December 3, 1984

City of Wichita
Dept. of Engineering
City Hall - Seventh Floor
455 N. Main St.
Wichita, Ks. 67202

Att'n: Mr. Don Schneider, P.E.

Subject: Proposed Encroachment in Platted Floodway -Walnut Creek Addition

Dear Don:

This report describes my analysis of the effect of a proposed swimming pool and tennis court encroachment in the platted floodway of subject addition. The developer retained the services of Planning Development Services to design those facilities along with other improvements and amenities to be located within the platted floodway. Because the pool-courts encroachment will require a significant change in the grading plan approved along with the subdivision plat, PDS asked that I analyze its effect on the 100 year flood profile which I had calculated for PEC as a condition of approval of the Walnut Creek and Whistling Walk Estates 4th Additions. PDS provided a proposed Grading Plan showing the location and elevation of the encroachment together with a modified geometric model and cross-section H to accommodate the proposed fill. Another feature of the PDS amentities plan is the connection of two abandoned Cowskin Creek meanders to form a small lake.

(con't.)

M.S. Mitchell

M. S. Mitchell
Flood Plain Management & Land Development Specialist
1215 Forest • Wichita, KS. 67203
(316) 265-9812

When I did the Floodway analysis for the plats, I did not show the Cowskin meanders on Sections H or J because, by themselves, they did not contribute to the effective flow capacity of Cowskin Creek for the 100 yr. flood discharge - and I wanted the developer to have the freedom to fill or modify all, or portions, of them without having to prove that such action would not raise the 100 year frequency flood. Now that they are to be connected I have made the HEC-2 program calculations for two conditions at Sections H; one with the pool-courts fill as an encroachment but no lake excavation (Plan 5A), and the other with the maximum lake width considered (Plan 5B). The calculations are begun at Section G where there is no change from the plat encroachment plan (Plan 4A), run thru Section H for each case described above and tie in to Section I (no effect of lake considered).

In the process of locating the proposed pool-courts encroachment on the model and sections I discovered that Section H of the plat sections showed the Cowskin Creek channel to be plotted exactly 100 feet west (right bank side) of its actual location. The correction was made and new calculations made for Sections G thru I with only minor differences in the 100 year profile. During preliminary discussions of the pool-courts plan the County DPW staff suggested that the developer consider raising the pool-courts fill to just above the 10 year frequency flood and permit inundation by less frequent floods. To evaluate that suggestion I ran a HEC-2 profile for the 10 year flood (lake not considered) using the discharge (6570 cfs) from the Flood Insurance Study. This exercise indicated that at Section H there would be only 2.5 feet difference between the two floods and I recommended that the fill be placed to provide three feet of feeboard above the 100 year flood.

The HEC-2 program calculations for the Flood Insurance Study discharge of 15050 cfs show that within the accuracy accepted for such studies there is no effect on the 100 yr. flood profile by adding the pool-courts fill in the platted floodway whether or not the lake is considered to add to the effective flow capacity of Cowskin Creek. Exhibits attached to this letter are:

Exhibit 1 - Geometric Model submitted for Walnut Creek Add.
2 - HEC-2 calculation sheet 2 for Walnut Creek Add.
3 - Coordinates for correcting Section H.

(con't.)

Exhibit 4 - Section Properties for correcting Section H.
5 - HEC-2 calculations for correcting Section H.
6 - HEC-2 calculations for 10-year flood profile (2 pages).
7 - Plan of Walnut Creek Addition showing Section H, proposed pool-courts encroachment and lake.
8 - Enlarged plan for pool, tennis courts and lake.
9 - Coordinates for Section H Encroachment Plans 5A and 5B.
10 - Section Properties for Section H, Plans 5A & 5B.
11 - HEC-2 calculations for Sections G, H & I, Plan 5A.
12 - HEC-2 calculations for Sections G, H & I, Plan 5B.

Please review the letter and exhibits and call me if you have any questions or want additional materials to support the requested approval. If you are going to require prior or concurrent written approval of the County DPW or Division of Water Resources - Kansas State Board of Agriculture, please advise by letter so that I can prepare additional exhibits and transmittals without further delay.

