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**WATER SUPPLY NEEDS AND SOURCES ASSESSMENT
ALTERNATIVE WATER SUPPLY STRATEGIES INVESTIGATION
SURFACE WATER WITHDRAWAL SITES**

BY

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EXECUTIVE SUMMARY

This technical memorandum (TM) is the second in a series of three TMs that address the feasibility of developing surface water for domestic water supply within the St. Johns River Water Management District (SJRWMD). The first TM inventories available surface water resources data and establishes an evaluation methodology. This TM focuses on the selection of candidate withdrawal sites for surface water availability and yield analysis. The third TM will present the results of the surface water availability and yield analysis, including estimated facilities requirements and water supply yield relationships for the candidate withdrawal sites recommended in this TM.

The objective of surface water withdrawal site selection is to identify candidate surface water supply source locations that are within reasonable proximity to centers of significant increases in regional domestic water supply demand. The locations of the candidate withdrawal sites are governed by the availability of streamflow records, the amount of divertable streamflow available for water supply, and the expected increase in demand in the vicinity of the withdrawal site.

The following process was used to select candidate withdrawal sites:

- Plot projected public supply demand increases by county or major demand center on a planning area base map.
- On a similar base map, plot the approximate maximum developable surface water supply for each stream gauging station identified in *Technical Memorandum B.1.f, Surface Water Data Acquisition and Evaluation Methodology*.
- By visual inspection of the relative geographic location of demand centers and the magnitude of the potential surface water yield, develop the list of candidate withdrawal sites.

This process yielded the following six candidate withdrawal sites:

- Lake Griffin (Haines Creek) in Lake County near Leesburg
- St. Johns River near Cocoa
- St. Johns River near Titusville
- St. Johns River at Sanford (Lake Monroe)
- St. Johns River at DeLand
- St. Johns River near Switzerland (northern St. Johns County)

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INTRODUCTION

This technical memorandum (TM) is the second in a series of three TMs that address the feasibility of developing surface water for domestic water supply within the St. Johns River Water Management District (SJRWMD). The first TM, *Technical Memorandum B.1.f, Surface Water Data Acquisition and Evaluation Methodology* (CH2M HILL, 1996), provides an inventory of the surface water resources data available for the analysis and establishes an evaluation methodology. This TM identifies six candidate withdrawal sites for surface water availability and yield analysis. The third TM will present the results of the surface water availability and yield analysis, including estimated facilities requirements and water supply yield relationships for each selected candidate withdrawal site.

Future phases of this alternative water supply planning project will develop construction, capital, operation and maintenance (O&M), and equivalent annual cost estimates for each of the surface water supply systems identified and evaluated in this first phase of the project.

PURPOSE AND SCOPE

The surface water supply analysis is being conducted to evaluate the water supply potential of selected surface water sources. The surface water sources considered include the St. Johns River, Haines Creek, and the Palatlahaha Chain of Lakes. The portions of the St. Johns River included in the investigation occur above Crows Bluff (in Volusia County), below Wolf Creek (in Brevard County), and in the vicinity of northern St. Johns County. The Haines Creek/Palatlahaha Chain of Lakes hydrologic system is located entirely in Lake County and forms the headwater of the Ocklawaha River.

The St. Johns River is being evaluated as a potential source to meet a portion of the domestic water supply needs in Volusia, Orange, Seminole, and northern Brevard counties, and in St. Johns County. The Haines Creek/Palatlahaha Chain of Lakes hydrologic system will be evaluated as a potential source to meet water supply needs in Lake County.

This TM discusses surface water withdrawal site selection, which was conducted to identify candidate sites for feasibility analysis. The feasibility analysis for the recommended surface water withdrawal sites is the subject of the third TM, *Technical Memorandum B.1.j, Surface Water Availability and Yield Analysis*.

SURFACE WATER SUPPLY EVALUATION OVERVIEW

The objective of the surface water supply evaluation is to determine, on a preliminary feasibility level, the type and size of water supply facilities needed to develop a potential surface water source for public supply. General surface water supply facility requirements are discussed in *Technical Memorandum B.1.f, Surface Water Data Acquisition and Evaluation Methodology*, and include a raw water diversion and pumping station, a raw water storage reservoir, a water treatment plant, and a product water aquifer storage and recovery (ASR) system. The following major factors will govern the magnitude of the facilities required for a given candidate withdrawal site:

- Streamflow characteristics, including magnitude and variability
- Minimum streamflow requirements and other withdrawal constraints
- Demand characteristics, including magnitude and seasonal distribution
- Required system reliability

A structured continuous simulation approach will be used to estimate the required surface water supply facilities.

The methodology for the water supply system simulation and the water supply availability and yield analysis was developed for *Technical Memorandum B.1.f, Surface Water Data Acquisition and Evaluation Methodology*. As part of the water supply availability and yield analysis, the following major steps will be performed for each of the selected withdrawal sites:

- Develop a flow duration curve from the streamflow record.
- Establish the minimum streamflow requirements and maximum diversion rate from the flow duration curve.
- Develop an array of divertable monthly streamflows.
- Develop a potential yield curve.
- Establish ten target water supply yields.
- Establish six trial water supply systems.
- Conduct sixty long-term system simulations to establish reliability of each water supply system relative to each target demand.
- Establish a water supply yield versus facility requirement relationship.

METHODS

The methodology used to select the candidate withdrawal sites for the feasibility analysis is defined in *Technical Memorandum B.1.f, Surface Water Data Acquisition and Evaluation Methodology*. To clarify the outcome of this portion of the surface water development project, this section summarizes the objectives of site selection and the methodology used during the selection process.

OBJECTIVES OF WITHDRAWAL SITE SELECTION

The objective of surface water withdrawal site selection is to identify candidate surface water supply source locations that are in reasonable proximity to centers of significant regional domestic water supply demand increases. Demand increase data are taken from Vergara (1994). Factors considered in determining the locations of candidate withdrawal sites include the availability of streamflow records, amount of divertable streamflow available for water supply, and expected demand increases in the vicinity of the withdrawal site.

