APPENDIX A
WATER DISTRIBUTION SYSTEM

EXHIBIT 1
WATER DISTRIBUTION SYSTEM

Short Term Goal

NORTH CENTER POINT ROAD FROM BURD LANE TO MIDWAY ROAD

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	WATER MAIN 12"	2000	LF	$ 90.00	$ 180,000.00
2	WATER MAIN 12" IN CASING	100	LF	$ 150.00	$ 15,000.00
3	WATER MAIN 8"	1300	LF	$ 60.00	$ 78,000.00
4	REMOVAL OF DRIVEWAY	60	SY	$ 10.00	$ 600.00
5	VALVE, 12"	12	EA	$ 1,450.00	$ 17,400.00
6	WATER SERVICE SHORT	3	EA	$ 1,500.00	$ 4,500.00
7	WATER SERVICE LONG	1	EA	$ 2,500.00	$ 2,500.00
8	FIRE HYDRANT ASSEMBLEY	8	EA	$ 4,000.00	$ 32,000.00
9	DRIVEWAY, PAVED, PCC, 6"	60	SY	$ 50.00	$ 3,000.00
10	SEEDING/TOPSOIL	1.5	ACRE	$ 15,000.00	$ 22,500.00
11	ROCK EXCAVATION	370	CY	$ 65.00	$ 24,050.00
12	MOBILIZATION, TRAFFIC CONTROL, ETC.	1	LS	$ 19,000.00	$ 19,000.00
1	WATER MAIN 12"	2000	LF	$ 90.00	$ 180,000.00
				Subtotal:	$399,000.00
				Contingency (20%):	$80,000.00
				CONSTRUCTION TOTAL:	$479,000.00
				Other Project Costs	
				Engineering, Construction, and Administration:	$86,000.00
				TOTAL PROJECT COST:	**$565,000.00**

EXHIBIT 2
WATER DISTRIBUTION SYSTEM

Short Term Goal

D&M ADDITION

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	TOPSOIL, ON-SITE	846	CY	$ 12.50	$ 10,575.00
2	EXCAVATION, CLASS 13	1	LS	$ 5,000.00	$ 5,000.00
3	SUBBASE, MODIFIED, 6"	207	SY	$ 15.00	$ 3,105.00
4	REMOVAL OF KNOWN PIPE CULVERT, RCP, 15"	20	LF	$ 15.00	$ 300.00
5	REMOVAL OF KNOWN PIPE CULVERT, CMP, 15"	109	LF	$ 5.00	$ 545.00
6	REMOVAL OF KNOWN PIPE CULVERT, CMP, 30"	41	LF	$ 5.00	$ 205.00
7	ROCK EXCAVATION	10	CY	$ 150.00	$ 1,500.00
8	TRENCH FOUNDATION	8.46	TON	$ 80.00	$ 676.80
9	TRENCH COMPACTION TESTING	1	LS	$ 1,000.00	$ 1,000.00
10	STORM SEWER, TRENCHED, CMP, 15"	107	LF	$ 47.50	$ 5,082.50
11	PIPE CULVERT, TRENCHED, CMP, 18"	39	LF	$ 65.00	$ 2,535.00
12	PIPE CULVERT, TRENCHED, CMP, 30"	31	LF	$ 95.00	$ 2,945.00
13	PIPE APRON, CMP, 18"	2	EA	$ 500.00	$ 1,000.00
14	PIPE APRON, CMP, 30"	2	EA	$ 650.00	$ 1,300.00
15	SUBDRAIN, TRENCHED, HDPE, 8"	2265	LF	$ 16.50	$ 37,372.50
16	SUBDRAIN, TRENCHLESS, SOLID WALL PVC, 8"	508	LF	$ 65.00	$ 33,020.00
17	SUBDRAIN CLEANOUT, TYPE A-2, 8"	10	LF	$ 500.00	$ 5,000.00
18	SUBDRAIN OUTLETS AND CONNECTIONS, CMP, 8"	2	EA	$ 185.00	$ 370.00
19	STORM SEWER SERVICE STUB, PVC, 4"	180	LF	$ 40.00	$ 7,200.00
20	WATER MAIN, TRENCHED, DIP CLASS 52, 12"	533	LF	$ 60.00	$ 31,980.00
21	WATER MAIN, TRENCHLESS, PVC C900 DR 18, 8"	2602	LF	$ 50.00	$ 130,100.00
22	WATER MAIN, FITTINGS	532	LBS	$ 9.50	$ 5,054.00

23	WATER SERVICE PIPE, COPPER, 1"	1347	LF	$ 25.00	$ 33,675.00
24	WATER SERVICE CORPORATION, COPPER, 1"	28	EA	$ 80.00	$ 2,240.00
25	WATER SERVICE CURB STOP AND BOX, COPPER, 1"	28	EA	$ 200.00	$ 5,600.00
26	VALVE, GATE VALVE, 8"	4	EA	$ 1,600.00	$ 6,400.00
27	VALVE, GATE VALVE, 12"	1	EA	$ 2,500.00	$ 2,500.00
28	FIRE HYDRANT ASSEMBLY	8	EA	$ 4,300.00	$ 34,400.00
29	DISINFECTION AND HYDROSTATIC TESTING	1	LS	$ 3,500.00	$ 3,500.00
30	INTAKE, SW-512, 24"	2	EA	$ 1,800.00	$ 3,600.00
31	PAVEMENT, HMA	59.13	TON	$ 200.00	$ 11,826.00
32	REMOVAL OF DRIVEWAY	37	SY	$ 20.00	$ 740.00
33	DRIVEWAY, PAVED, PCC, 6"	37	SY	$ 65.00	$ 2,405.00
34	DRIVEWAY, GRANULAR	68.22	TON	$ 30.00	$ 2,046.60
35	PAVEMENT REMOVAL	180	SY	$ 10.00	$ 1,800.00
36	TEMPORARY TRAFFIC CONTROL	1	LS	$ 5,000.00	$ 5,000.00
37	FLAGGERS	10	EA	$ 350.00	$ 3,500.00
38	HYDRAULIC SEEDING, SEEDING, FERTILIZING, AND MULCHING (TYPE 4)	1.08	AC	$ 2,000.00	$ 2,160.00
39	SWPPP MANAGEMENT	1	LS	$ 2,000.00	$ 2,000.00
40	FILTER SOCK, 12"	1155	LF	$ 2.75	$ 3,176.25
41	FILTER SOCK, REMOVAL	1155	LF	$ 0.45	$ 519.75
42	RIP RAP, CLASS E	20.53	TON	$ 75.00	$ 1,539.75
43	MOBILIZATION	1	LS	$ 25,000.00	$ 25,000.00
44	CONCRETE WASHOUT	1	LS	$ 250.00	$ 250.00

Subtotal:	$440,000.00
Contingency (20%):	---
CONSTRUCTION TOTAL:	$440,000.00

Other Project Costs

Right-of-Way:	$1,500.00
Engineering, Construction, and Administration:	$107,000.00
TOTAL PROJECT COST:	**$548,500.00**

EXHIBIT 3
WATER DISTRIBUTION SYSTEM

Short Term Goal

QUASS ROAD FROM D&M ADDITION TO KINGS WAY (Future)

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	WATERMAIN 12"	2660	LF	$ 90.00	$ 239,400.00
2	VALVE, 12"	2	EA	$ 1,450.00	$ 2,900.00
3	WATER SERVICE SHORT	1	EA	$ 1,500.00	$ 1,500.00
4	FIRE HYDRANT ASSEMBLEY	3	EA	$ 4,000.00	$ 12,000.00
5	SEEDING/TOPSOIL	2	ACRE	$ 15,000.00	$ 30,000.00
6	ROCK EXCAVATION	296	CY	$ 65.00	$ 19,240.00
7	MOBILIZATION, TRAFFIC CONTROL, ETC.	1	LS	$ 46,000.00	$ 46,000.00
				Subtotal:	$351,000.00
				Contingency (20%):	$70,000.00
				CONSTRUCTION TOTAL:	$421,000.00
				Other Project Costs	
				Engineering, Construction, and Administration:	$36,000.00
				TOTAL PROJECT COST:	**$457,000.00**

EXHIBIT 4
WATER DISTRIBUTION SYSTEM

Short Term Goal

KINGS WAY (Future) FROM CAMBRIDGE HEIGHTS ADDITION TO QUASS ROAD

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	WATERMAIN 12"	2900	LF	$ 110.00	$ 319,000.00
2	VALVE, 12"	8	EA	$ 1,450.00	$ 11,600.00
3	FIRE HYDRANT ASSEMBLEY	8	EA	$ 4,000.00	$ 32,000.00
4	SEEDING/TOPSOIL	0.7	ACRE	$ 15,000.00	$ 10,500.00
5	ROCK EXCAVATION	320	CY	$ 65.00	$ 20,800.00
6	PRV RECONFIGURATION	1	LS	$ 24,000.00	$ 24,000.00
7	MOBILIZATION, TRAFFIC CONTROL, ETC.	1	LS	$ 20,000.00	$ 20,000.00
				Subtotal:	$438,000.00
				Contingency (20%):	$88,000.00
				CONSTRUCTION TOTAL:	$526,000.00
				Other Project Costs	
				Right-of-Way:	$87,000.00
				Engineering, Construction, and Administration:	$67,000.00
				TOTAL PROJECT COST:	**$680,000.00**

EXHIBIT 5
WATER DISTRIBUTION SYSTEM

Short Term Goal

BOOSTER STATION IMPROVEMENTS

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	WATERMAIN 12"	---	---	---	---
2	VALVE, 12"	---	---	---	---
3	FIRE HYDRANT ASSEMBLEY	---	---	---	---
4	SEEDING/TOPSOIL	---	---	---	---
5	ROCK EXCAVATION	---	---	---	---
6	MOBILIZATION, TRAFFIC CONTROL, ETC.	---	---	---	---

Subtotal:	---
Contingency (20%):	---
CONSTRUCTION TOTAL:	---
Other Project Costs	
Engineering, Construction, and Administration:	$60,000.00
TOTAL PROJECT COST:	**$60,000.00**

EXHIBIT 6
WATER DISTRIBUTION SYSTEM

Intermediate Goal

LANDAU STREET

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	WATERMAIN 8"	1200	LF	$ 50.00	$60,000.00
2	VALVE, 8"	4	EA	$ 1,450.00	$5,800.00
3	FIRE HYDRANT ASSEMBLY	4	EA	$ 4,000.00	$16,000.00
4	SEEDING/TOPSOIL	0.3	ACRE	$ 15,000.00	$4,500.00
5	ROCK EXCAVATION	130	CY	$ 65.00	$8,450.00
6	MOBILIZATION, TRAFFIC CONTROL, ETC.	1	LS	$ 15,000.00	$15,000.00
7	WATER SERVICE SHORT	1	EA	$ 1,500.00	$1,500.00
8	REMOVAL OF DRIVEWAY	170	CY	$ 10.00	$1,700.00
9	REMOVAL OF PAVEMENT	98	SY	$ 15.00	$1,470.00
10	PAVEMENT, PCC<=, 8"	98	SY	$ 70.00	$6,860.00
11	DRIVEWAY, PAVED, PCC, 6"	170	SY	$ 50.00	$8,500.00
				Subtotal:	$130,000.00
				Contingency (20%):	$26,000.00
				CONSTRUCTION TOTAL:	$156,000.00
				Other Project Costs	
				Engineering, Construction, and Administration:	$28,100.00
				TOTAL PROJECT COST:	**$184,100.00**

EXHIBIT 7
WATER DISTRIBUTION SYSTEM

Intermediate Goal

COUNTY HOME ROAD FROM EPIC EVENT CENTER TO C AVENUE EXT

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	WATERMAIN 16"	2700	LF	$ 80.00	$216,000.00
2	VALVE, 16"	9	EA	$ 1,750.00	$15,750.00
3	WATER SERVICE LONG	1	EA	$ 2,500.00	$2,500.00
4	FIRE HYDRANT ASSEMBLEY	9	EA	$ 4,000.00	$36,000.00
5	SEEDING/TOPSOIL	0.6	ACRE	$ 15,000.00	$9,000.00
6	ROCK EXCAVATION	330	CY	$ 65.00	$21,450.00
7	MOBILIZATION, TRAFFIC CONTROL, ETC.	1	LS	$ 15,000.00	$15,000.00
8	REMOVAL OF PAVEMENT	75	SY	$ 15.00	$1,125.00
9	PAVEMENT, PCC<=, 8"	75	SY	$ 70.00	$5,250.00
				Subtotal:	$322,000.00
				Contingency (20%):	$64,000.00
				CONSTRUCTION TOTAL:	$386,000.00
				Other Project Costs	
				Engineering, Construction, and Administration:	$69,500
				TOTAL PROJECT COST:	**$455,500.00**

EXHIBIT 8
WATER DISTRIBUTION SYSTEM

Intermediate Goal

COUNTY HOME ROAD FROM NORTH CENTER POINT ROAD TO QUASS ROAD

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	WATERMAIN 16"	4225	LF	$ 80.00	$338,000.00
2	REMOVAL OF DRIVEWAY	0	SY	$ 10.00	$ -
3	VALVE, 16"	14	EA	$ 1,750.00	$24,500.00
4	WATER SERVICE SHORT	6	EA	$ 1,500.00	$9,000.00
5	WATER SERVICE LONG	5	EA	$ 2,500.00	$12,500.00
6	FIRE HYDRANT ASSEMBLEY	14	EA	$ 4,000.00	$56,000.00
7	DRIVEWAY, PAVED, PCC, 6"	0	SY	$ 50.00	$ -
8	SEEDING/TOPSOIL	1	ACRE	$ 15,000.00	$15,000.00
9	ROCK EXCAVATION	520	CY	$ 65.00	$33,800.00
10	MOBILIZATION, TRAFFIC CONTROL, ETC.	1	LS	$ 20,000.00	$20,000.00
11	REMOVAL OF PAVEMENT	350	CY	$ 15.00	$5,250.00
12	PAVEMENT, PCC<=, 8"	350	SY	$ 70.00	$24,500.00
				Subtotal:	$539,000.00
				Contingency (20%):	$108,000.00
				CONSTRUCTION TOTAL:	$647,000.00
				Other Project Costs	
				Engineering, Construction, and Administration:	$117,000.00
				TOTAL PROJECT COST:	**$764,000.00**

EXHIBIT 9
WATER DISTRIBUTION SYSTEM

Intermediate Goal

QUASS ROAD FROM KINGS WAY (Future) TO COUNTY HOME ROAD

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	WATERMAIN 12"	800	LF	$ 75.00	$60,000.00
2	VALVE, 12"	3	EA	$ 1,450.00	$4,350.00
3	WATER SERVICE SHORT	1	EA	$ 1,500.00	$1,500.00
4	FIRE HYDRANT ASSEMBLY	3	EA	$ 4,000.00	$12,000.00
5	SEEDING/TOPSOIL	0.2	ACRE	$ 15,000.00	$3,000.00
6	ROCK EXCAVATION	90	CY	$ 65.00	$5,850.00
7	MOBILIZATION, TRAFFIC CONTROL, ETC.	1	LS	$ 12,000.00	$12,000.00
				Subtotal:	$99,000.00
				Contingency (20%):	$20,000.00
				CONSTRUCTION TOTAL:	$119,000.00
				Other Project Costs	
				Engineering, Construction, and Administration:	$21,500.00
				TOTAL PROJECT COST:	**$140,500.00**

EXHIBIT 10
WATER DISTRIBUTION SYSTEM

Long Term Goal

COUNTY HOME ROAD FROM QUASS ROAD TO NORTH TROY ROAD

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	WATERMAIN 16"	2650	LF	$ 80.00	$212,000.00
2	REMOVAL OF PAVEMENT	330	SY	$ 15.00	$4,950.00
3	VALVE, 16"	9	EA	$ 1,750.00	$15,750.00
4	WATER SERVICE SHORT	2	EA	$ 1,500.00	$3,000.00
5	WATER SERVICE LONG	2	EA	$ 2,500.00	$5,000.00
6	FIRE HYDRANT ASSEMBLEY	9	EA	$ 4,000.00	$36,000.00
7	PAVEMENT, PCC<=, 8"	330	SY	$ 70.00	$23,100.00
8	SEEDING/TOPSOIL	0.6	ACRE	$ 15,000.00	$9,000.00
9	ROCK EXCAVATION	330	CY	$ 65.00	$21,450.00
10	MOBILIZATION, TRAFFIC CONTROL, ETC.	1	LS	$ 15,000.00	$15,000.00
				Subtotal:	$345,000.00
				Contingency (20%):	$69,000.00
				CONSTRUCTION TOTAL:	$414,000.00
				Other Project Costs	
				Engineering, Construction, and Administration:	$74,500.00
				TOTAL PROJECT COST:	**$488,500.00**

EXHIBIT 11
WATER DISTRIBUTION SYSTEM

Long Term Goal

COUNTY HOME ROAD FROM NORTH TROY ROAD TO EPIC EVENT CENTER

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	WATERMAIN 16"	2550	LF	$ 80.00	$204,000.00
2	VALVE, 16"	9	EA	$ 1,750.00	$15,750.00
3	WATER SERVICE SHORT	2	EA	$ 1,500.00	$3,000.00
4	WATER SERVICE LONG	0	EA	$ 2,500.00	$ -
5	FIRE HYDRANT ASSEMBLEY	9	EA	$ 4,000.00	$36,000.00
6	SEEDING/TOPSOIL	0.6	ACRE	$ 15,000.00	$9,000.00
7	ROCK EXCAVATION	330	CY	$ 65.00	$21,450.00
8	MOBILIZATION, TRAFFIC CONTROL, ETC.	1	LS	$ 15,000.00	$15,000.00
9	REMOVAL OF PAVEMENT	70	SY	$ 15.00	$1,050.00
10	PAVEMENT, PCC<=, 8"	70	SY	$ 70.00	$4,900.00
11	WATER MAIN 16" IN CASING	100	LF	$ 320.00	$32,000.00
				Subtotal:	$342,000.00
				Contingency (20%):	$68,000.00
				CONSTRUCTION TOTAL:	$410,000.00
				Other Project Costs	
				Engineering, Construction, and Administration:	$73,800.00
				TOTAL PROJECT COST:	**$483,800.00**

EXHIBIT 12
WATER DISTRIBUTION SYSTEM

Long Term Goal

NORTH CENTER POINT ROAD FROM WILD ROSE ROAD TO WEST MAIN STREET

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	WATERMAIN 16"	4310	LF	$ 80.00	$344,800.00
2	REMOVAL OF DRIVEWAY	40	SY	$ 10.00	$400.00
3	REMOVAL OF PAVEMENT	210	SY	$ 15.00	$3,150.00
4	VALVE, 16"	14	EA	$ 1,750.00	$24,500.00
5	WATER SERVICE SHORT	6	EA	$ 1,500.00	$9,000.00
6	WATER SERVICE LONG	4	EA	$ 2,500.00	$10,000.00
7	FIRE HYDRANT ASSEMBLEY	14	EA	$ 4,000.00	$56,000.00
8	DRIVEWAY, PAVED, PCC, 6"	40	SY	$ 50.00	$2,000.00
9	PAVEMENT, PCC<=, 8"	210	SY	$ 70.00	$14,700.00
10	SEEDING/TOPSOIL	1	ACRE	$ 15,000.00	$15,000.00
11	ROCK EXCAVATION	530	CY	$ 65.00	$34,450.00
12	MOBILIZATION, TRAFFIC CONTROL, ETC.	1	LS	$ 22,000.00	$22,000.00
				Subtotal:	$536,000.00
				Contingency (20%):	$107,000.00
				CONSTRUCTION TOTAL:	$643,000.00
				Other Project Costs	
				Engineering, Construction, and Administration:	$115,800.00
				TOTAL PROJECT COST:	**$758,800.00**

EXHIBIT 13
WATER DISTRIBUTION SYSTEM

Long Term Goal

NORTH CENTER POINT ROAD FROM TOWER TERRACE ROAD TO CHESTER ROAD

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	WATERMAIN 16"	2810	LF	$ 80.00	$224,800.00
2	REMOVAL OF DRIVEWAY	170	SY	$ 10.00	$1,700.00
3	VALVE, 16"	9	EA	$ 1,750.00	$15,750.00
4	WATER SERVICE SHORT	4	EA	$ 1,500.00	$6,000.00
5	WATER SERVICE LONG	8	EA	$ 2,500.00	$20,000.00
6	FIRE HYDRANT ASSEMBLEY	9	EA	$ 4,000.00	$36,000.00
7	DRIVEWAY, PAVED, PCC, 6"	170	SY	$ 50.00	$8,500.00
8	SEEDING/TOPSOIL	0.6	ACRE	$ 15,000.00	$9,000.00
9	ROCK EXCAVATION	350	CY	$ 65.00	$22,750.00
10	MOBILIZATION, TRAFFIC CONTROL, ETC.	1	LS	$ 15,000.00	$15,000.00
				Subtotal:	$360,000.00
				Contingency (20%):	$72,000.00
				CONSTRUCTION TOTAL:	$432,000.00
				Other Project Costs	
				Engineering, Construction, and Administration:	$77,800.00
				TOTAL PROJECT COST:	**$509,800.00**

EXHIBIT 14
WATER DISTRIBUTION SYSTEM

Long Term Goal

TOWER TERRACE ROAD FROM NORTH CENTER POINT ROAD TO ROBINS ROAD

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	WATERMAIN 16"	5230	LF	$ 80.00	$418,400.00
2	REMOVAL OF DRIVEWAY	100	SY	$ 10.00	$1,000.00
3	VALVE, 16"	17	EA	$ 1,750.00	$29,750.00
4	WATER SERVICE SHORT	2	EA	$ 1,500.00	$3,000.00
5	FIRE HYDRANT ASSEMBLEY	17	EA	$ 4,000.00	$68,000.00
6	DRIVEWAY, PAVED, PCC, 6"	100	SY	$ 50.00	$5,000.00
7	SEEDING/TOPSOIL	1.2	ACRE	$ 15,000.00	$18,000.00
8	ROCK EXCAVATION	650	CY	$ 65.00	$42,250.00
9	MOBILIZATION, TRAFFIC CONTROL, ETC.	1	LS	$ 25,000.00	$25,000.00
10	REMOVAL OF PAVEMENT	180	SY	$ 15.00	$2,700.00
11	PAVEMENT, PCC<=, 8"	180	SY	$ 70.00	$12,600.00
				Subtotal:	$626,000.00
				Contingency (20%):	$125,000.00
				CONSTRUCTION TOTAL:	$751,000.00
				Other Project Costs	
				Engineering, Construction, and Administration:	$135,200.00
				TOTAL PROJECT COST:	**$886,200.00**

EXHIBIT 15
WATER DISTRIBUTION SYSTEM

Long Term Goal

EAST KNOLL DRIVE FROM NORTH CENTER POINT ROAD TO ROBINS ROAD

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	WATERMAIN 16"	2300	LF	$ 80.00	$184,000.00
2	REMOVAL OF DRIVEWAY	70	SY	$ 10.00	$700.00
3	REMOVAL OF PAVEMENT	310	SY	$ 15.00	$4,650.00
4	VALVE, 16"	8	EA	$ 1,750.00	$14,000.00
5	WATER SERVICE SHORT	4	EA	$ 1,500.00	$6,000.00
6	WATER SERVICE LONG	4	EA	$ 2,500.00	$10,000.00
7	FIRE HYDRANT ASSEMBLEY	8	EA	$ 4,000.00	$32,000.00
8	DRIVEWAY, PAVED, PCC, 6"	70	SY	$ 50.00	$3,500.00
9	PAVEMENT, PCC<=, 8"	310	SY	$ 70.00	$21,700.00
10	SEEDING/TOPSOIL	0.5	ACRE	$ 15,000.00	$7,500.00
11	ROCK EXCAVATION	270	CY	$ 65.00	$17,550.00
12	MOBILIZATION, TRAFFIC CONTROL, ETC.	1	LS	$ 20,000.00	$20,000.00
				Subtotal:	$322,000.00
				Contingency (20%):	$64,000.00
				CONSTRUCTION TOTAL:	$386,000.00
				Other Project Costs	
				Engineering, Construction, and Administration:	$69,500.00
				TOTAL PROJECT COST:	**$455,500.00**

EXHIBIT 16
WATER DISTRIBUTION SYSTEM

Long Term Goal

NORTH MENTZER ROAD FROM EAST KNOLL DRIVE TO COUNTY HOME ROAD

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	WATERMAIN 12"	7100	LF	$ 75.00	$532,500.00
2	REMOVAL OF DRIVEWAY	0	SY	$ 10.00	$ -
3	VALVE, 12"	24	EA	$ 1,150.00	$27,600.00
4	WATER SERVICE SHORT	4	EA	$ 1,500.00	$6,000.00
5	WATER SERVICE LONG	1	EA	$ 2,500.00	$2,500.00
6	FIRE HYDRANT ASSEMBLEY	24	EA	$ 4,000.00	$96,000.00
7	DRIVEWAY, PAVED, PCC, 6"	0	SY	$ 50.00	$ -
8	SEEDING/TOPSOIL	1.6	ACRE	$ 15,000.00	$24,000.00
9	ROCK EXCAVATION	790	CY	$ 65.00	$51,350.00
10	MOBILIZATION, TRAFFIC CONTROL, ETC.	1	LS	$ 30,000.00	$30,000.00
				Subtotal:	$770,000.00
				Contingency (20%):	$154,000.00
				CONSTRUCTION TOTAL:	$924,000.00
				Other Project Costs	
				Engineering, Construction, and Administration:	$166,500.00
				TOTAL PROJECT COST:	**$1,090,500.00**

EXHIBIT 17
WATER DISTRIBUTION SYSTEM

Long Term Goal

STAMY ROAD (Future) FROM TOWER TERRACE ROAD TO SOUTH MORRISON DRIVE

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	WATERMAIN 12"	4830	LF	$ 75.00	$362,250.00
2	VALVE, 12"	16	EA	$ 1,450.00	$23,200.00
3	WATER SERVICE SHORT	1	EA	$ 1,500.00	$1,500.00
4	FIRE HYDRANT ASSEMBLEY	16	EA	$ 4,000.00	$64,000.00
5	SEEDING/TOPSOIL	1.1	ACRE	$ 15,000.00	$16,500.00
6	ROCK EXCAVATION	570	CY	$ 65.00	$37,050.00
7	MOBILIZATION, TRAFFIC CONTROL, ETC.	1	LS	$ 22,500.00	$22,500.00
8	WATER SERVICE SHORT	3	EA	$ 1,500.00	$4,500.00
				Subtotal:	$532,000.00
				Contingency (20%):	$106,000.00
				CONSTRUCTION TOTAL:	$638,000.00
				Other Project Costs	
				Easements:	$83,000.00
				Engineering, Construction, and Administration:	$115,000.00
				TOTAL PROJECT COST:	**$836,000.00**

EXHIBIT 18
WATER DISTRIBUTION SYSTEM

Long Term Goal

TOWER TERRACE ROAD FROM ROBINS ROAD TO COUNCIL STREET NE

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	WATERMAIN 16"	4000	LF	$ 80.00	$320,000.00
2	VALVE, 16"	13	EA	$ 1,750.00	$22,750.00
3	FIRE HYDRANT ASSEMBLEY	13	EA	$ 4,000.00	$52,000.00
4	SEEDING/TOPSOIL	1	ACRE	$ 15,000.00	$15,000.00
5	ROCK EXCAVATION	490	CY	$ 65.00	$31,850.00
6	MOBILIZATION, TRAFFIC CONTROL, ETC.	1	LS	$ 20,000.00	$20,000.00
7	REMOVAL OF PAVEMENT	100	SY	$ 15.00	$1,500.00
8	PAVEMENT, PCC<=, 8"	100	SY	$ 70.00	$7,000.00
				Subtotal:	$470,000.00
				Contingency (20%):	$94,000.00
				CONSTRUCTION TOTAL:	$564,000.00
				Other Project Costs	
				Easements:	$70,000.00
				Engineering, Construction, and Administration:	101,500.00
				TOTAL PROJECT COST:	**$735,500.00**

