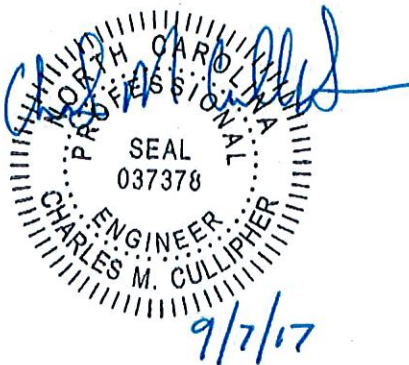


**ENGINEERING CALCULATIONS
for
CYPRESS COVE APARTMENTS**



**Owner:
Cypress Cove of Wilmington, LLC
108 Professional Park Dr.
Beaufort, NC 28516
(252)504-3996**



**Engineer:
Stroud Engineer, P.A.
Charles M. Cullipher, PE
151-A Hwy 24
Morehead City , NC 28557
(252) 247-7479**

**Final SW Calcs
10/10/2017
SWP 2017043
KAC**

TABLE OF CONTENTS

1. Narrative
2. Appendix B – Pre-Development Runoff Calculations
3. Appendix C – Pond Designs
4. Appendix D – Storm Drainage Design
5. Appendix E – Spread Calculations
6. Appendix F – Culvert Design
7. Appendix G – Dissipater Pad Design

Narrative

City of Wilmington Storm Water Application Cypress Cove Apartments

Owner:

Cypress Cove of Wilmington, LLC
PO Box 2400
Beaufort, NC 28516
252-504-3996

Engineer:

Stroud Engineer, P.A.
Charles M. Cullipher, PE
151-A Hwy 24
Morehead City , NC 28557
(252) 247-7479

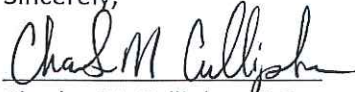
Stroud Engineering, P.A. is requesting a City of Wilmington Storm Water Permit for the development of Cypress Cove Apartments. This development is a 200 unit multi-family affordable housing complex with a clubhouse, outside amenities, drives, parking, sidewalk and accompanying utility infrastructure. The tract is properly zoned as MF-M and has a total area of 14.78 acres. The ten proposed buildings and other associated impervious area totals 6.64 acres of built-upon-area. The tract has an existing wetlands and stream on the south end and an existing wetlands (classified as swamp forest) in the center of the tract running from east to west. The site topography generally slopes from the south toward the west and middle of the tract (wetlands) and from the north to the west and middle of the tract. Approximate high elevations are 25.0' at both the north and south ends with the low elevation at approximately 16.0' in the wetlands.

The proposed stormwater collection and management system consists of a proposed storm drain network that discharges into one of four stormwater wet detention ponds. All roof drains shall tie into the storm drain networks. The wet detention ponds were designed in accordance with NCDENR and the City of Wilmington standards. These standards typically require that the permanent pool elevation (PPE) of a pond be based upon the seasonal high water table (SHWT). A report for the SHWT is attached to this letter. However, due to the proximity of the proposed ponds to the existing wetlands and stream features on this site it was determined to lower the PPE closer in elevation to the water elevations in the features. Pond #1 is adjacent to a small patch of wetlands and an approximately 4' wide unnamed tributary stream. The top of bank for the stream is approximately elevation 18.0'. In order to be within 6" of this water elevation the PPE for Pond #1 was set at 17.5'. For Pond #2 and Pond #3 they are adjacent to the larger wetland area in the center of the tract. The limits of the wetlands in this area vary in elevation from 19.0' to 16.0' with it predominantly in the 17.5' range. In order for the PPE of these two ponds to be within 6" of the existing water elevation the PPE for Pond #2 and Pond #3 was set at 17.5'. Pond #4 is also adjacent to the larger wetlands in the center of the tract, however is further west and slightly more downstream. The extents of the wetlands varies in elevation from 17.0' to 16.0' and the PPE for Pond #4 is set at 16.5' in order to be within 6" of this existing water elevation.

There is a proposed extension of a 60' right-of-way connecting Emory St. to this project. Utilizing this public right-of-way stormwater easements are proposed extending from this right-of-way to provide the City of Wilmington with access to the wetlands and the pond outfalls discharging to the wetlands. The easement meets the City standards for depth and pipe size by holding the minimum width of 20'. The easement also offsets 5' from the wetlands line for maintenance of the wetlands. All ponds have a minimum 5' wide berm on the downstream end and are adjacent to drive aisles and parking lots. These berms typically tie near in elevation to these adjacent vehicular areas allowing maintenance access by the Owner.

Thank you for your assistance in this project. If there are any questions or comments please contact myself using the below information.

Sincerely,



Charles M. Cullipher, P.E.

License #: 037378

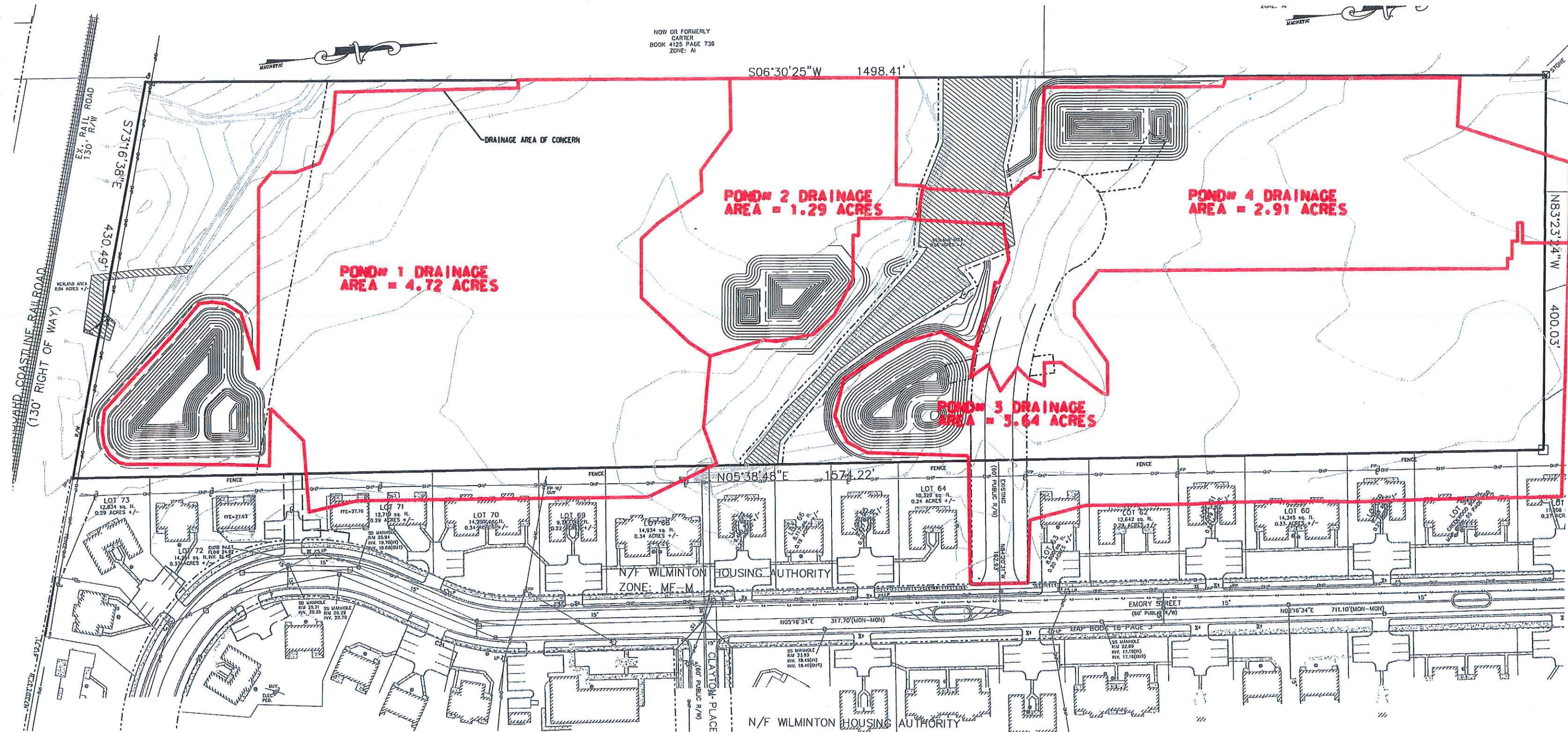
252-247-7479 ext. 225

ccullipher@stroudengineer.com

APPENDIX B
PREDEVELOPMENT RUNOFF CALCULATIONS

PRE-DEVELOPMENT DRAINAGE AREAS OF CONCERN
PONDS 1, 2, 3 AND, 4
11X17 SCALE: 1"=100'

NOW OR FORMERLY
CARTER
BOOK 4125 PAGE 736
ZONE: M



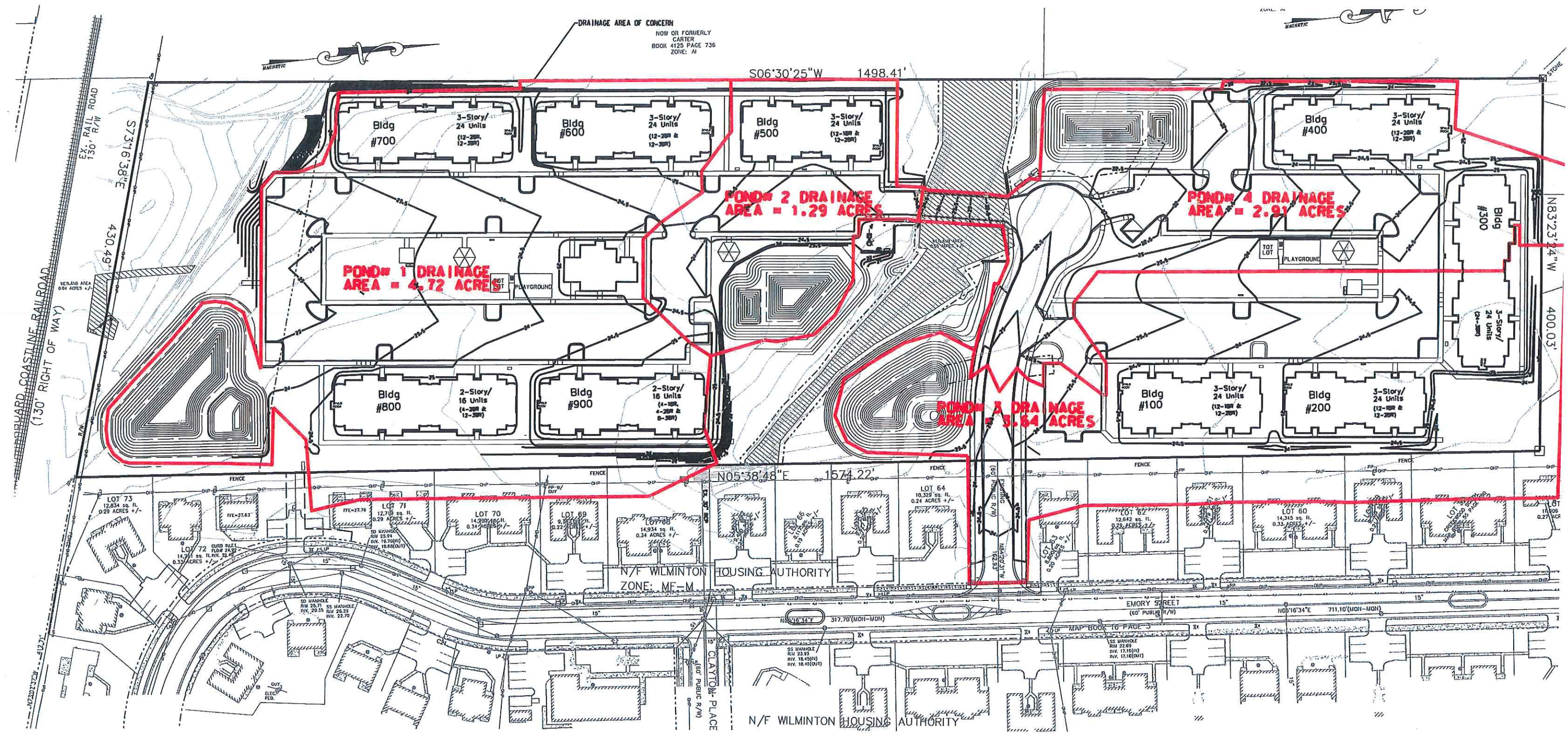
COW SW Design Calculations

Project: Cypress Cove Apartments
 Job #: PM858~36
 Engineer: CMC
 Date: 7/21/17

DA #1	DA #2	DA #3	DA #4
DRAINAGE AREA "DA" (AC): 4.72	DRAINAGE AREA "DA" (AC): 1.29	DRAINAGE AREA "DA" (AC): 3.64	DRAINAGE AREA "DA" (AC): 2.91
PREDEVELOPMENT BUA (AC): 0.00	PREDEVELOPMENT BUA (AC): 0.00	PREDEVELOPMENT BUA (AC): 0.10	PREDEVELOPMENT BUA (AC): 0.00
PERVIOUS "C": 0.15	PERVIOUS "C": 0.15	PERVIOUS "C": 0.15	PERVIOUS "C": 0.15
IMPERVIOUS "C": 0.95	IMPERVIOUS "C": 0.95	IMPERVIOUS "C": 0.95	IMPERVIOUS "C": 0.95
PREDEVELOPMENT WEIGHTED "C": 0.15	PREDEVELOPMENT WEIGHTED "C": 0.15	PREDEVELOPMENT WEIGHTED "C": 0.17	PREDEVELOPMENT WEIGHTED "C": 0.15
OVERLAND WATERSHED LENGTH (FT): 620	OVERLAND WATERSHED LENGTH (FT): 287	OVERLAND WATERSHED LENGTH (FT): 675	OVERLAND WATERSHED LENGTH (FT): 550
OVERLAND WATERSHED HEIGHT (FT): 1	OVERLAND WATERSHED HEIGHT (FT): 7	OVERLAND WATERSHED HEIGHT (FT): 8	OVERLAND WATERSHED HEIGHT (FT): 8.5
KIRPICH CORRECTION FACTOR: 1	KIRPICH CORRECTION FACTOR: 1	KIRPICH CORRECTION FACTOR: 1	KIRPICH CORRECTION FACTOR: 1
T _c (min): 13.1	T _c (min): 2.5	T _c (min): 6.5	T _c (min): 5.0
.:Use a T _c (min) of: 10	.:Use a T _c (min) of: 5	.:Use a T _c (min) of: 5	.:Use a T _c (min) of: 5
2 YR INTENSITY (IN/HR): 5.06	2 YR INTENSITY (IN/HR): 5.88	2 YR INTENSITY (IN/HR): 5.88	2 YR INTENSITY (IN/HR): 5.88
10 YR INTENSITY (IN/HR): 6.30	10 YR INTENSITY (IN/HR): 7.23	10 YR INTENSITY (IN/HR): 7.23	10 YR INTENSITY (IN/HR): 7.23
25 YR INTENSITY (IN/HR): 7.13	25 YR INTENSITY (IN/HR): 8.15	25 YR INTENSITY (IN/HR): 8.15	25 YR INTENSITY (IN/HR): 8.15
50 YR INTENSITY (IN/HR): 7.79	50 YR INTENSITY (IN/HR): 8.87	50 YR INTENSITY (IN/HR): 8.87	50 YR INTENSITY (IN/HR): 8.87
100 YR INTENSITY (IN/HR): 8.49	100 YR INTENSITY (IN/HR): 9.60	100 YR INTENSITY (IN/HR): 9.60	100 YR INTENSITY (IN/HR): 9.60
PREDEVELOPMENT 2 YR Q (CFS): 3.58	PREDEVELOPMENT 2 YR Q (CFS): 1.14	PREDEVELOPMENT 2 YR Q (CFS): 3.67	PREDEVELOPMENT 2 YR Q (CFS): 2.57
PREDEVELOPMENT 10 YR Q (CFS): 4.46	PREDEVELOPMENT 10 YR Q (CFS): 1.40	PREDEVELOPMENT 10 YR Q (CFS): 4.51	PREDEVELOPMENT 10 YR Q (CFS): 3.16
PREDEVELOPMENT 25 YR Q (CFS): 5.04	PREDEVELOPMENT 25 YR Q (CFS): 1.58	PREDEVELOPMENT 25 YR Q (CFS): 5.09	PREDEVELOPMENT 25 YR Q (CFS): 3.56
PREDEVELOPMENT 50 YR Q (CFS): 5.51	PREDEVELOPMENT 50 YR Q (CFS): 1.72	PREDEVELOPMENT 50 YR Q (CFS): 5.54	PREDEVELOPMENT 50 YR Q (CFS): 3.88
PREDEVELOPMENT 100 YR Q (CFS): 6.01	PREDEVELOPMENT 100 YR Q (CFS): 1.86	PREDEVELOPMENT 100 YR Q (CFS): 5.99	PREDEVELOPMENT 100 YR Q (CFS): 4.20

