HAIGHT CREEK

Site Information

Site Location: Coast Range, S Willamette Valley, Siuslaw River Tributary, near Alma

Year Installed: Pre-1987

Lat/Long: 123°30'1.49"W 43°52'32.70"N

Watershed Area (mi²): 3.76

Stream Slope (ft/ft)[1]: 0.0077

Channel Type: Pool-riffle

Bankfull Width (ft): 19

Survey Date: March 8, 2007

[1]*Water surface slope extending up to 20 channel widths up and downstream of crossing.*

Culvert Information

Culvert Type: Open-bottom arch

Culvert Material: Annular CMP

Culvert Width: 19

Outlet Type: Mitered

Culvert Length: 62

Inlet Type: Mitered

Pipe Slope (structure slope): 0.005

Culvert Bed Slope: 0.001

(First hydraulic control upstream of inlet to first hydraulic control downstream of outlet.)

Culvert width as a percentage of bankfull width: 1.01

Alignment Conditions: Appears to have been aligned to minimize length under road. Inlet is shifted too far to the left, and is likely creating the erosion observed on left bank upstream of inlet.

Bed Conditions: Bedrock (sandstone) dominates in pipe. Bedrock scoured in places. Some gravel/cobble forming riffle at downstream portion of pipe. Material possibly remaining in pipe due to Siuslaw backwater.

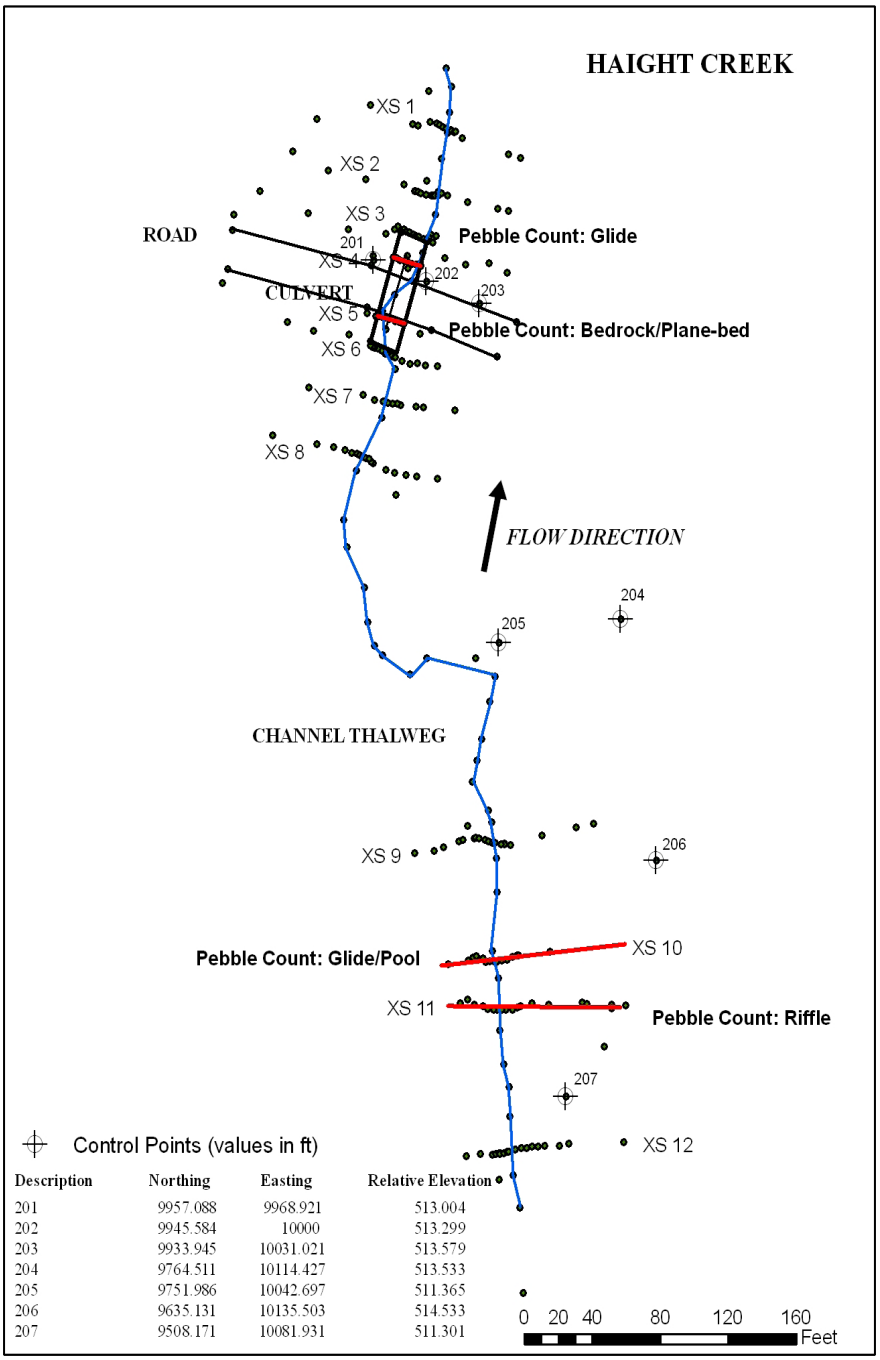
Pipe Condition: Light to medium rust. Some structure joints open.

Hydrology

Discharge (cfs) for indicated recurrence interval

25% 2-yr	Q_{bf}[2]	2-year	5-year	10-year	50-year	100-year
41	150	165	242	295	418	471

[2]*Bankfull flow estimated by matching modeled water surface elevations to field-identified bankfull elevations.*



Description	Northing	Easting	Relative Elevation
201	9957.088	9968.921	513.004
202	9945.584	10000	513.299
203	9933.945	10031.021	513.579
204	9764.511	10114.427	513.533
205	9751.986	10042.697	511.365
206	9635.131	10135.503	514.533
207	9508.171	10081.931	511.301

Points represent survey points

Figure 1—Plan view map.

HISTORY

The exact installation date is unknown, but the culvert was included in the 1987 Western Federal Lands Highway Division (WFLHD) "Oregon Culvert Fish Passage Survey;" the field survey for the WFLHD study was conducted on December 8, 1987. With respect to fish passage, Oregon Department of Fish and Wildlife staff rated the site as a "good" installation. Their comments consisted of the following "access to stream good at most flows, except extreme low summertime. Metal of culvert beginning to corrode near waterline, but concrete sill shows no sign of wear. No buildup of gravel or other material. Soft sandstone bedrock bottom. Bridge was offset from normal stream channel by 15 feet on upstream end. Bridge should have been placed more directly inline with streamflow. Some erosion noted at this point, probably due to creation of back eddy." WFLHD staff rated the condition of the foundation as "fair," with negligible outlet scour. The culvert hydraulics were rated as "compatible" with the natural stream hydraulics. They note that because the foundation is located on sandstone, scour at the foundations may be a problem.

The following are photos from the WFLHD study:

Culvert inlet.

Typical stream channel.

SITE DESCRIPTION

The Haight Creek culvert is a bottomless arch mitered to conform to the slope of the road fill. Exposed footings run along the length of the crossing. Riprap lines both banks upstream of the culvert. The channel through the culvert is made up of sandstone bedrock overlain by sand and small gravels. For the most part, the bed lacks any bedforms with the exception of a scour pool towards the downstream end.

The transition from the Haight Creek drainage into the flood plain of the Siuslaw River is accompanied by an abrupt flattening out of the gradient. Due to the location of the crossing immediately downstream of this transition, the influence of the Siuslaw on the hydraulics and geomorphic condition of the culvert are significant. Suspected backwatering during low to mid-range floods through and upstream of the culvert forced the location of the upstream representative reach to be pushed a significant way upstream, past a sharp bend in the channel.

The upstream representative reach had riffles interspersed by glides/pools. High banks along both sides indicate that the channel may be somewhat incised through this reach, an observation supported by the results from the

hydraulic model. Incision through this reach is likely a contributor to narrow bankfull widths measured as equal as or less than the culvert. The growth of vegetation along the banks and out over the channel adds roughness to the channel and also provides shade and cover.

Downstream of the culvert the stream channel is influenced by the Siuslaw River. Bank height and channel dimensions do not bear any signature of Haight Creek. The deposition of fines and sand along the banks, through the culvert, and extending upstream to a bar located at a sharp bend in the channel indicate that the hydraulic effects of the Siuslaw on the channel are frequent and extensive. Based on the profile, minor changes in stage of the Siuslaw (i.e., less than a foot) would result in water backing up into the culvert. Without knowledge of the timing of floods on Haight Creek and the Siuslaw and without survey data and a stage-discharge relationship for the Siuslaw, it is hard to know the specific extent or frequency of backwater.

SURVEY SUMMARY

Twelve cross sections and a longitudinal profile were surveyed along Haight Creek in March 2007 to characterize the culvert and an upstream representative reach. No downstream representative reach was established due to the proximity of the confluence with the Siuslaw River. Two representative cross sections were taken through the culvert; one along the plane-bed section and the other through the downstream scour pool. One additional cross section was surveyed upstream to characterize the inlet as well as the contraction of flow. Another two cross sections were surveyed downstream of the culvert to characterize the outlet and the expansion of flow.

Representative cross sections in the upstream representative reach were taken through a riffle and a glide/pool. Two additional sections were surveyed to characterize the upstream and downstream ends of the reach.

PROFILE ANALYSIS SEGMENT SUMMARY

The profile analysis resulted in a total of nine profile segments. The culvert consisted of one profile segment that extended into inlet and outlet transition areas. The culvert segment was compared to one representative profile segment in the upstream channel. The gradients are 63-percent different between these two segments, but because of their very flat profiles and similarity in channel type, they are considered suitable comparisons. The downstream transition area was compared to one representative profile segment in the upstream channel. A transition area comparison was not made for the upstream transition because the culvert segment extends through the upstream transition area. Therefore, the culvert segment also represents conditions in the upstream transition area that is affected by the culvert. See figure 2 and table 1.

SCOUR CONDITIONS

Observed conditions

Footing scour – There is scour upstream of the inlet on the right bank at the base of the riprap bank. There is scour at the inlet on the left bank along the footing. There is approximately 20 lineal feet of scour (18 inches deep) at the downstream end of the culvert on the right bank. These areas of scour are in the sandstone bedrock.

Culvert-bed adjustment – The culvert is primarily (80 percent) sandstone bedrock. It is unknown whether streambed material was placed on the bed during construction.

Profile characteristics – The profile shape is concave with the maximum concavity focused upstream of the inlet. The crossing is located in an area of valley transition where the Haight Creek valley meets the broad valley of the Siuslaw River.

Residual depths – Culvert residual depths are greater than the residual depths in the corresponding profile segment (G) (figure 21). Residual depths in the downstream transition segment (A) are comparable to those in the corresponding profile segment (I).

Substrate – The culvert is primarily sandstone bedrock. The alluvial material that is present is primarily composed of fine material. The bed material distribution in the culvert is negatively skewed, indicating more fine particles than coarse particles. The bed material in the culvert is heavily influenced by backwater from the Siuslaw during high flows. The upstream representative segment has significant portions of bedrock and sand. Large deposits of sand in the upstream transition segment are a result of backwater from the Siuslaw.

Predicted conditions

Cross-section characteristics – The culvert affects flow geometry at the crossing. The width-related parameters (top width and wetted perimeter) are actually greater in the culvert at low flows and lower at high flows (figures 6 and 8). Values of maximum hydraulic radius and maximum depth in the culvert are greater than in the corresponding profile segment (figures 9 and 14). The box plots do not adequately represent conditions in the culvert because the culvert segment extends into inlet and outlet transition areas. The downstream transition segment (A) has lower width and wetted perimeter but similar depth and hydraulic radius when compared to the corresponding profile segment (I).

