

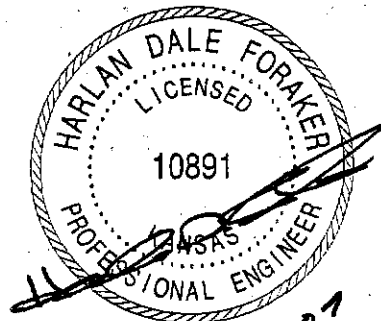
# **DRAINAGE PLAN AND SUPPORTING CALCULATIONS**

**FOR  
SUNFLOWER BROADCASTING INC. ADDITION  
2815 EAST 37<sup>TH</sup> ST. NORTH  
WICHITA, KANSAS 67219**

**PREPARED FOR:  
GARBER SURVEYING SERVICE, P.A.  
423 WEST FIRST AVENUE  
HUTCHINSON, KS 67501**

**OCTOBER 22, 2007**

**PREPARED BY:  
CERTIFIED ENGINEERING DESIGN, P.A.  
810 WEST DOUGLAS, SUITE C  
WICHITA, KANSAS 67203-6105  
(316)262-8808 PHONE  
(316)262-1669 FAX**





**Public Works, Engineering Division  
Stormwater Management Subdivision Submittal Checklist**

Reviewer: _____	Date: <u>10-22-07</u>
Subdivision Name: <u>SUNFLOWER BROADCASTING ADDITION</u>	Location: <u>2815 E. 37TH ST. NORTH</u>
Total Land Area Of Ownership: <u>25.6</u> Acres	
Type: Residential <input type="checkbox"/> Commercial <input checked="" type="checkbox"/> Industrial <input type="checkbox"/> Recreation <input type="checkbox"/> Municipal <input type="checkbox"/> Other <input type="checkbox"/>	
Applicant: <u>SUNFLOWER BROADCASTING INC</u>	Contact: <u>JOAN BARRETT</u> Phone #: <u>831-6000</u>
Engineer: <u>CERTIFIED ENG. DESIGN</u>	Contact: <u>MARLAN FORTALE</u> Phone #: <u>242-8808</u>

Please check the appropriate box:

I = Included; NA = Non-Applicable  
(If "NA" is checked, an explanation must be entered)

Tab 1. Project Narrative	Applicant			Engr	
	I	NA	Explanation / Location in Plan	I	NA
A. Site Location Map, using USGS Map				<input checked="" type="checkbox"/>	
B. Discussion of development, existing conditions, and proposed impacts on stormwater, wetland, riparian, and flood plain				<input checked="" type="checkbox"/>	
C. Discussion of offsite conditions				<input checked="" type="checkbox"/>	
D. Summary of runoff calculations (pre/post development) No increase in peak discharge for all storm series				<input checked="" type="checkbox"/>	
E. Narrative description of the type and function of the permanent best management practices that are incorporated into the site design				<input checked="" type="checkbox"/>	
F. Copy of the plat				<input checked="" type="checkbox"/>	
G. Four Corner Lot Grading plan				<input checked="" type="checkbox"/>	
H. Professional Engineer seal, signature and date (on cover of report and all pull-outs)				<input checked="" type="checkbox"/>	

Tab 2. Existing Conditions Runoff Calculations	Applicant			Engr	
	I	NA	Explanation / Location in Plan	I	NA
A. Copy of applicable digital orthophoto showing proposed project boundaries (preferable in color)				<input checked="" type="checkbox"/>	
B. Runoff Method (Rational, Hydrograph Method)				<input checked="" type="checkbox"/>	
C. Existing topography (no greater than 2-foot contours, 1-foot recommended)				<input checked="" type="checkbox"/>	
D. Total Site Area and Total Impervious Area (acres)				<input checked="" type="checkbox"/>	
E. Benchmarks used for site control				<input checked="" type="checkbox"/>	
F. Perennial and intermittent streams labeled				<input checked="" type="checkbox"/>	
G. Predominant soils from USDA soil surveys, and/or on site soil borings				<input checked="" type="checkbox"/>	
H. Boundaries of existing predominant vegetation.				<input checked="" type="checkbox"/>	
I. Location and boundaries of natural feature protection and conservation areas such as wetlands, lakes, ponds, and other setbacks (e.g., stream buffers, drinking water well setbacks, septic setbacks, etc.) with the normal water elevation noted					<input checked="" type="checkbox"/>
J. Location of existing roads, buildings, parking lots and other impervious areas				<input checked="" type="checkbox"/>	

Stormwater Management Subdivision Submittal Checklist

K. Location of existing utilities (e.g., water, sewer, gas, electric) and easements				✓	
L. Location of existing conveyance systems such as storm drains, inlets, catch basins, channels, swales, and areas of overland flow				✓	
M. Flow paths				✓	
N. Location and dimensions of existing channels, bridges or culvert crossings				✓	
O. Existing conditions hydrologic analysis for runoff rates, volumes and velocities showing methodologies used and supporting calculations (2, 5, 10, 25 & 100 year, 24-hour storm events) or Critical Duration				✓	
P. Assumed pre-developed runoff curve numbers				✓	
Q. Existing time of concentrations used in calculations				✓	
R. Existing downstream capacity			REDUCTION IN PEAK DISCHARGE		✓
S. Existing structural elevations (e.g., invert of pipes, manholes, etc.)				✓	
T. Cross-section data for open channels			IMPROVEMENTS OUTSIDE CHANNELS		✓
U. Ground water elevations (basements)			NOT AVAILABLE		✓

Tab 3. Post-Development Hydrologic Analysis	Applicant			Engr	
	I	NA	Explanation / Location in Plan	I	NA
A. Proposed (post-development) conditions hydrologic and hydraulic analysis for runoff rates, volumes, HGL, and velocities showing the methodologies used and supporting calculations for all applicable design storms (2, 5, 10, 25 & 100 year, 24-hour storm events)				✓	
B. Proposed time of concentrations used in calculations				✓	
C. Assumed post-developed runoff curve numbers				✓	
D. Proposed contours with location of drainageways				✓	
E. Final sizing calculations for stormwater controls including contributing drainage area, storage, and outlet configuration				✓	
F. Stage-storage-discharge or outlet rating curves and inflow and outflow hydrographs for storage facilities				✓	
G. Final analysis of potential upstream/downstream impact/effects of project, where necessary				✓	
H. Dam safety and breach analysis, where necessary					✓
I. Existing and proposed structural elevations (e.g., invert of pipes, manholes, etc.)				✓	
J. Design water surface elevations, normal pool elevation and pond bottoms					✓
K. Structural details and specifications of structural control designs, outlet structures, embankments, spillways, grade control structures, conveyance channels, etc.					✓
L. Proposed limits of clearing and grading					✓
M. Location of existing and proposed roads, buildings, parking lots and other impervious areas.				✓	
N. Location of existing and proposed utilities (e.g., water, sewer, gas, electric) and easements				✓	
O. Location of existing and proposed conveyance systems such as storm drains, inlets, catch basins, channels, swales, and areas of overland flow			NOT APPLICABLE		✓
P. Preliminary location and dimensions of proposed channel modifications, such as bridge or culvert crossings			"		✓
Q. Preliminary selection and location of stormwater					✓

Stormwater Management Subdivision Submittal Checklist

controls					
R. Emergency overflow structure's flow path				✓	
S. Detention facility provides one-foot of freeboard above the HWL and emergency outfall shown (top of berm elevation shown)				✓	
T. The 10-year and 100-year HWL delineated on the plan for detention pond				✓	
U. Minimum pad elevations table on the plat for structures located adjacent to channels or ponds				✓	
V. Stormwater Management Facilities located within a Reserve					✓

Tab 4. Floodplain Submittal	Applicant		Engr	
	I	NA	I	NA
A. Provide source of flood profile			✓	
B. Nearest base flood elevations			✓	
C. Delineation of pre-developed regulatory floodplain/floodway limits			✓	
D. Delineation of post-developed regulatory floodplain and floodway limits				✓
E. Floodplain boundary determination per elevation (project limits shown)				
F. Provide source of floodway data table and discharges				
G. Provide all hydrologic and hydraulic study information for site-specific floodplain studies, unnumbered Zone A area elevation determinations and flood plain map revisions				
H. Provide regulatory floodway and four natural profile models (10,50,100, and 500-yr) for existing and future watershed conditions				
I. Location of floodplain/floodway limits and relationship of site to upstream/downstream properties (floodplain limits to be per elevation and scaled location)			✓	
J. Flood plains and floodways located within a Reserve			✓	

Tab 5. Evidence of Acquisition of Applicable Federal and State Permits	Applicant		Engr	
	I	NA	I	NA
A. USACE Regulatory Program permits (401 water quality certification)				✓
B. Kansas Division of Water Resources Permit (Stream Obstruction, Channel Change, Flood Plain Fill, Levee, Water Appropriations, Dam safety permit, etc.)				✓
C. FEMA Letter of Map Changes (LOMA, LOMR, LOMR-f, CLOMR, etc.)				✓
D. Kansas Department of Wildlife and Parks				✓
E. Kansas Department of Transportation				✓
F. United States Fish & Wildlife				✓
G. Environmental Protection Agency				✓

Stormwater Management Subdivision Submittal Checklist

Tab 6. Other	Applicant			Engr	
	I	NA	Explanation / Location in Plan	I	NA
A. Evidence of acquisition of all necessary legal agreements (e.g., easements, covenants, land trusts, etc.)					✓
B. Maintenance of stormwater management facility specified in the platters text as the responsibility of the Homeowner or Business Association			1 LOT PLAT BY HOMEOWNER		✓
C. CD of drainage plan in PDF format (one file)				✓	

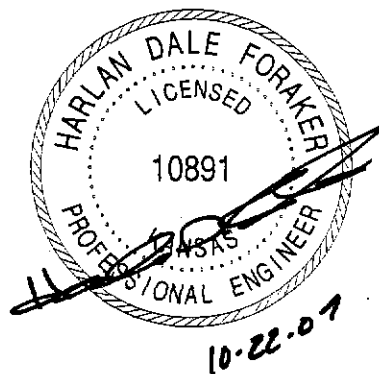
# **DRAINAGE PLAN AND SUPPORTING CALCULATIONS**

**FOR  
SUNFLOWER BROADCASTING INC. ADDITION  
2815 EAST 37<sup>TH</sup> ST. NORTH  
WICHITA, KANSAS 67219**

**PREPARED FOR:  
GARBER SURVEYING SERVICE, P.A.  
423 WEST FIRST AVENUE  
HUTCHINSON, KS 67501**

**OCTOBER 22, 2007**

**PREPARED BY:  
CERTIFIED ENGINEERING DESIGN, P.A.  
810 WEST DOUGLAS, SUITE C  
WICHITA, KANSAS 67203-6105  
(316)262-8808 PHONE  
(316)262-1669 FAX**



Sunflower Broadcasting Inc. Drainage Plan(Con't)  
Ms. Vicki Huang, P.E.  
September 22, 2007

**CERTIFIED ENGINEERING DESIGN, P.A**  
810 West Douglas, Suite C  
Wichita, KS 67203-6105  
(316)262-8808 Office  
(316)262-1669 Fax

## **LETTER OF TRANSMITTAL**

DATE: October 22, 2007

TO: Ms. Vicky Huang, P.E.  
Engineering Division  
455 North Main  
Wichita, KS 67202

RE: Drainage Plan  
Sunflower Broadcasting Inc. Addition  
Wichita, KS

FROM: Harlan D. Foraker, P.E.

### **I. PROJECT NARRATIVE**

The site is located west of Hillside Avenue on the south side of 37<sup>th</sup> Street North at an address of 2815 East 37<sup>th</sup> Street North and is currently developed with a commercial building, parking lots, lawn grass cover and a few trees on the property. The predominant SCS soil type present within Sunflower Broadcasting Inc. Addition are Elandco Silt Loam which is a SCS Type B and Farnum Loam which is a SCS Type B Soil.

### **II. EXISTING CONDITIONS RUNOFF CALCULATIONS**

The rational method will be used to determine the peak discharges from the subareas of the study area. Rational 'C' Factors were assigned to the existing site and proposed improvements from "Interim Drainage and Storm Sewer Policy for Design Criteria and Documentation" for the City of Wichita, Kansas.

The rainfall intensity tables for the Sedgwick County, Kansas which were obtained from the Kansas Department of Transportation were utilized to determine the rainfall intensity for the 5 and 100 year design storms.

The Soil Conservation Service TR-55 manual was used to compute the Time of Concentration for the drainage subareas. A design assumptions was made as follows that the minimum subarea time of concentration is 15 minutes

Sunflower Broadcasting Inc. Drainage Plan(Con't)

Ms. Vicki Huang, P.E.

September 22, 2007

Soil types were determined from the SCS Soil Survey for Sedgwick County, Kansas.

The developed drainage subareas have been delineated on the 1" = 60' site and topographic mapping survey performed for this site.

Design Storm Events Evaluated: 2, 5, 10, 25, 50 and 100 yr. storm events

The runoff calculations for the proposed building addition and parking lot addition have been completed utilizing the 5 year storm. A check of the drainage system has been made using the 100 year storm event.

The following tables summarize the peak discharges for existing conditions for three subbasins which have been identified within Sunflower Broadcasting Addition which have a total area of 25.6 acres.

EXISTING PEAK RUNOFF					
Description	C	Tc	I	Area	Q(cfs)
Existing SubArea 1(2 yr.)	.16	15	3.80	8.86	5.4
Existing SubArea 1(5 yr.)	.18	15	4.62	8.86	7.4
Existing SubArea 1(10 yr.)	.24	15	5.21	8.86	11.1
Existing SubArea 1(25 yr.)	.30	15	6.06	8.86	16.1
Existing SubArea 1(50 yr.)	.35	15	6.73	8.86	20.9
Existing SubArea 1(100 yr.)	.37	15	7.40	8.86	24.3
Existing SubArea 2(2 yr.)	.16	15	3.80	10.3	6.3
Existing SubArea 2(5 yr.)	.18	15	4.62	10.3	8.6
Existing SubArea 2(10 yr.)	.24	15	5.21	10.3	12.9
Existing SubArea 2(25 yr.)	.30	15	6.06	10.3	18.7
Existing SubArea 2(50 yr.)	.35	15	6.73	10.3	24.3
Existing SubArea 2(100 yr.)	.37	15	7.40	10.3	28.2
Existing SubArea 3(2 yr.)	.16	15	3.80	6.55	4.0
Existing SubArea 3(5 yr.)	.18	15	4.62	6.55	5.4
Existing SubArea 3(10 yr.)	.24	15	5.21	6.55	8.2
Existing SubArea 3(25 yr.)	.30	15	6.06	6.55	11.9
Existing SubArea 3(50 yr.)	.35	15	6.73	6.55	15.4
Existing SubArea 3(100 yr.)	.37	15	7.40	6.55	17.9

The storm runoff from the existing site drains in a manner which is depicted on the attached site drainage plan.

### III. POST DEVELOPMENT HYDROLOGIC ANALYSIS

Design Storm Events Evaluated: 2, 5, 10, 25, 50 and 100 yr. storm events

The runoff calculations for the street, drainage channel design, drainage pipe design and detention pond storage have been completed utilizing the 5 year

Sunflower Broadcasting Inc. Drainage Plan(Con't)

Ms. Vicki Huang, P.E.

September 22, 2007

storm. A check of the drainage system has been made using the 100 year storm event.

Storm sewer was analyzed for full flow conditions was using "Flowmaster" by Haestad Methods Inc.

A detention analysis shall be performed in conjunction with design of the site grading plan during preparation of construction documents using the computer program by Hydraflow Hydrographs by Intellisolve.

The following tables summarize the peak discharges for developed conditions for three subbasins within the Sunflower Broadcasting Inc. Addition which have a total area of 25.6 acres.

