Minimum Flows and Water Levels (MFLs) Methodology

The District's minimum flows and water levels (MFLs) methodology is briefly described in this appendix. Detailed descriptions of the methodology used for establishing MFLs can be found in documents cited in Hancock and Leeper (2020) and at the District's MFLs (Environmental Flows) Documents and Reports web page at https://www.swfwmd.state.fl.us/projects/mfl/documents-and-reports.

Technical Approach to the Establishment of MFLs

The minimum flow for a given watercourse is defined by statute as "the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area" (Section 373.042, Florida Statues (F.S.)). The minimum water level of an aquifer or surface waterbody is similarly defined by statute as "the level of groundwater in an aquifer and the level of surface water at which further withdrawals would be significantly harmful to the water resources or ecology of the area." The District's technical approach for establishing MFLs addresses all relevant requirements expressed in the Florida Water Resources Act of 1972 (Chapter 373, F.S.) and the Water Resource Implementation Rule (Chapter 62-40, Florida Administrative Code (F.A.C.)). The approach assumes that alternative hydrologic regimes may exist that differ from Historic conditions but are sufficient to protect water resource features from significant harm. Rule 40D-8.021, F.A.C. defines "Historic" as a "Long-term period when there are no measurable impacts due to withdrawals and Structural Alterations are similar to current conditions." "Long-term" is defined as "a period which spans the range of hydrologic conditions which can be expected to occur based upon historical records, ranging from high water levels to low water levels." "Structural Alterations," as defined in the Rule, "means human alteration of an inlet outlet of a lake or wetland that affects water levels." For example, consider a Historic condition for an unaltered river or lake system with no local ground or surface water withdrawal impacts. A new hydrologic regime for the system would be associated with each increase in water use, from small withdrawals that have no measurable effect on the Historic regime, to large withdrawals that could substantially alter the regime. A threshold hydrologic regime may exist that is lower or less than the Historic regime, but which protects the water resources and ecology of the system from significant harm. This threshold regime could conceptually allow for water withdrawals while protecting the water resources and ecology of the area. Minimum flows and levels (MFLs) may therefore represent minimum acceptable conditions rather than Historic or potentially optimal hydrologic conditions.

Ongoing Work, Reassessment and Future Development

The District continues to conduct the necessary activities to support the adoption of MFLs into its Water Levels and Rates of Flow rules (Chapter 40D-8, F.A.C.) according to the District's Priority List and Schedule for MFLs establishment. Refinement and development of new methodologies are also ongoing. In accordance with the Florida Water Resources Act, MFLs are established based upon the best available information. The District plans to conduct periodic reevaluations of adopted MFLs based on consideration of the significance of specific MFLs in water supply planning, the relevance of new data that may become available, and rule-specified reevaluation schedules.

Scientific Peer Review

The Florida Water Resources Act permits affected parties to request independent scientific peer review of the scientific and technical data and methodologies used to determine MFLs. In addition to supporting any requested peer review processes, the District voluntarily seeks independent scientific peer review of MFL methodologies that are developed for all priority water bodies, as well as the review of proposed MFLs for specific priority water bodies in accordance with criteria identified in the Water Resource Implementation Rule.

Methodology

Wetlands

The District has developed methods for establishing minimum levels for wetlands classified as either mesic or xeric. Mesic pertains to geographically isolated freshwater lentic systems (e.g., lakes and wetlands) situated within landscapes characterized by mesic soils, predominantly found in the context of flatwoods environments with a shallow, semi-confined water table hydrogeologic setting. Xeric waterbodies are geographically isolated freshwater lentic systems that are situated in landscapes where xeric soils prevail, commonly linked with ecosystems characterized by deep water-table conditions, such as sand pine scrub or longleaf pine-turkey oak hills.

For mesic palustrine cypress wetlands (i.e., isolated, freshwater, cypress-dominated wetlands) a method referred to as the Cypress Offset method is used for establishing minimum levels and is based on a statistical assessment of the relationship between hydrology and certain ecologic parameters in a number of wetlands. The goal for the method and Minimum Wetland Levels (MWLs) developed using the method is to identify a hydrologic threshold, expressed as a water level, beyond which it would be reasonable to expect that significant harm may occur in a wetland. A MWL for mesic palustrine cypress wetlands is determined by surveying a normal pool elevation based on "Hydrologic Indicators" occurring within the wetland and calculating an elevation 1.8 feet below the normal pool. Rule 40D-8.021, F.A.C., defines "Hydrologic Indicators" as "those biological and physical features, which are representative of previous water levels as listed in Section 373.4211(20), F.S."

