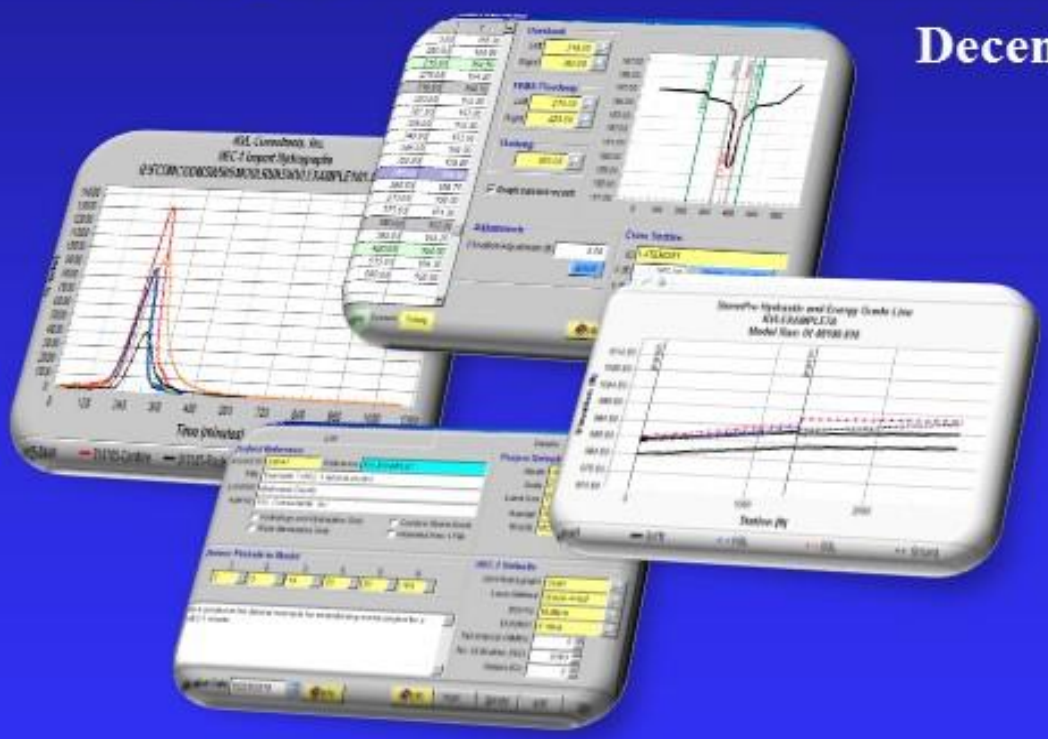
The Flood Control District of Maricopa County

DDMSW Training Workshops

HYDROLOGY and STORM DRAINAGE HYDRAULICS

December 4, 2018



Maricopa County Department of Transportation (MCDOT)
Computer Training Room
2919 W Durango St, Phoenix, Arizona 85009

Presented by:

Kenneth Lewis, P.E.
KVL Consultants, Inc.

The Flood Control District of Maricopa County

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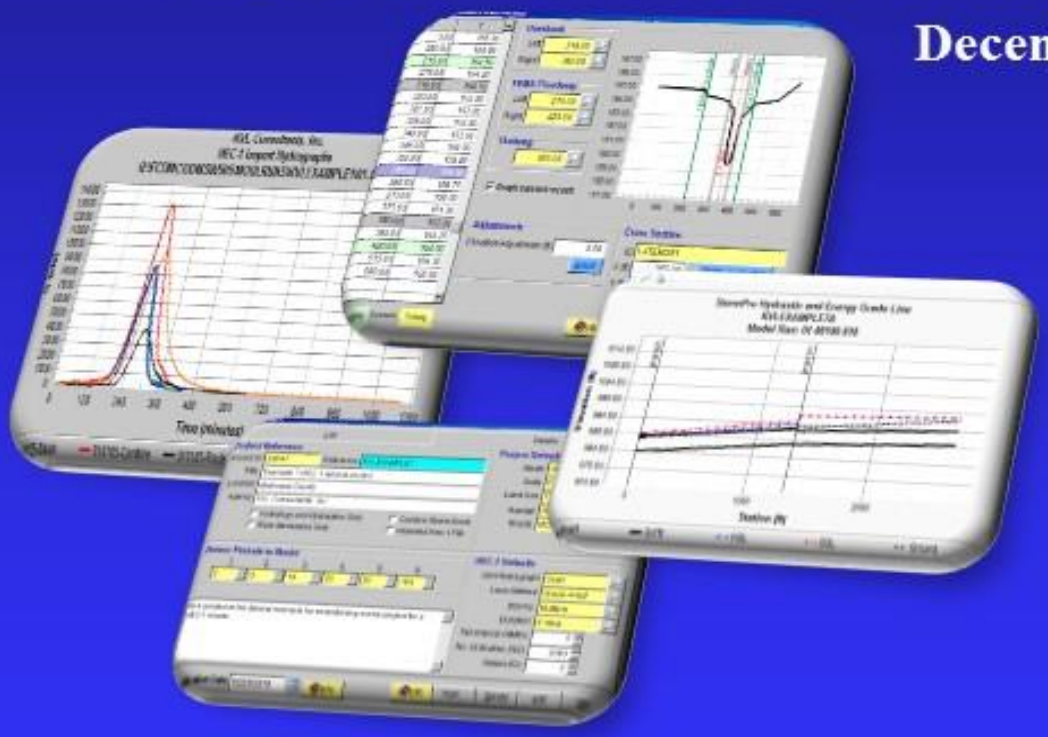

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DDMSW Training Workshops

Hydrology and Storm Drainage Hydraulics

Training Dates: December 4, 2018 (Tuesday)
December 11, 2018 (Tuesday)

Location: Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, Arizona 85009

Instructor: Kenneth V. Lewis, P.E.
DDMSW Developer

This training class is designed for hydraulic and hydrologic engineers interested in learning DDMSW, an application program that implements District's Drainage Design Methodologies and Standards.

Agenda

8:30 – 9:00	**Application Overview** *System Overview, Program Installation, General Features, Files, Tools, Administration, Help, New Features*
9:00 – 9:45	**Application Defaults** *Agency Defaults, Project Defaults, Rainfall, Soils, Land Use*
9:45 – 10:00	**Morning Break**
10:00 – 11:00	**HEC-1 Overview** *Major Basins, Sub-Basins, Diversions, Routing, Storage, Network, Modeling, Graphs*
11:00 – 12:00	**Rational Method and Storm Drain Overview** *Major Basins, Sub-Basins, Diversions, Storage, Hydraulics, Network, Modeling, Conveyance Facilities, Street Drainage, StormPro Backwater Modeling*
12:00 – 1:00	**Lunch Break**
1:00 – 2:45	**HEC-1 Tutorial**
2:45 – 3:00	**Afternoon Break**
3:00 – 4:30	**Rational Method and Storm Drain Tutorial**

DDMSW 5.6.0
TRAINING WORKSHOPS

HYDROLOGY
AND
STORM DRAINAGE
HYDRAULICS

Engineering Application Development and River Mechanics Branch
Engineering Division
Flood Control District of Maricopa County

December 2018

This document contains step-by-step tutorials on standard hydrologic methods used by the District that are implemented in **DDMSW**. *The tutorials were designed to encapsulate the capabilities and features of* **DDMSW** *to build hydrologic models such as* **HEC-1** *and the* **Rational Method**. *The tutorial for the development of the* **HEC-1** *model uses the* **CLARK UNIT HYDROGRAPH** *and the tutorial for the* **RATIONAL METHOD** *model includes a storm drain example, which is used for the* **STORMPRO BACKWATER MODELING** *tutorial.*

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Appendix A - DDMSW Users Manual

I. HYDROLOGY AND STORM DRAINAGE HYDRAULICS

1.1 HEC-1 MODELING USING CLARK UNIT HYDROGRAPH

1.1.1 Problem Statement

To estimate the 100-year design discharge using **GIS** data for sub basins, land use, soils and time of concentration with the following given conditions:

- HEC-1 Model
- FCDMC Soils
- FCDMC Land Use
- NOAA14 Rainfall
- MCDOT Roads (not applicable)
- Clark Unit Hydrograph
- Green-Ampt Loss Method
- Single Storm
- 24-Hour Duration
- Tab Interval: 5 Minutes
- Number of Ordinates: 2000
- Output Level: 5

1.1.2 Step-by-Step Procedures

Step 1: Establish a New Project and Default Set-up.

Step 2: Set Model Runs Path

Step 3: Prepare Maps

Step 4: Establish Rainfall Data from **GIS**

Step 5: Establish Sub-Basin, Land Use and Soils Data from **GIS**

Step 6: Review Established Sub-Basin, Land Use and Soils Data

Step 7: Establish Storage Facilities Data

Step 8: Establish Routing Data

Step 9: Develop Hydrology Network

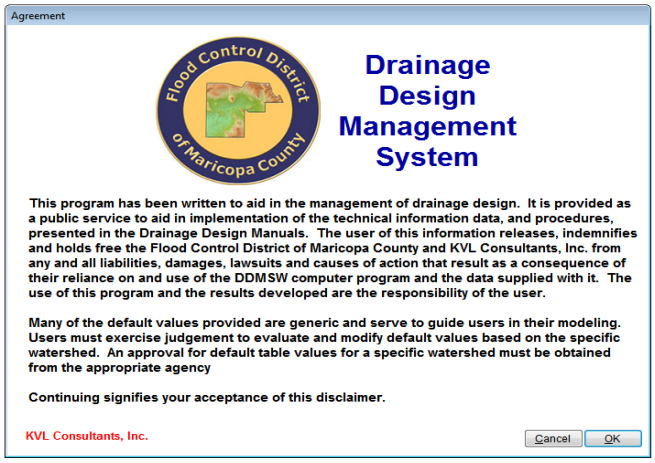
Step 10: Run **HEC-1** Model

Step 11: Review Model Results

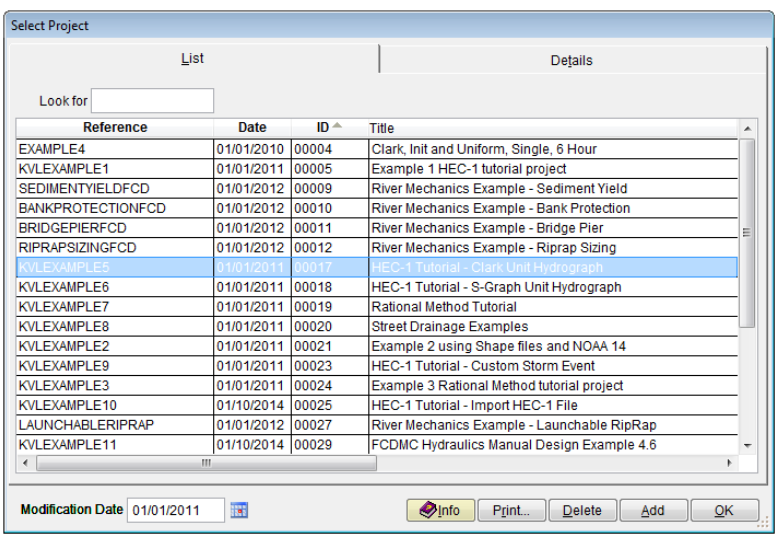
Step 12: Backup Project

(A) Step 1 - Establish a New Project and Defaults Set-Up

(a) Click the **DDMSW** icon on the Desktop or Program menu to launch the **DDMSW**. Click **OK** to accept the software disclaimer as is shown in the following figure.



After the **DDMSW** is launched, the **SELECT PROJECT** window is automatically opened as is shown in the following figure.



(b) Click the **Add** button on the **SELECT PROJECT** window to start a new project (Or **File ➔ New Project ➔ Add**).

(c) On the **NEW PROJECT OPTIONS** form, select **Hydrology and Hydraulics** checkbox and select the **Standard** radio button. Click **OK** to close the form.

(d) Type "*KVLEXAMPLE5A*" into the **Reference** textbox. This is the name of the new project. The users can choose the name as long as it does not exist in the **DDMSW** project list.

(e) Type into the **Title** textbox a brief descriptive title of this project. ***(Optional)***

(f) Type into the **Location** textbox the location of this project. ***(Optional)***

(g) Type into the **Agency** textbox the agency or company name. ***(Optional)***

(h) Type a detailed description of this project into the textbox on the bottom left side of the window. ***(Optional)***

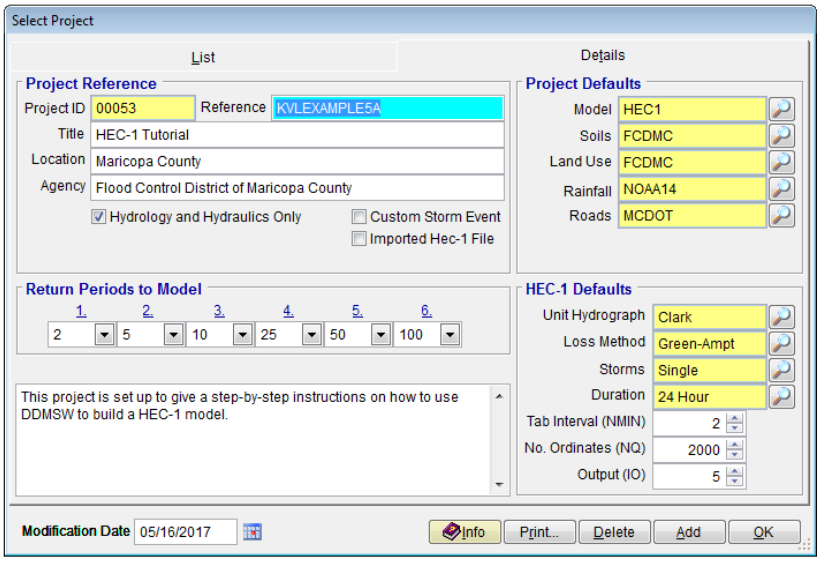
(i) In the **Project Defaults** frame, keep all the default data settings.

(j) Under **HEC-1 Defaults** frame, change the default **Storms** from "*Multiple*" to "*Single*" by clicking on the magnifying glass (Selector button).

(k) Under **HEC-1 Defaults** frame, change the default **Duration** from "*6 Hour*" to "*24 Hour*" by clicking on the magnifying glass (Selector button). Also change the Tab Interval (NMIN) from 5 to 2.

(l) Click the **Save** button to save the entered data.

(m) Click the **OK** button on the **SELECT PROJECT** form to close the window. The following figure shows what the window looks like.



Note: The **Project ID**"*00053*" in the above figure is the database record unique read-only project identifier, which is automatically generated by the program when a new project is created. When users create a new project in this tutorial, the **Project ID** of the new project will not be the same as the **Project ID** shown in the above figure.

(B) Step 2 - Set Model Runs Path

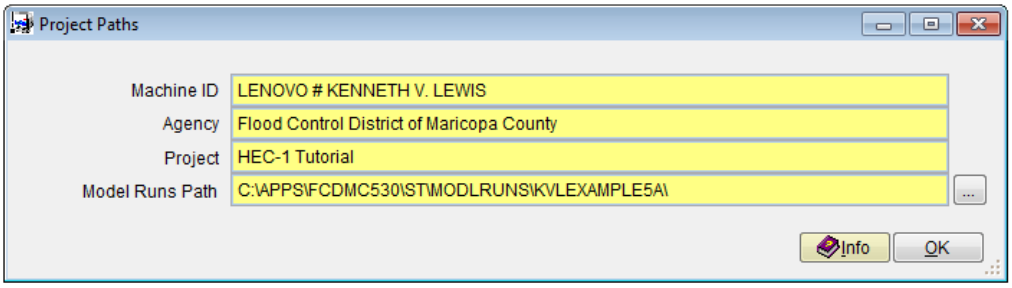
When running the **HEC-1** model in **DDMSW**, the names of the input and output files are automatically established. The basic file format is *XX-YYY* where *XX* is the name of the major basin and *YYY* is the return period. So for Major Basin *01* and Return Period *100-years*, the file name would be *01-100*. The input file uses **.dat* as the file extension and the output file uses **.out* as the extension. Because the file names for all projects are the same, it is necessary to establish unique folders for the model runs for each project.

(a) From the menu bar of the main application window, click **File ➔ Project Paths** to open the **PROJECT PATHS** form.

(b) Click the browse button ... to the right of **Model Runs Path** textbox.

(c) Navigate to the "***Modlruns***" folder and highlight "***Modlruns***" folder. Click **Make New Folder** button on the **BROWSE FOR FOLDER** form and enter "*KvlExample5A*".

(d) After setting the project path, click the **OK** button to close the **BROWSE FOR FOLDER** window.



(e) Click **Save** and then click **OK** to close the **PROJECT PATHS** window.

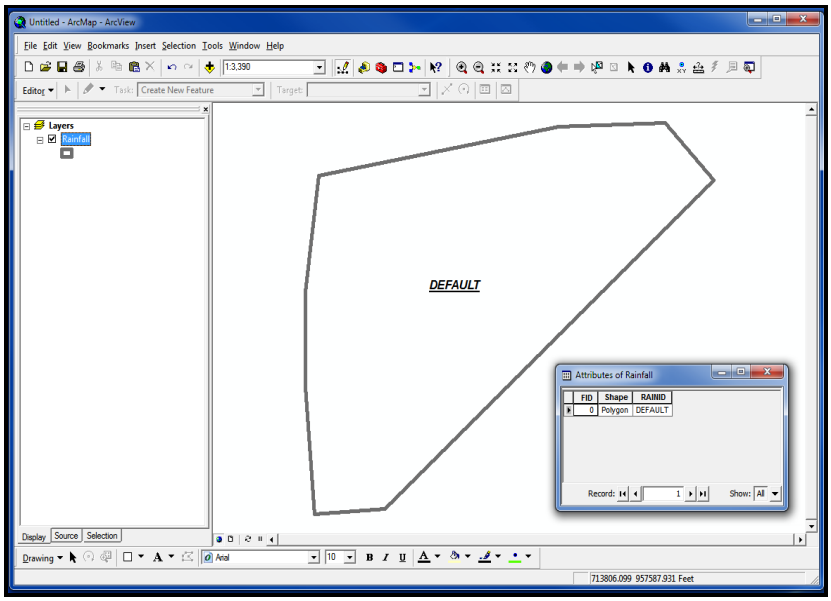
(C) Step 3 - Prepare ESRI Shape Files

This step is only for information purposes. There is no action required for the tutorial user in this step. Several ESRI shape files must be prepared. They are, *Rainfall, Sub-Basin, LandUse, Soils* and *Tc*. As part of the shape files, the table structures must include specific fields. For the purposes of this tutorial, all these shape files have already been prepared. This tutorial does not cover the creation of the shape files. For tutorials on how to create ESRI shape files, please refer to "**HOW TO PREPARE ESRI SHAPE FILES FOR DDMSW**" document that can be downloaded from the District website (**https://www.maricopa.gov/264/How-to-Prepare-ESRI-Shape-Files**).

This section describes the general requirement for the required shape file tables. Assigning file names to the shape files to be used are not critical. For the purpose of this tutorial, however, map files are named based on the data they represent. It is important, however, that field names, data types and formats inside the tables must be fixed as described in the following sections.

(C.1) Rainfall

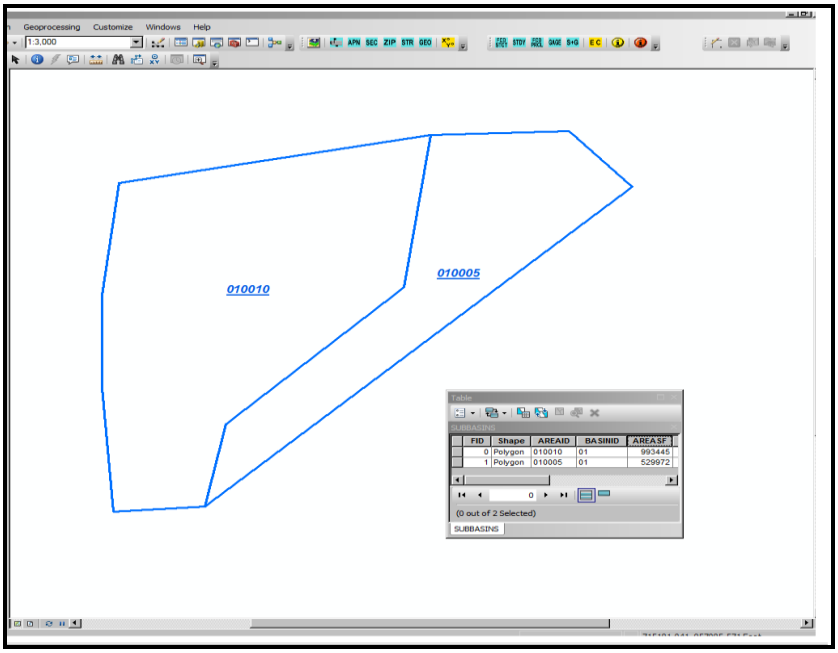
The Rainfall map (*Rainfall.shp*) will contain a single polygon and have a field named **RAINID,** which is defined as Character 8 data type indicating a Text data field of 8 characters long. The Rainfall map can be created after the Sub-Basins map (*Subbasins.shp*) has been prepared and is basically the combined polygon areas of the modeled Sub-Basins.



(C.2) Sub-Basins

The Sub-Basins map (*Subbasins.shp*) will contain one polygon for each Sub-Basin in the project. The required fields include:

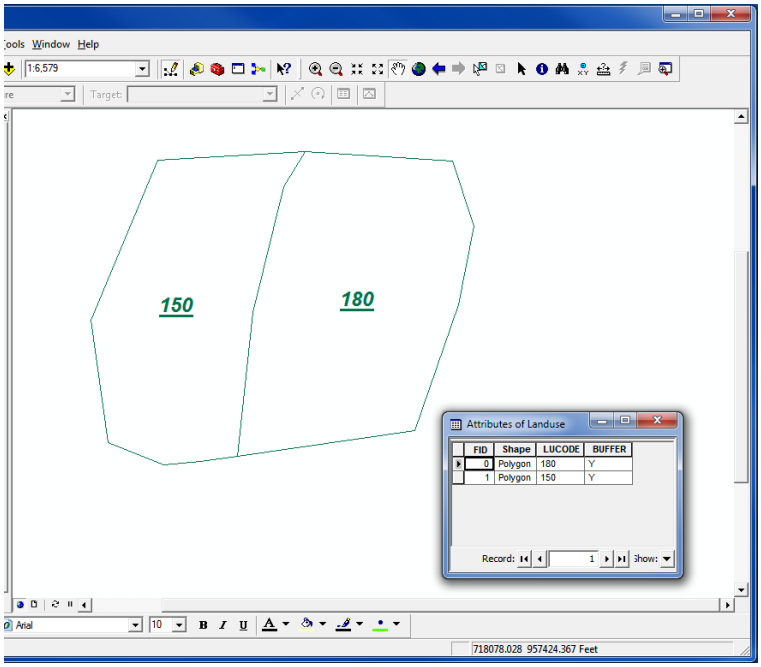
- **AREAID** Character 6 Enter unique **Sub-Basin ID**
- **BASINID** Character 2 Enter **Major Basin ID**
- **AREASF** Numeric 12.0 Data entered into this field will be overwritten internally by **DDMSW**. This field contains the Sub-Basin area in square feet. The data for this field is calculated automatically when the **Update** button is clicked on the **UPDATE HYDROLOGY FROM GIS** form in **DDMSW**.



(C.3) Land Use

The Land Use map (*Landuse.shp*) will contain polygons for land use data. There can be more than one polygon with the same land use ID. It is vitally necessary that the land use coverage extends beyond the extent of all Sub-Basins. The required fields include:

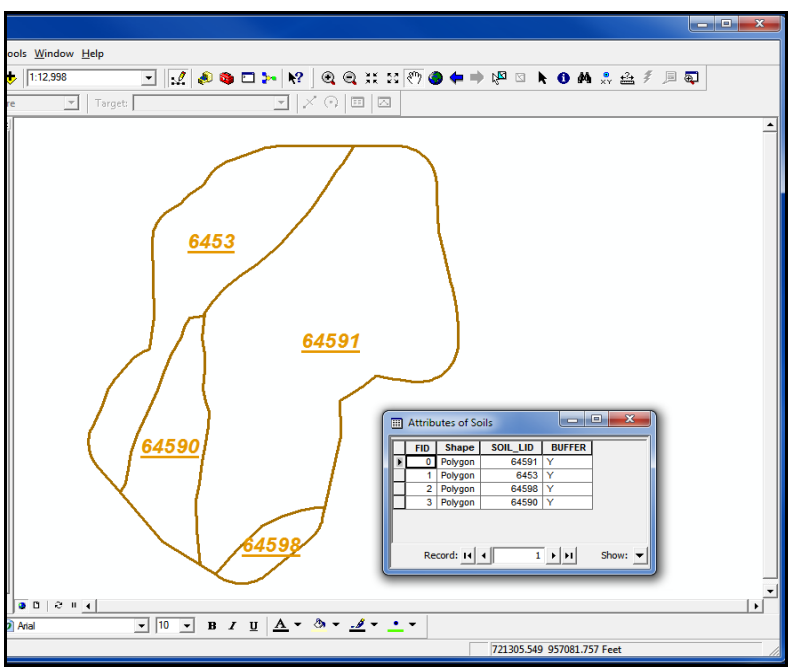
- **LUCODE** Character 15 **LUCODE** values should be consistent with the values in the **DDMSW** land use defaults table.



(C.4) Soils

The Soils map (*Soils.shp*) will contain polygons for soils data. A **GIS** map for soils data can be obtained from the Flood Control District. There can be more than one polygon with the same Soil ID. It is vitally necessary that the soils coverage extends beyond the extent of all Sub-Basins. The required fields include:

- **SOIL_LID** Numeric 15 — **SOIL_LID** values should be consistent with the values in the **DDMSW** soil defaults table.

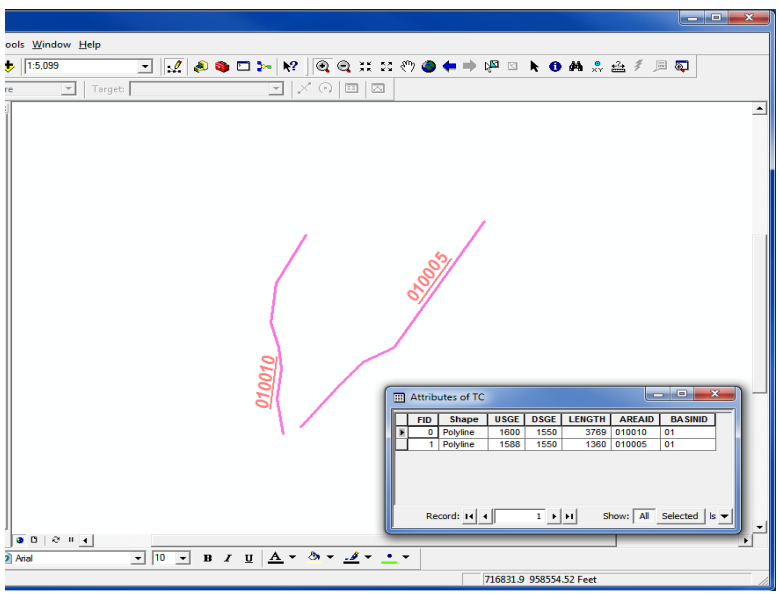


(C.5) Tc

The Time of Concentration map (*TC.shp*) will contain polylines for Tc data. There needs to be one Tc polyline for each Sub-Basin in the project and each polyline must be completely contained within its respective Sub Basin. The required fields include:

- **AREAID** Character 6 This is determined internally by **DDMSW**.
- **BASINID** Character 2 This is determined internally by **DDMSW**.
- **LENGTH** Numeric 12.0 This is determined internally by **DDMSW**.
- **USGE** Numeric 9.2 Enter the upstream ground elevation.
- **DSGE** Numeric 9.2 Enter the downstream ground elevation.

