DEPARTMENT OF THE ARMY   EC 1105-2-412
U.S. Army Corps of Engineers
CECW-CP   Washington, D.C. 20314-1000

Circular
No. 1105-2-412   31 March 2011

EXPIRES 31 March 2013
Planning
ASSURING QUALITY OF PLANNING MODELS

1. Purpose. This circular establishes the process and the requirements for assuring the quality of planning models.

2. Applicability. This circular applies to all USACE elements, Major Subordinate Commands (MSCs), and district commands having Civil Works responsibility. This guidance applies to planning models as defined in Paragraph 5 of this Circular.

3. References.

 a. The Information Quality Act, Public Law No. 106-554.

 b. Engineer Regulation 1105-2-100, Planning Guidance Notebook, April 2000.

 c. Engineering and Construction Bulletin 2007-6: Model Certification Issues for Engineering Software in Planning Studies.

 d. U.S. Army Corps of Engineers, Report of the Planning Models Improvement Task Force, September 2003.

 e. Office of Management and Budget, Final Information Quality Bulletin for Peer Review, Federal Register Vol. 70, No. 10, January 14, 2005, pp 2664-2677.

4. Background.

 a. The Corps of Engineers Planning Models Improvement Program (PMIP) was established in 2003 to assess the state of planning models in the Corps 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 U.S. Army Corps of Engineers (USACE) Civil Works business programs." In carrying out this initiative, a PMIP Task Force was established to examine planning model issues, assess the state of planning models in the Corps, and develop recommendations on improvements to planning models and related analytical tools. The PMIP Task Force collected the views of Corps leaders and recognized technical experts, and conducted investigations and numerous discussions and debates on issues related to planning models. It 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, formulated recommendations, and wrote a final report that is the basis for the development of this Circular. The Task Force considered ongoing Corps initiatives to address planning capability, and built upon these where possible.

b. The process of assuring quality and effectiveness in planning models will be based on a few simple but fundamental principles:

(1)   Confidence and transparency in models are of the utmost importance.

(2)   Models and methods must keep current with advancements in knowledge, technology and Corps policy.

(3)   Model documentation must be clear and thorough - agency and external review panels must have enough information to understand the model, its intended usage, and its limitations.

(4)   Practicality is necessary in data requirements as well as ease of use.

(5)   Flexibility in models is needed for a wide range of applications.

(6)   No more "home grown" models – models must be developed in collaboration with the Planning Centers of Expertise and HQUSACE, not in isolation.

(7)   Success will be:

(a)   Complete toolbox of models.

(b)   Trained users.

(c)   Corporate process to keep models current.

(d)   Appropriate, timely and cost-effective analysis to support decision making.

5. Definitions.

a. Planning models - For the purposes of this Circular, planning models are defined as any models and analytical tools that planners use to define water resources management problems and opportunities, to formulate potential alternatives to address the problems and take advantage of the opportunities, to evaluate potential effects of alternatives and to support decision-making. It includes all models used for planning, regardless of their scope or source, as specified in the following sub-paragraphs. This EC does not cover engineering models used in planning - activities. Guidance on quality assurance for engineering models is contained in ER 1110-2-1150, Engineering and Design for Civil Works Projects. - Planning models are categorized according to their origins, as follows.

(1) Corporate models – developed by Corps laboratories/Field Operating Agencies (FOAs) which have nationwide applicability (HEC-FDA, IWR-PLANNING SUITE, BEACH-FX, etc.)

(2) Regional/local models – typically developed by district offices to address a particular local project/problem, and could have broader regional applicability. This category includes all spreadsheets and software applications developed by analysts for planning purposes as well as specific applications of commercially developed software (e.g., @RISK based applications, etc. Such commercially developed software do not need certification in themselves, but the planning applications do).

(3) Commercial off-the-shelf (COTS) models – developed by private industry that may have applicability to Corps planning.

(4) Models developed by others– developed by other Federal agencies, non-Federal government entities (states, counties, etc.), Non-Governmental Organizations (NGOs) or academic institutions that may have applicability to Corps planning.

b. Certified model. A planning model that has been reviewed and certified by the appropriate Planning Center of Expertise (PCX) and Headquarters (HQ) in accordance with the rules and procedures specified in this Circular. Model certification is a corporate determination that the model is a technically and theoretically sound and functional tool that can be applied during the planning process by knowledgeable and trained staff for purposes consistent with the model's purposes and limitations. Only models developed by the Corps of Engineers will be certified.

c. Approved model. A planning model that has been reviewed and approved by the appropriate PCX and HQ in accordance with the rules and procedures specified in this Circular. Models will be considered for approval (rather than certification) if they have been developed by an entity outside the Corps. Models will also be considered for approval in cases where a model has been developed by the Corps and is viewed by the vertical team (including the District, MSC, PCX, and HQ) as single-use or study-specific (which will include many ecosystem output models). Model approval is a corporate determination that the model is a technically and theoretically sound and functional tool that can be applied during the planning process by knowledgeable and trained staff for purposes consistent with the model's purposes and limitations.

d. Planning Centers of Expertise (PCXs). The PCXs were established in 2003 to enhance the Corps planning capability for inland navigation, deep-draft navigation, ecosystem restoration, hurricane and storm damage reduction, flood damage reduction and water reallocation. The PCXs are part of a national initiative to improve the quality and effectiveness of the Corps water resources planning program. The PCXs will be responsible for the implementation of the certification and approval assessment processes stated in this EC.

e. Proponents. Model certification proponents are any districts, MSCs, Corps laboratories, model developers or Headquarters that identify a need for and request certification or approval.

f. Model Certification Headquarters (HQ) Panel. The Planning Community of Practice (CoP) and CECW-P will establish and select members for a Model Certification HQ Panel to serve in a deliberative role to support the Planning CoP in its decisions associated with model certification/approval. The panel will be headed by a senior member of the Planning CoP and will consist of representatives from CECW-P (including the Office of Water Project Review), CECW-E, the Institute for Water Resources, and other offices as appropriate. The panel will be selected to represent disciplines including engineering, plan formulation, economics, and ecosystem restoration. CECW-P, in consultation with the panel, will make the final decision on all model certification and approval actions.

g. Peer Support. A means of assisting in the development of new models, or revision of existing certified models, that consists of ongoing involvement of expertise from inside and outside of the Corps and other technical/administrative support as appropriate.

