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FINAL REPORT

PHASE I:
REPLACEMENT OF POTABLE QUALITY WATER FOR LANDSCAPE IRRIGATION

BY

EDWARD H. TALTON, JR., P.E.
ROBERT A. MORRELL, P.E.
JO ANN JACKSON, P.E.
OF
POST, BUCKLEY, SCHUH & JERNIGAN, INC.

PREPARED FOR
ST. JOHNS RIVER WATER MANAGEMENT DISTRICT

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EXECUTIVE SUMMARY

The evaluation of the data availability and methodology to determine if replacement of potable public supply water for landscape irrigation is a feasible water use reduction strategy has been completed for St. Johns River Water Management District (SJRWMD) as part of Post, Buckley, Schuh & Jernigan Inc.'s (PBS&J's) contract assessing water conservation and reuse of reclaimed water as effective alternative water supply strategies. This report specifically addresses Task I - Replacement of Potable Quality Water for Landscape Irrigation.

The scope of work included:

1) contacting and surveying the 25 largest utilities in the water resource caution area (WRCA).

2) conducting a literature review of recent, applicable water use technical references to help establish landscape irrigation and water use quantities.

3) contacting various experts on water use.

4) developing a methodology to quantify public water supply landscape irrigation use in the WRCA.

5) developing a methodology to quantify the use of self-supply wells for landscape irrigation.

6) developing a methodology to estimate costs for replacing public supply landscape irrigation with reuse.

7) developing a methodology to estimate costs for replacing public supply landscape irrigation with self-supply irrigation wells.

A successful telephone survey was accomplished with all 25 utilities participating. These 25 utilities account for approximately 90 percent of the water withdrawn from the WRCA. Only five of the utilities had

estimates of landscape irrigation usage within their service areas. The five utilities provided estimates of landscape irrigation percentages from 10 to 50 percent of the total water used, generally based on residential use. The 10 percent estimate was for Daytona Beach and may be partially attributable to the prevalent use of self-supply irrigation wells in the City. Only one utility, Titusville, had an estimate of the number of self-supply irrigation wells in their service area (8,000 wells). Each utility in the survey was asked about the availability of water meter records, existing and future reuse plans, irrigation meter data, water conservation, Geographic Information System data base, and billing data.

A literature review was conducted and over 25 recent, applicable references were obtained. Many of the references contained information regarding water use in Florida. Outdoor water use, of which landscape irrigation is the primary component, can account for 50-70 percent of the total residential water use in Florida (USEPA, 1992). Water use experts with the State and local utilities were contacted for additional references.

Total monthly water use records for 12 of the 25 largest utilities were available from SJRWMD. A brief review of the data was conducted. It appears that total water use is consistently lowest during the months of December and January and highest during the spring and summer. This difference could give a good representation of outdoor water use.

Because landscape irrigation is dependent on a number of factors, including location, a broad study-area-wide percentage would not accurately quantify landscape irrigation. This can be seen from the broad range of public supply landscape irrigation percentages already encountered (10 to 50 percent) and differences between low month and average monthly water use for the 12 utilities reviewed. It is recommended that landscape irrigation quantities and percentages be estimated for at least 12 utilities surveyed in Phase II. Four estimation methods were reviewed. Subtraction of estimated indoor water use from outdoor water use was determined to be a simple and effective methodology to estimate current landscape irrigation quantities.

Once potable and total landscape irrigation water quantities are estimated the feasibility of replacing the potable quantities with reclaimed water and self-supply wells can be determined. In Phase II, capital and operation and maintenance costs will be calculated for providing landscape irrigation using two alternative sources:

1) Reuse of Reclaimed Water

2) Self-Supply Irrigation Wells

Reclaimed water availability must be assessed in Phase II. SJRWMD has a spreadsheet data base and GIS mapping of wastewater treatment plants (WWTPs) by County. The data base summarizes permitted capacities and existing reuse flows. Data availability regarding projected future WWTP flows and future reuse plans are not included in the data base. It is recommended that the SJRWMD data base be utilized with the knowledge that it represents current conditions.

Unit costs will be developed for the study area for construction of reuse and self-supply irrigation system by using in-house cost data bases, consultation with utilities, and consultation with well contractors. Equivalent annual costs will be generated.

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INTRODUCTION

BACKGROUND

St. Johns River Water Management District (SJRWMD) is responsible for managing ground water resources in a 19-county area of northeastern Florida. Ground water aquifers are currently the primary sources of potable water supply in SJRWMD. The most dependable ground water source is the Floridan aquifer. However, the *Water Supply Needs and Sources Assessment* (Vergara 1994) projected shortfalls in available water supply in certain critical areas throughout SJRWMD boundaries by the year 2010. Areas with existing or 2010 projected water supply problems were designated as water resource caution areas (WRCAs).

As a result of the *Water Supply Needs and Sources Assessment*, SJRWMD embarked on an Investigation of Alternative Water Supply Strategies. Strategies being investigated include using lower quality ground water supplies, surface water, reclaimed water, aquifer recharge, aquifer storage and recovery, mitigation and avoidance, and various water conservation techniques.

SJRWMD contracted with Post, Buckley, Schuh & Jernigan, Inc. (PBS&J) to perform various tasks for the purpose of assessing water conservation and the reuse of reclaimed water as effective alternative water supply strategies. This report specifically addresses Phase I elements of Task I - Replacement of Potable Quality Water for Landscape Irrigation.

Studies in Florida have shown outdoor use, primarily consisting of landscape irrigation, to account for 50 to 70 percent of the total residential water consumption (U.S. Environmental Protection Agency 1992). This makes landscape irrigation the largest non-potable urban water use and a target for reductions in potable water consumption.

PURPOSE

The purpose of the Task I study is to develop information to assist in determining if the replacement of potable quality water for some non-potable urban uses is a feasible strategy to reduce ground water withdrawals by public supply utilities. The specific non-potable use targeted for replacement is residential landscape irrigation. The study area for this assignment is the WRCA established by SJRWMD in the *Water Supply Needs and Sources Assessment* (Vergara, 1994). The specific objectives of Task I are as follows:

1. Determine the Quantity of Water Used in the Study Area to Irrigate Landscaping.

2. Assess the Cost of Replacing Potable Water Sources with Self-Supply Wells for Landscape Irrigation.

3. Assess the Cost of Replacing Potable Water Sources with Reclaimed Water for Landscape Irrigation.

Task I is being performed in two phases. This report represents Phase I of the investigation. The purpose of Phase I was to develop a methodology and assess data availability to perform the evaluation in Phase II. The following products were developed:

1. Assessment of data availability required to implement the proposed methodologies.

2. Recommendations for sources of alternative or surrogate data.

3. Proposed methodologies for performing Phase II.

4. Key staff assignments for Phase II.

5. Projected Phase II budget.

SCOPE OF WORK (TASK I - PHASE I SUBTASKS)

The Phase I Scope of Work included the following tasks:

1. Develop methodologies for performing Phase II services.

2. Assess the availability of data required for implementing the proposed methodologies in Phase II, including the following.

   a) Contact a sufficient number of utilities within Florida to obtain existing local estimates of landscape irrigation water use and the estimated proportion of future average annual water demand serving new developments and collect available data from those utilities.

   b) Identify and contact representative utilities within SJRWMD that offer irrigation meters, to determine the quantities of water accounted for by such meters and collect available data from those utilities.

   c) Conduct a literature review to find sufficient existing references to the quantity and percentage of water used for landscape irrigation.

   d) Consult water use experts at local utilities, water supply authorities, and other water management districts for representative information concerning the quantity and percentage of water used for landscape irrigation in Florida.

   e) Consult water use experts at local utilities, water supply authorities, and other water management districts for water use data.

3. Recommend sources of alternative data, if needed.

4. Name the key staff who would perform the work specified in Phase II.

5. Provide the charge for performing the prescribed work in Phase II.

METHODOLOGY

GENERAL

The general methodology for conducting Phase I of the Task I study was as follows:

1) Determine and identify a sufficient number of utilities to represent the study area.

2) Generate and perform a survey of the selected utilities to determine the extent and availability of data relevant to landscape irrigation.

3) Conduct a literature review to find sufficient existing references yielding information regarding quantity and percentage of water used for landscape irrigation.

4) Consult water use experts at local utilities, water supply authorities, and other water management districts for general and landscape irrigation water use information.

5) Identify sources of alternative or surrogate data, as needed.

UTILITIES

SJRWMD identified the 25 largest utilities within the WRCA in terms of actual water withdrawn. These utilities represent approximately 90 percent of the public water supply use in the study area. These 25 utilities were selected for contact in the survey.

SURVEY

A survey was developed to assess the availability of data which could be used to complete Task I. A questionnaire was developed to provide structure to the survey which was performed primarily via telephone. A copy of the questionnaire is provided in Appendix A. Key personnel within the utilities were contacted and asked to complete the questionnaire if possible. The survey identified appropriate contact persons and queried for landscape irrigation estimates, data availability, and other pertinent information. The following subjects were addressed in the questionnaire.

Contact

The identification of key contacts within each utility was attempted. Specifically staff with general knowledge of the water systems were identified as the primary contact. Staff with knowledge of the utility's reuse system, water data record keeping, GIS, water rates, conservation and reuse initiative were also identified.

Water Conservation Plans

Water conservation plans could potentially provide useful information regarding water use. Utilities were asked about the existence and location of water conservation plans.

Reuse Plans

Utilities were asked about current and future plans for reusing reclaimed water. In order to assess current and future potable water use for landscape irrigation, it is important to quantify existing and planned, potential reclaimed water utilization. Reclaimed water utilization data are also necessary to assess the availability of supply for reuse. The availability of reuse master plans, feasibility studies, and delineations of service area boundaries was determined.

Reuse Meters

Utilities were asked about the use of meters for individual reuse customers. Reuse meter data could be used to estimate typical residential irrigation demands in the study area.

Potable Water Irrigation Quantity

Utilities were asked about the availability of potable water use estimates for landscape irrigation and the basis for those estimates.

Water Meter Data History

Utilities were asked about the extent, format and availability of historical water use data. The possibility of disaggregating the data into customer classes and the ability of making specific data queries was explored.

