



DRAINAGE DESIGN MANAGEMENT SYSTEM FOR WINDOWS VERSION 5.6.0

TUTORIAL # 16 HGL EVALUATION OF STORM DRAINAGE SYSTEM



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HGL EVALUATION OF STORM DRAINAGE SYSTEM

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This tutorial provides the procedure to develop and solve a storm drainage system model using DDMSW. The problem that is modeled in this tutorial is taken from the Design Example 4.6 presented in the Flood Control District's Hydraulics Manual (2013). The Storm Drain System Layout for the Example Problem is presented below. All the data used in DDMSW are exactly the same data from the Design Example in the Manual.

Sanitary Sewer Collection System Plan View

← Proposed Street Alignment

Retention Basin Bottom=1265.0'

8" RCP

010040 L=60', S=0.01637

010035 L=300', S=0.0067

8" RCP

MD10035 Ground=1274.22' Sub. Basin 0111

JO10040 Ground=1273.55'

Proposed Street Alignment

Utility Line

62°

29°

MD10025 L=100', S=0.00257

MD10025 Formed Abrupt Transition

MD10025 L=20', S=0.00257

MD10020 L=10', S=0.00257

JO10015 Formed T Transition

010015 L=20', S=0.00257

010010 L=10', S=0.00257

Catch basin 0108 TOC=1274.23' V=3.60'

0108 L=35', S=0.00257

P0108 L=35', S=0.00257

JO10010 Formed T Transition

010005 L=190', S=0.00257

P0106 L=38', S=0.00257

0106 L=38', S=0.00257

Catch basin 0106 TOC=1274.63' V=3.5'

JO10005

P0105 L=38', S=0.00257

0105 L=38', S=0.00257

Catch basin 0105 TOC=1274.63' V=3.5'

Catch basin 0107 TOC=1274.23' V=3.58'

0107 L=35', S=0.00257

P0107 L=35', S=0.00257

JO10015 Formed T Transition

← Existing Street

2.0 CREATING A NEW PROJECT

After launching DDMSW, open the **SELECT PROJECT** form (**File** → **Select Project**) and click the **'Add'** button to create a new project. Select **Hydrology and Hydraulics** and check **Standard**. Enter a unique **Reference** (maximum 16 characters, no spaces) name together with appropriate **Title** (Optional), **Location** (Optional), and **Agency** (Optional). For the purpose of this tutorial, enter the following information:

Project Reference and Other Info:

| | |
|--------------------|--|
| Reference | <i>DESIGNEX46</i> |
| Title | <i>FCDMC Hydraulics Manual Design Example 4.6</i> |
| Location | <i>Maricopa County, Arizona</i> |
| Agency | <i>Flood Control District of Maricopa County</i> |
| Comment Box | <i>Tutorial Project to solve Design Example 4.6 using StormPro</i> |

Project Defaults:

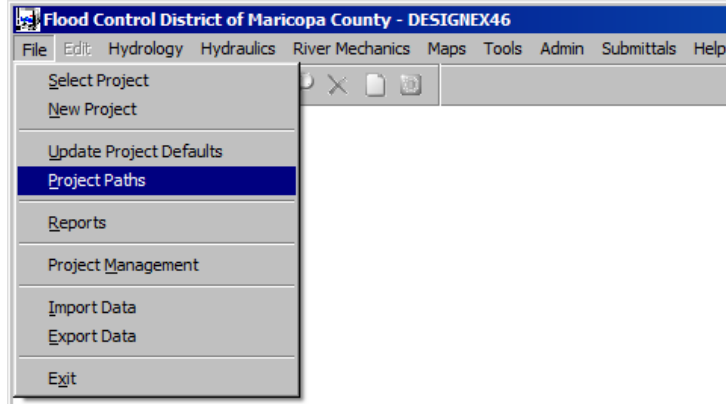
| | |
|-----------------|-----------------|
| Model | <i>Rational</i> |
| Land Use | <i>FCDMC</i> |
| Rainfall | <i>NOAA2</i> |
| Roads | <i>Phoenix</i> |
| Inlets | <i>Phoenix</i> |

Click **'Save'** to save the entered data for the new project. Click **'OK'** to proceed. Click **'OK'** to accept the defaults.

