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DEVELOPMENT OF REGIONAL WATER SHORTAGE MANAGEMENT RESPONSES AND RECOMMENDED PHASED RESPONSE METHODS

St. Johns River Water Management District

Development of Regional Water Shortage Management Responses and Recommended Phased Response Methods

Simmons Environmental Consulting

September 2013

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- Josh Schmitz, P.E., P.W.S. (Fruition Water Resources) provided input regarding resource protection.
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Max Castaneda	Michael Daly	Scott Laidlaw
Tom Blush	Cliff Neubauer	Wesley Curtis
Don Brandes	Patrick Burger	Don Boniol
Nathan Johnson	Aisa Ceric	

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EXECUTIVE SUMMARY

The St. Johns River Water Management District (SJRWMD, or the District) retained Simmons Environmental Consulting (SEC) to perform a literature review of water shortage determination methodologies and an analysis of District data, and to provide recommendations to improve its water shortage monitoring and response methods. The focus of the Literature Review was to identify methodologies to select water shortage indicators, develop and analyze thresholds for each indicator; and to identify water shortage conditions based on indicators and thresholds.

Using the literature, SEC provided definitions for different types of drought: meteorologic, agricultural, and hydrologic and presented commonly used indicators and thresholds used to determine drought. Because 90% of withdrawals in the District are from the Upper Floridan Aquifer (UFA), the focus of this study was on identifying methodologies used to develop and analyze indicators and thresholds for hydrologic drought. Except for methodologies used by other water management districts, methodologies identified in the literature applied to drought rather than to water shortage. But in all cases, the use of percentiles to establish threshold levels to identify hydrologic conditions and to define drought and water shortage phase conditions was prevalent. Therefore, SEC used percentiles to establish phase conditions for the UFA (see Table 4). Then, SEC developed and analyzed indicators, triggers, and phase sequencing using District-provided data for the Middle St. Johns Groundwater Basin from January 1998 to December 2012). The analysis performed for this study was limited to the UFA in one basin as a means to pilot the methodology for potential District-wide application. The analysis is summarized below:

- UFA threshold levels were developed for each month and for each well in the basin by striating (segregating) the District-provided groundwater data (monthly means) by month. SEC established four threshold categories relating to four phase conditions (see Table 4) for each well and for each month.
- SEC calculated single-period indicators (one-month) and multi-period indicators (MPIs) for two and three sequential months (see Section 17.0). Based on the results, SEC chose a two-month MPI for establishing water shortage phase conditions. Results of the single-period indicator and MPI calculations are provided in Tables A-1 through A-4 of Appendix 1.
- SEC performed a retrospective spatiotemporal analysis. Figures A-1 through A-9 in Appendix 2 are GIS maps identifying the spatial extent of water shortage for select months to demonstrate the spatial pattern of phase transitioning during the Turn-of-the-Century Drought.
- The probability of a well exhibiting a phase condition in any one month was calculated. These probabilities are provided in Table A-5.
- The stochastic behavior of the two-month MPI was evaluated by SEC through the development and implementation of a multi-variate homogeneous Markov Model. Results of the Markov Model presented in Table A-6 include a transitional probability matrix for each indicator well, for each month, and for each possible phase transition.

SEC recommends that the District perform the following analyses in future studies:

- Develop and implement a methodology to select and/or deselect apparently anomalous individual wells;
- Improve spatial analyses by using appropriate declustering weights prior to spatial interpolation or by using Kriging instead;
- Apply the phase methodology presented in the study to other groundwater basins and address interface issues between basins and bordering WMDs;
- Develop and apply a geostatistical method for treatment of basin boundaries;
- Perform spatial statistics on affected user groups and water withdrawal locations to inform phased water use restrictions;
- Evaluate potential spatiotemporal effects of water use restrictions imposed by bordering water management districts;
- Evaluate other regional indicators including precipitation, demand, springflow, and water quality; and
- Associate indicators, trigger levels, and phase definitions with “serious harm.”

The District currently monitors hydrologic conditions and delivers to the Governing Board monthly reports that include maps representing percentile categories of UFA levels. SEC recommends using the UFA dataset to perform analyses that lead to monthly staff recommendations regarding water shortage declarations by implementing the following approach:

- Monthly UFA water level data should be processed as provided in this study; specifically, the percentile values and phase conditions for each month should be calculated with the addition of wet categories. The categories shown in Table 6 should be used to determine phase conditions for each UFA well.
- Indicator values should be interpolated and a map developed to represent UFA level conditions in the District. For now, the District should interpolate categorical water shortage conditions across groundwater boundaries using all UFA wells, but as soon as practical, the spatial analysis should be improved as discussed above.
- When water shortage conditions are indicated, two-month MPI values should be calculated as described in Section 17.0 and a two-month MPI map be developed as discussed above.
- If conditions degrade or improve in such a way that a phase is skipped, the District should not skip a phase in its water shortage declarations except in extreme circumstances.
- When water shortage conditions are indicated, the interpolated two-month MPI phase conditions and the probabilities provided in Tables A-5 and A-6 should be used by the Water Shortage Group to develop a staff recommendation regarding water shortage declarations.
- When the District is experiencing water shortage conditions, the District should evaluate UFA levels and the Water Shortage Group should meet more frequently.
- When a water shortage declaration will be recommended by the Water Shortage Group, a third map representing the spatial extent of water shortage orders should be developed. Unless

there are compelling reasons for the District to do otherwise, the District should declare water shortages at the county level. If a water shortage phase declaration does not span the entire area of a County, the District should use major roadways to delineate and communicate the spatial extent of each phase.

The District should adopt the phase definitions and the methodology developed in this study and apply them District-wide or use this study to frame the District's consideration of a different set of phase definitions and processes for determining and declaring phased water shortages.

1.0 Project Introduction and Objectives

St. Johns River Water Management District's Water Shortage Plan required under Section 373.246(1), Florida Statutes (F.S.) is codified in Chapter 40C-21, Florida Administrative Code (F.A.C.).The purposes of the Plan are to:

- Protect the water resources of the District from serious harm;
- Assure equitable distribution of available water resources among all water users during times of shortage;
- Provide advance knowledge of the means by which water apportionments and reductions will be made during times of shortage; and,
- Promote greater security for water use permittees.

The District currently monitors and reports meteorologic (rainfall) and hydrologic (surface and groundwater) conditions, but water conditions are not directly associated with water shortage thresholds. Chapter 40C-21.221 describes the manner in which the District will periodically evaluate water conditions, thereby determining whether and to what extent a water shortage should be declared.

The District requested a literature review of water shortage determination methodologies and an analysis of its data be performed to further develop its water shortage monitoring and response methods. Therefore, the District retained SEC for this project. The project has the following objectives:

- To perform a literature review on the topic of the development of phased responses to water shortage indicators on a regional basis; and
- To perform an analysis of District-provided data based on a method identified in the Literature Review.

Because indicators and threshold values have not yet been identified and developed by the District, the focus of the Literature Review was to identify methodologies to:

- Select appropriate water shortage indicators;
- Develop and analyze thresholds for each indicator; and
- Identify water shortage conditions based on indicators and thresholds.

Section 2.0 through Section 9.0 includes information gleaned from the Literature Review Task of this project. Since drought is often a key factor in water shortage determinations, Section 2.0 includes an overview of different types of drought, their impacts and how they are defined. Section 3.0 provides definitions of water shortage, which links drought and water consumption. Since the focus of this study was to identify appropriate methods for selecting and evaluating indicators and their respective thresholds (or triggers), these terms are defined in Section 4.0. Section 5.0 includes an overview of commonly used drought indices, and national drought monitoring resources are presented in Section 6.0. In Section 7.0 and in Section 8.0, meteorlogic and hydrologic indicators and methods for evaluating them are provided, and Section 9.0 includes a step-wise procedure for developing, analyzing, and evaluating indicators and triggers.

Based on the findings of the Literature Review, SEC chose meteorlogic and hydrologic indicators and corresponding methods of evaluation, which are presented in Sections 10.0 and 11.0. In Section 11.0, the stepwise procedure presented in Section 9.0 is reiterated and amended to represent SEC's analytical approach to developing, analyzing, and evaluating SJRWMD hydrologic indicators and triggers for the Data Review and Analysis Task of this project. The methodology performed by SEC is detailed in Sections 12.0 through 19.0, along with calculations adapted from the Literature Review and the results are discussed in Section 20.0. The Literature Review and Analysis are summarized in Section 21 and finally, Section 22.0 includes recommended additional analyses and Section 23 includes monthly water shortage monitoring and reporting recommendations.

2.0 Defining Drought

The National Oceanic and Atmospheric Administration (NOAA) defines drought as a deficiency in precipitation over an extended period, usually a season or more, resulting in a lack of water availability that contributes to adverse impacts on vegetation, animals, and/or people. It is a normal, recurrent feature of climate that occurs in virtually all climate zones, from very wet to very dry. Drought is a temporary aberration from normal climatic conditions, thus it varies significantly from one region to another. In practice, drought is usually defined using three types of operational drought definitions: meteorological, agricultural, and hydrological, which generally occur in sequence as shown in Figure 1 and described in the following subsections.

2.1 Meteorologic Drought

Under any circumstance, meteorological measurements are the first indicators of drought. Meteorological drought is usually defined on the basis of the degree of dryness (in comparison to some "normal" or average amount of rainfall) and the duration of the dry period. Definitions of meteorological drought must be region specific since the atmospheric conditions that result in deficiencies of precipitation are highly variable from region to region. For example, Florida has seven different Climate Divisions, three of which are in the SJRWMD as shown in Figure 2.

2.2 Agricultural Drought

Agricultural drought links various characteristics of meteorologic and/or hydrologic drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evapotranspiration, soil water deficits, reduced groundwater or storage levels, and so forth. Agricultural drought generally happens after a meteorological drought but before a hydrological drought. Agriculture is usually the first economic sector to be affected by drought. A good definition of agricultural drought should be able to account for the variable susceptibility of crops during different stages of crop development, from emergence to maturity.

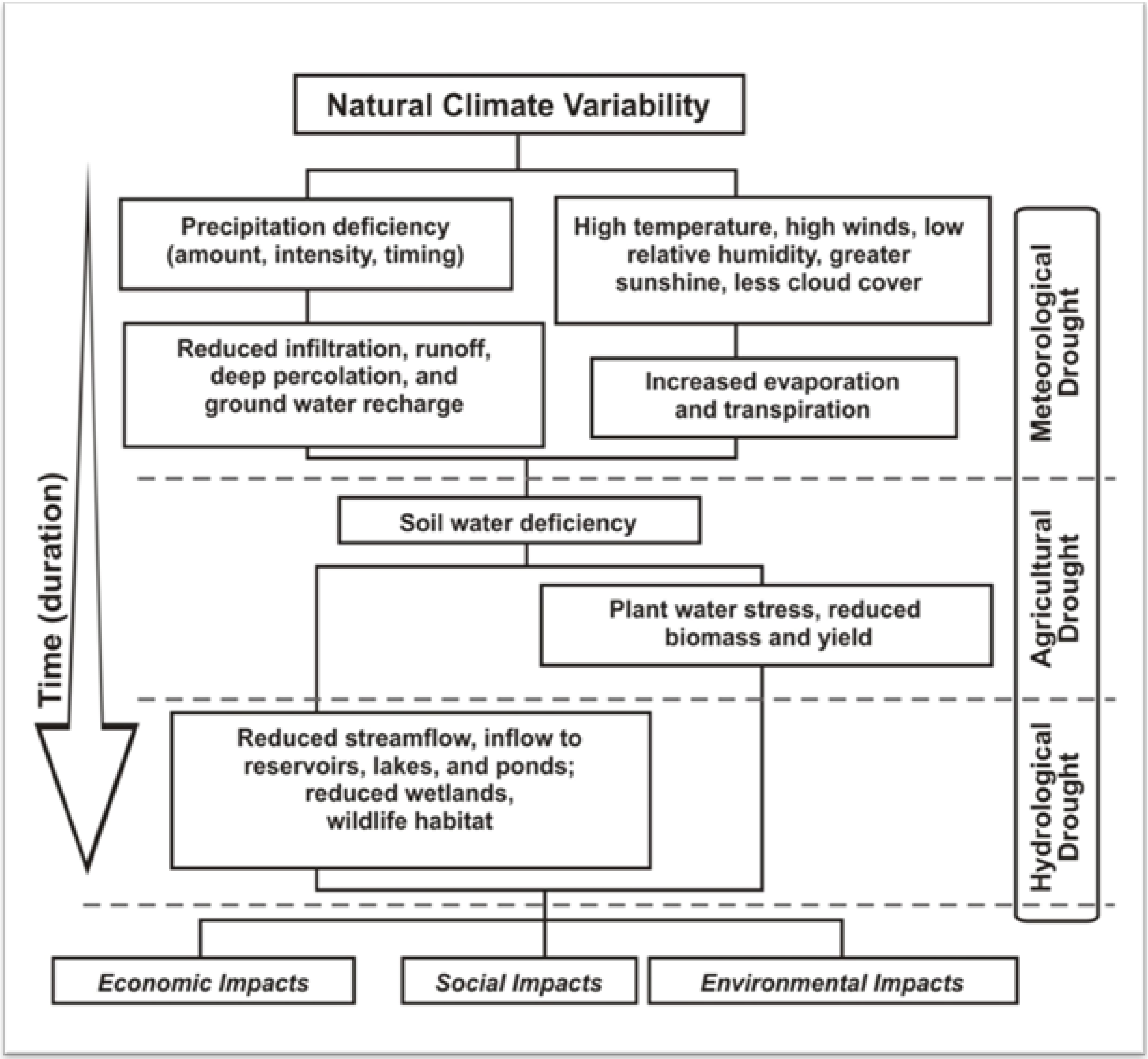

Figure 1. Types of Droughts and their Impact. (Source: NOAA)

2.3 Hydrologic Drought

A hydrologic drought refers to deficiencies in surface and/or subsurface water resources or supplies. A hydrologic drought links precipitation deficiencies to reductions in stream, river and/or spring flows; and/or lake, reservoir and groundwater levels. There is a time lag between lack of rain and reduced flow and levels, so hydrologic measurements are not the earliest indicators of drought.

3.0 Defining Water Shortage

Water shortage definitions are best framed from three perspectives as discussed in the following Subsections.

3.1 Water Shortage from the Perspective of Drought Management

Water shortage from a drought-management perspective is typically defined as a short-term condition by which water supplies are negatively impacted by drought combined with human (anthropogenic) impacts. In this definition, drought is the first stressor and increased consumption (usually for irrigation) exasperates the condition.

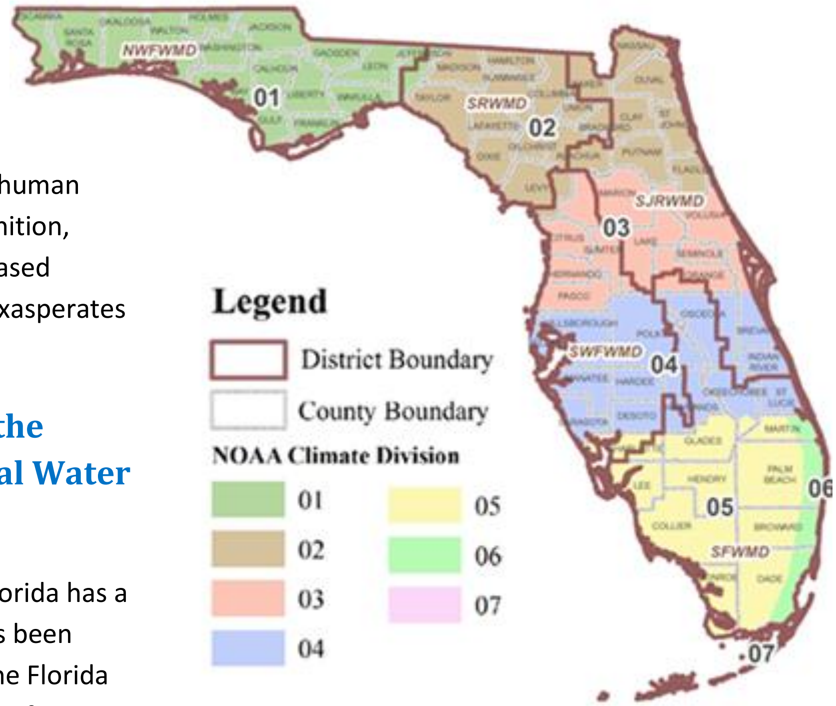

Figure 2. Florida's Climate Divisions.

3.2 Water Shortage from the Perspective of Regional Water Management

Each water management district in Florida has a Water Shortage Plan (WSP) which has been codified in its respective chapter of the Florida Administrative Code. The definitions of water shortage used in the respective Plans vary slightly. However, these slight variations can have significant impacts regarding how the Plan is implemented.

St. Johns River Water Management District's WSP defines water shortage as meaning a "situation within all or a specifically defined geographic area of the District when insufficient water is available to meet the needs of the users, or when conditions are such as to require temporary reduction in total use within a particular area to protect water resources from serious harm. A water shortage usually occurs due to drought." (SJRWMD WSP; Chapter 40C-21.051 F.A.C.)

The definition of water shortage used by South Florida Water Management District (SFWMD) and Suwannee River Water Management District (SRWMD) are similar to the definition used by SJRWMD. However, the definition used by Southwest Florida Water Management District (SWFWMD) includes two important differences (shown in italics) which can impact how a WSP is implemented. SWFWMD's WSP defines water shortage as meaning "*a drought* or other situation within all or part of the District, *for which the Governing Board has determined* that there is insufficient water to meet the present and anticipated needs of users, or conditions are such that there is a need to require temporary reduction in water use within a particular area to protect one or more Source Class or the water resource from serious harm." (SWFWMD WSP; Chapter 40D-21.051, F.A.C.)

SJRWMD, SRWMD, and SFWMD definitions state that a *water shortage usually occurs due to drought*. However, in SWFWMD 's definition, a drought *is* a water shortage. In other words, SWFWMD's definition implies that the District can issue a Water Shortage Order based on a meteorological drought alone. Another observed difference is SWFWMD's phrase regarding the Governing Board's determination. The inclusion of this phrase may be helpful to other districts because in plain terms, according to SWFWMD's definition, there isn't a water shortage unless the Governing Board determines that there is. In practice, and as required by 373.246 F.S., the Governing Board in each district declares a water shortage by issuing a Water Shortage Order (WSO) or ratifies a Water Shortage Emergency Order declared by a district's Executive Director. However, by including the phrase "for which the Governing Board has determined that there is insufficient water…," SWFWMD has reserved the right of determining if a water shortage condition exists. Without this key phrase, it is possible that stakeholders can assert that water shortage conditions exist but the Governing Board has chosen to not take action.

3.3 Water Shortage from the Perspective of Utility Management

At the utility level, a water shortage generally means that there is not enough supply to meet demand. An insufficient supply, however, does not necessarily mean that there is an insufficient source of water. From a utility's perspective, the water shortage may be caused by drought; however, a utility can experience a water shortage when there is no drought. An example would be a pump station being inoperable following a hurricane or flood event. In this example, the ground water supply can be near record high and/or surface water supplies can be at flood stage; however, a water shortage for the portion of the utility's service area that relies on the pump station certainly experiences an extreme water shortage. This type of supply shortage is not the focus of this study. Generally, the regional methods involve evaluation of the sources of water (groundwater, rivers, etc.) rather than evaluation of the physical components of an individual utility's withdrawal (well depth, for example), treatment, and distribution systems. However, because water management districts are the sole entities authorized by Florida Statutes to regulate water use in their respective jurisdictions, the District should develop a process by which it will declare a water shortage in a utility's service area (at the request of the utility) in response to supply issues discussed in this subsection.

4.0 Defining Indicators, Triggers, and Indices

Chapter 40C-21.221 describes the manner in which the District will periodically evaluate water conditions, thereby determining whether a water shortage should be declared, and the severity of the shortage. Per the District's Water Shortage Plan, the District is responsible for evaluating current and historical data to determine whether estimated present and anticipated available water supply will be insufficient to meet the estimated present and anticipated demands of the users, or whether serious harm to the water resources can be expected. Various metrics can be used to evaluate the sufficiency of water supplies and the likelihood of serious harm to water resources, including indicators, triggers and indices.

Drought and water shortage indicators can be meteorlogic (precipitation) or hydrologic (stream and spring flows; and lake, reservoir, and groundwater levels). Indicators are variables that are used to identify and assess drought and water shortage conditions. A drought or water shortage trigger is a threshold value of the indicator. Trigger values are used to establish drought categories which are typically defined levels of severity with corresponding conservation measures. Triggers are typically identified (or "set") by evaluating historical conditions to identify a normal value for the indicator over a period of record. Then, triggers are set based on the diversion from that norm. For example, typical indicators used to monitor hydrologic drought are lake and groundwater levels, and streamflow. Typically, the triggers for these indicators are set at certain percentiles. The percentiles may directly relate to a drought severity (Phase I, Phase II, etc.). However, it is more common to evaluate the individual indicators and their threshold values together along with other quantitative and qualitative factors when establishing the severity of a drought or water shortage phase.

An index blends multiple indicators into a single index value which directly corresponds to a level of severity. A drought index is a numerical scale that directly describes the severity of a drought. Similar to indicator threshold values, indices describe a diversion from the norm, which is typically zero. Dry conditions are indicated on the negative scale and positive values represent wet conditions. When an index is used, the severity of the drought is determined by computational methods alone. In other words, the decision or policy maker is removed from the "equation." However, when sufficient data exists for a geographic area of interest, water managers are more apt to evaluate a mix of individual indicators (which can also include popular indices) in determining drought or water shortage conditions for their area. The latter approach is broadly supported in the literature.

Unlike drought, water shortage is not commonly defined in terms of an index. However, there are several water scarcity indices. Water scarcity indices generally apply to evaluating the sustainability of water resources, or supply over the long term. Therefore, their use is not appropriate in the context of this project because water shortage refers to a temporary condition. The District evaluates and manages long-term water availability through their water resource assessments, Water Supply Plans, Water Use Permits, development of Minimum Flow and Level (MFL) assessments and recovery strategies; and other planning, monitoring, and permitting processes.

5.0 Commonly Used Drought Indices

There are numerous drought indices used throughout the U.S. and worldwide. Generally, the basis of all indices is a calculation that leads to a number that relates to a variance from normal conditions over a period of record. Similarly, individual indicators are also evaluated as a diversion from the norm. The effectiveness of each index has been studied to identify their strengths and weaknesses when applied at various geographic scales (local to worldwide), time scales (days to decades), and in various climates (Keyantash, et. al. 2002; Heim Jr., 2002, Hayes, 2012).

In most sources reviewed as part of this study and in most published index reports, there is typically a caveat explaining that the index value generated by the drought monitoring and reporting organization should not be used as a substitute for locally available data. The development of local indicators and triggers however, can include methodologies used to develop the nationally reported indices.

Therefore, understanding how the indices are calculated can guide methodologies for local indicator development and assessment.

As discussed in Section 1, the agreed upon approach for this project was to identify indicators and trigger levels appropriate for the District. Therefore, commonly used national indices are not detailed in this report. However, an overview of notable drought monitoring resources is presented in the following section to provide perspective

6.0 Drought Monitoring Resources

6.1 USGS WaterWatch

WaterWatch (http://waterwatch.usgs.gov) is a U.S. Geological Survey (USGS) website that displays maps, graphs, and tables describing real-time, recent, and past streamflow conditions for the United States. The real-time information generally is updated on an hourly basis. WaterWatch provides streamgauge-based maps that show the location of more than 3,000 long-term (30 years or more) USGS streamgauges; use colors to represent streamflow conditions compared to historical streamflow; feature a point-and-click interface allowing users to retrieve graphs of stream stage (water elevation) and flow; and highlight locations where extreme hydrologic events, such as floods and droughts, are occurring.

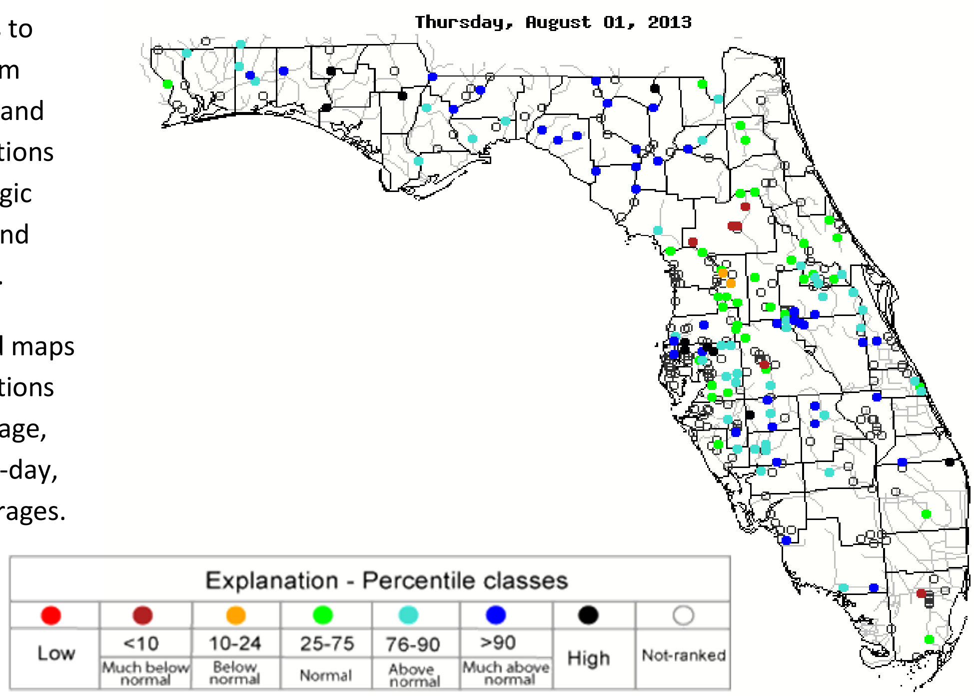

Figure 3. Streamflow Conditions for August 1, 2013. (Source: USGS WaterWatch)

The streamgauge-based maps show streamflow conditions for real-time, daily average, monthly average, and 7-day, 14-day, and 28-day averages. The USGS website reports hydrologic conditions as percentiles (P) for the day of the year using sites having at least 30 years of record and generally define conditions accordingly: P > 75 = above normal; 25 ≤ P ≤ 75 = normal; and P < 25 = below normal. A map of current stream conditions (7-day average flow) for August 1, 2013 is provided as Figure 3. Although Florida is in its wet season in August, the percentiles for Ocklawaha River is in the

6th percentile near Conner, and the 9th percentile at Eureka; and Silver River near Ocala is at its 4th percentile.

