3.0. HSPF MODEL INPUT DATA

HSPF was developed as a comprehensive model for the simulation of watershed hydrology and water quality. The origin of the model was the watershed and field-scale models Agricultural Runoff Model (ARM) and Non Point Source (NPS). A key impetus behind the development of HSPF was to provide a core data management structure which could support many different modeling algorithms developed to simulate different hydrologic and water quality processes. The model was originally centered around the 'time series store' (TSS) designed to hold the major input forcing functions and the numerous possible modeling time series outputs. An expanded database, WDM, was developed to hold tabular information as well. In an effort to promote data sharing, ease of modeling, and application of different methodologies, WDM supports HSPF and other models, as well as several large standardized government database sources for water resources data.

3.1. Input Data and Parameter Unit Systems

The HSPF model performs all calculations internally in S.I. metric units. Most input data may be provided in either English or metric units. A number of the more detailed process routines expect concentration values in customary metric units (i.e., mg/l). The routines using solar radiation measures expect data in the outmoded 'langleys'. Acceptable units for model inputs and parameters are listed in the model input in detail in Chapters 4 and 5 of this report. Unit conversions, if necessary, are straightforward and should not be a major concern of the monitoring program.

3.2. Model Sensitivity

While some preliminary estimates could be made at this time as to which model parameters are most sensitive to the modeling results, these estimates may prove meaningless in view of the changes being made in the model. The most appropriate determination at this time is that the water quality modeling results will be entirely dependent on the success of the hydrologic and hydraulic simulation. The bulk of the water quality parameters are derived values, to a lesser or greater extent, developed during the model calibration/verification process.

The most sensitive data collections will be those obtained from the subwatershed studies (land use loading, irrigation and BMP evaluations) because these data will be the most widely extrapolated. The data obtained from the long-term monitoring locations and the synoptic sampling efforts will provide an assessment of the validity of the results obtained from applying the limited loading data to be collected throughout the watershed. The outcome could be moderate adjustments to parameter values or significant additional sample collections. Obtaining truly representative data is not an easy task.

3.3. Overview of Modeling Information

The following information is organized to support the various program sections potentially to be used in each major program module during the modeling. This chapter outlines the available modeling options and the required inputs. Where known, methods for data development are suggested. A disclaimer must be injected at this point. HSPF is a work in progress which is constantly evolving. The latest documentation for the most current release of the model should always be consulted for current information, modified input data requirements and additional capabilities. Supporting material from which the model algorithms were originally developed should also be consulted. A number of useful sources for modeling support are identified in the bibliography of this report. In some cases, model algorithms may best be understood by studying the source code, particularly when problems are encountered in getting the model to perform as expected.

A number of changes have been introduced in the upland hydrologic routines and hydraulic reach routing capabilities for a revised HSPF model under previous SFWMD projects. Information for new input parameters has been produced by Hydrocomp/Aqua Terra.

Additional useful modifications of the model's water quality routines have been made in the past to overcome limitations in some of the algorithms or deficiencies in the modeling framework. Other modifications, some intended to address similar problems, have recently been made by other modeling groups. Model input requirements are described to address the data needs of the existing model. Information is also provided for the known data needs of recent revisions.

The HSPF model supports a number of different simulation algorithms at different levels of detail and sophistication, providing the user a choice of approaches. A simpler modeling approach can often provide the insight needed to address study objectives without requiring the data collection and development effort needed to quantify detailed subprocesses for a more detailed modeling approach.

The simulation algorithms available within HSPF are a mixture of physically-based and empirical approaches. Although some portions of the model employ algorithms and parameters which are not directly based on quantifiable physical and chemical phenomena, relationships can often be derived to develop those model parameters based on measurable quantities or characteristics of the watershed. In some cases, model algorithms and parameters remain strictly in the realm of mathematical constructs and may be used primarily for calibration purposes to adjust the response of the model.

It is important to understand and accommodate both the limitations of the available data and the simplifying assumptions incorporated in the simulation algorithms to best apply the model to the problems at hand. Careful selection of parameters to be used for model calibration purposes will generally allow a simulation to be developed which can reasonably mimic the performance of the

watershed under study. For example, the modeler may be able to characterize most soil nutrient processes reasonably well and choose to use the mineralization/demineralization rates to make the fine adjustments needed for calibration. Mineralization/demineralization rates may be the least understood and may be subject to significant variation during the year due to unsimulated factors such as aerobic or anaerobic soil conditions, making them good candidates for the sometimes arbitrary adjustments needed for model calibration. Chosen adjustments in selected parameter values may then be made to reflect expected changes resulting from modified management practices.

