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MINE ENGINEERING
MINE RECLAMATION

CIVIL ENGINEERING
CONST. MANAGEMENT

November 17, 2020

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

Re: Bowie Resources, LLC, Bowie No. 2 Mine
Technical Revision No. 122
Hydrology Revision
Permit C-1996-083

Dear Mr. Zuber:

On behalf of Bowie Resources, LLC, (BRL), enclosed is technical revision application No. 122. This revision will revise the hydrology in and around gob pile No. 3, and pond J.

Specifically:

- In order to remove sedimentation control and eventually an Outfall from the CDPHE discharge permit, SAE #10 will now be included into the hydrology network of Pond J.
- Remove the Clean Water Ditch (CW Diversion Ditch) from the hydrologic plan, and add flow from what was the CW ditch into the Pond J network. **Therefore, remove the CW ditch designs as shown on Volume XI, pages Exh. 69 through 79.**
- For completeness in modeling, Ditches D1 and D2 will now be part of the Pond J hydrology and included in Appendix B. These ditches convey from Drainage area "D" and West Diversion ditch #1 which are currently approved as part of the CW Ditch network. Notes will be added to pages **Exh. 8-11 and Exh. 8-12 and to where** to find the new ditch designs. Please also see revised pages **Exh. 8-29i & 8-31**
- In the location of the designed CW ditch, re-align the east underdrain. A revised typical section is shown on **Volume XI, page 4b**.
- Update Ditch J-10 on permit maps to more closely match on the ground conditions. A haul road will remain in place north of the gob pile, therefore the upper diversion ditch will not be at the toe of the pile, but rather on the outslope of the road.
- Remove Ditch J-20 from permit maps as flow from gob pile #3 is currently flowing into Ditch J-8 due to haul road north of gob pile.
- Provide design for Ditch J21 which was inadvertently not included in prior revisions.
- The flow for Culvert J3 was revised down, a networking error was discovered and changed.

- **Volume XI pages 5 and 7** have been revised and are included.
- Due to the numerous changes to Appendix B, the SedCad pages, **Volume XI pages, App. B-2 to B-77 are included.**

Please let me know if you have any additional questions.

Sincerely,

Tamme Bishop

Tamme Bishop, P.E.
Project Engineer

Cc: Basil Bear

Enclosures:

Volume II:	Maps 15-1, 15-3, 20, 21-1, 21-3 and 22
Volume III:	Pages App. B-11, 12, 29i & 31
Volume XI:	Text pages 5 & 7, Appendix B pages 2-77
	Remove currently approved pages App. B-69 through 79, pages to be replaced by new Appendix B pages.

COLORADO DIVISION OF RECLAMATION, MINING AND SAFETY
1313 Sherman Street, Room 215, Denver, Colorado 80203, (303) 866-3567

APPLICATION FORM FOR A REVISION TO A COAL MINING AND RECLAMATION PERMIT

This form must be completed and submitted with all requests for minor revisions, as defined in Rule 1.04(73), technical revisions, as defined in Rule 1.04(136), and permit revisions, as defined in Rule 1.04(90). All revisions are to address the requirements of Rule 2.08.4. Three (3) copies of the revision, including maps, must be submitted in order for it to be complete.

All revisions are to be formatted so they can be inserted into the permit to replace the revised sections, maps, tables and/or figures, with a revised table of contents, if necessary. The revision submittal date should be printed in the lower right corner of each revision page. A cover letter to the revision should explain the nature of the revision and reference the specific permit sections being revised.

For federal mines, a copy of the revision application must be submitted to all agencies on the federal mailing list (except OSM) at the same time the application is submitted to the Division, and proof of distribution must be submitted to the Division along with the application. Copies of revision pages modified during the review process must be distributed in the same manner, along with proof of distribution. Proof of distribution must be submitted prior to implementation of the revision.

Permit No.: C - 1996 - 083 Date: 11 / 18 / 2020

Permittee: Bowie Resources, LLC

Bowie No. 2 Mine

Street: P.O. Box 483

City: Paonia

State: CO Zip Code: 81428 -

Brief Description of Revision: Revise the hydrology of the Pond J network. Update on the ground locations of ditches, revise location of the East underdrain, and remove the clean water ditch and add flow from this area into the Pond J network.

