

In this example you will learn:

- The history of StormSHED at WSDOT.
- What the program does.
- An introduction of the program views and menus.
- How to customize a project file using the Project Configuration tabs.

About StormSHED

In the early 1990's, WSDOT purchased WaterWorks software as a design tool for hydrology applications. Due to proprietary issues, WaterWorks changed their name to StormSHED in the late 1990's. StormSHED 3G is the third generation of StormSHED, although WSDOT never upgraded to the second generation or StormSHED 2G. There are many similarities between 3G and the original StormSHED, making the learning curve short for experienced users. The biggest change in 3G is a more stable program. For those who got frustrated from being thrown out of the software, 3G will provide relief. Additional upgrades from StormSHED are too lengthy to list, however overall there are many more customization options that make modeling per the new HRM simpler.

What is StormSHED 3G?

StormSHED 3G is Single Event Model with an integrated set of hydrology design tools developed to address the need of the Engineers. StormSHED offers SCS (Soil Conservation Service), SBUH (Santa Barbara Unit Hydrograph), the Rational Method, level pool routing, pipe and ditch conveyance system analysis and backwater computation. StormSHED 3G can design and analyze a whole network of reaches consisting of any combination of circular, arch, box, or elliptical pipe, ditches, and channels. Designers have a choice between using Manning's equation (we call it the travel time shift) or one of four hydrograph routing options: storage, convex, kinematics wave or Muskingum-Cunge routing. Once the runoff has been conveyed to a detention pond, the Reservoir Routing operation would be the final step in the pond design.

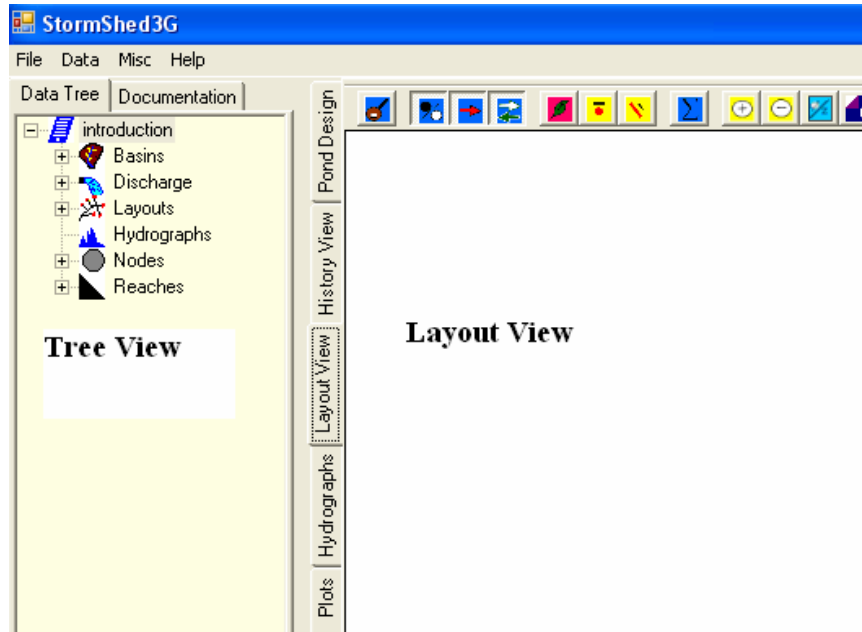
In support of reservoir routing (your typical detention pond), StormSHED 3G permits the user to select any combination of discharge structures to be used with the specified impoundment shape (it can be an above or below ground structure). The list of discharge structures includes weirs, orifice, culverts, vortex valve, infiltration rate (including using Ksat), overflow, and drywells. The user can also specify a secondary discharge control structure and even divert part of the flow.

3G added many new options that can customize a design and make following the new HRM requirements easier. For example designers can now set the duration of a design storm, making it simpler than the old 24 hour default when using design storms. Designers also have the option of selecting an AMC for the project as well as setting constraints on the minimum time of concentration. Multiple precipitation values can be input into a project file which makes going from a short duration storm to a long duration storm easier. Also, if the defaults set in lets say all the basins for a project need to be modified, they can be modified in all basins with one simple command. Lastly, a calculator has been added for quick analysis on flow profiles, swales, and pipes.