6. Policy. Use of certified or approved models for all planning activities is mandatory. This policy is applicable to all planning models currently in use, models under development and new models. District commanders are responsible for delivering high quality, objective, defensible, and consistent planning products. Development of these products requires the appropriate use of tested and defensible models. National certification and approval of planning models results in significant efficiencies in the conduct of planning studies and enhances the capability to produce high quality products. The appropriate PCX will be responsible for implementing the model certification/approval process. The goal of certification/approval is to ensure that Corps planning products are theoretically sound, compliant with Corps policy, computationally accurate, based on reasonable assumptions regarding the availability of data, transparent, and described to address any limitations of the model or its use. The use of a certified/approved model does not constitute technical review of the planning product. The selection and application of the model and the input data is still the responsibility of the users and is subject to Agency Technical Review and Independent External Peer Review (where applicable). Once a model is certified/approved, the PCXs will be responsible for assuring that model documentation and training on the use of the model are available (either from the PCX or the model developers), and for coordinating with model developers to assure the model reflects current procedures and policies. All certification/approval decisions will be in effect for a period specified by the Model Certification HQ Panel, not to exceed seven years.

7. Criteria for Model Certification/Approval. Technical soundness is the primary criterion on which model certification/approval decisions will be based. 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/approved model should: 1) be based on validated and accepted "state of the art" theory; 2) be consistent with Corps policies and requirements; 3) properly incorporate the conceptual theory into the software code; and, 4) clearly define the assumptions, sensitivities, uncertainties, and known limitations inherent in the model. In terms of computational correctness, the certified/approved model should: 1) be free of computational errors and employ proper numerical/mathematical methods to estimate functions and processes represented; and, 2) adequately characterize, estimate and forecast the actual parameters it is intended to represent. A certified/approved model will stand the test of technical

soundness and theory, computational correctness and usability and will be well documented. These criteria are discussed in more detail in Section 3a of Appendix A.

8. Certification/Approval Process.

   a. As soon as a model need is identified, the proponents in coordination with the applicable PCXs will determine whether a model exists for their specific needs. If there is an existing model that meets the needs and requirements of the proponents and it had been previously certified, use of the model will be approved for the planning effort. PCXs, upon request, can recommend sources of training and technical support. If the existing model is not certified, the process described in Exhibit 1 will be used for certification. If no model is available to meet the needs and requirements, the proponents will decide whether to develop a new model (in-house or through a Corps laboratory), to modify an existing model or to purchase a commercial application. In these cases, the process to certify these models is described in paragraph 9 of this EC. Figure 1 summarizes the model certification process for existing or revised models. Figure 1 includes an approximate timeline for each step, which will likely vary with each application depending on model complexity, the extent of comments received during the process, PCX schedules, and other variables.

   b. Each certification/approval action will require a customized certification plan akin to a PMP, both for billing purposes and for defining the scope of review. The certification plan should fulfill Steps 1-4 from the process described in Exhibit 1, as well as provide a cost estimate and schedule to the proponent. The PCX will submit each certification plan to CECW-P for approval (Step 5) prior to initiating the review.

   c. Model Certification: For models developed by the Corps that are anticipated to be applied on a regular basis or in multiple settings, the PCX will implement the process to certify these models.

   d. Model Approval (models developed by non-Corps entities): For models developed by entities outside the Corps, the PCX will implement the process to approve the use of these models based on an assessment of the documentation provided by the proponent that demonstrates the model satisfies the certification criteria (Appendix A).

   e. Model Approval (single use): For single-use or study specific models developed by the Corps, the PCX will implement the model approval process through technical review rather than through a separate model certification process. This means that technical review will necessarily be intensive since the basic requirements of the Certification Protocols (Appendix A) requiring documentation of technical and system quality must still be met.

   f. Certification/approval actions for revised models and those approaching their expiration date will be scoped to address any incremental revisions to the model, currency with respect to policy and the prevailing state-of-the-practice as well as the model's overall performance and adequacy of documentation. For revised models, the PCX will recommend whether previous versions of the models may still be used (possibly with conditions) or will be eliminated from use.

Exhibit 1 Certification/Approval Process for Existing (or Revised) Models	
Step 1	Proponent identifies model to be used for a national, regional, or local application and the PCX determines the need for certification or approval.
Step 2	Proponent submits model and documentation to the appropriate PCX.
Step 3	The PCX utilizes the following criteria to determine the appropriate level of review. The PCX has final approval on the level of review. Level 1 review is for highly complex models used in decision-making where there could be a high risk of making an incorrect investment decision (e.g., not justified, not optimal, etc.) that could result in major negative impacts. Level 2 review is for models of lesser complexity than Level 1 models with lower risks of making an incorrect investment decision that could result in minimum impacts. Level 3 review is for routine and non-complex models that have a minor impact on project decision-making Level 4 review is for current frequently used models that were developed by Corps Districts, Corps Labs/FOAs and other agencies and contractors that have withstood historical informal reviews. The capabilities and limitations of these models are generally well understood. The review of frequently used existing products will include examination of the individual product's review documentation to determine if the product warrants certification without a level 1 or 2 review.
Step 4	The PCX establishes a review team, identifies team members, identifies the team leader, and defines the anticipated charge and scope of review. The review charge and scope should guide the product reviewers and direct them to key issues, assumptions, routines, and aspects for review. A team selected from the roster of qualified reviewers maintained by the appropriate PCX, including external and internal reviewers, will conduct Level 1 and Level 2 reviews. Level 3 and Level 4 reviews may be conducted by Corps internal experts, but the review team, as deemed appropriate by the PCX, could include external individuals as well. Protocol and procedures for the model review process will be specified in the PCX standard operating procedures (SOP) and will reflect prevailing industry practices. standard operating procedures (SOP) and will reflect prevailing industry practices.

Exhibit 1	
Certification/Approval Process for Existing (or Revised) Models	
Step 5	The PCX develops a certification plan to include the information from Steps 1-4, defining the scope of review. The Certification Plan (and accompanying model documentation materials) is submitted to CECW-P for approval. Written approval from CECW-P must be received by the PCX prior to proceeding with the certification review.
Step 6	Once the PCX has received approval to proceed, the PCX will hold an initial meeting to begin the certification process to assure that all participants understand the nature of the effort, as well as to discuss any particular technical or administrative issues that will be important in the review. The meeting (which can be held by teleconference) will include representatives of the PCX, the model proponent and the review team. CECW-P will be notified of the meeting and invited to attend.
Step 7	In fulfilling its role, the review team will provide to the PCX a consolidated documentation of review comments and recommendations. The review should adhere to the review charge and scope provided by the PCX. The PCX will strive for consensus, but one or more reviewers may not concur with the views of the majority. Matters of disagreement should be addressed forthrightly in the report. As a final recourse, a reviewer may choose to prepare a brief dissent describing the issues of contention and the arguments in support of the minority view. To encourage reviewers to express their views freely, the review comments are treated as panel responses and are given to proponents with identifiers removed.
Step 8	Review comments are provided to the PCX within 90 days after submittal of the model for review to the review team. (Ninety days is the estimated maximum time for review of models in Level 1. For models in other categories, the review time will be adjusted accordingly, and is expected to be less than 90 days.) The PCX then assesses whether the review team fulfilled the charge and scope provided. When the PCX determines that the review charge and scope have been met, the comments are provided to the proponent for review and response, and a checkpoint meeting is scheduled to discuss the review comments and issues for response. The checkpoint meeting will be held with the same parties as the initial meeting in Step 6, above.
Step 9	Feedback from the proponent, within 30 days after receipt of the comments, is transferred through the PCX back to the review team until all comments are either resolved or all parties reach an agreement on outstanding issues. The PCX will strive to resolve all comments, but not all comments may be resolved. CECW-P in consultation with the HQ Model Certification Panel, the proponent and the PCX will have the final decision on comment resolution and product certification/approval. The final decision on model

