DOLPHIN GREEN
PRE DEVELOPMENT
2-YEAR STORM.

2-1/10

System A

1. Node $A_{01} - A_{02}$

$C_{A01-A02} = 0.35$

$Area_{A01-A02} = 0.034\ ac$

$\Sigma CA = 0.012$

$L = 100'$

$S = 0.052$, $L_M = 100'$

$T_i = 8.7\ min$

$I = 2.4\ in/hr$

$Q = \Sigma CAI$

$= (0.01)(2.4) = 0.03\ cfs$

$Q_{A02} = 0.03\ cfs$
$T_{C02} = 8.7\ min$

2. Node $A_{02} - A_{03}$

$C_{A02-A03} = 0.35$

$Area_{A02-A03} = 0.062\ ac$

$CA = 0.021$

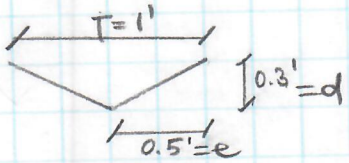
$\Sigma CA = 0.012 + (.35)(.062) = .012 + .022 = .034$

$L = 175'$
$S = 0.01$

Assume Q_{Ave} $A_{02}-A_{03}$, $q_{ave} = 0.05$ cfs/ac

$$Q_{ave} = Q_{A01-A02} + (q_{ave})(A_{A02-A03})/2$$
$$= 0.03 \text{ cfs} + .05 \text{ cfs}\,(0.62)/2$$
$$= 0.05 \text{ cfs}$$

Assume $V = 2.0$ f/s
$z = 1.5$
$n = 0.013$



$z = e/d = 1.67$

$$T_t = \frac{L/V}{60} = \frac{175/2.0}{60} = 1.46 \text{ min}$$

$$R = \frac{zd}{2(1+z^2)^{1/2}} = \frac{(.5/.3)(.3)}{2(1+(.5/.3)^2)^{1/2}}$$
$$= 0.128$$

$$= \frac{.5}{3.89} = 0.128$$

$T_c = 8.7 + 1.46$
$= 10.16$

$I = 2.2$ in/hr

$Q = (0.034)(2.2) = .075$ cfs $= Q_{A03}$

check:

$$Q_{ave} = Q_{A02} + (Q_{A03} - Q_{A02})/2$$
$$= 0.03 + (0.075 - 0.03)/2$$
$$= .05 \text{ cfs} = 0.05 \text{ ok}\checkmark$$

$Q_{A03} = 0.075$ cfs
$T_{C03} = 10.16$ min

3. Node $A_{03}-A_{04}$ (outlet 1)

$C_{A03-A04} = 0.35$
$A_{A03-A04} = 0.128$ ac
$\Sigma CA = .034 + (.35)(.128) = .0788$
$L = 76'$
$S = 0.061$

Assume Q_{Ave} A03 - A04, $q_{ave} = .5$ cfs/ac

$$Q_{ave} = Q_{A03} + q_{ave}\frac{(A_{A03-A04})}{2}$$

$$= 0.075 + \frac{.5 \text{ cfs/ac}(0.128)}{2}$$

$$= 0.075 + 0.064 = 0.14 \text{ cfs}$$

Assume $V = 2.0$ f/s
$z = 1.5$
$n = .013$

$$T_t = \frac{L/V}{60} = \frac{76/1}{60} = 0.63$$

$T_c = 10.16 \text{ min} + 0.63 = 10.8 \text{ min}$

$I = 2.2$ in/hr

$Q = \Sigma CA\, I = (0.0788)(2.2) = 0.17 \text{ cfs} = Q_{A04}$

check

$$Q_{ave} = Q_{A03} + \frac{(Q_{A04} - Q_{A03})}{2}$$

$$= 0.075 + \frac{(0.17 - 0.075)}{2}$$

$= 0.12 \approx 0.14$ cfs ok ✓

System A Summary Outlet at A04 SD on

$Q_A = 0.17$ cfs
$T_{c_A} = 10.8$ min
$I_A = 2.2$ in/hr
$Area_A = 0.22$ ac

} 2yr storm into SD on El Camino Real.

