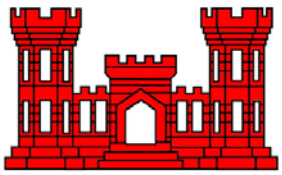
Volume 3
Part 6.2

Model Certification Review Report for Waterfowl Assessment Methodology



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Memphis District

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Final Model Certification Review Report for the Waterfowl Assessment Methodology

Prepared by
Battelle Memorial Institute

Prepared for
Department of the Army
U.S. Army Corps of Engineers
Ecosystem Restoration Planning Center of Expertise
Mississippi Valley Division

Contract No. W911NF-07-D-0001
Task Control Number: 09210
Delivery Order: 0799

February 18, 2010

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SHORT-TERM ANALYSIS SERVICE (STAS)

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Prepared by

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for:

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Scientific Services Program

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FINAL
MODEL CERTIFICATION REVIEW REPORT
for the
WATERFOWL ASSESSMENT METHODOLOGY

EXECUTIVE SUMMARY

A model certification review of the Waterfowl Assessment Methodology (WAM) was conducted for the U.S. Army Corps of Engineers (USACE) Ecosystem Restoration Planning Center of Expertise (ECO-PCX) under Contract Number W911NF-07-D-0001, Task Control Number 09210. The objective of the review was to evaluate the technical quality and usability of the WAM in accordance with USACE's *Planning Models Improvement Program: Model Certification* (EC 1105-2-407, dated May 31, 2005) and *Protocols for Certification of Planning Models* (July 2007). The WAM is not a software- or spreadsheet-based model and, therefore, was not evaluated for system quality. USACE's ultimate goal is to certify the WAM for use within the geographic area specified in the model documentation. The review did not include a technical evaluation of the application of the model to a specific project.

The USACE Planning Models Improvement Program (PMIP) was established in 2003 to assess the state of USACE planning models and to assure that high quality methods and tools are available so that informed decisions on investments in the Nation's water resources infrastructure and natural environment can be made. The main objective of the PMIP is to carry out "a process to review, improve and validate analytical tools and models for USACE Civil Works business programs" (EC 1105-2-407, May 2005). In accordance with the *Planning Models Improvement Program: Model Certification* (EC 1105-2-407, May 2005), certification is required for all planning models developed and/or used by USACE. The objective of model certification is to ensure that models used by USACE are technically and theoretically sound, computationally accurate, and in compliance with USACE planning policy.

As a 501(c)(3) nonprofit science and technology organization with experience in establishing and administering peer review panels for USACE, Battelle was engaged to conduct the model certification review for the WAM. Independent, objective peer review is regarded as a critical element in ensuring technical quality, system quality, and usability of the models. Three subject matter experts (i.e., model reviewers) were selected to serve on the model review panel from 20 identified candidates. As appropriate for the technical nature of the WAM, the technical expertise of the three selected peer reviewers included one civil works planner with experience in Habitat Evaluation Procedures and two waterfowl biologists.

The model reviewers were provided with an electronic version of the WAM document along with a charge (included as part of Attachment A) that solicited their comments on specific aspects of the document. The charge questions solicited comments regarding key technical quality and usability criteria that are critical for model certification as described in the USACE *Protocols for Certification of Planning Models* (July 2007). The WAM is not a software- or spreadsheet-based model and, therefore, was not evaluated for system quality. Other than the kickoff teleconference, there was no communication between the model reviewers and the model developers during the review of the WAM document.

Approximately 100 individual comments were received from the model reviewers in response to 30 charge questions. Following the individual reviews of the model documentation by the model reviewers, a model review teleconference was conducted to review comments on the key model review criteria, discuss charge questions for which there were conflicting responses, and reach agreement on the Final Panel Comments to be provided to USACE. The panel members' findings regarding the model's technical quality and usability are documented in specific sections of this report, and Final Panel Comments are provided in Appendix B.

This Final Model Certification Review Report for the WAM summarizes the model review process, describes the model reviewers and their selection, and summarizes the findings and Final Panel Comments of the model reviewers. Comments on the Draft Model Certification Review Report were received from USACE on February 10, 2010 and discussed with the model reviewers during a teleconference at 3:00 PM EST on February 16, 2010. This final report presents the results of the model review and will be taken into consideration for certifying or revising the WAM.

Overall, the model reviewers agreed that the concept and application of the WAM are sound for planning efforts. Models are simple representations of complex systems and, as such, must balance complexity and reality with simplicity and usability. For the WAM, this goal has been achieved. The model seems to sufficiently capture the habitats being modeled and does not have any irreparable deficiencies.

However, there were some concerns regarding the accuracy of the WAM's model inputs, the ability to measure uncertainty, and the completeness of the documentation. The model review panel provided the following recommendations for improving the model based on the most significant concerns identified by the model reviewers.

1. Construct a simpler model that includes more known inputs based on key studies versus a review of all studies from which a mean is then chosen.
2. The model's time frame should be extended into April to address species that remain in the upper Mississippi Alluvial Valley (MAV) well into spring.
3. Include a section in the WAM manual that addresses the issue of model applicability and accuracy relative to all potential model uses.
4. Incorporate stochasticity into the WAM model for calculating duck-use-days (DUDs) in the MAV by using point estimates and a measure of precision.
5. Include a section early in the WAM manual that lists key model assumptions.
6. Provide better justification of the 4x multiplier by using time budget data along with the resting metabolic rate (RMR) equation to calculate an energy budget for at least mallards, which will provide a better defense of the 4x multiplier or potentially lead to a different multiplier.
7. Acknowledge that daily existence energy (DEE) likely varies over the nonbreeding period, regardless of the multiplier, and have the model examine potential changes in DUD estimates over time (e.g., early, mid-, and late in the nonbreeding period).
8. Include temperature in the estimation of DEE.

9. Make the WAM more user-friendly and decrease errors by translating it into spreadsheet or database software.
10. Correct the typographical or mathematical error in the example on page 25.

The reviewers suggest incorporating the recommended resolutions to the issues identified into the WAM and WAM documentation to improve the model for widespread use for planning purposes. The model will be better able to achieve its stated purpose with less potential for errors if suggested revisions are made.

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3. The document would benefit from a separate section which details each of the model's assumptions.
4. The model does not adjust for the changes in Daily Existence Energy (DEE) requirements across the nonbreeding period.
5. The model would be easier to use if developed into a spreadsheet or relational database.
6. There appears to be a typographical or mathematical error in the example at the top of page 25.

Attachment A: Work Plan

LIST OF ACRONYMS

BLH	Bottomland Hardwood Forest
COI	Conflict of Interest
DEE	Daily Existence Energy
DUD	Duck-Use-Days
EC	Engineering Circular
ECO-PCX	Ecosystem Restoration Planning Center of Expertise
HEP	Habitat Evaluation Procedures
MAV	Mississippi Alluvial Valley
PMIP	Planning Models Improvement Program
RMR	Resting Metabolic Rate
TME	True Metabolizable Energy
USACE	United States Army Corps of Engineers
WAM	Waterfowl Assessment Methodology

1 INTRODUCTION

A model certification review of the Waterfowl Assessment Methodology (WAM) was conducted for the U.S. Army Corps of Engineers (USACE) Ecosystem Restoration Planning Center of Expertise (ECO-PCX) under Contract Number W911NF-07-D-0001, Task Control Number 09210. The objective of the review was to evaluate the technical quality and usability of the WAM in accordance with USACE's *Planning Models Improvement Program: Model Certification* (EC 1105-2-407, dated May 31, 2005) and the *Protocols for Certification of Planning Models* (July 2007). The WAM is not a software- or spreadsheet-based model and, therefore, was not evaluated for system quality. USACE's ultimate goal is to certify the WAM for widespread use within the geographic area specified in the model documentation. The review did not include a technical evaluation of the application of the model on a specific project.

1.1 Model Purpose

As stated in the WAM documentation, the WAM is a modeling approach that estimates the number of individual waterfowl that could potentially be supported within a particular area or habitat type for a particular period of time, or "duck-use days" (DUDs). The objective of the WAM documentation is to identify quantitative methods to estimate DUDs, based on daily energy requirements of waterfowl species. The objective of the method is to determine incremental benefits or impacts of land and water resource development projects on waterfowl habitats and populations in the Mississippi Alluvial Valley (MAV) during the nonbreeding period (ca. September–March). The WAM uses the basic concepts of estimating DUDs from resource abundance in the MAV and expands data and model equations using contemporary data on: 1) daily energetic needs of waterfowl species commonly present in the Upper MAV during the nonbreeding period; 2) estimates of resource values and dynamics in a complete array of Upper MAV habitats and management scenarios; 3) estimates of energy values of specific foods relative to different species; and 4) seasonal and annual probabilities of foods being available to waterfowl.

1.2 Model Assessment

The USACE Planning Models Improvement Program (PMIP) was established in 2003 to assess the state of USACE planning models and to assure that high quality methods and tools are available so that informed decisions on investments in the Nation's water resources infrastructure and natural environment can be made. The main objective of the PMIP is to carry out "a process to review, improve and validate analytical tools and models for USACE Civil Works business programs" (USACE, 2005). In accordance with the *Planning Models Improvement Program: Model Certification* (USACE, 2005; EC 1105-2-407), certification is required for all planning models developed for and/or used by USACE. The objective of model certification is to ensure that models used by USACE are technically and theoretically sound, computationally accurate, and in compliance with USACE planning policy. Model assessments are conducted in accordance with the USACE *Protocols for Certification of Planning Models* (USACE, 2007).

The following outlines the basic steps of the USACE model certification process which are designed to guide the model review. Model development is a multi-step, iterative process, with the number of steps and iterations being dependent upon the complexity of the model. In general, these steps occur in four fundamental stages.

- Stage 1 (Requirements Stage) involves identifying the need for a specific analytical capability and the options for tools to meet the need.
- Stage 2 (Development Stage) involves the development of software programming code or a spreadsheet and testing by the model developer.
- Stage 3 (Model Testing Stage) involves a beta test of the model by selected users whose objective is to validate the model and ensure that it is usable in real-world applications.
- Stage 4 (Implementation Stage) involves providing training, user support, maintenance and continuous evaluation of the model.

The certification procedure depends on the stage of model development. The process may include the following steps.

1. Model reviewers determine whether project needs/objectives are clearly identified and whether the model described is meeting those needs/objectives.
2. Model reviewers evaluate the technical quality of the model (review of model documentation), including whether:
   a. The model is based on well-established contemporary theory.
   b. The model is a realistic representation of the actual system.
   c. Analytical requirements of the model are properly identified and the model addresses and properly incorporates the analytical requirements.
   d. Assumptions are clearly identified, valid, and support the analytical requirements.
   e. USACE policies and procedures related to the model are clearly identified, and the model properly incorporates USACE policies and accepted procedures.
   f. Formulas used in the model are correct and model computations are appropriate and done correctly.
3. Model reviewers evaluate system quality (review by running test data sets or reviewing the results of beta tests) to determine whether:
   a. The rationale for selection of supporting software tool/programming language and hardware platform is adequately described, and supporting software tool/programming language is appropriate for the model.
   b. The supporting software and hardware are readily available.
   c. The programming was done correctly.
   d. The model has been tested and validated, and all critical errors have been corrected.
   e. Data can be readily imported from/into other software analysis tools, if applicable.
4. Model reviewers evaluate the usability of the model to:
   a. Examine the data required by the model and determine the availability of the required data.

b. Examine how easily model results are understood.
c. Evaluate how useful the information in the results is for supporting project objectives.
d. Evaluate the ability to export results into project reports.
e. Determine whether training is readily available.
f. Determine whether user documentation is available, user friendly and complete.
g. Determine whether adequate technical support is available for the model.
h. Determine whether the software/hardware platform is available to all or most users.
i. Determine whether the model is easily accessible.
j. Determine whether the model is transparent and allows for easy verification of calculations and outputs.

In addition to providing an assessment of Steps 1, 2, and 4 above, this review is intended to help with the continued maintenance and evaluation of the WAM for widespread use. Because the WAM is being reviewed for certification, most of the assessment criteria are being evaluated by independent external peer review; however, some of the assessment criteria can only be evaluated internally by USACE, including whether the model complies with USACE policy and procedures, the model is easily accessible, training is readily available, and adequate technical support is available.

The level of effort for a model review depends on the complexity of the model developed, the risks associated with planning decisions made using the model, and the stage of model development. The WAM has undergone an intermediate level of review based on the model's intermediate level of complexity relative to other planning models. The intermediate level of review, which is the subject of this report, included a model certification review of the WAM documentation.

1.3 Contribution to Planning Effort

The WAM has been developed with the intent of making a technique for modeling waterfowl habitat use available to a wide range of stakeholders.

1.4 Report Organization

This report is organized into the following sections:

Section 2.0	Model Description — Describes the applicability of the model for planning projects and summarizes the model inputs and components.
Section 3.0	Model Evaluation — Describes the criteria used to assess technical quality, system quality, and usability; summarizes the approach to the model review; and describes the results of the model assessment.
Section 4.0	Conclusions — Summarizes the overall conclusions of the model review.
Section 5.0	References — Lists the references used for this model assessment.
Appendix A	Contains biographic information on the model reviewers selected to perform the review of the model certification assessment criteria.

Appendix B Contains the Final Panel Comment forms, which include the key comments from the model review as well as each comment's basis, significance, and recommendations for resolution.

Attachment A This is the Final Work Plan for the Four Ecological Models Model Certification Review (of which the Waterfowl Assessment Methodology is a part) which contains the final charge guidance and questions to the model reviewers to guide the review of the models and model documentation.

2 MODEL DESCRIPTION

2.1 Model Applicability

The WAM is designed to determine how many individual waterfowl an area/habitat type will support during a particular period. The user must identify the daily nutrient requirements of a given waterfowl species and the amount and availability of resources in the area by habitat type. The WAM is best used as an assessment of waterfowl populations and habitats before and after a specific land and water resource development project implemented in the MAV during the nonbreeding period (September-March). The WAM can also be used to compare different potential management actions.

The variety of habitats and communities in the MAV include bottomland hardwood forest (BLH), floodplain forest, riverfront forest, seasonal herbaceous wetland including bottomland prairie, shrub/scrub, dead timber, open water/aquatic, and agricultural fields. The WAM was specifically developed for use in the MAV.

2.2 Model Summary

The WAM is a modeling approach that estimates the number of individual waterfowl that could potentially be supported on a particular area or habitat type for a particular period of time, or DUDs. The objective of the WAM documentation is to identify quantitative methods to estimate DUDs. The objective of the model is to estimate DUDs based on daily energy requirements of waterfowl species to determine incremental benefits or impacts of land and water resource development projects on waterfowl habitats and populations in the MAV during the nonbreeding period (ca. September-March). The WAM documentation uses the basic concepts of estimating DUDs from resource abundance in the MAV and expands data and model equations using contemporary data on: 1) daily energetic needs of waterfowl species commonly present in the Upper MAV during the nonbreeding period; 2) estimates of resource values and dynamics in a complete array of Upper MAV habitats and management scenarios; 3) estimates of energy values of specific foods relative to different species; and 4) seasonal and annual probabilities of foods being available to waterfowl.