SELECTION PROCESS

To develop a realistic estimate of the amount of water supply potentially available at each of the selected water withdrawal sites, minimum streamflow and maximum allowable diversion rate criteria were established as a function of streamflow characteristics. Application of these criteria suggests that about 15 to 20 percent of the total watershed flow could be available to meet future water supply demands. The water supply potential of the Palatlahaha River/Haines Creek watershed is relatively modest and is exceeded by that of the St. Johns River watershed.

The following process was used to select the candidate withdrawal sites:

- Plot projected public supply demand increases by county or major demand center on a planning area base map. Counties considered in the surface water analysis include Brevard, Lake, Orange, St. Johns, Seminole, and Volusia.
- On a similar base map, plot the approximate maximum developable surface water supply for each stream gauging station identified in *Technical Memorandum B.1.f, Surface Water Data*

Acquisition and Evaluation Methodology. Maximum developable yield is estimated to be 20 percent of the mean annual streamflow.

- Identify candidate withdrawal sites by visual inspection of the relative geographic location of demand centers and the magnitude of the potential surface water yield.

DISCUSSION

Surface water is one of several alternative water supply sources being evaluated by SJRWMD. Because surface water systems are typified by highly variable streamflows, the selection of water supply withdrawal sites is an important part of any surface water supply system evaluation. On the basis of surface water availability and the locations of the projected water supply demands, one withdrawal site within the Palatlahaha River/Haines Creek system and five withdrawal sites along the St. Johns River are proposed for this evaluation, as follows:

- Lake Griffin (Haines Creek) in Lake County near Leesburg
- St. Johns River near Cocoa
- St. Johns River near Titusville
- St. Johns River at Sanford (Lake Monroe)
- St. Johns River at DeLand
- St. Johns River near Switzerland (northern St. Johns County)

This section discusses the rationale for selecting the sites within each system and the criteria for transferring data from the existing gauging and water quality stations to the proposed surface water supply withdrawal site, as needed.

SELECTED WITHDRAWAL SITES

Palatlahaha River/Haines Creek System

The locations of the Palatlahaha River/Haines Creek watershed stream gauging stations are shown in Figure 1, along with the estimated maximum developable surface water supply yield associated with each station. As evident from Figure 1, the potential water supply yield is limited in the southern portions of the watershed but increases to the north. Haines Creek, a major tributary to Lake Griffin, has a water supply potential of nearly 32 million gallons per day (mgd). The Apopka-Beauclair Canal, which connects Lake Apopka to Lake Dora, also has a potential of nearly 10 mgd.

Figure 2 illustrates the projected increase in public water supply demand (between 1990 to 2010) for selected demand centers in Lake County. Of the many small water supply utilities in Lake County, the following utilities illustrated in Figure 2 have the largest projected

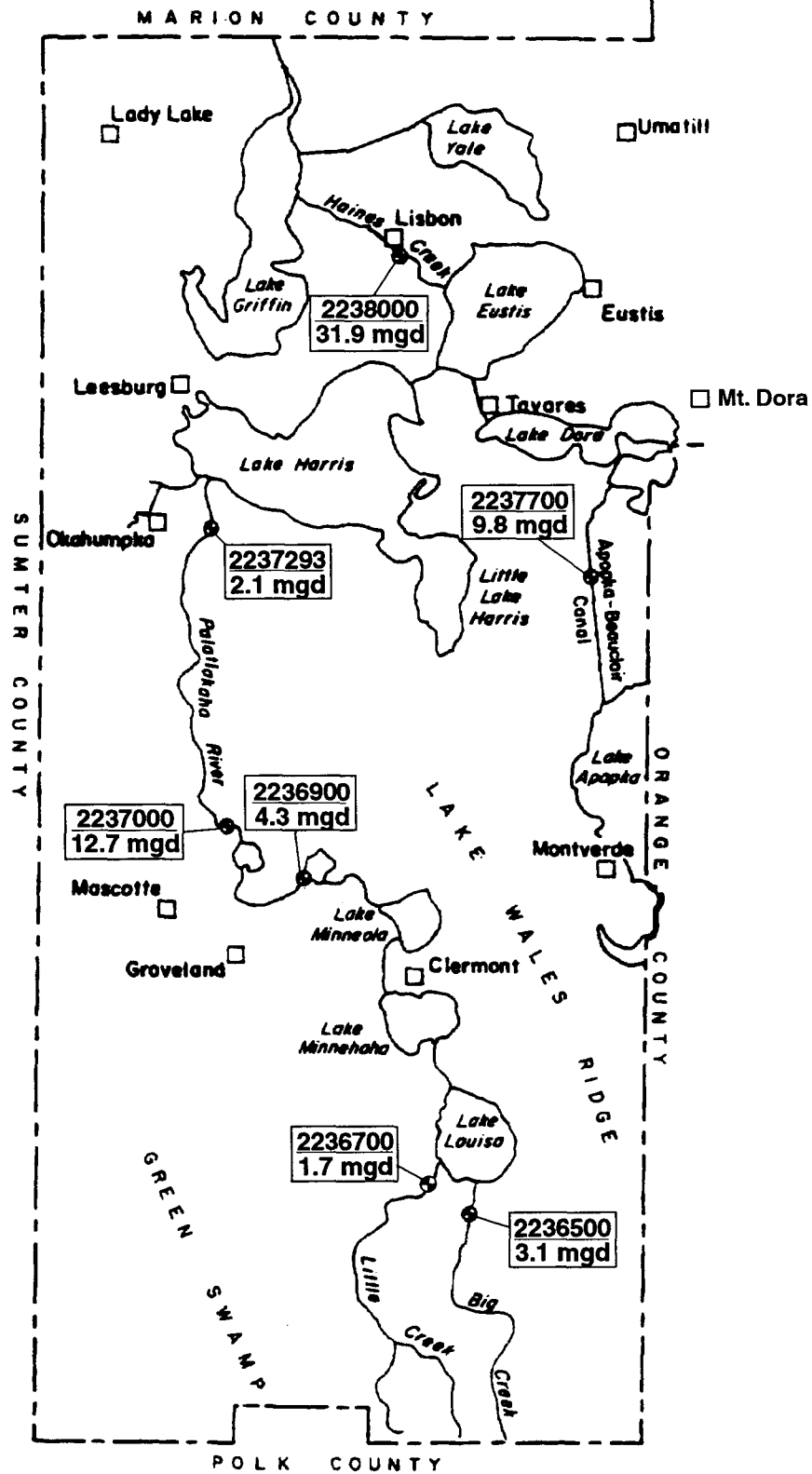


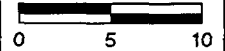
Figure 1. Locations of Long-Term Stream Gauging Stations and Approximate Maximum Developable Surface Water Supplies in Lake County.

