

## HY-8 Quick Start Guide

This Quick Start guide is intended to provide essential information for installing and running the updated version 7.1 of the HY-8 culvert hydraulic analysis and design program (HY-8 7.1).

HY-8 is a computerized implementation of FHWA culvert hydraulic approaches and protocols. The HY-8 program is available at no charge to the hydraulic and transportation communities.

The FHWA has been producing computerized culvert hydraulic software since the early 1960's (with the HY-1 program). The FHWA released the initial version of the HY-8 program in the early 1980's and released a Windows version (7.0) in March 2007. The HY-8 program has successfully operated on all current "flavors" of the Windows operating system.

HY-8 7.1 represents the second phase of the FHWA's multi-phase culvert hydraulic software upgrade plan. The plan calls for incremental upgrades and additions of features, based on available time, budget, and adoption of new hydraulic practices and techniques.

## What's in this Quick Start Document

This document includes information about:

- Technical Methods
- Downloading Software
- Installing the program
- What's New
- Means to report bugs or other problems.

## Technical Methods

The technical methods applied in the updated HY-8 program are based on the FHWA publications:

- "Hydraulic Design Series 5: Hydraulic Design of Highway Culverts" (HDS-5) [publication FHWA-NHI-01-020, May 2005 revision]
- "Hydraulic Engineering Circular 14: Hydraulic Design of Energy Dissipaters for Culverts and Channels" (HEC-14) [publication FHWA-NHI-06-086, Third Edition, July 2006]

These documents should be considered the primary technical reference for the software.

FHWA certifies that this version of HY-8 7.1 continues to represent reviewed, tested, and accepted software for the purposes of performing FHWA culvert analyses regulated under 23 CFR 650 Subpart A and meeting 44 CFR 65.6(a)(6) in the FEMA NFIP regulations.

NOTE: To save download time, the HY-8 installation file DOES NOT include the HDS-5 and HEC-14 documents as a portable document format (PDF) file.

However, both documents can be downloaded from the FHWA website and placed onto the HY8 folder. Once there they are accessible from the HY-8 program Help menu. Hard copies of HDS-5 and HEC-14 can be created by printing the PDF files.

## Downloading

The installation package zip file (“HY8\_7\_1\_0.zip”) can be obtained by downloading from the FHWA Hydraulic website at: <http://www.fhwa.dot.gov/engineering/hydraulics/software/hy8>.

As stated in the FHWA Hydraulics website, by downloading the software, the user is agreeing that they accept responsibility for understanding the following conditions and limitations, and agrees to them:

- FHWA does not provide user assistance or support for this software.
- The application of this software is the responsibility of the user. It is imperative that the responsible engineer understands the potential accuracy limitations of the program results, independently cross checks those results with other methods, and examines the reasonableness of the results with engineering knowledge and experience.
- There are no expressed or implied warranties.
- The download file is relatively large – 36 megabytes (MB). This is a result of adopting a different installation program, and more significantly, including Microsoft’s .NET 2.0 redistributable package (.NET) as a part of the installation. The .NET file is a 22 MB download. HY-8 depends on having this package installed for some of the features such as the virtual earth map locator tool. The installation program checks whether .NET is installed on the computer, and if not, it is automatically installed.
- The installation package can be downloaded to any location (for example, folder “C:\Temp”) on the user’s computer.

### ***Prior to Installation***

The development team modified this release so that older versions of HY-8 can remain on the user’s system. In doing so, the user may end up with multiple versions (DOS, version 7.0, etc) on their computer.

If a user wishes to remove the older Windows versions, they can go to the Windows Control Panel and use the Add/Remove programs command. When doing so, project files you have created will not be deleted, but will remain in the program folder.