2.3 Model Components

The outputs produced by the WAM methodology are DUDs, which represent the energy needs of an individual waterfowl for one day. As stated in the WAM documentation, estimates of DUD

vary in relation to: 1) species, sex, mean body mass, and annual cycle events of waterfowl; 2) area of specific habitats; 3) amount of food produced and available to ducks in various habitat types; 4) nutritional composition of food types; 5) the efficiency of waterfowl in converting food nutrients to metabolizable energy; 6) environmental/climatic conditions; 7) decomposition rates of food types; 8) consumption of foods by non-waterfowl species; and 9) densities of food at which waterfowl cease foraging due to low foraging efficiency (often referred to as a "giving up density").

The main elements of the WAM include the following:

- The daily nutrient requirements of waterfowl species present during different periods of the year and annual cycle events in which they are engaged.
- The abundance of resources potentially present in an area by habitat type.
- The availability of resources in an area by habitat type related to waterfowl species foraging capabilities and climatic/hydrological events.

Nutrient Requirements of Waterfowl

The WAM uses a 4x resting metabolic rate (RMR) allometric equation (Miller and Eadie, 2006) to estimate daily existence energy (DEE) requirements for waterfowl species in the upper MAV and uses kcal as the energy currency. Using a value 4x the RMR helps to account for a variety of nonbreeding season daily activities, including flight, swimming, courtship, nutrient deposition, and molting. DEE for waterfowl species commonly present in the MAV was calculated from published information on body mass from a variety of sources and the 4x RMR equations.

A related model element is the measurement of the amount of energy available to waterfowl through their diet, or true metabolizable energy (TME). Estimates of TME for most of the major food groups consumed by waterfowl in the MAV are available from published literature.

Food Abundance

Food abundance in the MAV varies depending on the season, annual temperature and rainfall, growing season days and latitudinal position, timing of floods or droughts, water depth, and food consumption by other wildlife (e.g., blackbirds). Waterfowl food in the MAV habitats can be generally classified into eight groups:

1. Mast (hard and soft)
2. Invertebrates and zooplankton
3. Seeds from herbaceous and aquatic plants
4. Below-ground tubers, roots, rhizomes
5. Above-ground browse
6. Aquatic plants and algae
7. Small vertebrates
8. Agricultural grains and browse

Calculating DUDs for MAV waterfowl requires matching food abundance and availability (see next section) by habitat type to species. The WAM documentation provides an example: food abundance and habitat values for hooded mergansers is primarily a function of small vertebrate and invertebrate foods in forest and open water/aquatic habitats while green-winged teal consume mostly seed and invertebrate foods in seasonally flooded and open areas.

With long-term MAV annual food production studies lacking, estimates of food abundance often are based on short time periods, period-specific habitat conditions (e.g., flooding regimes, management practices, plant species composition), or similar habitats outside the MAV that may not accurately reflect MAV conditions. The WAM documentation has presented data means and ranges where available and an attempt was made to provide a reasonable (i.e., conservative) estimate of average potential annual food abundance and production among habitat types. Future research will help to provide more accurate and reliable quantification of these data.

Food Availability

Food availability in the MAV varies depending on the birds' behavioral/ morphological adaptations, foraging capabilities, and climatic/hydrologic events (e.g., floods, droughts, water depth, etc.). Food availability in the MAV also depends on which species is foraging as well as what life stage or annual event an individual bird is experiencing. An abundant food resource in the MAV is not necessarily completely available for foraging waterfowl. Availability of food is influenced by:

- Chronology of seasonal production and presence in the foraging space of species
- Annual dynamics of extent and depth of flooding
- Decomposition and deterioration rates
- Consumption by nonwaterfowl species
- Disturbance or other factors preventing physical or behavioral access to foods
- Thresholds of foraging efficiency

For the model, food availability is determined by: 1) when production occurs and whether it is within the foraging space of a species, and 2) when the habitat becomes flooded (annually or seasonally), as some foods must be flooded before they become accessible to waterfowl. The WAM documentation also discusses evidence that waterfowl may stop foraging for specific foods in certain habitats if the quantity of food becomes low or the food is difficult to obtain, thereby reducing the feeding efficiency for the birds (i.e., giving up density). The WAM manual provides a hypothetical matrix of the percentage of food availability by type and time (Table 14 in the WAM documentation). This matrix combines the seasonal dynamics of production with the cumulative effects of germination, deterioration, and consumption (including a giving up density) by nonbreeding waterfowl.

Another important factor influencing food availability is disturbance or other factors limiting physical or behavioral access. Access can be restricted because of water depth, species morphology, location and attributes of fields/tracts, competition from other species, predation risk, or human-caused disturbance. In the MAV, human disturbance, in particular from hunting, may be a significant factor affecting waterfowl use of habitats, although few data exist on how

much use of habitats is affected. Assuming that there is at least some hunting-related impact on food availability to foraging waterfowl in the MAV, the WAM manual uses an average of 25% reduction in food availability for all food types in hunted sites during November to January (waterfowl hunting season).

Another factor affecting food availability is whether habitats on a site are recently restored or have been relatively unaltered over time. For example, substantial areas in the MAV have been restored under the U.S. Department of Agriculture Wetland Reserve Program during the past decade and former agricultural land has been reforested or restored to other wetland communities. Sites at different stages of restoration provide different food sources. Assessing food types and production in restored sites will require site-specific evaluation, and perhaps field data collection, to determine production dynamics.

Other WAM Inputs

In addition to the DEE, TME, and food abundance and availability requirements discussed above, the WAM user must provide field data on: 1) the number and species of waterfowl present in an area/region; 2) habitat types present, management, and the area of each; 3) composition, stand density, and tree size of forested habitats; 4) annual flood frequency by area and habitat; and 5) the presence or absence of hunting.

3 MODEL EVALUATION

USACE requires that planning models be reviewed, and those intended for widespread, repeated use are also required to be certified. Independent, objective peer review is regarded as a critical element in ensuring technical quality, system quality, and usability of the models. The purpose of the WAM review is to evaluate the technical quality and usability of the planning model. The WAM is not a software- or spreadsheet-based model and, therefore, was not evaluated for system quality. The results of the model review will be used by USACE to determine whether to certify the model for inclusion in the toolbox of USACE planning models. As a 501(c)(3) nonprofit science and technology organization with experience in establishing and administering external peer review panels for USACE, Battelle was engaged to conduct the model certification review for the WAM.

3.1 Model Review Approach

Details of the review process and charge guidance are provided in the Final Charge for the Model Certification Review for the Waterfowl Assessment Methodology (part of Attachment A). The review consisted of eight tasks, including:

Task 1 – Participate in Kick-off Meeting
Task 2 – Prepare Work Plan
Task 3 – Prepare and Finalize Charge to Model Reviewers
Task 4 – Identify Candidate Model Reviewers and Select and Finalize Contracts with Model Reviewers

Task 5 – Conduct Model Assessment
Task 6 – Prepare Draft Report for Model Review
Task 7 – Participate in Meeting to Discuss Draft Report for Model Review
Task 8 – Prepare Final Report for Model Review

Battelle participated in a kick-off teleconference meeting with representatives from the USACE ECO-PCX and the model developers (Task 1). The purpose of the meeting was to allow Battelle to brief USACE on the approach used to conduct the model review and for USACE to brief Battelle on USACE's specific goals and objectives for the model review. Battelle prepared a draft and final work plan, which included charge questions and guidance to the model review panel that were based on the goals and objectives discussed as well as the USACE Statement of Work (SOW) (Tasks 2 and 3).

Battelle initially identified more than 20 candidate model reviewers, evaluated their technical expertise, and inquired about potential conflicts of interest (COI). Of those contacted initially, Battelle chose four of the most qualified candidates based on background, years of experience, and lack of actual or perceived COI (Task 4) and confirmed their interest and availability. Of those four candidates, three were proposed for the final model review panel and one was proposed as a backup model reviewer. These experts were approved by the USACE ECO-PCX (Task 4). The three proposed primary model reviewers constituted the final panel. The remaining candidates were not proposed as model reviewers for a variety of reasons, including lack of availability, disclosed conflicts of interest, or because they did not possess the precise technical expertise required.

The model review panel included:

- A civil works planner/Habitat Evaluation Procedures (HEP) expert with experience in floodplain management including ecosystem restoration and knowledge of the Lower Mississippi River Valley.
- Two (2) waterfowl biologists with experience with methods for evaluating waterfowl habitat suitability and knowledge of the Mississippi River Valley migratory waterfowl.

Information on the experts selected for the model review panel is summarized in Table 1, and a short biography for each model reviewer is provided in Appendix A.

Table 1. Experts Selected for the Waterfowl Assessment Methodology Review

Name	Affiliation	Location	Education	Experience (years)
Civil Works Planner/HEP Specialist				
Richard Stiehl	Independent consultant	Tucson, AZ	Ph.D. in environmental science/biology	25+
Waterfowl Biologists				
Stephen Dinsmore	Iowa State University	Ames, IA	Ph.D. in fishery and wildlife biology	20
Guy Baldassarre	SUNY College of Environmental Science and Forestry	Syracuse, NY	Ph.D. in wildlife science	30

After the model reviewers were under subcontract, Battelle conducted a kick-off teleconference to brief them on the purpose and approach for the review process. Another kick-off teleconference was convened with Battelle, the model reviewers, representatives from the USACE ECO-PCX, and the model developers to provide the model reviewers an opportunity to be briefed specifically on the models and to ask questions directly of USACE. The model reviewers were provided with an electronic version of the review document, along with guidance and a charge that solicited their comments on specific aspects of the document that was to be reviewed.

The document that was provided to the model reviewers for the review was the *Manual for Calculating Duck-use-days to Determine Habitat Resource Values and Waterfowl Population Energetic Requirements in the Mississippi Alluvial Valley*. The following additional documents were provided for reference only and were not to be reviewed:

1. Protocols for Certification of Planning Models (http://www.usace.army.mil/CECW/PlanningCOP/Pages/models.aspx)
2. EC 1105-2-407, Planning Models Improvement Program: Model Certification (http://www.usace.army.mil/CECW/PlanningCOP/Pages/models.aspx)

The model reviewers were asked to review the WAM documentation using guidance and charge questions provided to them. There was no communication between the model reviewers and the model developers during the peer review process. The guidance and charge questions were based on the model certification criteria discussed in *Protocols for the Certification of Planning* Models (USACE, 2007). The intent of the charge questions was to focus the review on the assessment criteria that are critical for the certification of planning models. The process and evaluation criteria for the review are outlined by USACE (2007) and described in Section 1.2 (Model Assessment) of this report.

Thirty charge questions developed by Battelle and approved by USACE were provided to the model reviewers to guide them during their review. Following the model reviewers' individual

reviews of the WAM documentation, individual comments were compiled into a merged comment form. Approximately 100 individual comments were received.

A panel review teleconference was conducted to discuss the key technical and conflicting comments identified from all of the individual comments, and to reach agreement on the key findings of the review that should be provided to USACE in the Model Certification Review Report. At the conclusion of the teleconference meeting, six Final Panel Comments had been developed. These six comments discuss the key issues identified with the model and model document during the review and present recommendations for resolution. The model reviewers were also assigned the responsibility of drafting specific sections of the Model Certification Review Report. Battelle assembled the individual report sections and developed the summary of the review results and conclusions of the review. The results and conclusions of the model review are discussed in Sections 3.4 through 4.0 of this final report. Final Panel Comments are provided in Appendix B.

Battelle and the model reviewers met via teleconference with USACE representatives and model developers to discuss the Draft Model Certification Review Report on February 16, 2010 at 3PM EST. No revisions to the report were suggested, and Battelle provided USACE with the Final Model Certification Review Report within two working days of the teleconference.

3.2 Assessment Criteria

In accordance with USACE (2005), the Waterfowl Assessment Methodology was subjected to an independent external peer review. The review was conducted based on guidance in the USACE *Protocols for Certification of Planning Models* (July 2007). As required by the PMIP, the WAM model was reviewed and assessed for technical quality and usability. The WAM is not a software- or spreadsheet-based model and, therefore, was not evaluated for system quality. The review of technical quality and usability is described in the following sections.

3.2.1 Technical Quality

Analytical tools, including models, used for planning purposes need to be technically sound and based on widely accepted contemporary scientific theory. The waterfowl populations and habitats in the MAV must be realistically represented by the components of the models. The architecture of the model calculations must reflect how the system is expected to respond to changes in measured variables based on the application of scientific theory. Formulas and calculation routines that form the mechanics of the models must be accurate and correctly applied, with sound relationships among variables. The models should be able to reflect natural changes as well as the influence of anthropogenic laws, policies and practices. All model assumptions must be valid and should be well-documented. The analytical requirements of the models must be identified, and the model must address these requirements. The models should also produce robust, reproducible results that stand up to the rigorous scrutiny in later stages of the plan formulation process.

3.2.2 System Quality

As previously discussed, a review of the system quality was not performed as part of this effort because the WAM does not have any software and is not spreadsheet-based.

3.2.3 Usability

Usability refers to how easily model users can access and run the models, interpret the model output, and use the model output to support planning decisions. An assessment of model usability includes evaluating the availability of data required to run the models and the ability of the user to learn how to use the model properly and effectively. Model outputs must also be easy to interpret, useful for supporting the purpose of the models, easy to export to project reports, and sufficiently transparent to allow for easy verification of calculations and outputs.

3.3 Approach to Model Testing

The WAM model reviewers did not test the model because the WAM does not have software and is not spreadsheet-based.

3.4 Technical Quality Assessment

The WAM technical quality assessment was based on an assessment of the criteria described in Section 1.2 of this report. Without knowing all of the relevant USACE policies and procedures, the model reviewers were only able to perform a limited assessment of whether the model properly incorporates USACE policies and procedures. The results of the model reviewers' assessment of the other criteria are summarized in the following sections.

3.4.1 Review of Theory and External Model Components

Model certification requires that each model is "based on well-established contemporary theory" (USACE, 2007). Contemporary theory may be based on professional judgment, literature reviews, and/or current and previous research.

The WAM model is founded on well-established theory and the model documentation contains the most current information on waterfowl ecology, waterfowl energetic requirements, food abundance, and food availability. Most of the model inputs have been published in respected peer-reviewed journals; those that haven't are gleaned from unpublished sources or the personal experience of the author, who is an acknowledged expert on this topic in the Mississippi Alluvial Valley. This information has been assembled into a DUD model that has a long history of use in estimating carrying capacity of waterfowl during a specified period (Reinecke et al., 1989). While DUD models are useful, they are not without problems. The equation for a DUD is simplistic and incorporates constants such as estimates of food availability, true metabolizable energy (TME), and DEE. Site-specific data are often not included (and may not be available), temporal variation is not formally addressed, and the models are often broadly applied to large areas where inputs would be expected to be variable. Despite these limitations, the concept of a DUD has the potential to be a useful tool to guide project management where waterfowl are a focus.

Estimates of DUDs vary in response to many factors including (but not necessarily limited to): 1) species, sex, body size, and portion of the annual cycle; 2) habitat area; 3) forage production and availability to waterfowl; 4) nutritive composition of forage types; 5) waterfowl efficiency converting food to metabolizable energy; 6) environmental conditions; 7) forage decomposition rates; 8) forage consumption by non-waterfowl species; and 9) food densities at which waterfowl

cease feeding. Collectively, this list touches on all of the key factors known to influence the calculation of a DUD, and each of these is considered in the WAM model.