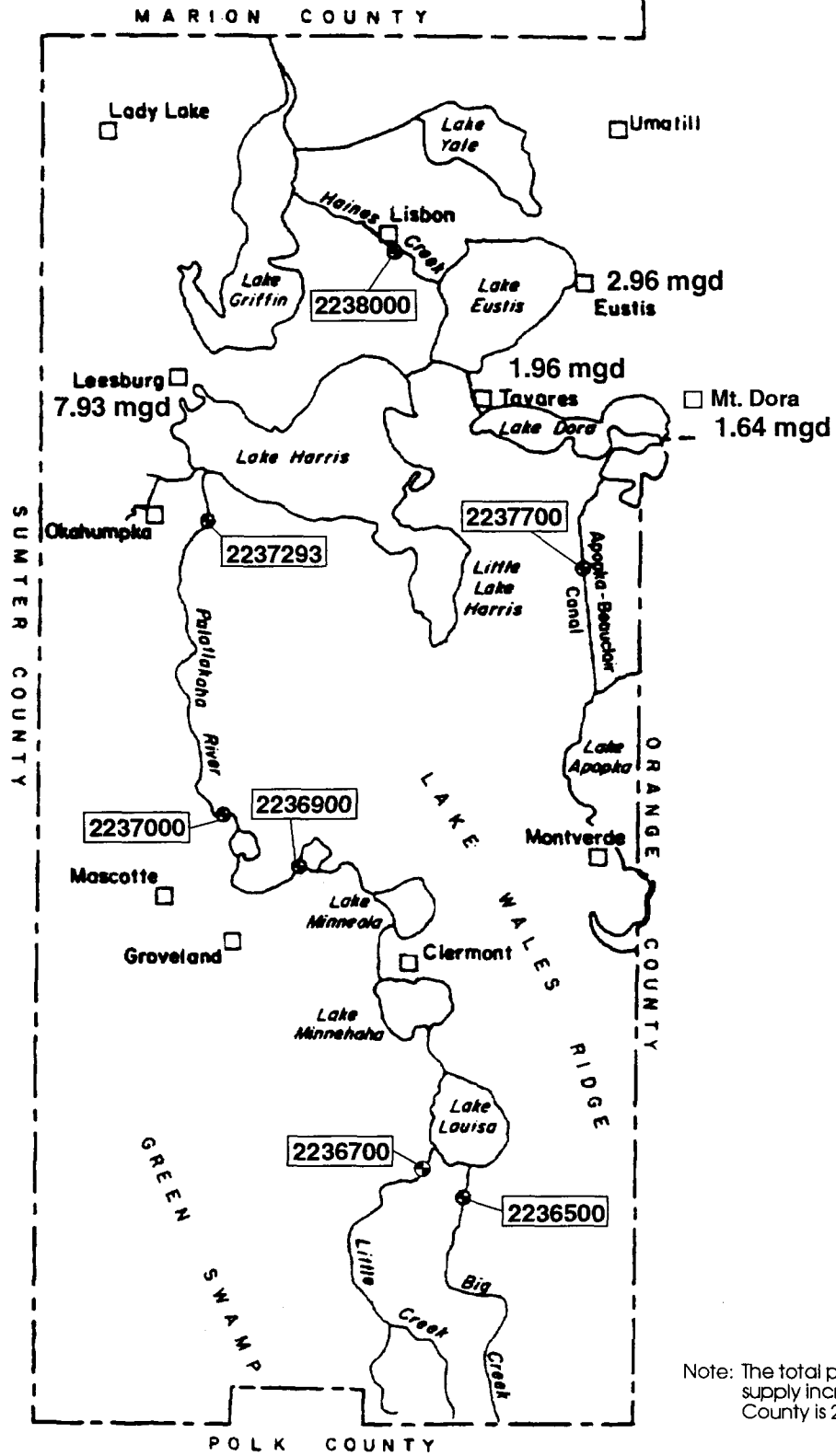
● Stream gauging site

2236500
3.1 mgd

Gauging station number/ approximate maximum developable surface water supply


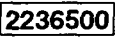
Approximate Scale in Miles

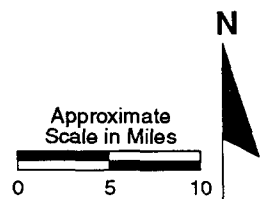




Note: The total projected water supply increase for Lake County is 23.25 mgd.

Figure 2. Projected Water Supply Demand Increases Greater than 5 Percent of the Total Increase for Lake County.

-  Stream gauging site
-  Gauging station number
- 7.93 mgd** Projected public water supply increase



increase and account for over 60 percent of the countywide total increase:

- Leesburg, 7.93 mgd
- Eustis, 2.96 mgd
- Tavares, 1.96 mgd
- Mt. Dora, 1.64 mgd

Leesburg alone accounts for 34 percent of the countywide total increase, which is projected to be 23.25 mgd. These demand centers are also all located in the northern portion of the county where potential surface water supplies are the greatest.

