Drainage Study
for:
Hawthorne Estates
Vanderburgh Co. Indiana

April 7, 2004

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DRAINAGE CALCULATIONS FOR HAWTHORNE ESTATES
SEIB ROAD
VANDERBURGH COUNTY, INDIANA

SITE LOCATION:

The proposed site is located on the west side of Seib Road, between Boonville-New Harmony Road and Kansas Road.

GENERAL NOTES:

The proposed development will have 103 Lots with two lakes situated on 39.93 acres

EXISTING CONDITIONS:

Previous Use: Agricultural and one residence with associated structures.

Gross Area = 39.93 Acres

EXISTING DRAINAGE PATTERN:

There is a prominent ditch that drains the watershed of this development that flows from the Northeast corner of the site to the Southwest corner of the site. This ditch is fed by smaller swales and ditches , enter at various locations as indicated by the existing topographic map.

By review of County Planametric and GIS maps it was determined that the proposed development is part of a 70 acre watershed. 19.75 acres of this watershed drains from offsite and enters via a ditch entering from the north. 13.4 acres of this watershed drains from offsite and enters via a 24 inch culvert under Seib Road entering from the east. 0.90 acre drains from offsite overland from the north onto the site, 0.6 acres drains from offsite overland from the west and 1.38 acres drains from offsite overland from the south.

1.73 acres, located at the Northwest corner does not enter this ditch and discharges overland to the north. An additional 2.43 acres, located at the southeast corner, also does not enter this ditch and drains to an area drain located on the common lot line of lots 57 and 58 of Eagle Crossing Subdivision Section 2, Plat Book P, Page 96.

By examination of satellite photos of this area a more detailed breakdown of existing land use was possible. Those land uses were as follows:

Existing Watershed Geometry:

Area: 70.0 Acres (gross)

Existing Structures = 0.06 acres	C= 0.98
Existing Residential Lawn and Landscape = 5.01 acres	C=0.15
Existing Roads and Drives = 1.16 acres	C=0.85

Existing Wooded areas = 22.58 (slopes of 5% to 10%) C=0.36
Existing Agricultural = 41.19 acres (slopes of 2% to 5%) C=0.35

All undeveloped runoff coefficients were taken from the Vanderburgh County Drainage Ordinance with the exception of the runoff coefficient for Roads and Drives. This area is a combination of surfaces including: asphalt roadways, concrete driveways, gravel driveways and gravel roads. It was thus determined to use a more conservative value of 0.85 for the runoff coefficient.

$$\frac{(0.06*0.98)+(5.01*0.15)+(1.16*0.85)+(22.58*0.36)+(41.19*0.35)}{70.0}$$

The Undeveloped Runoff Coefficient = 0.35

L = 3262 feet
H = 464-403 = 61 feet
t_c = 18 minutes as per attached nomograph

From the Rainfall Intensity as per Vanderburgh County Drainage Ordinance
i = 4.257"/hour for a 10 year storm, 4.756"/hr for a 25 year storm and 5.877"/hr for the 100 year storm.

Q for the 10 year storm = CiA = 0.35 * 4.257 * 70 = 104.297 CFS
Q for the 25 year Storm = CiA = 0.35 * 4.756 * 70 = 116.522 CFS
Q for the 100 year Storm = CiA = 0.35 * 5.877 * 70.0 = 143.987 CFS

Proposed Watershed Geometry:

Total area = 39.93 Acres

New Structures = 103 lots x 4000 sf/ea = 412,000 SF = 9.458 acres	C=0.98
Private driveways = 103 lots x 16' x 35.5' = 58,504 SF = 1.343 acres	C=0.96
Patios and walks = 103 lots x 1000sf/ea = 103,000 SF = 2.365 acres	C=0.92
Roadways = 188,336.326 SF = 4.324 acres	C=0.95
Sidewalks = 45,781 SF = 1.051 acres	C=0.95
Yard Area = 18.798 acres	C=0.25
Lakes = 112,845.759 SF = 2.591 acres	C=1.00

Developed runoff coefficient =

$$\frac{(9.458*0.98)+(1.343*0.96)+(2.365*0.92)+(4.324*0.95)+(1.051*0.95)+(18.798*0.25)+(2.591*1.0)}{39.93}$$

Developed runoff coefficient = 0.63

SEE FORM 800 - ATTACHED TO THIS REPORT

The proposed retention facility must be able to allow the discharge of the undeveloped Q for the 10 year event (104.294 CFS) and yet "demonstrate clearly that the post development peak rate of storm water runoff during a twenty-five (25) year return period storm is controlled sufficiently so that it will not exceed the peak runoff rate from the same Project site in its pre development condition during a ten (10) year return period

storm."

It is the developers desire to install a retention lake as indicated on the plans. This lake will be fed by the major ditch which drains the watershed. A two stage weir is proposed with the first weir allowing the 10 year developed storm to pass (104.294 CFS). The second stage of the weir would allow the 25 year developed storm (149.04 CFS- see below) for the entire storm to pass.

Detention will be provided by the creation of new 1.87 acre lake (this is the down stream lake). This lake will be created by excavating along approximately 670 lineal feet of the existing ditch and installing a low earthen dam at the southern end as indicated on plans. The normal or low water elevation will be 408.00. The detention or high water elevation will be 409.55. This provides for 117,144.36 cubic feet of storage (116,537.22 required).

The outlet control for the proposed lake will be provided by a concrete weir box. This design has been used by this office successfully in Warrick County, Indiana at Copper Creek Subdivision on Bell Road, the conceptual design of which was reviewed and approved by Morley and Associates and Commonwealth Engineering This structure allows for 3 separate weirs to function along the sides of a square structure located within the lake. An outlet pipe than carries the weir discharge to an existing ditch or creek.

The required weir to pass the 10 year event must be capable of passing 34.76 CFS, as stated above. Computer analysis indicates the following:

WEIRS

Enter up to 10 weirs.
Enter <Return> only for flowrate and length to end.

FLOWRATE (CFS)	LENGTH (FT)	COEFF (-)	HEAD (FT)
34.76	6.8	2.630	1.55

The outlet control structure will then have 3 weirs with a combined length of 20.4 feet. Normal or low water elevation has been set at 408.00 and an allowable head of 1.55 feet to prevent water from backing up into the storm water systems that will be discharging into the lake. Therefore, the highwater, or detention elevation will be 408.0 + 1.55 = 409.55

The top of the Outlet Control Structure must have sufficient area to pass the 25 and 100 year event.

SERIES 100 - STORM SEWERS - 5.24 CFS
SERIES 200 - STORM SEWERS - 14.13 CFS
SERIES 400 - STORM SEWERS - 85.47 CFS (This includes offsite areas 100 and 101)
SERIES 500 - STORM SEWERS - 25.54 CFS
LAKE 2 - 18.66 CFS

TOTAL = 149.04 CFS - 25 YEAR STORM

SERIES 100 - STORM SEWERS - 6.47 CFS
SERIES 200 - STORM SEWERS - 17.45 CFS
SERIES 400 - STORM SEWERS - 106.3 CFS (This includes offsite areas 100 and 101)
SERIES 500 - STORM SEWERS - 31.54 CFS
LAKE 2 - 23.67 CFS

TOTAL = 185.41 CFS - 100 YEAR STORM

The release box will require a minimum inside width of 7.5 feet to provide the 6.8 feet weirs. This results in a box with an opening of 56.25 SF. Utilizing the formula below, the head can be solved to determine the the water elevation during the 100 year event.

Q= 0.6 A * √2GH, where

A = area of orifice
G = gravity (32.2)
H = head

$$185.41 = 0.6 * 56.25 * (\sqrt{2 * 32.2 * H}$$

H = 0.47 feet. Therefore, the highwater elevation for the 100 year event = 409.55 + 0.47 = 410.02, say 410. This assumes that the weirs are clogged. If the weirs remain open and operational and passing the allowed 104.297 CFS, the lake will raise only another 0.13 feet with the top of the box acting as an orifice.

The discharge pipe out of the Outlet Control Structure has been sized to pass the 25 year event based on the following:

SEWER PIPES

Enter up to 10 pipes.
Enter <Return> only for flowrate and diameter to end.

FLOWRATE (CFS)	DIAMETER (IN)	FRICTION (FT^1/6)	SLOPE (%)	VELOCITY (FPS)
149.04	54.00	0.0130	0.74	10.30

The elevation of the top of the dam has been set at 412.00 and an emergency spillway provided adjacent to the proposed outlet structure. The spillway will have a width of 40 feet and a head of 1.35 based on the following computer analysis:

WEIRS

Enter up to 10 weirs.
Enter <Return> only for flowrate and length to end.

