KTP ADDITION
DRAINAGE ANALYSIS
SEPTEMBER 2001

INTRODUCTION

This report contains supporting documentation and calculations for the proposed KTP Addition. The existing site is an undeveloped 51 acre tract of land at the northwest corner of Central Ave. and K-96 highway. The site is currently pasture land with two major drainage ways through the site. One drainage way is in the southwest corner of the property and the other is in central portion of the property flowing from north to south. Existing off-site drainage enters the site from one location on the west and two locations on the north lines of this property.

The drainage from the north comes from three (3) 8.5 sq. ft. RCPH pipes under K-96 that drains the K-96 right-of-way on the east and a proposed 8' x 5' RCB from Balthrop 4th Addition on the west. The drainage from the west comes from a pond just west of the subject property and drains approximately 424 acres to the west and north. Both drainage ways are controlled by existing reinforced concrete box culverts (RCB's) under Central Ave.

The site will be developed into commercial lots with on-site detention to be accomplished using the two (2) existing ponds in the center of the property and a proposed third pond in the reserve adjacent to Central Ave. Detention for this site will also include the required detention for the Balthrop 4th Addition. A portion of the cost for the required drainage improvements on this site will be covered by the developer of Balthrop 4th Addition.

HYDROLOGY

Peak flow rates for the offsite flows were determined from a combination of drainage data from Professional Engineering Consultants, P.A. for the Balthrop 4th Addition and the U.S. Army Corps of Engineers HEC-HMS model. The HY-8 data from the box culverts under Central Ave. was used in the model as downstream controls for this site.

Additional information was obtained from the drainage map and plan and profile sheets of the construction plans for Central Avenue, County Project No. 618-34 dated July 1997.

The rational method was used to determine peak flow rates for the basins located within the plat. See the "Hydrology Data" section of this report for calculations and results for this project.

HYDRAULICS

Hydraulic characteristics and design for the channels and outfall structures for the ponds were determined using the Haestad Methods Open Channel Flow Module. The model utilizes the Manning's Equation for open-channel flow to determine depths and velocities. The channels were also checked for soil stability using the determined channel characteristics based on the North American Green - Erosion Control Materials Design Software Ver.4.11 for channels. Proposed flow line and road surface elevations will be finalized during the design of the street from Balthrop 4th Addition to Central Avenue. All other sites shall be graded in accordance with the drainage plan and shall adhere to the required minimum building pads.

All minimum pads are based on the HEC-HMS model high water elevations for the proposed and existing detention ponds on this site. There are no flood hazard areas on this site as shown on the Sedgwick County, Kansas flood maps.

CONCLUSION

The proposed and existing detention ponds will provide sufficient storage to detain the necessary flow from both this site and Balthrop 4th Addition. Weir structures must be constructed on both Pond 1 and Pond 2 to control the outflow from the detention ponds. Pond 1 shall have a ten foot (10') broad-crested weir and Pond 2 shall have a twenty-four foot (24') broad-crested weir. The control structure for the proposed Pond 3 is the 7'x7' RCB under Central Ave.

All interior drainage from Basins B through E shall be routed to the detention ponds and Basins F and G shall be routed to the existing storm water sewer system on the north side of Central Ave. Basin A shall be routed directly to the box culvert at the southwest corner of the plat.

The following table breaks down the proposed and existing 100 year frequency rainfall event flow rates for this project.

Basin	Q100 (developed)	Q100 (existing)
A & West Offsite	1,154.6 cfs	1,153.7 cfs
B-E & North Offsite	432.0 cfs	433.8 cfs
F	30.1 cfs	25.2 cfs
G	31.3 cfs	26.2 cfs
Total	**1,648.0 cfs**	**1,638.9 cfs**

Hydrology Data

Onsite Hydrology

Proposed Runoff Data (All Basins)

Hydrologic Soil Group D
Assume commercial development for all basins
$C_5 = 0.69$
$C_{100} = 0.80$
Assume all drainage areas have a T_C of 15 minutes, which is the minimum per the City of Wichita Design Criteria.
$I_5 = 4.56$ in/hr
$I_{100} = 7.37$ in/hr

Area A

Area = 10.2 acres
$Q_5 = 0.69(4.56)(10.2) = 32.1$ cfs
$Q_{100} = 0.80(7.37)(10.2) = 60.2$ cfs

Area B

Area = 6.7 acres
$Q_5 = 0.69(4.56)(6.7) = 21.1$ cfs
$Q_{100} = 0.80(7.37)(6.7) = 39.5$ cfs

Area C

Area = 3.5 acres
$Q_5 = 0.69(4.56)(3.5) = 11.0$ cfs
$Q_{100} = 0.80(7.37)(3.5) = 20.7$ cfs

Area D

Area = 1.0 acres
$Q_5 = 0.69(4.56)(1.0) = 3.1$ cfs
$Q_{100} = 0.80(7.37)(1.0) = 5.9$ cfs

Area E

Area = 19.5 acres
$Q_5 = 0.69(4.56)(19.5) = 61.4$ cfs
$Q_{100} = 0.80(7.37)(19.5) = 115.0$ cfs

Area F

Area = 5.1 acres
$Q_5 = 0.69(4.56)(5.1) = 16.1$ cfs
$Q_{100} = 0.80(7.37)(5.1) = 30.1$ cfs

Area G

Area = 5.3 acres
$Q_5 = 0.69(4.56)(5.3) = 16.7$ cfs
$Q_{100} = 0.80(7.37)(5.3) = 31.3$ cfs

Offsite Hydrology

West Offsite Drainage

Area = 424 acres +/- = 0.66 sq. mi
L = 6,519 ft = 1.23 mi
L_{CA} = 3,911 ft = 0.74 mi
Slope = 59.5 ft/ 6519 ft = 0.00913 ft/ft = 48.2 ft/mi

2 of the 4 parameters fit the requirement of the Snyder Unit Hydrograph Equation and the other 2 are close, so the Snyder parameters will be used for the west offsite basin.

See following page for data.

North Offsite Drainage Basins

Balthrop 4th Addition

All proposed flow rates taken from the Professional Engineering Consultants, P.A. Drainage Plan for Balthrop 4th Addition.

K-96 Right-of-Way

Area = 57.4 acres
T_C = 23 min.
I_{100} = 6.13 in/hr
C = 0.69
Q_{100} = 0.69(6.13)(57.4) = 242.8 cfs

Tulsa District Method for Estimating Snyder Parameters

The Tulsa District of the U. S. Army Corps of Engineers has developed the following equation for Snyder's watershed lag for natural watersheds in rural areas of central and norteastern Oklahoma.

$$T = 1.42 \times [(L \times Lca)/sq.rt.\ S)]^{0.39}$$

in which:

T = watershed lag in hours
L = watershed length in miles
Lca = length to centroid in miles
S = watershed slope in feet per mile.