6.2 U.S. Drought Monitor

The National Drought Mitigation Center produces drought monitoring tools and information to help people assess drought severity, including the widely used and accepted Drought Monitor. The Drought Monitor is intended to provide a general and up-to-date summary of current drought conditions across the 50 states, Puerto Rico, and the Pacific possessions. This national product is designed to provide the "big picture" so the general public, media, government officials, and others can see what is happening around the country. To keep the map from becoming too complex, the drought categories shown represent typical drought intensities, not every drought intensity, within the area. The US Drought Monitor uses a mix of the Palmer Drought Index (PDI), Climate Prediction Center (CPC) outlooks, the Standard Precipitation Index (SPI), USGS Weekly Steamflow Reports (see Section 6.1) and other objective short- and long-term indicator blends to develop a drought severity classification system. The map is not designed to depict local conditions or to replace drought warnings and watches issued by local or regional government entities.

6.3 Maps from NASA's Gravity Recovery and Climate Experiment

Scientists at NASA's Goddard Space Flight Center generate maps of surface and root-zone soil moisture and groundwater storage each week. These maps are based on terrestrial water storage observations derived from Gravity Recovery and Climate Experiment (GRACE) satellite data. Values for these indicators are expressed as percentiles showing the probability of occurrence within the period of record from 1948 to the present. Figure 4 shows areas of low aquifer storage volumes (orange and yellow) for September 2013 within the SJRWMD.

7.0 Meteorlogic Indicators and Trigger Levels

Some definitions of meteorological drought identify periods of drought on the basis of the number of days with precipitation less than some specified threshold. This measure is only appropriate for regions characterized by a year-round precipitation regime such as a tropical rainforest, humid subtropical climate, or humid mid-latitude climate (http://water.unl.edu/web/drought/typesofdrought). The climate of the north and central parts of Florida is humid subtropical and South Florida has a tropical climate. Therefore, comparing current cumulative rainfall to historical norms is appropriate method for Florida. Because Florida has a wet and a dry season, it is important to compare current cumulative monthly or seasonal rainfall to the historical average or mean for the same month or season.

Even though groundwater may not be immediately directly impacted by dry climatological conditions (especially in a confined aquifer), a meteorological drought can indirectly impact groundwater through an increased demand on the resource, such as for irrigation due to lack of rainfall. Because meteorological measurements are the first indicators of drought, most drought and water shortage monitoring and response plans include rainfall deficits in its consideration of drought phases. Since most water use in the District is from semi-confined and/or confined aquifers, rainfall is not immediately related to a potential insufficiency of available water supplies; however, the District monitors rainfall data as discussed in the following Subsection.

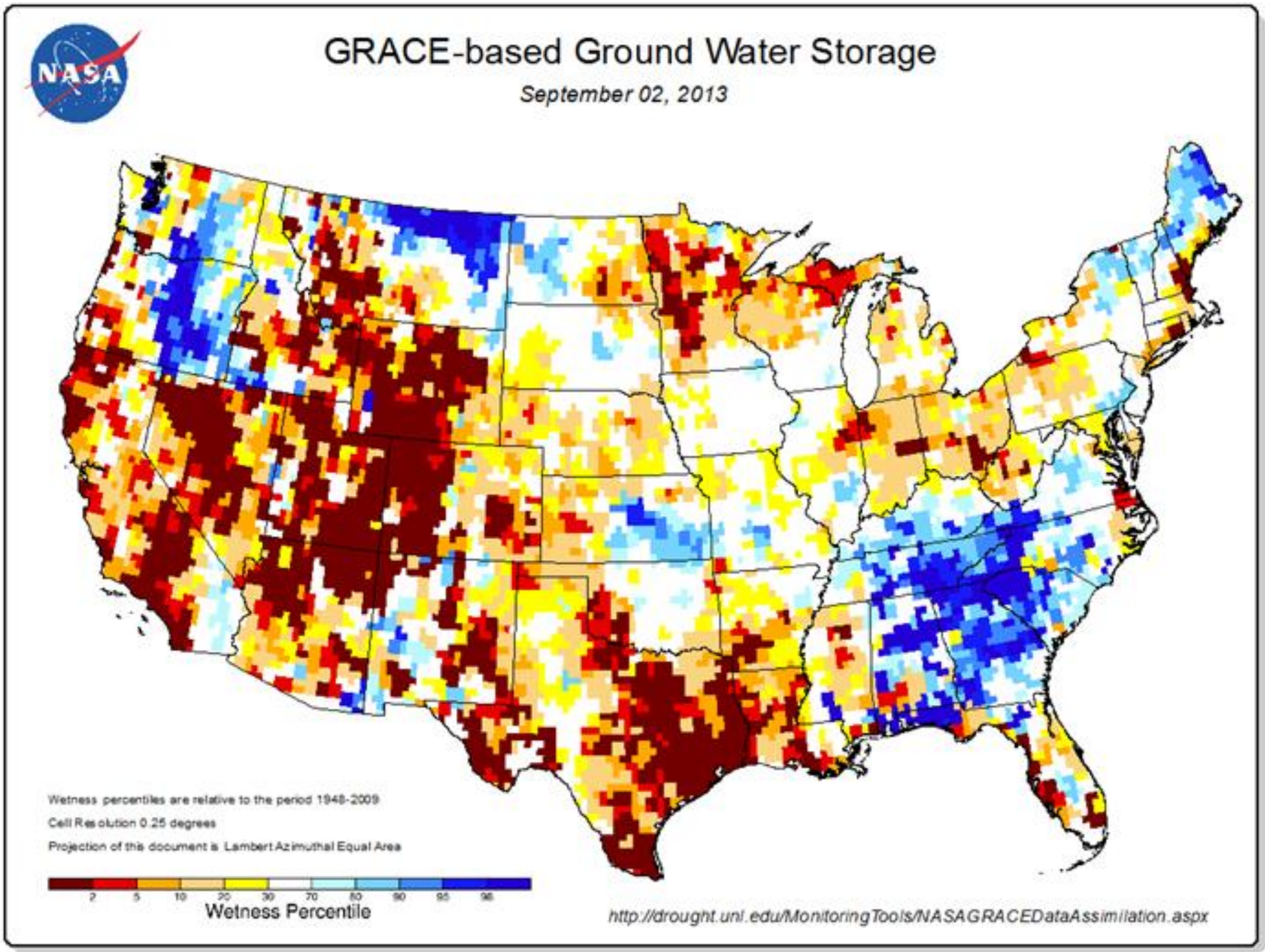

Figure 4. GRACE-based Groundwater Storage. (Source: NOAA)

7.1 SJRWMD's Current Method of Monitoring and Reporting Meteorlogic Conditions

The District uses data from weather stations with adequate historical records to calculate normal cumulative rainfall. A District-wide GIS surface map is created by interpolating the discrete station data in ArcGIS using spline interpolation (with the tension option). The map represents normal cumulative rainfall conditions for the District. Each month, the District compares current NEXRAD (Next-generation Radar) data to normal cumulative rainfall conditions. NEXTRAD is a network of 159 high-resolution S-band Doppler weather radar locations operated by the National Weather Service, an agency of NOAA.

Using the NEXRAD data, the District compares the radar raster surface with the normal surface to calculate monthly rainfall deficits at various moving averages. The resulting maps (see Figure 5) are presented each month to the Governing Board and included in the District's Hydrologic Conditions Report (HCR). The HCR is further discussed in Subsection 8.1.1.

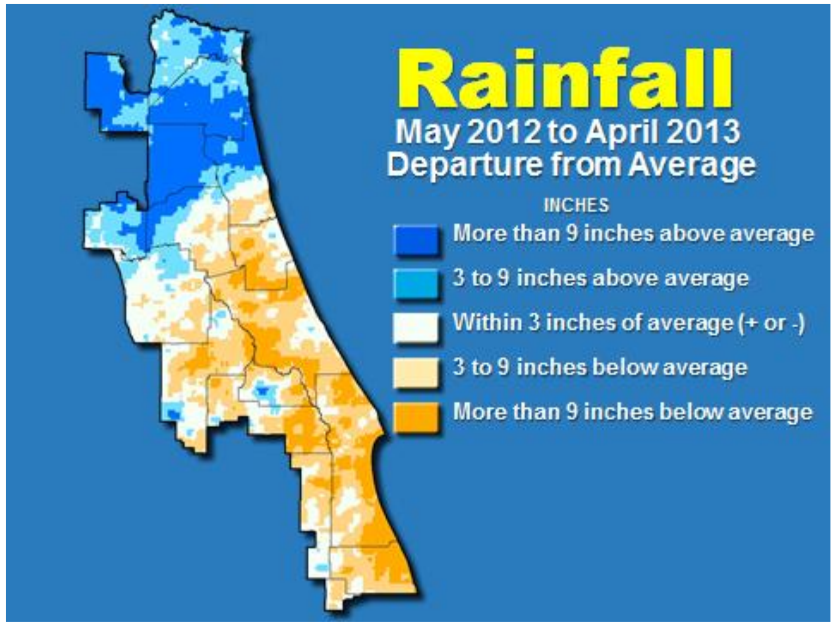

Figure 5. Example of SJRWMD's Meteorlogic Reporting.

7.2 SJRWMD's Rainfall Frequency-analysis Pilot Study

Another meteorlogic monitoring effort by the District is a pilot rainfall frequency analysis (Neubauer, 2013). Frequency analyses are used to assign probabilities/return intervals to defined events. Neubauer performed a pilot study with long-term (1867-2006) monthly rainfall totals for Jacksonville, Florida. Frequency curves were developed for monthly, and multiple consecutive-month time periods. Neubauer performed the analysis to provide curves that could be used to assess current rainfall deficit conditions and to inform staff recommendations regarding water shortage declarations. Conceptually, current rainfall conditions (e.g., this year's cumulative rainfall) can be compared to the appropriate curves to determine rainfall drought severity (e.g., 5-year drought, 10-year drought, or 100-year drought). Further, individual month curves could be used to determine the probabilities of various rainfall scenarios (e.g., no rain next month or how much rain would be needed to return to normal precipitation conditions).

8.0 Hydrologic Indicators and Trigger Levels

The most widely used and accepted method of evaluating hydrologic conditions is by the variable threshold level method (TLM). In the TLM, a drought or water shortage condition is observed once the variable of interest (e.g. streamflow, groundwater level) is equal to or drops below a predefined threshold. This threshold can either be defined from its observation percentile statistics, generally taken as the 25th percentile (denoted as P_{25}) of the hydrological variable of interest, also known as the 75th exceedance percentile (or probability of exceedance), or by fitting some kind of statistical function through the data (normal, gamma, beta, etc.) from which probabilities can be estimated. The benefit of applying the latter approach is that it leads to more robust statistics when a limited time series is available. However, a drawback of this method is that, especially for extreme situations (both during extreme dry and wet conditions), the distribution does not fit the entire range of observations (van

Huijgevoort, 2012). Therefore, when long time series are available, calculating percentile statistics is expected to lead to more robust results.

During the course of this project, the District indicated that it wanted SEC to focus its efforts on identifying methodologies to select and evaluate UFA indicators and their respective threshold values. Therefore, this project included an extensive literature review to identify the most robust approach to establishing groundwater-level threshold values. Four methods for establishing groundwater level thresholds were identified: (1) the Percentile Method; (2) the Jacques Whitford (JW) Method; (3) the Groundwater Resource Index method; and (4) Triggers based on Impacts. These methods are described and compared in the subsections below.

8.1 The Percentile Method

The Percentile Method is a standard statistical method. A percentile is a statistic that gives the relative standing of a numerical data point when compared to all other data points in a distribution. A percentile is a value on a scale of 0 to 100 that indicates the percentage of observations that is equal to or below it. For example, the 25^{th} percentile (P_{25}) is a number such that 25% of values in the distribution are equal to or less than that number.

The USGS uses the Percentile Method for calculating and reporting streamflow conditions on its WaterWatch website (see Subsection 6.1). Also, other USGS literature reviewed in the course of this study indicated the sole use of the Percentile Method for establishing drought threshold values for streamflow and groundwater levels (Socolow, et.al., 1994, and Schreffler, 1994). SJRWMD and SWFWMD also use percentiles as discussed in the Subsections 8.1.1 and 8.1.2.

Similar to this study, a comprehensive literature review of groundwater indicator thresholds used in North America was conducted this year by the Nottawasaga Valley Conservation Authority in Canada (Post, 2013). This recent Canadian study found that “groundwater drought indicators are limitedly utilized in the United States and Canada: notably in Alabama, Connecticut, Georgia, Maryland, Massachusetts, New Jersey, New York, Pennsylvania, Rhode Island, Virginia and Manitoba. These **[North American] jurisdictions employ a *widespread application of the percentile method for a groundwater indicator insomuch as no other applied groundwater indicator methodology was found to be used***.”

8.1.1 SJRWMD’s Use of the Percentile Method

The District currently uses two different groundwater level datasets to monitor hydrologic conditions. The difference between the two sets and how each set is treated is provided in the following subsections. The results from both analyses are used in the Water Shortage Group’s monthly meetings to frame the Group’s discussion which, in times of lower-than-normal water levels, leads to the “Staff Recommendation” to the Governing Board or Executive Director regarding the need to declare a Water Shortage or Water Shortage Emergency. Also, results of both analyses are presented in the District’s monthly Hydrologic Conditions Report, and summarized and presented to the Governing Board monthly.

8.1.1.1 Percentile Maps Developed Using the Hydstra Dataset

The District has an extensive network of groundwater monitoring wells, some of which are owned and maintained by the District. For some of the District-owned wells, data is collected via telemetry, while for others, groundwater levels are collected manually each month. The dataset also include monitor wells owed and maintained by others, including SRWMD and the USGS. The District uses a proprietary software suite called Hydstra to manage this set of groundwater level data and to develop an ArcGIS map of the condition of groundwater levels for the District's monthly Hydrologic Conditions Report. Each month, as groundwater levels are uploaded to Hydstra, District staff runs a statistics report within Hydstra to identify groundwater level conditions based on percentile values. Percentiles for each well are based on water levels for the well for all months using a period of record (POR) from 1980 to 2009. It is important to note that there is only one set of percentile-based thresholds for each well, rather than a set of 12 thresholds corresponding to each historical month in the POR. Another important distinction is that the POR for this evaluation does not move, meaning that water levels that postdate 2009 do not contribute to the percentile values. However, the District is considering amending the statistics reporting functions to allow for yearly or monthly POR updates, and possibly monthly percentiles. Using this dataset, the monthly water level (WL) in groundwater wells are categorized as high (WL > P_{75}), normal ($P_{75} \geq$ WL $\geq P_{25}$), low (P_{25} > WL $\geq P_{10}$), and very low (P_{10} > WL). The percentile range for the wells are entered into ArcGIS and the category values for each well are interpolated using inverse distance weighting to create a map that depicts the estimated spatial extent of the categorical water levels across the District. The map is included in the District's monthly Hydrologic Conditions Report (see Figure 6).

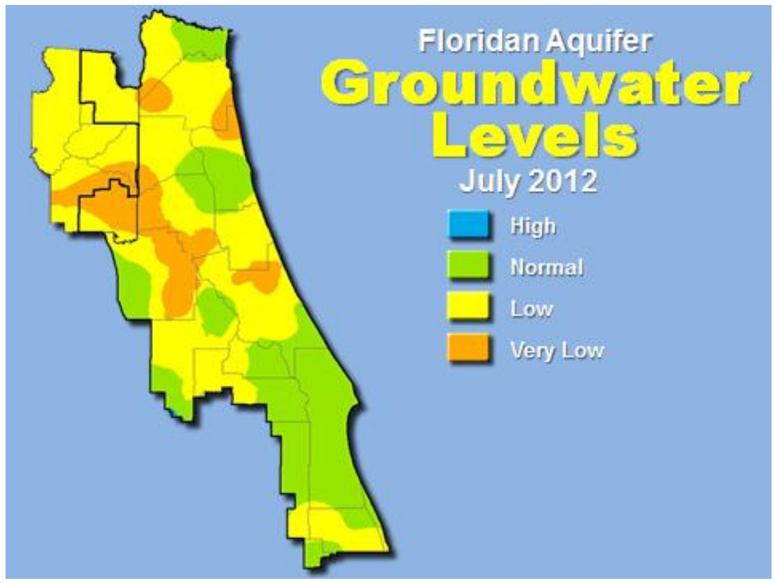

Figure 6. Percentile Map Developed from Hydstra Dataset.

8.1.1.2 Percentile Maps and Graphs Using Upper Florida Aquifer Wells with Telemetry

The other dataset used by the District to monitor and report hydrologic conditions is a set of 107 Upper Floridan Aquifer wells. This dataset is also included in the Hydstra dataset, but it is treated differently: data from these wells are striated (segregated) by month prior to calculating percentile ranks, so each well has a set of 12 percentile ranks, one for each month in the POR. The POR for this set is also treated differently than the Hydstra dataset. The POR is from 1998 to present day, meaning that percentile rank calculations include new monthly data. After new percentile ranks are calculated each month, they are displayed on a map as discrete values (they are not interpolated to create a GIS surface). Also, percentiles for each well are aggregated at the District level and graphed. The map and the graph are provided to the District's Water Shortage Group each month in an Upper Floridan Water Levels Report (Johnson, 2013). The graph is included in the District's monthly Hydrologic Conditions Report (see Figure 7).

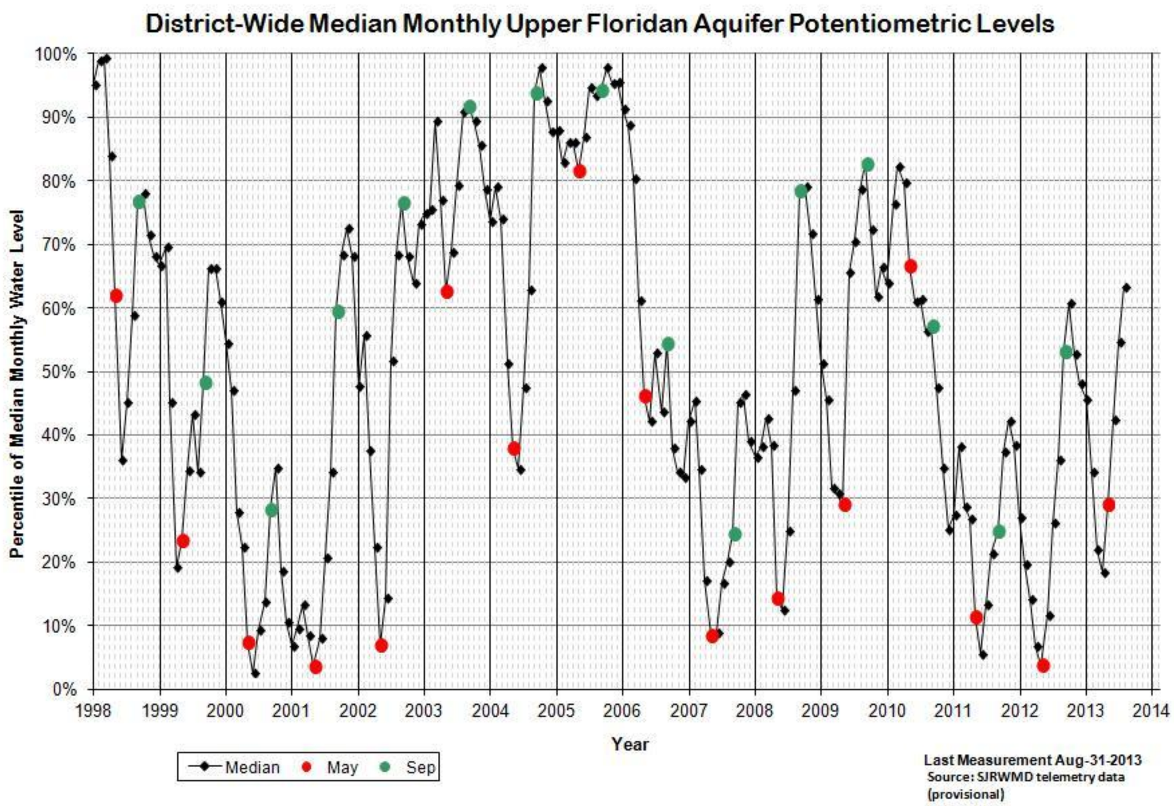

Figure 7. UFA Water Level Percentiles Aggregated at the District-wide Levle. (Source: SJRWMD HCR)

8.1.2 SWFWMD's Use of the Percentile Method

SWFWMD calculates an Aquifer Resource Index (ARI) as a groundwater indicator. To determine the ARI value for a geographic area, each well is compared to its respective low-normal value (25th percentile) weekly, and the difference is calculated. The weekly differences are used to determine the regional ARI value and the resulting ARI value represents how far water levels in the aquifer must rise or fall to reach their respective low-normal value. SWFWMD reports the ARI in its monthly Hydrologic Conditions Report. However, with respect to declaring water shortages, the levels of drought severity are based on weekly groundwater levels as compared to monthly historic percentile values and the duration as shown in Table 1. Therefore, it can be said that SWFWMD's water shortage monitoring efforts are also based on the Percentile Method.

Table 1. Excerpt from SWFWMD's Water Shortage Scorecard for Southern Counties in its District (Source: SWFWMD).

Regional Drought Indicators	Moderately Abnormal*	Severely Abnormal*	Extremely Abnormal*	Critically Abnormal*
Rainfall: 12-month moving sum - Southern Counties	<= P25	<= P20	<= P10	<= P5
Rainfall: 24-month moving sum - Southern Counties	<= P25	<= P20	<= P10	<= P5
Streamflow: 8-week moving average - Peace River @ Arcadia	<= P25	<= P20	<= P10	<= P5
Streamflow: 7-day average - Peace River @ Arcadia	<= P25	<= P20	<= P10	<= P5
Streamflow: 7-day average - Peace River @ Bartow	<= P25	<= P20	<= P10	<= P5
Aquifer Resource Indicator: Southern Counties	<= P25	<= P25 for 4 wks., or < P16	< P16 for 4 wks.	< P16 for 8 wks.

Annotated Version of Table 21-2 from Rule 40D-21 IF THIS COMBINATION OF DROUGHT INDICATORS EXISTS	THEN CONSIDER THIS ACTION
Drought Condition Level 1 = At least one Drought Indicator is Moderately Abnormal	Phase I
Drought Condition Level 2 = Multiple Drought Indicators are Moderately Abnormal, or one Drought Indicator is Severely Abnormal	Phase II
Drought Condition Level 3 = Multiple Drought Indicators are Severely Abnormal, or one Drought Indicator is Extremely Abnormal	Phase III
Drought Condition Level 4 = Multiple Drought Indicators are Extremely Abnormal, and/or at least one Drought Indicator is Critically Abnormal	Phase IV

** Classifications based on Table 21-1 in Rule 40D-21*

8.2 Jacques Whitford Method

Jacques Whitford completed a groundwater indicator study in which a methodology for evaluating groundwater data for the Ontario Low Water Response (OLWR) program. The methodology that was developed is referred to as the Jacques Whitford Method (Post, 2013). To apply it, calendar monthly average water levels are compared against two triggers to determine low water conditions. The trigger values were determined as follows:

- The Trigger I value is defined as the historical mean groundwater level in a month minus the standard deviation of historical daily average water levels for that month. Thus, there are 12 Trigger I values: one corresponding to each month of the year;
- The Trigger II value is selected based on the depth of the well, properties of the aquifer, and characteristics of the groundwater users that depend on the resources monitored by the well; or, absent this information, the lowest daily average level that has been observed in the well. The lowest valid daily average level ever recorded was used as the Trigger II.

The corresponding groundwater OLWR conditions were established accordingly:

- Level I conditions occur when the 30-day average water level falls below the Trigger I value for that month.
- Level II conditions occur when the 30-day average water level is below the Trigger I value for 3 months in a row, or the daily average water level is below Trigger II for one day in the previous month.
- Level III conditions occur when the 30-day average water level is below the Trigger II value.

In 2009, the Rideau Valley Conservation Authority performed a pilot study comparing the JW method to the percentile method (Rideau Valley Conservation Authority, 2009). The study concluded "both the JW and Percentile indicators seem suitable, and the use of both can complement each other by fully capturing the water level trends and aquifer behavior in response to climate changes or anthropogenic activities. However, considering easier mathematical formulas for percentiles, simpler understanding of the percentile concept, and that the percentile triggers are flexible (values can be easily redefined to better represent aquifer response to the climate changes), ***the Percentile approach is at an advantage***."

The Upper Thames River Conservation Authority also evaluated the potential use of the JW method as compared to the percentile method (The Upper Thames River Conservation Authority, 2008). That study concluded: "the Percentile Method is a standard groundwater evaluation tool in the United States being used by the United States Geological Survey (USGS) but they do have long-term data to support this tool. The JW Method was developed due to the lack of long-term data and is very defensible statistically. Consideration should be made to apply a standard method for both surface and groundwater. ***The Percentile Method would ensure a simpler and more consistent standard to compare both groundwater and surface water conditions.***"

8.3 Groundwater Resource Index

Recently developed by Mendicino et al. (2008), the Groundwater Resource Index (GRI) is based on a normal distribution of the simulated groundwater storage in porous media at a site. To date, the GRI has been employed only in an academic evaluation where the performance was tested by Mendicino et al. (2008) with 40-years of simulated data. The simulated data were generated by a hydrological model which used precipitation, air temperature, and air pressure data as driving forces. They compared the GRI with the Standard Precipitation Index (SPI) of 6-, 12-, and 24-months. They found that the GRI was a better indicator for droughts in the Mediterranean area than the SPI.