In mesic wetlands where a reliable normal pool elevation is not available, a method is used that is referenced as the Mesic Wetland Offset. Based on the same principle as the Cypress Offset, the Mesic Wetland Offset uses a Historic 50th percentile (P50) water level elevation rather than a field-derived normal pool elevation. A MWL for mesic wetlands using the Mesic Wetland Offset is established by determining an elevation that is 0.8 feet below the Historic P50 water level elevation of the wetland.

For wetlands classified as xeric, the Xeric Wetland Offset is applied, analogous to the Mesic Wetland Offset approach. However, this method calculates the MWL as an offset of 2.2 feet below the Historic P50 water level elevation. A complete description of the methodology used for establishing MWLs can be found in SWFWMD (2022).

Wetland water levels are determined to be above the MWL if the long-term (as defined in the Rule) median stage is at or above the adopted minimum level. If insufficient hydrologic data exists to determine if water levels in a wetland are above or below an adopted MWL, a wetland can be evaluated based on a comparison with wetlands that are hydrologically or hydrogeologically similar, located in close proximity, or by use of aerial photographs or evaluation of available hydrologic data or Hydrologic Indicators in the subject wetland.

Lakes

Minimum levels for lakes, including a Minimum Lake Level (MLL) and High Minimum Lake Level (HMLL) are determined through analysis of measured and modeled lake stage and other hydrologic data, consideration of structural alterations, evaluation or surveying of basin-specific features or conditions, and through identification of appropriate lake-specific significant change standards.

In 2022, the District finalized a multiyear effort to review and update criteria and methods used to support development of minimum levels for lakes. For establishment of minimum lake levels, priority lakes are classified as either mesic or xeric based on characteristics such as soils, physiographic and hydrogeologic setting, water level behavior, and surrounding ecosystems.

For development of minimum lake levels, environmental criteria and their corresponding methodologies are delineated into two categories: standards and screenings. A standard delineates a possible minimum level; from the array of potential levels derived through various standards, the one that is most sensitive and suitable is chosen. Screening involves evaluating the specific sensitivity of a lake to a proposed minimum level for a certain environmental value. Should the screening reveal a potential sensitivity, further investigations are conducted for the lake, and if required, the proposal for minimum levels based on standards is revised. This methodology prioritizes criteria/methods with the highest level of confidence initially yet permits the incorporation of additional criteria/methods on an as-needed basis for each site to ensure adequate protection against significant environmental harm for all pertinent environmental values.

A standard establishes a threshold for the P50 (median water level) below which there is a considerable risk of significant harm to a particular environmental value. Currently, lakes are evaluated against two standards: the Species Richness Standard and the corresponding Wetland Standard (Cypress Offset, Mesic Wetland Offset, and Xeric Wetland Offset). Among the two standards applied to a lake, the more sensitive of the two (i.e., the one associated with a higher water level) is chosen as the proposed minimum level, contingent on the outcomes of the screenings.

Cypress Offset Standard

The Cypress Offset standard has traditionally served as a benchmark for determining minimum lake and wetland levels. Its application is currently expected to focus predominantly on mesic cypress domes and select mesic wetlands. The standard allows for the P50 water level to fall no lower than 1.8 feet below the Normal Pool, which is a high-water reference datum derived from field measurements.

Mesic Wetland Offset Standard

The Mesic Wetland Offset standard is used for mesic lakes and specific mesic wetlands. It is intended to mitigate significant harm to wetlands and their habitats as a result of water level reductions due to withdrawals. This standard integrates the Cypress Offset with statistical data on the hydrology of cypress domes that are minimally affected by water withdrawals. Instead of using the Normal Pool, which may not be available for all water bodies, it uses the Historic P50 as the reference datum. According to this standard, the P50 level can be no more than 0.8 feet below the Historic P50.