Irrigation Meters

The existence of separate irrigation meters on the potable water supply was investigated since separate meter data could be useful in estimating urban landscape irrigation water use.

Self-Supply Irrigation Wells

As with existing reuse systems, the prevalence of self-supply irrigation wells impacts estimates of potable water used for landscape irrigation, as well as the potential to replace potable irrigation supplies with self-supply wells. Based on initial interviews with the utility personnel, information was gathered regarding prevalence of individual self-supply irrigation wells. Names of personnel familiar with irrigation self-supply well data were recorded for future contact.

LITERATURE REVIEW

A literature review was conducted to determine the availability of additional data on landscape irrigation use quantities and characteristics. Technical publications were researched and reviewed to obtain information regarding general and landscape irrigation water use. A sufficient number of existing references were identified and studied to give reasonable estimates of typical percentages and quantities of landscape irrigation. Because water use patterns have changed over time, emphasis was placed on reviewing current sources. Efforts were made to identify Florida-based references to increase the accuracy of the data. References were researched on topics of water use, water consumption, water conservation, irrigation and household water use. Specific references are contained throughout this report and are documented in the References section.

WATER USE EXPERTS

Telephone interviews were conducted with water use experts from the selected utilities, USGS, and other utilities. Specific contacts are indicated throughout this report and are documented in the Reference section.

ALTERNATIVE/SURROGATE DATA

Based on the utility contacts, literature review, and interviews with water use experts, alternative or surrogate data sources were identified. Alternative or surrogate data are defined as other data sources not included in the Phase I investigations which could be used to identify landscape irrigation quantities.

DISCUSSION

INTRODUCTION

Information provided by SJRWMD showed that the 25 largest utilities in the study area account for approximately 90 percent of the public water supply withdrawals. Figure 1 shows the relative water withdrawals for these 25 utilities. The 25 largest utilities represent a wide cross-section of the study area including inland areas such as the cities of Orlando and Leesburg, as well as coastal areas including the cities of Cocoa and Daytona Beach. Because water use can vary geographically it was important to attain the wide cross-section.

SURVEY RESULTS

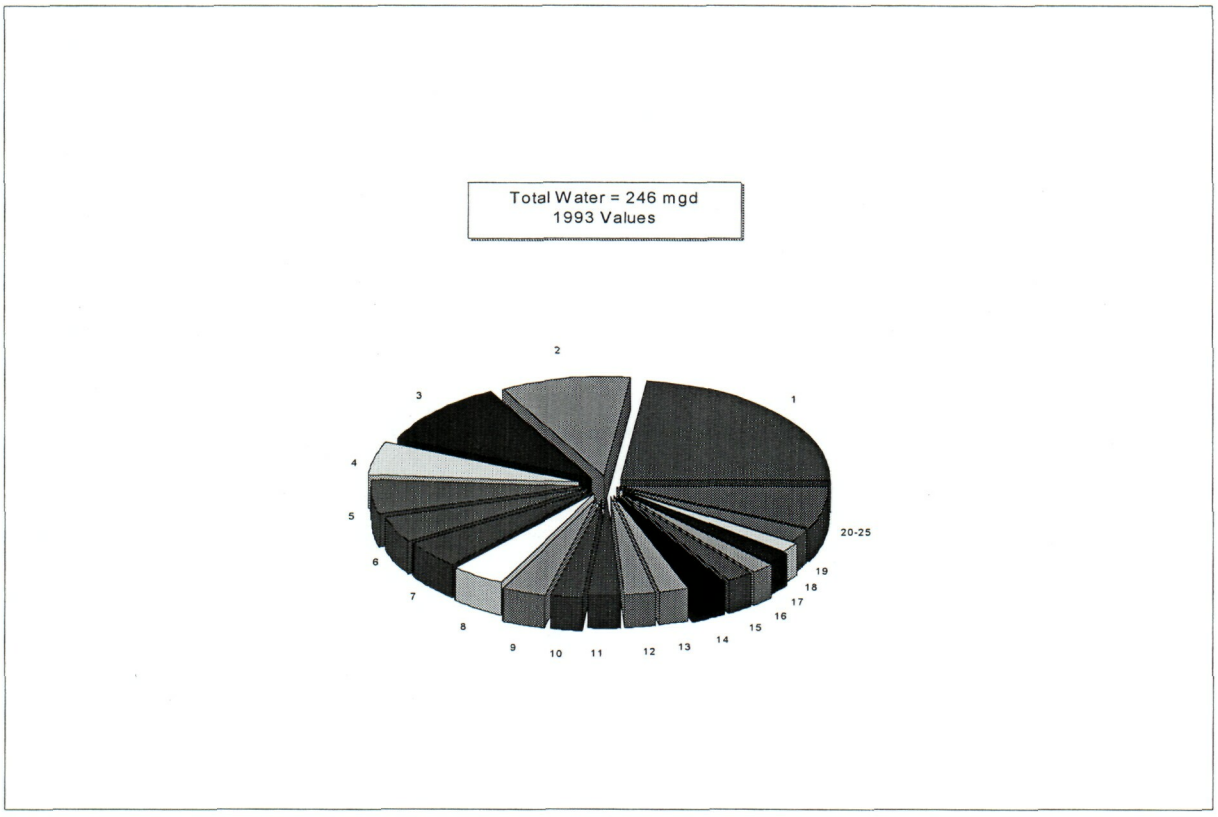
The survey of the selected 25 utilities assessed the availability of data which could be used to complete the second phase of Task I. Results of the survey were compiled into a data base for reference purposes. The survey reference data base and questionnaires are included in Appendix A.

A brief summary of the survey results follows.

Contact

The primary contact person for the survey was generally a utility administrator who was familiar with the water and/or wastewater systems. Future communications and data requests will be directed through the primary contact person. Other contacts regarding reuse system, water data record keeping, GIS, and water rates were identified and recorded, and were occasionally the same person as the primary contact.

Figure 1: Water Withdrawal (25 Largest Utilities in Study Area)



Legend:

1.	Orlando Utility Commission	23.0%	14.	City of Apopka	2.7%
2.	Orange County	10.0%	15.	City of Ormond Beach	2.1%
3.	City of Cocoa	10.5%	16.	City of DeLand	1.8%
4.	City of Daytona Beach	5.4%	17.	City of New Smyrna Beach	1.9%
5.	City of Winter Park	5.6%	18.	City of Winter Springs	1.6%
6.	Seminole County	4.3%	19.	City of Leesburg	2.2%
7.	So. States Util./Deltona	4.6%	20.	Villages of Lake Sumter, Inc.	0.5%
8.	Sanlando Utilities	4.3%	21.	City of Ocoee	1.3%
9.	City of Altamonte Springs	3.4%	22.	City of Maitland	1.3%
10.	City of Casselberry	2.5%	23.	City of Mt. Dora	1.2%
11.	City of Titusville	2.5%	24.	Town of Eustis	1.3%
12.	City of Sanford	2.4%	25.	City of Oviedo	1.3%
13.	City of Port Orange	2.2%			

Source: SJRWMD Water Supply Needs and Sources Assessment (Vergara 1994)

Water Conservation Plans

Most all of the utilities had some form of water conservation plan. It was determined that SJRWMD had a copy of all conservation plans on record. The review of the water conservation plans will be discussed later in this report.

Reuse Plans

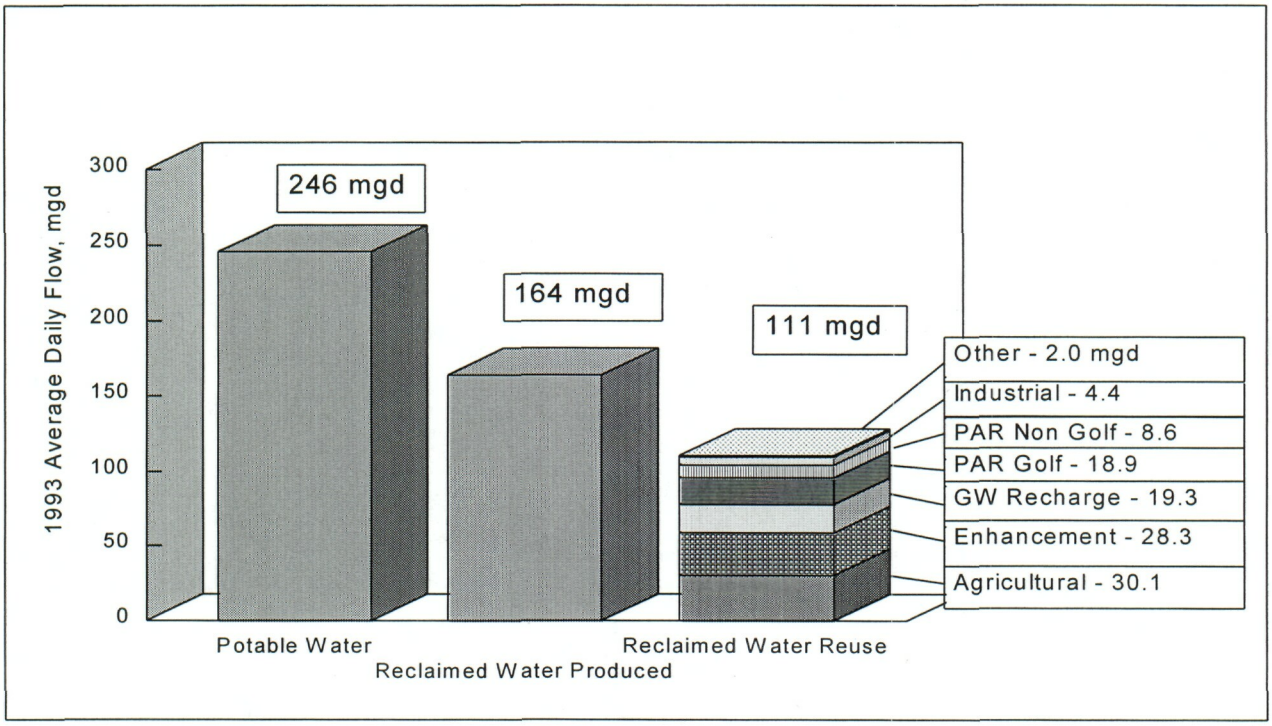
The City of Titusville was the only utility surveyed not currently reusing reclaimed water, although the City has pending reuse plans. Eight of the utilities reuse 100 percent of their reclaimed water. Seventeen of the 25 utilities employ public access reuse (PAR), and two more utilities have future plans to add PAR. Ten of the utilities operate urban reuse systems for landscape irrigation and six utilities have future plans for urban reuse. Three of the 10 urban reuse systems serve non-residential customers only; i.e., schools, commercial properties, common areas, etc. Figure 2 gives a comparison of approximate reuse quantities compared to total water and reclaimed water quantities for the 25 utilities.

