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March 22, 1999

HAND DELIVERY

Ms. Blanca Bayo, Director
Division of Records and Reporting
Florida Public Service Commission
2540 Shumard Oak Boulevard
Tallahassee, Florida 32399-0850

Re: Application by United Water Florida Inc. for an Extension of Service Area in St. Johns County, Florida, Docket No. 981637-WS

Dear Ms. Bayo:

In connection with the above-referenced matter, please find enclosed the following documents for filing:

1. Original and seven (7) copies of a Notice of Filing

2. Original and fifteen (15) copies of Direct Testimonies and Exhibits on behalf of United Water Florida Inc. by the following witnesses:

   a. Randall W. Corbin 03700-99
   b. Todd D. Mackey 03701-99
   c. David B. deNagy 03702-99
   d. Gary R. Moseley 03703-99

3. A double sided high density diskette, WordPerfect for Windows 6.1, containing the Testimony

Please file the originals of the Notice of Filing, Direct Testimonies, and Exhibits and distribute the copies in accordance with your usual procedures.

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Notice

DOCUMENT NUMBER-DATE

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FPSC-RECORDS/REPORTING

If you have any questions or comments regarding this matter, please do not hesitate to call.

Sincerely yours,

Scott G. Schildberg

SGS:dws
Enclosures

cc: Mr. Gary R. Moseley
Mr. Randall W. Corbin
Ms. Rosanne Gervasi
Mr. Kenneth A. Hoffman
Ms. Suzanne Brownless
Mr. F. Marshall Deterding

BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

In re: Application by United Water Florida Inc. For an Extension of Service Area in St. Johns County, Florida	DOCKET NO.: 981637-WS Date Submitted for Filing: March 22, 1999

NOTICE OF FILING DIRECT TESTIMONY
ON BEHALF OF UNITED WATER FLORIDA INC.

United Water Florida Inc., by and through its undersigned attorneys, hereby files an original and fifteen (15) copies of the Direct Testimony by the following witnesses: Randall W. Corbin, Todd D. Mackey, David B. deNagy, and Gary R. Moseley.

DATED this 22nd day of March, 1999.

MARTIN, ADE, BIRCHFIELD & MICKLER, P.A.

By: [signature]
James L. Ade
Florida Bar No. 0000460
Scott G. Schildberg
Florida Bar No. 0613990
3000 Independent Square
Jacksonville, FL 32202
Telephone: (904) 354-2050

Attorneys for United Water Florida Inc.

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that the original and seven copies of the Notice of Filing Direct Testimony on Behalf of United Water Florida Inc. have been furnished by hand delivery this 22nd day of March, 1999, to Blanca Bayo, Director, Division of Records and Reporting, Florida Public Service Commission, 2540 Shumard Oak Boulevard, Tallahassee, Florida 32399-0850, and a copy of the foregoing has been furnished to Rosanne Gervasi, Esquire, Florida Public Service Commission, Division of Legal Services, Tallahassee, Florida 32399-0850, Kenneth A. Hoffman, Esquire, Rutledge Law Firm, Post Office Box 551, Tallahassee, Florida 32302, Suzanne Brownless, Esquire, Suzanne Brownless, P.A., 1311-B Paul Russell Road, Suite 201, Tallahassee, Florida 32301, and F. Marshall Deterding, Esquire, Rose, Sundstrom & Bentley, LLP, 2548 Blairstone Pines Drive, Tallahassee, Florida 32301, by U.S. Mail, this 22nd day of March, 1999.

Attorney

Docket No. 981637-WS
Exhibit TDM-2
T. Mackey Exhibit No. ____________
UWF's Master Plan

Master Plan for Water and Wastewater Systems

St. Johns North Service Area

Prepared for

United Water
Jacksonville, Florida

Prepared by

CH2MHILL

June 1997

Master Plan for Water and Wastewater Systems

St. Johns North Service Area

Prepared for

United Water

United Water Florida
1400 Millcoe Road
Jacksonville, Florida 32225

Prepared by

CH2MHILL
7751 Belfort Parkway, Suite 320
Jacksonville, Florida 32256-6921

137651.A0.MP
June 1997

Executive Summary

Executive Summary

United Water Florida (UWFL) authorized CH2M HILL to prepare a Master Plan for water and wastewater facilities for a 20-year planning period commencing in 1997. The Master Plan provides UWFL with a facility planning *road map* including capacities, locations, phasing recommendations, cost estimates, and an implementation schedule. Because the majority of the service area is undeveloped and is expected to develop rapidly, it is recommended that the UWFL periodically update this Master Plan.

Water and Wastewater Service Demand Projections

UWFL's St. Johns North water and wastewater proposed service area consists of approximately 66 square miles in St. Johns County adjacent to southwestern Duval County. Although the area is largely undeveloped, it has great potential for development because of its proximity to Jacksonville, access to I-95 and US 1, and suburban characteristics that appeal to both new and existing residents in Duval County. Exhibits ES-1 and ES-2 present water and wastewater demand growth projections.

EXHIBIT ES-1
St. Johns North Water System Flow Projections, Including Likely Expansion Areas (in mgd)
Master Plan for Water and Wastewater Systems, St. Johns North Study Area

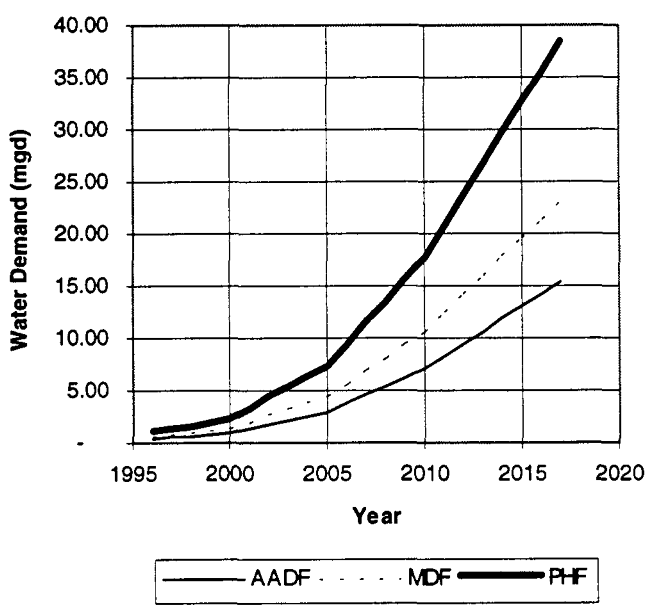
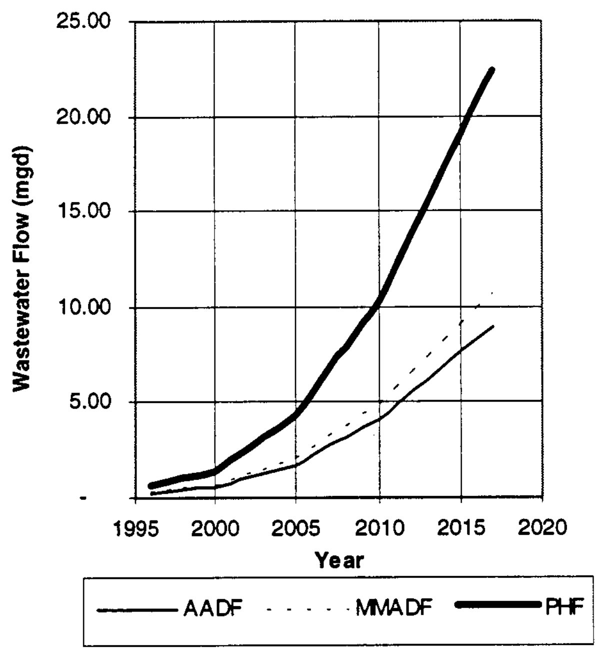


EXHIBIT ES-2
St. Johns North Wastewater Flow Projections, Including Likely Expansion Areas (in mgd)
Master Plan for Water and Wastewater Systems, St. Johns North Study Area



Water System

Two water system alternatives were evaluated; one alternative contained four water treatment facilities (WTFs) and the other contained three WTFs. Based on the results of an alternatives analysis, the alternative with four WTFs is recommended for implementation. Two WTFs will be located within the western portion of the service area. The third WTF will be located in the central portion of the service area, near County Road (CR) 210. The fourth will be located in the east, between I-95 and US 1.

One of the greatest challenges facing UWFL in the St. Johns North service area will be obtaining groundwater supply of high enough quality that treatment beyond conventional aeration will not be needed. The limited available groundwater data indicate that the only high quality groundwater from the Floridan aquifer is in the northwestern section of the service area. For the majority of the service area, the Floridan aquifer contains total dissolved solids (TDS) and sulfates at levels exceeding secondary drinking water standards. The shallow aquifer appears to contain high iron and color and well yields are much lower than the Floridan. Within the areas of poor quality groundwater, UWFL may be able to meet drinking water standards by blending Floridan water with shallow aquifer water and/or requesting a waiver on TDS and sulfate standards from the Florida Department of Environmental Protection (FDEP).

If blending or regulatory waivers are not feasible, more advanced treatment processes, such as membrane treatment, will be needed to remove TDS and sulfates. Disposal of concentrate from a membrane treatment process may be difficult to permit. Because of the ramifications of funding and permitting a membrane system, it is recommended that UWFL conduct hydrogeologic investigations as early as possible to establish water quality and quantity throughout the service area.

Wastewater System

Two wastewater system alternatives were evaluated; one alternative contained two wastewater treatment facilities (WWTFs) and the other contained one WWTF. Based on the results of an alternatives analysis, the alternative with one WWTF is recommended for implementation. The single regional WWTF will be located in the central part of the service area, just north of the Blacks Ford Swamp. The recommended effluent management system is disposal to receiving wetlands. Effluent standards for discharge to receiving wetlands is "5/5/3/1" (5 mg/L 5-day, carbonaceous biochemical oxygen demand [$CBOD_5$], 5 mg/L total suspended solids [TSS], 3 mg/L total nitrogen [TN], and 1 mg/L total phosphorus [TP]).

Biological nutrient removal and filtration will be needed to meet these standards. The Master Plan recommends implementing a sequencing batch reactor (SBR) system for the early phases of the Blacks Ford WWTF with a possible transition to an oxidation ditch system or a conventional Bardenpho system. At that point, the SBR tankage would be converted to aerobic digesters. Sludge from the digesters will be hauled as a liquid for land application.

During the early phases, effluent will be discharged to the adjacent Blacks Ford Swamp. Other potentially feasible receiving wetlands include Whites Ford Swamp and Molasses Branch Swamp, located south and east of Blacks Ford, and the Twelvemile Swamp, located between I-95 and US 1. The ultimate capacities of these swamp systems to receive effluent can only be determined after they are in operation. The systems may have the potential to manage the entire effluent flow from the service area through saturation development (buildout). If not, UWFL may need to pursue surface water discharge to the St. Johns River through an outfall diffuser system. However, it is expected that surface discharge may be difficult to permit.

Implementation Schedule

Exhibit ES-3 presents the implementation schedule, which is based on the water and wastewater demand projections presented above. While the exhibit shows a planning-level schedule for specific WWTF, WTF, water transmission main, and wastewater transmission main projects, the actual schedule for these facilities will be determined as developers request service. It is recommended that UWFL perform computer model simulations of future water and wastewater transmission mains as development occurs. These models will be used to address effects from development requests. It is also recommended that this Master Plan be updated at least every 5 years to account for actual development patterns and changing environmental and growth regulations. This updated Master Plan can then be the basis for future permitting such as Capacity Analysis Reports.

137651.A0.MP 4/97 GNV

Task	Year
Water System Improvements	
Conduct hydrogeologic investigations at St. Joes and CR210 sites	1997
Construct water main at Blacks Ford WWTF	1998
Design wellfields and WTFs at St. Joes and CR 210 sites	1998
Construct Phase I of St. Joes WTF and CR210 WTF	1998
Construct water mains along CR 210 corridor	2000
Connect St. Johns North WTF to transmission grid	2002
Conduct hydrogeologic investigation at US 1 site	2005
Construct Phase II of St. Johns North WTF, St. Joes WTF and CR 210 WTF. Construct Phase I of US1 WTF	2006
Construct Phase III of St. Johns North WTF, St. Joes WTF, CR 210 WTF	2010
Construct Phase II of US 1 WTF	2015
Wastewater System Improvements	
Construct Phase I of Blacks Ford WWTF, collection system modifications, and receiving wetlands	1998
Phase out St. Johns North WWTF and Sunray WWTF. Construct pump station and forcemains from Sunray area. Construct forcemains from I-95 rest area and from St. Joes area.	1999
Construct Phase II of Blacks Ford WWTF	2002
Construct Phase III of Blacks Ford WWTF	2004
Construct Phase IV of Blacks Ford WWTF	2007
Construct Effluent Main to Whites Ford and Molasses Branch Swamps	2007
Construct Phase V of Blacks Ford WWTF	2012

Exhibit ES-3. Proposed Project Implementation Schedule.
United Water Florida, St. Johns North

CH2MHILL

Table of Contents

Contents

Contents (Continued)

Contents (Continued)

Contents (Continued)

Acronyms

AADF	annual average daily flow
ac	acre
BEBR	Bureau of Economic and Business Research
BNR	biological nutrient removal
$CBOD_5$	5-day, carbonaceous biochemical oxygen demand
CFR	Code of Federal Regulations
CIR	color infrared
cm^2	centimeter squared
CR	County Road
CUP	consumptive use permit
DRI	Development of Regional Impact
DU	dwelling unit
EPA	U.S. Environmental Protection Agency
ERC	equivalent residential connection
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
GIS	geographic information system
gpm	gallons per minute
gpd	gallons per day
GST	ground storage tank
I/I	inflow and infiltration
in.	inch
JCU	Julington Creek Utilities
MCL	maximum contaminant level
MDF	maximum day flow
MG	million gallons
mgd	million gallons per day

Acronyms (Continued)

mg/L	milligrams per liter
MMADF	maximum month average daily flow
mWs	milliwatt seconds
NWI	National Wetland Inventory
PHF	peak hour flow
PD	positive displacement
RAS	return activated sludge
R/S	rural/silviculture
SBR	sequencing batch reactors
SCS	Soil Conservation Service
SJRWMD	St. Johns River Water Management District
SO_4	sulfate
TCLP	toxicity characteristic leaching procedure
TDS	total dissolved solids
TKN	total Kjeldahl nitrogen
TN	total nitrogen
TOC	total organic carbon
TP	total phosphorus
TSS	total suspended solids
USGS	U.S. Geological Service
UV	ultraviolet
UWFL	United Water Florida
WAS	waste activated sludge
wk	week
WTF	water treatment facility
WWTF	wastewater treatment facility
y	year

Section 1
Introduction

1. Introduction

1.1 Purpose

United Water Florida (UWFL) is planning to expand its St. Johns North water and wastewater service within northwestern St. Johns County by acquiring or serving the former utilities service areas of Sunray Utilities, St. Joes Utilities, and Container Corporation of America. The resulting expanded service area encompasses about 66 square miles.

UWFL authorized CH2M HILL to prepare a Master Plan for water and wastewater facilities for a 20-year planning period commencing in 1997. The Master Plan provides UWFL with a facility planning *road map* including capacities, locations, phasing recommendations, cost estimates, and an implementation schedule. Because the majority of the service area is undeveloped and is expected to develop rapidly, it is recommended that the UWFL periodically update this Master Plan.

1.2 Scope

The scope of work for the Master Plan includes the following major tasks. The detailed scope of work is contained in Appendix A.

- Develop the basis of design for the service area, including establishing the service area boundary and projecting water demand and wastewater flow.
- Establish wellfield, treatment plants, water and wastewater transmission mains, effluent management system, and land requirements.
- Evaluate two water system-wide alternatives and two wastewater system-wide alternatives for the service area. Select and recommend one alternative for each.
- Develop a phased conceptual approach for constructing recommended water and wastewater facilities.
- Develop an implementation schedule and cost estimates for water and wastewater facilities.

The following major assumptions were used in the development of the Master Plan:

- The planning period spans 20 years, from 1997 to 2017.
- Cost estimates are order-of-magnitude, based on a level of accuracy of +50 to -30 percent.

Specific site investigations for the water supply wellfield, water and wastewater plant locations, and effluent disposal systems were outside the scope of this Master Plan, but such studies are required as UWFL proceeds with project implementation.

Section 2
Basis of Design

2. Basis of Design

The service area for this Master Plan consists of UWFL's St. Johns North service area; the Sunray Utilities service area; the St. Joes Utilities, Inc. service area; and an additional uncertificated area east of I-95 (see Exhibit 2-1). The uncertificated area has been incorporated into this study because it is expected that the area can most economically be served by UWFL. UWFL is expected to ask the Public Service Commission to include this area within its certificated service area.

This section describes how the flows and loadings were computed for the Master Plan. This section is critical because these predictions form the basis for most of the analyses. Developing population and flow predictions in an undeveloped area is difficult because of the many socioeconomic and political factors that can affect growth. As described below, the population growth rate starts at the current rate and then increases. The growth rates are very high in the last half of the 20-year planning period. The implementation schedule should be revisited often by UWFL to track how growth is actually occurring. The procedures used to develop the population projections, growth rates, and flows and loads for this plan are described below.

2.1 Regional Population Projections

Regional population projection data were provided by the St. Johns County Planning Department, the City of Jacksonville Planning Department, and the Northeast Florida Planning Council. All of these entities primarily relied on population projections by the University of Florida's Bureau of Economic and Business Research (BEBR). Jacksonville's Planning Department provided historical population growth data from the adjacent Mandarin area of Duval County. This area has experienced rapid growth in the last 20 years and the UWFL service area is expected to experience similar growth.

Population projections for the areas inclusive of, and adjacent to, the service area are presented in Exhibit 2-2. U.S. Census Tract 208 is smaller than the service area and consists of the area within St. Johns County north of County Road (CR) 210. The Northwest (NW) Planning Zone is similar but slightly larger than Census Tract 208. The southeast planning district for Duval County, which is the Mandarin area, is also presented in Exhibit 2-2.

The population of St. Johns County is projected to increase 40 percent during the next 10 years. The County Planning Department projects the highest growth rates in the NW

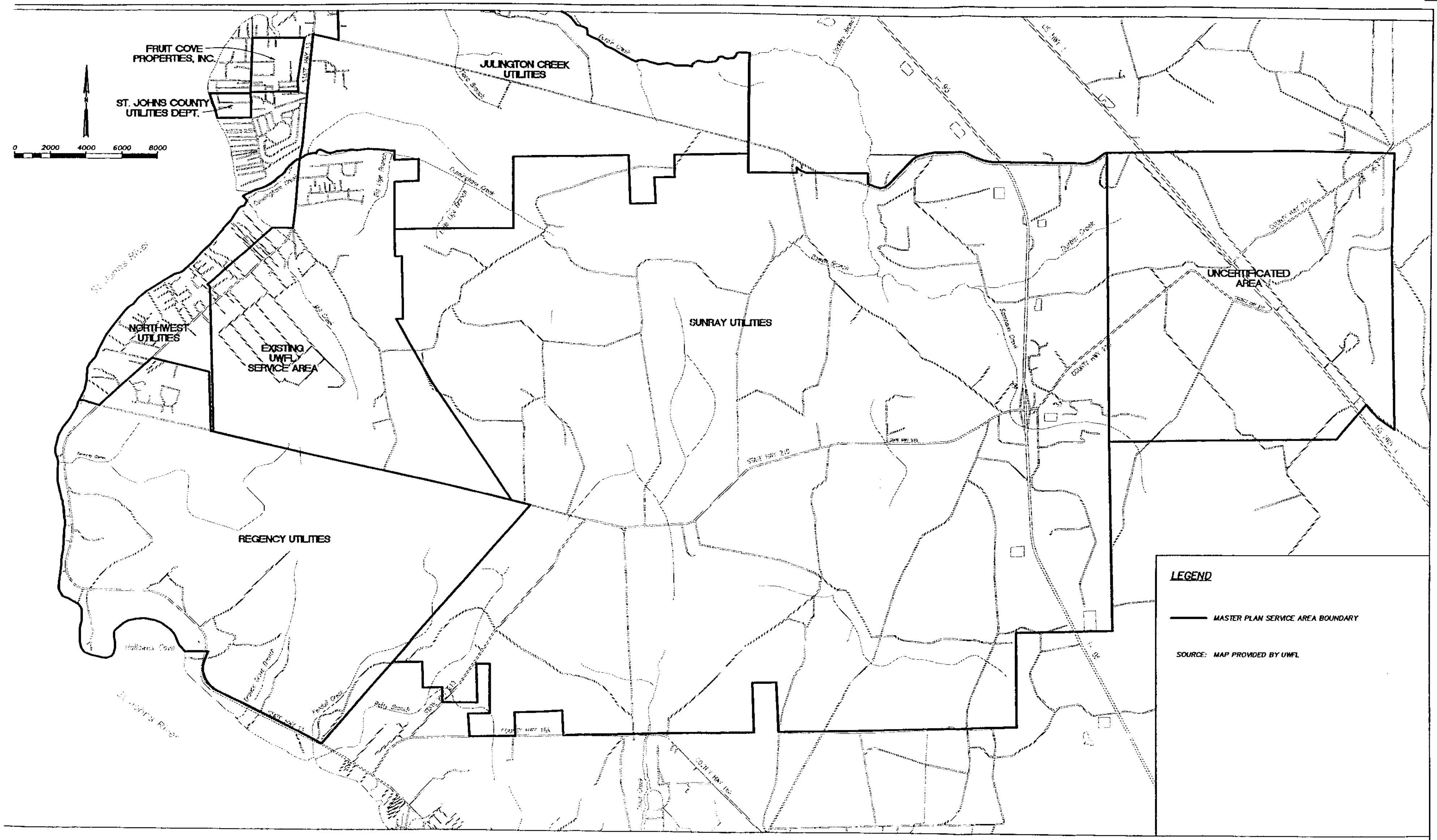


EXHIBIT 2-1
CURRENT SERVICE AREAS

EXHIBIT 2-2
Reported Population Growth for Northwest St. Johns County and Southwest Duval County
Master Plan for Water and Wastewater Systems, St. Johns North Study Area

	St. Johns Co.		U.S. Census Tract 208		St. Johns Co.	Mandarin Area	
Year	Population[a]	Average Increase	Population[b]	Average Increase	NW Planning Zone Population[c]	Population[d]	Average Increase
1990	97,695	-	6,548	-	NR	146,175	-
1995	111,993	2,860	9,009	492	9,393	167,080	4,181
2000	125,195	2,750	12,426	588	11,988	182,087	3,591
2005	135,997	2,553	17,182	709	15,301	190,121	2,930
2010	145,000	2,365	23,816	863	19,251	204,035	2,893
2015	155,000	2,292	NR	NR	NR	217,786	2,864
2020	163,900	2,207	NR	NR	NR	230,483	2,810

[a]Northeast Florida Planning Council through 2010, BEBR for Year 2020, Years 2010 & 2015 Interpolated.
[b]Reported in St. Johns County 1994 Water and Wastewater Master Plan.
[c]St. Johns Planning Department 1995.
[d]City of Jacksonville Planning and Development 1995.
[e]Average increase per year after 1990.
NR = not reported.

planning zone. The 1990 U.S. census data indicate that the average household size in St. Johns County is 2.5 people; therefore, based on the above population growth projections, an average of about 1,000 new dwelling units per year (DU/y) are projected within St. Johns County. The predicted growth rate most applicable to the study area, Census Tract 208, ranged from about 200 to 340 residential units per year.

The Mandarin area of Duval County has grown by approximately 61,500 people during the last 26 years. U.S. Census Tract 168, adjacent to St. Johns County, has experienced an increase of 510 housing units per year between 1990 and 1995. As the Mandarin region approaches saturation development, new development is expected to move south into northwest St. Johns County. This trend was factored into projections for growth within the Master Plan study area.

2.2 Growth Projections

The following discussion presents the approach to developing population and development projections for the study area. Based on this information, growth projections were developed for the study area. The overall projection for equivalent residential connections (ERCs) during the study period is presented in Exhibit 2-3.

EXHIBIT 2-3
Dwelling Unit Development Projection
Master Plan for Water and Wastewater Systems, St. Johns North Study Area

Year	Total ERCs
1996	893
2000	1,964
2005	6,107
2010	14,750
2015	27,214
2017	32,036
Saturation Development	51,700

2.2.1 Growth Projection Methodology

In addition to the information listed above, the following data were obtained by CH2M HILL for use in developing growth projections:

- U.S. Geologic Service (USGS) high altitude photographs, USGS topography maps, U.S. Agricultural Department Soil Conservation Service (SCS) maps, and U.S. Fish and Wildlife National Wetland Inventory (NWI) maps
- A previously-prepared Master Plan for UWFL's St. Johns North service area
- A Preliminary Master Plan document and other available population information from a draft Development of Regional Impact (DRI) study for the Sunray service area
- FDEP files in Jacksonville
- The Future Land Use Element from the St. Johns County Comprehensive Plan and discussions with County planners
- Discussions with UWFL staff on developers' proposed projects

Growth projections methodology consisted of projecting the saturation growth potential for the service area and then estimating the rate of growth within the 20-year planning period.

2.2.2 Saturation Development Growth Potential

Saturation development is the point at which all developable property is fully developed within the service area. A major factor affecting development potential is the large amount of undevelopable wetlands. NWI maps were used to estimate the available uplands in the service area. NWI maps were only available for the USGS Orangedale and Fleming Island quadrangles. They were not available for the Durbin quadrangle, which is the area generally east of I-95.

The St. Johns County Future Land Use Element of the Comprehensive Plan indicates that portions of the study area outside of the Julington Creek DRI are zoned for a maximum residential density of two and two to four dwelling units per acre (DU/ac). The current

Future Land Use Map is shown on Exhibit 2-4. Residentially-zoned areas comprise approximately 40 percent of the service area. No specific commercial or institutional areas are shown in the Comprehensive Plan except at the I-95 interchange.

The remaining portion of the study area, approximately 60 percent of the total, is zoned for rural/silviculture (R/S). The County's Land Use Plan states that R/S areas must be developed in 100-acre minimum parcels with a maximum of 20 clustered residential dwellings per 100-acre parcel. However, to enable greater development density, the R/S designation can be changed through an approval process. The Master Plan assumes that the existing land use designations will be modified to enable a greater dwelling unit density than is currently indicated in the Land Use Plan. It has also been assumed that only uplands, not wetlands, will be developed.

The current density in St. Johns North service area is about 1.2 DU/ac; however, this density includes a small portion of undevelopable wetland. A draft DRI developed for Sunray Utilities indicated an average density of 3 DU/ac in residential areas. One developer in the St. Johns North service area recently requested rezoning to a density higher than 3. Based on density regulations and actual developer density requests, an average density of 2 DU/ac appears to be a reasonable value for the study area.

2.2.3 Rate of Growth

The rate of growth must be estimated in order to estimate the water and wastewater service needs within the 20-year planning period. For this Master Plan, the overall rate of growth was estimated by assigning a growth potential rating of high, medium, and low to each section of land.

High growth potential sections have already experienced development and were assumed to approach saturation by 2006. Medium growth potential sections were assumed to have very limited existing development but would start intense development around 2004 and approach saturation development by 2017. Low potential growth sections would begin development near 2011 and continue to develop but not reach saturation development until after 2017. These ratings were assigned to particular sections based on existing land use patterns, proximity to developed roadways, and development information provided by developers to UWFL.

