APPENDIX A

SOUTH DIVERSION CHANNEL AND BERM

A

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CALCULATION COVER SHEET

Date: 7/23/08 **Page** 1 **of** 1

Project No.: 89241 **Project Title:** Pinon Ridge Mill Redesign

Calculation No.: 89241.6-3

Calculation Title: Mill Diversion Design

Design Verification Required: ☐ Yes ☒ No

Calculation Type: ☐ Scoping ☐ Preliminary ☒ Final ☐ Voided
☐ Superseded by Calculation No.: _____

ORIGINAL AND REVISED CALCULATIONS/ANALYSIS APPROVAL

	Rev. 1 Printed Name/Signature/Date	Rev. ____ Printed Name/Signature/Date	Rev. ____ Printed Name/Signature/Date
Originator:	T. Kluthe 7/23/08		
Checked By:	C. Larson 10/14/08		
Approved By:	C. Larson 12/1/08		
Other:			

AFFECTED DOCUMENTS

Document Number	Document Title	Rev. No.	Responsible Project Manager Initials
DEN 8R179	SITE DRAINAGE ANALYSIS AND DESIGN EA - PINON RIDGE PLOT		CL

RECORD OF REVISION

Rev.	Reason for Revision

ATTACHMENTS

Attachment No.	Title	Total Pages
1	Mill Diversion Design Calculations	19

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PROJECT Pinon Ridge PROJECT NO. 89241
SUBJECT Mill Diversion Hydrology BY TAK DATE 7/23/08
REVIEWED BY CCR DATE 12/1/08

Objective: Determine peak flows for 100-yr and 1,000-yr storms to design mill diversion berms / ditches.

Due to flow path discrepancies, two drainage alternatives will be analyzed, with the highest peak flow chosen as the design flow.

Alternative 1:

Assume all drainage is contributed by Basin 4.

Basin 4 Total Area = 412 ac.

Contributing Area = 179 ac.

Soil Type #	Veg. Type	CN	Area (ac)
56	Sag.	63	32
18	Sag.	51	32
79	Sag.	63	3
87	Pin	80	63
88	Pin	80	3
23	Pin	73	38
75	Pin	80	8
		Total =	179 ac

Weighted CN:

$$\frac{(63 \cdot 32)+(51 \cdot 32)+(63 \cdot 3)+(80 \cdot 63)+(80 \cdot 3)+(73 \cdot 38)+(80 \cdot 8)}{179} = 70$$

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PROJECT Pinon Ridge PROJECT NO. 89241
SUBJECT Mill Diversion Hydrology BY TKL DATE 7/23/08
REVIEWED BY COL DATE 12/1/08

Length of Watercourse: 1.25 mi

Slope of Watercourse: Effective Slope Eqn. (UDFCD, 2001)

$$S = \left[\frac{L_1 S_1^{0.24} + L_2 S_2^{0.24} + \dots L_n S_n^{0.24}}{L_1 + L_2 + \dots L_n}\right]^{4.17}$$

$L_1 = 4066$ ft
$S_1 = 0.31$ ft/ft
$L_2 = 2534$ ft
$S_2 = 0.05$ ft/ft

$$S_{eff} \left[\frac{4066\,ft \cdot 0.31\,ft/ft^{0.24} + 2534\,ft \cdot 0.05\,ft/ft^{0.24}}{4066\,ft + 2534\,ft}\right]^{4.17} = 0.17$$

$$S_{eff} = 0.17\,ft/ft \times \frac{5280\,ft}{mi} = 888\,ft/mi$$

Distance to Centroid: Assume 1/2 distance of watercourse for long, skinny basin.

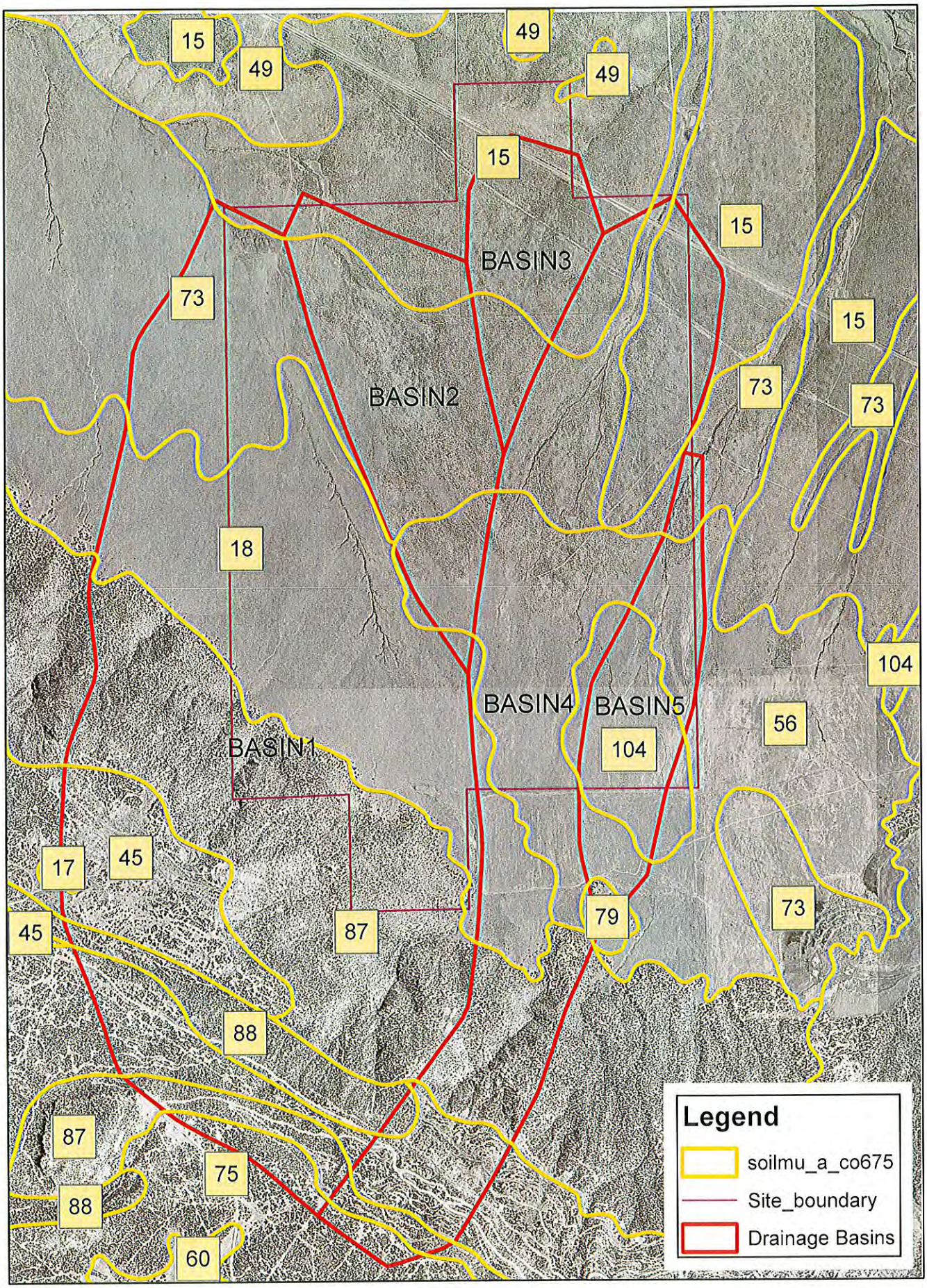
$L_{ca} = 1.25\,mi/2 = 0.63\,mi$

Lag Time:

$$L_g = 26\,K_n \left(\frac{L L_{ca}}{S^{0.5}}\right)^{0.33}$$

$$L_g = 26(0.07)\left(\frac{1.25\,mi \cdot 0.63\,mi}{888\,ft/mi^{0.5}}\right)^{0.33} = 0.55\,hrs$$