Ten of the utilities have a current reuse master plan, other utilities have performed reuse feasibility studies. The master plans and feasibility studies could be used to identify current and future reuse areas, and as a surrogate source for reuse cost information in Phase II.

Reuse Meters

Only two of the seven utilities with residential public access reuse meter reclaimed water customers. Several utilities, including the City of Oviedo, with future residential reuse plans intend to meter residential reuse. Data from one of the residential reuse metering utilities (City of Sanford) are available and would provide a good estimate of landscape irrigation quantities in the City's service area. The City estimated landscape irrigation demands prior to implementing their reuse program and has found that reclaimed water use has exceeded these projected demands. The other metering utility,

Figure 2: Potable Water, Reclaimed Water and Reuse Totals (For the 25 Study Area Utilities)



Notes:

Reclaimed water and reuse data was taken from SJRWMD data base.

Potable water withdrawal data was taken from SJRWMD Water Supply Need & Sources Assessment (Vergara 1994).

the City of Mt. Dora, has an insignificant number of residential reuse customers. The City of Altamonte Springs does not have individual reuse meters but does keep records of total reclaimed water use and connections, and has an extensive, City-wide reuse system which could provide a useful source of landscape irrigation information.

Potable Water Irrigation Quantity

Five of the utilities surveyed have estimates of potable water used for landscape irrigation. The estimation methods used by the five utilities were: 1) non-irrigation water use from 3000 homes with separate irrigation meters was used to establish an average indoor use, then the average indoor use was applied to the entire service area to estimate landscape irrigation use (Orlando Utilities Commission), (2) system knowledge and gross approximation (Daytona Beach), (3) maximum month/maximum day differences(Titusville), (4) difference in water and wastewater flows (Winter Springs), and (5) irrigation meter records (Maitland). The estimates for (3), (4) and (5) could be used for the respective utilities. The gross approximation is not recommended. OUC's methodology presents a viable way to estimate landscape irrigation water use for a utility and can be compared with literature data on indoor water use. Irrigation meter records can also be used to estimate irrigation rates, however, homes without separate meters typically use less water for irrigation than those with separate meters.

The quantity of water used for landscape irrigation for an individual home is highly variable. Landscape irrigation use for two monitored homes in the City of Winter Park ranged from 0 to 45,000 gallons per month over the course of one year according to information gathered in the survey.

Water Meter Data History

Generally, the utilities surveyed maintain a one-year active file on computer with previous years archived on hard copy. Many utilities maintain monthly summaries with users categorized. Annual summaries with meter customer class breakdown were available in

some cases, especially with utilities which had performed a recent rate study. Several utilities, however, could not separate irrigation meter users from other users. A number of utilities indicated that they could provide the results of special queries on the available historical data upon request.

Irrigation Meters

Twenty-three out of the 25 utilities allow the use of irrigation meters. Fifteen of the utilities allow separate residential and separate commercial irrigation meters with the remaining eight allowing separate commercial or common area irrigation meters only. Two of the utilities, the City of Cocoa and the City of Winter Springs, have separate residential irrigation meters in their systems but do not allow any new irrigation meters to be installed. Most of the utilities have less than 10 percent of the residential customers on irrigation meters. The irrigation meters are also generally located on the higher volume irrigation users and may not represent the entire population. The irrigation meter data should accurately represent that portion of the service area currently using the meters. The City of Maitland, however, has installed separate irrigation meters on the majority of its residential customers and uses the total metered irrigation value to estimate the quantity of water used for landscape irrigation.

Self-Supply Irrigation Wells

As with existing reuse systems, the prevalence of self-supply irrigation wells impacts estimates of potable water used for landscape irrigation. The use of self-supply wells for irrigation varies throughout the service area. Preliminary findings indicate that irrigation wells are very prevalent in coastal areas, but are not as predominant in the inland areas.

Many irrigation wells exist in public supply service areas because the wells were the primary source of potable water for residences prior to connection to the public supply. These wells were converted to irrigation-only use rather than abandoned.

Several cities and counties permit irrigation wells, but few keep records for locating or totalizing. Volusia County maintains an extensive data base, called VOLDATA, for all wells constructed in the County. The City of Titusville has an estimate for the number of irrigation wells within the City.

VOLDATA is a data base of wells constructed in Volusia County, listed by location and well use, since 1972. Tom Carey of Volusia County is knowledgeable of VOLDATA and stated that the records since 1985 are very good. The VOLDATA is available on Geographic Information System (GIS) and can be processed in a one month period given an area of interest. The VOLDATA data base contains information on approximately 25,000 wells.

The respective building departments for most cities and counties permit construction of irrigation wells but do not keep organized data. In areas with lake front homes, irrigation water is often drawn from the lakes in many cases as noted by the interviewee. Three of the cities in the survey did not allow irrigation wells within their service area. Names of personnel familiar with irrigation self-supply well data were recorded for future contact. Because of the scarcity of data, identification of the number of self-supply wells will be difficult. The personnel familiar with self-supply well data recorded from the survey along with well contractors and irrigation pump sales personnel may be the best sources for estimation. A person in the Orange County information services department was contacted to determine methods for locating self-supply wells using the County's computer system. No response has been received.

Results of the survey were compiled into a data base for reference purposes. The survey reference data base is included in Appendix A.

LITERATURE REVIEW AND WATER USE EXPERT INFORMATION

Landscape Irrigation

The quantity of water used for landscape irrigation is highly dependent on climate, location, area and type of landscape, type of irrigation system, conservation measures, cost of water, and socioeconomic factors (Prasifka 1987 and Marella 1992). Of these factors, the most important variables affecting water use for irrigation are water price, dwelling unit value, and precipitation (National Research Council 1977).

Two variables associated with climates, temperature and precipitation, exert the strongest influence on water demand used for lawn and garden watering (Marella 1992). Many references have shown a definite relationship between water use and rainfall (Morgan and Smolen 1976, National Research Council 1977, Hansen and Narayanan 1981, Maidment and Miaou 1986, Franklin and Maidment 1986, Whitlach and Martin 1988, Metzner 1989, Miaou 1990, Cuthbert, et. al. 1989, Gilbert, et. al. 1990, and Brandes undated). Water use was shown to decrease following periods of high rainfall and increase dramatically over periods with little or no rainfall. Because significant quantities of water can run off from large rainstorms, effective rainfall (ER) is generally calculated to determine grass and plant water requirements (Brown & Caldwell and Whitcomb 1993).

Temperature, solar radiation, wind speed, and type of soil and vegetation influence the potential for evapotranspiration (ET). High potential ET causes soil to "dry" out thereby leaving less water available for grass and plant uptake. The potential for ET increases in Florida during March, April and May, the same period that temperatures increase and, consequently, water consumption for grasses and plants increase, (Marella 1992). Turf grasses have a net irrigation requirement (NIR) equal to the difference between the ET and the ER (Brown & Caldwell and Whitcomb 1993). For SWFWMD from 1988 to 1992 for example, ET averaged 41 inches per year, and ER

averaged 18 inches out of a total rainfall of 51 inches per year, meaning the NIR equaled 23 inches per year. Irrigation efficiencies would have to be factored in to develop a total water requirement for landscape irrigation.

Geographical location has significant bearing on landscape irrigation water use. Soils and water table affect the watering requirements for grasses and plants. Geographical location may also impact the type of landscaping used for a residence.

Three general socioeconomic factors affect public water supply use in Florida: (1) income/property value, (2) household size, and (3) type of housing (single or multi-family) (Marella 1992). With regards to landscape irrigation, higher income homes are more apt to have larger yards, outdoor landscaping, and in-ground irrigation systems. The presence of an in-ground irrigation system has a dramatic affect on landscape irrigation water use. Homes with in-ground irrigation systems can use 15 percent (no timer) to 50 percent (with timer) more outdoor water than homes with manual hosed-based systems (Whitcomb 1991).

To illustrate the effect of income on landscape irrigation water use, two studies performed in Florida can be compared. Tampa, Florida studied 1,000 single family homes with a median household income of $10,000 to $20,000 and found the outdoor water use to be 50 gallons/day/household (Anderson, et. al. 1993). The community of Gulfstream, Florida with 700 single family homes with a median household income of $80,000 to $90,000 had an outdoor water use of 989 gallons/day/household (Ori and Barrington 1995).

Household size directly affects the amount of non-irrigation water use in a home, but has little or no direct bearing on water used for landscape irrigation . For this reason, outdoor and landscape irrigation water use are generally given in units of per household or connection. The per capita outdoor and total water use naturally increases for low occupancy homes such as retirement communities assuming similar irrigation requirements.

Single family homes use more landscape irrigation water than high density multifamily units, generally because of the difference in the irrigable area. Many multifamily units have relatively small common areas irrigated by property managers. The increased density of multifamily developments (6 to 12 unit/acre) inherently means significantly less irrigable area per household than single family developments (1 to 4 unit/acre).

Water Use Models

Several of the reviewed references developed water use models to correlate water use with many variables. One of the applicable models reviewed was SWFWMD model presented in the *Water Price Elasticity Study* (Brown & Caldwell and Whitcomb, 1993). SWFWMD is geographically similar to the study area for this project: both include inland and coastal areas in the Central Florida region.