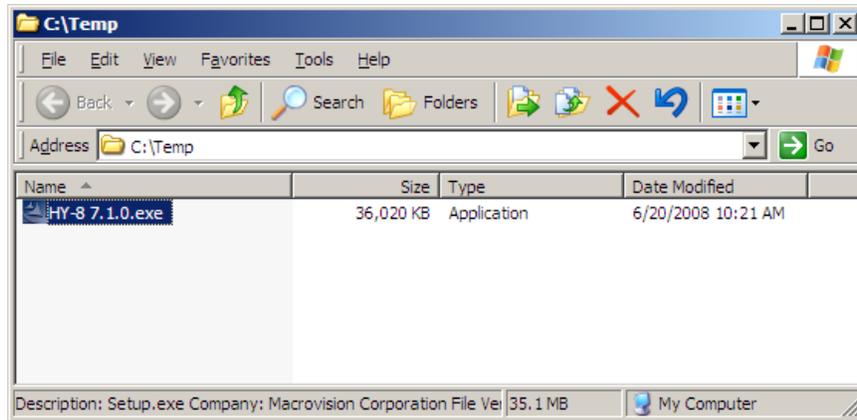
## Installation<sup>1</sup>

Once downloading “HY-8\_7.1.0.zip” to your computer, extract the installation package setup file “HY-8 7.1.0.exe” to the desired location (i.e., “C:\Temp”).

Begin the installation by going to the folder where the installation package setup file is located and double-clicking (opening) the file “HY-8 7.1.0.exe”.

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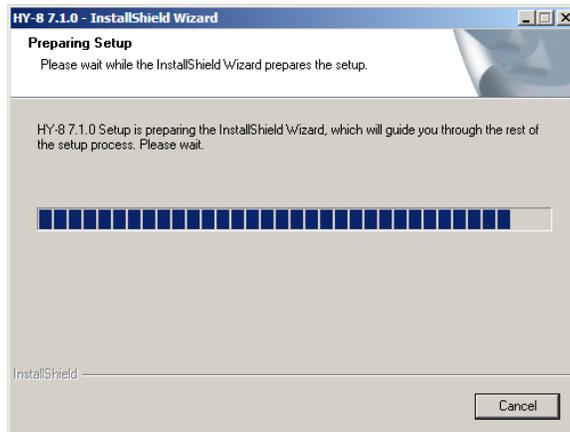
<sup>1</sup> Depending on the operating system, HY8 installation may require access to Administrator rights. Should this be the case, contact your system or network administrator for assistance.



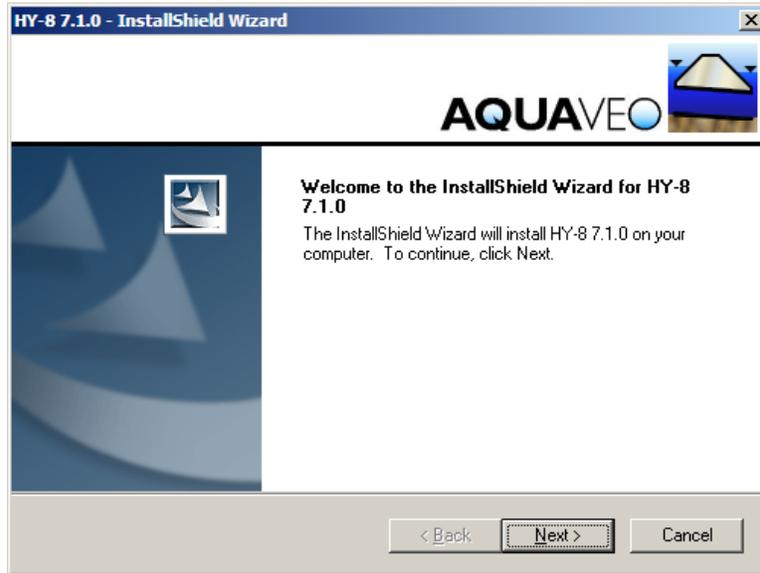
Once double-clicking (opening), you may get a screen such as:



FHWA is the Publisher of HY-8. Click “Run” to continue installation. You will see the InstallShield program preparing the setup (below)



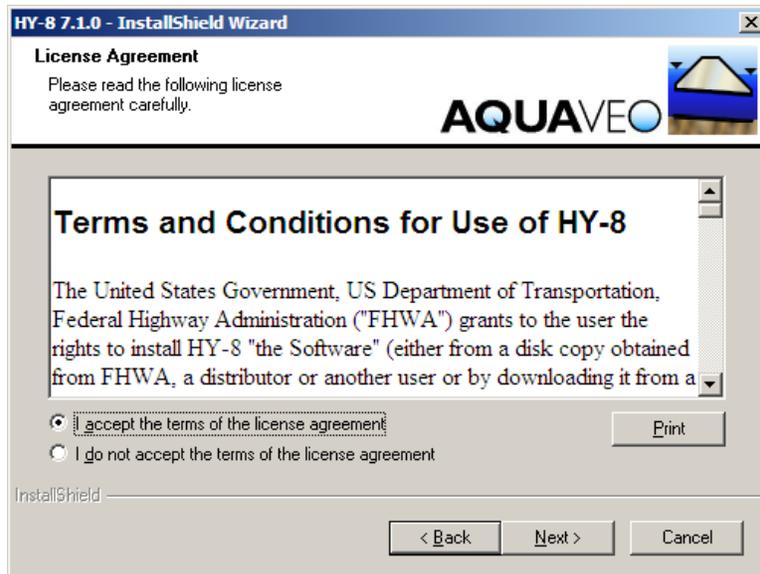
Then the first InstallShield Wizard setup screen will appear (AquaVeo is part of the HY-8 development team). Clicking “Next >” continues to the next screen.