The data for **AREAID**, **BASINID** and **LENGTH** are populated automatically when the **Update** button is clicked in the **UPDATE HYDROLOGY FROM GIS** form and any data entered will be over-written.



(D) Step 4 - Establish Rainfall Data from GIS

(D.1) Rainfall Ids

In **DDMSW**, different major basins can have different rainfall data. If there is only one major basin then the program will use the "*DEFAULT*" as rainfall.

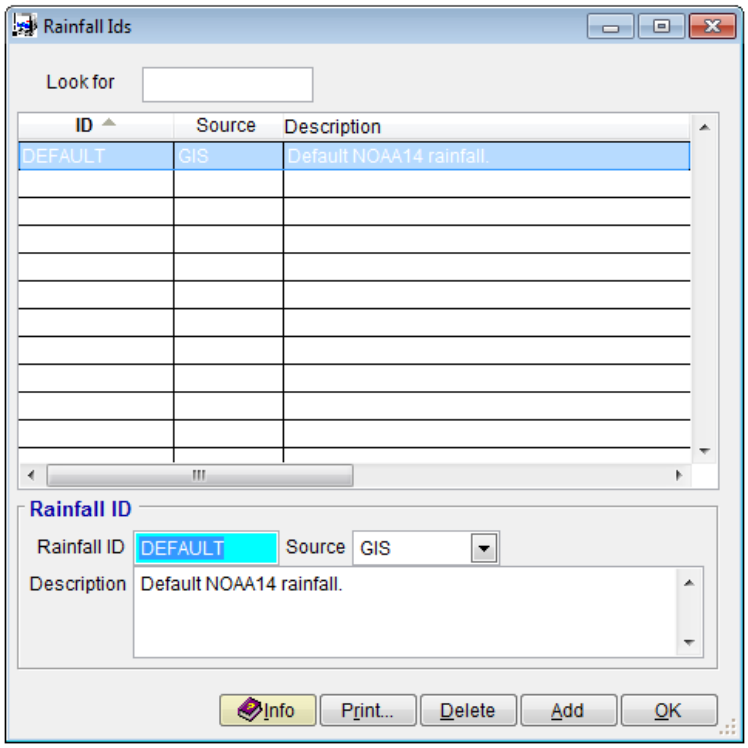
(a) From the menu bar of the main application window, click **Hydrology ➔ Rainfall Ids** as shown in the following figure and the **RAINFALL IDS** window opens.

(b) Select the **Source** (can be "*GIS*" or "*Manual*"). Since a rainfall map has been established, select "*GIS*".

(c) Entering **Description** information is optional.

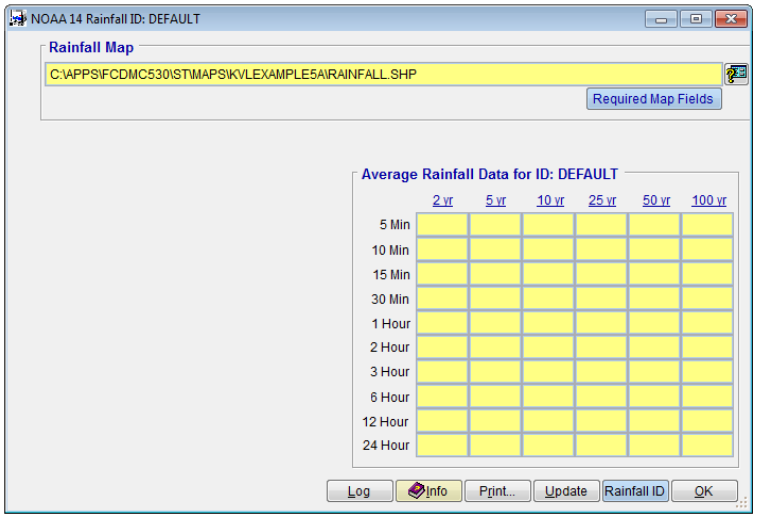
(d) After the data entry, click the **Save** button.

(e) Click the **OK** button to close the window.



(D.2) Rainfall

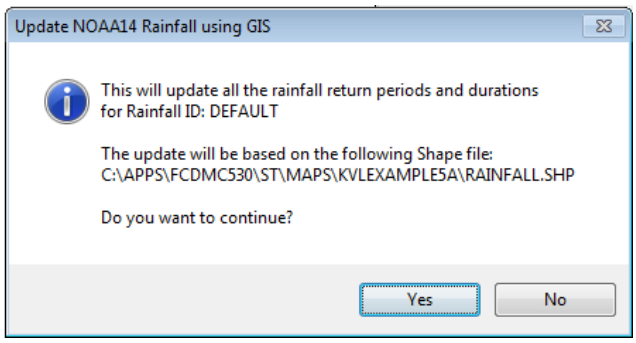
(a) From the menu bar of the main application window, click **Hydrology ➔ Rainfall** to open the **NOAA 14RAINFALL ID: DEFAULT** form.



(b) Click on the button at the right side of the **Rainfall Map** textbox and select the *Rainfall* map (*Rainfall.shp*) file established earlier. It may be necessary to migrate to the folder that the shape file is in.

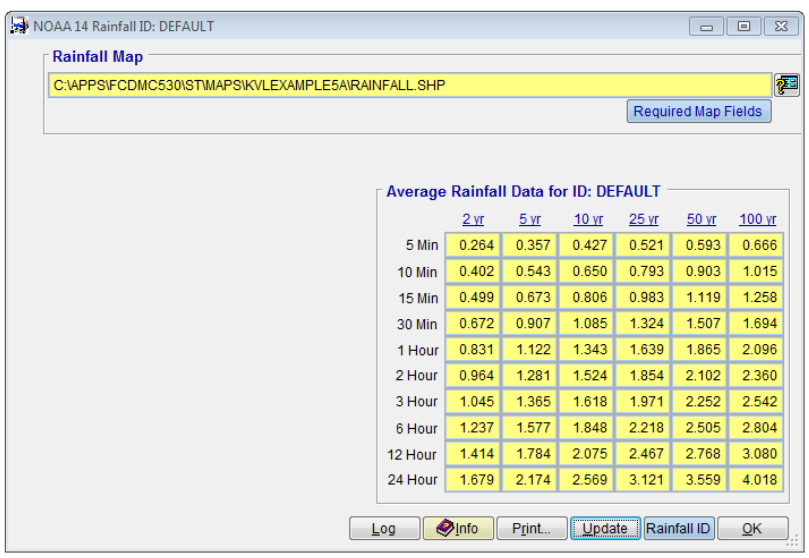
(c) After selecting the rainfall map, click the **Save** button.

(d) Click **Update** to create the NOAA14 rainfall data from the **GIS** map. An **UPDATE NOAA14 RAINFALL USING GIS** dialog box similar to the figure below will appear.



(e) Click the **Yes** to proceed.

(f) After the update is completed, the **NOAA 14 RAINFALL ID: DEFAULT** form will then have the updated data in the **Average Rainfall Data for ID: DEFAULT** frame as shown below.



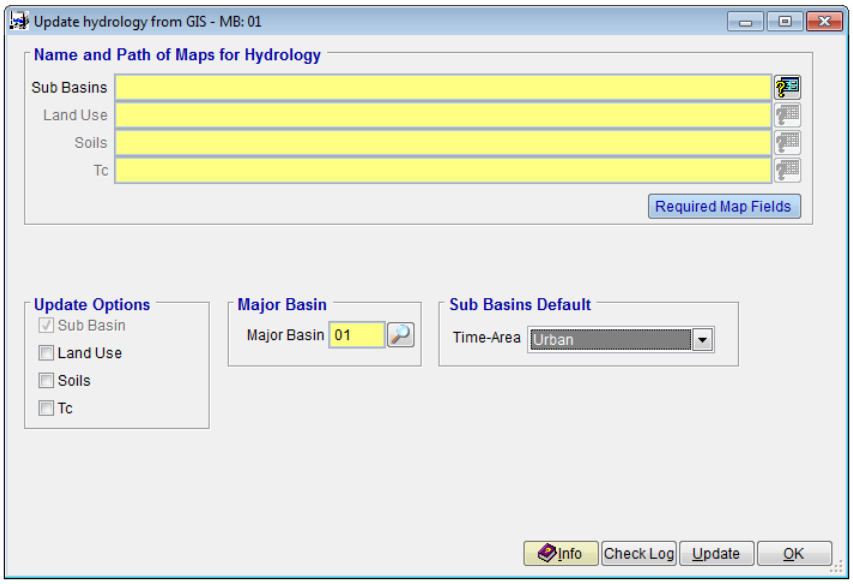
	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr
5 Min	0.264	0.357	0.427	0.521	0.593	0.666
10 Min	0.402	0.543	0.650	0.793	0.903	1.015
15 Min	0.499	0.673	0.806	0.983	1.119	1.258
30 Min	0.672	0.907	1.085	1.324	1.507	1.694
1 Hour	0.831	1.122	1.343	1.639	1.865	2.096
2 Hour	0.964	1.281	1.524	1.854	2.102	2.360
3 Hour	1.045	1.365	1.618	1.971	2.252	2.542
6 Hour	1.237	1.577	1.848	2.218	2.505	2.804
12 Hour	1.414	1.784	2.075	2.467	2.768	3.080
24 Hour	1.679	2.174	2.569	3.121	3.559	4.018

(g) Click the **OK** button to close the window.

(E) Step 5 - Establish Sub-Basin, Land Use and Soils Data from GIS

The project's Sub-Basin, land use and soils data can be populated in **DDMSW** from the maps created earlier.

(a) From the menu bar of the main application window, click **Maps ➔ Update Hydrology** to open the **UPDATE HYDROLOGY FROM GIS** window.



(b) On the **Update Options** data frame, check the **Land Use**, **Soils** and **Tc** checkboxes.

(c) In the **Map File Key Field Name** frame, enter "*LUCODE*" for **Land Use Code**.

(d) In the **Sub Basins Default** frame, select "*Urban*" from the drop-down list items for the **Time-Area**.

(e) Click the button to the right of the **Sub Basins** textbox and select the *Sub-Basins* map (*Subbasins.shp*). It may be necessary to migrate to the appropriate folder.

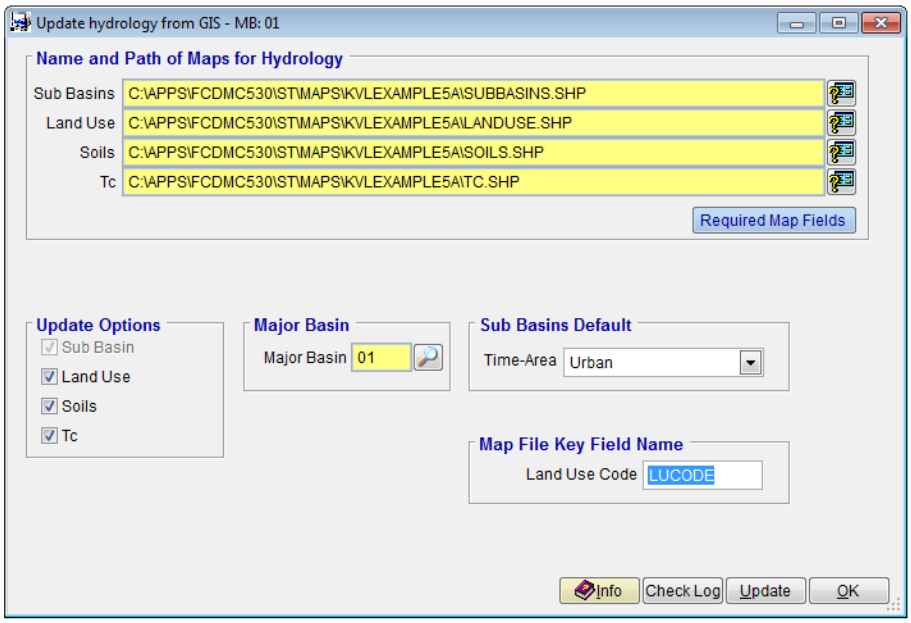
(f) Click the button to the right of the **Land Use** textbox and select the *LandUse* map (*Landuse.shp*).

(g) Click the button to the right of the **Soils** textbox and select the *Soils* map (*Soils.shp*).

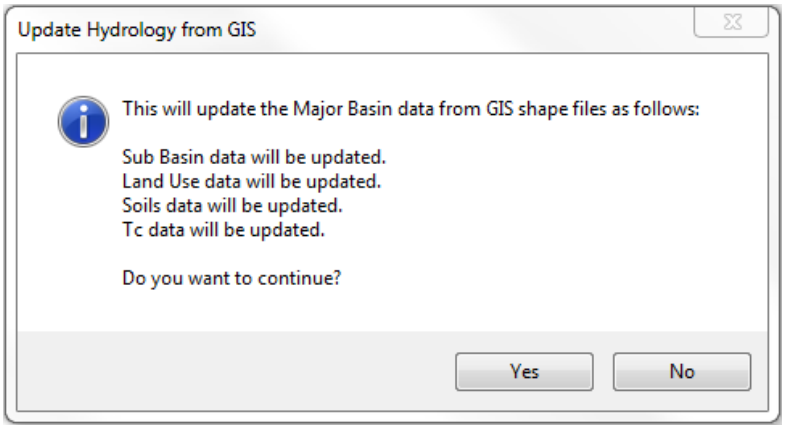
(h) Click the button to the right of the **Tc** and select the *Tc* map (*TC.shp*).

(i) Click **Save.**

Before update, the **UPDATE HYDROLOGY FROM GIS** form should look like the following figure.



(j) On the form, click **Update**. An **UPDATE HYDROLOGY FROM GIS** dialog box will appear.



(k) Click **Yes** to continue.

(l) Click the **OK** button to close the **UPDATE HYDROLOGY FROM GIS** window.

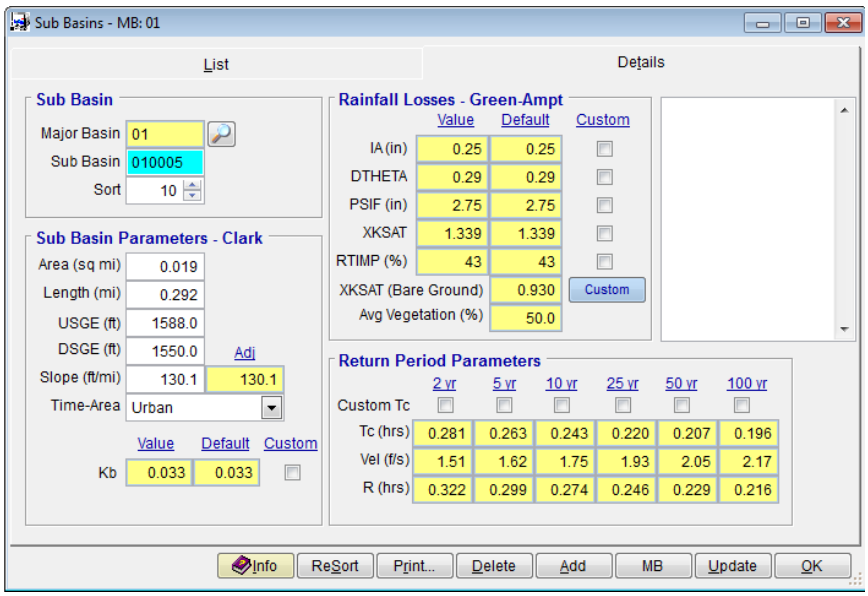
(F) Step 6 - Review Established Sub-Basin, Land Use, and Soils Data

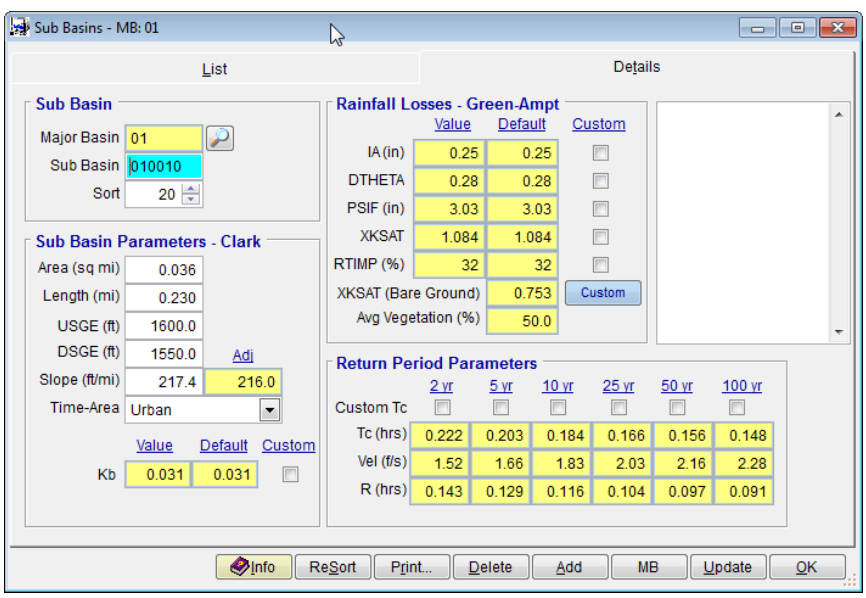
The Sub-Basin, Land Use, Soils, and TC data have been developed from **GIS**. It is necessary to review the data to make sure that all information is correct.

(F.1) Sub-Basins

(a) From the menu bar of the main application window, click **Hydrology ➔ Sub Basins** to open the **SUB BASINS** window. Click the **Details** tab to view the data details for each sub basin.

The forms below show the data for **Sub Basins***"010005" and "010010".*



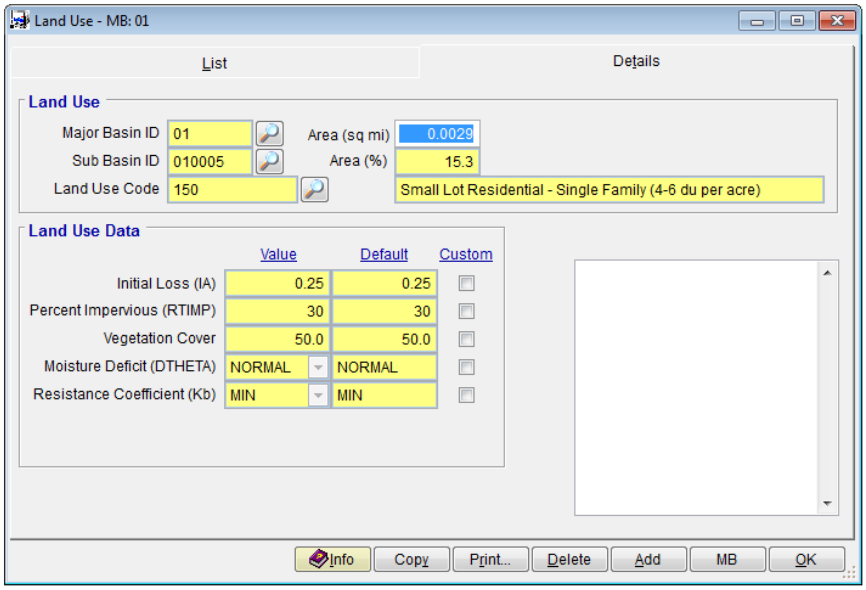


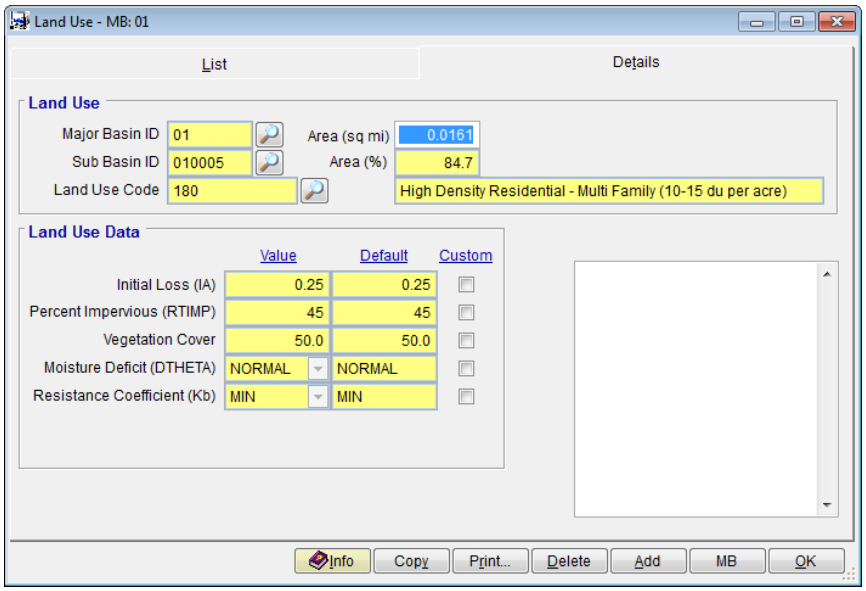
(b) Click the **OK** button to close the **SUB BASINS** form.

(F.2) Land Use

(a) From the menu bar of the main application window, click **Hydrology ➔ Land Use** to open the **LAND USE** form. Click the **Details** tab to view the land use data details for each record.

The forms below show the data details for **Land Use Codes***"150"* and "180" for **Sub Basin***"010005".*



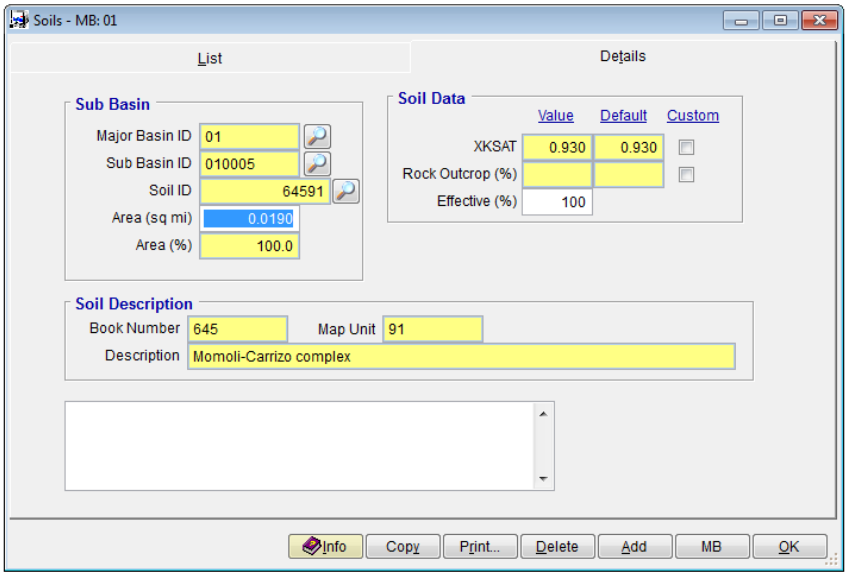


(b) Click the **OK** button to close the **LAND USE** form.

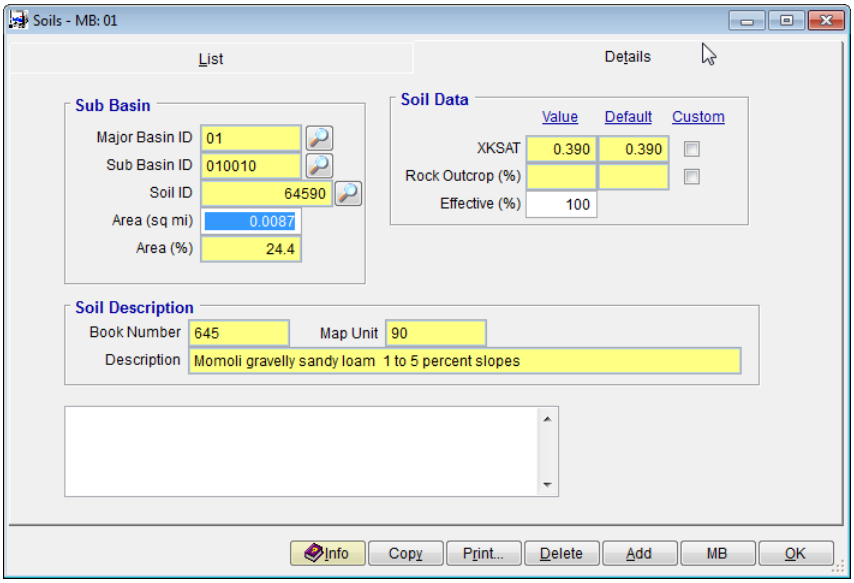
(F.3) Soils

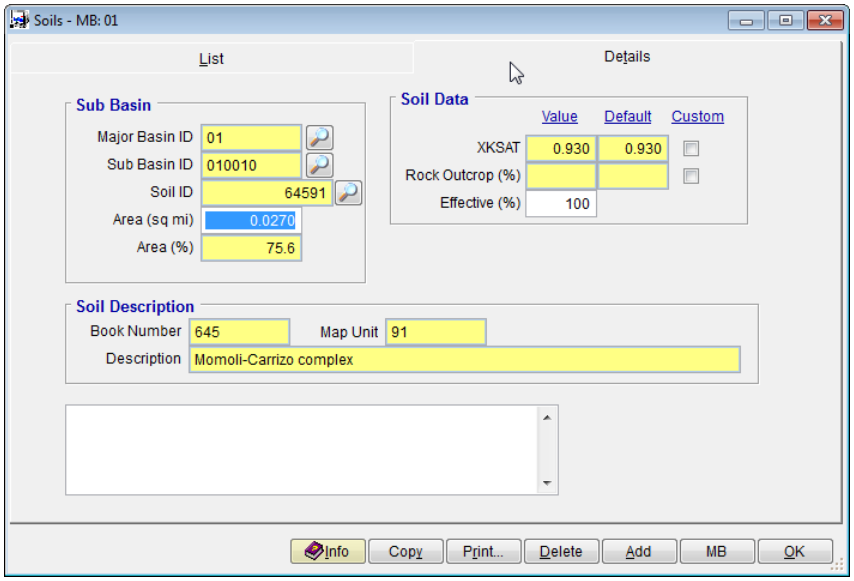
(a) From the menu bar of the main application window, click **Hydrology ➔ Soils** to open the **SOILS** form.

The form below shows the data details for **Soil ID***"64591"* for **Sub Basin***"010005"*.



Further, the forms below show the data details for **Soil IDs** *"64590"* and *"64591"* for **Sub Basin***"010010"*.





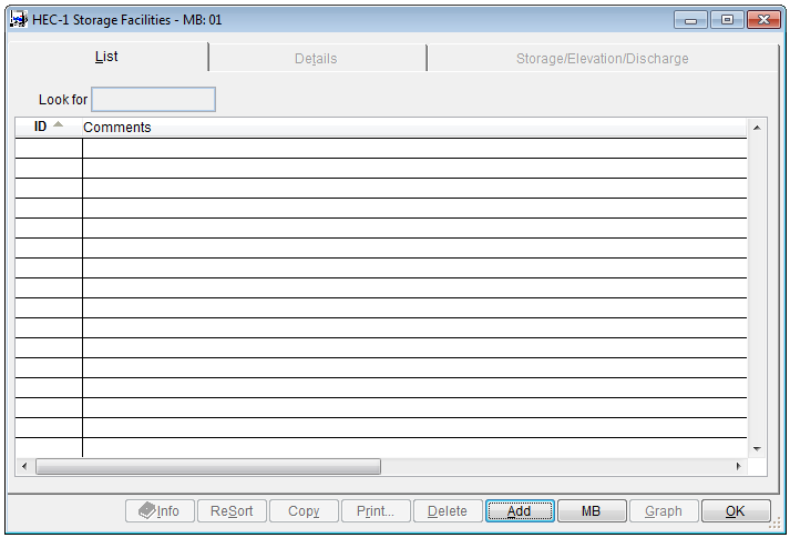
(b) Click the **OK** button to close the **SOILS** form.

