STATE OF COLORADO

DIVISION OF RECLAMATION, MINING AND SAFETY
Department of Natural Resources

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COLORADO DIVISION OF RECLAMATION MINING & SAFETY

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MEMORANDUM

To: Kate Pickford, Environmental Protection Specialist

From: Tim Cazier, P.E., Environmental Protection Specialist

Date: August 1, 2012

Re: Adequacy Review Animas Glacier Gravel, Permit No. M-2011-028
May 4, 2012 Drainage Report

The Division of Reclamation, Mining and Safety engineering staff (DRMS) have reviewed Russell Engineering's Animas Glacier Gravel Pit Drainage Report dated May 4th, 2012, but not received by the DRMS until July 16, 2012.

The following comments are specific to the revised drainage report.

1. Section III. Hydrologic Data:
   a. The peak flows for Basins #1 through #7 listed in Section III do not match those presented in the third summary table in Appendix B (Figure 3), labeled "Graphical Peak Discharge Method TR-55". Which set of values are correct? Please revise as appropriate.
2. Section IV. Culvert Design:
   a. The design flows for Design Points A through G listed in Section IV do not match those presented in the design point summary table in Appendix C (Figure 1). Which set of values are correct? Please revise as appropriate.
3. Section V. Basin Creek:
   a. The 6th paragraph begins discussion on the time to dewater the retention pond. The pond must be dewatered in 72 hours. If evaporation and infiltration do not achieve this, the dewater plan must be altered. Please describe how the pond will be emptied in 72 hours.
   b. Individual swales – the paragraph above Table -2 indicates all swales will be 24 inches deep. Design flow velocities above five feet per second (5 fps) will require armor protection. Russell Engineering submitted riprap calculations to the DRMS

engineering staff for review on July 31, 2012. The riprap will necessitate a higher Manning's n for design (typically 0.035 for stability and 0.040 for capacity). This additional roughness will increase the flow depth and likely require a deeper swale where riprap is used. Freeboard should be one foot or one velocity head ($V^2/2g$), whichever is greater. Please revise the channel designs to meet those criteria.

c. Overflow weir – the overflow weir requirements state indicate it will be armored with "D9-50 riprap". The DRMS believes this to be a typographical error. Please clarify how the weir will be armored and provide riprap calculations.

4. Appendix B, Figure 2:

   a. The times of concentration for the Historic Basin and Basin #1 appear excessively large. Please provide justification for using a Manning's n of 0.20 in the Open Channel Flow (t_2) Column.

   b. Similarly, please provide justification for using a Manning's n of 0.08 in the Open Channel Flow (t_2) Column (Basins #2 through #8) and in the Open Channel Flow (t_3) Column (Historic Basin and Basin #1)

5. Appendix C – Culvert calculations:

   a. A Manning's n of 0.024 is typically used for corrugated steel/metal pipe. Please provide justification for using a Manning's n of 0.022 or resubmit the analyses with n = 0.024. *Note: The DRMS engineering staff is aware there may be no difference in results as the culverts are as designed under inlet control. However, a higher Manning's n may result in barrel/outlet control due to the fixed tailwater depth.*

   b. There is an error on the input for Design Point D. The road elevation is 100 feet higher than presented in Appendix C, Figure 1. – Design Point Summary Table.

If you have any questions, please contact me at 303-866-3567 x8169 or tim.cazier@state.co.us.

