60% Design Cost Estimate
Interim Action
Rocky Mountain Arsenal
Basin F

Prepared for:
U.S. Army Corps of Engineers
Omaha District
Omaha Nebraska
August, 1987

Woodward-Clyde Consultants
In Association with HDR Infrastructure, Inc.
Consulting Engineers, Geologists and Environmental Scientists
Stanford Place 3, Suite 1000
4582 South Ulster Street Parkway
Denver, Colorado 80237
(303) 694-2770

Project No. 86C8554P
## Cost Estimates for the Following:

1. Rip-Rap Removal
2. Grading
3. Clay for Capping and Lining
4. Waste Pile Select Fill
5. Topsoil
6. Sumps and Piping
7. Debris Removal
8. Hauling Waste
9. Solidification
10. Roads
11. Filter
12. Drainage Net.
# Basin F 60% Design Cost Estimate w/ 2 Ft. Clay Liner & Cap

## Stage One Construction

<table>
<thead>
<tr>
<th>Activity</th>
<th>Volume</th>
<th>Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remove Rip Rap (So. End)</td>
<td>6,250 C.Y.</td>
<td>$5.50</td>
<td>$34,375.00</td>
</tr>
<tr>
<td>Regrade South Bern</td>
<td>32,250 C.Y.</td>
<td>$2.66</td>
<td>$85,785.00</td>
</tr>
<tr>
<td>Haul Sludge to Stockpile</td>
<td>91,370 C.Y.</td>
<td>$2.66</td>
<td>$243,044.20</td>
</tr>
<tr>
<td>Clay Cap (2 Ft.)</td>
<td>48,070 C.Y.</td>
<td>$6.87</td>
<td>$330,240.90</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td></td>
<td></td>
<td><strong>$693,445.10</strong></td>
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## Landfill Construction

<table>
<thead>
<tr>
<th>Activity</th>
<th>Volume</th>
<th>Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exterior Berms</td>
<td>20,200 C.Y.</td>
<td>$7.34</td>
<td>$148,268.00</td>
</tr>
<tr>
<td>Clay Liner - Bottom (2 Ft.)</td>
<td>43,300 C.Y.</td>
<td>$7.34</td>
<td>$317,822.00</td>
</tr>
<tr>
<td>Clay Liner - Top Sides (2 Ft.)</td>
<td>51,970 C.Y.</td>
<td>$10.78</td>
<td>$560,256.00</td>
</tr>
<tr>
<td>Internal Grading</td>
<td>48,600 C.Y.</td>
<td>$2.66</td>
<td>$129,276.00</td>
</tr>
<tr>
<td>Select Fill (2 Ft.)</td>
<td>56,760 C.Y.</td>
<td>$7.59</td>
<td>$430,808.40</td>
</tr>
<tr>
<td>Top Soil (6 in.)</td>
<td>13,000 C.Y.</td>
<td>$2.93</td>
<td>$38,090.00</td>
</tr>
<tr>
<td>Drainage Net (3 Layers)</td>
<td>1,986,410 S.F.</td>
<td>$0.35</td>
<td>$695,243.50</td>
</tr>
<tr>
<td>Synthetic Liner (2 Layers)</td>
<td>1,307,160 S.F.</td>
<td>$0.80</td>
<td>$1,045,728.00</td>
</tr>
<tr>
<td>Geotextile Fabrics (3 Layers)</td>
<td>1,986,410 S.F.</td>
<td>$0.25</td>
<td>$496,602.50</td>
</tr>
<tr>
<td>Sumps and Piping</td>
<td>1 L.S.</td>
<td>$36,120.00</td>
<td>$36,120.00</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td></td>
<td></td>
<td><strong>$3,898,195.00</strong></td>
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</table>

## North Lagoon (8.5 M Gal)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Volume</th>
<th>Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excavation</td>
<td>54,000 C.Y.</td>
<td>$2.66</td>
<td>$143,640.00</td>
</tr>
<tr>
<td>Clay Liner (2 Ft.)</td>
<td>11,000 C.Y.</td>
<td>$7.34</td>
<td>$80,740.00</td>
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<tr>
<td>Synthetic Liner (2 Layers)</td>
<td>296,600 S.F.</td>
<td>$0.80</td>
<td>$237,280.00</td>
</tr>
<tr>
<td>Drainage Net (1 Layer)</td>
<td>148,300 S.F.</td>
<td>$0.35</td>
<td>$51,905.00</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td></td>
<td></td>
<td><strong>$513,565.00</strong></td>
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## Leachate Lagoon (1.5 M Gal)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Volume</th>
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<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excavation</td>
<td>10,000 C.Y.</td>
<td>$2.66</td>
<td>$26,600.00</td>
</tr>
<tr>
<td>Clay Liner (2 Ft.)</td>
<td>3,750 C.Y.</td>
<td>$7.34</td>
<td>$27,525.00</td>
</tr>
<tr>
<td>Synthetic Liner (2 Layers)</td>
<td>101,250 S.F.</td>
<td>$0.80</td>
<td>$81,000.00</td>
</tr>
<tr>
<td>Drainage Net (1 Layer)</td>
<td>50,625 S.F.</td>
<td>$0.35</td>
<td>$17,718.75</td>
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<tr>
<td><strong>Subtotal</strong></td>
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<td><strong>$152,843.75</strong></td>
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## Liquid Removal

<table>
<thead>
<tr>
<th>Activity</th>
<th>Volume</th>
<th>Cost</th>
<th>Total Cost</th>
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</thead>
<tbody>
<tr>
<td>Pumps and Appurtenances</td>
<td>1 L.S.</td>
<td>$63,192.00</td>
<td>$63,192.00</td>
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<tr>
<td>Force Main</td>
<td>1 L.S.</td>
<td>$298,617.00</td>
<td>$298,617.00</td>
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<tr>
<td>Electrical</td>
<td>1 L.S.</td>
<td>$10,514.00</td>
<td>$10,514.00</td>
</tr>
<tr>
<td>O &amp; M</td>
<td>600 HRS</td>
<td>$13.76</td>
<td>$8,256.00</td>
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<tr>
<td><strong>Subtotal</strong></td>
<td></td>
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<td><strong>$388,579.00</strong></td>
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## Contaminated Material Removal

<table>
<thead>
<tr>
<th>Activity</th>
<th>Volume</th>
<th>Cost</th>
<th>Total Cost</th>
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</thead>
<tbody>
<tr>
<td>Remove Rip Rap</td>
<td>18,750 C.Y.</td>
<td>$5.50</td>
<td>$103,125.00</td>
</tr>
<tr>
<td>Remove Sew &amp; Misc.</td>
<td>15,000 C.Y.</td>
<td>$4.88</td>
<td>$73,200.00</td>
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<tr>
<td>Haul Waste to Solidification</td>
<td>337,540 C.Y.</td>
<td>$4.08</td>
<td>$1,377,163.20</td>
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<tr>
<td>Haul to Waste Pile</td>
<td>337,540 C.Y.</td>
<td>$4.32</td>
<td>$1,458,172.80</td>
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<tr>
<td><strong>Subtotal</strong></td>
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<td><strong>$3,011,661.00</strong></td>
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</table>

## Solidification

<table>
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<tr>
<th>Activity</th>
<th>Volume</th>
<th>Cost</th>
<th>Total Cost</th>
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</thead>
<tbody>
<tr>
<td>Facilities Construction</td>
<td>1 L.S.</td>
<td>$442,344.00</td>
<td>$442,344.00</td>
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<tr>
<td>Equipment</td>
<td>1 L.S.</td>
<td>$730,572.00</td>
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<tr>
<td>Electrical</td>
<td>1 L.S.</td>
<td>$178,752.00</td>
<td>$178,752.00</td>
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<tr>
<td>Electrical Power</td>
<td>1 L.S.</td>
<td>$71,400.00</td>
<td>$71,400.00</td>
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<tr>
<td>Fly Ash</td>
<td>40,000 C.Y.</td>
<td>$28.70</td>
<td>$1,148,000.00</td>
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**Total Cost: $6,607,206.70**
### O & M

**ADDITIONAL CHEMICALS**

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Unit Cost</th>
<th>Total Cost</th>
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</thead>
<tbody>
<tr>
<td>1 L.S.</td>
<td>1,197,566.00</td>
<td>1,197,566.00</td>
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<tr>
<td>1 L.S.</td>
<td>4,670.00</td>
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<td><strong>Subtotal</strong></td>
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<td><strong>$3,773,304.00</strong></td>
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### SITE IMPROVEMENTS

#### ROADWAYS (25 FT.) LEVEL B

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Unit Cost</th>
<th>Total Cost</th>
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<tbody>
<tr>
<td>4,167 C.Y.</td>
<td>11.33</td>
<td><strong>$47,212.11</strong></td>
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<tr>
<td>2,315 C.Y.</td>
<td>9.89</td>
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<tr>
<td>1 L.S.</td>
<td>10,000.00</td>
<td><strong>$10,000.00</strong></td>
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<tr>
<td>6,000 L.F.</td>
<td>12.00</td>
<td><strong>$72,000.00</strong></td>
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<td><strong>Subtotal</strong></td>
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<td><strong>$152,107.46</strong></td>
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#### ROADWAYS (25 FT.) LEVEL D

#### SIGNING

#### FENCING (6" W/ 3 BARBS)

### RUNOFF/DUST CONTROL

#### PUMPING

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Unit Cost</th>
<th>Total Cost</th>
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</thead>
<tbody>
<tr>
<td>1 L.S.</td>
<td>50,000.00</td>
<td>50,000.00</td>
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<tr>
<td>25,000 L.F.</td>
<td>1.00</td>
<td>25,000.00</td>
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<tr>
<td>1 L.S.</td>
<td>50,000.00</td>
<td>50,000.00</td>
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<tr>
<td><strong>Subtotal</strong></td>
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#### BIKES

#### DUST CONTROL

### LEACHATE/BLLOWDOWN LIQUID HANDLING

#### TRANSPORT TO LAGOONS

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Unit Cost</th>
<th>Total Cost</th>
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</thead>
<tbody>
<tr>
<td>1,500,000 GAL.</td>
<td>0.10</td>
<td><strong>$150,000.00</strong></td>
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<tr>
<td><strong>Subtotal</strong></td>
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<td><strong>$150,000.00</strong></td>
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### EQUIPMENT DECONTAMINATION

#### SOLIDIFICATION FACILITY

#### LAGOONS

#### PUMP STATION AND FORCE MAIN

#### DECON AREA & MISC.

### BASIN CAPPING/TOPSOILING

#### GRADE AND SHAPE

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Unit Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>224,500 C.Y.</td>
<td>2.66</td>
<td><strong>$597,170.00</strong></td>
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<tr>
<td>215,160 C.Y.</td>
<td>6.87</td>
<td><strong>$1,478,149.20</strong></td>
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<tr>
<td>73,880 C.Y.</td>
<td>2.93</td>
<td><strong>$216,666.40</strong></td>
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<tr>
<td>510,000 S.Y.</td>
<td>0.15</td>
<td><strong>$76,500.00</strong></td>
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<tr>
<td><strong>Subtotal</strong></td>
<td></td>
<td><strong>$2,368,287.60</strong></td>
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</table>

### TOTAL

**$15,286,987.91**

**10% CONTINGENCY**

**$1,528,698.79**

**5% MOBILIZATION**

**$764,349.40**

**4% COST GTH MDPT**

**$611,479.52**

**7% SUPERVISION**

**$1,070,089.15**

**12% O & P**

**$1,834,438.55**

**Grand Total**

**$21,096,043.32**
## Stage One Construction

- **Move Material on South End of Basin and Place Clay Cap to Allow Construction of Waste File and Solidification Facility.**

  - **Remove Rip Rap South End**

    \[
    \text{Quantity} = \frac{1}{4} (25,000 \text{ CY}) = 6250 \text{ CY} \\
    \text{Unit Price} = \$5.50/\text{CY} \\
    \text{(See Cost Item 1)} \\
    \text{Cost} = 6250 \text{ CY} \times \$5.50/\text{CY} = \$34,375
    \]

  - **Regrade South Berm**

    \[
    \text{Quantity} = \frac{1}{4} (29,000 \text{ CY}) = 32,250 \text{ CY} \\
    (129,000 \text{ CY} = \text{Total Basin F Berm Quantity}) \\
    \text{Unit Price} = \$2.46/\text{CY} \\
    \text{(See Cost Item 2)} \\
    \text{Cost} = 32,250 \text{ CY} \times \$2.46/\text{CY} = \$85,785
    \]

- **Haul Sludge to Stockpile**

  \[
  \text{Quantity} = 91,870 \text{ CY} \\
  \text{Unit Price} = \$2.66/\text{CY} \\
  \text{Cost} = 91,870 \text{ CY} \times \$2.66/\text{CY} = \$243,414.20
  \text{(See Cost Item 2)}
  \]

- **Place Clay Cap for Basin**

  \[
  \text{Quantity} = 91,870 - 43,900 = 47,970 \text{ CY} \\
  (\text{Total Stage 1 Area - Area of Landfill Using 2 FT Thick Cap}) \\
  \text{Unit Price} = \$6.87/\text{CY} \\
  \text{(See Cost Item 3)}
  \]

*Woodward-Clyde Consultants*
Place Clay Cap for Basin F (continued)

- Item 3 = 4,142 $/cy
- Item 4 = 2,452 $/cy
- Total = 6,594 $/cy

Cost = 48,070.67 $/cy x 6,594 $/cy = 330,240 $
<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
<th>Quantity</th>
<th>Unit Price</th>
<th>Total</th>
<th>Cost</th>
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<tbody>
<tr>
<td>LANDFILL</td>
<td>CONSTRUCTION</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>EXTERIOR BEAM CONSTRUCTION</td>
<td>20,200 CY</td>
<td>$7 3/4/COY</td>
<td>$148,268</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ITEM 3: $4 4/COY</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ITEM 5: $2 3/8/COY</td>
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<tr>
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<td>TOTAL: $7 3/4/COY</td>
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<tr>
<td></td>
<td>CLAY LINER - BOTTOM</td>
<td>4,330 CY</td>
<td>$7 3/4/COY</td>
<td>$317,822</td>
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<tr>
<td></td>
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<td></td>
<td>ITEM 3: $4 4/COY</td>
<td></td>
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<tr>
<td></td>
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<td>ITEM 5: $2 3/8/COY</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TOTAL: $7 3/4/COY</td>
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<tr>
<td></td>
<td>CLAY LINER - TOP AND SIDES</td>
<td>51,970 CY</td>
<td>$10 7/8/COY</td>
<td>$560,236</td>
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<td>TOTAL: $10 7/8/COY</td>
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<tr>
<td>Task</td>
<td>Description</td>
<td>Quantity</td>
<td>Unit Price</td>
<td>Cost</td>
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<td>----------</td>
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<td></td>
</tr>
<tr>
<td>1</td>
<td>Internal Grading</td>
<td>48,600 CY</td>
<td>$2.46/CY</td>
<td>$120,276.00</td>
<td></td>
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<tr>
<td>2</td>
<td>Place SEIF Fill (Soil Layer)</td>
<td>56,760 CY</td>
<td>$7.51/CY</td>
<td>$439,808.00</td>
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<tr>
<td>3</td>
<td>Topsoil</td>
<td>13,000 CY</td>
<td>$2.33/CY</td>
<td>$30,900.00</td>
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<tr>
<td>4</td>
<td>Drainage Net</td>
<td>1,986,910 SF</td>
<td>$0.35/SF</td>
<td>$695,243.50</td>
<td></td>
</tr>
</tbody>
</table>

*Please note that the table values are calculated based on the provided quantities and unit prices.*
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Quantity</th>
<th>Unit Price</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Synthetic Liner</td>
<td>1,307,160SF</td>
<td>$0.80/SF</td>
<td>$1,045,728</td>
</tr>
<tr>
<td>2</td>
<td>Geotextile Fabric</td>
<td>1,986,410SF</td>
<td>$0.35/SF</td>
<td>$700,602</td>
</tr>
<tr>
<td>3</td>
<td>Sumps and piping</td>
<td></td>
<td>$36,120</td>
<td>$36,120</td>
</tr>
</tbody>
</table>

Subject: BASIN F 60% Cost Estimate
By: D. Hawk
Checked By: Tony Kelly
Date: 7/8/87

Project No. 86 C8554P
Task No. 2
File No. 21947
Sheet 3 of 3

Woodward-Clyde Consultants
## NORTH LAGOON CONSTRUCTION

### Excavation

- **Quantity:** 54,000 CY
  - **Unit Price:** $2.64/CY (see Cost Item 2)
  - **Cost:** 54,000 CY × $2.64/CY = $143,640

### Clay Liner (2 ft.)

- **Quantity:** 2 x 148,300 SF / 2750 SF = 10,985 CY
  - **Unit Price:** $7.25/CY (see Cost Items 3 & 5)
  - **Item 3:** $4.42/CY
  - **Item 5:** $2.83/CY
  - **Total:** $7.25/CY
  - **Cost:** 11,000 CY × $7.25/CY = $80,750

### Synthetic Liner (2 Layers)

- **Quantity:** 2 x 148,300 SF = 296,600 SF
  - **Unit Price:** $0.80/SF (see Cost Item 10)
  - **Cost:** 296,600 SF × $0.80/SF = $237,280

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Woodward-Clyde Consultants
Drainage Net (1 layer)

Quantity = 148,300 SF

Unit Price = $0.35/SF (See Cost Item)

Cost = 148,300 SF x $0.35/SF = $51,905
LEACHATE LAGOON CONSTRUCTION

- **Excavation**
  
  \[ \text{Quantity} = 10,000 \text{ CY} \]
  \[ \text{Unit Price} = \$2.26/\text{CY} \] (See Cost Item 2)
  \[ \text{Cost} = \$26,600.00 \]

- **Clay Liner**
  
  \[ \text{Quantity} = 50,625 \text{ SF} \times 2 \text{ FT} \div 27 \text{ SF} \]
  \[ = 3750 \text{ CY/FC} \]
  \[ \text{Unit Price} = \$73.50/\text{CY} \] (See Cost Item 3 & 5)
  
  \[ \text{Item 3} = \$4.92/\text{CY} \]
  \[ \text{Item 5} = \$2.92/\text{CY} \]
  \[ \text{Total} = \$7.84/\text{CY} \]
  \[ \text{Cost} = 3750 \text{ CY} \times \$7.84/\text{CY} = \$27,525.00 \]

- **Synthetic Liner (2 Layers)**
  
  \[ \text{Quantity} = 2 \times 50,625 \text{ SF} = 101,250 \text{ SF} \]
  \[ \text{Unit Price} = \$0.80/\text{SF} \] (See Cost Item 10)
  \[ \text{Cost} = 101,250 \text{ SF} \times \$0.80/\text{SF} = \$81,000.00 \]

- **Drainage Net (1 Layer)**
  
  \[ \text{Quantity} = 50,625 \text{ SF} \]
  \[ \text{Unit Price} = \$0.25/\text{SF} \] (See Cost Item 10)
  \[ \text{Cost} = 50,625 \text{ SF} \times \$0.25/\text{SF} = \$12,656.25 \]
LIQUID REMOVAL SYSTEM (See Cost Item 12)

- **PUMPS AND APPURTENANCES**
  - WATER: $9,603.00
  - CONCRETE SLABS: $4,393.00
  - GUARDRAILS: $1,455.00
  - AIR SUPPLY SYSTEM: $19,822.00
  - PUMPS: $27,668.00
  - **TOTAL**: $63,192.00

- **FORCE MAIN**
  - LABOR: $148,857
  - MATERIAL: $148,748
  - EQUIPMENT: $1012
  - **TOTAL**: $298,617.00

- **ELECTRICAL**
  - BRANCH TO COMPRESSOR PAD: $15,672
  - LIGHTING TO COMPRESSOR PAD: $2842
  - **TOTAL**: $18,514.00

- **O & M**
  - 600 HRS x $13.75/HR = $8250.00

---

Woodward-Clyde Consultants
CONTAMINATED MATERIAL REMOVAL

- Remove Rip Rap

  Quantity = 25,000 CY \times \frac{3}{4} = 18,750 CY

  Unit Price = \$5.50/CY (See Cost Item 1)

  Cost = 18,750 CY \times \$5.50/CY = \$103,125.00

- Remove Sewer and Miscellaneous Debris

  Quantity = 12,000 CY \times 1.25 = 15,000 CY

  (12,000 CY from Closure Plan, Basin F,
  Rocky Mountain Arsenal, EBASCO,
  December, 1985 with 25% Contingency)

  Unit Price = \$4.88/CY (See Cost Items 13, 14)

  Cost Item 13 = \$4.88/CY

  Cost Item 14 = \$0.00/CY

  Total = \$4.88/CY

  Cost = 15,000 CY \times \$4.88/CY = \$73,200.00

- Haul Waste to Solidification

  Quantity = 362,540 CY - 25,000 CY Rip-Rap

  = 337,540 CY

  Unit Price = \$408/CY (See Cost Item 13)

  Cost = 337,540 CY \times \$408/CY

  = \$1,377,163.20

Woodward-Clyde Consultants
Haul Waste to Waste Pile

Quantity = 337,540 CY

Unit Price = $4.32 (See Cost Items 14 & 15)

Item 14 = $0.82/CY
Item 15 = $3.50/CY

Total = $4.32/CY

Cost = 337,540 CY x $4.32/CY = $1,458,172.00
SOLIDIFICATION (See Cost Item 16)

- FACILITIES CONSTRUCTION
  
  **Wood Wall**  $95,785.00
  **Site Work**  $19,511.00
  **Concrete Slab**  $413,230.00
  
  Total  $442,344.00

- EQUIPMENT
  
  **Fly Ash Tanks**  $128,000.00
  **Pig Mills**  $485,698.00
  **Dust Control System**  $22,560.00
  **Ammonia Scrubber System**  $94,314.00
  
  Total  $730,572.00

- ELECTRICAL
  
  Total  $178,752.00

- ELECTRICAL POWER
  
  Total  $71,400.00

- FLY ASH
  
  Total  $1,148,000.00

- O & M
  
  **Man Power Equipment**  $457,202.00
  
  Total  $1,197,566.00

- ADDITIONAL CHEMICALS
  
  $H_2SO_4$  $380.00$
  $NaClO$  $360.00$
  $NaOCH_3$  $510.00$
  
  Total  $1,467.00

Woodward-Clyde Consultants
SITE IMPROVEMENTS

- **Roadways (Level B)**
  
  Quantity = 9,000 ft $\times$ 25 ft $\times$ 0.5 ft $\div$ 27 CF
  
  $\text{CY} = 4,167 \text{ CY}$

  Unit Price = $61.33/\text{CY} \quad \text{(See Cost Item 17)}$

  Cost = 4,167 CY $\times$ $61.33/\text{CY} = $257,212

- **Roadways (Level D)**
  
  Quantity = 5,000 ft $\times$ 25 ft $\times$ 0.5 ft $\div$ 27 CF
  
  $\text{CY} = 2,315 \text{ CY}$

  Unit Price = $989/\text{CY} \quad \text{(See Cost Item 18)}$

  Cost = 2,315 CY $\times$ $989/\text{CY} = $2,285,351

- **Signing**
  
  Quantity = 50 signs (estimated)

  Unit Price = $200/sign (estimated)

  Cost = 50 $\times$ $200/\text{sign} = $10,000

- **Fencing**
  
  Quantity = 6,000 LF (estimated)

  Unit Price = $12.00/\text{LF}

  (1987 Means 2.7-090-0600)

  6' high galvanized steel w/ 3 backs = $9.50/\text{LF}$

  $\text{SY} = 9.00/\text{LF}$

  Cost = 6,000 LF $\times$ $12.00/\text{LF} = $72,000
Runoff / Dust Control

* Pumping

\[ \text{Quantity} = 5,000,000 \text{ gallons (estimated)} \]
\[ \text{Unit Price} = \$0.01/\text{gallon} \]

From Means 1987 2.3-100888
8 hrs attended 2" diaphragm pump
Say averages 50 gpm @ 8 hrs/day

\[ \frac{50 \text{ gal/min} \times 60 \text{ min}}{8 \text{ hrs}} = 24,000 \text{ gal/day} \]
\[ \text{Price} = \frac{\$263}{8 \text{ hrs}} \]
\[ \text{Unit Price} = \frac{\$263}{24,000 \text{ gal/day}} = \$0.01/\text{gal} \]

Cost = 5,000,000 \text{ gal} \times \$0.01/\text{gal} = \$50,000

* Dikes

\[ \text{Quantity} = 25,000 \text{ LF (estimated)} \]
\[ \text{Unit Price} = \$100/\text{LF (estimated)} \]

Cost = 25,000 \text{ LF} \times \$100/\text{LF} = \$2,500,000

* Dust Control

Cost = \$50,000 (estimated)
LEACHATE / BLOWDOWN LIQUID HANDLING

TRANSPORT TO LAGOONS

- Quantity = 1,500,000 gallons
  (volume of pond)
- Unit Price = $0.10/gallon
- Use 4,000,000 gal ÷ 388,579 gal
  From Liquid Removal Item = $0.10/gal
- Cost = 1,500,000 gal x $0.10/gal = $150,000
Equipment Decontamination

• Solidification Facility
  Cost = $25,000 (Estimated)

• Lagoons
  Cost = 2 x 10,000 $ = $20,000 $ (Estimated)

• Pump Station and Force Main
  Cost = $7,500 $ (Estimated)

• Decon Area and Miscellaneous
  Cost = $7,500 $ (Estimated)
Basin Capping/Torsouling

- Grade and Shape
  \[ \text{Quantity} = 224,500 \text{ CY} \]
  \[ (250,750 - 32,250 \text{ (stage 1)}) \]
  \[ \text{Unit Price} = \$2.56/\text{CY} \text{ (see Cost Item 2)} \]
  \[ \text{Cost} = 224,500 \text{ CY} \times \$2.56/\text{CY} = \$577,170 \text{ 00} \]

- Clay Cap (2 ft)
  \[ \text{Quantity} = 304,530 - 48,070 - 43,300 \]  
  \[ = 215,160 \text{ CY} \]
  \[ (\text{Basin F Proper - Stage 1 Cap - Barrier Cap}) \]
  \[ \text{Unit Price} = \$6.87/\text{CY} \text{ (see Cost Items 3/4)} \]
  \[ \text{Item 3} = \$4.42/\text{CY}, \]
  \[ \text{Item 4} = \$2.45/\text{CY}, \]
  \[ \text{Total} = \$6.87/\text{CY} \]
  \[ \text{Cost} = 215,160 \text{ CY} \times \$6.87/\text{CY} = 1,478,449 \text{ 29} \]

- Torsouling
  \[ \text{Quantity} = 73,880 \text{ CY} \]
  \[ \text{Unit Price} = \$2.92/\text{CY} \text{ (see Cost Item 9)} \]
  \[ \text{Cost} = 73,880 \text{ CY} \times \$2.92/\text{CY} = 216,468 \text{ 20} \]
- Seeding

Quantity = 514,000 SY  
(105 acre x 43,560 = 9 = 508,200 SY)

Unit Price = $0.15/ SY  
(4750 $/acre x 43,560 x 9 = $0.15/ SY)

Cost = 514,000 SY x $0.15/ SY = $76,570
1) Excavate For Wastepile & Solidification Area
810 x 850 = 685,500 b.f. x 27 x 4/27 = 51,000 c.y.
150 x 300 = 45,000 b.f. x 25 x 3/27 = 3,333 c.y.
So. 500' x 500' x 1,000 x 2/27 = 37,037 c.y.
91,370 c.y.