PEAK RUNOFF FOR DR. AREA 2					
PROPOSED SITE IMPROVEMENTS					
AREA = 1.25 acres					
Description	C	Tc	I	Area	Q(cfs)
Existing SubArea 2(2 yr.)	.16	15	3.80	1.25	0.73
Existing SubArea 2(5 yr.)	.18	15	4.62	1.25	1.04
Existing SubArea 2(10 yr.)	.24	15	5.21	1.25	1.56
Existing SubArea 2(25 yr.)	.30	15	6.06	1.25	2.27
Existing SubArea 2(50 yr.)	.35	15	6.73	1.25	2.95
Existing SubArea 2(100 yr.)	.37	15	7.40	1.25	3.42
Improved SubArea 2(2 yr.)	.26	15	3.80	1.25	1.23
Improved SubArea 2(5 yr.)	.27	15	4.62	1.25	1.56
Improved SubArea 2(10 yr.)	.33	15	5.21	1.25	2.15
Improved SubArea 2(25 yr.)	.38	15	6.06	1.25	2.88
Improved SubArea 2(50 yr.)	.43	15	6.73	1.25	3.62
Improved SubArea 2(100 yr.)	.45	15	7.40	1.25	4.16

There area no improvements proposed within Drainage Area 1 and 3 and subsequently there will be no change in the peak discharges from the previously computed peak runoff conditions. The parking lot and building improvements are proposed within Drainage Area 1 but will only add 1.25 acres of impervious area to Drainage Area 2. The existing surface conditions from Area 2 was assigned an existing rational c factor of 0.18 for the 5 year return period and a c faction of 0.37 for the 100 year return period. If 1.25 acres of existing turf is converted to roof and parking lot the 'c' factor is increased from 0.18 to 0.88 for the 5 year event and from 0.37 to 0.90 for the 100 year event. The new weighted 'c' factors for the proposed 1.25 acres of site improvements have been computed and are presented with the improved peak discharges in the table above.

The existing peak discharge from the 1.25 acres within Drainage Area 2 is 1.05 cubic feet per second(cfs) for the 5 year return period. The developed or improved discharge from the 1.25 acres withing Drainage Area 2 is 1.57 cfs for the 5 year return period. The proposed improvements result in an increase of 0.52 cfs for Drainage Area 2. The existing peak discharge from Drainage Area 2 is 3.48 cubic feet per second(cfs) for the 100 year return period. The developed or improved discharge from Drainage Area 2 is

Sunflower Broadcasting Inc. Drainage Plan(Con't)

Ms. Vicki Huang, P.E.

September 22, 2007

4.24 cfs for the 100 year return period. The proposed improvements result in an increase of 0.76 cfs for the proposed site improvements Drainage Area 2. As Drainage previously mentioned Area 1 and 3 result in no increase in peak runoff.

A small shallow detention storage pond is proposed on the east side of the new parking lot. The dimensions of the proposed detention pond is 20' x 390' with depth of one(1) foot. The detention pond will collect runoff from the proposed improvements as it discharges from the parking lot and discharge runoff from the south end where a 10' weir will be constructed. The impact of the detention pond is to reduce the 5 year developed peak runoff from 1.57 cfs to 0.80 cfs at a depth in the pond of . The existing 5 year peak discharge is 1.05 cfs. The proposed detention pond will reduce the 100 year peak developed runoff from 4.24 cfs to 2.63 cfs. The existing 100 year peak discharge is 3.48 cfs. The proposed detention pond will control peak developed runoff from the proposed parking lot and building improvement area.

**IV. FLOODPLAIN SUBMITTAL** – A FEMA floodplain map is attached in the appendix and the floodway and floodplain is depicted on the drainage plan. A parking lot and building addition are proposed within the floodway fringe area. The floodway and floodplain are depicted on the attached drainage plan. The existing finished floor has been determined to be 1343.09. The new building addition finished floor is proposed to be constructed to an elevation of 1343.09. The 100 year Base Flood Elevation is 1341 for the location of the proposed building addition.

**V. FEDERAL, STATE AND LOCAL PERMITS**

- A. US Army Corp of Engineers-Not Applicable  
Kansas Dept. of Agriculture-Not required per Dan Garber discussion with Scott Lindebak. Local jurisdiction can be exercised.
- B. FEMA-Not Applicable
- C. Kansas Department of Transportation-Not Applicable
- D. Sedgwick County Right-of-Way Permit-Not Applicable

**VII. APPENDIX I:**

All charts, graphs, tables including a 1"=60' scale drainage plan map are included for review.

**VIII. SUMMARY DISCUSSION:**

A summary discussion of the existing peak discharge and developed peak discharge from the proposed development area and the developed peak discharge has been previously presented.

PROJECT: SUNFLOWER BROADCASTING

DATE 10-22-07

LOCATION: 2815 East 37th St. North

BY HOF CKD

CLIENT: \_\_\_\_\_

JOB NO. \_\_\_\_\_ SHEET NO. \_\_\_\_\_ OF \_\_\_\_\_

WEIGHTED RUNOFF COEFFICIENT FOR 1.25 ACRES IN SUBAREA 2  
8.86 - 1.25 = 7.61

$$\underline{C_2} \quad \frac{0.16(7.61) + .87(1.25)}{8.86} = 0.26$$

$$\underline{C_5} \quad \frac{0.18(7.61) + .87(1.25)}{8.86} = 0.27$$

$$\underline{C_{10}} \quad \frac{0.24(7.61) + .88(1.25)}{8.86} = 0.33$$

$$\underline{C_{25}} \quad \frac{0.30(7.61) + .88(1.25)}{8.86} = 0.38$$

$$\underline{C_{50}} \quad \frac{0.35(7.61) + .89(1.25)}{8.86} = 0.43$$

$$\underline{C_{100}} \quad \frac{0.37(7.61) + .89(1.25)}{8.86} = 0.45$$

# Hydrograph Plot

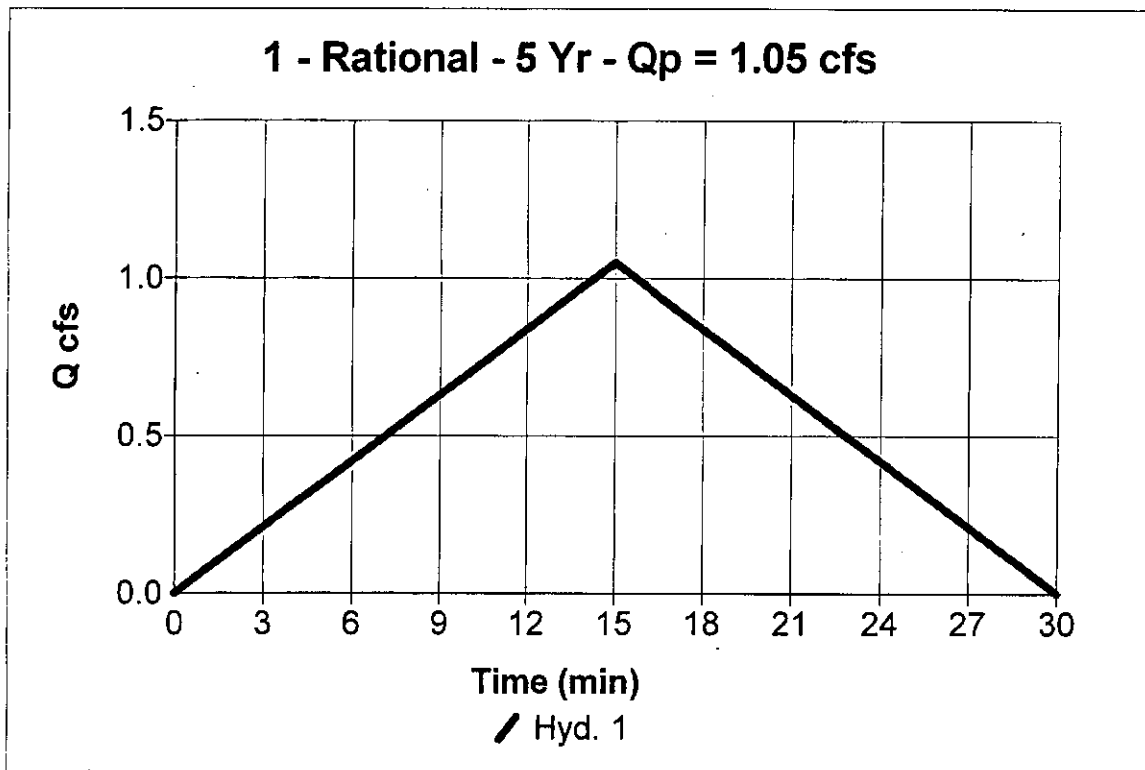
Hydraflow Hydrographs by Intelisolve

## Hyd. No. 1

Existing Dr. Area

Hydrograph type	= Rational	Peak discharge	= 1.05 cfs
Storm frequency	= 5 yrs	Time interval	= 1 min
Drainage area	= 1.3 ac	Runoff coeff.	= 0.18
Intensity	= 4.663 in/hr	Time of conc. (Tc)	= 15 min
IDF Curve	= SedgwickCountyKSRAINii.idf	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 944 cuft



# Hydrograph Plot

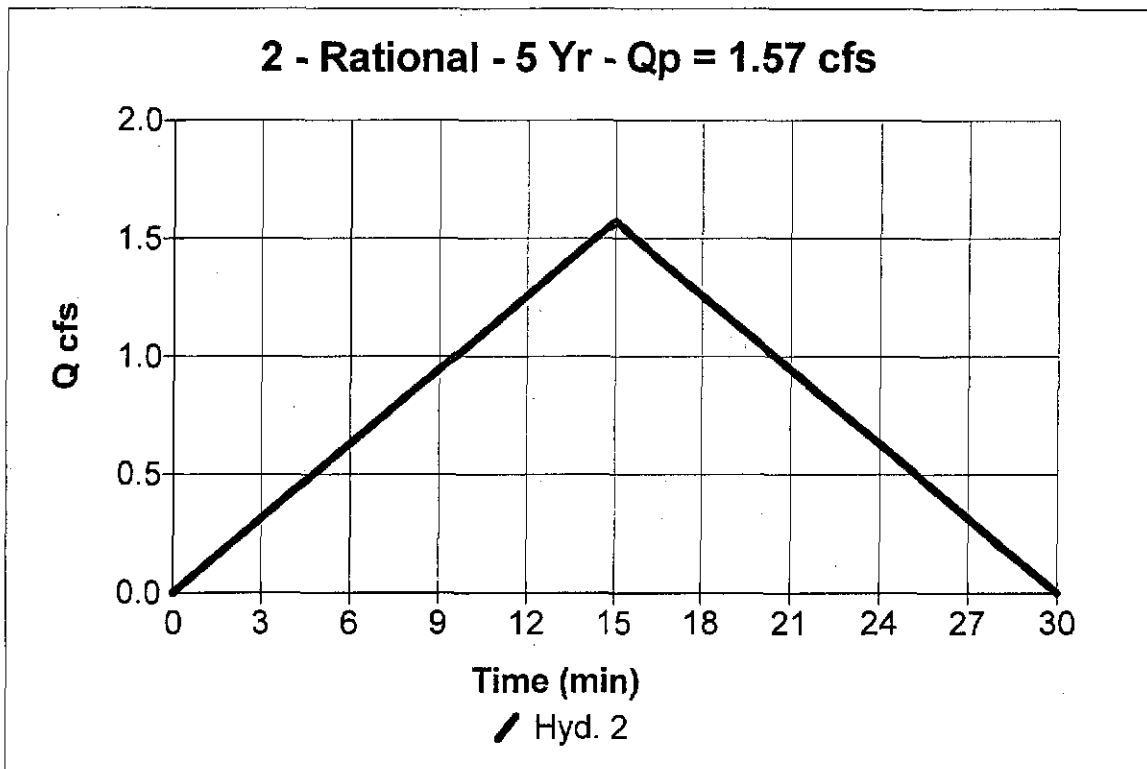
Hydraflow Hydrographs by Intelisolve

## Hyd. No. 2

Improved Dr. Area

Hydrograph type	= Rational	Peak discharge	= 1.57 cfs
Storm frequency	= 5 yrs	Time interval	= 1 min
Drainage area	= 1.3 ac	Runoff coeff.	= 0.27
Intensity	= 4.663 in/hr	Time of conc. (Tc)	= 15 min
IDF Curve	= SedgwickCountyKSRainii.idf	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 1,416 cuft



# Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

## Hyd. No. 3

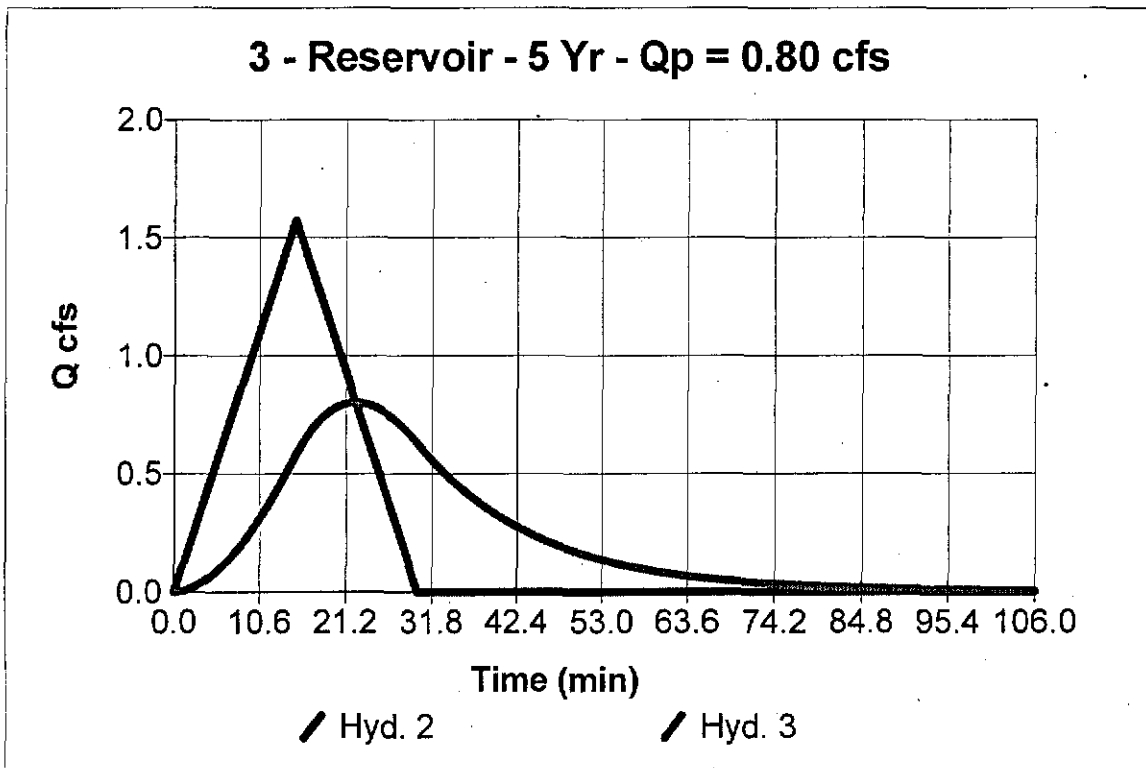
Shallow Det. Pond

Hydrograph type = Reservoir  
Storm frequency = 5 yrs  
Inflow hyd. No. = 2  
Max. Elevation = 1340.08 ft

Peak discharge = 0.80 cfs  
Time interval = 1 min  
Reservoir name = Pr. Pond East o  
Max. Storage = 722 cuft

Storage Indication method used.