(G) Step 7 - Establish Storage Facilities Data

To enter Storage Facility data, do the following:

(a) From the menu bar of the main application window, click **Hydrology ➔ HEC-1 ➔ Storage** to open the **HEC-1 STORAGE FACILITIES** form.

(b) On the **HEC-1 STORAGE FACILITIES** form, click **Add** to add a record.



(c) On the **Details** tab, select *"SL, SS, ST"* on the **Discharge Options** frame.

(d) Check the following checkboxes in the **Discharge Options** frame. Ignore the Warning messages, if there are.

- **Low-Level Outlet (SL)**
- **Spillway Characteristics (SS)**
- **Top of Dam Overflow (ST)**

(e) For the **Storage ID**, enter "*ST0010*".

(f) For the **Low-Level Outlet (SL)** data card, enter the following:

- **Centerline Elevation:** *96.00*
- **Cross-Section Area:** *4.00*
- **Discharge Coefficient:** *0.70*
- **Orifice Equation Exponent:** *0.50*

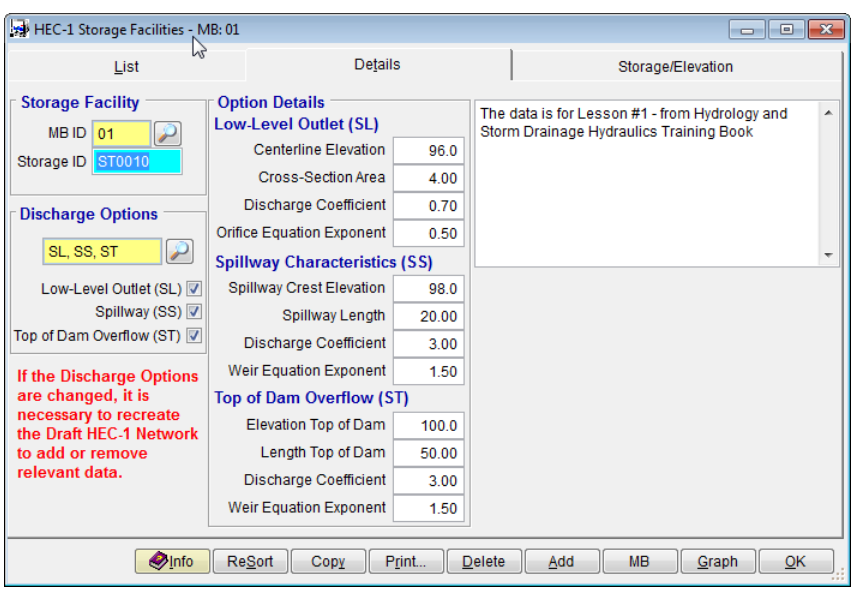
(g) For the **Spillway Characteristics (SS)** data card, enter the following:

- **Spillway Crest Elevation:** *98.00*
- **Spillway Length:** *20.00*
- **Discharge Coefficient:** *3.00*
- **Weir Equation Exponent:** *1.50*

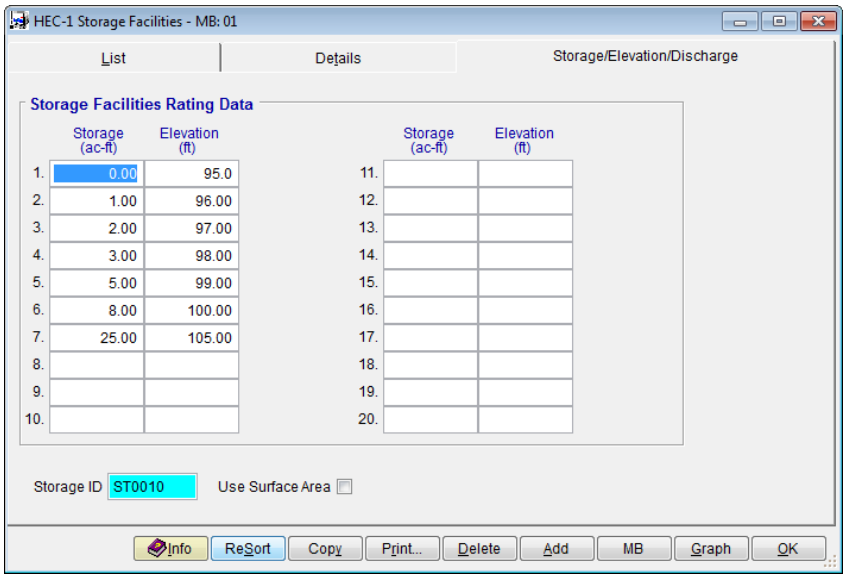
(h) For the **Top of Dam Overflow (ST)** data card, enter the following:

- **Elevation Top of Dam:** *100.00*
- **Length Top of Dam:** *50.00*
- **Discharge Coefficient:** *3.00*
- **Weir Equation Exponent:** *1.50*

(i) Click **Save** to save the data entered. After the data entries, the **HEC-1 STORAGE FACILITIES** form should look like the following figure.



(j) Click the **Storage/Elevation** tab to enter the rating data shown below:



(k) Click the **Save** button to save the entered data.

(l) Click the **OK** button to close the **HEC-1 STORAGE FACILITIES** form.

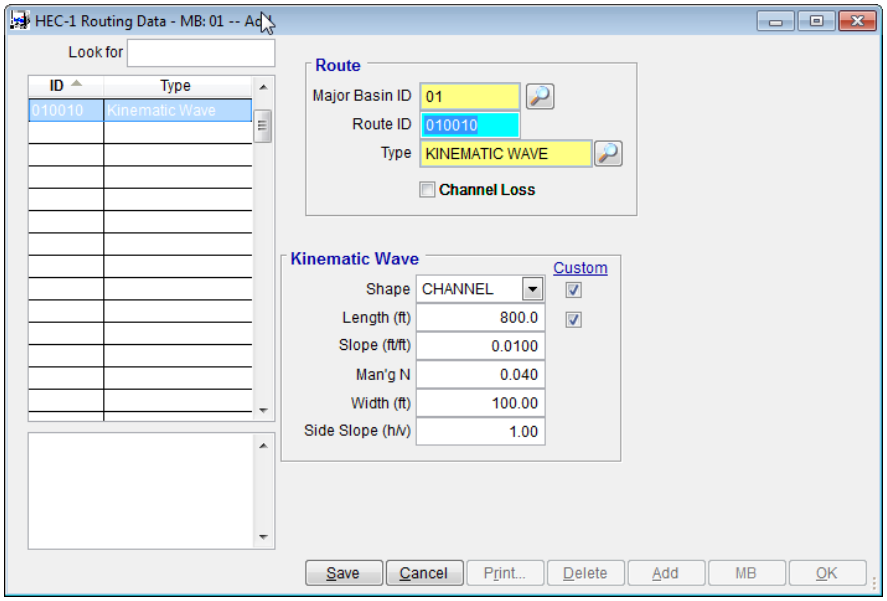
(H) Step 8 - Establish Routing Data

To enter Routing Data do the following:

(a) From the menu bar of the main application window, click **Hydrology ➔ HEC-1 ➔ Routing** to open the**HEC-1 ROUTING DATA** window.

(b) Click **Add** to add a record and enter the following data:

- **Route ID:** *010010*
- **Type:** *Kinematic Wave*
- **Shape:** *CHANNEL*
- **Length (ft):** *800.00*
- **Slope (ft/ft):** *0.0100*
- **Manning's N:** *0.040*
- **Width (ft):** *100.00*
- **Side Slope (h:v):** *1.00*
- **Channel Loss** checkbox**:** *Uncheck*



(c) Click the **Save** button to save the entered data.

(d) Click the **OK** button to close the **HEC-1 ROUTING DATA** form.

(I) Step 9 - Develop Hydrology Network

To develop the Model Network, do the following steps:

(a) From the menu bar of the main application window, click **Hydrology ➔ HEC-1 ➔ Network** to open the **HEC-1 MODEL NETWORK** form.

(b) On the **HEC-1 MODEL NETWORK** window, click **Add** to add a record and select "*Basin*" from the **SELECT TYPE** window.

(c) Click **OK** to close the **SELECT TYPE** window.

(d) Click the "Magnifying Glass" (or Selector) button to the right of **ID** textbox and select **Sub Basin ID**"*010005*"

(e) Click **OK** to close the **SELECT ID** window.

(f) Click **Save** to save the entered data.

(g) Click the **Basin** button to add another Sub Basin and select "*010010*" from the **SELECT ID** window.

(h) Click **OK** to close the **SELECT ID** window.

(i) Click the **Combine** button to combine the preceding two (2) Sub Basins.

(j) Click **Storage** to add a Storage Facility and select "*ST0010*" from the **SELECT ID** window.

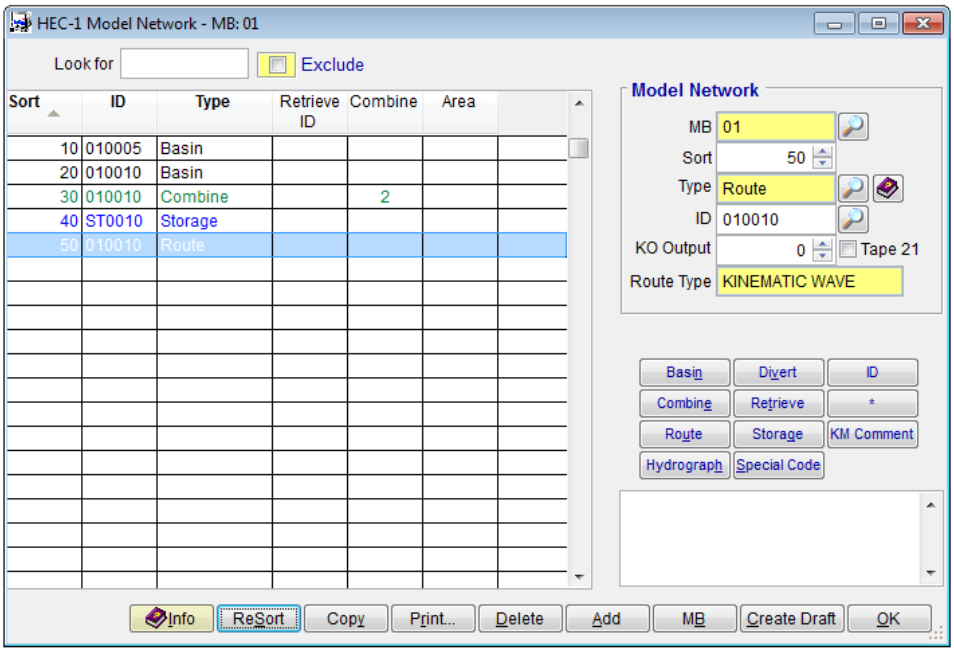
(k) Click **OK** to close the **SELECT ID** window.

(l) Click **Route** to add a Route and select "*010010*" from the **SELECT ID** window.

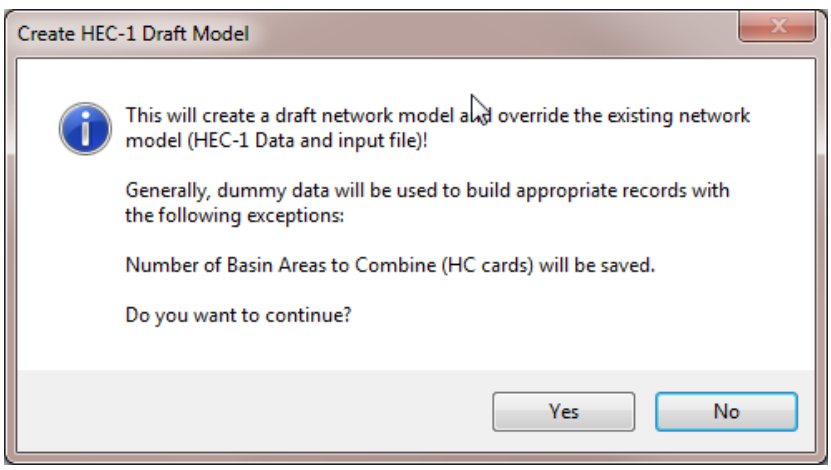
(m) Click **OK** to close the **SELECT ID** window.

(n) Click **ReSort** to provide more room for inclusive records if needed.

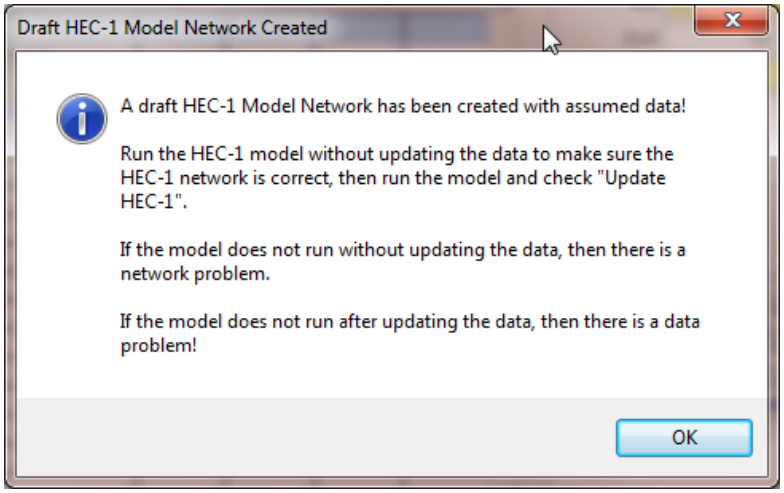
Before creating a draft model, the **HEC-1 MODEL NETWORK** form should look like the following figure.



(o) Click **Create Draft** to create the draft **HEC-1** model.

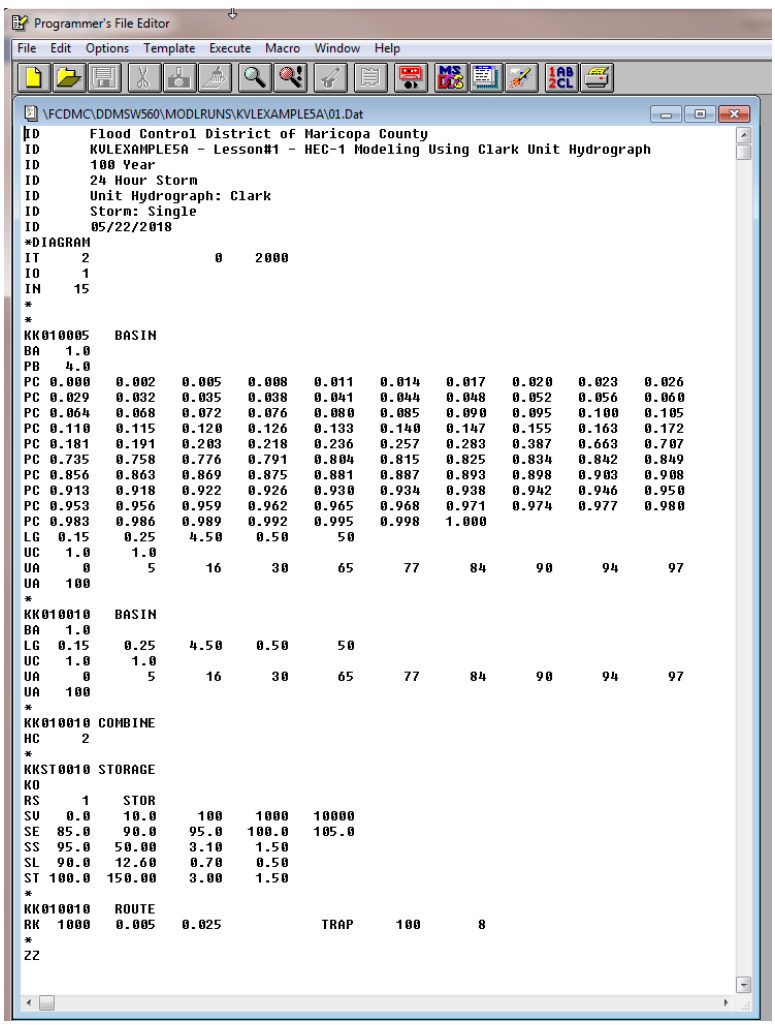


(p) Click **Yes** to continue and to close the **CREATE HEC-1 DRAFT MODEL** dialog box.



(q) Click **OK** to continue and to close the **DRAFT HEC-1 MODEL NETWORK CREATED** dialog box.

Subsequent to closing of the **DRAFT HEC-1 MODEL NETWORK CREATED** dialog box, the **PROGRAMMER'S FILE EDITOR** form opens showing the draft HEC-1 model.



(r) Close the **PROGRAMMER'S FILE EDITOR.**

(s) Close the **HEC-1 MODEL NETWORK** form by clicking the **OK** button.

(J) Step 10 - Run HEC-1 Model

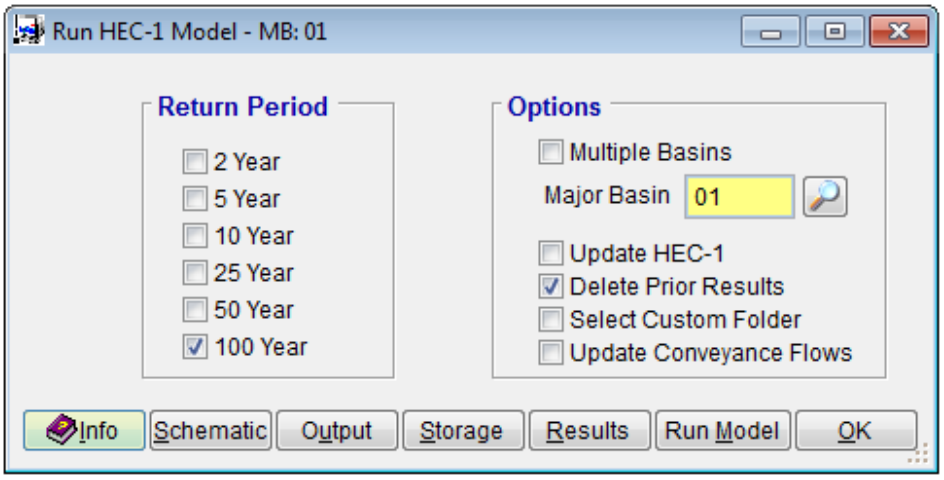
To run the **HEC-1** model, do the following steps:

(a) From the menu bar of the main application window, click **Hydrology ➔ HEC-1 ➔ Model** to open the **RUN HEC-1 MODEL** form.

(J.1) Run the Draft Model

Initially, the model will be run with "dummy" data developed for the draft input file. If the model runs without errors, then it can be assumed that the network has been developed correctly.

(a) On the **RUN HEC-1 MODEL** form, uncheck all return periods except for the **100 year**.



(b) Uncheck **Update HEC-1**

(c) Check **Delete Prior Results**

(d) Uncheck **Select Custom Folder**

(e) Uncheck **Update Conveyance Flows**

(f) Click the **Save** button to save the entered data

(g) Click **Run Model** to run the draft model

(h) Click **Yes** when the **RUN HEC-1 MODEL** dialog box appears.

(J.2) Run the Model

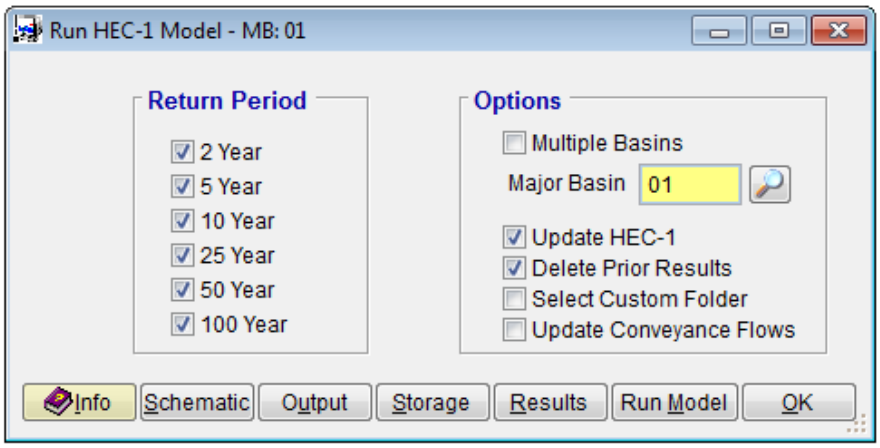
If no errors were generated when running the Draft Model, then do the following steps:

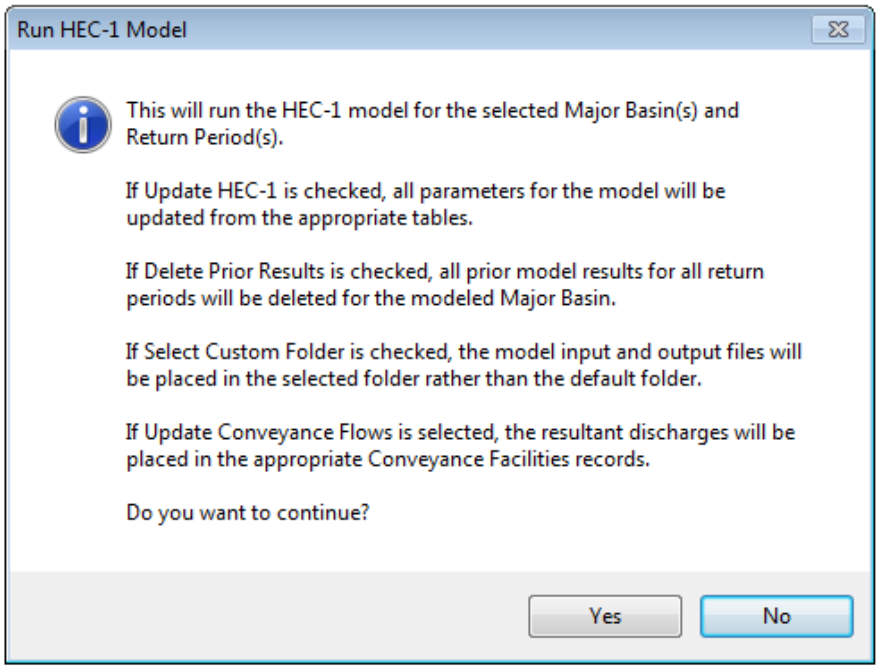
(a) Check all return periods

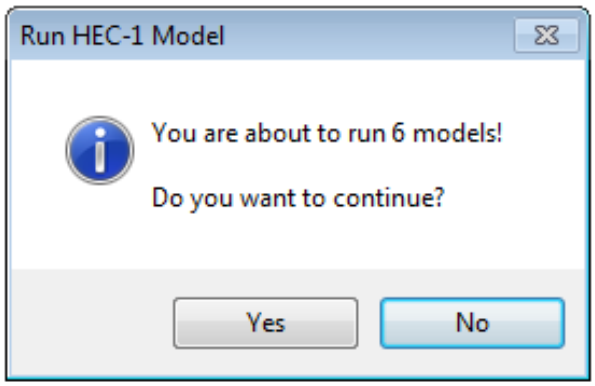
(b) Check **Update HEC-1**

(c) Click **Save** button to save the entered data

(d) Click **Run Model** to run the models







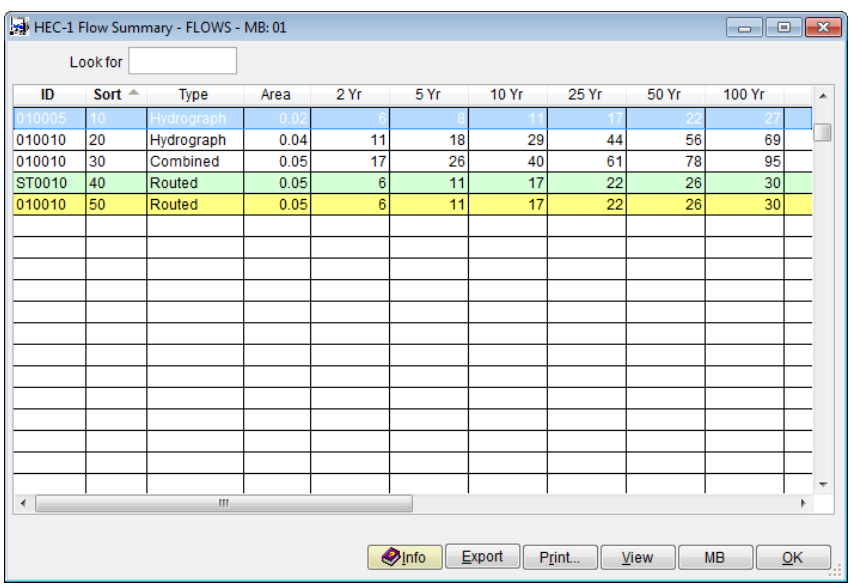
(e) Click **Yes** to both messages to run the models.

(f) Click **OK** to close the **RUN HEC-1 MODEL** form after the successful execution of the HEC-1 models.

(K) Step 11 - Review Model Results

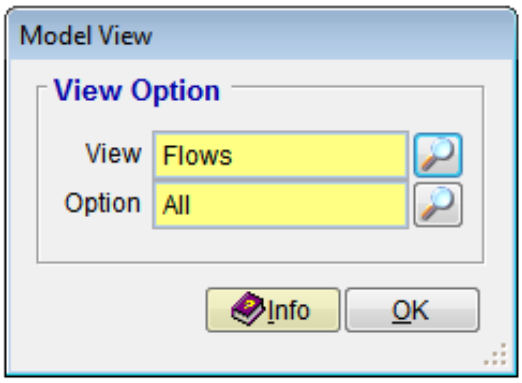
To view the **HEC-1** model flow and volume results do the following:

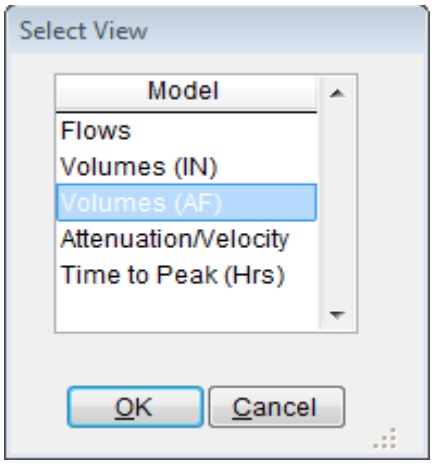
(a) From the menu bar of the main application window, click **Hydrology ➔ HEC-1 ➔ Flow Summary** to open the**HEC-1 FLOW SUMMARY** form.



ID	Sort	Type	Area	2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
010005	10	Hydrograph	0.02	6	8	11	17	22	27
010010	20	Hydrograph	0.04	11	18	29	44	56	69
010010	30	Combined	0.05	17	26	40	61	78	95
ST0010	40	Routed	0.05	6	11	17	22	26	30
010010	50	Routed	0.05	6	11	17	22	26	30

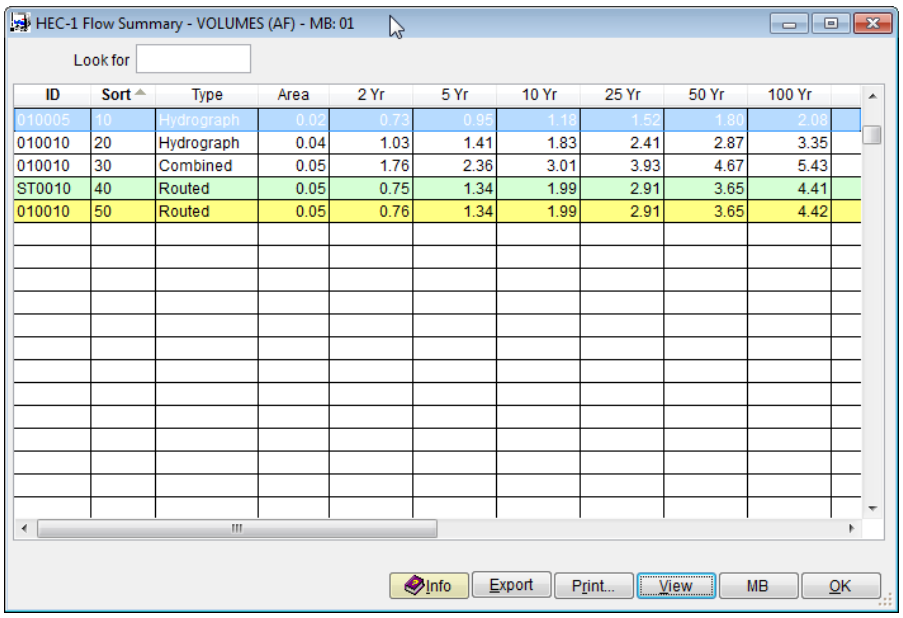
(b) To view model volume results, click the **View** button on the **HEC-1 FLOW SUMMARY – FLOWS** form. On the **MODEL VIEW** dialog box, click the "Magnifying Glass" button to the right of **View** to open the **SELECT VIEW** window. Select "*Volumes (AF)*" from the list.





