

August 9, 2002

Vicky Huang, P.E.  
City of Wichita – Engineering  
7<sup>th</sup> Floor – City Hall  
455 N. Main  
Wichita, KS 67202

Re: Final Drainage Plan – Sierra Hills Addition

Dear Ms. Huang,

Enclosed, please find the final drainage plan and supporting calculations for Sierra Hills Addition, a residential subdivision situated in Wichita, Kansas.

The drainage calculations used to size detention ponds and storm water sewer systems follow the drainage guidelines outlined in the Interim Drainage and Storm Water Sewer Policy for Design Criteria and Documentation, Wichita, Kansas, dated 7-1-87. References to runoff coefficients, velocities, and times of concentration are all as outlined in this policy.

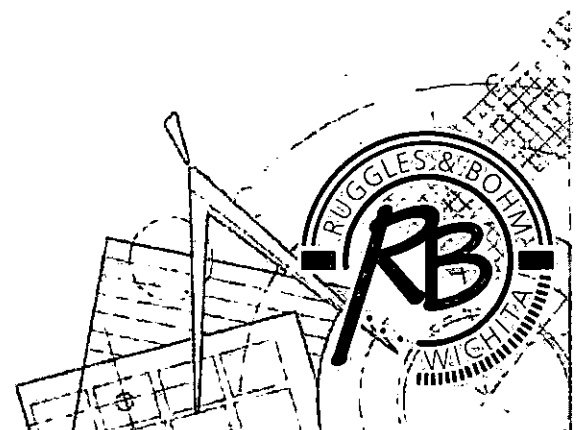
Although not included with the documentation, the ability of the streets to contain the two year storm within the curbs, and the one hundred year storm within the right-of-way have been determined. Each of the storm water sewer systems will be checked for capacity and efficiency when the actual system design is undertaken.

Please review this report and advise. If you require any additional information, please do not hesitate to contact me.

Regards,

Christopher M. Bohm, P.E.

Encl.



Sierra Hills Addition  
Residential Subdivision  
Final Drainage Plan  
August 8, 2002

### **East Detention Pond (situated in Reserve A)**

Total Area served by detention pond = 27.6 acres  
Off site area (Catholic Diocese of Wichita) = 6.1 Acres  
Sierra Hills Area = 21.5 Acres

### **Time of concentration calculations for detention pond: SCS velocity method**

Total longest path to proposed storm water sewer inlet = 660 feet

First 400 feet, shallow concentrated flow at 1.5 percent grade  
 $V1 = 0.365 \text{ f/s}$  (City of Wichita Attachment E, Average overland flow velocity)  
 $T1 = 400' * (1/0.365 \text{ f/s}) = 1095 \text{ seconds} = 18.3 \text{ minutes}$

Next portion of overland flow = 260 feet, grassed waterway at 1.5% grade  
 $V2 = 1.33 \text{ f/s}$  (Attachment E)  
 $T2 = 260' * (1/1.33 \text{ f/s}) = 195 \text{ seconds} = 3.3 \text{ minutes}$

Balance of flow via 500' of storm water sewer pipe  
 $V3 = 4.0 \text{ f/s}$  (assumed)  
 $T3 = 500' * (1/4.0 \text{ f/s}) = 125 \text{ seconds} = 2.1 \text{ minutes}$

Total time of concentration =  $T1 + T2 + T3 = 23.7 \text{ minutes}$ . This value is less than  $0.29 * \text{the Lag Time}$ , so increase the pond time of concentration to 30 minutes for a more accurate model of the system.

### **Peak Pond Outflow**

The allowable flow rate from the proposed pond is governed by the drainage plan for Equestrian Estates (platted by Poe and Associates). The drainage plan prepared for this addition indicates 50.75 acres draining to a proposed pond situated in Reserve E, Equestrian Estates, resulting in an undeveloped runoff amount of 124 cfs. The offsite area indicated by the Poe plan is 34.7 acres. Based on these numbers, the ratio of offsite drainage area divided by the total drainage area =  $34.7 \text{ ac}/50.75 \text{ ac} = 0.684$ .

Applying this ratio to the total undeveloped flow into the Equestrian Estates pond yields  $0.684 * 124 \text{ cfs} = 85 \text{ cfs}$ . This is the total allowable runoff that can be handled by the Equestrian Estates pond, and the target outflow for the new, Sierra Hills pond situated in Reserve A.

### **SCS Curve Numbers for Pond Routing**

From the Soil Survey of Sedgwick County, Kansas, the area feeding the Sierra Hills Pond in Reserve A is predominately type Ia soils, hydrological soil group D. Utilizing this information, the following can be used to determine a weighted SCS Curve Number (CN):

Offsite area (terraced, small grain, good condition) = 6.1 acres, CN = 81  
Residential Area, hard surface, type D soils = 21.5 acres, CN = 92

Weighted CN =  $((6.1 * 81) + (21.5 * 92)) / 27.6 \text{ acres} = 89.56$ , use **CN = 90 for design**

Calculate Existing Runoff

Utilizing the Army Corps of Engineers HEC-1 program, input the following data:

BA (basin area) = 27.6 Acres / 640 acres/sq. mile = 0.0431 square miles

SCS Lag =  $0.6 * T_c = 0.60 * 20 \text{ minutes} * 60 \text{ min/hour} = 0.20 \text{ hours}$

CN (composite) = 90

Rainfall = 100 year – 24 hour storm = 7.8 inches, using SCS Type II rainfall distribution

File U:\hecpack\sierra\leponds.hcl; Result Q100 = 128 cfs

### **Design of Detention Pond**

The detention pond will need to limit the outflow to 85 cfs from an existing peak of 128 cfs. Based on the proposed grading of the site, a two-step pond will be designed to provide detention. The model will route the entire storm through the top pond, and then, through a weir, into the second pond. The outlet weir for the lower (second) pond will limit the flow leaving the site. This model will be conservative, for not all of the flow will reach the top pond prior to routing to the second, however, for simplicity of the model, will provide a satisfactory result.

Upper pond configuration:

Static Pool = 1337.0

Outlet weir = concrete, sharp crested, width = 7.0 feet

$Q_{weir} = CLH * 1.5$ , where  $C = 3.0$  for the broad crested weir

Lower pond configuration:

Static Pool = 1335.0

Outlet weir = concrete, sharp crested, width = 5.0 feet

$Q_{weir} = CLH * 1.5$ , where  $C = 3.0$  for the broad crested weir

Stage-storage and stage-discharge information follow on the next page, as well as a summary table of the routing results, and the output file from the routing procedure.

Refinements to the actual storage volumes and weir configuration will be done at the time of the design of the pond and storm water sewer system.

Upper Pond Weir Flow and Storage Information						
Weir Length (L) = 7.0 feet						
Elevation	Head (H) feet	Length (feet)	H*1.5	Q (cfs)	Storage (sq. feet)	Storage (acres)
1337	0	7	0.00		23001	0.53
1337.5	0.5	7	0.35	7.4		
1338	1	7	1.00	21.0	27045	0.62
1338.5	1.5	7	1.84	38.6		
1339	2	7	2.83	59.4	31524	0.72
1339.5	2.5	7	3.95	83.0		
1340	3	7	5.20	109.1	35628	0.82
1340.5	3.5	7	6.55	137.5		
1341	4	7	8.00	168.0	40167	0.92

Lower Pond Weir Flow and Storage Information						
Weir Length (L) = 5.0 feet						
Elevation	Head (H) feet	Length (feet)	H*1.5	Q (cfs)	Storage (sq. feet)	Storage (acres)
1335	0	5	0.00		20553	0.47
1335.5	0.5	5	0.35	5.3		
1336	1	5	1.00	15.0	24238	0.56
1336.5	1.5	5	1.84	27.6		
1337	2	5	2.83	42.4	28086	0.64
1337.5	2.5	5	3.95	59.3		
1338	3	5	5.20	77.9	32097	0.74
1338.5	3.5	5	6.55	98.2		
1339	4	5	8.00	120.0	36273	0.83

Results of the pond routing (both ponds) can be found in the file eponds.out, the results of which are provided here:

Pond	Static Pool Elevation	Q <sub>in</sub> (cfs)	Q <sub>out</sub> (cfs)	100 year Water surface
Upper	1337.00	128	110	1340.0
Lower	1335.00	100	91	1338.4

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*****
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*
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1) *
ENGINEERS *
* MAY 1991 *
CENTER *
* VERSION 4.0.1E *
STREET *
*
95616 *
* RUN DATE 08/08/2002 TIME 12:47:10 *
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*
*
* U. S. ARMY CORPS OF
* HYDROLOGIC ENGINEERING
*
* 609 SECOND
*
* DAVIS, CALIFORNIA
*
* (916) 756-1104
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:::
::: Full Microcomputer Implementation :::
::: by :::
::: Haestad Methods, Inc. :::
:::::
:::::
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37 Brookside Road \* Waterbury, Connecticut 06708 \* (203) 755-1666