**APPENDIX C
POND DESIGNS**

POST-DEVELOPMENT DRAINAGE AREAS OF CONCERN
PONDS 1, 2, 3 AND, 4
11X17 SCALE: 1"=100'



NCDENR Stormwater Design Calculations

Wet Pond 1

Project: Cypress Cove Apartments
 Job #: PM858-36-001
 Engineer: CMC
 Date: 9/5/2017

Rational Method

(See accompanying figures and tables as noted)

Predevelopment Land Use

Description	C	Area (ac)
Total area		4.72
Impervious	0.95	0.00
Pervious	0.15	4.72

Weighted C: 0.15
 Impervious (ex) 0.0%

drainage area input

total area	205405.56 sf
sidewalks	0 sf
streets	0 sf
lots	0 sf
other	0 sf
total ex BUA	0 sf

Postdevelopment Land Use

Description	C	Area (ac)
Total area		4.72
Impervious	0.95	2.69
Pervious	0.15	2.02

Weighted C: 0.61
 Impervious (prop) 57.1%

drainage area input

total area	205405.56 sf
sidewalks	16136.54 sf
streets/parking	54068.08 sf
buildings	45246.94 sf
other	1782.75 sf
reserve	0 sf
total prop BUA	117234.31 sf

Impervious Ratio

Drainage Area (ac):	Postdevelopment 4.72
Net Impervious Area (ac):	2.69
Impervious Ratio	0.57

Schuler's Simple Method

$$R_v = 0.05 + 0.9 * \text{Impervious Ratio} \quad R_v = 0.564$$

$$\text{Control Volume} = 3630 * R_d * R_v * A \quad \text{where } R_d = 1.5 \text{ in.}$$

$$\text{Water Quality Required Storage} = 14473 \text{ cf}$$

USE: 14473 CF FOR POND DESIGN

Basin Dimensions

Below Permanent Pool - Main Pool Depth

El.	SA Pond	Inc. Vol. Pond	Total Vol Pond
8	0	0	0
9	0	0	0
10	0	0	0
11	2013	0	0
12	2540	2277	2277
13	3108	2824	5101
14	3716	3412	8513

15	4356	4036	12549
16	5024	4690	17239
17	5717	5371	22609
17.5	6804	3130	25739

Total Volume= cf is > Required, OK

State Required Depth/Surface Area Calculation

VPP (Volume of Permanent Pool) =
 APP (Area of Permanent Pool) =
 Average Depth Using Equation 2= ft is > 3.0', OK
 Table 2 SA/DA lower depth interval:
 Impervious Cover Ratio=
 Table 2 SA/DA lower %BUA interval:
 Enter Table 2 SA/DA values for depth and %BUA:

<input type="text" value="3.65"/>	<input type="text" value="2.87"/>
<input type="text" value="4.35"/>	<input type="text" value="3.31"/>

Calculated SA/DA=

Required Surface Area= sf

Note: Based on SA=SA/DA*Area*43560/100

Permanent Pool SA= sf is > required SA, OK

Below Permanent Pool - Forebay Depth (15-20% Main Pond Volume)

El.	SA Pond	Inc. Vol. Pond	Total Vol Pond
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
12	0	0	0
13	0	0	0
14	0	0	0
15	1353	0	0
16	1645	1499	1499
17	1961	1803	3302

17.5	2208	1042	4344
------	------	------	------

Minimum Allowable Forebay Volume (15%)	3861
Forebay Volume =	4344
Maximum Allowable Forebay Volume (20%)	5148

is within range, OK

Above Permanent Pool

EL.	Stage	SA	Inc. Vol. Pond	Total Vol. Pond
17.5	0	9012	0	0
18	0.5	10641	4913	4913
18.85	1.35	11874	9569	14482
19	1.5	12011	11326	16239
20	2.5	13441	12726	28965
21	3.5	14932	14187	43152
22	4.5	16481	15707	58858
23	5.5	18087	17284	76142
23.5	6	18912	9250	85392

State Stage=	1.35	ft
State EL=	18.85	ft
State Volume =	14482.13	cf
Top EL.=	23.50	
Freeboard=	4.65	ft

is > Required, OK

is > 1.0', OK

2-5 Day Drawdown for State Volume

Max (2 Day) Flow=	0.08	cfs
Min (5 Day) Flow=	0.03	cfs

Slot Stage=	1.35	ft
Avg Head=	0.45	ft

2 Day Area=	0.026	sf
5 Day Area=	0.010	sf

2 Day Diameter=	2.181	in
5 Day Diameter=	1.379	in

Provide Orifice=	1.50	in
------------------	------	----

Drawdown Flow=	0.04	cfs
Drawdown Time=	4.2	days

is < predevelopment discharge, OK

is within 2-5 days, OK

COW SW Design Calculations

Project: Cypress Cove Apartments

Job #: PM858-36

Engineer: CMC

Date: 9/5/17

PEAK RUNOFF PER RATIONAL METHOD

DRAINAGE AREA "DA" (AC):	4.72
POSTDEVELOPMENT BUA (AC):	2.69
PERVIOUS "C":	0.15
IMPERVIOUS "C":	0.95
POSTDEVELOPMENT WEIGHTED "C":	0.61
OVERLAND WATERSHED LENGTH (FT):	95
OVERLAND WATERSHED HEIGHT (FT):	1
KIRPICH CORRECTION FACTOR:	1
T_c (min):	1.5
PAVED WATERSHED LENGTH (FT):	0
PAVED WATERSHED HEIGHT (FT):	1
KIRPICH CORRECTION FACTOR:	0.4
T_c (min):	0.0
PIPED WATERSHED LENGTH (FT):	730
PIPED WATERSHED HEIGHT (FT):	4
KIRPICH CORRECTION FACTOR:	0.2
T_c (min):	1.9
Total T_c (min):	3.4
∴ Use a T_c (min) of:	5
2 YR INTENSITY (IN/HR):	5.88
10 YR INTENSITY (IN/HR):	7.23
25 YR INTENSITY (IN/HR):	8.15
50 YR INTENSITY (IN/HR):	8.87
100 YR INTENSITY (IN/HR):	9.60
POSTDEVELOPMENT 2 YR Q (CFS):	16.82
POSTDEVELOPMENT 10 YR Q (CFS):	20.68
POSTDEVELOPMENT 25 YR Q (CFS):	23.31
POSTDEVELOPMENT 50 YR Q (CFS):	25.37
POSTDEVELOPMENT 100 YR Q (CFS):	27.46

TIME TO PEAK RUNOFF

USE HYDRAULIC SOIL GROUP:	A	
CURVE NUMBER "CN", PREDEV.:	39	
CURVE NUMBER "CN", IMPERVIOUS:	98	
CURVE NUMBER "CN", WEIGHTED:	73	
SOIL STORAGE CAPACITY "S" (IN):	3.77	NOTE: $S = (1000 / CN) - 10$
2 YR, 24 HR PRECIPITATION "P" (IN):	4.50	
10 YR, 24 HR PRECIPITATION "P" (IN):	6.72	
25 YR, 24 HR PRECIPITATION "P" (IN):	8.01	
50 YR, 24 HR PRECIPITATION "P" (IN):	9.01	
100 YR, 24 HR PRECIPITATION "P" (IN):	10.00	
2 YR, 24 HR RUNOFF "RO" (IN):	1.87	NOTE: $RO = ((P - 0.2 * S)^2) / (P + 0.8 * S)$
10 YR, 24 HR RUNOFF "RO" (IN):	3.66	
25 YR, 24 HR RUNOFF "RO" (IN):	4.78	
50 YR, 24 HR RUNOFF "RO" (IN):	5.67	
100 YR, 24 HR RUNOFF "RO" (IN):	6.57	
2 YR, 24 HR TIME TO PEAK "T _p " (MIN):	23	NOTE: $T_p = (43.5 * DA * RO) / Q$
10 YR, 24 HR TIME TO PEAK "T _p " (MIN):	36	
25 YR, 24 HR TIME TO PEAK "T _p " (MIN):	42	
50 YR, 24 HR TIME TO PEAK "T _p " (MIN):	46	
100 YR, 24 HR TIME TO PEAK "T _p " (MIN):	49	

POND DIMENSIONS

EL.	SA	Incr. Vol.	Tot. Vol.	Stage		
17.5	9012	0	0	0.0	1.50	DRAWDOWN ORIFICE DIAMETER (IN)
					0.13	DRAWDOWN ORIFICE DIAMETER (FT)
18.0	10641	4913	4913	0.5	0.01	DRAWDOWN ORIFICE AREA (SF)
19.0	12011	11326	16239	1.5	0.00	DRAWDOWN ORIFICE STAGE (FT)
20.0	13441	12726	28965	2.5		
21.0	14932	14187	43152	3.5	1.20	DRAWDOWN SLOT LENGTH (FT):
22.0	16481	15707	58858	4.5	1	NUMBER OF DRAWDOWN SLOTS
23.0	18087	17284	76142	5.5	0.50	DRAWDOWN SLOT HEIGHT (FT)
23.5	18912	9250	85392	6.0	0.60	DRAWDOWN SLOT AREA (SF)
					1.35	DRAWDOWN SLOT BOTTOM STAGE (FT)
					1.60	DRAWDOWN SLOT CENTROID (FT)
					1.85	DRAWDOWN SLOT TOP (FT)
					16.00	OUTLET STRUCTURE WEIR LENGTH (FT)
					4.50	OUTLET STRUCTURE WEIR STAGE (FT)
					5.00	EMERGENCY WEIR STAGE (FT)
					30.00	EMERGENCY WEIR LENGTH (FT)

STAGE-STORAGE CURVE	

Cypress Cove -- Pond #1

2 YEAR STORM ROUTING				
Time (min)	Inflow (CFS)	Storage (CF)	Stage (ft)	Outflow (CFS)
0	0.00	0	0.00	0.00
3	0.71	0	0.00	0.00
6	2.71	127	0.01	0.01
9	5.67	614	0.06	0.01
12	9.10	1633	0.15	0.02
15	12.40	3266	0.30	0.03
18	15.04	5493	0.51	0.04
21	16.56	8193	0.75	0.05
24	16.70	11164	1.01	0.06
27	15.45	14160	1.27	0.07
30	13.19	16930	1.50	0.29
33	11.12	19252	1.70	0.81
36	9.37	21107	1.85	1.53
39	7.90	22519	1.97	1.83
42	6.65	23611	2.05	2.03
45	5.61	24443	2.12	2.17
48	4.73	25062	2.17	2.27
51	3.98	25505	2.20	2.33
54	3.36	25802	2.23	2.38
57	2.83	25978	2.24	2.40
60	2.38	26055	2.25	2.41
63	2.01	26049	2.25	2.41
66	1.69	25977	2.24	2.40
69	1.43	25849	2.23	2.38
72	1.20	25677	2.22	2.36
75	1.01	25468	2.20	2.33
78	0.85	25232	2.18	2.29
81	0.72	24973	2.16	2.25
84	0.61	24697	2.14	2.21
87	0.51	24408	2.12	2.16
90	0.43	24111	2.09	2.11

3.58

10 YEAR STORM ROUTING				
Time (min)	Inflow (CFS)	Storage (CF)	Stage (ft)	Outflow (CFS)
0	0.00	0	0.00	0.00
4	0.61	0	0.00	0.00
8	2.38	147	0.01	0.01
12	5.09	716	0.07	0.02
16	8.42	1933	0.18	0.03
20	11.98	3947	0.36	0.04
24	15.34	6813	0.62	0.05
28	18.11	10484	0.95	0.06
32	19.96	14817	1.32	0.07
36	20.67	19592	1.73	0.91
40	20.16	24336	2.11	2.15
44	18.48	28658	2.45	2.76
48	16.09	32431	2.74	3.18
52	13.94	35528	2.97	3.49
56	12.08	38038	3.16	3.71
60	10.47	40047	3.30	3.87
64	9.07	41630	3.41	4.00
68	7.86	42848	3.50	4.09
72	6.81	43753	3.56	4.16
76	5.90	44390	3.60	4.20
80	5.12	44798	3.63	4.23
84	4.43	45010	3.65	4.25
88	3.84	45055	3.65	4.25
92	3.33	44957	3.64	4.24
96	2.88	44737	3.63	4.23
100	2.50	44415	3.61	4.20
104	2.17	44006	3.58	4.17
108	1.88	43524	3.54	4.14
112	1.63	42981	3.51	4.10
116	1.41	42387	3.47	4.06
120	1.22	41752	3.42	4.01

4.46

Cypress Cove -- Pond #1

25 YEAR STORM ROUTING				
Time (min)	Inflow (CFS)	Storage (CF)	Stage (ft)	Outflow (CFS)
0	0.00	0	0.00	0.00
5	0.80	0	0.00	0.00
10	3.10	241	0.02	0.01
15	6.57	1168	0.11	0.02
20	10.75	3134	0.29	0.03
25	15.05	6349	0.58	0.05
30	18.88	10849	0.98	0.06
35	21.72	16496	1.47	0.22
40	23.17	22946	2.00	1.91
45	23.03	29323	2.50	2.84
50	21.33	35382	2.96	3.47
55	18.48	40740	3.35	3.93
60	15.84	45107	3.65	4.25
65	13.57	48582	3.89	4.49
70	11.63	51307	4.07	4.66
75	9.96	53398	4.20	4.78
80	8.54	54953	4.30	4.87
85	7.31	56052	4.37	4.93
90	6.27	56767	4.42	4.97
95	5.37	57156	4.44	4.99
100	4.60	57269	4.45	5.00
105	3.94	57150	4.44	4.99
110	3.38	56835	4.42	4.97
115	2.89	56355	4.39	4.95
120	2.48	55739	4.35	4.91
125	2.12	55009	4.31	4.87
130	1.82	54184	4.25	4.83
135	1.56	53282	4.20	4.78
140	1.34	52317	4.13	4.72
145	1.15	51302	4.07	4.66
150	0.98	50249	4.00	4.59

