Engineering Calculations

DEMOLITION DEBRIS
&
WASTE SOURCE VOLUME CALCULATIONS

Sunchief Mill Site
Tonto National Forest
Gila County, Arizona

Prepared for:

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Checked By: Rob Ederer, P.E.  Date: February 23, 2012
Submitted: March 2, 2012
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SECTION 1.0   PROBLEM STATEMENT

Objective: To estimate the volume of waste material (demolition debris, overburden/waste rock, tailings) located within the boundaries of the Sunchief Mill Site.

SECTION 2.0   ESTIMATING TECHNIQUE

Dimensions used to calculate volume of waste material are estimated based on field measurements and approximations, GPS data, and survey topographic data provided by the USFS. Surveyed measurements of the waste sources and structures were not taken. Structure footprint dimensions were gathered using a tape measure or measuring wheel or a combination thereof. Estimated depths and representative geometric shapes of soil/rock materials were made through visual observation.

Given the deteriorating state and complex nature of the on-site structures, exact feature dimensions (support beams, roof trusses, staircases, etc.) were not taken for demolition debris estimating. Instead, Federal Emergency Management Agency (FEMA) (September 2010) and California Emergency Management Agency (CEMA) debris estimating techniques (January 2010) and equations were used for estimating structure demolition debris unless otherwise noted.

Due to the estimative nature of the volume estimates, all calculated volumes were rounded up 5-12%.

SECTION 3.0   ABBREVIATIONS AND CONVERSION FACTORS

<table>
<thead>
<tr>
<th>Abbreviations</th>
<th>Conversion Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>C&amp;D</td>
<td>Construction and demolition</td>
</tr>
<tr>
<td>CY</td>
<td>Cubic yards</td>
</tr>
<tr>
<td>cf</td>
<td>Cubic feet</td>
</tr>
<tr>
<td>ea</td>
<td>Each</td>
</tr>
<tr>
<td>ft</td>
<td>Feet</td>
</tr>
<tr>
<td>ft²</td>
<td>Square feet</td>
</tr>
<tr>
<td>ft³</td>
<td>Cubic feet</td>
</tr>
<tr>
<td>SA</td>
<td>Surface area</td>
</tr>
<tr>
<td>SY</td>
<td>Square yards</td>
</tr>
<tr>
<td>V</td>
<td>Volume</td>
</tr>
</tbody>
</table>

1 ft² = 1/9 SY
1 ft³ = 1/27 CY
1 ton of C&D debris = 2 CY (Per FEMA debris estimating field guide)
1 CY waste source material = 1.76 tons

SECTION 4.0   EMPIRICAL EQUATIONS


\[
\frac{\text{Length} \times \text{Width} \times \text{Height} \times 0.33}{27} = \text{CY}
\]

Mobile Home Debris Estimation Formula (Per CEMA, Disaster Debris Management, Chapter 4, Debris Forecasting and Estimating. Dated January 2010 [Rev.]):

\[
\frac{\text{Length} \times \text{Width} \times \text{Height}}{27} = \text{CY}
\]
SECTION 5.0 MACHINE SHOP

Objective: Calculate the estimated volume of C&D debris material that will result from the demolition of the Machine Shop (including the Lab area). The structure has a total length of 125 ft and width of 35 ft. The Machine Shop has estimated height of 30 ft.

Solution: Using the FEMA debris estimating empirical equation for General Buildings, calculate the estimated C&D debris for the structure. For volume estimating purposes, assume a uniform height across the length and width of the structure, including the laboratory area.

\[
\text{General Building C&D Debris Volume} = \frac{Length \times Width \times Height \times 0.33}{27} = CY
\]

\[
\text{General Building C&D Debris Volume} = \frac{(125 \text{ ft}) \times (30 \text{ ft}) \times (30 \text{ ft}) \times 0.33}{27} = CY
\]

\[
\text{General Building C&D Debris Volume} = 1604 \text{ CY} \approx 1650 \text{ CY}
\]
SECTION 6.0  MACHINE SHOP FOUNDATION

Objective: Calculate the estimated volume of C&D debris material that will result from the demolition of the Machine Shop foundation. The foundation is assumed to be a spread footing type running the length of the machine shop’s east and west walls. Dimensions are as assumed in the drawing below.

