RETENTION REPORT

FOR:

COPPERFIELD SUBDIVISION

SECTION II

OWNER: JOHN ELPERS

ENGINEER: MORLEY AND ASSOCIATES, INC.

JAMES Q. MORLEY
REGISTERED
No. 13817
STATE OF INDIANA
PROFESSIONAL ENGINEER

OCTOBER 21, 1991

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APPENDIX

COPPERFIELD SUBDIVISION
SECTION II

The site is located approximately 1200 feet west of Highway 41 North along Mt. Pleasant Road in Center Township. The 30.5 acre site consists of 68 lots on the south side of Mt. Pleasant Road, adjacent to the Deerfield subdivision.

The existing site is largely pasture with small hills along the west side, Little Pigeon Creek along the east side, and a ditch dividing the north and south halves, and a ditch along the south side. The east portion of the property is subject to high return period flooding. The 100 year flood elevation for the northeast corner has been determined to be 388.65. Likewise, the 100 year flood elevation for the southeast corner has been determined to be 386.50.

The 30 acre site is divided into three general drainage areas. The northern area will be referred to as Drainage Area A. The middle area will be Drainage Area B. The southern area will be Drainage Area C.

The preliminary drainage plan for this subdivision was approved by the Vanderburgh County Drainage Board on January 28, 1991 on the condition of detention being provided. The attached information is presented to satisfy that requirement.

91-2281-4 Elpers 10-17-91

Copperfield II

①

Detention Plan

Undeveloped Conditions

Watershed Area A

$Q_u^A = c\,i\,A$

where $A_A = 11.21$ Ac.

$c_A = 0.30$ (pasture flat - silt loam; flat woodland)

$N = 0.4$

$H = 392 - 385 = 7$ $t_c = .827\left[\dfrac{0.4\,(750)}{\sqrt{.0093}}\right]^{.467} = 35.3$ min

$= 750$

$S = \dfrac{7}{750} = .0093$

$i_{25} = 3.15)$

$Q_u^A = (0.30)(3.15)(11.21) = 10.59$ cfs

Watershed Area B

$A_B = (495)(160) + (160)(1150) + \tfrac{1}{2}(110)(400) + (375)(110) + \tfrac{1}{2}(375)(240) = 8.53$ Ac.

$c_B = (.25)(.36) + (.75)(.30) = 0.32$

$N = 0.4$

$H = 417.5 - 385 = 32.5$

$L = 260 + 440 + 160 + 460 = 1320$

$= \dfrac{32.5}{1320} = 0.0246$

$t_c = .827\left[\dfrac{.4\,(1320)}{\sqrt{.0246}}\right]^{.467} = 36.7$ min

$i_{25} = 3.1$ in/hr

$Q_u^B = (0.32)(3.1)(8.53) = 8.46$ cfs

Watershed Area C

A_c = 10.76 Ac.

$C_c = (.20)(.36) + (.80)(.30) = 0.31$

$N_c = 0.40$

$H = 411 - 385 = 26'$

$L = 1320$

$S = \frac{26}{1320} = 0.0197$

$$t_c = .827\left[\frac{.4(1320)}{\sqrt{.0197}}\right]^{.467} = 38.6 \text{ min}$$

$i_{25} = 2.95$ in/hr

$Q_u^c = (0.31)(2.95)(10.76) = 9.84$ cfs

Developed Coefficients

A ⇒ 0.40

B ⇒ 0.40

C ⇒ 0.40

10-18-91

Retention Information

③

25 YEAR VOLUME

$$\begin{array}{ccccccccc} & A & & B & & C & & & \\ V_{25} = & 9827 & + & 6866 & + & 9933 & = & 26,626\ ft^3 \\ & .23 & & .16 & & .23 & = & .611\ AFt \end{array}$$

100 YEAR VOLUME

73 k

$$\begin{array}{cccccccc} & A & & B & & C & & \\ V_{100} = & .335 & + & .241 & + & .333 & = & 0.909\ Ac\text{-}ft = 39,600\ ft^3 \end{array}$$

Available Storage Volume

$$V_{ave} = \left(\frac{24,860 + 21,691}{2}\right)(1.25) = 29,094\ ft^3$$

Normal pool = 383.37

Storage pool = 384.62

Release Rate

Undeveloped flow

Outflow Rate

$$\begin{array}{cccccccc} & A & & B & & C & & \\ Q_u = & 10.6 & + & 8.5 & + & 9.8 & = & 28.9\ cfs \end{array}$$

Developed flow

$$Q_D^A = 11.57\ cfs$$

$$Q_D^B = 13.24\ cfs$$

$$Q_D^C = 9.2\ cfs$$

Hold

∴ Controlled outflow = 28.9 - (11.57 + 9.2) = 8.13 cfs

④

INLET CONTROL
NOMOGRAPH FOR PROJECTING CONCRETE PIPE
(Socket End)

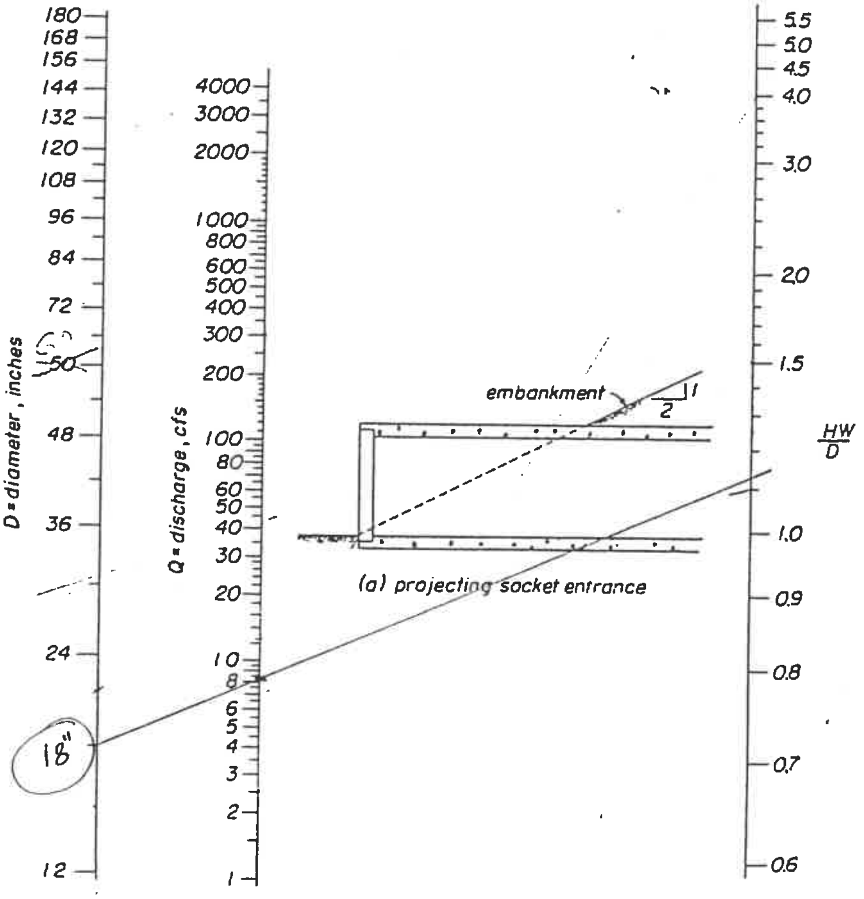


Fig. B-1

CONTROLLED OUTLET PIPE

$\frac{H_w}{D} = 1.13$

$H_w = (1.13)(1.5')$

$H_w = 1.70'$

$Q = 8.1$ cfs

$H_{dw} = 85.1 - 83.37$

$= 1.73$

Ⓐ

INLET CONTROL
NOMOGRAPH FOR PROJECTING CONCRETE PIPE
(Socket End)