5.04

50 YEAR STORM ROUTING				
Time (min)	Inflow (CFS)	Storage (CF)	Stage (ft)	Outflow (CFS)
0	0.00	0	0.00	0.00
5	0.74	0	0.00	0.00
10	2.86	221	0.02	0.01
15	6.12	1075	0.10	0.02
20	10.14	2905	0.27	0.03
25	14.46	5938	0.55	0.04
30	18.57	10262	0.93	0.06
35	22.00	15816	1.41	0.12
40	24.35	22379	1.95	1.80
45	25.34	29143	2.49	2.82
50	24.87	35901	3.00	3.52
55	22.99	42307	3.46	4.05
60	20.11	47988	3.85	4.45
65	17.45	52686	4.16	4.74
70	15.15	56499	4.40	4.96
75	13.15	59556	4.59	6.33
80	11.41	61601	4.71	9.79
85	9.90	62086	4.74	10.79
90	8.59	61818	4.72	10.23
95	7.46	61326	4.69	9.25
100	6.47	60788	4.66	8.26
105	5.62	60253	4.63	7.35
110	4.88	59732	4.60	6.57
115	4.23	59224	4.57	5.91
120	3.67	58720	4.54	5.39
125	3.19	58204	4.50	5.06
130	2.77	57643	4.47	5.02
135	2.40	56967	4.43	4.98
140	2.08	56193	4.38	4.94
145	1.81	55336	4.33	4.89
150	1.57	54411	4.27	4.84

Cypress Cove -- Pond #1

CLOGGED 50 YEAR STORM ROUTING				
Time (min)	Inflow (CFS)	Storage (CF)	Stage (ft)	Outflow (CFS)
0	0.00	0	0.00	0.00
5	0.74	0	0.00	0.00
10	2.86	221	0.02	0.00
15	6.12	1078	0.10	0.00
20	10.14	2913	0.27	0.00
25	14.46	5955	0.55	0.00
30	18.57	10293	0.93	0.00
35	22.00	15864	1.41	0.00
40	24.35	22463	1.96	0.00
45	25.34	29768	2.54	0.00
50	24.87	37371	3.11	0.00
55	22.99	44833	3.64	0.00
60	20.11	51728	4.10	0.00
65	17.45	57761	4.48	0.00
70	15.15	62997	4.79	0.00
75	13.15	67541	5.05	1.05
80	11.41	71169	5.25	11.34
85	9.90	71191	5.25	11.42
90	8.59	70736	5.23	9.79
95	7.46	70378	5.21	8.56
100	6.47	70048	5.19	7.47
105	5.62	69748	5.17	6.53
110	4.88	69476	5.16	5.70
115	4.23	69228	5.15	4.98
120	3.67	69002	5.13	4.36
125	3.19	68797	5.12	3.81
130	2.77	68610	5.11	3.33
135	2.40	68440	5.10	2.92
140	2.08	68285	5.09	2.55
145	1.81	68144	5.09	2.24

100 YEAR STORM ROUTING				
Time (min)	Inflow (CFS)	Storage (CF)	Stage (ft)	Outflow (CFS)
0	0.00	0	0.00	0.00
5	0.70	0	0.00	0.00
10	2.71	209	0.02	0.01
15	5.84	1019	0.10	0.02
20	9.77	2767	0.26	0.03
25	14.10	5689	0.52	0.04
30	18.40	9908	0.90	0.06
35	22.22	15410	1.38	0.08
40	25.18	22049	1.93	1.73
45	26.98	29082	2.48	2.81
50	27.44	36332	3.03	3.56
55	26.51	43495	3.54	4.14
60	24.28	50205	4.00	4.59
65	21.33	56113	4.37	4.94
70	18.69	61031	4.67	8.70
75	16.37	64028	4.85	15.32
80	14.34	64343	4.87	16.12
85	12.56	63808	4.84	14.77
90	11.01	63146	4.80	13.17
95	9.64	62497	4.76	11.69
100	8.45	61884	4.73	10.37
105	7.40	61307	4.69	9.22
110	6.48	60762	4.66	8.21
115	5.68	60244	4.63	7.34
120	4.98	59746	4.60	6.59
125	4.36	59262	4.57	5.96
130	3.82	58782	4.54	5.45
135	3.35	58293	4.51	5.09
140	2.93	57768	4.48	5.03
145	2.57	57140	4.44	4.99

NCDENR Stormwater Design Calculations

Wet Pond 2

Project: Cypress Cove Apartments
 Job #: PM858-36-001
 Engineer: CMC
 Date: 9/5/2017

Rational Method

(See accompanying figures and tables as noted)

Predevelopment Land Use

Description	C	Area (ac)
Total area		1.29
Impervious	0.95	0.00
Pervious	0.15	1.29

Weighted C: 0.15
 Impervious (ex) 0.0%

drainage area input

total area	56292.89 sf
sidewalks	0 sf
streets	0 sf
lots	0 sf
other	0 sf
total ex BUA	0 sf

Postdevelopment Land Use

Description	C	Area (ac)
Total area		1.29
Impervious	0.95	0.73
Pervious	0.15	0.56

Weighted C: 0.60
 Impervious (prop) 56.5%

drainage area input

total area	56292.89 sf
sidewalks	4601.05 sf
streets/parking	17356.31 sf
buildings	8685.63 sf
other	1152.8 sf
reserve	0 sf
total prop BUA	31795.79 sf

Impervious Ratio

Drainage Area (ac):	1.29
Net Impervious Area (ac):	0.73
Impervious Ratio:	0.56

Schuler's Simple Method

$$R_v = 0.05 + 0.9 * \text{Impervious Ratio} \quad R_v = 0.558$$

$$\text{Control Volume} = 3630 * R_d * R_v * A \quad \text{where } R_d = 1.5 \text{ in.}$$

$$\text{Water Quality Required Storage} = \boxed{3929} \text{ cf}$$

USE: **3929** CF FOR POND DESIGN

Basin Dimensions

Below Permanent Pool - Main Pool Depth

El.	SA Pond	Inc. Vol. Pond	Total Vol Pond
8	0	0	0
9	0	0	0
10	0	0	0
11	556	0	0
12	778	667	667
13	1037	908	1575
14	1333	1185	2760

15	1664	1499	4258
16	2026	1845	6103
17	2418	2222	8325
17.5	3063	1370	9695

Total Volume= cf is > Required, OK

State Required Depth/Surface Area Calculation

VPP (Volume of Permanent Pool) =
 APP (Area of Permanent Pool) =
 Average Depth Using Equation 2= ft is > 3.0', OK
 Table 2 SA/DA lower depth interval:
 Impervious Cover Ratio=
 Table 2 SA/DA lower %BUA interval:
 Enter Table 2 SA/DA values for depth and %BUA:

<input type="text" value="3.65"/>	<input type="text" value="2.87"/>
<input type="text" value="4.35"/>	<input type="text" value="3.31"/>

Calculated SA/DA=

Required Surface Area= sf

Note: Based on SA=SA/DA*Area*43560/100

Permanent Pool SA= sf is > required SA, OK

Below Permanent Pool - Forebay Depth (15-20% Main Pond Volume)

El.	SA Pond	Inc. Vol. Pond	Total Vol Pond
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
12	0	0	0
13	0	0	0
14	243	0	0
15	395	319	319
16	578	487	806
17	794	686	1492

17.5	913	427	1918
------	-----	-----	------

Minimum Allowable Forebay Volume (15%)	1454
Forebay Volume =	1918
Maximum Allowable Forebay Volume (20%)	1939

is within range, OK

Above Permanent Pool

EL.	Stage	SA	Inc. Vol. Pond	Total Vol. Pond
17.5	0	3976	0	0
18	0.5	5121	2274	2274
18.34	0.84	5426	1793	4067
19	1.5	6057	5589	7863
20	2.5	7058	6558	14421
21	3.5	8125	7592	22012
22	4.5	9261	8693	30705
23	5.5	10474	9868	40573

State Stage=	0.84	ft
State El.=	18.34	ft
State Volume =	4067.24	
Top El.=	23.00	
Freeboard=	4.66	ft

is > Required, OK

is > 1.0', OK

2-5 Day Drawdown for State Volume

Max (2 Day) Flow=	0.02	cfs
Min (5 Day) Flow=	0.01	cfs

Slot Stage=	0.84	ft
Avg Head=	0.28	ft

2 Day Area=	0.009	sf
5 Day Area=	0.004	sf

2 Day Diameter=	1.279	in
5 Day Diameter=	0.809	in

Provide Orifice=	1.00	in
------------------	------	----

Drawdown Flow=	0.01	cfs
Drawdown Time=	3.3	days

is < predevelopment discharge, OK

is within 2-5 days, OK

COW SW Design Calculations

Project: Cypress Cove Apartments Pond #2
Job #: PM858-36
Engineer: CMC
Date: 9/5/17

PEAK RUNOFF PER RATIONAL METHOD

DRAINAGE AREA "DA" (AC):	1.29
POSTDEVELOPMENT BUA (AC):	0.73
PERVIOUS "C":	0.15
IMPERVIOUS "C":	0.95
POSTDEVELOPMENT WEIGHTED "C":	0.60
OVERLAND WATERSHED LENGTH (FT):	75
OVERLAND WATERSHED HEIGHT (FT):	1
KIRPICH CORRECTION FACTOR:	1
T _c (min):	1.1
PAVED WATERSHED LENGTH (FT):	0
PAVED WATERSHED HEIGHT (FT):	1
KIRPICH CORRECTION FACTOR:	0.4
T _c (min):	0.0
PIPED WATERSHED LENGTH (FT):	377
PIPED WATERSHED HEIGHT (FT):	4
KIRPICH CORRECTION FACTOR:	0.2
T _c (min):	0.9
Total T _c (min):	2.0
∴Use a T _c (min) of:	5
2 YR INTENSITY (IN/HR):	5.88
10 YR INTENSITY (IN/HR):	7.23
25 YR INTENSITY (IN/HR):	8.15
50 YR INTENSITY (IN/HR):	8.87
100 YR INTENSITY (IN/HR):	9.60
POSTDEVELOPMENT 2 YR Q (CFS):	4.57
POSTDEVELOPMENT 10 YR Q (CFS):	5.62
POSTDEVELOPMENT 25 YR Q (CFS):	6.34
POSTDEVELOPMENT 50 YR Q (CFS):	6.90
POSTDEVELOPMENT 100 YR Q (CFS):	7.46

TIME TO PEAK RUNOFF

USE HYDRAULIC SOIL GROUP:	A	
CURVE NUMBER "CN", PREDEV.:	39	
CURVE NUMBER "CN", IMPERVIOUS:	98	
CURVE NUMBER "CN", WEIGHTED:	72	
SOIL STORAGE CAPACITY "S" (IN):	3.81	NOTE: $S = (1000 / CN) - 10$
2 YR, 24 HR PRECIPITATION "P" (IN):	4.50	
10 YR, 24 HR PRECIPITATION "P" (IN):	6.72	
25 YR, 24 HR PRECIPITATION "P" (IN):	8.01	
50 YR, 24 HR PRECIPITATION "P" (IN):	9.01	
100 YR, 24 HR PRECIPITATION "P" (IN):	10.00	
2 YR, 24 HR RUNOFF "RO" (IN):	1.85	NOTE: $RO = ((P - 0.2 * S)^2) / (P + 0.8 * S)$
10 YR, 24 HR RUNOFF "RO" (IN):	3.63	
25 YR, 24 HR RUNOFF "RO" (IN):	4.75	
50 YR, 24 HR RUNOFF "RO" (IN):	5.64	
100 YR, 24 HR RUNOFF "RO" (IN):	6.54	
2 YR, 24 HR TIME TO PEAK "T _p " (MIN):	23	NOTE: $T_p = (43.5 * DA * RO) / Q$
10 YR, 24 HR TIME TO PEAK "T _p " (MIN):	36	
25 YR, 24 HR TIME TO PEAK "T _p " (MIN):	42	
50 YR, 24 HR TIME TO PEAK "T _p " (MIN):	46	
100 YR, 24 HR TIME TO PEAK "T _p " (MIN):	49	

POND DIMENSIONS

EL.	SA	Incr. Vol.	Tot. Vol.	Stage		
17.5	3976	0	0	0.0	1.00	DRAWDOWN ORIFICE DIAMETER (IN)
18.0	5121	2274	2274	0.5	0.08	DRAWDOWN ORIFICE DIAMETER (FT)
19.0	6057	5589	7863	1.5	0.01	DRAWDOWN ORIFICE AREA (SF)
20.0	7058	6558	14421	2.5	0.00	DRAWDOWN ORIFICE STAGE (FT)
21.0	8125	7592	22012	3.5	1.00	DRAWDOWN SLOT LENGTH (FT):
22.0	9261	8693	30705	4.5	1	NUMBER OF DRAWDOWN SLOTS
23.0	10474	9868	40573	5.5	0.25	DRAWDOWN SLOT HEIGHT (FT)
					0.25	DRAWDOWN SLOT AREA (SF)
					0.84	DRAWDOWN SLOT BOTTOM (FT)
					0.97	DRAWDOWN SLOT CENTROID (FT)
					1.09	DRAWDOWN SLOT TOP (FT)
					16.00	OUTLET STRUCTURE WEIR LENGTH (FT)
					4.00	OUTLET STRUCTURE WEIR STAGE (FT)
					4.50	EMERGENCY WEIR STAGE (FT)
					10.00	EMERGENCY WEIR LENGTH (FT)

Total =	40573
---------	-------

STAGE-STORAGE CURVE

Cypress Cove Apartments -- Pond #2

2 YEAR STORM ROUTING				
Time (min)	Inflow (CFS)	Storage (CF)	Stage (ft)	Outflow (CFS)
0	0.00	0	0.00	0.00
3	0.19	0	0.00	0.00
6	0.74	35	0.01	0.00
9	1.55	168	0.03	0.00
12	2.49	447	0.09	0.01
15	3.39	894	0.17	0.01
18	4.10	1502	0.29	0.01
21	4.51	2238	0.42	0.02
24	4.54	3046	0.57	0.02
27	4.18	3859	0.72	0.02
30	3.56	4608	0.85	0.03
33	3.00	5243	0.97	0.16
36	2.52	5754	1.06	0.33
39	2.13	6148	1.13	0.51
42	1.79	6439	1.18	0.58
45	1.51	6656	1.22	0.63
48	1.27	6814	1.24	0.66
51	1.07	6923	1.26	0.68
54	0.90	6993	1.27	0.70
57	0.76	7029	1.28	0.70
60	0.64	7039	1.28	0.71
63	0.54	7027	1.28	0.70
66	0.45	6997	1.27	0.70
69	0.38	6952	1.27	0.69
72	0.32	6897	1.26	0.68
75	0.27	6832	1.25	0.67
78	0.23	6761	1.23	0.65
81	0.19	6685	1.22	0.64
84	0.16	6604	1.21	0.62
87	0.14	6522	1.19	0.60
90	0.11	6438	1.18	0.58

1.14

10 YEAR STORM ROUTING				
Time (min)	Inflow (CFS)	Storage (CF)	Stage (ft)	Outflow (CFS)
0	0.00	0	0.00	0.00
4	0.17	0	0.00	0.00
8	0.65	40	0.01	0.00
12	1.39	195	0.04	0.01
16	2.29	527	0.10	0.01
20	3.26	1075	0.20	0.01
24	4.18	1855	0.35	0.02
28	4.93	2854	0.54	0.02
32	5.43	4033	0.75	0.02
36	5.62	5331	0.98	0.19
40	5.48	6635	1.21	0.63
44	5.01	7798	1.41	0.84
48	4.36	8802	1.58	0.98
52	3.78	9614	1.71	1.08
56	3.28	10263	1.82	1.15
60	2.84	10773	1.90	1.20
64	2.46	11166	1.97	1.24
68	2.13	11458	2.01	1.27
72	1.85	11664	2.05	1.29
76	1.60	11798	2.07	1.30
80	1.39	11869	2.08	1.31
84	1.20	11887	2.08	1.31
88	1.04	11861	2.08	1.31
92	0.90	11797	2.07	1.30
96	0.78	11700	2.05	1.29
100	0.68	11577	2.03	1.28
104	0.59	11432	2.01	1.27
108	0.51	11269	1.98	1.25
112	0.44	11090	1.95	1.23
116	0.38	10899	1.92	1.22
120	0.33	10699	1.89	1.19