On the basis of developable supply and projected water supply increases, Haines Creek appears to be the most appropriate water body for development at this stage in the evaluation. Although Haines Creek is the candidate raw water source, the actual withdrawal site could be located either in the creek or downstream in Lake Griffin. Although Haines Creek flow records should be used to evaluate water supply potential, a water supply withdrawal site near Leesburg in Lake Griffin is recommended, as shown in Figure 3.

St. Johns River System

The approximate maximum developable surface water supply varies along the length of the St. Johns River, as shown in Figure 4. Estimated maximum potential water supply yield varies from 85 mgd near Melbourne to 768 mgd at Palatka. The water supply potential of the St. Johns River is clearly greater than that of the Palatlahaha River/Haines Creek watershed.

As shown in Figure 5, the increase in projected public water supply demand along the St. Johns River is also variable, with the highest increases occurring near the central-Florida portion of the river. Projected demand growth in Orange, Seminole, and Volusia counties totals 153 mgd, considering only the SJRWMD portion of Orange County. If all of Orange County is included, the projected increase totals about 196 mgd.

Considering available supply and high projected water supply demand increases, the majority of the proposed withdrawal sites are located along the St. Johns River (see Figure 6). The following

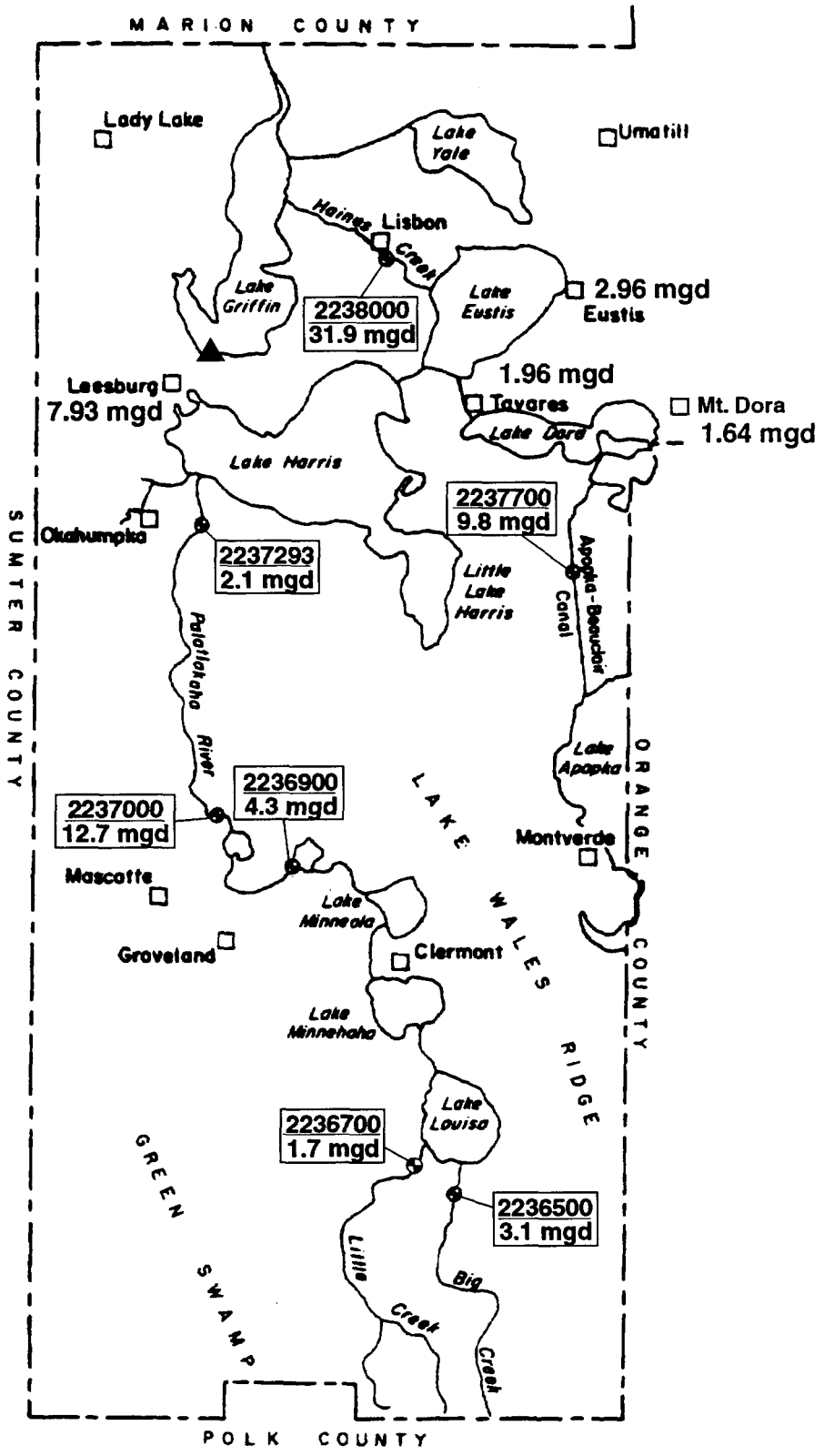


Figure 3. Location of the Candidate Surface Water Withdrawal Site in Lake County.

- Stream gauging site
- 2236500**
3.1 mgd Gauging station number/ approximate maximum developable surface water supply
- 7.93 mgd** Projected public water supply increase
- Withdrawal site