Solution: Using the surface area method volume method, calculate the estimated volume of material in the foundation.

\[
\begin{align*}
\text{Volume} &= \text{Surface Area} \times \text{Length} \times (2 \text{ ea.}) \\
\text{Volume} &= 4.33 \text{ ft}^2 \times 125 \text{ ft} \times 2 \\
\text{Volume} &= 1083.3 \text{ ft}^3/27 \\
\text{Volume} &= 40.1 \text{ CY} \equiv 45 \text{ CY}
\end{align*}
\]

\[
\begin{align*}
\text{Surface Area} &= A_{\text{top}} + A_{\text{bottom}} \\
\text{Surface Area} &= 192 \text{ in}^2 + 432 \text{ in}^2 \\
\text{Surface Area} &= 624 \text{ in}^2/144 \text{ in}^2/\text{ft}^2 \\
\text{Surface Area} &= 4.33 \text{ ft}^2
\end{align*}
\]

\[
\begin{align*}
A_{\text{top}} &= \text{Length} \times \text{Width} \\
A_{\text{top}} &= 24\text{in} \times 8\text{in} \\
A_{\text{top}} &= 192 \text{ in}^2 \\
A_{\text{bottom}} &= \text{Length} \times \text{Width} \\
A_{\text{bottom}} &= 36\text{in} \times 12\text{in} \\
A_{\text{bottom}} &= 432 \text{ in}^2
\end{align*}
\]
SECTION 7.0   OFFICE

Objective: Calculate the estimated volume of C&D debris material that will result from the demolition of the Office building. The structure has a total length of 65 ft and width of 25 ft. The Office has estimated height of 10 ft.

Solution: Using the FEMA debris estimating empirical equation for General Buildings, calculate the estimated C&D debris for the structure. For volume estimating purposes, assume a uniform height across the length and width of the structure.

\[
\text{General Building C&D Debris Volume} = \frac{\text{Length} \times \text{Width} \times \text{Height} \times 0.33}{27} = CY
\]

\[
\text{General Building C&D Debris Volume} = \frac{(65 \text{ ft}) \times (25 \text{ ft}) \times (10 \text{ ft}) \times 0.33}{27} = CY
\]

\[
\text{General Building C&D Debris Volume} = 198.6 \text{ CY} \equiv 225 \text{ CY}
\]
SECTION 8.0  TRAILER

Objective: Calculate the estimated volume of C&D debris material that will result from the demolition of the Office building. The structure has a total length of 65 ft and width of 25 ft. The Office has estimated height of 10 ft.

Solution: Using the CEMA debris estimating empirical equation for a Mobile Home, calculate the estimated C&D debris for the structure. For volume estimating purposes, assume a uniform height across the length and width of the structure.

![Plan View](image)

**Dimensions:**
Length = 50 ft  
Width = 20 ft  
Height = 8 ft

\[
\text{Mobile Home C&D Debris Volume} = \frac{\text{Length} \times \text{Width} \times \text{Height} \times 0.33}{27} = CY
\]

\[
\text{Mobile Home C&D Debris Volume} = \frac{(50 \, ft) \times (20 \, ft) \times (8 \, ft)}{27} = CY
\]

\[
\text{Mobile Home C&D Debris Volume} = 296.3 \, CY \equiv 325 \, CY
\]
SECTION 9.0  BUNKER COMPLEX

Objective:  Calculate the estimated volume of C&D debris material that will result from the demolition of the Bunker Complex.  The structure and concrete slabs have the dimensions shown below and discussed herewith.  The bunker building itself has a height of 12 ft and maintains a 6-in concrete wall and floor thickness throughout.  For estimating purposes, assume the bunker building has a door opening 9 ft tall by 8 ft wide.  The bunker cells stand 4 ft above grade; assume the bunker cell concrete walls extend 3 ft bgs.  The debris pile is estimated to be 30 CY.

Solution:  Using geometric equations, calculate the estimated C&D debris for the structure.  Split the large slab into 3 parts: left, middle and right.  Split the bunker cells into two parts, the back knee wall and bunker cell walls.