Public Notice Attached: Yes ✓ No __ *(Required for PRs and TRs)*

Bond Increase: Yes __ No ✓ **Federal** ✓ **Non-Federal** __ **Mine**

Proposed Change in:

Permit Area -

Disturbed	(+/-) __ __ 0 . 0	Acres
Permit	(+/-) __ __ 0 . 0	Acres
Affected	(+/-) __ __ 0 . 0	Acres

Surface Ownership -

Private Land	(+/-) __ __ 0 . 0	Acres
Federal Land	(+/-) __ __ 0 . 0	Acres
State Land	(+/-) __ __ 0 . 0	Acres

Mineral Ownership -

Mineral Private	(+/-) __ __ 0 . 0	Acres
Mineral Federal	(+/-) __ __ 0 . 0	Acres
Mineral State	(+/-) __ __ 0 . 0	Acres

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Ditch D-D2

Ditch D-D2 is formed when the flow from ditch D-D1 and ditch D-E1 join below sediment pond C. From the intersection of the two flows the ditch becomes a V-Ditch that must be capable of handling the combined flow from the two ditches.

Ditches D1, D2, Culvert D1, Drainage area E, and Ditch E-1 have been incorporated into Volume XI

** SEE DESIGN BEGINNING ON PAGE VOLUME XI, APP. B-29

Culvert C-D1, D2 & E1

** SEE DESIGN BEGINNING ON PAGE VOLUME XI, APP. B-41

Culvert C-E1

Culvert C-E1 was deleted from the design Jan. 1998

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.									

