

ASBUILT STORMWATER DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING

Millpond Apartments
BAX PROJECT NO. 01-11372C
October 28, 2009

INTRODUCTION

The Millpond Apartment development was constructed on a 3.14 acre tract of land in the City of O'Fallon. Bax Engineering performed an asbuilt detention analysis to determine if the detention basin attenuated the additional runoff from the site based on the asbuilt field data.

The construction of the detention basin and the outfall structure varied from the approved construction plans and therefore the basin must be reanalyzed to determine its functionality. Based on the information obtained for the field survey after construction the basin was analyzed for the required design storms and found to not attenuate the quantity of runoff as required by the City of O'Fallon.

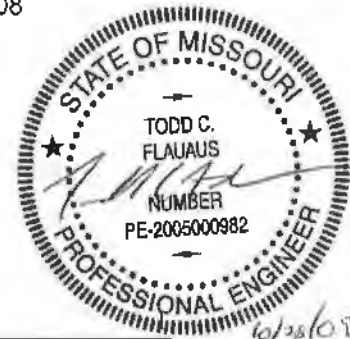
Based on these results the modifications to the outfall structure were designed to provide the required attenuation

The basin has been analyzed for the 2- year, 15-year, and 25 year 20 minute design storms and all have been checked for safe passage of the 100 year, 20 minute design storm under low-flow blocked conditions.

GENERAL SITE AND RUNOFF CALCULATIONS

The pre-developed and post-developed P.I. factors used in the analysis are:

	20 minute storm 2 year	20 minute storm 15 year	20 minute storm 25 year	20 minute storm 100 year
Imperviousness				
Undeveloped/Greenspace - 5%	1.15	1.87	2.31	2.95
Commercial - 100%	2.39	3.85	4.75	6.08



PREDEVELOPED RUNOFF

15 YR – 20 Minute Storm

Ac		cfs/Ac	=	cfs
3.14	@	1.87	=	5.87
Total =				5.87

2 Year-20 Minute Storm:	3.61 cfs
15 Year-20 Minute Storm:	5.87 cfs
25 Year-20 Minute Storm:	7.25 cfs
100 Year-20 Minute Storm:	9.26 cfs

POSTDEVELOPED RUNOFF

15 YR – 20 Minute Storm

Ac		cfs/Ac	=	cfs
2.02	@	1.87	=	3.78
1.12	@	3.85	=	4.31
Total =				8.09

2 Year-20 Minute Storm:	5.00 cfs
15 Year-20 Minute Storm:	8.09 cfs
25 Year-20 Minute Storm:	9.99 cfs
100 Year-20 Minute Storm:	12.77 cfs

REQUIRED ATTENUATION

Design Storm	Postdeveloped Runoff	-	Predeveloped Runoff	=	Required Attenuation
2 Year	5.00 cfs	-	3.61 cfs	=	1.39 cfs
15 Year	8.09 cfs	-	5.87 cfs	=	2.22 cfs
25 Year	9.99 cfs	-	7.25 cfs	=	2.73 cfs

INFLOW TO DETENTION BASINS

2 Year-20 Minute Storm:	3.46 cfs
15 Year-20 Minute Storm:	5.57 cfs
25 Year-20 Minute Storm:	6.87 cfs
100 Year-20 Minute Storm:	8.80 cfs

ALLOWABLE RELEASE RATE

Design Storm	Basin Inflow	-	Required Attenuation	=	Allowable Release Rate
2 Year	3.46 cfs	-	1.39 cfs	=	2.07 cfs
15 Year	5.57 cfs	-	2.22 cfs	=	3.35 cfs
25 Year	6.87 cfs	-	2.73 cfs	=	4.14 cfs

STORM ROUTING CALCULATIONS AND RESULTS

A computer program, Pond Pack 10 was used to aid in the routing of the basin. The 100-year low flow blocked analysis was also checked for the basin. As found in the routing calculations attached, the results are as follows for free outlet flow:

Design Storm	Basin Inflow	Allowable Release Rate	Calculated Release Rate	High Water
2 Year	3.46 cfs	2.07 cfs	1.89 cfs	557.67
15 Year	5.57 cfs	3.35 cfs	2.16 cfs	558.86
25 Year	6.87 cfs	4.14 cfs	2.28 cfs	559.44
100 Year (low flow blocked)	8.80 cfs	----- cfs	6.45 cfs	561.79

OUTFALL STRUCTURE DESIGN

Basin I

The outfall structure as constructed in the field needs to have the orifices at elevations 555.43 and 554.43 grouted closed to produce the results shown in this detention report. All other orifices and top elevations are to remain as built. These changes reduce the discharge to acceptable levels for the basin as it was constructed.