![Plan View](not to scale)

**Bunker Building**

**Dimensions:**
- Length = 20 ft
- Width = 20 ft
- Height = 12 ft
- Door = 9 ft x 8 ft

\[
V_{WALLS} = [(20 \text{ ft} \times 12 \text{ ft}) \times 4 \text{ ea.} - (8 \text{ ft} \times 9 \text{ ft})] \times 0.5 \text{ ft}
\]

\[
V_{WALLS} = 444 \text{ ft}^3
\]

\[
V_{FLOOR} = 20 \text{ ft} \times 20 \text{ ft} \times 0.5 \text{ ft}
\]

\[
V_{FLOOR} = 200 \text{ ft}^3
\]

\[
V_{ROOF} = V_{FLOOR}
\]

\[
V_{ROOF} = 200 \text{ ft}^3
\]

\[
V_{WALLS} = V_{WALLS} + V_{FLOOR} + V_{ROOF}
\]

\[
V_{WALLS} = 444 \text{ ft}^3 + 200 \text{ ft}^3 + 200 \text{ ft}^3
\]

\[
V_{WALLS} = 844 \text{ ft}^3 / 27
\]

\[
V_{BUNKER \ BLDG} = 31.3 \text{ CY} \approx 35 \text{ CY}
\]

(Calculations continued on the next page)
**Small Slab**

Dimensions:
- Length = 20 ft
- Width = 20 ft
- Thickness = 6 in

Volume_{\text{SMALL SLAB}} = L \times W \times t
Volume_{\text{SMALL SLAB}} = 20 \text{ ft} \times 20 \text{ ft} \times 0.5 \text{ ft}
Volume_{\text{SMALL SLAB}} = 200 \text{ ft}^3/27
Volume_{\text{SMALL SLAB}} = 7.4 \text{ CY} \approx 8 \text{ CY}

**Large Slab**

Dimensions:
- Length = 20 ft
- Width = 20 ft
- Thickness = 6 in

Volume_{\text{LARGE SLAB}} = V_{\text{LEFT SLAB}} + V_{\text{MIDDLE SLAB}} + V_{\text{RIGHT SLAB}}
Volume_{\text{LARGE SLAB}} = (20 \text{ ft} \times 34 \text{ ft}) + (10 \text{ ft} \times 20 \text{ ft}) + (30 \text{ ft} \times 15 \text{ ft}) \times 0.5 \text{ ft}
Volume_{\text{LARGE SLAB}} = 665 \text{ ft}^3/27
Volume_{\text{LARGE SLAB}} = 24.6 \text{ CY} \approx 28 \text{ CY}

**Bunker Cells**

Dimensions:
- Knee Wall:
  - Length = 34 ft
  - Width = 1 ft
  - Height = 7 ft
- Cell Walls:
  - Length = 3 ft
  - Width = 2 ft
  - Height = 7 ft

Volume_{\text{CELLS}} = V_{\text{KNEE WALL}} + V_{\text{CELL WALLS}}
Volume_{\text{CELLS}} = (34 \text{ ft} \times 1 \text{ ft} \times 7 \text{ ft}) + (3 \text{ ft} \times 2 \text{ ft} \times 7 \text{ ft}) \times 5 \text{ ea}
Volume_{\text{CELLS}} = 448 \text{ ft}^3/27
Volume_{\text{CELLS}} = 16.6 \text{ CY} \approx 19 \text{ CY}

Volume_{\text{BUNKER COMPLEX}} = Volume_{\text{BUNKER BLDG}} + Volume_{\text{SMALL SLAB}} + Volume_{\text{LARGE SLAB}} + Volume_{\text{CELLS}} + V_{\text{DEBRIS}}^*$
Volume_{\text{BUNKER COMPLEX}} = 35 \text{ CY} + 8 \text{ CY} + 28 \text{ CY} + 19 \text{ CY} + 30 \text{ CY}^*$
Volume_{\text{BUNKER COMPLEX}} \approx 120 \text{ CY}

*Reference Objective statement and Plan View for volume estimate \approx 30 \text{ CY}
SECTION 10.0 MILL BUILDING COMPLEX

Objective: Calculate the estimated volume of C&D debris material that will result from the demolition of the Mill Building complex. The structures and concrete slabs have the dimensions shown below and discussed herewith.