This SJRWMD study did not further evaluate the GRI as a potential indicator because the literature review was not able to identify an instance where the GRI had been used or even evaluated in North America and because development of the index is data intensive and requires hydrologic modeling.

8.4 Impact-based Triggers

Examples of demand (impact) based triggers include water supply less than 60% of normal (used by the National Weather Service's Western Region) and various crop loss thresholds (used by the U.S. Department of Agriculture). Also, the Drought Mitigation Center has a Drought Impact Monitor. Minimum flows and levels use impact thresholds to determine whether a recovery strategy is needed; however, these thresholds are generally based on extended departures from recurrent, long term measures. In theory; correlations between temporary impacts and indicator values could be used to develop impact-based triggers.

During the development of Georgia's statewide Drought Plan, stakeholders considered impact-based thresholds; however in that case, ***"trying to associate drought levels with an explicit assessment of***

impacts proved to be analytically intractable" (Steinemann, 2006). Instead, the State considered impacts through the selection of indicators representing vulnerable areas and sectors and the selection of triggers representing management responses to mitigate impacts.

9.0 Methods for Developing, Analyzing and Evaluating Indicators and Triggers

As defined earlier in this report, an indicator is a variable used to identify drought or water shortage conditions. Drought and water shortage triggers are a set of threshold values of the indicator that distinguishes a drought or water shortage category and determines when drought response actions, such as conservation measures, should begin or end. Drought and water shortage categories are levels of severity and are defined by thresholds in one, all, or a combination of indicators. When multiple indicators, and more so, multiple types of indicators are considered for defining drought categories, it can be challenging to tie the indicators together into a uniform framework that defines drought categories because multiple indicators can have significant spatial and temporal inconsistencies. Therefore, using the Percentile Method or any another method to establish trigger levels is only the first step to a well vetted phased water shortage monitoring and management system. The next steps involve performing statistical analyses of trigger behaviors by applying a proposed set of trigger values retrospectively to the historical records of the selected indicators. Most of the drought plans reviewed simply listed trigger values as percentiles, or in some cases, temporal values were also assigned to drought levels. However, two literature sources did in fact provide detailed methodologies for developing and analyzing drought indicators and triggers (Steinemann, 2003, Steinemann and Cavalcanti, 2006). These literature sources were in regards to the Steinemann's 4-yr efforts to develop a statewide Drought Plan for Georgia. Below is the stepwise methodology she used to develop the Georgia Drought Management Plan (GDMP) (Steinemann and Cavalcanti, 2006).

1. Develop indicators and triggers:
    a. Define scale and scope of analysis;
    b. Develop drought indicators;
    c. Establish drought plan levels and triggering scale; and
    d. Develop triggering objectives.
2. Analyze indicators and triggers:
    a. Transform indicators to triggering scale and levels;
    b. Calculate multiperiod indicators;
    c. Calculate individual and multiple triggering sequences; and
    d. Calculate final drought sequences.
3. Evaluate indicators and triggers:
    a. Elicit expert assessments;
    b. Compare final drought sequences with expert assessments;

c. Refine final drought sequences and iterate evaluation process; and
d. Select final indicators and triggers for drought plan.

10.0 Selecting Meteorlogic Indicators and Methods of Evaluation

Since most water use in the District is from semi-confined and/or confined aquifers, rainfall is not immediately related to a potential insufficiency of available water supplies. Therefore, the District currently does not intend to use rainfall deficits as a water shortage indicator. However, as the District significant surface water projects for alternative water supplies are developed, Neubauer's work may be consulted and the methodology applied (along with hydrologic investigations) to respective surface water resources basins in order to evaluate and determine drought sensitivity of potential surface water supplies. Further, as the projects are implemented, the importance of monitoring rainfall and the use of probability curves for respective basis will be extremely important. In addition, although a rainfall deficit will not trigger a phase per District water shortage philosophy, these curves should be developed in other areas of the District (where acceptable data is available to support the analysis) and referred to in water shortage events because District staff should communicate to the Governing Board that the District or part of the District appears to be experiencing a 5-year, 10-year, etc. drought. If historical rainfall data is insufficient, it may be appropriate to extrapolate Neubauer's results from the Jacksonville gauge to the area of the District that is also in NOAA Climate Division 2. It is recommended that this analysis be performed on at least one other station in each of the District's other Climate Divisions (see Figure 2).

11.0 Selecting Hydrologic Indicators, Triggers and Analysis Approach

Based on District preferences, below-normal groundwater levels must be present in order for the District to declare a water shortage. This is because approximately 90% of water withdrawals in the District are from the confined and semi-confined Upper Floridan Aquifer. Therefore, the data review and analysis for this project was generally confined to UFA groundwater levels. As such, it followed that the UFA levels would serve as water shortage indicators. The overall approach to develop and analyze indicators and triggers was generally based on Steinemann's work in Georgia, with exceptions as noted below and discussed further in the following sections.

1. Develop indicators and triggers:
    a. <u>Define scale and scope of analysis</u>: The scale for SJRWMD will ultimately be regional (District-wide), but the analysis performed in this report was limited to one groundwater basin. For the GDMP, although the scale was statewide, the analysis was performed regionally based on Climate Divisions.
    b. <u>Develop drought indicators</u>: GDMP used SPI, streamflow, and groundwater levels for indicators and used the Percentile Method to establish thresholds. For this study, only groundwater levels were evaluated, also using the Percentile Method. SEC performed correlation and regression analyses to estimate missing data. Treatment of missing observations was not discussed in the Steinemann article. Georgia evaluated 10

indicator wells for the entire state and used a majority of triggered wells (6 of 10) to establish a trigger condition for groundwater levels for the State. SEC evaluated 20 wells for one groundwater basin alone and used spatial interpolation across the basin to determine the spatial extent of phase conditions.

c. Establish drought plan levels and triggering scale: The Georgia Plan used the following percentile thresholds: 35th, 20th, 10th, and 5th. For the SJRWMD, percentile values were piloted by SEC at the 20th, 15th, 10th, and 5th percentiles

d. Develop triggering objectives: Triggering objectives used to evaluate trigger behavior was developed by SEC for this study. Objectives included early warning without a false alarm for going into a phase, and stability within a phase, consistent with Georgia's triggering objectives. However, the triggering objectives SEC chose for moving to a less severe phase from a more severe phase was less conservative than Georgia's objectives.

2. Analyze indicators and triggers:

    a. Transform indicators to triggering scale and levels: It was necessary for Steinemann to do this for Georgia because the SPI was included as an indicator. She transformed the SPI to a percentile scale that the SPI could be used with streamflow and groundwater level percentiles. This approach was not needed for the subject study.

    b. Calculate multiperiod indicators: SEC calculated multi-period indicators exactly as performed in Georgia by Steinemann.

    c. Calculate individual and multiple triggering sequences: SEC calculated triggering sequences similar to Steinemann with the difference being that Steinemann used a different multiperiod indicator for drought progressing than drought receding; SEC used the same multiperiod indicator for both progressing and receding.

    d. Calculate final drought sequences. Additional refinement of the sequences was not performed for this SJRWMD study as the process is subject to further consideration by the District.

3. Evaluate indicators and triggers:

    a. Elicit expert assessments: After observing the behavior of a single-period (one month) and two multiperiod indicators (two and three consecutive months), it was clear to SEC which one met triggering objectives established by SEC for SJRWMD for the purposes of this study. Triggering behavior was further studied by SEC through the development and implementation of a multi-variate homogeneous Markov Model for the selected two-month multiperiod trigger. The use of this model was identified through the literature review as being appropriate for evaluating the stochastic behavior of indicators and triggers (Steinemann, 2003). Results of the Markov Model presented in the Appendix of this study include a probability matrix for each indicator well and for each month. SEC approached the Markov Model differently than Steinemann in that SEC used monthly striated data rather than data for all months in the POR, an approach noted by Steinemann as being more robust. The results of this study will be presented to the District's Water Shortage Team, District leadership, and stakeholders which include experts in the field of hydrogeology, hydrology, geospatial analyses, water supply and resource management, intergovernmental affairs, utility management, and policy and regulation.

b. Compare final drought sequences with expert assessments: Preliminary stakeholder outreach was conducted by the District for this pilot study. Utility stakeholders expressed an interest in further development of District water shortage management responses and additional coordination with utility drought and water shortage management efforts. Further recommendations for stakeholder involvement are included in Section 22.

c. Refine final drought sequences and iterate evaluation process: Further refinement may be a topic of future studies.

d. Select final indicators and triggers for drought plan: After the approach detailed in this Report or an alternative approach has been agreed to by the District, a final selection of indicators and triggers will be established for District-wide implementation. This step is beyond the scope and schedule of the current study.

12.0 Selecting the Water-level Indicator Dataset

SEC considered the use of the two datasets detailed in Subsections 8.1.1.1 and 8.1.1.2. After considering both datasets, SEC selected the UFA dataset consisting of 107 wells across the District because the data is on telemetry and can therefore be used to make mid-month decisions if deemed necessary. Further, because the scope of the analysis is regional rather than local, it was important to select indicator wells (or index wells) that are not greatly influenced by localized pumping; however, it was acceptable (and unavoidable unless the data were detrended) for the wells to include general (regional) anthropogenic effects. The District's UFA monitoring well network was established with similar objectives so it appeared to be the most appropriate dataset for performing the analyses. The District provided a GIS raster file of modeled drawdowns to SEC. SEC used the raster file to assign drawdown values to each of the wells used in this analysis. Then, a coefficient of correlation for drawdown vs. the sum of all phase conditions from January 1998 to December 2012 was calculated for each well in the study area (the Middle St. Johns Groundwater Basin). A coefficient of correlation (r) was also calculated for drawdown versus the average phase condition of each well (average of all dates from January 1998 – December 2012, and also for March 2000 – September 2002). In all three tests, a correlation could not be established between drawdown and phase conditions of individual wells. While this type of comparison does not replace a direct analysis of well data for determining pumping effects, the analysis helped to verify that general phase conditions in the dataset were not driven by modeled pumping effects.

13.0 Selecting the Area of Analysis

District direction provided to SEC was to select 10 wells in the Central Area of the District. Based on this direction, SEC selected the Middle St. Johns Groundwater Basin (MSJGB) for the area to be analyzed because the boundary for the Central Florida Water Initiative (CFWI) includes more of the MSJGB than the Upper St. Johns Groundwater Basin (USJGB), the other centrally located basin that is also partially included within the CFWI boundary as shown on Figure 8. Specifically, 36.4% of the MSJGB is located within the CFWI boundary, and 33.5% of the USJGB is within the CFWI boundary. The CFWI overlap is important because the sustainable yield of the Floridan Aquifer System (FAS) in this area is currently being studied in a coordinated effort by SJRWMD, SWFWMD, and SFWMD. Also shown in Figure 8, the MSJGB contains 20 wells. Although using all 20 wells nearly doubled the effort of the analysis, SEC included all the wells to the District's benefit. Results of this study may be used to deselect index wells in the basin, an effort to be considered in future studies.

One advantage to evaluating water shortage conditions at the basin level is that the wells are likely to have experienced similar background hydrogeologic (and perhaps hydrologic) conditions. Furthermore, the entire MSJGB is in Climate Division 03 (see Figure 2), therefore; climatic conditions should also be similar throughout the basin. Although climatic conditions do not readily and directly impact confined aquifers, climatic conditions are usually well correlated with water demand (withdrawals), and drawdown caused by withdrawals in confined aquifers are generally greater than in unconfined aquifers. Therefore, climate conditions can be said to readily impact water levels in a confined aquifer through anthropogenic effects: as the temperature and the rate of evapotranspiration increases, and precipitation decreases, irrigation demand increases. The degree to which climatic conditions affect demand and UFA levels was not evaluated in this study; however, a strong relationship between climatic conditions and irrigation demand has been demonstrated in countless studies throughout Florida.

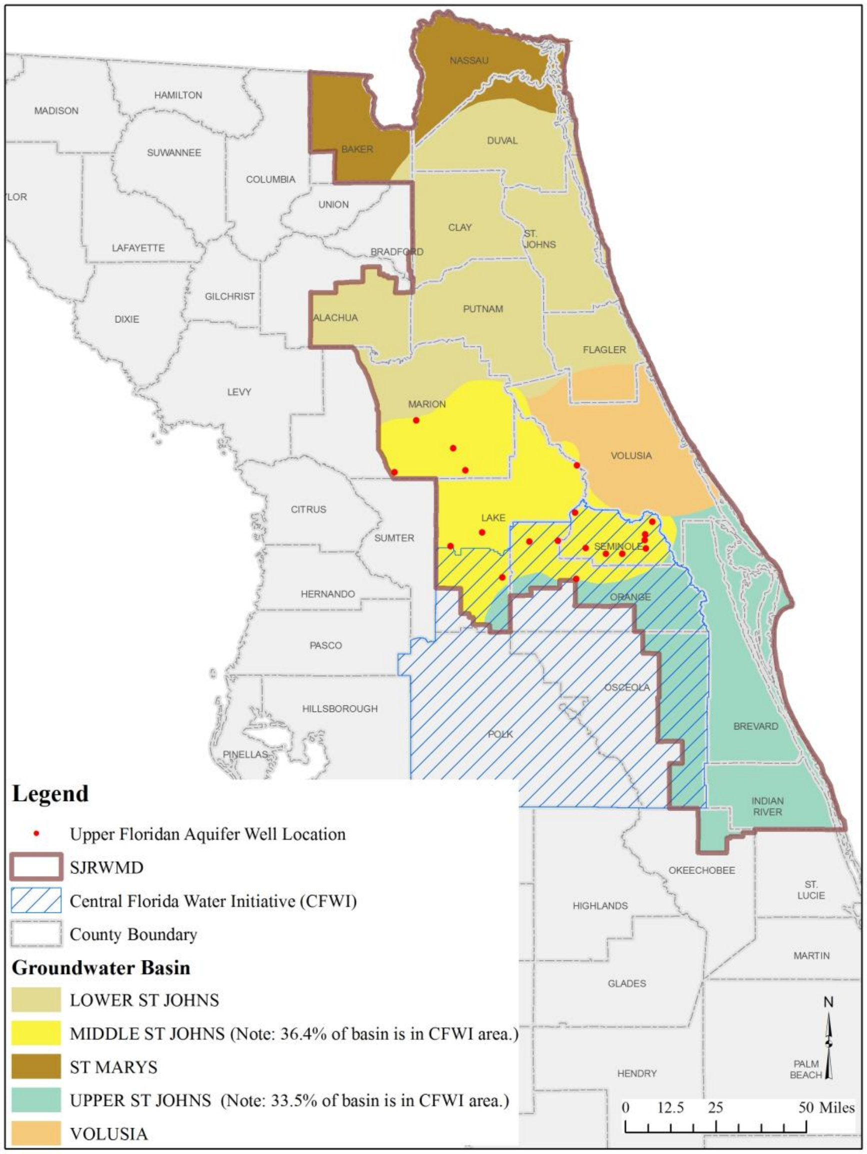

Figure 8. Central Florida Water Initiative Area.

Another advantage to evaluating water shortage conditions at the basin level is that the approach is generally more defensible when communicating the District's water shortage monitoring and management processes to the public and to water use permittees that use the FAS. For example, consider two contiguous groundwater basins, 'Basin A' and 'Basin B,' and consider that the method of interpolating phase conditions irrespective of basin boundaries was the practice used to determine the spatial extent of water shortage conditions. It is possible that an index well (or several wells) in 'Basin A' could trigger a water shortage phase, yet during the same time period, conditions observed in 'Basin B' index wells do not trigger a water shortage phase. However, due to the spatial distribution of index wells, and the method of interpolating phases across basin boundaries, the spatial extent of water shortage conditions could easily include part of 'Basin B.' Now, consider a water use permittee with a wellfield located in 'Basin B.' Depending on the spatial distribution of index wells in each basin, and the location of the permittee relative to 'Basin-B ' index wells, 'Basin A' index wells, and the severity of the phase condition of 'Basin A' index wells in the proximity to the permittee, it is possible that water use restrictions triggered by a 'Basin-A' index well (or wells) would be imposed on the permittee. In this case, the permittee could argue that 'Basin A' index wells are closer to his/her wellfield than 'Basin B' index wells, but do not represent the hydrogeologic condition of his/her wellfield which is located in 'Basin B.'

14.0 Selecting the Period of Record

A Period of Record that reflects the expected range of water conditions and user demand is best suited for water shortage determination, because the determination is based on whether existing supply is sufficient to meet user demand and the potential for serious harm to water resources. The selected POR represents the historical data for the purposes of evaluating water conditions under 40C-21.221. This approach varies from that used for MFLs, which consider pre-development conditions to protect resources from being significantly harmed by water withdrawals. For this study, four periods of record were evaluated for the 20 wells in the MSJGB as shown in Table 2. Of the four potential PORs, SEC recommended to use a 15-yr POR (POR_{15}) for the analysis for the following reasons:

Table 2. Periods of Record Considered.

Period of Record (POR)	Number of Years	Range of Dates
POR_{15}	15	Jan 1998 - Dec 2012
POR_{20}	20	Jan 1993 - Dec 2012
POR_{25}	25	Jan 1988 - Dec 2012
POR_{30}	30	Jan 1983 - Dec 2012

- Record high and/or low groundwater levels occurred within the 15-yr POR for most indicator wells.
- For some wells, the percent missing data increased significantly for longer PORs (see Table 3);
- Longer PORs include pre- and low-development groundwater levels in areas where withdrawals have increased since the beginning of the POR. Therefore, longer PORs would result in higher values of percentile thresholds. Because a water shortage is defined as a short-term condition, it was best to choose a POR which represented modern (developed) aquifer conditions.

15.0 Selecting Threshold Levels and Phase Conditions

As discussed in Section 8.0, the literature indicated that the Percentile Method is used exclusively in practical applications for establishing and monitoring hydrologic drought. Therefore, the Percentile Method was chosen as the method for establishing indicator trigger values. For the SJRWMD, the Percentile Method offers the following benefits:

- The science/statistics is easy to understand and therefore easy to communicate;
- The District has sufficient data quality to use the method;
- The method is consistent with current practices of the District, in particular, the District's monthly Hydrologic Conditions and UFA Water Level Reports;
- If the District incorporates other indicators which are not percentile-based (e.g., SPI and/or PDI), those indicators can be transformed to a percentile-based scale so that the indicators can be used together (Steinemann, 2003, Steinemann and Cavalcanti, 2006).
- The method is used by bordering water management districts, and is explicitly defined by SWFWMD's WSP (Chapter 40D-21.051, F.A.C.).

Table 3. Percent Missing Data for the PORs Considered.

County	Well ID	POR_{15}	POR_{20}	POR_{25}	POR_{30}
MARION	M-0013	1%	0%	0%	0%
	M-0026	0%	0%	1%	1%
	M-0031	1%	13%	29%	41%
	M-0483	14%	22%	25%	29%
LAKE	L-0043	0%	0%	1%	6%
	L-0059	12%	34%	47%	56%
	L-0095	0%	0%	7%	22%
	L-0199	0%	6%	13%	28%
SEMINOLE	S-0001	0%	0%	0%	0%
	S-0086	0%	0%	2%	18%
	S-1014	0%	7%	25%	38%
	S-1056	0%	21%	37%	47%
	S-1193	1%	17%	34%	45%
	S-1201	1%	18%	34%	45%
	S-1230	0%	16%	33%	44%
	S-1253	1%	19%	35%	46%
ORANGE	OR0009	1%	2%	2%	3%
	OR0046	1%	1%	1%	2%
	OR0106	2%	1%	2%	16%
	OR0548	0%	0%	19%	32%

The literature indicated that most agencies begin Phase I Water Shortages (least severe phase) at the 25^{th} percentile, and the 5^{th} percentile is usually associated with the most severe water shortage. Because SJRWMD has four phases, SEC chose the 5^{th} percentile for the threshold associated with the most severe phase, and then selected the other three thresholds in equal percentile ranges. The four percentile ranges selected by SEC to represent the District's four water shortage phases is shown in Table 4. These threshold levels provide a good starting point for the purposes of this study. It is important to understand that the threshold values listed in Table 4 do not represent a recommended final set of phase definitions, rather they represent phase conditions for individual indicator wells. The final set of water shortage phase definitions will include a temporal and possibly a spatial component.

Table 4. Percentile Triggers and Phase Conditions.

Water Shortage Condition (Phase)	Water Level (WL) at Phase Condition
None	$P_{100} \geq WL \geq P_{20}$
Phase I	$P_{20} > WL \geq P_{15}$
Phase II	$P_{15} > WL \geq P_{10}$
Phase III	$P_{10} > WL \geq P_5$
Phase IV	$P_5 > WL$

To develop phase conditions for each well, water-level data was stratified by month and then percentile values for each well and each month were calculated for the 15-yr POR. It is important to understand that a calculated phase condition in a well does not necessarily lead to the corresponding water shortage phase. The monthly phase conditions, which are provided in Table A-1, can be used directly to establish water shortage declarations. However, a more refined approach involves using one-month conditions to develop and compare multiperiod indicators as discussed in Section 17.0.

16.0 Estimating Water Levels and Phase Conditions for Missing Observations

Currently, the District does not estimate missing water-level data when calculating monthly percentile values for each well. For this study, percentile values and phase conditions were first calculated for all wells without estimating missing data. After reviewing the preliminary resulting phase conditions, it became clear which missing observations would present challenges when calculating and evaluating multi-period indicators over the period of record. Model calculations treated missing water level observations as a Phase 0 (indicated as “none” in Table 4.) condition, which was acceptable if the observation was in between several other Phase 0 conditions. This is because regardless of the exact water level, it was reasonable to assume that the level would not have triggered a water shortage phase for that month. However, if a water level observation was missing near or during a water shortage phase condition, then it would not be acceptable to allow the model to assume a Phase 0 condition. Therefore, missing water level observations and phase conditions were treated using two approaches:

1. Wells for which it was acceptable to allow missing observations to count as a 0 Phase condition were wells which had an acceptable amount of missing observations (less than 5%) and the missing observations were in between several months of non-triggering water levels. For these wells, missing water levels were not estimated and percentile values were calculated using only the available observations. In order for the model to perform correctly, a “0” was entered into the model as the phase condition for the missing months. The wells for which missing data was treated in this manner included M-0013, M-0031, S-1193, S-1201, OR0009, and OR0046.
2. Two wells had a significant amount of missing observations for the 15-yr POR. Well M-0483 was missing 14% of monthly mean water levels, and L-0059 was missing 12%. Well S-1253 was only missing 1% of data and OR0106 only 2%; however, missing values were near or amidst periods of water shortage conditions. For these four wells, correlation and regression analyses were used to estimate missing water levels, and then the regression-estimated values were entered into the model where values were missing. Details of the correlation and regression analyses used to estimate missing data are provided below.

When the correlation between water levels in well pairs is strong (identified by a correlation analysis), a linear regression equation can be developed (identified by a regression analysis) that estimates water levels in one well based on water levels in the other (Schreffler, 1997).

These analyses were used in this study to estimate missing water-level observations that were within the 15-yr POR and were sandwiched by observations. However, if a longer POR is evaluated by the District at a later time, say for example a 30-yr POR with a start date of January 1983, the District will be faced with either using a smaller set of wells (so that all wells have a similar or older start date with acceptable missing data percentages), or estimating well levels for observations that pre-date the POR for newer wells. This methodology can be applied to long periods of missing data to accommodate an analysis with longer PORs.

16.1 Performing a Correlation Analysis to Identify Well Pairs with a Strong Linear Relationship between Water Levels

The result of any correlation is a correlation coefficient (r) which is greater than -1 and less than 1. The closer the coefficient is to 1 or -1, the greater the strength of linear relation between well pairs and the greater the likelihood that water-level estimates of one well based on the other will be accurate. The USGS used this methodology to estimate water levels in wells with shorter PORs than index wells (Schreffler, 1997). For the USGS study, Schreffler considered r values greater than 0.85 as being indicative of a reasonably strong linear relationship between water levels in well pairs.

For the MSJGB, this standard correlation technique was used to quantify the strength of linear relations of water levels between M-0483, L-0059, S-1253, and OR0106 and the other 16 wells in the MSJGB. In order to estimate missing monthly water levels correlation coefficients between these four wells and the other wells in the MSJGB were calculated using a period of analysis from January 2005 through July 2013. This period of analysis was chosen because there were no missing observations for any of the wells within that period and because the period of analysis was long enough to establish a relationship. The results of the correlation analysis identified three correlated wells with r values greater than 0.85 for each of M-0483, L-0059, S-1253, and OR0106.

16.2 Performing a Regression Analysis to Identify the Linear Relationship between Water Levels in two Different Wells

A linear regression analysis can be used to develop a linear equation that relates sets of water levels, thereby allowing prediction of water levels in one well based on water levels in the other well. For this study, a linear regression analysis based on a least-squares algorithm was used to evaluate the relationship between water levels in M-0483, L-0059, S-1253, and OR0106 and the top three correlated wells identified by high r values. The same POR used in the correlation analysis was used in the regression analyses. Each analysis was reviewed to determine the most robust equation for predicting missing data values for in M-0483, L-0059, S-1253, and OR0106. This determination was made by comparing R-squared values, also known as the coefficient of determination. In a linear regression analysis, R-squared values represent the proportion of variability in the response variable that can be explained by the explanatory variables. The equation was then subsequently used to predict the missing data values for the wells.