USBR Lag Eqn.
Where;
L_g = Lag time (hrs)
K_n = Roughness
L_{ca} = Distance to Centroid (mi)
S = Slope (ft/mi)
L = Longest Watercourse (mi)



1 inch equals 1,500 feet

0 750 1,500 3,000 Feet

Pinon Ridge Basins Map
Drainage Alternative 1

N

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PROJECT Piñon Ridge PROJECT NO. 89241
SUBJECT Mill Diversion Hydrology BY TKC DATE 7/23/08
REVIEWED BY CCL DATE 12/1/08

Alternative 2:

Assume all drainage contributed by Basin 4
Basin 4 Total Area = 687 ac
Contributing Area = 448 ac.

Soil Type #	Veg. Type	CN	Area (ac)
56	Sag.	63	31
104	Sag	70	2
18	Sag.	51	34
79	Sag.	63	1
87	Pin	80	202
45	Pin	80	24
88	Pin	80	48
23	Pin	73	80
75	Pin	80	26
		Total =	448 ac

Weighted CN:

$$\frac{(63\cdot31)+(70\cdot2)+(51\cdot34)+(63\cdot1)+(80\cdot202)+(80\cdot24)+(80\cdot48)+(73\cdot80)+(80\cdot26)}{448ac}$$

CN = 75

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PROJECT Pinon Ridge PROJECT NO. 89241
SUBJECT Mill Diversion Hydrology BY TRC DATE 7/23/08
REVIEWED BY CCL DATE 12/1/08

Length of Watercourse: 1.31 mi
6930 ft

Slope of Watercourse: Use Effective Slope Eqn. (UDFCD, 2001)

$L_1 = 4080$ ft
$S_1 = 0.33$ ft/ft

$L_2 = 2850$ ft
$S_2 = 0.04$ ft/ft

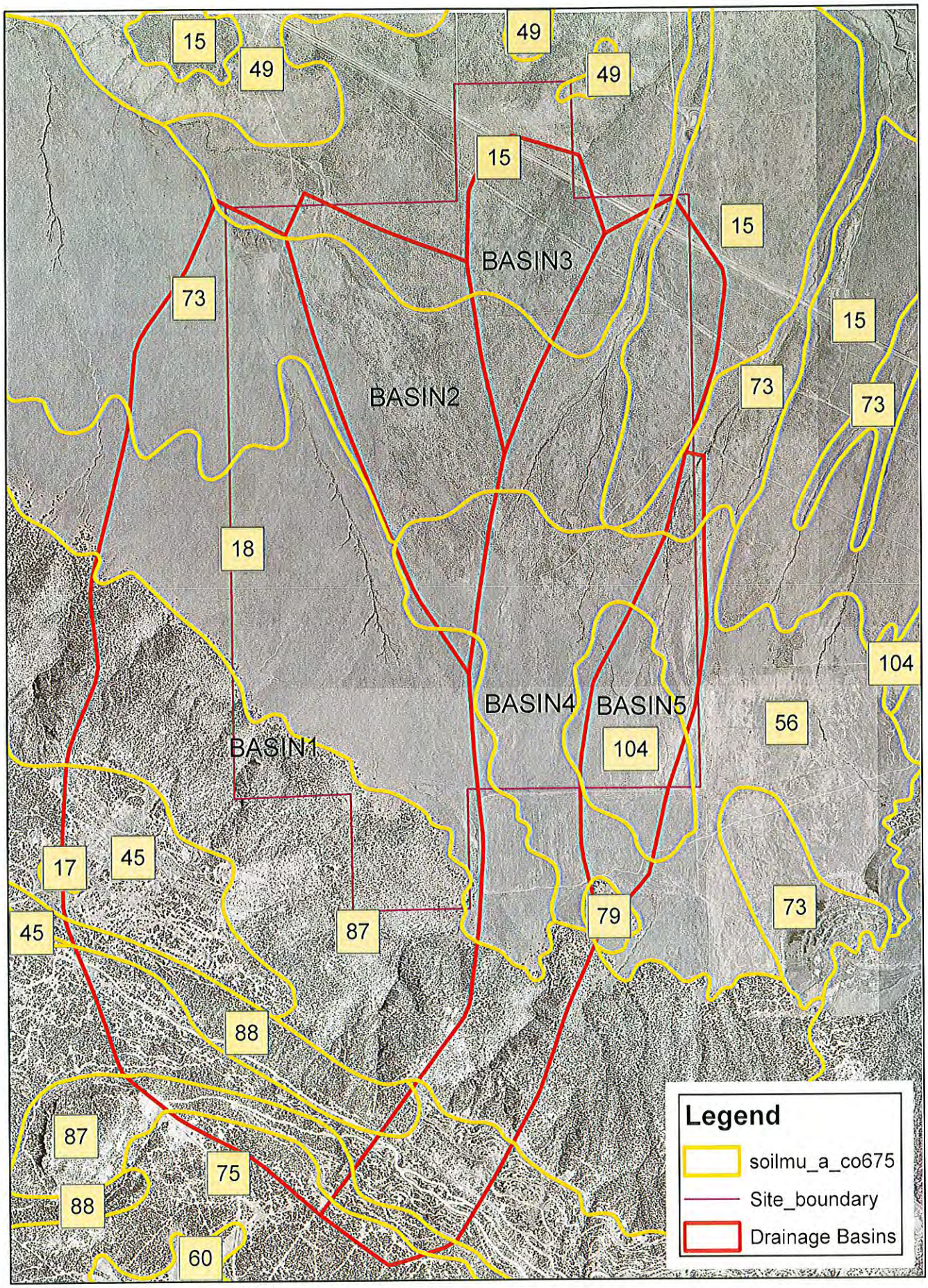
$$S_{eff} = \left[\frac{4080\,ft \cdot 0.33^{0.24}\,ft/ft + 2850\,ft \cdot 0.04^{0.24}\,ft/ft}{4080\,ft + 2850\,ft}\right]^{4.17} = 0.16$$

$$S_{eff} = 0.16\,ft/ft \times \frac{5280\,ft}{mi} = 827\,ft/mi$$

Distance to Centroid: Assume 1/2 distance of watercourse.

$$L_{ca} = 1.31\,mi/2 = 0.66\,mi$$

Lag Time: $$L_g = 26(0.07)\left[\frac{1.31\,mi \cdot 0.66\,mi}{827\,ft/mi^{0.5}}\right]^{0.33} = 0.57\,hrs$$