Yours truly,

enclosures

MSM/e

BACKWATER COMPUTATION WORK SHEET

Project: Cowskin Creek - Encroachment Plan 4A
119th Street West to 135th Street (Walnut Valley and Whistling Walk Estates 4th Additions)

Page 3 of 4

Computed by: MSM **Date** Mar, 1983

Checked by: MSM **Date** Mar, 1983

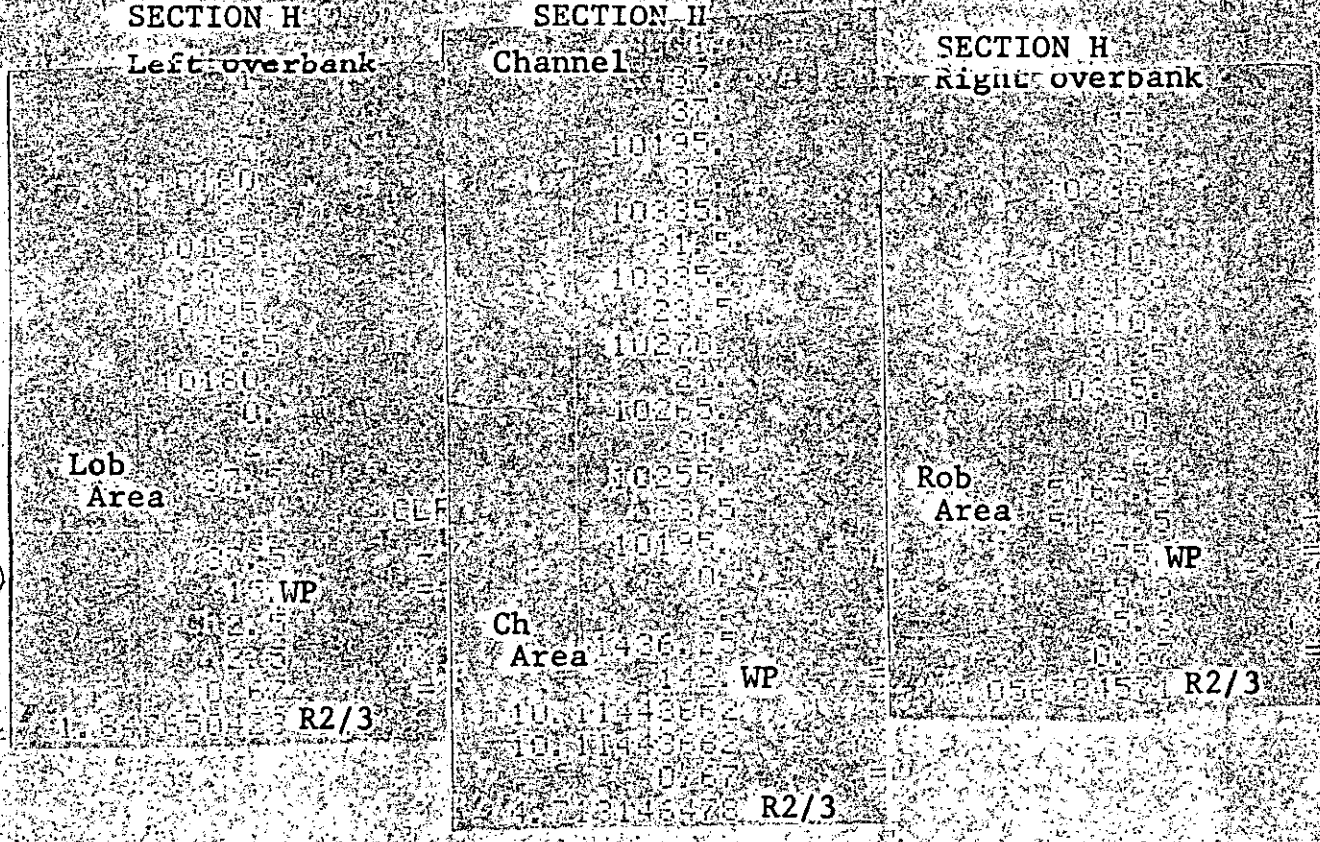
Q = 15050 cfs = 100 Yr FIS **n =** .035

Mile or Sec. No.	Reach Length	Est. W.S. Elev.	Area	2/3 r	K ×10³	K̄ ×10³	S̄f	hf	K³/A² ×10⁶	α	V	αV²/2g	Δhv	ho	H	Comp. Elev.	
Sec F	436	1336.2	2896		474.0		.00098	.38		1.27	5.20	.53	0	0	.38	1336.13	
Sec G		1336.5	1751	2.31	17.2				165								
			1548	4.54	298.4				11,086								
			1950	2.94	243.4				3793								
	199		3673		559.0	516.5	.00085	.17	15,044	1.16	4.10	.30	.23	.02	.42	1336.55	ΔH = 1.05 OK
Sec H		1337.0	288	1.85	22.6				139								
			1436	4.71	287.2				11,483								
			4638	3.06	602.6				10,171								
	679		6362		912.3	735.6	.00042	.29	21,794	1.16	2.37	.10	.20	.02	.52	1337.07	ΔH = 1.07 OK
Sec I		1337.1	0	0	0				0								
			1598	4.05	274.8				8124								
			3450	2.30	336.9				3213								
	284		5048		611.7	762.0	.00057	.10	11,337	1.26	2.98	.17	-.07	.02	.05	1337.12	ΔH = 1.02 OK
Sec J		1337.2	0	0	0				0								
			1423	3.90	235.6				6760								
			4579	3.16	614.3				11,058								
	212		6002		850.0	732.2	.00042	.09	17,818	1.03	2.50	.10	.07	.01	.17	1337.29	ΔH = 1.09 OK

Walnut Valley & Whistling Walk Estates 4th Additions

Encroachment Plan 4A & Natural Sections

CORRECTION FOR LOCATION OF CHANNEL ON SECTION H



Cowskin Creek - 119th to 13th
Section Properties - Encroachment Plan 4A Correction