2) Wastepile Beam
(755 + 805) = 3,120 b.f.
5 x 20 = 5 x 15 = 175 b.f.
(3,120) (175) / 27 = 20,222 c.y.
Say 20,200 c.y.

3) Clay Blanket For Wastepile
(740 x 790) 4' (110%) / 27 = 95,208 c.y. Say 95,000 c.y.
Bottom = 740 x 790 x 2 ft / 27 = 443,800 c.y.
Top = 790 x 45 = 95,270 c.y. = 43,300 = 51,970 c.y.

4) Clay For Basin 'E' Proper
[95 A. (43,500) - (740 x 790)] / 27 = 306,530

5) Toppel For Wastepile
(740 x 790) 0.5' (12.5%) / 27 = 12,991 c.y. Say 13,000 c.y.

6) Toppel For Basin 'E' Proper
[105 A. (43,500) - (740 x 790)] 0.5' / 27 = 73,874 c.y.

7) Excavate For Basin 'E' ( Entire Site
incl. Wastepile )
362,542 c.y.

8) Grading For Basin 'E'
C = 256,744 c.y. Say 256,750 c.y.
F = 271,208 - 20,222 = 255,986 c.y.

9) Internal Coring ( Waste Pile )
(700' x 750 x 0.5) / 27 = 48,411 c.y. Say 48,600 c.y.

10) Select Fill ( Waste Pile )
(310 x 800 x 2/27) 110% = 56,740 c.y.

11) Stage One Removal
YA Bern V. I. (129,000) = 32,250 c.y.
Berm = 85,600 C.Y.
Fill = 315,500 C.Y.
Cut (incl. Berm) = 154,000 C.Y.

Rip-Rap Qty.
North Pool

Area = 870, Cell = 2.5
Ave. Depth = 0.33 ft. (based on info in 23 Oct 86 letter of Holmes Roberts & Owen)
Vol. = (870, cell)(0.33)(7.48) = 2,149,303 gal.

Southwest Pool

Area = 114,515 = 193 = 114,317 sq. ft.
Ave. Depth = 0.23 ft. (based on 23 Oct 86 letter)
Vol. = 114,317(0.23)(7.48) = 200,139 gal.

Southeast Pool

Area = 139,741 sq. ft.
Ave. Depth = 0.45 ft. (based on 23 Oct 86 letter)
Vol. = 139,741(0.45)(7.48) = 470,431 gal.

2 S.E. Pools

Area = 7,451 + 5,814 = 13,265 sq. ft.
Ave. Depth = 0.1 ft. (assumed)
Vol. = 13,265(0.1)(7.48) = 9,923 gal.

Total Vol. = 2,829,794 gal. on 10/25/86
Subject: LINEAR QUANTITY

By: D. Hawk
Checked By: 200

Date: 3/21/87

Landfill

Top Area: 500 x 550 = 275,000 sf x 1.02 = 280,500
Side Area: 143.7 x 2720 LF = 390,930 sf x 1.02 = 398,750
Bottom Area: 810 x 760 = 615,600 sf x 1.02 = 627,910

Total: 1,307,160 sf

Drainage Nets

1 Bottom = 627,910 = 627,910
2 Sides = 2 x 280,500 = 561,000
2 Sides = 2 x 398,750 = 797,500

Total: 1,986,410

Synthetic Liners

1 Bottom
1 Side
1 Top

See above: 1,307,160 sf

Geotextile Nets

1 Bottom
2 Tops
2 Sides

See Drainage Nets: 1,986,410

Woodward-Clyde Consultants
**Subject:** Excavation for North Lagoon  
**Project No.:** B6C8554P  
**Task No.:** 2  
**File No.:** 81947  
**checked by:** T. Fill  
**Date:** 7/11/87  
**Sheet:** 1 of 1

---

**North Lagoon: Quantity for Excavation**

From Design Dimensions: 60%  

- **310' @ Bottom**  
- **382' @ Top**  

**Volume**:

\[
\frac{310^2 + 382^2}{2} \times 12 \div 27 = 53,783 \text{ CY}
\]

**area**:

\[
\text{Bottom Length} = 2 \times \sqrt{12^2 + 36^2} + 310 = 385'
\]

\[
\text{Area} = (385')^2 = 148,225 \text{ SF}
\]

Say 148,300 SF O.K.

---

Woodward-Clyde Consultants
Subject: Quantities for Leachate Lagoon

By: D. Hawk

Checked By: T. Kelly

Date: 7/9/87

Project No. 86 CB 554P

Task No. 

File No. 21947

Sheet 1 of 1

Leachate Lagoon (1.5 million gallons)

200'  

120'

w

Area of Liner (Use 225' w/ Borms) =

225' \times 225' = 50,625\, \text{sf}'

Volume of excavation

V = \left(\frac{200}{2}\right)^2 + \left(\frac{120}{2}\right)^2 \times 10\, \text{ft} + 27\, \text{cft}

= 10,074\, \text{cy}

SAY 10,000\, \text{cy} O.K.
5) Area & Excavation Below El. 5108 (Clay Cup would be part 2 & Fill) = 60 A.

Vol. = 60 x 43,540 x 2 / 27 = 190,000 C.Y.

6) Cover (Size Must Equal Topsoil)

Area = 11.0 A.

Assume 1' depth

Vol = 110 (43,540)(1) / 27 = 177,500 C.Y.

7) Wastepile Beam Qty

28' hr. pile (25' waste + 3' cover) = 12 A. square

Beam Length = 723' + 7' = 730'

V.C. = 15 x 14 + 14 (4 x 14) = 994 S.F.

V.C./L.F. = 994 / 27 = 36.8 C.Y.

Vol. = 36.8 (4 x 730) = 167,500 C.Y.

8) Qty Waste (incl Rip-Rip)

393,300 C.Y.

9) Clay Cup

93.5 A. - 3.5A - 12A = 78 A.

Vol = 70 x 2 x 43,540 / 27 = 2,515,500 C.Y.
1) Rip Rep Qty

Assume 8" - 10" wide = 24" thick

11.5" x (187.71') x 2' x 51' x (17 CF/1 CF) = 8,155 C.Y.

10" x (187.71') x 2' x 25.5' (1/27) = 4,735 C.Y.

7" x (187.71') x 2' x 9.5' (1/27) = 9,245 C.Y.

Approx. Rip Rep Qty = 24,135 C.Y. based on 24" thick

Say 25,000 C.Y.

2) Beam Qty

From CADD Vol. = 85,400 C.Y.

3) Fill Qty

From CADD Vol. = 315,500 C.Y.

4) Cut (incl. Beam)

From CADD Vol. = 154,000 C.Y.
RIP RAP REMOVAL UNIT RATES

1) Dozer 300 HP
   Daily Rate $980

2) Front End Loader 225 cy
   432

3) 2 Equip Operators O 166
   332

4) 3 12yd End Dumps O 279
   334

5) 3 Truck Operators O 135
   406

2903

$2900/800 cy = $3.62/cy

W/ Safety @ 50% - $1.80/cy

Total $5.40/cy 344 5 52/61
<table>
<thead>
<tr>
<th>CREW DESCRIPTION</th>
<th>NO. REQUIRED IN CREW</th>
<th>HOURLY RATE ($/HR)</th>
<th>TOTAL FOR CREW ($/HR)</th>
<th>HOURLY RATE ($/HR)</th>
<th>TOTAL FOR CREW ($/HR)</th>
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<tbody>
<tr>
<td>CAT DBL Dozer</td>
<td>1</td>
<td>16 86</td>
<td>16 86</td>
<td>106 27</td>
<td>106 27</td>
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<tr>
<td>CAT 966 D Loader</td>
<td>1</td>
<td>16 86</td>
<td>16 86</td>
<td>61 10</td>
<td>61 10</td>
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<tr>
<td>12 CY End Dump Tandem Axle</td>
<td>3</td>
<td>16 70</td>
<td>50 24</td>
<td>37 30</td>
<td>111 90</td>
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| TOTALS                        | MANHOURS | 5                  | LABOR COST 84 10     | EQUIPMENT COST 279 31 |

<table>
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<tr>
<th>WORK TASK</th>
<th>PRODUCTIVITY RATE UNIT/HR</th>
<th>LABOR 1 MH/UNIT</th>
<th>EQUIPMENT 2 $/UNIT</th>
<th>COMMENTS</th>
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</thead>
<tbody>
<tr>
<td>Excavation / Hauling</td>
<td>98 CY/HR</td>
<td>0 06 /CY</td>
<td>2 85 /CY</td>
<td>5 66 /CY</td>
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<tr>
<td>SAFETY</td>
<td></td>
<td></td>
<td>1 95 /CY</td>
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<td>TOTAL EQUIPMENT, LABOR &amp; SAFETY</td>
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</table>

* Including fringe benefits

DA FORM 5419-R, Apr 88
## CREW AND PRODUCTIVITY WORKSHEET

**PROJECT:** RMA  
**LOCATION:** Denver, CO

**DATE PREPARED:** 5/2/87  
**PREPARED BY:** D. Hawk  
**CHECKED BY:** T. Kelly

### CREW COMPOSITION

<table>
<thead>
<tr>
<th>CREW DESCRIPTION</th>
<th>NO. REQUIRED IN CREW</th>
<th>HOURLY* RATE ($/HR)</th>
<th>TOTAL FOR CREW ($/HR)</th>
<th>HOURLY EQUIPMENT RATE ($/HR)</th>
<th>TOTAL EQUIPMENT FOR CREW ($/HR)</th>
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<tbody>
<tr>
<td>Heavy Equipment</td>
<td>5</td>
<td>38.00</td>
<td>191.00</td>
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### CREW PRODUCTIVITY

<table>
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<th>WORK TASK</th>
<th>PRODUCTIVITY RATE UNIT/HR</th>
<th>LABOR</th>
<th>EQUIPMENT $/UNIT</th>
<th>COMMENTS</th>
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<tbody>
<tr>
<td>Safety</td>
<td>98 cu/hr</td>
<td>1 cu/hr</td>
<td>$ 195/cy</td>
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</table>

*(Including fringe benefits)*

DA FORM 5419-R, Apr 86
- Sludge Handling
- Stage 1 Stockpiling
- Regrade Berms
- Waste Pile Internal Grading
- North Lagoon Excavation
- Grade and Shape Basin F
- Leachate Lagoon Excavation
- Topsoil Grading
**CREW AND PRODUCTIVITY WORKSHEET**

**For use of this form, see TM 5-800-2. The preparer agency is USAEC**

**DATE PREPARED:** 3-18-87

**PROJECT:** RMA

**PREPARED BY:** D. Hawk

**LOCATION:** Denver, Co.

**CHECKED BY:** T. Keiley 3/18/87

### CREW COMPOSITION

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<tr>
<th>CREW DESCRIPTION</th>
<th>NO. REQUIRED</th>
<th>HOU. RATE ($/HR)</th>
<th>TOTAL FOR CREW ($/HR)</th>
<th>HOU. RATE ($/HR)</th>
<th>TOTAL FOR CREW ($/HR)</th>
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<tr>
<td>CAT 627 B Scapers</td>
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<td>17.02</td>
<td>102.18</td>
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<td>CAT 627 B Scapers (Standby)</td>
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**TOTALS**

- **MANHOURS:** 15
- **LABOR COST:** 246.01
- **EQUIPMENT COST:** 1412.57

### CREW PRODUCTIVITY

**WORK TASK**

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<th>PRODUCTIVITY RATE UNIT/HR</th>
<th>LABOR</th>
<th>EQUIPMENT</th>
<th>COMMENTS</th>
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<tbody>
<tr>
<td>EXCAVATION/HAULING</td>
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<tr>
<td>SAFETY</td>
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<td>0.15/cy</td>
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**TOTAL EQUIPMENT MANHOURS LABOR & SAFETY**

- **2.67/cy**

*Including fringe benefits*

DA FORM 5418-R, Apr 85
**CREW AND PRODUCTIVITY WORKSHEET**

For use of this form, see TM 5-800-3. The originating agency is USACE.

**PROJECT**
RMA

**PREPARED BY**
D. Hawk

**CREW REF NO.**

**LOCATION**
DENVER, CO.

**CHECKED BY**
T. Kelley 3-18-87

**DATE PREPARED**
3-18-87

---

**CREW COMPOSITION**

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<tr>
<th>WORK TYPE</th>
<th>WORK SCHEDULE</th>
<th>SPECIAL INFORMATION</th>
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<th>STAGE I</th>
<th>STOCKPILING</th>
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<td>EXCAVATION/Hauling</td>
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**TOTALS**

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**CREW PRODUCTIVITY**

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<th>COMMENTS</th>
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<td>$/UNIT</td>
</tr>
<tr>
<td>SAFETY</td>
<td>870 cu/HR</td>
<td>*0.15/hr</td>
<td></td>
<td>0.58/hr</td>
</tr>
</tbody>
</table>

* Including fringe benefits

DA FORM 5419-R, Apr 85
SLUDGE HANDLING; COSTS TO STOCKPILE

The work will include excavating and hauling excavated material from the solidification area and the landfill area, outside the inner berm, to the sludge stockpile area inside the berm where it will be disced and allowed to dry.

Dozers will be used to excavate material down to the liner and push load scrapers. Additional dozers will be used to excavate the material below the liner down to the finished grade. The scrapers will be used to haul material to the sludge stockpile where a light dozer will assist in moving material and a tractor with disc attachment will be used for discing and aerating the material. A motor grader will be used to maintain haul roads to the stockpile and 2 laborers will be used as spotters.

It was assumed that portions of the excavation area and sludge could have rolling resistances as high as 15% to 20%, whereas other parts of the haul would be on haul roads with very low rolling resistance. Thus, an average rolling resistance of 10% was assumed for the haul.
Subject: LAND FILL CONSTRUCTION - SLUDGE REMOVAL COSTS  Project No. 4.6.C.8.5S.4.P  

By TCK  Checked By D. Hawk  

Date 3/13/87  Date 3/18/87  

Sheet 2 of 4  

---

### ESTIMATED CYCLE TIMES

HAUL PROFILE (CAT 627 B SCRAPER) FROM BOTTOM OF EXCAVATION TO TOP OF STOCKPILE

<table>
<thead>
<tr>
<th></th>
<th>LENGTH</th>
<th>LOADED TR TIME</th>
<th>UNLOADED TR TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>200'</td>
<td>10% 0.31</td>
<td>10% 0.22</td>
</tr>
<tr>
<td>B</td>
<td>200'</td>
<td>12% 0.35</td>
<td>8% 0.19</td>
</tr>
<tr>
<td>C</td>
<td>200'</td>
<td>10% 0.31</td>
<td>10% 0.22</td>
</tr>
<tr>
<td>D</td>
<td>200'</td>
<td>12% 0.35</td>
<td>8% 0.19</td>
</tr>
<tr>
<td>E</td>
<td>200'</td>
<td>10% 0.31</td>
<td>10% 0.22</td>
</tr>
</tbody>
</table>

**TOTAL TIME**

@ 93% ALTITUDE

1.75 / 1.12

**TOTAL ESTIMATED CYCLE TIME**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HAUL</td>
<td>1.75 / 1.12</td>
</tr>
<tr>
<td>RETURN</td>
<td>1.12 / 1.12</td>
</tr>
<tr>
<td>LOAD</td>
<td>0.8 / SELF LOAD OR PUSH LOAD</td>
</tr>
<tr>
<td>MANEUVER &amp; DUMP</td>
<td>0.8 /</td>
</tr>
</tbody>
</table>

4.47 min/cycle @ 100% eff.
Estimation of Production:

1) Estimated Load
   (0.8 Assumed Load Factor)
   180cy x 0.8 LF = 14.4 cy/load

2) Cycles Per Hour
   (60 min/hr) (1 cycle/4.47 min) = 13.4 cycles/hr

3) Hourly Unit Production
   (13.4 cycles/hr) x 14.4 (cy/cycle) = 193 cy/hr

4) Need 1 Scrapper Every 0.8 Minutes
   4.47 min/0.8 = 5.59
   Use 6 scrapers

5) Check Push Dozer Balance

   Dozer Cycle 1.4(0.8) + 0.25 = 1.37 minutes

   \[
   \frac{\text{Scraper cycle}}{\text{Dozer cycle}} = \frac{4.47}{1.37} = 3.26
   \]
   So use 2 dozers to handle 6 scrapers.

6) Fleet Production Efficiency @ 100% Efficiency
   6 x 193 cy/hr = 1,158 cy/hr

7) Adjusted Production
   (Use 45 min/hr for Level B)
   \[
   1,158 \text{ cy/hr} \times 0.95 = 870 \text{ cy/hr}
   \]
Subject: LANDFILL CONSTRUCTION - SLUDGE REMOVAL COSTS  
Project No. 86C8554P

By: T.E.K.  
Checked By: D. Hawk

Date: 3/13/87  
Date: 3/18/87

Task No. 2  
File No. 21947

Sheet 4 of 4

---

**EQUIPMENT AND FLEET COSTS**

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Rate ($/hr)</th>
<th>Hours</th>
<th>Total ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 CAT 627 B Scrapers</td>
<td>$134.80</td>
<td></td>
<td>808.80</td>
</tr>
<tr>
<td>3 CAT D-6 Dozers</td>
<td>$123.25</td>
<td></td>
<td>370.25</td>
</tr>
<tr>
<td>1 CAT 627 B Scraper (Standby)</td>
<td>$75.37</td>
<td></td>
<td>75.37</td>
</tr>
<tr>
<td>1 CAT 14G Motor Grader</td>
<td>$92.65</td>
<td></td>
<td>92.65</td>
</tr>
<tr>
<td>2 Laborers</td>
<td></td>
<td></td>
<td>125.35</td>
</tr>
<tr>
<td>1 Tractor with disc attachment</td>
<td></td>
<td></td>
<td>99.97</td>
</tr>
<tr>
<td>1 CAT D-6 Dozer</td>
<td></td>
<td></td>
<td>1658.58</td>
</tr>
</tbody>
</table>

**Total Cost: $1,658.58/hr + $870/cy/hr = $1,818/cy

---

*Note: No safety considerations taken into account for this cost except 45/60 % efficiency.*
Haul Clay from Borrow to Stockpile
# CREW AND PRODUCTIVITY WORKSHEET

For use of this form, see TM 5-800 2. The proponent agency is USACE

**PROJECT**  
RMA

**PREPARED BY**  
D. Hawk

**DATE PREPARED**  
5/2/87

**LOCATION**  
DENVER, CO

**CHECKED BY**  
Tim Kelly

## CREW COMPOSITION

<table>
<thead>
<tr>
<th>CREW DESCRIPTION</th>
<th>NO. REQUIRED IN CREW</th>
<th>LABOR COST</th>
<th>EQUIPMENT COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT 245 BACKHOE</td>
<td>1</td>
<td>17.83</td>
<td></td>
</tr>
<tr>
<td>CAT D&amp;L DOZER</td>
<td>1</td>
<td>16.58</td>
<td></td>
</tr>
<tr>
<td>CAT D&amp;D DOZER</td>
<td>1</td>
<td>16.58</td>
<td></td>
</tr>
<tr>
<td>MRS 1-1000 TRACTOR w/ DISC</td>
<td>1</td>
<td>16.50</td>
<td></td>
</tr>
<tr>
<td>10,000 GALLON WATER TANKER</td>
<td>1</td>
<td>17.09</td>
<td></td>
</tr>
<tr>
<td>END DUMP 18 CY.</td>
<td>11</td>
<td>17.09</td>
<td></td>
</tr>
</tbody>
</table>

**TOTALS**

MANHOURS: 14  
LABOR COST: **272.75**  
EQUIPMENT COST: **949.93**

## CREW PRODUCTIVITY

<table>
<thead>
<tr>
<th>WORK TASK</th>
<th>PRODUCTIVITY RATE</th>
<th>LABOR</th>
<th>EQUIPMENT</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXCAVATE AND HAUL CLAY TO STOCKPILE</td>
<td>310 CY/HR</td>
<td>0.88/CY</td>
<td>3.06/CY</td>
<td>BASED ON QUANTITY ESTIMATED AFTER PLACEMENT</td>
</tr>
<tr>
<td>STRIPPING</td>
<td>0.48/CY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL EXCAVATE, HAUL AND STRIP</td>
<td></td>
<td></td>
<td></td>
<td><strong>4.12/CY</strong></td>
</tr>
</tbody>
</table>

**Note:** INCLUDES SOME MOISTURE CONDITIONING AND ASSUMES 5 MILE HAUL (1-WAY)

*including fringe benefits
From Preliminary Construction Cost Estimates

**GIVEN:**

- About 360,000 CY are required (compact-clay)
- Clay in-place @ 100% compaction
  $V_d = 113.3 \text{ ft}^3$
  $M_c = 14 \%$
- Assumed clay in-situ
  $V_d = 96.3 \text{pcf}$
- Clay swell in truck = 25\% vs compacted
  $V_d = 113.3 - 1.25 = 90 \text{pcf}$

**THUS:**

Amount of material in-situ required

\[
360,000 \text{CY} \times 113.3 \frac{\text{ft}^3}{96.3} = 423,500 \text{CY}
\]

Area assuming clay is 5' thick and 80% usable

\[
\frac{1}{0.80} \times 423,500 \text{CY} \times 27.06 \frac{\text{ft}^3}{\text{CY}} \times \frac{1}{5 \text{ ft}} \times \frac{\text{acre}}{43,560 \text{ ft}^2} = 65.6 \text{ acre}
\]

For haulage by volume

\[
360,000 \times \frac{113.3}{90} = 453,200 \text{CY}
\]
Subject: Clay borrow Cost Estimate

Project No.: 86C8554P

Task No.: 2

File No.: 01947

Sheet: 2 of 9

By: D. Hawk

Checked By: T

Date: 2/13/87

Date: 7/1/87

---

1. Borrow 108 Dozer - 1 ea  excavation
2. 245 Backhoe - 2 ea
3. Wheel tractor w/ disc
4. Water tank
5. Dozer - 1 ea  Support

(2) Trucks 18, 74

---

Assume:
1. Strip 1.0' to get to borrow
2. Clay borrow 5' deep
3. 80% borrow usable
4. Moisture conditioning included
5. Clay dumped over fence into hot zone

---

Woodward-Clyde Consultants
Equipment

**Truck:** Use 6x4/6x2 Diesel Powered Trucks Rear-Dump

- **Struck Capacity:** 12-18 CY
- **Monthly Rate:** $4130.00
- **Operator:** $17.00/HR

1984 Adjustment Rate = .90

Say 173 HR/Month

\[
105\times901\times4130.00 \div 173 = 22\text{ CY}
\]

\[
18\text{ CY} \div 17\text{ HR} = 1.06\text{ CY/HR}
\]

**Equipment Operator:** $59.22/HR w/operator

**Backhoe:** Use CAT 24E HoE w/ 325 CY Bucket 325 HP

- **Monthly Rate:** $19,695.00
- **Operator:** $17.00/HR

1984 Adjustment Rate = .90

\[
185\times843\times9.69 \div 173 = 100\text{ CY}
\]

\[
18\text{ CY} \div 17\text{ HR} = 1.06\text{ CY/HR}
\]

**Equipment Operator:** $159.10/HR w/operator

**Cycle Time**

**Backhoe Cycle Time:** 23 seconds with 325 CY Bucket from CAT Performance Handbook.

**Use 23 second cycle time with 3 CY Bucket**

\[
\text{Load Time for 18 CY Struck Capacity Truck} = 18 \text{ CY} / 3 \text{ CY} \times 23 \text{ SEC} = 138 \text{ SEC}
\]

\[
\frac{138 \text{ SEC}}{60 \text{ SEC/Min}} = 2.3 \text{ minutes, Load Time}
\]
**Truck Cycle** 10 Mile Haul (5 Mile 1-Way)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turn &amp; Position Load</td>
<td>2.3</td>
</tr>
<tr>
<td>Transport Load</td>
<td>10.8</td>
</tr>
<tr>
<td>Turn &amp; Dump</td>
<td>1.0</td>
</tr>
<tr>
<td>Transport Empty</td>
<td>7.1</td>
</tr>
<tr>
<td><strong>Total Cycle</strong></td>
<td>21.7</td>
</tr>
<tr>
<td>Add 1 min Misc.</td>
<td>2.0</td>
</tr>
<tr>
<td>Start/Stop Time Each Way</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>23.7</td>
</tr>
</tbody>
</table>

### Loaded

<table>
<thead>
<tr>
<th>Speed</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-30 mph</td>
<td>0.8 min</td>
</tr>
<tr>
<td>30 mph</td>
<td>9.2 min</td>
</tr>
<tr>
<td>0-0 mph</td>
<td>0.9 min</td>
</tr>
</tbody>
</table>

- 30 mph (net 27 mph avg)
- 0-0 mph

### Unloaded

<table>
<thead>
<tr>
<th>Speed</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-45 mph</td>
<td>0.5 min</td>
</tr>
<tr>
<td>45 mph</td>
<td>6.1 min</td>
</tr>
<tr>
<td>0-0 mph</td>
<td>0.5 min</td>
</tr>
</tbody>
</table>

- 45 mph (net 37 mph avg)
- 0-0 mph

Use 24 minute cycle time.