1 inch equals 1,500 feet

0 750 1,500 3,000 Feet

Pinon Ridge Basins Map
Drainage Alternative 1

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cor 12/1/08

ROCKY MOUNTAIN (THUNDERSTORM) UNIT HYDROGRAPH 23-Jul-08

Pinon Ridge Uranium Mill Site Diversion Alternative 1

Drainage Area =	0.28	sq. miles	Lg+D/2 =	0.59	Hours
Basin Slope =	888.00	ft./mile	Basin Factor =	0.03	
L =	1.25	mi., Length of Watercourse	V' =	7.53	cfs/Day
Lca =	0.63	mi., Distance to Centroid	Qs =	12.8	* q, cfs
Kn =	0.070	-, Ave. Weighted Manning's n			

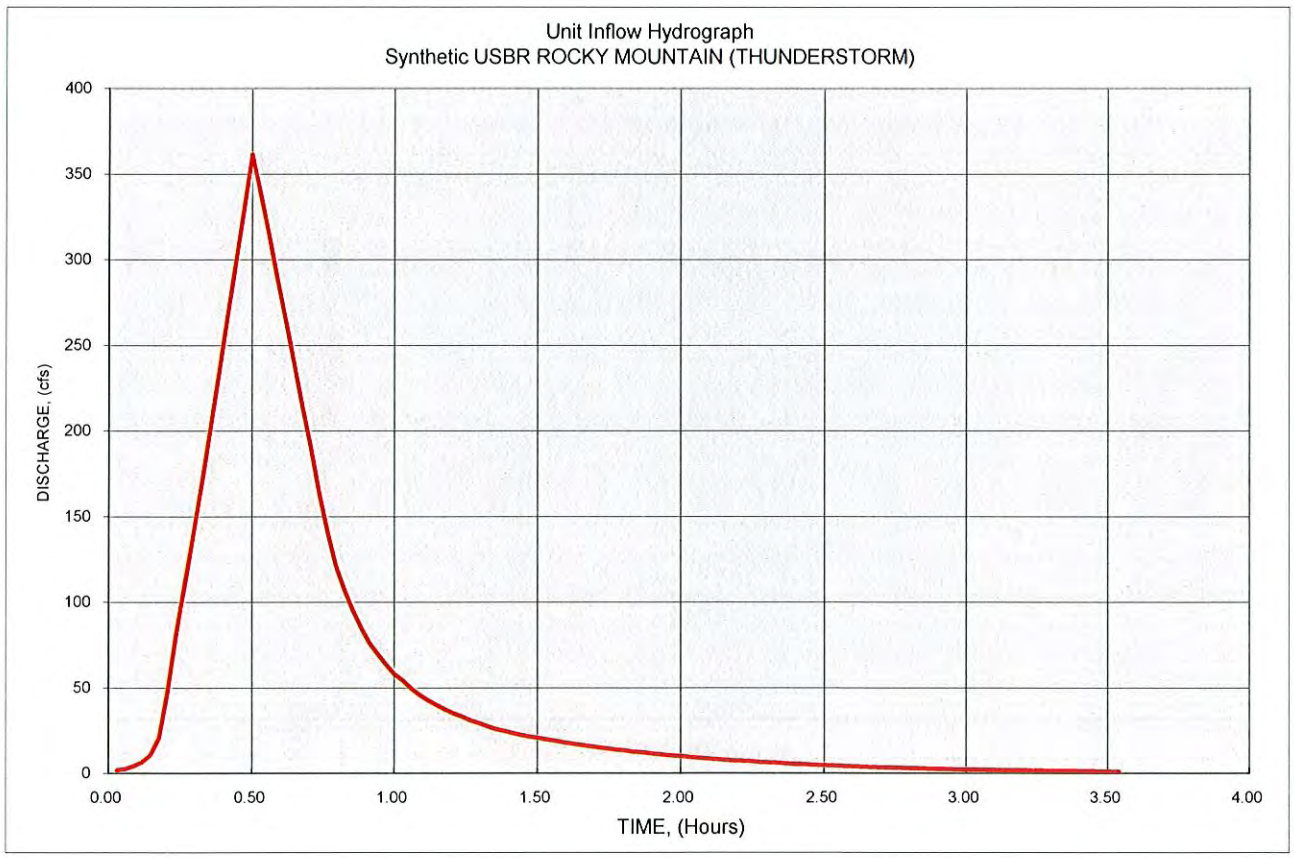
PARAMETERS:

Calculated: Lag Time, Lg = 0.55 Hours Unit Duration, D = 5.99 minutes

Calculated Timestep = 1.77 minutes

Data to be used in Analysis Unit Duration, D = 5 minutes, round down to nearest of 5, 10, 15, 30, 60, 120, 180, or 360

Selected Timestep = 5 minutes, integer value evenly divisible into 60



UI Record - Unit Graph 5 **minute interval**

UI	4	17	95	178	268	360	295	225	155	105
UI	76	59	47	39	33	27	23	21	18	16
UI	14	13	11	10	9	8	7	6	5	5
UI	4	4	3	3	3	2	2	2	2	2
UI	1	1								
UI										
UI										
UI										
UI										
UI										
UI										
UI										

USBR calculated unitgraph peak = 362 Interpolated Peak = 360

A

COL 12/1/03

ROCKY MOUNTAIN (THUNDERSTORM) UNIT HYDROGRAPH 23-Jul-08

Pinon Ridge Uranium Mill Site Diversion Alternative 2

Drainage Area =	0.70	sq. miles	Lg+D/2 =	0.61	Hours
Basin Slope =	827.00	ft./mile	Basin Factor =	0.03	
L =	1.31	mi., Length of Watercourse	V' =	18.82	cfs/Day
Lca =	0.66	mi., Distance to Centroid	Qs =	30.6	* q, cfs
Kn =	0.070	-, Ave. Weighted Manning's n			

