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Hydrologic Engineering Center

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# Hydrologic Modeling System HEC-HMS

## *Release Notes*

Version 3.2  
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## Hydrologic Modeling System HEC-HMS, Release Notes

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## Introduction

Version 3.1.0 of the Hydrologic Modeling System (HEC-HMS) was completed in December 2006 and released for general use shortly thereafter. Several new simulation features have been added to the program since that time. These include a new reservoir spillway method, reservoir dam seepage, an optional time-series of controlled releases, and an optional auxiliary reservoir discharge location. The number of results accessible from the basin map was increased and graph properties may now be customized. Other minor enhancements were also added. The development team has also continued careful and systematic testing of the program since the last release. The results of that testing in combination with reports from users has allowed the identification and repair of various problems. Some of these affected simulation results and are described in detail later in this document. Some problems that did not affect results but caused problems in the program interface have been repaired without being specifically documented. The result is this Version 3.2 release. It is currently available for the Microsoft Windows® operating system and also is available for the Sun Microsystems Solaris™ operating system.

The program has been designed to be easy to use. However, an understanding of how the program works is critical to producing accurate results. It is suggested that a new user read the *Quick Start Guide* (Version 3.2 March 2008). The guide briefly describes the basic features of the program in enough detail to begin using it. The guide also includes a step-by-step tutorial.

## Installation

The installation program and all documentation are available on the HEC website at <http://www.hec.usace.army.mil/>. This new release is installed independently of any previous versions of the program so you will need to remove Version 3.1.0 if you do not want to use it anymore. However, you may keep different versions of the program installed for parallel use or testing if you choose to do so. This new version will automatically open projects developed with any previous version of the program. However, once a project has been opened in Version 3.2, it may not be possible to open it with older versions of the program.

The new installation package is designed to be easy to use. It will take you through the steps of selecting a directory for the program files and making other settings. Use the following steps to install the program on the Microsoft Windows® operating system:

1. Download the installation package from the HEC website to a temporary folder on the computer. If the software was provided to you on a CD-ROM or other media, insert it in the appropriate drive.
2. Run the installation program. In Windows Explorer, double-click the icon for the installation program. You must have administrator privileges to run the installer.
3. Follow the on-screen prompts to install the program.

Instructions for installing the program on the Sun Microsystems Solaris™ operating system can be found in Chapter 2 of the User's Manual.

## New Capabilities

Previous versions of the program included two methods for calculating spillway flow at a reservoir: broad-crested or ogee. Spillways can only be specified as part of reservoir elements configured to use the "outflow structures" method with a storage curve given in combination with the physical description of outlet structures. A third method has been added for a custom spillway. The user may select an elevation-discharge curve that specifies the spillway flow as a function of reservoir pool elevation. Currently there is no consideration of tailwater so this option should only be used for spillways that cannot experience tailwater submergence.

A dam seepage option has been added to the reservoir element. The new option can only be used with reservoir elements configured to use the "outflow structures" method. The option can be used to model seepage from the tailwater into the pool as often happens with interior ponds. The option can also be used to model seepage from the pool through the dam face. The head differential between the tailwater and the pool is used to determine the direction of flow and the driving force for seepage. An elevation-discharge curve can be specified separately for seepage into or out of the reservoir pool.

Situations can arise with the reservoir using the "outflow structures" routing method when a specified release is needed in addition to uncontrolled releases. The uncontrolled releases may be modeled effectively using spillways, outlets, and possibly other structures. It is now possible to include an additional release beyond the releases through structures. The specified release is given in a time-series and may represent, for example, discharge through a gated spillway making scheduled releases.

Previous versions of the program discharge all reservoir releases through the tailwater and downstream to the next element. It is now possible to add an auxiliary discharge location when using the "outflow structures" reservoir routing method. By default all of the structures specified in the reservoir will discharge through the main tailwater. However, for each structure you now have the option of discharging it through the auxiliary discharge. The auxiliary discharge has a separate tailwater condition and can be connected back into the element network at any location that is computationally downstream from the reservoir.