17.0 Calculating Multiperiod Phase Conditions

In this step, indicators based on single time periods (see Table A-1) were converted to indicators for multiple and sequential time periods, herein called "multiperiod indicators." The multiperiod indicators, or MPIs, are important to meet performance objectives: to provide more stable and less oscillatory water shortage triggers, to minimize possible false alarms, and to reduce the risk of missing a lagged or persistent water shortage signal. This methodology was adapted from the Georgia statewide drought planning effort (Steinemann and Cavalcanti, 2006). Using this method, multiperiod indicators were calculated for two and three consecutive indicator periods using the following calculations:

$$If\ \{P_{(1)i}, P_{(1)i-1}, \ldots P_{(1)i-(n-1)}\} \geq P_{(n)i-1},$$
$$then\ P_{(n)i} = the\ least\ value\ among\ \{P_{(1)i}, P_{(1)i-1}, \ldots P_{(1)i-(n-1)}\} \quad \text{(Equation 1)}$$

$$If\ \{P_{(1)i}, P_{(1)i-1}, \ldots P_{(1)i-(n-1)}\} \leq P_{(n)i-1},$$
$$then\ P_{(n)i} = the\ greatest\ value\ among\ \{P_{(1)i}, P_{(1)i-1}, \ldots P_{(1)i-(n-1)}\} \quad \text{(Equation 2)}$$

$$If\ at\ least\ one\ among\ \{P_{(1)i}, P_{(1)i-1}, \ldots P_{(1)i-(n-1)}\} \geq P_{(n)i-1}$$
$$and\ at\ least\ one\ among\ \{P_{(1)i}, P_{(1)i-1}, \ldots P_{(1)i-(n-1)}\} \leq P_{(n)i-1},$$
$$then\ P_{(n)i} = P_{(n)i-1} \quad \text{(Equation 3)}$$

Where: *P* = phase level of the indicator;

n = number of indicator time periods; and

i = current indicator period analyzed.

Equation 1 relates to going to an equal or more severe water shortage phase from $P_{(n)i-1}$ to $P_{(n)}$, and Equation 2 relates to going to an equal or less severe water shortage phase from $P_{(n)i-1}$ to $P_{(n)}$. If the logic conditions for Equation 1 and Equation 2 are not true, then the logic conditions of Equation 3 establish$P_{(n)i}$.

Single-period indicators, as well as two- and three-month MPIs from Jan 1998 to July 2013 were calculated for each month and each well in the basin. Results are included in the tables of the Appendix 1. The values (0, 1, 2, 3, and 4) shown in the Appendix tables correspond to phase conditions for each well (None, Phase I, Phase II, Phase III, and Phase IV) listed in Table 4. Table A-1 includes the results for the single-period indicator for each well. Table A-2 includes the results of the MPI analysis for a consecutive two-month period (n=2 in Equations 1 through 3). Although a consecutive three-month MPI (n=3) was calculated for each well, results of the three-month MPI for each well are not included in the Appendix.

Table A-3 is the numerical average of wells in each county, and Table A-4 is the numerical average of all the wells in the basin. Tables A-3 and A-4 include values for the single-period indicator (n=1) and multiperiod indicators for two and three consecutive months (n= 2, and n=3).

After calculating the one-, two-, and three-month indicators, SEC selected the two-month MPI for entering and exiting phases. The justification for this decision is covered in the Discussion of Results.

18.0 Identifying the Spatial Extent of Phase Conditions

After selecting the two-month MPI for the MSJGB pilot, SEC plotted the phases for individual wells for select months in ArcGIS. Then, the discrete phase values of the wells were interpolated throughout the basin using the ArcGIS Spatial Analyst inverse distance weighting (IDW) function. Wells outside the basin boundary were not used to treat the 'edge effect' (effect of interpolating to a boundary with no data outside the boundary to affect interpolation results). Rather, the edge effect was addressed by spatial extrapolation. This approach seemed appropriate for a basin-level analysis for reasons discussed in Section 13.0. However, the following caveats should be considered when referring to the maps developed for this pilot analysis:

- The maps do not represent measured water levels, or exact water-level percentiles (for example, the 22nd or 3rd percentile). Rather, the maps represent information, specifically phase levels. For example, all wells below the 5th percentile (regardless of the exact percentile level) are associated with a Phase IV condition. The phase condition (information) at each well is the value that is spatially interpolated.
- For the subject basin, there are several wells in close proximity to each other in Seminole County, and two wells in Orange County are shown to be 'on top' of each other. These wells were not declustered prior to performing the IDW function.

Figures A-1 through A-9 in Appendix 2 are GIS maps identifying the spatial extent of water shortage for select months in the POR to demonstrate the spatial pattern of phase transitioning during the Turn-of-the-Century Drought:

- Figure A-1 represents conditions in March 2000 when the drought began impacting UFA levels in the basin, which first occurred in the eastern part of the basin.
- Figure A-2 represents conditions in April and May 2000 (same conditions both months), and Figure A-3 represents conditions in July 2000 showing the drought progressing spatially (from east to west) and also progressing in intensity.
- Figure A-4 represents conditions in September 2000, when the entire basin (except for a small area in Marion County defined by well M-0483) experienced water shortage phase conditions.
- Figure A-5 shows that from December 2000 through February 2001, the entire basin was in a Phase IV Water Shortage, except for a small area in Marion County defined by well M-0483, which experienced Phase III conditions. This time period represents the height of the hydrogeologic drought for the MSJGB. The drought began to slowly recede after February 2001.
- Figure A-6 shows July 2001, which was the first month since the drought began that groundwater levels in an indicator well in the basin returned to a non-triggering level.

- Figure A-7 (October 2001) shows the drought conditions receding both spatially (from east to west) and in intensity. It is interesting to note that the eastern part of the basin was the first to enter into a water shortage and the first to exit.
- Figure A-8 (April 2002) and Figure A-9 (September 2002) show that the drought continued to recede from east to west.

Figure A-10 shows water shortage conditions during July 2012. During May 2012, most of the UFA wells experienced record lows or lows not seen since the Turn-of-the-Century Drought. Figure A-10 is provided to demonstrate that, based on parameters used in this study, much of the western part of the basin was still recovering in July 2012, meaning that UFA levels in July 2012 were below normal July levels for the 15-yr POR. This finding is generally consistent with Figure 6. Percentile-based groundwater-level conditions in the Figure-6 map are based on July 2012 as compared to all months from 1980 to 2009. Figure 6 also demonstrates that the eastern part of the basin was in recovery.

19.0 Analyzing the Stochastic Behavior of Indicators and Triggers

Performing a retrospective stochastic analysis helps to determine if indicators and triggers, and the water shortage phases they define are in parity with water shortage definitions and triggering objectives and the results can also be used to predict future phase conditions. Therefore, the stochastic behavior of indicators and triggers were evaluated as part of this study. The work conducted by Steinemann for the GDMP framed this analysis. However, in Georgia, the stochastic behavior of indicators and triggers were evaluated across all months in Georgia's POR; whereas in this study, the stochastic behavior was evaluated for each month separately. This part of the analysis is more robust than what was undertaken in Georgia; therefore, using the results to predict indicator and trigger behavior should be more accurate.

The probability that a well will be in a certain phase in a certain month was calculated for each well. Let P_t represent the phase condition for the present time period t. Let *i* represent the phase (0, I, II, III, or IV) at *time t.* Estimates of the probability that a well will exhibit a particular phase can be estimated from the quotient of the cumulative relative frequency of the phase counts m_i and the number of observations in the POR:

$$Pr_i = \frac{m_i}{\sum observations} \qquad \text{(Equation 4)}$$

These probabilities are provided in Table A-5 in the Appendix. Table A-5 can be used to answer the question: "what is the percent chance that a particular index well will not be triggered or will exhibit Phase I, II, III, or IV conditions (represented by Phase 0, 1, 2, 3, and 4) during a particular month?"

A multistate Markov Model can be used to evaluate the stochastic behavior of triggering sequences (Steinemann, 2003), and was therefore used in this study to evaluate transitioning, duration, and frequency of the two-month MPI for each well and for each month. The performance of indicators in the Markov process can be described by transition probabilities which are conditional probabilities of being in a certain phase, P_{t+1} for the future time period *t+1*, given a certain phase P_t for the present time period *t*. Let *i* represent the phase (0, I, II, III, and IV) at *time t=1,* and let *j* represent the phase at time *t+1.* Let Pr_{ij} represent the transition probability that P_n will be in Phase *i* at time *n* and Phase *j* at time *n+1.* Transition probabilities, Pr_{ij} *,* can be estimated from the conditional relative frequencies of the transition counts m_{ij}:

$$Pr_{ij} = \frac{m_{ij}}{\sum_j m_{ij}} \qquad \text{(Equation 5)}$$

Table A-6 includes transition probability matrices for each well and each month using the two-month MPI. Table A-6 can be used to answer the question: "what is the percent chance that a particular index well exhibiting Phase 0, I, II, III, or IV this month will exhibit Phase 0, I, II, III, or IV next month?"

20.0 Discussion of Results

In the following subsections, results of the analyses that were performed are discussed and examples of how the results can be used to further refine the District's water shortage monitoring and management efforts are provided.

20.1 Results of the Multiperiod Analysis

After calculating the one-, two-, and three-month indicators, the advantage of using a two- or three-month MPI became apparent. The two-month MPI greatly smoothed transitions from one phase to another, and the three-month MPI provided even smoother transitions. What is meant by smooth transitioning is that indicators generally transition through phases sequentially and have stability within a phase. This effect is clearly demonstrated by comparing Table A-1 with Table A-2 (phase conditions for individual wells using one-month and two-month indicators), and by observing the effect that MPIs have on phase conditions when evaluated at the numerically aggregated county- and basin-levels (see Tables A-3 and A-4). Based on these results, SEC chose the two-month MPI for this pilot study.

Although using a three-month MPI would provide smoother transitions, and overall would result in less severe phases, SEC was concerned that a three-month MPI would not be sufficiently proactive for water shortage progressing (going from a less severe shortage to a more severe shortage), because indicator wells would need to be triggered for three months before a water shortage would be declared. Georgia also selected a two-month MPI for drought progressing. However, Georgia selected a four-month MPI for drought receding (going from a more severe drought to a less severe drought). Based on results of the MPI analysis for the MSJGB, SEC chose the two-month MPI for drought regressing. Using a three- or four-month MPI for drought regressing seemed overly conservative because corresponding water use restrictions would linger an additional one or two months at each phase. Also, based on the results of the MPI analysis, the three-month MPI did not offer a significant improvement with respect to smoothing phase progressing or phase regressing scenarios.

20.2 Results of the Spatiotemporal Analysis

For this study, each well in the MSJGB was considered an indicator and each well had equal weight. For the GDMP, Georgia evaluated each index well (total of ten for the state), but the "indicator," was actually "groundwater levels," and the groundwater level was not triggered until at least six of the ten index wells were triggered. If the District considers an approach similar to Georgia's application of the majority rule, SEC recommends that the majority rule be applied to a well-defined boundary. For example, the District could calculate indicator values for all wells, and then employ the majority rule at the county level. That approach however is not consistent with using spatial interpolation to identify the spatial extent of phase conditions. The use of GIS to perform spatial analyses for the GDMP was not indicated in the literature. However, the approach used by SEC in this study leveraged the power of GIS to estimate the spatial extent of phases, which is a more sophisticated method than the majority-rule method. However, the GIS analysis conducted for this study could be further refined as detailed in this subsection and also in the Section 22.

Tables A-1 through A-4 and Figures A-1 through A-9 demonstrate the spatiotemporal behavior of the indicators and triggers in the MSJGB. The analysis demonstrated a pattern of phase progressing and phase receding behavior from east to west in the basin. That is to say that generally, the eastern part of the basin is the first to trigger and the first to recover. Results from a spatial analysis, such as this, can be used to further refine water shortage indicators and phase thresholds to meet the District's ultimate set of triggering objectives and phase definitions. An example of how these results can be applied to refine the final set of indicators, triggers, and phase definitions is provided below.

If the District decides to declare Water Shortage Orders at the basin level (similar to SWFWMD's planning-region level approach), an option to consider for the MSJGB would be to use eastern wells for entering a phase and western wells for exiting a phase. For example, since water shortage conditions in the MSJGB have a clear progressing pattern from east to west, the District could conservatively choose to use indicators in the eastern part of the District to declare a basin-wide water shortage with the goal of avoiding (rather than mitigating) anthropogenic impacts in the western part of the basin, while mitigating (because the eastern part would have already been triggered) anthropogenic impacts in the eastern part. Similarly, the District could use wells in the western part of the District to signal basin recovery, meaning that the basin would remain under a Water Shortage Order until the western part of the basin has recovered. SEC considers this option to be relatively conservative, yet appropriate for basin-wide declarations. If the District decides to declare water shortages at the county level, a similar approach can be implemented. If using this approach at the county level, it would likely be more reasonable to select individual wells for entering and exiting a phase, which could be "set" (always use index well XX for going into a water shortage, and index well YY for exiting a water shortage). Alternatively, the entering and exiting wells could be identified monthly.

Another finding of the spatiotemporal analysis is that Marion County well, M-0483, appeared to be out of phase with other wells in its proximity during the progressing stages of the Turn-of-the-Century Drought (see Figure A-4 and A-5). Specifically, it was the last well in its proximity to exhibit water shortage conditions (at each phase). Its recovery from the Drought was also relatively strong (see Figure A-7 and A-8), but not as unique as its drought resistance during the onset of the Drought. The interesting finding is that the behavior of this indicator well significantly changed sometime after the Drought. From mid-2007 to present day, M-0483 triggers sooner, experiences greater phase severity, and is slow to recover as compared to conditions observed in other wells in its vicinity during the same time periods. Addressing apparently anomalous individual well behavior is outside the scope of this analysis, but such anomalies should be considered when selecting individual index wells in future studies.

21.0 Summary of Literature Review and Analysis

SEC performed a literature review to identify methodologies used by others to develop, evaluate, and analyze water shortage conditions. Except for methodologies used by other WMDs, methodologies identified in the literature applied to drought rather than to water shortage. But in all cases, the use of percentiles to establish threshold levels to identify hydrologic conditions and to define drought and water shortage phase conditions was prevalent. Therefore, SEC used percentiles to establish phase conditions for the UFA (see Table 4). Then, using two key sources (Steinemann 2003, Steinemann and Cavalcanti, 2006), SEC developed and analyzed indicators, triggers, and phase sequencing using District-provided data (UFA water levels in the MSJGB from January 1998 to December 2012). This study was limited to the UFA in the MSJGB as a means to pilot a methodology for potential District-wide application. The MSJGB UFA effort is summarized below:

- UFA threshold levels were developed for each month and for each well in the MSJGB by striating the District-provided groundwater data (monthly means). SEC established four threshold categories relating to four phase conditions (Phase I through Phase IV) as shown in Table 4. Also, a Phase 0 category was established to represent normal to above normal UFA levels.
- SEC developed triggering objectives to evaluate trigger behavior for this study: triggers should be more stable and less oscillatory to minimize possible false alarms, and to reduce the risk of missing a lagged or persistent water shortage signal.
- SEC calculated multi-period indicators for two and three sequential months (see Section 17.0). Based on the calculated MPIs, SEC chose a two-month MPI for water shortage progressing (going from a less severe to more severe phase) and for water shortage receding (going from a more sever phase to a less severe phase) as best meeting SEC-established triggering objectives. Results of the MPI calculations are provided in Tables A-1 through A-4 of Appendix 1.
- The probability of a well exhibiting a phase condition in any one month was calculated. These probabilities are provided in Table A-5.
- The stochastic behavior of the two-month MPI was evaluated by SEC through the development and implementation of a multi-variate homogeneous Markov Model. Results of the Markov Model presented in Table A-6 of this study include a transitional probability matrix for each indicator well, for each month, and for each possible phase transition.

- SEC performed a retrospective spatiotemporal analysis. Figures A-1 through A-9 in Appendix 2 are GIS maps identifying the spatial extent of water shortage for select months to demonstrate the spatial pattern of phase transitioning during the Turn-of-the-Century Drought.

22.0 Recommended Additional Analyses and Stakeholder Processes

This study should be considered a pilot study in that only one groundwater basin (the MSJGB) and one type of indicator (UFA water levels) were studied. To date, the District has not established trigger-based phase definitions. The District should either adopt the phase definitions and triggering objectives established by SEC in this study, or use the methodology SEC used to frame the District's consideration of a different set of phase definitions and triggering objectives. Specific analyses for future studies are detailed below.

Additional spatial analyses:

- Develop and implement a methodology to select and/or deselect apparently anomalous individual wells;
- Determine appropriate declustering weights and apply to wells prior to performing IDW-based interpolation, or use Kriging instead;
- Apply the phase methodology presented in the study to other groundwater basins and address interface issues between basins and bordering WMDs.
- Develop and apply a geostatistical method for treatment of basin boundaries;
- Consider the alternative approach of creating a normal water level surface for each month of the POR (12 total); create a water level surface for each new month, and then calculate the departure from normal each month. Note this alternative method was not indicated in the literature. It is a method recommended by SEC for consideration;
- Perform spatial statistics on affected user groups and water withdrawal locations to inform phased water use restrictions; and
- Evaluate potential spatiotemporal effects of water use restrictions imposed by bordering WMDs over the period of record.

Evaluate other types of indicators:

- Precipitation;
- Water demand;
- Springflow; and
- Water quality (e.g. chlorides and/or total dissolved solids).

- Consider collecting water quality data from indicator wells.
- Associate indicators, trigger levels, and phase definitions with "serious harm."
- Conduct additional stakeholder outreach and incorporate stakeholder comments to the selection and use of indicators and phase determinations. The stakeholder process should result

in phase determinations which promote an equitable distribution of water resources among users during times of water shortage.

23.0 Monthly Water Shortage Monitoring and Reporting Recommendations

The District currently uses two methodologies and datasets to monitor and report hydrologic conditions (see Subsection 8.1.1). Each method has its benefits and together, both datasets/methods provide a comprehensive presentation of hydrologic conditions in the District. Further, the Hydstra dataset includes conditions beyond the District's political boundary. Results of both methods are presented to the Water Shortage Group and to the Governing Board monthly. The District should continue with its current approach to monitoring and reporting on hydrologic conditions with the following minor recommendations:

Table 5. UFA Percentile Categories Currently used by SJRWMD.

Red	0% - 10%
Orange	10% - 20%
Yellow	20% - 40%
Light blue	40% - 60%
Medium blue	60% - 80%
Blue	80% - 90%
Dark blue	90% - 100%

- Each map should indicate the basis for the categories (percentiles based on all months or each month, and the POR used).
- The UFA threshold categories in Table 5 are included in the legend for monthly UFA water level maps. For the UFA maps, the categories are shown as discrete categorical ranges at each well. The categories shown in Table 5 overlap which can result in a water level being in two categories simultaneously. For example, if a water level is equal to the 20th percentile, it could be represented by orange or yellow because the value exists in both categories. This categorical overlap should be addressed.
- The legend used on the maps that are created by interpolating the Hydstra dataset (see Figure 6) do not indicate values for the categories (high, normal, low, and very low). SEC recommends including the threshold ranges for each category in the legend.
- The District currently does not save meteorologic or hydrologic (groundwater) GIS surfaces after they are developed; rather, to save server space, the files are overwritten each month. The District should save the monthly layers so that layer-to-layer spatiotemporal analyses can be performed in the future without recreating layers from datatables.

The recommendations provided above refer to slight improvements for the District's consideration regarding its monthly Hydrologic Conditions Report. The recommendations are provided as suggestions that resulted from SEC's review of HCRs and UFA Water Level Reports. A third monthly report is recommended by SEC, which is a Water Shortage Monitoring Report (WSMR). For the WSMR, SEC recommends using the UFA dataset because the wells are on telemetry and are owned by the District. Also, this dataset is already striated by month and the District currently calculates percentile values each month using an updated POR. The District currently calculates threshold-value categories (see Table 5) for this dataset and displays the color-coded categories as discrete points (representing wells) on a map.

In other words, this dataset is not spatially interpolated. SEC recommends that the treatment of this dataset be amended and augmented for monthly WSMRs as follows:

- SEC recommends that monthly UFA data be processed as provided in this study; specifically, the percentile values and phase conditions for each month should be calculated with the addition of wet categories. The categories shown in Table 6 should be used to determine phase conditions for each UFA well.
- The values in Table 6 should be interpolated and a map developed to represent UFA level conditions in the District. District staff should indicate on the map and communicate to the Governing Board that percentile threshold categories were developed for each month and for each well and represent the current month only (e.g. it is based on values of one-month indicators rather than on two-month MPIs). A relevant map to also show would be the previous month's condition. For now, the District should interpolate categorical water shortage conditions across groundwater boundaries using all UFA wells, but as soon as practical, the spatial analysis should be improved as follows:
    - Declustering weights should be applied to wells prior to performing the IDW-based interpolation, or the District should use Kriging instead.
    - A geostatistical method for treating groundwater basin boundaries should be applied.
- When water shortage conditions are indicated, two-month MPI values should be calculated as described in Section 17.0 and a two-month MPI map be developed as discussed above. Indicate on the two-month MPI map and communicate to the Board that percentile threshold categories were developed for each month and for each well based on the condition existing for two months.

Table 6. Percentile Triggers and Phase Conditions.

Water Level (WL) Condition	Value to be used in Spatial Analysis and to Calculate Two-month MPI
WL > P_{95}	-4
$P_{95} \geq$ WL > P_{90}	-3
$P_{90} \geq$ WL > P_{85}	-2
$P_{85} \geq$ WL > P_{80}	1
$P_{80} \geq$ WL $\geq P_{20}$	0
P_{20} > WL $\geq P_{15}$	1
P_{15} > WL $\geq P_{10}$	2
P_{10} > WL $\geq P_{5}$	3
P_{5} > WL	4

- One reason to use a two-month MPI is that this study showed that phases generally occurred in sequence without skipping a phase. However, if conditions degrade or improve in such a way that a phase is skipped, it is recommended that the District does not skip a phase in its water shortage declarations except in extreme circumstances. For example, if the District (or part of the District) is currently under a Phase I Water Shortage Order and a two-month MPI for the next month exhibits Phase III conditions, it is recommended that the District declare a Phase II Water Shortage rather than a Phase III Water Shortage.
- When water shortage conditions are indicated, the interpolated two-month MPI phase conditions and the probabilities provided in Tables A-5 and A-6 should be used by the Water Shortage Group to develop a staff recommendation regarding water shortage declarations.
- When the District or part of the District is experiencing water shortage conditions, it is recommended that the District evaluate UFA levels and the Water Shortage Group meet more

frequently. This would help to alleviate issues associated with conditions skipping phases. For example, if the District (or part of the District) is currently under a Phase I Water Shortage Order, and conditions in two weeks represent a Phase II Water Shortage, the District's Executive Director can declare a Phase II Water Shortage mid-month (for example) using an Emergency Water Shortage Order. In this case the Emergency Order would either be ratified or rejected by the Governing Board at the next scheduled Governing Board meeting.

- When a water shortage declaration will be recommended by the Water Shortage Group, a third map representing the spatial extent of water shortage declarations should be developed. SEC recommends that unless there are compelling reasons for the District to do otherwise, the District should declare water shortages at the county level. If a water shortage phase declaration does not span the entire area of a County, it is recommended that the District use major roadways to delineate and communicate the spatial extent of each phase. In this case, the map should include a layer of the major roadways. This approach is recommended because it is easier for the District to communicate, and for water users to understand. This approach also makes it easier for municipalities and local governments to enforce corresponding water-use restrictions thereby improving implementation success.

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APPENDIX 1 – TABLES

Table A-1. Phase Conditions of Wells based on One-month Indicator Values.

	M-0013	M-0026	M-0031	M-0483	L-0043	L-0059	L-0095	L-0199	S-0001	S-0086	S-1014	S-1056	S-1193	S-1201	S-1230	S-1253	OR0009	OR0046	OR0106	OR0548
Jan - 1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb - 1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar - 1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr - 1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May - 1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun - 1998	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	2	2	0	0
Jul - 1998	0	0	0	0	0	0	0	0	0	0	0	2	3	0	0	0	0	2	0	0
Aug - 1998	0	0	0	0	0	0	0	0	0	0	0	4	2	0	0	0	0	0	0	0
Sep - 1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct - 1998	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
Nov - 1998	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
Dec - 1998	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
Jan - 1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb - 1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar - 1999	0	0	0	0	0	0	0	0	0	0	0	2	3	2	2	0	0	0	0	0
Apr - 1999	0	0	0	0	0	0	0	0	2	0	3	4	4	3	3	0	3	3	0	0
May - 1999	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Jun - 1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jul - 1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug - 1999	0	0	0	0	0	0	0	0	0	0	3	0	0	3	3	0	2	2	0	0
Sep - 1999	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Oct - 1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov - 1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec - 1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A-1 cont'd. Phase Conditions of Wells based on One-month Indicator Values.

	M-0013	M-0026	M-0031	M-0483	L-0043	L-0059	L-0095	L-0199	S-0001	S-0086	S-1014	S-1056	S-1193	S-1201	S-1230	S-1253	OR0009	OR0046	OR0106	OR0548
Jan - 2000	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
Feb - 2000	0	0	0	0	0	1	0	0	0	0	0	0	3	2	1	0	0	0	0	0
Mar - 2000	0	0	0	0	0	3	0	0	0	0	3	3	4	3	3	0	2	3	0	0
Apr - 2000	0	0	0	0	0	2	0	0	0	0	2	3	0	0	2	0	2	2	0	0
May - 2000	0	0	0	0	0	3	0	0	2	0	4	4	4	4	3	0	4	4	0	0
Jun - 2000	0	2	0	2	0	4	0	0	4	4	4	4	2	4	4	4	4	3	3	0
Jul - 2000	3	3	3	0	2	4	0	2	4	4	4	4	2	4	4	3	4	4	3	0
Aug - 2000	3	4	4	4	2	4	2	3	4	4	4	3	4	4	4	4	4	4	3	3
Sep - 2000	4	4	4	0	3	4	2	3	4	3	4	4	3	4	4	3	4	4	2	2
Oct - 2000	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3
Nov - 2000	4	4	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Dec - 2000	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Jan - 2001	4	4	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Feb - 2001	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3
Mar - 2001	4	4	4	3	4	4	3	4	4	4	4	4	0	4	4	4	4	4	4	3
Apr - 2001	3	4	3	3	4	4	2	4	4	4	4	0	2	4	4	4	4	4	4	3
May - 2001	3	4	3	2	4	3	3	4	4	4	3	3	0	3	4	4	3	3	4	3
Jun - 2001	4	4	4	3	4	3	4	4	3	0	2	0	4	3	3	3	0	0	4	3
Jul - 2001	4	4	4	4	4	0	3	4	3	2	2	0	4	0	2	4	0	0	4	3
Aug - 2001	4	3	3	0	3	0	3	4	2	0	0	0	0	0	0	2	0	0	4	0
Sep - 2001	3	3	3	2	2	0	0	4	0	0	0	0	0	0	0	0	0	0	3	0
Oct - 2001	2	3	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	2	0
Nov - 2001	1	3	2	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	2	0
Dec - 2001	2	2	1	0	2	0	0	3	0	0	0	0	0	0	0	0	2	2	2	0
Jan - 2002	2	2	2	2	0	0	0	3	0	0	0	0	0	0	0	0	3	3	2	0
Feb - 2002	1	1	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2	0
Mar - 2002	2	2	2	2	0	0	0	3	0	0	0	0	0	0	0	0	0	0	3	0
Apr - 2002	2	3	2	0	2	0	0	3	0	0	0	0	0	0	0	0	0	0	2	0
May - 2002	2	3	2	3	3	0	0	3	0	0	2	2	0	2	0	0	2	2	3	0
Jun - 2002	2	3	3	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	2
Jul - 2002	0	2	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Aug - 2002	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Sep - 2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct - 2002	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0

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Table A-1 cont'd. Phase Conditions of Wells based on One-month Indicator Values.