Section ID	W.S. Elev.	Area	W.P.	R	$R^{2/3}$	$K \times 10^{-3}$	%KT	φ_{us}	φ_{ds}	$\bar{\varphi}$	l	$l\bar{\varphi}$	$\Sigma \frac{l\bar{\varphi}}{\varphi} = L$
From Encroachment Plan 4A													
G	1336.5												
Lob		175	50	3.5	2.31	17.2	3	462	1695	1079	170	183,356	
Ch		1548	162	9.55	4.54	298.4	53	8034	8976	8505	190	1,615,959	199
Rob		1950	390	5	2.94	243.4	44	6554	4379	5466	220	1,202,606	
		3673				559.0						3,001,921	
Corrected X-Section													
H	1337.0												
Lob		37.5	15	2.5	1.85	2.9	0.3	46	462	254	760	193,079	
Ch		1436	142	10.11	4.71	287.2	30	4495	8034	6264	840	5,262,055	674
Rob		5168	975	5.3	3.06	671.4	69.7	10,509	6554	8532	550	4,692,379	
						961.5						10,147,513	
I	1337.1	0	0	0	0	0	0	0	46	23	270	6210	
		1598	198	8.07	4.05	274.8	45	6761	4495	5628	260	1,463,280	254
		3450	995	3.47	2.30	336.9	55	8289	10,509	9398	250	2,349,750	
												3,819,240	
~~Encroachment Plan 5~~													
H	1337.0	VOID - See Plan 5A & 5B											
Lob		0	0	0	0	0	0	0	462	231	760	175,560	
Ch		1666	177	9.41	4.49	317.6	39	5901	8034	6968	840	5,852,730	687
Rob		3790	715	5.3	3.06	492.4	61	9149	6554	7851	550	4,318,305	
												10,346,595	
Plan 4A Section													
I	1337.1												
Ch		1598	198	8.07	4.05	274.8	45	6761	5901	6331	260	1,646,060	254
Rob		3450	995	3.47	2.30	336.9	55	8289	9149	8919	250	2,179,750	
												3,825,810	

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HEC-2 WATER SURFACE PROFILE CALCULATIONS

DISCHARGE 100 YR 15050 cfs STREAM CONSKIN CREEK PROJECT Walnut Creek Addition Correction for Cross-Section H of Encroachment Plan 4A