(c) Click **OK** to close the **SELECT VIEW** dialog box

(d) Click **OK** to close the **MODEL VIEW** dialog box

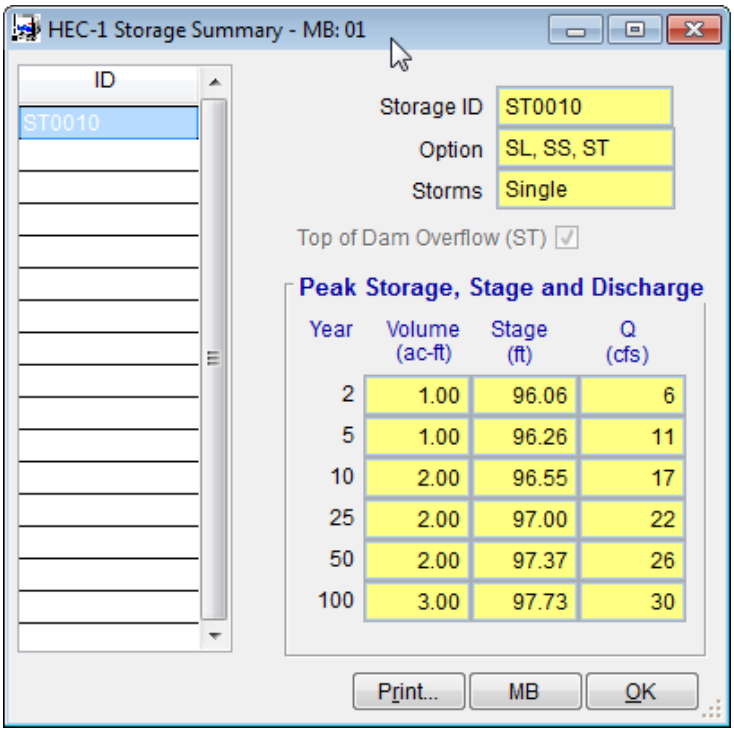


ID	Sort	Type	Area	2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
010005	10	Hydrograph	0.02	0.73	0.95	1.18	1.52	1.80	2.08
010010	20	Hydrograph	0.04	1.03	1.41	1.83	2.41	2.87	3.35
010010	30	Combined	0.05	1.76	2.36	3.01	3.93	4.67	5.43
ST0010	40	Routed	0.05	0.75	1.34	1.99	2.91	3.65	4.41
010010	50	Routed	0.05	0.76	1.34	1.99	2.91	3.65	4.42

(e) After examining the tabulated results, click **OK** to close the **HEC-1 FLOW SUMMARY– VOLUMES (AF)** form.

(f) To view the Model Storage results, click **Hydrology ➔ HEC-1 ➔ Storage Summary** to open the **HEC-1 STORAGE SUMMARY** form.

(g) On the **HEC-1 STORAGE SUMMARY** form, click the **Details** tab to view the storage volume and stage results.



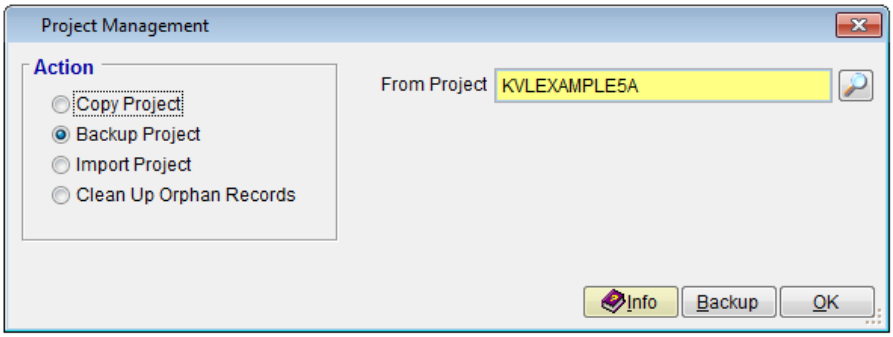
(h) After examining the results, click **OK** to close the **HEC-1 STORAGE SUMMARY** window.

(L) Step 12 - Backup Project

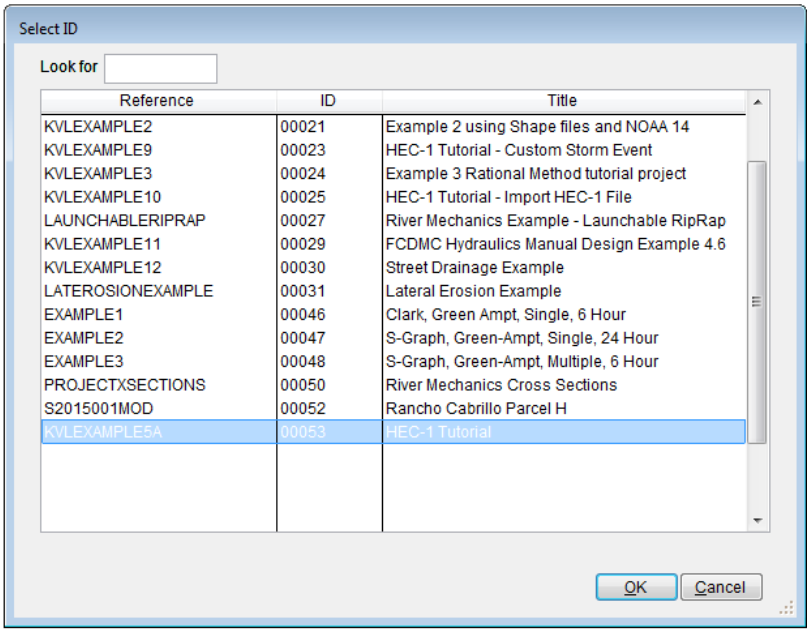
To create a backup file for the project, do the following:

(a) From the menu bar of the main application window, click **File ➔ Project Management** to open the **PROJECT MANAGEMENT** dialog box.

(b) On the **PROJECT MANAGEMENT** dialog box, select the **Backup Project** radio button.



(c) Click the "Magnifying Glass" button to the right of **From Project** to open the **SELECT ID** form.

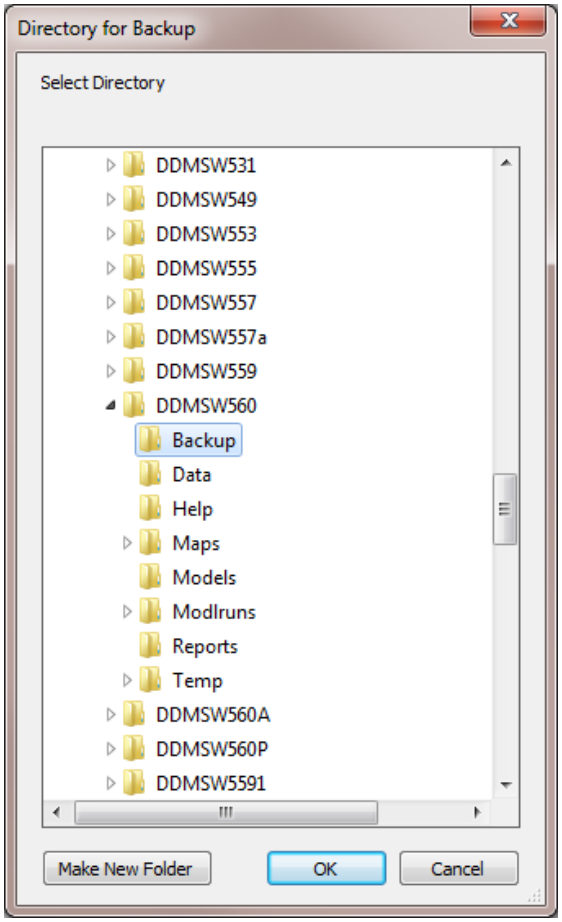


(d) Select "*KVLEXAMPLE5A*" (if not selected already) and click the **OK** button to close the **SELECT ID** form.

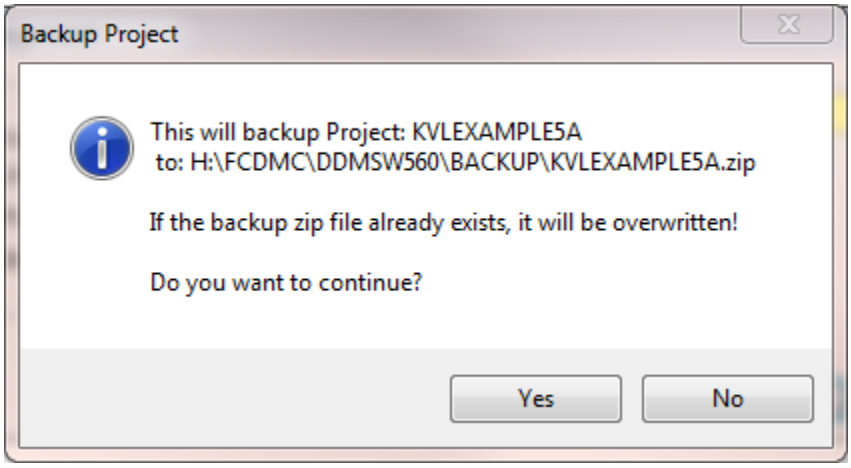
(e) Click **Save** on the **PROJECT MANAGEMENT** dialog box to save the data.

(f) Click the **Backup** button.

(g) Select a folder where the backup file will be saved (defaults to ***Backup*** sub directory)



(h) Click **OK**. On the **BACKUP PROJECT** dialog box, click **Yes** to continue.

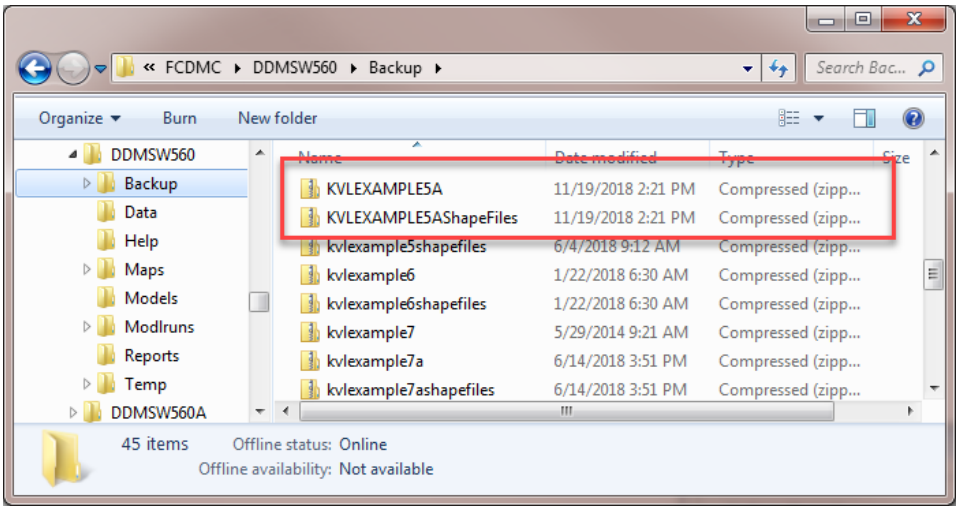


(i) After the backup files had been successfully created, click **OK** to close the **PROJECT MANAGEMENT** dialog box.

(j) To check the backup files that were just created, navigate to the **Backup** folder. Notice the two new zip files in the list as follows:

(1) KVLEXAMPLE5A.zip

(2) KVLEXAMPLE5AShapeFiles.zip



This concludes this tutorial.

1.2 RATIONAL METHOD

1.2.1 Problem Statement

Estimate the 10-year design discharge for a storm drainage system using **GIS** data for Sub Basins, Land Use and Time of Concentration (Tc) with the following given conditions:

- Rational Method Model
- FCDMC Land Use
- NOAA14 Rainfall
- MCDOT Roads
- Minimum Tc
- Maximum Tc

1.2.2 Step-by-Step Procedures

Step 1: Establish a New Project and Default Set-up.

Step 2: Prepare Maps

Step 3: Establish Rainfall Data from **GIS**

Step 4: Establish Sub Basin and Land Use Data from **GIS**

Step 5: Review Established Sub Basin and Land Use Data

Step 6: Establish Conveyance Facility Data

Step 7: Develop **RATIONAL METHOD** Network

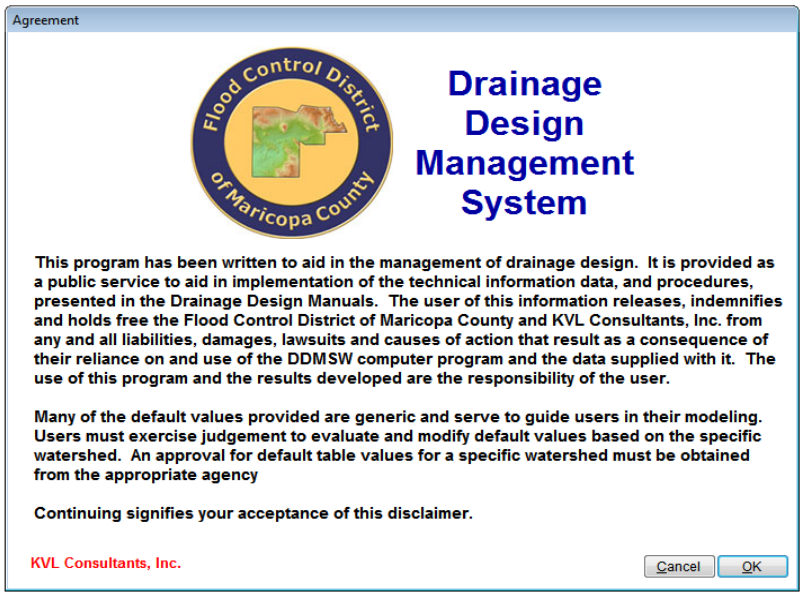
Step 8: Run **RATIONAL METHOD** Model

Step 9: Review Model Results

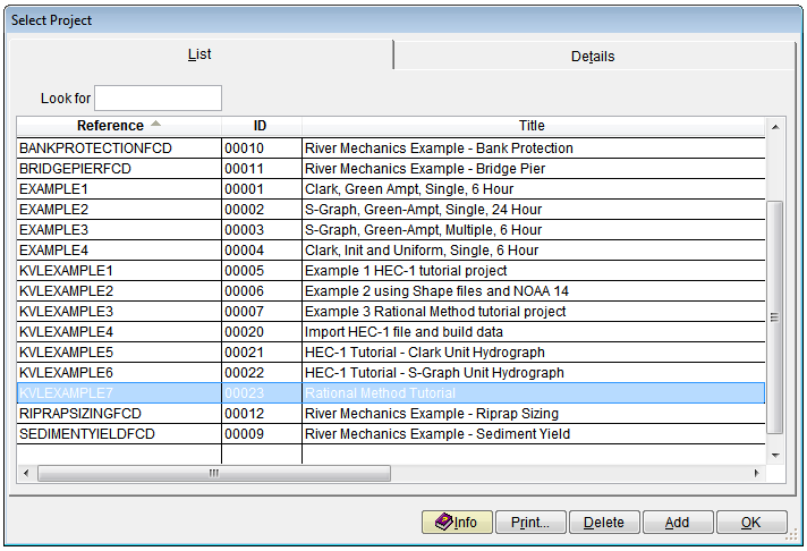
Step 10: Backup Project

(A) Step 1 - Establish a New Project and Defaults Set-Up

(a) Click the **DDMSW** icon on the Desktop or Program menu to launch the **DDMSW**. Click **OK** to accept the software disclaimer as is shown in the following figure.



After the **DDMSW** is launched, the **SELECT PROJECT** window is automatically opened as is shown in the following figure.



(b) Click the **Add** button on the **SELECT PROJECT** window to start a new project (Or **File ➔ New Project ➔ Add**).

(c) On the **NEW PROJECT OPTIONS** dialog box, select **Hydrology and Hydraulics** checkbox and select the **Standard** radio button. Click the **OK** button to close the dialog box.

(d) On the **SELECT PROJECT** form, type *"KVLEXAMPLE7A"* into the **Reference** textbox. This is the name of this newly created project. The users can choose the name as long as it does not exist in the DDMSW database.

(e) Type into the **Title** textbox a brief descriptive title of this project. ***(Optional)***

(f) Type into the Location textbox the location of this project. ***(Optional)***

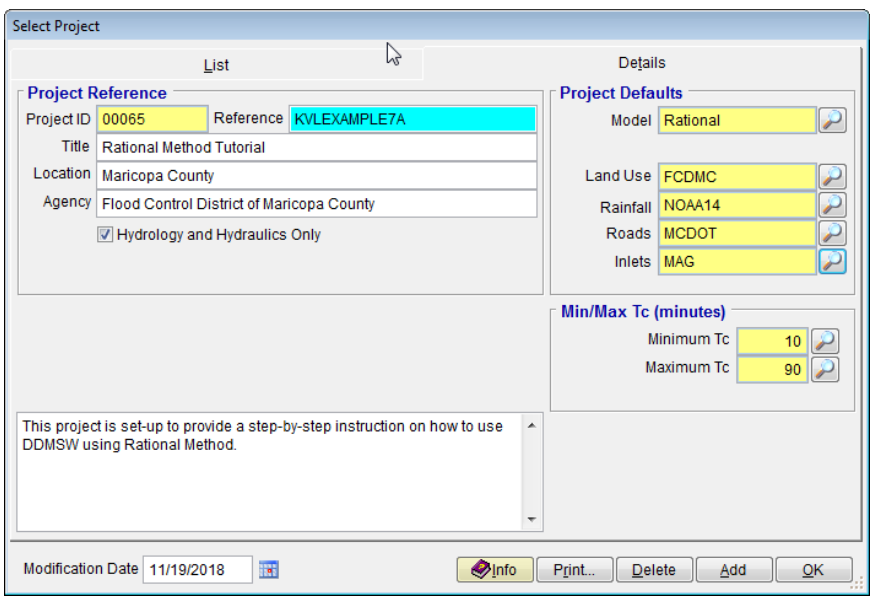
(g) Type into the **Agency** textbox the agency or company name. ***(Optional)***

(h) Type a detailed description of this project into the textbox on the bottom left side of the window. ***(Optional)***

(i) Under **Project Defaults** frame, change the default Model from "*HEC1*" to "*Rational*" by clicking on the magnifying glass.

(j) Click the **Save** button to save the entered data.

(k) Click the **OK** button on the **SELECT PROJECT** window to close it. The screen shot below shows the completed form after data entries made.



(l) Click **OK** button on the pop-up message box.

<u>**Note**</u>: The **Project ID** *"00051"* in the above figure is the unique read-only project identifier in the project database, which is automatically generated by the program when a new project is created. When users create the new project, the **Project ID** generated will not be the same as the **Project ID** shown in the above figure.

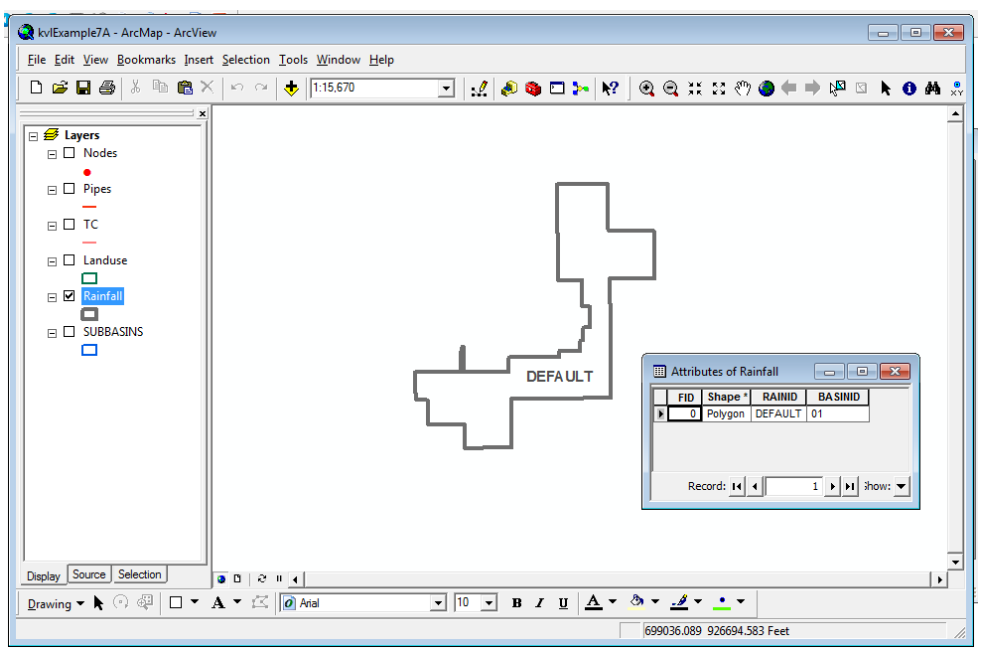
(B) Step 2 - Prepare ESRI Shape Files

This step is only for information purposes. There is no action required for the tutorial user in this step. Several ESRI shape files must be prepared. They are *rainfall*, *sub basin*, *land use* and *Tc*. As part of the shape files, the table structures must include specific fields. For the purposes of this tutorial, all these shape files have already been prepared. This tutorial does not cover the creation of the shape files. For tutorials on how to create ESRI shape files, please refer to **"HOW TO PREPARE ESRI SHAPE FILES FOR DDMSW"** document that can be downloaded from the District website (**https://www.maricopa.gov/264/How-to-Prepare-ESRI-Shape-Files**).

This section describes the general requirement for the required shape file tables. Assigning file names to the shape files to be used are not critical. For the purpose of this tutorial, however, map files are named based on the data they represent. It is important, however, that field names inside the tables must be fixed as provided in the following sections.

(B.1) Rainfall

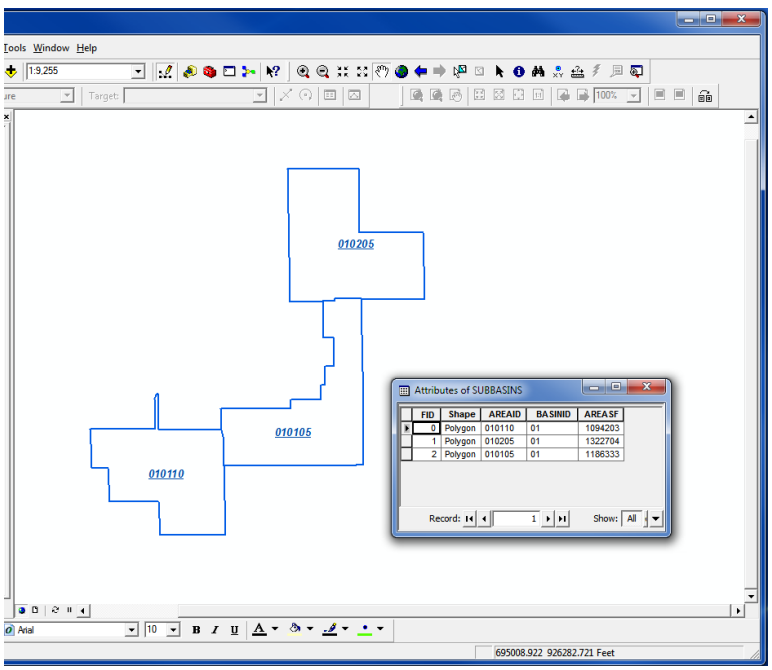
The Rainfall map (*Rainfall.shp*) will contain a single polygon with two attribute fields namely, "**RAINID**" and **"BASINID"**. **RAINID** is a Character 8 data type, indicating a Text or String data field that is 8 characters long. **BASINID,** on the other hand, is a Character 2 data type indicating a Text or String data field of 2 characters long. The Rainfall map can be created after the Sub Basins map (*Subbasins.shp*) has been prepared and is the combined polygon area of all the modeled Sub Basins.



(B.2) Sub Basins

The Sub Basins map (*Subbasins.shp*) will contain one polygon for each Sub Basin in the project. The required fields include:

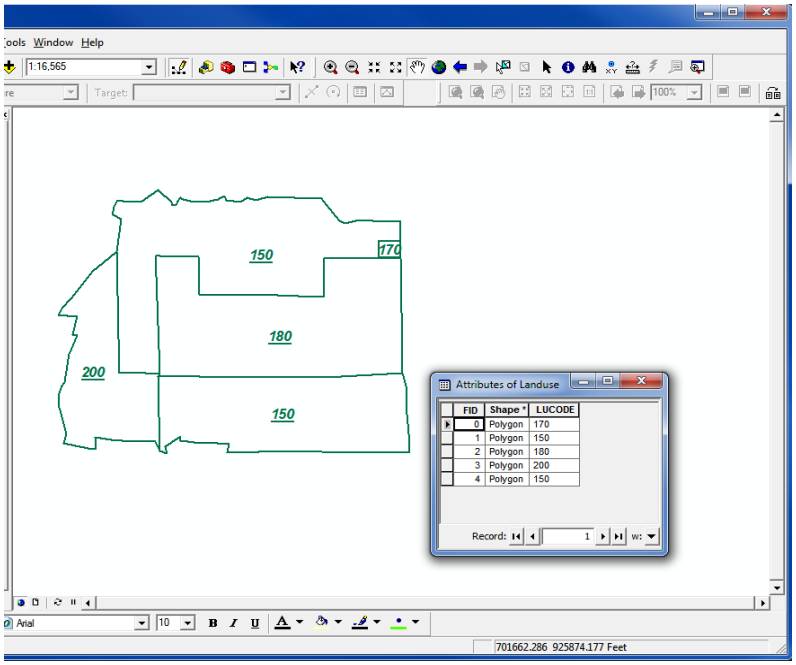
- **AREAID** Character 6 Enter unique **SubBasin ID**
- **BASINID** Character 2 Enter **Major Basin ID**
- **AREASF** Numeric 12.0 Data entered into this field will be overwritten internally by DDMSW. This field contains the Sub Basin area in square feet. The data for this field is calculated automatically when the **Update** button is clicked in the **UPDATE HYDROLOGY FROM GIS** form in DDMSW.



(B.3) Land Use

The Land Use map (*Landuse.shp*) will contain polygons for Land Use data. There can be more than one polygon with the same **Land Use ID**. It is vitally necessary that the Land Use coverage extends beyond the extent of all Sub Basins. The only required attribute field for the Land Use map is:

- **LUCODE** Character 15 **LUCODE** values should be consistent with the values in the DDMSW Land Use defaults table.

