STORMWATER DETENTION REPORT

FOR

WINGHAVEN

PHASE I

Prepared by

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APPROVED

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Project Summary

The Winghaven site is a tract of land located O'Fallon, Missouri. The site is loosely bounded on the south by Dardenne Creek; on the north by Missouri Route N; on the west by Highway 40/61 and Post Road; and on the east by Bates Road. A mixed-use development is planned for this site consisting of single- and multi-family residential; business parks for office, retail, industrial, and institutional use; and an 18-hole golf course with maintenance, clubhouse, and practice facilities. McBride and Sons, Inc. has currently undertaken the development of the residential and golf course portions of the project.

Several lakes of varying sizes are planned as part of the golf course development. These lakes, which will serve both aesthetic and stormwater detention purposes, receive flow from approximately 26% of the project site.

The existing site can be broken down into seven major drainage basins as shown in Figure 1 of this report. Figure 2 depicts the post-development watershed areas. As noted on Figures 1 and 2, four of the drainage areas are directly tributary to Dardenne Creek. The remaining three areas are also tributary to Dardenne Creek, but travel through adjacent property before reaching the main waterway.

Prior to development, the site consisted primarily of cultivated fields, woods, and isolated industrial areas. When these areas are converted to golf course use, peak stormwater runoff can often be significantly reduced as the dense grass and well-drained soils result in decreased runoff factors and increased time of concentration. For this reason, detention usually becomes necessary only in those areas where construction of subdivision improvements significantly increases the percentage of impervious area.

As required by the ordinances of the City of O'Fallon, the United States Department of Agriculture Soil Conservation Service (SCS) Technical Release 55 "Urban Hydrology for Small Watersheds" method, Version 2.0, is utilized in evaluating each of the seven basins. A brief description of the characteristics of the existing and proposed drainage basins follows, along with the results of the pre- and post-development stormwater runoff calculations. Both the 25-year, 24-hour and the 100-year, 24-hour storm events are examined.

Detention, as delineated in this report, is proposed on this site to ensure that calculated post-development peak runoff does not exceed pre-development levels. The stormwater detention calculations for each lake utilize a Modified Puls method. As before, calculations are presented for both the 25-year, 24-hour and 100-year, 24-hour storm events.

The USDA Soil Conservation Service Soil Survey of St. Charles County, Missouri, 1982, classifies the majority of soils on the Winghaven site as Type C soils. These soils generally have a higher runoff potential due to their low rates of infiltration and water transmission. A few locations on the Winghaven site are identified as having Type B soils, which provide more favorable hydrologic conditions; however, these areas are small and isolated, so the more conservative assumption of Type C conditions is applied to the entire site. The soil maps of the site and map key are included as Figures 3 and 4.

The planned improvements in the Winghaven site will significantly increase the post-development runoff volume in three of the seven major drainage basins. However, the net change in runoff volume for the entire Winghaven site remains signifcantly less than pre-development levels. This is due to the fact that dramatic reductions in post-development runoff volume from Areas B, C, and D are more than adequate to offset the increases from the remainder of the Winghaven site. The following Table 1 presents a summarization of the net change in pre- and post-development runoff volume for the entire site for the 25-year, 24-hour storm event. Table 2 presents the results of the 100-year, 24-hour storm event analysis.

Table 1 - 25-Year, 24-Hour Runoff Volumes

Area I.D.	A	B	C	D	E	G	Total
Pre-Development (cfs)	119	699	187	404	131	59	1599
Post-Development (cfs) w/ Detention	160	637	61	171	137	48	1214
Net Change (cfs)	+ 41	- 62	-126	-233	+ 6	- 11	-385

Table 2 - 100-Year, 24-Hour Runoff Volumes

Area I.D.	A	B	C	D	E	G	Total
Pre-Development (cfs)	161	934	247	535	177	83	2137
Post-Development (cfs) w/ Detention	208	847	86	216	186	67	1610
Net Change (cfs)	+ 47	- 87	-161	-319	+ 9	- 16	-527

Area A

This section of the report contains the pre- and post-development runoff calculations for Area "A", as designated in Figures 1 and 2. The entire area drains to a single release point on Dardenne Creek along the west property line.

The Area A pre-development drainage basin of approximately 29 acres will be increased slightly during development to roughly 31.0 acres. Further, the land use will be changed significantly. Pages A2-A5 of this report present the pre- and post-development runoff curve number and time of concentration calculations. This data details the effects of converting woods and cultivated fields to subdivision. Page A6-A9 present the results of the tabular hydrograph calculations for pre- and post-development conditions for the 25 year, 24 hour and 100-year, 24-hour storm events.

The calculations indicate that the peak stormwater runoff rate in this area for the 25-year storm event was increased from 119 cubic feet per second (cfs) to 160 cfs. The 100-year runoff was increased from 161 cfs to 208 cfs. Stormwater detention is therefore required for this watershed. Due to space restrictions, however, stormwater detention for this area will be provided through a reduction in the runoff volume from Area B and the Area C detention ponds. These ponds also drain to Dardenne Creek, approximately 2400 feet downstream of the Area A outfall.

Area Summary

Storm Event	Pre-Development	Post-Development	Net Change
25-year, 24-hour	119 cfs	160 cfs	+ 41 cfs
100-year, 24-hour	161cfs	208 cfs	+ 47 cfs

RUNOFF CURVE NUMBER COMPUTATION Version 2.00

Project : WINGHAVEN User: RLW Date: 05-05-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: PRE-DEVELOPMENT RUNOFF FOR AREA 'A'
Subarea : A

COVER DESCRIPTION			Hydrologic Soil Group A	B	C	D
			Acres (CN)			
CULTIVATED AGRICULTURAL LANDS						
Row crops	SR + Crop residue	good	-	-	18.5(82)	-
OTHER AGRICULTURAL LANDS						
Woods		good	-	-	10.2(70)	-
Total Area (by Hydrologic Soil Group)					28.7	

SUBAREA: A TOTAL DRAINAGE AREA: 28.7 Acres WEIGHTED CURVE NUMBER: 78

A2

TIME OF CONCENTRATION AND TRAVEL TIME Version 2.00

Project : WINGHAVEN User: RLW Date: 05-05-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: PRE-DEVELOPMENT RUNOFF FOR AREA 'A'

Subarea #1 - A

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	3.50	100	0.01	C					0.099
Shallow Concent'd		750	0.044	U					0.062
Open Channel		1050						5	0.058
								Time of Concentration =	0.22*

--- Sheet Flow Surface Codes ---

A Smooth Surface
B Fallow (No Res.)
C Cultivated < 20 % Res.
D Cultivated > 20 % Res.
E Grass-Range, Short
F Grass, Dense
G Grass, Burmuda
H Woods, Light
I Woods, Dense
J Range, Natural

--- Shallow Concentrated --- Surface Codes ---

P Paved
U Unpaved

* - Generated for use by TABULAR method

A3

RUNOFF CURVE NUMBER COMPUTATION Version 2.00

Project : WINGHAVEN User: RLW Date: 05-06-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: POST-DEVELOPMENT RUNOFF FOR AREA 'A'
Subarea : A

COVER DESCRIPTION		Hydrologic Soil Group A	B	C	D
		Acres (CN)			
FULLY DEVELOPED URBAN AREAS (Veg Estab.)					
Open space (Lawns,parks etc.)					
Good condition; grass cover > 75%		-	-	1.77(74)	-
Streets and roads					
Paved; curbs and storm sewers		-	-	7.15(98)	-
Residential districts	Avg % imperv				
(by average lot size)					
1/4 acre	38	-	-	22.1(83)	-
Total Area (by Hydrologic Soil Group)				31.0	

SUBAREA: A TOTAL DRAINAGE AREA: 31.02 Acres WEIGHTED CURVE NUMBER: 86

A4

TIME OF CONCENTRATION AND TRAVEL TIME Version 2.00

Project : WINGHAVEN User: RLW Date: 05-06-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: POST-DEVELOPMENT RUNOFF FOR AREA 'A'

---------- Subarea #1 - A ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	3.50	50	0.01	F					0.172
Shallow Concent'd		150	0.04	P					0.010
Open Channel		1350						8	0.047

Time of Concentration = 0.23*
=====

--- Sheet Flow Surface Codes ---

A Smooth Surface
B Fallow (No Res.)
C Cultivated < 20 % Res.
D Cultivated > 20 % Res.
E Grass-Range, Short
F Grass, Dense
G Grass, Burmuda
H Woods, Light
I Woods, Dense
J Range, Natural

--- Shallow Concentrated --- --- Surface Codes ---

P Paved
U Unpaved

* - Generated for use by TABULAR method

TABULAR HYDROGRAPH METHOD Version 2.00

Project : WINGHAVEN User: RLW Date: 05-05-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: PRE-DEVELOPMENT RUNOFF FOR AREA 'A'

Total watershed area: 0.045 sq mi Rainfall type: II Frequency: 25 years

---------- Subareas ----------

	A
Area(sq mi)	0.04*
Rainfall(in)	5.7
Curve number	78*
Runoff(in)	3.32
Tc (hrs)	0.22*
(Used)	0.20
TimeToOutlet	0.00
Ia/P	0.10
(Used)	0.10

Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs) A
11.0	3	3
11.3	5	5
11.6	7	7
11.9	31	31
12.0	60	60
12.1	110	110
12.2	119P	119P
12.3	72	72
12.4	37	37
12.5	25	25
12.6	19	19
12.7	15	15
12.8	13	13
13.0	10	10
13.2	9	9
13.4	8	8
13.6	7	7
13.8	7	7
14.0	6	6
14.3	5	5
14.6	5	5
15.0	4	4
15.5	4	4
16.0	4	4
16.5	3	3
17.0	3	3
17.5	3	3
18.0	3	3
19.0	2	2
20.0	2	2
22.0	2	2
26.0	0	0

P - Peak Flow * - value(s) provided from TR-55 system routines

TABULAR HYDROGRAPH METHOD Version 2.00

Project : WINGHAVEN User: RLW Date: 05-05-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: PRE-DEVELOPMENT RUNOFF FOR AREA 'A'

Total watershed area: 0.045 sq mi Rainfall type: II Frequency: 100 years

---------- Subareas ----------

	A
Area(sq mi)	0.04*
Rainfall(in)	7.0
Curve number	78*
Runoff(in)	4.47
Tc (hrs)	0.22*
(Used)	0.20
TimeToOutlet	0.00
Ia/P	0.08
(Used)	0.10

Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs) A
11.0	5	5
11.3	6	6
11.6	9	9
11.9	42	42
12.0	81	81
12.1	148	148
12.2	161P	161P
12.3	97	97
12.4	50	50
12.5	33	33
12.6	26	26
12.7	20	20
12.8	17	17
13.0	14	14
13.2	12	12
13.4	11	11
13.6	10	10
13.8	9	9
14.0	8	8
14.3	7	7
14.6	7	7
15.0	6	6
15.5	5	5
16.0	5	5
16.5	4	4
17.0	4	4
17.5	4	4
18.0	4	4
19.0	3	3
20.0	3	3
22.0	2	2
26.0	0	0

P - Peak Flow * - value(s) provided from TR-55 system routines

TABULAR HYDROGRAPH METHOD Version 2.00

Project : WINGHAVEN User: RLW Date: 05-06-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: POST-DEVELOPMENT RUNOFF FOR AREA 'A'

Total watershed area: 0.048 sq mi Rainfall type: II Frequency: 25 years

---------- Subareas ----------

	A
Area(sq mi)	0.05*
Rainfall(in)	5.7
Curve number	86*
Runoff(in)	4.12
Tc (hrs)	0.23*
(Used)	0.20
TimeToOutlet	0.00
Ia/P	0.06
(Used)	0.10

Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs) A
11.0	5	5
11.3	6	6
11.6	9	9
11.9	42	42
12.0	81	81
12.1	148	148
12.2	160P	160P
12.3	96	96
12.4	50	50
12.5	33	33
12.6	26	26
12.7	20	20
12.8	17	17
13.0	14	14
13.2	12	12
13.4	11	11
13.6	10	10
13.8	9	9
14.0	8	8
14.3	7	7
14.6	7	7
15.0	6	6
15.5	5	5
16.0	5	5
16.5	4	4
17.0	4	4
17.5	4	4
18.0	4	4
19.0	3	3
20.0	3	3
22.0	2	2
26.0	0	0

P - Peak Flow * - value(s) provided from TR-55 system routines

TABULAR HYDROGRAPH METHOD Version 2.00

Project : WINGHAVEN User: RLW Date: 05-06-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: POST-DEVELOPMENT RUNOFF FOR AREA 'A'

Total watershed area: 0.048 sq mi Rainfall type: II Frequency: 100 years

---------- Subareas ----------

	A
Area(sq mi)	0.05*
Rainfall(in)	7.0
Curve number	86*
Runoff(in)	5.37
Tc (hrs)	0.23*
(Used)	0.20
TimeToOutlet	0.00
Ia/P	0.05
(Used)	0.10

Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs) A
11.0	6	6
11.3	8	8
11.6	12	12
11.9	54	54
12.0	105	105
12.1	192	192
12.2	208P	208P
12.3	125	125
12.4	65	65
12.5	43	43
12.6	33	33
12.7	27	27
12.8	22	22
13.0	18	18
13.2	16	16
13.4	14	14
13.6	13	13
13.8	11	11
14.0	10	10
14.3	9	9
14.6	9	9
15.0	8	8
15.5	7	7
16.0	6	6
16.5	5	5
17.0	5	5
17.5	5	5
18.0	5	5
19.0	4	4
20.0	3	3
22.0	3	3
26.0	0	0

P - Peak Flow * - value(s) provided from TR-55 system routines

Area B

This section of the report contains the pre- and post-development runoff calculations for Area B, as designated in Figures 1 and 2. This area also drains to Dardenne Creek along the west property line.

Prior to development, the Area B drainage basin consisted of roughly 218 acres of woods and cultivated fields. This area will be slightly reduced during development, encompassing roughly 191 acres of golf course and subdivision improvements. Pages B2-B5 of this report present the pre- and post-development runoff curve number and time of concentration calculations. This data details the effects of converting woods and cultivated fields to golf course, lakes, and subdivision. Page B6-B9 present the results of the tabular hydrograph calculations for pre- and post-development conditions for the 25 year, 24 hour and 100-year, 24-hour storm events.

The results indicate the 25-year outflow will be *decreased* from 699 cfs to 637 cfs, and the 100-year outflow from 934 cfs to 847 cfs. This is due to the fact that converting agricultural fields to golf courses, given the dense vegetation coverage and contoured slopes of the courses, actually increases the time of concentration, lowers SCS curve numbers, and thereby reduces the post development runoff volume. In this particular area, the ratio of golf course area to residential area is large enough to offset the newly added impervious areas.