RM / X-SEC	1 Reach Length	2 Flowline Elev.	3 Trial W.S. Elev.	4 Area 'A'	5 $R^{2/3}$	6 'n'	7 K	8 K_T	9 'Sf'	10 'hf'	11 K^2/A_{1+2}	12 'α'	13 'V'	14 $V^2/2g$	15 $\alpha(V^2/2g)$	16 Δh_v	17 h_o	18 H	Final W.S. Elev.	20 Remarks
	Begin @ Section G of Encroachment Plan 4A dated March 1983																			
G		1320	1336.5																	
	Lt overbank	—		175	2.31	.035	17,163				165									
	Chan			1548	4.54	.035	298,385				11,086									
	Rob			1950	2.94	.035	293,407				3793									
	199			3673			558,956	516,500	.00085	.17	15,044	1.16	4.10	.26	.30	.23	.02	.42	1336.55	ΔH = +.05 OK
H		1321	1337.0																	
	Lob			37.5	1.85	.035	2945				18									
	Ch			1436	4.71	.035	287,161				11,483									
	Rob			5168	3.06	.035	671,421				11,333									
	674			6641.5			961,528	760,242	.00039	.26	22,834	1.13	2.27	.08	.09	.21	.02	.49	1337.04	ΔH = +.04 OK
I		1321	1337.1																	
	Lob			0	0	0	0				0									
	Ch			1598	4.05	.035	274,800				8124									
	Rob			3450	2.30	.035	336,900				3212									
	254			5048			611,700	786,614	.00037	.09	11,337	1.26	2.97	.13	.17	-.08	.02	.03	1337.07	ΔH = -.03 OK
	New X-Section H - Encroachment Plan 5																			
H		1321	1337.0				VOID - See Plans 5A & 5B													
	Lob			0	0	0	0				0									
	Ch			1666	4.49	.035	317,594				11,542									
	Rob			3790	3.06	.035	492,392				8,311									
	687			5456			809,986	684,471	.00048	.33	19,853	1.11	2.76	.12	.13	.17	.02	.52	1337.07	ΔH = +.07 OK
I																				
	Ch			1598	4.05	.035	274,800													
	Rob			3450	2.30	.035	336,900													
	254						611,700	710,843	.00045	.11		1.26	2.98	.13	.17	-.04	.01	.08	1337.15	ΔH = +.05 OK

EFFICIENCY LINE 22-211

$K = \frac{C_m}{n} A R^{2/3}$ $C_m = 1.486$ $R_T = \frac{1}{2}(K_{us} + K_{ds})$ $S_f = (Q/K_T)^2$ $h_f = L S_f$ $\alpha = (A_T)^2 \Sigma (K^3/A^2) \div (K_T)^3$ $V = Q/A$ $\Delta h_v = \alpha(V^2/2g)_{ds} - \alpha(V^2/2g)_{us}$ $h_o = C_e(-\Delta h_v)$ or $C_c(+\Delta h_v)$ $H = h_f \pm \Delta h_v + h_o$

Exhibit 5

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HEC-2 WATER SURFACE PROFILE CALCULATIONS

10 YR
DISCHARGE 6570 cfs STREAM Cowskin Creek PROJECT Walnut Creek Tennis Courts & Swimming Pool Encroachment Plan 5

RM / X-Sec	1 Reach Length	2 Flowline Elev.	3 W.S. Elev. Trial	4 Area 'A'	5 $R^{2/3}$	6 'n'	7 K	8 Kr	9 Sf	10 hf	11 $K^2/A\Delta10^6$	12 α	13 'V'	14 $V^2/2g$	15 $\alpha(V^2/2g)$	16 Δhv	17 h_o	18 H	Final W.S. Elev.	20 Remark
1	HNTB FIS Pg 3-30																		1332.8	
20.974				3826			318,162					1	1.72	.05	.05					
3																				
A 4			1332.8																	
5	Lob			672	1.99	.035	56,777				405									
6	ch			1400	4.61	.035	274,018				10,497									
7	Rob			581	1.71	.035	42,182				222									
8	80			2653			372,977	345,570	.00036	.03	11,125	1.51	2.48	.10	.14	-.09	.03	-.03	1332.77	OK
9																				
B 10			1332.8																	
11	Lob			390	1.38	.035	22,850				78									
12	ch			1194	3.80	.035	192,637				5014									
13	Rob			353	1.23	.035	18,434				50									
14	139			1937			233,921	303,449	.00047	.07	5142	1.51	3.39	.18	.27	-.13	.04	-.02	1332.75	OK
15																				
C 16			1332.9																	
17	Lob			112	1.25	.035	5944				17									
18	ch			1311	4.22	.035	234,891				7540									
19	Rob			582	1.58	.035	39,042				176									
20	296			2005			279,277	256,299	.00065	.19	7733	1.42	3.28	.17	.24	.03	0	.22	1332.97	OK
21																				
D 22			1333.1																	
23	Lob			272	1.37	.035	15,821				54									
24	ch			1194	4.05	.035	205,310				6070									
25	Rob			300	1.80	.035	22,927				134									
26	159			1766			244,058	261,968	.00063	.10	6258	1.34	3.72	.21	.29	.05	.01	.16	1333.13	OK
27																				
28																				
29																				
30																				
31																				