System B

1. Node B01 → B02

$C = 0.35$ $\quad E_1 = 177.5$
$A = 0.085\,ac$ $\quad E_2 = 176.0$
$\Sigma CA = 0.03$ $\quad L = 69'$
$S = 0.022$

$L_m = 85'$
$T_i = 10\,min$
$I = 2.5\,in/hr$

$$Q_{B02} = \Sigma CAI = (0.03)(2.5) = 0.075\,cfs$$

$Q_{B02} = 0.075\,cfs$
$T_{B02} = 10\,min$

2. Node B02 → B03

$C = 0.35$
$A = 0.52\,ac$
$\Sigma CA = .030 + (.35)(.51) = 0.21$

$E_1 = 178.50$
$E_2 = 156.06$
$L = 367'$
$S = 0.061$

Assume $Q_{Ave\ B02-B03}$. $q_{ave} = 0.6$ cfs/ac

$$Q_{Ave} = Q_{B02} + \frac{(q_{ave})(A_{B02 \to B03})}{2}$$

$$= 0.075 + \frac{(0.4)(.52)}{2}$$

$$= 0.23\ cfs$$

Assume $V = 3.5\,f/s$, $n = .035$ natural l' v ditch

$$T_t = \frac{L/V}{60} = \frac{367/3.5}{60} = 1.75\,min$$

$T_C = 10\,min + 1.75\,min$
$= 12\,min$

$I = 2.0\,in/hr$

$$Q = \Sigma CAI = (0.21)(2.0) = 0.42\ cfs = Q_{B03}$$

Check:

$$Q_{Ave} = Q_{B02} + \frac{(Q_{B03} - Q_{B02})}{2}$$

$$= .075 + \frac{0.42 - .075}{2}$$

$$= 0.25 \approx 0.23 \quad \checkmark ok$$

System B Summary at B03

$Q_B = 0.42$ cfs
$T_{cB} = 12$ min
$I_B = 2.0$ in/hr
$Area_B = 0.6$ ac

System C

1. Node C01 → B03

$C = 0.35$
$A = 0.23 ac$
$\Sigma CA = 0.08$

$E_1 = 164'$
$E_2 = 156.06'$
$L = 180'$
$S = 0.044$

$L_m = 100'$

$T_i = 9.5 min.$

$I = 2.3 in/hr$

$Q = \Sigma CAI = 0.08\ (2.3) = 0.18\ cfs = Q_{C01-B01}$

System C Summary

$Q_C = 0.18\ cfs$
$T_{c_C} = 9.5\ min$
$I_C = 2.3\ in/hr$
$Area\ C = 0.23\ ac$

System D

1. Node D01 → D02

$C = 0.90$
$A = 0.11$ ac
$\Sigma CA = 0.10$

$E_1 = 179.0'$
$E_2 = 174.2'$
$L = 78'$
$S = 0.062$

$L_m = 90'$
$T_i = 2.8$ min
$I = 3.5$ in/hr
$Q = \Sigma CA\, I = 0.095(3.5) = 0.33$

$Q_{D02} = 0.33$ cfs
$T_{C\,D02} = 2.8$ min

2. Node D02 → D03

$C = 0.35$
$A = 0.197$
$\Sigma CA = 0.095 + (0.35)(0.197)$
$= 0.16$

$E_1 = 172.50$
$E_2 = 165.50$
$L = 141'$
$S = 0.05$

Use condition for natural 1' V ditch, $n = 0.035$

Assume $q_{ave} = 1$ cfs/ac, $v = 3$ f/s

$$Q_{ave} = Q_{D01-D02} + \frac{(q_{ave})(A_{D2})}{2} = 0.33 + 0.099 = 0.43 \text{ cfs}$$

$$T_t = \frac{L/v}{60} = \frac{141/3}{60} = 0.78 \text{ min}$$

$T_C = 2.8 + 0.78 = 3.6$ min, $I = 3.5$ in/hr

$Q = \Sigma CA\, I = 0.16(3.5) = 0.56$

$Q_{D03} = 0.56$ cfs
$T_{C\,D03} = 3.6$ min

Check $Q_{ave} = 0.33 + \frac{.56 - .33}{2} = 0.45$ ac ≈ 0.43 cfs ✓ OK

System D Summary

$Q_D = 0.56$ cfs
$T_{C_D} = 3.5$ min
$I_D = 3.5$ in/hr
$A_D = 0.30$ ac

System E

1. Node E01 → B03

$C = 0.82$
$A = 0.086$ ac
$ECA = (0.82)(.086)$
$= 0.071$

$E_1 = 165.13$
$E_2 = 156.06$
$L = 135'$
$S = 0.067$

$L_m = 90'$
$T_i = 2.8$ min

$I = 3.5$ in/hr

$Q = ECA\,I = (0.071)(3.5) = .25$ cfs $= Q_{E01 \rightarrow B03}$

2. Junction of Systems B, C, E @ B03

System	Q (cfs)	T_c (min)	I (in/hr)	A (ac)	ECA
B = z	0.42	12	2.0	0.6	0.21
C = y	0.18	9.5	2.3	0.23	0.08
E = x	0.25	2.8	3.5	0.086	0.071
				0.92	0.36