It was assumed that during the early years of the planning period, the initial growth rate would be held near the lower end of the range because of factors such as limited infrastructure. The growth rate will accelerate once infrastructure is installed. The annual rate of growth is very high after about 10 years; therefore, UWFL should carefully consider

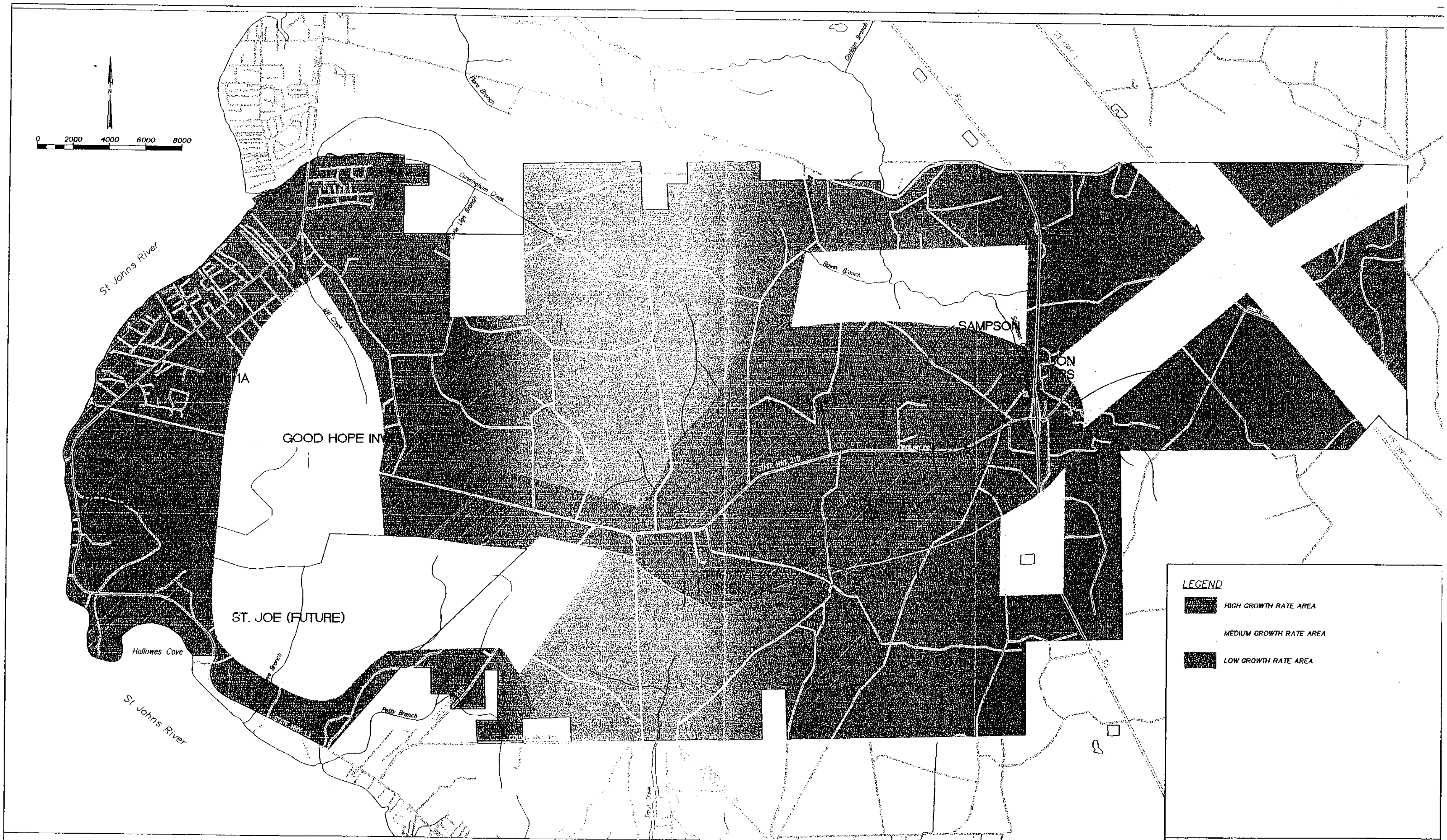


EXHIBIT 2-5
DEVELOPMENTS REQUESTING WATER AND WASTEWATER SERVICE
AND ASSUMED AREA WIDE RATES OF GROWTH

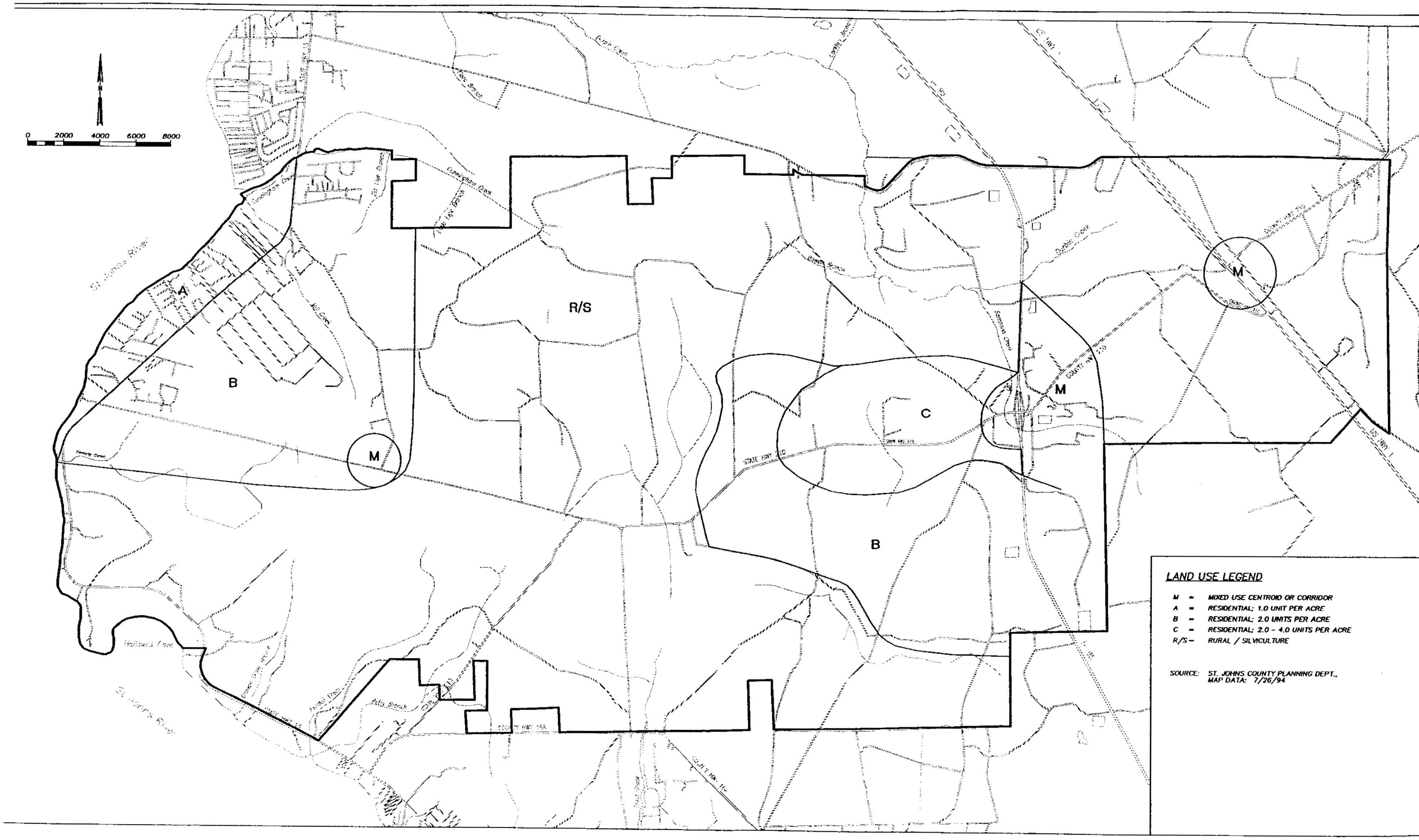


EXHIBIT 2-4
FUTURE LAND USE MAP

the implications of these predictions. The implementation of this plan's recommendations needs to be flexible if the actual growth rate differs significantly from the estimated growth rate used in this plan.

As previously discussed, the study area consists of the existing UWFL St. Johns North service area, the certificated areas of the former St. Joes Utilities, Sunray Utilities, and areas that are uncertificated. The following is a summary of the most current information on development activities within these areas. Exhibit 2-5 presents known development activity within the study area where the developers have requested water and wastewater service. It also shows assumed area-wide rates of growth for use in this Master Plan.

2.2.3.1 St. Johns North Service Area (Existing)

The existing St. Johns North service area is located in the northwest quadrant of the study area. Development has grown from the western half of the area and is currently growing along the northern boundary. New connections have increased to about 160 per year between 1992 and 1994. This high value has moderated somewhat to about 125 connections per year. This trend is assumed to be linear because the initial startup period has apparently ended.

2.2.3.2 St. Joes Service Area

The St. Joes service area has experienced very little development. Developers have recently approached UWFL with plans to develop approximately 3,100 lots. The proposed developments would cover slightly less than half the available service area. Areas not included in the proposed developments include commercial and mixed use lands that may be a much higher density.

2.2.3.3 Sunray Service Area

Approximately 1,500 lots are planned for development in the near future. However, currently there are only approximately 100 ERCs. A draft DRI for the Sunray service area estimated 23,383 residential units and additional commercial and industrial units. At saturation development, 25,600 ERCs, or about 64,000 people, are projected.

2.2.3.4 Currently Uncertificated Areas

The eastern portion of the study area, in the I-95 and US 1 corridor, is currently not certificated for service by any water or wastewater utility. This area is expected to develop at an above average rate when water and sewer service is available. This area is expected to fall within the medium growth rate category as described above.

2.3 Flows and Loads

Dwelling unit demands for water and wastewater services have been assumed to equal 280 gallons per day per equivalent residential connection (gpd/ERC) for annual average day wastewater flow and 480 gpd/ERC for annual average day water flow.

2.3.1 Wastewater Unit Flows

UWFL has determined that typical wastewater demand in its service areas is 280 gpd/ERC, annual average day. This number is based on approximately 100 gpd for each person, allowing for inflow and infiltration (I/I). Recent estimates of wastewater demand in the existing St. Johns North service area is 252 gpd/ERC and the trend is increasing slightly. As the collection system expands, I/I will also increase, bringing flows closer to the planning level of 280 gpd/ERC.

2.3.2 Water Unit Flows

UWFL typically uses 350 gpd/ERC, annual average day, for water system planning. Previous studies for UWFL have determined that the 700 existing water connections in the Cunningham Creek development were using approximately 460 gpd/ERC. This higher per unit usage is most likely attributable to the makeup of the customer base and above average irrigation usage on larger-than-average lots. The adjacent Julington Creek Plantation development utilizes 350 gpd/ERC for planning, but their engineers acknowledge that this value does not include irrigation usage. For planning purposes, UWFL recommended that 480 gpd/ERC be utilized in this Master Plan.

2.3.3 Design Flow

For purposes of establishing and expressing design flows, the following definitions are used in this Master Plan:

- Annual Average Daily Flow (AADF)—The total flow volume in millions of gallons during a given calendar year, divided by 365 days
- Maximum Month Average Daily Flow (MMADF)—The highest monthly flow in a given year divided by the number of days in that month
- Maximum Day Flow (MDF)—The highest flow volume in millions of gallons during any consecutive 24-hour period in a given year

- Maximum Hour Flow (MHF)—The highest flow volume in millions of gallons during any hour of a given year, multiplied by 24 to express in millions of gallons per day (mgd)

2.3.3.1 Basis of Design for Potable Water Systems

AADF and MDF are used for wellfield capacity planning, MDF and MHF are used for water storage and transmission piping planning, and MDF is used for air stripping, chlorination, and high-service pumping planning.

2.3.3.2 Basis of Design for Wastewater Systems

AADF is used for effluent system planning, PHF is used for piping and pumping sizing in collection and effluent transmission planning and plant hydraulics design, and MMADF is used for process design in activated sludge systems.

2.3.3.3 Design Flow Peaking Factors

Peaking factors are applied to the annual average day flow to estimate the MMADF, MDF, and MHF. For this Master Plan, the following peaking factors have been assumed:

Water System:	MDF = 1.5 times AADF MHF = 2.5 times AADF
Wastewater System:	MMADF = 1.2 times AADF MHF = 2.5 times AADF

Based on the projected dwelling unit growth rates, gpd/ERC flow rates, and the above peaking factors, flow projections have been developed for the service area (Exhibits 2-6 through 2-8).

EXHIBIT 2-6
St. Johns North Water Flow Projections, Including Likely Expansion Areas (in mgd)
Master Plan for Water and Wastewater Systems, St. Johns North Study Area

Year	AADF	MDF	PHF
1996	0.43	0.64	1.07
1997	0.53	0.80	1.34
1998	0.64	0.96	1.60
1999	0.74	1.11	1.86
2000	0.95	1.41	2.36
2001	1.35	2.02	3.37
2002	1.74	2.61	4.36
2003	2.14	3.21	5.35
2004	2.53	3.80	6.34
2005	2.93	4.40	7.32
2006	3.76	5.64	9.40
2007	4.59	6.89	11.48
2008	5.42	8.13	13.55
2009	6.25	9.38	15.63
2010	7.08	10.61	17.71
2011	8.28	12.41	20.69
2012	9.47	14.21	23.68
2013	10.67	16.00	26.67
2014	11.86	17.80	29.66
2015	13.06	19.60	32.65
2016	14.22	21.32	35.54
2017	15.37	23.07	38.44

MDF = 1.50 x AADF.
PHF = peak hour flow.
PHF = 2.50 x AADF.

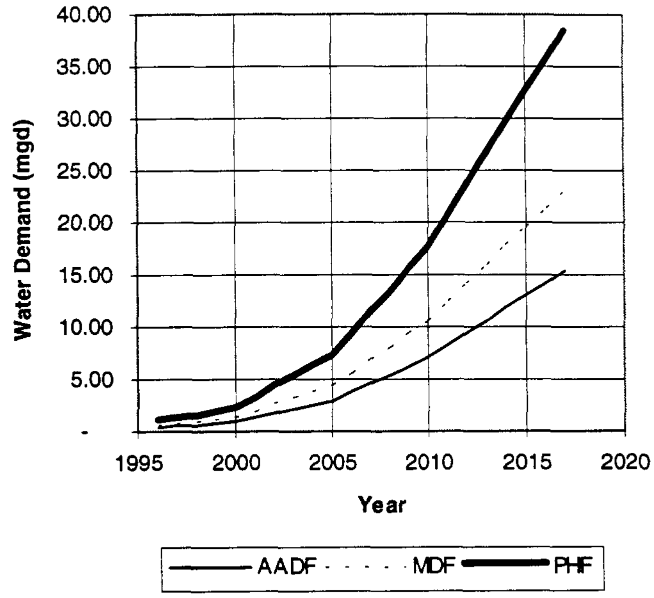


EXHIBIT 2-7
St. Johns North Wastewater Flow Projections, Including Likely Expansion Areas (in mgd)
Master Plan for Water and Wastewater Systems, St. Johns North Study Area

Year	AADF	MMADF	PHF
1996	0.25	0.30	0.63
1997	0.33	0.40	0.83
1998	0.40	0.48	1.00
1999	0.48	0.58	1.20
2000	0.55	0.66	1.37
2001	0.78	0.94	1.95
2002	1.01	1.21	2.53
2003	1.25	1.50	3.13
2004	1.48	1.78	3.70
2005	1.71	2.05	4.27
2006	2.19	2.63	5.48
2007	2.68	3.22	6.70
2008	3.16	3.79	7.90
2009	3.65	4.38	9.13
2010	4.13	4.96	10.33
2011	4.83	5.80	12.08
2012	5.53	6.64	13.83
2013	6.22	7.46	15.55
2014	6.92	8.30	17.30
2015	7.62	9.14	19.05
2016	8.30	9.96	20.75
2017	8.97	10.76	22.43

MMADF = 1.20 x AADF.
PHF = 2.50 x AADF.

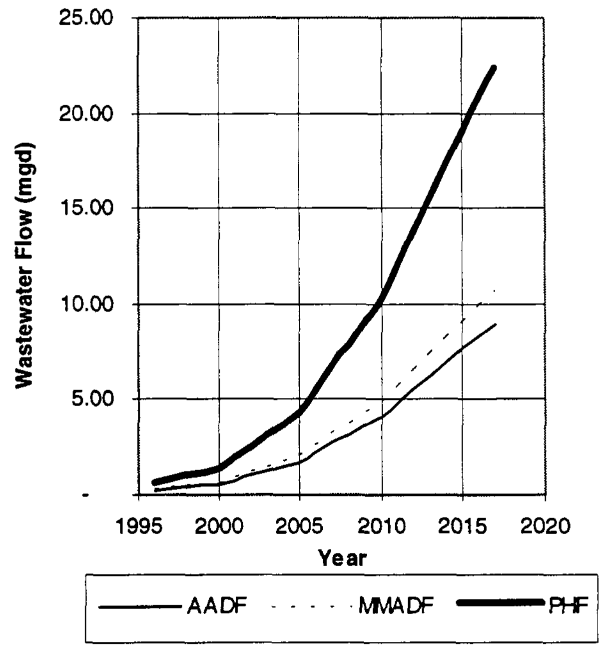


EXHIBIT 2-8
Water Demand and Wastewater Flow Projections (in mgd)
Master Plan for Water and Wastewater Systems, St. Johns North Study Area

		Water			Wastewater		
Year	**Total ERCs**	**AADF**	**MDF**	**MHF**	**AADF**	**MMADF**	**MHF**
1996	893	0.43	0.64	1.07	0.25	0.30	0.63
2000	1,964	0.95	1.41	2.36	0.55	0.66	1.37
2005	6,107	2.93	4.40	7.32	1.71	2.05	4.27
2010	14,750	7.08	10.61	17.71	4.13	4.96	10.33
2015	27,214	13.06	19.60	32.65	7.62	9.14	19.05
2017	32,036	15.37	23.07	38.44	8.97	10.76	22.43
Saturation Development	51,700	24.80	37.22	62.04	14.48	17.37	36.19

Section 3
Water and Wastewater Systems
Alternatives Evaluation

3. Water and Wastewater Systems Alternatives Evaluation

Two potentially viable alternatives were developed for each water and wastewater system prior to conducting more detailed evaluations of the development plan. The initial comparisons were made at the buildout condition. This section presents the results of the comparative evaluation. The supporting cost estimates are presented in Appendix B and summarized in this section. UWFL reviewed the evaluation and cost information and picked the alternative that best met its needs for providing service to this area. The selected water and wastewater alternatives are more fully developed in Sections 4 and 5 for water and wastewater, respectively.

3.1 Water Systems Alternatives

The water system evaluations assumed that multiple wellfields are needed to provide all of the water required for this service area. A looped water distribution network will be developed in pieces, dictated primarily by growth patterns. The primary difference in the alternatives will be whether three or four wellfields and WTFs are developed. It was assumed for the initial comparison that no special treatment will be required.

3.1.1 Description

Alternative 1 involves the construction of four wellfields and four WTFs, as presented in Exhibit 3-1. The four potential WTFs are located as follows:

1. St. Johns North WTF, located near Big Lige Branch, in the northwestern portion of the study area
2. St. Joes WTF, located near Kentucky Branch, in the western portion of the study area (near Switzerland, Florida)
3. County Road (CR) 210 WTF, located north of CR 210 near the Sunray Utilities WTF, in the central portion of the study area
4. US 1 WTF, located south of CR 210, between I-95 and US 1

Alternative 2 involves the construction of three, instead of four, wellfields and three WTFs, as presented in Exhibit 3-1. The three potential WTFs are located as follows:

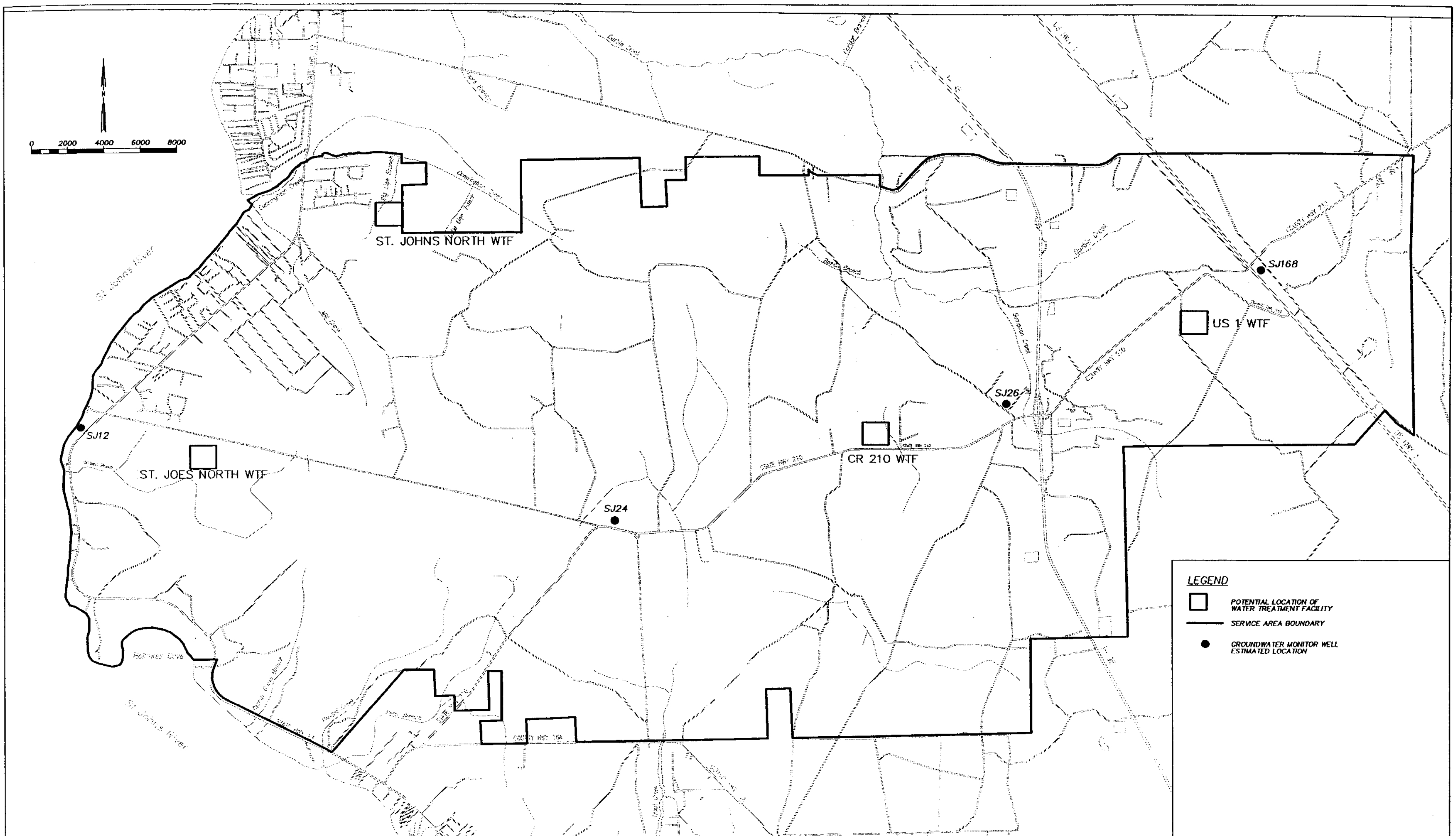


EXHIBIT 3-1
POTENTIAL WATER TREATMENT FACILITY LOCATIONS

1. St. Johns North WTF, located near Big Lige Branch, in the northwestern portion of the study area
2. St. Joes WTF, located near Kentucky Branch, in the western portion of the study area (near Switzerland, Florida)
3. CR 210 WTF, located north of CR 210, in the central portion of the study area

Alternative 2 is the same as Alternative 1, except that it does not include the US 1 WTF.

3.1.2 Evaluation of Alternatives

Economic and non-economic factors were considered in the evaluation of the alternatives. Discussion on each is presented in the following subsections.

3.1.2.1 Economic Factors

A relative alternative cost comparison was performed for both water alternatives. The cost estimates are based on facilities needed at complete system buildout and conventional tray aeration treatment at the WTFs. Costs were based on general estimating information, information provided by UWFL, experience on previous projects of similar scope, cost curve data, and quantity takeoffs from conceptual layouts using unit costs. No contingency, engineering, legal, or administrative costs were included in the estimates. No land costs were included in the estimates. The total annualized cost is based on a 20-year recovery period and an annual interest rate of 7.625 percent. Results of the cost comparison are presented in Exhibit 3-2.

EXHIBIT 3-2
Relative Alternative Cost Comparison Summary
Master Plan for Water and Wastewater Systems, St. Johns North Study Area

Alternative	Buildout Construction Costs	Buildout Annual O&M Costs	Total Annualized Cost
Alternative 1 - four WTFs St. Johns North (5.5 mgd, MDF) St. Joes (6.9 mgd, MDF) CR 210 (15.4 mgd, MDF) US 1 (9.3 mgd, MDF)	\$30,668,000	\$1,724,000	\$4,764,000
Alternative 2 - three WTFs St. Johns North (6.1 mgd, MDF) St. Joes (7.1 mgd, MDF) CR 210 (24.0 mgd, MDF)	\$31,369,000	\$1,459,000	\$4,567,000

The two water treatment alternatives compare closely in cost, with the four WTF alternative having a slightly higher total annualized cost than the three WTF alternative.

3.1.2.2 Non-Economic Factors

Operation and maintenance (O&M) demands will be slightly greater for the four WTF system. However, benefits of the four WTF system include improved system redundancy in the event that one of the plants has to be taken out of service; smaller water transmission main diameters in the eastern portion of the service area; and greater distribution of wellfield withdrawals within the service area, thus reducing localized impacts of groundwater withdrawals.

3.1.3 Selection of the Water System Alternative

Water Alternative 1 with four WTFs is recommended for Master Plan implementation. Factors in the selection were improved system redundancy and greater distribution of groundwater withdrawals. As Alternative No. 1 is implemented, UWFL may be able to initially construct a repump station at the site of the U.S. 1 WTF. The repump station would consist of a ground storage tank and high-service pumps. Later, water supply wells and treatment facilities could be added as demands warrant.

3.2 Wastewater Systems Alternatives

3.2.1 Description

Wastewater Alternative 1 is based on one regional WWTF, as presented in Exhibit 3-3. The potential wastewater system is located as follows:

1. Blacks Ford Swamp WWTF, located north of CR 210, near Blacks Ford Swamp

Alternative 2 is based on two regional WWTFs, as presented in Exhibit 3-3. The two potential wastewater systems are located as follows:

1. Blacks Ford Swamp WWTF, located north of CR 210, near Blacks Ford Swamp
2. US 1 WWTF, located south of CR 210, between I-95 and US 1

3.2.2 Evaluation of Alternatives

Economic and non-economic factors were considered in the evaluation of the alternatives. Discussion on each is presented in the following.