The objective of SWFWMD study was to quantify the relationship between water price and water demand for customers. A flexible form model was developed to capture both nonlinear relationships and interactions between variables. Other models reviewed were simple linear models. SWFWMD report generated separate models for single family homes and commercial customers (including apartments). Regression analysis was performed based on cross-sectional time series data to determine the functional relationship between water use and a set of explanatory variables. The variables found by the study to correlate for single family homes are listed below:

- number of occupants
- net irrigation requirement (NIR)
- lot size of home
- irrigation restrictions, days per week
- average well depth
- property value
- marginal water and sewer price
- presence of a pool

SWFWMD model, although developed for individual homes, could be applied to large areas to show the effects of weather, cost, socioeconomic and hydrogeological factors on water use.

Another reference examined the effects of climatic variables on the weekly variations in water use (Brandes 1990). The author developed many combinations of models to determine which climatic variable were the most important regarding variations in water use. Rainfall, lagged rainfall, daylight and high temperature proved to be the most relevant variables (Brandes 1990). A good correlation was shown for a two-variable model using one month's cumulative rainfall and daylight.

When performing planning level studies and using data from a one or two year period it is important to adjust the data to represent an "average" year. A simple model such as the two-variable model by Brandes could be used to adjust a specific year of water use data to represent an average rainfall year.

Indoor Residential Water Use

One method of estimating landscape irrigation water usage is to identify the portion of water used indoors and subtract this portion from the total water usage for residential customers. Indoor water uses include bathing, toilet flushing, drinking, cooking, clothes and dishwashing, and miscellaneous faucet use (DeOreo, et. al. 1995). Indoor water use is much less variable than outdoor water use. It varies less with seasonal and socioeconomic factors. The national average taken from a study performed by the Housing and Urban Development (HUD) in the early 1980s found indoor water use for single family residential homes to be 77 gallons/capita/day (gpcd) for non-conserving homes and 60 gpcd for conserving homes (Prasifka 1988). Many of the references listed herein used the HUD results as the baseline for data regarding indoor water use. In the state of Florida, indoor water use was found to vary from 50 to 90 gpcd with large population averages of around 70 gpcd (Kemp and Mathews 1993, Anderson, et. al 1993 and Davis and Nero 1994). Figure 3 shows

a comparison of local in-state area and national averages for indoor water use.

Indoor water use is affected by seasonal, socioeconomic, and conservation factors. Indoor use can vary with seasons, mostly due to increased occupancy caused by Florida's "snowbird" population. Socioeconomic factors which affect indoor water include household income, household size, and type of housing unit. Conservation implementation in a community can reduce indoor water use by 10 to 25 percent (Vickers 1990 and Maddaus 1987).

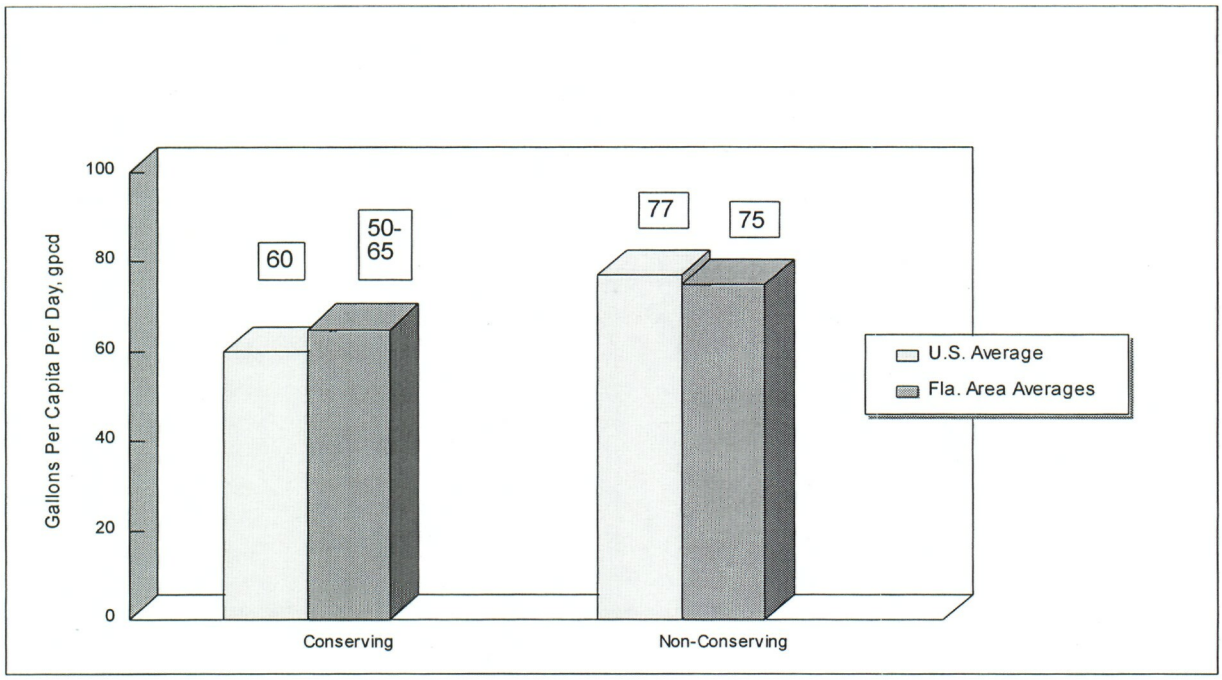
Household income is related to the number of water-using appliances, such as dishwashers. Higher income users are also less affected by the price of water. To illustrate the affect of income on indoor water use the same two studies, Tampa and Gulfstream, previously mentioned were again compared. Tampa, Florida studied 1,000 single family homes with a median household income of $10,000 to $20,000 and found the indoor water use to be 50 gallons/day/household (Anderson, et. al. 1993). The community of Gulfstream, Florida with 700 single family homes with a median household income of $80,000 to $90,000 had an indoor water use of 90 gallons/day/household (Ori and Barrington 1995).

Household size directly affects indoor water use. The more people residing in a home, the higher the water use in that home. For this reason indoor water use is usually expressed in terms of per occupant or capita.

The type of housing unit significantly affects indoor water use. Multi-family residences use less water than single family residences primarily because the household size is usually less for multifamily units than for single family unit. Multifamily units also tend to have fewer water intensive appliances such as clothes washing machines.

A summary of indoor water use values found in the literature review is given in Appendix B.

Figure 3: Indoor Residential Water Use (State and National Data)



Notes:

U.S. Averages were taken from an early 1980s HUD national study (Prasifka 1988). Florida Area Averages were taken from various sources.

Other Outdoor Water Use

Other outdoor water uses include automobile washing, pool filling and miscellaneous cleaning uses. The majority of outdoor water use, however, consists of landscape irrigation (U.S. Environmental Protection Agency 1992). No references addressed the specific percentage of total outdoor use accounted for by landscape irrigation . The small portion of non-irrigation outdoor water use must be subtracted from the total outdoor use to determine a true landscape irrigation usage.

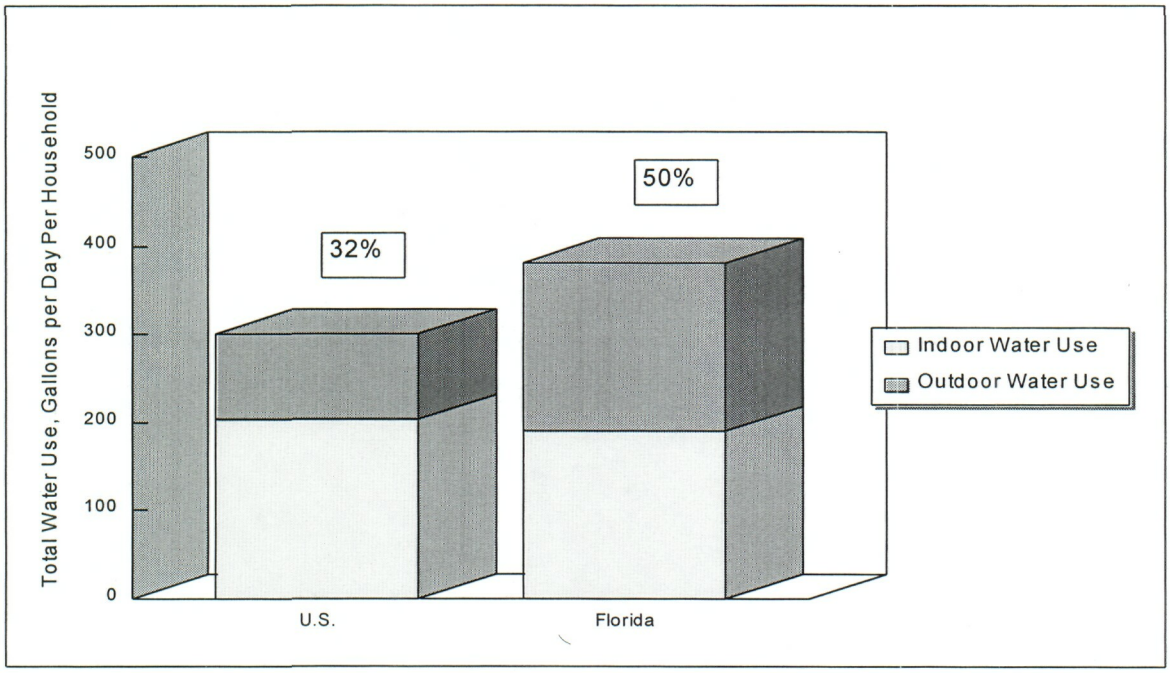
The national average for outdoor water use is 32 percent of total water use, but ranges from 7 to 70 percent depending on the area of the United States (U.S. Environmental Protection Agency 1992). Studies performed in Florida have shown outdoor use to range from 50 to 70 percent of the total water use (U.S. Environmental Protection Agency 1992). Various references for communities in Florida excluding the two income specific area mentioned previously showed outdoor use averages from 140 to 205 gallons/household/day (Kemp and Mathews 1993 and Davis and Nero 1994). Figure 4 shows a comparison of local in-state area and national outdoor water use values. A summary of outdoor water use is given in Appendix B.