At this time, the Washington State Department of Transportation (WSDOT) supports StormSHED for conveyance design only in Western Washington. WSDOT utilizes all of StormSHED capabilities in Eastern Washington.

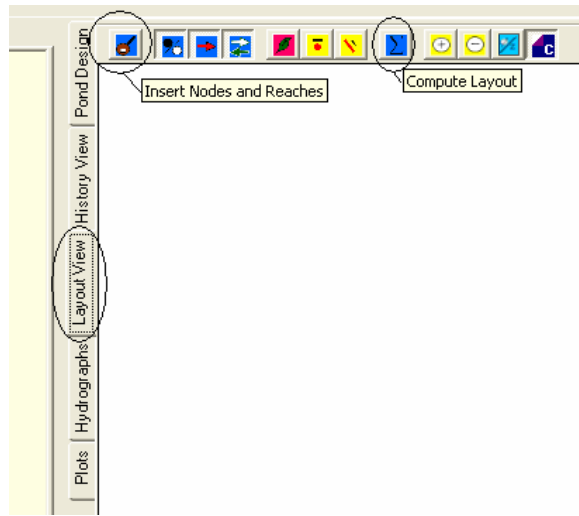
Overview

The program window is divided into two sections, each of which has several tabs. The major sections are the data Data Tree View and the Layout View. When StormSHED 3G is opened, it will open to the last file used and this is what it should look like:



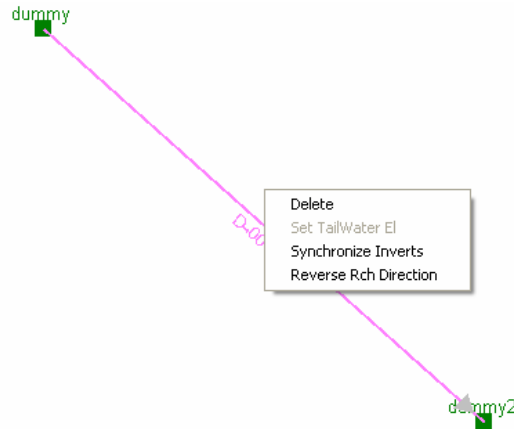
1. **Data Tree View** has two tabs.
 - *The Data Tree* tab contains access to all of the items that the project is made up of including the basins, ponds, pipes, ditches, hydrographs, etc.
 - *The Documentation* tab provides information about particular methods used for the analysis. For example if you want to see how the time of concentration is determined or how runoff is estimated the methods are described in this view.
2. **Layout View** has 5 separate tabs, each consisting of different major functions in the program.
 - *Pond Design* is used for designing ponds. Western Washington still uses a modified single event (Stormshed) method for expanding existing detention ponds.
 - *History View* displays the computed information that affects the hydrographs from the pond design and layout compute command. There is no running log of computations, only the last computation is maintained. The data in the history view will need to be cut and pasted into a word document for the final report.
 - *Hydrographs* all hydrographs created by the program are reported here along with several options for manipulating hydrographs.
 - *Plots* will generate different plots depending on the input parameters.
 - *Layout View* is used to create a graphical representation of the drainage network. It is a schematic layout tool in that the dimensions of the layout (nodes and

reaches) are not drawn to scale. A typical layout consists of a series of nodes connected by reaches. The next figure shows the Layout View.



The program makes extensive use of the mouse buttons in the **Layout View** to facilitate program interaction. The following mouse button clicks are supported.

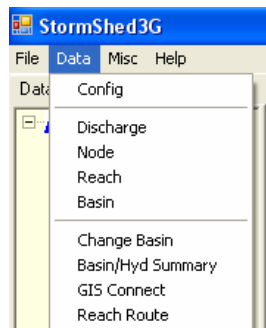
- Left Mouse Button (LMB) click and hold while dragging mouse to reposition a node.
- LMB double click on a node or reach to display appropriate input dialog.
- Right Mouse Button (RMB) single click on a node or reach to activate a popup menu. The popup menu has four choices:
 - a: *Delete* - Deletes the node or reach from the layout. It does not delete the node or reach from the database!
 - b: *Set TW Elevation* (Nodes only) allows definition of starting HGL elevation. Typically used only for the outlet node.
 - c: *Synchronize Inverts* – This command will reset the invert elevations all way to the final node. This command is especially useful when an invert elevation is modified upstream that requires modification of downstream invert elev.
 - d: *Reverse Reach Direction* – when a reach is input in the wrong direction, this command will reverse the direction.