N

Approximate Scale in Miles

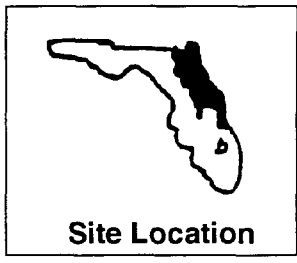
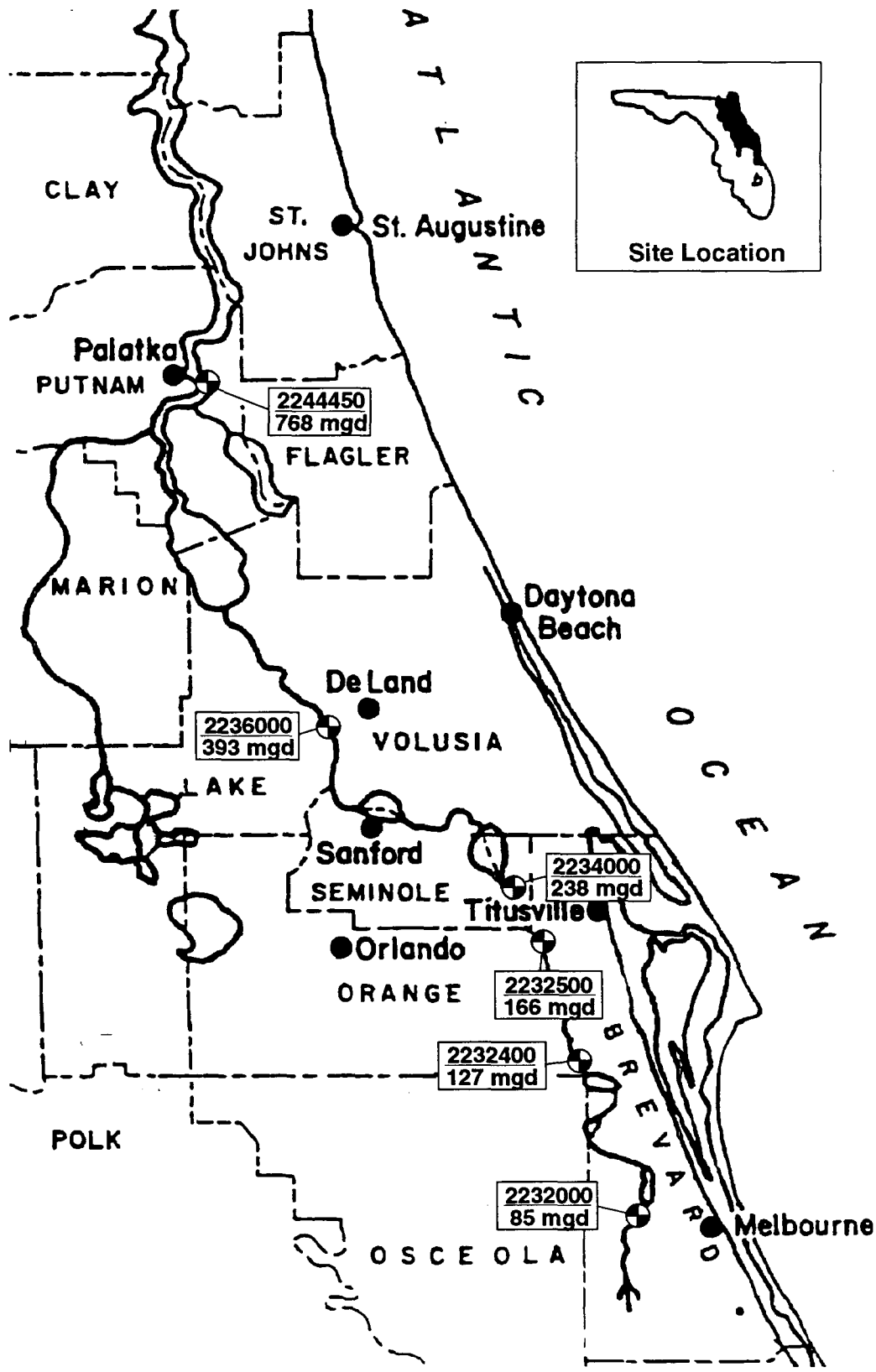

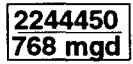
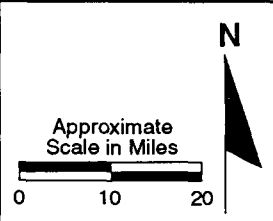
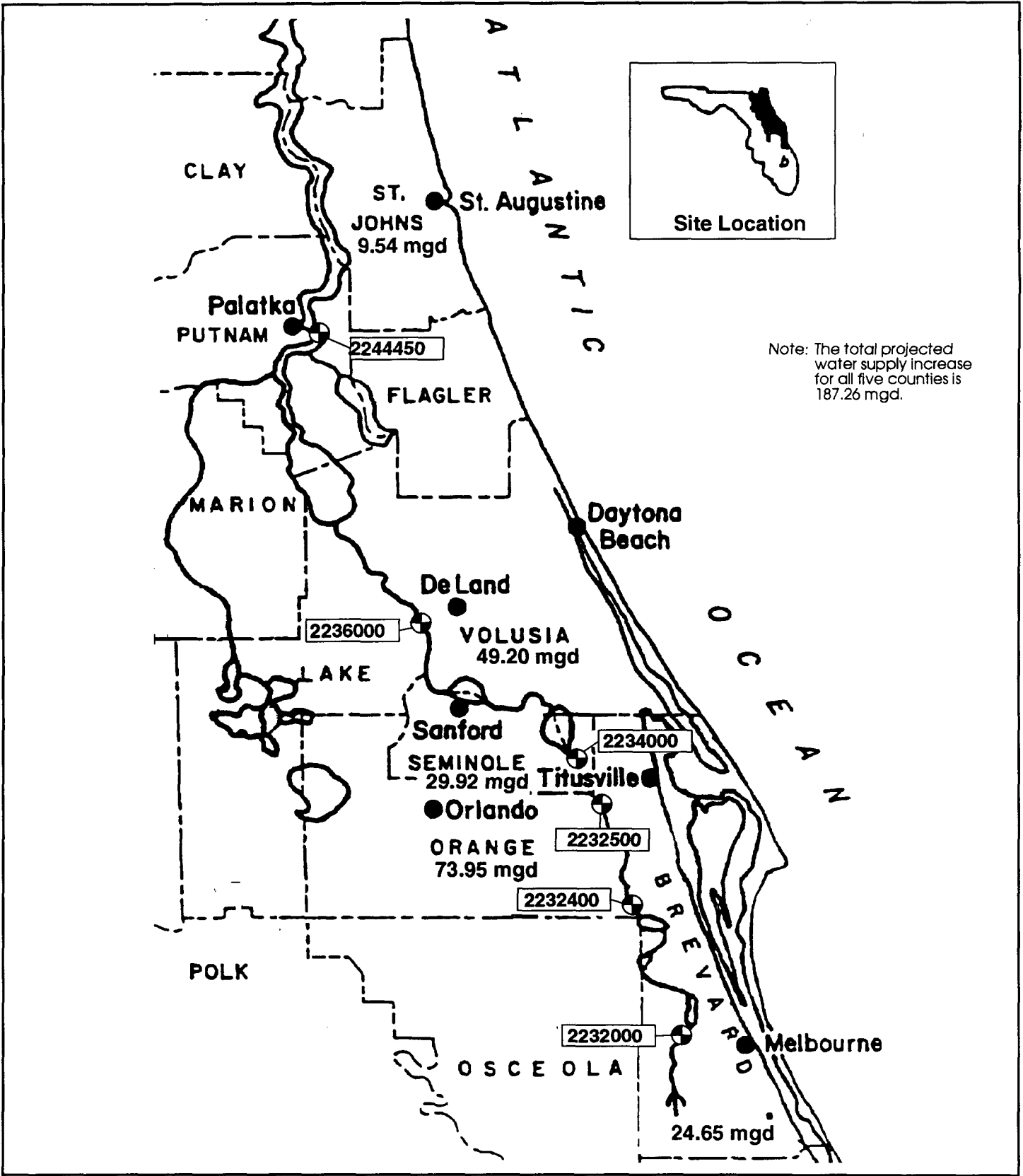