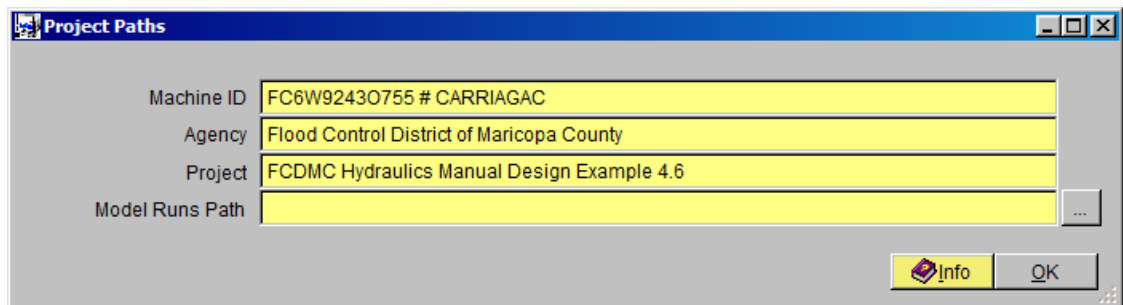
The name of the new project is **DESIGNEX46**.

3.0 SET THE PROJECT PATH

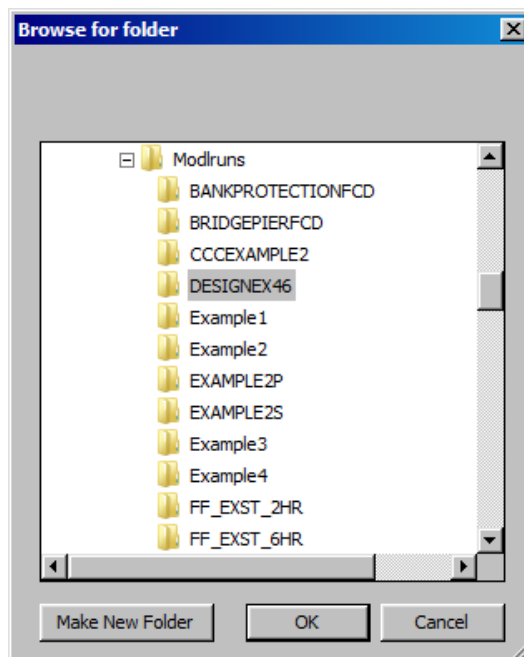
Open the **PROJECT PATHS** form (**File** → **Project Paths**) to define the **Model Runs Path** for the new project.



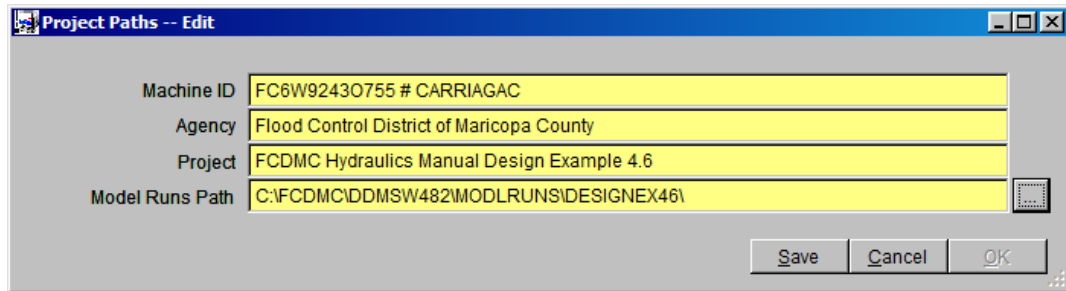
On the **PROJECT PATHS** form, click the ellipse (...) button on the right of the **Model Runs Path** textbox field.



On the **BROWSE FOR FOLDER** form, navigate to the desired folder location where model run files for the project will be saved. If the desired folder location does not exist, click the '**Make New Folder**' button to create the folder. Rename the folder (use *DESIGNEX46*) and select it. Click '**OK**' to close the form.