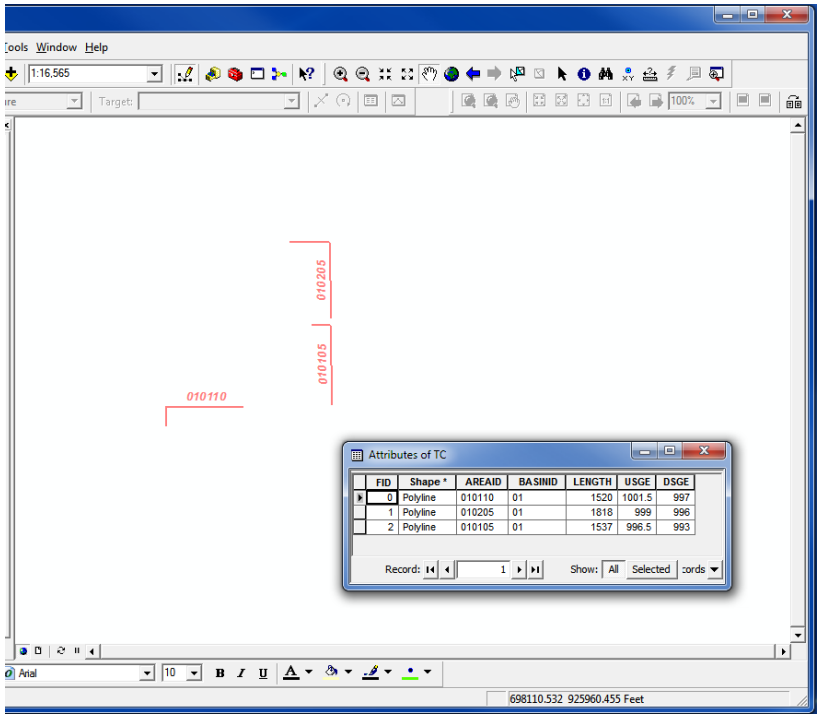


(B.4) Tc

The Time of Concentration map (*Tc.shp*) will contain polylines for Tc data. There needs to be one Tc polyline for each Sub Basin in the project and each polyline must be completely contained within its respective Sub Basin. The required fields include:

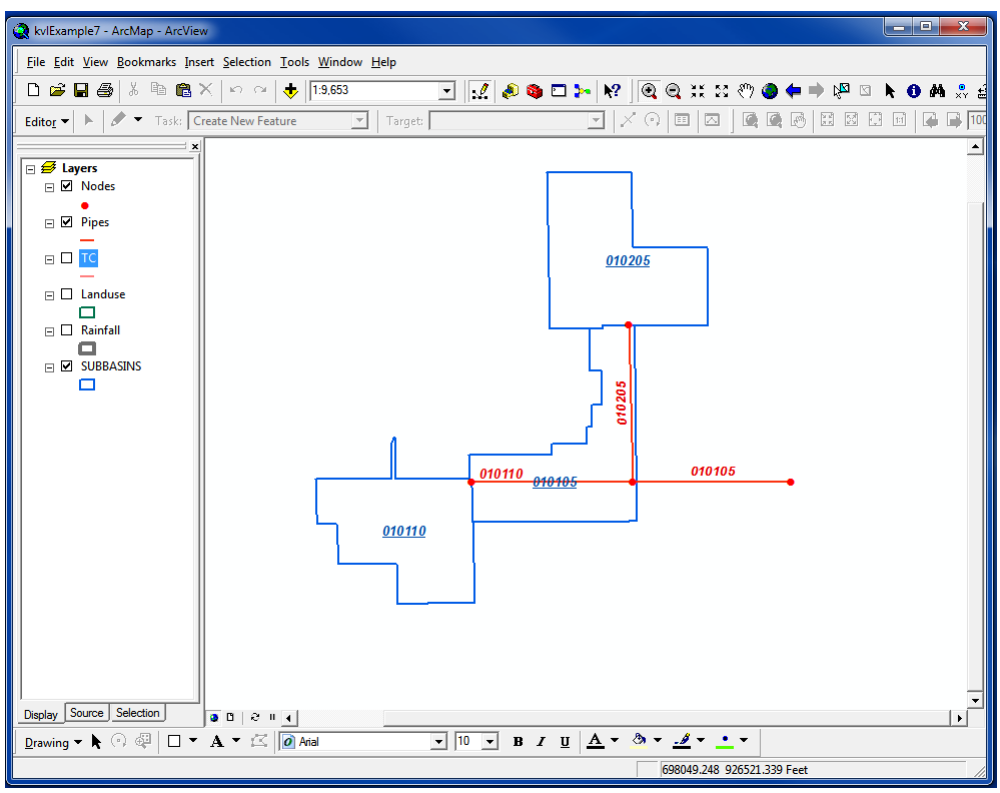
- **AREAID** Character 6 This is determined internally by DDMSW.
- **BASINID** Character 2 This is determined internally by DDMSW.
- **LENGTH** Numeric 12.0 The value of this attribute field is calculated internally by DDMSW
- **USGE** Numeric 9.2 Enter the upstream ground elevation in feet.
- **DSGE** Numeric 9.2 Enter the downstream ground elevation in feet.

The data for **AREAID**, **BASINID** and **LENGTH** are populated automatically when the **Update** button is clicked in the **UPDATE HYDROLOGY FROM GIS** form. Any data manually entered will be over-written.



(B.5) Layout

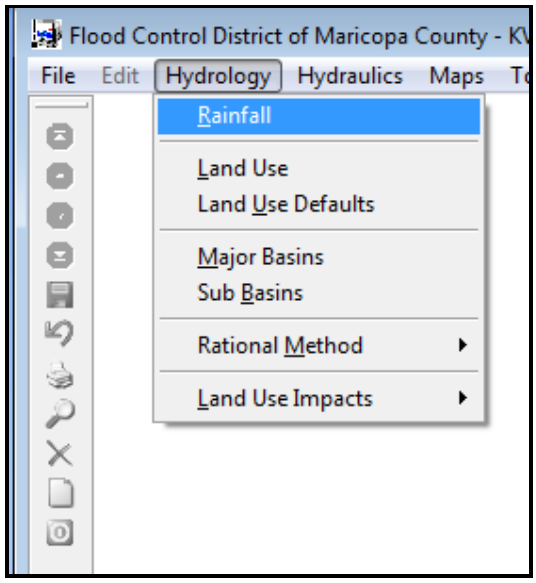
This map is for information only. It shows the layout of the Pipes (*Pipes.shp*) and Sub Basins (*Subbasins.shp*). Use this map as a guide when establishing the model network (which will be done later in this tutorial).



(C) Step 3 - Establish Rainfall Data from GIS

(C.1) Rainfall

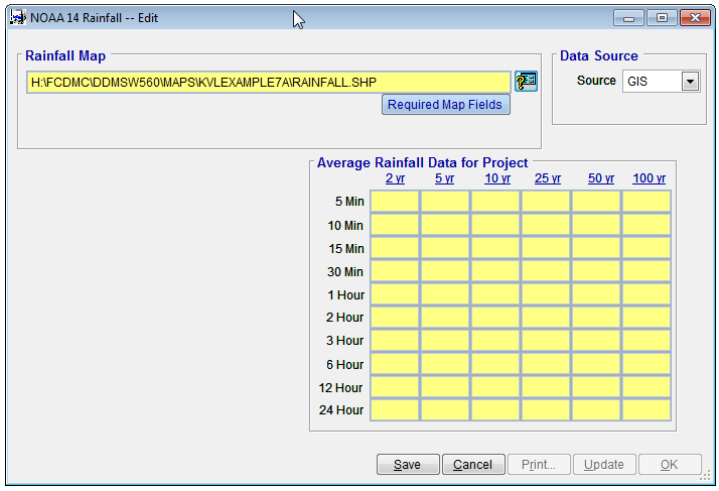
(a) From the menu bar of the main application window, click **Hydrology ➔ Rainfall** as shown in the following figure to open the **NOAA 14 RAINFALL** window.



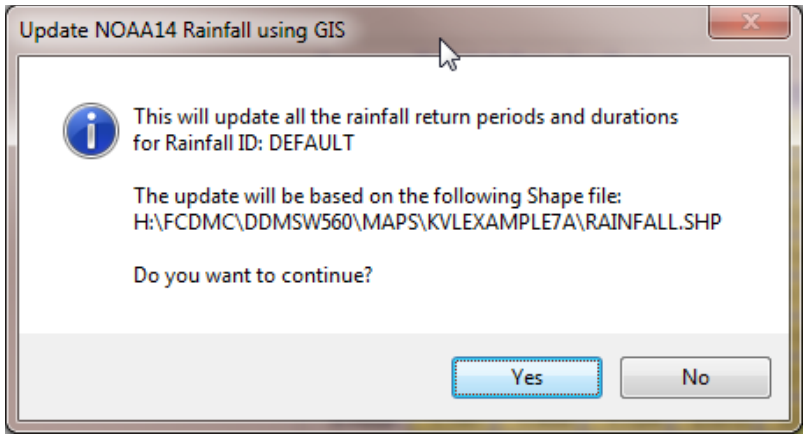
(b) Ensure that the **Data Source** is set to "*GIS*". If the **Data Source** is not yet set to "*GIS*" then select "*GIS*" from the pull down menu

(c) Click on the button in the **Rainfall Map** textbox and select the Rainfall (*Rainfall.shp*) established earlier. It may be necessary to migrate to the folder where the shape file is in.

(d) After selecting the rainfall map (*Rainfall.shp*), click the **Save** button.

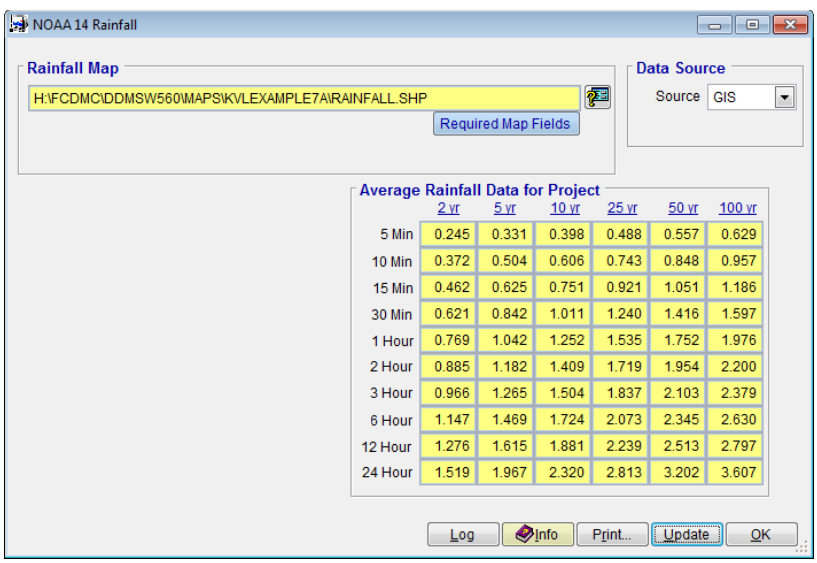


(e) Click **Update** to create the NOAA14 rainfall data from the **GIS** map. An **UPDATE NOAA14 RAINFALL USING GIS** dialog box will appear as shown below.



(f) Click **Yes** to proceed.

(g) When the update is finished, you will see the following results:



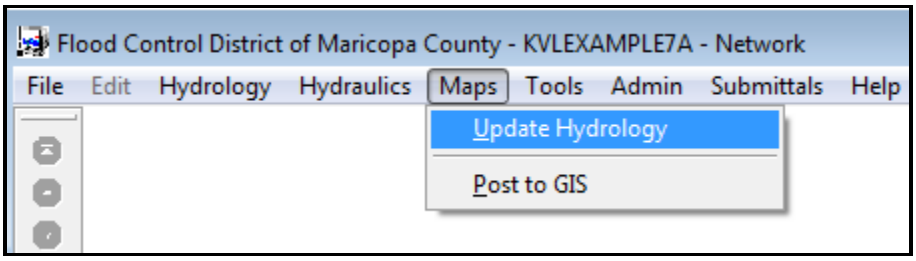
	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr
5 Min	0.245	0.331	0.398	0.488	0.557	0.629
10 Min	0.372	0.504	0.606	0.743	0.848	0.957
15 Min	0.462	0.625	0.751	0.921	1.051	1.186
30 Min	0.621	0.842	1.011	1.240	1.416	1.597
1 Hour	0.769	1.042	1.252	1.535	1.752	1.976
2 Hour	0.885	1.182	1.409	1.719	1.954	2.200
3 Hour	0.966	1.265	1.504	1.837	2.103	2.379
6 Hour	1.147	1.469	1.724	2.073	2.345	2.630
12 Hour	1.276	1.615	1.881	2.239	2.513	2.797
24 Hour	1.519	1.967	2.320	2.813	3.202	3.607

(h) Click the **OK** button to close the **NOAA 14 RAINFALL** window.

(D) Step 4 - Establish Sub Basin and Land Use Data from GIS

The project's Sub Basin and Land Use data can be populated in DDMSW from the maps created earlier.

(a) From the menu bar of the main application window, click **Maps ➔ Update Hydrology** as shown in the following figure to open the **UPDATE HYDROLOGY FROM GIS** window.



(b) In the **Update Options** frame, check the **Land Use** and **Tc** check boxes.

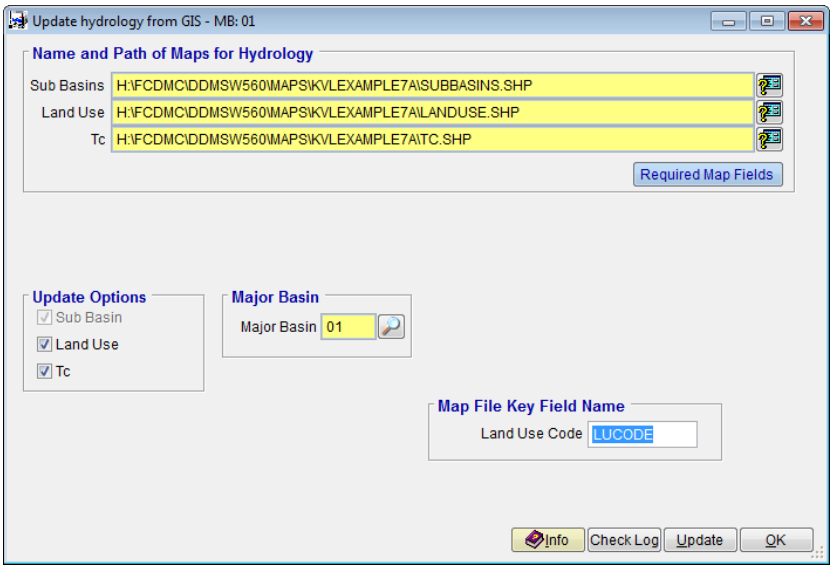
(c) In the **Map File Key Field Name** frame, enter "*LUCODE*" for **Land Use Code**.

(d) Click the button to the right of the **Sub Basins** and select the *SUBBASINS.shp* file. It may be necessary to migrate to the appropriate folder

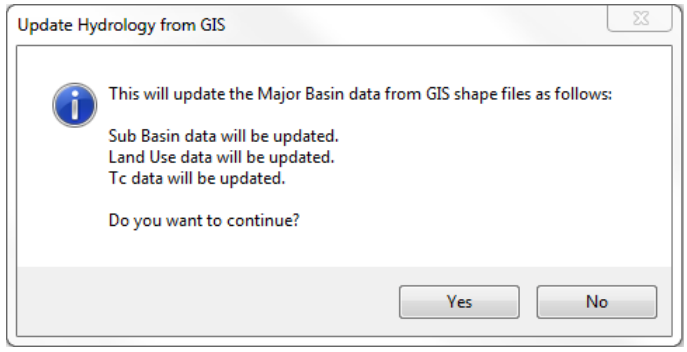
(e) Click the to the right of the **Land Use** and select the *Landuse.shp* file

(f) Click the button to the right of the **Tc** and select the *TC.shp* file

(g) Click **Save.** After saving the entries, the form should look like the figure below.



(h) Click **Update**. An **UPDATE HYDROLOGY FROM GIS** dialog box will appear as shown below.



(i) Click **Yes** to continue.

(j) Click the **OK** button to close the **UPDATE HYDROLOGY FROM GIS** window.

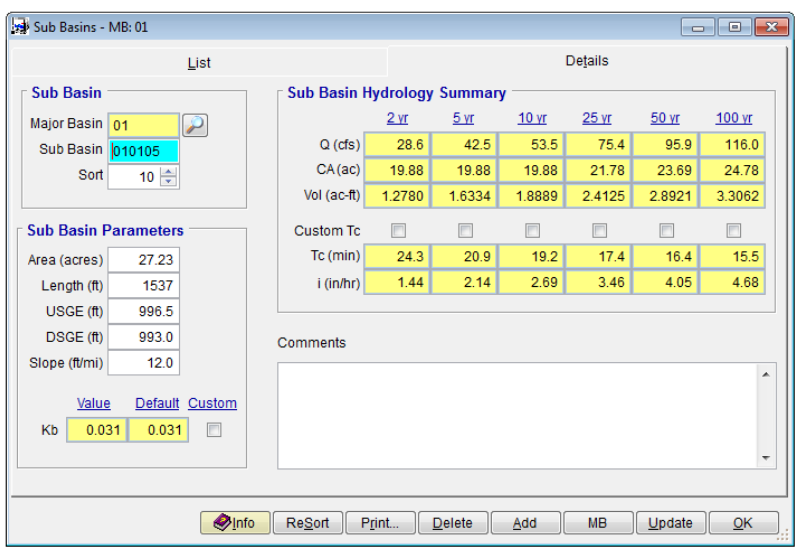
(E) Step 5 - Review the Established Sub Basin and Land Use Data

The Sub Basin and Land Use data has been developed from the GIS maps. It is necessary to review the data to make sure everything looks sensical.

(E.1) Sub Basins

(a) From the menu bar of the main application window, click **Hydrology ➔ Sub Basins** to open the **SUB BASINS** form.

(b) Click on the **Details** tab to view the data results summary of the three sub basins. The screen shot provided below shows the detailed data results summary for **Sub Basin** *"010105".*

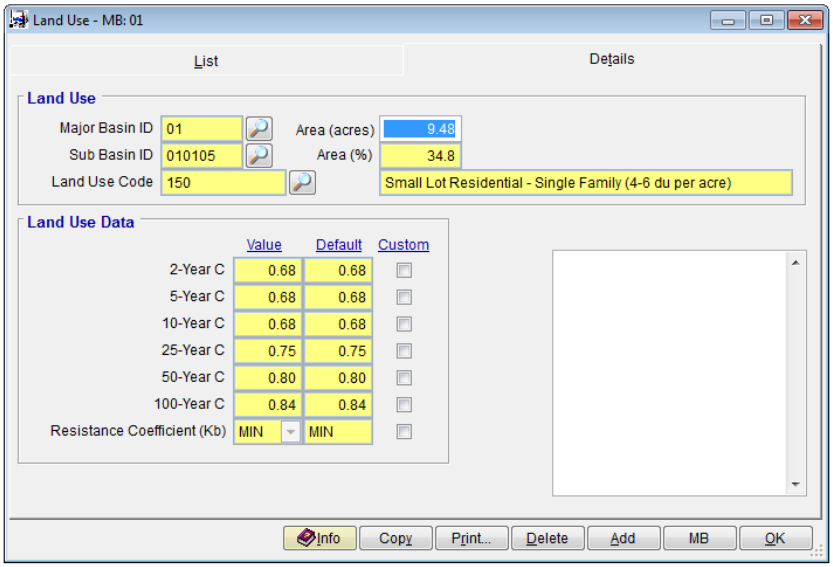


(c) Click the **OK** button to close the **SUB BASINS** window.

(E.2) Land Use

(a) From the menu bar of the main application window, click **Hydrology ➔ Land Use** to open the **LAND USE** form.

(b) Click on the **Details** tab to view the data



(c) Click the **OK** button to close the **LAND USE** window.

(F) Step 6 - Establish Conveyance Facility Data

To enter Conveyance Facility data, which include the pipe network that conveys the system flows, do the following steps:

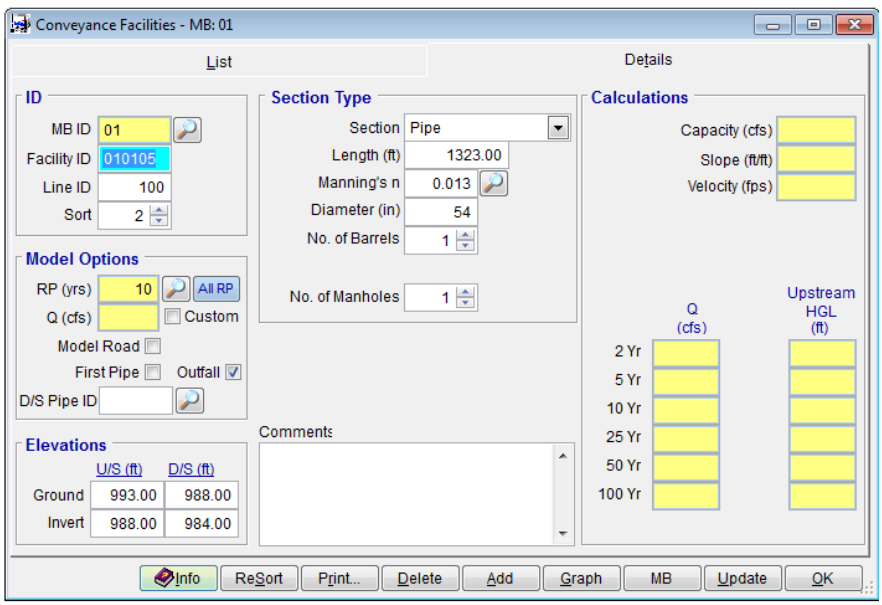
(a) From the menu bar of the main application window, click **Hydraulics ➔ Conveyance Facilities** to open the **CONVEYANCE FACILITIES** window.

(b) Click the **Add** button to add a record and enter the following data:

- **Facility ID:** Enter *"010105"*
- **Line ID:** Enter*"100"*
- **RP (yrs):** Select *"10"* from the **RP (yrs)** drop down by clicking on the magnifying glass.
- **Model Road:** Uncheck the **Model Road** checkbox in the **Model Options** frame.
- **First Pipe:** Uncheck the **First Pipe** checkbox in the **Model Options** frame.
- **Outfall:** Check the **Outfall** checkbox in the **Model Options** frame. This is the outfall for the Main Pipe.
- **D/S Pipe ID:** Leave the **D/S Pipe ID** textbox blank.

- **Ground U/S (ft):** Enter "*993.00*" in the **Elevations** frame
- **Ground D/S (ft):** Enter "*988.00*" in the **Elevations** frame
- **Invert U/S (ft):** Enter "*988.00*" in the **Elevations** frame
- **Invert D/s (ft):** Enter "*984.00*" in the **Elevations** frame
- **Section:** Select "*Pipe*" from the pull down in the **Section Type** frame
- **Length (ft):** Enter "*1323.00*" in the **Section Type** frame
- **Manning's n:** Select *"Concrete Pipe for closed conduit"* in the **Section Type** frame by clicking on the magnifying glass.
- **Diameter (in):** Enter "*54*" in the **Section Type** frame
- **No. of Barrels:** Enter *"1"* in the **Section Type** frame.
- **No. of Manholes:** Enter *"1"* in the **Section Type** frame.

(c) Click the **Save** button to save the entered data. The completed data form for **Facility ID** "*010105*" should look like the following figure:

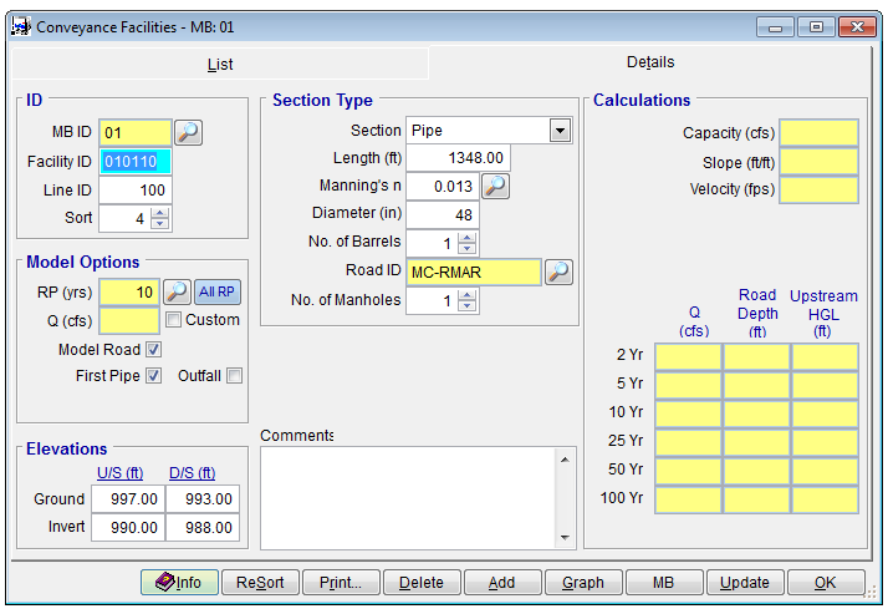


(d) Click **Add** to add a new record and enter the following data:

- **Facility ID:** Enter "*010110*"
- **Line ID:** Enter *"100"*
- **Model Road:** Check the **Model Road** check box in **the Model Options** frame
- **First Pipe:** Check the **First Pipe** check box in the **Model Options** frame
- **Outfall:** Uncheck the **Outfall** checkbox in the **Model Options** frame.

- **Ground U/S (ft):** Enter *"997.00"* in the **Elevations** frame
- **Ground D/S (ft):** Enter *"993.00"* in the **Elevations** frame
- **Invert U/S (ft):** Enter *"990.00"* in the **Elevations** frame
- **Invert D/S (ft):** Enter *"988.00"*in the **Elevations** frame
- **Section:** Select *"Pipe"* from the pull down in the **Section Type** frame
- **Length (ft):** Enter *"1348.00"* in the **Section Type** frame
- **Manning's n:** Select *"Concrete Pipe for closed conduit"* in the **Section Type** frame by clicking on the magnifying glass
- **Diameter (in):** Enter *"48"* in the **Section Type** frame
- **No. of Barrels:** Enter *"1"* in the **Section Type** frame
- **Road ID:** Select *"MC-RMAR"* in the **Section Type** frame by clicking on the magnifying glass
- **No. of Manholes:** Enter *"1"* in the **Section Type** frame

(e) Click the **Save** button to save the entered data. The completed data form for **Facility ID***"010110"* should look like the following figure:

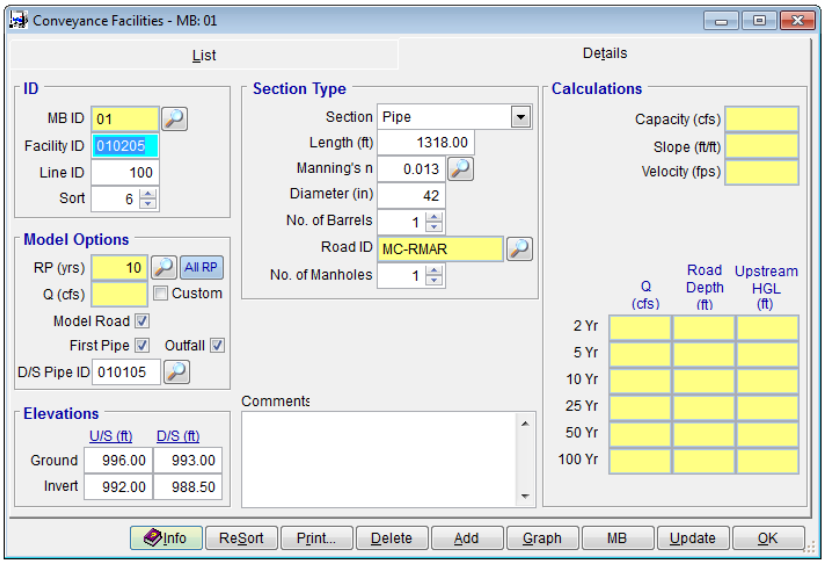


(f) Click **Add** to add another record and enter the following data:

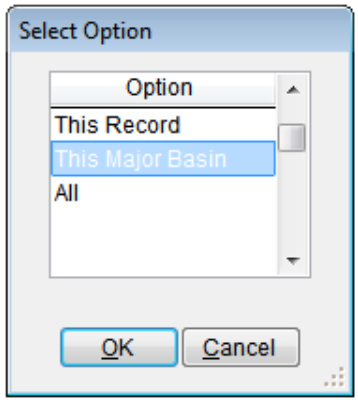
- **Facility ID**: Enter *"010205"*
- **Model Road**: Check the **Model Road** in the **Model Options** frame
- **First Pipe**: Check the **First Pipe** in the **Model Options** frame
- **Outfall:** Check the **Outfall** checkbox in the **Model Options** frame. This is the outfall for the lateral pipe.