	M-0013	M-0026	M-0031	M-0483	L-0043	L-0059	L-0095	L-0199	S-0001	S-0086	S-1014	S-1056	S-1193	S-1201	S-1230	S-1253	OR0009	OR0046	OR0106	OR0548
Nov - 2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec - 2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan - 2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb - 2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar - 2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr - 2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May - 2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun - 2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jul - 2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug - 2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep - 2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct - 2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov - 2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec - 2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan - 2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb - 2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar - 2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr - 2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May - 2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun - 2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jul - 2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug - 2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep - 2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct - 2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov - 2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec - 2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan - 2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb - 2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar - 2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr - 2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A-1 cont'd. Phase Conditions of Wells based on One-month Indicator Values.

	M-0013	M-0026	M-0031	M-0483	L-0043	L-0059	L-0095	L-0199	S-0001	S-0086	S-1014	S-1056	S-1193	S-1201	S-1230	S-1253	OR0009	OR0046	OR0106	OR0548
May - 2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun - 2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jul - 2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug - 2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep - 2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct - 2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov - 2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec - 2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan - 2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb - 2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar - 2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr - 2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May - 2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun - 2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jul - 2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug - 2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Sep - 2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Oct - 2006	0	0	1	0	2	0	2	0	0	2	3	3	0	3	3	2	3	3	0	4
Nov - 2006	0	0	0	0	2	2	0	0	0	2	3	3	0	2	3	0	3	3	0	3
Dec - 2006	0	0	0	0	0	0	0	0	0	2	2	0	0	2	3	0	0	0	0	2
Jan - 2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
Feb - 2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	1	0	0
Mar - 2007	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	3	2	0	2
Apr - 2007	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	2
May - 2007	0	0	0	0	0	0	0	0	0	3	0	0	3	0	2	2	0	0	0	2
Jun - 2007	0	0	0	0	3	0	2	0	0	2	3	2	0	0	2	0	3	4	0	4
Jul - 2007	0	0	0	2	3	3	4	0	0	3	3	3	0	3	3	2	3	3	2	4
Aug - 2007	0	0	0	2	4	3	4	0	3	3	2	2	3	2	2	3	3	3	2	4
Sep - 2007	0	0	0	4	4	3	4	2	3	4	3	3	4	3	3	4	3	3	4	4
Oct - 2007	0	0	0	2	3	3	0	2	3	0	2	2	0	0	2	3	2	2	3	2
Nov - 2007	0	0	0	0	3	0	0	2	2	0	2	2	2	0	2	2	2	0	3	2
Dec - 2007	0	0	0	0	3	2	0	2	2	0	3	3	0	0	2	2	3	3	3	3
Jan - 2008	0	0	0	0	3	2	0	2	0	2	3	3	0	2	2	3	0	0	3	2
Feb - 2008	0	0	0	1	1	0	0	1	0	0	1	1	0	0	0	2	0	0	1	1
Mar - 2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Table A-1 cont'd. Phase Conditions of Wells based on One-month Indicator Values.

	M-0013	M-0026	M-0031	M-0483	L-0043	L-0059	L-0095	L-0199	S-0001	S-0086	S-1014	S-1056	S-1193	S-1201	S-1230	S-1253	OR0009	OR0046	OR0106	OR0548
Apr - 2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May - 2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Jun - 2008	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	2	0	0	2	0
Jul - 2008	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug - 2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep - 2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct - 2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov - 2008	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec - 2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan - 2009	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb - 2009	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar - 2009	0	0	0	0	2	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0
Apr - 2009	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
May - 2009	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun - 2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jul - 2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug - 2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep - 2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct - 2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov - 2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec - 2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan - 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb - 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar - 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr - 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May - 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun - 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jul - 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A-1 cont'd. Phase Conditions of Wells based on One-month Indicator Values.

	M-0013	M-0026	M-0031	M-0483	L-0043	L-0059	L-0095	L-0199	S-0001	S-0086	S-1014	S-1056	S-1193	S-1201	S-1230	S-1253	OR0009	OR0046	OR0106	OR0548
Aug - 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep - 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct - 2010	0	0	0	0	0	0	0	0	2	3	0	0	0	1	0	0	0	0	0	0
Nov - 2010	0	0	0	0	0	3	0	0	3	3	0	0	0	3	0	3	0	0	0	0
Dec - 2010	0	0	0	0	0	3	2	0	3	3	0	2	2	3	0	3	0	0	0	0
Jan - 2011	0	0	0	0	0	3	0	0	3	3	0	0	2	3	0	2	0	0	0	0
Feb - 2011	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Mar - 2011	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	2	0	0	0	0
Apr - 2011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May - 2011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun - 2011	0	0	0	0	0	0	0	0	2	3	0	0	0	2	0	0	0	0	0	0
Jul - 2011	2	0	2	0	0	0	2	0	0	0	0	0	0	2	0	0	0	0	0	2
Aug - 2011	2	0	2	3	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Sep - 2011	2	2	2	3	0	2	3	0	2	2	0	2	2	2	0	2	1	1	0	3
Oct - 2011	3	2	3	3	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov - 2011	3	2	3	4	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec - 2011	3	3	3	3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan - 2012	3	3	3	4	2	0	3	0	2	0	2	2	0	0	0	0	2	2	0	3
Feb - 2012	2	2	2	2	2	2	2	0	2	2	2	2	0	0	0	1	2	2	0	2
Mar - 2012	3	3	3	4	3	2	4	2	3	3	0	0	0	0	0	3	0	0	2	4
Apr - 2012	4	2	4	4	3	3	4	2	3	3	0	2	3	2	0	3	0	0	3	4
May - 2012	4	2	4	4	2	2	4	2	3	2	0	0	0	0	0	0	0	0	2	4
Jun - 2012	3	0	2	4	0	0	3	2	0	0	0	0	0	0	0	0	0	0	0	0
Jul - 2012	0	0	0	3	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0
Aug - 2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep - 2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct - 2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov - 2012	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Dec - 2012	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan - 2013	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0
Feb - 2013	0	0	0	1	2	0	0	0	1	0	2	2	0	0	0	0	2	2	2	1
Mar - 2013	2	0	0	3	2	1	1	1	3	2	0	0	0	0	0	2	0	0	2	2
Apr - 2013	2	0	0	3	2	0	2	1	2	0	0	0	0	0	0	1	0	0	0	2
May - 2013	1	0	0	3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun - 2013	1	0	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Jul - 2013	1	0	0	3	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0

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Table A-2. Phase Conditions of Wells based on Consecutive Two-month Indicator Values.

	M-0013	M-0026	M-0031	M-0483	L-0043	L-0059	L-0095	L-0199	S-0001	S-0086	S-1014	S-1056	S-1193	S-1201	S-1230	S-1253	OR0009	OR0046	OR0106	OR
Jan - 1998	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Feb - 1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar - 1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr - 1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May - 1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun - 1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jul - 1998	0	0	0	0	0	0	0	0	0	0	0	2	3	0	0	0	0	2	0	0
Aug - 1998	0	0	0	0	0	0	0	0	0	0	0	2	3	0	0	0	0	2	0	0
Sep - 1998	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0
Oct - 1998	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Nov - 1998	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
Dec - 1998	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
Jan - 1999	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
Feb - 1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar - 1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr - 1999	0	0	0	0	0	0	0	0	0	0	0	2	3	2	2	0	0	0	0	0
May - 1999	0	0	0	0	0	0	0	0	0	0	0	2	3	2	2	0	0	0	0	0
Jun - 1999	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Jul - 1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug - 1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep - 1999	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Oct - 1999	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Nov - 1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec - 1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A-2 cont'd. Phase Conditions of Wells based on Consecutive Two-month Indicator Values.

	M-0013	M-0026	M-0031	M-0483	L-0043	L-0059	L-0095	L-0199	S-0001	S-0086	S-1014	S-1056	S-1193	S-1201	S-1230	S-1253	OR0009	OR0046	OR0106	OR
Jan - 2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb - 2000	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
Mar - 2000	0	0	0	0	0	1	0	0	0	0	0	0	3	2	1	0	0	0	0	0
Apr - 2000	0	0	0	0	0	2	0	0	0	0	2	3	3	2	2	0	2	2	0	0
May - 2000	0	0	0	0	0	2	0	0	0	0	2	3	3	2	2	0	2	2	0	0
Jun - 2000	0	0	0	0	0	3	0	0	2	0	4	4	3	4	3	0	4	3	0	0
Jul - 2000	0	2	0	0	0	4	0	0	4	4	4	4	2	4	4	3	4	3	3	0
Aug - 2000	3	3	3	0	2	4	0	2	4	4	4	4	2	4	4	3	4	4	3	0
Sep - 2000	3	4	4	0	2	4	2	3	4	4	4	4	3	4	4	3	4	4	3	2
Oct - 2000	4	4	4	0	3	4	2	3	4	4	4	4	3	4	4	3	4	4	3	2
Nov - 2000	4	4	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3
Dec - 2000	4	4	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Jan - 2001	4	4	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Feb - 2001	4	4	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Mar - 2001	4	4	4	3	4	4	3	4	4	4	4	4	2	4	4	4	4	4	4	3
Apr - 2001	4	4	4	3	4	4	3	4	4	4	4	4	2	4	4	4	4	4	4	3
May - 2001	3	4	3	3	4	4	3	4	4	4	4	3	2	4	4	4	4	4	4	3
Jun - 2001	3	4	3	3	4	3	3	4	4	4	3	3	2	3	4	4	3	3	4	3
Jul - 2001	4	4	4	3	4	3	3	4	3	2	2	0	4	3	3	4	0	0	4	3
Aug - 2001	4	4	4	3	4	0	3	4	3	2	2	0	4	0	2	4	0	0	4	3
Sep - 2001	4	3	3	2	3	0	3	4	2	0	0	0	0	0	0	2	0	0	4	0
Oct - 2001	3	3	3	2	2	0	0	4	0	0	0	0	0	0	0	0	0	0	3	0
Nov - 2001	2	3	2	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	2	0
Dec - 2001	2	3	2	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	2	0
Jan - 2002	2	2	2	0	0	0	0	3	0	0	0	0	0	0	0	0	2	2	2	0
Feb - 2002	2	2	2	0	0	0	0	3	0	0	0	0	0	0	0	0	2	2	2	0
Mar - 2002	2	2	2	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	2	0
Apr - 2002	2	2	2	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	2	0
May - 2002	2	3	2	0	2	0	0	3	0	0	0	0	0	0	0	0	0	0	2	0
Jun - 2002	2	3	2	0	2	0	0	3	0	0	0	0	0	0	0	0	0	0	2	0
Jul - 2002	2	3	2	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Aug - 2002	0	2	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Sep - 2002	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Oct - 2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Table A-2 cont'd. Phase Conditions of Wells based on Consecutive Two-month Indicator Values.

	M-0013	M-0026	M-0031	M-0483	L-0043	L-0059	L-0095	L-0199	S-0001	S-0086	S-1014	S-1056	S-1193	S-1201	S-1230	S-1253	OR0009	OR0046	OR0106	OR
Nov - 2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec - 2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan - 2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb - 2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar - 2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr - 2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May - 2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun - 2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jul - 2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug - 2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep - 2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct - 2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov - 2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec - 2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan - 2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb - 2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar - 2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr - 2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May - 2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun - 2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jul - 2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug - 2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep - 2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct - 2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov - 2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec - 2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan - 2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb - 2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar - 2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr - 2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Table A-2 cont'd. Phase Conditions of Wells based on Consecutive Two-month Indicator Values.

	M-0013	M-0026	M-0031	M-0483	L-0043	L-0059	L-0095	L-0199	S-0001	S-0086	S-1014	S-1056	S-1193	S-1201	S-1230	S-1253	OR0009	OR0046	OR0106	OR
May - 2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun - 2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jul - 2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug - 2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep - 2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct - 2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov - 2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec - 2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan - 2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb - 2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar - 2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr - 2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May - 2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun - 2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jul - 2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug - 2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep - 2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct - 2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Nov - 2006	0	0	0	0	2	0	0	0	0	2	3	3	0	2	3	0	3	3	0	3
Dec - 2006	0	0	0	0	2	0	0	0	0	2	3	3	0	2	3	0	3	3	0	3
Jan - 2007	0	0	0	0	0	0	0	0	0	2	2	0	0	2	3	0	0	0	0	2
Feb - 2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
Mar - 2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	1	0	0
Apr - 2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	2
May - 2007	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	2
Jun - 2007	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	2	0	0	0	2
Jul - 2007	0	0	0	0	3	0	2	0	0	2	3	2	0	0	2	2	3	3	0	4
Aug - 2007	0	0	0	2	3	3	4	0	0	3	3	2	0	2	2	2	3	3	2	4
Sep - 2007	0	0	0	2	4	3	4	0	3	3	3	2	3	2	2	3	3	3	2	4
Oct - 2007	0	0	0	2	4	3	4	2	3	3	3	2	3	2	2	3	3	3	3	4
Nov - 2007	0	0	0	2	3	3	0	2	3	0	2	2	2	0	2	3	2	2	3	2
Dec - 2007	0	0	0	0	3	2	0	2	2	0	2	2	2	0	2	2	2	2	3	2
Jan - 2008	0	0	0	0	3	2	0	2	2	0	3	3	0	0	2	2	2	2	3	2
Feb - 2008	0	0	0	0	3	2	0	2	0	0	3	3	0	0	2	0	0	0	3	2
Mar - 2008	0	0	0	0	1	0	0	1	0	0	1	1	0	0	0	0	0	0	1	1

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Table A-2 cont'd. Phase Conditions of Wells based on Consecutive Two-month Indicator Values.

	M-0013	M-0026	M-0031	M-0483	L-0043	L-0059	L-0095	L-0199	S-0001	S-0086	S-1014	S-1056	S-1193	S-1201	S-1230	S-1253	OR0009	OR0046	OR0106	OR
Apr - 2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May - 2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun - 2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Jul - 2008	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Aug - 2008	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep - 2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct - 2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov - 2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec - 2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan - 2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb - 2009	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar - 2009	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr - 2009	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
May - 2009	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun - 2009	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Jul - 2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug - 2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep - 2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct - 2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov - 2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec - 2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan - 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb - 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar - 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr - 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May - 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun - 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jul - 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A-2 cont'd. Phase Conditions of Wells based on Consecutive Two-month Indicator Values.

	M-0013	M-0026	M-0031	M-0483	L-0043	L-0059	L-0095	L-0199	S-0001	S-0086	S-1014	S-1056	S-1193	S-1201	S-1230	S-1253	OR0009	OR0046	OR0106	OR
Aug - 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep - 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct - 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov - 2010	0	0	0	0	0	0	0	0	2	3	0	0	0	1	0	0	0	0	0	0
Dec - 2010	0	0	0	0	0	3	0	0	3	3	0	0	0	3	0	3	0	0	0	0
Jan - 2011	0	0	0	0	0	3	0	0	3	3	0	0	2	3	0	3	0	0	0	0
Feb - 2011	0	0	0	0	0	3	0	0	3	3	0	0	2	3	0	2	0	0	0	0
Mar - 2011	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	2	0	0	0	0
Apr - 2011	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	2	0	0	0	0
May - 2011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun - 2011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jul - 2011	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Aug - 2011	2	0	2	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Sep - 2011	2	0	2	3	0	2	0	0	0	2	0	0	0	2	0	0	0	0	0	0
Oct - 2011	2	2	2	3	0	2	3	0	0	2	0	0	0	2	0	0	0	0	0	0
Nov - 2011	3	2	3	3	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec - 2011	3	2	3	3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan - 2012	3	3	3	3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb - 2012	3	3	3	3	2	0	3	0	2	0	2	2	0	0	0	0	2	2	0	2
Mar - 2012	3	3	3	3	2	2	3	0	2	2	2	2	0	0	0	1	2	2	0	2
Apr - 2012	3	3	3	4	3	2	4	2	3	3	0	2	0	0	0	3	0	0	2	4
May - 2012	4	2	4	4	3	2	4	2	3	3	0	2	0	0	0	3	0	0	2	4
Jun - 2012	4	2	4	4	2	2	4	2	3	2	0	0	0	0	0	0	0	0	2	4
Jul - 2012	3	0	2	4	0	0	3	2	2	0	0	0	0	0	0	0	0	0	0	0
Aug - 2012	0	0	0	3	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Sep - 2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct - 2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov - 2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec - 2012	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan - 2013	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb - 2013	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0
Mar - 2013	0	0	0	2	2	0	0	0	1	0	1	0	0	0	0	0	1	1	2	1
Apr - 2013	2	0	0	3	2	0	1	1	2	0	0	0	0	0	0	1	0	0	2	2
May - 2013	2	0	0	3	2	0	2	1	2	0	0	0	0	0	0	1	0	0	0	2
Jun - 2013	1	0	0	3	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Jul - 2013	1	0	0	3	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A-3. Phase Condition of Counties based on Average Phase Condition of Wells using Single-period (1-mo) and Multiperiod (2-mo and 3-mo) Indicators

	Marion County			Lake County			Seminole County			Orange County		
	1-mo	2-mo	3-mo	1-mo	2-mo	3-mo	1-mo	2-mo	3-mo	1-mo	2-mo	3-mo
Jan - 1998	0	1	1	0	0	0	0	0	0	0	0	0
Feb - 1998	0	0	1	0	0	0	0	0	0	0	0	0
Mar - 1998	0	0	0	0	0	0	0	0	0	0	0	0
Apr - 1998	0	0	0	0	0	0	0	0	0	0	0	0
May - 1998	0	0	0	0	0	0	0	0	0	0	0	0
Jun - 1998	0	0	0	0	0	0	1	0	0	1	0	0
Jul - 1998	0	0	0	0	0	0	1	1	0	1	1	0
Aug - 1998	0	0	0	0	0	0	1	1	1	0	1	0
Sep - 1998	0	0	0	0	0	0	0	1	1	0	0	0
Oct - 1998	0	0	0	0	0	0	0	0	1	0	0	0
Nov - 1998	0	0	0	0	0	0	0	0	0	0	0	0
Dec - 1998	0	0	0	0	0	0	0	0	0	0	0	0
Jan - 1999	0	0	0	0	0	0	0	0	0	0	0	0
Feb - 1999	0	0	0	0	0	0	0	0	0	0	0	0
Mar - 1999	0	0	0	0	0	0	1	0	0	0	0	0
Apr - 1999	0	0	0	0	0	0	2	1	0	2	0	0
May - 1999	0	0	0	0	0	0	0	1	0	0	0	0
Jun - 1999	0	0	0	0	0	0	0	0	0	0	0	0
Jul - 1999	0	0	0	0	0	0	0	0	0	0	0	0
Aug - 1999	0	0	0	0	0	0	1	0	0	1	0	0
Sep - 1999	0	0	0	0	0	0	0	0	0	0	0	0
Oct - 1999	0	0	0	0	0	0	0	0	0	0	0	0
Nov - 1999	0	0	0	0	0	0	0	0	0	0	0	0
Dec - 1999	0	0	0	0	0	0	0	0	0	0	0	0

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Table A-3 cont'd. Phase Condition of Counties based on Average Phase Condition of Wells using Single-period (1-mo) and Multiperiod (2-mo and 3-mo) Indicators

	Marion County			Lake County			Seminole County			Orange County		
	1-mo	2-mo	3-mo	1-mo	2-mo	3-mo	1-mo	2-mo	3-mo	1-mo	2-mo	3-mo
Jan - 2000	0	0	0	0	0	0	0	0	0	0	0	0
Feb - 2000	0	0	0	0	0	0	1	0	0	0	0	0
Mar - 2000	0	0	0	1	0	0	2	1	0	1	0	0
Apr - 2000	0	0	0	1	1	0	1	2	1	1	1	0
May - 2000	0	0	0	1	1	1	3	2	1	2	1	1
Jun - 2000	1	0	0	1	1	1	4	3	1	3	2	1
Jul - 2000	2	1	0	2	1	1	4	4	3	3	3	2
Aug - 2000	4	2	1	3	2	1	4	4	4	4	3	3
Sep - 2000	3	3	2	3	3	2	4	4	4	3	3	3
Oct - 2000	4	3	3	4	3	3	4	4	4	4	3	3
Nov - 2000	4	4	3	4	4	3	4	4	4	4	4	3
Dec - 2000	4	4	4	4	4	4	4	4	4	4	4	4
Jan - 2001	4	4	4	4	4	4	4	4	4	4	4	4
Feb - 2001	3	4	4	3	4	4	3	4	4	3	4	4
Mar - 2001	4	4	4	4	4	4	4	4	4	4	4	4
Apr - 2001	3	4	4	4	4	4	3	4	4	4	4	4
May - 2001	3	3	4	4	4	4	3	4	4	3	4	4
Jun - 2001	4	3	4	4	4	4	2	3	4	2	3	4
Jul - 2001	4	4	4	3	4	4	2	3	3	2	2	3
Aug - 2001	3	4	4	3	3	4	1	2	2	1	2	2
Sep - 2001	3	3	4	2	3	3	0	1	2	1	1	2
Oct - 2001	1	3	3	1	2	3	0	0	1	1	1	1
Nov - 2001	2	2	3	1	1	2	0	0	0	1	1	1
Dec - 2001	1	2	2	1	1	1	0	0	0	2	1	1
Jan - 2002	2	2	2	1	1	1	0	0	0	2	2	1
Feb - 2002	1	2	2	1	1	1	0	0	0	1	2	1
Mar - 2002	2	2	2	1	1	1	0	0	0	1	1	1
Apr - 2002	2	2	2	1	1	1	0	0	0	1	1	1
May - 2002	3	2	2	2	1	1	1	0	0	2	1	1
Jun - 2002	2	2	2	1	1	1	0	0	0	1	1	1
Jul - 2002	1	2	2	1	1	1	0	0	0	0	0	1
Aug - 2002	1	1	2	1	1	1	0	0	0	0	0	0
Sep - 2002	0	1	1	0	1	1	0	0	0	0	0	0
Oct - 2002	0	0	1	0	0	1	0	0	0	0	0	0
Nov - 2002	0	0	0	0	0	0	0	0	0	0	0	0
Dec - 2002	0	0	0	0	0	0	0	0	0	0	0	0

Table A-3 cont'd. Phase Condition of Counties based on Average Phase Condition of Wells using Single-period (1-mo) and Multiperiod (2-mo and 3-mo) Indicators

	Marion County			Lake County			Seminole County			Orange County		
	1-mo	2-mo	3-mo	1-mo	2-mo	3-mo	1-mo	2-mo	3-mo	1-mo	2-mo	3-mo
Jan - 2003	0	0	0	0	0	0	0	0	0	0	0	0
Feb - 2003	0	0	0	0	0	0	0	0	0	0	0	0
Mar - 2003	0	0	0	0	0	0	0	0	0	0	0	0
Apr - 2003	0	0	0	0	0	0	0	0	0	0	0	0
May - 2003	0	0	0	0	0	0	0	0	0	0	0	0
Jun - 2003	0	0	0	0	0	0	0	0	0	0	0	0
Jul - 2003	0	0	0	0	0	0	0	0	0	0	0	0
Aug - 2003	0	0	0	0	0	0	0	0	0	0	0	0
Sep - 2003	0	0	0	0	0	0	0	0	0	0	0	0
Oct - 2003	0	0	0	0	0	0	0	0	0	0	0	0
Nov - 2003	0	0	0	0	0	0	0	0	0	0	0	0
Dec - 2003	0	0	0	0	0	0	0	0	0	0	0	0
Jan - 2004	0	0	0	0	0	0	0	0	0	0	0	0
Feb - 2004	0	0	0	0	0	0	0	0	0	0	0	0
Mar - 2004	0	0	0	0	0	0	0	0	0	0	0	0
Apr - 2004	0	0	0	0	0	0	0	0	0	0	0	0
May - 2004	0	0	0	0	0	0	0	0	0	0	0	0
Jun - 2004	0	0	0	0	0	0	0	0	0	0	0	0
Jul - 2004	0	0	0	0	0	0	0	0	0	0	0	0
Aug - 2004	0	0	0	0	0	0	0	0	0	0	0	0
Sep - 2004	0	0	0	0	0	0	0	0	0	0	0	0
Oct - 2004	0	0	0	0	0	0	0	0	0	0	0	0
Nov - 2004	0	0	0	0	0	0	0	0	0	0	0	0
Dec - 2004	0	0	0	0	0	0	0	0	0	0	0	0
Jan - 2005	0	0	0	0	0	0	0	0	0	0	0	0
Feb - 2005	0	0	0	0	0	0	0	0	0	0	0	0
Mar - 2005	0	0	0	0	0	0	0	0	0	0	0	0
Apr - 2005	0	0	0	0	0	0	0	0	0	0	0	0
May - 2005	0	0	0	0	0	0	0	0	0	0	0	0
Jun - 2005	0	0	0	0	0	0	0	0	0	0	0	0
Jul - 2005	0	0	0	0	0	0	0	0	0	0	0	0
Aug - 2005	0	0	0	0	0	0	0	0	0	0	0	0
Sep - 2005	0	0	0	0	0	0	0	0	0	0	0	0
Oct - 2005	0	0	0	0	0	0	0	0	0	0	0	0
Nov - 2005	0	0	0	0	0	0	0	0	0	0	0	0
Dec - 2005	0	0	0	0	0	0	0	0	0	0	0	0
Jan - 2006	0	0	0	0	0	0	0	0	0	0	0	0
Feb - 2006	0	0	0	0	0	0	0	0	0	0	0	0
Mar - 2006	0	0	0	0	0	0	0	0	0	0	0	0
Apr - 2006	0	0	0	0	0	0	0	0	0	0	0	0
May - 2006	0	0	0	0	0	0	0	0	0	0	0	0
Jun - 2006	0	0	0	0	0	0	0	0	0	0	0	0

