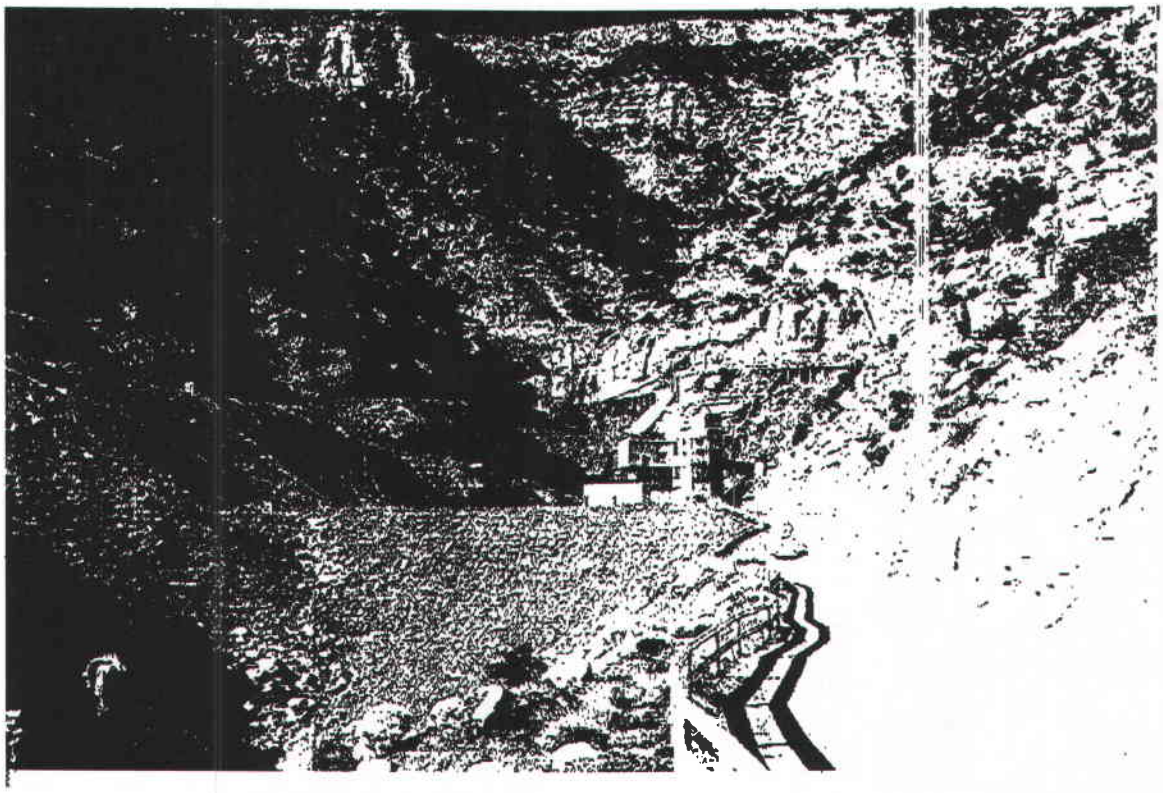
DES-BEE-DOVE MINES

2001 RECLAMATION PROJECT

SCOPE OF WORK

PHASE 1

CONTRACTOR BID PACKAGE



MARCH 2001

File in:
☐ Confidential
☐ Shelf
☒ Expandable
Refer to Record No 0012 Date 03092001
In C 0150017 2001, Filming
For additional information

0012

ENERGY WEST Mining Co.

PO Box 310
Huntington, Utah 84528

COPY

File in: C/015/0017 2001 Incoming
Refer to:
- ☐ Confidential
- ☐ Shelf
- ☒ Expandable

Date 03090 For additional information

FAX TRANSMITTAL MEMO

Incoming
C/015/017
Copy Sent

Date 3/9/01

PLEASE DELIVER TELECOPY TO: DARON HADDOCK

LOCATION: DOGM SLC

FROM: CHUCK SEMBOROSKI

NUMBER OF PAGES, INCLUDING THIS PAGE: _____

COMMENTS: DCS-REC-DOVE PHASE I RECLAMATION

This facsimile message is confidential. It may contain privileged information or be subject to other confidentiality requirements and exemptions from disclosure under applicable law. It is solely intended for the above-named individual(s). If you are not the intended recipient(s), or the person responsible to deliver this message to the intended recipient(s), you are hereby advised that any dissemination, distribution or copying of the communication is prohibited. If you have received this facsimile in error, please notify the sender immediately by calling (801) 687-4750. (Collect, if necessary.)
faxform.wpd

DES-BEE-DOVE MINES
2001 RECLAMATION PROJECT
SCOPE OF WORK
PHASE 1

Item 1. **Asphalt/Concrete Removal (refer to attached map)**

A. Bathhouse Pad Area
Load/haul approximately 2000 cubic yards of previously excavated asphalt/concrete from the bathhouse pad to the Nielson landfill located near the Emery County landfill. Asphalt/concrete material was excavated in 1999 and stored along bathhouse pad cut during facility removal project.

B. Beehive Mine Culvert Inlet
Excavate and dispose of approximately 63 yard^3 of asphalt (250' approximate length x 30' average width x 3" average thickness) to the Nielson landfill.

- → Round trip haul distance from Des-Bee-Dove mines to Nielson landfill is approximately 12 miles.
- → Contractor will be responsible to arrange landfill deposit fee with landfill operator. Energy West will compensate operator for disposal cost upon receipt of weigh tickets.
- → Energy West personnel will monitor process of bathhouse pad and Beehive culvert inlet refuse loading to assure complete removal

Item 2. **Beehive Water Storage Tank Substation Area Reclamation (refer to attached map)**

All surface facilities, including concrete footers, in the Beehive Storage Tank Substation Area have been dismantled and removed (12/99) from the disturbed area. This area consists of an two (2) access roads and two (2) level pads on which the water storage tank and substation were located and a small turnout area. The total area covers approximately 0.75 acres. Backfill and grading will use existing fill, no importation required. Approximately 2,500 cubic yards will be required to complete this task. The area will be contoured and roughened by deep gouging, and will model the existing topography. A trail will be reestablished and or retained for cattle access to East Mountain.

DES-BEE-DOVE MINES
2001 RECLAMATION PROJECT
SCOPE OF WORK
PHASE 1

Two (2) types of sediment control structures exist in the Beehive Water Storage Tank Substation Area. These structures will be removed. Type 1 - Earth berms along the access roads will be removed and used as backfill. Type 2 - Remove 24" culvert from substation area to drop inlet. All non-coal waste will be removed and disposed of at the Emery County landfill.

Reclamation of the Beehive Storage Tank Substation Area is estimated to take less than two (2) weeks. Table 1 below shows the procedures used to reclaim the Beehive Water Storage Tank Substation Area and the order in which the procedures will be performed.

Item 3. **Little Dove/Beehive Mine Portal Area Reclamation (refer to attached map)**

All surface facilities, including concrete footers (except for a bin retaining wall located below the portal area) in the Little Dove/Beehive Portal Area have been dismantled and removed (12/99) from the disturbed area. The total area consists of approximately 2.13 acres. Backfill and grading will use existing fill, no importation required. Excess yardage will be hauled to the main access road and used as fill or hauled to the bathhouse pad for storage. Approximately 15,000 cubic yards will be required to complete this task. Actual yardage is difficult to assess due to the lack of a pre-existing topographic base map. Historical aerial photographs indicate the slope below the portal consists of a layer (depth unknown) of large boulders and actual land configuration is unknown. Energy West desires to establish drainage channels capable of handling a one hundred (100) year six (6) storm event. Large boulders excavated from below the pad will be used as riprap. Excess boulders will be hauled to the main access road and used as erosion protection or hauled to the bathhouse pad for storage. The area will be contoured and roughened by deep gouging, and will model the existing topography.

Reclamation of the Little Dove/Beehive Portal Area is estimated to take approximately forty five (45) days to complete. Table 1 below shows the procedures used to reclaim the Little Dove/Beehive Portal Area and the order in which the procedures will be performed.

DES-BEE-DOVE MINES
2001 RECLAMATION PROJECT
SCOPE OF WORK
PHASE 1

Item 4. **Little Dove/Beehive Mine Main Access Road Reclamation (refer to attached map)**

Surface facilities, including guard rail and concrete footers, shotcrete and retaining cables, will have to be dismantled and removed from the disturbed area. The total area consists of approximately 0.97 acres. Backfill and grading will use existing fill and excess fill from the Little Dove/Beehive Portal Area. Approximately 3,000 cubic yards will be required to complete this task. The area will be contoured and roughened by deep gouging, and will model the existing topography. A trail will be reestablished and or retained for cattle access to East Mountain.

Reclamation of the Little Dove/Beehive Portal Main Access Road is estimated to take approximately thirty (30) days to complete. Table 1 below shows the procedures used to reclaim the Little Dove/Beehive Main Access Road and the order in which the procedures will be performed.

DES-BEE-DOVE MINES
2001 RECLAMATION PROJECT
SCOPE OF WORK
PHASE 1

Procedural Steps of Reclamation Table.

1. Non-coal waste clean-up.	Remove and transport all non-coal waste in and around the disturbed area to the Nielson landfill.
2. Clean up coal mine waste.	Remove all coal waste material in the disturbed area and bury prior to backfilling.
3. Drainage conveyance removal.	Beehive Water Storage Tank/Substation Area: Excavate and remove 24" culvert from substation pad to drop inlet. Main Access Roadway: Excavate and remove 48" (including inlet structure and concrete thrust blocks) culvert from Beehive drop inlet to Deseret Fan area. Culvert material will be removed from the site and disposed of at the Nielson landfill. Energy West will be responsible for landfill fee.

DES-BEE-DOVE MINES
2001 RECLAMATION PROJECT
SCOPE OF WORK
PHASE 1

4. Backfill and grading.	Beehive Water Storage Tank/Substation Area: Backfill and grade utilizing existing fill material. Topsoil and subsoil material were not stripped or stored at the site. Fill material will be acquired from berms around the access roads and from below tank and substation pads. Fill will be distributed along the pad cuts and access roads to resemble the surrounding environment and to achieve approximate original contour and cut elimination. Convert roadway to cattle access trail approximately six (6) feet in width. Little Dove/Beehive Mine Portal Area: Backfill and grade utilizing existing fill material. Topsoil and subsoil material were not stripped or stored at the site. Fill material will be acquired from berms around the pad area and from below the portal pad. As indicated earlier, actual yardage is difficult to assess due to the lack of a pre-existing topographic base map. Historical aerial photographs indicate the slope below the portal consist of a layer (depth unknown) of large boulders and actual land configuration is unknown. Energy West desires to establish drainage channels capable of handling a one hundred (100) year six (6) storm event. Large boulders excavated from below the pad will be used as riprap. Excess boulders and fill will be hauled to the main access road and used as fill and erosion protection or hauled to the bathhouse pad for storage. During excavation of the slope below the portal pad, removal of a metal binwall will be required. Binwall material can be salvaged or disposed of at the Nielson landfill. Energy West will be responsible for landfill fee. Fill will be distributed along the portal pad cuts to resemble the surrounding environment and to achieve approximate original contour and cut elimination. Little Dove/Beehive Main Access Road Area: Backfill and grade utilizing existing fill material and excess fill from the portal area. Topsoil and subsoil material were not stripped or stored at the site. Fill material will be acquired from berms around the access roads and from the mine portal area. Fill will be distributed along the pad cuts and access roads to resemble the surrounding environment and to achieve

DES-BEE-DOVE MINES
2001 RECLAMATION PROJECT
SCOPE OF WORK
PHASE 1

5. Soil stabilization	Compaction efforts will be applied as lifts of material are placed. Material will be compacted with the bucket of the loader or other acceptable means. Large boulders will be removed to allow compaction in the separate lifts. Lifts not to exceed two (2) feet. Various sized rock and boulders will be placed on prepared slopes and nested into the material at random locations. Rock distribution will be positioned to help provide natural esthetic appearance as well as slope containment. All prepared slopes will be placed on 1 ½H:1V or 2H:1V.
6. Reestablish minor drainages.	Reestablishment minor drainages: Storage Tank Area: reestablish minor drainage located along access road near turnoff to storage tank utilizing excavator/backhoe. Blend surrounding area to resemble drainage above access road (drainage design\riprap not required). Boulders will be placed along channel as erosion protection. Boulders will be acquired onsite. Little Dove/Beehive Pad: reestablish three (3) minor drainages located near old portals utilizing excavator/backhoe. Blend surrounding area to resemble drainage above access road. Boulders will be placed along channel as erosion protection. Boulders will be acquired onsite. Energy West will provide channel design capable of handling a one hundred (100) year/six (6) hour storm event and areas of required riprap (refer to Channel Design). Channels #2 and #3 will require construction of riprap gradation (refer to Riprap Gradation Calculations for Filter Design of Channels). Drainage Reconstruction: Drainage #1: Length - 60' of reestablish natural channel - no riprap required Drainage #2: Length - 210' of reconstructed drainage Drainage #3: Length - 240' of reconstructed drainage * Importation of riprap filter maybe required *

DES-BEE-DOVE MINES
2001 RECLAMATION PROJECT
SCOPE OF WORK
PHASE 1

7. Recontour and roughen location of substation and water storage tank.	Recontouring consists of blending disturbed area with existing topography. As recontouring of an area is completed , it will be fertilized, mulched, then roughened by deep gouging (pocking) with a trackhoe bucket or similar equipment that produces a depression approximately 3.0' dia. x 1.5' deep. These depressions will be developed throughout the reclaimed area and will influence the retention of moisture and greatly reduce sediment contributions to stream flow. Mulching will require a certified weed free alfalfa hay be contemporaneously incorporated into the soil. Application rate will be approximately one (1) ton/acre. Energy West will provide the contractor with the certified weed free alfalfa. Alfalfa will be stored at Energy West's Central Warehouse. Contractor will be responsible for transportation from Central Warehouse to mine site.
8. Seed area	Seeding will be conducted contemporaneously with items 5, 6 and 7. Energy West will provide seed as recommended by the Division. Pocking techniques will mix the hay mulch into the upper portion of the soil. The seed mixture will be broadcast using a "hurricane spreader" or applied using a hydro seeder. If the seed mixture is broadcast, the area in question will be hand raked to cover the seeds. If the seed mixture is hydro seeded, a small amount of wood fiber mulch will be added to mark the area of coverage during application (Energy West will contract with an hydro seed application company, operator responsible for scheduling of application with the contractor). If seed is applied by the hydro seeding method, a wood fiber or other acceptable mulch will be applied at a rate of 1000 lbs./acre. A tackifier (plantago or other similar tackifier) will be added to the mulch and applied at a rate of 500 lbs/acre. Mulch and tackifier will be applied simultaneously.

