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July 14, 2005

REC'D JUL 14 2005

Mr. Bryan Behrmann
West Chester Township
Department of Planning and Zoning
9577 Beckett Road, Suite 100
West Chester, OH 45069

Re: Chesterwood Village
Retention Basin Analysis

Dear Mr. Behrmann,

Enclosed is one copy of the retention basin analysis at Chesterwood Village. We have run the analysis assuming existing conditions were farmland. The proposed conditions were calculated based on known information of the developed portions of the site and future areas were assumed to be developed with an impervious area of 85% of the land area.

The current detention requirements listed in the Butler County Subdivision Regulations require a 50-year post-developed storm be held to a pre-developed 10-year storm. Based on the assumptions above, and the subdivision requirements, the retention basins working together provide the required retention basin volume prior to flowing through their respective emergency spillways. Both retention basins control the 100-year flow without overtopping the dams.

Please review the calculations and let us know if you have any questions or comments.

Sincerely,

Robert W. Bailey

Robert W. Bailey, P. E.

Enclosure

Cc: Eric Pottenger – with calculations
Brent Dixon - with calculations

O:\2005Jobs\05F077\WCTwp 05F077 L01.doc

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Storm Water Detention/Retention Design

Date:	7/14/2005	Revised:		Design Method:	
Design By:	EDA	Revised:			SCS & TR-55 Method Using
Checked By:	RWB	Revised:			Hydroflow Hydrographs

Project: Chesterwood Village — File No.: J:\2005\05F077\Calcs\Detention 05F077.xls

County: Butler — City/Township: West Chester Twp.

Design Criteria And Comments:

Reduce 50 year post-developed storm runoff to that of a 10 year pre-developed storm runoff. Check 100 year runoff for post-developed conditions.

Site Area: 52.12 Acres

Soils: See B:1-2 — Miamian; Xenia — Russel; Ragsdale — Fincastle

Soils Type: ____ % A — 45.5 % B — 54.5 % C — ____ % D

Cover: Existing: 80% Agricultural; 15% Pasture; 5% Wooded

Proposed: 63.9% Impervious; 36.1% Grass Future: 85% Impervious Assumed

Present: CN = 79.97 (See B:1-2)

Time of Concentration: 2199' @ 0.93%

t_c = 64.79 minutes (See A & Right)

Q_{10} = 56.44 cfs (See C)

$i_{10} = \frac{170}{64.79+23} = 1.93$ in

$Q_{10} = .7997 \times 1.93 \times 52.12$ → 80.7 cfs

L (ft) =	2199.00
L' (ft) =	2144.00
Elev 1 =	894.00
Elev 2 =	874.00
s (%) =	0.93
c =	0.35
t_c (min) =	64.79
$=1.8(1.1-c)L^{1/2}/s^{1/3}$	

Developed: 32.93 Impervious Area — 19.19 Grass Area

CN = 86.99 (See D)

t_c = 21.80 minutes from Stm Calcs on file (See E)

t_c = 21.80 minutes

Q_{50} = 174.80 cfs (See F)

$L_{50} = \frac{750}{21.8+27} = 5.123$

$Q_{50} = .8699 \times 5.123 \times 52.12$ → 232.27 cfs

Detention/Retention must detain $Q_{50} - Q_{10}$ = 118.36 cfs 151.57 cfs

Retention provided in two lakes.

Offsite Area: 0.00 Acres

Site Area: 9.30 Acres

Total Drainage Area: 9.30 Acres

Basin Description: East Basin

Soils: See B-2 & G | Miamian
Xenia | Russel
Ragsdale | Fincastle

Soils Type: ____ % A 27.9 % B 72.1 % C ____ % D

Cover:
Impervious Area = 6.81 Acres, Grass Area = 2.49 Acres

CN = 90.61 (See G)

Time of Concentration: 11.20 minutes from Storm Calcs on File

t_c = 11.20 minutes (See H)

Q_{50} = 41.36 cfs (See I)

L (ft) =
L' (ft) =
Elev 1 =
Elev 2 =
s (%) =
c =
t_c (min) =
$=1.8(1.1-c)L^{1/2}/s^{1/3}$

Basin must reduce flow by: 118.36 cfs

Detention Volume: 1.01 Acre-ft at Elevation: 886.51 (See J:1-3)

Outflow Structure: 2'x1.5' window in Riser @ 884.92, 95'-30" STM @ 1.67%

Inlet Inv. = 881.65 Outlet Inv = 880.06

Rout Through Basin (See K)

Basin Reduces Flow By:

41.36 cfs Inflow - 23.90 cfs Outflow = 17.46 cfs - Insufficient

Detention/Retention Elevation: 886.51

100 Year Flow:

CN = 90.61 (See G)

Time of Concentration: 11.20 minutes from Storm Calcs on File

t_c = 11.20 minutes (See H)

Q_{100} = 45.71 cfs (See L)

Rout Through Basin (See M)

Basin Reduces Flow By:

45.71 cfs Inflow - 27.54 cfs Outflow = 18.17 cfs

$Elev_{100}$ = 886.60

Spillway: $Q_{100} = C\,L\,H^{3/2}$ C = 2.6 L = 35.00 H = 0.63

Spillway Invert = 886.59 100-Yr Weir Flow = 887.22

Top of Dike Elevation = 886.75 Freeboard = -0.47

Spillway Side Slope (_ : 1) = 4.50

Comments: Emergency spillway alone does not handle the 100-yr flow, however it does provided the outlet structure remains functional. Add outflow to additional drainage area and route through West Basin to achieve remaining reduction in flow rate.