### ***Accepting Terms and Conditions***

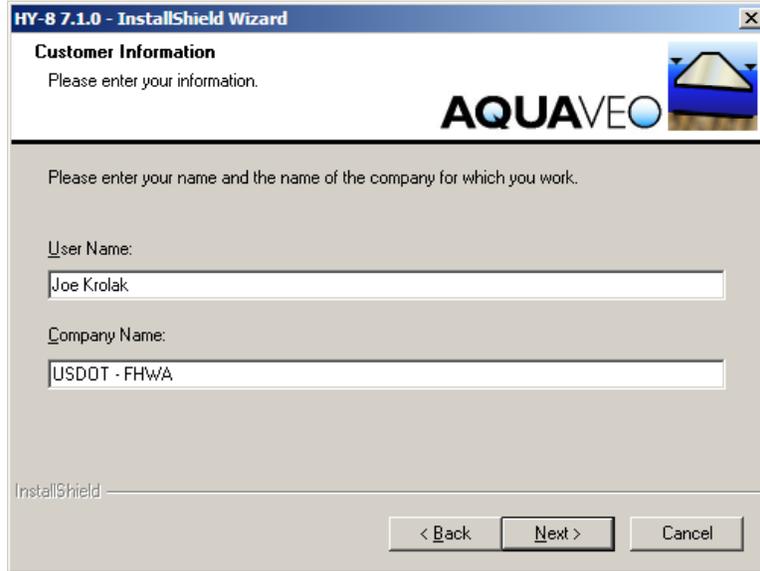
During the installation, the user is once again asked to review and accept the Terms and Conditions for using the HY-8 software.

Please read these carefully! Failure to accept these terms will result in non-installation of the program. The “Next >” option only becomes active when accepting the agreement.



### Customer Information

The user will be prompted for their name and organization for which they work. The default information is taken from the user’s computer. Information needs to be placed in BOTH fields (the information is not yet used by the program, but may be used later for user support purposes).



### Type of Installation

The setup program will next prompt whether the user wishes to have “Complete” or “Custom” installation.



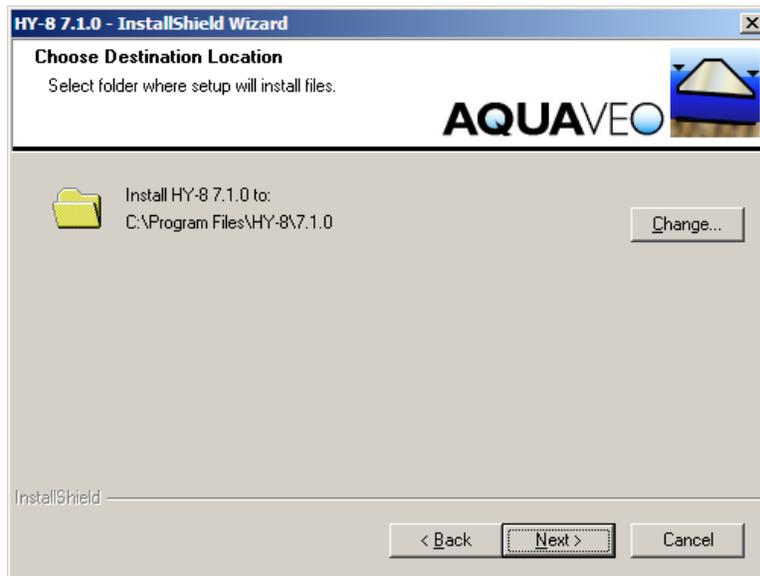
## Complete Installation

Selecting “Complete” and clicking on “Next >” installs the program in the default location for program installation folder: “C:\Program Files\HY-8\7.1.0\”. This scheme allows the user to keep version 7.1.0 and older versions on their system.

