Southwest Florida Water Management District

Water Use Permit Applicant's Handbook

PART C
WATER USE DESIGN AIDS

July 2012

WATER USE DESIGN AIDS

TABLE OF CONTENTS

2. SALINE WATER MONITORING PROGRAM

Saline water intrusion is defined for the purposes of this manual to include inland movement of salt water in coastal areas and upconing of brackish water in inland areas. Monitoring movement of saline water is important since it may affect water availability for existing and future users. The following guidelines are intended to assist the Permittee in designing a saline water monitoring program (SWMP). In situations where there is no significant threat to a drinking water supply, production wells may provide sufficient information.

Because of the complexity of the saline intrusion problem, these guidelines are general in nature. Specific details and requirements for each program will be prepared on a case-by-case basis within the context of these guidelines. Before designing a SWMP, the Permittee should schedule a meeting with District staff to reach a consensus on the scope of the SWMP.

A SWMP is required when there is concern for saline water intrusion. The applicant may be required to provide data to assess the impacts of pumpage on the movement of saline water. This data may include water-quality information from production wells or water-quality monitor wells. Typically, monitor wells are required when:

1. a history of saline water intrusion or increasing saline concentrations exists for either ground or surface water in the vicinity of the withdrawal, and there is reasonable concern that the requested withdrawal would further degrade water quality; or,

2. staff evaluation indicates that, at the proposed withdrawal rates, saline water intrusion may occur to the extent that the existing treatment process will no longer be capable of producing potable water.

A. **Data, Frequency, and Reporting for SWMP** – Although water quality is the primary data sampled, analyzed, and reported for a SWMP, other data may be required. Listed below are the data typically required for SWMP.

    1. Water Quality – Typically, monitoring of saline water is accomplished by measuring chloride, sulfate, Total Dissolved Solids (TDS), or a combination of these constituents, at predetermined sampling points. Saline concentrations versus time data are used to infer movement of the saline water.

    2. Withdrawals – Where appropriate, withdrawal quantities are reported to the District to correlate water-quality trends with pumpage.

    3. Water Levels – Water levels may be required to evaluate the location of saline water, and to ensure appropriate aquifer pressure gradients are maintained to minimize saline water intrusion.

B. **Water-Quality Sampling, Handling, and Analysis** – To detect water-quality changes, representative and reproducible ground-water samples must be obtained for analyses in a laboratory. Three phases or sampling are 1) obtaining a representative sample, 2) proper handling and preservation of the sample, and 3) analyzing the sample by an approved method within the holding times designated for a particular parameter. These procedures refer to the three parameters most often required to be monitored by permit condition: TDS, chloride, and sulfate. By utilizing this standardized sampling procedure the permittee will reduce the variability associated with sampling and will enable staff to detect and compare water-quality data changes within the District.

1. Sampling Procedure – To obtain a water sample that is representative of the portion of the aquifer in question, the monitoring or production well used for sampling must be properly purged of water. The well should be pumped until the water temperature, conductivity, and pH, are stabilized (it may not always be necessary to measure all parameters). Typically, this stabilization is accomplished following the removal of three well-volumes of water. The permittee can document the duration and pumping rate required to remove the quantity of water necessary to provide stabilization of the three parameters listed above. Subsequent samplings can be made based on the duration and pumping rate without the need to measure temperature, conductivity, and pH. Documenting the well purging time is required only once unless the permittee modifies the pump or the well, or the permittee notes a substantial loss in pumping efficiency, in which case the permittee should recalibrate the pumping time required to collect a water sample. Samples should be collected from the wellhead or sampling tap near the wellhead. Sample containers should be rinsed 3 times with the well water to be sampled.

2. Sample Handling – Three concerns are addressed in the sample handling procedure. These are the sample container, holding time, and preservation. By utilizing the appropriate sample container (e.g. laboratory approved convention polyethylene, Teflon, or linear polyethylene containers) the interaction with the parameter to be quantified is minimized. In addition, some parameters are not stable over extended periods of time. Maximum holding periods are designated for each parameter as well as preserving the sample by keeping it cool in order to slow chemical and biochemical reactions.

   The following is the minimum volume required for analysis along with the sample preservation required and the maximum holding time for a particular parameter. Sample preservation should occur in the field.

Parameter	Minimum Vol. (ml)	Preservation	Maximum Holding Times
Chloride	50	None	28 days
Sulfate	50	Cool, 4ºC	28 days
Total Dissolved	50	Cool, 4ºC	7 days

   Samples stored on ice in a cooler are adequate for preservation. If the analytical lab gives other directions for sample preservation or treatment, then their directions should be followed but noted to the District if different from any directions above.

3. Analytical Methods – The following analytical methods are acceptable:

	E.P.A. Method No.	AWWA Method No.
Chloride	325.1, 325.2, 325.3	407A, 407B, 407C, 407D

Sulfate	375.1, 375.2, 375.3, 375.4	426A, 426B, 426C, 426D
TDS	160.1	209D

C. **Delineation of the Saline Water Interface** – The number and locations of wells to be drilled as part of a SWMP are dependent on several factors including: location, quantities, and duration of withdrawals, aquifer characteristics of the site, and extent of monitoring in the surrounding area. If a monitor well(s) is required as part of a SWMP, well construction procedures as listed in Design Aid 5 "Ground-Water Level Monitoring Program", or equivalent procedures, must be followed. Additionally, procedures equivalent to the following must be adhered to as the saline-water interface is approached:

1. A test hole(s) is drilled, utilizing a clean water drilling method (e.g. reverse air rotary) as the interface is approached.

2. Water-quality samples are taken at small intervals (e.g. 10 feet to one drill rod length). The water-quality samples should be collected after the hole has been pumped at a sufficient rate to insure a representative sample from the bottom of the hole.

3. Drilling ceases when it is evident that the interface has been penetrated.

4. Once the depth of the saline water interface has been identified, the drill hole should be properly back filled (grouted) and completed in the most permeable bed above, but near the bottom of the freshwater bearing aquifer. The well should be properly developed to ensure good interconnection with the aquifer.

3. AQUIFER TEST PROGRAM

When the impacts resulting from a proposed ground-water withdrawal cannot be adequately predicted, the District may request that the applicant develop and implement an Aquifer Test Program (ATP). This is typically the case where withdrawals are requested which appear to have the potential to cause significant adverse impacts, and in areas with insufficient or conflicting aquifer characteristics information.

An ATP is a hydrogeologic investigation intended to define aquifer characteristics such as transmissivity, leakance, and storage, for one or more aquifers or producing zones. Because ATPs generally require considerable time and expense, applicants are encouraged to discuss their intentions in a pre-application meeting with District staff, so that any aquifer testing needs may be identified early in the development process. In most cases, it is preferable to complete any needed aquifer tests prior to submittal of the permit application.