A new objective function option has been added to optimization trials. The new function computes the mean-square error after taking the logarithm of all flows. The logarithmic transformation has the effect of reducing the significance of high flows. Therefore, this new function can be a good choice when emphasis is needed on low flows between storm events.

Previous versions of the program only provided access to results for optimization trials and depth-area analyses on the "Results" tab of the *Watershed Explorer*. It is now possible to view these same results directly from the basin map. The **Results** menu will automatically update when a simulation run, optimization trial, or depth-area analysis is selected to show the results that are available. Graphs, summary tables, and time-series tables can be accessed for each element through the **Results** menu, toolbar buttons, or the right-mouse menu directly in the basin map.

Additional time-series results have been added for subbasin elements. Previous versions of the program computed precipitation, excess precipitation, and loss as incremental. That is, the amount for each time interval is shown in a time-series.

The same results are also shown now in cumulative form. Both results are available on the "Results" tab of the *Watershed Explorer*.

New observed results have been added. It is now possible to specify observed snow water equivalent at subbasin elements and observed pool elevation for reservoirs. When specified, the observed results are automatically plotted with the computed results in graphs. The results are also available on the "Results" tab of the *Watershed Explorer*.

It is now possible to control the properties of time-series graphs. Previous versions of the program automatically determined line properties and other characteristics of the graph. These defaults are still used when the graph first opens. However, the user now has the option of editing the properties to control the characteristics of lines, axis, title, legend, etc.

A variety of formats are supported for background maps in the basin model. One format commonly used is the Shapefile. Drawing for Shapefiles is now significantly enhanced. Previous versions of the program automatically drew the Shapefile maps with arbitrary coloring. The coloring and other properties can now be controlled by the user. For example, the line style, weight, color, and fill properties can be controlled for a polygon Shapefile. The selections by the user are stored in a special configuration file in the same directory as the Shapefile, with the same file name, but with a special file extension.

Support has been added for MrSid images in the basin map background. The MrSid files can be added and managed similar to the other supported formats.

New tools have been added to improve management of the elements in the basin map. It is not uncommon to begin development of a basin model with no background maps. Later when a background map is added, it can be difficult to get the existing elements to be placed correctly on top of the map. The elements can be dragged as a group to be on top of the map. However, it is likely that the elements will be at a different scale than the map. A new command has been added to the **View** menu. With it a group of elements selected in the basin map can be scaled up or down until they match the scale of the new background map. It can also be easy to accidentally move the element locations with the mouse. There is now an option on the **View** menu to lock the locations of the elements so they cannot be moved.

## Changes in Operation

The program continuously tracks changes to the project components along with the date each simulation was last computed. This information is used to determine if results need to be computed before graphs, summary tables, and time-series tables can be viewed. The last version of the program attempted to improve the efficiency of computing results by only computing those components which had changed since the last compute. All components would be computed regardless of status if the *control* key were held down while starting a compute. The mechanism did significantly improve the efficiency of simulations in large models with many components. However, in some cases, a change in component data was not successfully detected and results were not correctly updated. The use of the efficiency mechanism is now optional. A program setting determines if efficiency will be used during a compute. The default behavior is that all components will be recomputed regardless of whether their status has changed since the last compute. By using the optional setting, only

components that have changed will be recomputed. The control key can still be used to force all components to compute if the efficiency program setting is used.

Some simulations require large amounts of computer memory. For example, a basin model with 25 subbasins using continuous simulation for a multi-decade time window could require more than 1 GB of memory to complete successfully. A new memory management option was added to the last version of the program that required a change to be made in the program settings. While use of the setting allowed large models to compute in a small memory footprint, it had the side effect of increasing compute time by an order of magnitude. The setting has been removed and replaced by a new automatic memory management feature. Large models can still be computed in a small memory footprint, but it happens automatically and without the side effects of increased compute time.