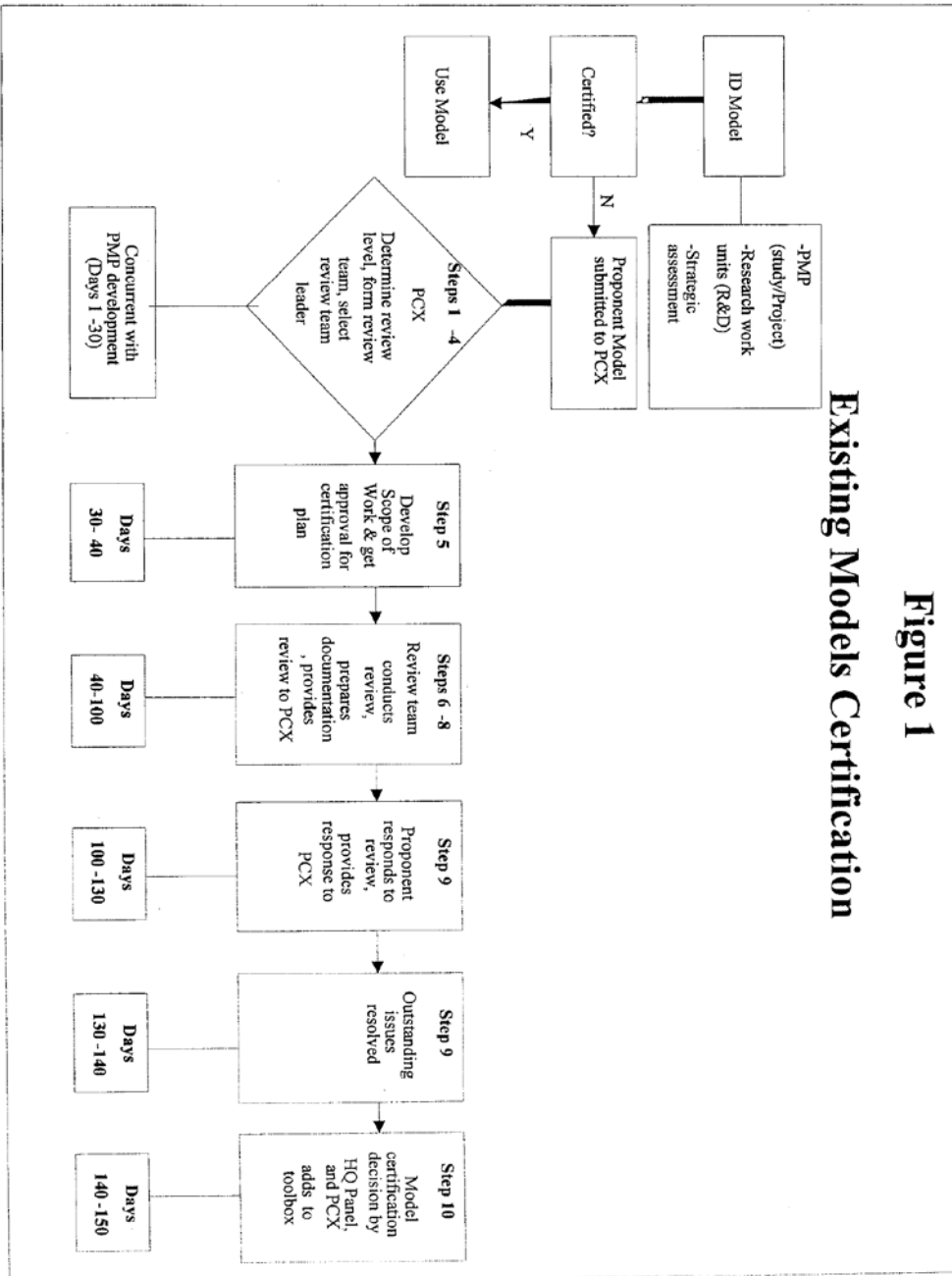| | Exhibit 1
Certification/Approval Process for Existing (or Revised) Models | |
|---|---|
| | certification/approval should be made within 90 days after initial submittal of review comments to the proponent. (In cases where substantial revisions are made to the model, this time period may be longer.) |
| Step 10 | The PCX will furnish Headquarters Planning Community of Practice Leader the documentation of the review, model documentation, and a recommendation for or against certification/approval. CECW-P, in consultation with the Model Certification HQ Panel, will make the determination to certify/approve or not certify/approve the model. Upon certification/approval, CECW-P will issue a certification/approval memorandum and (for certified models) instruct the PCX to add the model to the National toolbox of certified models. |
| | |

Figure 1

Existing Models Certification

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-PMP
(study/Project)
-Research work
units (R&D)
-Strategic
assessment
        |
        v
ID Model ----> Certified? --Y--> Use Model
                  |
                  N
                  |
                  v
Proponent Model
submitted to PCX
        |
        v
Steps 1-4
PCX
Determine review
level, form review
team, select
review team
leader                    <---- Concurrent with
                                PMP development
                                (Days 1-30)
        |
        v
Step 5                    <---- Days
Develop                         30-40
Scope of
Work & get
approval for
certification
plan
        |
        v
Steps 6-8                 <---- Days
Review team                     40-100
conducts
review,
prepares
documentation
, provides
review to PCX
        |
        v
Step 9                    <---- Days
Proponent                       100-130
responds to
review,
provides
response to
PCX
        |
        v
Step 9                    <---- Days
Outstanding                     130-140
issues
resolved
        |
        v
Step 10                   <---- Days
Model                           140-150
certification
decision by
HQ Panel,
and PCX
adds to
toolbox
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9. <u>Development and Certification of New Models</u>. New models will continue to be required, particularly in business programs that lack corporate or commercial models. No new model development should commence without engaging the appropriate PCX. The process described in the following sub-paragraphs applies for new models developed for Corps use.

