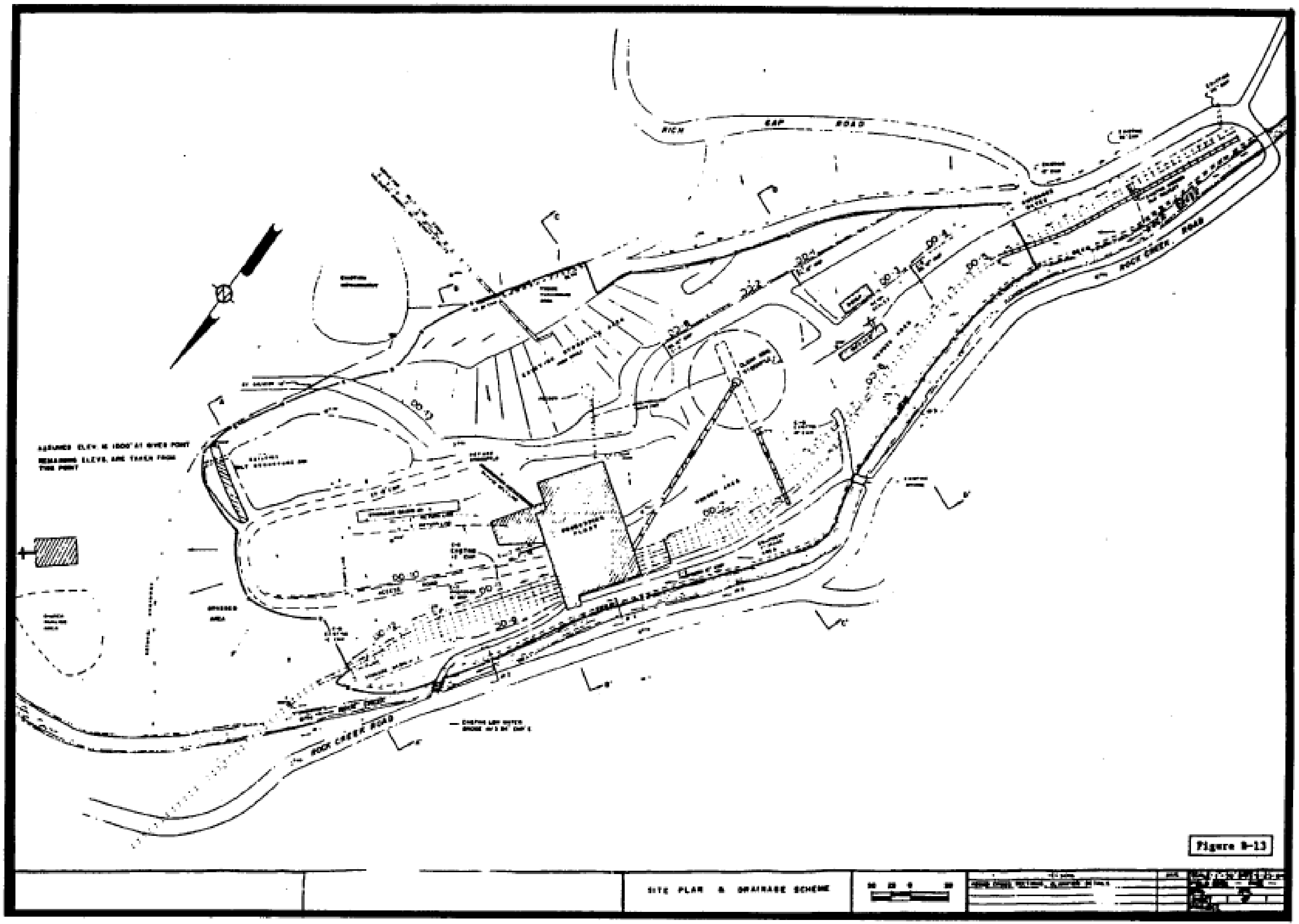

Creek
Rock
Creek
Tipple
Tipple
Strip Mine
Strip Mine
1300
1400
1500
1600
1700
1800
1900
2000
2100
400 0 400 800 1200
SCALE (FEET)

Figure B-12



PROFILE CROSS SECTIONS
REFUSE AREA #1

Figure 8-11


RICH GAP ROAD
ROCK CREEK ROAD
ASSUMED ELEV. @ 1000' AT RIVER POINT
REMAINING ELEVS. ARE TAKEN FROM THIS POINT
SITE PLAN & DRAINAGE SCHEME
Figure 8-13

APPENDIX C: OVERHEAD AND PROFIT RATE DETERMINATION

Overhead and profit rates are based on actual average benchmarks for the heavy construction industry (**Table C1-A**). Overhead costs are those cost associated with General and Administrative (G&A) expenses. For financial reporting these costs are expressed as a percentage of revenue to adhere to accounting standards for making cross-industry comparisons. Revenue serves as the base being that it is consistently measured across industries. For our purpose for reclamation bond calculations direct cost is the starting component and foundation for applying indirect costs rates and profit to obtain a full cost.