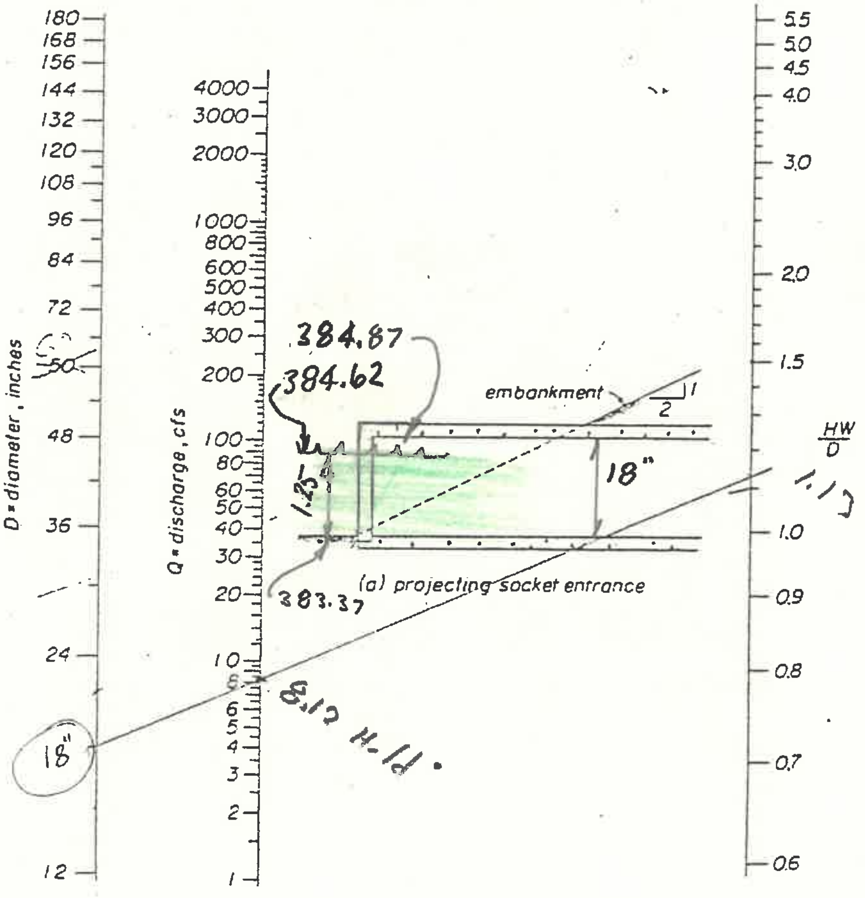


Fig. B-1

CONTROLLED OUTLET PIPE

$\frac{H_w}{D} = 1.13$

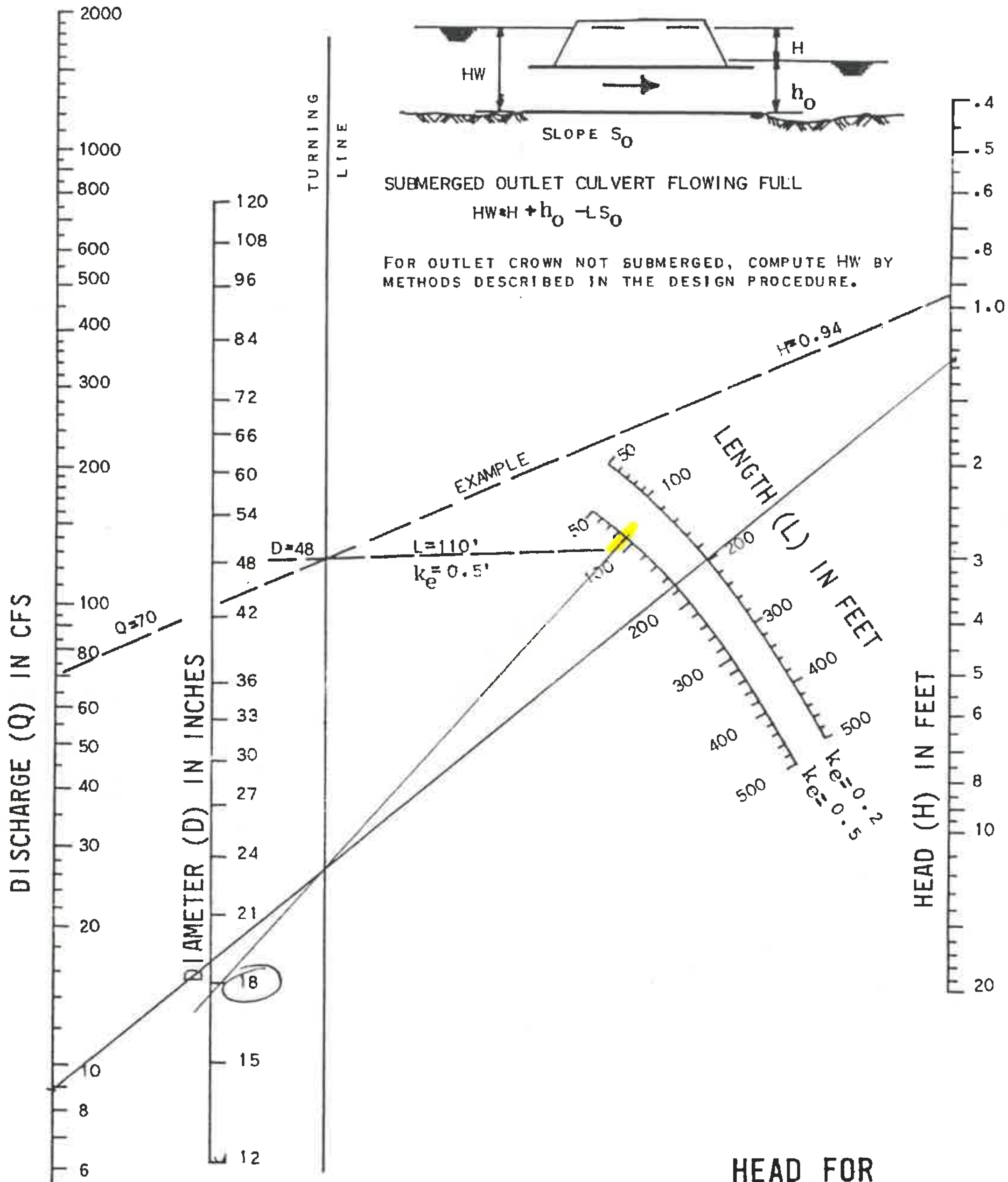
$H_w = (1.13)(1.5') \times 1.5'$

$H_w = 1.70'$

$Q = 8.1$ cfs

$H_{dw} = 85.1 - 83.37$

$= 1.73$



HEAD FOR
CONCRETE PIPE CULVERTS
FLOWING FULL
n=0.012

EQUALIZER PIPE

FIG. 7-430.01 W

$Q = \frac{2}{3}(13.24) = 8.8$ cfs
$H = 1.25'$
$L = 90'$
$K_e = 0.5$

APPENDIX

A

PROJECT: COP. II-A DATE: 10/17/91
ENGINEER:MORLEY AND ASSOCIATES,INC

DESIGN RETURN PERIOD: 5\25\100
RELEASE RATE PERIOD: 5\25\100
WATERSHED AREA (ACRES): 11.21
TIME OF CONCENTRATION(UNDEVELOPED): 35.3
RAINFALL INTENSITY (INCHES/HR): 3.15
UNDEVELOPED RUNOFF COEFFICIENT: 0.3
UNDEVELOPED RUNOFF RATE (CFS): 0
DEVELOPED RUNOFF COEFFICIENT: 0.4

25 YEAR STORM

STORM DURATION (HRS)	RAINFALL INTENSITY (INCH/HR)	INFLOW RATE (CFS)	OUTFLOW RATE (CFS)	STORAGE RATE (CFS)	REQUIRED STORAGE (ACRE-FT)	
0.08	6.85	30.72	10.59	20.12	0.134	
0.17	5.45	24.44	10.59	13.84	0.196	
0.25	4.65	20.85	10.59	10.26	0.214	
0.33	4.15	18.61	10.59	8.02	0.220	
0.42	3.80	17.04	10.59	6.45	0.226	9746 cf
0.50	3.40	15.25	10.59	4.65	0.194	
0.58	3.20	14.35	10.59	3.76	0.182	
0.67	2.85	12.78	10.59	2.19	0.122	
0.75	2.75	12.33	10.59	1.74	0.109	
0.83	2.60	11.66	10.59	1.06	0.074	
0.92	2.45	10.99	10.59	0.39	0.030	
1.00	2.30	10.31	10.59	-0.28	-0.023	
1.25	2.05	9.19	10.59	-1.40	-0.146	
1.50	1.85	8.30	10.59	-2.30	-0.287	
1.75	1.60	7.17	10.59	-3.42	-0.499	
2.00	1.40	6.28	10.59	-4.32	-0.719	
2.50	1.25	5.61	10.59	-4.99	-1.039	
3.00	1.10	4.93	10.59	-5.66	-1.415	
4.00	0.84	3.77	10.59	-6.83	-2.276	

PEAK STORAGE (ACRE/FT): 0.23 .224 AF
PEAK STORAGE (CUBIC FT): 9827.19 9746 cf

PROJECT: COP. II-B
ENGINEER:MORLEY AND ASSOCIATES,INC

DATE: 10/17/91

B

DESIGN RETURN PERIOD: 5\25\100
RELEASE RATE PERIOD: 5\25\100
WATERSHED AREA (ACRES): 8.53
TIME OF CONCENTRATION(UNDEVELOPED): 36.7
RAINFALL INTENSITY (INCHES/HR): 3.1
UNDEVELOPED RUNOFF COEFFICIENT: 0.32
UNDEVELOPED RUNOFF RATE (CFS): 0
DEVELOPED RUNOFF COEFFICIENT: 0.4

25 YEAR STORM

STORM DURATION (HRS)	RAINFALL INTENSITY (INCH/HR)	INFLOW RATE (CFS)	OUTFLOW RATE (CFS)	STORAGE RATE (CFS)	REQUIRED STORAGE (ACRE-FT)
0.08	6.85	23.37	8.46	14.91	0.099
0.17	5.45	18.60	8.46	10.13	0.144
0.25	4.65	15.87	8.46	7.40	0.154
0.33	4.15	14.16	8.46	5.70	0.157
0.42	3.80	12.97	8.46	4.50	0.158
0.50	3.40	11.60	8.46	3.14	0.131
0.58	3.20	10.92	8.46	2.46	0.119
0.67	2.85	9.72	8.46	1.26	0.070
0.75	2.75	9.38	8.46	0.92	0.058
0.83	2.60	8.87	8.46	0.41	0.028
0.92	2.45	8.36	8.46	-0.10	-0.008
1.00	2.30	7.85	8.46	-0.61	-0.051
1.25	2.05	6.99	8.46	-1.47	-0.153
1.50	1.85	6.31	8.46	-2.15	-0.269
1.75	1.60	5.46	8.46	-3.00	-0.438
2.00	1.40	4.78	8.46	-3.68	-0.614
2.50	1.25	4.27	8.46	-4.20	-0.874
3.00	1.10	3.75	8.46	-4.71	-1.177
4.00	0.84	2.87	8.46	-5.60	-1.865

6809 cf

PEAK STORAGE (ACRE/FT): 0.16 .158
PEAK STORAGE (CUBIC FT): 6866.55 6809 cF

C1

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PROJECT: COP. II-C                                  DATE:     10/17/91
ENGINEER:MORLEY AND ASSOCIATES,INC

DESIGN RETURN PERIOD:                         5\25\100
RELEASE RATE PERIOD:                          5\25\100
WATERSHED AREA (ACRES):                          10.76
TIME OF CONCENTRATION(UNDEVELOPED):               38.6
RAINFALL INTENSITY (INCHES/HR):                   2.95
UNDEVELOPED RUNOFF COEFFICIENT:                   0.31
UNDEVELOPED RUNOFF RATE (CFS):                       0
DEVELOPED RUNOFF COEFFICIENT:                      0.4




25 YEAR STORM

  STORM   RAINFALL  INFLOW    OUTFLOW  STORAGE REQUIRED
DURATION INTENSITY  RATE       RATE     RATE    STORAGE
  (HRS)  (INCH/HR)  (CFS)     (CFS)    (CFS)  (ACRE-FT)
-------------------------------------------------------
    0.08      6.85    29.48     9.84    19.64    0.131
    0.17      5.45    23.46     9.84    13.62    0.193
    0.25      4.65    20.01     9.84    10.17    0.212
    0.33      4.15    17.86     9.84     8.02    0.221
    0.42      3.80    16.36     9.84     6.52    0.228     9850 cf
    0.50      3.40    14.63     9.84     4.79    0.200
    0.58      3.20    13.77     9.84     3.93    0.190
    0.67      2.85    12.27     9.84     2.43    0.135
    0.75      2.75    11.84     9.84     2.00    0.125
    0.83      2.60    11.19     9.84     1.35    0.093
    0.92      2.45    10.54     9.84     0.70    0.054
    1.00      2.30     9.90     9.84     0.06    0.005
    1.25      2.05     8.82     9.84    -1.02   -0.106
    1.50      1.85     7.96     9.84    -1.88   -0.235
    1.75      1.60     6.89     9.84    -2.95   -0.431
    2.00      1.40     6.03     9.84    -3.81   -0.636
    2.50      1.25     5.38     9.84    -4.46   -0.929
    3.00      1.10     4.73     9.84    -5.11   -1.276
    4.00      0.84     3.62     9.84    -6.22   -2.075

PEAK STORAGE (ACRE/FT):            0.23
PEAK STORAGE (CUBIC FT):        9933.04    9850 cf
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PRELIMINARY

DRAINAGE REPORT

FOR:

COPPERFIELD SUBDIVISION
SECTION II

OWNER: EXCLUSIVE PROPERTIES, A LAND TRUST

ENGINEER: MORLEY AND ASSOCIATES, INC.

JAMES Q. MORLEY
No. [illegible]629

James Q. Morley

JANUARY 22, 1991

COPPERFIELD SUBDIVISION
SECTION II

The site is located approximately 1200 feet west of Highway 41 North along Mt. Pleasant Road in Center Township. The 30.5 acre site consists of 68 lots on the south side of Mt. Pleasant Road, adjacent to the Deerfield subdivision.