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW. THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE. THE DEFINITION OF -AMSK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION

NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION , DSS:WRITE STAGE FREQUENCY, DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

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LINE      ID. ....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
*** FREE ***
1         ID   FOX RUN ADDITION DETENTION POND CALCS - 100 YEAR EVENT
2         ID   FIRST RUN IS TOTAL UNDEVELOPED AREA
3         ID
4         IT   .5           289
5         IN   30
6         IO   4

7         KK   UNDEV
8         PC   0   0.04   0.08   .12   .17   .22   .27   .32   .37   .43
9         PC   .49   .56   .62   .69   .77   .85   .94   1.04   1.15   1.27
10        PC   1.41   1.59   1.83   2.21   5.17   5.73   6.02   6.23   6.40   6.54
11        PC   6.65   6.76   6.86   6.95   7.02   7.09   7.16   7.23   7.29   7.36
12        PC   7.43   7.49   7.54   7.59   7.63   7.68   7.72   7.76   7.80
13        BA   0.0431
14        UD   0.30
15        LS   0   90

16        KK   POND1
17        RS   1   ELEV   1337
18        SA   0.52   0.62   0.72   0.82
19        SE   1337   1338   1339   1340
20        SQ   .5   7.4   21   38.6   59.4   83   109
21        SE   1337   1337.5   1338   1338.5   1339   1339.5   1340

22        KK   POND2
23        RS   1   ELEV   1335
24        SA   0.47   0.56   0.64   0.73   0.83
25        SE   1335   1336   1337   1338   1339
26        SQ   0.5   5.3   15   27.6   42.4   59.3   77.9
27        SE   1335   1335.5   1336   1336.5   1337   1337.5   1338
28        ZZ
    
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*****
*****
*
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1)
ENGINEERS
* MAY 1991
CENTER
* VERSION 4.0.1E
STREET
*
95616
* RUN DATE 08/08/2002 TIME 12:47:10
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*
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*****

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*
* U. S. ARMY CORPS OF
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*
* 609 SECOND
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* (916) 756-1104
*

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FOX RUN ADDITION DETENTION POND CALCS - 100 YEAR EVENT  
 FIRST RUN IS TOTAL UNDEVELOPED AREA

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6 IO      OUTPUT CONTROL VARIABLES
          IPRNT      4  PRINT CONTROL
          IPLOT      0  PLOT CONTROL
          OSCAL      0. HYDROGRAPH PLOT SCALE

IT        HYDROGRAPH TIME DATA
          NMIN       5  MINUTES IN COMPUTATION INTERVAL
          IDATE      1  0  STARTING DATE
          ITIME      0000 STARTING TIME
          NQ         289 NUMBER OF HYDROGRAPH ORDINATES
          NDDATE     2  0  ENDING DATE
          NDTIME     0000 ENDING TIME
          ICENT      19  CENTURY MARK

          COMPUTATION INTERVAL 0.08 HOURS
          TOTAL TIME BASE      24.00 HOURS

```

ENGLISH UNITS

DRAINAGE AREA	SQUARE MILES
PRECIPITATION DEPTH	INCHES
LENGTH, ELEVATION	FEET
FLOW	CUBIC FEET PER SECOND
STORAGE VOLUME	ACRE- FEET
SURFACE AREA	ACRES
TEMPERATURE	DEGREES FAHRENHEIT

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*****
*
*
7 KK      UNDEV
*
*****

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5 IN      TIME DATA FOR INPUT TIME SERIES
          JXMIN      30  TIME INTERVAL IN MINUTES
          JXDATE     1  0  STARTING DATE
          JXTIME     0  STARTING TIME

```

SUBBASIN RUNOFF DATA

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13 BA     SUBBASIN CHARACTERISTICS
          TAREA      0.04 SUBBASIN AREA

          PRECIPITATION DATA

```



COMPUTED STORAGE -ELEVATION DATA

STORAGE	0.00	0.57	1.24	2.01
ELEVATION	1337.00	1338.00	1339.00	1340.00

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	0.00	0.27	0.57	0.89	1.24	1.61	2.01
OUTFLOW	0.50	7.40	21.00	38.60	59.40	83.00	109.00
ELEVATION	1337.00	1337.50	1338.00	1338.50	1339.00	1339.50	1340.00

WARNING --- ROUTED OUTFLOW ( 110.) IS GREATER THAN MAXIMUM OUTFLOW ( 109.) IN STORAGE-OUTFLOW TABLE

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*****
*          *
22 KK * POND2 *
*          *
*****
    
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HYDROGRAPH ROUTING DATA

23 RS	STORAGE ROUTING						
	NSTPS	1	NUMBER OF SUBREACHES				
	ITYP		TYPE OF INITIAL CONDITION				
	RSVRIC	1335.00	INITIAL CONDITION				
	X	0.00	WORKING R AND D COEFFICIENT				
24 SA	AREA	0.5	0.6	0.6	0.7	0.8	
25 SE	ELEVATION	1335.00	1336.00	1337.00	1338.00	1339.00	
26 SQ	DISCHARGE	1.	5.	15.	28.	42.	59. 78.
27 SE	ELEVATION	1335.00	1335.50	1336.00	1336.50	1337.00	1337.50 1338.00

\*\*\*

COMPUTED STORAGE -ELEVATION DATA

STORAGE	0.00	0.51	1.11	1.80	2.58
ELEVATION	1335.00	1336.00	1337.00	1338.00	1339.00

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	0.00	0.25	0.51	0.80	1.11	1.44	1.80	2.58
OUTFLOW	0.50	5.30	15.00	27.60	42.40	59.30	77.90	115.10
ELEVATION	1335.00	1335.50	1336.00	1336.50	1337.00	1337.50	1338.00	1339.00

RUNOFF SUMMARY  
 FLOW IN CUBIC FEET PER SECOND  
 TIME IN HOURS, AREA IN SQUARE MILES

TIME OF STAGE	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	MAX
					6-HOUR	24-HOUR	72-HOUR			
0.04	HYDROGRAPH AT			UNDEV	128.	12.08	24.	8.	8.	
12.2	ROUTED TO	POND1	110.	12.25	23.	8.	8.	0.04	1340.02	
12.50	ROUTED TO	POND2	91.	12.50	23.	8.	8.	0.04	1338.36	

\*\*\* NORMAL END OF HEC-1 \*\*\*

Please note that the lower pond allows 91.0 cfs instead of 85.0 cfs to discharge. This issue will need to be addressed at the time of the actual pond design, and the actual storage characteristics of the facility can be fine-tuned.

**Storm water sewer system design:**

The rational method of stormwater runoff was utilized for the analysis of the proposed storm water sewer system. Again, the type D hydrological soil group was used for analysis, with a minimum time of concentration of 15 minutes.

Each of the systems has been designed for 100-year capacity utilizing Haestad Methods *Stormcad* software. Please see the accompanying storm water sewer system profiles for detailed information about conduit size, flowline elevations, and hydraulic grade line elevations within each system.

Again, the hydraulic efficiency of each system will be confirmed as a part of the final system design.

The following table outlines each drainage basin, and the resulting 2 year and 100 year runoff totals. This same table is reproduced on the drainage plan map, included with this report.

Basin	Area (ac) (acres)	Use	Tc (minutes)	C2	C100	I2 (in-hour)	I100 (in-hour)	Q2 (cfs)	Q100 (cfs)
1A	1.73	Lots	15	0.48	0.68	3.83	7.37	3.2	8.7
1B	1.1	rear yard	15	0.24	0.51	3.83	7.37	1.0	4.1
1C	1.48	rear yard	15	0.24	0.51	3.83	7.37	1.4	5.6
1-OFF	4.4	field	20	0.3	0.65	3.33	6.53	4.4	18.7
1D	4.8	Lots	15	0.48	0.68	3.83	7.37	8.8	24.1
1E	3.3	Lots	15	0.48	0.68	3.83	7.37	6.1	16.5
2A	0.4	rear yard	15	0.24	0.51	3.83	7.37	0.4	1.5
2B	0.85	rear yard	15	0.24	0.51	3.83	7.37	0.8	3.2
2C	0.85	rear yard	15	0.24	0.51	3.83	7.37	0.8	3.2
2D	0.39	rear yard	15	0.24	0.51	3.83	7.37	0.4	1.5
2E	1.06	Lots	15	0.48	0.68	3.83	7.37	1.9	5.3
3A	8.56	Lots	15	0.48	0.68	3.83	7.37	15.7	42.9
3B	1.38	rear yard	15	0.24	0.51	3.83	7.37	1.3	5.2
3C	0.9	rear yard	15	0.24	0.51	3.83	7.37	0.8	3.4
3D	3.81	Lots	15	0.48	0.68	3.83	7.37	7.0	19.1
4A	1.43	Lots	15	0.48	0.68	3.83	7.37	2.6	7.2
4B	0.47	rear yard	15	0.24	0.51	3.83	7.37	0.4	1.8
5A	1.17	rear yard	15	0.24	0.51	3.83	7.37	1.1	4.4
5B	1	rear yard	15	0.24	0.51	3.83	7.37	0.9	3.8
5C	4.4	Lots	15	0.48	0.68	3.83	7.37	8.1	22.1

From these flows, a storm water sewer system has been sized for each of the basins indicated by a node on the attached drainage plan. Please refer to the following hydraulic profiles for each storm water sewer system for information about pipe sizes, slopes, and hydraulic gradient.

