Patrick Tara, PE – Lead Expert, MFLs and Groundwater / Surface Water Modeling and Analysis

Patrick Tara has 28 years of experience in water resources engineering, focused on surface water hydrology, groundwater, hydraulics, and integrated surface water/groundwater (SW/GW) hydrologic systems. His experience includes hydrologic data collection and analysis (both temporal and spatial), and the development and application of SW/GW, hydrologic, hydraulic, transport, water quality, and salinity numerical models. His data collection efforts include tracer studies for the evaluation of flushing. Mr. Tara has applied various models to watersheds, estuaries, rivers, lakes, reservoirs, and tidal inlets to support establishing minimum flows and levels (MFLs) needed to protect ecological resources, manage water supplies and natural systems, evaluate and implement restoration alternatives and actions, and estimate water quality impacts and sediment transport. He is experienced in temporal hydrologic data analysis including water budget studies, statistical modeling, and trend and cluster analysis. Mr. Tara routinely uses geographic information systems (GIS) as a tool for spatial data management and processing, particularly as it is related to land-use analysis and the assessment and management of water resources. His hydrologic data collection experience includes the installation and maintenance of equipment to record tide levels, water levels in wells, lake/river stage, rainfall, Doppler velocity, weather, pan evapotranspiration (ET), and soil moisture. Mr. Tara is proficient in using a wide variety of hydrologic and hydraulic modeling software and codes including MODFLOW, HSPF (Hydrological Simulation Program – FORTRAN), PRMS, HEC-RAS (Hydrologic Engineering Center River Analysis System), IHM (Integrated Hydrologic Model), MIKE SHE, HydQual, and PEST (Parameter ESTimation).

Years of Experience: 28

Education:

- MSCE, 1991, Civil Engineering, University of South Florida
- BSCE, 1989, Civil Engineering, University of South Florida

Professional Registrations/Affiliations:

- Professional Engineer, Florida, 1995, No. 48877
- Professional Hydrologist, AIH, 2005, No. 1644
- Member, American Water Resources Association
- Member, American Institute of Hydrology

Professional History:

2003 – Present	Senior Water Resources Engineer – INTERA Inc., Tampa, FL
1990 – 2003	Water Resources Engineer – University of South Florida, Tampa, Florida

Specialized Software Training:

- U.S. Environmental Protection Agency (EPA) Better Assessment Science Integrating Point and Non-Point Sources (BASINS), 2004
- Mike SHE integrated hydrologic model, 2005
- Mike 21 hydraulic model, 2008
- EPA Water Quality Analysis Simulation Program (WASP), 2006

Representative Project Experience

Peer Review of the Keystone Heights Area Lakes Transient Model, St. Johns River Water Management District, Palatka, FL. 2017 – Present. *Project Manager*. Reviewed the transient MODFLOW model of the Keystone Heights area and the baseline flows developed using the transient model. Responsibilities include project management, review of model data sets and methodology for the development of baseline flows. Results of the review were received by the District and used to strengthen the methodology for the calculation of baseline flows in support of the MFLs for Lakes Geneva and Brooklyn.

Independent Peer Review of MFL Programs (De Leon Springs, Alexander Springs, Gemini Springs Silver Glen Springs), St. Johns River Water Management District, Palatka, FL 2016 – 2017. *Project Manager*. Reviewed EFDC and HSPF models as well as supporting data collection used in the analysis of Minimum Flows and Levels for the respective water bodies. The review focused on the appropriate conceptualization of the model, appropriate data collected, and the use of a weight-of-evidence approach to evaluate impacts to the Silver River system. Model and parameter uncertainty was a focus of the review. Review technical memorandums recommended improvements for the MFL documentation, modeling strategy, and statistical tests for enhancements and increased defensibility of the final MFL development. For each water body, internal teleconferences were held presenting review findings to District staff.

Impact Analysis and Hydrologic Modeling of the Apalachicola, Chattahoochee, and Flint (ACF) Rivers, Florida Department of Environmental Protection (FDEP), Tallahassee, FL. 2010 – 2016. *Project Manager and Technical Lead.* Represented the FDEP in legal dispute between the state of Florida and the state of Georgia to protect Florida's interests in the water resources in the Apalachicola River and Bay. Provided process modeling and statistical analysis for the ACF rivers to support the legal action. Led the application of hydrologic and hydraulic models, including RESSIM, PRMS, xpSWMM, ROMS, and MODFLOW, to represent scenarios of un-impacted and future impacted conditions as well as multiple recovery strategies. Also led

statistical analysis of the observed flows used to define the boundary conditions to the model. Also performed technical review of legal expert reports.