DES-BEE-DOVE MINES
2001 RECLAMATION PROJECT
SCOPE OF WORK
PHASE 1

8. Fugitive dust	Traffic control measures will be implemented to regulate traffic speeds to ten (10) miles per hour within the construction and road haulage areas. Contractor responsible for dust control on reclamation site. No water is available onsite. Water available at the Cottonwood Mine site.
9. Install signs.	Signs will be placed around the reclamation site. Energy West will provide signs and post.

Additional Provisions: Code of Standards: The equipment supplied by the contractor shall conform and be maintained to the latest Standards and Guidelines published by the following organizations where applicable:

Mine Safety and Health Administration, Coal Safety and Health (MSHA, CFR Title 30).

Any local, State or Federal codes, standards and regulations in effect having jurisdiction in the area.

DES-BEE-DOVE MINES
2001 RECLAMATION PROJECT
SCOPE OF WORK
PHASE 1

COST PROPOSAL

- ➔ Provide description summary of reclamation techniques itemized in the **Procedural Steps of Reclamation Table.**
- ➔ Provide list of equipment and cost breakdown utilizing the following table format:

SPECIFICATIONS			REQUIRED RESPONSE					
#	TYPE OF EQUIPMENT	EQUIPMENT DESCRIPTION MANUFACTURE/MODEL OR EQUIVALENT	EQUIPMENT MANUFACTURE	CAPACITY	APPROXIMATE EQUIPMENT HOURS	LABOR RATES	RENTAL RATE/HOUR EQUIPMENT ONLY	RENTAL RATE/HOUR EQUIPMENT WITH AN OPERATOR
ITEM 1 ASPHALT/CONCRETE REMOVAL								
ITEM 2 BEEHIVE WATER STORAGE TANK/SUBSTATION AREA RECLAMATION								
ITEM 3 LITTLE DOVE/BEEHIVE MINE PORTAL AREA RECLAMATION								
ITEM 4 LITTLE DOVE/BEEHIVE MINE MAIN ACCESS ROAD RECLAMATION								

DES-BEE-DOVE MINES
2001 RECLAMATION PROJECT
SCOPE OF WORK
PHASE 1

PROJECT TIMING

- ➔ Project Pre-Bid Completed by March 14, 2001
- ➔ Contract Awarded by March 23, 2001
- ➔ Backfill/Grading and seeding must be completed by May15, 2001
- ➔ Provide project timing schedule

DES-BEE-DOVE MINES
2001 RECLAMATION PROJECT
SCOPE OF WORK
PHASE 1

DOGM RECOMMENDED SEED MIXTURE

DES-BEE-DOVE MINES
2001 RECLAMATION PROJECT
SCOPE OF WORK
PHASE 1

Des Bee Dove Aggressive Steep Slope Seed Mixture

**Shrubs	PLS lbs./acre	#Seed/ft^2
Atriplex canescens (Fourwing saltbush)	4	4.7
Atriplex confertifolia (Shadscale)	3.5	5.1
Ceratoides lanata (winterfat)	3.5	4.5
Chysothamnus viscidiflorus (Low rabbitbrush)	.3	5.1
Cool Season Grasses		
Achnatherum hymenoides (Indian ricegrass)	1.5	4.9
Elymus lanceolatus (Thickspike wheatgrass)	1	3.5
Elymus salinus (Salina wildrye), if available otherwise substitue with Western wheatgrass	2	
Elymus elymoides (Bottlebrush squirreltail)	1	4.4
Leymus cinereus (Great Basin wildrye)	2	6
Pasopyrum smithii (Western wheatgrass)	2	5
Pseudoroegneria spicata (Bluebunch wheatgrass)	1.5	4.8
Forbs		
Penstemon palmeri (Palmer penstemon)	.5	7
Aster chilensis (Pacific aster)	.1	6
Total Broadcast Rate	**22.9 PLS lbs./acre**	**61 seeds/ft^2**

Cool season mixture 48 seeds/ft^2
Warm season mixture 24 seeds/ft^2

** Augment with transplants to provide visual attributes. Use largest sizes available and practical.

Suggestions
Amelanchier alnifolia (Saskatoon serviceberry)
Cercocarpus ledifolius (Curl-leaf mountain mahogany)
Juniperus scopulorum (Rocky Mountain juniper)
Pinus edulis (Pinyon pine)

DES-BEE-DOVE MINES
2001 RECLAMATION PROJECT
SCOPE OF WORK
PHASE 1

PHASE 1
DRAINAGE DESIGN

DES-BEE-DOVE MINES
2001 RECLAMATION PROJECT
SCOPE OF WORK
PHASE 1

CHANNEL DESIGN

R645-301-762.100: Restoration of Natural Drainage Patterns in reference to R645-301-740

Phase 1 reclamation will involve restoring three separate drainages to their original location as close as possible. Channel design calculations are discussed below.

Discharge Methodologies

Before channel design can begin, peak runoff flows must be determined. Runoff depth resulting from a given rainfall event was determined utilizing the United States Soil Conservation Service (SCS) methods. According to the curve number methodology, the relationship between storm rainfall, soil moisture storage, and runoff can be expressed by the equations:

$$P = \frac{(P - 0.2S)^2}{P + 0.8S} \qquad (1)$$

$$CN = \frac{1000}{10 + S} \qquad (2)$$

Where,

Q = direct runoff depth (inches)
P = storm rainfall depth (inches)
S = maximum infiltration depth (inches)
CN = Curve Number

Determination of runoff from Equation 1 is only valid when $P \geq 0.2S$. Below this point, no runoff can occur.

Estimates of the peak discharge were made using the unit hydrograph procedure developed by the SCS. Figure 7-1 shows a runoff hydrograph and the associated terminology.

Use of Equations 1 and 2 require the selection of a curve number, which is a function of vegetative cover, hydrologic soil groups, and Antecedent Moisture Conditions (AMC). Curve number information for the area was taken, when possible, from previous soil and vegetative surveys. Modifications to, or additional curve numbers used were obtained according to information found using Table 7-1 of the SCS National Engineering Handbook (1972), Section 4, Chapter 7. Vegetation information contained in the MRP indicates that the cover type is Pinyon-Juniper with approximately 40% ground cover density. Figure 7-2, also obtained from the SCS handbook illustrates the relationship of curve number to ground cover density for a Juniper-Grass complex.

DES-BEE-DOVE MINES
2001 RECLAMATION PROJECT
SCOPE OF WORK
PHASE 1

The P value was determined using the NOAA Atlas 2, Volume VI-Utah, Precipitation-Frequency Atlas of the Western United States (1973). This value was found to be 2.2 inches for the designed 100 year / 6 hour storm event. The P value was adjusted based on a recorded event of 2.5 inches (August 12 , 1983 - East Mountain Weather Station)

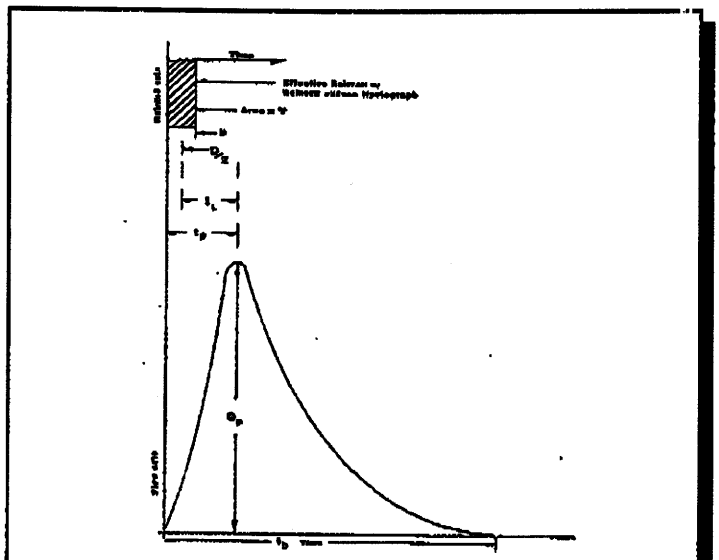


Figure 1. Unit hydrograph terminology.

DES-BEE-DOVE MINES
2001 RECLAMATION PROJECT
SCOPE OF WORK
PHASE 1

A hyetograph of a single block of rainfall excess with duration D is shown in the upper portion of Figure 7-1. The lower portion of the figure contains the resultant runoff hydrograph. For runoff from excess rainfall, the area under the hydrographic curve and the area enclosed by the rainfall hyetograph represent the same volume of water Q. The peak flow rate for the hydrograph is represented by Qp. The base time tb is the duration of the hydrograph. The time from the center of mass of rainfall excess to the peak of the runoff hydrograph is the lag time t_L. The time of concentration t_c (not shown on Figure 7-1) is defined as the time required for flow from the hydraulically most remote point in a basin to reach the basin outlet.

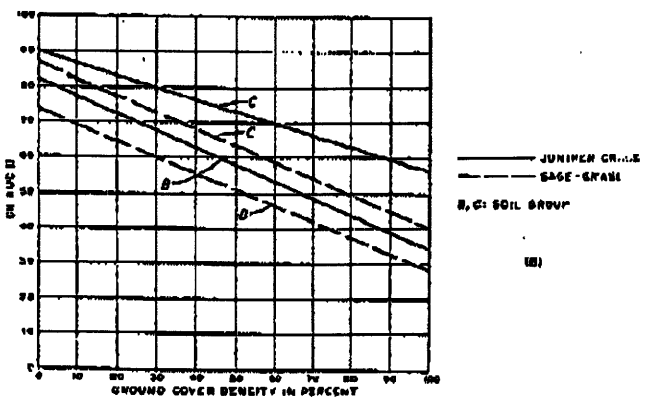


Figure 7-2: Variation of CN with ground cover density and hydrologic soil group for forest-range in the Western United States (taken and recreated from the USDA Soil Conservation Service, 1972).

DES-BEE-DOVE MINES
2001 RECLAMATION PROJECT
SCOPE OF WORK
PHASE 1

The time to peak t_p, is assumed to be a function of watershed lag t_L, which is determined according to the equation:

$$t_L = \frac{l^{0.8}(S+1)^{0.7}}{1900\sqrt{Y}} \qquad (3)$$

Where,

t_L = watershed lag time (hrs.)
l = hydraulic length of the mainstream to the farthest divide (ft)
Y = Average watershed slope (%)

and S is as previously defined. Values of Y were obtained using the topographic map CS-1814D. The hydraulic length was taken from same map, while S was determined from Equation 2 once the curve number had been estimated.

According to the SCS, the watershed lag time is equal to $0.6t_c$ and the time of concentration tc is equal to $1.5t_p$. By combining these two expressions, it can be seen that:

$$t_p = 1.11t_L \qquad (4)$$

where both variables are as previously defined.

The peak discharge constant used in the dimensionless unit hydrograph method is determined according to the equation:

$$q_p = \frac{484AQ}{t_p} \qquad (5)$$

Where,

q_p = unit hydrograph peak flow rate (cfs)
A = drainage area (sq. mi.)
Q = runoff depth (Equation 1)
484 = conversion factor

and t_p is as previously defined in hours.

DES-BEE-DOVE MINES
2001 RECLAMATION PROJECT
SCOPE OF WORK
PHASE 1

Stream flow peaks from the watershed subdrainage areas are shown in Table 7-1 below.

Table 7-2: Des-Bee-Dove Reclamation Phase 1 Watershed Runoff Characteristics.

Watershed Sub-area*	Area (acres)	Curve Number	Hydraulic Length (ft)	Elevation Change (ft)	Average Slope (%)	100 Year/6 Hour Event (cfs)
Area 1	4.0	84	1373	975	71	2.85
Area 2	26.58	84	1940	1140	59	18.4
Area 3	88.13	84	2403	1285	53	61

* See Drawing: Des-Bee-Dove Mines - Hydrologic Drainage Areas Above Little Dove/Beehive Mines

The construction of the hydrographs for these watersheds utilized STORM® for determining flows from a 100-yr./6-hr. storm event. Three storm hydrographs were constructed. One for each of the sub-drainages. Channel design employs the information gathered from these three hydrographs.

Open Channel Design

Open channel development began by routing the individual sub-drainages from their point of entrance in the reclamation area to their point of exit. The final reclamation topographic configuration channel is presented in Drawing CS-1814D. Utilizing the final configuration, average slope of each reach was calculated. The slope of the channel is incorporated into the mathematical design utilizing open channel flow equations, such as the Manning's equation.

Open channel design was determined using the SCS method (Haan et. al. 1994). The SCS method expresses velocity as a function of riprap diameter. The procedure is based on a chart that can be approximated by

$$D_{50} = 9d^{1.1}S \qquad (6)$$

or

$$d_{max} = \left(\frac{D_{50}}{9S}\right)^{0.91} \qquad (7)$$

Where

d_{max} = maximum depth of flow in the channel.
D_{50} = riprap diameter (ft) such that 50% of the stones have a diameter smaller than D_{50}.
S = Slope

The SCS also presented a chart based on the Isbash curves, which can be approximated by the expression

$$v = 12.84\, D_{50}^{0.51} \qquad (8)$$

DES-BEE-DOVE MINES
2001 RECLAMATION PROJECT
SCOPE OF WORK
PHASE 1

If Equation 6 is substituted into Equation 8, a velocity analogous to the Manning's equation becomes the resultant.