```

----- Beginning Calculation Cycle -----
Discharge: 18.70 cfs at node I-3
Discharge: 40.90 cfs at node I-5
Discharge: 51.10 cfs at node I-2
Discharge: 61.30 cfs at node I-1
Discharge: 61.30 cfs at node Outlet
Beginning iteration 1
Discharge: 18.70 cfs at node I-3
Discharge: 40.90 cfs at node I-5
Discharge: 51.10 cfs at node I-2
Discharge: 61.30 cfs at node I-1
Discharge: 61.30 cfs at node Outlet
Discharge Convergence Achieved in 1 iterations: relative error: 0.0
** Warning: Design constraints not met.
Warning: No Duration data exists in IDF Table
Information: Outlet Known flow propogated from upstream junctions.
Information: P-2 Surcharged condition
Information: P-3 Surcharged condition
Information: P-4 Surcharged condition
Violation: P-4 does not meet minimum cover constraint at downstream end.
Information: P-5 Surcharged condition
----- Calculations Complete -----

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** Analysis Options **
Friction method: Manning's Formula
HGL Convergence Test: 0.001000
Maximum Network Traversals: 5
Number of Pipe Profile Steps: 5
Discharge Convergence Test: 0.001000
Maximum Design Passes: 3

```

----- Network Quick View -----

Label	Length	Size	Discharge	Hydraulic Grade	
				Upstream	Downstream
P-2	120.00	36 inch	61.30	1,341.01	1,340.00
P-3	34.00	36 inch	51.10	1,341.80	1,341.60
P-4	150.00	36 inch	40.90	1,342.77	1,342.20
P-5	160.00	24 inch	18.70	1,344.12	1,343.03

Label	Discharge	Elevations		
		Ground	Upstream HGL	Downstream HGL
Outlet	61.30	1,342.00	1,340.00	1,340.00
I-1	61.30	1,343.40	1,341.60	1,341.01
I-2	51.10	1,343.40	1,342.20	1,341.80
I-5	40.90	1,346.00	1,343.03	1,342.77
I-3	18.70	1,348.00	1,344.12	1,344.12

Elapsed: 0 minute(s) 1 second(s)

----- Beginning Calculation Cycle -----

Discharge: 1.90 cfs at node I-4  
 Discharge: 3.80 cfs at node I-3  
 Discharge: 7.90 cfs at node I-2  
 Discharge: 8.70 cfs at node I-5  
 Discharge: 16.60 cfs at node I-1  
 Discharge: 16.60 cfs at node Outlet  
 Beginning iteration 1  
 Discharge: 1.90 cfs at node I-4  
 Discharge: 3.80 cfs at node I-3  
 Discharge: 7.90 cfs at node I-2  
 Discharge: 8.70 cfs at node I-5  
 Discharge: 16.60 cfs at node I-1  
 Discharge: 16.60 cfs at node Outlet  
 Discharge Convergence Achieved in 1 iterations: relative error: 0.0  
 \*\* Warning: Design constraints not met.  
 Warning: No Duration data exists in IDF Table  
 Information: Outlet Known flow propagated from upstream junctions.  
 Information: P-1 Surcharged condition  
 Information: P-2 Surcharged condition  
 Violation: P-2 does not meet minimum cover constraint at upstream end.  
 Violation: P-5 does not meet minimum cover constraint at upstream end.  
 Information: P-3 Surcharged condition  
 Violation: P-3 does not meet minimum cover constraint at downstream end.  
 Information: P-4 Surcharged condition  
 Violation: P-4 does not meet minimum cover constraint at downstream end.

----- Calculations Complete -----

\*\* Analysis Options \*\*

Friction method: Manning's Formula  
 HGL Convergence Test: 0.001000  
 Maximum Network Traversals: 5  
 Number of Pipe Profile Steps: 5  
 Discharge Convergence Test: 0.001000  
 Maximum Design Passes: 3

----- Network Quick View -----

Label	Length	Size	Discharge	Hydraulic Grade	
				Upstream	Downstream
P-1	81.00	24 inch	16.60	1,343.47	1,343.03
P-2	135.00	18 inch	7.90	1,344.45	1,343.68
P-3	140.00	15 inch	3.80	1,345.09	1,344.60
P-4	34.00	15 inch	1.90	1,345.19	1,345.16
P-5	117.00	18 inch	8.70	1,348.14	1,343.68

Label	Discharge	Elevations		
		Ground	Upstream HGL	Downstream HGL
Outlet	16.60	1,346.00	1,343.03	1,343.03
I-1	16.60	1,346.80	1,343.68	1,343.47
I-2	7.90	1,345.50	1,344.60	1,344.45
I-3	3.80	1,346.80	1,345.16	1,345.09
I-4	1.90	1,346.80	1,345.19	1,345.19
I-5	8.70	1,351.90	1,348.14	1,348.14

Elapsed: 0 minute(s) 0 second(s)

----- Beginning Calculation Cycle -----

Discharge: 1.50 cfs at node I-4  
 Discharge: 1.50 cfs at node I-6  
 Discharge: 4.70 cfs at node I-5  
 Discharge: 9.40 cfs at node I-3  
 Discharge: 12.00 cfs at node I-2  
 Discharge: 14.70 cfs at node I-1  
 Discharge: 14.70 cfs at node Outlet  
 Beginning iteration 1  
 Discharge: 1.50 cfs at node I-4  
 Discharge: 1.50 cfs at node I-6  
 Discharge: 4.70 cfs at node I-5  
 Discharge: 9.40 cfs at node I-3  
 Discharge: 12.00 cfs at node I-2  
 Discharge: 14.70 cfs at node I-1  
 Discharge: 14.70 cfs at node Outlet  
 Discharge Convergence Achieved in 1 iterations: relative error: 0.0  
 \*\* Warning: Design constraints not met.  
 Warning: No Duration data exists in IDF Table  
 Information: Outlet Known flow propogated from upstream junctions.  
 Information: P-1 Surcharged condition  
 Information: P-2 Surcharged condition  
 Information: P-3 Surcharged condition  
 Violation: P-3 does not meet minimum cover constraint at upstream end.  
 Violation: P-6 does not meet minimum cover constraint at downstream end.  
 Information: P-4 Surcharged condition  
 Violation: P-4 does not meet minimum cover constraint at downstream end.  
 Violation: P-5 does not meet minimum cover constraint at downstream end.

----- Calculations Complete -----

\*\* Analysis Options \*\*

Friction method: Manning's Formula  
 HGL Convergence Test: 0.001000  
 Maximum Network Traversals: 5  
 Number of Pipe Profile Steps: 5  
 Discharge Convergence Test: 0.001000  
 Maximum Design Passes: 3

----- Network Quick View -----

Label	Length	Size	Discharge	Hydraulic Grade	
				Upstream	Downstream
P-1	160.00	24 inch	14.70	1,339.08	1,338.40
P-2	34.00	24 inch	12.00	1,339.34	1,339.25
P-3	120.00	18 inch	9.40	1,340.42	1,339.45
P-4	423.00	15 inch	4.70	1,342.88	1,340.64
P-5	200.00	15 inch	1.50	1,343.48	1,342.99
P-6	265.00	15 inch	1.50	1,340.76	1,340.64

Label	Discharge	Elevations		
		Ground	Upstream HGL	Downstream HGL
Outlet	14.70	1,341.00	1,338.40	1,338.40
I-1	14.70	1,344.50	1,339.25	1,339.08
I-2	12.00	1,344.50	1,339.45	1,339.34
I-3	9.40	1,344.00	1,340.64	1,340.42
I-4	1.50	1,345.00	1,340.76	1,340.76
I-5	4.70	1,346.00	1,342.99	1,342.88
I-6	1.50	1,346.00	1,343.48	1,343.48

Elapsed: 0 minute(s) 0 second(s)



----- Beginning Calculation Cycle -----

Discharge: 14.30 cfs at node I-3  
 Discharge: 14.30 cfs at node I-4  
 Discharge: 42.90 cfs at node I-2  
 Discharge: 3.40 cfs at node I-8  
 Discharge: 8.60 cfs at node I-7  
 Discharge: 18.10 cfs at node I-6  
 Discharge: 27.70 cfs at node I-5  
 Discharge: 70.60 cfs at node I-1  
 Discharge: 70.60 cfs at node Outlet  
 Beginning iteration 1  
 Discharge: 14.30 cfs at node I-3  
 Discharge: 14.30 cfs at node I-4  
 Discharge: 42.90 cfs at node I-2  
 Discharge: 3.40 cfs at node I-8  
 Discharge: 8.60 cfs at node I-7  
 Discharge: 18.10 cfs at node I-6  
 Discharge: 27.70 cfs at node I-5  
 Discharge: 70.60 cfs at node I-1  
 Discharge: 70.60 cfs at node Outlet  
 Discharge Convergence Achieved in 1 iterations: relative error: 0.0  
 \*\* Warning: Design constraints not met.  
 \*\* Problem: Flooding in system  
 Warning: No Duration data exists in IDF Table  
 Information: Outlet Known flow propagated from upstream junctions.  
 Information: P-1 Surcharged condition  
 Violation: P-1 does not meet minimum cover constraint at upstream end.  
 Information: P-2 Surcharged condition  
 Violation: P-2 does not meet minimum cover constraint at downstream end.  
 Violation: P-5 does not meet minimum cover constraint at downstream end.  
 Violation: P-6 does not meet minimum cover constraint at upstream end.  
 Information: P-3 Surcharged condition  
 Violation: P-3 does not meet minimum cover constraint at downstream end.  
 Information: P-4 Surcharged condition  
 Violation: P-4 does not meet minimum cover constraint at downstream end.  
 Information: I-3 The hydraulic grade exceeds the Rim/Ground elevation  
 Information: I-3 Flooding condition.  
 Violation: P-7 does not meet minimum cover constraint at downstream end.  
 Information: P-8 Surcharged condition  
 Violation: P-8 does not meet minimum cover constraint at downstream end.  
 Information: I-4 The hydraulic grade exceeds the Rim/Ground elevation  
 ----- Calculations Complete -----

\*\* Analysis Options \*\*

Friction method: Manning's Formula  
 HGL Convergence Test: 0.001000  
 Maximum Network Traversals: 5  
 Number of Pipe Profile Steps: 5  
 Discharge Convergence Test: 0.001000  
 Maximum Design Passes: 3

----- Network Quick View -----

Label	Length	Size	Discharge	Hydraulic Grade	
				Upstream	Downstream
P-1	65.00	36 inch	70.60	1,335.03	1,334.30
P-2	200.00	36 inch	42.90	1,336.63	1,335.80
P-3	35.00	24 inch	14.30	1,337.06	1,336.92
P-4	80.00	24 inch	14.30	1,337.24	1,336.92

P-5	143.00	36 inch	27.70	1,335.70	1,335.80
P-6	35.00	24 inch	18.10	1,336.93	1,336.33
P-7	140.00	15 inch	8.60	1,339.81	1,337.31
P-8	168.00	15 inch	3.40	1,340.65	1,340.19

Label	Discharge	Elevations		
		Ground	Upstream HGL	Downstream HGL
Outlet	70.60	1,337.00	1,334.30	1,334.30
I-1	70.60	1,337.00	1,335.80	1,335.03
I-2	42.90	1,337.00	1,336.92	1,336.63
I-3	14.30	1,337.00	1,337.00	1,337.00
I-4	14.30	1,337.30	1,337.24	1,337.24
I-5	27.70	1,341.00	1,336.05	1,335.70
I-6	18.10	1,341.00	1,337.31	1,336.93
I-7	8.60	1,341.00	1,340.19	1,339.81
I-8	3.40	1,341.00	1,340.65	1,340.65

Elapsed: 0 minute(s) 1 second(s)

