APPENDIX A - CULVERT PERFORMANCE CHARTS

These charts provide nomographs to determine inlet and outlet control headwater depths for common culvert shapes. Nomographs for additional culvert shapes are in FHWA Hydraulic Design Series No. 5 “Hydraulic Design of Highway Culverts.”

Note: *The outlet control nomographs provide accurate estimates of headwater depths if there is full flow in the culvert barrel and a submerged outlet. The nomographs may slightly overestimate headwater depths if the barrel flows partially full.*

INDEX TO CULVERT PERFORMANCE CHARTS

Chart	Shape	Material	Control	Comments
1	Circular	Concrete	Inlet	Inlet projecting or in headwall
2	Circular	Concrete	Inlet	Prefabricated concrete end section
3	Circular	Metal	Inlet	Corrugated or structural plate pipe with inlet projecting, mitered, or in headwall. **(Use Scale 2 for ODOT sloped end with or without slope paving.)**
4	Circular	Metal	Inlet	Safety end section with bars **(Use for concrete or metal barrel.)**
5	Circular	Metal	Inlet	Prefabricated metal end section
6	Circular	Metal	Inlet	Reinforced concrete beveled ring around inlet
7	Circular	Concrete	Outlet	
8	Circular	Metal	Outlet	Corrugated metal pipe

INDEX TO CULVERT PERFORMANCE CHARTS, CONTD.

Chart	Shape	Material	Control	Comments
9	Circular	Metal	Outlet	Structural plate pipe
10	Box	Concrete	Inlet	Top edge square with wingwalls
11	Box	Concrete	Inlet	Top edge beveled with wingwalls **(Use Scale 2 for box culvert shown on ODOT Standard Drawing BR 800.)**
12	Box	Concrete	Outlet	
13	Pipe-Arch	Metal	Inlet	Corrugated pipe-arch with inlet projecting, mitered, or in headwall **(Use Scale 2 for ODOT sloped end with or without slope paving.)**
14	Pipe-Arch	Metal	Inlet	Structural plate pipe-arch with inlet projecting, or in headwall with or without beveled edge and 18-inch corner radius
15	Pipe-Arch	Metal	Inlet	Structural plate pipe-arch with inlet projecting, or in headwall with or without beveled edge and 31-inch corner radius
16	Pipe-Arch	Metal	Outlet	Corrugated metal
17	Pipe-Arch	Metal	Outlet	Structural plate with 18-inch corner radius
18	Arch	Metal	Inlet	Structural plate arch with inlet projecting, mitered, or in headwall with $0.3 \leq \text{Rise/Span} < 0.4$

INDEX TO CULVERT PERFORMANCE CHARTS, CONTD.

Chart	Shape	Material	Control	Comments
19	Arch	Metal	Inlet	Structural plate arch with inlet projecting, mitered, or in headwall with $0.4 \leq$ Rise/Span < 0.5
20	Arch	Metal	Inlet	Structural plate arch with inlet projecting, mitered, or in headwall with $0.5 \leq$ Rise/Span
21	Arch	Metal	Outlet	Structural plate arch with earth bottom and $0.3 \leq$ Rise/Span < 0.4
22	Arch	Metal	Outlet	Structural plate arch with earth bottom and $0.4 \leq$ Rise/Span < 0.5
23	Arch	Metal	Outlet	Structural plate arch with earth bottom and $0.5 <$ Rise/Span