FLOWRATE (CFS)	LENGTH (FT)	COEFF (-)	HEAD (FT)
185.41	40.0	2.700	1.43

Setting the spillway elevation equal to the highwater elevation for the 100 year event (410.0) and adding 1.43 feet for the required head results in a water elevation equal to 411.43 feet. This provides for 0.57 feet of required freeboard during the 100 year event.

The channel to carry the 100 year storm to the headwall in Eagle Crossing is designed based on the

following:

MAN-MADE CHANNELS

VARIABLES LIST:
Y - FLOW DEPTH B - CHANNEL BOTTOM WIDTH S - CHANNEL SLOPE
Q - FLOWRATE M - CHANNEL SIDE SLOPE N - CHANNEL ROUGHNESS

VARIABLE TO BE SOLVED (Y,Q,B,M,S OR N) ? B

Y (FT) ? 1.35
Q (CFS) ? 167
M (FT/FT) ? 3
S (FT/FT) ? 0.027
N (FT^1/6) ? 0.035

RESULTS
==========
B= 12.94 FT
A= 24.63 SF
P= 21.98 FT
V= 7.53 FPS
F= 1.07 SUPER-CRITICAL FLOW

The spillway channel is 16 foot wide at the base with 3 to 1 side slopes with a the bottom slope equal to 2.70%. This will be a grass lined channel with North American Green C125 Erosion Control Mats installed with Staple pattern D.

SUB-DRAINAGE AREA Off-site 100

AREA 860,336

Description	Area (S.F.)	C	n
WOODLAND	457,114	0.24	0.60
PAVEMENT	19,380	0.94	0.02
STRUCTURES	2400	0.94	0.02
GRAVEL DRIVE	2390	0.70	0.10
AGRICULTURAL	160,619	0.35	0.20
GREEN SPACE	218,433	0.15	0.40
	0		

Cd 0.2510233

nd 0.45847204

Length of watershed (L) 1547
Height of watershed (H) 39
Slope of watershed (H/L)= 0.02521008

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467} =$ 41.885

i_{25} 3.04

Q=ciA= 15.07189442

i_{100} 3.837

Q_{100}=ciA= 19.02330884

n*L= 709.25624588

$\sqrt{S}$= 0.15877682

n*L/$\sqrt{S}$= 4467.00120257

SUB-DRAINAGE AREA Off-site 101

AREA 585,105

Description	Area (S.F.)	C	n
AGRICULTURAL	526,594.50	0.50	0.20
WOODLAND	58510.50	0.36	0.60

Cd 0.486

nd 0.24

Length of watershed (L) 1274
Height of watershed (H) 78
Slope of watershed (H/L)= 0.06122449

$t_c = 0.827\{(n*L)/\sqrt{S}\}^{0.467}$ = 22.984

i_{25} 4.295

Q=ciA= 28.03789311

i_{100} 5.350

Q_{100}=ciA= 34.92496581

n*L= 305.76

$\sqrt{S}$= 0.24743583

n*L/$\sqrt{S}$= 1235.71432642

SUB-DRAINAGE AREA 101

AREA 65297.8488

Houses	21000	C=	0.95	n=	0.02
Patios & Walks	9000	C=	0.95	n=	0.02
Roads	12138.2422	C=	0.95	n=	0.02
Sidewalks	1960.7804	C=	0.95	n=	0.02
Greenspace	21198.8262	C=	0.25	n=	0.40

Cd 0.72274629

nd 0.1433663

Length of watershed (L) 803

Height of watershed (H) 24.9

Slope of watershed (H/L)= 0.03100872

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467}$ = 17.073

i_{25} 4.841

Q=ciA= 5.24483653

n*L= 115.1231389

$\sqrt{S}$ = 0.17609293

$n*L/\sqrt{S}$ = 653.76354917

i_{100} 5.975

Q_{100}=ciA= 6.47343488

SUB-DRAINAGE AREA 200

AREA 17033.6450

Houses	0	C= 0.95	n= 0.02
Patios & Walks	0	C= 0.95	n= 0.02
Roads	10970.7644	C= 0.95	n= 0.02
Sidewalks	2257.3032	C= 0.95	n= 0.02
Greenspace	3805.5774	C= 0.15	n= 0.40

Cd 0.77126774

nd 0.10489782

Length of watershed (L) 610.1705
Height of watershed (H) 9.01
Slope of watershed (H/L)= 0.01476636

tc= $0.827\{(n*L)/\sqrt{S}\}^{0.467}$ = 15.434

i_{25} 4.993

Q=ciA= 1.50586644

n*L= 64.00555528

$\sqrt{S}$= 0.12151691

n*L/$\sqrt{S}$= 526.72138618

i_{100} 6.148

Q_{100}=ciA= 1.85420926

CIA =
.77 x 5.0 x 0.4 =

.77
x 5
3.85
.04
1440

SUB-DRAINAGE AREA 201

AREA 10273.9270

Houses	0	C= 0	n= 0
Patios & Walks	0	C= 0	n= 0
Roads	6194.7857	C= 0.95	n= 0.02
Sidewalks	1541.3348	C= 0.95	n= 0.02
Greenspace	2537.8065	C= 0.15	n= 0.40

Cd 0.75238859

nd 0.11386542

Length of watershed (L) 428.6382

Height of watershed (H) 5.36

Slope of watershed (H/L)= 0.01250472

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467} =$ 14.137

i_{25} 5.187

Q=ciA= 0.92046452

n*L= 48.80706867

$\sqrt{S}$ = 0.11182451

$n*L/\sqrt{S}$ = 436.46127911

i_{100} 6.355

Q_{100}=ciA= 1.12773318

SUB-DRAINAGE AREA 202

AREA 15693.0113

Houses	3500	C= 0.95	n= 0.02
Patios & Walks	1500	C= 0.95	n= 0.02
Roads	0	C= 0	n= 0
Sidewalks	0	C= 0	n= 0
Greenspace	10693.0113	C= 0.25	n= 0.40

Cd 0.47302922

nd 0.278927

Length of watershed (L) 173.7932
Height of watershed (H) 6
Slope of watershed (H/L)= 0.03452379

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467}$ = 11.117

i_{25} 5.726

Q=ciA= 0.97579307

n*L= 48.4756159
$\sqrt{S}$= 0.18580579
$n*L/\sqrt{S}$= 260.89400067

i_{100} 6.918

Q_{100}=ciA= 1.17892708

SUB-DRAINAGE AREA 203

AREA 36698.7170

Houses	7000	C= 0.95	n= 0.02
Patios & Walks	3000	C= 0.95	n= 0.02
Roads	0	C= 0	n= 0
Sidewalks	0	C= 0	n= 0
Greenspace	26698.717	C= 0.25	n= 0.40

Cd 0.44074236

nd 0.29645415

Length of watershed (L) 355.7256
Height of watershed (H) 17
Slope of watershed (H/L)= 0.04778964

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467}$ = 14.813

i_{25} 5.066

Q=ciA= 1.88110479

n*L= 105.45633038
$\sqrt{S}$ = 0.21860842
$n*L/\sqrt{S}$ = 482.39830094

i_{100} 6.229

Q_{100}=ciA= 2.31294941

SUB-DRAINAGE AREA 204

AREA 18125.9269

Houses	2625	C=	0.95	n=	0.02
Patios & Walks	1125	C=	0.95	n=	0.02
Roads	5282.6428	C=	0.95	n=	0.02
Sidewalks	1284.3668	C=	0.95	n=	0.02
Greenspace	7808.9173	C=	0.25	n=	0.40

Cd 0.64842965

nd 0.18370962

Length of watershed (L) 327.1663
Height of watershed (H) 17.07
Slope of watershed (H/L)= 0.0521753

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467} =$ 11.162

i_{25} 5.718

Q=ciA= 1.5428346

n*L= 60.10359665
$\sqrt{S}$= 0.22841913
$n*L/\sqrt{S}$= 263.12855955

i_{100} 6.909

Q_{100}=ciA= 1.86419102

SUB-DRAINAGE AREA 205

AREA 8958.1094

Houses	0	C= 0	n= 0
Patios & Walks	0	C= 0	n= 0
Roads	5344.8563	C= 0.95	n= .02
Sidewalks	1322.1260	C= 0.95	n= 0.02
Greenspace	2291.1271	C= 0.25	n= 0.40

Cd 0.77096792

nd 0.11718884

Length of watershed (L) 348.0812
Height of watershed (H) 17.07
Slope of watershed (H/L)= 0.04904028

$t_c = 0.827\{(n*L)/\sqrt{S}\}^{0.467}$ = 9.449

i_{25} 6.066

Q=ciA= 0.96176109

n*L= 40.79123205
$\sqrt{S}$ = 0.2214504
$n*L/\sqrt{S}$ = 184.20030874

i_{100} 7.274

Q_{100}=ciA= 1.15328885

SUB-DRAINAGE AREA 206

AREA 43762.7932

Houses	13125	C= 0.95	n= 0.02
Patios & Walks	5625	C= 0.95	n= 0.02
Roads	0	C= 0	n= 0
Sidewalks	0	C= 0	n= 0
Greenspace	25012.7932	C= 0.25	n= 0.40