The range of hydrologic characteristics of the watersheds studied in developing this equation are as follows:

Watershed Area: From 0.88 sq. mi. to 502 sq. mi.
Watershed Slope: From 4.1 feet per mile to 82.1 feet per mile
Watershed Length: From 1.4 miles to 60.5 miles
Length to Centroid: From 0.6 miles to 33.0 miles

Basin Name	Area (acres)	Area (sq. mi.)	L (mi)	Lca (mi)	S (ft/mi)	T (hr)	qp (cfs/sq.mi.)	Cp (cf/sq.mi.)
KTP Offsite West	*424.00*	*0.6625*	*1.23*	*0.74*	*48*	0.64	*570.53*	0.573

Box Culvert Analysis
Under Central Ave.
HY-8 Data

2 - 7'x7' RCB

CURRENT DATE: 08-30-2001
CURRENT TIME: 08:24:46

FILE DATE: 08-30-2001
FILE NAME: ktp_3

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.0

CULVERT NO.	INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	1340.80	1340.50	94.00	2 RCB	7.00	7.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: ktp_3 DATE: 08-30-2001

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
1340.80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1344.69	120.0	120.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1345.18	240.0	240.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1345.17	360.0	360.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1346.09	480.0	480.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1346.94	600.0	600.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1347.73	720.0	720.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1348.48	840.0	840.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1349.33	960.0	960.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1350.07	1080.0	1056.3	0.0	0.0	0.0	0.0	0.0	21.48	6
1350.22	1155.0	1075.8	0.0	0.0	0.0	0.0	0.0	71.26	5
1349.86	1029.3	1029.3	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: ktp_3 DATE: 08-30-2001

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
1340.80	0.000	0.00	0.00	0.00
1344.69	0.000	120.00	0.00	0.00
1345.18	0.000	240.00	0.00	0.00
1345.17	0.000	360.00	0.00	0.00
1346.09	0.000	480.00	0.00	0.00
1346.94	0.000	600.00	0.00	0.00
1347.73	0.000	720.00	0.00	0.00
1348.48	0.000	840.00	0.00	0.00
1349.33	0.000	960.00	0.00	0.00
1350.07	-0.004	1080.00	2.22	0.21
1350.22	-0.007	1155.00	7.96	0.69

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

PERFORMANCE CURVE FOR CULVERT 1 - 2(7.00 (ft) BY 7.00 (ft)) RCB

DISCHARGE FLOW (cfs)	HEADWATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	1340.80	0.00	-0.30	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
120.00	1344.69	1.96	3.89	1-S2n	1.26	1.32	1.26	1.61	6.79	4.52
240.00	1345.18	3.11	4.38	1-S2n	2.05	2.09	2.05	2.29	8.35	5.47
360.00	1345.17	4.12	4.37	3-M1t	2.75	2.74	2.79	2.79	9.22	6.10
480.00	1346.09	5.06	5.29	2-M2c	3.40	3.32	3.32	3.20	10.31	6.59
600.00	1346.94	5.94	6.14	2-M2c	4.02	3.86	3.86	3.55	11.11	6.98
720.00	1347.73	6.79	6.93	2-M2c	4.62	4.36	4.36	3.86	11.81	7.32
840.00	1348.48	7.65	7.68	2-M2c	5.22	4.83	4.83	4.15	12.43	7.62
960.00	1349.33	8.53	8.39	2-M2c	5.80	5.28	5.28	4.41	12.99	7.89
1056.30	1350.06	9.26	8.95	2-M2c	6.27	5.62	5.62	4.79	13.41	8.27
1075.78	1350.22	9.42	9.06	2-M2c	7.00	5.69	5.69	4.87	13.50	8.36

El. inlet face invert 1340.80 ft El. outlet invert 1340.50 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **********

INLET STATION	0.00 ft
INLET ELEVATION	1340.80 ft
OUTLET STATION	94.00 ft
OUTLET ELEVATION	1340.50 ft
NUMBER OF BARRELS	2
SLOPE (V/H)	0.0032
CULVERT LENGTH ALONG SLOPE	94.00 ft

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	BOX
BARREL SPAN	7.00 ft
BARREL RISE	7.00 ft
BARREL MATERIAL	CONCRETE
BARREL MANNING'S n	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	1:1 BEVEL (45 DEG. FLARE)
INLET DEPRESSION	NONE

TAILWATER

******* REGULAR CHANNEL CROSS SECTION ****************

BOTTOM WIDTH	10.00 ft
SIDE SLOPE H/V (X:1)	4.0
CHANNEL SLOPE V/H (ft/ft)	0.007
MANNING'S n (.01-0.1)	0.030
CHANNEL INVERT ELEVATION	1340.50 ft
CULVERT NO.1 OUTLET INVERT ELEVATION	1340.50 ft

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	1340.50	0.000	0.00	0.00	0.00
120.00	1342.11	0.630	1.61	4.52	0.70
240.00	1342.79	0.640	2.29	5.47	1.00
360.00	1343.29	0.640	2.79	6.10	1.22
480.00	1343.70	0.650	3.20	6.59	1.40
600.00	1344.05	0.650	3.55	6.98	1.55
720.00	1344.36	0.660	3.86	7.32	1.69
840.00	1344.65	0.660	4.15	7.62	1.81
960.00	1344.91	0.660	4.41	7.89	1.92
1080.00	1345.29	0.670	4.79	8.27	2.09
1155.00	1345.37	0.670	4.87	8.36	2.13

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	49.00 ft

***** USER DEFINED ROADWAY PROFILE

CROSS-SECTION COORD. NO.	X ft	Y ft
1	5700.00	1350.56
2	5800.00	1350.24
3	5900.00	1349.92
4	5950.00	1349.86
5	6000.00	1350.00
6	6050.00	1350.24

7'x7' RCB

CURRENT DATE: 08-30-2001
CURRENT TIME: 08:32:05

FILE DATE: 08-30-2001
FILE NAME: ktp_1

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.0

CULVERT NO.	INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	1339.55	1339.50	93.50	1 RCB	7.00	7.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: ktp_1 DATE: 08-30-2001

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
1339.55	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1341.48	50.0	50.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1342.57	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1343.49	150.0	150.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1344.31	200.0	200.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1345.07	250.0	250.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1345.76	300.0	300.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1346.44	350.0	350.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1347.05	400.0	400.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1347.68	450.0	450.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1348.39	500.0	500.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1349.24	554.4	554.4	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: ktp_1 DATE: 08-30-2001

