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MINE ENGINEERING **CIVIL ENGINEERING**
MINE RECLAMATION **CONST. MANAGEMENT**

January 13, 2021

Rob Zuber
Division of Reclamation, Mining & Safety
1313 Sherman St., Room 215
Denver, CO 80203

Re: Bowie No. 2 Mine, Permit C-1996-083,
Technical Revision Number 122 (TR-122),
Adequacy Response #1

Dear Mr. Zuber:

DRMS' letter dated December 21, 2020 transmitted its adequacy review for the referenced technical revision. On behalf of Bowie Resources, LLC following are its responses to the DRMS's comments and concerns.

Adequacy Items

1. **DRMS:** In Volume III, page EXH 8-29I (possibly, it should be 8-29i), it appears that the page numbers referencing the SEDCAD model are not correct. Please check this and revise as appropriate.

BRL: Please see revised **Page EXH 8-29i**. The page references have been updated, and the page corrected to EXH 8-29i, and the revision number has been added to the page.

2. **DRMS:** In Volume XI, page 5 states that a 10-year storm will generate 2.9 acre feet of runoff from the Pond J watershed. This appears to be incorrect per page B-4 of Appendix B in the TR-122 submittal; the total runoff volume on B-4 is 3.03 acre feet. Please address this by changing the text on this page, or explain the apparent discrepancy in your adequacy response.

   BRL: Please see revised **Volume XI, page 5** as well as the runoff has been updated on **Map 22-J.**

3. **DRMS:** Within the text of Volume XI (mostly likely on page 6), additional explanation should be added. While the underdrain design proposed with TR-122 does address seepage from the Fire Mountain Canal, additional text should state that this water control system will also control other potential sources of groundwater around Gob Pile #3. In particular, it should explain why the east side of the gob pile does not require an underdrain such as the one that is constructed under the west side of the pile.

BRL: Please see explanation beginning on **page 6**.

4. **DRMS:** While reviewing the text in Volume XI, some issues on page 6 came to light. The text on this page discusses a "three feet wide by one feet wide drain for the East subdrainage system." There appear to be typographical errors in this phrase. Also, this appears to contradict page 7, which states that the cross-section is four square feet.

BRL: The cross section will be 4 square feet. Please see revised **page 7.**

5. **DRMS:** The four-square feet on page 7 of Volume XI text also appears to contradict page 4b of this same volume. The figure on page 4b (Gob Pile #3 Drying/Placement Location Operational Sedimentation Control Plan) shows the typical section as two feet by one foot. Please address this apparent discrepancy.

BRL: Please see revised **Page 4b**, the underdrain will be four square feet.

6. **DRMS:** On page 7 of Volume XI there appears to be an error. Perhaps the value of 9.6 cubic feet per minute should be 64. Please check this and revise as appropriate. Also, the reference is listed twice but only needs to be listed once.

BRL: Please see revised **page 7**.

7. **DRMS:** On pages B-5 and B-6 (Appendix B) the flow over the pond spillway is 45.4 cfs. On page B-51 (SEDCAD for the 25-year event) the peak discharge is 67.7 cfs. Please discuss if/how these two flows are related, and edit the text or SEDCAD as necessary.

BRL: The discrepancy comes from the error of at one time running a 25-year 6-hour event (67.7 cfs). The correct event is the 25-year 24-hour event which generates the correct flow of 45.4 cfs. Please see revised pages **Volume XI, App. B-51 through B-53.**

8. **DRMS:** On pages B-5 and B-6 (Appendix B) the width of the spillway is listed as 8 feet. In Map 22-J, however, the bottom width is 5 feet. Please check this and revise as appropriate.

BRL: The correct width is 8'. Please see revised **Map 22-J.**

9. **DRMS:** Please discuss in your response letter (and update any submitted pages, as appropriate) the construction plans for ditches, given some discrepancies. Ditch D-1 and Ditch D-2 are examples. Within the table on page B-2 (operations summary of ditches and culverts), these ditches are listed as V-shaped ditches, but in the SEDCAD model they are trapezoidal ditches with a 10-foot bottom (D-1) and a 5-foot bottom (D-2).

BRL: Please see revised pages **Volume XI, page App. B-29 & 30.**

10. **DRMS:** There is a discrepancy with the design flow for Ditch J7. It is 32.6 cfs in the summary table but 30.86 cfs in SEDCAD. Please address this. Also, the summary table may have errors for Ditch J21 (the type and bottom width are not clear.

BRL: Inexplicably, the flow for Ditch J7 is 32.6 on the structure summary page (App. B-12), but 30.86 on the structure detail page. The same is the case for Culvert J3. Please see revised pages **App. B-22 and B-34**. The design for Ditch J21 should have been a V-Ditch. Please see revised pages **App. B-66 and App. B-2.**

11. **DRMS:** Please explain some possible errors in the SEDCAD pages for the 25-year event. On page B-48 the design storm is described as a 24-hour event, but on page B-49 it is said to be a 6-hour event.

BRL: The design even is a 25-year, 24-hour event. Please see revised **page B-51**.

12. **DRMS:** Please explain why pages in the SEDCAD models appear to be mixed together for different model runs. For example, pages B-54 and B-55 have "25-year" in the footer, but they are in the section for the 100-year model.

BRL: The 25-year pages were inadvertently inserted into the 100-year SEDCAD run. They have been removed and replaced with the 100-year structure summary pages. Please see revised **pages App. B-56 & 57.**

The following adequacy items relate to maps. Please check that other related maps also address the items. For example, culverts and ditches on Map 20 should match their counterparts on Maps 21-1 through 21-4.

13. **DRMS:** On Map 15-3 the sediment control BMP near the Filter Building may be located incorrectly (perhaps it should be north of Deer Trail Ditch). Please check this and revise as appropriate.

BRL: Please see revised **Map 15-3**.

14. Map 20 does not clearly show the method for conveying flow from ditch J11 to culvert J4. Please revise the map to show this. Also, there are two "C-J4" labels, and this appears to be an error.

BRL: Please see revised **Maps-20, 21-3 and 15-3.**

15. **DRMS:** Map 20 does not show culvert J9 crossing the Fire Mountain Canal. Please revise the map.

BRL: Please see revised **Map-20** and **Maps 15-3 and 21-3** as those maps did not clearly show Culvert J9 crossing the FMC either.

16. **DRMS:** Map 20 does not clearly show the method for conveying flow from culvert D2 to culvert J9 (over the Deer Trail Ditch and across a slope). Please revise the map to show this.

BRL: BRL was able to locate in the field the flow path from Culvert D2 to Culvert J9. The culvert currently labeled as D2 is likely a CDOT culvert and should not have been included in the site hydrology. The correct culvert D2 was discovered in the field, and is to the East of what is currently labeled culvert D2. Flow from the revised location of Culvert D2 will flow into a newly discovered culvert (New Culvert J20), and culvert J20 will flow into Culvert J9. There are a series of small connecting ditches that have not been named or incorporated into the design due to their small size in nature. **Maps 20, 15-1 and 15-3** have been revised. In addition, new Culvert J20 has been included in the site hydrology. Please see **page App. B-42.** Due to the number of pages that will be impacted with the addition of a new culvert, the entirety of **Appendix B** has

been renumbered and included as part of this adequacy response. Culvert J20 has been included on **page App. B-2 and Map 22-J**

17. **DRMS:** Map 20 does not indicate the route of flow the leaves Pond C. It is not clear if this flow enters the Pond J system or not. Please revise the map to make this clearer.

BRL: The flow from Pond C is shown on Maps 20, 15-1 and 21-1. The primary spillway is a series of pipes that flow from the embankment of pond C to the emergency spillway of Pond D. "Dewatering Pipe" is annotated on both maps 15-1 and 21-1 and will now be on revised Map 20. If Pond C discharges over the emergency spillway, the flow would be conveyed via Ditch D1 to Culvert C1.

18. **DRMS:** On Map 22-J the word "Emergency" is misspelled. This should be edited if other changes are made to this map.

BRL: Please see revised **Map-22-J**

Please let me know if you have any questions.

Sincerely,

Tamme Bishop

Tamme Bishop, P.E.
Project Engineer

Enclosures:
Volume II: Maps 15-1, 15-3, 20, 21-1, 21-3 & 22-J
Volume III: Page Exh. 8-29i
Volume XI: Text pages 4b through 8, Appendix B Pages App. B-2 through 80

Cc via email: Basil Bear, Bowie Resources, LLC

APPENIDX B - **OPERATIONS**

Summary Coal Mine Waste Disposal Area Ditches and Culverts

Ditch		DITCH TYPE	MAX GRADE	BOTTOM WIDTH (ft.)	DITCH DEPTH (ft.)	RIP RAP (in.)	Design Event	Peak Flow (cfs)	Design Flow (cfs)
	i1	TRAP.	1.0%	1.0	0.5	-	10-Year	0.6	0.6
	i2	DELTED FROM DESIGN							
	J1	V-DITCH	1.2%	-	1.0	-	10-Year	1.8	1.8
	J2	*DELETED FROM DESIGN (TR-91)*							
	J3	TRAP.	0.6%	3.0	2.3	-	100-Year	60.9	60.9
	J4	V-DITCH	0.1%	-	3.4	-	10-Year	32.6	32.6
	J5	V-DITCH	0.1%	-	1.0	-	10-Year	0.7	0.7
	J6	V-DITCH	0.1%	-	1.0	-	10-Year	0.5	0.5
	J7	V-DITCH	33.0%	-	1.7	9.0	10-Year	32.6	32.6
	J8	TRAP.	0.7%	3.0	0.5		100-Year	1.3	1.3
	J9	TRAP.	11.0%	3.0	1.3	15.0	100-Year	15.5	15.5
	J10	TRAP.	1.0%	3.0	2.2	-	100-Year	27.2	27.2
	J11	TRAP.	8.0%	3.0	1.6	18.0	100-Year	34.4	34.4
	J11 Optional	1/2 Cluvert	8.0%		1.1		100-Year	11.0	11.0
	J12	V-DITCH	2.0%	-	0.7	-	100-Year	5.5	5.5
	J13	V-DITCH	2.0%	-	0.7	-	100-Year	5.6	5.6
	J14	V-DITCH	5.0%	-	0.8	-	10-Year	1.4	1.4
	J15	V-DITCH	10.0%	-	0.6	-	10-Year	0.8	0.8
	J16	V-DITCH	10.0%	-	0.5	-	10-Year	0.3	0.3
	J17	V-DITCH	10.0%	-	1.3	-	10-Year	0.4	0.4
	J18	V-DITCH	15.0%	-	1.1	9.0	10-Year	0.8	0.8
	J19	V-DITCH	30.0%	-	1.1	9.0	10-Year	0.5	0.5
	J20	*DELETED FROM DESIGN (TR-122)*							0.0
	D-J21	1.0%	1.0%		2.2	-	100-Year	7.3	7.3
	W. Div. Ditch #1	V-DITCH	5.0%	-	0.5	-	100-Year	9.2	9.2
	Ditch-D1	TRAP.	8.0%	10.0	0.5		10-Year	7.9	7.9
	Ditch D-2	V-DITCH	3.0%	-	1.3	-	10-Year	9.6	9.6
	Ditch E-1	V-DITCH	2.0%	-	0.5	-	10-Year	1.7	1.7
	Coverfill SAE to CW 1% Seg.	V-DITCH	1.0%		0.8		10-Year	0.9	0.9

*Culvert:									
J1	24"						10-Year	21.4	31.4
J2	24"						10-Year	32.6	32.6
J3	12"						10-Year	1.2	1.2
J4	30"						100-Year	34.4	34.4
J5	12"						10-Year	0.3	0.3
J6	12"						10-Year	0.4	0.4
J7	12"						10-Year	0.8	0.8
J8	24"						100-Year	7.2	7.2
J9	Double barrel 24"						100-Year	25.2	25.2
J10	24" *(temporary)*						100-Year	4.9	4.9
J11	1/2 30" Optional						100-Year	11.0	11.0
J12	12"						10-Year	0.8	0.8
J13	12"						10-Year	2.4	2.4
J14	12"						10-Year	2.4	2.4
J15	30" Half Culvert						10-Year	2.4	2.4
J16	18" *(Temporary)*						100-Year	11.0	11.0
J17	*Intenionally left blank*						100-Year		
J18	24"						100-Year	7.3	7.3
J19	18"						100-Year	15.5	15.5
J20	24"						10-Year	9.6	9.6
D1	18"						10-Year	9.6	9.6
D2	24"						10-Year	9.6	9.6

* Culvert size is minimum size

Flow depth includes freeboard.