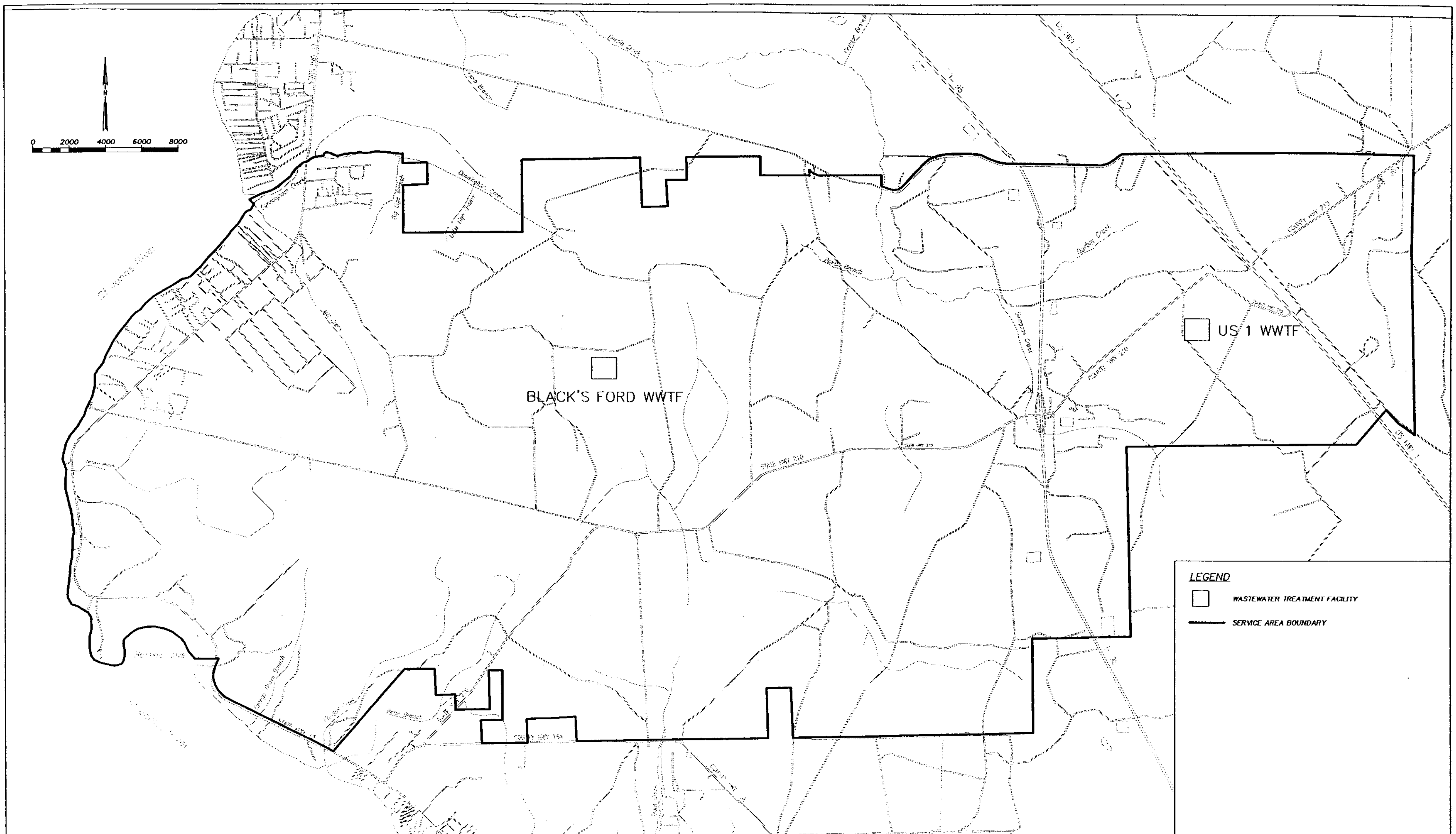


EXHIBIT 3-3
POTENTIAL WASTEWATER TREATMENT FACILITY LOCATIONS

3.2.2.1 Economic Factors

A relative alternative cost comparison was performed for both of the wastewater treatment alternatives. The cost estimates are based on facilities needed at complete system buildout. Costs were based on general estimating information, information provided by UWFL, experience on previous projects of similar scope, cost curve data, and quantity takeoffs from conceptual layouts using unit costs. No contingency, engineering, legal, or administrative costs were included in the estimates. No land costs were included in the estimates. The total annualized cost is based on a 20-year recovery period and an annual interest rate of 7.625 percent. Results of the cost comparison are presented in Exhibit 3-4. Alternative 2, with two WWTFs, had a higher total annualized cost than Alternative 1.

EXHIBIT 3-4
Relative Alternative Cost Comparison Summary
Master Plan for Water and Wastewater Systems, St. Johns North Study Area

Alternative	Buildout Construction Costs	Buildout Annual O&M Costs	Total Annualized Cost
Alternative 1 - one regional WWTF Blacks Ford Swamp (17.4 mgd, MMADF)	$68,617,000	$2,450,000	$9,250,000
Alternative 2 - two regional WWTFs Blacks Ford Swamp (7.4 mgd, MMADF) US 1 (10.0 mgd, MMADF)	$81,208,000	$2,451,000	$10,498,000

3.2.2.2 Non-Economic Factors

O&M would be consolidated at one WWTF site under Alternative 1, which would enable UWFL to realized reduced O&M costs compared to the two WWTF alternative. While the reliability of the system is somewhat reduced with the one WWTF alternative, it is not unusual for a service area of this size to be served by one WWTF. Additionally, intense development is expected near the second (easterly) WWTF.

3.2.3 Selection of the Wastewater System Alternative

Alternative 1 is recommended for Master Plan implementation. Factors in the selection were lower annualized cost and a desire by UWFL to consolidate WWTFs. Therefore, the Master Plan will be based upon one WWTF located north of Blacks Ford Swamp.

Section 4
Water Supply, Treatment, and Transmission

4. Water Supply, Treatment, and Transmission

This section describes the selected water system alternative including a discussion of water supply, water treatment, water storage and high-service pumping, and water transmission and distribution.

4.1 Potential Site Selection

Based on a preliminary evaluation and workshop results, four locations were selected for wellfields and WTFs:

1. St. Johns North WTF, located near Big Lige Branch, in the northwestern portion of the study area
2. St. Joes WTF, located near Kentucky Branch, in the western portion of the study area (near Switzerland, Florida)
3. CR 210 WTF, located north of CR 210, in the central portion of the study area
4. US 1 WTF, located south of CR 210, between I-95 and US 1

These locations were selected because they are near projected high-density population areas. Site-specific investigations will be needed before property acquisition to confirm site suitability.

4.2 Groundwater Supply and Quality

Groundwater supply for drinking water production is available in the Floridan aquifer system and the shallow aquifer system. Typical treatment in the region consists of hydrogen sulfide stripping and disinfection. High-quality groundwater is generally available only in the Floridan aquifer in the extreme western part of the service area near the St. Johns River. The limited hydrogeologic data indicate potential problems meeting drinking water standards in the majority of the service area. TDS concentrations vary from 114 mg/L near the St. Johns River to 999 mg/L in the central and eastern section of the service area (USGS, 1992). The secondary drinking water standard for TDS is 500 mg/L. Other major constituents in the groundwater are calcium, magnesium, sulfate, and bicarbonate. Data are not available on the color and total organic carbon (TOC) concentrations in the Floridan aquifer; however, the concentrations are expected to be low. Representative Floridan water quality analyses are presented in Exhibit 4-1.

EXHIBIT 4-1
Representative Floridan Water Quality Analyses (1988)
Master Plan for Water and Wastewater Systems, St. Johns North Study Area

	Local Well No.				
	West			East	Secondary Drinking
Groundwater Constituent	SJ-12	SJ-24	SJ-26	SJ-168	Water Standards
pH (SU)	8.1	7.6	7.6	7.5	6.5 to 8.5
Silica (SiO_2) (mg/L)	12	17	20	19	NA
Calcium (Ca) (mg/L)	18	75	95	170	NA
Magnesium (Mg) (mg/L)	10	40	46	60	NA
Sodium (Na) (mg/L)	5.5	12	14	15	NA
Potassium (K) (mg/L)	1.6	2.8	2.9	3.0	NA
Strontium (Sr) (mg/L)	0.8	4.0	5.2	7.8	NA
Chloride (Cl) (mg/L)	4.8	14	18	34	250
Sulfate (SO_4) (mg/L)	15	350	310	540	250
Fluoride (F) (mg/L)	0.5	0.6	0.7	0.9	2.0
Alkalinity (mg/L as $CaCO_3$)	81	103	121	109	NA
Hardness (mg/L as $CaCO_3$)	87	na	430	680	NA
TDS (mg/L)	114	521	651	999	500

$CaCO_3$ = calcium carbonate.
Note: See Exhibit 3-1 for well locations.
Source: USGS, 1992

In areas with high TDS, sulfate concentrations also exceed secondary drinking water standards. Sulfate concentrations vary from 15 mg/L near the St. Johns River to 540 mg/L in the central and eastern section of the service area. The secondary drinking water standard for sulfate is 250 mg/L.

The shallow aquifer system in the study area actually is composed of two separate aquifers. The uppermost of these aquifers is the surficial aquifer (also referred to as the *water table* or unconfined aquifer). The deeper component of the shallow aquifer is the intermediate aquifer (also referred to as the *secondary artesian aquifer*). With only a few exceptions, published groundwater reports covering the study area provide little useful information on shallow aquifers.

FDEP rules allow the TDS standard of 500 mg/L to be exceeded if no other maximum contaminant level is exceeded. However, for those wells that exceed the TDS standard, the sulfate standard of 250 mg/L is also generally exceeded. FDEP's Northeast District has granted sulfate limit waivers of up to 500 mg/L to other utilities. A new federal regulatory proposal for a sulfate standard of 500 mg/L is expected to be accepted by EPA. UWFL should monitor the status of the sulfate rule because the outcome will be important to water system planning in the St. Johns North service area.

4.2.1 Wellfield Locations

Under the selected alternative, four wellfields will be located in the St. Johns North service area. The four wellfields will be co-located with the four WTFs. Additional investigation is required before the final sites for the wellfields are selected. All potential sites in the study appear to be suitable for locating a wellfield. Of all the water plant sites, extensive groundwater quality information was available in this study only for the St. Johns North plant, which obtains high-quality groundwater from the Floridan aquifer. The St. Joes site is expected to have good quality Floridan groundwater. The CR 210 and US 1 sites are expected to have poorer water quality and be similar in water quality and well-specific capacity. Except for the water quality differences in the Floridan previously described, no known hydrogeologic conditions within the study area favor selecting any particular site for development of a wellfield. Wellfield siting has been based primarily upon proximity to the planned water plants.

4.2.2 Well Yields and Well Design

Wellfield capacity is generally based on MDF demands. It is also recommended that a reserve capacity of 20 percent of total capacity be provided for backup and reliability. For very small systems, at least one supply well should be provided for backup. In the future, as the service area develops and interconnections are achieved between subregional WTFs, some backup wells can be shared as part of the overall system redundancy evaluation.

A typical 16-inch Floridan aquifer well, cased to about 250 feet and drilled to between 650 and 950 feet, can be expected to yield between 1,200 and 1,600 gallons per minute (gpm). For planning purposes, these wells should be spaced 1,000 to 2,000 feet apart. Shallow aquifer wells are expected to yield from 100 to 400 gpm in favorable locations but be highly variable from place to place. Shallow well spacing is expected to range from approximately 600 to 1,500 feet.

4.2.3 Blending to Achieve Quality Goals

Based on a preliminary review of hydrogeologic information for the study area, groundwater supplies will be adequate to yield projected 2017 demands. The primary production zone in the Floridan aquifer will be the upper Floridan aquifer and the upper part of the lower Floridan aquifer. At the CR 210 WTF and the US 1 WTF, UWFL may be able to blend low sulfate and TDS water from the shallow aquifer with water from the Floridan aquifer to produce water that complies with drinking water standards.

Under a blending plan, groundwater withdrawn from both the Floridan and shallow aquifers could be blended in proportions needed to yield a finished water that meets federal and state drinking water standards. Blending is currently practiced at the Sunray Utilities WTF. There, a 50/50 blend of Floridan and shallow aquifer water is provided to yield a finished water in compliance with regulations. Preliminary indications are that a 50/50 blend of Floridan shallow aquifer water will be needed to meet that objective at the two eastern proposed plant sites. Less, and possibly no, blending with shallow aquifer water may be needed for blending at the western plant sites.

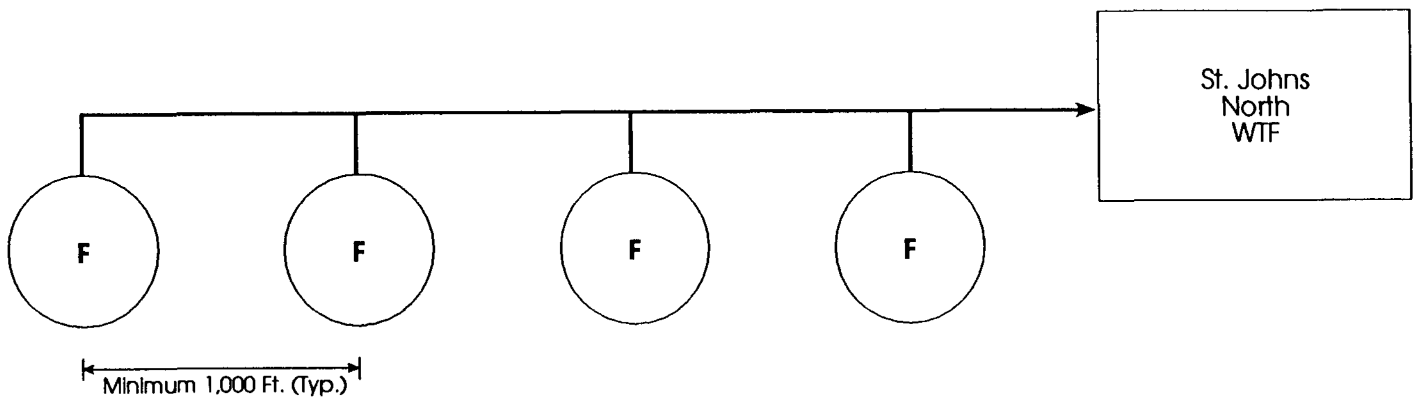
For shallow aquifer water to blend with Floridan water, wells will be installed in clusters that consist of one Floridan well and multiple shallow aquifer wells at the CR 210 WTF and the US 1 WTF. Schematic wellfield drawings for each of the four WTF sites are presented in Exhibits 4-2 through 4-5. Exhibit 4-6 summarizes the required water supply system for each of the four WTF sites. The estimate of well quantities is preliminary and is based on the assumption that Floridan wells and shallow wells will have average yields of 1,200 gpm and 300 gpm, respectively. Additionally, the estimate is based on assuming that four 300-gpm shallow wells will blend with each 1,200-gpm Floridan well to yield a blended water in compliance with TDS and sulfate regulations. These assumptions will need to be confirmed by site-specific hydrogeological investigations. The wells and well pumps have been sized to meet MDF.

4.2.4 Groundwater Feasibility Study

As discussed previously, very limited data is available on the quantity and quality of groundwater in the service area. Although data exist for Duval County, the data are not representative of the St. Johns North service area. Based on experience in the St. Augustine, Palatka, and Palm Coast areas, significant variability in yield and water quality of the shallow aquifer and quality of the Floridan aquifer can be expected. Therefore, a planning phase groundwater feasibility study is recommended at all sites prior to WTF implementation.

4.2.4.1 General Approach

The wellfield feasibility investigation should be planned and conducted in two phases. The approach to each phase is discussed in the following sections.



Legend

F Floridan Aquifer Well and Well Pump

Exhibit 4-2. St. Johns North WTF Wellfield Schematic.
United Water Florida, St. Johns North

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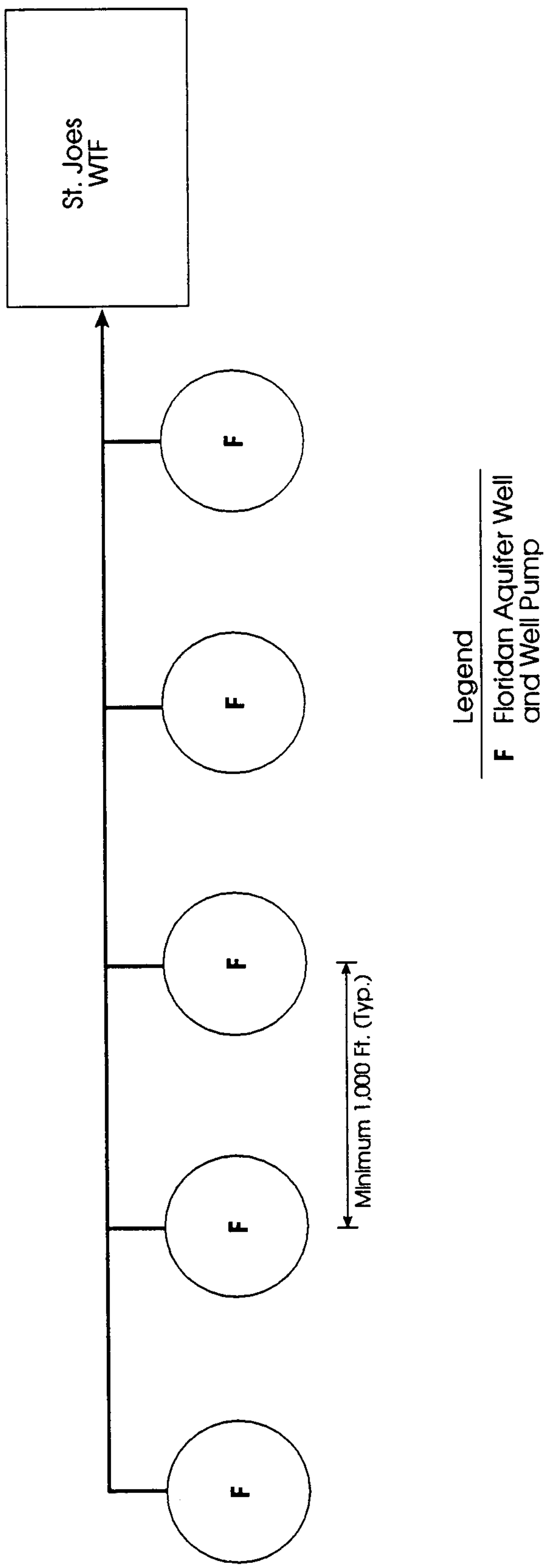

Exhibit 4-3. St. Joes WTF Wellfield Schematic.
United Water Florida, St. Johns North

137651.A0.MP 4/97 GNV

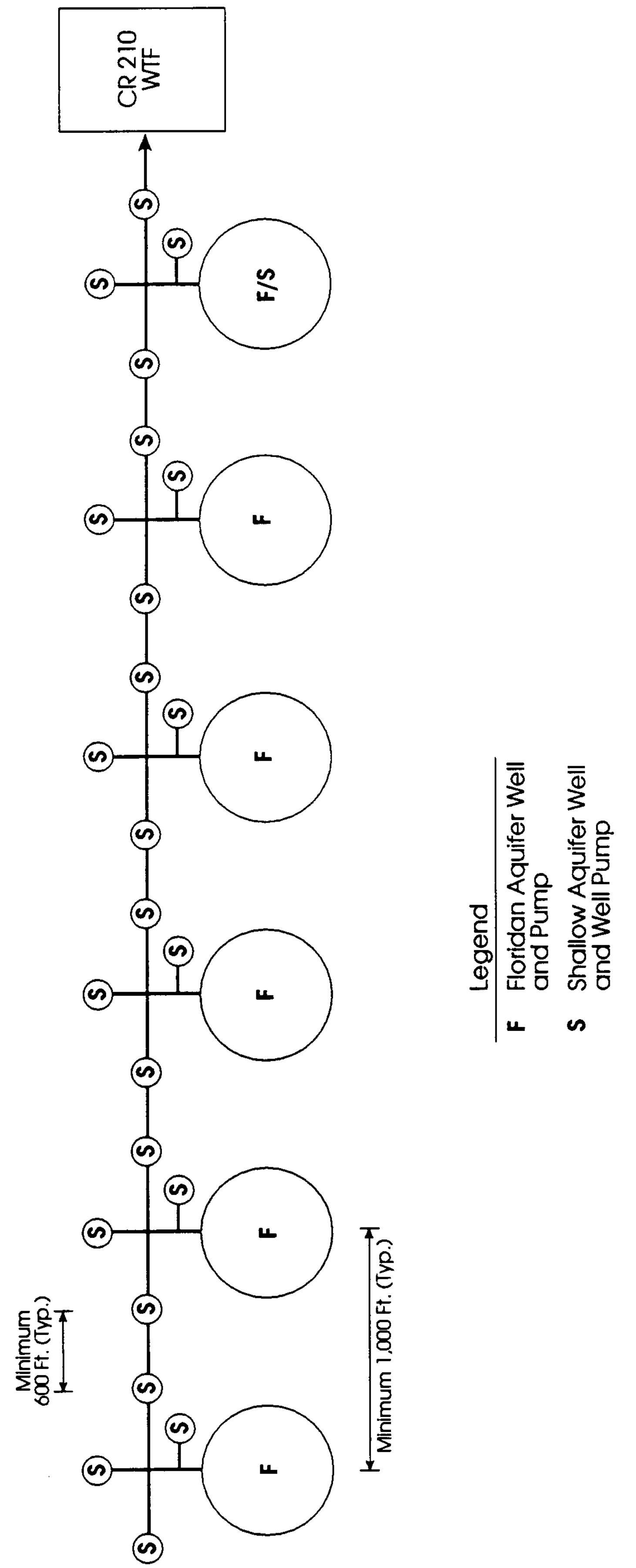

Exhibit 4-4. CR 210 WTF Wellfield Schematic
United Water Florida, St. Johns North

CH2MHILL

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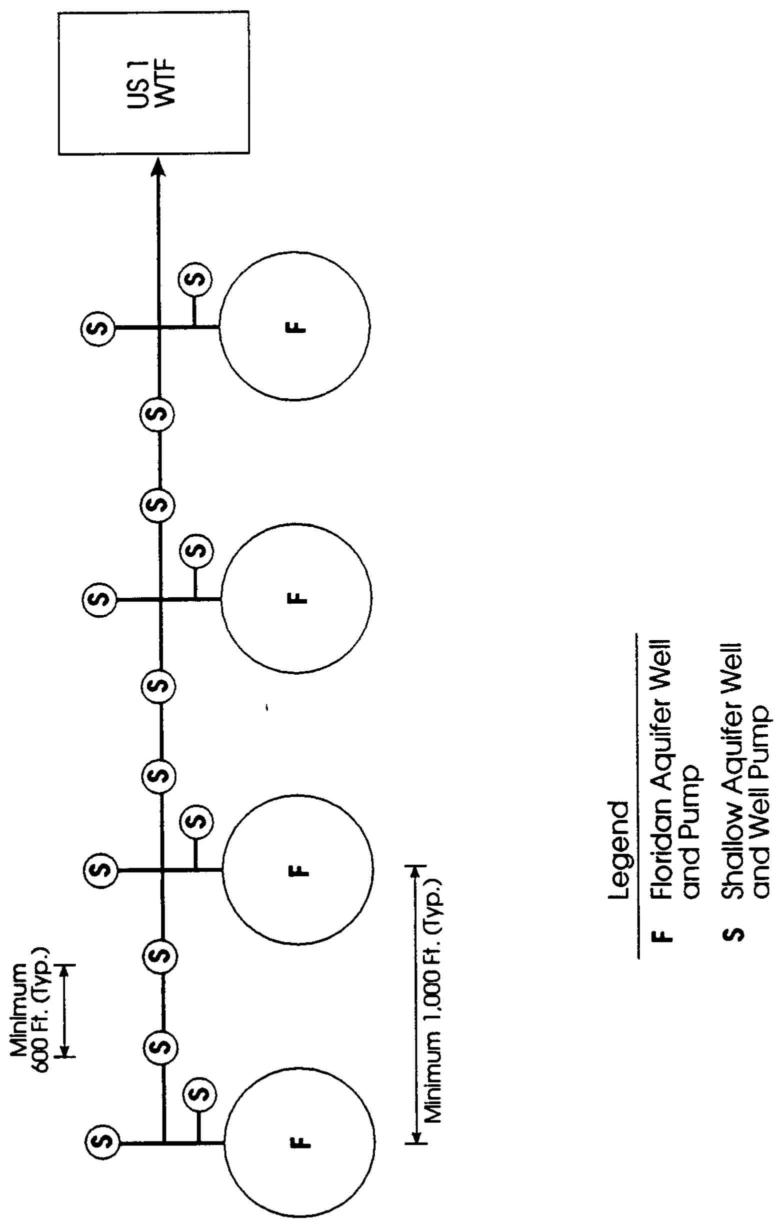


Exhibit 4-5. US 1 WTF Wellfield Schematic
United Water Florida, St. Johns North

CH2MHILL

EXHIBIT 4-6
Water Supply System Summary
Master Plan for Water and Wastewater Systems, St. Johns North Study Area

	St. Johns North WTF	St. Joes WTF	CR 210 WTF	US 1 WTF
MDF (mgd)	5.5	6.9	15.4	9.3
Number of Floridan Wells (1,200 gpm each)				
Firm	3	4	5	3
Reserve[a]	1	1	1	1
Total	4	5	6	4
Number of Shallow Wells (300 gpm each)				
Firm	0	0	18	11
Reserve[a]	0	0	4	2
Total	0	0	24	13

[a]Reserve capacity based on 20 percent minimum of firm capacity wells.

4.2.4.2 General Approach

The wellfield feasibility investigation should be planned and conducted in two phases. The approach to each phase is discussed in the following sections.

Phase I Feasibility Investigation

Phase I would assess groundwater quality and availability in the area, based on a more in-depth, comprehensive review of available data. Phase I investigations should include the following data sources:

- Consultant reports prepared in support of consumptive water use permits and filed with the St. Johns River Water Management District (SJRWMD)
- SJRWMD water use and well construction permit files

Phase I investigations would identify potential groundwater sources and indicate areas potentially most favorable for groundwater development. In the Phase I investigation, an expected range of water quality indicators would be defined, and a conceptual design for production wells (size, depth, yield, spacing, etc.) would be completed. The Phase I findings are expected to yield more definitive information for the Floridan aquifer than for the shallow aquifer. Few reports on the shallow aquifer are expected to be on file because the 4-inch casing diameter of most wells completed in either component of the shallow aquifer is below the threshold size for which obtaining a water use permit is required.

Phase II Feasibility Investigations

Phase II investigations would focus on the shallow aquifer and on specific sites and would include test drilling, aquifer testing, and groundwater sampling to confirm Phase I findings and to develop initial design criteria for water production and treatment facilities.

The recommended test drilling will probably include drilling at two locations near each of the four proposed WTF sites (eight locations). There will be two shallow wells at each location; one 6-inch production test well and one 4-inch observation well (sixteen wells). Six-inch test wells are proposed because test results from 4-inch wells translate poorly into actual achievable production rates. UWFL could elect to increase the size of the larger test well to 8 inches and convert it to a production well later.

It is recommended that Floridan aquifer test wells be drilled at each proposed plant site to provide specific aquifer hydraulic characteristics to support wellfield design and permitting activities and also to establish groundwater quality for establishing treatment requirements.

4.2.4.3 Wetlands Issues

SJRWMD will probably require groundwater modeling to assess the impact of wellfield pumpage where wetlands are adjacent. SJRWMD has already performed some modeling as well as a District-wide assessment of *Potential Impacts on Wetlands* using a geographic information system (GIS). SJRWMD's work addresses impacts of withdrawals from the Floridan aquifer. The effect of pumping from the shallow aquifer, especially the water table portion, may be greater. However, these effects of pumping may be offset to some degree by the proposed application of wastewater in wetland areas if the application and pumping take place in the same general area.

