Quality Assurance Project Plan

for

HSPF Model for the Lake Thunderbird Watershed

Prepared by:

Water Quality Division

Oklahoma Department of Environmental Quality

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March 2, 2010

SECTION A
PROJECT MANAGEMENT

A1 TITLE AND APPROVAL SHEET

Oklahoma Department of Environmental Quality
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Planning Section, Water Quality Division

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Mark Derichsweiler Date

Karen Khalafian
Quality Assurance Officer, DEQ

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Karen Khalafian Date

Karen Miles
QA Coordinator, Water Quality Division

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Karen Miles Date

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ACRONYMS AND ABBREVIATIONS

CD-ROM	Compact Disc – Read Only Memory
CGI	Common Gateway Interface
DEM	Digital Elevation Model
GIS	Geographic Information System
HTTP	Hypertext Transfer Protocol
km	kilometer
NED	National Elevation Data set
NHD	National Hydrography Data set
NLCD	National Land Cover Data set
NRCS	Natural Resource Conservation Service of the USDA
DEQ	Oklahoma Department of Environmental Quality
OCC	Oklahoma Conservation Commission
OSE	Oklahoma Office of the Secretary of Environment
OWRB	Oklahoma Water Resources Board
PM	Project Manager
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QAS	Quality Assurance Specialist
STATSGO	USDA State Soil Geographic Database
TMDL	Total Maximum Daily Load
USACOE	United States Army Corps of Engineers
USBOR	United States Bureau of Reclamation

USDA	United States Department of Agriculture
EPA	United States Environmental Protection Agency
USGS	United States Geological Survey

A3 DISTRIBUTION LIST

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A4 PROJECT/TASK ORGANIZATION

The project will be managed by the Water Quality Division (WQD) in the Oklahoma Department of Environmental Quality (DEQ). The Project Manager will coordinate with others including the Project Modeler, WQD's QA Coordinator, and the DEQ's QA Officer. WQD management has the ultimate authority to continue or modify work in a significant fashion, based on the recommendations of the Project Manager and/or other involved parties. The Project Manager is responsible for modifying conditions to achieve results which he believes are realistic and supportable by actual conditions, and which he thinks would reflect probable results should future sampling be undertaken in attempts to verify modeling results. The principal individuals participating in this project are described below:

MARK DERICHSWEILER – DEQ SECTION MANAGER AND PROJECT MANAGER

The section manager is responsible for direct supervision of the Project Manager and reporting progress on the project to other managers in the water quality division. As Project Manager, he is responsible for ensuring that the project and its resulting deliverables meet the project requirements. In addition, he reviews project deliverables to ensure that tasks in the work plan are completed as specified, and data is of known and sufficient quality, as specified in the QAPP.

ANDREW FANG – DEQ PROJECT MODELER

The modeler is responsible for developing and calibrating the HSPF model as specified in the QAPP.