Basin models and meteorologic models can be imported into a project. In previous versions only the actual element data was imported. In this version the data is checked before it is imported to determine if time-series data, paired data, or gridded data is used in the model. If the model is found to require any of these types of data, the user is given the option of importing the necessary data at the same time as the basin model or meteorologic model. The program then automatically imports the requested data and adds it to the project.

The program continuously monitors the computed simulation results and any data used to produce those results. In previous versions, any visualization results (graphs, summary tables, time-series tables) were automatically closed when the data used to produce them changed. Results now remain open when the data changes but are flagged as being "expired." When the simulation is recomputed the results are automatically updated with the revised results. It continues to be the case that results cannot be opened if the results are expired. Nevertheless, once the results are open, they will be updated whenever necessary.

There are required conventions for all of the time-series data, paired data, and gridded data stored in external HEC-DSS files. The conventions cover data type, units, and pathname C-part. Some of these conventions have changed for solar radiation. The User's Manual includes detailed information in Chapter 5.

## **Problems Repaired**

The development team continues to test the software even after a new release is made. The last version released was no exception. The team found and repaired a number of problems. Problems were also repaired after they were reported by users. The issues ranged from relatively minor cosmetic problems in the interface to computation errors. The following descriptions focus on the major issues that affect accuracy of results or other significant issues.

Changes to the missing flow setting in the basin model are now saved correctly. The changes were only recognized as long as the basin model remained active in computer memory. Changes are now persistent between user sessions with the program.

Unit hydrograph paired data now updates correctly when the time interval is changed. Specified values in annual pattern paired data are now copied when a pattern is copied. Gage graphs now update immediately after data changes are saved. In short, the component editors for paired data and time-series no longer

have problems with changing units or time intervals. Data issues are now cleared up.

A number of error messages were added to the reservoir to facilitate diagnosis of problems when a compute fails. Areas improved include: pool elevation above maximum or below minimum storage specified, outlet sufficient submergence, non-level dam top cross section. A number of problems were also solved where a component editor for the reservoir did not correctly update if a paired data function or time-series gage were added to or removed from the project. The editors now update correctly whenever data changes occur.

The Smith Parlange loss rate method did not correctly use temperature data. Even if a temperature gage was specified, the temperature was assumed to be 25C during the simulation. The time-series of temperature data is now used correctly.

The processing of observed flow and observed stage data was upgraded. This solved some problems where in rare cases the observed data was not shown correctly. Also, inconsistencies in the observed data after a failed compute were solved so that displayed results are always correct.

A rarely encountered problem with the Snyder unit hydrograph transform was fixed. The problem only occurred for some rare combinations of  $T_p$  and  $C_p$ , when  $T_p$  is small. The transform now works correctly even for these combinations that lead to very quick rise times.

Several problems were repaired with the saved states. The linear reservoir baseflow method only started from a saved state correctly if one groundwater layer was used. Temperature index snowmelt did not correctly store state information and consequently could not accurately start from a saved state. The soil moisture accounting method also did not save all necessary data. Loss rate calculations regardless of loss method were incorrect when states were saved part way through a simulation. All components are now correctly storing state data and starting from a saved state successfully.

The initial abstraction for SCS curve number loss rate method is automatically computed as  $0.2S$  if no value is entered by the user. The abstraction was not computed correctly during optimization if the basin model used System International units. The abstraction is now computed correctly in all contexts including optimization.

Several problems with soil moisture accounting have been fixed. Evapo-transpiration was not occurring from the soil if the surface layer was set to zero storage. The program would "crash" when switching to the soil moisture accounting loss rate method immediately after switching to the ModClark transform method. Lateral outflow from groundwater layers was shifted one time interval. The percolation and saturation fraction time-series were not computed if temperature index snowmelt was used. Loss calculations were incorrect after switching from soil moisture accounting to any other method, until after restarting the program. All of these issues with soil moisture accounting have been repaired.

Several problems with temperature index snowmelt were identified and repaired. The time-series of loss data was not correct. The average liquid water available at the soil surface was not computed correctly if multiple elevation bands were used. Both of these issues are fixed.