3.4. Time Series Data Requirements

The input time series are the forcing functions which drive the simulation model. As such, the development of reliable, representative time series inputs is critical to successful simulation. Time series inputs include such items as precipitation, air temperature, dewpoint temperature, wind movement, solar radiation, evaporation/evapotranspiration and upstream inflows, lateral sediment inputs, upstream or tributary inflows, and external constituent mass loadings. Examples of mass loadings are constituents entrained in influxes (stream inflow), periodic fertilizer applications, and bulk precipitation. Developing representative forcing functions is fundamental to performing successful water quality simulation.

Chapters 4 and 5 identify the time series required for the individual model sections. Optional time series inputs available for external flows and mass loadings from outside of the watershed are also identified. HSPF provides numerous internal time series connections to transfer flows and entrained or dissolved constituents from one simulated upland or waterbody to another. This provides the means to separate the simulation into smaller pieces to accommodate very large or complex watersheds. Many of the time series can be output and can also serve as additional inputs. For example, a point source nutrient loading to a reach can be prepared externally and can be targeted to the same input time series as the other reach inputs from upstream inflows and upland loadings.

Basic meteorological data such as precipitation, pan evaporation, and air temperature are usually readily available in most areas, although monitoring stations may not be directly located within the basin being modeled and data collected at the desired simulation time step may not be available. Statistical analysis of the available data may be needed to derive characteristics for the local area. Pseudo-stations may also be developed using statistical methods to interpolate additional stations and provide added spatial variability to the inputs driving the simulation. This is particularly applicable to precipitation records when the watershed is large. The monitoring program will provide supplemental precipitation records at various locations throughout the watershed.

3.5. Tabular Data Requirements

Chapters 4 and 5 of this report provide detailed information regarding tabular input parameters and a description of available options, such as monthly varying inputs, which may be available.

The information presented has drawn heavily on the HSPF model documentation, experience in applying the model to Florida water quantity and quality simulations, and other reference material. The information below is organized in the same sequence as in the HSPF documentation and supplements parameter descriptions with additional available information.

Tabular data used by HSPF includes program control flags, parameters and constants for model algorithms, and state variables to set initial conditions. Program control flags are used to specify which model sections will be activated, which algorithms will be used when choices are available, and what data sources will be used. Some initial conditions can be ignored because the values apply only to the first time step of the simulation run and the algorithms will quickly generate a calculated result. In some cases, initial conditions must be specified because calculation errors will otherwise occur and the run will not proceed. A number of algorithms will allow use of a single constant, monthly-varying values or an input time series.

The HSPF model is currently undergoing revision to improve hydrologic and hydraulic simulation capabilities. Most existing capabilities are generally preserved when such upgrades are introduced so that old and new methods can be run. This provides necessary continuity in the life of a simulation model because it provides the modeling confidence to move from known, if poor or inadequate, results from previous modeling efforts to improved results with new algorithms. Frequently the comparison is needed to demonstrate the value of the revised approach. Often, as is the case with the hydrologic and hydraulic revisions underway, model changes are needed to provide capabilities not foreseen or required by the original model developers.

One issue which cannot be adequately addressed until the revised model is fully functional and available for testing is the impact of the hydrologic and hydraulic revisions on the water quality calculations. It is possible that modeling approaches may have to be revised to adapt to changes in model performance. However, it appears that some existing difficulties in the water quality routines, such as the leaching of soluble materials from the soil layers, will be partially corrected or even eliminated by the hydrologic improvements alone.

3.6. Overview of Model Sections for the Pervious Upland Module (PERLND)

The PERLND module performs the simulation of pervious upland areas. Two basic modeling approaches differing in the level of detail are available for the simulation of hydrologic, sediment and nutrient loadings. The sections of PERLND which are needed to perform a simpler simulation are ATEMP, PWATER, SEDMNT and PQUAL. Depending on the reach water quality modeling approach, section PWTGAS may also be needed. The sections of PERLND which are needed to perform a more detailed simulation are ATEMP, PWATER, SEDMNT, PSTEMP, PWTGAS, MSTLAY, NITR, and PHOS. The following tables list required and optional input time series and parameter tables for these sections. Detailed descriptions of the time series and table parameters are provided in Chapter 4.