1.4

Cypress Cove Apartments -- Pond #2

25 YEAR STORM ROUTING				
Time (min)	Inflow (CFS)	Storage (CF)	Stage (ft)	Outflow (CFS)
0	0.00	0	0.00	0.00
5	0.22	0	0.00	0.00
10	0.84	65	0.01	0.00
15	1.79	318	0.06	0.01
20	2.92	852	0.16	0.01
25	4.09	1726	0.33	0.02
30	5.13	2950	0.55	0.02
35	5.91	4484	0.83	0.02
40	6.30	6249	1.14	0.54
45	6.26	7977	1.44	0.86
50	5.80	9597	1.71	1.07
55	5.02	11013	1.94	1.23
60	4.30	12152	2.12	1.33
65	3.69	13042	2.26	1.41
70	3.16	13725	2.37	1.47
75	2.71	14232	2.44	1.51
80	2.32	14592	2.50	1.53
85	1.99	14828	2.53	1.55
90	1.70	14959	2.55	1.56
95	1.46	15002	2.56	1.56
100	1.25	14970	2.56	1.56
105	1.07	14877	2.54	1.55
110	0.92	14732	2.52	1.54
115	0.79	14544	2.49	1.53
120	0.67	14321	2.46	1.51
125	0.58	14069	2.42	1.49
130	0.49	13794	2.38	1.47
135	0.42	13501	2.33	1.45
140	0.36	13194	2.29	1.42
145	0.31	12875	2.24	1.40
150	0.27	12550	2.19	1.37

1.58

50 YEAR STORM ROUTING				
Time (min)	Inflow (CFS)	Storage (CF)	Stage (ft)	Outflow (CFS)
0	0.00	0	0.00	0.00
5	0.20	0	0.00	0.00
10	0.78	60	0.01	0.00
15	1.66	292	0.06	0.01
20	2.76	789	0.15	0.01
25	3.93	1613	0.31	0.01
30	5.05	2787	0.52	0.02
35	5.98	4296	0.80	0.02
40	6.62	6083	1.12	0.49
45	6.89	7920	1.43	0.85
50	6.76	9731	1.73	1.09
55	6.25	11432	2.01	1.27
60	5.47	12927	2.24	1.40
65	4.75	14147	2.43	1.50
70	4.12	15121	2.58	1.57
75	3.57	15886	2.69	1.62
80	3.10	16471	2.78	1.66
85	2.69	16902	2.84	1.69
90	2.34	17202	2.88	1.71
95	2.03	17390	2.91	1.72
100	1.76	17481	2.92	1.73
105	1.53	17491	2.92	1.73
110	1.33	17430	2.92	1.73
115	1.15	17310	2.90	1.72
120	1.00	17140	2.87	1.71
125	0.87	16928	2.84	1.69
130	0.75	16680	2.81	1.68
135	0.65	16402	2.77	1.66
140	0.57	16100	2.72	1.64
145	0.49	15778	2.68	1.62
150	0.43	15440	2.63	1.59

Cypress Cove Apartments – Pond #2

CLOGGED 50 YEAR STORM ROUTING				
Time (min)	Inflow (CFS)	Storage (CF)	Stage (ft)	Outflow (CFS)
0	0.00	0	0.00	0.00
5	0.20	0	0.00	0.00
10	0.78	60	0.01	0.00
15	1.66	293	0.06	0.00
20	2.76	792	0.15	0.00
25	3.93	1619	0.31	0.00
30	5.05	2797	0.53	0.00
35	5.98	4312	0.80	0.00
40	6.62	6106	1.12	0.00
45	6.89	8091	1.46	0.00
50	6.76	10158	1.80	0.00
55	6.25	12187	2.13	0.00
60	5.47	14062	2.42	0.00
65	4.75	15702	2.66	0.00
70	4.12	17126	2.87	0.00
75	3.57	18361	3.05	0.00
80	3.10	19434	3.20	0.00
85	2.69	20365	3.32	0.00
90	2.34	21172	3.43	0.00
95	2.03	21874	3.52	0.00
100	1.76	22482	3.60	0.00
105	1.53	23010	3.67	0.00
110	1.33	23469	3.72	0.00
115	1.15	23866	3.77	0.00
120	1.00	24212	3.82	0.00
125	0.87	24511	3.85	0.00
130	0.75	24772	3.88	0.00
135	0.65	24997	3.91	0.00
140	0.57	25193	3.94	0.00
145	0.49	25363	3.96	0.00
150	0.43	25511	3.97	0.00

100 YEAR STORM ROUTING				
Time (min)	Inflow (CFS)	Storage (CF)	Stage (ft)	Outflow (CFS)
0	0.00	0	0.00	0.00
5	0.19	0	0.00	0.00
10	0.74	57	0.01	0.00
15	1.59	277	0.05	0.01
20	2.65	751	0.14	0.01
25	3.83	1544	0.29	0.01
30	5.00	2689	0.51	0.02
35	6.04	4182	0.78	0.02
40	6.84	5986	1.10	0.47
45	7.33	7898	1.43	0.85
50	7.46	9843	1.75	1.10
55	7.21	11750	2.06	1.30
60	6.61	13523	2.34	1.45
65	5.80	15070	2.57	1.57
70	5.09	16341	2.76	1.66
75	4.46	17370	2.91	1.72
80	3.90	18190	3.02	1.77
85	3.42	18830	3.11	1.81
90	3.00	19313	3.18	1.84
95	2.63	19660	3.23	1.86
100	2.30	19891	3.26	1.87
105	2.02	20020	3.27	1.88
110	1.77	20061	3.28	1.88
115	1.55	20027	3.28	1.88
120	1.36	19928	3.26	1.87
125	1.19	19773	3.24	1.86
130	1.04	19570	3.21	1.85
135	0.91	19327	3.18	1.84
140	0.80	19049	3.14	1.82
145	0.70	18741	3.10	1.80
150	0.61	18410	3.05	1.79

NCDENR Stormwater Design Calculations

Wet Pond 3

Project: Cypress Cove Apartments
 Job #: PM858-36-001
 Engineer: CMC
 Date: 9/5/2017

Rational Method

(See accompanying figures and tables as noted)

Predevelopment Land Use

Description	C	Area (ac)
Total area		3.64
Impervious	0.95	0.10
Pervious	0.15	3.55

Weighted C: 0.17
 Impervious (ex) 2.7%

drainage area input

total area	158725.35 sf
sidewalks	0 sf
streets	0 sf
lots	0 sf
other	4224.87 sf
total ex BUA	4224.87 sf

Postdevelopment Land Use

Description	C	Area (ac)
Total area		3.64
Impervious	0.95	1.69
Pervious	0.15	1.95

Weighted C: 0.52
 Impervious (prop) 46.5%

drainage area input

total area	158725.35 sf
sidewalks	10223.03 sf
streets/parking	34297.66 sf
buildings	23187.78 sf
other	1889.08 sf
offsite	4224.87 sf
total prop BUA	73822.42 sf

Impervious Ratio

Drainage Area (ac):	Postdevelopment 3.64
Net Impervious Area (ac):	1.69
Impervious ratio:	0.47

Schuler's Simple Method

$$R_v = 0.05 + 0.9 * \text{Impervious Ratio} \quad R_v = 0.469$$

$$\text{Control Volume} = 3630 * R_d * R_v * A \quad \text{where } R_d = 1.5 \text{ in.}$$

$$\text{Water Quality Required Storage} = \boxed{9297} \text{ cf}$$

USE: **9297** CF FOR POND DESIGN

Basin Dimensions

Below Permanent Pool - Main Pool Depth

El.	SA Pond	Inc. Vol. Pond	Total Vol Pond
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
12	1858	0	0
13	2352	2105	2105
14	2887	2620	4725

15	3463	3175	7900
16	4078	3771	11670
17	4724	4401	16071
17.5	5750	2619	18690

Total Volume= cf

is > Required, OK

State Required Depth/Surface Area Calculation

VPP (Volume of Permanent Pool) =

APP (Area of Permanent Pool) =

Average Depth Using Equation 2= ft

is > 3.0', OK

Table 2 SA/DA lower depth interval:

Impervious Cover Ratio=

Table 2 SA/DA lower %BUA interval:

Enter Table 2 SA/DA values for depth and %BUA:

<input type="text" value="2.96"/>	<input type="text" value="2.26"/>
<input type="text" value="3.65"/>	<input type="text" value="2.87"/>

Calculated SA/DA=

Required Surface Area= sf

Note: Based on SA=SA/DA*Area*43560/100

Permanent Pool SA= sf

is > required SA, OK

Below Permanent Pool - Forebay Depth (15-20% Main Pond Volume)

El.	SA Pond	Inc. Vol. Pond	Total Vol Pond
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
12	59	0	0
13	159	109	109
14	305	232	341
15	500	403	744
16	742	621	1365
17	1032	887	2252

17.5	1195	557	2808
------	------	-----	------

Minimum Allowable Forebay Volume (15%)	2803
Forebay Volume =	2808
Maximum Allowable Forebay Volume (20%)	3738

is within range, OK

Above Permanent Pool

EL.	Stage	SA	Inc. Vol. Pond	Total Vol. Pond
17.5	0	6945	0	0
18	0.5	8601	3887	3887
18.61	1.11	9355	5477	9363
19	1.5	9851	9226	13113
20	2.5	10467	10159	23272
21	3.5	11097	10782	34054
22	4.5	12734	11916	45969
23	5.5	14187	13461	59430

State Stage=	1.11	ft
State El.=	18.61	ft
State Volume =	9363.08	cf
Top El.=	23.00	
Freeboard=	4.39	ft

is > Required, OK

is > 1.0', OK

2-5 Day Drawdown for State Volume

Max (2 Day) Flow=	0.05	cfs
Min (5 Day) Flow=	0.02	cfs
Slot Stage=	1.11	ft
Avg Head=	0.37	ft
2 Day Area=	0.018	sf
5 Day Area=	0.007	sf
2 Day Diameter=	1.836	in
5 Day Diameter=	1.161	in
Provide Orifice=	1.50	in
Drawdown Flow=	0.04	cfs
Drawdown Time=	3.0	days

is < predevelopment discharge, OK

is within 2-5 days, OK

COW SW Design Calculations

Project: Cypress Cove Apartments -- Pond #3

Job #: PM858-36

Engineer: CMC

Date: 9/5/17

PEAK RUNOFF PER RATIONAL METHOD

DRAINAGE AREA "DA" (AC):	3.64
POSTDEVELOPMENT BUA (AC):	1.69
PERVIOUS "C":	0.15
IMPERVIOUS "C":	0.95
POSTDEVELOPMENT WEIGHTED "C":	0.52
OVERLAND WATERSHED LENGTH (FT):	100
OVERLAND WATERSHED HEIGHT (FT):	1
KIRPICH CORRECTION FACTOR:	1
T _c (min):	1.6
PAVED WATERSHED LENGTH (FT):	0
PAVED WATERSHED HEIGHT (FT):	1
KIRPICH CORRECTION FACTOR:	0.4
T _c (min):	0.0
PIPED WATERSHED LENGTH (FT):	701
PIPED WATERSHED HEIGHT (FT):	4
KIRPICH CORRECTION FACTOR:	0.2
T _c (min):	1.8
Total T _c (min):	3.4
∴ Use a T _c (min) of:	5
2 YR INTENSITY (IN/HR):	5.88
10 YR INTENSITY (IN/HR):	7.23
25 YR INTENSITY (IN/HR):	8.15
50 YR INTENSITY (IN/HR):	8.87
100 YR INTENSITY (IN/HR):	9.60
POSTDEVELOPMENT 2 YR Q (CFS):	11.16
POSTDEVELOPMENT 10 YR Q (CFS):	13.72
POSTDEVELOPMENT 25 YR Q (CFS):	15.47
POSTDEVELOPMENT 50 YR Q (CFS):	16.84
POSTDEVELOPMENT 100 YR Q (CFS):	18.22

TIME TO PEAK RUNOFF

USE HYDRAULIC SOIL GROUP:	A	
CURVE NUMBER "CN", PREDEV.:	39	
CURVE NUMBER "CN", IMPERVIOUS:	98	
CURVE NUMBER "CN", WEIGHTED:	66	
SOIL STORAGE CAPACITY "S" (IN):	5.06	NOTE: $S = (1000 / CN) - 10$
2 YR, 24 HR PRECIPITATION "P" (IN):	4.50	
10 YR, 24 HR PRECIPITATION "P" (IN):	6.72	
25 YR, 24 HR PRECIPITATION "P" (IN):	8.01	
50 YR, 24 HR PRECIPITATION "P" (IN):	9.01	
100 YR, 24 HR PRECIPITATION "P" (IN):	10.00	
2 YR, 24 HR RUNOFF "RO" (IN):	1.42	NOTE: $RO = ((P - 0.2 * S)^2) / (P + 0.8 * S)$
10 YR, 24 HR RUNOFF "RO" (IN):	3.02	
25 YR, 24 HR RUNOFF "RO" (IN):	4.06	
50 YR, 24 HR RUNOFF "RO" (IN):	4.90	
100 YR, 24 HR RUNOFF "RO" (IN):	5.75	
2 YR, 24 HR TIME TO PEAK "T _p " (MIN):	20	NOTE: $T_p = (43.5 * DA * RO) / Q$
10 YR, 24 HR TIME TO PEAK "T _p " (MIN):	35	
25 YR, 24 HR TIME TO PEAK "T _p " (MIN):	42	
50 YR, 24 HR TIME TO PEAK "T _p " (MIN):	46	
100 YR, 24 HR TIME TO PEAK "T _p " (MIN):	50	

POND DIMENSIONS

EL.	SA	Incr. Vol.	Tot. Vol.	Stage		
17.5	6945	0	0	0.0	1.50	DRAWDOWN ORIFICE DIAMETER (IN)
					0.13	DRAWDOWN ORIFICE DIAMETER (FT)
18.0	8601	3887	3887	0.5	0.01	DRAWDOWN ORIFICE AREA (SF)
19.0	9851	9226	13113	1.5	0.00	DRAWDOWN ORIFICE STAGE (FT)
20.0	10467	10159	23272	2.5		
21.0	11097	10782	34054	3.5	2.00	DRAWDOWN SLOT LENGTH (FT):
22.0	12734	11916	45969	4.5	1	NUMBER OF DRAWDOWN SLOTS
23.0	14187	13461	59430	5.5	0.33	DRAWDOWN SLOT HEIGHT (FT)
					0.66	DRAWDOWN SLOT AREA (SF)
					1.11	DRAWDOWN SLOT BOTTOM (FT)
					1.28	DRAWDOWN SLOT CENTROID (FT)
					1.44	DRAWDOWN SLOT TOP (FT)
					16.00	OUTLET STRUCTURE WEIR LENGTH (FT)
					4.00	OUTLET STRUCTURE WEIR STAGE (FT)
					4.50	EMERGENCY WEIR STAGE (FT)
					15.00	EMERGENCY WEIR LENGTH (FT)