Shear stress – Shear stress in the culvert is lower and less variable than in the natural channel (figure 10). Shear stress has higher values and a greater range of values in the downstream transition segment at the Q_{50} and above.

Excess shear – The excess shear analysis shows little difference between the culvert and the channel. Bed mobilization would be affected by backwater conditions during high flows on the Siuslaw, which the excess shear analysis does not consider.

Velocity – Velocity in the culvert is greater and less variable than the corresponding profile segment, particularly at flows above the Q_{10} (figure 11). Velocity in the downstream transition segment (A) is greater and more variable than the corresponding profile segment (I) at most flows.

Scour summary

There is scour into the sandstone bedrock upstream of the inlet, at the inlet on the left bank and at the downstream end of the culvert on the right bank. There is scour along the footing within the culvert but the footing base is not exposed. The footing depth is unknown. Scour upstream of the inlet and at the inlet may be related to constriction of the channel at this location (necks down to 9 feet at one location) and to the sharp bend as the channel enters the culvert.

Channel incision is apparent upstream of the inlet and may be the result of this or a previous installation.

The culvert affects flow geometry and hydraulics but shear stress and excess shear do not indicate significant risk of scour to the culvert bed. The potential for scour is further reduced by the common occurrence of backwater from the Siuslaw River at high flows. The sandstone bed, however, is easily eroded and continued erosion may undermine footings over time.

AOP CONDITIONS

Cross-section complexity – The sum of squared height differences in the culvert cross sections are either less than (upstream cross section) or greater than (downstream cross section) the values in the representative channel (table 3).

Profile compolexity – Vertical sinuosity in the culvert and in the downstream transition segment is similar to that found in corresponding profile segments (table 4).

Depth distribution – There is less channel margin habitat in the culvert compared to the channel at the 25 percent Q_2 (table 5).

Habitat units – The culvert is composed of glide and pool habitat whereas the upstream representative reach is composed of riffle and pool habitat (table 6).

Residual depths – Culvert residual depths are greater than the residual depths in the corresponding profile segment (G) (figure 21). Residual depths in the downstream transition segment (A) are comparable to those in the corresponding profile segment (I).

Substrate – The culvert is primarily sandstone bedrock. The alluvial material that is present is primarily composed of fine material. The bed material distribution in the culvert is negatively skewed, indicating more fine particles than coarse particles. The bed material in the culvert is heavily influenced by backwater from the Siuslaw during high flows. The upstream representative segment has significant portions of bedrock and sand. Large deposits of sand in the upstream transition segment are a result of backwater from the Siuslaw.

Large woody debris – There was one small piece of LWD at the inlet (table 8). The representative channel had low LWD abundance. LWD formed occasional scour pools in the channel outside the crossing. There were no features in the culvert that mimicked the role of wood in the natural channel.

AOP summary

Although the complexity metrics do not capture it, site observations indicate that the bedrock bed of the culvert has much less complexity than the natural channel upstream of the culvert. The culvert is considered a poor design with respect to fish passage, with very little shallow channel margin habitat available and very little velocity refuge such as what is provided by substrate and pools in the natural channel. At low flows, shallow sheet flow over bedrock may present passage limitations. There are no streambanks to concentrate flows for passage or to allow for passage of terrestrial organisms. At higher flows, however, backwatered conditions from the Siuslaw may allow for easy fish passage through the crossing.

DESIGN CONSIDERATIONS

Inlet scour may be reduced with an installation that is more inline with the original channel, which would require a longer culvert. Using a wider culvert and constructing a stable bed foundation may allow for material to be retained within the pipe. Constructing banks using stable bed elements (i.e., boulders) within the culvert would protect the footings from being undermined by scour of the sandstone bedrock. This would also allow for the passage of terrestrial organisms; however, passage of terrestrial organisms may be limited at higher flows when the culvert is backwatered by the Siuslaw River.

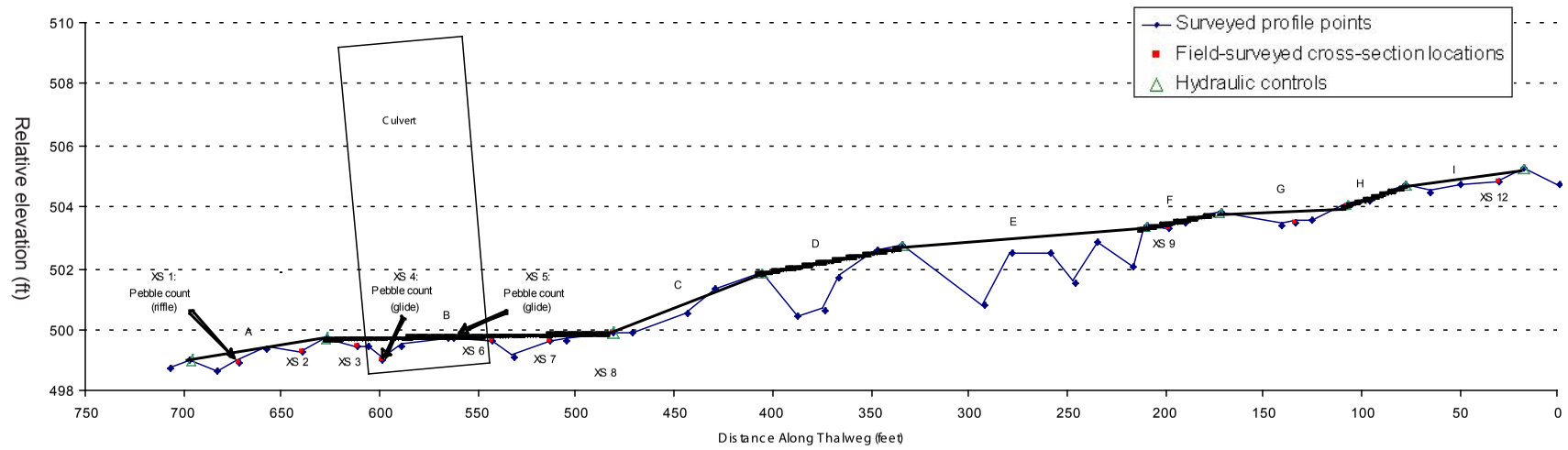


Figure 2—Haight Creek longitudinal profile.

Table 1—Segment comparisons

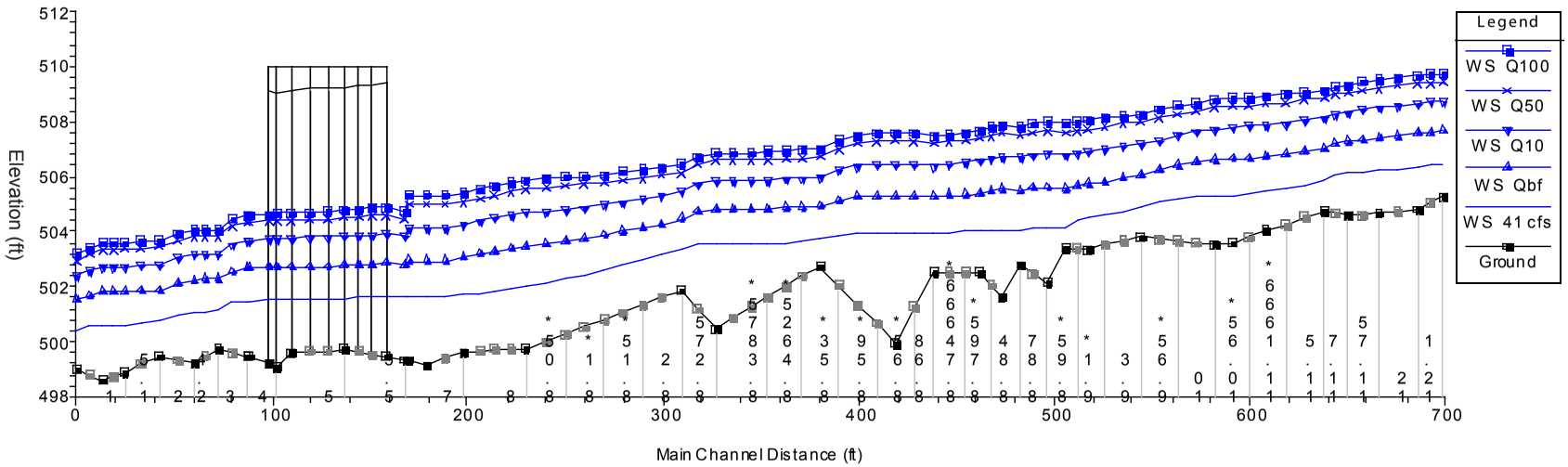
Culvert Segment	Representative Channel Segment	% Difference in Gradient
B	G	62.6%
Downstream Transition		
A	I	13.3%

Segment	Segment Length (ft)	Segment Gradient
A	69	0.010
B	146	0.001
C	76	0.025
D	71	0.013
E	124	0.005
F	38	0.012
G	64	0.003
H	30	0.022
I	60	0.009

Table 2—Summary of segments used for comparisons

Segment	Range of Manning's n values[1]	# of measured XSs	# of interpolated XSs
A	0.048 – 0.0492	2	9
B	0.03 – 0.0635	6	16
G	0.0629 – 0.0632	2	6
I	0.0638 – 0.0646	1	8

[1]Obtained using equation from Jarrett (1984): n = 0.39S0.38R-0.16, where S=stream slope; R=hydraulic radius. Jarrett's equation only applied within the following ranges: S = 0.002 to 0.08, R = 0.5 ft to 7 ft. For cross sections outside these ranges, n was computed either from adjacent sections that fell within the ranges, using the guidance of Arcement and Schneider (1987), or from the HEC-RAS recommendations for culvert modeling.



Stations with decimal values are interpolated cross sections placed along the surveyed profile.

Figure 3—HEC-RAS profile.