The two small lakes located in the north central section of the development are to be fitted with control structures which will minimize the outflow. However, since these lakes are relatively small and have a drainage area of just under 8 acres, it is not possible to retain enough stormwater in this location to produce any significant additional reduction in stormwater runoff.

Area Summary

Storm Event	Pre-Development	Post-Development	Net Change
25-year, 24-hour	699 cfs	637 cfs	- 62 cfs
100-year, 24-hour	934 cfs	847 cfs	- 87 cfs

RUNOFF CURVE NUMBER COMPUTATION Version 2.00

Project : WINGHAVEN User: RLW Date: 05-05-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: PRE-DEVELOPMENT RUNOFF FOR AREA 'B'
Subarea : B

COVER DESCRIPTION			Hydrologic Soil Group A	B	C	D
			Acres (CN)			
CULTIVATED AGRICULTURAL LANDS						
Row crops	SR + Crop residue	good	-	-	176(82)	-
OTHER AGRICULTURAL LANDS						
Woods		good	-	-	39.1(70)	-
Total Area (by Hydrologic Soil Group)					215.	
					====	

SUBAREA: B TOTAL DRAINAGE AREA: 215.1 Acres WEIGHTED CURVE NUMBER: 80

B2

TIME OF CONCENTRATION AND TRAVEL TIME Version 2.00

Project : WINGHAVEN User: RLW Date: 05-05-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: PRE-DEVELOPMENT RUNOFF FOR AREA 'B'

Subarea #1 - B

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	3.50	100	0.03	C					0.064
Shallow Concent'd		1000	0.031	U					0.098
Open Channel		4040						5	0.224
								Time of Concentration =	0.39*
									=====

--- Sheet Flow Surface Codes ---

A Smooth Surface
B Fallow (No Res.)
C Cultivated < 20 % Res.
D Cultivated > 20 % Res.
E Grass-Range, Short
F Grass, Dense
G Grass, Burmuda
H Woods, Light
I Woods, Dense
J Range, Natural

--- Shallow Concentrated --- Surface Codes ---

P Paved
U Unpaved

* - Generated for use by TABULAR method

RUNOFF CURVE NUMBER COMPUTATION Version 2.00

Project : WINGHAVEN User: RLW Date: 05-05-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: POST-DEVELOPMENT RUNOFF FOR AREA 'B'
Subarea : B

COVER DESCRIPTION		Hydrologic Soil Group A	B	C	D
			Acres (CN)		
FULLY DEVELOPED URBAN AREAS (Veg Estab.)					
Open space (Lawns,parks etc.)					
Good condition; grass cover > 75%		-	-	103(74)	-
Streets and roads					
Paved; curbs and storm sewers		-	-	22.9(98)	-
Residential districts	Avg % imperv				
(by average lot size)					
1/8 acre (town houses)	65	-	-	15.3(90)	-
1/4 acre	38	-	-	47.9(83)	-
User defined urban (F9 to define)		-	-	1.5(98)	-
% impervious				100%	
% unconnected impervious				0%	
pervious curve number				82	
Total Area (by Hydrologic Soil Group)				190.	
				====	

SUBAREA: B TOTAL DRAINAGE AREA: 190.6 Acres WEIGHTED CURVE NUMBER: 81

TIME OF CONCENTRATION AND TRAVEL TIME Version 2.00

Project : WINGHAVEN User: RLW Date: 05-05-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: POST-DEVELOPMENT RUNOFF FOR AREA 'B'

---------- Subarea #1 - B ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	3.50	100	0.01	D					0.228
Shallow Concent'd		750	0.037	U					0.067
Open Channel		2250						5	0.125
								Time of Concentration =	0.42*
									=====

--- Sheet Flow Surface Codes ---

A Smooth Surface	F Grass, Dense	--- Shallow Concentrated ---
B Fallow (No Res.)	G Grass, Burmuda	--- Surface Codes ---
C Cultivated < 20 % Res.	H Woods, Light	P Paved
D Cultivated > 20 % Res.	I Woods, Dense	U Unpaved
E Grass-Range, Short	J Range, Natural	

* - Generated for use by TABULAR method

TABULAR HYDROGRAPH METHOD Version 2.00

Project : WINGHAVEN User: RLW Date: 05-05-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: PRE-DEVELOPMENT RUNOFF FOR AREA 'B'

Total watershed area: 0.336 sq mi Rainfall type: II Frequency: 25 years

---------- Subareas ----------

	B
Area(sq mi)	0.34*
Rainfall(in)	5.7
Curve number	80*
Runoff(in)	3.51
Tc (hrs)	0.39*
(Used)	0.40
TimeToOutlet	0.00
Ia/P	0.09
(Used)	0.10

Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs) B
11.0	21	21
11.3	30	30
11.6	42	42
11.9	91	91
12.0	166	166
12.1	320	320
12.2	552	552
12.3	699P	699P
12.4	677	677
12.5	509	509
12.6	352	352
12.7	255	255
12.8	192	192
13.0	123	123
13.2	91	91
13.4	74	74
13.6	65	65
13.8	58	58
14.0	52	52
14.3	45	45
14.6	40	40
15.0	37	37
15.5	33	33
16.0	30	30
16.5	26	26
17.0	25	25
17.5	24	24
18.0	21	21
19.0	19	19
20.0	17	17
22.0	14	14
26.0	0	0

P - Peak Flow * - value(s) provided from TR-55 system routines

B6

TABULAR HYDROGRAPH METHOD Version 2.00

Project : WINGHAVEN User: RLW Date: 05-05-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: PRE-DEVELOPMENT RUNOFF FOR AREA 'B'

Total watershed area: 0.336 sq mi Rainfall type: II Frequency: 100 years

---------- Subareas ----------

	B
Area(sq mi)	0.34*
Rainfall(in)	7.0
Curve number	80*
Runoff(in)	4.69
Tc (hrs)	0.39*
(Used)	0.40
TimeToOutlet	0.00
Ia/P	0.07
(Used)	0.10

Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs) B
11.0	28	28
11.3	39	39
11.6	57	57
11.9	121	121
12.0	222	222
12.1	428	428
12.2	738	738
12.3	934P	934P
12.4	906	906
12.5	680	680
12.6	470	470
12.7	341	341
12.8	257	257
13.0	164	164
13.2	121	121
13.4	99	99
13.6	87	87
13.8	77	77
14.0	69	69
14.3	60	60
14.6	54	54
15.0	49	49
15.5	44	44
16.0	39	39
16.5	35	35
17.0	33	33
17.5	32	32
18.0	28	28
19.0	25	25
20.0	22	22
22.0	19	19
26.0	0	0

P - Peak Flow * - value(s) provided from TR-55 system routines

B7

TABULAR HYDROGRAPH METHOD Version 2.00

Project :-WINGHAVEN User: RLW Date: 05-05-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: POST-DEVELOPMENT RUNOFF FOR AREA 'B'

Total watershed area: 0.298 sq mi Rainfall type: II Frequency: 25 years

---------- Subareas ----------

	B
Area(sq mi)	0.30*
Rainfall(in)	5.7
Curve number	81*
Runoff(in)	3.61
Tc (hrs)	0.42*
(Used)	0.40
TimeToOutlet	0.00
Ia/P	0.08
(Used)	0.10

Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs) B
11.0	19	19
11.3	27	27
11.6	39	39
11.9	83	83
12.0	152	152
12.1	291	291
12.2	503	503
12.3	637P	637P
12.4	617	617
12.5	464	464
12.6	321	321
12.7	232	232
12.8	175	175
13.0	112	112
13.2	83	83
13.4	68	68
13.6	59	59
13.8	53	53
14.0	47	47
14.3	41	41
14.6	37	37
15.0	33	33
15.5	30	30
16.0	27	27
16.5	24	24
17.0	23	23
17.5	22	22
18.0	19	19
19.0	17	17
20.0	15	15
22.0	13	13
26.0	0	0

P - Peak Flow * - value(s) provided from TR-55 system routines

TABULAR HYDROGRAPH METHOD Version 2.00

Project : WINGHAVEN User: RLW Date: 05-05-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: POST-DEVELOPMENT RUNOFF FOR AREA 'B'

Total watershed area: 0.298 sq mi Rainfall type: II Frequency: 100 years

---------- Subareas ----------

	B
Area(sq mi)	0.30*
Rainfall(in)	7.0
Curve number	81*
Runoff(in)	4.81
Tc (hrs)	0.42*
(Used)	0.40
TimeToOutlet	0.00
Ia/P	0.07
(Used)	0.10

Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs) B
11.0	26	26
11.3	36	36
11.6	52	52
11.9	110	110
12.0	202	202
12.1	388	388
12.2	670	670
12.3	847P	847P
12.4	821	821
12.5	617	617
12.6	426	426
12.7	309	309
12.8	233	233
13.0	149	149
13.2	110	110
13.4	90	90
13.6	79	79
13.8	70	70
14.0	63	63
14.3	54	54
14.6	49	49
15.0	44	44
15.5	40	40
16.0	36	36
16.5	31	31
17.0	30	30
17.5	29	29
18.0	26	26
19.0	23	23
20.0	20	20
22.0	17	17
26.0	0	0

P - Peak Flow * - value(s) provided from TR-55 system routines

Area C

This section of the report contains the pre- and post-development runoff calculations for Area C, as designated in Figure 1 and 2 of this report.

Prior to development, Area C consisted of about 40 acres of cultivated fields, woods, and a small section of industrial development. An increase in the size of the contributory drainage basin to roughly 52 acres and construction of the clubhouse site and various other improvements will increase the post-development runoff volume. However, converting cultivated fields to golf course fairways will result in increased time of concentration and decreased runoff curve numbers, reducing the magnitude of the changes in the post-development runoff volume. Pages C2-C5 present the pre- and post-development runoff curve number calculations and time of concentration calculations, and pages C6-C9 the tabular hydrograph calculations. This information is presented for both the 25-year and 100-year storm events.

The calculations show the 25 year, 24 stormwater runoff rate has been increased from 185 cfs to 196 cfs, and the 100-year runoff increased from 247 cfs to 261cfs. The two-tiered lake system in Area C will be outfitted with control structures which will reduce the post-development contributions to Dardenne Creek. Sufficient storage is provided to reduce the 25-year, 24-hour post-development outflow from the Area C detention lakes to just 61cfs. This reduction fully compensates for the increase in post-development runoff from Area C and Area A. This is necessary since the developer is unable to provide sufficient stormwater detention within the boundaries of Area A to fully compensate for the increased runoff from that area. Pages C10-C19 present the detention calculations for the Area-C lakes for each critical storm event.

Area Summary

Storm Event	Pre-Development	Post-Development	Post-Development w/ Detention	Net Change
25-year, 24-hour	187 cfs	196 cfs	61 cfs	- 126 cfs
100-year, 24-hour	247cfs	261 cfs	86 cfs	- 161 cfs

RUNOFF CURVE NUMBER COMPUTATION Version 2.00

Project : WINGHAVEN PHASE 1 DETENTION User: RLW Date: 02-24-98
County : ST. CHARLES State: IL Checked: ____ Date: _____
Subtitle: PRE-DEVELOPMENT RUNOFF FOR AREA 'C'
Subarea : C

COVER DESCRIPTION			Hydrologic Soil Group A	B	C	D
			Acres (CN)			
FULLY DEVELOPED URBAN AREAS (Veg Estab.)						
Urban Districts	Avg % imperv					
Industrial	72		-	-	6.5(91)	-
CULTIVATED AGRICULTURAL LANDS						
Row crops	SR + Crop residue	good	-	-	29.4(82)	-
OTHER AGRICULTURAL LANDS						
Woods		good	-	-	4.3(70)	-
Total Area (by Hydrologic Soil Group)					40.2	

SUBAREA: C TOTAL DRAINAGE AREA: 40.2 Acres WEIGHTED CURVE NUMBER: 82

C2

TIME OF CONCENTRATION AND TRAVEL TIME Version 2.00

Project : WINGHAVEN PHASE 1 DETENTION User: RLW Date: 02-24-98
County : ST. CHARLES State: IL Checked: ____ Date: _____
Subtitle: PRE-DEVELOPMENT RUNOFF FOR AREA 'C'

---------- Subarea #1 - C ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	3.5	100	0.010	C					0.099
Shallow Concent'd		800	0.041	U					0.068
Open Channel		1500						5	0.083
								Time of Concentration =	0.25*
									=====

--- Sheet Flow Surface Codes ---

A Smooth Surface	F Grass, Dense	--- Shallow Concentrated ---	
B Fallow (No Res.)	G Grass, Burmuda	---	Surface Codes ---
C Cultivated < 20 % Res.	H Woods, Light		P Paved
D Cultivated > 20 % Res.	I Woods, Dense		U Unpaved
E Grass-Range, Short	J Range, Natural		

* - Generated for use by TABULAR method

RUNOFF CURVE NUMBER COMPUTATION Version 2.00

Project : WINGHAVEN PHASE 1 DETENTION User: RLW Date: 02-24-98
County : ST. CHARLES State: IL Checked: ____ Date: _____
Subtitle: POST-DEVELOPMENT RUNOFF FOR AREA 'C'
Subarea : C

COVER DESCRIPTION	Hydrologic Soil Group A	B	C	D
	Acres (CN)			
FULLY DEVELOPED URBAN AREAS (Veg Estab.)				
Open space (Lawns,parks etc.)				
Good condition; grass cover > 75%	-	-	33.6(74)	-
Impervious Areas				
Paved parking lots, roofs, driveways	-	-	8.7(98)	-
Urban Districts Avg % imperv				
Industrial 72	-	-	6.5(91)	-
User defined urban (F9 to define)	-	-	2.7(98)	-
% impervious			100%	
% unconnected impervious			0%	
pervious curve number			82	
Total Area (by Hydrologic Soil Group)			51.5	

SUBAREA: C TOTAL DRAINAGE AREA: 51.5 Acres WEIGHTED CURVE NUMBER: 81

TIME OF CONCENTRATION AND TRAVEL TIME Version 2.00

Project : WINGHAVEN PHASE 1 DETENTION User: RLW Date: 02-24-98
County : ST. CHARLES State: IL Checked: ____ Date: _____
Subtitle: POST-DEVELOPMENT RUNOFF FOR AREA 'C'

---------- Subarea #1 - C ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	3.5	100	0.020	F					0.227
Shallow Concent'd		80	0.150	U					0.004
Shallow Concent'd		170	0.03	U					0.017
Open Channel		710						5	0.039
								Time of Concentration =	0.29*