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
1339.55	0.000	0.00	0.00	0.00
1341.48	0.000	50.00	0.00	0.00
1342.57	0.000	100.00	0.00	0.00
1343.49	0.000	150.00	0.00	0.00
1344.31	0.000	200.00	0.00	0.00
1345.07	0.000	250.00	0.00	0.00
1345.76	0.000	300.00	0.00	0.00
1346.44	0.000	350.00	0.00	0.00
1347.05	0.000	400.00	0.00	0.00
1347.68	0.000	450.00	0.00	0.00
1348.39	0.000	500.00	0.00	0.00

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

PERFORMANCE CURVE FOR CULVERT 1 - 1(7.00 (ft) BY 7.00 (ft)) RCB

DISCHARGE FLOW (cfs)	HEADWATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	1339.55	0.00	-0.05	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
50.00	1341.48	1.74	1.93	2-M2c	2.13	1.17	1.17	1.02	6.11	3.50
100.00	1342.57	2.77	3.02	2-M2c	3.53	1.85	1.85	1.47	7.70	4.29
150.00	1343.49	3.63	3.94	2-M2c	4.82	2.43	2.43	1.81	8.82	4.81
200.00	1344.31	4.45	4.76	2-M2c	6.05	2.94	2.94	2.09	9.71	5.21
250.00	1345.07	5.22	5.52	2-M2c	7.00	3.42	3.42	2.33	10.45	5.54
300.00	1345.76	5.95	6.21	2-M2c	7.00	3.86	3.86	2.55	11.11	5.82
350.00	1346.44	6.66	6.89	2-M2c	7.00	4.28	4.28	2.75	11.70	6.06
400.00	1347.05	7.37	7.50	2-M2c	7.00	4.67	4.67	2.93	12.23	6.28
450.00	1347.68	8.09	8.13	2-M2c	7.00	5.05	5.05	3.10	12.72	6.48
500.00	1348.39	8.84	8.73	2-M2c	7.00	5.42	5.42	3.26	13.17	6.66

El. inlet face invert 1339.55 ft El. outlet invert 1339.50 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **********

INLET STATION	0.00 ft
INLET ELEVATION	1339.55 ft
OUTLET STATION	93.50 ft
OUTLET ELEVATION	1339.50 ft
NUMBER OF BARRELS	1
SLOPE (V/H)	0.0005
CULVERT LENGTH ALONG SLOPE	93.50 ft

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	BOX
BARREL SPAN	7.00 ft
BARREL RISE	7.00 ft
BARREL MATERIAL	CONCRETE
BARREL MANNING'S n	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	1:1 BEVEL (45 DEG. FLARE)
INLET DEPRESSION	NONE

TAILWATER

******* REGULAR CHANNEL CROSS SECTION **********

BOTTOM WIDTH	10.00 ft
SIDE SLOPE H/V (X:1)	4.0
CHANNEL SLOPE V/H (ft/ft)	0.007
MANNING'S n (.01-0.1)	0.030
CHANNEL INVERT ELEVATION	1339.50 ft
CULVERT NO.1 OUTLET INVERT ELEVATION	1339.50 ft

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	1339.50	0.000	0.00	0.00	0.00
50.00	1340.52	0.613	1.02	3.50	0.44
100.00	1340.97	0.624	1.47	4.29	0.64
150.00	1341.31	0.630	1.81	4.81	0.79
200.00	1341.59	0.635	2.09	5.21	0.91
250.00	1341.83	0.638	2.33	5.54	1.02
300.00	1342.05	0.641	2.55	5.82	1.12
350.00	1342.25	0.644	2.75	6.06	1.20
400.00	1342.43	0.646	2.93	6.28	1.28
450.00	1342.60	0.648	3.10	6.48	1.36
500.00	1342.76	0.650	3.26	6.66	1.42

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	49.00 ft

***** USER DEFINED ROADWAY PROFILE

CROSS-SECTION COORD. NO.	X ft	Y ft
1	6050.00	1350.24
2	6300.00	1349.60
3	6400.00	1349.34
4	6500.00	1349.24
5	6600.00	1350.06
6	6700.00	1351.06

Open Channel Data

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: K96 -Pond2

Comment: Channel from K96 drainage to pond 2

Solve For Depth

Given Input Data:

Bottom Width.....	30.00 ft
Left Side Slope..	4.00:1 (H:V)
Right Side Slope.	4.00:1 (H:V)
Manning's n.....	0.030
Channel Slope....	0.0080 ft/ft
Discharge.....	240.00 cfs

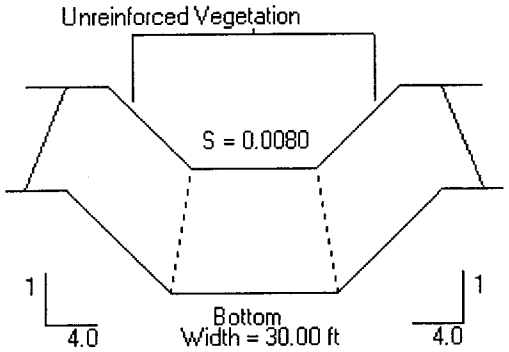
Computed Results:

Depth.....	1.37 ft
Velocity.....	4.94 fps
Flow Area.....	48.60 sf
Flow Top Width...	40.96 ft
Wetted Perimeter.	41.30 ft
Critical Depth...	1.19 ft
Critical Slope...	0.0131 ft/ft
Froude Number....	0.80 (flow is Subcritical)

North American Green - Erosion Control Materials Design Software Ver.4.11 - Channel	8/29/01	10:06 AM	COMPUTED BY: JDS
PROJECT NAME: KTP Addition	PROJECT NO.: 1851P		
FROM STATION/REACH: ~~Pond 2~~ P96	TO STATION/REACH: ~~Pond~~ P2	DRAINAGE AREA: 0.231 sq. mi.	DESIGN FREQUENCY: 100 Yr.

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
241.0	1.0	4.95	48.73	1.18	1.37



Not to Scale

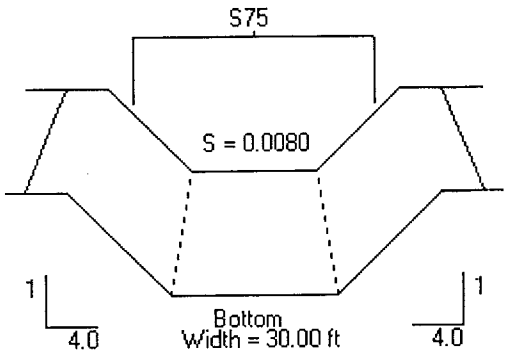
LINER RESULTS

Reach	Material Type / Staple Pattern	Phase / Class	Veg. Type / Veg. Density	Soil Type	Manning's 'n'	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	Unreinforced		Sod		0.030	3.33	0.69	4.86	STABLE
		D	50-75%	Clay Loam		0.050	0.056	0.90	UNSTABLE

North American Green - Erosion Control Materials Design Software Ver.4.11 - Channel	8/29/01	09:12 AM	COMPUTED BY: JDS
PROJECT NAME: KTP Addition			PROJECT NO.: 1851P
FROM STATION/REACH: ~~KTP~~ K96	TO STATION/REACH: Pond 2	DRAINAGE AREA: 0.090 sq. mi.	DESIGN FREQUENCY: 100 Yr.