Culvert Summary and Minimum Size Requirements

		Drainage or Culvert Contributing Flow				Maximum Flow CFS	Minimum Culvert Inches	
Culverts	C-B1	Ditch B1	1.88			1.88	12	
	C-B2	Deleted from Design						
	C-B3	Drainage Area	0.67			0.67	12	
	C-B4	Deleted from Design						
	C-B5	Deleted from Design						
	C-B6	Deleted from Design						
	C-B7	Ditch B9	0.24	Ditch B8	0.67	0.91	12	
	C-B8	Ditch B10	1.17			1.17	12	
	C-B9	Ditch B12	1.62	Ditch B36	0.16	1.78	12	
	C-B10	Deleted from Design						
	C-B11	Ditch B15	3.56			3.56	18	
	C-B12	Drainage Area	1.76	Ditch B20	0.55	2.31	18	
	C-B13	Ditch B37	0.42			0.42	12	
	C-B14	Ditch B16	4.44			4.44	18	
	C-B15	Ditch B21	7.69	Ditch B24	2.63	10.32	24	Note 2
	C-B16	Ditch B23	10.71			10.71	24	Note 2
	C-B17	Ditch B-19	6.46	Ditch B-26	0.45	6.91	24	
	C-B18	Ditch B27 & 32	1.24	Ditch B22	0.45	1.69	12	
	C-B19	Culvert B18	1.69	Culvert B16	10.71	12.40	24	
	C-B20	Deleted from Design				0.00		
	C-B21	Drainage Area B - 25 Year Event				22.43	36	
	C-B22	Ditch B15	3.56			3.56	18	
	C-B23	Ditch B16	4.44			4.44	18	
	C-B24	Ditch B13	0.78			0.78	12	
	C-B25	Ditch B35	0.82			0.82	12	
	C-B26	Ditch B25	0.64			0.64	12	
	C-B27	Culvert B19	12.40			12.40	24	
	C-B28	Ditch B29	13.33			13.33	30	
	C-B29	Pond B/C Diversion Structure				0.00	18	Note 4
Culverts	C-C1	Ditch C1	1.42			1.42	12	
	C-C2	Deleted from Design - Plugged with TR-119				0.00	12	
	C-C3	Ditch C2	1.46			1.46	12	
	C-C4	Ditch C4	6.38			6.38	24	
	C-C5	Culvert C13	11.57	Culvert C4	6.38	17.95	30	
	C-C6	Deleted from Design						
	C-C7	Ditch C8	33.95			33.95	36	
	C-C8	Drainage Area	0.09			0.09	12	
	C-C9	Deleted from Design						
	C-C10	Ditch C15	0.75			0.75	12	
	C-C11	Ditch C12	6.84			6.84	24	Note 2
	C-C12	Ditch C17	1.33	Ditch C24	6.84	8.17	24	Note 2
	C-C13	Drainage Area D-C5 renamed C-C13 (page 63)				11.57	24	
	C-C14	Ditch C12	6.84			6.84	24	Note 2
	C-C15	Ditch C21	1.02	Ditch C22	8.87	9.89	24	Note 2
	C-C16	Ditch C18	8.50			8.50	24	Note 2
	C-C17	Ditch C19	0.29			0.29	12	
	C-C18	Deleted from Design						
	C-C19	Ditch C17	1.33			1.33	12	
	C-C20	Ditch C11	37.54			37.54	36	
	C-C21	Ditch C-C20	0.93			0.93	12	
	C-C22	Drainage Area	0.25			0.25	12	
	C-C23	Drainage Area	0.21			0.21	12	
	C-C24	Ditch C1	1.42			1.42	12	
	C-C25	Mine Water	0.50			0.50	12	
	C-C26	Drainage Area	1.66			1.66	36*	
	C-C27	Ditch B3	0.43			0.43	12	
Culverts	C-D1	SEE DESIGN BEGINNING ON PAGE VOLUME XI, B-41						
	C-D2	SEE DESIGN BEGINNING ON PAGE VOLUME XI, B-42						
	C-E1	Ditch E-1	0.00			0.00	12	
	C-G1	Deleted from design						
	C-G2	Ditch D-D4	0.42			0.42	12	
	C-G3	Ditch D-D3 & D6	1.07			1.07	24	
	C-G4	Ditch D-5	0.86				12	
	C-G5	Culvert D-1	9.70			9.70	36	
	C-G6	Pond C Primary Discharge				0.72	12	
	C-H1	Ditch H1	2.57			23.73	36**	
		CW Ditch	8.79	Ponds C& D Discharge		12.37		
		"J" Culvert designs located in Volume XI, Appendix B						
		** 36" in-place, design of C-26 requries a minimum of 10" be installed						
		** 42" in-place, design of C-H1 requries a minimum of 36" be installed						
	C-K1	Ditch K1	0.46	Ditch K2	0.97	1.43	12	
	C-K2	Ditch K3	1.70			1.70	12	
	C-K3	Wash down water	1.00			1.00	24	
	C-L1	Deleted from design.						
Culverts	SAE1	Deleted from design.						
	SAE2	Deleted from design.						
Note 1	End sections must conform to fill slopes.							
Note 2	An 18-inch culvert will handle 11 cfs with a HW/D ratio of 2.0. If an 18-inch culvert is to be used, assure rock headwall or road will provide 1.5' of head over top of culvert.							
Note 3	Culverts C-B19, B20,B21 & SAE2 are located under old State Highway 133. Maintenance and repair of these culverts is the responsibility of the operator.							
Note 4	Culvert B29 is the Pond B/C diversion structure. Water will be diverted to C-B29 only during times when maintenance or clean out of Pond C is necessary.							

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 2.9 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

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
where:

Q = rate of water flow calculated by formula (0.1 to 9.6 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.

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

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%	3.0	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	V-DITCH	13.0%	-	0.5		10-Year	7.9	7.9
	Ditch D-2	V-DITCH	2.0%	-	0.5	-	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	30.9	32.6
J3	12"						10-Year	1.1	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
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:

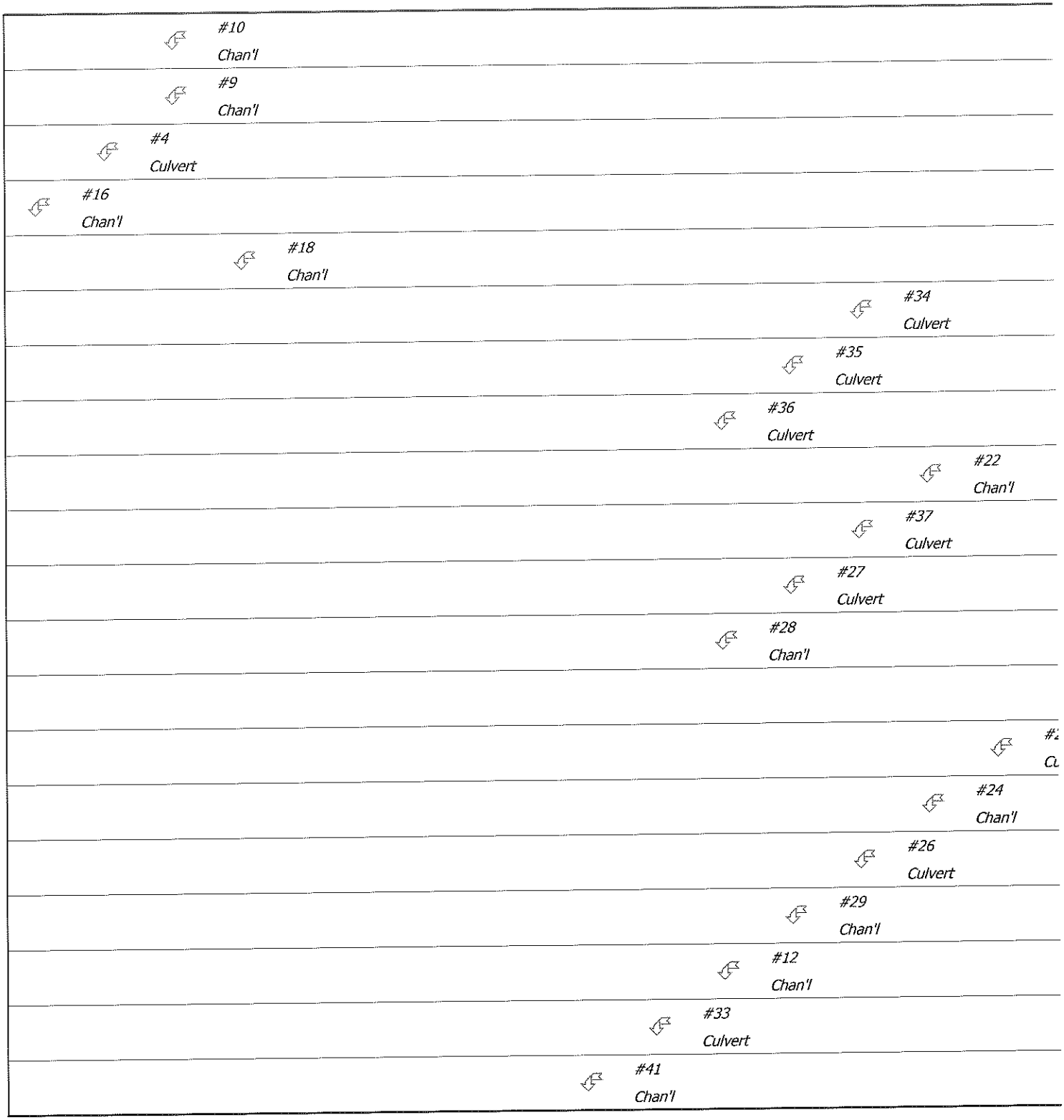
	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#10	0.600	0.600	0.49	0.03
#9	0.800	0.800	0.66	0.05
#4	0.000	1.400	1.15	0.08
#16	1.300	2.700	1.40	0.10
#18	4.200	4.200	0.60	0.09
#34	3.580	3.580	2.41	0.18
#35	0.000	3.580	2.41	0.18
#36	0.000	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
#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
#2	0.000	114.510	31.41	2.75