Table A-3 cont'd. Phase Condition of Counties based on Average Phase Condition of Wells using Single-period (1-mo) and Multiperiod (2-mo and 3-mo) Indicators

	Marion County			Lake County			Seminole County			Orange County		
	1-mo	2-mo	3-mo	1-mo	2-mo	3-mo	1-mo	2-mo	3-mo	1-mo	2-mo	3-mo
Jul - 2006	0	0	0	0	0	0	0	0	0	0	0	0
Aug - 2006	0	0	0	0	0	0	0	0	0	1	0	0
Sep - 2006	0	0	0	0	0	0	0	0	0	0	0	0
Oct - 2006	0	0	0	1	0	0	2	0	0	3	0	0
Nov - 2006	0	0	0	1	1	0	2	2	0	2	2	0
Dec - 2006	0	0	0	0	1	0	1	2	1	1	2	1
Jan - 2007	0	0	0	0	0	0	0	1	1	0	1	1
Feb - 2007	0	0	0	0	0	0	0	0	1	1	0	1
Mar - 2007	0	0	0	0	0	0	0	0	1	2	1	1
Apr - 2007	1	0	0	0	0	0	1	0	1	1	1	1
May - 2007	0	0	0	0	0	0	1	1	1	1	1	1
Jun - 2007	0	0	0	1	0	0	1	1	1	3	1	1
Jul - 2007	1	0	0	3	1	0	2	1	1	3	3	1
Aug - 2007	1	1	0	3	3	1	3	2	1	3	3	3
Sep - 2007	1	1	1	3	3	3	3	3	2	4	3	3
Oct - 2007	1	1	1	2	3	3	2	3	2	2	3	3
Nov - 2007	0	1	1	1	2	3	2	2	2	2	2	3
Dec - 2007	0	0	1	2	2	2	2	2	2	3	2	3
Jan - 2008	0	0	0	2	2	2	2	2	1	1	2	3
Feb - 2008	0	0	0	1	2	2	1	1	1	1	1	3
Mar - 2008	0	0	0	0	1	2	0	0	1	0	1	1
Apr - 2008	0	0	0	0	0	1	0	0	1	0	0	1
May - 2008	0	0	0	0	0	0	0	0	0	0	0	0
Jun - 2008	0	0	0	1	0	0	0	0	0	1	0	0
Jul - 2008	0	0	0	1	1	0	0	0	0	0	0	0
Aug - 2008	0	0	0	0	1	0	0	0	0	0	0	0
Sep - 2008	0	0	0	0	0	0	0	0	0	0	0	0
Oct - 2008	0	0	0	0	0	0	0	0	0	0	0	0
Nov - 2008	0	0	0	1	0	0	0	0	0	0	0	0
Dec - 2008	0	0	0	0	0	0	0	0	0	0	0	0
Jan - 2009	0	0	0	1	0	0	0	0	0	0	0	0
Feb - 2009	0	0	0	0	0	0	0	0	0	0	0	0
Mar - 2009	0	0	0	1	0	0	0	0	0	0	0	0
Apr - 2009	0	0	0	1	1	0	0	0	0	0	0	0
May - 2009	0	0	0	1	1	1	0	0	0	0	0	0
Jun - 2009	0	0	0	0	1	1	0	0	0	0	0	0
Jul - 2009	0	0	0	0	0	1	0	0	0	0	0	0
Aug - 2009	0	0	0	0	0	0	0	0	0	0	0	0
Sep - 2009	0	0	0	0	0	0	0	0	0	0	0	0
Oct - 2009	0	0	0	0	0	0	0	0	0	0	0	0
Nov - 2009	0	0	0	0	0	0	0	0	0	0	0	0
Dec - 2009	0	0	0	0	0	0	0	0	0	0	0	0

Table A-3 cont'd. Phase Condition of Counties based on Average Phase Condition of Wells using Single-period (1-mo) and Multiperiod (2-mo and 3-mo) Indicators

	Marion County			Lake County			Seminole County			Orange County		
	1-mo	2-mo	3-mo	1-mo	2-mo	3-mo	1-mo	2-mo	3-mo	1-mo	2-mo	3-mo
Jan - 2010	0	0	0	0	0	0	0	0	0	0	0	0
Feb - 2010	0	0	0	0	0	0	0	0	0	0	0	0
Mar - 2010	0	0	0	0	0	0	0	0	0	0	0	0
Apr - 2010	0	0	0	0	0	0	0	0	0	0	0	0
May - 2010	0	0	0	0	0	0	0	0	0	0	0	0
Jun - 2010	0	0	0	0	0	0	0	0	0	0	0	0
Jul - 2010	0	0	0	0	0	0	0	0	0	0	0	0
Aug - 2010	0	0	0	0	0	0	0	0	0	0	0	0
Sep - 2010	0	0	0	0	0	0	0	0	0	0	0	0
Oct - 2010	0	0	0	0	0	0	1	0	0	0	0	0
Nov - 2010	0	0	0	1	0	0	2	1	0	0	0	0
Dec - 2010	0	0	0	1	1	0	2	2	1	0	0	0
Jan - 2011	0	0	0	1	1	1	2	2	1	0	0	0
Feb - 2011	0	0	0	0	1	1	0	2	1	0	0	0
Mar - 2011	0	0	0	0	0	1	1	1	1	0	0	0
Apr - 2011	0	0	0	0	0	0	0	1	1	0	0	0
May - 2011	0	0	0	0	0	0	0	0	1	0	0	0
Jun - 2011	0	0	0	0	0	0	1	0	1	0	0	0
Jul - 2011	1	0	0	1	0	0	0	0	1	1	0	0
Aug - 2011	2	1	0	1	0	0	0	0	1	0	0	0
Sep - 2011	2	2	1	1	1	0	2	1	1	1	0	0
Oct - 2011	3	2	2	1	1	1	0	1	1	0	0	0
Nov - 2011	3	3	2	1	1	1	0	0	1	0	0	0
Dec - 2011	3	3	3	1	1	1	0	0	0	0	0	0
Jan - 2012	3	3	3	1	1	1	1	0	0	2	0	0
Feb - 2012	2	3	3	2	1	1	1	1	0	2	2	0
Mar - 2012	3	3	3	3	2	1	1	1	0	2	2	1
Apr - 2012	4	3	3	3	3	2	2	1	1	2	2	1
May - 2012	4	4	3	3	3	3	1	1	1	2	2	2
Jun - 2012	2	4	3	1	3	3	0	1	1	0	2	2
Jul - 2012	1	2	3	0	1	3	0	0	1	1	0	2
Aug - 2012	0	1	2	0	0	1	0	0	0	0	0	0
Sep - 2012	0	0	1	0	0	0	0	0	0	0	0	0
Oct - 2012	0	0	0	0	0	0	0	0	0	0	0	0
Nov - 2012	1	0	0	0	0	0	0	0	0	1	0	0
Dec - 2012	1	1	0	0	0	0	0	0	0	0	0	0
Jan - 2013	1	1	1	0	0	0	0	0	0	1	0	0
Feb - 2013	0	1	1	1	0	0	1	0	0	2	1	0
Mar - 2013	1	1	1	1	1	0	1	0	0	1	1	0
Apr - 2013	1	1	1	1	1	1	0	0	0	1	1	0
May - 2013	1	1	1	1	1	1	0	0	0	0	1	0
Jun - 2013	1	1	1	0	1	1	0	0	0	0	0	0
Jul - 2013	1	1	1	1	1	0	0	0	0	0	0	0

Table A-4. Phase Condition of the MSJGB based on Average Phase Condition of Wells using Single-period (1-mo) and Multiperiod (2-mo and 3-mo) Indicators

	1-mo	2-mo	3-mo
Jan - 1998	0	0	0
Feb - 1998	0	0	0
Mar - 1998	0	0	0
Apr - 1998	0	0	0
May - 1998	0	0	0
Jun - 1998	1	0	0
Jul - 1998	0	0	0
Aug - 1998	0	0	0
Sep - 1998	0	0	0
Oct - 1998	0	0	0
Nov - 1998	0	0	0
Dec - 1998	0	0	0
Jan - 1999	0	0	0
Feb - 1999	0	0	0
Mar - 1999	0	0	0
Apr - 1999	1	0	0
May - 1999	0	0	0
Jun - 1999	0	0	0
Jul - 1999	0	0	0
Aug - 1999	1	0	0
Sep - 1999	0	0	0
Oct - 1999	0	0	0
Nov - 1999	0	0	0
Dec - 1999	0	0	0
Jan - 2000	0	0	0

Table A-4 cont'd. Phase Condition of the MSJGB based on Average Phase Condition of Wells using Single-period (1-mo) and Multiperiod (2-mo and 3-mo) Indicators

	1-mo	2-mo	3-mo
Feb - 2000	0	0	0
Mar - 2000	1	0	0
Apr - 2000	1	1	0
May - 2000	2	1	1
Jun - 2000	2	2	1
Jul - 2000	3	2	2
Aug - 2000	4	3	2
Sep - 2000	3	3	3
Oct - 2000	4	3	3
Nov - 2000	4	4	3
Dec - 2000	4	4	4
Jan - 2001	4	4	4
Feb - 2001	3	4	4
Mar - 2001	4	4	4
Apr - 2001	3	4	4
May - 2001	3	4	4
Jun - 2001	3	3	4
Jul - 2001	3	3	3
Aug - 2001	1	3	3
Sep - 2001	1	2	2
Oct - 2001	1	1	2
Nov - 2001	1	1	1
Dec - 2001	1	1	1
Jan - 2002	1	1	1
Feb - 2002	0	1	1
Mar - 2002	1	1	1
Apr - 2002	1	1	1
May - 2002	1	1	1
Jun - 2002	1	1	1
Jul - 2002	0	1	1
Aug - 2002	0	0	1

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Table A-4 cont'd. Phase Condition of the MSJGB based on Average Phase Condition of Wells using Single-period (1-mo) and Multiperiod (2-mo and 3-mo) Indicators

	1-mo	2-mo	3-mo
Sep - 2002	0	0	0
Oct - 2002	0	0	0
Nov - 2002	0	0	0
Dec - 2002	0	0	0
Jan - 2003	0	0	0
Feb - 2003	0	0	0
Mar - 2003	0	0	0
Apr - 2003	0	0	0
May - 2003	0	0	0
Jun - 2003	0	0	0
Jul - 2003	0	0	0
Aug - 2003	0	0	0
Sep - 2003	0	0	0
Oct - 2003	0	0	0
Nov - 2003	0	0	0
Dec - 2003	0	0	0
Jan - 2004	0	0	0
Feb - 2004	0	0	0
Mar - 2004	0	0	0
Apr - 2004	0	0	0
May - 2004	0	0	0
Jun - 2004	0	0	0
Jul - 2004	0	0	0
Aug - 2004	0	0	0
Sep - 2004	0	0	0
Oct - 2004	0	0	0
Nov - 2004	0	0	0
Dec - 2004	0	0	0
Jan - 2005	0	0	0
Feb - 2005	0	0	0
Mar - 2005	0	0	0
Apr - 2005	0	0	0

Table A-4 cont'd. Phase Condition of the MSJGB based on Average Phase Condition of Wells using Single-period (1-mo) and Multiperiod (2-mo and 3-mo) Indicators

	1-mo	2-mo	3-mo
May - 2005	0	0	0
Jun - 2005	0	0	0
Jul - 2005	0	0	0
Aug - 2005	0	0	0
Sep - 2005	0	0	0
Oct - 2005	0	0	0
Nov - 2005	0	0	0
Dec - 2005	0	0	0
Jan - 2006	0	0	0
Feb - 2006	0	0	0
Mar - 2006	0	0	0
Apr - 2006	0	0	0
May - 2006	0	0	0
Jun - 2006	0	0	0
Jul - 2006	0	0	0
Aug - 2006	0	0	0
Sep - 2006	0	0	0
Oct - 2006	2	0	0
Nov - 2006	1	1	0
Dec - 2006	1	1	1
Jan - 2007	0	1	1
Feb - 2007	0	0	1
Mar - 2007	0	0	0
Apr - 2007	0	0	0
May - 2007	1	0	0
Jun - 2007	1	0	0
Jul - 2007	2	1	0
Aug - 2007	2	2	1
Sep - 2007	3	2	2
Oct - 2007	2	2	2
Nov - 2007	1	2	2
Dec - 2007	2	1	2
Jan - 2008	1	1	2
Feb - 2008	0	1	2
Mar - 2008	0	0	1

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Table A-4 cont'd. Phase Condition of the MSJGB based on Average Phase Condition of Wells using Single-period (1-mo) and Multiperiod (2-mo and 3-mo) Indicators

	1-mo	2-mo	3-mo
Apr - 2008	0	0	0
May - 2008	0	0	0
Jun - 2008	0	0	0
Jul - 2008	0	0	0
Aug - 2008	0	0	0
Sep - 2008	0	0	0
Oct - 2008	0	0	0
Nov - 2008	0	0	0
Dec - 2008	0	0	0
Jan - 2009	0	0	0
Feb - 2009	0	0	0
Mar - 2009	0	0	0
Apr - 2009	0	0	0
May - 2009	0	0	0
Jun - 2009	0	0	0
Jul - 2009	0	0	0
Aug - 2009	0	0	0
Sep - 2009	0	0	0
Oct - 2009	0	0	0
Nov - 2009	0	0	0
Dec - 2009	0	0	0
Jan - 2010	0	0	0
Feb - 2010	0	0	0
Mar - 2010	0	0	0
Apr - 2010	0	0	0
May - 2010	0	0	0
Jun - 2010	0	0	0
Jul - 2010	0	0	0
Aug - 2010	0	0	0

Table A-4 cont'd. Phase Condition of the MSJGB based on Average Phase Condition of Wells using Single-period (1-mo) and Multiperiod (2-mo and 3-mo) Indicators

	1-mo	2-mo	3-mo
Sep - 2010	0	0	0
Oct - 2010	0	0	0
Nov - 2010	1	0	0
Dec - 2010	1	1	0
Jan - 2011	1	1	1
Feb - 2011	0	1	1
Mar - 2011	0	0	1
Apr - 2011	0	0	0
May - 2011	0	0	0
Jun - 2011	0	0	0
Jul - 2011	1	0	0
Aug - 2011	1	0	0
Sep - 2011	2	1	0
Oct - 2011	1	1	1
Nov - 2011	1	1	1
Dec - 2011	1	1	1
Jan - 2012	2	1	1
Feb - 2012	1	1	1
Mar - 2012	2	2	1
Apr - 2012	2	2	1
May - 2012	2	2	2
Jun - 2012	1	2	2
Jul - 2012	0	1	2
Aug - 2012	0	0	1
Sep - 2012	0	0	0
Oct - 2012	0	0	0
Nov - 2012	0	0	0
Dec - 2012	0	0	0
Jan - 2013	0	0	0
Feb - 2013	1	0	0
Mar - 2013	1	1	0
Apr - 2013	1	1	0
May - 2013	0	1	0
Jun - 2013	0	0	0
Jul - 2013	0	0	0

Table A-5. Percent Chance that Well will Exhibit Phase Condition (based on Data from 1998 - 2012).

Phase Condition	M-0013	M-0026	M-0031	M-0483	L-0043	L-0059	L-0095	L-0199	S-0001	S-0086	S-1014	S-1056	S-1193	S-1201	S-1230	S-1253	OR0009	OR0046	OR0106	OR0548
JANUARY																				
0	80%	80%	80%	80%	87%	80%	87%	80%	80%	80%	80%	87%	80%	80%	73%	80%	80%	80%	80%	80%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	7%	0%	0%	0%	0%	0%
2	7%	7%	7%	7%	0%	7%	0%	7%	7%	7%	7%	0%	7%	7%	7%	7%	13%	13%	7%	13%
3	7%	7%	7%	13%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	0%	0%	7%	0%
4	7%	7%	7%	0%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%
FEBRUARY																				
0	80%	80%	80%	87%	80%	80%	80%	80%	80%	87%	80%	80%	80%	87%	80%	87%	80%	80%	80%	80%
1	0%	0%	0%	0%	0%	0%	7%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	7%	7%	7%	0%	7%	7%	0%	7%	7%	0%	7%	7%	7%	0%	7%	7%	13%	13%	7%	13%
3	7%	7%	7%	13%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	0%	0%	0%	7%	0%
4	7%	7%	7%	0%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%
MARCH																				
0	80%	80%	80%	87%	80%	80%	80%	80%	80%	80%	80%	80%	87%	87%	80%	80%	80%	80%	80%	80%
1	0%	0%	0%	0%	7%	7%	7%	7%	0%	0%	7%	7%	0%	0%	7%	7%	7%	7%	7%	7%
2	7%	7%	7%	0%	7%	7%	0%	0%	13%	13%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%
3	7%	7%	7%	13%	0%	0%	13%	7%	0%	0%	0%	0%	7%	0%	0%	0%	0%	0%	0%	7%
4	7%	7%	7%	0%	7%	7%	0%	7%	7%	7%	7%	7%	0%	7%	7%	7%	7%	7%	7%	0%
APRIL																				
0	80%	80%	80%	87%	87%	80%	80%	80%	80%	80%	87%	73%	80%	80%	80%	80%	80%	80%	80%	80%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	7%	7%	0%	0%
2	7%	7%	7%	0%	0%	13%	7%	7%	7%	7%	7%	13%	7%	13%	13%	7%	7%	7%	13%	7%
3	7%	7%	7%	7%	7%	0%	7%	7%	7%	7%	0%	7%	13%	0%	0%	7%	0%	0%	0%	7%
4	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	0%	7%	7%	7%	7%	7%	7%	7%
MAY																				
0	80%	80%	80%	87%	80%	80%	80%	80%	87%	80%	87%	73%	80%	80%	80%	80%	87%	87%	80%	80%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	7%	7%	7%	0%	7%	13%	7%	7%	0%	7%	7%	13%	7%	13%	13%	7%	7%	7%	13%	7%
3	7%	7%	7%	7%	7%	0%	7%	7%	7%	7%	0%	13%	13%	0%	0%	7%	0%	0%	0%	7%
4	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	0%	0%	7%	7%	7%	7%	7%	7%	7%
JUNE																				
0	80%	80%	80%	87%	80%	80%	80%	80%	80%	80%	87%	87%	80%	87%	80%	80%	87%	87%	80%	80%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	7%	7%	7%	0%	13%	7%	7%	7%	7%	13%	0%	0%	13%	0%	7%	13%	0%	0%	13%	7%
3	7%	7%	7%	7%	0%	13%	7%	7%	7%	0%	7%	7%	7%	7%	7%	0%	7%	13%	0%	7%
4	7%	7%	7%	7%	7%	0%	7%	7%	7%	7%	7%	7%	0%	7%	7%	7%	7%	0%	7%	7%

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Table A-5 cont'd. Percent Chance that Well will Exhibit Phase Condition (based on Data from 1998 - 2012).

Phase Condition	M-0013	M-0026	M-0031	M-0483	L-0043	L-0059	L-0095	L-0199	S-0001	S-0086	S-1014	S-1056	S-1193	S-1201	S-1230	S-1253	OR0009	OR0046	OR0106	OR0548
JULY																				
0	80%	80%	80%	87%	87%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	73%	87%	80%	87%	87%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	7%	7%	13%	0%	0%	7%	7%	7%	7%	13%	7%	13%	7%	7%	7%	13%	0%	7%	0%	0%
3	7%	7%	0%	7%	7%	7%	13%	7%	7%	0%	7%	0%	7%	7%	7%	7%	7%	13%	7%	7%
4	7%	7%	7%	7%	7%	7%	0%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	0%	7%	7%
AUGUST																				
0	80%	80%	80%	80%	80%	80%	87%	80%	80%	80%	80%	80%	80%	80%	80%	80%	87%	80%	80%	87%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	7%	7%	7%	7%	7%	7%	0%	7%	7%	7%	7%	13%	7%	13%	13%	7%	0%	7%	7%	0%
3	7%	7%	7%	13%	7%	7%	7%	7%	7%	7%	7%	0%	7%	0%	0%	7%	7%	7%	7%	7%
4	7%	7%	7%	0%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%
SEPTEMBER																				
0	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	87%	80%	87%	87%	80%	87%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	7%	7%	7%	13%	7%	7%	7%	7%	7%	7%	7%	13%	7%	13%	7%	7%	0%	0%	7%	7%
3	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	0%	13%	0%	0%	13%	7%	7%	7%	0%
4	7%	7%	7%	0%	7%	7%	7%	7%	7%	7%	7%	7%	0%	7%	7%	0%	7%	7%	7%	7%
OCTOBER																				
0	80%	80%	80%	80%	80%	80%	80%	80%	87%	80%	80%	87%	80%	80%	80%	87%	87%	87%	80%	87%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	7%	7%	7%	13%	7%	7%	7%	7%	0%	7%	7%	7%	7%	13%	13%	0%	0%	0%	0%	7%
3	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	0%	13%	0%	0%	13%	7%	7%	20%	0%
4	7%	7%	7%	0%	7%	7%	7%	7%	7%	7%	7%	7%	0%	7%	7%	0%	7%	7%	0%	7%
NOVEMBER																				
0	80%	80%	80%	80%	80%	80%	87%	80%	80%	80%	80%	80%	80%	80%	80%	87%	80%	80%	80%	80%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	7%	0%	0%	0%	0%	0%	0%
2	7%	7%	7%	7%	7%	7%	0%	7%	7%	7%	7%	7%	7%	7%	7%	0%	7%	7%	7%	7%
3	7%	7%	7%	13%	7%	7%	7%	7%	7%	7%	7%	7%	7%	0%	7%	7%	7%	7%	7%	13%
4	7%	7%	7%	0%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	0%
DECEMBER																				
0	80%	80%	80%	80%	80%	80%	87%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	7%	7%	7%	7%	7%	7%	0%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%
3	7%	7%	7%	13%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%
4	7%	7%	7%	0%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%

Table A-6. Transitional Probabilities based on Two-month Multiperiod Indicator Values.

Phase Condition	M-0013					M-0026					M-0031					M-0483 (S)				
Percent Chance that Phase i (row header) in Jan will Transition to Phase j (column header) in Feb (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
3	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%
Percent Chance that Phase i (row header) in Feb will Transition to Phase j (column header) in Mar (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%
3	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%
Percent Chance that Phase i (row header) in Mar will Transition to Phase j (column header) in Apr (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%
3	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	50%	50%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%
Percent Chance that Phase i (row header) in Apr will Transition to Phase j (column header) in May (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%
3	0%	0%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%
4	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in May will Transition to Phase j (column header) in Jun (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%
3	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in Jun will Transition to Phase j (column header) in Jul (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	92%	0%	8%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%
3	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%
4	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%

Table A-6 cont'd. Transitional Probabilities based on Two-month Multiperiod Indicator Values.

Phase Condition	M-0013					M-0026					M-0031					M-0483 (S)				
Percent Chance that Phase i (row header) in Jul will Transition to Phase j (column header) in Aug (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	83%	0%	8%	8%	0%	100%	0%	0%	0%	0%	83%	0%	8%	8%	0%	92%	0%	8%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%
3	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%
Percent Chance that Phase i (row header) in Aug will Transition to Phase j (column header) in Sep (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	92%	0%	0%	8%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%
3	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	50%	0%	50%	0%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%
Percent Chance that Phase i (row header) in Sep will Transition to Phase j (column header) in Oct (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	92%	0%	8%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%
3	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%
Percent Chance that Phase i (row header) in Oct will Transition to Phase j (column header) in Nov (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	92%	0%	0%	8%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%	50%	0%	50%	0%	0%
3	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%
Percent Chance that Phase i (row header) in Nov will Transition to Phase j (column header) in Dec (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	92%	0%	8%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
3	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%
Percent Chance that Phase i (row header) in Dec will Transition to Phase j (column header) in Jan (Dec 1998 to Jan 1999, … Dec 2012 - Jan 2013)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%
3	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%

Table A-6 cont'd. Transitional Probabilities based on Two-month Multiperiod Indicator Values.

Phase Condition	L-0043					L-0059					L-0095					L-0199				
Percent Chance that Phase i (row header) in Jan will Transition to Phase j (column header) in Feb (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	92%	0%	8%	0%	0%	100%	0%	0%	0%	0%	92%	8%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%
3	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in Feb will Transition to Phase j (column header) in Mar (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	83%	8%	8%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
3	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in Mar will Transition to Phase j (column header) in Apr (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	92%	0%	8%	0%	0%
1	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
2	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
3	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	50%	50%	0%	0%	0%	100%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in Apr will Transition to Phase j (column header) in May (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	92%	0%	8%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%
3	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in May will Transition to Phase j (column header) in Jun (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	100%	0%	0%	0%	0%	50%	50%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%
3	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in Jun will Transition to Phase j (column header) in Jul (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	92%	0%	0%	8%	0%	92%	0%	8%	0%	0%	92%	0%	8%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%
3	0%	0%	0%	0%	0%	0%	0%	0%	50%	50%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%

SIMMONS ENVIRONMENTAL CONSULTING

Table A-6 cont'd. Transitional Probabilities based on Two-month Multiperiod Indicator Values.