$T_{CE} < T_{CC} < T_{CB}$
$\uparrow \quad \uparrow \quad \uparrow$
$x \quad y \quad z$

$$Q_{TX} = Q_X + \frac{T_X}{T_Y} Q_Y + \frac{T_X}{T_Z} Q_Z$$

$$= 0.25 + \frac{(2.8)(0.18)}{9.5} + \frac{(2.8)(0.42)}{12}$$

$$= 0.25 + 0.05 + 0.098 = 0.40 \text{ cfs}$$

$$Q_{TY} = Q_Y + \frac{I_Y}{I_X} Q_X + \frac{I_Y}{T_Z} Q_Z$$

$$= 0.18 + \frac{2.3}{3.5}(.25) + \frac{9.5}{12}(0.42)$$

$$= 0.18 + 0.17 + 0.33 = 0.68 \text{ cfs}$$

$$Q_{TZ} = Q_Z + \frac{I_Z}{I_X} Q_X + \frac{I_Z}{I_Y} Q_Y$$

$$= 0.42 + \frac{2.0}{3.5}(.25) + \frac{2.0}{2.3}(.18)$$

$$= 0.42 + 0.14 + 0.16 = 0.72 \text{ cfs}$$

Largest $Q = Q_{TZ} = 0.72$ cfs

$T_{C_B} = 12$ min

∴ At Junction B03:

$Q_{B03} = 0.72$ cfs $A = 0.92$ ac

$T_{C_{B03}} = 12$ min $\Sigma CA = 0.36$

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3. Junction B03 → E02 (Street Flow before CB)

$Q_{B03} = 0.72$ cfs
$T_{C_{B03}} = 12$ min
$A_{B03} = 0.92$ ac
$\Sigma CA = 0.36$

$E_1 = 156.06'$
$E_2 = 148.32'$
$L = 238'$
$S = 0.033$
$A_{E2} = 0.16$ ac

Assume Q_{AVE} B03 → E02 = $Q_{B03} + (q_{ave})(A_{E2}/2)$

Assume $q_{ave} = 1.6$ cfs/ac

$Q_{AVE} = 0.72 + (1.6 \text{ cfs/ac})(.16 \text{ ac}/2)$
$= 0.85$ cfs

$V = 3.5$ f/s from Fig. 3-6

$T_t = \frac{L/V}{60} = \frac{238/3.5}{60} = 1.13$ min

$T_{C_{E02}} = 11 \text{ min} + 1.13 = 12$ min
$I = 2.0$ in/hr

$Q = \Sigma CAI = [0.36 + (.82)(.16)]\,2.5$
$= 0.98$ cfs $= Q_{E02}$

check
$Q_{ave} = 0.72 + (.98 - .72)/2$
$= 0.85$ cfs $= .85$ ✓ok

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System E Summary

$Q_E = 0.85$ cfs

$T_{cE} = 12$ min

$I_E = 2.0$ in/hr

$A = 1.08$ ac

4. Junction of systems D & E @ EO2

System	Q (cfs)	Tc (min)	I (in/hr)	A (ac)	ΣCA
D = Y	0.56	3.5	3.5	0.30	0.16
E = Z	0.85	12	2.0	1.08	0.49
				1.38	

$0 < T_{cD}^{Y} < T_{cE}^{Z}$ ×

$$Q_{TY} = Q_Y + \frac{T_Y}{T_Z} Q_Z = 0.56 + \frac{3.5}{12}(0.86) = 0.81 \text{ cfs}$$

$$Q_{TZ} = Q_Z + \frac{I_Z}{I_Y} Q_Y = 0.85 + \frac{2.0}{3.5}(.56) = 1.17 \text{ cfs}$$

In SD Inlet on Via Las Rosas:

$Q_{2yr} = 1.17$ cfs $I = 2.0$ in/hr

$T_c = 12$ min $A = 1.38$ ac

DOLPHIN GREEN PRE-DEVELOPMENT 10-1/11

10-YEAR STORM

System A

1. Node A01 → A02

$C = 0.35$ $L = 100'$

$A_1 = 0.034 ac$ $S = 0.052$

$\Sigma CA = 0.012$ $Lm = 100'$

$T_i = 8.7 min$

$I = 3.4 in/hr$

$Q_{A02} = \Sigma CA I = (.012)3.4 = 0.041 cfs$

$Q_{A02} = 0.041 cfs$
$T_{cA02} = 8.7 min$

2. Node A02 → A03

$CA = 0.35$ $L = 175'$ Assume Qave, $q_{ave} = 1 cfs/ac$

$A_2 = 0.062 ac$ $S = 0.01$ $n = 0.013$ $V = 2 ft/s$

$CA = 0.022$

$\Sigma CA = 0.012 + 0.022 = 0.034$

$Q_{ave} = .041 + (1)(.062)/2 = 0.072 cfs$

$T_t = \frac{L/V}{60} = 1.46 min$, $T_c = 8.7 + 1.46 = 10.2 min$

$I = 3.0 in/hr$

$Q_{A03} = \Sigma CA I = (.034)(3.0) = 0.1 cfs$

$Q_{A03} = 0.1 cfs$
$T_{cA03} = 10.2 min$

check

$Q_{ave} = .041 + (.1 - .041)/2 = .07 cfs$ ✓ ok

10/7/11

3. Node A03 → A04 (Outlet 1)

C = 0.35
A = 0.128 ac
CA = 0.045
ΣCA = 0.034 + .045 = 0.079

L = 76'
S = 0.061

Assume q_{ave} = 1.1 cfs/ac
V = 2.5 ft/s

Q_{Ave} = 0.1 cfs + (1.1)(.128)/2 = .17 cfs

$T_t = \frac{L/V}{60} = \frac{76/2.5}{60} = 0.51$ min, T_c = 10.2 + .5 = 10.7 min

I = 2.9 in/hr

$Q_{A04} = \Sigma CA\, I = (0.079)(2.9) = 0.23$ cfs

Check:

Qave = 0.1 + (.23 − .1)/2 = 0.17 cfs ✓ ok

System A

Q_A = 0.23 cfs
T_{cA04} = 10.7 min
I = 2.9 in/hr
A = 0.22 ac

} 10yr storm Volume to SD on El Camino Real

10 3/11

System B

1. Node B01 → B02

C = 0.35
A = 0.085 ac
ECA = 0.030

L = 69'
S = 0.022

Lm = 85'
Ti = 10.9 min
I = 2.8 in/hr

$Q_{B02} = 0.083$ cfs
$T_{cB02} = 10.9$ min

$Q = ECAI = (0.030)(2.8) = 0.083$ cfs

2. Node B02 → B03

C = 0.35
A = 0.515
CA = 0.18
ECA = .03 + .18 = .21

L = 367'
S = 0.061
n = 0.035 ← natural

Assume $q_{ave} = 2.6$ cfs/ac, V = 3 ft/s

$Q_{Ave} = 0.083 + (2.6)(.515)/2 = 0.75$ cfs

$T_t = \frac{L/V}{60} = \frac{(367/3)}{60} = 2.03$ min, $T_c = 10.9 + 2 = 13$ min
I = 2.6 in/hr

$Q_{B03} = ECAI = (0.21)(2.6) = 0.55$ cfs

$Q_{B03} = 0.55$ cfs
$T_{cB03} = 13$ min

Check 2

$Q_{ave} = 0.53 + (0.55 - 0.083)/2 = 0.76$ cfs ≈ 0.75 cfs ✓ok

10-4/11

System B:

$Q_B = 0.55$ cfs
$Tc_{B03} = 13$ min
$I = 2.6$ in/hr
$A = 0.60$ ac

} to Confluence with Systems C & E @ Junction B03

System C

1. Node C01 → B03

$C = 0.35$ $L = 180'$

$A = 0.23 ac$ $S = .044$

$\Sigma CA = 0.08$ $L_m = 100'$

$T_i = 9.5 min$

$I = 3.1$ in/hr

$Q_{B03(c)} = \Sigma CAI = (0.08)(3.1) = 0.25$ cfs

$Q_{B03(c)} = 0.25$ cfs $T_c = 9.5$ min $I = 3.1$ in/hr $A = 0.23$ ac	To confluence w/ Systems B & E @ Junction B03

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System D

1. Node D01 → D02

C = 0.90 L = 78' T_i = 2.8 min
A = 0.11 ac S = 0.062 I = 4.8 in/hr
ΣCA = 0.1 Lm = 90

$Q_{D02} = \Sigma CAI = (0.1)(4.8) = 0.48$ cfs

$Q_{D02} = 0.48$ cfs
$T_c = 2.8$ min

2. Node D02 → D03

C = 0.35 L = 141'
A = 0.197 ac S = 0.05
CA = 0.07
ΣCA = 0.1 + 0.07 = 0.17

Assume q_{ave} = 1.7 cfs/ac V = 2.5 ft/s

$Q_{ave} = 0.48 + (1.7)(.197)/2 = 0.65$ cfs

$T_t = \frac{L/V}{60} = \frac{141/2.5}{60} = 0.94$ min $T_c = 2.8 + 0.94 = 3.7$ min

$Q_{D03} = \Sigma CAI = (0.17)(4.8) = 0.82$ cfs I = 4.8 in/hr

10/7/11

Check)

$Q_{ave} = 0.48 + (0.82 - .48)/2$

$= 0.65$ cfs $= .65$ cfs ✓ O.K.