With 24 minute cycle time and 2.3 minute load time:

\[
24 \div 2.3 = 10.4
\]

Use 11 trucks
CALCULATE UNIT RATE / HOUR AND PRODUCTION RATE

Production Rate Based on Backhoe

\[
\text{2 CY/hr} \times \frac{60 \text{ sec}}{1 \text{ min}} \times \frac{60 \text{ min}}{1 \text{ hr}} \times \frac{50 \text{ (efficiency)}}{60} = 391 \text{ CY/HR (loose)}
\]

Cost 1 Backhoe = $159.12/HR = $159.10

11 Trucks = $800.07/HR

\[
\text{UNIT RATE} = \frac{\$800.07/HR}{391 \text{ CY/HR}} = \$2.03/\text{CY/HR}
\]

Convert from loose to in-place at landfill

\[
\text{\$2.03/\text{CY} \times \frac{113.3 \text{ pcf}}{90 \text{ pcf}} = \$2.53/\text{CY (amended)}}
\]

In-Place Production = 391 x 90 = 310 CY/HR
**Additional Costs**

1. **Cost of Stripping**

   \[ 1.0 \text{ ft} \times 65.4 \text{ Acre} \times \frac{42,360 \text{ ft}^3}{\text{acre}} \times \frac{27}{105,835 \text{ cy. acre}} = 1.89 \text{ /cy} \]

   **From Means: 2.3 - 164 - 0300**

   **Common Earth Screener Excavation with 1500 ft. Haul**

   **Unit Rate = $1.89 /cy**

   \[ 105,935 \times 1.89 /cy = 203,000 \text{ cy} \]

   **Unit Rate = 203,000 / 300,000 = 0.5 /cy**

   **Savings: 0.43 /cy**

2. **Add 2 dozers for production time (12.5 - 15.0)**

   \[ \frac{24 \text{ min}}{\text{cycle}} \times \frac{1 \text{ cycle}}{150 \text{ (10x2)} \text{ ft. haul}} = \frac{1.4 \text{ min}}{60 \text{ min}} \times 2 \text{ days} \]

   \[ = 137 \text{ work days} \]

**From Blue Goat Rental for D8L (535 HP)**

**1984 Adjustment Rate**

**See Analysis**

**Operating Cost**

\[ \frac{1.35 / \text{hr}}{123.35 / \text{hr} \times 3 \text{ hr} = 936 / \text{hr}} \]
D&D FOR SUPPORT 140 HP

1984 Adjustment .910
EQUIPMENT - $105 x 5920.00 = .910 / 173 = 32.70
= 13.20
= 16.44

* 63.29 / Hr x 8 Hr / DAY = * 506.24 / DAY

For D3L & D6D costs

* (986.00 + 506.24) x 137 DAYS = * 204,000
3) Process clay for moisture content

**USE 1 TRACTOR WITH DISC AND 1 WATER TRUCK**

*Use 10,000 gal water tanker, off-highway 330 HP*

1984 Rate Adjustment = 1.83

Equipment: 83% × 15,575 = 8347

Operator = 85.55

Operator = 17.50

*136 1/4 HR w/ oper.*

137 × 8 × 136 1/4 = $149,000

Assume water provided on-site by RMA

**USE 1 WHEEL TRACTOR w/DISC ATTACHMENT**

*Use MRS 1-100 S 310 HP wheel tractor w/disc*

1984 Rate Adjustment = 1.83

Equipment: 83% × 405 = 335

Operator = 10.50

Operator = 6.90

Disc Rental = 400 × 877 × 105 / 173 = 263

Operator = 0.25

*99.57 HR w/oper.*

137 days × 8.5% day × 99.57 HR = $110,000

**Total = $110,000 + 149,000 = $259,000**
Subject: Clay borrow Cost Estimate

By: D. Hawk

Checked By: Tek

Project No.: BGC8551P

Task No.: 2

File No.: 01947

Date: 2/16/87

Date: Sheet: 9 of 9

---

**Total Cost to Excavate and Process Clay**

\[ \text{\#2} \times \frac{1}{24} \times 360,000 = \text{\#} 420,000 \]

\[ \text{\#1} \]

\[ \text{\#2} \]

\[ \text{\#3} \]

\[ \text{\#1} \]

\[ \text{\#2} \]

\[ \text{\#3} \]

**Unit Rate**

\[ \frac{420,000}{360,000} = \text{\#} 4 \frac{1}{4} \text{cy} \]
• Clay - Stockpile to Cap Basin F
## CREW AND PRODUCTIVITY WORKSHEET

### Project Information
- **Location:** Denver, CO
- **Prepared by:** T. Kelley
- **Checked by:** D. Hawk 3/18/87

### CREW COMPOSITION

<table>
<thead>
<tr>
<th>Work Type</th>
<th>Placement</th>
<th>Work Schedule</th>
<th>Special Information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Excavation</strong></td>
<td></td>
<td></td>
<td>Clay - stockpile to cap basin E</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CREW DESCRIPTION</th>
<th>NO. REQUIRED IN CREW</th>
<th>HOURLY RATE ($/HR)</th>
<th>TOTAL FOR CREW ($/HR)</th>
<th>HOURLY RATE ($/HR)</th>
<th>TOTAL FOR CREW ($/HR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT 627B Scraper</td>
<td>8</td>
<td>1703</td>
<td>13624</td>
<td>117.34</td>
<td>942.16</td>
</tr>
<tr>
<td>CAT D8L Dozer</td>
<td>3</td>
<td>1686</td>
<td>5064</td>
<td>106.37</td>
<td>319.44</td>
</tr>
<tr>
<td>CAT 825C Compactor</td>
<td>1</td>
<td>1686</td>
<td>1686</td>
<td>90.22</td>
<td>90.22</td>
</tr>
<tr>
<td>10000 GALLON WATER TANKER</td>
<td>1</td>
<td>1702</td>
<td>1702</td>
<td>119.02</td>
<td>119.02</td>
</tr>
<tr>
<td>CAT 14G MOTOR GRADER</td>
<td>1</td>
<td>1703</td>
<td>1703</td>
<td>75.61</td>
<td>75.61</td>
</tr>
<tr>
<td>MRS 1-100S TRACTOR W/DISC</td>
<td>1</td>
<td>1680</td>
<td>1680</td>
<td>83.04</td>
<td>83.04</td>
</tr>
<tr>
<td>LABORERS</td>
<td>3</td>
<td>12.75</td>
<td>38.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAT 627B Scrapers (standby)</td>
<td>2</td>
<td></td>
<td>75.37</td>
<td>150.74</td>
<td></td>
</tr>
</tbody>
</table>

### TOTALS
- **Mannahours:** 18
- **Labor Cost:** $293.52
- **Equipment Cost:** $1780.25

### CREW PRODUCTIVITY

<table>
<thead>
<tr>
<th>WORK TASK</th>
<th>PRODUCTIVITY RATE LIMIT/HR</th>
<th>LABOR</th>
<th>EQUIPMENT</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Excavation</strong></td>
<td>1176 cc/Hr</td>
<td>0.25/</td>
<td>0.25</td>
<td>151/</td>
</tr>
<tr>
<td><strong>Safety</strong></td>
<td>1176 cc/Hr</td>
<td>0.20/</td>
<td>0.49</td>
<td></td>
</tr>
</tbody>
</table>

**Total Equipment, Labor, Safety: $245.1 ccy**

*Including fringe benefits*
**CREW AND PRODUCTIVITY WORKSHEET**

For use of this form, see TM 5-800-2; the approving agency is USACE.

<table>
<thead>
<tr>
<th>PROJECT</th>
<th>PREPARED BY</th>
<th>CREW REF NO</th>
</tr>
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<tbody>
<tr>
<td>RMA</td>
<td>T. KELLEY</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>CHECKED BY</th>
<th>DATE PREPARED</th>
</tr>
</thead>
<tbody>
<tr>
<td>DENVER, CO</td>
<td>D. HAWK</td>
<td>3/18/87</td>
</tr>
</tbody>
</table>

**CREW COMPOSITION**

**WORK TYPE**

- SAFETY

**WORK SCHEDULE**

**SPECIAL INFORMATION**

- CLAY - STOCKPILE
- TO CAD BASIN E

<table>
<thead>
<tr>
<th>CREW DESCRIPTION</th>
<th>NO. REQUIRED IN CREW</th>
<th>HOURLY* RATE ($/HR)</th>
<th>TOTAL FOR CREW ($/HR)</th>
<th>HOURLY RATE ($/HR)</th>
<th>TOTAL FOR CREW ($/HR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEAVY EQUIPMENT</td>
<td>15</td>
<td>-</td>
<td>-</td>
<td>38.20</td>
<td>573.00</td>
</tr>
<tr>
<td>STANDBY EQUIPMENT</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>4.50</td>
<td>8.90</td>
</tr>
<tr>
<td>LABORERS</td>
<td>3</td>
<td>78.05</td>
<td>234.15</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**TOTALS**

- MANHOURS
- LABOR COST: 234.15
- EQUIPMENT COST: 581.90

**CREW PRODUCTIVITY**

**WORK TASK**

<table>
<thead>
<tr>
<th>SAFETY</th>
</tr>
</thead>
</table>

**PRODUCTIVITY RATE UNIT/HR**

- 176 cc/hr.

**LABOR**

- MH/UNIT: 0.20
- S/UNIT: 0.42

**EQUIPMENT S/UNIT**

- 0.20

**COMMENTS**

---

*Including fringe benefits*
Placement of Clay Cap for Basin F

The work involved will consist of hauling clay from stockpiles within Basin F to the Basin F area for capping. This will be performed as excavation progresses to minimize area of Basin F exposed for runoff. Two D1 dozers will be used for loading scrapers and another to assist in spreading clay over basin bottom. A CAT 14G motor grader will be used for leveling and spreading. The material will be discos and moisture conditioned during placement and compacted with a CAT B25C compactor. These laborers for spotting and grade checking will be required.

The clay stockpile area used for landfill construction will be used for clay cap over Basin F.

Assume all of the work performed in level B.
**Subject**: Earthwork Costs - Basin F Construction  
**By**: D. Hawk  
**Checked By**: T.C.  
**Date**: 3/10/87  
**Project No.**: 860 B554-P  
**Task No.**: 2  
**File No.**: 2147  
**Sheet**: 2 of 4

### Average Haul Profile - Based on Excavation Plan

- **A**: 200'  
- **B**: 400'  
- **C**: 600'  
- **D**: 200'  

**Profile Details**:
- **C**: 0% CE, 10% RR
- **D**: 5% RR

### Estimate Cycle Time (CAT 627B Scrapers)

<table>
<thead>
<tr>
<th>Section</th>
<th>Length</th>
<th>Tr. Time</th>
<th>TR Time</th>
<th>Loaded</th>
<th>Unloaded</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>200'</td>
<td>10%</td>
<td>.31</td>
<td>10%</td>
<td>.23'</td>
</tr>
<tr>
<td>B</td>
<td>800'</td>
<td>5%</td>
<td>.65</td>
<td>5%</td>
<td>.50'</td>
</tr>
<tr>
<td>C</td>
<td>400'</td>
<td>-1% (-)</td>
<td>.18</td>
<td>9%</td>
<td>.38'</td>
</tr>
<tr>
<td>D</td>
<td>200'</td>
<td>10%</td>
<td>.31</td>
<td>10%</td>
<td>.23'</td>
</tr>
</tbody>
</table>

**Notes**:  
- 25 mph assumed  
- 93% altitude (median 1.5% grade)

**Total Cycle Time**
- **Haul**: 1.56 min  
- **Return**: 1.44 min  
- **Load**: .60 min  
- **Maneuver & Dump**: .60 min  
- **Additional Maneuver**: .26 min

**Total**: 4.40 min @ 100% Eff.

Woodward-Clyde Consultants
Subject  

**earthwork cost - basin F construction**  

Project No.  

By  

D. Hawk  

Checked By  

T. K.  

Task No.  

File No.  

Date 3/10/87  

Date 3/12/87  

Sheet 4 of 4

---

**equipment list and costs**

<table>
<thead>
<tr>
<th>No.</th>
<th>Equipment</th>
<th>Quantity</th>
<th>Rate (per unit)</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>627 B scrapes</td>
<td>8</td>
<td>$134.80</td>
<td>$1078.30</td>
</tr>
<tr>
<td>2</td>
<td>Cat DBL Diggers</td>
<td>3</td>
<td>$123.55</td>
<td>$369.15</td>
</tr>
<tr>
<td>3</td>
<td>Cat 825C Compressor</td>
<td>1</td>
<td>$107.80</td>
<td>$107.80</td>
</tr>
<tr>
<td>4</td>
<td>Water Tanker (10,000 gal)</td>
<td>1</td>
<td>$156.41</td>
<td>$156.41</td>
</tr>
<tr>
<td>5</td>
<td>Cat 144 motor grader</td>
<td>1</td>
<td>$92.84</td>
<td>$92.84</td>
</tr>
<tr>
<td>6</td>
<td>Tractor w/disk attachment</td>
<td>1</td>
<td>$99.97</td>
<td>$99.97</td>
</tr>
<tr>
<td>7</td>
<td>627B scrapes (standard)</td>
<td>2</td>
<td>$75.37</td>
<td>$150.74</td>
</tr>
<tr>
<td>8</td>
<td>Laborers</td>
<td>3</td>
<td>$12.28</td>
<td>$36.84</td>
</tr>
</tbody>
</table>

**total cost**  

$2073.20

---

**unit cost of clay placement for basin F cap**

$2073.28/HR ÷ 1176 CY/HR = $1.78/CY

**note:** this cost is without safety considerations except production efficiency of 45/60.

---

Woodward-Clyde Consultants
**Estimate Production**

1. **Estimated Load**: 18 LCY x 0.80 = 14.4 LCY / Load

2. **Cycles Per Hour**: 60 min / 4.40 min cycle = 13.6 cycles / hr.

3. **Hourly Production Rate**: 14.4 LCY / Load x 13.6 cycles / hr = 196 LCY / hr.

4. **Need one scraper every 0.6 minutes**: 4.40 min / 0.6 minutes = 7.3 scrapers. Use 8.

5. **Check Pusher Combination**
   
   Pusher Cycle Time = 1.10 + 2.25 = 1.09 min
   
   Scraper Cycle Time = 4.40 min
   
   => 4.40 / 1.09 = 4.0
   
   Each doper can handle 4.0 scrapers OK.

6. **Hourly Fleet Production**

   8 Scrapers x 196 LCY / hr = 1568 LCY / hr.

7. **Adjusted Production - (Use 45/60 Efficiency to Account)**

   (For Level B Protection)

   45/60 x 1568 LCY / hr = 1176 LCY / hr.

8. **Check Compaction Balance**

   1 CAT 825 C @ 6 mph 1/6" lift, 3 ft.

   Production = 1444 LCY / hr
   
   Altitude Factor = .94
   
   Efficiency = 45/60

   1444 x .94 x 45/60 = 1010 LCY / hr < 1176 LCY / hr

   Assume additional compaction from scrapers & water tanker OK OK.
- Stockpiled Clay to Waste Pile Bottom Clay Liner
- Stockpiled Clay to Waste Pile Berms
- Stockpiled Clay to North Lagoon Liner
- Stockpiled Clay to Leachate Lagoon Liner
**CREW AND PRODUCTIVITY WORKSHEET**

For use of this form, see TM 5-800-2. The proponent agency is USACE.

**PROJECT**
RMA

**LOCATION**
Denver, CO

**PREPARED BY**
D. Hawk

**CHECKED BY**
T. Kelley

**CREW DESCRIPTION**

<table>
<thead>
<tr>
<th>CREW DESCRIPTION</th>
<th>NO. REQUIRED IN CREW</th>
<th>HOURLY RATE (S/HR)</th>
<th>TOTAL FOR CREW (S/HR)</th>
<th>TOTAL FOR CREW (S/HR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT 627 B Scrapers</td>
<td>9</td>
<td>17 $2</td>
<td>153 $2</td>
<td>117 $2</td>
</tr>
<tr>
<td>CAT D &amp; L Diggers</td>
<td>3</td>
<td>16 $2</td>
<td>50 $2</td>
<td>104 $2</td>
</tr>
<tr>
<td>CAT 825C Compactor</td>
<td>1</td>
<td>16 $2</td>
<td>16 $2</td>
<td>90 $2</td>
</tr>
<tr>
<td>10,000 gallon Water Tanker</td>
<td>1</td>
<td>17 $2</td>
<td>17 $2</td>
<td>119 $2</td>
</tr>
<tr>
<td>CAT 14 G Motor Grader</td>
<td>1</td>
<td>17 $2</td>
<td>17 $2</td>
<td>75 $2</td>
</tr>
<tr>
<td>MRS 1-100$ Tractor w/Disc</td>
<td>1</td>
<td>16 $2</td>
<td>16 $2</td>
<td>83 $2</td>
</tr>
<tr>
<td>Laborers</td>
<td>3</td>
<td>12 $2</td>
<td>38 $2</td>
<td></td>
</tr>
<tr>
<td>CAT 627 B Scrapers (Standb)</td>
<td>2</td>
<td></td>
<td></td>
<td>75 $2</td>
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</tbody>
</table>

**TOTALS**

<table>
<thead>
<tr>
<th>MANHOURS</th>
<th>LABOR COST</th>
<th>EQUIPMENT COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>510 $2</td>
<td>1898 $2</td>
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</tbody>
</table>

**CREW PRODUCTIVITY**

<table>
<thead>
<tr>
<th>WORK TASK</th>
<th>PRODUCTIVITY RATE UNIT/HR</th>
<th>LABOR</th>
<th>EQUIPMENT</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excavation / Placement</td>
<td>1050 $4/yc</td>
<td>$0.36 $/yc</td>
<td>$0.61 $/yc</td>
<td></td>
</tr>
<tr>
<td>Safety</td>
<td>1050 $4/yc</td>
<td>$0.22 $/yc</td>
<td>$0.53 $/yc</td>
<td></td>
</tr>
<tr>
<td>Total equipment</td>
<td></td>
<td></td>
<td></td>
<td>$0.92 $/yc</td>
</tr>
<tr>
<td>Labor &amp; Safety</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Including fringe benefits*

DA FORM 5419-R, Apr 85
## CREW AND PRODUCTIVITY WORKSHEET

**For use of this form, see TM 5-800-2. The procurement agency is USAEC.**

**DATE PREPARED:** 3-18-87

### PROJECT
- **RMA**

### PREPARED BY
- **D. Hawk**

### CHECKED BY
- **T. Kojek** 3/18/87

### CREW REF NC
- **Denver, CO.**

---

### CREW COMPOSITION

<table>
<thead>
<tr>
<th>CREW DESCRIPTION</th>
<th>NO. REQUIRED IN CREW</th>
<th>LABOR COST</th>
<th>EQUIPMENT COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEAVY EQUIPMENT</td>
<td>14</td>
<td>38.20</td>
<td>411.20</td>
</tr>
<tr>
<td>STANDBY EQUIPMENT</td>
<td>2</td>
<td>44.05</td>
<td>89.00</td>
</tr>
<tr>
<td>LABOR</td>
<td>3</td>
<td>78.95</td>
<td>234.15</td>
</tr>
</tbody>
</table>

**TOTALS**
- **MANKHOURS:** 234.15
- **LABOR COST:** 620.10
- **EQUIPMENT COST:**

---

### CREW PRODUCTIVITY

<table>
<thead>
<tr>
<th>WORK TASK</th>
<th>PRODUCTIVITY RATE</th>
<th>LABOR</th>
<th>EQUIPMENT</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAFETY</td>
<td>1050 cu/hr</td>
<td>0.62/hr</td>
<td>0.59/hr</td>
<td></td>
</tr>
</tbody>
</table>

*Including fringe benefits*

---

DA FORM 5419-R, Apr 86
Subject: LANDFILL CONSTRUCTION - EARTHWORK
Project No. 86055547

By: D. Hanks
Checked By: T.

Date: 3/4/87

Task No. 2
File No. 5.3.17
Sheet 1 of 5

CLAY TO LANDFILL CLAY LINERS

--- Diagram of clay layers and dimensions

ESTIMATED CYCLE TIMES

<table>
<thead>
<tr>
<th>SECTION</th>
<th>LENGTH</th>
<th>TR.</th>
<th>TIME</th>
<th>TR.</th>
<th>TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>200'</td>
<td>10%</td>
<td>.30</td>
<td>10%</td>
<td>.25</td>
</tr>
<tr>
<td>B</td>
<td>750'</td>
<td>0%</td>
<td>.45</td>
<td>6%</td>
<td>.50</td>
</tr>
<tr>
<td>C</td>
<td>600'</td>
<td>6%</td>
<td>.52</td>
<td>10%</td>
<td>.45</td>
</tr>
<tr>
<td>D</td>
<td>300'</td>
<td>10%</td>
<td>.41</td>
<td>10%</td>
<td>.32</td>
</tr>
</tbody>
</table>

1) CAT 627B LOADED @ 1850' = 1.68
2) CAT 627B EMPTY @ 1850' = 1.52
3) LOAD TIME = .60
4) MANEUVER TIME = .60
5) ADDITIONAL MANEUVER (TIME TO STORE) = .20

4.60 min

@ 93% efficiency (altitude adjustment) - 5.0 min.
Need one scraper every 0.6 minutes:

5.0 min/cycle + 0.6 minute = 8.3 scrapers

Use 2 D8L push CATS for nine scrapers

Check balance:

Boost Time = 0.1 min  = 0.1
Return Time = 0.4 x (6) = 2.4
Maneuver = 0.15  = 0.15
Load Time = 0.6

\[ 1.09 \text{ min/acyl} \]

Scaper Cycle = 5.0 min
Push Cycle = 1.1 min

Each Push CAT can handle \[ \frac{50}{1.1} = 45 \text{ scoop} \]

2 D8L Push CATS can handle 9 scrapers
Production

With 9 scrapers hauling @ 18 LCY/load

From Geotechnical Information

Clay @ 100% Compaction ASTM-D-476 = 113.3pcf
Opt. MC = 14.6%
Say 113 pcf @ 15% MC

Load Factor for Clay = 0.8 Assumed.

18 LCY x 0.8 = 14.4 CY/Load
Say 14 CY/Load

Cycle Time = 5.0 minutes @ 100% efficiency

Production = \( \frac{60\text{min} - 5\text{min}}{\text{cycle}} = 12 \text{ cycles/HR/unit} \)

Unit Production = \( \frac{14 \text{ CY} \times 12 \text{ cycles}}{\text{cycle}} = 168 \text{ CY/HR} \)

Adjusted Production = \( \frac{168 \text{ CY} \times 45\text{ min}}{60\text{ min}} = 126 \text{ CY/HR} \)

Fleet Production = \( \frac{6.3 \text{ units} \times 126 \text{ CY}}{\text{HR/unit}} = 1050 \text{ CY/HR} \)
Equipment List

9 Cat 627 B Scrapers
3 Cat D8L Dozers
1 Cat B2C Compactor w/ Dozer
1 Diesel Powered Water Tanker (10,000 gallons)
1 Cat 14G Motor Grader
2 Cat 627B Scrapers (Standby)
1 Tractor w/ Disc Attachment
3 Laborers (Cisterns - Grade Check)

Note: All equipment costs determined previously for general fill except tractor w/disc

Tractor w/ Disc Attachment:

Use Mars 1-1005 310 HP

Equipment: $405.00 x 12 = $4,860.00

Operating: 20.5 = 20.5

Operator: 16.00 = 16.00

Total: $9,999.00

Disc Attachment (Means 1986)

Equipment: $400.00 x 12 = $4,800.00

Operating: 0.05 = 0.05

Operator: 0.00 = 0.00

Total: $495.00

Total cost tractor w/disc = $9,999.00
CLAY LINER PLACEMENT COSTS / HOUR

9 Screers @ 134.60 = 1,213.20
3 Dozers @ 123.25 = 369.75
1 Compactor @ 107.40 = 107.40
1 Water Tanker @ 136.11 = 136.11
1 Motor Grader @ 92.64 = 92.64
3 Laborers @ 12.30 = 36.90
2 Screers Standby @ 75.27 = 150.54
1 Excav w/ 0.50c @ 99.57 = 99.57

$2,208.54 / hr

UNIT COST WITHOUT SAFETY

$2,208.54 / hr ÷ 1050 cu/hr = $2.10 / cu
- Stockpiled Clay to Waste Pile Top and Side Clay Liner
CLAY COVER PLACEMENT FOR TOP AND SLOPES OF THE WASTEPILE

1) Placement must be carefully performed because it is above synthetic liners.

2) Placement will be similar to sand drain placement; however, a compactor will be required and material costs will be similar to that for other clay placed.

3) For Clay Cover Crew

From Activity (A) (Attached)
- a) Labor = 20704
- b) Equipment = 675 40
- c) Safety on Labor = 234 15
- d) Safety on Equipment = 384 45

From Sheet 0 of Equipment Costs
For Cat 825 C Compactor
- a) Labor = 16 88
- b) Equipment = 90 52
- c) Safety on Labor = 
- d) Safety on Equipment = 28 20

Total Cost = $1598 64/HR

Production = 251 64/HR

(From Activity (A))

4) Costs
- a) Labor & Equipment = 1598 64/251 = $6 36/64
- b) Materials (From Activity (B)) = $4 42/64

Total = $10 28/64
**CREW AND PRODUCTIVITY WORKSHEET**  
**DATE PREPARED:** 3-18-87

**PROJECT:** RMA  
**PREPARED BY:** T. KELLEY  
**CREW REF NO:**  
**CHECKED BY:** D. HAWK 3/18/87  
**LOCATION:** DENVER, CO

### CREW COMPOSITION

#### WORK TYPE
- **Excavation/Placement**

#### SPECIAL INFORMATION
- **Supply and Place Sand Drains**

### CREW DESCRIPTION

<table>
<thead>
<tr>
<th>CREW DESCRIPTION</th>
<th>NO. REQUIRED</th>
<th>LABOR COST</th>
<th>EQUIPMENT COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT D8L DOZER</td>
<td>1</td>
<td>16.88</td>
<td>106.37</td>
</tr>
<tr>
<td>CAT 966D LOADER</td>
<td>1</td>
<td>16.88</td>
<td>61.10</td>
</tr>
<tr>
<td>12 CUBIC YARD END DUMP TRUCK</td>
<td>4</td>
<td>16.76</td>
<td>14.92</td>
</tr>
<tr>
<td>CAT D6 DOZER</td>
<td>2</td>
<td>16.88</td>
<td>46.40</td>
</tr>
<tr>
<td>CAT 14G MOTOR GRADER</td>
<td>1</td>
<td>17.03</td>
<td>75.61</td>
</tr>
<tr>
<td>12,000 gallon WATER TANKER</td>
<td>1</td>
<td>17.02</td>
<td>119.02</td>
</tr>
<tr>
<td>LABORERS</td>
<td>3</td>
<td>12.76</td>
<td>38.28</td>
</tr>
<tr>
<td>END DUMP TRUCK (STANDBY)</td>
<td>1</td>
<td>—</td>
<td>21.30</td>
</tr>
</tbody>
</table>

### TOTALS
- **MANHOURS:** 13  
- **LABOR COST:** 207.04
- **EQUIPMENT COST:** 625.80

### CREW PRODUCTIVITY

<table>
<thead>
<tr>
<th>WORK TASK</th>
<th>PRODUCTIVITY RATE</th>
<th>LABOR</th>
<th>EQUIPMENT</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXCAVATION/PLACEMENT</td>
<td>251 CY/HR</td>
<td>10.92/10</td>
<td>24.92/10</td>
<td></td>
</tr>
<tr>
<td>SAFETY</td>
<td>251 CY/HR</td>
<td>10.93/10</td>
<td>15.23/10</td>
<td></td>
</tr>
<tr>
<td>MATERIALS DELIVERED TO STOCKPILE</td>
<td>10.20/10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL EQUIPMENT, MATERIALS, LABOR, SAFETY</td>
<td>15.92/10 / CY</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Including fringe benefits*

**DA FORM 5415-R, Apr 85**
<table>
<thead>
<tr>
<th>CREW DESCRIPTION</th>
<th>NO. INCLUDED IN CREW</th>
<th>LABOR COST</th>
<th>EQUIPMENT COST</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NO.</td>
<td>Hourly Rate ($/HR)</td>
<td>Total for Crew ($/HR)</td>
</tr>
<tr>
<td>HEAVY EQUIPMENT</td>
<td>10</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>STANDBY HEAVY EQUIPMENT</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>LABORERS</td>
<td>3</td>
<td>78.05</td>
<td>234.50</td>
</tr>
</tbody>
</table>

**TOTALS**

- **MANHOURS**
- **LABOR COST**
- **EQUIPMENT COST**

- **Crew Productivity**

<table>
<thead>
<tr>
<th>WORK TASK</th>
<th>PRODUCTIVITY RATE UNIT/HR</th>
<th>LABOR</th>
<th>EQUIPMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>MH/UNIT</td>
<td>$/UNIT</td>
</tr>
<tr>
<td>SAFETY</td>
<td>251.50 CY/HR</td>
<td>0.93</td>
<td>1.38</td>
</tr>
</tbody>
</table>

*(Including fringe benefits)*

DA FORM 5410-R, Apr 86
Placement of Sand Drain Systems

The washed sand required will be obtained from off-site. The materials will be delivered by the supplier to the Level B line and dumped from a ramp across to a specified stockpile area. The stockpile area will be prepared using clear general fill. It is assumed that 10% of the washed sand will be wasted because it will become mixed with fines in the stockpile (primarily at the stockpile base).