Offsite Area: 7.06 Acres

Site Area: 41.11 Acres

Total Drainage Area: 48.17 Acres

Basin Description: West Basin

Soils: See B-2 & N; Xenia; Ragsdale; Miamian; Russel; Fincastle

Soils Type: _____ % A 57.5 % B 42.5 % C _____ % D

Cover: 54.2% Imervious; 31.1% Grass; 14.7%Offsite

Impervious Area = 26.12Acres, Grass Area = 14.99 Acres

CN = 84.58 (See N)

Time of Concentration: 21.80 min from Storm Calcs on file

t_c = 21.80 minutes (See E)

Q_{50} = 151.15 cfs (See O)

L (ft) =

L' (ft) =

Elev 1 =

Elev 2 =

s (%) =

c =

t_c (min) =

$=1.8(1.1-c)L^{1/2}/s^{1/3}$

Add hydrographs: Add East Basin Out (See P)

Total Q_{50}= 171.61 cfs

Basin must reduce flow by: 100.90 cfs

Detention Volume: 6.97 Acre-ft at Elevation: 876.53 (See Q1-3)

Outflow Structure: 75'-6.6'x5' Ultra Flow @ 0.50%, 25' Spillway @ 877.39

Inlet Inv. = 873.42 Outlet Inv = 873.04

Rout Through Basin (See R)

Basin Reduces Flow By:

171.61 cfs Inflow - 55.73 cfs Outflow = 115.88 cfs - OK

Detention/Retention Elevation: 876.53

100 Year Flow:

CN = 84.58 (See N)

Time of Concentration: 21.80 min from Storm Calcs on file

t_c = 21.80 minutes (See E)

Q_{100} = 169.64 cfs (See S)

Add hydrographs: Add East Basin Out (See T)

Total Q_{100}= 193.99 cfs

Rout Through Basin (See U)

Basin Reduces Flow By:

193.99 cfs Inflow - 63.14 cfs Outflow = 130.85 cfs

$Elev_{100}$ = 876.85

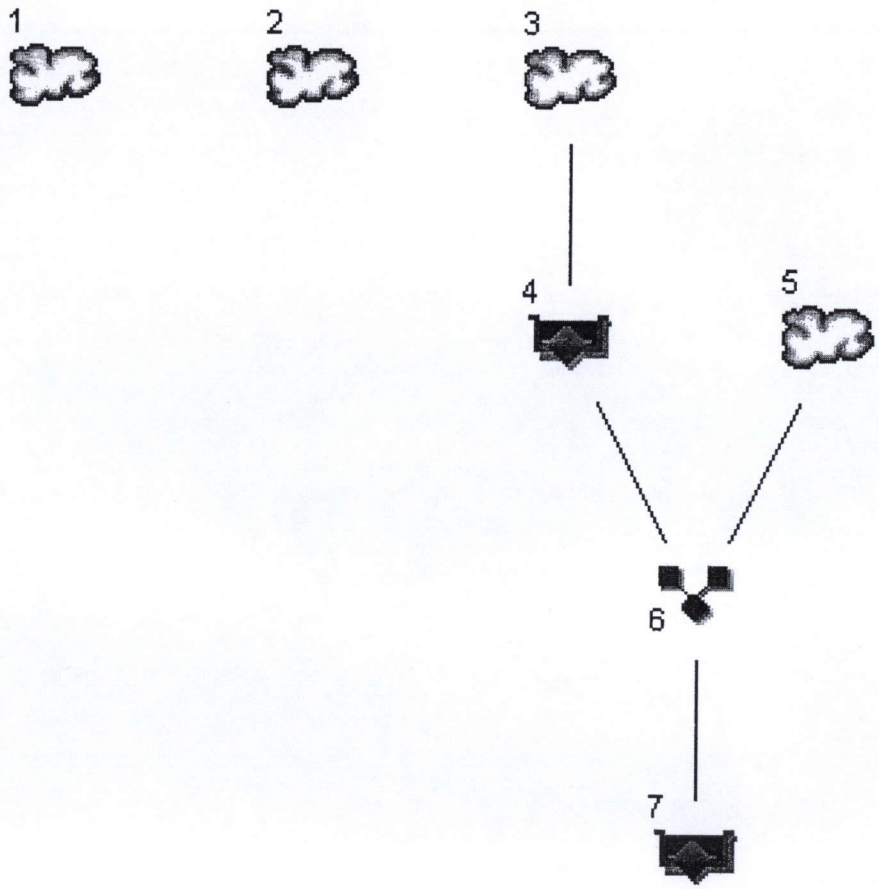
Spillway: $Q_{100} = C L H^{3/2}$ C = 2.6 L = 20.00 H = 2.41

Spillway Invert = 877.39 100-Yr Weir Flow = 879.80

Top of Dike Elevation = 880.50 Freeboard = 0.70

Spillway Side Slope (_ : 1) = 3.00

Comments: Pipe Arch modelled as an equivalent 72" diameter circular pipe.



