PROFESSIONAL
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PROFESSIONAL ASSOCIATION

[redacted]

# DRAINAGE PLAN

# AND

# SUPPORTING CALCULATIONS

# FOR

# CLARK ADDITION

# (NOW KNOWN AS BALTHROP 4TH ADDITION)

WICHITA, SEDGWICK COUNTY, KS

FEBRUARY 29, 1996

(REVISED OCTOBER 13, 1999)

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# CLARK ADDITION
## WICHITA, SEDGWICK COUNTY, KANSAS
February 23, 1996

Clark Addition is single family residential development in Northeast Wichita encompassing approximately 37 acres. The computations and supporting data for the a drainage plan of the Clark are presented herein.

## Hydrology
The Rational Method has been used for hydrologic analysis of all storm sewer systems that serve the residential streets and yards. The analysis made is based on the available site data which includes a 1" = 100' topographic map with 2' contours of the site and adjacent areas on K-96 and Balthrop Addition. Flows discharged from culverts on K-96 were derived from 100 year flow data shown on the highway plans.

A grass swale has been designed to convey flow form the culvert under K-96 through lots 19, 20 and 21, block 1 to the Clark Addition storm water sewer. Sufficient drainage easement is available for a 12 foot trapezoidal channel with 4:1 side slopes. It was found that a 60 foot drainage is sufficient for major storm discharges flowing through the Clark plat from both culverts under K-96. Flow from the extreme east side of the property remains within the 60 drainage easement with a 20 foot trapezoidal channel with 6:1 side slopes.

## Inlet Design
For local street conveyance, curb-deep flow is tolerable for the minor, or 2 year storm. For each inlet, street flooding and inlet capacity has been checked for the minor storm. An eight foot dry center lane is maintained on collector streets throughout for minor storm flows. It has been assumed 3/8 in./ft. street cross-slopes, 6-5/8" standard curb and gutter and City of Wichita Type 1A street inlets will be used throughout. Minimum walk grade has been assumed to be 0.3 feet above top of curb unless otherwise noted.

Due to the desired architectural style of the homes, this plat proposes a series of back yard drainage systems to public easements. Detailed grade design is crucial for the back yard drains to function properly in the comprehensive drainage scheme. Standard 4' x 2' grate inlets were assumed for back yard drains with 2% longitudinal cross slopes to the inlets where possible.
Where practical, a "cascade effect" has been designed to provide a drainage release point in the event of system failure. Lots abutting back yard drainage

systems will have minimum low opening criteria above the drainage release point on the four-corner lot grading plan.

## Pipe Design

Hydraulic computations for the pipe system were performed using Manning's Equation. All pipes were assumed to be reinforced concrete with a Manning's "n" factor of 0.013. It has been checked to be certain the hydraulic grade line is approximately one foot below the top of curb elevations for the minor storm. The main line pipe, which carries a large flow from a culvert passing under K-96, has been designed for the major storm, or 100 year storm. Systems designed for the minor storm or 2 year storm, have major storm overflows directed through inlets at sump locations, nodes 102 and 103.

To simplify analysis the following assumptions were made:

1. The time of concentration is identical for both pipe flow and street flow for both major and minor storm; a conservative estimate since pipe velocities generally exceed gutter velocities.

2. Street conveyance was analyzed using only the street width. Depths above curb up to the walk grade were used, but the conveyance of the parking was neglected. In general, the parking area conveyance is quite small, due to a relatively higher "n" factor.

## Design Aids

This section includes material used to assist in designing the drainage system. A 1"=100' scale drainage map is enclosed in the pocket.

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✓MWB 2·25·96

Project Clark Addition

Item BACKYARD INLET DESIGN - Q2

z/n = 1/.002 / .03 = 1667

# INLET CAPACITY

| NODE | HYDROLOGY | | APPROACHING FLOW | | | | INLET | | ON-GRADE COMP | | | SUMP COMP. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. | $Q_o$ cfs | $Q_o+Q_b$ cfs | $S_o$ o/o | $S_x$ % ~~in/ft~~ | d ft | T ft | TYPE | L | Lt ft | L/Lt | E ft | di ft | d ft | T ft | $Q_i$ cfs | Qb cfs |
| (118) C | 1.95 | — | 2.0 | OK | BY | INSP | 1 – | STD. | 4'x2' Sump Grate. | | | | | | 1.95 | 0 |
| (117) B | 1.56 | — | 2.0 | OK | By | INSP. | 1 – | STD. | 4'x2' Sump Grate. | | | | | | 1.56 | 0 |
| (113) H | 1.17 | — | 1.5 | OK | BY | INSP. | 1 | STD | 4'x2' SUMP GRATE | | | | | | 1.17 | 0 |
| (112) I | 1.11 | — | 1.5 | OK | BY | INSP. | 1 | STD | 4'x2' SUMP GRATE | | | | | | 1.11 | 0 |
| (111) J | 2.72 | — | 1.5 | OK | BY | INSP. | 1 | STD | 4'x2' SUMP GRATE | | | | | | 2.72 | 0 |
| (108) P | 1.54 | — | 2.0 | OK | BY | INSP. | 1 | STD | 4'x2' SUMP GRATE | | | | | | 1.54 | 0 |
| (107) Q | 1.30 | — | 2.0 | OK | BY | INSP. | 1 | STD | 4'x2' SUMP GRATE | | | | | | 1.30 | 0 |
| (104) U | 1.00 | — | 2.0 | OK | BY | INSP | 1 | STD | 4'x2' SUMP GRATE | | | | | | 1.00 | 0 |
| (105) T | 1.00 | — | 2.0 | OK | BY | INSP | 1 | STD | 4'x2' SUMP GRATE. | | | | | | 1.00 | 0 |
| (106) R | 1.95 | — | 1.5 | 2.0 | OK | BY INSP | 1 – | STD | 4'x2' SUMP GRATE | | | | | | 1.95 | 0 |
| (116) O | 1.0 | — | 2.0 | .33 | OK | BY INSP | 1 | STD | 4'x2' Sump Grate | | | | | | 1.90 | 0 |

Note: (104) (107) (108) ON $Q_{100}$ PIPE ∴ No overflows will be used for those Areas.

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Project Clark Addition

Item Street Inlets – Q 2

z/n = (1/.0313) / .016 = 2000

# INLET CAPACITY

| | HYDROLOGY | | APPROACHING FLOW | | | | INLET | | ON-GRADE COMP | | | SUMP COMP. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NODE No. | $Q_o$ cfs | $Q_o+Q_b$ cfs | $S_o$ o/o | $S_x$ in/ft | d ft | T ft | TYPE | L | Lt ft | L/Lt | E ft | di ft | d ft | T ft | $Q_i$ cfs | Qb cfs |
| D | 7.47 | | .32 | 3/8" | .41 | 13.1' | | | | | | | | | | |
| E | 2.46 | | .32 | ↓ | .28 | 10' | | | | | | .78 | .61 | 19.5 | 9.93 | 0 |
| (115) | | 9.93 | | | | | 1A | 10' | | | | .48 | .31 | 9.9 | 9.93 | 0 |
| F | 0.98 | | .32 | | .19 | 7' | | | | | | | | | | |
| G | 0.33 | | .32 | | OK BY | INSP | | | | | | OK | BY | INSP | 1.31 | 0 |
| (114) | | 1.31 | | | | | 1A | 5' | | | | | | | | |
| K | 3.52 | | 1.07 | | .26 | 9.0' | | | | | | | | | | |
| L | 2.33 | | .32 | | .28 | 9.9' | 1A | 5' | | | | .43 | .26 | 8.31 | 5.85 | 0 |
| (110) | | 5.85 | | | | | | | | | | | | | | |
| M | 0.74 | | 1.07 | | OK BY | INSP. | | | | | | | | | | |
| N | 1.11 | | .32 | | OK BY | INSP. | 1A | 5' | | | | OK | BY | INSP | 1.85 | 0 |
| (109) | | 1.85 | | | | | | | | | | | | | | |

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Item Street INLET Q100 (102)

z/n = 2000

# INLET CAPACITY

| NODE No. | HYDROLOGY $Q_o$ cfs | HYDROLOGY $Q_o+Q_b$ cfs | APPROACHING FLOW $S_o$ o/o | APPROACHING FLOW $S_x$ in/ft | APPROACHING FLOW d ft | APPROACHING FLOW T ft | INLET TYPE | INLET L | ON-GRADE COMP Lt ft | ON-GRADE COMP L/Lt | ON-GRADE COMP E ft | SUMP COMP. di ft | SUMP COMP. d ft | SUMP COMP. T ft | $Q_i$ cfs | Qb cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STREET FLOW ON E. Side of (102) | | | | | | | | | | | | | | | | |
| X | 16.05 | | .33 | 3/8" | | | | | | | | | | | | |
| Y | 5.13 | | .33 | | | | | | | | | | | | | |
| Σ = 21.18 | | | .33 | | .61 | 22' | | | | | | | $\Sigma Q_{iE}$ = | | 21.18 | |
| STREET FLOW ON W. Side of (102) | | | | | | | | | | | | | | | | |
| $Q_{100} = Q_2$ bypass to (102) | | | | | | | | | | | | | | | | 14.98 |
| D | 14.98 | | | | | | | | | | | | | | | 7.07 |
| K | 7.07 | | | | | | | | | | | | | | | 4.69 |
| L | 4.69 | | | | | | | | | | | | | | $\Sigma Q_{bW}$ = | 26.74 |
| Z | 19.61 | 46.35 | .45 | | .79 | 30' | | | | | | | | | | |
| (102) | 40.79 | 67.53 | | | | | 2@1A | 10' | | | | 1.0 | .83 | 26.5 | 45.0 | 22.53 |

DRIVE WAY CONSTRAINTS.