Many of the tables and time series shown as optional will be needed to specify model inputs and parameters. They are not strictly required to make the model run because default values will apply.

Table 3.1. Model Sections Needed For Simpler Upland Simulation with PERLND.

Required Section	Optional Section	Required Table	Optional Table	Required Time Series	Optional Time Series
	ATEMP		ATEMP-DAT		AIRTMP
PWATER			PWAT-PARM1	PREC	
PWATER		PWAT-PARM2		PETINP	
PWATER			PWAT-PARM3		
PWATER		PWAT-PARM4			
PWATER			PWAT-STATE1		
PWATER			Monthly Tables		
SEDMNT			SED-PARM1		SLSED
SEDMNT		SED-PARM2			
SEDMNT		SED-PARM3			
SEDMNT			Monthly Tables		
SEDMNT			SED-STOR		
	PWTGAS		PWT-PARM1		
	PWTGAS		PWT-PARM2		
	PWTGAS		Monthly Tables		
	PWTGAS		Initial Value Tables		
PQUAL			NQUALS		
PQUAL		QUAL-PROPS			
PQUAL			QUAL-INPUT		
PQUAL			Monthly Tables		

3.7. Model Sections Required for Simpler Upland Simulation

Section ATEMP is needed only if the input air temperature time series is obtained from a station at a significantly different elevation than the watershed land surface and it is desired to correct for this elevation difference. PWATER is the workhorse section of the PERLND module which performs the basic water balance and generates upland outflows. Section SEDMNT performs calculations to estimate sediment production and removal from the watershed.

The primary distinction between the more detailed and the simpler modeling approaches is whether or not subsurface soil processes are to be simulated in detail. As a simpler approach to modeling, PERLND provides section PQUAL for water quality simulation. PQUAL uses simple user-defined relationships of the quality constituent to water and sediment yield. This section will not provide fully detailed simulation of internal mechanisms and requires user-supplied values for subsurface outflows but can be useful to simplify the simulation task. Values for sediment potency factors and accumulation and washoff rates must be determined by fitting the observed data.

Table 3.2. Model Sections Needed For More Detailed Upland Simulation with PERLND.

Required Section	Optional Section	Required Table	Optional Table	Required Time Series	Optional Time Series
	ATEMP		ATEMP-DAT		AIRTMP
PWATER			PWAT-PARM1	PREC	
PWATER		PWAT-PARM2		PETINP	
PWATER			PWAT-PARM3		
PWATER		PWAT-PARM4			
PWATER			PWAT-STATE1		
PWATER			Monthly Tables		
SEDMNT			SED-PARM1		SLSED
SEDMNT		SED-PARM2			
SEDMNT		SED-PARM3			
SEDMNT			Monthly Tables		
SEDMNT			SED-STOR		
PSTEMP			PSTEMP-PARM1		

Table 3.2. Model Sections Needed For More Detailed Upland Simulation with PERLND.

Required Section	Optional Section	Required Table	Optional Table	Required Time Series	Optional Time Series
PSTEMP		PSTEMP-PARM2			
PSTEMP			Monthly Tables		
	PWTGAS		PWT-PARM1		
	PWTGAS		PWT-PARM2		
	PWTGAS		Monthly Tables		
	PWTGAS		Initial Value Tables		
MSTLAY		MST-PARM			
NITR		SOIL-DATA			
NITR		NIT-FLAGS			
NITR			NIT-UPTAKE		
NITR			MON-NITUPT		
NITR		NIT-FSTGEN			
NITR		NIT-FSTPM			
NITR			NIT-CMAX		
NITR			NIT-SVALPM		
NITR		NIT-STOR1			
NITR		NIT-STOR2			
PHOS		SOIL-DATA (only for NITR if NITR & PHOS are active)			
PHOS		PHOS-FLAGS			
PHOS			PHOS-UPTAKE		
PHOS			MON-PHOSUPT		

Table 3.2. Model Sections Needed For More Detailed Upland Simulation with PERLND.