APPENDIX B
OPERATIONS CONFIGURATION
BOWIE NO. 2 MINE

PROTECTION OF THE HYDROLOGIC BALANCE
GOB PILE NO. 3

STORM EVENTS

10 YEAR 24 HOUR EVENT	1.8 INCHES
25 YEAR 24 HOUR EVENT	2.1 INCHES
100 YEAR 24 HOUR EVENT	2.6 INCHES

The information presented for peak flow calculations is developed with the use of SEDCAD. The output from SEDCAD follows is summarized on the ditch design sheets.

The upland run-off areas are shown on Map No. 20. The run-off curve numbers are developed based upon vegetation and soil types. Vegetation data is presented in Exhibit 5 and shown on Map 3. Soils data are presented in Exhibit 7 and shown on Map 4. Drainage plans are shown on Maps 21 1/4 & 3/4.

There are three soil types that will be disturbed at the loadout. They are Work, Progresso and Potts loam. Work and Progresso are soil type C and Potts is a soil type B. The C soil type will be used for the run-off calculations.

The vegetation study for the loadout is located in Volume III Tab 5. Cover data for the vegetation types is presented in Table I in the vegetation study.

Disturbed

Table 2-2c-Runoff curve numbers for arid and semiarid rangelands

Cover Type - Herbaceous-mixture of grass, weeds brush	
Hydrologic Condition	Fair
Soil Type - Loam	C
Curve Number	81

Disturbed

Table 2-2d-Runoff curve numbers for arid and semiarid rangelands

Cover Type - Brush-weeds-grass mixture with brush major element	
Hydrologic Condition	Fair
Soil Type - Loam	C
Curve Number	70

Disturbed

Table 2-2d-Runoff curve numbers for arid and semiarid rangelands

Cover Type - Herbaceous-mixture of grass, weeds brush	
Hydrologic Condition	Good
Soil Type - Loam	C
Curve Number	74

Disturbed

Table 2-2a-Runoff curve numbers for urban areas

Gravel - including right-of-way	
Soil Type - Loam	Fair
Curve Number	C
Curve Number	89

Disturbed

Table 2-2a-Runoff curve numbers for urban areas
Dirt - including right-of-way
Soil Type - Loam C
Curve Number 87

Disturbed

Table 2-2a-Runoff curve numbers for urban areas
Impervious areas - streets and roads
Soil Type - Loam C
Curve Number 98

Coal Mine Waste

Table 2-2d-Runoff curve numbers for arid and semiarid rangelands
Cover Type - Herbaceous-mixture of grass, weeds and brush
Hydrologic Condition Poor
Soil Type D
Curve Number 90

RUN-OFF VOLUME - POND J

Area	Acres	Curve #	Precip Amount	Direct Run-off	Run-off Vol A-F
Disturbed	9.69	74	1.8	0.26	0.21
Undisturbed	50.66	57	1.8	0.01	0.05
Undisturbed	15.20	61	1.8	0.04	0.05
Disturbed	10.63	87	1.8	0.75	0.67
Disturbed	4.70	70	1.8	0.17	0.07
Disturbed	4.28	89	1.8	0.86	0.31
Disturbed	0.20	98	1.8	1.58	0.03
Disturbed	11.13	81	1.8	0.48	0.45
Coal Waste	15.72	90	1.8	0.93	1.21
TOTAL	122.21				3.03

TOTAL REQUIRED WATER VOLUME - - A-F **3.03**

SEDIMENT VOLUME - Pond J

Use the universal soil loss equation.

A = R K L S C P

R = rainfall factor 30.00
K = soil erodibility factor - Work soil 0.37
LS = combined length slope factor 2000' - .5% 0.23
C = cropping management factor - Figure 6 1.00
P = erosion control practice factor 1.00

A = sediment, tons/acre/year 2.55

THREE YEAR SEDIMENT VOLUME - ACRE FEET 0.374
122.21 ACRES - 115 #/CF

TOTAL REQUIRED SEDIMENT POND CAPACITY -- AF **3.41**

PEAK FLOW CALCULATIONS

The following peak flow calculations were compiled with the computer program SEDCAD version 4.0. Details of the run-off calculations are shown on the following pages.

	10-YR 24 HR Event	25-YR 24 HR Event
Pond J Drainage	33.96	45.40

Flow calculations for "J" ditches and culverts are presented in following sections of this exhibit.

Spillway Pond J

Manning's Equation

Flow In a Trapezoidal Channel

DEPTH	D	0.850	FEET
WIDTH	W	8.000	FEET
Slope	S	0.020	EXPRESS AS DECIMAL
Mannings "N"	N	0.030	EXPRESS AS DECIMAL
SIDE SLOPE	X	2.000	SLOPE = X:1

AREA=(W*D)+(X*D^2)=	8.25	$Feet^2$
WETTED PERIMETER=(W)+2*[$((X*D)^2+D^2)^{1/2}$]	11.80	Feet
R=AREA/WETTED PERIMETER	0.70	
V=(1.49/N)*($R^{2/3}$)*($S^{1/2}$)=	5.53	Ft/Sec
Q = A X V =	45.60	CFS
Q REQUIRED - Peak Discharge	45.40	CFS

Spillway Pond J

Riprap Sizing - Across top of Embankment

D50 = Size of Riprap
D50 = ((V X S^.17)/7.58))^2
D50 = Diameter in feet
V = Velocity
S = Slope

D50 =	0.14 feet	1.7 inches	None Required

Spillway Pond J

Determine flow velocity down 3h:1v embankment

Pond J Emergency Spillway

Manning's Equation

Flow In a Trapezoidal Channel

DEPTH	D	0.500	FEET
WIDTH	W	8.000	FEET
Slope	S	0.330	EXPRESS AS DECIMAL
Mannings "N"	N	0.040	EXPRESS AS DECIMAL
SIDE SLOPE	X	2.000	SLOPE = X:1

AREA=(W*D)+(X*D^2)=	4.50	FEET^2
WETTED PERIMETER=(W)+2*[((X*D)^2+D^2)^0.5]	10.24	FEET
R=AREA/WETTED PERIMETER	0.44	
V=(1.49/N)*(R^.667)*(S^.5)=	12.37	FT/SEC
Q = A X V =	55.67	CFS
Q REQUIRED - Peak Discharge	45.40	CFS

Sediment Pond J

Riprap Sizing - Down Face of Embankment - Pond J

D50 = Size of Riprap
D50 = ((V X S^.17)/7.58))^2
D50 = Diameter in feet
V = Velocity
S = Slope

D50 = 1.8 feet 22 inches

Pond Dewatering

POND J DEWATERING
USE A PUMP WITH A CAPACITY TO DEWATER IN 48-HOURS

	POND J	
RUNOFF FROM 10-YEAR, 24-HOUR EVENT	3.03	Acre-Feet
VOLUME	988448	Gallons
PUMP CAPACITY	343	GPM
PUMP SIZE	4"	
Dewatering Time	2880.00	Minutes
	48.00	Hours
	2.00	Days

Subwatershed information for "H" and "I" ditches found in Volume III, Exhbit 8

Ditch H-1

Ditch H-1 receives flow from Drainage Area F, Pond F dewatering pump, and local run-off.
Ditch H-1 exists as a trapezoidal channel, so evaluation for trapezoidal channel will remain.

Drainage Ditch D-H1 14% Slope Reach

Manning's Equation

Flow In a Trapezoidal Channel

DEPTH	D	0.300	FEET		
WIDTH	W	2.000	FEET		
Slope	S	0.140	EXPRESS AS DECIMAL		
Mannings "N"	N	0.040	EXPRESS AS DECIMAL		
SIDE SLOPE	X	2.000	SLOPE = X:1		
AREA=(W*D)+(X*D^2)=				0.78	FEET^2
WETTED PERIMETER=(W)+2*[((X*D)^2+D^2)^0.5]				3.34	FEET
R=AREA/WETTED PERIMETER				0.23	
V=(1.49/N)*(R^.667)*(S^.5)=				5.28	FT/SEC
Q = A X V =				4.12	CFS
Q REQUIRED - Peak Discharge				3.07	CFS

Riprap Sizing - Drainage Ditch D-H1 14% Slope Reach

D50 = Size of Riprap
D50 = ((V X S^.17)/7.58))^2
D50 = Diameter in feet
V = Velocity
S = Slope

D50 =	0.2	feet	3	inches

Drainage Ditch D-H1 1% Slope Reach

Manning's Equation

Flow In a Trapezoidal Channel

DEPTH	D	0.500	FEET		
WIDTH	W	2.000	FEET		
Slope	S	0.010	EXPRESS AS DECIMAL		
Mannings "N"	N	0.030	EXPRESS AS DECIMAL		
SIDE SLOPE	X	2.000	SLOPE = X:1		
AREA=(W*D)+(X*D^2)=				1.50	FEET^2
WETTED PERIMETER=(W)+2*[((X*D)^2+D^2)^0.5]				4.24	FEET
R=AREA/WETTED PERIMETER				0.35	
V=(1.49/N)*(R^.667)*(S^.5)=				2.49	FT/SEC
Q = A X V =				3.73	CFS
Q REQUIRED - Peak Discharge				3.07	CFS

Riprap Sizing - Drainage Ditch D-H1 1% Slope Reach

D50 = Size of Riprap
D50 = ((V X S^.17)/7.58))^2
D50 = Diameter in feet
V = Velocity
S = Slope

D50 = 0.02 feet 0.3 inches

None Required

Concrete Ditch

Flow From I-1 and J 4 - 10 Year Event
Manning's Equation

Flow In a Trapezoidal Channel

DEPTH	D	0.130	FEET
WIDTH	W	2.000	FEET
Slope	S	0.010	EXPRESS AS DECIMAL
Mannings "N"	N	0.015	EXPRESS AS DECIMAL
SIDE SLOPE	X	1.000	SLOPE = X:1

AREA=(W*D)+(X*D^2)=	0.28	FEET^2
WETTED PERIMETER=(W)+2*[((X*D)^2+D^2)^0.5]	2.37	FEET
R=AREA/WETTED PERIMETER	0.12	
V=(1.49/N)*(R^.667)*(S^.5)=	2.38	FT/SEC
Q = A X V =	0.66	CFS
Q REQUIRED - Peak Discharge	0.60	CFS

Gob Pile #3 - Pond J

Ditches designed for the 10-year 24-hour Event

Tamme Bishop

J.E. Stover & Associates, Inc.
2352 N. 7th Street, Unit B
Grand Junction, CO 81501

Phone: 970-245-4101
Email: tamme.jestover@bresnan.net

General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	10 yr - 24 hr
Rainfall Depth:	1.800 inches

Structure Summary:

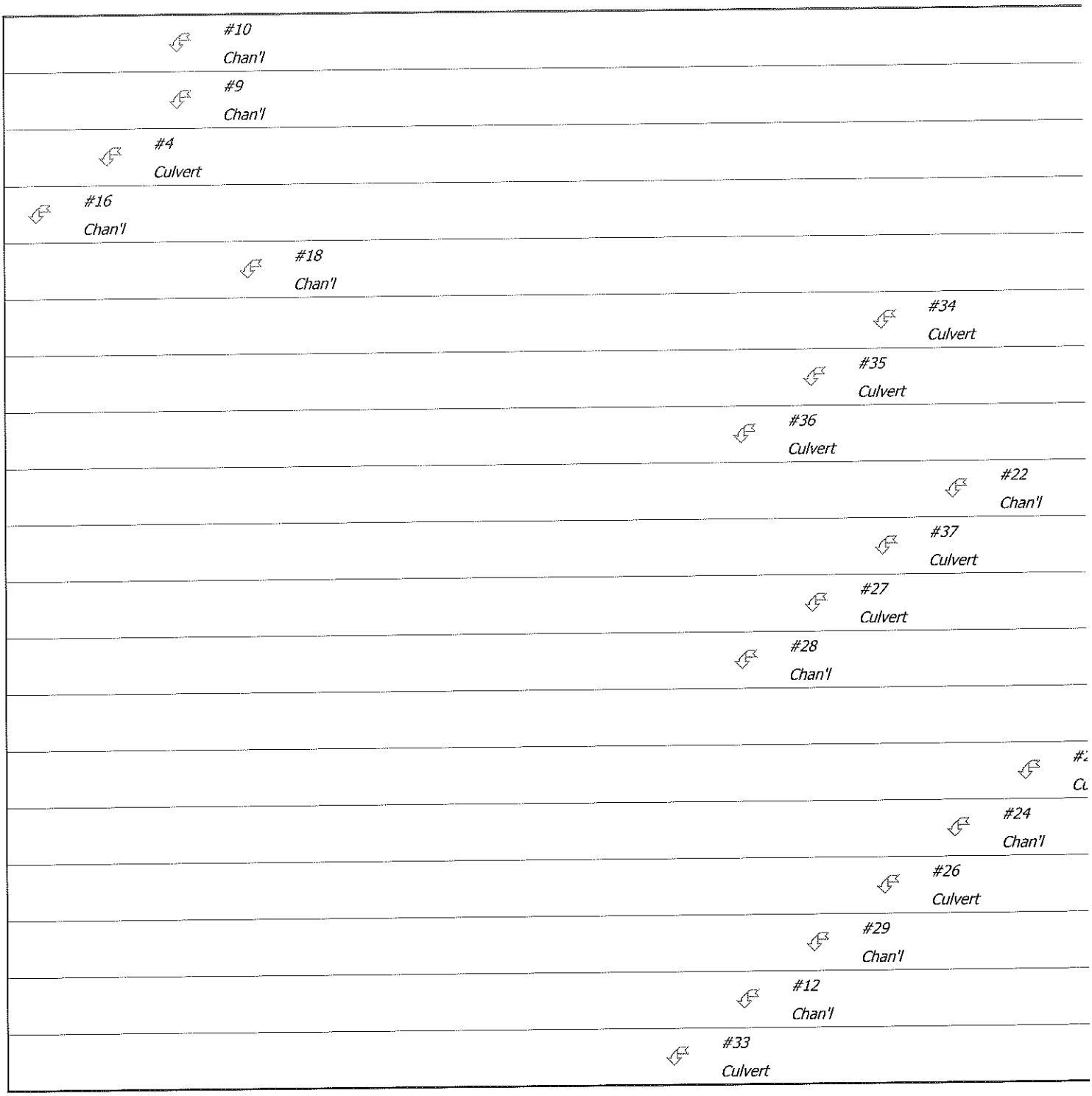
	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#10	0.600	0.600	0.49	0.03
#9	0.800	0.800	0.66	0.05
#4	0.000	1.400	1.15	0.08
#16	1.300	2.700	1.40	0.10
#18	4.200	4.200	0.60	0.09
#34	3.580	3.580	2.41	0.18
#35	0.000	3.580	2.41	0.18
#36	0.000	3.580	2.41	0.18
#22	0.910	0.910	0.75	0.06
#37	0.000	0.910	0.75	0.06
#27	0.000	0.910	0.75	0.06
#28	0.050	0.960	0.79	0.06
#23	0.330	0.330	0.27	0.02
#25	0.000	0.330	0.27	0.02
#24	0.180	0.510	0.42	0.02
#26	0.000	0.510	0.42	0.02
#29	0.050	0.560	0.46	0.02
#12	1.290	1.850	0.56	0.05
#33	0.000	6.390	3.76	0.29
#41	0.100	6.490	3.84	0.30
#38	0.000	6.490	3.84	0.30
#14	3.520	3.520	3.20	0.28
#30	1.870	11.880	8.52	0.71
#39	0.000	11.880	8.52	0.71
#15	3.580	3.580	3.25	0.28
#48	5.700	5.700	1.70	0.12
#42	32.280	32.280	4.44	0.34
#43	45.820	78.100	7.91	0.67
#44	0.000	83.800	9.62	0.80
#46	0.000	83.800	9.62	0.80
#45	0.000	83.800	9.62	0.80
#49	0.000	83.800	9.62	0.80
#47	0.000	83.800	9.62	0.80
#13	1.360	85.160	10.71	0.90
#31	1.190	89.930	14.92	1.26
#20	0.000	89.930	14.92	1.26
#7	9.140	110.950	29.64	2.61
#5	3.560	3.560	1.77	0.13

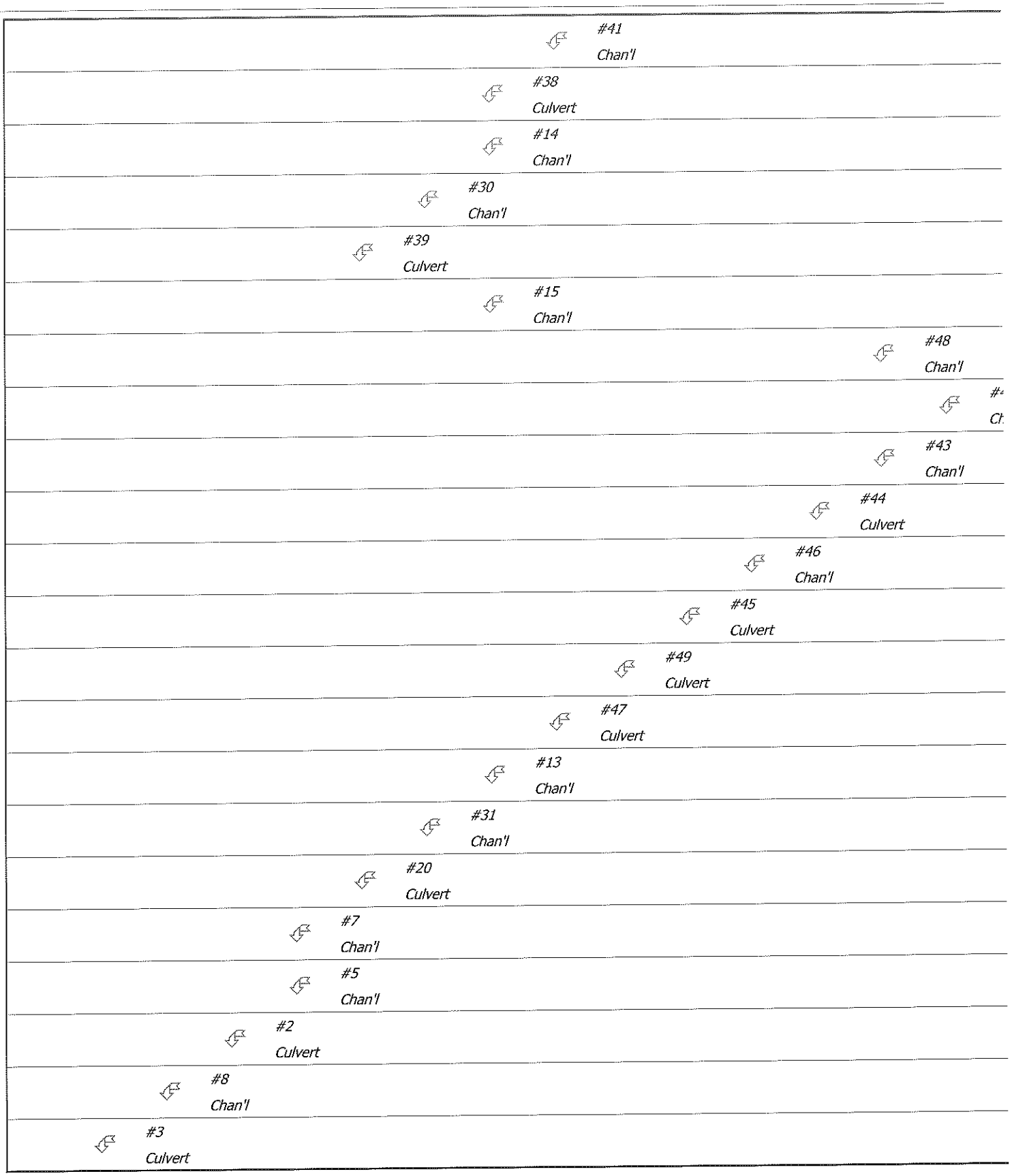
	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#2	0.000	114.510	31.41	2.75
#8	0.800	119.510	32.56	2.89
#3	0.000	119.510	32.56	2.89
#11	0.000	119.510	32.56	2.89
#1	0.000	122.210	33.96	2.98

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	POND J
Culvert	#2	==>	#8	0.000	0.000	CULVERT J1
Culvert	#3	==>	#11	0.000	0.000	CULVERT J2
Culvert	#4	==>	#16	0.000	0.000	CULVERT J3
Channel	#5	==>	#2	0.000	0.000	DITCH J1
Channel	#7	==>	#2	0.000	0.000	DITCH J3
Channel	#8	==>	#3	0.000	0.000	DITCH J4
Channel	#9	==>	#4	0.000	0.000	DITCH J5
Channel	#10	==>	#4	0.000	0.000	DITCH J6
Channel	#11	==>	#1	0.000	0.000	DITCH J7
Channel	#12	==>	#33	0.000	0.000	DITCH J8
Channel	#13	==>	#31	0.000	0.000	DITCH J10
Channel	#14	==>	#30	0.000	0.000	DITCH J12
Channel	#15	==>	#31	0.000	0.000	DITCH J13
Channel	#16	==>	#1	0.000	0.000	DITCH J14
Channel	#18	==>	#8	0.000	0.000	DITCH I-1
Culvert	#20	==>	#7	0.000	0.000	CULVERT J-4
Channel	#22	==>	#37	0.000	0.000	DITCH J-15
Channel	#23	==>	#25	0.000	0.000	DITCH J-16
Channel	#24	==>	#26	0.000	0.000	DITCH J-17
Culvert	#25	==>	#24	0.000	0.000	CULVERT J-5
Culvert	#26	==>	#29	0.000	0.000	CULVERT J-6
Culvert	#27	==>	#28	0.000	0.000	CULVERT J-7
Channel	#28	==>	#33	0.000	0.000	DITCH J-18
Channel	#29	==>	#12	0.000	0.000	DITCH J-19
Channel	#30	==>	#39	0.000	0.000	DITCH J9
Channel	#31	==>	#20	0.000	0.000	DITCH J11
Culvert	#33	==>	#41	0.000	0.000	CULVERT J8
Culvert	#34	==>	#35	0.000	0.000	CULVERT J-13
Culvert	#35	==>	#36	0.000	0.000	CULVERT J-14
Culvert	#36	==>	#33	0.000	0.000	CULVERT J-15
Culvert	#37	==>	#27	0.000	0.000	CULVERT J-12
Culvert	#38	==>	#30	0.000	0.000	CULVERT J18
Culvert	#39	==>	#7	0.000	0.000	CULVERT J19
Channel	#41	==>	#38	0.000	0.000	Ditch 21
Channel	#42	==>	#43	0.000	0.000	W Div #1
Channel	#43	==>	#44	0.000	0.000	DITCH D1
Culvert	#44	==>	#46	0.000	0.000	Culvert D1
Culvert	#45	==>	#49	0.000	0.000	Culvert D2
Channel	#46	==>	#45	0.000	0.000	Ditch D2

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#47	==>	#13	0.000	0.000	Culvert J9
Channel	#48	==>	#44	0.000	0.000	Ditch E1
Culvert	#49	==>	#47	0.000	0.000	CULVERT J20




#41
Chan'l
#38
Culvert
#14
Chan'l
#30
Chan'l
#39
Culvert
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#13
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#31
Chan'l
#20
Culvert
#7
Chan'l
#5
Chan'l
#2
Culvert
#8
Chan'l
#3
Culvert

#11
Chan'l

#1
Null

Structure Detail:

Structure #18 (Nonerodible Channel)

DITCH I-1

Trapezoidal Nonerodible Channel Inputs:

Material: Concrete

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
1.00	1.0:1	1.0:1	1.0	0.0150	0.30		

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.60 cfs	
Depth:	0.19 ft	0.49 ft
Top Width:	1.37 ft	1.97 ft
Velocity:	2.73 fps	
X-Section Area:	0.22 sq ft	
Hydraulic Radius:	0.144 ft	
Froude Number:	1.20	

Structure Detail:

Structure #5 (Erodible Channel)

DITCH J1

Triangular Erodible Channel Inputs:

Material: Shales and hardpans

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.5:1	1.5:1	1.2	0.0250	0.30			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.77 cfs	
Depth:	0.66 ft	0.96 ft
Top Width:	1.97 ft	2.87 ft
Velocity:	2.75 fps	
X-Section Area:	0.64 sq ft	
Hydraulic Radius:	0.273 ft	
Froude Number:	0.85	

Structure Detail:

Structure #8 (Erodible Channel)

DITCH J4

Triangular Erodible Channel Inputs:

Material: Shales and hardpans

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.5:1	1.5:1	0.1	0.0250	0.30			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	32.56 cfs	
Depth:	3.11 ft	3.41 ft
Top Width:	9.34 ft	10.24 ft
Velocity:	2.24 fps	
X-Section Area:	14.54 sq ft	
Hydraulic Radius:	1.295 ft	
Froude Number:	0.32	