Hydrograph Volume = 1,415 cuft



# Hydrograph Plot

Hydraflow Hydrographs by Intellisolve

## Hyd. No. 3

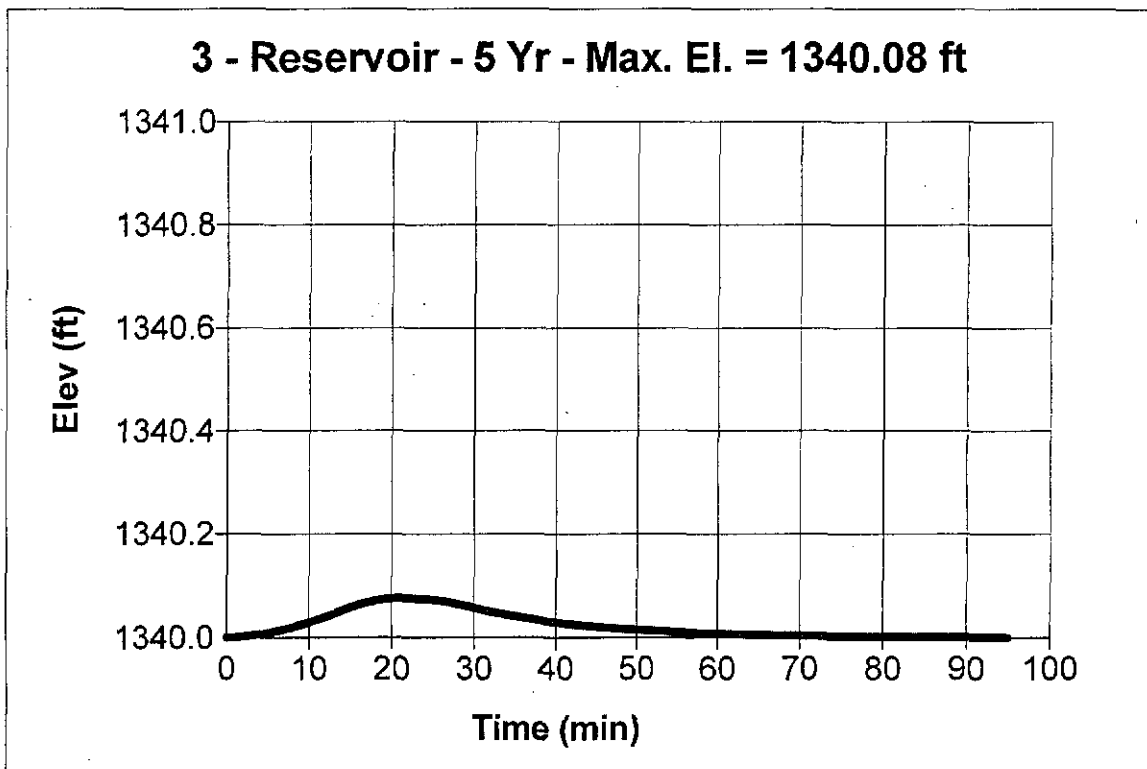
Shallow Det. Pond

Hydrograph type = Reservoir  
Storm frequency = 5 yrs  
Inflow hyd. No. = 2  
Max. Elevation = 1340.08 ft

Peak discharge = 0.80 cfs  
Time interval = 1 min  
Reservoir name = Pr. Pond East o  
Max. Storage = 722 cuft

Storage Indication method used.

Hydrograph Volume = 1,415 cuft



# Hydrograph Plot

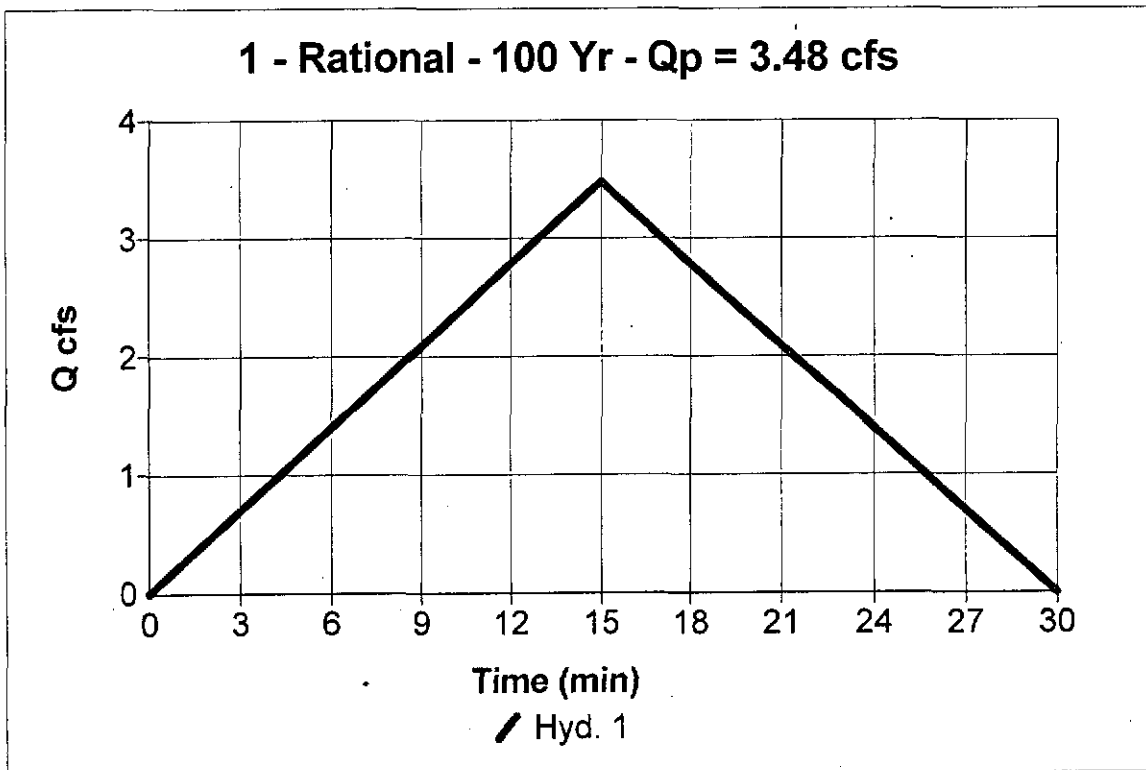
Hydraflow Hydrographs by Intelisolve

## Hyd. No. 1

Existing Dr. Area

Hydrograph type	= Rational	Peak discharge	= 3.48 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 1.3 ac	Runoff coeff.	= 0.37
Intensity	= 7.533 in/hr	Time of conc. (Tc)	= 15 min
IDF Curve	= SedgwickCountyKSRAINii.idf	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 3,136 cuft



# Hydrograph Plot

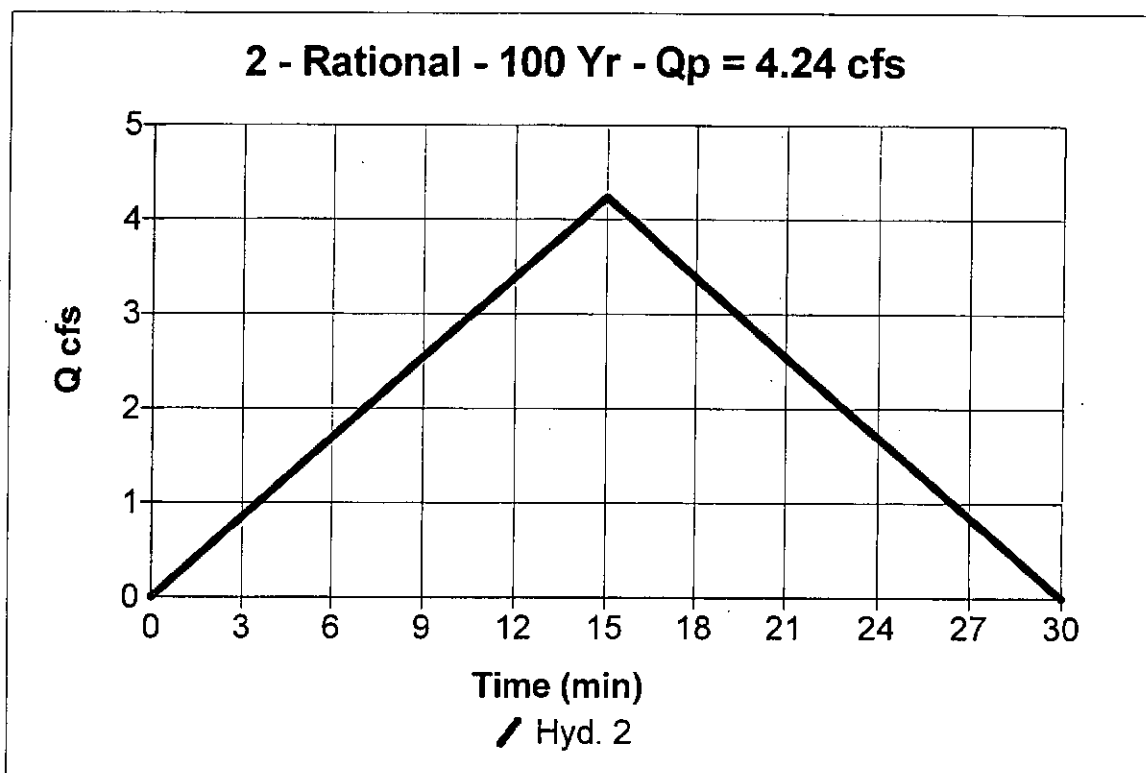
Hydraflow Hydrographs by Intelisolve

## Hyd. No. 2

Improved Dr. Area

Hydrograph type	= Rational	Peak discharge	= 4.24 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 1.3 ac	Runoff coeff.	= 0.45
Intensity	= 7.533 in/hr	Time of conc. (Tc)	= 15 min
IDF Curve	= SedgwickCountyKSRAINii.idf	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 3,814 cuft



# Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

## Hyd. No. 3

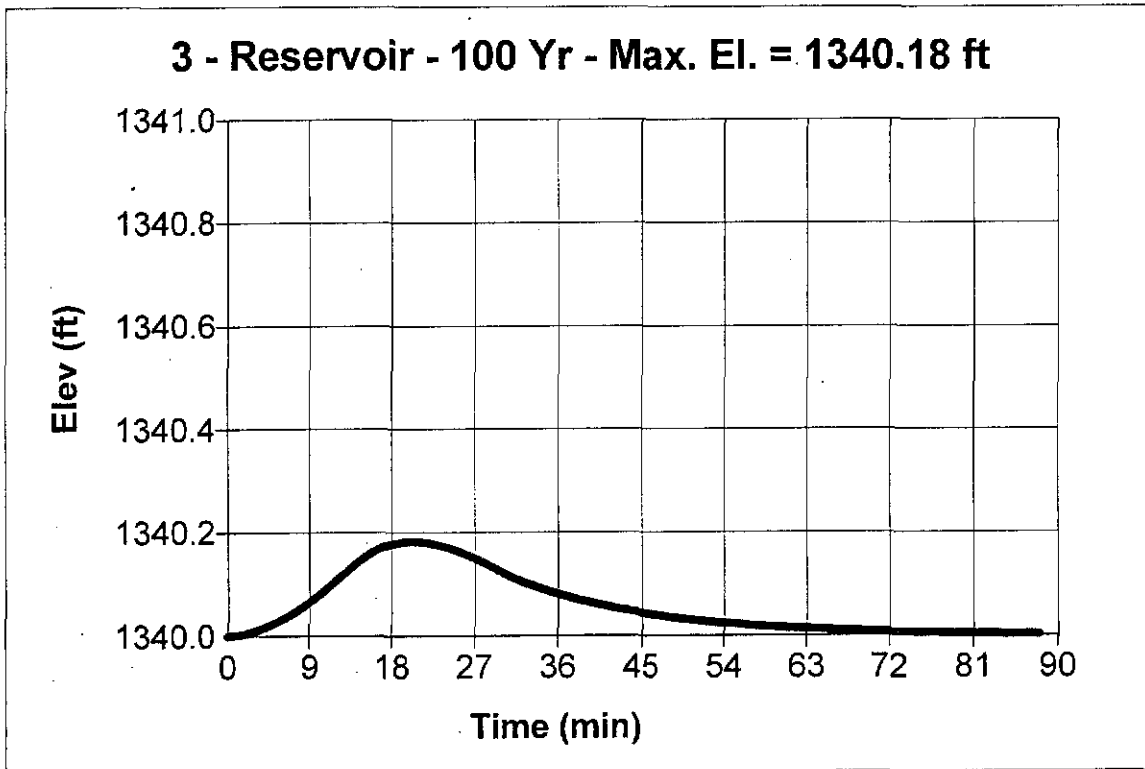
Shallow Det. Pond

Hydrograph type = Reservoir  
Storm frequency = 100 yrs  
Inflow hyd. No. = 2  
Max. Elevation = 1340.18 ft

Peak discharge = 2.63 cfs  
Time interval = 1 min  
Reservoir name = Pr. Pond East o  
Max. Storage = 1,721 cuft

Storage indication method used.

Hydrograph Volume = 3,813 cuft



# Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

## Hyd. No. 3

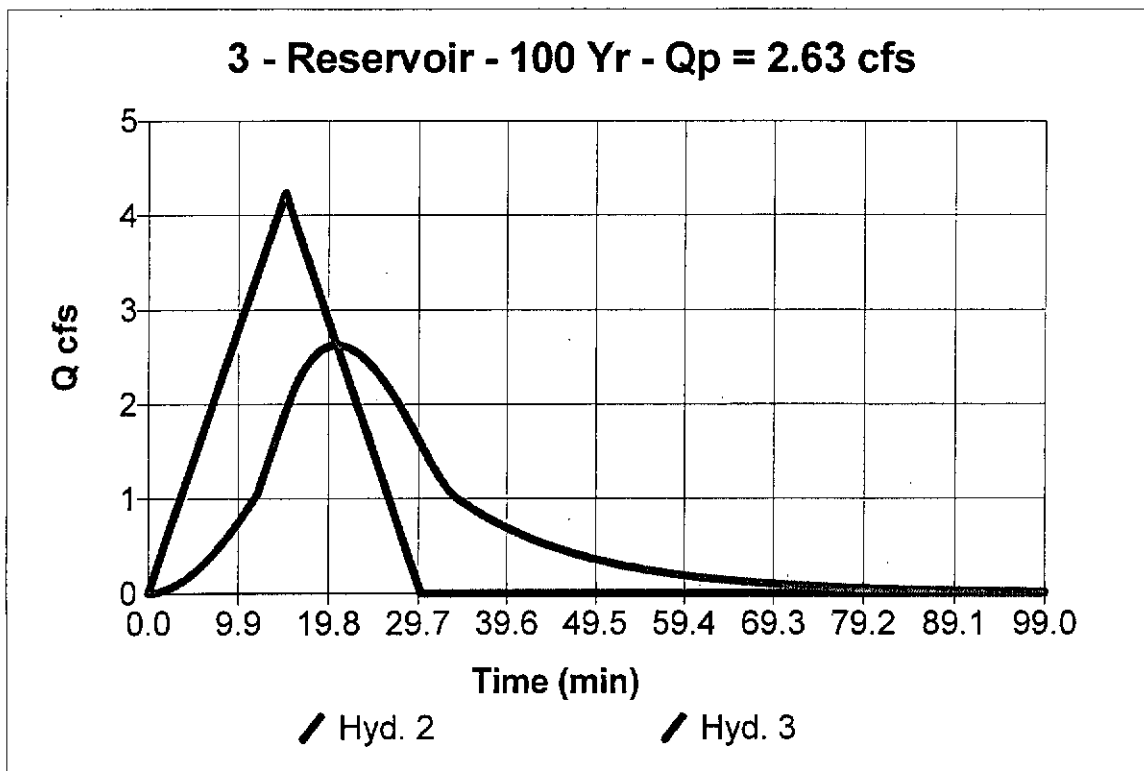
Shallow Det. Pond

Hydrograph type = Reservoir  
Storm frequency = 100 yrs  
Inflow hyd. No. = 2  
Max. Elevation = 1340.18 ft

Peak discharge = 2.63 cfs  
Time interval = 1 min  
Reservoir name = Pr. Pond East o  
Max. Storage = 1,721 cuft

Storage Indication method used.