Since $Q = vA$, and the area A of a trapezoidal channel is $Bd + Zd2$, where B is an assumed bottom width and Z is the ratio of the side slopes (2:1), the diameter of riprap for the channel can be calculated. Thus, the Manning's equation becomes

$$Q = 12.84\, D_{50}^{0.51}\left[B\left(\frac{D_{50}}{9S}\right)^{0.91} + 2\left(\left(\frac{D_{50}}{9S}\right)^{0.91}\right)^{2}\right] \qquad (9)$$

As mentioned above, the channel bottom width was assumed. This is not exactly a correct statement. Haestad Methods *FlowMaster*® (version 5.13) was used to determine a workable bottom width, depth and velocity. The idea was to determine these parameters of the channel while keeping in mind the economics of constructing the channel. Having to remove a large quantity of material to cut a channel would increase construction costs. Likewise, keeping the channel shallow and wide would increase costs by involving more riprap work. Thus, a trial and error method in FlowMaster® was utilized to determine the ideal channel parameters.

Mannings "n" used in the *FlowMaster* model, was calculated using $n = 0.395(D_{50})1/6$ (Haan et. al. 1994) for the Des-Bee-Dove riprapped channels. The maximum n found using this equation was 0.044. This equation was used to calculate the roughness coefficients for all riprapped portions of the channel. For the portion of the channel not lined with riprapped, the roughness coefficient was estimated using table values found in *Stream Corridor Restoration*, a document prepared by the Federal Interagency Stream Restoration Working Group. The correction process starts with a base value (n_b) for a straight, uniform, smooth channel in natural materials. This base value is then adjusted to account for channel irregularities, vegetation, obstructions, and sinuosity of the channel. The n for the unlined channels at the Des-Bee-Dove mines adjusted to 0.040.

Trapezoidal channel design results are presented in **Attachment - Des-Bee-Dove Phase 1 Reclamation Channel Design**. Table 7-3 summarizes the channel dimensions, expected flow characteristics, and the D_{50} riprap requirements of the three channels that exist at the Deer Creek Mine.

DES-BEE-DOVE MINES
2001 RECLAMATION PROJECT
SCOPE OF WORK
PHASE 1

Table 7-3: Table summarizing the designed watershed drainage channels for Phase 1 Reclamation.

Channel Slope (ft/ft)	Bottom Width (ft)	Side Slope (ft:V)	Flow Depth (ft)	Mannings n	Flow Area (ft^2)	Wetted Parameter (ft)	Velocity (fps)	Critical Depth (ft)	Froude Number	Calculated D_{50} (ft)	Channel Depth (ft)	Riprap Thickness (ft)
Drainage #1: 2.85 cfs												
0.33	2.0	2:1	0.19	0.040	0.45	2.85	6.27	0.35	2.73	0.42	2.00	1.00
Drainage #2: 18.4 cfs												
0.40	5.0	2:1	0.32	0.040	1.82	6.44	10.11	0.68	3.32	0.94	1.50	2.00
Drainage #3: 61 cfs												
0.31	10.0	2:1	0.47	0.040	5.19	12.12	11.75	0.98	3.14	1.14	1.50	2.00

DES-BEE-DOVE MINES
2001 RECLAMATION PROJECT
SCOPE OF WORK
PHASE 1

Riprap filter gradation requirements were determined using the following equations as given by Haan et. al., 1994:

$$\frac{D_{50}(riprap)}{D_{50}(filter)} < 40$$

$$\frac{D_{15}(riprap)}{D_{15}(filter)} < 40$$

$$\frac{D_{15}(riprap)}{D_{85}(filter)} < 5$$

Filter riprap design calculations using the above-described equations for each stream segment of the three channels were found to need riprap filter material sized between 1/8 inch (D_{15}) and 1 inch (D_{85}). Tables displaying filter design calculations are presented in **Attachment - Des-Bee-Dove Phase 1 Riprap Gradation Calculation for Filter Design.**

DES-BEE-DOVE MINES
2001 RECLAMATION PROJECT
SCOPE OF WORK
PHASE 1

DRAINAGE CHANNEL DESIGN
100 YEAR/6 HOUR STROM EVENT

Area 1:

Acreage:	4.0 acres
Δ Elevation:	975'
Slope Length:	1373'
Average Slope:	71 %
Curve Number:	84 (Appendix VII)
Precipitation:	2.5" Actual Event 1983 (2.2" NOAA 100Y/6H)
Peak Flow:	2.85cfs

Area 2:

Acreage:	26.58 acres
Δ Elevation:	1140'
Slope Length:	1940'
Average Slope:	59 %
Curve Number:	84 (Appendix VII)
Precipitation:	2.5" Actual Event 1983 (2.2" NOAA 100Y/6H)
Peak Flow:	18.4 cfs

Area 3:

Acreage:	88.13 acres
Δ Elevation:	1285'
Slope Length:	2403'
Average Slope:	53 %
Curve Number:	84 (Appendix VII)
Precipitation:	2.5" Actual Event 1983 (2.2" NOAA 100Y/6H)
Peak Flow:	61 cfs

OSM Storm Input:

Curve Number:	84	Hansen, Allen & Luce Report, Appendix VII (Hydrologic Soil Group D) [Design Hydrology and Sedimentology for Small Catchments: Table 3.16, Wood or forest land, thin stand, poor cover, no mulch, hydrologic soil group D = Curve Number 83)
Area:		Acres (digitized, see Figure entitled: Hydrologic Drainage Areas - Above Little Dove/Beehive Mines)
Concentration time type:	SCS Upland Curve (ephemeral drainage)	
Unit Hydrograph Type:	Forested	
Storm Type:		SCS 6 hour design storm

DES-BEE-DOVE MINES
2001 RECLAMATION PROJECT
SCOPE OF WORK
PHASE 1

CHANNEL DESIGN (Trapezoidail Channel)

General Assumptions:

Method:	**Manning's Formula**
Left Side Slope:	**2.0H:V**
Right Side Slope:	**2.0H:V**

Drainage 1

Elevation ft/ft:	7935' - 7915'
Δ Elevation:	20'
Length:	60'
Channel Slope:	0.33
Peak Flow:	2.85 cfs
Bottom Width:	2.0'
Mannings Coefficient:	0.040

Haestad FlowMaster Results (refer to attached printouts):

Depth:	0.19'
Velocity:	6.27 ft/s

Drainage 2

Elevation ft/ft:	7935' - 7850'
Δ Elevation:	85'
Length:	210'
Channel Slope:	0.40
Peak Flow:	18.4 cfs
Bottom Width:	5.0'
Mannings Coefficient:	0.040

Haestad FlowMaster Results (refer to attached printouts):

Depth:	0.32'
Velocity:	10.11ft/s

Drainage 3

Elevation ft/ft:	7925' - 7850
Δ Elevation:	75'
Length:	240'
Channel Slope:	0.31
Peak Flow:	61 cfs
Bottom Width:	10.0'
Mannings Coefficient:	0.040

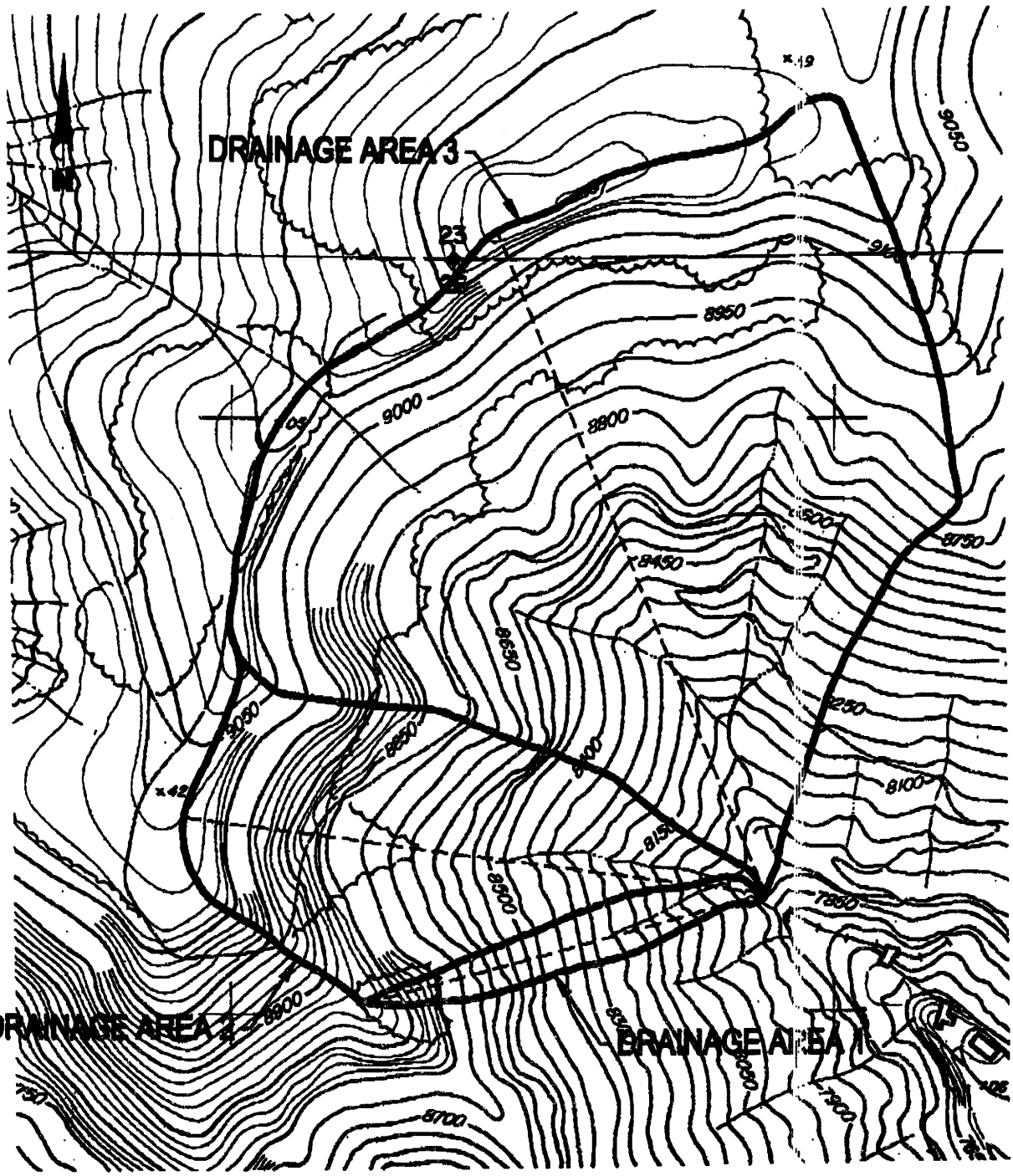
Haestad FlowMaster Results (refer to attached printouts):

Depth:	0.47'
Velocity:	11.75 ft/s

DES-BEE-DOVE MINES
2001 RECLAMATION PROJECT
SCOPE OF WORK
PHASE 1

PHASE 1

CHANNEL DESIGN CALCULATIONS



CAD FILE NAME/DISK#:

ENERGY WEST
MINING COMPANY
HUNTINGTON, UTAH 84528

DES-BEE-DOVE MINES
HYDROLOGIC DRAINAGE AREAS
ABOVE LITTLE DOVE/BEEHIVE MINES

DRAWN BY:	K. LARSEN	...	
SCALE:	1" =500'	DRAWING #:	
DATE:	MARCH 1, 2001	SHEET 1 OF 1	REV.

Project Title = Des-Bee-Dove Mine (Phase 1: Area 1)
WATERSHED HYDROGRAPH
Inflow into structure # 1
Structure type: Null

-- Watershed data for watershed # 1
Curve number = 84.0
Area = 4.0 acres
Hydraulic length = 1373.00 Feet
Elevation change = 975.0 feet.
Concentration time = 0.03 hours
Concentration time type = SCS Upland Curves
Unit hydrograph type = Forested

-- Total Area = 4.0 acres

-- Storm data
Total precipitation = 2.5 inches
Storm type = SCS 6 hour design storm
Peak Discharge = 2.85 cfs
Discharge volume = 0.37 acre ft

time (hr.)	rainfall (in.)	hydrograph (cfs)		time (hr.)	rainfall (in.)	hydrograph (cfs
0.00	0.000	0.000	*	0.10	0.016	0.00
0.20	0.016	0.000	*	0.30	0.016	0.00
0.40	0.016	0.000	*	0.50	0.016	0.00
0.60	0.024	0.000	*	0.70	0.024	0.00
0.80	0.024	0.000	*	0.90	0.024	0.00
1.00	0.024	0.000	*	1.10	0.026	0.00
1.20	0.026	0.000	*	1.30	0.027	0.00
1.40	0.026	0.000	*	1.50	0.026	0.00
1.60	0.047	0.000	*	1.70	0.047	0.01
1.80	0.048	0.055	*	1.90	0.047	0.10
2.00	0.047	0.158	*	2.10	0.186	0.71
2.20	0.186	1.325	*	2.30	0.186	1.86
2.40	0.186	2.371	*	2.50	0.186	2.84
2.60	0.050	2.074	*	2.70	0.050	1.72
2.80	0.050	1.681	*	2.90	0.050	1.63
3.00	0.050	1.578	*	3.10	0.040	1.41
3.20	0.040	1.295	*	3.30	0.040	1.20
3.40	0.040	1.135	*	3.50	0.040	1.08
3.60	0.027	0.935	*	3.70	0.027	0.86
3.80	0.027	0.837	*	3.90	0.028	0.81
4.00	0.027	0.793	*	4.10	0.024	0.74
4.20	0.024	0.720	*	4.30	0.024	0.70
4.40	0.025	0.695	*	4.50	0.024	0.68
4.60	0.020	0.636	*	4.70	0.020	0.61
4.80	0.020	0.599	*	4.90	0.020	0.59
5.00	0.020	0.583	*	5.10	0.018	0.55
5.20	0.018	0.540	*	5.30	0.018	0.53
5.40	0.018	0.527	*	5.50	0.018	0.52
5.60	0.020	0.542	*	5.70	0.020	0.55
5.80	0.020	0.557	*	5.90	0.020	0.56
6.00	0.020	0.566	*	6.10	0.000	0.35

time (hr.)	rainfall (in.)	hydrograph (cfs)		time (hr.)	rainfall (in.)	hydrograph (cfs)
6.10	0.000	0.350				
6.20	0.000	0.234	*	6.30	0.000	0.18
6.40	0.000	0.147	*	6.50	0.000	0.11
6.60	0.000	0.078	*	6.70	0.000	0.05
6.80	0.000	0.031	*	6.90	0.000	0.01
7.00	0.000	0.005	*			