Structure Detail:

Structure #9 (Erodible Channel)

DITCH J5

Triangular Erodible Channel Inputs:

Material: Shales and hardpans

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.5:1	1.5:1	0.1	0.0250	0.30			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.66 cfs	
Depth:	0.72 ft	1.02 ft
Top Width:	2.16 ft	3.06 ft
Velocity:	0.84 fps	
X-Section Area:	0.78 sq ft	
Hydraulic Radius:	0.300 ft	
Froude Number:	0.25	

Structure Detail:

Structure #10 (Erodible Channel)

DITCH J6

Triangular Erodible Channel Inputs:

Material: Shales and hardpans

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.5:1	1.5:1	0.1	0.0250	0.30			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.49 cfs	
Depth:	0.65 ft	0.95 ft
Top Width:	1.94 ft	2.84 ft
Velocity:	0.79 fps	
X-Section Area:	0.63 sq ft	
Hydraulic Radius:	0.269 ft	
Froude Number:	0.24	

Structure Detail:

Structure #11 (Riprap Channel)

DITCH J7

Triangular Riprap Channel Inputs:

Material: Riprap

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
1.5:1	1.5:1	33.0	0.30		

Riprap Channel Results:

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	32.56 cfs	
Depth:	1.40 ft	1.70 ft
Top Width:	4.20 ft	5.10 ft
Velocity:	11.06 fps	
X-Section Area:	2.94 sq ft	
Hydraulic Radius:	0.583 ft	
Froude Number:	2.33	
Manning's n:	0.0540	
Dmin:	5.00 in	
D50:	9.00 in	
Dmax:	12.00 in	

Structure Detail:

Structure #16 (Erodible Channel)

DITCH J14

Triangular Erodible Channel Inputs:

Material: Alluvial silts colloidal

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.5:1	1.5:1	5.0	0.0250	0.30			5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.40 cfs	
Depth:	0.46 ft	0.76 ft
Top Width:	1.37 ft	2.27 ft
Velocity:	4.41 fps	
X-Section Area:	0.31 sq ft	
Hydraulic Radius:	0.190 ft	
Froude Number:	1.62	

Structure Detail:

Structure #22 (Erodible Channel)

DITCH J-15

Triangular Erodible Channel Inputs:

Material: Shales and hardpans

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.5:1	1.5:1	10.0	0.0250	0.30			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.75 cfs	
Depth:	0.32 ft	0.62 ft
Top Width:	0.95 ft	1.85 ft
Velocity:	4.89 fps	
X-Section Area:	0.15 sq ft	
Hydraulic Radius:	0.132 ft	
Froude Number:	2.16	

Structure Detail:

Structure #23 (Erodible Channel)

DITCH J-16

Triangular Erodible Channel Inputs:

Material: Shales and hardpans

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.5:1	1.5:1	10.0	0.0250	0.30			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.27 cfs	
Depth:	0.21 ft	0.51 ft
Top Width:	0.64 ft	1.54 ft
Velocity:	3.76 fps	
X-Section Area:	0.07 sq ft	
Hydraulic Radius:	0.089 ft	
Froude Number:	2.03	

Structure Detail:

Structure #24 (Erodible Channel)

DITCH J-17

Triangular Erodible Channel Inputs:

Material: Shales and hardpans

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.5:1	1.5:1	10.0	0.0250	1.00			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.42 cfs	
Depth:	0.26 ft	1.26 ft
Top Width:	0.77 ft	3.77 ft
Velocity:	4.24 fps	
X-Section Area:	0.10 sq ft	
Hydraulic Radius:	0.107 ft	
Froude Number:	2.09	

Structure Detail:

Structure #28 (Riprap Channel)

DITCH J-18

Triangular Riprap Channel Inputs:

Material: Riprap

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
1.5:1	1.5:1	15.0	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.79 cfs	
Depth:	0.13 ft	1.13 ft
Top Width:	0.40 ft	3.40 ft
Velocity*:		
X-Section Area:	0.03 sq ft	
Hydraulic Radius:	0.056 ft	
Froude Number*:		
Manning's n*:		
Dmin:	3.00 in	
D50:	9.00 in	
Dmax:	11.25 in	

Velocity and Manning's n calculations may not apply for this method.

Structure Detail:

Structure #29 (Riprap Channel)

DITCH J-19

Triangular Riprap Channel Inputs:

Material: Riprap

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
1.5:1	1.5:1	30.0	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.46 cfs	
Depth:	0.05 ft	1.05 ft
Top Width:	0.15 ft	3.15 ft
Velocity*:		
X-Section Area:	0.00 sq ft	
Hydraulic Radius:	0.021 ft	
Froude Number*:		
Manning's n*:		
Dmin:	3.00 in	
D50:	9.00 in	
Dmax:	11.25 in	

Velocity and Manning's n calculations may not apply for this method.

Structure Detail:

Structure #43 (Erodible Channel)

DITCH D1

Trapezoidal Erodible Channel Inputs:

Material: Shales and hardpans

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	1.5:1	1.5:1	8.0	0.0250	0.30			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	7.91 cfs	
Depth:	0.16 ft	0.46 ft
Top Width:	10.48 ft	11.38 ft
Velocity:	4.85 fps	
X-Section Area:	1.63 sq ft	
Hydraulic Radius:	0.154 ft	
Froude Number:	2.17	

Structure Detail:

Structure #46 (Erodible Channel)

Ditch D2

Triangular Erodible Channel Inputs:

Material: Shales and hardpans

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.5:1	1.5:1	3.0	0.0250	0.30			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	9.62 cfs	
Depth:	1.04 ft	1.34 ft
Top Width:	3.12 ft	4.02 ft
Velocity:	5.91 fps	
X-Section Area:	1.63 sq ft	
Hydraulic Radius:	0.433 ft	
Froude Number:	1.44	

Structure Detail:

Structure #48 (Erodible Channel)

Ditch E1

Trapezoidal Erodible Channel Inputs:

Material: Shales and hardpans

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.00	1.5:1	1.5:1	2.0	0.0250	0.30			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.70 cfs	
Depth:	0.20 ft	0.50 ft
Top Width:	3.59 ft	4.49 ft
Velocity:	2.63 fps	
X-Section Area:	0.65 sq ft	
Hydraulic Radius:	0.175 ft	
Froude Number:	1.09	

Structure Detail:

Structure #2 (Culvert)

CULVERT J1

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
66.00	0.50	0.0260	9.00	0.00	0.20

Culvert Results:

Design Discharge = 31.41 cfs

Minimum pipe diameter: 1 - 24 inch pipe(s) required

Structure Detail:

Structure #3 (Culvert)

CULVERT J2

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
100.00	6.00	0.0240	6.00	0.00	0.20

Culvert Results:

Design Discharge = 30.86 cfs

Minimum pipe diameter: 1 - 24 inch pipe(s) required

Structure Detail:

Structure #4 (Culvert)

CULVERT J3

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
60.00	13.00	0.0240	4.00	0.00	0.90

Culvert Results:

Design Discharge = 1.15 cfs

Minimum pipe diameter: 1 - 6 inch pipe(s) required

Structure Detail:

Structure #25 (Culvert)

CULVERT J-5

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
48.00	4.20	0.0240	0.28	0.00	4.00

Culvert Results:

Design Discharge = 0.27 cfs

Minimum pipe diameter: 1 - 12 inch pipe(s) required

Structure Detail:

Structure #26 (Culvert)

CULVERT J-6

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
30.00	0.10	0.0240	0.40	0.00	0.90

Culvert Results:

Design Discharge = 0.42 cfs

Minimum pipe diameter: 1 - 12 inch pipe(s) required

Structure Detail:

Structure #27 (Culvert)

CULVERT J-7

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
30.00	0.10	0.0240	0.70	0.00	0.90

Culvert Results:

Design Discharge = 0.75 cfs

Minimum pipe diameter: 1 - 12 inch pipe(s) required

Structure Detail:

Structure #37 (Culvert)

CULVERT J-12

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
31.00	2.00	0.0150	0.55	0.00	0.90

Culvert Results:

Design Discharge = 0.75 cfs

Minimum pipe diameter: 1 - 12 inch pipe(s) required

Structure Detail:

Structure #34 (Culvert)

CULVERT J-13

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
38.00	2.00	0.0150	1.20	0.00	0.90

Culvert Results:

Design Discharge = 2.41 cfs

Minimum pipe diameter: 1 - 12 inch pipe(s) required

Structure Detail:

Structure #35 (Culvert)

CULVERT J-14

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
166.00	10.00	0.0150	1.20	0.00	0.90

Culvert Results:

Design Discharge = 2.41 cfs

Minimum pipe diameter: 1 - 12 inch pipe(s) required

Structure Detail:

Structure #36 (Culvert)

CULVERT J-15

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
107.00	20.00	0.0190	1.20	0.00	0.90

Culvert Results:

Design Discharge = 2.41 cfs

Minimum pipe diameter: 1 - 12 inch pipe(s) required

Structure Detail:

Structure #49 (Culvert)

CULVERT J20

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
60.00	1.30	0.0240	2.00	0.00	0.90

Culvert Results:

Design Discharge = 9.62 cfs

Minimum pipe diameter: 1 - 24 inch pipe(s) required

Structure Detail:

Structure #44 (Culvert)

Culvert D1

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
60.00	2.00	0.0240	3.50	0.00	0.90

Culvert Results:

Design Discharge = 9.62 cfs

Minimum pipe diameter: 1 - 18 inch pipe(s) required

Structure Detail:

Structure #45 (Culvert)

Culvert D2

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
30.00	2.00	0.0240	3.00	0.00	0.90

Culvert Results:

Design Discharge = 9.62 cfs

Minimum pipe diameter: 1 - 18 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#10	1	0.600	0.087	0.000	0.000	87.000	TR55	0.49	0.034
	Σ	**0.600**						**0.49**	**0.034**
#9	1	0.800	0.065	0.000	0.000	87.000	TR55	0.66	0.050
	Σ	**0.800**						**0.66**	**0.050**
#4	Σ	**1.400**						**1.15**	**0.084**
#16	1	0.130	0.042	0.000	0.000	74.000	TR55	0.04	0.001
	2	1.170	0.002	0.000	0.000	70.000	TR55	0.21	0.013
	Σ	**2.700**						**1.40**	**0.097**
#18	1	0.670	0.187	0.000	0.000	87.000	TR55	0.49	0.041
	2	3.530	0.376	0.000	0.000	70.000	TR55	0.27	0.049
	Σ	**4.200**						**0.60**	**0.091**
#34	1	2.180	0.013	0.000	0.000	81.000	TR55	1.21	0.087
	2	0.200	0.444	0.000	0.000	98.000	TR55	0.24	0.020
	3	1.200	0.100	0.000	0.000	87.000	TR55	0.99	0.075
	Σ	**3.580**						**2.41**	**0.182**
#35	Σ	**3.580**						**2.41**	**0.182**
#36	Σ	**3.580**						**2.41**	**0.182**
#22	1	0.910	0.033	0.000	0.000	87.000	TR55	0.75	0.057
	Σ	**0.910**						**0.75**	**0.057**
#37	Σ	**0.910**						**0.75**	**0.057**
#27	Σ	**0.910**						**0.75**	**0.057**
#28	1	0.050	0.007	0.000	0.000	87.000	TR55	0.04	0.001
	Σ	**0.960**						**0.79**	**0.058**
#23	1	0.330	0.023	0.000	0.000	87.000	TR55	0.27	0.016
	Σ	**0.330**						**0.27**	**0.016**
#25	Σ	**0.330**						**0.27**	**0.016**
#24	1	0.180	0.016	0.000	0.000	87.000	TR55	0.15	0.007
	Σ	**0.510**						**0.42**	**0.023**
#26	Σ	**0.510**						**0.42**	**0.023**
#29	1	0.050	0.007	0.000	0.000	87.000	TR55	0.04	0.001