$K = \frac{C_m}{n} A R^{2/3}$ $C_m = 1.486$ $R_T = \frac{1}{2}(K_{us} + K_{ds})$ $Sf = (Q/K_T)^2$ $hf = L Sf$ $\alpha = (A_T)^2 \Sigma (K^3/A^2) \div (K_T)^3$ $V = Q/A$ $\Delta hv = \alpha(V^2/2g)_{ds} - \alpha(V^2/2g)_{us}$ $h_o = C_e(-\Delta hv)$ or $C_c(+\Delta hv)$ $H = hf + \Delta hv + ho$

Exhibit 6

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Pg 2 of 2

HEC-2 WATER SURFACE PROFILE CALCULATIONS

DISCHARGE 10yr 6570 STREAM Cowskin Creek PROJECT Walnut Creek Encroachment Plan 5

RM / X-SEC	1 Reach Length	2 Flowline Elev.	3 Trial W.S. Elev.	4 Area 'A'	5 $R^{2/3}$	6 'n'	7 K ~~*10~~	8 K_T ~~*10~~	9 'Sf'	10 'hf'	11 K^2/A_{*10}	12 'α'	13 'V'	14 $V^2/2g$	15 $\alpha(V^2/2g)$	16 Δh_v	17 h_o	18 H	19 Final W.S. Elev.	20 Remarks
D 1	159		1333.1	1766		.035	244,058	261,968	.00063	.10	6258	1.34	3.72	.21	.29	.05	.01	.16	1333.13	
2																				
E 3			1333.4																	
4	Lob			114	1.54	.035	7454				32									
5	Chan			1072	4.39	.035	199,807				6941									
6	Rob			666	2.20	.035	62,208				543									
7	397			1852			269,469	256,763	.00065	.26	7516	1.32	3.55	.20	.26	.03	0	.29	1333.42	OK
8																				
F 9			1333.7																	
10	Lob			208	1.69	.035	14,925				77									
11	Chan			1023	4.38	.035	190,239				6579									
12	Rob			540	1.70	.035	38,976				203									
13	393			1771			244,140	256,804	.00065	.26	6859	1.48	3.71	.21	.32	.06	.01	.33	1333.75	OK
14																				
G 15																				
16			1333.9																	
17	Lob			45	0.93	.035	1777				3									
18	Chan			1132	3.72	.035	178,789				4460									
19	Rob			936	1.80	.035	71,532				418									
20	199			2113			252,097	248,118	.00070	.14	4880	1.36	3.11	.15	.20	.12	.01	.27	1334.02	OK
21																				
H 22			1334.4																	
23	Lob			0	0	.035	0				0									
24	Chan			1076	3.74	.035	170,858				4308									
25	Rob			2633	1.95	.035	217,990				1494									
26	687			3709			388,848	320,472	.00042	.29	5802	1.36	1.77	.05	.07	.13	.01	.43	1334.45	OK
27																				
28																				
29																				
30																				
31																				

$K = \frac{C_m}{1.49} A R^{2/3}$ $C_m = 1.486$ $K_T = \frac{1}{2}(K_{us} + K_{ds})$ $S_f = (Q/K_T)^2$ $h_f = L S_f$ $\alpha = (A_T)^2 \Sigma(K^3/A^2) \div (K_T)^3$ $V = Q/A$ $\Delta h_v = \alpha(V^2/2g)_{ds} - \alpha(V^2/2g)_{us}$ $h_o = C_e(-\Delta h_v)$ or $C_c(+\Delta h_v)$ ($C_e = .3$, $C_c = .1$) $H = h_f \pm \Delta h_v + h_o$