A dozer will be required to work the stockpile so that continual dumping may occur. Once in the basin, the sand will be loaded with front-end loaders into trucks and carried to the landfill where it will be dumped and then spread using dozers and motor graders. Compaction will be performed by several passes with a tracked dozer and moisture added with a water truck. Several spotter will be required in this operation to position trucks and check grades.

Light trucks such as ten-twelve cubic yard tandems will be used for making sand in basin F because they will be running over liner with only 1-foot of cover. Possibly may build half roads of general fill out over sand drainage blanket to allow trucks to get close to dumping point without damaging liner. Half road would probably be 1 to 2 feet of general fill over 1 foot drain sand.
Cost of Sand Drain Material From Supplier

Attached are price quotes from suppliers for washed sand delivered to RMA Filter Material CDOH Class A, B, or C. Probably acceptable Page 701 CDOH specs 1981

Cost of Materials (Delivered)

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Haul</th>
<th>Type</th>
<th>Cost/ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile Premix</td>
<td>5 mi</td>
<td>B</td>
<td>$2.25/ton</td>
</tr>
<tr>
<td>(THORNTON)</td>
<td>5 mi</td>
<td>C</td>
<td>$4.35/ton</td>
</tr>
<tr>
<td></td>
<td>5 mi</td>
<td>Gravel 1½'</td>
<td>$7.25/ton</td>
</tr>
<tr>
<td></td>
<td>10 mi</td>
<td>Road base 2½'</td>
<td>$3.75/ton</td>
</tr>
<tr>
<td>ALBERT FEI</td>
<td>5 mi</td>
<td>B</td>
<td>$4.25/ton</td>
</tr>
<tr>
<td>&amp; Sons</td>
<td>5 mi</td>
<td>C</td>
<td>$4.25/ton</td>
</tr>
<tr>
<td>(HENDERSON)</td>
<td>5 mi</td>
<td>Road base</td>
<td>$3.25/ton</td>
</tr>
<tr>
<td>BENKMAN</td>
<td>5 mi</td>
<td>Filter Sand</td>
<td>$4.75/ton</td>
</tr>
<tr>
<td>WOODWARD</td>
<td>5 mi</td>
<td>Road base</td>
<td>$3.25/ton</td>
</tr>
<tr>
<td>CONSTRUCTION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(HENDERSON)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From quoted information assume material at plant will cost $4.25/ton

Delivery will probably be from within 6 mile radius of RMA and assume 4 mile on-site haul.

Delivery will be about 10 miles @ about $4.25/ton mile

\[ \text{Total cost} = 4.25/\text{ton} + 10 \text{ miles} \times 0.30/\text{ton-mile} = 7.15/\text{ton} \]

Use 2400 lb/cu yd in-place

\[ \text{Total cost} = \frac{1000}{2400} \times 2400/\text{cu yd} = 10.20/\text{cu yd} \]
A CAT 966C loader with a 2.5 cu yd bucket will be used to load trucks @ 100% eff.

\[
4 \times \frac{2\times 120}{3600} = 2.29 \text{ tons/ho}\]

Cycle time for loader = 0.40 minutes/350

Trucks are 12 cu yd at rest, miles, end units
Use 0.2 minutes for first load + 0.4 minutes thereafter

\[
0.2 + 2 \times 0.40 \text{ minutes} = 1.0 \text{ min/12yd} \quad (250)
\]

966 C has no derating factor for grade @ 5000 ft.

Truck cycle time for short haul ~ 2000 LF one way will be about the same as

screwpiles (13 mph).

Additional haul length will be required for trucks as they will have to stay on designated haul routes in landfill to avoid damage to HDP liner.

\[\Rightarrow \text{Add } 300' \text{ to average haul from stockpile to landfill which was 1700'} \text{ for screw piles.}\]

\[\Rightarrow \text{ Avg. haul for trucks } = 2000' \]

Due to grades involved and short haul restrictions, return trip is just slightly faster than loaded trip - say 16 mph avg.

\[
\text{Loaded Haul = 2000'} \times \frac{1 \text{ min/3 mi}}{5280 \text{ ft/mi}} \times \frac{60 \text{ sec/min}}{60 \text{ sec/min}} = 1.15
\]

\[
\text{Empty } = 2000' \times \frac{1 \text{ min/3 mi}}{5280 \text{ ft/mi}} \times \frac{60 \text{ sec/min}}{60 \text{ sec/min}} = 1.92
\]

Exchange time 0.50
Load 1.00
Haul Loaded 1.75
Maneuver & Dump 0.70
Return 1.42

\[
5.27 \text{ min} \]

Say 5.4 min.

Exchange and load = 1.5 min and with 5.4 min/cycle

We need \[
\frac{5.4}{1.5} = 3.6 \quad \text{use 4 trucks}
\]
Estimate Production

Average Haul = 10 CY Loose

Load Fracture Sand = .9

∴ 10 CY Hauled = 10(.9) = 9 CY in-place

Unit Production @ 100% Efficiency

\[
\text{Production} = \text{Load} \times \text{Cycle Time} = 15.8 \text{min} \times \frac{9 \text{ CY}}{5.8 \text{ min}} = 93 \text{ CY/HR}
\]

We actually have only 3/4 units hauling in cycle effectively.

\[
\text{Production} = 0.75 \times 93 \text{ CY/HR} = 69.75 \text{ CY/HR}
\]

\[
\text{Production with Inefficiency} = 1.25 \times 69.75 = 87.19 \text{ CY/HR}
\]

Equipment List

1. CAT 08L to work stockpile
2. CAT 960D to load & stockpile
3. 12 CY TANDEM AXLE END DUMPS
4. CAT D4 dozers to spread
5. CAT 114G motor grader to level
6. 10,000 GALLON WATER TANKER for moisture
7. STANDBY TANDEM AXLE END DUMP
8. LABORS (SEMIS & GEARBOX CHECKERS)
### Equipment & Labor Costs

1. **CAT DLE**
   - Equipment: 74% x 85% x 0.891 x 1.05 = $123.25/hr
   - Operating = 20.0% = $20.00/hr
   - Operator = 16.0% = $16.00/hr
   - **Total** = $77.28/hr

2. **Tandem Axle End Dump**
   - Equipment: 39.5% x 40% x 1.05 = $21.70/hr
   - Operating = 10.0% = $2.00/hr
   - Operator = 10.0% = $2.00/hr
   - **Total** = $54.70/hr

3. **CAT D4 Dozers (140 HP)**
   - Equipment: 5920% x 1.05 = $13.20/hr
   - Operating = 10.0% = $1.30/hr
   - Operator = 10.0% = $1.30/hr
   - **Total** = $16.80/hr

4. **CAT 14G Motor Grader**
   - **Total** = $92.60/hr

5. **Water Tanker (10,000 Gallon Capacity) 950 HP**
   - **Total** = $93.30/hr

6. **Standby Tandem Axle End Dump**
   - **Total** = $21.30/hr

7. **Laborers (Group 1)**
   - **Total** = $12.30/hr

---

*Note: Costs generated in general fill cost calculations.*
## Total Equipment Costs

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Rate (hr⁻¹)</th>
<th>Unit Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>DBL DOZER</td>
<td>$123.25/hr</td>
<td>$1,066.90</td>
</tr>
<tr>
<td>CAT 964 D Loader</td>
<td>$77.8/hr</td>
<td>$5,866.60</td>
</tr>
<tr>
<td>END DUMPS</td>
<td>$54.8/hr</td>
<td>$2,740.80</td>
</tr>
<tr>
<td>CAT DC DOZERS</td>
<td>$63.8/hr</td>
<td>$3,948.80</td>
</tr>
<tr>
<td>CAT 14G GRADER</td>
<td>$92.6/hr</td>
<td>$3,089.60</td>
</tr>
<tr>
<td>WATER TANKER</td>
<td>$136.4/hr</td>
<td>$20,960.00</td>
</tr>
<tr>
<td>STAND BY END DUMPS</td>
<td>$21.8/hr</td>
<td>$450.40</td>
</tr>
<tr>
<td>LABORERS</td>
<td>$12.2/hr</td>
<td>$466.40</td>
</tr>
</tbody>
</table>

**Total** = $8,325/hr

## Cost to Deliver Sand, Haul to Landfill from Stockpile, Spread & Place

1. **Material Delivered to Stockpile** = $1,020/hr
2. **Haul & Place** = $832/hr/hr x $32/hr = $267/hr

**Total** = $3,387/hr

**Note:** This cost is without safety considerations for Item 2, except for production efficiency of 85%.
- Waste Pile Select Fill
# CREW AND PRODUCTIVITY WORKSHEET

For use of this form, see TM 5-600.2: the responsible agency is USACE.

**PROJECT**
RMA

**PREPARED BY**
T. KELLEY

**LOCATION**
DENVER, CO

**CHECKED BY**
D. HAN \(3/19/87\)

**CREW REF NO**

**DATE PREPARED**
3-18-87

---

## CREW COMPOSITION

**WORK TYPE**
EXCAVATION/PLACEMENT

**WORK SCHEDULE**

**SPECIAL INFORMATION**
GENERAL Fill - BORROW TO STOCKPILE

<table>
<thead>
<tr>
<th>CREW DESCRIPTION</th>
<th>NO. REQUIRED IN CREW</th>
<th>HOURLY RATE ($/HR)</th>
<th>TOTAL FOR CREW ($/HR)</th>
<th>HOURLY RATE ($/HR)</th>
<th>TOTAL FOR CREW ($/HR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT 966D LOADERS</td>
<td>2</td>
<td>16 88</td>
<td>33 76</td>
<td>61 10</td>
<td>122 20</td>
</tr>
<tr>
<td>CAT DBL DOZERS</td>
<td>3</td>
<td>16 88</td>
<td>50 64</td>
<td>106 32</td>
<td>319 11</td>
</tr>
<tr>
<td>18 CUBIC YARD END DUMP TRUCK</td>
<td>5</td>
<td>17 92</td>
<td>85 48</td>
<td>41 15</td>
<td>205 22</td>
</tr>
<tr>
<td>LABORERS</td>
<td>3</td>
<td>12 76</td>
<td>38 25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18 CUBIC YARD END DUMP (STANDBY)</td>
<td>1</td>
<td></td>
<td></td>
<td>22 58</td>
<td>22 58</td>
</tr>
</tbody>
</table>

| TOTALS                            | MANHOURS 13          | LABOR COST 208 12    | EQUIPMENT COST 669 72    |

---

## CREW PRODUCTIVITY

**WORK TASK**

**PRODUCTIVITY RATE UNITS/HR**

| EXCAVATION/PLACEMENT               | 5480 CY/HR           |
| SAFETY                             | 5480 CY/HR           |
| TOTAL EQUIPMENT, LABOR, SAFETY     |                      |

| **PRODUCTIVITY RATE UNITS/HR**     | **LABOR**            | **EQUIPMENT**        |
| **UNIT**                           | **UNIT**             | **UNIT**             |
| EXCAVATION/PLACEMENT               | 0 38 64/yr           | 1 22 63/yr           |
| SAFETY                             | 0 21 64/yr           |
| TOTAL EQUIPMENT, LABOR, SAFETY     | 1 81 64/yr           |

*Including fringe benefits

DA FORM 5415-R, Apr 85
### Crew and Productivity Worksheet

**Project:** RMA  
**Location:** Denver, CO  
**Prepared by:** T. Kelley  
**Checked by:** D. Hawk 3/18/87

#### Crew Composition

<table>
<thead>
<tr>
<th>Crew Description</th>
<th>No. Required in Crew</th>
<th>Labor Cost</th>
<th>Equipment Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy Equipment (Level D)</td>
<td>8</td>
<td>-</td>
<td>495 * 3560</td>
</tr>
<tr>
<td>Heavy Equipment (Level B)</td>
<td>2</td>
<td>-</td>
<td>3820 7640</td>
</tr>
<tr>
<td>Heavy Equipment (Standby)</td>
<td>1</td>
<td>-</td>
<td>495 495</td>
</tr>
</tbody>
</table>

*2 CAT DDL Diggers in Level B Conditions, all other heavy equipment in Level D.*

#### Totals

- **Manhours:**  
- **Labor Cost:**  
- **Equipment Cost:** 11645

#### Crew Productivity

<table>
<thead>
<tr>
<th>Work Task</th>
<th>Productivity Rate</th>
<th>Labor</th>
<th>Equipment</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>548 c/y/HR</td>
<td>0</td>
<td>0</td>
<td>02/87</td>
</tr>
</tbody>
</table>

*Including fringe benefits*

---

DA FORM 5415-9, Apr 88
**GENERAL Fill - Barrow to Stockpile**

The work involved in this cost will consist of excavating general fill from nearly a stockpile area (assume 0.75 mile distance) and dumping the material in a stockpile just inside the level D3 zone. Because of the transfer of material across the fence line it is assumed that end dumpers would be more practical as placing or bottom dumpers would have difficulty with the maneuver without crossing the boundary.

Several ramps will be constructed up to the fence line (one barrier) and haul roads constructed such that the end dumpers may turn and dump efficiently. Two dozers will be required to move material from the ramp areas and spread it to other parts of the stockpile. Two CAT 966 D loaders with the assistance of a D8C dozer will load trucks in the borrow area. No moisture conditioning will be performed at this time. All work outside of the level B zone will be performed at level C. Three spotters will be required in level D zone.

Assume stripping costs will be considered elsewhere. (See D Topsoil)
**Subject:** Earthwork Costs - Landfill Construction

**Project No.:** 86 C8554P

**Task No.:** 2

**File No.:** 21947

---

**By:** D. Hawk

**Checked By:** T. K

**Date:** 3/15/87

**Date:** 3/18/87

**Sheet:** 2 of 4

---

**Haul Cycle**

(3/4 mile one-way) Use 4000'

Travel at Tandem Axle 18 CY capacity

<table>
<thead>
<tr>
<th>A</th>
<th>500'</th>
<th>0-25</th>
<th>25 mph</th>
<th>25-0</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>3000'</td>
<td>25</td>
<td>35</td>
<td>1.34</td>
</tr>
<tr>
<td>C</td>
<td>500'</td>
<td>12.5</td>
<td>17.5</td>
<td>.45</td>
</tr>
</tbody>
</table>

---

**Example Calculation:**

\[
\text{Haul Cycle: Use 2 CAT 966D in combination with 1 DPL CAT 966D uses 4 CY buckets.}
\]

Load Production = 100 CY @ 50 ft. DBw/30 ton

No Loader Design Factor for ruts of 5000'

Use .5 min fill pass + .4 min for additional passes.

For 4 CY bucket @ .9 Load Factor = 3.6 CY/Load

18 CY/3.6 CY/load = 5 Passes of Loader

\[
.2 + 4(4) = 1.80 \text{ min/Load (truck)}@100\% \text{ EFF.}
\]

* Caterpillar Performance Handbook (Pt. 37)

---

Woodward-Clyde Consultants
**Total Truck Cycle Time**

<table>
<thead>
<tr>
<th>Exchange Time</th>
<th>0.50 minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load (2 loads @ 10 cu)</td>
<td>0.90 minutes</td>
</tr>
<tr>
<td>Haul</td>
<td>2.26</td>
</tr>
<tr>
<td>Maneuver &amp; Dump</td>
<td>0.70 minutes</td>
</tr>
<tr>
<td>Return</td>
<td>1.61</td>
</tr>
</tbody>
</table>

Total Cycle = 5.97 minutes @ 100% Eff

Exchange & Load = 1.40 minutes with 5.97 min cycle

⇒ We need 5.97/1.4 = 4.3 Trucks Use 5 Production based on 4.3 Trucks

**Estimate Production**

1) Avg. Load per Cycle = 18 cu loose
   Load Factor = .85
   Avg. Load = 18 cu * .85 = 15.3 cu/Load

2) Cycles per Hour = 60 min/hr / cycle / 5.97 min = 10.0 cycles/hr

3) Hourly Production Rate = 15.3 cu/Load * 10.0 cycles/hr = 153 cu/hr

4) Hourly Fleet Production = 4.3 Trucks * 153 cu/hr = 658 cu/hr

5) Check Daily Production = 1200 cu * .85 = 1020 cu/hr > 658 cu/hr

6) Adjusted Production = 5% 658 cu/hr * 0.95 = 548 cu/hr
- Waste Pile Select Fill
### Equipment List and Costs

<table>
<thead>
<tr>
<th>Item</th>
<th>Rate</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 2 CAT 446 D LOADERS</td>
<td>$77.23</td>
<td>$155.46</td>
</tr>
<tr>
<td>2. 2 CAT 886 DOZER (MM9B)</td>
<td>123</td>
<td>246.00</td>
</tr>
<tr>
<td>3. 1 CAT 886 DOZER</td>
<td>123</td>
<td>123.00</td>
</tr>
<tr>
<td>4. 5 TANDEM AXLE END DUMPS 1804</td>
<td>68.00</td>
<td>291.00</td>
</tr>
<tr>
<td>5. 1 TANDEM AXLE STANDENY</td>
<td>22.50</td>
<td>22.50</td>
</tr>
<tr>
<td>6. 3 LABORERS</td>
<td>18.25</td>
<td>54.80</td>
</tr>
</tbody>
</table>

**Total Cost** = $877.92

*All equipment level D except as noted.*

Cost to haul general fill from borrow to stockpile:

\[
\text{Cost} = \text{Rate} \times \text{Volume} = 877.92 \times 548.00 = 490.00 \ coherent units
\]
COST ITEM 9

- Topsoil for Waste Pile
# CREW AND PRODUCTIVITY WORKSHEET

**DATE PREPARED**

3-18-87

**PROJECT**

RMA

**PREPARED BY**

T. KELLEY

**CHECKED BY**

D. HAWK 3/18/87

**LOCATION**

DENVER, CO

**CREW REF NO.**


## CREW COMPOSITION

### WORK TYPE

**Excavation/Placement**

1. **Cat Dbl Dozer**
   - No. Required: 1
   - Hourly Rate (E/HR): $16.88
   - Total for Crew (E/HR): $16.88
   - Hourly Rate (E/HR): $106.37
   - Total for Crew (E/HR): $106.37

2. **Cat 966 D Loader**
   - No. Required: 1
   - Hourly Rate (E/HR): $16.88
   - Total for Crew (E/HR): $16.88
   - Hourly Rate (E/HR): $61.10
   - Total for Crew (E/HR): $61.10

3. **12 Cubic Yard End Dump Truck**
   - No. Required: 4
   - Hourly Rate (E/HR): $16.88
   - Total for Crew (E/HR): $67.12
   - Hourly Rate (E/HR): $37.30
   - Total for Crew (E/HR): $149.20

4. **Cat D6 Dozer**
   - No. Required: 2
   - Hourly Rate (E/HR): $16.88
   - Total for Crew (E/HR): $33.76
   - Hourly Rate (E/HR): $46.40
   - Total for Crew (E/HR): $92.80

5. **Cat 14G Motor Grader**
   - No. Required: 1
   - Hourly Rate (E/HR): $17.03
   - Total for Crew (E/HR): $17.03
   - Hourly Rate (E/HR): $75.61
   - Total for Crew (E/HR): $75.61

6. **9000 Gallon Water Tanker**
   - No. Required: 1
   - Hourly Rate (E/HR): $17.02
   - Total for Crew (E/HR): $17.02
   - Hourly Rate (E/HR): $119.02
   - Total for Crew (E/HR): $119.02

7. **Laborers**
   - No. Required: 3
   - Hourly Rate (E/HR): $12.76
   - Total for Crew (E/HR): $38.28

8. **END DUMP TRUCK (STANDBY)**
   - No. Required: 1
   - Hourly Rate (E/HR): $12.76
   - Total for Crew (E/HR): $38.28

### TOTALS

- **MANNOURS**: 13
- **LABOR COST**: $207.04
- **EQUIPMENT COST**: $625.40

## CREW PRODUCTIVITY

### WORK TASK

- **Excavation/Placement**
  - Productivity Rate
    - **251 CY/HR**
  - Labor
    - **$0.82/UNIT**
  - Equipment
    - **$10.82/UNIT**

- **Safety**
  - **251 CY/HR**
  - Labor
    - **$0.93/UNIT**
  - Equipment
    - **$10.82/UNIT**

### Comments

- Total equipment, labor, safety without materials
  - **$10.82/UNIT**
  - **$578/UNIT**

- Total equipment, materials, labor, safety
  - **$15.98/UNIT**

*Including fringe benefits*
# Crew and Productivity Worksheet

**Project:** RMA  
**Prepared by:** T. Kelley  
**Location:** Denver, CO  
**Checked by:** D. Hawk 3/16/87

## Crew Composition

<table>
<thead>
<tr>
<th>Crew Description</th>
<th>No. Required in Crew</th>
<th>Hourly Rate ($/HR)</th>
<th>Total for Crew ($/HR)</th>
<th>Labor Cost</th>
<th>Equipment Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Heavy Equipment</strong></td>
<td>10</td>
<td>—</td>
<td>—</td>
<td>38 20</td>
<td>38 20</td>
</tr>
<tr>
<td><strong>Standby Heavy Equipment</strong></td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>4 45</td>
<td>4 45</td>
</tr>
<tr>
<td><strong>Laborers</strong></td>
<td>3</td>
<td>78 05</td>
<td>234 15</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

**Totals**  
**Manhours:**  
**Labor Cost:** 234 15  
**Equipment Cost:** 386 15

## Crew Productivity

<table>
<thead>
<tr>
<th>Work Task</th>
<th>Productivity Rate ($/HR)</th>
<th>Labor</th>
<th>Equipment</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>251 0.70</td>
<td>9.93/1</td>
<td>4 100</td>
<td></td>
</tr>
</tbody>
</table>

*Including fringe benefits*

DA FORM 5416-4, Apr 85
Placement of Sand Drain Systems

The washed sand required will be obtained from off-site. The materials will be delivered by the supplier to the Level B Line and dumped from a ramp access to a specified stockpile area. The stockpile area will be prepared using clean general fill. It is assumed that 10% of the washed sand will be wasted because it will become mixed with fines in the stockpile (primarily at the stockpile base).

A dozer will be required to work the stockpile so that continual dumping may occur. Once in the basin, the sand will be loaded with front-end loaders into trucks and hauled to the landfill where it will be dumped and then spread using dozers and motor graders. Compaction will be performed by several passes with a tracked dozer, and moisture added with a water truck. Several spotters will be required in this operation to position trucks and check grades.

Light trucks such as ten-twelve cubic yard tandems will be used for moving sand in basin F because they will be running over liners with only 1-foot of cover. Possibly, they could build half roads of general fill out over sand drainage blanket to allow trucks to get close to dumping point without damaging liners. Half road would probably be 1 to 2 feet of general fill over 1 foot drain sand.
Cost of Sand Drain Material From Supplier

Attached are price quotes from suppliers for washed sand delivered to RMA filter material CDOH class A, B, or C. Probably adequate pace 701 CDOH specs 1981.

Cost of Materials (Delivered)

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Haul</th>
<th>Type</th>
<th>Cost</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile Premier</td>
<td></td>
<td>B</td>
<td>$8/ton</td>
<td>9.25/ton</td>
</tr>
<tr>
<td>(Huntington)</td>
<td></td>
<td>C</td>
<td>$4/ton</td>
<td>4.25/ton</td>
</tr>
<tr>
<td>Albert Fest &amp;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sons</td>
<td>5 mi</td>
<td>B</td>
<td>4.25/ton</td>
<td>4.25/ton</td>
</tr>
<tr>
<td>(Henderson)</td>
<td></td>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benckman</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Woodward</td>
<td>5 mi</td>
<td>B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Henderson)</td>
<td></td>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From quoted information assume material at plant will cost $4/20/ton.

Delivery will probably be from within 1.5-mile radius of RMA and assume 4.25/ton-

Delivery will be about 10 miles @ about 0.522/ton-mile.

\[ 4.25/ton + 10 \text{ miles} \times 0.522 \text{ ton/mile} = 46/ton \]

Use 3/400 ton/yr in-place:

\[ \frac{3/400 \text{ ton}}{1 \text{ yr}} \times \frac{1 \text{ ton}}{0.002 \text{ cu yd}} = \frac{1020}{1 \text{ cu yd}} \]

Woodward-Clyde Consultants
Subject: **Landfill Construction - Footwork Costs**

By: D. Hawk

Checked By: TCK

Date: 5/7/87

---

A CAT 946C* LOWERE WITH 4 CY BUCKET WILL BE USED TO LOAD TRUCKS @ 95% EFF 4 X 50 = 300 CY/LOAD

**Cycle Time for Loader:**

- **Time:** 0.40 minutes / 35 CY
- **Trucks are 12 CY transition with side dump.**
- Use 0.2 minutes for first load, 0.4 minutes thereafter.