a. Upon recognition that a new model is needed to address an immediate or emerging Corps need, the proponent shall contact the appropriate PCX to initiate a peer support process for the modeling development effort, to be documented in a certification plan.

b. The PCX will provide peer support for new modeling efforts. The purpose of peer support is to provide proponents with early and ongoing advice, assistance, and review from experts during the development and initial application of models. Peer support could be provided from the PCXs, HQ, MSCs, districts, IWR, ERDC, and non-Corps entities. The process will emphasize model development and model review to ensure that upon completion of the model, the development and peer review process utilized will lead to product certification/approval. The PCX will provide or identify a source of experts to provide peer support to develop a new model or modify an existing model as required. The PCXs will identify and involve appropriate experts from academia, industry and other agencies as needed. Protocols and procedures for model development and review process will be specified in the PCX SOP (for the new model to be developed) and will reflect prevailing industry practices.

c. Models currently under development will be considered as new models under this EC. Proponents should immediately contact the PCXs to initiate the model certification/approval process in accordance with the procedures specified herein.

d. Proposed revisions of existing certified models will also follow the peer support process described herein.

10. <u>Roles of PCXs</u>. The PCXs are responsible for the implementation of the certification process as defined in this EC. Specifically, the PCXs are responsible for developing and maintaining a PMP, as defined in paragraph 14a of this Circular; for implementation and documentation of the certification process; for developing and maintaining an inventory of models to be considered for certification and identifying appropriate level of certification; for identifying models to be eliminated from use; for setting priorities for certification; for establishing and maintaining rosters of qualified individuals, both external and internal to the Corps, to serve as model reviewers; for developing the review charge and scope for each model; and, for developing a cost estimate for certification. The PCXs will incorporate certified models in the National toolbox. The PCXs will produce an annual audit of processes, activities and accomplishments of the model certification activities to be provided to CECW-P.

11. <u>Models associated with business programs for which there are no designated PCX</u>. For models associated with business programs for which there is no officially designed PCX, such as recreation, the proponents should contact CECW-CP for additional information on how to proceed for model certification.

12. PMIP Administration Toolbox. The PCXs in coordination with CECW-CP will be the lead organizations for creating and maintaining a corporate toolbox of certified planning models. CECW-CP and the PCXs will define the information required for the toolbox of certified models. The toolbox will be maintained at a site accessible to all Corps planners for ready reference. Single-use or study specific models will not be included in the toolbox. Models in the toolbox must be assessed periodically to assure that they are still current with respect to the state of the practice and agency policy. Models that are being revised or are approaching their expiration date must be recertified or approved, as described in paragraph 8.f. above.

13. Funding mechanisms. Funding for model certification will be secured from various sources depending on the model category. For corporate models with National applicability, Headquarters will finance the costs associated with certification. For models that have specific study/local applicability, the costs of certification will be covered by the specific study or studies. The cost of certification will be considered when developing the PMP for a particular study, if the use of a model that requires certification is planned. For models of regional application, the MSCs could consider sharing the costs of certification among the districts that would use the model. Financing required for the administration of the PMIP by each PCX, other than the costs associated with model certification, will be included in the annual budget request for each PCX.

14. Implementation:

    a. Project Management Plan (PMP). Each PCX will develop a PMP for implementation of the requirements of this EC in coordination with other PCXs.

    b. Training. PCXs will assure that training is provided on the use of certified models, either directly by the PCX or in association with the model developers such as ERDC, IWR or IWR-HEC.

    c. Communication. The PCXs will coordinate with the Planning Community of Practice to facilitate communication among model users, promote the toolbox, the training opportunities available, corporate models in development and future direction of the model development activities.

  d. The requirements stated in this Circular are effectively immediately for new models under development or ongoing revisions to existing models, proponents should contact the PCXs immediately to initiate the certification/approval process.

FOR THE COMMANDER:

Appendix A
Certification/Approval of
Planning Models

ALVIN B. LEE
Colonel, Corps of Engineers
Executive Director of Civil Works

DEPARTMENT OF THE ARMY   EC 1105-2-412
U.S. Army Corps of Engineers
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No. 1105-2-412   31 March 2011

Protocols for Certification/Approval
of Planning Models

TABLE OF CONTENTS

SUBJECT   PAGE

Tables

APPENDIX A

Protocols for Certification/Approval
of Planning Models

1. Introduction.

    a. Purpose. The purpose of this appendix is to provide information on the certification/approval process and on the criteria to be used to ensure high quality models for use by Corps planners. These protocols reflect consideration of similar standards and requirements in use in other agencies of the Federal Government, private industry, academia, and international organizations as well as consideration of the various practices and procedures already in place within Corps research labs and field offices.

    b. Organization of Document. The remainder of this document is organized as follows:

    (1) Section 2 addresses the issues of what constitutes a "model", what are the major stages in the development of a model, who are the principal developers of models used by the Corps, and what constitutes a planning model. The purpose of this section is to provide additional clarification of the definition of planning models that are subject to certification/approval.

    (2) Section 3 addresses the issue of the criteria to be considered and the procedure to be followed in determining whether a model warrants certification versus approval. The section also includes guidance on the level of effort in certifying/approving national-use and regional-use models, existing and new models, and in the type and level of documentation, user training and technical support required for each type of model. Models used by the Corps but developed by others (i.e., commercial off the shelf models, models developed by other Federal and non-Federal agencies) are also addressed. These models will not be "certified" by the Corps, but will instead be assessed on the same criteria to determine if they are "approved for use" in Corps Planning studies.

    (3) Section 4 summarizes the model certification/approval process.

    (4) Definitions of key words and/or activities used or referenced in this document are provided in Attachment 1.

2. Models.

    a. Definition. A definition of a model commonly used in industry and academia is "a representation of a system for a purpose"[1].

The definition can be further expanded as follows:

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[1] Dr. Sharon DeMonsabert, George Mason University

(1) A way to represent a system for the purposes of reproducing, simplifying, analyzing, or understanding it.

(2) A way to analyze the possible effects of changes in the underlying process based on changes in the model, i.e. evaluate alternatives.

This definition states that a model represents a system. This Circular expands this definition to include analytical tools, such as spreadsheets and others, used by planners in decision making (paragraph 5) that represent sub-components of a system or the system as a whole. All models that represent environmental or economic systems are subject to certification or approval. The vast majority of these models will be software tools. Generic software packages that contain multiple capabilities to enable a user to build a project specific application are considered models as defined in this Circular. A physical model when used for formulation and evaluation purposes would also fit the definition of a model under this Circular.

b. Planning Models. The main body of this Circular provides the following definition of a planning model:

"any models and analytical tools that planners use to define water resources management problems and opportunities, to formulate potential alternatives to address the problems and take advantage of the opportunities, to evaluate potential effects of alternatives and to support decision-making."