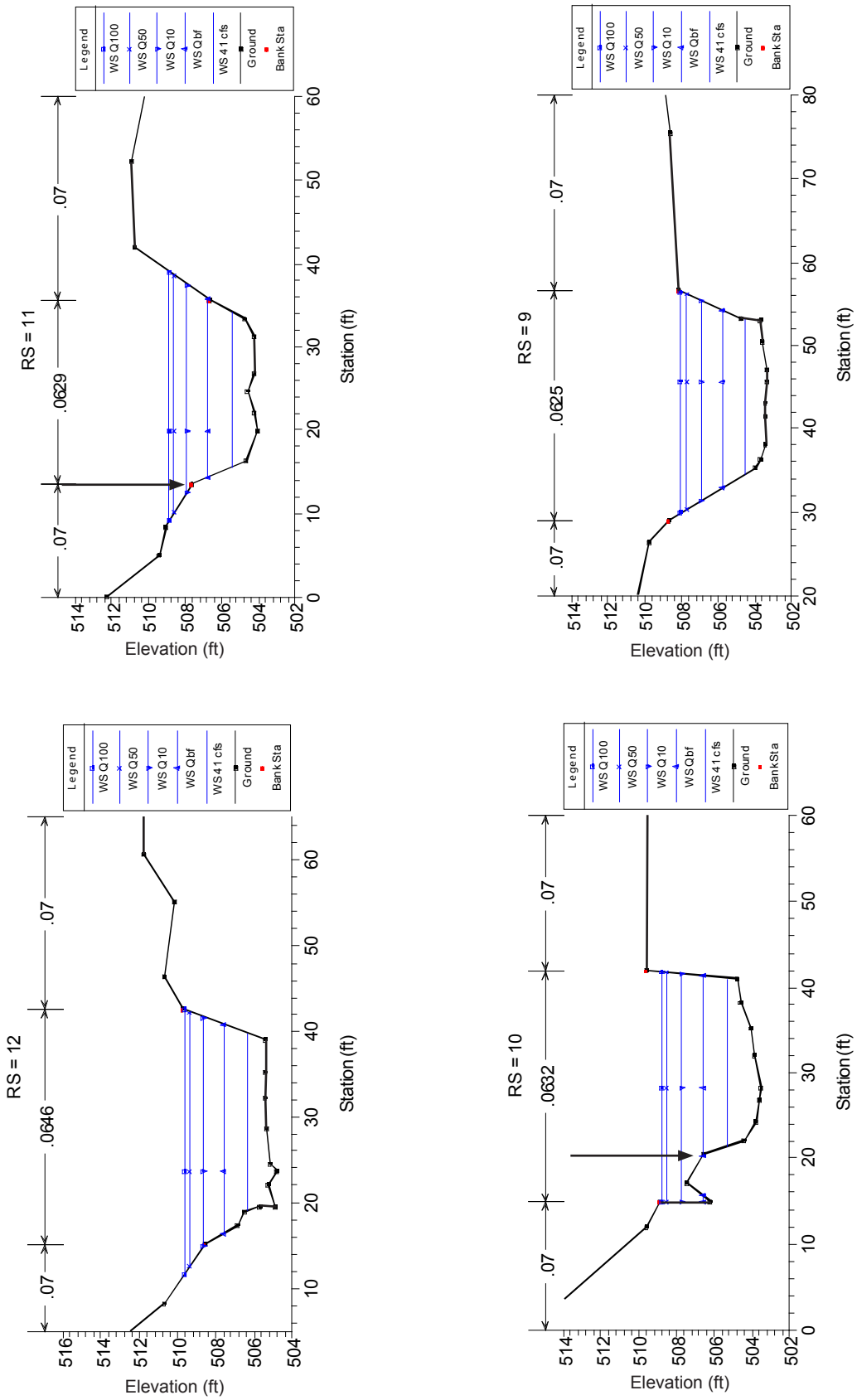
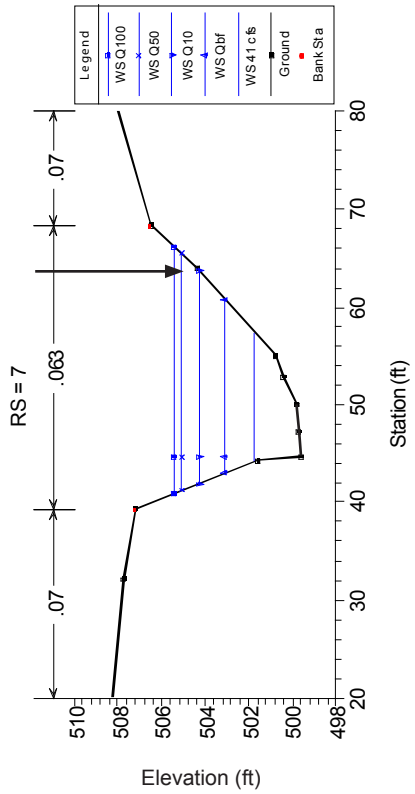
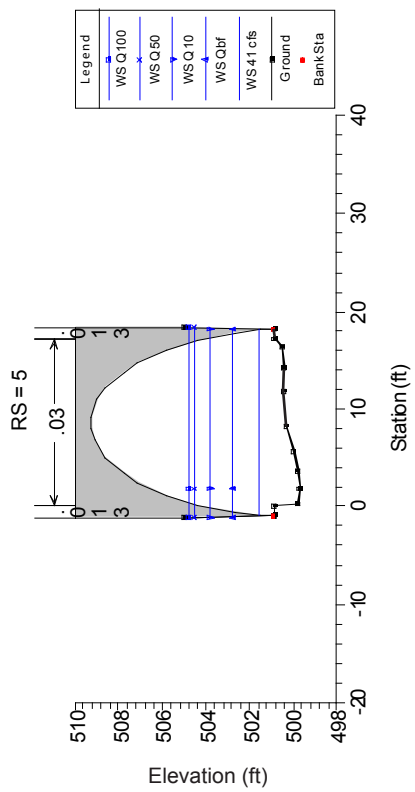
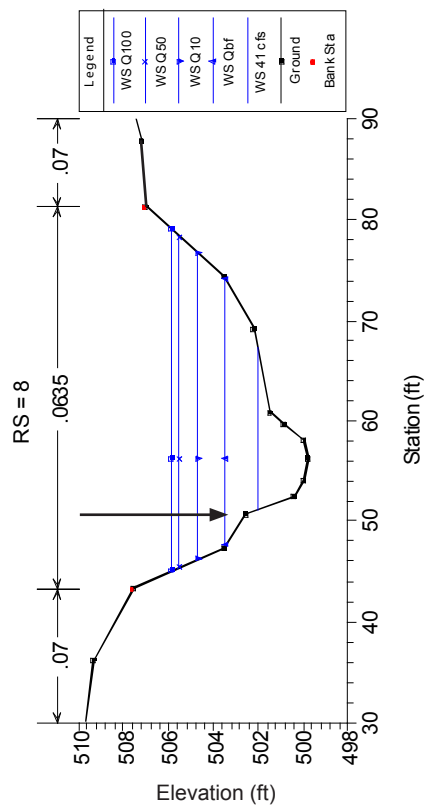
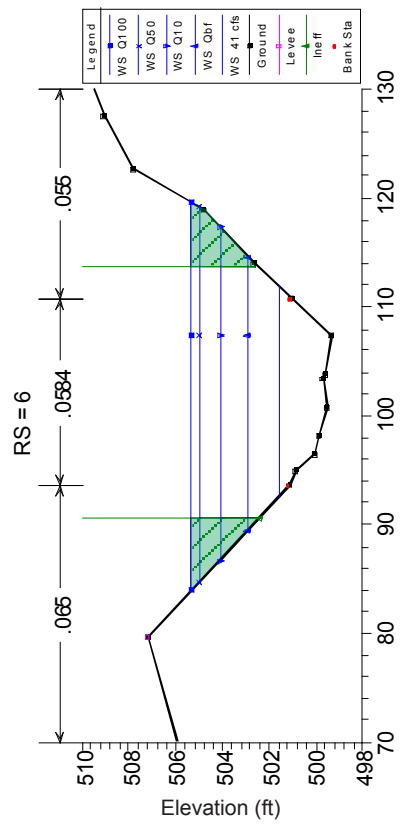


Figure 4—Cross-section plots. Only measured cross sections are included. Manning's n values are included at the top of the cross section. The stationing (RS) corresponds to the stationing on the HEC-RAS profile. Green arrows define the ineffective flow areas. Black arrows represent points identified in the field as the bankfull channel boundary. Only those points identified in the field and supported by hydraulic and topographic analyses are shown below.









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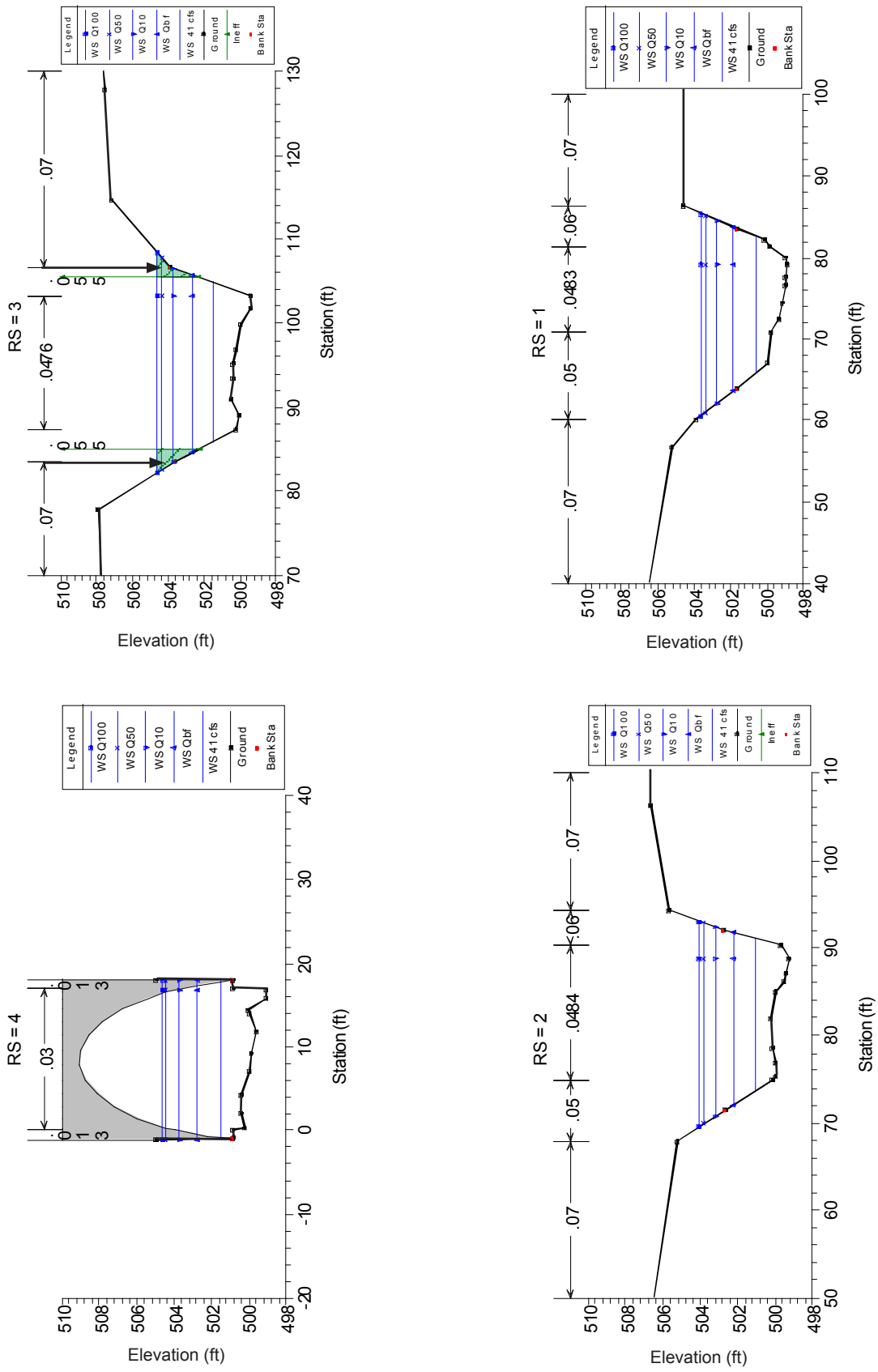