CHART 1

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

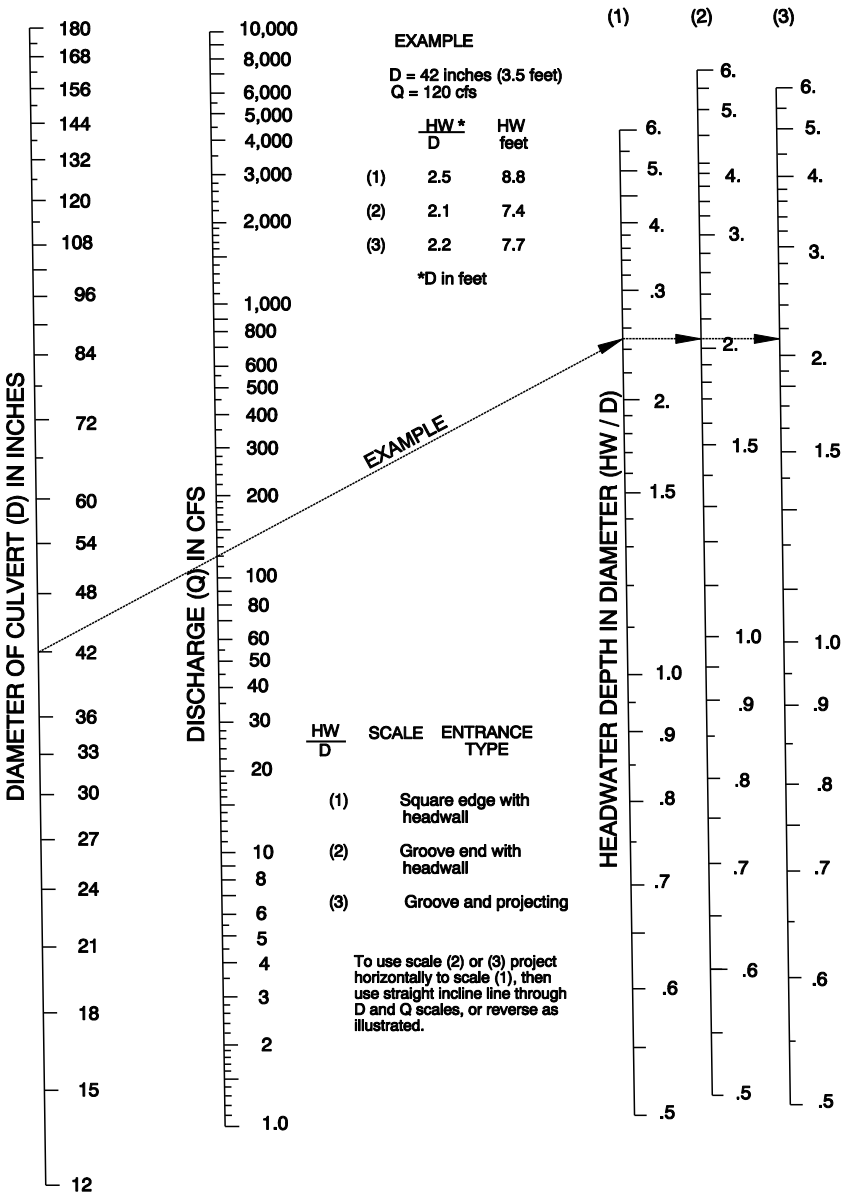


CHART 2

HEADWATER DEPTH FOR PREFABRICATED CONCRETE END SECTION IN INLET CONTROL

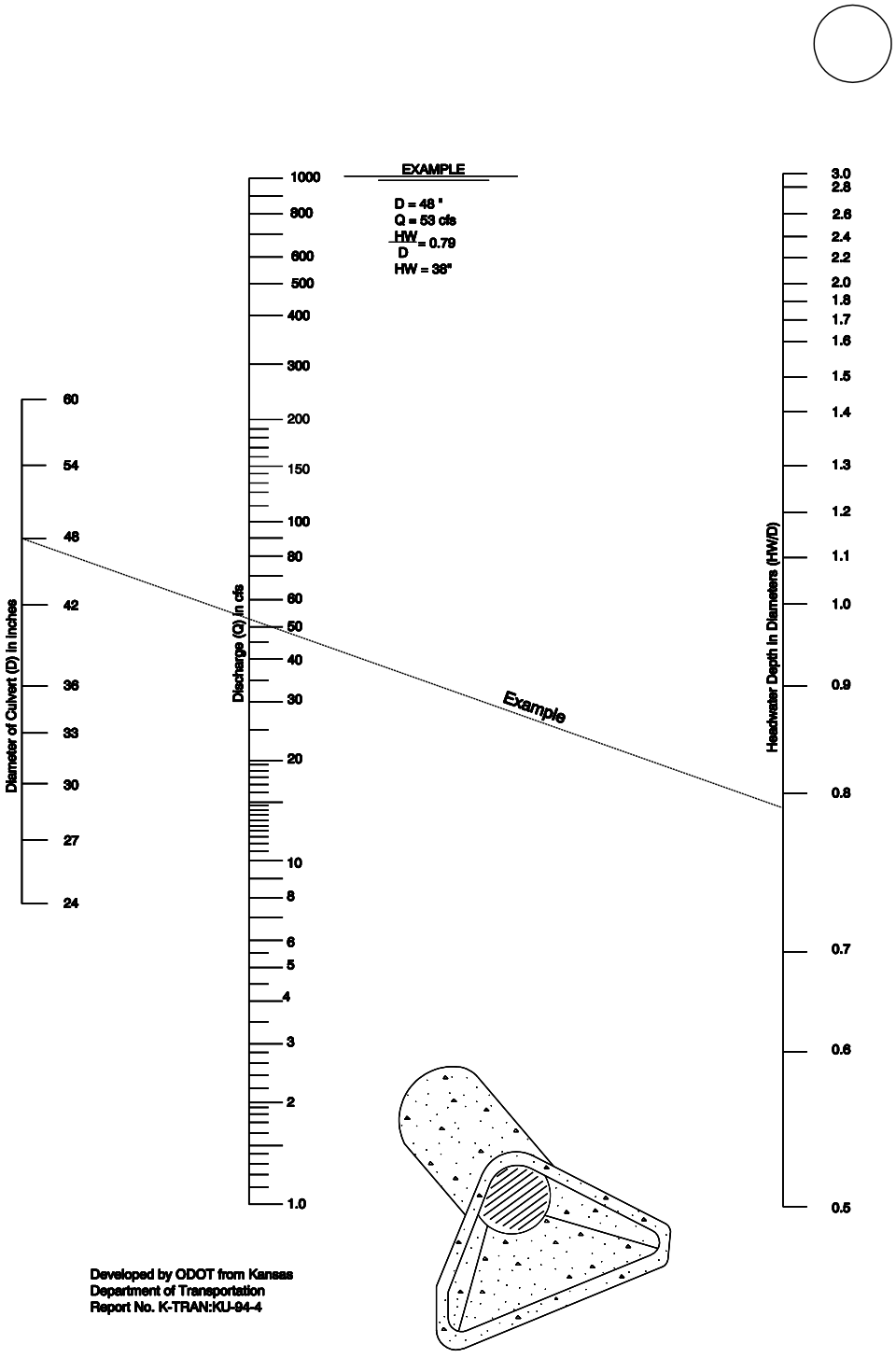


CHART 3

HEADWATER DEPTH FOR C.M. CULVERTS WITH INLET CONTROL

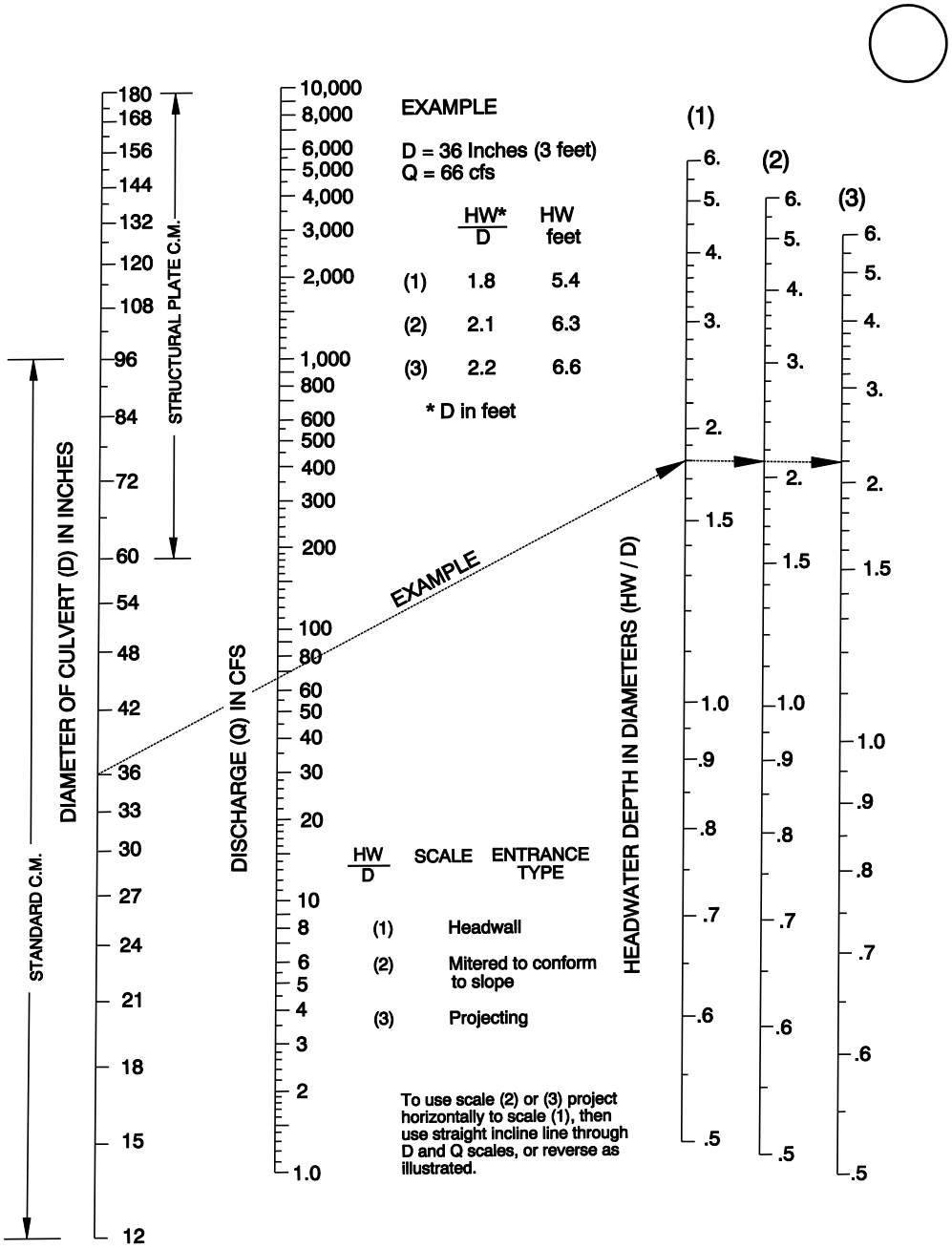


CHART 4

HEADWATER DEPTH FOR SAFETY END SECTIONS WITH SAFETY BARS IN INLET CONTROL

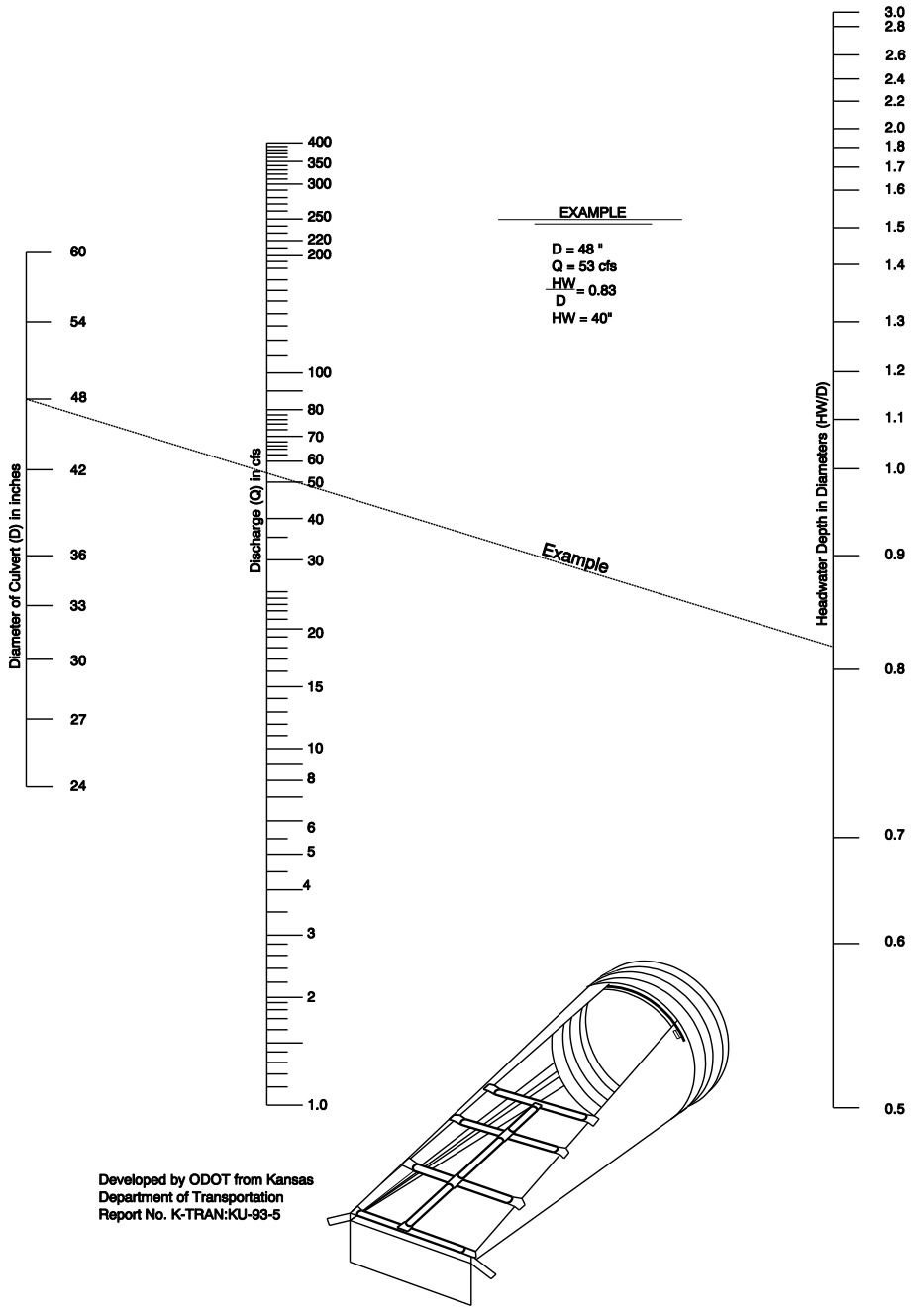