Xeric Wetland Offset Standard

The Xeric Wetland Offset standard is used for xeric lakes and wetlands to prevent significant harm to these habitats from declines in water levels due to withdrawals. This standard was established based on prior research conducted for the Cypress and Mesic Wetland Offset standards along with an acknowledgement of the hydrological distinctions between xeric and mesic ecosystems and therefore analyzed data from stressed and not stressed xeric lakes and wetlands. According to this standard, the P50 water level must not fall more than 2.2 feet below the Historic P50.

Species Richness Standard

The Species Richness standard is a criterion applied to lakes to prevent adverse impacts on species diversity arising from water level reductions due to withdrawals. This standard draws upon extensive field research conducted in Florida, which demonstrated a direct correlation between a reduction in waterbody surface area by 15 percent and the loss of one bird species. This standard stipulates that the median area of lakes should not decrease by more than 15 percent relative to historical median values.

Aesthetics Screening

Aesthetics Screening is applied to lakes to mitigate effects of water level reductions due to withdrawals on the visual and recreational qualities of lakes. This methodology was derived from survey data indicating the preferences of various types of lake users in Florida, who favor water levels within a specific range: above the P80 (a low water level; bottom quintile) and below the P10 (a high water level; upper decile). The protocol assumes that the aesthetic integrity of lakes is maintained if the median water level does not fall below the Historic P80 threshold.

Aquatic Habitat Zone Screening

The Aquatic Habitat Zone Screening is implemented with lakes to prevent significant harm related to average areal reductions in habitats critical for fish/wildlife sustenance and recreational activities, attributable to declines in lake water levels from withdrawals. This screening methodology was developed based on comprehensive insights into the prevalence and significance of varied depth-dependent aquatic habitats within lakes, alongside an empirically supported threshold for change set at 15 percent. It operates under the assumption that the integrity of aquatic habitats is preserved if the hydrologic conditions maintained by establishing a minimum water level do not permit a reduction exceeding 15 percent, in comparison to historical norms, in the average extent of specified aquatic habitat zones.

Basin Connectivity Screening

The Basin Connectivity Screening targets lakes with basins that are interconnected with other aquatic systems. This screening aims to prevent the detrimental impacts on hydrological connectivity and faunal migration among lake basins or connected water bodies, which can be caused by the reduction of lake water levels due to withdrawals. The development of this screening approach leverages data indicating that most fish species require a minimum water depth of 0.6 feet to navigate between basins successfully. The criterion for maintaining basin connectivity under this screening is that empirical water level records for a lake must demonstrate that critical basin connection points maintain a minimum water depth of 0.6 feet for at least 80 percent of the time.

Dock Use Screening

The Dock Use Screening is designed for lakes that are equipped with operational, fixed-elevation docks. Its purpose is to safeguard against significant declines in the utility of these docks that may result from decreases in lake water levels due to withdrawals. This screening method is underpinned by data concerning the water depths required to facilitate boat mooring. It assesses the potential alterations in dock usage relative to historical benchmarks, contingent upon the implementation of a proposed minimum water level. This evaluation incorporates both professional scientific analysis and input from relevant stakeholders.

The Minimum Lake Level (MLL) is the elevation that a lake's water levels are required to equal or exceed 50 percent of the time on a long-term basis. Establishment of the MLL involves the application of specific environmental criteria, including the appropriate wetland offset standard and the species richness standard. The selection of the standard for MLL determination is based on identifying the criterion that offers the highest sensitivity and appropriateness for the specific lake ecosystem under consideration. The screening process entails a detailed assessment of the lake's vulnerability to the proposed minimum water level with respect to a particular environmental value. Should the preliminary screening indicate a potential sensitivity, further detailed investigations are initiated for the lake. Based on the outcomes of these investigations, if necessary, the initial minimum level proposal is refined to align with the identified environmental standards and lake-specific ecological requirements.

The High Minimum Lake Level (HMLL) is the elevation that a lake's water levels are required to equal or exceed ten percent of the time on a long-term basis. The HMLL is developed by summing the MLL elevation and the expected difference between the median lake stage and the water level equaled or exceeded 10 percent of the time. A complete description of the methodology used for establishing MLLs can be found in SWFWMD (2022).