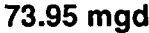
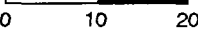


Figure 4. Locations of Long-Term Stream Gauging Stations and Approximate Maximum Developable Surface Water Supplies on the St. Johns River.

 Stream gauging site
 Gauging station number/approximate maximum developable surface water supply





| | | |
|---|---|---|
| <p>Figure 5. Projected Water Supply Demand Increases within the Planning Area by County.</p> | <ul style="list-style-type: none">  Stream gauging site  Gauging station number  Projected public water supply increase | <p style="text-align: right;">N</p> <p style="text-align: center;">Approximate Scale in Miles</p>  |
|---|---|---|

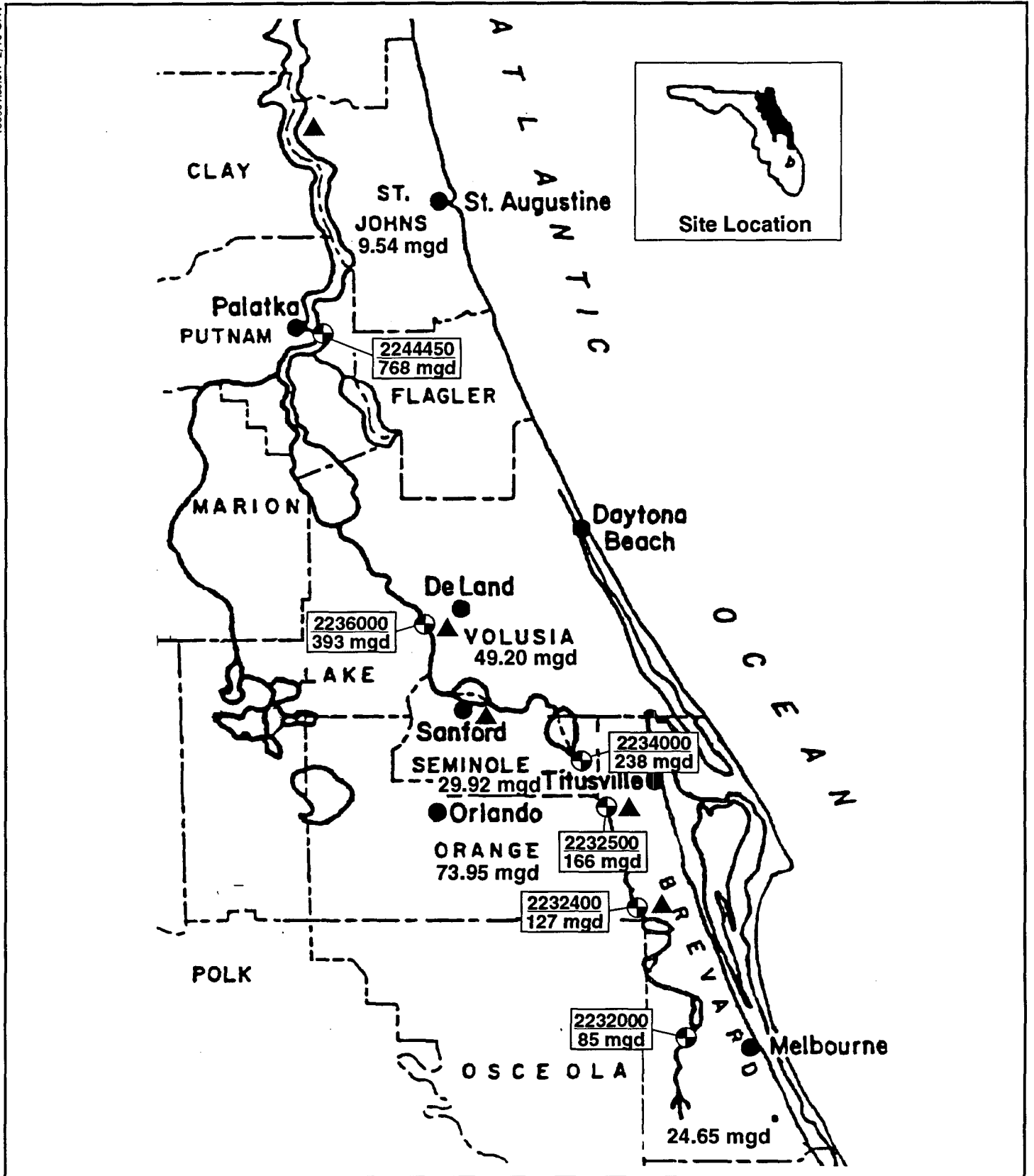


Figure 6. Locations of Candidate Surface Water Withdrawal Sites on the Main Stem of the St. Johns River.