Project Title = Des-Bee-Dove Mine (Phase 1: Area 2)
WATERSHED HYDROGRAPH
Inflow into structure # 1
Structure type: Null

-- Watershed data for watershed # 1
Curve number = 84.0
Area = 26.6 acres
Hydraulic length = 1940.00 Feet
Elevation change = 1140.0 feet.
Concentration time = 0.04 hours
Concentration time type = SCS Upland Curves
Unit hydrograph type = Forested

-- Total Area = 26.6 acres

-- Storm data
Total precipitation = 2.5 inches
Storm type = SCS 6 hour design storm
Peak Discharge = 18.36 cfs
Discharge volume = 2.47 acre ft

time (hr.)	rainfall (in.)	hydrograph (cfs)		time (hr.)	rainfall (in.)	hydrograph (cfs
0.00	0.000	0.000	*	0.10	0.016	0.00
0.20	0.016	0.000	*	0.30	0.016	0.00
0.40	0.016	0.000	*	0.50	0.016	0.00
0.60	0.024	0.000	*	0.70	0.024	0.00
0.80	0.024	0.000	*	0.90	0.024	0.00
1.00	0.024	0.000	*	1.10	0.026	0.00
1.20	0.026	0.000	*	1.30	0.027	0.00
1.40	0.026	0.000	*	1.50	0.026	0.00
1.60	0.047	0.000	*	1.70	0.047	0.09
1.80	0.048	0.350	*	1.90	0.047	0.67
2.00	0.047	1.014	*	2.10	0.186	4.48
2.20	0.186	8.492	*	2.30	0.186	11.99
2.40	0.186	15.278	*	2.50	0.186	18.35
2.60	0.050	13.715	*	2.70	0.050	11.13
2.80	0.050	10.935	*	2.90	0.050	10.79
3.00	0.050	10.600	*	3.10	0.040	9.77
3.20	0.040	9.114	*	3.30	0.040	8.62
3.40	0.040	8.158	*	3.50	0.040	7.75
3.60	0.027	6.670	*	3.70	0.027	5.99
3.80	0.027	5.747	*	3.90	0.028	5.59
4.00	0.027	5.459	*	4.10	0.024	5.15
4.20	0.024	4.956	*	4.30	0.024	4.85
4.40	0.025	4.769	*	4.50	0.024	4.70
4.60	0.020	4.370	*	4.70	0.020	4.16
4.80	0.020	4.083	*	4.90	0.020	4.02
5.00	0.020	3.975	*	5.10	0.018	3.80
5.20	0.018	3.689	*	5.30	0.018	3.63
5.40	0.018	3.594	*	5.50	0.018	3.56
5.60	0.020	3.671	*	5.70	0.020	3.73
5.80	0.020	3.764	*	5.90	0.020	3.75
6.00	0.020	3.816	*	6.10	0.000	2.48

time (hr.)	rainfall (in.)	hydrograph (cfs)		time (hr.)	rainfall (in.)	hydrograph (cfs)
6.10	0.000	2.482				
6.20	0.000	1.664	*	6.30	0.000	1.36
6.40	0.000	1.108	*	6.50	0.000	0.87
6.60	0.000	0.674	*	6.70	0.000	0.49
6.80	0.000	0.343	*	6.90	0.000	0.21
7.00	0.000	0.120	*	7.10	0.000	0.05
7.20	0.000	0.011	*			

Project Title = Des-Bee-Dove Mine (Phase 1: Area 3)
WATERSHED HYDROGRAPH
Inflow into structure # 1
Structure type: Null

-- Watershed data for watershed # 1
Curve number = 84.0
Area = 88.1 acres
Hydraulic length = 2403.00 Feet
Elevation change = 1285.0 feet.
Concentration time = 0.05 hours
Concentration time type = SCS Upland Curves
Unit hydrograph type = Forested

-- Total Area = 88.1 acres

-- Storm data
Total precipitation = 2.5 inches
Storm type = SCS 6 hour design storm
Peak Discharge = 60.68 cfs
Discharge volume = 8.20 acre ft

time (hr.)	rainfall (in.)	hydrograph (cfs)		time (hr.)	rainfall (in.)	hydrograph (cfs
0.00	0.000	0.000	*	0.10	0.016	0.00
0.20	0.016	0.000	*	0.30	0.016	0.00
0.40	0.016	0.000	*	0.50	0.016	0.00
0.60	0.024	0.000	*	0.70	0.024	0.00
0.80	0.024	0.000	*	0.90	0.024	0.00
1.00	0.024	0.000	*	1.10	0.026	0.00
1.20	0.026	0.000	*	1.30	0.027	0.00
1.40	0.026	0.000	*	1.50	0.026	0.00
1.60	0.047	0.000	*	1.70	0.047	0.30
1.80	0.048	1.107	*	1.90	0.047	2.16
2.00	0.047	3.318	*	2.10	0.186	14.23
2.20	0.186	27.271	*	2.30	0.186	39.4
2.40	0.186	50.422	*	2.50	0.186	60.6
2.60	0.050	46.755	*	2.70	0.050	38.1
2.80	0.050	35.896	*	2.90	0.050	35.7
3.00	0.050	35.492	*	3.10	0.040	33.2
3.20	0.040	31.444	*	3.30	0.040	30.0
3.40	0.040	28.851	*	3.50	0.040	27.5
3.60	0.027	24.029	*	3.70	0.027	21.4
3.80	0.027	20.055	*	3.90	0.028	19.2
4.00	0.027	18.863	*	4.10	0.024	17.9
4.20	0.024	17.199	*	4.30	0.024	16.7
4.40	0.025	16.466	*	4.50	0.024	16.2
4.60	0.020	15.154	*	4.70	0.020	14.4
4.80	0.020	14.035	*	4.90	0.020	13.8
5.00	0.020	13.658	*	5.10	0.018	13.1
5.20	0.018	12.723	*	5.30	0.018	12.5
5.40	0.018	12.354	*	5.50	0.018	12.2
5.60	0.020	12.567	*	5.70	0.020	12.7
5.80	0.020	12.874	*	5.90	0.020	12.9
6.00	0.020	13.020	*	6.10	0.000	8.8

time (hr.)	rainfall (in.)	hydrograph (cfs)		time (hr.)	rainfall (in.)	hydrograph (cfs)
6.10	0.000	8.851				
6.20	0.000	6.100	*	6.30	0.000	4.77
6.40	0.000	3.976	*	6.50	0.000	3.25
6.60	0.000	2.601	*	6.70	0.000	2.01
6.80	0.000	1.505	*	6.90	0.000	1.06
7.00	0.000	0.693	*	7.10	0.000	0.40
7.20	0.000	0.188	*	7.30	0.000	0.05
7.40	0.000	0.000	*			

DBD Phase 1 Drainage #3
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\haestad\fmw\dbd_phas.fm2
Worksheet	Phase 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

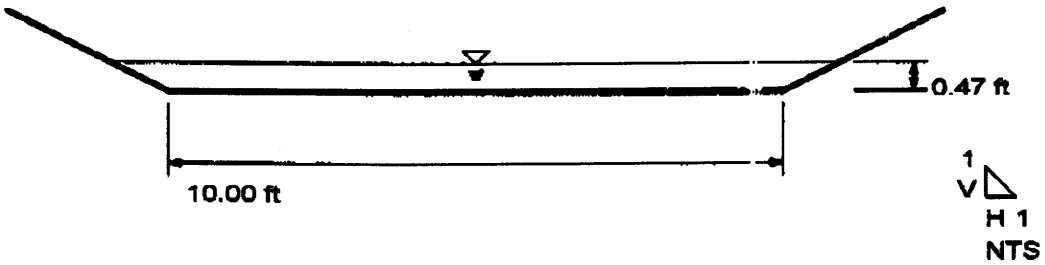
Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.310000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	10.00	ft
Discharge	61.00	cfs

Results		
Depth	0.47	ft
Flow Area	5.19	ft²
Wetted Perimeter	12.12	ft
Top Width	11.90	ft
Critical Depth	0.98	ft
Critical Slope	0.025790	ft/ft
Velocity	11.75	ft/s
Velocity Head	2.15	ft
Specific Energy	2.62	ft
Froude Number	3.14	
Flow is supercritical.		

DBD Phase 1 Drainage #3
Cross Section for Trapezoidal Channel

Project Description	
Project File	c:\haestad\fmw\dbd_phas.fm2
Worksheet	Phase 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.040	
Channel Slope	0.310000	ft/ft
Depth	0.47	ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	10.00	ft
Discharge	61.00	cfs

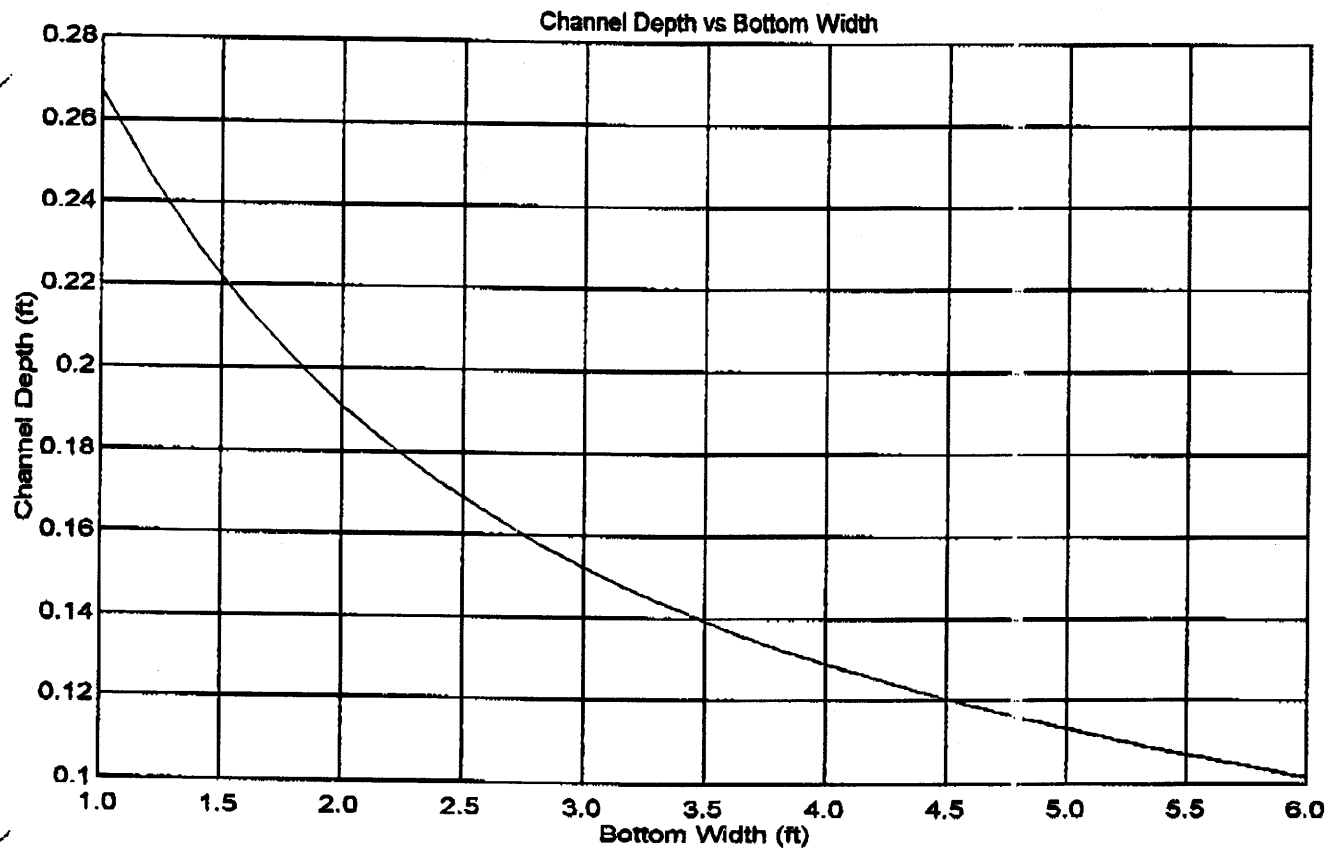


DBD Phase 1 Drainage #1
Plotted Curves for Trapezoidal Channel

Project Description	
Project File	c:\haestad\fmw\dbd_phas.fm2
Worksheet	Phase 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Mannings Coefficient	0.040
Channel Slope	0.330000 ft/ft
Left Side Slope	2.000000 H : V
Right Side Slope	2.000000 H : V
Discharge	2.85 cfs