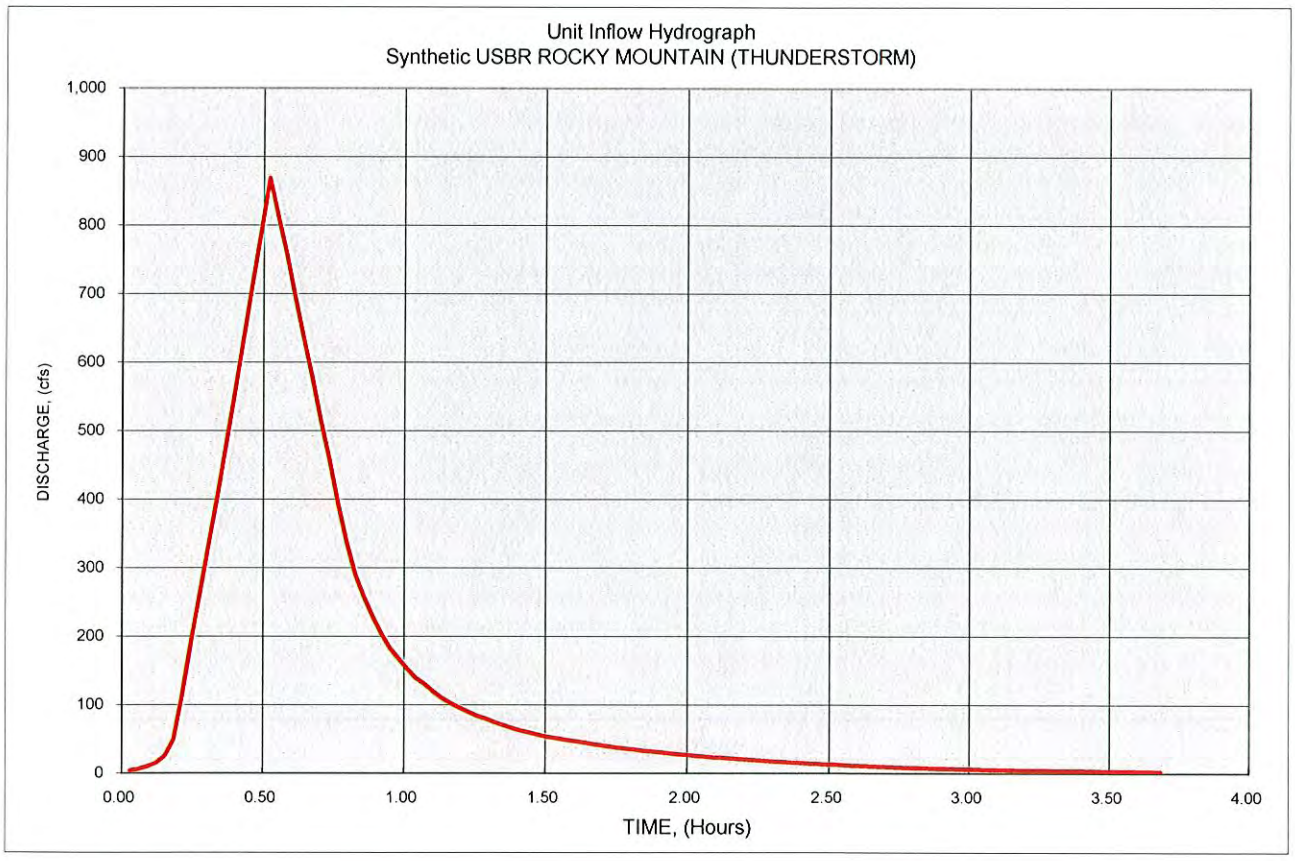
PARAMETERS:

Calculated: Lag Time, Lg = 0.57 Hours Unit Duration, D = 6.25 minutes

Calculated Timestep = 1.84 minutes

Data to be used in Analysis Unit Duration, D = 5 minutes, round down to nearest of 5, 10, 15, 30, 60, 120, 180, or 360

Selected Timestep = 5 minutes, integer value evenly divisible into 60



UI Record - Unit Graph 5 **minute interval**

UI	9	36	205	396	603	813	758	595	432	287
UI	209	159	127	102	86	73	62	54	48	43
UI	38	34	30	27	24	21	19	17	15	13
UI	12	10	9	8	7	7	6	5	5	4
UI	4	3	3	3						
UI										
UI										
UI										
UI										
UI										
UI										
UI										

USBR calculated unitgraph peak = 869 Interpolated Peak = 813

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1*****************************************
 *                                       *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
 *              JUN   1998               *
 *           VERSION 4.1                 *
 *                                       *
 *  RUN DATE   23JUL08  TIME  10:46:36   *
 *                                       *
 *****************************************
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*************************************
*                                   *
*    U.S. ARMY CORPS OF ENGINEERS   *
*    HYDROLOGIC ENGINEERING CENTER  *
*          609 SECOND STREET        *
*       DAVIS, CALIFORNIA 95616     *
*           (916) 756-1104          *
*                                   *
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X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X               X
XXXXXXX  XXXX     X        XXXXX  X
X     X  X        X               X
X     X  X        X     X         X
X     X  XXXXXXX   XXXXX         XXX
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THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1 HEC-1 INPUT PAGE 1

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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID   ENERGY FUELS - PINON RIDGE URANIUM MILL
  2           ID   PTOJECT NO. 89241
  3           ID   10 YEAR MILL DIVERSION DESIGN HYDROLOGY
  4           ID   ROCKY MOUNTAIN LOCAL STORM UNIT GRAPH  KN=0.07
  5           IT       5       0       0     300
  6           IO       5       1

  7           KK  A110
  8           KM   DRAINAGE ALTERNATIVE 1
  9           BA    0.28
 10           IN      60
 11           PB       0
 12           PC   0.022   0.044   0.070   0.096   0.128   0.160   0.196   0.240   0.294   0.362
 13           PC   0.470   1.362   1.544   1.640   1.700   1.760   1.796   1.832   1.868   1.904
 14           PC   1.928   1.952   1.976   2.000
 15           LS       0      70       5
 16           UI       4      17      95     178     268     360     295     225     155     105
 17           UI      76      59      47      39      33      27      23      21      18      16
 18           UI      14      13      11      10       9       8       7       6       5       5
 19           UI       4       4       3       3       3       2       2       2       2
              *

 20           KK  A210
 21           KM   DRAINAGE ALTERNATIVE 2
 22           BA    0.70
 23           LS       0      75       5
 24           UI       9      36     205     396     603     813     758     595     432     287
 25           UI     209     159     127     102      86      73      62      54      48      43
 26           UI      38      34      30      27      24      21      19      17      15      13
 27           UI      12      10       9       8       7       7       6       5       5       4
 28           UI       4       3       3       3
              *
              *
              *
 29           KM   100 YEAR MILL DIVERSION DESIGN HYDROLOGY

 30           KK  A1100
 31           KM   DRAINAGE ALTERNATIVE 1
 32           BA    0.28
 33           IN      60
 34           PB       0
 35           PC   0.033   0.066   0.105   0.144   0.192   0.240   0.294   0.360   0.441   0.543
 36           PC   0.705   1.989   2.316   2.460   2.550   2.640   2.694   2.748   2.802   2.856
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 37          PC   2.892   2.928   2.964   3.000
 38          LS       0      70       5
 39          UI       4      17      95     178     268     360     295     225     155     105
 40          UI      76      59      47      39      33      27      23      21      18      16
 41          UI      14      13      11      10       9       8       7       6       5       5
 42          UI       4       4       3       3       3       2       2       2       2
             *
1                                          HEC-1 INPUT                                          PAGE  2

LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 43          KK  A2100
 44          KM   DRAINAGE ALTERNATIVE 2
 45          BA    0.70
 46          LS       0      75       5
 47          UI       9      36     205     396     603     813     758     595     432     287
 48          UI     209     159     127     102      86      73      62      54      48      43
 49          UI      38      34      30      27      24      21      19      17      15      13
 50          UI      12      10       9       8       7       7       6       5       5       4
 51          UI       4       3       3       3
             *
             *
             *
 52          KM   1000 YEAR MILL DIVERSION DESIGN HYDROLOGY