Total =				59430		
---------	--	--	--	-------	--	--

STAGE-STORAGE CURVE

Cypress Cove -- Pond #3

2 YEAR STORM ROUTING				
Time (min)	Inflow (CFS)	Storage (CF)	Stage (ft)	Outflow (CFS)
0	0.00	0	0.00	0.00
3	0.60	0	0.00	0.00
6	2.26	107	0.01	0.01
9	4.63	513	0.06	0.01
12	7.21	1344	0.16	0.02
15	9.43	2637	0.31	0.03
18	10.84	4329	0.50	0.04
21	11.12	6273	0.72	0.05
24	10.21	8265	0.95	0.06
27	8.51	10092	1.15	0.11
30	7.02	11605	1.31	0.61
33	5.78	12758	1.44	1.19
36	4.77	13585	1.52	1.66
39	3.93	14145	1.58	1.84
42	3.24	14521	1.62	1.95
45	2.67	14753	1.65	2.02
48	2.20	14871	1.66	2.05
51	1.81	14898	1.66	2.06
54	1.50	14855	1.66	2.04
57	1.23	14756	1.65	2.02
60	1.02	14615	1.63	1.98
63	0.84	14442	1.61	1.93
66	0.69	14246	1.59	1.87
69	0.57	14033	1.57	1.80
72	0.47	13811	1.55	1.73
75	0.39	13583	1.52	1.66
78	0.32	13354	1.50	1.58
81	0.26	13128	1.48	1.49
84	0.22	12906	1.45	1.41
87	0.18	12692	1.43	1.15
90	0.15	12517	1.41	1.06

3.67

10 YEAR STORM ROUTING				
Time (min)	Inflow (CFS)	Storage (CF)	Stage (ft)	Outflow (CFS)
0	0.00	0	0.00	0.00
4	0.44	0	0.00	0.00
8	1.70	105	0.01	0.01
12	3.62	512	0.06	0.01
16	5.96	1379	0.16	0.02
20	8.42	2804	0.33	0.03
24	10.67	4815	0.56	0.04
28	12.43	7365	0.85	0.05
32	13.49	10337	1.17	0.16
36	13.69	13535	1.52	1.64
40	13.02	16427	1.82	2.43
44	11.57	18967	2.08	2.94
48	9.97	21037	2.29	3.30
52	8.59	22638	2.45	3.54
56	7.40	23849	2.57	3.71
60	6.37	24733	2.66	3.83
64	5.49	25343	2.72	3.91
68	4.73	25723	2.75	3.96
72	4.08	25908	2.77	3.98
76	3.51	25930	2.77	3.99
80	3.03	25816	2.76	3.97
84	2.61	25589	2.74	3.94
88	2.25	25269	2.71	3.90
92	1.94	24871	2.67	3.85
96	1.67	24412	2.63	3.79
100	1.44	23903	2.58	3.72
104	1.24	23355	2.52	3.64
108	1.07	22778	2.47	3.56
112	0.92	22179	2.41	3.47
116	0.79	21566	2.35	3.38
120	0.68	20945	2.28	3.28

4.51

Cypress Cove -- Pond #3

25 YEAR STORM ROUTING				
Time (min)	Inflow (CFS)	Storage (CF)	Stage (ft)	Outflow (CFS)
0	0.00	0	0.00	0.00
5	0.55	0	0.00	0.00
10	2.10	164	0.02	0.01
15	4.46	792	0.09	0.02
20	7.27	2124	0.25	0.03
25	10.15	4297	0.50	0.04
30	12.69	7330	0.84	0.05
35	14.53	11121	1.26	0.41
40	15.41	15356	1.71	2.18
45	15.21	19328	2.12	3.01
50	13.96	22989	2.49	3.59
55	12.02	26099	2.79	4.01
60	10.28	28502	3.02	4.30
65	8.79	30297	3.18	4.49
70	7.52	31586	3.30	4.63
75	6.43	32452	3.38	4.72
80	5.50	32966	3.42	4.77
85	4.70	33185	3.44	4.79
90	4.02	33158	3.44	4.79
95	3.44	32928	3.42	4.77
100	2.94	32531	3.39	4.73
105	2.52	31996	3.34	4.67
110	2.15	31349	3.28	4.61
115	1.84	30613	3.21	4.53
120	1.57	29806	3.14	4.44
125	1.35	28946	3.06	4.35
130	1.15	28046	2.97	4.24
135	0.98	27119	2.89	4.13
140	0.84	26174	2.80	4.02
145	0.72	25222	2.70	3.90
150	0.62	24269	2.61	3.77

5.09

50 YEAR STORM ROUTING				
Time (min)	Inflow (CFS)	Storage (CF)	Stage (ft)	Outflow (CFS)
0	0.00	0	0.00	0.00
5	0.48	0	0.00	0.00
10	1.88	145	0.02	0.01
15	4.03	707	0.08	0.02
20	6.68	1911	0.22	0.03
25	9.54	3908	0.45	0.04
30	12.26	6757	0.78	0.05
35	14.54	10420	1.18	0.18
40	16.12	14728	1.65	2.01
45	16.81	18961	2.08	2.94
50	16.54	23122	2.50	3.61
55	15.33	27000	2.87	4.12
60	13.44	30364	3.19	4.50
65	11.67	33045	3.43	4.78
70	10.13	35112	3.62	4.97
75	8.80	36660	3.75	5.11
80	7.64	37766	3.85	5.21
85	6.64	38495	3.91	5.27
90	5.76	38904	3.94	5.31
95	5.00	39040	3.95	5.32
100	4.35	38946	3.95	5.31
105	3.77	38656	3.92	5.29
110	3.28	38202	3.88	5.25
115	2.85	37611	3.83	5.20
120	2.47	36905	3.77	5.14
125	2.15	36106	3.70	5.06
130	1.86	35230	3.63	4.99
135	1.62	34294	3.54	4.90
140	1.41	33310	3.46	4.80
145	1.22	32291	3.36	4.70
150	1.06	31247	3.27	4.59

Cypress Cove -- Pond #3

CLOGGED 50 YEAR STORM ROUTING				
Time (min)	Inflow (CFS)	Storage (CF)	Stage (ft)	Outflow (CFS)
0	0.00	0	0.00	0.00
5	0.48	0	0.00	0.00
10	1.88	145	0.02	0.00
15	4.03	710	0.08	0.00
20	6.68	1919	0.22	0.00
25	9.54	3924	0.46	0.00
30	12.26	6785	0.78	0.00
35	14.54	10463	1.19	0.00
40	16.12	14826	1.66	0.00
45	16.81	19662	2.15	0.00
50	16.54	24706	2.65	0.00
55	15.33	29667	3.12	0.00
60	13.44	34266	3.54	0.00
65	11.67	38297	3.89	0.00
70	10.13	41798	4.18	0.00
75	8.80	44838	4.43	0.00
80	7.64	47478	4.64	2.30
85	6.64	49081	4.76	5.99
90	5.76	49277	4.78	6.50
95	5.00	49055	4.76	5.92
100	4.35	48781	4.74	5.22
105	3.77	48520	4.72	4.57
110	3.28	48280	4.70	4.01
115	2.85	48061	4.68	3.51
120	2.47	47862	4.67	3.08
125	2.15	47680	4.65	2.70
130	1.86	47514	4.64	2.37
135	1.62	47363	4.63	2.08
140	1.41	47225	4.62	1.82
145	1.22	47099	4.61	1.60
150	1.06	46985	4.60	1.41

100 YEAR STORM ROUTING				
Time (min)	Inflow (CFS)	Storage (CF)	Stage (ft)	Outflow (CFS)
0	0.00	0	0.00	0.00
5	0.45	0	0.00	0.00
10	1.74	134	0.02	0.01
15	3.76	654	0.08	0.02
20	6.30	1776	0.21	0.03
25	9.11	3657	0.43	0.04
30	11.93	6380	0.74	0.05
35	14.47	9943	1.13	0.08
40	16.48	14260	1.60	1.87
45	17.78	18643	2.05	2.88
50	18.22	23110	2.50	3.61
55	17.77	27494	2.92	4.18
60	16.48	31573	3.30	4.63
65	14.57	35127	3.62	4.98
70	12.80	38006	3.87	5.23
75	11.23	40276	4.06	6.10
80	9.86	41817	4.19	9.39
85	8.66	41959	4.20	9.77
90	7.60	41626	4.17	8.90
95	6.68	41237	4.14	7.96
100	5.86	40851	4.11	7.13
105	5.15	40472	4.07	6.41
110	4.52	40091	4.04	5.83
115	3.97	39698	4.01	5.42
120	3.48	39262	3.97	5.34
125	3.06	38706	3.93	5.29
130	2.69	38036	3.87	5.23
135	2.36	37271	3.80	5.17
140	2.07	36428	3.73	5.09
145	1.82	35521	3.65	5.01
150	1.60	34563	3.57	4.92

NCDENR Stormwater Design Calculations

Wet Pond 4

Project: Cypress Cove Apartments
 Job #: PM858-36-001
 Engineer: CMC
 Date: 9/5/2017

Rational Method

(See accompanying figures and tables as noted)

Predevelopment Land Use

Description	C	Area (ac)
Total area		2.91
Impervious	0.95	0.00
Pervious	0.15	2.91

Weighted C: 0.15
 Impervious (ex) 0.0%

drainage area input

total area	126949.13 sf
sidewalks	0 sf
streets	0 sf
lots	0 sf
other	0 sf
total ex BUA	0 sf

Postdevelopment Land Use

Description	C	Area (ac)
Total area		2.91
Impervious	0.95	1.61
Pervious	0.15	1.30

Weighted C: 0.59
 Impervious (prop) 55.2%

drainage area input

total area	126949.13 sf
sidewalks	10292.8 sf
streets/parking	41095.83 sf
buildings	16318.64 sf
other	2396.34 sf
offsite	0 sf
total prop BUA	70103.61 sf

Impervious Ratio

Drainage Area (ac):	2.91
Net Impervious Area (ac):	1.61
Impervious Ratio:	0.55

Schuler's Simple Method

$$R_v = 0.05 + 0.9 * \text{Impervious Ratio} \quad R_v = 0.547$$

$$\text{Control Volume} = 3630 * R_d * R_v * A \quad \text{where } R_d = 1.5 \text{ in.}$$

$$\text{Water Quality Required Storage} = 8680 \text{ cf}$$

USE: 8680 CF FOR POND DESIGN

Basin Dimensions

Below Permanent Pool - Main Pool Depth

El.	SA Pond	Inc. Vol. Pond	Total Vol Pond
7	0	0	0
8	0	0	0
9	470	0	0
10	773	622	622
11	1108	941	1562
12	1475	1292	2854
13	1874	1675	4528

14	2305	2090	6618
15	2768	2537	9154
16	3263	3016	12170
16.5	4065	1832	14002

Total Volume= cf

is > Required, OK

State Required Depth/Surface Area Calculation

VPP (Volume of Permanent Pool) =

APP (Area of Permanent Pool) =

Average Depth Using Equation 2=

ft

is > 3.0', OK

Table 2 SA/DA lower depth interval:

Impervious Cover Ratio=

Table 2 SA/DA lower %BUA interval:

Enter Table 2 SA/DA values for depth and %BUA:

<input type="text" value="3.65"/>	<input type="text" value="2.87"/>
<input type="text" value="4.35"/>	<input type="text" value="3.31"/>

Calculated SA/DA=

Required Surface Area=

sf

Note: Based on SA=SA/DA*Area*43560/100

Permanent Pool SA=

sf

is > required SA, OK

Below Permanent Pool - Forebay Depth (15-20% Main Pond Volume)

El.	SA Pond	inc. Vol. Pond	Total Vol Pond
7	0	0	0
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
12	125	0	0
13	250	188	188
14	406	328	516
15	595	501	1016
16	815	705	1721

16.5	1068	471	2192
------	------	-----	------

Minimum Allowable Forebay Volume (15%)	2100
Forebay Volume =	2192
Maximum Allowable Forebay Volume (20%)	2800

is within range, OK

Above Permanent Pool

EL.	Stage	SA	Inc. Vol. Pond	Total Vol. Pond
16.5	0	5133	0	0
17	0.5	6305	2860	2860
17.86	1.36	7264	5835	8694
18	1.5	7425	6865	9725
19	2.5	8616	8021	17745
20	3.5	9577	9097	26842
21	4.5	10429	10003	36845
22	5.5	11317	10873	47718
22.5	6	11774	5773	53490

State Stage=	1.36	ft
State EL.=	17.86	ft
State Volume =	8694.17	cf
Top EL.=	22.50	
Freeboard=	4.64	ft

is > Required, OK

is > 1.0', OK

2-5 Day Drawdown for State Volume

Max (2 Day) Flow=	0.05	cfs
Min (5 Day) Flow=	0.02	cfs

Slot Stage=	1.36	ft
Avg Head=	0.45	ft

2 Day Area=	0.015	sf
5 Day Area=	0.006	sf

2 Day Diameter=	1.686	in
5 Day Diameter=	1.066	in

Provide Orifice=	1.25	in
------------------	------	----

Drawdown Flow=	0.03	cfs
Drawdown Time=	3.6	days

is < predevelopment discharge, OK

is within 2-5 days, OK

COW SW Design Calculations

Project: Cypress Cove Apartments -- Pond #4
 Job #: PM858-36
 Engineer: CMC
 Date: 9/5/17

PEAK RUNOFF PER RATIONAL METHOD

DRAINAGE AREA "DA" (AC):	2.91
POSTDEVELOPMENT BUA (AC):	1.61
PERVIOUS "C":	0.20
IMPERVIOUS "C":	0.95
POSTDEVELOPMENT WEIGHTED "C":	0.61
OVERLAND WATERSHED LENGTH (FT):	105
OVERLAND WATERSHED HEIGHT (FT):	1
KIRPICH CORRECTION FACTOR:	1
T _c (min):	1.7
PAVED WATERSHED LENGTH (FT):	0
PAVED WATERSHED HEIGHT (FT):	1
KIRPICH CORRECTION FACTOR:	0.4
T _c (min):	0.0
PIPED WATERSHED LENGTH (FT):	408
PIPED WATERSHED HEIGHT (FT):	5.3
KIRPICH CORRECTION FACTOR:	0.2
T _c (min):	0.9
Total T _c (min):	2.5
∴ Use a T _c (min) of:	5
2 YR INTENSITY (IN/HR):	5.88
10 YR INTENSITY (IN/HR):	7.23
25 YR INTENSITY (IN/HR):	8.15
50 YR INTENSITY (IN/HR):	8.87
100 YR INTENSITY (IN/HR):	9.60
POSTDEVELOPMENT 2 YR Q (CFS):	10.52
POSTDEVELOPMENT 10 YR Q (CFS):	12.94
POSTDEVELOPMENT 25 YR Q (CFS):	14.58
POSTDEVELOPMENT 50 YR Q (CFS):	15.87
POSTDEVELOPMENT 100 YR Q (CFS):	17.18