If the ATP is not accomplished prior to application submittal, it may be requested as additional information in support of a permit application, or may be required as a permit condition. If the test program is not intended to provide information in support of a Water Use Permit application, and the wells will not be used after the test for withdrawals, an ATP should still be submitted so that the District can review it regarding potential impacts. In such a case, test well construction permits must be obtained and the District will request the results of the testing for informational purposes.

As an aid to permit applicants the District has compiled a set of guidelines for developing and implementing an ATP. The guidelines describe the basic elements of an ATP, and may be modified as necessary to address specific situations. Since the District does not formally approve ATPs, it is the applicant's responsibility to ensure that the Program provides the information needed to support the application. For this reason, it is essential that the applicant discuss the ATP with District staff, and inform staff of any modifications to the program once implemented.

The successful completion of an ATP will not necessarily result in a staff recommendation for the quantity of water requested by the Applicant. The data collected during an ATP, however, often supports a request for the withdrawal of ground-water.

These guidelines include a discussion of the following topics:

A. Initial Site Investigation
B. Single-well Aquifer Tests
C. Multi-well Aquifer Tests
D. Aquifer Test Program Report
E. References and Bibliography

A. **Initial Site Investigation**

1. The initial site investigation should be performed as the first step in an ATP. During the initial site investigation, the following items should be identified:

   a. The hydrologic units to be tested (surficial, intermediate, Floridan aquifers.)

   b. The most probable drilling depth and yield for a proposed test production well. These should be determined by reviewing existing data such as geologic and geophysical well logs and hydrogeologic reports. A preliminary cross-section indicating the thickness and water quality (if appropriate) associated with various production and confining zones should be constructed prior to selecting a drilling depth.

c. The location of possible sources of ground-water contamination.

d. The location of adjacent surface-water bodies that may interact with the ground-water system.

e. The best means of routing the discharge water from the test production well site.

f. The location, total depth, cased depth, withdrawal rate, pumping schedule, prepumping water level, and specific capacity of adjacent pumping wells. Water levels should be referenced to the National Geodetic Vertical Datum (NGVD).

g. The location, total depth, cased depth, and static water level of existing wells that may serve as observation wells during the constant rate discharge. Water levels should be referenced to NGVD.

h. The tentative locations, total depths, and cased depths for the proposed test production well and observation wells necessary for the aquifer test (see the subsection on Construction of Test/Monitor Wells for the recommended number of wells, radial distances and depths). The potential adverse impacts that proposed withdrawals may have on existing uses or environmental features should be considered when locating the test production well.

i. The locations and results of other aquifer tests performed in the area.

2. After completing the initial site investigation, the Applicant or Permittee should schedule a meeting and present the proposed ATP to District staff for discussion. The proposed ATP should specify:

    a. the location, total depth, and cased depth of the proposed test wells and observation wells;

    b. drilling methods and well construction details;

    c. the pump discharge rate and the routing of pump discharge water;

    d. the method and frequency of collecting water level data;

    e. the method and frequency of collecting water-quality data;

    f. geophysical logging to be performed, if applicable; and

    g. potential impacts to existing legal users.

    The proposed ATP should follow the criteria specified in the following sections of these guidelines unless otherwise discussed with District staff. All proposed ATP should be discussed with the Staff prior to accepting bids on the installation of test wells, test production wells or any services associated with the ATP, in order to cost-effectively design the program.

B. **Single-well Aquifer Test** (Specific Capacity Test)

In cases where aquifer storativity and leakance information are not necessary (i.e. these data can reasonably be estimated based on other regional information), only a single-well specific capacity test may need to be performed to derive an estimated transmissivity. This information can then be used to predict the drawdown that will occur at proposed pumpage rates. The procedure for conducting a single-well aquifer test is described below.

1. General Guidelines

   a. This test is to be performed under conditions with no rain.

   b. There must be a means of obtaining access to the water in the production well so that the depth to water surface (water level) within the casing can be determined by using an electric water level probe or metal measuring tape.

   c. The pump used during the specific capacity test must be capable of operating at the proposed discharge rate. A calibrated orifice weir or some other calibrated flow meter should be installed on the discharge side of the pump so that the pump discharge can be determined.

   d. For a water table or poorly-confined aquifer, if the pumped water cannot be routed to a storage tank or off-site through an existing water distribution system, a closed conduit or plastic lined trench should be used to transport the pumped water to an area 500 feet down gradient from the production well before it is discharged onto the land surface. As an alternative, it may be possible to route the pumped water to an existing adjacent surface-water body. If the well is not in the water table aquifer or in a leaky confined aquifer, then the discharge distance may be reduced to 100 feet from the production well.

   e. The specific capacity test should be performed at the proposed constant discharge rate which represents the maximum pumpage capacity of the production well. The well should be pumped until the water level in the well nears stabilization (typically on the order of about 8 hours). Aquifer Test Data Forms are provided at the end of this design aid to facilitate the compilation of data.

      1. Take drawdown measurements every 30 seconds for the first 5 minutes, recording the water levels to the nearest one tenth of a foot (0.1 foot). Water levels should be taken every 5 minutes for minutes 5–30, and at 10 minute intervals for minutes 30-90. After 90 minutes, measurements should be increased to every 30 minutes until the test is discontinued.

      2. For each water level measurement record the time, the distance from top of the casing to the water surface, the difference between the initial water level and the depth to water surface (drawdown), and the discharge rate.

      3. After the water levels have approximately stabilized (approximately within one tenth of a foot, 0.1 foot, per hour) stop pumping and let the

water level recover to prepumping conditions (approximately within one tenth of a foot, 0.1 ft., of the prepumping level). Measure and record the recovering water levels as was done for the pumping levels. A copy of the raw data collected during the test should be provided to District staff.

2. Drawdowns observed within the test production well should be adjusted for well efficiency losses (see Driscoll, 1986; Chapters 9 and 16).

3. Analysis of Single-Well Aquifer (Specific Capacity) Test Data

   a. Single-well aquifer test data may be analyzed by several different methods. Methods have been developed by Theis, Brown and Meyer (U.S.G.S., 1962), for water table and confined conditions. Hurr (1966) developed a method for water table aquifers, and Worthington (1981) developed a method for leaky-confined aquifers.

   b. One of the simplest methods of deriving Transmissivity from a specific capacity test involves the use of empirical equations based on the Jacob's equation (Cooper and Jacob, 1946), which states:

$$s = \frac{2640}{T} \log \frac{0.3Tt}{r^2S}$$

where:
s = well drawdown, in feet
Q = well yield, in gallons per minute (gpm)
T = transmissivity, in gallons per day per foot (gpd/ft)
t = time of pumping, in days (divide minutes pumped by 1440)
r = radius of the well, in feet
S = storage coefficient of the aquifer

By rearranging terms, transmissivity may be estimated based on the specific capacity, as follows:

$$T = \frac{Q}{s\ 264} \log \frac{0.3Tt}{r^2S}$$

This equation can be simplified assuming typical values (Driscoll, 1986), so that, for most cases, the following simplified formula can be used:

$$T = \frac{Q}{s\ 2000}$$

That is: divide the discharge amount (Q), in gpm, by the drawdown at the end of the test(s), in feet, and multiply by 2000 to derive an estimated transmissivity value.

   c. Well Efficiency Losses must be accounted for and removed from the drawdown value prior to using the above equation. A method for calculating well efficiency is as follows:

Well Efficiency = actual specific capacity divided by theoretical specific capacity (Driscoll, 1986).