Cd 0.5499123

nd 0.23719047

Length of watershed (L) 397.7158
Height of watershed (H) 19.0
Slope of watershed (H/L)= 0.04777281

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467} =$ 14.063

i_{25} 5.200

Q=ciA= 2.87285654

n*L= 94.33439753

$\sqrt{S}$= 0.21856992

$n*L/\sqrt{S}$= 431.59826169

i_{100} 6.369

Q_{100}=ciA= 3.51869679

SUB-DRAINAGE AREA 207

AREA 7694.1390

Houses	0	C= 0	n= 0
Patios & Walks	0	C= 0	n= 0
Roads	4455.4258	C= 0.95	n= 0.02
Sidewalks	1227.9824	C= 0.95	n= 0.02
Greenspace	2010.7308	C= 0.25	n= 0.40

Cd 0.76706705

nd 0.11930646

Length of watershed (L) 236.2127
Height of watershed (H) 8.710
Slope of watershed (H/L)= 0.03687355

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467} = 8.498$

i_{25} 6.310

$Q = ciA =$ 0.85493844

n*L= 28.18170104
$\sqrt{S}$= 0.19202487
$n*L/\sqrt{S}$= 146.76068282

i_{100} 7.529

$Q_{100} = ciA =$ 1.02010008

SUB-DRAINAGE AREA 208

AREA 23549.5158

Houses	4375	C= 0.95	n= 0.02
Patios & Walks	1875	C= 0.95	n= 0.02
Roads	4589.9262	C= 0.95	n= 0.02
Sidewalks	1214.8904	C= 0.95	n= 0.02
Greenspace	11494.6992	C= 0.25	n= 0.40

Cd 0.60832463

nd 0.20548091

Length of watershed (L) 235.4292
Height of watershed (H) 12.94
Slope of watershed (H/L)= 0.05496345

$t_c = 0.827\{(n*L)/\sqrt{S}\}^{0.467} = 9.964$

i_{25} 5.934

$Q = ciA =$ 1.95153819

n*L= 48.37620626

$\sqrt{S}$ = 0.23444285

n*L/$\sqrt{S}$ = 206.34541109

i_{100} 7.136

$Q_{100} = ciA =$ 2.34684471

SUB-DRAINAGE AREA 209

AREA 14035.7301

Houses	0	C= 0	n= 0
Patios & Walks	0	C= 0	n= 0
Roads	7482.8142	C= 0.95	n= 0.02
Sidewalks	1864.1100	C= 0.95	n= 0.02
Greenspace	4688.8059	C= 0.25	n= 0.40

Cd 0.71615651

nd 0.14694361

Length of watershed (L) 453.1248
Height of watershed (H) 19.7
Slope of watershed (H/L)= 0.04347588

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467} =$ 12.218

i_{25} 5.529

Q=ciA= 1.27585603

n*L= 66.58379389
$\sqrt{S}$= 0.2085087
$n*L/\sqrt{S}$= 319.33340858

i_{100} 6.713

Q_{100}=ciA= 1.54907244

SUB-DRAINAGE AREA 210

AREA 18816.8202

Houses	0	C= 0	n= 0
Patios & Walks	0	C= 0	n= 0
Roads	7592.8334	C= 0.95	n= 0.02
Sidewalks	1962.0256	C= 0.95	n= 0.02
Greenspace	9261.9612	C= 0.25	n= 0.40

Cd 0.60544801

nd 0.20704251

Length of watershed (L) 494.2754
Height of watershed (H) 20.27
Slope of watershed (H/L)= 0.04100953

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467} =$ 15.138

i_{25} 5.020

Q=ciA= 1.31292204

n*L= 102.33601945
$\sqrt{S}$= 0.2025081
n*L/$\sqrt{S}$= 505.3428453

i_{100} 6.179

Q_{100}=ciA= 1.61604487

SUB-DRAINAGE AREA 300

AREA 99305.2071

Houses	14000	C=	0.95	n=	0.02
Patios & Walks	6000	C=	0.95	n=	0.02
Roads	3052.5741	C=	0.95	n=	0.02
Sidewalks	25540.0665	C=	1.00	n=	0.001
Greenspace	50712.5665	C=	0.25	n=	0.40

Cd 0.60538773

nd 0.20916948

Length of watershed (L) 529.8657
Height of watershed (H) 19.65
Slope of watershed (H/L)= 0.03708487

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467} =$ 16.086

i_{25} 4.9326

Q=ciA= 6.80759426

n*L= 110.83173294
$\sqrt{S}$= 0.19257432
n*L/$\sqrt{S}$= 575.52706373

i_{100} 6.079

Q_{100}=ciA= 8.38976716

SUB-DRAINAGE AREA 301

AREA 18582.2000

Houses	0	C= 0.95	n= 0.02
Patios & Walks	0	C= 0.95	n= 0.02
Roads	8003.5152	C= 0.95	n= 0.02
Sidewalks	1835.1440	C= 0.95	n= 0.02
Greenspace	8743.5408	C= 0.25	n= 0.40

Cd 0.62062681

nd 0.19880259

Length of watershed (L) 499.7276
Height of watershed (H) 15.38
Slope of watershed (H/L)= 0.03077677

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467} =$ 15.965

i_{25} 4.947

Q=ciA= 1.30972978

n*L= 99.34714117
$\sqrt{S}$= 0.17543309
$n*L/\sqrt{S}$= 566.29647902

i_{100} 6.092

Q_{100}=ciA= 1.6128712

SUB-DRAINAGE AREA 302

AREA 9008.761

Houses	0	C= 0	n= 0
Patios & Walks	0	C= 0	n= 0
Roads	5191.5449	C= 0.95	n= 0.02
Sidewalks	1342.4148	C= 0.95	n= 0.02
Greenspace	2474.8013	C= 0.25	n= 0.40

Cd 0.75770265

nd 0.12438999

Length of watershed (L) 368.8440
Height of watershed (H) 11.74
Slope of watershed (H/L)= 0.03182917

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467} =$ 11.043

i_{25} 5.739

$Q = ciA =$ 0.8993158

n*L= 45.88050147
$\sqrt{S}$= 0.17840731
$n*L/\sqrt{S}$= 257.16716131

i_{100} 6.932

$Q_{100} = ciA =$ 1.08626192

SUB-DRAINAGE AREA 303

AREA 23118.8082

Houses	3500	C= 0.95	n= 0.02
Patios & Walks	1500	C= 0.95	n= 0.02
Roads	0	C= 0	n= 0
Sidewalks	0	C= 0	n= 0
Greenspace	18118.8082	C= 0.25	n= 0.40

Cd 0.40139189

nd 0.31781583

Length of watershed (L) 346.2150
Height of watershed (H) 17
Slope of watershed (H/L)= 0.04910244

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467} =$ 15.015

i_{25} 5.032

Q=ciA= 1.07198028

n*L= 110.03260758
$\sqrt{S}$= 0.2215907
n*L/$\sqrt{S}$= 496.55787711

i_{100} 6.192

Q_{100}=ciA= 1.31909815

SUB-DRAINAGE AREA 400

AREA 923,674.3528

Description	Area (S.F.)	C	n
WOODLAND	457,114	0.24	0.60
PAVEMENT	19,380	0.94	0.02
STRUCTURES	9400	0.94	0.02
GRAVEL DRIVE	2390	0.70	0.10
AGRICULTURAL	160,619	0.35	0.20
Patios and Walks	3000	0.94	0.02
GREEN SPACE	271771.3528	0.15	0.40

Cd 0.25401238

nd 0.45034848

Length of watershed (L) 1547

Height of watershed (H) 39

Slope of watershed (H/L)= 0.02521008

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467}$ = 41.590

i_{25} 3.040

Q=ciA= 16.37417702

i_{100} 3.857

Q_{100}=ciA= 20.77473709

n*L= 696.68909856

$\sqrt{S}$= 0.15877682

n*L/$\sqrt{S}$= 4387.85144179

SUB-DRAINAGE AREA 401

AREA 191904.1200

Houses	28000	C= 0.95	n= 0.02
Patios & Walks	12000	C= 0.95	n= 0.02
Roads	13548.89	C= 0.95	n= 0.02
Sidewalks	3193.40	C= 0.95	n= 0.02
Greenspace	135161.83	C= 0.25	n= 0.40