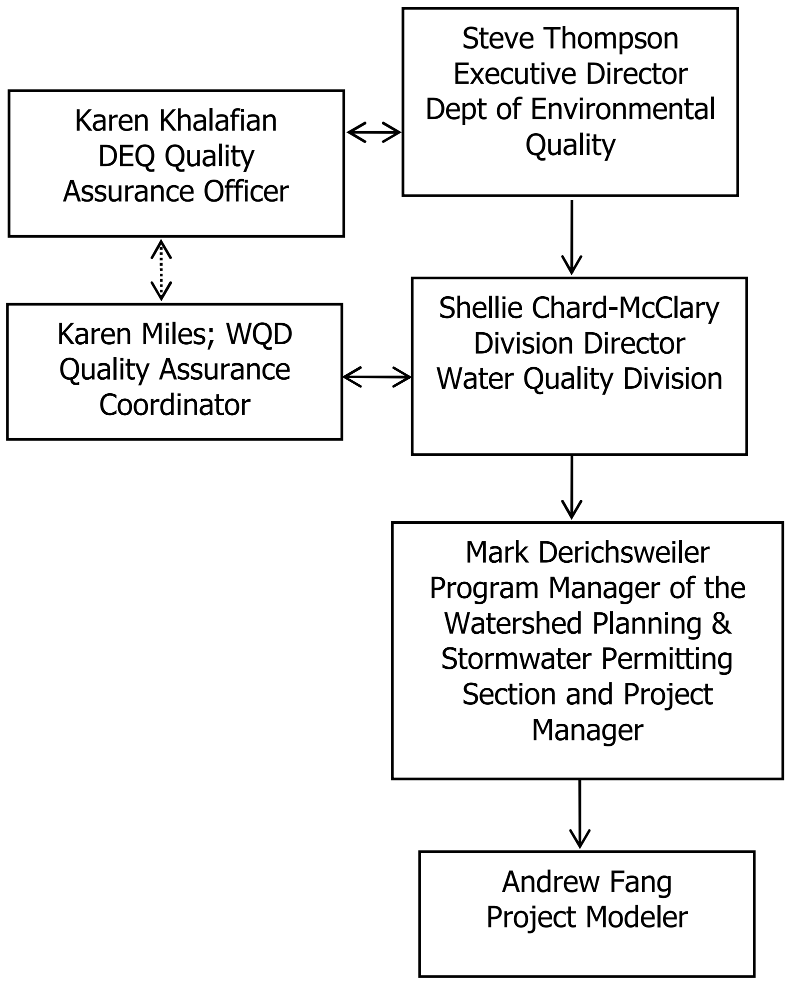
KAREN KHALAFIAN – DEQ QA OFFICER

Reviews and approves QAPP (including any revisions) to ensure project will deliver data of known and sufficient quality to achieve project objectives. Conveys QA problems to appropriate DEQ management. Monitors implementation of corrective action.

KAREN MILES – DEQ WQD QA COORDINATOR

Reviews and approves QAPP (including any revisions) to ensure project will deliver data of known and sufficient quality to achieve project objectives. Conveys QA problems to appropriate DEQ water quality division (WQD) management. Monitors implementation of corrective action.

Figure 1: Organizational Chart for HSPF Model Modification



A5 PROBLEM DEFINITION/BACKGROUND

The Federal Clean Water Act (CWA) requires states to identify waterbodies that are not meeting state water quality standards. These waterbodies are identified in the Integrated Water Quality Monitoring and Assessment Report (Integrated Report). This report integrates the Water Quality Inventory Report (Section 305(b) of the CWA) and the Impaired Waterbodies List (Section 303(d) of the CWA). The Integrated Report is intended to provide an effective tool for maintaining high quality waters and improving the quality of waters that do not attain water quality standards. Oklahoma's 2008 Integrated Report can be found at: http://www.deq.state.ok.us/wqdnew/305b_303d/2008_integrated_report_entire_document.pdf. This report also designates the beneficial uses and impairments of each waterbody in Oklahoma. Beneficial uses include water for drinking, recreation, aesthetics, irrigation, fishing, and swimming.

Located in the City of Norman, Cleveland County, Oklahoma, Lake Thunderbird, a 6,070-acre reservoir lake, is listed on Oklahoma's 2008 303(d) list for impaired uses of warm water aquatic community and public and private water supply. The causes of the impairments are low dissolved oxygen (DO), high turbidity and high chlorophyll-*a* (chl-*a*) concentration. These impairments were determined based on Oklahoma Water Quality Standards (WQS). The Oklahoma Water Quality Standards were developed by the Oklahoma Water Resources Board (OWRB) and can be found in Title 785, Chapter 45 of Oklahoma Administrative Code [http://www.owrb.ok.gov/util/rules/pdf_rul/Chap45.pdf]. The Water Quality Standards set a limit of 2 mg/L (50% of the samples) for DO, 25 NTU (10% of the samples) for turbidity, and 0.010 mg/L (long-term average) for chl-*a*. Because there is no point source discharge in the Lake Thunderbird watershed, nutrients and sediment loadings from nonpoint sources discharging during runoff events through tributary streams are believed to be the major sources of the pollutants. According to the Oklahoma Water Quality Standards (WQS), Lake Thunderbird is designated as a sensitive water supply lake [785:45-5-25(c)(4)[1]] in a nutrient limited watershed [785:45-5-29[2]].

Lake Thunderbird serves as a drinking water source for the cities of Norman, Midwest City, and Del City. It is also a major recreation destination providing boating, fishing and other water related opportunities. There are three major municipalities in the Lake Thunderbird watershed: Norman, Moore, and Oklahoma City. Located in one of the fastest growing areas in the state, Lake Thunderbird watershed has seen rapid urban development over the last decade. More development is forecast by local governments. Urban development, if progressing without appropriate mitigation of its environmental impact, will exacerbate the water quality problems currently experienced by the Lake. In addition, the watershed still maintains a substantial agricultural presence, mostly pasture operations. Proper management of agricultural operations is another key to improving the Lake's water quality.