--- Sheet Flow Surface Codes ---

A Smooth Surface	F Grass, Dense
B Fallow (No Res.)	G Grass, Burmuda
C Cultivated < 20 % Res.	H Woods, Light
D Cultivated > 20 % Res.	I Woods, Dense
E Grass-Range, Short	J Range, Natural

--- Shallow Concentrated --- Surface Codes ---

P Paved
U Unpaved

* - Generated for use by TABULAR method

TABULAR HYDROGRAPH METHOD Version 2.00

Project : WINGHAVEN PHASE 1 DETENTION User: RLW Date: 02-24-98
County : ST. CHARLES State: IL Checked: ____ Date: _____
Subtitle: PRE-DEVELOPMENT RUNOFF FOR AREA 'C'

Total watershed area: 0.063 sq mi Rainfall type: II Frequency: 25 years

---------- Subareas ----------

	C
Area(sq mi)	0.06*
Rainfall(in)	5.7
Curve number	82*
Runoff(in)	3.71
Tc (hrs)	0.25*
(Used)	0.20
TimeToOutlet	0.00
Ia/P	0.08
(Used)	0.10

Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs) C
11.0	5	5
11.3	7	7
11.6	11	11
11.9	49	49
12.0	94	94
12.1	172	172
12.2	187P	187P
12.3	112	112
12.4	58	58
12.5	39	39
12.6	30	30
12.7	24	24
12.8	20	20
13.0	16	16
13.2	14	14
13.4	13	13
13.6	11	11
13.8	10	10
14.0	9	9
14.3	8	8
14.6	8	8
15.0	7	7
15.5	6	6
16.0	6	6
16.5	5	5
17.0	5	5
17.5	4	4
18.0	4	4
19.0	4	4
20.0	3	3
22.0	3	3
26.0	0	0

P - Peak Flow * - value(s) provided from TR-55 system routines

C6

TABULAR HYDROGRAPH METHOD Version 2.00

Project :-WINGHAVEN PHASE 1 DETENTION User: RLW Date: 02-24-98
County : ST. CHARLES State: IL Checked: ____ Date: _____
Subtitle: PRE-DEVELOPMENT RUNOFF FOR AREA 'C'

Total watershed area: 0.063 sq mi Rainfall type: II Frequency: 100 years

---------- Subareas ----------

	C
Area(sq mi)	0.06*
Rainfall(in)	7.0
Curve number	82*
Runoff(in)	4.92
Tc (hrs)	0.25*
(Used)	0.20
TimeToOutlet	0.00
Ia/P	0.06
(Used)	0.10

Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs) C
11.0	7	7
11.3	10	10
11.6	15	15
11.9	65	65
12.0	124	124
12.1	228	228
12.2	247P	247P
12.3	149	149
12.4	77	77
12.5	51	51
12.6	40	40
12.7	31	31
12.8	27	27
13.0	22	22
13.2	19	19
13.4	17	17
13.6	15	15
13.8	14	14
14.0	12	12
14.3	11	11
14.6	10	10
15.0	9	9
15.5	8	8
16.0	7	7
16.5	6	6
17.0	6	6
17.5	6	6
18.0	6	6
19.0	5	5
20.0	4	4
22.0	4	4
26.0	0	0

P - Peak Flow * - value(s) provided from TR-55 system routines

C1.

TABULAR HYDROGRAPH METHOD Version 2.00

Project : WINGHAVEN PHASE 1 DETENTION User: RLW Date: 02-24-98
County : ST. CHARLES State: IL Checked: ____ Date: _____
Subtitle: POST-DEVELOPMENT RUNOFF FOR AREA 'C'

Total watershed area: 0.080 sq mi Rainfall type: II Frequency: 25 years

---------- Subareas ----------

	C
Area(sq mi)	0.08*
Rainfall(in)	5.7
Curve number	81*
Runoff(in)	3.61
Tc (hrs)	0.29*
(Used)	0.30
TimeToOutlet	0.00
Ia/P	0.08
(Used)	0.10

Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs) C
11.0	6	6
11.3	8	8
11.6	12	12
11.9	34	34
12.0	68	68
12.1	130	130
12.2	196P	196P
12.3	196	196
12.4	133	133
12.5	82	82
12.6	57	57
12.7	42	42
12.8	33	33
13.0	23	23
13.2	19	19
13.4	17	17
13.6	15	15
13.8	13	13
14.0	12	12
14.3	11	11
14.6	10	10
15.0	9	9
15.5	8	8
16.0	7	7
16.5	6	6
17.0	6	6
17.5	6	6
18.0	5	5
19.0	5	5
20.0	4	4
22.0	3	3
26.0	0	0

P - Peak Flow * - value(s) provided from TR-55 system routines

TABULAR HYDROGRAPH METHOD Version 2.00

Project : WINGHAVEN PHASE 1 DETENTION User: RLW Date: 02-24-98
County : ST. CHARLES State: IL Checked: ____ Date: _____
Subtitle: POST-DEVELOPMENT RUNOFF FOR AREA 'C'

Total watershed area: 0.080 sq mi Rainfall type: II Frequency: 100 years

---------- Subareas ----------

	C
Area(sq mi)	0.08*
Rainfall(in)	7.0
Curve number	81*
Runoff(in)	4.81
Tc (hrs)	0.29*
(Used)	0.30
TimeToOutlet	0.00
Ia/P	0.07
(Used)	0.10

Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs) C
11.0	8	8
11.3	11	11
11.6	16	16
11.9	46	46
12.0	91	91
12.1	173	173
12.2	261P	261P
12.3	261	261
12.4	177	177
12.5	109	109
12.6	76	76
12.7	56	56
12.8	44	44
13.0	31	31
13.2	26	26
13.4	22	22
13.6	20	20
13.8	18	18
14.0	16	16
14.3	14	14
14.6	13	13
15.0	12	12
15.5	11	11
16.0	9	9
16.5	9	9
17.0	8	8
17.5	7	7
18.0	7	7
19.0	6	6
20.0	5	5
22.0	5	5
26.0	0	0

P - Peak Flow * - value(s) provided from TR-55 system routines

DETENTION BASIN DESIGN JOB NO 970231 06-May-98
FILE: C-25.XLS
25 YEAR, 24 HOUR DESIGN
I1+I2+[(2S1/T)-O1] = [(2S2/T)+O2]
(SEE McCUEN, 1989, HYDROLOGIC ANALYSIS AND DESIGN, P554)
Ix = INFLOW RATE @ TIME x
Sx = STORAGE VOLUME @ TIME x
Ox = OUTFLOW RATE @ TIME x

SOLUTION PROCEDURE
1. CHOOSE SITE FOR DETENTION & ESTABLISH TRIAL VOLUME.
2. DETERMINE Qunimproved.
3. CHOOSE & EVALUATE A DISCHARGE SYSTEM
4. DEVELOP Qout VS STORAGE CURVE OR EQUATION.
5. DEVELOP Qout HYDROGRAGH (ROUTING CURVE).
6. COMPARE Qout HYDROGRAPH TO Qunimproved HYDROGRAPH, ADJUST IF NECESSARY.

I. SITE PLAN: SEE ATTACHED DRAWING.

II. DETERMINE PEAK Qunimproved & Qimproved & STORAGE CURVE.

Qmax <= Qunimproved

STORM	C(1)	i(2)	concentration time min	AREA ACRES	Qunimprved CFS
25 YR, 24 HR					185.00

STORM YR,MINUTES DURATION	C(1)	i(2)	AREA ACRES	Qimprved CFS
25 YR, 24 HR				196.00

(1) ASCE, 1970, DESIGN OF SANITARY & STORM SEWERS,P.51.
(2) IDOT DRAINAGE MANUAL FIGURE 4-103d

C10

III. EVALUATE DISCHARGE SYSTEM UPPER LAKE

DIAMETER OF ROUND SPILLWAY STRUCTURE = 5 FT

OUTLET NUMBER	HEIGHT ABOVE PON FLOOR IN POND, FT	HEAD ON OUTLET FT	SIZE OF OUTLET REA,SQFT ENGTH,FT	COEFF. FOR OUTLET	EXPONENT ON HEAD		Q CFS	ELEVATION	AREA SQFT	AVG AREA SQFT	CUMULAT STORAGE CUFT	TIME INTERVAL MIN	(2S/T)+O CFS
1	0	0	15.71 FT	3.56	1.5	CIRCULAR WEIR	0.00	567	63390		0	6	0.00
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOT	0.00						
										65072			
1	1	1	15.71 FT	3.56	1.5	CIRCULAR WEIR	55.92	568	66754		65072	6	417.43
2	0	0	0.00 FT	3	1.5	BROADCREST WEIR	0.00						
						SUBTOT	55.92						
										67609			
1	1.5	1.5	15.71 FT	3.1	1.5	CIRCULAR WEIR	89.46	568.5	68464		98877	6	638.77
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOT	89.46						
										69319			
1	2	2	15.71 FT	2.46	1.5	CIRCULAR WEIR	109.29	569	70174		133536	6	851.16
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOT	109.29						
										71913			
1	3	3	15.71 FT	1.7	1.5	CIRCULAR WEIR	138.76	570	73652		205449	6	1280.14
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOT	138.76						

IV. RELATIONSHIP BETWEEN Q,T,STORAGE

TOTAL STORAGE 205449

Q CFS	(2S/T)+O	STORAGE-DISCHRGE CURVE Y=MX+B:Q=M[(2S/T)+0]+Bq M	B	DEPTH FT	Q = (M1 * DEPTH) + B1 M1	B1
0.00	0.00	0.134	0.000	0.00	55.92	0.000
55.92	417.43	0.152	-7.329	1.00	67.08	-11.155
89.46	638.77	0.093	29.797	1.50	39.67	29.947
109.29	851.16	0.069	50.840	2.00	29.46	50.373
138.76	1280.14			3.00		

C11

V. DEVELOP Qout HYDROGRAPH UPPER LAKE

ROUTING CURVE

TIME	INFLOW I	2S/T - O	2S/T + O	OUTFLOW O	DEPTH
HOURS	CFS			CFS	FT
10.9	0.00	0	0	0.00	0.00
11.0	5.00	3.66	5.00	0.67	0.01
11.1	6.00	4.39	6.00	0.80	0.01
11.2	6.00	12.00	16.39	2.20	0.04
11.3	7.00	18.30	25.00	3.35	0.06
11.4	9.00	25.11	34.30	4.60	0.08
11.5	10.00	32.29	44.11	5.91	0.11
11.6	11.00	39.01	53.29	7.14	0.13
11.7	24.00	54.18	74.01	9.92	0.18
11.8	37.00	84.32	115.18	15.43	0.28
11.9	49.00	124.69	170.32	22.82	0.41
12.0	94.00	195.97	267.69	35.86	0.64
12.1	172.00	336.63	461.97	62.67	1.10
12.2	187.00	506.09	695.63	94.77	1.63
12.3	112.00	595.11	805.09	104.99	1.89
12.4	58.00	562.59	765.11	101.26	1.80
12.5	39.00	476.79	659.59	91.40	1.55
12.6	30.00	395.05	545.79	75.37	1.29
12.7	24.00	327.63	449.05	60.71	1.07
12.8	20.00	272.06	371.63	49.78	0.89
12.9	18.00	226.99	310.06	41.54	0.74
13.0	16.00	191.06	260.99	34.96	0.63
13.1	15.00	162.57	222.06	29.75	0.53
13.2	14.00	140.24	191.57	25.66	0.46
13.3	14.00	123.16	168.24	22.54	0.40
13.4	13.00	109.93	150.16	20.12	0.36
13.5	12.00	98.78	134.93	18.08	0.32
13.6	11.00	89.15	121.78	16.31	0.29
13.7	11.00	81.37	111.15	14.89	0.27
13.8	10.00	74.94	102.37	13.71	0.25
13.9	10.00	69.51	94.94	12.72	0.23
14.0	9.00	64.79	88.51	11.86	0.21

C12

III. EVALUATE DISCHARGE SYSTEM LOWER LAKE

DIAMETER OF ROUND SPILLWAY STRUCTURE = 5 FT

OUTLET NUMBER	HEIGHT ABOVE PON FLOOR IN POND, FT	HEAD ON OUTLET FT	SIZE OF OUTLET REA,SQFT ENGTH,FT	COEFF. FOR OUTLET	EXPONENT ON HEAD		Q CFS	ELEVATION	AREA SQFT	AVG AREA SQFT	CUMULAT STORAGE CUFT	TIME INTERVAL MIN	(2S/T)+O CFS
1	0	0	15.71 FT	3.56	1.5	CIRCULAR WEIR	0.00	567	58908		0	6	0.00
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOT	0.00						
										60447			
1	1	1	15.71 FT	3.56	1.5	CIRCULAR WEIR	55.92	568	61986		60447	6	391.74
2	0	0	0.00 FT	3	1.5	BROADCREST WEIR	0.00						
						SUBTOT	55.92						
										62756			
1	1.5	1.5	15.71 FT	3.1	1.5	CIRCULAR WEIR	89.46	568.5	63525		91825	6	599.60
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOT	89.46						
										64295			
1	2	2	15.71 FT	2.46	1.5	CIRCULAR WEIR	109.29	569	65064		123972	6	798.03
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOT	109.29						
										66603			
1	3	3	15.71 FT	1.7	1.5	CIRCULAR WEIR	138.76	570	68142		190575	6	1197.51
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOT	138.76						

IV. RELATIONSHIP BETWEEN Q,T,STORAGE

TOTAL STORAGE 190575

Q CFS	(2S/T)+O	STORAGE-DISCHRGE CURVE Y=MX+B:Q=M[(2S/T)+0]+Bq M	B
0.00	0.00	0.143	0.000
55.92	391.74	0.161	-7.286
89.46	599.60	0.100	29.517
109.29	798.03	0.074	50.442
138.76	1197.51		