For consistency with financial reporting we must convert reported rates to a direct cost percentage. To accomplish this, it is necessary to bridge these rates using a common project in dollar costs but expressed on both percentage basis (**Table C1-B**). Given a $25 million project, $3.5 million (14% of $25 million) accounts for overhead and profit leaving $21.5 million ($25 - $3.5 million) for the remaining other indirect cost and direct cost. In our bond calculation other indirect cost is 23% of direct cost, including mobilization and demobilization (7%), engineering redesign fee (7%), reclamation project management fee (5%), and contingency cost (4%). We can infer a direct cost in dollars of $17.48 million ($21.5 x 1.00/1.23), using the proportionality factor of direct cost (1.00) to total other indirect and direct cost (1.23). With the projects direct cost in dollars, we infer all other percentages expressed as a percentage of direct cost. On a direct cost basis, overhead rate is 13% ($2.25/$17.48) and the profit rate becomes 7% ($1.25/$17.48). As percentage equivalents to industry financial reporting rates these rates serve as our average overhead and profit rates applied in our reclamation cost estimates.

Although overhead and profit are commonly paired under the label “O & P” in construction cost estimation, project-specific rates for overhead are independent of project profit rates. Overhead rates are size dependent while profit variation is typically dependent on inherent risks of projects.

Table C1-A: National Construction Benchmarks for Overhead and Profit Reported as Percentage of Revenue

	General and Administrative Expenses	Industry Earnings (EBTI)
2018	8.8%	4.9%
2017	9.3%	4.9%
2016	9.2%	5.3%
Three-year average	**9.1%**	**5.0%**

Source: 2019 CLA Civil Construction Benchmark Report

Table C1-B: Financial Benchmark Percentages Equivalents with Direct Cost Percentages on Project-level

	Percent of Revenue for financial reporting	Project in dollars (millions)	Percent of Direct Cost for bond cost estimation
Overhead rate (G&A expense)	9%	$2.25	13%
Profit rate (Earnings)	5%	$1.25	7%
Total Overhead and Profit	**14%**	**$3.50**	**20%**
Other Indirect cost	16%	$4.02	23%
Direct cost	70%	$17.48	100%
Other indirect cost and direct cost	**86%**	**$21.50**	**123%**
Total Revenue = Total project cost, plus profit	**100%**	**$25.00**	**143%**

Other indirect cost of 23% includes mobilization and demobilization (7%), engineering redesign fee (7%), reclamation project management fee (5%), and contingency cost (4%).

Table C1-C: Acreage Statistics for Permitted Mine Sites in Federal Programs

Acreage Category	**Mean**	**Median**	**Range** Min	Max	**Percent of Total Sites**	**Percent of Total Acreage**
< 90 acres	34	28	2	89	52%	3%
≥90 and ≤ 700 acres	286	250	92	664	39%	17%
>700 acres	5,825	2,644	730	44,073	9%	80%
All sites	**658**	**84**	**2**	**44,073**	**100%**	**100%**

Source: Office of Surface Mining Inspection & Enforcement (I&E) tracking system from Mine Site Inspection (MSI) reports.

Higher rates of overhead are applied to smaller projects in part because such projects generate relatively less revenue for a given amount fixed costs or assets they use. In addition, fixed transactions cost such as those for billing are higher on a per project basis. For example, the amount of administrative time used for processing accounting and billing documents for small projects might be the same as for large projects. Greater efficiencies achieved on larger projects is generally referred to as economies of size benefit. These pre-determined costs are necessary to give contracting firms the capacity or suitable operating scale for which to provide service for expected reclamation workload over multiple months and years. Thereby, such costs are deemed "fixed overhead" with respect to individual projects.

We establish broad categories of actual mine site (**Table C1-C)** for assigning overhead rates. Statistically variable overhead rates would approximate the industry's overall long-term overhead rate benchmark rate. We accomplish this using three categories for project size with corresponding overhead rates. A large proportion of sites (52%) are of less than 90 acres and are assigned the highest overhead rate of 15%. Projects sizes that are greater or equal to 90 acres but less than or equal to 700 acres are assigned a 13% overhead rate. Projects greater than 700 acres are assigned the lowest overhead rate of 10%. Although this category accounts for the fewest projects (9%) the category accounts for the bulk of total acreage (80%) due to the significantly larger sites with a mean of 5,825 acres.

This approach using physical units of measure of size calibrated to an industry benchmark eliminates the problem of ever-changing sizes by costs measured in nominal dollars. These rates are is consistent from our review of Federal indirect cost guidelines (**Table C1-D**) including BLM (2012), USACE (2002), and DOE (2014) all with profit and overhead rates independently specified.

Table C1-D: Indirect Cost Guidelines

Indirect Cost Component	USACE/EPA	BLM Handbook H-3809-1 (Sep 2012)	DOE (June 2014)	BLM Alaska Guide (Sep 2014)
Mobilization and Demobilization	Applied as a direct cost	--	--	--
Contingency Allowance	10-25%	4-10%	20%	15%
Engineering Redesign	6-20%	4-8%	10-25%	4-8%
Project Management Fee	5-10%	6-10%	15%	6-10%
Contractor Overhead	5-25%	--	--	10-15%
Contractor Profit	8-10%	10%	10%	10%