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[1] http://www.owrb.ok.gov/util/rules/pdf_rul/Chap45.pdf, pages 21 and 67.

[2] http://www.owrb.ok.gov/util/rules/pdf_rul/Chap45.pdf, page 24.

In light of the unique challenges associated with reducing nonpoint source contributions, DEQ is proposing the use of a watershed-based plan in lieu of a total maximum daily load (TMDL) for Lake Thunderbird. The scientific basis for the plan development includes two water quality models: the Environmental Fluid Dynamics Code (EFDC) model for the Lake and the Hydrologic Simulation Program-FORTRAN (HSPF) model for the contributing watershed. The models will be used to establish nutrients (phosphorus and nitrogen) and turbidity reduction goals from the watershed, a key component of the watershed-based plan. The models will also provide information on sources of loadings and potential management options. Output from the HSPF watershed model serves as the input for the EFDC lake model. This QAPP addresses the HSPF modeling process.

HSPF model (Bicknell et al, 2000) is a comprehensive, continuous, lumped parameter, watershed−scale model that simulates the movement of water, sediment, pesticides, and nutrients on pervious and impervious surfaces, in soil profiles, and within streams and well−mixed impoundments. HSPF is supported by the EPA and is one of the main modeling tools available through EPA's BASINS modeling platform for water quality assessment and TMDL development.

A6 PROJECT/TASK DESCRIPTION

Task: Develop and Calibrate the HSPF Model for the Lake Thunderbird Watershed

The sole task of this project is to develop and calibrate the HSPF model for the Lake Thunderbird watershed. The output of the model will be used as the input for the lake EDFC model. The location of the project area is shown in Figure 2. Because HSPF is a distributed watershed model, data requirements are vast. A variety of available data are used in HSPF:

- USGS 2001 land cover
- 10 m USGS DEM
- 1:250,000 NRCS STATSGO soils data
- Weather data from the Oklahoma Mesonet meteorological monitoring network
- Rainfall data collected at 5 monitoring stations located in the watershed (Figure 2) by the Oklahoma Conservation Commission (OCC)
- Stream flow depth data collected at 5 monitoring stations located in the watershed by the OCC
- Stream nutrients, sediment, and organic carbon concentration data collected at 5 monitoring stations located in the watershed by OCC
- Oklahoma Mesonet (mesoscale network) Norman station meteorological data

The HSPF model will be calibrated for flow for the period April 2008 to April 2009 for the 5 monitoring stations, and then calibrated for nutrients, sediment and organic carbon for the same period. The calibration will follow standard modeling procedures based on observed data and established statistical criteria.

This project is scheduled to be completed by April 2, 2010.