Input Data			
	Minimum	Maximum	Increment
Bottom Width	1.00	6.00	0.20 ft



DBD Phase 1 Drainage #2
Rating Table for Trapezoidal Channel

Rating Table

Discharge (cfs)	Bottom Width (ft)	Mannings Coefficient	Depth (ft)	Velocity (ft/s)
2.85	2.00	0.036	0.18	6.73
2.85	2.00	0.037	0.18	6.61
2.85	2.00	0.038	0.19	6.49
2.85	2.00	0.039	0.19	6.38
2.85	2.00	0.040	0.19	6.27
2.85	2.00	0.041	0.19	6.17
2.85	2.00	0.042	0.20	6.07
2.85	2.00	0.043	0.20	5.97
2.85	2.00	0.044	0.20	5.88
2.85	2.00	0.045	0.20	5.79
2.85	3.00	0.030	0.13	6.81
2.85	3.00	0.031	0.13	6.67
2.85	3.00	0.032	0.13	6.53
2.85	3.00	0.033	0.14	6.41
2.85	3.00	0.034	0.14	6.29
2.85	3.00	0.035	0.14	6.17
2.85	3.00	0.036	0.14	6.06
2.85	3.00	0.037	0.15	5.95
2.85	3.00	0.038	0.15	5.85
2.85	3.00	0.039	0.15	5.76
2.85	3.00	0.040	0.15	5.66
2.85	3.00	0.041	0.15	5.57
2.85	3.00	0.042	0.16	5.49
2.85	3.00	0.043	0.16	5.41
2.85	3.00	0.044	0.16	5.33
2.85	3.00	0.045	0.16	5.25
2.85	4.00	0.030	0.11	6.22
2.85	4.00	0.031	0.11	6.09
2.85	4.00	0.032	0.11	5.97
2.85	4.00	0.033	0.12	5.86
2.85	4.00	0.034	0.12	5.75
2.85	4.00	0.035	0.12	5.65
2.85	4.00	0.036	0.12	5.55
2.85	4.00	0.037	0.12	5.45
2.85	4.00	0.038	0.13	5.36
2.85	4.00	0.039	0.13	5.27
2.85	4.00	0.040	0.13	5.19
2.85	4.00	0.041	0.13	5.11
2.85	4.00	0.042	0.13	5.03
2.85	4.00	0.043	0.13	4.96
2.85	4.00	0.044	0.14	4.89
2.85	4.00	0.045	0.14	4.82
2.85	5.00	0.030	0.10	5.76
2.85	5.00	0.031	0.10	5.65

DBD Phase 1 Drainage #2
Rating Table for Trapezoidal Channel

Rating Table

Discharge (cfs)	Bottom Width (ft)	Mannings Coefficient	Depth (ft)	Velocity (ft/s)
2.85	5.00	0.032	0.10	5.54
2.85	5.00	0.033	0.10	5.43
2.85	5.00	0.034	0.10	5.33
2.85	5.00	0.035	0.10	5.24
2.85	5.00	0.036	0.11	5.15
2.85	5.00	0.037	0.11	5.06
2.85	5.00	0.038	0.11	4.98
2.85	5.00	0.039	0.11	4.90
2.85	5.00	0.040	0.11	4.82
2.85	5.00	0.041	0.11	4.75
2.85	5.00	0.042	0.12	4.68
2.85	5.00	0.043	0.12	4.61
2.85	5.00	0.044	0.12	4.54
2.85	5.00	0.045	0.12	4.48
2.85	6.00	0.030	0.09	5.40
2.85	6.00	0.031	0.09	5.29
2.85	6.00	0.032	0.09	5.19
2.85	6.00	0.033	0.09	5.09
2.85	6.00	0.034	0.09	5.00
2.85	6.00	0.035	0.09	4.91
2.85	6.00	0.036	0.10	4.83
2.85	6.00	0.037	0.10	4.75
2.85	6.00	0.038	0.10	4.67
2.85	6.00	0.039	0.10	4.60
2.85	6.00	0.040	0.10	4.52
2.85	6.00	0.041	0.10	4.46
2.85	6.00	0.042	0.10	4.39
2.85	6.00	0.043	0.11	4.33
2.85	6.00	0.044	0.11	4.27
2.85	6.00	0.045	0.11	4.21
3.35	1.00	0.030	0.25	8.96
3.35	1.00	0.031	0.25	8.75
3.35	1.00	0.032	0.26	8.56
3.35	1.00	0.033	0.26	8.37
3.35	1.00	0.034	0.27	8.19
3.35	1.00	0.035	0.27	8.03
3.35	1.00	0.036	0.27	7.87
3.35	1.00	0.037	0.28	7.71
3.35	1.00	0.038	0.28	7.57
3.35	1.00	0.039	0.29	7.43
3.35	1.00	0.040	0.29	7.29
3.35	1.00	0.041	0.29	7.16
3.35	1.00	0.042	0.30	7.04
3.35	1.00	0.043	0.30	6.92

DBD Phase 1 Drainage #2
Rating Table for Trapezoidal Channel

Rating Table

Discharge (cfs)	Bottom Width (ft)	Mannings Coefficient	Depth (ft)	Velocity (ft/s)
3.35	1.00	0.044	0.31	6.81
3.35	1.00	0.045	0.31	6.70
3.35	2.00	0.030	0.18	8.02
3.35	2.00	0.031	0.18	7.84
3.35	2.00	0.032	0.18	7.68
3.35	2.00	0.033	0.19	7.52
3.35	2.00	0.034	0.19	7.37
3.35	2.00	0.035	0.19	7.23
3.35	2.00	0.036	0.20	7.10
3.35	2.00	0.037	0.20	6.97
3.35	2.00	0.038	0.20	6.85
3.35	2.00	0.039	0.21	6.73
3.35	2.00	0.040	0.21	6.61
3.35	2.00	0.041	0.21	6.50
3.35	2.00	0.042	0.22	6.40
3.35	2.00	0.043	0.22	6.30
3.35	2.00	0.044	0.22	6.20
3.35	2.00	0.045	0.22	6.11
3.35	3.00	0.030	0.14	7.22
3.35	3.00	0.031	0.14	7.07
3.35	3.00	0.032	0.15	6.93
3.35	3.00	0.033	0.15	6.79
3.35	3.00	0.034	0.15	6.66
3.35	3.00	0.035	0.15	6.54
3.35	3.00	0.036	0.16	6.42
3.35	3.00	0.037	0.16	6.31
3.35	3.00	0.038	0.16	6.20
3.35	3.00	0.039	0.17	6.10
3.35	3.00	0.040	0.17	6.00
3.35	3.00	0.041	0.17	5.90
3.35	3.00	0.042	0.17	5.81
3.35	3.00	0.043	0.17	5.72
3.35	3.00	0.044	0.18	5.64
3.35	3.00	0.045	0.18	5.56
3.35	4.00	0.030	0.12	6.60
3.35	4.00	0.031	0.12	6.47
3.35	4.00	0.032	0.12	6.34
3.35	4.00	0.033	0.13	6.22
3.35	4.00	0.034	0.13	6.10
3.35	4.00	0.035	0.13	5.99
3.35	4.00	0.036	0.13	5.89
3.35	4.00	0.037	0.14	5.79
3.35	4.00	0.038	0.14	5.69
3.35	4.00	0.039	0.14	5.60

DBD Phase 1 Drainage #2
Rating Table for Trapezoidal Channel

Rating Table

Discharge (cfs)	Bottom Width (ft)	Mannings Coefficient	Depth (ft)	Velocity (ft/s)
3.35	4.00	0.040	0.14	5.51
3.35	4.00	0.041	0.14	5.42
3.35	4.00	0.042	0.15	5.34
3.35	4.00	0.043	0.15	5.26
3.35	4.00	0.044	0.15	5.19
3.35	4.00	0.045	0.15	5.11
3.35	5.00	0.030	0.10	6.13
3.35	5.00	0.031	0.11	6.00
3.35	5.00	0.032	0.11	5.89
3.35	5.00	0.033	0.11	5.78
3.35	5.00	0.034	0.11	5.67
3.35	5.00	0.035	0.12	5.57
3.35	5.00	0.036	0.12	5.47
3.35	5.00	0.037	0.12	5.38
3.35	5.00	0.038	0.12	5.29
3.35	5.00	0.039	0.12	5.21
3.35	5.00	0.040	0.12	5.12
3.35	5.00	0.041	0.13	5.05
3.35	5.00	0.042	0.13	4.97
3.35	5.00	0.043	0.13	4.90
3.35	5.00	0.044	0.13	4.83
3.35	5.00	0.045	0.13	4.76
3.35	6.00	0.030	0.09	5.75
3.35	6.00	0.031	0.10	5.63
3.35	6.00	0.032	0.10	5.52
3.35	6.00	0.033	0.10	5.42
3.35	6.00	0.034	0.10	5.32
3.35	6.00	0.035	0.10	5.23
3.35	6.00	0.036	0.11	5.14
3.35	6.00	0.037	0.11	5.05
3.35	6.00	0.038	0.11	4.97
3.35	6.00	0.039	0.11	4.89
3.35	6.00	0.040	0.11	4.81
3.35	6.00	0.041	0.11	4.74
3.35	6.00	0.042	0.12	4.67
3.35	6.00	0.043	0.12	4.60
3.35	6.00	0.044	0.12	4.54
3.35	6.00	0.045	0.12	4.47
3.85	1.00	0.030	0.27	9.32
3.85	1.00	0.031	0.27	9.11
3.85	1.00	0.032	0.28	8.90
3.85	1.00	0.033	0.28	8.71
3.85	1.00	0.034	0.29	8.52
3.85	1.00	0.035	0.29	8.35

DBD Phase 1 Drainage #2
Rating Table for Trapezoidal Channel

Rating Table

Discharge (cfs)	Bottom Width (ft)	Mannings Coefficient	Depth (ft)	Velocity (ft/s)
3.85	1.00	0.036	0.30	8.18
3.85	1.00	0.037	0.30	8.02
3.85	1.00	0.038	0.30	7.87
3.85	1.00	0.039	0.31	7.72
3.85	1.00	0.040	0.31	7.58
3.85	1.00	0.041	0.32	7.45
3.85	1.00	0.042	0.32	7.32
3.85	1.00	0.043	0.32	7.20
3.85	1.00	0.044	0.33	7.08
3.85	1.00	0.045	0.33	6.96
3.85	2.00	0.030	0.19	8.40
3.85	2.00	0.031	0.20	8.21
3.85	2.00	0.032	0.20	8.04
3.85	2.00	0.033	0.20	7.88
3.85	2.00	0.034	0.21	7.72
3.85	2.00	0.035	0.21	7.57
3.85	2.00	0.036	0.21	7.43
3.85	2.00	0.037	0.22	7.29
3.85	2.00	0.038	0.22	7.16
3.85	2.00	0.039	0.22	7.04
3.85	2.00	0.040	0.23	6.92
3.85	2.00	0.041	0.23	6.80
3.85	2.00	0.042	0.23	6.69
3.85	2.00	0.043	0.24	6.59
3.85	2.00	0.044	0.24	6.49
3.85	2.00	0.045	0.24	6.39
3.85	3.00	0.030	0.15	7.59
3.85	3.00	0.031	0.16	7.43
3.85	3.00	0.032	0.16	7.28
3.85	3.00	0.033	0.16	7.13
3.85	3.00	0.034	0.17	7.00
3.85	3.00	0.035	0.17	6.87
3.85	3.00	0.036	0.17	6.74
3.85	3.00	0.037	0.17	6.62
3.85	3.00	0.038	0.18	6.51
3.85	3.00	0.039	0.18	6.40
3.85	3.00	0.040	0.18	6.30
3.85	3.00	0.041	0.18	6.20
3.85	3.00	0.042	0.19	6.10
3.85	3.00	0.043	0.19	6.01
3.85	3.00	0.044	0.19	5.92
3.85	3.00	0.045	0.19	5.83
3.85	4.00	0.030	0.13	6.95
3.85	4.00	0.031	0.13	6.81

DBD Phase 1 Drainage #2
Rating Table for Trapezoidal Channel

Rating Table

Discharge (cfs)	Bottom Width (ft)	Mannings Coefficient	Depth (ft)	Velocity (ft/s)
3.85	4.00	0.032	0.14	6.68
3.85	4.00	0.033	0.14	6.55
3.85	4.00	0.034	0.14	6.43
3.85	4.00	0.035	0.14	6.31
3.85	4.00	0.036	0.14	6.20
3.85	4.00	0.037	0.15	6.09
3.85	4.00	0.038	0.15	5.99
3.85	4.00	0.039	0.15	5.89
3.85	4.00	0.040	0.15	5.80
3.85	4.00	0.041	0.16	5.71
3.85	4.00	0.042	0.16	5.62
3.85	4.00	0.043	0.16	5.54
3.85	4.00	0.044	0.16	5.46
3.85	4.00	0.045	0.17	5.38
3.85	5.00	0.030	0.11	6.46
3.85	5.00	0.031	0.12	6.33
3.85	5.00	0.032	0.12	6.21
3.85	5.00	0.033	0.12	6.09
3.85	5.00	0.034	0.12	5.98
3.85	5.00	0.035	0.12	5.87
3.85	5.00	0.036	0.13	5.77
3.85	5.00	0.037	0.13	5.67
3.85	5.00	0.038	0.13	5.57
3.85	5.00	0.039	0.13	5.48
3.85	5.00	0.040	0.14	5.40
3.85	5.00	0.041	0.14	5.32
3.85	5.00	0.042	0.14	5.24
3.85	5.00	0.043	0.14	5.16
3.85	5.00	0.044	0.14	5.09
3.85	5.00	0.045	0.15	5.01
3.85	6.00	0.030	0.10	6.06
3.85	6.00	0.031	0.10	5.94
3.85	6.00	0.032	0.11	5.83
3.85	6.00	0.033	0.11	5.72
3.85	6.00	0.034	0.11	5.61
3.85	6.00	0.035	0.11	5.51
3.85	6.00	0.036	0.11	5.42
3.85	6.00	0.037	0.12	5.33
3.85	6.00	0.038	0.12	5.24
3.85	6.00	0.039	0.12	5.15
3.85	6.00	0.040	0.12	5.07
3.85	6.00	0.041	0.12	5.00
3.85	6.00	0.042	0.13	4.92
3.85	6.00	0.043	0.13	4.85