Required Section	Optional Section	Required Table	Optional Table	Required Time Series	Optional Time Series
PHOS		PHOS-FSTGEN			
PHOS		PHOS-FSTPM			
PHOS			PHOS-CMAX		
PHOS			PHOS-SVALPM		
PHOS		PHOS-STOR1			
PHOS		PHOS-STOR2			

Many of the tables and time series shown as optional will be needed to specify model inputs and parameters. They are not strictly required to make the model run because default values will apply.

3.8. Model Sections Required for Detailed Upland Simulation

Section ATEMP is needed only if the input air temperature time series is obtained from a station at a significantly different elevation than the watershed land surface and it is desired to correct for this elevation difference. PWATER is the workhorse section of the PERLND module which performs the basic water balance and generates upland outflows. Section SEDMNT performs calculations to estimate sediment production and removal from the watershed.

PSTEMP is used to generate soil temperatures for the various simulated soil layers. Temperatures are estimated as a departure from air temperature and from other data such as groundwater temperatures. Soil temperatures affect equilibrium calculations for constituents adsorbed to the soils and first order rate controlled processes. Section PWTGAS calculates O_2 and CO_2 gas dissolved in discharges from the watershed. This information is of further use in the receiving reach water quality simulation.

Section MSTLAY is a utility section which takes the results of the PWATER calculations and converts them into moisture storages and inter-layer fluxes for use in determining solute transport. This operation is required to use the agrichemical sections NITR and PHOS. NITR performs a nearly complete system simulation of nitrogen transport and soil reactions. PHOS likewise performs a nearly complete system simulation of phosphorus transport and soil reactions. Both nutrient sections are similar and model the transport, plant uptake, adsorption/desorption, immobilization, and mineralization of the various chemical forms. Section NITR allows the simulation to further distinguish denitrification and plant uptake of nitrate/nitrite and ammonium. Neither PHOS or NITR

currently include a plant dieback mechanism to return nutrients to the soil. This is not a serious limitation for simulation of agricultural crops with harvesting but does not allow complete cycling of nutrients over the annual cycle in natural systems.

3.9. Revised PERLND Module

The HSPF PERLND module has undergone revision and documentation has been included to provide the new input parameters and modified simulation capabilities. Material related to the revised PERLND module may be subject to future changes.

It is not completely known how the water quality sections of the HSPF model will interact with the revised PERLND routines. The modelers have made an effort to preserve the existing PERLND capabilities in the revised model for testing and comparison purposes. It is reasonable to predict that water quality simulation capability will improve to the extent that the revised model improves the hydrologic simulation. It is also expected that different calibration parameter values will be derived because of differences in model performance. The following table identifies additional tables for use with the revised PERLND module.

Many of the tables shown as optional will be needed to specify model inputs and parameters. They are not strictly required to make the model run because default values will apply.

Table 3.3. Revised PERLND Section PWATER Requirements.

Required Section	Optional Section	Required Table	Optional Table	Required Time Series	Optional Time Series
PWATER			PWAT-PARM1	PREC	
PWATER		PWAT-PARM2		PETINP	
PWATER			PWAT-PARM3		
PWATER		PWAT-PARM4			
PWATER		PWAT-PARM6			
PWATER		PWAT-PARM7			
PWATER			PWAT-STATE1		
PWATER			Monthly Tables		

3.10. Impervious Land Module (IMPLND)

The Impervious Land Module (IMPLND) may be used for urbanized areas where little or no infiltration occurs. The use of this module can be avoided during this watershed-scale study because suitable parameter assignments can be made to simulate urbanized areas reasonably well with the PERLND module. The greatest difficulty with the IMPLND module is that it assumes that absolutely no infiltration occurs and thus subsurface processes do not occur and are not simulated. This situation is rarely true and when true accounts for only a small portion of the total subbasin area.

There are no especially useful simulation algorithms available only for impervious areas that make it worthwhile to expend the effort to further segment the watershed so that these areas may be simulated separately. The parameters employed by the PERLND routines can be assigned to urbanized land use classes to limit infiltration and generate increased sediment loads or reflect sediment removal by street sweeping, as appropriate. Area-weighted parameter averaging with appropriate assignments for urban classifications will sufficiently account for increases in runoff, nutrient and sediment loading due to the presence of relatively impervious areas within the subbasin. Storm water retention/detention storage can be effectively added to the existing reach area or may be modeled as a separate reach which does not discharge until storage capacity is filled or does not discharge at all. The HSPF routing capabilities do not yet support detailed evaluation of urban stormwater systems, so there is generally little to be gained from focusing separately on urban areas with the model while these areas can be adequately represented as part of a larger watershed area.