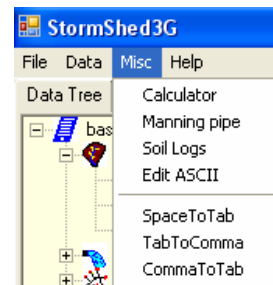
Menu Options

Above the **Data Tree View**, there are 4 menu options: File, Data, Misc, and Help. All four are further discussed below.

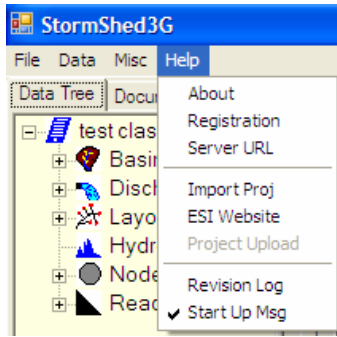
- **File** – allows the user to open an existing file, create a new file, save a file, delete a existing project or exit the program.
- **Data** – The Config command is the starting place for every project and allows the designer to set project defaults. The discharge, node, reach, and basin can be opened directly from here, as well as in the tree view. The Change Basin option, allows the designer to change the rain type, hydrograph interval, storm duration, and design method of all the basins selected. The Basin/Hydrograph Summary Report allows the user to send selected basin or hydrograph information to the History View. Designers can also route hydrographs through a reach for a quick analysis with the Reach Route option. The GIS Connect allows designers to import basin information from GIS. The GIS program 3G utilizes is not supported at WSDOT, so this feature will not be covered.



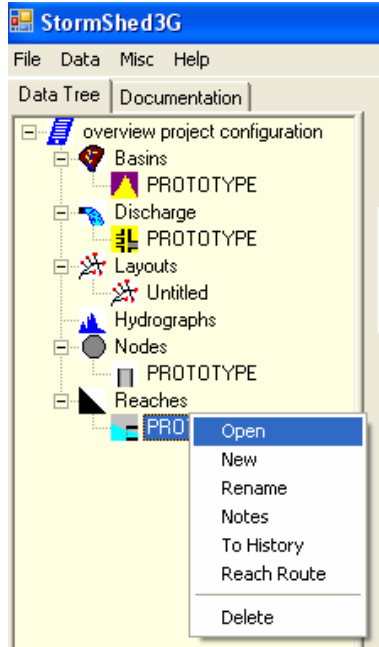
- **Misc** – In this tab designers can access a calculator used to estimating flow profile, pipe, and swales. The Manning pipe, is also a calculator that uses Manning's equation to size a pipe. Designers can input Soil Logs, open/edit text files, and several utilities options (SpaceToTab, TabToComma, and CommaToTab) that allow designers to work between project files. The Edit ASCII option, allows designers to edit .RAC files or other program defaults.



- **Help** – Contains information about licensing, registration, and server URL. The ESI Website link allows designers to access the Engenious website directly. The Import Project command can be used to import and convert old StormSHED files. It should be noted that while StormSHED files can be transferred into 3G the layouts created in StormSHED files can not and designers need to recreate them in 3G. The Revision Log will provide a list of any changes or updates that have been made to the program. If the Start Up Message is checked, the Revision Log will appear everytime 3G is opened.



The first line in the **Data Tree View** begins with the name of the current file (in the view below the project name was 'overview project configuration'). Within each database there are six (6) types of records, they are Basins, Discharge, Hydrographs, Layouts, Nodes and Reaches. A + (plus) symbol to the right of each category indicates the presence of database records for the category.



Categories are expanded by Left Mouse Button (LMB) clicking on the + (plus) symbol to the left of the category. Within each category there can be several record types. As an example, for Basins, there can be SBUH, SCS, and Rational basins. The program has a different icon symbol for each record type within a category. This provides a visual clue of the record type without directly accessing the record.