Cd 0.45697629

nd 0.28764144

Length of watershed (L) 637.0054

Height of watershed (H) 18.94

Slope of watershed (H/L)= 0.02973287

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467} = 21.420$

i_{25} 4.439

Q=ciA= 8.9366601

n*L= 183.22915054

$\sqrt{S}$= 0.17243222

n*L/$\sqrt{S}$= 1062.61550504

i_{100} 5.515

Q_{100}=ciA= 11.10287913

SUB-DRAINAGE AREA 401-1

AREA 109,776.925

Houses	7000	C= 0.95	n= 0.02
Patios & Walks	3000	C= 0.95	n= 0.02
Roads	9046.33	C= 0.95	n= 0.02
Sidewalks	1933.911	C= 0.95	n= 0.02
Greenspace	88796.684	C= 0.25	n= 0.40

Cd 0.38378193

nd 0.32737552

Length of watershed (L) 497.7349

Height of watershed (H) 18.94

Slope of watershed (H/L)= 0.03805238

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467}$ = 19.143

i_{25} 4.650

Q=ciA= 4.4973912

n*L= 162.94622171

$\sqrt{S}$ = 0.19507019

n*L/$\sqrt{S}$ = 835.32097708

i_{100} 5.756

Q_{100}=ciA= 5.56709328

SUB-DRAINAGE AREA 401-2

AREA 82,127.1953

Houses	17500	C= 0.95	n= 0.02
Patios & Walks	7500	C= 0.95	n= 0.02
Roads	4,484.5596	C= 0.95	n= 0.02
Sidewalks	1,259.489	C= 0.95	n= 0.02
Greenspace	51383.1467	C= 0.25	n= 0.40

Cd 0.51204272

nd 0.25774824

Length of watershed (L) 598.03

Height of watershed (H) 18.94

Slope of watershed (H/L)= 0.03167065

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467} =$ 22.754

i_{25} 4.316

Q=ciA= 4.16664742

n*L= 154.14117997

$\sqrt{S}$= 0.1779625

n*L/$\sqrt{S}$= 866.14415942

i_{100} 5.374

Q_{100}=ciA= 5.18803597

SUB-DRAINAGE AREA 402

AREA 66119.7044

Houses	11375	C= 0.95	n= 0.02
Patios & Walks	4875	C= 0.95	n= 0.02
Roads	11268.74	C= 0.95	n= 0.02
Sidewalks	2812.92	C= 0.95	n= 0.02
Greenspace	35788.0444	C= 0.25	n= 0.40

Cd 0.57111701

nd 0.22567934

Length of watershed (L) 468.6997

Height of watershed (H) 16.94

Slope of watershed (H/L)= 0.03614255

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467}$ = 15.834

i_{25} 4.956

Q=ciA= 4.29634774

n*L= 105.77583895

$\sqrt{S}$= 0.19011194

n*L/$\sqrt{S}$= 556.38714196

i_{100} 6.106

Q_{100}=ciA= 5.29328073

SUB-DRAINAGE AREA 403

AREA 14690.00

Houses	0	C= 0.0	n= 0.0
Patios & Walks	0.0	C= 0.0	n= 0.0
Roads	8437.9881	C= 0.95	n= 0.02
Sidewalks	2297.14	C= 0.95	n= 0.02
Greenspace	3954.8719	C= 0.25	n= 0.40

Cd 0.76154457

nd 0.12230438

Length of watershed (L) 589.5533

Height of watershed (H) 7.22

Slope of watershed (H/L)= 0.01224656

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467}$ = 17.046

i_{25} 4.844

Q=ciA= 1.24403725

n*L= 72.10495083

$\sqrt{S}$ = 0.11066418

n*L/$\sqrt{S}$ = 651.56540111

i_{100} 5.978

Q_{100}=ciA= 1.53527141

SUB-DRAINAGE AREA 404

AREA 87394.6627

Houses	23625	C= 0.95	n= 0.02
Patios & Walks	10125	C= 0.95	n= 0.02
Roads	0.0	C= 0.0	n= 0.0
Sidewalks	0.0	C= 0.0	n= 0.0
Greenspace	53644.6627	C= 0.25	n= 0.40

Cd 0.52032543

nd 0.25325191

Length of watershed (L) 378.3854
Height of watershed (H) 15.9
Slope of watershed (H/L)= 0.04202065

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467} =$ 14.598

i_{25} 5.105

Q=ciA= 5.3292714

n*L= 95.82682527
$\sqrt{S}$= 0.20498939
n*L/$\sqrt{S}$= 467.47212268

i_{100} 6.269

Q_{100}=ciA= 6.54440791

SUB-DRAINAGE AREA 405

AREA 198552.9689

Houses	22750	C= 0.95	n= 0.02
Patios & Walks	9750	C= 0.95	n= 0.02
Roads	8758.5343	C= 0.95	n= 0.02
Sidewalks	2468.4972	C= 0.95	n= 0.02
Greenspace	154825.9374	C= 0.25	n= 0.40

Cd 0.40415998

nd 0.31631315

Length of watershed (L) 398.8532
Height of watershed (H) 12.88
Slope of watershed (H/L)= 0.03229258

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467} =$ 17.651

i_{25} 4.788

Q=ciA= 8.82055604

n*L= 126.16251208
$\sqrt{S}$= 0.17970136
$n*L/\sqrt{S}$= 702.06765313

i_{100} 5.914

Q_{100}=ciA= 10.89489733

SUB-DRAINAGE AREA 406

AREA 13398.6964

Houses	0.0	C= 0.0	n= 0.0
Patios & Walks	0.0	C= 0.0	n= 0.0
Roads	8241.2832	C= 0.95	n= 0.02
Sidewalks	2150.1608	C= 0.95	n= .02
Greenspace	3007.2524	C= 0.15	n= 0.40

Cd 0.77044508

nd 0.10528859

Length of watershed (L) 313.6336
Height of watershed (H) 6.172
Slope of watershed (H/L)= 0.01967901

$t_c = 0.827\{(n*L)/\sqrt{S}\}^{0.467}$ = 10.596

i_{25} 5.819

Q=ciA= 1.37900144

n*L= 33.02203952

$\sqrt{S}$ = 0.14028189

$n*L/\sqrt{S}$ = 235.39773751

i_{100} 7.015

Q_{100}=ciA= 1.66243256

SUB-DRAINAGE AREA 500

AREA 25842.5369

Houses	10500	C= 0.95	n= 0.02
Patios & Walks	4500	C= 0.95	n= 0.02
Roads	5181.9306	C= 0.95	n= 0.02
Sidewalks	1088.00	C= 0.95	n= 0.02
Greenspace	4572.6063	C= 0.25	n= 0.40

Cd 0.82614125

nd 0.08723761

Length of watershed (L) 280.1731
Height of watershed (H) 10.05
Slope of watershed (H/L)= 0.03587068

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467} =$ 8.003

i_{25} 6.437

Q=ciA= 3.15489631

n*L= 24.44163163
$\sqrt{S}$= 0.18939556
n*L/$\sqrt{S}$= 129.05071075

i_{100} 7.662

Q_{100}=ciA= 3.75529215

SUB-DRAINAGE AREA 501

AREA 3686.9041

Houses	0.0	C= 0.0	n= 0.0
Patios & Walks	0.0	C= 0.0	n= 0.0
Roads	2263.6355	C= 0.95	n= 0.02
Sidewalks	560.7320	C= 0.95	n= 0.02
Greenspace	862.5366	C= 0.25	n= 0.40

Cd 0.78623777

nd 0.10889949

Length of watershed (L) 156.8169

Height of watershed (H) 5.27

Slope of watershed (H/L)= 0.03360607

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467} = 6.873$

i_{25} 6.727

$Q = ciA =$ 0.44766104

n*L= 17.07728043

$\sqrt{S}$= 0.18331958

n*L/$\sqrt{S}$= 93.15579072

i_{100} 7.966

$Q_{100} = ciA =$ 0.53011266

SUB-DRAINAGE AREA 502

AREA 67299.8446

Houses	21000	C= 0.95	n= 0.02
Patios & Walks	9000	C= 0.95	n= 0.02
Roads	12143.7500	C= 0.95	n= 0.02
Sidewalks	3096.2896	C= 0.95	n= 0.02
Greenspace	22059.805	C= 0.25	n= 0.40

Cd 0.72055128

nd 0.14455788

Length of watershed (L) 590.3298
Height of watershed (H) 13.02
Slope of watershed (H/L)= 0.02205547

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467}$ = 16.074

i_{25} 4.878

Q=ciA= 5.43041325

n*L= 85.33682439
$\sqrt{S}$= 0.14851084
n*L/$\sqrt{S}$= 574.61680501

i_{100} 6.080

Q_{100}=ciA= 6.76853476

SUB-DRAINAGE AREA 503

AREA 13311.2362

Houses	6125	C= 0.95	n= 0.02
Patios & Walks	2625	C= 0.95	n= 0.02
Roads	0.0	C= 0.0	n= 0.0
Sidewalks	0.0	C= 0.0	n= 0.0
Greenspace	4561.2362	C= 0.15	n= 0.40