Contemporary modeling theory suggests that the many factors that contribute to variation in DUDs could be best represented in a stochastic model (see Final Panel Comments 1 and 2). This is easy to handle mathematically, although model calculations may be too complicated to do by hand and may require the development of simple spreadsheets to aid computations (see Final Panel Comment 5). A stochastic model could be built to produce a probability of each outcome. The user is then presented with a range of options, each with an associated probability, and thus has greater insight into how the system is behaving. The model reviewers further note that stochastic models are often the preferred modeling approach in systems (e.g., wintering waterfowl in the MAV) where there is information to specify the frequency distributions of model inputs. While this does not affect model theory per se, it does highlight that the theory is there to support a more complex model (one with stochasticity) to assess waterfowl responses to USACE management actions and project development.

3.4.2 Review of Representation of the System

By definition, models are abstractions of real-world systems and, as such, they are inherently simpler than the ecosystems they represent. While basic ecological conditions are represented in the models, human disturbance factors, which may impact the analysis, are not consistently or thoroughly incorporated into the evaluation process. A project site should not be considered isolated in space; ecological processes are often impacted by adjacent or surrounding human activities. Land use changes (e.g., increased impervious surface area or increased high intensity uses) should be considered when predicting future ecological conditions at the site level. Similarly, larger-scale drivers that are affected by anthropogenic activities (e.g., climate change, sea level rise (SLR), change in storm frequency/intensity, change in river sediment loads, etc.) should be considered in these models.

The WAM documentation states that the model seeks to identify quantitative methods to estimate DUDs based on daily energy requirements of waterfowl species in the MAV during the nonbreeding period (September-March). The estimate of maximum DUDs requires three key inputs for each habitat type involved: 1) an estimate of DEE, 2) the amount of food present in a given habitat, and 3) the energy yield of that food in terms of TME. However, the documentation also presents methodologies to adjust the maximum DUD estimate by adjusting the amount of food present based on availability (Table 14 in the WAM documentation), flooding probability, and availability as influenced by hunting.

The model reviewers believe that representation of the system in the WAM documentation is near flawless in relation to the task of calculating both maximum and adjusted DUDs. Every significant natural and man-made habitat important to nonbreeding waterfowl in the MAV has been included, including eight major types and associated subtypes: 1) bottomland hardwood forest (low, intermediate, and high); 2) floodplain forest; 3) riverfront forest; 4) seasonal herbaceous and bottomland prairie wetlands (including “moist-soil impoundments); 5) scrub/shrub; 6) dead timber; 7) open water/aquatic; and 8) agricultural fields. The model also considers every major food category used by nonbreeding waterfowl in the MAV, which included eight major types: 1) mast (hard and soft); 2) invertebrates and zooplankton; 3) seeds;

4) belowground tubers, roots, rhizomes; 5) aboveground browse; 6) aquatic plants and algae; 7) small invertebrates; and 8) agricultural grains and browse. The adjustments of maximum DUDs as influenced by food availability are also based on the key factors involved (e.g., Table 14 in the WAM documentation).

3.4.3 Review of Analytical Requirements

Determining DUDs requires knowledge of the amount of a given food type, the caloric value of that food type, and the DEE requirement for a given species. The analytical requirements are simple, straightforward, and comprehensive (unless temporal variation in DEE is a desired variable) and are clearly stated in the last section of the model documentation. These analytical requirements include: 1) number and species of waterfowl present in an area/region; 2) habitat types present, management, and the area of each; 3) composition, stand density, and tree size of forested habitats; 4) annual flood frequency by area and habitat; and 5) presence or absence of hunting. The number and species of waterfowl present in an area/region may be difficult to accurately assess across large areas or broad time periods. Determining the habitat types present along with their area and management could utilize GIS data for most/all sites. It may be difficult to classify emergent marshes and moist-soil impoundments as they cycle through stages known as dry marsh, regenerating marsh, degenerating marsh, and lake marsh.

Although the model will generate precise results, it will not necessarily generate accurate results, given the variability in the input parameters. This model does a good job identifying many analytical requirements for calculating DUDs. Any model must balance between simplicity and complexity. Simple models have fewer assumptions and more straightforward inputs, and are easier and more useable. Increasing model complexity results in more assumptions and requires more field work to gather variable data, therefore making it more expensive to run and perhaps of limited use for more sensitive applications.

3.4.4 Review of Model Assumptions

The WAM model requires inputs that fall into three general categories, each of which has associated assumptions: 1) calculation of DEE requirements, 2) abundance of food, and 3) availability of food. The author has addressed the assumptions for each input parameter throughout the model's description and has chosen conservative inputs based on the data available. However, given the combination of variability, limitations, and, in some cases, sparse input data on food abundance and availability, some assumptions are considerably less reliable than others. For example, following a review of the food abundance assumptions the author correctly states, "Undoubtedly, future investigation will refine, and provide, more accurate and reliable quantification of these estimates."

Relative to the three general input parameters, the model review panel believes the assumption that DEE is best estimated by multiplying RMR equations (presented in Miller and Eadie, 2006) by 4x is not well justified. Also, the assumption that a single calculation of DEE is representative for the entire nonbreeding period does not account for variations due to temperature and activities; hence, calculation of DUDs could be very different during mild versus cold winters. There are data (e.g., time budgets) that could be used to provide better defense of the 4x multiplier, and calculation of DEE can be adjusted for ambient temperature.

Relative to estimates of food abundance, there is tremendous variation in the quality and hence reliability of input data, varying from fairly accurate estimates for agricultural grains (e.g., waste rice) to virtually nothing for belowground roots, tubers, rootlets and other groups. The model documentation states that this variation is an issue but still offers an input variable for each food group. Hence, there is a tacit assumption that all model inputs are of equal reliability. For example, under the Aquatic Plants and Algae section it states, "In the absence of having specific data on potential waterfowl forage from these aquatic foods, an estimate of 100 kg/ha aquatic vegetation is used in this manual." Reliability of input variables is a critical assumption to the model and hence should be more strongly defended, which can potentially be done by working with a few major studies (e.g., those with large sample sizes, low variation, broader spatial scales), as opposed to using all available studies on a given input parameter to generate input variables. In contrast, where input data are especially limited, the model could provide a single, "best justified" estimate as input for a variety of habitat types (as on pg. 15). In some cases, it may be best not to provide an estimate at all, as was done for the Small Vertebrates section.

The food availability assumptions are probably the most problematic, in large part because estimating them is so difficult. The model documentation identifies six factors that affect availability (pg. 16), but extrapolating existing data into estimates used in the model are tenuous for some of these factors. For example, the review panel finds little basis for to assume that food availability is reduced by 25% due to hunting activity (pg. 20). Also, the values presented in Table 14 in the WAM documentation are very important to assumptions about food availability but are weakly justified. Essentially, the values in Table 14 are supported by 21 literature citations, but there is again a tacit assumption that all are of equal value in providing estimates for input variables; hence, it becomes difficult to assess the reliability of the inputs because the user has not detailed assessment of the strength/reliability of the underlying source of the data. Lastly, the review panel believes that the calculation of rice deterioration may not be correct in relation to estimates outlined by Stafford et al. (2006), which appear to be much greater than those presented for use in the WAM.

3.4.5 Review of Ability to Evaluate Risk and Uncertainty

Ecological models are most useful when they incorporate uncertainty directly into estimates of model outcomes. In the case of the WAM model, the model reviewers recognized that this was a deterministic model that failed to directly incorporate uncertainty. However, the model documentation identified ranges of values for many model inputs (e.g., acorn production) and these could easily be incorporated into the WAM model to evaluate risk and uncertainty. The panel suggests that the DUD model be used to develop a range of possible outcomes resulting from different model inputs. For example, a range of values could be input for acorn availability, producing a range of estimated DUDs. This would allow a user to tailor the model to local conditions (inputs) and evaluate potential DUDs for a range of conditions. The use of a range of input values will also counter the model uncertainty that arises from sparse data supporting some input values.

The model documentation further states that the equations "represent potential maximum carrying capacity for areas/habitats by assuming all foods are present and available in all months and years" and that "the actual carrying capacity of areas/habitats is at some level below the

maximum potential." The model reviewers believe that knowing the maximum potential only is not enough information to support key decision-making activities. Nor should the user rely on simple linear correction factors (e.g., the 0.75 multiplier for hunting) to approximate actual carrying capacity. The best solution is to incorporate model uncertainty either with the use of a stochastic model (see Final Panel Comment 2), or by evaluating a range of model inputs.

3.4.6 Review of Ability to Calculate Benefits for Total Project Life

Based on the model's calculations of waterfowl population variability factors other than the supply of food resources (e.g., changes in migratory and breeding habitats), the WAM is not designed to provide long-term (Total Project Life) estimates. The model produces comparable before-and-after project impacts that can provide valid estimates of functional losses or gains via a particular project, but calculation of long-term benefits is not possible because the WAM does not incorporate natural changes in area and/or composition of wintering habitat. Through a series of calculations, it may be possible, albeit tedious to determine benefits over the life of the project. Such a series would need to include any change in areas, and predict any potential change in the food available. The last example in the manual (pgs. 25-27) briefly mentions how the WAM can be used for mitigation, and this example warrants a more thorough discussion. As stated above, the WAM is well-suited to assessing simple before-and-after project impacts relative to project implementation. However, if uncertainty were incorporated directly into the equations to produce a realistic range of values for a site, the model would be more useful for longer time periods, perhaps for Total Project Life. The WAM may be used to determine the relative changes in DUDs due to a proposed project; however the calculation of long-term benefits would be cumbersome and tedious, as the data for both area and food availability would need to be repeatedly entered to conduct the long term analysis.

3.4.7 Review of Model Calculations/Formulas

The WAM model formulae and calculations are generally correct and easy to follow. The model reviewers did find one error (see Final Panel Comment 6). In the example beginning on the top of page 25, the opening sentence reads:

> For example, 100 ha of naturally flooded BLH habitat with a medium 50-60 basal area of red oak and medium size tree stand producing 300 kg acorns/ha, a TME value of 2.67 kcal/g for acorns, a total winter period, flooded at a 5-year or 20% flood frequency recurrence interval, and hunted would equate to:
>
> 100 ha x [300 kg/ha x 1 (total winter availability) x 0.2 annual recurrence x 1.0 hunting availability] =
>
> 6,000,000 kcal available
> ---------- = 13,261 mallard DUD annualized/year
> 452.44 DEE for mallards

The word "hunted" appears near the end of this sentence, so the panel was expecting that the equation below this sentence would contain a hunting availability value of 0.75. Instead, this value is 1.0, which according to earlier material indicates that this system is not hunted. The next two equations on this page, which are part of this same example, appear to correctly handle

the hunting availability term. Because hunting availability is a key term in model calculations, the panel believes it is critical that this be presented as accurately as possible in this section.

The panel checked the remaining formulae and calculations and did not find any errors. However, the model reviewers have two additional comments on this topic:

1) All formulae in the WAM model documentation appear to have been written in plain text and some (e.g., Equation 3) are difficult to interpret. The panel suggests presenting all equations and sample calculations using mathematical software (e.g., the Microsoft Equation function in Microsoft Word) (see Final Panel Comment 5). This will consolidate the formulae, substantially reduce wasted "white space," and make operators such as summations easier to calculate.
2) Throughout the calculations, the shift from calories to kcal is not clear or explicitly stated. For example, in the calculation on page 22, the numerator has a value of 540,000 kcal/ha. However, by just doing the math in the previous step this number is 540 [(150*2.5) + (15*4) + (30*3.5) = 540)]. This is also true in all remaining calculations.

The model reviewers suggest that the single error be corrected and that the two suggestions noted above be incorporated in the final WAM model.

3.5 System Quality

In this case, a review of the system quality was not performed because the Waterfowl Assessment Methodology does not have software and is not spreadsheet-based.

3.6 Usability

3.6.1 Review of Data Availability

The WAM methodology lists five data inputs needed to calculate DUDs in addition to the DEE and food abundance values: 1) number and species of waterfowl present in the target areas; 2) habitat types present, management, and area; 3) composition, stand density, and tree size of forested habitats; 4) annual flood frequency; and 5) presence or absence of hunting.
The number and species of waterfowl present are available from surveys conducted by state or federal personnel or new surveys can be conducted on site. However, the WAM documentation provides no time frame for collecting such data (e.g., weekly, biweekly, monthly). For example, the Midwinter Survey conducted by the U.S. Fish and Wildlife Service is an annual survey, which might not be sufficient depending on the area involved for calculation of DUDs.
As stated, documentation of habitat types and area present can usually be done via maps and photographs for a given site, but field evaluation may be needed to "ground-truth." Field reconnaissance also may be needed to delineate subtypes of habitats such as low, intermediate, and high bottomland hardwood forest (BHF) and other habitats where the differentiation of boundaries may be difficult to discern from maps and/or photographs. The management regime can be determined by presence or absence of structures such as dikes or water control structures, and consultation with local resource agency personnel.

Field work will be required to document composition, stand density, and tree size of forested habitats. Such measurements will need to include species composition, size, and density. As

standard forest mensuration techniques exist to measure these variables, the collection of these data is straightforward.

Annual flood frequency data are generally attainable from U.S. Army Corps of Engineers District offices. More localized data could be needed and may be available from satellite imagery or other local records, as stated in the WAM documentation.

Information on the presence or absence of hunting can be obtained for some areas, especially state and federal refuges and private hunting areas. However, the WAM documentation is very unclear on how hunting values are generated in terms of affecting the model. For example, it is unclear how much hunting needs to occur before food abundance input into the DUD equation is adjusted by 25%, or 50%, or 100%.

3.6.2 Review of Results

The WAM results are extremely easy to understand. The model output is in DUDs, a well-established, widely-used measure of carrying capacity. DUD is clearly defined in the beginning of the documentation so the reader should be able to interpret the numerical model output. The model accounts for food deterioration and various other factors (e.g., water levels, flooding) that can affect food availability and resulting DUDs. The model addresses four needs: 1) evaluating project impacts; 2) determining carrying capacity of a given area; 3) setting habitat and conservation goals; and 4) evaluating management actions and techniques. The model use is most valid for items 1 and 3, least valid for item 2, and somewhat valid for item 4.
The model provides a general framework for comparing potential management scenarios by calculating estimates of DUDs, and therefore, the potential ecological benefits and losses associated with a project. As extensive data and multipart mathematical operations are required, and all inputs of model data (with field verification as recommended on pg. 28) are subject to entry error, the use of the model may be limited to "professional" users, or cases where accurate estimates of waterfowl wintering habitat quality are desired.

The model would be valuable in comparing potential changes in waterfowl habitat as the result of a proposed project. The model produces comparable before and after estimates that can then provide valid estimates of function losses or gains via a particular project, but calculation of long-term assessment is not possible in the current configuration as the model does not incorporate natural changes in either area or composition or both of wintering habitat. If a spreadsheet or relational database application were developed, and changes in habitat area and habitat values needed to evaluate impacts were added, then life of the project mitigation could be calculated through the application of a computer-aided application. However, if there is uncertainty in the pre- or post-project conditions, independent model runs will need to be jointly evaluated because the model is deterministic rather than stochastic.

The overall accuracy of model predictions is questionable, as some model inputs are not well supported by published studies (e.g., the DEE multiplier) or are based on conflicting data (e.g., acorn production). However, the potential ecological benefits and losses may be relatively compared. The model would be valuable in comparing potential changes in waterfowl habitat as the result of a proposed project. Its best use is as a project planning tool.