Legend

Hyd.	Origin	Description
1	SCS Runoff	Existing Site
2	SCS Runoff	Proposed Site
3	SCS Runoff	Drainage to East Basin
4	Reservoir	East Basin
5	SCS Runoff	Drainage to West Basin
6	Combine	Add - To West Basin
7	Reservoir	West Basin

Hydrograph Return Period Recap

Hyd. No.	Hydrograph type (origin)	Inflow Hyd(s)	Peak Outflow (cfs)								Hydrograph description
			1-Yr	2-Yr	3-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	
1	SCS Runoff	-------	16.39	29.70	-------	44.34	56.44	72.31	80.39	91.35	Existing Site
2	SCS Runoff	-------	49.42	77.57	-------	106.76	130.05	159.86	174.80	194.86	Proposed Site
3	SCS Runoff	-------	13.50	19.95	-------	26.48	31.60	38.11	41.36	45.71	Drainage to East Basin
4	Reservoir	3	3.82	6.48	-------	10.59	15.00	21.15	23.90	27.54	East Basin
5	SCS Runoff	-------	38.68	62.88	-------	89.04	110.16	137.43	151.15	169.64	Drainage to West Basin
6	Combine	4, 5	42.24	68.75	-------	98.01	122.94	155.09	171.61	193.99	Add - To West Basin
7	Reservoir	6	10.10	19.50	-------	30.03	38.98	50.21	55.73	63.14	West Basin

Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (acft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (acft)	Hydrograph description
1	SCS Runoff	16.39	6	756	3.042	----	------	------	Existing Site
2	SCS Runoff	49.42	6	726	4.678	----	------	------	Proposed Site
3	SCS Runoff	13.50	6	720	0.952	----	------	------	Drainage to East Basin
4	Reservoir	3.82	6	738	0.951	3	885.60	0.403	East Basin
5	SCS Runoff	38.68	6	732	3.701	----	------	------	Drainage to West Basin
6	Combine	42.24	6	732	4.652	4, 5	------	------	Add - To West Basin
7	Reservoir	10.10	6	768	4.648	6	874.41	1.819	West Basin

Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (acft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (acft)	Hydrograph description
1	SCS Runoff	29.70	6	756	5.197	----	------	------	Existing Site
2	SCS Runoff	77.57	6	726	7.242	----	------	------	Proposed Site
3	SCS Runoff	19.95	6	720	1.412	----	------	------	Drainage to East Basin
4	Reservoir	6.48	6	738	1.411	3	885.89	0.582	East Basin
5	SCS Runoff	62.88	6	726	5.926	----	------	------	Drainage to West Basin
6	Combine	68.75	6	732	7.337	4, 5	------	------	Add - To West Basin
7	Reservoir	19.50	6	762	7.334	6	874.92	2.915	West Basin

Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (acft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (acft)	Hydrograph description
1	SCS Runoff	44.34	6	756	7.587	----	------	------	Existing Site
2	SCS Runoff	106.76	6	726	9.946	----	------	------	Proposed Site
3	SCS Runoff	26.48	6	720	1.888	----	------	------	Drainage to East Basin
4	Reservoir	10.59	6	738	1.887	3	886.12	0.738	East Basin
5	SCS Runoff	89.04	6	726	8.313	----	------	------	Drainage to West Basin
6	Combine	98.01	6	732	10.200	4, 5	------	------	Add - To West Basin
7	Reservoir	30.03	6	756	10.196	6	875.41	4.113	West Basin

Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (acft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (acft)	Hydrograph description
1	SCS Runoff	56.44	6	756	9.577	----	------	------	Existing Site
2	SCS Runoff	130.05	6	726	12.132	----	------	------	Proposed Site
3	SCS Runoff	31.60	6	720	2.268	----	------	------	Drainage to East Basin
4	Reservoir	15.00	6	732	2.267	3	886.27	0.838	East Basin
5	SCS Runoff	110.16	6	726	10.263	----	------	------	Drainage to West Basin
6	Combine	122.94	6	732	12.530	4, 5	------	------	Add - To West Basin
7	Reservoir	38.98	6	756	12.526	6	875.81	5.092	West Basin