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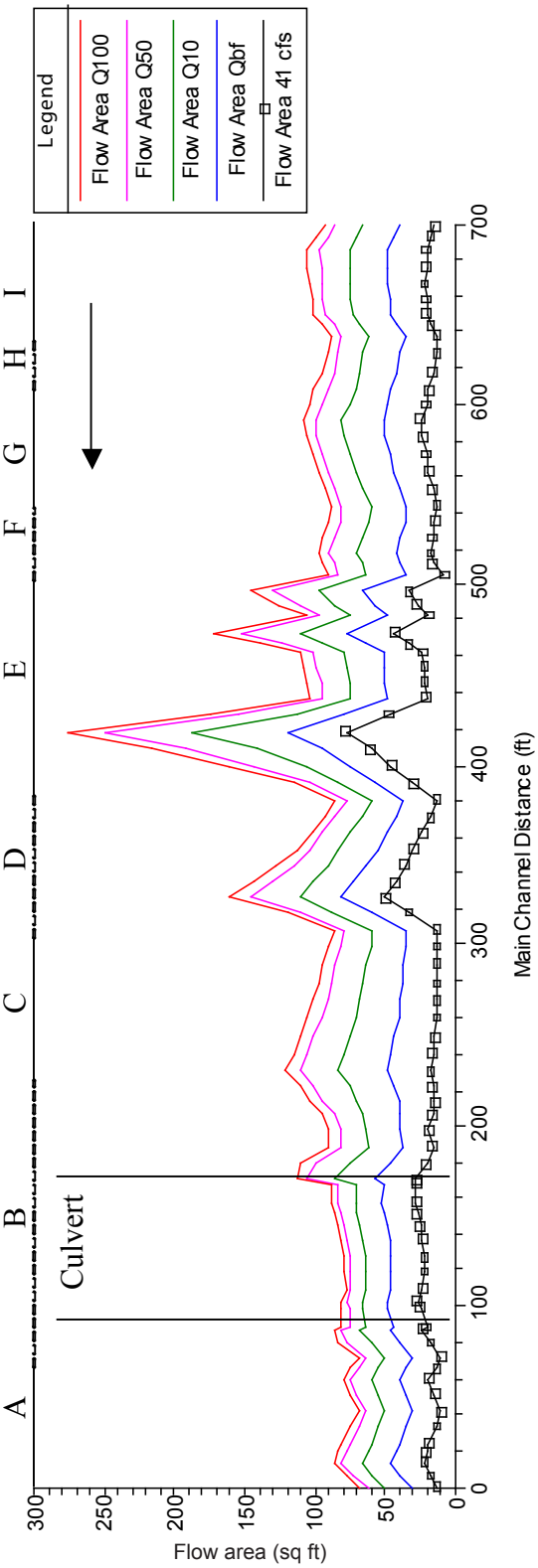


Figure 5—Flow area (total) profile plot.

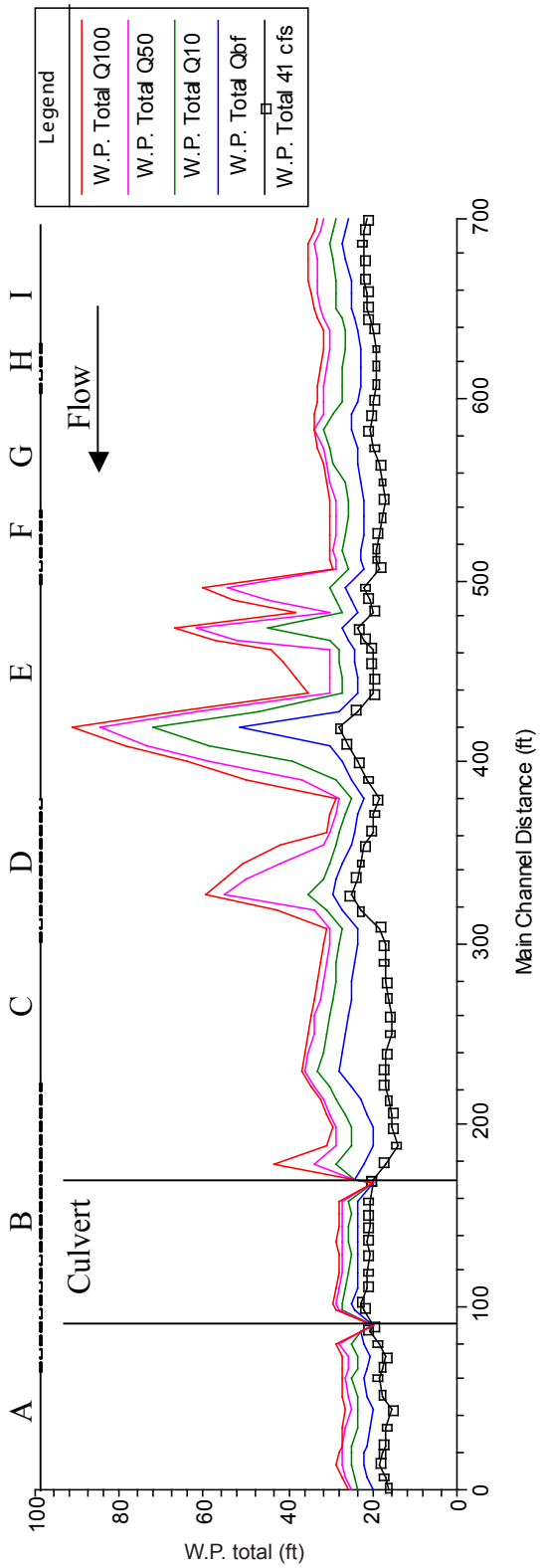


Figure 6—Wetted perimeter.

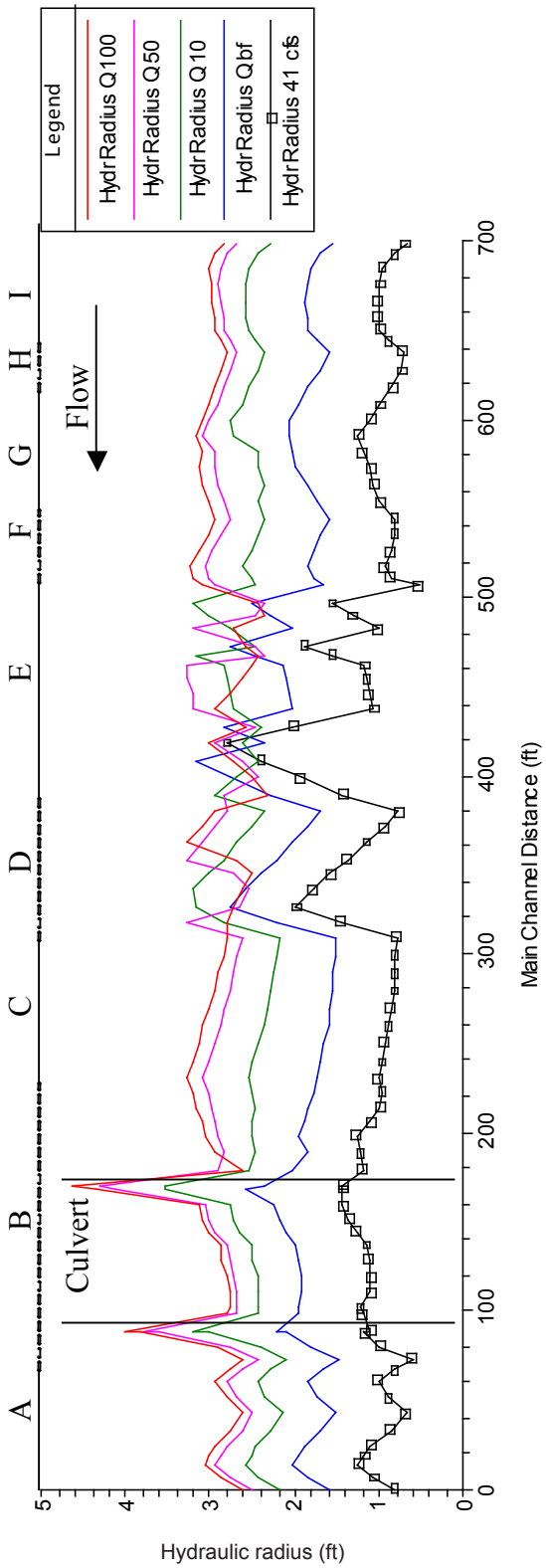


Figure 7—Hydraulic radius.

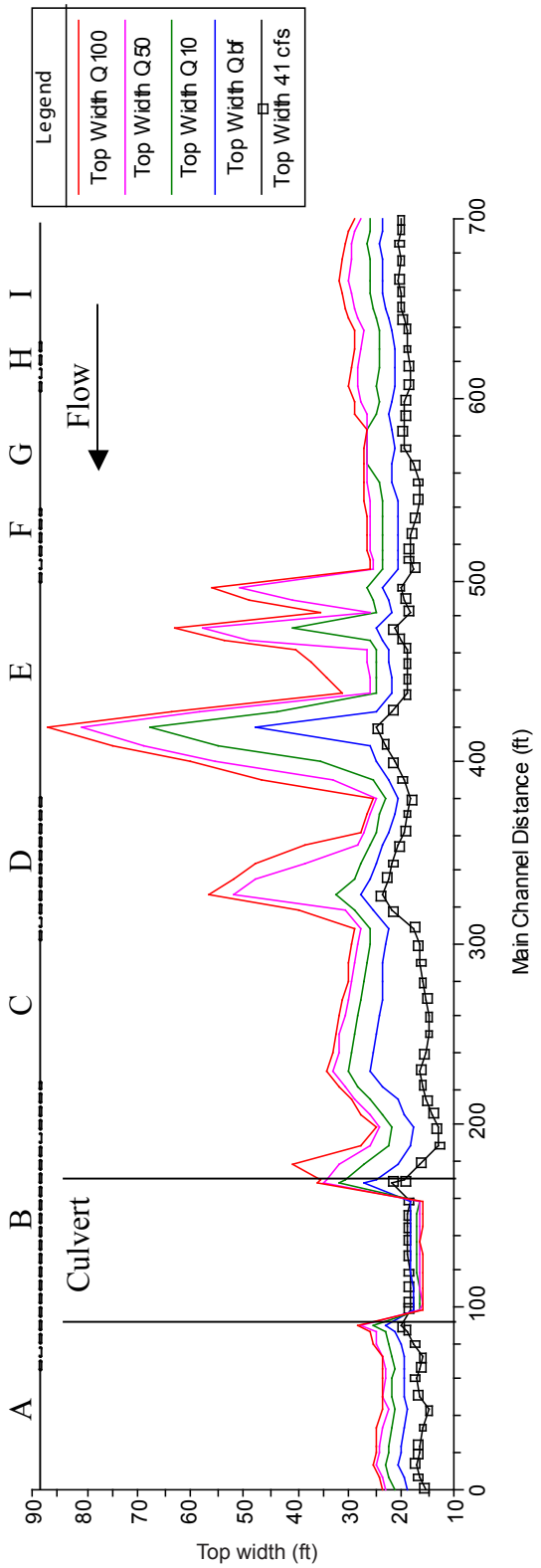


Figure 8—Top width.