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
	Σ	**0.560**						**0.46**	**0.025**
#12	1	1.290	0.336	0.000	0.000	74.000	TR55	0.22	0.028
	Σ	**1.850**						**0.56**	**0.053**
#33	Σ	**6.390**						**3.76**	**0.293**
#41	1	0.100	0.100	0.000	0.000	87.000	TR55	0.08	0.003
	Σ	**6.490**						**3.84**	**0.296**
#38	Σ	**6.490**						**3.84**	**0.296**
#14	1	3.520	0.142	0.000	0.000	90.000	TR55	3.20	0.276
	Σ	**3.520**						**3.20**	**0.276**
#30	1	0.650	0.069	0.000	0.000	90.000	TR55	0.63	0.049
	2	1.220	0.256	0.000	0.000	90.000	TR55	1.04	0.093
	Σ	**11.880**						**8.52**	**0.713**
#39	Σ	**11.880**						**8.52**	**0.713**
#15	1	3.580	0.169	0.000	0.000	90.000	TR55	3.25	0.280
	Σ	**3.580**						**3.25**	**0.280**
#48	1	5.700	0.000	0.000	0.000	74.000	TR55	1.70	0.124
	Σ	**5.700**						**1.70**	**0.124**
#42	1	23.500	0.268	0.000	0.000	57.000	TR55	0.04	0.021
	2	0.150	0.100	0.000	0.000	74.000	TR55	0.04	0.001
	3	7.910	0.021	0.000	0.000	81.000	TR55	4.39	0.317
	4	0.720	0.100	0.000	0.000	61.000	TR55	0.00	0.000
	Σ	**32.280**						**4.44**	**0.339**
#43	1	2.250	0.005	0.000	0.000	57.000	TR55	0.00	0.000
	2	8.670	0.006	0.000	0.000	61.000	TR55	0.04	0.028
	3	22.100	0.012	0.000	0.000	57.000	TR55	0.04	0.020
	4	3.140	0.028	0.000	0.000	89.000	TR55	2.90	0.226
	5	1.040	0.002	0.000	0.000	81.000	TR55	0.58	0.042
	6	2.800	0.012	0.000	0.000	57.000	TR55	0.00	0.000
	7	5.820	0.016	0.000	0.000	61.000	TR55	0.03	0.019
	Σ	**78.100**						**7.91**	**0.673**
#44	Σ	**83.800**						**9.62**	**0.797**
#46	Σ	**83.800**						**9.62**	**0.797**
#45	Σ	**83.800**						**9.62**	**0.797**
#49	Σ	**83.800**						**9.62**	**0.797**

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#47	**Σ**	**83.800**						**9.62**	**0.797**
#13	1	1.360	0.242	0.000	0.000	90.000	TR55	1.18	0.104
	Σ	**85.160**						**10.71**	**0.901**
#31	1	0.430	0.052	0.000	0.000	87.000	TR55	0.35	0.023
	2	0.760	0.040	0.000	0.000	90.000	TR55	0.74	0.058
	Σ	**89.930**						**14.92**	**1.262**
#20	**Σ**	**89.930**						**14.92**	**1.262**
#7	1	4.630	0.014	0.000	0.000	90.000	TR55	4.50	0.357
	2	4.510	0.461	0.000	0.000	87.000	TR55	2.65	0.280
	Σ	**110.950**						**29.64**	**2.612**
#5	1	1.140	0.100	0.000	0.000	89.000	TR55	1.05	0.082
	2	2.420	0.100	0.000	0.000	74.000	TR55	0.72	0.053
	Σ	**3.560**						**1.77**	**0.134**
#2	**Σ**	**114.510**						**31.41**	**2.746**
#8	1	0.800	0.062	0.000	0.000	87.000	TR55	0.66	0.050
	Σ	**119.510**						**32.56**	**2.887**
#3	**Σ**	**119.510**						**32.56**	**2.887**
#11	**Σ**	**119.510**						**32.56**	**2.887**
#1	**Σ**	**122.210**						**33.96**	**2.984**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#5	1	3. Short grass pasture	8.42	70.00	831.00	2.320	0.099
#5	**1**	**Time of Concentration:**					**0.100**
#5	2	2. Minimum tillage cultivation	9.18	80.00	871.00	1.510	0.160
#5	**2**	**Time of Concentration:**					**0.100**
#7	1	5. Nearly bare and untilled, and alluvial valley fans	22.86	56.00	245.00	4.780	0.014
#7	**1**	**Time of Concentration:**					**0.014**
#7	2	6. Grassed waterway	0.55	10.00	1,826.48	1.100	0.461
#7	**2**	**Time of Concentration:**					**0.461**
#8	1	7. Paved area and small upland gullies	1.00	4.50	450.00	2.010	0.062
#8	**1**	**Time of Concentration:**					**0.062**
#9	1	7. Paved area and small upland gullies	1.00	4.69	471.02	2.000	0.065
#9	**1**	**Time of Concentration:**					**0.065**

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#10	1	5. Nearly bare and untilled, and alluvial valley fans	1.02	3.20	315.02	1.000	0.087
#10	**1**	**Time of Concentration:**					**0.087**
#12	1	5. Nearly bare and untilled, and alluvial valley fans	0.48	4.00	835.00	0.690	0.336
#12	**1**	**Time of Concentration:**					**0.336**
#13	1	5. Nearly bare and untilled, and alluvial valley fans	0.94	8.00	847.00	0.970	0.242
#13	**1**	**Time of Concentration:**					**0.242**
#14	1	5. Nearly bare and untilled, and alluvial valley fans	2.48	20.00	806.00	1.570	0.142
#14	**1**	**Time of Concentration:**					**0.142**
#15	1	5. Nearly bare and untilled, and alluvial valley fans	2.21	20.00	903.05	1.480	0.169
#15	**1**	**Time of Concentration:**					**0.169**
#16	1	3. Short grass pasture	11.00	45.00	409.00	2.650	0.042
#16	**1**	**Time of Concentration:**					**0.042**
#16	2	5. Nearly bare and untilled, and alluvial valley fans	38.71	24.00	62.00	6.220	0.002
#16	**2**	**Time of Concentration:**					**0.002**
#18	1	5. Nearly bare and untilled, and alluvial valley fans	3.28	40.00	1,220.03	1.810	0.187
#18	**1**	**Time of Concentration:**					**0.187**
#18	2	2. Minimum tillage cultivation	3.28	40.00	1,220.03	0.900	0.376
#18	**2**	**Time of Concentration:**					**0.376**
#22	1	5. Nearly bare and untilled, and alluvial valley fans	5.84	17.00	291.00	2.410	0.033
#22	**1**	**Time of Concentration:**					**0.033**
#23	1	5. Nearly bare and untilled, and alluvial valley fans	5.26	10.00	190.00	2.290	0.023
#23	**1**	**Time of Concentration:**					**0.023**
#24	1	5. Nearly bare and untilled, and alluvial valley fans	7.50	12.00	160.00	2.730	0.016
#24	**1**	**Time of Concentration:**					**0.016**
#28	1	5. Nearly bare and untilled, and alluvial valley fans	9.76	8.00	82.00	3.120	0.007
#28	**1**	**Time of Concentration:**					**0.007**
#29	1	5. Nearly bare and untilled, and alluvial valley fans	10.53	8.00	76.00	3.240	0.006
#29	**1**	**Time of Concentration:**					**0.007**
#30	1	5. Nearly bare and untilled, and alluvial valley fans	5.47	32.00	585.01	2.330	0.069
#30	**1**	**Time of Concentration:**					**0.069**
#31	1	5. Nearly bare and untilled, and alluvial valley fans	10.10	60.00	594.00	3.170	0.052
#31	**1**	**Time of Concentration:**					**0.052**
#31	2	5. Nearly bare and untilled, and alluvial valley fans	9.09	40.00	440.00	3.010	0.040
#31	**2**	**Time of Concentration:**					**0.040**

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#34	1	5. Nearly bare and untilled, and alluvial valley fans	12.43	21.00	169.00	3.520	0.013
#34	**1**	**Time of Concentration:**					**0.013**
#34	2	5. Nearly bare and untilled, and alluvial valley fans	0.25	2.00	800.00	0.500	0.444
#34	**2**	**Time of Concentration:**					**0.444**
#48	1	8. Large gullies, diversions, and low flowing streams	400.00	600.00	150.00	60.000	0.000
#48	**1**	**Time of Concentration:**					**0.000**

Subwatershed Muskingum Routing Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#16	1	4. Cultivated, straight row	7.77	60.00	772.00	2.490	0.086
#16	**1**	**Muskingum K:**					**0.000**

Gob Pile #3 - Pond J

Ditches designed for the 25-year 24-hour Event

Tamme Bishop

J.E. Stover & Associates, Inc.
2352 N. 7th Street, Unit B
Grand Junction, CO 81501

Phone: 970-245-4101
Email: tamme.jestover@bresnan.net

General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	25 yr - 24 hr
Rainfall Depth:	2.100 inches

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#10	0.600	0.600	0.63	0.05
#9	0.800	0.800	0.84	0.07
#4	0.000	1.400	1.48	0.11
#16	1.300	2.700	1.91	0.14
#18	4.200	4.200	1.00	0.14
#34	3.580	3.580	3.17	0.24
#35	0.000	3.580	3.17	0.24
#36	0.000	3.580	3.17	0.24
#22	0.910	0.910	0.96	0.07
#37	0.000	0.910	0.96	0.07
#27	0.000	0.910	0.96	0.07
#28	0.050	0.960	1.01	0.08
#23	0.330	0.330	0.35	0.02
#25	0.000	0.330	0.35	0.02
#24	0.180	0.510	0.54	0.03
#26	0.000	0.510	0.54	0.03
#29	0.050	0.560	0.59	0.03
#12	1.290	1.850	0.81	0.08
#33	0.000	6.390	4.99	0.40
#41	0.100	6.490	5.10	0.40
#38	0.000	6.490	5.10	0.40
#14	3.520	3.520	4.05	0.35
#30	1.870	11.880	11.04	0.94
#39	0.000	11.880	11.04	0.94
#15	3.580	3.580	4.11	0.36
#48	5.700	5.700	2.64	0.19
#42	32.280	32.280	6.10	0.53
#43	45.820	78.100	11.06	1.07
#44	0.000	83.800	13.70	1.26
#46	0.000	83.800	13.70	1.26
#45	0.000	83.800	13.70	1.26
#49	0.000	83.800	13.70	1.26
#47	0.000	83.800	13.70	1.26
#13	1.360	85.160	15.11	1.40
#31	1.190	89.930	20.45	1.86
#20	0.000	89.930	20.45	1.86
#7	9.140	110.950	39.45	3.61
#5	3.560	3.560	2.44	0.18

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#2	0.000	114.510	41.89	3.80
#8	0.800	119.510	43.49	4.00
#3	0.000	119.510	43.49	4.00
#11	0.000	119.510	43.49	4.00
#1	0.000	122.210	45.40	4.14

Gob Pile #3 - Pond J

Ditches designed for the 100-year 24-hour Event

Tamme Bishop

J.E. Stover & Associates, Inc.
2352 N. 7th Street, Unit B
Grand Junction, CO 81501

Phone: 970-245-4101
Email: tamme.jestover@bresnan.net

General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	100 yr - 24 hr
Rainfall Depth:	2.600 inches

Structure Summary:

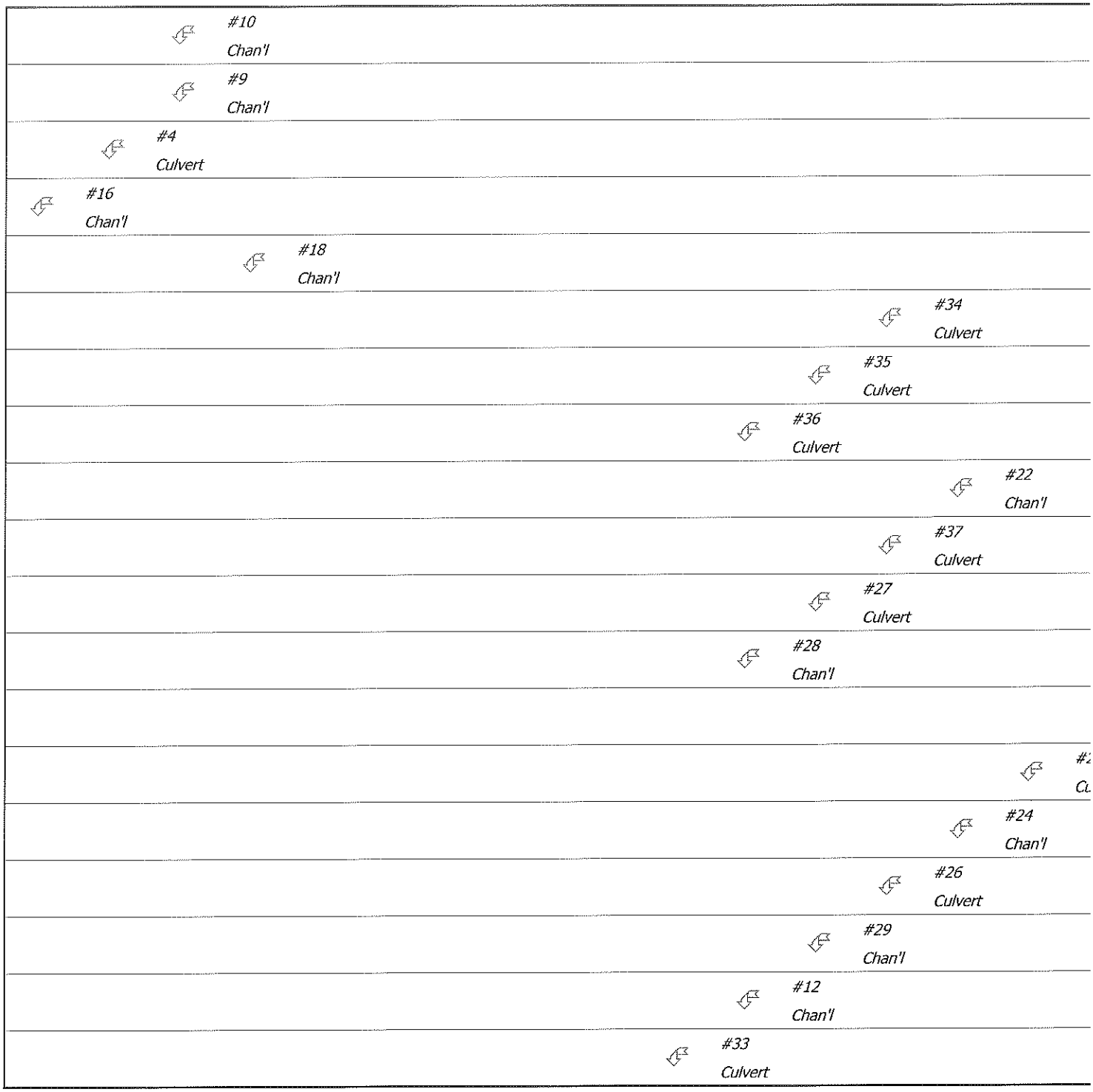
	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#10	0.600	0.600	0.87	0.07
#9	0.800	0.800	1.16	0.09
#4	0.000	1.400	2.03	0.16
#16	1.300	2.700	2.82	0.21
#18	4.200	4.200	1.88	0.22
#34	3.580	3.580	4.50	0.36
#35	0.000	3.580	4.50	0.36
#36	0.000	3.580	4.50	0.36
#22	0.910	0.910	1.32	0.11
#37	0.000	0.910	1.32	0.11
#27	0.000	0.910	1.32	0.11
#28	0.050	0.960	1.39	0.11
#23	0.330	0.330	0.48	0.03
#25	0.000	0.330	0.48	0.03
#24	0.180	0.510	0.74	0.05
#26	0.000	0.510	0.74	0.05
#29	0.050	0.560	0.81	0.05
#12	1.290	1.850	1.30	0.12
#33	0.000	6.390	7.19	0.59
#41	0.100	6.490	7.34	0.60
#38	0.000	6.490	7.34	0.60
#14	3.520	3.520	5.48	0.48
#30	1.870	11.880	15.45	1.33
#39	0.000	11.880	15.45	1.33
#15	3.580	3.580	5.57	0.49
#48	5.700	5.700	4.39	0.32
#42	32.280	32.280	9.19	0.95
#43	45.820	78.100	20.83	2.03
#44	0.000	83.800	25.21	2.34
#46	0.000	83.800	25.21	2.34
#45	0.000	83.800	25.21	2.34
#49	0.000	83.800	25.21	2.34
#47	0.000	83.800	25.21	2.34
#13	1.360	85.160	27.15	2.53
#31	1.190	89.930	34.42	3.17
#20	0.000	89.930	34.42	3.17
#7	9.140	110.950	60.85	5.64
#5	3.560	3.560	3.64	0.28

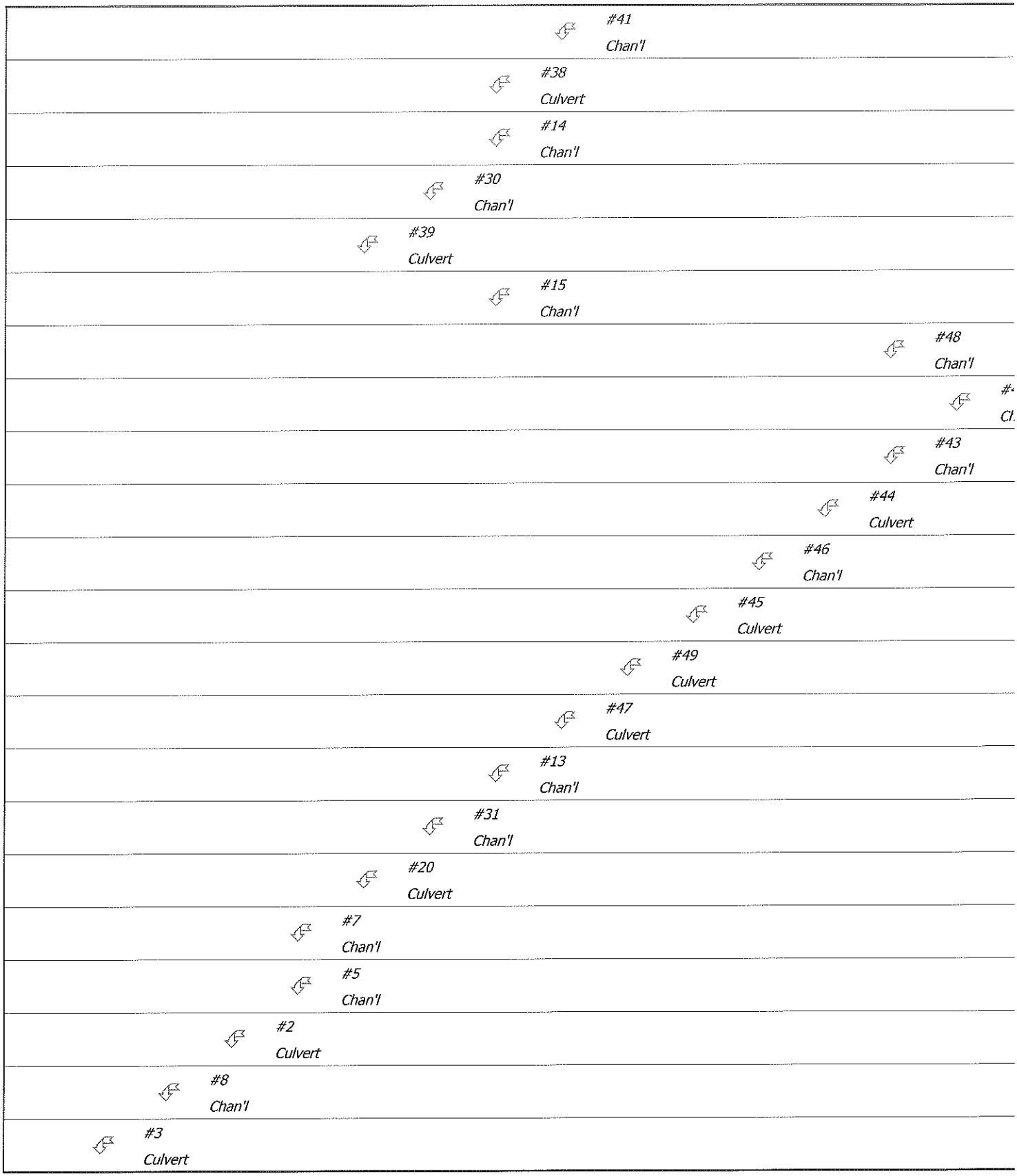
	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#2	0.000	114.510	64.49	5.92
#8	0.800	119.510	67.07	6.23
#3	0.000	119.510	67.07	6.23
#11	0.000	119.510	67.07	6.23
#1	0.000	122.210	69.89	6.45

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	POND J
Culvert	#2	==>	#8	0.000	0.000	CULVERT J1
Culvert	#3	==>	#11	0.000	0.000	CULVERT J2
Culvert	#4	==>	#16	0.000	0.000	CULVERT J3
Channel	#5	==>	#2	0.000	0.000	DITCH J1
Channel	#7	==>	#2	0.000	0.000	DITCH J3
Channel	#8	==>	#3	0.000	0.000	DITCH J4
Channel	#9	==>	#4	0.000	0.000	DITCH J5
Channel	#10	==>	#4	0.000	0.000	DITCH J6
Channel	#11	==>	#1	0.000	0.000	DITCH J7
Channel	#12	==>	#33	0.000	0.000	DITCH J8
Channel	#13	==>	#31	0.000	0.000	DITCH J10
Channel	#14	==>	#30	0.000	0.000	DITCH J12
Channel	#15	==>	#31	0.000	0.000	DITCH J13
Channel	#16	==>	#1	0.000	0.000	DITCH J14
Channel	#18	==>	#8	0.000	0.000	DITCH I-1
Culvert	#20	==>	#7	0.000	0.000	CULVERT J-4
Channel	#22	==>	#37	0.000	0.000	DITCH J-15
Channel	#23	==>	#25	0.000	0.000	DITCH J-16
Channel	#24	==>	#26	0.000	0.000	DITCH J-17
Culvert	#25	==>	#24	0.000	0.000	CULVERT J-5
Culvert	#26	==>	#29	0.000	0.000	CULVERT J-6
Culvert	#27	==>	#28	0.000	0.000	CULVERT J-7
Channel	#28	==>	#33	0.000	0.000	DITCH J-18
Channel	#29	==>	#12	0.000	0.000	DITCH J-19
Channel	#30	==>	#39	0.000	0.000	DITCH J9
Channel	#31	==>	#20	0.000	0.000	DITCH J11
Culvert	#33	==>	#41	0.000	0.000	CULVERT J8
Culvert	#34	==>	#35	0.000	0.000	CULVERT J-13
Culvert	#35	==>	#36	0.000	0.000	CULVERT J-14
Culvert	#36	==>	#33	0.000	0.000	CULVERT J-15
Culvert	#37	==>	#27	0.000	0.000	CULVERT J-12
Culvert	#38	==>	#30	0.000	0.000	CULVERT J18
Culvert	#39	==>	#7	0.000	0.000	CULVERT J19
Channel	#41	==>	#38	0.000	0.000	Ditch 21
Channel	#42	==>	#43	0.000	0.000	W Div #1
Channel	#43	==>	#44	0.000	0.000	DITCH D1
Culvert	#44	==>	#46	0.000	0.000	Culvert D1
Culvert	#45	==>	#49	0.000	0.000	Culvert D2
Channel	#46	==>	#45	0.000	0.000	Ditch D2

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#47	==>	#13	0.000	0.000	Culvert J9
Channel	#48	==>	#44	0.000	0.000	Ditch E1
Culvert	#49	==>	#47	0.000	0.000	CULVERT J20




#41
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#7
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#5
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#2
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#8
Chan'l
#3
Culvert

#11
Chan'l

#1
Null

Structure Detail:

Structure #7 (Erodible Channel)

DITCH J3

Trapezoidal Erodible Channel Inputs:

Material: Shales and hardpans

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.00	1.5:1	1.5:1	0.6	0.0250	0.30			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	60.85 cfs	
Depth:	2.03 ft	2.33 ft
Top Width:	9.09 ft	9.99 ft
Velocity:	4.96 fps	
X-Section Area:	12.27 sq ft	
Hydraulic Radius:	1.189 ft	
Froude Number:	0.75	

Structure Detail:

Structure #12 (Erodible Channel)

DITCH J8

Trapezoidal Erodible Channel Inputs:

Material: Alluvial silts noncolloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.00	1.5:1	1.5:1	0.7	0.0200	0.30			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.30 cfs	
Depth:	0.20 ft	0.50 ft
Top Width:	3.60 ft	4.50 ft
Velocity:	1.97 fps	
X-Section Area:	0.66 sq ft	
Hydraulic Radius:	0.177 ft	
Froude Number:	0.81	

Structure Detail:

Structure #30 (Riprap Channel)

DITCH J9

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.00	1.5:1	1.5:1	11.0	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	15.45 cfs	
Depth:	0.30 ft	1.30 ft
Top Width:	3.91 ft	6.91 ft
Velocity*:		
X-Section Area:	1.05 sq ft	
Hydraulic Radius:	0.256 ft	
Froude Number*:		
Manning's n*:		
Dmin:	5.00 in	
D50:	15.00 in	
Dmax:	18.75 in	

Velocity and Manning's n calculations may not apply for this method.