Cd 0.67587152

nd 0.15021103

Length of watershed (L) 258.1450

Height of watershed (H) 5

Slope of watershed (H/L)= 0.01936896

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467} =$ 11.464

i_{25} 5.664

Q=ciA= 1.16981695

n*L= 38.77622634

$\sqrt{S}$= 0.13917241

n*L/$\sqrt{S}$= 278.62006801

i_{100} 6.853

Q_{100}=ciA= 1.41538763

SUB-DRAINAGE AREA 504

AREA 9919.6699

Houses	5250	C= 0.95	n= 0.02
Patios & Walks	1875	C= 0.95	n= 0.02
Roads	0.0	C= 0.0	n= 0.0
Sidewalks	0.0	C= 0.0	n= 0.0
Greenspace	2794.6699	C= 0.25	n= 0.40

Cd 0.75278891

nd 0.12705745

Length of watershed (L) 227.6507
Height of watershed (H) 6.00
Slope of watershed (H/L)= 0.02635617

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467} = 9.303$

i_{25} 6.104

$Q = ciA =$ 1.04639845

n*L= 28.92471743
$\sqrt{S}$= 0.16234583
n*L/$\sqrt{S}$= 178.16729527

i_{100} 7.313

$Q_{100} = ciA =$ 1.25365528

SUB-DRAINAGE AREA 505

AREA 31092.9665

Houses	3500	C=	0.95	n=	0.02
Patios & Walks	1500	C=	0.95	n=	0.02
Roads	18581.2054	C=	0.95	n=	0.02
Sidewalks	4833.44	C=	0.95	n=	0.02
Greenspace	2678.3211	C=	0.15	n=	0.40

Cd 0.8810887

nd 0.05273287

Length of watershed (L) 743.5751

Height of watershed (H) 13.570

Slope of watershed (H/L)= 0.01824967

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467}$ = 11.685

i_{25} 5.624

Q=ciA= 3.53703397

n*L= 39.21084908

$\sqrt{S}$= 0.13509134

$n*L/\sqrt{S}$= 290.25434998

i_{100} 6.812

Q_{100}=ciA= 4.28418838

SUB-DRAINAGE AREA 506

AREA 102147.6133

Houses	28000	C= 0.95	n= 0.02
Patios & Walks	12000	C= 0.95	n= 0.02
Roads	0.0	C= 0.0	n= 0.0
Sidewalks	0.0	C= 0.0	n= 0.0
Greenspace	62147.6133	C= 0.25	n= 0.40

Cd 0.52411311

nd 0.25119574

Length of watershed (L) 505.7087
Height of watershed (H) 19.34
Slope of watershed (H/L)= 0.03824336

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467} =$ 17.022

i_{25} 4.846

Q=ciA= 5.95591904

n*L= 127.03187112
$\sqrt{S}$= 0.1955591
n*L/$\sqrt{S}$= 649.58302181

i_{100} 5.980

Q_{100}=ciA= 7.34964834

SUB-DRAINAGE AREA 507

AREA 19777.8338

Houses	4375	C= 0.95	n= 0.02
Patios & Walks	1875	C= 0.95	n= 0.02
Roads	0.0	C= 0.0	n= 0.0
Sidewalks	0.0	C= 0.0	n= 0.0
Greenspace	13527.8338	C= 0.25	n= 0.40

Cd 0.47120724

nd 0.27991607

Length of watershed (L) 273.4396
Height of watershed (H) 14.75
Slope of watershed (H/L)= 0.05394244

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467} = 12.399$

i_{25} 5.497

Q=ciA= 1.17605747

n*L= 76.54013821

$\sqrt{S}$ = 0.23225512

$n*L/\sqrt{S}$ = 329.55199528

i_{100} 6.679

Q_{100}=ciA= 1.42894084

SUB-DRAINAGE AREA 508

AREA 63419.5229

Houses	13125	C= 0.95	n= 0.02
Patios & Walks	5625	C= 0.95	n= 0.02
Roads	8002.4934	C= 0.95	n= 0.02
Sidewalks	1889.5240	C= 0.95	n= 0.02
Greenspace	34777.5055	C= 0.25	n= 0.40

Cd 0.56613944

nd 0.22838145

Length of watershed (L) 448.6079
Height of watershed (H) 15.52
Slope of watershed (H/L)= 0.03459591

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467} = 15.760$

i_{25} 4.963

Q=ciA= 4.09074855

n*L= 102.45372268
$\sqrt{S}$= 0.18599976
n*L/$\sqrt{S}$= 550.82717677

i_{100} 6.114

Q_{100}=ciA= 5.03945933

SUB-DRAINAGE AREA 509

AREA 19950.0852

Houses	3500	C=	0.95	n=	0.02
Patios & Walks	1500	C=	0.95	n=	0.02
Roads	9287.7052	C=	0.95	n=	0.02
Sidewalks	2312.8044	C=	0.95	n=	0.02
Greenspace	3349.5756	C=	0.25	n=	0.40

Cd 0.83247153

nd 0.08380117

Length of watershed (L) 337.042

Height of watershed (H) 7.96

Slope of watershed (H/L)= 0.02361723

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467} = 9.439$

i_{25} 6.069

$Q = ciA =$ 2.31389374

n*L= 28.24451394

$\sqrt{S}$ = 0.15367898

$n*L/\sqrt{S}$ = 183.78905131

i_{100} 7.277

$Q_{100} = ciA =$ 2.77446115

SUB-DRAINAGE AREA 600

AREA 4895.7518

Houses	0.0	C= 0.0	n= 0.0
Patios & Walks	0.0	C= 0.0	n= 0.0
Roads	4895.7518	C= 0.95	n= 0.02
Sidewalks	0.0	C= 0.0	n= 0.0
Greenspace	0	C= 0.0	n= 0.0

Cd 0.95

nd 0.02

Length of watershed (L) 318.9977
Height of watershed (H) 11.01
Slope of watershed (H/L)= 0.03451436

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467} =$ 10.02

i_{25} 5.925

Q=ciA= 0.63262082

n*L= 6.379954

$\sqrt{S}$= 0.18578041

$n*L/\sqrt{S}$= 34.34137108

i_{100} 7.122

Q_{100}=ciA= 0.76042624

SUB-DRAINAGE AREA 700

AREA 1896.3890

Houses	0.0	C= 0.0	n= 0.0
Patios & Walks	0.0	C= 0.0	n= 0.0
Roads	1896.3890	C= 0.95	n= 0.02
Sidewalks	0.0	C= 0.0	n= 0.0
Greenspace	0	C= 0.0	n= 0.0

Cd 0.95

nd 0.02

Length of watershed (L) 148.6113

Height of watershed (H) 6.98

Slope of watershed (H/L)= 0.04696816

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467}$ = 10.00

i_{25} 5.925

Q=ciA= 0.2450482

n*L= 2.972226

$\sqrt{S}$= 0.21672139

n*L/$\sqrt{S}$= 13.71450229

i_{100} 7.126

Q_{100}=ciA= 0.29471957

SUB-DRAINAGE AREA 900 - REAR YARD

AREA 18141.9220

Houses	0	C= 0	n= 0
Patios & Walks	0	C= 0	n= 0
Roads	0	C= 0	n= 0
Sidewalks	0	C= 0	n= 0
Greenspace	18141.922	C= 0.25	n= 0.40

Cd 0.25

nd 0.4

Length of watershed (L) 630

Height of watershed (H) 20

Slope of watershed (H/L)= 0.03174603

$t_c = 0.827\{(n*L)/\sqrt{S}\}^{0.467}$ = 23.268

i_{25} 4.269

n*L= 252

$\sqrt{S}$= 0.17817416

n*L/$\sqrt{S}$= 1414.34650232

Q=ciA= 0.44448958

i_{100} 5.320

Q_{100}=ciA= 0.553920002

SUB-DRAINAGE AREA LAKE 2

AREA 320304.7016

Houses	59500	C= 0.95	n= 0.02
Patios & Walks	25,500	C= 0.95	n= 0.02
Roads	81506.8681	C= 1.00	n= 0.00
Sidewalks	0.00	C= 0.95	n= 0.02
Greenspace	153797.8335	C= 0.25	n= 0.40