Where: actual specific capacity = discharge divided by drawdown;

Theoretical specific capacity = transmissivity divided by 2000

C. **Multi-well Aquifer Test**

1. In cases where aquifer storage, leakance, and transmissivity characteristics cannot be reasonably estimated (e.g. conflicting regional information, large withdrawals in sensitive areas, etc.), a multi-well ATP will be required.

2. Background Data Collection – General Guidelines

   a. Prior to initiating the multi-well test, the prepumping static water level (referenced to NGVD) should be determined in all observation wells, the test production well and adjacent surface-water bodies for five days prior to the test. These water levels should be determined to the nearest 1/100 foot (0.01 ft).

   b. At least one ATP observation well should be equipped with a continuous recorder to allow for tidal and barometric corrections, as well as influences by nearby pumpage.

   c. The time distribution and volume of adjacent pumpage and rainfall occurring at least 24 hours prior to initiating the ATP should be recorded. If possible, adjacent pumpage should be curtailed by agreement.

3. The aquifer test should be continued until equilibrium conditions are established. In general, a six day or greater discharge period is recommended.

4. Procedure and Guidelines

   a. Not less than 24 hours prior to initiating the ATP, the valve located on the test production well pump should be adjusted so that the initial discharge of the pump will be close to the constant discharge rate selected for the test. The discharge rate should approach the design capacity of the well.

   b. The actual pump discharge should be recorded throughout the test. A calibrated orifice weir or some other calibrated flow meter should be installed on the discharge side of the pump so that the pump discharge can be determined.

   c. If the pumped water cannot be routed to a storage tank or off-site through an existing water distribution system, a closed conduit or plastic lined trench should be used to transport the pumped water to an area 500 feet down gradient from the test production well before it is discharged onto the land surface. As an alternative, it may be possible to route the pumped water to an existing adjacent surface-water body.

d. Drawdown and recovery water level measurements should be made to the nearest 1/100 foot (0.01 ft). Measurements should be made with a steel tape, graduated surveyor's chain, electric probe, continuous analog water level recorder or analog/digital recorder, or pressure-transducer recorder.

e. A predetermined schedule for measuring drawdowns should be initiated as soon as the test production well pump starts to discharge. It is suggested that drawdown measurements be made according to the following schedule:

Frequency of Measurement	Time After Pumping Started
every 15 seconds	0 to 2 minutes
every 30 seconds	2 to 5 minutes
every 1 minute	5 to 15 minutes
every 5 minutes	15 to 60 minutes
every 10 minutes	60 to 120 minutes
every 0.5 hour	2 to 5 hours
every 1 hour	thereafter

f. After pumping the well at a constant rate for the appropriate discharge period, the pump is stopped and recovery water level measurements are made. Recovery data should be collected after the pump is stopped or until water levels have recovered within 0.05 feet of the initial static water level. It is suggested that recovery measurements be made according to the following schedule:

Frequency of Measurement	Time After Pumping Stopped
every 15 seconds	0 to 2 minutes
every 30 seconds	2 to 5 minutes
every 1 minute	5 to 15 minutes
every 5 minutes	15 to 60 minutes
every 10 minutes	60 to 120 minutes
every 0.5 hour	2 to 5 hours
every 1 hour	thereafter

g. Rainfall during the aquifer test should be recorded. The aquifer test should be terminated if water levels in observation wells start to rise due to the effects of recharge from rainfall. Some fluctuations may be due to tidal or barometric effects, and these effects should also be accounted for in the analysis.

h. A copy of all raw data collected during the aquifer test shall be provided to District staff.

5. Construction of Test/Monitor Wells

a. In most cases, a minimum of three production zone observation wells and one surficial or adjacent aquifer observation well are necessary to conduct a multi-well aquifer test. Depending on the hydrogeology, other observation wells may be needed in other artesian aquifer producing zones to evaluate anisotropy or effects on adjacent users, and more surficial or adjacent aquifer wells may be needed to assess leakance variability. The construction of observation wells may be initiated after the proposed ATP has been agreed upon.

b. The radial distance of the observation wells from the test production well will vary depending on the type of aquifer, its thickness, its average conductivity and stratification. Presented here are some general rules to follow for the observation well placement:

1. For confined and semi-confined aquifers the production zone observation wells should be located based on the aquifer properties, discharge rate, and well construction. This distance typically is between 100 and 700 feet in the District.

2. For unconfined or water-table aquifers the production zone observation wells should also be located based on aquifer properties, discharge rate, and well construction. The typical distance in these aquifers ranges from 30-400 feet from the pumped well.

3. The observation wells should be placed along a line perpendicular to the regional ground-water flow, unless testing for anisotropy.

4. The production zone observation wells should have screened or open hole segments that correspond to those of the test production well.

5. The shallow or adjacent aquifer observation well(s) should be located approximately 50 feet from the test production well and constructed such that the anisotropic characteristics of the production zone (in the water table aquifer case) or the extent of the hydraulic connection across the semi-confining layers overlying or underlying the production zones (in the leaky artesian aquifer case) can be determined.

6. All wells should be developed in such a manner that a good hydraulic connection exists between the wells and the zones being monitored.

c. During the installation of the test production well and all observation wells, cuttings should be collected at every ten feet or lithology change.

d. Geophysical logging for all production and observation wells is recommended. A geologic log should be made for each well and a hydrogeologic cross section for the site of investigation should be developed using the geologic and geophysical logs from each well.

e. During drilling of the test production well, water-quality samples should be collected every 50 feet or at water-quality changes.

6. Analysis of Multi-well Aquifer Test Data

a. The Multi-well Aquifer Test raw data should be analyzed by means of analytical or graphical techniques which are based on theory which reasonably depicts on-site conditions. The analysis should determine the transmissivity (gpd/ft) and storage coefficient of the production zone as well as the leakance (gpd/ft^3) of any confining zones. Recharge from surface-water sources should be considered in the analysis. An attempt should be made to explain inconsistencies in the observed data. When necessary, the raw drawdown and recovery data should be adjusted to account for the effects of tidal fluctuations, well efficiency losses, adjacent pumpage, recharge from surface water, atmospheric pressure changes, and partial penetration.

b. References for aquifer test analysis methods are numerous. Comprehensive discussions and reports of the various methods are included in: Stallman (1971), Driscoll (1986), National Water Well Association (1987), Lohman (1979), Walton (1987), Kruseman and Deridder (1979), and Newman and Witherspoon (1972).