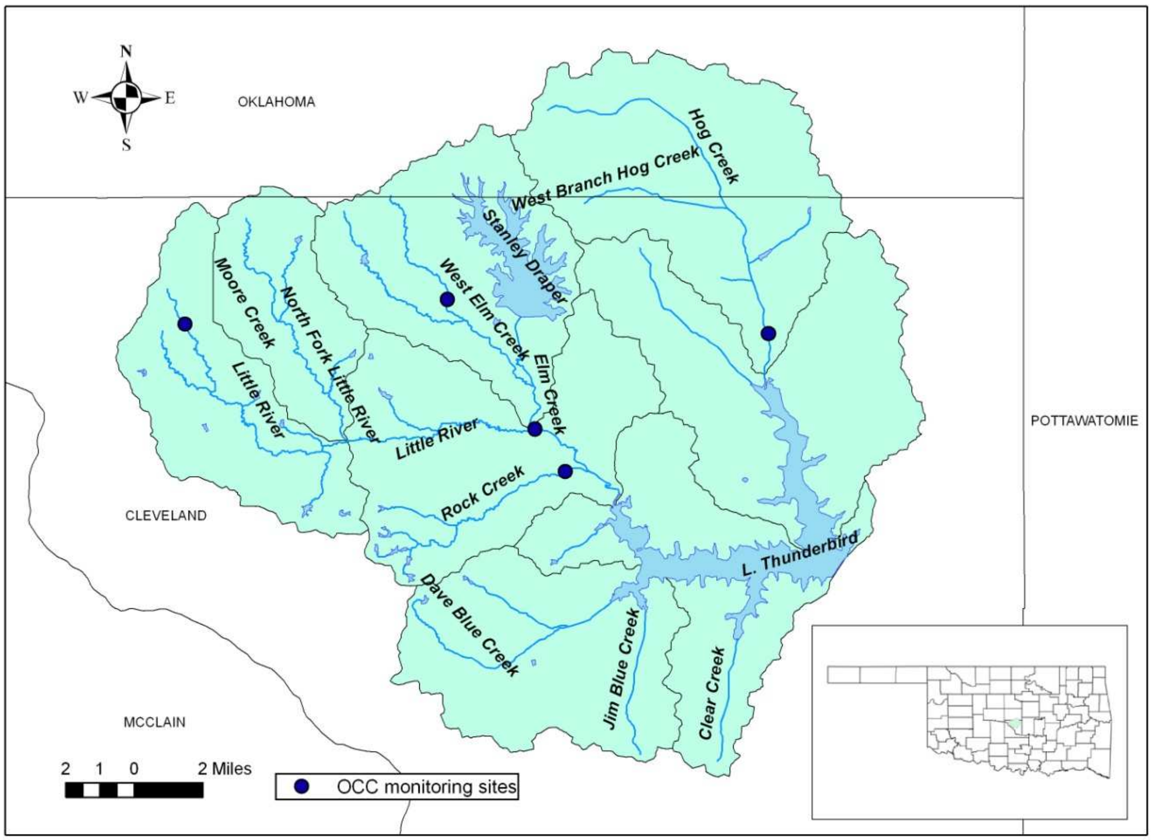

Figure 2. Location of Project area and Stream Monitoring Stations

A7 QUALITY OBJECTIVES AND CRITERIA

Data to be used in the model are all secondary data from previous monitoring projects in the watershed or part of the nation-wide or state-wide data compilation efforts. The stream flow and water quality monitoring data and part of the precipitation data were collected by OCC in a EPA funded 319(h) project. That project had an EPA approved QAPP for OCC's *Priority Watershed and Special Projects Water Quality Monitoring* projects (See Appendix A). Federal agencies such as USGS and USDA have their formal QA/QC procedures for data collection and publication. Data from those agencies will be used at face value. Meteorological data will also come from the Norman station of the Oklahoma Mesonet meteorological monitoring network, which is a partnership of the University of Oklahoma and Oklahoma State University with sponsorship from various state agencies. The Mesonet data covers the entire State of

Oklahoma with at least one station per county. In addition to its status as the most comprehensive data available in the state of Oklahoma, Mesonet with its Norman station is the only available data source for 5-min temperature, humidity, solar radiation, and wind records for the project area. As such, Mesonet data will be used in the project at face value.

The HSPF model must be calibrated so that the output for stream flow matches monitoring data. Most analytical results will have confidence intervals that range between +/- 15% to +/- 30% of the specific parameter measured. The limitations of the HSPF model in representing true physical and biological processes in a watershed are well-understood in the modeling community. The applicability of the model output as the input to the EFDC model and potentially in future watershed management activities will, therefore, be cautioned against these limitations. The “data users” here are the EFDC modelers, who will use the HSPF output as the input for the EFDC lake model. The EFDC modelers will be advised of HSPF model limitations.

There is no ultimate “decision error” associated with this project. Decision errors related to the use of historical or regional background data can be “lumped” into apparent analytical results by model calibration. Uncertainties in flow, climate, assumptions about land use, permeability, and pollutant fate-and-transport in the modeled system, etc., are all reflected by the error associated with analytical measurements when computer models are calibrated.

The primary success criterion for watershed modeling will be the acceptance of the calibrated model as the input for the EFDC model and as a potential tool for assessing impact of landuse management options on the stream water quality in the watershed. Final acceptance must come from other state agencies, and EPA. Watershed stakeholders must also be comfortable that the model gives a reasonable representation of local conditions.

A8 SPECIAL TRAINING REQUIREMENTS/CERTIFICATIONS

The project modeler, in addition to his general training as an engineer with experience in watershed modeling, received formal HSPF training in an EPA-sponsored workshop.