DBD Phase 1 Drainage #2
Rating Table for Trapezoidal Channel

Rating Table

Discharge (cfs)	Bottom Width (ft)	Mannings Coefficient	Depth (ft)	Velocity (ft/s)
3.85	6.00	0.044	0.13	4.78
3.85	6.00	0.045	0.13	4.72
4.35	1.00	0.030	0.29	9.65
4.35	1.00	0.031	0.29	9.43
4.35	1.00	0.032	0.30	9.21
4.35	1.00	0.033	0.30	9.01
4.35	1.00	0.034	0.31	8.82
4.35	1.00	0.035	0.31	8.64
4.35	1.00	0.036	0.32	8.46
4.35	1.00	0.037	0.32	8.30
4.35	1.00	0.038	0.32	8.14
4.35	1.00	0.039	0.33	7.99
4.35	1.00	0.040	0.33	7.84
4.35	1.00	0.041	0.34	7.70
4.35	1.00	0.042	0.34	7.57
4.35	1.00	0.043	0.35	7.44
4.35	1.00	0.044	0.35	7.32
4.35	1.00	0.045	0.35	7.20
4.35	2.00	0.030	0.21	8.74
4.35	2.00	0.031	0.21	8.55
4.35	2.00	0.032	0.21	8.37
4.35	2.00	0.033	0.22	8.20
4.35	2.00	0.034	0.22	8.03
4.35	2.00	0.035	0.23	7.88
4.35	2.00	0.036	0.23	7.73
4.35	2.00	0.037	0.23	7.59
4.35	2.00	0.038	0.24	7.45
4.35	2.00	0.039	0.24	7.32
4.35	2.00	0.040	0.24	7.20
4.35	2.00	0.041	0.25	7.08
4.35	2.00	0.042	0.25	6.96
4.35	2.00	0.043	0.25	6.85
4.35	2.00	0.044	0.26	6.74
4.35	2.00	0.045	0.26	6.64
4.35	3.00	0.030	0.16	7.92
4.35	3.00	0.031	0.17	7.76
4.35	3.00	0.032	0.17	7.60
4.35	3.00	0.033	0.17	7.45
4.35	3.00	0.034	0.18	7.31
4.35	3.00	0.035	0.18	7.17
4.35	3.00	0.036	0.18	7.04
4.35	3.00	0.037	0.19	6.91
4.35	3.00	0.038	0.19	6.80
4.35	3.00	0.039	0.19	6.68

DBD Phase 1 Drainage #2
Rating Table for Trapezoidal Channel

Rating Table

Discharge (cfs)	Bottom Width (ft)	Mannings Coefficient	Depth (ft)	Velocity (ft/s)
4.35	3.00	0.040	0.20	6.57
4.35	3.00	0.041	0.20	6.47
4.35	3.00	0.042	0.20	6.37
4.35	3.00	0.043	0.20	6.27
4.35	3.00	0.044	0.21	6.17
4.35	3.00	0.045	0.21	6.08
4.35	4.00	0.030	0.14	7.28
4.35	4.00	0.031	0.14	7.13
4.35	4.00	0.032	0.15	6.98
4.35	4.00	0.033	0.15	6.85
4.35	4.00	0.034	0.15	6.72
4.35	4.00	0.035	0.15	6.60
4.35	4.00	0.036	0.16	6.48
4.35	4.00	0.037	0.16	6.37
4.35	4.00	0.038	0.16	6.26
4.35	4.00	0.039	0.16	6.16
4.35	4.00	0.040	0.17	6.06
4.35	4.00	0.041	0.17	5.97
4.35	4.00	0.042	0.17	5.88
4.35	4.00	0.043	0.17	5.79
4.35	4.00	0.044	0.18	5.70
4.35	4.00	0.045	0.18	5.62
4.35	5.00	0.030	0.12	6.76
4.35	5.00	0.031	0.13	6.63
4.35	5.00	0.032	0.13	6.50
4.35	5.00	0.033	0.13	6.37
4.35	5.00	0.034	0.13	6.26
4.35	5.00	0.035	0.13	6.14
4.35	5.00	0.036	0.14	6.04
4.35	5.00	0.037	0.14	5.93
4.35	5.00	0.038	0.14	5.83
4.35	5.00	0.039	0.14	5.74
4.35	5.00	0.040	0.15	5.65
4.35	5.00	0.041	0.15	5.56
4.35	5.00	0.042	0.15	5.48
4.35	5.00	0.043	0.15	5.40
4.35	5.00	0.044	0.15	5.32
4.35	5.00	0.045	0.16	5.25
4.35	6.00	0.030	0.11	6.35
4.35	6.00	0.031	0.11	6.22
4.35	6.00	0.032	0.11	6.10
4.35	6.00	0.033	0.12	5.99
4.35	6.00	0.034	0.12	5.88
4.35	6.00	0.035	0.12	5.77

DBD Phase 1 Drainage #2
Rating Table for Trapezoidal Channel

Rating Table

Discharge (cfs)	Bottom Width (ft)	Mannings Coefficient	Depth (ft)	Velocity (ft/s)
4.35	6.00	0.036	0.12	5.67
4.35	6.00	0.037	0.12	5.58
4.35	6.00	0.038	0.13	5.49
4.35	6.00	0.039	0.13	5.40
4.35	6.00	0.040	0.13	5.31
4.35	6.00	0.041	0.13	5.23
4.35	6.00	0.042	0.13	5.16
4.35	6.00	0.043	0.14	5.08
4.35	6.00	0.044	0.14	5.01
4.35	6.00	0.045	0.14	4.94
4.85	1.00	0.030	0.30	9.95
4.85	1.00	0.031	0.31	9.72
4.85	1.00	0.032	0.31	9.50
4.85	1.00	0.033	0.32	9.29
4.85	1.00	0.034	0.32	9.09
4.85	1.00	0.035	0.33	8.90
4.85	1.00	0.036	0.33	8.72
4.85	1.00	0.037	0.34	8.55
4.85	1.00	0.038	0.34	8.39
4.85	1.00	0.039	0.35	8.23
4.85	1.00	0.040	0.35	8.08
4.85	1.00	0.041	0.36	7.94
4.85	1.00	0.042	0.36	7.80
4.85	1.00	0.043	0.37	7.67
4.85	1.00	0.044	0.37	7.54
4.85	1.00	0.045	0.37	7.42
4.85	2.00	0.030	0.22	9.06
4.85	2.00	0.031	0.22	8.86
4.85	2.00	0.032	0.23	8.67
4.85	2.00	0.033	0.23	8.49
4.85	2.00	0.034	0.24	8.32
4.85	2.00	0.035	0.24	8.16
4.85	2.00	0.036	0.24	8.00
4.85	2.00	0.037	0.25	7.86
4.85	2.00	0.038	0.25	7.71
4.85	2.00	0.039	0.25	7.58
4.85	2.00	0.040	0.26	7.45
4.85	2.00	0.041	0.26	7.32
4.85	2.00	0.042	0.27	7.20
4.85	2.00	0.043	0.27	7.09
4.85	2.00	0.044	0.27	6.98
4.85	2.00	0.045	0.28	6.87
4.85	3.00	0.030	0.18	8.23
4.85	3.00	0.031	0.18	8.06

DBD Phase 1 Drainage #2
Rating Table for Trapezoidal Channel

Project Description	
Project File	c:\haestad\fmw\dbd_phas.fm2
Worksheet	Phase 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Channel Slope	0.330000 ft/ft
Left Side Slope	2.000000 H : V
Right Side Slope	2.000000 H : V

Input Data	Minimum	Maximum	Increment
Mannings Coefficient	0.030	0.045	0.001
Bottom Width	1.00	6.00	1.00 ft
Discharge	2.85	5.00	0.50 cfs

Rating Table

Discharge (cfs)	Bottom Width (ft)	Mannings Coefficient	Depth (ft)	Velocity (ft/s)
2.85	1.00	0.030	0.23	8.55
2.85	1.00	0.031	0.23	8.35
2.85	1.00	0.032	0.24	8.17
2.85	1.00	0.033	0.24	7.99
2.85	1.00	0.034	0.24	7.82
2.85	1.00	0.035	0.25	7.66
2.85	1.00	0.036	0.25	7.51
2.85	1.00	0.037	0.26	7.37
2.85	1.00	0.038	0.26	7.23
2.85	1.00	0.039	0.26	7.09
2.85	1.00	0.040	0.27	6.97
2.85	1.00	0.041	0.27	6.84
2.85	1.00	0.042	0.27	6.73
2.85	1.00	0.043	0.28	6.62
2.85	1.00	0.044	0.28	6.51
2.85	1.00	0.045	0.28	6.40
2.85	2.00	0.030	0.16	7.59
2.85	2.00	0.031	0.16	7.43
2.85	2.00	0.032	0.17	7.28
2.85	2.00	0.033	0.17	7.13
2.85	2.00	0.034	0.17	6.99
2.85	2.00	0.035	0.18	6.85

DBD Phase 1 Drainage #2
Rating Table for Trapezoidal Channel

Rating Table

Discharge (cfs)	Bottom Width (ft)	Mannings Coefficient	Depth (ft)	Velocity (ft/s)
4.85	3.00	0.032	0.18	7.89
4.85	3.00	0.033	0.19	7.74
4.85	3.00	0.034	0.19	7.59
4.85	3.00	0.035	0.19	7.45
4.85	3.00	0.036	0.20	7.31
4.85	3.00	0.037	0.20	7.18
4.85	3.00	0.038	0.20	7.06
4.85	3.00	0.039	0.20	6.94
4.85	3.00	0.040	0.21	6.82
4.85	3.00	0.041	0.21	6.71
4.85	3.00	0.042	0.21	6.61
4.85	3.00	0.043	0.22	6.51
4.85	3.00	0.044	0.22	6.41
4.85	3.00	0.045	0.22	6.32
4.85	4.00	0.030	0.15	7.57
4.85	4.00	0.031	0.15	7.42
4.85	4.00	0.032	0.15	7.27
4.85	4.00	0.033	0.16	7.13
4.85	4.00	0.034	0.16	6.99
4.85	4.00	0.035	0.16	6.87
4.85	4.00	0.036	0.17	6.74
4.85	4.00	0.037	0.17	6.63
4.85	4.00	0.038	0.17	6.51
4.85	4.00	0.039	0.17	6.41
4.85	4.00	0.040	0.18	6.30
4.85	4.00	0.041	0.18	6.21
4.85	4.00	0.042	0.18	6.11
4.85	4.00	0.043	0.18	6.02
4.85	4.00	0.044	0.19	5.93
4.85	4.00	0.045	0.19	5.85
4.85	5.00	0.030	0.13	7.05
4.85	5.00	0.031	0.13	6.90
4.85	5.00	0.032	0.14	6.77
4.85	5.00	0.033	0.14	6.64
4.85	5.00	0.034	0.14	6.52
4.85	5.00	0.035	0.14	6.40
4.85	5.00	0.036	0.15	6.29
4.85	5.00	0.037	0.15	6.18
4.85	5.00	0.038	0.15	6.08
4.85	5.00	0.039	0.15	5.98
4.85	5.00	0.040	0.16	5.88
4.85	5.00	0.041	0.16	5.79
4.85	5.00	0.042	0.16	5.71
4.85	5.00	0.043	0.16	5.62

DBD Phase 1 Drainage #2
Rating Table for Trapezoidal Channel

Rating Table

Discharge (cfs)	Bottom Width (ft)	Mannings Coefficient	Depth (ft)	Velocity (ft/s)
4.85	5.00	0.044	0.16	5.54
4.85	5.00	0.045	0.17	5.46
4.85	6.00	0.030	0.12	6.62
4.85	6.00	0.031	0.12	6.49
4.85	6.00	0.032	0.12	6.36
4.85	6.00	0.033	0.12	6.24
4.85	6.00	0.034	0.13	6.13
4.85	6.00	0.035	0.13	6.02
4.85	6.00	0.036	0.13	5.91
4.85	6.00	0.037	0.13	5.81
4.85	6.00	0.038	0.14	5.72
4.85	6.00	0.039	0.14	5.63
4.85	6.00	0.040	0.14	5.54
4.85	6.00	0.041	0.14	5.45
4.85	6.00	0.042	0.14	5.37
4.85	6.00	0.043	0.15	5.29
4.85	6.00	0.044	0.15	5.22
4.85	6.00	0.045	0.15	5.15

DBD Phase 1 Drainage #2
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\haestad\fmw\dbd_phas.fm2
Worksheet	Phase 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

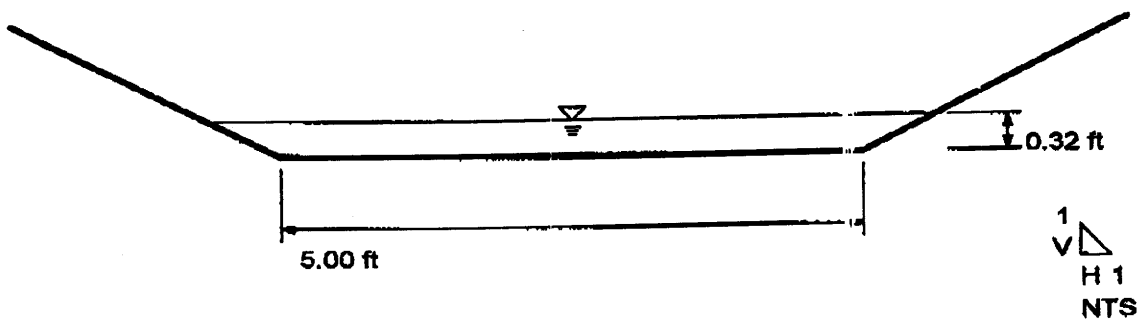
Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.400000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	5.00	ft
Discharge	18.40	cfs

Results		
Depth	0.32	ft
Flow Area	1.82	ft^2
Wetted Perimeter	6.44	ft
Top Width	6.29	ft
Critical Depth	0.68	ft
Critical Slope	0.029853	ft/ft
Velocity	10.11	ft/s
Velocity Head	1.59	ft
Specific Energy	1.91	ft
Froude Number	3.32	
Flow is supercritical.		