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
241.0	1.0	4.61	52.23	1.24	1.46



Not to Scale

LINER RESULTS

Reach	Material Type / Staple Pattern	Phase / Class	Veg. Type / Veg. Density	Soil Type	Manning's 'n'	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75				0.033	1.55	0.73	2.13	STABLE
	Staple D								

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: KTP Addition

Description: Channel from Pond 2 to Pond 3

Solve For Depth

Given Constant Data;

Bottom Width.....	30.00
Z-Left.....	2.00
Z-Right.....	2.00
Mannings 'n'.....	0.030
Channel Slope.....	0.0100

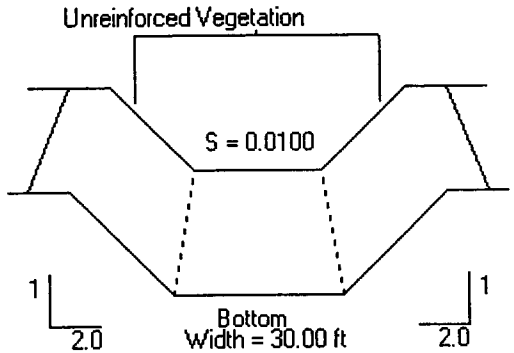
Variable Input Data	Minimum	Maximum	Increment By
Channel Discharge	0.00	518.00	50.00

Bottom Width ft	Z-Left (H:V)	Z-Right (H:V)	Mannings 'n'	Channel Slope ft/ft	COMPUTED VARIABLE COMPUTED Channel Depth ft	Channel Discharge cfs	Velocity fps
Unable to compute this instance.							
30.00	2.00	2.00	0.030	0.0100	0.52	50.00	3.11
30.00	2.00	2.00	0.030	0.0100	0.78	100.00	4.04
30.00	2.00	2.00	0.030	0.0100	1.00	150.00	4.70
30.00	2.00	2.00	0.030	0.0100	1.18	200.00	5.23
30.00	2.00	2.00	0.030	0.0100	1.35	250.00	5.67
30.00	2.00	2.00	0.030	0.0100	1.50	300.00	6.05
30.00	2.00	2.00	0.030	0.0100	1.64	350.00	6.39
30.00	2.00	2.00	0.030	0.0100	1.78	400.00	6.70
30.00	2.00	2.00	0.030	0.0100	1.91	450.00	6.98
30.00	2.00	2.00	0.030	0.0100	2.03	500.00	7.24
30.00	2.00	2.00	0.030	0.0100	2.14	550.00	7.48

North American Green - Erosion Control Materials Design Software Ver.4.11 - Channel	8/29/01	09:14 AM	COMPUTED BY: JDS
PROJECT NAME: KTP Addition		PROJECT NO.: 1851P	
FROM STATION/REACH: Pond 2	TO STATION/REACH: Pond 3	DRAINAGE AREA: 0.231 sq. mi.	DESIGN FREQUENCY: 100 Yr.

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
518.0	1.0	7.33	70.67	1.80	2.07



Not to Scale

LINER RESULTS

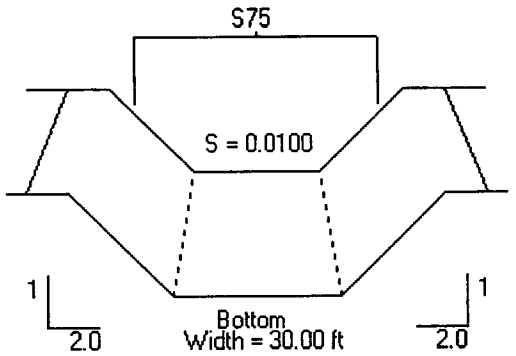
Reach	Material Type / Staple Pattern	Phase / Class	Veg. Type / Veg. Density	Soil Type	Manning's 'n'	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	Unreinforced		Sod		0.030	3.33	1.29	2.58	STABLE
		D	50-75%	Clay Loam		0.050	0.105	0.48	UNSTABLE

North American Green - Erosion Control Materials Design Software Ver.4.11 - Channel	8/29/01	09:15 AM	COMPUTED BY: JDS

PROJECT NAME: KTP Addition		PROJECT NO.: 1851P	
FROM STATION/REACH: Pond 2	TO STATION/REACH: Pond 3	DRAINAGE AREA: 0.231 sq. mi.	DESIGN FREQUENCY: 100 Yr.

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
518.0	1.0	8.35	62.05	1.62	1.84



Not to Scale

LINER RESULTS

Reach	Material Type / Staple Pattern	Phase / Class	Veg. Type / Veg. Density	Soil Type	Manning's 'n'	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75				0.025	1.55	1.15	1.35	STABLE
	Staple D								

Weir Design Data

Project

By Date Page Of

SRB 924 NORTH MAIN WICHITA, KANSAS 67203 http://www.feist.com/~srb
316-264-8008 FAX 264-4621 srb@feist.com
SAVOY, RUGGLES & BOHM, P. A.
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Weir Design

Broad-crested Weir: $Q = C_w L h^{3/2}$

where $C_w = 3.58$ @ $h = 1.5$
$= 3.56$ @ $h = 2.0$
$= 3.60$ @ $h = 3.5$
$= 3.68$ @ $h = 5.0$

Since we are dealing with no more than 3.0' of head, we will assume $C_w = 3.58$.

$\therefore Q = 3.58 L (h^{3/2})$

For Pond 1, use $L = 10'$

For Pond 2, use $L = 24'$

Weir Rating Curve For Numerous Broadcrested Weirs

H	Q	C= 3.58 L= 5.0
0.0	0.00	
0.2	1.60	
0.4	4.53	
0.6	8.32	
0.8	12.81	
1.0	17.90	
1.2	23.53	
1.4	29.65	
1.6	36.23	
1.8	43.23	
2.0	50.63	
2.2	58.41	
2.4	66.55	
2.6	75.04	
2.8	83.87	
3.0	93.01	
3.2	102.47	
3.4	112.22	
3.6	122.27	
3.8	132.60	
4.0	143.20	

H	Q	C= 3.58 L= 10.0
0.0	0.00	
0.2	3.20	
0.4	9.06	
0.6	16.64	
0.8	25.62	
1.0	35.80	
1.2	47.06	
1.4	59.30	
1.6	72.45	
1.8	86.46	
2.0	101.26	
2.2	116.82	
2.4	133.11	
2.6	150.09	
2.8	167.73	
3.0	186.02	
3.2	204.93	
3.4	224.44	
3.6	244.53	
3.8	265.19	
4.0	286.40	