CHART 5
HEADWATER DEPTH FOR PREFABRICATED METAL END SECTIONS IN INLET CONTROL

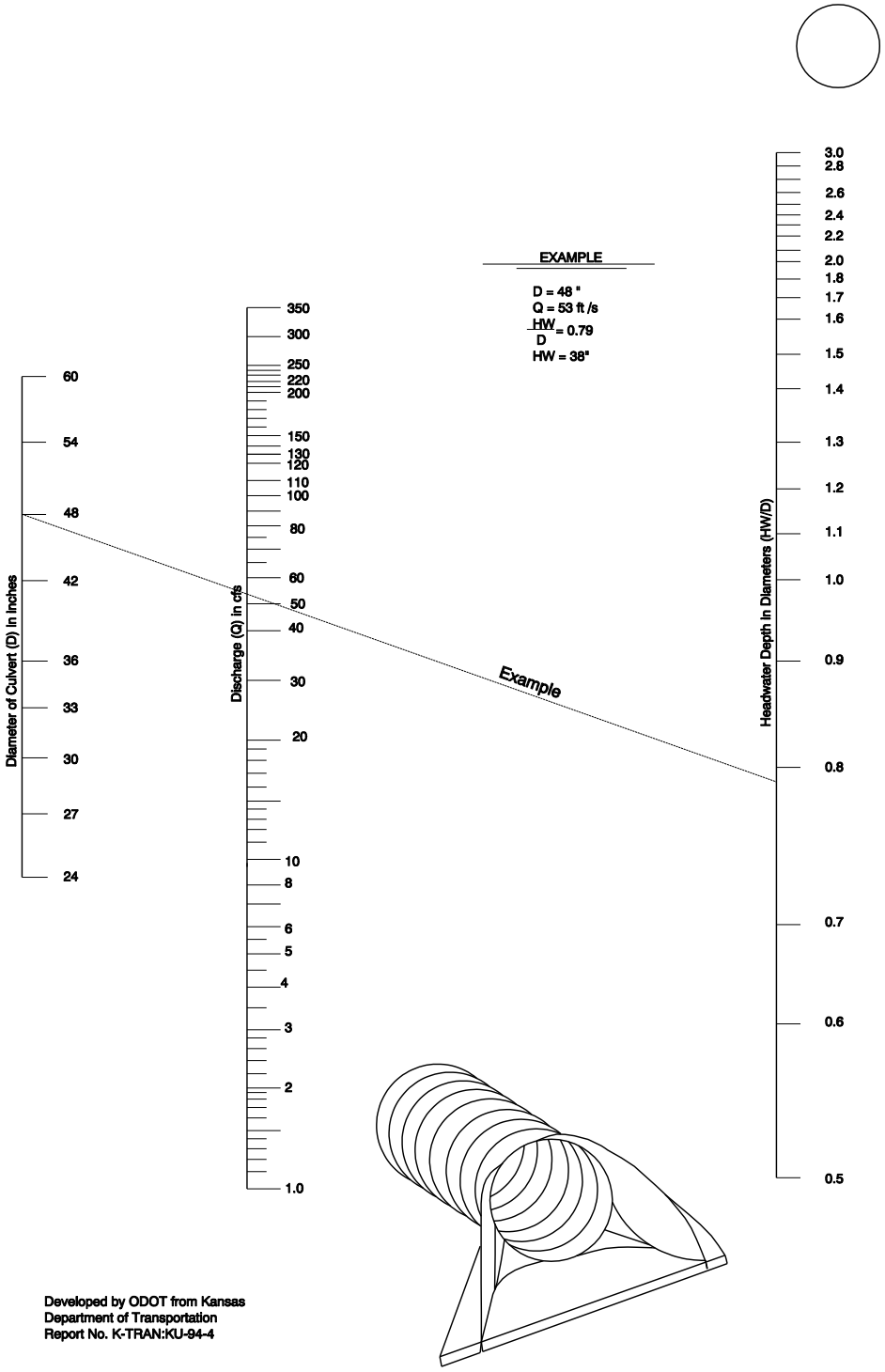


CHART 6

HEADWATER DEPTH FOR CIRCULAR PIPE CULVERTS WITH BEVELED RING INLET CONTROL

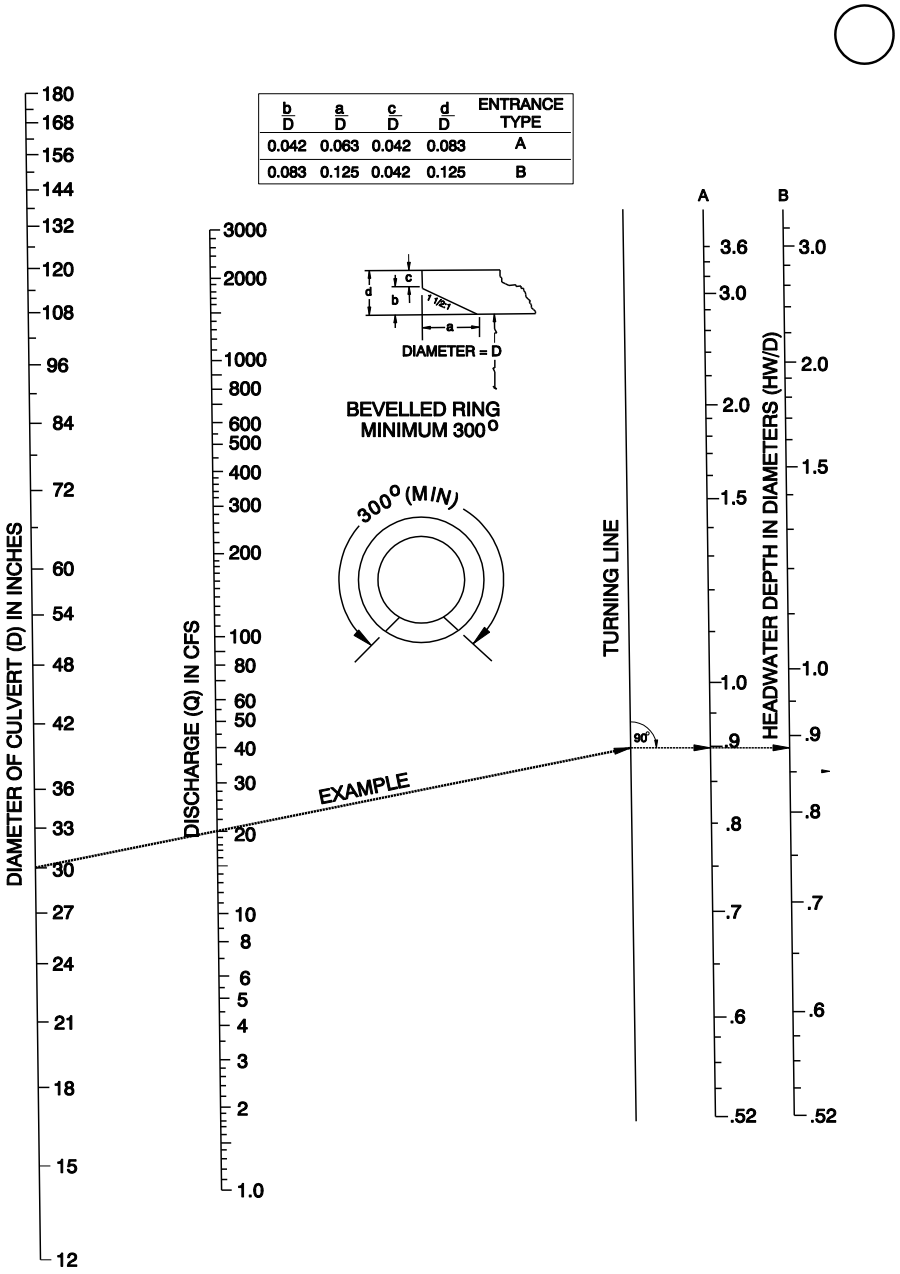


CHART 7

HEAD FOR CONCRETE PIPE CULVERTS FLOWING FULL IN OUTLET CONTROL n = 0.012

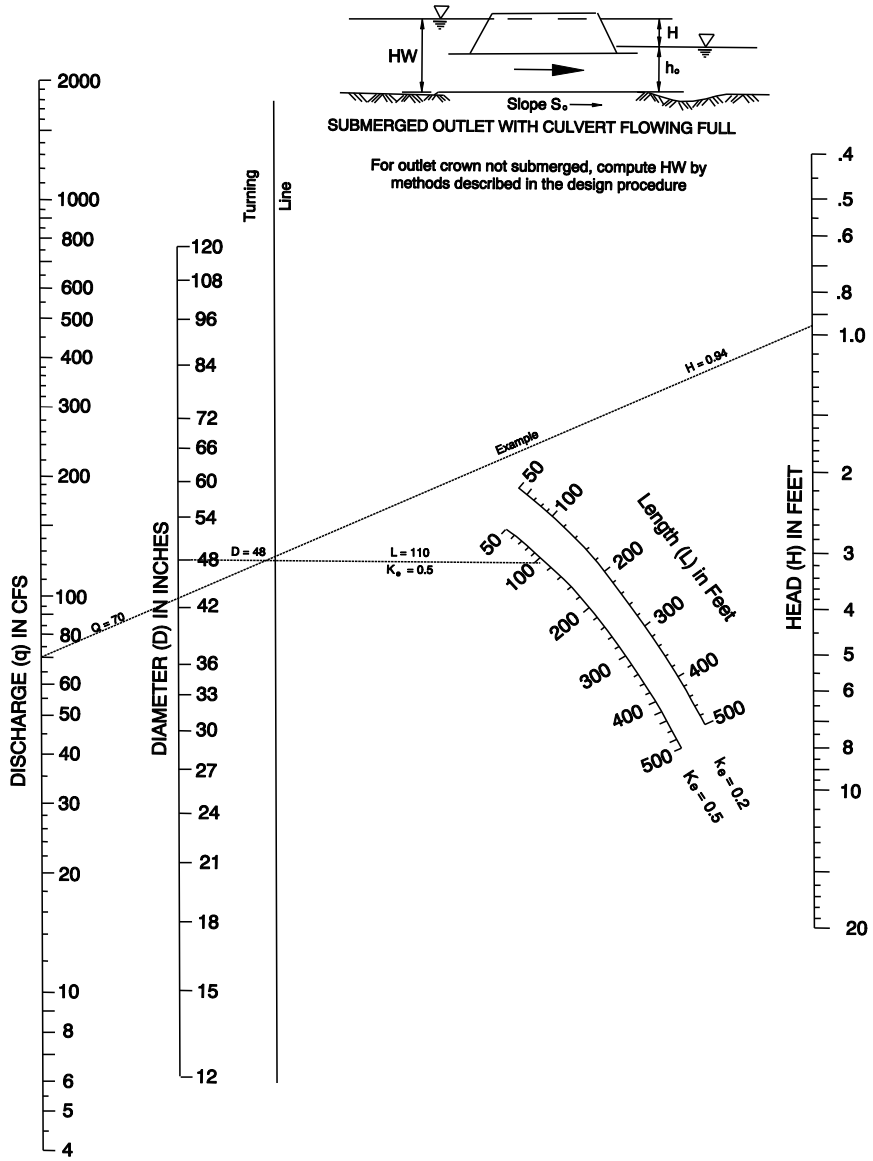


CHART 8

HEAD FOR STANDARD C.M. PIPE CULVERTS FLOWING FULL IN OUTLET CONTROL n = 0.024