System D

$Q_{D03} = 0.82$ cfs

$T_c = 3.7$ min

$I = 4.8$ in/hr

$A = 0.30$ ac

To confluence w/ System E @ Junction E03 (Existing SD)

10-8/11

System E

1. Node E01 → B03

$C = 0.82$ $L = 135'$ $T_i = 2.8$ min

$A = 0.08$ ac $S = 0.067$

$\Sigma CA = 0.071$ $L_m = 90'$ $I = 4.8$ in/hr

$$Q_{B03(E)} = \Sigma CA\, I = (0.071)(4.8) = 0.34 \text{ cfs}$$

2. Junction of systems B, C, E @ B03

System	Q (cfs)	Tc (min)	I (in/hr)	A (ac)	ΣCA
B = Z	0.55	13	2.6	0.6	0.21
C = Y	0.25	9.5	3.1	0.23	0.08
E = X	0.34	2.8	4.8	0.086	0.071

$T_X < T_Y < T_Z \rightarrow T_{CE} < T_{CY} < T_{CB}$

$$Q_{Tx} = Q_X + \frac{T_X}{T_Y} Q_Y + \frac{T_X}{T_Z} Q_Z$$

$$= 0.34 + \frac{2.8}{9.5}(0.25) + \frac{2.8}{13}(0.55) = 0.52 \text{ cfs}$$

10-9/11

$$Q_{Ty} = Q_y + \frac{I_y}{I_x} Q_x + \frac{T_y}{T_z} Q_z$$

$$= 0.25 + \frac{3.1}{4.8}(0.34) + \frac{9.5}{13}(0.55) = 0.87 \text{ cfs}$$

$$Q_{Tz} = Q_z + \frac{I_z}{I_x} Q_x + \frac{I_z}{I_y} Q_y$$

$$= 0.55 + \frac{2.6}{4.8}(.34) + \frac{2.6}{3.1}(.25) = 0.94 \text{ cfs}$$

Largest $Q = Q_{Tz} = 0.94$ cfs, $T_c = 13$ min

At Junction B03:

$Q_{B03} = 0.94$ cfs
$T_c = 13$ min
$I = 4.8$ in/hr
$A = 0.92$ ac
$\Sigma CA = 0.36$

} Street flow to E02

10-10/11

3. Junction B03 → E02

C = 0.82
A = 0.16 ac
CA = 0.13

L = 238'
S = 0.033
n = 0.013

ΣCA = 0.36 + .13 = 0.49

Assume q_{ave} = 1.5 cfs/ac , V = 2.25 ft/s

Q_{ave} = 0.94 + (1.5)(.16)/2 = 1.06 cfs

$$T_t = \frac{L/V}{60} = \frac{238/2.25}{60} = 1.76 \text{ min}$$

T_c = 13 + 1.76 = 14.8 min , I = 2.4 in/hr

Q_{E02} = ΣCAI = (0.49)(2.4) = 1.18 cfs

Check → Q_{ave} = 0.94 + (1.18 − 0.94)/2
= 1.06 cfs ✓ok

Q_E = 1.18 cfs
T_c = 14.8 min
I = 2.4 in/hr
A = 1.08 ac
ΣCA = 0.49

To confluence w/ System D @ Junction E02

10/11

4. Junction of System D & E @ E02

System	Q (cfs)	T_c (min)	I (in/hr)	A (ac)	ΣCA
D = y	0.82	3.7	4.8	0.30	0.17
→ E = z	1.18	14.8	2.4	1.08	0.49

$0 < T_{CD} < T_{CE}$

$$Q_{TY} = Q_y + \frac{T_y}{T_z} Q_z = 0.82 + \frac{3.7}{14.8}(1.18) = 1.11 \text{ cfs}$$

$$Q_{TZ} = Q_z + \frac{I_z}{I_y} Q_y = 1.18 + \frac{2.4}{4.8}(0.82) = \underline{\underline{1.59 \text{ cfs}}}$$

In SD Inlet on Via Las Rosas:

$Q_{10yr} = 1.59$ cfs
$T_c = 14.8$ min
$I = 2.4$ in/hr
$A = 1.38$