```

----- Beginning Calculation Cycle -----
Discharge: 1.80 cfs at node I-3
Discharge: 5.40 cfs at node I-2
Discharge: 9.00 cfs at node I-1
Discharge: 9.00 cfs at node Outlet
Beginning iteration 1
Discharge: 1.80 cfs at node I-3
Discharge: 5.40 cfs at node I-2
Discharge: 9.00 cfs at node I-1
Discharge: 9.00 cfs at node Outlet
Discharge Convergence Achieved in 1 iterations: relative error: 0.0
** Warning: Design constraints not met.
** Problem: Flooding in system
Warning: No Duration data exists in IDF Table
Information: Outlet Known flow propogated from upstream junctions.
Information: P-1 Surcharged condition
Violation: P-1 does not meet minimum slope constraint.
Information: P-2 Surcharged condition
Information: P-3 Surcharged condition
Violation: P-3 does not meet minimum cover constraint at upstream end.
Information: I-3 The hydraulic grade exceeds the Rim/Ground elevation
Information: I-3 Flooding condition.
----- Calculations Complete -----

```

```

** Analysis Options **
Friction method: Manning's Formula
HGL Convergence Test: 0.001000
Maximum Network Traversals: 5
Number of Pipe Profile Steps: 5
Discharge Convergence Test: 0.001000
Maximum Design Passes: 3

```

----- Network Quick View -----

Label	Length	Size	Discharge	Hydraulic Grade	
				Upstream	Downstream
P-1	180.00	24 inch	9.00	1,334.58	1,334.30
P-2	35.00	15 inch	5.40	1,334.89	1,334.65
P-3	126.00	15 inch	1.80	1,335.14	1,335.04

Label	Discharge	Ground	Elevations	
			Upstream HGL	Downstream HGL
Outlet	9.00	1,337.00	1,334.30	1,334.30
I-1	9.00	1,338.00	1,334.65	1,334.58
I-2	5.40	1,338.00	1,335.04	1,334.89
I-3	1.80	1,335.00	1,335.04	1,335.04

Elapsed: 0 minute(s) 0 second(s)

----- Beginning Calculation Cycle -----

Discharge: 4.40 cfs at node I-5  
 Discharge: 8.20 cfs at node I-4  
 Discharge: 8.20 cfs at node I-3  
 Discharge: 19.20 cfs at node I-2  
 Discharge: 30.30 cfs at node I-1  
 Discharge: 30.30 cfs at node Outlet  
 Beginning iteration 1  
 Discharge: 4.40 cfs at node I-5  
 Discharge: 8.20 cfs at node I-4  
 Discharge: 8.20 cfs at node I-3  
 Discharge: 19.20 cfs at node I-2  
 Discharge: 30.30 cfs at node I-1  