EXHIBIT 19
WATER DISTRIBUTION SYSTEM

Long Term Goal

ROBINS ROAD FROM TOWER TERRACE ROAD TO WEST MAIN STREET

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	WATERMAIN 12"	5500	LF	$ 75.00	$412,500.00
2	REMOVAL OF DRIVEWAY	410	SY	$ 10.00	$4,100.00
3	REMOVAL OF PAVEMENT	250	SY	$ 15.00	$3,750.00
4	VALVE, 12"	18	EA	$ 1,450.00	$26,100.00
5	WATER SERVICE SHORT	4	EA	$ 1,500.00	$6,000.00
6	FIRE HYDRANT ASSEMBLEY	18	EA	$ 4,000.00	$72,000.00
7	DRIVEWAY, PAVED, PCC, 6"	410	SY	$ 50.00	$20,500.00
8	PAVEMENT, PCC<=, 8"	250	SY	$ 70.00	$17,500.00
9	SEEDING/TOPSOIL	1.3	ACRE	$ 15,000.00	$19,500.00
10	ROCK EXCAVATION	640	CY	$ 65.00	$41,600.00
11	MOBILIZATION, TRAFFIC CONTROL, ETC.	1	LS	$ 22,000.00	$22,000.00
				Subtotal:	$646,000.00
				Contingency (20%):	$129,000.00
				CONSTRUCTION TOTAL:	$775,000.00
				Other Project Costs	
				Engineering, Construction, and Administration:	$139,500.00
				TOTAL PROJECT COST:	**$914,500.00**

EXHIBIT 20
WATER DISTRIBUTION SYSTEM

Long Term Goal

C AVENUE EXT FROM EAST KNOLL DRIVE TO COUNTY HOME ROAD (Upsize)

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	WATERMAIN 12"	8550	LF	$ 75.00	$641,250.00
2	VALVE, 12"	29	EA	$ 1,450.00	$42,050.00
3	WATER SERVICE SHORT	5	EA	$ 1,500.00	$7,500.00
4	WATER SERVICE LONG	6	EA	$ 2,500.00	$15,000.00
5	FIRE HYDRANT ASSEMBLEY	29	EA	$ 4,000.00	$116,000.00
6	SEEDING/TOPSOIL	2	ACRE	$ 15,000.00	$30,000.00
7	ROCK EXCAVATION	1000	CY	$ 65.00	$65,000.00
8	MOBILIZATION, TRAFFIC CONTROL, ETC.	1	LS	$ 20,000.00	$20,000.00
				Subtotal:	$937,000.00
				Contingency (20%):	$187,000.00
				CONSTRUCTION TOTAL:	$1,124,000.00
				Other Project Costs	
				Engineering, Construction, and Administration:	$202,300.00
				TOTAL PROJECT COST:	**$1,326,300.00**

EXHIBIT 21
WATER DISTRIBUTION SYSTEM

Ultimate Buildout

NORTH CENTER POINT ROAD FROM COUNTY HOME ROAD TO SEGMENT 1

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	WATERMAIN 12"	1900	LF	$ 75.00	$142,500.00
2	VALVE, 12"	6	EA	$ 1,450.00	$8,700.00
3	WATER SERVICE SHORT	1	EA	$ 1,500.00	$1,500.00
4	WATER SERVICE LONG	0	EA	$ 2,500.00	---
5	FIRE HYDRANT ASSEMBLEY	6	EA	$ 4,000.00	$24,000.00
6	SEEDING/TOPSOIL	0.44	ACRE	$ 15,000.00	$6,600.00
7	ROCK EXCAVATION	220	CY	$ 65.00	$14,300.00
8	MOBILIZATION, TRAFFIC CONTROL, ETC.	1	LS	$ 20,000.00	$20,000.00
9	REMOVAL OF DRIVEWAY	20	SY	$ 10.00	$200.00
10	DRIVEWAY, PAVED, PCC, 6"	20	SY	$ 50.00	$1,000.00
				Subtotal:	$219,000.00
				Contingency (20%):	$44,000.00
				CONSTRUCTION TOTAL:	$263,000.00
				Other Project Costs	
				Engineering, Construction, and Administration:	$47,500.00
				TOTAL PROJECT COST:	**$310,500.00**

EXHIBIT 22
WATER DISTRIBUTION SYSTEM

Ultimate Buildout

NORTH TROY ROAD FROM EAST MAIN STREET TO COUNTY HOME ROAD

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	WATERMAIN 16"	8350	LF	$ 80.00	$668,000.00
2	REMOVAL OF DRIVEWAY	250	SY	$ 10.00	$2,500.00
3	REMOVAL OF PAVEMENT	75	SY	$ 15.00	$1,125.00
4	VALVE, 16"	28	EA	$ 1,750.00	$49,000.00
5	WATER SERVICE SHORT	6	EA	$ 1,500.00	$9,000.00
6	WATER SERVICE LONG	5	EA	$ 2,500.00	$12,500.00
7	FIRE HYDRANT ASSEMBLEY	28	EA	$ 4,000.00	$112,000.00
8	DRIVEWAY, PAVED, PCC, 6"	250	SY	$ 50.00	$12,500.00
9	PAVEMENT, PCC<=, 8"	75	SY	$ 70.00	$5,250.00
10	SEEDING/TOPSOIL	2	ACRE	$ 15,000.00	$30,000.00
11	ROCK EXCAVATION	1030	CY	$ 65.00	$66,950.00
12	MOBILIZATION, TRAFFIC CONTROL, ETC.	1	LS	$ 40,000.00	$40,000.00
				Subtotal:	$1,009,000.00
				Contingency (20%):	$202,000.00
				CONSTRUCTION TOTAL:	$1,211,000.00
				Other Project Costs	
				Engineering, Construction, and Administration:	$218,000.00
				TOTAL PROJECT COST:	**$1,429,000.00**

EXHIBIT 23
WATER DISTRIBUTION SYSTEM

Ultimate Buildout

NORTH TROY ROAD (Future) FROM COUNTY HOME ROAD TO MIDWAY ROAD

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	WATERMAIN 16"	5280	LF	$ 80.00	$422,400.00
2	VALVE, 16"	18	EA	$ 1,750.00	$31,500.00
3	FIRE HYDRANT ASSEMBLEY	18	EA	$ 4,000.00	$72,000.00
4	SEEDING/TOPSOIL	1.2	ACRE	$ 15,000.00	$18,000.00
5	ROCK EXCAVATION	660	CY	$ 65.00	$42,900.00
6	MOBILIZATION, TRAFFIC CONTROL, ETC.	1	LS	$ 25,000.00	$25,000.00
7	REMOVAL OF PAVEMENT	40	SY	$ 15.00	$600.00
8	PAVEMENT, PCC<=, 8"	40	SY	$ 70.00	$2,800.00
9	WATER MAIN 16" IN CASING	100	LF	$ 320.00	$32,000.00
				Subtotal:	$647,000.00
				Contingency (20%):	$129,000.00
				CONSTRUCTION TOTAL:	$776,000.00
				Other Project Costs	
				Easements:	$93,000.00
				Engineering, Construction, and Administration:	$139,700.00
				TOTAL PROJECT COST:	**$1,008,700.00**

EXHIBIT 24
WATER DISTRIBUTION SYSTEM

Ultimate Buildout

C AVENUE EXT (Future) FROM COUNTY HOME ROAD TO MIDWAY ROAD

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	WATERMAIN 16"	5420	LF	$ 80.00	$433,600.00
2	REMOVAL OF DRIVEWAY	60	SY	$ 10.00	$600.00
3	VALVE, 16"	18	EA	$ 1,750.00	$31,500.00
4	WATER SERVICE SHORT	5	EA	$ 1,500.00	$7,500.00
5	WATER SERVICE LONG	1	EA	$ 2,500.00	$2,500.00
6	FIRE HYDRANT ASSEMBLEY	18	EA	$ 4,000.00	$72,000.00
7	DRIVEWAY, PAVED, PCC, 6"	60	SY	$ 50.00	$3,000.00
8	SEEDING/TOPSOIL	1.2	ACRE	$ 15,000.00	$18,000.00
9	ROCK EXCAVATION	640	CY	$ 65.00	$41,600.00
10	MOBILIZATION, TRAFFIC CONTROL, ETC.	1	LS	$ 20,000.00	$20,000.00
11	REMOVAL OF PAVEMENT	150	SY	$ 15.00	$2,250.00
12	PAVEMENT, PCC<=, 8"	150	SY	$ 70.00	$10,500.00
13	WATER MAIN 16" IN CASING	100	LF	$ 320.00	$32,000.00
				Subtotal:	$675,000.00
				Contingency (20%):	$135,000.00
				CONSTRUCTION TOTAL:	$810,000.00
				Other Project Costs	
				Engineering, Construction, and Administration:	$145,800.00
				TOTAL PROJECT COST:	**$955,800.00**

EXHIBIT 25
WATER DISTRIBUTION SYSTEM

Ultimate Buildout

QUASS ROAD (Future) FROM COUNTY HOME ROAD TO MIDWAY ROAD

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	WATERMAIN 12"	5400	LF	$ 75.00	$405,000.00
2	VALVE, 12"	18	EA	$ 1,150.00	$20,700.00
3	FIRE HYDRANT ASSEMBLEY	18	EA	$ 4,000.00	$72,000.00
4	SEEDING/TOPSOIL	1.2	ACRE	$ 15,000.00	$18,000.00
5	ROCK EXCAVATION	630	CY	$ 65.00	$40,950.00
6	MOBILIZATION, TRAFFIC CONTROL, ETC.	1	LS	$ 20,000.00	$20,000.00
7	WATER MAIN 12" IN CASING	100	LF	$ 300.00	$30,000.00
8	WATER SERVICE SHORT	1	EA	$ 1,500.00	$1,500.00
9	WATER SERVICE LONG	1	EA	$ 2,500.00	$2,500.00
10	REMOVAL OF PAVEMENT	80	SY	$ 15.00	$1,200.00
11	PAVEMENT, PCC<=, 8"	80	SY	$ 70.00	$5,600.00
12	WATERMAIN 12"	5400	LF	$ 75.00	$405,000.00
				Subtotal:	$617,000.00
				Contingency (20%):	$123,000.00
				CONSTRUCTION TOTAL:	$740,000.00
				Other Project Costs	
				Easements:	93,000.00
				Engineering, Construction, and Administration:	$133,200.00
				TOTAL PROJECT COST:	**$966,200.00**

EXHIBIT 26
WATER DISTRIBUTION SYSTEM

Ultimate Buildout

FLYNN'S FIRST ADDITION

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	WATERMAIN 8"	3850	LF	$ 50.00	$192,500.00
2	REMOVAL OF DRIVEWAY	60	SY	$ 10.00	$600.00
3	REMOVAL OF PAVEMENT	370	SY	$ 15.00	$5,550.00
4	VALVE, 8"	13	EA	$ 1,150.00	$14,950.00
5	WATER SERVICE SHORT	11	EA	$ 1,500.00	$16,500.00
6	WATER SERVICE LONG	5	EA	$ 2,500.00	$12,500.00
7	FIRE HYDRANT ASSEMBLEY	13	EA	$ 4,000.00	$52,000.00
8	DRIVEWAY, PAVED, PCC, 6"	60	SY	$ 50.00	$3,000.00
9	PAVEMENT, PCC<=, 8"	370	SY	$ 70.00	$25,900.00
10	SEEDING/TOPSOIL	0.9	ACRE	$ 15,000.00	$13,500.00
11	ROCK EXCAVATION	430	CY	$ 65.00	$27,950.00
12	MOBILIZATION, TRAFFIC CONTROL, ETC.	1	LS	$ 15,000.00	$15,000.00
				Subtotal:	$380,000.00
				Contingency (20%):	$76,000.00
				CONSTRUCTION TOTAL:	$456,000.00
				Other Project Costs	
				Easements:	$30,000.00
				Engineering, Construction, and Administration:	$82,100.00
				TOTAL PROJECT COST:	**$568,100.00**

EXHIBIT 27
WATER DISTRIBUTION SYSTEM

Ultimate Buildout

SINGER HILL LANE FROM NORTH CENTER POINT ROAD TO I-380

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	WATERMAIN 8"	2370	LF	$ 50.00	$118,500.00
2	REMOVAL OF DRIVEWAY	30	SY	$ 10.00	$300.00
3	VALVE, 8"	10	EA	$ 1,150.00	$11,500.00
4	WATER SERVICE SHORT	5	EA	$ 1,500.00	$7,500.00
5	FIRE HYDRANT ASSEMBLEY	10	EA	$ 4,000.00	$40,000.00
6	DRIVEWAY, PAVED, PCC, 6"	30	SY	$ 50.00	$1,500.00
7	SEEDING/TOPSOIL	0.54	ACRE	$ 15,000.00	$8,100.00
8	ROCK EXCAVATION	260	CY	$ 65.00	$16,900.00
9	MOBILIZATION, TRAFFIC CONTROL, ETC.	1	LS	$ 12,000.00	$12,000.00
				Subtotal:	$216,000.00
				Contingency (20%):	$43,000.00
				CONSTRUCTION TOTAL:	$259,000.00
				Other Project Costs	
				Engineering, Construction, and Administration:	$46,600.00
				TOTAL PROJECT COST:	**$305,600.00**

EXHIBIT 28
WATER DISTRIBUTION SYSTEM

Ultimate Buildout

BRIARWOOD LANE FROM EAST KNOLL DRIVE TO MAPLE STREET

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	WATERMAIN 8"	1140	LF	$ 50.00	$57,000.00
2	REMOVAL OF DRIVEWAY	20	SY	$ 10.00	$200.00
3	VALVE, 8"	4	EA	$ 1,150.00	$4,600.00
4	WATER SERVICE SHORT	4	EA	$ 1,500.00	$6,000.00
5	WATER SERVICE LONG	3	EA	$ 2,500.00	$7,500.00
6	FIRE HYDRANT ASSEMBLEY	4	EA	$ 4,000.00	$16,000.00
7	DRIVEWAY, PAVED, PCC, 6"	20	SY	$ 50.00	$1,000.00
8	SEEDING/TOPSOIL	0.3	ACRE	$ 15,000.00	$4,500.00
9	ROCK EXCAVATION	130	CY	$ 65.00	$8,450.00
10	MOBILIZATION, TRAFFIC CONTROL, ETC.	1	LS	$ 5,000.00	$5,000.00
				Subtotal:	$110,000.00
				Contingency (20%):	$22,000.00
				CONSTRUCTION TOTAL:	$132,000.00
				Other Project Costs	
				Easements:	$8,000.00
				Engineering, Construction, and Administration:	$23,800.00
				TOTAL PROJECT COST:	**$163,800.00**

EXHIBIT 29
WATER DISTRIBUTION SYSTEM

Ultimate Buildout

VOGT STREET FROM EAST KNOLL DRIVE TO NORTH END

OPINION OF PROBABLE PROJECT COSTS					
ITEM #	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED PRICE**
1	WATERMAIN 8"	1400	LF	$ 50.00	$70,000.00
2	REMOVAL OF DRIVEWAY	60	SY	$ 10.00	$600.00
3	REMOVAL OF PAVEMENT	110	SY	$ 15.00	$1,650.00
4	VALVE, 8"	5	EA	$ 1,150.00	$5,750.00
5	WATER SERVICE SHORT	8	EA	$ 1,500.00	$12,000.00
6	WATER SERVICE LONG	3	EA	$ 2,500.00	$7,500.00
7	FIRE HYDRANT ASSEMBLEY	5	EA	$ 4,000.00	$20,000.00
8	DRIVEWAY, PAVED, PCC, 6"	60	SY	$ 50.00	$3,000.00
9	PAVEMENT, PCC<=, 8"	110	SY	$ 70.00	$7,700.00
10	SEEDING/TOPSOIL	0.32	ACRE	$ 15,000.00	$4,800.00
11	ROCK EXCAVATION	160	CY	$ 65.00	$10,400.00
12	MOBILIZATION, TRAFFIC CONTROL, ETC.	1	LS	$ 6,000.00	$6,000.00
				Subtotal:	$149,000.00
				Contingency (20%):	$30,000.00
				CONSTRUCTION TOTAL:	$179,000.00
				Other Project Costs	
				Engineering, Construction, and Administration:	$32,400.00
				TOTAL PROJECT COST:	**$211,400.00**

EXHIBIT 30
WATER DISTRIBUTION SYSTEM

CITY OF ROBINS INFORMATION REQUEST FOR CEDAR RAPIDS WATER

City of Robins
Information Request for Cedar Rapids Water

Date Prepared:	Project Name/Description:
APPLICANT	ENGINEER
Name: Address: City, State, Zip: Representative: Telephone: Email:	Firm: Address: City, State, Zip: Project Officer: Telephone: Email:

1. List the purpose of the project (e.g. expand service area, improve system pressures or flows):

2. Is this a City of Robins public improvement project? Yes ☐ No ☐
   If Yes: Are there 2 copies of a Concept Plan accompanying this application? Yes ☐ No ☐
   If No: Are there 3 copies of the Preliminary Plat accompanying this application? Yes ☐ No ☐

3. Type and number of new connections to water system:

Residential:	Commercial:	Other (specify):
Average Daily Usage	Peak Daily Usage	Needed Fire Flow

4. Proposed water main information

Location (Street or Intersection)	Pipe Material (PVC,DIP)	Diameter (inches)	Length (feet)	Public or Private Main

5. Estimated Start Date:	
6. Estimated Completion Date:	

APPLICANT or ENGINEER

Signature:	Date:	
Typed or Printed Name:		

City of Robins
Information Request for Cedar Rapids Water

To be completed by the City of Cedar Rapids Water Department

1. Does the system have the hydraulic capacity to serve the proposed new users without causing the pressure within the system to fall below 45 psi under normal conditions? Yes ☐ No ☐

2. Does the system have the hydraulic capacity to serve the proposed new users and supply required fire flow without causing pressure anywhere in the system to fall below 20 psi? Yes ☐ No ☐

3. Does the system have adequate source, storage, and treatment plant capacity to serve both existing and proposed users? Yes ☐ No ☐

4. Development is served from which service zone?
   Boyson tank ☐ Robins Booster ☐
   Robins Booster, then through PRV ☐

5. Available water system information:

Location (Street or Intersection)	Maximum Available Fire Flow (gpm) **	Maximum Static Pressure (psi) *	Minimum Static Pressure (psi)	Estimated Chlorine Residual (mg/L)***

* If Maximum Static Pressure exceeds 90 psi, use of a mainline pressure reducing valve must be reviewed.
The use of individual pressure reducing valves may be required in accordance with the International Plumbing Code.
** At 20 psi residual pressure. International Fire Code requires 1,000 gpm for Residential and 1,500 gpm for Commercial.
*** If estimated chlorine residual is less than 2.5 mg/L, a plan to maintain the minimum chlorine residual must be provided by the applicant.

CITY OF CEDAR RAPIDS WATER DEPARTMENT

Signature:	Date:	
Typed or Printed Name:		

Submittal Process

Water Main Additions in City of Robins

- Private development project:
  - Developer to submit 3 copies of form to the City of Robins with the Draft Preliminary Plat
  - City of Robins submits 3 copies of form and Draft Preliminary Plat to City of Cedar Rapids Water Division
    - Cedar Rapids Water Division to review and return 2 copies within 30 days – keeps one copy of submittal
    - City of Robins to return 1 copy to Developer – keeps one copy of submittal
  - City of Robins submits final approved Preliminary Plat to Cedar Rapids Water Division for their records
  - Developer submits draft Plan of Improvements to Cedar Rapids Water Division and City of Robins for review
    - Cedar Rapids Water Division to review and return comments to the Developer and to City of Robins within 30 days
  - Developer submits final Plan of Improvements and IDNR construction permit applications to Cedar Rapids Water Division and copies City of Robins on the submittal
    - Cedar Rapids Water Division to review and return for corrections, or return approved permits, within 2 weeks
    - City of Robins will not review the permits
  - Developer and Contractor to schedule a Pre-Construction meeting with Robins and Cedar Rapids Water Division minimum of one week prior to commencing work.
  - Contractor to obtain a “Start” Work Order from the Cedar Rapids Water Division minimum of 48 hours in advance of beginning construction (this initiates inspection)
  - Cedar Rapids Water Division will:
    - Provide inspections of water system additions during construction.
    - Collect GPS data for water system mapping.
    - Prepare a water improvements “punch list”: at substantial completion (copies to the Contractor, the Developer, and to the City of Robins).
    - Conduct final inspection of water system additions.
    - Send Letter of Recommendation regarding acceptance of water system additions by the City of Robins.
  - Developer submits Final Plat to City of Robins.

- City of Robins capital improvement project:
    - City of Robins to submit 2 copies of form to City of Cedar Rapids Water Division with the concept plans
        - City of Cedar Rapids Water Division to review and return within 30 days – keeps one copy
    - City of Robins to submit Plan of Improvements to Cedar Rapids Water Division for review
        - City of Cedar Rapids Water Division to review and return comments within 30 days
    - City of Robins to submit final Plan of Improvements and IDNR construction permit applications for Cedar Rapids Water Division review and permit signature
        - City of Cedar Rapids Water Division to review and return for corrections, or return approved permits, within 2 weeks
    - City of Robins to notify Cedar Rapids Water Division within 5 days of Award of Contract.
    - City of Robins to invite Cedar Rapids Water Division to the Pre-Construction meeting with one week's notice.
    - Contractor to obtain a "Start" Work Order from the Cedar Rapids Water Division minimum of 48 hours in advance of beginning construction (this initiates inspection)
    - Cedar Rapids Water Division will:
        - Provide inspections of water system additions during construction.
        - Collect GPS data for water system mapping.
        - Prepare a water improvements "punch list: at substantial completion (copies to the Contractor and the City of Robins).
        - Conduct final inspection of water system additions.
        - Send Letter of Recommendation regarding acceptance of water system additions by the City of Robins.

EXHIBIT 31
WATER DISTRIBUTION SYSTEM

MODELING SCENARIOS MEMORANDUM

Memorandum

To:

From:

CC:

RE: Modeling Scenarios – Robins Water Distribution System Evaluation

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Here is a more detailed scope and timeline. Attached is a map showing the hydraulic modeling locations.

ADDITIONAL INFORMATION

- We are limiting ourselves to a maximum 16" main. Our current goal is to know what we can do with a 16" or 12" main, not how big of a main to install to meet potential demands.
    - 1500-2500 gpm Fire Flow @ 20 psi would be our likely target.
    - 35 psi and 75 psi residual pressure are our point for domestic demand.
    - We want to be able to tell developers that we can provide XXX gpm @ 35 psi and 75 psi for domestic flow and fire flow of XXX gpm, while maintaining a 20 psi residual throughout the system, at a defined location.
- Segments 1a, 1b, and 1c are scheduled to be completed by 2020.

LOCATIONS

A. Fire and Domestic flow and pressure at the intersection of Tower Terrace and North Center Point Road.
B. Fire and Domestic flow and pressure at the proposed intersection of Tower Terrace and Stamy Road.
C. Fire and Domestic flow and pressure at the intersection of Tower Terrace and robins Road.
D. Fire and Domestic flow and pressure at the intersection of Robins Road and Main Street.
E. Fire and Domestic flow and pressure at the intersection of C Ave and County Home Road
F. Fire and Domestic flow and pressure at the intersection of North Mentzer Road and County Home Road.
G. Fire and Domestic flow and pressure at the intersection of Troy Road and County Home Road.
H. Fire and Domestic flow and pressure at the proposed intersection of the Troy Road extension and Midway Road.

I. Fire and Domestic flow and pressure at the proposed intersection of C Ave extension and Midway Road.
J. Fire and Domestic flow and pressure at the intersection of the Quass Road extension and Midway Road
K. Fire and Domestic flow and pressure at the intersection of Quass Road and County Home Road
L. Fire and Domestic flow and pressure at the proposed intersection of Quass Road and Kings Way extension.
M. Fire and Domestic flow and pressure at the intersection of North Center Point Road and Midway Road.
N. Fire and Domestic flow and pressure at the intersection of North Center Point Road and MacKenzie Drive.
O. Fire and Domestic flow and pressure at the end of Singer Hill Lane.
P. Fire and Domestic flow and pressure at the end of the north portion of the current Stamy Road.
Q. Fire and Domestic flow and pressure
R. Fire and Domestic flow and pressure

INFRASTRUCTURE LAYOUT

1. Current Infrastructure – 600 gpm Booster Station with 12" Gravity Bypass (Serves elevations higher than 900 feet)
    a. Projects Scheduled to be completed in 2019, which include segments 1a, 1b, and 1 c.
    b. The booster station is located West of Quass on Main Street
2. Segment 2a is on North Center Point Road from Wild Rose to Main Street
3. Segment 3 is on North Center Point Road from County Home Road to Midway
4. Segment 4b is on County Home Road from C Ave to the east and is roughly 2500 feet
5. Segment 5 is the extension of Kings Way
6. Segment 6 Beverly Street and is a priority by residential needs
7. Segment 7 connects Segment 6 to Segment 5 on Quass Road
8. Segment 8 is on County Home Road from North Center Point Road to Quass
9. Segment 9 is an Extension of Segment 7, it will connect Segment 8 to Segment 7 on Quass
10. Segment 10a is on County Home Road from Quass to Troy
11. Segment 4a is on County Home Road from troy to C Ave
12. Segment 2b and 2c are on Tower Terrace from North Center Point Road to Robins Road
13. Segment 11 is on Mentzer road from East Knoll Drive to County Home Road
14. Segment 12 will be on the future Stamy Road extension
15. Segment 2d will be on the Tower Terrace extension to Council Street in Cedar Rapids
16. Segment 13 is on Robins Road From Tower Terrace to Main Street
17. Segment 14a is on C Ave from East Knoll to County Home Road
18. Segments 15, 10c, 14b, and 9b are many years into the future

SCHEDULE

Attached to this letter is a layout of future and current watermain segments. They are numbered according expected construction sequence. The scenarios all involve the segments scheduled to be complete in 2019. An uppercase P will indicate that all previous segments including the segment exist in the scenario. (e.g. 11P.G means that segment 4a and all other previous segments are involved in that particular scenario and the pressure location desired would be at the intersection of Troy Road and County Home Road).