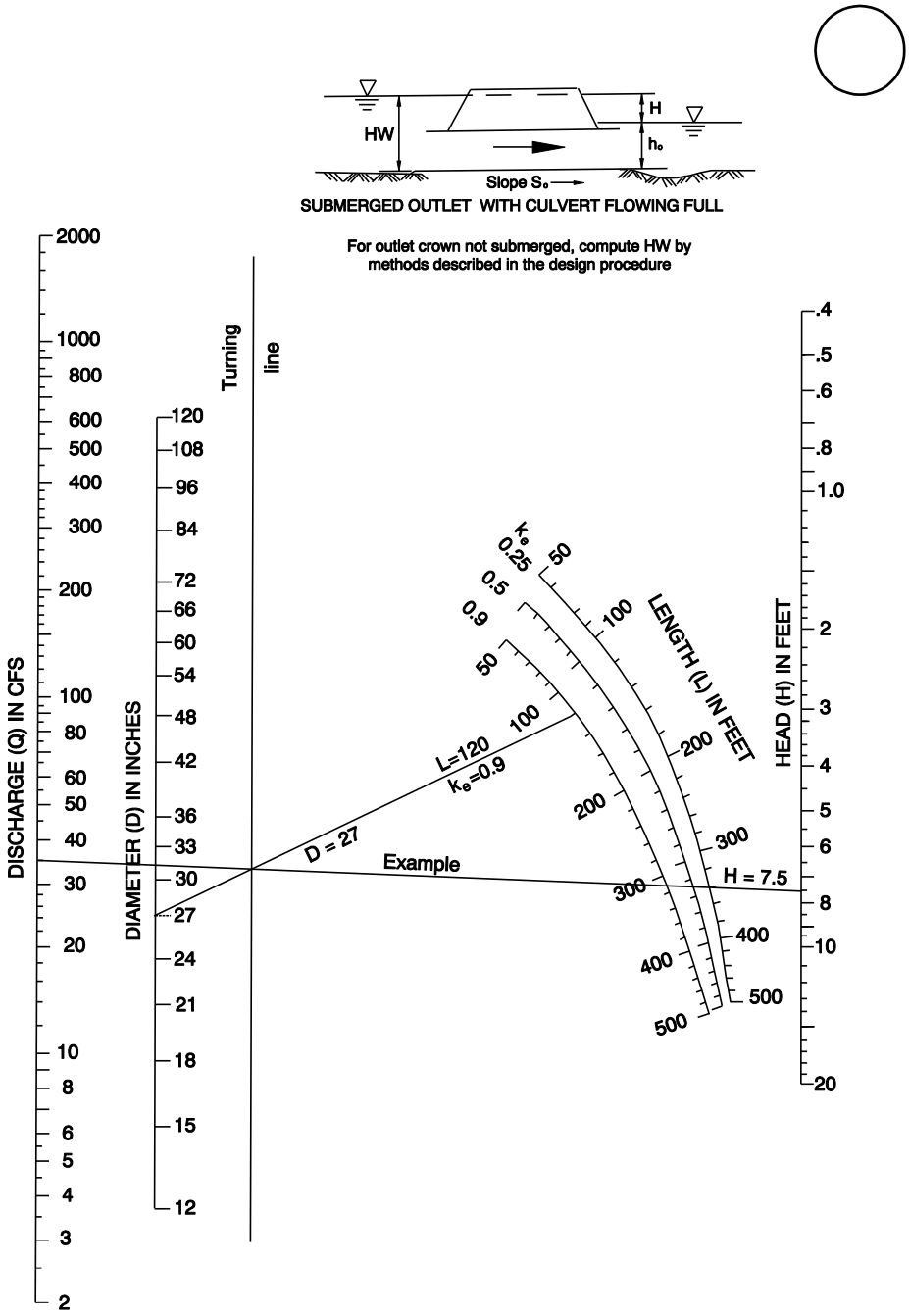


CHART 9

HEAD FOR STRUCTURAL PLATE CORR. METAL PIPE CULVERTS FLOWING FULL IN OUTLET CONTROL N = 0.0328 TO 0.0302

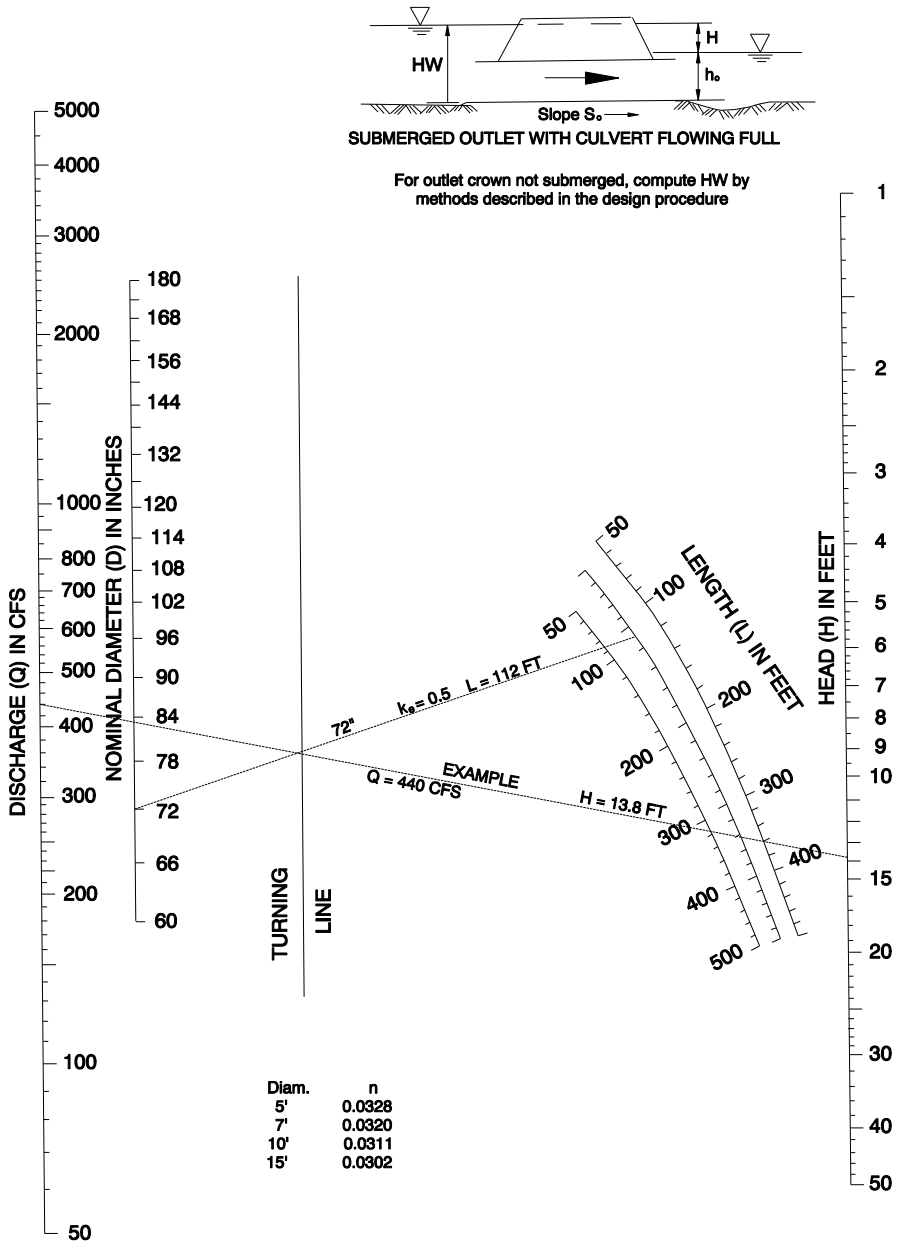


CHART 10

HEADWATER DEPTH FOR BOX CULVERTS WITH INLET CONTROL

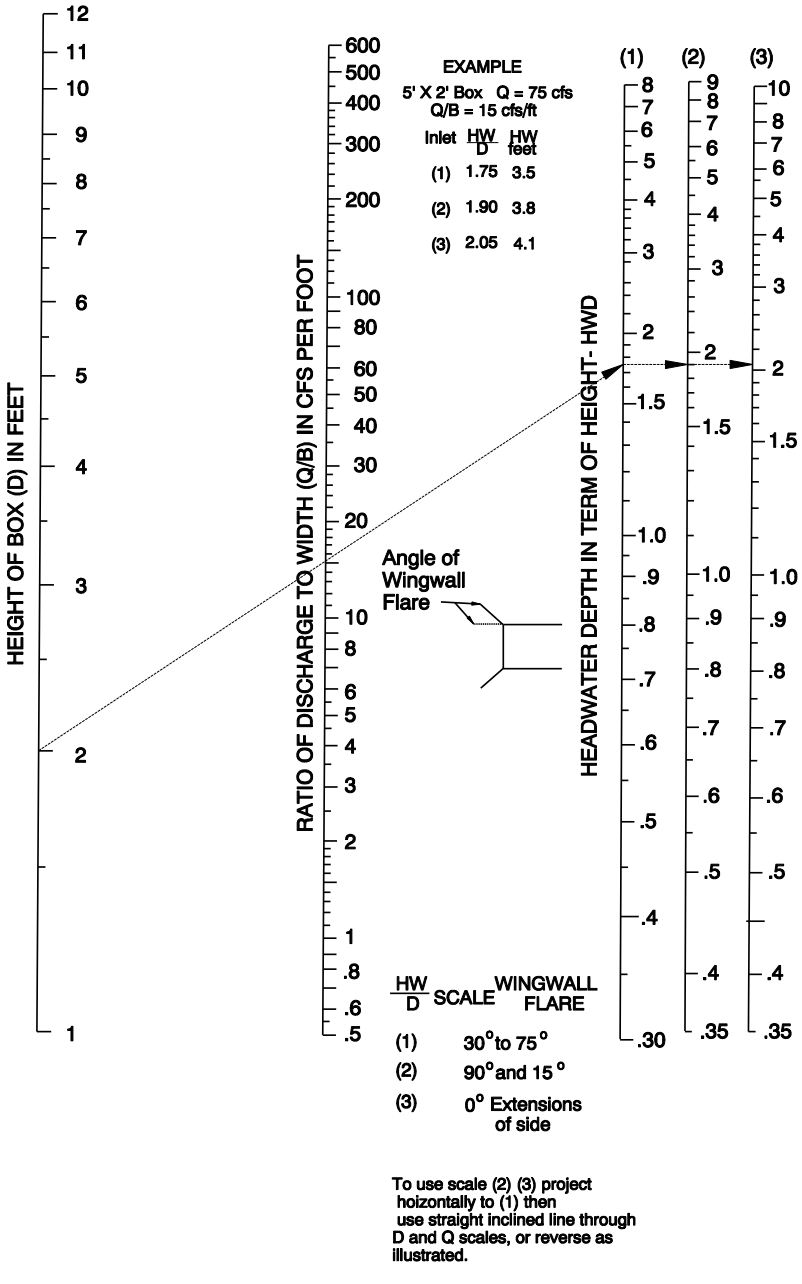


CHART 11

HEADWATER DEPTH FOR RECTANGULAR BOX CULVERTS WITH INLET CONTROL FLARED WINGWALLS 18° TO 33.7° AND 45° WITH BEVELED EDGE AT TOP OF INLET