3.10.1. Time Series and Tabular Data Requirements

Time series and tabular data requirements for IMPLND are generally identical or similar to the corresponding PERLND requirements. The IMPLND section IQUAL is similar to the PERLND PQUAL section for water quality simulation of surface water outflows. Other sections allow simulation of solids accumulation and removal independent of runoff. This could be used to simulate street sweeping. The impact of street sweeping can be incorporated indirectly in a PERLND-based simulation by reducing accumulation rates in urban areas with sweeping relative to urban areas that have no sweeping.

3.11. Future Wetland Module

The HSPF model has been undergoing a series of revisions aimed at improving the hydrologic and hydraulic simulation capabilities of the modeling system. The development of a wetland module incorporating features of PERLND and RCHRES with other enhancements is currently underway. It is not known at this time how the completed wetland module will simulate water quality. The most useful approach would likely also combine water quality algorithms available for PERLND to perform a detailed simulation of subsurface soil processes and the water quality capabilities of

RCHRES to simulate processes in surface water storages. Additional routines to simulate wetland vegetation and sediment interactions such as nutrient cycling would be very desirable.

The development of an HSPF wetland module was previously completed for detailed water quality simulation of the entire lower Kissimmee River basin (U.S. Army Engineer Jacksonville District, 1985). Wetland simulation was a critical need for modeling of that system. The modeling approach incorporated both PERLND and RCHRES features and proved quite successful.

Detailed data requirements for the wetland module are currently undefined. Based on the proposed modeling approach, most data requirements should be identical or very similar to the needs of the existing PERLND and RCHRES water quality routines.

3.12. Overview of Model Sections of the Reach/Reservoir Routing Module (RCHRES)

The RCHRES module is used to simulate waterbodies, including free-flowing reaches and well-mixed reservoirs, in the watershed. The RCHRES module utilizes a uniform one-dimensional, well-mixed approach. After accounting for outflows, inflows, accumulation, and chemical or biological activity, all water within a given storage node is considered to be uniformly well-mixed. This has important water quality simulation implications related to the interaction between the simulation time step and the segmentation of the watershed into subbasin and reach areas.

Section HYDR performs the basic hydraulic routing. Section ADCALC performs calculations to simulate longitudinal advection of dissolved or entrained constituents. Section CONS is used to simulate conservative constituents using user-defined unit definitions. Section HTRCH determines the temperature in the reach. Section SEDTRN simulates transport, deposition and scour of sediments in the reach. These sections are generally needed to support either a simpler or more detailed reach simulation.

The simpler reach simulation will use section GQUAL. Section GQUAL provides an array of capabilities to simulate a generalized quality constituent. Capabilities include advection of dissolved material and decay processes such as hydrolysis, oxidation, photolysis, volatilization, biodegradation, and generalized first-order decay. Sediment-associated processes such as advection, deposition and scour of adsorbed material, the decay of suspended and bed material, and adsorption/desorption between the dissolved and adsorbed phase may be considered. The use of section GQUAL constitutes a simpler simulation approach because the user may choose which processes to simulate. For example, it may prove sufficient to provide for advection and first-order decay and possibly some sediment interaction and transport to perform a reasonably complete simulation for the key estuary loading issues. Such a simulation would use only a small part of what is available in GQUAL. The following table specifies the required and optional model requirements for simpler simulation with RCHRES. Detailed descriptions of time series inputs and model parameters are provided in Chapter 5.

Table 3.4. Model Sections Needed For Simpler Reach Simulation with RCHRES.