Scenarios			

EXHIBIT 32
WATER DISTRIBUTION SYSTEM

2019 MODELING SCENARIOS

Table 1: Current Infrastructure (Construction of Segment 1)-Predicted Hydraulic Parameters at Points of Interest								
					45 psi Zone Lower Limt		20 psi Zone Lower Limit	
Flow Hydrant	**Location**	Service Zone	**Elevation**	**Static Pressure (psi*)**	Residual Pressure (psi)	Flow (gpm)	Residual Pressure (psi)	Flow (gpm)
A) 827A-D	NE corner Interchange of I-380 with County Home Rd - Burds Convenience Store	Robins - Boosted	858	102 (61)	69	828	42	1,166
E) 1127D-F	N. Center Point Rd & Chester Rd	Robins - PRV	856	58 (58)	50	972	22	1,497
F) 827A-B	N. Center Point Rd & County Home Rd	Robins - Boosted	861	101 (60)	69	828	42	1,166
G) 927A-A	New Covenant Bible Church	Robins - Boosted	865	99 (58)	68	828	42	1,166
H) 927B-A	Kink of Kings Lutheran Church	Robins - PRV	854	65 (63)	64	828	44	1,166
I) 927D-B	N. Center Point Rd & West Main St	Robins - Boosted	909	80 (39)	50	828	24	1,167
P) 822A-A	C Ave Ext & County Home Rd	Robins - Boyson	876	54 (54)	Static Pressure at 1025C-A is 37 psi		20	720
R) 1023A-A	N. Mentzer Rd & E. Knoll Dr	Robins - Boyson	850	65 (65)	Static Pressure at 1025C-A is 37 psi		57	2,000
S) 1022B-A	C Ave Ext & E. Knoll Dr	Robins - Boyson	872	56 (56)	Static Pressure at 1025C-A is 37 psi		48	2,000
T)	W. Main St & Quass Rd	Robins - Boyson	834	72 (72)	Static Pressure at 1025C-A is 37 psi		55	2,000
U) 1025C-C	W. Main St & Robins Rd	Robins - Boyson	878	53 (53)	Static Pressure at 1025C-A is 37 psi		41	2,000
V) 1125B-D	W. Main St & Troy Rd	Robins - Boyson	846	67 (67)	Static Pressure at 1025C-A is 37 psi		59	2,000
W) 1124B-A	W Main St & Mentzer Rd	Robins - Boyson	864	59 (59)	Static Pressure at 1025C-A is 37 psi		54	2,000
AA) 1224D-A	Emery Place Assisted Living & Memory Care	Robins - Boyson	869	57 (57)	Static Pressure at 1025C-A is 37 psi		52	2,000
AB)	N. Center Point Rd & Wild Rose Rd	Robins - PRV	824	72 (72)	64	972	37	1,496
AD)1126B-A	South end of Stamy Rd	Robins - Boosted	918	76 (35)	46	844	20	1,362

Notes:

(*) The static pressure is shown for both "boosted" flow and "gravity" flow (in parentheses).

The "zone lower limit" only considers pressure in the service zone that the fire hydrant is located in. It does not consdier other service zone pressures.

Table 2: Tower Terrace Rd and N. Center Point Rd Loop (Construction of Segments 1, 2, 11, and 12)-Predicted Hydraulic Parameters at Points of Interest

					45 psi Zone Lower Limt		20 psi Zone Lower Limit	
Flow Hydrant	**Location**	Service Zone	**Elevation**	**Static Pressure (psi*)**	Residual Pressure (psi)	Flow (gpm)	Residual Pressure (psi)	Flow (gpm)
A) 827A-D	NE corner Interchange of I-380 with County Home Rd - Burds Convenience Store	Robins - Boosted	858	102 (61)	69	826	42	1,166
D) 627A-A	N. Center Point Rd & Midway Rd	Robins - Boosted	836	111 (71)	76	826	47	1,166
E) 1127D-F	N. Center Point Rd & Chester Rd	Robins - PRV	856	58 (58)	52	1,033	30	2,000
F) 827A-B	N. Center Point Rd & County Home Rd	Robins - Boosted	861	101 (60)	69	826	42	1,166
G) 927A-A	New Covenant Bible Church	Robins - Boosted	865	99 (58)	68	826	42	1,166
H) 927B-A	Kink of Kings Lutheran Church	Robins - PRV	854	65 (63)	64	826	44	1,166
I) 927D-B	N. Center Point Rd & West Main St	Robins - Boosted	909	80 (39)	50	826	24	1,167
J)	N. Center Point Rd & Singer Hill Ln	Robins - PRV	851	60 (60)	55	1,031	33	2,000
P) 822A-A	C Ave Ext & County Home Rd	Robins - Boyson	876	54 (54)	Static Pressure at 1025C-A is 37 psi		20	720
R) 1023A-A	N. Mentzer Rd & E. Knoll Dr	Robins - Boyson	850	65 (65)	Static Pressure at 1025C-A is 37 psi		57	2,000
S) 1022B-A	C Ave Ext & E. Knoll Dr	Robins - Boyson	872	56 (56)	Static Pressure at 1025C-A is 37 psi		48	2,000
T)	W. Main St & Quass Rd	Robins - Boyson	834	72 (72)	Static Pressure at 1025C-A is 37 psi		55	2,000
U) 1025C-C	W. Main St & Robins Rd	Robins - Boyson	878	53 (53)	Static Pressure at 1025C-A is 37 psi		41	2,000
V) 1125B-D	W. Main St & Troy Rd	Robins - Boyson	846	67 (67)	Static Pressure at 1025C-A is 37 psi		59	2,000
W) 1124B-A	W Main St & Mentzer Rd	Robins - Boyson	864	59 (59)	Static Pressure at 1025C-A is 37 psi		54	2,000
X)	N. Center Point Rd & Tower Terrace Rd	Robins - PRV	858	57 (57)	50	1,033	26	2,000
Y)	Tower Terrace Rd & Stamy Rd (future)	Robins - PRV	866	53 (53)	46	1,033	21	2,000
Z)	Tower Terrace Rd & Robins Rd	Robins - PRV	836	66 (66)	58	1,033	31	2,000
AA) 1224D-A	Emery Place Assisted Living & Memory Care	Robins - Boyson	869	57 (57)	Static Pressure at 1025C-A is 37 psi		52	2,000
AB)	N. Center Point Rd & Wild Rose Rd	Robins - PRV	824	72 (72)	66	1,032	45	2,000
AD)1126B-A	South end of Stamy Rd	Robins - Boosted	918	76 (35)	46	844	20	1,382

Notes:
(*) The static pressure is shown for both "boosted" flow and "gravity" flow (in parentheses).
The "zone lower limit" only considers pressure in the service zone that the fire hydrant is located in. It does not consdier other service zone pressures.

Table 3: County Home Rd Extension Option 1 (Construction of Segment 3)-Predicted Hydraulic Parameters at Points of Interest

					45 psi Zone Lower Limt		20 psi Zone Lower Limit	
Flow Hydrant	**Location**	Service Zone	**Elevation**	**Static Pressure (psi*)**	Residual Pressure (psi)	Flow (gpm)	Residual Pressure (psi)	Flow (gpm)
A) 827A-D	NE corner Interchange of I-380 with County Home Rd - Burds Convenience Store	Robins - Boosted	858	102 (61)	69	828	42	1,166
E) 1127D-F	N. Center Point Rd & Chester Rd	Robins - PRV	856	58 (58)	50	972	22	1,497
F) 827A-B	N. Center Point Rd & County Home Rd	Robins - Boosted	861	101 (60)	69	828	42	1,166
G) 927A-A	New Covenant Bible Church	Robins - Boosted	865	99 (58)	68	828	42	1,166
H) 927B-A	Kink of Kings Lutheran Church	Robins - PRV	854	65 (63)	64	828	44	1,166
I) 927D-B	N. Center Point Rd & West Main St	Robins - Boosted	909	80 (39)	50	828	24	1,167
O)	N Mentzer Rd & County Home Rd	Robins - Boyson	874	55 (55)	Static Pressure at 1025C-A is 37 psi		20	722
P) 822A-A	C Ave Ext & County Home Rd	Robins - Boyson	876	54 (54)	Static Pressure at 1025C-A is 37 psi		20	720
R) 1023A-A	N. Mentzer Rd & E. Knoll Dr	Robins - Boyson	850	65 (65)	Static Pressure at 1025C-A is 37 psi		57	2,000
S) 1022B-A	C Ave Ext & E. Knoll Dr	Robins - Boyson	872	56 (56)	Static Pressure at 1025C-A is 37 psi		48	2,000
T)	W. Main St & Quass Rd	Robins - Boyson	834	72 (72)	Static Pressure at 1025C-A is 37 psi		55	2,000
U) 1025C-C	W. Main St & Robins Rd	Robins - Boyson	878	53 (53)	Static Pressure at 1025C-A is 37 psi		41	2,000
V) 1125B-D	W. Main St & Troy Rd	Robins - Boyson	846	67 (67)	Static Pressure at 1025C-A is 37 psi		59	2,000
W) 1124B-A	W Main St & Mentzer Rd	Robins - Boyson	864	59 (59)	Static Pressure at 1025C-A is 37 psi		54	2,000
AA) 1224D-A	Emery Place Assisted Living & Memory Care	Robins - Boyson	869	57 (57)	Static Pressure at 1025C-A is 37 psi		52	2,000
AB)	N. Center Point Rd & Wild Rose Rd	Robins - PRV	824	72 (72)	64	972	37	1,496
AD)1126B-A	South end of Stamy Rd	Robins - Boosted	918	76 (35)	46	844	20	1,362

Notes:
(*) The static pressure is shown for both "boosted" flow and "gravity" flow (in parentheses).
The "zone lower limit" only considers pressure in the service zone that the fire hydrant is located in. It does not consdier other service zone pressures.

Table 4: County Home Rd Extension Option 2 (Construction of Segments 3, 1, 9, and 10)-Predicted Hydraulic Parameters at Points of Interest

					45 psi Zone Lower Limt		20 psi Zone Lower Limit	
Flow Hydrant	**Location**	Service Zone	**Elevation**	**Static Pressure (psi*)**	Residual Pressure (psi)	Flow (gpm)	Residual Pressure (psi)	Flow (gpm)
A) 827A-D	NE corner Interchange of I-380 with County Home Rd - Burds Convenience Store	Robins - Boosted	858	102 (61)	69	826	42	1,166
B) 828B-A	Quass Rd & County Home Rd	Robins - Boyson	848	66 (66)	Static Pressure at 1025C-A is 37 psi		37	640
E) 1127D-F	N. Center Point Rd & Chester Rd	Robins - PRV	856	58 (58)	52	1,033	30	2,000
F) 827A-B	N. Center Point Rd & County Home Rd	Robins - Boosted	861	101 (60)	69	826	42	1,166
G) 927A-A	New Covenant Bible Church	Robins - Boosted	865	99 (58)	68	826	42	1,166
H) 927B-A	Kink of Kings Lutheran Church	Robins - PRV	854	65 (63)	64	826	44	1,166
I) 927D-B	N. Center Point Rd & West Main St	Robins - Boosted	909	80 (39)	50	826	24	1,167
J)	N. Center Point Rd & Singer Hill Ln	Robins - PRV	851	60 (60)	55	1,031	33	2,000
M)	County Home Rd & Troy Rd	Robins - Boyson	872	56 (56)	Static Pressure at 1025C-A is 37 psi		27	640
O)	N Mentzer Rd & County Home Rd	Robins - Boyson	874	55 (55)	Static Pressure at 1025C-A is 37 psi		26	644
P) 822A-A	C Ave Ext & County Home Rd	Robins - Boyson	876	54 (54)	Static Pressure at 1025C-A is 37 psi		25	650
R) 1023A-A	N. Mentzer Rd & E. Knoll Dr	Robins - Boyson	850	65 (65)	Static Pressure at 1025C-A is 37 psi		57	2,000
S) 1022B-A	C Ave Ext & E. Knoll Dr	Robins - Boyson	872	56 (56)	Static Pressure at 1025C-A is 37 psi		48	2,000
T)	W. Main St & Quass Rd	Robins - Boyson	834	72 (72)	Static Pressure at 1025C-A is 37 psi		55	2,000
U) 1025C-C	W. Main St & Robins Rd	Robins - Boyson	878	53 (53)	Static Pressure at 1025C-A is 37 psi		41	2,000
V) 1125B-D	W. Main St & Troy Rd	Robins - Boyson	846	67 (67)	Static Pressure at 1025C-A is 37 psi		59	2,000
W) 1124B-A	W Main St & Mentzer Rd	Robins - Boyson	864	59 (59)	Static Pressure at 1025C-A is 37 psi		54	2,000
AA) 1224D-A	Emery Place Assisted Living & Memory Care	Robins - Boyson	869	57 (57)	Static Pressure at 1025C-A is 37 psi		52	2,000
AB)	N. Center Point Rd & Wild Rose Rd	Robins - PRV	824	72 (72)	66	1,032	45	2,000
AD)1126B-A	South end of Stamy Rd	Robins - Boosted	918	76 (35)	46	844	20	1,382

Notes:
(*) The static pressure is shown for both "boosted" flow and "gravity" flow (in parentheses).
The "zone lower limit" only considers pressure in the service zone that the fire hydrant is located in. It does not consdier other service zone pressures.

Table 5: County Home Rd N. Center Point Rd and Tower Terrace Rd Loop (Construction of Segments 1, 3, 7, 9, 10, 11, and 12)-Predicted Hydraulic Parameters at Points of Interest

					45 psi Zone Lower Limt		20 psi Zone Lower Limit	
Flow Hydrant	**Location**	Service Zone	**Elevation**	**Static Pressure (psi*)**	Residual Pressure (psi)	Flow (gpm)	Residual Pressure (psi)	Flow (gpm)
A) 827A-D	NE corner Interchange of I-380 with County Home Rd - Burds Convenience Store	Robins - Boosted	858	102 (61)	69	826	40	1,582
B) 828B-A	Quass Rd & County Home Rd	Robins - Boyson	848	66 (66)	Static Pressure at 1025C-A is 37 psi		37	640
E) 1127D-F	N. Center Point Rd & Chester Rd	Robins - PRV	856	58 (58)	51	1,320	38	2,000
F) 827A-B	N. Center Point Rd & County Home Rd	Robins - Boosted	861	101 (60)	69	826	41	1,581
G) 927A-A	New Covenant Bible Church	Robins - Boosted	865	99 (58)	68	826	41	1,563
H) 927B-A	Kink of Kings Lutheran Church	Robins - PRV	854	65 (63)	64	826	43	1,566
I) 927D-B	N. Center Point Rd & West Main St	Robins - Boosted	909	80 (39)	50	826	24	1,548
J)	N. Center Point Rd & Singer Hill Ln	Robins - PRV	851	60 (60)	54	1,316	42	2,000
M)	County Home Rd & Troy Rd	Robins - Boyson	872	56 (56)	Static Pressure at 1025C-A is 37 psi		27	640
O)	N Mentzer Rd & County Home Rd	Robins - Boyson	874	55 (55)	Static Pressure at 1025C-A is 37 psi		26	644
P) 822A-A	C Ave Ext & County Home Rd	Robins - Boyson	876	54 (54)	Static Pressure at 1025C-A is 37 psi		25	650
R) 1023A-A	N. Mentzer Rd & E. Knoll Dr	Robins - Boyson	850	65 (65)	Static Pressure at 1025C-A is 37 psi		57	2,000
S) 1022B-A	C Ave Ext & E. Knoll Dr	Robins - Boyson	872	56 (56)	Static Pressure at 1025C-A is 37 psi		48	2,000
T)	W. Main St & Quass Rd	Robins - Boyson	834	72 (72)	Static Pressure at 1025C-A is 37 psi		55	2,000
U) 1025C-C	W. Main St & Robins Rd	Robins - Boyson	878	53 (53)	Static Pressure at 1025C-A is 37 psi		41	2,000
V) 1125B-D	W. Main St & Troy Rd	Robins - Boyson	846	67 (67)	Static Pressure at 1025C-A is 37 psi		59	2,000
W) 1124B-A	W Main St & Mentzer Rd	Robins - Boyson	864	59 (59)	Static Pressure at 1025C-A is 37 psi		54	2,000
X)	N. Center Point Rd & Tower Terrace Rd	Robins - PRV	858	57 (57)	50	1,310	35	2,000
Y)	Tower Terrace Rd & Stamy Rd (future)	Robins - PRV	866	53 (53)	45	1,310	29	2,000
Z)	Tower Terrace Rd & Robins Rd	Robins - PRV	836	66 (66)	57	1,310	39	2,000
AA) 1224D-A	Emery Place Assisted Living & Memory Care	Robins - Boyson	869	57 (57)	Static Pressure at 1025C-A is 37 psi		52	2,000
AB)	N. Center Point Rd & Wild Rose Rd	Robins - PRV	824	72 (72)	66	1,320	53	2,000
AD)1126B-A	South end of Stamy Rd	Robins - Boosted	918	76 (35)	46	844	20	1,571

Notes:
(*) The static pressure is shown for both "boosted" flow and "gravity" flow (in parentheses).
The "zone lower limit" only considers pressure in the service zone that the fire hydrant is located in. It does not consdier other service zone pressures.

Table 6: County Home Rd, N. Center Point Rd, Tower Terrace Rd and Robins Rd Loop (Construction of Segments 1, 3, 7, 9, 10, 11, 12, and 16)-Predicted Hydraulic Parameters at Points of Interest

					45 psi Zone Lower Limt		20 psi Zone Lower Limit	
Flow Hydrant	**Location**	Service Zone	**Elevation**	**Static Pressure (psi*)**	Residual Pressure (psi)	Flow (gpm)	Residual Pressure (psi)	Flow (gpm)
A) 827A-D	NE corner Interchange of I-380 with County Home Rd - Burds Convenience Store	Robins - Boosted	858	102 (61)	69	900	40	1,607
B) 828B-A	Quass Rd & County Home Rd	Robins - Boyson	848	66 (66)	Static Pressure at 1025C-A is 37 psi		37	640
E) 1127D-F	N. Center Point Rd & Chester Rd	Robins - PRV	856	62 (62)	51	2,000	51	2,000
F) 827A-B	N. Center Point Rd & County Home Rd	Robins - Boosted	861	101 (60)	69	900	41	1,606
G) 927A-A	New Covenant Bible Church	Robins - Boosted	865	99 (58)	68	900	41	1,587
H) 927B-A	Kink of Kings Lutheran Church	Robins - PRV	854	65 (63)	64	900	43	1,591
I) 927D-B	N. Center Point Rd & West Main St	Robins - Boosted	909	80 (39)	50	900	24	1,571
J)	N. Center Point Rd & Singer Hill Ln	Robins - PRV	851	65 (65)	54	1,875	52	2,000
M)	County Home Rd & Troy Rd	Robins - Boyson	872	56 (56)	Static Pressure at 1025C-A is 37 psi		27	640
O)	N Mentzer Rd & County Home Rd	Robins - Boyson	874	55 (55)	Static Pressure at 1025C-A is 37 psi		26	644
P) 822A-A	C Ave Ext & County Home Rd	Robins - Boyson	876	54 (54)	Static Pressure at 1025C-A is 37 psi		25	650
R) 1023A-A	N. Mentzer Rd & E. Knoll Dr	Robins - Boyson	850	65 (65)	Static Pressure at 1025C-A is 37 psi		57	2,000
S) 1022B-A	C Ave Ext & E. Knoll Dr	Robins - Boyson	872	56 (56)	Static Pressure at 1025C-A is 37 psi		48	2,000
T)	W. Main St & Quass Rd	Robins - Boyson	834	72 (72)	Static Pressure at 1025C-A is 37 psi		52	1,915
U) 1025C-C	W. Main St & Robins Rd	Robins - Boyson	878	53 (53)	Static Pressure at 1025C-A is 37 psi		42	2,000
V) 1125B-D	W. Main St & Troy Rd	Robins - Boyson	846	67 (67)	Static Pressure at 1025C-A is 37 psi		59	2,000
W) 1124B-A	W Main St & Mentzer Rd	Robins - Boyson	864	59 (59)	Static Pressure at 1025C-A is 37 psi		54	2,000
X)	N. Center Point Rd & Tower Terrace Rd	Robins - PRV	858	62 (62)	50	2,000	50	2,000
Y)	Tower Terrace Rd & Stamy Rd (future)	Robins - PRV	866	58 (58)	47	2,000	47	2,000
Z)	Tower Terrace Rd & Robins Rd	Robins - PRV	836	71 (71)	60	2,000	60	2,000
AA) 1224D-A	Emery Place Assisted Living & Memory Care	Robins - Boyson	869	57 (57)	Static Pressure at 1025C-A is 37 psi		52	2,000
AB)	N. Center Point Rd & Wild Rose Rd	Robins - PRV	824	76 (76)	65	1,963	65	2,000
AD)1126B-A	South end of Stamy Rd	Robins - Boosted	918	76 (35)	46	919	20	1,593

Notes:
(*) The static pressure is shown for both "boosted" flow and "gravity" flow (in parentheses).
The "zone lower limit" only considers pressure in the service zone that the fire hydrant is located in. It does not consdier other service zone pressures.

Table 7: N. Mentzer Rd, County Home Rd, N. Center Point Rd, and Tower Terrace Rd Loop (Construction of Segments 1, 3, 7, 9, 10, 11, 12, & 13)-Predicted Hydraulic Parameters at Points of Interest

					45 psi Zone Lower Limt		20 psi Zone Lower Limit	
Flow Hydrant	**Location**	Service Zone	**Elevation**	**Static Pressure (psi*)**	Residual Pressure (psi)	Flow (gpm)	Residual Pressure (psi)	Flow (gpm)
A) 827A-D	NE corner Interchange of I-380 with County Home Rd - Burds Convenience Store	Robins - Boosted	858	102 (61)	69	826	44	2,000
B) 828B-A	Quass Rd & County Home Rd	Robins - Boyson	848	66 (66)	Static Pressure at 1025C-A is 37 psi		38	2,000
E) 1127D-F	N. Center Point Rd & Chester Rd	Robins - PRV	856	58 (58)	51	1,686	44	2,000
F) 827A-B	N. Center Point Rd & County Home Rd	Robins - Boosted	861	101 (60)	69	826	46	2,000
G) 927A-A	New Covenant Bible Church	Robins - Boosted	865	99 (58)	68	826	45	2,000
H) 927B-A	Kink of Kings Lutheran Church	Robins - PRV	854	65 (63)	64	826	45	2,000
I) 927D-B	N. Center Point Rd & West Main St	Robins - Boosted	909	80 (39)	50	826	27	2,000
J)	N. Center Point Rd & Singer Hill Ln	Robins - PRV	851	60 (60)	54	1,700	48	2,000
M)	County Home Rd & Troy Rd	Robins - Boyson	872	56 (56)	Static Pressure at 1025C-A is 37 psi		30	2,000
O)	N Mentzer Rd & County Home Rd	Robins - Boyson	874	55 (55)	Static Pressure at 1025C-A is 37 psi		33	2,000
P) 822A-A	C Ave Ext & County Home Rd	Robins - Boyson	876	54 (54)	Static Pressure at 1025C-A is 37 psi		30	2,000
R) 1023A-A	N. Mentzer Rd & E. Knoll Dr	Robins - Boyson	850	65 (65)	Static Pressure at 1025C-A is 37 psi		57	2,000
S) 1022B-A	C Ave Ext & E. Knoll Dr	Robins - Boyson	872	56 (56)	Static Pressure at 1025C-A is 37 psi		49	2,000
T)	W. Main St & Quass Rd	Robins - Boyson	834	72 (72)	Static Pressure at 1025C-A is 37 psi		55	2,000
U) 1025C-C	W. Main St & Robins Rd	Robins - Boyson	878	53 (53)	Static Pressure at 1025C-A is 37 psi		42	2,000
V) 1125B-D	W. Main St & Troy Rd	Robins - Boyson	846	67 (67)	Static Pressure at 1025C-A is 37 psi		59	2,000
W) 1124B-A	W Main St & Mentzer Rd	Robins - Boyson	864	59 (59)	Static Pressure at 1025C-A is 37 psi		54	2,000
X)	N. Center Point Rd & Tower Terrace Rd	Robins - PRV	858	57 (57)	49	1,633	41	2,000
Y)	Tower Terrace Rd & Stamy Rd (future)	Robins - PRV	866	53 (53)	45	1,624	36	2,000
Z)	Tower Terrace Rd & Robins Rd	Robins - PRV	836	66 (66)	55	1,633	45	2,000
AA) 1224D-A	Emery Place Assisted Living & Memory Care	Robins - Boyson	869	57 (57)	Static Pressure at 1025C-A is 37 psi		52	2,000
AB)	N. Center Point Rd & Wild Rose Rd	Robins - PRV	824	72 (72)	65	1,714	59	2,000
AD)1126B-A	South end of Stamy Rd	Robins - Boosted	918	76 (35)	46	845	20	1,762

Notes:
(*) The static pressure is shown for both "boosted" flow and "gravity" flow (in parentheses).
The "zone lower limit" only considers pressure in the service zone that the fire hydrant is located in. It does not consdier other service zone pressures.

Table 8: N. Mentzer Rd, County Home Rd, N. Center Point Rd, Tower Terrace Rd, and Robins Rd Loop (Construction of Segments 1, 3, 7, 9, 10, 11, 12, 13, and 16)-Predicted Hydraulic Parameters at Points of Interes

					45 psi Zone Lower Limt		20 psi Zone Lower Limit	
Flow Hydrant	Location	Service Zone	Elevation	Static Pressure (psi*)	Residual Pressure (psi)	Flow (gpm)	Residual Pressure (psi)	Flow (gpm)
A) 827A-D	NE corner Interchange of I-380 with County Home Rd - Burds Convenience Store	Robins - Boosted	858	102 (61)	69	900	44	2,000
B) 828B-A	Quass Rd & County Home Rd	Robins - Boyson	848	66 (66)	Static Pressure at 1025C-A is 37 psi		38	2,000
E) 1127D-F	N. Center Point Rd & Chester Rd	Robins - PRV	856	62 (62)	52	2,000	52	2,000
F) 827A-B	N. Center Point Rd & County Home Rd	Robins - Boosted	861	101 (60)	68	900	46	2,000
G) 927A-A	New Covenant Bible Church	Robins - Boosted	865	99 (58)	68	900	45	2,000
H) 927B-A	Kink of Kings Lutheran Church	Robins - PRV	854	65 (63)	64	900	45	2,000
I) 927D-B	N. Center Point Rd & West Main St	Robins - Boosted	909	80 (39)	50	900	28	2,000
J)	N. Center Point Rd & Singer Hill Ln	Robins - PRV	851	65 (65)	55	2,000	55	2,000
M)	County Home Rd & Troy Rd	Robins - Boyson	872	56 (56)	Static Pressure at 1025C-A is 37 psi		30	2,000
O)	N Mentzer Rd & County Home Rd	Robins - Boyson	874	55 (55)	Static Pressure at 1025C-A is 37 psi		33	2,000
P) 822A-A	C Ave Ext & County Home Rd	Robins - Boyson	876	54 (54)	Static Pressure at 1025C-A is 37 psi		30	2,000
R) 1023A-A	N. Mentzer Rd & E. Knoll Dr	Robins - Boyson	850	65 (65)	Static Pressure at 1025C-A is 37 psi		57	2,000
S) 1022B-A	C Ave Ext & E. Knoll Dr	Robins - Boyson	872	56 (56)	Static Pressure at 1025C-A is 37 psi		49	2,000
T)	W. Main St & Quass Rd	Robins - Boyson	834	72 (72)	Static Pressure at 1025C-A is 37 psi		52	1,910
U) 1025C-C	W. Main St & Robins Rd	Robins - Boyson	878	53 (53)	Static Pressure at 1025C-A is 37 psi		42	2,000
V) 1125B-D	W. Main St & Troy Rd	Robins - Boyson	846	67 (67)	Static Pressure at 1025C-A is 37 psi		59	2,000
W) 1124B-A	W Main St & Mentzer Rd	Robins - Boyson	864	59 (59)	Static Pressure at 1025C-A is 37 psi		54	2,000
X)	N. Center Point Rd & Tower Terrace Rd	Robins - PRV	858	62 (62)	51	2,000	51	2,000
Y)	Tower Terrace Rd & Stamy Rd (future)	Robins - PRV	866	58 (58)	48	2,000	48	2,000
Z)	Tower Terrace Rd & Robins Rd	Robins - PRV	836	71 (71)	61	2,000	61	2,000
AA) 1224D-A	Emery Place Assisted Living & Memory Care	Robins - Boyson	869	57 (57)	Static Pressure at 1025C-A is 37 psi		52	2,000
AB)	N. Center Point Rd & Wild Rose Rd	Robins - PRV	824	76 (76)	67	2,000	67	2,000
AD)1126B-A	South end of Stamy Rd	Robins - Boosted	918	76 (35)	46	920	20	1,797

Notes:
(*) The static pressure is shown for both "boosted" flow and "gravity" flow (in parentheses).
The "zone lower limit" only considers pressure in the service zone that the fire hydrant is located in. It does not consdier other service zone pressures.