These include but are not limited to models used to define the future without project condition, models used for plan formulation, models used to compute economic benefits, models used to assess the environmental impacts of alternatives, conceptual models that represent relationships among natural forces and factors, and human activities (intended or not) that are believed to impact, influence, or lead to a target condition (mostly ecological models) and any other models essential to the planning process. Models used by planners in support of planning activities and decision making are clearly planning models. Models used by consultants performing tasks that would otherwise be done by planners are also planning models. Models used by non-planners in support of planning efforts will be categorized as planning or non-planning models on a case by case basis.

Models that represent engineering systems such as models used to perform hydrologic and hydraulic analyses are engineering models and not Planning Models for the purposes of this Circular. The Engineering and Construction Community of Practice (E&C CoP) is implementing the Science and Engineering Technology Program (SET) with similar objectives as the PMIP and is planning to develop and implement an appropriate process to document the quality of commonly used engineering software. In the meantime, it is the responsibility of the Engineering function to ensure that the application and proper use of the software is documented in the Technical Review process. More information on the SET interim guidance is found in Engineering and Construction Bulletin No. 2007-6 issued 10 April 2007.

c. Stages of Model Development. Model development is a multi-step and iterative process with the number of steps and iterations depending upon the complexity of the system being

modeled. However, at its most fundamental level, model development can be considered as a four-stage process. The first stage, the requirements stage, involves identifying a need for some type of analytical capability and addressing options for tools to meet the need. The second stage, the development stage, involves the development of software programming code or a spreadsheet and testing by the model developer. The third stage is testing of the model by selected users whose objective is to validate the model and to ensure that the model is usable in real world applications. The fourth stage, the implementation stage, involves the provision of training, user support, maintenance and continuous evaluation of the model. Each stage is discussed in greater detail below.

(1) Requirements Stage. The requirements stage, one of the most important stages in the process of model development, precedes actual model construction and is the time when the need for an analytical capability or tool is identified. The requirements stage includes a detailed identification of needs; consideration of proper applicable theory, policies and procedures; and an assessment of how the model will assist in the evaluation of Corps studies. The requirements stage will also include consideration of the availability of data needed for the model and an assessment of available options to meet the analytical needs. Options to consider are modifications of existing models, off the shelf models or development of a new model. Peer review is a particularly important part of the requirements stage of model development. The requirements for a new or upgraded model should be based on current and anticipated future field user needs as identified by field planners and other knowledgeable individuals both within and outside the Corps.

(2) Development Stage. The development stage consists of the construction and Alpha testing of the model, usually in the form of software code, as each routine and formula is added to the model. Model construction includes the examination of alternative solutions with the intent of selecting the optimum design based upon criteria established by the proponent and the user community. It generally involves the development of a design document which includes the proposed software architecture, theory, assumptions, usability, etc.

Alpha tests are performed by the model developer. Examples of Alpha tests usually performed during the construction of a model are:

(a) Component testing – test accuracy of individual formulas and subroutines.

(b) Coupled-component testing – test interactions between components to ensure interaction does not introduce distortions into the computational scheme.

(c) Formula Test – Each formula is tested separately.

(d) Regression Test – Ensure that no adverse changes are introduced to the application during maintenance changes, upgrades, or other modifications. Uses a suite of components that are rerun when any one-application component has been modified. Provides confidence that the system will function with newly implemented requirements. Typically an iterative process during a testing cycle. The test is accomplished by maintaining input test files and running the files through the original upgraded model with the upgrade feature switch turned off. The results

should match the outputs of the original model. The upgraded model is then run with the update feature switch turned on. Depending on the upgrade, internally computed values should either remain the same or change.

In addition to typical software tests to ensure software quality, model developers during this stage should ensure that the software meets the criteria for certification/approval in terms of technical quality and usability. The stage includes validation, which is the comparison of model outputs to known system characteristics to determine if the model output accurately represents the system. The stage should also include testing with irrational data to confirm how the model performs with erroneous data, and to identify means to minimize unintended results.

Modifications and upgrades of existing models should also include Alpha testing. At this stage, the testing is intended to address accuracy of the model, as previously stated for new models, and to ensure that the modification/upgrade does not cause unforeseen errors in the original model.

   (3) External (Beta) Testing Stage. The external (Beta) testing stage consists of field testing of the model following its construction but prior to its public release. User application (Beta) tests are also performed during this stage to identify problems in inputting, running, or interpreting the output of the model; determining if outputs are correct and meet the identified needs; ease of use; and any possible theoretical, policy or computational problems that did not surface during Alpha testing. External testing is typically performed by experienced analysts with backgrounds in using earlier versions of the model or in using models similar to the one being tested.

   (4) Implementation Stage. The objective of this stage is to distribute and encourage the use of the technology Corps-wide and to provide follow-up support to users. Implementation planning activities include promotion, packaging, development of an installation package and distribution, training, user support, and securing funding for these activities. Responsibilities for carrying out the various implementation activities will be assigned to implementing organizations (typically a Planning Center of Expertise, IWR or ERDC) with appropriate funding and organizational support. Evaluations of the technology and the various elements of the technology transfer plan should be conducted periodically. Implementation planning is necessary for all Corporate and Regional models that have multiple users.

   d. Categorization of Models. This Circular lists four categories of models classified by developing entity which may require different treatment or levels of review by the certification/approval team. The categories of models are: 1) corporate models developed by the Corps; 2) regional/local models developed by or for Corps field offices; 3) commercial off-the-shelf (COTS) models; and 4) models developed by other Federal agencies or other entities. Each of these in defined in greater detail below.

(1) Corporate Models. Corporate models are models developed by Corps laboratories and field operating activities (FOAs) that have nationwide applicability (i.e., HEC-FDA, IWR-PLANNING SUITE, BEACH-FX, etc.) Most of these models are developed under the Corps research program and, in general, they are developed according to prescribed standards, are thoroughly tested and validated, and have user manuals. Training and technical support are generally available.

(2) Regional/Local Models. Regional/Local models are typically developed by field offices of the Corps for specific applications that cannot be adequately addressed using available corporate models. These models are typically conceived to address unique regional/local situations for major studies where accuracy in depicting the specific characteristics of the study area is critical to the outcomes of the model and when it is more effective to develop a regional/local model than to develop or modify a National model. Other regional/local models are conceived based on alternative views of the workings of the marketplace (economics) or environment than those considered in National models.

(3) Commercial Off-the-Shelf Models (COTS). Commercial off-the-shelf (COTS) and proprietary models are developed by private corporations and marketed to a wide range of private and government users. The Planning Centers of Expertise (PCX) will consider these models for approval for use (rather than certification) based on an assessment of the documentation provided by the proponents that demonstrates the model satisfies the certification criteria.