 53          KK  A11000
 54          KM   DRAINAGE ALTERNATIVE 1
 55          BA    0.28
 56          IN      60
 57          PB       0
 58          PC   0.000   0.049   0.097   0.155   0.213   0.284   0.354   0.434   0.532   0.651
 59          PC   0.802   1.041   2.937   3.420   3.633   3.766   3.898   3.978   4.058   4.138
 60          PC   4.217   4.271   4.324   4.377   4.430
 61          LS       0      70       5
 62          UI       4      17      95     178     268     360     295     225     155     105
 63          UI      76      59      47      39      33      27      23      21      18      16
 64          UI      14      13      11      10       9       8       7       6       5       5
 65          UI       4       4       3       3       3       2       2       2       2
             *

 66          KK  A21000
 67          KM   DRAINAGE ALTERNATIVE 2
 68          BA    0.70
 69          LS       0      75       5
 70          UI       9      36     205     396     603     813     758     595     432     287
 71          UI     209     159     127     102      86      73      62      54      48      43
 72          UI      38      34      30      27      24      21      19      17      15      13
 73          UI      12      10       9       8       7       7       6       5       5       4
 74          UI       4       3       3       3
 75          ZZ
1*****************************************                                  ****************************************
*                                         *                                  *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)     *                                  *   U.S. ARMY CORPS OF ENGINEERS       *
*              JUN   1998                 *                                  *   HYDROLOGIC ENGINEERING CENTER      *
*            VERSION 4.1                  *                                  *          609 SECOND STREET           *
*                                         *                                  *       DAVIS, CALIFORNIA 95616        *
*  RUN DATE   23JUL08  TIME  10:46:36     *                                  *          (916) 756-1104              *
*                                         *                                  *                                      *
*****************************************                                  ****************************************

                        ENERGY FUELS - PINON RIDGE URANIUM MILL
                        PTOJECT NO. 89241
                        10 YEAR MILL DIVERSION DESIGN HYDROLOGY
                        ROCKY MOUNTAIN LOCAL STORM UNIT GRAPH  KN=0.07

   6 IO          OUTPUT CONTROL VARIABLES
                       IPRNT           5  PRINT CONTROL
                       IPLOT           1  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE

     IT          HYDROGRAPH TIME DATA
                        NMIN           5  MINUTES IN COMPUTATION INTERVAL
                       IDATE      1    0  STARTING DATE
                       ITIME        0000  STARTING TIME
                          NQ         300  NUMBER OF HYDROGRAPH ORDINATES
                      NDDATE      2    0  ENDING DATE
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4/

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NDTIME        0055  ENDING TIME
ICENT           19  CENTURY MARK

COMPUTATION INTERVAL     .08 HOURS
    TOTAL TIME BASE    24.92 HOURS

ENGLISH UNITS
     DRAINAGE AREA          SQUARE MILES
     PRECIPITATION DEPTH    INCHES
     LENGTH, ELEVATION      FEET
     FLOW                   CUBIC FEET PER SECOND
     STORAGE VOLUME         ACRE-FEET
     SURFACE AREA           ACRES
     TEMPERATURE            DEGREES FAHRENHEIT
1
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RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	A110	20.	11.33	7.	2.	2.	.28		
+	HYDROGRAPH AT	A210	80.	11.33	24.	8.	8.	.70		
+	HYDROGRAPH AT	A1100	58.	11.33	18.	6.	6.	.28		
+	HYDROGRAPH AT	A2100	193.	11.25	60.	20.	19.	.70		
+	HYDROGRAPH AT	A11000	137.	12.25	41.	13.	13.	.28		
+	HYDROGRAPH AT	A21000	412.	12.25	125.	40.	38.	.70		

*** NORMAL END OF HEC-1 ***

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PROJECT Pinon Ridge PROJECT NO. 89241
SUBJECT Mill Diversion Design BY TKL DATE 7/23/08
REVIEWED BY CLA DATE 12/1/08

HEC-1 Model Results:

Peak Flows (cfs)

	10yr	100yr	1000yr
Alternative 1	20	58	137
Alternative 2	80	193	412

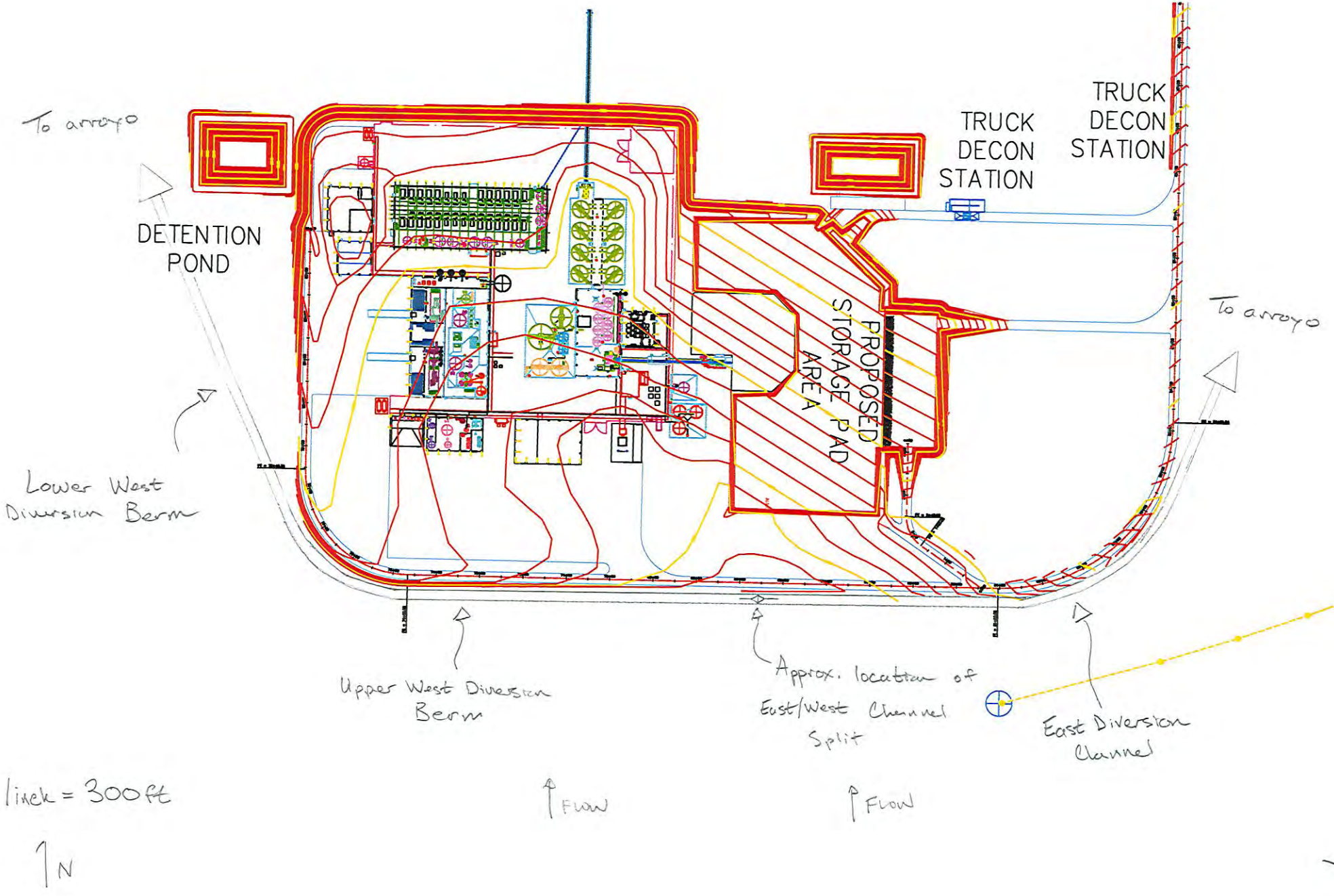
Alternative 2 > Alternative 1 Flows ∴ Use Alternative 2 as design flows

Divide design flows in half, diverting drainge equally to the West and East of the mill area

Ditch / Berm Design Flows

100 yr = 97 cfs
1,000 yr = 206 cfs

General Locations of Diversion Channels



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PROJECT Pinon Ridge PROJECT NO. 89241
SUBJECT Mill Diversion Design BY TKK DATE 7/28/08
REVIEWED BY CCL DATE 12/1/08

Objective: Determine size of diversion berm for drainage to East and West.