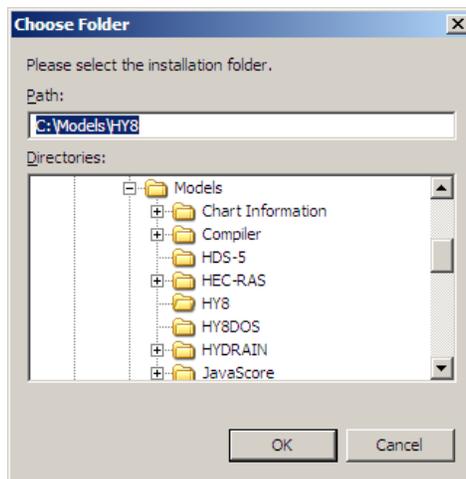
As well as installing Program Files, the setup program also adds a tutorial (“QuickTutorial.dpf”) and sample input files to the system. Altogether, these Program, Tutorial, and Sample files require about 45 MB of free storage space.

## Custom Installation

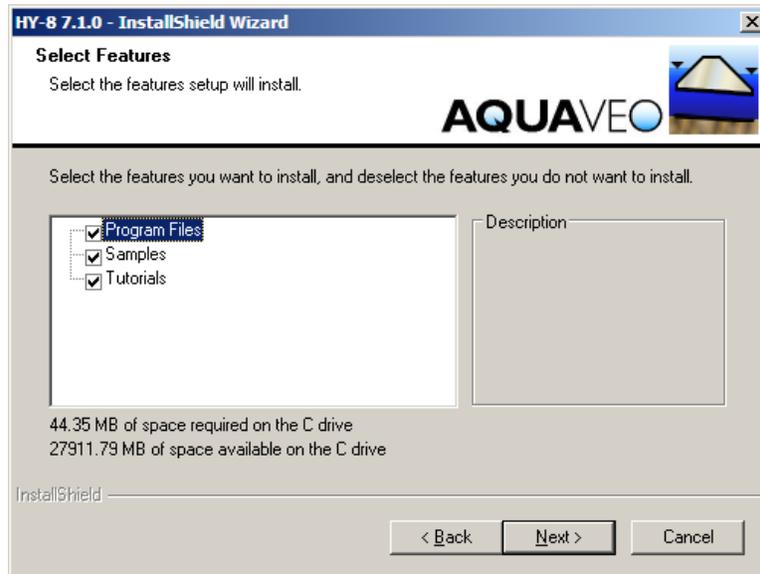
Selecting “Custom” allows a user to change the location to any directory without affecting the performance of the program.



Use the “Change” option to select an alternative (or new) folder. (As depicted in the example below, the user decided to install HY-8 7.1.0 into a folder “C:\Models\HY8” ...)



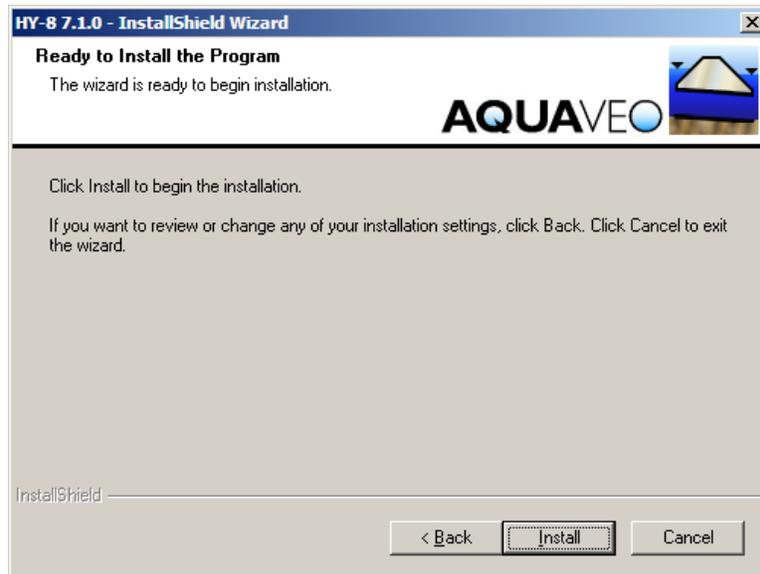
Once clicking on “OK”, the “Custom” installation option allows the user to specify which features they wish to install. (Note: the Program Files MUST be installed for HY-8 to work. The Samples and Tutorial files only consist of approximately 1 to 2 MB of space).