Hydrograph Volume = 3,813 cuft



# Reservoir Report

Reservoir No. 1 - Pr. Pond East of Lot

Hydraflow Hydrographs by Intelisolve

## Pond Data

Pond storage is based on known contour areas. Average end area method used.

### Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	1340.00	7,791	0	0
1.00	1341.00	11,132	9,462	9,462

### Culvert / Orifice Structures

	[A]	[B]	[C]	[D]
Rise in	= 0.0	0.0	0.0	0.0
Span in	= 0.0	0.0	0.0	0.0
No. Barrels	= 0	0	0	0
Invert El. ft	= 0.00	0.00	0.00	0.00
Length ft	= 0.0	0.0	0.0	0.0
Slope %	= 0.00	0.00	0.00	0.00
N-Value	= .000	.000	.000	.000
Orif. Coeff.	= 0.00	0.00	0.00	0.00
Multi-Stage	= n/a	No	No	No

### Weir Structures

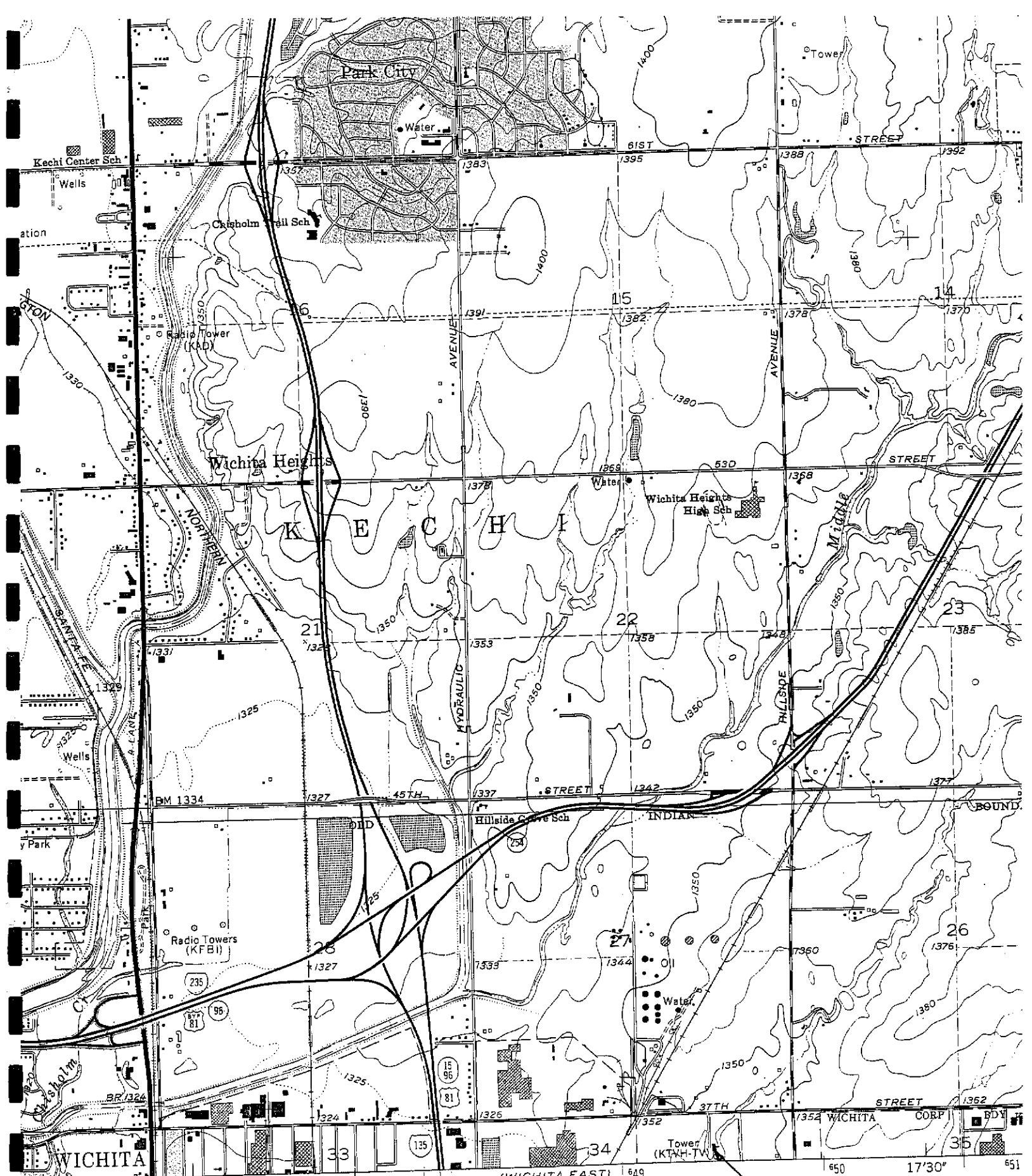
	[A]	[B]	[C]	[D]
Crest Len ft	= 10.00	0.00	0.00	0.00
Crest El. ft	= 1340.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	0.00	0.00	0.00
Weir Type	= Rect	---	---	---
Multi-Stage	= No	No	No	No

Exfiltration Rate = 0.00 in/hr/sqft Tailwater Elev. = 0.00 ft

Note: All outflows have been analyzed under inlet and outlet control.

### Stage / Storage / Discharge Table

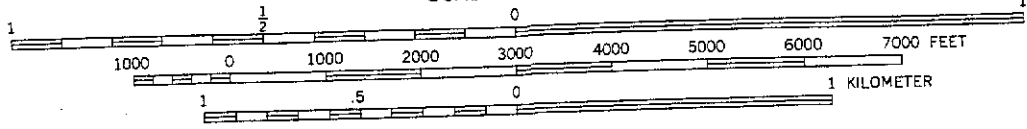
Stage ft	Storage cuft	Elevation ft	Civ A cfs	Civ B cfs	Civ C cfs	Civ D cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Total cfs
0.00	0	1340.00	---	---	---	---	0.00	---	---	---	---	0.00
1.00	9,462	1341.00	---	---	---	---	33.30	---	---	---	---	33.30



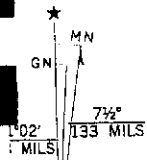
20 SOUTH WICHITA INTERCHANGE 11 MIL

(WICHITA EAST) 6559 III NE

SCALE 1:24 000

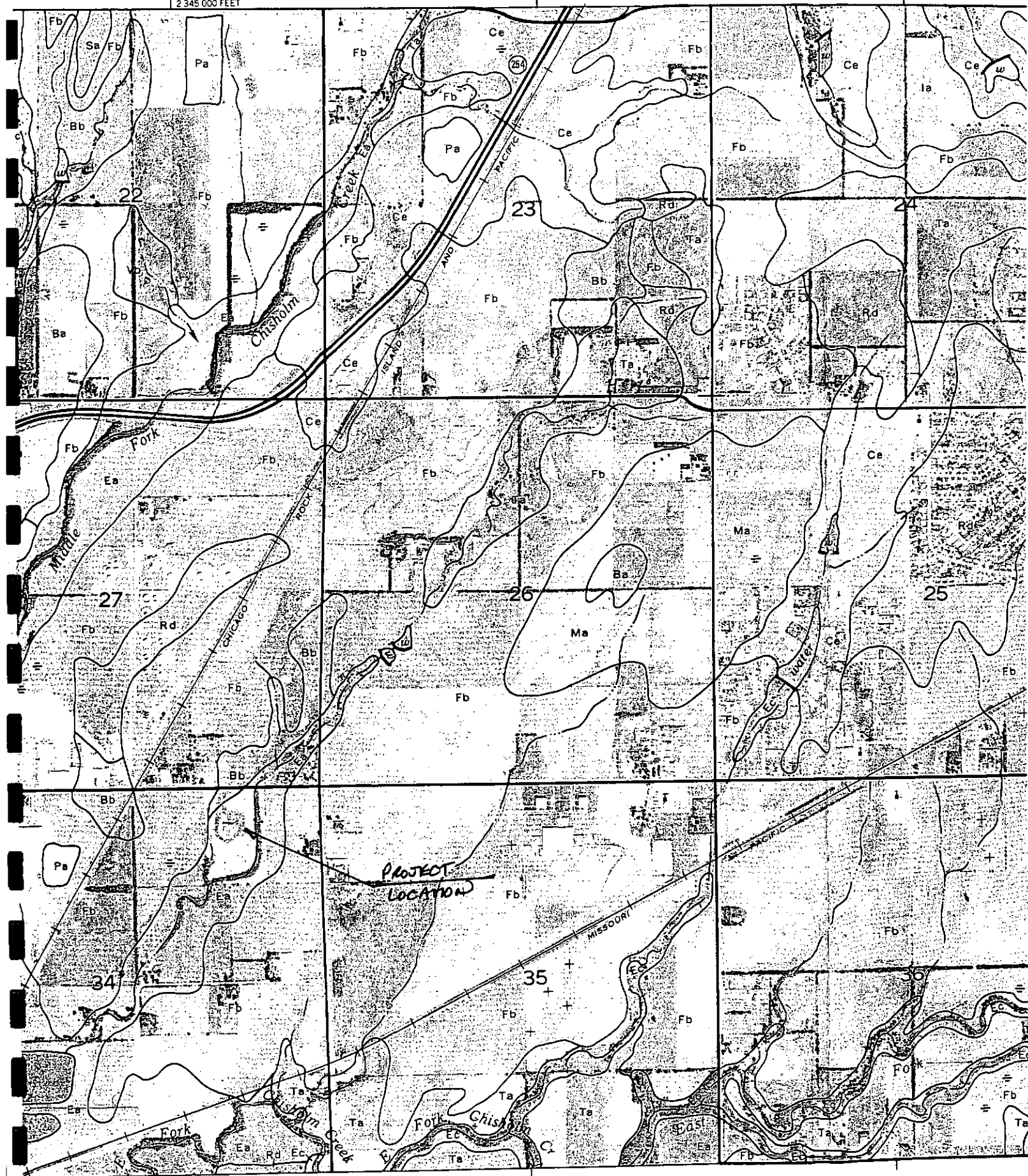


CONTOUR INTERVAL 10 FEET  
 DOTTED LINES REPRESENT 5-FOOT CONTOURS  
 DATUM OF 1929



*PROJECT LOCATION*

2 345 000 FEET





INTERIM DRAINAGE AND STORM SEWER POLICY  
FOR  
DESIGN CRITERIA AND DOCUMENTATION

CITY OF WICHITA, KANSAS

Policy Statement

The objectives of this policy statement are to provide needed order to drainage planning and design in the Wichita region, to improve the urban environment, and to provide a sound basis for the expenditure of future drainage funds.

Planning and design of drainage systems will not be based on the premise that problems can be transferred from one location to another or that existing problems can be compounded. Drainage facilities cannot be properly designed using a piecemeal approach. Consideration must be given to upstream, downstream and adjacent basins with potential for their ultimate development.

Every urban area has four separate and distinct drainage systems: (1) is the major system which frequently consists of open channels and may include storage areas in the channels or in ponds; (2) is the initial system which usually consists of a closed conduit with area inlets and curb inlets; (3) is paved streets which are used to convey runoff from individual lots to the initial system; and (4) is proper individual lot grading to convey runoff from the lot to the paved street and/or area inlets. Obviously the primary function of streets is to convey traffic and drainage must be considered secondary in varying degrees to traffic needs.

Desired control of runoff can only be achieved with proper design of the previously identified four systems. Properly designing only one or two of the four distinct systems, while ignoring the others, guarantees construction of intolerable drainage problems much like what exists in certain areas of the City today. Solutions to such problems always require additional expenditures of considerable funds. When proper design considerations are given to the four distinct systems from the beginning, functional systems can be installed with minimum costs.

Great latitude has been permitted in the design of drainage improvements in the past. Past experience documents a need for uniformity in criteria, methodology, and documentation in drainage design. This can only come about with a written policy statement specifying acceptable criteria, acceptable procedures, and required documentation.

Development of such criteria, acceptable procedures, and required documentation is not perceived to be a unilateral decision by any one person but a policy to be developed by general consensus of those professionals with expertise who are willing to provide input into a working interim policy which then can be developed to fit the needs experienced in our City. Development of such a policy in such a manner requires a point of beginning. This document and the information contained herein is to be considered as that beginning point. Feedback from professionals directly involved with drainage design in the City is desired and expected.

All documentation submitted shall include identification of project, project number, consultant, employee performing and/or submitting computations for approval, system type, and return frequency of the design storm. Drainage documentation submittals shall either include indexes or be separated into related sections with tabs identifying subject covered by the section. The first sheet of all drainage documentation submittals shall be sealed by the seal of the licensed professional engineer having responsible charge for the information contained in the submittal.

RECEIVED JUN 13 1988

General Drainage Information

Several existing manuals concerning drainage criteria, methodology, and documentation have been reviewed with regards to suitability for a basis for development of such a manual applicable in all respects to the City of Wichita. The manual selected as most appropriate for adoption as a point of beginning is entitled "~~Design of Urban Storm Drainage~~", prepared by Reitz and Jens, Inc., Consulting Engineers, under the sponsorship of the United States Department of Transportation, reprinted in April, 1980. The manual also includes identification as FHWA-TS-79-225. This manual shall be identified as ~~Manual No. 1~~ for purposes of discussion in this policy statement.

Design procedures, nomenclature, documentation, and tabulation of results shall conform to that which is presented in Manual No. 1 except as otherwise herein modified and/or expanded.

Another manual used as reference material is entitled "~~Drainage of Highway Pavements~~" and was prepared by Tye Engineering, Inc. also under the sponsorship of the United States Department of Transportation, dated March, 1984. This manual also includes identification as Highway Engineering Circular No. 12, FHWA-TS-84-202. When reference is to be made to this manual in this policy statement, the manual will be identified as ~~Manual No. 2~~.

Such manuals are available from the National Technical Information Service, Springfield, Virginia 22161.

Supplementary Information to Manual No. 1

The following statements provide supplementary information to Manual No. 1 as indicated:

A. List of Symbols Comments and Modifications

1. Symbols used in drainage calculations and tabulations shall conform to the list of symbols shown on pages III, IV, V, VI, VII and VIII of the manual. Symbols used in calculations and tabulations which are not shown on this list shall be clearly identified in the calculations or tabulations. All drainage calculations shall be performed using English units of measurement and City of Wichita elevation datum. City of Wichita datum equals U.S.G.S. datum minus 1,187.4 feet.

B. Chapter 1 Comments and Modifications - "General Principles of Stormwater Design"

1. Narrative in Chapter 1 shall be considered as background information and not necessarily adopted City of Wichita policy. The City of Wichita does not presently require treatment of storm water sewer discharges. Consultants are encouraged, however, to incorporate measures in all projects which will reduce pollution especially from soil erosion.

Frequently drainage design will be developed with projects administered by other governmental agencies. Such drainage shall be developed in conformance with the governmental agencies' criteria having administrative control if such criteria is equal to or more stringent than adopted City of Wichita criteria.