Structure Detail:

Structure #13 (Erodible Channel)

DITCH J10

Trapezoidal Erodible Channel Inputs:

Material: Shales and hardpans

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.00	1.5:1	1.5:1	1.0	0.0250	1.00			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	27.15 cfs	
Depth:	1.15 ft	2.15 ft
Top Width:	6.46 ft	9.46 ft
Velocity:	4.97 fps	
X-Section Area:	5.46 sq ft	
Hydraulic Radius:	0.762 ft	
Froude Number:	0.95	

Structure Detail:

Structure #31 (Riprap Channel)

DITCH J11

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.00	1.5:1	1.5:1	8.0	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	34.42 cfs	
Depth:	0.61 ft	1.61 ft
Top Width:	4.83 ft	7.83 ft
Velocity*:		
X-Section Area:	2.38 sq ft	
Hydraulic Radius:	0.459 ft	
Froude Number*:		
Manning's n*:		
Dmin:	6.00 in	
D50:	18.00 in	
Dmax:	22.50 in	

Velocity and Manning's n calculations may not apply for this method.

Structure Detail:

Structure #14 (Erodible Channel)

DITCH J12

Triangular Erodible Channel Inputs:

Material: Shales and hardpans

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
20.0:1	3.0:1	2.0	0.0250	0.30			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	5.48 cfs	
Depth:	0.41 ft	0.71 ft
Top Width:	9.32 ft	16.22 ft
Velocity:	2.90 fps	
X-Section Area:	1.89 sq ft	
Hydraulic Radius:	0.202 ft	
Froude Number:	1.14	

Structure Detail:

Structure #15 (Erodible Channel)

DITCH J13

Triangular Erodible Channel Inputs:

Material: Shales and hardpans

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.0:1	20.0:1	2.0	0.0250	0.30			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	5.57 cfs	
Depth:	0.41 ft	0.71 ft
Top Width:	9.38 ft	16.28 ft
Velocity:	2.91 fps	
X-Section Area:	1.91 sq ft	
Hydraulic Radius:	0.203 ft	
Froude Number:	1.14	

Structure Detail:

Structure #41 (Erodible Channel)

Ditch 21

Triangular Erodible Channel Inputs:

Material: Shales and hardpans

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.5:1	1.5:1	1.0	0.0250	1.00			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	7.34 cfs	
Depth:	1.16 ft	2.16 ft
Top Width:	3.47 ft	6.47 ft
Velocity:	3.66 fps	
X-Section Area:	2.00 sq ft	
Hydraulic Radius:	0.481 ft	
Froude Number:	0.85	

Structure Detail:

Structure #42 (Erodible Channel)

W Div #1

Trapezoidal Erodible Channel Inputs:

Material: Shales and hardpans

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
15.00	1.5:1	15.0:1	5.0	0.0250	0.30			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	9.19 cfs	
Depth:	0.15 ft	0.45 ft
Top Width:	17.55 ft	22.50 ft
Velocity:	3.65 fps	
X-Section Area:	2.52 sq ft	
Hydraulic Radius:	0.143 ft	
Froude Number:	1.70	

Structure Detail:

Structure #20 (Culvert)

CULVERT J-4

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
28.00	2.00	0.0240	5.00	0.00	0.90

Culvert Results:

Design Discharge = 34.42 cfs

Minimum pipe diameter: 1 - 30 inch pipe(s) required

Structure Detail:

Structure #33 (Culvert)

CULVERT J8

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
80.00	2.00	0.0150	2.50	0.00	0.90

Culvert Results:

Design Discharge = 7.19 cfs

Minimum pipe diameter: 1 - 15 inch pipe(s) required

Structure Detail:

Structure #47 (Culvert)

Culvert J9

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
30.00	2.00	0.0240	5.00	0.00	0.90

Culvert Results:

Design Discharge = 25.21 cfs

Minimum pipe diameter: 1 - 24 inch pipe(s) required

* DOUBLE BARREL 24" PIPES *

Structure Detail:

Structure #38 (Culvert)

CULVERT J18

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
30.00	2.00	0.0150	2.75	0.00	0.90

Culvert Results:

Design Discharge = 7.34 cfs

Minimum pipe diameter: 1 - 15 inch pipe(s) required

Structure Detail:

Structure #39 (Culvert)

CULVERT J19

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
30.00	5.00	0.0150	4.50	0.00	0.90

Culvert Results:

Design Discharge = 15.45 cfs

Minimum pipe diameter: 1 - 18 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#10	1	0.600	0.087	0.000	0.000	87.000	TR55	0.87	0.069
	Σ	**0.600**						**0.87**	**0.069**
#9	1	0.800	0.065	0.000	0.000	87.000	TR55	1.16	0.092
	Σ	**0.800**						**1.16**	**0.092**
#4	Σ	**1.400**						**2.03**	**0.161**
#16	1	0.130	0.042	0.000	0.000	74.000	TR55	0.10	0.004
	2	1.170	0.002	0.000	0.000	70.000	TR55	0.69	0.049
	Σ	**2.700**						**2.82**	**0.214**
#18	1	0.670	0.187	0.000	0.000	87.000	TR55	0.90	0.077
	2	3.530	0.376	0.000	0.000	70.000	TR55	1.27	0.146
	Σ	**4.200**						**1.88**	**0.223**
#34	1	2.180	0.013	0.000	0.000	81.000	TR55	2.45	0.184
	2	0.200	0.444	0.000	0.000	98.000	TR55	0.35	0.033
	3	1.200	0.100	0.000	0.000	87.000	TR55	1.74	0.139
	Σ	**3.580**						**4.50**	**0.356**
#35	Σ	**3.580**						**4.50**	**0.356**
#36	Σ	**3.580**						**4.50**	**0.356**
#22	1	0.910	0.033	0.000	0.000	87.000	TR55	1.32	0.105
	Σ	**0.910**						**1.32**	**0.105**
#37	Σ	**0.910**						**1.32**	**0.105**
#27	Σ	**0.910**						**1.32**	**0.105**
#28	1	0.050	0.007	0.000	0.000	87.000	TR55	0.07	0.003
	Σ	**0.960**						**1.39**	**0.108**
#23	1	0.330	0.023	0.000	0.000	87.000	TR55	0.48	0.035
	Σ	**0.330**						**0.48**	**0.035**
#25	Σ	**0.330**						**0.48**	**0.035**
#24	1	0.180	0.016	0.000	0.000	87.000	TR55	0.26	0.016
	Σ	**0.510**						**0.74**	**0.050**
#26	Σ	**0.510**						**0.74**	**0.050**
#29	1	0.050	0.007	0.000	0.000	87.000	TR55	0.07	0.003

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
	Σ	**0.560**						**0.81**	**0.054**
#12	1	1.290	0.336	0.000	0.000	74.000	TR55	0.70	0.071
	Σ	**1.850**						**1.30**	**0.125**
#33	Σ	**6.390**						**7.19**	**0.589**
#41	1	0.100	0.100	0.000	0.000	87.000	TR55	0.15	0.007
	Σ	**6.490**						**7.34**	**0.596**
#38	Σ	**6.490**						**7.34**	**0.596**
#14	1	3.520	0.142	0.000	0.000	90.000	TR55	5.48	0.482
	Σ	**3.520**						**5.48**	**0.482**
#30	1	0.650	0.069	0.000	0.000	90.000	TR55	1.05	0.087
	2	1.220	0.256	0.000	0.000	90.000	TR55	1.79	0.162
	Σ	**11.880**						**15.45**	**1.328**
#39	Σ	**11.880**						**15.45**	**1.328**
#15	1	3.580	0.169	0.000	0.000	90.000	TR55	5.57	0.490
	Σ	**3.580**						**5.57**	**0.490**
#48	1	5.700	0.000	0.000	0.000	74.000	TR55	4.39	0.316
	Σ	**5.700**						**4.39**	**0.316**
#42	1	23.500	0.268	0.000	0.000	57.000	TR55	0.74	0.271
	2	0.150	0.100	0.000	0.000	74.000	TR55	0.12	0.005
	3	7.910	0.021	0.000	0.000	81.000	TR55	8.88	0.668
	4	0.720	0.100	0.000	0.000	61.000	TR55	0.16	0.010
	Σ	**32.280**						**9.19**	**0.953**
#43	1	2.250	0.005	0.000	0.000	57.000	TR55	0.19	0.026
	2	8.670	0.006	0.000	0.000	61.000	TR55	1.95	0.163
	3	22.100	0.012	0.000	0.000	57.000	TR55	1.87	0.253
	4	3.140	0.028	0.000	0.000	89.000	TR55	4.91	0.403
	5	1.040	0.002	0.000	0.000	81.000	TR55	1.17	0.088
	6	2.800	0.012	0.000	0.000	57.000	TR55	0.24	0.032
	7	5.820	0.016	0.000	0.000	61.000	TR55	1.31	0.110
	Σ	**78.100**						**20.83**	**2.027**
#44	Σ	**83.800**						**25.21**	**2.343**
#46	Σ	**83.800**						**25.21**	**2.343**
#45	Σ	**83.800**						**25.21**	**2.343**
#49	Σ	**83.800**						**25.21**	**2.343**

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#47	**Σ**	**83.800**						**25.21**	**2.343**
#13	1	1.360	0.242	0.000	0.000	90.000	TR55	2.02	0.183
	Σ	**85.160**						**27.15**	**2.525**
#31	1	0.430	0.052	0.000	0.000	87.000	TR55	0.62	0.049
	2	0.760	0.040	0.000	0.000	90.000	TR55	1.23	0.102
	Σ	**89.930**						**34.42**	**3.166**
#20	**Σ**	**89.930**						**34.42**	**3.166**
#7	1	4.630	0.014	0.000	0.000	90.000	TR55	7.49	0.624
	2	4.510	0.461	0.000	0.000	87.000	TR55	5.01	0.520
	Σ	**110.950**						**60.85**	**5.639**
#5	1	1.140	0.100	0.000	0.000	89.000	TR55	1.78	0.146
	2	2.420	0.100	0.000	0.000	74.000	TR55	1.86	0.134
	Σ	**3.560**						**3.64**	**0.280**
#2	**Σ**	**114.510**						**64.49**	**5.919**
#8	1	0.800	0.062	0.000	0.000	87.000	TR55	1.16	0.092
	Σ	**119.510**						**67.07**	**6.234**
#3	**Σ**	**119.510**						**67.07**	**6.234**
#11	**Σ**	**119.510**						**67.07**	**6.234**
#1	**Σ**	**122.210**						**69.89**	**6.448**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#5	1	3. Short grass pasture	8.42	70.00	831.00	2.320	0.099
#5	**1**	**Time of Concentration:**					**0.100**
#5	2	2. Minimum tillage cultivation	9.18	80.00	871.00	1.510	0.160
#5	**2**	**Time of Concentration:**					**0.100**
#7	1	5. Nearly bare and untilled, and alluvial valley fans	22.86	56.00	245.00	4.780	0.014
#7	**1**	**Time of Concentration:**					**0.014**
#7	2	6. Grassed waterway	0.55	10.00	1,826.48	1.100	0.461
#7	**2**	**Time of Concentration:**					**0.461**
#8	1	7. Paved area and small upland gullies	1.00	4.50	450.00	2.010	0.062
#8	**1**	**Time of Concentration:**					**0.062**
#9	1	7. Paved area and small upland gullies	1.00	4.69	471.02	2.000	0.065
#9	**1**	**Time of Concentration:**					**0.065**