 Discharge: 30.30 cfs at node Outlet  
 Discharge Convergence Achieved in 1 iterations: relative error: 0.0  
 \*\* Warning: Design constraints not met.  
 Warning: No Duration data exists in IDF Table  
 Information: Outlet Known flow propogated from upstream junctions.  
 Information: P-1 Surcharged condition  
 Information: P-2 Surcharged condition  
 Information: P-3 Surcharged condition  
 Information: P-4 Surcharged condition  
 Violation: P-4 does not meet minimum cover constraint at upstream end.  
 Information: P-5 Surcharged condition  
 Violation: P-5 does not meet minimum cover constraint at downstream end.  
 ----- Calculations Complete -----

\*\* Analysis Options \*\*

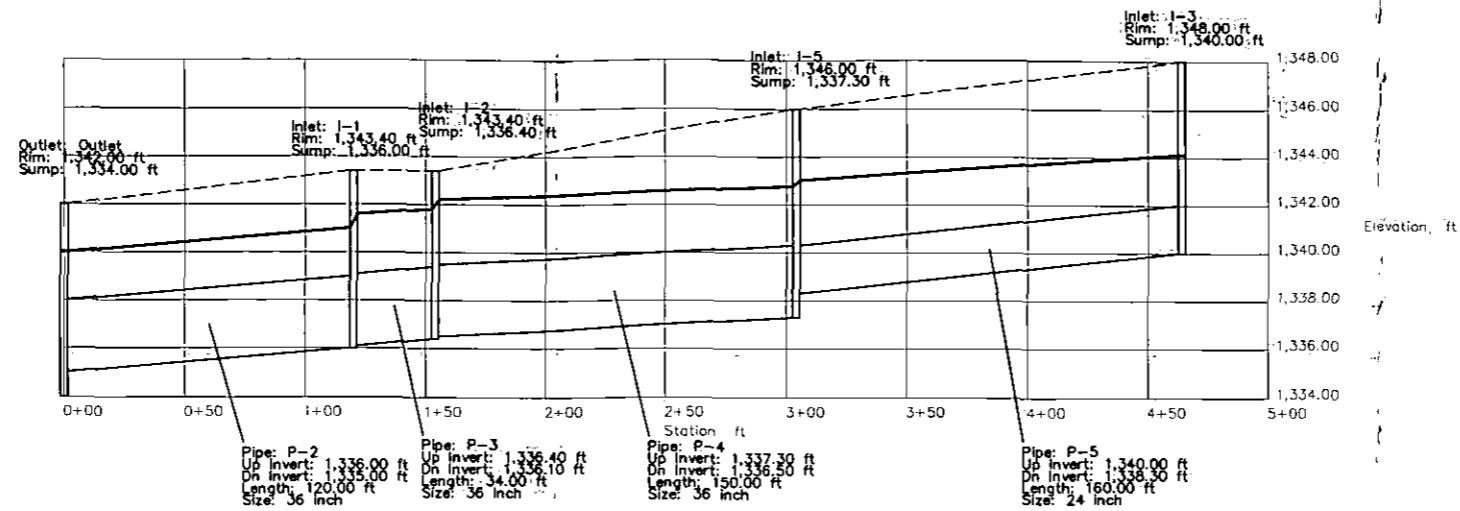
Friction method: Manning's Formula  
 HGL Convergence Test: 0.001000  
 Maximum Network Traversals: 5  
 Number of Pipe Profile Steps: 5  
 Discharge Convergence Test: 0.001000  
 Maximum Design Passes: 3

----- Network Quick View -----

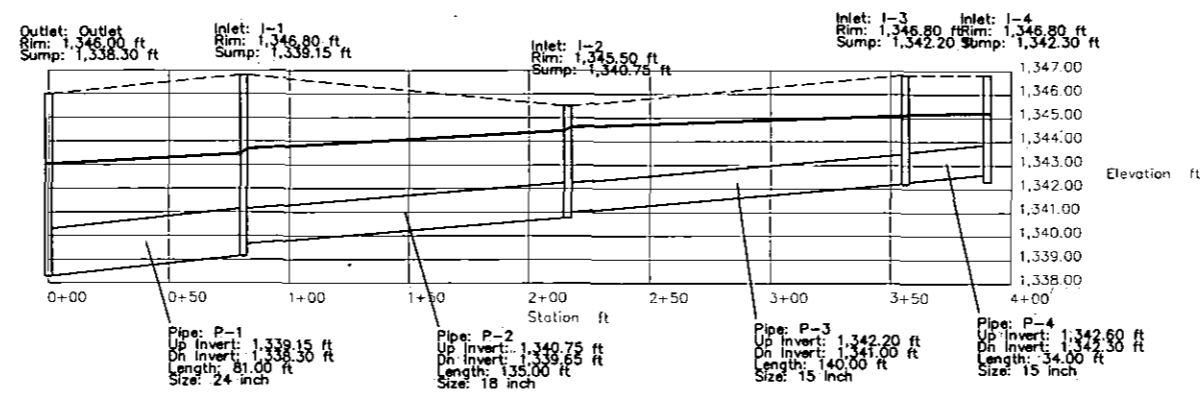
Label	Length	Size	Discharge	Hydraulic Grade	
				Upstream	Downstream
P-1	400.00	36 inch	30.30	1,339.73	1,338.90
P-2	38.00	24 inch	19.20	1,340.14	1,339.87
P-3	210.00	18 inch	8.20	1,341.71	1,340.43
P-4	305.00	18 inch	8.20	1,343.74	1,341.88
P-5	200.00	18 inch	4.40	1,344.26	1,343.91

Label	Discharge	Elevations		
		Ground	Upstream HGL	Downstream HGL
Outlet	30.30	1,340.00	1,338.90	1,338.90
I-1	30.30	1,346.30	1,339.87	1,339.73
I-2	19.20	1,346.30	1,340.43	1,340.14
I-3	8.20	1,344.50	1,341.88	1,341.71
I-4	8.20	1,345.00	1,343.91	1,343.74
I-5	4.40	1,345.00	1,344.26	1,344.26

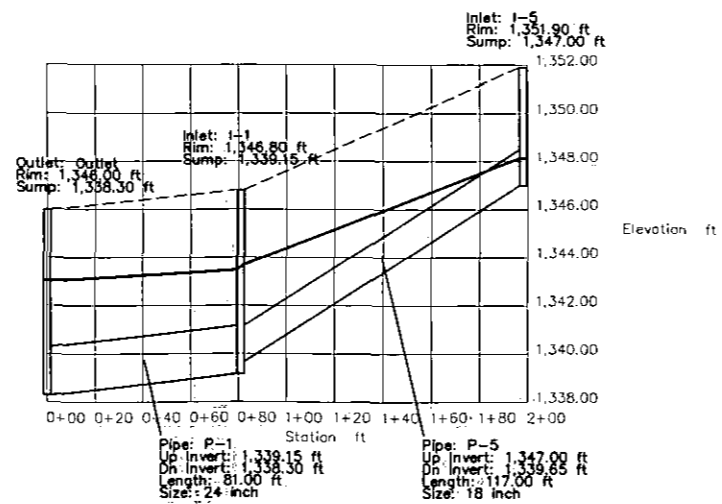
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LINE 1 PROFILE

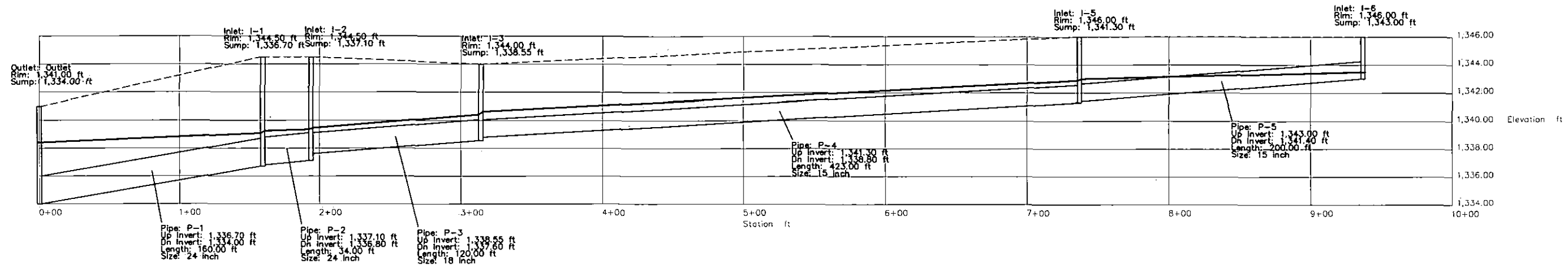


LINE 1A PROFILE



LINE 1B PROFILE

<b>SIERRA HILLS ADDITION SERIES 1 SWS PROFILES</b>			
	<b>Ruggles &amp; Bohm, P.A.</b> Engineering, Surveying, Land Planning		DESIGN <b>CMB</b>
	924 North Main Wichita, Kansas 67203 www.rbkansas.com		DRAWN <b>CMB</b>
(316) 264-8008 (316) 264-4621 fax E-mail: info@rbkansas.com		REVIEW	SHEET OF
DRAWING FILE Sierra Hills SWS Profiles		UTILITY	DATE <b>8-8-02</b>



LINE 2 PROFILE