With the exception of the Hydrograph category, all categories have at least a single prototype record when a new project is opened. The PROTOTYPE record can be thought of as the default record. When the program creates a new record for a category, it uses the PROTOTYPE record as its template. This feature is provided to save on repetitive data input. **DO NOT DELETE OR RENAME THE PROTOTYPE.**

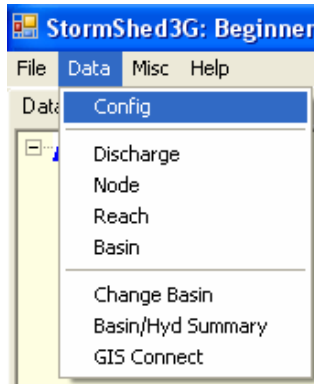
When a record is RMB clicked, it pulls up a dialog of some type. Generally this allows the designer to modify the record including: open, rename, create, write notes, send information to the history view and delete.

When a record is double LMB clicked, the input dialog for that record appears. The input dialog is also accessible through the **Data Tree View** menu as discussed above.

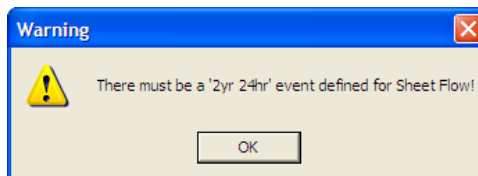
Project Configuration

After a project is created, the next step is to set the project defaults. In this section we will set the project defaults that need to be modified for our example and then review the remaining defaults tabs.

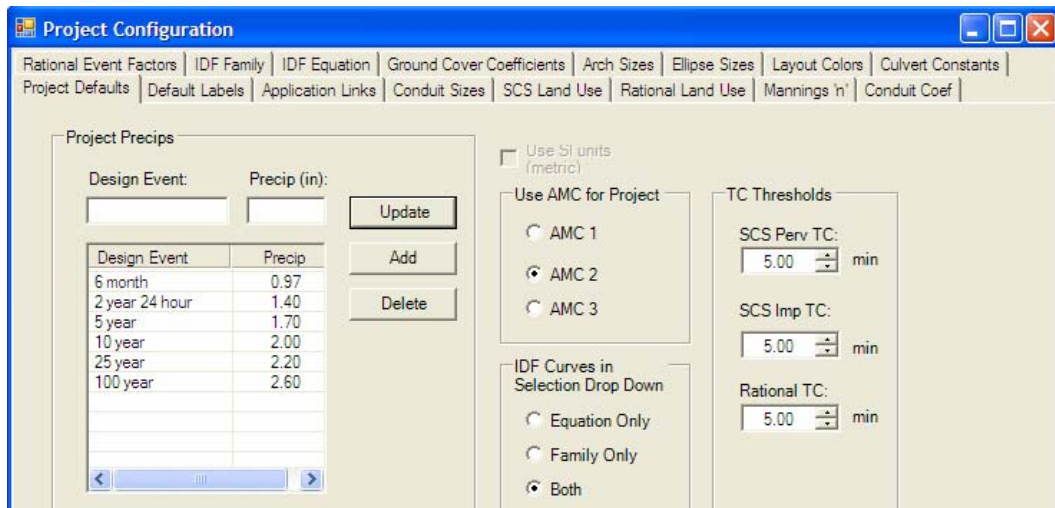
Select **Data>Config.**



Before the **Project Configuration** tab opens, the **Warning** shown below will appear. Designers must input a 2 year 24 hour precipitation value even if the value is not needed for the design of the project, it is needed for the calculation of sheet flow. The **2 year 24 hour or 2yr 24hr**, must be noted either way in the Project Precipitation box. Select **OK** to close the **Warning** dialog box.



The Project Configuration box will open as shown below. The defaults set in this dialog box will be reflected in the pull-down menus of other dialog boxes as well as in the layout presentation.



Of the tabs in the **Project Configuration** dialog box, the **Project Defaults** tab will likely be used the most by designers. This is where the precipitation values are set for each project location.

Project Precips – After determining the precipitation values (see the short duration and long duration storm sections), input the values as shown.

- To modify an existing value, highlight the design event and then input the precipitation. Accept the change by selecting the update button.
- To add a new value, input a title for the design event and precipitation, then select the add button.

There are no limits on the number of precipitation values that can be input. That means for projects using the short and long duration storm, all the precipitation values can be input at one time and then selected when needed.

Use AMC for Project - The AMC or antecedent moisture condition classifies (groups 1, 2, or 3) the preexisting soil wetting at the project site. The three groups are: 1) dry, cracked soils, 2) a typical condition, and 3) saturated soil. All the CN values in the **SCS Land Use Tab** (see several boxes), are based on AMC Group 2. Designers should leave this as Group 2 when starting a project and always input the CN values for group 2. Then after the project is completed, change to group 1 or 3 and the program will automatically adjust the CN values in the final computations, the actual values input will not be modified. There is also an option of temporarily modifying the AMC group value for each basin to see how the runoff could be affected by this change.