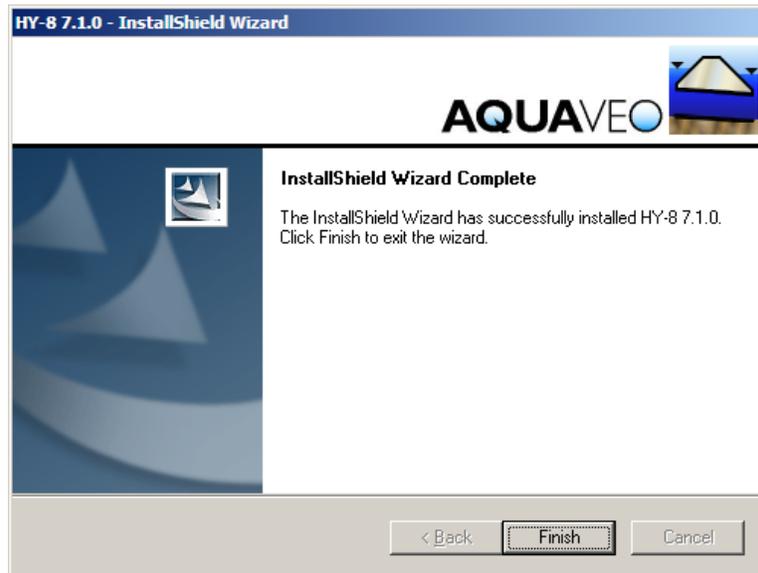
Clicking “Next >” leads the user to the Installation screen.

### ***Installation Screen***

Whether selecting the “Complete” or “Custom” installation type, the next screen prompts the user to install the program. Clicking on “Install” begins actual installation ...

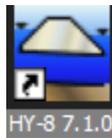


After installing all required files, the final screen in the setup Wizard will prompt the user to “Finish”. Clicking “Finish” returns the user to their desktop.



### ***Accessing the HY-8 program file***

The installation program will place a shortcut to the HY-8 program on the desktop.



The Setup program will also automatically add a link to the HY-8 program that can be accessed by clicking on *Start*, selecting *Programs*, and looking under the *HY-8* folder until encountering the *HY8* program icon.

Users with some experience with Windows may create additional shortcuts from here or by selecting the HY8.exe file found within the (default) C:\Program Files\HY-8\7.1.0\ folder.

After Installation, a user is ready to run the HY-8 program (there should be no need to Restart the computer).

## **Windows & DOS Versions: Changes and Additions**

An important objective of the conversion of the HY-8 program to a Windows platform was maintaining the basic philosophy and simplicity of model input and operation. Additionally, a project development goal was to provide some backward compatibility in reading the existing input files (.INP).

While FHWA and the development team feels these goals and objectives have been largely achieved, there were obviously some things that FHWA wanted to change and add in order to take advantage of the more modern Windows operating system. This section outlines these

changes and new features and will serve as a road map to users who have long used the DOS version of HY-8.

### ***The Project File Approach***

The new version of HY-8 differs from earlier DOS based version in adopting a *Project File* approach. These project files are implemented into the *Project Explorer* – allowing quick selection and application of a specific culvert system<sup>2</sup>. As described below, the addition of this approach adds utility in (1) organizing and applying culvert systems within multiple drainage crossings and (2) during analyses of different design configurations and materials.

### **Multiple Drainage Crossings**

The DOS version of HY-8 only allowed analysis or design of a single drainage crossing. While the user could define multiple culverts and barrels (systems) at this crossing, if an overall roadway project included many such crossing sites, each would need to be separated into a different input file.

This led to the proliferation of many separate culvert input files associated with a single roadway project. Some practitioners described their confusion in distinguishing which culvert file was associated with which drainage crossing within a project.

In the new version of HY-8, any number of crossings can be defined within the *project file*. Users now have the option of performing an analysis on several crossings and grouping them together. A new mapping feature (described below) helps the user to create a map identifying each crossing that can be included in their report.

Of course, the Windows version retains the older version's ability to consider only a single drainage crossing. This single crossing can also still consist of multiple culvert systems (e.g., three circular barrels at one invert [system 1] and a box culvert at another invert [system 2] at the same roadway crossing).