Peer Review of the Minimum Flow and Level Modeling of the Silver Springs, Silver River, and Upper Ocklawaha River, St. Johns River Water Management District, Palatka, FL. 2013 – Present. *Project Manager*. Reviewed the steady-state HEC-RAS model of the Silver River system as well as the draft hydrologic data inventory. The review focused on conceptualization of the model and the use of a weight-of-evidence approach to evaluate impacts to the river system. The final review recommended improvements for the modeling strategy and statistical tests for enhancements to the final MFL development. An additional phase of this project included the review of the HSPF models of the Ocklawaha River Basin. Current efforts include, reviewing documents, representing the District in public meetings, and recommending future analyses.

Peer Review Services for the Application of the Integrated Hydrologic Model (IHM) for the Old Tampa Bay Integrated Modeling System, Tampa Bay Estuary Program (TBEP), Tampa, FL. 2013. *Technical Peer Review*. Reviewed and supported the application of the IHM as a component of the Old Tampa Bay Integrated Modeling System. The IHM was used to simulate the inflow quantity and quality into Old Tampa Bay. The IHM integrates both surface water and groundwater processes. Both are very important to isolate the component of streamflow to the Bay as their water quality concentrations can be different. TBEP consultants modified the IHM boundaries to extend the simulation to include water quality sampling efforts.

Peer Review and Development of Recharge and Groundwater Evapotranspiration Rates for the Northern District Model, Southwest Florida Water Management District, Brooksville, FL. 2013. *Project Manager*. This project provided model peer review and technical support for recalibration of the Northern District Model. As a part of the recalibration efforts, an HSPF model is being developed to compute the recharge and groundwater ET boundary conditions for the Northern District Model domain. In support of this effort, responsibilities included review of the model recalibration and recommendations to the District for model improvements.

Peer Review of the SSARR and HSPF Watershed and Lake Models, St. Johns River Water Management District, Palatka, FL. 2009-present. *Project Manager/Technical Lead*. Reviewed SSARR and HSPF models for eight lakes (Cowpen Lake, Etonia Chain of Lakes, Lake Tarhoe, Sylvan Lake, Lake Hiawassee, Prevatt Lake, Johns Lake, and Lake Avalon). The models are used to evaluate lake MFLs, and the review process included examining model boundary conditions, calibration, and sensitivity analysis. An emphasis was placed on the appropriate conceptualization and constraint of both the contributing watersheds and receiving waterbodies. The water balances of the models were closely examined to determine whether the models simulate appropriate fluxes for components such as rainfall, evapotranspiration, infiltration, baseflow, and surface runoff. The reviews highlighted the unconstrained fluxes in the models, such as lake seepage fluxes and ungauged lake outflows, and recommended improvements for the modeling strategy and future enhancements to the MFL development. These enhancements included the scrutiny of the water balance during model calibration, the inclusion of the water balance in the model documentation, and the performance of additional sensitivity analysis to model boundary conditions.

Peer Review of the St Johns River Watershed Water Supply Impact Study (WSIS) Model, St. Johns River Water Management District, Palatka, FL. 2009. *Project Manager/Technical Lead*. The District developed an HSPF model to evaluate the potential environmental impacts to the St. Johns River due to future surface water withdrawals. With this goal in mind, the watershed hydrology component of the WSIS was reviewed to assure the model was conceptualized, constructed, and calibrated using current and proper engineering practices. In the review process, emphasis was placed on the replication of the water balance. The water balance is the dominant component of the watershed hydrology model and alternative comparison. Finding of the review led to recalibration of the model parameters.

Peer Review of the District-Wide Regulation Model, Southwest Florida Water Management District, Tampa, FL. 2009. *Review Panel Member*. The District-Wide Regulation Model (DWRM) was developed to evaluate groundwater withdrawal permit applications. The model allows the evaluation to account for cumulative impacts. The DWRM also has a telescopic mesh refinement procedure built to better evaluate the nearfield impacts of the groundwater withdrawals. The comprehensive review included the evaluation of the model conceptualization, construction, and calibration, as well as an evaluation of the telescopic mesh refinement. The review team determined the validity of applying the DWRM for groundwater permitting review. Calibration was identified as a critical concern. The accuracy of the model calibration as it applied to meeting the model objectives was a component of the review team analysis. The construction of the river cells and drain cells were also of concern to the review team. The overall water balance and the model's ability to represent the physical processes were also components of the review process. Recommended model enhancements were adopted and applied.