Table 9: C Ave Ext, County Home Rd N. Center Point Rd, and Tower Terrace Rd Loop (Construction of Segment 1, 3, 7, 9, 10, 11, 12, and 17)-Predicted Hydraulic Parameters at Points of Interest

					45 psi Zone Lower Limt		20 psi Zone Lower Limit	
Flow Hydrant	Location	Service Zone	Elevation	Static Pressure (psi*)	Residual Pressure (psi)	Flow (gpm)	Residual Pressure (psi)	Flow (gpm)
A) 827A-D	NE corner Interchange of I-380 with County Home Rd - Burds Convenience Store	Robins - Boosted	858	102 (61)	69	826	46	2,000
B) 828B-A	Quass Rd & County Home Rd	Robins - Boyson	848	66 (66)	Static Pressure at 1025C-A is 37 psi		43	2,000
E) 1127D-F	N. Center Point Rd & Chester Rd	Robins - PRV	856	58 (58)	50	1,756	46	2,000
F) 827A-B	N. Center Point Rd & County Home Rd	Robins - Boosted	861	101 (60)	69	826	48	2,000
G) 927A-A	New Covenant Bible Church	Robins - Boosted	865	99 (58)	68	826	47	2,000
H) 927B-A	Kink of Kings Lutheran Church	Robins - PRV	854	65 (63)	64	826	47	2,000
I) 927D-B	N. Center Point Rd & West Main St	Robins - Boosted	909	80 (39)	50	826	29	2,000
J)	N. Center Point Rd & Singer Hill Ln	Robins - PRV	851	60 (60)	54	1,780	50	2,000
M)	County Home Rd & Troy Rd	Robins - Boyson	872	56 (56)	Static Pressure at 1025C-A is 37 psi		35	2,000
O)	N Mentzer Rd & County Home Rd	Robins - Boyson	874	55 (55)	Static Pressure at 1025C-A is 37 psi		38	2,000
P) 822A-A	C Ave Ext & County Home Rd	Robins - Boyson	876	54 (54)	Static Pressure at 1025C-A is 37 psi		39	2,000
R) 1023A-A	N. Mentzer Rd & E. Knoll Dr	Robins - Boyson	850	65 (65)	Static Pressure at 1025C-A is 37 psi		57	2,000
S) 1022B-A	C Ave Ext & E. Knoll Dr	Robins - Boyson	872	56 (56)	Static Pressure at 1025C-A is 37 psi		48	2,000
T)	W. Main St & Quass Rd	Robins - Boyson	834	72 (72)	Static Pressure at 1025C-A is 37 psi		55	2,000
U) 1025C-C	W. Main St & Robins Rd	Robins - Boyson	878	53 (53)	Static Pressure at 1025C-A is 37 psi		41	2,000
V) 1125B-D	W. Main St & Troy Rd	Robins - Boyson	846	67 (67)	Static Pressure at 1025C-A is 37 psi		59	2,000
W) 1124B-A	W Main St & Mentzer Rd	Robins - Boyson	864	59 (59)	Static Pressure at 1025C-A is 37 psi		54	2,000
X)	N. Center Point Rd & Tower Terrace Rd	Robins - PRV	858	57 (57)	49	1,696	42	2,000
Y)	Tower Terrace Rd & Stamy Rd (future)	Robins - PRV	866	53 (53)	44	1,696	37	2,000
Z)	Tower Terrace Rd & Robins Rd	Robins - PRV	836	66 (66)	55	1,696	47	2,000
AA) 1224D-A	Emery Place Assisted Living & Memory Care	Robins - Boyson	869	57 (57)	Static Pressure at 1025C-A is 37 psi		52	2,000
AB)	N. Center Point Rd & Wild Rose Rd	Robins - PRV	824	72 (72)	65	1,796	61	2,000
AD)1126B-A	South end of Stamy Rd	Robins - Boosted	918	76 (35)	46	844	20	1,818

Notes:
(*) The static pressure is shown for both "boosted" flow and "gravity" flow (in parentheses).
The "zone lower limit" only considers pressure in the service zone that the fire hydrant is located in. It does not consdier other service zone pressures.

Table 10: Full System Improvements Loop (Construction of Segments 1, 3, 7, 9, 10, 11, 12, 13, 16, and 17)-Predicted Hydraulic Parameters at Points of Interest

					45 psi Zone Lower Limt		20 psi Zone Lower Limit	
Flow Hydrant	**Location**	Service Zone	**Elevation**	**Static Pressure (psi*)**	Residual Pressure (psi)	Flow (gpm)	Residual Pressure (psi)	Flow (gpm)
A) 827A-D	NE corner Interchange of I-380 with County Home Rd - Burds Convenience Store	Robins - Boosted	858	102 (61)	69	901	47	2,000
B) 828B-A	Quass Rd & County Home Rd	Robins - Boyson	848	66 (66)	Static Pressure at 1025C-A is 37 psi		50	2,000
E) 1127D-F	N. Center Point Rd & Chester Rd	Robins - PRV	856	62 (62)	53	2,000	53	2,000
F) 827A-B	N. Center Point Rd & County Home Rd	Robins - Boosted	861	101 (60)	69	900	49	2,000
G) 927A-A	New Covenant Bible Church	Robins - Boosted	865	99 (58)	68	901	47	2,000
H) 927B-A	Kink of Kings Lutheran Church	Robins - PRV	854	65 (63)	64	900	48	2,000
I) 927D-B	N. Center Point Rd & West Main St	Robins - Boosted	909	80 (39)	50	901	30	2,000
J)	N. Center Point Rd & Singer Hill Ln	Robins - PRV	851	65 (65)	55	2,000	55	2,000
M)	County Home Rd & Troy Rd	Robins - Boyson	872	56 (56)	Static Pressure at 1025C-A is 37 psi		43	2,000
O)	N Mentzer Rd & County Home Rd	Robins - Boyson	874	55 (55)	Static Pressure at 1025C-A is 37 psi		46	2,000
P) 822A-A	C Ave Ext & County Home Rd	Robins - Boyson	876	54 (54)	Static Pressure at 1025C-A is 37 psi		45	2,000
R) 1023A-A	N. Mentzer Rd & E. Knoll Dr	Robins - Boyson	850	65 (65)	Static Pressure at 1025C-A is 37 psi		58	2,000
S) 1022B-A	C Ave Ext & E. Knoll Dr	Robins - Boyson	872	56 (56)	Static Pressure at 1025C-A is 37 psi		50	2,000
T)	W. Main St & Quass Rd	Robins - Boyson	834	72 (72)	Static Pressure at 1025C-A is 37 psi		52	1,927
U) 1025C-C	W. Main St & Robins Rd	Robins - Boyson	878	53 (53)	Static Pressure at 1025C-A is 37 psi		42	2,000
V) 1125B-D	W. Main St & Troy Rd	Robins - Boyson	846	67 (67)	Static Pressure at 1025C-A is 37 psi		59	2,000
W) 1124B-A	W Main St & Mentzer Rd	Robins - Boyson	864	59 (59)	Static Pressure at 1025C-A is 37 psi		54	2,000
X)	N. Center Point Rd & Tower Terrace Rd	Robins - PRV	858	62 (62)	52	2,000	52	2,000
Y)	Tower Terrace Rd & Stamy Rd (future)	Robins - PRV	866	58 (58)	48	2,000	48	2,000
Z)	Tower Terrace Rd & Robins Rd	Robins - PRV	836	71 (71)	61	2,000	61	2,000
AA) 1224D-A	Emery Place Assisted Living & Memory Care	Robins - Boyson	869	57 (57)	Static Pressure at 1025C-A is 37 psi		52	2,000
AB)	N. Center Point Rd & Wild Rose Rd	Robins - PRV	824	76 (76)	67	2,000	67	2,000
AD)1126B-A	South end of Stamy Rd	Robins - Boosted	918	76 (35)	46	920	20	1,885

Notes:
(*) The static pressure is shown for both "boosted" flow and "gravity" flow (in parentheses).
The "zone lower limit" only considers pressure in the service zone that the fire hydrant is located in. It does not consdier other service zone pressures.

Table 11: Water Infrastructure Full Build Out (Construction of all Segments)-Predicted Hydraulic Parameters at Points of Interest

					45 psi Zone Lower Limit		20 psi Zone Lower Limit	
Flow Hydrant	**Location**	Service Zone	**Elevation**	**Static Pressure (psi*)**	Residual Pressure (psi)	Flow (gpm)	Residual Pressure (psi)	Flow (gpm)
A) 827A-D	NE corner Interchange of I-380 with County Home Rd - Burds Convenience Store	Robins - Boyson	858		Static Pressure at 1025C-A is 37 psi			
B) 828B-A	Quass Rd & County Home Rd	Robins - Boyson	848		Static Pressure at 1025C-A is 37 psi			
C) 628B-A	Quass Rd (future) & Midway Rd	Robins - Boyson	854		Static Pressure at 1025C-A is 37 psi			
D) 627A-A	N. Center Point Rd & Midway Rd	Robins - Boyson	836		Static Pressure at 1025C-A is 37 psi			
E) 1127D-F	N. Center Point Rd & Chester Rd	Robins - PRV	856					
F) 827A-B	N. Center Point Rd & County Home Rd	Robins - Boyson	861		Static Pressure at 1025C-A is 37 psi			
G) 927A-A	New Covenant Bible Church	Robins - Boyson	865		Static Pressure at 1025C-A is 37 psi			
H) 927B-A	Kink of Kings Lutheran Church	Robins - Boyson	854		Static Pressure at 1025C-A is 37 psi			
I) 927D-B	N. Center Point Rd & West Main St	Robins - Boosted	909					
J)	N. Center Point Rd & Singer Hill Ln	Robins - PRV	851					
K)	West end of Singer Hill Ln	Robins - PRV	884					
L)	Quass Rd & Kings Way (future)	Robins - Boyson	864		Static Pressure at 1025C-A is 37 psi			
M)	County Home Rd & Troy Rd	Robins - Boyson	872		Static Pressure at 1025C-A is 37 psi			
N)	Troy Rd (future) & Midway Rd	Robins - Boyson	850		Static Pressure at 1025C-A is 37 psi			
O)	N Mentzer Rd & County Home Rd	Robins - Boyson	874		Static Pressure at 1025C-A is 37 psi			
P) 822A-A	C Ave Ext & County Home Rd	Robins - Boyson	876		Static Pressure at 1025C-A is 37 psi			
Q)	C Ave Ext & Midway Rd	Robins - Boyson	892		Static Pressure at 1025C-A is 37 psi			
R) 1023A-A	N. Mentzer Rd & E. Knoll Dr	Robins - Boyson	850		Static Pressure at 1025C-A is 37 psi			
S) 1022B-A	C Ave Ext & E. Knoll Dr	Robins - Boyson	872		Static Pressure at 1025C-A is 37 psi			
T)	W. Main St & Quass Rd	Robins - Boyson	834		Static Pressure at 1025C-A is 37 psi			
U) 1025C-C	W. Main St & Robins Rd	Robins - Boyson	878		Static Pressure at 1025C-A is 37 psi			
V) 1125B-D	W. Main St & Troy Rd	Robins - Boyson	846		Static Pressure at 1025C-A is 37 psi			
W) 1124B-A	W Main St & Mentzer Rd	Robins - Boyson	864		Static Pressure at 1025C-A is 37 psi			
X)	N. Center Point Rd & Tower Terrace Rd	Robins - PRV	858					
Y)	Tower Terrace Rd & Stamy Rd (future)	Robins - PRV	866					
Z)	Tower Terrace Rd & Robins Rd	Robins - PRV	836					
AA) 1224D-A	Emery Place Assisted Living & Memory Care	Robins - Boyson	869		Static Pressure at 1025C-A is 37 psi			
AB)	N. Center Point Rd & Wild Rose Rd	Robins - PRV	824					
AC)	MacKenzie Dr & Morgan Ct	Robins - Boosted	900					
AD)1126B-A	South end of Stamy Rd	Robins - Boosted	918					

Notes:
(*) The static pressure is shown for both "boosted" flow and "gravity" flow (in parentheses).
The "zone lower limit" only considers pressure in the service zone that the fire hydrant is located in. It does not consdier other service zone pressures.
Converted area north of West Main St to Robins - Boyson service zone.

Table 12: Additional Scenario A (Construction of Segments 2, 4, & 6)-Predicted Hydraulic Parameters at Points of Interest

					45 psi Zone Lower Limt		20 psi Zone Lower Limit	
Flow Hydrant	**Location**	Service Zone	**Elevation**	**Static Pressure (psi*)**	Residual Pressure (psi)	Flow (gpm)	Residual Pressure (psi)	Flow (gpm)
A) 827A-D	NE corner Interchange of I-380 with County Home Rd - Burds Convenience Store	Robins - Boyson	858	61 (61)	Static Pressure at 1025C-A is 37 psi		23	1,602
D) 627A-A	N. Center Point Rd & Midway Rd	Robins - Boyson	836	71 (71)	Static Pressure at 1025C-A is 37 psi		24	1,602
E) 1127D-F	N. Center Point Rd & Chester Rd	Robins - PRV	856	58 (58)	49	1,069	22	1,506
F) 827A-B	N. Center Point Rd & County Home Rd	Robins - Boyson	861	60 (60)	Static Pressure at 1025C-A is 37 psi		24	1,602
G) 927A-A	New Covenant Bible Church	Robins - Boyson	865	58 (58)	Static Pressure at 1025C-A is 37 psi		25	1,593
H) 927B-A	Kink of Kings Lutheran Church	Robins - Boyson	854	63 (63)	Static Pressure at 1025C-A is 37 psi		30	1,611
I) 927D-B	N. Center Point Rd & West Main St	Robins - Boosted	909	81 (39)	50	943	24	1,233
L)	Quass Rd & Kings Way (future)	Robins - Boyson	864	59 (59)	Static Pressure at 1025C-A is 37 psi		29	2,000
P) 822A-A	C Ave Ext & County Home Rd	Robins - Boyson	876	54 (54)	Static Pressure at 1025C-A is 37 psi		20	720
R) 1023A-A	N. Mentzer Rd & E. Knoll Dr	Robins - Boyson	850	65 (65)	Static Pressure at 1025C-A is 37 psi		57	2,000
S) 1022B-A	C Ave Ext & E. Knoll Dr	Robins - Boyson	872	56 (56)	Static Pressure at 1025C-A is 37 psi		48	2,000
T)	W. Main St & Quass Rd	Robins - Boyson	834	72 (72)	Static Pressure at 1025C-A is 37 psi		55	2,000
U) 1025C-C	W. Main St & Robins Rd	Robins - Boyson	878	53 (53)	Static Pressure at 1025C-A is 37 psi		41	2,000
V) 1125B-D	W. Main St & Troy Rd	Robins - Boyson	846	67 (67)	Static Pressure at 1025C-A is 37 psi		59	2,000
W) 1124B-A	W Main St & Mentzer Rd	Robins - Boyson	864	59 (59)	Static Pressure at 1025C-A is 37 psi		54	2,000
AA) 1224D-A	Emery Place Assisted Living & Memory Care	Robins - Boyson	869	57 (57)	Static Pressure at 1025C-A is 37 psi		52	2,000
AB)	N. Center Point Rd & Wild Rose Rd	Robins - PRV	824	72 (72)	64	1,069	37	1,505
AD)1126B-A	South end of Stamy Rd	Robins - Boosted	918	77 (35)	46	955	20	1,379

Notes:
(*) The static pressure is shown for both "boosted" flow and "gravity" flow (in parentheses).
The "zone lower limit" only considers pressure in the service zone that the fire hydrant is located in. It does not consdier other service zone pressures.
Converted area north of West Main St to Robins - Boyson service zone.

Table 13: Additional Scenario B (Construction of Segments 2, 6, 7, & 8)-Predicted Hydraulic Parameters at Points of Interest

					45 psi Zone Lower Limt		20 psi Zone Lower Limit	
Flow Hydrant	**Location**	Service Zone	**Elevation**	**Static Pressure (psi*)**	Residual Pressure (psi)	Flow (gpm)	Residual Pressure (psi)	Flow (gpm)
A) 827A-D	NE corner Interchange of I-380 with County Home Rd - Burds Convenience Store	Robins - Boyson	858	61 (61)	Static Pressure at 1025C-A is 37 psi		25	1,625
B) 828B-A	Quass Rd & County Home Rd	Robins - Boyson	848	66 (66)	Static Pressure at 1025C-A is 37 psi		33	1,727
D) 627A-A	N. Center Point Rd & Midway Rd	Robins - Boyson	836	71 (71)	Static Pressure at 1025C-A is 37 psi		26	1,625
E) 1127D-F	N. Center Point Rd & Chester Rd	Robins - PRV	856	58 (58)	49	1,069	22	1,506
F) 827A-B	N. Center Point Rd & County Home Rd	Robins - Boyson	861	60 (60)	Static Pressure at 1025C-A is 37 psi		26	1,620
G) 927A-A	New Covenant Bible Church	Robins - Boyson	865	58 (58)	Static Pressure at 1025C-A is 37 psi		25	1,564
H) 927B-A	Kink of Kings Lutheran Church	Robins - Boyson	854	63 (63)	Static Pressure at 1025C-A is 37 psi		30	1,573
I) 927D-B	N. Center Point Rd & West Main St	Robins - Boosted	909	81 (39)	50	943	24	1,233
L)	Quass Rd & Kings Way (future)	Robins - Boyson	864	59 (59)	Static Pressure at 1025C-A is 37 psi		29	2,000
P) 822A-A	C Ave Ext & County Home Rd	Robins - Boyson	876	54 (54)	Static Pressure at 1025C-A is 37 psi		20	720
R) 1023A-A	N. Mentzer Rd & E. Knoll Dr	Robins - Boyson	850	65 (65)	Static Pressure at 1025C-A is 37 psi		57	2,000
S) 1022B-A	C Ave Ext & E. Knoll Dr	Robins - Boyson	872	56 (56)	Static Pressure at 1025C-A is 37 psi		48	2,000
T)	W. Main St & Quass Rd	Robins - Boyson	834	72 (72)	Static Pressure at 1025C-A is 37 psi		55	2,000
U) 1025C-C	W. Main St & Robins Rd	Robins - Boyson	878	53 (53)	Static Pressure at 1025C-A is 37 psi		41	2,000
V) 1125B-D	W. Main St & Troy Rd	Robins - Boyson	846	67 (67)	Static Pressure at 1025C-A is 37 psi		59	2,000
W) 1124B-A	W Main St & Mentzer Rd	Robins - Boyson	864	59 (59)	Static Pressure at 1025C-A is 37 psi		54	2,000
AA) 1224D-A	Emery Place Assisted Living & Memory Care	Robins - Boyson	869	57 (57)	Static Pressure at 1025C-A is 37 psi		52	2,000
AB)	N. Center Point Rd & Wild Rose Rd	Robins - PRV	824	72 (72)	64	1,069	37	1,505
AD)1126B-A	South end of Stamy Rd	Robins - Boosted	918	77 (35)	46	955	20	1,380

Notes:

(*) The static pressure is shown for both "boosted" flow and "gravity" flow (in parentheses).

The "zone lower limit" only considers pressure in the service zone that the fire hydrant is located in. It does not consdier other service zone pressures.

Converted area north of West Main St to Robins - Boyson service zone.

EXHIBIT 33
WATER DISTRIBUTION SYSTEM

2013 WEST SIDE WATER DISTRIBUTION SYSTEM EVALUATION

WEST SIDE WATER DISTRIBUTION SYSTEM EVALUATION

Robins

Community Family Friends

JULY 2013

SNYDER & ASSOCIATES
Engineers and Planners

WEST SIDE WATER DISTRIBUTION SYSTEM EVALUATION

Robins

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JULY 2013

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CITY OF ROBINS
WEST SIDE WATER DISTRIBUTION SYSTEM EVALUATION

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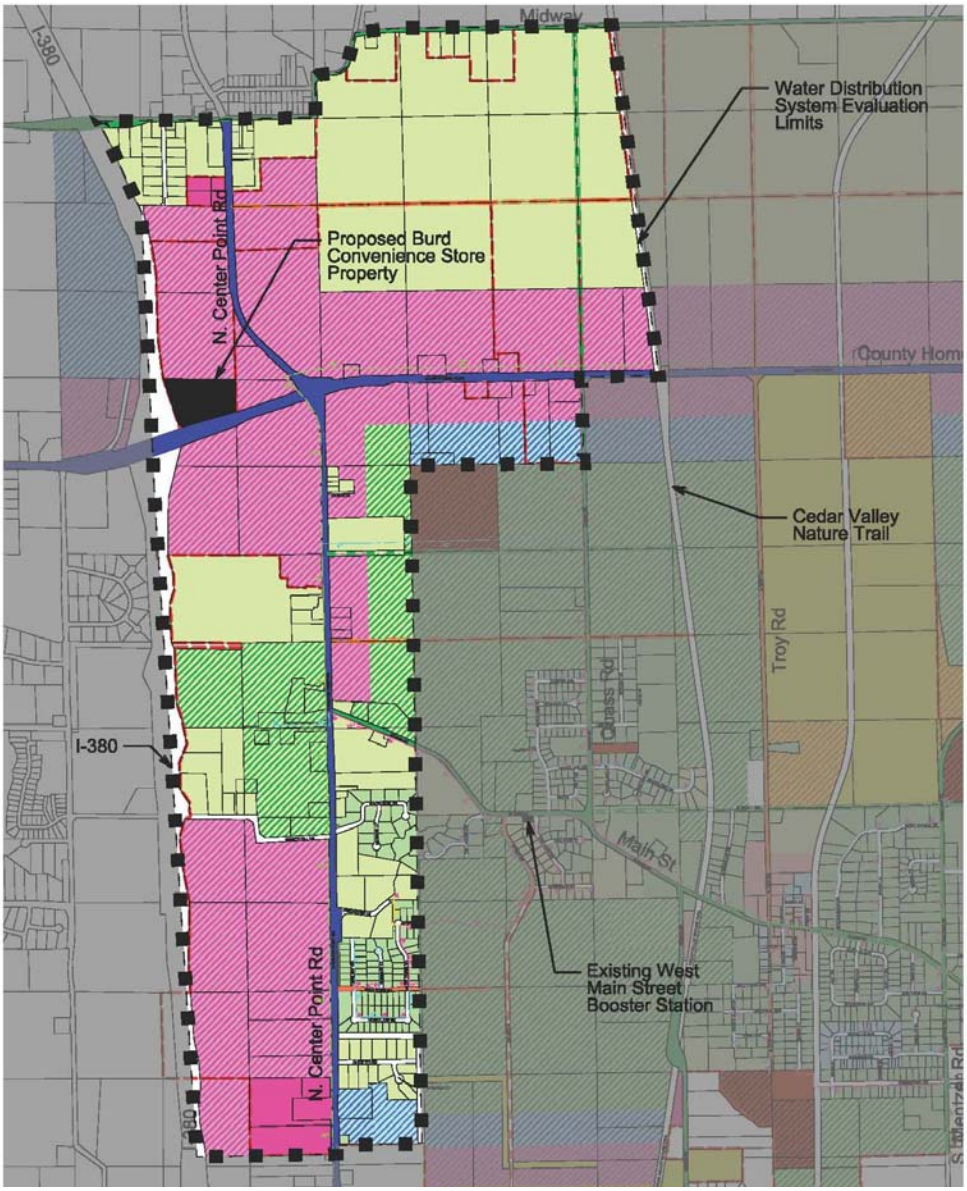
I. INTRODUCTION

The City of Robins has directed Snyder & Associates, Inc. to perform a West Side Water Distribution System Evaluation with limits as shown in Exhibit 1 below. The need for an evaluation was prompted by proposed construction of the Burd Convenience Store, slated to start this year, and the desire to ensure adequate water service for daily demands and fire flows for future growth in the developing areas within the west side of Robins.

The City will be able to use this report as a planning tool to determine what improvements are needed in order to meet public water supply safety and consumer demands, and how to sequence the improvements. In addition, the City will be able to use this information to inform potential developers of the availability of water and the respective fire flows and pressures.

Exhibit 1: Robins West Side Water Distribution System Evaluation Area



II. BACKGROUND

Robins' water system is connected to the City of Cedar Rapids distribution system via three 16" mains located along South Mentzer Road, East Main Street and East Knoll Drive. Each of these connections are served by the Boyson Road water tower.

In 2003, the Main Street Booster Station was constructed to provide adequate system pressures to the "Robins Alps." This area includes the development along Stamy Road, the Irish Hills Subdivision, the Oaks Subdivision and a large area of undeveloped land.

At this time the entire distribution system west of Troy Road, including the "Robins Alps", is served by a singe 16" main that is reduced to a 12" main at Robins Road. Once the currently planned Price Development is completed, an 8" main will be in place from Robinwood Drive to Woodland Drive which will allow the City to provide a second connection to the area west of Troy Road. This 8" main will only provide minimal water service west of Troy Road in the event that the Main Street line was to break west of Robinwood Drive.

With the existing infrastructure, the area within this study is strictly served by one connection which flows through the Main Street Booster Station. Much of this area is well below the elevation that requires a boosted pressure, such as Wildflower Estates, the New Covenant Church and King of King's Church. In the case of Wildflower, a pressure reducing valve was installed in order to reduce the pressures from 80 psi to 55 psi.

III. USAGE

Robins and the City of Cedar Rapids have a 28E agreement that was implemented in 1998 and expires in 2024. According to the agreement, Cedar Rapids has limited Robins to a "total daily metered capacity on a 30 day average to be 1,050 gallons per incorporated acre per day and a total peak day metered capacity to be 2,000 gallons per incorporated acre per day." Robins' incorporated area is currently 3,662 acres, of that approximately 1,400 acres are developed.

Table 1: Existing Water Usage vs. Limitations

	Area (Acres)	**Average Daily Usage (Gallons)**	**Peak Daily Usage (Gallons)**
Robins 2012	1,400 (Developed)	259,000 (metered)	N/A
28E Limits	3,662 (Incorporated)	3,845,100*	7,324,000*

*As limited by the 1998 "Water Service Contract between the City of Robins and the City of Cedar Rapids"

IV. SYSTEM GOALS

Currently no information has been compiled by the City to provide to developers regarding the existing fire flows and pressures they could expect if they were to build within the study area. This is partially because the infrastructure has not yet been developed, but also due to the fact the City has grown so quickly that a lot of improvements have been completed on an as needed basis. The goal of this evaluation is to provide the estimated fire flows available given the current infrastructure, how proposed improvements could change these values and what order improvements should be implemented within the study area.

Provided below is a summary of preliminary sizing and locations for infrastructure improvements to be used for planning and development within the west side of Robins. Since there isn't much existing development, nor a good handle on potential industries that may come to Robins, this information is subject to change as more detailed information becomes available.

V. SYSTEM OPTIONS

Snyder & Associates worked with the City of Cedar Rapids to evaluate many water distribution scenarios within Robins' study area. The "West Side Water Distribution System Evaluation for the City of Robins" prepared by Bruce Jacobs, P.E, and James Greene, P.E. is included within Appendix A of this report. The fire flows and pressures that were evaluated within the City of Cedar Rapids modeling report include the following locations:

- Proposed Burd Convenience Store.
- Intersection of County Home Road and Quass Road.
- Intersection of Midway Road and Quass Road.
- Intersection of North Center Point Road and Midway Road.
- Intersection of Chester Road and North Center Point Road.
- New Covenant Bible Church
- King of King's Lutheran Church
- Intersection of North Center Point and West Main St.

As noted above, the attached Cedar Rapids study modeled water distribution capabilities throughout the entire west side evaluation area, however the following only summarizes the fire flows at the intersection of North Center Point Road and County Home Road. Exhibit B1, within Appendix B, shows each of the improvements graphically. The sequence of the construction would generally follow the segment numbering with the exception of Segment 2 & 3 which will likely occur simultaneously.