D. Aquifer Test Program Report

As the final step in an Aquifer Testing Program, the Applicant or Permittee should assemble a hydrogeologic study report including the following items:

1. A section describing the geologic and hydrogeologic conditions at the site of investigation. The description should incorporate a hydrogeologic cross section developed from the geologic and geophysical well logs compiled for the test production well and the three production zone observation wells. The cross section should indicate the thickness and relative location of each production zone and confining zone as well as the water quality and the relative head for each zone.

2. A section describing the construction of the test production well, observation wells required for the multi-well aquifer test, and any other adjacent wells. The cased and uncased depth of each well should be indicated on the hydrogeologic cross section. The locations of pertinent wells and surface-water bodies should be indicated on aerial photography with a minimum scale of 1" = 2000', or a 7 ½ minute USGS quadrangle map. The report should indicate the distance from each well or surface-water body to the test well.

3. A section describing the procedure used for running the aquifer test(s) as well as the technique used in determining the discharge of the test production well, in routing the pumped water away from the test production well, and in determining the changes in water levels.

4. A section describing how the data collected during the aquifer test(s) was analyzed to determine the hydraulic characteristics of the hydrogeologic system. Use the terms s, Q, t, and r, where s = drawdown, Q = discharge, t = time, and r = radius from pumped well, to describe the data.

    a. The analysis of the data collected during a single well aquifer test should include a plot of drawdown versus time.

    b. The analysis of the data collected during a multi-well aquifer test should include individual plot figures indicating the drawdown data collected from each well. Such plots should be provided on 3 x 5 cycle logarithmic paper (e.g. K&E 46-7522 or National 12-191), or semi-log paper, dependent on the appropriate method. If a graphical solution involving type curves is used in the determination of the aquifer characteristics, the pertinent Reference, curves and match points should be provided. The report should discuss the reasons for choosing the method(s) used. The report should also indicate the basis for selecting the value of transmissivity, storage coefficient and leakance most representative of the hydrogeologic system.

5. A section tabulating all water level, rainfall, pump discharge and adjacent pumping data collected throughout the ATP program. Copies of hydrographs should also be included in this section. All water levels should be referenced to the National Geodetic Vertical Datum (NGVD).

6. A discussion of all corrections made to the raw data (barometric, etc.) must be included, including the pertinent calculations.

E. **References and Bibliography**

Stallman, R. W., 1971. Aquifer test design, observation, and analysis. Techniques of Water Resources Investigations of the United States Geological Survey, Book 3, Chapter B1.

Walton, W. C., 1987. Groundwater Pumping Tests – Design and Analysis. Lewis Publishers/NWWA, Chelsea, Michigan.

Driscoll, F. G., 1986. Groundwater and Wells. Second Edition, Johnson Division, St. Paul, Minn.

Cooper, H. H., and Jacob, C. E., 1946. A generalized graphical method for evaluating formation constants and summarizing well field history. Transactions, American Geophysical Union, Vol. 27, No. 4.

Kruseman, G. P., and N. A. DeRidder, Analysis and Evaluation of Pumping Test Data. Inter. Institute for Land Reclamation and Improvement.

Worthington, P. F., 1981. Estimation of the transmissivity of thin leaky-confined aquifers from single well aquifer tests. Journal of Hydrology, Vol. 49

Theis, C. V., Brown, R. H., and R. R. Meyer, 1962. Estimating the transmissibility of aquifers from specific capacity of wells. U. S. Geological Survey Water Supply Paper 1536-I.

Hurr, R. T., 1966. A new approach for estimating transmissibility from specific capacity. Water Resources Research, Vol. 2, No. 4.

Lohman, S. W., 1979. Ground-water Hydraulics. U. S. Geological Survey Professional Paper 708.

National Water Well Association, 1987. Aquifer Analysis. National Water Well Association, Dublin, Ohio.

Neuman, S. P., and P. A. Witherspoon, 1972. Field Determination of the Hydraulic Properties of Leaky Multiple Aquifer Systems, Water Resources Research v. 8 (5), pp. 1284-1298.

4. AGRICULTURAL WATER USE ALLOTMENTS

A. Calculation of Total Allocation Per Crop Per Season

The distribution and amounts of Florida's rainfall are not always adequate to meet a crop's water demand. For many crops supplemental irrigation is required to produce optimum yields. In addition, irrigation is used for field preparation, crop establishment, frost-freeze protection, heat stress relief, salt leaching, chemigation, and system flushing and maintenance.

The District typically allocates agricultural water use based on a modified Blaney-Criddle method and other methods as described below; other appropriate methods may be used. Permittees and applicants may present data demonstrating their water needs. For each crop type, the permittee shall not exceed the total allocated quantity. This quantity is determined by multiplying the total irrigated acres by the total allocated quantity per irrigated acre per season.

Allocated inches per irrigated acre per season are determined for three major water use categories. The total allocation per irrigated acre for a growing period, represented by the following formula, is the sum of allocated water per irrigated acre for field preparation/crop establishment, supplemental irrigation and other uses. An irrigated acre is defined as the gross acreage under cultivation, including areas used for water conveyance such as ditches, but excluding uncultivated areas such as wetland, retention ponds, and perimeter drainage ditches.

$$(1)\quad TAI_g = (CE + GIR + OT) * AI * 27154$$

where

TAI_g	=	total quantity allocated per crop per season (gallons)
CE	=	field preparation/crop establishment allocated inches per season per acre
GIR	=	supplemental irrigation allocated inches per season per acre
OT	=	other uses allocated inches per season per acre
AI	=	irrigated area (acre).

Irrigation systems that cannot provide the calculated quantities are permitted based on the system's maximum capacities.

B. Determining Total Allocated Inches Per Acre Per Season

1. Field Preparation/Crop Establishment

Irrigation is provided before tilling and bedding, to construct compact moist beds. This moisture allows effective chemical treatment and enhances cover crop decay. In addition, moist beds facilitate capillary rise to provide water to the root zone.

Only seasonal crops are allocated irrigation quantities for field preparation and crop establishment. This quantity is for raising the water table depending on the season and soil type. Fall crops are assumed to need half of the quantity for this parameter than Spring crops because Fall crops are preceded by the wet season.

The allocated water comes from the maximum available water in the soil's horizon. To compensate for lateral flow, deep percolation and other losses this quantity is divided by the assigned crop establishment irrigation efficiency. Soil and water table information are found in the United States Department of

Agriculture – Natural Resource Conservaiton Services (USDA – NRCS) "Florida Irrigation Guide," and in county soil surveys.

Field preparation and crop establishment quantities are increased for soils that are chemically treated. These soils maintain a high moisture content for about four weeks. The first month's evapotranspiration (ET) is added to the quantity used to raise the water table. The ET quantity offsets losses from soil evaporation during the treatment period. Again, to compensate for lateral flow, deep percolation and other losses this quantity is divided by the assigned crop establishment irrigation efficiency. The following formulas describe both of the aforementioned scenarios.

a. Field preparation and crop establishment for crops that do not require chemical soil treatment.

$$(2a)\ CE = \frac{SW}{EF_{ac}}$$

b. Field preparation and crop establishment for crops requiring chemical soil treatment.

$$(2b)\ CE = \frac{SW + U(1)}{EF_{ac}}$$

where

CE	=	total allocated inches per acre per season for field preparation/crop establishment
SW	=	soil's available water in top 18 inches for Fall crops and 36 inches for Spring crops
U(1)	=	first month evapotranspirational losses (inches)
EF_{ac}	=	assigned crop establishment irrigation efficiency.