TIME TO PEAK RUNOFF

USE HYDRAULIC SOIL GROUP:	A	
CURVE NUMBER "CN", PREDEV.:	39	
CURVE NUMBER "CN", IMPERVIOUS:	98	
CURVE NUMBER "CN", WEIGHTED:	72	
SOIL STORAGE CAPACITY "S" (IN):	3.96	NOTE: $S = (1000 / CN) - 10$
2 YR, 24 HR PRECIPITATION "P" (IN):	4.50	
10 YR, 24 HR PRECIPITATION "P" (IN):	6.72	
25 YR, 24 HR PRECIPITATION "P" (IN):	8.01	
50 YR, 24 HR PRECIPITATION "P" (IN):	9.01	
100 YR, 24 HR PRECIPITATION "P" (IN):	10.00	
2 YR, 24 HR RUNOFF "RO" (IN):	1.79	NOTE: $RO = ((P - 0.2 * S)^2) / (P + 0.8 * S)$
10 YR, 24 HR RUNOFF "RO" (IN):	3.55	
25 YR, 24 HR RUNOFF "RO" (IN):	4.66	
50 YR, 24 HR RUNOFF "RO" (IN):	5.55	
100 YR, 24 HR RUNOFF "RO" (IN):	6.44	
2 YR, 24 HR TIME TO PEAK "T _p " (MIN):	22	NOTE: $T_p = (43.5 * DA * RO) / Q$
10 YR, 24 HR TIME TO PEAK "T _p " (MIN):	35	
25 YR, 24 HR TIME TO PEAK "T _p " (MIN):	40	
50 YR, 24 HR TIME TO PEAK "T _p " (MIN):	44	
100 YR, 24 HR TIME TO PEAK "T _p " (MIN):	47	

POND DIMENSIONS

EL.	SA	Incr. Vol.	Tot. Vol.	Stage		
16.5	5133	0	0	0.0	1.25	DRAWDOWN ORIFICE DIAMETER (IN)
17.0	6305	2860	2860	0.5	0.10	DRAWDOWN ORIFICE DIAMETER (FT)
18.0	7425	6865	9725	1.5	0.01	DRAWDOWN ORIFICE AREA (SF)
19.0	8616	8021	17745	2.5	0.00	DRAWDOWN ORIFICE STAGE (FT)
20.0	9577	9097	26842	3.5	2.00	DRAWDOWN SLOT LENGTH (FT):
21.0	10429	10003	36845	4.5	1	NUMBER OF DRAWDOWN SLOTS
22.0	11317	10873	47718	5.5	0.20	DRAWDOWN SLOT HEIGHT (FT)
22.5	11774	5551	53268	6.0	0.40	DRAWDOWN SLOT AREA (SF)
					1.36	DRAWDOWN SLOT BOTTOM (FT)
					1.46	DRAWDOWN SLOT CENTROID (FT)
					1.56	DRAWDOWN SLOT TOP (FT)
Total = 53268						

STAGE-STORAGE CURVE	
16.00	OUTLET STRUCTURE WEIR LENGTH (FT)
4.50	OUTLET STRUCTURE WEIR STAGE (FT)
5.00	EMERGENCY WEIR STAGE (FT)
15.00	EMERGENCY WEIR LENGTH (FT)

Cypress Cove -- Pond #4

2 YEAR STORM ROUTING				
Time (min)	Inflow (CFS)	Storage (CF)	Stage (ft)	Outflow (CFS)
0	0.00	0	0.00	0.00
3	0.49	0	0.00	0.00
6	1.88	89	0.01	0.00
9	3.90	427	0.06	0.01
12	6.18	1127	0.17	0.02
15	8.28	2236	0.34	0.02
18	9.82	3723	0.56	0.03
21	10.50	5485	0.81	0.04
24	10.20	7369	1.08	0.04
27	8.98	9198	1.33	0.05
30	7.49	10805	1.55	0.56
33	6.25	12053	1.72	1.04
36	5.22	12992	1.85	1.25
39	4.36	13706	1.94	1.39
42	3.64	14240	2.01	1.49
45	3.04	14627	2.06	1.55
48	2.53	14894	2.10	1.59
51	2.11	15063	2.12	1.62
54	1.77	15152	2.13	1.63
57	1.47	15176	2.13	1.64
60	1.23	15146	2.13	1.63
63	1.03	15073	2.12	1.62
66	0.86	14966	2.10	1.61
69	0.72	14831	2.09	1.58
72	0.60	14675	2.07	1.56
75	0.50	14502	2.04	1.53
78	0.42	14316	2.02	1.50
81	0.35	14121	1.99	1.47
84	0.29	13919	1.97	1.43
87	0.24	13714	1.94	1.39

2.57

10 YEAR STORM ROUTING				
Time (min)	Inflow (CFS)	Storage (CF)	Stage (ft)	Outflow (CFS)
0	0.00	0	0.00	0.00
4	0.42	0	0.00	0.00
8	1.62	100	0.02	0.01
12	3.44	487	0.07	0.01
16	5.65	1309	0.20	0.02
20	7.97	2662	0.40	0.03
24	10.10	4569	0.68	0.03
28	11.76	6985	1.02	0.04
32	12.73	9797	1.42	0.13
36	12.90	12822	1.82	1.22
40	12.24	15626	2.19	1.71
44	10.84	18154	2.51	2.04
48	9.34	20267	2.77	2.27
52	8.04	21963	2.97	2.44
56	6.92	23307	3.13	2.56
60	5.96	24354	3.25	2.65
64	5.13	25149	3.34	2.72
68	4.42	25729	3.41	2.76
72	3.81	26127	3.45	2.79
76	3.28	26370	3.48	2.81
80	2.82	26482	3.49	2.82
84	2.43	26482	3.49	2.82
88	2.09	26388	3.48	2.81
92	1.80	26215	3.46	2.80
96	1.55	25976	3.43	2.78
100	1.34	25680	3.40	2.76
104	1.15	25339	3.36	2.73
108	0.99	24960	3.32	2.70
112	0.85	24549	3.27	2.67
116	0.74	24114	3.22	2.63

3.16

90	0.20	13507	1.91	1.35
----	------	-------	------	------

120	0.63	23659	3.17	2.59
-----	------	-------	------	------

Cypress Cove -- Pond #4

25 YEAR STORM ROUTING				
Time (min)	Inflow (CFS)	Storage (CF)	Stage (ft)	Outflow (CFS)
0	0.00	0	0.00	0.00
5	0.54	0	0.00	0.00
10	2.09	163	0.02	0.01
15	4.41	787	0.12	0.01
20	7.16	2105	0.32	0.02
25	9.92	4244	0.63	0.03
30	12.30	7212	1.06	0.04
35	13.93	10890	1.56	0.68
40	14.58	14867	2.09	1.59
45	14.14	18764	2.58	2.11
50	12.68	22374	3.02	2.48
55	10.81	25436	3.37	2.74
60	9.21	27859	3.64	2.92
65	7.84	29744	3.85	3.06
70	6.68	31180	4.00	3.15
75	5.69	32238	4.11	3.22
80	4.84	32979	4.19	3.26
85	4.12	33453	4.23	3.29
90	3.51	33702	4.26	3.31
95	2.99	33764	4.26	3.31
100	2.55	33669	4.25	3.30
105	2.17	33441	4.23	3.29
110	1.85	33105	4.20	3.27
115	1.57	32678	4.15	3.25
120	1.34	32176	4.10	3.21
125	1.14	31614	4.04	3.18
130	0.97	31003	3.98	3.14
135	0.83	30352	3.91	3.10
140	0.70	29671	3.84	3.05
145	0.60	28967	3.76	3.00

3.56

50 YEAR STORM ROUTING				
Time (min)	Inflow (CFS)	Storage (CF)	Stage (ft)	Outflow (CFS)
0	0.00	0	0.00	0.00
5	0.49	0	0.00	0.00
10	1.92	148	0.02	0.01
15	4.09	722	0.11	0.01
20	6.74	1944	0.29	0.02
25	9.54	3960	0.59	0.03
30	12.14	6814	1.00	0.04
35	14.22	10444	1.50	0.38
40	15.51	14596	2.06	1.55
45	15.86	18786	2.59	2.11
50	15.22	22912	3.08	2.53
55	13.68	26721	3.52	2.84
60	11.81	29971	3.87	3.07
65	10.20	32594	4.15	3.24
70	8.81	34681	4.36	3.36
75	7.60	36314	4.52	3.55
80	6.56	37529	4.63	5.84
85	5.67	37747	4.65	6.41
90	4.89	37524	4.63	5.82
95	4.22	37244	4.61	5.15
100	3.65	36967	4.58	4.55
105	3.15	36694	4.55	4.06
110	2.72	36421	4.53	3.67
115	2.35	36136	4.50	3.44
120	2.03	35807	4.47	3.43
125	1.75	35387	4.43	3.40
130	1.51	34890	4.38	3.38
135	1.30	34331	4.32	3.34
140	1.13	33719	4.26	3.31
145	0.97	33064	4.19	3.27

150	0.51	28246	3.69	2.95
-----	------	-------	------	------

150	0.84	32375	4.12	3.23
-----	------	-------	------	------

Cypress Cove -- Pond #4

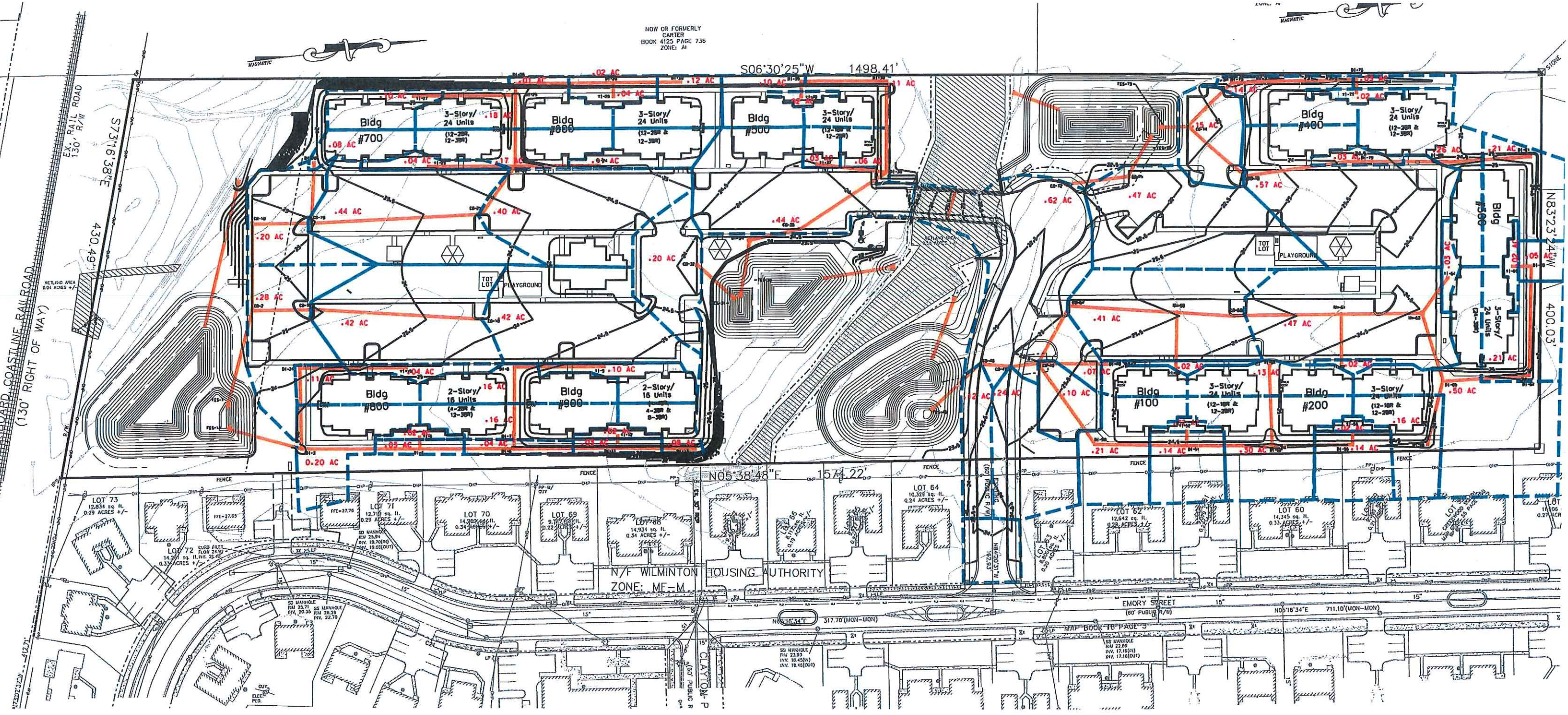
CLOGGED 50 YEAR STORM ROUTING				
Time (min)	Inflow (CFS)	Storage (CF)	Stage (ft)	Outflow (CFS)
0	0.00	0	0.00	0.00
5	0.49	0	0.00	0.00
10	1.92	148	0.02	0.00
15	4.09	723	0.11	0.00
20	6.74	1950	0.29	0.00
25	9.54	3973	0.59	0.00
30	12.14	6836	1.00	0.00
35	14.22	10479	1.51	0.00
40	15.51	14745	2.08	0.00
45	15.86	19398	2.66	0.00
50	15.22	24157	3.23	0.00
55	13.68	28724	3.74	0.00
60	11.81	32826	4.17	0.00
65	10.20	36370	4.52	0.00
70	8.81	39430	4.81	0.00
75	7.60	42072	5.05	0.47
80	6.56	44211	5.23	5.05
85	5.67	44665	5.27	6.35
90	4.89	44461	5.25	5.75
95	4.22	44203	5.23	5.03
100	3.65	43962	5.21	4.38
105	3.15	43743	5.19	3.81
110	2.72	43545	5.18	3.32
115	2.35	43365	5.16	2.89
120	2.03	43202	5.15	2.52
125	1.75	43054	5.13	2.20
130	1.51	42919	5.12	1.92
135	1.30	42798	5.11	1.67
140	1.13	42687	5.10	1.46
145	0.97	42586	5.09	1.28

100 YEAR STORM ROUTING				
Time (min)	Inflow (CFS)	Storage (CF)	Stage (ft)	Outflow (CFS)
0	0.00	0	0.00	0.00
5	0.47	0	0.00	0.00
10	1.81	140	0.02	0.01
15	3.89	682	0.10	0.01
20	6.49	1846	0.28	0.02
25	9.31	3786	0.56	0.03
30	12.05	6568	0.97	0.04
35	14.41	10170	1.47	0.26
40	16.15	14416	2.03	1.52
45	17.06	18806	2.59	2.11
50	17.06	23291	3.13	2.56
55	16.14	27641	3.62	2.91
60	14.41	31610	4.04	3.18
65	12.56	34979	4.39	3.38
70	10.96	37735	4.65	6.38
75	9.55	39109	4.78	10.73
80	8.33	38755	4.75	9.50
85	7.26	38404	4.72	8.35
90	6.33	38078	4.68	7.35
95	5.52	37773	4.66	6.48
100	4.82	37486	4.63	5.73
105	4.20	37213	4.60	5.08
110	3.66	36949	4.58	4.52
115	3.19	36692	4.55	4.05
120	2.78	36434	4.53	3.68
125	2.43	36164	4.50	3.45
130	2.12	35858	4.47	3.43
135	1.85	35465	4.43	3.41
140	1.61	34996	4.39	3.38
145	1.40	34465	4.33	3.35

APPENDIX D
STORM DRAINAGE DESIGN

STORM DRAIN DELINEATIONS PER DRAINAGE
STRUCTURE
11X17 SCALE: 1"=100'