4.2.5 Estimated Well Construction Cost

Estimated cost of constructing a typical 16-inch Floridan well, 950 feet deep, is $80,000 to $120,000, not including land and surface facilities. The estimated cost of constructing a typical 12-inch shallow aquifer well, 120 to 140 feet deep, is $15,000 to $20,000, excluding land and surface facilities. Estimated test well construction cost is $50,000 to $70,000 for the shallow aquifer testing.

4.3 Water Treatment Process Description

The current water treatment practice in the St. Johns North service area is limited to hydrogen sulfide stripping and disinfection. If blending is not feasible, sulfate and TDS removal may be required. Another potential option for UWFL is to request a waiver on sulfate limits up to 500 mg/L. When the sites for the proposed WTFs have been finalized, the raw water at each site must be thoroughly investigated and regulatory limits established before WTF design begins. Also, during the course of the planning period, there is the potential for changes in water treatment requirements if new, more stringent maximum contaminant levels are established by FDEP and the U.S. Environmental Protection Agency (EPA). It is possible that currently acceptable treatment methods will not adequately comply with future regulations.

4.3.1 Treatment Standards

Treated water will need to meet primary and secondary drinking water standards, as contained in Chapter 62-520, Florida Administrative Code (FAC).

4.3.2 Process Options

If blending and/or regulatory waivers are not feasible, potentially feasible treatment process alternatives for sulfate removal are anion exchange and membrane technologies. Membranes would be suitable for both TDS and sulfate removal. For each treatment technology, a waste stream will be generated. If water quality data indicate that further treatment is required, pilot treatment studies should be conducted to determine the most cost-effective treatment system.

4.3.2.1 Anion Exchange Process

Small demonstration studies at several south Florida utilities have shown the anion exchange process effective at reducing natural organic matter. Anion exchange resins are commonly used in industrial applications to remove organic concentrations in the production of high purity water and decolorization of food components (syrup, molasses, etc.). Applications in municipal drinking water systems are limited. The reasons for limited use of anion exchange technology generally revolve around the difficulty of disposing of regenerant, variable organic removal efficiency depending upon natural organic chemistry, and the potential for irreversible organic fouling if the resin is not properly selected or regenerated. Anion exchange pilot studies have been conducted in Palm Coast, Florida; Broward County, Florida; Pembroke Pines, Florida; and Cooper City, Florida.

Anion exchange has been used on a limited basis for color removal and sulfate removal. Generally, sulfate is preferentially removed by anion exchange resin. The exchange resins used in sulfate removal tend to have short run times; therefore, more regenerant is required and more spent regenerant is created. Potentially feasible options for regenerant disposal include sending it to the WWTF through the sanitary sewer system or blending it with WWTF effluent for wetlands disposal.

4.3.2.2 Membrane Technologies

Membrane technologies include reverse osmosis and nano-filtration (membrane softening). Both membrane types are capable of removing TDS and sulfates. An advantage of membrane technology over anion exchange is the ability to remove a broader range of constituents, thereby producing an overall higher quality of finished water. A disadvantage of membranes is the higher cost of construction and operation. Membrane processes will generate reject-water (or concentrate) that could total 10 to 20 percent of the finished water flow. Potentially feasible options for reject-water disposal include sending it to the WWTF through the sanitary sewer or blending it with WWTF effluent for wetlands disposal.

4.3.2.3 Water Treatment Recommendations

UWFL should pursue the lowest cost options for meeting drinking water standards. These would include continuing hydrogen sulfide stripping or oxidation and groundwater blending where feasible. If blending is not feasible and regulatory waivers cannot be obtained, anion exchange and membrane treatment should be more fully investigated. Disposal of the waste streams from either of these processes may be difficult to permit.

4.3.3 Disinfection Options

A variety of methods are currently used for disinfecting drinking water. The following sections describe the available options.

4.3.3.1 Chorine Gas

Gaseous chlorine is a proven disinfection method for water and provides a residual in the distribution system. It is also well-suited for facility expansions. In water treatment systems, a chlorine contact tank is not required. However, there are safety issues related to the potential release of chlorine gas to the environment, and it is likely that the chlorine storage and feed areas would need to be in an enclosed building with an automatic sprinkler system, leak detectors, alarms, and an emergency gas scrubber.

4.3.3.2 Liquid Hypochlorite

Sodium hypochlorite has become a popular alternative to gaseous chlorine. It provides similar disinfection properties as gaseous chlorine as well as a residual in the distribution system. The additional cost of this method is associated with the purchase and storage of the liquid hypochlorite, and the purchase, operation, and maintenance of the chemical feed pumps. Alternatively, systems can be purchased that generate hypochlorite onsite using brine solutions as the source. Because these are liquid systems, an emergency gas scrubbing system would not be required.

4.3.3.3 Water Disinfection Recommendations

In the early phases of the individual water plants, UWFL should use gaseous chlorine for disinfection. As expansions are implemented, UWFL should evaluate conversion to liquid sodium hypochlorite. Sodium hypochlorite has a higher O&M cost but offers a safety advantage over gaseous chlorine.

4.3.4 Unit Process Summary

The proposed basic water supply and treatment process is presented schematically in Exhibit 4-7.

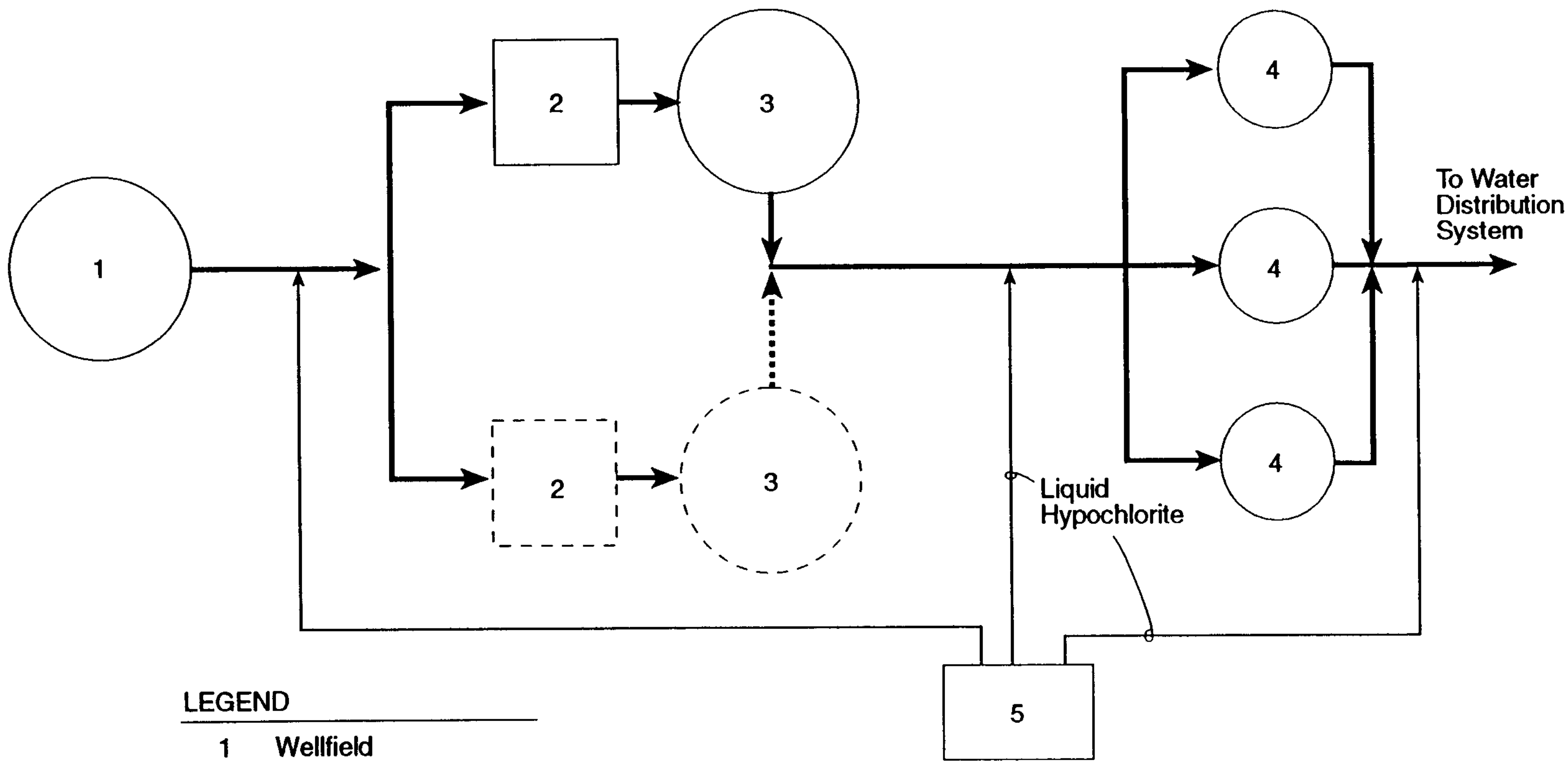
4.4 Water Storage and High-Service Pumping

Storage tank capacity is typically based on equalization storage capacity requirements plus fire flow storage requirements. Equalization storage is calculated by subtracting the MDF from the MHF and multiplying the difference by an assumed duration that MHF exceeds MDF. Typically, it is assumed that the MHF may exceed the MDF for 6 hours. For example, to calculate equalization storage capacity in 2017, the difference between MHF and MDF is 15.37 mgd (equal to 38.44 mgd minus 23.07 mgd) or 10,667 gpm during a 6-hour period, equal to 360 minutes; a total equalization storage volume of 3.8 MG is recommended.

Fire flow requirements within the study area have been reported by UWFL to be 500 gpm for residential areas and 2,000 gpm for commercial and multi-story non-residential development. The assumed duration to meet fire fighting requirements is 2 hours (120 minutes) for a 2,000-gpm fire flow (AWWA Manual M31). This represents a fire demand storage requirement of 240,000 gallons (0.24 MG).

Additional storage tank capacity must be provided to account for dead space within the bottom of the tank needed to avoid pump cavitation and sediment disturbance. It is recommended that 25 percent of tank capacity be reserved for dead storage contingency.

It has been assumed that, at saturation development, each water plant would have two storage tanks, each with one half of the total storage needs. Tank diameters were determined by selecting the *most economical diameter* as reported by the Crom Corporation of Gainesville, Florida. Exhibit 4-8 summarizes the storage tank needs for the two system alternatives.



LEGEND

1 Wellfield
2 Tray Aerator
3 Ground Storage
4 High-Service Pump
5 Hypochlorite Facilities
—— Initial
- - - - Future

Exhibit 4-7. Water Treatment Facility Simplified Flow Schematic.
United Water Florida, St. Johns North.

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Finished water storage and high-service pumping capacity will be provided to meet near-term demand projects. Initially, one ground storage tank (GST) will be provided per WTF site. As demands increase, a second GST will be added at each WTF site and additional high-service pumps will be provided.

EXHIBIT 4-8
Water Storage Requirements
Master Plan for Water and Wastewater Systems, St. Johns North Study Area

Facility	No. of Tanks	Capacity, each	Total Capacity	Diameter, feet
St. Johns North WTF	2	1.0 MG	2.0 MG	80
St. Joes WTF	2	1.1 MG	2.2 MG	80
CR 210 WTF	2	2.1 MG	4.2 MG	100
US 1 WTF	2	1.4 MG	2.8 MG	90

4.5 Land Requirements

Estimated total land requirements for the WTFs are presented in Exhibit 4-9. Minimum land needs are based on conventional treatment, and maximum land needs are based on membrane treatment. Land allowance includes civil/site requirements. For wells, a parcel on the order of 20 feet square is recommended for shallow wells and 30 feet square for Floridan wells.

EXHIBIT 4-9
Land Requirements for WTFs
Master Plan for Water and Wastewater Systems, St. Johns North Study Area

Facility	Capacity at Buildout (MDF)	Land Requirements	
		Minimum	Maximum
St. Johns North WTF	5.5 mgd	4 acres	7 acres
St. Joes WTF	6.9 mgd	4 acres	7 acres
CR 210 WTF	15.4 mgd	6 acres	10 acres
US 1 WTF	9.3 mgd	5 acres	8 acres

4.6 Water Transmission

The future water transmission system was developed through the use of CH2M HILL's computer hydraulic network model, NETWK. Input parameters to the model included pipe length, internal diameter, and roughness coefficient; pipe junctions (nodes); flow demands; and pump characteristics.

The model was developed using a map of the service area and routing future pipes along roadway corridors and utility easements, where possible, and routing across undeveloped areas where no corridor or other right-of-way exists. The criteria for the network modeling of the water system included the following:

- Pressure at the discharge of high-service pumps are 70 psi. Normal operating pressures in the distribution system are between 50 and 60 pounds per square inch (psi).
- Maintain minimum pressures in trunk mains at 30 psi during emergencies and fire flows. The minimum level of service should be 20 psi. This approach provides a 10 psi contingency for pressure losses in the smaller distribution mains coming off the trunk mains.
- Evaluate pressures at PHF conditions.
- Evaluate pressures at MDF conditions with fire flows.
- Assume fire flows at 2,000 gpm in commercial areas and 500 gpm in residential areas.

Water demands throughout the service area were allocated to pipe nodes within the model. The demands were distributed geographically to be representative of estimated growth characteristics of the service area. No more than one fire flow at a time was modeled. Fire flow simulations were run with fire demands at six different locations, generally at the fringes of the main system, to stress the network.

The pipe diameters presented in Exhibit 4-10 represent capacity requirements for fire flows and buildout water demands. UWFL may elect to install smaller size pipes in the early phases of development of the service area. As development occurs, UWFL should rerun the network model to assess the impacts of the development and to select actual pipe size for implementation. The sizes shown on Exhibit 4-1 are intended to serve as a *road map* for planning purposes. UWFL may elect to install smaller pipes but the buildout model presents a forecast of the sizes that will ultimately be needed to meet demands.

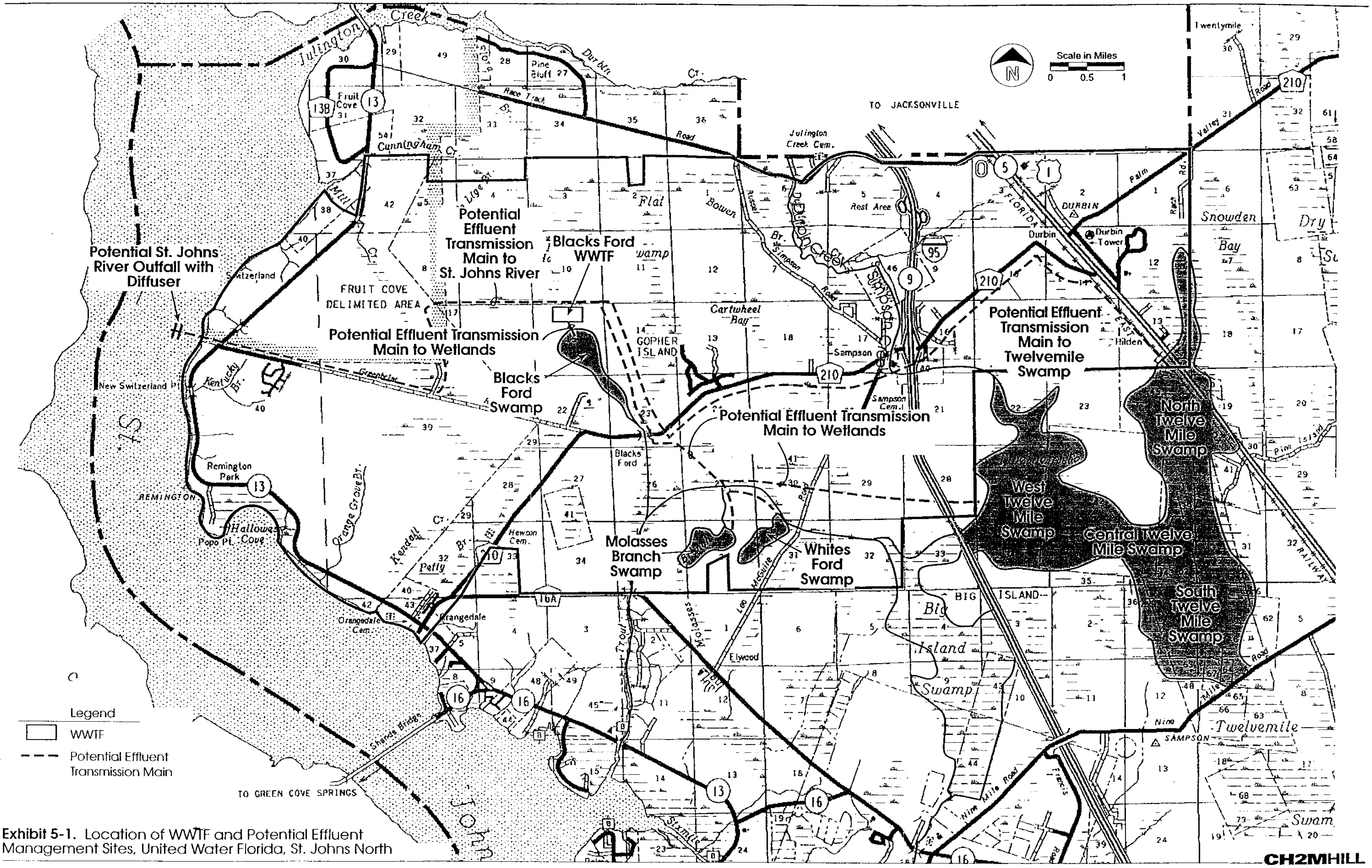

Exhibit 5-1. Location of WWTF and Potential Effluent Management Sites, United Water Florida, St. Johns North

CH2MHILL

4.7 Phasing Plan

Phasing of water system facilities will be driven largely by the location of development projects. As development occurs, UWFL will need to evaluate alternatives for providing water service, taking into account which WTF is best suited to meet service and transmission requirements. The first areas expected to be developed are along SR 13 and CR 210.

4.7.1 Water Supply and Treatment Phasing

UWFL will need to allow adequate time to complete investigations, especially before the first phase of the three planned WTFs. For all but the existing St. Johns North WTF, UWFL will need to conduct hydrogeologic investigations to establish groundwater quality, to establish the feasibility of blending (if needed), and to determine if additional treatment is needed. UWFL should consider implementing these investigations early because if it is determined that additional treatment is needed, considerable time may be needed to plan for more costly treatment systems and to resolve regulatory issues related to process waste stream disposal.

Initially, only one ground storage tank will be constructed at each WTF. As water demands increase, a second and final tank will be constructed at each site. Well installation and high-service pumping capacity will be constructed to meet near-term demand projection on a site-by-site basis.

4.7.2 Water Transmission Phasing

As with supply and treatment, transmission main phasing will be dependent on development activity. Mains are expected to be needed along SR 13 and CR 210 during the early phases of the planning period. The pipes shown on Exhibit 4-10 represent buildout needs and UWFL has some latitude to construct smaller mains initially as suits the development needs. However, many of the main sizes were established based on meeting fire demands, and UWFL will probably find that meeting fire demand requirements will govern minimum transmission main sizes.

Section 5

Wastewater Transmission, Treatment, and Disposal

5. Wastewater Transmission, Treatment, and Disposal

This section describes the selected wastewater system alternative and the associated methods of effluent management, effluent disinfection, wastewater treatment, and wastewater collection.

5.1 Potential Site Selection

Based on a preliminary evaluation and workshop results, the selected location for a regional WWTF for the St. Johns North service area is north of CR 210, near Blacks Ford Swamp. This site was selected because it is central to the St. Johns North service area, near the initial proposed receiving wetland, Blacks Ford Swamp, and remote from developed areas. Site-specific investigations are planned to confirm site suitability for placement of the WWTF.

5.2 Effluent Management Options

Effluent management options include wetlands application, surface discharge, and water reclamation. Exhibit 5-1 presents the proposed location of the WWTF and prospective effluent management facilities including a surface discharge outfall and receiving wetlands. These potentially feasible effluent management methods are discussed in the following section.

5.2.1 Wetland Application

FDEP regulations allow two types of wetlands systems to receive wastewater effluent: treatment wetlands and receiving wetlands. As the name implies, treatment wetlands provide additional treatment beyond that provided at the WWTF for permitting purposes; typically further reduction of phosphorus and nitrogen. Receiving wetlands serve as an effluent disposal system. Treatment wetlands are very land intensive and typically require modification to control flow patterns and specific vegetation to achieve the treatment goals. Operational monitoring requirements are also much more extensive than for receiving wetlands. For this reason, land acquisition and costs can be high.

Because there are extensive existing wetland systems within the service area, this Master Plan evaluation will focus on the feasibility of using receiving wetlands for effluent management. FDEP rules allow receiving wetlands to start at a hydraulic loading rate of

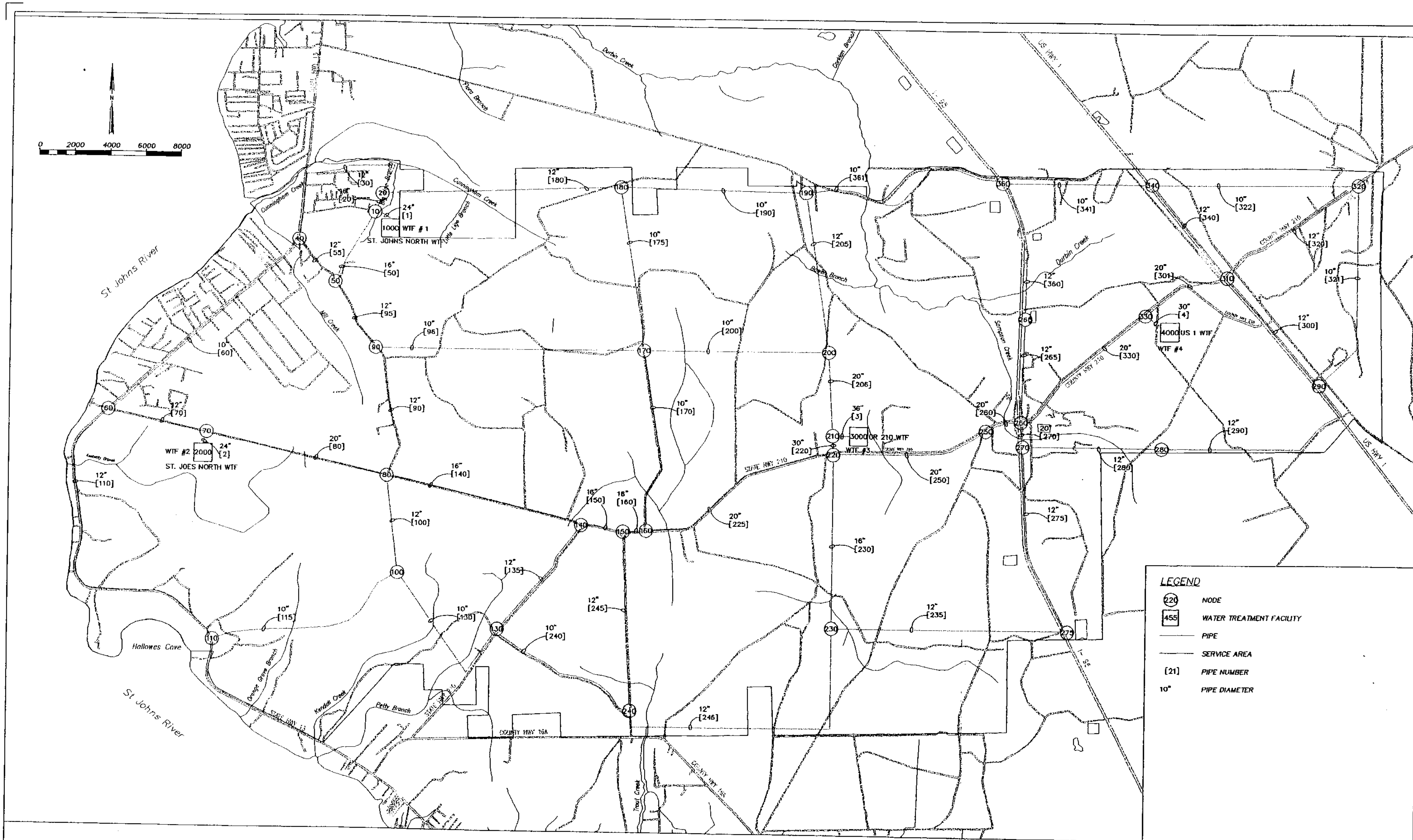

EXHIBIT 4-10
FUTURE WATER TRANSMISSION MAIN NETWORK

2 inches per week. If the ecosystems within the wetland are not negatively affected after operation, the rules allow the loading rate to increase to up to 6 inches per week. Exhibit 5-1 A preliminary wetland investigation has been performed by CH2M HILL to identify potential wetlands for wastewater disposal. Information was collected and a preliminary assessment performed of potential wetland sites through field reconnaissance including both windshield and walking assessments and aerial photo/map interpretation. Potential wetlands were assessed relative to size, dominant vegetation, estimated flow capacity, and overall suitability for wastewater disposal.

Exhibit 5-2 summarizes the size, dominant vegetation, estimated flow capacity, and potential for use for each of the wetlands assessed as part of this effort. Discussion on each of these potentially-feasible receiving wetlands is presented in the following sections.

EXHIBIT 5-2
Possible Treatment and Receiving Wetland Sites in North St. Johns County
Master Plan for Water and Wastewater Systems, St. Johns North Study Area

Site Name	Wetland Site Area (acres)	Estimated Flow Capacity[a]	Dominant Plant Communities	Receiving Waters	Estimated Suitability
Blacks Ford Swamp	260	2.0	Mixed Pine/ Hardwood Swamp	Trout Creek/ St. Johns River	3
Sampson Swamp	440	3.4	Mixed Pine/ Hardwood Swamp	Trout Creek/ St. Johns River	1
Molasses Branch Swamp	100	0.8	Hardwood Swamp	Trout Creek/ St. Johns River	4
Whites Ford Swamp	140	1.1	Hardwood Swamp	Trout Creek/ St. Johns River	4
Twelvemile Swamp @ I-95	300	2.3	Mixed Pine/ Hardwood Swamp	Trout Creek/ St. Johns River	2
Twelvemile Swamp-North	200	1.5	Hardwood Swamp	Trout Creek/ St. Johns River	4
Twelvemile Swamp-Central	200	1.5	Hardwood Swamp	Trout Creek/ St. Johns River	4
Twelvemile Swamp-South	300	2.3	Hardwood Swamp	Trout Creek/ St. Johns River	4

Note: Estimated suitability for compliance with the biological and design criteria in Chapter 62-611 FAC based on a scale of 1 to 5, with 5 indicating highest estimated suitability.
[a]In mgd at 2 inches per week.
Source: Technical Memorandum from Bob Borer/CH2M HILL (11/7/96).

5.2.1.1 Blacks Ford Swamp

Blacks Ford Swamp was initially investigated by CH2M HILL as a future wetland application site for wastewater treatment from the St. Johns North WWTF. Blacks Ford Swamp is a Class III freshwater, forested wetland located 5 miles east of Switzerland, Florida. Blacks Ford Swamp includes about 200 acres of mixed deciduous swamp and

95 acres of loblolly bay (*Gordonia lasianthus*) forest for a total of about 295 acres. The discharge from Blacks Ford Swamp flows south under CR 210 and joins with the east branch of Trout Creek.