IDF Curves in Selection Drop Down - StormShed 3G supports the Rational Method and allows the designer two options for referencing IDF curves; either by equation using a table of data (like the data found in Chapter 2 of the Hydraulics Manual) or referencing an IDF curve. In this box the designer can indicate how many options there will be in the **Basins** Dialog input box if the Rational Method as a **Design Methods** from the pull-down menu. For this training we will not be using the Rational Method, so we will leave it on the default setting of 'Both'.

TC Thresholds – Chapter 2 of the Hydraulics Manual requires a minimum Time of Concentration of 5 minutes. In order to ensure this value is 5 minutes, designers have the option of setting minimum Tc values for both the SCS (also applies to SBUH) impervious and pervious conditions as well as for the Rational Method. For this training we will leave the values set at 5 the default values of minutes.

The screenshot shows the 'Project Configuration' dialog box with the 'Default Labels' tab selected. The tab is circled in red. The dialog has a blue title bar and a menu bar with the following items: Rational Event Factors, IDF Family, IDF Equation, Ground Cover Coefficients, Arch Sizes, Ellipse Sizes, Layout Colors, Culvert Const, Project Defaults, Default Labels (selected), Application Links, Conduit Sizes, SCS Land Use, Rational Land Use, Mannings 'n', and Conduit Coef. The main area contains a table for 'Default Labels' with columns: Next Index, Increment, Prefix, Padding, Suffix, and Example. The rows are for Reaches, Nodes, Discharge, and Basins. At the bottom, there is a checkbox labeled 'Enable Auto_Verification of labels' which is checked.

	Next Index	Increment	Prefix	Padding	Suffix	Example
Reaches	1	1	P-	3		P-001
Nodes	1	1	N-	3		N-001
Discharge	1	1	D-	3		D-001
Basins	1	1	B-	3		B-001

☒ Enable Auto_Verification of labels

Next select the **Default Labels** tab. This is where the designer can customize the labels for new reaches, nodes, discharge, and basins. While it is often convenient to use the auto labels, be sure to check the “Enable Auto-Verification of Labels” box. This will allow the designer to override the StormSHED 3G auto labels and instead create a label that is more meaningful to the project.

The screenshot shows the 'Project Configuration' dialog box with the 'Application Links' tab selected. The tab is circled in red. The dialog has a blue title bar and a menu bar with the following items: Rational Event Factors, IDF Family, IDF Equation, Ground Cover Coefficients, Arch Sizes, Ellipse Sizes, Layout Colors, Culvert Const, Project Defaults, Default Labels, Application Links (selected), Conduit Sizes, SCS Land Use, Rational Land Use, Mannings 'n', and Conduit Coef. The main area contains three sections: 'Conduit Adjustment' with a 'Pond routing adjustment increment' set to 20 ft or meters; 'Location of Local RAC/IDF/TSS files' with a text box containing 'C:\AAWork\3G\RAC' and buttons for file selection and clearing; 'Location of Video Training' with a text box containing 'C:\AAWork\3G\Video Tutorials' and buttons for file selection and clearing; and 'Location of Replacement DRDB and Template Project' with an empty text box and buttons for file selection and clearing.

Conduit Adjustment
Pond routing adjustment increment
20 ft or meters

Location of Local RAC/IDF/TSS files
C:\AAWork\3G\RAC ... Clear

Location of Video Training
C:\AAWork\3G\Video Tutorials ... Clear

Location of Replacement DRDB and Template Project
... Clear

The **Application Links** tabs, indicates where the RAC Files/IDF Files and Training Videos are located on our computer. **Do not save either** in the same folder as the program or project files, as they could be deleted when the software is upgraded. Instead save them in a completely different folder and path the location by selecting the ‘...’ button to the left of the clear button.

Conduit Adjustment¹ – This option only applies to Detention Ponds that use conduit as a discharge structure; 3G requires that the length be increased automatically. Designers have the option of adjusting the conduit length. Remember the smaller the value, the longer it will take StormShed to perform this computation.