Segment 1: North Center Point Road and County Home Road – King's Way to Burd Convenience Store

This scenario includes a 16" water main extension along North Center Point Road to County Home Road and a 12" main west along County Home Road to the proposed location of the Burd Convenience store. This improvement would be constructed strictly to provide water service to the County Home Road and North Center Point Road area.

Segment 2 & 3: Quass Road and King's Way – Juniper Avenue to North Center Point Road

This scenario includes a 12" water main extension along Quass Road and a 12" water main on King's Way to be connected to the 16" North Center Point Road water main creating a looped system. This would provide a connection to North Center Point Road that could bypass the West Main Street Booster Station. With a series of valves, the City would be able

to isolate the "Robins Alps" and achieve larger fire flows to the evaluated locations, as the higher elevations will no longer limit the residual pressure and flows. Valving could also allow a back feed to "Robins Alps" as a method to increase fire flows to that area.

Segment 4: Tower Terrace Road and North Center Point Road – Main Street to Council Street

The Tower Terrace Road connection would not only provide a second connection to the West half of Robins from the City of Cedar Rapids distribution system, but would also allow Robins to isolate the high pressure zone, by way of valving, eliminating the need to pump water to the study area. Again, larger fire flows to the evaluated locations could be achieved, as the higher elevations will no longer restrict the residual pressure and flows, and valving could allow a back feed to "Robins Alps," through Wildflower Estates, that could increase fire flows to that area. Due to the length and expense associated with this segment, it is expected that it will be developed as several projects over a number of fiscal years.

Segment 5: Quass Road – King's Way to County Home Road

This scenario includes a 12" water main extension along Quass Road from King's Way to County Home Road. This scenario would be constructed to expand the service area.

Segment 6: County Home Road – North Center Point Road to Quass Road

This scenario includes a 16" water main extension along County Home Road from North Center Point Road to Quass Road. This scenario would be provided to expand the service area and create an additional distribution system connection for redundancy.

Segment 7: North Center Point Road – County Home Road to Midway Road

This scenario includes a 12" water main extension along North Center Point Road from County Home Road to Midway Road. This scenario would be constructed to expand the service area to Midway.

Segment 8: Quass Road – County Home Road to Midway Road

This scenario includes a 12" water main extension along Quass Road from County Home Road to Midway Road. This scenario would expand the service area to Midway.

Segment 9: County Home Road and Troy Road – Quass Road to Main Street

This scenario includes a 16" water main extension along County Home Road east to Troy Road and south to Main Street. This scenario would expand the service area as well as provide an additional redundant connection.

Robins Water Tower

Constructing a water tower in Robins would nearly eliminate the residual pressure restrictions within "Robins Alps" occurring during fire flow events. This is because the water would already be available during fire events and would not have to be transported through miles of water main prior to its destination. The water tower would need to be

located within the "Robins Alps" and likely near the West Main Street and North Center Point Road intersection. For modeling purposes a 500,000 gallon tank was used. Water stagnancy would be a concern due to the minimal amount of development that would be served by the tower in the near term, but would be less of an issue once a loop to the east side of Robins is constructed. When the connection to Tower Terrace Road is completed, the water tower would no longer be required to provide fire flows within the 2,000 to 2,500 gallon per minute range.

Booster Station Modifications

The West Main Street Booster Station was designed and constructed with space for two additional pumps. The pumps were intended to be approximately the same size as the current pumps at 300 gallons per minute each. A designated space for a fire pump was not included due to the understanding that a second connection to the City of Cedar Rapids, likely Tower Terrace Road, was to be constructed by Cedar Rapids. Some reconfiguring of the piping could be done to install a fire pump in the booster station. The fire pump would be designed to reduce the limiting effects the high pressure zone has on the available fire flows. The 12" water main coming in to the Booster Station would then be the limiting factor for flow with this scenario. When the connection to Tower Terrace Road is completed, the fire pump would no longer be necessary as Wildflower Estates, the New Covenant Church and King of King's Church, would ultimately be served by other improvements.

VI. FIRE FLOWS

The following table summarizes the fire flows available at the County Home Road and North Center Point Road intersection and how additions to the distribution system affect them. A fire flow of 2,000 to 2,500 gallons per minute would be sufficient to serve most facilities in Robins, both currently and in the future.

Table 2: Fire Flow Summary at the Intersection of County Home Road and North Center Point Road

Improvement	Main Size (Inches)	Flow* (Gallons per Minute)
Segment 1	16	1300
Segments 1, 2 & 3	16, 12, 12	1600 (1700**)
Segments 1 & 4	16, 16	2600
Segments 1, 2, 3, 4, 5 & 6	16, 12, 12, 16, 12, 16	2600 (3600**)
Segments 1, 2, 5, 6 & 8	16, 12, 12, 16, 12	1150*** (1400**)
Segments 1, 2, 5, 6, 8 & 9	16, 12, 12, 16, 12, 16	2450
Segment 1 & Fire Pump	16	1850
Segments 1 & 4 & Tower	16	4500
Segments 1, 2, 3, 4, 5, & 6 & Tower	16	4500

*Flows shown indicate the minimum available assuming an improvement size of 12".
**Flows in parentheses represent a network consisting of all 16" mains.
***Flow for this improvement is less than Segment 1 alone due to distribution system valving and this area no longer being served by the Booster Station.

VII. COST SUMMARY AND FINANCING

A. COST SUMMARY

Table 3 contains a summary of the estimated costs associated with the Robins west side water distribution system improvements. These estimates represent approximate project costs, and include engineering and construction costs. These estimates should be used for planning only. All costs shown represent year 2013 construction estimates and should be inflated to the anticipated year of construction for budgeting purposes.

Table 3: Cost Summary of Improvements

Improvement	Main Size Inches	Cost*	Cumulative Improvement Costs
Segment 1	16	$310,000	$310,000
Segment 2	12	$260,000	$570,000
Segment 3	12	$500,000	$1,070,000
Segment 4**	16	$2,825,000	$3,895,000
Segment 5	12	$357,000	$4,252,000
Segment 6	16	$734,000	$4,986,000
Segment 7	12	$743,000	$5,729,000
Segment 8	12	$866,000	$6,595,000
Segment 9	16	$2,080,000	$8,675,000
500,000 Gallon Tower	-	$1,500,000 + land acquisition	$10,175,000
Booster Station Modifications	-	$65,000	$10,240,000

*Estimated costs are based on 2013 values and include Design and Construction Engineering fees

**Segment 4 could be constructed as early as 2018 in conjunction with the Tower Terrace Road construction. Segments 1, 2 & 3 would be constructed prior to Segment 4.

B. FINANCING

The following is a brief overview of potential funding sources for capital improvements. The City may consider adding a surcharge to the water rates to facilitate the construction of the distribution system improvements in lieu of relying on G.O. Bonds and TIF revenue as has been done in the past. This would allow the City to separate water costs from other improvement projects as well as facilitate budget projections.

1. Revenue Bonds

Revenue Bonds may be issued in anticipation of income generated from water service charges in accordance with rates established by ordinance. Revenue bonds are entirely self-liquidating with debt service payable from system revenues. Revenue bonds incur no general tax liability or obligation. Revenues must be sufficient to pay the cost of operation and maintenance plus debt service. The financial soundness of the utility is the governing factor in determining marketability of revenue bonds.

To make water revenue bonds marketable, the net operating revenue after deduction of operating expenses should be a minimum of 130% of the annual principal and interest payment. In addition, it is generally necessary under current market conditions to capitalize a reserve fund with an amount equal to the largest single year's principal and interest payment. This capitalized reserve fund is security to the bondholders in the event of a potential default. The surplus that accrues from the coverage for revenue bonds can be used for capital improvements. Revenue bonds can be issued without voter approval. Revenue bonds may be issued for any reasonable period. In today's market, revenue bonds are generally most marketable with a period of between 10 and 20 years.

2. State Revolving Funds

State Revolving Funds (SRF) have been developed and implemented by the Iowa Department of Natural Resources (IDNR) to assist municipalities with financing publicly owned drinking water and wastewater infrastructure projects. The SRF program features low interest loans made from a fund comprised of a federal grant to the state and state matching funds obtained by a state bond sale. The loan interest rate that municipalities pay is approximately two percentage points or more below the interest rate of the state's bonds, which also enjoy a double tax exemption. The state bond rate is based on the project pool for each year and, therefore, could vary from year to year.

Beside the attractive interest rates, these loans need not tie up general obligation bonding capacity. The loan is similar to revenue bonding in that user charge revenues are generally used to secure the loan. Eligibility is determined by a State Priority List based on human health risk, infrastructure and engineering, affordability, and other criteria.

3. General Obligation (G.O.) Bonds

G.O. Bonds may be issued for this type of improvement. G.O. Bonds are repaid from tax levies against properties in the City. It is becoming more popular to retire G.O. Bonds with Utility revenues. G.O. Bonds do not require coverage or excess revenues to be accrued, as the bonds are serviced by the taxable value of the governmental unit.

4. Other Financing Methods

Tax Incremental Financing (TIF) is a financing method that may be used by cities to finance certain types of development costs. Tax incremental financing enables a city to use the additional property taxes generated by new development to finance certain development expenses such as land acquisition and construction of public infrastructure.

A tax increment finance district may be created by City ordinance and the incremental taxes from such a district may be allocated to a special fund for the payment of principal and interest on bonds or for loans or other indebtedness for public infrastructure. TIF financing will not be evaluated in detail, but should be kept in mind as a method for financing any portion of the total capital investment.

VIII. SYSTEM RECOMMENDATIONS

Snyder & Associates recommends proceeding with each improvement as funds become available and as development progresses. Segment 1 is set to begin construction summer of 2013. The next proposed improvements would be Segments 2, 3 & 4 which can be constructed any time and would create a looped distribution system that would allow separation of the Booster Station service area from the Boyson Tower tank zone. Construction of Segment 4 would likely proceed in conjunction with the Tower Terrace Road project which could happen as soon as 2018. Segments 5, 6, 7, 8 & 9 can progress as finances allow and as the needs develop.

The installation of a fire pump is not recommended at this time as it would be minimally beneficial and the benefit would diminish as the distribution system improvements are made.

Construction of a Robins water tower is not recommended at this time. The high cost of the improvement versus the amount of water distribution system that could be constructed for the same price is the main reason. The other is water stagnancy will be an issue in the near term and possibly the long term if development is slow to take off. Significantly more flow can be achieved with the installation of a tower (4,500 gpm), but it may be deemed excessive if the desired fire flow remains in the 2,000 to 2,500 gallon per minute range, which will be sufficient for a majority of users and can be achieved through the development of the distribution system.

APPENDIX A

Technical Report

West Side
Water Distribution System Evaluation
for the
City of Robins

June 3, 2013

Utilities Department – Water Division
Cedar Rapids, Iowa

Prepared by:

Bruce Jacobs, P.E.
Utilities Engineering Manager

James Greene, P.E.
Water Utility Engineer

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Acknowledgements:

The authors gratefully acknowledge the contributions of Ken Russell, P.E., Water System Engineering Design Manager, and Haley Roe, Utilities GIS Tech, to the preparation of this report. We also acknowledge and appreciate the opportunity to assist the City of Robins and their engineer, Snyder Associates, Inc., with their planning efforts with respect to the Robins water supply.

1.0 Introduction

Water distribution modeling was performed to analyze system capacities in the Robins area along North Center Point Rd (Robins) between West Main St and County Home Rd. This is associated with a near term Robins plan to extend either a 12-inch or 16-inch water main along North Center Point Rd from the current terminus (near King of Kings Church-Kings Way) to the intersection with County Home Rd.

Additional modeling was performed to consider the location and sizing of future water main improvements for the west side of Robins for the area including lands adjacent to North Center Point Rd, I-380, West Main St and Midway Dr. The general area for the modeling is shown in Figure 1.

1.1 Background

Under typical domestic (non-fire flow) demand conditions, the area studied is supplied from the Robins Booster Station located at the intersection of Stamy Dr and West Main St. The booster station has two identical pumps each designed to supply 300 gpm at 105 feet of head. The pumps draw suction from the Boyson Rd Tank zone. Currently, only one pump is in operation at a time with the second pump serving as a backup.

On a branch downstream of the pumps, there is a pressure relief valve (PRV) that regulates the discharge pressure from the station. The current discharge pressure setting for the PRV is approximately 80 psi. Within the area served by the Booster Station, there is a lower lying area (Wildflower Estates) for which the line pressure is further reduced through another pressure reducing valve. The current setting for this additional PRV is 55 psi.

The setting of the pressure relief valve in the booster station forces an operating point that is similar to the pump's design point. The difference between the flow supplied by the pump and the flow demanded within the boosted district is directed through the recirculation line and fed back into the 12-inch supply line to the station.

There is a check valve on the suction line within the station. Under fire flow or other high demand conditions when there is a sufficient pressure drop within the boosted zone, the check valve opens to allow additional flow through the station that bypasses the pumps. For the purposes of this study, the terms "boosted flow" will be used to describe the condition wherein the pumps alone are setting the station discharge pressure (domestic water demand) and "gravity flow" will be used to describe the condition wherein the check valve is open and the by-pass line is influencing the station discharge pressure (e.g., a fire hydrant demand).

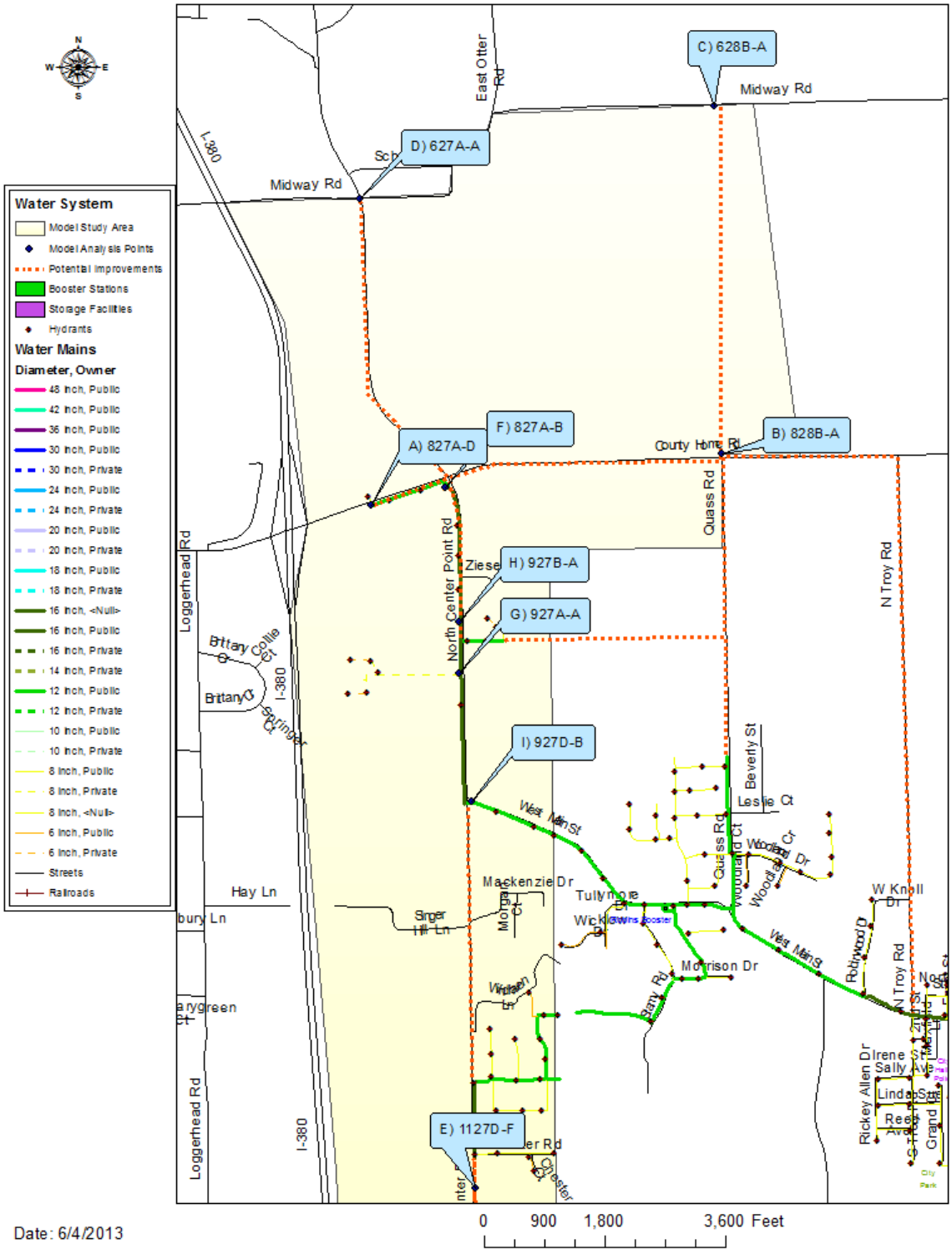


Figure 1. North Center Point Rd Hydraulic Study Area

2.0 System Modeling and Calibration

The analysis was conducted using WaterGEMS distribution modeling software. The data file used for the analysis is stored under "Base Model March 2013 JJG from GIS with Hydrants-Robins-4-14-13.wtg."

The base demand condition is for average day, with a total system demand of 36 MGD.

To verify model calibration, simulated fire flows were compared with the results of field fire flow tests conducted by City staff as well as design information from a sprinkler design firm. This comparison is discussed in Appendix A. The model compares very well to the measured field results.

There currently is not a reliable communication link between the booster station flow meter and pressure transmitters and the SCADA software that stores trends within the distribution system for system plant operators. Consequently, there were no historical trends readily available for flow and pressure at the booster station. During a field visit, an instantaneous read indicated a flow of 25 gpm. This was the assumed average flow for modeling current conditions.

For the analysis under typical (non-fire flow) water demand conditions, the overall capacity of the booster station was considered with the constraint that the residual pressure at any point within the boosted district would not fall below a minimum pressure of 45 psi. Since the current demand is well below the capacity of the station, the domestic demand is not considered a major concern for the near future. Meeting fire flow requirements for current and future needs is considered the controlling priority and focus of this study.

The geographic area currently served by the Robins Booster Station is primarily comprised of low-density development such as single-family residential lots. A fire flow of 1,000 gpm at 20 psi is considered adequate for this type of land use. However, the future land use map for the City of Robins shows future growth of the water system to areas that will have commercial and other zoning classifications along the North Center Point Rd/County Home Rd corridor that would likely have higher fire flow requirements. There are also two major church structures on N Center Point Rd. Therefore, a minimal fire flow requirement of 1,500 at 20 psi was used as the criteria to evaluate adequacy of the system for future expansion and compare improvement scenarios.

Alternatives were set up to analyze fire flows within Robins at existing hydrants and at major road intersections in future growth areas under various improvement scenarios. The hydrant locations monitored for this study are labeled in Figure 1. A key feature of the modeling software is the ability to monitor residual pressures at a specific hydrant and other nodes within the system to ensure that the minimum residual throughout the system during a hydrant flow does not fall below a specified target. A global minimum residual of 20 psi within the Robins boosted pressure zone was specified as the criteria to meet when calculating a fire flow capacity at a given hydrant.

3.0 Initial Analysis – North Center Point Road Main Size

The three scenarios modeled for the initial analysis are described in Table 1 and illustrated in Figure 2. As a basis for comparison, an extension of a 16-inch main along N Center Point Rd to the intersection with County Home Rd was considered. Point A (hydrant 827A-B) is at the end of a 12-inch main

extended west from the intersection of Center Point Rd and County Home Rd to a development. The results for this base analysis are shown in Table 2.

Scenario	Comments
A) Existing System Conditions-Extend Water Main to County Home Rd	12-inch and 16-inch extensions were evaluated.
B) Additional Improvement to add 2nd feed to North Center Point Rd via Quass Rd and Kings Way -district division point between zones on Kings Way east of Center Point Rd	12-inch and 16-inch extensions were evaluated. A check valve is used to separate the Boyson Rd Tank and Robins Boosted zones along the main in Kings Way. (2nd feed corresponds with Segments 2 & 3 in Figure 2)
C) Additional Improvement to add 2nd feed to North Center Point Rd via Quass Rd and Kings Way- district division point between zones on North Center Point Rd south of Kings Way.	12-inch and 16-inch extensions were evaluated. A check valve is used to separate the Boyson Rd Tank and Robins Boosted zones along the main in North Center Point Rd (2nd feed corresponds with Segments 2 & 3 in Figure 2)

Table 1: Scenarios Considered

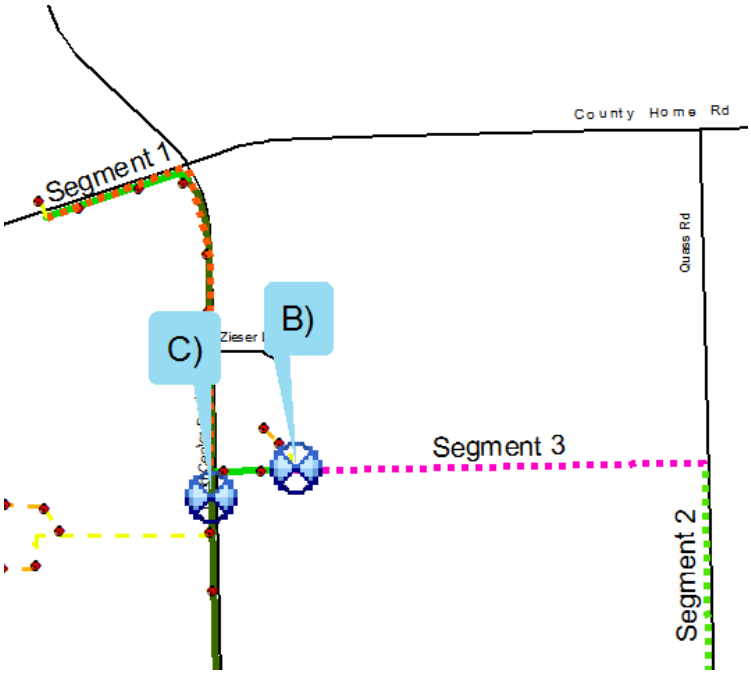


Figure 2: Improvement to Add 2nd Feed to N. Center Point Rd via Quass Rd and Kings Way (future)

Flow Hydrant	Location	Static Pressure (psi) **	Residual Pressure at fire flow capacity (psi)	Reported Fire flow capacity (gpm) *
827A-B	West of the intersection of N. Center Point Rd & County Home Rd (Elev. = 870)	97 (57)	39	1,300
927A-A	New Covenant Bible Church (Elev. = 865)	98 (58)	42	1,300
927B-A	King of Kings Lutheran Church (Elev. = 854)	105 (65)	48	1,300
927D-B	N. Center Point Rd & West Main St (Elev. = 909)	80 (40)	25	1,300

Table 2: Predicted Fire Flows for Points of Interest for Base Scenario A (16-inch water main extension to County Home Rd)

(*) The maximum fire flow is calculated such that the minimum pressure for a node within the pressure zone at or above 20 psi. Results are rounded to the nearest 50 gpm.

(**) The static pressure is shown both for "boosted" flow and "gravity" flow (in parentheses). If the pumps don't operate, for example in the event of a power outage, the static pressure would be governed by what is available from the suction zone.

3.1 Initial Analysis – Results

The current configuration of the water system to and within the Robins Boosted zone cannot meet a minimum fire flow requirement of 1,500 gpm at 20 psi residual pressure in the system.

Fire flow capacities and associated static and residual pressures were evaluated at the proposed endpoint of the current North Center Point Rd extension project (west of the intersection of North Center Point Rd with County Home Rd). The results of these model runs are summarized in Table 3.

The results for the base scenario A indicate that the maximum fire flow available is 1,300 gpm. The residual pressures at the fire flow locations for this scenario are higher than 20 psi (e.g. 39 psi for Hydrant 827A-B). This is due to the high elevations on the ridge within the study area (over 55 feet higher than the fire flow location), and the limiting constraint being the need to maintain 20 psi residual at all points in the system.

For the current configuration of the water system west of Troy Rd, there is a marginal difference in fire flow residual pressure between a 12-inch and 16-inch main segment for the current project. This is due to the restriction imposed by the single 12-inch main along West Main Street west of Troy Rd supplying the study area, and the requirement to maintain a 20 psi residual at the high points within the Robins Boosted District.

Scenario	Extension size (inch)	Static Pressure (psi)**	Residual Pressure at fire flow capacity (psi)	Reported Fire flow capacity (gpm) *
A) Existing System Conditions-Extend Water Main to intersection of Center Point Rd and County Home Rd	12	106 (66)	42	1,300
	16	106 (66)	47	1,300
B) Add 2nd feed to North Center Point Rd via Quass Rd and looping back to the intersection with Kings Way-district **division point** between zones on **Kings Way**.	12	106 (66)	40	1,600
	16	106 (66)	48	1,700
C) Add 2nd feed to North Center Point Rd via Quass Rd and looping back the intersection with Kings Way- district **division point** between zones on **North Center Point Rd**	12	66	34	1,400
	16	66	48	1,400

Table 3: Predicted Fire Flows at Proposed End of Extension to County Home Rd for Various Scenarios. Scenarios assume all 12-inch main or all 16-inch main.

(*) The maximum fire flow is calculated such that the minimum pressure for a node *within the pressure zone* at or above 20 psi. Results are rounded to the nearest 50 gpm.

(**) The static pressure is shown both for "boosted" flow and "gravity" flow (in parentheses). If the pumps don't operate, for example in the event of a power outage, the static pressure would be governed by what is available from the suction zone.

The limiting factors for the current water system in western Robins achieving a higher fire flow for points of interest along North Center Point Rd are high elevations along West Main St on the ridge, and the fire supply needing to pass through the booster station. The high elevations area a constraint since 20 psi must be maintained throughout the district in a fire flow condition.

Having to route all the fire flow through the booster station is a limitation as there is a currently a single water main feeding along West Main St on both the suction side and discharge side of the booster station. Moreover, there is a single 12-inch main feeding along West Main St west of N. Mentzer Rd. A large proportion of this supply (nearly a mile in length) is 12-inch main. The cumulative pressure loss through a 12-inch main can be substantial under fire flow conditions. For example, for a flow of 1,500 gpm, the head loss over a mile length of 12-inch main is approximately 28 feet (or 12 psi). In comparison, head loss for a 16-inch main over the same length is 7 feet (or 3 psi).

A proposed improvement to enhance fire flow capacities along the N Center Point Rd corridor was modeled with the assumed route shown in Figure 2. Since the new supply is from the Boyson Rd Tank district, a check valve is needed to separate the zones. Two alternate locations of the division valve were considered as shown in Figure 2 (and labeled according to the Scenario).

The modeling indicates that a second feed to North Center Point Rd from Quass Rd via a future extension of Kings Way or via County Home Rd would improve fire flow capacities with higher residual pressures. A check valve must be installed to operate during fire flow if the target area is kept on the Robins Boosted District, as in Scenario B. There will still be a limiting constraint due to the high elevation areas along West Main St.

The results for Scenario C indicate that there would be a minor increase in flows compared to Scenario A if the area north of West Main St was moved to the Boyson Rd Tank zone. This is due to there still being the restriction imposed by a single 12-inch line of supply along West Main Street west of Troy Rd to the study area, and only one feed during fire flows via the Kings Way route rather than in parallel through the Robins Booster Station as in scenario B. Locating the check valve on N Center Point Rd prevents the boosted zone mains from contributing to the fire supply in the area of the Center Point Rd and County Home Rd intersection.

4.0 Future Delineation of the Robins Boosted Pressure Zone

It is important to be aware of the range of system pressures and the effect of the configuration of the district when considering future improvements for the area served by the Robins Booster District.