OVER CROWN TO (103)

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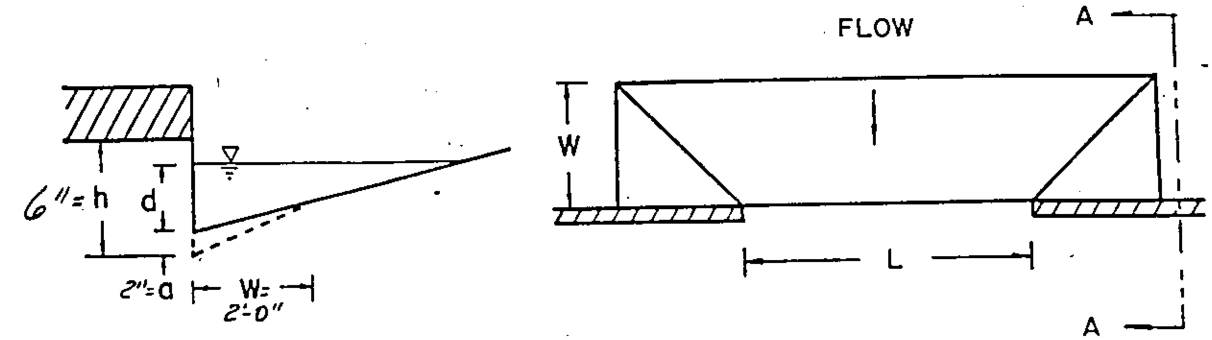
Item Street INLET $Q_{100}$ (103)

$z/n = \frac{1/.0313}{.016} = 2000$

# INLET CAPACITY

| | HYDROLOGY | | APPROACHING FLOW | | | | INLET | | ON-GRADE COMP | | | SUMP COMP. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NODE No. | $Q_o$ cfs | $Q_o+Q_b$ cfs | $S_o$ o/o | $S_x$ in/ft | d ft | T ft | TYPE | L | Lt ft | L/Lt | E ft | di ft | d ft | T ft | $Q_i$ cfs | Qb cfs |
| V | 6.13 | | .33 | 3/8" | | | | | | | | | | | 6.13 | |
| W | 4.79 | | .45 | | | | | | | | | ΣQi to (103) → | | | 4.79<br>10.92 | |
| $Q_{100}-Q_2$ overflow to (103) | | | | | | | | | | | | | | | | |
| F | 1.97 | | .45 | | | | | | | | | | | | | 1.97 |
| G | .66 | | .45 | | | | | | | | | | | | | .66 |
| M | 1.49 | | .45 | | | | | | | | | | | | | 1.49 |
| W | 2.23 | | .45 | | | | | | | | | Σ Qb to (103) | | | | 2.23<br>6.35 |
| STREET FLOW ON E. Side of (103) | | | | | | | | | | | | | | | | |
| V | 6.13 | | .33 | | .39 | 14 | | | | | | | | | | |
| STREET FLOW ON W. Side of (103) | | | | | | | Σ of F, G, M, N, W | | | | | | | | | |
| ΣQ | 4.79 | 11.14 | .45 | | .45 | 16 | | | | | | | | | | |
| (103) | 10.92 | 39.77 | | | | | 2@1A | 10' | | | | .80 | .63 | 20.13 | 39.77 | 0 |