The Blacks Ford Swamp basin is large enough to accommodate 2 mgd of treated effluent at an average annual hydraulic loading rate of 2 inches per week. The soil is organic and poorly drained. Blacks Ford Swamp is presently owned by Rayonier and is within an area of intensive forest management activity. Exhibit 5-2 summarizes the size, vegetation, estimated flow capacity, and potential for use of the wetland areas for Blacks Ford Swamp.

The discharge from Blacks Ford Swamp flows south under CR 210 and joins with the east branch of Trout Creek. Trout Creek is a Class III waterbody that drains south to the St. Johns River, also a Class III waterbody in St. Johns County. Trout Creek's flow is from a low-fertility, forested watershed consisting of pine plantations and hardwood deciduous swamp, including blackgum (*Nyssa sylvatica var. biflora*), cypress (*Taxodium ascendens*), bays, and red maple (*Acer rubrum*).

Maximum capacities for Blacks Ford Swamp have been estimated for two different influent hydraulic loading rates. At 2 inches per week (recommended for unaltered treatment and receiving wetlands), the maximum hydraulic loading into the Blacks Ford swamp would be 2 mgd. At 6 inches per week (common for hydrologically altered treatment wetlands), the loading would be approximately 6.1 mgd.

5.2.1.2 Whites Ford and Molasses Branch Swamps

Whites Ford and Molasses Branch Swamps are shown on Exhibit 3-3. Whites Ford Swamp, which is located east of Molasses Branch Swamp, is approximately 140 acres compared to the 100 acres of Molasses Branch Swamp. A windshield investigation was conducted on both swamps, and a walking investigation was conducted on Whites Ford Swamp. Based on a review of aerial photographs, it is assumed that Molasses Branch Swamp possesses similar vegetation, soils, and hydrology as compared to Whites Ford Swamp at 2 inches per week. Whites Ford and Molasses Branch Swamps have a combined hydraulic loading capacity of 1.9 mgd. Discharges from both Whites Ford and Molasses Branch Swamps flow into a common discharge channel and eventually into Trout Creek, which flows south.

5.2.1.3 Twelvemile Swamp

Twelvemile Swamp North, Central, and South refer to potential treatment or receiving wetlands. Twelvemile Swamp, a large forested wetland system, comprises more than 1,000 acres in St. Johns County. Its flow patterns are not well defined because of the flat terrain and nearby logging activities. The Western portion drains northwest to Durbin

Creek and west (under I-95) to Trout Creek. The Western portion merges with the Central portion, which primarily drains toward the south. Twelvemile Swamp has the only identifiable creeks to the south. The North and South portions also drain to the south under Ninemile Road.

CH2M HILL has performed a cursory investigation of Twelvemile Swamp at three locations: along I-95 (western portion), along US1 (northern portion), and along Ninemile Road (central and southern portion). The investigation has found Twelvemile Swamp to be a very diverse system. Exhibit 5-2 summarizes the size, vegetation, estimated flow capacity, and potential for use of the wetland areas within Twelvemile Swamp.

Mesic to hydric communities were discovered at each point of the investigation. Initial analysis of the color infrared (CIR) aerial photographs of the area showed three different potential areas (central, north, south) that may be used for future wastewater treatment. These areas were not investigated because they were inaccessible. These three areas have similar vegetative signatures as Whites Ford/Molasses Branch Swamps, which suggest that they may also have similar hydrology and potential for wastewater disposal. Twelvemile Swamp at US 1 and Ninemile Road were not included because of its low potential for wastewater disposal.

5.2.1.4 Sampson Swamp

Sampson Swamp is located approximately 1.8 miles south of the Sampson interchange, 2.3 miles southeast of the community of Cimmarone, and 7.3 miles from the existing St. Johns North WWTF. It is located northeast of Whites Ford Swamp but is not shown in Exhibit 5-1 because it is not recommended. Access to the swamp is possible from the north, along Leo McGuire Road which bisects the swamp. A summary of size, dominant vegetation, estimated flow capacity, and potential for use are presented in Exhibit 5-2.

Sampson Swamp discharges to the south into the same discharge channel as Whites Ford/Molasses Branch Swamps, and eventually into Trout Creek. A windshield investigation of the swamp indicated that the swamp has been altered, primarily by logging practices, for many years. Mature and newly planted pine communities were evident during the windshield investigation of the swamp and verified by the CIR aerial photos. There is a low likelihood that Sampson Swamp would be a suitable treatment or receiving wetland. Vegetation, soils, and hydrology are highly variable within Sampson Swamp and are not supportive of wastewater addition.

5.3.1 Process Options

Treatment process options that can achieve biological nutrient removal (BNR) for discharge to a receiving wetlands include conventional modified Bardenpho process (rectangular, common-wall construction), modified Bardenpho oxidation ditch, and SBRs. A discussion of each option is provided in the following sections.

5.3.1.1 Conventional Modified Bardenpho

The conventional modified Bardenpho process is a biological nutrient removal system (including phosphorus removal) utilizing common-wall rectangular tank construction similar to a conventional activated sludge plant. The plant typically provides an aerobic solids retention time (SRT) of 6 to 10 days with separate tankage providing anoxic and anaerobic reactors. The conventional modified Bardenpho process can be described as follows: screened influent is mixed with returned activated sludge (RAS) without aeration in the fermentation (anaerobic) zone. The fermentation zone is used to select microorganisms that uptake an increased amount of phosphorus during aeration.

After contact, the liquid flows to the first anoxic zone (no oxygen added), where nitrate-rich mixed liquor is blended from the first aeration zone, and denitrification occurs. The next stage is the first aeration zone where $CBOD_5$ is removed and ammonia is converted to nitrates. In the second anoxic zone, additional nitrates are converted to nitrogen gas. The second aeration zone is the final zone. Here nitrogen gas is stripped and oxygen is added to prevent biological phosphorus release before clarification.

A minimum of two secondary clarifiers are provided for reliability. Mixed liquor from the second aeration zone is split to the clarifiers from an aboveground splitter structure with isolation gates and weirs. RAS and waste activated sludge (WAS) pumping is from a common RAS/WAS pumping station.

5.3.1.2 Modified Bardenpho Oxidation Ditch

Oxidation ditches are a modification of the plug flow activated sludge process. Several vendors, such as Kruger, EIMCO, and Lakeside, offer oxidation ditches. Note that "ditch" refers to a type of technology and the tankage is usually aboveground and constructed of cast-in-place reinforced concrete. A schematic of the system is shown in Exhibit 5-3. For the modified Bardenpho oxidation ditch process, the aeration tank is typically arranged as a ring- or oval-shaped channel and is usually aerated or mixed using mechanical aerators. This process is similar to the conventional modified Bardenpho process except the final three zones are included in the oxidation ditch instead of in separate tanks. Also, diffused

5.2.1.5 Additional Wetlands Investigation

Further investigation and field reconnaissance are necessary to fully evaluate the feasibility of using the Whites Ford, Molasses Branch, and Twelvemile Swamps for the discharge of reclaimed wastewater. Reconnaissance should be conducted at each major regional unit of the swamp. These investigations should include walking transects of the swamp to identify dominant plant species and hydrologic patterns. Also, an aerial flight should be performed of the Twelvemile Swamp area to identify existing conditions not visible from the limited ground reconnaissance.

5.2.2 Surface Discharge

A potential effluent outfall pipeline route from the Blacks Ford WWTF to the St. Johns River is presented in Exhibit 5-1. This route has the most direct access to the river and follows existing rights-of-way as much as possible. The St. Johns River outfall would be equipped with a diffuser to dilute the effluent within the river at the point of discharge.

5.2.3 Water Reclamation

Currently, no significant demand for reclaimed water appears to exist in the St. Johns North service area. However, as development increases, the demand for reclaimed water may increase. A potential use is irrigation of golf courses, public parks, and residential developments. Through the consumptive use permit (CUP) process, the SJRWMD is encouraging wastewater reuse. UWFL should look for opportunities to reuse reclaimed water and pursue implementation if feasible.

5.2.4 Selected Effluent Management Option

The recommended effluent management option is initial application to Blacks Ford Swamp. Future application sites are Whites Ford Swamp, Molasses Branch Swamp, and Twelvemile Swamp. Surface discharge to the St. Johns River would be difficult to permit with FDEP because the location of the prospective discharge point is in an area where the tidal flushing of effluent nutrients is undetermined and because historically public concern with direct discharges has been high.

5.3 Wastewater Treatment and Residuals

Wastewater effluent from the St. Johns North service area will need to meet FDEP treatment standards of 5 mg/L $CBOD_5$, 5 mg/L TSS, 3 mg/L TN, and 1 mg/L TP for receiving wetlands discharge. To accomplish these results, biological treatment with nutrient removal followed by filtration will be required.

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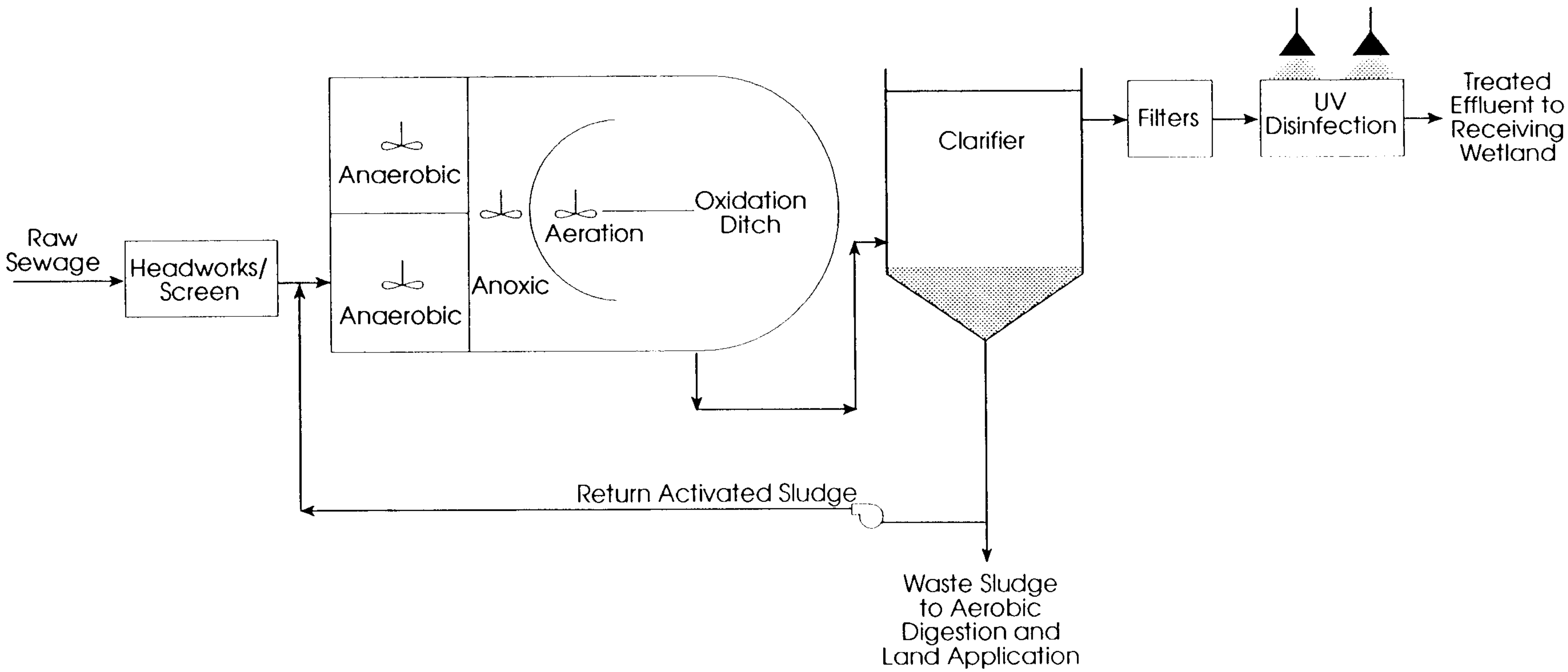


Exhibit 5-3. Modified Bardenpho Oxidation Ditch Process Schematic.
United Water Florida, St. Johns North

CH2MHILL

air is typically used in the conventional modified Bardenpho process, while mechanical aerators are used in the ditch for aeration.

Oxidation ditches are frequently operated in extended aeration mode at an SRT of 10 to 20 days or more. A minimum of two secondary clarifiers are used to separate mixed liquor solids from the treated effluent, and these solids are returned to the anaerobic tank and/or wasted from the process in the same fashion as with conventional activated sludge treatment.

For $CBOD_5$ removal and nitrification, this process brings return activated sludge and screened influent into the anoxic tank. Biological nutrient removal is accomplished with the addition of anaerobic and anoxic zones upstream of the oxidation ditch, and extra volume is provided in the ditch to allow additional anoxic cycling after aeration. Since Class III reliability is required for receiving wetlands, only one oxidation ditch was used in the following cost analysis, although two ditches may be desired for redundancy and maintenance.

5.3.1.3 SBRs

SBRs treat municipal wastewater using multiple process tanks in parallel with sequencing, or alternating, feed. Wastewater is treated within a single process tank in a series of steps. These steps include anoxic, anaerobic, and/or aerated fill, react, settle, decant, and sludge waste. Thus the process is a true batch process, and each batch sequence mode is analogous to a tank in a conventional activated sludge plant. Like the conventional system, the effective aerobic SRT is typically 6 to 10 days. However, unlike conventional systems, there are no secondary clarifiers or RAS pumping. The basins themselves provide clarification at the end of the treatment cycle when the biomass is allowed to settle and the effluent is decanted. A schematic diagram of the SBR system is shown in Exhibit 5-4.

The anaerobic/anoxic fill stage occurs when the raw wastewater is pumped into the basin along with settled biomass. The aerated fill occurs when air is introduced to the stream of settled biomass (biomass retained after decant) and raw wastewater. The react stage occurs after the raw wastewater feed is discontinued and can be cycled to provide both aerobic and anoxic treatment. The settle and decant stages occur after the react stage(s) are discontinued and are similar to the sedimentation which occurs within a secondary clarifier.

SBR blowers are similar to those used in the conventional complete mix activated sludge process. Small capacity SBRs typically use positive displacement (PD) blowers because their flat performance curve allows nearly constant airflow with varying head conditions.

processes can be fine tuned. In addition, because of the longer SRT, the oxidation ditch is less likely to provide efficient biological phosphorus removal and may require supplemental chemical addition.

5.3.2.3 Land Requirements

The oxidation ditch has the largest footprint. SBRs have the smallest footprint because they have no secondary clarifiers.

5.3.2.4 Equipment Maintenance

Equipment maintenance slightly favors SBRs since they can be constructed with all equipment external to the basins and, in general, with less mechanical equipment (no clarifiers and RAS pumps). The conventional Bardenpho system requires more pumps than the oxidation ditch.

5.3.2.5 Expandability

In smaller capacity ranges, SBRs are suitable for expansion because of their compartmental arrangements. However, for WWTFs of 5 mgd or more, multi-compartmented SBRs would be cumbersome to operate. At these higher flows, the more conventional treatment systems are better suited. Conventional Bardenpho systems may have a slight edge over oxidation ditch Bardenpho systems in terms of expandability.

5.3.2.6 Treatment Process Recommendations

SBRs are recommended during the early phases of the Blacks Ford WWTF. When flows increase, it is recommended that UWFL transition to an oxidation ditch system, which will be easier to operate than a large, multi-compartmented SBR system. When this transition occurs, the SBRs should be converted to digesters. A phasing plan is presented later in this chapter.

5.3.3 Disinfection Options

The following sections describe the variety of methods currently used for disinfection of treated wastewater.

5.3.3.1 Chlorination/Dechlorination

Chlorination is the most widely used method of disinfection of wastewater in the United States. Chlorine is typically fed as a solution of chlorine gas or as sodium hypochlorite solution. There are important safety issues related to the potential release of chlorine gas to the environment, and it is likely that the chlorine storage and feed areas would need to be in an enclosed building with an automatic sprinkler system, leak detectors, alarms, and an

However, centrifugal blowers have been used successfully for larger SBR facilities. They are generally quieter and can be turned down to provide more efficient aeration.

There are several vendors marketing SBRs, each with their own process patent and unique configuration. For example, some use surface aerators and mixers and some use diffusers and mixers. The SBR unit for this analysis uses jets rather than diffusers for aeration, and an air header is manifolded with the jets and with the discharge from "motive" pumps. The motive pumps pull liquid from the basin and discharge it through the jets back into the basin. This arrangement allows mixing of the biomass in the SBR with or without aeration.

SBRs can be used to achieve secondary treatment, similar to conventional treatment. Batch reactors with slightly larger reactor volumes can also provide BNR. Nitrification occurs in the aerated fill and aerated react stages. A denitrification (no aeration) stage is required to maximize nitrate removal following aerated react. Biological phosphorus removal can also be achieved by adjusting the anoxic fill cycle time to provide the anaerobic conditions needed to provide luxury uptake of phosphorus during the aeration cycle.

One major difference between SBRs and continuous flow systems is the need to accommodate the high rate of flow during decant. With a two-basin SBR, the entire plant flow must typically exit during eight, 45- to 60-minute decant periods, or 6 to 8 hours a day. This requires that effluent filtration, disinfection and pumping systems be sized for three to four times the peak day flow, or that the effluent be equalized. Typically, providing an effluent equalization tank is a cost-saving alternative.

5.3.2 Process Options Comparison

The three process options discussed above are briefly compared in the following section. The comparison is based on ease of operation, process control, land requirements, equipment maintenance, and expandability.

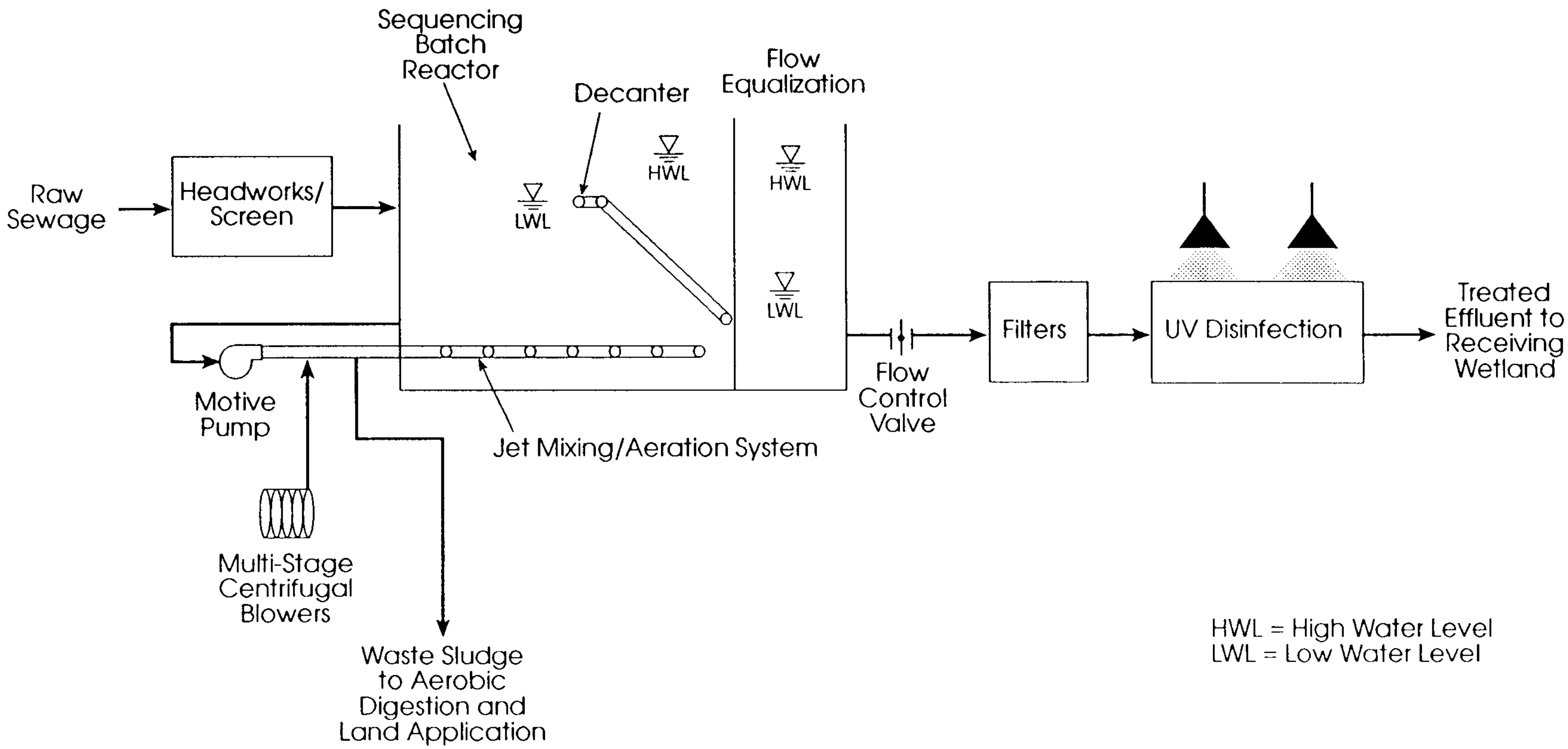
5.3.2.1 Ease of Operation

For SBRs, operation is highly dependent on control valves and sequencing of pumps and blowers. Although less dependent, the conventional Bardenpho system still relies on multiple pumps for recycle streams. The oxidation ditch employs gravity flow for all but the RAS recycle, and does not require a computer control system to keep it functioning. Ditch systems offer the easiest operation of the options.

5.3.2.2 Process Control

There is less process control with the oxidation ditch because it has less ability to fine tune the recycles and adjust the time of each treatment zone. SBRs and conventional Bardenpho

Exhibit 5-4. SBR Process Schematic.
United Water Florida, St. Johns North



emergency scrubber. Liquid hypochlorite provides disinfection properties similar to gaseous chlorine, without the safety issues associated with chlorine gas but at higher chemical costs.

Chlorinated effluent must be dechlorinated prior to wetlands application or surface water discharge. Sulfur dioxide is most commonly used for dechlorination because of its low chemical cost. However, it is a toxic gas and is on the *USEPA List of Extremely Hazardous Substances*. For this reason, bisulfite salts, primarily sodium bisulfite, are often used for dechlorination. Sodium bisulfite is readily available, easy to handle, and reacts quickly with chlorine. It is usually purchased as a solution and is classified as a corrosive material and irritant to eyes, skin, and throat, similar to sodium hypochlorite.

5.3.3.2 Ultraviolet Disinfection

Ultraviolet (UV) disinfection is a proven technology that is used in a wide range of water sources from wastewater to pharmaceutical-grade process water. There are currently over 500 wastewater treatment facilities in the United States that use UV for disinfection. UV disinfection is a physical process that uses electromagnetic energy emitted from UV lamps to prevent cell DNA and RNA from further replication. The process leaves no residual and thus is well suited for effluent disposal by wetlands application or surface discharge. Overdosing is not of concern, other than for the sake of economy.

UV lamps can be installed either in an enclosed reactor or in an open channel configuration. Most UV installations in North America are open channel. The UV dose is expressed in milliwatt seconds per square centimeter (mWs/cm^2) and depends on the effluent quality required and the transmittance of the wastewater being treated, with low-turbidity effluent preferable.

5.3.3.3 Ozone Disinfection

Ozone (O_3) is one of the strongest oxidants available for use in wastewater treatment and has been primarily used for disinfection. Ozone must be generated on site because it quickly deteriorates in both its gaseous form or in solution. Ozone is generated by passing filtered and dried air or oxygen through a high-voltage electrical current between two electrodes. Ozone disinfection systems typically consist of gas preparation, ozone generation, and ozone dissolution. Ozone dissolution must be provided in an enclosed contactor because it is an irritant and air pollutant. The off-gases from the contactor must be treated to remove the ozone, normally by passing the gas through a thermal/catalytic destruction device.

The feasibility of ozone for disinfection depends on the quality of the wastewater because ozone is a strong oxidant and will react with carbonaceous and other materials. The ozone

5.3.4.3 Residuals Management Recommendations

The recommended wastewater residuals disposal method is offsite agricultural land application of aerobically digested sludge. To reduce the volume to be land applied, the sludge should be partially thickened by decanting before it is hauled offsite.

5.4 Wastewater Transmission

The future wastewater transmission system was developed through the use of CH2M HILL's computer hydraulic network model, NETWK. Input parameters to the model included pipe length, internal diameter, and roughness coefficient; pipe junctions (nodes); flow demands; and pump characteristics.

The model was developed using a map of the service area and routing future pipes along roadway corridors and utility easements, where possible, and routing across undeveloped areas where no corridor or other right-of-way presently exists. The criteria for the network modeling of the wastewater system included the following:

- Keep maximum pressures at pump stations at 60 psi. (This pressure is generally the upper range of standard submersible pump operating pressures such as Flygt pumps which are UWFL's standard submersible pump.)
- Evaluate pressures at PHF conditions with all pumps "ON".

Wastewater flows throughout the service area were allocated to pump station nodes within the model. The demands were distributed geographically to be representative of estimated growth characteristics of the service area.

The pipe diameters presented in Exhibit 5-5 represent capacity requirements for the 20-year planning horizon and for buildout wastewater flows. It will be prudent for UWFL to install smaller force mains in the early phases of development of the service area to reduce septic conditions and hydrogen sulfide problems. As development occurs, UWFL should rerun the network model to assess the impacts of the development and to select actual pipe size for implementation. The sizes shown on Exhibit 5-5 are intended to serve as a *road map* for planning purposes. The model presents a forecast of the sizes that will ultimately be needed to meet demands.

dosage required is primarily determined by the ozone demand of the wastewater which must be overcome before disinfection can be obtained. Of the disinfection alternatives under consideration, ozone has the highest capital and O&M costs.

5.3.3.4 Disinfection Recommendation

UV disinfection is recommended as the preferred alternative for disinfecting wastewater at the Blacks Ford WWTF. It is a reliable, low-cost, proven technology for disinfection of low-turbidity wastewaters. It does not have the safety hazards associated with chlorine gas, the need for dechlorination associated with all forms of chlorine, and the high capital and O&M costs associated with ozone.

5.3.4 Residuals Management Options

Landfilling and agricultural land application are two potentially feasible residuals management options. These are discussed in the following sections.

5.3.4.1 Landfilling

Landfilling of sludge is regulated under solid waste regulations (40 Code of Federal Regulations [CFR] 257 and Florida Department of Environmental protection [FDEP] Chapter 17-701 FAC). Landfilling does not require that the sludge be stabilized. Generally, the only significant requirement to be met by municipal sludge is that it pass the paint filter test (FAC Chapter 17-701.300(10)). Essentially, this means that the sludge must be dewatered. In addition, the sludge must pass the toxicity characteristic leaching procedure (TCLP), but this would not be a problem for municipal sludge. It should be noted that use of the sludge in final surface cover at a landfill may require meeting stabilization requirements under 40 CFR Part 503.

5.3.4.2 Agricultural Land Application

Agricultural land application of sludge is the predominant method of sludge disposal in Florida. The sludge can be applied in either liquid or cake (dewatered) form and must be stabilized to Class A or Class B standards. Pasture land and sod farms are the primary disposal outlets because they require only Class B stabilization with minimal site restrictions. Application to row crops generally requires Class A stabilization.