Hydrograph Summary Report

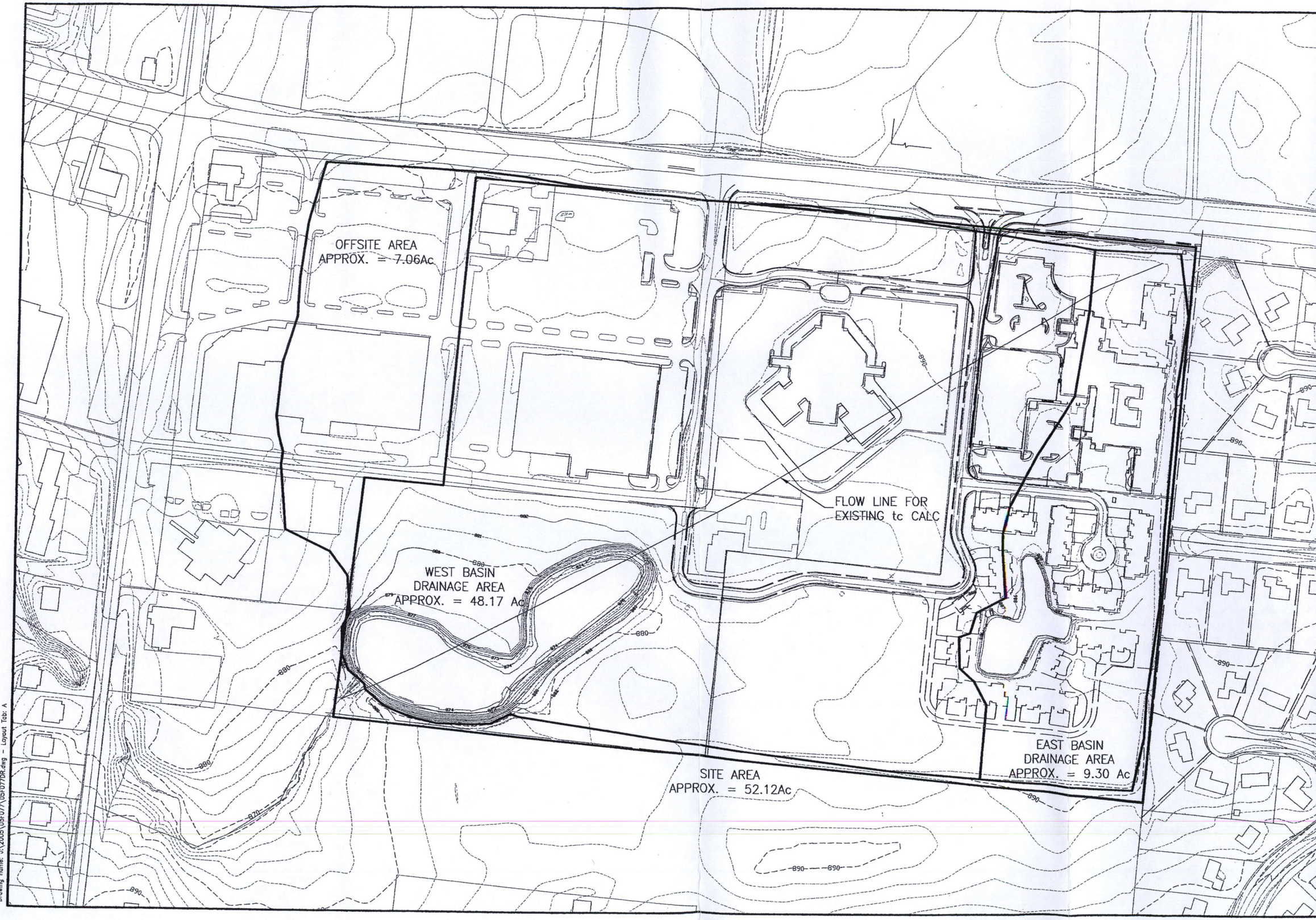
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (acft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (acft)	Hydrograph description
1	SCS Runoff	72.31	6	756	12.212	----	------	------	Existing Site
2	SCS Runoff	159.86	6	726	14.968	----	------	------	Proposed Site
3	SCS Runoff	38.11	6	720	2.757	----	------	------	Drainage to East Basin
4	Reservoir	21.15	6	732	2.756	3	886.44	0.955	East Basin
5	SCS Runoff	137.43	6	726	12.809	----	------	------	Drainage to West Basin
6	Combine	155.09	6	732	15.565	4, 5	------	------	Add - To West Basin
7	Reservoir	50.21	6	756	15.562	6	876.30	6.343	West Basin

Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (acft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (acft)	Hydrograph description
1	SCS Runoff	80.39	6	756	13.564	----	------	------	Existing Site
2	SCS Runoff	174.80	6	726	16.403	----	------	------	Proposed Site
3	SCS Runoff	41.36	6	720	3.003	----	------	------	Drainage to East Basin
4	Reservoir	23.90	6	732	3.002	3	886.51	1.008	East Basin
5	SCS Runoff	151.15	6	726	14.103	----	------	------	Drainage to West Basin
6	Combine	171.61	6	726	17.106	4, 5	------	------	Add - To West Basin
7	Reservoir	55.73	6	756	17.102	6	876.53	6.974	West Basin

Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (acft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (acft)	Hydrograph description
1	SCS Runoff	91.35	6	756	15.406	----	------	------	Existing Site
2	SCS Runoff	194.86	6	726	18.343	----	------	------	Proposed Site
3	SCS Runoff	45.71	6	720	3.335	----	------	------	Drainage to East Basin
4	Reservoir	27.54	6	732	3.334	3	886.60	1.077	East Basin
5	SCS Runoff	169.64	6	726	15.858	----	------	------	Drainage to West Basin
6	Combine	193.99	6	726	19.193	4, 5	------	------	Add - To West Basin
7	Reservoir	63.14	6	756	19.189	6	876.85	7.821	West Basin



SCALE: 1" = 100'

Item	Revision Description	Date	Drwn: Chk:

CHESTERWOOD VILLAGE DETENTION ANALYSIS

WEST CHESTER TWP, BUTLER COUNTY, OHIO
SECTION 11, TOWN 3, RANGE 2

DRAINAGE AREAS

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Drawing:	05F077DR
Drawn by:	EDA
Checked By:	RWB
Issue Date:	07/14/05
Sheet:	A

Plot time: Jul 14, 2005 - 2:04pm
Drawing name: J:\2005\05F077\05F077DR.dwg - Layout Tab: A

Soil Information

Site Drainage Area

Soils		Area (ft^2)	A Soil (ft^2)	B Soil (ft^2)	C Soil (ft^2)	D Soil (ft^2)
XeB Ra	Xenia Ragsdale	1000126	-	1000126	-	-
MsC2	Miamian Russell	140174	-	32941	107233	-
			-	0	0	-
FcB,FcA	Fincastle	1130203	-	-	1130203	-
Totals		2270503	0	1033067	1237436	0
Percentages		100.00		45.50	54.50	

Note:

Soil areas calculated based on A, B, C, and D soils rather than individually. B/C soils were calculated based on the percentages of B and C soils.