Renee Murch, PE – Lead Expert, Statistical Modeling and Analysis

Renee Murch has 14 years of experience in water resources, hydrology, and civil infrastructure. Her areas of expertise include the development and application of hydraulic, hydrologic, and statistical models to support minimum flow and level (MFL) development, restoration of surface water resources, evaluation of saltwater and freshwater interaction, simulation of regional- and local-scale hydrologic conditions as part of water resource planning efforts, and assessment of scouring and erosion processes associated with the construction of bridges and other civil infrastructure. Ms. Murch has specialized expertise in the development and application of statistical models, including multiple linear regression, artificial neural networks (ANNs), and Markov Chain Monte Carlo (MCMC) probabilistic simulations. She has developed, calibrated and applied models using such applications as HEC-RAS, MODFLOW, HSPF, ELM, XPSWMM, SSARR, and the Integrated Hydrologic Model (IHM). She has evaluated radiological and hydrologic data using methods such as principal component analysis, agglomerative hierarchical cluster analysis (AHCA), analysis of variance (ANOVA), bivariate correlation, multivariate regression, artificial neural networks, and hypothesis testing. Her experience also includes the application of geographic information system (GIS) tools for data analysis and model input development and hydrologic data collection. She has field experience related to instrumentation and data collection on water resources- and geotechnical-related projects, including the installation and maintenance of well transducers; weather stations; evaporation pans; and stream stage, runoff test bed, soil moisture, and tide gauges. Her current work focuses on developing, calibrating, and application of surface water, groundwater, and statistical models using applications such as MODFLOW, HEC-RAS, CE-QualW2, ELM, HSPF, IHM, SPLUS, and R to support water supply planning and MFL development in Florida.

Years of Experience: 14

Education:

- MS, 2002, Civil Engineering, University of South Florida
- BS, 2000, Civil Engineering, University of South Florida

Professional Registrations/Affiliations:

- Professional Engineer, Florida, 2006, No. 64678
- Member, American Public Works Association
- Member, American Water Resources Association, Florida Section
- Florida Department of Environmental Protection Certified Erosion and Sediment Control Inspector

Professional History:

2008 – Present	Senior Water Resource Engineer – INTERA Inc., Lutz, FL
2002 – 2005	Senior Professional Engineer Trainee – Florida Department of Transportation, State Materials Office, Gainesville, FL
1999 – 2002	Research Assistant – University of South Florida, Tampa, FL
1998 – 2000	Engineering Assistant – Hayward Baker Inc., Tampa, FL
1998	Engineering Technician – Florida Cities Water Company, Sarasota, FL

Specialized Training & Software:

- HEC-RAS, CE-QualW2, Hydqual, HSPF, IHM, SSARR
- BASINS, IOWDM, ANNIE, GenScn, WDMUtil
- DMSTA, ELM, ICPR, Crystal Ball, ProUCL, XPSWMM
- MODFLOW, Groundwater Vistas
- SPLUS, R, Statistica, ArcMap, Map Windows, Visual Basic, perl

Representative Project Experience

Peer Review of the Keystone Heights Area Lakes Transient Model, St. Johns River Water Management District, Palatka, FL. 2017 – Present. *Project Manager.* Reviewed the transient MODFLOW model of the Keystone Heights area and the baseline flows developed using the transient model. Responsibilities included review of MODFLOW data sets, model output, and review of the District's baseline flow methodology. Results of the review were received by the District and used to strengthen the methodology for the calculation of baseline flows in support of the MFLs for Lakes Geneva and Brooklyn.

Statistical Analysis and Modeling of the Apalachicola, Chattahoochee, and Flint (ACF) Rivers, Florida Department of Environmental Protection (FDEP), Tallahassee, FL. 2012 – 2016. *Project Engineer.* Provided modeling and statistical analysis for developing a revised alternative operations plan for the ACF rivers. Performed statistical analysis and modeling for the FDEP to support discussions between the state of Florida and the state of Georgia, protecting Florida's interests in the water resources in Apalachicola River and Bay. Served as the primary modeler for applying hydrologic and hydraulic models including: RESSIM, PRMS, xpSWMM, ROMS, and MODFLOW. Analyzed observed flow data to determine statistically significant trends. Simulated alternative unimpacted and impacted flow scenarios by modifying boundary flows in a Northwest Florida Water Management District xpSWMM distributary model of the lower Apalachicola River.