Solution: Using the FEMA debris estimating empirical equations for General Buildings and geometric equations, calculate the estimated C&D debris for the structure. Due to the dilapidated and ‘open air’ condition of the structure, apply a 0.10 multiplier to the FEMA debris estimating formula as opposed to the 0.33 multiplier used for more standard, robust structures. To estimate the volume of the spread footing foundation, use the surface area method.

For volume estimating purposes, assume that the slab is 12 in thick. There are 15 visible courses of 8-in tall concrete masonry units (CMU) serving as the Upper Level foundation; for volume estimating purposes assume the CMU foundation wall extends an additional 5 CMU courses bgs onto a spread footing. The assumed spread footing is assumed to have the dimensions shown below. Assume a 100 CY contingency for unknown subgrade conditions and miscellaneous foundations (i.e., ball mill footers, conveyor trench, loading ramp, stairs and landings, etc). Assume 125 CY of miscellaneous debris (i.e., metal, trash, etc.) are present.

(Mill Building Complex figures continued on the next page)
Project Name: Sunchief Mill Site
Task: Engineering Evaluation & Cost Analysis
Problem Statement: Demolition Debris & Waste Source Volume Calculations

Prepared by: Brendon Loucks, E.I.T.
Date: February 22, 2012
Checked By: Rob Ederer, P.E.
Date: February 23, 2012

(calculations begin on the next page)
### Upper Level

**General Building C&D Debris Volume**

\[
\text{Volume} = \frac{\text{Length} \times \text{Width} \times \text{Height} \times 0.10}{27} = \text{CY}
\]

- **Dimensions:**
  - Length = 30 ft
  - Width = 30 ft
  - Height = 30 ft

\[
\text{General Building C&D Debris Volume} = \frac{30 \text{ ft} \times 30 \text{ ft} \times 30 \text{ ft} \times 0.10}{27} = \text{CY}
\]

- **General Building C&D Debris Volume** = 100 CY \(\approx 110\) CY

### Lower Level

**General Building C&D Debris Volume**

\[
\text{Volume} = \frac{\text{Length} \times \text{Width} \times \text{Height} \times 0.10}{27} = \text{CY}
\]

- **Dimensions:**
  - Length = 125 ft
  - Width = 30 ft
  - Height = 40 ft

\[
\text{General Building C&D Debris Volume} = \frac{125 \text{ ft} \times 30 \text{ ft} \times 40 \text{ ft} \times 0.10}{27} = \text{CY}
\]

- **General Building C&D Debris Volume** = 555.6 CY \(\approx 575\) CY

### CMU Foundation Wall

**Volume**

\[
\text{Volume} = \text{L} \times \text{W} \times \text{H}
\]

- **Dimensions:**
  - Length = 30 ft
  - Width = 0.667 ft (8 in)
  - Height = 15 ea x (8 in/12 in/ft) + 5 ea x (8 in/12 in/ft) = 13.33 ft

\[
\text{Volume} = 30 \text{ ft} \times 0.667 \text{ ft} \times 13.33 \text{ ft} = 19.8 \text{ CY} \approx 22 \text{ CY}
\]

### CMU Wall Spread Footing Foundation

**Surface Area**

\[
\text{Surface Area} = A_{\text{top}} + A_{\text{bottom}}
\]

- **Dimensions:**
  - *As shown in figure.*

\[
\text{Volume} = \text{Surface Area} \times \text{Length} \times 2 \text{ ea}
\]

\[
\text{Volume} = 4.33 \text{ ft}^2 \times 30 \text{ ft} \times 2 \text{ ea}
\]

- **Volume** = 259.8 ft³/27

- **Volume** = 9.6 CY \(\approx 11\) CY

### Large Slab

**Volume**

\[
\text{Volume} = \text{L} \times \text{W} \times \text{H}
\]