# CONDUIT DESIGN




DEF. SKETCH, C.O.W. TYPE 1A INLET

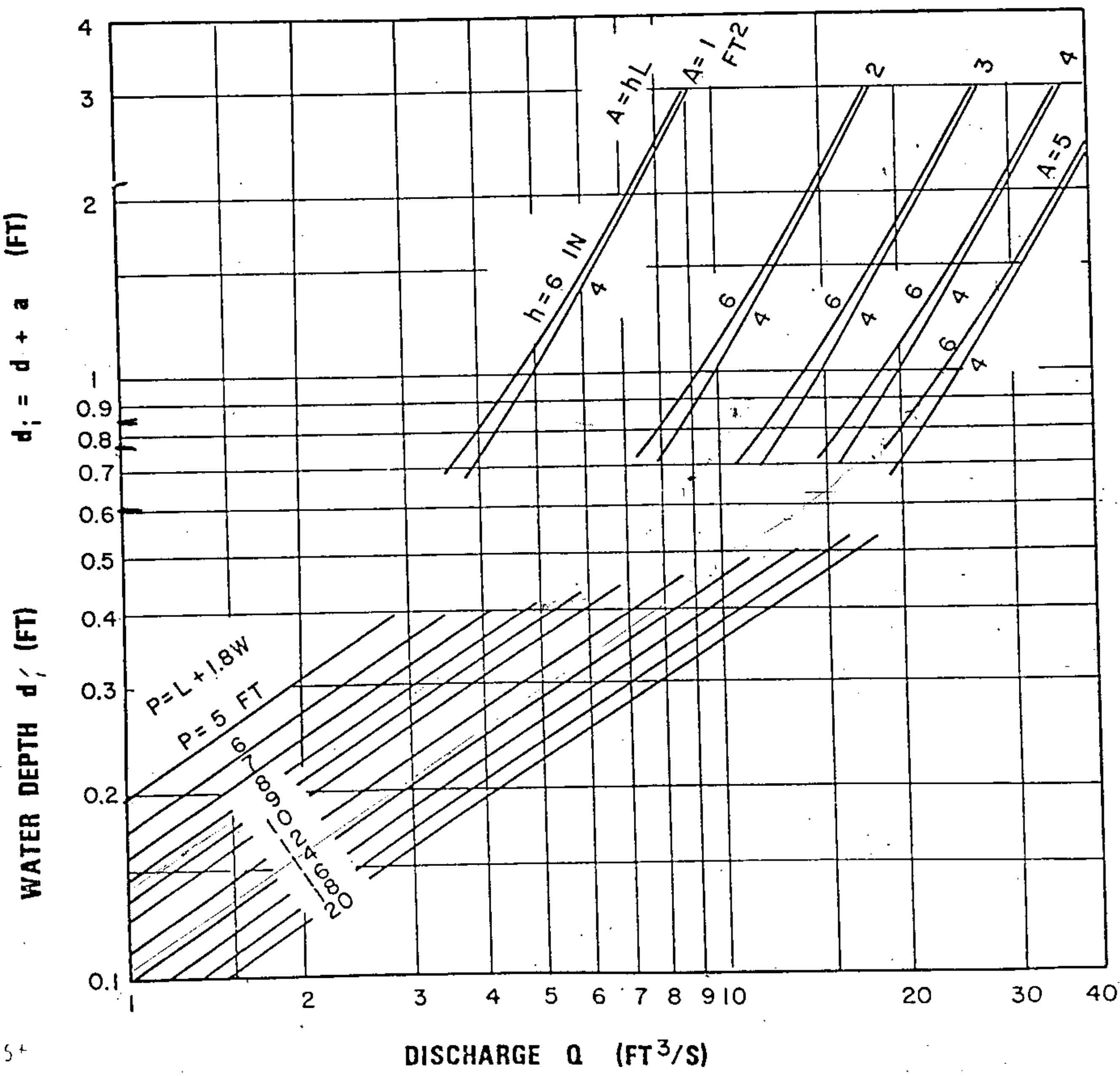



**CHART 12. Depressed curb-opening inlet capacity in sump locations.**

*FROM: HEC-12, DRAINAGE OF HIGHWAY PAVEMENTS, F.H.W.A., MAR., 1984*

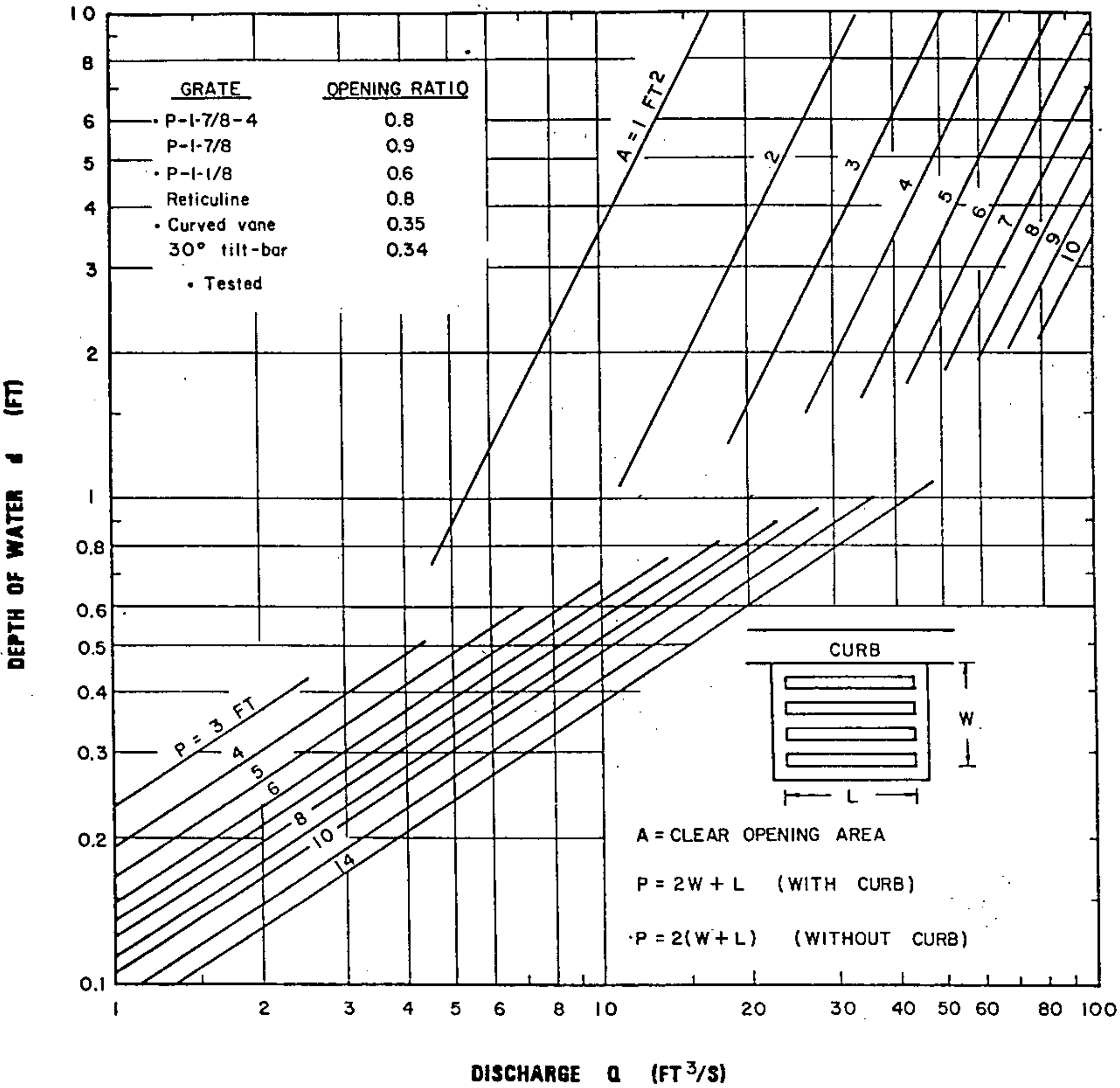
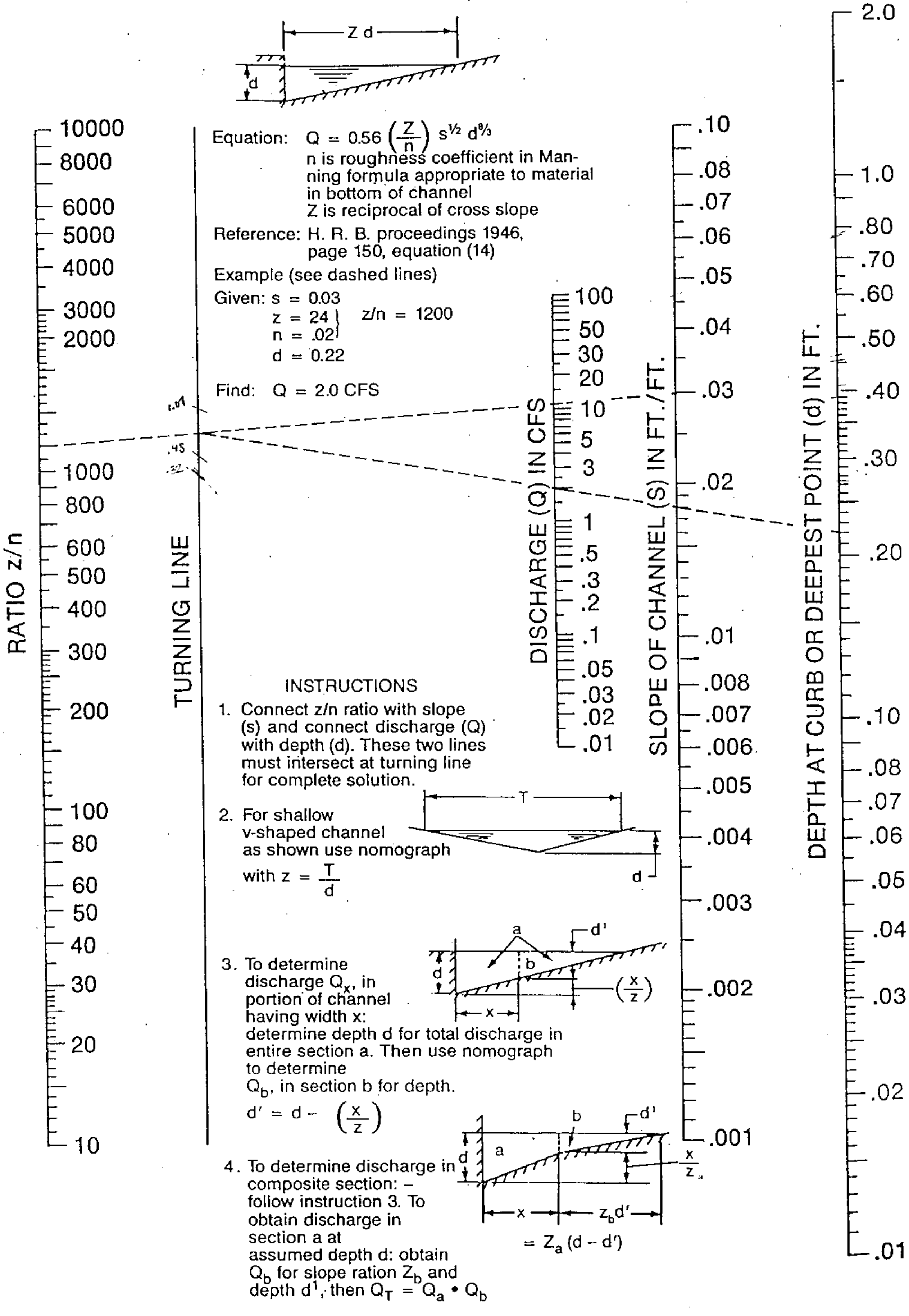



**CHART 11. Grate inlet capacity in sump conditions.**

*FROM: HEC-12, DRAINAGE OF HIGHWAY PAVEMENTS, F.H.W.A., MAR 1984*


Z d
d
Equation: Q = 0.56 (Z/n) s½ d⁸⁄₃
n is roughness coefficient in Manning formula appropriate to material in bottom of channel
Z is reciprocal of cross slope
Reference: H. R. B. proceedings 1946, page 150, equation (14)
Example (see dashed lines)
Given: s = 0.03
z = 24
n = .02
z/n = 1200
d = 0.22
Find: Q = 2.0 CFS
RATIO z/n
10000
8000
6000
5000
4000
3000
2000
1000
800
600
500
400
300
200
100
80
60
50
40
30
20
10
TURNING LINE
DISCHARGE (Q) IN CFS
100
50
30
20
10
5
3
1
.5
.3
.2
.1
.05
.03
.02
.01
SLOPE OF CHANNEL (S) IN FT./FT.
.10
.08
.07
.06
.05
.04
.03
.02
.01
.008
.007
.006
.005
.004
.003
.002
.001
DEPTH AT CURB OR DEEPEST POINT (d) IN FT.
2.0
1.0
.80
.70
.60
.50
.40
.30
.20
.10
.08
.07
.06
.05
.04
.03
.02
.01
INSTRUCTIONS
1. Connect z/n ratio with slope (s) and connect discharge (Q) with depth (d). These two lines must intersect at turning line for complete solution.
2. For shallow v-shaped channel as shown use nomograph with z = T/d
T
d
3. To determine discharge Qx, in portion of channel having width x: determine depth d for total discharge in entire section a. Then use nomograph to determine Qb, in section b for depth.
d' = d − (x/z)
a
b
d'
d
(x/z)
x
4. To determine discharge in composite section: – follow instruction 3. To obtain discharge in section a at assumed depth d: obtain Qb for slope ration Zb and depth d1, then QT = Qa • Qb
a
b
d'
d
x/z
x
zbd'
= Za (d − d')