Phase Condition	L-0043					L-0059					L-0095					L-0199				
Percent Chance that Phase i (row header) in Jul will Transition to Phase j (column header) in Aug (1998-2012)																				
	0	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**
0	92%	0%	8%	0%	0%	92%	0%	0%	8%	0%	100%	0%	0%	0%	0%	92%	0%	8%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	100%	0%	0%	0%	0%
3	0%	0%	0%	100%	0%	100%	0%	0%	0%	0%	50%	0%	0%	50%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in Aug will Transition to Phase j (column header) in Sep (1998-2012)																				
	0	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**
0	100%	0%	0%	0%	0%	92%	0%	8%	0%	0%	92%	0%	8%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
3	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%
4	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in Sep will Transition to Phase j (column header) in Oct (1998-2012)																				
	0	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**
0	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	92%	0%	0%	8%	0%	92%	0%	8%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
3	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in Oct will Transition to Phase j (column header) in Nov (1998-2012)																				
	0	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**
0	92%	0%	8%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%	100%	0%	0%
3	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%
4	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Percent Chance that Phase i (row header) in Nov will Transition to Phase j (column header) in Dec (1998-2012)																				
	0	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**
0	100%	0%	0%	0%	0%	92%	0%	0%	8%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%
3	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in Dec will Transition to Phase j (column header) in Jan (Dec 1998 to Jan 1999, … Dec 2012 - Jan 2013)																				
	0	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**
0	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%
3	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%

SIMMONS ENVIRONMENTAL CONSULTING

Table A-6 cont'd. Transitional Probabilities based on Two-month Multiperiod Indicator Values.

Phase Condition	S-0001					S-0086					S-1014					S-1056				
Percent Chance that Phase i (row header) in Jan will Transition to Phase j (column header) in Feb (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	92%	0%	8%	0%	0%	1	0%	0%	0%	0%	92%	0%	8%	0%	0%	92%	0%	8%	0%	0%
1	0%	0%	0%	0%	0%	0	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	100%	0%	0%	0%	0%	1	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%
3	0%	0%	0%	100%	0%	0	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	0%	100%	0	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in Feb will Transition to Phase j (column header) in Mar (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	92%	0%	8%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%
3	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in Mar will Transition to Phase j (column header) in Apr (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	92%	0%	8%	0%	0%	83%	0%	8%	8%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
2	0%	0%	50%	50%	0%	0%	0%	50%	50%	0%	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%
3	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in Apr will Transition to Phase j (column header) in May (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	92%	0%	8%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%
3	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%
Percent Chance that Phase i (row header) in May will Transition to Phase j (column header) in Jun (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	92%	0%	8%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	100%	0%	0%	0%	0%
3	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	50%	50%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%
Percent Chance that Phase i (row header) in Jun will Transition to Phase j (column header) in Jul (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	92%	0%	0%	0%	8%	92%	0%	0%	8%	0%	85%	0%	15%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	0%	0%	100%	50%	0%	50%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
3	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
4	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%

Table A-6 cont'd. Transitional Probabilities based on Two-month Multiperiod Indicator Values.

Phase Condition	S-0001					S-0086					S-1014					S-1056				
Percent Chance that Phase i (row header) in Jul will Transition to Phase j (column header) in Aug (1998-2012)																				
	0	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**
0	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	100%	0%	0%	0%	0%	50%	50%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%
3	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in Aug will Transition to Phase j (column header) in Sep (1998-2012)																				
	0	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**
0	92%	0%	0%	8%	0%	92%	0%	8%	0%	0%	92%	0%	8%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%
3	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in Sep will Transition to Phase j (column header) in Oct (1998-2012)																				
	0	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**
0	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	50%	0%	50%	0%	0%
3	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in Oct will Transition to Phase j (column header) in Nov (1998-2012)																				
	0	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**
0	92%	0%	8%	0%	0%	83%	0%	8%	8%	0%	92%	0%	0%	8%	0%	92%	0%	0%	8%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%
3	0%	0%	0%	100%	0%	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in Nov will Transition to Phase j (column header) in Dec (1998-2012)																				
	0	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**
0	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%
3	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in Dec will Transition to Phase j (column header) in Jan (Dec 1998 to Jan 1999, … Dec 2012 - Jan 2013)																				
	0	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**
0	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%
3	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%

Table A-6 cont'd. Transitional Probabilities based on Two-month Multiperiod Indicator Values.

Phase Condition	S-1193					S-1201					S-1230					S-1253				
Percent Chance that Phase i (row header) in Jan will Transition to Phase j (column header) in Feb (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	92%	0%	0%	8%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
3	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in Feb will Transition to Phase j (column header) in Mar (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	92%	0%	8%	0%	0%	92%	8%	0%	0%	0%	92%	8%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%
3	0%	0%	0%	100%	0%	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%
4	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in Mar will Transition to Phase j (column header) in Apr (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	92%	0%	0%	8%	0%	92%	0%	8%	0%	0%	92%	0%	8%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%
2	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%
3	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
4	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in Apr will Transition to Phase j (column header) in May (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	92%	0%	8%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
3	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in May will Transition to Phase j (column header) in Jun (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	92%	0%	8%	0%	0%	92%	0%	8%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	100%	0%	0%	50%	0%	0%	0%	50%	50%	0%	0%	50%	0%	0%	0%	100%	0%	0%
3	0%	0%	50%	50%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%
4	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in Jun will Transition to Phase j (column header) in Jul (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	92%	0%	0%	8%	0%	92%	0%	8%	0%	0%	100%	0%	0%	0%	0%	92%	0%	0%	8%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	50%	0%	0%	0%	50%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%
3	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%
4	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%

SIMMONS ENVIRONMENTAL CONSULTING

Table A-6 cont'd. Transitional Probabilities based on Two-month Multiperiod Indicator Values.

Phase Condition	S-1193					S-1201					S-1230					S-1253				
Percent Chance that Phase i (row header) in Jul will Transition to Phase j (column header) in Aug (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	92%	0%	8%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	50%	0%	50%	0%	0%
3	0%	0%	0%	100%	0%	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in Aug will Transition to Phase j (column header) in Sep (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	92%	0%	0%	8%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	50%	0%	50%	0%	0%	0%	0%	0%	100%	0%
3	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
4	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	100%	0%	0%
Percent Chance that Phase i (row header) in Sep will Transition to Phase j (column header) in Oct (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	92%	0%	8%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
3	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%
Percent Chance that Phase i (row header) in Oct will Transition to Phase j (column header) in Nov (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	83%	8%	8%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	0%	100%	0%	100%	0%	0%	0%	0%	0%	0%	50%	50%	0%	0%	0%	0%	0%	0%
3	0%	0%	50%	0%	50%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	50%	50%
4	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%
Percent Chance that Phase i (row header) in Nov will Transition to Phase j (column header) in Dec (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	92%	0%	0%	8%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%
3	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in Dec will Transition to Phase j (column header) in Jan (Dec 1998 to Jan 1999, … Dec 2012 - Jan 2013)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	92%	0%	8%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%
3	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%

Table A-6 cont'd. Transitional Probabilities based on Two-month Multiperiod Indicator Values.

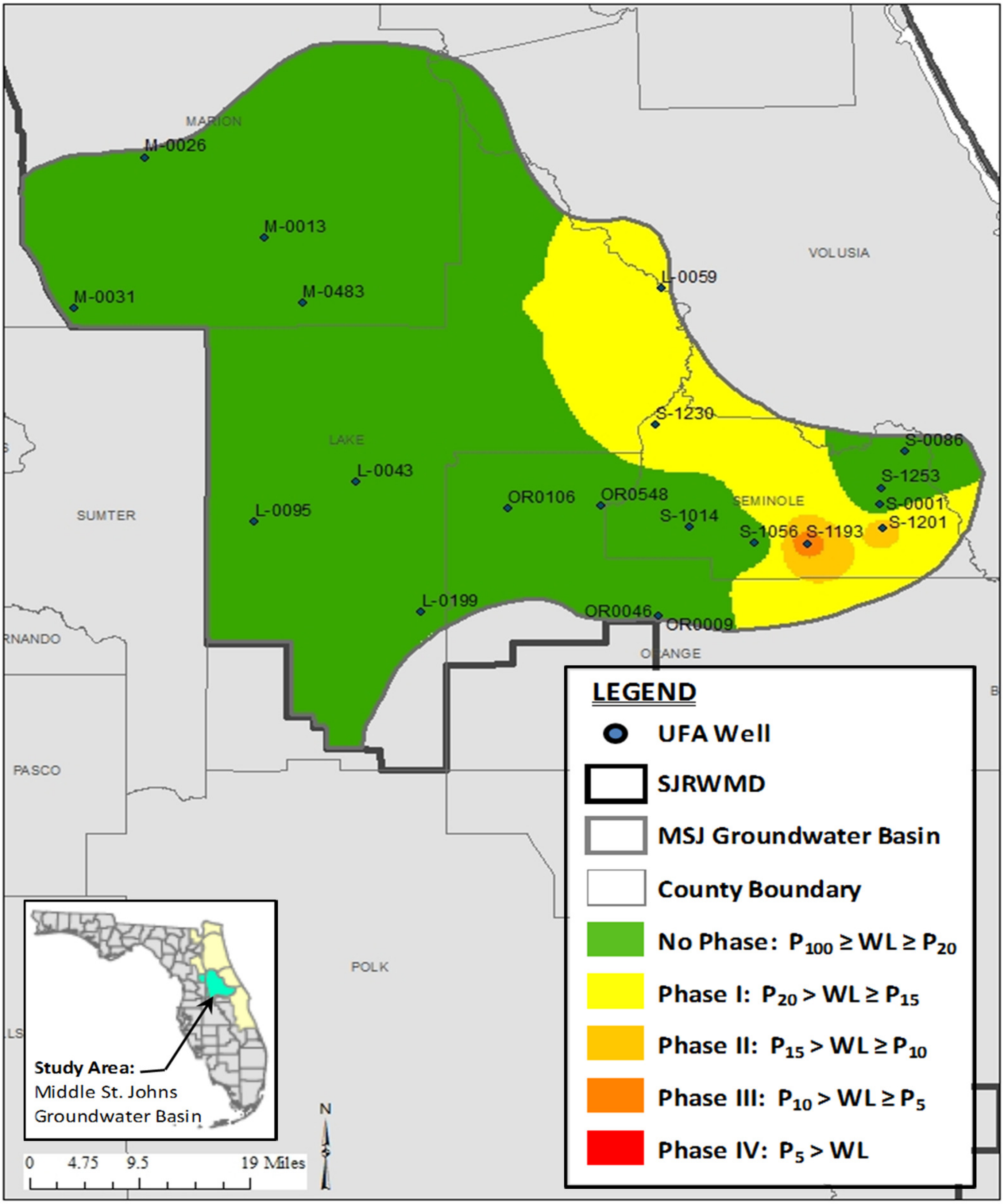
Phase Condition	OR0009					OR0046					OR0106					OR0548				
Percent Chance that Phase i (row header) in Jan will Transition to Phase j (column header) in Feb (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	92%	0%	8%	0%	0%	92%	0%	8%	0%	0%	100%	0%	0%	0%	0%	92%	0%	8%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	50%	0%	50%	0%	0%	50%	0%	50%	0%	0%	0%	0%	100%	0%	0%	50%	0%	50%	0%	0%
3	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in Feb will Transition to Phase j (column header) in Mar (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	92%	8%	0%	0%	0%	92%	8%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	50%	0%	50%	0%	0%	50%	0%	50%	0%	0%	0%	0%	100%	0%	0%	0%	50%	50%	0%	0%
3	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%
Percent Chance that Phase i (row header) in Mar will Transition to Phase j (column header) in Apr (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	92%	0%	8%	0%	0%	92%	0%	8%	0%	0%	92%	0%	8%	0%	0%	92%	0%	8%	0%	0%
1	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
2	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%
3	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%
Percent Chance that Phase i (row header) in Apr will Transition to Phase j (column header) in May (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%
3	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in May will Transition to Phase j (column header) in Jun (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%
3	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in Jun will Transition to Phase j (column header) in Jul (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	92%	0%	0%	8%	0%	85%	0%	8%	8%	0%	92%	0%	0%	8%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%
3	100%	0%	0%	0%	0%	50%	0%	0%	50%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	100%	0%	0%	0%	0%

SIMMONS ENVIRONMENTAL CONSULTING

Table A-6 cont'd. Transitional Probabilities based on Two-month Multiperiod Indicator Values.

Phase Condition	OR0009					OR0046					OR0106					OR0548				
Percent Chance that Phase i (row header) in Jul will Transition to Phase j (column header) in Aug (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	92%	0%	8%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
3	0%	0%	0%	100%	0%	0%	0%	0%	50%	50%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in Aug will Transition to Phase j (column header) in Sep (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	92%	0%	8%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%
3	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	100%	0%	0%	0%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in Sep will Transition to Phase j (column header) in Oct (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%
3	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%
Percent Chance that Phase i (row header) in Oct will Transition to Phase j (column header) in Nov (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	92%	0%	0%	8%	0%	92%	0%	0%	8%	0%	100%	0%	0%	0%	0%	92%	0%	0%	8%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
3	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	33%	33%	33%	0%	0%	0%	0%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%
Percent Chance that Phase i (row header) in Nov will Transition to Phase j (column header) in Dec (1998-2012)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%
3	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	50%	50%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%
Percent Chance that Phase i (row header) in Dec will Transition to Phase j (column header) in Jan (Dec 1998 to Jan 1999, … Dec 2012 - Jan 2013)																				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
0	92%	0%	8%	0%	0%	92%	0%	8%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%
3	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%
4	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%

APPENDIX 2 – FIGURES



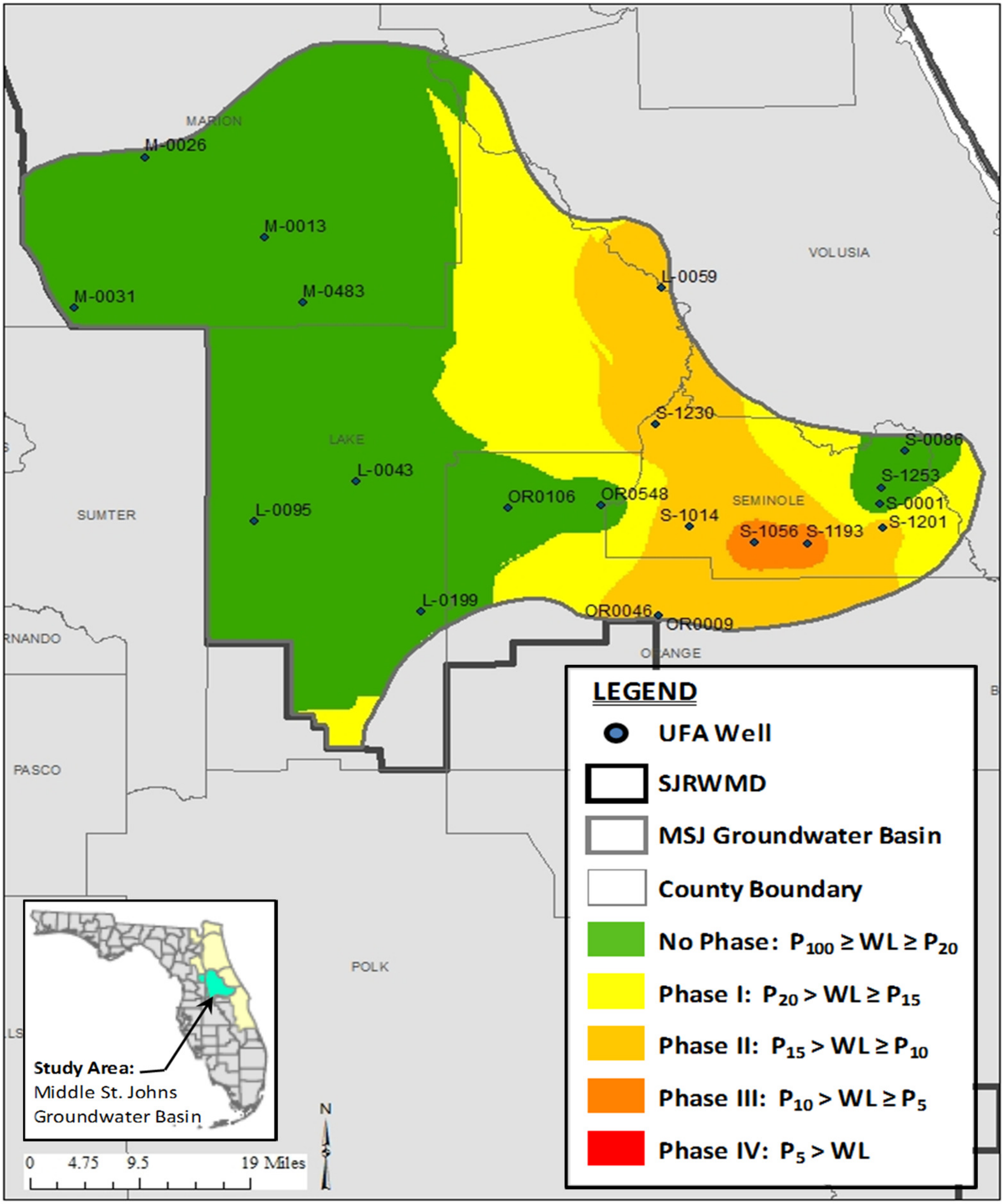
SIMMONS ENVIRONMENTAL CONSULTING

Figure A-1
Condition of the Upper Floridan Aquifer in the Middle St. Johns Groundwater Basin
March 2000

Notes : Condition is based on the percentile (P) of monthly-mean water levels (WLs). Percentiles calculated using each March from 1998 through 2012 (a 15-yr Period of Record). Phase definitions evaluated in this study do not represent SJRWMD rules or policy.

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT

Water Shortage Management
Contract 27625

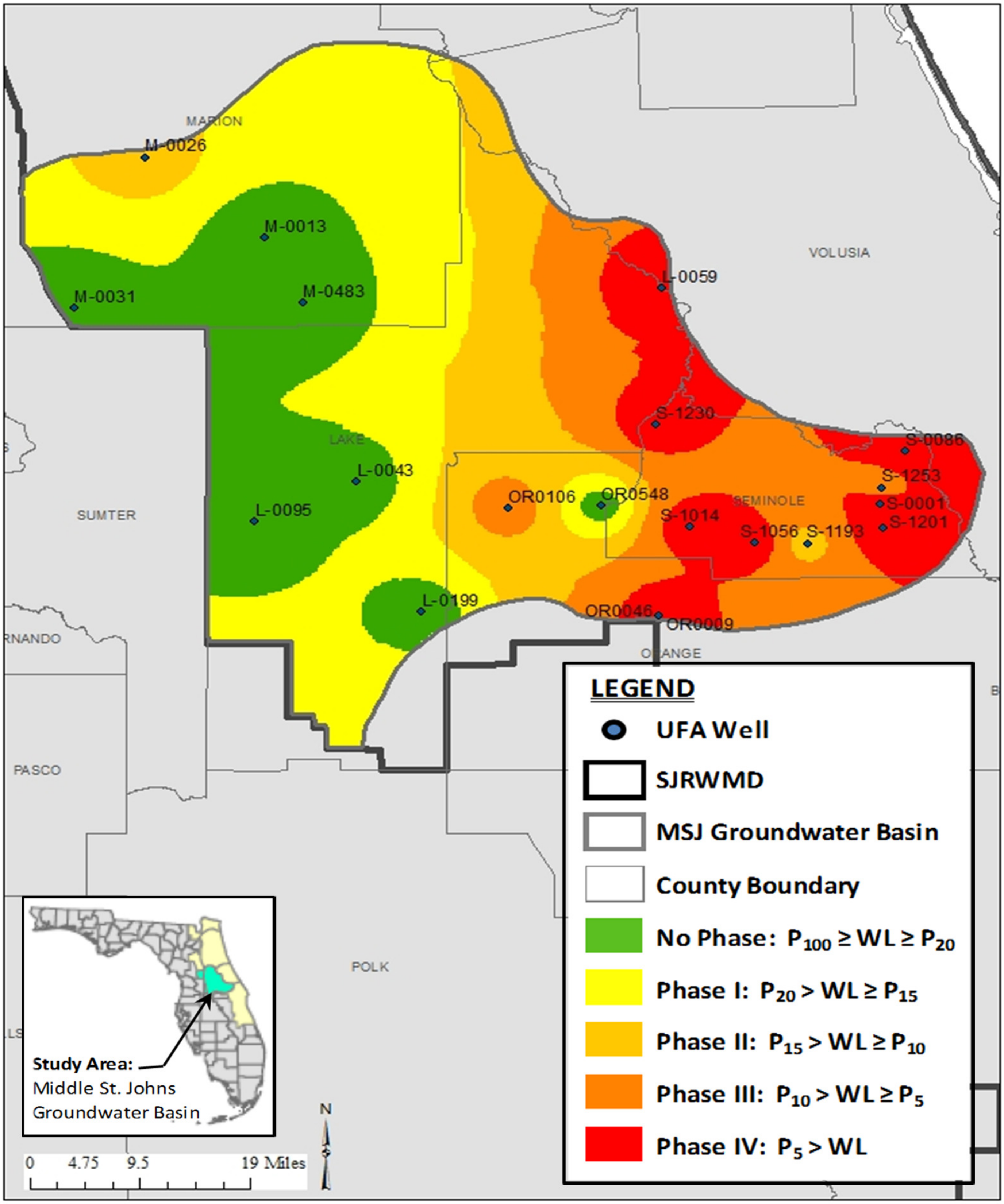


SIMMONS ENVIRONMENTAL CONSULTING

Figure A-2
Condition of the Upper Floridan Aquifer in the Middle St. Johns Groundwater Basin
April and May 2000

Notes : Condition is based on the percentile (P) of monthly-mean water levels (WLs). Percentiles calculated using each April and May from 1998 through 2012 (a 15-yr Period of Record). Phase definitions evaluated in this study do not represent SJRWMD rules or policy.

Water Shortage Management
Contract 27625



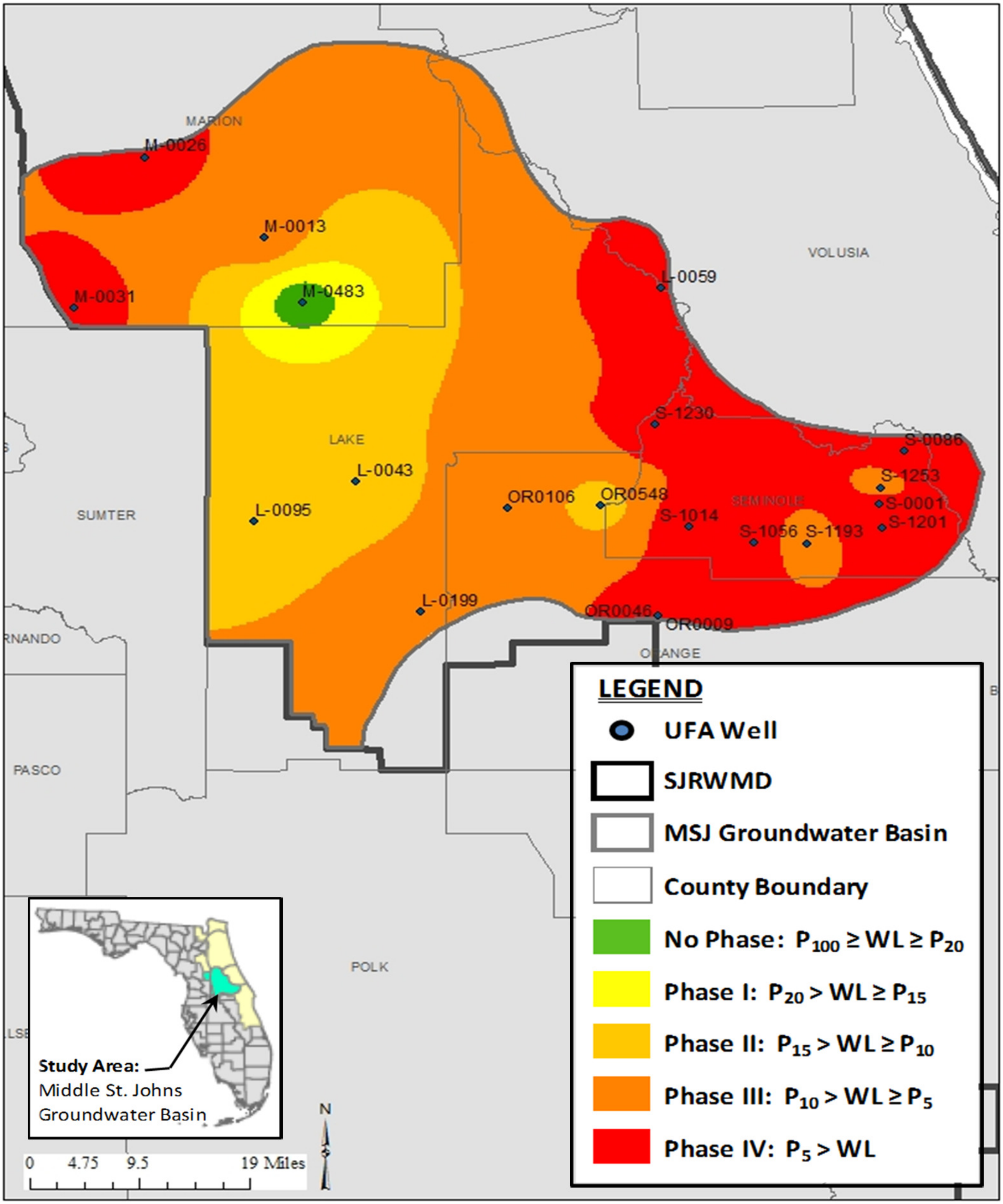
SIMMONS ENVIRONMENTAL CONSULTING

Figure A-3
Condition of the Upper Floridan Aquifer in the Middle St. Johns Groundwater Basin
July 2000

Notes : Condition is based on the percentile (P) of monthly-mean water levels (WLs). Percentiles calculated using each July from 1998 through 2012 (a 15-yr Period of Record). Phase definitions evaluated in this study do not represent SJRWMD rules or policy.