Exhibit 6

AMRAD EFFICIENCY® LINE 22-211

COWSKIN CREEK

Walnut Valley and Whistling Walk Estates 4th Additions

ENCROACHMENT PLANS 5A & 5B for Tennis Courts and Swimming Pool

SECTION H

CHANNEL Plan 5A & B	RIGHT OVERBANK Plan 5A	RIGHT OVERBANK Plan 5B
Elev 37.0	Elev 37.	Elev 37.
37.	36.	37.
10180.	10555.	10555.
37.	37.	37.
10370.	10310.	10310.
31.5	31.	31.
10370.	11310.	11310.
31.5	31.	31.
10335.	10840.	10840.
27.5	32.	20.
10270.	10630.	10810.
31.5	31.5	20.
10265.	10555.	10660.
27.5	0.	32.
10255.	25.	31.5
33.5	Area 4157.25	10630.
10195.	CLR	31.5
35.5	4157.25 WP	10555.
10180.	5.505960665 R	0.
0.	5.505960665 Y	25.
25.	0.767 n	Area 6227.25
Area 1666.25	1.35970783 R2/3	6227.25 WP
1666.25 WP	CLR	8.204216074 R
1666.25 CLR		8.204216074 Y
1666.5		0.9 n
1925 WP		1.409642358 R2/3
8.677083333 R		CLR
8.677083333 Y		
0.67 n		
1.531477708 R2/3		
CLR		

Exhibit 9

Cowskin Creek - 119th to 13th

Section Properties - Encroachment Plans 5A & 5B

Section ID	W.S. Elev.	Area	W.P.	R	$R^{2/3}$	$K \times 10^{-3}$	% KT	Q_{us}	Q_{ds}	$\bar{Q}$	ℓ	$\frac{\ell}{\bar{Q}}$	$\sum \frac{\ell}{\bar{Q}} = L$
From Encroachment Plan 4A													
G	1336.5												
Lob		175	50	3.5	2.31	17.2	3	462	1695	1079	170	183,356	
Ch		1548	162	9.55	4.54	298.4	53	8034	8976	8505	190	1,615,959	199
Rob		1950	390	5.0	2.94	243.4	44	6554	4379	5466	220	1,202,606	
		3673				559.0						3,001,921	
From Encroachment Plan 5B													
H	1337.0												
Lob		0	0	0	0	0	0	0	462	231	760	175,560	
Ch		1666	192	8.68	4.25	300.6	22	5268	8034	6651	840	4,744,487	662
Rob		6227	759	8.20	4.10	1084.0	78	11,782	6554	9168	550	5,042,500	
												9,962,747	
From Encroachment Plan 4A													
I	1337.1												
Lob		0	0	0	0	0	0	0	0	0	0	0	
Ch		1598	198	8.07	4.05	274.8	45	6761	3268	5015	260	1,303,770	753
Rob		3450	995	3.47	2.30	336.9	55	8289	11,782	10,035	250	2,508,875	
												3,812,645	
From Encroachment Plan 5A													
H	1337.0												
Lob		0	0	0	0	0	0	0	462	231	760	175,560	
Ch		1666	192	8.68	4.25	300.6	35	5293	6761	6027	840	5,062,575	678
Rob		4157	755	5.51	3.14	559.2	65	9757	8289	9023	550	4,962,717	
						854.8						10,200,853	
I	1337.1												
Lob		0	0	0	0	0	0	0	0	0	0	0	
Ch		1598	198	8.07	4.05	274.8	45	6761	5293	6027	260	1,567,020	254
Rob		3450	995	3.47	2.30	336.9	55	8289	9757	9023	250	2,255,750	
												3,822,770	

Exhibit 10

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HEC-2 WATER SURFACE PROFILE CALCULATIONS

DISCHARGE 100 YR 150,50 cfs STREAM Cowskin Creek PROJECT Walnut Valley Addition Encroachment Plan 5A for tennis courts & pool November, 1984

RM / X-SEC	1 Reach Length	2 Flowline Elev.	3 Trial W.S. Elev.	4 Area 'A'	5 $R^{2/3}$	6 'n'	7 K	8 K_T	9 'Sf'	10 'hf'	11 K^2/A_{M10}	12 'α'	13 'V'	14 $V^2/2g$	15 $\alpha(V^2/2g)$	16 Δh_v	17 h_o	18 H	Final W.S. Elev.	20 Remarks
1	Begin e	Section G	of Encroachment Plan 4A	dated March 1983																
Section G 2		1320	1336.5																	
Lob 3				175	2.31	.035	17,163				165									
Ch 4				1548	4.54	.035	298,385				11,086									
Rob 5				1950	2.94	.035	243,407				3793									
6				3673			558,956	516,500	.00085	.17	15,044	1.16	4.10	.26	.30	.23	.02	.42	1336.55	ΔH=+.05 OK
7																				
Plan 5A 8																				
Sec H 9		1321	1337.0																	
Lob 10				0	0	0	0				0									
Ch 11				1666	4.25	.035	300,618				9788									
Rob 12				4157	3.14	.035	554,192				9850									
13	678			5823			854,810	706,883	.00045	.31	19,638	1.07	2.58	.10	.11	.19	.02	.52	1337.07	ΔH=+.07 OK
14																				
Plan 4A 15																				
Sec I 16		1321	1337.1																	
Lob 17				0	0	0	0				0									
Ch 18				1598	4.05	.035	274,800				8124									
Rob 19				3450	2.38	.035	336,900				3212									
20	754			5048			611,700	733,255	.00042	.11	11,337	1.26	2.98	.13	.17	-.06	.02	.07	1337.14	ΔH=-.04 OK
21																				
22																				
23																				
24																				
25																				
26																				
27																				
28																				
29																				
30																				
31																				