General drainage criteria in the City of Wichita shall be as identified in the following tables for the initial storm:

TABLE I

INITIAL DESIGN STORM FREQUENCY

<u>Land Use</u>	<u>Initial Design Storm Return Period</u>
1. Residential and Public Park Areas	2 years
2. General Commercial Areas	5 years
3. Public Building Areas	5 years
4. Industrial Areas	5 years
5. High Value Downtown Business Areas	5 years
6. Major Airport Terminal Areas	5 years

TABLE II

ALLOWABLE PAVEMENT ENCROACHMENT FOR INITIAL DESIGN STORM

<u>Street Classification</u>	<u>Allowed Encroachment</u>
1. Local	No curb overtopping. Flow may spread across crown.
2. Collector	No curb overtopping. One 8' lane width must be free of water.
3. Arterial	No curb overtopping. One 8' through lane width in each direction must be free of water.
4. Expressways and Freeways	No curb overtopping. Encroachment permitted in not more than one through lane width in each direction. <i>was compatible</i>

An additional requirement to the initial system criteria is that the runoff from the 100-year frequency major storm for time of concentrations identical to the initial system design must be retained within public rights-of-way in all cases. This 100-year frequency major storm requirement must be evaluated for projects in existing developed areas and when identified as prohibitive because of estimated costs, the consultant shall provide criteria recommendations to the City Engineer for such projects which will provide a reasonable cost/benefit ratio for the project.

C. Chapter 2 Comments and Modifications ~~"Precipitation"~~

1. Precipitation intensity for the various durations and frequencies shall be as shown in the table attached to this document and identified as "Attachment A". When intensities are required for durations not shown in the table in the range between 2-hour and 24-hour durations, such intensities shall be computed as straight line interpolations.

RECEIVED JUN 13 1968

D. Chapter 3 Comments and Modifications [REDACTED]

- 1. Interception by vegetation is not a required consideration.
- 2. Infiltration loss on pervious surfaces shall be considered in those cases where such losses become significant. Infiltration loss for pervious surfaces for use with the S.C.S. dimensionless unit hydrograph method shall conform to the table attached to this document and identified as "Attachment B". Infiltration losses are included in the coefficients of runoff provided for use with the modified rational method.

Logic and documentation of infiltration losses shall be provided in writing when final drainage computations are submitted to the City Engineer, or his authorized representative, for approval.

- 3. Depression storage loss shall be considered in those cases where such losses become significant. Depression storage loss for pervious and impervious surfaces for use with the S.C.S. dimensionless unit hydrograph method shall conform to the table attached to this document and identified as "Attachment C". Depression storage losses are included in the coefficients of runoff provided for use with the modified rational method.

Logic and documentation of depression storage losses shall be provided in writing when final drainage computations are submitted to the City Engineer, or his authorized representative, for approval.

- 4. Reduction for gutter storage shall be taken into account where such storage is a significant factor. Logic and documentation of gutter storage shall be provided in writing when final drainage computations are submitted to the City Engineer, or his authorized representative, for approval. Use of this reduction will be by specific approval from the City Engineer, or his authorized representative, on a case-by-case basis.

- 5. Reduction of peak flow rate due to conduit storage will not usually be a consideration. Use of this reduction may be a significant factor where large conduits are required. Use of this reduction will be by specific approval from the City Engineer, or his authorized representative, on a case-by-case basis.

Logic and documentation for this reduction must be submitted in writing to the City Engineer, or his authorized representative, for approval.

- 6. [REDACTED] Design runoff from areas between 320 acres and 750 acres shall be computed using both the rational method and the S.C.S. dimensionless unit hydrograph method and whichever method produces the larger peak runoff shall be used to design the system for the area tributary to the design point being considered. The S.C.S. dimensionless unit hydrograph method shall be used to design systems for areas of more than 750 acres and less than 780,000 acres tributary to the design point being considered.

- 7. Coefficients of runoff used in the rational method shall be as indicated in the table attached to this document and identified as "Attachment D" for the storm frequencies shown. Development of composite runoff coefficients for drainage areas and/or sub-areas shall be documented and correlated with such areas shown on a drainage area map.

Documentation of logic and computations for composite coefficients shall be provided in writing with the required drainage area map when final drainage computations are submitted to the City Engineer, or his authorized representative, for approval.

- 8. The minimum inlet time or time of concentration used shall be 15 minutes. Inlet time or time of concentration shall be computed using the procedures identified as follows:

- a. Travel time in street gutter sections shall be determined using the procedures identified in Section 4.1.3. of Manual No. 2.

- b. Overland sheet flow time shall be determined using the kinematic wave theory as presented in Section 4.1.3. of Manual No. 2, except that when the product of the rainfall intensity and the length of flow as determined by this method is less than 500, the kinematic wave theory is not valid for this situation and in these cases, the overland flow time shall be determined as identified in (c.) below.

- c. Overland sheet flow time shall be computed using average flow velocities as determined from the attached table identified as "Attachment E" and the estimated flow lengths involved when the kinematic wave theory is determined to be invalid as identified in (b.) above. Velocities for slopes not shown in "Attachment E" shall be computed as a straight line interpolation and/or extrapolation within the ranges shown.

- d. When the inlet time or time of concentration computed by the above procedures is less than 15 minutes, the minimum of 15 minutes shall be used as the inlet time or time of concentration.

Logic and documentation of inlet time or time of concentration shall be provided in writing when final drainage computations are submitted to the City Engineer, or his authorized representative, for approval.

- 9. Composite infiltration rates for use with the S.C.S. dimensionless unit hydrograph method shall be based on procedures identified in Figure 3-9 of Section 3.3.5.2. of Manual No. 1. Logic and documentation of such composite infiltration rates shall be provided in writing when final drainage computations are submitted to the City Engineer, or his authorized representative, for approval. See Exhibit Nos. 1 and 2 showing general soil types in the Wichita area.

- 10. ~~Documentation of logic and computations for unit hydrographs shall be provided in writing when final drainage computations are submitted to the City Engineer, or his authorized representative, for approval.~~ Documentation to be included in submittal to City Engineer, or his authorized representative, for approval shall include all computations in the order identified in the example, a tabulation of unit hydrograph coordinates, a plot of unit hydrograph, a tabulation of effective rainfall, a tabulation of storm hydrograph coordinates for the drainage area, a plot of the storm hydrograph for the drainage area, a map of the drainage area, and computations showing determination of the percentage of impervious surface. Locations of soil types involved shall be shown on the map of drainage area.

E. Chapter 4 Comments and Modifications

1. The Division of Water Resources of the Kansas State Board of Agriculture has adopted specific requirements governing design of dams for detention storage. Such requirements are contained in documents identified as Engineering Guide - 1 and Engineering Guide - 2. Requirements identified in the latest revision of these two documents shall be adhered to when designing facilities addressed by the documents.

Criteria, standards, and documentation identified in Chapter 4 of Manual No. 1 shall be adhered to in all cases where such criteria and standards do not conflict with the Division of Water Resources requirements contained in their engineering guides.

Documentation as indicated in the example problems in said Chapter 4 shall be submitted in writing when final drainage computations are submitted to the City Engineer, or his authorized representative, for approval.

F. Chapter 5 Comments and Modifications - "Roadway Drainage"

1. Criteria, standards, and documentation identified in Manual No. 2 revises and expands upon such items as contained in Chapter 5 of Manual No. 1. Such criteria, standards, and documentation contained in Manual No. 2 shall supersede, revise, and expand like items as contained in Chapter 5 of Manual No. 1, otherwise criteria, standards, and documentation identified in Chapter 5 of Manual No. 1 shall be in effect.
2. Topics contained in Section 4.0., 4.1., 4.1.1., 4.1.2., 4.1.3., 4.1.4. and 4.2. of Manual No. 2 have been discussed previously in this policy statement; therefore, requirements for topics contained in these sections will be as previously identified.
3. Symbols used in computations related to highway or street pavement drainage shall conform to the list of symbols contained on pages 10, 11, and 12 of Manual No. 2. Such computations shall use English units of measure and City of Wichita datum elevation.
4. Curb opening inlets shall be approved and adopted City of Wichita standards. Inlets proposed for construction on grades in excess of 3.0% shall include curb openings and gutter grate openings. Adopted standards for such curb opening inlets with gutter grates will be developed with projects as needed. Gutter grates shall be of the curved vane type and incorporate features of existing standard curb opening inlets functioning on the sweeper principle. Inlets with grates must be located to minimize hazards to pedestrians and bicycles. Curved vane gutter grates shall be of the type indicated on page 42 of Manual No. 2.
5. Design and evaluation of City Standard Type I inlets proposed for construction on grade operating as a weir shall follow procedures identified in solution (2) of Example 11 on pages 63 and 64 of Manual No. 2. Design and evaluation of City Standard Type IA inlets proposed for construction on grade operating as a weir shall follow the same procedures as identified above for Type I inlets except the formula used for determining inlet efficiency in Chart 10 shall be revised to  $(L + 1) - L_T$  to compensate for increased efficiency of inlets constructed in the set back location.

RECEIVED JUN 13 1968

6. Design and evaluation of City Standard Type I inlets proposed for construction in sumps operating as a weir shall follow procedures identified by Chart 12 on page 77 of Manual No. 2. Design and evaluation of City Standard Type I inlets proposed for construction in sumps operating as an orifice shall follow procedures identified by Chart 14 on page 79 of Manual No. 2. Water depth ( $d_o$ ) used with Chart 14 shall be based on the formula identified with drawing (b) of Figure 21 on page 75 of Manual No. 2 where  $d_i$  in such formula is the distance from the point shown in the drawing for where the angle  $\theta$  is measured to the water surface elevation. Design and evaluation of City Standard Type IA inlets proposed for construction in sumps operating as a weir shall follow procedures identified by Chart 12 on page 77 of Manual No. 2 except the formula used for determining P shall be revised to  $P = L + 1 + 1.8 W$  to compensate for increased efficiency of inlets constructed in the set back location. Design and evaluation of City Standard Type IA inlets proposed for construction in sumps operating as an orifice shall follow procedures identified by Chart 12 on page 77 of Manual No. 2.
7. Design and evaluation of City Standard Type I and Type IA inlets proposed for construction on grade operating as orifices shall follow procedures identified for design and evaluation of such inlets in sumps operating as orifices.
8. Format, computation, and documentation required for design of storm sewer systems shall be as shown in the example provided in Manual No. 1 beginning with Section 5.11. Documentation to be included in submittal to City Engineer, or his authorized representative, for approval shall include all computations in the order identified in the example, a tabulation of design computations as identified in Table 5-7 in Manual No. 1, a plan of the system as identified in Figure 5-38(a) in Manual No. 1, a profile of the system as identified in Figure 5-38(b) in Manual No. 1, and tabulations of inlet design computations as indicated in Exhibit Nos. 4 and 5. The numbering of the various points for design consideration shall follow procedures indicated in Figure 5-39 in Manual No. 1. The City of Wichita requires designs and bids on alternate pipe material using concrete pipe and corrugated metal pipe unless otherwise approved by the City Engineer or his authorized representative. Any request for approval to not design for alternate pipe material systems must be requested in writing stating reasons for the basis of the request.

## 6. Supplementary Design Information and Criteria

### Section I: General Criteria for Open Channels, Ditches and Related Appurtenances

#### 1. Introduction

Open channels for use in the major drainage system have significant advantage in regard to cost, capacity, multiple use for recreational and aesthetic purposes and potential for detention storage. Disadvantages include right-of-way needs and maintenance costs. Careful planning and design are needed to minimize the disadvantages and to increase the benefits.

RECEIVED JUN 13 1988

2. Geometric Features <sup>was applicable</sup>

- a. Where ~~possible~~ a primary and an auxiliary channel shall be employed. Purpose of the primary channel is to carry the design flood discharge. Purpose of the auxiliary channel is to contain daily flow, minimize the portion of channel bottom which is normally wet and reduce bank erosion caused by the natural tendency of stream flow to meander from bank to bank.
- b. Side slopes of the primary channel shall be no steeper than 4 horizontal to 1 vertical.
- c. Minimum bottom width of either primary or auxiliary channel shall be 4 feet.
- d. Side slopes of the auxiliary channel shall be 0.5 horizontal to 1 vertical.
- e. Maximum width of the auxiliary channel shall be 10 feet.
- f. Maximum depth of the auxiliary channel shall be 2 feet.
- g. The auxiliary channel shall be centered in the primary channel wherever sufficient bottom width is available.
- h. Where primary channel bottom width dictates that the auxiliary channel be set to one side of the primary channel, the near side overbank distance shall be a minimum of 2 feet; the far side overbank distance shall be a minimum of 10 feet. The cross-slope on the overbank channel shall be 2%.
- i. Where primary channel width will not accommodate an auxiliary channel, the primary channel shall feature a "Y" bottom using 2% cross slope. <sup>added</sup>
- j. Auxiliary or "Y" geometric features may be disregarded in hydraulic computations, such as computations for water surface profiles.

3. Manning's formula constants for roughness factor (n).

- a. For grass-lined channel -  $n = 0.030$ .
- b. For rip-rap, basket gabions, blanket gabions, rock fill -  $n = 0.045$ .
- c. For portland cement concrete-lined channels -  $n = 0.013$ .

4. Channel Surface Protection

- a. Surface protection is an integral part of the design of any channel. Provision for channel surface protection must be made in contract documents and responsibility for maintenance of the channel between the time when earthwork is completed and installation of surface protection should be clearly stated.
- b. Where computed average velocity in section exceeds 6 feet per second, an energy dissipater, concrete lining, stone rip-rap, rip-rap bags, fabric or gabions must be used to protect the channel surface from erosion. Surface protection for velocities 6 feet per second or less shall be evaluated consistent with involved soil types.

- c. Adjustments of channel gradients which are too steep for design conditions are best made by channel drops. Normally it is better to employ several low head drops instead of high drops. Sloped drops which fit channel topography are usually the most cost efficient. Sloped drops should have a rough surface and be no steeper than 2 to 1. All channel drops must be protected from erosion and being washed out.

## 5. Outfall Structures

- a. Protection from erosion is required at all locations where a side drain or storm water sewer enters an open channel.
- b. If the open channel is grass-lined, the side drain may employ a head-wall, apron and wingwalls which are designed to fit the channel bank; or if the side drain is pipe, an end section may be used provided it is supported by a toewall at least 2' in depth using portland cement concrete, grouted stone rip-rap, rip-rap bags, fabriform or gabions.
- c. For grass-lined channels, the erosion protection in the form of portland cement concrete slab, stone rip-rap, rip-rap bags, fabriform or gabions shall extend across the overbank channel, down into and across the auxiliary channel (if applicable) and at least 2 feet up the opposite primary channel bank.
- d. Erosion protection shall extend upstream and downstream from the center-line of any side drain a distance of 1 1/2 pipe diameters each direction or a minimum of 3 feet each direction.

## 6. Water Surface Profiles

- a. Channel design must be accompanied by water surface profiles in a format which presents not only the profile but the geometric and hydraulic elements which are employed in the profile computations.
- b. Any method which employs the Manning equation in a step-type iterative backwater analysis is acceptable for channel reaches between structures. At structures, an accounting for area reduction and wetted perimeter increase, such as at piers, piles, walls, etc. must be entered into the water surface elevation computations. Suggested text for analysis of flow through structures is "Hydraulics of Bridge Waterways" published by the Bureau of Public Roads, source of which is available by contacting the City/County Engineer.
- c. An excellent example of method for computing water surface profiles is the Hydrologic Engineering Center Computer Program designated "HEC-2, Water Surface Profiles".
- d. Where access to the HEC-2 computer program is not practical, the procedures outlined in Hydrologic Engineering Center Report, Volume 6, Water Surface Profiles, is recommended.
- e. Where the starting elevation of a water surface profile is not known, it should be estimated by making a "slope-area" or a "critical depth" computation for the channel being studied.

RECEIVED JUN 13 1988

## 7. Freeboard

- a. To protect against the damaging effects of wave action, air bulking, splash and spray, man-made channels should provide a minimum of one foot of freeboard above the computed water surface profile for the design storm.
- b. The minimum freeboard above flood of record or computed flood insurance base flood water surface profiles for natural rivers, creeks, sloughs, etc. shall be one foot.
- c. Where buildings are immediately adjacent to a natural or man-made channel, the minimum building pad elevation for such structures is recommended to be one foot above the computed 100-year return flood water surface profile.