SJRWMD maintains a data base of monthly water use for selected utilities. The data base includes 12 of the 25 largest utilities considered in this study. For each of the 12, December and January typically have the lowest water use, with peaks occurring in the spring and summer. Even in December and January, some outdoor water use would occur, but it would be expected to be minimal. The low months could be assumed to represent an approximation of total indoor water use. The difference between total water use and the low monthly water use could then be taken to represent outdoor water use.

Water Conservation Plans

Most of the utilities had water conservation plans in some form, although some were more in depth than others. The plans reviewed

Figure 4: Outdoor Residential Water Use (State and National Data)



Assuming:

2.65 People per household as average U.S. occupancy (Vickers 1990).
2.45 People per household as average Florida (Univ. Of Florida BEBR 1995).

were obtained from SJRWMD. Copies of the water conservation plans were requested from and provided by SJRWMD.

The conservation plans were reviewed and it was determined that very little useful data could be gleaned from the plans. Only one plan, the City of Cocoa's, contained any historical water use information.

Self-Supply Irrigation Wells

SWFWMD *Water Price Elasticity Study* (Brown & Caldwell and Whitcomb 1993) suggests that the number of irrigation wells were influenced by high ground water levels, stating that "in areas with high ground water levels, water users have a readily available substitute to utility water for irrigation." Water price also affects the number of self-supply irrigation wells. SWFWMD water model contains a sub-model which estimates the probability of a home having a self-supply irrigation well. The probability is dependent on the price of water and the relative depth of the usable ground water. The sub-model could be used to estimate the number of self-supply irrigation wells in other similar areas.

CONCLUSIONS

INTRODUCTION

Based on the survey of the 25 largest utilities in the WRCA, a review of the available references, and consultation with water use experts, it is possible to accomplish Phase II of Task I - Replacement of Potable Quality Water for Landscape Irrigation with a planning-level approach. The methodology must be based on using data which could be readily collectable for most if not all of the 25 utilities. Because the 25 utilities account for 90 percent of the water use in the study area, results should be applicable to other utilities.

The complex portion of this project lies in estimating the quantities of landscape irrigation water used from the public supply and self-supply irrigation wells. Very little historical data are maintained by utilities on these items. Once the quantities have been estimated the effort to assess the cost of replacement of public supply landscape irrigation with self-supply irrigation wells or reclaimed water is fairly straightforward.

LANDSCAPE IRRIGATION QUANTITIES

The literature review showed that residential landscape irrigation accounts for approximately 50 percent of the total residential water used in Florida. Very few references are available on commercial landscape irrigation. Five utilities estimated landscape irrigation to be from 10 to 50 percent of their publicly supplied demand. Because landscape irrigation is dependent on many factors including geographic location, water cost, and socioeconomic factors, a broad study-area-wide percentage would not accurately quantify landscape irrigation. Instead, the results of the utility survey and the literature/water expert review should be used in conjunction with the water use data for each utility in the study area to estimate landscape irrigation quantities and percentages.

LANDSCAPE IRRIGATION ESTIMATION METHODS

A variety of methods can be used for each utility depending on the availability of data. The various estimates can be compared and a "best" estimate selected. A brief description of the various methods is listed below:

1) Estimates provided by individual utilities can be used based on availability.

2) Indoor use for each utility could be estimated based on literature per capita usage data together with estimates of people per household. It can also be estimated based on the lowest monthly water use for each utility. This indoor use could be subtracted from total water use to yield outside water use, which can then be used to estimate potable water landscape irrigation quantities.

3) SWFWMD model can be used with specific data from each selected utility to calculate total landscape irrigation use for each of the utilities. Subtract self-supply well and reuse irrigation to yield the amount of potable water used for landscape irrigation.

4) The difference in water and wastewater flows can be used to estimate potable landscape irrigation quantities if water and wastewater service areas correspond. Addition of self-supply well and reuse irrigation would give a <u>total</u> amount of water used for landscape irrigation. This method was recommended by water use expert Richard Marella of the USGS (Marella 1996).

For a planning-level study, the simplest approach that will provide meaningful results is preferable. Although predictive modeling for each utility may provide more accurate information, it is beyond the level of detail practical for this study.

The simplest method would be to use the estimates from the individual utilities (1); however, landscape irrigation estimates were only available from 5 of the 25 utilities. Therefore, other methods would have to be used.

The other three methods can provide good approximations. The water/wastewater difference method (4) may not be applicable or available for all utilities but would provide a simple, effective method for many of the utilities. The indoor/outdoor water use method (2) and SWFWMD model method (3) should be viable for all 25 utilities. An overall methodology that combines each of the four approximation methodologies, based on the availability of data, should provide meaningful results for the investigation of the feasibility of eliminating potable water use for landscape irrigation.

SELF-SUPPLY IRRIGATION WELLS

Quantities for self-supply irrigation wells will be a gross approximation at best due to the limited amount of data available. Results from SWFWMD model and information from Volusia County's VOLDATA data base could be used to verify approximations. This information is needed only if methodology (3) is selected.

REUSE IRRIGATION QUANTITIES

Information for existing and future reuse systems is available from utility personnel and documentation such as reuse master plans and feasibility studies. Reuse data will be used to determine existing quantities of reclaimed water reused for landscape irrigation in the study area for methodology (3).

RECOMMENDATIONS

INTRODUCTION

The following methodology is recommended for Phase II services to investigate the feasibility of using reclaimed water and shallow wells as alternative sources for urban landscape irrigation. The methodology is based on: estimating outdoor water use by evaluating the difference between monthly low and average water use for 12 or more of the 25 largest utilities; estimating reclaimed water availability from existing data available from SJRWMD; estimating general costs for serving landscape irrigation demands with self supply irrigation wells; and estimating general costs for serving landscape irrigation demands with reclaimed water.

SUBTASK 1 - ESTIMATES OF LANDSCAPE IRRIGATION

Monthly water use data from representative utilities will be used to provide an estimate of potable water used for landscape irrigation. Based on the assumption that the months with the lowest water consumption rates represent periods of little to no irrigation, the low months will be used to represent indoor water use. The difference in the average monthly water use and indoor water use will be used to provide an estimate of total outdoor water use. Computing the outdoor water use will be accomplished graphically or by comparing averages. This estimate will be conservatively low, since some irrigation most likely occurs even in the lowest water consumption months. It would be impractical to offset all of this estimated outdoor water use with self supply wells or with reclaimed water. In Subtasks 4 and 5, the estimated percentage of the total outdoor water use than can be offset by these methods is presented. The following describes the steps to estimate the average outdoor water use for selected representative utilities:

1.1 PBS&J will utilize five years of monthly water use data provided by SJRWMD in digital format for the following 12 utilities for the Phase II investigation:

- Orlando Utilities Commission
- Orange County Utilities
- City of Cocoa
- City of Daytona Beach
- City of Winter Park
- Deltona Utilities (Southern States Utilities)
- City of Titusville
- City of Sanford
- City of Port Orange
- City of Ormond Beach
- City of Leesburg
- City of Oviedo

1.2 PBS&J will collect available monthly water use data from up to five other utilities (of the 25 largest utilities). Data considered available will be up to three years of monthly water use in digital format.

1.3 For each of the utilities included in the analysis, the average indoor water use will be estimated from the monthly water use data by determining the lowest monthly water use over the period.

1.4 Average total water use for each of the utilities will be estimated from the monthly water use data.

1.5 The average outdoor water use for each utility will be estimated by taking the difference between estimates derived in Subtasks 1.4 and 1.3.

SUBTASK 2 - DETERMINATION OF TOTAL QUANTITY OF LANDSCAPE IRRIGATION WATER USED BY 25 LARGEST UTILITIES IN STUDY AREA

The total quantity of water used for landscape irrigation for the remainder of the 25 largest utilities in the study area not included in Subtask 1 will be estimated. Calls will be placed to these remaining utilities to determine if they can readily provide information on average water use and monthly low water use. For utilities that do not have these data readily available, the percent outdoor water use for the utilities evaluated in Subtask 1 will be applied to the other utilities. Similarities between utilities will be established based on geographic location, utility size, and whether there is existing extensive use of other water supplies for landscape irrigation (reclaimed water or irrigation wells). The following subtasks will be performed:

2.1 Remainder of 25 utilities not included in Subtask 1 will be contacted to obtain low month and average water use information over the telephone.

2.2 For utilities that cannot readily provide these data, the following will be conducted:

- Identify similar utilities.
- Calculate percent total outdoor water use based on Subtask 1.
- Apply percentages to similar utilities not included in Subtask 1.

SUBTASK 3 - RECLAIMED WATER AVAILABILITY

The current availability of reclaimed water will be estimated to assist water utilities in evaluating the feasibility of using reclaimed water to meet landscape irrigation demands. Based on the WWTP data base provided by SJRWMD in Phase I, PBS&J will estimate the current availability of reclaimed water in the study area. This will be accomplished by comparing the annual average reclaimed water production to the annual average reclaimed water reused for purposes other than ground water recharge and environmental enhancement. Reclaimed water currently reused for ground water recharge and environmental enhancement will be assumed to be available.

Since availability is not constant throughout the year, the reliable supply must be determined. The reliable supply will be based on the assumption that diurnal variations in supply can be attenuated through operational storage; however seasonal or weather-related variations typically require storage volumes that cannot cost effectively be provided. A percentage of the reclaimed water produced must be dedicated to provide for seasonally high demands. These percentages are expected to range from 30 percent to 50 percent of the average irrigation demand. To assess the seasonal needs, data from several existing reclaimed water systems in the service area will be analyzed. The following subtasks will be performed.

3.1 Calculate average reclaimed water availability using SJRWMD data base.

3.2 Collect monthly reclaimed water data from up to three facilities with existing reuse systems serving landscape irrigation demands. Potential reclaimed water systems that will be considered include Altamonte Springs, Cocoa Beach, Apopka, Seminole County, Sanford, and Daytona Beach.

3.3 Evaluate reclaimed water data to determine the peak seasonal needs compared to average annual reclaimed water demands.

SUBTASK 4 - ESTIMATED COST FOR LANDSCAPE IRRIGATION WITH SELF-SUPPLY IRRIGATION WELLS

The following methodology will be conducted to estimate the cost of replacing public supply landscape irrigation water with water from self-supply irrigation wells:

4.1 The average unit landscape irrigation water usage per self-supply well for a typical single family residence will be estimated using a 1-inch per week irrigation rate over the irrigable portion of a typical -acre lot.