(4) Models Developed by Others.

(a) Other Federal Agencies. Models developed by other Federal Agencies are subject to the requirements stated in the Data Quality Act and OMB Final Information Quality Bulletin for Peer Review. These models are subject to approval for use (rather than certification) based on an assessment of the model's compliance with the requirements and criteria for certification of Corporate or Regional models. Documentation for these models should be available as part of the respective agency's compliance with the Data Quality Act and provided by the proponent when requesting approval for use. As with COTS, the PCX will implement the process to approve the use of these models based on an assessment of the documentation provided by the proponents that demonstrates the model satisfies the certification criteria.

(b) Other Entities. This category includes models developed by non-Federal government entities (states, counties, etc.), NGOs or academic institutions which are proposed for use as part of a Corps planning study. The PCX will implement the process to approve the use of these models based on an assessment of the documentation provided by the proponents that demonstrates the model satisfies the certification criteria.

(c) Models subject to Corps Certification and/or Approval. Models developed by or for the Corps (categories 1 and 2) are the only models subject to certification by the Corps. The Corps will not certify commercial-off-the-shelf models, models developed by other Federal agencies, models developed by non-Federal government entities, academic institutions and other entities (categories 3 and 4). The Corps will, however, approve or disapprove these non-Corps models for general use in Corps planning studies. Once approved, these models will be added to the

roster of certified/approved for use models. Table 1 lists the four categories of models and whether they require certification or approval.

The proponents requesting approval to use a non-Corps model must provide to the PCX the documentation stated in Table 2, information on use of the model in other studies and an assessment of the performance and testing of the model.

Table 1: Certification or Approval by Model Type		
Category of Model	Certification	Approval
Corps Corporate	X	
Corps Regional/Local	X	X
COTS		X
Other non-Corps		X
Single-use		X

3. <u>Model Certification/Approval</u>. The criteria for certification or approval of models for use in Corps planning efforts are discussed in the following paragraphs. The criteria will also be the basis of documentation to be submitted to the PCX by the proponent of the model when requesting certification or approval for use.

   a. Certification Criteria. The certification criteria are categorized in terms of: 1) technical quality, 2) system quality, and 3) usability. These criteria are further defined below.

   (1) Technical Quality. A model that meets this criterion is one that is based on good science and/or theory and that depicts the system being modeled in computer code with a high degree of accuracy and precision. To ensure technical quality, it is important to verify that the correct formulas and relationships are used and that the calculations are done correctly; that the outputs are correct; that the logic of the model makes sense, and that the assumptions, data requirements and outputs are fully documented. Specifically, the documentation should demonstrate the following:

   (a) Model is based on well-established contemporary theory – All models must fully satisfy this criterion. Well-established contemporary theory should be defined by the certification team on the basis of professional judgment, literature reviews, professional publications, etc.

   (b) Model is a realistic representation of the actual system – The description of the system and its components must be reviewed and its accuracy and completeness must be assessed. For the model to be certified, all critical components of the system which significantly impact the analysis and the outputs of the model must be adequately represented in the model.

   (c) Model clearly addresses identified analytical requirements – Two factors to consider for certification under this criterion are: 1) the analytical requirements were properly identified; and 2) the model actually addresses and properly incorporates the analytical requirements. These two factors must be fully satisfied for certification.

(d) Assumptions used in creating the model are valid and support the analytical requirements – A list of key assumptions and the basis for them must be provided to the certification review team. The team will identify the critical assumptions and assess their validity and adequacy of support provided. For model certification, all critical assumptions must be validated and acceptable.

(e) Model and documentation identify relationships to relevant Corps policies and accepted procedures – Criterion must be fully satisfied for certification. The certification review team will assess how analytical requirements and assumptions incorporated in the model relate to Corps policies and accepted procedures.

(f) Formulas used in the model are correct and model computations are appropriate and done correctly – Satisfaction of this criterion requires an assessment by the certification review team based on evidence provided by the proponent of testing conducted and/or actual results from the model. The formulas and computations must also reflect the relationships specified among the components of the system as defined in the system description. In the case of spreadsheet models, cell references imbedded in the formulas must be reviewed for accuracy.

(2) System Quality. System quality refers to the quality of the entire system related to the development, use, and support of the model. The system includes the software used to develop the model and the hardware platform upon which the software is based. The quality of the system is ensured by system level functional testing of hardware and software system components, design verification planning for customer acceptance, third party interoperability, compatibility with various hardware and operating systems such as USB and Windows, and the development of problem tracking database. For purposes of Corps certification, the following criteria for system quality will be considered:

(a)   The supporting software tool/programming language is appropriate for the model.

(b) The programming was done correctly - no evidence of consequential source code errors as a result of tests conducted.

(c) The supporting hardware and software is available to users or can be readily provided.

Model has been tested and validated – Evidence of tests conducted and results will be provided for evaluation by the certification team. The team could conduct additional tests or request that additional tests be conducted by the proponent. All critical errors must have been corrected for the model to be certified.

The data can be readily imported into other software analysis tools, if applicable (interoperability issue)

Review to determine system quality could be performed by running the models using test datasets where the results are known and comparing the results. The reviewers could also review the results of beta tests conducted by the model developers. If the reviewers have questions

about results or model performance and they suspect the problem could be in the source code, they should coordinate with the model developer to identify the potential problems in the source code and resolve the issue. The source code of Corporate models will normally not be provided to external reviewers for certification review.

(3) Usability. Usability refers to the ability to access the model, receive training to run the model, secure input data required for the model, run the model, obtain outputs from the model as well as receive documentation to guide the process and technical support if problems occur. The following criteria will be considered in terms of usability:

(a) Availability of data – This criterion will assess the data required by the model and the potential sources. The certification team will not certify the quality of the data which should be done as part of the technical review process. However, model certification will require an examination of the data required by the model and the availability of the data. Proponents for data driven models must provide evidence that the data will be available and accessible to model users.

(b) Results are presented in a format that is clearly understandable.

(c) Results provide useful information to the user to support project analysis.

(d) Ability to export results into project reports.

(e) Training is readily available.

(f) Users documentation is available, user friendly and complete.

(g) Adequate technical support is available for the model.

(h) The software/hardware platform used is available to all or most users.

(i) Ease of accessibility of the model.

(j) Model is transparent, allows for easy verification of calculations and outputs.

b. Certification Process. The certification process begins with the identification of the models (existing or new) to be used in the study and ends when the model is certified. For existing models, the proponent (the individual or entity requesting certification) will provide to the PCX documentation to address the items outlined in Table 2. To the extent possible, the documentation will be developed in close coordination with the model developers. For new models, the proponent (which in this case could also be the model developer) will include the PCX in each of the stages of model development and document each stage as the stage is completed. Once the model is completed, if the PCX has been actively engaged during the process and all the certification criteria have been met, the model should be ready for certification with minimal review.