Compost is a disinfected, humus-like material produced from a combination of sludge and a bulking agent, such as yard waste. It could be marketed as a soil conditioner with such products as peat, soil, and mulch. A potential market may exist, but significant effort would be required to establish this market.

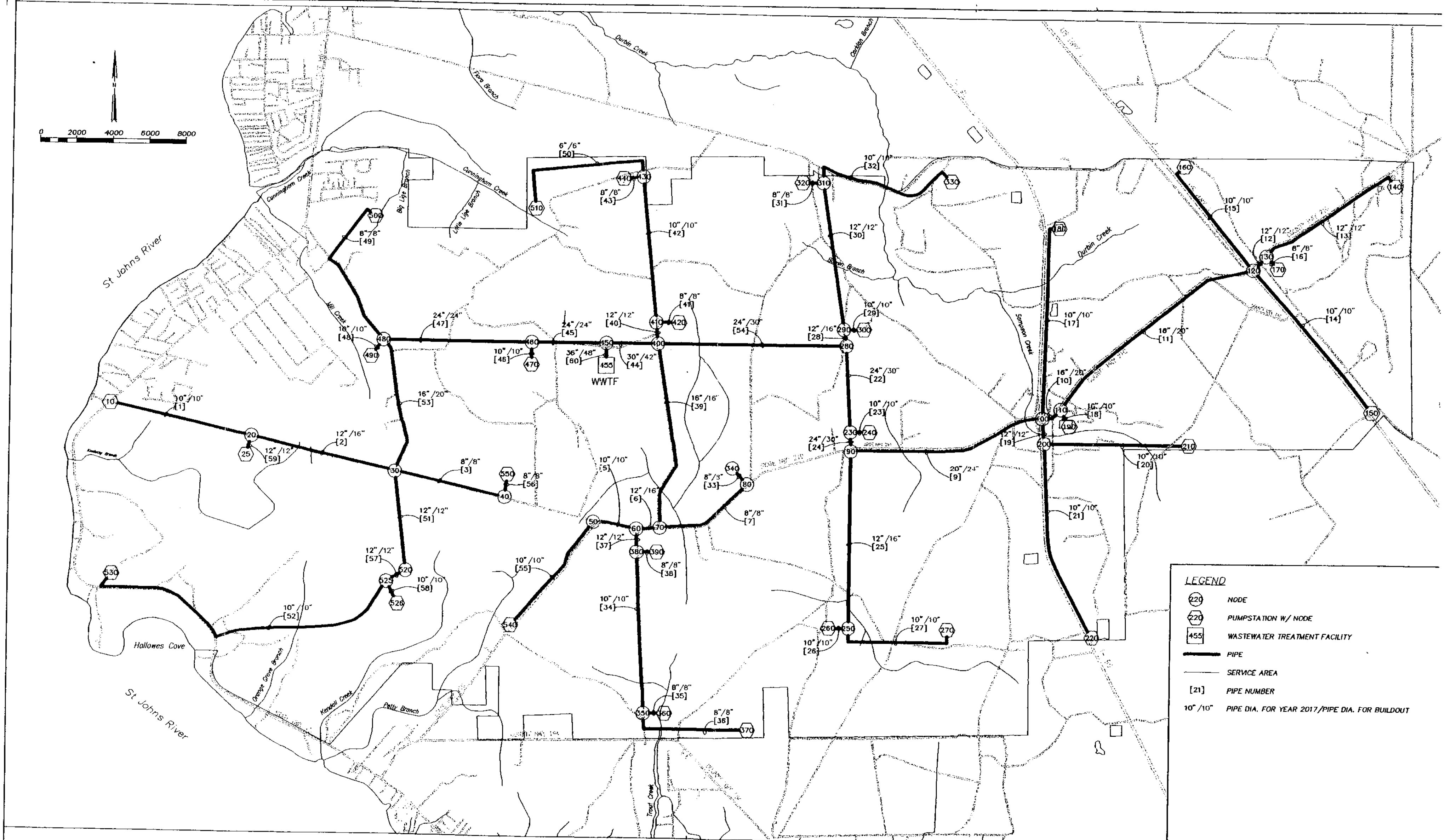


EXHIBIT 5-5
FUTURE WASTEWASTER TRANSMISSION MAIN NETWORK

EXHIBIT 5-6
Wastewater Treatment and Residuals Unit Process Summary
Master Plan for Water and Wastewater Systems, St. Johns North Study Area

Phase	Year	Projected AADF (mgd)	Total WWTF Capacity (mgd)	Treatment Process	Clarifiers	Digesters
I	1998	0.40	1.0	New 1-mgd SBR	None	One 2.3-MG cell
II	2002	1.01	1.5	Add 0.5-mgd SBR	None	Construct new filter
III	2004	1.48	3.0	First 3-mgd oxidation ditch	Two	Convert SBRs to digesters
IV	2007	2.68	6.0	Second 3-mgd oxidation ditch	Sufficient capacity exists	Sufficient capacity exists
V	2012	5.53	9.0	Third 3-mgd oxidation ditch	Add one	Sufficient capacity exists

Depending on the outcome of the wetlands capacity maximization, UWFL may need to access the Twelvemile Swamp for additional disposal capacity. If necessary, pipe capacity and routing will need to be determined once the required capacity has been established.

5.5.3 Transmission System Phasing

Collection systems currently exist within the St. Johns North and former Sunray service areas. As required in the FDEP permit for St. Johns North, the existing WWTF will need to be phased out of service by December 1, 1999. To redirect sewage from the St. Johns North collection system to the Blacks Ford WWTF, the existing influent pump station at St. Johns North will need to be modified. It is expected that new pumps will be needed because the existing pumps are low head and, most likely, will not have the head to pump to Blacks Ford. A new force main will be needed from the St. Johns North WWTF to Blacks Ford.

The Sunray collection system currently pumps to the WWTF located adjacent to the Southern Grove subdivision. When demands warrant, UWFL will need to construct a master lift station and force main to direct the sewage from the CR 210 area to the Blacks Ford WWTF.

5.5 Phasing Plan

5.5.1 Treatment Phasing

The proposed treatment process to achieve these effluent limits in the early phases of the Blacks Ford WWTF is SBRs, followed by effluent filtration and UV disinfection. In later phases, the SBRs will be converted to aerobic digesters and new oxidation ditches will be constructed.

Phase I will consist of a two 0.5-mgd SBR cells (1.0 mgd total) with a third cell used as an aerobic digester. In Phase II, a new 0.5-mgd SBR will be constructed. Phase III presents an opportunity for UWFL to transition the Blacks Ford WWTF to an oxidation ditch system. The transition to the oxidation ditch system would entail construction of the ditches, clarifiers, and conversion of the SBRs to digesters. The transition will be relatively costly compared to continuing with SBRs. UWFL could elect to continue with SBRs in Phase III to defer the capital investment of the transition to ditches. However, the long-term cost of deferring the transition could be higher because, in the long-term, unusable tankage would be constructed.

A phasing plan for the Blacks Ford WWTF is summarized in Exhibit 5-6. The plan is based on five phases throughout the planning period with the conversion to oxidation ditches occurring in Phase III. Phases IV and V involve expansion of the oxidation ditch system in 3.0-mgd increments. At the completion of Phase V, adequate capacity will exist to treat the year 2017 AADF.

5.5.2 Receiving Wetlands System Phasing

UWFL should add receiving wetland system capacity as needed, maximizing the hydraulic loading to existing receiving wetlands before implementing new receiving wetlands. At the initial loading of 2 inches per week, Blacks Ford Swamp has an estimated capacity of 2 mgd AADF. After operation begins, UWFL will monitor the wetland system according to regulatory conditions and pursue the maximum loading of 6 inches per week if feasible.

Even at the 6 inches per week loading, Blacks Ford Swamp will not provide the capacity of 9 mgd needed in 2017. Additional wetland capacity should be pursued in the Whites Ford and Molasses Branch systems because these are closer than the Twelvemile Swamp. A similar capacity maximization process should be followed within these systems.

Section 6
Schedule and Costs

6. Schedule and Costs

6.1 Implementation Schedule

Exhibit 6-1 presents the implementation schedule for the selected water and wastewater alternatives. Assumptions have been made on the schedule for WTF construction and transmission main construction. Until development occurs, it is not possible to accurately predict the schedule for these specific projects. Exhibit 6-2 presents the proposed schedule by task for the implementation of this master plan.

EXHIBIT 6-1
St. Johns North Project Phasing
Master Plan for Water and Wastewater Systems, St. Johns North Study Area

Year	Water System Improvements	Wastewater System Improvements
1997	Conduct hydrogeologic investigations at St. Joes, CR 210, and US 1 sites	
1998	Design wellfields and WTFs at St. Joes and CR 210 sites	Complete Phase I (1.0 mgd) of Blacks Ford WWTF, collection system modifications, and receiving wetlands
1999	Complete Phase I of St. Joes WTF (1.4 mgd) and CR 210 WTF (3.2 mgd); St. Johns North WTF supplies 1.1 mgd	Phase out St. Johns North WWTF and Sunray WWTF; construct pump station and force mains from Sunray area; construct force mains from I-95 rest area and from St. Joes area.
2000	Construct water mains along CR 210 corridor	
2002	Connect St. Johns North WTF to transmission grid	Complete Phase II of Blacks Ford WWTF (Total capacity = 1.5 mgd)
2004		Complete Phase III of Blacks Ford WWTF (Total capacity = 3.0 mgd)
2005	Conduct hydrogeologic investigation at US 1 site	
2007	Complete Phase II of St. Johns North WTF (2.2 mgd), St. Joes WTF (2.8 mgd) and CR 210 WTF (3.7 mgd); complete Phase I of US 1 WTF (2.9 mgd)	Complete Phase IV of Blacks Ford WWTF; complete effluent transmission main to Whites Ford and Molasses Branch Swamps (Total capacity = 6.0 mgd)
2011	Complete Phase III of St. Johns North WTF (3.4 mgd), St. Joes WTF (4.3 mgd), CR 210 WTF (9.6 mgd); US 1 WTF supplies 2.9 mgd	
2012	Complete Phase II of US 1 WTF (5.8 mgd)	Complete Phase V of Blacks Ford WWTF (Total capacity = 9.0 mgd)

Exhibit 6-2. Proposed Project Implementation Schedule.
United Water Florida, St. Johns North

Task	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Water System Improvements																				
Conduct hydrogeologic investigations at St. Joes and CR210 sites	X																			
Construct water main at Blacks Ford WWTF		X																		
Design wellfields and WTFs at St. Joes and CR 210 sites		X																		
Construct Phase I of St. Joes WTF and CR210 WTF		X																		
Construct water mains along CR 210 corridor				X																
Connect St. Johns North WTF to transmission grid						X														
Conduct hydrogeologic investigation at US 1 site									X											
Construct Phase II of St. Johns North WTF, St. Joes WTF and CR 210 WTF. Construct Phase I of US1 WTF										X										
Construct Phase III of St. Johns North WTF, St. Joes WTF, CR 210 WTF														X						
Construct Phase II of US 1 WTF																			X	
Wastewater System Improvements																				
Construct Phase I of Blacks Ford WWTF, collection system modifications, and receiving wetlands		X																		
Phase out St. Johns North WWTF and Sunray WWTF. Construct pump station and forcemains from Sunray area. Construct forcemains from I-95 rest area and from St. Joes area.			X																	
Construct Phase II of Blacks Ford WWTF						X														
Construct Phase III of Blacks Ford WWTF								X												
Construct Phase IV of Blacks Ford WWTF											X									
Construct Effluent Main to Whites Ford and Molasses Branch Swamps											X									
Construct Phase V of Blacks Ford WWTF																X				

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Planning for major facilities should allow time for the following tasks:

- Twelve months for designing and permitting the water supply and treatment system and the wastewater treatment and effluent disposal system
- Twelve months for baseline monitoring each natural receiving wetland
- Nine months for designing the water distribution mains and the wastewater collection and transmission system, excluding any major delays during the process of procuring easements
- Twelve months for the construction and startup of the water supply and treatment system and wastewater treatment and effluent disposal system

6.2 Cost Estimates

The approximate cost of each project phase is presented in Exhibits 6-3 and 6-4. Estimated costs are in 1997 dollars and represent construction costs only.

EXHIBIT 6-3
Costs Associated with Project Phases, Water System
Master Plan for Water and Wastewater Systems, St. Johns North Study Area

Water System Improvements	Year	Estimated Construction Cost
Conduct hydrogeologic investigations at St. Joes and CR 210 sites	1997	$200,000
Complete Phase I of St. Joes WTF (1.4 mgd) and CR 210 WTF (3.2 mgd); St. Johns North WTF supplies 1.1 mgd	1999	$7,793,000[a]
Construct water mains along CR 210 corridor	2000	$3,600,000
Connect St. Johns North WTF to transmission grid	2002	$700,000
Conduct hydrogeologic investigation at US 1 site	2005	$100,000
Complete Phase II of St. Johns North WTF (2.2 mgd), St. Joes WTF (2.8 mgd) and CR 210 WTF (3.7 mgd); complete Phase I of US 1 WTF (2.9 mgd)	2007	$5,700,000[a]
Complete Phase III of St. Johns North WTF (3.4 mgd), St. Joes WTF (4.3 mgd), CR 210 WTF (9.6 mgd); US 1 WTF supplies 2.9 mgd	2011	$5,800,000[a]
Complete Phase II of US 1 WTF (5.8 mgd)	2016	$2,000,000[a]

[a] Assumes conventional treatment by aeration and chlorine disinfection.

EXHIBIT 6-4
Costs Associated with Project Phases, Wastewater System
Master Plan for Water and Wastewater Systems, St. Johns North Study Area

Wastewater System Improvements	Year	Estimated Construction Cost
Complete Phase I of Blacks Ford WWTF and receiving wetlands	1998	$4,900,000
Phase out St. Johns North WWTF and Sunray WWTF; construct pump station and force mains from Sunray area; construct force mains from I-95 rest area and from St. Joes area	1998	$5,600,000
Complete Phase II of Blacks Ford WWTF	2002	$1,900,000
Complete Phase III of Blacks Ford WWTF	2004	$8,000,000
Complete Phase IV of Blacks Ford WWTF	2007	$8,000,000
Complete effluent transmission main and diffuser to Molasses Branch and Whites Ford Swamps	2007	1,400,000
Complete Phase V of Blacks Ford WWTF	2012	$6,900,000

Appendix A
Task Order

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Task Order 96-8
Water and Wastewater Master Plan for St. Johns North Service Area

The work described herein is a task order to the contractual agreement between Jacksonville Suburban Utilities Corporation, now known as United Water Florida (hereafter referred to as UWFL) and CH2M HILL, Inc. (hereafter referred to as CH2M HILL) executed on January 27, 1994 (the AGREEMENT).

Purpose of Task Order

UWFL requires a Water and Wastewater Master Plan for its St. Johns North service area. The major objective of the Master Plan is the identification of the most economical plan for providing water and wastewater service to the largely undeveloped area. The Master Plan will evaluate service alternatives for water supply, treatment, storage, and transmission and wastewater collection, treatment, and effluent disposal. For the recommended alternative, an implementation phasing plan with cost estimates will be prepared for a twenty year planning period.

CH2M HILL will utilize growth and wastewater flow projections previously developed under Task Order No. 96-3R. New growth and water and wastewater flow projections will be developed under this task order for an additional area comprised of nine land sections adjacent to the intersection of US 1 and SR 210. Projections for this additional area will be merged with the original area to develop new projections for the entire study area.

Article 1. Scope of Services

Task 1 - Project Management and Client Coordination

The purpose of this task is to provide overall project management and coordination for this project. This task includes the following items:

1.1. Plan, organize, direct, schedule and control the project team's efforts.

1.2. Conduct workshops with UWFL at key decision points in project's progress.

Task 2 - Develop Water Demand and Wastewater Flow Projections

This task will generate water demand and wastewater flow projections for the study area. Information already generated for areas within the study area by CH2M HILL will be utilized. New information will need to be obtained and developed for the area in the study area that was not addressed in previous CH2M HILL studies for UWFL. Specific tasks to be performed are as follows:

2.1. Develop population and non-residential growth projections for low, medium, and high development pressure.

2.2. From available data, estimate per capita water demands and wastewater flows and non-residential water and wastewater usage on a per-acre basis.

2.3. Prepare water demand and wastewater flow projection matrix for years 1997, 2002, 2007, 2012, 2017 and buildout for the following parameters:

- Water – Annual Average Day, Maximum Day, and Peak Hour
- Wastewater – Annual Average Day, Maximum Month Average Day, and Peak Hour

Projections for above parameters will also be based on differing development pressure scenarios.

2.4. Prepare draft chapter for final report documenting demand and flow projections.

Task 3 - Establish Land Requirements and Prospective Sites for Wellfields, Effluent Management Systems, and Treatment Plants

The purpose of this task is to establish the land requirements and prospective locations for water and wastewater facilities. As in Task 2, information already obtained under previous studies for UWFL will be utilized. Tasks to be performed are as follows:

3.1. Conduct windshield survey of study area including visits to existing water and wastewater treatment facilities at UWFL's St. Johns North and St. Johns Forest sites.

3.2. Assess suitability of existing facilities and/or sites to be utilized throughout 20-year planning period.

3.3. Review and summarize Florida Department of Environmental Protection and St. Johns River Water Management District regulations of relevance to water and wastewater alternatives.

3.4. Identify prospective effluent management alternatives including reuse, wetlands disposal, and direct surface water discharge.

3.5. Identify prospective sites for wellfield locations.

3.6. Identify prospective sites for water and wastewater treatment facilities.

3.7. Prepare draft chapter for final report summarizing estimated land requirements and prospective areas for effluent management system, wellfields, and plant locations.

3.8. Conduct Workshop with UWFL to review results of Tasks 2 and 3 Revise chapters based on results of meeting.

Task 4 - Evaluate Alternatives for Regionalization of Water and Wastewater System

The purpose of this task is to evaluate alternatives for regionalization of water and wastewater facilities and to determine the most economical alternative. Information developed by CH2M HILL for UWFL in previous studies will be utilized in this evaluation.

Specific tasks to be performed include the following:

4.1. Identify two alternatives for evaluation based on the following:

- Alternative No. 1 - One regional WWTF and up to four regional WTFs.
- Alternative No. 2 - Two subregional WWTFs and up to four subregional WTFs.

4.2. Determine collection and transmission requirements for each of the two alternatives to include the following:

- Master sewage pump station capacities and locations
- Trunk force main diameters and lengths
- Effluent force main diameters and lengths
- Water supply wellfield raw water piping diameter and lengths
- Water transmission main diameter and lengths

4.3. Determine treatment requirements to include the following:

- Raw and finished drinking water quality criteria
- Raw and treated effluent quality criteria
- Sludge stabilization criteria

4.4. Identify water treatment processes to meet finished water quality criteria

4.5. Identify wastewater treatment processes to meet effluent quality criteria

4.6. Determine finished water and effluent storage requirements

4.7. Develop preliminary phasing plan for new facilities during twenty year planning period

4.8. Develop capital and operation and maintenance costs for each of the two alternatives. Estimates will be prepared for the purpose of comparison only and will be order-of-magnitude level of accuracy.

4.9. Prepare present worth cost comparison analysis.

4.10. Prepare draft chapter for final report summarizing findings of this task and providing recommendations on a selected alternative.

4.11. Conduct Workshop meeting with UWFL to review draft chapter and reach consensus on selected alternative. Revise chapter based on results of meeting.

Task 5 - Develop Master Plan

The purpose of this task is to develop a master plan for the water and wastewater system to include a facilities phasing plan and capital cost estimates. Specific tasks to be performed are described in the following:

5.1. For selected regionalization alternative, develop basis for design for major facilities including number of units, capacity, and approximate sizes for the facilities listed below. Basis of design will also be based on selected phasing plan.

- Wells
- Raw water mains
- Water treatment plant(s)
- Finished water storage both on-site at WTFs and off-site
- Water transmission mains
- Master sewage pump stations
- Trunk force mains
- Wastewater treatment plant(s)
- Effluent management facilities including transmission mains
- Sludge stabilization facilities

5.2. Develop order-of-magnitude cost estimates for capital facilities

5.3. Prepare implementation plan to include identifying schedules for planning, design, and construction of major facilities

5.4. Prepare draft chapter for final report documenting findings of this task.

5.5. Conduct Workshop with UWFL to review basis of design, cost estimates, and implementation plan. Revise chapter based on results of meeting.

Task 6 - Prepare Final Report

This task includes preparation of a written report summarizing the results of the study. This task includes the following items:

6.1. Prepare five copies of the draft Master Plan report and deliver to UWFL.

6.2. Conduct a review meeting with UWFL to go over comments on the final report.

6.3. Fixup draft and prepare and deliver twelve copies of the final report to UWFL.

Deliverables

The Consultant will prepare the following deliverable documents under this Task Order:

- List of Information Needs
- Draft chapter - Water Demand and Wastewater Flow Projections
- Draft chapter - Land Requirements and Prospective Sites for New Facilities
- Draft chapter - Evaluation of Regionalization Alternatives
- Draft chapter - Capital Facilities Plan and Implementation Plan
- Draft Master Plan Report (5 copies)
- Final Master Plan report (12 copies)

Assumptions

The scope of services is based on the following assumptions:

- Study will be based on a single, defined service area.
- Master Plan will be based on a twenty year planning horizon.
- Growth projections, wastewater flow projections, and effluent disposal planning results developed by CH2M HILL previously will provide the basis for this Master Plan.
- Identification of potential areas for location of water and wastewater facilities will not be based on site specific investigations performed by the Consultant.
- UWFL will provide Consultant with requested information within 2 weeks of request.
- Consultant will utilize in-house computer program NETWK to size pressure mains.
- Sludge will be aerobically digested on-site at WWTF(s) and land applied by a private hauler. Evaluation of sludge management alternatives will not be required in this study.
- Evaluation of reuse alternatives can be provided as an additional service.
- Fire flows will be assumed to be 500 gpm for residential development and 1,500 gpm for commercial development.

Schedule

An estimated schedule for completion of the project is presented in the following:

- Deliver draft chapters on Flow Projections, and Land Requirements and Prospective Sites for New Facilities within 3 weeks of notice to proceed.
- Deliver draft chapter on Evaluation of Regionalization Alternatives within 4 weeks of UWFL acceptance of Land Requirements chapter
- Deliver draft chapter on Basis of Design and Implementation Plan within 3 weeks of UWFL acceptance of Regionalization Alternatives chapter.
- Deliver draft Master Plan report within 2 weeks of UWFL acceptance of the Basis of Design/Implementation Plan chapter.
- Deliver final Master Plan within 2 weeks of UWFL acceptance of revised draft report.

Earliest completion date is estimated to be 14 weeks after receipt of notice to proceed.

Article 2. Compensation

The total budget for this Task Order is $74,600, as shown on Table 1, unless authorized to conduct further effort. Compensation terms are set forth in the referenced AGREEMENT.

Other Provisions

Obligations of Owner

Obligations of the Owner are as follows:

- Provide water demand and wastewater flow records for service area and other similar service areas as requested by the Consultant.
- Provide available information on development activities and projections for study area.
- Provide delineation of boundaries of study area.
- Provide access to sites, including those not owned by UWFL, if required for completion of study.
- Assess the availability of property for location of new water and wastewater facilities. For planning analysis, Consultant will assume that property is available.
- Review submittals from Consultant in a timely manner.
- Select a single alternative at workshops and "freeze" decisions made at workshops that have significant impact on later phases of the project.
- Provide Consultant with other pertinent information that would be beneficial to the study.

Task Order 96-8 will become part of the referenced AGREEMENT when executed by both parties.

Approved for UWFL

By: [signature]
Title: VICE-PRESIDENT
Date: 10/31/96

Approved for CH2M HILL

By: Thomas L. Waldeck
Title: Vice President
Date: 10/29/96

Table 1
UWFL
St. Johns North Water and Wastewater Master Plan
Budget Estimate

Task	Description	Total Hours	Labor Budget: Engineers/ Scientists	Technicians	Office	Total Cost
1	Project Management & Client Coordination	24	$1,800	$0	$175	$1,975
2	Develop Water Demand and Wastewater Flow Projections	36	$2,210	$440	$175	$2,825
3	Review Existing Facilities, Establish Site Needs, ID Sites	122	$10,420	$0	$175	$10,595
4	Evaluate Alternatives for Regionalization	294	$20,320	$3,950	$440	$24,710
5	Develop Master Plan	248	$12,100	$6,730	$570	$19,400
6	Prepare Final Report	72	$5,180	$440	$525	$6,145
TOTAL LABOR		796	$52,030	$11,560	$2,060	$65,650
EXPENSES						$8,950
TOTAL BUDGET						$74,600

Appendix B

Water and Wastewater Alternatives Cost Comparison

APPENDIX B

Water and Wastewater Alternatives Cost Comparison

Basis of Cost Estimates

The purpose of the cost comparison of the two water and wastewater alternatives was to select one overall water system plan and one overall wastewater system plan from which to develop the detailed master plan. Construction and operation and maintenance (O&M) cost estimates were compared for the two water and wastewater alternatives. Costs for plants, pump stations, and storage tanks were based primarily on unit costs per gallon of capacity and price quotes from suppliers. Costs for pipelines and wells were based primarily on construction pricing data for similar projects. O&M cost estimates were based primarily on cost curve information.

Pipeline quantities were based on the computer piping network model results presented in this report. Water plant and well field capacities were based on meeting build-out demand projections as described in the report.

The construction cost estimates are based on the facilities needed at complete system build out. Construction phasing costs were not considered because it was assumed that these costs would not differ significantly for each alternative. All estimates are order-of-magnitude as defined by the American Association of Cost Engineers.

Water system alternative costs are presented in Exhibit 3-2. Wastewater system alternative costs are presented in Exhibit 3-4. An annualized cost comparison was developed for each alternative by applying a 7.625 percent discount rate to construction costs then adding the annual O&M cost. Exhibits 3-2 and 3-4 summarizes the annualized costs comparison for the alternatives.

Water and Wastewater Transmission Systems Modeling Results

To develop cost for the future transmission systems, computer models were developed using CH2M HILL's computer hydraulic network model, NETWK. Input parameters to the model included pipe length, internal diameter, roughness coefficient, pipe junctions (nodes), flow demands, and pump characteristics.

The model was developed using a map of the service area and routing future pipes along roadway corridors and utility easements, where possible, and routing across undeveloped areas where no corridor or other right-of-way presently exists.

The criteria for the network modeling of the water system included the following:

- Maintain minimum pressures in trunk mains at 30 pounds per square inch (psi). The minimum level of service should be 20 psi. This approach provides a 10 psi contingency for pressures losses in the smaller distribution mains coming of the trunk mains.
- Evaluate pressures at PHF conditions.
- Evaluate pressures at MDF conditions with fire flows.
- Assume fire flows at 2,000 gpm in commercial areas and 500 gpm in residential areas.

The criteria for the network modeling of the wastewater system included the following:

- Keep maximum pressures at pump stations at 60 psi. This pressure is generally the upper range of standard submersible pump operating pressures (e.g., Flygt pumps, which are UWFL's standard submersible pump supplier).
- Evaluate pressures at PHF conditions with all pumps "ON".

Water demands throughout the service area were allocated to pipe nodes within the model. The demands were distributed geographically to represent estimated growth characteristics of the service area. No more than one fire flow at a time was modeled. Fire flow simulations were run at six different locations. Generally, fire flow demands were placed at the fringes of the main system in order to stress the network's ability to meet the demand. Fire flow demands and locations are shown in Exhibit B-1.