HOW OR FORMERLY
CARTER
BOOK 4125 PAGE 736
ZONE: AI



C-Values & Flows Per Drainage Area - DRAINAGE BASIN #1										
Structure	Total Area (ac)	Impervious Area (ac)	Impervious C-Value	Pervious Area (ac)	Pervious C-Value	Weighted C-Value	10 YR Intensity (in/hr)	Q10 (cfs)	50 YR Intensity (in/hr)	Q50 (cfs)
CB-2	0.28	0.15	0.90	0.13	0.30	0.62	7.23	1.26	8.87	1.54
DI-2A	0.11	0.08	0.90	0.03	0.30	0.74	7.23	0.59	8.87	0.72
DI-3	0.20	0.08	0.90	0.12	0.30	0.54	7.23	0.78	8.87	0.96
DI-4	0.03	0.01	0.90	0.02	0.30	0.50	7.23	0.11	8.87	0.13
YI-5	0.02	0.00	0.90	0.02	0.30	0.30	7.23	0.04	8.87	0.05
DI-6	0.04	0.02	0.90	0.02	0.30	0.60	7.23	0.17	8.87	0.21
DI-7	0.16	0.12	0.90	0.04	0.30	0.75	7.23	0.87	8.87	1.06
DI-8	0.16	0.12	0.90	0.04	0.30	0.75	7.23	0.87	8.87	1.06
YI-9	0.10	0.06	0.90	0.04	0.30	0.66	7.23	0.48	8.87	0.59
CB-10	0.42	0.30	0.90	0.12	0.30	0.73	7.23	2.21	8.87	2.71
DI-11	0.03	0.01	0.90	0.02	0.30	0.50	7.23	0.11	8.87	0.13
YI-12	0.02	0.00	0.90	0.02	0.30	0.30	7.23	0.04	8.87	0.05
DI-13	0.08	0.06	0.90	0.02	0.30	0.75	7.23	0.43	8.87	0.53
YI-15	0.04	0.00	0.90	0.04	0.30	0.30	7.23	0.09	8.87	0.11
CB-16	0.42	0.28	0.90	0.14	0.30	0.70	7.23	2.13	8.87	2.61
CB-18	0.20	0.13	0.90	0.07	0.30	0.69	7.23	1.00	8.87	1.22
CB-19	0.44	0.26	0.90	0.18	0.30	0.65	7.23	2.08	8.87	2.55
DI-20	0.08	0.06	0.90	0.02	0.30	0.75	7.23	0.43	8.87	0.53
CB-21	0.40	0.33	0.90	0.07	0.30	0.80	7.23	2.30	8.87	2.82
DI-22	0.17	0.12	0.90	0.05	0.30	0.72	7.23	0.89	8.87	1.09
YI-23	0.04	0.00	0.90	0.04	0.30	0.30	7.23	0.09	8.87	0.11
YI-24	0.11	0.06	0.90	0.05	0.30	0.63	7.23	0.50	8.87	0.61
DI-25	0.18	0.14	0.90	0.04	0.30	0.77	7.23	1.00	8.87	1.22
DI-26	0.01	0.00	0.90	0.01	0.30	0.30	7.23	0.02	8.87	0.03
YI-27	0.10	0.05	0.90	0.05	0.30	0.60	7.23	0.43	8.87	0.53
DI-28	0.02	0.00	0.90	0.02	0.30	0.30	7.23	0.04	8.87	0.05
YI-29	0.04	0.01	0.90	0.03	0.30	0.45	7.23	0.13	8.87	0.16
DI-30	0.12	0.07	0.90	0.05	0.30	0.65	7.23	0.56	8.87	0.69

C-Values & Flows Per Drainage Area - DRAINAGE BASIN #2										
Structure	Total Area (ac)	Impervious Area (ac)	Impervious C-Value	Pervious Area (ac)	Pervious C-Value	Weighted C-Value	10 YR Intensity (in/hr)	Q10 (cfs)	50 YR Intensity (in/hr)	Q50 (cfs)
CB-32	0.20	0.17	0.90	0.03	0.30	0.81	7.23	1.17	8.87	1.44
CB-35	0.44	0.37	0.90	0.07	0.30	0.80	7.23	2.56	8.87	3.14
DI-36	0.06	0.04	0.90	0.02	0.30	0.70	7.23	0.30	8.87	0.37
YI-37	0.03	0.01	0.90	0.02	0.30	0.50	7.23	0.11	8.87	0.13
DI-38	0.11	0.06	0.90	0.05	0.30	0.63	7.23	0.50	8.87	0.61
DI-39	0.10	0.06	0.90	0.04	0.30	0.66	7.23	0.48	8.87	0.59
YI-40	0.02	0.00	0.90	0.02	0.30	0.30	7.23	0.04	8.87	0.05

C-Values & Flows Per Drainage Area - DRAINAGE BASIN #3										
Structure	Total Area (ac)	Impervious Area (ac)	Impervious C-Value	Pervious Area (ac)	Pervious C-Value	Weighted C-Value	10 YR Intensity (in/hr)	Q10 (cfs)	50 YR Intensity (in/hr)	Q50 (cfs)
CB-46	0.12	0.08	0.90	0.04	0.30	0.70	7.23	0.61	8.87	0.75
CB-47	0.24	0.09	0.90	0.15	0.30	0.53	7.23	0.91	8.87	1.12
CB-48	0.10	0.10	0.90	0.00	0.30	0.90	7.23	0.65	8.87	0.80
DI-49	0.07	0.05	0.90	0.02	0.30	0.73	7.23	0.37	8.87	0.45
DI-50	0.21	0.06	0.90	0.15	0.30	0.47	7.23	0.72	8.87	0.88
DI-51	0.14	0.03	0.90	0.11	0.30	0.43	7.23	0.43	8.87	0.53
YI-52	0.02	0.00	0.90	0.02	0.30	0.30	7.23	0.04	8.87	0.05
DI-53	0.30	0.03	0.90	0.27	0.30	0.36	7.23	0.78	8.87	0.96
YI-54	0.13	0.08	0.90	0.05	0.30	0.67	7.23	0.63	8.87	0.77
DI-55	0.14	0.04	0.90	0.10	0.30	0.47	7.23	0.48	8.87	0.59
YI-56	0.02	0.00	0.90	0.02	0.30	0.30	7.23	0.04	8.87	0.05
CB-57	0.41	0.28	0.90	0.13	0.30	0.71	7.23	2.10	8.87	2.58
YI-59	0.02	0.01	0.90	0.01	0.30	0.60	7.23	0.09	8.87	0.11
CB-60	0.47	0.36	0.90	0.11	0.30	0.76	7.23	2.58	8.87	3.17
YI-62	0.02	0.00	0.90	0.02	0.30	0.30	7.23	0.04	8.87	0.05
YI-64	0.03	0.01	0.90	0.02	0.30	0.50	7.23	0.11	8.87	0.13
DI-65	0.50	0.12	0.90	0.38	0.30	0.44	7.23	1.61	8.87	1.97
DI-66	0.16	0.07	0.90	0.09	0.30	0.56	7.23	0.65	8.87	0.80
DI-67	0.21	0.05	0.90	0.16	0.30	0.44	7.23	0.67	8.87	0.82
DI-68	0.05	0.01	0.90	0.04	0.30	0.42	7.23	0.15	8.87	0.19
YI-69	0.02	0.01	0.90	0.01	0.30	0.60	7.23	0.09	8.87	0.11

C-Values & Flows Per Drainage Area - DRAINAGE BASIN #4										
Structure	Total Area (ac)	Impervious Area (ac)	Impervious C-Value	Pervious Area (ac)	Pervious C-Value	Weighted C-Value	10 YR Intensity (in/hr)	Q10 (cfs)	50 YR Intensity (in/hr)	Q50 (cfs)
CB-71	0.47	0.23	0.90	0.24	0.30	0.59	7.23	2.02	8.87	2.47
CB-72	0.62	0.40	0.90	0.22	0.30	0.69	7.23	3.08	8.87	3.78
CB-74	0.15	0.14	0.90	0.01	0.30	0.86	7.23	0.93	8.87	1.14
DI-75	0.14	0.04	0.90	0.10	0.30	0.47	7.23	0.48	8.87	0.59
DI-76	0.03	0.01	0.90	0.02	0.30	0.50	7.23	0.11	8.87	0.13
YI-77	0.02	0.00	0.90	0.02	0.30	0.30	7.23	0.04	8.87	0.05
CB-78	0.57	0.38	0.90	0.19	0.30	0.70	7.23	2.88	8.87	3.54
DI-79	0.03	0.01	0.90	0.02	0.30	0.50	7.23	0.11	8.87	0.13
DI-80	0.26	0.18	0.90	0.08	0.30	0.72	7.23	1.34	8.87	1.65
DI-81	0.21	0.07	0.90	0.14	0.30	0.51	7.23	0.77	8.87	0.95

APPENDIX

SPREAD CALCULATIONS

Project: Cypress Cove Apartments
 Project #: PM858-37
 Engineer: C. Cullipher
 Date: 6/6/17

Spread Calculation Formula

$$T = \left[\frac{nQ}{K_u S_x^{1.67} \sqrt{S_L}} \right]^{0.375}$$

where:

- T = Spread, ft
- Q = Flow, cfs
- K_u = 0.56
- n = Manning's coefficient
- S_x = Cross Slope
- S_L = Longitudinal Slope

5 Year Spread Calculations - On Grade

*This assumes 0% catchment from structure

Structure ID	=	CB-46	
C	=	0.7	
I	=	6.63 in/hr	
A	=	0.12 ac	
Q 5	=	0.56 cfs	
K _u	=	0.56	
n	=	0.013	
S _x	=	0.02	
S _L	=	0.005	
T	=	6.13 Ft	From Face of Curb
T (Street)	=	4.63 FT	From Edge of Pavement

OK, Less than 1/2 Lane Width
 *This assumes 0% catchment

Structure ID	=	CB-47	
C	=	0.53	
I	=	6.63 in/hr	
A	=	0.24 ac	
Q 5	=	0.84 cfs	
K _u	=	0.56	
n	=	0.013	
S _x	=	0.02	
S _L	=	0.005	
T	=	7.16 Ft	From Face of Curb
T (Street)	=	5.66 FT	From Edge of Pavement

OK, Less than 1/2 Lane Width
 *This assumes 0% catchment

5 Year Spread Calculations - In Sag

* This assumes 50% clogged inlet

Neenha Flow Calculations for R-3346-A, Type C Grate, Combination Curb Inlet

Utilizing 0.5' of Head (Assuming Flow Will Not Top Curb)

Allowable Transitional Flow = 6.2 cfs

Assuming Inlet is 50% Clogged, Flow = 3.1 cfs

Structure ID	=	CB-72	
C	=	0.69	
I	=	6.63 in/hr	
A	=	0.62 ac	
Q 5	=	2.84 cfs	OK, 50% Clogged Flow is Greater Than Flow to Inlet

Catalog Number and Grate Type:

R-3246-A-C

Feet perimeter (P):	Head in feet (h):	Free open area in sq. ft. (A):
6.9	.5	2.2

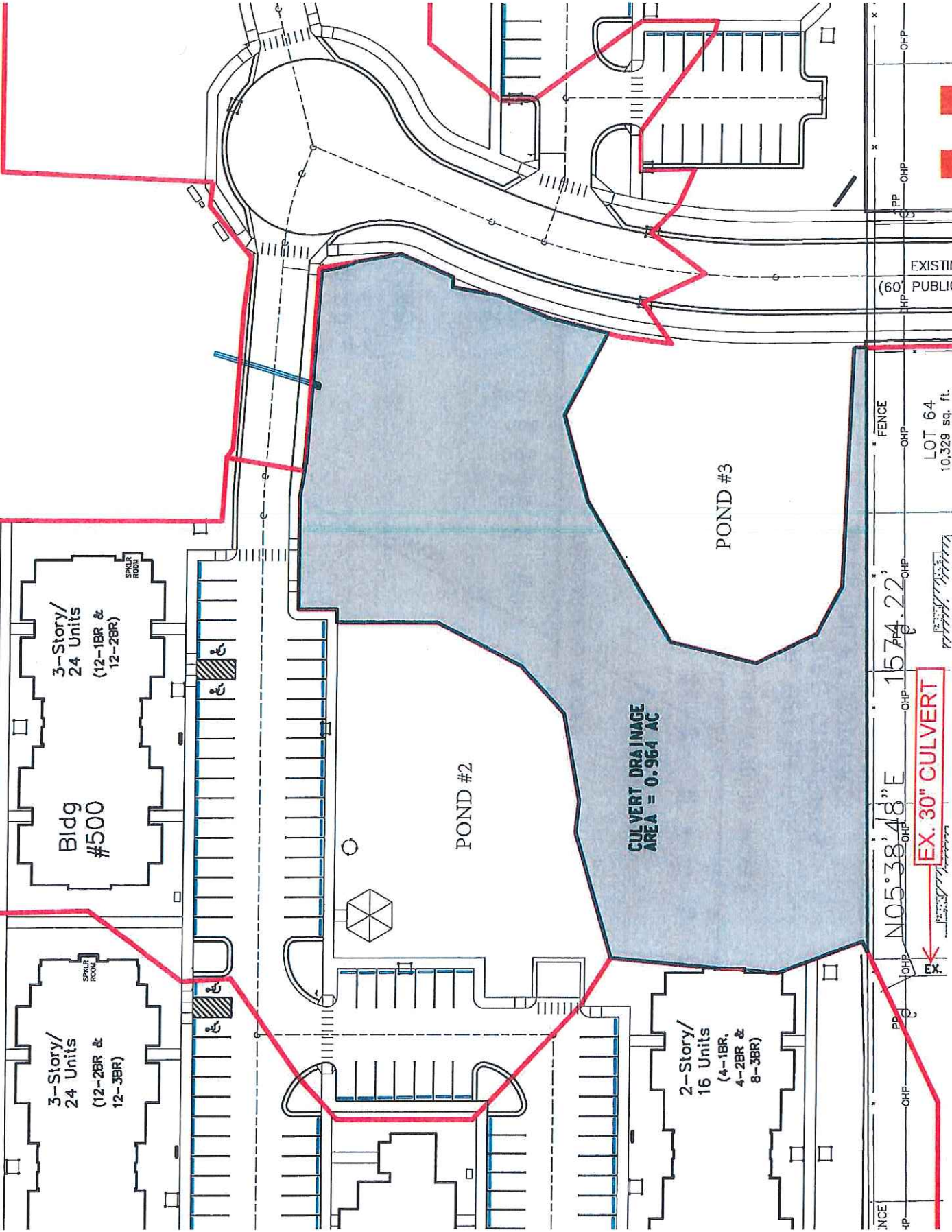
Calculate

Weir capacity in cfs:	Transitional flow in cfs:	Orifice capacity in cfs:
	6.2	

**APPENDIX F
CULVERT DESIGN**

PROPOSED CULVERT DRAINAGE AREA MAP
SCALE ON 8.5"x11" : 1" = 60'

S06°30'25"W 1498.41'



FENCE
LOT 64
10,329 sq. ft.

N05°38'48"E 1574.22'

EX. 30" CULVERT

N05°38'48"E

1574.22'

FENCE

EX.

EXISTING 30" CULVERT W/ 1.2 HW/D
AND GROOVE END PROJECTING

CITY OF GREENVILLE, N.C. — ENGINEERING DEPT.