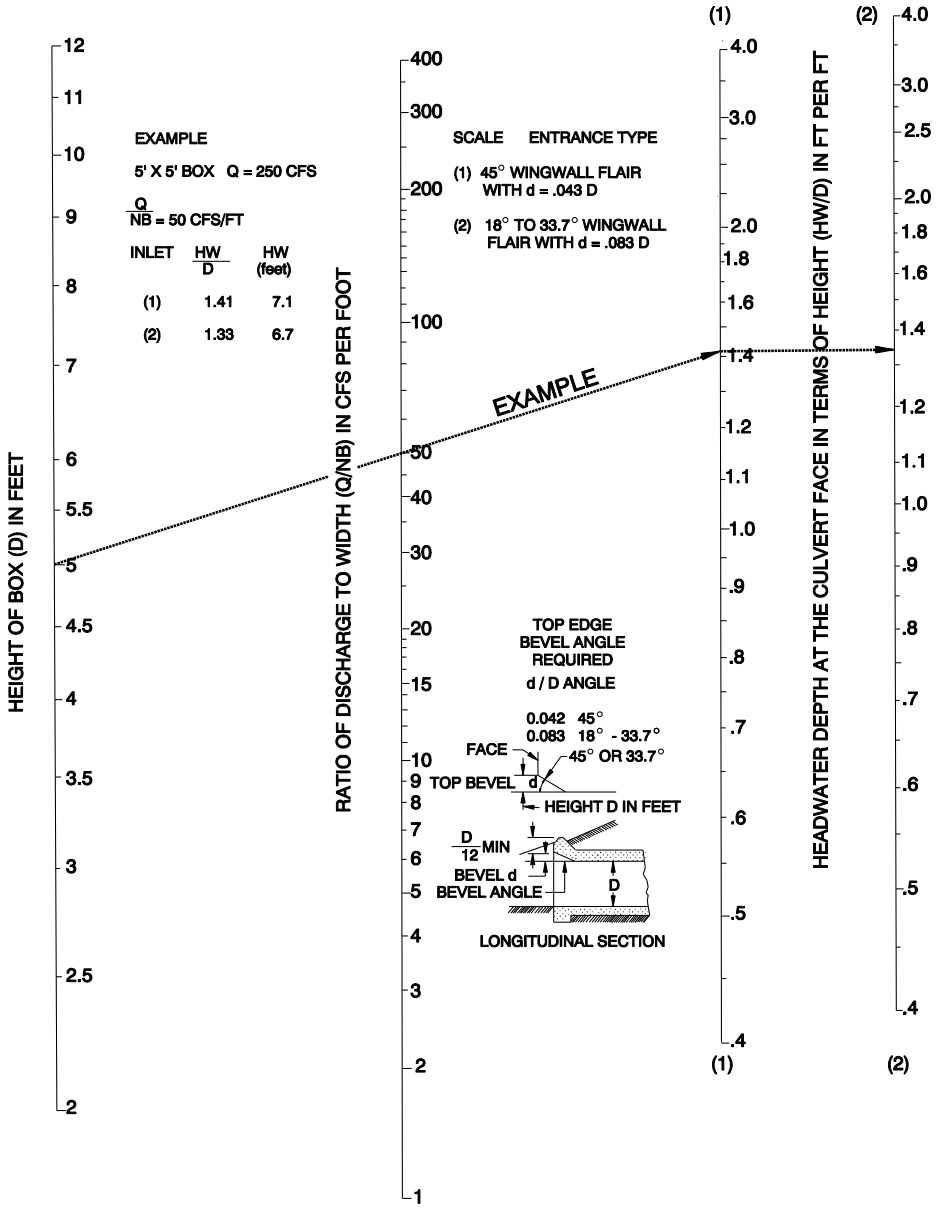


CHART 12

HEAD FOR CONCRETE BOX CULVERTS FLOWING FULL IN OUTLET CONTROL n = 0.012

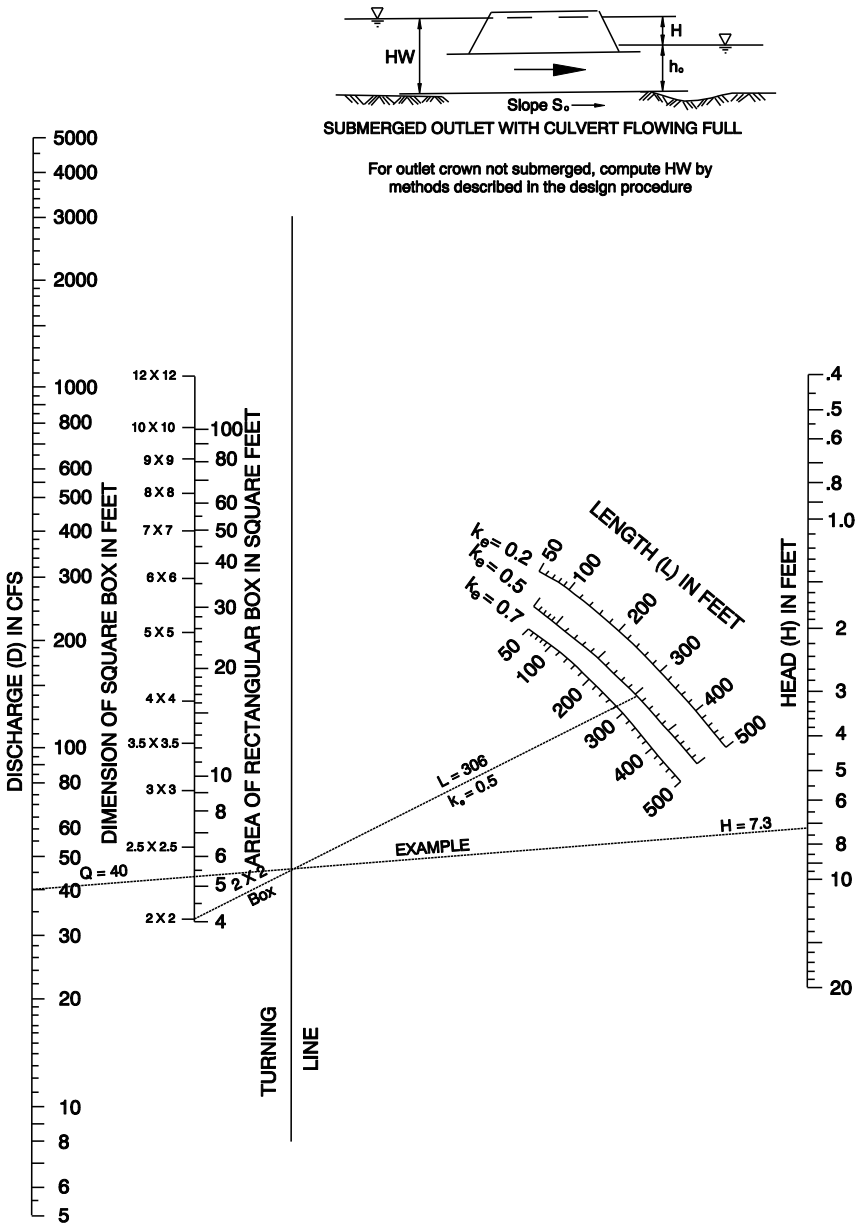
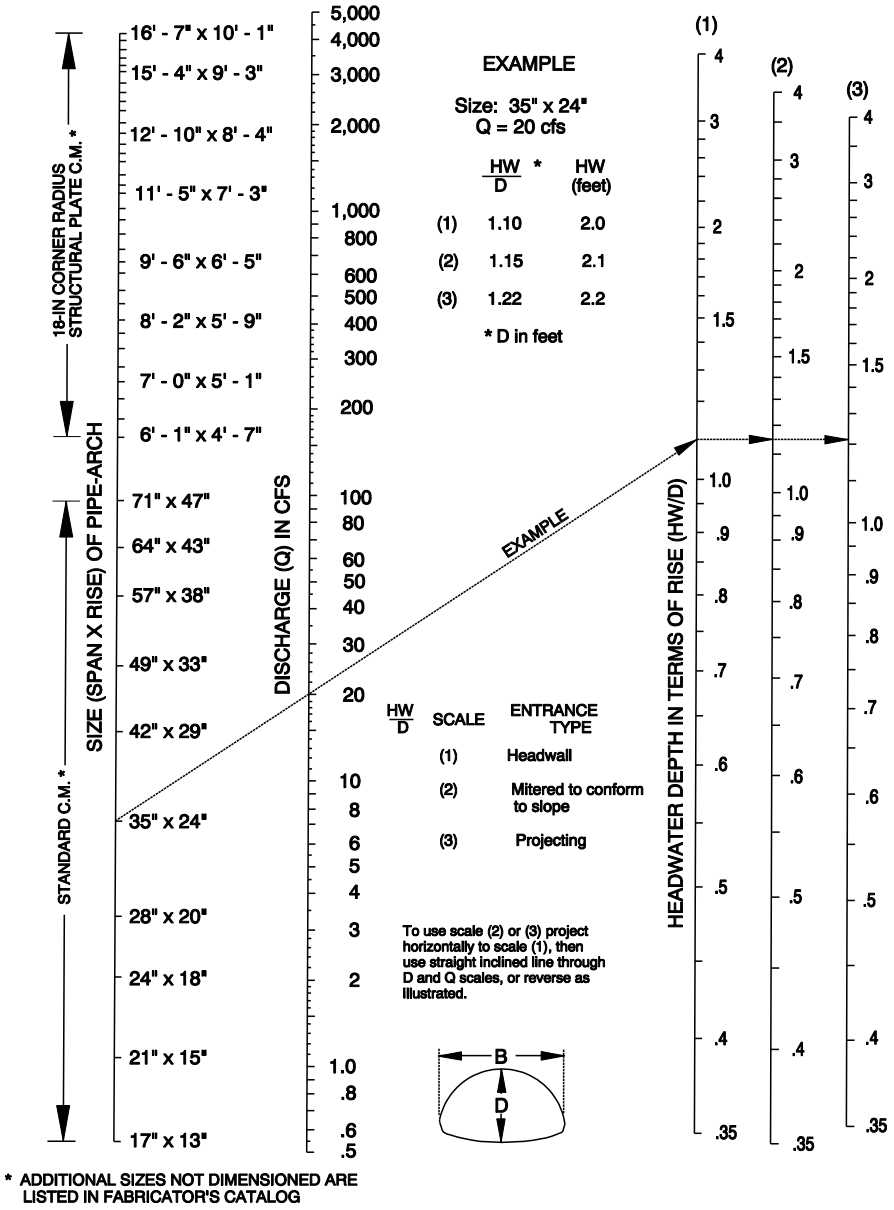