As currently configured, the Booster Station supplies the west end of Robins along West Main St west of Stamy Rd. The approximate elevation range within the current service area is between 820 and 920 feet (USGS datum). For current conditions with a pressure relief valve in operation, this corresponds with static pressure ranging between 75 and 120 psi. If the pressure relief valve is inoperable for some reason, the pressures could be 10 psi higher. Some of the lower lying areas are protected from excessive pressures by a pressure reducing valve installation in the Wildflower Estates. However, for the lower lying areas that are not downstream of the pressure reducing valve, excessive pressures can potentially have negative consequences such as increased leakage, increased breaks, water loss through pressure relief valves and increased forces inside water heaters and other appliances. The Uniform Plumbing Code calls for pressure reduction in service lines to 80 psi if the line pressure is excessive.

When an additional connection to the Boyson Rd Tank zone is available in the future, the lower elevation areas should be switched over to the Boyson Tank gradient. This will provide more moderate static pressures.

Another advantage to configuring the lower elevation areas in the Boyson District when an alternate feed is added will include increased fire flows. The constraint of providing adequate residual pressures at the highest ground under fire flow conditions would be eased. Converting these areas to this district would mean an increase of available fire flow at a 20 psi residual since a larger pressure drop from the static pressure would be practical. The current highest ground would remain in the boosted district and residual pressures for these areas would not be as significantly impacted by fire flows within the Boyson District.

Figure 3: Higher Ground within Robins Booster District (Elev. >= 880 feet)

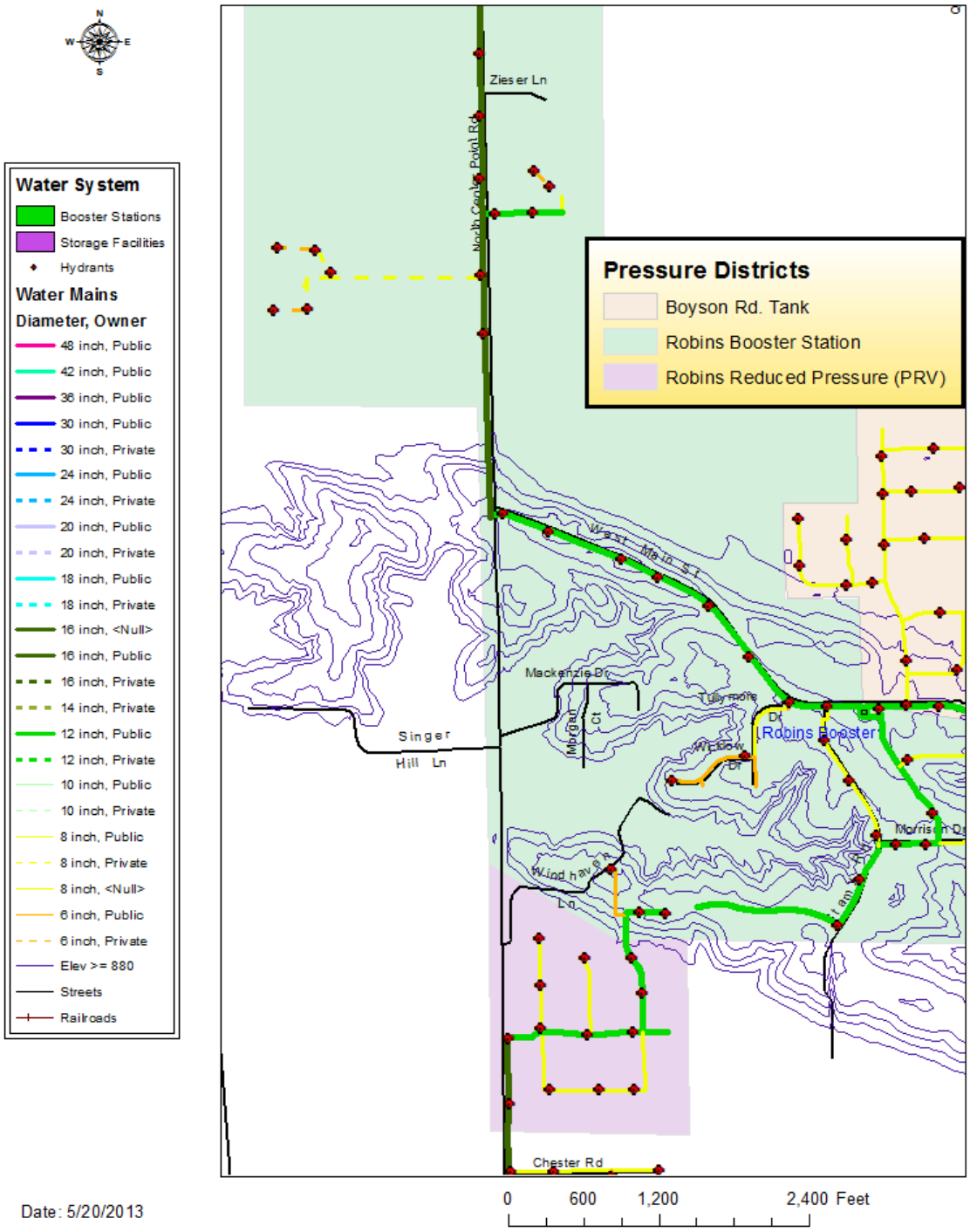


Figure 3. West end of ridge in western Robins.

Figure 3 illustrates the existing Robins Boosted District. The areas that are at ground elevation of 880 feet or above are illustrated with contour lines. Since the ground elevations for areas adjacent to North Center Point Rd are downhill from the intersection of West Main St and North Center Point Rd, these lower areas should be served by the Boyson Rd Tank hydraulic gradient.

4.1 Longer Term Future Improvements in the Robins Boosted District

Given the fire flow constraints for the current system, some hypothetical capital improvements were simulated as part of overall growth for the City of Robins. These may be done independent of, or in coordination with other work such as paving projects. Several improvements considered involve construction of new transmission mains that would augment supply to the current Robins Boosted District. Installation of a fire pump in the booster station or construction of a new elevated water tank, were also examined. Nine potential water main extensions are shown in Figure 4 and summarized in Table 4.

Twelve scenarios were modeled using twenty-one combinations of changes to the system. The potential improvements and corresponding scenarios modeled are summarized in Table 5.

Figure 4: Water System Improvements Considered

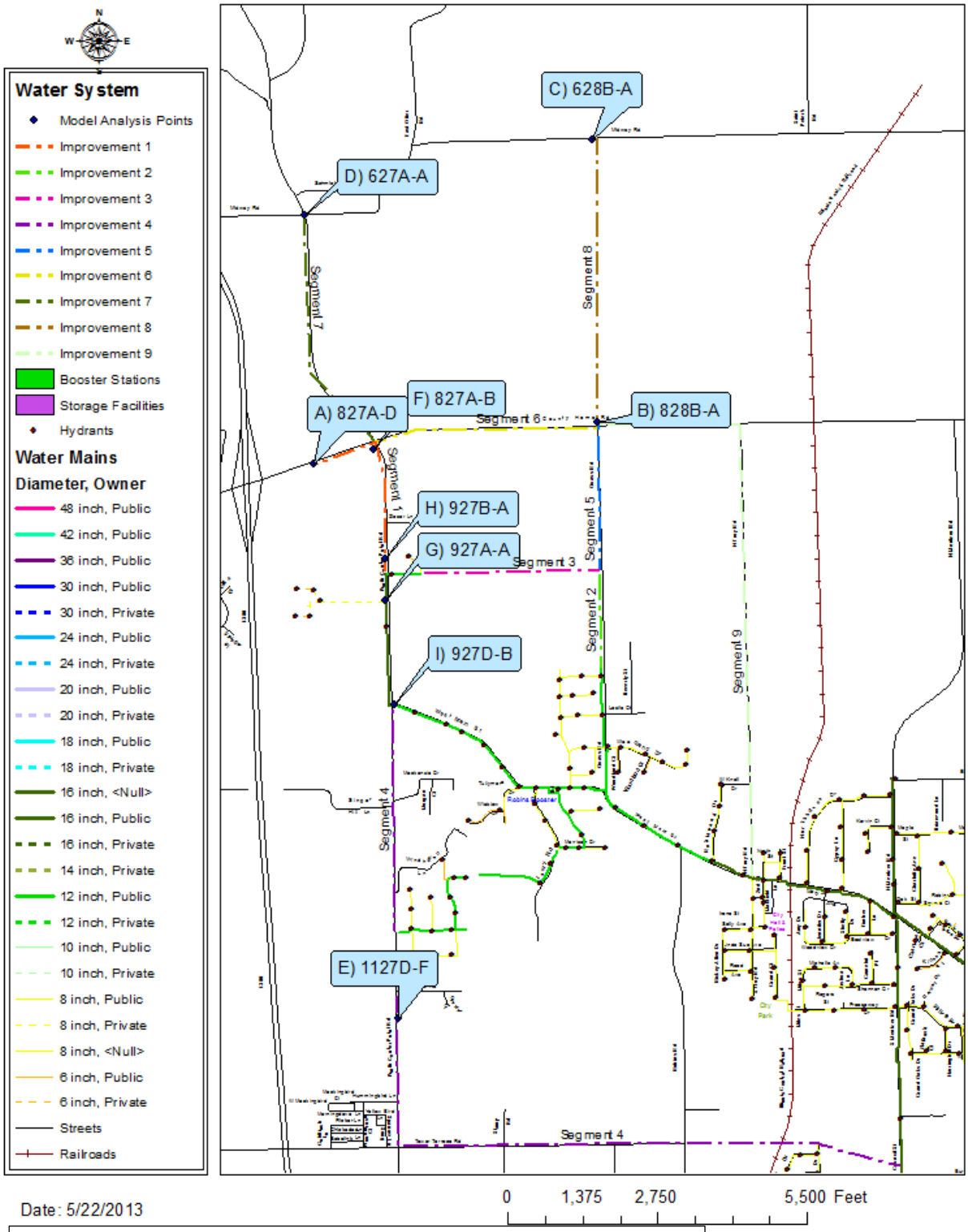


Figure 4. Water system improvements considered for this study.

Water Main Improvement Alternative	Notes
Segment 1) Construction of a water main along the North Center Point Rd right-of-way to the intersection with County Home Rd; also includes construction of a 12-inch main along County Home Rd west of N. Center Point Rd to the location of a proposed development.	12-inch and 16-inch sizes for the extension along North Center Point Rd are considered. The construction of this segment is planned to be constructed this year (2013).
Segment 2) Construction of a water main along Quass Rd right-of-way from the end of the existing system (north of Leslie Ln.) to the intersection with the future King's Way.	12-inch and 16-inch sizes are considered.
Segment 3) Construction of a water main along future King's Way right-of-way from the intersection with Quass Rd and completing a loop with the stub located in Kings Way.	12-inch and 16-inch sizes are considered. Since the feed from Quass Rd is on the lower pressure district (Boyson Rd Tank), a division point is required between the two (2) zones when they are connected. For example, in some scenarios, a check valve is modeled near the connection to the King's Way stub that allows additional flow into the boosted district during fire flow demands.
Segment 4) Construction of a water main along Tower Terrace Rd right-of-way from Council St to North Center Point Rd; extension of a main along North Center Point Rd from Tower Terrace to West Main St (excludes an existing segment between the Wildflower Estates and Chester Rd)	12-inch and 16-inch sizes are considered. The hydraulic grades for the Wildflower Estates are comparable to the Boyson Rd District, so a direct connection from the Council Street main to Chester Rd main is permitted. However, a division point must be created for the segment connecting to the existing West Main St to separate the boosted district from the lower pressure district.
Segment 5) Construction of a water main along Quass Rd right-of-way from Kings Way (future) to County Home Rd	12-inch and 16-inch sizes are considered.
Segment 6) Construction of a water main along County Home Rd right-of-way from Quass Rd to North Center Point Rd	12-inch and 16-inch sizes are considered. The mains in North Center Point Rd and Quass Rd are on different hydraulic grade zones, so a division between the two zones must be defined when this connection is simulated.
Segment 7) Construction of a water main along North Center Point Rd right-of-way from County Home Rd to Midway Rd	12-inch and 16-inch sizes are considered.
Segment 8) Construction of a water main along Quass Rd right-of-way from County Home Rd to Midway Rd	12-inch and 16-inch sizes are considered.
Segment 9) Construction of a water main along N. Troy Rd right-of-way from Main St to County Home Rd and along County Home Rd from N. Troy to Quass Rd	12-inch and 16-inch sizes are considered.

Table 4: Future Hypothetical Water Main Construction Segments (as shown in Figure 4-Page 13).

Table 5: Future Water System Improvements Considered

Modeling Scenario	Child Scenario (if any)	Extension size (inch)	Notes
1. **Current Infrastructure:** Construction of Segment 1 (Figure 4).	1.1	12	Alternate sizes for only the segment in North Center Point Rd were considered.
	1.2	16	
2. Quass Rd and King's Way Loop: Construction of Segments 1, 2 & 3 (Figure 4).	2.1	12	A 16-inch size for Segment 1 is assumed for this and subsequent scenarios. A **check valve** is simulated near the connection to the stub **at Kings Way.**
	2.2	16	
3. Connection at Tower Terrace Rd (to West Main St): Construction of Segments 1 & 4 (Figure 4).	3.1	12	A **division point** at the intersection of **N. Center Point Rd and W. Main St** is simulated. This allows the area along N. Center Point. Rd to be transferred to the Boyson Rd district.
	3.2	16	
4. **Robins Water Tower:** Construction of Segments 1 & 4 (Figure 4) plus construction of a 500,000 gallon water tank near the intersection of North Center Point Rd with West Main St.		N/A	A 0.5 MG tank is simulated with an overflow elevation comparable to the Boyson Rd Tank.
		16	
5. **Quass Rd/ Kings Way Loop & Tower Terrace Rd Connection:** Construction of Segments 1, 2, 3, 4, 5 & 6 (Figure 4).	5.1	12	Alternate sizes for Segments 2, 3 & 4 are considered. A **division point** at the intersection of **N. Center Point Rd and W. Main St** is simulated.
	5.2	16	
6. **Quass Rd/ Kings Way & Tower Terrace Rd Loops & Robins Water Tank:** Construction of Segments 1 through 6 (Figure 4) and a 500,000 gallon water tank near the intersection of North Center Point Rd with West Main St.		NA	Only 16-inch improvements are considered since this would likely be the minimum size for a tank fill line.
		16	
7. **Add Fire Pump to Booster Station:** Construction of Segment 1 (Figure 4) and addition of a fire pump to existing station; the hypothetical pump was assumed to have an operating point of at 750 gpm.		NA	This assumes the current extent of the water system with the addition of a hypothetical fire pump (750 gpm at 120 feet) at the Booster Station.
		16	

8. **Growth to Midway Rd/North Center Point Rd:** Construction of Segments 1 & 7 (Figure 4).	8.1	12	The new growth area remains on Robins Boosted district.
	8.2	16	
9. Growth to Midway Rd/North Center Point Rd & County Home Loop: Construction of Segments 1, 2, 5, 6 & 7 (Figure 4).	9.1	12	Alternate sizes for Segments 2, 5, 6 & 7 are considered. A **division point** at the intersection of **N. Center Point Rd and W. Main St** is simulated.
	9.2	16	
10. **Growth to Midway Rd/Quass Rd:** Construction of Segments 1, 2, 5 & 8 (Figure 4).	10.1	12	The new growth area is on the Boyson Rd Tank District.
	10.2	16	
11. **Growth to Midway Rd/Quass Rd & County Home Rd Loop:** Construction of Segments 1, 2, 5, 6, & 8 (Figure 4).	11.1	12	The new growth area is on the Boyson Rd Tank District. A **division point** at the intersection of N. Center Point Rd and W. Main St is simulated.
	11.2	16	
12. Growth to Midway Rd/Quass Rd / County Home Rd Loop & N. Troy Rd Loop: Construction of Segments 1, 2, 5, 6, 8 and 9 (Figure 4).	12.1	12	The new growth area is on the Boyson Rd Tank District. A **division point** at the intersection of N. Center Point Rd and W. Main St is simulated. Add N. Troy Rd 16-inch connection
	12.2	16	

Table 5: Future Water System Improvements Considered (continued)

4.2 Results – Modeling of Longer Term Improvements

The results for the various modeling scenarios for points of interest are summarized in Appendix B (Tables B.1 through B.12). Table numbers correspond with Scenario numbers listed in Table 5. These include estimation of domestic flow and fire flow capacities. In many cases, 12-inch and 16-inch sizes for construction of new improvements were considered. For the tank modeling scenarios, it was deemed appropriate to only consider 16-inch mains as this would be the minimum size for a supply line to a new tank. The residual pressures at the points of interest are shown for the reported capacity at domestic and fire flow conditions.

When considering domestic capacities for the area currently supplied by the Robins Booster District, the approach used was to monitor the system pressures for various demand scenarios. Appendices C through E contain a detailed discussion on how system curves are generated and capacity assessed for the current pump station configuration. A similar methodology to assess fire flow capacities was also used for domestic flows, but a minimum of 45 psi service pressure was specified instead of a 20 psi residual pressure under fire flow conditions. The domestic demand was assumed to be concentrated at each node of interest.

The design of each pump in the booster station is 300 to 400 gpm with a discharge pressure of about 80 psi. For a minimum service pressure of 45 psi, the model predicts flow through the pump station is over 600 gpm, which exceeds the maximum design flow for each of the pumps. Maximum flow for a pump is referred to as “run out”. Operating the pumps at run out for extended periods is inefficient and will physically damage a pump by cavitation. Domestic capacity in the boosted zone is limited to the firm capacity of the booster station, or one pump. For scenarios under which the points of interest are moved to the Boyson Rd service district for supply, the modeling indicates that the capacity during domestic demand conditions increases as a result of moving them to the Boyson Rd service district.

When considering fire flow capacities for the area currently served by the Robins Booster District, a minimum flow of 1,500 gpm at 20 psi is used as the criterion to meet for future land uses designated for commercial zoning. Depending upon the land use or type of development, a value greater than 1,500 gpm may be required. For current conditions (See Table B.1 for Scenario 1), the model predicts that for most of the study area, a maximum flow available is 1,300 gpm.

As shown in the results for Scenarios 8 and 10 (Tables B.8 and B.10), the fire flow capacity will still be an issue for northernmost portions of the study area if expansion of the water system along North Center Point Rd and Quass Rd is continued without augmenting the supply with a second feed from the Boyson Rd Tank service area.

When improvements that include additional supply routes (Scenarios 2, 3, 4, 5, 6, 9, 11 and 12) are simulated, in most circumstances there is an improvement of fire flows that often exceed the 1,500 gpm minimum. For Scenarios 2 (water main along Quass Rd) and 3 (water main connection along future Tower Terrace Rd to Council St), addition of one new feed is simulated. Comparison of the results for Scenarios 2 and 3 indicate that creating an additional looped connection from Council St along Tower Terrace Rd and North Center Point Rd (see Figure 5) results in a significant improvement of fire flows. Installation of a 16-inch main from the Tower Terrace connection would result in fire flows that exceed 2,500 gpm at 20 psi. Having two additional feeds as in Scenarios 5 and 6 (Table D.5 and D.6) would also further increase flows substantially and, more importantly, provide additional system reliability.

Figure 5: Tower Terrace Improvement
Alternate Route (primarily) within Robins City Limits

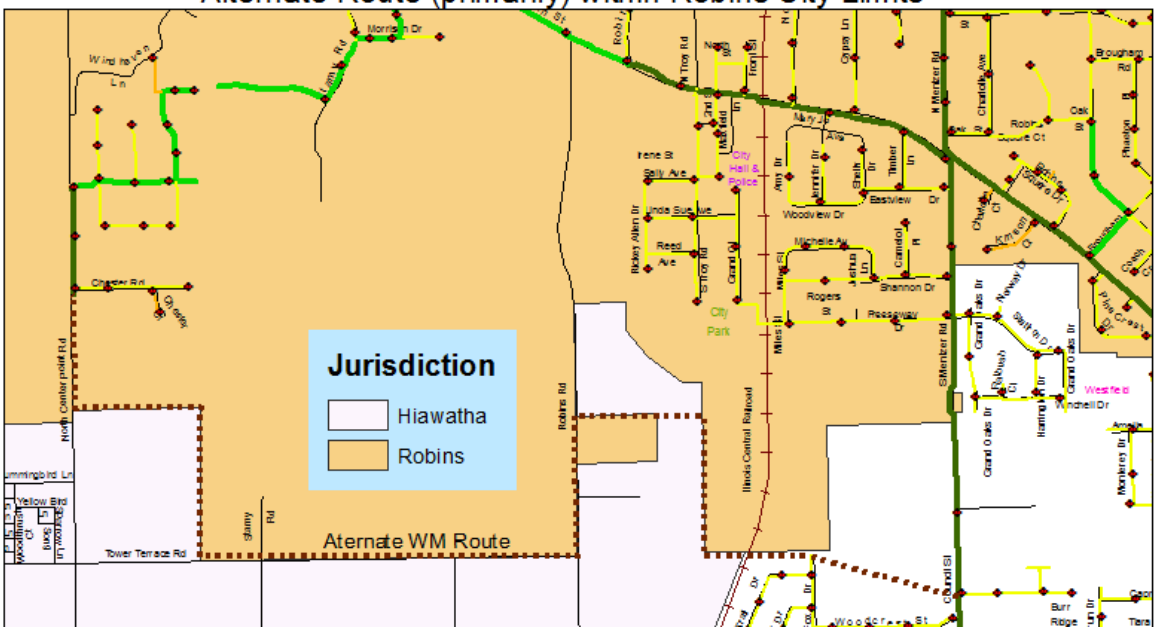


Figure 5. Potential route for a future Tower Terrace water main.

The results for Scenario 3 show that a 16-inch extension from Council Street to West Main via Tower Terrace Rd could provide a substantial gain in fire flow capabilities as well as allow for system redundancy in case of failure of the main along West Main St between Quass Rd and N Mentzer Rd.

Comparing scenarios 3 (segments 1 and 4 constructed, no tank) and 4 (segment 1 and 4 constructed, tank added), and scenarios 5 (segments 1 through 6 constructed, no tank) and 6 (segments 1 through 6 constructed, tank added), shows that once the water main improvements are in place, a tank is not necessary to meet target fire flows. Consideration of the costs of construction of the tank, the current lack of hydraulic connectivity between a tank in west Robins and the rest of the distribution system, and the real benefits of investing in transmission capacity and connectivity, lead to the conclusion that an elevated tank is not justifiable.

The modeling of Scenario 7 indicates that installation of a fire pump in the booster station to improve fire flows in the district would be technically feasible. A hypothetical pump with a design point of 750 gpm at 120 feet was assumed. For the assumed pump, the fire flow capacity increased to 1,850 gpm (with 20 psi at the high point). However, the discharge pressure at the station is increased to approximately 95 psi. This could be problematic since static pressures for the boosted district are already on the high side. Installation of a second supply feed from the Boyson Rd Tank service zone to the lower lying areas of the boosted zone north and south of the ridge would provide more benefits such as having a redundant supply, more moderate pressures, and similar available fire flows.

For the Scenarios that simulate flows for the growth area served by a future Quass Rd extension towards County Home Rd and onward to Midway Dr (see Tables D.10 and D.11) it is apparent that an additional supply to that area would be required to produce fire flows of 1,500 gpm at 20 psi residual. Scenario 12 was added to simulate an additional feed towards the northeast corner of the study area. This should include a future looped connection along North Troy Rd and then to the west toward Quass Rd. The benefits of this loop include higher hydraulic capacity and a redundant feed to the area north of the ridge that parallels the West Main Street 12-inch main. The model indicates that if a 16-inch main is installed along Quass Rd (Segments 2,5 & 8) and a 16-inch loop from N Troy Rd to the intersection of Quass Rd and County Home Rd (Segment 9) was added, a minimum fire flow of 2, 400 gpm becomes available at the intersection of Center Point Rd and County Home Rd, and a fire flow of 1,500 gpm would be available at the future intersection of Quass Rd with Midway Rd (See Table B.12). The available fire flows at New Covenant and at King of Kings churches are also significantly improved.

The modeling indicates that construction of one or more additional feeds from the Boyson Rd Tank District would improve fire flows. These would also provide redundant supply to western Robins, which currently relies for supply on a lone water main nearly a mile in length, reducing from 16-inch to 12-inch diameter. A beneficial improvement to the current system would be a 16-inch connection that would provide a parallel supply route to the current West Main St feed, for the area south of the ridge.

5.0 Conclusions

1. With only a simple extension of the water main on N Center Point Rd, fire flows in excess of 1,300 gpm in the Center Point Rd – County Home Rd intersection area will result in system pressures below 20 psi at higher elevations along the ridge in the Robins distribution system. The current configuration of the water system within the area served by the booster station

cannot meet a minimum fire flow requirement of 1,500 gpm with a 20 psi residual pressure in the system.

2. Once the Boyson Rd Tank service zone is connected to the water main on N Center Point Rd, a check valve must be installed to separate the Boyson Rd Tank service area from the area served by the booster station. Locating the check valve on King's Way east of N Center Point Rd allows the boosted zone mains to augment the fire supply in the area of the Center Point Rd and County Home Rd intersection. Once the area of the intersection is connected to the Boyson Rd Tank zone, the check valve would need to be re-located to the area of Center Point Rd and West Main St.

3. Focusing on the service area along N Center Point Rd and County Home Rd, extension of a 16-inch main along N Center Point Rd provides superior fire protection to the area, and preserves hydraulic capacity for future northward growth in Robins. Extension of 12-inch or 16-inch mains along Quass Rd (segment 2) and along a future King's Way extension (segment 3) improve the fire flow capacity, with marginal advantage using 16-inch main.

4. Adding a 16-inch main along N Troy Rd significantly improves fire supply to the County Home Rd and Center Point Rd intersection, and eliminates much of the risk of the lone supply to western Robins west of the Illinois Central railroad tracks. Providing an additional supply route west from Council St along the future Tower Terrace Rd or north from N Mentzer Rd to N Troy Rd would eliminate all of this risk.

5. When an additional connection to the Boyson Rd Tank zone is available in the future, the lower elevation areas north and south of the ridge should be changed to the Boyson Rd Tank gradient. This will provide more moderate static pressures, increased fire flows, or increased residual pressures in the system. Placing the Wildflower Estates area in the Boyson Rd Tank gradient provides a redundant supply and alleviates risk associated with a malfunction of the PRV currently regulating pressure to this area.

6. Domestic supply capacity in the boosted zone is limited to the firm capacity of the booster station, or one pump. When the points of interest for this study are transferred from the boosted zone to the Boyson Rd service district for supply, the capacity during domestic demand and fire flow conditions increase as a result.

7. Once needed water main improvements are in place, a tank is not necessary to meet target fire flows. Consideration of the costs of construction of a tank, the current lack of hydraulic connectivity between a tank in west Robins and the rest of the distribution system, and the real benefits of investing in transmission capacity and connectivity lead to the conclusion that an elevated tank is not justifiable.

8. Installation of a fire pump in the booster station to improve fire flows in the boosted zone has the disadvantage of discharge pressure at the station increasing to 95 psi. Pressures for the boosted district are already high. Installation of a second supply feed from the Boyson Rd Tank service zone to the lower lying areas of the boosted zone north and south of the ridge would

provide more benefits including a redundant supply, more moderate pressures, and similar available fire flows.

6.0 Recommendations

Based on the system modeling conducted for this study, the following recommendations are made:

1. **Install a 16-inch main for the current extension along North Center Point Rd**. The predicted fire flows available for the single supply of a 12-inch or 16-inch extension are below the threshold of 1,500 gpm at 20 psi. Installation of a 16-inch will preserve system capacity if higher fire flows are required in this vicinity in the future (along North Center Point Rd and County Home Rd) and position Robins for future extension northward once additional connections are made. For current conditions, there is not a significant difference between fire flows produced between installation of a 12-inch and 16-inch. However, as the system expands having a 16-inch main will reserve more capacity for future northward growth and contribute to the fire flow capacity available to the major structures along Center Point Rd.