- **D/S Pipe ID:** Click the "Magnifying Glass" on the right of the **D/S Pipe ID** textbox and select *"10105".*
- **Ground U/S (ft):** Enter *"996.00"* in the **Elevations** frame
- **Ground D/S (ft)**: Enter *"993.00"* in the **Elevations** frame
- **Invert U/S (ft)**: Enter *"992.00"* in the **Elevations** frame
- **Invert D/S (ft)**: Enter *"988.50"* in the **Elevations** frame
- **Section:** Select *"Pipe"* from the pull down in the **Section Type** frame
- **Length (ft):** Enter *"1318.00"*in the **Section Type** frame
- **Manning's n:** Select *"Concrete Pipe for closed conduit"* in the **Section Type** frame by clicking on the magnifying glass
- **Diameter (in):** Enter *"42"* in the **Section Type** frame
- **No. of Barrels:** Enter *"1"* in the **Section Type** frame
- **Road ID:** Select *"MC-RMAR"* in the **Section Type** frame by clicking on the magnifying glass
- **No. of Manholes:** Enter *"1"* in the **Section Type** frame

(g) Click the **Save** button to save the entered data. The completed data form for Facility ID*"010205"* should look like the following figure:



(h) Click the **Update** button to perform hydraulic analysis for the conveyance facilities.

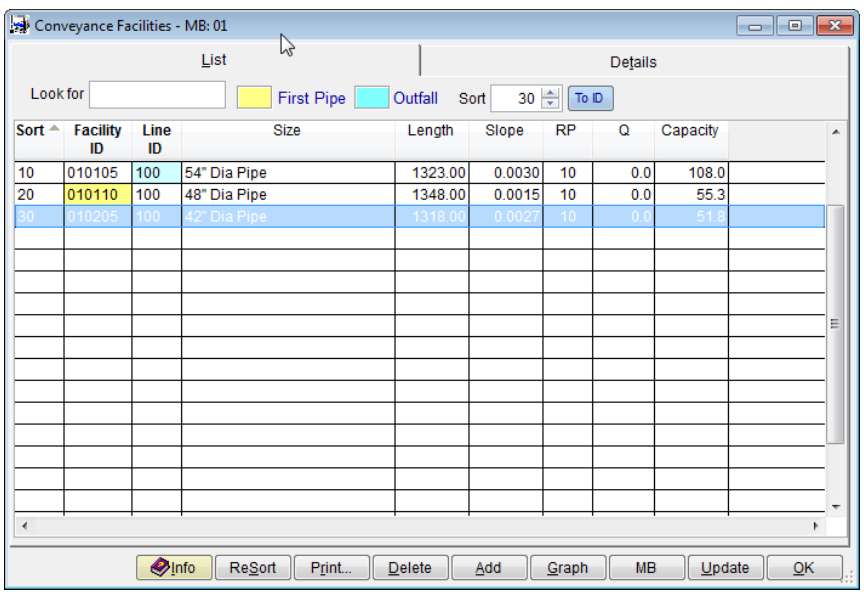


(i) Select "*This Major Basin*" from the **SELECT OPTION** window.

(j) Click **OK** to continue.

(k) When the **UPDATE CONVEYANCE DATA** dialog box appears, click **Yes**.

The Normal Depth Capacity of the Conveyance facilities are calculated as shown below.



Sort	Facility ID	Line ID	Size	Length	Slope	RP	Q	Capacity
10	010105	100	54" Dia Pipe	1323.00	0.0030	10	0.0	108.0
20	010110	100	48" Dia Pipe	1348.00	0.0015	10	0.0	55.3
30	010205	100	42" Dia Pipe	1318.00	0.0027	10	0.0	51.8

(l) Click the **OK** button to close the **CONVEYANCE FACILITIES** window.

(G) Step 7 - Develop Rational Method Network

To enter Network data do the following:

(a) From the menu bar of the main application window, click **Hydrology ➔ Rational Method ➔ Network** to open the **RATIONAL METHOD NETWORK** window.

(b) Click **Add** to add a record and select **Sub Basin** from the **SELECT TYPE** window.

(c) Click **OK** to close the **SELECT TYPE** window.

(d) Click the button "Magnifying Glass" to the right of **ID** and select **Sub Basin ID***"010205".*

(e) Click **OK** to close the **SUB BASIN ID** window.

(f) Click **Save** to save the entered data.

(g) Click **Convey** and select *"010205"* from the **CONVEYANCE ID** window.

(h) Click **OK** to close the **CONVEYANCE ID** window.

(i) Click **Hold** and select *"010205"*from the **HOLD ID** window.

(j) Click **OK** to close the **HOLD ID** window.

(k) Click **Sub Basin** and select *"010110"* from the **SUB BASIN ID** window.

(l) Click **OK** to close the **SUB BASIN ID** window.

(m) Click **Convey** and select *"010110"*from the **CONVEYANCE ID** window.

(n) Click **OK** to close the **CONVEYANCE ID** window.

(o) Click **Receive** and select *"010205"* from the **RECEIVE ID** window.

(p) Click **OK** to close the **RECEIVE ID** window.

(q) Click **Sub Basin** and select *"010105"* from the **SUB BASIN ID** window.

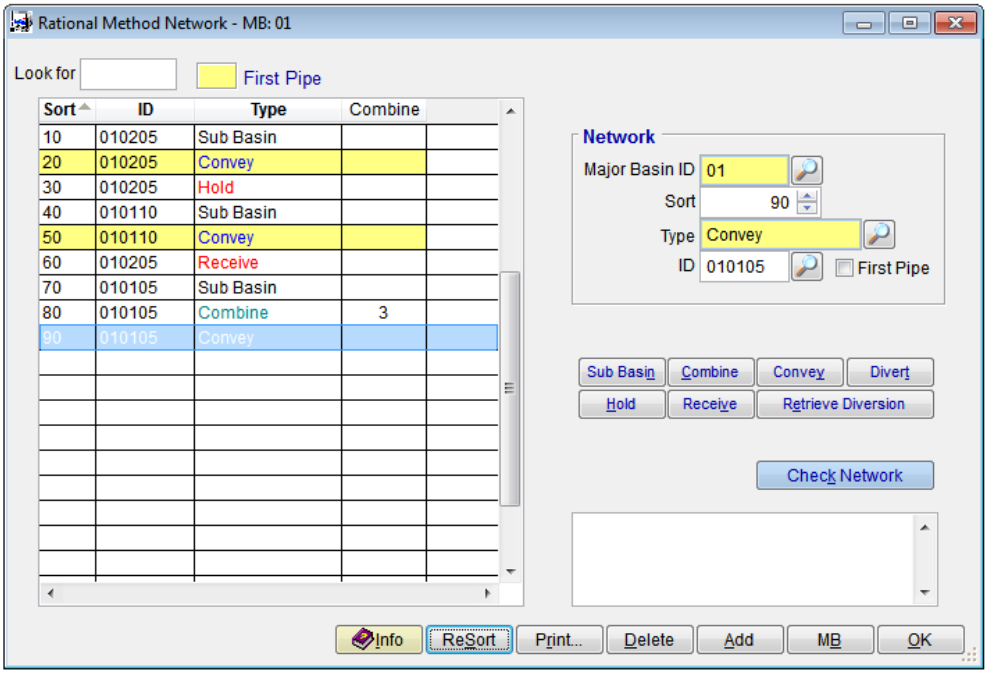
(r) Click **OK** to close the **SUB BASIN ID** window.

(s) Click the **Combine** button and change the **Combine** value from *"2"* to *"3"* in the **Network** frame.

(t) Click **Save** to save the data.

(u) Click **Convey** and select *"010105"* from the **CONVEYANCE ID** window.

(v) Click **ReSort** to resort the data in increments of *"10".*



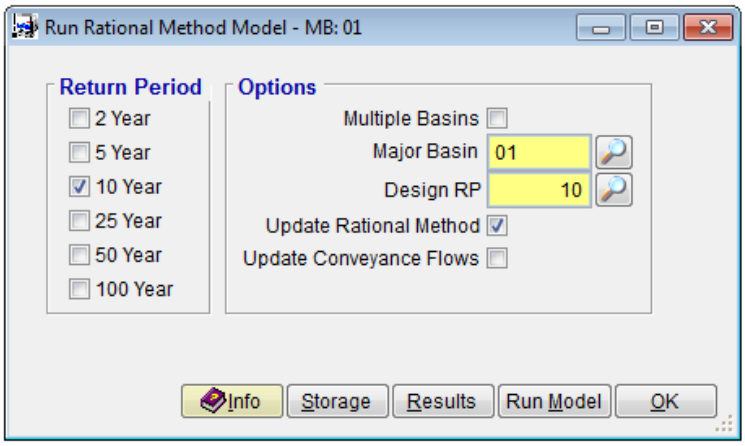
(w) Click the **OK** button to close the **RATIONAL METHOD NETWORK** window.

(H) Step 8 - Run Rational Method Model

To run a Draft Model of the Rational Method, do the following steps:

(a) From the menu bar of the main application window, click **Hydrology ➔ Rational Method ➔ Model** to open the **RUN RATIONAL METHOD MODEL** window.

(b) Using a ***10-Year*** **Return Period**, and with the **Update Rational Method** check box checked, run the model by clicking the **Run Model** button.



(H.1) Run Model

If there are no errors running the Draft Model, then do the following:

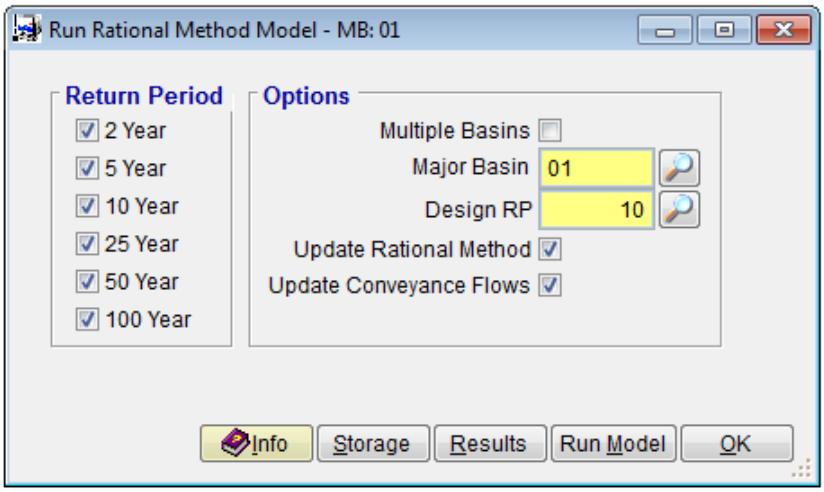
(a) Check all return periods

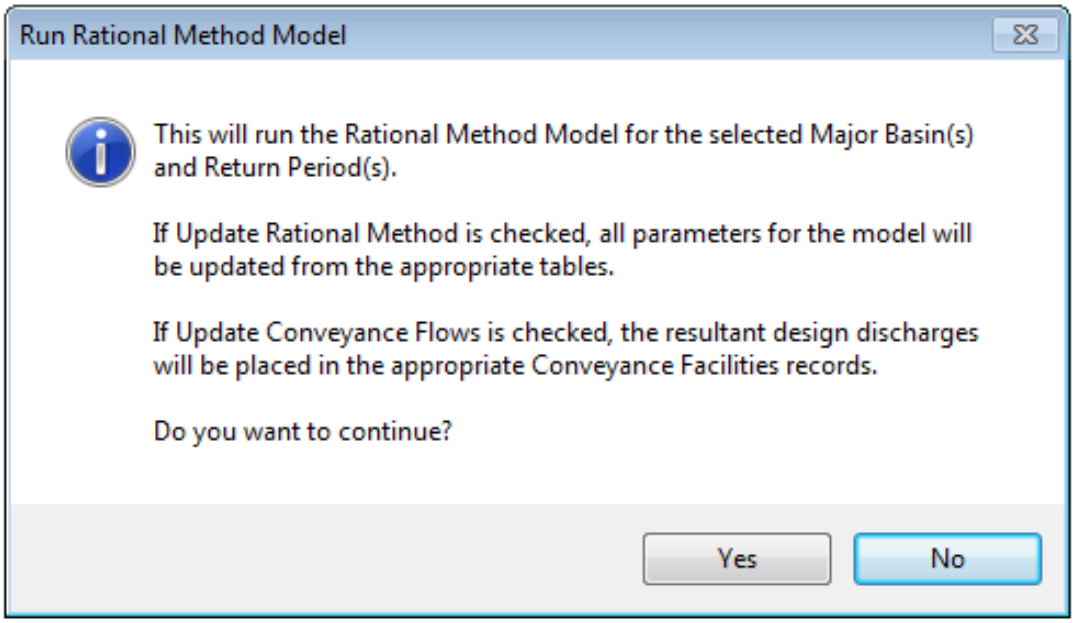
(b) Check the **Update Rational Method** check box

(c) Check the **Update Conveyance Flows** check box

(d) Click **Save**

(e) Click **Run Model**.





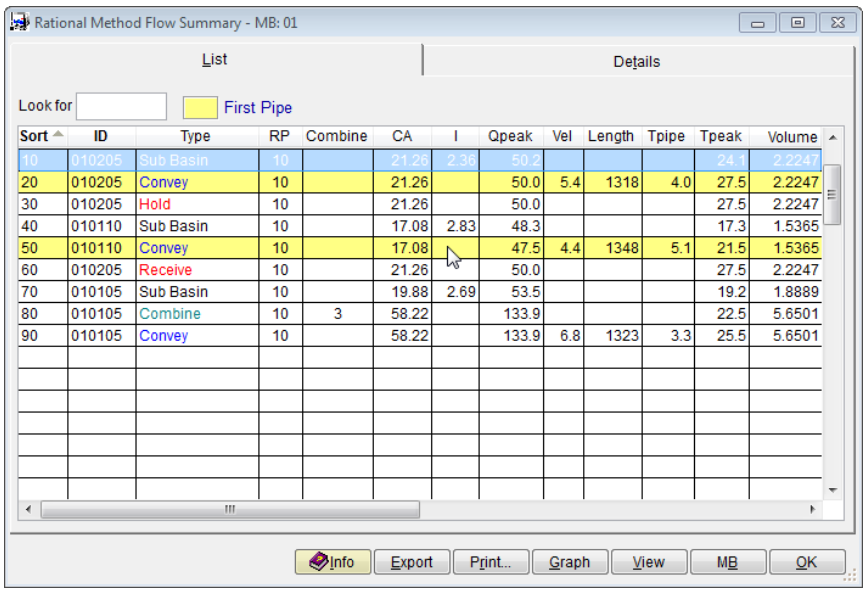
(f) When the **RUN RATIONAL METHOD MODEL** dialog box appears, click **Yes** to continue.

(g) Click the **OK** button to close the Window.

(I) Step 9 - Review Model Results

To view the model results from the Rational Method analysis, do the following steps:

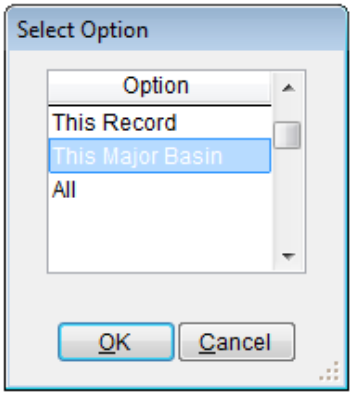
(a) From the menu bar of the main application window, click **Hydrology ➔ Rational Method ➔ Flow Summary** to open the **RATIONAL METHOD FLOW SUMMARY** window.



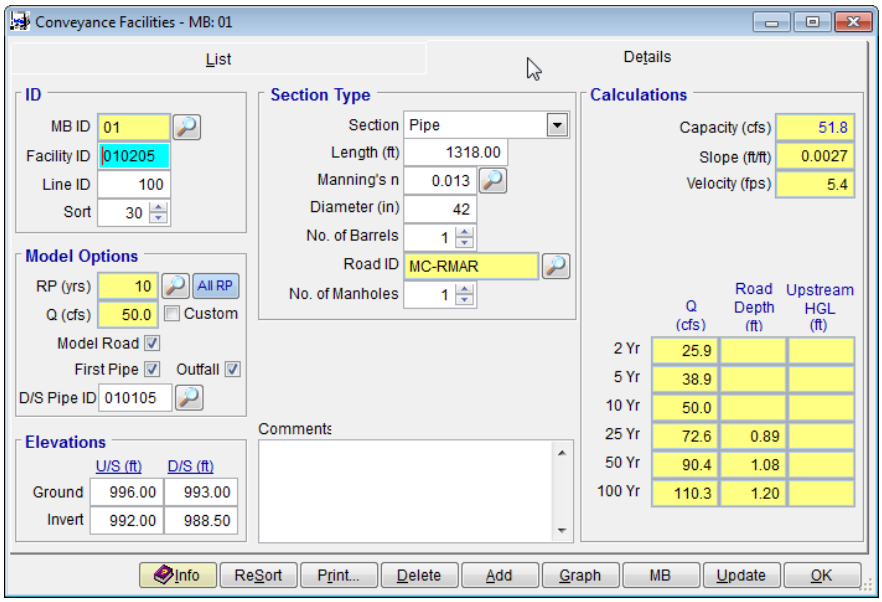
Sort	ID	Type	RP	Combine	CA	I	Qpeak	Vel	Length	Tpipe	Tpeak	Volume
10	010205	Sub Basin	10		21.26	2.36	50.2				24.1	2.2247
20	010205	Convey	10		21.26		50.0	5.4	1318	4.0	27.5	2.2247
30	010205	Hold	10		21.26		50.0				27.5	2.2247
40	010110	Sub Basin	10		17.08	2.83	48.3				17.3	1.5365
50	010110	Convey	10		17.08		47.5	4.4	1348	5.1	21.5	1.5365
60	010205	Receive	10		21.26		50.0				27.5	2.2247
70	010105	Sub Basin	10		19.88	2.69	53.5				19.2	1.8889
80	010105	Combine	10	3	58.22		133.9				22.5	5.6501
90	010105	Convey	10		58.22		133.9	6.8	1323	3.3	25.5	5.6501

(b) To view the model conveyance results, click **Hydraulics ➔ Conveyance Facilities** to open the **CONVEYANCE FACILITIES** window.

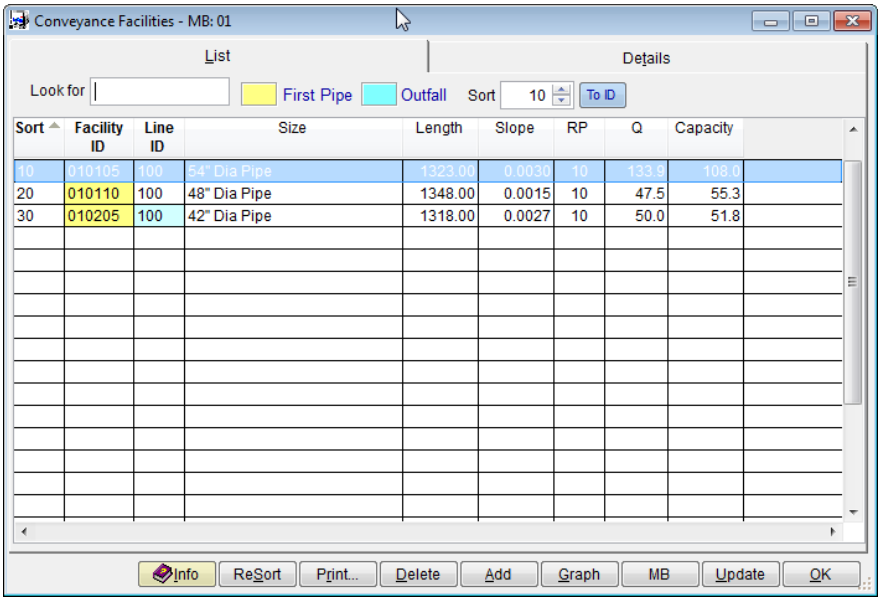
(c) Migrate to **Facility ID***"010105"* and click **Update**. This will update Road Depths of flow.



(d) Select **This Major Basin**. The following form shows the results for **Facility ID***"010205"*



(e) Further, the Conveyance Facilities (**Hydraulics ➔ Conveyance Facilities**) summary results show the calculated Q for each pipe.

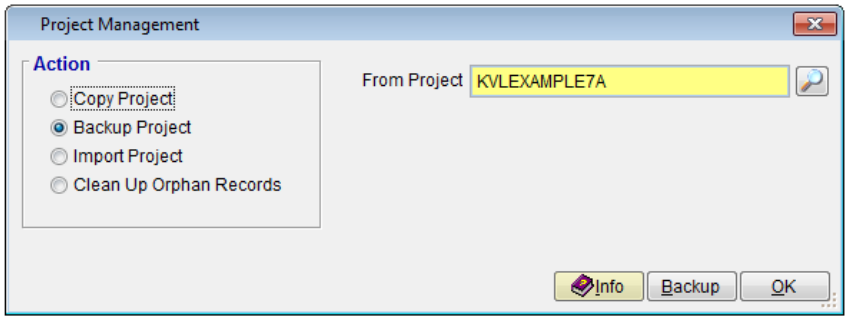


(f) Click **OK** to close the **Conveyance Facilities** window.

(J) Step 10 - Backup Project

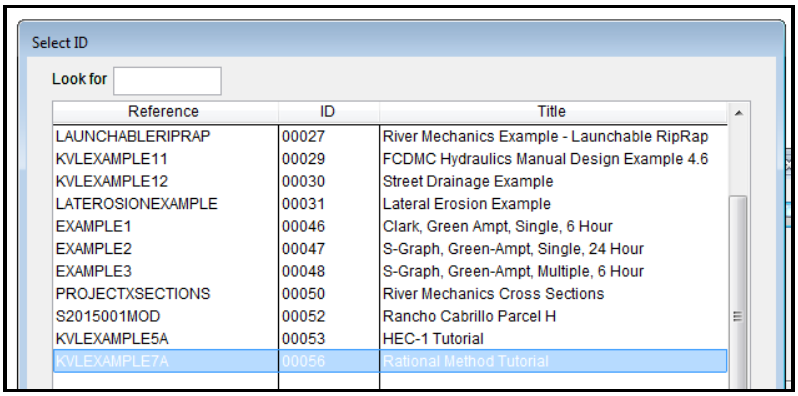
To create backup files for the project, perform the following steps:

(a) From the menu bar of the main application window, click **File ➔ Project Management** to open the **PROJECT MANAGEMENT** window.



(b) Check **Backup Project**

(c) Click the "Magnifying Glass" button to the right of **From Project** textbox to open the **SELECT ID** window.

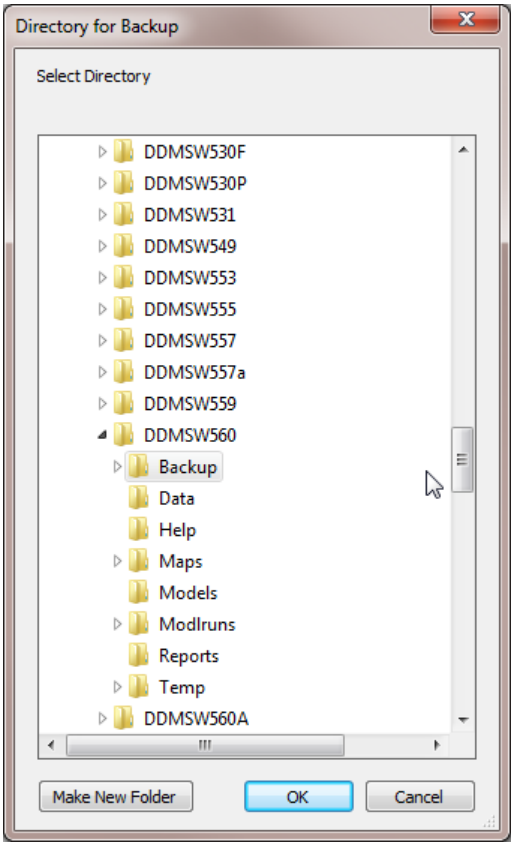


(d) Select "*KVLEXAMPLE7A*" (if not already selected) and click the **OK** button to close the window.

(e) Click **Save** to save the data on the **PROJECT MANAGEMENT** window.

(f) Click **Backup**.

(g) Select a folder where to save your backup file(s) (defaults to **Backup** sub directory)



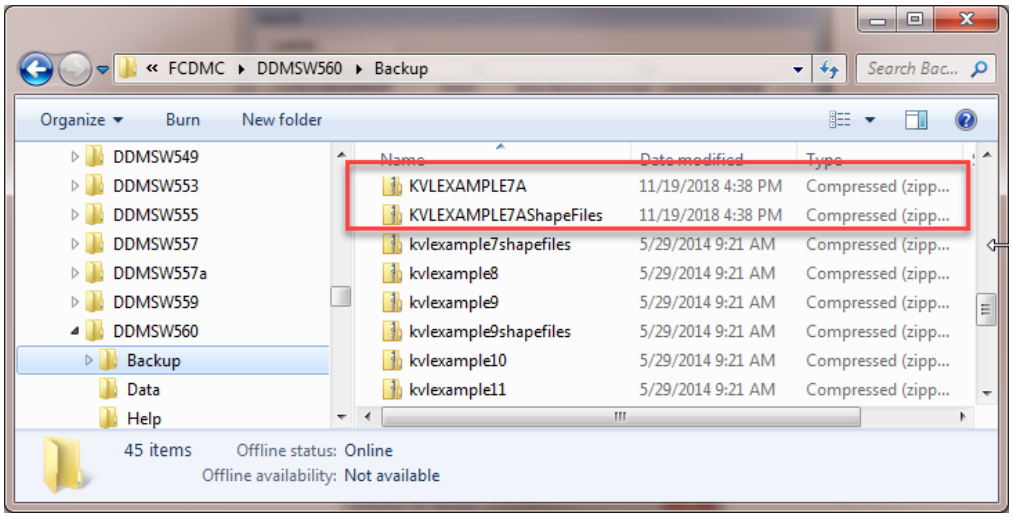
(h) Click **OK** to create backup file(s) for KVLEXAMPLE7A.

(i) After the backup file(s) has been successfully created, click **OK** to close the **PROJECT MANAGEMENT** dialog box.

(j) To check the backup file(s) that were just created, navigate to the **Backup** folder. Notice the two new zip files in the list as follows:

(1) KVLEXAMPLE7A.zip

(2) KVLEXAMPLE7AShapeFiles.zip



This concludes this tutorial.