3.6.3 Review of Model Documentation

The WAM model is mathematically simple (there are only five equations) and hence easy to use, but that simplicity does not detracts from its usefulness. The overall approach is very user-friendly, beginning with a documentation of the rationale and data required for all model inputs, including an extensive number of tables (16) and figures (7). Hence, the user has a very well documented review of the state of knowledge relative to all aspects of the model — in essence, a reference. The WAM then presents the model equations, starting with the most simple. Easily followed examples are presented for each of the five equations, followed by a brief section on input data requirements and availability.

Overall, the WAM is a thorough representation of feeding waterfowl ecology in the MAV during the nonbreeding season (September-March). The model then guides the user well with useful examples for every step and equation. Hence, the model is simple and easy to use.

3.7 Model Assessment Summary

A review of the technical quality and usability of the WAM determined that the model and approach are of high technical quality and usability, but some improvements and corrections to the methodology are needed. In addressing and answering charge questions designed to focus the review of WAM based on the model assessment criteria in the USACE *Protocols for Certification of Planning Models*, the following underlying issues were identified:

1. Due to the Mississippi Alluvial Valley (MAV) being such a broad geographic area and the inherent variability in the data needed to feed the model, the accuracy of some of the model inputs are very poorly known, making the overall accuracy of the model predictions questionable.
2. The model is written as deterministic rather than stochastic, which does not account for uncertainty in inputs and model predictions (i.e., outputs).
3. The document would benefit from a separate section which details each of the model's assumptions.
4. The model does not adjust for the changes in DEE requirements across the nonbreeding period.
5. The model would be easier to use if developed into a spreadsheet or relational database.
6. There appears to be a typographical or mathematical error in the example at the top of page 25.

These underlying issues are further discussed in Appendix B: Final Panel Comments.

4 CONCLUSIONS

Overall, the model reviewers agreed that the concept and application of the WAM are sound for planning efforts. Models are simple representations of complex systems and, as such, must balance complexity and reality with simplicity and usability. For the WAM, this goal has been

achieved. The model seems to sufficiently capture the habitats being modeled and does not have any irreparable deficiencies.

However, there were some concerns regarding the accuracy of the WAM's model inputs, the ability to measure uncertainty, and completeness of the documentation. The model reviewers provided the following recommendations for improving the model based on the most significant concerns identified by the model reviewers.

1. Construct a simpler model that includes more known inputs based on key studies versus a review of all studies from which a mean is then chosen.
2. The model's time frame should be extended into April to address species that remain in the upper Mississippi Alluvial Valley (MAV) well into spring.
3. Include a section in the WAM manual that addresses the issue of model applicability and accuracy relative to all potential model uses.
4. Incorporate stochasticity into the WAM model for calculating DUDs in the MAV by using point estimates and a measure of precision.
5. Include a section early in the WAM manual that lists key model assumptions.
6. Provide better justification of the 4x multiplier by using time budget data along with the RMR equation to calculate an energy budget for at least mallards, which will provide a better defense of the 4x multiplier or potentially lead to a different multiplier.
7. Acknowledge that DEE likely varies over the nonbreeding period, regardless of the multiplier, and have the model examine potential changes in DUD estimates over time (e.g., early, mid-, and late in the nonbreeding period).
8. Include temperature in the estimation of DEE.
9. Make the WAM more user-friendly and decrease errors by translating it into spreadsheet or database software.
10. Correct the typographical or mathematical error in the example on page 25.

The reviewers suggest incorporating the recommended resolutions to the issues identified into the WAM and WAM documentation to improve the model for widespread use for planning purposes. The model will be better able to achieve its stated purpose with less potential for errors if suggested revisions are made.

5 REFERENCES

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Appendix A

Biographic Information for Model Review Panel Experts

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Habitat Evaluation Procedures Expert - Richard Stiehl

Dr. Stiehl earned his Ph.D in environmental science/biology from Portland State University in 1978 and has over 25 years of experience with Habitat Evaluation Procedures (HEP), wildlife biology, avian ecology, and habitat and community modeling. He is currently an independent consultant. He completed his original HEP training in 1981 and the U.S. Fish and Wildlife Service (USFWS) invited him to write several sections and be the chief editor of the new (and still in use) USFWS HEP Manual. To date, Dr. Stiehl has taught over 30 certified HEP workshops. Other work with USFWS has included revising and/or writing all HEP manuals, rewriting HEP and Habitat Suitability Index (HSI) software, and conducting wildlife research. He has provided HEP expertise to 20 states and many federal agencies, including USACE, Bureau of Land Management (BLM), Natural Resources Conservation Service (NRCS), and U.S Environmental Protection Agency (USEPA), and has led HEP teams on large projects, including HEP analyses for shorebird habitat and the impacts of weapons training for the U.S. Air Force in Utah. After leaving USFWS, he continued his HEP leadership role as a private consultant, constructing community HSI models for riparian, desert, and desert wetland habitats. He has developed software to evaluate long-term impacts to desert ecosystems for the Washington Department of Wildlife and the Columbia Basin Fish and Wildlife Agency. Other high profile HEP projects include consulting with General Electric for Upper Hudson River PCB contamination, New York State for post-9/11 communications network evaluation, and the Theodore Roosevelt Conservation Trust for impacts in central Wyoming gas/oil field development. His experience in the Lower Mississippi River Valley includes his being an assistant and associate professor of biology at Southeast Missouri State University (Cape Girardeau, MO) for ten years and conducting extensive fieldwork in southeastern Missouri on fish and bird populations. Dr. Stiehl also has experience conducting restoration and mitigation analyses for USFWS and tribal lands.

Waterfowl Biology Expert – Guy Baldassarre

Dr. Baldassarre earned a Ph.D. in wildlife science from Texas Tech University in 1982 and is currently a Distinguished Teaching Professor in the wildlife sciences program at the State University of New York (SUNY), College of Environmental Science and Forestry. At SUNY, he teaches courses in ornithology, waterfowl ecology, and wildlife ecology and management. He has also taught a course entitled "Waterfowl Ecology and Management" through the National Conservation Training Center of the U.S. Fish and Wildlife Service several times. He has conducted research in Texas and Louisiana on the role of wetland complexes in meeting the life-history requirements of nonbreeding waterfowl. Dr. Baldassarre's experience with large civil works projects includes his work studying waterfowl responses to hydrological management of Wetlands Reserve Program habitats in New York. He also served on the Advisory Board for the expansion of the Montezuma National Wildlife Refuge, a board appointed by the New York State Department of Environmental Conservation (DEC) Commissioner and regional director of the U.S. Fish and Wildlife Service. Other relevant research has included studies of wood ducks in Alabama and Georgia, wintering green-winged teal in Louisiana, and mallards and black ducks in New York State. He is a past Editor-in-Chief for *The Journal of Wildlife Management* (1998-99), author of two editions of *Waterfowl Ecology and Management* (1994 and 2006), and editor of *Conservation Biology of Flamingos*, a special publication of the Waterbirds Society (2000). He has mentored more than 40 graduate students and authored more than 75 referred papers on various ecological aspects of waterfowl, flamingos, and other wetland birds, working

in the United States, Mexico, Canada, and Venezuela. In 2008, he received a Ducks Unlimited Conservation Achievement Award in the research/technical category. His current work is focused on a revision of the classic waterfowl book, *Ducks, Geese and Swans of North America.*

Waterfowl Biology Expert – Stephen Dinsmore

Dr. Dinsmore earned his Ph.D. in fishery and wildlife biology from Colorado State University in 2001. Currently Dr. Dinsmore is an associate professor of wildlife ecology for the Department of Natural Resource Ecology and Management at Iowa State University, and has taught graduate and undergraduate courses in ornithology, avian biology, and applied wildlife population ecology. He has over eight years of professional experience as a wildlife ecologist, and prior to his university appointments worked for federal, state, and private organizations. Dr. Dinsmore has extensive experience with avian ecology, including waterfowl ecology, which is the focus of his current research program at Iowa State University. Dr. Dinsmore has worked with Habitat Evaluation Procedures (HEP) for mountain plovers in Montana and piping plovers on the Atlantic Coast and is broadly familiar with other approaches or assessing wildlife habitat use. He has extensive knowledge of bird use of the entire Mississippi Valley, both from personal interests as an avid birdwatcher and his research activities, including habitat use modeling in the Lower Mississippi Alluvial Valley. Other research activities include projects assessing wintering waterfowl use of the Mississippi Delta region in MS/LA/AR, participation in joint venture activities to benefit shorebirds, and formal shorebird surveys in the Mississippi Delta region of northwestern Mississippi. He has conducted intermittent contractual bird surveys for the USACE Rock Island District, Saylorville Lake Project, and is familiar with large civil works projects. Dr. Dinsmore has also provided bird survey data used to modify pool level management on the Saylorville project. Additionally, in the late 1990s, he had provided public comment on proposed changes to the Saylorville Lake Project. He has authored or co-authored over 30 peer reviewed journal articles and five textbooks on wildlife ecology. Dr. Dinsmore has served as the Associate Editor for the Auk since 2006 and has been a member of the Cooper Ornithological Society since 1993.

Appendix B

Final Panel Comments

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Final Panel Comments

Final Panel Comment 1:
Due to the Mississippi Alluvial Valley (MAV) being such a broad geographic area and the inherent variability in the data needed to feed the model, the accuracy of some of the model inputs are very poorly known, making the overall accuracy of the model predictions questionable.
Basis for Comment:
The Waterfowl Assessment Methodology (WAM) model will produce precise estimates of before and after duck-use days (DUDs) for a given project. However, the model reviewers believe accuracy of model inputs is important to properly evaluate any given project. As an example, if accuracy of "before project" input data were biased low in terms of DUDs but "after project" inputs were biased high, project benefits would be overestimated (or vice versa). A specific example is the Stafford et al. (2006) study that reexamined the amounts of waste rice remaining after harvest in the MAV, finding that carrying capacity for waterfowl may have been previously underestimated by 53-83%. Hence, accuracy of input data was of obvious importance for a very significant food source for waterfowl in the MAV, especially in the lower MAV. The accuracy issue arises because the WAM model seeks to explain DUDs over eight primary habitat types, eight food types, and multiple factors that affect food availability within habitat types. These combinations lead to two sources of uncertainty in the model, both of which will affect model accuracy. First, model inputs, except DUDs, are notorious for their high variability, wherein choosing mean values for use in the model is tenuous, albeit more so for some inputs than others. As an example, estimates of moist-soil seed abundance range from 45 to 3,155 kilograms/hectare (kg/ha; Table 11), and yet the model uses values from 422-1,000 kg/ha, based on management intensity (Table 12). Invertebrate abundance among habitat types ranges from 0.5 kg/ha in flooded rice to 80 kg/ha in bottomland hardwood forest (BLH), but the model uses 5-50 kg/ha (Table 10). Production estimates for acorns range from <10 to >400 kg/ha in one example and 131-807 kg/ha in another (pg.10), which is followed by five tables on acorn abundance, culminating in recommended averages that range from 200-350 kg/ha, based on tree size, basal area, and flooding regime. Table 14, which provides estimates of food availability over winter, is another example where tremendous variability is condensed to single point estimates of questionable validity. Second, some input variables are highly uncertain estimates based on limited data (e.g., below ground roots/tubers, above-ground browse, aquatic plants/algae, small vertebrates). The assessment of factors affecting availability (i.e., Table 14, flooding regime, management status, and hunting) also introduces significant variation in the model. In particular, the author does not provide a basis for the assumption that food availability is reduced 25% due to hunting, or even what constitutes hunting intensity an area, which should include consideration of the number of hunters and the frequency with which they use a given site. Lastly, although the primary objective of the WAM is to estimate DUDs as a measure of benefits or impacts of water development projects in the MAV (pgs. 2-3), other potential uses are referenced in the first paragraph: 1) determining carrying capacity of local and regional landscapes, 2) setting habitat and acreage goals for conservation, and 3) evaluating the effectiveness of management actions. Although the model reviewers believe inherent variability of the input data is a general problem for the primary objective of the WAM model, such variability also can differentially affect use of the model if considered for other purposes (i.e., it is more accurate for some uses than others). Specifically, accuracy of input variables is considerably more important when estimating carrying

capacity (Use 1, above), as over or underestimates of food abundance and availability will dramatically affect DUDs. Perhaps the best example of such a case again is the example from harvested rice fields in the lower MAV, where earlier estimates of waste remaining after harvest dramatically underestimated DUDs wherein the study recommended that 1980s-estimates of 1,858 DUDs for waste rice in the MAV be reduced to 325 (Stafford et al., 2006). In contrast, the WAM appears more accurate in determining acreage goals for various conservation plans (Use 2) in that it does identify important habitats and hence can provide a guide to acreages and/or targeted habitats to protect. Use 3, above is very similar to the primary objective and thus subject to the same accuracy issues.

Significance – Medium:

The accuracy of model inputs affects model usability and level of performance by limiting the ability of the model to generate accurate DUD estimates, which in turn can inhibit the model's ability to evaluate before and after project impacts

Recommendations for Resolution:

To resolve these concerns, the WAM model reviewers recommend:

- Constructing a simpler model that includes more known inputs based on *key* studies versus a review of all studies from which a mean is then chosen. For example, estimates of waste rice in the MAV can be nicely defended by referring to only a few major studies (Manley et al., 2004; Stafford et al., 2006; Kross et al., 2008).
    - Similarly, a few major studies from moist-soil and BLH would yield a more defendable and accurate estimate of food abundance and availability of all studies.
- Grouping the lesser known habitats, such as was done for open water/aquatic, scrub/shrub, and others (pg.15). In general, for example, data are probably strongest for habitats such as BLH, moist-soil, and agriculture, and much less so for habitats such as scrub/shrub, dead timber, etc.
- Considering calculating DUDs based on average values for guilds (e.g., puddle ducks, diving ducks) instead of for each species.
- Extending the model's time frame into April to address species that remain in the upper MAV well into spring.
- Including a section in the WAM manual that addresses the issue of model applicability and accuracy relative to all potential model uses.

References:

Kross, J., R. M. Kaminski, K. J. Reinecke, and A. T. Pearse. 2008. Conserving waste rice for wintering waterfowl in the Mississippi Alluvial Valley. Journal of Wildlife Management 72:1383-1387.

Manley, S. W., R. M. Kaminski, K. J. Reinecke. 2004. Waterbird foods in winter managed ricefields in Mississippi. Journal of Wildlife Management 68:78-83.

Stafford, J.D., R.M. Kaminski, K.J. Reinecke and S.W. Manley. 2006. Waste rice for waterfowl in the Mississippi Alluvial Valley. Journal of Wildlife Management 70:61-69.

Final Panel Comment 2:

The model is written as deterministic rather than stochastic, which does not account for uncertainty in inputs and model predictions (i.e., outputs).

Basis for Comment:

Models can be extremely useful tools for predicting future outcomes. In general, a model can be classified as deterministic or stochastic. In a deterministic model the value of every variable (model input) is specified exactly and the mathematical equation will always produce the same outcome. This is contrasted with a stochastic model where model inputs are not known exactly and are instead specified as a range of values (random variables) that produces a probability distribution of potential outcomes.

The Waterfowl Assessment Methodology (WAM) model is deterministic and many model inputs represent an average or conservative estimate from a range of values published in the literature. In some cases, the numerical range of values was so large that the use of the mean may mask much of the underlying information. For example, the values for acorn production (kg/ha) in tables 4-7 of the WAM document are so variable that the derivation of a single value (Table 8) for duck-use day (DUD) models may not be appropriate for all sites.