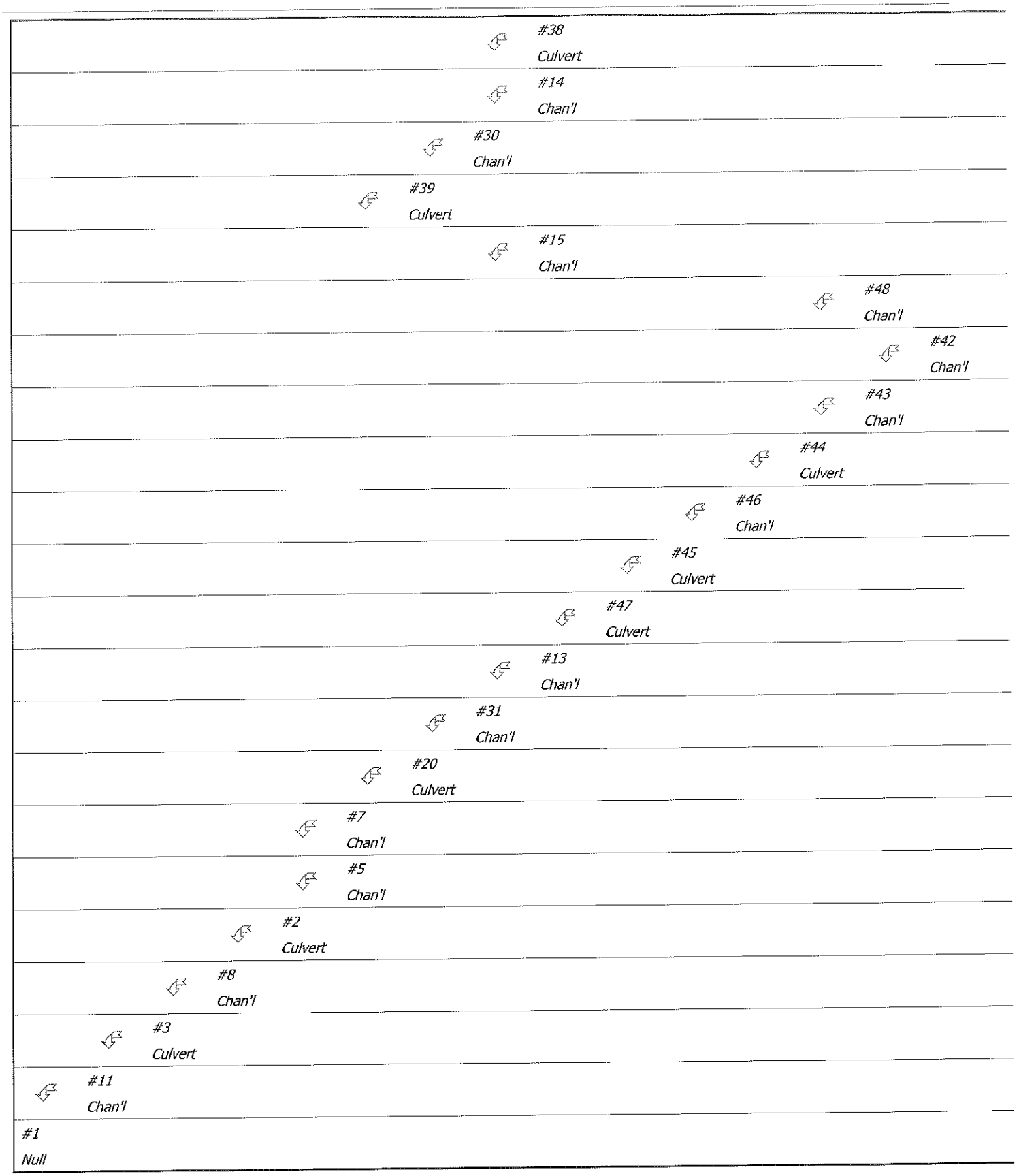
	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#8	0.800	119.510	32.56	2.89
#3	0.000	119.510	32.56	2.89
#11	0.000	119.510	32.56	2.89
#1	0.000	122.210	33.96	2.98

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	==>	#47	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