Lake MFLs are met when the long-term median lake stage is at or above the MLL and the long-term water level equaled or exceeded 10 percent of the time is at or above the HMLL. If insufficient data exists to determine if lake levels are above or below the MFLs, the lake can be evaluated based on a comparison with lakes that are hydrologically or hydrogeologically similar, located in close proximity to each other, or by use of aerial photographs or evaluation of available hydrologic data or Hydrologic Indicators at the lake. Status assessment is described in Cameron et al. (2022a, 2022b).

Aquifers

Saltwater Intrusion Minimum Aquifer Levels (SWIMALs) have been developed for the upper Floridan aquifer (UFA) in the Northern Tampa Bay Water Use Caution Area (NTBWUCA) to prevent regional saltwater intrusion and in the Southern Water Use Caution Area (SWUCA) to slow the rate of saltwater intrusion. A Minimum Aquifer Level (MAL) has been developed for the Dover/Plant City Water Use Caution Area (DPCWUCA) to maintain UFA levels above a level that was associated with formation of a large number of sinkholes and well failures during an extreme frost/freeze event in 2010. Due to differing hydrogeologic conditions and water use patterns, the approaches used to determine SWIMALs or MALs differed slightly in these three areas.

The development and implementation of a SWIMAL is a three-step process. The first step is to assess the current status and anticipated future advancement of saltwater intrusion. For the NTBWUCA, current and future status of regional saltwater intrusion was assessed through use of a sharp interface model. For the SWUCA, the number of wells and water supply potentially at risk to saltwater intrusion over the next 50 years was determined through review of existing hydrogeologic and water use data and use of a solute transport model. The second step for SWIMAL development involves identification of a proposed goal for the SWIMAL. In the NTBWUCA, the goal was to prevent further advancement of regional saltwater intrusion. In the SWUCA, the goal was to slow the rate of saltwater intrusion to the rate that occurred for the period from 1990 to 1999, based on the number of wells and water supply potentially at risk to saltwater intrusion in the Most Impacted Area (MIA) of the SWUCA. Finally, for development and implementation of a SWIMAL, a network of monitor wells and corresponding water levels is selected to evaluate SWIMAL status based on a long-term average (NTBWUCA) or ten-year moving annual average (SWUCA) UFA water levels. A complete description of methodology used for developing SWIMALS can be found in SWFWMD (1999a, 1999b, and 2002).

The MAL for the DPCWUCA was developed through review of complaints concerning regional well conditions and information on reported sinkholes that occurred in association with groundwater withdrawals used for frost/freeze protection during an extremely cold period in January 2010 (Weber and Peterson, 2010). Maximum regional aquifer level drawdown information was also used, along with other available geologic and hydrogeologic data and groundwater flow modeling to identify an appropriate MAL. The goal for the MAL was to identify a regional potentiometric level for the UFA that would reduce the likelihood of well failures and other potential impacts during future prolonged freeze events.

The status of the DPCWUCA MAL is evaluated using a groundwater flow model simulation of the permitted groundwater frost/freeze withdrawals in the DPCWUCA. Based on an annual simulation, the MAL is met if the resulting potentiometric level of the UFA is at or above the MAL elevation.

Flowing Surface Waters: Rivers, Estuaries, and Springs

The natural flow of a river, estuary, or spring varies on time scales of hours, days, seasons, years, and longer. Many years of observation from a streamflow gauge are generally needed to describe the characteristic pattern of a river's flow quantity, timing, and variability (i.e., its natural flow regime) (Poff, 1997). Flows also vary from point to point within a system; for example, the headwaters of a river have less water and lower flows than downstream reaches. Minimum flows are developed to protect this natural flow regime from significant harm as described in Section 373.042, F.S.

Development of minimum flows for flowing surface waters begins with the compilation of a historical flow record or records from gaging stations located throughout each system. This observed flow record is modified based on water use data and the measured impacts of water withdrawals to create a baseline flow record. The baseline flow record describes the flows that would have occurred in the absence of withdrawals. This baseline flow record is incrementally reduced to simulate flow regimes that would occur with incremental increases in water withdrawal impacts. These incrementally reduced flow regimes are termed “flow reduction scenarios.”