The existing site is largely pasture with small hills along the west side, Little Pigeon Creek along the east side, and a ditch dividing the north and south halves, and a ditch along the south side. The east portion of the property is subject to high return period flooding. The 100 year flood elevation for the northeast corner has been determined to be 388.65. Likewise, the 100 year flood elevation for the southeast corner has been determined to be 386.50.

The 30 acre site is divided into three general drainage areas. The northern area will be referred to as Drainage Area A. The middle area will be Drainage Area B. The southern area will be Drainage Area C. All drainage areas are designed without detention facilities due to the location at the bottom of the watershed areas and abutting Little Pigeon Creek.

Drainage Area A is the lowest 13 acres of a watershed area totaling 32 acres. This watershed includes the northern section of Deerfield as well as all of Copperfield Section I. The Deerfield development was designed to detain its runoff to a rate of 10 cubic feet per second (cfs). This is the maximum rate that exits the eastern lake. The storm water system in Copperfield Section I was designed to carry this outflow rate in addition to all of the developed flow rate for Copperfield Section I without detention facilities. At the time of construction of Copperfield Section I, the trunk line of the system was installed completely. The storm water runoff in Copperfield Section II will be made to drain toward the existing storm sewer trunk line constructed for Copperfield Section I. This trunk line runs west to east and lies 21.8 feet south of the centerline of Benningfield Drive. It will be necessary to install the curb inlets and laterals for the Northfield Drive and Southport Drive intersections.

Drainage Area B will include the watershed north of the small ridge at the southwest corner. This runoff will be directed into a concrete pipe system that flows generally from the west line to the south side of Beringer Drive, thence east to the intersection of Northfield Drive, and thence north to the existing ditch. This drainage area will carry a minimal amount of runoff from the abutting Deerfield development because most of the runoff will be intercepted by a new ditch along the west side and directed into Drainage Area C. This runoff will be directed to the existing ditch along the north line of Lot 44 through 49 and 87 through 90. This ditch will be cleaned and straightened.

Drainage Area C will have runoff flowing south from the small ridge to the existing ditches along the south side and to Little

Pigeon Creek to the east. The proposed streets in the north/south direction will drain from the existing high points to the south, or will drain to a forced low point in order to drain into the creek. The existing ditch along the south side of the development will be cleaned and straightened. This ditch will carry the developed runoff from this development as well as runoff from the 15 acres of the watershed area immediately west and currently contributing to this ditch.

All pipes are designed to carry a 25 year return period storm under developed conditions using the Rational Method.

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APPENDIX

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SECTION A

①

Sub-basin #21 $A_{21} = (286)(370) = 2.43$ Ac.

str.	$(6.5)(1600) = 11{,}700\ ft^2 = \overset{11\%}{0.27\ Ac}$ @ $0.95 \Rightarrow$	0.10
drive	$(6)(685) = 4110\ ft^2 = \overset{4\%}{0.09\ Ac}$ @ $0.95 \Rightarrow$	0.04
pavmt.	$(286+355)(15)+(195)(12)+1425 = \underset{72\%}{13{,}380}\ ft^2 = \overset{13\%}{0.31\ Ac}$ @ $0.95 \Rightarrow$	0.12
lawn	@ $0.185 \Rightarrow$	0.13
		$C_{21} = 0.39$

$$N_{21} = (.72)(.40) + (.28)(.02) = 0.29$$

$H = 397 - 389 = 8$

$L = 143 + 355 + 125 = 623$

$S = \frac{8}{623} = 0.0128$

$$t_c = .827\left[\frac{.29(623)}{\sqrt{.0128}}\right]^{.467} = 25.9 \text{ min}$$

$i_{25} = 3.65$ in/hr

$$Q_{21} = (0.43)(3.65)(2.43) = 3.81 \text{ cfs}$$

Sub basin #20 $A_{20} = (286)(253) = 1.67$ Ac.

str.	$(4)(1800) = 7200\ ft^2 = \overset{10\%}{0.16\ Ac}$ @ $0.95 \Rightarrow$	0.09
drive	$(4)(685) = 2740\ ft^2 = \overset{4\%}{0.06\ Ac}$ @ $0.95 \Rightarrow$	0.04
pavmt.	$(286+240+240)(15) = 11{,}490\ ft^2 = \overset{16\%}{\underset{70\%}{0.26\ Ac}}$ @ $0.95 \Rightarrow$	0.15
lawns	@ $0.185 \Rightarrow$	0.13
		$C_{20} = 0.41$

$$N_{20} = (.70)(.40) + (.30)(.02) = 0.29$$

$H = 398.5 - 389 = 9.50$

$L = 240 + 286 = 526$

$S = \frac{9.5}{526} = 0.0181$

$$t_c = .827\left[\frac{.29(526)}{\sqrt{.0181}}\right]^{.467} = 22.1 \text{ min}$$

$i_{25} = 3.85$ in/hr

$$Q_{20} = (0.45)(3.85)(1.67) = 2.89 \text{ cfs}$$

1-17-91

②

Sub-basin #22 $A_{22} = (230)(71.5) + (50)(25) = 0.41$ Ac.

str. $(1)(1800) = 1800 ft^2 = \overset{10\%}{0.04}$ Ac @ 0.95 ⇒ 0.10

drive $(2)(685) = 1370 ft^2 = \overset{8\%}{0.03}$ Ac @ 0.95 ⇒ 0.07

front. $(255+35)(15) = 4350 ft^2 = \overset{25\%}{0.10}$ Ac @ 0.95 ⇒ 0.23

lawn $\overset{57\%}{}$ @ 0.185 ⇒ 0.11

$C_{22} = 0.51$

$N_{22} = (.57)(.40) + (.43)(.02) = 0.24$

$H = 392 - 389 = 3$

$L = (71 + 240) = 311$

$S = \frac{3}{311} = 0.0096$ $t_c = .827\left[\frac{.24(311)}{\sqrt{.0096}}\right]^{.467} = 18.3$ min

$i_{25} = 4.3$ in/hr $Q_{22} = (0.56)(4.3)(0.41) = 0.99$ cfs

Sub-basin #23 $A_{23} = (345)(71.5) + (50)(25) = 0.60$ Ac.

str. $(1.5)(1800) = 2700 ft^2 = \overset{10\%}{0.06}$ Ac @ 0.95 ⇒ 0.10

drives $(3)(685) = 2055 ft^2 = \overset{8\%}{0.05}$ Ac @ 0.95 ⇒ 0.07

front. $(370 + 35)(15) = 6075 ft^2 = \overset{25\%}{0.14}$ Ac @ 0.95 ⇒ 0.22

lawn $\overset{59\%}{}$ @ 0.185 ⇒ 0.11

$C_{23} = 0.50$

$N_{23} = (.59)(.40) + (.41)(.02) = 0.24$

$H = 390 - 389 = 1$

$L = 345$

$S = \frac{1}{345} = 0.0029$ $t_c = .827\left[\frac{.24(345)}{\sqrt{.0029}}\right]^{.467} = 25.5$ min

$i_{25} = 3.7$ in/hr

$Q_{23} = (0.55)(3.7)(.60) = 1.22$ cfs

Sub-basin #24 $A_{24} = (215)(255) = 1.26$ Ac.

10%

sdw. (3)(1800) = 5400 ft² = 0.12 Ac @ 0.95 ⇒ 0.09

25%

drive (2)(685) = 1370 ft² = 0.03 Ac @ 0.95 ⇒ 0.02

12%

pavmt. (180)(12)+(215)(15)+1425 = 6810 ft² = 0.16 Ac @ 0.95 ⇒ 0.12

75.5%

lawns @ 0.185 ⇒ 0.14

$C_{24} = 0.37$

$N_{24} = (.755)(.40) + (.245)(.02) = 0.31$

H = 389.5 - 388 = 1.5

L = 71 + 240 + 125 = 436

$S = \frac{1.5}{436} = 0.0034$

$$t_c = .827\left[\frac{.31(436)}{\sqrt{.0031}}\right]^{.467} = 30.7 \text{ min}$$

$i_{25} = 3.25$ in/hr

$Q_{24} = (0.41)(3.25)(1.26) = 1.68$ cfs

Sub-basin #25 $A_{25} = (215)(355) = 1.75$ Ac.

12%

sdw. (5)(1800) = 9000 ft² = 0.21 Ac @ 0.95 ⇒ 0.11

4%

drive (4)(685) = 2740 ft² = 0.06 Ac @ 0.95 ⇒ 0.03

10%

pavmt (2[illegible])(12)+(194)(17)+1425 = 7293 ft² = 0.17 Ac @ 0.95 ⇒ 0.09

74%

lawns @ 0.185 ⇒ 0.14

$C_{25} = 0.37$

$N_{25} = (.74)(.40) + (.26)(.02) = 0.30$

H = 389 - 387.75 = 1.25

L = 105 + 120 + 245 = 470

$S = \frac{1.25}{470} = 0.0027$

$$t_c = .827\left[\frac{.30(470)}{\sqrt{.0027}}\right]^{.467} = 33.3 \text{ min.}$$

$i_{25} = 3.2$ in/hr

$Q_{25} = (.41)(3.2)(1.75) = 2.30$ cfs

1-17-91

Sub-basin # 26 $A_{26} = (80)(575) = 1.06$ Ac

str. $(2.5)(1800) = 4500$ ft^2 = $\overset{10\%}{0.10}$ Ac @ 0.95 ⇒ 0.09

drive $(5)(685) = 3425$ ft^2 = $\overset{7\%}{0.08}$ Ac @ 0.95 ⇒ 0.07

pvmt. $(165+210)(12) + 2850 = 7350$ ft^2 = $\overset{16\%}{0.17}$ Ac @ 0.95 ⇒ 0.15

lawn $\overset{67\%}{}$ @ 0.185 ⇒ 0.12

$C_{26} =$ 0.43

$$N = (.67)(.40) + (.33)(.02) = 0.27$$

$H = 390.50 - 387.95 = 2.55$

$L = 60 + 230 = 290$

$S = \frac{2.55}{290} = 0.0088$

$$t_c = .827 \left[\frac{.27\,(290)}{\sqrt{.0088}} \right]^{.467} = 19.1 \text{ min}$$