Required Section	Optional Section	Required Table	Optional Table	Required Time Series	Optional Time Series
HYDR		HYDR-PARM1		PREC	
HYDR		HYDR-PARM2		POTEV	
HYDR			MON-CONVF		IVOL
HDYR			HYDR-INIT		
ADCALC			ADCALC-DATA		
	CONS		NCONS		
	CONS	CONS-DATA			
HTRCH			HEAT-PARM	SOLRAD	
HTRCH			HEAT-INIT	CLOUD	
HTRCH				DEWTMP	
HTRCH				GATMP	
HTRCH				WIND	
SEDTRN			SANDFG		ISED
SEDTRN		SED-GENPARM			
SEDTRN		SED-HYDPARM			
SEDTRN		SAND-PM			
SEDTRN		SILT-CLAY-PM			
SEDTRN			SSED-INIT		
SEDTRN			BED-INIT		
GQUAL			GQ-GENDATA		IDQUAL
GQUAL		GQ-QALDATA			ISQUAL
GQUAL			GQ-QALFG		PHVAL
GQUAL			GQ-FLG2		ROC
GQUAL		GQ-HYDPM if hydrolysis			BIO

Table 3.4. Model Sections Needed For Simpler Reach Simulation with RCHRES.

Required Section	Optional Section	Required Table	Optional Table	Required Time Series	Optional Time Series
GQUAL		GQ-ROXPM if oxidation			PHYTO
GQUAL			GQ-PHOTPM if photolysis		
GQUAL		GQ-CFGAS if volatilization			
GQUAL		GQ-BIOPM if biodegrad.			
GQUAL		MON-BIO if biodegrad.			
GQUAL		GQ-GENDECAY if general decay			
GQUAL			GQ-SEDDECAY if sed. assoc.		
GQUAL		GQ-KD if sed. assoc.			
GQUAL		GQ-ADRATE if sed. assoc.			
GQUAL			GQ-ADTHETA if sed. assoc.		
GQUAL			GQ-SEDCONC if sed. assoc.		
GQUAL			GQ-VALUES		
GQUAL			MON-WATEMP		
GQUAL			MON-PHVAL		
GQUAL			MON-ROXYGEN		
GQUAL		GQ-ALPHA if photolysis			
GQUAL			GQ-GAMMA if photolysis		

Table 3.4. Model Sections Needed For Simpler Reach Simulation with RCHRES.

Required Section	Optional Section	Required Table	Optional Table	Required Time Series	Optional Time Series
GQUAL			GQ-DELTA if photolysis		
GQUAL			GQ-CLDFACT if photolysis		
GQUAL			MON-CLOUD		
GQUAL			MON-SEDCONC		
GQUAL			MON-PHYTO		
GQUAL			OX-FLAGS if volatilization		
GQUAL			ELEV if volatilization		
GQUAL			OX-CFOREA if volatilization		
GQUAL			OX-TSIVOGLOU if volatilization		
GQUAL		OX-LEN-DELTH if volatilization			
GQUAL			OX-TCGINV if volatilization		
GQUAL		OX-REAPARM if volatilization			
GQUAL			GQ-DAUGHTER daughter products from decay		

Many of the tables and time series shown as optional will be needed to specify model inputs and parameters. They are not strictly required to make the model run because default values will apply.

A more detailed simulation of in-stream processes can be performed using section RQUAL. Section RQUAL controls a set of detailed calculations to simulate biochemical transformations. RQUAL controls the execution of sections OXRX, NUTRX, PLANK, and PHCARB. These sections allow the simulation of dissolved oxygen, biological oxygen demand, nutrient species interactions,

phytoplankton, benthic algae, zooplankton, pH and carbon dioxide. The sections available under RQUAL are sequentially dependent so that simulation of reach pH with this approach would require data development and parameterization of all preceding sections. Some options are available to specify which mechanisms are simulated in each individual section, but the activation of the whole biochemical package requires a significant effort.

It is possible to mix the modeling approaches, using GQUAL for part of the simulation and RQUAL routines through NUTRX for other nutrient processes.

Table 3.5. Model Sections Needed For More Detailed Reach Simulation with RCHRES.

Required Section	Optional Section	Required Table	Optional Table	Required Time Series	Optional Time Series
HYDR		HYDR-PARM1		PREC	
HYDR		HYDR-PARM2		POTEV	
HYDR			MON-CONVF		IVOL
HDYR			HYDR-INIT		
ADCALC			ADCALC-DATA		
	CONS		NCONS		
	CONS	CONS-DATA			
HTRCH			HEAT-PARM	SOLRAD	
HTRCH			HEAT-INIT	CLOUD	
HTRCH				DEWTMP	
HTRCH				GATMP	
HTRCH				WIND	
SEDTRN			SANDFG		ISED
SEDTRN		SED-GENPARM			
SEDTRN		SED-HYDPARM			
SEDTRN		SAND-PM			
SEDTRN		SILT-CLAY-PM			

Table 3.5. Model Sections Needed For More Detailed Reach Simulation with RCHRES.