2. **Prioritize construction of a second supply to western Robins.** This will supply fire flows of greater than 1,500 gpm for commercial and other zoning. An improvement that would provide significant benefit to the area north of the ridge would be construction of a 16-inch main along North Troy Rd looped to Quass Rd and on to North Center Point Rd. Compare scenario 12 to scenario 11. An additional feed along future Tower Terrace Rd to Center Point Rd completing a loop to West Main St would benefit the area south of the ridge. These improvements would allow re-districting of low elevation areas in the system currently on the boosted pressure zone to service by the Boyson Rd Tank zone. Check valves could be added where the Boyson and boosted zones meet to augment fire flows to the area that remains in the boosted district. These looping mains will provide system redundancy in the event of a failure of the water main along West Main St west of Troy Rd. The proposed feed from Quass Rd to the north and west (as in Scenario 2) reinforces fire flow to the County Home Rd area but does not address the risk posed by the single 12-inch feed upstream of this proposed connection.

3. **Start planning for future configuration of the Robins Boosted District.** When an additional connection to the Boyson Rd Tank zone is available in the future, the lower elevation areas should be switched over to the Boyson Tank gradient. This should include delineation of the future extent of the district and moving existing areas to the Boyson Rd Tank gradient. When an additional feed to the area along North Center Point Rd is provided, the lower elevation areas on the Robins Booster zone would be more effectively supplied by the Boyson Rd Tank zone and fire flows could be improved as a consequence. Note that the static pressures for the low lying areas are currently excessive. For example, at an elevation of 870 feet (USGS datum), the static pressure for areas fed by the Robins Booster Station are in excess of 95 psi. Static pressures from Boyson Rd district at this elevation would be about 55 psi.

4. **Start planning a route for a Tower Terrace Rd main including necessary agreements.** The route shown in Figure 4 (Segment 4) shows an alignment that corresponds with the future alignment of Tower Terrace Rd that crosses through both the Hiawatha and Robins jurisdictions. This would require agreements such as a 28-E agreement between the two jurisdictions to allow

them to share the right-of-way within Center Point Rd and Tower Terrace Rd to accommodate respective utilities. Cedar Rapids and Hiawatha recently negotiated a similar agreement to share the right-of-way of Tower Terrace Rd near the I-380 crossing. This might provide a template to base a mutual agreement between Robins and Hiawatha. Without such an agreement, the route for a water main within Tower Terrace Rd will look more the one shown in Figure 5.

5. **When considering fire flow capacities for the area**, a minimum flow of 1,500 gpm at 20 psi is recommended for use as the criterion to meet for future land uses designated for commercial zoning. Depending upon the land use or type of development, a value greater than 1,500 gpm may be required.

6. **Continue, and refine, this study.** This modeling exercise assumed average day demand conditions. Maximum day demand conditions would be a more appropriate condition to model. Some better estimate of the future type and density of development in the study areas would be useful. The City of Cedar Rapids Utilities Department, Water Distribution Engineering Section is prepared to assist the City of Robins with water system planning efforts, but needs advance notice so we can fit this activity into our work load. These study efforts are more efficient and effective when undertaken prior to the design and bidding of future water system additions.

References

Haestad Methods, "Advanced Water Distribution Modeling and Management," *First Addition*

Walski, T.M. et al, "Developing system head curves for closed systems," *AWWA Journal*-Sept. 2010

APPENDICES

Appendix A-Model Calibration Check: To check the calibration of the model, recorded results from three (3) fire flow tests were used. City staff and a fire sprinkler contractor performed these tests. A comparison is shown in Table A.1 below:

Flow Hydrant	Location	Static Pressure (psi)	Residual Pressure (psi)	Field flow (gpm)
927A-A	New Covenant Bible Church	98 (field) 99 (model)	42 (field) 43 (model)	950
927B-A	King of Kings Lutheran Church	105 (field) 105 (model)	55 (field) 53 (model)	1,160
1025C-B	Quass Rd & West Main St.	44 (field) 42 (model)	39 (field) 38 (model)	1,060

Table A.1: Calibration Comparison between Field and Simulated Results for Flow Tests

The simulated static and residual pressures are within a few psi (pounds per square inch) of the field tests when a demand equal to the observed field flow is applied.

Appendix B: Tabulation of Results for Calculated Hydraulic Parameters

Flow Hydrant	Location	Improve-ment size (inch)	Static Pressure (psi) *	Residual Pressure at domestic capacity (psi)	Reported domestic flow capacity (gpm)* *	Residual Pressure at fire flow capacity (psi)	Reported Fire flow capacity (gpm) ***
A) 827A-D	NE corner Interchange of I-380 with County Home Rd –Burds Convenience Store (Elev. =851)	12	106 (66)	75	550	42	1,300
		16	106 (66)	75	550	45	1,300
B) 828B-A	Quass Rd & County Home Rd (Elev. = 846)	12	N/A	N/A	N/A	N/A	N/A
		16	N/A	N/A	N/A	N/A	N/A
C) 628B-A	Quass Rd (future) & Midway Rd (Elev.=854)	12	N/A	N/A	N/A	N/A	N/A
		16	N/A	N/A	N/A	N/A	N/A
D) 627A-A	N. Center Point Rd & Midway Rd (Elev.= 836)	12	N/A	N/A	N/A	N/A	N/A
		16	N/A	N/A	N/A	N/A	N/A
E) 1127D-F	N. Center Point Rd & Chester Rd (Elev.=855)	12	61	60	550	29	1,450
		16	61	60	550	29	1,450
F) 827A-B	N. Center Point Rd & County Home Rd (Elev. = 870)	12	97 (57)	67	550	35	1,300
		16	97 (57)	67	550	39	1,300
G) 927A-A	New Covenant Bible Church (Elev. = 865)	12	98 (58)	70	550	42	1,300
		16	98 (58)	70	550	42	1,300
H) 927B-A	King of Kings Lutheran Church (Elev. = 854)	12	105 (65)	74	550	47	1,300
		16	105 (65)	74	550	48	1,300
I) 927D-B	N. Center Point Rd & West Main St (Elev. = 909)	12	80 (40)	51	550	25	1,300
		16	80 (40)	51	550	25	1,300

Table B.1: Current Infrastructure (Construction of Segment 1)-Predicted Hydraulic Parameters at Points of Interest

Notes:

(*) The static pressure is shown both for “boosted” flow and “gravity” flow (in parentheses).

(**) The minimum required pressure for maximum domestic flow is 45 psi throughout zone. (***) The maximum fire flow is calculated such that the minimum pressure for nodes *within the pressure zone* is at least 20 psi. Minimum fire flow of 1,500 gpm at 20 psi not met.

Flow Hydrant	Location	Improve-ment size (inch)	Static Pressure (psi) *	Residual Pressure at domestic capacity (psi)	Reported domestic flow capacity (gpm)* *	Residual Pressure at fire flow capacity (psi)	Reported Fire flow capacity (gpm) ***
A) 827A-D	NE corner Interchange of I-380 with County Home Rd –Burds Convenience Store (Elev. =851)	12	106 (66)	75	550	45	1,600
		16	106 (66)	75	550	45	1,700
B) 828B-A	Quass Rd & County Home Rd (Elev. = 846)	12	N/A	N/A	N/A	N/A	N/A
		16	N/A	N/A	N/A	N/A	N/A
C) 628B-A	Quass Rd (future) & Midway Rd (Elev.=854)	12	N/A	N/A	N/A	N/A	N/A
		16	N/A	N/A	N/A	N/A	N/A
D) 627A-A	N. Center Point Rd & Midway Rd (Elev.= 836)	12	N/A	N/A	N/A	N/A	N/A
		16	N/A	N/A	N/A	N/A	N/A
E) 1127D-F	N. Center Point Rd & Chester Rd (Elev.=855)	12	61	60	550	28	1,500
		16	61	60	550	28	1,500
F) 827A-B	N. Center Point Rd & County Home Rd (Elev. = 870)	12	97 (57)	67	550	39	1,600
		16	97 (57)	67	550	39	1,700
G) 927A-A	New Covenant Bible Church (Elev. = 865)	12	98 (58)	70	550	42	1,600
		16	98 (58)	70	550	43	1,700
H) 927B-A	King of Kings Lutheran Church (Elev. = 854)	12	105 (65)	74	550	48	1,600
		16	105 (65)	74	550	48	1,700
I) 927D-B	N. Center Point Rd & West Main St (Elev. = 909)	12	80 (40)	51	550	25	1,600
		16	80 (40)	51	550	25	1,700

Table B.2: Quass Rd and King's Way Loop (Construction of Segments 1, 2 & 3)-Predicted Hydraulic Parameters at Points of Interest

Notes:

(*) The static pressure is shown both for "boosted" flow and "gravity" flow (in parentheses).

(**) The minimum required pressure for maximum domestic flow is 45 psi throughout zone. (***) The maximum fire flow is calculated such that the minimum pressure for nodes *within the pressure zone* is at least 20 psi. Minimum fire flow of 1,500 gpm at 20 psi met.

Flow Hydrant	Location	Improve-ment size (inch)	Static Pressure (psi) *	Residual Pressure at domestic capacity (psi)	Reported domestic flow capacity (gpm)* *	Residual Pressure at fire flow capacity (psi)	Reported Fire flow capacity (gpm) ***
A) 827A-D	NE corner Interchange of I-380 with County Home Rd –Burds Convenience Store (Elev. =851)	12	66	59	600	40	1,500
		16	68	66	1,300	30	2,600
B) 828B-A	Quass Rd & County Home Rd (Elev. = 846)	12	N/A	N/A	N/A	N/A	N/A
		16	N/A	N/A	N/A	N/A	N/A
C) 628B-A	Quass Rd (future) & Midway Rd (Elev.=854)	12	N/A	N/A	N/A	N/A	N/A
		16	N/A	N/A	N/A	N/A	N/A
D) 627A-A	N. Center Point Rd & Midway Rd (Elev.= 836)	12	N/A	N/A	N/A	N/A	N/A
		16	N/A	N/A	N/A	N/A	N/A
E) 1127D-F	N. Center Point Rd & Chester Rd (Elev.=855)	12	64	59	1,200	43	2,300
		16	64	59	1,700	46	3,400
F) 827A-B	N. Center Point Rd & County Home Rd (Elev. = 870)	12	58	52	600	34	1,500
		16	58	50	1,100	27	2,600
G) 927A-A	New Covenant Bible Church (Elev. = 865)	12	60	54	1,100	37	1,500
		16	60	53	600	32	2,600
H) 927B-A	King of Kings Lutheran Church (Elev. = 854)	12	65	59	600	42	1,500
		16	65	58	1,100	38	2,600
I) 927D-B	N. Center Point Rd & West Main St (Elev. = 909)	12	80 (40)	41	550	24	2,200
		16	80 (40)	41	550	24	2,900

Table B.3: Connection at Tower Terrace Rd to West Main St. (Construction of Segments 1 & 4)-Predicted Hydraulic Parameters at Points of Interest.

Notes:

(*) The static pressure is shown both for “boosted” flow and “gravity” flow (in parentheses).

(**) The minimum required pressure for maximum domestic flow is 35 psi throughout zone.

(***) The maximum fire flow is calculated such that the minimum pressure for nodes *within the pressure zone* is above 20 psi.

Minimum fire flow of 1,500 gpm at 20 psi met.

Flow Hydrant	Location	Improve-ment size (inch)	Static Pressure (psi) *	Residual Pressure at domestic capacity (psi)	Reported domestic flow capacity (gpm)* *	Residual Pressure at fire flow capacity (psi)	Reported Fire flow capacity (gpm) ***
A) 827A-D	NE corner Interchange of I-380 with County Home Rd –Burds Convenience Store (Elev. =851)	12	N/A	N/A	N/A	N/A	N/A
		16	66	41	3,400	23	3,400
B) 828B-A	Quass Rd & County Home Rd (Elev. = 846)	12	N/A	N/A	N/A	N/A	N/A
		16	N/A	N/A	N/A	N/A	N/A
C) 628B-A	Quass Rd (future) & Midway Rd (Elev.=854)	12	N/A	N/A	N/A	N/A	N/A
		16	N/A	N/A	N/A	N/A	N/A
D) 627A-A	N. Center Point Rd & Midway Rd (Elev.= 836)	12	N/A	N/A	N/A	N/A	N/A
		16	N/A	N/A	N/A	N/A	N/A
E) 1127D-F	N. Center Point Rd & Chester Rd (Elev.=855)	12	N/A	N/A	N/A	N/A	N/A
		16	64	59	3,500	56	4,500
F) 827A-B	N. Center Point Rd & County Home Rd (Elev. = 870)	12	N/A	N/A	N/A	N/A	N/A
		16	58	41	3,400	29	4,500
G) 927A-A	New Covenant Bible Church (Elev. = 865)	12	N/A	N/A	N/A	N/A	N/A
		16	60	49	3,400	41	4,500
H) 927B-A	King of Kings Lutheran Church (Elev. = 854)	12	N/A	N/A	N/A	N/A	N/A
		16	64	54	3,400	47	4,500
I) 927D-B	N. Center Point Rd & West Main St (Elev. = 909)	12	N/A	N/A	N/A	N/A	N/A
		16	80 (40)	41	600	37	4,500

Table B.4: Elevated Water Tank (Construction of Segments 1 & 4 and new tank) -Predicted Hydraulic Parameters at Points of Interest

Notes:

(*) The static pressure is shown both for “boosted” flow and “gravity” flow (in parentheses).

(**) The minimum required pressure for maximum domestic flow is 35 psi throughout zone. (***) The maximum fire flow is calculated such that the minimum pressure for nodes *within the pressure zone* is at least 20 psi. Minimum fire flow of 1,500 gpm at 20 psi met.

Flow Hydrant	Location	Improve-ment size (inch)	Static Pressure (psi) *	Residual Pressure at domestic capacity (psi)	Reported domestic flow capacity (gpm)* *	Residual Pressure at fire flow capacity (psi)	Reported Fire flow capacity (gpm) ***
A) 827A-D	NE corner Interchange of I-380 with County Home Rd –Burds Convenience Store (Elev. =851)	12	66	58	1.100	34	2,500
		16	66	54	1,750	34	2,500
B) 828B-A	Quass Rd & County Home Rd (Elev. = 846)	12	N/A	N/A	N/A	N/A	N/A
		16	N/A	N/A	N/A	N/A	N/A
C) 628B-A	Quass Rd (future) & Midway Rd (Elev.=854)	12	N/A	N/A	N/A	N/A	N/A
		16	N/A	N/A	N/A	N/A	N/A
D) 627A-A	N. Center Point Rd & Midway Rd (Elev.= 836)	12	N/A	N/A	N/A	N/A	N/A
		16	N/A	N/A	N/A	N/A	N/A
E) 1127D-F	N. Center Point Rd & Chester Rd (Elev.=855)	12	64	58	1,500	40	3,000
		16	64	58	1,950	42	4,000
F) 827A-B	N. Center Point Rd & County Home Rd (Elev. = 870)	12	58	51	1,100	30	2,500
		16	58	49	1,750	24	3,600
G) 927A-A	New Covenant Bible Church (Elev. = 865)	12	60	52	1,100	35	2,500
		16	60	52	1,750	32	3,600
H) 927B-A	King of Kings Lutheran Church (Elev. = 854)	12	65	59	1,100	41	2,500
		16	65	57	1,750	38	3,650
I) 927D-B	N. Center Point Rd & West Main St (Elev. = 909)	12	80 (40)	41	600	25	2,400
		16	80 (40)	41	600	25	3,050

Table B.5: Quass Rd/ Kings Way Loop & Tower Terrace Rd Connection (Construction of Segments 1, 2, 3, 4, 5 & 6) -Predicted Hydraulic Parameters at Points of Interest

Notes: (*) The static pressure is shown both for “boosted” flow and “gravity” flow (in parentheses). (**) The minimum required pressure for maximum domestic flow is 35 psi throughout zone. (***) The maximum fire flow is calculated such that the minimum pressure for nodes *within the pressure zone* is at least 20 psi. Minimum fire flow of 1,500 gpm at 20 psi met.

Flow Hydrant	Location	Improve-ment size (inch)	Static Pressure (psi) *	Residual Pressure at domestic capacity (psi)	Reported domestic flow capacity (gpm)* *	Residual Pressure at fire flow capacity (psi)	Reported Fire flow capacity (gpm) ***
A) 827A-D	NE corner Interchange of I-380 with County Home Rd –Burds Convenience Store (Elev. =851)	12	N/A	N/A	N/A	N/A	N/A
		16	66	N/A	N/A	39	4,500
B) 828B-A	Quass Rd & County Home Rd (Elev. = 846)	12	N/A	N/A	N/A	N/A	N/A
		16	N/A	N/A	N/A	N/A	N/A
C) 628B-A	Quass Rd (future) & Midway Rd (Elev.=854)	12	N/A	N/A	N/A	N/A	N/A
		16	N/A	N/A	N/A	N/A	N/A
D) 627A-A	N. Center Point Rd & Midway Rd (Elev.= 836)	12	N/A	N/A	N/A	N/A	N/A
		16	N/A	N/A	N/A	N/A	N/A
E) 1127D-F	N. Center Point Rd & Chester Rd (Elev.=855)	12	N/A	N/A	N/A	N/A	N/A
		16	64	N/A	N/A	59	3,500
F) 827A-B	N. Center Point Rd & County Home Rd (Elev. = 870)	12	N/A	N/A	N/A	N/A	N/A
		16	58	N/A	N/A	40	3,500
G) 927A-A	New Covenant Bible Church (Elev. = 865)	12	N/A	N/A	N/A	N/A	N/A
		16	60	N/A	N/A	48	3,500
H) 927B-A	King of Kings Lutheran Church (Elev. = 854)	12	N/A	N/A	N/A	N/A	N/A
		16	64	N/A	N/A	54	3,500
I) 927D-B	N. Center Point Rd & West Main St (Elev. = 909)	12	N/A	N/A	N/A	N/A	N/A
		16	80	N/A	N/A	38	3,500

Table B.6: Quass Rd/ Kings Way & Tower Terrace Rd Loops & Robins Water Tank (Construction of Segments 1 through 6 and new tank) -Predicted Hydraulic Parameters at Points of Interest

Notes:

(*) The static pressure is shown both for “boosted” flow and “gravity” flow (in parentheses).

(**) The minimum required pressure for maximum domestic flow is 35 psi throughout zone.

(***) The maximum fire flow is calculated such that the minimum pressure for nodes *within the pressure zone* is at least 20 psi.
Minimum fire flow of 1,500 gpm at 20 psi met.

Flow Hydrant	Location	Improve-ment size (inch)	Static Pressure (psi) *	Residual Pressure at domestic capacity (psi)	Reported domestic flow capacity (gpm)**	Residual Pressure at fire flow capacity (psi)	Reported Fire flow capacity (gpm) ***
A) 827A-D	NE corner Interchange of I-380 with County Home Rd –Burds Convenience Store (Elev. =851)	12	N/A	N/A	N/A	N/A	N/A
		16	106 (66)	N/A	N/A	41	1,850
B) 828B-A	Quass Rd & County Home Rd (Elev. = 846)	12	N/A	N/A	N/A	N/A	N/A
		16	N/A	N/A	N/A	N/A	N/A
C) 628B-A	Quass Rd (future) & Midway Rd (Elev.=854)	12	N/A	N/A	N/A	N/A	N/A
		16	N/A	N/A	N/A	N/A	N/A
D) 627A-A	N. Center Point Rd & Midway Rd (Elev.= 836)	12	N/A	N/A	N/A	N/A	N/A
		16	N/A	N/A	N/A	N/A	N/A
E) 1127D-F	N. Center Point Rd & Chester Rd (Elev.=855)	12	N/A	N/A	N/A	N/A	N/A
		16	61	N/A	N/A	20	1,850
F) 827A-B	N. Center Point Rd & County Home Rd (Elev. = 870)	12	N/A	N/A	N/A	N/A	N/A
		16	97 (57)	N/A	N/A	35	1,850
G) 927A-A	New Covenant Bible Church (Elev. = 865)	12	N/A	N/A	N/A	N/A	N/A
		16	98 (58)	N/A	N/A	39	1,850
H) 927B-A	King of Kings Lutheran Church (Elev. = 854)	12	N/A	N/A	N/A	N/A	N/A
		16	105(65)	N/A	N/A	44	1,850
I) 927D-B	N. Center Point Rd & West Main St (Elev. = 909)	12	N/A	N/A	N/A	N/A	N/A
		16	80 (40)	N/A	N/A	24	1,850

Table B.7: Add Fire Pump to Booster Station (Construction of Segment 1 and fire pump at existing station) -Predicted Hydraulic Parameters at Points of Interest

Notes:

(*) The static pressure is shown both for “boosted” flow and “gravity” flow (in parentheses).

(**) The minimum required pressure for maximum domestic flow is 45 psi throughout zone.

(***) The maximum fire flow is calculated such that the minimum pressure for nodes *within the pressure zone* is at least 20 psi.
Minimum fire flow of 1,500 gpm at 20 psi met.

Flow Hydrant	Location	Improve-ment size (inch)	Static Pressure (psi) *	Residual Pressure at domestic capacity (psi)	Reported domestic flow capacity (gpm)* *	Residual Pressure at fire flow capacity (psi)	Reported Fire flow capacity (gpm) ***
A) 827A-D	NE corner Interchange of I-380 with County Home Rd –Burds Convenience Store (Elev. =851)	12	106 (66)	75	550	42	1,300
		16	106 (66)	75	550	45	1,300
B) 828B-A	Quass Rd & County Home Rd (Elev. = 846)	12	N/A	N/A	N/A	N/A	N/A
		16	N/A	N/A	N/A	N/A	N/A
C) 628B-A	Quass Rd (future) & Midway Rd (Elev.=854)	12	N/A	N/A	N/A	N/A	N/A
		16	N/A	N/A	N/A	N/A	N/A
D) 627A-A	N. Center Point Rd & Midway Rd (Elev.= 836)	12	112 (72)	81	550	45	1,300
		16	112 (72)	81	550	52	1,300
E) 1127D-F	N. Center Point Rd & Chester Rd (Elev.=855)	12	61	60	550	29	1,450
		16	61	60	550	29	1,450
F) 827A-B	N. Center Point Rd & County Home Rd (Elev. = 870)	12	97 (57)	67	550	34	1,300
		16	97 (57)	67	550	34	1,300
G) 927A-A	New Covenant Bible Church (Elev. = 865)	12	98 (58)	70	550	37	1,300
		16	98 (58)	70	550	42	1,300
H) 927B-A	King of Kings Lutheran Church (Elev. = 854)	12	105 (65)	74	550	42	1,300
		16	105 (65)	74	550	42	1,300
I) 927D-B	N. Center Point Rd & West Main St (Elev. = 909)	12	80 (40)	51	550	25	1,300
		16	80 (40)	51	550	25	1,300

Table B.8: Growth to Midway Rd/North Center Point Rd (Construction of Segments 1 & 7)-Predicted Hydraulic Parameters at Points of Interest

Notes:

(*) The static pressure is shown both for “boosted” flow and “gravity” flow (in parentheses).

(**) The minimum required pressure for maximum domestic flow is 45 psi throughout zone. (***) The maximum fire flow is calculated such that the minimum pressure for nodes *within the pressure zone* is at least 20 psi. Minimum fire flow of 1,500 gpm at 20 psi not met.

Flow Hydrant	Location	Improve-ment size (inch)	Static Pressure (psi) *	Residual Pressure at domestic capacity (psi)	Reported domestic flow capacity (gpm)* *	Residual Pressure at fire flow capacity (psi)	Reported Fire flow capacity (gpm) ***
A) 827A-D	NE corner Interchange of I-380 with County Home Rd –Burds Convenience Store (Elev. =851)	12	66	60	550	44	1,150
		16	66	60	750	47	1,400
B) 828B-A	Quass Rd & County Home Rd (Elev. = 846)	12	68	58	N/A	46	1,400
		16	68	61	N/A	53	1,400
C) 628B-A	Quass Rd (future) & Midway Rd (Elev.=854)	12	68	50	900	32	1,400
		16	68	57	900	48	1,400
D) 627A-A	N. Center Point Rd & Midway Rd (Elev.= 836)	12	N/A	N/A	N/A	N/A	N/A
		16	N/A	N/A	N/A	N/A	N/A
E) 1127D-F	N. Center Point Rd & Chester Rd (Elev.=855)	12	61	60	550	29	1,450
		16	61	60	550	29	1,450
F) 827A-B	N. Center Point Rd & County Home Rd (Elev. = 870)	12	58	52	550	37	1,150
		16	58	52	750	41	1,400
G) 927A-A	New Covenant Bible Church (Elev. = 865)	12	60	54	550	39	1,100
		16	60	54	550	39	1,350
H) 927B-A	King of Kings Lutheran Church (Elev. = 854)	12	64	60	550	44	1,100
		16	64	60	550	44	1,400
I) 927D-B	N. Center Point Rd & West Main St (Elev. = 909)	12	81 (41)	41	550	25	1,600
		16	81 (41)	41	550	25	1,600

Table B.9: Growth to Midway Rd/North Center Point Rd & County Home Rd Loop (Construction of Segments 1, 2, 5, 6 & 7) -Predicted Hydraulic Parameters at Points of Interest

Notes: (*) The static pressure is shown both for “boosted” flow and “gravity” flow (in parentheses). (**) The minimum required pressure for maximum domestic flow is 45 psi throughout zone. (***) The maximum fire flow is calculated such that the minimum pressure for nodes *within the pressure zone* is at least 20 psi. Minimum fire flow of 1,500 gpm at 20 psi not met.

Flow Hydrant	Location	Improve-ment size (inch)	Static Pressure (psi) *	Residual Pressure at domestic capacity (psi)	Reported domestic flow capacity (gpm)* *	Residual Pressure at fire flow capacity (psi)	Reported Fire flow capacity (gpm) ***
A) 827A-D	NE corner Interchange of I-380 with County Home Rd –Burds Convenience Store (Elev. =851)	12	106 (66)	75	550	42	1,300
		16	106 (66)	75	550	45	1,300
B) 828B-A	Quass Rd & County Home Rd (Elev. = 846)	12	68	58	900	53	1,400
		16	68	58	900	53	1,400
C) 628B-A	Quass Rd (future) & Midway Rd (Elev.=854)	12	65	50	900	32	N/A
		16	65	50	900	48	N/A
D) 627A-A	N. Center Point Rd & Midway Rd (Elev.= 836)	12	N/A	N/A	N/A	N/A	N/A
		16	N/A	N/A	N/A	N/A	N/A
E) 1127D-F	N. Center Point Rd & Chester Rd (Elev.=855)	12	61	60	550	29	1,450
		16	61	60	550	29	1,450
F) 827A-B	N. Center Point Rd & County Home Rd (Elev. = 870)	12	97 (57)	67	550	35	1,300
		16	97 (57)	67	550	39	1,300
G) 927A-A	New Covenant Bible Church (Elev. = 865)	12	98 (58)	70	550	42	1,300
		16	98 (58)	70	550	42	1,300
H) 927B-A	King of Kings Lutheran Church (Elev. = 854)	12	105 (65)	74	550	47	1,300
		16	105 (65)	74	550	48	1,300
I) 927D-B	N. Center Point Rd & West Main St (Elev. = 909)	12	80 (40)	51	550	25	1,300
		16	80 (40)	51	550	25	1,300

Table B.10: Growth to Midway Rd/Quass Rd (Construction of Segments 1, 2, 5 & 8) -Predicted Hydraulic Parameters at Points of Interest

Notes:

(*) The static pressure is shown both for “boosted” flow and “gravity” flow (in parentheses).

(**) The minimum required pressure for maximum domestic flow is 35 psi throughout zone.

(***) The maximum fire flow is calculated such that the minimum pressure for nodes *within the pressure zone* is at least 20 psi.

Minimum fire flow of 1,500 gpm at 20 psi not met.