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#10	1	5. Nearly bare and untilled, and alluvial valley fans	1.02	3.20	315.02	1.000	0.087
#10	**1**	**Time of Concentration:**					**0.087**
#12	1	5. Nearly bare and untilled, and alluvial valley fans	0.48	4.00	835.00	0.690	0.336
#12	**1**	**Time of Concentration:**					**0.336**
#13	1	5. Nearly bare and untilled, and alluvial valley fans	0.94	8.00	847.00	0.970	0.242
#13	**1**	**Time of Concentration:**					**0.242**
#14	1	5. Nearly bare and untilled, and alluvial valley fans	2.48	20.00	806.00	1.570	0.142
#14	**1**	**Time of Concentration:**					**0.142**
#15	1	5. Nearly bare and untilled, and alluvial valley fans	2.21	20.00	903.05	1.480	0.169
#15	**1**	**Time of Concentration:**					**0.169**
#16	1	3. Short grass pasture	11.00	45.00	409.00	2.650	0.042
#16	**1**	**Time of Concentration:**					**0.042**
#16	2	5. Nearly bare and untilled, and alluvial valley fans	38.71	24.00	62.00	6.220	0.002
#16	**2**	**Time of Concentration:**					**0.002**
#18	1	5. Nearly bare and untilled, and alluvial valley fans	3.28	40.00	1,220.03	1.810	0.187
#18	**1**	**Time of Concentration:**					**0.187**
#18	2	2. Minimum tillage cultivation	3.28	40.00	1,220.03	0.900	0.376
#18	**2**	**Time of Concentration:**					**0.376**
#22	1	5. Nearly bare and untilled, and alluvial valley fans	5.84	17.00	291.00	2.410	0.033
#22	**1**	**Time of Concentration:**					**0.033**
#23	1	5. Nearly bare and untilled, and alluvial valley fans	5.26	10.00	190.00	2.290	0.023
#23	**1**	**Time of Concentration:**					**0.023**
#24	1	5. Nearly bare and untilled, and alluvial valley fans	7.50	12.00	160.00	2.730	0.016
#24	**1**	**Time of Concentration:**					**0.016**
#28	1	5. Nearly bare and untilled, and alluvial valley fans	9.76	8.00	82.00	3.120	0.007
#28	**1**	**Time of Concentration:**					**0.007**
#29	1	5. Nearly bare and untilled, and alluvial valley fans	10.53	8.00	76.00	3.240	0.006
#29	**1**	**Time of Concentration:**					**0.007**
#30	1	5. Nearly bare and untilled, and alluvial valley fans	5.47	32.00	585.01	2.330	0.069
#30	**1**	**Time of Concentration:**					**0.069**
#31	1	5. Nearly bare and untilled, and alluvial valley fans	10.10	60.00	594.00	3.170	0.052
#31	**1**	**Time of Concentration:**					**0.052**
#31	2	5. Nearly bare and untilled, and alluvial valley fans	9.09	40.00	440.00	3.010	0.040
#31	**2**	**Time of Concentration:**					**0.040**

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#34	1	5. Nearly bare and untilled, and alluvial valley fans	12.43	21.00	169.00	3.520	0.013
#34	**1**	**Time of Concentration:**					**0.013**
#34	2	5. Nearly bare and untilled, and alluvial valley fans	0.25	2.00	800.00	0.500	0.444
#34	**2**	**Time of Concentration:**					**0.444**
#48	1	8. Large gullies, diversions, and low flowing streams	400.00	600.00	150.00	60.000	0.000
#48	**1**	**Time of Concentration:**					**0.000**

Subwatershed Muskingum Routing Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#16	1	4. Cultivated, straight row	7.77	60.00	772.00	2.490	0.086
#16	**1**	**Muskingum K:**					**0.000**

V-Ditch Design

		Ditch Grade		Minimum Grade		Maximum Grade		RipRap	Peak
		Min	Max	Depth	Velocity	Depth	Velocity	D_{50} Inch	Flow
	C12	7.0%	12.0%	0.84	6.5	0.76	8.0	9	6.84
	C13	7.0%	11.0%	0.39	3.9	0.36	4.6		0.86
**	C14	5.0%	50%	Trapezoidal Channel C-Gulch					39.61
	C15	7.0%	11.0%	0.38	3.8	0.35	4.6		0.75
	C16	2.0%	5.0%	1.98	6.2	1.68	8.7	9	37.59
	C17	7.0%	11.0%	0.46	4.4	0.42	5.1		1.33
***	C18	33%	33%	0.68	12.3	0.68	12.3	9	8.50
	C19	25%	25%	0.21	4.9	0.21	4.9		0.29
	C-20	7.0%	11.0%	0.40	4.0	0.37	4.7		0.93
	C-21	7.0%	11.0%	0.38	3.8	0.35	4.6		1.02
	C-22	7.0%	11.0%	0.91	6.9	0.84	8.2	9	8.87
	C-23	7.0%	11.0%	0.97	7.2	0.89	8.5	9	10.31
	C-24	40.0%	40.0%	0.61	12.6	0.61	15.5	21	6.84
	C-25	10.0%	20.0%	0.18	2.8	0.16	3.5		0.16
	C-26	7%	7%	1.00	7.3	1.00	7.3		10.74
**	Riprap lined trapezoidal channel in C-Gulch - See pages 8-14 - 8-16								
***	Line with gunnite, concrete or other material to prevent infiltration.								
Ditch	D1	SEE DESIGN BEGINNING ON PAGE VOLUME XI, B-29							
	D2	SEE DESIGN BEGINNING ON PAGE VOLUME XI, B-30							
	D3	20%	50%	0.10	8.5	0.30	4.2	6	0.60
	D4	2%	10%	0.44	2.3	0.33	4.2		0.78
	D5	2%	2%	0.38	2.6	0.38	2.58		0.74
	D6	2%	2%	0.36	2.4	0.36	2.39		0.47
Ditch	E1	SEE DESIGN BEGINNING ON PAGE VOLUME XI, B-31							
	G1	Renamed Ditch D-4							
	G2	Deleted from Design							
Ditch	SAE1	Deleted from Design							
	SAE2	Deleted from Design							
Ditch	FG1	30%	30%	0.21	5.4	0.21	5.4		0.33
Ditch	GVB1	28%	28%	0.16	4.3	0.16	4.3		0.16
	GVB2	17%	17%	0.15	3.2	0.15	3.2		0.11
	GVB3	10%	10%	0.17	2.7	0.17	2.7		0.11
	GVB4	47%	47%	0.20	6.5	0.20	6.5	6	0.35
	GVB5	35%	35%	0.18	5.2	0.18	5.2		0.25
	GVB6	15%	15%	0.20	3.7	0.20	3.7		0.20
	GVB7	10%	2%	0.30	3.9	0.43	2.2		0.60
Berm along coal stockpile pad - flow in ditches B 30, 31, 32									
				Height	Velocity	Height	Velocity		
		1%	2%	1.00	2.8	0.87	3.6		4.00
Berms Freeman Gulch									
		2%	4%	0.34	1.9	0.30	2.5		0.33
			Provide riprap, gunnite or concrete lined V-Ditch as						
			necessary for erosion protection.						
			Ditches cut in rock will not require erosion protection.						
Flow depth in feet does not include 0.3 feet freeboard									

Water Control Measures

Rule 4.09.1(13) requires that an appropriate underdrain be installed if seeps, springs or waterways, natural or manmade, are in the coal waste disposal footprint area. A June 2013 inspection of the site found that seepage from the Fire Mountain Canal had surfaced in the upper diversion ditch. Wet areas were also noted below the upper diversion ditch. The seepage did not cause any perceptible flow. The design of a rock subdrainage system is detailed below.

The run-off and collection ditches are shown on Map 21 and Volume XI Figure 1. Run-off from the benches will be directed to the east and west to collection ditches. The east and west collection ditches D-J8 and D-J9 are; 1) lined with riprap where necessary to ensure they are stable; 2) constructed off the fill and; 3) designed to safely pass the run-off from the 100-year, 24-hour precipitation event.

See Appendix B for detailed design information of the run-off and collection ditches.

Sedimentation Pond

Sediment Pond J was modified so it will contain the additional run-off from the coal mine refuse disposal area. The sediment pond and the general drainage plan for the waste disposal site were prepared by Tammerin Kae Stover-Bishop, Colorado Professional Engineer, No. 43402. See Map 22-J.

The total drainage area associated with the new coal mine waste disposal area is approximately 37 acres. The area was divided into separate watersheds draining into run-off and collection ditches designed to handle the run-off from the 100-year, 24-hour precipitation event. The drainage areas are shown on Map 20 in Volume II.

The modified sediment pond was sized to contain the run-off from the 10-year 24-hour precipitation event (1.8 inches). This storm event will generate approximately 3.0 acre feet of runoff. Sediment accumulation was estimated with the use of the Universal Soil Loss Equation. The pond has been designed to contain approximately 3.93 acre feet of water and .58 acre feet of sediment. The sediment pond will be dewatered if it contains water above the maximum

sediment level. This dewatering event should occur within 48 hours after the storm event which caused the water accumulation. When sediment accumulation reaches 75% of the maximum sediment storage elevation, the sediment will be removed and placed in the waste pile.

The mine waste pile and associated sedimentation structures are designed for compliance with the effluent limitations of Rule 4.05.2. Drainage calculations are presented in Appendix B.

Sediment pond J has been designed to increase its capacity. Material from the excavation was placed in the foundation of the access road along the southern border of the pond. The embankment will not be modified.

Subdrainage System

The purpose of the subdrainage system is to 1) intercept all sources of water, 2) be protected by an adequate filter, and 3) be covered so as to protect against the entrance of surface water or leachate or other coal processing waste. In the case of gob pile #3, there have been no springs or seeps identified in the footprint of the pile. The only source of water identified is from the Fire Mountain Canal.

Two rock subdrainage systems consisting of durable non-acid-forming and non-toxic-forming rock will be constructed to intercept seepage from the Fire Mountain Canal to assure the foundation of the coal mine waste pile does not become saturated. The West drain will be about 100 feet wide near where the seepage emerges below the upper diversion ditch and then taper down to a two-foot wide by two feet deep trench. A perforated pipe will be installed in the rock drain. See Map 21-1 for details.

The location of the East subdrainage system is shown on Figure 1. The subdrainage systems will be very similar in design, the main difference will be the amount of rock in the upper area of the trenches. The subdrains will be referred to as “West” and “East” subdrainage systems.

The two subdrains are different in appearance, but function the same. The intent of each subdrain is to capture water from the fire mountain canal and direct it

away from the gob pile. There has been no groundwater, seeps, or springs identified in the footprint, so there is no need to have the east underdrain match the design and configuration of the west subdrain.

For the West subdrain, the majority of the rock drain has 4 square feet of 3/4" screened or washed rock. The upper section of the rock drain has approximately 200 square feet of screened or washed rock. The drain has a slope of 2% to 8%. Darcy's Law was used to calculate the flow though the drain.

Darcy's Law is Q = kA dh/dl
where:

Q = rate of water flow calculated by formula (0.16 to 64.0 cubic feet per minute)
k = hydraulic conductivity of clean gravel (2.0 to 200 ft/minute)[1]
A = column cross sectional area (4 SF)
dh/dl = hydraulic gradient, the change in head over the length of interest (0.02 to 0.08).

The estimated flow rate through the rock drain is 1.2 to 479 gallons per minute. The seepage from the Fire Mountain Canal does not have a perceptible flow. Therefore, even if the rock drain can only pass 1.2 gallons per minute, it is adequate for the seepage from the Fire Mountain Canal. The perforated pipe in the rock drain will significantly increase its flow capacity.

The rock drain including the upper wide and tapering segment of the drain was wrapped in geotextile fabric. Twelve inches of common fill was placed over the rock drain so as to protect against the entrance of surface water or leachate from the coal processing waste. The perforated pipe in the rock drain extends the full length of the drain except for the final 20 feet which is a solid pipe. The solid pipe will discharge into ditch D-J3. A screen was placed over the outlet of the solid pipe to keep rodents out of the pipe.

For the East subdrain, the majority of the rock drain will have 4 square feet of 3/4" screened or washed rock. The upper section of the rock drain will have up to 200 square feet of screened or washed rock. The drain will have a slope of approximately 2%. Darcy's Law can be used to calculate the flow though the drain.

Darcy's Law is Q = kA dh/dl

1 Principles of Geotechnical Engineering, Braja M. DAS, 1985, page 84.

where:

Q = rate of water flow calculated by formula (0.1 to 64 cubic feet per minute)
k = hydraulic conductivity of clean gravel (2.0 to 200 ft/minute)[2]
A = column cross sectional area (4 SF)
dh/dl = hydraulic gradient, the change in head over the length of interest (0.02 to .08).

The estimated flow rate through the rock drain is 1.2 to 479 gallons per minute. The seepage from the Fire Mountain Canal does not have a perceptible flow. Therefore, even if the rock drain can only pass 1.2 gallons per minute, it is adequate for the seepage from the Fire Mountain Canal. The perforated pipe in the rock drain will significantly increase its flow capacity.

The rock drain including the upper wide and tapering segment of the drain will be wrapped in geotextile fabric. Twelve inches of common fill will be placed over the rock drain so as to protect against the entrance of surface water or leachate from the coal processing waste. The perforated pipe in the rock drain will extend the full length of the drain except for the final 20 feet which shall be a solid pipe. The underdrain will discharge into ditch D-J11. A screen shall be placed over the outlet of the solid pipe to keep rodents out of the pipe.