1.3 STORMPRO BACKWATER MODEL

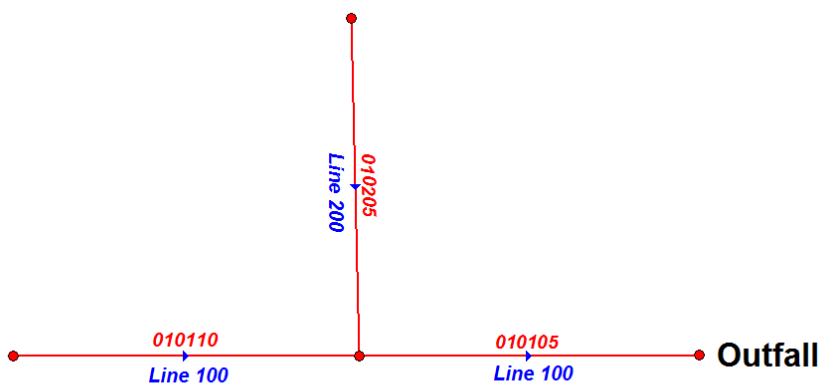
1.3.1 Problem Statement

This tutorial provides a working example for the use of the **STORMPRO** Backwater Model. For this example, before developing the backwater model, it is necessary to develop the hydrology using the Rational Method and enter the data for all conveyance facilities. The detailed procedure for the Rational Method and Conveyance Facilities for this tutorial is provided in **SECTION 1.2 - RATIONAL METHOD**. This tutorial starts after the **RATIONAL METHOD TUTORIAL** in **SECTION 1.2** is concluded.

1.3.2 Step-by-Step Procedures

The specific requirements for running **STORMPRO** using the pipe network shown below include:

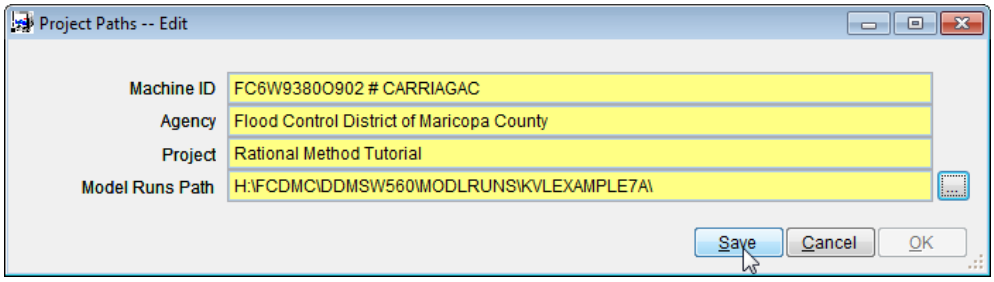
1. Establishing a folder for the model runs
2. Modifying the Conveyance Facilities
3. Establishing the details for the Line IDs
4. Running the Model
5. Viewing Backwater Conveyance Results
6. Creating Backup for the Project



KvlExample7A Pipe Network

(A) Step 1 - Establish a Folder for Model Runs
(File ➔ Project Paths)

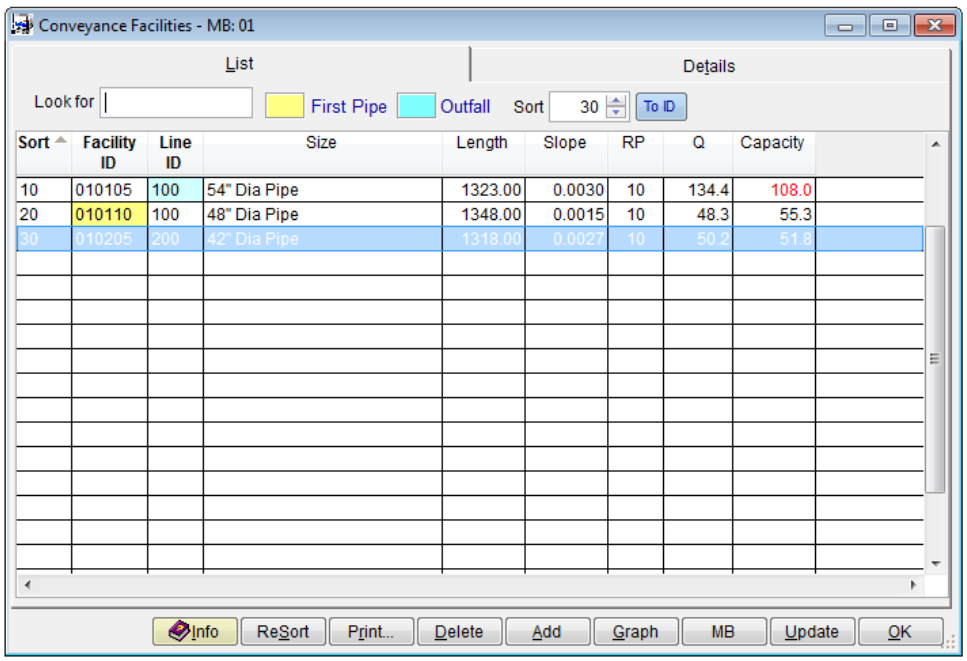
For this example, create a new folder in **\ModlRuns**:



(B) Step 2 - Modify the Conveyance Facilities

(Hydraulics ➔Conveyance Facilities)

The screen captures provided below shows the current data in the **CONVEYANCE FACILITIES** form. Some data that were not required when completing the **CONVEYANCE FACILITIES** form for Rational Method are now required for the **STORMPRO** Backwater Model.



Sort	Facility ID	Line ID	Size	Length	Slope	RP	Q	Capacity
10	010105	100	54" Dia Pipe	1323.00	0.0030	10	134.4	108.0
20	010110	100	48" Dia Pipe	1348.00	0.0015	10	48.3	55.3
30	010205	200	42" Dia Pipe	1318.00	0.0027	10	50.2	51.8

Provided below are brief descriptions of important data items on the **CONVEYANCE FACILITIES** form:

Line ID: **STORMPRO** models each line separately starting with the lowest **Line ID.** It is important to enter the **Line ID**'s in the order that the model should run. This is to establish the starting water surface elevation for Lines entering another Line. In the above network, all conveyance facilities in the **Main Line** (that goes to an Outfall) are labeled **Line ID**"*100*". The upstream Line in this example is labeled **Line ID**"*200*".

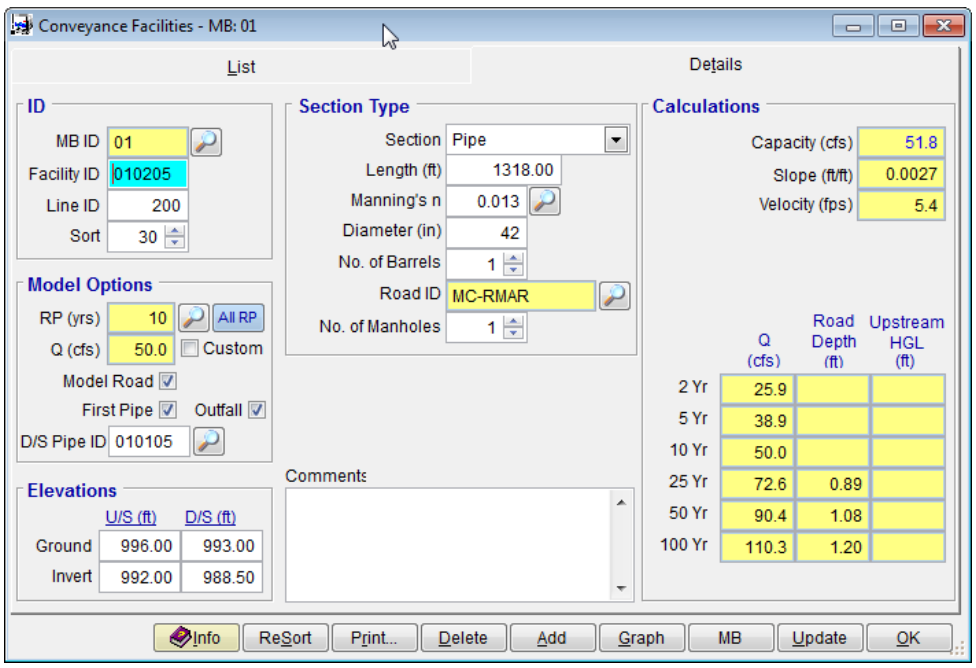
Sort: For **StormPro** to run correctly, the **Facility ID**'s must be sorted in the order from Downstream to Upstream**.** Use the **Sort** field to force the correct order. **This is critical.**

Outfall: If a **Facility ID** is an Outfall, then check the **Outfall** checkbox. In this case, there are two outfalls. They are **Facility IDs** *"010105"* and *"010205"* for **Line IDs** *"100"* and *"200",* respectively.

D/S Pipe ID: If a **Facility ID** enters a Downstream Line, then enter the **D/S Pipe ID.** In the case of **Facility ID** *"010205"* for **Line ID** *"200"*, enter **Pipe ID** *"010105"* (of **Line ID***"100"*) as the **D/S Pipe ID**.

Manholes: Enter the number of manholes in each **Facility ID**.

The screen capture of the form for **Facility ID** *"010205"* is shown below.

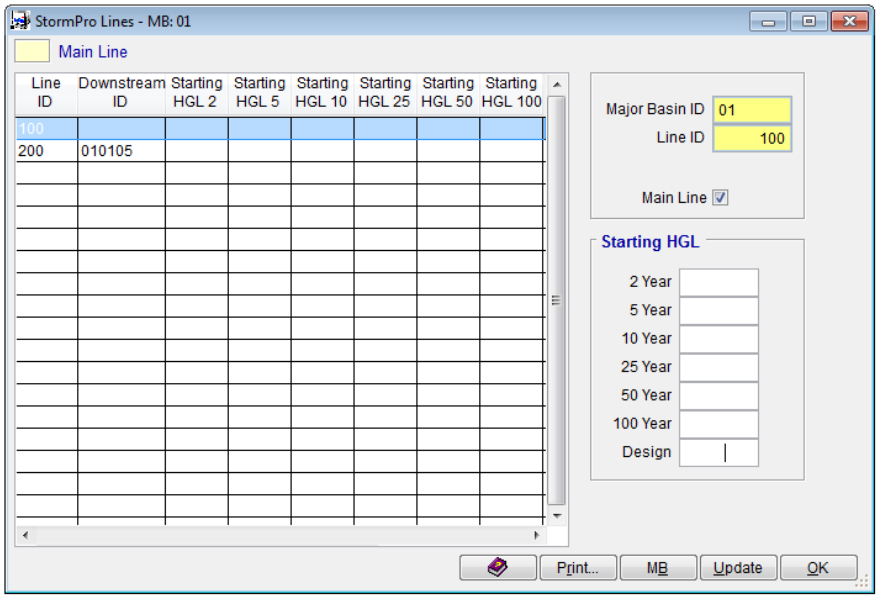


(C) Step 3 - Establish the Line IDs
(Hydraulics ➔StormPro Backwater ➔Lines)

When first going into this form, there will be no data and there will not be an **Add** button. The data for the Lines is established when clicking the **Update** button.

In this case, a warning will be given that there is no **Downstream ID** for **Line ID** *"100"* (because it is an **Outfall**). For this **Line ID** *"100"*, check **Main Line** and click

Update. It is important to note that if the Conveyance Facilities are modified, then the **StormPro** Lines should be updated before running a **StormPro** Model.

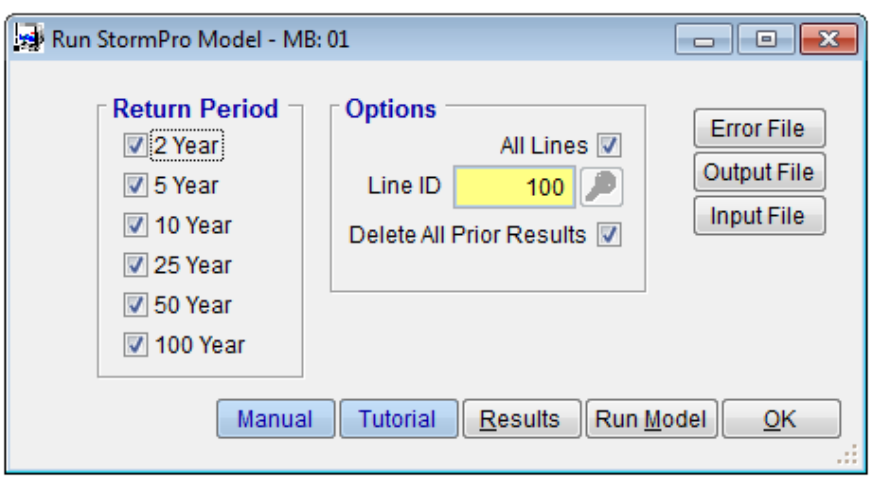


For a **Main Line**, the Starting Hydraulic Grade Line for each return period can be entered. If left blank, the model uses the formula (Dc+D)/2, where Dc is the critical depth and D is the height of the **Facility ID**.

For Lines that are not a Main Line, a Starting Hydraulic Grade Line can be entered by checking the appropriate **Custom** for each return period. If left blank, the model establishes the value from the modeled Line that this Line enters.

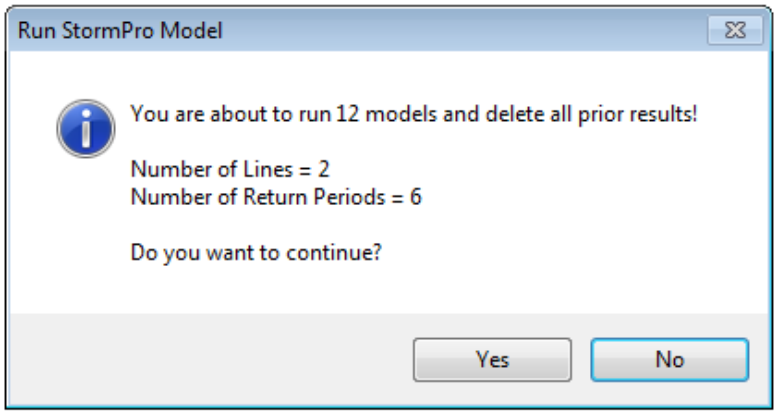
(D) Step 4 - Run Model

(Hydraulics ➔StormPro Backwater ➔ Model)



Options when running a **StormPro** Model include **Return Period**, **Line ID** and **Delete All Prior Results**. If **All Lines** is checked, then **StormPro** will model all the selected return periods for **Line**"*100*" then model all the selected return periods for **Line**"*200*" (in that order).

Click **Run Model** to run the model. Click **Yes** to continue.

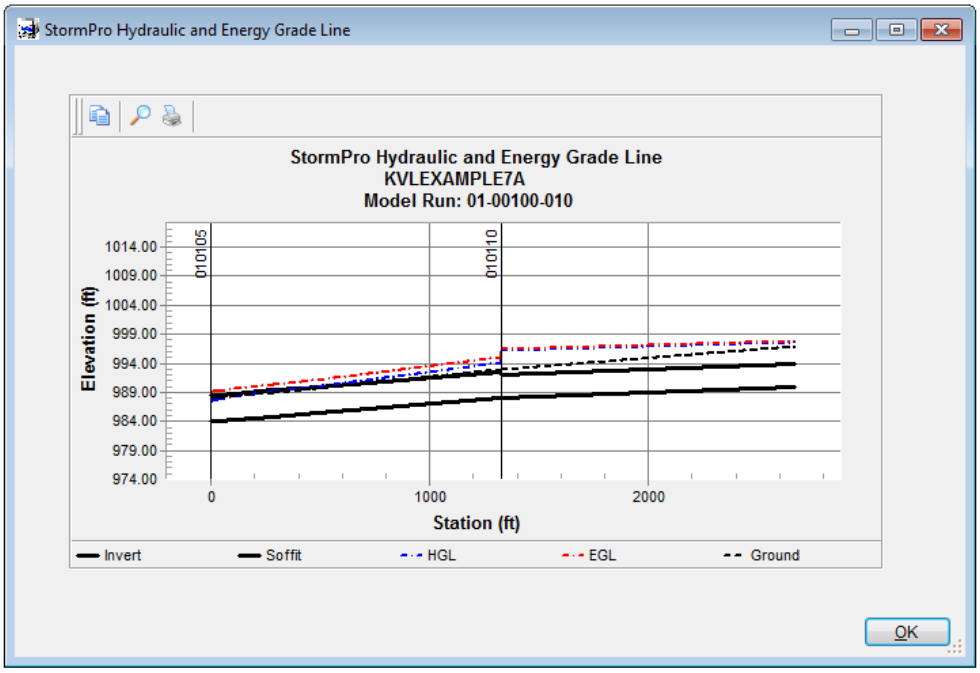


After successfully running the model, Click **Results** to view the model results

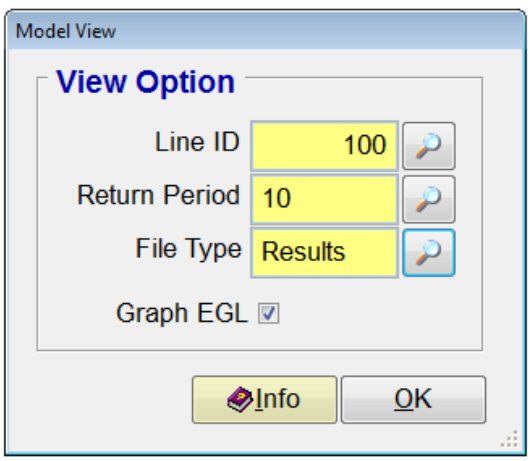
Click **View** and select *"100"* for **Line ID** and *"10"* for **Return Period** to view the 10-year return period for Line "*100*".

Line ID	RP	ID	Size	Station	Flow	Velocity	Inv	HGL	GE	HGL>GE
100	10	010105	54" Dia Pipe	0.00	133.9	10.37	984.00	987.41	988.00	
100	10	010105	54" Dia Pipe	6.98	133.9	9.89	984.02	987.59	988.03	
100	10	010105	54" Dia Pipe	37.85	133.9	9.43	984.11	987.88	988.14	
100	10	010105	54" Dia Pipe	113.41	133.9	8.99	984.34	988.33	988.43	
100	10	010105	54" Dia Pipe	287.14	133.9	8.57	984.87	989.15	989.09	0.06
100	10	010105	54" Dia Pipe	425.82	133.9	8.42	985.29	989.79	989.61	0.18
100	10	010105	54" Dia Pipe	1323.00	133.9	8.42	988.00	993.98	993.00	0.98
100	10	010110	48" Dia Pipe	1328.00	47.5	3.78	988.00	996.07	993.01	3.06
100	10	010110	48" Dia Pipe	2671.00	47.5	3.78	990.00	997.55	997.00	0.55

Click **Graph** to view the graph of the model results.



To view another line and/or return period, click the **View** button.



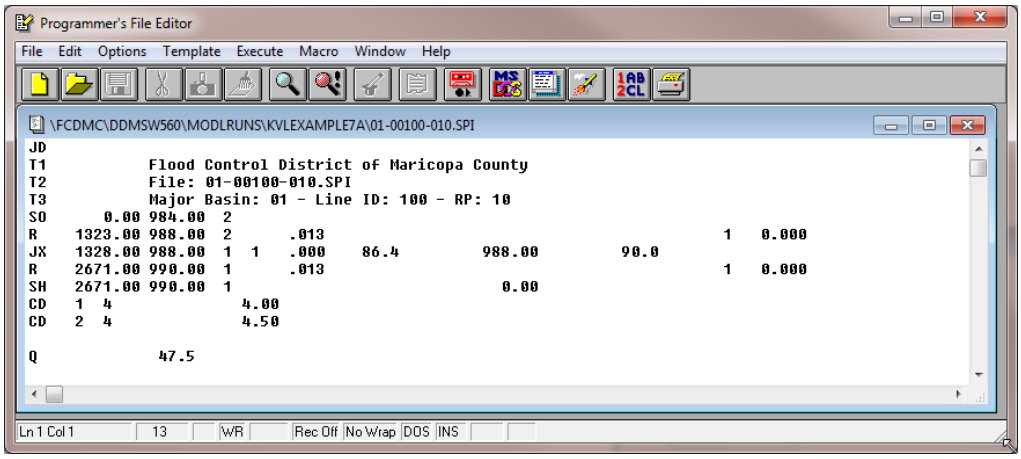
Options include selecting the **Line ID**, **Return Period**, **File Type** and an option to graph the Energy Grade Line (**Graph EGL**). When selecting a **File Type** the following options are available:

"Results" will select the data from the **StormPro Results** filtered for the selected **Line ID** and **Return Period**.

"HGL>GE" will select the data from the **StormPro Results** filtered for the selected **Line ID**, **Return Period** and sections where the hydraulic grade line is above the ground elevation.

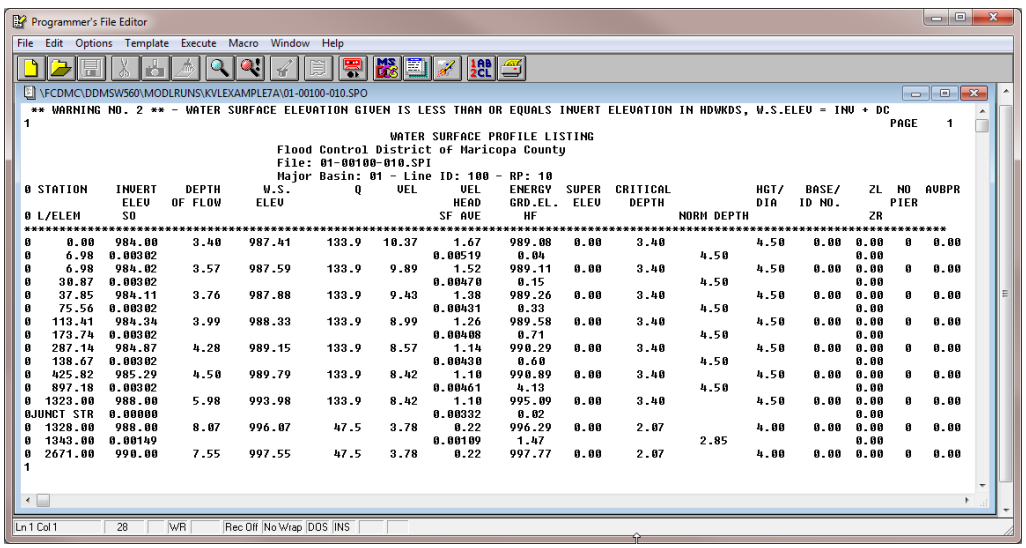
"Input", "Output" and *"Warning"* will open the model Input, Output and Warning files, respectively (See below for examples of the Input File, Output File, and Warning File).

INPUT FILE:



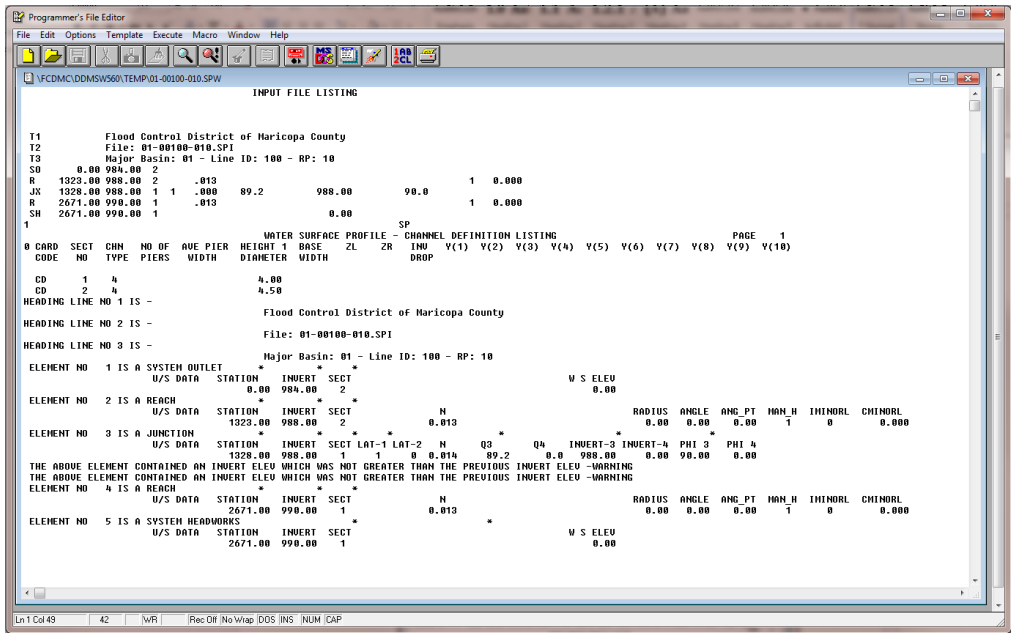
```
JD
T1          Flood Control District of Maricopa County
T2          File: 01-00100-010.SPI
T3          Major Basin: 01 - Line ID: 100 - RP: 10
SO      0.00 984.00  2
R    1323.00 988.00  2      .013                                          1   0.000
JX   1328.00 988.00  1  1   .000    86.4         988.00         90.0
R    2671.00 990.00  1      .013                                          1   0.000
SH   2671.00 990.00  1                              0.00
CD   1  4              4.00
CD   2  4              4.50

Q             47.5
```

OUTPUT FILE:



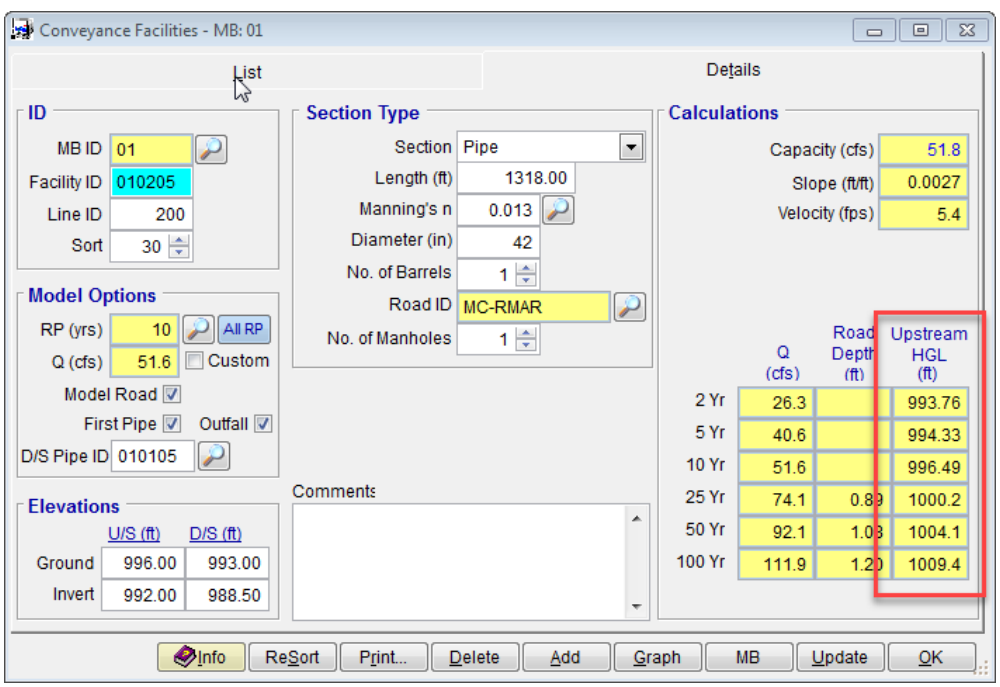
```
 ** WARNING NO. 2 ** - WATER SURFACE ELEVATION GIVEN IS LESS THAN OR EQUALS INVERT ELEVATION IN HDWKDS, W.S.ELEV = INV + DC
1                                                                                                                    PAGE    1
                                                WATER SURFACE PROFILE LISTING
                                     Flood Control District of Maricopa County
                                     File: 01-00100-010.SPI
                                     Major Basin: 01 - Line ID: 100 - RP: 10
0 STATION    INVERT    DEPTH      W.S.         Q     VEL      VEL    ENERGY  SUPER  CRITICAL            HGT/   BASE/    ZL  NO  AVBPR
              ELEV   OF FLOW     ELEV                          HEAD    GRD.EL.  ELEV    DEPTH            DIA   ID NO.     PIER
0 L/ELEM       SO                                         SF AVE      HF                     NORM DEPTH                ZR
*****************************************************************************************************************************
0     0.00   984.00     3.40    987.41     133.9   10.37     1.67    989.08    0.00     3.40                4.50    0.00  0.00   0   0.00
0     6.98  0.00302                                      0.00519     0.04                          4.50                      0.00
0     6.98   984.02     3.57    987.59     133.9    9.89     1.52    989.11    0.00     3.40                4.50    0.00  0.00   0   0.00
0    30.87  0.00302                                      0.00470     0.15                          4.50                      0.00
0    37.85   984.11     3.76    987.88     133.9    9.43     1.38    989.26    0.00     3.40                4.50    0.00  0.00   0   0.00
0    75.56  0.00302                                      0.00431     0.33                          4.50                      0.00
0   113.41   984.34     3.99    988.33     133.9    8.99     1.26    989.58    0.00     3.40                4.50    0.00  0.00   0   0.00
0   173.74  0.00302                                      0.00408     0.71                          4.50                      0.00
0   287.14   984.87     4.28    989.15     133.9    8.57     1.14    990.29    0.00     3.40                4.50    0.00  0.00   0   0.00
0   138.67  0.00302                                      0.00430     0.60                          4.50                      0.00
0   425.82   985.29     4.50    989.79     133.9    8.42     1.10    990.89    0.00     3.40                4.50    0.00  0.00   0   0.00
0   897.18  0.00302                                      0.00461     4.13                          4.50                      0.00
0  1323.00   988.00     5.98    993.98     133.9    8.42     1.10    995.09    0.00     3.40                4.50    0.00  0.00   0   0.00
0JUNCT STR  0.00000                                      0.00332     0.02                                                    0.00
0  1328.00   988.00     8.07    996.07      47.5    3.78     0.22    996.29    0.00     2.07                4.00    0.00  0.00   0   0.00
0  1343.00  0.00149                                      0.00109     1.47                          2.85                      0.00
0  2671.00   990.00     7.55    997.55      47.5    3.78     0.22    997.77    0.00     2.07                4.00    0.00  0.00   0   0.00
1
```

WARNING FILE:



(E) Step 5 – View Backwater Results on Conveyance Facilities *(Hydraulics ➔Conveyance Facilities)*

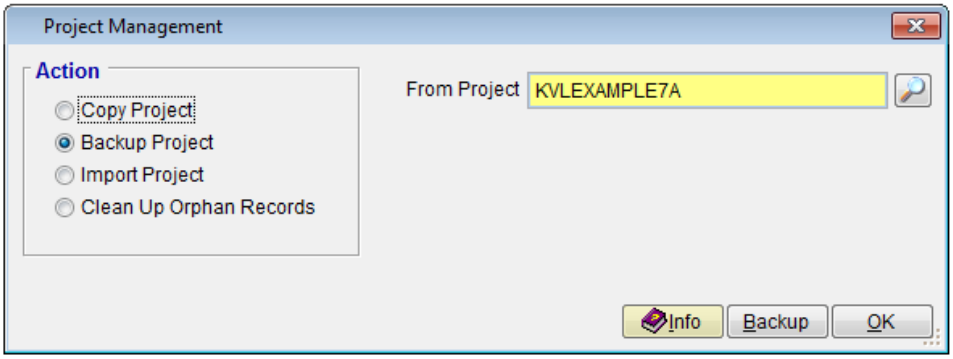
The following screen cap shows the Upstream HGL for Facility ID "*010205*".