$i_{25} = 4.1$ in/hr

$$Q_{26} = (0.47)(4.1)(1.06) = 1.74 \text{ cfs}$$

Ⓐ

* Flow from Deerfield

STORM SEWER DESIGN SHEET – RATIONAL METHOD

PROJECT Copperfield Sec. II Ⓐ DATE 1-17-91 SHEET ____ OF ____

ENGINEER Morley & Associates, K. Free DESIGN STORM 25 YR. MANNINGS n 0.013

Line Number	Upstream Manhole	Downstream Manhole	Length (Ft)	C_j	A_j (Acres)	C_jA_j	ΣA_jC_j	t_j (min)	t_{cum} (min)	i $\left[\frac{\text{inches}}{\text{hr}}\right]$	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	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
											x0.0											
1	700	701	33	0.22	0.67	.15	.15	10.5	10.5	5.4	10.8	18"	1.67	14	8.7	0.1						
2	701	702	278.7	0.42	1.21	0.51	.66	16.4	16.4	4.5	12.97	18"	2.28	16.5	10.0	0.5						
3	702	704	286	.41	2.44	1.00	2.35	23.6	23.6	3.8	18.93	21"	1.78	22	9.6	0.5						
4	704	706	36.4	.43	2.43	1.04	4.14	25.9	25.9	3.65	25.11	27"	0.9	31	7.23	0.1						
5	706	708	250	.50	.60	.30	4.67	25.5	26.0	3.65	27.0	27"	0.9	31	7.23	0.6						
6	708	710	30	.41	1.75	.72	5.91	33.3	33.3	3.2	23.9	27"	0.9	31	7.3	0.1						
7	710	3IT	119	.47	1.06	.50	6.41	19.1	33.3	3.2	30.5	27"	0.9	31	7.4	0.3						
8	703	702	44	.39	1.77	0.69	.69	20.4	20.4	4.1	2.83	12"	1.0	3.6	5.0	0.15						
9	705	704	44	.45	1.67	.75	.75	22.1	22.1	3.85	2.89	12"	1.0	3.6	5.0	0.15						
10	707	706	44	.56	.41	.23	.23	18.3	18.3	4.3	0.99	12"	1.77	4.8	4.6	0.16						
11	709	708	44	.41	1.26	.52	.52	30.7	30.7	3.25	1.68	12"	1.0	3.6	4.4	0.17						

Figure 7.1 Storm Sewer Design Sheet - Rational Method

⑤

Pipe Velocity and Travel Time Ⓐ

Line # 1

$\frac{10.8}{14} = 0.77 \quad \therefore \quad V = (1.12)(7.8) = 8.7 \frac{ft}{sec}$

$t = \frac{1\ min}{60\ sec} \Big| \frac{1\ sec}{8.7\ ft} \Big| 33\ ft = 0.06\ min$

Line # 2

$\frac{12.97}{16.5} = .79 \quad \therefore \quad V = (1.12)(8.9) = 10.0$

$t = \frac{278.7}{(60)(10.0)} = 0.5\ min$

Line # 8

$\frac{2.83}{3.6} = .79 \quad \therefore \quad V = (1.12)(4.5) = 5.0$

$t = \frac{44}{(60)(5)} = 0.15\ min$

Line # 3

$\frac{18.93}{21} = .90 \quad \therefore \quad V = (1.14)(8.4) = 9.6$

$t = \frac{286}{(60)(9.6)} = 0.5\ min$

Line # 9

$\frac{2.89}{3.6} = .80 \quad \therefore \quad V = (1.125)(4.5) = 5.06$

$t = \frac{44}{(60)(5.06)} = 0.14\ min$

Line # 4

$\frac{25.11}{31} = .81 \quad \therefore \quad V = (1.13)(6.4) = 7.23$

$t = \frac{36.1}{(60)(7.23)} = 0.08\ min$

Line # 10

$\frac{.99}{4.8} = .21 \quad \therefore \quad V = (.76)(6) = 4.56$

$t = \frac{44}{(60)(4.56)} = 0.16$

1-17-91

Ⓐ

Line 5

$\frac{27}{31} = .87 \therefore V = (1.13)(6.4) = 7.23$

$t = \frac{250}{(60)(7.23)} = 0.58$ min

Line 11

$\frac{1.68}{3.6} = .47 \therefore V = (.97\ (4.5) = 4.36$

$t = \frac{44}{(60)(4.36)} = 0.17$

Line #6

$\frac{28.5}{31} = .93 \therefore V = (1.14)(6.4) = 7.30$

$t = \frac{30}{(60)(7.30)} = 0.07$ min

Line #7

$\frac{30.5}{31} = .98 \therefore V = (1.15)\ (6.4) = 7.36$

$t = \frac{119}{(60)(7.36)} = 0.27$ min

SECTION B & C

Copperfield - Section II

Drainage Calculations

Developed Conditions

Assumptions: average structure = 1800 ft^2

average drive per lot = (20)(9.25+25) = 685 ft^2

Return period = 25 years

$C^{25} = 1.1C$

Sub-Basin #1 $A_1 = 46,450\ ft^2 = 1.07\ Ac$

structures	3(1800) = 5400 ft^2 =	12%	0.12 Ac. @	0.95	⇒	0.11
drives	3(685) = 2055 ft^2 =	4%	0.05 Ac. @	0.95	⇒	0.04
pvmt.	(255)(12) + 1425 = 4485 ft^2 =	10%	0.10 Ac. @	0.95	⇒	0.09
lawn		74%	@	0.185	⇒	0.14

$C_1 = 0.38$

H = 417.25 - 405 = 12.25

L = 130 + 135 = 265'

$S = \frac{12.25}{265} = 0.0462$

$N_1 = (.74)(.40) + (.26)(.02) = 0.30$

$$t_c = .827\left[\frac{.30(265)}{\sqrt{.0462}}\right]^{.467} = 13.1\ min.$$

$i_{25} = 4.9\ in/hr$

$Q_1^{25} = (0.42)(4.9)(1.07) = 2.20\ cfs$

Sub-basin #2 $A_2 = 19,125\ ft^2 = 0.44\ Ac.$

str.	1(1800) = 1800 ft^2 =	9%	0.04 Ac. @	0.95	⇒	0.09
drives	2(685) = 1370 ft^2 =	7%	0.03 Ac. @	0.95	⇒	0.07
pvmt.	4485 ft^2 =	23%	0.10 Ac @	0.95	⇒	0.22
lawn		61%	@	0.185	⇒	0.11

$C_2 = 0.49$

H = 408 - 404 = 4

L = 150 + 30 = 180

$S = \frac{4}{180} = 0.0222$

$N_2 = (.61)(.40) + (.39)(.02) = 0.25$

$$t_c = .827\left(\frac{.25(180)}{\sqrt{.0222}}\right)^{.467} = 11.9\ min$$

$i_{25} = 5.20\ in/hr$

$Q_2 = (0.54)(5.20)(.44) = 1.24\ cfs$

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Sub-basin #3

$A_3 = 9700\ ft^2 = 0.22\ Ac.$

str. $.75(1800) = 1350\ ft^2 = \overset{14\%}{0.03}\ Ac.$ @ 0.95 ⇒ 0.13

drives 0

pmnt. 0

lawn 86% @ 0.185 ⇒ 0.16

$C_3 = 0.29$

$H = 408 - 402 = 6'$

$N_3 = (.86)(.40) + (.14)(.02) = 0.35$

$L = 100$

$S = \frac{6}{100} = 0.0600$

$t_c = .827\left[\frac{.35(100)}{\sqrt{.06}}\right]^{.467} = 8.4\ min$

$i_{25} = 5.75\ in/hr$

$Q_3 = (0.32)(5.75)(0.22) = 0.40\ cfs$

Sub-basin #4

$A_4 = 42{,}150\ ft^2 = 0.97\ Ac.$

str. $(3.5)(1800) = 6300\ ft^2 = \overset{15\%}{0.14}\ Ac.$ @ 0.95 ⇒ 0.14

drives $(3)(500) = 1500\ ft^2 = \overset{4\%}{0.03}\ Ac.$ @ 0.95 ⇒ 0.03

pmnt. 0

lawn 81% @ 0.185 ⇒ 0.15

$C_4 = 0.32$

$H = 405 - 399 = 6$

$N_4 = (.81)(.40) + (.19)(.02) = 0.33$

$L = 120 + 210 = 330'$

$S = \frac{6}{330} = 0.0182$

$t_c = .827\left[\frac{.33(330)}{\sqrt{.0182}}\right]^{.467} = 18.8\ min$

$i_{25} = 4.15\ in/hr$

$Q_4 = (0.35)(4.15)(.97) = 1.41\ cfs$

1-14-91

Sub. basin #5 $A_5 = 18{,}400\ ft^2 = 0.42\ Ac$

Str. (0.5)(1800) = 900 ft^2 = $\overset{5\%}{0.02\ Ac}$ @ 0.95 ⇒ 0.05

drives (1)(685) = 685 ft^2 = $\overset{4\%}{0.02\ Ac}$ @ 0.95 ⇒ 0.04

pavmt (230)(15)+(79)(13.5)+(203)(12)+(30)(12) = 7312.5 ft^2 = $\overset{40\%}{0.17\ Ac}$ @ .95 ⇒ 0.38

lawn $\overset{51\%}{}$ @ .185 ⇒ 0.09

$C_5 = 0.56$

$H = 407.5 - 397 = 10.5$

$L = 230 + 79 + 30 = 339$

$S = \frac{10.5}{339} = 0.0310$

$N_5 = (.51)(.40) + (.49)(.02) = 0.21$

$$t_c = .827 \left[\frac{.21(339)}{\sqrt{.0310}} \right]^{.467} = 13.6\ min$$

$i_{25} = 4.8\ in/hr$

$$Q_5 = (0.62)(4.8)(0.42) = 1.25\ cfs$$

Sub. basin #6 $A_6 = 72{,}700\ ft^2 = 1.67\ Ac$

str. (5)(1800) = 9000 ft^2 = $\overset{12\%}{0.21\ Ac}$ @ 0.95 ⇒ 0.12

drives (5)(685) = 3425 ft^2 = $\overset{5\%}{0.08\ Ac}$ @ 0.95 ⇒ 0.04

pavmt (245)(15)+(79)(13.5)+(30)(12) = 5101.5 ft^2 = $\overset{7\%}{0.12\ Ac}$ @ 0.95 ⇒ 0.07

lawn $\overset{76\%}{}$ @ .185 ⇒ 0.14

$C_6 = 0.37$

$H = 418 - 396 = 22$

$L = 245 + 79 + 30 + 150 = 504$

$S = \frac{22}{504} = 0.0437$

$N_6 = (.76)(.40) + (.24)(.02) = 0.31$

$$t_c = .827 \left[\frac{.31(504)}{\sqrt{.0437}} \right]^{.467} = 18.2\ min$$

$i_{25} = 4.15\ in/hr$

$$Q_6 = (0.41)(4.15)(1.67) = 2.84\ cfs$$

1-14-91

⑪

Sub. basin #7 $A_7 = 10{,}800\ ft^2 = 0.25$ Ac.

str. $(0.5)(1800) = 900\ ft^2 = \overset{8\%}{0.02\ Ac}$ @ 0.95 ⇒ 0.08

drives $(2)(685) = 1370\ ft^2 = \overset{13\%}{0.03\ Ac}$ @ 0.95 ⇒ 0.12

pvmt $(203)(12) = 2436\ ft^2 = \overset{23\%}{0.06\ Ac}$ @ 0.95 ⇒ 0.21

lawn $\overset{56\%}{}$ @ 0.185 ⇒ 0.10

$C_7 = 0.51$

$H = 403.75 - 396 = 7.75$

$L = 203$

$S = \frac{7.75}{203} = 0.0382$

$N_7 = (.56)(.40) + (.44)(.02) = 0.23$

$$t_c = .827\left[\frac{.23(203)}{\sqrt{.0382}}\right]^{.467} = 10.7 \text{ min}$$