Curve Number Calculations

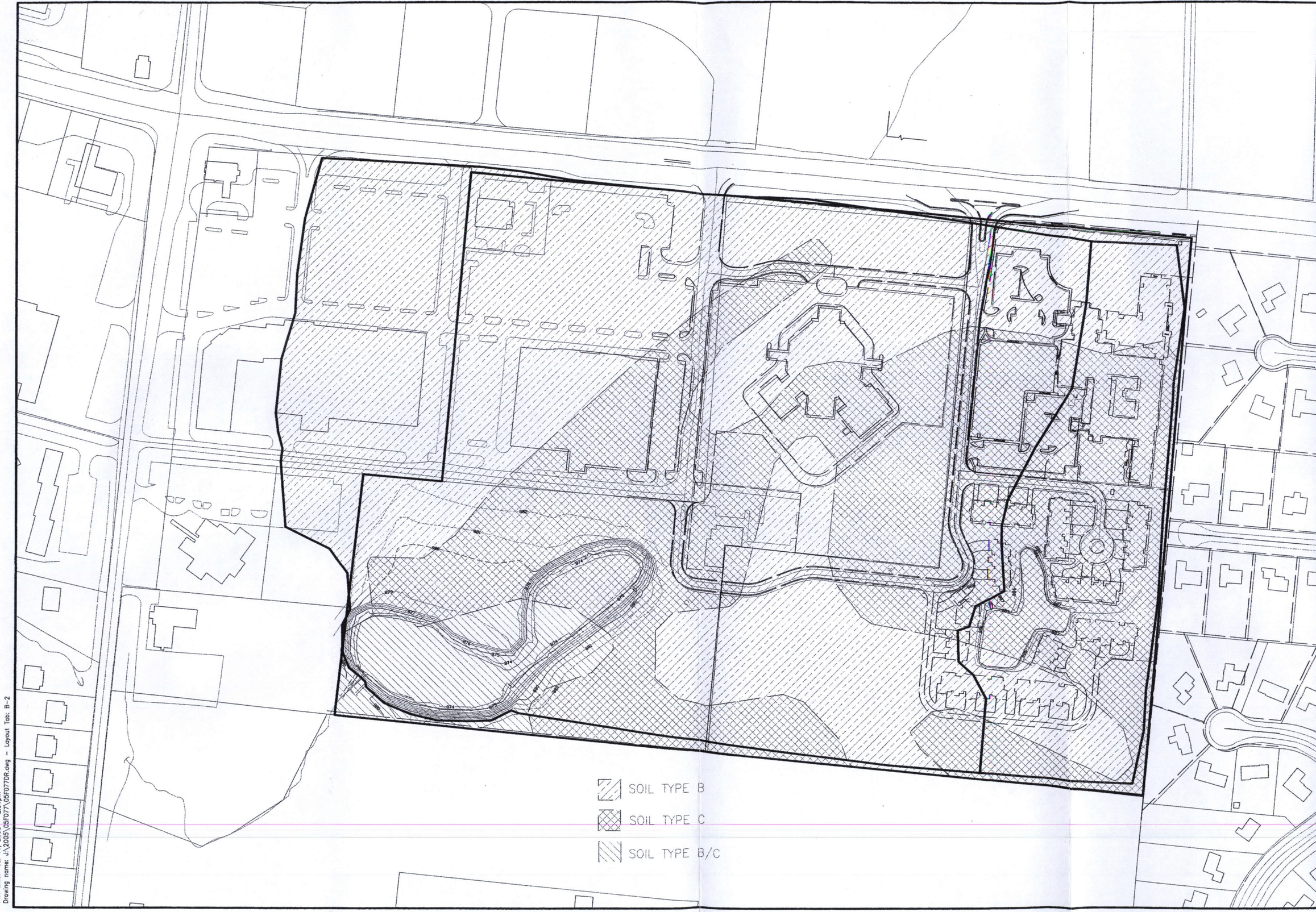
Predeveloped Site

Land Use	%	A Soil	B Soil	C Soil	D Soil
Agricultural	80.0	67	78	85	89
Pasture	15.0	49	69	79	84
Wooded	5.0	36	60	73	79
Composite	79.97	=	34.5 +	45.5	

A*B*C
28.392
4.709
1.365
34.466

Developed Site

Land Use	%	A Soil	B Soil	C Soil	D Soil
Impervious	63.2	98	98	98	98
Grass	36.8	39	61	74	80
Composite	86.99		38.4	48.6	



Plot time: Jul 14, 2005 - 2:01pm
Drawing name: J:\2005\05F077\05F077DR.dwg - Layout Tab: B-2

Item	Revision Description	Date	Drwn:	Chk:

CHESTERWOOD VILLAGE DETENTION ANALYSIS

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Drawing: 05F077DR
Drawn by: EDA
Checked By: RWB
Issue Date: 07/14/05
Sheet: B-2

Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

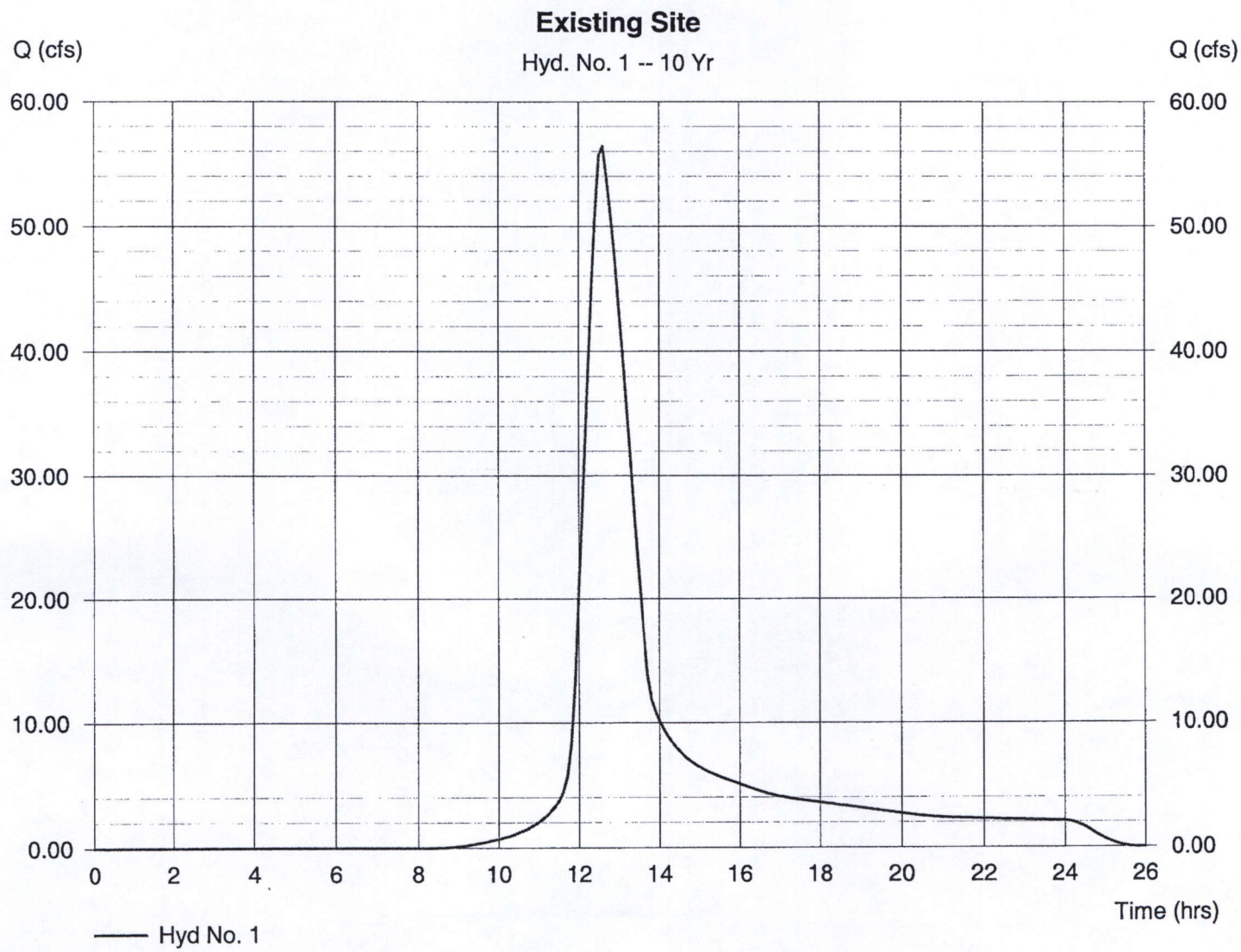
Thursday, Jul 14 2005, 3:39 PM

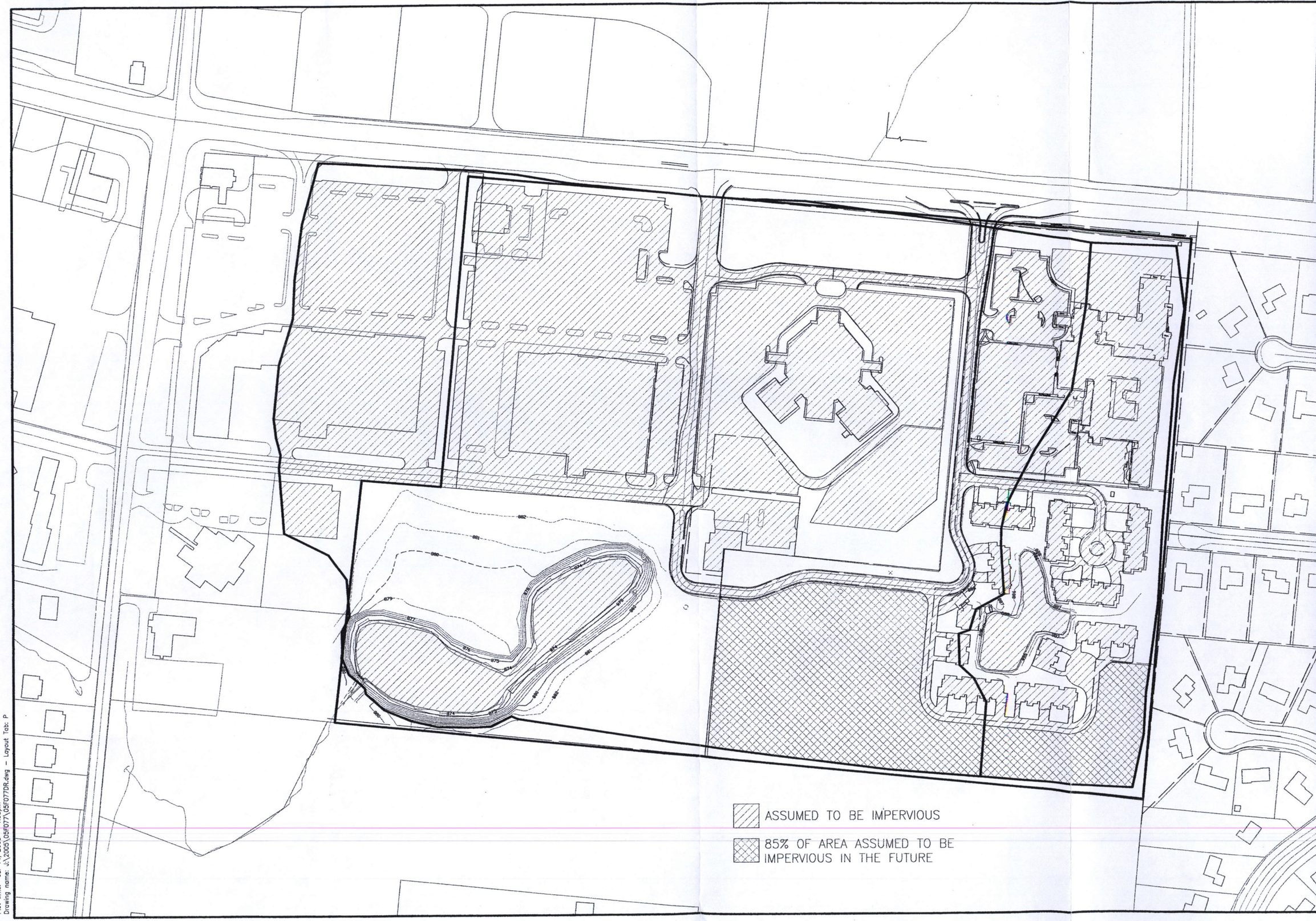
Hyd. No. 1

Existing Site

Hydrograph type	= SCS Runoff	Peak discharge	= 56.44 cfs
Storm frequency	= 10 yrs	Time interval	= 6 min
Drainage area	= 52.120 ac	Curve number	= 80
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 64.80 min
Total precip.	= 4.15 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Volume = 9.577 acft





0 100 200
SCALE: 1" = 100'

Item	Revision Description	Date	Drwn:	Chk:

CHESTERWOOD VILLAGE DETENTION ANALYSIS

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Checked By:	RWB
Issue Date:	07/14/05
Sheet:	D

Plot time: Jul 14, 2005 – 1:58pm
Drawing name: J:\2005\05F077\05F077DR.dwg – Layout Tab: P

E

STORM SEWERS

* (Use n=.015)

formulae used:
$Q_R = ACi$ (required)
$V_p = \frac{1.486}{n} R^{2/3} S^{1/2}$
$Q_p = A_p V_p$

Bayer - Becker Engineers
designed by: CLM
reviewed by: CAR
date: September 30, 1996

project: 9579
Chesterwood Retirement Comm.