4.2 Based on discussions with utility representatives and engineering judgement, a maximum percentage of the total landscape irrigation quantity estimated in Subtask 1 that could effectively be replaced with self-supply irrigation wells will be estimated. This estimated percentage will be a single value applied to the entire study area, rather than utility-specific estimates. It will be assumed to represent the amount of landscape irrigation water supplied through in-ground systems as opposed to portable hoses and sprinklers.

4.3 A maximum total number of self-supply irrigation wells which would be needed will be estimated by dividing the estimated landscape irrigation quantity in Subtask 4.2 by the average unit landscape irrigation water usage per self-supply well calculated in Subtask 4.1.

4.4 Building department personnel, SJRWMD data, and well contractors will be contacted for well depth and cost information for self-supply irrigation wells. Unit construction and O&M costs will be developed based on average or typical cost throughout the study area.

SUBTASK 5 - ESTIMATED COST FOR LANDSCAPE IRRIGATION WITH RECLAIMED WATER

To develop the quantities and costs of replacing public supply water used for landscape irrigation with reclaimed water the following methodology will be used:

5.1 Based on discussions with utility representatives and engineering judgement, a maximum percentage of the total landscape irrigation quantity estimated in Subtask 1 that could effectively be replaced with reclaimed water will be estimated. This estimated percentage will be a single value applied to the entire study area, rather than utility-specific estimates. It will be assumed to represent the amount of landscape irrigation water supplied through in-ground systems as opposed to portable hoses and sprinklers.

5.2 Planning-level cost data will be developed for treatment plant improvements needed to meet high level disinfection requirements of FDEP for public assess reuse and to provide operational storage and pumping facilities.

5.3 The distribution system cost estimates will be divided into the macro-distribution and micro-distribution costs. The macro-distribution system will consist of the main network of pipelines which distribute reclaimed water throughout the service area and the micro-distribution system will consist of the smaller network of pipes used to deliver reclaimed water to individual users within residential developments.

The macro-distribution system costs will be developed on a per gallon basis.

Micro-distribution system costs will be developed based on per acre of residential development. Costs will be developed based on a range of costs to account for participation rate and

irrigation rate variability within the study area. The costs will be based on generalized information rather than site or utility specific data. Data from existing utilities, literature, and other in-house sources will be utilized to estimate the costs.

5.4 Transmission system costs (for bringing reclaimed water from the source to the area being served) will be based on data developed by Law Engineering under separate assignment to SJRWMD.

SUBTASK 6 - REPORT PREPARATION

The following deliverables will be included with the report:

6.1 A report will be prepared which summarizes the methodologies, results, and conclusions of the Phase II study.

6.2 Estimated percentages, quantities, and ranges for outdoor water use will be provided.

6.3 Estimated existing availability of reclaimed water will be provided.

6.4 Estimated costs of irrigating residential landscaping with individual self-supply wells will be presented and will include:

a) Unit costs for self-supply wells.

b) Estimation of maximum volume of water use that can be offset per utility using self-supply irrigation wells.

c) Tabulation and summary of data and specifications used to generate estimated self-supply irrigation water costs.

6.5 Estimated costs of irrigating residential landscaping with reclaimed water will be presented and will include:

a) Estimation of maximum volume of water use that can be offset per utility using reclaimed water.

b) Unit costs for reclaimed water treatment, storage, pumping and distribution systems.

c) Tabulation and summary of data and specifications used to generate estimated reuse irrigation water costs.

SUBTASK 7 - PROJECT PROGRESS MEETINGS

This task is to cover up to two project meetings in Palatka with the PBS&J and SJRWMD task team members. Periodic conference call meetings may also be held, as needed, through the course of the work and these are included in association with the development of each task.

Coordination meetings held with members of other consulting teams involved in other task assignments of the Investigation of Alternative Water Supply Strategies, utility presentations, and other meetings not specifically identified in this scope in this scope of services will be considered additional services and budgeted separately.

KEY STAFF ASSIGNMENTS

The key staff associated with this work are listed in Table 1.

Table 1. Key Project Staff

Staff Member	Project Roles
Jo Ann Jackson, P.E. (PBS&J)	Project Manager
Edward H. Talton, P.E. (PBS&J)	Project Engineer
Robert A. Morrell, P.E. (PBS&J)	Senior Technical Review

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APPENDIX A

UTILTIY SURVEY QUESTIONNAIRE AND RESULTS

SJRWMD Alternative Water Supply Project
Task 1 - Utility Irrigation Information Questionnaire

Utility Name: _____

Mailing Address: _____

Contact 1 - Name: _____ Telephone: _____

Contact 2 - Name: _____ Telephone: _____

Do you have a Water Conservation Plan?: _____

(Request Copy) _____

_____

Water Conservation Manager or Expert: _____ Tel: _____

What are current and future plans for reuse wihtin your service area? What documentation of these plans do you have that we could use (studies, master plans, permitted service areas, etc.)?

(Request Copy) _____

_____

_____

_____

_____

_____

Reuse Contact: _____ Tel: _____

_____

Do you have estimates of Current Potable Water Use for Landscape Irrigation? _____

_____

How Estimated: _____

_____

What is the extent and format fo your historical water meter data?: _____

_____

_____

_____

_____

Does your utility provide separate Irrigation Meters: _____ To Whom: _____

_____

_____

_____

_____

Are residential reclaimed water customers metered: _____

Water Meter Data Contact: _____ Tel: _____

Do you have any data or special studies which quantify water use/irrigation within households?

Do you permit self supply irrigation wells or have any other information which could assist in estimating how much of your service area currently irrigates with self supply wells? _____

Do you have a GIS that includes water use, land use, property tax records, PUD/DRI development information or other information that could be used to estimate potable water irrigation use? _____

GIS Contact: _____ Tel: _____

Please Send GIS Directory: _____

Water-rate model questionnaire (Financial/Billing Questions) Contact: _____

Tel: _____

Other Comments: _____

Interviewer: _____ Date(s): _____

Appendix A
SJRWMD Alternative Water Supply Strategy
Utility Questionnaire Summary

Rec No.	Utility Name		Utility Mailing Address	Contact 1 Name	Contact Telephone	Water Conservation Plan	WC Plan Location
1	OUC	*	P.O. Box 3193, Orlando, FL 32802	Ray Boyd	407-423-9195	Yes	SJRWMD
2	Orange County	*	109 East Church St., Orlando, FL 32801	Chris Beatham	407-836-7231	Yes	SJRWMD
3	City of Cocoa		600 School Street, City of Cocoa, FL 32922	Everett Wegerif	407-639-7665	Yes	SJRWMD
4	City of Daytona Beach	*	P.O. Box 2451, Daytona Beach, FL 32115-31	Richard Dembinsky	904-258-3174	Yes	SJRWMD
5	City of Winter Park	*	401 Park Avenue South, Winter Park, FL 327	James Robards	407-623-3335	Yes, not full blown	SJRWMD
6	Seminole County	*	3000-A Southgate Drive, Sanford,FL 32773	Roger Smith	407-323-9615x211	Yes	Attached
7	So. States Util./Deltona Plant	*	1000 Color Place, Apopka, FL 32703	Ralph Terrero	407-884-8777 x199	No	N/A
8	Sanlando Utilities	*	P.O. Box 3884, Longwood, FL 32791	Jerry Salsano	407-788-3600		
9	City of Altamonte Springs	*	225 Newburyport Ave., Alt. Springs, FL 3270	Glenn Forrest	407-830-3857	Yes	
10	City of Casselberry	*	95 Lake Triplet Dr., Casselberry, FL 32781	Tony Segretto	407-263-3970	Yes	
11	City of Titusville	*	2836 Garden St., Titusville, FL 32781	James Chaffee	407-268-6050	Yes, Updated in 1992	
12	City of Sanford	*	P.O. Box 1788, Sanford, FL 32772	Bill Marcous	407-330-5649	No, not a formal 1 w/distr.	
13	City of Port Orange	*	1000 City Center Cr., Port Orange, FL 32127	Fred Griffith	904-757-5378		
14	City of Apopka		P.O. Box 1229, Apopka, FL 32704-1229	Bob Elmquist	407-889-1731	Yes	SJRWMD
15	City of Ormond Beach	*	501 N. Orchard St., Ormond Beach, FL 3217	Frank Soloducha	904-676-3436	Yes	SJRWMD
16	City of DeLand	*	P.O. Box , DeLand, FL 32720	John Jeffery	904-736-3900	Yes, AWWA Award	SJRWMD
17	City of New Smyrna Beach	*	P.O. Box 100, New Smyrna Beach, FL 3217	Pete Korelich	904-427-1361		
18	City of Winter Springs	*	1126 E. S.R. 434, Winter Springs, FL 32708	Kipton Lockcuff	407-327-2669	Yes	SJRWMD (West CUP)
19	City of Leesburg	*	223 South 5th Street, Leesburg, FL 32748	Mark Odell	904-728-9840	Yes	SJRWMD
20	Villages of Lake Sumter, Inc.	*	101 Oak Meadow Ln., Lady Lake, FL 32159	Russell Vaughn	904-753-1756	Yes	
21	City of Ocoee	*	150 N. Lakeshore Drive, Ocoee, FL 34761	Jim Shira	407-656-2322 x142	No formal document	
22	City of Maitland	*	1776 Independance Drive, Maitland FL 32751	Fabian Hurtado	407-539-6252	Yes	SJRWMD
23	City of Mt. Dora	*	P.O. Box 176, Mt. Dora, FL 32757	Rod Stroupe	904-735-7151	Yes	SJRWMD
24	Town of Eustis	*	P.O. Drawer 68, Eustis, FL 32727	Irwin Gajentan	904-357-5618	Yes, Not very detailed.	SJRWMD
25	City of Oviedo	*	400 Alexandria Blvd., Oviedo, FL 32765	Charles Smith	407-977-6029	Not Presently	N/A

Appendix A
SJRWMD Alternative Water Supply Strategy
Utility Questionnaire Summary (Continued)