Table 2
U.S. Corps of Engineers (mild) Method Riprap Size Calculation

Riprap Channel Evaluation
DRMS Civil Engineering
PROJECT NO.: M-2011-028

Date:	7/31/12
By:	TC1
Chkd:	-
Apprvd:	-

	USACE Method Riprap Calculations for Mild Riprap (Bed Slopes <2%)						
Reach Designation	Design Flow Q (cfs)	Normal Flow Depth d (ft)	Depth Averaged Velocity V (ft/s)	Velocity Distribution Coefficient C_V	Channel Side Slopes Correction K_1	Calculated Particle Size D_{30} (ft)	Riprap Size D_{50} (in)
Page 1 (n=0.02)	167.1	1.58	5.80	1.19	0.93	0.28	4.4
Page 1 (n=0.035)	167.1	2.11	3.88	1.19	0.93	0.10	1.5
Page 1 (n=0.040)	167.1	2.25	3.53	1.19	0.93	0.07	1.2
Page 2 (n=0.02)	167.1	1.31	7.40	1.19	0.93	0.55	8.5
Page 2 (n=0.035)	167.1	1.76	4.98	1.19	0.93	0.19	2.9
Page 2 (n=0.040)	167.1	1.89	4.53	1.19	0.93	0.15	2.3
Page 3 (n=0.02)	11.7	0.39	2.58	1.22	0.93	0.05	0.8
Page 3 (n=0.035)	11.7	0.54	1.78	1.22	0.93	0.02	0.3
Page 3 (n=0.040)	11.7	0.58	1.63	1.22	0.93	0.02	0.2
Page 4 (n=0.02)	11.7	0.32	3.23	1.22	0.93	0.10	1.6
Page 4 (n=0.035)	11.7	0.44	2.24	1.22	0.93	0.04	0.6
Page 4 (n=0.040)	11.7	0.48	2.05	1.22	0.93	0.03	0.5

USACE Paper EM 1110-2-1601, 6/30/94

$$D_{30} = S_f C_s C_V C_T d \left[\left(\frac{\gamma_w}{\gamma_s - \gamma_w} \right) \frac{V}{\sqrt{K_1 g d}} \right]^{2.5}$$

Inputs below as determined in EM 1110-2-1601, 6/30/94

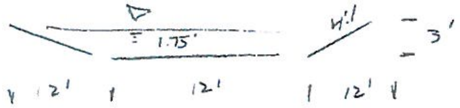
1.1	S_f: Minimum safety factor of 1.1 for moderate debris impact
0.375	C_s: Value of 0.30 for angular rock
155	γs: Density of solids (pcf)
2.2	Cg: Gradation Coefficient (D_{85}/D_{15})
2.0	T: Riprap Thickness (x D_{50})
0.910	C_T: Correction for thickness > 1.5 * D_{50}

Note: A C_V of 1.25 should be used downstream of concrete channels due to the difference in velocity profiles

Riprap D50 determined as recommended in EM 1110-2-1601, 6/30/94

$$D_{50} = D_{30} \left(\frac{D_{85}}{D_{15}} \right)^{1/3}$$

Table 2
U.S. Corps of Engineers (mild) Method Riprap Size Calculation



07-31-2012
Rip Rap Calculations
Animas Glacier Grove
For 0.50% Swale &
100 year Disturbed Flow

$$D_{30} = S_f\, C_s\, C_v\, C_T\, d \left[\left(\frac{\gamma_w}{\gamma_s-\gamma_w}\right)^{1/2} \times \frac{V}{\sqrt{K_1 g d}}\right]^{2.5}$$

$S_f = 1.1$ ✓

$C_s = 0.375$ — for rounded rock — not recommended, ANGULAR ROCK IS MORE STABLE DUE TO INTERLOCKING

$C_v = 1.283 - 0.2 \log\left(\frac{R}{W}\right) = 1.19$ ok — what is bend radius

$C_T = 1.0$ — Don't know gradation (D_{100}) or TS spec is $T = 1.5\, D_{50}$)
But ok

$d = 18.93''$ per channel calculator, use 1.75' — Depth appears to be Based on a Manning's n of 0.02. The appropriate value is generally $0.035 \le n \le 0.04$

$\gamma_w = 62.4$ lbs/ft³

$\gamma_s = 155$ lbs/ft³ Ok

$V_{ss} = 8.72$ ft/sec side slopes only? — Need bottom too!! also should be based on a higher Manning's n

$K_1 = 0.93$ — Appears $\phi = 40°$ used — probably not valid for rounded riprap

$g = 32.2$ ft/sec²

$$D_{30} = (1.1)(0.375)(1.19)(1.0)(1.75)\left[\left(\frac{62.4}{155-62.4}\right)^{1/2} \times \frac{8.72}{\sqrt{0.93 \times (32.2)(1.75)}}\right]^{2.5}$$

$D_{30} = 0.86\,[0.82 \times 1.20]^{2.5}$ — Depends on gradation of riprap
Incl: $D_{50} = D_{30} \cdot 12 \cdot C_g^{1/3}$
Where: $C_g = D_{85}/D_{15}$
D_{50} in inches
D_{30} in feet

$D_{30} = 0.83' = 10''$

$D_{50} = D_{30}\left(\frac{D_{85}}{D_{15}}\right)^{1/3} = 0.83\,(2.2)^{1/3} = 13''$ ← OK