| | |
|--------------------|---|
| ⊕ | Stream gauging site |
| 2244450 768 mgd | Gauging station number/approximate maximum developable surface water supply |
| 73.95 mgd | Projected public water supply increase |
| ▲ | Withdrawal site |

N

Approximate Scale in Miles

individual sites were selected based on their proximity to projected demand increases:

- St. Johns River near Cocoa to meet the increased demands in Brevard County
- St. Johns River near Titusville to meet demands in northern Brevard Orange and eastern Seminole counties
- St. Johns River at Sanford (Lake Monroe) to meet the increased demands in Seminole and Orange counties
- St. Johns River at DeLand to meet the increased demands in Volusia County

For the purposes of this areawide planning project, the most useful information will be developed by focusing the water availability and yield analysis on the central-Florida portion of the river, where the most significant demand increases will occur and where tidal influences are at a minimum.

However, to develop a complete picture of the water supply availability and yield potential of the entire St. Johns River, one additional candidate withdrawal site is selected for analysis. This site is located in northern St. Johns County near Switzerland. A surface water supply located in this vicinity could serve portions of northern St. Johns and Clay counties, or southern Duval County. The river at this point is tidal, and the development of a surface water supply would be more difficult than at upstream central-Florida locations.

STREAMFLOW AND WATER QUALITY DATA TRANSFER

Historical data will be used to analyze the water supply potential of each of the proposed surface water withdrawal sites. For five of the six candidate sites, U.S. Geological Survey (USGS) streamflow records will be used directly in the analysis. However, because the candidate withdrawal site on the St. Johns River at Sanford is located between two gauging stations, the observed record must be adjusted to adequately estimate withdrawal site streamflow characteristics.

Water quality data from the gauging station closest to the proposed withdrawal sites will be used in the analysis. In all cases, USGS water quality data corresponding to the selected USGS stream gauging

station are also available. These water quality data include the following water quality parameters:

- Temperature
- Turbidity
- Color
- Specific conductance
- pH
- Alkalinity
- Ammonia
- Nitrate
- Total organic carbon
- Hardness
- Chlorides

Palatlakaha River/Haines Creek System

No data transfer is required for the candidate withdrawal site in this system. The water availability and yield analysis will be based on data from USGS gauging station 2238000 in Haines Creek at Lisbon, Florida (see Figure 3). A total of 43 years of record are available for this station, which covers a gauged tributary area of 648 square miles (mi²). Because the candidate withdrawal site is located in Lake Griffin downstream from the measured flows, however, the results of the analysis will be somewhat conservative.

St. Johns River System

Table 1 presents summary characteristics for the St. Johns River candidate withdrawal sites, including drainage area, distance from the mouth of the river, USGS stream gauge number, years of record, required adjustments to the streamflow record (if any), the measured or estimated mean annual flow rate in cubic feet per second (cfs), and the approximate maximum water supply yield.

As shown in Table 1, the Sanford (Lake Monroe) site is the only one that will require adjustment of observed streamflow records. For this site, flow rates at DeLand will be adjusted (decreased) to account for the smaller tributary area and yield at this upstream location. An adjustment factor of 0.797 was established by using a two-step process. First, the drainage area at Sanford was estimated by interpolating between the gauged drainage areas at Geneva (Lake Harney) and DeLand. Then, the mean annual flow at Sanford was estimated by applying the equation shown in Figure 7 for the relationship between

Table 1. Summary Characteristics for St. Johns River Candidate Withdrawal Sites

| Withdrawal Site | Drainage Area (mi ²) | Distance from River Mouth (miles) | USGS Stream Gauge | Length of Record (years) | Streamflow Data Adjustment | Mean Annual Flow (cfs) | Approximate Maximum Water Supply Yield (mgd) |
|--|----------------------------------|-----------------------------------|-------------------|--------------------------|-------------------------------------|------------------------|--|
| Near Cocoa (Central Brevard County) | 1,331 | 232 | 2232400 | 41 | None | 986 | 127 |
| Near Titusville (Northern Brevard and Orange County) | 1,539 | 209 | 2232500 | 61 | None | 1,281 | 166 |
| Sanford, Lake Monroe (Seminole and Orange County) | 2,490 | 163 | 2236000 | 60 | Multiply DeLand flow rates by 0.797 | 2,425 | 314 |
| DeLand (Volusia County) | 3,070 | 142 | 2236000 | 60 | None | 3,043 | 393 |
| Near Switzerland (northern St. Johns County) | 8,350 | 41 | 2246500 | 23 | None | 5,687 | 734 |