DEPTH FT	Q = (M1 * DEPTH) + B1 M1	B1
0.00	55.92	0.000
1.00	67.08	-11.155
1.50	39.67	29.947
2.00	29.46	50.373
3.00		

V. DEVELOP Qout HYDROGRAPH LOWER LAKE

ROUTING CURVE

TIME	INFLOW I	2S/T - O	2S/T + O	OUTFLOW . O	DEPTH
HOURS	CFS			CFS	FT
10.9	0.00	0	0	0.00	0.00
11.0	0.67	0.48	0.67	0.10	0.00
11.1	0.80	0.57	0.80	0.11	0.00
11.2	2.20	2.39	3.34	0.48	0.01
11.3	3.35	3.38	4.73	0.67	0.01
11.4	4.60	6.56	9.18	1.31	0.02
11.5	5.91	9.03	12.64	1.80	0.03
11.6	7.14	13.07	18.29	2.61	0.05
11.7	9.92	17.76	24.85	3.55	0.06
11.8	15.43	25.47	35.64	5.09	0.09
11.9	22.82	36.07	50.49	7.21	0.13
12.0	35.86	54.84	76.76	10.96	0.20
12.1	62.67	86.86	121.56	17.35	0.31
12.2	94.77	132.52	185.47	26.48	0.47
12.3	104.99	181.85	254.52	36.33	0.65
12.4	101.26	234.75	328.55	46.90	0.84
12.5	91.40	270.26	378.25	53.99	0.97
12.6	75.37	293.20	411.37	59.09	1.05
12.7	60.71	300.65	422.37	60.86	1.07
12.8	49.78	297.92	418.35	60.21	1.06
12.9	41.54	287.45	402.89	57.72	1.03
13.0	34.96	273.42	382.67	54.63	0.98
13.1	29.75	256.32	358.74	51.21	0.92
13.2	25.66	238.67	334.04	47.68	0.85
13.3	22.54	220.50	308.60	44.05	0.79
13.4	20.12	203.24	284.45	40.61	0.73
13.5	18.08	186.56	261.11	37.27	0.67
13.6	16.31	171.25	239.67	34.21	0.61
13.7	14.89	156.85	219.53	31.34	0.56
13.8	13.71	143.81	201.27	28.73	0.51
13.9	12.72	131.80	184.46	26.33	0.47
14.0	11.86	121.02	169.38	24.18	0.43

C14

DETENTION BASIN DESIGN JOB NO 970231 06-May-98
FILE: C-100.XLS
100 YEAR, 24 HOUR DESIGN
I1+I2+[(2S1/T)-O1] = [(2S2/T)+O2]
(SEE McCUEN, 1989, HYDROLOGIC ANALYSIS AND DESIGN, P554)
Ix = INFLOW RATE @ TIME x
Sx = STORAGE VOLUME @ TIME x
Ox = OUTFLOW RATE @ TIME x

SOLUTION PROCEDURE
1. CHOOSE SITE FOR DETENTION & ESTABLISH TRIAL VOLUME.
2. DETERMINE Qunimproved.
3. CHOOSE & EVALUATE A DISCHARGE SYSTEM
4. DEVELOP Qout VS STORAGE CURVE OR EQUATION.
5. DEVELOP Qout HYDROGRAGH (ROUTING CURVE).
6. COMPARE Qout HYDROGRAPH TO Qunimproved HYDROGRAPH, ADJUST IF NECESSARY.

I. SITE PLAN: SEE ATTACHED DRAWING.

II. DETERMINE PEAK Qunimproved & Qimproved & STORAGE CURVE.

Qmax <= Qunimproved

STORM	C(1)	i(2)	concentration time min	AREA ACRES	Qunimprved CFS
100 YR, 24 HR					247.00

STORM YR,MINUTES DURATION	C(1)	i(2)	AREA ACRES	Qimprved CFS
100 YR, 24 HR				261.00

(1) ASCE, 1970, DESIGN OF SANITARY & STORM SEWERS,P.51.
(2) IDOT DRAINAGE MANUAL FIGURE 4-103d

C15

III. EVALUATE DISCHARGE SYSTEM UPPER LAKE

DIAMETER OF ROUND SPILLWAY STRUCTURE = 5 FT

OUTLET NUMBER	HEIGHT ABOVE PON FLOOR IN POND, FT	HEAD ON OUTLET FT	SIZE OF OUTLET REA,SQFT ENGTH,FT	COEFF. FOR OUTLET	EXPONENT ON HEAD		Q CFS	ELEVATION	AREA SQFT	AVG AREA SQFT	CUMULAT STORAGE CUFT	TIME INTERVAL MIN	(2S/T)+O CFS
1	0	0	15.71 FT	3.56	1.5	CIRCULAR WEIR	0.00	567	63390		0	6	0.00
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOT	0.00						
										65072			
1	1	1	15.71 FT	3.56	1.5	CIRCULAR WEIR	55.92	568	66754		65072	6	417.43
2	0	0	0.00 FT	3	1.5	BROADCREST WEIR	0.00						
						SUBTOT	55.92						
										67609			
1	1.5	1.5	15.71 FT	3.1	1.5	CIRCULAR WEIR	89.46	568.5	68464		98877	6	638.77
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOT	89.46						
										69319			
1	2	2	15.71 FT	2.46	1.5	CIRCULAR WEIR	109.29	569	70174		133536	6	851.16
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOT	109.29						
										71913			
1	3	3	15.71 FT	1.7	1.5	CIRCULAR WEIR	138.76	570	73652		205449	6	1280.14
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOT	138.76						

IV. RELATIONSHIP BETWEEN Q,T,STORAGE

TOTAL STORAGE 205449

Q CFS	(2S/T)+O	STORAGE-DISCHRGE CURVE Y=MX+B:Q=M[(2S/T)+0]+Bq M	B
0.00	0.00	0.134	0.000
55.92	417.43	0.152	-7.329
89.46	638.77	0.093	29.797
109.29	851.16	0.069	50.840
138.76	1280.14		

DEPTH FT	Q = (M1 * DEPTH) + B1 M1	B1
0.00	55.92	0.000
1.00	67.08	-11.155
1.50	39.67	29.947
2.00	29.46	50.373
3.00		

V. DEVELOP Qout HYDROGRAPH UPPER LAKE

ROUTING CURVE

TIME	INFLOW I	2S/T - O	2S/T + O	OUTFLOW O	DEPTH
HOURS	CFS			CFS	FT
10.9	0.00	0	0	0.00	0.00
11.0	7.00	5.12	7.00	0.94	0.02
11.1	8.00	5.86	8.00	1.07	0.02
11.2	8.00	16.00	21.86	2.93	0.05
11.3	9.00	24.16	33.00	4.42	0.08
11.4	11.00	32.33	44.16	5.92	0.11
11.5	13.00	41.24	56.33	7.55	0.13
11.6	14.00	49.95	68.24	9.14	0.16
11.7	23.00	63.66	86.95	11.65	0.21
11.8	32.00	86.87	118.66	15.90	0.28
11.9	40.00	116.30	158.87	21.28	0.38
12.0	80.00	172.99	236.30	31.66	0.57
12.1	151.00	295.75	403.99	54.12	0.97
12.2	229.00	489.93	675.75	92.91	1.59
12.3	229.00	716.05	947.93	115.94	2.23
12.4	155.00	847.27	1100.05	126.39	2.58
12.5	96.00	845.74	1098.27	126.27	2.58
12.6	66.00	767.64	1007.74	120.05	2.37
12.7	49.00	659.73	882.64	111.46	2.07
12.8	39.00	548.46	747.73	99.63	1.76
12.9	33.00	447.09	620.46	86.68	1.46
13.0	27.00	368.08	507.09	69.51	1.20
13.1	25.00	307.44	420.08	56.32	1.01
13.2	22.00	259.47	354.44	47.48	0.85
13.3	21.00	221.43	302.47	40.52	0.72
13.4	19.00	191.39	261.43	35.02	0.63
13.5	18.00	167.20	228.39	30.60	0.55
13.6	17.00	148.02	202.20	27.09	0.48
13.7	17.00	133.25	182.02	24.38	0.44
13.8	16.00	121.71	166.25	22.27	0.40
13.9	15.00	111.80	152.71	20.46	0.37
14.0	14.00	103.07	140.80	18.86	0.34

III. EVALUATE DISCHARGE SYSTEM LOWER LAKE

DIAMETER OF ROUND SPILLWAY STRUCTURE = 5 FT

OUTLET NUMBER	HEIGHT ABOVE PON FLOOR IN POND, FT	HEAD ON OUTLET FT	SIZE OF OUTLET REA,SQFT ENGTH,FT	COEFF. FOR OUTLET	EXPONENT ON HEAD		Q CFS	ELEVATION	AREA SQFT	AVG AREA SQFT	CUMULAT STORAGE CUFT	TIME INTERVAL MIN	(2S/T)+O CFS
1	0	0	15.71 FT	3.56	1.5	CIRCULAR WEIR	0.00	567	58908		0	6	0.00
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOT	0.00						
										60447			
1	1	1	15.71 FT	3.56	1.5	CIRCULAR WEIR	55.92	568	61986		60447	6	391.74
2	0	0	0.00 FT	3	1.5	BROADCREST WEIR	0.00						
						SUBTOT	55.92						
										62756			
1	1.5	1.5	15.71 FT	3.1	1.5	CIRCULAR WEIR	89.46	568.5	63525		91825	6	599.60
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOT	89.46						
										64295			
1	2	2	15.71 FT	2.46	1.5	CIRCULAR WEIR	109.29	569	65064		123972	6	798.03
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOT	109.29						
										66603			
1	3	3	15.71 FT	1.7	1.5	CIRCULAR WEIR	138.76	570	68142		190575	6	1197.51
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOT	138.76						

IV. RELATIONSHIP BETWEEN Q,T,STORAGE

TOTAL STORAGE 190575

Q CFS	(2S/T)+O	STORAGE-DISCHRGE CURVE Y=MX+B:Q=M[(2S/T)+0]+Bq M	B
0.00	0.00	0.143	0.000
55.92	391.74	0.161	-7.286
89.46	599.60	0.100	29.517
109.29	798.03	0.074	50.442
138.76	1197.51		

DEPTH FT	Q = (M1 * DEPTH) + B1 M1	B1
0.00	55.92	0.000
1.00	67.08	-11.155
1.50	39.67	29.947
2.00	29.46	50.373
3.00		

C18

V. DEVELOP Qout HYDROGRAPH LOWER LAKE

ROUTING CURVE

TIME	INFLOW I	2S/T - O	2S/T + O	OUTFLOW O	DEPTH
HOURS	CFS			CFS	FT
10.9	0.00	0	0	0.00	0.00
11.0	0.94	0.67	0.94	0.13	0.00
11.1	1.07	0.77	1.07	0.15	0.00
11.2	2.93	3.24	4.54	0.65	0.01
11.3	4.42	4.47	6.26	0.89	0.02
11.4	5.92	8.63	12.08	1.73	0.03
11.5	7.55	11.75	16.44	2.35	0.04
11.6	9.14	16.93	23.69	3.38	0.06
11.7	11.65	22.11	30.94	4.42	0.08
11.8	15.90	29.98	41.96	5.99	0.11
11.9	21.28	39.32	55.04	7.86	0.14
12.0	31.66	55.40	77.53	11.07	0.20
12.1	54.12	81.97	114.73	16.38	0.29
12.2	92.91	128.59	179.97	25.69	0.46
12.3	115.94	180.08	252.03	35.98	0.64
12.4	126.39	248.56	347.88	49.66	0.89
12.5	126.27	300.59	422.28	60.85	1.07
12.6	120.05	349.84	495.00	72.58	1.25
12.7	111.46	379.17	538.31	79.57	1.35
12.8	99.63	400.31	569.52	84.61	1.43
12.9	86.68	405.59	577.31	85.86	1.45
13.0	69.51	400.26	569.45	84.59	1.43
13.1	56.32	386.13	548.59	81.23	1.38
13.2	47.48	364.91	517.25	76.17	1.30
13.3	40.52	341.69	482.98	70.64	1.22
13.4	35.02	317.60	447.41	64.90	1.13
13.5	30.60	294.17	412.81	59.32	1.05
13.6	27.09	271.31	379.71	54.20	0.97
13.7	24.38	249.47	349.15	49.84	0.89
13.8	22.27	229.12	320.66	45.77	0.82
13.9	20.46	210.28	294.31	42.01	0.75
14.0	18.86	193.09	270.25	38.58	0.69

Area D

This section of the report contains the pre- and post-development runoff calculations for Area D, as designated in Figure 1 and 2 of this report. This area drains to the southwest towards Bates Road.

Prior to development, Area D consisted of about 87 acres of cultivated fields and woods. The drainage basin will be reduced to approximately 85 acres during development. However, the construction of subdivision improvements will result in increased post-development runoff volumes. Unlike Area B, the ratio of golf course area to subdivision area is too low to compensate fully for the added impervious area. Pages D2-D5 present the pre- and post-development runoff curve number calculations and the time of concentration calculations, and pages D6-D9 present the tabular hydrograph calculations. This information is presented for both the 25-year and 100-year storm events.

As the calculations show, the 25 year, 24 stormwater runoff rate will be increased from 404 cfs to 426 cfs, and the 100-year, 24-hour runoff rate will increase from 535 cfs to 557 cfs.. The two-tiered lake system located in Area D will provide the required stormwater detention. The larger of the two lakes, roughly 4 acres in area, will be outfitted with a control structure which will reduce the outflow from the lakes to just 171 cfs for the 25, year 24 hour storm event and 216 cfs for the 100-year storm event. Detention calculations for these lakes are included on pages D10-D19 of this report.