### **Design Alternatives**

The new version of HY-8 also provides an improved means to consider separate design alternatives of the same crossing within the same project file. In the DOS version of HY-8, a user would either have to load them as separate files, or make the incremental changes and reevaluate a single file.

The new version of HY-8 provides the user the option of “copying” a culvert and associated crossing information. With this “duplicate crossing” the user can make any change(s) they wish to evaluate. The project explorer then makes it easy to toggle back and forth between the alternative crossing designs.

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<sup>2</sup> As in prior versions of HY-8, a *culvert system* is considered as a collection of culverts, having the same type, material, inlet, dimension, and layout (invert elevations, length) characteristics. So a single barrel corrugated metal pipe or a box culvert with cell barrels (cells) would be considered a system, whereas, if a crossing had both a circular HDPE AND a pipe arch, these would be considered two systems. A potential reason for multiple culvert systems at a crossing would be to allow “critter crossings” in one system and normal discharge through the other system.

## File Conventions

The Windows version of HY-8 saves these Project Files using a “.HY8” extension. Unlike the DOS version of HY-8, the new version allows any file name format and length allowed by Windows. While HY-8 can read in older version .INP files, to protect this new utility and format, files can only be saved using this new format (and using the new “.HY8” files extension).

## Order of Input

The DOS version of HY-8 presented the input as a series of linear, sequential input screens. The order always began with the discharge, followed by the culvert information, followed by the tailwater data, and ended with the roadway information.

In the Windows version of HY-8, a single input screen presents all of the input necessary to analyze a single crossing.

However, there are some important subtleties - the grouping of the information has been organized into “crossing” information and the “culvert” information. The discharge, tailwater, and roadway data are unique to the crossing while the culvert shape, inlet conditions, and site data define a culvert within the crossing.

This grouping, and therefore subsequent tabbing through the main input screen, does not follow the same linear progression of input as the DOS versions of HY-8.

## What's New in 7.1.0?

Notable new features completed during this phase includes:

- Incorporates energy dissipator module
- Performs analyses of partially embedded (buried) culverts
- Allows use of modified outlet loss coefficients
- Incorporates dynamic culvert shape database with new materials
- Implements various improvements, technical updates, and bug corrections

Additionally, during this phase the development team conducted research focused on incorporating hydraulic jumps, adverse slopes, and broken back culverts into the software. This research raised some technical issues that need FHWA resolution before incorporating into the HY-8 program. For this and other reasons, the FHWA decided to release this phase (HY-8 7.1) without these capabilities. The FHWA fully intends to add the results of this research into future phases of the HY-8 update effort.

## Energy Dissipation

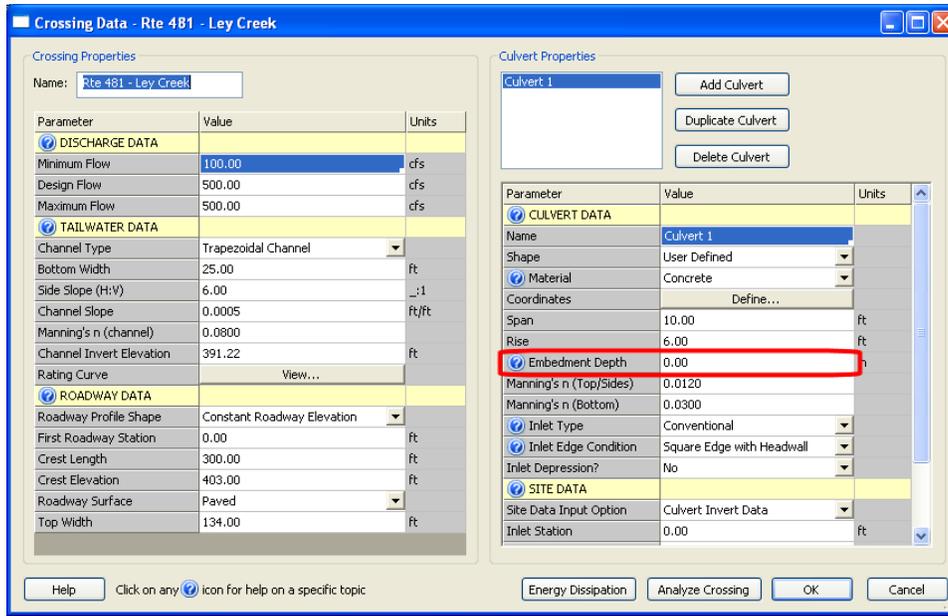
The 2006 update of HEC-14 added four additional energy dissipators not available in the DOS version of HY-8. Additionally, earlier programs (and documentation) had technical and implementation issues (e.g., inconsistencies in the rip rap basin design results; inconsistent nomenclature between documentation and program; etc).