Pond 1 Weir

H	Q	C= 3.58 L= 12.0
0.0	0.00	
0.2	3.84	
0.4	10.87	
0.6	19.97	
0.8	30.74	
1.0	42.96	
1.2	56.47	
1.4	71.16	
1.6	86.94	
1.8	103.75	
2.0	121.51	
2.2	140.18	
2.4	159.73	
2.6	180.10	
2.8	201.28	
3.0	223.23	
3.2	245.92	
3.4	269.33	
3.6	293.44	
3.8	318.23	
4.0	343.68	

H	Q	C= 3.58 L= 14.0
0.0	0.00	
0.2	4.48	
0.4	12.68	
0.6	23.29	
0.8	35.86	
1.0	50.12	
1.2	65.88	
1.4	83.02	
1.6	101.44	
1.8	121.04	
2.0	141.76	
2.2	163.55	
2.4	186.35	
2.6	210.12	
2.8	234.83	
3.0	260.43	
3.2	286.90	
3.4	314.22	
3.6	342.35	
3.8	371.27	
4.0	400.96	

Weir Rating Curve For Numerous Broadcrested Weirs

H	Q	C= 3.58 L= 21.0
0.0	0.00	
0.2	6.72	
0.4	19.02	
0.6	34.94	
0.8	53.79	
1.0	75.18	
1.2	98.83	
1.4	124.54	
1.6	152.15	
1.8	181.56	
2.0	212.64	
2.2	245.32	
2.4	279.52	
2.6	315.18	
2.8	352.24	
3.0	390.65	
3.2	430.36	
3.4	471.33	
3.6	513.52	
3.8	556.90	
4.0	601.44	

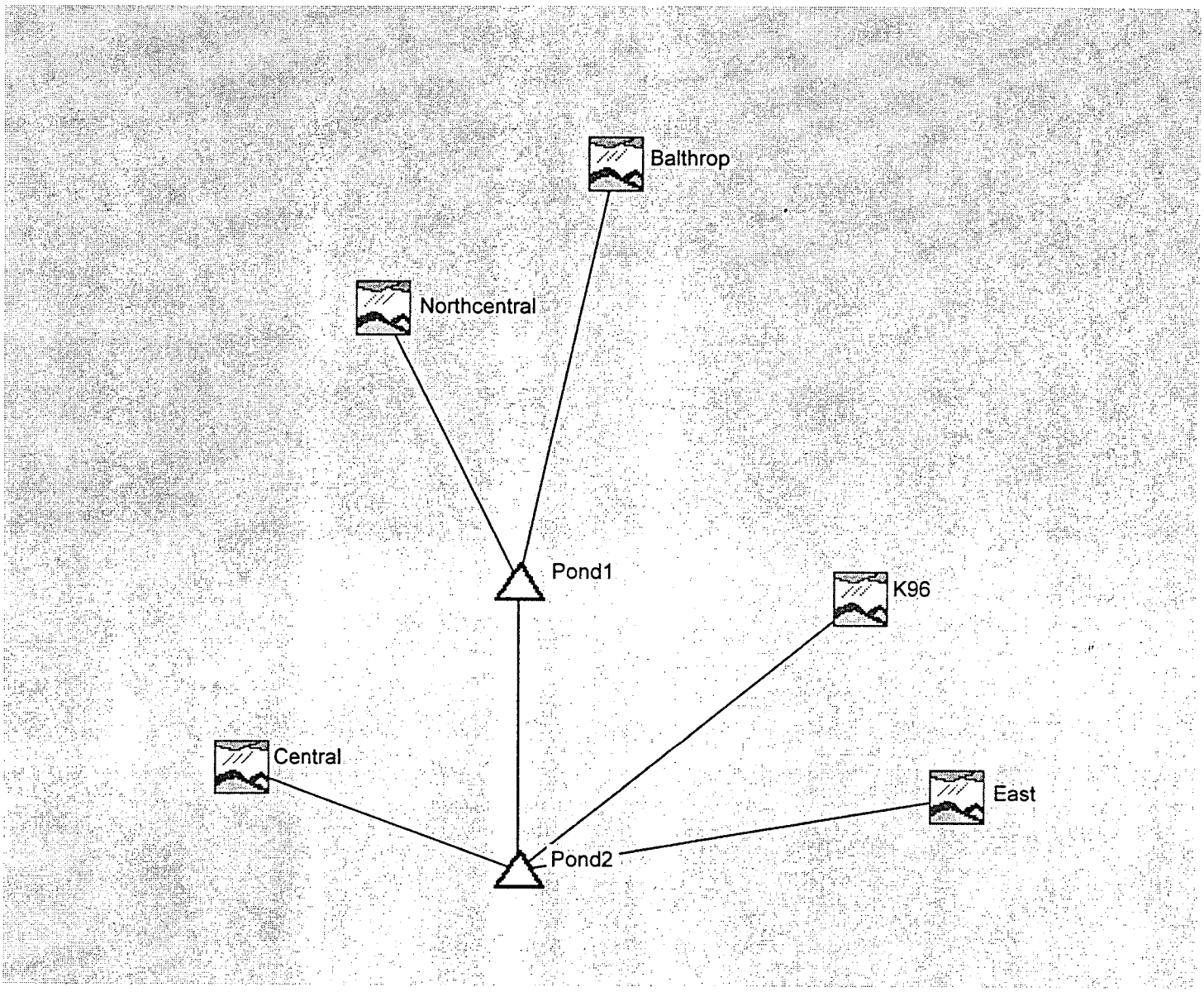
H	Q	C= 3.58 L= 22.0
0.0	0.00	
0.2	7.04	
0.4	19.92	
0.6	36.60	
0.8	56.36	
1.0	78.76	
1.2	103.53	
1.4	130.47	
1.6	159.40	
1.8	190.20	
2.0	222.77	
2.2	257.00	
2.4	292.83	
2.6	330.19	
2.8	369.01	
3.0	409.25	
3.2	450.85	
3.4	493.77	
3.6	537.97	
3.8	583.42	
4.0	630.08	

H	Q	C= 3.58 L= 23.0
0.0	0.00	
0.2	7.36	
0.4	20.83	
0.6	38.27	
0.8	58.92	
1.0	82.34	
1.2	108.24	
1.4	136.40	
1.6	166.64	
1.8	198.85	
2.0	232.89	
2.2	268.69	
2.4	306.15	
2.6	345.20	
2.8	385.79	
3.0	427.85	
3.2	471.34	
3.4	516.21	
3.6	562.42	
3.8	609.94	
4.0	658.72	