Flow Hydrant	Location	Improve-ment size (inch)	Static Pressure (psi) *	Residual Pressure at domestic capacity (psi)	Reported domestic flow capacity (gpm)* *	Residual Pressure at fire flow capacity (psi)	Reported Fire flow capacity (gpm) ***
A) 827A-D	NE corner Interchange of I-380 with County Home Rd –Burds Convenience Store (Elev. =851)	12	66	60	550	44	1,150
		16	66	60	750	47	1,400
B) 828B-A	Quass Rd & County Home Rd (Elev. = 846)	12	68	58	N/A	46	1,400
		16	68	61	N/A	53	1,400
C) 628B-A	Quass Rd (future) & Midway Rd (Elev.=854)	12	68	50	900	32	1,400
		16	68	57	900	48	1,400
D) 627A-A	N. Center Point Rd & Midway Rd (Elev.= 836)	12	N/A	N/A	N/A	N/A	N/A
		16	N/A	N/A	N/A	N/A	N/A
E) 1127D-F	N. Center Point Rd & Chester Rd (Elev.=855)	12	61	60	550	29	1,450
		16	61	60	550	29	1,450
F) 827A-B	N. Center Point Rd & County Home Rd (Elev. = 870)	12	58	52	550	37	1,150
		16	58	52	750	41	1,400
G) 927A-A	New Covenant Bible Church (Elev. = 865)	12	60	54	550	39	1,100
		16	60	54	550	39	1,350
H) 927B-A	King of Kings Lutheran Church (Elev. = 854)	12	64	60	550	44	1,100
		16	64	60	550	44	1,400
I) 927D-B	N. Center Point Rd & West Main St (Elev. = 909)	12	81 (41)	41	550	25	1,600
		16	81 (41)	41	550	25	1,600

Table B.11: Growth to Midway Rd/Quass Rd & County Home Rd Loop (Construction of Segments 1, 2, 5, 6, & 8) -Predicted Hydraulic Parameters at Points of Interest

Notes:

(*) The static pressure is shown both for “boosted” flow and “gravity” flow (in parentheses).

(**) The minimum required pressure for maximum domestic flow is 45 psi throughout zone.

(***) The maximum fire flow is calculated such that the minimum pressure for nodes *within the pressure zone* is at least 20 psi.

Minimum fire flow of 1,500 gpm at 20 psi not met.

Flow Hydrant	Location	Improve-ment size (inch)	Static Pressure (psi) *	Residual Pressure at domestic capacity (psi)	Reported domestic flow capacity (gpm)* *	Residual Pressure at fire flow capacity (psi)	Reported Fire flow capacity (gpm) ***
A) 827A-D	NE corner Interchange of I-380 with County Home Rd –Burds Convenience Store (Elev. =851)	12	66	60	700	43	1,550
		16	66	60	1,200	47	2,450
B) 828B-A	Quass Rd & County Home Rd (Elev. = 846)	12	68	58	N/A	39	1,300
		16	68	61	N/A	53	2,450
C) 628B-A	Quass Rd (future) & Midway Rd (Elev.=854)	12	68	48	1,300	42	2,050
		16	68	57	1,400	44	2,450
D) 627A-A	N. Center Point Rd & Midway Rd (Elev.= 836)	12	N/A	N/A	N/A	N/A	N/A
		16	N/A	N/A	N/A	N/A	N/A
E) 1127D-F	N. Center Point Rd & Chester Rd (Elev.=855)	12	61	60	550	24	1,650
		16	61	60	550	22	1,750
F) 827A-B	N. Center Point Rd & County Home Rd (Elev. = 870)	12	58	52	700	36	1,550
		16	58	52	1,200	37	2,450
G) 927A-A	New Covenant Bible Church (Elev. = 865)	12	60	54	600	39	1,300
		16	60	54	850	38	2,450
H) 927B-A	King of Kings Lutheran Church (Elev. = 854)	12	64	60	600	44	1,300
		16	64	60	850	43	1,850
I) 927D-B	N. Center Point Rd & West Main St (Elev. = 909)	12	81 (41)	41	600	25	1,950
		16	81 (41)	41	600	25	2,250

Table B.12: Growth to Midway Rd/Quass Rd/ County Home Rd & N. Troy Rd Loops (Construction of Segments 1, 2, 5, 6, 8 and 9) -Predicted Hydraulic Parameters at Points of Interest. Notes:

(*) The static pressure is shown both for “boosted” flow and “gravity” flow (in parentheses).

(**) The minimum required pressure for maximum domestic flow is 45 psi throughout zone.

(***) The maximum fire flow is calculated such that the minimum pressure for nodes *within the pressure zone* is at least 20 psi.
Minimum fire flow of 1,500 gpm at 20 psi met with a 16-inch main.

Appendix C – Robins Booster Pump Curve

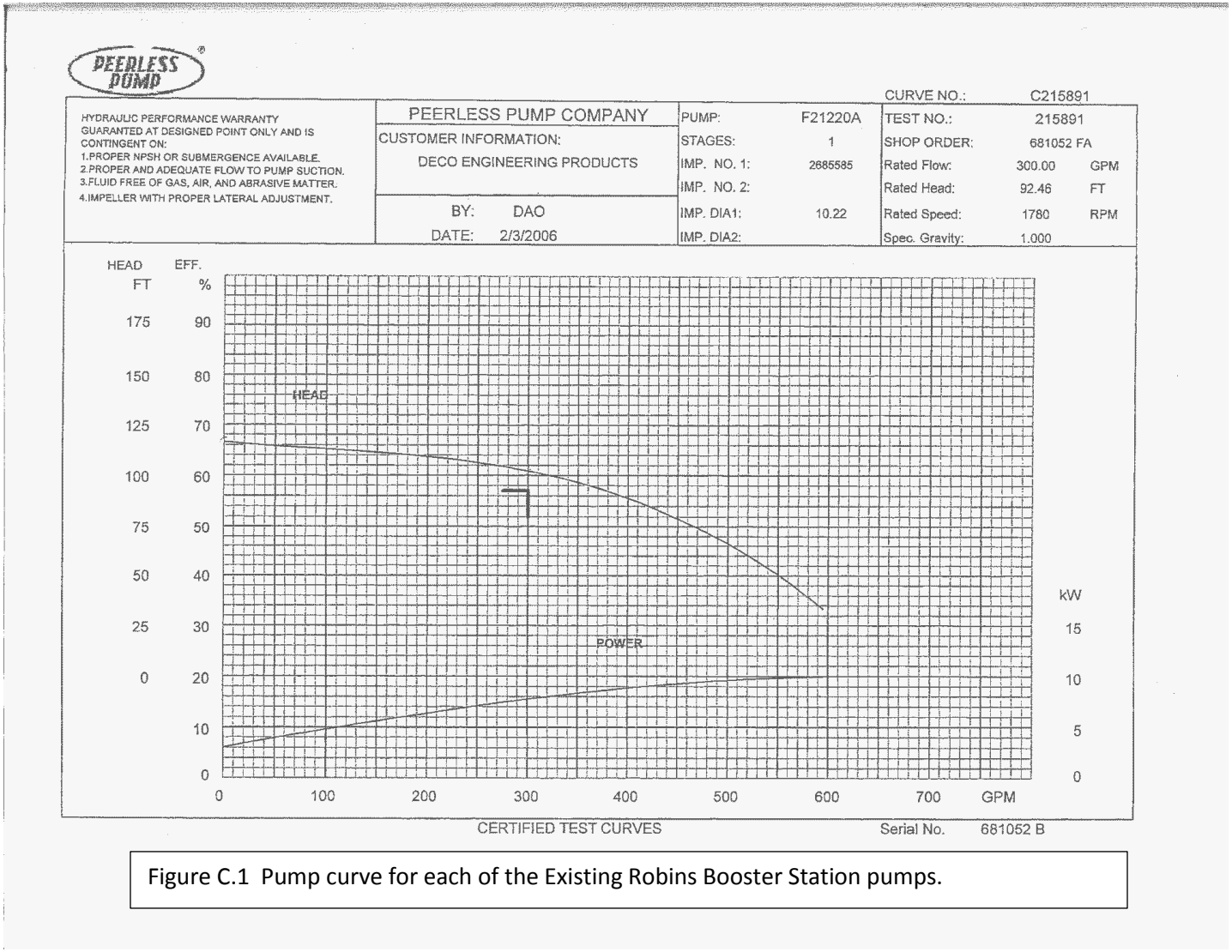
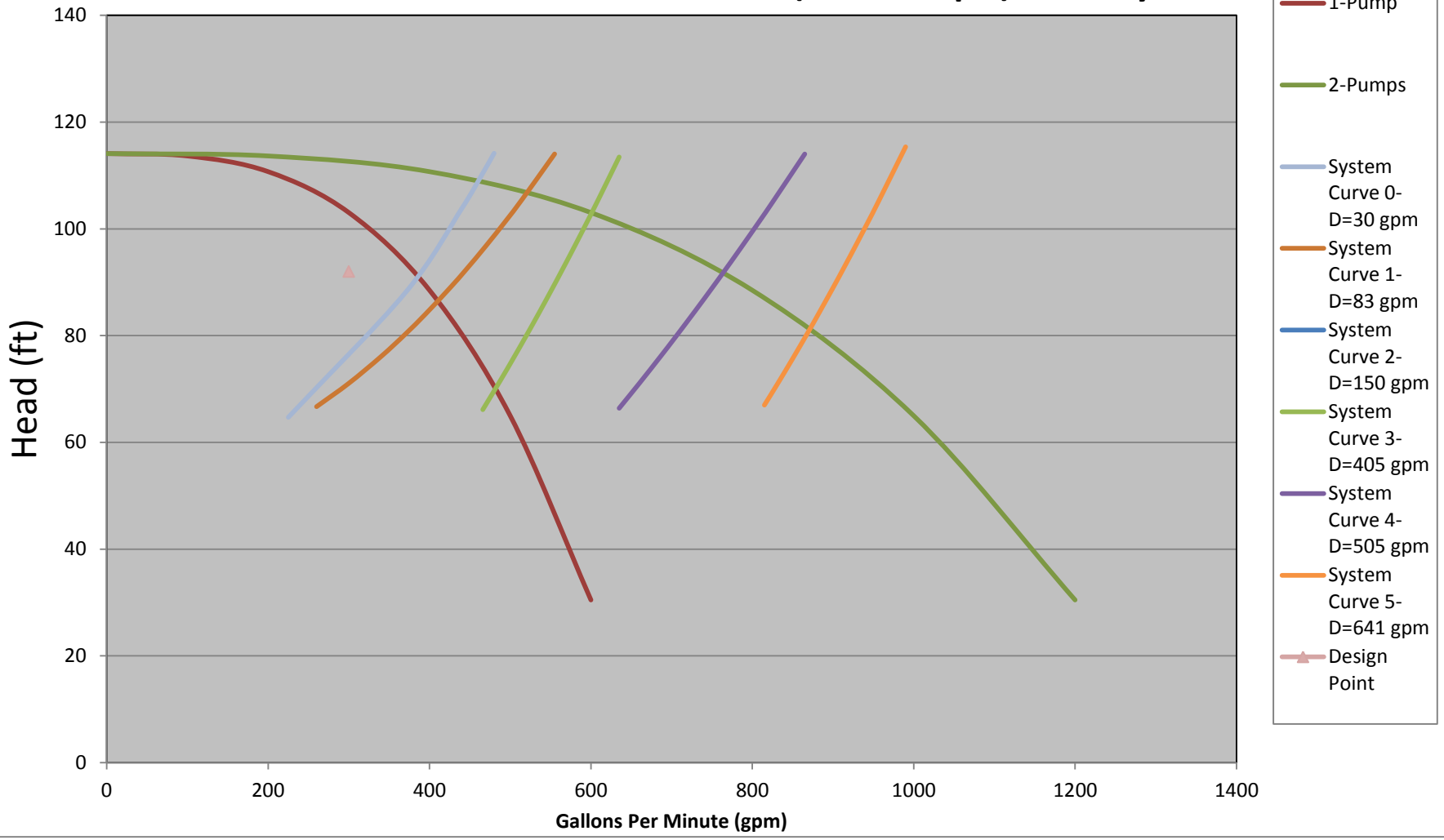


Figure C.1 Pump curve for each of the Existing Robins Booster Station pumps.

Figure C.2 Robins Booster-Existing Pumps-Peerless F21220A Trim 10.22 Inches with Pressure Relief Valve (Set at 80 psi) in Analysis



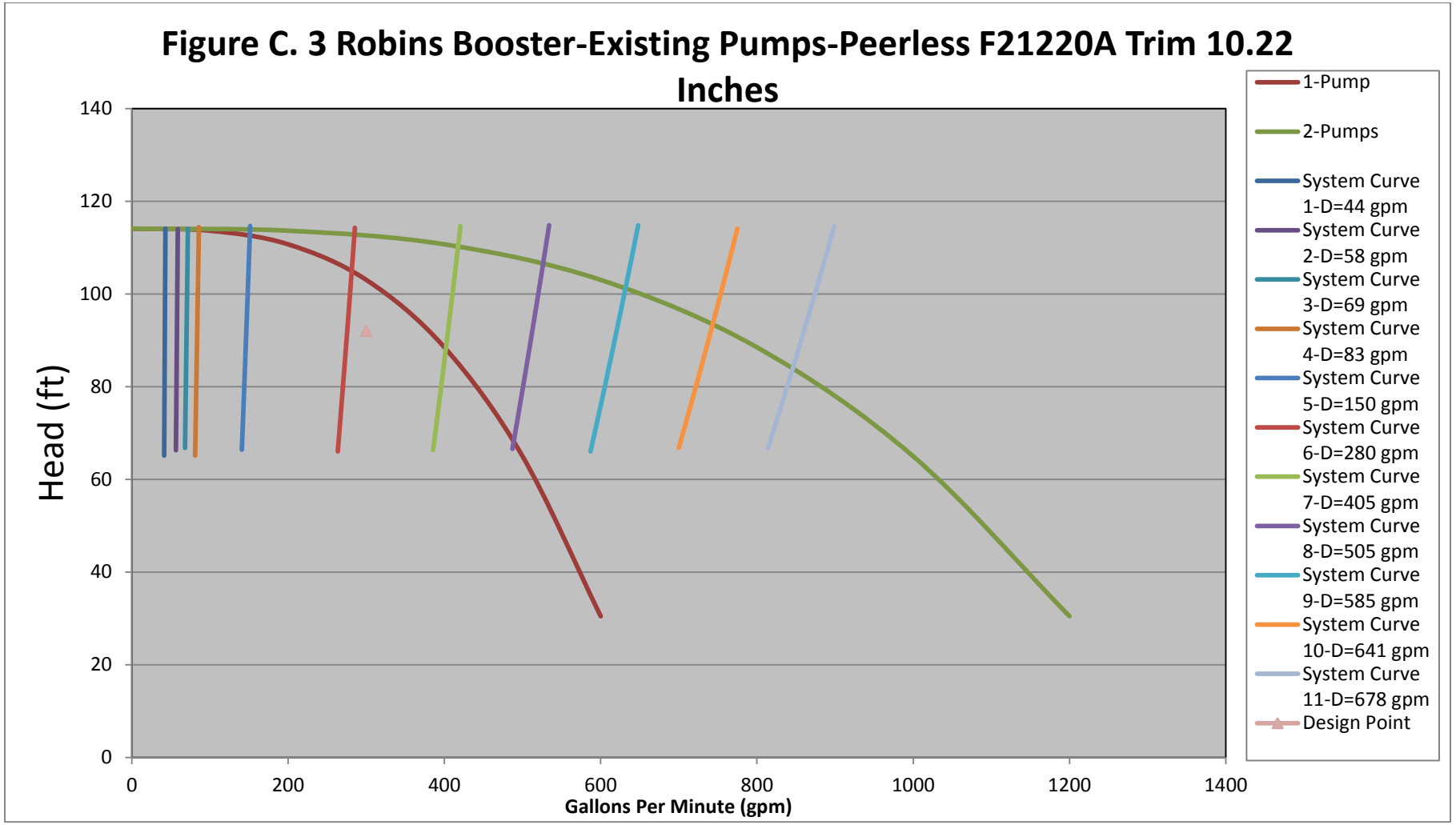


Figure C. 3 Robins Booster-Existing Pumps-Peerless F21220A Trim 10.22 Inches
Head (ft)
0
20
40
60
80
100
120
140
0
200
400
600
800
1000
1200
1400
Gallons Per Minute (gpm)
1-Pump
2-Pumps
System Curve 1-D=44 gpm
System Curve 2-D=58 gpm
System Curve 3-D=69 gpm
System Curve 4-D=83 gpm
System Curve 5-D=150 gpm
System Curve 6-D=280 gpm
System Curve 7-D=405 gpm
System Curve 8-D=505 gpm
System Curve 9-D=585 gpm
System Curve 10-D=641 gpm
System Curve 11-D=678 gpm
Design Point

Appendix D- System Curve Generation

As discussed in hydraulic modeling literature, there are unique challenges related to generating system curves for closed systems with no discharge-side tank. When generating a system curve, the supply and demand into a booster station must be balanced. If there is a tank on the discharge side, differences between the flow supplied by a pump station and customer demand can be balanced by flow into or out of the tank. However, in a closed system without a tank, it is more difficult to adjust demand to match supply. Literature sources (such as Walski, T.M et al) and the WaterCAD program documentation recommend that a "pressure-dependent" demand function be used to model nodal demand. In this way, the demand is allowed to vary slightly with pressure and the flow into and out of a pump station can be balanced.

When nodal demand is modeled as "pressure dependent", each node behaves like an orifice with the demand calculated either by a power function or piecewise linear curve. For example, for a power function option, the calculation for demand is described by the following:

$$\frac{Q_i^s}{Q_{ri}} = \begin{cases} 0 & H_i \le 0 \\ \left(\frac{H_i}{H_{ri}}\right)^{\alpha} & 0 < H_i < H_t \\ \left(\frac{H_t}{H_{ri}}\right)^{\alpha} & H_i \ge H_t \end{cases}$$

Where:

H_i = calculated pressure at node i
Q_{ri} = requested demand or reference demand at node i
Q^s_i = calculated demand at node i
H_{ri} = reference pressure that is deemed to supply full requested/reference demand
H_t = pressure threshold above which the demand is independent of nodal pressure
α= exponent of pressure demand relationship.

As pointed out in literature, a system head curve for a closed system can vary significantly dependent upon system demand conditions. Moreover, the slope of the curve can be relatively steep i.e. there are large changes in head required for relatively small changes in flow (see Figure D.1 below, for an example from a different study). The resulting curve will have limited applicability for certain demand conditions and ranges of flows.

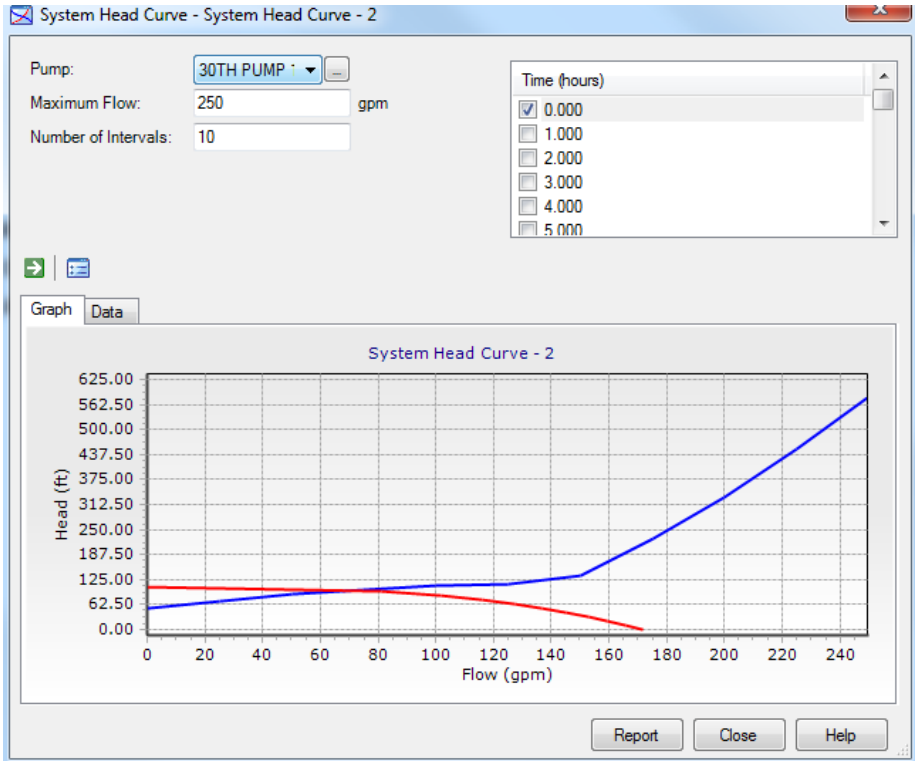


Figure D.1: System Curve for Pump 1- EPS Simulation of Maximum Day Demand (time = 0 hours)

In order to generate a series of curves to represent varying demand conditions and produce similar flows, a steady state analysis may be used with different *k*-coefficients.

The demand at a node is calculated using the following orifice equation for Flow Emitters:

$$Q = kP^n$$

Where:

Q is flow

k is the emitter coefficient and is a property of the node.

P is pressure

n is emitter coefficient; the default value is 0.5

As example of how this methodology was used for a similar system, in the case of the 30th Street Drive Booster Station, the total average flow calculated as a function of the differing *k*-coefficients is reported in Table D.1.

k	Calculated Demand (gpm)
0.25	32
.5	63
1.0	126
1.5	186
2	242
3	340
4	413
5	463
6	498

Table D.1: Calculated Demand for Steady State Conditions as a Function of Emitter Coefficient "*k*"

The WaterGEMS program can generate a series of curves for different demand conditions and when they are plotted on the same graph, they are relatively parallel to each other. Operating points for varying flow and pumping conditions can be estimated from the generated curves and if necessary parameters for intermediate demand conditions (not explicitly shown on the graphs) be approximated by interpolation.

Appendix E-System Curve Generation for the Robins Booster Station

The characteristics of and methodology used for generation of system curves within a closed system (without storage) such as the Robins Boosted District are discussed in further detail in Appendix D. Since there is not a storage tank available to balance the flows into and out of the booster station, a "pressure-dependent" demand function must be used to simulate a range of flows and generate corresponding points along a particular system curve. In order to generate a series of curves to represent varying demand a steady state analysis may be used with different *k*-coefficients.

For each alternative, the demand for each node within the study area was simulated as flow emitter and a constant coefficient *'k'* was assigned for each node in the district. The total flow calculated for the district as a function of the different *k*-coefficients is reported in Table E.1.

k	Calculated Demand (gpm)
0.01	30
0.02	44
0.03	58
0.04	69
0.05	83
0.08	118
0.1	150
0.15	208
0.2	280
0.25	335
0.3	405
0.35	449
0.4	505
0.5	585
0.6	641
0.7	678

Table E.1: Calculated Demand for Steady State Conditions as a Function of Emitter Coefficient "*k*"

The WaterGEMS program was used to generate a series of system curves for different demand conditions and when they are plotted on the same graph, they are relatively parallel to each other as shown in Figures C.2 & C.3. The plotted curves can be used to estimate operating points for a range of demand scenarios and interpolation used to estimate operating points for demands in between those for which the curves are shown.

Two series of system curves were generated representing conditions:

a) with the pressure relief valve (PRV) in service set at 80 psi (Figure C.2) and

b) without the pressure relief valve (PRV) in service (Figure C.3).

Comparison of the two graphs provides insight on how the operation of pressure relief valve (PRV) influences the operating point of the booster pump for varying demand conditions within the boosted district. This analysis can be used to predict system behavior when the discharge pressure is not controlled by the pressure relief valve.

For a low demand condition without a pressure relief valve in the analysis, the operating point (found by intersecting a pump curve with the system curve for a given demand condition) for a pump would be close to shut off head (116 feet). The discharge pressure would be 89 psi. When the pressure relief valve is simulated, the model predicts that the discharge head is reduced by 20 feet or more below the shut-off head. For an average demand of 30 gpm, the model predicts that the pump would add 95 feet of head creating a discharge pressure of 80 psi.

The pressure relief valve provides recirculation within the booster station piping when the demand is low. This prevents heating of the water trapped in an operating pump at dead head (no flow), extending the life of the pumps by preventing them from needing to operate at dead head for extended periods.

If the demand increased dramatically (to a flow in the several hundred gpm range), the head added drops off more significantly and there is a transition zone beyond which the discharge pressure drops below 80 psi and the pressure relief valve would shut and no longer influence the discharge pressure. As the maximum rated flow for the PRV is approached, the head losses become excessive as to restrict the amount of flow that can be passed through the recirculation line. Literature for a similar 3" PRV indicates that the maximum flow it could effectively handle would be approximately 300 gpm.

Based on review of the manufacturers' literature for the equipment installed in the booster station (pumps and pressure relief valves) and modeling results, the following qualitative generalizations are made with regard to the current configuration of the booster station for a range of system demands:

- The pressure relief valve can effectively operate and hold the discharge pressure setting (~80 psi) up to a flow rate of approximately 300 gpm.

- The design capacity for one pump at the booster station is 300 to 400 gpm with 80 psi on the discharge. The run out flow for one pump is approximately 600 gpm. This corresponds with the maximum operating flow rate indicated on the manufacturer's curve. It also corresponds to the maximum flow rate at which a minimum residual pressure of 45 psi can be maintained at the highest elevation within the boosted district (~920 feet) for typical conditions. (The calculation of pressure assumes a suction hydraulic grade of around 1000 feet and pump head of 25 feet). Operating the pumps at run out for extended periods is inefficient and detrimental to the pumps.

APPENDIX B

Segment 1
Segment 2
Segment 3
Segment 4
Segment 5
Segment 6
Segment 7
Segment 8
Segment 9
N. Center Point Rd
Quass Rd
Troy Rd
Main St
Tower Terrace
Robins Rd
I-380
MIDWAY ROAD
COUNTY HOME ROAD
ZIESER LN
W MAIN ST
TOWER TERRACE RD
CHESTER RD
CHESTER CT
WINDHAVEN LN
MACKENZIE DR
SINGER HILL LN
MORRISON DR
OAK PARK CT
WOODLAND DR
JUNIPER AVE
HEMLOCK CT
WHITE PINE
LESLIE CT
BEVERLY ST
TAMARACK LN
WHITE
W KNOLL DR
NORTHAVEN DR
N MENTZER RD
N TROY RD
NORTH ST
FRONT ST
E MAIN ST
MARFIELD LN
MARY JO AVE
SALLY KAE AVE
LINDA SUE AVE
REED AVE
MICHELLE AVE
SHANNON DR
FREEWAY DR
EAST VIEW DR
WOODVIEW AVE
ROBBINS RD
CEDAR VALLEY NATURE TRAIL
STAMY RD
ASTER RD
WILD ROSE RD
HEARTLEAF RD
CROSSRAIL CT
QUASS RD
ODESSA RD
MORGAN CT
PINE MOOR RD
OAK PARK DR
OAKWOOD DR
ROSEWOOD DR
CEDAR CT
ODYSSY LN
MILES ST
ROGERS ST
CAMELOT DR
SHELLY DR
KAY RD
JENNIFER RD
GRANT CT
I-380
N CENTER POINT RD
16″
12″
8″
20″
6″

CITY OF ROBINS WEST SIDE WATER DISTRIBUTION SYSTEM
PROPOSED SYSTEM IMPROVEMENTS

SNYDER & ASSOCIATES
Engineers and Planners

EXHIBIT B1

1:1220.59
Snyder
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V8iColorHalfWeightPDF.pltcfg
7/23/2013
KJS
M:\2013_PROJECTS\113.0215_Robins_Water Service Study\Cadd\exhibits\Future_Imprvs.exh
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