#38
Culvert
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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:	30.86 cfs	
Depth:	1.37 ft	1.67 ft
Top Width:	4.12 ft	5.02 ft
Velocity:	10.91 fps	
X-Section Area:	2.83 sq ft	
Hydraulic Radius:	0.571 ft	
Froude Number:	2.32	
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: Cobbles and shingles

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	5.0	0.0350	0.30			5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	7.91 cfs	
Depth:	0.22 ft	0.52 ft
Top Width:	10.67 ft	11.57 ft
Velocity:	3.41 fps	
X-Section Area:	2.32 sq ft	
Hydraulic Radius:	0.215 ft	
Froude Number:	1.29	

Structure Detail:

Structure #46 (Riprap Channel)

Ditch D2

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)
5.00	1.5:1	1.5:1	10.0	0.30		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	9.62 cfs	
Depth:	0.19 ft	0.49 ft
Top Width:	5.56 ft	6.46 ft
Velocity*:		
X-Section Area:	0.99 sq ft	
Hydraulic Radius:	0.174 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 #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 #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**
#47	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)
#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**
#10	1	5. Nearly bare and untilled, and alluvial valley fans	1.02	3.20	315.02	1.000	0.087

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#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**
#34	1	5. Nearly bare and untilled, and alluvial valley fans	12.43	21.00	169.00	3.520	0.013

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#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 - 6 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	0.94	0.05
#9	0.800	0.800	1.25	0.07
#4	0.000	1.400	2.19	0.11
#16	1.300	2.700	2.92	0.14
#18	4.200	4.200	1.49	0.14
#34	3.580	3.580	4.76	0.25
#35	0.000	3.580	4.76	0.25
#36	0.000	3.580	4.76	0.25
#22	0.910	0.910	1.42	0.07
#37	0.000	0.910	1.42	0.07
#27	0.000	0.910	1.42	0.07
#28	0.050	0.960	1.50	0.08
#14	3.520	3.520	5.81	0.35
#30	1.870	5.390	8.41	0.53
#39	0.000	5.390	8.41	0.53
#23	0.330	0.330	0.52	0.03
#25	0.000	0.330	0.52	0.03
#24	0.180	0.510	0.80	0.04
#26	0.000	0.510	0.80	0.04
#29	0.050	0.560	0.88	0.04
#12	1.290	7.240	9.55	0.62
#33	0.000	11.780	15.81	0.95
#41	0.100	11.880	15.97	0.95
#38	0.000	11.880	15.97	0.95
#15	3.580	3.580	5.90	0.36
#48	5.700	5.700	4.26	0.19
#42	32.280	32.280	9.40	0.53
#43	45.820	78.100	17.93	1.09
#44	0.000	83.800	22.19	1.28
#46	0.000	83.800	22.19	1.28
#45	0.000	83.800	22.19	1.28
#47	0.000	83.800	22.19	1.28
#13	1.360	85.160	24.13	1.41
#31	1.190	89.930	31.77	1.87
#20	0.000	89.930	31.77	1.87
#7	9.140	110.950	58.75	3.65
#5	3.560	3.560	3.75	0.18
#2	0.000	114.510	62.50	3.83
#8	0.800	119.510	64.79	4.04

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#3	0.000	119.510	64.79	4.04
#11	0.000	119.510	64.79	4.04
#1	0.000	122.210	67.71	4.18

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:

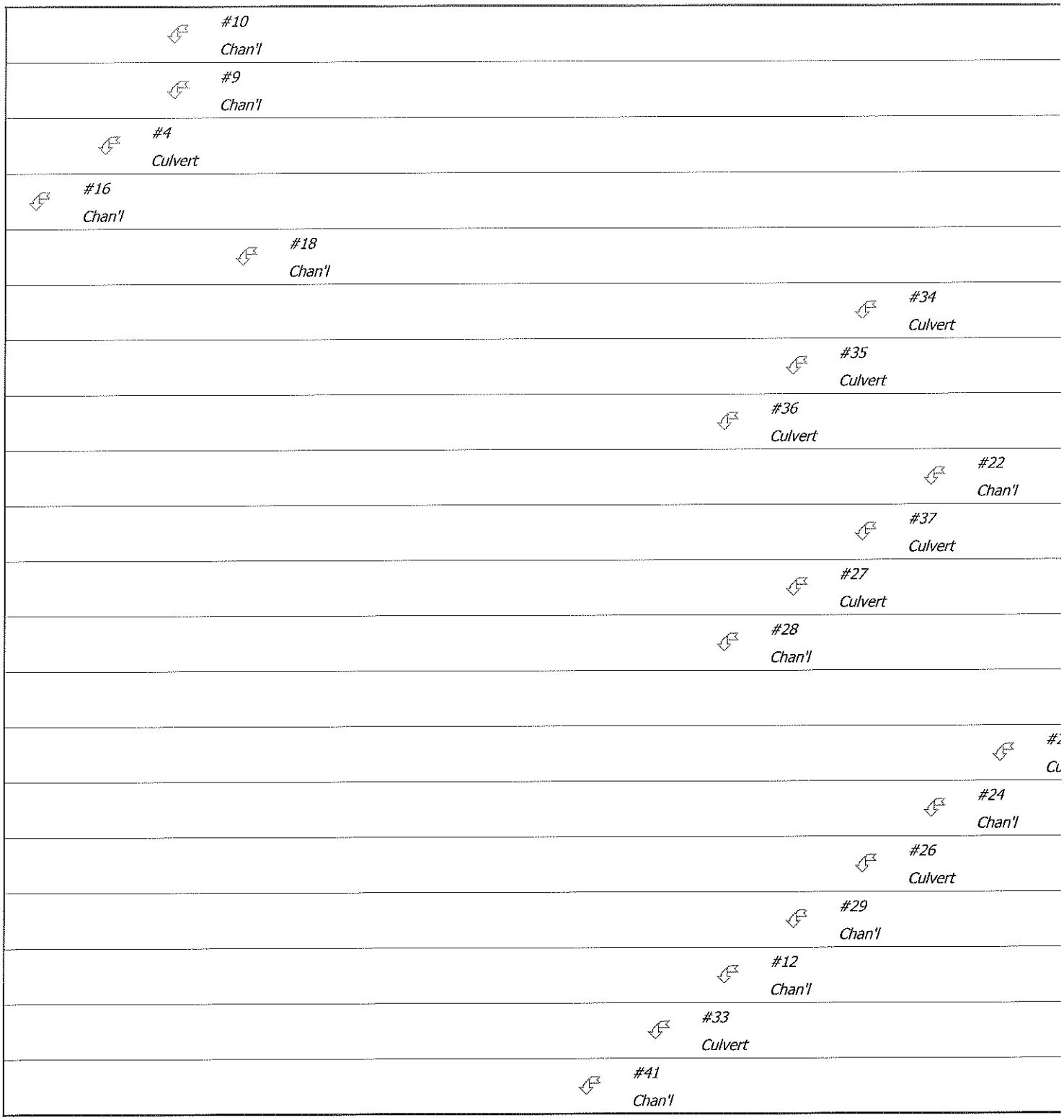
	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#10	0.600	0.600	0.63	0.05
#9	0.800	0.800	0.84	0.07
#4	0.000	1.400	1.48	0.11
#16	1.300	2.700	1.91	0.14
#18	4.200	4.200	1.00	0.14
#34	3.580	3.580	3.17	0.24
#35	0.000	3.580	3.17	0.24
#36	0.000	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
#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
#2	0.000	114.510	41.89	3.80