The model review panel believes that the WAM model could be strengthened if it were stochastic and included uncertainty in model inputs. For this to happen, the model needs defensible estimates of model inputs along with some sense of variation in those inputs (e.g., regionally or by habitat type). Up front, some model input values were not well justified. This was primarily because: a) model input values varied across the large region included in the Mississippi Alluvial Valley (MAV) and it is difficult to assign a single representative value, or b) data to estimate some model inputs are sparse. In the case of (a), the panel believes the model would be more realistic with less bias if these values were input as a point estimate with an associated measure of precision (e.g., standard error or confidence interval). A stochastic model could then be built and it would produce a probability of each outcome. The user is then presented with a range of options, each with an associated probability, and thus has greater insight into how the system is behaving. The model reviewers further note that stochastic models are often the preferred modeling approach in systems where there is information to specify the frequency distributions of model inputs. The MAV is one such system with respect to wintering waterfowl.

Significance – Medium:

The use of a deterministic model for calculating DUDs in the MAV may not accurately reflect waterfowl responses to management actions and, therefore, affects model performance. The use of point estimates only for model inputs in a deterministic model should be avoided when there is sufficient information to specify distributions for some/all inputs.

Recommendations for Resolution:

To resolve these concerns, the WAM model reviewers recommend:

- Incorporating stochasticity into the WAM model for calculating DUDs in the MAV by using point estimates and a measure of precision.
    - Not all parameters need to be stochastic, although this could easily be done for any model input for which there are differing estimates (e.g., from different parts of the MAV or from studies using different methodology).

Final Panel Comment 3:
The document would benefit from a separate section which details each of the model's assumptions.
Basis for Comment:
The Waterfowl Assessment Methodology (WAM) model for calculating duck-use-days (DUDs) in the Mississippi Alluvial Valley (MAV) makes many assumptions about model inputs. Unfortunately, these assumptions are scattered throughout the text of the WAM model and are not readily and easily available to the reader. The model reviewers suggest that a list of key model assumptions should be included near the beginning of the WAM document. This list does not need to be exhaustive and could focus on key assumptions only.
Significance – Low:
Model assumptions should be listed up-front because they are an integral part of the model documentation. This is important so that the reader can evaluate the utility of this model for their particular needs.
Recommendations for Resolution:
To resolve these concerns, the WAM model reviewers recommend: ▪ Adding a section entitled "Key model assumptions" or something similar early in the WAM model documentation, perhaps on pg. 3 before the section on daily existence energy (DEE). At a minimum, we suggest including the following topics in this list: o The choice of a formula for calculating resting metabolic rate (RMR). o Why the 4x multiplier of resting metabolic rate (RMR) was used to calculate DEE. o The choice of the 0.75 hunting availability multiplier

Final Panel Comment 4:
The model does not adjust for the changes in daily existence energy (DEE) requirements across the nonbreeding period.
Basis for Comment:
The Waterfowl Assessment Methodology (WAM) model appropriately uses the equation presented in Miller and Eadie (2006) for calculation of resting metabolic rate (RMR), which is a critical model input. As the author notes, however, RMR must be adjusted to account for energy expenditure due to normal daily activities (e.g., flying, feeding. preening feathers), as well as major life-history events such as molting and migration. So, RMR must be adjusted to produce an estimate of DEE requirements, for which the WAM model chooses a 4x multiplier. The model reviewers believe the choice of the 4x multiplier in the model was not well justified. Further, a single calculation of DEE for the entire wintering period cannot account for variations due to temperature and activities; hence, the model could be biased toward a high estimate of duck use days (DUDs) during a mild winter, or mild periods within a given winter, because less energy is required by wintering ducks. The opposite would be true during a cold winter.
Significance – Low:
This shortcoming affects the technical quality of the model in that the calculation of DEE is not as accurate as it could be.
Recommendations for Resolution:
To resolve these concerns, the WAM model reviewers recommend: ▪ Including better justification of the 4x multiplier by using time budget data along with the RMR equation to calculate an energy budget for at least mallards, which will provide a better defense of the 4x multiplier or potentially lead to a different multiplier. ▪ Acknowledging that DEE likely varies over the nonbreeding period, regardless of the multiplier, and having the model examine potential changes in DUD estimates over time (e.g., early, mid-, and late in the nonbreeding period). ▪ Including temperature in the estimation of DEE.

Reference:

Miller, M.R. and J.M. Eadie. 2006. The allometric relationship between resting metabolic rate and body mass in wild waterfowl (Anatidae) and an application to estimation of winter habitat requirements. Condor 108:166-177.

Final Panel Comment 5:
The model would be easier to use if developed into a spreadsheet or relational database.
Basis for Comment:
Extensive data and multipart mathematical operations are required, and as any input is subject to entry error and extensive input is tedious, the use of the model may be limited only to cases where accurate estimates of waterfowl wintering habitat quality are desired. Development of a spreadsheet or relational database application would reduce errors and increase usability.
Significance – Low:
The addition of a computer-based calculation would enhance the usability of the model, but will not affect the performance of the model.
Recommendations for Resolution:
To resolve these concerns, the WAM model reviewers recommend: ▪ Developing the appropriate spreadsheet or database software.

Final Panel Comment 6:

There appears to be a typographical or mathematical error in the example at the top of page 25.

Basis for Comment:

The Waterfowl Assessment Methodology (WAM) includes detailed examples illustrating the calculation of duck-use-days (DUDs) in several scenarios. These examples are a critical component of the manual and will provide a basis for the reader to understand and later apply these equations to particular management scenarios. As such, it is important that these be mathematically correct and clearly written so that they are easy to follow.

The model reviewers studied the examples carefully and found only one possible error. In the example beginning on the top of pg. 25, the opening sentence reads:

"For example, 100 ha of naturally flooded BLH habitat with a medium 50-60 basal area of red oak and medium size tree stand producing 300 kg acorns/ha, a TME value of 2.67 kcal/g for acorns, a total winter period, flooded at a 5-year or 20% flood frequency recurrence interval, and **hunted** would equate to:

100 ha x [300 kg/ha x 1 (total winter availability) x 0.2 annual recurrence x 1.0 hunting availability] =

$$\frac{\text{6,000,000 kcal available}}{\text{452.44 DEE for mallards}} = \text{13,261 mallard DUD annualized/year}$$

The word "hunted" appears near the end of this sentence, so the panel was expecting that the equation below this sentence would contain a hunting availability value of 0.75. Instead, this value is 1.0, which according to earlier material indicates this system is not hunted. The next two equations on this page, which are part of this same example, appear to correctly handle the hunting availability term.

Significance – Low:

This is the only error found in the six pages of examples and it directly affects the technical quality of the model documentation. It is important that all of the examples be correct because they form a template for others to follow.

Recommendations for Resolution:

To resolve these concerns, the WAM model reviewers recommend:

- Correcting the hunting availability term in this equation (replace 1.0 with 0.75). This will reduce the numerator of the equation to 4,500,000 kcal and the solution will be 9,946 mallard DUDs annualized/year.

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ATTACHMENT A

Work Plan

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US Army Corps of Engineers®

REVISED FINAL WORK PLAN

INDEPENDENT EXTERNAL PEER REVIEW

for

Certification of Four Ecological Models: EnviroFish, Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley, Waterfowl Assessment Methodology (WAM), and the Delta Region of Arkansas Hydrogeomorphic Methodology (HGM) Guidebook

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Prepared for
U.S. Army Corps of Engineers
Ecosystem Planning Center of Expertise

Contract No. W911NF-07-D-0001
Task Control Number: 09-210
Delivery Order Number: 0799

October 8, 2009

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Independent External Peer Review
for
Certification of Four Ecological Models:
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Department of the Army
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Prepared by:

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REVISED FINAL WORK PLAN
Independent External Peer Review
for
Certification of Four Ecological Models:
EnviroFish, Waterfowl Assessment Methodology (WAM), Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley, and the Delta Region of Arkansas Hydrogeomorphic Methodology (HGM) Guidebook

General Project Information

- Project Title: Independent External Peer Review (IEPR) for Model Certification for Four Ecological Models: EnviroFish, Waterfowl Assessment Methodology (WAM), Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley, and the Delta Region of Arkansas Hydrogeomorphic Methodology (HGM) Guidebook (Four Ecological Models Review).
- Project Number: TG/G898592
- Client: U.S. Army Corps of Engineers, Ecosystem Planning Center of Expertise
- Effective Date of Work Plan: September 8, 2009
- Version Number: 1
- Project Manager: Karen Johnson-Young
- Deputy Project Manager: Amanda Maxemchuk
- Deliverable Due Dates: Draft Work Plan: October 1, 2009; Final Work Plan: October 8, 2009; Draft Charge: October 1, 2009; Final Charge: October 8, 2009; List of Peer Reviewers: October 16, 2009; Draft Model Review Reports: (A) January 5, 2009, (B) March 1, 2010; (C) February 3, 2010; (D) February 3, 2010; Final Model Review Reports: (A) January 22, 2010; (B) March 17, 2010; (C) February 22, 2010; (D) February 22, 2010
- Period of Performance: September 8, 2009 – April 30, 2010

1.0 Background, Objectives, and Scope of Work

1.1 Background

Planning models are defined as any models and analytical tools that planners use to define water resources management problems and opportunities, formulate potential alternatives to address the problems and take advantage of the opportunities, and evaluate potential effects of alternatives and to support decision-making. The United States Army Corps of Engineers (USACE) Planning Models Improvement Program (PMIP) was established in 2003 to assess the state of planning models in the USACE and to make recommendations to assure that high quality methods and tools are available to enable informed decisions on investments in the Nation's water resources infrastructure and natural environment. The main objective of the PMIP is to carry out a process to review, improve and validate analytical tools and models for USACE Civil Works business programs. The PMIP Task Force collected the views of USACE leaders and recognized technical experts, and conducted investigations and numerous discussions and

debates on issues related to planning models. This task force identified an array of model-related problems, conducted a survey of planning models, prepared papers on model-related issues, analyzed numerous options for addressing these issues, and formulated recommendations.

Use of certified models for all USACE planning activities is mandatory. This policy is applicable to all planning models currently in use by USACE, as well as models under development and new models. District Commanders are responsible for providing high quality, objective, defensible, and consistent planning products. Development of these products requires the use of tested and defensible models. National certification of planning models will result in significant efficiencies in the conduct of planning studies and enhance the capability to produce high quality products. The appropriate USACE Planning Center of Expertise (PCX) will be responsible for model certification. The goal of certification is to establish that USACE planning products are theoretically sound, compliant with USACE policy, computationally accurate, based on reasonable assumptions, and are in compliance with the requirements of the Office of Management and Budget's *Final Information Quality Bulletin for Peer Review* (Federal Register Vol. 70, No. 10, January 14 2005, pp 2664-2677). The use of a certified model does not constitute technical review of the planning product. Independent technical review of the selection and application of the model and the input data is still the responsibility of the users. Once a model is certified, the PCXs will work with model developers and managers to ensure that documentation and training in model use are available and that model updates comply with certification requirements.

The primary criterion identified for model certification is technical soundness. Technical soundness reflects the ability of the model to represent or simulate the processes and/or functions it is intended to represent. The performance metrics for this criterion are related to theory and computational correctness. In terms of the theory, the certified model should: 1) be based on validated and accepted "state of the art" theory; 2) incorporate USACE policies and requirements; 3) properly incorporate the conceptual theory into the software code; and, 4) clearly define the assumptions inherent in the model. In terms of computational correctness, the certified model should: 1) employ proper functions and mathematics to estimate functions and processes represented; and, 2) properly estimate and forecast the actual parameters it is intended to estimate and forecast. Other criteria for certification are efficiency, effectiveness, usability, and clarity in presentation of results. A certified model will stand the tests of technical soundness based on theory and computational correctness, efficiency, effectiveness, usability and clarity in presentation of results.

1.2 Objectives

The objectives of this work are to conduct a review for the USACE Ecosystem Planning Center of Expertise (ECO-PCX) to evaluate the technical quality, system quality, and usability of the following models in accordance with *Planning Models Improvement Program: Model Certification* (EC 1105-2-407, dated May 31, 2005) and the *Protocols for Certification of Planning Models* (July 2007), with the goal of certifying each model for use within the geographic area specified in the model documentation.

Model A EnviroFish Functional Reproductive Habitat Model

Model B Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley
Model C Waterfowl Assessment Methodology (WAM)
Model D Delta Region of Arkansas Regional HGM Guidebook

The review will not include a technical evaluation of the application of these models on a specific project. However, sample documentation of model application may be provided for informational purposes.

The general objectives of this work are to: a) prepare a work plan that will describe the process for conducting the model certification reviews of the four ecological models, b) identify potential panel members for the external peer review panel, and c) execute the work plan to conduct the model certification review.

1.3 Scope of Work

As a 501(c)(3) nonprofit science and technology organization with experience in establishing and administering peer review panels for USACE, Battelle was engaged to conduct the Model Review of the Four Ecological Models. Independent review ensures the quality and credibility of USACE planning tools. The Model Certification Review will follow the procedures described in the Department of the Army, USACE guidance entitled *Planning Models Improvement Program: Model Certification* (EC 1105-2-407), dated May 31, 2005, and the PMIP document entitled *Protocols for the Certification of Planning Models*, dated July 2007.

To accomplish the model certification review, subject matter experts will be recruited to participate on the peer review panel. Potential candidates for the peer review panel will be screened for availability, interest, and technical experience in defined areas of expertise and any actual or perceived conflicts of interest (COIs) will be determined. Ultimately, no more than 12 total panel members will be selected for the model certification review panels using predetermined criteria related to technical expertise and credentials in the subject matters related to the documents and materials to be reviewed. The following is a list of documents and reference materials that will be provided to the panel members for the review.

1. EnviroFish User Manual
2. EnviroFish Software
3. EnviroFish model code
4. Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley documentation
5. Habitat Model for Migrating Shorebirds communications
6. A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Forested Wetlands in the Delta Region of Arkansas, Lower Mississippi River Alluvial Valley, including HGM spreadsheets (Appendix D) and spatial data (Appendix E)
7. Waterfowl Assessment Methodology (WAM), also called the Duck-use-day Model

2.0 **Methods and Technical Approach**

One of the initial steps in the review process is to prepare a detailed work plan (this document) under Task 2. Additional tasks are detailed below in Section 2.0 (this section). The tasks described are based on the key tasks defined and described in detail in the USACE Model Certification For Four Ecological Models: Envirofish, Waterfowl Assessment Methodology (WAM), Migrating Shorebird Habitat Suitability Index Model, and the Delta Region of Arkansas Hydrogeomorphic Methodology (HGM) Guidebook Statement of Work (SOW). All tasks for the reviews shall be performed independent of government supervision, direction, or control.

Task 1: Kick-off Meeting.
Battelle will hold a kick-off teleconference with the PMIP team and representatives from the ECO-PCX. The purpose of the kick-off is to review the schedule, discuss the model review process, and address any questions regarding the scope, review documents, or required panel member expertise. Battelle will review the model documentation provided with the SOW and, based on a comparison with Table 2 of the USACE *Protocols for the Certification of Planning Models*, determine if additional information will be required to conduct the model reviews. A plan for the ECO-PCX providing the additional information required will be developed at this kick-off meeting.