$i_{25} = 5.4$ in/hr

$Q_7 = (0.56)(5.4)(0.25) = 0.76$ cfs

Sub. basin #8 $A_8 = 29{,}625\ ft^2 = 0.68$ Ac

str. $(1.75)(1800) = 3150\ ft^2$ $\overset{11\%}{0.07\ Ac}$ @ 0.95 ⇒ 0.10

drives $(2)(685) = 1370\ ft^2 = \overset{5\%}{0.03\ Ac}$ @ 0.95 ⇒ 0.04

pvmt. $(270)(12) + (120)(12) = 5470\ ft^2 = \overset{18.5\%}{0.13\ Ac}$ @ 0.95 ⇒ 0.18

lawn $\overset{65.5\%}{}$ @ 0.185 ⇒ 0.12

$C_8 = 0.44$

$H = 400 - 391 = 9$

$L = 120 + 110 + 0 = 290$

$S = \frac{9}{290} = 0.0310$

$N_8 = (.655)(.40) + (.345)(.02) = 0.27$

$$t_c = .827\left[\frac{.27(290)}{\sqrt{.0310}}\right]^{.467} = 14.2 \text{ min}$$

$i_{25} = 4.8$ in/hr

$Q_8 = (0.48)(4.8)(0.68) = 1.57$ cfs

1-14-91

⑫

Sub-basin # 9A

A_{9A} = 10,275 ft^2 = 0.24 Ac.

str. (0.5)(1800) = 900 ft^2 = 0.02 Ac @ 0.95 ⇒ 9% 0.08

drivea (1)(685) = 685 ft^2 = 0.02 Ac @ 0.95 ⇒ 7% 0.06

pvmt. (140 + 120)(15) = 3900 ft^2 = 0.09 Ac @ 0.95 ⇒ 38% 0.36

lawn @ 0.185 ⇒ 46% 0.09

C_{9A} = 0.59

H = 392 - 390 = 2

L = 120

$S = \frac{2}{120}$ 0.0167

$N_{9A} = (.46)(.40) + (.54)(.02) = 0.19$

$$t_c = .827 \left[\frac{.19(120)}{\sqrt{.0167}}\right]^{.467} = 9.3 \text{ min}$$

i_{25} = 5.5 in/hr

$Q_{9A} = (0.65)(5.5)(.24) = 0.86$ cfs

Subbasin # 10

A_{10} = 38,425 ft^2 = 0.88 Ac

str. (2)(1800) = 3600 ft^2 = 0.08 Ac @ 0.95 ⇒ 9% 0.09

drivea (2)(685) = 1370 ft^2 = 0.03 Ac @ 0.95 ⇒ 4% 0.03

pvmt. (270 + 130)(15) = 6000 ft^2 = 0.14 Ac @ 0.95 ⇒ 16% 0.15

lawn @ 0.185 ⇒ 71% 0.13

C_{10} = 0.40

H = 396 - 391 = 5

L = 245

$S = \frac{5}{245}$ = 0.0204

$N_{10} = (.71)(.40) + (.29)(.02) = 0.29$

$$t_c = .827 \left[\frac{.29(245)}{\sqrt{.0204}}\right]^{.467} = 15.0 \text{ min}$$

i_{25} = 4.7 in/hr

$Q_{10} = (.44)(4.7)(.88) = 1.82$ cfs

Sub-basin #11 A_{11} = 20,300 ft² = 0.47 Ac

str. (1)(1800) = 1800 ft² = $\overset{9\%}{0.04}$ Ac @ 0.95 ⇒ 0.08

drive (1)(685) = 685 ft² = $\overset{3\%}{0.02}$ Ac @ 0.95 ⇒ 0.03

pvmt. (140+145)(15) = 4275 ft² = $\overset{21\%}{0.10}$ Ac @ 0.95 ⇒ 0.20

lawn 67% @ 0.185 ⇒ 0.12

C_{11} = 0.43

H = 389.5 - 389.0 = 0.5

L = 145

$S = \frac{0.5}{145} = 0.0034$

$N_{11} = (.67)(.40) + (.33)(.02) = 0.27$

$t_c = .827 \left[\frac{.27(145}{\sqrt{.0034}} \right]^{.467} = 17.2$ min

i_{25} = 4.4 in/hr

$Q_{11} = (.47)(4.4)(.47) = 0.97$ cfs

Subbasin #9B A_{9B} = 30,625 ft² = 0.70 Ac.

str. (2.5)(1800) = 4500 ft² = $\overset{15\%}{0.10}$ Ac @ 0.95 ⇒ 0.14

drive 0

pvmt. 0

lawn 85% @ 0.185 ⇒ 0.16

C_{9B} = 0.30

H = 388 - 386 = 2

L = 300

$S = \frac{2}{300} = 0.0067$

$N = (.85)(.40) + (.15)(.02) = 0.34$

$t_c = .827 \left[\frac{.34(300)}{\sqrt{.0067}} \right]^{.467} = 23.1$ min

i_{25} = 3.8 in/hr

$Q_{9B} = (.33)(3.8)(.70) = 0.88$ cfs

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⑭

Sub-basin # 12 $A_{12} = 20,030\ ft^2 = 0.46\ Ac$

str. $(1)(1800) = 1800\ ft^2 = \overset{9\%}{0.04}\ Ac\ @\ 0.95 \Rightarrow$ 0.09

drive $(2)(685) = 1370\ ft^2 = \overset{7\%}{0.03}\ Ac\ @\ 0.95 \Rightarrow$ 0.06

prom. $(90)(15)+(78)(13.5)+(70)(12) = 4443\ ft^2 = \overset{22\%}{0.10}\ Ac\ @\ 0.95 \Rightarrow$ 0.21

lawn $\overset{62\%}{}\ @\ 0.185 \Rightarrow$ 0.11

$C_{12} = 0.47$

$H = 389 - 387.5 = 1.50$

$L = 180 + 15 = 195$

$S = \frac{1.5}{195} = 0.0077$

$N_{12} = (.62)(.40) + (.38)(.02) = 0.26$

$$t_c = .827\left[\frac{.26(195)}{\sqrt{.0077}}\right]^{.467} = 16.1\ min$$

$i_{25} = 4.5\ in/hr$

$$Q_{12} = (0.52)(4.5)(0.46) = 1.08\ cfs$$

Sub-basin # 13 $A_{13} = 36,975\ ft^2 = 0.85\ ft^2$

str. $(25)(1800) = 4500\ ft^2 = \overset{12\%}{0.10}\ Ac\ @\ 0.95 \Rightarrow$ 0.12

drive $(5)(685) = 3425\ ft^2 = \overset{9\%}{0.08}\ Ac\ @\ 0.95 \Rightarrow$ 0.09

prom. $4443\ ft^2 = \overset{12\%}{0.10}\ Ac\ @\ 0.95 \Rightarrow$ 0.11

lawn $\overset{67\%}{}\ @\ 0.185 \Rightarrow$ 0.12

$C_{13} = 0.44$

$N_{13} = (.67)(.40) + (.33)(.02) = 0.27$

$H = 389 - 387.5 = 1.5$

$L = 195$

$S = \frac{1.5}{195} = 0.0077$

$$t_c = .827\left[\frac{.27(195)}{\sqrt{.0077}}\right]^{.467} = 16.4\ min$$

$i_{25} = 4.45\ in/hr$

$$Q_{13} = (0.48)(4.45)(.85) = 1.82\ cfs$$

Sub-basin #14 $A_{14} = 7675\ ft^2 = 0.18\ Ac$

str. $(0.5)(1800) = 900\ ft^2 = 0.02\ Ac$ (12%) @ 0.95 ⇒ 0.11

drive 0

pvmt. 0

lawn 88% @ 0.185 ⇒ 0.16

$C_{14} = 0.27$

$H = 408 - 400 = 8$

$L = 150$

$S = \frac{8}{150} = 0.0533$

$N_{14} = (.88)(.40) + (.12)(.02) = 0.35$

$$t_c = .827 \left[\frac{.35(150)}{\sqrt{.0533}} \right]^{.467} = 10.4\ min$$

$i_{25} = 5.35\ in/hr$

$Q_{14} = (.30)(5.35)(.18) = 0.29\ cfs$

Sub-basin #15 $A_{15} = 34{,}100\ ft^2 = 0.78\ Ac$

str. $(1.75)(1800) = 3150\ ft^2 = 0.07\ Ac$ (9%) @ 0.95 ⇒ 0.09

drive $(2)(685) = 1370\ ft^2 = 0.03\ Ac$ (4%) @ 0.95 ⇒ 0.04

pvmt. $(183)(24) + 2850 = 7242\ ft^2 = 0.17\ Ac$ (21) @ 0.95 ⇒ 0.20

lawn 66% @ 0.185 ⇒ 0.12

$C_{15} = 0.45$

$H = 408 - 397 = 11$

$L = 50 + 130 + 110 = 290$

$S = \frac{11}{290} = .0379$

$N_{15} = (.66)(.40) + (.34)(.02) = 0.27$

$$t_c = .827 \left[\frac{.27(290)}{\sqrt{.0379}} \right]^{.467} = 13.6\ min$$

$i_{25} = 4.9\ in/hr$

$Q_{15} = (0.50)(4.9(0.78) = 1.91\ cfs$

Sub-basin # 16

$A_{16} = 42,125 \text{ ft}^2 = 0.97 \text{ Ac}$

16%

str. $(3.75)(1800) = 6750 \text{ ft}^2 = 0.16 \text{ Ac} @ 0.95 \Rightarrow$ 0.15

65%

drive $(4)(685) = 2740 \text{ ft}^2 = 0.06 \text{ Ac} @ 0.95 \Rightarrow$ 0.06

front. 0

77.5%

lawn $@ 0.185 \Rightarrow$ 0.14

$C_{16} = 0.35$

$H = 403.5 - 391 = 12$

$L = 120 + 285 = 405$

$S = \frac{12}{405} = 0.0296$

$N = (.775)(.40) + (.225)(.02) = 0.31$

$$t_c = .827 \left[\frac{.31(405)}{\sqrt{.0296}} \right]^{.467} = 18.0 \text{ min}$$

$i_{25} = 4.2 \text{ in/hr}$

$Q_{16} = (.385)(4.2)(.97) = 1.57 \text{ cfs}$

Sub-basin # 17

$A_{17} = 89,700 \text{ ft}^2 = 2.06 \text{ Ac}$

12%

str. $(6)(1800) = 10,800 \text{ ft}^2 = 0.25 \text{ Ac} @ 0.95 \Rightarrow$ 0.11

6%

drive $(8)(685) = 5480 \text{ ft}^2 = 0.13 \text{ Ac} @ 0.95 \Rightarrow$ 0.06

13%

front $(303)(29) + 2850 = 11,637 \text{ ft}^2 = 0.27 \text{ A} @ 0.95 \Rightarrow$ 0.12

69%

lawn $@ 0.185 \Rightarrow$ 0.13

$C_{17} = 0.42$

$H = 399 - 389 = 10$

$L = 145 + 360 = 505$

$S = \frac{10}{505} \; 0.0198$

$N_{17} = (.69)(.40) + (.31)(.02) = 0.28$

$$t_c = .827 \left[\frac{.28(505)}{\sqrt{.0198}} \right]^{.467} = 20.9 \text{ min}$$