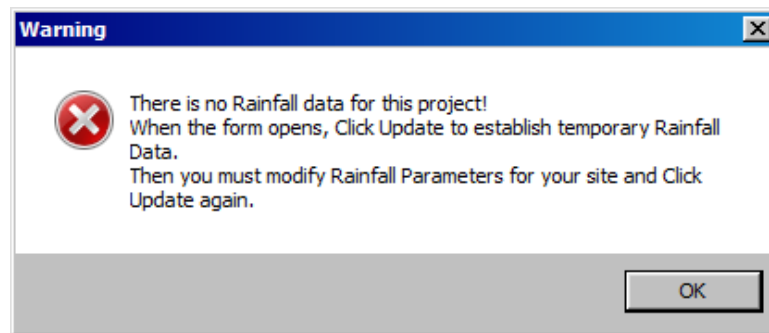
On the **PROJECT PATHS** form, click '**Save**' to save the data and click '**OK**' to close the form.



The screenshot shows a Windows-style dialog box titled "Project Paths -- Edit". It contains four labeled text fields: "Machine ID" with the value "FC6W92430755 # CARRIAGAC", "Agency" with "Flood Control District of Maricopa County", "Project" with "FCDMC Hydraulics Manual Design Example 4.6", and "Model Runs Path" with "C:\FCDMC\DDMSW482\MODLRUNS\DESIGNEX46\". At the bottom right, there are three buttons: "Save", "Cancel", and "OK".

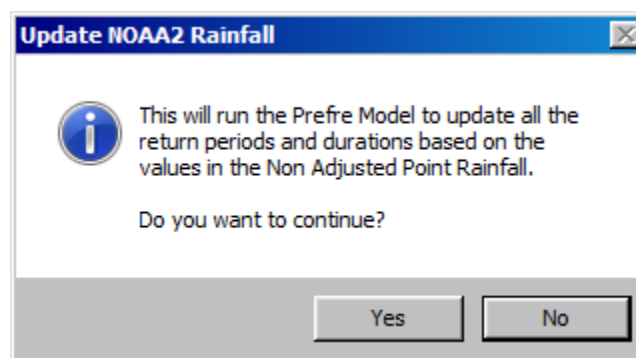
4.0 DEVELOP THE RAINFALL DATA

Open the **NOAA2 RAINFALL DATA** form (*Hydrology → Rainfall*) to develop the rainfall data for the project. If a **WARNING** dialog box shows up indicating that '*There is no Rainfall data for the project*', click the '**OK**' button to create a temporary Rainfall Data.



The screenshot shows a "Warning" dialog box with a red 'X' icon. The text inside reads: "There is no Rainfall data for this project! When the form opens, Click Update to establish temporary Rainfall Data. Then you must modify Rainfall Parameters for your site and Click Update again." There is an "OK" button at the bottom right.

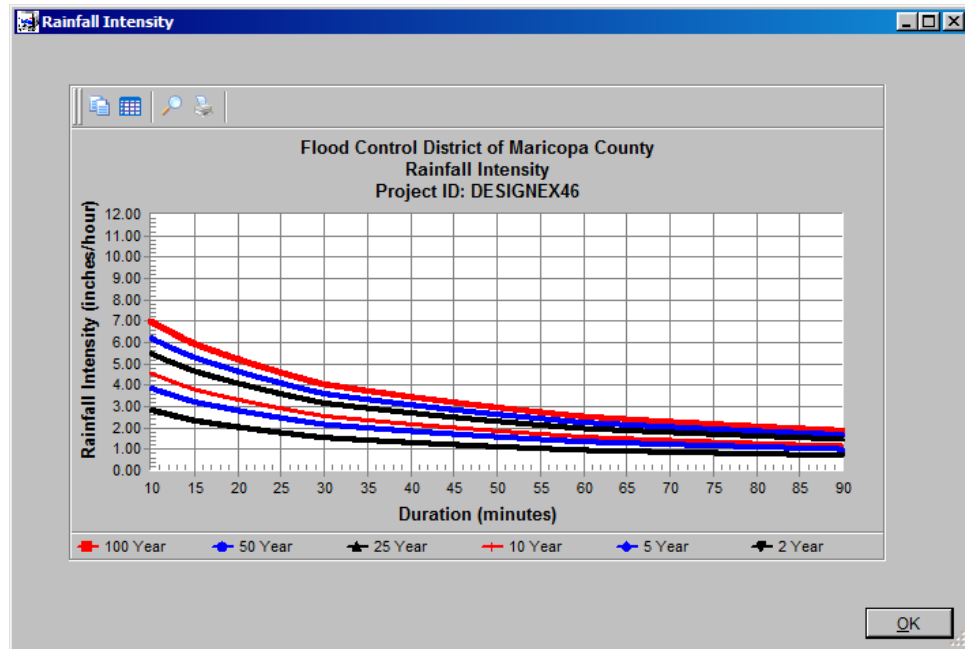
On the **NOAA2 RAINFALL DATA** form, click the '**Update**' button to create a temporary data. Click '**OK**' to continue.