- **Dimensions:**
  - Length = 125 ft
  - Width = 125 ft
  - Height = 12 in = 1 ft

\[
\text{Volume} = 125 \text{ ft} \times 125 \text{ ft} \times 1 \text{ ft} = 15625 \text{ ft}^3/27
\]

- **Volume** = 578.7 CY \(\approx 625\) CY

**Volume**

\[
\text{Volume}_{\text{MILL BLDG COMPLEX}} = V_{\text{UPPER LEVEL}} + V_{\text{LOWER LEVEL}} + V_{\text{CMU WALL}} + V_{\text{CMU FOOTING}} + V_{\text{SLAB}} + V_{\text{CONC CONTINGENCY}} + V_{\text{DEBRIS}}
\]

\[
\text{Volume}_{\text{MILL BLDG COMPLEX}} = 110 \text{ CY} + 575 \text{ CY} + 22 \text{ CY} + 11 \text{ CY} + 625 \text{ CY} + 100 \text{ CY} + 125 \text{ CY}
\]

- **Volume** = 1568 CY

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**WESTON SOLUTIONS**

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SECTION 11.0 WASTE SOURCE, ASBESTOS

Objective: Calculate the estimated volume of waste material with asbestos detections at the Sunchief Mill Site. For volume estimating purposes, assume the piles lie in approximate geometric shapes as observed and noted during the field investigation or as observed in available photographs.

Solution: Use approximate geometric shapes and estimated dimensions observed during the field investigation to calculate estimated volumes of material. Shapes, dimensions, and associated notes gathered from the field log book/documents are presented in Table 1. For unnamed piles, utilize available figures and photographs to scale approximate dimensions. Pile IDs correlate to waste pile source identifications presented on Figure 8, in the EE/CA report.

Table 1 – Summary of Waste Source Piles, Asbestos Detections

<table>
<thead>
<tr>
<th>Pile ID (Figure 8)</th>
<th>Type</th>
<th>Shape</th>
<th>Length (ft)</th>
<th>Width (ft)</th>
<th>Height/Depth (ft)</th>
<th>Diameter (ft)</th>
<th>Footprint (ft²)</th>
<th>Surface Area (ft²)</th>
<th>Volume (cf)</th>
<th>Volume (cy)</th>
<th>Volume, rounded up 5-12% (cy)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Waste Source</td>
<td>Rectangle</td>
<td>25</td>
<td>10</td>
<td>7</td>
<td>-</td>
<td>250</td>
<td>990</td>
<td>1750</td>
<td>64.8</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Waste Source</td>
<td>Rectangle</td>
<td>30</td>
<td>15</td>
<td>3</td>
<td>-</td>
<td>450</td>
<td>1170</td>
<td>1350</td>
<td>50.0</td>
<td>55</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>Waste Source</td>
<td>Rectangle</td>
<td>75</td>
<td>50</td>
<td>12</td>
<td>-</td>
<td>3750</td>
<td>2100</td>
<td>9000</td>
<td>333</td>
<td>350</td>
<td>Only southern portion of pile had asbestos detection. Assumed as 20% of total volume of Pile G.</td>
</tr>
<tr>
<td>M</td>
<td>Waste Source</td>
<td>Rectangle</td>
<td>30</td>
<td>18</td>
<td>15</td>
<td>-</td>
<td>540</td>
<td>2520</td>
<td>8100</td>
<td>300</td>
<td>325</td>
<td></td>
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<tr>
<td>O</td>
<td>Waste Source</td>
<td>Rectangle</td>
<td>150</td>
<td>6</td>
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<td>-</td>
<td>900</td>
<td>3360</td>
<td>4500</td>
<td>167</td>
<td>175</td>
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<tr>
<td>GG</td>
<td>Waste Source</td>
<td>Rectangle</td>
<td>20</td>
<td>15</td>
<td>2</td>
<td>-</td>
<td>300</td>
<td>740</td>
<td>600</td>
<td>22.2</td>
<td>25</td>
<td>Dimensions and shape were estimated from Figure 8 and photos.</td>
</tr>
<tr>
<td>HH</td>
<td>Waste Source</td>
<td>Cone</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>20</td>
<td>314</td>
<td>1904</td>
<td>524</td>
<td>19.4</td>
<td>22</td>
<td>Dimensions and shape were estimated from Figure 8 and photos.</td>
</tr>
<tr>
<td>II</td>
<td>Waste Source</td>
<td>Cone</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>20</td>
<td>314</td>
<td>1904</td>
<td>524</td>
<td>19.4</td>
<td>22</td>
<td>Dimensions and shape were estimated from Figure 8 and photos.</td>
</tr>
</tbody>
</table>