SIERRA HILLS ADDITION  
SERIES 2 SWS PROFILES



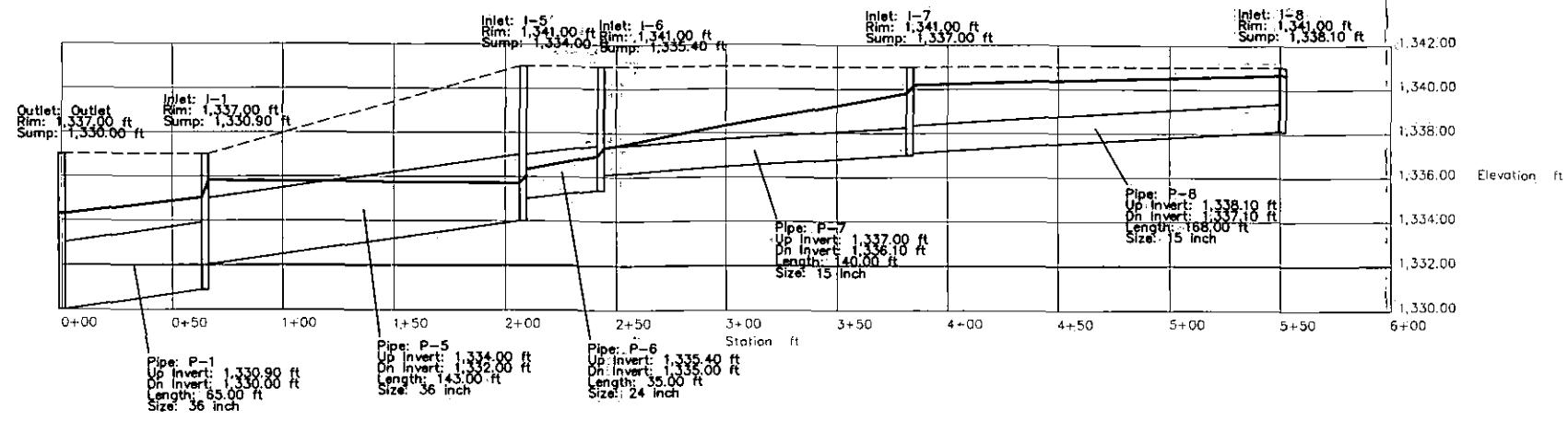
Ruggles & Bohm, P.A.  
Engineering, Surveying, Land Planning

924 North Main (316) 264-8008  
Wichita, Kansas 67203 (316) 264-4621 fax  
www.rbkansas.com E-mail: info@rbkansas.com

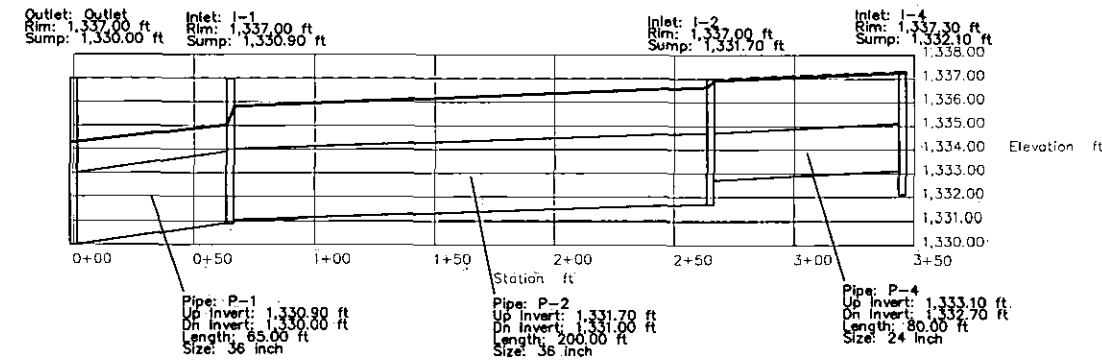
DRAWING FILE  
Sierra Hills SWS Profiles

PROJECT NUMBER

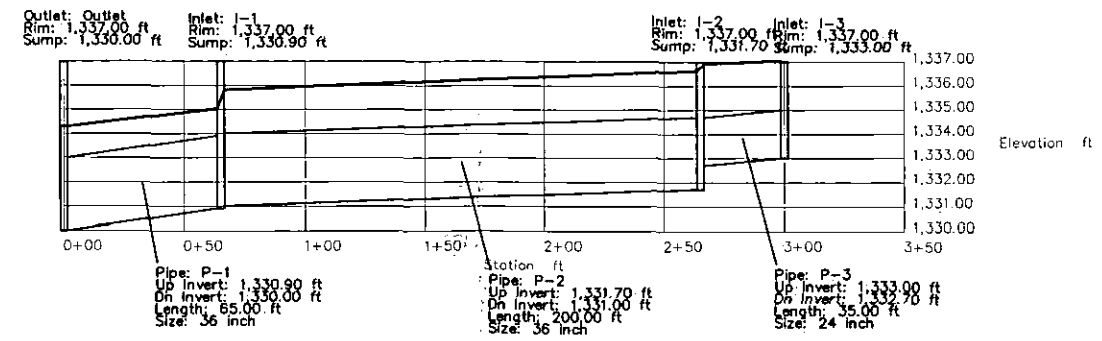
DESIGN CMB	OF 2
DRAWN CMB	
REVIEW	SHEET
UTILITY	
DATE 8-8-02	OF




LINE 3 PROFILE

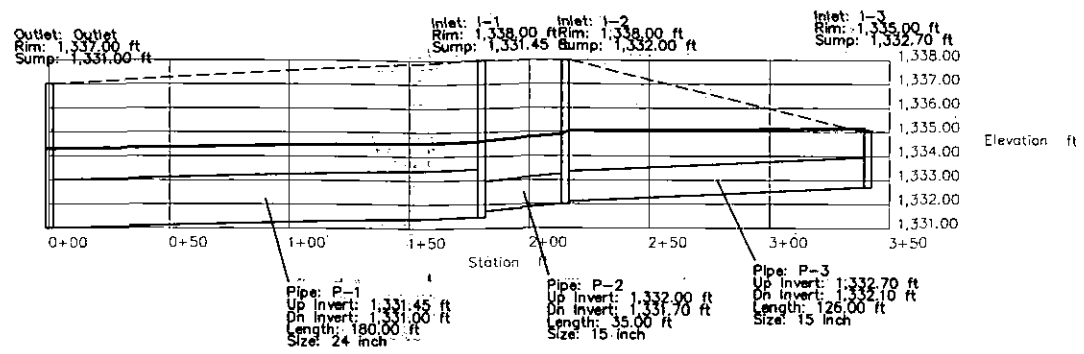


LINE 3A PROFILE

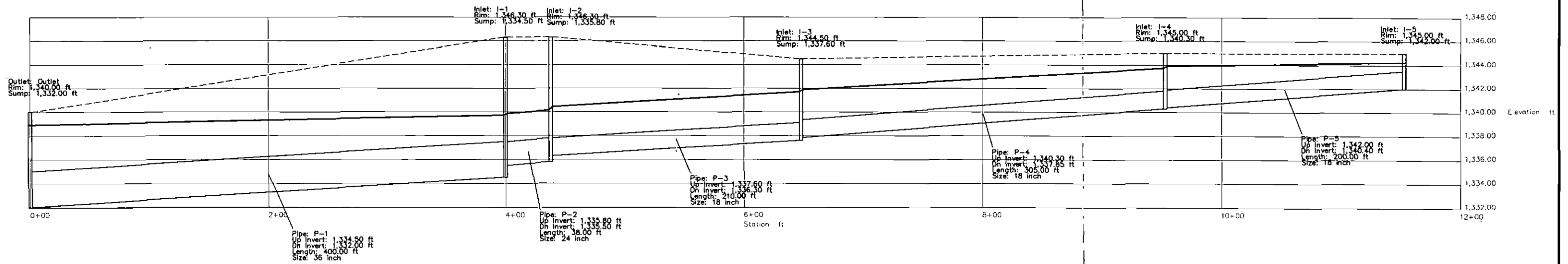


LINE 3B PROFILE

<b>SIERRA HILLS ADDITION SERIES 3 SWS PROFILES</b>		DESIGN CMB	REVISION
 <b>Ruggles &amp; Bohm, P.A.</b> Engineering, Surveying, Land Planning		DRAWN CMB	DATE 8-8-02
924 North Main Wichita, Kansas 67203 www.rbkansas.com		(316) 264-8008 (316) 264-4621 fax E-mail: info@rbkansas.com	REVIEW UTILITY OF
DRAWING FILE Sierra Hills SWS Profiles	PROJECT NUMBER	DATE	




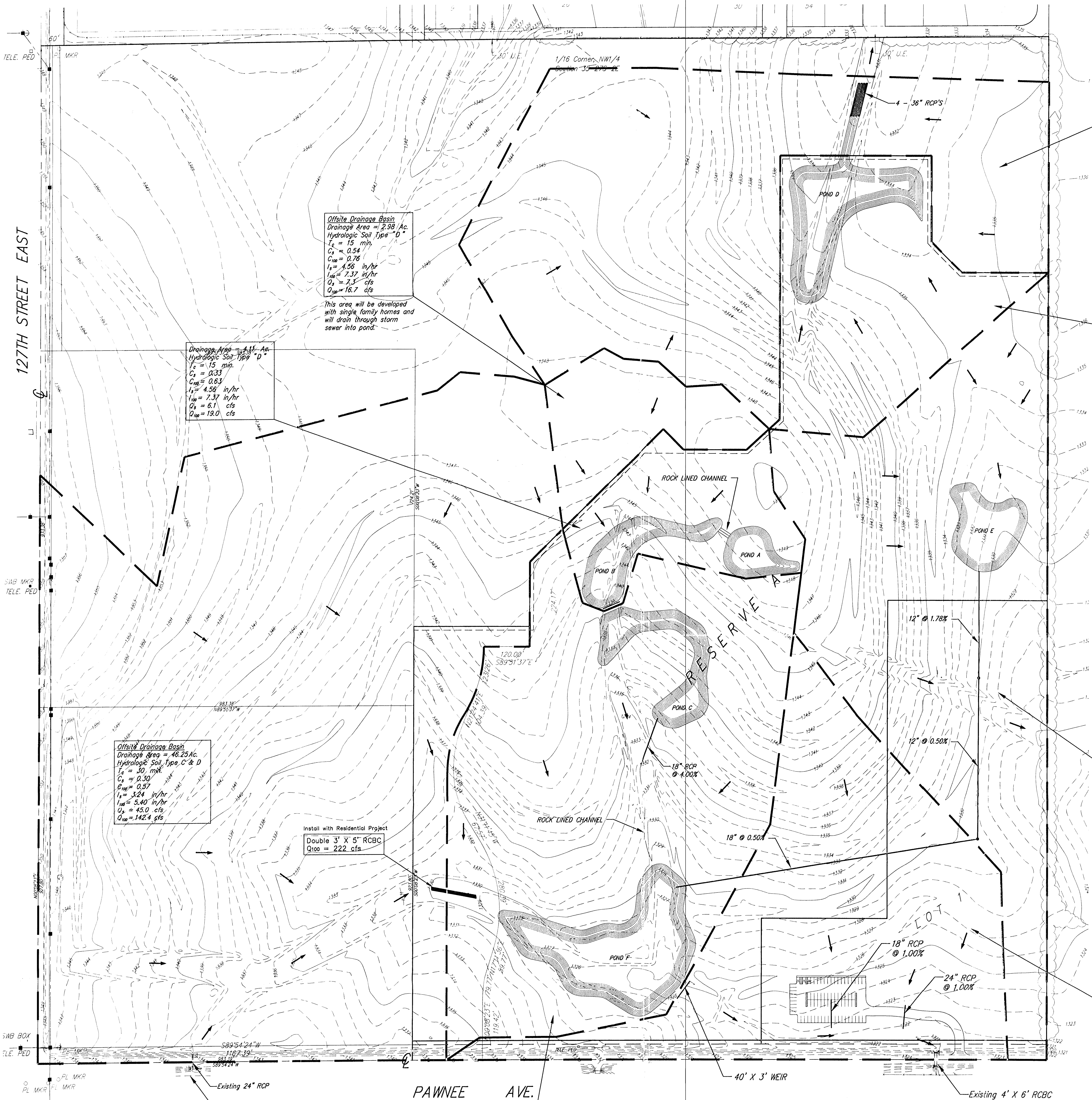
LINE 4 PROFILE



LINE 5 PROFILE

**SIERRA HILLS ADDITION  
SERIES 4 and 5 SWS PROFILES**

	<b>Ruggles &amp; Bohm, P.A.</b> Engineering, Surveying, Land Planning		DESIGN <b>CMB</b>	SHEET OF
	924 North Main Wichita, Kansas 67203 www.rbkansas.com		(318) 264-8008 (315) 264-4621 fax E-mail: info@rbkansas.com	
DRAWING TITLE Sierra Hills SWS Profiles		PROJECT NUMBER	DATE B-8-02	



Offsite Drainage Basin  
 Drainage Area = 19.12 Ac.  
 Hydrologic Soil Type "D"  
 $T_c = 15$  min.  
 $C_s = 0.54$   
 $C_{100} = 0.78$   
 $I_s = 4.96$  in/hr  
 $I_{100} = 7.37$  in/hr  
 $Q_s = 47.1$  cfs  
 $Q_{100} = 107.1$  cfs

This area will be developed with single family homes and will drain through storm sewer into pond.

Offsite Drainage Basin  
 Drainage Area = 2.98 Ac.  
 Hydrologic Soil Type "D"  
 $T_c = 15$  min.  
 $C_s = 0.54$   
 $C_{100} = 0.78$   
 $I_s = 4.96$  in/hr  
 $I_{100} = 7.37$  in/hr  
 $Q_s = 7.5$  cfs  
 $Q_{100} = 16.7$  cfs

This area will be developed with single family homes and will drain through storm sewer into pond.

Drainage Area = 1.11 Ac.  
 Hydrologic Soil Type "D"  
 $T_c = 15$  min.  
 $C_s = 0.33$   
