BANK ARMORING PLAN

This bank armoring plan is presented to explain the bank armoring and slope protection proposed for two mining phases that will be reclaimed as lined water storage reservoirs, and where mining will be within 400 feet of the western bank of the South Platte River. The bank armoring is intended to protect the finished slopes of the reservoir phases in case of a 100-year flood event occurring after the phase has been reclaimed. The 100-year Floodplain line information has been included on all of the **MAP EXHIBITS** in the application Packet.

The two phases that have mining within 400 feet of the South Platte River are Northeast #1 and Northeast #3. The locations of the proposed bank armoring in these two phases are shown on **MAP EXHIBIT F - RECLAMATION PLAN MAP**. Northeast #1 Phase has approximately 1,030 feet of reservoir banks that will be armored, starting at the southeast corner and going north along the eastern perimeter. Northeast #3 has approximately 900 feet of reservoir banks that will be armored, starting at the southeast corner and going north along the eastern perimeter. Armoring will only be installed on the inside banks of the reservoirs. Armoring will not be installed on the river bank itself because the river bank is 300 feet or farther from of the top of the slope of the mining limits, the river bank is outside the permit area, and it is not on land owned by L.G. Everist, Inc.

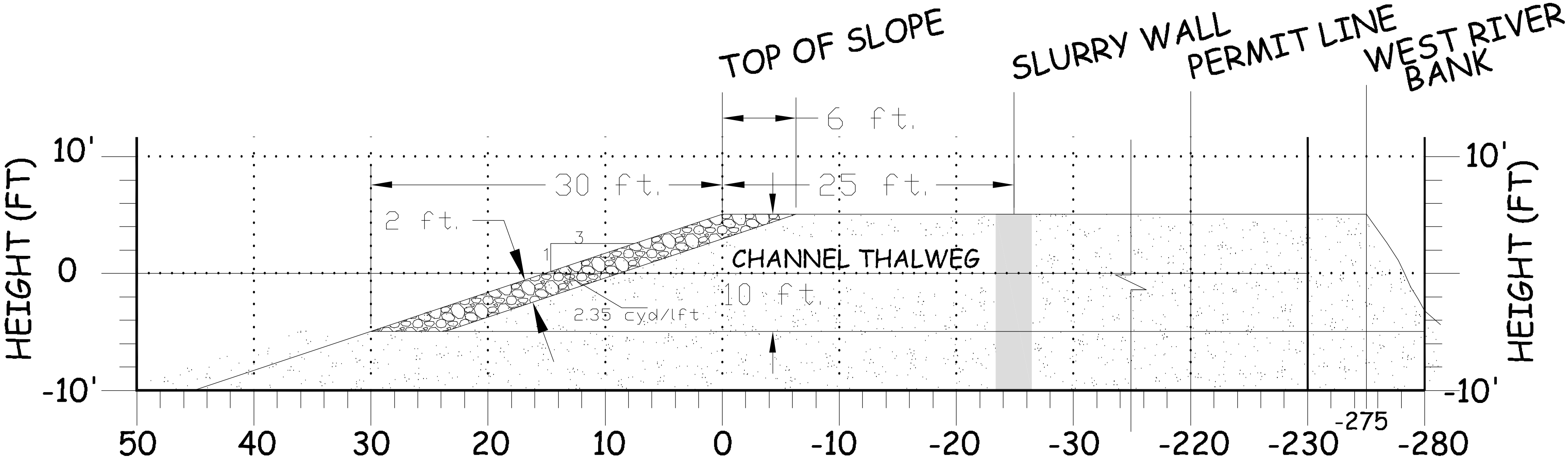
Reservoir Bank Armoring Methods and Materials

The finished reservoir banks in Northeast #1 and Northeast #3 will be armored as mining progresses through the Phase. The toe of the slope armoring will be at least 5 feet below the thalweg of the South Platte River channel. The base of the armoring will average 8 feet below the existing ground surface at the mine. The armoring will have a 3h to 1v slope and will be 2 feet or more thick. This will leave an armored face along the top of the bank and the slope into the reservoir that is 31.6 feet wide. This will require approximately 2.35 cyd/lft, along the finished reservoir slopes. Using the formula $C=(A^2+B^2)^{½}$ to determine the armoring length on the slope. Then the unit volume is
$V_U=(L*W*H)/27cft/cyd$; where L=31.6', W=1.0', H=2'
$V_U=(31.6*1*2)/27=2.34cy/lft$ rounded to 2.35 cy/lft

Armoring material will be recycled concrete fragments with surface rebar removed, so that it meets the definition of Inert Materials. The concrete will be sized 9 to 15 inches averaging 12 inches. After the larger material is placed, fines will be mixed in to fill voids. This size of material has a Safety Factor of

BANK ARMORING PLAN

FIGURE 1



TYPICAL RESERVOIR BANK ARMORING
NO SCALE

NOTES:

1. BANK ARMORING SHOWN ON RECLAMATION MAPS IS APPROXIMATE LOCATION. ACTUAL LOCATION WILL DEPEND ON LOCATION OF TOP OF SLOPE AT THE TIME IT IS INSTALLED.