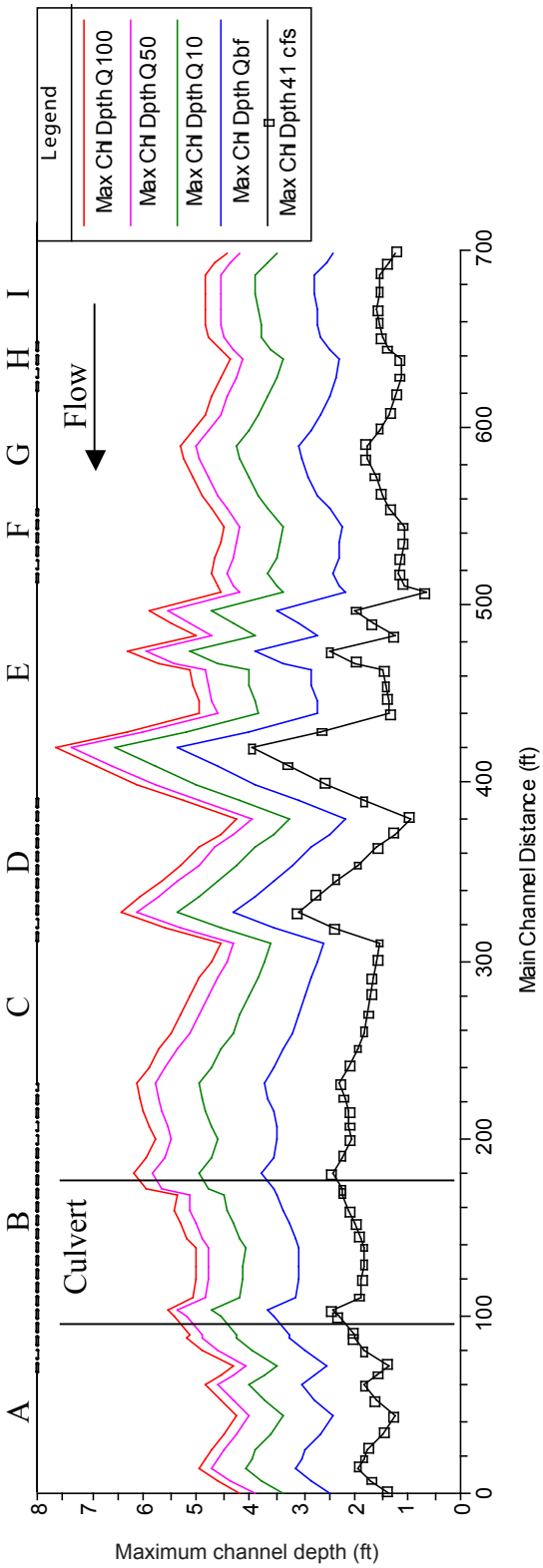


Figure 9—Maximum depth.

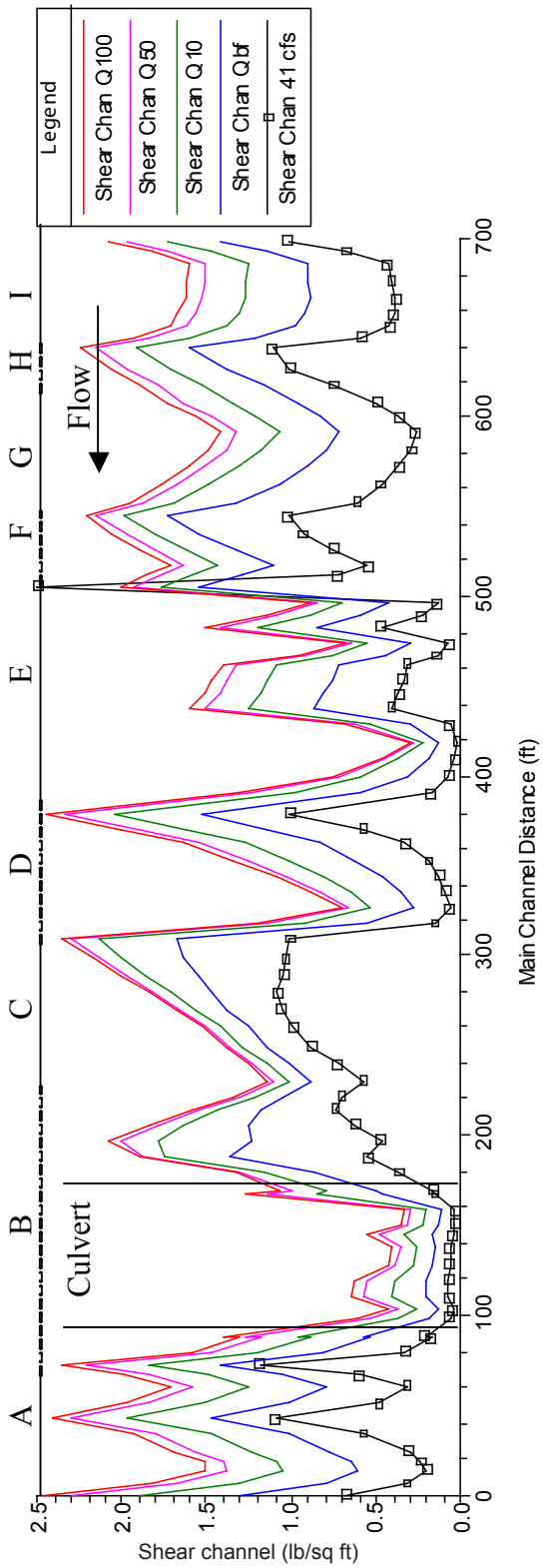


Figure 10—Shear stress (channel) profile.

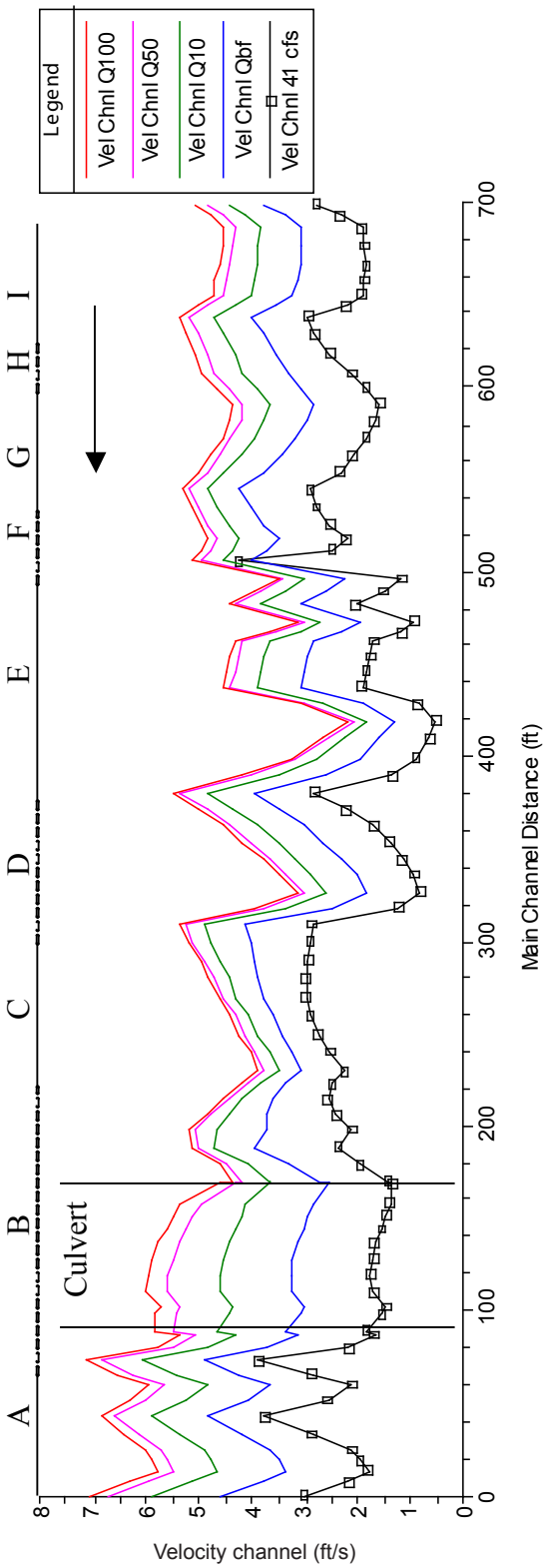
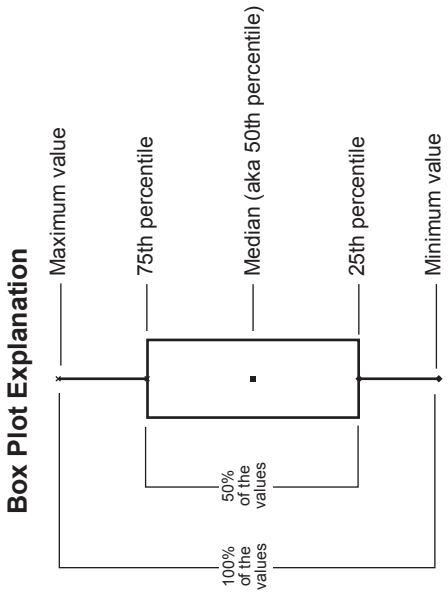


Figure 11—Velocity (channel) profile plot.



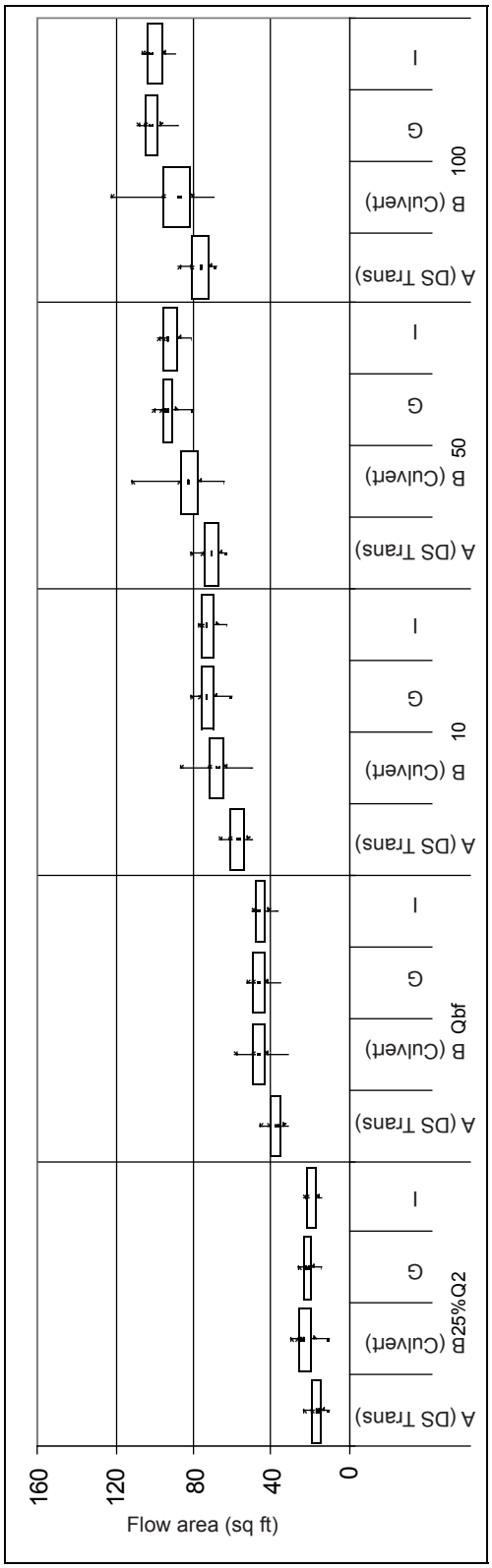


Figure 12—Flow area (total).