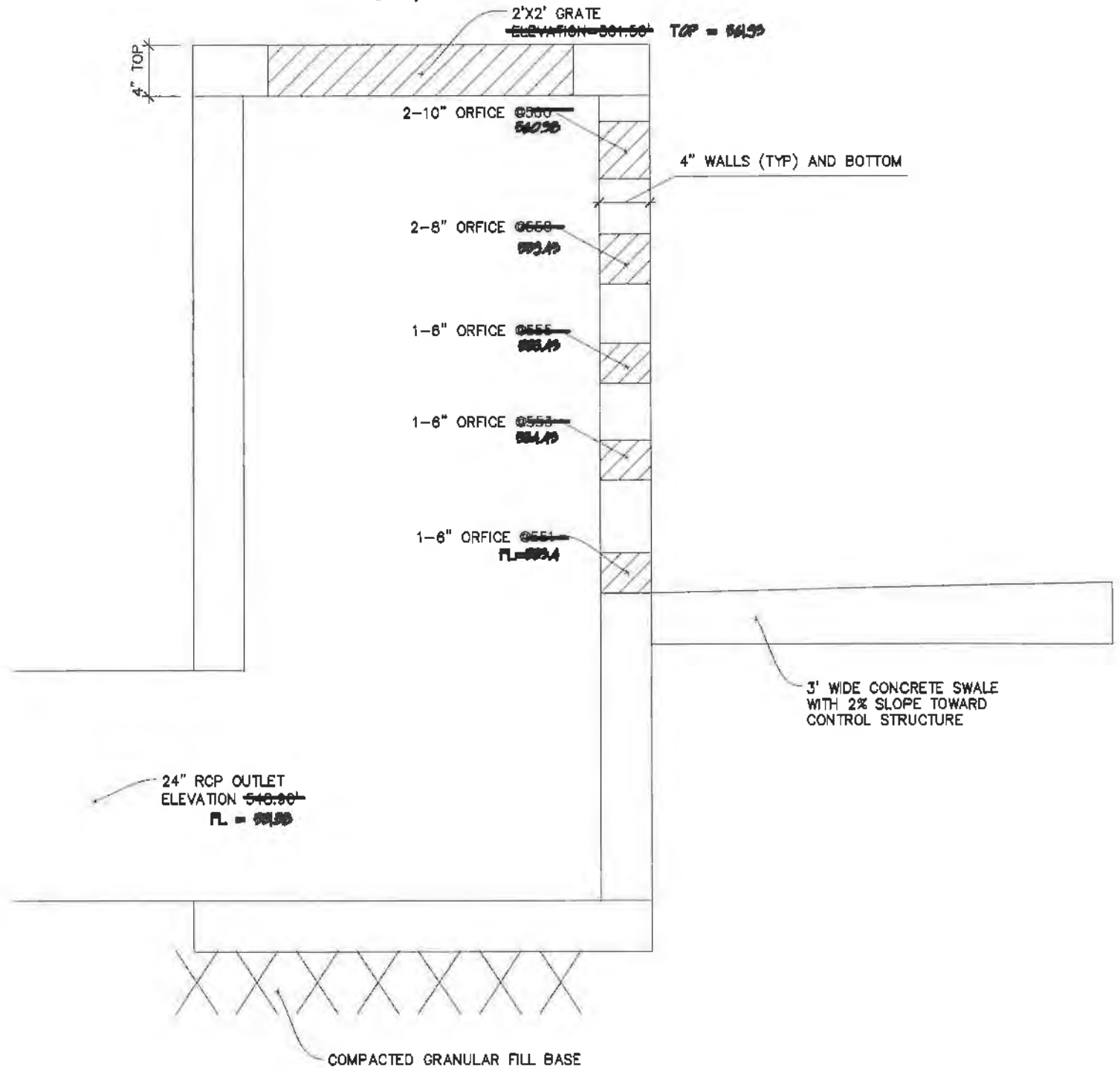
SUMMARY

2 Year, 20 Minute H.W.	557.67
15 Year, 20 Minute H.W.	558.86
25 Year, 20 Minute H.W.	559.44
100 Year, 20 Minute Blocked	561.79
Top of Dam	563.00
Freeboard for 100 Year with low flow blocked	1.21'

STRUCTURE DETAILS

DETENTION BASIN CONTROL STRUCTURE

NOT TO SCALE
CSI DETAIL



POND 10
Routing Calculations for
2, 15, and 25 Year 20 Minute Design Storms

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POND VOLUME CALCULATIONS

Planimeter scale: 1.00 ft/in

Elevation (ft)	Planimeter (sq.in)	Area (acrea)	A1+A2+sqr(A1*A2) (acres)	Volume (cu.ft)	Volume Sum (cu.ft)
553.40	.000	.0000	.0000	0	0
555.00	40.000	.0009	.0009	21	21
556.00	465.000	.0107	.0147	214	235
557.00	1007.000	.0231	.0495	719	954
558.00	1564.000	.0359	.0878	1275	2229
559.00	2112.000	.0485	.1261	1831	4060
560.00	2978.000	.0684	.1744	2533	6593
561.00	3850.000	.0884	.2345	3405	9998
562.00	4827.000	.1108	.2982	4329	14327
563.00	6205.000	.1424	.3789	5502	19829

POND VOLUME EQUATIONS

* Incremental volume computed by the Conic Method for Reservoir Volumes.

$$\text{Volume} = (1/3) * (\text{EL2}-\text{EL1}) * (\text{Area1} + \text{Area2} + \text{sq.rt.}(\text{Area1}*\text{Area2}))$$

where: EL1, EL2 = Lower and upper elevations of the increment
Area1, Area2 = Areas computed for EL1, EL2, respectively
Volume = Incremental volume between EL1 and EL2

Name... asbuilt-modified

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REQUESTED POND WS ELEVATIONS:

Min. Elev.= 553.40 ft
 Increment = .10 ft
 Max. Elev.= 563.00 ft

OUTLET CONNECTIVITY

- > Forward Flow Only (UpStream to DnStream)
- <--- Reverse Flow Only (DnStream to UpStream)
- <---> Forward and Reverse Both Allowed

Structure	No.		Outfall	E1, ft	E2, ft
Orifice-Circular	4	--->	cv	559.430	563.000
Orifice-Circular	5	--->	cv	560.380	563.000
Inlet Box	6	--->	cv	561.930	563.000
Orifice-Circular	1	--->	cv	553.400	563.000
Culvert-Circular	cv	--->	TW	551.580	563.000
TW SETUP, DS Channel					

OUTLET STRUCTURE INPUT DATA

Structure ID = 4
Structure Type = Orifice-Circular

of Openings = 2
Invert Elev. = 559.43 ft
Diameter = .6667 ft
Orifice Coeff. = .600

Structure ID = 5
Structure Type = Orifice-Circular

of Openings = 2
Invert Elev. = 560.38 ft
Diameter = .8333 ft
Orifice Coeff. = .600

Structure ID = 6
Structure Type = Inlet Box

of Openings = 1
Invert Elev. = 561.93 ft
Orifice Area = 4.0000 sq.ft
Orifice Coeff. = .600
Weir Length = 8.00 ft
Weir Coeff. = 3.000
K, Reverse = 1.000
Mannings n = .0000
Kev, Charged Riser = .000
Weir Submergence = No

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OUTLET STRUCTURE INPUT DATA

Structure ID = 1
Structure Type = Orifice-Circular

of Openings = 1
Invert Elev. = 553.40 ft
Diameter = .5000 ft
Orifice Coeff. = .600

Structure ID = cv
Structure Type = Culvert-Circular

No. Barrels = 1
Barrel Diameter = 2.0000 ft
Upstream Invert = 551.58 ft
Dnstream Invert = 547.13 ft
Horiz. Length = 143.57 ft
Barrel Length = 143.64 ft
Barrel Slope = .03100 ft/ft

OUTLET CONTROL DATA...