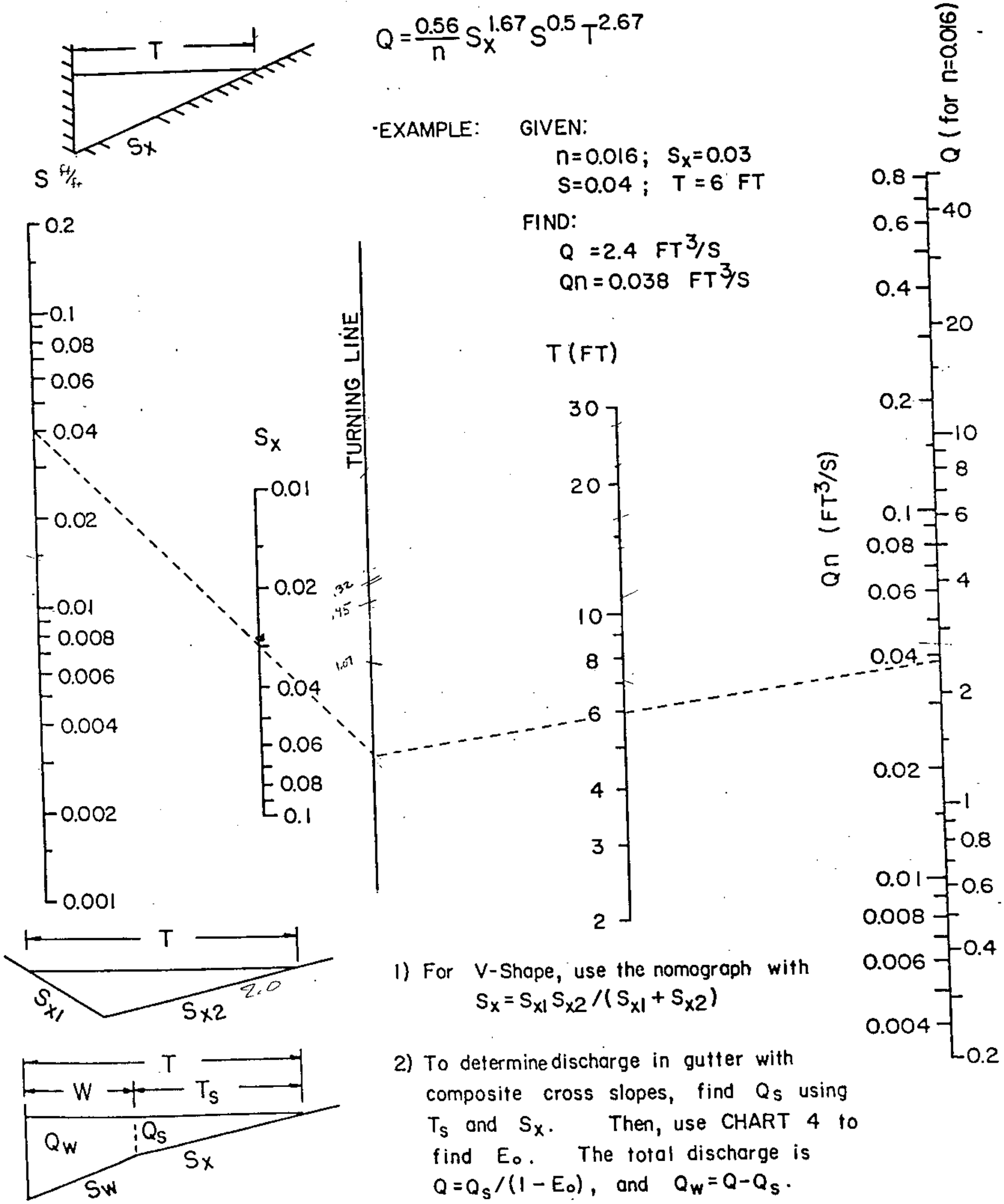



**CHART 3. Flow in triangular gutter sections.**

*From: HEC-12: Drainage of Highway Pavements, F.H.W.A., Mar. 1984*

Pipe Design

April 15, 1986

ATTACHMENT A
DRAINAGE CRITERIA MANUAL

CITY OF WICHITA, KANSAS

RAINFALL INTENSITY TABLE FOR SEDGWICK COUNTY, KANSAS

The following tabulation contains rainfall intensity in inches per hour as derived from ESSA Weather Bureau Technical Paper 40 Modified to NWS Hydro-35, 1977 During First Hour

| DURATION IN MINUTES | RETURN PERIODS OF 1-YR | 2-YR | 5-YR | 10-YR | 25-YR | 50-YR | 100-YR |
|---|---|---|---|---|---|---|---|
| 5 | 4.18 | 5.57 | 6.53 | 7.41 | 8.52 | 9.48 | 10.32 |
| 6 | 3.99 | 5.32 | 6.25 | 7.09 | 8.16 | 9.09 | 9.89 |
| 7 | 3.81 | 5.09 | 5.99 | 6.81 | 7.84 | 8.74 | 9.50 |
| 8 | 3.66 | 4.89 | 5.75 | 6.55 | 7.55 | 8.42 | 9.15 |
| 9 | 3.52 | 4.70 | 5.54 | 6.31 | 7.28 | 8.13 | 8.83 |
| 10 | 3.39 | 4.52 | 5.34 | 6.09 | 7.04 | 7.86 | 8.54 |
| 11 | 3.27 | 4.36 | 5.16 | 5.89 | 6.81 | 7.61 | 8.27 |
| 12 | 3.18 | 4.21 | 4.99 | 5.71 | 6.60 | 7.38 | 8.02 |
| 13 | 3.05 | 4.08 | 4.84 | 5.53 | 6.41 | 7.17 | 7.79 |
| 14 | 2.96 | 3.95 | 4.69 | 5.37 | 6.23 | 6.97 | 7.57 |
| 15 | 2.87 | 3.83 | 4.56 | 5.22 | 6.06 | 6.78 | 7.37 |
| 16 | 2.78 | 3.72 | 4.43 | 5.08 | 5.90 | 6.60 | 7.18 |
| 17 | 2.71 | 3.61 | 4.31 | 4.95 | 5.75 | 6.44 | 7.00 |
| 18 | 2.63 | 3.51 | 4.20 | 4.83 | 5.61 | 6.29 | 6.84 |
| 19 | 2.56 | 3.42 | 4.10 | 4.71 | 5.47 | 6.14 | 6.68 |
| 20 | 2.50 | 3.33 | 4.00 | 4.60 | 5.35 | 6.00 | 6.53 |
| 21 | 2.44 | 3.25 | 3.90 | 4.50 | 5.23 | 5.87 | 6.39 |
| 22 | 2.38 | 3.17 | 3.81 | 4.40 | 5.12 | 5.75 | 6.26 |
| 23 | 2.32 | 3.10 | 3.73 | 4.31 | 5.01 | 5.63 | 6.13 |
| 24 | 2.27 | 3.03 | 3.65 | 4.22 | 4.91 | 5.52 | 6.01 |
| 25 | 2.22 | 2.96 | 3.57 | 4.13 | 4.81 | 5.41 | 5.90 |
| 26 | 2.20 | 2.90 | 3.50 | 4.05 | 4.72 | 5.31 | 5.79 |
| 27 | 2.16 | 2.84 | 3.43 | 3.98 | 4.63 | 5.21 | 5.69 |
| 28 | 2.14 | 2.78 | 3.37 | 3.90 | 4.55 | 5.12 | 5.59 |
| 29 | 2.11 | 2.72 | 3.30 | 3.83 | 4.47 | 5.03 | 5.49 |
| 30 | 2.08 | 2.67 | 3.24 | 3.76 | 4.39 | 4.94 | 5.40 |
| 31 | 2.05 | 2.62 | 3.19 | 3.70 | 4.32 | 4.86 | 5.32 |
| 32 | 2.02 | 2.57 | 3.10 | 3.63 | 4.25 | 4.79 | 5.22 |
| 33 | 1.99 | 2.52 | 3.05 | 3.57 | 4.18 | 4.71 | 5.14 |
| 34 | 1.96 | 2.48 | 3.01 | 3.51 | 4.11 | 4.63 | 5.07 |
| 35 | 1.93 | 2.44 | 2.98 | 3.46 | 4.05 | 4.56 | 5.00 |
| 36 | 1.91 | 2.39 | 2.93 | 3.41 | 3.99 | 4.50 | 4.93 |
| 37 | 1.89 | 2.35 | 2.88 | 3.36 | 3.93 | 4.43 | 4.86 |
| 38 | 1.87 | 2.32 | 2.84 | 3.31 | 3.87 | 4.37 | 4.79 |
| 39 | 1.85 | 2.28 | 2.80 | 3.26 | 3.82 | 4.31 | 4.73 |
| 40 | 1.83 | 2.24 | 2.76 | 3.22 | 3.76 | 4.25 | 4.66 |
| 41 | 1.81 | 2.21 | 2.72 | 3.17 | 3.71 | 4.19 | 4.60 |
| 42 | 1.79 | 2.18 | 2.68 | 3.13 | 3.66 | 4.13 | 4.54 |
| 43 | 1.77 | 2.14 | 2.64 | 3.09 | 3.61 | 4.08 | 4.49 |
| 44 | 1.75 | 2.11 | 2.61 | 3.05 | 3.57 | 4.03 | 4.43 |
| 45 | 1.73 | 2.08 | 2.57 | 3.01 | 3.52 | 3.98 | 4.38 |