 $C_{100} = 0.63$   
 $I_s = 4.96$  in/hr  
 $I_{100} = 7.37$  in/hr  
 $Q_s = 6.1$  cfs  
 $Q_{100} = 19.0$  cfs

Drainage Area = 7.36 Ac.  
 Hydrologic Soil Type "D"  
 $T_c = 15$  min.  
 $C_s = 0.33$   
 $C_{100} = 0.63$   
 $I_s = 4.96$  in/hr  
 $I_{100} = 7.37$  in/hr  
 $Q_s = 11.1$  cfs  
 $Q_{100} = 34.2$  cfs

Offsite Drainage Basin  
 Drainage Area = 46.25 Ac.  
 Hydrologic Soil Type "C & D"  
 $T_c = 30$  min.  
 $C_s = 0.30$   
 $C_{100} = 0.57$   
 $I_s = 3.24$  in/hr  
 $I_{100} = 5.40$  in/hr  
 $Q_s = 45.0$  cfs  
 $Q_{100} = 142.4$  cfs

Install with Residential Project  
 Double 3' X 5' RCBC  
 $Q_{100} = 222$  cfs

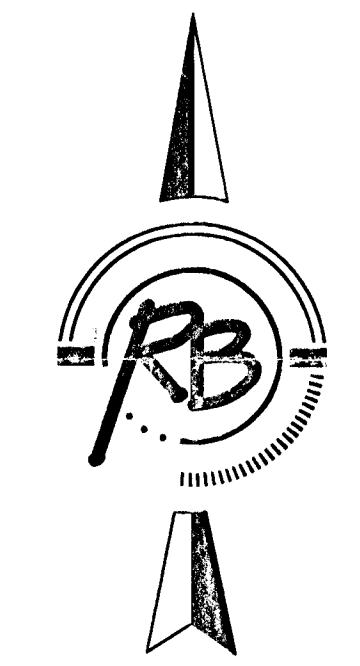
Drainage Area = 17.5 Ac.  
 Hydrologic Soil Type "C & D"  
 $T_c = 20$  min.  
 $C_s = 0.30$   
 $C_{100} = 0.57$   
 $I_s = 4.00$  in/hr  
 $I_{100} = 6.53$  in/hr  
 $Q_s = 21.0$  cfs  
 $Q_{100} = 65.1$  cfs

Drainage Area = 14.4 Ac.  
 Hydrologic Soil Type "D"  
 $T_c = 20$  min.  
 $C_s = 0.30$   
 $C_{100} = 0.57$   
 $I_s = 4.00$  in/hr  
 $I_{100} = 6.53$  in/hr  
 $Q_s = 17.3$  cfs  
 $Q_{100} = 53.6$  cfs

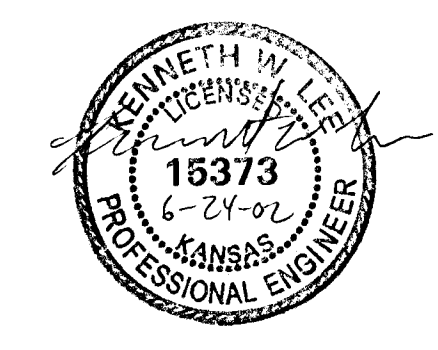
Offsite Drainage Basin  
 Drainage Area = 28.70 Ac.  
 Hydrologic Soil Type "C"  
 $T_c = 30$  min.  
 $C_s = 0.27$   
 $C_{100} = 0.51$   
 $I_s = 3.24$  in/hr  
 $I_{100} = 5.40$  in/hr  
 $Q_s = 25.1$  cfs  
 $Q_{100} = 79.0$  cfs

Higher intensity storm runoff overflows east along south road ditch.

Drainage Area = 25.0 Ac.  
 Hydrologic Soil Type "C & D"  
 $T_c = 20$  min.  
 $C_s = 0.30$   
 $C_{100} = 0.57$   
 $I_s = 4.00$  in/hr  
 $I_{100} = 6.53$  in/hr  
 $Q_s = 30.0$  cfs  
 $Q_{100} = 93.1$  cfs



SCALE: 1" = 100'



Pond	Static	Pool	Bottom	Surface Area	Q100 (IN)	Q100 (OUT)	Max. W.S.
A	1345.0	1335.0	0.46	N/A	N/A	N/A	N/A
B	1342.0	1335.0	0.74	43.2	33.8	1342.7	
C	1338.0	1331.0	0.86	33.8	17.3	1338.9	
D	1332.0	1322.0	1.42	159.7	96.7	1334.3	
E	1331.0	1324.0	0.75	N/A	N/A	N/A	
F	1328.0	1318.0	2.30	396.9	347.0	1330.0	