Area Summary

Storm Event	Pre-Development	Post-Development	Post-Development w/ Detention	Net Change
25-year, 24-hour	404 cfs	426 cfs	171 cfs	- 233 cfs
100-year, 24-hour	535 cfs	557 cfs	216 cfs	- 319 cfs

RUNOFF CURVE NUMBER COMPUTATION Version 2.00

Project : WINGHAVEN User: RLW Date: 05-05-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: PRE-DEVELOPMENT RUNOFF FOR AREA 'D'
Subarea : D

COVER DESCRIPTION			Hydrologic Soil Group A	B	C	D
				Acres (CN)		
CULTIVATED AGRICULTURAL LANDS						
Row crops	SR + Crop residue	good	-	-	83.8(82)	-
OTHER AGRICULTURAL LANDS						
Woods		good	-	-	3.22(70)	-
Total Area (by Hydrologic Soil Group)					87.0	

SUBAREA: D TOTAL DRAINAGE AREA: 87.02.Acres WEIGHTED CURVE NUMBER: 82

D2

TIME OF CONCENTRATION AND TRAVEL TIME Version 2.00

Project : WINGHAVEN User: RLW Date: 05-05-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: PRE-DEVELOPMENT RUNOFF FOR AREA 'D'

Subarea #1 - D

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	3.5	100	0.040	C					0.057
Shallow Concent'd		450	0.038	U					0.040
Open Channel		2150						5	0.119
								Time of Concentration =	0.22*
									=====

--- Sheet Flow Surface Codes ---

A Smooth Surface	F Grass, Dense	--- Shallow Concentrated ---	
B Fallow (No Res.)	G Grass, Burmuda	---	Surface Codes ---
C Cultivated < 20 % Res.	H Woods, Light		P Paved
D Cultivated > 20 % Res.	I Woods, Dense		U Unpaved
E Grass-Range, Short	J Range, Natural		

* - Generated for use by TABULAR method

RUNOFF CURVE NUMBER COMPUTATION Version 2.00

Project : WINGHAVEN PHASE 1 DETENTION User: RLW Date: 05-07-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: POST-DEVELOPMENT RUNOFF FOR AREA 'D'
Subarea : ONE

COVER DESCRIPTION		Hydrologic Soil Group A	B	C	D
			Acres (CN)		
FULLY DEVELOPED URBAN AREAS (Veg Estab.)					
Open space (Lawns,parks etc.)					
Good condition; grass cover > 75%		-	-	32.6(74)	-
Streets and roads					
Paved; curbs and storm sewers		-	-	10.2(98)	-
Residential districts	Avg % imperv				
(by average lot size)					
1/8 acre (town houses)	65	-	-	36.8(90)	-
User defined urban (F9 to define)		-	-	5.2(98)	-
% impervious				100%	
% unconnected impervious				0%	
pervious curve number				82	
Total Area (by Hydrologic Soil Group)				84.8	
				====	

SUBAREA: ONE TOTAL DRAINAGE AREA: 84.8 Acres WEIGHTED CURVE NUMBER: 85

D4

TIME OF CONCENTRATION AND TRAVEL TIME Version 2.00

Project : WINGHAVEN PHASE 1 DETENTION User: RLW Date: 05-07-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: POST-DEVELOPMENT RUNOFF FOR AREA 'D'

---------- Subarea #1 - ONE ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	3.5	50	0.01	F					0.172
Shallow Concent'd		200	0.020	P					0.019
Open Channel		1350						10	0.038

Time of Concentration = 0.23*
=====

--- Sheet Flow Surface Codes ---

A Smooth Surface	F Grass, Dense	--- Shallow Concentrated ---
B Fallow (No Res.)	G Grass, Burmuda	--- Surface Codes ---
C Cultivated < 20 % Res.	H Woods, Light	P Paved
D Cultivated > 20 % Res.	I Woods, Dense	U Unpaved
E Grass-Range, Short	J Range, Natural	

* - Generated for use by TABULAR method

TABULAR HYDROGRAPH METHOD Version 2.00

Project : WINGHAVEN User: RLW Date: 05-05-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: PRE-DEVELOPMENT RUNOFF FOR AREA 'D'

Total watershed area: 0.136 sq mi Rainfall type: II Frequency: 25 years

---------- Subareas ----------

	D
Area(sq mi)	0.14*
Rainfall(in)	5.7
Curve number	82*
Runoff(in)	3.71
Tc (hrs)	0.22*
(Used)	0.20
TimeToOutlet	0.00
Ia/P	0.08
(Used)	0.10

Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs) D
11.0	12	12
11.3	16	16
11.6	24	24
11.9	105	105
12.0	203	203
12.1	373	373
12.2	404P	404P
12.3	243	243
12.4	126	126
12.5	84	84
12.6	65	65
12.7	51	51
12.8	43	43
13.0	35	35
13.2	31	31
13.4	27	27
13.6	25	25
13.8	22	22
14.0	20	20
14.3	18	18
14.6	17	17
15.0	15	15
15.5	14	14
16.0	12	12
16.5	11	11
17.0	10	10
17.5	10	10
18.0	9	9
19.0	8	8
20.0	7	7
22.0	6	6
26.0	0	0

P - Peak Flow * - value(s) provided from TR-55 system routines

D6

TABULAR HYDROGRAPH METHOD Version 2.00

Project : WINGHAVEN User: RLW Date: 05-05-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: PRE-DEVELOPMENT RUNOFF FOR AREA 'D'

Total watershed area: 0.136 sq mi Rainfall type: II Frequency: 100 years

---------- Subareas ----------

	D
Area(sq mi)	0.14*
Rainfall(in)	7.0
Curve number	82*
Runoff(in)	4.92
Tc (hrs)	0.22*
(Used)	0.20
TimeToOutlet	0.00
Ia/P	0.06
(Used)	0.10

Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs) D
11.0	15	15
11.3	21	21
11.6	31	31
11.9	140	140
12.0	269	269
12.1	494	494
12.2	535P	535P
12.3	322	322
12.4	167	167
12.5	111	111
12.6	86	86
12.7	68	68
12.8	57	57
13.0	47	47
13.2	41	41
13.4	36	36
13.6	33	33
13.8	29	29
14.0	27	27
14.3	23	23
14.6	22	22
15.0	20	20
15.5	18	18
16.0	16	16
16.5	14	14
17.0	13	13
17.5	13	13
18.0	12	12
19.0	11	11
20.0	9	9
22.0	8	8
26.0	0	0

P - Peak Flow * - value(s) provided from TR-55 system routines

D7

TABULAR HYDROGRAPH METHOD Version 2.00

Project : WINGHAVEN PHASE 1 DETENTION User: RLW Date: 05-07-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: POST-DEVELOPMENT RUNOFF FOR AREA 'D'

Total watershed area: 0.133 sq mi Rainfall type: II Frequency: 25 years

	Subareas
	ONE
Area(sq mi)	0.13*
Rainfall(in)	5.7
Curve number	85*
Runoff(in)	4.02
Tc (hrs)	0.23*
(Used)	0.20
TimeToOutlet	0.00
Ia/P	0.06
(Used)	0.10

Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs)
		ONE
11.0	12	12
11.3	17	17
11.6	25	25
11.9	111	111
12.0	215	215
12.1	394	394
12.2	426P	426P
12.3	256	256
12.4	133	133
12.5	88	88
12.6	68	68
12.7	54	54
12.8	46	46
13.0	37	37
13.2	32	32
13.4	29	29
13.6	26	26
13.8	23	23
14.0	21	21
14.3	19	19
14.6	18	18
15.0	16	16
15.5	14	14
16.0	13	13
16.5	11	11
17.0	11	11
17.5	10	10
18.0	10	10
19.0	9	9
20.0	7	7
22.0	6	6
26.0	0	0

P - Peak Flow * - value(s) provided from TR-55 system routines

D8

TABULAR HYDROGRAPH METHOD Version 2.00

Project : WINGHAVEN PHASE 1 DETENTION User: RLW Date: 05-07-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: POST-DEVELOPMENT RUNOFF FOR AREA 'D'

Total watershed area: 0.133 sq mi Rainfall type: II Frequency: 100 years

---------- Subareas ----------

	ONE
Area(sq mi)	0.13*
Rainfall(in)	7.0
Curve number	85*
Runoff(in)	5.25
Tc (hrs)	0.23*
(Used)	0.20
TimeToOutlet	0.00
Ia/P	0.05
(Used)	0.10

Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs) ONE
11.0	16	16
11.3	22	22
11.6	33	33
11.9	145	145
12.0	280	280
12.1	514	514
12.2	557P	557P
12.3	335	335
12.4	174	174
12.5	116	116
12.6	89	89
12.7	71	71
12.8	60	60
13.0	49	49
13.2	42	42
13.4	38	38
13.6	34	34
13.8	31	31
14.0	28	28
14.3	24	24
14.6	23	23
15.0	21	21
15.5	19	19
16.0	17	17
16.5	15	15
17.0	14	14
17.5	13	13
18.0	13	13
19.0	11	11
20.0	9	9
22.0	8	8
26.0	0	0

P - Peak Flow * - value(s) provided from TR-55 system routines

DETENTION BASIN DESIGN JOB NO 970231 07-May-98
FILE: D-25.XLS
25 YEAR, 24 HOUR DESIGN
I1+I2+[(2S1/T)-O1] = [(2S2/T)+O2]
(SEE McCUEN, 1989, HYDROLOGIC ANALYSIS AND DESIGN, P554)
Ix = INFLOW RATE @ TIME x
Sx = STORAGE VOLUME @ TIME x
Ox = OUTFLOW RATE @ TIME x

SOLUTION PROCEDURE
1. CHOOSE SITE FOR DETENTION & ESTABLISH TRIAL VOLUME.
2. DETERMINE Qunimproved.
3. CHOOSE & EVALUATE A DISCHARGE SYSTEM
4. DEVELOP Qout VS STORAGE CURVE OR EQUATION.
5. DEVELOP Qout HYDROGRAGH (ROUTING CURVE).
6. COMPARE Qout HYDROGRAPH TO Qunimproved HYDROGRAPH, ADJUST IF NECESSARY.

I. SITE PLAN: SEE ATTACHED DRAWING.

II. DETERMINE PEAK Qunimproved & Qimproved & STORAGE CURVE.

Qmax <= Qunimproved

STORM	C(1)	i(2)	concentration time min	AREA ACRE	Qunimprved CFS
STORM					
25 YR, 24 HR					404.00

STORM YR,MINUTES	C(1) DURATION	i(2)		AREA ACRE	Qimprved CFS
25 YR, 24 HR					426.00

(1) ASCE, 1970, DESIGN OF SANITARY & STORM SEWERS,P.51.
(2) IDOT DRAINAGE MANUAL FIGURE 4-103d

D16

III. EVALUATE DISCHARGE SYSTEM UPPER LAKE

DIAMETER OF ROUND SPILLWAY STRUCTURE = 5 FT

OUTLET NUMBER	HEIGHT ABOVE POND FLOOR IN POND, FT	HEAD ON OUTLET FT	SIZE OF OUTLET AREA,SQFT LENGTH,FT	COEFF. FOR OUTLET	EXPONENT ON * HEAD		Q CFS	ELEVATIO	AREA SQFT	AVG AREA SQFT	CUMULATIV STORAGE CUFT	TIME NTERVA MIN	(2S/T)+O CFS
1	0	0	15.71 FT	3.56	1.5	CIRCULAR WEIR	0.00	587	59044		0	6	0.00
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOTAL	0.00						
										60634			
1	1	1	15.71 FT	3.56	1.5	CIRCULAR WEIR	55.92	588	62223		60634	6	392.77
2	0	0	0.00 FT	3	1.5	BROADCREST WEIR	0.00						
						SUBTOTAL	55.92						
										63031			
1	1.5	1.5	15.71 FT	3.1	1.5	CIRCULAR WEIR	89.46	588.5	63839		92149	6	601.40
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOTAL	89.46						
										64646			
1	2	2	15.71 FT	2.46	1.5	CIRCULAR WEIR	109.29	589	65454		124472	6	800.81
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOTAL	109.29						
										67096			
1	3	3	15.71 FT	1.7	1.5	CIRCULAR WEIR	138.76	590	68738		191568	6	1203.02
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOTAL	138.76						
						TOTAL STORAGE					191568		

IV. RELATIONSHIP BETWEEN Q,T,STORAGE

Q CFS	(2S/T)+O	STORAGE-DISCHRGE CURVE Y=MX+B:Q=M[(2S/T)+0]+Bq M	B
0.00	0.00	0.142	0.000
55.92	392.77	0.161	-7.221
89.46	601.40	0.099	29.632
109.29	800.81	0.073	50.639
138.76	1203.02		

DEPTH FT	Q = (M1 * DEPTH) + B1 M1	B1
0.00	55.92	0.000
1.00	67.08	-11.155
1.50	39.67	29.947
2.00	29.46	50.373
3.00		

V. DEVELOP Qout HYDROGRAPH UPPER LAKE

ROUTING CURVE

TIME	INFLOW I	2S/T - O	2S/T + O	OUTFLOW O	DEPTH
HOURS	CFS			CFS	FT
10.9	0.00	0	0	0.00	0.00
11.0	2.00	1.43	2.00	0.28	0.01
11.1	2.00	3.88	5.43	0.77	0.01
11.2	2.00	5.64	7.88	1.12	0.02
11.3	2.00	6.89	9.64	1.37	0.02
11.4	3.00	8.51	11.89	1.69	0.03
11.5	3.00	10.38	14.51	2.07	0.04
11.6	3.00	11.71	16.38	2.33	0.04
11.7	7.00	15.53	21.71	3.09	0.06
11.8	11.00	23.98	33.53	4.77	0.09
11.9	15.00	35.75	49.98	7.12	0.13
12.0	30.00	57.76	80.75	11.50	0.21
12.1	54.00	101.39	141.76	20.18	0.36
12.2	59.00	153.34	214.39	30.52	0.55
12.3	35.00	176.91	247.34	35.22	0.63
12.4	18.00	164.45	229.91	32.73	0.59
12.5	12.00	139.08	194.45	27.68	0.50
12.6	9.00	114.50	160.08	22.79	0.41
12.7	7.00	93.34	130.50	18.58	0.33
12.8	6.00	76.06	106.34	15.14	0.27
12.9	6.00	62.98	88.06	12.54	0.22
13.0	5.00	52.92	73.98	10.53	0.19
13.1	5.00	45.00	62.92	8.96	0.16
13.2	4.00	38.63	54.00	7.69	0.14
13.3	4.00	33.35	46.63	6.64	0.12
13.4	4.00	29.57	41.35	5.89	0.11
13.5	4.00	26.88	37.57	5.35	0.10
13.6	4.00	24.94	34.88	4.97	0.09
13.7	4.00	23.56	32.94	4.69	0.08
13.8	3.00	21.86	30.56	4.35	0.08
13.9	3.00	19.93	27.86	3.97	0.07
14.0	3.00	18.54	25.93	3.69	0.07

III. EVALUATE DISCHARGE SYSTEM LOWER LAKE

DIAMETER OF ROUND SPILLWAY STRUCTURE = 7 FT

OUTLET NUMBER	HEIGHT ABOVE POND FLOOR IN POND, FT	HEAD ON OUTLET FT	SIZE OF OUTLET AREA,SQFT LENGTH,FT	COEFF. FOR OUTLET	EXPONENT ON HEAD		Q CFS	ELEVATIO	AREA SQFT	AVG AREA SQFT	CUMULATIV STORAGE CUFT	TIME NTERVA MIN	(2S/T)+O CFS
1	0	0	21.99 FT	3.77	1.5	CIRCULAR WEIR	0.00	567	207342		0	6	0.00
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOTAL	0.00						
										210937			
1	1	1	21.99 FT	3.77	1.5	CIRCULAR WEIR	82.91	568	214531		210937	6	1254.78
2	0	0	0.00 FT	3	1.5	BROADCREST WEIR	0.00						
						SUBTOTAL	82.91						
										216343			
1	1.5	1.5	21.99 FT	3.52	1.5	CIRCULAR WEIR	142.21	568.5	218155		319108	6	1915.03
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOTAL	142.21						
										219966			
1	2	2	21.99 FT	3.19	1.5	CIRCULAR WEIR	198.42	569	221778		429091	6	2582.26
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOTAL	198.42						
										225431			
1	3	3	21.99 FT	2.32	1.5	CIRCULAR WEIR	265.10	570	229083		654522	6	3901.34
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOTAL	265.10						