LOCATION			TOPOGRAPHY					TIME					DESIGN					REMARKS		
Street	from	to	No. of Area	Acres	"C" Value	AC for Area	AC Accumulate	To inlet T minutes	In pipe Tp minutes	Concentration T minutes	Intensity inches/hour 10 Yr. Storm	Qr c.f.s. required	Pipe Size inches	"n" Value	Slope in %	Velocity ft./sec.	Qp c.f.s. provided capacity	Length of Pipe	Time in Pipe (minutes)	
	CB 11	CB 13	11	—	—	—	.966	—	—	11.8	4.9	4.73	18	.015	2.50	6.22	4.88	208	.6	
	CB 12	CB 13	12	.108	.67	.072	—	9.9	—	9.9	~~4.6~~	~~2.85~~ 2.52	12	.015	1.00	3.93	3.09	26	.1	
	13	14	13	1.033	.85	.878	7.141	18.5	.4	18.9	4.1	29.28	24	.015	2.25	9.36	29.42	70	.1	
	14	15	14	2.264	.85	1.924	9.065	18.9	.1	19.0	4.0	36.26	30	.015	1.10	7.60	37.29	300	.7	
	16	15	16	2.680	.47	1.260	—	21.0	—	21.0	3.9	4.91	12	.015	2.60	6.34	4.98	26	.1	
	15	17	15	9.110	.85	7.744	18.069	21.0	.1	21.1	3.9	70.47	42	.015	0.70	7.58	72.95	188	.4	
	17	18	—	—	—	—	18.069	21.1	.4	21.5	3.8	68.66	42	.015	0.70	7.58	72.95	142	.3	
	19	18	19	.152	.85	.129	—	4.5	—	4.5	6.2	.80	12	.015	1.00	3.93	3.09	26	.1	
	18	20	18	.052	.95	.049	18.247	21.5	.3	21.8	3.8	69.34	42	.015	0.70	7.58	72.95	146		