- Design for 100-yr flow of 97cfs with freeboard and 1,000-yr flow of 206 cfs at bank full conditions. Diversion berm will start at road station 67+50 and run West, following general alignment and slope of road.
- Natural upstream slope approximately 4.5%
- Maximum berm slope of 3H:1V on North and South side of berm.
- Assume natural soil channel with minimal vegetation for typical section. Maximum allowable velocity for channel is approx. 3 fps. w/o riprap protection.

velocity does not exceed the values of permissible velocity shown in Table 3.2.

Table 3.2 Limiting Velocities and Tractive Forces for Open Channels. (Straight after Aging)

Material	n	For Clear Water: Velocity, fps	For Clear Water: Tractive Force, psf	Water Transporting Colloidal Silts: Velocity, fps	Water Transporting Colloidal Silts: Tractive Force, psf
Fine sand colloidal	0.020	1.50	0.027	2.50	0.075
Sandy loam noncolloidal	0.020	1.75	0.037	2.50	0.075
Silt loam noncolloidal	0.020	2.00	0.048	3.00	0.110
Alluvial silts noncolloidal	0.020	2.00	0.048	3.50	0.150
Ordinary firm loam	0.020	2.50	0.075	3.50	0.150
Volcanic ash	0.020	2.50	0.075	3.50	0.150
Stiff clay very colloidal	0.025	3.75	0.260	5.00	0.460
Alluvial silts colloidal	0.025	3.75	0.260	5.00	0.460
Shales and hardpans	0.025	6.00	0.670	6.00	0.670
Fine gravel	0.020	2.50	0.075	5.00	0.320
Graded loam to cobbles when noncolloidal	0.030	3.75	0.380	5.00	0.660
Graded silts to cobbles when colloidal	0.030	4.00	0.430	5.50	0.800
Coarse gravel noncolloidal	0.025	4.00	0.300	6.00	0.670
Cobbles and shingles	0.035	5.00	0.910	5.50	1.100

From Lane (1955).

When using the limiting tractive force concept, a channel with adequate capacity and having an average shear stress τ given by equation 3.18 that is less than the values tabulated in Table 3.2 is sought. For channels in noncohesive materials, the particles on the channel sides may move due to the combined force exerted by the flowing water and the weight component of the particles down the side of the channel. Chow (1959) should be referred to for a treatment of tractive force considerations and noncohesive materials. In cohesive materials, the cohesion generally is much greater than the gravity component so that average shear based on equation 3.18 can be used in design.

Applied Hydrology and Sedimentology for Disturbed Areas
Barfield, et al., 1981

EXAMPLE PROBLEM 3.3

Design a channel to carry 20 cfs down a 0.5% slope. The channel m is to be an ordinary firm loam. The water will be transporting colloidal silt channel is to be trapezoidal with 3:1 side slopes. Use (a) the limiting ve approach and (b) the limiting tractive force approach.

Solution:

(a) From Table 3.2 $V_p = 3.5$ fps, $n = 0.020$

$$V_p = \frac{1.49}{n} R^{2/3} S^{1/2}$$

$$R = \left[\frac{V_p n}{1.49 S^{1/2}}\right]^{3/2} = \left[\frac{3.5\,(.020)}{1.49\sqrt{.005}}\right]^{3/2} = 0.54$$

$$A = Q/V_p = \frac{20.00}{3.5} = 5.71$$

$$R = \frac{bd + zd^2}{b + 2d\sqrt{z^2+1}} = \frac{bd + 3d^2}{b + 6.32\,d} = 0.54$$