IV. RELATIONSHIP BETWEEN Q,T,STORAGE

TOTAL STORAGE 654522

Q CFS	(2S/T)+O	STORAGE-DISCHRGE CURVE Y=MX+B:Q=M[(2S/T)+0]+Bq M	B
0.00	0.00	0.066	0.000
82.91	1254.78	0.090	-29.794
142.21	1915.03	0.084	-19.121
198.42	2582.26	0.051	67.873
265.10	3901.34		

DEPTH FT	Q = (M1 * DEPTH) + B1 M1	B1
0.00	82.91	0.000
1.00	118.60	-35.698
1.50	112.42	-26.421
2.00	66.69	65.048
3.00		

V. DEVELOP Qout HYDROGRAPH LOWER LAKE

ROUTING CURVE

TIME HOURS	INFLOW FROM UPPER LAKE CFS	INFLOW FROM BASIN CFS	TOTAL INFLOW CFS	2S/T - O	2S/T + O	UTFLOW O CFS	DEPTH FT
10.9	0.00	0.00	0.00	0	0	0.00	0.00
11.0	0.28	11.00	11.28	9.79	11.28	0.75	0.01
11.1	0.77	12.00	12.77	29.38	33.85	2.24	0.03
11.2	1.12	13.00	14.12	48.84	56.27	3.72	0.04
11.3	1.37	14.00	15.37	67.98	78.33	5.18	0.06
11.4	1.69	17.00	18.69	88.56	102.05	6.74	0.08
11.5	2.07	20.00	22.07	112.23	129.32	8.54	0.10
11.6	2.33	22.00	24.33	137.67	158.63	10.48	0.13
11.7	3.09	47.00	50.09	184.06	212.09	14.01	0.17
11.8	4.77	72.00	76.77	269.84	310.93	20.54	0.25
11.9	7.12	97.00	104.12	391.17	450.73	29.78	0.36
12.0	11.50	187.00	198.50	602.10	693.78	45.84	0.55
12.1	20.18	342.00	362.18	1009.12	1162.78	76.83	0.93
12.2	30.52	370.00	400.52	1513.14	1771.83	129.35	1.39
12.3	35.22	223.00	258.22	1844.18	2171.87	163.85	1.69
12.4	32.73	116.00	148.73	1910.08	2251.13	170.52	1.75
12.5	27.68	77.00	104.68	1837.22	2163.50	163.14	1.69
12.6	22.79	59.00	81.79	1720.97	2023.69	151.36	1.58
12.7	18.58	47.00	65.58	1592.31	1868.34	138.02	1.46
12.8	15.14	40.00	55.14	1464.89	1713.03	124.07	1.35
12.9	12.54	36.00	48.54	1346.39	1568.57	111.09	1.24
13.0	10.53	32.00	42.53	1238.83	1437.46	99.31	1.14
13.1	8.96	30.00	38.96	1142.73	1320.32	88.79	1.05
13.2	7.69	28.00	35.69	1056.51	1217.38	80.44	0.97
13.3	6.64	27.00	33.64	977.06	1125.84	74.39	0.90
13.4	5.89	25.00	30.89	903.94	1041.59	68.82	0.83
13.5	5.35	24.00	29.35	836.77	964.18	63.71	0.77
13.6	4.97	23.00	27.97	775.93	894.08	59.07	0.71
13.7	4.69	22.00	26.69	720.83	830.59	54.88	0.66
13.8	4.35	20.00	24.35	669.87	771.87	51.00	0.62
13.9	3.97	20.00	23.97	623.29	718.19	47.45	0.57
14.0	3.69	19.00	22.69	581.41	669.94	44.27	0.53

DETENTION BASIN DESIGN JOB NO 970231 07-May-98
FILE: D-100.XLS
100 YEAR, 24 HOUR DESIGN
I1+I2+[(2S1/T)-O1] = [(2S2/T)+O2]
(SEE McCUEN, 1989, HYDROLOGIC ANALYSIS AND DESIGN, P554)
Ix = INFLOW RATE @ TIME x
Sx = STORAGE VOLUME @ TIME x
Ox = OUTFLOW RATE @ TIME x

SOLUTION PROCEDURE
1. CHOOSE SITE FOR DETENTION & ESTABLISH TRIAL VOLUME.
2. DETERMINE Qunimproved.
3. CHOOSE & EVALUATE A DISCHARGE SYSTEM
4. DEVELOP Qout VS STORAGE CURVE OR EQUATION.
5. DEVELOP Qout HYDROGRAGH (ROUTING CURVE).
6. COMPARE Qout HYDROGRAPH TO Qunimproved HYDROGRAPH, ADJUST IF NECESSARY.

I. SITE PLAN: SEE ATTACHED DRAWING.

II. DETERMINE PEAK Qunimproved & Qimproved & STORAGE CURVE.

Qmax <= Qunimproved

STORM	C(1)	i(2)	concentration time min	AREA ACRE	Qunimprved CFS
100 YR, 24 HR					535.00

STORM YR,MINUTES DURATION	C(1)	i(2)		AREA ACRE	Qimprved CFS
100 YR, 24 HR					557.00

(1) ASCE, 1970, DESIGN OF SANITARY & STORM SEWERS,P.51.
(2) IDOT DRAINAGE MANUAL FIGURE 4-103d

D15

III. EVALUATE DISCHARGE SYSTEM UPPER LAKE

DIAMETER OF ROUND SPILLWAY STRUCTURE = 5 FT

OUTLET NUMBER	HEIGHT ABOVE POND FLOOR IN POND, FT	HEAD ON OUTLET FT	SIZE OF OUTLET AREA,SQFT. LENGTH,FT	COEFF. FOR OUTLET	EXPONENT ON HEAD		Q CFS	ELEVATIO	AREA SQFT	AVG AREA SQFT	CUMULATIV STORAGE CUFT	TIME NTERVA MIN	(2S/T)+O CFS
1	0	0	15.71 FT	3.56	1.5	CIRCULAR WEIR	0.00	587	59044		0	6	0.00
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOTAL	0.00						
										60634			
1	1	1	15.71 FT	3.56	1.5	CIRCULAR WEIR	55.92	588	62223		60634	6	392.77
2	0	0	0.00 FT	3	1.5	BROADCREST WEIR	0.00						
						SUBTOTAL	55.92						
										63031			
1	1.5	1.5	15.71 FT	3.1	1.5	CIRCULAR WEIR	89.46	588.5	63839		92149	6	601.40
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOTAL	89.46						
										64646			
1	2	2	15.71 FT	2.46	1.5	CIRCULAR WEIR	109.29	589	65454		124472	6	800.81
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOTAL	109.29						
										67096			
1	3	3	15.71 FT	1.7	1.5	CIRCULAR WEIR	138.76	590	68738		191568	6	1203.02
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOTAL	138.76						

IV. RELATIONSHIP BETWEEN Q,T,STORAGE

TOTAL STORAGE 191568

Q CFS	(2S/T)+O	STORAGE-DISCHRGE CURVE Y=MX+B:Q=M[(2S/T)+0]+Bq M	B
0.00	0.00	0.142	0.000
55.92	392.77	0.161	-7.221
89.46	601.40	0.099	29.632
109.29	800.81	0.073	50.639
138.76	1203.02		

DEPTH FT	Q = (M1 * DEPTH) + B1 M1	B1
0.00	55.92	0.000
1.00	67.08	-11.155
1.50	39.67	29.947
2.00	29.46	50.373
3.00		

D16

V. DEVELOP Qout HYDROGRAPH UPPER LAKE

ROUTING CURVE

TIME	INFLOW I	2S/T - O	2S/T + O	OUTFLOW O	DEPTH
HOURS	CFS			CFS	FT
10.9	0.00	0	0	0.00	0.00
11.0	2.00	1.43	2.00	0.28	0.01
11.1	2.00	3.88	5.43	0.77	0.01
11.2	2.00	5.64	7.88	1.12	0.02
11.3	3.00	7.61	10.64	1.51	0.03
11.4	3.00	9.73	13.61	1.94	0.03
11.5	3.00	11.25	15.73	2.24	0.04
11.6	4.00	13.06	18.25	2.60	0.05
11.7	9.00	18.64	26.06	3.71	0.07
11.8	15.00	30.50	42.64	6.07	0.11
11.9	20.00	46.85	65.50	9.32	0.17
12.0	38.00	74.99	104.85	14.93	0.27
12.1	70.00	130.89	182.99	26.05	0.47
12.2	76.00	198.04	276.89	39.42	0.70
12.3	46.00	228.91	320.04	45.57	0.81
12.4	24.00	213.80	298.91	42.56	0.76
12.5	16.00	181.53	253.80	36.13	0.65
12.6	12.00	149.87	209.53	29.83	0.53
12.7	10.00	122.93	171.87	24.47	0.44
12.8	8.00	100.80	140.93	20.06	0.36
12.9	8.00	83.54	116.80	16.63	0.30
13.0	7.00	70.48	98.54	14.03	0.25
13.1	7.00	60.43	84.48	12.03	0.22
13.2	6.00	52.52	73.43	10.45	0.19
13.3	6.00	46.15	64.52	9.19	0.16
13.4	5.00	40.87	57.15	8.14	0.15
13.5	5.00	36.39	50.87	7.24	0.13
13.6	5.00	33.18	46.39	6.60	0.12
13.7	5.00	30.88	43.18	6.15	0.11
13.8	4.00	28.53	39.88	5.68	0.10
13.9	4.00	26.13	36.53	5.20	0.09
14.0	4.00	24.41	34.13	4.86	0.09

D17

III. EVALUATE DISCHARGE SYSTEM LOWER LAKE

DIAMETER OF ROUND SPILLWAY STRUCTURE = 7 FT

OUTLET NUMBER	HEIGHT ABOVE POND FLOOR IN POND, FT	HEAD ON OUTLET FT	SIZE OF OUTLET AREA,SQFT LENGTH,FT	COEFF. FOR OUTLET	EXPONENT ON HEAD		Q CFS	ELEVATIO	AREA SQFT	AVG AREA SQFT	CUMULATIV STORAGE CUFT	TIME NTERVA MIN	(2S/T)+Q CFS
1	0	0	21.99 FT	3.77	1.5	CIRCULAR WEIR	0.00	567	207342		0	6	0.00
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOTAL	0.00			210937			
1	1	1	21.99 FT	3.77	1.5	CIRCULAR WEIR	82.91	568	214531		210937	6	1254.78
2	0	0	0.00 FT	3	1.5	BROADCREST WEIR	0.00						
						SUBTOTAL	82.91			216343			
1	1.5	1.5	21.99 FT	3.52	1.5	CIRCULAR WEIR	142.21	568.5	218155		319108	6	1915.03
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOTAL	142.21			219966			
1	2	2	21.99 FT	3.19	1.5	CIRCULAR WEIR	198.42	569	221778		429091	6	2582.26
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOTAL	198.42			225431			
1	3	3	21.99 FT	2.32	1.5	CIRCULAR WEIR	265.10	570	229083		654522	6	3901.34
2	0	0	0.00 FT	2.7	1.5	BROADCREST WEIR	0.00						
						SUBTOTAL	265.10						

IV. RELATIONSHIP BETWEEN Q,T,STORAGE

TOTAL STORAGE 654522

Q CFS	(2S/T)+O	STORAGE-DISCHRGE CURVE Y=MX+B:Q=M[(2S/T)+0]+Bq M	B
0.00	0.00	0.066	0.000
82.91	1254.78	0.090	-29.794
142.21	1915.03	0.084	-19.121
198.42	2582.26	0.051	67.873
265.10	3901.34		

DEPTH FT	Q = (M1 * DEPTH) + B1 M1	B1
0.00	82.91	0.000
1.00	118.60	-35.698
1.50	112.42	-26.421
2.00	66.69	65.048
3.00		

V. DEVELOP Qout HYDROGRAPH LOWER LAKE

ROUTING CURVE

TIME HOURS	INFLOW FROM UPPER LAKE CFS	INFLOW FROM BASIN CFS	TOTAL INFLOW CFS	2S/T - O	2S/T + O	UTFLOW O CFS	DEPTH FT
10.9	0.00	0.00	0.00	0	0	0.00	0.00
11.0	0.28	14.00	14.28	12.40	14.28	0.94	0.01
11.1	0.77	16.00	16.77	37.71	43.45	2.87	0.03
11.2	1.12	18.00	19.12	63.88	73.61	4.86	0.06
11.3	1.51	19.00	20.51	89.84	103.52	6.84	0.08
11.4	1.94	22.00	23.94	116.55	134.29	8.87	0.11
11.5	2.24	25.00	27.24	145.56	167.72	11.08	0.13
11.6	2.60	28.00	30.60	176.52	203.40	13.44	0.16
11.7	3.71	61.00	64.71	235.91	271.83	17.96	0.22
11.8	6.07	94.00	100.07	347.74	400.69	26.47	0.32
11.9	9.32	126.00	135.32	506.08	583.13	38.53	0.46
12.0	14.93	244.00	258.93	781.35	900.33	59.49	0.72
12.1	26.05	447.00	473.05	1301.07	1513.33	106.13	1.20
12.2	39.42	484.00	523.42	1948.68	2297.55	174.43	1.79
12.3	45.57	291.00	336.57	2388.94	2808.67	209.87	2.17
12.4	42.56	151.00	193.56	2488.17	2919.06	215.45	2.26
12.5	36.13	100.00	136.13	2397.20	2817.86	210.33	2.18
12.6	29.83	77.00	106.83	2237.47	2640.16	201.35	2.04
12.7	24.47	62.00	86.47	2059.46	2430.77	185.66	1.89
12.8	20.06	52.00	72.06	1882.53	2217.99	167.73	1.73
12.9	16.63	47.00	63.63	1716.42	2018.22	150.90	1.58
13.0	14.03	42.00	56.03	1565.84	1836.07	135.12	1.44
13.1	12.03	40.00	52.03	1432.80	1673.90	120.55	1.32
13.2	10.45	37.00	47.45	1316.61	1532.28	107.83	1.21
13.3	9.19	35.00	44.19	1214.87	1408.25	96.69	1.12
13.4	8.14	33.00	41.14	1126.22	1300.19	86.99	1.03
13.5	7.24	32.00	39.24	1047.15	1206.60	79.72	0.96
13.6	6.60	30.00	36.60	974.60	1123.00	74.20	0.89
13.7	6.15	29.00	35.15	908.08	1046.35	69.14	0.83
13.8	5.68	27.00	32.68	846.95	975.91	64.48	0.78
13.9	5.20	26.00	31.20	790.46	910.83	60.18	0.73
14.0	4.86	24.00	28.86	738.13	850.52	56.20	0.68

Area E

This section of the report contains the pre- and post-development runoff calculations for Area D, as designated in Figure 1 and 2 of this report. This area drains to the southwest towards Bates Road.