Crop establishment irrigation for strawberry production is mainly for stress relief. The applied water reduces transplant stress and allows roots to develop. For strawberries the total allocated water for field preparation and crop establishment is 380,156 gallons (14 inches) per acre per season except in the Southern Water Use Caution Area where that quantity is 12 inches. This quantity includes water for field preparation and crop establishment. Crop establishment quantities are from Institute of Food and Agricultural Services (IFAS) research at the Dover Station, Project #9, 1978 (Albregts, 1978).

2. Supplemental Irrigation

Under ideal conditions, the amount of water required for optimum crop production is the amount of water lost or used during growth. These losses consist of evaporation from the soil and plant transpiration. When limited climatic parameters are available the Blaney-Criddle method is used to estimate these evapotranspirational (ET) losses.

The Blaney-Criddle method is widely used to estimate ET. This empirical method was originally developed in the arid western United States. Blaney-Criddle uses long term local climatic data (temperature and solar radiation) and crop information to estimate ET.

During certain times of the year the Blaney-Criddle method tends to overestimate ET in humid areas. Researchers have adapted the Blaney-Criddle method to humid areas (Shih, et al, 1981; Shih, et al, 1983;

Doorenbos & Pruitt, 1977). It was determined that by substituting solar radiation for daylight the method will give more accurate ET estimates. This change is incorporated into the District's methodology.

a. The Blaney-Criddle equation with a Florida modification for calculating evapotranspiration in its ~~'~~ basic form is:

$$(3) \qquad U = k \sum_{1}^{m} p \; t/100$$

where

U	=	total crop evapotranspiration for a given period
k	=	an annual, seasonal, or monthly empirical consumptive use coefficient which varies according to the crop (see description below)
p	=	percent of solar radiation during the period
t	=	mean temperature for the period, in degrees Fahrenheit
m	=	month

b. The following modification to account for crops and seasonal conditions has been made to the above equation:

$$(4) \quad k = kt * kc$$

where

kt	=	climatic coefficient related to the mean air temperature
		= .0173t - .314
kc	=	growth coefficient reflecting the growth stage of the crop.

a. The crop growth coefficient (kc) is determined as follows:

1. For perennial crops, monthly growth coefficients are used (refer to the coefficients used in most recent version of AGMOD or contact District Staff for further information).
2. For seasonal crops, to determine monthly values, the coefficients at certain percentages of the growing season are averaged (refer to the coefficients used in most recent version of AGMOD or contact District Staff for further information).

   For example, if a crop with a four month growing season is planted in September, the coefficients for five percent through twenty-five percent of its early development are averaged to give a growth coefficient for September, the coefficients for thirty percent through fifty percent of its early to mid-development are averaged to give a coefficient for October, and so on.

Effective rainfall and supplemental irrigation provide a crop's water requirements. Effective rainfall is the amount of rain stored in a crop's root zone. It is based on soil and crop root zone. Supplemental irrigation is the difference between crop water use (ET) and effective rainfall, divided by the assigned irrigation efficiency. Equations to calculate effective rainfall are from USDA - NRCS TR-21 "Irrigation Water Requirements."

Field conditions and cropping patterns can affect the amount of effective rainfall. The amount of usable rain on plastic mulched beds could be limited. Most of the crop's roots are in the bed and cannot directly utilize rain. Therefore, for permitting purposes, effective rainfall for plastic mulched crop production is assumed to be zero. This assumption will be used until additional data is available.

c. The supplemental irrigation is calculated as follows:

(5) $SUP = U - re(d\ 2/10, s)$

where

SUP	=	supplemental crop requirement for the growing period in inches
re	=	effective rainfall, (amount of rain stored in the root zone) normalized to the 2-in-10 year drought (d 2/10), and the soil type(s).

The gross irrigation quantity equals the supplemental irrigation requirements divided by the assigned irrigation efficiency. By using the assigned efficiency the applicant is allocated quantities that include crop requirements and water lost during delivery. These losses include water supply, conveyance, system and application.

The assigned supplemental irrigation efficiency is based on the application efficiency. This irrigation efficiency is a measurement of the effectiveness of an irrigation system to deliver water to a crop's root zone. It is the ratio of the water in the root zone to the water pumped. The District generally uses the average application efficiency values cited in IFAS publications. However, in WUCA's, where there is increased competition for the resources, higher than average application efficiencies are used.

d. The allocated supplemental irrigation is calculated as follows:

(6) $GIR = (SUP/EF_{as})$

where

GIR	=	total allocation for supplemental irrigation (inches per acre)
EF_{as}	=	assigned supplemental irrigation efficiency.

The District uses a computer program to calculate the allocated supplemental crop water requirement. The program approximates equations (3) through (6) as follows:

(7)	f(m)	=	(t(m) * p(m)) / 100
(8)	kt(m)	=	(0.0173 * t(m)) – 0.314
(9)	k(m)	=	kt(m) * kc(m)
(10)	u(m)	=	f(m) * k(m)
(11)	rtl(m)	=	(0.70917 * (rt(m) ** 0.82416) – 0.11556)

(12)	ul(m)	=	10 ** (0.02426 * u(m))
(13)	fl	=	.531747 + (.295154 * D) – (.057697 * D ** 2) + (.003804 * D **3)
(14)	re(m)	=	rtl(m) * ul(m) * fl
(15)	re2(m)	=	re(m) * f2

where

m	=	month of year
u(m)	=	average monthly evapotranspiration
rt(m)	=	average monthly rainfall (see coefficients used in most recent version of AGMOD or contact District Staff)
f(m)	=	monthly evapotranspiration factor
t(m)	=	average monthly temperature (see coefficients used in most recent version of AGMOD or contact District Staff)
p(m)	=	monthly percentage of solar radiation (see coefficients used in most recent version of AGMOD or contact District Staff)
re(m)	=	monthly effective rainfall
re2(m)	=	monthly effective rainfall normalized to 2-in-10 year drought
kt(m)	=	monthly climatical coefficient
kc(m)	=	monthly crop growth coefficient (see coefficients used in most recent version of AGMOD or contact District Staff)
rt1(m)	=	average monthly effective rainfall factor considering average monthly rainfall
u1(m)	=	average monthly effective rainfall factor considering average monthly evapotranspiration
D	=	net depth of application (sum of each average soil water holding capacity in the soil horizon times the root-zone horizon)
f1	=	soil factor
f2	=	ratio of 2-in10 year growing-season effective rainfall to average annual rainfall (see ratios used in most recent version of AGMOD or contact District Staff).