EXHIBIT B-1
Fire Flow Demands Used in Water Transmission System Modeling

Node	Fire Flow (gpm)
110	500
130	2,000
180	2,000
275	2,000
290	2,000
320	2,000
360	2,000

Two alternative scenarios for the water system were modeled: one for the four WTF alternatives (Alternative 1) and one for the three WTF alternatives (Alternative 2). The results of the modeling effort are shown in Exhibits B-2 and B-3. The water system pipe diameters represent capacity requirements for fire flows and build-out water demands. In the western half of the service area, pipe sizes did not differ significantly for either alternative. The largest variance in diameters was observed in the eastern areas where the fourth WTF was located.

For the wastewater transmission model, wastewater demands throughout the service area were allocated to pump station nodes within the model. The demands were distributed geographically to represent estimated growth characteristics of the service area. Two alternative scenarios were modeled: Alternative 1 had one WWTF and Alternative 2 had two WWTFs. For Alternative No. 2, the following phasing scenario was developed:

- Initially, UWFL would implement the Blacks Ford WWTF and utilize the westerly wetlands system comprised of the Blacks Ford, Whites Ford, and Molasses Branch Swamps as receiving wetlands.
- When the capacity limitations of these wetlands systems were reached, UWFL would implement the second WWTF located between I-95 and U.S. 1. This WWTF would utilize the Twelvemile Swamp system as its receiving wetland.
- The wastewater transmission system would be configured to enable development in the eastern sections of the service area to be served by the Blacks Ford WWTF until the time that the eastern WWTF came online (see Exhibit B-5).
- When the eastern WWTF comes online, the transmission system would be isolated from the Blacks Ford transmission system and the eastern WWTF would serve all areas east of I-95 initially and later serve areas generally east of the existing Cimmarone development (see Exhibit B-6).

The advantage of this approach is that it defers the construction of the eastern WWTF until it is needed to provide capacity above the Blacks Ford WWTF capacity. The results of the modeling effort for Wastewater Alternative 1 is presented in Exhibit B-4 and the results of the modeling effort for Wastewater Alternative 2 is shown in Exhibits B-5 and B-6. The wastewater main diameters represent capacity requirements for the 20-year planning horizon and for build-out wastewater flows.

UWFL may elect to install smaller pipes in the early development phases of the service area. UWFL should install smaller force mains in the early phases of development of the service area to reduce septicity and hydrogen sulfide problems. As development occurs, UWFL should rerun the network model to assess the impacts of the development and to select actual pipe sizes for implementation. The sizes are intended to serve as a *road map* for planning purposes. The build-out diameters forecast the sizes that will ultimately be needed to meet demands.

Conclusions

The findings of the cost comparison were presented to UWFL at a workshop held in Jacksonville on January 29, 1997. In that workshop, Water Alternative 1 with four WTFs Wastewater Alternative 1 with one WWTP was selected for detailed master planning. Although Water Alternative 1 had a slightly higher annualized cost than Alternative 2, within the level of accuracy of the cost estimates, Alternative 1 was approximately equivalent to Alternative 2. Water Alternative 1 differed from No. 2 in that it had a fourth water plant located between U.S. 1 and I-95. The advantages of this alternative were a greater distribution of well fields within the service area, thereby reducing localized demands, greater plant redundancy, and smaller water transmission mains in the eastern portion of the service area.

Wastewater Alternative 1 differed from Alternative 2 in that it was based on a one rather than two WWTFs. The one WWTF alternative offered a 13 percent lower annualized cost than the two plant alternative. It was also concluded that the single WWTF, located north of the Blacks Ford Swamp, was less likely of being closely surrounded by future development when compared with the other WWTF site located between U.S. 1 and I-95.

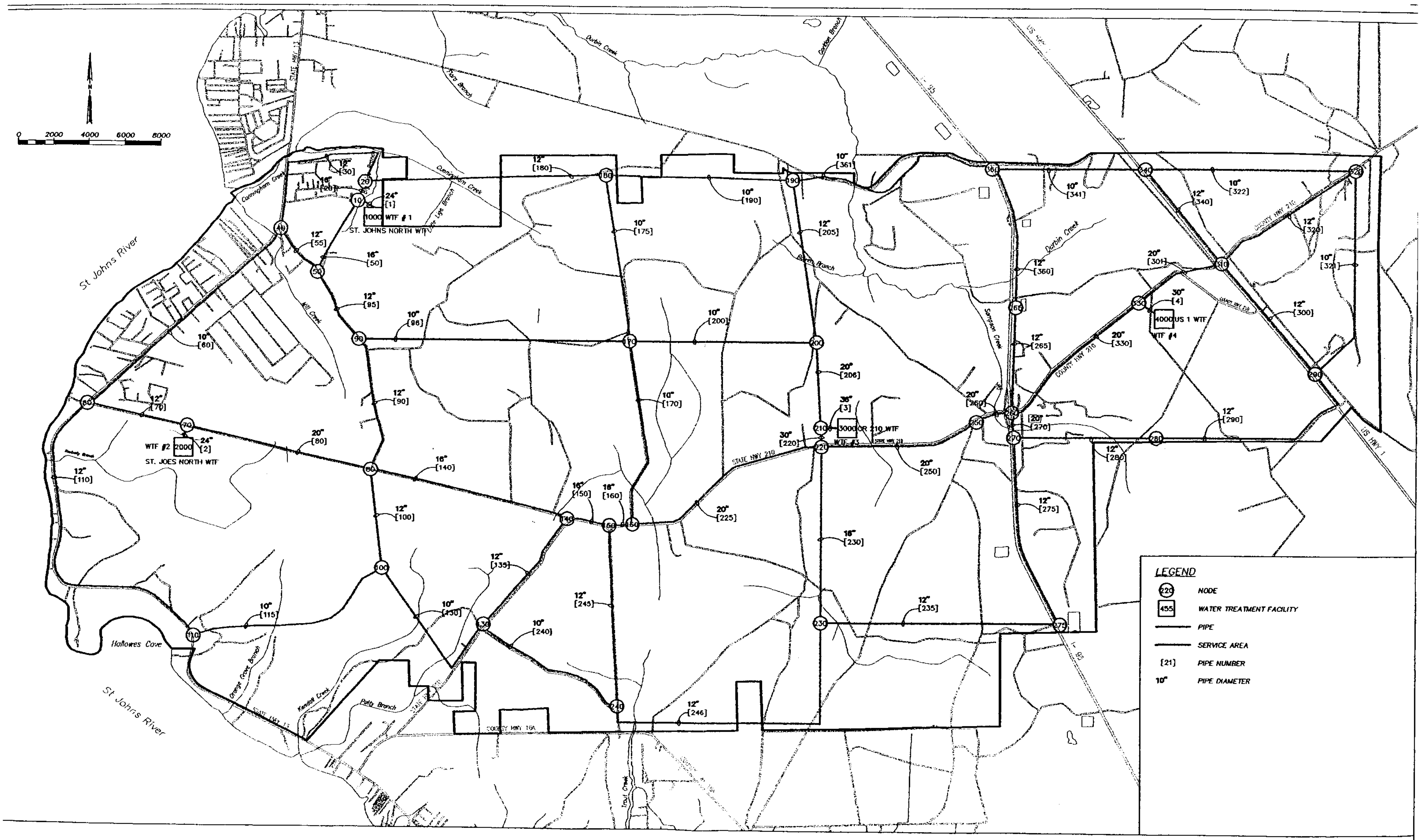

EXHIBIT B-2

WATER SYSTEM ALTERNATIVE 1 - 4 WTFS

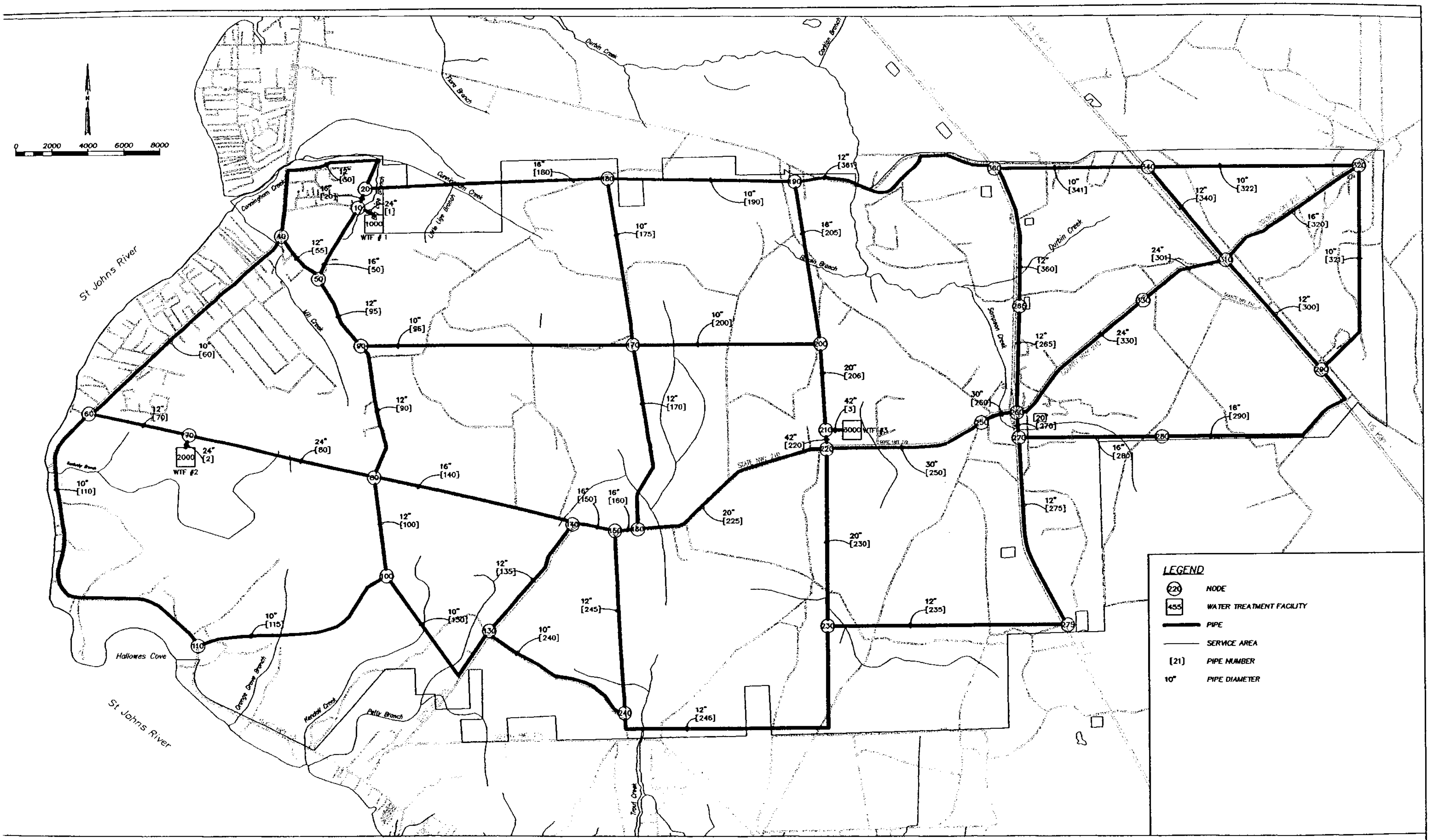

EXHIBIT B-3
WATER SYSTEM ALTERNATIVE 2 - 3 WTPS

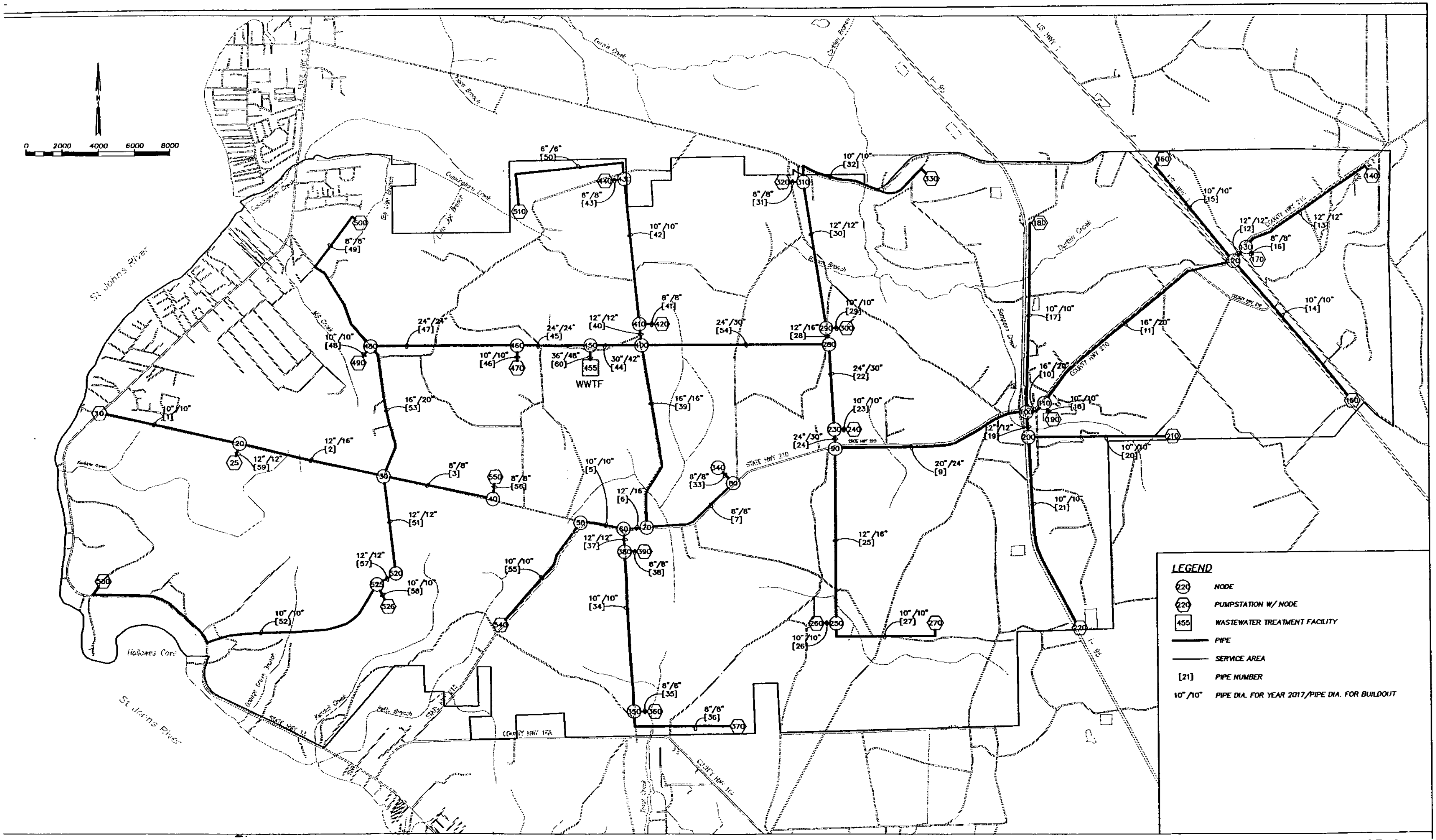

EXHIBIT B-4
FUTURE WASTEWASTER TRANSMISSION MAIN NETWORK

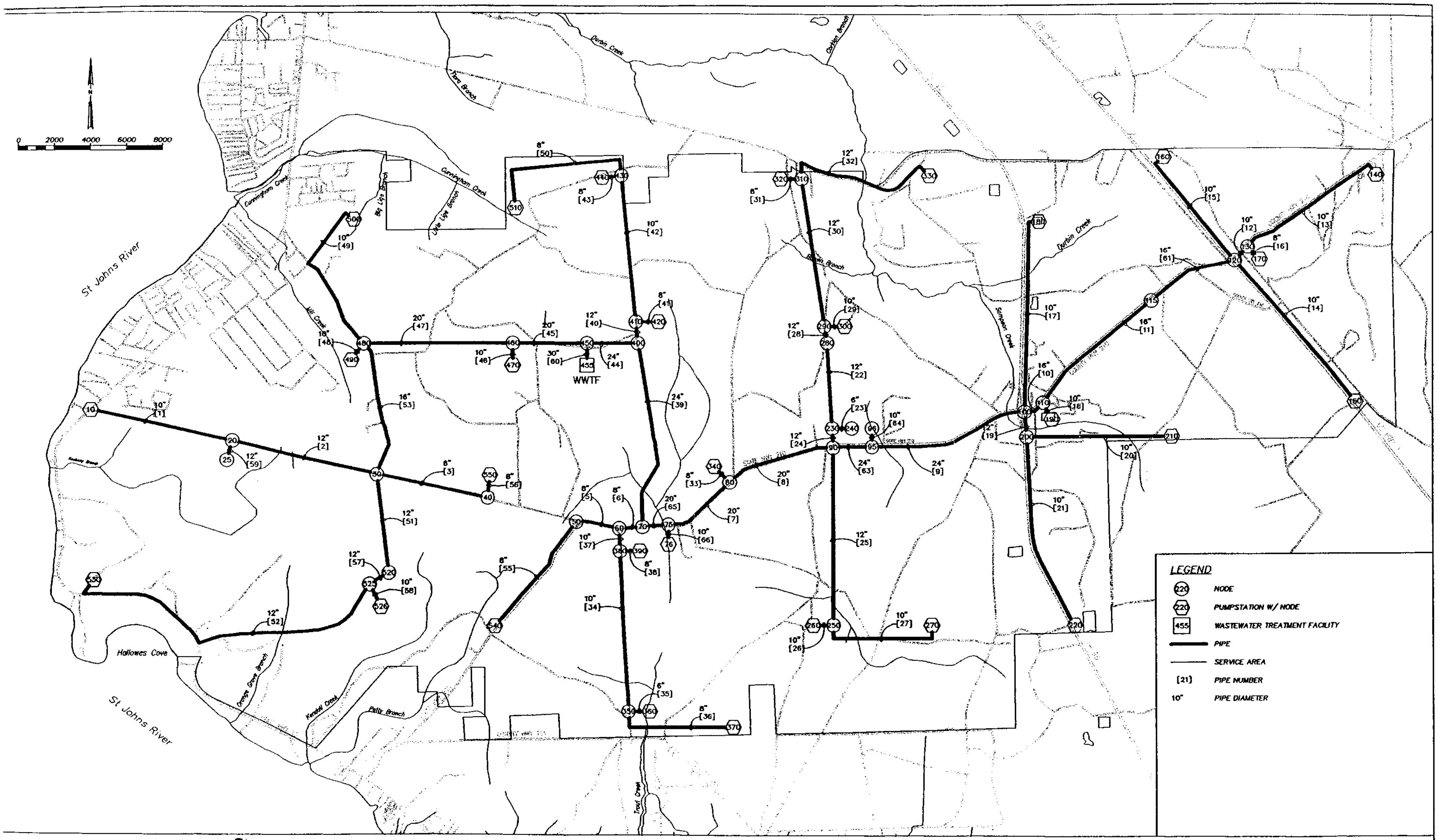

EXHIBIT B-5
WASTEWATER ALT NO. 2A - YEAR 2013

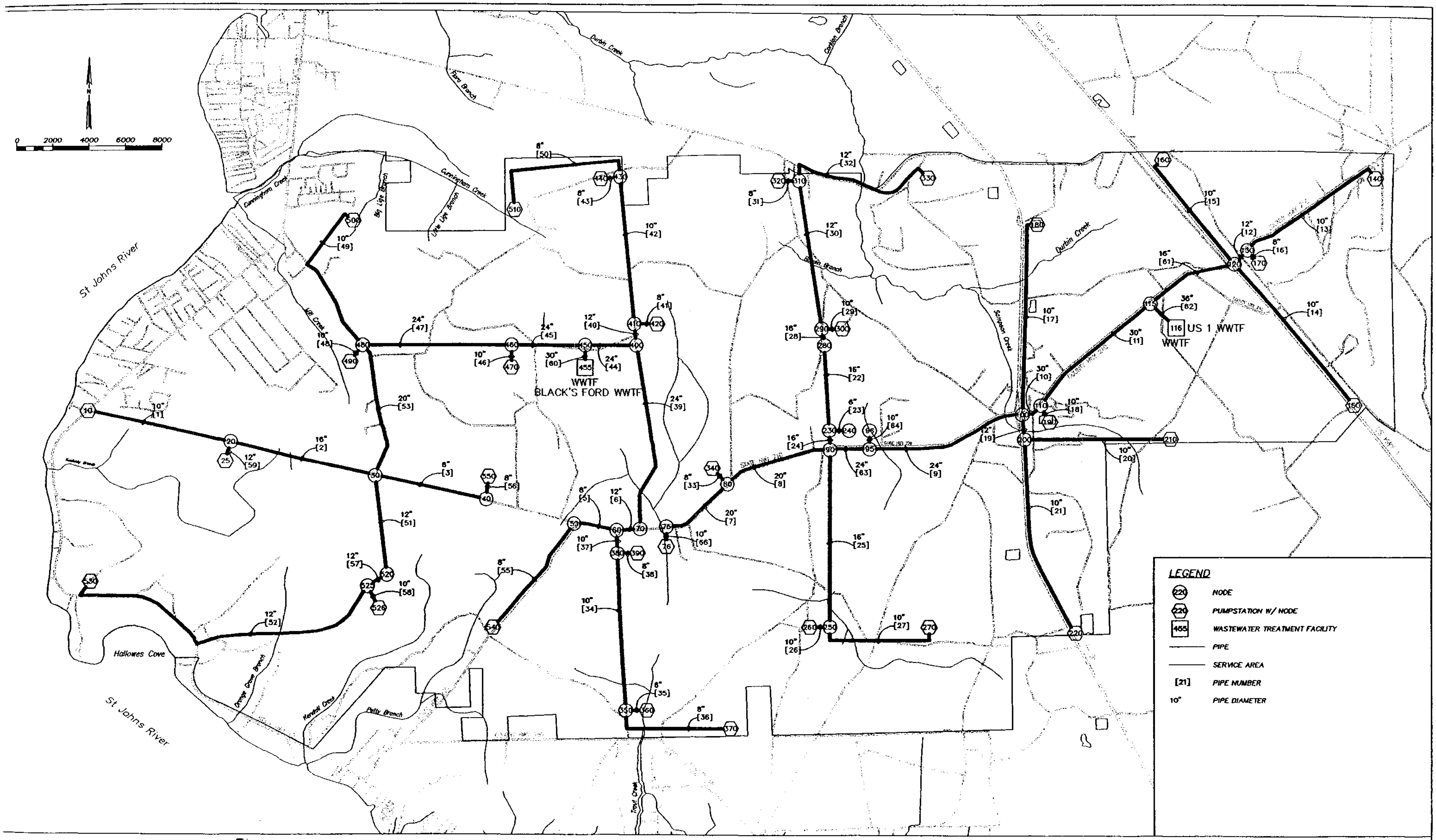

EXHIBIT B-6
WASTEWATER ALT NO. 2B - 2 WWTFS BUILD OUT

EXHIBIT 1
Water System Alternative 1, Four WTFs
Plant Construction Cost Estimates

Component	Quantity	Size	Unit	Unit Cost ($/gal)	Cost ($)
Ground Storage Tanks:					
St. Johns North	2	1.0	MG	$0.50	$1,000,000
St. Joe Area	2	1.1	MG	$0.48	$1,056,000
CR 210 Area	2	2.1	MG	$0.40	$1,680,000
US 1/I-95 Area	2	1.4	MG	$0.45	$1,260,000
					$4,996,000
Wells					
St. Johns North	4	1,200	gpm	$250,000	$1,000,000
St. Joe Area	4	1,200	gpm	$250,000	$1,000,000
CR 210 Area	9	1,200	gpm	$250,000	$2,250,000
US 1/I-95 Area	6	1,200	gpm	$250,000	$1,500,000
					$5,750,000
High Service Pump Station					
St. Johns North	1	6,420	gpm	$80.00	$513,600
St. Joe Area	1	7,981	gpm	$80.00	$638,480
CR 210 Area	1	17,871	gpm	$70.00	$1,250,970
US 1/I-95 Area	1	10,757	gpm	$74.00	$796,018
					$3,199,068
Chlorination & Generator					
St. Johns North	1				$400,000
St. Joe Area	1				$400,000
CR 210 Area	1				$622,000
US 1/I-95 Area	1				$450,000
					$1,872,000
Total Construction Cost					$15,817,068

EXHIBIT 2
Water System Alternative 1, Four New WTFs
Water Main Cost Estimate

Item	Construction Cost			
	Quantity (ft)	Size (in.)	Unit Cost	Cost
Water Pipelines				
Transmission Pipelines	0	42	$126	$0
	500	36	$108	$54,000
	1,000	30	$90	$90,000
	1,000	24	$72	$72,000
	56,215	20	$60	$3,372,900
	30,560	16	$48	$1,466,900
	201,400	12	$30	$6,042,000
	151,625	10	$25	$3,790,600
	0	8	$20	$0
	0	6	$15	$0
Total Construction Cost				**$14,888,400**

EXHIBIT 3
Water System Alternative 2, Three WTFs
Plant Construction Cost Estimates

Component	Quantity	Size	Unit	Unit Cost ($/gal)	Cost ($)
Ground Storage Tanks					
St. Johns North	2	1.2	MG	$0.47	$1,128,000
St. Joe Area	2	1.25	MG	$0.47	$1,175,000
CR 210 Area	2	3.2	MG	$0.36	$2,304,000
					$4,607,000
Wells					
St. Johns North	4	1,200	gpm	$250,000	$1,000,000
St. Joe Area	4	1,200	gpm	$250,000	$1,000,000
CR 210 Area	14	1,200	gpm	$250,000	$3,500,000
US 1/I-95 Area	0	1,200	gpm	$250,000	$0
					$5,500,000
High Service Pump Station					
St. Johns North	1	7,113	gpm	$80	$569,040
St. Joe Area	1	8,155	gpm	$80	$652,400
CR 210 Area	1	27,760	gpm	$65	$1,804,400
US 1/I-95 Area	1	0	gpm	$74	$0
					$3,025,840
Chlorination & Generator					
St. Johns North	1				$400,000
St. Joe Area	1				$400,000
CR 210 Area	1				$700,000
US 1/I-95 Area	1				$0
					$1,500,000
Total Construction Cost					**$14,632,840**

EXHIBIT 4
Water System Alternative 2, Three New WTFs Buildout System
Water Main Cost Estimates

Item	Construction Cost			
	Quantity (ft)	Size (in.)	Unit Cost	Cost
Water Pipelines				
Transmission Pipelines	1,000	42	$126	$126,000
	0	36	$108	$0
	11,225	30	$90	$1,010,300
	26,500	24	$72	$1,908,000
	30,290	20	$60	$1,817,400
	79,510	16	$48	$3,816,500
	145,150	12	$30	$4,354,500
	148,125	10	$25	$3,703,100
	0	8	$20	$0
	0	6	$15	$0
Total Construction Cost				**$16,735,800**

EXHIBIT 5
Wastewater System Alternative 1, One WWTF
Wastewater Force Main Cost Estimates

Item	Construction Cost				
	Quantity (ft)	Size (in.)	Life	Unit Cost	Cost
Wastewater Pipelines					
Force Mains	500	48	50	$144	$72,000
	4,000	42	50	$126	$504,000
	0	36	50	$108	$0
	16,250	30	50	$90	$1,462,500
	25,000	24	50	$72	$1,800,000
	22,500	20	50	$60	$1,350,000
	31,850	16	50	$48	$1,528,800
	31,200	12	50	$30	$936,000
	125,000	10	50	$25	$3,125,000
	32,925	8	50	$20	$658,500
	8,750	6	50	$15	$131,300
Total Construction Cost					**$11,568,100**