H	Q	C= 3.58 L= 24.0
0.0	0.00	
0.2	7.68	
0.4	21.74	
0.6	39.93	
0.8	61.48	
1.0	85.92	
1.2	112.94	
1.4	142.33	
1.6	173.89	
1.8	207.49	
2.0	243.02	
2.2	280.37	
2.4	319.46	
2.6	360.21	
2.8	402.56	
3.0	446.45	
3.2	491.83	
3.4	538.66	
3.6	586.88	
3.8	636.46	
4.0	687.36	

Pond 2 Weir

HEC-HMS Analysis
Existing East Basin


Balthrop
Northcentral
Pond1
K96
Central
East
Pond2

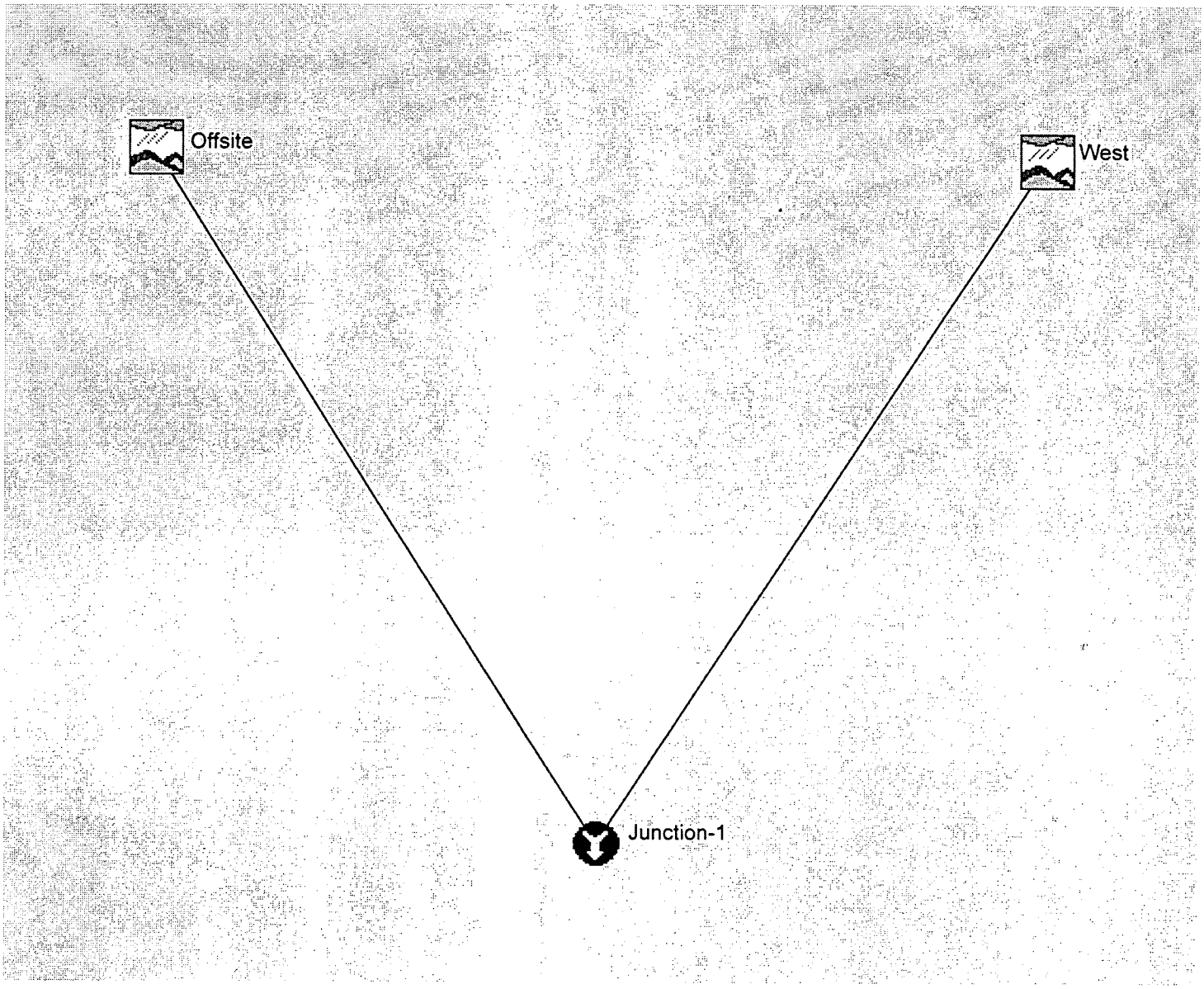
HMS * Summary of Results

Project : KTP Run Name : Run 3

Start of Run : 28Aug01 1200 Basin Model : KTP-Und
End of Run : 29Aug01 1200 Met. Model : 100
Execution Time : 04Sep01 1428 Control Specs : 100

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
Northcentral	34.081	29 Aug 01 0015	3.0710	0.010
Balthrop	253.30	29 Aug 01 0025	29.394	0.096
Pond1	261.00	29 Aug 01 0030	30.776	0.106
Central	17.041	29 Aug 01 0015	1.5355	0.005
K96	222.04	29 Aug 01 0025	27.533	0.090
East	102.23	29 Aug 01 0015	9.2127	0.030
Pond2	433.76	29 Aug 01 0040	68.747	0.231

HEC-HMS Analysis
Existing West Basin


Offsite
West
Junction-1

HMS * Summary of Results

Project : KTP Run Name : Run 4

Start of Run	: 28Aug01 1200	Basin Model	: KTP-UndW
End of Run	: 29Aug01 1200	Met. Model	: 100
Execution Time	: 04Sep01 1432	Control Specs	: 100_West

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
Offsite	1136.5	29 Aug 01 0040	221.99	0.663
West	54.528	29 Aug 01 0015	4.9136	0.016
Junction-1	1153.7	29 Aug 01 0040	226.90	0.679

HEC-HMS Analysis
Proposed East Basin

Project: KTP Addition Drainage Plan
By: JDS | Date: 8-28-01 | Page: 1 | Of:

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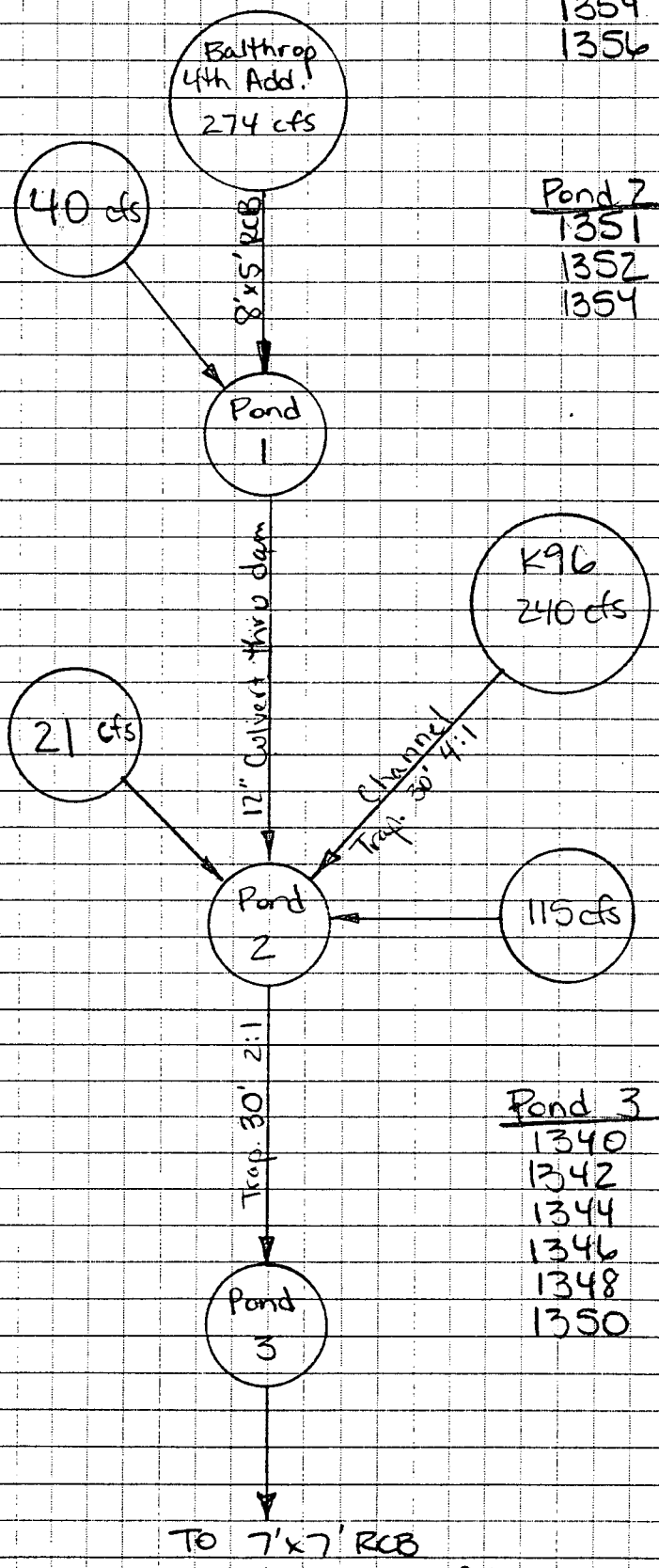


Pond 1

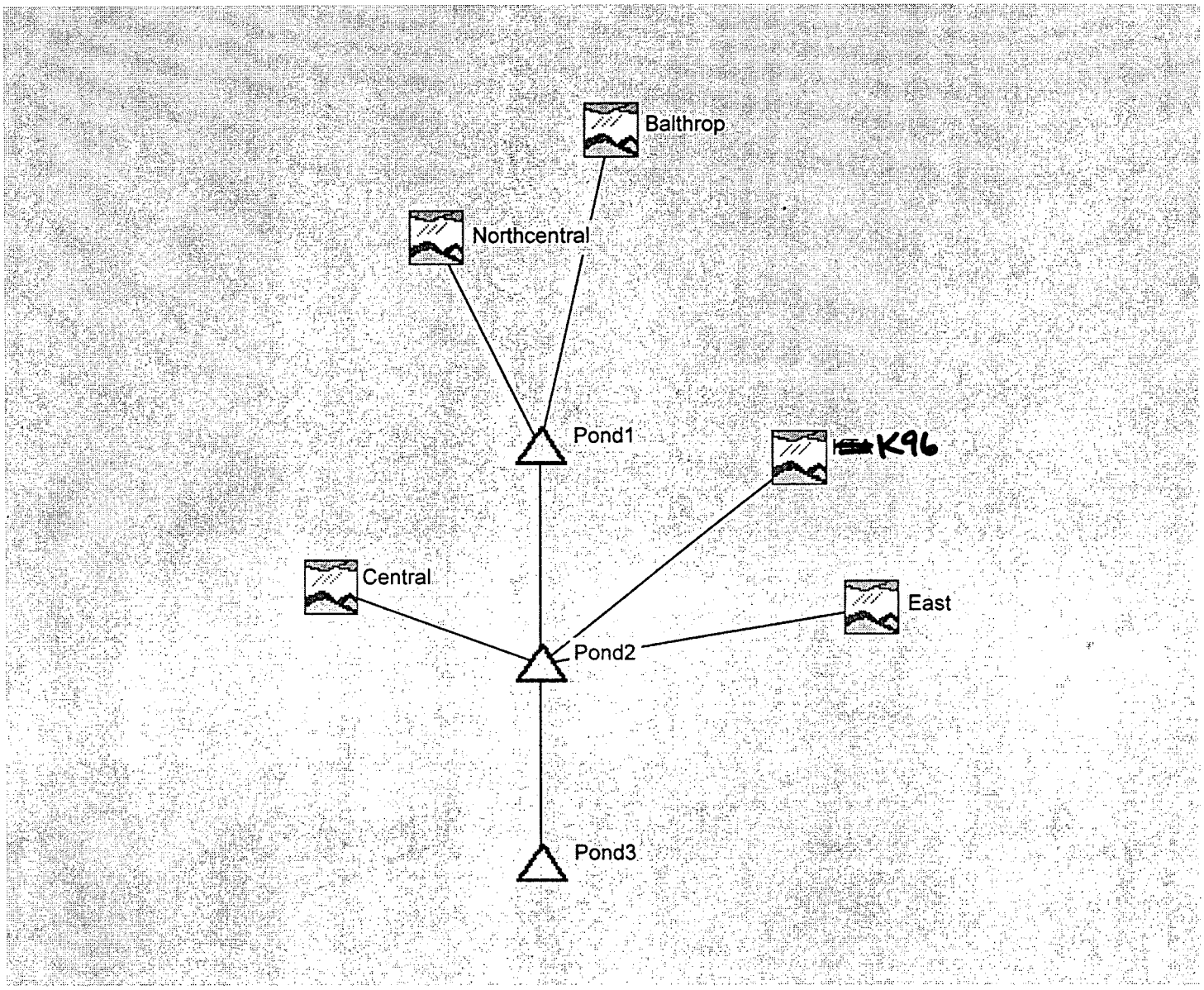
1352	42050	0.97
1354	69410	1.59
1356	109928	2.52

Pond 2

1351	149792	3.44
1352	162660	3.73
1354	262886	6.04

Pond 3

1340	10755	0.25
1342	14831	0.34
1344	19293	0.44
1346	28490	0.65
1348	37216	0.85
1350	46768	1.07


Balthrop
Northcentral
Pond1
K96
Central
East
Pond2
Pond3

HMS * Summary of Results

Project : KTP Run Name : Run 1

Start of Run : 28Aug01 1200 Basin Model : KTP-East
End of Run : 29Aug01 1200 Met. Model : 100
Execution Time : 04Sep01 1822 Control Specs : 100