| DURATION IN MINUTES | RETURN PERIODS OF 1-YR | 2-YR | 5-YR | 10-YR | 25-YR | 50-YR | 100-YR |
|---|---|---|---|---|---|---|---|
| 46 | 1.70 | 2.05 | 2.54 | 2.97 | 3.48 | 3.93 | 4.33 |
| 47 | 1.67 | 2.02 | 2.50 | 2.93 | 3.44 | 3.88 | 4.28 |
| 48 | 1.66 | 2.00 | 2.47 | 2.90 | 3.39 | 3.84 | 4.23 |
| 49 | 1.64 | 1.97 | 2.44 | 2.86 | 3.35 | 3.79 | 4.18 |
| 50 | 1.61 | 1.95 | 2.41 | 2.83 | 3.32 | 3.75 | 4.13 |
| 51 | 1.59 | 1.92 | 2.38 | 2.79 | 3.28 | 3.71 | 4.09 |
| 52 | 1.56 | 1.89 | 2.35 | 2.76 | 3.24 | 3.67 | 4.05 |
| 53 | 1.54 | 1.86 | 2.33 | 2.73 | 3.20 | 3.63 | 4.00 |
| 54 | 1.52 | 1.84 | 2.30 | 2.70 | 3.17 | 3.59 | 3.96 |
| 55 | 1.50 | 1.81 | 2.27 | 2.67 | 3.14 | 3.55 | 3.92 |
| 56 | 1.47 | 1.79 | 2.25 | 2.64 | 3.10 | 3.51 | 3.88 |
| 57 | 1.45 | 1.76 | 2.22 | 2.61 | 3.07 | 3.48 | 3.84 |
| 58 | 1.43 | 1.74 | 2.20 | 2.59 | 3.04 | 3.44 | 3.81 |
| 59 | 1.42 | 1.72 | 2.18 | 2.56 | 3.01 | 3.41 | 3.77 |
| 60 | 1.40 | 1.69 | 2.15 | 2.53 | 2.98 | 3.37 | 3.73 |
| 61 | 1.38 | 1.67 | 2.13 | 2.51 | 2.95 | 3.34 | 3.70 |
| 62 | 1.36 | 1.65 | 2.11 | 2.48 | 2.92 | 3.31 | 3.[illegible] |
| 63 | 1.34 | 1.63 | 2.09 | 2.46 | 2.89 | 3.28 | 3[illegible] |

**TABLE 3**

**FULL FLOW COEFFICIENT VALUES CIRCULAR CONCRETE PIPE**

| D Pipe Diameter (inches) | A Area (Square Feet) | R Hydraulic Radius (Feet) | Value of $C_1 = \frac{1.486}{n} \times A \times R^{2/3} = K$ n=0.010 | n=0.011 | n=0.012 | n=0.013 |
|---|---|---|---|---|---|---|
| 8 | 0.349 | 0.167 | 15.8 | 14.3 | 13.1 | 12.1 |
| 10 | 0.545 | 0.208 | 28.4 | 25.8 | 23.6 | 21.8 |
| 12 | 0.785 | 0.250 | 46.4 | 42.1 | 38.6 | 35.7 |
| 15 | 1.227 | 0.312 | 84.1 | 76.5 | 70.1 | 64.7 |
| 18 | 1.767 | 0.375 | 137 | 124 | 114 | 105 |
| 21 | 2.405 | 0.437 | 206 | 187 | 172 | 158 |
| 24 | 3.142 | 0.500 | 294 | 267 | 245 | 226 |
| 27 | 3.976 | 0.562 | 402 | 366 | 335 | 310 |
| 30 | 4.909 | 0.625 | 533 | 485 | 444 | 410 |
| 33 | 5.940 | 0.688 | 686 | 624 | 574 | 530 |
| 36 | 7.069 | 0.750 | 867 | 788 | 722 | 666 |
| 42 | 9.621 | 0.875 | 1308 | 1189 | 1090 | 1006 |
| 48 | 12.566 | 1.000 | 1867 | 1698 | 1556 | 1436 |
| 54 | 15.904 | 1.125 | 2557 | 2325 | 2131 | 1967 |
| 60 | 19.635 | 1.250 | 3385 | 3077 | 2821 | 2604 |
| 66 | 23.758 | 1.375 | 4364 | 3967 | 3636 | 3357 |
| 72 | 28.274 | 1.500 | 5504 | 5004 | 4587 | 4234 |
| 78 | 33.183 | 1.625 | 6815 | 6195 | 5679 | 5242 |
| 84 | 38.485 | 1.750 | 8304 | 7549 | 6920 | 6388 |
| 90 | 44.170 | 1.875 | 9985 | 9078 | 8321 | 7681 |
| 96 | 50.266 | 2.000 | 11850 | 10780 | 9878 | 9119 |
| 102 | 56.745 | 2.125 | 13940 | 12670 | 11620 | 10720 |
| 108 | 63.617 | 2.250 | 16230 | 14760 | 13530 | 12490 |
| 114 | 70.882 | 2.375 | 18750 | 17040 | 15620 | 14420 |
| 120 | 78.540 | 2.500 | 21500 | 19540 | 17920 | 16540 |
| 126 | 86.590 | 2.625 | 24480 | 22260 | 20400 | 18830 |
| 132 | 95.033 | 2.750 | 27720 | 25200 | 23100 | 21330 |
| 138 | 103.870 | 2.875 | 31210 | 28370 | 26010 | 24010 |
| 144 | 113.100 | 3.000 | 34960 | 31780 | 29130 | 26890 |

$Q = K\sqrt{S}$

$K = \frac{Q}{\sqrt{S}}$ $S = \frac{Q^2}{K^2}$

Table 1. Classification of Vegetal Covers as to Degree of Retardance. (4)

| Retardance Class | Cover | Condition |
|---|---|---|
| A | Weeping lovegrass ......... | Excellent stand, tall (average 30") (76 cm) |
| | Yellow bluestem Ischaemum ............... | Excellent stand, tall (average 36") (91 cm) |
| B | Kudzu ...................... | Very dense growth, uncut |
| | Bermuda grass ............. | Good stand, tall (average 12") (30 cm) |
| | Native grass mixture (little bluestem, bluestem, blue gamma, and other long and short midwest grasses)......... | Good stand, unmowed |
| | Weeping lovegrass ......... | Good stand, tall (average 24") (61 cm) |
| | Lespedeza sericea ......... | Good stand, not woody, tall (average 19") (48 cm) |
| | Alfalfa ................... | Good stand, uncut (average 11") (28 cm) |
| | Weeping lovegrass ......... | Good stand, unmowed (average 13") (33 cm) |
| | Kudzu ..................... | Dense growth, uncut |
| | Blue gamma ................ | Good stand, uncut (average 13") (28 cm) |
| C | Crabgrass ................. | Fair stand, uncut (10 to 48") (25 to 120 cm) |
| | Bermuda grass ............. | Good stand, mowed (average 6") (15 cm) |
| | Common lespedeza .......... | Good stand, uncut (average 11") (28 cm) |
| | Grass-legume mixture--summer (orchard grass, redtop, Italian ryegrass, and common lespedeza).... | Good stand, uncut (6 to 8 inches) (15 to 20 cm) |
| | Centipedegrass............. | Very dense cover (average 6 inches) (15 cm) |
| | Kentucky bluegrass......... | Good stand, headed (6 to 12 inches (15 to 30 cm) |
| D | Bermuda grass.............. | Good stand, cut to 2.5-inch height (6 cm) |
| | Common lespedeza .......... | Excellent stand, uncut (average 4.5") (11 cm) |
| | Buffalo grass ............. | Good stand, uncut (3 to 6 inches (8 to 15 cm) |
| | Grass-legume mixture--fall, spring (orchard grass, redtop, Italian ryegrass, and common lespedeza)............... | Good stand, uncut (4 to 5 inches) (10 to 13 cm) |
| | Lespedeza sericea ......... | After cutting to 2-inch height (5 cm) Very good stand before cutting |
| E | Bermuda grass ............. | Good stand, cut to 1.5 inch height (4 cm) |
| | Bermuda grass ............. | Burned stubble |

NOTE: Covers classified have been tested in experimental channels. Covers were green and generally uniform.