For perennial crops the computer solves equation (5) for each month of the year. For seasonal crops the equation is solved for each month of the growing season. The monthly difference between evapotranspiration and 2-in-10 year effective rainfall is the basis of the allocated supplemental irrigation. The monthly differences are divided by an assigned supplemental irrigation efficiency and summed to determine the annual crop water requirement in inches (6).

3. Other Use

There are several other water uses related to crop production. Water is applied for chemigation, cold protection, cooling, leaching of salts from the soil, and for flushing and maintaining irrigation systems. Most of these quantities are crop and system related. Water requirements for leaching and cold protection are found in USDA-NRCS and IFAS publications.

Cold protection quantities are based on the warmth created by the latent heat of fusion~~. The daily quantity (24 hours) for citrus is 72,000 gal/acre, and for strawberries 162,924 gal/acre.~~ This water use is not accounted for when evaluating annual water use compliance. However, it is included in maximum daily amounts. Cold protection quantities must be reported and should not exceed the listed amounts for a 24-hour use.

All remaining "other water" uses are permitted as a percentage of the quantity allotted for gross irrigation. Ten percent of the gross irrigation requirements are added to micro-irrigation systems and five percent to all other systems. The five percent difference is because micro-irrigation systems usually require more water for flushing and leaching. Additionally, chemigation is applied directly through micro-irrigation systems.

1. Other water uses for micro-irrigation systems

   (16) OT = .1 * GIR

   where

   OT = other water uses (inches).

2. Other water uses for non micro-irrigation systems

   (17) OT = .05 * GIR

C. Examples of Total Allocated Inches Per Acre Per Season

As a general guide, the total allocated inches per acre per season for common crops and soil types, with typical planting dates and season length are available in the most recent version of AGMOD. If further information is required, please contact District staff. Quantities can be converted to gallons by multiplying them by 27,154.

For crops, soil types, planting dates, and length of growing season not in those tables or for crops planted outside the WUCA's, you can get the total allocated inches per acre per season utilizing procedures described above. Or, complete the Agricultural Water Allotment Form and submit it to the District. The District will return the form with the total allocated inches per acre per season per crop based on the information provided.

<u>Please note that all examples/equations above have been used as of July 19, 2012. Please contact District Staff for information pertaining to examples which use the equations currently used.</u>

D. Additional Information

Additional details may be found in the following sources:

Albregts, Howard, "<u>Intermittent Overhead Sprinkler Irrigation to Establish Strawberry Plants in the Fruiting Field</u>," Research Report, Project #9, 1978.

Albregts, Howard, "<u>Water Use in Strawberry Transplant Establishment</u>," Research Report, DOV-1985-2.

Cohen, "<u>Agricultural Water Use Model</u>" SWFWMD, 1990.

Doorenbos & Pruitt, "Guidelines for Prediction Crop Water Requirements," FAO Irrigation and Drainage Paper 24, 1977.

"Irrigation Water Requirements," Technical Release No. 21, USDA, Soil Conservation Service, Engineering Division, 1970.

Parsons et al. "Low Volume Micro Sprinkler Undertree Irrigation for Frost Protection of Young Citrus Trees," Procedure Florida State Horticultural Society 94:55-59-1981.

SFWMD. "Agricultural Water Use Model," computer disk.

SFWMD. "Permit Information Manual Volume III," June, 1985.

Shih et al. "Comparison of Methods of Evapotranspiration Estimation," American Society of Agricultural Engineers Paper No. 81-2015.

Shih et al. "Basinwide Water Requirements Estimation in Southern Florida," American Society of Agricultural Engineers Transactions, 1983.

SJRWMD. "Technical Memorandum 30 Year Mean Blaney-Criddle Supplemental Irrigation Requirements."

Smajstrla et al. "Characteristics of Potential Evapotranspiration in Florida," American Society of Agricultural Engineers Paper No. FSC-84-003.

Smajstrla et al. "Efficiencies of Florida's Agricultural Irrigation Systems," IFAS 1988.

U.S. Dept. of Agriculture, Soil Conservation Service. "Florida Irrigation Guide," August, 1982.

October 1990

Southwest Florida
Water Management District
2379 Broad Street • Brooksville, FL 34604-6899 • (352) 796-7211 • 1-800-423-1476 (FL only);
Suncom 628-4150 • TDD only: 1-800-231-6103 (FL only) • http://www.swfwmd.state.fl.us

AGRICULTURAL WATER ALLOTMENT FORM

To determine the inch per acre allotment for your crop(s), complete this form and return it to the District. The District will return to you the calculated inches per acre. Submit one form for each water use permit.

NOTE: In the table below, the numbered columns may be used for different crops of different planting dates. If you have more than four crops or planting dates, use additional forms.

	1	2	3	4
County				
Crop				
Planting Date				
Season Length (days)				
Primary Soil Type				
Irrigation System Type (1)				
(2)				

WUP No. ______________________________

Name: ____

Address: ____

City, State, ZIP: ____

Telephone: (___)____

For District Use Only:

*	INCHES	COMMENTS
1		
2		
3		
4		

NOTE: Quantities based on assumption that there is sufficient system capacity.

5. GROUND-WATER LEVEL MONTORING PROGRAM

A ground-water level monitoring program may be required to adequately indicate the impact of the proposed use on existing legal uses, water bodies, land uses, environmental features such as wetlands, saline water intrusion, or the aquifer. These guidelines are intended to help the Permittee in developing a ground-water level monitoring program.

Staff determines the scope of a Permittee's monitoring program by the size of the withdrawal, the hydrologic properties of the aquifer, the amount and type of other water use in the aquifer, and the land use surrounding the withdrawal. The number of wells required for monitoring will normally be specified in the special conditions of the permit. For example, a water use of less than one million gallons per day in a relatively undeveloped inland area may require only one monitoring well, while a use of several million gallons per day from a highly-stressed coastal aquifer subject to salt water intrusion may require a number of monitoring wells at several depths located at various directions and distances from the withdrawal.

Since the hydrologic aspects of each withdrawal will differ these guidelines are general in nature and may be modified where appropriate. A monitoring program for flowing wells will require a different methodology. Specific details and requirements for each program will be prepared on a case-by-case basis within the context of these guidelines. The Permittee should meet with District staff prior to monitor well construction in order to review the design and scope of the monitoring program.

A. Monitor Well Design, Construction, Documentation, and Recorder.

   1. Well Network Design Guidelines

      a. The specific number, depth, location and design specifications of monitoring wells are determined on a case-by-case basis.

      b. Individual well locations are determined after the consideration of factors such as saline water bodies, potential pollution sources, nearby wells, surface-water bodies and wetlands, and the boundary of the cone of depression.

      c. Design and construction specifications for each well, include drilling method, total depth, casing depth and type, and well finish. The specifications are developed based on factors such as local geology, drilling conditions, nearby wells completed either in the production zone or adjacent zones or aquifers, and the parameters to be monitored from the well.