CHART 13

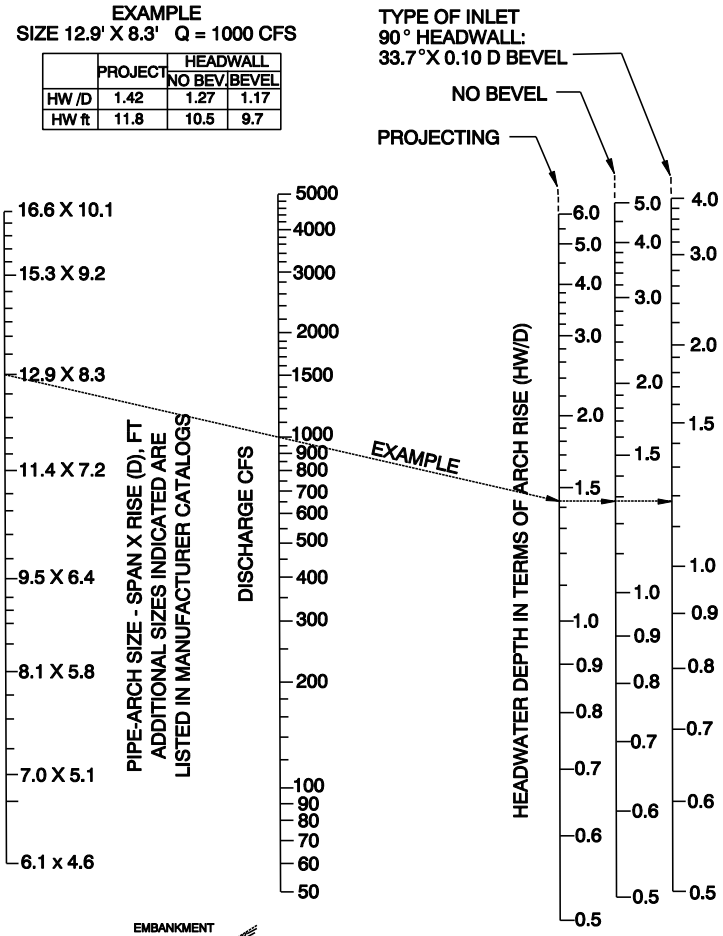
HEADWATER DEPTH FOR C.M. PIPE-ARCH CULVERTS WITH INLET CONTROL

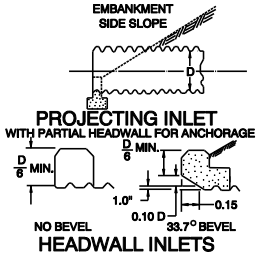


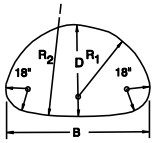
* ADDITIONAL SIZES NOT DIMENSIONED ARE LISTED IN FABRICATOR'S CATALOG

CHART 14

HEADWATER DEPTH FOR STRUCTURAL PLATE PIPE-ARCH CULVERTS WITH INLET CONTROL



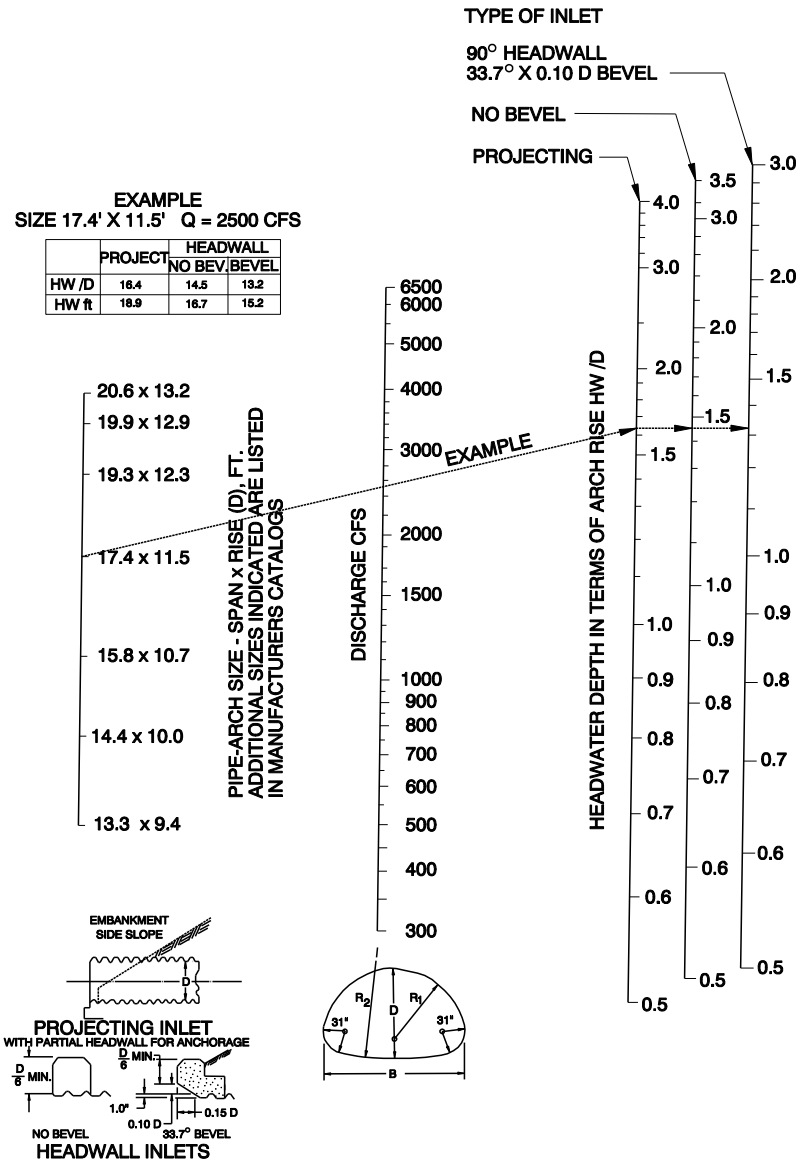




18-IN. RADIUS CORNER PLATE
PROJECTING OR HEADWALL INLET
HEADWALL WITH OR WITHOUT EDGE BEVEL

CHART 15

HEADWATER DEPTH FOR STRUCTURAL PLATE PIPE-ARCH CULVERTS WITH INLET CONTROL



31-IN. RADIUS CORNER PLATE
PROJECTING OR HEADWALL INLET
HEADWALL WITH OR WITHOUT EDGE BEVEL

CHART 16

HEAD FOR STANDARD C.M. PIPE-ARCH CULVERTS FLOWING FULL IN OUTLET CONTROL n = 0.024

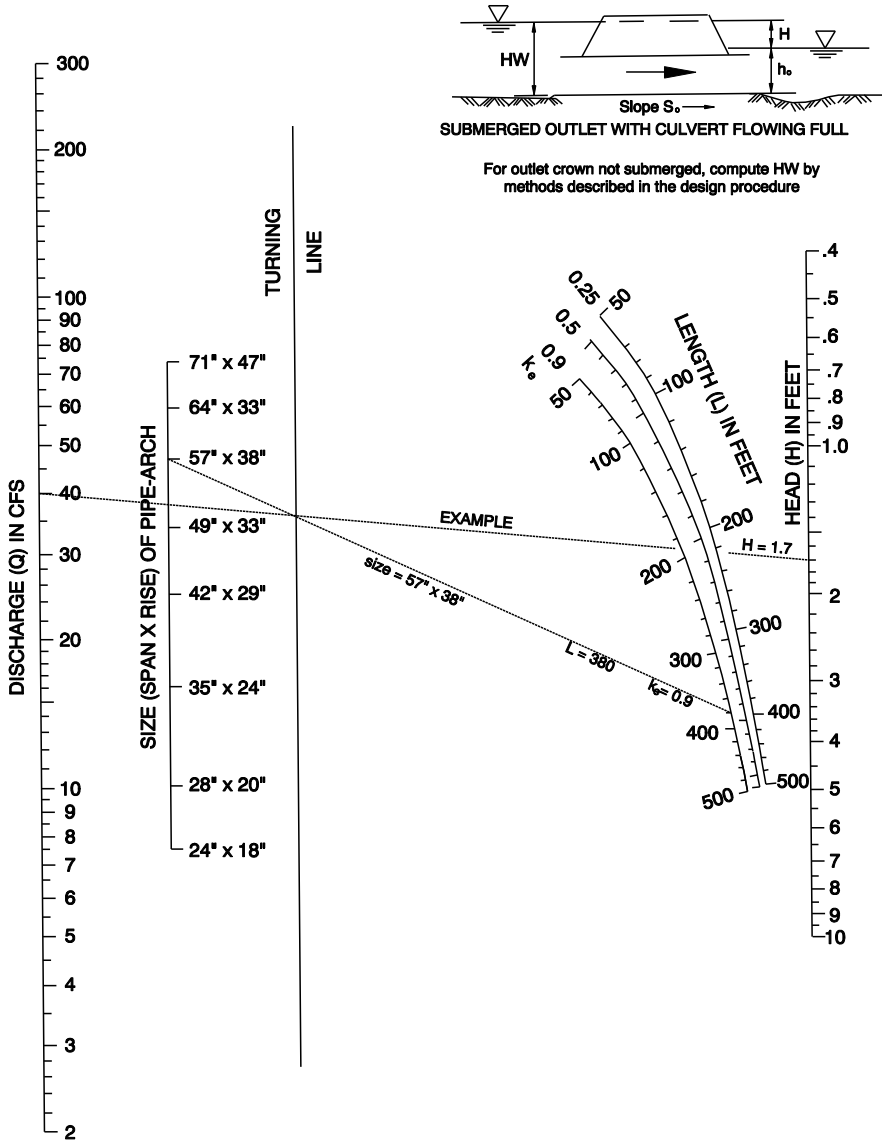


CHART 17

HEAD FOR STRUCTURAL PLATE CORRUGATED METAL PIPE ARCH CULVERTS 18 IN. CORNER RADIUS FLOWING FULL IN OUTLET CONTROL n= 0.0327 TO 0.0306