DBD Phase 1 Drainage #2
Cross Section for Trapezoidal Channel

Project Description	
Project File	c:\haestad\fmw\dbd_phas.fm2
Worksheet	Phase 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.040	
Channel Slope	0.400000	ft/ft
Depth	0.32	ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	5.00	ft
Discharge	18.40	cfs

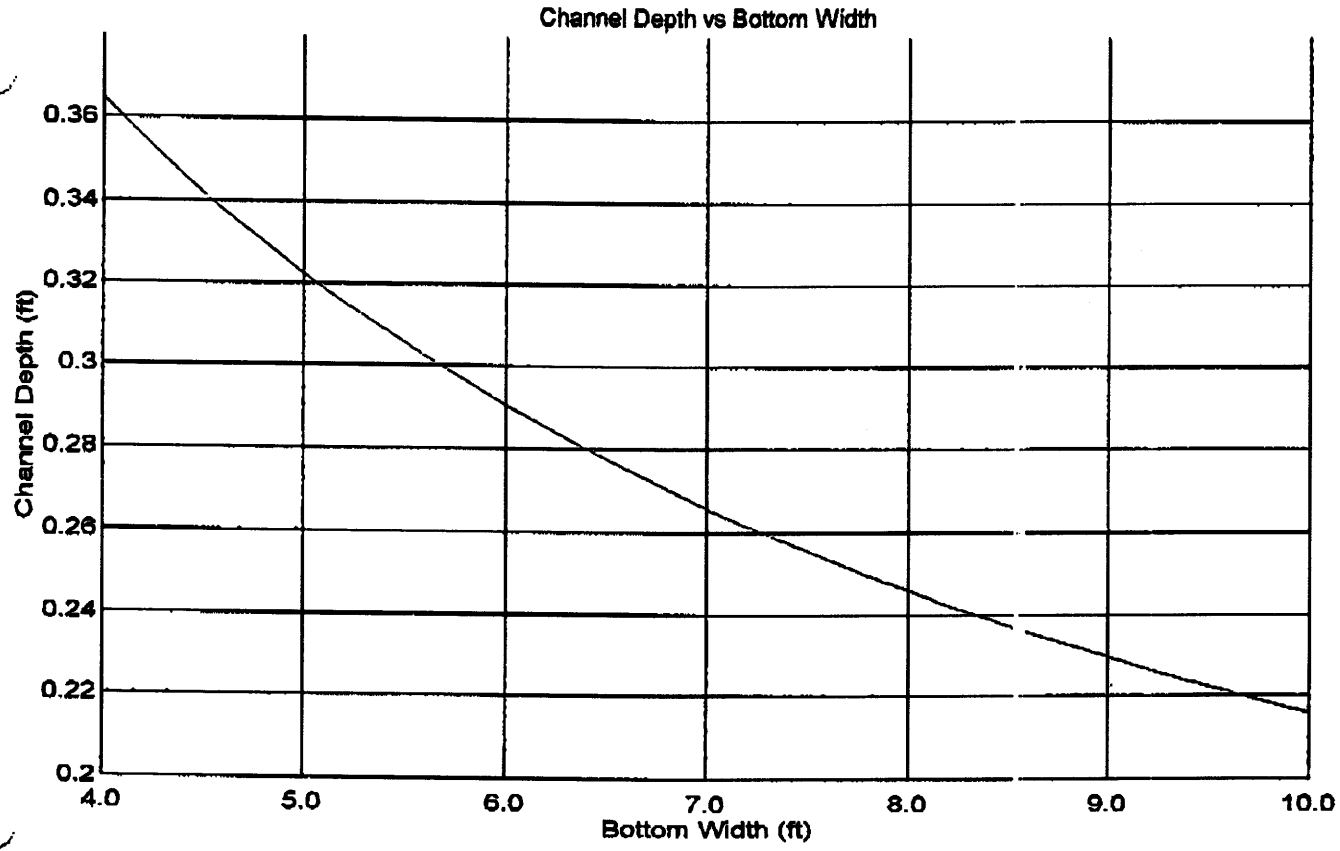


DBD Phase 1 Drainage #2
Plotted Curves for Trapezoidal Channel

Project Description	
Project File	c:\haestad\fmw\dbd_phas.fm2
Worksheet	Phase 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Mannings Coefficient	0.040
Channel Slope	0.400000 ft/ft
Left Side Slope	2.000000 H : V
Right Side Slope	2.000000 H : V
Discharge	18.40 cfs

Input Data			
	Minimum	Maximum	Increment
Bottom Width	4.00	10.00	0.20 ft



DBD Phase 1 Drainage #2
Rating Table for Trapezoidal Channel

Project Description	
Project File	c:\haestad\fmw\dbd_phas.fm2
Worksheet	Phase 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Channel Slope	0.400000 ft/ft
Left Side Slope	2.000000 H : V
Right Side Slope	2.000000 H : V
Discharge	18.40 cfs

Input Data	Minimum	Maximum	Increment
Mannings Coefficient	0.030	0.045	0.001
Bottom Width	4.00	10.00	1.00 ft

Rating Table

Bottom Width (ft)	Mannings Coefficient	Depth (ft)	Velocity (ft/s)
4.00	0.030	0.31	12.92
4.00	0.031	0.31	12.64
4.00	0.032	0.32	12.38
4.00	0.033	0.33	12.13
4.00	0.034	0.33	11.89
4.00	0.035	0.34	11.66
4.00	0.036	0.34	11.45
4.00	0.037	0.35	11.24
4.00	0.038	0.35	11.04
4.00	0.039	0.36	10.85
4.00	0.040	0.36	10.67
4.00	0.041	0.37	10.50
4.00	0.042	0.37	10.33
4.00	0.043	0.38	10.17
4.00	0.044	0.39	10.01
4.00	0.045	0.39	9.87
5.00	0.030	0.27	12.19
5.00	0.031	0.28	11.93
5.00	0.032	0.28	11.69
5.00	0.033	0.29	11.46
5.00	0.034	0.29	11.24
5.00	0.035	0.30	11.03

DBD Phase 1 Drainage #2
Rating Table for Trapezoidal Channel

Rating Table

Bottom Width (ft)	Mannings Coefficient	Depth (ft)	Velocity (ft/s)
5.00	0.036	0.30	10.83
5.00	0.037	0.31	10.64
5.00	0.038	0.31	10.46
5.00	0.039	0.32	10.28
5.00	0.040	0.32	10.11
5.00	0.041	0.33	9.95
5.00	0.042	0.33	9.80
5.00	0.043	0.34	9.65
5.00	0.044	0.34	9.50
5.00	0.045	0.35	9.36
6.00	0.030	0.25	11.56
6.00	0.031	0.25	11.32
6.00	0.032	0.25	11.10
6.00	0.033	0.26	10.88
6.00	0.034	0.26	10.68
6.00	0.035	0.27	10.48
6.00	0.036	0.27	10.29
6.00	0.037	0.28	10.11
6.00	0.038	0.28	9.94
6.00	0.039	0.29	9.78
6.00	0.040	0.29	9.62
6.00	0.041	0.29	9.47
6.00	0.042	0.30	9.32
6.00	0.043	0.30	9.18
6.00	0.044	0.31	9.05
6.00	0.045	0.31	8.92
7.00	0.030	0.22	11.02
7.00	0.031	0.23	10.79
7.00	0.032	0.23	10.58
7.00	0.033	0.24	10.38
7.00	0.034	0.24	10.18
7.00	0.035	0.25	10.00
7.00	0.036	0.25	9.82
7.00	0.037	0.25	9.65
7.00	0.038	0.26	9.49
7.00	0.039	0.26	9.34
7.00	0.040	0.27	9.19
7.00	0.041	0.27	9.04
7.00	0.042	0.27	8.91
7.00	0.043	0.28	8.78
7.00	0.044	0.28	8.65
7.00	0.045	0.29	8.53
8.00	0.030	0.21	10.55
8.00	0.031	0.21	10.33

DBD Phase 1 Drainage #2
Rating Table for Trapezoidal Channel

Rating Table			
Bottom Width (ft)	Mannings Coefficient	Depth (ft)	Velocity (ft/s)
8.00	0.032	0.22	10.13
8.00	0.033	0.22	9.94
8.00	0.034	0.22	9.75
8.00	0.035	0.23	9.58
8.00	0.036	0.23	9.41
8.00	0.037	0.23	9.25
8.00	0.038	0.24	9.10
8.00	0.039	0.24	8.95
8.00	0.040	0.25	8.81
8.00	0.041	0.25	8.67
8.00	0.042	0.25	8.54
8.00	0.043	0.26	8.42
8.00	0.044	0.26	8.30
8.00	0.045	0.26	8.18
9.00	0.030	0.19	10.14
9.00	0.031	0.20	9.93
9.00	0.032	0.20	9.74
9.00	0.033	0.20	9.55
9.00	0.034	0.21	9.38
9.00	0.035	0.21	9.21
9.00	0.036	0.22	9.05
9.00	0.037	0.22	8.90
9.00	0.038	0.22	8.75
9.00	0.039	0.23	8.61
9.00	0.040	0.23	8.47
9.00	0.041	0.23	8.34
9.00	0.042	0.24	8.22
9.00	0.043	0.24	8.10
9.00	0.044	0.24	7.98
9.00	0.045	0.25	7.87
10.00	0.030	0.18	9.77
10.00	0.031	0.19	9.57
10.00	0.032	0.19	9.39
10.00	0.033	0.19	9.21
10.00	0.034	0.20	9.04
10.00	0.035	0.20	8.88
10.00	0.036	0.20	8.73
10.00	0.037	0.21	8.58
10.00	0.038	0.21	8.44
10.00	0.039	0.21	8.30
10.00	0.040	0.22	8.18
10.00	0.041	0.22	8.05
10.00	0.042	0.22	7.93
10.00	0.043	0.23	7.82

DBD Phase 1 Drainage #2
Rating Table for Trapezoidal Channel

Rating Table			
Bottom Width (ft)	Mannings Coefficient	Depth (ft)	Velocity (ft/s)
10.00	0.044	0.23	7.71
10.00	0.045	0.23	7.60

DBD Phase 1 Drainage #1
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\haestad\fmw\dbd_phas.fm2
Worksheet	Phase 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

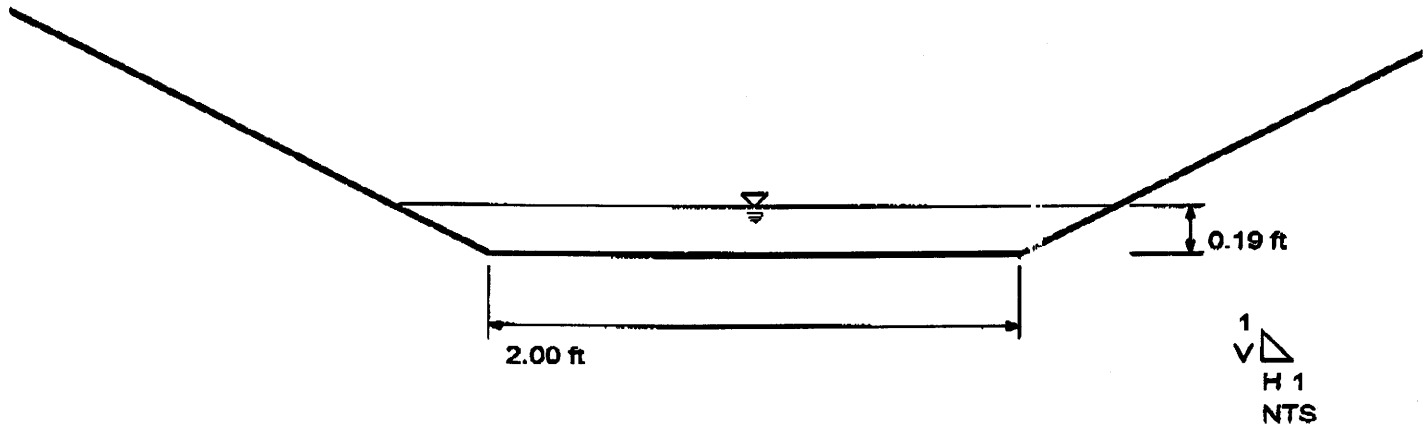
Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.330000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	2.00	ft
Discharge	2.85	cfs

Results		
Depth	0.19	ft
Flow Area	0.45	ft^2
Wetted Perimeter	2.85	ft
Top Width	2.76	ft
Critical Depth	0.35	ft
Critical Slope	0.038012	ft/ft
Velocity	6.27	ft/s
Velocity Head	0.61	ft
Specific Energy	0.80	ft
Froude Number	2.73	
Flow is supercritical.		