Mannings n = .0130
Ke = .2000 (forward entrance loss)
Kb = .012411 (per ft of full flow)
Kr = .2000 (reverse entrance loss)
HW Convergence = .001 +/- ft

INLET CONTROL DATA...

Equation form = 1
Inlet Control K = .0045
Inlet Control M = 2.0000
Inlet Control c = .03170
Inlet Control Y = .6900
T1 ratio (HW/D) = .000
T2 ratio (HW/D) = 1.182
Slope Factor = -.500

Use unsubmerged inlet control Form 1 equ. below T1 elev.
Use submerged inlet control Form 1 equ. above T2 elev.

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

At T1 Elev = 551.58 ft ---> Flow = 15.55 cfs
At T2 Elev = 553.94 ft ---> Flow = 17.77 cfs

OUTLET STRUCTURE INPUT DATA

Structure ID = TW
Structure Type = TW SETUP, DS Channel

FREE OUTFALL CONDITIONS SPECIFIED

CONVERGENCE TOLERANCES...
Maximum Iterations= 40
Min. TW tolerance = .01 ft
Max. TW tolerance = .01 ft
Min. HW tolerance = .01 ft
Max. HW tolerance = .01 ft
Min. Q tolerance = .00 cfs
Max. Q tolerance = .00 cfs

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***** COMPOSITE OUTFLOW SUMMARY *****

WS Elev, Total Q		Converge		Notes
Elev. ft	Q cfs	TW Elev ft	Error +/-ft	Contributing Structures
553.40	.00	Free Outfall		(no Q: 4,5,6,1,cv)
553.50	.02	Free Outfall	1,cv	(no Q: 4,5,6)
553.60	.09	Free Outfall	1,cv	(no Q: 4,5,6)
553.70	.19	Free Outfall	1,cv	(no Q: 4,5,6)
553.80	.31	Free Outfall	1,cv	(no Q: 4,5,6)
553.90	.47	Free Outfall	1,cv	(no Q: 4,5,6)
554.00	.56	Free Outfall	1,cv	(no Q: 4,5,6)
554.10	.63	Free Outfall	1,cv	(no Q: 4,5,6)
554.20	.70	Free Outfall	1,cv	(no Q: 4,5,6)
554.30	.76	Free Outfall	1,cv	(no Q: 4,5,6)
554.40	.82	Free Outfall	1,cv	(no Q: 4,5,6)
554.50	.87	Free Outfall	1,cv	(no Q: 4,5,6)
554.60	.92	Free Outfall	1,cv	(no Q: 4,5,6)
554.70	.97	Free Outfall	1,cv	(no Q: 4,5,6)
554.80	1.01	Free Outfall	1,cv	(no Q: 4,5,6)
554.90	1.06	Free Outfall	1,cv	(no Q: 4,5,6)
555.00	1.09	Free Outfall	1,cv	(no Q: 4,5,6)
555.10	1.14	Free Outfall	1,cv	(no Q: 4,5,6)
555.20	1.18	Free Outfall	1,cv	(no Q: 4,5,6)
555.30	1.21	Free Outfall	1,cv	(no Q: 4,5,6)
555.40	1.25	Free Outfall	1,cv	(no Q: 4,5,6)
555.50	1.28	Free Outfall	1,cv	(no Q: 4,5,6)
555.60	1.32	Free Outfall	1,cv	(no Q: 4,5,6)
555.70	1.35	Free Outfall	1,cv	(no Q: 4,5,6)
555.80	1.39	Free Outfall	1,cv	(no Q: 4,5,6)
555.90	1.42	Free Outfall	1,cv	(no Q: 4,5,6)
556.00	1.45	Free Outfall	1,cv	(no Q: 4,5,6)
556.10	1.48	Free Outfall	1,cv	(no Q: 4,5,6)
556.20	1.51	Free Outfall	1,cv	(no Q: 4,5,6)
556.30	1.54	Free Outfall	1,cv	(no Q: 4,5,6)
556.40	1.56	Free Outfall	1,cv	(no Q: 4,5,6)
556.50	1.60	Free Outfall	1,cv	(no Q: 4,5,6)
556.60	1.62	Free Outfall	1,cv	(no Q: 4,5,6)
556.70	1.65	Free Outfall	1,cv	(no Q: 4,5,6)
556.80	1.68	Free Outfall	1,cv	(no Q: 4,5,6)
556.90	1.70	Free Outfall	1,cv	(no Q: 4,5,6)
557.00	1.73	Free Outfall	1,cv	(no Q: 4,5,6)
557.10	1.75	Free Outfall	1,cv	(no Q: 4,5,6)

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***** COMPOSITE OUTFLOW SUMMARY *****