F

Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

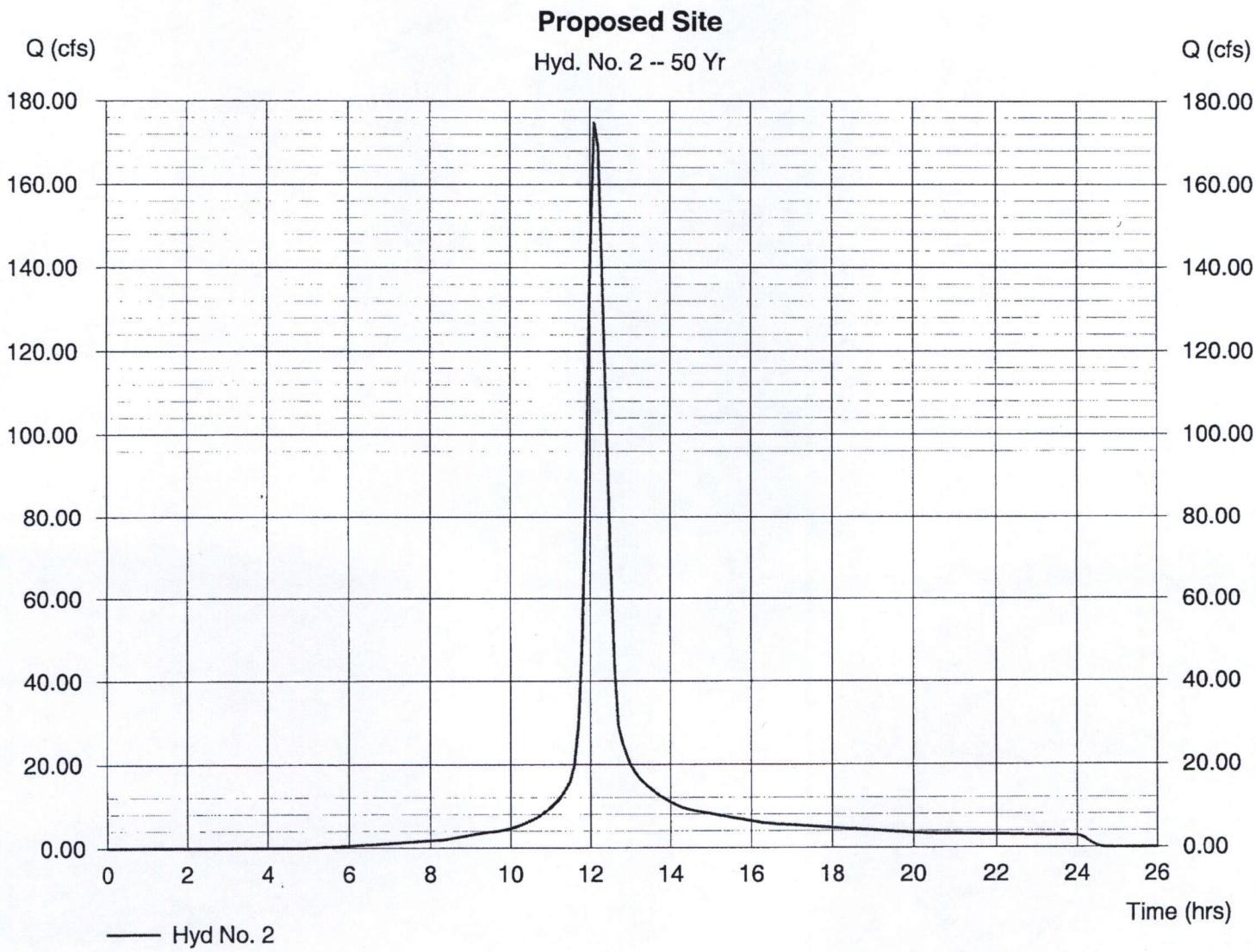
Thursday, Jul 14 2005, 3:39 PM

Hyd. No. 2

Proposed Site

Hydrograph type	= SCS Runoff	Peak discharge	= 174.80 cfs
Storm frequency	= 50 yrs	Time interval	= 6 min
Drainage area	= 52.120 ac	Curve number	= 87.2
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 21.80 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Volume = 16.403 acft



Soil Information

G

Basin Description: East Basin

Soils		Area (ft^2)	A Soil (ft^2)	B Soil (ft^2)	C Soil (ft^2)	D Soil (ft^2)
XeB Ra	Xenia Ragsdale	112924	-	112924	-	-
MsC2	Miamian Russell	0	-	0	0	-
			-	0	0	-
FcB,FcA	Fincastle	292217			292217	
Totals		405141	0	112924	292217	0
Percentages		100.00		27.87	72.13	

Note:

Soil areas calculated based on A, B, C, and D soils rather than individually. B/C soils were calculated based on the percentages of B and C soils.

Curve Number Calculations

Land Use	%	A Soil	B Soil	C Soil	D Soil
Impervious	73.2	98	98	98	98
Grass	26.8	39	61	74	80
Offsite	0.0	49	69	79	84
Composite	90.61		24.6	66.1	

STORM SEWERS

H.

formulae used:
$Q_R = ACi$ (required)
$V_p = \frac{1.486}{n} R^{2/3} S^{1/2}$
$Q_p = A_p V_p$

project: Chesterwood Retirement Community : Phase 3

Layer Decker Engineering
designed by: CAR
reviewed by:
date: November 1996

LOCATION			TOPOGRAPHY				AC Accumulate	TIME			Intensity inches/hour 10 Yr. Storm	Q_R c.f.s. Required	DESIGN					REMARKS
Street	from	to	No. of Area	Acres	"C" Value	AC for Area		T_o inlet T_i minutes	In Pipe T_p minutes	Concentration "T" minutes			Pipe Size inches	"n" Value	Slope in %	Velocity ft./sec.	Q_p c.f.s. provided capacity	
Sta. 7+95, Lt. Cul-de-sac				1.52	0.35	0.44	0.44	13	—	13	4.72	2.08	12	0.015	1.40	4.65	3.65	$T_p = 110' \div (4.65 \times 60) = 0.4$ min.
Sta. 5+00, Cul-de-sac				0.11	0.35	0.09	0.09	10	—	10	5.15	0.46	12	0.015	0.45	2.64	2.07	$T_p = 125' \div (2.64 \times 60) = 0.8$ min.
Sta. 4+75, Cul-de-sac				0.22	0.35	0.19	0.18	10	0.8	10.8	5.03	1.41	12	0.015	0.50	2.78	2.18	$T_p = 126' \div (2.78 \times 60) = 0.9$ min.
Sta. 3+65, Cul-de-sac				0.54	0.35	0.46	0.46	10	—	10	5.15	2.37	15	0.015	0.56	3.41	4.18	$T_p = 70' \div (3.41 \times 60) = 0.3$ min.
Sta. 2+48, Cul-de-sac				0.48	0.35	0.41	0.87	10	0.3	10.3	5.11	4.45	18	0.015	0.53	3.75	6.63	$T_p = 126' \div (3.75 \times 60) = 0.9$ min.
Sta. 0+50, Cul-de-sac				0.72	0.35	0.61	1.48	10.3	0.9	11.2	4.91	7.36	18	0.015	2.36	4.81	8.15	$T_p = 50' \div (4.81 \times 60) = 0.2$ min.

DIP
5-11-01