$i_{25} = 4.05 \text{ in/hr}$

$Q_{17} = (0.46)(4.05)(2.06)$

$= 3.84 \text{ cfs}$

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⑱

Sub-basin # 18 $A_{18} = 27{,}600\ ft^2 = 0.63\ Ac.$

str.	$(2.5)(1800) = 4500\ ft^2 =$	16% $0.10\ Ac$ @ 0.95 ⇒		0.15
drive	0			
pvmt	0			
lawn		84% @ 0.185 ⇒		0.16
				$C_{18} = 0.31$

$H = 389 - 386 = 3$

$L = 60 + 235 = 295$

$S = \frac{3}{295} = 0.0102$

$N_{18} = (.84)(.40) + (.16)(.02) = 0.34$

$t_c = .827 \left[\frac{.34\,(295)}{\sqrt{.0102}}\right]^{.467} = 20.8\ min$

$i_{25} = 4.05\ in/hr$

$Q_{18} = (0.34)(4.05)(.63) = 0.87\ cfs$

Sub-basin # 19 $A_{19} = 46{,}400\ ft^2 = 1.06\ Ac.$

str.	$(3)(1800) = 5400\ ft^2 =$	12% $0.12\ Ac$ @ 0.95 ⇒	0.11
drive	$(6)(685) = 4110\ ft^2 =$	9% $0.09\ Ac$ @ 0.95 ⇒	0.08
pvmt.	$(165)(24) + 2850 = 6810\ ft^2 =$	15% $0.16\ Ac$ @ 0.95 ⇒	0.14
lawn		64% @ 0.185 ⇒	0.12
			$C_{19} = 0.45$

$H = 389 - 387.50 = 1.5$

$L = 80 + 225 = 305$

$S = \frac{1.5}{305} = 0.0049$

$N_{19} = (.64)(.40) + (.36)(.02) = 0.26$

$t_c = .827 \left[\frac{.26\,(305)}{\sqrt{.0049}}\right]^{.467} = 22.0\ min$

$i_{25} = 4.0\ in/hr$

$Q_{19} = (0.50)(4.0)(1.06) = 2.12\ cfs$

Sub-basin # 17A

$A_{17A} = (145)(390) = 56,550\ ft^2 = 1.30\ Ac$

13%

str. (4)(1800) = 7200 ft² = 0.165 Ac @ 0.95 ⇒ 0.12

5%

drive (4)(685) = 2740 ft² = 0.06 Ac @ 0.95 ⇒ 0.05

11%

pvmt (303)(15) + 1425 = 5970 ft² = 0.14 Ac @ 0.95 ⇒ 0.10

71%

lawn @ 0.185 ⇒ 0.13

$C_{17A} = 0.40$

$N_{17A} = (.71)(.40) + (.29)(.02) = 0.29$

H = 399 − 389 = 10

L = 130 + 370 = 500

$S = \frac{10}{500} = 0.0200$

$$t_c = .827\left[\frac{.29(500)}{\sqrt{.0200}}\right]^{.467} = 21.1\ min$$

$i_{25} = 4.5\ in/hr$

$Q_{17A} = (.44)(4.5)(1.30) = 2.57\ cfs$

Sub-basin # 17B

$A_{17B} = (90)(390) = 35,100\ ft^2 = 0.81\ Ac$

10%

str (2)(1800) = 3600 ft² = 0.08 Ac @ 0.95 ⇒ 0.10

8%

drives (4)(685) = 2740 ft² = 0.06 Ac @ 0.95 ⇒ 0.07

17%

pvmt. (303)(15) + 1425 = 5970 ft² = 0.14 Ac @ 0.95 ⇒ 0.16

65%

lawn @ 0.185 ⇒ 0.12

$C_{17B} = 0.45$

$N_{17B} = (.65)(.40) + (.35)(.02) = 0.27$

H = 393 − 389 = 4

L = 360

$S = \frac{4}{360} = 0.0111$

$$t_c = .827\left[\frac{.27(360)}{\sqrt{.0111}}\right]^{.467} = 20.0\ min$$

$i_{25} = 4.1\ in/hr$

$Q_{17B} = (0.50)(4.1)(0.81) = 1.66\ cfs$

1-17-91

Sub-basin #18 $A_{18} = 27{,}600\ ft^2 = 0.63\ Ac$

str. (2.5)(1800) = 4500 ft² = $\overset{16\%}{0.10\ Ac}$ @ 0.95 ⇒ 0.15

drive 0

pont 0

lawn 84% @ 0.185 ⇒ 0.16

$C_{18} = 0.31$

$N_{18} = (.84)(.40) + (.16)(.02) = 0.34$

H = 389 - 386 = 2

L = 60 + 235 = 295

$S = \frac{2}{295} = 0.0068$

$$t_c = .827\left[\frac{.34(295)}{\sqrt{.0068}}\right]^{.467} = 22.8\ min$$

$i_{25} = 4.7\ in/hr$

$Q_{18} = (.34)(4.7)(0.63) = 1.01\ cfs$

Sub-basin #19 $A_{19} = 46{,}400\ ft^2 = 1.06\ Ac$

str. (3)(1800) = 5400 ft² = $\overset{12\%}{0.12\ Ac}$ @ 0.95 ⇒ 0.11

drives (6)(685) = 4110 ft² = $\overset{9\%}{0.09\ Ac}$ @ 0.95 ⇒ 0.08

pont (165)(24) + 2850 = 6810 ft² = $\overset{15\%}{0.16\ Ac}$ @ 0.95 ⇒ 0.14

lawn 64% @ 0.185 ⇒ 0.12

$C_{19} = 0.45$

$N_{19} = (.64)(.40) + (.36)(.02) = 0.26$

H = 389 - 387.5 = 1.5

L = 80 + 220 = 300

$S = \frac{1.5}{300} = 0.0050$

$$t_c = .827\left[\frac{.26(300)}{\sqrt{.0050}}\right]^{.467} = 21.8\ min$$

$i_{25} = 4.0\ in/hr$

$Q_{19} = (.50)(4.0)(1.06) = 2.12\ cfs$

SECT. Ⓑ

STORM SEWER DESIGN SHEET – RATIONAL METHOD

PROJECT Copperfield Section II Ⓑ DATE 1-17-91 SHEET ____ OF ____

ENGINEER Morley & Associates K. Pofe DESIGN STORM 25 Year MANNINGS n 0.013

Line Number	Upstream Manhole	Downstream Manhole	Length (Ft)	C_j	A_j (Acres)	C_jA_j	ΣA_jC_j	t_j (min)	t_{cum} (min)	i [inches/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	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1B	1400	1401	24	.42	1.07	.45	.45	13.1	13.1	4.9	2.20	12"	0.5	2.55	3.67	0.11						
2B	1401	1402	131.75	.54	.44	.24	.69	11.9	13.2	4.9	3.38	12"	1.0	3.6	5.13	0.43						
3B	1402	1403	199	.32	.22	.07	.76	8.4	13.6	4.8	3.65	12"	1.25	4.0	5.75	0.56						
4B	1403	1404	123	.35	.97	.34	1.10	18.8	18.8	4.15	4.56	12"	1.75	4.75	6.78	0.30						
5B	1404	1406	36	.62	.42	.26	1.36	13.6	19.1	4.1	5.58	15"	0.8	6.0	5.42	0.11						
6B	1406	1407	245	.56	.25	.14	2.18	10.7	19.2	4.1	8.94	18"	0.7	9.2	5.69	0.72						
7B	1407	1408	44	.48	.68	.33	2.51	14.2	19.9	4.1	10.29	18"	0.9	11	6.50	0.11						
8B	1408	1410	44	.65	.24	.16	2.66	9.3	20.0	4.1	10.91	18"	0.9	11	6.55	0.11						
9B	1410	1411	118	.47	.47	.22	3.27	17.2	20.1	4.05	13.24	18"	1.4	15.5	7.91	0.25						
10B	1405	1406	36.5	.41	1.67	.68	.68	18.2	18.2	4.15	2.84	12"	0.7	3.05	4.33	0.14						
11B	1409	1410	44	.44	.88	.39	.39	15.0	15.0	4.7	1.83	12"	0.5	2.6	3.47	0.21						

Figure 7.1 Storm Sewer Design Sheet - Rational Method

Sect. Ⓒ

STORM SEWER DESIGN SHEET – RATIONAL METHOD

PROJECT Copperfield Section II Ⓒ DATE 1-18-91 SHEET ____ OF ____

ENGINEER Morley & Associates, Inc / K. Poff DESIGN STORM 25 YR. MANNINGS n 0.013

Line Number	Upstream Manhole	Downstream Manhole	Length (Ft)	C_j	A_j (Acres)	C_jA_j	ΣA_jC_j	t_j (min)	t_{cum} (min)	i $\left[\frac{\text{inches}}{\text{hr}}\right]$	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	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1C	1412	1413	120	.33	.70	.23	.23	23.1	23.1	3.8	.88	12	0.2	1.6	2.09	0.96						
2C	1413	1414	25	.52	.46	.24	.47	16.1	24.1	3.75	1.76	12	0.3	2.0	2.32	0.15						
3C	1414	1415	122	.48	.85	.41	.88	16.4	24.2	3.75	3.30	15	0.3	3.75	3.34	0.61						
1D	1416	1417	55	.50	.78	.39	.39	13.6	13.6	4.9	1.91	12	0.5	2.6	3.52	0.26						

Ⓒ

Figure 7.1 Storm Sewer Design Sheet - Rational Method

Line 1B $\frac{2.20}{2.55} = .86 \Rightarrow V = 1.13(3.25) = 3.67$

$t = \frac{24}{(60)(3.67)} = 0.11$ min

Line 2B $\frac{3.38}{3.6} = .94 \Rightarrow V = 1.14(4.5) = 5.13$

$t = \frac{131.75}{(60)(5.13)} = 0.43$ min

Line 3B $\frac{3.\overset{65}{\cancel{86}}}{4} = \overset{.91}{\cancel{.97}} \Rightarrow V = 1.15(5) = 5.75$

$t = \frac{199}{(60)(5.75)} = 0.58$ min

Line 4B $\frac{4.56}{4.75} = .96 \Rightarrow V = 1.15(5.9) = 6.78$

$t = \frac{123}{(60)(6.78)} = 0.30$ min

Line 5B $\frac{5.56}{6} = .93 \Rightarrow V = 1.14(4.75) = 5.42$

$t = \frac{36}{(60)(5.42)} = 0.11$ min

Line 10B $\frac{2.84}{3.05} = .93 \Rightarrow V = 1.14(3.8) = 4.33$

$t = \frac{36.5}{(60)(4.33)} = 0.14$ min

Line 6B $\frac{8.91}{9.2} = .97 \Rightarrow V = 1.15(4.95) = 5.69$

$t = \frac{245}{(60)(5.69)} = 0.72$ min

$18 = 1.77 \text{ ft}^2$

Line 7B $\frac{10.29}{11} = .94 \Rightarrow V = 1.14(5.7) = 6.50$

$t = \frac{44}{(60)(6.50)} = 0.11$ min

Line 9B $\frac{13.24}{15.5} = .85 \Rightarrow 1.13(7) = 7.91$

$t = \frac{118}{(60)(7.91)} = 0.25$ min

Line 8B $\frac{10.91}{11} = .99 \Rightarrow V = 1.15(5.7) = 6.55$

$t = \frac{44}{(60)(6.55)} = 0.11$ min

Line 11B $\frac{1.83}{2.6} = .70 \Rightarrow 1.085(3.2) = 3.47$

$t = \frac{44}{(60)(3.47)} = 0.21$

1-18-91

Line 1C

$$\frac{.88}{1.6} = .55 \Rightarrow V = 1.02(2.05) = 2.09$$

$$t = \frac{120}{(60)(2.09)} = 0.96$$

Line 2C

$$\frac{1.76}{2} = .88 \Rightarrow V \neq 1.13(2.5) = 2.82$$

$$t = \frac{25}{(60)(2.82)} = 0.15$$

Line 3C

$$\frac{3.75}{3.75} = 1.00 \Rightarrow V = 1.15(2.9) = 3.34$$

$$t = \frac{122}{(60)(3.34)} = 0.61$$

Line 1D

$$\frac{1.91}{2.6} = .74 \Rightarrow V = 1.10(3.2) = 3.52$$

$$t = \frac{55}{(60)(3.52)} = 0.26 \text{ min}$$

PRELIMINARY

DRAINAGE REPORT

FOR

COPPERFIELD SUBDIVISION

OWNER: EXCLUSIVE PROPERTIES,
A LAND TRUST

ENGINEER : MORLEY AND ASSOCIATES, INC.