**Truck Cycle Time for Short Haul - 2000 LF One Way**

- Will be about the same as scrapers (13 mph).

**Additional Haul Length will be required for trucks as they will have to stay at designated haul roads in landfill to avoid damage to hope line.**

\[ \text{Add 390' to average haul from stockpile to landfill which is 1700' for scrapers} \]

**Avg. Haul for Trucks = 2000'**

DUE TO GRADES INVOLVED AND SHORT HAUL RESTRICTIONS, RETURN TRIP IS SLOWEST FASTER THAN LOADED TRIP = 344 MPH AVG.

**Loaded Haul = 2000' x 144/139 = 160%**

**Empty = 2000' x 144/148 = 142%**

<table>
<thead>
<tr>
<th>Exchange Time</th>
<th>0.50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load</td>
<td>1.80</td>
</tr>
<tr>
<td>Haul Loaded</td>
<td>1.75</td>
</tr>
<tr>
<td>Maneuver &amp; Dump</td>
<td>0.70</td>
</tr>
<tr>
<td>Return</td>
<td>1.42</td>
</tr>
</tbody>
</table>

**Total:** 5.37 Min.

**Exchange and Load = 15 Min and with 5.4 Min/cycle**

We need \( \frac{5.4}{1.5} = 3.4 \) Use 4 Trucks

---

Woodward-Clyde Consultants
**Estimate Production**

<table>
<thead>
<tr>
<th>Avg. Haul = 10 ct. Loosely</th>
<th>Load Factor Sand = 0.9</th>
<th>10 ct. Haulable = 10(0.9) = 9 ct. 100%-Place</th>
</tr>
</thead>
</table>

**Unit Production @ 100% Efficiency**

\[
\text{1 day / 15.8 min} \times \frac{9 \text{ ct.}}{\text{load}} = \frac{93 \text{ ct.}}{\text{hr}} \text{ /12-Unit}
\]

We actually have only 36 units hauling in cycle effectively.

\[
\Rightarrow \text{Production} = 3.6 \times 93 \text{ ct./hr} = 335 \text{ ct./hr} \\
\Rightarrow \text{Production @ inefficiency} = 45\% \times 335 = 251 \text{ ct./hr}
\]

**Equipment List**

- 1 CAT 08L TO WORK STOCKPILE
- 1 CAT 944D TO LOAD & STOREPILE
- 1 12 CY TANDEM AXLE END DUMPS
- 2 CAT D6 6000 LB TO SPRAY
- 1 CAT 144 MOTOR GENERATOR TOライト
- 1 10,000 GALLON WATER TANKER FOR MOISTURIZE
- 1 STANDBY TANDEM AXLE END DUMP
- 3 LABORS (SPRAYS & GENERATOR CHECKERS)
**Equipment & Labor Costs**

1) **CAT D2L**
   - Equipment: $123/HR

2) **CAT 966 D. Loader (205 HP)**
   - Equipment: $140/HR
   - Operating: $20/HR
   - Operator: $16/HR
   - Total: $77/HR

3) **Tandem Axle End Dump, P4 20-8 6x4 w/ Bow Axle (300 HP)**
   - Equipment: $21.28/HR
   - Operating: $16.26/HR
   - Operator: $16.26/HR
   - Total: $54.80/HR

4) **CAT D6 Dozers (140 HP)**
   - Equipment: $32.23/HR
   - Operating: $13.23/HR
   - Operator: $16.83/HR
   - Total: $63.2/HR

5) **CAT 14G Motor Grader**
   - $92/HR

6) **Water Tanker (10,000 Gallon Capacity)**
   - $13.44/HR

7) **Standby Tandem Axle End Dump**
   - $21.28/HR

8) **Laborers (Group)**
   - $12.2/HR

*Note: Costs generated in general fill cost calculations.*
Subject: Landfill Construction - Earthwork Costs

By: D. Hawk
Checked By: T.E.K

Date: 3/8/87

<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
<th>Rate</th>
<th>Hours</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>D8L Dozer</td>
<td>$123.25/hr</td>
<td></td>
<td>$123.25</td>
</tr>
<tr>
<td>4</td>
<td>END Dumps</td>
<td>$77.28/hr</td>
<td></td>
<td>$77.28</td>
</tr>
<tr>
<td>2</td>
<td>CAT D6 Dozers</td>
<td>$63.48/hr</td>
<td></td>
<td>$126.96</td>
</tr>
<tr>
<td>1</td>
<td>CAT 144 Grader</td>
<td>$92.64/hr</td>
<td></td>
<td>$92.64</td>
</tr>
<tr>
<td>1</td>
<td>WATER Tanker</td>
<td>$134.52/hr</td>
<td></td>
<td>$134.52</td>
</tr>
<tr>
<td>3</td>
<td>LABORERS</td>
<td>$21.00/hr</td>
<td></td>
<td>$63.00</td>
</tr>
</tbody>
</table>

**Total Equipment Costs:** $832.51

Cost to Deliver Sand, Haul to Landfill from Stockpile, Scrape 1 Place:

1. Material Delivered to Stockpile = $1020.00
2. Haul & Place (Scrape to Landfill) = 832.51/hr x 1/257.04 = $203.04

**Total:** $1355.04

Note: This cost is without safety considerations for 1.75m2, except for production efficiency of 95%.
COST ITEM 10

- 60 mil HDPE Liner
- 12 oz. Geotextile Filter Fabric
- 200 mil HDPE Geonet (Drainage Net)
TOPSOIL Summary

a) BORROW to STOCKPILE Activity
   
   Date: 7/25/87

b) STOCKPILE to BASIN E Activity
   
   Date: 7/33/87

Date: 7/13/87
## CREW AND PRODUCTIVITY WORKSHEET

**LOCATION**: DENVER, CO  
**PREPARED BY**: T. KELLEY  
**CHECKED BY**: D. HAWK 3/18/87

### CREW COMPOSITION

<table>
<thead>
<tr>
<th>CREW DESCRIPTION</th>
<th>NO. REQUIRED IN CREW</th>
<th>HOURLY* RATE ($/HR)</th>
<th>TOTAL FOR CREW ($/HR)</th>
<th>HOURLY RATE ($/HR)</th>
<th>TOTAL FOR CREW ($/HR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT 627B SCRAPER</td>
<td>8</td>
<td>17.03</td>
<td>136.24</td>
<td>11.77</td>
<td>942.16</td>
</tr>
<tr>
<td>CAT D6 DOZER</td>
<td>1</td>
<td>16.88</td>
<td>16.88</td>
<td>46.90</td>
<td>46.90</td>
</tr>
<tr>
<td>LABORER</td>
<td>1</td>
<td>12.76</td>
<td>12.76</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>CAT 627B SCRAPER (STANDBY)</td>
<td>2</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

**TOTALS**  
**MANHOURS**: 10  
**LABOR COST**: $165.88  
**EQUIPMENT COST**: $1139.50

### CREW PRODUCTIVITY

<table>
<thead>
<tr>
<th>WORK TASK</th>
<th>PRODUCTIVITY RATE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>UNITS/HR</td>
</tr>
</tbody>
</table>

**EXCAVATION/PLACEMENT**  
**PRODUCTIVITY RATE**: 847 BCY/HR  
**LABOR**: 0.20  
**EQUIPMENT**: 1.34

**SAFETY**  
**PRODUCTIVITY RATE**: 847 BCY/HR  
**LABOR**: 0.06

**TOTAL EQUIPMENT LABOR AND SAFETY**  
**PRODUCTIVITY RATE**: 847 BCY/HR

**COMMENTS**

*Including fringe benefits*

DA FORM 5419-R, Apr 86
## CREW AND PRODUCTIVITY WORKSHEET

**DATE PREPARED**: 3/18/67

**PROJECT**: RMA

**LOCATION**: DENVER, CO

**PREPARED BY**: T. KELLEY

**CHECKED BY**: D. K. 3/18/67

### CREW COMPOSITION

<table>
<thead>
<tr>
<th>CREW DESCRIPTION</th>
<th>NO. REQUIRED IN CREW</th>
<th>HOUURLY RATE ($/HR)</th>
<th>TOTAL FOR CREW ($/HR)</th>
<th>HOUURLY RATE ($/HR)</th>
<th>TOTAL FOR CREW ($/HR)</th>
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</thead>
<tbody>
<tr>
<td>STAND BY EQUIPMENT</td>
<td>11</td>
<td>48.5</td>
<td>489.5</td>
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### CREW PRODUCTIVITY

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<thead>
<tr>
<th>WORK TASK</th>
<th>PRODUCTIVITY RATE</th>
<th>LABOR</th>
<th>EQUIPMENT</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAFETY</td>
<td>847 cy/unit</td>
<td>0.06</td>
<td>/UNIT</td>
<td>ALL EQUIPMENT EXCEPT TRUCKS ON STAND BY SAFETY FOR LEVELD</td>
</tr>
</tbody>
</table>

*Including fringe benefits

**DA FORM 5419-R, Apr 66**
Topsoil Costs - Borrow to Stockpile

The work involved in this cost will involve stripping of topsoil and placement in a stockpile near Basin F. It is assumed that all topsoil used for both the landfill and Basin Cove will be found within 1 mile of Basin F. Some, if not all, of this material may originate from the general fill borrow area. If the actual clay borrow source is 5 miles away, topsoil from this area probably won't be hauled to Basin F due to the haul length.

The CAT 627B scrapers should be well suited for topsoil loading without dozer assistance. Some increase in load time and reduction in pay load may be expected however. Load reduction will be accounted for in load factor (use 0.70).

One CAT dozer will be used to shape stockpile and as needed for support. One spotter will be used at area being stripped.
**Cycle Time CAT 627B Scrapers**

Assume average haul length < 1 mile, use 3/4 mile
Assume average grade resistance = 5%

Haul Length = 3/4 (5280) = 3960' Use 4000'

At 5% TR and 4000' haul and 93% altitude descent

<table>
<thead>
<tr>
<th>Description</th>
<th>Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haul Time</td>
<td>(2.63 \text{ min} \times (2.45 \div 0.93))</td>
</tr>
<tr>
<td>Return Time</td>
<td>(1.88 \text{ min} \times (1.75 \div 0.93))</td>
</tr>
<tr>
<td>Load Time</td>
<td>.60 \text{ min} \times 0.91</td>
</tr>
<tr>
<td>Maneuver Dump</td>
<td>.60 \text{ min} \times 0.91</td>
</tr>
</tbody>
</table>

Total Cycle Time = 5.91 min @ 100% EFL

**Estimate Production**

1. Estimated Load = 18 cy \(\times 0.70 \text{ (L.F.)} = 12.6 \text{ cy/load}\)

2. Cycles per hour = \(60 \text{ min} \times \frac{1 \text{ cycle}}{5.91 \text{ min}} = 10.1 \text{ cycles/hr}\)

3. Hourly Unit Production = 12.6 cy/hr \(\times 10.1 \text{ cycles/hr} = 127 \text{ cy/hr}\)

4. Need one scraper every 0.8 minutes

\(5.91 \div 0.8 = 7.4\) 594 8 scrapers

5. Hourly Fleet Production

8 scrapers \(\times 127 \text{ cy/hr} = 1016 \text{ cy/hr}\)

6. Adjusted Production (50 minute hour non-chargeable)

\(50/60 \times 1016 \text{ cy/hr} = 847 \text{ cy/hr}\)

Woodward-Clyde Consultants
Equipment List & Costs

1) 8 CAT 627 B Scrapers @ $134.80 = $1078.40
2) 1 CAT D6 Dozer @ 63.28 = 63.28
3) 2 CAT 627 B Scrapers (Standby) @ 75.22 = 150.44
4) 1 Labourer (Spitter) @ 12.75 = 12.75

$1,305.66

Cost to Strip and Stockpile Topsoil Near Basin F

$1305.66/HR x 1 HR/847 BCY = $1.54/BCY
## CREW AND PRODUCTIVITY WORKSHEET

**DATE PREPARED:** 3/18/87

<table>
<thead>
<tr>
<th>PROJECT</th>
<th>PREPARED BY: T. KELLEY</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOCATION: DENVER, CO</td>
<td>CHECKED BY: D. HAWK 3/18/87</td>
</tr>
</tbody>
</table>

### CREW COMPOSITION

<table>
<thead>
<tr>
<th>WORK TYPE/PLACEMENT</th>
<th>WORK SCHEDULE</th>
<th>SPECIAL INFORMATION</th>
<th>CREW DESCRIPTION</th>
<th>NO. REQUIRED IN CREW</th>
<th>HOU RLY* RATE (S/HR)</th>
<th>TOTAL FOR CREW (S/HR)</th>
<th>HOURLY RATE (S/HR)</th>
<th>TOTAL FOR CREW (S/HR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXCAVATION/PLACEMENT</td>
<td></td>
<td>TOPSOIL-STOCKPILE TO BASIN F</td>
<td>CAT 627B SCRAPER</td>
<td>6</td>
<td>17.03</td>
<td>102.18</td>
<td>117.52</td>
<td>706.62</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>CAT D6L DOZERS</td>
<td>2</td>
<td>16.88</td>
<td>33.76</td>
<td>106.39</td>
<td>212.74</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CAT 14G MOTOR GRADER</td>
<td>1</td>
<td>17.03</td>
<td>17.03</td>
<td>75.61</td>
<td>75.61</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CAT D6 DOZER</td>
<td>1</td>
<td>16.88</td>
<td>16.88</td>
<td>46.40</td>
<td>46.40</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LABORERS</td>
<td>2</td>
<td>12.76</td>
<td>25.52</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CAT 627B SCRAPER (STANDBY)</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>75.37</td>
<td>75.37</td>
</tr>
</tbody>
</table>

**TOTALS**

- **MANHOURS:** 12
- **LABOR COST:** 195.37
- **EQUIPMENT COST:** 1116.74

### CREW PRODUCTIVITY

<table>
<thead>
<tr>
<th>WORK TASK</th>
<th>PRODUCTIVITY RATE UNIT/HR</th>
<th>LABOR</th>
<th>EQUIPMENT</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXCAVATION/PLACEMENT</td>
<td>1020 SCY/HR</td>
<td>0.9/84</td>
<td>0.09/10</td>
<td>133/CCY</td>
</tr>
<tr>
<td>SAFETY</td>
<td></td>
<td></td>
<td>0.05/84</td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL EQUIPMENT, LABOR, AND SAFETY**: 133 SCY
## CREW AND PRODUCTIVITY WORKSHEET

**For use of this form, see TM 5-600-2; the responsible agency is USACE.**

<table>
<thead>
<tr>
<th>PROJECT</th>
<th>PREPARED BY</th>
<th>CREW REF NO.</th>
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<tbody>
<tr>
<td>RMA</td>
<td>T. KELLEY</td>
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<table>
<thead>
<tr>
<th>LOCATION</th>
<th>CHECKED BY</th>
<th>DATE PREPARED</th>
</tr>
</thead>
<tbody>
<tr>
<td>DENVER CO</td>
<td>D. Hawk 3/13/87</td>
<td></td>
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</table>

### CREW COMPOSITION

<table>
<thead>
<tr>
<th>CREW DESCRIPTION</th>
<th>NO. REQUIRED IN CREW</th>
<th>HOUURLY* RATE ($/HR)</th>
<th>TOTAL FOR CREW ($/HR)</th>
<th>HOUURLY* RATE ($/HR)</th>
<th>TOTAL FOR CREW ($/HR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>STANDBY EQUIPMENT</td>
<td>11</td>
<td></td>
<td></td>
<td>4.95</td>
<td>48.95</td>
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</table>

### TOTALS

<table>
<thead>
<tr>
<th>MANHOURS</th>
<th>LABOR COST</th>
<th>EQUIPMENT COST</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>48.95</td>
</tr>
</tbody>
</table>

### CREW PRODUCTIVITY

<table>
<thead>
<tr>
<th>WORK TASK</th>
<th>PRODUCTIVITY RATE UNIT/HR</th>
<th>LABOR</th>
<th>EQUIPMENT $/UNIT</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAFETY</td>
<td>1020 ccm/hr</td>
<td></td>
<td>0.05</td>
<td>ALL EQUIPMENT EXCEPT TRUCKS ON STANDBY SAFETY FOR LEVEL D.</td>
</tr>
</tbody>
</table>

*Including fringe benefits

**DA FORM 5413-R, Apr 85**
### Topsoil Costs - Stockpile to Basin F

The work involved in this cost will involve picking up topsoil from a stockpile near Basin F and placing it above the basin and landfill clay caps. Cat 627B scrapers will be used assisted by 2 Cat D8L dozers at the stockpile. The topsoil will be placed in-place with a Cat D6 Dozer and spread and leveled with one Cat 144 Motor Grader. Two laborers will be required for spotting and grade checking.

It is assumed that all topsoil placement will be performed after clay cap placement under level, D dekeet of hazard conditions.

<table>
<thead>
<tr>
<th>Task No.</th>
<th>Date</th>
<th>File No.</th>
<th>Sheet</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>3/10/87</td>
<td>3/10/87</td>
<td>1</td>
</tr>
</tbody>
</table>

Woodward-Clyde Consultants
**Estimated Cycle Times**

Haul Profile (627B Scrapper)

<table>
<thead>
<tr>
<th>Section</th>
<th>Length</th>
<th>Loaded TR Time</th>
<th>Unloaded TR Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>600'</td>
<td>5% 0.50'</td>
<td>5% 0.41'</td>
</tr>
<tr>
<td>B</td>
<td>600'</td>
<td>0% 0.40'</td>
<td>5% 0.41'</td>
</tr>
<tr>
<td>C</td>
<td>200'</td>
<td>10% 0.31'</td>
<td>10% 0.23'</td>
</tr>
</tbody>
</table>

Total Time: 1.21 min

Vehicle Diameter: 93% Altitude Derating: 1.30 min

**Total Estimated Cycle Time**

- Haul = 1.30 min
- Return = 1.20 min
- Load = 0.60 min
- Maneuver & Dump = 0.60 min

Total Cycle Time: 3.70 min at 100% Efficiency
Estimated Production

1) Estimated Load

18 cu x 1.70 (load factor) = 30.6 cu/Load

2) Cycles per Hour

\[
\frac{60 \text{ min}}{\text{hr}} \times \frac{\text{cycles}}{9.70 \text{ min}} = 6.2 \text{ cycles/hr}
\]

3) Hourly Unit Production

\[
12.6 \text{ cu} \times 6.2 \text{ cycles} = 78.36 \text{ cu/hr}
\]

4) Need 1 Scraper every 0.6 minutes

\[
3.70 \div 0.6 = 6.2 \text{ scrapers} \Rightarrow \text{Use 6}
\]

5) Check Push Dozer Balance

\[
\text{Dozer cycle} = 1.46 + 1.25 = 2.71 \text{ minutes}
\]

\[
\text{Scraper cycle} = \frac{3.70}{1.09} = 3.4 \text{ scrapers/dozer}
\]

\[
\Rightarrow \text{Each dozer can handle 3+ scrapers}
\]

6) Fleet Production

\[
6 \times 204 \text{ cu/hr} = 1224 \text{ cu/hr}
\]

7) Adjusted Production

\[
\frac{50}{60} \times 1224 \text{ cu/hr} = 1020 \text{ cu/hr}
\]

(Use 50 minute hour)

(Level D Protection)
<table>
<thead>
<tr>
<th>Equipment</th>
<th>Quantity</th>
<th>Rate</th>
<th>Description</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT 627 B Scrapers</td>
<td>6</td>
<td>$134.80</td>
<td></td>
<td>$808.80</td>
</tr>
<tr>
<td>CAT D8L Dozers</td>
<td>2</td>
<td>$123.85</td>
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<td>$247.70</td>
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<tr>
<td>CAT 144 Motor Grader</td>
<td>1</td>
<td>$92.44</td>
<td></td>
<td>$92.44</td>
</tr>
<tr>
<td>CAT D6 Dozer</td>
<td>1</td>
<td>$63.28</td>
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<td>$63.28</td>
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<tr>
<td>CAT 627 B Scraper (Standing)</td>
<td>1</td>
<td>$75.27</td>
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<td>$75.27</td>
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<tr>
<td>LUGGERS</td>
<td>2</td>
<td>$12.75</td>
<td></td>
<td>$25.50</td>
</tr>
</tbody>
</table>

**Total Cost** = $1312.4/hec

**Cost to plant topsoil - stockpile to Basin F**

\[
\text{Cost} = \text{Total Cost} \times \text{Rate per 1020 cc/y} = 1.29/1020 cc/y
\]
COST ITEM 11

- Waste Pile Sumps and Piping
RECORD OF VERBAL QUOTE

Project: Name: Basin F
Location: RMA

Quote #: 18-1 (Estimate Sh. No. _________)

Firm: Name: See below
Location: ___________________________
Telephone No.: ( )
Person Talked To: ___________________

Type of Quote: __ Supplier, material only (FOB Point: __________)
X Subcontractor, material installed (Cost to Prime)

Scope/Description/Amount of Quote:
Our cost estimate was based upon an independent calculation of the hours required to install these materials added to the manufacturing cost, and upon telephone estimates from the three leading companies in manufacture/installation of HDPE geomembranes. All costs were based upon installation of synthetic materials under summer conditions and in level B personal protective gear. The cost estimates do not include: construction field and office engineering; independent quality assurance engineering; preparation of subgrade 'out-and-fill, compaction, removal of rocks larger than 1/2-inch); site dewatering; pump station for leachate/leak removal. We also assume that our conceptual design (with a minimum number of penetrations or liner) will be implemented. The estimates are displayed in the accompanying table.

<table>
<thead>
<tr>
<th>ITEM</th>
<th>ESTIMATED COST ($/LAYER/SF)</th>
<th>ESTIMATED BY</th>
<th>INSTALLATION COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 60-mil. HDPE Geomembrane</td>
<td>$0.74 HDR</td>
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<td>Level B PPG</td>
</tr>
<tr>
<td></td>
<td>$0.75 Gundle</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>$0.80 National Seal</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$0.88 Schlegel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. 16 oz. PP Geotextile</td>
<td>$0.24 Sublugol</td>
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<tr>
<td></td>
<td>$0.22 National Seal</td>
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<td>3. Drainage Net (Geonet)</td>
<td>$0.32 National Seal</td>
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<td></td>
<td>$0.26 Gundle</td>
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Date Quote Received: ___________________
Quote Received By: D. Sprague
FML INSTALLATION COST ESTIMATE

ASSUME: Supplied Air
Protective Clothing
20,000 sq. ft./day

<table>
<thead>
<tr>
<th>LABOR CLASSIFICATION</th>
<th>DAYS</th>
<th>SALARY</th>
<th>RENTAL</th>
<th>PER DIEM</th>
<th>MOBILIZATION PERSONNEL EQUIPMENT</th>
<th>SAFETY EQUIPMENT + FEE</th>
<th>DIRECT + PROFIT</th>
<th>SALARY + PROFIT</th>
<th>TOTAL</th>
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<tbody>
<tr>
<td>Supervisor (1)</td>
<td>46</td>
<td>$5,497</td>
<td>$0</td>
<td>$2,287</td>
<td>$1,200</td>
<td>$3,430</td>
<td>$7,609</td>
<td>$6,322</td>
<td>$13,931</td>
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<tr>
<td>Head Welder (1)</td>
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<td>$4,398</td>
<td>$0</td>
<td>$2,287</td>
<td>$1,200</td>
<td>$3,430</td>
<td>$7,609</td>
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<td>$12,667</td>
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<tr>
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<td>$4,574</td>
<td>$2,400</td>
<td>$6,861</td>
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<td>$9,104</td>
<td>$24,322</td>
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<td>Technicians (3)</td>
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<td>Qual. Contr. (1)</td>
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<td>$3,438</td>
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<td>Laborers (12)</td>
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<td>$26,256</td>
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<td>$0</td>
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1007                  | $88,859| $22,869| $18,296| $9,600   | $1,000                           | $72,044                 | $136,182        | $78,960         | $215,142 |

$ 0.235 per sq. ft. labor
$ 0.220 per sq. ft. material
$ 0.180 per sq. ft. profit and overhead

SUBTOTAL = $ 0.635 per sq. ft.
$ 0.739 incl. contingency
USE $0.68/SF WHICH INCLUDES SUB O/P
BUT NOT CONTRACTOR O/P

$0.90/SF w/o O/P

\[ \times 1.12 \text{ O/P} \]
COST ITEM 12

- Liquid Removal System
# CONSTRUCTION COSTESTIMATE

**PROJECT:** RMA  
**LOCATION:** Denver, CO  
**ARCHITECT ENGINEER:** WCC/HDR

**BASIS FOR ESTIMATE**  
- [ ] CODE A (No design completed)  
- [ ] CODE B (Preliminary design)  
- [ ] CODE C (Final design)  
- [ ] OTHER (Specify) 60% DESIGN

**DRAWING NO.**  
**ESTIMATOR** D. Hawk  
**CHECKED BY** Tom Kelly

## LANDFILL BUMPS & DRAINAGE

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Labor</th>
<th>Material</th>
<th>Total Cost</th>
</tr>
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<tbody>
<tr>
<td><strong>Pipe</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6&quot; PVC</td>
<td>2100</td>
<td>18,144</td>
<td>11,676</td>
<td>29,820</td>
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<tr>
<td>10&quot; PVC</td>
<td>105</td>
<td>2240</td>
<td>3559</td>
<td>5808</td>
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<tr>
<td><strong>Gravel</strong></td>
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<td></td>
<td>6</td>
<td>24</td>
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<tr>
<td><strong>Excavation</strong></td>
<td>6</td>
<td>3</td>
<td>400</td>
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</table>

B INDICATES LEVEL B HAZARD - USE 6" LARGER DRAINAGE  
B* INDICATES LEVEL B HAZARD - SAFETY INCLUDED

**TOTAL** $36,124  
**SAV** $26,120
COST ITEM 13

- Sewer and Miscellaneous Debris Removal
- Haul Waste to Solidification
## Site Work