A9 DOCUMENTATION AND RECORDS

Much work has already been done and published information is already available. The Project Manager will clearly indicate material which is used in this project, and will clearly indicate any material which he discards and the reasons for not using material. Notes are adequate for this purpose.

All documents and electronic files will be archived by Oklahoma DEQ for at least five years. These documents will include data used in the project, the final model code, calibration and/or validation data, and HSPF model results.

A9.1 INFORMATION TO BE INCLUDED IN REPORTING PACKAGES

At this time, this project consists solely of data evaluation, data input to the computer model HSPF, and data output from the HSPF model.

For the present, then, two general forms of records are needed.

1. An inventory of data input parameters for the model, including those used for calibration.

2. Output from the computer model.

A9.2 DATA REPORTING PACKAGE FORMAT AND DOCUMENTATION CONTROL

The DEQ Project Manager is responsible for retaining this information and will do so both in electronic and hard-copy form. Electronic files stored on DEQ computer servers are automatically backed up daily by the State's data maintenance center. All official records of the agency are stored according to the State's recording keeping policy. The Project Manager should do so in such a fashion that another person could duplicate his work with a reasonable amount of similar effort. Computer output material can be tabular, graphical, and can be obtained via computer monitor or printer. The Project Manager can best decide the approach to this when he moves into the actual modeling work involved.

The lake modeler has developed a tool to direct read results from HSPF model output data and format them into EFDC input files. Therefore, model code and associated HSPF input data, which are essential text files, will be sent to the EFDC modeler as the final product of this project.

A9.3 DATA REPORTING PACKAGE ARCHIVE AND RETRIEVAL

Electronic data packages are the natural result of computer modeling. The Project Manager will retain this material, as he will use it in additional work for the watershed. In addition, the Project Manager will retain his work and results in an easily-contained, easily-referenced hardcopy form. A three-ring binder is recommended, but the final form is discretionary. The Project Manager must arrange for data archival and storage for a time frame sufficient to meet regulatory requirements, and part of his responsibility for this project is to be aware of this requirement, which may differ from the requirements of other state and federal programs.

SECTION B
DATA ACQUISITION

B1 SAMPLING PROCESS DESIGN

No new measurements are to be undertaken as part of this project.

B2 SAMPLING METHODS REQUIREMENTS

This section is not relevant to the project.

B3 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

This section is not relevant to the project.

B4 ANALYTICAL METHODS REQUIREMENTS

This section is not relevant to the project.

B5 QUALITY CONTROL

This section is not relevant to the project.

B6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE REQUIREMENTS

This section is not relevant to the project.

B7 INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

This section is not relevant to the project.

B8 INSPECTION/ACCEPTANCE REQUIREMENTS FOR SUPPLIES AND CONSUMABLES

This section is not relevant to the project.

B9 NON-DIRECT MEASUREMENTS

All model parameters used in these computations are critical, and output for the model, like all computer models, must be examined by the modeler and the Project Manager for reasonableness, checked for sensitivity to various input parameters, and calibrated to match assumptions with actual behavior of the system being modeled. The list of input parameters is extensive, and will not be dealt with in detail in this QAPP.

Historical environmental data such as precipitation and soil types drive and define the model for local conditions. Field data such as stream flow are critical in model calibration. Historical data from various sources and recent information from stream monitoring will be gathered and applied to the computer-modeling effort. Table 1 shows these data and their sources. Data input include land use, soil types, rainfall, air and water temperatures, reaction mechanisms, contaminant loadings, flow rates and resistance to flows. Table 1 identifies the most important data published (with exceptions noted). These data come from a variety of sources.

Table 1: Selected Secondary Data for Basin/Subbasin Modeling

Data set	Applications	Notes	Sources
Soil general map unit boundaries and properties	Assignment of soil properties to HSPF subwatersheds	National STATSGO database.	USDA NRCS
10-m digital elevation model (DEM)	Definitions of subbasins for meteorology data and spatially-distributed simulation	USGS national DEM dataset	USGS GIS data repositories
5-min weather data: precipitation, temperature, solar radiation, humidity, and wind	HSPF input: time series meteorology data	Point measurements at the Norman Mesonet station and precipitation data only at 5 stream monitoring stations.	Oklahoma Mesonet (a partnership of U. of OK and OK State U.) and OCC
Streamflow	Calibration. Checking of precipitation data.	Measurements at OCC monitoring stations. (Figure 2)	OCC
Nutrients, sediment, and organic carbon loadings and concentrations in streams	Calibration.	Measurements at OCC monitoring stations. (Figure 2)	OCC
Land cover maps	Area of land of each type in each subwatershed; Input for HSPF model.	USGS 2001 national land cover data set; adjusted based on updated local information	USGS

Often there are several data sets available from which to choose for a particular modeling task. The sources of secondary data will be identified in all deliverables. These data are evaluated based on the following criteria:

1. GIS Data Detail

GIS data come in a variety of detail levels, which may be expressed as a resolution or map scale. When available in different scales, the finest scale data will be used in the project.