Prior to development, Area E consisted of about 37 acres of cultivated fields and woods. The drainage basin will be enlarged to approximately 41 acres during development. This combined with the construction of subdivision improvements will produce a slight increase in the post-development runoff volume. Pages E2-E5 present the runoff curve number calculations and the time of concentration calculations, and pages E6-E9 present the pre- and post-development tabular hydrographs for Area E.

As the calculations show, the 25 year, 24 stormwater runoff rate will be increased from 131 cfs to 137 cfs, and the 100-year, 24-hour runoff increases from 177 cfs to 186 cfs. However, the tiered lake system located near the center of Area D, which lies immediately upstream of Area E, provides sufficient stormwater detention to compensate for both Areas D and E. This lake system reduces the post-development outflow by approximately 200 cfs.

Area Summary

Storm Event	Pre-Development	Post-Development	Net Change
25-year, 24-hour	131 cfs	137 cfs	+ 6 cfs
100-year, 24-hour	177 cfs	186 cfs	+ 9 cfs

RUNOFF CURVE NUMBER COMPUTATION Version 2.00

Project : WINGHAVEN User: RLW Date: 05-05-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: PRE-DEVELOPMENT RUNOFF FOR AREA 'E'
Subarea : E

COVER DESCRIPTION		Hydrologic Soil Group A	B	C	D
			Acres (CN)		
FULLY DEVELOPED URBAN AREAS (Veg Estab.)					
Open space (Lawns,parks etc.)					
Fair condition; grass cover 50% to 75%		-	-	33.2(79)	-
OTHER AGRICULTURAL LANDS					
Woods	good	-	-	4.2(70)	-
Total Area (by Hydrologic Soil Group)				37.4	

SUBAREA: E TOTAL DRAINAGE AREA: 37.4 Acres WEIGHTED CURVE NUMBER: 78

E2

TIME OF CONCENTRATION AND TRAVEL TIME Version 2.00

Project : WINGHAVEN User: RLW Date: 05-05-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: PRE-DEVELOPMENT RUNOFF FOR AREA 'E'

---------- Subarea #1 - E ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	3.50	100	0.03	J					0.118
Shallow Concent'd		980	0.045	U					0.080
Open Channel		2320						5	0.129
								Time of Concentration =	0.33*
									=====

--- Sheet Flow Surface Codes ---

A Smooth Surface	F Grass, Dense	--- Shallow Concentrated ---
B Fallow (No Res.)	G Grass, Burmuda	--- Surface Codes ---
C Cultivated < 20 % Res.	H Woods, Light	P Paved
D Cultivated > 20 % Res.	I Woods, Dense	U Unpaved
E Grass-Range, Short	J Range, Natural	

* - Generated for use by TABULAR method

E3

RUNOFF CURVE NUMBER COMPUTATION Version 2.00

Project : WINGHAVEN User: RLW Date: 05-05-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: POST-DEVELOPMENT RUNOFF FOR AREA 'E'
Subarea : E

COVER DESCRIPTION	Hydrologic Soil Group A	B	C	D
	Acres (CN)			
FULLY DEVELOPED URBAN AREAS (Veg Estab.)				
Open space (Lawns,parks etc.)				
Good condition; grass cover > 75%	-	-	33.1(74)	-
Streets and roads				
Paved; curbs and storm sewers	-	-	0.7(98)	-
Residential districts Avg % imperv				
(by average lot size)				
1/8 acre (town houses) 65	-	-	6.2(90)	-
User defined urban (F9 to define)	-	-	0.4(98)	-
% impervious			100%	
% unconnected impervious			0%	
pervious curve number			82	
Total Area (by Hydrologic Soil Group)			40.4	
			====	

SUBAREA: E TOTAL DRAINAGE AREA: 40.4 Acres WEIGHTED CURVE NUMBER: 77

E4

TIME OF CONCENTRATION AND TRAVEL TIME Version 2.00

Project : WINGHAVEN User: RLW Date: 05-05-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: POST-DEVELOPMENT RUNOFF FOR AREA 'E'

---------- Subarea #1 - E ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	3.50	50	0.01	F					0.172
Shallow Concent'd		270	0.030	P					0.021
Open Channel		2800						5	0.156

Time of Concentration = 0.35*
=====

--- Sheet Flow Surface Codes ---

A Smooth Surface
B Fallow (No Res.)
C Cultivated < 20 % Res.
D Cultivated > 20 % Res.
E Grass-Range, Short
F Grass, Dense
G Grass, Burmuda
H Woods, Light
I Woods, Dense
J Range, Natural

--- Shallow Concentrated Surface Codes ---

P Paved
U Unpaved

* - Generated for use by TABULAR method

E5

TABULAR HYDROGRAPH METHOD Version 2.00

Project : WINGHAVEN User: RLW Date: 05-05-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: PRE-DEVELOPMENT RUNOFF FOR AREA 'E'

Total watershed area: 0.058 sq mi Rainfall type: II Frequency: 25 years

---------- Subareas ----------

	E
Area(sq mi)	0.06*
Rainfall(in)	5.7
Curve number	78*
Runoff(in)	3.32
Tc (hrs)	0.33*
(Used)	0.30
TimeToOutlet	0.00
Ia/P	0.10
(Used)	0.10

Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs) E
11.0	4	4
11.3	5	5
11.6	8	8
11.9	23	23
12.0	46	46
12.1	87	87
12.2	131P	131P
12.3	131	131
12.4	89	89
12.5	55	55
12.6	38	38
12.7	28	28
12.8	22	22
13.0	15	15
13.2	13	13
13.4	11	11
13.6	10	10
13.8	9	9
14.0	8	8
14.3	7	7
14.6	6	6
15.0	6	6
15.5	5	5
16.0	5	5
16.5	4	4
17.0	4	4
17.5	4	4
18.0	3	3
19.0	3	3
20.0	3	3
22.0	2	2
26.0	0	0

P - Peak Flow * - value(s) provided from TR-55 system routines

E6

TABULAR HYDROGRAPH METHOD Version 2.00

Project : WINGHAVEN User: RLW Date: 05-05-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: PRE-DEVELOPMENT RUNOFF FOR AREA 'E'

Total watershed area: 0.058 sq mi Rainfall type: II Frequency: 100 years

---------- Subareas ----------

	E
Area(sq mi)	0.06*
Rainfall(in)	7.0
Curve number	78*
Runoff(in)	4.47
Tc (hrs)	0.33*
(Used)	0.30
TimeToOutlet	0.00
Ia/P	0.08
(Used)	0.10

Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs) E
11.0	5	5
11.3	7	7
11.6	11	11
11.9	31	31
12.0	61	61
12.1	117	117
12.2	177P	177P
12.3	177	177
12.4	120	120
12.5	74	74
12.6	51	51
12.7	38	38
12.8	30	30
13.0	21	21
13.2	17	17
13.4	15	15
13.6	13	13
13.8	12	12
14.0	11	11
14.3	10	10
14.6	9	9
15.0	8	8
15.5	7	7
16.0	6	6
16.5	6	6
17.0	5	5
17.5	5	5
18.0	5	5
19.0	4	4
20.0	3	3
22.0	3	3
26.0	0	0

P - Peak Flow * - value(s) provided from TR-55 system routines

E7

TABULAR HYDROGRAPH METHOD Version 2.00

Project : WINGHAVEN User: RLW Date: 05-05-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: POST-DEVELOPMENT RUNOFF FOR AREA 'E'

Total watershed area: 0.063 sq mi Rainfall type: II Frequency: 25 years

---------- Subareas ----------

	E
Area(sq mi)	0.06*
Rainfall(in)	5.7
Curve number	77*
Runoff(in)	3.22
Tc (hrs)	0.35*
(Used)	0.30
TimeToOutlet	0.00
Ia/P	0.10

Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs) E
11.0	4	4
11.3	5	5
11.6	8	8
11.9	23	23
12.0	47	47
12.1	90	90
12.2	137P	137P
12.3	137	137
12.4	93	93
12.5	57	57
12.6	40	40
12.7	30	30
12.8	23	23
13.0	16	16
13.2	14	14
13.4	12	12
13.6	10	10
13.8	9	9
14.0	9	9
14.3	8	8
14.6	7	7
15.0	6	6
15.5	6	6
16.0	5	5
16.5	4	4
17.0	4	4
17.5	4	4
18.0	4	4
19.0	3	3
20.0	3	3
22.0	2	2
26.0	0	0

P - Peak Flow * - value(s) provided from TR-55 system routines

E8

TABULAR HYDROGRAPH METHOD Version 2.00

Project : WINGHAVEN User: RLW Date: 05-05-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: POST-DEVELOPMENT RUNOFF FOR AREA 'E'

Total watershed area: 0.063 sq mi Rainfall type: II Frequency: 100 years

---------- Subareas ----------

	E
Area(sq mi)	0.06*
Rainfall(in)	7.0
Curve number	77*
Runoff(in)	4.37
Tc (hrs)	0.35*
(Used)	0.30
TimeToOutlet	0.00
Ia/P	0.09
(Used)	0.10

Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs) E
11.0	6	6
11.3	8	8
11.6	11	11
11.9	33	33
12.0	65	65
12.1	123	123
12.2	186P	186P
12.3	186	186
12.4	126	126
12.5	78	78
12.6	54	54
12.7	40	40
12.8	31	31
13.0	22	22
13.2	18	18
13.4	16	16
13.6	14	14
13.8	13	13
14.0	12	12
14.3	10	10
14.6	9	9
15.0	9	9
15.5	8	8
16.0	7	7
16.5	6	6
17.0	6	6
17.5	5	5
18.0	5	5
19.0	4	4
20.0	4	4
22.0	3	3
26.0	0	0

P - Peak Flow * - value(s) provided from TR-55 system routines

Area F

Area F will not be substantially modified as part of the currently planned subdivision and golf course improvements. Therefore, this area is not evaluated for pre- and post-devlopment runoff in this report. Should additional development occur in this area at a later date, it will be necessary to perform a detailed analysis at that time.

Area G

This section of the report contains the pre- and post-development runoff calculations for Area G, as designated in Figures 1 and 2. This area also drains to Dardenne Creek across the west property line.

Prior to development, the Area G drainage basin consisted of roughly 16.4 acres of fallow fields and woods. This area will be slightly reduced during development, encompassing roughly 15.7 acres of golf course. Pages G2-G5 of this report present the pre- and post-development runoff curve number and time of concentration calculations. This data details the effects of converting woods and open fields to golf course. Page G6-G9 present the results of the tabular hydrograph calculations for pre- and post-development conditions for the 25 year, 24 hour and 100-year, 24-hour storm events.

The results indicate the 25-year outflow will be *decreased* from 59 cfs to 48 cfs, and the 100-year outflow from 83 cfs to 67 cfs.

Area Summary

Storm Event	Pre-Development	Post-Development	Net Change
25-year, 24-hour	59 cfs	48 cfs	- 11 cfs
100-year, 24-hour	83 cfs	67 cfs	- 16 cfs

RUNOFF CURVE NUMBER COMPUTATION Version 2.00

Project : WINGHAVEN User: RLW Date: 05-08-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: PRE-DEVELOPMENT RUNOFF FOR AREA 'G'
Subarea : G

COVER DESCRIPTION		Hydrologic Soil Group A	B	C	D
			Acres (CN)		
FULLY DEVELOPED URBAN AREAS (Veg Estab.)					
Open space (Lawns,parks etc.)					
Good condition; grass cover > 75%		-	-	15.0(74)	-
OTHER AGRICULTURAL LANDS					
Woods	good	-	-	1.4(70)	-
Total Area (by Hydrologic Soil Group)				16.4	

SUBAREA: G TOTAL DRAINAGE AREA: 16.4 Acres WEIGHTED CURVE NUMBER: 74

TIME OF CONCENTRATION AND TRAVEL TIME Version 2.00

Project : WINGHAVEN User: RLW Date: 05-08-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: PRE-DEVELOPMENT RUNOFF FOR AREA 'G'

Subarea #1 - G

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	3.50	100	0.04	B					0.049
Shallow Concent'd		325	0.037	U					0.029
Open Channel		1212						5	0.067
								Time of Concentration =	0.15*

--- Sheet Flow Surface Codes ---

A Smooth Surface	F Grass, Dense	--- Shallow Concentrated ---	
B Fallow (No Res.)	G Grass, Burmuda	---	Surface Codes ---
C Cultivated < 20 % Res.	H Woods, Light		P Paved
D Cultivated > 20 % Res.	I Woods, Dense		U Unpaved
E Grass-Range, Short	J Range, Natural		

* - Generated for use by TABULAR method

TABULAR HYDROGRAPH METHOD Version 2.00

Project : WINGHAVEN User: RLW Date: 05-08-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: PRE-DEVELOPMENT RUNOFF FOR AREA 'G'

Total watershed area: 0.026 sq mi Rainfall type: II Frequency: 25 years

---------- Subareas ----------

	G
Area(sq mi)	0.03*
Rainfall(in)	5.7
Curve number	74*
Runoff(in)	2.93
Tc (hrs)	0.15*
(Used)	0.20
TimeToOutlet	0.00
Ia/P	0.12

Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs) G
11.0	2	2
11.3	2	2
11.6	3	3
11.9	14	14
12.0	28	28
12.1	54	54
12.2	59P	59P
12.3	36	36
12.4	19	19
12.5	13	13
12.6	10	10
12.7	8	8
12.8	7	7
13.0	5	5
13.2	5	5
13.4	4	4
13.6	4	4
13.8	3	3
14.0	3	3
14.3	3	3
14.6	3	3
15.0	2	2
15.5	2	2
16.0	2	2
16.5	2	2
17.0	2	2
17.5	2	2
18.0	1	1
19.0	1	1
20.0	1	1
22.0	1	1
26.0	0	0

P - Peak Flow * - value(s) provided from TR-55 system routines

TABULAR HYDROGRAPH METHOD Version 2.00

Project : WINGHAVEN User: RLW Date: 05-08-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: PRE-DEVELOPMENT RUNOFF FOR AREA 'G'

Total watershed area: 0.026 sq mi Rainfall type: II Frequency: 100 years

---------- Subareas ----------

	G
Area(sq mi)	0.03*
Rainfall(in)	7.0
Curve number	74*
Runoff(in)	4.04
Tc (hrs)	0.15*
(Used)	0.20
TimeToOutlet	0.00
Ia/P	0.10

Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs) G
11.0	2	2
11.3	3	3
11.6	5	5
11.9	22	22
12.0	42	42
12.1	77	77
12.2	83P	83P
12.3	50	50
12.4	26	26
12.5	17	17
12.6	13	13
12.7	11	11
12.8	9	9
13.0	7	7
13.2	6	6
13.4	6	6
13.6	5	5
13.8	5	5
14.0	4	4
14.3	4	4
14.6	3	3
15.0	3	3
15.5	3	3
16.0	2	2
16.5	2	2
17.0	2	2
17.5	2	2
18.0	2	2
19.0	2	2
20.0	1	1
22.0	1	1
26.0	0	0

P - Peak Flow * - value(s) provided from TR-55 system routines

RUNOFF CURVE NUMBER COMPUTATION Version 2.00

Project : WINGHAVEN User: RLW Date: 05-08-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: POST-DEVELOPMENT RUNOFF FOR AREA 'G'
Subarea : G

COVER DESCRIPTION	Hydrologic Soil Group A	B	C	D
	Acres (CN)			
FULLY DEVELOPED URBAN AREAS (Veg Estab.)				
Open space (Lawns,parks etc.)				
Good condition; grass cover > 75%	-	-	15.7(74)	-
Total Area (by Hydrologic Soil Group)			15.7	

SUBAREA: G TOTAL DRAINAGE AREA: 15.7 Acres WEIGHTED CURVE NUMBER: 74

G6

TIME OF CONCENTRATION AND TRAVEL TIME Version 2.00

Project : WINGHAVEN User: RLW Date: 05-08-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: POST-DEVELOPMENT RUNOFF FOR AREA 'G'

---------- Subarea #1 - G ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	3.50	100	0.04	F					0.172
Shallow Concent'd		265	0.030	U					0.026
Open Channel		1140						5	0.063
								Time of Concentration =	0.26*
									=====

--- Sheet Flow Surface Codes ---

A Smooth Surface	F Grass, Dense	--- Shallow Concentrated ---
B Fallow (No Res.)	G Grass, Burmuda	--- Surface Codes ---
C Cultivated < 20 % Res.	H Woods, Light	P Paved
D Cultivated > 20 % Res.	I Woods, Dense	U Unpaved
E Grass-Range, Short	J Range, Natural	

* - Generated for use by TABULAR method

TABULAR HYDROGRAPH METHOD Version 2.00

Project : WINGHAVEN User: RLW Date: 05-08-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: POST-DEVELOPMENT RUNOFF FOR AREA 'G'

Total watershed area: 0.025 sq mi Rainfall type: II Frequency: 25 years

---------- Subareas ----------

	G
Area(sq mi)	0.02*
Rainfall(in)	5.7
Curve number	74*
Runoff(in)	2.93
Tc (hrs)	0.26*
(Used)	0.30
TimeToOutlet	0.00
Ia/P	0.12

Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs) G
11.0	1	1
11.3	2	2
11.6	3	3
11.9	8	8
12.0	15	15
12.1	31	31
12.2	47	47
12.3	48P	48P
12.4	33	33
12.5	21	21
12.6	14	14
12.7	11	11
12.8	8	8
13.0	6	6
13.2	5	5
13.4	4	4
13.6	4	4
13.8	3	3
14.0	3	3
14.3	3	3
14.6	3	3
15.0	2	2
15.5	2	2
16.0	2	2
16.5	2	2
17.0	2	2
17.5	1	1
18.0	1	1
19.0	1	1
20.0	1	1
22.0	1	1
26.0	0	0

P - Peak Flow * - value(s) provided from TR-55 system routines

TABULAR HYDROGRAPH METHOD Version 2.00

Project : WINGHAVEN User: RLW Date: 05-08-98
County : ST. CHARLES State: MO Checked: ____ Date: _____
Subtitle: POST-DEVELOPMENT RUNOFF FOR AREA 'G'

Total watershed area: 0.025 sq mi Rainfall type: II Frequency: 100 years

	Subareas
	G
Area(sq mi)	0.02*
Rainfall(in)	7.0
Curve number	74*
Runoff(in)	4.04
Tc (hrs)	0.26*
(Used)	0.30
TimeToOutlet	0.00
Ia/P	0.10

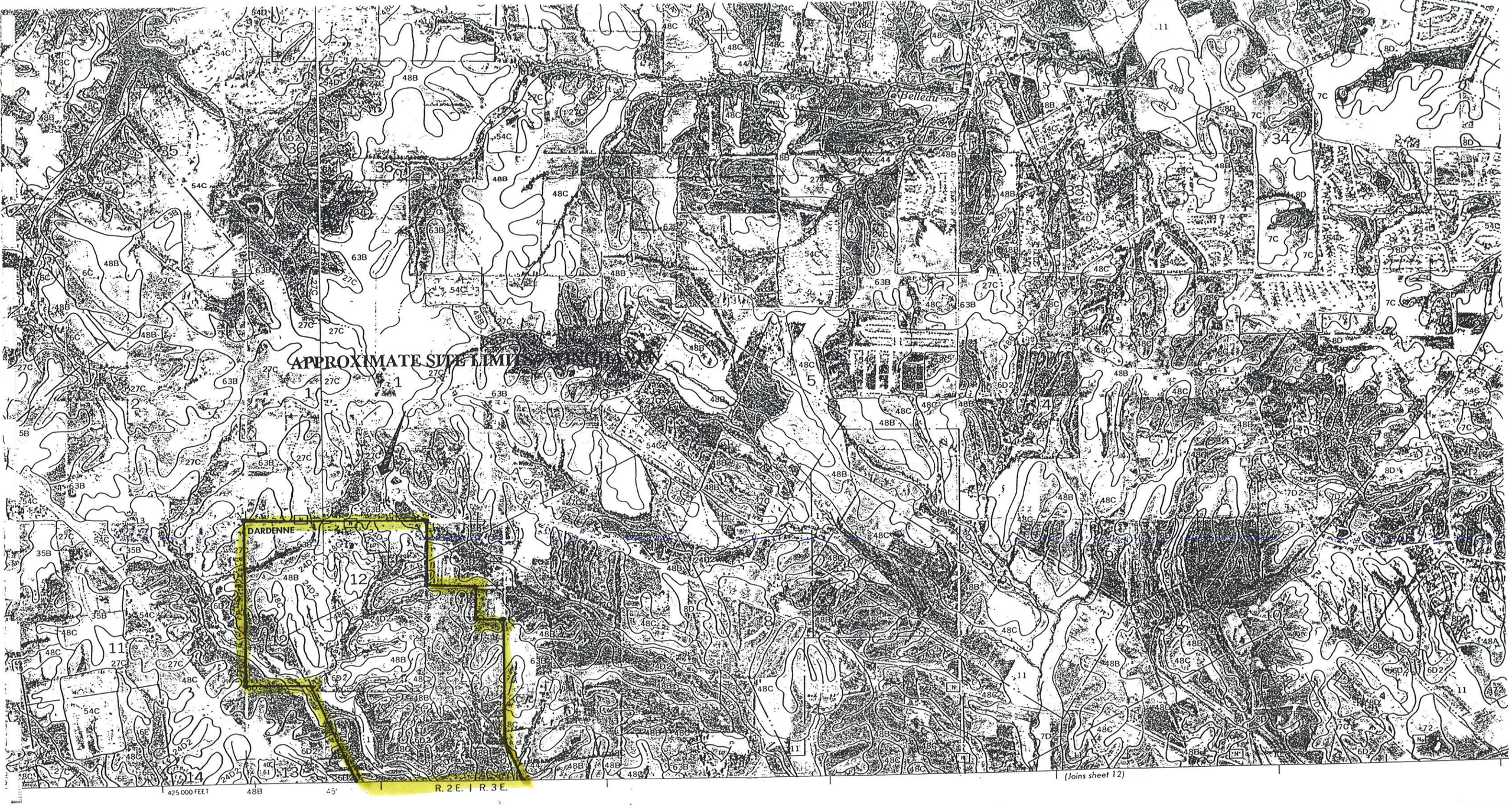
Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs) G
11.0	2	2
11.3	3	3
11.6	4	4
11.9	12	12
12.0	23	23
12.1	44	44
12.2	67P	67P
12.3	67	67
12.4	46	46
12.5	28	28
12.6	19	19
12.7	14	14
12.8	11	11
13.0	8	8
13.2	7	7
13.4	6	6
13.6	5	5
13.8	5	5
14.0	4	4
14.3	4	4
14.6	3	3
15.0	3	3
15.5	3	3
16.0	2	2
16.5	2	2
17.0	2	2
17.5	2	2
18.0	2	2
19.0	2	2
20.0	1	1
22.0	1	1
26.0	0	0

P - Peak Flow * - value(s) provided from TR-55 system routines

Conclusions

The planned improvements in the Winghaven site will significantly increase the post-development runoff volume in four of the seven major drainage basins. However, the net change in runoff volume for the entire Winghaven site reinains signifcantly less than pre-development levels. This is due to the fact that dramatic reductions in post-development runoff volume from Areas B, C, and D are more than adequate to offset the increases from the remainder of the Winghaven site. The following table presents a summarization of the net change in pre- and post-development runoff volume for the entire site for the 25-year, 24-hour storm event.

Area I.D.	A	B	C	D	E	F	G	Total
Pre-Development (cfs)	119	699	187	404	131	224	205	1969
Post-Development (cfs)	160	637	61	171	137	231	365	1762
Net Change (cfs)	+41	- 62	-126	-233	+6	+7	+160	-207



N

This map was compiled by U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies on 1980 orthophotography obtained from U.S. Department of the Interior, Geological Survey.

1 3/4 1/2 1/4 0 1 2 MILES

1 0.5 0 2 KILOMETERS

Scale 1:24000

ST. CHARLES COUNTY, MISSOURI NO. 6

SOILS MAP
FIGURE 3

SOIL LEGEND

Map symbols consist of numbers or a combination of numbers and letters. The initial numbers represent the kind of soil. A capital letter following these numbers indicates the class of slope. Symbols without a slope letter are for nearly level soils or miscellaneous areas. A final number of 2 following the slope letter indicates that the soil is moderately eroded.

SYMBOL	NAME
2D	Goss silt loam, 5 to 14 percent slopes
2F	Goss cherty silt loam, 14 to 35 percent slopes
3	Twomile silt loam
4D	Menfro-Goss silt loams, 9 to 14 percent slopes
6C	Crider silt loam, 5 to 9 percent slopes
6D2	Crider silt loam, 9 to 14 percent slopes, eroded
6E	Crider silt loam, 14 to 20 percent slopes
7B	Menfro silt loam, 2 to 5 percent slopes
7C	Menfro silt loam, 5 to 9 percent slopes
7D2	Menfro silt loam, 9 to 14 percent slopes, eroded
7E2	Menfro silt loam, 14 to 20 percent slopes, eroded
7F	Menfro silt loam, 20 to 30 percent slopes
8C	Winfield silt loam, 5 to 9 percent slopes
8D	Winfield silt loam, 9 to 14 percent slopes
8E2	Winfield silty clay loam, 14 to 20 percent slopes, eroded
9E	Holstein loam, 14 to 35 percent slopes
10F	Gasconade-Rock outcrop complex, 15 to 50 percent slopes
11	Dockery silt loam
12	Kennebec silt loam
13	Auxvasse silt loam
22F	Gatewood-Gasconade-Crider complex, 15 to 50 percent slopes
24D2	Keswick silt loam, 9 to 14 percent slopes, eroded
27C	Armster silt loam, 5 to 9 percent slopes
31C	Hatton silt loam, 5 to 9 percent slopes
34E	Lindley loam, 14 to 20 percent slopes
35B	Mexico silt loam, 1 to 5 percent slopes
37	Marion silt loam
40	Westerville silt loam
41	Freeburg silt loam
43	Cedargap silt loam
44	Sensabaugh silt loam
48A	Weller silt loam, 0 to 2 percent slopes
48B	Weller silt loam, 2 to 5 percent slopes
48C	Weller silt loam, 5 to 9 percent slopes
54C	Harvester-Urban land complex, 2 to 9 percent slopes
54D	Harvester-Urban land complex, 9 to 14 percent slopes
62	Edinburg silty clay loam
63B	Herrick silt loam, 2 to 5 percent slopes
67E	Menfro silt loam, karst, 5 to 20 percent slopes
70	Booker clay
71	Waldron silty clay
72	Blake silty clay loam
73	Haynie silt loam
74	Carr fine sandy loam
75	Hodge loamy fine sand
76	Haynie-Blake complex
77	Hodge-Blake complex
79	Dupo silt loam
80	Portage clay
81	Haymond silt loam
82	Chequest silt loam
83	Lomax loam
84	Blase silty clay loam
85	Carlow silty clay loam
86	Kampville silt loam
90	Hurst silt loam
91	Pits, quarries

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- State
- County
- Reservation (wildlife area)
- Land grant
- Neatline

AD HOC BOUNDARY (label)

- Cemetery

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections)

ROAD EMBLEMS & DESIGNATIONS

- Interstate (70)
- Federal (67)
- State (94)
- County (N)

LEVEES

DAMS

- Large (to scale)
- Medium or small (water, w)

PITS

- Mine or quarry

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Drainage ditch

LAKES, PONDS AND RESERVOIRS (water, w, int, i)

- Perennial
- Intermittent

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS (2F, 24D2)

SHORT STEEP SLOPE

DEPRESSION OR SINK

MISCELLANEOUS

- Gravelly spot
- Sandy spot

SOIL MAP KEY

FIGURE 4

HIGHWAY N

POST ROAD

AREA A
31.02 ACRES

AREA B
190.56 ACRES

AREA C
51.43 ACRES

AREA D
84.77 ACRES

AREA E
40.43 ACRES

AREA F
54.13 ACRES

N

SCALE: 1" = 300'

300 0 300 600

WINGHAVEN
POSTDEVELOPMENT DRAINAGE BASINS

Kuhlmann Design Group, Inc.

15 E. Washington
Belleville, IL 62220-1421
Tel: (618) 234-6898

Belleville, Illinois
St. Louis, Missouri
St. Charles, Missouri

KDG

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NO.	DATE	

PROJECT NO.	CONTRACT NO.
970231	0002
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BSM	DLK

DATE
MAY 4, 1998

FIGURE 2

HIGHWAY N

POST ROAD

AREA G
16.4 ACRES

AREA B
214.08 ACRES

AREA A
28.72 ACRES

AREA D
87.02 ACRES

AREA C
40.18 ACRES

AREA E
37.42 ACRES

AREA F
52.5 ACRES

N

SCALE: 1" = 300'

300 0 300 600

WINGHAVEN
PREDEVELOPMENT DRAINAGE BASINS

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KdG

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DATE
MAY 29, 1998

FIGURE 1