TOTALS: 6818 14689 26347 976 ≈ 1044

Surface Area (SA) Formulas Used:

- \( SA, \text{Rectangle} = 2([h \times w] + [l \times h] + [l \times w]) \)
- \( SA, \text{Cone} = \pi r s + \pi r^2 \text{ where } s = \sqrt{r^2 + h^2} \text{ & } r = d/2 \)

Volume Formulas Used:

- \( Volume, \text{Rectangle} = l \times w \times h \)
- \( Volume, \text{Cone} = \left(\frac{1}{3}\right)\pi r^2 h \text{ where } r = d/2 \)
SECTION 12.0 WASTE SOURCE, METALS

Objective: Calculate the estimated volume of waste material with metals detections above nrSRLs at the Sunchief Mill Site. For volume estimating purposes, assume the piles lie in approximate geometric shapes as observed and noted during the field investigation or as observed in available photographs.

Solution: Use approximate geometric shapes and estimated dimensions observed during the field investigation to calculate estimated volumes of material. Shapes, dimensions, and associated notes gathered from the field log book/documents are presented in Table 2. For unnamed piles, utilize available figures and photos to scale approximate dimensions. Pile IDs correlate to waste pile source identifications presented on Figure 8, in the EE/CA report.

Table 2 Summary of Waste Source Piles, Metal Detections Above nrSRLs

<table>
<thead>
<tr>
<th>Pile ID</th>
<th>Type</th>
<th>Shape</th>
<th>Length (ft)</th>
<th>Width (ft)</th>
<th>Height/Depth (ft)</th>
<th>Diameter (ft)</th>
<th>Footprint (ft²)</th>
<th>Surface Area (ft²)</th>
<th>Volume (cf)</th>
<th>Volume (cy)</th>
<th>Volume, rounded up 5-12% (cy)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>Waste Source</td>
<td>Rectangle</td>
<td>75</td>
<td>50</td>
<td>12</td>
<td>-</td>
<td>3750</td>
<td>8400</td>
<td>36000</td>
<td>1333</td>
<td>1400</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>Waste Source</td>
<td>Rectangle</td>
<td>30</td>
<td>150</td>
<td>8</td>
<td>-</td>
<td>4500</td>
<td>11880</td>
<td>36000</td>
<td>1333</td>
<td>1400</td>
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<tr>
<td>Q</td>
<td>Waste Source</td>
<td>Cone</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>20</td>
<td>314</td>
<td>1904</td>
<td>524</td>
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<td>U</td>
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<td>Cone</td>
<td>-</td>
<td>-</td>
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<td>25</td>
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<td>12</td>
<td>5</td>
<td>-</td>
<td>720</td>
<td>2160</td>
<td>3600</td>
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<td>15</td>
<td>2.5</td>
<td>-</td>
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<td>2</td>
<td>-</td>
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<td>-</td>
<td>-</td>
<td>12</td>
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<td>-</td>
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<td>10</td>
<td>3</td>
<td>-</td>
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<td>19 TCLP exceeds RCRA limits for Lead</td>
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TOTALS, All Piles 12334 35752 83418 3090 ≈ 3233

Lead TCLP Totals 404 1996 874 32.4 ≈ 37

Surface Area (SA) Formulas Used:

\[ SA, Rectangle = 2[(h \times w) + (l \times h) + (l \times w)] \]
\[ SA, Cone = \pi rs + \pi r^2 \text{ where } s = \sqrt{r^2 + h^2} \text{ and } r = d/2 \]

Volume Formulas Used:

\[ Volume, Rectangle = l \times w \times h \]
\[ Volume, Cone = \left(\frac{1}{3}\right)\pi r^2 h \text{ where } r = d/2 \]
SECTION 13.0   TOTAL VOLUME OF WASTE MATERIALS

Objective: Calculate the total volume of waste materials at the Sunchief Mill Site. Provide a segregation of material type into C&D debris versus waste source material.