## Section II: General Criteria for Detention Design and Standards

### 1. Introduction

Storm water detention is a method by which the peak discharge of a drainage system is reduced through temporary storage in a reservoir having a control structure as its outlet. The capacity of the outlet structure limits the outflow of the reservoir to a quantity less than the inflow. Detention is used to decrease the required capacity of new drainage systems and to relieve or prevent over-charging of existing drainage systems. The City desires that detention storage be sized to reduce and/or limit peak runoff for the 5-year and 100-year frequency storms from urbanized areas to the peak runoff for such storms as if the area was not urbanized.

The purpose of this section is to state the procedure and criteria to be used in the design and construction of detention systems.

As per current Kansas State Statutes, all dams capable of impounding thirty acre-feet or more at maximum stage require design approval and a permit from the Division of Water Resources of the Kansas State Board of Agriculture. Those structures of this size or larger must, therefore, meet both the design standards as herein set forth and the design standards and procedures of the Division of Water Resources.

### 2. Design Criteria

#### a. Site Exploration

Prior to design of a detention facility, the site shall be explored for surface and subsurface conditions, such as soil composition, water table, and subsurface geology.

#### b. Detention Storage Dam Design

All dams to be constructed within the urbanized area of the City of Wichita shall be designed for Class C High Hazard in accordance with the Engineering Guide - 1 identified previously in comments on Chapter 4 of Manual No. 1.

c. Design Inflow

aa. Peak flow rates

The methods of computing peak inflow are described in the previous discussion of Manual No. 1.

R 4  
Section  
6

bb. Soil Groups

For both urban and rural basins, the hydrologic soil groups will be found using the S.C.S. "Soil Survey of Sedgwick County".

d. Inflow Hydrograph

Inflow hydrographs for drainage areas ranging from 320 to 1,280,000 acres shall be developed using the S.C.S. dimensionless unit hydrograph procedures previously identified in Chapter 3 of Manual No. 1. Inflow hydrographs for drainage areas less than 320 acres shall be developed based on the 10-minute unit hydrograph equations shown in Table 4-5 of Manual No. 1 and the methodology as presented in the example beginning in Section 4.6.4.2. of Manual No. 1. The value for  $\theta$  shall be as identified in the table provided as "Attachment F".

e. Routing Methods

Routing of the inflow storm through the detention pond shall utilize the procedures identified in Chapter 4 of Manual No. 1. Complete dewatering of the detention portion of the facility shall take no more than 4 days.

f. Design and Construction of the Facility

Due to the great variance in soil types and subsurface conditions throughout this area, it is not practical to develop one specification for construction of embankments and ponds. There are, however, several general requirements that can be recommended at this time.

aa. As previously mentioned, prior to design the site shall be explored for surface and subsurface conditions. This work shall be done by a qualified testing laboratory under the direction of a licensed engineer.

bb. The core of the embankment and the core trench shall be composed of impervious material.

4:1

cc. Side slopes of the pond and embankment will be constructed in accordance with the standards stated in the section on open channel design.

1:50:1

dd. Freeboard shall be designed following the same criteria as used in open channel design.

ee. All areas above the static pool shall be seeded and mulched or sodded in compliance with the standards of the City.

ff. During construction, there will be continual testing and inspection by a qualified testing laboratory under the direction of a licensed engineer with reports submitted to the City.

Section III: General Criteria for Storm Water Sewer Design and Standards

1. Introduction

Storm water sewer systems shall be designed as pressure systems for the initial storm when possible. Hydraulic grade line shall be a minimum of 6" below the street pavement gutter flow line at locations of inlets and man-holes.

2. Design Criteria

a. Manning's coefficient of friction shall be as follows:

Reinforced concrete pipe (all sizes)  $n = 0.013$ ; corrugated metal pipe 2 2/3" x 1/2" helical and circumferential corrugations (all sizes)  $n = 0.024$ ; corrugated metal pipe 3" x 1" helical and circumferential corrugations (all sizes)  $n = 0.027$ ; corrugated metal pipe 6" x 2" helical and circumferential corrugations (all sizes)  $n = 0.033$ .

b. Storm sewers are required to be designed to provide for a minimum cleansing velocity of 2 feet per second at a depth of flow of 0.2 of the diameter or rise of the pipe.

Section IV: General Rules of Thumb for Design of Drainage and Storm Water Sewers

1. Whenever possible, set flow line elevations of pipes in structures such that the crowns of the pipes are at the same elevation.
2. Flow lines of pipes in structures may be set at elevations such that the 0.8 depth points of the pipes are at the same elevation.
3. When main line pipe sizes change at a structure, the drop in flow line through the structure should be equal to the difference in the sizes of the pipe.
4. Provide 0.2 foot drop in the main line pipes through structures when the structures includes one side lateral. Provide 0.3 foot drop in the main line pipes through structures when the structures includes two or more laterals.
5. Provide 0.1 foot drop in the main line pipes through structures whenever the horizontal alignment of the main line pipes changes by 45° or greater.
6. A clearance of 2 feet is required <sup>desired</sup> between the top of the outside diameter of the pipe and the bottom of the street pavements when pipes are installed under or in close proximity to such pavement. A clearance of less than 2 feet will require specific approval by the City Engineer or his authorized representative.

RECEIVED JUN 13 1988

7. Manholes used on storm sewers normally will be City standard shallow Type A, shallow Type B, standard Type A, standard Type B, and standard reinforced concrete. Standard reinforced concrete manholes are normally used with pipe sizes 42" or larger. All openings into structures which are to be utilized to facilitate maintenance operations shall be centered on pipes entering and/or exiting such structures when possible.
8. Inlet, manhole, and headwall structures must always be evaluated to ensure that the structures have sufficient size to accommodate the various inflow and outflow pipes based on the alignment shown on the plan.
9. Drainage plans which require construction of erosion protection will be required to include detail drawings for the placement of such erosion protection for each specific location. Such details must show required elevations and horizontal dimensions.
10. All projects which require construction of channels and/or ponds shall include provisions for establishing grass cover as necessary to minimize erosion. Such projects shall also include provisions for mulching of slopes which are more susceptible to erosion. Types of grass cover specified shall be compatible with the types of soil involved. Projects which have soil types that will not support development of good grass cover will require placement of suitable topsoil.
11. The City of Wichita prefers inlet-manhole combination structures whenever possible. The City also prefers to construct manholes outside the limits of street pavement whenever possible. When necessary to construct manholes in street pavement, such manholes shall be Type B.
12. State and federal government agencies permit or approval requirements as related to certain types of drainage improvements must be adhered to as follows:
  - a. Construction plan approval is required from the Tulsa Branch of the Corps of Engineers whenever a project requires crossing a Corps constructed levee or discharge into a Corps constructed channel. The Wichita - Valley Center Floodway was constructed by the Corps. This project included levees along the Big Arkansas River upstream from the point of diversion of the Big Arkansas River into the floodway and upstream from the point of discharge of the floodway back into the Big Arkansas River. The project also included a diversion channel and levees between the Big and Little Arkansas Rivers along with the Chisholm Creek Diversion Channel and levee system.
  - b. The Kansas City Branch of the Corps of Engineers has jurisdiction of construction within the limits of the high bank or across the Little and Big Arkansas Rivers. Plans requiring construction within these limits must be sent to the Kansas City Branch of the Corps of Engineers for determination of permit requirements.
  - c. A permit is required from the Division of Water Resources of the Kansas State Board of Agriculture when projects require excavation or construction of fill in a floodplain. The application of this permit requirement to projects which require construction in floodplains will be determined on an individual project basis on identification of the type and extent of the work involved.

RECEIVED JUN 13 1988

- d. A permit is required from the Division of Water Resources of the Kansas State Board of Agriculture for those projects which include construction of a dam which would impound more than 30 acre-feet of water at the elevation of the top of the dam.
  - e. Contractors are required to obtain a permit from the Division of Water Resources of the Kansas State Board of Agriculture when it is necessary to dewater with wells and well points to facilitate construction.
13. Occasionally exceptions to the above-stated rules of thumb may arise. Such exceptions will be evaluated and approved on an individual case basis.

RECEIVED JUN 13 1968

**ATTACHMENT B**  
**DRAINAGE CRITERIA MANUAL**  
**CITY OF WICHITA, KANSAS**

**INCREMENTAL INFILTRATION VALUES IN INCHES**

Time Minutes**	SCS Hydrologic Soil Group			
	A	B	C	D
5	.33	.26	.19	.12
10	.25	.17	.09	.04
15	.18	.11	.05	.02
20	.13	.07	.03	.02
25	.10	.05	.03	.02
30	.08	.05	.03	.02
35	.08	.05	.03	.02
40	.08	.05	.03	.02
45	.08	.05	.03	.02
50	.08	.05	.03	.02
55	.08	.05	.03	.02
60	.08	.05	.03	.02
65	.08	.05	.03	.02
70	.08	.05	.03	.02
75	.08	.05	.03	.02
80	.08	.05	.03	.02
85	.08	.05	.03	.02
90	.08	.05	.03	.02
95	.08	.05	.03	.02
100	.08	.05	.03	.02
105	.08	.05	.03	.02
110	.08	.05	.03	.02
115	.08	.05	.03	.02
120	.08	.05	.03	.02

\*\*Time at end of the time increment

NOTE: Values for 125 minutes and additional 5 minute increments shall be the same as those shown for 120 minutes.

ATTACHMENT C

DRAINAGE CRITERIA MANUAL  
CITY OF WICHITA, KANSAS

DEPRESSION STORAGE LOSSES

<u>Surface Type</u>	<u>Total Loss (Inches)</u>
Impervious:	
Paved Areas	0.1
Flat Roofs	0.1
Sloped Roofs	0.05
Pervious:	
Lawns and Grass	0.3
Wooded Areas and Open Fields	0.4

RECEIVED JUN 13 1993

**ATTACHMENT F**

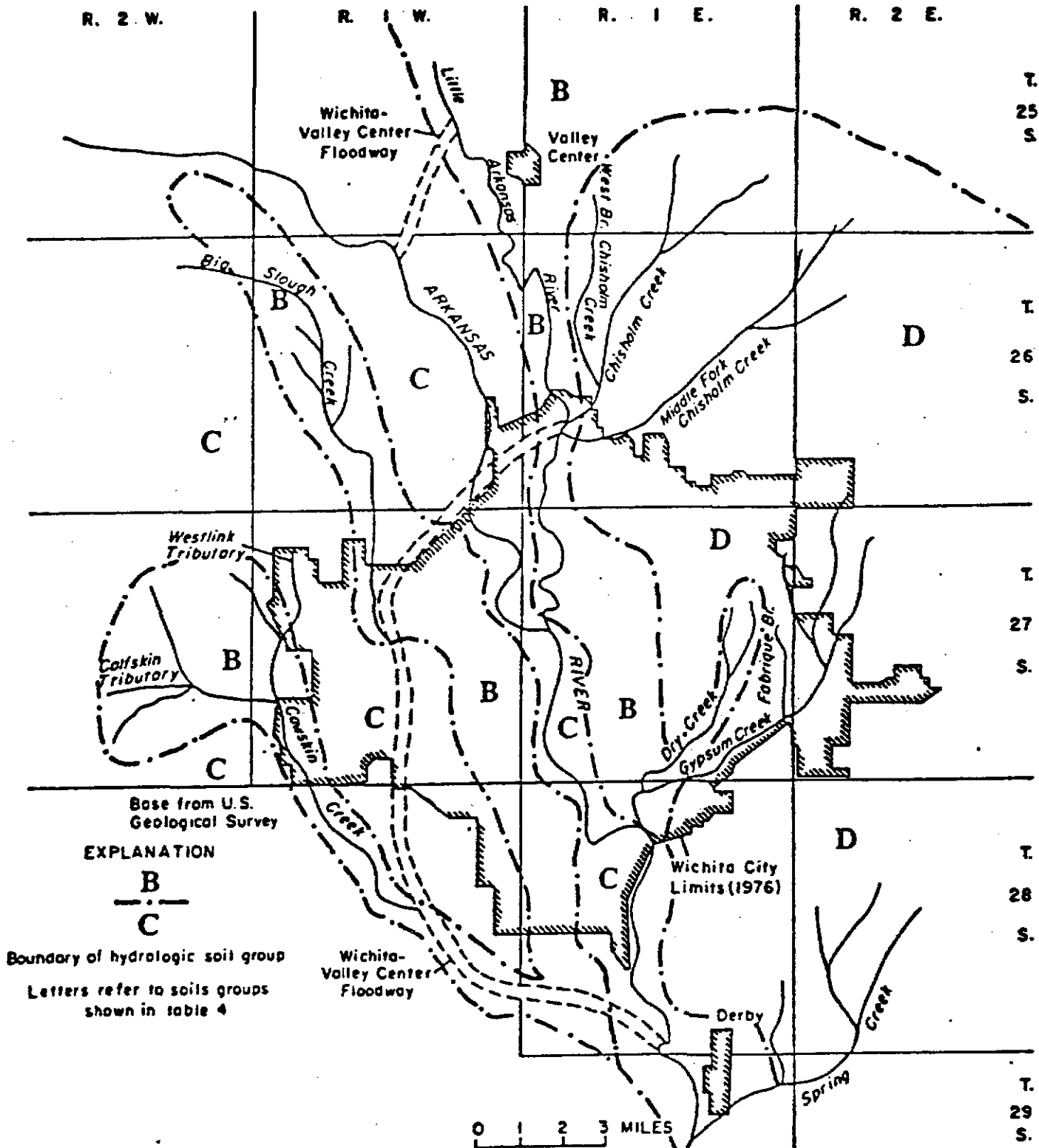
**DETERMINATION OF DIMENSIONLESS  
WATERSHED CONVEYANCE FACTOR ( $\theta$ )**

$$\theta = \theta_1 + \theta_2$$

$\theta_1$	Classification
0.6	Extensive channel improvement and storm sewer system, closed conduit channel system
0.7	Moderate channel improvement and storm sewer system.
0.8	Some channel improvement and storm sewers, mainly cleaning and enlargement of existing channel.
0.9	Little channel improvement and storm sewers.
1.0	Natural channel conditions.
$\theta_2$	Classification
0.0	No channel vegetation.
0.1	Light channel vegetation.
0.2	Moderate channel vegetation.
0.3	Heavy channel vegetation.

RECEIVED JUN 13 1988

**EXHIBIT NO. 2**



RECEIVED JUN 13 1983

EXHIBIT NO. 3

SUMP INLETS DESIGN DATA TABULATION

Project Title \_\_\_\_\_ Gutter Depression at Inlets (Standard = 2") \_\_\_\_\_  
 Project Number \_\_\_\_\_ Width of Gutter Depression at Inlets (Standard = 2'0") \_\_\_\_\_  
 Design Storm Frequency \_\_\_\_\_

Inlet Location	Top of Inlet Elevation	Inlet Drainage Area Size in Acres	Time of Concentration in Minutes	Composite Runoff Coefficient	Rainfall Intensity	Inlet Drainage Area Flow Q (cfs)	Carry Over Flow From Other Inlets Q <sub>b</sub> (cfs)	Inlet Capacity Required Q <sub>i</sub> (cfs)

Inlet Length Required in Feet	Inlet Length Provided in Feet	Computed Pondered Surface Elevation	Allowable Pondered Surface Elevation	Computed Pavement Spread in Feet	Allowable Pavement Spread in Feet	Pavement Width Bk. - Bk. in Feet	Pavement Cross-Slope in Ft./Ft.	Street Classification

NOTE: Inlet capacity required (Q<sub>i</sub>) must equal the sum of inlet drainage area flow (Q) and carry over flow from other inlets (Q<sub>b</sub>) for ponding depths and/or pavement spreads allowed by criteria.