Independent Peer Review of MFL Programs (De Leon Springs, Alexander Springs, Gemini Springs Silver Glen Springs), St. Johns River Water Management District, Palatka, FL 2016 – 2017. *Lead Reviewer*. Reviewed EFDC and HSPF models as well as supporting data collection used in the analysis of Minimum Flows and Levels for the respective water bodies. The reviews focused on the appropriate conceptualization of the model, appropriate data collected, and the use of a weight-of-evidence approach to evaluate impacts to the Silver River system. Model and parameter uncertainty was a focus of the review. Review technical memorandums recommended improvements for the MFL documentation, modeling strategy, and statistical tests for enhancements and increased defensibility of the final MFL development. For each water body, internal teleconferences were held presenting review findings to District staff.

Peer Review for Caloosahatchee River (C-43) West Basin Storage Reservoir Freeboard Analysis and Separator Dam Update, South Florida Water Management District, West Palm Beach, FL. 2016. *Project Manager and Peer Reviewer*. Provided peer review services for a freeboard analysis and separator dam design of C-43 West Basin Storage Reservoir. Recommendations based on review of the model documentation included modifying the analysis to assume that outlet structures are wide open during the design event, the need to recommend a final freeboard height in the documentation and modifications to the documentation to provide additional modeling details. Responsibilities included review of consultant reports, participation in conference calls, and documentation of the peer review.

Peer Review of the Upper Ocklawaha River Basin Model, St. Johns River Water Management District, Palatka, FL. 2014. *Project Engineer*. Served as the primary reviewer for the HSPF model of the Upper Ocklawaha River Basin. The review focused on the appropriate conceptualization and calibration of the HSPF model to evaluate impacts to the Upper Ocklawaha system. The final review document recommended improvements for the modeling strategy and statistical tests for enhancements to the MFL development.

Peer Review of the HEC-RAS Model and Statistical Analysis of Silver Springs and the Silver River, St. Johns River Water Management District, Palatka, FL. 2013. *Project Engineer*. Served as the primary reviewer for the steady-state HEC-RAS model of the Silver River system, as well as with the review of the hydrologic data inventory draft document for the District. The review focused on the appropriate conceptualization of the HEC-RAS model and the use of a weight-of-evidence approach to evaluate impacts to the Silver River system. The final review document recommended improvements for the modeling strategy and statistical tests for enhancements to the MFL development.

Peer Review and Development of Recharge and Groundwater Evapotranspiration Rates for the Northern District Model, Southwest Florida Water Management District, Brooksville, FL. 2013. *Project Engineer*. This project provided model peer review and technical support for recalibration of the Northern District Model. As a part of the recalibration efforts, an HSPF model is being developed to compute the recharge and groundwater ET boundary conditions for the Northern District Model domain. In support of this effort, responsibilities included review of the model recalibration and recommendations to the District for model improvements.

Review of the SSARR and HSPF Watershed and Lake Models, St. Johns River Water Management District, Palatka, FL. 2009-present. *Project Engineer.* Reviewed SSARR and HSPF models for eight lakes (Cowpen Lake, Etonia Chain of Lakes, Lake Tarhoe, Sylvan Lake, Lake Hiawassee, Prevatt Lake, Johns Lake, and Lake Avalon). The models are used to evaluate lake MFLs, and the review process included examining model boundary conditions, calibration, and sensitivity analysis. The water balances of the models were closely examined to determine whether the models simulate appropriate fluxes for components such as rainfall, evapotranspiration, infiltration, baseflow, and surface runoff. The reviews highlighted the unconstrained fluxes in the models, such as lake seepage fluxes and ungauged lake outflows, and recommended improvements for the modeling strategy and future enhancements to the MFL development. These enhancements included the scrutiny of the water balance during model calibration, the inclusion of the water balance in the model documentation, and the performance of additional sensitivity analysis to model boundary conditions.

Review of the St. Johns River Watershed Water Supply Impact Study (WSIS) Model, St. Johns River Water Management District, Palatka, FL. 2009. *Lead Model Reviewer*. Served as primary model reviewer for an HSPF model to evaluate the potential environmental impacts to the St. Johns River due to future surface water withdrawals. The watershed hydrology component of the WSIS was reviewed to assure the model was conceptualized, constructed, and calibrated using current and proper engineering practices. In the review process, emphasis was placed on the replication of the water balance. Findings of the model review resulted in model recalibration of the model parameters by the District.