2. Age of Data

Some data are more time sensitive than others. For example, land cover may change dramatically over the span of a decade, where as soils typically change only over geologic time. The most recent data will be used for time sensitive datasets. Adjustment will be made based on locally available information. For example, since the publish of the USGS 2001 land cover maps, Lake Thunderbird watershed has seen rapid urban- and suburbanization. During model development, this fact will be considered in accurately presenting the land use distribution of the watershed.

3. Accuracy

When accuracy information is not available, the data must be assessed by professional judgment.

4. Temporal Continuity

Temporal continuity is of great importance when selecting meteorological, stream flow, or water quality data. Weather information should ideally be continuous minimally on an hourly basis for the HSPF model, although it is possible to estimate missing data based on other data. Stream flow data should cover the periods where high flow occurs in the streams. Temporal continuity for water quality data is not a necessary condition for developing and calibrating HSPF. Ideally, available data should cover the entire range of potential flow rate distribution in the stream while concentrated on the high end of the distribution as most of the pollutant loading takes place when flow is high.

5. Spatial Consistency

Spatial consistency is often sacrificed to use the most current data available. Most data sets cover only a limited area such as a state or county. A basin is typically not limited to those same boundaries, and often cross both state and county lines. This leads to the use of multiple GIS data sets to define a single model input layer and may create a lack of consistency across the basin.

Quality and Limitations of HSPF Model Data

It is not currently possible to comprehensively quantify the error in HSPF model predictions. Thus there are no quantitative data quality requirements. It is possible, however, to list model limitations. Model limitations may be the result of data used in the model, inadequacies in the model, or using the model to simulate situations for which it was not designed. Hydrologic models will always have limitations, because the science behind the model is neither perfect nor complete. A model by definition is a simplification of the real world. The following is a list of notable HSPF model limitations:

1. Weather

Weather is the driving force for any hydrologic model. Rainfall can be quite variable, especially in the spring when convective (“pop-up”) thunderstorms produce precipitation with a high degree of spatial variability. It may rain heavily at one weather station, but may be dry a short distance away. On an average annual or average monthly basis, these errors may cancel. HSPF has an hourly time-step and thus is subject to such rainfall data variation.

2. Radical Parameter Changes

Scenarios involving radical changes to the basin result in greater uncertainty. The HSPF model is calibrated using estimates of what is presently occurring in the basin. Large departures from calibration conditions raise the level of uncertainty in model predictions.

3. Small Land Covers

Land uses that cover very small areas are not represented in the HSPF model. Land uses that occupy limited areas such as unpaved roads, bare areas, construction sites, and some row crops may not be simulated. In addition, most of these features may not be depicted in the available land cover. Some of these small areas may contribute substantial amount of sediment on a per unit area basis in intense precipitation conditions. Such small scale activities may not be able to be simulated with the currently available data.

4. Calibration parameters

In HSPF, some model parameters are nominally physically based and act as calibration parameters. While a carefully executed calibration can yield good agreement between model output and monitoring data, these parameters may require adjustment if the model is to be applied in conditions that are different from those of the calibration.

5. Management Uncertainty

There is a great deal of uncertainty associated with land management practices. In reality, management varies significantly from field to field for crop land and from neighborhood to neighborhood in urban areas. It is not possible to easily determine what is happening where, or to simulate all these activities in the model, especially when HSPF is simulating the watershed on an hourly basis. Therefore, categories are created to cover reasonable management choices only.

B10 DATA MANAGEMENT

At DEQ, the data processing and management equipment are personal computers and network stations using the Windows operating systems. A water quality model (Section A6) will be used in the project. Output data from this model will be stored in text format in a network drive and removable media. Backup copies for network drives, one of which is off-site, are created everyday by the State’s central data service to prevent any potential data losses. The modeler will be responsible for storing and backing up the data on a daily basis.