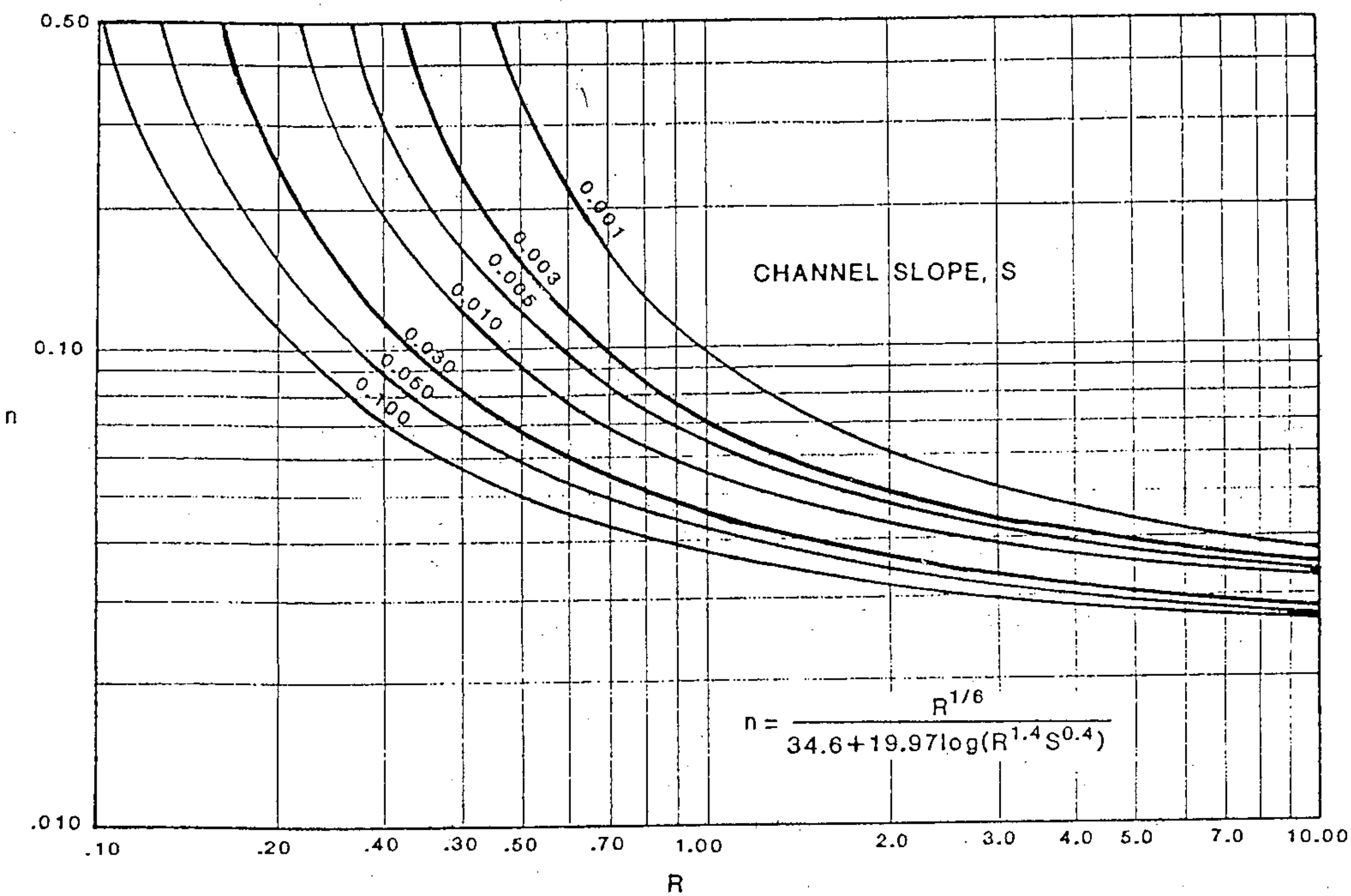



Chart 8. Manning's n versus hydraulic radius, R, for class D vegetation. (after 5)

# DESIGN AIDS

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Project Clark Addition

Item Pipe Sizing

* Denotes $Q_{100}$

| Node | Q | Elev @ Grand | |
|---|---|---|---|
| 119 | 115.82 * | 62.2 | |
| 118 | 1.95 | 63.75 | |
| 117 | 1.56 | 63.0 | |
| 116 | 1.90 | 62.0 | |
| 115 | 9.93 | 64.7 | FL of Gutter |
| 114 | 1.31 | 64.7 | FL of Gutter |
| 113 | 1.17 | 74.4 | |
| 112 | 1.11 | 73.5 | |
| 111 | 2.72 | 67.8 | |
| 110 | 5.85 | 62.85 | FL of Gutter |
| 109 | 1.85 | 62.85 | FL of Gutter |
| 108 | 4.62 * | 60.91 | |
| 107 | 3.90 * | 60.82 | |
| 106 | 1.95 | 61 | |
| 105 | 1.0 | 60.7 | |
| 104 | 2.95 * | 60.72 | |
| 103 | 17.27 * | 60.65 | FL of Gutter |
| 102 | 67.53 * | 60.65 | FL of Gutter |
| 101 | Outlet | 53.8 | FL of Pipe |

Assumptions

- $t_c$ = 15 min
- Std. 6 5/8" Curb & Gutter.
- 1.5' min Cover.
- Starting H.G.L. El. = 59.05
- n = .013

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Project Clark Addition

Item Pipe Sizing

| Node | → Node | L | ESTIMATED DIA. | BEND | MIN Slope = .06% |
|---|---|---|---|---|---|
| 119 | 116 | 60' | 60" | 110° | |
| 118 | 117 | 250' | 15" | 0° | |
| 117 | 116 | 190' | 15" | 105° | |
| 116 | 115 | 180' | 78" | 0 | |
| 115 | 114 | 45' | 84" | 40° | |
| 114 | 108 | 215' | 84" | 0° | CAN USE 48" @ 1%. |
| 113 | 112 | 175' | 15" | 0° | |
| 112 | 111 | 500' | 15" | 90° | |
| 111 | 110 | 300' | 18" | 0° | |
| 110 | 109 | 45' | 30" | 0° | |
| 109 | 108 | 160' | 30" | 110° | |
| 108 | 107 | 160' | 84" | 0° | |
| 107 | 104 | 155' | 84" | 0° | |
| 106 | 105 | 200' | 15" | 0° | |
| 105 | 104 | 215' | 15" | 85° | |
| 104 | 103 | 130' | 84" | 0° | |
| 103 | 102 | 45' | 90" | 0° | |
| 102 | 101 | 150' | 102" | 0° | |

Date: 02-29-1996
Time: 08:10:47

Input File: clark.stm

Clark Addition
PDM 2/23/96

Storm Frequency = 100-Year

* * * HYDROLOGY * * *

| Node | to Node | C | Area (Ac) | Slope (%) | Length (Ft) | TC(0) (Min) | I(0) (In/Hr) | Q(0) (CFS) | TC (Min) | I (In/Hr) | Q (CFS) | Sum Q (CFS) | Size | Velocity (Ft/Sec) | Length (Ft) | TT (Min) | TT+TC (Min) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tributary Area | | | | | | | | | Hydrology Summation | | | | Conduit Data | | | | |
| 119 | 116 | .00 | .00 | .00 | .0 | 28.00 | 5.59 | 115.82 | 28.00 | 5.59 | 115.82 | 115.82 | 60" | 5.90 | 60.00 | .17 | 28.17 |
| 118 | 117 | .00 | .00 | .00 | .0 | 15.00 | 7.37 | 1.95 | 15.00 | 7.37 | 1.95 | 1.95 | 15" | 1.59 | 250.00 | 2.62 | 17.62 |
| 117 | 116 | .00 | .00 | .00 | .0 | 15.00 | 7.37 | 1.56 | 17.62 | 6.90 | 1.46 | 3.41 | 15" | 2.78 | 190.00 | 1.14 | 18.76 |
| 116 | 115 | .00 | .00 | .00 | .0 | 15.00 | 7.37 | 1.90 | 28.17 | 5.57 | 1.44 | 120.09 | 60" | 6.12 | 180.00 | .49 | 28.66 |
| 115 | 114 | .00 | .00 | .00 | .0 | 15.00 | 7.37 | 9.93 | 28.66 | 5.53 | 7.45 | 127.53 | 60" | 6.50 | 45.00 | .12 | 28.78 |
| 114 | 108 | .00 | .00 | .00 | .0 | 15.00 | 7.37 | 1.31 | 28.78 | 5.52 | .98 | 128.51 | 60" | 6.55 | 215.00 | .55 | 29.32 |
| 113 | 112 | .00 | .00 | .00 | .0 | 15.00 | 7.37 | 1.17 | 15.00 | 7.37 | 1.17 | 1.17 | 15" | .95 | 175.00 | 3.06 | 18.06 |
| 112 | 111 | .00 | .00 | .00 | .0 | 15.00 | 7.37 | 1.11 | 18.06 | 6.83 | 1.03 | 2.20 | 15" | 1.79 | 500.00 | 4.65 | 22.71 |
| 111 | 110 | .00 | .00 | .00 | .0 | 15.00 | 7.37 | 2.72 | 22.71 | 6.17 | 2.28 | 4.48 | 18" | 2.53 | 300.00 | 1.97 | 24.68 |
| 110 | 109 | .00 | .00 | .00 | .0 | 15.00 | 7.37 | 5.85 | 24.68 | 5.94 | 4.71 | 9.19 | 18" | 5.20 | 45.00 | .14 | 24.83 |
| 109 | 108 | .00 | .00 | .00 | .0 | 15.00 | 7.37 | 1.85 | 24.83 | 5.92 | 1.49 | 10.68 | 24" | 3.40 | 160.00 | .78 | 25.61 |
| 108 | 107 | .00 | .00 | .00 | .0 | 15.00 | 7.37 | 4.62 | 29.32 | 5.46 | 3.43 | 141.94 | 66" | 5.97 | 160.00 | .45 | 29.77 |
| 107 | 104 | .00 | .00 | .00 | .0 | 15.00 | 7.37 | 3.90 | 29.77 | 5.42 | 2.87 | 144.81 | 66" | 6.10 | 155.00 | .42 | 30.19 |
| 106 | 105 | .00 | .00 | .00 | .0 | 15.00 | 7.37 | 1.95 | 15.00 | 7.37 | 1.95 | 1.95 | 15" | 1.59 | 200.00 | 2.10 | 17.10 |
| 105 | 104 | .00 | .00 | .00 | .0 | 15.00 | 7.37 | 1.00 | 17.10 | 6.99 | .95 | 2.90 | 15" | 2.36 | 215.00 | 1.52 | 18.62 |
| 104 | 103 | .00 | .00 | .00 | .0 | 15.00 | 7.37 | 2.95 | 30.19 | 5.39 | 2.16 | 149.28 | 66" | 6.28 | 130.00 | .34 | 30.54 |
| 103 | 102 | .00 | .00 | .00 | .0 | 15.00 | 7.37 | 17.27 | 30.54 | 5.36 | 12.55 | 161.84 | 8.00 X 5.00 | 4.05 | 45.00 | .19 | 30.72 |
| 102 | 101 | .00 | .00 | .00 | .0 | 15.00 | 7.37 | 67.53 | 30.72 | 5.34 | 48.94 | 210.77 | 8.00 X 5.00 | 5.27 | 150.00 | .47 | 31.20 |