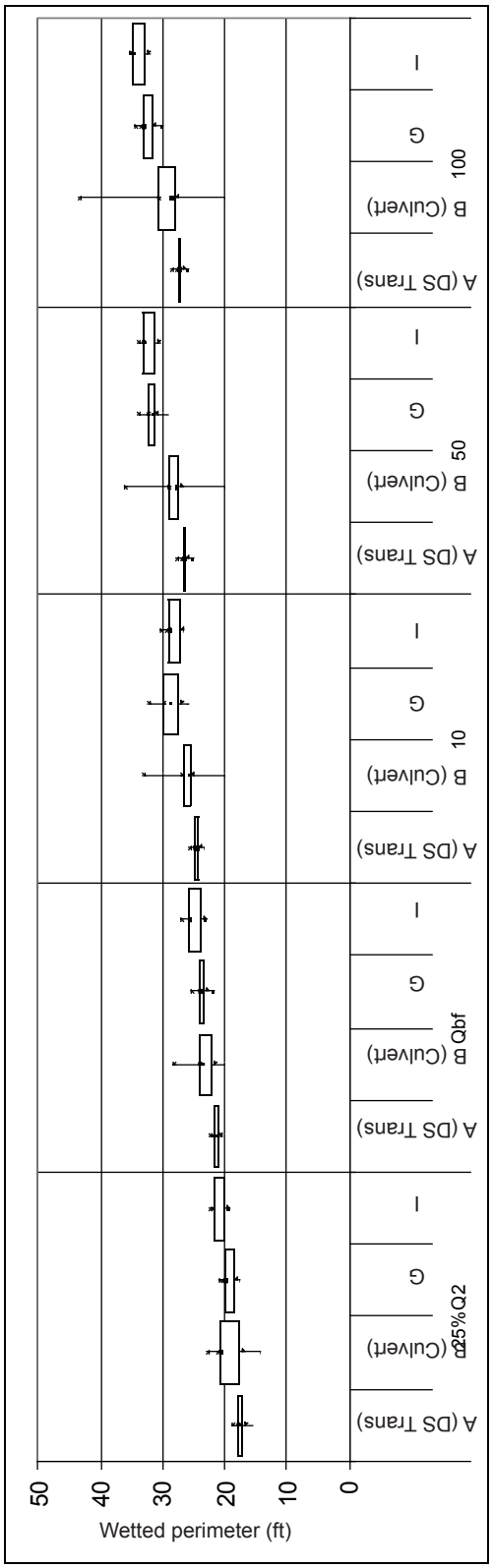


Figure 13—Wetted perimeter.

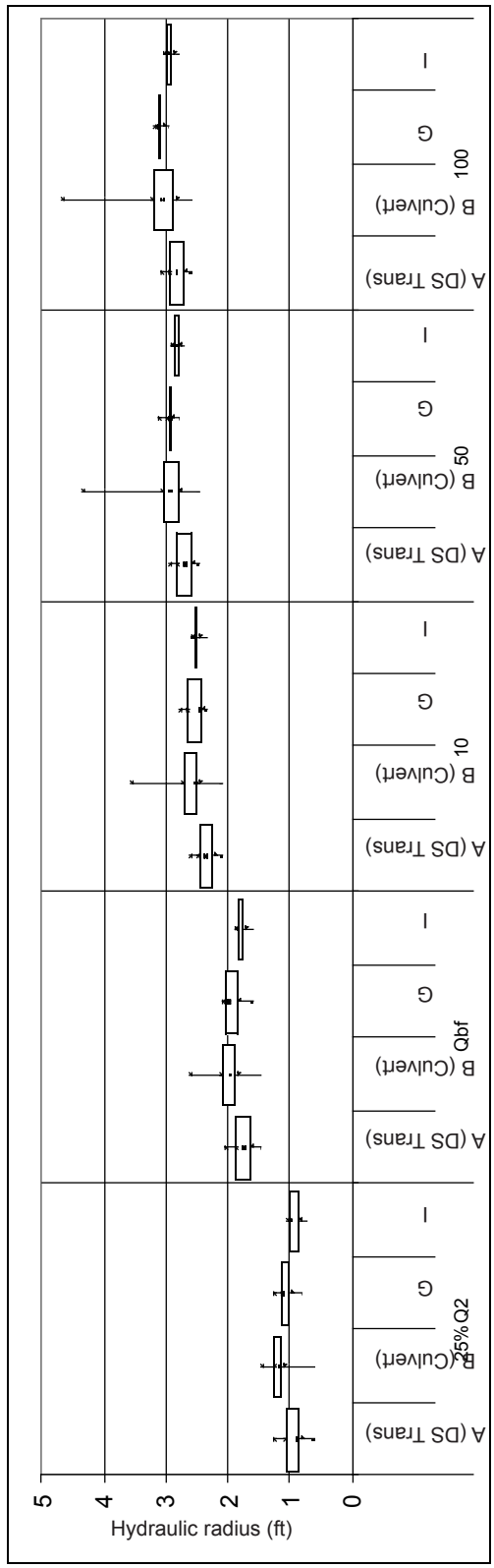


Figure 14—Hydraulic radius.

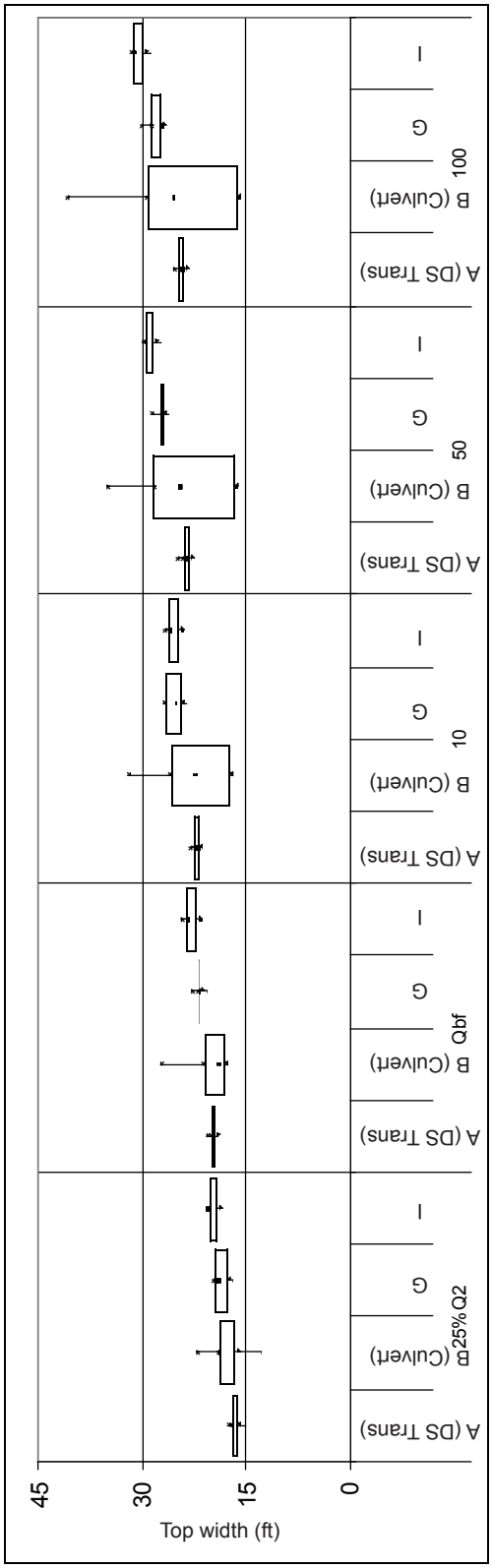


Figure 15—Top width.

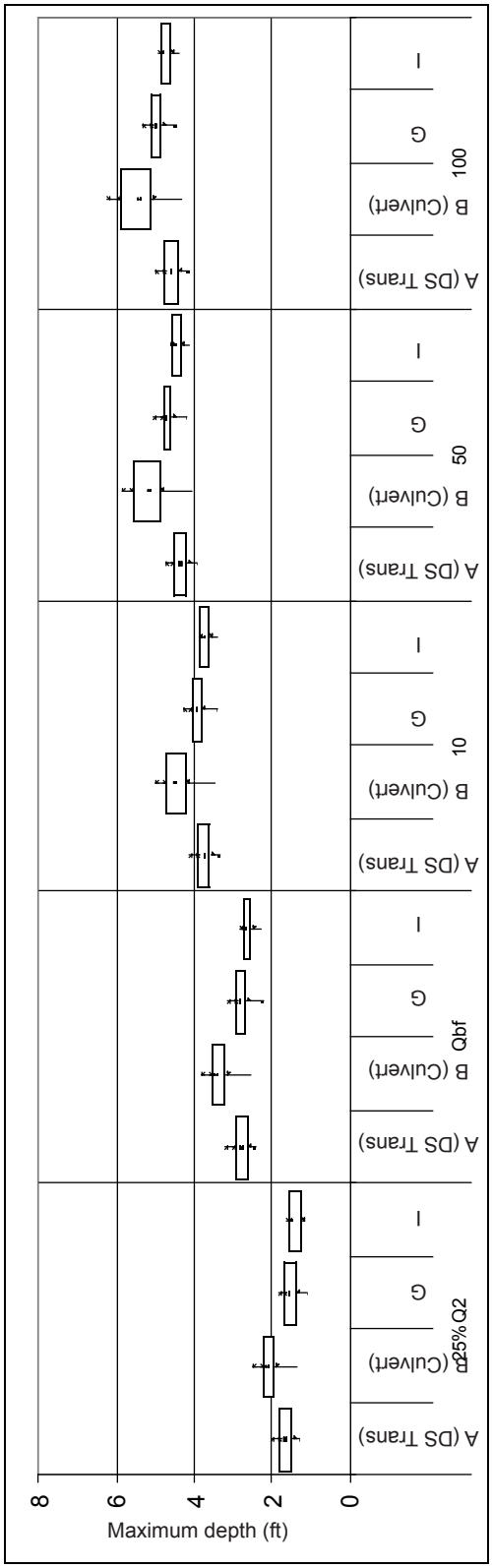


Figure 16—Maximum depth.

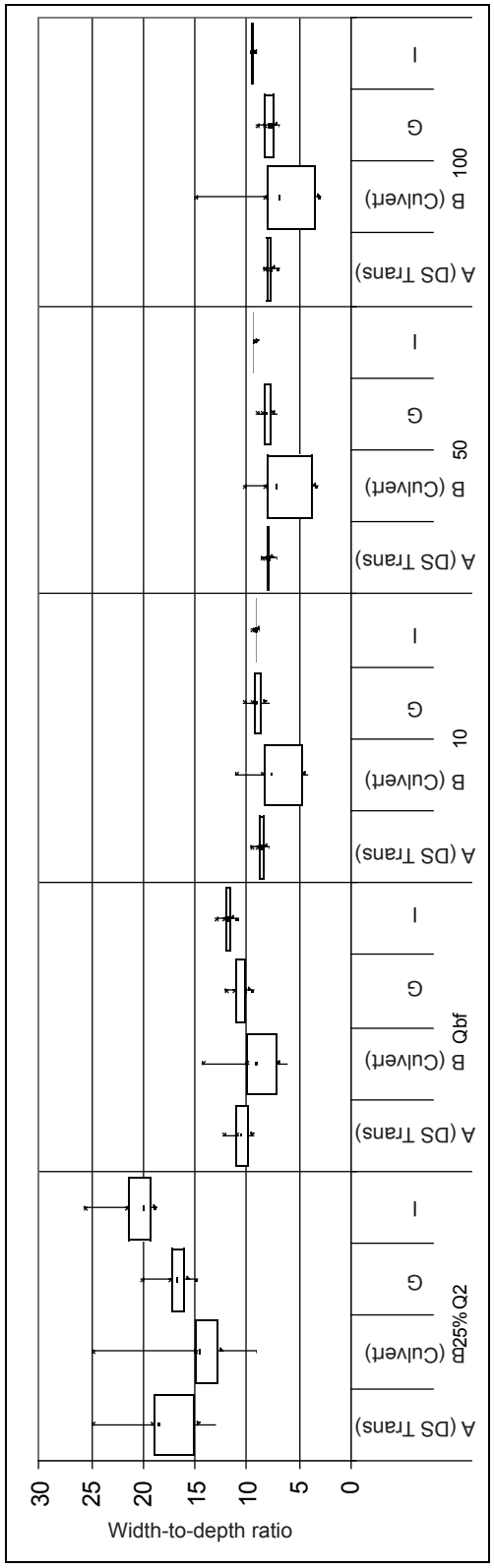


Figure 17—Width-to-depth ratio.