(F) Step 6 - Backup the Project

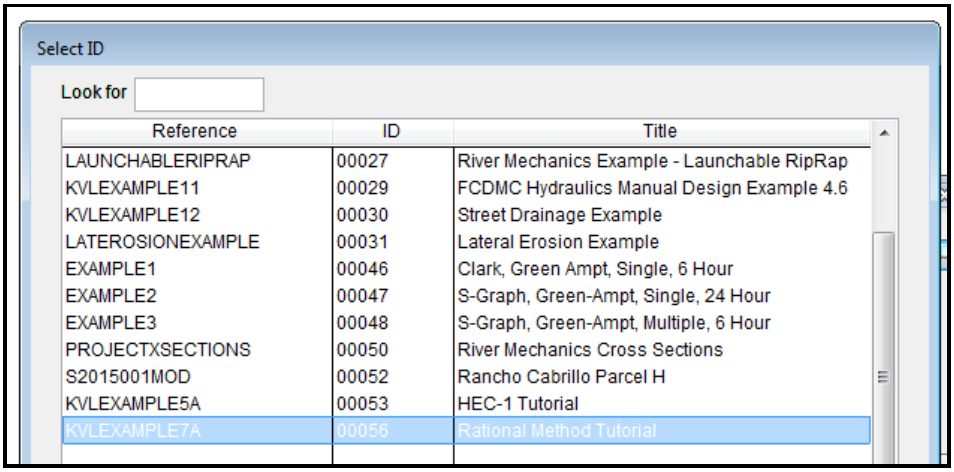
To create backup project file(s), perform the following steps:

(a) From the menu bar of the main application window, click **File ➔ Project Management** as shown in the following figure and the **PROJECT MANAGEMENT** window opens.



(b) Check **Backup Project**

(c) Click the "Magnifying Glass" button to the right of **From Project** to open the **SELECT ID** window.

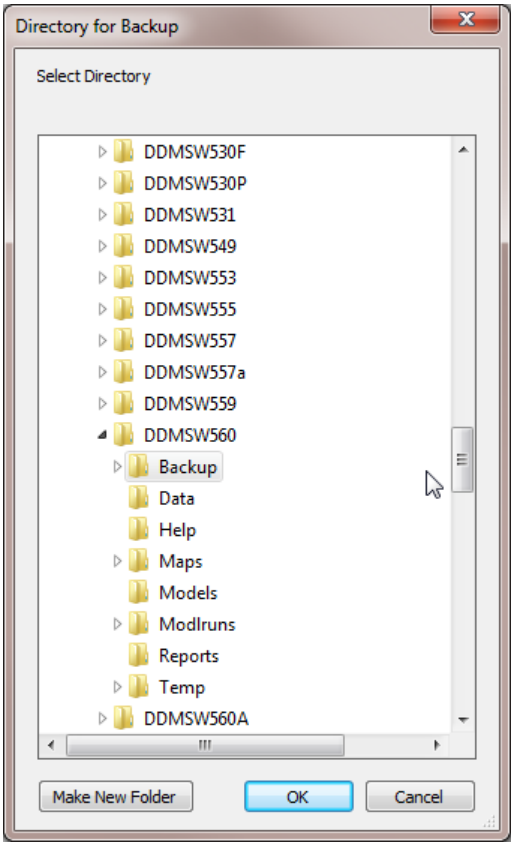


(d) Select "*KVLEXAMPLE7A*" and click the **OK** button to close the window.

(e) Click **Save** on the **PROJECT MANAGEMENT** window to save the data.

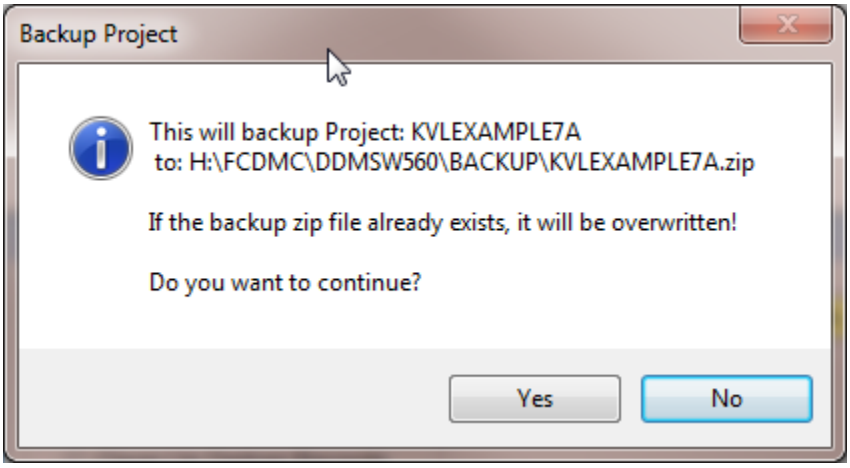
(f) Click **Backup**.

(g) Select a folder where the backup file(s) will be saved (defaults to **Backup** sub directory)



(h) Click **OK** to save the folder setting.

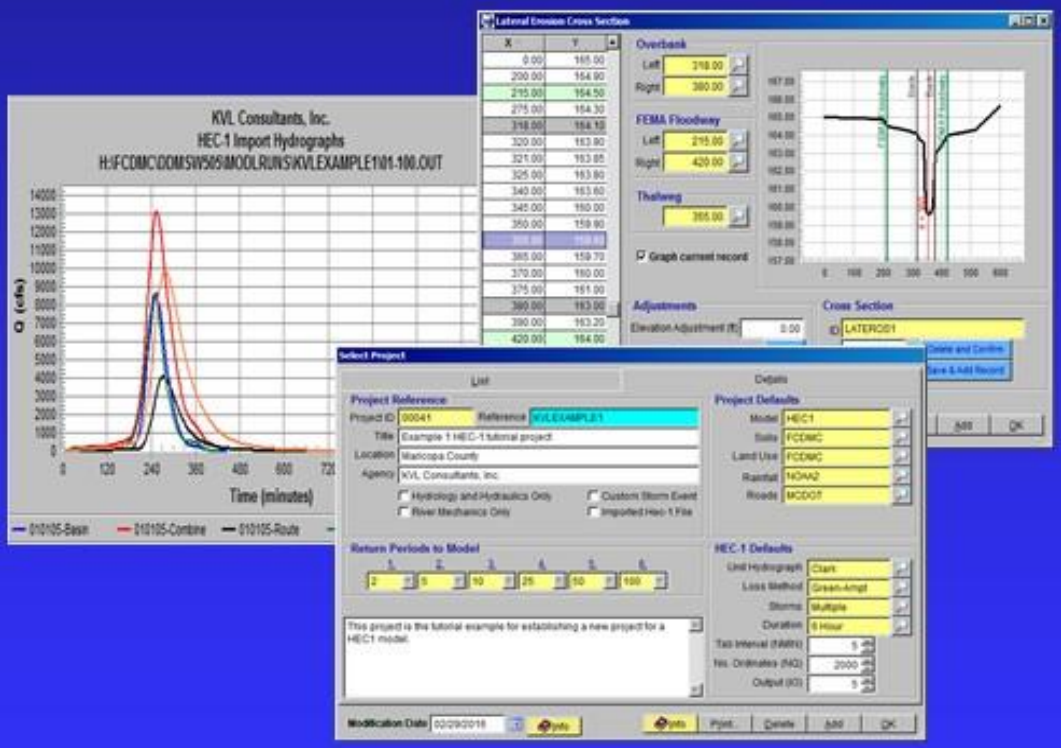
(i) When the **BACKUP PROJECT** dialog box appears, click **Yes** to continue.



This concludes this tutorial.

APPENDIX A – DDMSW USER'S MANUAL

DDMSW User's Manual



Flood Control District of Maricopa County

2801 W Durango St, Phoenix

Arizona 85009

Drainage Design Management System for Windows

User’s Manual

KVL Consultants, Inc.

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KVL Consultants, Inc.

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Chapter 1 Introduction

System Overview

The Drainage Design Management System for Windows (DDMSW) has been written to facilitate data management and computational procedures required for drainage analysis. This manual serves as a guide in the use of the program and is intended to be used in conjunction with the Agency's Drainage Design Manuals.

The program is written in Microsoft Visual FoxPro and generally includes modules for File, Edit, Hydrology, Hydraulics, Tools, Admin, Agency and Help. Agency is only available with a password.

DDMSW is a relational database that can manage multiple projects from one single location. The System is a multi-tasking window based application that enables the user to open several 'windows' simultaneously. New features include pull-down menus, user-friendly screens which the user can arrange on the desktop, and windows editing tools to facilitate data entry. DDMSW utilizes a relational database that includes tables for data entry and editing. Each table appears as a separate '.DBF' file on disk. The tables are related to each other based on the key field 'ProjectID' which is established when starting a new project. Model runs are automated from a menu and the data for running the models is extracted from the various tables in the database.

• Basic Database Terminology

The application stores data (values) in a relational Database. This data is organized into *tables, fields*, and *records* to make it more meaningful. For example, 01 by itself is meaningless. However, in a table called 'Basins', in a field called 'BasinId', in a record corresponding to 'EXAMPLE1', we now understand that 01 is a major basin in project EXAMPLE1.

A table is a grouping of data. The data is dynamic because it can be modified, deleted, added to and used in other relations. The following is an example of a table:

Table: Basins

ProjectID	BasinID	Description	Sort
00002	01	Major Basin 01	10
00002	02	Major Basin 02	20

A table is composed of one or more fields. In the example, the fields are ProjectID, BasinID, Description, and Sort. Fields are similar to columns in a spreadsheet. All fields in a table have the same format (e.g. text of maximum 70 characters, numeric 12 places with 2 decimals) and they share the same characteristics.

A table also consists of one or more records. Records are similar to rows in a spreadsheet. In the example, “00002, 01, Major Basin 01, 10’ compose one record in the table ‘Basins’. The example shows a total of two records and four fields.

In DDMSW, the database is composed of tables that organize and store information. A common field in each table, ProjectID, ties all the table data together for each individual project.

Program Installation

• DDMSW

The software used in DDMSW requires:

DDMSW	Compiled application
Acrobat Reader	PDF file reader

All required software for DDMSW (including models and other external programs) is included except Acrobat Reader, which can be downloaded from the Web.

Generally, the software comes as a self-extracting executable file. The setup files should be extracted to a temp directory. Then by running Setup.exe, the program can be installed. As it is installing, follow the instructions on the screen.

The user can choose the program’s location, but assuming C:\DDMSW\ST\ the following directory structure will be created:

C:\DDMSW\ST	Program files
C:\DDMSW\ST\Backup	Directory for archiving data
C:\DDMSW\ST\Data	Data Files
C:\DDMSW\ST\Help	Help files
C:\DDMSW\ST\Maps	Example map files
C:\DDMSW\ST\Models	Model programs
C:\DDMSW\ST\ModlRuns	Directory for example model runs
C:\DDMSW \ST\Reports	Reports
C:\DDMSW\ST\Temp	Directory for temp files

The procedure will notify the user when the installation is complete.

• Adobe Acrobat Reader

Adobe Acrobat Reader is required to print the user manual and view other files. If Adobe Acrobat Reader is not currently installed on your computer, then it will be necessary to install the program. The latest version can be downloaded from Adobe’s website at www.Adobe.Com. Follow their instructions to download and install ‘Acrobat Reader’.

Starting the Software

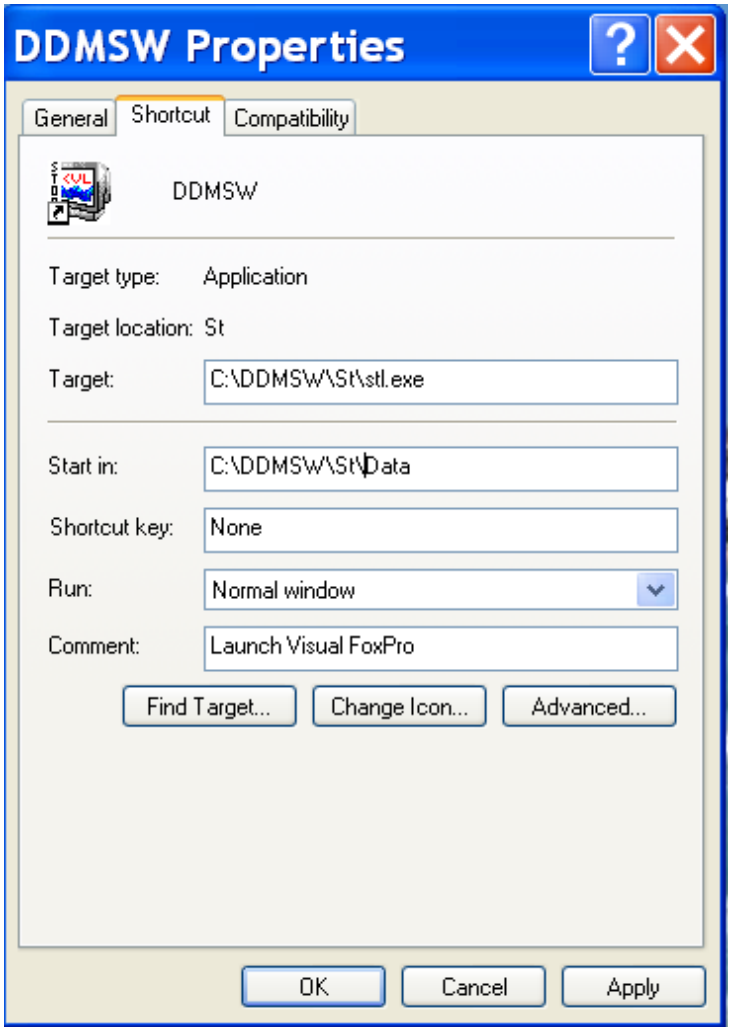
DDMSW is started by running ‘STL.EXE’. The program can be accessed from the Windows Startup menu or other selected folder or by double-clicking on the icon.

The Startup directory should be 'C:\DDMSW\ST\Data' or wherever the data files are located.

When the software is first installed, it is necessary to access:

1. ‘File/Select Project to establish project defaults.
2. ‘File/Project Paths to establish project paths.
3. ‘Tools/Options’ to establish system settings and paths.

The following is a sample of the desktop icon to run the application and the properties of the program. These may vary depending on the installation directory selected.



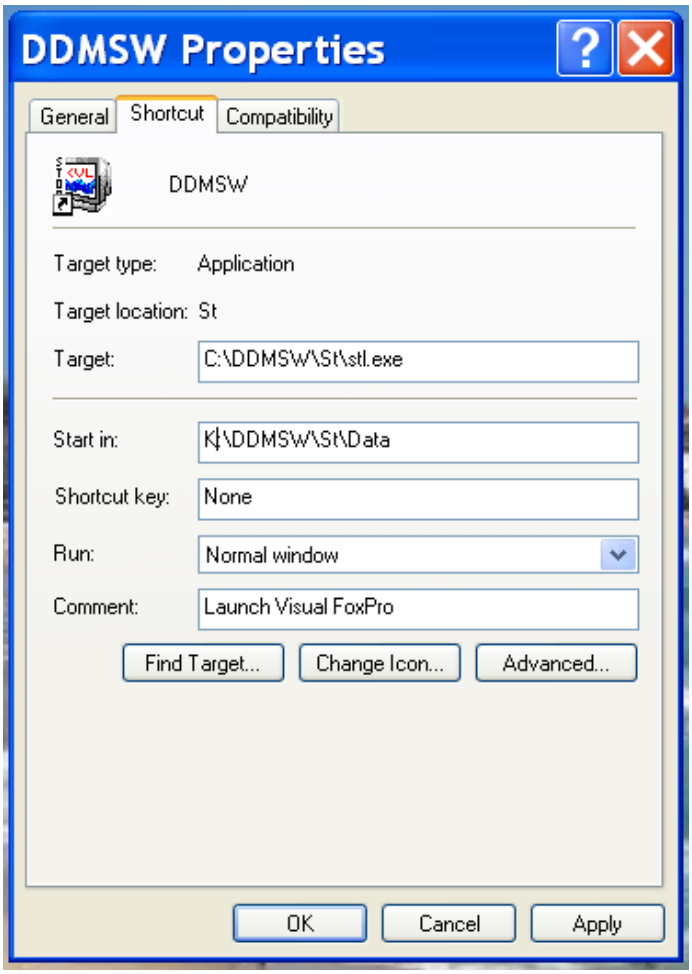
NOTE
If the startup icon is lost from the system and needs to be reconstructed do the following:

1. Create a shortcut on the desktop for the file STL.EXE (located in the ST directory)
2. Right click on the icon and open properties.
3. Change the “Start in” to the data directory (ST\Data)

Network Installation

For Users wishing to manage their projects on a network, the following procedure should be followed:

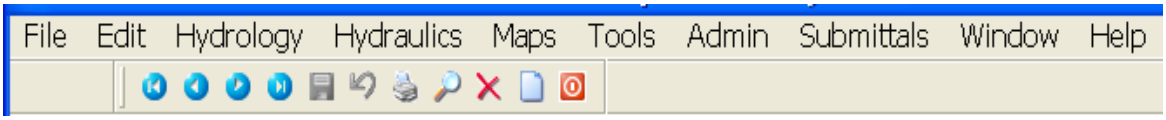
1. Install the application on all computers that will be running the application.
2. Install the application on the network drive (Shown as K: on the figure below).Right click on the icon used to start the software and select properties.
3. Modify the Start in property to point to the “Data” subdirectory on the Network Drive. For example, assume that the network installation for DDMSW is located at “K:\DDMSW\ST” where “K” is a mapped directory to the local network, and then modify the “Start in:” field of the DDMSW properties to “K:\DDMSW\ST\Data”.



When software patches become available, it is ONLY NECESSARY TO UPDATE THE NETWORK INSTALLATION. When individual users access the network data, a check of the Network's application version, reports, models and help files is carried out and any necessary updates to the local machine are carried out automatically.

Chapter 2 General Features

Main Menu



The Main Menu is the center of the application. This is the screen that is displayed when the user starts the application. It is also the screen the user is always returned to after closing a submenu or screen.

Specific actions can be accessed through the pull-down menus shown on the Main Menu bar. This manual will explain the functions available on each menu and will describe the individual elements shown on data entry screens. Depending on the type of application installed, some of these menu options may not be available.

Standard Buttons

There is a toolbar of standard buttons, which is identical on each data entry screen. The buttons become available/unavailable depending on the current action.

Goes to the first record in the table.

Moves to the previous record.

Moves to the next record.

Goes to the last record in the table.

Save the changes to the current record.

Undoes the last command or action.

Prints a report of the current table to the screen.

Searches for the first record based on the typed selection criterion.

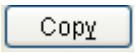
Deletes the current record. Use this with caution! Deleted records cannot be retrieved.

Use this to add a new record. When this button is clicked, a blank record appears for the user to enter values. Select *Save* to keep the data, or *Cancel* to discard the addition.

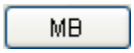
Closes the current screen and returns the user to the Main Menu or previous screen. Pressing [Esc] will also close the screen and return the user to the previous screen. However, changes to the current record may not take effect.

Common Buttons

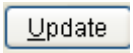
The following buttons appear on several forms and basically perform the same function:



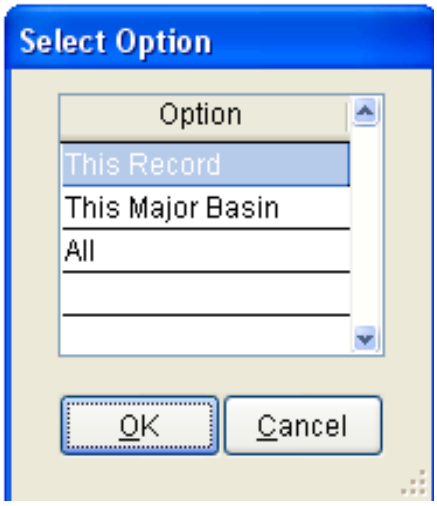
Copies the existing record to a new record so that only changes need to be edited.

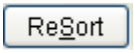


Shows a screen of all available major basins in the current project. Data on open forms will be filtered to the selected major basin.

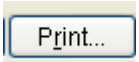


There are two types of update:
On a default form, it updates default data from agency data. Check the options to be updated. On a non-default form, it updates the data by performing calculations. The user selects the This Record, This Major Basin or All for the entire project to be updated.

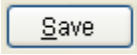




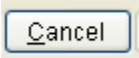
This renumbers the current 'sort' data in tens.



Prints the corresponding report for this data.



Saves the record with the current edits. This is only visible in “Edit” mode.



Discards all current edits. This is only visible in “Edit” mode.

Shows instructions for the currently opened form.

Data Screens

Screens display multiple records on a grid and details of the current record. Only data for the current record can be edited. Use the vertical scroll bar to move through records on the grid and highlight a record to edit.

The user can move and resize screens according to preference. Changes made to window position are retained in the application.

Detailed information is available on the Info Button on each form.

Edit Menu

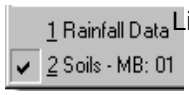
The Edit menu is available to the user during data entry or editing. The menu comprises the following functions. Some or all may be available depending on the action currently being executed.

Undo	Undoes the last command or action.
Redo	Repeats the last command or action.
Cut	Removes the selection and places it onto the Clipboard.
Copy	Copies the selection onto the Clipboard.
Paste	Pastes the contents of the Clipboard.
Clear	Removes the selection and does not place it onto the Clipboard.
Select All	Selects all text or items in the current window.
Find	Not available
Replace	Not available

Window

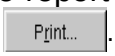
This menu item is available when a screen is opened.

Arrange All	Arranges the open screens tiled on the desktop.
Cascade	Arranges the open screens in a cascading from left to right on the desktop.
Close All	Closes all open screens.



Lists all open screens with a checkmark next to the current one.

Printing

Select the report to be printed, and choose the output location (Screen or Printer), and click 

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Page 1

FCDMC
Drainage Design Management System
SOILS
Project Reference: EXAMPLE1

Area ID	Soil ID	Area (sq mi)	Area (%)	XKSAT	Rock Percent (%)	Effective Rock (%)
1A	64512	1.720	25.70	0.01	-	100
	64519	0.450	6.70	0.19	-	100
	64512	0.270	4.00	0.01	-	100
	64572	0.890	13.30	0.09	30.00	100
	64522	0.670	10.00	0.04	-	100
	64577	0.220	3.30	0.05	-	100
	64522	1.120	16.80	0.04	-	100
	64524	1.340	20.10	0.02	-	100
1B	64512	1.380	24.20	0.01	-	100
	64519	1.230	21.50	0.19	-	100

Keep in mind that when a report outputs to the screen, the user is able to select to print or export it by using the Reports toolbar at the top of the report. By clicking , the user can choose to print all or selected pages of the report. Click the Export Icon to select a format and destination for the export file. This enables the user to exchange project data with other applications. Always close the current report view when you are finished, otherwise the report generator will remain open.

Graphs Toolbar

When graphs are opened the following tools are commonly available on the graph screen:

Copies the graph to the clipboard as a bitmap, metafile, text or OLE object.

Data Editor. This displays the data values at the bottom of the screen. These values can be edited, and the graph dynamically reflects these changes.

	1	2	3	4	5	6	7	8
— 1	510	1510	1585	1596	1600	1612	1662	2262
	99.70	94.10	93.60	92.20	92.20	93.60	94.90	99.70

Zoom tool. Click this icon and draw an area of the graph to be magnified.

Prints the graph.

Please note that the data for the graphs has been rounded to facilitate the graphing function. Therefore the data is not as precise as the data in the application.

Reindex Data

! Caution: Reindexing and packing tables take a few minutes to complete. Interrupting the process once it has begun will result in data corruption.

This function can only be used when there are no other users accessing the application. The option is used for two purposes. In the event of a corrupt index, the administrator needs to reindex tables and rebuild the table indexes.

The option also packs all tables in the database. When a record is deleted, it is not physically erased from disk until the database is packed. Packing permanently removes deleted records and restores disk space occupied by those deleted records. The database should be packed occasionally to restore disk space.

Agency Password

Access to the Agency menu is restricted. Enter the password to access the Agency menu.

Change Agency Password

This is only visible if an appropriate Agency password has been entered. This enables the user to change the password. A window appears confirming the new password. If this is correct, click *OK* to confirm the change.