SECTION C
ASSESSMENT AND OVERSIGHT

C1 ASSESSMENT AND RESPONSE ACTIONS

As discussed in Section A, the acceptability of modeling results will be determined by the statistics aided with the general modeling experience of the modeler and the Project Manager. The primary response actions if quantitative inadequacies are uncovered are:

- Informing the EFDC modeler in writing possible ranges of flow and pollutant loading values for the HSFP simulation results that realistically represent uncertainty;
- isolating key weaknesses in input data or algorithms, and addressing them via supplemental research, replacement, or new data collection.

The watershed modeling task is an iterative one in which early results are evaluated to refine subsequent work.

<u>This project breaks down into these general phases:</u>

1. Model input data and monitoring data will be gathered and assimilated by DEQ. During this event, outliers can be identified and documented.
2. Data input will be performed by the modeler under the direction and supervision of the Project Manager. Flow modeling and pollutant fate-and-transport modeling for the watershed system are the resulting output. Model calibration will be carried out in this phase. The Project Manager’s judgment will be the guiding force in assessing the success of this phase of the project.
3. The last phase of the project results in a final HSPF model. The model will be used to generate input for the Lake Thunderbird EFDC model and serve as the basis for future watershed management.

The modeler will keep a journal of this project, such that input and output of computer analysis can be tracked and reproduced if necessary.

C2 REPORTS TO MANAGEMENT

The Project Manager will work closely with the modeler. Face to face discussions between the Project Manager and the modeler will provide almost daily progress report on the completion of the project.

SECTION D
DATA VALIDATION AND USABILITY

D1 DATA REVIEW, VERIFICATION AND VALIDATION

Published reports and locally collected stream water quality data will be the primary sources of data used for this project. No new water quality sampling will be undertaken as part of this project. The organizations that collected the data used in this project are listed in Table 1 in Section B9. In most cases, they are the sole provider of the particular dataset. The stream flow and water quality monitoring data and part of the precipitation data were collected by the Oklahoma Conservation Commission (OCC) in an EPA funded 319(h) project. That project had an EPA approved QAPP for OCC's *Priority Watershed and Special Projects Water Quality Monitoring* projects (see Appendix A). Federal agencies such as USGS and USDA have their formal QA/QC procedures for data collection and publication. Data from those agencies will be used at face value. Meteorological data will also come from the Norman station of the Oklahoma Mesonet meteorological monitoring network, which is a partnership of the University of Oklahoma and Oklahoma State University with sponsorship from varies state agencies. The Mesonet data covers the entire State of Oklahoma with at least one station per county. In addition to its status as the most comprehensive data available in the state of Oklahoma, Mesonet with its Norman station is the only available data source for 5-min temperature, humidity, solar radiation, and wind records for the project area. As such, Mesonet data will be used in the project at face value.

Input data compilation is an important part of the model development phase. Criteria used for accepting, rejecting, or qualifying these secondary data include GIS data detail, age of data, data accuracy, data temporal continuity, and spatial consistency.

GIS data come in a variety of detail levels, which may be expressed as a resolution or map scale. When available in different scales, the finest scale data will be used in the project. Some data are more time sensitive than others. For example, land cover may change dramatically over the span of a decade, where as soils typically change only over geologic time. The most recent data will be used for time sensitive datasets. Adjustment will be made based on locally available information. GIS data for this project mainly came from USDA and USGS. They will be acceptable at face value. When data accuracy information is not available, the data must be assessed by professional judgment.

Temporal continuity is of great importance when selecting weather, stream flow, or water quality data. Weather should ideally be continuous minimally on an hourly basis for the HSPF model, although it is possible to estimate missing data based on other data. Data collected by the rain gages at OCC monitoring stations (Figure 1) in the watershed provide the precipitation data for the project. They will be compared to the Oklahoma Mesonet 5-min meteorological dataset in case questionable data points are discovered. The Mesonet dataset will also be used as the data source for filling missing OCC precipitation data at the monitoring stations. Stream flow data should cover the periods where high flow occurs in the streams. Temporal continuity for water quality data is not a necessary condition for developing and calibrating HSPF. Ideally, available data should cover the entire range of potential flow rate distribution in the stream while concentrated on the high end of the distribution as most of the pollutant loading takes place when flow is high. Flow and water quality data were generated from the OCC monitoring stations. Because there are no other similar data sources in the watershed, professional judgment by the project modeler and the manager will determine the acceptable of individual data points when obvious deviation from commonly seen flow or water quality patterns is observed during the project.