Cd 0.62661062

nd 0.19737186

Length of watershed (L) 793.75

Height of watershed (H) 8

Slope of watershed (H/L)= 0.01007874

$tc = 0.827\{(n*L)/\sqrt{S}\}^{0.467} =$ 25.631

i_{25} 4.050

Q=ciA= 18.66071228

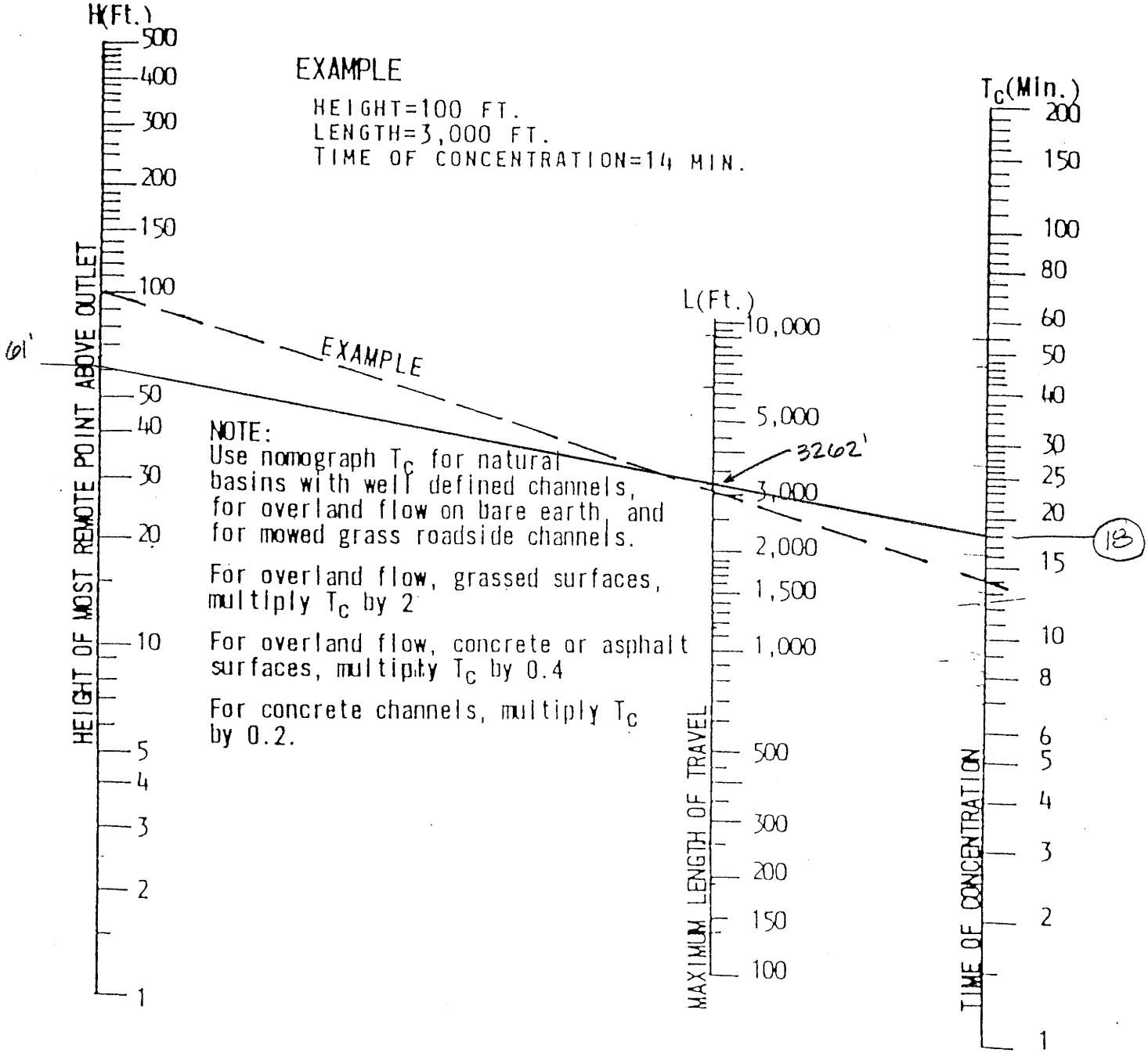
n*L= 156.66391388

$\sqrt{S}$= 0.10039293

$n*L/\sqrt{S}$= 1560.50743693

i_{100} 5.137

Q_{100}=ciA= 23.66915531



TIME OF CONCENTRATION OF SMALL DRAINAGE BASINS

FOR EXAMPLE: SEE 3) PAGE 41

FIG. 7-425.04A

Project: Hawthorne Estates - detention calculation

Designer: Easley Engineering

Detention Facility Design Return Period: 25 YEAR

Release Rate Return Period: 10 YEAR

Watershed Area: 70.0

Time of Concentration'. 18 minutes

Rainfall Intensity: (i,,) = 4.257

Undeveloped Runoff Coefficient (Cu) = 0.35

Undeveloped Runoff Rate (Q=(Cu)(iu)(A,,) = 104.2965

Developed Runoff Coefficient (CD)= 0.63

Storm Duration	Rainfall Intensity	Inflow Rate	Outflow Rate	Storage Rate	Required Storage
td (hrs)	Id (in./hr)	Cd'idAD (cfs)	CuiuAu (cfs)	I(td)_O (cfs)	[I(td)-0 td}/12 (acre-ft)
.170	5.925	261.2925	104.2965	156.996	2.22411
.33	4.571	201.5811	104.2965	97.2846	2.6753265
.50	3.646	160.7886	104.2965	56.4921	2.3538375
.67	3.123	137.7243	104.2965	33.4278	1.8663855
.83	2.601	114.7041	104.2965	10.4076	0.719859
1	2.078	91.6398	104.2965	-12.6567	-1.054725
1.5	1.739	76.6899	104.2965	-27.6066	-3.450825
2	1.40	61.74	104.2965	-42.5565	-7.09275
3	1.019	44.9379	104.2965	-59.3586	-14.83965

Peak storage requirement = 2.6753265 acre-feet = 116537.22234 cubic feet of storage.

PROJECT Hawthorne Estates - 100 Series DATE 6/24/04 SHEET 1 OF 8

ENGINEER Andy Easley Engineering, Inc. DESIGN STORM 25 YEAR MANNINGS n 0.013

LINE #	Upstream Manhole	Downstream Manhole	Length (ft)	Cj	Aj (Acres)	CjAj	ΣCjAj	tj (min)	tcum min.	I "/hr	Q (cfs)	Pipe Diameter inches	Pipe slope (%)	Pipe capacity (cfs)	Velocity (ft/sec)	Travel Time (min)	Rim Elevation Upstream	Rim Elevation Downstream	Invert Elevation Upstream	Invert Elevation Downstream	Pipe Cover Upstream	Pipe Cover Downstream
1	2	1	4	5	6	7	8	9	10	10	12	13	14	15	16	17	18	19	20	21	22	23
1	100	101	119.07	0.72	1.50	1.08	1.08	17.073	17.073	4.841	5.24	15	0.74	5.56	4.46	0.4449	411.35	410.50	408.88	408.00	1.00	1
							1.08									0					-0.25	
							1.08									0					-0.25	
							1.08									0					-0.25	
							1.08									0					-0.25	
							1.08									0					-0.25	
							1.08									0					-0.25	
							1.08									0					-0.25	
							1.08									0					-0.25	
							1.08									0					-0.25	
							1.08									0					-0.25	
							1.08									0					-0.25	
							1.08									0					-0.25	
							1.08									0						

Figure 7.2.1
Storm Sewer Design Sheet - Rational Method

PROJECT Hawthorne Estates - 200 Series DATE 4/26/04 SHEET 2 OF 5

ENGINEER Andy Easley Engineering, Inc. DESIGN STORM 25 YEAR MANNINGS n 0.013

LINE #	Upstream Manhole	Downstream Manhole	Length (ft)	Cj	Aj (Acres)	CjAj	ΣCjAj	tj (min)	tcum min.	I "/hr	Q (cfs)	Pipe Diameter inches	Pipe slope (%)	Pipe capacity (cfs)	Velocity (ft/sec)	Travel Time (min)	Rim Elevation Upstream	Rim Elevation Downstream	Invert Elevation Upstream	Invert Elevation Downstream	Pipe Cover Upstream	Pipe Cover Downstream
1	2	1	4	5	6	7	8	9	10	10	12	13	14	15	16	17	18	19	20	21	22	23
207	200	201	29.00	0.77	0.3910	0.30107	0.30	15.434	15.434	4.993	1.506	12	0.86	3.30	3.46	0.13969171	432.64	432.64	430.39	430.14	1	1.25
206	201	202	129.50	0.75	0.2359	0.18	0.478	14.137	15.574	4.980	2.380	15	1.70	8.42	5.00	0.43166	432.64	431.00	430.14	427.94	1	1.56
205	202	203	179.90	0.47	0.3603	0.169	0.647	11.117	16.261	4.916	3.181	15	6.11	15.97	10.58	0.2833	431.00	420.2	427.94	416.95	1.56	1.75
209	204	205	30.73	0.648	0.4161	0.2696	0.2696	11.162	11.162	5.718	1.543	12	0.81	3.30	3.46	0.1480	420.94	420.94	418.69	418.44	1	1.25
208	205	206	200.77	0.77	0.2056	0.1583	0.428	9.449	11.302	5.693	2.436	12	4.07	7.19	6.98	0.4793	420.94	420.2	418.44	416.95	1.25	1.75
																0					-0.25	
204	203	206	158.73	0.441	0.8425	0.3715	1.018	14.813	16.544	4.890	4.98	15	2.96	11.11	7.41	0.3570	420.2	415.5	416.95	412.25	1.75	1.75
211	207	208	29.00	0.77	0.1766	0.1359	0.1359	8.498	8.498	6.310	0.855	12	0.71	3.00	2.80	0.1726	413.06	413.06	410.81	410.61	1	1.20
210	208	206	16.53	0.61	0.5406	0.3297	0.466	9.964	9.964	6.310	2.938	12	2.15	5.22	5.76	0.04782	413.06	415.5	410.61	410.25	1.2	4.0
203	206	209	120.17	0.55	1.0047	0.552585	2.464	14.063	16.852	4.862	11.98	24	0.88	21.22	5.86	0.3417	415.5	413.19	410.25	409.19	3	1.75
202	209	210	69.49	0.473	0.3222	0.1524	2.6170	11.117	17.194	4.830	12.64	24	0.48	15.67	4.73	0.2448	413.19	412.37	409.19	408.85	1.75	1.27
201	210	211	176.04	0.75	0.4320	0.324	2.941	14.137	17.439	4.807	14.13	24	0.48	15.67	4.73	0.6202	412.37	411.25	408.85	408.00	1.27	1.0