EXHIBIT NO. 4

ON GRADE INLETS DESIGN DATA TABULATION

Project Title \_\_\_\_\_  
 Project Number \_\_\_\_\_  
 Design Storm Frequency \_\_\_\_\_  
 Gutter Depression at Inlets (Standard = 2") \_\_\_\_\_  
 Width of Gutter Depression of Inlets (Standard = 2'0") \_\_\_\_\_

Inlet Location	Top of Inlet Elevation	Inlet Drainage Area Size in Acres	Time of Concentration in Minutes	Composite Runoff Coefficient	Rainfall Intensity	Inlet Drainage Area Flow Q (cfs)	Carry Over Flow From Upstream Inlets Ob (cfs)	Total Flow to Inlet Q <sub>t</sub> (cfs)	Inlet Intercept Flow Q <sub>i</sub> (cfs)	Bypass Flow to Downstream Inlet Ob (cfs)

Inlet Length Required in Feet	Inlet Length Provided in Feet	Computed Water Surface Elevation in Gutter	Computed Pavement Spread in Feet	Allowable Water Surface Elevation in Gutter	Allowable Pavement Spread in Feet	Pavement Width Bk. - Bk. in Feet	Pavement Cross-Slope in Ft./Ft.	Longitudinal Gutter Slope in Ft./Ft.	Street Classification

NOTE: Inlet intercept flow (Q<sub>i</sub>) must be as required to limit pavement spread or ponding as allowed by criteria.

RECEIVED JUN 13 1962

ATTACHMENT E  
 DRAINAGE CRITERIA  
 CITY OF WICHITA, KANSAS  
  
*Handwritten:*  
 Length = 100  
 500 x m  
 100  
 1000 ft  
 1000 ft

AVERAGE OVERLAND FLOW VELOCITY FOR USE WITH URBANIZED AREAS

Surface Type	VELOCITY IN FEET/SECOND FOR SLOPES IN PERCENT SHOWN																			
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	20.0
Forest with Heavy Ground Litter or Meadow	0.03	0.04	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.16	0.21	0.28	0.33	0.39	0.46	0.53	0.60	0.72	1.10
Fallow or Minimum Tillage Cultivation	0.06	0.08	0.10	0.12	0.13	0.14	0.16	0.17	0.18	0.19	0.29	0.40	0.51	0.66	0.78	0.91	1.05	1.20	1.44	2.10
Short Grass Pasture or Lawns	0.09	0.13	0.15	0.18	0.20	0.21	0.23	0.25	0.26	0.28	0.45	0.60	0.77	0.96	1.17	1.33	1.50	1.68	1.98	3.20
Almost Bare Ground	0.16	0.22	0.28	0.31	0.35	0.38	0.41	0.44	0.46	0.49	0.70	0.85	1.05	1.26	1.50	1.75	2.03	2.32	2.79	4.40
Grassed Waterway	0.35	0.48	0.58	0.67	0.77	0.84	0.91	0.98	1.05	1.12	1.54	1.82	2.10	2.38	2.78	3.20	3.66	4.14	4.56	7.00
Paved Areas (Sheet Flow) or Shallow Gutter Flow	0.44	0.62	0.77	0.91	1.05	1.12	1.19	1.26	1.33	1.40	2.00	2.55	3.20	3.83	4.41	5.04	5.70	6.00	6.20	9.00

EXHIBIT NO. 1

SOIL LEGEND

<u>SYMBOL</u>	<u>HYDROLOGIC GROUP</u>	<u>NAME</u>
Aa	B	Albion-Shellabarger sandy loams, 1 to 4 percent slopes
Ab	B	Albion and Shellabarger sandy loams, 7 to 15 percent slopes
Ba	C	Blanket silt loam, 0 to 1 percent slopes
Bb	C	Blanket silt loam, 1 to 3 percent slopes
Ca	B	Canadian fine sandy loam
Cb	B	Canadian-Waldeck fine sandy loams
Cc	D	Carwile fine sandy loam
Cd	B	Clark-Ost clay loams, 1 to 4 percent slopes
Ce	C	Clime silty clay, 3 to 6 percent slopes
Ea	B	Elandco silt loam
Eb	B	Elandco silt loam, occasionally flooded
Ec	B	Elandco silt loam, frequently flooded
Fa	B	Farnum loam, 0 to 1 percent slopes
Fb	B	Farnum loam, 1 to 3 percent slopes
Fc	B	Farnum loam, sandy substratum, 0 to 1 percent slopes
Ga	D	Goessel silty clay, 0 to 1 percent slopes
Gb	D	Goessel silty clay, 1 to 2 percent slopes
Ia	D	Irwin silty clay loam, 1 to 3 percent slopes
Ib	D	Irwin silty clay loam, 3 to 6 percent slopes
Ic	D	Irwin silty clay loam, 2 to 6 percent slopes, eroded
La	C	Lesho loam
Lb	A	Lincoln soils
Ma	B	Milan loam, 1 to 3 percent slopes
Mb	B	Milan form, 3 to 6 percent slopes
Mc	B	Milan clay loam, 2 to 6 percent slopes, eroded
Na	B	Naron fine sandy loam
Oc	D	Owens clay loam, 1 to 3 percent slopes
Od	D	Owens-Rock outcrop complex, 3 to 10 percent slopes
Pa		Pits
Pb	D	Plevna fine sandy loam
Pc	A	Pratt loamy fine sand, undulating
Pd	A	Pratt-Tivoli complex, rolling
Ra	D	Renfrow silty clay loam, 1 to 3 percent slopes
Rb	D	Renfrow silty clay loam, 3 to 6 percent slopes
Rc	D	Renfrow-Owens clay loams, 1 to 4 percent slopes
Rd	D	Rosehill silty clay, 1 to 3 percent slopes
Sa	B	Shellabarger sandy loam, 1 to 3 percent slopes
Sb	B	Shellabarger sandy loam, 3 to 6 percent slopes
Sc	B	Shellabarger sandy loam, 3 to 6 percent slopes, eroded
Ta	D	Tabler silty clay loam
Tb	D	Tabler-Drummond complex
Ua	B	Urban land-Canadian complex
Ub	B	Urban land-Elandco complex
Uc	B	Urban land-Farnum complex, 0 to 3 percent slopes
Ud	D	Urban land-Irwin complex, 1 to 3 percent slopes
Ue	D	Urban land-Tabler complex
Va	B	Vanoss silt loam, 0 to 1 percent slopes
Vb	B	Vanoss silt loam, 1 to 3 percent slopes
Vc	B	Vanoss silt loam, 3 to 6 percent slopes
Vd	B	Vanoss silt loam, 3 to 6 percent slopes, eroded
Ve	D	Vernon sandy loam, 1 to 3 percent slopes
Vf	D	Vernon sandy loam, 3 to 6 percent slopes
Wa	C	Waldeck sandy loam
Wb	D	Waurika silt loam

(SECTION 5.10, B. - CONTINUED)

FIGURE 5-3

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.

DURATION IN MINUTES	RETURN PERIODS OF						
	1-YR	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
5	4.67	6.23	8.00	9.34	10.67	12.23	13.79
6	4.35	5.80	7.45	8.70	9.94	11.39	12.84
7	4.09	5.46	7.02	8.19	9.36	10.72	12.09
8	3.88	5.18	6.66	7.77	8.89	10.18	11.48
9	3.71	4.95	6.36	7.43	8.49	9.72	10.96
10	3.56	4.75	6.11	7.13	8.15	9.33	10.52
11	3.43	4.58	5.89	6.87	7.85	8.99	10.14
12	3.32	4.40	5.69	6.64	7.59	8.69	9.80
13	3.21	4.29	5.51	6.43	7.35	8.42	9.50
14	3.12	4.17	5.36	6.25	7.14	8.18	9.23
15	3.04	4.06	5.21	6.08	6.95	7.97	8.98
16	2.96	3.96	5.09	5.93	6.78	7.77	8.76
17	2.90	3.86	4.97	5.79	6.62	7.59	8.55
18	2.83	3.78	4.86	5.67	6.48	7.42	8.37
19	2.77	3.70	4.76	5.55	6.34	7.27	8.19
20	2.72	3.63	4.66	5.44	6.22	7.12	8.03
21	2.67	3.56	4.57	5.34	6.10	6.99	7.88
22	2.62	3.49	4.49	5.24	5.99	6.86	7.74
23	2.57	3.43	4.41	5.15	5.89	6.74	7.60
24	2.53	3.38	4.34	5.07	5.79	6.63	7.48
25	2.49	3.32	4.27	4.99	5.70	6.53	7.36
26	2.45	3.23	4.21	4.91	5.61	6.43	7.25
27	2.42	3.18	4.15	4.84	5.53	6.33	7.14
28	2.38	3.05	4.09	4.77	5.45	6.25	7.04
29	2.35	2.97	4.02	4.68	5.38	6.16	6.95
30	2.32	2.89	3.92	4.56	5.31	6.08	6.79
31	2.29	2.82	3.82	4.44	5.19	6.00	6.62
32	2.26	2.75	3.73	4.33	5.07	5.87	6.45
33	2.24	2.68	3.64	4.23	4.95	5.73	6.30
34	2.19	2.62	3.55	4.13	4.83	5.60	6.16
35	2.14	2.57	3.47	4.04	4.73	5.47	6.02
36	2.09	2.51	3.40	3.95	4.62	5.35	5.89
37	2.05	2.46	3.33	3.87	4.52	5.23	5.76
38	2.00	2.41	3.26	3.79	4.43	5.13	5.64
39	1.96	2.36	3.19	3.71	4.34	5.02	5.53
40	1.92	2.32	3.13	3.64	4.26	4.92	5.42
41	1.89	2.27	3.07	3.57	4.18	4.83	5.32
42	1.85	2.23	3.01	3.51	4.10	4.74	5.22
43	1.82	2.19	2.96	3.44	4.02	4.65	5.13
44	1.78	2.15	2.91	3.38	3.95	4.56	5.03
45	1.75	2.11	2.86	3.32	3.88	4.48	4.95

(SECTION 3.10, B. - CONTINUED)

FIGURE 5-3 (Continued)

DURATION IN MINUTES	RETURN PERIODS OF						
	1-YR	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
46	1.72	2.08	2.81	3.27	3.82	4.41	4.86
47	1.69	2.04	2.76	3.21	3.75	4.33	4.78
48	1.67	2.01	2.72	3.16	3.69	4.26	4.70
49	1.64	1.98	2.67	3.11	3.63	4.19	4.63
50	1.61	1.95	2.63	3.06	3.58	4.13	4.56
51	1.59	1.92	2.59	3.01	3.52	4.06	4.49
52	1.56	1.89	2.55	2.97	3.47	4.00	4.42
53	1.54	1.86	2.51	2.92	3.42	3.94	4.35
54	1.52	1.84	2.48	2.88	3.37	3.88	4.29
55	1.50	1.81	2.44	2.84	3.32	3.83	4.23
56	1.47	1.79	2.41	2.80	3.27	3.77	4.17
57	1.45	1.76	2.37	2.76	3.23	3.72	4.11
58	1.43	1.74	2.34	2.73	3.19	3.67	4.06
59	1.42	1.72	2.31	2.69	3.14	3.62	4.01
60	1.40	1.69	2.28	2.65	3.10	3.57	3.95
61	1.38	1.67	2.25	2.62	3.06	3.53	3.90
62	1.36	1.65	2.22	2.59	3.02	3.48	3.85
63	1.34	1.63	2.20	2.55	2.99	3.44	3.81
64	1.33	1.61	2.17	2.52	2.95	3.40	3.76
65	1.31	1.59	2.14	2.49	2.92	3.35	3.71
66	1.30	1.57	2.12	2.46	2.88	3.31	3.67
67	1.28	1.56	2.09	2.44	2.85	3.27	3.63
68	1.26	1.54	2.07	2.41	2.81	3.24	3.59
69	1.25	1.52	2.05	2.38	2.78	3.20	3.54
70	1.24	1.50	2.02	2.35	2.75	3.16	3.51
71	1.22	1.49	2.00	2.33	2.72	3.13	3.47
72	1.21	1.47	1.98	2.30	2.69	3.09	3.43
73	1.20	1.46	1.96	2.28	2.66	3.06	3.39
74	1.18	1.44	1.94	2.25	2.63	3.03	3.36
75	1.17	1.43	1.92	2.23	2.61	3.00	3.32
76	1.16	1.41	1.90	2.21	2.58	2.96	3.29
77	1.15	1.40	1.88	2.18	2.55	2.93	3.25
78	1.13	1.38	1.86	2.16	2.53	2.90	3.22
79	1.12	1.37	1.84	2.14	2.50	2.88	3.19
80	1.11	1.36	1.82	2.12	2.48	2.85	3.16
81	1.10	1.34	1.81	2.10	2.46	2.82	3.13
82	1.09	1.33	1.79	2.08	2.43	2.79	3.10
83	1.08	1.32	1.77	2.06	2.41	2.76	3.07
84	1.07	1.31	1.75	2.04	2.39	2.74	3.04
85	1.06	1.30	1.74	2.02	2.37	2.71	3.01
86	1.05	1.28	1.72	2.00	2.34	2.69	2.99
87	1.04	1.27	1.71	1.99	2.32	2.66	2.96
88	1.03	1.26	1.69	1.97	2.30	2.64	2.93
89	1.02	1.25	1.68	1.95	2.28	2.62	2.91
90	1.01	1.24	1.66	1.93	2.26	2.59	2.88

ATTACHMENT A CONTINUED  
Page 3

<u>DURATION IN MINUTES</u>	<u>RETURN PERIODS OF</u>						
	<u>1-YR</u>	<u>2-YR</u>	<u>5-YR</u>	<u>10-YR</u>	<u>25-YR</u>	<u>50-YR</u>	<u>100-YR</u>
91	1.00	1.23	1.65	1.92	2.24	2.57	2.86
92	1.00	1.22	1.63	1.90	2.22	2.55	2.83
93	0.99	1.21	1.62	1.89	2.20	2.53	2.81
94	0.98	1.20	1.61	1.87	2.19	2.51	2.79
95	0.97	1.19	1.59	1.85	2.17	2.49	2.76
96	0.96	1.18	1.58	1.84	2.15	2.46	2.74
97	0.96	1.17	1.57	1.82	2.13	2.44	2.72
98	0.95	1.16	1.56	1.81	2.12	2.42	2.70
99	0.94	1.15	1.54	1.80	2.10	2.41	2.67
100	0.93	1.14	1.53	1.78	2.08	2.39	2.65
101	0.93	1.13	1.52	1.77	2.07	2.39	2.65
102	0.92	1.13	1.51	1.75	2.05	2.35	2.61
103	0.91	1.12	1.50	1.74	2.04	2.33	2.59
104	0.90	1.11	1.49	1.73	2.02	2.31	2.57
105	0.90	1.10	1.47	1.72	2.01	2.30	2.55
106	0.89	1.09	1.46	1.70	1.99	2.28	2.54
107	0.88	1.09	1.45	1.69	1.98	2.26	2.52
108	0.88	1.08	1.44	1.68	1.96	2.25	2.50
109	0.87	1.07	1.43	1.67	1.95	2.23	2.48
110	0.87	1.06	1.42	1.65	1.93	2.21	2.46
111	0.86	1.06	1.41	1.64	1.92	2.20	2.45
112	0.85	1.05	1.40	1.63	1.91	2.18	2.43
113	0.85	1.04	1.39	1.62	1.89	2.17	2.41
114	0.84	1.03	1.38	1.61	1.88	2.15	2.40
115	0.84	1.03	1.37	1.60	1.87	2.14	2.38
116	0.83	1.02	1.36	1.59	1.86	2.12	2.36
117	0.82	1.01	1.36	1.58	1.84	2.11	2.35
118	0.82	1.01	1.35	1.57	1.83	2.09	2.33
119	0.81	1.00	1.34	1.56	1.82	2.08	2.32
120	0.81	0.99	1.33	1.55	1.81	2.07	2.30