In addition to flows, data is collected on water levels, velocity, salinity, floodplain elevations, riverbank habitat, fish habitat, wetland vegetation, and other physical, chemical, and biological characteristics of the ecosystem. These data are analyzed to develop quantitative relationships between flows and environmentally relevant metrics. For example, the weighted useable area of a fish habitat is a commonly used metric in freshwater streams, while the total volume of water less than 2 practical salinity unity (PSU) is commonly used in estuaries. The metrics, data, and analytical tools used depend on the best available information and the characteristics of each system. These metrics, in turn, are related to the ten environmental values listed in Rule 62-40.473, F.A.C.

Minimum flows are commonly expressed as percent-of-flow, corresponding to one of the flow reduction scenarios described above (Flannery et al., 2002). There may be more than one minimum flow determined for a system based on partitioning the natural flow regime into, for example, low, medium, and high flow “blocks”. Such a system typically has a low-flow block based on the minimum depth required for fish passage, a medium-flow block based on fish habitat area, and a high-flow block based on floodplain inundation. However, it is common for springs and estuaries to have only one flow block representing the entire natural flow regime. The intrinsic variation in the natural flow regime and its effects on environmental metrics determines whether the minimum flow for each system will be partitioned into multiple blocks.

Minimum flows are based on quantitatively determining the flow reduction scenarios associated with crossing a threshold for significant harm. It is common for significant harm threshold to be determined as a 15 percent loss of habitat associated with one of the quantified metrics. However, significant harm is determined on a case-by-case basis and is also commonly quantified by crossing an established threshold, as is the case for the fish passage criterion. Individual minimum flows and levels reports, found at https://www.swfwmd.state.fl.us/projects/mfl/documents-and-reports, provide full details of the metrics and technical methods used for each system.

References

Cameron, C., J. Qi, Y. Ghile, and L. Yang, 2022a. *Governing Document: MFLs Status Assessment*. Southwest Florida Water Management District (SWFWMD), Brooksville, FL.

Cameron, C., D. Leeper, G. Herrick, R. Basso, and T.J. Venning, 2022b. *Validation of the Cypress Offset and Mesic Wetland Offset for Development of Minimum Wetland and Lake Levels*. SWFWMD, Brooksville, FL.

Flannery, M.S., E.B. Peebles, and R.T. Montgomery, 2002. *A Percent-of-flow Approach for Managing Reductions of Freshwater Inflows from Unimpounded Rivers to Southwest Florida Estuaries.* Estuaries, Volume 25, 1318-1332.

Hancock, M.C., and D.A. Leeper, 2020. *Minimum flows and levels development, status assessment, and implementation in the Southwest Florida Water Management District*. SWFWMD, Brooksville, FL.

Poff, N.L., J.D. Allan, M.B. Bain, J.R. Karr, K.L. Prestegaard, B.D. Richter, R.E. Sparks, and J.C. Stromberg, 1997. *The Natural Flow Regime*. BioScience, Volume 47, Issue 11, 769-784.

SWFWMD, 1999a. *Environmental minimum aquifer levels as used in Rule 40D-8, F.A.C., in Northern Tampa Bay minimum flows and levels white papers: white papers supporting the establishment of minimum flows and levels for isolated cypress wetlands, Category 1 and 2 lakes, seawater intrusion, environmental aquifer levels, and Tampa Bypass Canal*; peer-review final draft, March 19, 1999. Brooksville, FL.

SWFWMD, 1999b. *Seawater intrusion minimum levels for northern Tampa Bay, in Northern Tampa Bay minimum flows and levels white papers: white papers supporting the establishment of minimum flows and levels for isolated cypress wetlands, Category 1 and 2 lakes, seawater intrusion, environmental aquifer levels, and Tampa Bypass Canal*; peer-review final draft, March 19, 1999. Brooksville, FL.

SWFWMD, 2002. *Saltwater intrusion and the minimum aquifer level in the Southern Water Use Caution Area*, *August 21, 2002 draft*. SWFWMD, Brooksville, FL.

SWFWMD, 2022. *Environmental Criteria and Methods Used to Support the Development of Lake Minimum Levels*, December 12, 2022. SWFWMD, Brooksville, FL.

Weber, K. and R. Peterson, 2010. *Determining the need for a cap on groundwater use for freeze protection in the Dover/Plant City area*. SWFWMD, Brooksville, FL.