DBD Phase 1 Drainage #1
Cross Section for Trapezoidal Channel

Project Description	
Project File	c:\haestad\fmw\dbd_phas.fm2
Worksheet	Phase 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.040	
Channel Slope	0.330000	ft/ft
Depth	0.19	ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	2.00	ft
Discharge	2.85	cfs

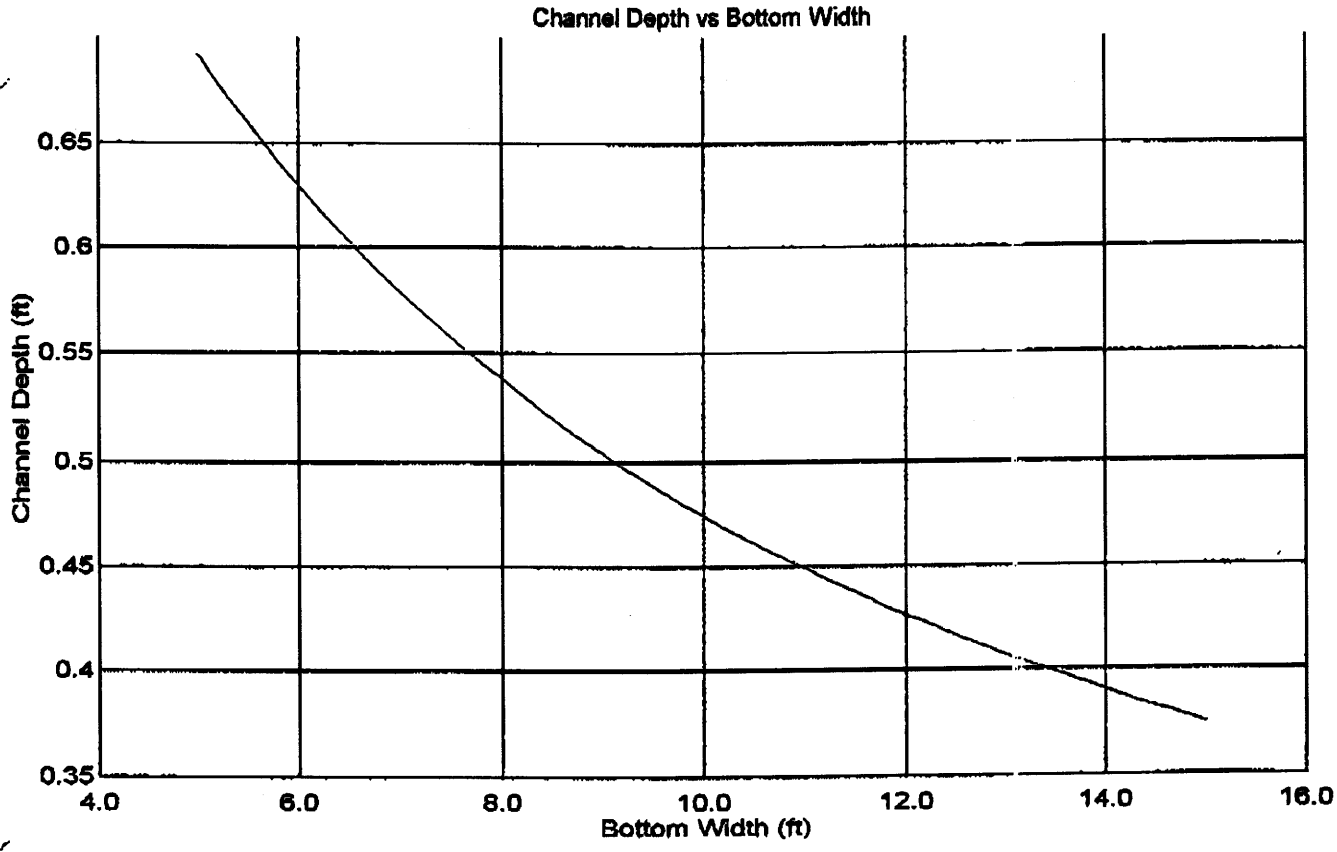


DBD Phase 1 Drainage #3
Plotted Curves for Trapezoidal Channel

Project Description	
Project File	c:\haestad\fmw\dbd_phas.fm2
Worksheet	Phase 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Mannings Coefficient	0.040
Channel Slope	0.310000 ft/ft
Left Side Slope	2.000000 H : V
Right Side Slope	2.000000 H : V
Discharge	61.00 cfs

Input Data	Minimum	Maximum	Increment
Bottom Width	5.00	15.00	0.20 ft



DBD Phase 1 Drainage #3
Rating Table for Trapezoidal Channel

Project Description	
Project File	c:\haestad\fmw\dbd_phas.fm2
Worksheet	Phase 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Channel Slope	0.310000 ft/ft
Left Side Slope	2.000000 H : V
Right Side Slope	2.000000 H : V
Discharge	61.00 cfs

Input Data	Minimum	Maximum	Increment
Mannings Coefficient	0.030	0.045	0.001
Bottom Width	5.00	15.00	1.00 ft

Rating Table

Bottom Width (ft)	Mannings Coefficient	Depth (ft)	Velocity (ft/s)
5.00	0.030	0.59	16.81
5.00	0.031	0.60	16.44
5.00	0.032	0.61	16.09
5.00	0.033	0.62	15.75
5.00	0.034	0.63	15.44
5.00	0.035	0.64	15.13
5.00	0.036	0.65	14.84
5.00	0.037	0.66	14.57
5.00	0.038	0.67	14.31
5.00	0.039	0.68	14.05
5.00	0.040	0.69	13.81
5.00	0.041	0.70	13.58
5.00	0.042	0.71	13.36
5.00	0.043	0.72	13.14
5.00	0.044	0.73	12.94
5.00	0.045	0.74	12.74
6.00	0.030	0.53	16.18
6.00	0.031	0.54	15.83
6.00	0.032	0.55	15.50
6.00	0.033	0.56	15.19
6.00	0.034	0.57	14.89
6.00	0.035	0.58	14.60

DBD Phase 1 Drainage #3
Rating Table for Trapezoidal Channel

Rating Table

Bottom Width (ft)	Mannings Coefficient	Depth (ft)	Velocity (ft/s)
6.00	0.036	0.59	14.33
6.00	0.037	0.60	14.07
6.00	0.038	0.61	13.82
6.00	0.039	0.62	13.58
6.00	0.040	0.63	13.35
6.00	0.041	0.64	13.13
6.00	0.042	0.65	12.92
6.00	0.043	0.66	12.71
6.00	0.044	0.66	12.52
6.00	0.045	0.67	12.33
7.00	0.030	0.49	15.60
7.00	0.031	0.50	15.27
7.00	0.032	0.51	14.95
7.00	0.033	0.52	14.65
7.00	0.034	0.53	14.37
7.00	0.035	0.54	14.10
7.00	0.036	0.54	13.84
7.00	0.037	0.55	13.59
7.00	0.038	0.56	13.35
7.00	0.039	0.57	13.12
7.00	0.040	0.58	12.90
7.00	0.041	0.59	12.70
7.00	0.042	0.60	12.49
7.00	0.043	0.60	12.30
7.00	0.044	0.61	12.11
7.00	0.045	0.62	11.93
8.00	0.030	0.45	15.06
8.00	0.031	0.46	14.75
8.00	0.032	0.47	14.45
8.00	0.033	0.48	14.16
8.00	0.034	0.49	13.89
8.00	0.035	0.50	13.63
8.00	0.036	0.51	13.38
8.00	0.037	0.51	13.14
8.00	0.038	0.52	12.92
8.00	0.039	0.53	12.70
8.00	0.040	0.54	12.49
8.00	0.041	0.55	12.29
8.00	0.042	0.55	12.10
8.00	0.043	0.56	11.91
8.00	0.044	0.57	11.73
8.00	0.045	0.58	11.56
9.00	0.030	0.43	14.57
9.00	0.031	0.43	14.27

DBD Phase 1 Drainage #3
Rating Table for Trapezoidal Channel

Rating Table			
Bottom Width (ft)	Mannings Coefficient	Depth (ft)	Velocity (ft/s)
9.00	0.032	0.44	13.98
9.00	0.033	0.45	13.71
9.00	0.034	0.46	13.45
9.00	0.035	0.47	13.20
9.00	0.036	0.47	12.96
9.00	0.037	0.48	12.73
9.00	0.038	0.49	12.51
9.00	0.039	0.50	12.31
9.00	0.040	0.50	12.11
9.00	0.041	0.51	11.91
9.00	0.042	0.52	11.73
9.00	0.043	0.53	11.55
9.00	0.044	0.53	11.38
9.00	0.045	0.54	11.22
10.00	0.030	0.40	14.12
10.00	0.031	0.41	13.83
10.00	0.032	0.42	13.55
10.00	0.033	0.42	13.29
10.00	0.034	0.43	13.04
10.00	0.035	0.44	12.80
10.00	0.036	0.45	12.57
10.00	0.037	0.45	12.35
10.00	0.038	0.46	12.14
10.00	0.039	0.47	11.94
10.00	0.040	0.47	11.75
10.00	0.041	0.48	11.57
10.00	0.042	0.49	11.39
10.00	0.043	0.49	11.22
10.00	0.044	0.50	11.05
10.00	0.045	0.51	10.90
11.00	0.030	0.38	13.71
11.00	0.031	0.39	13.43
11.00	0.032	0.39	13.16
11.00	0.033	0.40	12.91
11.00	0.034	0.41	12.67
11.00	0.035	0.41	12.44
11.00	0.036	0.42	12.22
11.00	0.037	0.43	12.00
11.00	0.038	0.44	11.80
11.00	0.039	0.44	11.61
11.00	0.040	0.45	11.42
11.00	0.041	0.46	11.25
11.00	0.042	0.46	11.07
11.00	0.043	0.47	10.91

DBD Phase 1 Drainage #3
Rating Table for Trapezoidal Channel

Rating Table

Bottom Width (ft)	Mannings Coefficient	Depth (ft)	Velocity (ft/s)
11.00	0.044	0.47	10.75
11.00	0.045	0.48	10.60
12.00	0.030	0.36	13.33
12.00	0.031	0.37	13.06
12.00	0.032	0.37	12.80
12.00	0.033	0.38	12.56
12.00	0.034	0.39	12.32
12.00	0.035	0.39	12.10
12.00	0.036	0.40	11.89
12.00	0.037	0.41	11.68
12.00	0.038	0.41	11.49
12.00	0.039	0.42	11.30
12.00	0.040	0.43	11.12
12.00	0.041	0.43	10.95
12.00	0.042	0.44	10.78
12.00	0.043	0.45	10.62
12.00	0.044	0.45	10.47
12.00	0.045	0.46	10.32
13.00	0.030	0.34	12.99
13.00	0.031	0.35	12.72
13.00	0.032	0.36	12.47
13.00	0.033	0.36	12.23
13.00	0.034	0.37	12.01
13.00	0.035	0.38	11.79
13.00	0.036	0.38	11.59
13.00	0.037	0.39	11.39
13.00	0.038	0.40	11.20
13.00	0.039	0.40	11.02
13.00	0.040	0.41	10.84
13.00	0.041	0.41	10.68
13.00	0.042	0.42	10.51
13.00	0.043	0.43	10.36
13.00	0.044	0.43	10.21
13.00	0.045	0.44	10.07
14.00	0.030	0.33	12.67
14.00	0.031	0.34	12.41
14.00	0.032	0.34	12.17
14.00	0.033	0.35	11.94
14.00	0.034	0.35	11.72
14.00	0.035	0.36	11.51
14.00	0.036	0.37	11.31
14.00	0.037	0.37	11.11
14.00	0.038	0.38	10.93
14.00	0.039	0.38	10.75

DBD Phase 1 Drainage #3
Rating Table for Trapezoidal Channel

Rating Table

Bottom Width (ft)	Mannings Coefficient	Depth (ft)	Velocity (ft/s)
14.00	0.040	0.39	10.58
14.00	0.041	0.40	10.42
14.00	0.042	0.40	10.27
14.00	0.043	0.41	10.12
14.00	0.044	0.41	9.97
14.00	0.045	0.42	9.83
15.00	0.030	0.32	12.37
15.00	0.031	0.32	12.12
15.00	0.032	0.33	11.89
15.00	0.033	0.33	11.66
15.00	0.034	0.34	11.45
15.00	0.035	0.35	11.24
15.00	0.036	0.35	11.05
15.00	0.037	0.36	10.86
15.00	0.038	0.36	10.68
15.00	0.039	0.37	10.51
15.00	0.040	0.37	10.34
15.00	0.041	0.38	10.19
15.00	0.042	0.39	10.03
15.00	0.043	0.39	9.89
15.00	0.044	0.40	9.75
15.00	0.045	0.40	9.61

DES-BEE-DOVE MINES
2001 RECLAMATION PROJECT
SCOPE OF WORK
PHASE 1

PHASE 1

RIPRAP GRADATION CALCULATION FOR FILTER DESIGN

Deer Canyon Channel

Rip-Rap Gradation

Segment - **Drainage #1**

	(ft)	(mm)
D_{50} Riprap = x	0.42	128.1
D_{15} RipRap = y	0.13	38.43

D_{50} Filter = a
D_{15} Filter = b
D_{85} Filter = c

Criteria
1) D_{50} RipRap/D_{50} Filter < 40
2) D_{15} RipRap/D_{15} Filter > 5
D_{15} RipRap/D_{15} Filter < 40
3) D_{15} RipRap/D_{85} Filter < 5

or

1) x/a < 40
2) y/b > 5
y/b < 40
3) y/c < 5

Therefore,

	(mm)	(ft)	(in)
D_{50} Filter >	3.20	0.01	1/8
D_{15} Filter <	7.69	0.03	1/2
D_{15} Filter >	0.96	0.00	1/8
D_{85} Filter >	7.69	0.03	1/2

Deer Canyon Channel

Rip-Rap Gradation

Segment - **Drainage #2**

	(ft)	(mm)
D_{50} Riprap = x	0.94	286.7
D_{15} RipRap = y	0.28	86.01

D_{50} Filter = a
D_{15} Filter = b
D_{85} Filter = c

Criteria
1) D_{50} RipRap/D_{50} Filter < 40
2) D_{15} RipRap/D_{15} Filter > 5
D_{15} RipRap/D_{15} Filter < 40
3) D_{15} RipRap/D_{85} Filter < 5

or

1) x/a < 40
2) y/b > 5
y/b < 40
3) y/c < 5

Therefore,

	(mm)	(ft)	(in)
D_{50} Filter >	7.17	0.02	1/4
D_{15} Filter <	17.20	0.06	3/4
D_{15} Filter >	2.15	0.01	1/16
D_{85} Filter >	17.20	0.06	3/4

Deer Canyon Channel

Rip-Rap Gradation

Segment - **Drainage #3**

	(ft)	(mm)
D_{50} Riprap = x	1.14	347.7
D_{15} RipRap = y	0.34	104.31

D_{50} Filter = a
D_{15} Filter = b
D_{85} Filter = c

Criteria
1) D_{50} RipRap/D_{50} Filter < 40
2) D_{15} RipRap/D_{15} Filter > 5
D_{15} RipRap/D_{15} Filter < 40
3) D_{15} RipRap/D_{85} Filter < 5

or

1) x/a < 40
2) y/b > 5
y/b < 40
3) y/c < 5

Therefore,

	(mm)	(ft)	(in)
D_{50} Filter >	8.69	0.03	1/2
D_{15} Filter <	20.86	0.07	1
D_{15} Filter >	2.61	0.01	1/16
D_{85} Filter >	20.86	0.07	1