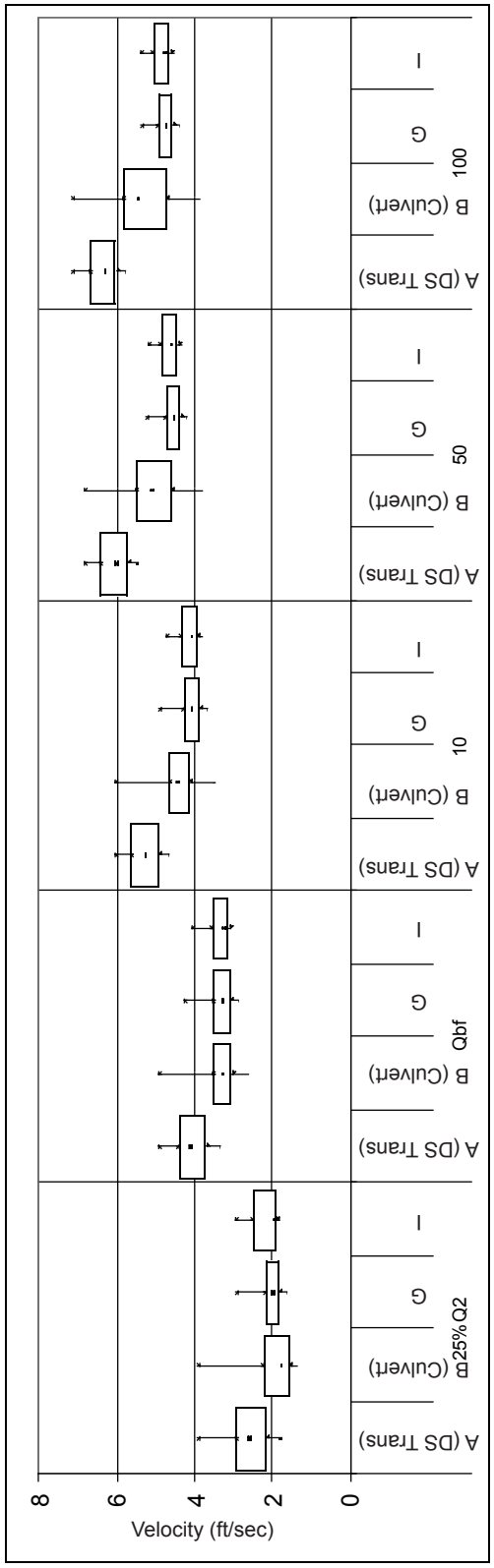


Figure 18—Velocity (channel).

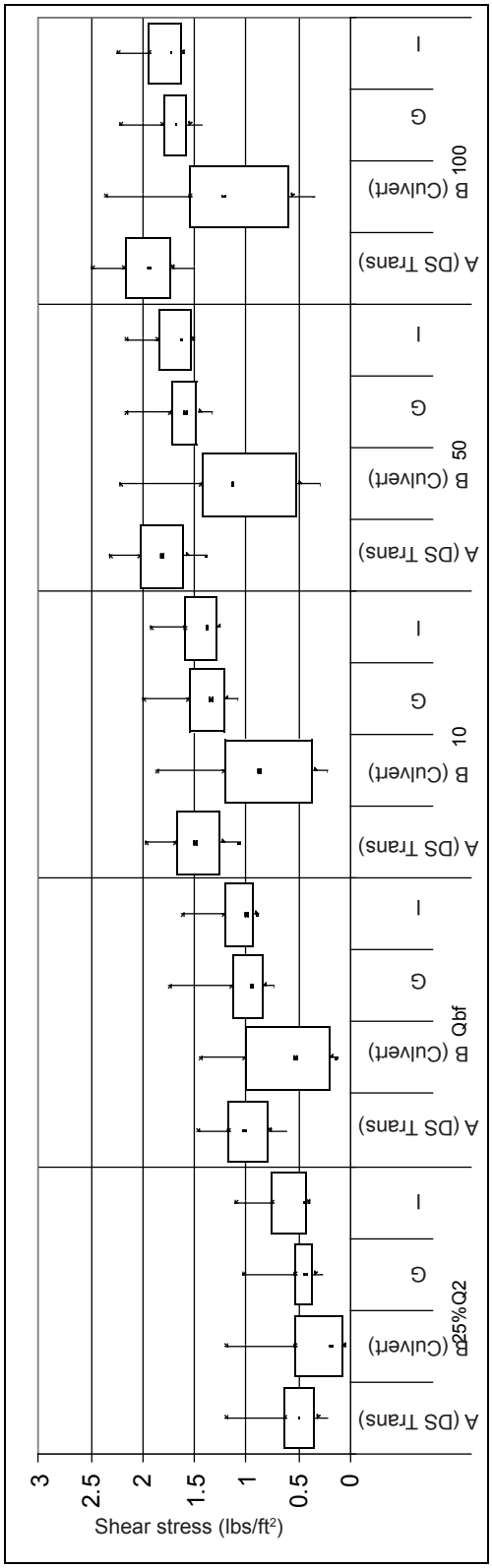
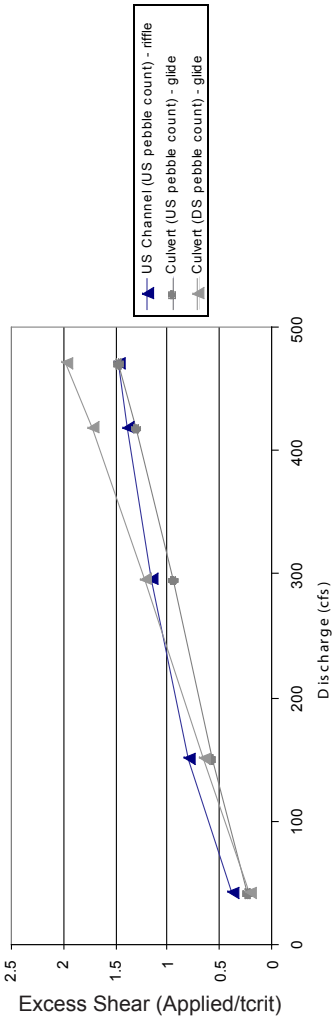


Figure 19—Shear stress (channel).



Excess shear stress is the channel shear divided by the critical shear for bed entrainment of the D84 particle size. Values of excess shear greater than 1 indicate bed movement for the D84 particle size.

Figure 20—Excess shear stress.

Table 3—Sum of squared height difference

Reach	XS Location	Unit type	Sum of squared height difference	Within range of channel conditions?
Culvert	US	Glide	0.01	No
	DS	Glide	0.08	No
Upstream	US	Riffle	0.05	
	DS	Pool	0.05	

Table 4—Vertical sinuosity

Segment	Location	Vertical Sinuosity (ft/ft)
A	DS transition	1.000
B	Culvert	1.000
C	US channel	1.000
D	US channel	1.002
E	US channel	1.003
F	US channel	1.000
G	US channel	1.000
I	US channel	1.000

Table 5—Depth distribution

Reach	XS Location	25% Q_2	Within range of channel conditions?
Culvert	US	0	No
	DS	0	No
Upstream	US	1	
	DS	2	

Table 6—Habitat unit composition

	Percent of surface area			
Reach	Pool	Glide	Riffle	Step
Culvert	31%	55%	0%	0%
Upstream Channel	36%	0%	64%	0%

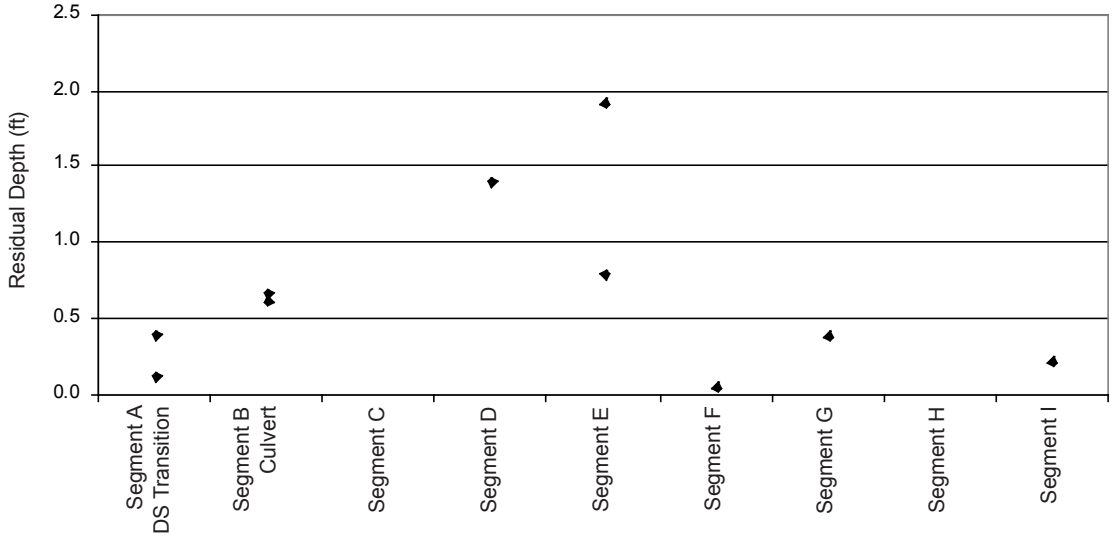


Figure 21—Residual depths.

Table 7—Bed material sorting and skewness

Reach	XS Location	Unit Type	Sorting	Within range of channel conditions?	Skewness	Within range of channel conditions?
Culvert	US	Glide	2.76	No	-0.05	No
	DS	Glide	2.66	No	-0.01	No
Upstream	US	Riffle	2.11		0.35	
	DS	Pool	2.63		0.60	
Downstream	US	Riffle	2.12		0.24	

Table 8—Large woody debris

Reach	Pieces/Channel Width
Culvert	0.3
Upstream	0.8

Terminology:

US = Upstream

DS = Downstream

RR = Reference reach

XS = Cross section

View upstream through culvert.

View downstream of culvert inlet.

Upstream reference reach.

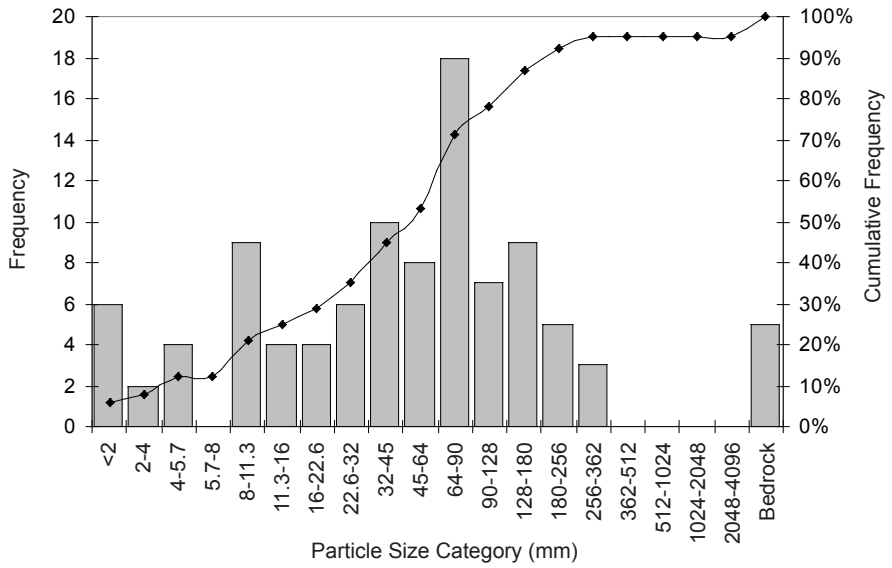
Downstream view from road. Siuslaw River in background.