Project Configuration

Rational Event Factors | IDF Family | IDF Equation | **Ground Cover Coefficients** | Arch Sizes | Ellipse Sizes | Layout Colors | Culvert Const

Project Defaults | Default Labels | Application Links | **Conduit Sizes** | SCS Land Use | Rational Land Use | Mannings 'n' | Conduit Coef

Description	Diameter
6 in Diam	6.00
8 in Diam	8.00
12 in Diam	12.00
15 in Diam	15.00
18 in Diam	18.00
21 in Diam	21.00
24 in Diam	24.00
27 in Diam	27.00
30 in Diam	30.00
36 in Diam	36.00
42 in Diam	42.00
48 in Diam	48.00
54 in Diam	54.00
60 in Diam	60.00
66 in Diam	66.00
72 in Diam	72.00
78 in Diam	78.00
84 in Diam	84.00
90 in Diam	90.00
108 in Diam	108.00
114 in Diam	114.00

Description:

Diameter: ☐ SI Units (metric)

Update Add Delete

The **Conduit Sizes**¹, **Arch Sizes**¹, and **Ellipse Sizes**¹ tabs are used to modify or add the default pipe sizes (the **Conduit Sizes** tab is shown above). These sizes and dimensions can be found in the Reach Dialog box pull-down menus to set pipe sizes. *Note the SI Units tab is only there to modify a design that is already been created in US units and then change to SI and the report will be printed in metric.*

Project Configuration

Rational Event Factors | IDF Family | IDF Equation | Ground Cover Coefficients | Arch Sizes | Ellipse Sizes | Layout Colors | Culvert Const

Project Defaults | Default Labels | Application Links | Conduit Sizes | **SCS Land Use** | Rational Land Use | Mannings 'n' | Conduit Coef

Land Use: HSG A: HSG B: Update

Description: HSG C: HSG D: Add

☒ Urban Areas ☐ Developing Urban ☐ Cultivated Agriculture ☐ Other Agriculture ☐ Arid Rangeland

Land Code: Pct DCIA Imperv: Delete

Land use	Description	HSG A	HSG B	HSG C	HSG D	C...	%...
Commercial & Business	85% impervious	89	92	94	95		0...
Dirt roads & Parking Lots	normal	72	82	87	89		0...
Gravel Roads & Parking Lots	normal	76	85	89	91		0...
Herbaceous (Poor)	Poor	0	80	87	93		0...
Impervious surfaces (pavements, roofs, etc)	pavements, roofs, etc	98	98	98	98		0...
Industrial	72% impervious	81	88	91	93		0...
Open spaces, lawns, parks (50-75% grass)	grass cover on 50% to 75% of ar...	77	85	90	92		0...
Open spaces, lawns, parks (<50% grass)	Grass cover < 50%	68	79	86	89		0...
Open spaces, lawns, parks (>75% grass)	grass cover on 75% or more of a...	68	80	86	90		0...
Paved curbs and storm sewers	Curbs and storm sewers	98	98	98	98		0...
Residential districts - 1 acre	20% impervious	51	68	79	84		0...

Close

The **SCS Land Use**¹ tab contains the CN values for the group 2 AMC. Designers can modify or add CN values in this tab. Notice the CN values are separated by land use; they will be accessed under these categories in the **Basin** pull down menus.

Project Configuration

Project Defaults | Default Labels | Application Links | **Conduit Sizes** | SCS Land Use | Rational Land Use | Mannings 'n' | Conduit C
 Rational Event Factors | IDF Family | IDF Equation | **Ground Cover Coefficients** | Arch Sizes | Ellipse Sizes | Layout Colors | Culvert

Description:
 Method: Coeff:

Update

Add

Delete

Method	Description	Coeff
Sheet	Bermuda grass.: 0.41	0.41
Sheet	Cultivated Soil w/ residue cover (<=20%): 0.06	0.06
Sheet	Cultivated Soil w/ residue cover (>20%): 0.17	0.17
Sheet	Dense grasses : 0.24	0.24
Sheet	Fallow Fields of Loose Soil Surface.: 0.05	0.05
Sheet	Range (natural): 0.13	0.13
Sheet	Short prairie grass and lawns.: 0.15	0.15
Sheet	Smooth Surfaces.: 0.011	0.011
Sheet	Woods or forest with dense underbrush.: 0.80	0.80
Sheet	Woods or forest with light underbrush.: 0.40	0.40
Shallow	Brushy ground with some trees (n=0.060)	0.06
Shallow	Fallow or minimum tillage cultivation (n=0.04)	0.04
Shallow	Forest w/ heavy ground litter & meadows (n=0.10)	0.10
Shallow	High grass (n=0.035)	0.035
Shallow	Nearly bare ground (n=0.025)	0.025
Shallow	Paved	0.01
Shallow	Paved and gravel areas (n=0.012)	0.012