Solution: Sum the totals from the previous calculation to determine the total C&D debris and total waste source material. Sum the total C&D debris and total waste source material to determine the total volume waste present at the Sunchief Mill Site.

C&D Debris

C&D Quantities:
\[ V_{\text{MACHINE SHOP}} = 1650 \text{ CY} \]
\[ V_{\text{MACHINE SHOP FOUNDATION}} = 45 \text{ CY} \]
\[ V_{\text{OFFICE}} = 225 \text{ CY} \]
\[ V_{\text{TRAILER}} = 325 \text{ CY} \]
\[ V_{\text{BUNKER COMPLEX}} = 120 \text{ CY} \]
\[ V_{\text{MILL BLDG COMPLEX}} = 1568 \text{ CY} \]

\[ V_{\text{TOTAL, C&D DEBRIS}} = V_{\text{MACHINE SHOP}} + V_{\text{MACHINE SHOP FOUNDATION}} + V_{\text{OFFICE}} + V_{\text{TRAILER}} + V_{\text{BUNKER COMPLEX}} + V_{\text{MILL BLDG COMPLEX}} \]
\[ V_{\text{TOTAL, C&D DEBRIS}} = 1650 \text{ CY} + 45 \text{ CY} + 225 \text{ CY} + 325 \text{ CY} + 120 \text{ CY} + 1568 \text{ CY} \]
\[ V_{\text{TOTAL, C&D DEBRIS}} = 3933 \text{ CY} \]

\[ V_{\text{TOTAL, C&D DEBRIS (tons)}} = 3933 \text{ CY}/(2\text{CY/tn}) = 1967 \text{ tons} \]

Waste Source Material

Waste Source Quantities:
\[ V_{\text{WASTE SOURCE, ASBESTOS}} = 1044 \text{ CY} \]
\[ V_{\text{WASTE SOURCE, METALS}} = 3233 \text{ CY} \]

\[ V_{\text{TOTAL, WASTE SOURCE}} = V_{\text{WASTE SOURCE, ASBESTOS}} + V_{\text{WASTE SOURCE, METALS}} \]
\[ V_{\text{TOTAL, WASTE SOURCE}} = 1044 \text{ CY} + 3233 \text{ CY} \]
\[ V_{\text{TOTAL, WASTE SOURCE}} = 4277 \text{ CY} \]

\[ V_{\text{TOTAL, WASTE SOURCE (tons)}} = 4277 \text{ CY} \times (1.76 \text{ tons/1 CY}) = 7528 \text{ tons} \]

Total Waste Material

\[ V_{\text{TOTAL}} = V_{\text{TOTAL, C&D DEBRIS}} + V_{\text{TOTAL, WASTE SOURCE}} \]
\[ V_{\text{TOTAL}} = 3933 \text{ CY} + 4277 \text{ CY} \]
\[ V_{\text{TOTAL}} = 8210 \text{ CY} \]

or

\[ V_{\text{TOTAL}} = 1967 \text{ tons} + 7528 \text{ tons} \]
\[ V_{\text{TOTAL}} = 9495 \text{ tons} \]
SECTION 14.0 ON-SITE REPOSITORY VOLUME ESTIMATES

Objective: Estimate the following quantities for the proposed on-site repository at the Sunchief Mill Site. The existing tailings pond in Area 5 is proposed as the on-site repository location.

1. Available volumetric capacity for use as a repository.
2. Thickness of the waste material proposed for consolidation within the repository.
3. Volume of material needed for use as general fill (minimum of 2 feet general fill required).
4. Volume of berm material available for ‘knock down’ use as general fill.
5. Conclude if the available berm material is sufficient for use as general fill.