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT

Water Shortage Management
Contract 27625

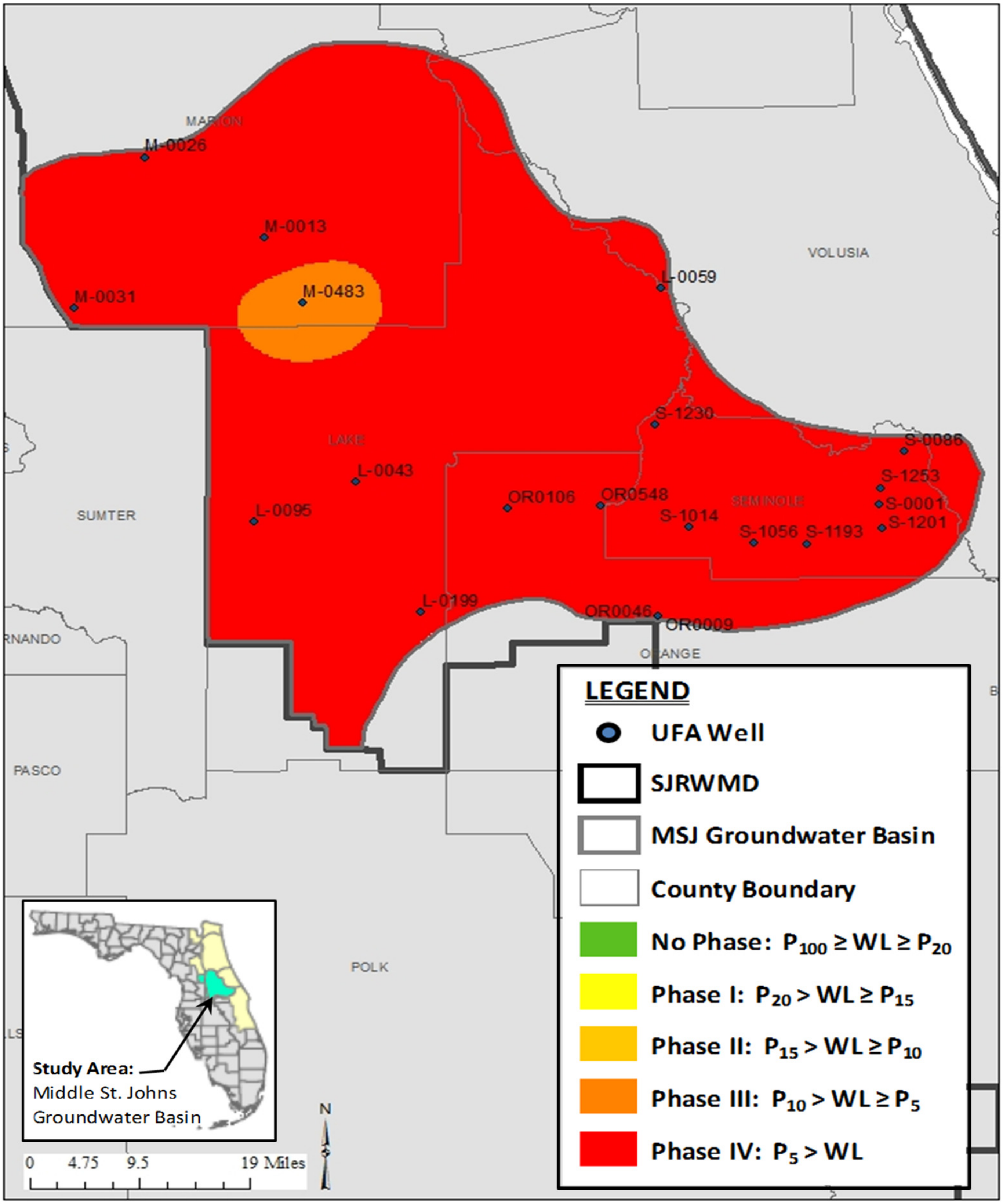


SIMMONS ENVIRONMENTAL CONSULTING

Figure A-4
Condition of the Upper Floridan Aquifer in the Middle St. Johns Groundwater Basin
September 2000

Notes: Condition is based on the percentile (P) of monthly-mean water levels (WLs). Percentiles calculated using each September from 1998 through 2012 (a 15-yr Period of Record). Phase definitions evaluated in this study do not represent SJRWMD rules or policy.

Water Shortage Management
Contract 27625

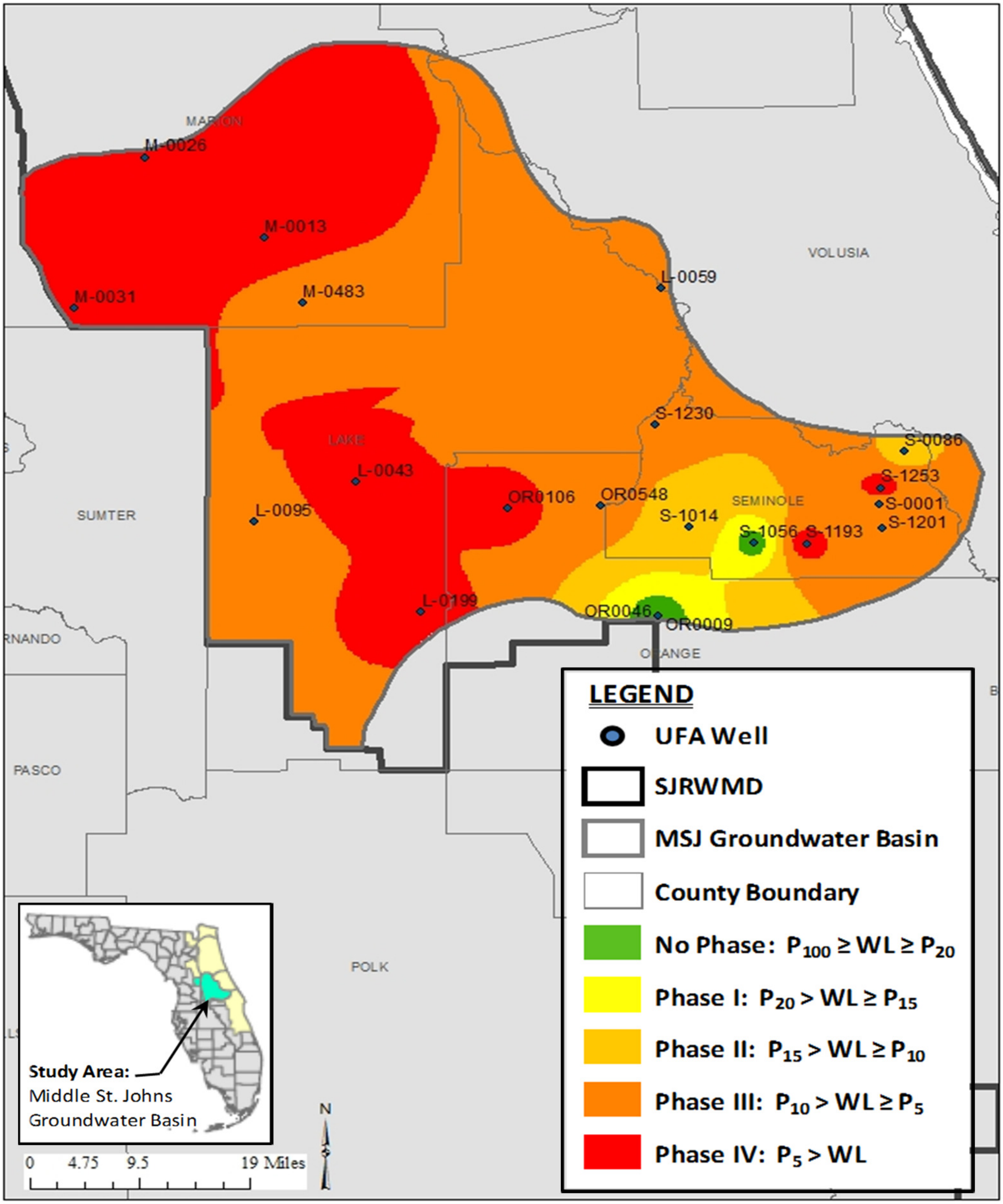


SIMMONS ENVIRONMENTAL CONSULTING

Figure A-5
Condition of the Upper Floridan Aquifer in the Middle St. Johns Groundwater Basin December 2000 through February 2001

Notes : Condition is based on the percentile (P) of monthly-mean water levels (WLs). Percentiles calculated using each Dec, Jan, and Feb from 1998 through 2012 (a 15-yr Period of Record). Phase definitions evaluated in this study do not represent SJRWMD rules or policy.

Water Shortage Management
Contract 27625

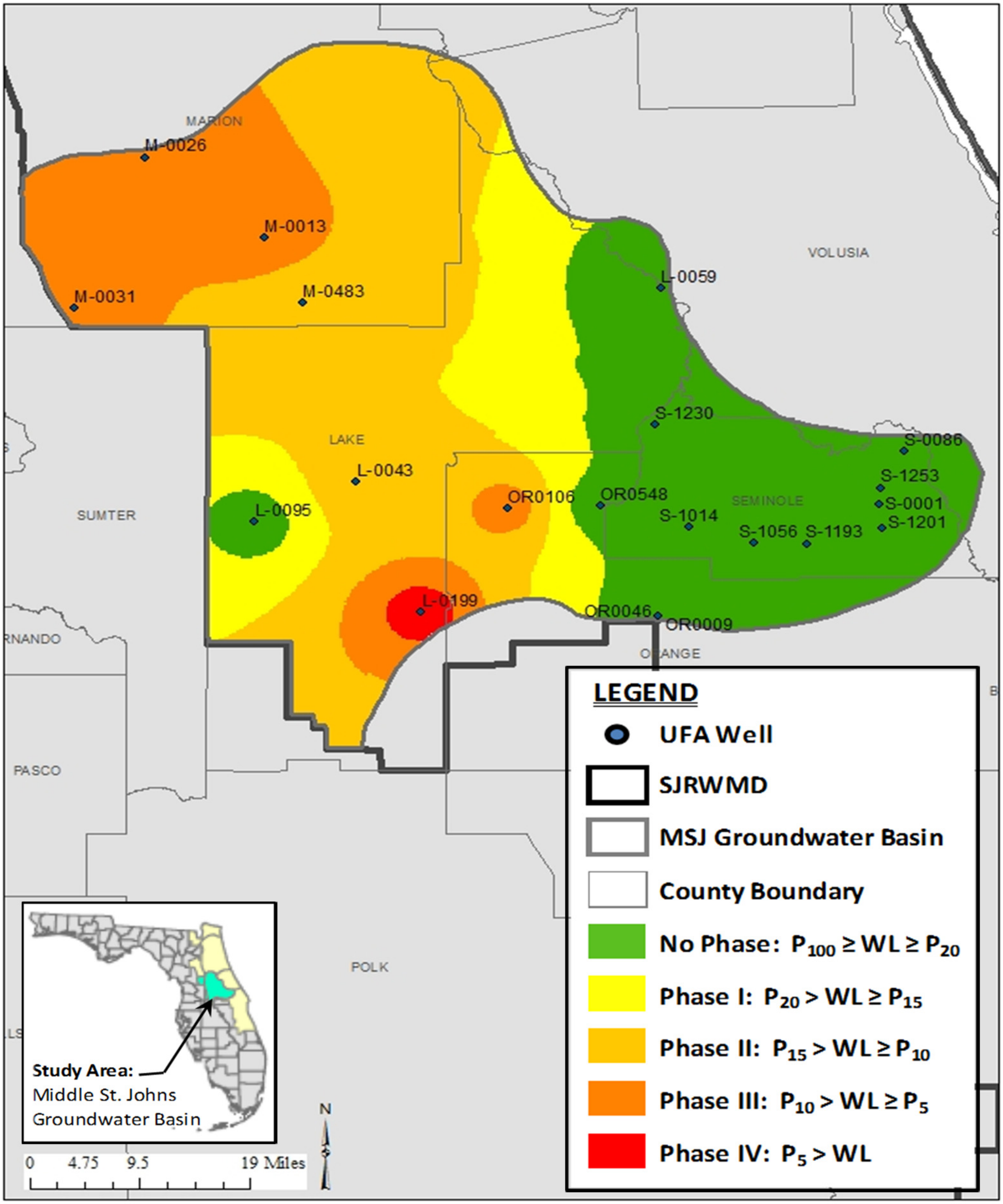


SIMMONS ENVIRONMENTAL CONSULTING

Figure A-6
Condition of the Upper Floridan Aquifer in the Middle St. Johns Groundwater Basin
July 2001

<u>Notes</u> : Condition is based on the percentile (P) of monthly-mean water levels (WLs). Percentiles calculated using each July from 1998 through 2012 (a 15-yr Period of Record). Phase definitions evaluated in this study do not represent SJRWMD rules or policy.

Water Shortage Management
Contract 27625

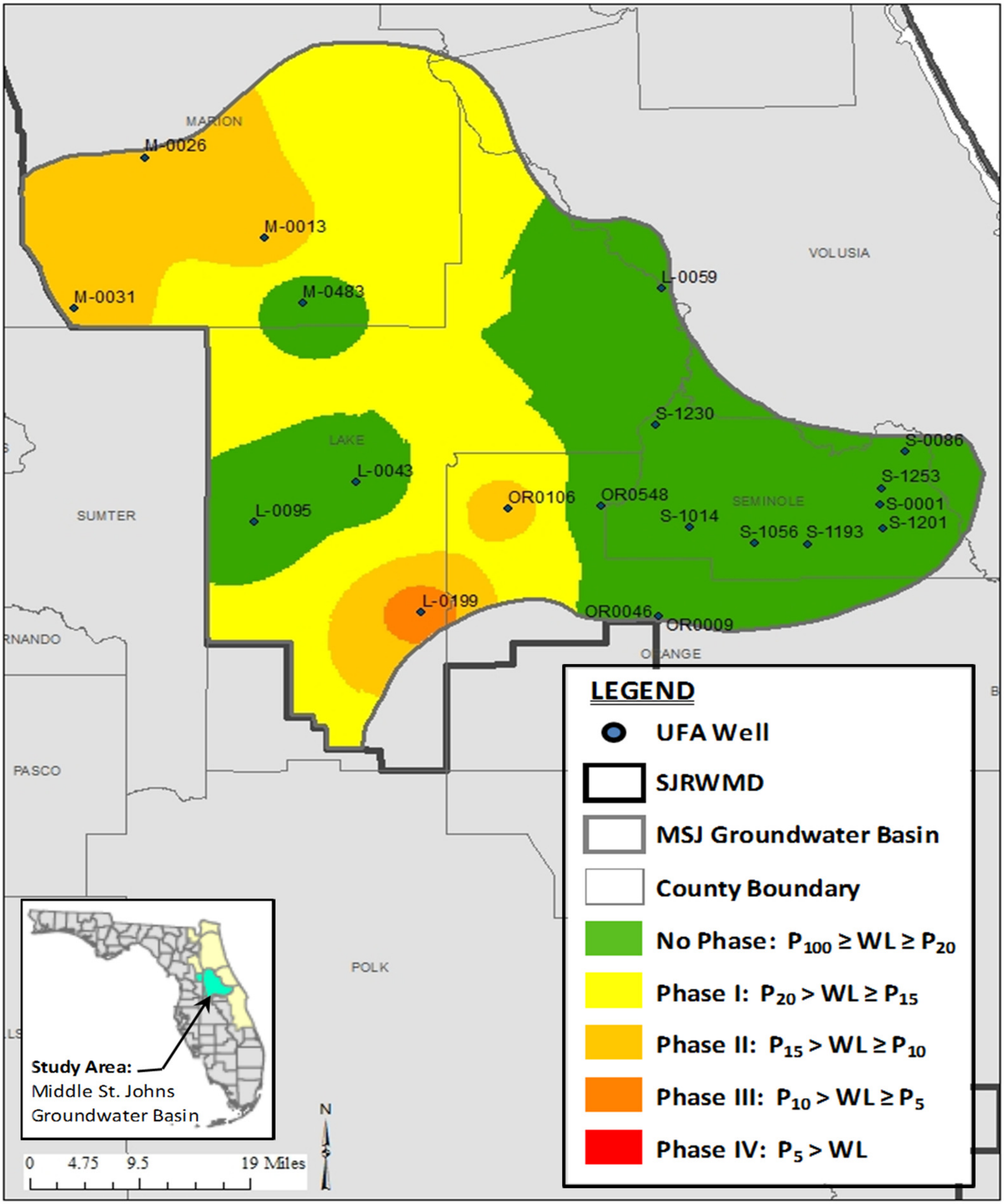


SIMMONS ENVIRONMENTAL CONSULTING

Figure A-7
Condition of the Upper Floridan Aquifer in the Middle St. Johns Groundwater Basin
October 2001

<u>Notes</u>: Condition is based on the percentile (P) of monthly-mean water levels (WLs). Percentiles calculated using each October from 1998 through 2012 (a 15-yr Period of Record). Phase definitions evaluated in this study do not represent SJRWMD rules or policy.

Water Shortage Management
Contract 27625

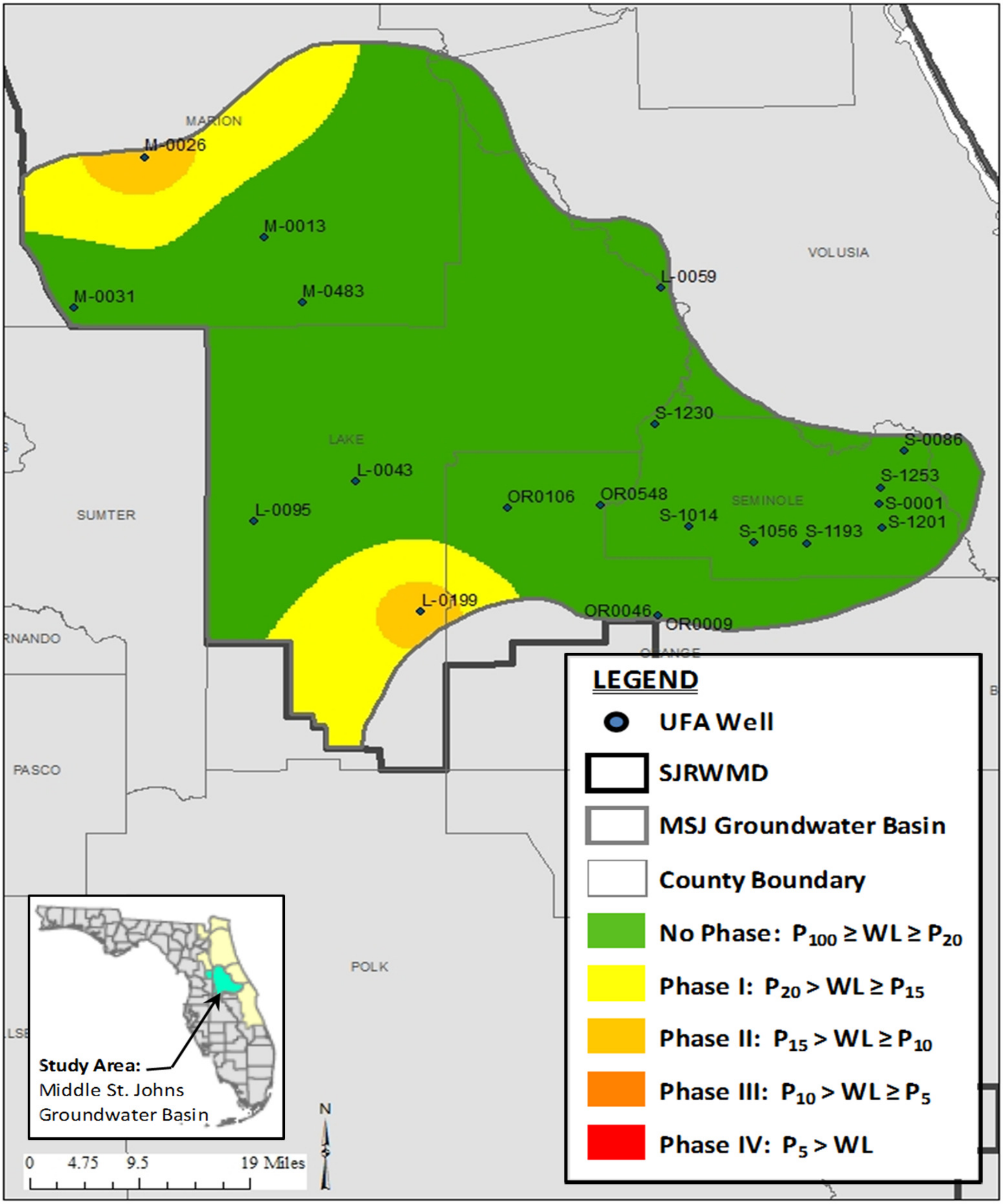


SIMMONS ENVIRONMENTAL CONSULTING

Figure A-8
Condition of the Upper Floridan Aquifer in the Middle St. Johns Groundwater Basin
March and April 2002

<u>Notes</u>: Condition is based on the percentile (P) of monthly-mean water levels (WLs). Percentiles calculated using each March and April from 1998 through 2012 (a 15-yr Period of Record). Phase definitions evaluated in this study do not represent SJRWMD rules or policy.

Water Shortage Management
Contract 27625

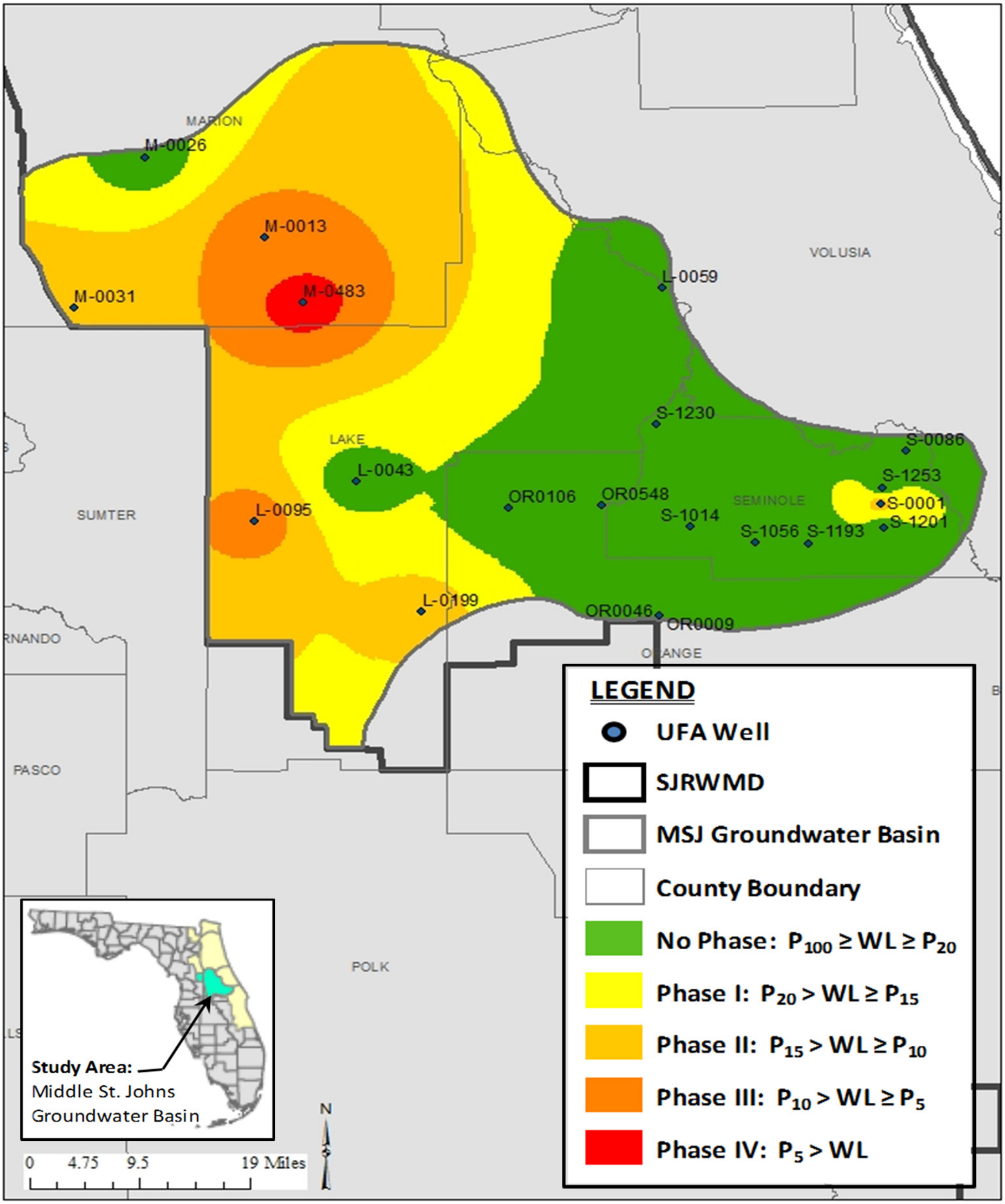


SIMMONS ENVIRONMENTAL CONSULTING

Figure A-9
Condition of the Upper Floridan Aquifer in the Middle St. Johns Groundwater Basin
September 2002

<u>Notes</u> : Condition is based on the percentile (P) of monthly-mean water levels (WLs). Percentiles calculated using each September from 1998 through 2012 (a 15-yr Period of Record). Phase definitions evaluated in this study do not represent SJRWMD rules or policy.

Water Shortage Management
Contract 27625



SIMMONS ENVIRONMENTAL CONSULTING

Figure A-10
Condition of the Upper Floridan Aquifer in the Middle St. Johns Groundwater Basin
July 2012

<u>Notes</u> : Condition is based on the percentile (P) of monthly-mean water levels (WLs). Percentiles calculated using each July from 1998 through 2012 (a 15-yr Period of Record). Phase definitions evaluated in this study do not represent SJRWMD rules or policy.

Water Shortage Management
Contract 27625