## Future Plans

Land surface erosion and channel sediment transport is under development. Initially two simple methods will be provided for simulating land surface erosion as part of subbasin calculations. Eventually more complex methods will be added to the subbasin. A simplified channel transport capability will be added to reach elements. It will handle erosion and deposition within the channel in addition to transport down the channel, all in a simplified approach appropriate for hydrologic simulation. It is not anticipated to include a movable bed. Additional components will also be provided at source, diversion, and reservoir elements to include the movement of sediment throughout the element network.

Several features will be added to the reservoir element. Methods for simulating evaporation from the pool and direct precipitation are being considered, along with percolation. Capability will be developed to specify a new type of spillway gate using a family of elevation-discharge curves. Plans are also underway to provide additional options for controlling the opening and closing of spillway gates. Finally, we are investigating ways to simulate the infiltration-runoff response of exposed ground when the pool is drawn down.

Significant upgrades to the basin map are also in the planning stage. An option is being developed to represent subbasins and reservoirs with polygons instead of a simple icon. Similarly, the reach would be represented with a line that follows the actual stream location. This will increase the spatial context of the basin model and create opportunities for visualizing parameter data or simulation results directly in the map through color-coded animations of the polygons.

## Documentation

The *Hydrologic Modeling System HEC-HMS: Quick Start Guide* (Version 3.2 March 2008) provides a brief description of the program for new users. It describes the different parts of the interface and the basic steps necessary to obtain simulation results. A tutorial takes the user through the creation of a new project and shows how to obtain results. The guide has been updated to reflect changes in the interface.

The *Hydrologic Modeling System HEC-HMS: User's Manual* (Version 3.2 March 2008) contains extensive information on installing and using the program. Details on the use of each of the features and capabilities in the program are included. The manual has been updated with information describing new features added to the program for this Version 3.2 release. Most of the updates are confined to Chapter 6 on basin models, Chapter 9 on optimization trials, and Chapter 10 on depth-area analyses.

The *Hydrologic Modeling System HEC-HMS: Technical Reference Manual* (March 2000) continues to accurately describe the mathematical models included in the program. New simulation capabilities have been added to the program and are not included in the manual. The manual is currently undergoing a major revision to expand documentation of existing mathematical models and fully describe the newly added models.

The *Hydrologic Modeling System HEC-HMS: Applications Guide* (March 2008) also continues to accurately describe how to apply the program to various engineering problems. However, the guide is undergoing revision to add guidance on how to use new features of the program to more efficiently solve problems.



## Support Policy

Technical support for program users within the Corps of Engineers is provided through an annual subscription service. Subscribing offices can expect full support from HEC staff in the routine application of the program. Users are strongly urged to consult with HEC staff on the technical feasibility of using the program before beginning a project with unique requirements such as grid cell hydrology, snow melt, or continuous simulation. Extended support for large or complex projects can be arranged under a separate reimbursable project agreement.

Support can not be provided to users outside the Corps of Engineers. Domestic and foreign vendors are available that provide fee-for-service support similar to the support provided to subscribing Corps offices. Such service agreements are between the user and the vendor and do not include HEC staff. Vendors do contact HEC on behalf of their users when unusual problems or errors are encountered. A list of vendors can be found at <http://www.hec.usace.army.mil/>.

Reporting of suspected program errors is unrestricted and we will reply to all correspondence concerning such errors. We are continuously working to improve the program and possible bugs should always be reported. Reports should include a written description of the steps that lead to the problem and the effects that result from it. If we cannot reproduce the reported problem, we may ask you to send a copy of your project.

Request support or report program errors through the following channels:

- Call 530.756.1104, 7:30 am to 4:30 pm PT Monday through Friday.
- Fax 530.756.8250 any time.
- Write to U.S. Army Corps of Engineers, Institute for Water Resources, Hydrologic Engineering Center, 609 Second Street, Davis, CA 95616 USA.
- Send email to [hec.hms@usace.army.mil](mailto:hec.hms@usace.army.mil) on the internet.
- Visit our web site at <http://www.hec.usace.army.mil>.