### Civil

<table>
<thead>
<tr>
<th>Water</th>
<th>Top Existing 2&quot; Line</th>
<th>2</th>
<th>EA</th>
<th>10.00 B</th>
<th>120</th>
<th>210</th>
<th>27.00</th>
<th>30</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Pipe PVC Class 160 2&quot;</td>
<td>315</td>
<td>LF</td>
<td>1.76 B</td>
<td>3,226</td>
<td>0.32</td>
<td>101</td>
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<tr>
<td></td>
<td>Backflow Preventer &amp; 2&quot;</td>
<td>2</td>
<td>EA</td>
<td>24.00 B</td>
<td>312</td>
<td>420</td>
<td>340</td>
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<tr>
<td></td>
<td>Manhole 4&quot;ID x 6&quot;Deep</td>
<td>2</td>
<td>EA</td>
<td>52.00 B</td>
<td>624</td>
<td>320</td>
<td>640</td>
<td>20 - 4</td>
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<tr>
<td></td>
<td>Manhole Top 8&quot; Thick</td>
<td>2</td>
<td>EA</td>
<td>52.00 B</td>
<td>624</td>
<td>320</td>
<td>640</td>
<td>20 - 4</td>
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<tr>
<td></td>
<td>Manhole Covers 24&quot;D 300H</td>
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<td>EA</td>
<td>48.00 B</td>
<td>576</td>
<td>115</td>
<td>230</td>
<td>50 - 3</td>
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<tr>
<td></td>
<td>Screened Stone Bedding For</td>
<td>2</td>
<td>CY</td>
<td>3.72 B</td>
<td>45</td>
<td>1,600</td>
<td>32</td>
<td>3.10</td>
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<tr>
<td></td>
<td>Manholes Compacted 24-1/2&quot;</td>
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<td>CY</td>
<td>0.86 B</td>
<td>212</td>
<td>-</td>
<td>1.21 - 5</td>
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<td></td>
<td>Excavation for Manholes Using Backhoe 1 Cycle</td>
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<td>CY</td>
<td>5.22 B</td>
<td>282</td>
<td>-</td>
<td>0.45 -</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Backfill by hand Vt Phle</td>
<td>29</td>
<td>CY</td>
<td>3.47 B</td>
<td>604</td>
<td>-</td>
<td>0.78 -</td>
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</tbody>
</table>

### Process Foremost

| Pipe PVC Containment 6" | 1600 | LF | - | Included in material total 85.00 | 136,000 | Grade #5 |
| Valves PVC Ball 4" | 1 | EA | 18.41 B | 11 | 288.00 | 288 |
| Diaphragm - Non-press Lined 6" | 1 | EA | 160.00 B | 960 | 1,100 | 1,100 | Val. #7 |

### Pipe Supports: Total of 160

| Pipe Clamps Salv. 10" | 160 | EA | 3.45 B | 3,312 | 19.45 | 3109 |
| Galv. Threaded Rod ½" | 640 | LF | 1.28 B | 4.916 | 0.38 | 343 |

### Concrete

| Concrete | 83 | CY | 4.96 B | 2470 | 0.31 | 26 | 0.31 - 21 |

**Subtotal** = 148,857 / 149,479

1 "B" Designates Level B. Labor multiplies by factor of 6.
## CONSTRUCTION COST ESTIMATE

**PROJECT**
- **BASIN E**

**LOCATION**
- **RNA Denver**

**ARCHITECT ENGINEER**
- **HDR**

**Estimator**
- **D.A. Kottwitz**

**Check by**
- **A.C. Erickson**

### Pump Station

#### Structural Summary

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Unit</th>
<th>Rate</th>
<th>Total</th>
<th>Unit Rate</th>
<th>Total</th>
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<tbody>
<tr>
<td>Concrete (Div. 3)</td>
<td></td>
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<tr>
<td>Slabs on Grade:</td>
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<tr>
<td>Concrete - 1000 psi</td>
<td>11</td>
<td>CY</td>
<td>7.45</td>
<td>492</td>
<td>54.20</td>
<td>596</td>
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<tr>
<td>Placing</td>
<td>11</td>
<td>CY</td>
<td>7.45</td>
<td>492</td>
<td>0.96</td>
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<tr>
<td>WWF - 6 x 6 #4/4</td>
<td>5.95</td>
<td>CSF</td>
<td>13.10</td>
<td>468</td>
<td>20.20</td>
<td>120</td>
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<tr>
<td>Edge Forms</td>
<td>136</td>
<td>LF</td>
<td>1.04</td>
<td>849</td>
<td>0.16</td>
<td>22</td>
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<tr>
<td>Screed - 2 x 4</td>
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<td>LF</td>
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<td>58</td>
<td>0.79</td>
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<td>Finishing (Broom Finish)</td>
<td>595</td>
<td>SF</td>
<td>0.23</td>
<td>821</td>
<td>0.04</td>
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<tr>
<td>Curing (Sprayed Membrane)</td>
<td>5.95</td>
<td>CSF</td>
<td>2.71</td>
<td>97</td>
<td>1.70</td>
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<td>Equipment Pids:</td>
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<tr>
<td>Concrete - 1000 psi</td>
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<td>CY</td>
<td>7.45</td>
<td>45</td>
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<td>CSF</td>
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<td>10</td>
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<td>Placing</td>
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<td>CY</td>
<td>7.45</td>
<td>45</td>
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</tr>
<tr>
<td>Forms</td>
<td>50</td>
<td>LF</td>
<td>1.04</td>
<td>312</td>
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<tr>
<td>Finishing (Float Finish)</td>
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<td>SF</td>
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<td>63</td>
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<tr>
<td>Curing (Sprayed Membrane)</td>
<td>0.48</td>
<td>CSF</td>
<td>2.71</td>
<td>99</td>
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<td>Anchor Bolts 3/8 x 12&quot;</td>
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<td>EA</td>
<td>2.00</td>
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<tr>
<td>1/4&quot; x 6&quot;</td>
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<td>- Painting</td>
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<td>- Anchor Bolts 20 EA</td>
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<td>EA</td>
<td>2.06</td>
<td>747</td>
<td>1.88</td>
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<td>- Bolt Layout &amp; Drilling</td>
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<td>EA</td>
<td>6.30</td>
<td>756</td>
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<td>1,294</td>
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(1) "B" Designates Level B. Labor multiplied by factor of 6.
CONSTRUCTION COST ESTIMATE

PROJECT
RACIN F

LOCATION
PMA Design

ARCHITECT ENGINEER
NCR

ESTIMATOR
D. A. Kubitze

CHECKED BY
AC Erickson

Pump Station

<table>
<thead>
<tr>
<th>Mechanical Process</th>
<th>Summary</th>
<th>Quantity</th>
<th>LABOR (H, H)</th>
<th>MATERIAL</th>
<th>TOTAL COST</th>
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<tr>
<td></td>
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<tr>
<td>Air Supply System</td>
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<td>Air Compressor -330cF</td>
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<td>24.0</td>
<td>144.0</td>
<td>17,800</td>
<td>17,800 Quote</td>
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<tr>
<td>@ 125 psig</td>
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<td>842 Quote</td>
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<tr>
<td>Air Piping (- Steel 2&quot;</td>
<td>75 LF</td>
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<td>17.5</td>
<td>2.13</td>
<td>160</td>
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<td>Mod: - Steel 3/4&quot;</td>
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<td>4.8</td>
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<td>Pressure Reducing Valve 2&quot;</td>
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<td>4.2</td>
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<td>260</td>
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<tr>
<td>Ball Valves (- Steel 1/2&quot;</td>
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<td>5.08</td>
<td>5</td>
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<td>- Steel 3/4&quot;</td>
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<td>2.4</td>
<td>3.08</td>
<td>3</td>
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<td>2 EA</td>
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<td>21</td>
</tr>
<tr>
<td>- Steel 2&quot;</td>
<td>1 EA</td>
<td>3.25</td>
<td>19.2</td>
<td>27.54</td>
<td>30</td>
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<tr>
<td>Pipe Supports - Concrete Block</td>
<td>7 EA</td>
<td>1.0</td>
<td>42.0</td>
<td>4.17</td>
<td>9</td>
</tr>
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<td>- Pipe Clamps</td>
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<td>13.9</td>
<td>1.32</td>
<td>9</td>
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<td>- 2&quot; Unions</td>
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<td>- 2&quot; Red.</td>
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<td>3.2</td>
<td>1.53</td>
<td>3</td>
</tr>
<tr>
<td>threaded (- 2&quot; Tees)</td>
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<td>1.45</td>
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<td>6</td>
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<td>- 1&quot; Unions</td>
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<td>- 3/4&quot; Red.</td>
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<td>3.53</td>
<td>6</td>
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<tr>
<td>- 3/4&quot; Elbows</td>
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<td>4</td>
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Subtotal                  460.8  19,362

(1) "E" Designates Level E. Labor Multiplied by Factor of 6.
### Pump Station

#### Mechanical Process

<table>
<thead>
<tr>
<th>Item Description</th>
<th>No.</th>
<th>Units</th>
<th>Unit</th>
<th>Per Unit</th>
<th>Total (MH)</th>
<th>Per Unit</th>
<th>Total</th>
<th>Cost</th>
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</thead>
<tbody>
<tr>
<td>Diaphragm Pumps - 150 gpm</td>
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<td>EA</td>
<td>3.2</td>
<td>B</td>
<td>8.338</td>
<td>16.676</td>
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<tr>
<td>@ 150 FT TON (115 BF)</td>
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<tr>
<td>Flex. Connectors - 1/2&quot; x 4&quot;</td>
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<td>EA</td>
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<td>B</td>
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<td>Quick Coupling - 3/4&quot; Maint. 4&quot;</td>
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<td>EA</td>
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<td>Flex Suct. Hose w/ Span. 6&quot;</td>
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<td>EA</td>
<td>1.5</td>
<td>B</td>
<td>90.0</td>
<td>530.45</td>
<td>5305</td>
<td>Quote</td>
</tr>
<tr>
<td>Quick Coupling Ext. - 3/4&quot; x 30'</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Electrical

- Branch to Comp. Pad: 1500 ft
- Lighting to Comp. Pad

#### Labor

- 24 Hours for 25 MW: 600 hrs * 8256 = 8256

1. *"B" Designates Level B. Labor Multiplied by Factor of 6.
RECORD OF VERBAL QUOTE

Project: Name: BASIN F
Location: DENVER

Quote #: / (Estimate Sh. No. )

Firm: Name: INGERSOLL-RAND
Location: OMAHA
Telephone No.: (402) 330-5831
Person Talked To: STEVE ZIMMERLE

Type of Quote: V Supplier, material only (FOB Point: DENVER )
V Subcontractor, material installed (Cost to Prime)

Scope/Description/Amount of Quote:

MODEL SSR EP 75
w/ • Reduced voltage starting
• Protective shutdown annunciation
• TEFC motor
• Dust inlet

electrical 460V 3p 60Hz
330 cfm Free Air Delivery @ 125 psig
$17,800 ea

Weight = 2350 lb

Date Quote Received: 11/9/87
Quote Received By: FURNE
RECORD OF VERBAL QUOTE

Project: Name: Basin F
Location: RMA Denver

Quote #: Z (Estimate Sh. No. 1)

Firm: Name: CPI Sales
Location: Omaha
Telephone No.: (402) 324-7317
Person Talked To: Brad Baustead

Type of Quote: X Supplier, material only (FOB Point: Denver)
Subcontractor, material installed (Cost to Prime)

Scope/Description/Amount of Quote:

Air Operated Diaphragm Pumps
Wilden Model M-15

Accessories & Options:
Non Waffed Parts: Cast Iron
Ball Valves: Neoprene
Value Seats: Neoprene
Diaphragms: Neoprene

Oiler
Filter
Regulator
Polypropylene Surge Suppressor

TOTAL COST FOB = 6.4/65
Weight = 215/16 each

Date Quote Received: 1-19-87
Quote Received By: FURNE
RECORD OF VERBAL QUOTE

Project: Name: Basin E
Location: Denver

Quote #: 4 (Estimate Sh. No.: )

Firm: Name: Ranger Rubber
Location: Omaha, NE
Telephone No.: (402) 551-2300
Person Talked To: John

Type of Quote: X Supplier, material only (FOB Point: )
_ Subcontractor, material installed (Cost to Prime)

Scope/Description/Amount of Quote:

4" Suction Hose w/5 ft. 5th quick couplings
All chemical type hose
20 ft lengths
Male x Female Couplings

$530 $ each

Date Quote Received: 3-17-87
Quote Received By: D. Kathweitz
RECORD OF VERBAL QUOTE

Project: Name: **BASIN F**
Location: **DENVER**

Quote #: **S** (Estimate Shpt. No. ___________

Firm: Name: **Gartner & Assoc. Co. Inc.**
Location: **Omaha, NE**
Telephone No.: (402) 572-6969
Person Talked To: **Rene Nelson**

Type of Quote: **X** Supplier, material only (FOB Point: **Denver**)

Subcontractor, material installed (Cost to Prime)

Scope/Description/Amount of Quote:

For phone conversation 3-19-87 determined that $35/FT is price including installation excluding pipe supports.

Date Quote Received: **2-20-87**
Quote Received By: **Fur eve**
RECORD OF VERBAL QUOTE

Project: Name: BASIN F
Location: RMA Denver

Quote #: 6 (Estimate Sh. No. )

Firm: Name: INGERSOLL-RAND
Location: OMAHA, NEBRASKA
Telephone No.: (402) 330-5831
Person Talked To: Steve Eimmark

Type of Quote: X Supplier, material only (FOB Point: Denver)

Subcontractor, material installed (Cost to Prime)

Scope/Description/Amount of Quote:

Model VCG2912 Air Receiver
120 gal
Coast Guard Approved
Epoxy Coated

$842 FOB Denver

Weight -

Date Quote Received: 3-17-87
Quote Received By: D.A. Kothu'z


RECORD OF VERBAL QUOTE

Project: Name: BASIN
Location: DENVER

Quote #1 7 (Estimate Shet. No. )

Firm: Name: Central States Industrial Supply, Inc.
Location: Omaha, NE
Telephone No.: (402) 344-8900

Person Talked To: Keith

Type of Quote: X Supplier, material only (FOB Point: Denver)
Subcontractor, material installed (Cost to Prime)

Scope/Description/Amount of Quote:

6" Saunders Straight Thru Diaphragm Valve
with neoprene lining and neoprene diaphragm.
Weight = 250 lb.

$1,100 FOB Denver

Date Quote Received: 3-18-87
Quote Received By: D.A. Kottwitz
- Sewer and Miscellaneous Debris Removal (Compaction in Waste Pile)
- Haul Waste to Waste Pile (Compaction in Waste Pile)
CREW AND PRODUCTIVITY WORKSHEET
For use of this form, see TM 5-800-2. The proponent agency is USACE

DATE PREPARED: 3-18-87

PROJECT
RMA

PREPARED BY
D. Hawk

LOCATION
DENVER, CO.

CHECKED BY
T. Kelley 3-18-87

CREW REF NO

CREW COMPOSITION

WORK TYPE
EXCAVATION/Hauling

WORK SCHEDULE

SPECIAL INFORMATION
SLUDGE HANDLING
BASIN F TO SOLIDIFICATION FACILITY

CREW DESCRIPTION

NO REQUIRED
IN CREW

L Abor Cost

EQUIPMENT COST

HOURLY
RATE
($/HR)

TOTAL
FOR CREW
($/HR)

HOURLY
RATE
($/HR)

TOTAL
FOR CREW
($/HR)

CAT 627 B Scrapers
4
17.03
68.12
111.22
471.82

CAT D&L Diggers
2
16.88
33.76
106.37
212.74

CAT D& Digger
1
16.88
16.88
46.03
46.03

CAT 14 G Motor Grader
1
17.03
17.03
75.11
75.11

MRS 1-100 T Tractor w/Disc
1
16.88
16.88
83.09
83.09

Laborers
2
12.76
25.52
—
-

CAT 627 B Scrapers (standby)
1
—
—
75.37
75.37

TOTALS
11
178.19
EQUIPMENT
964.27

CREW PRODUCTIVITY

WORK TASK
EXCAVATION/Hauling
SAFETY

PRODUCTIVITY
404 CY/HR
404 CY/HR

UNIT/HR

LABOR

EQUIPMENT

COMMENTS

UNIT/UNIT

$0.44/CY
$2.39/CY

$0.44/CY
$2.39/CY

$0.80/CY
$0.80/CY

$4.08/CY

* Including fringe benefits

DA FORM 5418-R, Apr 95
**CREW AND PRODUCTIVITY WORKSHEET**

*For use of this form, see TM 5-8002; the preparer agency is USACE*

**PROJECT**
RMA

**LOCATION**
DENVER, CO

**CREW COMPOSITION**

<table>
<thead>
<tr>
<th>WORK TYPE</th>
<th>WORK SCHEDULE</th>
<th>SPECIAL INFORMATION</th>
<th>CREW DESCRIPTION</th>
<th>NO. REQUIRED IN CREW</th>
<th>HOURLY RATE ($)</th>
<th>TOTAL FOR CREW ($)</th>
<th>HOURLY RATE ($)</th>
<th>TOTAL FOR CREW ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAFETY</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**CREW DESCRIPTION**

- **HEAVY EQUIPMENT**
  - 9
- **STANDBY HEAVY EQUIPMENT**
  - 1
- **LABORERS**
  - 2

**TOTALS**

- **MANHOURS**
  - 156
- **LABOR COST**
  - 156
- **EQUIPMENT COST**
  - 348

**CREW PRODUCTIVITY**

<table>
<thead>
<tr>
<th>WORK TASK</th>
<th>PRODUCTIVITY RATE UNIT/HR</th>
<th>LABOR</th>
<th>EQUIPMENT</th>
<th>COMMENTS</th>
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<tbody>
<tr>
<td></td>
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</tr>
<tr>
<td>SAFETY</td>
<td>404 CV/42</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

*Including fringe benefits

**DATE PREPARED**
3-18-87

**PREPARED BY**
D. Hawk

**CHECKED BY**
T. Kelley 3-18-87
SLUDGE HANDLING AND HAULING BASIN F TO SOLIDIFICATION

This work will include mixing and drying sludge, excavating to final grade and haul to the solidification area.

It is envisioned that dozers will be used to excavate material down to liner grade and to push load scrapers. Additional dozers will be used to excavate below the liner to the finished grade. Scanners will be used to haul excavated material from Basin F to the solidification area rather than trucks as it was assumed they'd be more mobile. It was assumed that portions of the excavation area and sludge could have rolling resistances as high as 15 to 20% whereas other portions of the haul would be on haul roads with very low rolling resistance. Thus, an average rolling resistance of 110% was assumed for the haul.

It was estimated that mixing and drying of the sludge would be achieved by discing with a tractor and disc attachment and a light dozer. A motor grader was envisioned being used for maintaining the haul roads. It was also assumed that 2 laborers would be used as spotters.

Daily production for the excavation fleet should roughly match that of the solidification bag mill.
REQUIRED PRODUCTION:

It is estimated that the pug-mill will have a production of 300 cy/hr. and will operate 14 hours a day productively.

\[
PUG\ MILL\ PRODUCTION = 300\ cy/hr \times 14\ hrs/day = 4,200\ cy/day
\]

In terms of bank cubic yards:

\[
\text{excavate} \rightarrow \text{(O.B.LF)} \rightarrow \text{pug mill} \rightarrow \text{(410% by vol.)} \rightarrow \text{landfill}
\]

Vol. of 3375 lbs sludge: 1cy — 1.25cy — 1.37cy

\[
\text{BCY Production} = \frac{4,200\ cy}{1.37\ cy} = 3,066\ bcy/day
\]

For excavation crew at 8 hours per day

\[
3,066\ bcy/day \times \frac{1\ day}{8\ hours} = 383\ bcy^{3}/hr
\]
Subject: Land Fill Construction - Sludge removal/cost
Project No.: 86005540

By: TEK
Checked By: D. Hawk
Task No.: 2
File No.: 21947

Date: 3/16/87
Date: 3/18/87
Sheet: 3 of 5

Estimated Cycle Times

Haul Profile (CAT 627B Scraper) from bottom of excavation to solidification area. Assume profile is essentially the same as that for sludge excavation and hauling to stockpile except average haul is approx. 1600 ft. + 300 ft. maneuvering = 1900 ft. as shown below.

<table>
<thead>
<tr>
<th>Haul Leg Length</th>
<th>TR Time</th>
<th>TR Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 300'</td>
<td>0.39</td>
<td>0.32</td>
</tr>
<tr>
<td>B 200'</td>
<td>0.35</td>
<td>0.24</td>
</tr>
<tr>
<td>C 900'</td>
<td>1.12</td>
<td>0.76</td>
</tr>
<tr>
<td>D 200'</td>
<td>0.35</td>
<td>0.24</td>
</tr>
<tr>
<td>E 300'</td>
<td>0.39</td>
<td>0.32</td>
</tr>
</tbody>
</table>

Total Time: 2.60 min. 1.88 min. 2.02 min.

@ 93% Altitude Deration: 2.80 min. 2.02 min.

Total Estimated Cycle Time:
- Haul: 2.80 min.
- Return: 2.02 min.
- Load: 0.8 min.
- Maneuver and Dump: 0.8 min.

Total: 6.42 min./cycle @ 100% eff.

Woodward-Clyde Consultants
ESTIMATED PRODUCTION

DESTINED LOAD

(0.8 assumed load factor)

\[
18 \text{ cy} \times 0.8 \text{ L.F.} = 14.4 \text{ cy/load} \checkmark
\]

2) CYCLES PER HOUR

\[
\left( \frac{60 \text{ min/hr.}}{1 \text{ cycle}} \right) \left( \frac{1 \text{ cycle}}{6.42 \text{ min.}} \right) = 9.34 \text{ cycles/hr.} \checkmark
\]

3) ADJUSTED HOUURLY UNIT PRODUCTION (45 min/hr for 16:18)

\[
\left( \frac{45 \text{ min}}{60 \text{ min}} \right) (9.34 \text{ cycles/hr}) (14.4 \text{ cy/load}) = 100.9 \text{ cy/hr.} \checkmark
\]

4) NEED 383 \text{ cy/hr.}

\[
\frac{383 \text{ cy/hr.}}{100 \text{ cy/unit}} = 3.80 \checkmark
\]

Use 4 scrapers \checkmark

5) CHECK PUSHER DOZER BALANCE

DOZER CYCLE

\[
1.4 (0.8) + 0.25 = 1.37 \text{ minutes} \checkmark
\]

SCRAPER CYCLE

\[
\frac{6.42 \text{ min}}{1.37 \text{ min}} = 4.69. \checkmark
\]

So use 1 dozer to handle 4 scrapers \checkmark

6) FLEET PRODUCTION @ LEVELB EFFICIENCY (45min/hr)

\[
4 \times 100.9 \text{ cy/hr} = 403.6 \text{ cy/hr.} \checkmark
\]
EQUIPMENT AND FLEET COSTS:

4 CAT 627B SCRAPERS @ $134.80 = $539.20 ✓
4 CAT D-8L DOZERS @ $123.25 = $493.00 ✓
1 CAT 627B SCRAPER
   (STANDBY) @ $75.37 = $75.37 ✓
1 CAT 14G MOTOR GRADER @ $264 = $264 ✓
1 CAT D-6 DOZER @ $632.25 = $632.25 ✓
1 TRACTOR WITH DISC ATTACHMENT @ $99.97 = $99.97 ✓
2 LABORERS @ $12.75 = $25.50 ✓

Total Cost: $1142.48 ✓

\[
\frac{\$1142.48}{\text{HR}} = \frac{\$2.83}{\text{cy}}
\]

403.6 cy/HR ✓

Woodward-Clyde Consultants
• Haul Waste to Waste Pile
**CREW AND PRODUCTIVITY WORKSHEET**

For use of this form, see TM 5-800.2. The preparing agency is USACE.

<table>
<thead>
<tr>
<th>PROJECT</th>
<th>PREPARED BY</th>
<th>CREW REF NO</th>
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<tbody>
<tr>
<td>RMA</td>
<td>D. Hawk</td>
<td></td>
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<table>
<thead>
<tr>
<th>LOCATION</th>
<th>CHECKED BY</th>
<th>DATE PREPARED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denver, CO</td>
<td>T. Kelley</td>
<td>3-18-87</td>
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</table>

**CREW COMPOSITION**

<table>
<thead>
<tr>
<th>WORK TYPE</th>
<th>WORK SCHEDULE</th>
<th>SPECIAL INFORMATION SLUDGE HANDLING</th>
<th>CREW COMPOSITION</th>
<th>GRADE AND COMPOST IN LANDFILL</th>
</tr>
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</table>

**CREW DESCRIPTION**

<table>
<thead>
<tr>
<th>CREW DESCRIPTION</th>
<th>NO. REQUIRED IN CREW</th>
<th>HOURLY RATE ($/HR)</th>
<th>TOTAL FOR CREW ($/HR)</th>
<th>HOURLY RATE ($/HR)</th>
<th>TOTAL FOR CREW ($/HR)</th>
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</thead>
<tbody>
<tr>
<td>Cat 825 C Compactor</td>
<td>1</td>
<td>16 88</td>
<td>16 88</td>
<td>90 32</td>
<td>90 32</td>
</tr>
<tr>
<td>Cat Dbl Dozer</td>
<td>1</td>
<td>16 88</td>
<td>16 88</td>
<td>106 37</td>
<td>106 37</td>
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**TOTALS**

<table>
<thead>
<tr>
<th>MANHOURS</th>
<th>LABOR COST</th>
<th>EQUIPMENT COST</th>
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<tbody>
<tr>
<td>2</td>
<td>33 72</td>
<td>196 89</td>
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</table>

**CREW PRODUCTIVITY**

<table>
<thead>
<tr>
<th>WORK TASK</th>
<th>PRODUCTIVITY RATE</th>
<th>LABOR</th>
<th>EQUIPMENT</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grading/Compaction</td>
<td>383 Cy/hr</td>
<td>$0 02/yr</td>
<td>$0 51/cy</td>
<td></td>
</tr>
<tr>
<td>Safety</td>
<td></td>
<td></td>
<td>$0 29/cy</td>
<td></td>
</tr>
<tr>
<td>Total Equipment, Labor &amp; Safety</td>
<td>$0 80/cy</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Including fringe benefits*
<table>
<thead>
<tr>
<th>CREW AND PRODUCTIVITY WORKSHEET</th>
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</thead>
<tbody>
<tr>
<td>PROJECT: RMA</td>
</tr>
<tr>
<td>LOCATION: DENVER, CO.</td>
</tr>
<tr>
<td>PREPARED BY: D. HAWK</td>
</tr>
<tr>
<td>CHECKED BY: T. KELLY 3-18-87</td>
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</table>

**Crew Composition**

<table>
<thead>
<tr>
<th>Work Type</th>
<th>Work Schedule</th>
<th>Special Information</th>
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<tbody>
<tr>
<td>SAFETY</td>
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<table>
<thead>
<tr>
<th>Crew Description</th>
<th>No. Required in Crew</th>
<th>Labor Cost</th>
<th>Equipment Cost</th>
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<tbody>
<tr>
<td>HEAVY EQUIPMENT</td>
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<td>38.20</td>
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<table>
<thead>
<tr>
<th>TOTALS</th>
<th>MANNOURS</th>
<th>LABOR COST</th>
<th>EQUIPMENT COST</th>
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</thead>
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<tr>
<td></td>
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<td>76.40</td>
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</table>

**Crew Productivity**

<table>
<thead>
<tr>
<th>Work Task</th>
<th>Productivity Rate UNIT/Hr</th>
<th>Labor</th>
<th>Equipment UNIT</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAFETY</td>
<td>385 e/2</td>
<td></td>
<td>80 e/2</td>
<td></td>
</tr>
</tbody>
</table>

*Including fringe benefits*
Subject: Landfill Costs - Landfill grading and construction

By: TEK

Checked By: D. Hawk

Date 3/17/87

Task No. 2

File No. 21947

Sheet 1 of 2

GRADE AND PLACE WASTE IN LANDFILL

This work will include spreading of the solidified material dumped by the scrapers, and compacting in the landfill.