Rec No.	WC Manager	WC Telephone	Current Reuse	Future Reuse	Reuse Contact	Reuse Telephone
1	Don Meyers, Dir.	407-423-9101	6 mgd use at power plant	plan for another 6 mgd in 2-3 years	Kathi Bowman	407-423-9100
2	No	N/A	17 mgd exist South-<1 PAR, 12 mgd East no PAR, 3 mgd N	Future PAR is in Plan	Chris Brooke	407-836-7208
3	Don Downs	407-639-7656	PAR 500 customers inc. residential, air cond. concrete plant	Adding more customers	Everett Wegerif	407-639-7665
4	No	N/A	Major user PAR golf courses, parks, cemeteries,schools	All Future dev.>15ac. will do urban PAR	Richard Dembinsky	904-258-3174
5	No	N/A	2 Golf Courses, 1 Cemetery, 1 Park ~ 0.5 mgd	No Plans, Feas. Study (Rick Johnson now w/	Jim Anselmo	407-623-3338
6	Hugh Sipes	407-323-9615x	RIBs, Reuse on comm. properties	Golf course, other comm. properties	Ruth Lala	407-321-0349
7	Chris Arcand	407-884-8777x	2 Golf Courses	No other plans or studies.	Chris Arcand	407-884-8777 x 19
8			Firm plans hinge on IRS agreement, if not tax exempt, can't do		Jerry Salsano	407-788-3600
9			Have built-out reuse system within City limits.	May be opportunity to expand outside the City		
10			Plant at 1.5 mgd. Out to bid on Construction			
11	Gary Hendricks	407-268-6065	No current reuse.	Plan for 1.5-2mgd,limited 10-15% irrigation	Janet Elrod	407-268-6078
12	Bill Marcous	407-330-5649	Contact Paul Moore for details. Reclaimed serving 10% of City		Paul Moore	
13			Serves 858 connections w/reclaimed	To serve 3,000		
14	No	N/A	100% Golf C., 2 Nursuries, City, 111 Res.,Restricted Sprayfiel	More Nursuries, Res. Users	Bob Elmquist	407-889-1731
15	No	N/A	30% of WW-rest to Halifax River. Serves 489 conn.	To expand to 1300 connections	Frank Soloducha	904-676-3436
16	John Jeffery	904-736-3900	Golf Course, Parks, On-site irrigation	More non-residential reuse	Jim Ailes	904-736-3900x145
17			Yes, in progress of revising master plan		Pete Korelich	904-427-1361
18	No	N/A	West permitted, Golf Course/Parks	East in permitting process - public access	Kipton Lockcuff	407-327-2669
19	No	N/A	Hayfields and tree farm, Reuse Feas. Study	No Plans for PAR	Charlie Bowman	904-728-9845
20	No	N/A	100% to Golf Courses & RIBs, 153 ac. permitted service area	Another 9-hole Golf Course	Russell Vaughn	904-753-1756
21	No	N/A	All effluent Forest Lake Golf C.-PAR & RIBs	PEC preparing Reuse Feas. Study	Jim Shira	407-656-2322 x142
22	No-Cheryl Peter	407-875-2115	Altamonte Springs will serve part of Maitland w/ reuse	No Plans	Cheryl Peters	407-875-2115
23	No	N/A	Public and Non-Public Access, permitted service area	See Reuse Feasibility Study	Mr. Snell	904-735-7151
24	No	N/A	Hayfield, Tree Farm, Perc Pond backup	PAR, add filters, White Rose Nurs. (Chin Cor)	Butch Ziegengeist	904-357-4282
25	No	N/A	No current reuse, City requires all new dev. install dry lines	New Devolpmts. required to install dry lines	Charles Smith	407-977-6029

Appendix A
SJRWMD Alternative Water Supply Strategy
Utility Questionnaire Summary (Continued)

Rec No.	Potable Water Irrigation Quantity	PWIQ Estimation Method	Water Meter Data History
1	About 48-50% of water use	Based on non-irrig. use from 3000 homes on separate	Call Cliff Russell - 12 month active file. Don't know about previus data.
2	No estimate	N/A	Books for 5 years, computer for 1 year
3	No formal estimate, guess around 30%	Guess	15 years, 1989 on have more detailed breakdowns
4	0.5 mgd of 12.5 mgd or 4% estimated	Estimate	10 year
5	No formal estimate	use greater than 12,000 gal/month is irrigation	Data would be questionable due to inverted block & irrig. meters in 1992
6	No estimate	N/A	2 year billing data
7	No estimate	Only data is comparison of flow demands by season fro	Computerized database. Keep about 5 years of data.
8	No estimate	N/A	Propriety mainframe - only can output in print form. Buss - Cobol system
9	No estimate, very little within City	N/A	Keep records for 3 years. Can be put in spreadsheet format.
10	CUP - on record at SJRWMD	See CUP	24 mo. - system storage - can be dumped
11	In 1995 - 0.5 mgd (annual average)	Based on max. day, max. month	Not extractable to spreadsheets
12	No estimate	N/A	Mainframe custom HT program
13	No estimate	N/A	1 year only Comp./HTE Mainframe. Have 20 yr. history of wkly total water us
14	No estimate	N/A	Keeps Monthly summaries
15	No estimate	N/A	Can be provided on disk. Have several year's data
16	No estimate	N/A	No Answer
17	No estimate	N/A	Finance Dept. need to be contacted through Pete. Insufficient manpower no
18	Not ADF, Affluent area - a lot of irrigatio	Assume >10,000 gpmo/Water minus Wastewater is irrig.	7 Years for CUP
19	No estimate	N/A	24 months
20	No estimate	N/A	10 years - water use - historical in CUP
21	No estimate	N/A	Katy Girik - PEC has summarized data
22	50% Res., 63% Comm., 46% City	Irrigation Meters	5 + years , See Finance Department
23	See CUP	Not Sure	3 years, Revenue Report summarizes
24	See CUP	Irrigation Meter Analysis-(Chin Cor)	1 year, quart analysis res/comm
25	No estimate	N/A	2 years of billing history for all customers

Appendix A
SJRWMD Alternative Water Supply Strategy
Utility Questionnaire Summary (Continued)

Rec No.	Water Meter Data Forma	Irrigation Meter	Irrigation Meter Users	Residential Reuse Meters	Water Meter Contact	Water Meter Telephone	Data on Household Water Use
1		Yes		Plan to do, N/A at this time	N/A		Houses w/ inground irrig./sep. mtrs are
2	Computer	Yes	On Request	No Data	Chris Beatham	407-836-7231	No
3	AS400	Yes/No	Not allowed anymore	No, only non-irr. & >1"	Don Downs	407-639-7656	No recent data
4	Unknown	Yes	Residential & Commercial	No, flat charge	Richard Dembinsky	904-258-3174	50 to 100 gpcd, 70 gpcd avg
5	Summarized	Yes	Residential & Commercial	N/A	Delthia Stone	407-623-3371	2 Cases -2000-45000 gal/mo irrigation
6	AS-400, ASCI	Yes	Residential & Commercial	N/A	Dan Cotterman	407-323-9615 x2150	One case. See Roger Smith
7		No	N/A	N/A	N/A		No
8		Yes	Commercial	N/A	Jerry Salsano	407-788-3600	No
9		No	N/A	No			375 gpd/unit water,280ww, 95 irrigatio
10		Yes	System-wide meters	Yes, not on line			No
11		Yes	Yes, but discouraged.	N/A	Denise Pierce	407-269-4400 x252	No
12		Yes	Non-residential only	Yes			Yes
13		Yes	878 customers "sprinkler Meters"	No			No
14	Summarized	Yes	Commercial Only, can't distinguish	No, master meter for S/D	Bob Elmquist	407-889-1731	No
15		Yes		No			Reclaimed water by flow/total accts.
16	No Answer	Yes	Residential & Commercial	N/A	John Jeffery	904-736-3900	No
17	.	Yes	All customers, including residential	No			Nothing recent
18	Customized soft-ITX NC	Yes	Commons/Commercial, no new Res	No, Only 50,000/month +	Harry Martin, Fin.Dir.	407-327-1800	No
19	AS-400, ASCI	Yes	Some Residential, mostly Commerc	N/A	Jane Mallory/Stan C.	904-728-9800	No
20		Yes	Commercial Only	Golf courses metered	Bill Baum	904-750-0000	No
21	See Katy Girik -PEC	Yes	Residential & Commercial	N/A - Golf Course	Jim Shira	407-656-2322 x142	No
22	Summarized	Yes	Residential/Commercial/City	N/A	Cheryl Peters	407-875-2115	DRMP 1988 Mast. Plan est. irrigation
23	IBM-HTE software	Yes	98 Com/23 Res out of 4000 total	Yes	Loreeta Devine	904-735-7128	No
24	Can summarize-IBM Mini	Yes	Residential & Commercial	N/A	Mike Shepherd	904-483-5440	Irrigation study, Water > 10,000 gal/mo
25	No Answer	Yes	Comm. on central sewer only	Will meter	David Mahler	407-977-6066	No

Appendix A
SJRWMD Alternative Water Supply Strategy
Utility Questionnaire Summary (Continued)

