Protocols for Certification of Planning Models

Planning Models Improvement Program

Prepared by:
Lillian Almodovar, CEIWR
Darrel Nolton, CEIWR
Bruce Carlson, CECW-P
Jeff Walaszek, ERDC
Bill Frechione, CELRP

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Protocols for Certification of Planning Models

1. Introduction

a. Purpose

The purpose of this paper is to provide information on the certification process and on the criteria to be used to ensure high quality models for use by Corps planners. The information was developed to provide additional details on the certification process, which is a new requirement for the Corps as stated in EC 1105-2-407, "Planning Models Improvement Program: Model Certification". Henceforth the Planning Models Improvement Program will be referred to as PMIP. 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 USACE 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 clarify and expand the definition of planning models that are subject to certification.

(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. The section also includes guidance on the level of effort in certifying 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 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:

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. EC 1105-2-407 (EC 407) 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 EC 407. A physical model when used for formulation and evaluation purposes would also fit the definition of a model under EC 407.

b. Planning Models

EC 1105-2-407 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.

[1] Dr. Sharon DeMonsabert, George Mason University

Models that represent engineering systems such as models used to perform hydrologic and hydraulic analyses are engineering models and not Planning Models. 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 Independent 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

users 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:

1) component testing – test accuracy of individual formulas and subroutines.

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

3) Formula Test **–** Each formula is tested separately.

4) 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 in terms of technical quality and usability. The stage also includes validation, which is the comparison of model outputs to known system characteristics to determine if the model output accurately represents the system.

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 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

EC 1105-2-407 lists four categories of models by developing entity that may require different treatment or levels of review by the certification 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. 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-PLAN, 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 approve the use of these models (rather than certify) based on an assessment of the documentation provided by the proponents that demonstrates the model satisfies the certification criteria.

4) Models developed by Others

i) 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) by the PCX 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 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.

ii) 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 Corps planning study. The PCX will 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.

e. 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 or specifically the PCX, however, will 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 of the model.

Table 1: Certification or Approval by Model Type

Category of Model	**Certification**	**Approval**
USACE Corporate	X	
USACE Regional/Local	X	
COTS		X
Other non-Corps		X

3. Model Certification

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:

- 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.

- 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.

- 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.

- 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.

- Model properly incorporates 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.

- 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:

- The supporting software tool/programming language is appropriate for the model.

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

- 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 by 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:

- 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 ITR 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.
- Results are presented in a format that is clearly understandable
- Results provide useful information to the user to support project analysis.
- Ability to export results into project reports
- Training is readily available
- Users documentation is available, user friendly and complete
- Adequate technical support is available for the model
- The software/hardware platform used is available to all or most users
- Ease of accessibility of the model
- 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.

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	

Table 2: Outline for Model Documentation			
	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	
	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	

Table 2: Outline for Model Documentation			
	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	

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.

c. Roles and Responsibilities

Three parties are intricately involved in the certification of Corps planning models: the proponent of the model, the developer of the model (to the extent available) and the PCX responsible for determining certification. 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 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 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
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

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

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. The 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.

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, and perhaps other interested parties with the PCX having final decision making authority. 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. Attachment 3 uses the Habitat Evaluation Procedure (HEP) to provide examples of what types of modifications to an existing tool would need to be certified or approved.

For non-Corps models, the review level would normally range from Intermediate to General.

The approach and scope of model review will vary depending on the category of the model and the level of review. A summary of the approach used for the certification review of Beach-fx, a Category 1 model with Extensive review, is provided in Attachment 4. This approach is provided as a guide to help the PCXs and the certification teams define the approach and scope of review required for a given model.

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 and the model developer 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

The PCX, in coordination with Headquarters, 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. 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 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 a report prepared by the PCX. The PCX will provide a Certification/Approval sheet (see example below) to the proponent once the process is completed and the model will be added to the toolbox.

Sample Certification/Approval Sheet

The (name of model) developed for use in (business line, discipline or study) is certified (or approved) as a (category of model). This certification is based on the recommendations of the certification review team and the PCX assessment of the review. There are no unresolved issues at this time.

_____

Director, (name of PCX)

4. Certified/Approved Models Toolbox

The Planning Community of Practice with input from 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. USACE 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 ITR 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 by the PCX. A nonstandard use of an existing model or tool from the toolbox will be subject to approval by the PCX.

5. Summary

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, and validated 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.

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 certify the model.

References:

a. EC 1105-2-407, Planning Models Improvement Program: Model Certification, 31 May 2005
b. Capability Maturity Model Integration (CMMI), Carnegie Mellon Software Engineering Institute. http://www.sci.cum.edu/cmmi/general/general.html
c. Report of the Planning Models Improvement Task Force, Final Report, September 2003. U.S. Army Corps of Engineers, Institute for Water Resources. http://www.iwr.usace.army.mil/iwr/planning/pmip.htm
d. OMB Peer Review. http://www.whitehouse.gov/omb/memoranda/fy2005/m05.html
e. Sponsoring Organization Model for Information Technology Certification Systems, USGS. http://www.stsc.hill.af.mil/crosstalk/1998/06/certification.asp
f. Numerical Models Meeting the Minimum Requirements of the National Flood Insurance Program. FEMA. http://www.fema.gov/fhm/en_modl.shtm
g. Certification Report: Monte Carlo Simulation Model for the Engineering and Economic Analysis of Coastal Protection Projects: Beach-fx; The Louis Berger Group and URS Corporation for IWR, June 2007
h. Assessment Report, Certification of Planning Models Under the Planning Models Improvement Program (PMIP); The Louis Berger Group and URS Corporation for IWR, June 2007

Attachment 1: Definitions

Alpha Tests: Tests performed to ensure computational accuracy by the model developer while the model is being developed.