It is assumed that one dozer will spread the material to grade and a compactor will compact the material with one pass. Two laborers will be used as spotters.

Production should roughly match that of the scrapers hauling the solidified material to the landfill (525 cy./hr. or 3835 cy./hr.).
REQUIRED PRODUCTION

Hourly prod. = 525 cy/hr. (32= 6cy/hr.)

Scraper cycle = 1.683 min @ 100% efficiency

4 scrapers, 1 scraper every 1.21 min.

CHECK COMPACTOR PRODUCTION:

CAT B25C Performance: 3 passes, 4 mph, 18 inch lift

(from CAT Performance Handbook)

production = 12.83 yd³/hr. x 60

12.83 x 60 = 762 yd³/hr.

so use 1 compactor assisted by 10-3 DOZER

FLEET COST

1 CAT B25C compactor @ $107.40 = $107.40

1 CAT D-3 DOZER @ $123.25 = $123.25

$230.65/hr

COST

$230.65/hr = $0.44/cy

$230.65/hr = $0.20/bcy

# Note: No safety considerations taken into account for this cost except 45/60% efficiency.
- Solidification
# CREW AND PRODUCTIVITY WORKSHEET

For use of this form, see TM 5-800-2, the proponent agency is USACE.

**DATE PREPARED:** 3-18-87

**PROJECT:** RMA

**PREPARED BY:** D. HAWK

**LOCATION:** DENVER, CO

**CHECKED BY:** T. KELLEY 3-18-87

---

**CREW COMPOSITION**

<table>
<thead>
<tr>
<th>CREW DESCRIPTION</th>
<th>NO. REQUIRED IN CREW</th>
<th>HOURLY RATE ($/HR)</th>
<th>TOTAL FOR CREW ($/HR)</th>
<th>HOURLY RATE ($/HR)</th>
<th>TOTAL FOR CREW ($/HR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT 627 B SCRAPERS</td>
<td>4</td>
<td>17 $</td>
<td>68 $</td>
<td>117 $</td>
<td>471 $</td>
</tr>
<tr>
<td>CAT D&amp;L DITCHERS</td>
<td>1</td>
<td>16 $</td>
<td>16 $</td>
<td>106 $</td>
<td>106 $</td>
</tr>
<tr>
<td>CAT 966D LOADERS</td>
<td>2</td>
<td>16 $</td>
<td>33 $</td>
<td>61 $</td>
<td>122 $</td>
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<tr>
<td>LABORERS</td>
<td>2</td>
<td>12 $</td>
<td>25 $</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAT 627 B SCRAPERS (STANDBY)</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>75 $</td>
<td>75 $</td>
</tr>
</tbody>
</table>

**TOTALS**

- MANHOURS: 9
- LABOR COST: 144 $
- EQUIPMENT COST: 775 $

---

**CREW PRODUCTIVITY**

<table>
<thead>
<tr>
<th>WORK TASK</th>
<th>PRODUCTIVITY RATE UNIT/HR</th>
<th>LABOR</th>
<th>EQUIPMENT</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXCAVATION/HAULING</td>
<td>383 $/CY</td>
<td>$0 28/CY</td>
<td>$0 28/CY</td>
<td>$382/CY</td>
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<tr>
<td>SAFETY</td>
<td>383 $/CY</td>
<td>$0 21/CY</td>
<td>$0 21/CY</td>
<td>$382/CY</td>
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</tbody>
</table>

**TOTAL EQUIPMENT WITH LABOR & SAFETY**

$382/CY

*Including fringe benefits*
**CREW AND PRODUCTIVITY WORKSHEET**

**DATE PREPARED:** 3-18-87

**PROJECT:** RMA

**PREPARED BY:** D. Hawk

**LOCATION:** Denver, Co.

**CHECKED BY:** T. Kelley 3-18-87

**CREW COMPOSITION**

<table>
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<tr>
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<th>NO. REQUIRED IN CREW</th>
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<th>TOTAL FOR CREW ($/HR)</th>
<th>H OURLY RATE ($/HR)</th>
<th>TOTAL FOR CREW ($/HR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy Equipment</td>
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**TOTALS**

<table>
<thead>
<tr>
<th>MANHOURS</th>
<th>LABOR COST</th>
<th>EQUIPMENT COST</th>
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<tbody>
<tr>
<td></td>
<td>156.10</td>
<td>271.85</td>
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**CREW PRODUCTIVITY**

<table>
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<tr>
<th>WORK TASK</th>
<th>PRODUCTIVITY RATE $/UNIT/HR</th>
<th>LABOR</th>
<th>EQUIPMENT $/UNIT</th>
<th>COMMENTS</th>
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<tbody>
<tr>
<td>Safety</td>
<td>383</td>
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<td>0.71</td>
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</table>
SLUDGE HAULING - SOLIDIFICATION AREA TO LANDFILL

This work will include loading material from the solidified sludge stockpile at the pug mill into scrapers and hauling and dumping it in the landfill.

It is assumed that loaders will be used to load scrapers. Scrapers will then haul the material to the landfill and dump it. A D-9 dozer will assist the loaders. Laborers will be used as spotters.

Daily production of the fleet should roughly match the output of the pug mill.
REQUIRED PRODUCTION:

**AVG MILL OUTPUT = 4,200 cy/day (3066 bcy/day)**

Adjusted Landfill hauling Fleet production for an 8-hour day  = 525 cy/hr

\[(525 \div 1.37) = (383 \\text{bcy/hr})\]

ESTIMATED CYCLE TIMES

**HAUL PROFILE (CAT 627B SCRAPERS) AVG Haul = 930 ft.**

*USE 1,000 ft WITH MANEUVERING*

<table>
<thead>
<tr>
<th>SECTION</th>
<th>LENGTH</th>
<th>LOADED TR</th>
<th>TIME (min)</th>
<th>UNLOADED TR</th>
<th>TIME (min)</th>
</tr>
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<tbody>
<tr>
<td>A</td>
<td>400'</td>
<td>10%</td>
<td>.54</td>
<td>10%</td>
<td>.41</td>
</tr>
<tr>
<td>B</td>
<td>400'</td>
<td>0%</td>
<td>.34</td>
<td>6%</td>
<td>.34</td>
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<tr>
<td>C</td>
<td>200'</td>
<td>39%</td>
<td>.25</td>
<td>39%</td>
<td>.19</td>
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</tbody>
</table>

**TOTAL TIME:**

@ 93% altitude correction

1.13 min. ✓ 0.94 min. ✓

LOAD CYCLE:

- USE 0.2 min. first load, 0.4 min. additional loads
- For 4-cy bucket, @ 1.0 load factor = 4.0 cy/load

\[(10 \text{cy, scraper vol.}) \times (4.0 \text{cy/load}) = 40 \text{passes of kicker (cy)}\]

0.2 + 4(0.4) = 1.8 min/load @ 100% eff

(No loader deviation for 5000' altitude.) ✓
TOTAL ESTIMATED CYCLE TIME

HAUL 1.22 min. ✓
RETURN 1.01 min. ✓
LOAD 1.8 min. ✓
MANEUVER & DUMP 0.8 min. ✓

4.83 min/cycle @ 100% eff.

ESTIMATED PRODUCTION:

1) ESTIMATED LOAD (1.0 assumed load factor)

18.0 cy/load x 1.0 L.F. = 18.0 cy/load ✓

2) Cycles per hour

(60 min/hr) \( \frac{1 \text{ cycle}}{4.83 \text{ min}} \) = 12.4 cycles/hour ✓

3) Adjusted Hourly Unit Production (45 min/hr. for Level B)

(45 min/60 min)(12.4 cycles/hr)(18.0 cy/load) = 167.4 cy/hr/unit

4) NEED 525 cy/hr. (loose)

\( \frac{525 \text{ cy/hr}}{167.4 \text{ cy/hr/unit}} \) = 3.19 ✓

use 4 scrapers ✓

5) Check loader balance

\( \frac{\text{Scraper cycle}}{\text{Loader cycle}} = \frac{4.83 \text{ min}}{1.8 \text{ min}} = 2.68 \text{ scrapers loader} \)

use 2 loaders for 4 scrapers ✓

6) FLEET Production @ Level B efficiency (45 min/hr.)

\( \frac{4 \times 167.4 \text{ cy/hr/unit}}{525 \text{ cy}} \times \frac{669.6 \text{ cy/hr}}{489.5 \text{ cy/hr}} = 489.5 \text{ cy/hr} \) ✓

Woodward-Clyde Consultants
By TEK  
Checked By D. HARR

Date 3/16/87  
Date 3/18/87

4. CAT 627B Scrapers @ $134.80 = $539.20 ✔
1. CAT 627B Scraper (Standby) @ $75.33 = $75.33 ✔
2. CAT 966D Front Loader @ $57.52 = $115.04 ✔
1. CAT D-8 Dozer @ $1,233.00 = $1,233.00 ✔
2. Tractor @ $127.60 = $255.20 ✔

Total Hourly $919.30 ✔

Cost Per CY.

$919.30/hr. / 525 CY/HR. = $1.75 CY ✔

$919.30/hr. / 383 BCY/HR. = $2.40 BCY ✔ Use This
Price Based On
BCY excavated.
This Will Include
10% Addition Of
Solidification
Material (Volume)

* Note: These costs do not include safety considerations
Costs except for 45/60% efficiency.
## Construction Cost Estimate

**Project:** Basin F - EIA  
**Location:** Denver, CO  
**Architect:** WCC/HDR  
**Labor:** Est. 6%  
**Level:** B  
**Estimator:** Kottwitz-Grachek  
**Checked by:** Erickson

### Absorption System Summary

<table>
<thead>
<tr>
<th>Material</th>
<th>No.</th>
<th>Unit</th>
<th>Per Unit</th>
<th>Total</th>
<th>Per Unit</th>
<th>Total</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wood Wall</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2x4 Frame</td>
<td>260</td>
<td>LF</td>
<td>1.92</td>
<td>443.6</td>
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<tr>
<td>1/2” Plywood</td>
<td>2160</td>
<td>SF</td>
<td>1.26</td>
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<td>Nails</td>
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<td>Extension Anchors</td>
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<td>11.82</td>
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<td>159</td>
<td>869</td>
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<td>2” PVC Water</td>
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<td>3315</td>
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<td>70</td>
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<td>9872</td>
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<td>Flue Ash Tanks</td>
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<td>40,000</td>
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<td>46,000</td>
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<td>4</td>
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<td>58.56</td>
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<td>12,700</td>
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<td>- Feeders, Motor</td>
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<td>17,000</td>
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<td>- Blower</td>
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<td>400</td>
<td>800</td>
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</table>

**Subtotal:** 636,281

**Total Cost:** 842,116

---

**Note:** The values are in USD, and the units are as specified in the table.
## CONSTRUCTION COST ESTIMATE

### PROJECT
- **Basin F - Pin A**

### LOCATION
- **Denver, CO**

### ARCHITECT ENGINEER
- **WCC/HOR**

### DRAWING NO.
- **KOTTITZ - GRAHEK**

### ESTIMATOR
- **CHECKED BY**
  - Al Erickson

### ABSORPTION AREA SUMMARY

<table>
<thead>
<tr>
<th>Material Description</th>
<th>No.</th>
<th>Unit</th>
<th>Per Unit</th>
<th>Total</th>
<th>Per Unit</th>
<th>Total</th>
<th>Cost</th>
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<td>Ea</td>
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<td>800</td>
<td>1,200</td>
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<td>1,148,000</td>
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<tr>
<td>H2SO4</td>
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<td>gal</td>
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<td>gal</td>
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<td></td>
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<td><strong>SUBTOTAL</strong></td>
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<td></td>
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<td>71,400</td>
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<td>Equipment</td>
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<td>4 Loaders 120 HP</td>
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<td>hrs</td>
<td>61.10</td>
<td>508,352</td>
<td>508,352</td>
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<td>Doser NO HP</td>
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<td>hrs</td>
<td>46.40</td>
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<td>46,000</td>
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<td>67,500</td>
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<td>CONC SLAB</td>
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<td>LS</td>
<td>329,422</td>
<td>83,816</td>
<td>413,236</td>
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<tr>
<td><strong>SUBTOTAL PG 2</strong></td>
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<td></td>
<td></td>
<td>859,664</td>
<td>2,068,524</td>
<td>2,928,18</td>
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<td><strong>SUBTOTAL PG 1</strong></td>
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<td></td>
<td></td>
<td>268,351</td>
<td>585,765</td>
<td>844,116</td>
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<td></td>
<td></td>
<td></td>
<td>1,118,015</td>
<td>2,656,289</td>
<td>3,773,305</td>
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**Note:** The cost calculations are approximate and may require further verification.
## CONSTRUCTION COST ESTIMATE

**DATE PREPARED:** 3/87  
**SHEET:** 1 of 2

### PROJECT
- RMA

### LOCATION
- Denver, CO

### ARCHITECT ENGINEER
- WCW/HD

### DRAWING NO.
- ERM-15

### ESTIMATOR
- Furne

### CHECKED BY
- Al Fink

### SUMMARY

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>QUANTITY</th>
<th>LABOR</th>
<th>MATERIAL</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GROUNDBASE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>125' x 100' x 8&quot;</td>
<td>0.75</td>
<td>12,500 SF</td>
<td>$0.46</td>
<td>34,500</td>
</tr>
<tr>
<td><strong>Rebar</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5&quot; - (30&quot; x 0.668 x 1/4) + (45&quot; x 0.668 x 1/4)</td>
<td>5.74</td>
<td>Ton 305 B</td>
<td>10,504</td>
<td>505</td>
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<tr>
<td>2.25&quot; - (30&quot; x 0.668 x 1/4)</td>
<td>0.59</td>
<td>Ton 230 B</td>
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<td>505</td>
</tr>
<tr>
<td><strong>Concrete</strong></td>
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<td></td>
</tr>
<tr>
<td>10' x 100' x 4&quot;</td>
<td>10,000</td>
<td>SF 0.43</td>
<td>25,90</td>
<td>0.71</td>
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<tr>
<td><strong>WRF. 6&quot; x 4&quot; #4A</strong></td>
<td>125</td>
<td>cSF 13.10</td>
<td>985</td>
<td>20.20</td>
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<tr>
<td><strong>Slab</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>SF 0.49</td>
<td>5,473</td>
<td>1.80</td>
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<tr>
<td><strong>Concrete</strong></td>
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<td></td>
</tr>
<tr>
<td>125' x 125&quot; x 0.608</td>
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<td>106</td>
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<td>1.70</td>
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**TOTAL COST**
## Construction Cost Estimate

### Project
- RMA

### Location
- Denver, Co

### Architect Engineer
- WCC/ME

### Drawing No.

### Estimator
- Furne

### Checked By
- Al Erick

<table>
<thead>
<tr>
<th>SUMMARY</th>
<th>QUANTITY</th>
<th>LABOR</th>
<th>MATERIAL</th>
<th>TOTAL COST</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>NO.</td>
<td>UNIT</td>
<td>MEAL</td>
<td>PER UNIT</td>
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<tr>
<td>Core Curb 125' Long</td>
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<td>LF</td>
<td>3.51</td>
<td>B</td>
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<td>CY</td>
<td>28</td>
<td>B</td>
</tr>
<tr>
<td>Refund</td>
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<td>900</td>
<td>LF</td>
<td>1.04</td>
<td>B</td>
</tr>
<tr>
<td>Footing</td>
<td>800</td>
<td>CFA</td>
<td>1.27</td>
<td>B</td>
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<tr>
<td>Walls</td>
<td>2,000</td>
<td>CFA</td>
<td>1.07</td>
<td>B</td>
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<tr>
<td>Excavation</td>
<td>940</td>
<td>CY</td>
<td>0.27</td>
<td>B</td>
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</table>

### Total Cost
- $329,422
- $53,816
- $483,238
• Haul Roads (Level B)
# CREW AND PRODUCTIVITY WORKSHEET

**DATE PREPARED:** 3/18/87

<table>
<thead>
<tr>
<th>PROJECT</th>
<th>RMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOCATION</td>
<td>DENVER, CO</td>
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</table>

## CREW COMPOSITION

<table>
<thead>
<tr>
<th>WORK TYPE</th>
<th>WORK SCHEDULE</th>
<th>SPECIAL INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXCAVATION/PLACEMENT</td>
<td></td>
<td>HAUL ROADS - LEVEL B AREAS</td>
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<table>
<thead>
<tr>
<th>CREW DESCRIPTION</th>
<th>NO. REQUIRED IN CREW</th>
<th>HOURLY RATE ($/HR)</th>
<th>TOTAL FOR CREW ($/HR)</th>
<th>HOURLY RATE ($/HR)</th>
<th>TOTAL FOR CREW ($/HR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT D-8 DOZER</td>
<td>2</td>
<td>16.88</td>
<td>33.76</td>
<td>106.37</td>
<td>212.74</td>
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<tr>
<td>CAT 966 LOADER</td>
<td>1</td>
<td>16.88</td>
<td>16.88</td>
<td>61.00</td>
<td>61.00</td>
</tr>
<tr>
<td>18 CUBIC YARD END DUMPTUCK</td>
<td>3</td>
<td>17.03</td>
<td>51.02</td>
<td>41.13</td>
<td>123.39</td>
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<tr>
<td>CAT 14G MOTOR GRADER</td>
<td>1</td>
<td>17.03</td>
<td>17.03</td>
<td>75.61</td>
<td>75.61</td>
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<tr>
<td>LABORERS</td>
<td>2</td>
<td>12.76</td>
<td>25.52</td>
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</table>

<table>
<thead>
<tr>
<th>TOTALS</th>
<th>MANHOURS</th>
<th>LABOR COST</th>
<th>EQUIPMENT COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>144.46</td>
<td>472.99</td>
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</table>

## CREW PRODUCTIVITY

<table>
<thead>
<tr>
<th>WORK TASK</th>
<th>PRODUCTIVITY RATE UN'T/HR</th>
<th>LABOR</th>
<th>EQUIPMENT</th>
<th>COMMENTS</th>
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</thead>
<tbody>
<tr>
<td>EXCAVATION/PLACEMENT</td>
<td>317 ccy/hr.</td>
<td>$0.42/hr.</td>
<td>$4.79/hr.</td>
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<tr>
<td>SAFETY</td>
<td>317 ccy/hr.</td>
<td>$0.39/hr.</td>
<td>$8.45/hr.</td>
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<tr>
<td>MATERIALS DELIVERED TO STOCKPILE</td>
<td>-</td>
<td>-</td>
<td>$8.05/hr.</td>
<td></td>
</tr>
</tbody>
</table>

| TOTAL EQUIPMENT MATERIALS, LABOR, SAFETY | $11.33/CCY |

*Including fringe benefits*
<table>
<thead>
<tr>
<th>CREW AND PRODUCTIVITY WORKSHEET</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATE PREPARED: 3-18-87</td>
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<tr>
<td>PROJECT: RMA</td>
</tr>
<tr>
<td>PREPARED BY: T. KELLEY</td>
</tr>
<tr>
<td>LOCATION: DENVER, CO</td>
</tr>
<tr>
<td>CHECKED BY: D. HOEK 3/18/87</td>
</tr>
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</table>

**CREW COMPOSITION**

<table>
<thead>
<tr>
<th>WORK TYPE</th>
<th>WORK SCHEDULE</th>
<th>SPECIAL INFORMATION</th>
<th>HAUL ROADS-LEVEL &amp; AREAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAFETY</td>
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<td></td>
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<table>
<thead>
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<th>NO. REQUIRED IN CREW</th>
<th>HOURLY RATE ($/HR)</th>
<th>TOTAL FOR CREW ($/HR)</th>
<th>HOURLY RATE ($/HR)</th>
<th>TOTAL FOR CREW ($/HR)</th>
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</thead>
<tbody>
<tr>
<td>HEAVY EQUIPMENT</td>
<td>7</td>
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<tr>
<td>LABORERS</td>
<td>2</td>
<td>7805</td>
<td>1560</td>
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**TOTALS**

<table>
<thead>
<tr>
<th>MANHOURS</th>
<th>LABOR COST</th>
<th>EQUIPMENT COST</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>1560</td>
<td>26740</td>
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**CREW PRODUCTIVITY**

<table>
<thead>
<tr>
<th>WORK TASK</th>
<th>PRODUCTIVITY RATE UNIT/HR</th>
<th>LABOR</th>
<th>EQUIPMENT B/UNIT</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAFETY</td>
<td>317 ccy/hr</td>
<td>0.491</td>
<td>0.841</td>
<td></td>
</tr>
</tbody>
</table>

*Including fringe benefits*
HAUL ROADS - LEVEL B AREAS

This work will include supplying and transporting haul road material to a stockpile just inside the level B zone, maintaining the stockpile in the level B area, and hauling and placing the material in the level B area.

Several ramps will be constructed up to the fence line (zone B boundary) and have roads constructed such that end dumps can turn and dump efficiently. A dumper will be required to move material from the ramp area to other parts of the stockpile. A Cat 966 loader, with the assistance of a D-B dozer, will load trucks in the stockpile area. The loaded trucks will then haul the material an assumed average distance of 1500 ft. and dump the material, where it will be spread by a D-B dozer. Two laborers will be used as spotters. A motor grader will be used to maintain the haul roads.
MATERIAL COST TO STOCKPILE:

<table>
<thead>
<tr>
<th>SUPPLIER</th>
<th>MAT'L</th>
<th>COST</th>
<th>HAULING</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brunner - Woodward Construction</td>
<td>3/8&quot; max. size</td>
<td>$388/</td>
<td>$185/ton (for 10</td>
<td>$473/</td>
</tr>
<tr>
<td></td>
<td>Pit Run gravel</td>
<td>TON</td>
<td>mile haul)</td>
<td>TON</td>
</tr>
</tbody>
</table>

COST PER CCY

\[
\text{Cost per ccy} = \left( \frac{\$485/\text{ton}}{2000 \text{ lbs}} \right) \left( \frac{123 \text{ lbs}}{\text{ccf}} \right) \left( \frac{2\text{ ft}^3}{1\text{ yd}^3} \right) = \$8.05/\text{ccy}
\]
Subject: [Redacted]

By: Tt

Checked By: D. Hawk

Date 3/17/87

File No. 21947

Task No. 2

Sheet 3 of 5

Assumed Load Factors

Haul to Site and Dump

Load Trucks and Haul

Dump and Spread with Dozer

Assumed Volume of 2650 lbs (111 pcf)

0.8 cc/y (123 pcf)

Load Factor for Loading and Hauling

= 1 cc/y / 0.9 cc/y

Load Cycle

- Use 0.2 min. for first pass and 0.4 min for additional passes
- For 4 cc Bucket @ 90% Eff. = 3.6 cc/Load (worse)
- 18 cc Truck /3.6 cc/Load = 5 Loads
- 0.2 + 4 (0.4) = 1.8 min to load truck with assistance of one D-B dozer

Haul Cycle

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>0-15</td>
<td>15</td>
<td>15-0</td>
</tr>
</tbody>
</table>

 Loaded Cycle

A

| 500' | 500' | 500' |
| 0-20 | 20 | 20-0 |

Empty Cycle

A

| 500' | 500' | 500' |
| 0-20 | 20 | 20-0 |

Aver. Speed

Travel Time

<table>
<thead>
<tr>
<th>SECTION</th>
<th>LENGTH</th>
<th>LOADED</th>
<th>EMPTY</th>
<th>LOADED</th>
<th>EMPTY</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>500'</td>
<td>7.5</td>
<td>10</td>
<td>0.76/0.57</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>500'</td>
<td>15</td>
<td>20</td>
<td>0.38/0.28</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>500'</td>
<td>7.5</td>
<td>10</td>
<td>0.76/0.57</td>
<td></td>
</tr>
</tbody>
</table>

Time = 500 ft / (5280 ft/hr) (60 min / hr) / (speed mi/hr) = 5.68 (min)

Woodward-Clyde Consultants
TOTAL TRUCK CYCLE

<table>
<thead>
<tr>
<th>Step</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exchange Time</td>
<td>0.5 min</td>
</tr>
<tr>
<td>Load</td>
<td>1.8 min</td>
</tr>
<tr>
<td>Haul</td>
<td>1.9 min</td>
</tr>
<tr>
<td>Return</td>
<td>1.42 min</td>
</tr>
<tr>
<td>Maneuver &amp; Dump</td>
<td>0.7 min</td>
</tr>
</tbody>
</table>

Total Cycle: 6.32 minutes @ 100% eff.

NO. OF TRUCKS

Exchange & Load Cycle

\[ 1.8\text{ min} + 0.5 = 2.3\text{ min} \]

\[ 6.32\text{ min} / 2.3\text{ min} = 2.75 \text{ Trucks} \]

Use 3 Trucks

Production based on 2.75 trucks

ESTIMATE PRODUCTION

1) Avg Load /cycle / unit

\[ = 18\text{ cy/unit load} \times 0.9 \text{ L.F.} = 16.2\text{ ccy/unit} \]

2) Cycles per hour

\[ (60\text{ min/hr}) / (6.32\text{ min/cycle}) = 9.49 \text{ cycles/hr} \]

3) Hourly Production Rate

\[ (16.2\text{ ccy/load}) \times (9.49 \text{ load/unit}) = 153.7 \text{ ccy/unit/hr} \]

4) Fleet Production

2.75 units \times 153.7 \text{ ccy/unit-hr} = 423 \text{ ccy/hr} \]

5) Check Dumper Production

\[ 1200 \text{ cy/hr} \times 0.9 \text{ ccy/cy} = 1080 \text{ ccy/hr} > 423 \text{ ccy/hr} \]

Woodward-Clyde Consultants
Subject: Construction - Level Bunk/Inc. Cost

By: TEK
Checked By: D. Hawk

Date: 3/17/87

---

6) Production adjusted for efficiency (45 min/60 min/hr)

\[
\text{Efficiency: } \frac{423 \text{ ccy/hr}}{45 \text{ min}} \times \frac{60 \text{ min}}{1} = 564 \text{ ccy/hr.}
\]

---

**Equipment List and Costs**

1) 2 CAT D-9 Dozers @ $123 = $246.00/hr.
2) 1 CAT 966 Loader @ $77.98 = $77.98/hr.
3) 3 18 CY End Dump Trucks @ $58.27 = $174.81/hr.
4) 2 Laborers @ $25.52 = $51.04/hr.
5) 1 CAT 14G Motor Grader @ $92.64 = $92.64/hr.