$$A = bd + zd^2 = bd + 3d^2 = 5.71$$

Substituting equation (b) into equation (a) yields

$$\frac{5.71}{b + 6.32\,d} = 0.54$$

or

$$b = 10.58 - 6.32\,d$$

Substituting this into equation (b) yields

$$(10.58 - 6.32\,d)\,d + 3d^2 = 5.71$$

$$-3.32\,d^2 + 10.58\,d - 5.71 = 0.00$$

This is a quadratic equation of the form

$$ax^2 + bx + c = 0$$

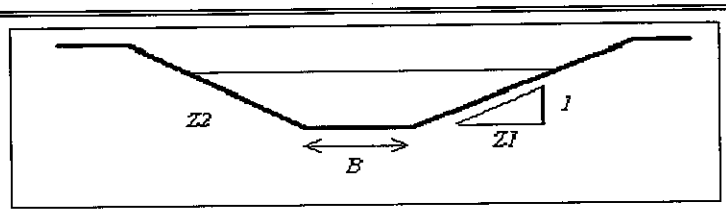
which has as a solution

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

WEST BERM

RATING CURVE FOR TRAPEZOIDAL CHANNEL

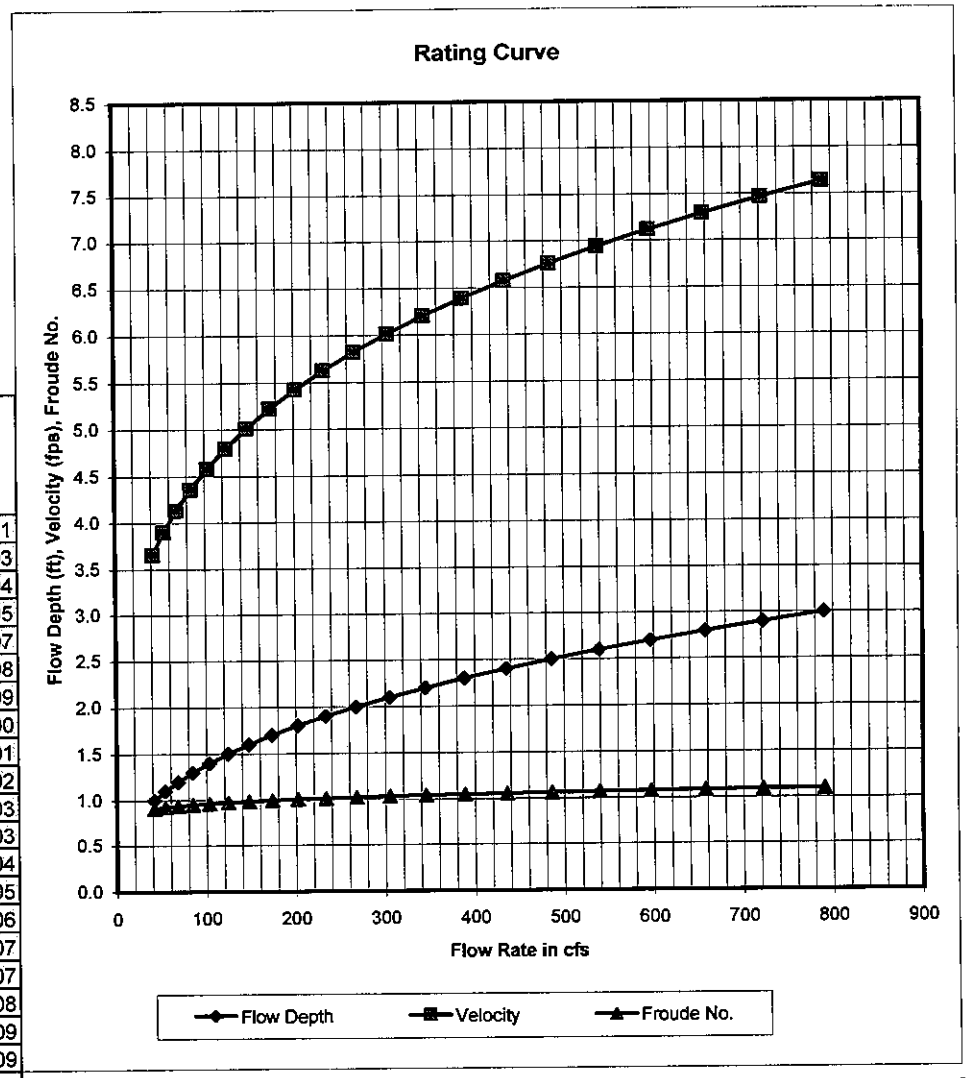
RATING CURVE FOR TRAPEZOIDAL CHANNEL



Bottom Width	B =	0.00	feet
Left Side Slope	Z1 =	3.00	ft/ft
Right Side Slope	Z2 =	20.00	ft/ft
Manning's n	n =	0.035	
Longitudinal Slope	S =	0.0190	ft/ft

Flow Depth Y (ft)	Flow Area A (sq ft)	Wetted Perimeter P (ft)	Hydraulic Radius R (ft)	Flow Velocity V (fps)	Flow rate Q (cfs)	Froude Number Fr
1.00	11.50	23.19	0.50	3.7	42.1	0.91
1.10	13.92	25.51	0.55	3.9	54.3	0.93
1.20	16.56	27.82	0.60	4.1	68.5	0.94
1.30	19.44	30.14	0.64	4.4	84.8	0.95
1.40	22.54	32.46	0.69	4.6	103.3	0.97
1.50	25.88	34.78	0.74	4.8	124.2	0.98
1.60	29.44	37.10	0.79	5.0	147.6	0.99
1.70	33.24	39.42	0.84	5.2	173.5	1.00
1.80	37.26	41.74	0.89	5.4	202.1	1.01
1.90	41.52	44.06	0.94	5.6	233.5	1.02
2.00	46.00	46.37	0.99	5.8	267.7	1.03
2.10	50.72	48.69	1.04	6.0	305.0	1.03
2.20	55.66	51.01	1.09	6.2	345.3	1.04
2.30	60.84	53.33	1.14	6.4	388.9	1.05
2.40	66.24	55.65	1.19	6.6	435.7	1.06
2.50	71.88	57.97	1.24	6.8	485.8	1.07
2.60	77.74	60.29	1.29	6.9	539.5	1.07
2.70	83.84	62.61	1.34	7.1	596.6	1.08
2.80	90.16	64.92	1.39	7.3	657.5	1.09
2.90	96.72	67.24	1.44	7.5	722.1	1.09
3.00	103.50	69.56	1.49	7.6	790.5	1.10

1000 yr → y=1.35



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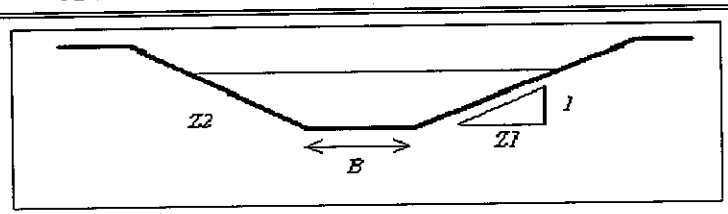
EAST CHANNEL

RATING CURVE FOR TRAPEZOIDAL CHANNEL

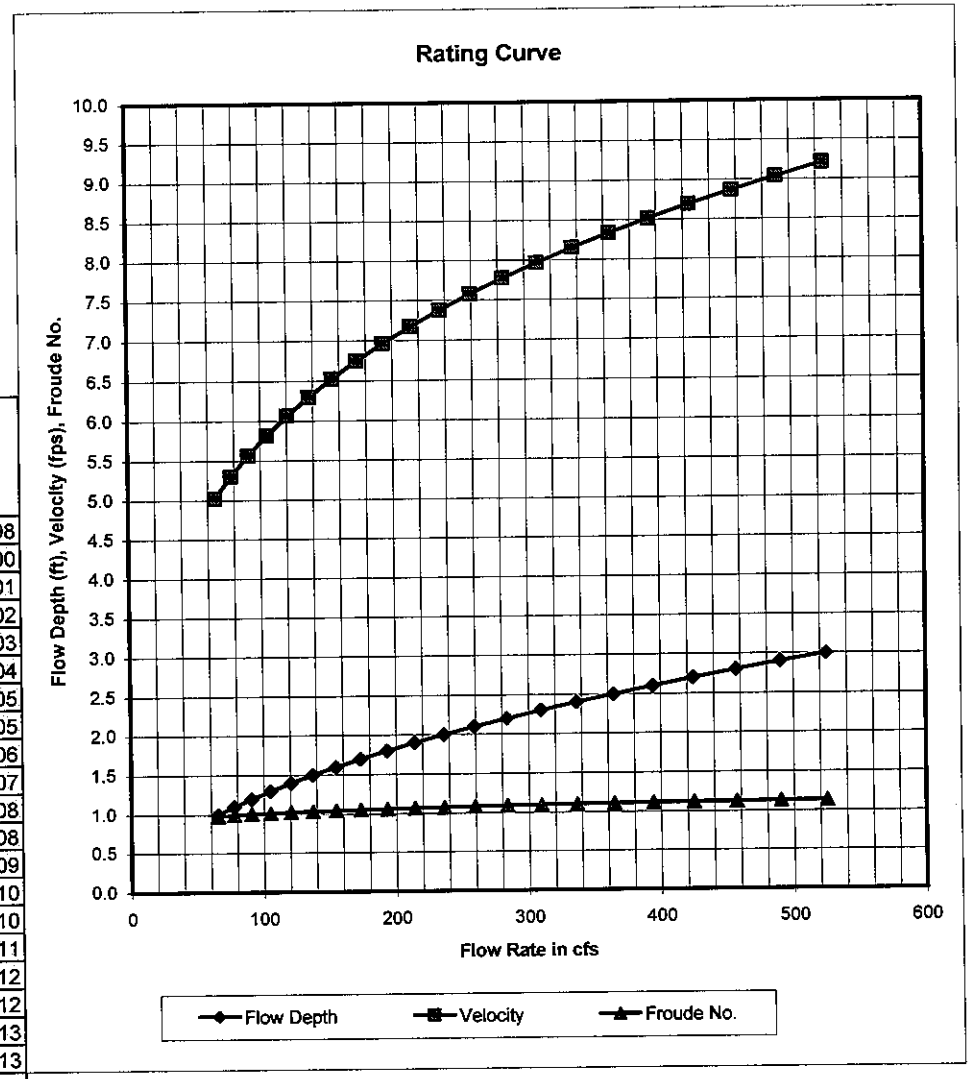


Bottom Width	B =	10.00	feet
Left Side Slope	Z1 =	3.00	ft/ft
Right Side Slope	Z2 =	3.00	ft/ft
Manning's n	n =	0.035	
Longitudinal Slope	S =	0.0190	ft/ft