Task 2: Work Plan.
Battelle will prepare a draft and final work plan (this document) that describes the process for conducting four separate and consecutive model reviews, including the screening criteria and process for selecting model review panel members, the schedule, charges to model review panel members (including charge questions), the process for conducting the reviews and drafting and finalizing four reports that summarize the results of each model review, communication and meetings with the USACE project team, and quality control. Battelle will also conduct a cursory review of each model to determine the level of effort required for panel members to conduct their reviews.

USACE has provided comments on the draft work plan and draft charge questions. Battelle has consolidated and address all comments in this final work plan, which was submitted within three (3) working days of the receipt of comments.

Task 3: Prepare and Finalize Charge to Reviewers.
Battelle will prepare and finalize the charge to each model review panel based on technical direction received from USACE and guidance provided in Department of the Army, U.S. Army Corps of Engineers EC No. 1105-2-407, *Planning Models Improvement Program: Model Certification*, dated 31 May 2005, and *Protocols for the Certification of Planning Models*, dated July 2007.

The process and evaluation criteria for the review, as outlined in the *Protocols for Certification of Planning Models* (July 2007), may include any or all of the following steps:

1. Panel members determine whether project needs/objectives are clearly identified and whether the model described is meeting those needs/objectives.

2. Panel members evaluate the technical quality of the models (review of model documentation).
    a. Model is based on well-established contemporary theory.
    b. Model is a realistic representation of the actual system.
    c. Analytical requirements of the model are properly identified and the model addresses and properly incorporates the analytical requirements.
    d. Assumptions are clearly identified, valid, and support the analytical requirements.
    e. USACE policies and procedures related to the model are clearly identified, and the model properly incorporates USACE policies and accepted procedures.
    f. Formulas used in the model are correct and model computations are appropriate and done correctly.
3. Panel members evaluate system quality (review by running test data sets or reviewing the results of beta tests).
    a. Rationale for selection of supporting software tool/programming language and hardware platform is adequately described, and supporting software tool/programming language is appropriate for the model.
    b. Supporting software and hardware is readily available.
    c. Programming was done correctly.
    d. Model has been tested and validated, and all critical errors have been corrected.
    e. Data can be readily imported from/into other software analysis tools, if applicable.
4. Panel members evaluate the usability of the model.
    a. Examine the data required by the model and the availability of the required data.
    b. Examine how easily model results are understood.
    c. Evaluate how useful the information in the results is for supporting project objectives.
    d. Evaluate the ability to export results into project reports.
    e. Training is readily available.
    f. User documentation is available, user friendly and complete.
    g. Adequate technical support is available for the model.
    h. Software/hardware platform is available to all or most users.
    i. Model is easily accessible.
    j. Model is transparent and allows for easy verification of calculations and outputs.

Each model review panel member will be provided with a charge that will guide their review of any model documentation, software, and code provided. The charge will include an assessment of the criteria listed above which are relevant to each review and ask panel members to respond to specific charge questions or directives regarding individual sections of the model document, as appropriate.

Battelle prepared a generic draft charge to the model review panels. The draft charge has been finalized based on technical direction received from USACE. The final charge is being submitted to USACE (Appendix A of this document) for final approval and distribution to the model review panel members.

Task 4: Identify Candidate Reviewers.

Screen Candidate Reviewers

Battelle will develop criteria for selecting the candidate reviewers; contact potential reviewers to evaluate technical skills, potential COIs, availability, and hourly rates; and identify up to 24 (12 primary and 12 backup) available potential experts to serve on the model review panels. The selection criteria used to identify candidate reviewers are provided in Appendix B to this work plan. Battelle will also develop a detailed COI screening questionnaire to be included in recruiting communications (Appendix C of this document). USACE will review the questionnaire, suggest changes (if needed), and approve this COI list prior to any potential reviewer receiving it.

To identify potential reviewers, Battelle will review candidates in Battelle's database of peer reviewers, seek recommendations from colleagues, contact former panel members, and conduct targeted internet searches. Preliminary information about the up to 24 potential reviewers, including brief biographical information and their responses to the COI questionnaire, will be provided to USACE as early as possible.

Specifically, the final model review panels will include members with the expertise described in Table 1 below.

Table 1. Number of Required Panel Members

Panel Member Expertise	A. EnviroFish Model	B. Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley	C. Waterfowl Assessment Model	D. HGM Guidebook
Civil Works Planner/Habitat Evaluation Procedures (HEP) Specialist	1	1	1	
Civil Works Planner/HGM Specialist				1
Programming/Spreadsheet Auditor	1			1
Fisheries Biologist	2			
Hydraulic Engineer	1			
Avian Biologist		2		
Waterfowl Biologist			2	
Wetland Ecologist				1
Forester				1
Total Number of Reviewers	**5**	**3**	**3**	**4**

Greater detail on the desired expertise for each of the panel members is presented in Appendix B of this work plan, along with the selection criteria. Each panel member will review one model, with the exception of the civil works planner/HEP specialist (who will review three models) and the programmer/spreadsheet auditor (who will review two models).

Finalize Contracts with Peer Reviewers

Battelle will identify up to 24 potential panel members and select no more than 12 final panel members according to the selection criteria. For each reviewer, Battelle will prepare a tailored scope of work that describes required panel member activities for this project. This scope of work description, along with a request for quotation and a COI inquiry form (Appendix C) will be sent to each selected peer reviewer. Upon receipt of the reviewers' written quotations indicating willingness to participate and the absence of a COI, Battelle will establish contracts with the panel members at agreed-upon rates and hours to ensure/secure participation. Each contract established also includes a non-disclosure statement.

The scope of work for each peer reviewer will consist of:

- Participation in a Battelle kick-off meeting (via teleconference)
- Participation in a USACE kick-off meeting (via teleconference) with the PDT and Battelle
- Participation in a Habitat Evaluation Procedures (HEP) training teleconference (8 panel members)
- Review and assessment of the technical quality, system quality, and usability of the Four Ecological Models and preparation of individual written comments
- Participation in a panel review teleconference to discuss findings and agree on a list of key topics/issues that will be presented in the Draft Model Certification Review Report and form the basis for the model certification review Final Panel Comments
- Preparation of the model certification review Final Panel Comments
- Review of the Draft Model Certification Review Report before it is submitted to USACE
- Review of USACE comments on the Draft Model Certification Review Report and Final Panel Comments
- Participation in a teleconference with USACE to discuss USACE's comments on the Draft Model Certification Review Report and Final Panel Comments
- Revision of the Draft Model Certification Review Report and Final Panel Comments in response to USACE comments
- Review of the Final Model Certification Review Report before it is submitted to USACE
- Provide additional technical support as directed.

Battelle has estimated the level-of-effort required for each panel member for the reviews in Table 2.

Table 2. Estimated Levels-of-Effort (hours) for Panel Members

	Kickoff Meeting	HEP short-course	A. EnviroFish Model	B. Shorebird Model	C. Waterfowl Model	D. HGM Guidebook	Total Hours
CWP/HEP Specialist	3	15	74	29	74		195

	Kickoff Meeting	HEP short-course	A. EnviroFish Model	B. Shorebird Model	C. Waterfowl Model	D. HGM Guidebook	Total Hours
Fisheries Biologists	3	3	74				80
Hydraulic Engineer	3	3	74				80
Spreadsheet Auditor	3		74			74	151
Avian Biologists	3	3		29			35
Waterfowl Biologists	3	3			74		80
CWP/HGM Specialist	3					74	77
Wetland Ecologist	3					74	77
Forester	3					74	77

Note: CWP = Civil Works Planner; HEP = Habitat Evaluation Procedures

The estimated hours listed above include time for the model review and charge question response, teleconferences, preparation of final comments and Draft Model Certification Review Report, report review, responding to USACE comments on the draft report, Final Model Certification Review Report review, and support-related activities.

Task 5 A-D: Conduct Assessment of Model.
A kick-off meeting with Battelle, the model review panel members, representatives from the USACE ECO-PCX, and Model Proponents will be held via teleconference to discuss the model certification requirements and expectations and to facilitate information exchange for each of the model reviews. One kick-off meeting will be conducted and it will cover all four model certification reviews for models A through D.

The description of the model review process in the following paragraphs applies to each of the four models being reviewed. Battelle will provide the panel members with electronic copies of the documentation for the model, software, and model code; *Protocols for Certification of Planning Models;* EC 1105-2-407, *Planning Models Improvement Program: Model Certification*; and other supporting documentation. USACE will provide these documents to Battelle via its FTP site. Battelle will prepare and deliver a memorandum instructing the panel members to undertake the review and outlining the steps and deadlines. Working with USACE, Battelle will respond to any panel member questions or information requests during the review process.

The panel members will complete their review and provide comments to Battelle. After receipt of all individual panel member comments, Battelle will merge all comments into one document and share the document with the panel members. In addition, Battelle will carefully review the comments and identify key issues/topics related to the technical quality, system quality, and usability of the model, as well as the model description and model testing. These key

issues/topics identified in the merged individual comments will be distributed to the panel members.

A panel review teleconference will be convened to ensure the exchange of technical information among the panel members, many of whom will be from diverse scientific backgrounds, and to identify key issues/topics specifically associated with the technical quality, system quality, and usability of the model. The result of the teleconference will be a list of key issues/topics (i.e., findings) that the panel members agree should be presented to USACE in the Draft Model Certification Review Report (Task 7) and as final panel comments. During the teleconference, the specific wording for the final panel comment statement will be agreed upon by all panel members, and final panel comments will be assigned "high," medium," or "low" significance based on the following definitions:

- High: Describes a fundamental problem with the model that could affect the model's ability to serve the intended purpose.
- Medium: Affects the completeness or understanding of the model, model usability, or the level of performance of the model.
- Low: Affects the technical quality of the model documentation but will not affect the performance of the model.

At the end of the teleconference, Battelle will prepare a memorandum to the panel members directing them to prepare specific sections of the Draft Model Certification Review Report (Task 6) based on the findings discussion and the technical quality, system quality, and usability criteria outlined in the *Protocols for Certification of Planning Models*, July 2007. The panel members will also be directed to prepare final panel comments, each of which will include the following four parts: (1) a clear statement of the comment; (2) the basis for the comment; (3) the significance of the comment (high, medium, or low); and (4) recommendations to resolve the comment (including additional research or analysis that may influence the conclusions). The individual comments in response to the charge and the panel review teleconference notes will be used as background information to prepare the final panel comments and the Model Certification Review Report.

Task 6 A-D: Prepare Draft Certification Report.
Four separate Draft Model Certification Review Reports for models A through D will be prepared and submitted. Battelle will prepare each Draft Model Certification Review Report and submit it to USACE for review. The report will assess the degree to which the model meets the technical quality, system quality, and usability criteria outlined in the *Protocols for Certification of Planning Models*, July 2007.

The report will follow the general outline below:

1.0 Introduction

1.1. Model Purpose

1.2. Model Assessment

1.3. Contribution to Planning Effort

1.4. Report Organization

2.0 Model Description

2.1. Model Applicability

2.2. Model Summary

2.3. Model Components

3.0 Model Evaluation

3.1. Assessment Criteria

3.1.1.Technical Quality

3.1.2.System Quality

3.1.3.Usability

3.2. Approach to Model Testing

3.3. Technical Quality Assessment

3.3.1.Review of Theory and External Model Components

3.3.2.Review of Representation of the System

3.3.3.Review of Analytical Requirement

3.3.4.Review of Model Assumptions

3.3.5.Review Ability to Evaluate Risk and Uncertainty

3.3.6.Review Ability to Calculate Benefits for Total Project Life

3.3.7.Review of Model Calculations/Formulas

3.4. System Quality

3.4.1.Review of Supporting Software

3.4.2.Review of Programming Accuracy

3.4.3.Review of Model Testing and Validation

3.5. Usability

3.5.1.Review of Data Availability

3.5.2.Review of Results

3.5.3.Review of Model Documentation

3.6. Model Assessment Summary

4.0 Conclusions

5.0 References

The final panel comments will be included as an appendix to the Draft Model Certification Review Reports. Individual comments will not be included in the Draft Model Certification Review Reports.

The Draft Model Certification Review Reports will be submitted electronically to USACE for review. The ECO-PCX and PMIP will review the Reports and provide comments back to Battelle.

Task 7 A-D: Meeting to Discuss Findings.

As necessary, for each model review (A – D), Battelle and the panel members will meet via teleconference with USACE's Technical Point of Contact, representatives from the ECO-PCX

and CECW-P, and Model Proponents to discuss their initial findings and ask clarifying questions that will aid in determining the information to be included in each of the Model Certification Review Reports.

Task 8 A-D: Prepare Final Certification Report.
For each model review (A – D), Battelle will prepare a Final Model Certification Review Report including a description of the process used to assess the model, assessment of the model based on the criteria outlined in Section 3.a. of *Protocols for Certification of Planning Models* (July 2007) and issues related to model recommendation.

3.0 Quality Control and Quality Assurance

During the review of the Four Ecological Models, there are numerous instances when quality assurance and/or quality control (QA/QC) practices will be implemented to ensure products of the highest quality are being provided to USACE. These QA/QC practices are described below.

Deliverable Review
It is Battelle policy that every deliverable be independently reviewed to ensure that it is accurate, technically sound, has objective interpretation, solid conclusions, satisfying presentation, and meets or exceeds client expectations. The deliverables for this project are listed in Section 4.0 of this work plan. The review may include a technical, editorial, and/or quality assurance component, depending on the document and project requirements. The Project Manager (PM) will determine the type(s) of review appropriate for each deliverable. In addition, per Battelle policy, all deliverables must have a one-over-one review and approval by the appropriate Battelle Manager prior to external distribution.

In addition to general technical, editorial, and/or QA reviews, Battelle will assign at least two people familiar with the project to review the panel members' responses to the charge questions. Because the charge question responses are used to develop the key themes of the panel members' findings, it is important that the responses be reviewed by a second person to ensure that the key themes have been appropriately captured. In addition to the charge question responses, each final panel comment is carefully reviewed by both the PM and the Deputy Project Manager (DPM) to ensure accuracy and thoroughness.

Peer Review Panel Recruitment
As an unbiased panel is critical to the successful completion of the Model Certification Review process, Battelle conducts a thorough peer review panel recruitment process. The first step in this process is the preparation of a COI questionnaire. Each potential panel member must fully complete the COI (see Appendix C for the COI issues identified for the Four Ecological Models reviews). In addition, USACE will provide information on more general COI issues that have been identified by USACE. USACE must approve the final list of potential COI issues before the questionnaire is distributed to potential panel members.

A detailed review is conducted for each candidate panel member. The Battelle recruitment team will present each candidate panel member's technical qualifications and COI screening responses to the Battelle PM and DPM. The candidate's qualifications are compared to the scope of work

and to the pool of potential candidates. If there are any outstanding questions regarding the candidates' responses to the COI screening, the candidate is contacted and the questions resolved prior to submitting the candidate's name to USACE.

Teleconferences

Teleconferences are an important component of conducting a Model Certification Review. They are critical to developing the final panel comments and discussing the final panel comments with USACE. Thus, accurate recording of action items, resolutions, and other information discussed during these teleconferences is critical to the process. To ensure that important information is not missed, Battelle provides at least two note-takers for all teleconferences and kick-off meetings with USACE and/or the panel members. All sets of notes taken by Battelle staff are compared and consolidated after each teleconference to provide one set of official notes. These notes are retained in the project files.