JAMES Q. MORLEY
REGISTERED
No. 12629
STATE OF INDIANA
LAND SURVEYOR

James Q. Morley

AUGUST 1988

COPPERFIELD SUBDIVISION

The site is located approximately 1200 feet west of Highway 41 North along Mt. Pleasant Road in Center Township. The 19.8 acre site consists of 43 lots on the south side of Mt. Pleasant Road, adjacent to the Deerfield subdivison. Copperfield is to be developed in two phases, with Phase I containing Lots 1 through 21.

The existing site is largely pasture with small hills along the west side, Little Pigeon Creek along the east side, and a ditch dividing the north and south half. There are also existing ditches along the northwest and south sides. The east portion of the property is subject to high return period flooding. The 100 year flood elevation for the northeast corner has been determined to be 389.50. Likewise, the 100 year flood elevation for the southeast corner has been determined to be 388.50.

The general drainage plan is to have individual lot swales drain across the curbs into the street gutters. The north-south streets would drain to the center street (Benningfield Drive). The storm water would then enter the pipe system through curb inlets placed at the intersections. The pipe system is designed to carry the maximum outflow from the neighboring lake in addition to the 25 year developed storm runoff from this site. The system will consist of RCP with large capacity curb inlets, all draining to the east nearly along the location of the existing ditch.

A temporary sediment basin will be constructed on Lot 41 and remain in place until 35 lots are improved or a lesser time as determined by the County Surveyor's office.

COPPERFIELD

DRAINAGE CALCULATIONS

UNDEVELOPED CONDITIONS

$$Q_{25} = c\, i_{25} A$$

where $A = 19.82$ acres

$$C = \left(\frac{\frac{0.5[(500)(30)+(220)(600)]}{43{,}560}}{19.82} \right)(0.36) + \left(\text{Remainder} \right)(0.30)$$

$$= (0.17)(0.36) + (0.83)(0.30)$$

$$C = 0.31$$

$H = 416 - 385 = 31$ ft

$L = 700 + 410 + 290 = 1400$ ft

$S = \frac{31}{1400} = 0.0221$

$N = 0.40$

$$t_c = .827 \left[\frac{.4(1400)}{\sqrt{.0221}} \right]^{.467} = 38.7 \text{ min}$$

$$i_{25} = 2.9 \text{ in}/\text{hr}$$

$$\therefore\ Q^{u}_{25} = (.31)(2.9)(19.82)$$

$$= 17.8 \text{ cfs}$$

8/4/88

COPPERFIELD

DEVELOPED CONDITIONS

AVERAGE ROOF PER LOT = 1800 ft^2

AVERAGE DRIVE PER LOT = $20' \times \left[\overset{C/W}{(25)} + \overset{BLD}{(25)} - 12\right] = 760\ ft^2$

SUB-BASIN 1 $A_1 = \frac{1}{2}\left[(100)(225) + (75)(285)\right] + (25)(285) = 29{,}063 = 0.67\ Ac$

Structures 1 = 1800 ft^2 = $\overset{6\%}{0.04\ Ac}$ @ 0.95 ⇒ 0.06

Lawn Flat (140)(70) = 9800 ft^2 = $\overset{34\%}{0.23\ Ac}$ @ 0.135 ⇒ 0.05

Rolling $\overset{60\%}{}$ @ 0.185 ⇒ 0.11

$C_1 = 0.22$

$H = 416 - 398 = 18$

$L = 285 + 95 = 380$

$S = \frac{18}{380} = 0.0474$

$N = (.08)(.02) + (.92)(0.40) = 0.37$

$$t_c = .827\left[\frac{.37(380)}{\sqrt{.0474}}\right]^{.467} = 10.5\ min$$

$i_{25} = 5.4\ in/hr$ $Q_{25} = (0.22)(5.4)(0.67) = 0.80\ cfs$

Sub-basin 2A

$A_{2A} = (45)(285) + \frac{1}{2}(75)(285) = 23{,}513 = 0.54\ Ac.$

Structures 1.5 = 2700 ft^2 = $\overset{11\%}{0.06\ Ac}$ @ 0.95 ⇒ 0.11

Drives 2 = 1520 ft^2 = $\overset{6\%}{0.03\ Ac}$ @ 0.95 ⇒ 0.06

Pvmt. $(130)(12) + \frac{1}{2}\left[(\pi)(30)^2\right] = 2974\ ft^2 = \overset{13\%}{0.07\ Ac}$ @ 0.95 ⇒ 0.13

Lawn $\overset{70\%}{Ac}$ @ 0.160 ⇒ 0.11

$C_{2A} = 0.41$

$H = 416 - 400.5 = 15.5$

$N = (.70)(.40) + (.30)(.02) = 0.29$

$L = 120 + 285 = 405$

$S = \frac{15.5}{405} = 0.0383$

$$t_c = .827\left[\frac{.29(405)}{\sqrt{.0383}}\right]^{.467} = 16.4\ min$$

$i_{25} = 4.5\ in/hr$ $Q_{25}^{2A} = (.41)(4.5)(.54) = 1.00\ cfs$

Sub-basin 2B

$A_{2B} = (45)(310) + 1/2\left[(95)(90) + (95)(220) + (30)(45)\right] = 29{,}350 \text{ ft}^2 = 0.67 \text{ Ac}$

Structures $2.5 = 4500 \text{ ft}^2 = \overset{15\%}{0.10 \text{ Ac}} \ @ \ 0.95 \Rightarrow 0.15$

Drives $3 = 2280 \text{ ft}^2 = \overset{8\%}{0.05 \text{ A}} \ @ \ 0.95 \Rightarrow 0.07$

Pvmt. $(12)(200) + 1413 \text{ ft}^2 = 3814 \text{ ft}^2 = \overset{13\%}{0.09 \text{ Ac}} \ @ \ 0.95 \Rightarrow 0.12$

$\overset{64\%}{}$

Lawn $@ \ 0.160 \Rightarrow \underline{0.10}$

$C_{2B} = 0.44$

$H = 412 - 400.5 = 11.5$ $\qquad N = .64(.4) + .36(.02) = 0.26$

$L = 140 + 220 = 360$

$S = \frac{11.5}{360} = 0.0319$ $\qquad t_c = .827\left[\frac{.26(360)}{\sqrt{.0319}}\right]^{.467} = 15.4 \text{ min}$

$i_{25} = 4.6 \text{ in}/\text{hr}$ $\qquad Q_{25}^{2B} = (.44)(4.6)(.67) = 1.36 \text{ cfs}$

Sub-basin 3A

$A_{3A} = (286)(270) = 77{,}220 \text{ ft}^2 = 1.77 \text{ Ac.}$

Structures $4 = 7200 \text{ ft}^2 = \overset{9\%}{0.17 \text{ Ac}} \ @ \ 0.95 \Rightarrow 0.09$

Drives $4 = 3040 \text{ ft}^2 = \overset{4\%}{0.07 \text{ Ac}} \ @ \ 0.95 \Rightarrow 0.04$

Pvmt. $(12)(286 + 270 + 130) + 1413 + 3/4\left[(\pi)(25)^2\right] = \underset{73\%}{11{,}034} \text{ ft}^2 = \overset{14\%}{0.25 \text{ Ac}} \ @ \ 0.95 \Rightarrow 0.14$

Lawn $@ \ 0.160 \Rightarrow \underline{0.12}$

$C_{3A} = 0.39$

$H = 412 - 395 = 17$ $\qquad N = .73(.4) + .27(.02) = 0.30$

$L = 270 + 286 = 556$

$S = \frac{17}{556} = 0.0306$ $\qquad t_c = .827\left[\frac{.30(556)}{\sqrt{.0306}}\right]^{.467} = 20.4 \text{ min}$

$i_{25} = 4.1 \text{ in}/\text{hr}$ $\qquad Q_{25}^{3A} = (.39)(4.1)(1.77) = 2.83 \text{ cfs}$

Sub-basin 3B

$A_{3B} = (286)(371) = 106{,}106\ ft^2 = 2.44\ Ac$

			16%		
Structures	6 =	16,800 ft^2 =	0.39 Ac	@ 0.95 ⇒	0.15
			4%		
Drives	6 =	4,560 ft^2 =	0.16 Ac	@ 0.95 ⇒	0.04
			11%		
Pvmt.		$(12)(284+200+200) + 2827 + \frac{1}{2}\left[(\pi)(25)^2\right] = 12{,}017\ ft^2$ =	0.28 Ac.	@ 0.95 ⇒	0.11
			69%		
Lawn				@ 0.160 ⇒	0.11

$C_{3B} = 0.41$

$H = 408 - 395 = 13$

$N = .69(.4) + .31(.02) = 0.28$

$L = 286 + 371 = 657$

$S = \frac{13}{657} = 0.0198$

$t_c = .827\left[\frac{.28(657)}{\sqrt{.0198}}\right]^{.467} = 23.6\ min$

$i_{25} = 3.8\ in/hr$

$Q_{25}^{3B} = (.41)(3.8)(2.42) = 3.77\ cfs$

Sub-basin 4A

$A_{4A} = (286)(270) = 77{,}220\ ft^2 = 1.77\ Ac.$

			9%		
Structures	4 =	7200 ft^2 =	0.17 Ac	@ 0.95 ⇒	0.09
			4%		
Drives	4 =	3040 ft^2 =	0.07 Ac.	@ 0.95 ⇒	0.04
			14%		
Pvmt.		11,094 ft^2 =	0.25 Ac.	@ 0.95 ⇒	0.14
			73%		
Lawn				@ 0.135 ⇒	0.10