A summary listing of the general criteria to be considered in the certification/approval process is provided in Table 2 and described in paragraph 3a of this document. All models must meet all of the technical quality (TQ) requirements and all of the System Quality (SQ) requirements except for interoperability which might not be needed for all models. Usability criteria are required for certification of Corporate models. In the case of Regional/local models, compliance with usability criteria is recommended but not required. However, all models shall meet the usability criteria related to availability of input data and the usefulness of the results to the planning and decision making efforts.

Table 2: Outline for Model Documentation			
Cover Sheet			
	a.	Model Name	
	b.	Functional Area	
	c.	Model Proponent	
	d.	Model Developer	
1. Background			
	a.	Purpose of Model	
	b.	Model Description and Depiction	
	c.	Contribution to Planning Effort	
	d.	Description of Input Data	
	e.	Description of Output Data	
	f.	Statement on the capabilities and limitations of the model	
	g.	Description of model development process including documentation on testing conducted (Alpha and Beta tests)	
2. Technical Quality			
	a.	Theory	
	b.	Description of system being represented by the model	
	c.	Analytical requirements	
	d.	Assumptions	
	e.	Conformance with Corps policies and procedures	
	f.	Identification of formulas used in the model and proof that the computations are appropriate and done correctly	
3. System Quality			
	a.	Description and rationale for selection of supporting software tool/programming language and hardware platform	
	b.	Proof that the programming was done correctly	

Table 2: Outline for Model Documentation			
	c.	Availability of software and hardware required by model	
	d.	Description of process used to test and validate model	
	e.	Discussion of the ability to import data into other software analysis tools (interoperability issue)	
4. Usability			
	a.	Availability of input data necessary to support the model	
	b.	Formatting of output in an understandable manner	
	c.	Usefulness of results to support project analysis	
	d.	Ability to export results into project reports	
	e.	Training availability	
	f.	Users documentation availability and whether it is user friendly and complete	
	g.	Technical support availability	
	h.	Software/hardware platform availability to all or most users	
	i.	Accessibility of the model	
	j.	Transparency of model and how it allows for easy verification of calculations and outputs	

    c. Roles and Responsibilities. Three parties are intricately involved in the implementation of the process for certification of Corps planning models: the proponent of the model, the developer of the model (to the extent available) and the PCX responsible for implementing the certification process. In the case of new corporate models, the model developer could also be the proponent for certification. The same three parties are generally involved in the implementation process for approval to use non-Corps models. The roles and responsibilities of each party in the certification/approval process are shown in tabular form in Table 3. The criteria listed under each stage of review are in the general order that the information, testing, and support activities are performed. Each certification action will require a customized certification plan akin to a PMP. A suggested outline for the certification review plan is provided in Attachment 2.

Table 3: Summary of Roles and Steps in Certification/Approval Process		
Step	Proponent/Model developer	PCX
1	Notify PCX of need for model certification	
2	Document plan to develop new model or document existing model (see Table 2)	
3	Send plan for model development or	

Step	Proponent/Model developer	PCX
	Table 3: Summary of Roles and Steps in Certification/Approval Process	
	documentation of existing model to PCX for review	
4		For new models, initial review of model concept and plan for development
5		Determine review level in coordination with Proponent and CECW-P
6	Negotiate a schedule and cost for performing the certification review	Develop certification review plan including the schedule and cost of certification review, in coordination with Proponent and approved by CECW-P
7		Assemble a certification review team in coordination with the Proponent
8		Review model concept and plan for development or existing model in terms of compliance with certification criteria and accepted model development process
9		Provide proponent with comments on plan for development of new model or existing model
10	Resolve issues regarding conceptual plan or existing model	Resolve issues regarding conceptual plan or existing model
11	Develop new model or revise existing model (if warranted)	Provide guidance if a member of the peer review team raises a policy issue
12	For new model, assemble team for Beta testing of new model	For new model, be a member of the Beta testing team
13	Conduct and document Beta tests	Participate in Beta tests or review Beta testing documentation in terms of:
		a. Beta tests that were performed
		b. Validation efforts
		c. Meaningfulness of output tables
		d. Usefulness of output tables and graphs
14		Assess and recommend additional Beta tests, if required
15	Conduct additional Beta tests, if required, until critical issues are resolved	
16		Document the certification/approval review process and make final recommendation on certification to Headquarters (CECW-P) for certification decision

Table 3: Summary of Roles and Steps in Certification/Approval Process		
Step	Proponent/Model developer	PCX

17		Transmit the following to the Toolbox Manager:
		    a. Certification/approval review documentation (including initial documentation of the model provided by the proponent)
		    b. Certification/approval sheet or declaration of non-certification/non-approval signed by Headquarters (CECW-P)

    d. Levels of Review. The level of review refers to the effort required by the certification team to ensure the model is a high quality model. To some extent the effort will vary depending upon the complexity of the model, the risk associated with making decisions based on the output of the model, and the developmental status of the model. The levels of review and a brief description of the scope are shown in Table 4.

Table 4: Levels of Review	
Review Level	Description
Extensive	Applicable to highly complex models used in decision-making where there could be a high risk of making an incorrect investment decision (e.g. not justified, not optimal, etc.) that could result in major negative impacts. Models shall comply with all certification criteria. Comprehensive model testing must be conducted. The certification team should include external reviewers. T he process will require extensive coordination between the proponent/developer, the certification team and the PCX.
Intermediate	Applicable to models of lesser complexity than category 1 models with lower risks of making an incorrect investment decision that could result in minimum impacts. Models shall comply with all certification criteria. The certification team may include a mix of internal and external reviewers. Some model testing may be required.
Limited	Applicable to routine and non-complex models that have a minor impact on project decision-making. Certification review should concentrate on compliance with technical quality criteria. Certification team could be limited to internal reviewers. Limited testing may be required.
General	Applicable to frequently used models that have withstood historical informal reviews, have been developed according to prescribed standards, and have been thoroughly tested and validated. Certification review would entail a review of model documentation to verify compliance with certification criteria and requirements. Depending on the category of the model and the previous extent of documented independent external

	participation, the PCX would determine the need for internal or external reviewers. It is recommended to use external reviewers on all new Corporate models under development. The PCX should consider using external reviewers for certification of legacy models on a case-by-case basis.