Development of Talking Points for Panel Review Teleconference

After reviewing all the panel members' comments in response to charge questions on the review documents, a talking points memorandum is developed by the DPM prior to the panel review teleconference. This document guides the teleconference and includes the key themes identified from the panel's comments, in addition to specific issues where the reviewers may have disagreed with one another. After drafting the talking points memo, the DPM sends it to at least one member of the Battelle project team to ensure that no important issues were omitted. The talking points are also provided to the panel members prior to the teleconference for review.

4.0 **Reporting**

Deliverables for the Certification of Four Ecological Models project include the following:

- Draft and final version of the work plan and Model Certification Review Charges
- Final list of up to 24 (primary and backup) selected model review panel members
- Draft and final Model Certification Review Report – EnviroFish Model
- Draft and final Model Certification Review Report – Shorebird Model
- Draft and final Model Certification Review Report – Waterfowl Model
- Draft and final Model Certification Review Report – HGM Guidebook

All draft and final deliverables will be provided to USACE electronically only and in PDF format, with the exception of each Final Model Certification Review Report, which will be sent to the USACE Technical Representative in hard copy (in addition to electronically). The draft work plan and charges were also provided to the USACE in Microsoft Word 2003 format to facilitate their review and allow comments and suggested revisions to be made in track changes.

There are no monthly report requirements for this project.

5.0 **Schedule**

The due dates for milestones and deliverables in Table 3 below are based on the date Battelle was supplied the final decision regarding the process to follow for conducting these four reviews (September 22, 2009). The asterisks indicate deliverables. All changes to the schedule will be documented and a revised schedule will be submitted to the USACE for approval.

Table 3. Four Ecological Models Certification Review Milestones and Deliverables

TASK	ACTION	DUE DATE
	Receipt of final decision on review process	**9/22/09**
	Review documents available	various
1	USACE/Battelle Kick-off Meeting	09/17/09
	USACE/Battelle/Panel Kick-off Meeting with all panel members	10/28/09
2	*Battelle submits Draft Work Plan to USACE	10/1/09
	USACE provides comments on Draft Work Plan	10/5/09
	Conference Call (if necessary)	TBD
	*Battelle submits Final Work Plan to USACE	10/8/09
3	*Battelle submits Draft Charge (combined with Draft Work Plan – Task 1) to USACE	10/1/09
	USACE provides comments on draft charge	10/5/09
	*Battelle submits Final Charge (combined with Final Work Plan – Task 1) to USACE	10/8/09
	USACE approves Final Charge	10/13/09
4	Battelle provides USACE with conflict of interest (COI) statements for review	9/14/09
	Battelle recruits and screens up to **24** candidate panel members	10/16/09
	*Battelle submits list and summary information of candidate panel members	10/16/09
	USACE provides comments on candidate panel members	10/21/09
	Battelle completes subcontracts for panel members	10/30/09
5A	Battelle provides review documents to panel members	11/2/09
	Panel **A** completes its review	11/20/09
	Battelle collates comments from panel **A**	11/24/09
	Battelle convenes panel review teleconference for panel **A**	12/01/09
	Panel **A** provides final panel comments and report section writing assignments to Battelle	12/11/09
6A	Battelle convenes teleconference with USACE to ask clarifying questions	As needed
7A	*Battelle submits Draft Model Certification Review Report **A** to USACE for review	1/5/10
	USACE provides comments on Draft Model Certification Review Report **A**	1/11/10
	Battelle convenes teleconference to discuss USACE comments on Draft Model Certification Review Report **A**	1/14/10
8A	*Battelle submits Final Model Certification Review Report **A** to USACE	1/22/10
5B	Battelle provides review documents to panel members	11/2/09
	Panel **B** completes its review	1/29/10
	Battelle collates comments from panel **B**	2/2/10

TASK	ACTION	DUE DATE
	Battelle convenes panel review teleconference for panel **B**	2/3/10
	Panel **B** provides final panel comments and report section writing assignments to Battelle	2/15/10
6B	Battelle convenes teleconference with USACE to ask clarifying questions	As needed
7B	*Battelle submits Draft Model Certification Review Report **B** to USACE for review	3/1/10
	USACE provides comments on Draft Model Certification Review Report **B**	3/8/10
	Battelle convenes teleconference to discuss USACE comments on Draft Model Certification Review Report **B**	3/10/10
8B	*Battelle submits Final Model Certification Review Report **B** to USACE	03/17/10
5C	Battelle provides review documents to panel members	11/2/09
	Panel **C** completes its review	1/7/09
	Battelle collates comments from panel **C**	1/11/09
	Battelle convenes panel review teleconference for panel **C**	1/12/09
	Panel **C** provides final panel comments and report section writing assignments to Battelle	1/20/10
6C	Battelle convenes teleconference with USACE to ask clarifying questions	As needed
7C	*Battelle submits Draft Model Certification Review Report **C** to USACE for review	2/3/10
	USACE provides comments on Draft Model Certification Review Report **C**	2/10/10
	Battelle convenes teleconference to discuss USACE comments on Draft Model Certification Review Report **C**	2/15/10
8C	*Battelle submits Final Model Certification Review Report **C** to USACE	2/22/10
5D	Battelle provides review documents to panel members	11/2/09
	Panel **D** completes its review	1/7/09
	Battelle collates comments from panel **D**	1/11/09
	Battelle convenes panel review teleconference for panel **D**	1/12/09
	Panel **D** provides final panel comments and report section writing assignments to Battelle	1/20/10
6D	Battelle convenes teleconference with USACE to ask clarifying questions	As needed
7D	*Battelle submits Draft Model Certification Review Report **D** to USACE for review	2/3/10
	USACE provides comments on Draft Model Certification Review Report **D**	2/10/10
	Battelle convenes teleconference to discuss USACE comments on Draft Model Certification Review Report **D**	2/15/10
8D	*Battelle submits Final Model Certification Review Report **D** to USACE	2/22/10
	Project Closeout	4/30/2010

Note: A indicates tasks for the review of the EnviroFish model, B indicates tasks for the review of the Habitat Model for Migrating Shorebirds in the Upper Mississippi Aluvial Valley, C indicates tasks for the review of the Waterfowl Assessment Methodology, and D indicates tasks for the review of the Delta Region of Arkansas Hydrogeomorphic Methodology Guidebook.
* = deliverable

6.0 **Project Organization and Communication**

Role and contact information for the key persons who will be working on the Four Ecological Models Review are presented in Table 4 (Battelle staff members), and Table 5 (USACE Project Delivery Team).

Table 4. Battelle Staff for the Four Ecological Models Project IEPR

Name	Project Role	Phone	E-mail
Karen Johnson-Young	Project Manager	(561) 656-6304	johnson-youngk@battelle.org
Amanda Maxemchuk	Deputy Project Manager	(781) 952-5384	maxemchuka@battelle.org
Rachel Sell; Corey Wisneski	Recruiting	(614) 424-3579; (781) 952-5296	sellr@battelle.org; wisneskic@battelle.org
Anne Gregg	Subcontracting Lead	(614) 424-7419	gregga@battelle.org

Table 5. USACE Staff for the Four Ecological Models Project

Name	Project Role	Phone	E-mail
Charles Theiling	Technical Representative/Point of Contact (Rock Island District)	(309) 794-5636	charles.h.theiling@usace.army.mil
Jodi K. Staebell	Alternate Technical Representative/Alternate Point of Contact (Mississippi Valley Division)	(309) 794-5448	jodi.k.staebell@usace.army.mil
Daniel Ward	Alternate Technical Representative/Alternate Point of Contact PDT (Memphis District)	(901) 544-0709	daniel.d.ward@usace.army.mil
Kelly Baerwaldt	Contracting Officer's Representative (Rock Island District)	(309) 794-5285	kelly.l.baerwaldt@usace.army.mil

Communication with USACE

Battelle's Point of Contact (POC) is the Technical Representative for the ECO-PCX. The alternate POC will be copied on all emails to the POC. If the POC is not available (e.g., on vacation), Battelle will contact the alternate POC directly. Communications may include status reports, questions, and/or requests for additional information from the panel.

Communication with the Model Review Panel

Battelle will be the main POC between USACE and model review panel members. Direct contact between the USACE and model review panel members will only occur during teleconferences with a Battelle representative present. All other communications will be directed through Battelle's Project Manager and Deputy Project Manager. The panel will be briefed that they are to have no direct communication with USACE and if they are contacted by USACE, they are to immediately inform Battelle.

7.0 **Budget**

The approved budget for this project is $392,531.

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APPENDIX A

Final Charge Guidance and Questions to the Peer Reviewers for the Model Certification Review of *Model Name*[1]

BACKGROUND
Model-specific background will be added.

OBJECTIVE

The objective of this effort is to conduct a review to evaluate the technical approach, system quality, and usability of the ***Model Name***. The ***Model Name*** will be evaluated in accordance with EC 1105-2-407, *Planning Models Improvement Program: Model Certification* (May 2005) and the *Protocols for Certification of Planning Models* (July 2007).

The U.S. Army Corps of Engineers Planning Models Improvement Program (PMIP) was established in 2003 to assess the state of planning tools and models in the U.S. Army Corps of Engineers (USACE) and to make recommendations to assure that high quality methods and tools are available to enable informed decisions on investments in the Nation's water resources infrastructure and natural environment. The main objective of the PMIP is to carry out "a process to review, improve and validate analytical tools and models for USACE Civil Works business programs." The model review for the ***Model Name*** will follow the guidance described in the Department of the Army, U.S. Army Corps of Engineers document entitled *Planning Models Improvement Program: Model Certification* (EC 1105-2-407), dated May 31, 2005, and the Planning Models Improvement Programs document entitled *Protocols for the Certification of Planning Models*, dated July 2007.

MODEL REVIEW

The following outlines the basic steps for the USACE model certification process. These steps are designed to guide the review of models being certified for widespread use and are also used to assess the technical quality and applicability of project-specific models. Model development is a multi-step, iterative process, with the number of steps and iterations being dependent upon the complexity of the model. In general, these steps occur in four fundamental stages.

- Stage 1 (Requirements Stage) involves identifying the need for a specific analytical capability and the options for tools to meet the need.
- Stage 2 (Development Stage) involves the development of software programming code or a spreadsheet and testing by the model developer.
- Stage 3 (Model Testing Stage) involves a beta test of the model by selected users whose objective is to validate the model and ensure that it is usable in real world applications.
- Stage 4 (Implementation Stage) involves providing training, user support, maintenance and continuous evaluation of the model.

[1] Note that all highlighted items in this draft charge will be changed to be specific for the model under review

The certification procedure depends on the stage of model development. The process may include the following steps.

1. Panel members determine whether project needs/objectives are clearly identified and whether the model described is meeting those needs/objectives.
2. Panel members evaluate the technical quality of the models (review of model documentation).
    a. Model is based on well-established contemporary theory.
    b. Model is a realistic representation of the actual system.
    c. Analytical requirement of the model are properly identified and the model addresses and properly incorporates the analytical requirements.
    d. Assumptions are clearly identified, valid, and support the analytical requirements.
    e. USACE policies and procedures related to the model are clearly identified, and the model properly incorporates USACE policies and accepted procedures.
    f. Formulas used in the model are correct and model computations are appropriate and done correctly.
3. Panel members evaluate system quality (review by running test data sets or reviewing the results of beta tests).
    g. Rationale for selection of supporting software tool/programming language and hardware platform is adequately described, and supporting software tool/programming language is appropriate for the model.
    h. Supporting software and hardware is readily available.
    i. Programming was done correctly.
    j. Model has been tested and validated, and all critical errors have been corrected.
    k. Data can be readily imported from/into other software analysis tools, if applicable.
4. Panel members evaluate the usability of the model.
    l. Examine the data required by the model and the availability of the required data.
    m. Examine how easily model results are understood.
    n. Evaluate how useful the information in the results is for supporting project objectives.
    o. Evaluate the ability to export results into project reports.
    p. Training is readily available.
    q. User documentation is available, user friendly and complete.
    r. Adequate technical support is available for the model.
    s. Software/hardware platform is available to all or most users.
    t. Model is easily accessible.
    u. Model is transparent and allows for easy verification of calculations and outputs.

The final deliverable for this effort will be a Model Certification Review Report that Battelle will deliver to USACE. The model review panel members will contribute to the preparation of the draft and final reports, as well as participate in two teleconferences with USACE and the Model Proponents to discuss review panel comments on the method (first teleconference) and USACE comments on the Draft Model Certification Review Report (second teleconference). The general outline for the report will be:

1.0 Introduction

1.1. Model Purpose

1.2. Model Assessment

1.3. Contribution to Planning Effort

1.4. Report Organization

2.0 Model Description

2.1. Model Applicability

2.2. Model Summary

2.3. Model Components

3.0 Model Evaluation

3.1. Assessment Criteria

3.1.1. Technical Quality

3.1.2. System Quality

3.1.3. Usability

3.2. Approach to Model Testing

3.3. Technical Quality Assessment

3.3.1. Review of Theory and External Model Components

3.3.2. Review of Representation of the System

3.3.3. Review of Analytical Requirement

3.3.4. Review of Model Assumptions

3.3.5. Review Ability to Evaluate Risk and Uncertainty

3.3.6. Review Ability to Calculate Benefits for Total Project Life

3.3.7. Review of Model Calculations/Formulas

3.4. System Quality

3.4.1. Review of Supporting Software

3.4.2. Review of Programming Accuracy

3.4.3. Review of Model Testing and Validation

3.5. Usability

3.5.1. Review of Data Availability

3.5.2. Review of Results

3.5.3. Review of Model Documentation

3.6. Model Assessment Summary

4.0 Conclusions

5.0 References

DOCUMENTS PROVIDED

The following is a list of documents and reference materials that will be provided for the review. **The documents and files presented in bold font are those which are to be reviewed.** All other documents are provided for reference.

- **Model Documentation**
- **Software**
- **Model Code**
- Department of the Army, U.S. Army Corps of Engineers *Planning Models Improvement Program: Model Certification* (EC 1105-2-407), dated May 31, 2005
- USACE Planning Models Improvement Programs document entitled: *Protocols for the Certification of Planning Models*, dated July 2007

SCHEDULE

Task	Activity	Due Date	Projected Date
5	*Conduct kick-off conference call with panel members and Model Proponents	Within 3 days of completing contracts	October 28, 2009
	Model review panel members submit comments to Battelle	Within 12 days of kick-off conference call with panel members	*Date*
	Contractor convenes meeting with panel members to discuss initial findings	Within 3 days of receipt of model team comments	*Date*
6	*Convene teleconference with USACE to ask clarifying questions on initial findings	Within 5 days of receipt of model team comments	As needed
	*Submit Draft Model Review Report to USACE for review	Within 14 days of receiving final panel comments and writing assignment from panel members	*Date*
	USACE provide comments on Draft Model Review Report	Within 5 days of receipt of draft report	*Date*
7	Convene a teleconference with USACE to discuss the Draft Review Report	Within 2 days of receipt of USACE comments	*Date*
8	*Submit the Final Model Review Report to the USACE	Within 5 days of review conference call on USACE draft report comments	*Date*

* denotes a deliverable

CHARGE FOR PEER REVIEW

The charge questions and guidelines are based on the model certification criteria discussed in the guidance document *Protocols for Certification of Planning Models* (July 2007) from the USACE

Planning Models Improvement Program. The intent of these questions is to focus your thinking, not to suggest or dictate your answers. We want you to consider several aspects of models during your review, from the inputs to the outputs to the underlying structure of the method.