WS Elev, Total Q		Converge		Notes	
Elev. ft	Q cfs	TW Elev ft	Error +/-ft	Contributing Structures	
557.20	1.78	Free	Outfall	1,cv	(no Q: 4,5,6)
557.30	1.80	Free	Outfall	1,cv	(no Q: 4,5,6)
557.40	1.83	Free	Outfall	1,cv	(no Q: 4,5,6)
557.50	1.85	Free	Outfall	1,cv	(no Q: 4,5,6)
557.60	1.87	Free	Outfall	1,cv	(no Q: 4,5,6)
557.70	1.90	Free	Outfall	1,cv	(no Q: 4,5,6)
557.80	1.92	Free	Outfall	1,cv	(no Q: 4,5,6)
557.90	1.95	Free	Outfall	1,cv	(no Q: 4,5,6)
558.00	1.97	Free	Outfall	1,cv	(no Q: 4,5,6)
558.10	1.99	Free	Outfall	1,cv	(no Q: 4,5,6)
558.20	2.01	Free	Outfall	1,cv	(no Q: 4,5,6)
558.30	2.04	Free	Outfall	1,cv	(no Q: 4,5,6)
558.40	2.06	Free	Outfall	1,cv	(no Q: 4,5,6)
558.50	2.08	Free	Outfall	1,cv	(no Q: 4,5,6)
558.60	2.10	Free	Outfall	1,cv	(no Q: 4,5,6)
558.70	2.12	Free	Outfall	1,cv	(no Q: 4,5,6)
558.80	2.14	Free	Outfall	1,cv	(no Q: 4,5,6)
558.90	2.17	Free	Outfall	1,cv	(no Q: 4,5,6)
559.00	2.19	Free	Outfall	1,cv	(no Q: 4,5,6)
559.10	2.21	Free	Outfall	1,cv	(no Q: 4,5,6)
559.20	2.23	Free	Outfall	1,cv	(no Q: 4,5,6)
559.30	2.25	Free	Outfall	1,cv	(no Q: 4,5,6)
559.40	2.27	Free	Outfall	1,cv	(no Q: 4,5,6)
559.43	2.27	Free	Outfall	1,cv	(no Q: 4,5,6)
559.50	2.31	Free	Outfall	4,1,cv	(no Q: 5,6)
559.60	2.46	Free	Outfall	4,1,cv	(no Q: 5,6)
559.70	2.70	Free	Outfall	4,1,cv	(no Q: 5,6)
559.80	3.02	Free	Outfall	4,1,cv	(no Q: 5,6)
559.90	3.40	Free	Outfall	4,1,cv	(no Q: 5,6)
560.00	3.83	Free	Outfall	4,1,cv	(no Q: 5,6)
560.10	4.35	Free	Outfall	4,1,cv	(no Q: 5,6)
560.20	4.64	Free	Outfall	4,1,cv	(no Q: 5,6)
560.30	4.90	Free	Outfall	4,1,cv	(no Q: 5,6)
560.38	5.09	Free	Outfall	4,1,cv	(no Q: 5,6)
560.40	5.14	Free	Outfall	4,5,1,cv	(no Q: 6)
560.50	5.45	Free	Outfall	4,5,1,cv	(no Q: 6)
560.60	5.85	Free	Outfall	4,5,1,cv	(no Q: 6)
560.70	6.35	Free	Outfall	4,5,1,cv	(no Q: 6)

***** COMPOSITE OUTFLOW SUMMARY *****

WS Elev, Total Q		Converge		Notes
Elev. ft	Q cfs	TW Elev ft	Error +/-ft	Contributing Structures
560.80	6.93	Free Outfall		4,5,1,cv (no Q: 6)
560.90	7.58	Free Outfall		4,5,1,cv (no Q: 6)
561.00	8.28	Free Outfall		4,5,1,cv (no Q: 6)
561.10	9.03	Free Outfall		4,5,1,cv (no Q: 6)
561.20	9.82	Free Outfall		4,5,1,cv (no Q: 6)
561.30	10.50	Free Outfall		4,5,1,cv (no Q: 6)
561.40	11.01	Free Outfall		4,5,1,cv (no Q: 6)
561.50	11.48	Free Outfall		4,5,1,cv (no Q: 6)
561.60	11.93	Free Outfall		4,5,1,cv (no Q: 6)
561.70	12.34	Free Outfall		4,5,1,cv (no Q: 6)
561.80	12.74	Free Outfall		4,5,1,cv (no Q: 6)
561.90	13.13	Free Outfall		4,5,1,cv (no Q: 6)
561.93	13.24	Free Outfall		4,5,1,cv (no Q: 6)
562.00	13.96	Free Outfall		4,5,6,1,cv
562.10	15.53	Free Outfall		4,5,6,1,cv
562.20	17.54	Free Outfall		4,5,6,1,cv
562.30	19.87	Free Outfall		4,5,6,1,cv
562.40	22.47	Free Outfall		4,5,6,1,cv
562.50	25.31	Free Outfall		4,5,6,1,cv
562.60	28.37	Free Outfall		4,5,6,1,cv
562.70	31.61	Free Outfall		4,5,6,1,cv
562.80	33.58	Free Outfall		4,5,6,1,cv
562.90	34.83	Free Outfall		4,5,6,1,cv
563.00	36.03	Free Outfall		4,5,6,1,cv

SUMMARY FOR HYDROGRAPH ADDITION
at Node: POND 10 IN

HYG Directory: \\2003server\Hydraulics\PONDPACK\A11000PLUS\11372c\

Upstream Link ID	Upstream Node ID	HYG file	HYG ID	HYG tag
WARNING: Missed peak when adding hydrograph...				
ADDLINK 10	HYD QUEUE 10		2	002

INFLOWS TO: POND 10 IN

HYG file	HYG ID	HYG tag	Volume cu.ft	Peak Time min	Peak Flow cfs
	2	002	4149	1.00	3.46

TOTAL FLOW INTO: POND 10 IN

HYG file	HYG ID	HYG tag	Volume cu.ft	Peak Time min	Peak Flow cfs
POND 10	IN	002	3734	3.00	3.46

TOTAL NODE INFLOW...

HYG file =
 HYG ID = POND 10 IN
 HYG Tag = 002

Peak Discharge = 3.46 cfs
 Time to Peak = 3.00 min
 HYG Volume = 3734 cu.ft

HYDROGRAPH ORDINATES (cfs)

Output Time increment = 3.00 min
 Time on left represents time for first value in each row.

Time min					
.00	.00	3.46	3.46	3.46	3.46
15.00	3.46	3.46	.00		

TOTAL NODE INFLOW...