Figure 7.2.1
Storm Sewer Design Sheet - Rational Method

PROJECT Hawthorne Estates - 400 Series - revised DATE 6/9/04 SHEET ____ OF ____

ENGINEER Andy Easley Engineering, Inc DESIGN STORM 25 YEAR MANNINGS n 0.013

LINE #	Upstream Manhole	Downstream Manhole	Length (ft)	Cj	aj (Acres)	CjAj	ΣCjAj	tt (min)	tcum min	I in/hr	Q (cfs)	Pipe Diameter inches	Pipe slope (%)	Pipe capacity (cfs)	Velocity (ft/sec)	Travel Time (min)	Rim Elevation Upstream	Rim Elevation Downstream	Invert Elevation Upstream	Invert Elevation Downstream	Pipe Cover Upstream	Pipe Cover
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
10	400	400A	76.65	0.25	21.205	5.30125	5.30	18	18.0	4.756	25.21	30	1.00	41.02	7.40	0.1726	426.70	425.91	422.93	422.16	1.02	1
9	400A	400B	139.61	*	*	*	5.30	*	18.17	4.756	25.21	30	1.00	41.02	7.40	0.3144	426.68	425.84	422.16	420.77	1.77	-20.16
8	400B	400C	34.66	*	*	*	5.30	*	18.48	4.756	25.21	30	1.00	41.02	7.40	0.0780	425.84	424.74	420.77	420.42	2.32	-20.90
6	400C	400D	70.65	*	*	*	5.30	*	18.56	4.756	25.21	30	1.00	41.02	7.40	0.1591	424.74				421.99	-25.2
							5.30125									0					-0.25	
15	401-1	402	29.00	0.38	2.52	0.9576	0.9576	19.143	19.143	4.650	4.49	15	1.00	6.46	4.81	0.1004	423.06	423.06	420.13	419.84	1.43	-1.27
7	402	400D	12.71	0.57	1.52	0.8664	1.824	15.83	19.14	4.650	8.48	21	1.00	15.85	5.63	0.0376	423.06	424.00	419.84	419.72	1.22	-4.2
5	400D	403	71.68	*	*	*	7.125	41.78	19.14	4.650	33.13	30	1.00	41.02	7.92	0.1508	424.00	423.88	419.72	419.00	1.53	-28.28
16	401-2	403	57.61	0.51	1.885	0.96135	0.961	22.75	22.75	4.316	4.166	15	1.00	6.46	4.81	0.1996	423.70	423.88	419.58	419.00	2.62	0.71
4	403	404	130.60	0.761	0.54	0.258	8.345	17.01	22.75	4.316	36.01	30	5.29	94.34	15.11	0.1440	423.88	417.10	419	412.09	2.13	-31
18	300B	300A	33.06	0.49	13.43	6.5807	6.58	22.98	22.98	4.295	28.04	24	9.38	69.29	17.59	0.03132	429.00	425.75	425.10	422.00	1.15	1.00
14	300	301	38.57	0.60	2.28	1.368	7.95	16.08	22.98	4.295	34.15	30	1.74	54.11	9.82	0.065	422.00	426.27	417.25	416.58	2.0	6.94
13	301	302	29.00	0.62	0.43	0.2666	8.22	15.97	23.04	4.295	35.30	30	1.74	54.11	9.82	0.049	426.27	426.27	416.58	416.07	6.94	7.45
12	302	303	130.48	0.76	0.207	0.15732	8.38	11.06	23.04	4.295	35.99	30	1.74	54.11	9.82	0.221	426.27	418.64	416.07	413.80	7.45	2.99
11	303	404	171.71	40	0.207	0.0828	8.46	11.01	23.04	4.295	36.35	30	1.00	41.02	8.11	0.353	418.64	417.10	413.80	412.09	2.09	2.26
3	404	405	130.51	0.52	2.00	1.04	17.84	14.6	23.04	4.295	76.63	42	1.00	100.61	9.21	0.236	417.10	415.62	412.09	410.76	2.09	1.11
2	405	406	29.00	0.40	4.56	1.824	19.66	17.63	23.04	4.295	84.43	42	1.00	100.61	9.18	0.053	415.62	415.62	410.76	410.47	1.11	1.40
1	406	407	145.96	0.77	0.31	0.2387	19.9	10.60	23.04	4.295	85.47	42	1.0	100.61	9.21	0.264	415.62	413.75	410.47	409.00	1.40	1.00

Figure 7.2.1
Storm Sewer Design Sheet - Rational Method

PROJECT Hawthorne Estates - 500 Series DATE 4/28/04 SHEET 5 OF 5

ENGINEER Andy Easley Engineering, Inc. DESIGN STORM 25 YEAR MANNINGS n 0.013

LINE #	Upstream Manhole	Dwnstream Manhole	Length (ft)	Cj	Aj (Acres)	Cj·Aj	$\sum$CjAj	tj (min)	tcum min	I "/hr	Q (cfs)	Pipe Diameter inches	Pipe slope (%)	Pipe capacity (cfs)	Velocity (ft/sec)	Travel Time (min)	Rim Elevation Upstream	Rim Elevation Downstream	Invert Elevation Upstream	Invert Elevation Downstream	Pipe Cover Upstream	Pipe Cover Downstream
1	2	1	4	5	6	7	8	9	10	10	12	13	14	15	16	17	18	19	20	21	22	23
510	500	501	46.95	0.83	0.593	0.49219	0.49	8.003	8.003	6.437	3.155	12	1.5	4.35	5.12	0.15283	426.95	426.60	424.69	423.99	1.01	1.36
509	501	502	215.41	0.79	0.085	0.07	0.56	6.873	8.003	6.437	3.605	12	3.38	6.55	7.18	0.50002	426.60	418.95	423.99	416.70	1.36	1.00
508	502	502A	29.00	0.72	1.545	1.1124	1.672	16.074	16.074	4.933	8.25	18	1.0	10.50	5.58	0.08661	418.95	418.95	416.20	415.91	1	1.29
507	502A	505	32.80	*	*	*	1.672	*	16.161	4.926	8.24	18	1.0	10.5	5.58	0.0979'	418.95	418.30	415.91	415.58	1.29	0.97
512	503	504	78.00	0.68	0.306	0.208	0.208	11.464	11.464	5.664	1.170	12	1.28	4.03	3.77	0.34482	424.00	423.00	421.75	420.75	1	1.08
511	504	505	119.33	0.75	0.228	0.171	0.379	9.303	11.464	5.664	2.147	12	4.330	7.41	6.92	0.2874	423.00	418.30	420.75	415.58	1	1.47
506	505	505A	34.23	0.88	0.714	0.62832	2.679	11.68	16.161	4.926	13.30	18	2.0	14.86	8.16	0.06991	418.30	419.00	415.58	414.90	0.97	2.35
505	505A	506	140.89	*	*	*	2.679	*	16.161	4.926	13.30	18	2.83	17.69	9.33	0.25167	419.0	413.65	414.90	410.90	2.35	1.50
504	506	507	114.00	0.52	2.34	1.2168	3.895	17.022	17.022	4.846	18.88	24	1.02	22.96	6.96	0.27298	413.65	413.75	410.40	409.23	1	2.27
503	507	508	64.09	0.47	0.454	0.21338	4.109	12.399	17.295	4.821	19.81	24	1.02	22.96	6.69	0.15966	413.75	412.48	409.23	408.57	2.27	-15.9
502	508	509	29.00	0.57	1.46	0.8322	4.941	15.760	17.455	4.806	23.75	30	1.02	41.43	7.34	0.06584	412.48	412.48	408.57	408.27	1.16	-19.54
501	509	510	146.59	0.83	0.458	0.38014	5.321	9.439	17.521	4.800	25.54	30	0.60	31.77	6.13	0.3985	412.48		408.27		1.46	-25.54
							5.32158									0						