General Charge Guidance

1. Please answer the scientific and technical questions listed below and conduct a broad overview of the model. Please focus on your areas of expertise and technical knowledge.
2. Evaluate the soundness of model as applicable and relevant to your area of expertise. Comment on whether model explains past events and how model will be validated.
3. Please focus the review on scientific information, including factual inputs, data, the use and soundness of model calculations, assumptions, and results that inform decision makers.
4. Offer opinions as to whether the model parameters and formulas are sufficient to quantify ecosystem function.
5. Panel members may contact each other. However, panel members **should not** contact anyone who is or was involved in the project, prepared the subject documents, developed the model, or was part of the USACE Independent Technical Review.
6. Please contact the Battelle Deputy Project Manager, Amanda Maxemchuk (maxemchuka@battelle.org) and cc: Karen Johnson-Young (johnson-youngk@battelle.org) if you have questions for Battelle or the USACE or need additional information.
7. In case of media contact, notify the Battelle project manager immediately.

Your name will appear as one of the panelists in the peer review. Your comments will be included in the Final Model Certification Review Report, but will remain unattributed. The Final Model Certification Review Report is expected to be released to the public by the USACE at some time in the future.

Please submit your comments in electronic form to Amanda Maxemchuk (maxemchuka@battelle.org) no later than *Date*.

MODEL ASSESSMENT CRITERIA

General Questions

1. Are the project needs/objectives clearly identified?

2. Does the model described meet those needs/objectives?

Technical Quality

3. Comment on the overall technical quality of the model.

4. Comment on the temporal and spatial resolution of the model.

5. Is it clear where the model's geographic boundaries fall?

6. Are the limitations of the model clearly defined?
   a. How do the limitations impact the ability of the model to evaluate ecological benefits?
   b. What are the potential impacts to the project?
   c. How can those limitations be overcome?

7. Is the model based on well-established contemporary theory?

8. Is the model a realistic representation of the actual ecosystem?

9. Does the model effectively capture the variables that are most important for the intended use of the model?

10. Comment on the precision and accuracy of the model for evaluating potential outcomes of project alternatives. What factors/variables provide the greatest impact on precision and accuracy?

11. Comment on the sensitivity of the model.

12. Are the analytical requirements of the model properly identified?

13. Does the model address and properly incorporate the analytical requirements?

14. Are the assumptions clearly identified, valid, and do they support the analytical requirements?

15. Comment on the ability of the model to evaluate risk and uncertainty.

16. Comment on the ability of the model to evaluate impacts and benefits for total project life.

17. Comment on the ability of the model to determine adequate compensatory mitigation.

18. Are the formulas used in the models correct and are the model macros and computations appropriate and done correctly?

19. Are USACE policies and procedures related to the model clearly identified, and does the model properly incorporate USACE policies and accepted procedures?

20. Do the models allow the user(s) to make assumptions regarding future global events such as, but not limited to, global climate change and changes to sea level.

System Quality

21. Is the rationale for the selection of the supporting software tool/programming language and hardware platform adequately described?

22. Is the supporting software tool/programming language is appropriate for the model?

23. Was the programming done correctly?

24. Can data be readily imported from/into other software analysis tools?

25. Has the model been sufficiently tested and validated, and have all critical errors been corrected?

26. Are error checks built into the models?

27. Do the models work using both sensible and non-sensible data?

Usability

28. Comment on the model usability.

29. Comment on the availability of the data required by the model.

30. How easily are model results understood?

31. Comment on how useful the information in the results is for supporting project objectives.

32. Comment on the usability of the model for selecting the best project alternative.

33. Is user documentation user friendly, and complete?

34. Are the models transparent and do they allow for easy verification of calculations and outputs?

APPENDIX B

Four Ecological Models Model Certification Review Panels Considerations and Proposed Selection/Exclusion Criteria

According to the documents for the Certification of Four Ecological Models, the overall model review scope includes:

- Two avian biologists (Migrating Shorebird Habitat Suitability Index Model)
- One civil works planner/HEP specialist (EnviroFish, Migrating Shorebird Habitat Suitability Index Model, Waterfowl Assessment Method)
- One civil works planner/HGM specialist (Delta Region of Arkansas HGM Guidebook)
- Two fisheries biologists (EnviroFish)
- One forester (Delta Region of Arkansas HGM Guidebook)
- One hydraulic engineer (EnviroFish)
- One programmer/spreadsheet auditor (EnviroFish, Delta Region of Arkansas HGM Guidebook)
- Two waterfowl biologists (Waterfowl Assessment Method)
- One wetland ecologist (Delta Region of Arkansas HGM Guidebook)

Technical Criteria /Areas of Expertise for Potential Independent External Peer Reviewers

All panel members should have at least 5-10 years of experience and have familiarity with large, complex civil works projects with high public and interagency interests. The panel members should at least have M.S. degrees, although Ph.Ds are preferred.

Technical areas related to **avian biology** (2 experts; Migrating Shorebird Habitat Suitability Index Model):

- Familiarity with methods for evaluating bird habitat suitability and have knowledge of the Lower Mississippi River Valley bird populations, specifically shorebirds.

Technical areas related to **civil works planning and Habitat Evaluation Procedures** (1 expert; EnviroFish, Migrating Shorebird Habitat Suitability Index Model, and Waterfowl Assessment Method reviews):

- Experience in the area of floodplain management including ecosystem restoration, impact analysis, compensatory mitigation and knowledge of Lower Mississippi River Valley ecosystems.
- Experience in the use of HEP.

Technical areas related to **civil works planning and Hydrogeomorphic Models** (1 expert; Delta Region of Arkansas HGM Guidebook):

- Experience in the area of floodplain management including ecosystem restoration, impact analysis, compensatory mitigation and knowledge of Lower Mississippi River Valley ecosystems.
- Experience in the use of Hydrogeomorphic approach for assessing wetland functions.

Technical areas related to **fisheries biology** (2 experts, EnviroFish):

- Familiarity with the methods for evaluating fish habitat suitability and have knowledge of the Lower Mississippi River Valley fisheries.
- Experience working with hydrologic and hydraulic modelers to evaluate floodplain hydraulics is desirable.

Technical areas related to **forestry** (1 expert, Delta Region of Arkansas HGM Guidebook):

- Experience in riverine forest ecology, experience in bottomland hardwood community structure and dynamics within the Lower Mississippi River Valley.
- Familiarity with ecosystem output evaluation, particularly the hydrogeomorphic approach to assessing wetland function, is essential.

Technical areas related to **hydraulic engineering** (1 expert, EnviroFish):

- Experience in estimating the effects of flood protection on floodplain hydrology using the HEC-RAS 1-D Flow and associated DSS (direct storage system) files and conducting ecosystem restoration output evaluations.

Technical areas related to **programmer/spreadsheet auditing** (1 expert, EnviroFish and Delta Region of Arkansas HGM Guidebook):

- Experience testing, debugging and auditing computer programs/spreadsheets to check for accuracy of formulas, cell references, and computer code.
- Must have experience with Java programming language.

Technical areas related to **waterfowl biology** (2 experts, Waterfowl Assessment Method):

- Familiarity with methods for evaluating waterfowl habitat suitability and have knowledge of the Mississippi River Valley migratory waterfowl.

Technical areas related to **wetland ecology** (1 expert, Delta Region of Arkansas HGM Guidebook):

- Experience in wetland ecology of large floodplain rivers, preferably experience in southern bottomland wetlands.
- Familiarity with ecosystem output evaluation, particularly the Hydrogeomorphic approach to assessing wetland function, is essential.

Other considerations:

- Participation in previous USACE technical review panels
- Other technical review panel experience

Reviewer Categories [candidate may fit into more than one category]

- Academic
- Consultant (company-affiliated, *e.g.*, architect-engineer or consulting firm)
- Consultant (independent)
- Non-governmental organization (*e.g.*, public agency)

Potential Exclusion Criteria/Conflicts of Interest

- Involvement by you or your firm[1] in any part of the development, assessment, or review of the following models:
    - EnviroFish Functional Reproductive Habitat Model
    - Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley/Migrating Shorebird Model
    - Waterfowl Assessment Methodology/ Duck Use Days Model
    - A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Forested Wetlands in the Delta Region of Arkansas, Lower Mississippi River Alluvial Valley
- Involvement by your firm[1] in any part of the St. Johns Bayou and New Madrid Floodway Environmental Impact Statement process, including:
    - Final Environmental Impact Statement entitled Mississippi River and Tributaries, Mississippi River Levees (MRL) and Channel Improvement (1976);
    - Final EIS entitled St. Johns Bayou/New Madrid Floodway Project Final EIS (1982);
    - 1998 Mississippi River Mainline Levees Enlargement and Seepage Control EIS
    - Draft Supplemental EIS (1999)
    - Final Supplemental EIS (2000)
    - Revised Supplemental EIS (2002); or,
    - Second Revised Supplemental EIS (2006).
- Any involvement by you or your firm[1] in the conceptual or actual design, construction, or O&M of the St. Johns Bayou and New Madrid Floodway, MO project or the Mississippi River and Tributaries Project.
- Involvement as an expert or provided testimony for the civil action (04-1575) Environmental Defense, et al. v. U.S. Army Corps of Engineers (USACE) et al.
- Involvement as an expert or provided testimony for Water Quality Certification for the St. Johns Bayou and New Madrid Floodway Project (06-0421) Missouri Coalition for the Environment, et al. v. Missouri Department of Natural Resources *et al*.
- Any involvement by you or your firm[1] in any litigation involving the United States of America and the U.S. Army Corps of Engineers in particular
- Any application by you or your firm[1] for a USACE permit of any nature or representation for a client that applied for a USACE permit of any nature within the boundaries of the Memphis or Vicksburg Districts.
- Current employment by the USACE.
- Current or previous employee or affiliation with the interagency mitigation team or the local sponsor, the U.S. Fish and Wildlife Service, Environmental Protection Agency, Missouri Department of Conservation, Missouri Department of Natural Resources, and the St. Johns Levee and Drainage District.
- Any employment as an individual or contractually by a State agency, levee or drainage district, or a city or municipality that had committed to serve as a local sponsor for a USACE project within the boundaries of the Memphis, or Vicksburg Districts.
- Current or previous employment or affiliation with Environmental Defense, National Wildlife Federation, or Missouri Coalition for the Environment (for pay or pro bono).

- Any voluntary service by you or your firm[1] to provide expert opinions or testimony in connection for any party in connection with a federal project.
- Current or future interests in the St. Johns Bayou and New Madrid Floodway Project.
- Involvement with paid or unpaid expert testimony related to the models or document listed above in numbers 1 and 2.
- Current personal involvement with other USACE projects, including whether involvement was to author any manuals or guidance documents for USACE. If yes, provide titles of documents or description of project, dates, and location (USACE district, division, Headquarters, ERDC, etc.), and position/role. Please highlight and discuss in greater detail any projects that are specifically with the Vicksburg District or the Memphis District.
- Current firm[1] involvement with other USACE projects, specifically those projects/contracts that are with the Vicksburg District or the Memphis District. If yes, provide title/description, dates, and location (USACE district, division, Headquarters, ERDC, etc.), and position/role.
- Previous employment by USACE as a direct employee or contractor (either as an individual or through your firm[1]) within the last 10 years, notably if those projects/contracts are with the Vicksburg District or the Memphis District. If yes, provide title/description, dates employed, and place of employment (district, division, Headquarters, ERDC, etc.), and position/role.
- Other USACE affiliation [e.g., scientist employed by USACE (except as described in NAS criteria, see EC 1105-2-410 section 8d)].
- Previous experience conducting technical peer reviews. If yes, please highlight and discuss any technical reviews concerning flood risk management projects, and include the client/agency and duration of review (approximate dates).
- A significant portion (i.e., greater than 50%) of personal or firm[1] revenues within the last 3 years came from USACE contracts.
- A significant portion (i.e., greater than 50%) of personal or firm[1] revenues within the last 3 years came from U.S. Fish and Wildlife Service contracts.
- Any publicly documented statement (including, for example, advocating for or discouraging against) related to the models or document listed above in numbers 1 and 2.
- Any publically documented statement advocating for or against the Mississippi River and Tributaries Project, including the St. Johns Bayou and New Madrid Floodway Project.
- Is there any past, present or future activity, relationship or interest (financial or otherwise) that could make it appear that you would be unable to provide unbiased services on this project? If so, please describe:
- Any other perceived COI not listed, such as:
    - Repeatedly served as USACE technical reviewer
    - Paid or unpaid participation in litigation related to the work of the USACE.
    - Prior repeated service as technical advisor to, or expert witness for, Environmental Defense, National Wildlife Federation, the Missouri Coalition for the Environment, or any other interest group that opposed a USACE Project.
    - Any other perceived COI not listed.

[1] Note: Includes any joint ventures in which your firm is involved.

APPENDIX C

Peer Review Conflict of Interest Inquiry

Dear (Peer Reviewer -- insert name):

You have been requested by the U.S. Army Corps of Engineers (USACE) to serve as an external peer reviewer for the Independent External Peer Review of the Model Certification for Four Ecological Models: EnviroFish, Waterfowl Assessment Methodology (WAM), Migrating Shorebird Habitat Suitability Index Model, and the Delta Region of Arkansas Hydrogeomorphic Methodology. Your participation in this review will be greatly appreciated. However, it is possible that your personal affiliations and involvement in particular activities could pose a conflict of interest or create the appearance that you lack impartiality in your involvement for this peer review. Although your involvement in these activities is not necessarily grounds for exclusion from the peer review, you should consult the contact named below or other appropriate official to discuss these matters. Affiliations or activities that could potentially lead to conflicts of interest might include:

a) current work or arrangements concerning future work in support of industries or other parties that could potentially be affected by developments or other actions based on material presented in the document (or review materials) that you have been asked to review;
b) your personal benefit (or benefit of your employer, spouse or dependent child) from the developments or other actions based on the document (or review materials) you have been asked to review;
c) any previous involvement you have had with the development of the document (or review materials) you have been asked to review;
d) any financial interest held by you (or your employer, spouse or dependent child) that could be affected by your participation in this matter;
e) any financial relationship you have or have had with USACE such as employment, research grants, or cooperative agreements;
f) significant portion (i.e., greater than 50%) of your personal or firm's revenues within the last 3 years came from USACE contracts;
g) you or your firm made a publicly documented statement advocating for or against the subject project;
h) litigation associated with USACE; and
i) past, present or future activity, relationship or interest (financial or otherwise) that could potentially be perceived by a third party, or give the appearance that you would be unable to provide independent unbiased subject matter knowledge, expertise, and/or services on this project.

[1] Note: Includes any joint ventures in which your firm is involved

If you have any concerns over a potential conflict of interest, please contact Mr. Mike Genovese, Battelle (GenoveseM@Battelle.org, (614) 424-4007) to discuss any potential conflict of interest

issues at your earliest convenience, but no later than two (2) days after receiving this request.

If you agree to be on this peer review panel, please check one of the following boxes, sign this form, and fax to Mr. Mike Genovese, Battelle, at (614) 458-4007 no later than two (2) days after receiving this request.

This form does not constitute an authorization to participate in this review; authorization for performance will come from Battelle's Government Subcontracts office.

[ ] I have no known existing or potential conflicts of interest associated with this task.

[ ] I have identified and disclosed in writing all known existing or potential conflicts of interest associated with this task.

_____ _____

Signature *Date* *Printed Name*