HYG file =

HYG ID = POND 10 IN

HYG Tag = 015

Peak Discharge = 5.57 cfs

Time to Peak = 3.00 min

HYG Volume = 6015 cu.ft

HYDROGRAPH ORDINATES (cfs)

Output Time increment = 3.00 min

Time |
min | Time on left represents time for first value in each row.

.00	.00	5.57	5.57	5.57	5.57
15.00	5.57	5.57	.00		

SUMMARY FOR HYDROGRAPH ADDITION
at Node: POND 10 IN

HYG Directory: \\2003server\Hydraulics\PONDPACK\A11000PLUS\11372c\

Upstream Link ID	Upstream Node ID	HYG file	HYG ID	HYG tag
ADDLINK 10	HYD QUEUE 10		25	025

INFLOWS TO: POND 10 IN

HYG file	HYG ID	HYG tag	Volume cu.ft	Peak Time min	Peak Flow cfs
	25	025	8243	1.00	6.87

TOTAL FLOW INTO: POND 10 IN

HYG file	HYG ID	HYG tag	Volume cu.ft	Peak Time min	Peak Flow cfs
POND 10	IN	025	7418	3.00	6.87

TOTAL NODE INFLOW...

HYG file =

HYG ID = POND 10 IN

HYG Tag = 025

Peak Discharge = 6.87 cfs

Time to Peak = 3.00 min

HYG Volume = 7418 cu.ft

HYDROGRAPH ORDINATES (cfs)

Output Time increment = 3.00 min

Time |
min | Time on left represents time for first value in each row.

.00	.00	6.87	6.87	6.87	6.87
15.00	6.87	6.87	.00		

LEVEL POOL ROUTING SUMMARY

HYG Dir = \\2003server\Hydraulics\PONDPACK\A11000PLUS\11372c\
Inflow HYG file = NONE STORED - POND 10 IN 002
Outflow HYG file = NONE STORED - POND 10 OUT 002

Pond Node Data = POND 10
Pond Volume Data = POND 10
Pond Outlet Data = asbuilt-modified

No Infiltration

INITIAL CONDITIONS

Starting WS Elev = 553.40 ft
Starting Volume = 0 cu.ft
Starting Outflow = .00 cfs
Starting Infiltr. = .00 cfs
Starting Total Qout= .00 cfs
Time Increment = 3.00 min

INFLOW/OUTFLOW HYDROGRAPH SUMMARY

Peak Inflow = 3.46 cfs at 3.00 min
Peak Outflow = 1.89 cfs at 18.00 min

Peak Elevation = 557.67 ft
Peak Storage = 1751 cu.ft

MASS BALANCE (cu.ft)

+ Initial Vol = 0
+ HYG Vol IN = 3734
- Infiltration = 0
- HYG Vol OUT = 3734
- Retained Vol = 0

Unrouted Vol = - cu.ft (.000% of Inflow Volume)

LEVEL POOL ROUTING SUMMARY

HYG Dir = \\2003server\Hydraulics\PONDPACK\A11000PLUS\11372c\
Inflow HYG file = NONE STORED - POND 10 IN 015
Outflow HYG file = NONE STORED - POND 10 OUT 015

Pond Node Data = POND 10
Pond Volume Data = POND 10
Pond Outlet Data = asbuilt-modified

No Infiltration

INITIAL CONDITIONS

Starting WS Elev = 553.40 ft
Starting Volume = 0 cu.ft
Starting Outflow = .00 cfs
Starting Infiltr. = .00 cfs
Starting Total Qout= .00 cfs
Time Increment = 3.00 min

INFLOW/OUTFLOW HYDROGRAPH SUMMARY

Peak Inflow = 5.57 cfs at 3.00 min
Peak Outflow = 2.16 cfs at 21.00 min
Peak Elevation = 558.86 ft
Peak Storage = 3771 cu.ft

MASS BALANCE (cu.ft)

+ Initial Vol = 0
+ HYG Vol IN = 6015
- Infiltration = 0
- HYG Vol OUT = 6015
- Retained Vol = 0
Unrouted Vol = 0 cu.ft (.000% of Outflow Volume)

LEVEL POOL ROUTING SUMMARY

HYG Dir = \\2003server\Hydraulics\PONDPACK\A11000PLUS\11372c\
 Inflow HYG file = NONE STORED - POND 10 IN 025
 Outflow HYG file = NONE STORED - POND 10 OUT 025

Pond Node Data = POND 10
 Pond Volume Data = POND 10
 Pond Outlet Data = asbuilt-modified

No Infiltration

INITIAL CONDITIONS

 Starting WS Elev = 553.40 ft
 Starting Volume = 0 cu.ft
 Starting Outflow = .00 cfs
 Starting Infiltr. = .00 cfs
 Starting Total Qout = .00 cfs
 Time Increment = 3.00 min

INFLOW/OUTFLOW HYDROGRAPH SUMMARY

=====

Peak Inflow	=	6.87 cfs	at	3.00 min
Peak Outflow	=	2.28 cfs	at	21.00 min

Peak Elevation	=	559.44 ft
Peak Storage	=	5068 cu.ft

=====

MASS BALANCE (cu.ft)

+ Initial Vol	=	0
+ HYG Vol IN	=	7418
- Infiltration	=	0
- HYG Vol OUT	=	7418
- Retained Vol	=	0

Unrouted Vol = 0 cu.ft (.000% of Outflow Volume)

LEVEL POOL ROUTING SUMMARY

HYG Dir = \\2003server\Hydraulics\PONDPACK\A11000PLUS\11372c\
Inflow HYG file = NONE STORED - POND 10 IN 100
Outflow HYG file = NONE STORED - POND 10 OUT 100

Pond Node Data = POND 10
Pond Volume Data = POND 10
Pond Outlet Data = asbuilt-modified

No Infiltration

INITIAL CONDITIONS

Starting WS Elev = 553.40 ft
Starting Volume = 0 cu.ft
Starting Outflow = .00 cfs
Starting Infiltr. = .00 cfs
Starting Total Qout= .00 cfs
Time Increment = 3.00 min