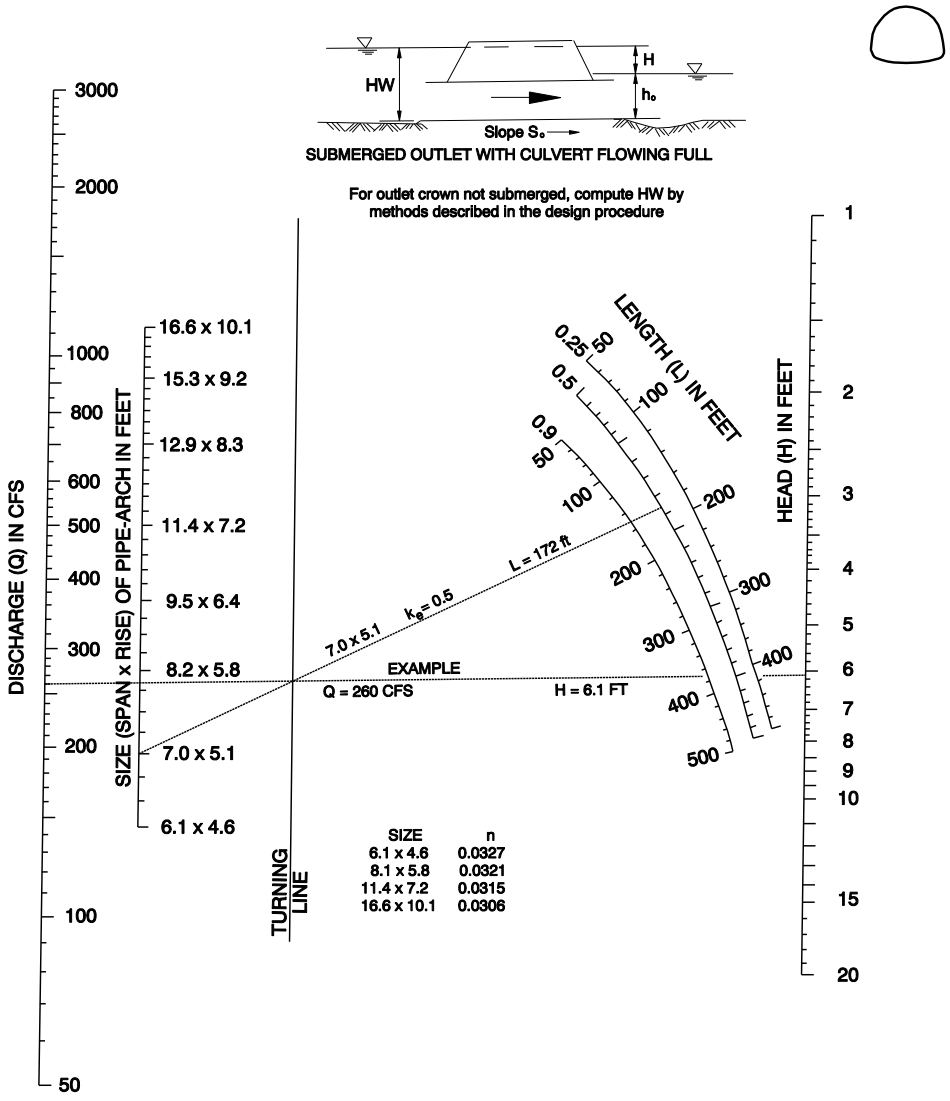


CHART 18

HEADWATER DEPTH FOR C.M. ARCH CULVERTS 0.3 ≤ RISE / SPAN <0.4 WITH INLET CONTROL

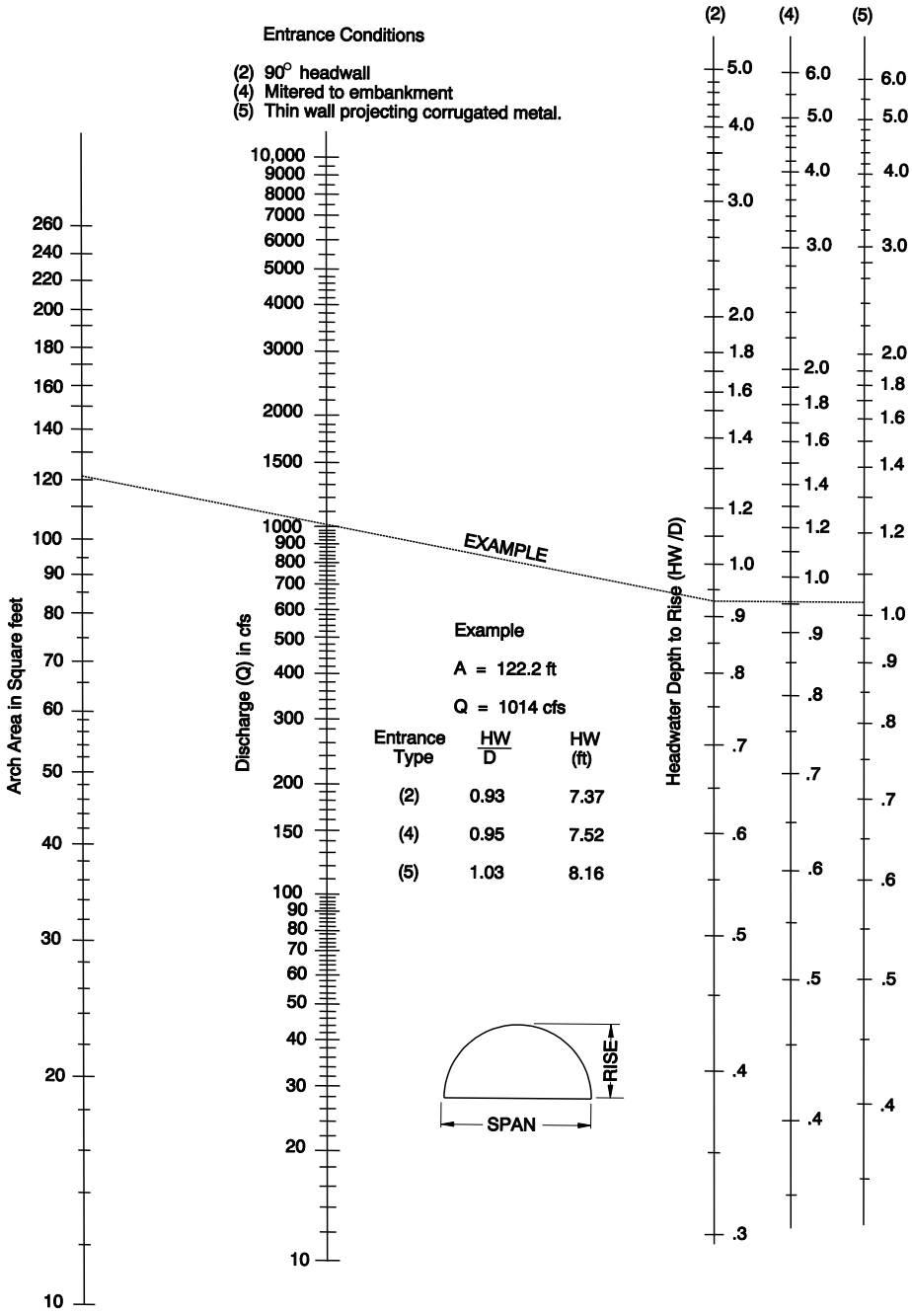


CHART 19

HEADWATER DEPTH FOR C.M. ARCH CULVERTS 0.4 ≤RISE / SPAN <0.5 WITH INLET CONTROL

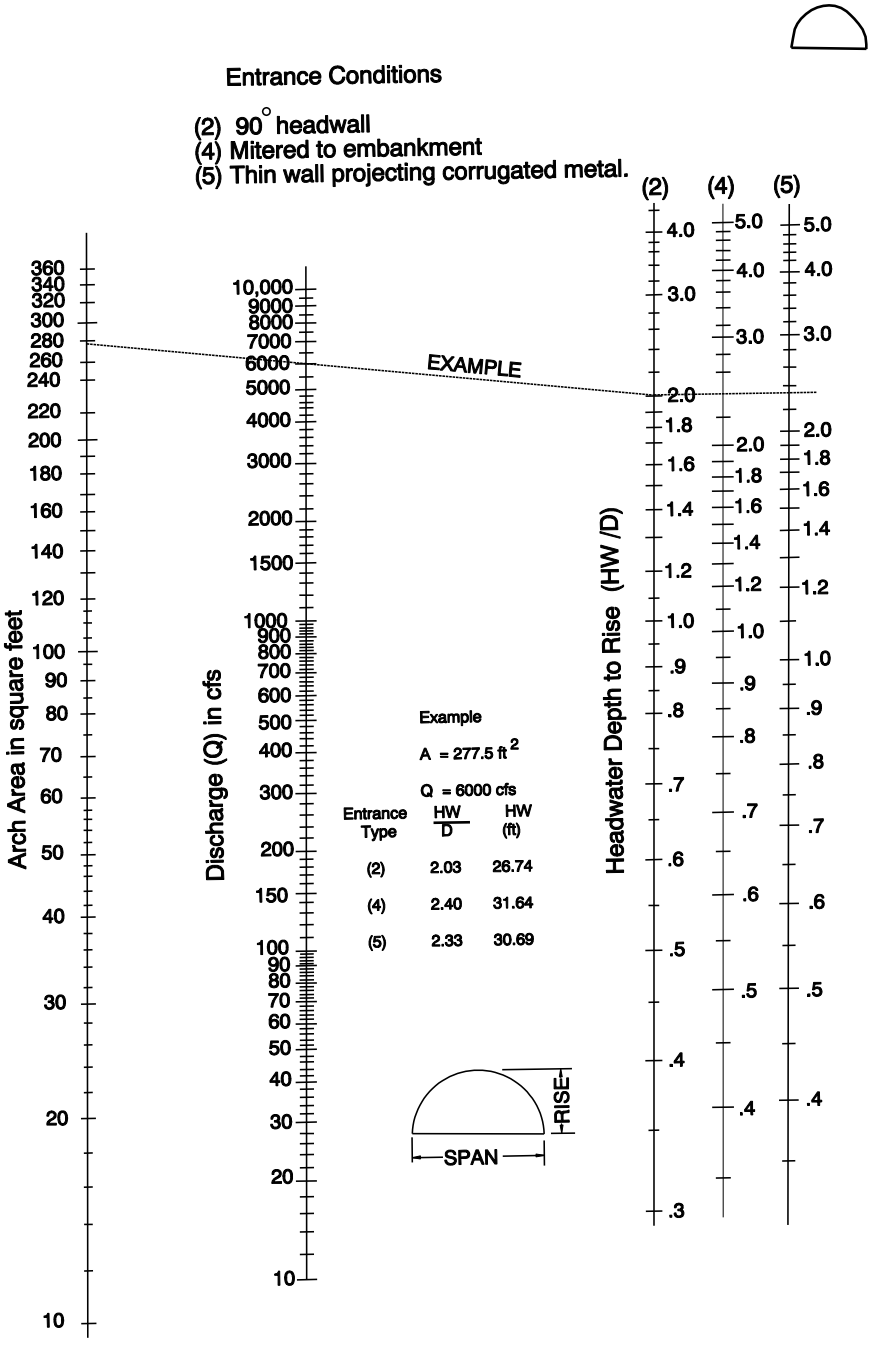


CHART 20

HEADWATER DEPTH FOR C.M. ARCH CULVERTS 0.5 ≤ RISE /SPAN WITH INLET CONTROL

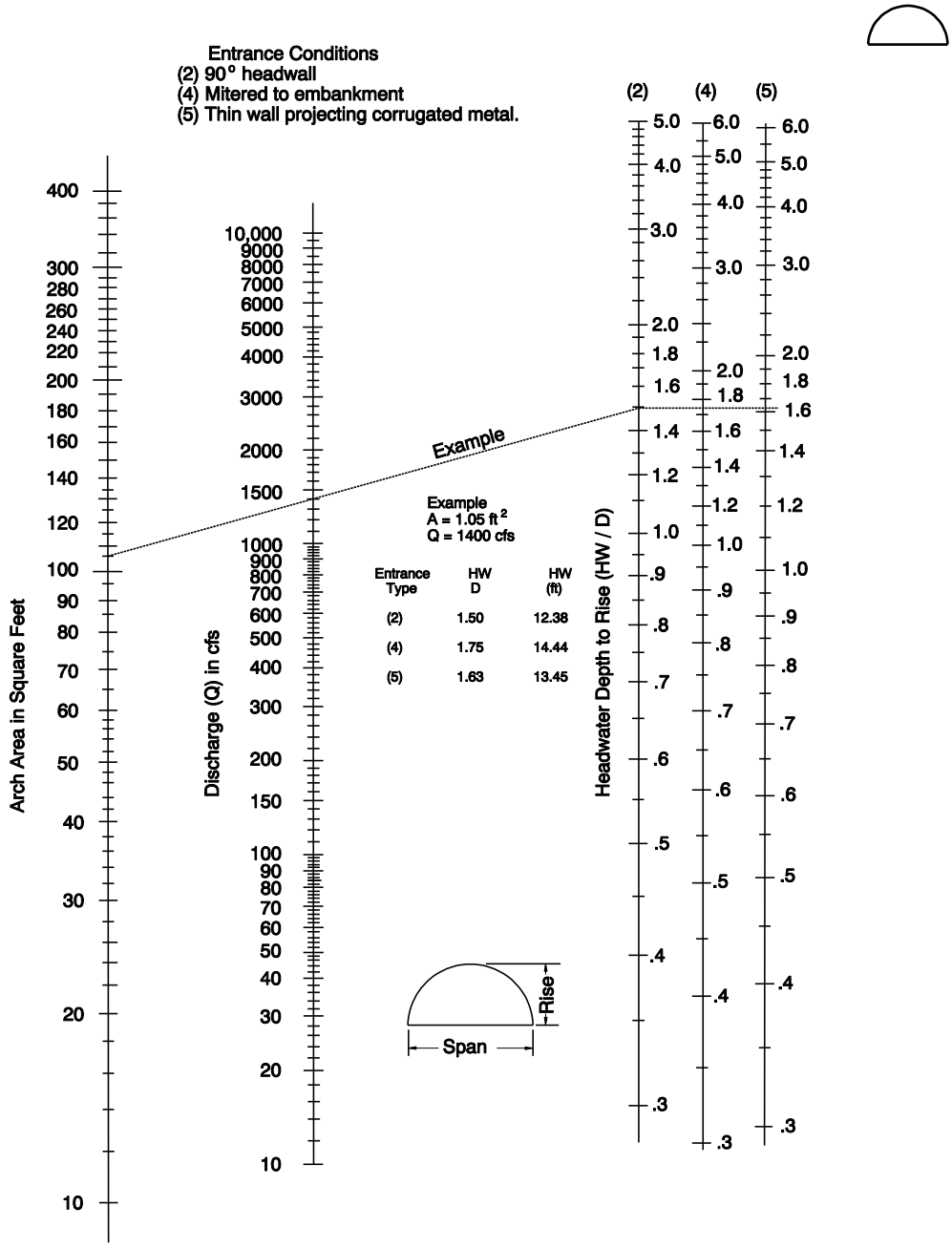