   2. Well Construction Guidelines

      a. All monitoring wells shall be installed by a registered well driller working under the direction of a licensed contractor.

      b. All materials and equipment shall be clean and free from oil, grease, solvents, or other contaminants.

      c. Upon completion, the monitoring well shall be capable of producing water substantially free of sand and completely free of drilling fluids, and shall be responsive to water level changes in the aquifer.

d. Sampling: Formation samples shall be collected during drilling every ten (10) feet or at each change of lithology, whichever occurs first. Samples shall be representative of the formation materials encountered at the depth at which they naturally occur in the borehole. Samples shall be clearly and indelibly labeled with the well identification and depth interval represented by the sample. A detailed driller's report shall be maintained and shall include, but not be limited to, a description of all formations encountered, depths at which the formations are encountered, and the number of feet drilled.

e. Casing: Well casing shall be new, schedule 40 PVC pipe or its equivalent, with a minimum 2-inch nominal diameter. The casing shall be assembled with threaded couplings, slip couplings, or flush joint threaded ends. If couplings are used, they may be secured to the casing with stainless steel screws that do not penetrate the PVC casing. Solvents and/or glue shall not be used to join casing. The well casing may extend above or below the protective steel casing. The top of the casing shall be fitted with a removable, vented cap.

f. Screen: Well screen shall be new, schedule 40 PVC slotted pipe or its equivalent, 3 to 5 feet long with a minimum 2 inch nominal diameter. Slot size shall be compatible with formation materials and artificial gravel pack. It shall be fitted with a tail pipe of new, schedule 40 PVC pipe or its equivalent, 2 feet long with a minimum 2 inch nominal diameter. The bottom of the tail pipe shall be assembled and attached to the casing in a manner similar to the assembly of the casing. The casing and screen shall be plumb and centralized within the borehole.

g. Gravel Pack: An artificial gravel pack of washed, well rounded, well sorted, silica gravel of a size compatible with formation materials and screen slot size shall be used. The gravel shall have a minimum thickness of 2 inches and shall be placed in the borehole in such a manner as to completely fill the annular space. The gravel pack shall extend from the bottom of the tail pipe to 2 feet above the top of the screen.

h. Sand Cap: A sand cap consisting of clean washed quartz (silica) filter sand having a diameter of approximately 0.04 inches (1 mm) shall be used. The sand cap shall extend from the top of the gravel pack to 2 to 3 feet above the top of the gravel pack. The sand cap shall be placed in the borehole in such a manner as to completely fill the annular space. The sand cap shall have a minimum thickness of 2 inches. Bentonite or similar clay materials shall not be used as a substitute for the sand cap.

i. Grout: Neat cement grout shall be placed in the borehole from the top of the sand cap to ground surface. No more than 6 gallons of water per cubic foot of cement shall be used. The grout shall have a minimum thickness of 1 inch and shall be placed in the borehole in such a manner as to completely fill the annular space.

j. Well Casing Protection: A protective steel casing or equivalent shall be placed around the well casing a minimum of 2 feet below land surface to a minimum of 2 feet above land surface. The protective steel casing shall be of a diameter that allows access to the well casing for water level measurements and water sampling. A cement or concrete pad with minimum dimensions of 2 feet on each side, 4 inches thick, shall be placed around the protective steel casing. The pad shall be sloped in such a manner as to convey water away from the protective steel casing. The protective steel casing shall be fitted with a cap or locking cap. A hole must be drilled in the protective steel casing near the top of the pad to prevent the accumulation of water in the protective steel casing. The monitoring well identification must be clearly and indelibly marked on the protective steel casing.

3. Well Construction Documentation Guidelines

   a. The District may require the collection of drill cuttings or cores, and the submittal of lithologic or geophysical logs, obtained during the drilling of observation wells.

   b. A completion report must be submitted pursuant to Chapter 40D-3, Florida Administrative Code.

   c. An accurate site map of the location of each monitoring well is required giving specific directions from landmarks to the well.

4. Water Level Recorders Guidelines

   a. Water level recorders which produce a page-type chart or a roll-type chart are recommended.

   b. Recorders which produce circular charts or digital-coded punched paper tapes are not acceptable. A digital-coded type recorder may be considered only if the data has been decoded with the levels referenced to NGVD and then the data submitted.

B. Data Collection and Submittal Guidelines

1. Establishment of Datum Reference for Monitoring Wells

   a. A measuring point (MP) is established for each well and used as a reference point for all ground-water level measurements. Normally, the measuring point is the top of the well casing.

   b. The datum reference is established by surveying the elevation of the measuring point above mean sea level. (0.0' NGVD)

2. Ground-Water Level Measurements

   a. Wetted Tape Measurement: This method uses a steel measuring tape or surveyor's chain, preferably graduated into hundredths of a foot. The bottom portion of the tape is coated with carpenter's chalk or fluid-level paste and the tape is lowered into the well a sufficient depth to allow part of the chalked portion of the tape to be below the water level. At this point, find a footage marker on the tape, hold it against the measuring point, and record that footage (HOLD). Withdraw the tape from the well, determine the footage at which the water level CUT the tape as indicated by the line between wet and dry chalk or paste, and subtract the CUT footage from the HOLD footage to obtain the ground-water level (GWL) below the measuring point. To express the water level in terms of NGVD reference, subtract the GWL measurements from the elevation of the measuring point.

b. Electric Probe Measurement: An electric probe is a device in which contact with the top of the water column in a well completes a circuit and sends a signal, usually through an ammeter on the device. The point at which the probe first touches water is determined, the probe cable is held against the measuring point, and the length of cable below the hold point is measured to determine the ground-water level. Subtract that level from the elevation of the measuring point to express the water level in NGVD reference.

c. Other Observations: Along with the ground-water level, the date and time of the measurement are recorded. It may also be useful to note items such as weather and precipitation, number of wells operating, etc.

3. Water Level Recorder Operation

a. Starting a Continuous Recorder Measurement: Measure the potentiometric level with steel tape of electric probe. Note the ground-water level (referenced to NGVD), date, time, and the initials of the person starting the record on the chart. Adjust the chart for the proper time of day and the recorder pen for the proper water level. Check the movement of the recorder float to be sure as upward movement in the well is shown as upward movement on the recorder.

b. Ending a Continuous Recorder Measurement: Measure the ground-water level (referenced to NGVD). If there is a large difference between the measured level and the level showing on the recorder, perform the measurement again. Note the level, date, time and inspector's initials on the chart. Also note any level discrepancy of 0.1 foot or more, and any time discrepancy of 1 hour or more per seven-day period.

4. Monthly Data Submittal Requirements

a. Ground-Water Levels: Field measurements of ground-water levels are submitted to the District during the month following the month in which the measurements were made. If any monitoring wells are equipped with water level recorders, the recorder charts are submitted with the field measurements.

b. Documentation: The project name and permit number must accompany all data submittals to the District.