INFLOW/OUTFLOW HYDROGRAPH SUMMARY

Peak Inflow = 8.80 cfs at 3.00 min
Peak Outflow = 3.88 cfs at 21.00 min
Peak Elevation = 560.01 ft
Peak Storage = 6622 cu.ft

MASS BALANCE (cu.ft)

+ Initial Vol = 0
+ HYG Vol IN = 9500
- Infiltration = 0
- HYG Vol OUT = 9500
- Retained Vol = 0
Unrouted Vol = 0 cu.ft (.000% of Outflow Volume)

Index of Starting Page Numbers for ID Names

----- A -----

asbuilt-modified... 2.01, 2.05

----- P -----

POND 10... 1.01

POND 10 IN 002... 3.01, 3.03,
3.05, 3.07, 3.08, 3.09, 3.10

POND 10
Routing Calculations for
100 Year 20 Minute Design Storms
Low Flow Slots Blocked

Table of Contents

***** POND VOLUMES *****

POND 10..... Vol: Planimeter 1.01

***** OUTLET STRUCTURES *****

LFB..... Outlet Input Data 2.01
Composite Rating Curve 2.04

***** POND ROUTING *****

POND 10 IN 100
Node: Pond Inflow Summary 3.01

POND 10 OUT 100
Pond Routing Summary 3.03

POND VOLUME CALCULATIONS

Planimeter scale: 1.00 ft/in

Elevation (ft)	Planimeter (sq.in)	Area (acres)	A1+A2+sqrt(A1*A2) (acres)	Volume (cu.ft)	Volume Sum (cu.ft)
553.40	.000	.0000	.0000	0	0
555.00	40.000	.0009	.0009	21	21
556.00	465.000	.0107	.0147	214	235
557.00	1007.000	.0231	.0495	719	954
558.00	1564.000	.0359	.0878	1275	2229
559.00	2112.000	.0485	.1261	1831	4060
560.00	2978.000	.0684	.1744	2533	6593
561.00	3850.000	.0884	.2345	3405	9998
562.00	4827.000	.1108	.2982	4329	14327
563.00	6205.000	.1424	.3789	5502	19829

POND VOLUME EQUATIONS

* Incremental volume computed by the Conic Method for Reservoir Volumes.

$$\text{Volume} = (1/3) * (\text{EL2}-\text{EL1}) * (\text{Area1} + \text{Area2} + \text{sq.rt.}(\text{Area1}*\text{Area2}))$$

where: EL1, EL2 = Lower and upper elevations of the increment
 Area1, Area2 = Areas computed for EL1, EL2, respectively
 Volume = Incremental volume between EL1 and EL2

Name.... LFB

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REQUESTED POND WS ELEVATIONS:

Min. Elev.= 553.40 ft
Increment = .10 ft
Max. Elev.= 563.00 ft

OUTLET CONNECTIVITY

- > Forward Flow Only (UpStream to DnStream)
<--- Reverse Flow Only (DnStream to UpStream)
<---> Forward and Reverse Both Allowed

Table with 6 columns: Structure, No., Outfall, E1, ft, E2, ft. Rows include Inlet Box, Orifice-Circular, and Culvert-Circular.

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OUTLET STRUCTURE INPUT DATA

Structure ID = 6
Structure Type = Inlet Box

of Openings = 1
Invert Elev. = 561.93 ft
Orifice Area = 4.0000 sq.ft
Orifice Coeff. = .600
Weir Length = 8.00 ft
Weir Coeff. = 3.000
K, Reverse = 1.000
Mannings n = .0000
Kev, Charged Riser = .000
Weir Submergence = No

Structure ID = 5
Structure Type = Orifice-Circular

of Openings = 2
Invert Elev. = 560.38 ft
Diameter = .8333 ft
Orifice Coeff. = .600

OUTLET STRUCTURE INPUT DATA

Structure ID = cv
Structure Type = Culvert-Circular

No. Barrels = 1
Barrel Diameter = 2.0000 ft
Upstream Invert = 551.58 ft
Dnstream Invert = 547.13 ft
Horiz. Length = 143.57 ft
Barrel Length = 143.64 ft
Barrel Slope = .03100 ft/ft

OUTLET CONTROL DATA...

Mannings n = .0130
Ke = .2000 (forward entrance loss)
Kb = .012411 (per ft of full flow)
Kr = .2000 (reverse entrance loss)
HW Convergence = .001 +/- ft

INLET CONTROL DATA...

Equation form = 1
Inlet Control K = .0045
Inlet Control M = 2.0000
Inlet Control c = .03170
Inlet Control Y = .6900
T1 ratio (HW/D) = 1.080
T2 ratio (HW/D) = 1.182
Slope Factor = -.500

Use unsubmerged inlet control Form 1 equ. below T1 elev.
Use submerged inlet control Form 1 equ. above T2 elev.

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

At T1 Elev = 553.74 ft ---> Flow = 15.55 cfs
At T2 Elev = 553.94 ft ---> Flow = 17.77 cfs

Structure ID = TW
Structure Type = TW SETUP, DS Channel

FREE OUTFALL CONDITIONS SPECIFIED

CONVERGENCE TOLERANCES...

Maximum Iterations= 40
Min. TW tolerance = .01 ft
Max. TW tolerance = .01 ft
Min. HW tolerance = .01 ft
Max. HW tolerance = .01 ft
Min. Q tolerance = .00 cfs
Max. Q tolerance = .00 cfs

Name... LFB

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***** COMPOSITE OUTFLOW SUMMARY ****