$K = \frac{C_m}{n} A R^{2/3}$ $C_m = 1.486$ $R_T = \frac{1}{2}(K_{us} + K_{ds})$ $S_f = (Q/K_T)^2$ $h_f = L S_f$ $\alpha = (A_T)^2 \Sigma (K^3/A^2) \div (K_T)^3$ $V = Q/A$ $\Delta h_v = \alpha(V^2/2g)_{ds} - \alpha(V^2/2g)_{us}$ $h_o = C_e(-\Delta h_v)$ or $C_c(+\Delta h_v)$ $H = h_f + \alpha h_v + h_o$

Exhibit 11

FOLD TO HERE

HEC-2 WATER SURFACE PROFILE CALCULATIONS

DISCHARGE 100 YR 15050 cfs STREAM Cowskin Creek PROJECT Walnut Valley Addition Encroachment Plan 5B for tennis courts & pool November, 1984

RM / X-SEC	1 Reach Length	2 Flowline Elev.	3 Trial W.S. Elev.	4 Area 'A'	5 $R^{2/3}$	6 'n'	7 K	8 K_T	9 'Sf'	10 'hf'	11 K^2/A_{10}^2	12 'α'	13 'V'	14 $V^2/2g$	15 $\alpha(V^2/2g)$	16 Δh_v	17 h_o	18 H	Final W.S. Elev.	20 Remarks
1	Begin @ Section G of Encroachment Plan 4A dated March 1983																			
Sec. G 2		1320	1336.5																	
Lob 3				175	2.31	.035	17,163				165									
Chan 4				1548	4.54	.035	298,385				11,086									
5				1950	2.94	.035	243,407				3793									
6	199			3673			558,956	516,500	.00085	.17	15,044	1.16	4.10	.26	.30	.23	.02	.42	1336.55	ΔH = +.05 OK
7																				
Plan 5B Sec H 8		1321	1337.0																	
Lob 9				0	0	0	0				0									
Ch 10				1666	4.25	.035	300,618				9788									
Rob 11				6227	4.10	.035	1,083,961				32846									
12	662			7893			1,384,578	971,767	.00024	.16	42,634	1.24	1.92	.06	.07	.22	.02	.40	1336.95	ΔH = -.05 OK
13																				
( ) 14																				
Plan 4A 15																				
Sec I 16		1321	1337.1																	
Lob 17				0	0	0	0				0									
Ch 18				1598	4.05	.035	274,800				8124									
Rob 19				3450	2.30	.035	336,900				3212									
20	253			6048			611,700	998,127	.00023	.06	11,337	1.26	2.98	.13	.17	-.10	.03	-.01	1336.92	ΔH = -.16 OK
21																				
22																				
23																				
24																				
25																				
26																				
27																				
28																				
29																				
30																				
31																				

$K = \frac{C_m}{n} A R^{2/3}$ $C_m = 1.486$ $R_T = \frac{1}{2}(K_{us} + K_{ds})$ $S_f = (Q/R_T)^2$ $h_f = L S_f$ $\alpha = (A_T)^2 \Sigma (K^3/A^3) \div (K_T)^3$ $V = Q/A$ $\Delta h_v = \alpha(V^2/2g)_{ds} - \alpha(V^2/2g)_{us}$ $h_o = C_e(-\Delta h_v)$ or $C_c(+\Delta h_v)$ ($C_e = .30$, $C_c = .10$) $H = h_f \pm \Delta h_v + h_o$

Exhibit 12