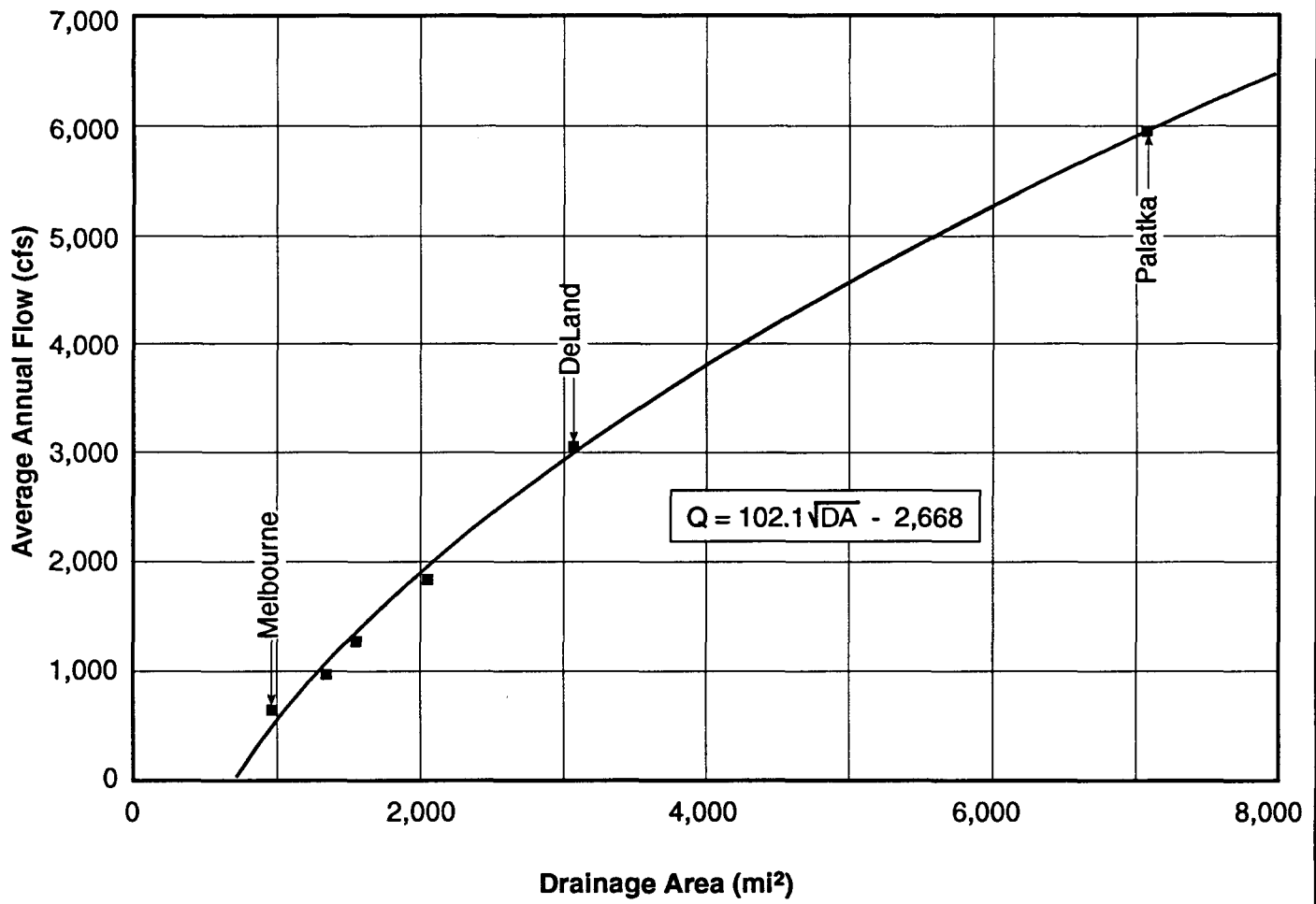


Figure 7. Drainage Area versus Mean Annual Flow for the St. Johns River Above Palatka.

drainage area and mean annual flow. The ratio of this value (2,425 cfs) to the mean annual flow at DeLand (3,043 cfs) is the appropriate flow adjustment factor.

Streamflow characteristics for the northern St. Johns County candidate withdrawal site will be based on flow records observed at the USGS Jacksonville gauge located about 18 miles downstream. Measured flow averages 5,687 cfs, and the gauged tributary area is 8,754 square miles.

The daily streamflow observations at this gauge were determined by measuring both incoming and outgoing flow rates. The difference between the incoming and outgoing flow volumes is then the net freshwater river outflow. The USGS considers the flow records at this location to be poor because of the inaccuracies inherent in measuring large and continuously variable flow rates. Therefore, the water supply yield analysis for this candidate withdrawal point is likely to be somewhat less reliable than the analysis at the upstream central-Florida locations, where tidal influences are much smaller and, thus, measurement inaccuracies are less.

The analysis will also be slightly conservative because the withdrawal point is somewhat upstream from the gauge location. However, this slight conservative bias is considered appropriate given the uncertainty associated with the accuracy of the available streamflow record.

SUMMARY AND RECOMMENDATIONS

SUMMARY

SJRWMD is evaluating surface water as one of several alternative water supply sources. Determining the type and size of water supply facilities required to develop selected surface water sources for public supply, on a preliminary feasibility level, is the primary objective of this evaluation and is being met in three major steps. The first step, which has been completed, provides an inventory of available information and establishes an evaluation procedure. The second step, which is documented in this TM, involves the selection of six candidate withdrawal sites for quantitative evaluation. The final step is the quantitative evaluation of estimated water supply yield and facilities requirements for the sites selected in Step 2.

The process used to select the withdrawal sites recommended in Step 2 is as follows:

- Plot projected public supply demand increases by county or major demand center on a planning area base map. Brevard, Lake, Orange, St. Johns, Seminole, and Volusia counties were included in the surface water analysis.
- On a similar base map, plot the approximate maximum developable surface water supply for each stream gauging station identified in *Technical Memorandum B.1.f, Surface Water Data Acquisition and Evaluation Methodology*. Maximum developable yield is estimated as 20 percent of the mean annual streamflow.
- Identify candidate withdrawal sites by visual inspection of the relative geographic location of demand centers and the magnitude of the potential surface water yield.

Application of this procedure yielded the following candidate withdrawal sites:

- Lake Griffin (Haines Creek) in Lake County near Leesburg
- St. Johns River near Cocoa
- St. Johns River near Titusville
- St. Johns River at Sanford (Lake Monroe)

- St. Johns River at DeLand
- St. Johns River near Switzerland (northern St. Johns County)

RECOMMENDATIONS

SJRWMD approval of the six candidate surface water withdrawal sites identified in this TM is recommended.

REFERENCES

CH2M HILL, January 1996. *Technical Memorandum B.1.f, Surface Water Data Acquisition and Evaluation Methodology, Task B, Surface Water Supply Development, Alternative Water Supply Strategies in the St. Johns River Water Management District.* Gainesville, FL.

Vergara, B. 1994. *Water Supply Needs and Sources Assessment, 1994.* Technical Publication SJ94-7. Palatka, FL: St. Johns River Water Management District.