$C_{4A} = 0.37$

$H = 399.5 - 390.5 = 9$

$N = .73(.4) + .27(.02) = 0.30$

$L = 270 + 286 = 556$

$S = \frac{9}{556} = 0.0162$

$t_c = .827\left[\frac{.30(556)}{\sqrt{.0162}}\right]^{.467} = 236\ min$

$i_{25} = 3.8\ in/hr$

$Q_{25}^{4A} = (.37)(3.8)(1.77) = 2.49\ cfs$

8/5/88

Sub-basin 4B

$A_{4B} = (286)(371) = 106,106\ ft^2 = 2.44\ Ac$

Structures $6 = 16,800\ ft^2 = \overset{16\%}{0.39}\ Ac. @ 0.95 \Rightarrow$ 0.15

Drives $6 = 4,560\ ft^2 = \overset{4\%}{0.10}\ Ac @ 0.95 \Rightarrow$ 0.04

Pvmt. $12,017\ ft^2 = \overset{11\%}{0.28}\ Ac @ 0.95 \Rightarrow$ 0.11

Lawn $\overset{69\%}{}$ $@ 0.135 \Rightarrow$ $\underline{0.09}$

$C_{4B} = 0.39$

$H = 3975 - 390.5 = 7$ $N = .69(.4) + .31(.02) = 0.28$

$L = 371 + 286 = 657$

$S = \frac{7}{657} = 0.0107$ $t_c = .827 \left[\frac{.28(657)}{\sqrt{.0107}}\right]^{.467} = 27.3\ min$

$i_{25} = 3.5\ in/hr$ $Q_{25}^{4B} = (.39)(3.5)(2.44) = 3.33\ cfs$

Sub-basin 5A

$A_{5A} = (286)(270) = 77,220\ ft^2 = 1.77\ Ac.$

Structures $4 = 7200\ ft^2 = \overset{9\%}{0.17}\ Ac @ 0.95 \Rightarrow$ 0.09

Drives $4 = 3040\ ft^2 = \overset{4\%}{0.07}\ Ac. @ 0.95 \Rightarrow$ 0.04

Pvmt. $(12)(286 + 130 + 130) + 2827 + \frac{1}{2}\left[(\pi)(25)^2\right] = 10,361\ ft^2 = \overset{13\%}{0.24}\ Ac @ 0.95 \Rightarrow$ 0.13

Lawn $\overset{74\%}{}$ $@ 0.135 \Rightarrow$ $\underline{0.10}$

$C_{5A} = 0.36$

$H = 392.5 - 387 = 5.5$ $N = .74(.4) + .26(.02) = 0.30$

$L = 270 + 286 = 556$

$S = \frac{5.5}{556} = 0.0099$ $t_c = .827 \left[\frac{.30(556)}{\sqrt{.0099}}\right]^{.467} = 26.5\ min$

$i_{25} = 3.6\ in/hr$ $Q_{25}^{5A} = (.36)(3.6)(1.77) = 2.29\ cfs$

⑥

Sub-basin 5B

$A_{5B} = (286)(371) = 106,106\ ft^2 = 2.44\ Ac.$

Structures 6 = 16,800 ft^2 = $\overset{16\%}{0.39}$ Ac. @ 0.95 ⇒ 0.15

Drives 6 = 4,560 ft^2 = $\overset{4\%}{0.10}$ Ac @ 0.95 ⇒ 0.04

Pvmt. 12,017 ft^2 = $\overset{11\%}{0.28}$ Ac @ 0.95 ⇒ 0.11

Lawn 69% @ 0.135 ⇒ 0.09

$C_{5B} = 0.39$

$h = 391.5 - 387 = 4.5$

$N = .69(.4) + .31(.02) = 0.28$

$L = 371 + 286 = 657$

$S = \frac{4.5}{657} = 0.0068$

$t_c = .827 \left[\frac{.28(657)}{\sqrt{.0068}} \right]^{.467} = 30.2\ min$

$i_{25} = 3.4\ in/hr$

$Q_{25}^{5B} = (.39)(3.4)(2.44) = 3.24\ cfs$

8/5/88

①

Sub-basin 6A

$A_{6A} = (270)(120) = 32,400\ ft^2 = 0.74\ Ac$

structures	2 =	5600 ft² =	$\overset{17\%}{0.13}$ Ac.	@ 0.95 ⇒	0.16
drives	2 =	1520 ft² =	$\overset{5\%}{0.03}$ Ac.	@ 0.95 ⇒	0.04
pvmt.	(12)(130) + 1413 =	2973 ft² =	$\overset{9\%}{0.07}$ Ac	@ 0.95 ⇒	0.09
Lawn			69%	@ 0.135 ⇒	0.09

$C_{6A} = 0.38$

f = 388.5 - 387 = 1.5 $\quad N = .69(.4) + .31(.02) = 0.28$

L = 60 + 270 = 330

$S = \frac{1.5}{330} = 0.0045 \qquad t_c = .827\left[\frac{.28(330)}{\sqrt{.0045}}\right]^{.467} = 24.1$ min

$i_{25} = 3.75$ in/hr $\qquad Q_{25}^{6A} = (.38)(3.75)(.74) = 1.06$ cfs

Sub-basin 6B

$A_{6B} = (371)(120) = 44,520\ ft^2 = 1.02\ Ac.$

structures	3 =	5400 ft² =	$\overset{12\%}{0.12}$ Ac	@ 0.95 ⇒	0.12
Drives	3 =	2280 ft² =	$\overset{5\%}{0.05}$ Ac	@ 0.95 ⇒	0.05
Pvmt.	(12)(200) + 1413 =	5013 ft² =	$\overset{11\%}{0.12}$ Ac	@ 0.95 ⇒	0.11
Lawn			72%	@ 0.135 ⇒	0.10

$C_{6B} = 0.38$

f = 388 - 387 = 1 $\quad N = .72(.4) + .28(.02) = 0.29$

L = 60 + 371 = 431

$S = \frac{1}{431} = 0.0023 \qquad t_c = .827\left[\frac{.29(431)}{\sqrt{.0023}}\right]^{.467} = 32.5$ min

$i_{25} = 3.3$ in/hr $\qquad Q_{25}^{6B} = (.38)(3.3)(1.02) = 1.28$ cfs

8/5/88

Combined Areas and Coefficients

Basin 2

$A_2 = A_{2A} + A_{2B}$

$= 0.54 + 0.67$

$= 1.21$ Ac

$C_2 = \left(\frac{.54}{1.21}\right)(0.41) + \left(\frac{.67}{1.21}\right)(0.44)$

$= 0.18 + 0.24$

$= 0.42$

$t_2 = 16.4$ min

Basin 3

$A_3 = 1.77 + 2.44$

$= 4.21$ Ac

$C_3 = \left(\frac{1.77}{4.21}\right)(0.39) + \left(\frac{2.44}{4.21}\right)(0.41)$

$= 0.16 + 0.24$

$= 0.40$

$t_3 = 23.6$ min

Basin 4

$A_4 = 1.77 + 2.44$

$= 4.21$

$C_4 = \left(\frac{1.77}{4.21}\right)(0.37) + \left(\frac{2.44}{4.21}\right)(0.39)$

$= 0.16 + 0.23$

$= 0.39$

$t_4 = 27.3$ min

Basin 5

$A_5 = 1.77 + 2.44$

$= 4.21$

$C_5 = \left(\frac{1.77}{4.21}\right)(0.36) + \left(\frac{2.44}{4.21}\right)(0.39)$

$= 0.15 + 0.23$

$= 0.38$

$t_5 = 30.2$ min

Basin 6

$A_6 = 0.74 + 1.02$

$= 1.76$ Ac

$C_6 = \left(\frac{.74}{1.76}\right)(0.38) + \left(\frac{1.02}{1.76}\right)(0.38)$

$= 0.38$

$t_6 = 32.5$ min

* NOTE: MAX FLOW FROM LAKE OUTLET = 10.0 cfs

$\frac{15.35}{1090} = 0.0141$

98.55
83.2

8/5/88

STORM SEWER DESIGN SHEET — RATIONAL METHOD

PROJECT COPPERFIELD DATE 8/5/88 SHEET 9 OF 10

ENGINEER K. POFF DESIGN STORM 25 YR. MANNINGS n 0.013

Line Number	Upstream Manhole	Downstream Manhole	Length (Ft)	C_j	A_j (Acres)	C_jA_j	ΣA_jC_j	t_j (min)	t_{cum} (min)	I $\left[\frac{\text{inches}}{\text{hr}}\right]$	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	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
										*	10.0											
1	INLET	1	38	0.22	0.67	0.15	0.15	10.5	10.5	5.4	10.8	18	1.0	41.25	6.9	0.1						
2	1	2	276	0.42	1.21	0.51	0.66	16.4	16.4	4.5	12.97	18	1.5	13.75	8.4	0.6						
3	2	3	286	0.40	4.21	1.68	2.34	23.6	23.6	3.8	18.89	21	1.5	19.9	9.1	0.5						
4	3	4	286	0.39	4.21	1.64	3.98	27.3	27.3	3.5	23.93	24	1.25	27.0	9.0	0.5						
5	4	5	34	0.38	4.21	1.60	5.58	30.2	30.2	3.4	28.97	24	1.5	29.0	10.1	0.1						
6	5	OUTLET	122	0.38	1.76	0.67	6.25	32.5	32.5	3.3	30.62	24	1.75	32.0	11.0	0.2						

Figure 7.1 Storm Sewer Design Sheet - Rational Method

Pipe Velocity and Travel Time

Line Number 1

$$\frac{10.8}{11.25} = .96 \quad \therefore \quad V = (6)(1.15) = 6.9\ \frac{ft}{sec}$$

$$T = \frac{6.9\,\cancel{ft}}{\cancel{sec}} \Bigg| \frac{60\,\cancel{sec}}{1\ min} \Bigg| \frac{}{38\,\cancel{ft}} = 0.09\ min$$

Line #2

$$\frac{12.97}{13.75} = .94 \quad \therefore \quad V = (7.4)(1.14) = 8.4\ \frac{ft}{sec}$$

$$T = \frac{276}{(8.4)(60)} = 0.55\ min$$

Line #3

$$\frac{18.89}{20} = .94 \quad \therefore \quad V = (8.0)(1.14) = 9.1\ ft/sec$$

$$T = \frac{286}{(9.1)(60)} = 0.52\ min$$

Line #4

$$\frac{23.93}{27.0} = .89 \quad \therefore \quad V = (8.0)(1.13) = 9.0\ ft/sec$$

$$T = \frac{286}{(9.0)(60)} = 0.53\ min$$

Line #5

$$\frac{28.97}{29} = 1.0 \quad \therefore \quad V = (8.8)(1.15) = 10.1\ ft/sec$$

$$T = \frac{-}{(10.1)(60)} = 0.06\ min$$

Line #6

$$\frac{30.62}{32} = .96 \quad \therefore \quad V = (9.6)(1.15) = 11.0\ ft/sec$$

$$T = \frac{122}{(11.0)(60)} = 0.18\ min$$