The approach and scope of model review will vary depending on the category of the model and the level of review. It is expected that the categorization of the model and the required level of review will be determined jointly by the PCX, the proponent of the model, Headquarters (CECW-P), and perhaps other interested parties. In addition to the complexity and risk factors, it is also expected that the categorization of a model and the required level of review will take into account whether it is an existing and widely used model, an existing model with limited use and limited testing, an existing model with limited use and extensive testing, or a new model.

Corps legacy models, normally developed by Corps laboratories, with a long history of use and good documentation are expected to require a General level of review while new models that are complex with high risks would require an Extensive level of review. Corporate models developed by Corps laboratories normally undergo a constant process of development and improvements. New versions of existing certified models should be submitted to the PCXs with documentation of all changes made to the model. The PCXs will determine if the modifications are significant enough to warrant re-certifying the model. For non-Corps models, the review level would normally range from Intermediate to General. Models in the toolbox that must be recertified or approved due to approaching expiration are expected to require a General level of review to assure that each model is still current with respect to the state of the practice and agency policy.

In cases where the proponent requests the certification of a model that uses input developed by other models, the PCX will make a determination whether the associated models need to be concurrently certified or approved.

    e. Certification Review Team. The PCX will assemble a certification review team based on expertise, experience, and skills from multiple disciplines as necessary to ensure a level of review commensurate with the complexity and categorization of the model (see Table 5). The PCX will coordinate and involve experts from IWR, HEC, ERDC and other Corps field experts as appropriate. The team may also involve members from other PCXs if the model generates data that is input to the analysis of these other functional areas. For General reviews the team shall consist of individuals with experience and knowledge in the certification process and in the functional field, i.e. economics, ecosystems, transportation, etc. For Extensive reviews, the team will include at least one non-Corps expert in the functional field being represented by the model. It is expected that other team members would, at a minimum, include Corps employees with expertise in the functional field, a planner familiar with all aspects and requirements of planning studies, and a software programmer or an expert familiar with the software tool used in the model. The certification team will implement and document the model review process, prepare a draft certification review report and make a recommendation on certification/approval. Once the initial review is completed, the certification review team will meet with the PCX, the proponent, the model developer and Headquarters (CECW-P) to discuss the findings and issues to be

resolved. During this meeting, the proponent/model developer will have an opportunity to clarify the issues, resolve some of them before the final report is developed, and discuss potential resolution of remaining issues. The PCX will maintain the documentation for future reference.

Table 5: Composition of Certification Team				
	Level of Review			
	Extensive	Intermediate	Limited	General
Functional Field Expert(s)	X	X	X	X
External Functional Field Expert(s)	X	X		
Planners/Formulators	X	X	X	X
Software programmer(s) or expert(s) familiar with software tool	X	X		X
Functional experts would include but are not limited to economists, environmental scientist, transportation specialist, etc.				

    f. Certification/Approval Review Report. The certification/approval review report prepared by the certification review team will document the review process and findings. It will include a copy of the documentation submitted by the proponent for review. It will include the results of the assessment of the model compliance with each certification criteria, all issues identified in terms of the criteria and the recommended approach to resolve those issues. Issues will be classified in two categories: 1) Significant issues impacting certification decision (concerns with validity of results and/or policy compliance; 2) Issues not impacting certification but recommended to be addressed on future revisions of the model. A recommendation to certify/approve (or not) the model will be included in the report.

g. Certification/Approval Decision. Headquarters (CECW-P) is responsible for the final decision regarding certification/approval of the model. The decision will be made considering the recommendations of the certification review team and the PCX. It is the responsibility of the PCX to work with the proponent/model developer to resolve all significant issues that impact the certification decision identified in the certification/approval review report. Coordination with the review team could be required to resolve the issues. Final decisions on the resolution of policy issues will be made by the PCX in coordination with Headquarters and documented in certification/approval review report.   Headquarters (CECW-P) will provide a Certification/Approval sheet (see example below) to the proponent once the process is completed and in cases where appropriate the model will be added to the toolbox. Certification/approval status of models must be assessed periodically to assure that all models are still current with respect to the state of the practice and agency policy. All certification/approval decisions will be in effect for a period not to exceed seven years.

Sample Certification/Approval Sheet

The (name of model and version number, if applicable) developed for use in (business line, discipline or study) is certified (or approved) as a (category of model). This certification is based on the decision of the Model Certification Headquarters Panel which considered recommendations of the certification review team and the PCX assessment of the review. There are no unresolved issues at this time.

Special Considerations (if any)

EXPIRES: (date)

_(signature and date)__
Chief, Planning Community of Practice

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4. Certified/Approved Models Toolbox. The Planning Community of Practice in coordination with the PCXs will provide a web-based listing of all models and tools that have been certified or approved for use. Models or tools listed in the toolbox will contain information on the conditions or purpose under which they may be used in support of planning studies and documentation on the certification review process. Corps planners should refer to this toolbox when the need arises for the use of a model or tool in support of a planning study. Users are strongly encouraged to use an existing model or tool from the toolbox whenever it meets the need of the project requirements. Using pre-approved or certified products from the toolbox will facilitate project execution and the technical review process. Any new models or modifications to existing algorithms and formulas within the existing models or tools listed in the toolbox will need to be certified/approved through the PCX. A nonstandard use of an existing model or tool from the toolbox will be subject to approval by the study's vertical team with input from the PCX. Models approved for single-use will not be included in the toolbox. Models in the toolbox that are approaching their expiration date will need to be recertified/approved through the PCX.

5. <u>Summary</u>. The purpose of the certification/approval process is to ensure the use of high quality models by Corps planners that are technically sound, that represent the system being modeled, and that have been corporately reviewed for theoretical soundness and compliance with Corps planning procedures. The overall goal of the program is to ensure the availability and use of thoroughly tested, verified, validated and documented models.

Certification applies to Corps planning models and analytical tools that planners use to define water resources management problems and opportunities, to formulate potential alternatives to address the problems and take advantage of the opportunities, to evaluate potential effects of alternatives and to support decision-making. Approval applies to non-Corps models used for the same purposes, and models that may be limited to a single application.

For all new planning models the certification team should be involved in the requirements and external testing stages. The level of involvement will depend on the complexity of the model and the risk associated with making decisions based partially on the output of the model. The certification team should also be involved in Beta testing and validating highly complex new models.

For existing models, the proponents or model developer will have to document the requirements, development, external testing, and implementation stages and forward the documentation to the certification team for review and comment. Upon resolution of all issues, the PCX will recommend to Headquarters to certify the model.

Suggested Outline Certification Review Plan

1. Purpose

2. References and Guidance

3. Background – brief model description and other pertinent information on model development, use, etc.

4. Documentation to be Provided by Proponent

5. Type/Scope of Review

6. Description of tasks

7. Certification Review Team Composition

8. Schedule of Deliverables

9. Cost Estimate

References:

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