Required Section	Optional Section	Required Table	Optional Table	Required Time Series	Optional Time Series
SEDTRN			SSED-INIT		
SEDTRN			BED-INIT		
RQUAL			BENTH-FLAG		
RQUAL			SCOUR-PARMS		
OXRX			OX-FLAGS		
OXRX		OX-GENPARM			
OXRX			ELEV		
OXRX			OX-BENPARM		
OXRX			OX-CFOREA		
OXRX			OX-TSIVOGLOU		
OXRX		OX-LEN-DELTH			
OXRX			OX-TCGINV		
OXRX		OX-REAPARM			
OXRX			OX-INIT		
NUTRX			NUT-FLAGS		
NUTRX			CON-VAL1		
NUTRX			NUT-BENPARM		
NUTRX		NUT-NITDENIT			
NUTRX			NUT-NH3VOLAT		
NUTRX			MON-PHVAL		

Table 3.5. Model Sections Needed For More Detailed Reach Simulation with RCHRES.

Required Section	Optional Section	Required Table	Optional Table	Required Time Series	Optional Time Series
NUTRX			NUT-BEDCONC		
NUTRX			NUT-ADSPARM		
NUTRX			NUT-ADSINIT		
NUTRX			NUT-DINIT		
	PLANK	PLNK-FLAGS			
	PLANK	PLNK-PARM1			
	PLANK		PLNK-PARM2		
	PLANK		PLNK-PARM3		
	PLANK	PHYTO-PARM			
	PLANK	ZOO-PARM1			
	PLANK		ZOO-PARM2		
	PLANK		BENAL-PARM		
	PLANK		PLNK-INIT		
	PHCARB		PH-PARM1		ICON Alkalinity
	PHCARB		PH-PARM2		
	PHCARB		PH-INIT		

Many of the tables and time series shown as optional will be needed to specify model inputs and parameters. They are not strictly required to make the model run because default values will apply.

3.13. Discussion of Suggested Modeling Approach

The basic modeling approach is to use the simpler simulation approaches initially for the uplands and reaches and expand later to incorporate more detailed processes as they are identified as critical issues. The benefit is that a simpler model will be in production sooner and available for evaluation work and may well prove to be all that is needed to address watershed problems.

The primary distinction between the more complex and the simpler simulations will be in the initial effort required to parameterize and calibrate the model. The data compilation hours previously listed are expected to be sufficient to prepare the data in the formats needed for model use, whether as direct model input data or for comparison with model output during calibration and verification efforts. The major distinction among the different proposed monitoring and sampling regimes is whether the program primarily supports initial model calibration work or on-going model use.

The long-term monitoring program serves both the calibration effort and the long-term continued modeling effort. This program will provide much of the data for continued modeling of the southern Estero Bay Watershed in the future.

The short-term monitoring studies provide the primary calibration data for the upland areas of the watershed. These data will be obtained from representative areas and model parameters derived from the data will be applied to similar land use areas throughout the watershed. The monitoring effort at each site includes one year of continuous weather station and site discharge data collection and 4 storm event sampling occurrences to obtain water quality data. The ranking of the short term monitoring land use studies is provided as a prioritized list that can be tackled over time as resources became available.

The modeling effort associated with the short term monitoring program will occur primarily during the initial model calibration work. Similarly, evaluation of BMPs through this monitoring effort will generate data to allow estimation of BMP effectiveness and guide the selection of model parameter changes for 'what if' modeling scenarios that might assume widespread implementation of similar BMPs in the watershed. The same logic applies to the suggested wetland restoration comparison study.

Estimation of calibration man-hours associated with the short term monitoring is somewhat discretionary and is somewhat dependent on how successful and consistent the data collections are, but an effort of 16 hours modeling effort per storm event monitored and 40 hours modeling effort for the continuous simulation for each site is probably a reasonable starting point (144 hrs per year per site).

The synoptic study data serve several purposes. For modeling support, these data collections will provide profiles along the length of the major tributaries to Estero Bay and at discharge locations of certain subbasins for comparison with model predictions at internal locations in the watershed. This will help to discriminate whether general parameter assignments are reasonable or whether unique situations exist that might warrant additional field investigation.