NO.	DATE	DESCRIPTION

DIAMETER OF CULVERT (D) IN INCHES
HEADWATER DEPTH FOR
CONCRETE PIPE CULVERTS
WITH INLET CONTROL

APPROVED: DATE MAY 8, 1964

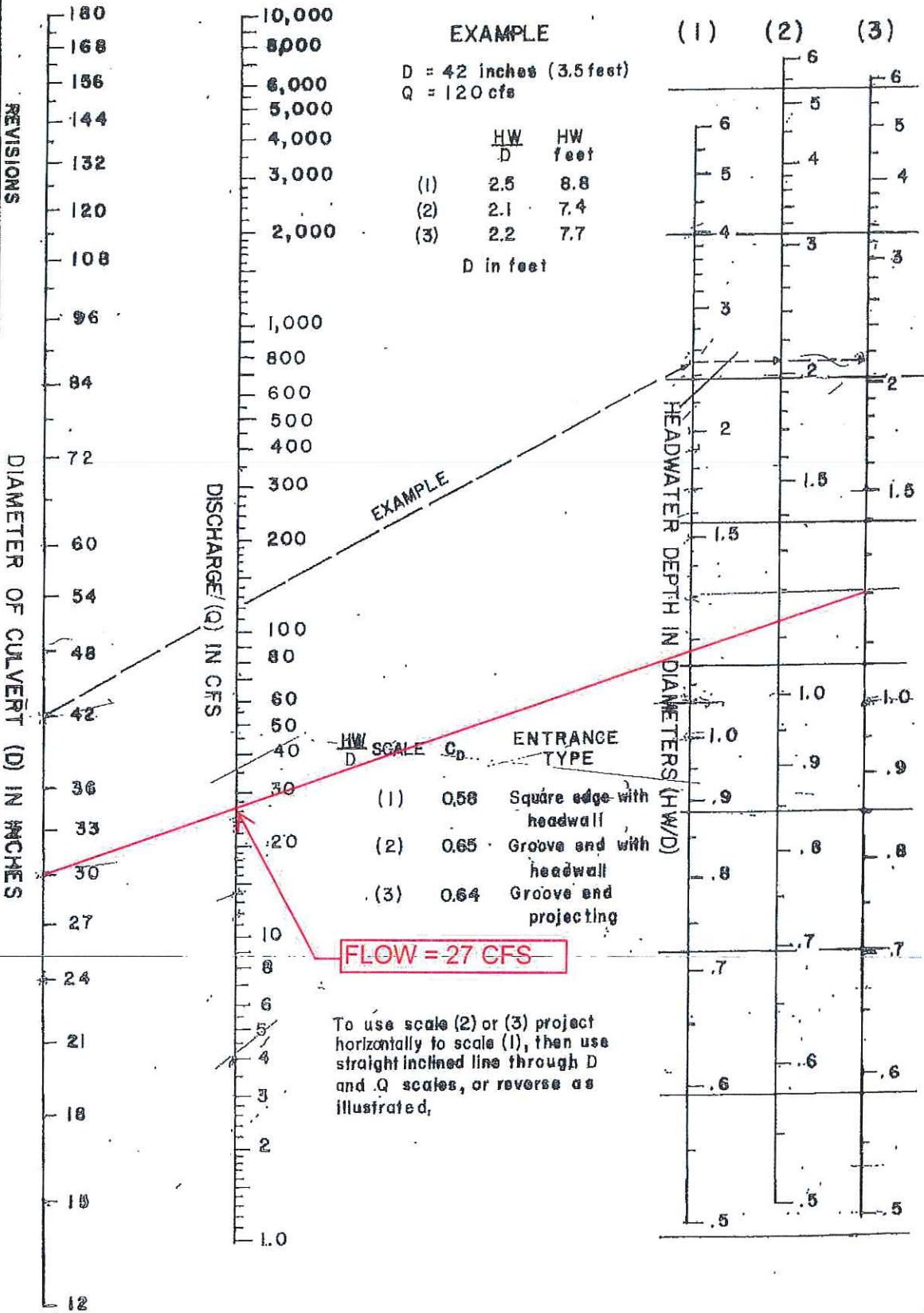


CHART SD-b

STD. NO. RE 1524

Project: Cypress Cove Apartments

Project #: PM858-37

Engineer: C. Cullipher

Date: 9/6/17

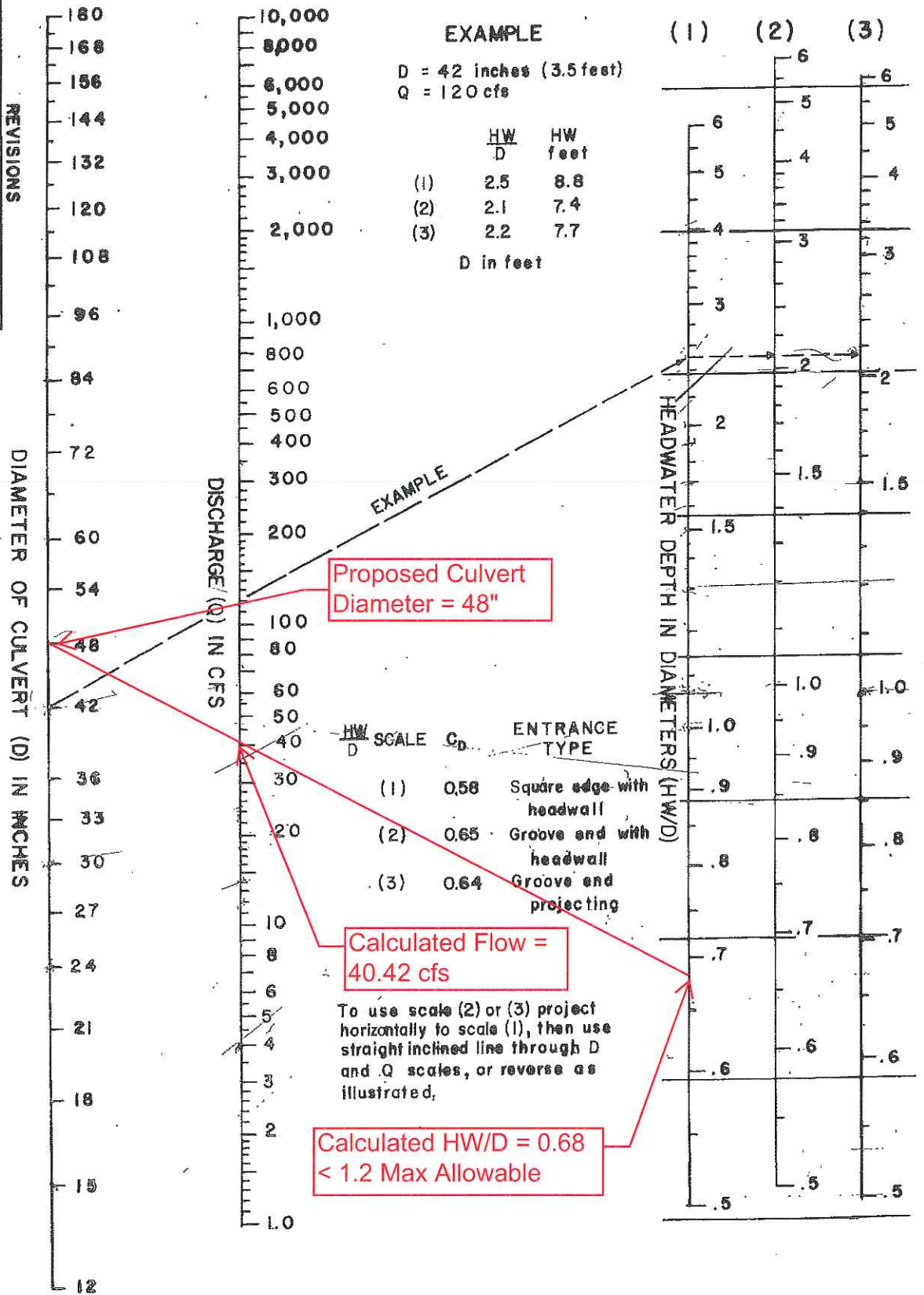
CULVERT FLOW CALCULATIONS	
Per Existing 30" Pipe Nomograph Assuming 1.2 HW/D with Grooved End Projectnig Pipe	
Flow =	27 cfs
See attached Nomograph	
Pond #2 Discharge	
Q 25 =	1.56 cfs
See Pond #2 Routing Calculations	
Pond #3 Discharge	
Q 25 =	4.79 cfs
See Pond #3 Routing Calculations	
Culvert Drainage Area	
Area =	0.964 ac
I =	8.15 in/hr
C =	0.9 *Assume All Wet - No Absorption
Q25 =	7.071 cfs
Total Flow to Proposed Culvert	
Q25 Total =	40.42 cfs
Using Q25 Total See Proposed Culvert Nomograph For 48" Culvert Provide HW/D = 0.68 OK, Less than HW/D = 1.2	

PROPOSED CULVERT WITH SQUARE
EDGE AND HEADWALL

CITY OF GREENVILLE, N.C. — ENGINEERING DEPT.

NO.	DATE	DESCRIPTION

HEADWATER DEPTH FOR
CONCRETE PIPE CULVERTS
WITH INLET CONTROL



EXAMPLE

D = 42 inches (3.5 feet)
Q = 120 cfs

	HW D	HW feet
(1)	2.5	8.8
(2)	2.1	7.4
(3)	2.2	7.7

D in feet

Proposed Culvert
Diameter = 48"

Calculated Flow =
40.42 cfs

Calculated HW/D = 0.68
< 1.2 Max Allowable

HW D SCALE	C _d	ENTRANCE TYPE
(1)	0.58	Square edge with headwall
(2)	0.65	Groove end with headwall
(3)	0.64	Groove end projecting

To use scale (2) or (3) project
horizontally to scale (1), then use
straight inclined line through D
and Q scales, or reverse as
illustrated.

CHART SD-b

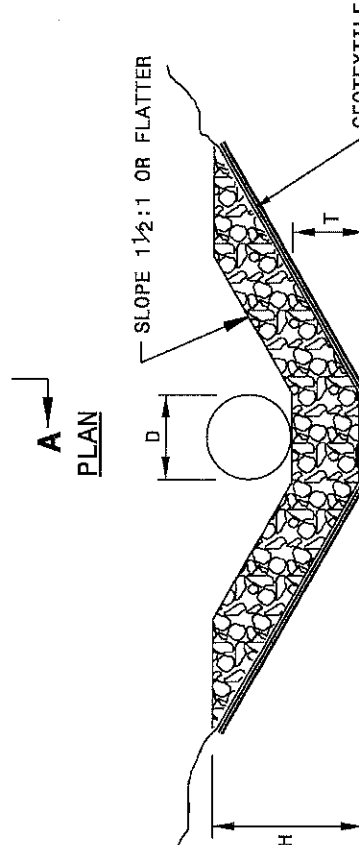
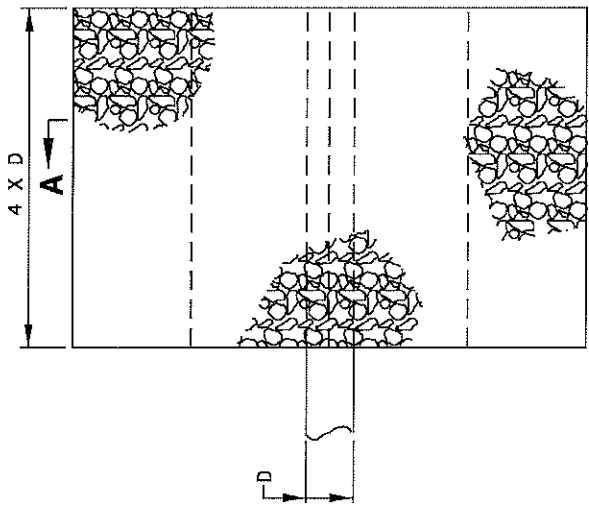
APPROVED: DATE MAY 8, 1980

STD. NO. REV.
1524

APPENDIX G
DISSIPATER PAD DESIGN

D	OUTLET W/DITCH			OUTLET W/O DITCH		
	CLASS 'B' RIP RAP TONS	CLASS 'B' RIP RAP TONS	CLASS 'B' RIP RAP TONS	CLASS 'B' RIP RAP TONS	CLASS 'B' RIP RAP TONS	CLASS 'B' RIP RAP TONS
12"	2	5	2	5	1	4
15"	2	7	3	7	1	4
18"	3	10	4	10	2	6
24"	5	14	7	15	3	8
30"	8	21	11	22	5	12
36"	11	28	15	30	7	17
42"	15	37	20	39	10	23
48"	-	-	26	50	-	30
54"	-	-	33	62	-	38
60"	-	-	40	75	-	47
66"	-	-	48	89	-	56
72"	-	-	57	104	-	67

NOTE:
FOR CALCULATION PURPOSES
CLASS 'B' RIP RAP = 100 LBS./FT³
CLASS I RIP RAP = 105 LBS./FT³

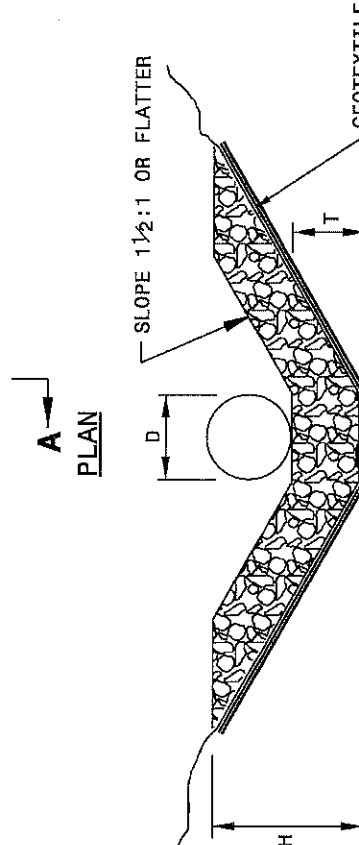
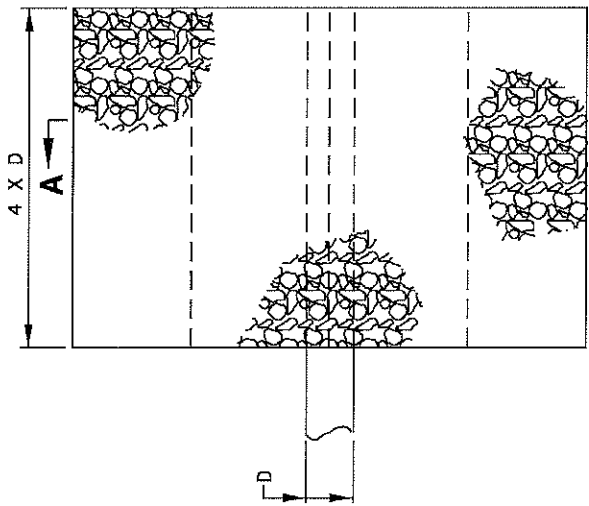


SECTION A-A
PIPE OUTLET WITH DITCH

H= RIP RAP TO TOP OF PIPE (MAX. H = D + T)
T= 15" CLASS I RIP RAP, UNLESS OTHERWISE SHOWN ON PLANS
T= 12" CLASS 'B' RIP RAP, UNLESS OTHERWISE SHOWN ON PLANS

D	OUTLET W/DITCH			OUTLET W/O DITCH		
	CLASS 'B' RIP RAP TONS	CLASS 'B' RIP RAP TONS	CLASS 'B' RIP RAP TONS	CLASS 'B' RIP RAP TONS	CLASS 'B' RIP RAP TONS	CLASS 'B' RIP RAP TONS
12"	2	5	2	5	1	4
15"	2	7	3	7	1	4
18"	3	10	4	10	2	6
24"	5	14	7	15	3	8
30"	8	21	11	22	5	12
36"	11	28	15	30	7	17
42"	15	37	20	39	10	23
48"	-	-	26	50	-	30
54"	-	-	33	62	-	38
60"	-	-	40	75	-	47
66"	-	-	48	89	-	56
72"	-	-	57	104	-	67

NOTE:
FOR CALCULATION PURPOSES
CLASS 'B' RIP RAP = 100 LBS./FT³
CLASS I RIP RAP = 105 LBS./FT³



SECTION A-A
PIPE OUTLET WITH DITCH

H= RIP RAP TO TOP OF PIPE (MAX. H = D + T)
T= 15" CLASS I RIP RAP, UNLESS OTHERWISE SHOWN ON PLANS
T= 12" CLASS 'B' RIP RAP, UNLESS OTHERWISE SHOWN ON PLANS