Solution: Using measurements collected during the field investigation and available maps, figures, and survey data calculate the required quantities. For estimation purposes assume the interior side walls of the pond are vertical (no slope). Use the following values for calculations (data sources where values were gather are listed in parenthesis to each value):

1. Available volumetric capacity for use as a repository.

Solution: Determine the surface area of the bottom of the repository. Extrude the surface area by the height of the repository to calculate volumetric capacity.

\[
\text{SA} = lw
\]
\[
\text{SA} = 215 \text{ ft x 285 ft}
\]
\[
\text{SA} = 61275 \text{ ft}^2
\]

\[
V = \text{SA} x h
\]
\[
V = 61275 \text{ ft}^2 x 15 \text{ ft}
\]
\[
V = 919125 \text{ ft}^3/27
\]
\[
V = 34042 \text{ CY}
\]

2. Thickness of the waste material proposed for consolidation within the repository.

Solution: Using the assumption that the interior side walls are vertical, determine the cubic yard per foot incremental capacity (IC) of the repository. Divide the total volume of waste to be consolidated into the repository \(V_{\text{TOTAL}} = 7804 \text{ CY}\) by the incremental capacity to determine the height/thickness \(t_{\text{WASTE}}\) of the waste material.

\[
\text{IC} = \frac{V_{\text{TOTAL}}}{h}
\]
\[
\text{IC} = 34042 \text{ CY / 15 ft}
\]
\[
\text{IC} = 2269 \text{ CY/ft}
\]
\[
t_{\text{WASTE}} = \frac{V_{\text{TOTAL}}}{\text{IC}}
\]
\[
t_{\text{WASTE}} = 8210 \text{ CY / 2269 CY/ft}
\]
\[
t_{\text{WASTE}} = 3.62 \text{ ft}
\]
Solution: Extrude the surface area of the repository by the depth of general fill materials needed to determine the volume of material needed for use as general fill. Include a swell factor of 20% and assume compaction of 95%.

\[
V_{\text{GENERAL FILL}} = S_{\text{REPOSITORY}} \times 2 \text{ ft} \\
V_{\text{GENERAL FILL}} = 61275 \text{ ft}^2 \times 2 \text{ ft} \\
V_{\text{GENERAL FILL}} = 122550 \text{ ft}^3/27 \\
V_{\text{GENERAL FILL}} = 4538 \text{ CY} \times (1+20\% \text{ for swell}) \times 95\% \text{ compaction} \\
V_{\text{GENERAL FILL}} = 5173 \text{ CY}
\]

4. **Volume of berm material available for ‘knock down’ use as general fill.**

Solution: Determine the effective thickness \( t_{\text{EFFECTIVE}} \) of berm material that can be utilized as general fill by subtracting the waste material thickness and general fill thickness from the berm height. The cover soil material thickness (6 inches of topsoil) will not affect the effective thickness because the disturbed top of berm area will also receive a topsoil cover. Extrude the top of berm surface area by \( t_{\text{EFFECTIVE}} \) to determine the volume of berm material that can be used as general fill. For estimation purposes use a waste material thickness of 4 ft.

\[
t_{\text{EFFECTIVE}} = h - t_{\text{WASTE}} - t_{\text{COVER}} \\
t_{\text{EFFECTIVE}} = 15 \text{ ft} - 4 \text{ ft} - 2 \text{ ft} \\
t_{\text{EFFECTIVE}} = 9 \text{ ft}
\]

\[
V_{\text{AVAILABLE BERM MATERIAL}} = S_{\text{TOP OF BERM}} \times t_{\text{EFFECTIVE}} \\
V_{\text{AVAILABLE BERM MATERIAL}} = 21185 \text{ ft}^2 \times 9 \text{ ft} \\
V_{\text{AVAILABLE BERM MATERIAL}} = 190665 \text{ ft}^3/27 \\
V_{\text{AVAILABLE BERM MATERIAL}} = 7062 \text{ CY}
\]

5. **Conclude if the available berm material is sufficient for use as general fill.**

Solution: Compare the volume of general fill needed to the volume of berm material available.

\[
V_{\text{GENERAL FILL}} = 5173 \text{ CY} < V_{\text{AVAILABLE BERM MATERIAL}} = 7062 \text{ CY}
\]

Therefore there is sufficient quantity available within the existing berm for use as ‘knock down’ general fill material.