Date: 02-29-1996
Time: 08:10:47

Input File: clark.stm

Clark Addition
PDM 2/23/96

Storm Frequency = 100-Year

* * * HYDRAULICS * * *

| Node | Hyd-Slope (Ft/Ft) | Friction (Ft) | Bend (Ft) | Transition (Ft) | Manhole (Ft) | Deflection (Ft) | Junction (Ft) | Total (Ft) | Hyd-Gl Elevation | Desired Elevation | Diff. (Ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 101 | .00000 | .0000 | .0000 | .0000 | .0000 | .0000 | .0000 | .0000 | 59.3000 | 60.8000 | 1.50 |
| 102 | .00120 | .1795 | .0000 | .0177 | .0000 | .0000 | .1793 | .3765 | 59.6765 | 61.2000 | 1.52 |
| 103 | .00071 | .0317 | .0000 | .0718 | .0000 | .0000 | -.1328 | -.0292 | 59.6473 | 61.2000 | 1.55 |
| 104 | .00198 | .2569 | .0000 | .0036 | .0000 | .0000 | .0813 | .3419 | 59.9891 | 60.7200 | .73 |
| 105 | .00201 | .4328 | .0000 | .0047 | .0000 | .0000 | .1023 | .5398 | 60.5289 | 60.7000 | .17 |
| 106 | .00091 | .1822 | .0000 | .0000 | .0000 | .0000 | .0000 | .1822 | 60.7112 | 61.0000 | .29 |
| 107 | .00186 | .2882 | .0000 | .0023 | .0000 | .0000 | .0545 | .3450 | 60.3341 | 60.8200 | .49 |
| 108 | .00179 | .2859 | .0000 | .0222 | .0000 | .0000 | .0382 | .3462 | 60.6804 | 60.9100 | .23 |
| 109 | .00223 | .3563 | .0000 | .0481 | .0000 | .0000 | -.1211 | .2833 | 60.9637 | 63.4000 | 2.44 |
| 110 | .00765 | .3444 | .0000 | .0320 | .0000 | .0000 | .6654 | 1.0418 | 62.0055 | 63.4000 | 1.39 |
| 111 | .00182 | .5448 | .0000 | .0050 | .0000 | .0249 | .1612 | .7359 | 62.7414 | 67.8000 | 5.06 |
| 112 | .00116 | .5792 | .0000 | .0036 | .0000 | .0000 | .0753 | .6581 | 63.3995 | 73.5000 | 10.10 |
| 113 | .00033 | .0574 | .0000 | .0000 | .0000 | .0000 | .0000 | .0574 | 63.4569 | 74.4000 | 10.94 |
| 114 | .00243 | .5235 | .0000 | .0010 | .0000 | .1238 | .0324 | .6807 | 61.3610 | 65.2500 | 3.89 |
| 115 | .00240 | .1079 | .0000 | .0074 | .0000 | .0000 | .1601 | .2755 | 61.6365 | 65.2500 | 3.61 |
| 116 | .00213 | .3827 | .0000 | .0041 | .0000 | .3437 | .0954 | .8258 | 62.4623 | 62.0000 | -.46 |
| 117 | .00279 | .5296 | .0000 | .0081 | .0000 | .0000 | .1710 | .7087 | 63.1710 | 63.0000 | -.17 |
| 118 | .00091 | .2278 | .0000 | .0000 | .0000 | .0000 | .0000 | .2278 | 63.3989 | 63.7500 | .35 |
| 119 | .00198 | .1187 | .0000 | .0000 | .0000 | .0000 | .0000 | .1187 | 62.5810 | 62.2000 | -.38 |

# INLET DESIGN

# CLARK ADDITION

## HYDROLOGY

2/28/96

| BASIN # | AREA (ac) | C2 * | C100 * | tc | i2 (in/hr) | i100 (in/hr) | Q2 (cfs) | Q100 (cfs) |
|---|---|---|---|---|---|---|---|---|
| A # | 3.35 | 0.44 | 0.72 | 15 | 3.83 | 7.37 | 5.69 | 17.92 |
| B # | 0.92 | 0.44 | 0.72 | 15 | 3.83 | 7.37 | 1.56 | 4.92 |
| C # | 1.15 | 0.44 | 0.72 | 15 | 3.83 | 7.37 | 1.95 | 6.15 |
| D | 4.03 | 0.48 | 0.75 | 15 | 3.83 | 7.37 | 7.47 | 22.45 |
| E | 1.33 | 0.48 | 0.75 | 15 | 3.83 | 7.37 | 2.46 | 7.41 |
| F | 0.53 | 0.48 | 0.75 | 15 | 3.83 | 7.37 | 0.98 | 2.95 |
| G | 0.18 | 0.48 | 0.75 | 15 | 3.83 | 7.37 | 0.33 | 1.00 |
| H | 0.63 | 0.48 | 0.75 | 15 | 3.83 | 7.37 | 1.17 | 3.51 |
| I | 0.60 | 0.48 | 0.75 | 15 | 3.83 | 7.37 | 1.11 | 3.34 |
| J | 1.47 | 0.48 | 0.75 | 15 | 3.83 | 7.37 | 2.72 | 8.19 |
| K | 1.90 | 0.48 | 0.75 | 15 | 3.83 | 7.37 | 3.52 | 10.59 |
| L | 1.26 | 0.48 | 0.75 | 15 | 3.83 | 7.37 | 2.33 | 7.02 |
| M | 0.40 | 0.48 | 0.75 | 15 | 3.83 | 7.37 | 0.74 | 2.23 |
| N | 0.60 | 0.48 | 0.75 | 15 | 3.83 | 7.37 | 1.11 | 3.34 |
| O | 0.58 | 0.44 | 0.72 | 15 | 3.83 | 7.37 | 0.99 | 3.10 |
| P | 0.83 | 0.48 | 0.75 | 15 | 3.83 | 7.37 | 1.54 | 4.62 |
| Q | 0.70 | 0.48 | 0.75 | 15 | 3.83 | 7.37 | 1.30 | 3.90 |
| R # | 1.15 | 0.44 | 0.72 | 15 | 3.83 | 7.37 | 1.95 | 6.15 |
| T | 0.53 | 0.48 | 0.75 | 15 | 3.83 | 7.37 | 0.98 | 2.95 |
| U | 0.53 | 0.48 | 0.75 | 15 | 3.83 | 7.37 | 0.98 | 2.95 |
| V | 1.10 | 0.48 | 0.75 | 15 | 3.83 | 7.37 | 2.04 | 6.13 |
| W | 0.86 | 0.48 | 0.75 | 15 | 3.83 | 7.37 | 1.59 | 4.79 |
| X # | 3.00 | 0.44 | 0.72 | 15 | 3.83 | 7.37 | 5.10 | 16.05 |
| Y | 0.92 | 0.48 | 0.75 | 15 | 3.83 | 7.37 | 1.70 | 5.13 |
| Z | 3.52 | 0.48 | 0.75 | 15 | 3.83 | 7.37 | 6.52 | 19.61 |
| Inflow from 16.5 SQ FT RCPHE | | | | | | | | |
| 2A | 32.00 | | 0.56 | 28 | | 5.59 | | 100.97 |
| Inflow from 3 - 8.5 SQ FT RCPH | | | | | | | | |
| 2B | 54.00 | | 0.51 | 30 | | 5.40 | | 149.91 |
| Flowing to east side drainage channel. | | | | | | | | |
| 2C # | 6.65 | | 0.72 | 15 | | 7.37 | | 35.57 |

* - Runoff coefficient "C" based on class D soils and 1/4 acre residential lots, except when noted by (#) which notes 1/2 acre lots

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Project Clark Addition

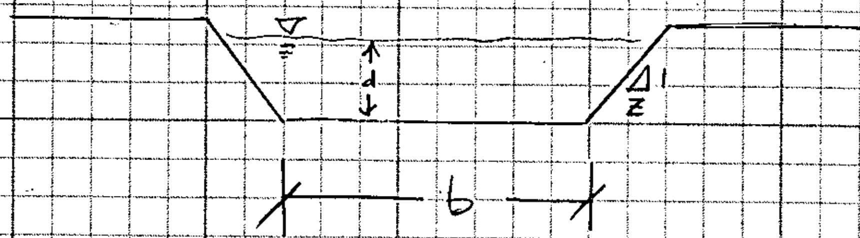
Item Drainage Channel K-96 → Clark Addition sws.