5. Annual Reporting Requirements

a. Hydrographs: The District may require that a hydrograph for each observation well be prepared at the end of each calendar year. The graph shall be prepared from the field ground-water level measurements taken in wells without water level recorders, or from the lowest water level occurring on the 5th, 10th, 15th, 20th, 25th and last day of the month in wells equipped with recorders. The water level scale on the hydrographs shall be held constant throughout the year.

b. Potentiometric Surface Map: For larger ground-water level monitoring networks, the District may require the submittal of wet season and dry season potentiometric surface maps. The maps shall be based on the May and November water level measurements. A separate map should be prepared for each monitored aquifer.

c. Documentation: The project name and permit number must accompany all data submittals to the District.

6. ENVIRONMENTAL MONITORING PROGRAM

An environmental monitoring program may be required for permits where there is a potential for withdrawals to cause significant adverse impacts to environmental features. The objectives of environmental monitoring are to document actual environmental impacts resulting from withdrawals. The following factors are considered in determining the need for an environmental monitoring program: the size of the withdrawal, its predicted impact on surface waters and the water table, and the sensitivity and value of the associated environmental features.

In assessing the need for environmental monitoring, the District at the time of permit application considers both the historical and existing conditions of associated environmental features. Previous physical alterations to environmental features, such as drainage systems or water control structures, are considered. For certain permits, the applicant may be required to supply additional information regarding the existing status and condition of associated environmental features. This information may consist of aerial photographs, topographic maps, hydrologic and/or environmental data, land cover assessments or other relevant information. Also, baseline hydrologic and/or environmental data collected prior to permit application should be provided if available. The need for additional information may be established through pre-application meetings with the District.

If an environmental monitoring program is required, the specific details of such program will be determined during the application process. Methods of data collection, sampling locations and sampling frequency must be approved by the District. The results of monitoring programs will be provided to the District in reports submitted at a frequency determined during permit application. Reports may be either of two types: 1) progress reports which contain raw data, data summaries and a brief description of monitoring progress; and 2) interpretive reports which contain analyses and interpretation of the monitoring program results. The basic format for data presentation and analysis contained in these reports will be reviewed and approved by the District.

Environmental monitoring programs will be designed for efficiency and cost effectiveness while achieving monitoring objectives. If determined to be adequate, environmental monitoring can be limited to water use and simple hydrologic data. In other cases, biological or ecological parameters must also be measured in order to evaluate relationships between environmental characteristics and hydrologic conditions.

Typically, environmental monitoring is limited to water use and hydrologic data when the following conditions exist:

1. The effects of the withdrawal are restricted to small changes in lake levels.

2. The withdrawal results in small or intermittent flow reductions in a stream or other water-course and existing information on the ecological structure of the water course is sufficient or additional information is determined to be unnecessary.

3. For withdrawals predicted to impact wetlands, it is determined by District staff that a sufficient water level monitoring program will adequately address hydrobiological relationships and impacts to wetlands communities.

Environmental monitoring may also include the measurement of biological or ecological parameters when the following conditions exist.

1. Lake levels are lowered to the degree that lake water quality or biological structure are significantly affected.

2. Stream-flow reductions are of sufficient magnitude that water quality or biological structure are affected, or insufficient data exist to make these assessments.

3. For withdrawals predicted to impact wetlands, it is determined by the District, based on wetlands size and quality and modeled water table drawdowns, that the monitoring biological parameters will be necessary to evaluate impacts to wetland communities. Wetlands quality will be assessed by considering such factors as the presence of rare or endangered species, species diversity, indicator species, and evidence of successional trends.

General types of data which may be required as part of environmental monitoring programs are listed below. This list is not all inclusive, and other types of data may be required if appropriate. Conversely, an environmental monitoring program may include only some of these types of data. Specific details of any environmental monitoring program will be established during the application process.

A. **Lakes**

1. Permits involving withdrawals which may cause adverse impacts to lakes, ponds, sinks or impoundments may be required to monitor:

   a. Surface-water levels.

   b. Ground-water levels.

   c. Rainfall at the project site.

   d. Surface-water quality.

   e. Biological parameters such as the abundance and species composition of benthic fauna, fishes, zooplankton, phytoplankton, submersed and emergent macrophytes, and periphyton, measured with recognized quantitative techniques.

B. **Streams and Water-Courses**

1. Permits involving withdrawals which may cause adverse impacts to streams, springs, canals, estuaries, or other water-courses may be required to monitor:

   a. Surface-water levels.

   b. Ground-water levels.

   c. Rainfall at the project site.

   d. Surface-water quality, including salinity distribution in estuaries.

   e. Biological parameters such as the abundance and species composition of benthic fauna, fishes, zooplankton, phytoplankton, submersed macrophytes, emergent or intertidal plants, and periphyton, measured with recognized quantitative techniques.

f. Sediment characteristics, such as particle size distribution and organic content.

g. Aerial photography identifying the distribution of riparian or estuarine vegetation.

h. Hydrographic parameters, such as bathymetry and the distribution of major bottom features such as sand bars, oyster bars, and mud flats.

C. Wetlands

1. Permits involving withdrawals which may cause impacts to wetlands may be required to monitor:

   a. Surface-water levels.

   b. Ground-water levels.

   c. Rainfall at the project area.

   d. Surface-water quality.

   e. Inventories of plants and animals found in or dependent upon the project area.

   f. Quantitative vegetation monitoring in representative areas for measurements of percent cover, standing crop, species composition and associated indices or other relevant ecological parameters.

   g. Wildlife monitoring (including birds, reptiles, amphibians, fish and invertebrates) using recognized quantitative methods.

   h. Systematic on-ground photography of representative areas of the project site.

   i. Aerial photography of the project site and adjacent areas which may be affected by withdrawals.

   j. Land cover assessments, at Florida Department of Transportation Level III, to include land area controlled by the applicant, or area within two miles of production wells, or all lands where hydrologic models indicate an effect of withdrawals on water table conditions.

INDEX
PERMIT INFORMATION MANUAL

INDEX (continued)

Southwest Florida Water Management District

2379 Broad Street (U.S. 41 South) Brooksville, Florida 34609-6899
Phone (904) 796-7211 or 1-800-423-1476 SUNCOM 628-4150
T.D.D. No. only: 1-800-231-6103

February 1993

To Whom it May Concern:

Fees for Water Use and Well Construction Permits are as follows:

Water Use Permit Fees:

	Individual (over 500,000 gpd)	General (100,000-499,000 gpd)	General (less than 100,000 gpd)
NEW	$1,000.00	$250.00	$50.00
RENEWAL	$750.00	$185.00	$35.00
MOD	$300.00	$75.00	$15.00
LETTER MOD	$N/C	$N/C	$N/C

Well Construction Permit Fees:

PUBLIC SUPPLY	$130.00
or other wells constructed to public supply standards	
PUBLIC SUPPLY IN CHAPTER 17-524 DELINEATED AREAS	$500.00
ALL OTHERS	$50.00

Domestic
Irrigation
Industrial
Repair/Modification
Test
Exploratory/Monitor
Injection

There are no fees for abandonment permits

Excellence Through Quality Service