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
Northcentral	39.137	29 Aug 01 0010	3.7041	0.010
Balthrop	274.05	29 Aug 01 0025	32.423	0.096
Pond1	241.95	29 Aug 01 0035	35.991	0.106
Central	19.569	29 Aug 01 0010	1.8521	0.005
K96	241.25	29 Aug 01 0025	30.372	0.090
East	117.39	29 Aug 01 0010	11.112	0.030
Pond2	442.02	29 Aug 01 0045	78.820	0.231
Pond3	431.98	29 Aug 01 0050	78.724	0.231

HMS * Summary of Results for Northcentral

Project : KTP Run Name : Run 1

Start of Run	: 28Aug01 1200	Basin Model	: KTP-East
End of Run	: 29Aug01 1200	Met. Model	: 100
Execution Time	: 29Aug01 1130	Control Specs	: 100

Computed Results

Peak Discharge	: 39.137 (cfs)	Date/Time of Peak Discharge	: 29 Aug 01 0010
Total Precipitation	: 8.16 (in)	Total Direct Runoff	: 6.95 (in)
Total Loss	: 1.20 (in)	Total Baseflow	: 0.00 (in)
Total Excess	: 6.96 (in)	Total Discharge	: 6.95 (in)

HMS * Summary of Results for Balthrop

Project : KTP Run Name : Run 1

Start of Run	: 28Aug01 1200	Basin Model	: KTP-East
End of Run	: 29Aug01 1200	Met. Model	: 100
Execution Time	: 29Aug01 1130	Control Specs	: 100

Computed Results

Peak Discharge	: 274.05 (cfs)	Date/Time of Peak Discharge	: 29 Aug 01 0025
Total Precipitation	: 8.16 (in)	Total Direct Runoff	: 6.33 (in)
Total Loss	: 1.79 (in)	Total Baseflow	: 0.00 (in)
Total Excess	: 6.37 (in)	Total Discharge	: 6.33 (in)

HMS * Summary of Results for Pond1

Project : KTP Run Name : Run 1

Start of Run	: 28Aug01 1200	Basin Model	: KTP-East
End of Run	: 29Aug01 1200	Met. Model	: 100
Execution Time	: 04Sep01 1858	Control Specs	: 100

Computed Results

Peak Inflow	: 303.05 (cfs)	Date/Time of Peak Inflow	: 29 Aug 01 0020
Peak Outflow	: 241.95 (cfs)	Date/Time of Peak Outflow	: 29 Aug 01 0035
Total Inflow	: 6.39 (in)	Peak Storage	: 5.6307 (in)
Total Outflow	: 6.37 (in)	Peak Elevation	: 1355.5 (in)

HMS * Summary of Results for Central

Project : KTP Run Name : Run 1

Start of Run	: 28Aug01 1200	Basin Model	: KTP-East
End of Run	: 29Aug01 1200	Met. Model	: 100
Execution Time	: 29Aug01 1130	Control Specs	: 100

Computed Results

Peak Discharge	: 19.569 (cfs)	Date/Time of Peak Discharge	: 29 Aug 01 0010
Total Precipitation	: 8.16 (in)	Total Direct Runoff	: 6.95 (in)
Total Loss	: 1.20 (in)	Total Baseflow	: 0.00 (in)
Total Excess	: 6.96 (in)	Total Discharge	: 6.95 (in)

HMS * Summary of Results for K96

Project : KTP Run Name : Run 1

Start of Run	: 28Aug01 1200	Basin Model	: KTP-East
End of Run	: 29Aug01 1200	Met. Model	: 100
Execution Time	: 29Aug01 1130	Control Specs	: 100

Computed Results

Peak Discharge	: 241.25 (cfs)	Date/Time of Peak Discharge	: 29 Aug 01 0025
Total Precipitation	: 8.16 (in)	Total Direct Runoff	: 6.33 (in)
Total Loss	: 1.79 (in)	Total Baseflow	: 0.00 (in)
Total Excess	: 6.37 (in)	Total Discharge	: 6.33 (in)

HMS * Summary of Results for East

Project : KTP Run Name : Run 1

Start of Run	: 28Aug01 1200	Basin Model	: KTP-East
End of Run	: 29Aug01 1200	Met. Model	: 100
Execution Time	: 29Aug01 1130	Control Specs	: 100

Computed Results

Peak Discharge	: 117.39 (cfs)	Date/Time of Peak Discharge	: 29 Aug 01 0010
Total Precipitation	: 8.16 (in)	Total Direct Runoff	: 6.95 (in)
Total Loss	: 1.20 (in)	Total Baseflow	: 0.00 (in)
Total Excess	: 6.96 (in)	Total Discharge	: 6.95 (in)

HMS * Summary of Results for Pond2

Project : KTP Run Name : Run 1

Start of Run	: 28Aug01 1200	Basin Model	: KTP-East
End of Run	: 29Aug01 1200	Met. Model	: 100
Execution Time	: 04Sep01 1822	Control Specs	: 100

Computed Results

Peak Inflow	: 546.76 (cfs)	Date/Time of Peak Inflow	: 29 Aug 01 0025
Peak Outflow	: 442.02 (cfs)	Date/Time of Peak Outflow	: 29 Aug 01 0045
Total Inflow	: 6.44 (in)	Peak Storage	: 13.198 (in)
Total Outflow	: 6.40 (in)	Peak Elevation	: 1354.0 (in)

HMS * Summary of Results for Pond3

Project : KTP Run Name : Run 1

Start of Run	: 28Aug01 1200	Basin Model	: KTP-East
End of Run	: 29Aug01 1200	Met. Model	: 100
Execution Time	: 04Sep01 1822	Control Specs	: 100

Computed Results

Peak Inflow	: 442.02 (cfs)	Date/Time of Peak Inflow	: 29 Aug 01 0045
Peak Outflow	: 431.98 (cfs)	Date/Time of Peak Outflow	: 29 Aug 01 0050
Total Inflow	: 6.40 (in)	Peak Storage	: 3.4954 (in)
Total Outflow	: 6.39 (in)	Peak Elevation	: 1347.4 (in)

HEC-HMS Analysis
Proposed West Basin

HMS * Summary of Results

Project : KTP Run Name : Run 2

Start of Run : 28Aug01 1200 Basin Model : KTP-West
End of Run : 29Aug01 1200 Met. Model : 100
Execution Time : 29Aug01 0916 Control Specs : 100_West

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
Offsite	1136.5	29 Aug 01 0040	221.99	0.663
West	58.775	29 Aug 01 0015	5.4188	0.016
Junction-1	1154.6	29 Aug 01 0040	227.41	0.679

Drainage Plan