Flow Depth Y (ft)	Flow Area A (sq ft)	Wetted Perimeter P (ft)	Hydraulic Radius R (ft)	Flow Velocity V (fps)	Flow rate Q (cfs)	Froude Number Fr
1.00	13.00	16.32	0.80	5.0	65.3	0.98
1.10	14.63	16.96	0.86	5.3	77.6	1.00
1.20	16.32	17.59	0.93	5.6	90.8	1.01
1.30	18.07	18.22	0.99	5.8	105.2	1.02
1.40	19.88	18.85	1.05	6.1	120.5	1.03
1.50	21.75	19.49	1.12	6.3	137.0	1.04
1.60	23.68	20.12	1.18	6.5	154.6	1.05
1.70	25.67	20.75	1.24	6.7	173.2	1.05
1.80	27.72	21.38	1.30	7.0	193.0	1.06
1.90	29.83	22.02	1.35	7.2	214.0	1.07
2.00	32.00	22.65	1.41	7.4	236.1	1.08
2.10	34.23	23.28	1.47	7.6	259.4	1.08
2.20	36.52	23.91	1.53	7.8	283.8	1.09
2.30	38.87	24.55	1.58	8.0	309.5	1.10
2.40	41.28	25.18	1.64	8.2	336.4	1.10
2.50	43.75	25.81	1.69	8.3	364.6	1.11
2.60	46.28	26.44	1.75	8.5	394.1	1.12
2.70	48.87	27.08	1.80	8.7	424.8	1.12
2.80	51.52	27.71	1.86	8.9	456.9	1.13
2.90	54.23	28.34	1.91	9.0	490.2	1.13
3.00	57.00	28.97	1.97	9.2	524.9	1.14

1,000 yr Flow

RATING CURVE FOR TRAPEZOIDAL CHANNEL



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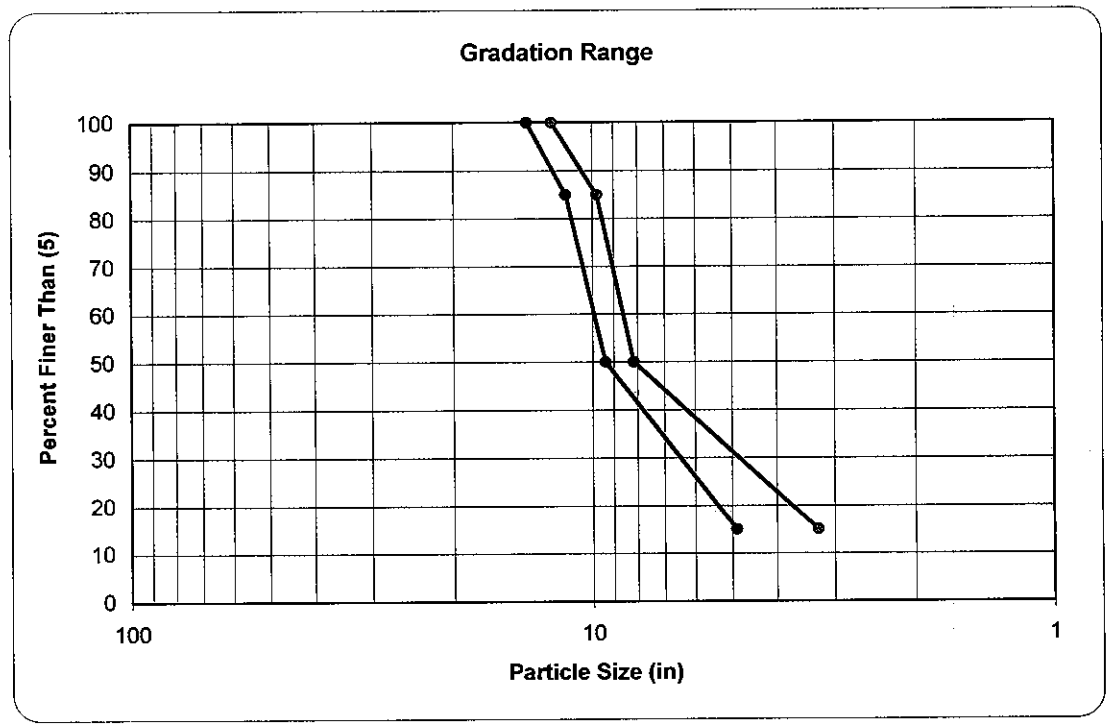
Riprap Size Determination
Based on HEC NO. 11 - Design of Riprap Revetment
Pinon Ridge Mill Diversion Channel

S_f =	1		Safety Factor	
C_{sg} =	1.39		Specific Gravity Coefficient	Equation (8) HEC No. 11
C_{sf} =	1.33		Stability Factor Coefficient	Based on Suggestions in Section 4.1.1.2 HEC No. 11
C =	1.85		Composite Coefficient	
R =	200	ft	Bend Radius	
W =	10	ft	Channel Width	
d =	2	ft	Flow Depth	
γ_w =	62.4	lb/ft^3	Unit Weight of Water	
γ_s =	145	lb/ft^3	Unit Weight of Stone	
V =	7.5	ft/s	Depth-Averaged Velocity	
Z =	3		ZH:1V Side Slope	
φ =	40	deg	Angle of Repose for Riprap	
θ =	18	deg	Angle of Side Slope	
K_1 =	0.87		Side Slope Correction Factor	
D_{50} =	0.68	ft	Grain Size	

$D_{50} \approx 9''$

Gradation		
Percent Finer Than	Particle Size (in)	
	Max	Min
100	14	12
85	11	10
50	9	8
15	5	3



12/1/08

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PROJECT Pinon Ridge PROJECT NO. 89241
SUBJECT Mill Diversion Design BY TR DATE 7/22/08
REVIEWED BY COL DATE 7/1/08

General Design Recommendations

* Use riprap lined channel w/ d_{50} = 9" for East diversion channel and face of West berm.

* All riprap layer thicknesses should be 2 D_{50}. All riprap sections should have drainage filter layer;

4" Type I CDOT
4" Type II CDOT
(UDFCD MD-66, 2001)

* Channels will follow the general alignment of the site access road until the terminate into natural drainages.