2. MATERIAL USED FOR ARMORING WILL BE WELL AGED BROKEN CONCRETE. THAT HAS ALL EXPOSED SURFACE REBAR REMOVED. AT A MINIMUM 2,350 CUBIC YARDS WILL BE STOCKPILED ON THE MINE FOR USE IN ARMORING. THIS IS ENOUGH TO MATERIAL TO ARMOR A MINIMUM OF 1000 FEET OF EXCAVATION BANK.

3. STOCKPILES OF ARMORING MATERIAL WILL BE PLACED PARALLEL TO THE RIVERBANK SO IT WILL NOT INTERFERE WITH FLOWS IN THE FLOOD PLAIN. THE STOCKPILES WILL BE PLACED BETWEEN THE PERMIT LINE AND THE TOP OF SLOPE WITHIN 500 FEET TO THE AREA WHERE IT WILL BE PLACED.

4. THE BANK ALONG THE EXCAVATED AREA WILL BE ARMORED FROM THE EXISTING SURFACE TO A POINT AT LEAST 5 FEET BELOW THE CHANNEL THALWEG.

5. THE SIZE OF THE MATERIAL WILL FALL IN THE RANGE OF 9 TO 15 INCHES AVERAGING 12 INCHES AS DISCUSSED IN THE BANK ARMORING PLAN AND WILL BE PLACED BELOW GRADE.

1.26. See the supporting document: **BANK ARMORING PLAN - SAFETY FACTOR CALCULATIONS .**

The bank armoring materials will be installed on 2,000 foot sections of finished reservoir slopes within 3 to 6 months after sloping is completed. At a minimum, 4,700 cubic yards will be stockpiled, on the mine for use in armoring, which is enough to armor a 2,000 feet of finished bank slopes. At no time will there be more than 2,000 feet of armoring needing to be placed.

Prior to installing the bank armoring, the stockpile of armoring materials will be placed in the setback area above the reservoir slopes so the materials can easily be pushed into place on the finished slopes. Any stockpiled materials will be placed parallel to possible water flows, so they will not interfere with water flows in the flood plain if flooding occurs.

Cross-Section Drawing

The attached **FIGURE 1** is a cross section drawing of the bank armoring plan and includes notes of the armoring methods and materials discussed in this section that will be used to protect the banks along the southeast and east sides of Northeast #1 and Northeast #2 Phases, respectively.

Supplied supporting documents

Figure 1 – Bank Protection Plan cross section

Safety factor calculation page

Sources

Armoring Plan designed is based on the Urban Drainage and Flood Control District Guideline published July 2013 starting with Section 2.4.1– Riprap. The Hydraulic Radius and Specific Gravity of the material were supplied by Mr. Tim Cazier – DRMS staff engineer.

$$SF = \frac{\cos\theta \ \tan\phi}{n\tan\phi + \sin\theta} \qquad \tau_s = \gamma RS \qquad n = \frac{21\,\tau_s}{(S_s - 1)\gamma\, D_{50}}$$

θ = face slope of pitside bank, in degrees to the horizontal

ϕ = angle of repose of pitside bank construction materials in degrees

n = stability factor

S_s = specific gravity of riprap particles

γ = specific weight of water = 62.4 lbs/ft^3

D_{50} = median riprap particle size, in feet

R = hydraulic radius at normal depth of flow down pitside slope, in feet

S = face slope of pitside bank, in feet per foot

$$\tau_s = \gamma RS$$

γ = 62.4

R = 2

S = 0.01

τ_s = 1.248

$$n = \frac{21\,\tau_s}{(S_s - 1)\gamma\, D_{50}}$$

τ_s = 1.248

S_s = 2.4

D_{50} = 1

$$n = \frac{26.2}{87.4}$$

n = 0.3

$$SF = \frac{\cos\theta \ \tan\phi}{n\tan\phi + \sin\theta}$$

θ = 18.43°

ϕ = 35°

n = 0.3

cosθ = 0.9487

tanØ = 0.7002

sinθ = 0.3161

$$SF = \frac{0.6643}{0.5262}$$

SF = 1.26