Upstream reference reach – first flag on right= upstream pebble count (riffle), second flag= downstream pebble count (glide/pool).

Inside culvert – downstream view.

Cross Section: Upstream representative channel – upstream pebble count

Material	Size Range (mm)	Count	Item %	Cumulative %
sand	<2	6	6%	6%
very fine gravel	2 - 4	2	2%	8%
fine gravel	4 - 5.7	4	4%	12%
fine gravel	5.7 - 8	0	0%	12%
medium gravel	8 - 11.3	9	9%	21%
medium gravel	11.3 - 16	4	4%	25%
coarse gravel	16 - 22.6	4	4%	29%
coarse gravel	22.6 - 32	6	6%	35%
very coarse gravel	32 - 45	10	10%	45%
very coarse gravel	45 - 64	8	8%	53%
small cobble	64 - 90	18	18%	71%
medium cobble	90 - 128	7	7%	78%
large cobble	128 - 180	9	9%	87%
very large cobble	180 - 256	5	5%	92%
small boulder	256 - 362	3	3%	95%
small boulder	362 - 512	0	0%	95%
medium boulder	512 - 1024	0	0%	95%
large boulder	1024 - 2048	0	0%	95%
very large boulder	2048 - 4096	0	0%	95%
bedrock	> 4096	5	5%	100%



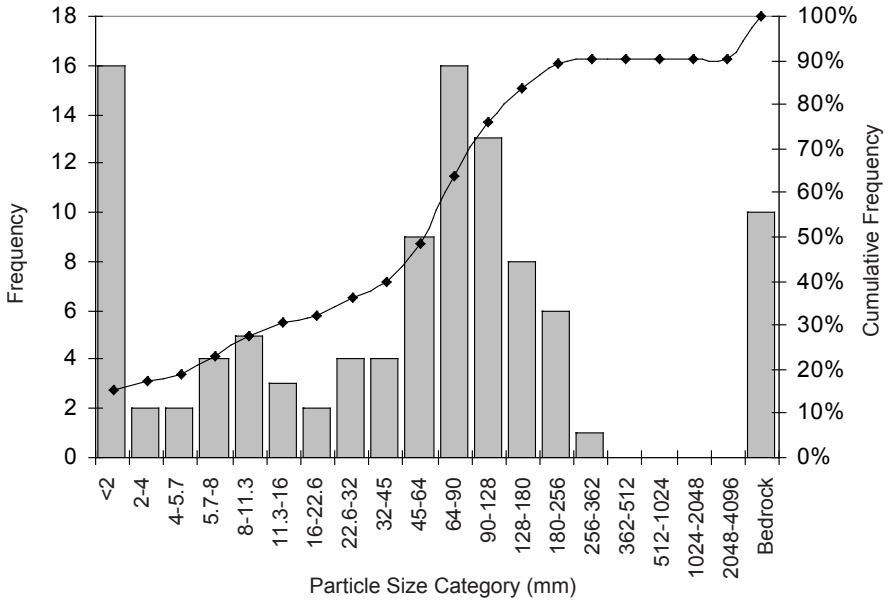
Size Class	Size percent finer than (mm)
D5	1
D16	10
D50	50
D84	130
D95	222
D100	360

Material	Percent Composition
Sand	6%
Gravel	47%
Cobble	39%
Boulder	3%
Bedrock	5%

Sorting Coefficient: 2.11
Skewness Coefficient: 0.35

Cross Section: Upstream representative cannel – downstream pebble count

Material	Size Class (mm)	Count	Item %	Cumulative %
sand	<2	16	15%	15%
very fine gravel	2 - 4	2	2%	17%
fine gravel	4 - 5.7	2	2%	19%
fine gravel	5.7 - 8	4	4%	23%
medium gravel	8 - 11.3	5	5%	28%
medium gravel	11.3 - 16	3	3%	30%
coarse gravel	16 - 22.6	2	2%	32%
coarse gravel	22.6 - 32	4	4%	36%
very coarse gravel	32 - 45	4	4%	40%
very coarse gravel	45 - 64	9	9%	49%
small cobble	64 - 90	16	15%	64%
medium cobble	90 - 128	13	12%	76%
large cobble	128 - 180	8	8%	84%
very large cobble	180 - 256	6	6%	90%
small boulder	256 - 362	1	1%	90%
small boulder	362 - 512	0	0%	90%
medium boulder	512 - 1024	0	0%	90%
large boulder	1024 - 2048	0	0%	90%
very large boulder	2048 - 4096	0	0%	90%
bedrock	Bedrock	10	10%	100%



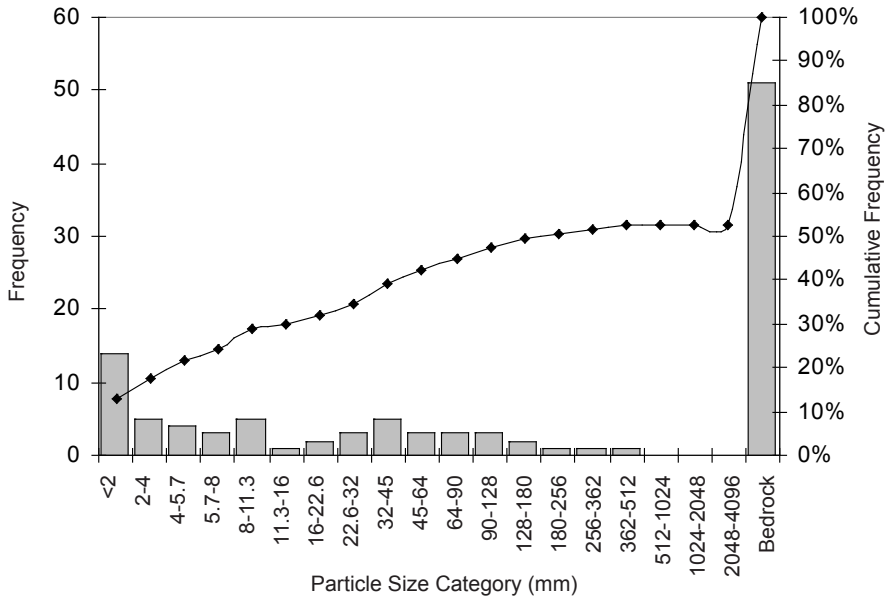
Size Class	Size percent finer than (mm)
D5	1
D16	2.04
D50	60
D84	124.8
D95	190
D100	340

Material	Percent Composition
Sand	15%
Gravel	33%
Cobble	41%
Boulder	1%
Bedrock	10%

Sorting Coefficient: 2.63
Skewness Coefficient: 0.60

Cross Section: Culvert – upstream pebble count

Material	Size Class (mm)	Count	Item %	Cumulative %
sand	<2	14	13%	13%
very fine gravel	2 - 4	5	5%	18%
fine gravel	4 - 5.7	4	4%	21%
fine gravel	5.7 - 8	3	3%	24%
medium gravel	8 - 11.3	5	5%	29%
medium gravel	11.3 - 16	1	1%	30%
coarse gravel	16 - 22.6	2	2%	32%
coarse gravel	22.6 - 32	3	3%	35%
very coarse gravel	32 - 45	5	5%	39%
very coarse gravel	45 - 64	3	3%	42%
small cobble	64 - 90	3	3%	45%
medium cobble	90 - 128	3	3%	48%
large cobble	128 - 180	2	2%	50%
very large cobble	180 - 256	1	1%	50%
small boulder	256 - 362	1	1%	51%
small boulder	362 - 512	1	1%	52%
medium boulder	512 - 1024	0	0%	52%
large boulder	1024 - 2048	0	0%	52%
very large boulder	2048 - 4096	0	0%	52%
bedrock	Bedrock	51	48%	100%



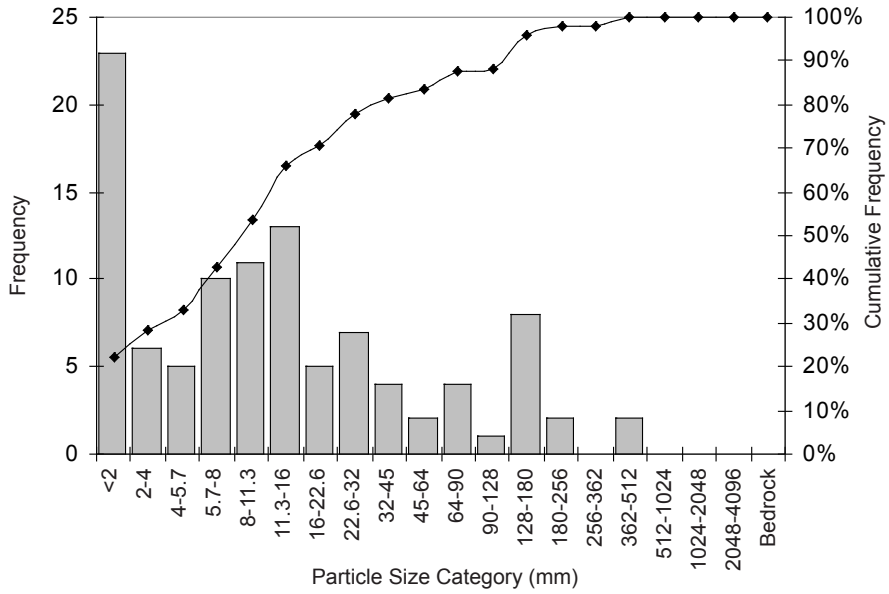
Size Class	Size percent finer than (mm)
D5	1
D16	1
D50	10
D84	90
D95	185
D100	500

Material	Percent Composition
Sand	13%
Gravel	29%
Cobble	8%
Boulder	2%
Bedrock	48%

Sorting Coefficient: 2.76
Skewness Coefficient: -0.05

Cross Section: Culvert – downstream pebble count

Material	Size Class (mm)	Count	Item %	Cumulative %
sand	<2	23	22%	22%
very fine gravel	2 - 4	6	6%	28%
fine gravel	4 - 5.7	5	5%	33%
fine gravel	5.7 - 8	10	10%	43%
medium gravel	8 - 11.3	11	11%	53%
medium gravel	11.3 - 16	13	13%	66%
coarse gravel	16 - 22.6	5	5%	71%
coarse gravel	22.6 - 32	7	7%	78%
very coarse gravel	32 - 45	4	4%	82%
very coarse gravel	45 - 64	2	2%	83%
small cobble	64 - 90	4	4%	87%
medium cobble	90 - 128	1	1%	88%
large cobble	128 - 180	8	8%	96%
very large cobble	180 - 256	2	2%	98%
small boulder	256 - 362	0	0%	98%
small boulder	362 - 512	2	2%	100%
medium boulder	512 - 1024	0	0%	100%
large boulder	1024 - 2048	0	0%	100%
very large boulder	2048 - 4096	0	0%	100%
bedrock	Bedrock	0	0%	100%



Size Class	Size percent finer than (mm)
D5	1
D16	1
D50	10
D84	69
D95	177
D100	400

Material	Percent Composition
Sand	22%
Gravel	61%
Cobble	15%
Boulder	2%
Bedrock	0%

Sorting Coefficient: 2.66
Skewness Coefficient: -0.01