The water column - sediment interaction study is discretionary and is presented as a one-time effort. This study would provide model calibration data for reach nutrient simulation.

The basic approach to modeling a watershed of this size and complexity is to perform a simulation for a small subset of the overall watershed initially and then expand the scope to include the remaining areas. The instrumented subwatershed areas proposed for the loading studies will provide ideal candidate sites for upland simulation calibration and verification. Similarly, in conjunction with the hydraulic revisions being developed for RCHRES, the simulation of the major conveyances should be approached incrementally. This is a fairly standard modeling approach because it allows successful methods applied to smaller areas for which more detailed data may be available to be applied to the remainder of the watershed with greater confidence that model predictions are realistic.

This approach will allow development and fine-tuning of data preparation methods and model parameter assignments. Initial calibration efforts will also be eased by the limited scope of the initial modeling. Basic work with a subset of the system will pay off significantly when the major 'production' effort to simulate the entire system is tackled.

A potential savings in effort can be obtained by performing the simulation for all upland areas and storing the results in database for later use by the reach routing elements. The upland contributions will not vary once the model is calibrated to generate the loadings. The reach routing elements generally require a significantly greater effort to model. Storing the upland outputs will save the time required for the model to recalculate the upland outputs during each iteration of the reach routing modeling. This approach may not be possible with the updated model if there is interaction between groundwater and reach water elevations.

It is recommended that water quality modeling should be approached by using the simpler modeling algorithms at first. Then, as time and budget permit and the need for more detail arises, efforts can be made to incorporate more detailed modeling approaches. The concern is that the significant additional effort required to use the more detailed approaches simply may not pay off in providing added insight.

For a nutrient loading example, if there is reason to believe that distinctions in individual processes of adsorption/desorption, mineralization/demineralization, and plant uptake rates hold the key to identifying the most effective management practices then the effort, cost and time required to fully characterize those processes from available literature data or newly funded laboratory and field studies may well be worthwhile. Otherwise, a simpler approach which assigns a more general loading rate based on land use/cover and management practices may be preferred. It must be considered that the simulation of hydrologic processes would be essentially identical for both of these modeling approaches. The simulation of management practices which basically affect runoff volumes and timing would produce similar results for either the simpler or more detailed modeling approach.

Similar distinctions can be made for detailed or simplified simulation of in-stream processes. For example, data may not be readily available to fully support the reach nutrient simulation capabilities within RQUAL. The monitoring program will provide the needed data to serve as calibration and verification targets but cannot directly provide the multitude of detailed rate parameters, algal respiration rates, zooplankton food quality, limiting nutrients for specific algal growth, etc. which could be used. A simpler approach using Section GQUAL with first order decay rates may be more appropriate for the initial simulation work and may well provide all the information needed to address the problems of the watershed in larger terms. However, increased familiarity with the watershed system as additional monitoring data is collected and the simulation work proceeds may well identify accelerated algal processes resulting from high nutrient loadings and leading to accelerated production of organic detrital material as a key issue in the loadings to the estuary. At that point in the watershed assessment it may well prove worthwhile to authorize the field and lab work efforts needed to characterize those processes in detail. It is not clear, however, that this information about the detailed processes would provide significantly greater understanding to formulate and implement useful management practices than an analysis that more simply evaluates overall loadings and methods to reduce those loadings.

A number of the time series inputs which can be used may alternatively be provided in tabular form as a set of monthly varying values or as a single constant value. This determination will have to be made following a detailed review of all available modeling data, including new data obtained from the monitoring program. It is often a matter of judgement to determine how reliably data can be extrapolated or interpolated.

Limited data are available in the literature to provide guidance in setting many of the required model coefficients and rate constants for the detailed model processes. Model default values may be arbitrary and not meaningful. Judgement and significant calibration efforts will be needed to guide the parameterization process. Selection of the model algorithms to be used can only be determined when the available data are compiled and reviewed.

An important overall modeling consideration is to coordinate the locations where hydrologic data and water quality data are collected with logical divisions in the modeled network to maximize the usage of existing historical data and new data to be collected during the monitoring program. A detailed assessment of the available data to develop modeling data should be made in coordination with a detailed review of the literature compilation.