Assumptions:

Class D Vegetation

$Q_{100}$ = 115 cfs

s = .33%




TRIAL #1

b = 10'

Z = 4'

d = 2.5'

(i) $Q = \frac{1.49}{n} A R^{2/3} s^{1/2}$

$A = 2.5(10) + 10(2.5) = 50$

$P = 10 + 2(10.3) = 30.62$

$R^{2/3} = \left(\frac{A}{P}\right)^{2/3} = \left(\frac{50}{30.62}\right)^{2/3} = 1.387$

$S^{1/2} = (.0033)^{1/2} = .0574$

(ii) Solve for n chart 8

$n = \frac{R^{1/6}}{34.6 + 10.97 \log (R^{1.4} S^{.4})}$

$n = .052$

(iii) $Q_{ALLOW} = \frac{1.49}{.052}(50)(1.387)(.0574)$

$Q_{ALLOW} = 114.0$ cfs $< Q_{100}$

TOO SMALL

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Project Clark Addition

Item DRAINAGE CHANNEL K-96 → Clark Addition SWS.

TRIAL #2

$b = 12'$ $S = .33\%$
$z = 4'$
$d = 2.5'$

(i) $A = 2.5(12) + 2.5(10) = 55 \text{ ft}^2$

$P = 12 + 2(2.5^2 + 10^2)^{1/2} = 32.62 \text{ ft}$

$R = \frac{A}{P} = \frac{55}{32.62} = 1.69$

$S = .33\%$

(ii) $n = \frac{R^{1/6}}{34.6 + 19.97 \log(R^{1.4} S^{.4})} = \frac{(1.69)^{.1667}}{34.6 + 19.97 \log (1.69)^{1.4}(.0033)^{.4}}$

$n = .052$

(iii) $Q_{ALLOW} = \frac{1.49}{.052}(55)(1.69)^{2/3}(.0033)^{.5}$

$Q_{ALLOW} = 128.4 \text{ cfs} > Q_{100}$ ok ✓

(iv) $V_{ALLOW} = 6 \text{ ft/s}$ $d \approx 2.3 \text{ ft}$ $\therefore A = 2.3(12) + 2.3(9.2) = 48.76$

$V = \frac{115}{48.8} = 2.36 \text{ ft/s} < V_{ALLOW}$ ok ✓

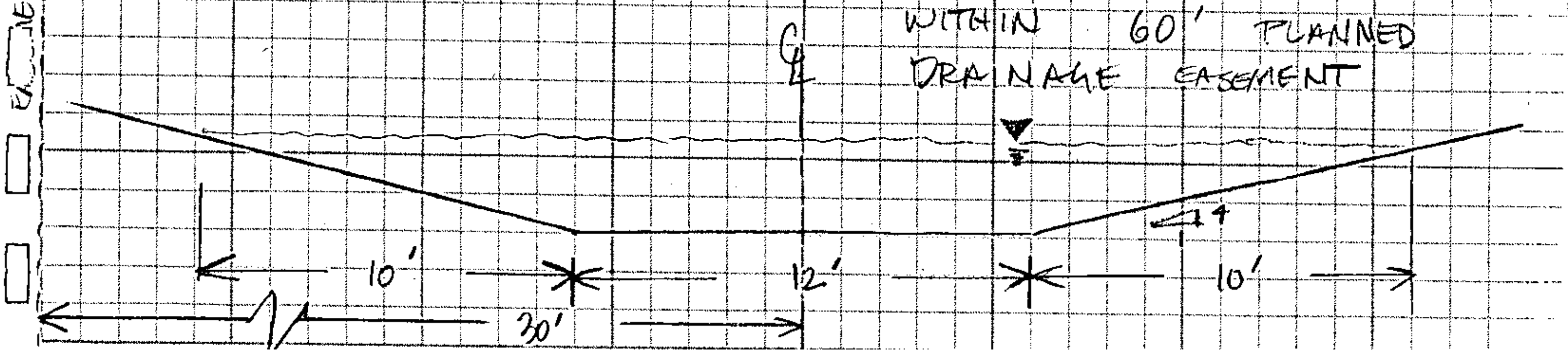
(v) ESMT REQ'D

$d + 1 = 3.3 \text{ ft}$

↑ Freeboard depth.

EASEMENT WIDTH = $12 + 2(13.2) = 38.4'$

OK ✓ CHANNEL WIDTH WITHIN 60' PLANNED DRAINAGE EASEMENT



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Project Clark Addition

Item DRAINAGE EASMENT Check for EAST CORNER,

(2B) (2C)

$Q_{100} = 149 + 35.6 = 184.6$ cfs.

Class D Vegetation

$S_{AVG}$: .8%

Current Drainage Esmt Width 60' ∴

$b = 20$
$z = 6$
$d = 2$ ft

$A = 2(20) + 2(12) = 64$

$P = 20 + 2(2^2 + 12^2)^{.5} = 44.33$

$R = \frac{A}{P} = 1.44$

$n = .048$

$Q_{ALLOW} = \frac{1.49}{.048}(64)(1.44)^{2/3}(.008)^{.5}$

$Q_{ALLOW} = 300$ cfs $> Q_{100}$

EASEMENT REQ'D
depth + Freeboard = 3 ft

EASEMENT Width = 20' + 2(18) = 56' < 60' ok ✓

$d \approx 1.5$ ft   $A = 1.5(20) + 1.5(9) = 43.5$

$V = \frac{Q}{A} = \frac{184.6}{43.5} = 4.24$ ft/s < $V_{allow}$ ok ✓

- Current & Future Drainage will remain within 60 Drainage Easement in Back YARDS of Lots 38 & 39 Block 1

# Hydrology

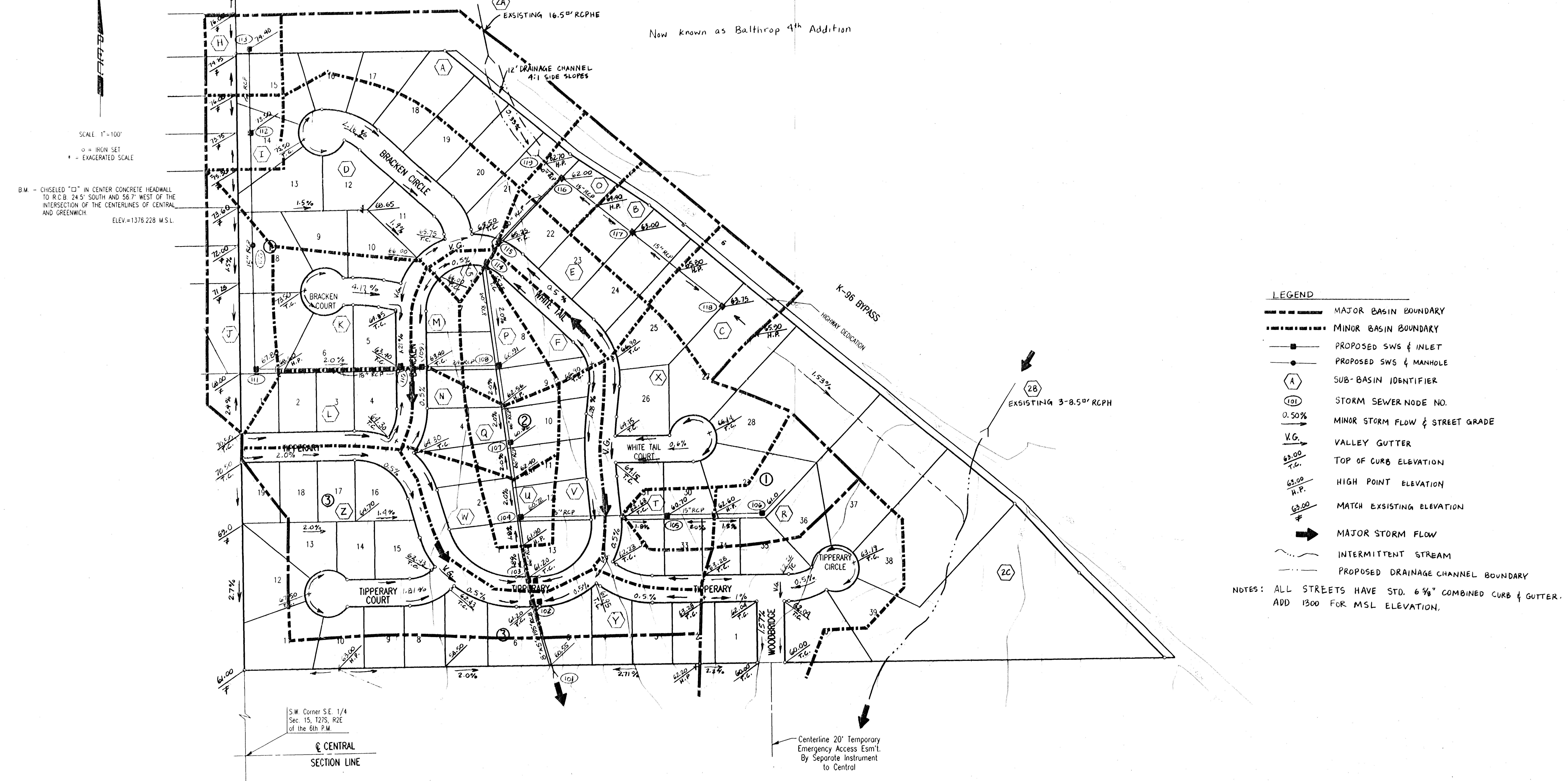
DRAINAGE PLAN

# CLARK ADDITION

TO WICHITA, SEDGWICK COUNTY, KANSAS

2-29-96

Now known as Balthrop 4th Addition




H.G. of 100 yr
Mor Ped
Detention System

Revised 10-14-99 KER