**Total Cost** = $617.95/hr.

---

**Cost to Haul From Stockpile and Place**

\[
\frac{617.95}{317 \text{ ccy/hr}} = 1.95 \text{ ccy/hr.}
\]

---

**Total Cost for Supplying and Placing**

\[
1.95 \text{ ccy/hr} + 8.05 \text{ ccy/hr} = 10.00 \text{ ccy/hr.}
\]

**Cost w/o Safety except 45%/60% Efficiency**
COST ITEM 18

- Haul Roads (Level D)
# CREW AND PRODUCTIVITY WORKSHEET

**COLUMN HEADERS**
- **PROJECT**
- **PREPARED BY**
- **CHECKED BY**
- **LOCATION**
- **CREW REF NO**
- **DATA PREPARED**

**LOCATION**
- **DENVER, CO**

**CREW COMPOSITION**

<table>
<thead>
<tr>
<th>CREW DESCRIPTION</th>
<th>NO. REQUIRED IN CREW</th>
<th>HOURLY RATE ($)</th>
<th>TOTAL FOR CREW ($)</th>
<th>HOURLY RATE ($)</th>
<th>TOTAL FOR CREW ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT D-30 DOZER</td>
<td>2</td>
<td>1680</td>
<td>3376</td>
<td>10637</td>
<td>21274</td>
</tr>
<tr>
<td>CAT 966 LOADER</td>
<td>1</td>
<td>1680</td>
<td>1680</td>
<td>6110</td>
<td>6110</td>
</tr>
<tr>
<td>18 CUBIC YARD END DUMP TRUCK</td>
<td>3</td>
<td>1703</td>
<td>5122</td>
<td>418</td>
<td>1234</td>
</tr>
<tr>
<td>CAT 14 G MOTOR GRADER</td>
<td>1</td>
<td>1703</td>
<td>1703</td>
<td>7581</td>
<td>7581</td>
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<tr>
<td>LABORER</td>
<td>2</td>
<td>1276</td>
<td>2552</td>
<td></td>
<td></td>
</tr>
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**TOTALS**
- **MANHOURS** 9
- **LABOR COST** 144.46
- **EQUIPMENT COST** 472.99

**CREW PRODUCTIVITY**

<table>
<thead>
<tr>
<th>WORK TASK</th>
<th>PRODUCTIVITY RATE UNITS/HR</th>
<th>LABOR</th>
<th>EQUIPMENT S/UNIT</th>
<th>COMMENTS</th>
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<tbody>
<tr>
<td>EXCAVATION/PLACEMENT</td>
<td>352 cc/y</td>
<td>#0.41/y</td>
<td>#1.32/cy</td>
<td>#0.989/cy</td>
</tr>
<tr>
<td>SAFETY</td>
<td>352 cc/y</td>
<td>#0.41/y</td>
<td>#1.32/cy</td>
<td>#0.989/cy</td>
</tr>
<tr>
<td>MATERIALS DELIVERED TO STOCKPILE</td>
<td>352 cc/y</td>
<td>#0.41/y</td>
<td>#1.32/cy</td>
<td>#0.989/cy</td>
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</tbody>
</table>

*including fringe benefits

DA: FORM 5419-R, Apr 88
**CREW AND PRODUCTIVITY WORKSHEET**

For use of this form, see Tbl B-200-2; the procuring agency is USACE.

**DATE PREPARED:** 3-18-87

<table>
<thead>
<tr>
<th>PROJECT</th>
<th>PREPARED BY</th>
<th>CREW REF NO</th>
</tr>
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<tbody>
<tr>
<td>RMA</td>
<td>T. KELLEY</td>
<td></td>
</tr>
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<table>
<thead>
<tr>
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<th>CHECKED BY</th>
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</thead>
<tbody>
<tr>
<td>DENVER, CO</td>
<td>D. Hawk</td>
<td>3/18/87</td>
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**CREW COMPOSITION**

<table>
<thead>
<tr>
<th>WORK TYPE</th>
<th>WORK SCHEDULE</th>
<th>SPECIAL INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAFETY</td>
<td></td>
<td>Haul Roads - Level D Areas</td>
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</table>

<table>
<thead>
<tr>
<th>CREW DESCRIPTION</th>
<th>NO. REQUIRED IN CREW</th>
<th>HOURLY* RATE ($/HR)</th>
<th>TOTAL FOR CREW ($/HR)</th>
<th>HOURLY* RATE ($/HR)</th>
<th>TOTAL FOR CREW ($/HR)</th>
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</thead>
<tbody>
<tr>
<td>HEAVY EQUIPMENT</td>
<td>7</td>
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<table>
<thead>
<tr>
<th>TOTALS</th>
<th>MANNHOURS</th>
<th>LABOR COST</th>
<th>EQUIPMENT COST</th>
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<td></td>
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<td>3/15</td>
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**CREW PRODUCTIVITY**

<table>
<thead>
<tr>
<th>WORK TASK</th>
<th>PRODUCTIVITY RATE (UNIT/HR)</th>
<th>LABOR</th>
<th>EQUIPMENT ($/UNIT)</th>
<th>COMMENTS</th>
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<tbody>
<tr>
<td>SAFETY</td>
<td>352 CY/1MC</td>
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<td>$0.09/RC</td>
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</tr>
</tbody>
</table>

*Including fringe benefits

DA FORM 5419-R, Apr 85
Haul Roads, Level D Areas

This work will include supplying and transporting haul road material to the site, stockpiling the material near the landfill site, but outside of the Level D area, maintaining the stockpile, and hauling and placing the material in the Level D area.

It is assumed that a dozer will be required to maintain the stockpile. A Cat 966 loader, with the assistance of a D-8 dozer, will load trucks in the stockpile area. The loaded trucks will then haul the material, an average distance of 1500 ft, and along the material, where it will be spread by a D-8 dozer. Two laborers will be used on spotters.
Material Costs to Stockpile

(See Level B haul roads.)

\[
\text{Cost per CCY} = \frac{\$8.05/\text{ccy}}{1000} = \frac{8.05}{1000} \times \frac{1 \, \text{ton}}{2000 \, \text{cf}} \times \frac{27 \, \text{cf}}{40^3} = \frac{8.05}{1000} \text{ton}
\]

**LOAD CYCLE**

= 1.2 min / truck for CAT 966 loader

with assistance from CAT 922 dozer

(see Level B haul roads)

**HAUL CYCLE**

<table>
<thead>
<tr>
<th>Section</th>
<th>Length</th>
<th>Avg. Speed</th>
<th>Loaded</th>
<th>Empty</th>
<th>Travel Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>500'</td>
<td>10</td>
<td>12.5</td>
<td>0.57</td>
<td>0.45</td>
</tr>
<tr>
<td>B</td>
<td>500'</td>
<td>20</td>
<td>25</td>
<td>0.28</td>
<td>0.23</td>
</tr>
<tr>
<td>C</td>
<td>500'</td>
<td>10</td>
<td>12.5</td>
<td>0.57</td>
<td>0.45</td>
</tr>
</tbody>
</table>

\[
\text{Time} = \frac{500' \times 60 \text{min/h}}{5280 \text{cm}^3} \times \frac{1}{\text{speed} \text{m/h}} = \frac{5.68 \text{m}}{\text{sec} \times \text{mph}}
\]

**TOTAL TRUCK CYCLE**

- Exchange time: 0.5 minutes
- Load: 1.6
- Haul: 1.42
- Maneuvers: 0.7
- Return: 1.13

Total Truck Cycle = 5.55 minutes

Woodward-Clyde Consultants
No. of Trucks

Exchange load cycle = 2.3 min.

Need 5.55 min/2.3 min = 2.41 trucks

Use 3 trucks

Production estimate based on 2.41 trucks

ESTIMATE PRODUCTION:

1) avg load/cycle/unit

18 cy x 0.9 = 16.2 cy/unit-load

(see line B brand BM-3's)

2) cycles per hr

(60 min/hr) x cycle / 5.55 min = 10.81 cycles/hr

3) hourly production rate

(16.2 cy/look) x 10.81 cycles/unit = 175.1 cy/hr

4) fleet production

(2.41 units) x 175.1 cy/hr/unit = 422 cy/hr

5) check tower production

1200 cy/hr x 0.8 cy/hr = 960 cy/hr

5 422 cy/hr

6) production adjusted for efficiency (50 min/hr)

(422 cy/hr) x 50 min / 60 min = 352 cy/hr
**Equipment List and Costs**

1. 2 Cat D-8 Dozers @ $123.25 = $246.50/hr.
2. 1 Cat 966 Loader @ $77.95 = $77.95/hr.
3. 3 Pocy and deep trench @ 58.02 = 174.06/hr.
4. 2 Haulers @ 12.36 = $25.52/hr.
5. 1 Cat/14G Motor Grader = $92.64/hr.

Total Cost = $617.45/hr.

**Cost to Haul from Stockpile and Place**

$617.45/hr. / 3.52 ccy/hr. = $175/ccy

**Total Cost for Supplying and Placing**

$175/ccy —

$855/ccy —

Total = $940/ccy *

* Cost w/o safety except 50/60 efficiency
COST FACTORS AS A PERCENTAGE

1. Mobilization - ranges from 2 to 5% of total direct construction costs; use 5% for preliminary estimate

2. Contingency - ranges from 15 to 25% of total construction cost; use 25% for preliminary estimate

3. Engineering - ranges from 7 to 15% of total construction cost; use 15% for preliminary estimate

4. Legal and Administration - ranges from 1 to 5% of total construction cost; use 5% for preliminary estimate

5. Protection Cost Factor - see Table 1 for different percentage at various protection levels; use most conservative value for preliminary estimate

6. Equipment O&M Costs

7. Insurance Cost - 3 to 5%/yr of equipment cost

8. Equipment Replacement

9. Labor Fringe Benefits for O&M Costs - 1% of total capital cost

10. Start Up and Shake Down Cost - 1% per year of capital cost

11. Supervision and Administration during Construction - 20 to 30% of wages

12. Engineering and Design during Construction - 5 to 20% of total capital cost; use 20% for complex systems

13. Change Order Contingency - 8% of estimated project cost

14. Non-component costs associated with a site where an onsite treatment facility will be built from "scratch" (applied to total construction costs).

   site preparation - 1-10%
   piping - 8-15%
   electrical - 5-12%
   instrumentation - 3-10%
AVERAGE PERCENT INCREASE FOR TOTAL COSTS AT FOUR DEGREE-OF-HAZARD LEVELS

<table>
<thead>
<tr>
<th>Unit Operation</th>
<th>Level A</th>
<th>Level B</th>
<th>Level C</th>
<th>Level D</th>
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<tbody>
<tr>
<td>Surface Water Controls</td>
<td></td>
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</tr>
<tr>
<td>1. Surface Sealing - Synthetic Membranes</td>
<td>119%</td>
<td>119%</td>
<td>122%</td>
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<tr>
<td>2. Surface Sealing - Clay</td>
<td>109%</td>
<td>113%</td>
<td>134%</td>
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<tr>
<td>3. Surface Sealing - Asbestos</td>
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<tr>
<td>4. Surface Sealing - Fly Ash</td>
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<td>12%</td>
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<tr>
<td>5. Grouting</td>
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<td>12%</td>
<td>12%</td>
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<tr>
<td>6. Contour Grading</td>
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<td>12%</td>
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<tr>
<td>7. Surface Water Disconnection Structures</td>
<td>12%</td>
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<tr>
<td>8. Dewatering and Pumping</td>
<td>12%</td>
<td>12%</td>
<td>12%</td>
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<tr>
<td>9. Other and roadway</td>
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<td>Ground Water Controls</td>
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<tr>
<td>1. Well Point System</td>
<td>119%</td>
<td>119%</td>
<td>122%</td>
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<tr>
<td>2. Deep well System</td>
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<tr>
<td>3. Drain System</td>
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<tr>
<td>4. Injection System</td>
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<td>5. Beneath Layer Trench</td>
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<tr>
<td>6. Grout Curtain</td>
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<tr>
<td>Gas Migration Controls</td>
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<tr>
<td>1. Passive Trench Vent</td>
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<td>2. Passive Trench Encapsulation</td>
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<td>3. Active Gas Extraction Systems</td>
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<tr>
<td>1. Chemical fixation (Solidification)</td>
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<td>2. Chemical Injection</td>
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<tr>
<td>3. Encapsulation of Waste/Contaminated Soil</td>
<td>127%</td>
<td>127%</td>
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<td>4. Leachate Treatment</td>
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<td>5. Treatment of Contaminated Water</td>
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<td>6. Dry Processing</td>
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<td>7. Bulk Tone Processing</td>
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<td>8. Temperature Processing</td>
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* Values given include 100 percent for base construction costs.
* This unit operation was deemed appropriate for performance only at Level C. Costs at Levels D, B, and A were not provided.

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<tr>
<th>Item descr.</th>
<th>Adjust</th>
<th>Blue Book</th>
<th>Hourly Rate</th>
<th>Operating Cost</th>
<th>Operator Rates</th>
<th>TOTAL ($/HR.)</th>
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<td>- Rear Dump</td>
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<tr>
<td>- 300 H.P.</td>
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<td>1.05</td>
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<td>91</td>
<td>1.05</td>
<td>12790</td>
<td>7040</td>
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<td>- CAT 25C</td>
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<td>- Front blade</td>
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<td>6220</td>
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<td>16108</td>
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<tr>
<td>- 10,000 gal</td>
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<td>- 450 H.P.</td>
<td>883</td>
<td>1.05</td>
<td>15575</td>
<td>8327</td>
<td>3520</td>
<td>1700</td>
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## Construction Cost Estimate Worksheet

**Project:**

- RMA

**Location:**

- DENVER, CO

**Plan No.:**

- 03-01-09

<table>
<thead>
<tr>
<th>Item Descr.</th>
<th>Estimator</th>
<th>Checked By</th>
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<tbody>
<tr>
<td>CAT 14G</td>
<td>T. Kelly</td>
<td>D. House</td>
</tr>
<tr>
<td>CAT 9666C</td>
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<tr>
<td>CAT 245</td>
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<tr>
<td>FLATBED</td>
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### Equipment Costs

<table>
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<tr>
<th>Item Descr.</th>
<th>Adjusted Adjusted Cost</th>
<th>Return Rate</th>
<th>Operating Cost</th>
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<tbody>
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<td>631000</td>
<td>4400</td>
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<td>CAT 9666C</td>
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<td>4600</td>
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<td>CAT 245</td>
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<td>FLATBED</td>
<td>105</td>
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<td>TOTAL</td>
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<td>205000</td>
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### Labor Costs

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<td>LABORER</td>
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**Note:**

- For use of this form, see TM 5-800-2; the responsible agency is USACE.
- Date Prepared: 3-18-87
- Sheet 2 of 2
**Wage Rates for Cost Estimating**

**Ref:** General Wage Decision No. CO86-1

- RMA is located in Adams County, Colorado T2E, R67N W1
- Basin FJ is in Section 20

<table>
<thead>
<tr>
<th>Category</th>
<th>Work Description</th>
<th>Wage</th>
<th>Fringe</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>1) Electricians</td>
<td>Electricians</td>
<td>16.85</td>
<td>2.10 + 3.3%</td>
<td>18.95 +</td>
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<tr>
<td></td>
<td>Cable Splicers</td>
<td>12.10</td>
<td>2.10 + 3.3%</td>
<td>14.20 +</td>
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<tr>
<td>2) Carpenters</td>
<td>All</td>
<td>13.90</td>
<td>3.22</td>
<td>17.12</td>
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<tr>
<td>3) Cement Masons</td>
<td>All</td>
<td>12.40</td>
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<td>4) Ironworkers</td>
<td>All</td>
<td>16.00</td>
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<td>5) Laborers</td>
<td>1) Earthmovers</td>
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<td>2) Minimum labor</td>
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<td>2.24</td>
<td>12.76</td>
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<tr>
<td></td>
<td>Fence Erectors</td>
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<tr>
<td></td>
<td>Seeding, stake chase</td>
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<tr>
<td></td>
<td>Ties, bars, chains, concrete finishing</td>
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<tr>
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<td>Hydraulic &amp; Electrical Tools</td>
<td>10.57</td>
<td>2.24</td>
<td>12.81</td>
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<td>Torches, drills, tampers, jack hammer, form setters, concrete spires, asphalt, labor, pipe changers, concrete pump operator</td>
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<td>Category</td>
<td>Work Description</td>
<td>Wage</td>
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<tr>
<td>6) Power Equipment Operators</td>
<td>Air Compressor Mechanic, Welder</td>
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<td>Light plants, Single unit conveyor, Pumps, Tractors under 70 HP</td>
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<td>≤ 360 CFM Compressor</td>
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<td>Conveyor, building materials, trencher, Pugmill, Self-propelled roller, rubber tired under 5 tons</td>
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<td>3.77</td>
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<td>Asphalt Plant, Concrete batch plant, Finish, Mechanic, Paving, Hoist 1 ton, Hydraulic backhoe under 7/4 cy, Loader ≤ 10 cy</td>
<td>13.11</td>
<td>3.77</td>
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<td>Motor grader (rough), roller, dozer 5 ft6, 10 HP John Deere tractor</td>
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<td>Crane and backhoes 5 cy and under</td>
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<td>Hydraulic Hoe 3/4 cy and over, Loader over 10 cy, Mechanic, Finish, motor grader, Multiple Unit Crusher, Scraper ≤ 40 cy</td>
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<td>Welder</td>
<td>13.41</td>
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<td>Heavy duty mechanic, welder, Scraper ≤ 40 cy</td>
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<tr>
<td>Category</td>
<td>Work Description</td>
<td>Wage</td>
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<td>1.</td>
<td>Pick-up, Truck Driver Tandems, Dumpers, Graders</td>
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<td>2.</td>
<td>Truck Driver ≤ 6cy Flat bed, Eng &amp; Exc, Shuttle truck, single axle liquid tanker</td>
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<td>16.65</td>
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<td>3.</td>
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<td>Truck driver, snow plow</td>
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DIRECT HEALTH AND SAFETY COSTS FOR EQUIPMENT

**CAT 627 B SCAPER & OPERATOR (HEAVY EQUIPMENT)**

- **a)** Enclosed Cab (range 240°-605°) = $4250/ mo
- **b)** Air Conditioner = $150/ mo
- **c)** Air Cylinders = $85/ mo
- **d)** Protective Clothes (emerg.) = $3085/ mo
- **e)** Dress/decon. 2 hr/day. 6/17/12/ hr = $875/ mo
- **f)** 1/4 Standby Operator @ 175/ hr 24/ 10 hrs/day = $1085/ mo

**Total Monthly** = $6015/ mo.

**One Time Costs**

- **a)** Brackets for cylinders = $500
- **b)** Air line System = $400
- **c)** Communication System (Radio) = $200
- **d)** First Aid Kit = $25
- **e)** Fire Extinguishers = $40
- **f)** Level B training = $1500
- **g)** Physical (2) @ 450/ hr = $900

**Total 1-time = $3500**

Assume 6 mo = $5925/ mo.

**Total Monthly Cost CAT 627 B Safety = $8610/ mo**

Assume 173 hr/ mo

**Total Hourly Cost = $35/ hr**

**Average cab cost used for this cost = 340°/ 605° = 425°**

Scrapers @ low end $240/ hr - 627B

Dozers @ high end $605/ hr - D8

**Note:** Use 4 working weeks and 30 calendar days per month.
DIRECT HEALTH & SAFETY FOR LABORERS IN AIR PAKS

1) Each laborer will be on 30 minute packs
   with 5 minute hi-breaks. About 1/3 back-up
   laborers will be required in rotating
   fashion per laborer. This will allow
   for 30 minutes on - 30 minutes off - 15 min
   walk to and from post / laborer. Five
   change outs of disposable garments are
   assumed.

   Daily Charges
   a) Protective clothes 4/3 = 43 00/day
   b) 5 Changeouts 2 10 = 30 00/day
   c) 1.5 Lab Hours 12 3/4 = 153 12 00/day
   d) Protective clothes for
      extra laborers 1.5(123 00)
   e) SCBA Refill 2.5 x 75 (915 00) = 22 00/Day
   f) Dressing 2.5 x 2hrs = 63 00/day
   Total Daily = 546 32 00/day

   One Time Charges / /mo.
   a) Level B training 1500 00 = 375 00
   b) Communication System 1000 00 = 250 00
   c) SCBA 2.5x 1500 00 = 3750 00
   d) Rubber Boots 200 00 x 2.5 = 500 00
   e) Phys Sec 500 00 x 2.5 = 2250 00
   Total one time = 10,050
   Assume 6 mo = 8175/mo.

   Total Hourly Costs
   546 32/8 + 1675/73 = 178 05/HR

   Note: This labor charge should be used only
   where air lines are impractical and production
   does not depend on laborer.
NON-OPERATIONAL HEALTH AND SAFETY COST FOR STAND BY

1) ONGOING RENTAL:
   a) Enclosed Cab (Range 240°-605°/mo) = $425°/mo
   b) Air Conditioner = $150°/mo
   c) TOTAL MONTHLY = $575°/mo

2) ONE TIME COSTS
   a) Brackets For Cylinders = $500°/t
   b) Airline System = $400°/t
   c) Communication System (light) = $20°/t
   d) First Aid Kit = $25°/t
   e) Fire Extinguisher = $40°
   
   TOTAL 1-Time = $1,165°/t
   ASSUME FOR 6 mo. = $194°/t/mo

   TOTAL MONTHLY STANDBY EQUIPMENT COST
   SAFETY COST = $769°/mo

   ASSUMING 173 hr/mo, STANDBY HOURLY = $494/hr
   SAY $495/HR.
DATE: 3/1/87
TIME: 2:50 PM

TELEPHONE
MEMORANDUM

PROJECT NO.
B6C8554P

(TO) (FROM) MR. Bob Adams

COMPANY：Thom Construction Co.

RECOROED BY：Don Huns

PROJECT：RMA

FILE: 5/19/87 T-2

Bob called back with estimate for level 3 equipment modification. The following information has provided:

1) Rate in Bob's files for heavy equipment $175.00/day/machine
   For monthly rate $210.00/month/machine (includes 10%)

2) Enclosed cab only: CAT 627B $275.00/mo.
   CAT 966 $240.00/mo.
   CAT 235 $250.00/mo.
   CAT 08 $410.00/mo.
   CAT 08 $605.00/mo.

3) Air Conditioner - Standard $150.00/mo/machine

4) Breathing Device Brackets outside of cab
   - one time expense $500.00/machine
   - negligible operating cost

5) Consider Hazardous Waste Premium
   due to risk involved. Contractors will
   send higher than expected. With six months guaranteed until the price will
   become refined (less contingency). Six months
   is not considered short term and will
   provide incentive.
**RECORD OF VERBAL QUOTE**

<table>
<thead>
<tr>
<th>Project:</th>
<th>Name: Rocky Mt. Arsenal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location:</td>
<td>Denver</td>
</tr>
</tbody>
</table>

Quote #1 Misc. (Estimate Sh. No. _____________)

<table>
<thead>
<tr>
<th>Firm:</th>
<th>Name: Henry's Safety &amp; Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location:</td>
<td>Golden, CO</td>
</tr>
<tr>
<td>Telephone No.:</td>
<td>(303) 279-8811</td>
</tr>
<tr>
<td>Person Talked To:</td>
<td>Ron</td>
</tr>
</tbody>
</table>

Type of Quote:  
- [ ] Supplier, material only (FOB Point: _____________)  
- [ ] Subcontractor, material installed (Cost to Prime)

**Scope/Description/Amount of Quote:**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 min. escape pack</td>
<td>mask, 5 min. bottle belt, pigtail</td>
<td>$612</td>
</tr>
<tr>
<td>Airline</td>
<td>$169.30 for 100 ft, $105 for 50 ft</td>
<td></td>
</tr>
<tr>
<td>Pigtail</td>
<td>$13.40 each</td>
<td></td>
</tr>
<tr>
<td>T's</td>
<td></td>
<td>$14.50 each</td>
</tr>
<tr>
<td>Regulator and filter</td>
<td>$145 or filter $10.5</td>
<td></td>
</tr>
<tr>
<td>Alarm (&lt;500 psi in cylinder)</td>
<td></td>
<td>$9.3 each</td>
</tr>
<tr>
<td>Microphone</td>
<td>Head mask (throat mic)</td>
<td>$19.8</td>
</tr>
<tr>
<td></td>
<td>Throat mic w/ radio transmitter and head set (earphone)</td>
<td>$184.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Survival 60 min SCBA (34 lb)</td>
<td></td>
<td>$179.5 list price</td>
</tr>
<tr>
<td>30 min SCBA (23 lb)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Date Quote Received: __________________________

Quote Received By: __________________________
RECORD OF VERBAL QUOTE

Project: Rocky Mtn. Arsenal
Location: Denver

Quote #: 2 misc. (Estimate Sh. No. __________)

Firm: Air Products
Location: Denver
Telephone No.: (303) 329-9353
Person Talked To: Dan Little

Type of Quote: [X] Supplier, material only (FOB Point: RMA)
[ ] Subcontractor, material installed (Cost to Prime)

Scope/Description/Amount of Quote:

They truck in all their air from Kansas. Not certified to pump air in Denver from their facility.

$15/cylinder

No delivery or pick-up charge

$3.95 charge per cylinder if keep past the end of the month

Date Quote Received: 3/17/87
Quote Received By: [Signature]
RECORD OF VERBAL QUOTE

Project: Name:  
Location: Denver, CO

Quote #: 3  MISC. (Estimate Sh. No. 

Firm: Name: Air Products  
Location: Denver  
Telephone No.: (303) 329-9353  
Person Talked To: Dan

Type of Quote:  
X Supplier, material only (FOB Point: 
Subcontractor, material installed (Cost to Prime)

Scope/Description/Amount of Quote:

New quote:
If they are looking at 30-40 cylinders a day, they will get certified to pump air in Denver. They will charge $8.50 cylinder $3.00 per cylinder for every cylinder kept past the end of the month.

Date Quote Received: 3/20/87  
Quote Received By: Chris Hertier