<u>DURATION IN HOURS</u>	<u>RETURN PERIODS OF</u>						
	<u>1-YR</u>	<u>2-YR</u>	<u>5-YR</u>	<u>10-YR</u>	<u>25-YR</u>	<u>50-YR</u>	<u>100-YR</u>
2	0.81	0.99	1.33	1.55	1.81	2.07	2.30
3	0.59	0.72	0.97	1.13	1.32	1.51	1.68
4	0.47	0.58	0.78	0.91	1.06	1.21	1.35
5	0.40	0.49	0.66	0.77	0.89	1.02	1.14
6	0.35	0.42	0.57	0.67	0.78	0.89	0.99
8	0.28	0.34	0.46	0.53	0.62	0.71	0.79
10	0.23	0.29	0.39	0.45	0.52	0.60	0.67
12	0.20	0.25	0.33	0.39	0.45	0.52	0.58
18	0.15	0.18	0.24	0.28	0.33	0.38	0.42
24	0.12	0.15	0.20	0.23	0.27	0.31	0.34

(SECTION 3.10, B. - CONTINUED)

FIGURE 5-3 (Continued)

DURATION IN MINUTES	RETURN PERIODS OF						
	1-YR	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
91	1.00	1.23	1.65	1.92	2.24	2.57	2.86
92	1.00	1.22	1.63	1.90	2.22	2.55	2.83
93	0.99	1.21	1.62	1.89	2.20	2.53	2.81
94	0.98	1.20	1.61	1.87	2.19	2.51	2.79
95	0.97	1.19	1.59	1.85	2.17	2.49	2.76
96	0.96	1.18	1.58	1.84	2.15	2.46	2.74
97	0.96	1.17	1.57	1.82	2.13	2.44	2.72
98	0.95	1.16	1.56	1.81	2.12	2.42	2.70
99	0.94	1.15	1.54	1.80	2.10	2.41	2.67
100	0.93	1.14	1.53	1.78	2.08	2.39	2.65
101	0.93	1.13	1.52	1.77	2.07	2.39	2.65
102	0.92	1.13	1.51	1.75	2.05	2.35	2.61
103	0.91	1.12	1.50	1.74	2.04	2.33	2.59
104	0.90	1.11	1.49	1.73	2.02	2.31	2.57
105	0.90	1.10	1.47	1.72	2.01	2.30	2.55
106	0.89	1.09	1.46	1.70	1.99	2.28	2.54
107	0.88	1.09	1.45	1.69	1.98	2.26	2.52
108	0.88	1.08	1.44	1.68	1.96	2.25	2.50
109	0.87	1.07	1.43	1.67	1.95	2.23	2.48
110	0.87	1.06	1.42	1.65	1.93	2.21	2.46
111	0.86	1.06	1.41	1.64	1.92	2.20	2.45
112	0.85	1.05	1.40	1.63	1.91	2.18	2.43
113	0.85	1.04	1.39	1.62	1.89	2.17	2.41
114	0.84	1.03	1.38	1.61	1.88	2.15	2.40
115	0.84	1.03	1.37	1.60	1.87	2.14	2.38
116	0.83	1.02	1.36	1.59	1.86	2.12	2.36
117	0.82	1.01	1.36	1.58	1.84	2.11	2.35
118	0.82	1.01	1.35	1.57	1.83	2.09	2.33
119	0.81	1.00	1.34	1.56	1.82	2.08	2.32
120	0.81	0.99	1.33	1.55	1.81	2.07	2.30
121	0.80	0.99	1.32	1.54	1.80	2.05	2.29
122	0.80	0.98	1.31	1.53	1.78	2.04	2.27
123	0.79	0.97	1.30	1.52	1.77	2.03	2.26
124	0.79	0.97	1.30	1.51	1.76	2.01	2.24
125	0.78	0.96	1.29	1.50	1.75	2.00	2.23
126	0.78	0.96	1.28	1.49	1.74	1.99	2.22
127	0.77	0.95	1.27	1.48	1.73	1.98	2.20

## ATTACHMENT D

## DRAINAGE CRITERIA

## CITY OF WICHITA, KANSAS

RECOMMENDED RUNOFF COEFFICIENTS FOR RATIONAL METHOD  
AND PERCENT IMPERVIOUS FOR UNIT HYDROGRAPH METHOD

Land Use or Surface Characteristics	Percent Impervious	Frequency			
		2	5	10	100
<b>1. Business:</b>					
Downtown Areas	95	0.84	0.85	0.87	0.91
Neighborhood Areas	70	0.68	0.69	0.73	0.80
<b>2. Residential:</b>					
<u>Single Family (Soil Group D)</u>					
1/8 Acre	50	0.57	0.61	0.66	0.79
1/4 Acre	38	0.50	0.54	0.62	0.76
1/3 Acre	30	0.46	0.50	0.59	0.73
1/2 Acre	25	0.42	0.48	0.56	0.72
3/4 Acre	22	0.42	0.46	0.55	0.71
1 Acre	20	0.41	0.45	0.54	0.71
<u>Multi-Family (Soil Group D)</u>					
Multi-Unit (detached)	60	0.62	0.66	0.72	0.82
Multi-Unit (attached)	65	0.64	0.68	0.73	0.83
Apartments	75	0.70	0.73	0.79	0.86
<u>Single Family (Soil Group C)</u>					
1/8 Acre	50	0.55	0.58	0.64	0.73
1/4 Acre	38	0.48	0.51	0.57	0.68
1/3 Acre	30	0.43	0.46	0.53	0.65
1/2 Acre	25	0.40	0.43	0.50	0.63
3/4 Acre	22	0.39	0.42	0.49	0.62
1 Acre	20	0.37	0.40	0.48	0.61
<u>Multi-Family (Soil Group C)</u>					
Multi-Unit (detached)	60	0.60	0.63	0.69	0.77
Multi-Unit (attached)	65	0.63	0.66	0.71	0.79
Apartments	75	0.68	0.72	0.77	0.83
<u>Single-Family (Soil Group B)</u>					
1/8 Acre	50	0.52	0.54	0.59	0.67
1/4 Acre	38	0.44	0.46	0.52	0.61
1/3 Acre	30	0.39	0.41	0.47	0.57
1/2 Acre	25	0.36	0.38	0.44	0.54
3/4 Acre	22	0.34	0.36	0.42	0.52
1 Acre	20	0.33	0.35	0.40	0.51
<u>Multi-Family (Soil Group B)</u>					
Multi-Unit (detached)	60	0.58	0.60	0.65	0.72
Multi-Unit (attached)	65	0.61	0.64	0.68	0.75
Apartments	75	0.67	0.70	0.74	0.80

Land Use or Surface Characteristics	Percent Impervious	Frequency			
		2	5	10	100
<u>Single Family (Soil Group A)</u>					
1/8 Acre	50	0.47	0.50	0.54	0.60
1/4 Acre	38	0.39	0.41	0.45	0.52
1/3 Acre	30	0.33	0.35	0.39	0.47
1/2 Acre	25	0.30	0.31	0.35	0.44
3/4 Acre	22	0.28	0.29	0.33	0.42
1 Acre	20	0.26	0.28	0.32	0.40
<u>Multi-Family (Soil Group A)</u>					
Multi-Unit (detached)	60	0.55	0.57	0.61	0.67
Multi-Unit (attached)	65	0.58	0.60	0.64	0.70
Apartments	75	0.65	0.68	0.72	0.77
3. Industrial:					
Light Areas	70	0.68	0.69	0.73	0.80
Heavy Areas	80	0.74	0.76	0.79	0.84
4. Playgrounds:					
	15	0.33	0.35	0.42	0.55
5. Schools:					
	40	0.49	0.51	0.56	0.66
6. Railroad Yard Areas:					
	30	0.43	0.45	0.50	0.62
7. Undeveloped Urban Areas: Offsite Flow Analysis (when land use not defined)					
	45	0.52	0.54	0.59	0.68
8. Streets:					
Paved	99	0.87	0.88	0.90	0.93
Gravel	00	0.24	0.26	0.33	0.48
9. Drive, Parking Lots and Walks:					
	96	0.87	0.87	0.88	0.89
10. Roofs:					
	90	0.80	0.85	0.90	0.93
11. Urban Lawn Areas (See Note No. 1 below):					
<u>Soil Group A</u>					
Slope less than 1%	00	0.08	0.09	0.13	0.23
Slope 1% to 4%	00	0.12	0.13	0.17	0.27
Slope more than 4%	00	0.16	0.17	0.21	0.31
<u>Soil Group B</u>					
Slope less than 1%	00	0.16	0.18	0.24	0.37
Slope 1% to 4%	00	0.20	0.22	0.28	0.41
Slope more than 4%	00	0.24	0.26	0.32	0.45
<u>Soil Group C</u>					
Slope less than 1%	00	0.24	0.27	0.35	0.51
Slope 1% to 4%	00	0.26	0.29	0.37	0.53
Slope more than 4%	00	0.28	0.31	0.39	0.55

Land Use or  
Surface Characteristics

Percent  
Impervious

Frequency

Soil Group D

		<u>2</u>	<u>5</u>	<u>10</u>	<u>100</u>
Slope less than 1%	00	0.28	0.33	0.43	0.63
Slope 1% to 4%	00	0.30	0.35	0.45	0.65
Slope more than 4%	00	0.32	0.37	0.47	0.67

Note No. 1: Coefficients shown in the above table are for pervious open space areas with thick turf which includes pervious areas in parks and cemeteries. Coefficients shown above must be increased 0.02 for use with agricultural pasture areas. Coefficients shown above must be reduced by 0.04 for use with agricultural cultivated areas. Group A soils are well-drained, coarse textured sands with high infiltration rates. Group B soils are moderately well-drained, moderately coarse textured soils with moderate infiltration rates. Group C soils are moderately poor-drained, moderately fine textured soils with slow infiltration rates. Group D soils are poor-drained, fine textured soils with very slow infiltration rates.

GENERAL NOTE: These Rational Formula Coefficients may not be valid for basins 320 acres or larger.

## DRAINAGE CRITERIA

## CITY OF WICHITA, KANSAS

RECOMMENDED RUNOFF COEFFICIENTS FOR RATIONAL METHOD  
AND PERCENT IMPERVIOUS FOR UNIT HYDROGRAPH METHOD

Land Use or Surface Characteristics	Percent Impervious	Frequency			
		2	5	10	100
<b>1. Business:</b>					
Downtown Areas	95	0.84	0.85	0.87	0.91
Neighborhood Areas	70	0.68	0.69	0.73	0.80
<b>2. Residential:</b>					
<u>Single Family (Soil Group D)</u>					
1/8 Acre	50	0.57	0.61	0.66	0.79
1/4 Acre	38	0.50	0.54	0.62	0.76
1/3 Acre	30	0.46	0.50	0.59	0.73
1/2 Acre	25	0.42	0.48	0.56	0.72
3/4 Acre	22	0.42	0.46	0.55	0.71
1 Acre	20	0.41	0.45	0.54	0.71
<u>Multi-Family (Soil Group D)</u>					
Multi-Unit (detached)	60	0.62	0.66	0.72	0.82
Multi-Unit (attached)	65	0.64	0.68	0.73	0.83
Apartments	75	0.70	0.73	0.79	0.86
<u>Single Family (Soil Group C)</u>					
1/8 Acre	50	0.55	0.58	0.64	0.73
1/4 Acre	38	0.48	0.51	0.57	0.68
1/3 Acre	30	0.43	0.46	0.53	0.65
1/2 Acre	25	0.40	0.43	0.50	0.63
3/4 Acre	22	0.39	0.42	0.49	0.62
1 Acre	20	0.37	0.40	0.48	0.61
<u>Multi-Family (Soil Group C)</u>					
Multi-Unit (detached)	60	0.60	0.63	0.69	0.77
Multi-Unit (attached)	65	0.63	0.66	0.71	0.79
Apartments	75	0.68	0.72	0.77	0.83
<u>Single-Family (Soil Group B)</u>					
1/8 Acre	50	0.52	0.54	0.59	0.67
1/4 Acre	38	0.44	0.46	0.52	0.61
1/3 Acre	30	0.39	0.41	0.47	0.57
1/2 Acre	25	0.36	0.38	0.44	0.54
3/4 Acre	22	0.34	0.36	0.42	0.52
1 Acre	20	0.33	0.35	0.40	0.51
<u>Multi-Family (Soil Group B)</u>					
Multi-Unit (detached)	60	0.58	0.60	0.65	0.72
Multi-Unit (attached)	65	0.61	0.64	0.68	0.75
Apartments	75	0.67	0.70	0.74	0.80

Land Use or face Characteristics	Percent Impervious	Frequency			
		2	5	10	100
<u>Single Family (Soil Group A)</u>					
1/8 Acre	50	0.47	0.50	0.54	0.60
1/4 Acre	38	0.39	0.41	0.45	0.52
1/3 Acre	30	0.33	0.35	0.39	0.47
1/2 Acre	25	0.30	0.31	0.35	0.44
3/4 Acre	22	0.28	0.29	0.33	0.42
1 Acre	20	0.26	0.28	0.32	0.40
<u>Multi-Family (Soil Group A)</u>					
Multi-Unit (detached)	60	0.55	0.57	0.61	0.67
Multi-Unit (attached)	65	0.58	0.60	0.64	0.70
Apartments	75	0.65	0.68	0.72	0.77
3. Industrial:					
Light Areas	70	0.68	0.69	0.73	0.80
Heavy Areas	80	0.74	0.76	0.79	0.84
4. Playgrounds:					
	15	0.33	0.35	0.42	0.55
5. Schools:					
	40	0.49	0.51	0.56	0.66
6. Railroad Yard Areas:					
	30	0.43	0.45	0.50	0.62
Undeveloped Urban Areas:					
Offsite Flow Analysis (when land use not defined)	45	0.52	0.54	0.59	0.68
8. Streets:					
Paved	99	0.87	0.88	0.90	0.93
Gravel	00	0.24	0.26	0.33	0.48
9. Drive, Parking Lots and Walks:					
	96	0.87	0.87	0.88	0.89
10. Roofs:					
	90	0.80	0.85	0.90	0.93
11. Urban Lawn Areas (See Note No. 1 below):					
<u>Soil Group A</u>					
Slope less than 1%	00	0.08	0.09	0.13	0.23
Slope 1% to 4%	00	0.12	0.13	0.17	0.27
Slope more than 4%	00	0.16	0.17	0.21	0.31
<u>Soil Group B</u>					
Slope less than 1%	00	0.16	0.18	0.24	0.37
Slope 1% to 4%	00	0.20	0.22	0.28	0.41
Slope more than 4%	00	0.24	0.26	0.32	0.45
<u>Soil Group C</u>					
Slope less than 1%	00	0.24	0.27	0.35	0.51
Slope 1% to 4%	00	0.26	0.29	0.37	0.53
Slope more than 4%	00	0.28	0.31	0.39	0.55

Land Use or Face Characteristics	Percent Impervious	Frequency			
		<u>2</u>	<u>5</u>	<u>10</u>	<u>100</u>
<u>Soil Group D</u>					
Slope less than 1%	00	0.28	0.33	0.43	0.63
Slope 1% to 4%	00	0.30	0.35	0.45	0.65
Slope more than 4%	00	0.32	0.37	0.47	0.67

Note No. 1: Coefficients shown in the above table are for pervious open space areas with thick turf which includes pervious areas in parks and cemeteries. Coefficients shown above must be increased 0.02 for use with agricultural pasture areas. Coefficients shown above must be reduced by 0.04 for use with agricultural cultivated areas. Group A soils are well-drained, coarse textured sands with high infiltration rates. Group B soils are moderately well-drained, moderately coarse textured soils with moderate infiltration rates. Group C soils are moderately poor-drained, moderately fine textured soils with slow infiltration rates. Group D soils are poor-drained, fine textured soils with very slow infiltration rates.

GENERAL NOTE: These Rational Formula Coefficients may not be valid for basins 320 acres or larger.