WS Elev, Total Q		Converge		Notes
Elev. ft	Q cfs	TW Elev ft	Error +/-ft	Contributing Structures
553.40	.00	Free Outfall		(no Q: 6, 5, cv)
553.50	.00	Free Outfall		(no Q: 6, 5, cv)
553.60	.00	Free Outfall		(no Q: 6, 5, cv)
553.70	.00	Free Outfall		(no Q: 6, 5, cv)
553.80	.00	Free Outfall		(no Q: 6, 5, cv)
553.90	.00	Free Outfall		(no Q: 6, 5, cv)
554.00	.00	Free Outfall		(no Q: 6, 5, cv)
554.10	.00	Free Outfall		(no Q: 6, 5, cv)
554.20	.00	Free Outfall		(no Q: 6, 5, cv)
554.30	.00	Free Outfall		(no Q: 6, 5, cv)
554.40	.00	Free Outfall		(no Q: 6, 5, cv)
554.50	.00	Free Outfall		(no Q: 6, 5, cv)
554.60	.00	Free Outfall		(no Q: 6, 5, cv)
554.70	.00	Free Outfall		(no Q: 6, 5, cv)
554.80	.00	Free Outfall		(no Q: 6, 5, cv)
554.90	.00	Free Outfall		(no Q: 6, 5, cv)
555.00	.00	Free Outfall		(no Q: 6, 5, cv)
555.10	.00	Free Outfall		(no Q: 6, 5, cv)
555.20	.00	Free Outfall		(no Q: 6, 5, cv)
555.30	.00	Free Outfall		(no Q: 6, 5, cv)
555.40	.00	Free Outfall		(no Q: 6, 5, cv)
555.50	.00	Free Outfall		(no Q: 6, 5, cv)
555.60	.00	Free Outfall		(no Q: 6, 5, cv)
555.70	.00	Free Outfall		(no Q: 6, 5, cv)
555.80	.00	Free Outfall		(no Q: 6, 5, cv)
555.90	.00	Free Outfall		(no Q: 6, 5, cv)
556.00	.00	Free Outfall		(no Q: 6, 5, cv)
556.10	.00	Free Outfall		(no Q: 6, 5, cv)
556.20	.00	Free Outfall		(no Q: 6, 5, cv)
556.30	.00	Free Outfall		(no Q: 6, 5, cv)
556.40	.00	Free Outfall		(no Q: 6, 5, cv)
556.50	.00	Free Outfall		(no Q: 6, 5, cv)
556.60	.00	Free Outfall		(no Q: 6, 5, cv)
556.70	.00	Free Outfall		(no Q: 6, 5, cv)
556.80	.00	Free Outfall		(no Q: 6, 5, cv)
556.90	.00	Free Outfall		(no Q: 6, 5, cv)
557.00	.00	Free Outfall		(no Q: 6, 5, cv)
557.10	.00	Free Outfall		(no Q: 6, 5, cv)

Name.... LFB

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***** COMPOSITE OUTFLOW SUMMARY *****

WS Elev, Total Q		Converge		Notes
Elev. ft	Q cfs	TW Elev ft	Error +/-ft	Contributing Structures
557.20	.00	Free Outfall		(no Q: 6, 5, cv)
557.30	.00	Free Outfall		(no Q: 6, 5, cv)
557.40	.00	Free Outfall		(no Q: 6, 5, cv)
557.50	.00	Free Outfall		(no Q: 6, 5, cv)
557.60	.00	Free Outfall		(no Q: 6, 5, cv)
557.70	.00	Free Outfall		(no Q: 6, 5, cv)
557.80	.00	Free Outfall		(no Q: 6, 5, cv)
557.90	.00	Free Outfall		(no Q: 6, 5, cv)
558.00	.00	Free Outfall		(no Q: 6, 5, cv)
558.10	.00	Free Outfall		(no Q: 6, 5, cv)
558.20	.00	Free Outfall		(no Q: 6, 5, cv)
558.30	.00	Free Outfall		(no Q: 6, 5, cv)
558.40	.00	Free Outfall		(no Q: 6, 5, cv)
558.50	.00	Free Outfall		(no Q: 6, 5, cv)
558.60	.00	Free Outfall		(no Q: 6, 5, cv)
558.70	.00	Free Outfall		(no Q: 6, 5, cv)
558.80	.00	Free Outfall		(no Q: 6, 5, cv)
558.90	.00	Free Outfall		(no Q: 6, 5, cv)
559.00	.00	Free Outfall		(no Q: 6, 5, cv)
559.10	.00	Free Outfall		(no Q: 6, 5, cv)
559.20	.00	Free Outfall		(no Q: 6, 5, cv)
559.30	.00	Free Outfall		(no Q: 6, 5, cv)
559.40	.00	Free Outfall		(no Q: 6, 5, cv)
559.50	.00	Free Outfall		(no Q: 6, 5, cv)
559.60	.00	Free Outfall		(no Q: 6, 5, cv)
559.70	.00	Free Outfall		(no Q: 6, 5, cv)
559.80	.00	Free Outfall		(no Q: 6, 5, cv)
559.90	.00	Free Outfall		(no Q: 6, 5, cv)
560.00	.00	Free Outfall		(no Q: 6, 5, cv)
560.10	.00	Free Outfall		(no Q: 6, 5, cv)
560.20	.00	Free Outfall		(no Q: 6, 5, cv)
560.30	.00	Free Outfall		(no Q: 6, 5, cv)
560.38	.00	Free Outfall		(no Q: 6, 5, cv)
560.40	.00	Free Outfall		5, cv (no Q: 6)
560.50	.09	Free Outfall		5, cv (no Q: 6)
560.60	.29	Free Outfall		5, cv (no Q: 6)
560.70	.59	Free Outfall		5, cv (no Q: 6)
560.80	.98	Free Outfall		5, cv (no Q: 6)

Name.... LFB

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***** COMPOSITE OUTFLOW SUMMARY *****