CHART 21

HEAD FOR C.M. ARCH CULVERTS FLOWING FULL EARTH BOTTOM (n_b = 0.022) 0.3 ≤ RISE / SPAN <0.4

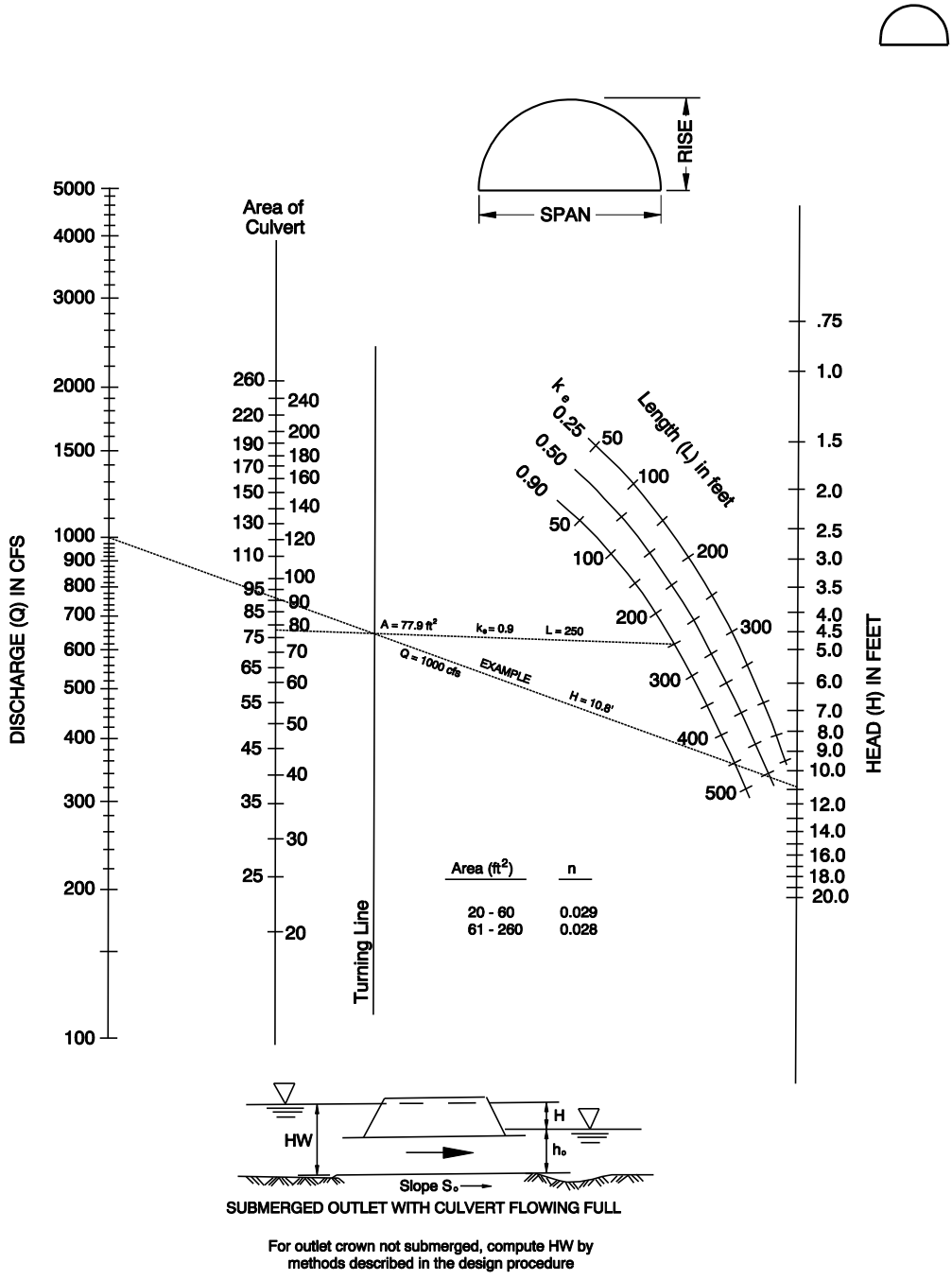


CHART 22

HEAD FOR C.M. ARCH CULVERTS FLOWING FULL IN OUTLET CONTROL EARTH BOTTOM (n_b =0.022) 0.4 ≤ RISE / SPAN < 0.5

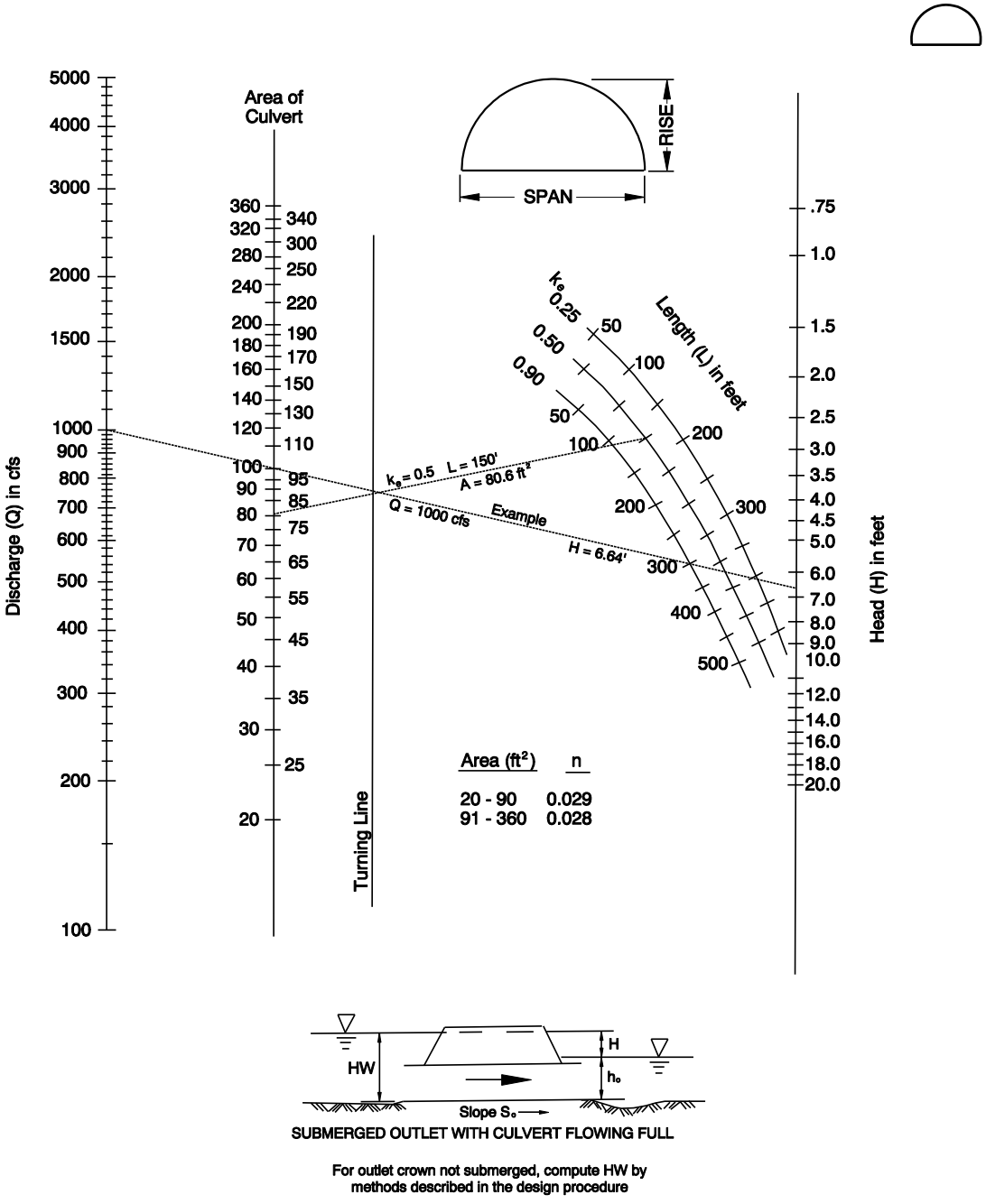


CHART 23

HEAD FOR C.M. ARCH CULVERTS FLOWING FULL IN OUTLET CONTROL EARTH BOTTOM (n_b=0.022) 0.5 ≤ RISE / SPAN