The **Ground Cover Coefficients¹** tab, contains the default values for the type of flow (sheet, shallow, concentrated, etc) found in the **Basin** Dialog Box pulldown TC menus. Unique values can be modified or added here.

Project Configuration

Rational Event Factors | IDF Family | IDF Equation | Ground Cover Coefficients | Arch Sizes | Ellipse Sizes | Layout Colors | Cul
 Project Defaults | Default Labels | Application Links | Conduit Sizes | SCS Land Use | **Rational Land Use** | Mannings 'n' | Condi

Land Use 'c' Value

Update

Add

Delete

Description	c
0.2 Dwelling Units / Gross Acre	0.17
0.4 Dwelling Units / Gross Acre	0.2
0.8 Dwelling Units / Gross Acre	0.27
1.0 Dwelling Units / Gross Acre	0.3
1.5 Dwelling Units / Gross Acre	0.33
2.0 Dwelling Units / Gross Acre	0.36
2.5 Dwelling Units / Gross Acre	0.39
3.0 Dwelling Units / Gross Acre	0.42
3.5 Dwelling Units / Gross Acre	0.45
4.0 Dwelling Units / Gross Acre	0.48
4.5 Dwelling Units / Gross Acre	0.51
5.0 Dwelling Units / Gross Acre	0.54
5.5 Dwelling Units / Gross Acre	0.57
6.0 Dwelling Units / Gross Acre	0.6
7 dwelling units	0.88
Dense Forest	0.1
Gravel areas	0.8
Light forest	0.15
Open water (Ponds, lakes, wetlands)	1

The **Rational Land Use¹** tab, contains the coefficients for ground cover that are applied when calculating the Time of Concentration using the Rational Method. These values match the values found in section 2-5 of the Hydraulics Manual 2-5. This tab can be used to modify or add values that will better represent a project location.

Project Configuration

Rational Event Factors | IDF Family | IDF Equation | Ground Cover Coefficients | Arch Sizes | Ellipse Sizes | Layout Colors | Culvert Constants | **Mannings 'n'** | Conduit Coef

Category: [] Description: [] Manning's: 0 [Update] [Add] [Delete]

Category	Description	Manning 'n'
Earth Channels	(a) Large drainage ditches <2.5 Hrad (0.040-0.0...	0.043
Earth Channels	(b) Large drainage ditches 2.5-4.0 Hrad (0.035-...	0.037
Earth Channels	(c) Large drainage ditches 4.0-5.0 Hrad (0.030-...	0.032
Earth Channels	(d) Large drainage ditches >5.0 Hrad (0.025-0.030)	0.028
Earth Channels	Earth bottom, rubble sides (0.028-0.035)	0.032
Earth Channels	Small drainage ditches (0.035-0.04)	0.04
Earth Channels	Stony bed, weeds on bank (0.025-0.040)	0.035
Earth Channels	Straight and uniform (0.017-0.025)	0.0225
Earth Channels	Winding, sluggish (0.0225-0.03)	0.025
Lined Channels	Asphalt, exposed prefabricated	0.015
Lined Channels	Asphaltic Concrete, machine placed	0.014
Lined Channels	Concrete (0.012-0.015)	0.015
Lined Channels	Concrete, rubble (0.016-0.029)	0.02
Lined Channels	Metal, corrugated (0.021-0.026)	0.024
Lined Channels	Metal, smooth, flumes (0.011-0.015)	0.013
Lined Channels	Plastic (0.012-0.014)	0.013
Lined Channels	Shotcrete (0.016-0.017)	0.016
Lined Channels	Wood, planed, flumes (0.009-0.016)	0.012

The **Mannings 'n'** and **Conduit Coef** tabs contains Manning's values directly from Appendix 4 of the Hydraulics Manual. These values can be selected from the pull down menu in the **Reach** Dialog Box. Use this tab to modify or add values that will more accurately reflect a project site.