Note: Inflow and Outflow Values are based on output from HEC-HMS. Ponds A and E are not designed for detention. Water will be pumped to Pond A as necessary to maintain water surface. All ponds shall be 3:1 below water surface and 5:1 above water surface. A 5' wide bench shall be implemented at a depth of 5'.

PAR 3 GOLF COURSE  
 DRAINAGE PLAN  
 WICHITA, SEDGWICK COUNTY, KANSAS

Ruggles & Bohm, P.A.  
 Engineering, Surveying, Land Planning

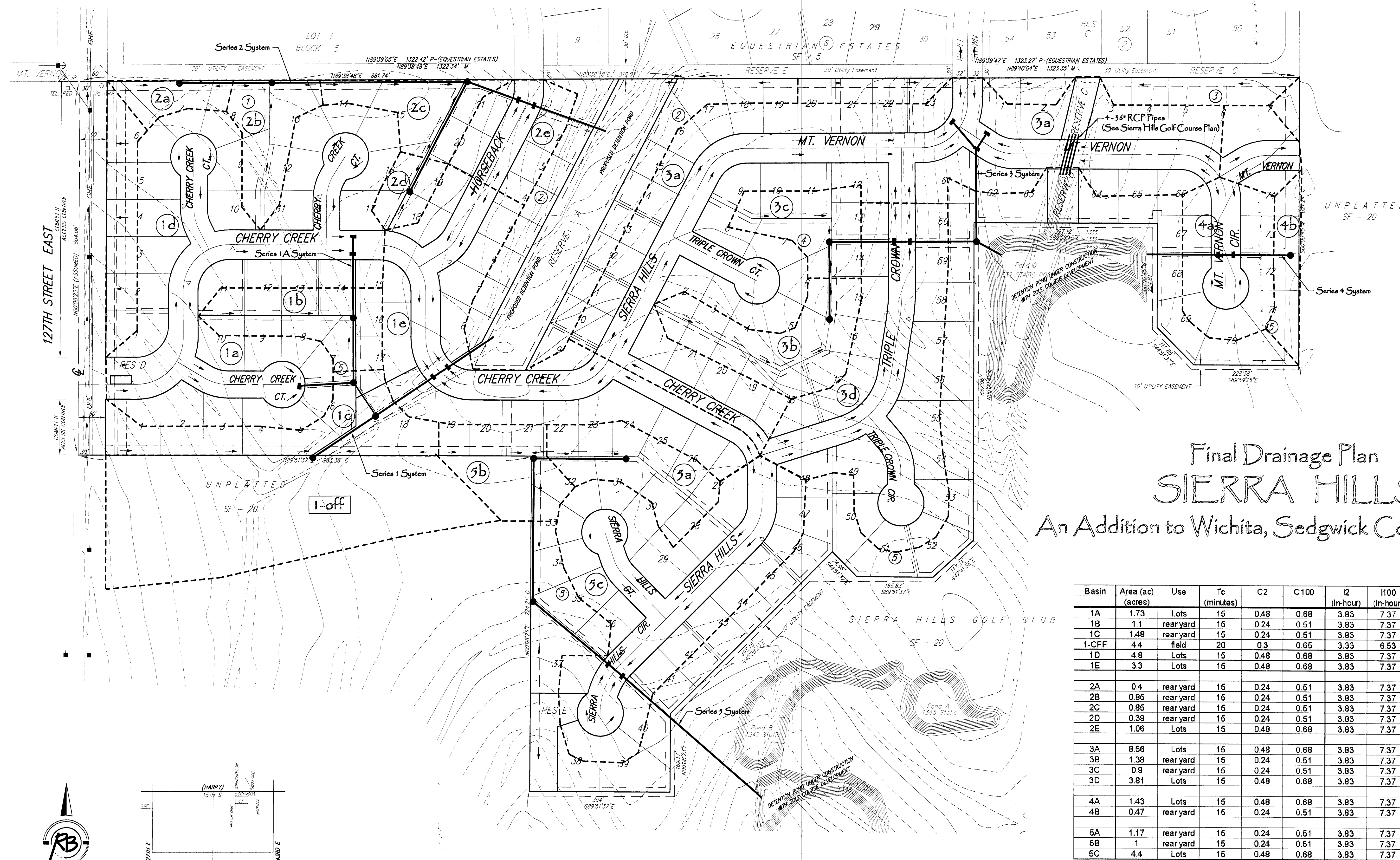
924 North Main  
 Wichita, Kansas 67203  
 www.rbkansas.com

(316) 264-8008  
 (316) 264-4021 fax  
 E-mail: info@rbkansas.com

DESIGN: KWL  
 DRAWN: KWL  
 REVIEW: KWL  
 UTILITY: KWL

PROJECT NUMBER: 1821plan2 (Entire Site)  
 DATE: Apr. 15, 2002

SHEET: 1 OF 1



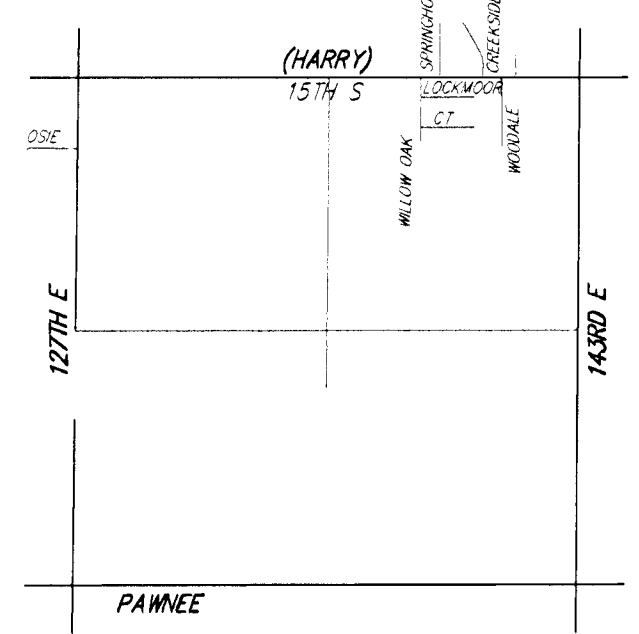
# Final Drainage Plan SIERRA HILLS

An Addition to Wichita, Sedgwick County, Kansas

Basin	Area (ac)	Use	Tc (minutes)	C2	C100	I2 (in-hour)	I100 (in-hour)	Q2 (cfs)	Q100 (cfs)
1A	1.73	Lots	15	0.48	0.68	3.83	7.37	3.2	8.7
1B	1.1	rear yard	15	0.24	0.51	3.83	7.37	1.0	4.1
1C	1.48	rear yard	15	0.24	0.51	3.83	7.37	1.4	5.6
1-OFF	4.4	field	20	0.3	0.85	3.33	6.53	4.4	19.7
1D	4.8	Lots	15	0.48	0.68	3.83	7.37	8.8	24.1
1E	3.3	Lots	15	0.48	0.68	3.83	7.37	6.1	16.5
2A	0.4	rear yard	15	0.24	0.51	3.83	7.37	0.4	1.5
2B	0.85	rear yard	15	0.24	0.51	3.83	7.37	0.8	3.2
2C	0.85	rear yard	15	0.24	0.51	3.83	7.37	0.8	3.2
2D	0.39	rear yard	15	0.24	0.51	3.83	7.37	0.4	1.5
2E	1.06	Lots	15	0.48	0.68	3.83	7.37	1.9	5.3
3A	8.56	Lots	15	0.48	0.68	3.83	7.37	15.7	42.9
3B	1.38	rear yard	15	0.24	0.51	3.83	7.37	1.3	5.2
3C	0.9	rear yard	15	0.24	0.51	3.83	7.37	0.8	3.4
3D	3.81	Lots	15	0.48	0.68	3.83	7.37	7.0	19.1
4A	1.43	Lots	15	0.48	0.68	3.83	7.37	2.6	7.2
4B	0.47	rear yard	15	0.24	0.51	3.83	7.37	0.4	1.8
6A	1.17	rear yard	15	0.24	0.51	3.83	7.37	1.1	4.4
6B	1	rear yard	15	0.24	0.51	3.83	7.37	0.9	3.8
6C	4.4	Lots	15	0.48	0.68	3.83	7.37	8.1	22.1

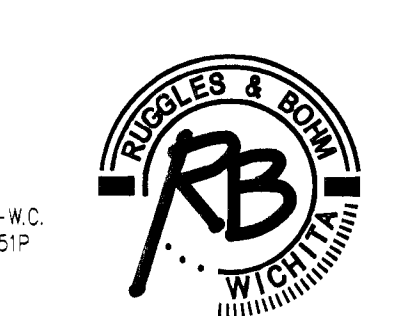


1 inch = 100 ft.



**FLOOD ZONE:**  
According to the FEMA/FIRM Community Panel No. 200321 0225 A, effective June 3, 1986; the property shown hereon is located in Zone C, an area of minimal flooding.

DWG FILE: 01951P-WC  
PROJECT NO. 01E01951P  
August 9, 2002



**Ruggles & Bohm, P.A.**  
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