Beta Test: A beta test is the second series of tests of a software in the user environment. The purpose of the test is to identify software bugs and other problems users may experience while using the software. Beta tests are usually conducted prior to formal release of the software.

Certification – Confirm that a model is an appropriate tool for Corps planners and that the computations are performed accurately.

Component Test – A form of Alpha test. Test each component (routine) separately.

Coupled-component Test – A form of Alpha test. Test a specific component together with other newly developed components. Tests the interface of two components and explores how the components interact with each other. Inspects the variables passed not only between two components, but also the global variables. Exposes problems that arise from the combination of components. Assumes that all components have passed their individual component test.

Hardware Platform – Hardware configuration on which a tool is most efficiently used. This includes the common desktop computer, the mainframe (e.g. Unix Workstation) and super computer (e.g. multiple processors) where parallelized code is most efficient.

Model: **"**a representation of a system for a purpose**".**

The definition was further expanded as follows:

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

2) A system that describes or predicts an associated process based on the definition of variables, rules and equations. A properly-defined model enables analyzing the possible effects of changes in the underlying process based on changes in the model.

Protocols – procedures to be followed in the certification process.

Science and Engineering Technology (SET) – SET is an initiative to improve use of computer-based technologies (e.g., software, guidance, databases, etc.) that support Science and Engineering (S&E) applications within USACE mission areas. Implementing the SET initiative will enable USACE S&E Communities of Practice to

standardize on common software, engineering models, etc. SET provides a corporate approach to the use of technology to support the regional execution of S&E missions.

Validation – the use of an independent data set (independent of those data used to calibrate the model) to check out the model calibration. The data used are independent field measurements of the same type as the data output from the model. This process determines the degree to which a model and its associated data are an accurate representation of the real world from the perspective of the intended uses of the model. An appropriately validated model has known levels of accuracy and precision. Sensitivity analysis is typically performed in both the calibration and validation steps and provides information on which parameters have the greatest effect on output.

Verification – the examination of the numerical technique or algorithms and computer code to determine that they truly and accurately represent the concept of how the system works and that there are no inherent problems with obtaining a solution.

Attachment 2. 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

Attachment 3: How the Certification Process Applies to a Sample Ecological Model

Because of the large number and variety of tools used in planning, three illustrations of the intent of coverage in the certification process are provided below.

The Datanet (Martin 2005) provides access to established datasets from sources such as other Federal agencies. Those datasets are maintained and updated by the owner agency and the Corps has permission to download and use those datasets. If a model uses those datasets directly, the datasets would not be subject to the certification process. If a model downloads those datasets and combines them into a new application, e.g., combining minimum hydrologic flow and land use / land cover into a screening tool, that tool would be subject to the certification process. The reason would be the possible entry point of errors in writing and programming software.

The Habitat Evaluation Procedures (HEP) is an established approach to assessment of natural resources, developed by the US Fish and Wildlife Service in conjunction with other agencies. The HEP approach has been well documented and is approved for use in Corps projects as an assessment framework that combines resource quality and quantity over time, and is appropriate throughout the United States. The Habitat Suitability Index (HSI) models are the format for quantity determinations that are applied within the HEP framework. The following guidelines are provided to help determine the need for certification. ITR of input data is required in all instances.

- New HSI models developed by the Corps are subject to certification.
- Published HSI models, while peer-reviewed and possibly tested by the developers, are subject to review and approval by the PCX.
- Modifications to published HSI models, where relationships or formulas are changed, are subject to certification.

Function Capacity Index (FCI) models, developed for specific resource assessments, will also require certification. For watershed assessments, new models may be developed that combine individual indices. The new models would be subject to the certification process.

A**ttachment 4: Example Scope of Certification Review: Beach-fx**

Technical Quality Assessment:

"While the technical quality assessment proceeded principally according to a series of specific tests concentrating on distinct inputs, functions or calculations, the assessment of usability and to a large extent that of system quality have been based on observations drawn from the general use and operation of the model. Throughout the review and testing process a dialogue was maintained between the review team and the development team, such that the review team gained valuable insights into the workings of the model, and so that the development team could be appraised of any issues and concerns arising from the review that could potentially affect certification.

The testing approach used in the technical review of Beach-fx was not intended to be absolutely comprehensive. Due to the complexity of the model not every constituent function, application or calculation could be fully explored within the constraints of time and budget. The model and supporting documentation were reviewed and examined and selected elements were identified for systematic testing. As the review and testing process evolved, further issues and areas for closer review were identified and examined in more detail.

In general, the method used to test for technical quality was to configure the model so as to isolate individual variables, applications or processes identified for assessment…A number of issues were identified following examination of outputs…In some cases, manual calculations were performed to confirm the processes involved and their accuracy of application. Where possible, individual model outputs were compared with output from external independently validated software. Some tests involved the input of irrational or erroneous data, in order to test the ability of the model to recognize input which may be the result of user error or faults in externally sourced data, and the ability of the model to prompt the user to revise it, as appropriate. The overall technical quality assessment also included considerations of the extent, clarity and quality of data outputs."

System Quality Assessment:

"The system quality of Beach-fx has been generally assessed via the routine installation and operation of the model, rather than according to a set of discrete tests or component assessments identified in advance, although some exercises were specifically undertaken to investigate certain aspects of the model associated with system quality."

Usability Assessment:

"The overall assessment of model usability has been formulated through a comprehensive review of the supporting documentation and through the general use and operation of the model. The review team generally divided observations and concerns regarding the usability of the model into two subject areas: supporting documentation and user interfaces."