This phase developed simulation algorithms for the new options and carefully checked the implementation of existing options. The energy dissipator user entry, option selection, and result screens were integrated into a culvert crossing within the project file concept.

Parameter	Value	Units
<b>Select Culvert and Flow</b>		
Crossing	Rte 481 - Ley Creek	
Culvert	Culvert 1	
Flow	500.00	cfs
<b>Culvert Data</b>		
Culvert Width	10.0	ft
Culvert Height	6.0	ft
Outlet Depth	6.00	ft
Outlet Velocity	8.33	ft/s
Froude Number	0.60	
Tailwater Depth	6.93	ft
Tailwater Velocity	1.08	ft/s
Tailwater Slope (50)	0.0005	
<b>External Dissipator Data</b>		
External Dissipator Category	Streambed Level Structures	
External Dissipator Type	Riprap Basin	
<b>Restrictions</b>		
Froude Number	<3	
<b>Input Data</b>		
Condition to be used to Compute Basin ...	Best Fit Curve	
<b>D50 of the Riprap Mixture</b>		
Note: Minimum HS/D50 = 2 is Obtained if D50 ...		
D50 of the Riprap Mixture	0.231	ft
DMax of the Riprap Mixture	0.500	ft
<b>Results</b>		
Brink Depth	6.000	ft

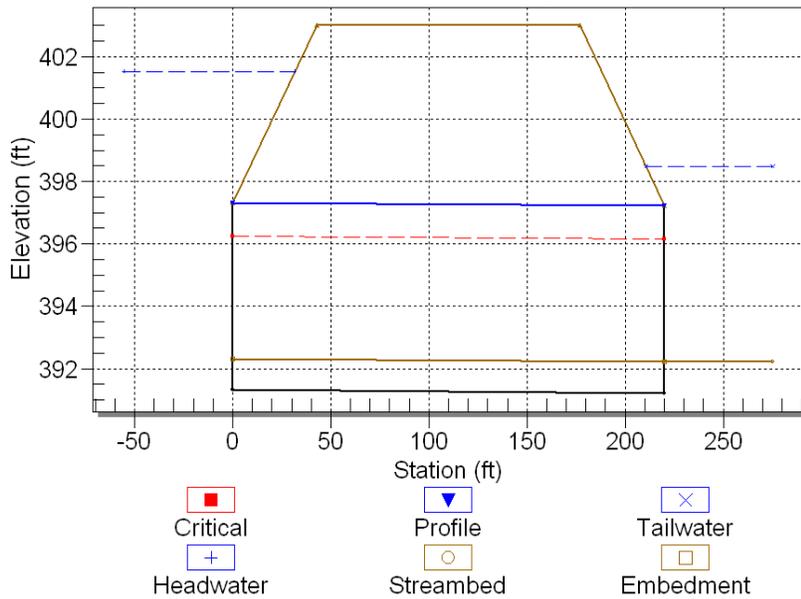
## Embedded Culverts

Utah State University, as part of a NCHRP effort, defined inlet loss coefficients (outlet control), headwater/depth relationships (inlet control) and Manning's n values for partially buried culverts. This newest phase of HY-8 formulated these results into the appropriate culvert materials and shapes to allow designers to account for this increasingly popular practice in culvert design.



Help describing this parameter has been added to the HY-8 help file and the computations have been added to the HY-8 analysis code. If a culvert is embedded, display options have been added to show the embedment depth and the culvert's downstream tailwater elevation, as shown in the following image.

Crossing - Rte 481 - Ley Creek, Design Discharge - 400.0 cfs  
 Culvert - Culvert 1, Culvert Discharge - 400.0 cfs



## Modified Outlet Loss Coefficients

Traditionally, the state-of-practice assumed that the outlet loss coefficient was equal to 1.0 (“Standard Method”). Utah State University has completed NCHRP research for modifying culvert outlet loss coefficients (outlet control).