Rec No.	Permit Self Supply Irrigation Wells	Well Contact	Well Telephone	GIS	GIS Contact	GIS Telephone
1	No, very few private wells	Cliff Russell	407-423-9101	City & County have GIS, but OUC has not used it.		
2	Yes, but no data			Full Blown PBS&J can get data	Bill Burkholder	407-836-7294
3	Check with Brevard County,prevalent	Brevard County		Not ready yet, use ARC/INFO	N/A	N/A
4	Yes, prevalent.	Richard Dembinsky	904-258-3174	No	N/A	N/A
5	Co. permits-many use lakes,no permit	Orange County	-	Small system (contact 2 Craig Campbell, 623-3355)	Butch Margus	407-623-3411
6	Wells allowed, No permits or data	-	-	GIS in development stage		
7	Util. no auth. Not allowed, deed restric.	-	-	Volusia County has extensive GIS	N/A	N/A
8	Restrict, small %,most on fringes of area			No		
9	Yes, not a significant number			Use ArcCAD, not GIS		
10	No date, 10-15 customers			May participate in County		
11	8,000 private wells in City for Irrigation			No, are just getting started on it	Ed Allen	407-268-6078
12	Many unpermitted wells in City			No, but are hoping to hook into County's system		
13	No, County has info. See VOLDATA			No		
14	Permit and encourage	Bruce Nelson	407-889-1715	No	N/A	N/A
15	No, believes there are a lot of wells	N/A	N/A	AutoCADD - City (No GIS) - Maps of relcaimed (Not on AutoCADD)		
16	Yes	John Jeffery	904-736-3900	No GIS	N/A	N/A
17	Prevalent use of wells in area,VOLDATA			Mapping - AutoCADD. No GIS		
18	Allow not permitted no way of estimating			No hardware,CDM-StormW MP NPDES, See County (JR Ball)	See Contact 1	See Contact 1
19	Ordinance against wells in City	N/A	N/A	ARC/INFO not prop. based,Stormwater study-impervious surface	John Meier	904-728-9755
20	No, probably not many in the distr.				N/A	N/A
21	Bldg. Dept. permits shallow irr. wells	Dan Flippen	407-656-2322 x133	Not available, under development, See Planning Dept.	Jim Shira	407-656-2322 x142
22	Allowed but no way of estimating	-	-	Land use, parcel boundaries, soils	PBSJ,Pete Manz	407-647-7275
23	Not many, pumping from lakes prevalen	N/A	N/A	Working on	Mark Reggettin	904-735-7124
24	Building Dept. Permits irrigation wells	Chip Delet	904-483-5462	No GIS, See Planning Dept.	Alton Roane	904-483-5462
25	No. Building Dept. will permit in future	-	-	Not presently available	N/A	N/A

Appendix A
SJRWMD Alternative Water Supply Strategy
Utility Questionnaire Summary (Continued)

Rec No.	Water Rate Contact	Water Rate Telephone	Comments	
1	Bob Savarese	407-423-2371		
2	Fritz Goode	407-836-7000	County divided into Eastern, Southern and Northwest service areas	
3	Don Downs	407-639-7656	City provides water to County & other cities, see other utilities for wastewater/reuse	
4	Richard Dembinsky	904-258-3174	Very little potable irrigation inside city. 100% future flow attributable to new development	
5	James Robards	407-623-3335	Believes best conservation practice is price increase	
6	Bob Briggs	407-323-9615 x2148	Mailed questionnaire in	
7	Forrest Ludsen	407-884-8777 x 221		
8	Jerry Salsano	407-788-3600	Many homeowners assoc. putting in wells for irrig. of common areas.	
9	Glenn Forrest	407-830-3857	AWWA has new publication on water conservation that may be useful	
10	Tony Segretto	407-263-3970	J2 to call David Gerach @ CPH for Reuse & Wtr Conserv. plans	
11	Denise Pierce	407-269-4400 x252	10 mgd - projected yr. 2015 water use for new develop.	
12	Paul Moore			
13	Fred Griffith	904-756-5378	Tom Cary - Permits irrig. self supply wells.	
14	Bob Elmquist	407-889-1731	More nursuries requesting reclaimed water.	Bob would like more residential users to use wells.
15	Frank Soloducha	904-676-3436		
16	John Jeffery	904-736-3900	Faxed questionnaire in	
17	Pete Korelich	407-423-7175 - Fax	Biggest benefit - beach side. Economics don't make sense.	
18	Kipton Lockcuff	407-327-2669	Changing rates, blocks not good enough	East 3.21 mgd water - 1.0 ww=2.21mgd irrigation
19	Jane Mallory	904-728-9800	Just redid water rate structure to step rate	
20	Bill Baum	904-750-0000	Fights w/WMD all the time.Requests letter to release info.	Retirees (1-2 people) per household hurts consumption
21	Jim Shira	407-656-2322 x142		
22	Fabian Hurtado	407-539-6252		
23	Loreeta Devine	904-735-7128		
24	Mike Shepherd	904-483-5440		
25	David Mahler	407-977-6066	Mailed questionnaire in	

APPENDIX B

LITERATURE REVIEW SUMMARY OF WATER USE

Summary of Water Use Values found in the Literature Review

Reference	Total Water Use gpcd	Total Water Use gpd/connection	Indoor Water Use gpcd	Outdoor Water Use gpd/connection	People/ Household	Other	Data Year	Data Location
Whitcomb 1991	151	452	81	209	3	SF,5.4 gpd/100sf turf	1990	Contra Costa, California
DeOreo, et. al. 1996	--	452	59	393	--	SF,9700sf med lot size, 8000 sf avg irrigable	1989-93	Boulder, Colorado
DeOreo, et. al. 1996	276	792	59	623	2.87	SF,Summer Use	1994	
Kemp & Mathews 1993	49	117	--	--	2.4	SF, Assuming 2.4 people per household	1988-92	Venice, Florida
Kemp & Mathews 1993	50	100	--	--	2.0	MF, Assuming 2.0 people per household	1988-92	Venice, Florida
Kemp & Mathews 1993	--	767	--	--	--	CM	1988-92	Venice, Florida
Kemp & Mathews 1993	124	297	63	147	2.4	SF, Assuming 2.4 people per household	1988-92	Sarasota, Florida
Kemp & Mathews 1993	--	--	63	--	2	MF, Assuming 2.0 people per household	1988-92	Sarasota, Florida
Kemp & Mathews 1993	--	150	--	140	--	CM	1988-92	Sarasota, Florida
Kemp & Mathews 1993	--	197	--	--	--	SF	1988-92	Cape Coral, Florida
Kemp & Mathews 1993	--	133	--	--	--	MF	1988-92	Cape Coral, Florida
Kemp & Mathews 1993	--	407	--	--	--	CM	1988-92	Cape Coral, Florida
Ori 1993	--	183	--	--	--	SF Average	1990's	Florida
Anderson, et. al. 1993	71	205	51	52	2.9	SF Low Income(10-20,000 1980 house income)	1991-92	Tampa, Florida
Ori & Barrington 1995	890	1,780	89	1,602	2	SF High Income(93200 1990 house income)	1989-1991	Gulfstream, Florida
Gleick 1993	--	--	--	67-141	--	Per 8000 sf lawn	1983	U.S.
Davis & Nero 1994	150	405	75	203	2.7	Estimated	1990's	Tampa, Florida
Nat. Res. Council 1977	174	458	104	186	2.63		1975	California
Turner 1982	--	--	--	--	--			
Anon. 1993	--	--	70	--	--		1990's	U.S.
Stone & Weiss 1995	--	--	80	--	--		1990's	U.S.
Prasifka 1988	--	--	77	--	--	Non-Conserving (1984 HUD Study)	1983	U.S.
Prasifka 1988	--	--	60	--	--	Conserving (1984 HUD Study)	1983	U.S.
Prasifka 1988	--	--	--	--	--	CM Water Demand is 15 to 20% of Total	1987	U.S.

Summary of Water Use Values found in the Literature Review

Reference	Total Water Use gpcd	Total Water Use gpd/connection	Indoor Water Use gpcd	Outdoor Water Use gpd/connection	People/ Household	Other	Data Year	Data Location
Marella 1992	--	--	--	--	--	Fla. CM Demand is 15% of Total	1990	Florida
Marella 1992	--	--	--	--	--	Fla. IND Demand is 9% of Total	1990	Florida
Marella 1992	--	--	--	--	--	Fla. PUB Demand is 7 to 15% of Total	1990	Florida
Marella 1992	123	303	--	--	2.46	Residential Only	1987	Florida
Marella 1992	--	--	--	--	--	Volusia Co. had 3200 lawn irr wells in 1988	1988	Volusia, Co. Florida
Marella 1992	165	--	--	--	--	Non-Conserv., Brev. Co. outside Melbourne	1980-87	Brevard Co. Florida
Marella 1992	125	--	--	--	--	Conservation, Melbourne		Melbourne Florida
Maddaus 1987	140	--	--	--	--	MF	1985	California
Grisham & Fleming 1989	--	--	--	--	--	50 % of SF res. water used outside	1989	U.S.
USEPA 1992	--	--	--	--	--	In FL 50 to 70% of all public water outside use	V. Studies	Florida
PBS&J 1995	88-282	211-677	--	--	2.4	SF Residential, SCPW area-S/D Range	1993	Seminole Co., Florida
PBS&J 1995	148	356	--	--	2.4	SF Residential, SCPW Service area-Average	1993	Seminole Co., Florida
PBS&J 1995	66	158	--	--	2.4	MF Residential, SCPW Service area	1993	Seminole Co., Florida
PBS&J 1995	--	158-677	--	--	2.4	Non-Residential, SCPW Service area	1993	Seminole Co., Florida

Note:

gallon per capita per day (gpcd) unit includes user class only, i.e. residential.

WATER USE RESEARCH SUMMARY

SINGLE FAMILY RESIDENTIAL		
Indoor Water Use		
U.S.		
	60 gpcd	Conserving (Prasifka 1988)
	77 gpcd	Non-Conserving (Prasifka 1988)
Florida		
	50 gpcd	Low Income homes (Anderson, et. al. 1993)
	89 gpcd	High Income homes (Ori & Barrington 1995)
	50-65 gpcd	Range for Conserving homes (Various)
	75 gpcd	Average for Non-Conserving homes (Davis & Nero 1993)
Outdoor Water Use		
U.S.		
	32 %	of total residential water use (USEPA 1992)
Florida		
	50-70 %	of total residential water use (USEPA 1992)
	52 gpd/house	Low Income homes (Anderson, et. al. 1993)
	1602 gpd/house	High Income homes (Ori & Barrington 1995)
	140-203 gpd/house	Average range for all homes (Various)
MULTI-FAMILY RESIDENTIAL		
Indoor Water Use		
Florida		
	50-63 gpcd	(Kemp & Mathews 1993)
Total Water Use		
Florida		
	140-200 gpd/unit	(Various)
COMMERCIAL		
Outdoor Water Use		
Florida		
	140 gpd/connection	(Kemp & Mathews 1993)
Total Water Use		
Florida		
	290-1700 gpd/connection	(Various)