Spatial consistency is often sacrificed to use the most current data available. Most data sets cover only a limited area such as a state or county. A basin is typically not limited to those same boundaries, and often cross both state and county lines. This leads to the use of multiple GIS data sets to define a single model input layer and may create a lack of consistency across the basin. The GIS data used in the project are from USGS and USDA. Spatial consistency will be checked again available aerial photos or field visit if necessary when spatial consistency of project area is in question.

The modeler, with consensus from the Project Manager, will scrutinize data that appears obviously out-of-scale. The Project Manager may, at his discretion, assume that analytical data generally fits a Gaussian distribution, calculate means, medians, sample and population standard deviations, and from these estimates, decide whether a given data point is an outlier. The Project Manager may have more sophisticated techniques available, but this is suggested as a starting point. An outlier might, therefore, lie outside of three sample standard deviations from the sample mean.

A formal HSPF model validation process is not included in this project because of the limited monitoring data available for calibration (only one full year of stream flow and water quality data) and the main purpose of the model development (to generate input for the lake model).

D2 VERIFICATION AND VALIDATION METHODS

Verification of the HSPF model is referred to as model calibration in computer based watershed modeling. Model calibration is the process by which model parameters are adjusted to make its predictions agree with measured data. Model parameters will only be adjusted within literature recommended ranges. Calibration generally improves the reliability and reduces the uncertainty of the model predictions. If enough data are available, then the models will be validated. Validation is similar to calibration except the model is not modified. Validation tests the model with measured data that are not used in the calibration process.

The HSPF model will be calibrated using data from OCC stream flow measurements at 5 stations within the basin from the April 1, 2008 to April 31, 2009. Nash-Sutcliffe Efficiency (NSE) and Coefficient of Determination (R^2) will be used as an indicator of goodness of fit (Nash and Sutcliffe, 1970). There are no standards or a range of values for goodness-of-fit statistical parameters that adjudge the model performance as acceptable (Loague and Green, 1991). In the past, other researchers have suggested values of goodness-of-fit statistics for determining the acceptable performance. Ramanarayanan et al. (1997) indicated that values close to zero for the correlation coefficient and/or the Nash-Sutcliffe coefficient indicated the model performance was unacceptable or poor. They judged the model performance as satisfactory or acceptable if the monthly correlation coefficient was greater than 0.5 and the monthly Nash-Sutcliffe coefficient was greater than 0.4. Santhi et al. (2001) assumed a monthly Nash-Sutcliffe coefficient greater than 0.5 and a monthly R^2 greater than 0.6 indicated acceptable model performance when calibrating and validating HSPF. However, acceptable statistical measures are project and model specific. Model performance on a daily basis will be somewhat different than monthly model runs. The HSPF model must be calibrated so that the output for stream flow matches monitoring records. Along with the NSE and R^2, HSPF will be calibrated so that predicted values for flow agree with measure values within the range between +/- 15% to +/- 30%, which is a generally accepted range for watershed models.

When calibration standards are not met, DEQ will check the measured data for deficiencies and correct them (if possible). The model will be re-calibrated if any deficiencies are found in the measured data and data analysis.

A formal HSPF model validation process is not included in this project because of the limited monitoring data available for calibration (only one full year of stream flow and water quality data) and the main purpose of the model development (to generate input for the Lake Thunderbird model).

D3 RECONCILIATION WITH DATA QUALITY OBJECTIVES

The limitations of the HSPF model in representing true physical and biological processes in a watershed are well-understood in the modeling community. The applicability of the model output as the input for the EFDC lake model will, therefore, be cautioned against these limitations.

The “data user” here is the Lake Thunderbird model Project Manager who will use the HSPF model output as in the input the lake model.

This scope and scale of this project are such that the primary person responsible for data selection, use, calibration and reconciliation, is the Project Manager. He may choose to solicit input from others, including the lake model Program Manager, the QA Coordinator, the QA Officer, or others. The specialized nature of the project, however, makes the Project Manager the true expert in accomplishing the project.

REFERENCES

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Appendix A

QAPP for

Priority Watershed and Special Projects Water Quality Monitoring

By

Oklahoma Conservation Commission