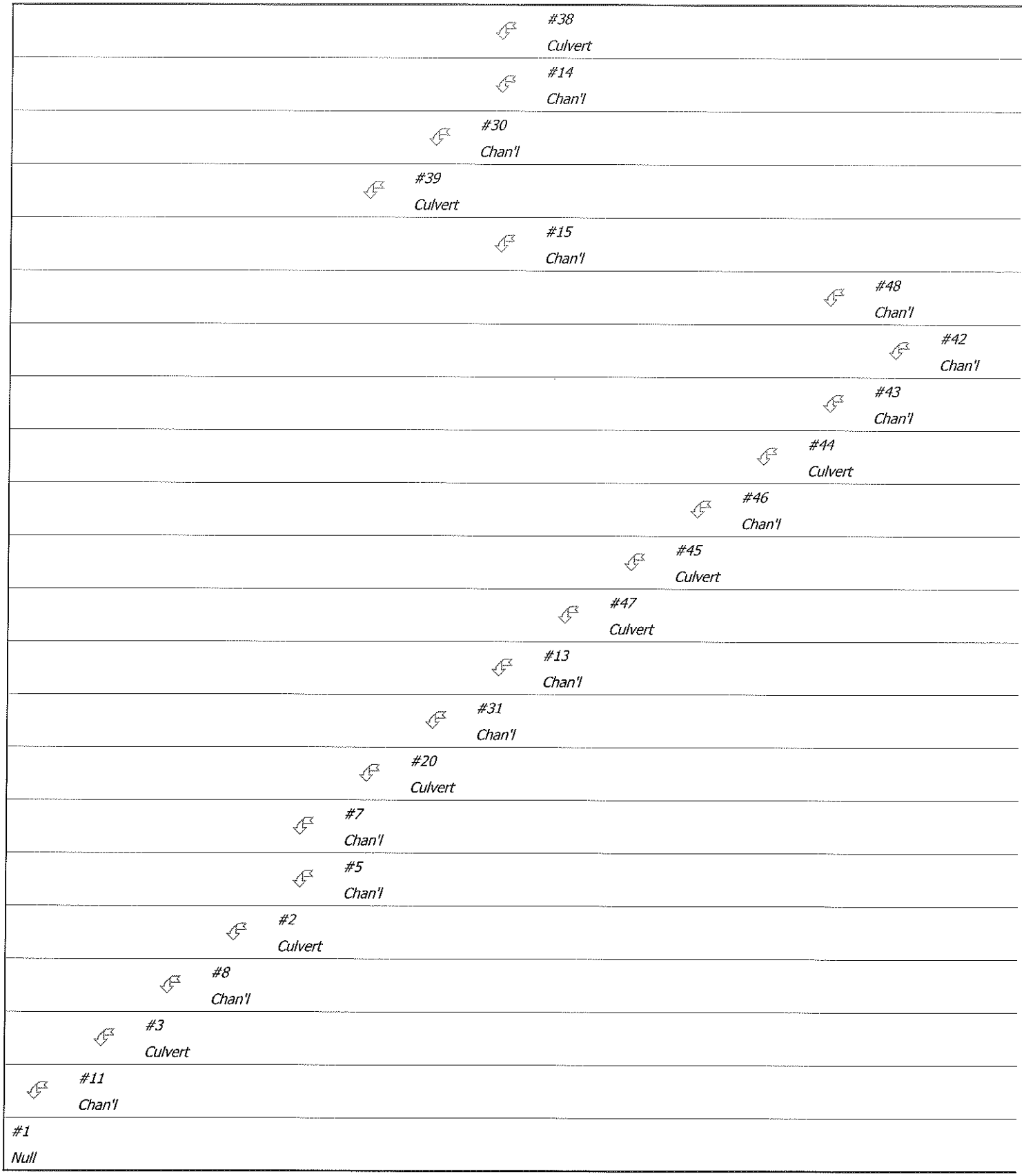
	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#8	0.800	119.510	43.49	4.00
#3	0.000	119.510	43.49	4.00
#11	0.000	119.510	43.49	4.00
#1	0.000	122.210	45.40	4.14

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	==>	#47	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




#38
Culvert
#14
Chan'l
#30
Chan'l
#39
Culvert
#15
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#43
Chan'l
#44
Culvert
#46
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#45
Culvert
#47
Culvert
#13
Chan'l
#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 #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

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)
0.00	1.5:1	1.5:1	1.0	0.0250	1.00			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	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**
#47	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)
#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**
#10	1	5. Nearly bare and untilled, and alluvial valley fans	1.02	3.20	315.02	1.000	0.087

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#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**
#34	1	5. Nearly bare and untilled, and alluvial valley fans	12.43	21.00	169.00	3.520	0.013

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#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**