EXHIBIT 6
Wastewater System Alternative 1, One WWTF
Pump Station Cost Estimates

Number	Demand (gpm)	Demand (mgd)	Head (ft)	Pressure (psi)	Horsepower (hp)	Annual Power Cost ($)	Cost ($)	
10	-642.5	0.92	123.31	53.43	26.7	$5,299	$222,931	
25	-1680	2.42	95.85	41.53	54.2	$10,771	$309,437	
140	-910	1.31	132.83	57.56	40.7	$8,085	$254,258	
150	-857.5	1.23	147.83	64.06	42.7	$8,479	$248,910	
160	-700	1.01	160.7	69.64	37.9	$7,524	$230,645	
170	-930	1.34	105.19	45.58	32.9	$6,544	$256,215	
180	-892.5	1.28	155.49	67.38	46.7	$9,283	$252,510	
190	-1275	1.83	109.97	47.65	47.2	$9,379	$284,611	
210	-692.5	1.00	130.42	56.52	30.4	$6,041	$229,676	
220	-872.5	1.26	156.11	67.65	45.9	$9,111	$250,471	
240	-1157.5	1.67	68.91	29.86	26.9	$5,335	$275,910	
260	-1290	1.86	93.39	40.47	40.6	$8,058	$285,664	
270	-815	1.17	112.99	48.96	31.0	$6,160	$244,335	
300	-1167.5	1.68	60.68	26.29	23.9	$4,739	$276,684	
320	-542.5	0.78	102.25	44.31	18.7	$3,710	$207,705	
330	-762.5	1.10	124.32	53.87	31.9	$6,341	$238,342	
340	-790	1.14	144.48	62.61	38.4	$7,635	$241,531	
360	-652.5	0.94	146.48	63.47	32.2	$6,393	$224,321	
370	-335	0.48	148.96	64.55	16.8	$3,338	$164,320	
390	-670	0.96	81.87	35.48	18.5	$3,669	$226,703	
420	-790	1.14	32.66	14.15	8.7	$1,726	$241,531	
440	-620	0.89	76.61	33.2	16.0	$3,177	$219,723	
470	-1270	1.83	38.61	16.73	16.5	$3,280	$284,257	
490	-1187.5	1.71	53.97	23.39	21.6	$4,287	$278,212	
500	-555	0.80	97.11	42.08	18.1	$3,605	$209,755	
510	-292.5	0.42	126.39	54.77	12.4	$2,473	$152,110	
526	-1037.5	1.49	107.02	46.38	37.4	$7,427	$266,059	
530	-642.5	0.92	165.1	71.54	35.7	$7,095	$222,931	
540	-662.5	0.95	101.13	43.83	22.6	$4,482	$225,690	
550	-405	0.58	104.45	45.26	14.2	$2,830	$181,398	
455	25097.5		20	8.67				
	-25098	-36.11	PHF		887.3	$176,276	$7,206,843	
		-14.44	ADF					
							$1,081,026	Contingency (15%)
					Total Construction Cost		$8,287,869	
Effluent Pump Station:								
	14500	20.86	183	79.22	893.4	$177,492	$942,500	
							$141,375	Contingency (15%)
					Total Construction Cost		$1,083,875	

EXHIBIT 7

Wastewater System Alternative 2, Two WWTFs

Wastewater Force Main Cost Estimates

	Construction Cost				
Item	Quantity (ft)	Size (in.)	Life	Unit Cost	Cost
Wastewater Pipelines					
Force Mains	0	48	50	$144	$0
	0	42	50	$126	$0
	2,750	36	50	$108	$297,000
	9,500	30	50	$90	$855,000
	39,750	24	50	$72	$2,862,000
	20,000	20	50	$60	$1,200,000
	30,860	16	50	$48	$1,481,300
	48,500	12	50	$30	$1,455,000
	106,750	10	50	$25	$2,668,800
	36,925	8	50	$20	$738,500
	1,500	6	50	$15	$22,500
Total Construction Cost					**$11,580,100**

EXHIBIT 8
Wastewater System Alternative 2, Two WWTFs
Pump Station Cost Estimates

Node Number	Demand (gpm)	Demand (mgd)	Head (ft)	Pressure (psi)	Horsepower (hp)	Annual Power Cost ($)	Cost ($)	
10	-642.5	0.92	123.8	53.65	26.8	$5,321	$222,931	
25	-1680	2.42	96.34	41.75	54.5	$10,826	$309,437	
76	-940	1.35	102.8	44.54	32.5	$6,464	$257,177	
96	-1067.5	1.54	92.27	39.98	33.2	$6,589	$268,625	
140	-910	1.31	100.49	43.55	30.8	$6,117	$254,258	
150	-857.5	1.23	84.29	36.53	24.3	$4,835	$248,910	
160	-700	1.01	97.17	42.11	22.9	$4,550	$230,645	
170	-930	1.34	41.66	18.05	13.0	$2,592	$256,215	
180	-892.5	1.28	108.06	46.83	32.5	$6,451	$252,510	
190	-1275	1.83	57.55	24.94	24.7	$4,908	$284,611	
210	-692.5	1.00	82.99	35.96	19.4	$3,844	$229,676	
220	-872.5	1.26	108.68	47.09	31.9	$6,343	$250,471	
240	-90	0.13	98.26	42.58	3.0	$592	$46,031	
260	-1290	1.86	123.55	53.54	53.7	$10,661	$285,664	
270	-815	1.17	143.15	62.03	39.3	$7,804	$244,335	
300	-1167.5	1.68	117.48	50.91	46.2	$9,174	$276,684	
320	-542.5	0.78	159.05	68.92	29.1	$5,772	$207,705	
330	-762.5	1.10	164.85	71.44	42.3	$8,408	$238,342	
340	-790	1.14	104.65	45.35	27.8	$5,530	$241,531	
360	-382.5	0.55	78.64	34.08	10.1	$2,012	$176,254	
370	-335	0.48	77.45	33.56	8.7	$1,736	$164,320	
420	-790	1.14	31.53	13.66	8.4	$1,666	$241,531	
440	-620	0.89	75.48	32.71	15.8	$3,130	$219,723	
470	-1270	1.83	39.1	16.94	16.7	$3,322	$284,257	
490	-1187.5	1.71	54.46	23.6	21.8	$4,326	$278,212	
500	-555	0.80	66.56	28.84	12.4	$2,471	$209,755	
510	-292.5	0.42	81.5	35.32	8.0	$1,595	$152,110	
526	-1037.5	1.49	107.51	46.59	37.6	$7,461	$266,059	
530	-642.5	0.92	137.36	59.52	29.7	$5,903	$222,931	
540	-662.5	0.95	112.37	48.69	25.1	$4,980	$225,690	
550	-405	0.58	109.5	47.45	14.9	$2,966	$181,398	
455	10502.5	-15.11	20	8.67				
116	14595	-21.00	20	8.67				
	-25097.5	-36.11	PHF			$158,345	$7,227,995	
		-14.44	ADF				$1,084,199	Contingency (15%)
					Total Construction Cost		$8,312,194	

GNV/1002510.XLS

Water Transmission System Model Output File

Conditions: Four WTFs

Buildout Peak Hour Flow

BOOSTER PUMPS 0
RESERVOIRS 4
MINOR LOSSES 0
PRVS 0
NOZZLES 0
CHECK VALVES 0
BACK PRES. V. 0

RESERVOIRS:

NODE	ELEVATION
1000	175.00
2000	177.00
3000	175.00
4000	187.00

NET SYSTEM DEMAND : 43010.00

SUM OF POSITIVE DEMANDS : 43010.00

NUMBER OF LOOPS, BAND WIDTH AND HALF BAND WIDTH= 19 13 6

ITERATION= 1 SUM OF DIFFERENCES= 57.1
ITERATION= 2 SUM OF DIFFERENCES= 23.9
ITERATION= 3 SUM OF DIFFERENCES= 3.46
ITERATION= 4 SUM OF DIFFERENCES= 0.310
ITERATION= 5 SUM OF DIFFERENCES= 0.667E-02
TVSUM= 2.0000 SUM= 0.0000

THE MINIMUM VELOCITY CRITERIA OF 0.0 FT/SEC (OR M/S) OR THE MAXIMUM VELOCITY CRITERIA OF 5.0 FT/SEC (OR M/S) HAS NOT BEEN MET IN THE FOLLOWING PIPES :

2	5.67	3	5.63	80	5.27	95	6.09
206	5.03	220	5.61	230	5.47	301	5.66

UNITS OF SOLUTION ARE:
DIAMETERS - inch
LENGTH - feet
HEADS - feet
ELEVATIONS - feet
PRESSURES - psi
FLOW - (gpm)
HAZEN-WILLIAMS FORMULA USED FOR COMPUTING HEAD LOSSES

```
******************************************
*                        *
*          NETWK           *
*     PIPE NETWORK ANALYSIS       *
*                        *
*        CH2M Hill, Inc.         *
*     2300 NW Walnut Boulevard       *
*         P.O. Box 428          *
*     Corvallis, Oregon  97330       *
*                        *
*        VERSION  8.86          *
*          19-JUL-95          *
*                        *
*      (C) COPYRIGHT 1995         *
*       CH2M-HILL INC.          *
*      ALL RIGHTS RESERVED         *
*                        *
*    RUN ON  01/23/97  17:36:18       *
*                        *
*          NOTE           *
* This page contains valuable information *
* that should be saved.  If it becomes    *
* necessary to rerun this analysis in the *
* future, this page will allow retrieval  *
* of the proper program and data files.   *
******************************************
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INPUT FILE : _PC: w1-mhf.dat
OUTPUT FILE : _PC: w1-mhf.OUT

NETWK 8.86, 19-JUL-95 CH2M HILL, INC. Pipe Network Analysis
****

FILES: Input- w1-mhf.dat````` Output- w1-mhf.OUT`````
RUN DATE: 01/23/97 TIME: 17:36:18

United Water Florida
St. Johns North Water & Wastewater Master Plan
137651.A0
Network for Water Distribution System
Alternative 1 - 3 New Water Plants
Ultimate Demand (Maximum Hourly Flow)

"SPECIF" PEAKING FACTOR = 2.5000

PIPES 53
NODES 38
SOURCE PUMPS 0

PIPE DATA:

	PIPE	NODES		LENGTH	DIAM	COEF	FLOW RATE	VELOCITY	HLOSS	HLOSS
	NO.	FROM	TO	(ft)	(in)		(gpm)	(ft/s)	(ft)	(ft/1000 ft)
	1	1000	10	500	24	140	6339.08	4.5	1.16	2.31
	2	2000	70	500	24	140	7993.76	5.67	1.78	3.55
	3	3000	210	500	36	140	17861.85	5.63	1.09	2.19
	4	4000	330	500	30	140	10815.31	4.91	1.05	2.1
	20	10	20	260	16	140	2355.68	3.76	0.69	2.66
	30	20	40	10000	12	140	817.08	2.32	15.21	1.52
	50	10	50	4000	16	140	3045.9	4.86	17.14	4.29
	55	40	50	2625	12	140	434.54	1.23	1.24	0.47
	60	40	60	14750	10	140	382.54	1.56	13.37	0.91
*	70	70	60	5025	12	140	1729.68	4.91	30.65	6.1
	80	70	80	11000	20	140	5161.59	5.27	42.23	3.84
	90	80	90	7250	12	140	1308.9	3.71	26.39	3.64
	95	50	90	5500	12	140	2147.94	6.09	50.1	9.11
	96	90	170	15500	10	140	309.34	1.26	9.48	0.61
	100	80	100	6000	12	140	1617.63	4.59	32.33	5.39
	110	60	110	19750	12	140	1012.21	2.87	44.66	2.26
*	115	100	110	12625	10	140	87.79	0.36	0.75	0.06
	130	100	130	11250	10	140	194.84	0.8	2.92	0.26
	135	140	130	8250	12	140	1304.56	3.7	29.84	3.62
	140	80	140	12000	16	140	902.56	1.44	5.41	0.45
*	150	150	140	2000	16	140	1519.49	2.42	2.36	1.18
*	160	160	150	1500	16	140	3033.76	4.84	6.38	4.25
	170	160	170	11000	10	140	801.26	3.27	39.21	3.56
*	175	180	170	10000	10	140	369.69	1.51	8.51	0.85
	180	20	180	13750	12	140	1538.6	4.36	67.52	4.91
	190	180	190	10750	10	140	111.41	0.46	0.99	0.09
*	200	200	170	10500	10	140	1009.71	4.12	57.43	5.47
*	205	200	190	10500	12	140	1511.89	4.29	49.92	4.75
	206	210	200	5500	20	140	4924.1	5.03	19.35	3.52
	220	210	220	500	30	140	12350.25	5.61	1.34	2.68
*	225	220	160	12500	20	140	4435.02	4.53	36.24	2.9
	230	220	230	10800	16	140	3430.51	5.47	57.68	5.34
	235	230	275	13000	12	140	121.68	0.35	0.58	0.04
	240	130	240	9000	10	140	366.9	1.5	7.55	0.84
	245	150	230	10500	12	140	791.77	2.25	15.07	1.43
*	246	230	240	19000	12	140	750.6	2.13	24.69	1.3
	250	220	250	8375	20	140	2837.22	2.9	10.61	1.27
	260	250	260	2850	20	140	1414.72	1.44	1	0.35
	265	260	265	6500	12	140	1669.1	4.73	37.11	5.71
	270	260	270	1490	20	140	3605.05	3.68	2.94	1.98
	275	270	275	11250	12	140	1355.82	3.85	43.71	3.89
	280	270	280	7500	12	140	1289.22	3.66	26.54	3.54
	290	280	290	13500	12	140	496.72	1.41	8.17	0.61
*	300	310	290	7750	12	140	1500.67	4.26	36.34	4.69
	301	330	310	6000	20	140	5545.87	5.66	26.31	4.39
	320	310	320	9000	12	140	1270.79	3.6	31.01	3.45
*	321	320	290	12000	10	140	260.1	1.06	5.32	0.44
	322	320	340	13750	10	140	243.18	0.99	5.39	0.39
	330	330	260	8500	20	140	4469.43	4.56	25	2.94
	340	310	340	7000	12	140	1586.91	4.5	36.4	5.2
	341	340	360	8250	10	140	627.6	2.56	18.7	2.27
	360	265	360	7750	12	140	1066.6	3.03	19.31	2.49
	361	190	360	12250	10	140	30.8	0.13	0.1	0.01

NODE DATA:

NODE	Demand		ELEV	HEAD	PRESSURE	HGL
NO.	(cfs)	(gpm)	(ft)	(ft)	(psi)	(ft)
10	2.089	937.5	25	148.84	64.5	173.84
20	0	0	25	148.15	64.2	173.15
40	0	0	26	131.94	57.18	157.94
50	2.969	1332.5	24	132.7	57.5	156.7
60	2.451	1100	16	128.57	55.72	144.57
70	2.456	1102.5	28	147.22	63.8	175.22
80	2.969	1332.5	25	107.99	46.8	132.99
90	7.013	3147.5	29	77.6	33.63	106.6
100	2.974	1335	31	69.66	30.19	100.66
110	2.451	1100	15	84.92	36.8	99.92
130	2.523	1132.5	29	68.74	29.79	97.74
140	2.49	1117.5	20	107.59	46.62	127.59
150	1.61	722.5	20	109.95	47.65	129.95
160	1.337	600	25	111.33	48.24	136.33
170	5.548	2490	25	72.12	31.25	97.12
180	2.356	1057.5	20	85.63	37.11	105.63
190	3.548	1592.5	22	82.64	35.81	104.64
200	5.353	2402.5	25	129.56	56.14	154.56
210	1.309	587.5	25	148.91	64.53	173.91
220	3.671	1647.5	25	147.57	63.95	172.57
230	7.464	3350	20	94.89	41.12	114.89
240	2.49	1117.5	25	65.19	28.25	90.19
250	3.169	1422.5	25	136.95	59.35	161.95
260	1.359	610	25	135.96	58.91	160.96
265	1.342	602.5	15	108.84	47.17	123.84
270	2.139	960	26	132.01	57.21	158.01
275	3.292	1477.5	30	84.3	36.53	114.3
280	1.766	792.5	30	101.47	43.97	131.47
290	5.03	2257.5	51	72.3	31.33	123.3
310	2.646	1187.5	50	109.64	47.51	159.64
320	1.71	767.5	50	78.63	34.07	128.63
330	1.782	800	35	150.95	65.41	185.95
340	2.679	1202.5	16	107.24	46.47	123.24
360	3.843	1725	20	84.53	36.63	104.53
1000	-14.124 -	6339.08	25	150	65	175
2000	-17.810 -	7993.76	27	150	65	177
3000	-40.796	7861.85	25	150	65	175
4000	-25.097	815.31	37	150	65	187

Wastewater Transmission System Model Output File

Conditions: One WWTF at Blacks Ford Site

Buildout Peak Hour Flow

```
******************************************
*                          *
*          NETWK          *
*     PIPE NETWORK ANALYSIS      *
*                          *
*       CH2M Hill, Inc.        *
*    2300 NW Walnut Boulevard      *
*        P.O. Box 428        *
*    Corvallis, Oregon  97330      *
*                          *
*        VERSION  8.86         *
*          19-JUL-95         *
*                          *
*      (C) COPYRIGHT 1995         *
*       CH2M-HILL INC.          *
*      ALL RIGHTS RESERVED         *
*                          *
*   RUN ON  01/22/97  09:35:40      *
*                          *
*          NOTE            *
* This page contains valuable information  *
* that should be saved.  If it becomes     *
* necessary to rerun this analysis in the  *
* future, this page will allow retrieval   *
* of the proper program and data files.    *
******************************************
```

INPUT FILE : _PC: ww1-mhf.dat
OUTPUT FILE : _PC: ww1-mhf.OUT

NETWK 8.86, 19-JUL-95 CH2M HILL, INC. Pipe Network Analysis
****

FILES: Input- ww1-mhf.dat```` Output- ww1-mhf.OUT````
RUN DATE: 01/22/97 TIME: 09:35:40

United Water Florida
St. Johns North Water & Wastewater Master Plan
137651.A0
Network for Sewer Collection System
Alternative 1 - 1 New Wastewater Plant
Ultimate Demand (Maximum Hourly Flow Basis)

"SPECIF" PEAKING FACTOR = -2.5000

PIPES 58
NODES 59
SOURCE PUMPS 0

BOOSTER PUMPS 0
RESERVOIRS 1
MINOR LOSSES 0
PRVS 0
NOZZLES 0
CHECK VALVES 0
BACK PRES. V. 0

RESERVOIRS:

NODE	ELEVATION
455	45.00

NET SYSTEM DEMAND : -25097.50

SUM OF POSITIVE DEMANDS : 0.00
TVSUM= 2.0000 SUM= 0.0000

THE MINIMUM VELOCITY CRITERIA OF 0.0 FT/SEC (OR M/S) OR THE MAXIMUM VELOCITY CRITERIA OF 5.0 FT/SEC (OR M/S) HAS NOT BEEN MET IN THE FOLLOWING PIPES :

7	5.04	9	5.06	12	5.22	16	5.94
18	5.21	26	5.27	33	5.04	41	5.04
45	5.26	46	5.19	54	5.84		

UNITS OF SOLUTION ARE:
DIAMETERS - inch
LENGTH - feet
HEADS - feet
ELEVATIONS - feet
PRESSURES - psi
FLOW - (gpm)
HAZEN-WILLIAMS FORMULA USED FOR COMPUTING HEAD LOSSES

PIPE DATA:

	PIPE NO.	NODES FROM	NODES TO	LENGTH (ft)	DIAM (inch)	COEF	FLOW RATE (gpm)	VELOCITY (ft/s)	HLOSS (ft)	HLOSS (ft/1000 ft)
	1	10	20	7750	10	140	642.5	2.62	18.35	2.37
	2	20	30	8500	16	140	2322.5	3.71	22.04	2.59
*	3	40	30	6375	8	140	405	2.59	19.04	2.99
	5	50	60	3250	10	140	662.5	2.71	8.15	2.51
*	6	60	70	1500	16	140	2320	3.7	3.88	2.59
	7	80	70	6500	8	140	790	5.04	66.91	10.29
	9	100	90	13250	24	140	7130	5.06	38.08	2.87
	10	110	100	1000	20	140	4672.5	4.77	3.19	3.19
	11	120	110	13250	20	140	3397.5	3.47	23.45	1.77
	12	130	120	750	12	140	1840	5.22	5.13	6.84
	13	140	130	11750	12	140	910	2.58	21.82	1.86
	14	150	120	10625	10	140	857.5	3.5	42.94	4.04
	15	160	120	7500	10	140	700	2.86	20.81	2.78
	16	170	130	300	8	140	930	5.94	4.18	13.92
	17	180	100	10625	10	140	892.5	3.65	46.24	4.35
	18	190	110	300	10	140	1275	5.21	2.53	8.43
	19	200	100	1750	12	140	1565	4.44	8.87	5.07
	20	210	200	8200	10	140	692.5	2.83	22.31	2.72
	21	220	200	11500	10	140	872.5	3.56	47.99	4.17
	22	230	280	5000	30	140	10392.5	4.72	9.74	1.95
	23	240	230	500	10	140	1157.5	4.73	3.52	7.04
	24	90	230	500	30	140	9235	4.19	0.78	1.57
	25	250	90	10600	16	140	2105	3.36	22.91	2.16
	26	260	250	500	10	140	1290	5.27	4.3	8.61
	27	270	250	6500	10	140	815	3.33	23.91	3.68
	28	290	280	500	16	140	2472.5	3.95	1.46	2.91
	29	300	290	500	10	140	1167.5	4.77	3.58	7.16
	30	310	290	9000	12	140	1305	3.7	32.58	3.62
	31	320	310	500	8	140	542.5	3.46	2.57	5.13
	32	330	310	8500	10	140	762.5	3.11	27.64	3.25
	33	340	80	500	8	140	790	5.04	5.15	10.29
	34	350	380	9750	10	140	987.5	4.03	51.18	5.25
	35	360	350	1000	8	140	652.5	4.16	7.22	7.22
	36	370	350	7000	8	140	335	2.14	14.71	2.1
	37	380	60	1200	12	140	1657.5	4.7	6.76	5.64
	38	390	380	500	8	140	670	4.28	3.79	7.59
	39	70	400	10750	16	140	3110	4.96	47.88	4.45
	40	410	400	500	12	140	1702.5	4.83	2.96	5.92
	41	420	410	500	8	140	790	5.04	5.15	10.29
	42	430	410	9000	10	140	912.5	3.73	40.81	4.53
	43	440	430	500	8	140	620	3.96	3.29	6.57
	44	400	450	4000	42	140	17677.5	4.09	4.05	1.01
	45	460	450	4500	24	140	7420	5.26	13.92	3.09
	46	470	460	500	10	140	1270	5.19	4.18	8.36
	47	480	460	7250	24	140	6150	4.36	15.85	2.19
	48	490	480	500	10	140	1187.5	4.85	3.69	7.39
	49	500	480	8750	8	140	555	3.54	46.84	5.35
	50	510	430	8750	6	140	292.5	3.32	58.06	6.64
	51	520	30	5250	12	140	1680	4.77	30.34	5.78
	52	530	525	20250	10	140	642.5	2.62	47.95	2.37
	53	30	480	8250	20	140	4407.5	4.5	23.64	2.87
	54	280	400	10750	30	140	12865	5.84	31.09	2.89
	55	540	50	8250	10	140	662.5	2.71	20.68	2.51
	56	550	40	500	8	140	405	2.59	1.49	2.99
	57	525	520	500	12	140	1680	4.77	2.89	5.78
	58	526	525	500	10	140	1037.5	4.24	2.88	5.75
	59	25	20	500	12	140	1680	4.77	2.89	5.78
*	60	450	455	500	48	140	25097.5	4.45	0.51	1.01

NODE DATA:

NODE	DEMAND		ELEV	HEAD	PRESSURE	HGL
NO.	(CFS)	(gpm)	(ft)	(ft)	(psi)	(ft)
10	-1.431	-642.5	16	123.31	53.43	139.31
20	0	0	28	92.96	40.28	120.96
25	-3.743	-1680	28	95.85	41.53	123.85
30	0	0	25	73.92	32.03	98.92
40	0	0	31	86.95	37.68	117.95
50	0	0	20	89.46	38.77	109.46
60	0	0	20	81.31	35.24	101.31
70	0	0	25	72.43	31.39	97.43
80	0	0	25	139.34	60.38	164.34
90	0	0	25	66.17	28.67	91.17
100	0	0	25	104.25	45.17	129.25
110	0	0	25	107.44	46.56	132.44
120	0	0	50	105.89	45.88	155.89
130	0	0	58	103.02	44.64	161.02
140	-2.027	-910	50	132.83	57.56	182.83
150	-1.911	-857.5	51	147.83	64.06	198.83
160	-1.56	-700	16	160.7	69.64	176.7
170	-2.072	-930	60	105.19	45.58	165.19
180	-1.989	-892.5	20	155.49	67.38	175.49
190	-2.841	-1275	25	109.97	47.65	134.97
200	0	0	0	138.12	59.85	138.12
210	-1.543	-692.5	30	130.42	56.52	160.42
220	-1.944	-872.5	30	156.11	67.65	186.11
230	0	0	25	65.38	28.33	90.38
240	-2.579	-1157.5	25	68.91	29.86	93.91
250	0	0	20	94.08	40.77	114.08
260	-2.874	-1290	25	93.39	40.47	118.39
270	-1.816	-815	25	112.99	48.96	137.99
280	0	0	25	55.65	24.11	80.65
290	0	0	25	57.1	24.74	82.1
300	-2.601	-1167.5	25	60.68	26.29	85.68
310	0	0	22	92.68	40.16	114.68
320	-1.209	-542.5	15	102.25	44.31	117.25
330	-1.699	-762.5	18	124.32	53.87	142.32
340	-1.76	-790	25	144.48	62.61	169.48
350	0	0	25	134.25	58.18	159.25
360	-1.454	-652.5	20	146.48	63.47	166.48
370	-0.746	-335	25	148.96	64.55	173.96
380	0	0	30	78.08	33.83	108.08
390	-1.493	-670	30	81.87	35.48	111.87
400	0	0	25	24.55	10.64	49.55
410	0	0	25	27.52	11.92	52.52
420	-1.76	-790	25	32.66	14.15	57.66
430	0	0	20	73.33	31.77	93.33
440	-1.381	-620	20	76.61	33.2	96.61
450	0	0	25	20.51	8.89	45.51
460	0	0	25	34.43	14.92	59.43
470	-2.83	-1270	25	38.61	16.73	63.61
480	0	0	29	46.27	20.05	75.27
490	-2.646	-1187.5	25	53.97	23.39	78.97
500	-1.237	-555	25	97.11	42.08	122.11
510	-0.652	-292.5	25	126.39	54.77	151.39
520	0	0	31	98.26	42.58	129.26
525	0	0	30	102.14	44.26	132.14
526	-2.312	-1037.5	28	107.02	46.38	135.02
530	-1.431	-642.5	15	165.1	71.54	180.1
540	-1.476	-662.5	29	101.13	43.83	130.13
550	-0.902	-405	15	104.45	45.26	119.45
455	55.918	25097.5	25	20	8.67	45