An additional combo box has been added to the “Macros” toolbar in HY-8. This combo box has two options: 1) Exit Loss: Standard Method and 2) Exit Loss: USU Method.



If the “Standard Method” is selected, HY-8 will use the current method for computing exit losses. If the “USU Method” is selected, HY-8 will use the USU (Borda-Carnot) equation to compute exit losses. Additional information on the USU method can be found in the HY-8 7.1.0 help file under the heading “Exit Loss Options”.

## Modified Shape and Coefficient Database

HY-8 7.1.0 has a new shape/coefficient database. This database allows FHWA<sup>3</sup> to add new or update older shapes or materials to the HY-8 interface. The database also allows FHWA to modify the analysis coefficients used to compute inlet control depths. In this manner, FHWA can create and disseminate new and updated shape and coefficient information without requiring users to reinstall the entire HY-8 package.

As an example, HY-8 7.1.0 incorporates different types of plastic pipes. Information on the coefficients and other options that have been added to allow modeling of plastic pipes is found in the HY-8 7.1.0 help file under the heading “Plastic Pipe Materials”. In future phases, FHWA anticipates adding CONSPAN, flared end, and other configurations of culvert shapes and configurations.

The FHWA is the only organization that makes the technical and policy decision to add or change pipe materials and/or coefficients found in HY-8 or any other of FHWA culvert or pipe related guidance. This ensures FHWA culvert guidance and products remain acceptable for purposes of performing FHWA culvert analyses regulated under 23 CFR 650 Subpart A and meeting 44 CFR 65.6(a)(6) in the FEMA NFIP regulations.

## Report Generation

The DOS version of HY-8 generated a comprehensive table that could be sent to a text file. However the old version lacked the ability to include graphs and take advantage of formatting in modern word processing programs

The Windows version of HY-8 includes Report Generation tools that are customizable, allow many options for plots, and are saved in rich text format (RTF) or portable document format

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<sup>3</sup> To ensure adherence to FHWA HDS-5 approaches, only FHWA will have the ability to access this file. The file and the contents are still considered to be under development and remain proprietary

(PDF). The primary target for the report is an MS-Word document; however, an rtf format is readable by many word processing programs.

A few issues related to Report Generation remain in this version. Each time a table or graph is written to the report, the report starts a new page. This can make reports longer (wasting paper). The HY-8 7.1 QuickTutorial document describes a workaround to this issue.

Among the changes, this latest version fixed several problems with displaying metric units and not printing values correctly to the report file. Version 7.1.0 has the capability to write energy dissipation reports from the energy dissipation dialog.

## Known HY-8 Issues

A few issues continue to exist in HY-8. The intent of the FHWA is to correct these and other issues as budget and time allow. The following is a list of these issues:

1. HY-8 does not attempt to show the location of a hydraulic jump in the culvert profile.
2. If more than one flow type exists for the culvert profile, HY-8 does not attempt to show multiple profiles, but only that of the design discharge.
3. **NOTE:** The user should be aware that when the tailwater elevation exceeds the elevation of the top of the culvert outlet, HY-8 assumes that the barrel flows full at the outlet and reports an outlet velocity corresponding to full flow. A more detailed description of this limitation is given in the Help document under the limitations topic.
4. To allow backward compatibility with DOS version input files, HY-8 only plots one barrel of a particular system in the front view option. So while the program plots multiple systems at a crossing, the number of barrels within each system is not plotted. This multi-barrel plotting capability will be added in a subsequent phase.
5. The new version of HY-8 does not support culverts with multiple slopes (broken back), hydraulic jumps, and adverse slopes. These are being added in the next phase of this effort.
6. The report functionality in HY-8 will be improved to support additional file formats and additional options.

## Getting Help

Beyond this and the HDS-5 document, the majority of the HY-8 documentation is self contained within the program. The functional use of the program is documented in the hyper-linked help file available from the Help menu or by selecting help buttons or icons (🔗) from the graphical user interface. While the help file is organized to provide context-sensitive help, it can be printed out and organized into a hard copy manual.

Additionally, the National Highway Institute provides courses on application of the HY-8 software (135081 – Introduction to Hydraulic Highway Software” and other courses).

While FHWA does not offer any user support (as described in the Terms and Conditions for downloading and using the program), comments and bug reports may be sent to:

[CommentsOnHY8@dot.gov](mailto:CommentsOnHY8@dot.gov)