Figure 7.2.1
Storm Sewer Design Sheet - Rational Method

PROJECT Hawthorne Estates - 600 Series DATE 5/18/04 SHEET 6 OF _____

ENGINEER Andy Easley Engineering, Inc. DESIGN STORM 25 YEAR MANNINGS n 0.013

LINE #	Upstream Manhole	Downstream Manhole	Length (ft)	Cj	Aj (Acres)	Cj·Aj	$\sum$Cj·Aj	tj (min)	tcum min.	I "/hr	Q (cfs)	Pipe Diameter inches	Pipe slope (%)	Pipe capacity (cfs)	Velocity (ft/sec)	Travel Time (min)	Rim Elevation Upstream	Rim Elevation Downstream	Invert Elevation Upstream	Invert Elevation Downstream	Pipe Cover Upstream	Pipe Cover Downstream
1	2	1	4	5	6	7	8	9	10	10	12	13	14	15	16	17	18	19	20	21	22	23
600	601	600	44.8540	0.95	0.112	0.1064	0.11	10.02	10.02	5.925	0.630	12	4.347	7.43	5.37	0.1392	430.64	424.25	426.64	422.00	2.75	1

Figure 7.2.1
Storm Sewer Design Sheet - Rational Method

PROJECT Hawthorne Estates - 700 Series DATE 5/18/04 SHEET 7 OF _____

ENGINEER Andy Easley Engineering, Inc. DESIGN STORM 25 YEAR MANNINGS n 0.013

LINE #	Upstream Manhole	Dwnstream Manhole	Length (ft)	Cj	Aj (Acres)	Cj-Aj	ΣCjAj	tj (min)	tcum min.	I "/hr	Q (cfs)	Pipe Diameter inches	Pipe slope (%)	Pipe capacity (cfs)	Velocity (ft/sec)	Travel Time (min)	Rim Elevation Upstream	Rim Elevation Downstream	Invert Elevation Upstream	Invert Elevation Downstream	Pipe Cover Upstream	Pipe Cover Downstream
1	2	1	4	5	6	7	8	9	10	10	12	13	14	15	16	17	18	19	20	21	22	23
700	701	700	171.90	0.95	0.044	0.0418	0.04	10.00	10.00	5.925	0.245	12	2.11	5.18	3.07	0.9332	434.67	430.25	431.62	428.00	1.8	1

Figure 7.2.1
Storm Sewer Design Sheet - Rational Method

PROJECT Hawthorne Estates - 800 Series DATE 6/30/04 SHEET 8 OF ______

ENGINEER Andy Easley Engineering, Inc. DESIGN STORM 25 YEAR MANNINGS n 0.013

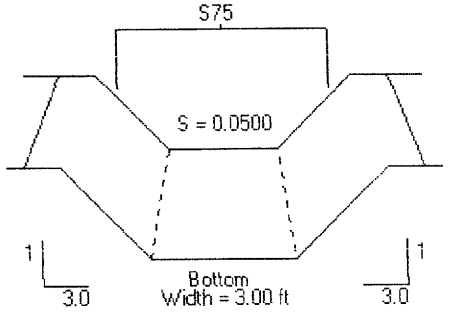
LINE #	Upstream Manhole	Dwnstream Manhole	Length (ft)	Cj	Aj (Acres)	CjAj	$\sum$CjAj	tj (min)	tcum min.	I "/hr	Q (cfs)	Pipe Diameter inches	Pipe slope (%)	Pipe capacity (cfs)	Velocity (ft/sec)	Travel Time (min)	Rim Elevation Upstream	Rim Elevation Downstream	Invert Elevation Upstream	Invert Elevation Downstream	Pipe Cover Upstream	Pipe Cover Downstream
1	2	1	4	5	6	7	8	9	10	10	12	13	14	15	16	17	18	19	20	21	22	23
802	802	801	184.2488	*	*	*	*	*	*	*	149.04	54	0.74	169.16	10.30	0.29813	411.00	410.08	405.55	404.2095	0.7	1.1205
803	803	801	278.2856	0.25	0.416	0.10	0.104	23.268	23.268	4.269	0.44	12	1.27	4.02	2.94	1.5775	410.5	410.08	407.75	404.2095	1.5	5.4305
801	801	800	28.31	*	*	*	*	*	*	*	149.04	54	0.74	169.16	10.30	0.0458	410.08	410.0	404.2095	404.00	1.1205	1.0
							0.104									0					-0.25	
							0.104									0					-0.25	
							0.104									0					-0.25	
							0.104									0					-0.25	
							0.104									0					-0.25	
							0.104									0					-0.25	
							0.104									0					-0.25	
							0.104									0					-0.25	
							0.104									0					-0.25	
							0.104									0					-0.25	
							0.104									0						

Figure 7.2.1
Storm Sewer Design Sheet - Rational Method

North American Green - Erosion Control Materials Design Software Ver.4.11 - Channel	7/1/2004	02:10 PM	COMPUTED BY:
PROJECT NAME: HAWTHORNE		PROJECT NO.: REAR YARD SWALE LOTS 1-4	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.9	1.0	2.37	1.22	0.25	0.31



Not to Scale

LINER RESULTS

Reach	Material Type / Staple Pattern	Phase / Class	Veg. Type / Veg. Density	Soil Type	Manning's 'n'	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75				0.055	1.55	0.97	1.60	STABLE
	Staple D								

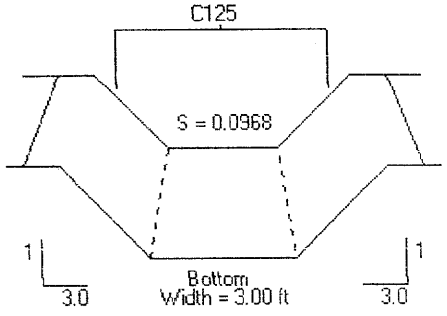
North American Green - Erosion Control Materials Design Software Ver.4.11 - Channel	7/1/2004	01:46 PM	COMPUTED BY:

PROJECT NAME: HAWTHORNE	PROJECT NO.: LOTS 41-51

FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
6.0	1.0	6.99	0.86	0.19	0.23



Not to Scale

LINER RESULTS

Reach	Material Type / Staple Pattern	Phase / Class	Veg. Type / Veg. Density	Soil Type	Manning's 'n'	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	C125				0.022	2.25	1.40	1.61	STABLE
	Staple D								

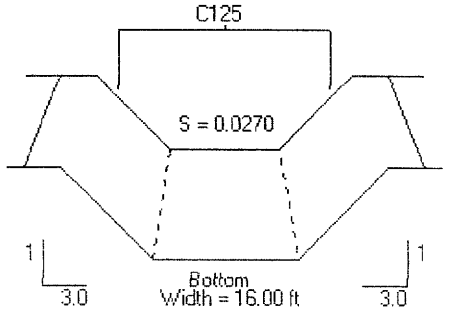
North American Green - Erosion Control Materials Design Software Ver.4.11 - Channel	7/1/2004	01:49 PM	COMPUTED BY:

PROJECT NAME: HAWTHORNE	PROJECT NO.: SPILLWAY

FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
185.4	1.0	10.64	17.42	0.80	0.93



Not to Scale

LINER RESULTS

Reach	Material Type / *Staple Pattern*	Phase / *Class*	Veg. Type / *Veg. Density*	Soil Type	Manning's 'n'	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	C125				0.020	2.25	1.56	1.44	STABLE
	Staple D								

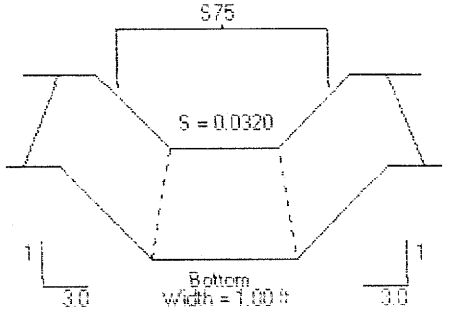
North American Green - Erosion Control Materials Design Software Ver.4.11 - Channel | 7/1/2004 | 02:30 PM | COMPUTED BY:

PROJECT NAME: | PROJECT NO.: REAR YARD LOTS 14-20

FROM STATION/REACH: | TO STATION/REACH: | DRAINAGE AREA: | DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
0.4	1.0	1.23	0.31	0.14	0.20



Not to Scale

LINER RESULTS

Reach	Material Type / Staple Pattern	Phase / Class	Veg. Type / Veg. Density	Soil Type	Manning's 'n'	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75				0.055	1.55	0.39	3.98	STABLE
	Staple D								