Project Configuration

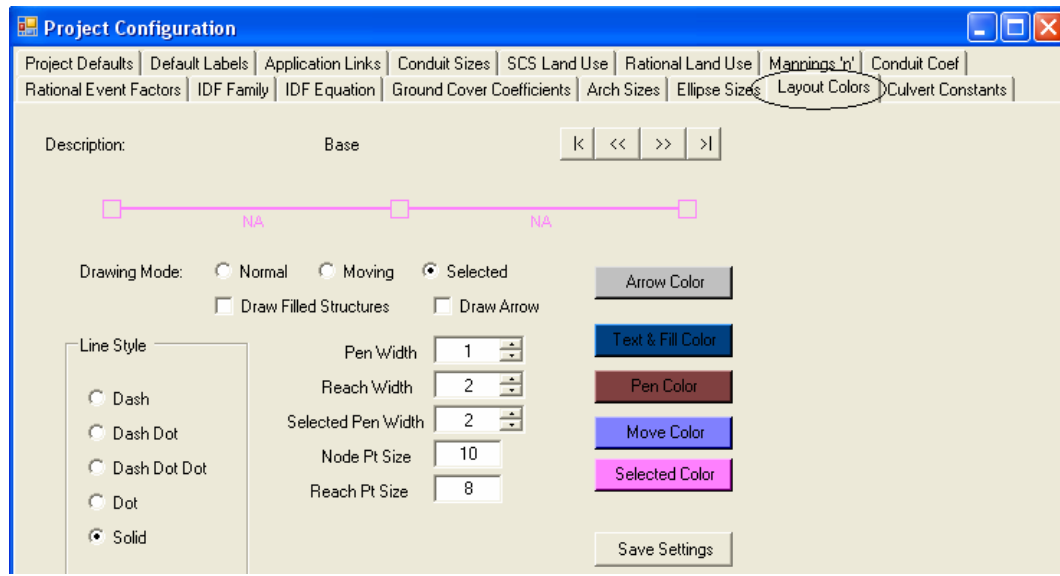
Project Defaults | Default Labels | Application Links | Conduit Sizes | SCS Land Use | Rational Land Use | Mannings 'n' | **Culvert Constants** | Conduit Coef

Rational Event Factors | IDF Family | IDF Equation | Ground Cover Coefficients | Arch Sizes | Ellipse Sizes | Layout Colors

Section Type: Circular [Reference: Hydraulic Design of Hyway Culverts: Hydraulic Design Series No. 5: Appendix A, Tables 8 and 9: Appendix A]

Type	Description	Chart No	Ke	Equation Form	K	M	C	Y
Circular Conc	Square Edge w/Headwall	1	0.5	1	0.0098	2	0.0398	0.67
Circular Conc	Groove End w/Headwall	1	0.2	1	0.0078	2	0.0292	0.74
Circular Conc	Groove End Projecting	1	0.2	1	0.0045	2	0.0317	0.69
Circular CMP	Headwall	2	0.5	1	0.0078	2	0.0379	0.69
Circular CMP	Mitered to slope	2	0.7	1	0.021	1.33	0.0463	0.75
Circular CMP	Projecting	2	0.9	1	0.034	1.5	0.0553	0.54
Circular	Beveled ring, 45 deg bevels	3	0.2	1	0.0018	2.5	0.030	0.74
Circular	Beveled ring, 33.7 deg bevels	3	0.2	1	0.0018	2.5	0.0243	0.83

The **Culvert Constants** tab contains the Coefficient information used in the **Reach** Dialog Box pulldown menus for entrance losses. These values are based on the FHWA guidelines and can not be modified although new values can be added.



Finally, the only tab we have not reviewed is the ***Layout Colors*** tab. Here the settings for the layout can be customized from the colors, the fill, to the line type. It is recommended that the values selected are easy for the designer and reviewer to see and use. *At this time, this feature has been disabled.*

1. If designers want to modify the variables in the ***Conduit Sizes***, ***SCS Land Use***, ***Rational Land Use***, ***Mannings 'n'***, or ***Conduit Coefficient***, the best place to customize is in a file that is referenced in the ***Applications Link*** tab. Modifications made only in the **Project Configurations** tab will be deleted whenever updates are made to 3G.