WS Elev, Total Q		Converge		Notes
Elev. ft	Q cfs	TW Elev ft	Error +/-ft	Contributing Structures
560.90	1.46	Free Outfall		5, cv (no Q: 6)
561.00	1.98	Free Outfall		5, cv (no Q: 6)
561.10	2.57	Free Outfall		5, cv (no Q: 6)
561.20	3.19	Free Outfall		5, cv (no Q: 6)
561.30	3.73	Free Outfall		5, cv (no Q: 6)
561.40	4.08	Free Outfall		5, cv (no Q: 6)
561.50	4.40	Free Outfall		5, cv (no Q: 6)
561.60	4.70	Free Outfall		5, cv (no Q: 6)
561.70	4.99	Free Outfall		5, cv (no Q: 6)
561.80	5.26	Free Outfall		5, cv (no Q: 6)
561.90	5.51	Free Outfall		5, cv (no Q: 6)
561.93	5.58	Free Outfall		5, cv (no Q: 6)
562.00	6.20	Free Outfall		6, 5, cv
562.10	7.68	Free Outfall		6, 5, cv
562.20	9.58	Free Outfall		6, 5, cv
562.30	11.84	Free Outfall		6, 5, cv
562.40	14.38	Free Outfall		6, 5, cv
562.50	17.17	Free Outfall		6, 5, cv
562.60	20.22	Free Outfall		6, 5, cv
562.70	23.46	Free Outfall		6, 5, cv
562.80	25.39	Free Outfall		6, 5, cv
562.90	26.57	Free Outfall		6, 5, cv
563.00	27.70	Free Outfall		6, 5, cv

SUMMARY FOR HYDROGRAPH ADDITION
at Node: POND 10 IN

HYG Directory: \\2003server\Hydraulics\PONDPACK\A11000PLUS\11372c\

Upstream Link ID	Upstream Node ID	HYG file	HYG ID	HYG tag
ADDLINK 10	HYD QUEUE 10		100	100

INFLOWS TO: POND 10 IN

HYG file	HYG ID	HYG tag	Volume cu.ft	Peak Time min	Peak Flow cfs
	100	100	10556	1.00	8.80

TOTAL FLOW INTO: POND 10 IN

HYG file	HYG ID	HYG tag	Volume cu.ft	Peak Time min	Peak Flow cfs
	POND 10	IN 100	9500	3.00	8.80

TOTAL NODE INFLOW...

HYG file =

HYG ID = POND 10 IN

HYG Tag = 100

Peak Discharge = 8.80 cfs
 Time to Peak = 3.00 min
 HYG Volume = 9500 cu.ft

HYDROGRAPH ORDINATES (cfs)

Output Time increment = 3.00 min

Time on left represents time for first value in each row.

Time min					
.00	.00	8.80	8.80	8.80	8.80
15.00	8.80	8.80	.00		

LEVEL POOL ROUTING SUMMARY

HYG Dir = \\2003server\Hydraulics\PONDPACK\A11000PLUS\11372c\
Inflow HYG file = NONE STORED - POND 10 IN 100
Outflow HYG file = NONE STORED - POND 10 OUT 100

Pond Node Data = POND 10
Pond Volume Data = POND 10
Pond Outlet Data = LFB

No Infiltration

INITIAL CONDITIONS

Starting WS Elev = 560.38 ft
Starting Volume = 7785 cu.ft
Starting Outflow = .00 cfs
Starting Infiltr. = .00 cfs
Starting Total Qout = .00 cfs
Time Increment = 3.00 min

INFLOW/OUTFLOW HYDROGRAPH SUMMARY

Peak Inflow = 8.80 cfs at 3.00 min
Peak Outflow = 5.24 cfs at 18.00 min
Peak Elevation = 561.79 ft
Peak Storage = 13349 cu.ft

MASS BALANCE (cu.ft)

+ Initial Vol = 7785
+ HYG Vol IN = 9500
- Infiltration = 0
- HYG Vol OUT = 9432
- Retained Vol = 7852

Unrouted Vol = - cu.ft (.001% of Inflow Volume)

Index of Starting Page Numbers for ID Names

----- L -----
LFB... 2.01, 2.04

----- P -----
POND 10... 1.01, 3.01, 3.03

Summary of Drainage Calculations (TR55):

Drainage Area: 3.54 Acres
 Soil Type: Hydrologic Soil Group D
 Pre-Development CN: 78
 Post-Development CN: 86

Design Storm (year)	Pre-Development Discharge (cfs)	Post-Development Discharge (cfs)	Required Detention Basin Size (CF)
2	1.50	2.10	10,200
5	2.21	2.91	13,200
10	2.80	3.56	15,600
25	3.40	4.22	18,200
100	4.66	5.56	23,100

Total Basin Volume - 34,000 CF

Pipe Sizing - Rational Method (15 yr, 20 min Storm):

Drainage Area	Total Area (Ac)	Impervious Area (Ac)	Pervious Area (Ac)	PI (15)	Q(cfs)
DA-1	0.12	0.12	0.00	3.30	0.40
DA-2	0.38	0.00	0.38	1.87	0.71
DA-3	0.12	0.08	0.04	3.30	0.40
DA-4	0.10	0.07	0.03	3.30	0.33
DA-5	0.10	0.08	0.02	3.30	0.33
DA-6	0.03	0.02	0.01	3.30	0.10
DA-7	0.18	0.13	0.05	3.30	0.59
DA-8	0.22	0.15	0.07	3.30	0.73
DA-9	0.22	0.18	0.04	3.30	0.73
DA-10	0.38	0.38	0.00	3.30	1.25
DA-11	1.69	0.00	1.69	1.87	3.16

Pipe Run	Pipe Size (in)	Material	Manning's n	Length(ft)	Slope(%)	Capacity (cfs)	Flow (cfs)	Remaining Capacity (cfs)
A	12	HDPE	0.010	101	1.0	4.63	0.73	3.90
B	12	HDPE	0.010	121	1.5	5.67	0.59	5.08
C	18	HDPE	0.010	45	4.4	28.64	1.42	27.22
D	18	HDPE	0.010	41	4.4	28.64	3.00	25.64
E	12	HDPE	0.010	68	5.5	10.86	0.73	10.13
F	24	HDPE	0.010	50	1.0	29.41	4.06	25.35
G	12	HDPE	0.010	25	1.3	4.06	0.40	3.66
H	12	HDPE	0.010	19	1.3	4.06	0.80	3.26
I	24	HDPE	0.010	127	1.0	29.41	4.86	24.55
J	24	HDPE	0.010	19	1.6	37.20	4.86	32.34
K	18	RCP	0.013	134	1.0	10.50	5.57	4.93