The screenshot shows an "Update NOAA2 Rainfall" dialog box with an information icon. The text inside reads: "This will run the Prefre Model to update all the return periods and durations based on the values in the Non Adjusted Point Rainfall. Do you want to continue?" There are "Yes" and "No" buttons at the bottom.

The **NOAA2 RAINFALL DATA FORM** shows the generated Rainfall Data.

On the **NOAA2 RAINFALL DATA** form, click '**Graph**' to view the IDF curves.



Click '**OK**' to close the **RAINFALL INTENSITY** form. Click '**OK**' to exit the **NOAA2 RAINFALL DATA** form.

5.0 DEVELOP THE SUB BASIN DATA

To enter the Sub Basin data, open the **SUB BASINS** form (**Hydrology** → **Sub Basins**). Click the '**Add**' button to start the data entry process. Enter the data for Sub Basins *0105*, *0106*, *0107*, *0108* and *0111* as shown below. Do not click '**Update**' yet until the land use data has been entered. If you click '**Save**' after entering the **USGE** and **DSGE**, the **Slope** will be automatically calculated.

| Sub Basin | Sort | Area (acres) | Length (ft) | USGE (ft) | DSGE (ft) | Slope (ft/mi) |
|-----------|------|--------------|-------------|-----------|-----------|---------------|
| 0105 | 10 | 0.47 | 390 | 100.0 | 97.0 | 40.6 |
| 0106 | 20 | 0.86 | 1000 | 100.0 | 83.0 | 89.8 |
| 0107 | 30 | 0.47 | 450 | 100.0 | 95.0 | 58.7 |
| 0108 | 40 | 0.67 | 510 | 100.0 | 97.0 | 31.1 |
| 0111 | 50 | 50.00 | 1350 | 100.0 | 90.0 | 39.1 |

After data are entered and saved for each Sub Basin, click **'Add'** to enter subsequent **Sub Basin** data. When finished, click **'OK'** to close the **SUB BASINS** form.

6.0 DEVELOP THE LAND USE DATA

To enter the land use data, open the **LAND USE** form (**Hydrology** → **Land Use**) then click **Add**. Enter the **Land Use** data for Sub Basins 0105, 0106, 0107, 0108 and 0111 as provided in the table below. It is necessary to modify the C values to come close to matching the values in Design Example 4.6

Land Use - MB: 01

List Details

Land Use

Major Basin ID 01 Area (acres) 0.47

Sub Basin ID 105 Area (%) 100.0

Land Use Code 600 General Transportation (Transportation where no detail avail)

Land Use Data

| | Value | Default | Custom |
|-----------------------------|-------|---------|-------------------------------------|
| 2-Year C | 0.91 | 0.95 | <input checked="" type="checkbox"/> |
| 5-Year C | 0.95 | 0.95 | <input type="checkbox"/> |
| 10-Year C | 0.95 | 0.95 | <input type="checkbox"/> |
| 25-Year C | 0.95 | 0.95 | <input type="checkbox"/> |
| 50-Year C | 0.95 | 0.95 | <input type="checkbox"/> |
| 100-Year C | 0.95 | 0.95 | <input type="checkbox"/> |
| Resistance Coefficient (Kb) | MIN | MIN | <input type="checkbox"/> |

Info Copy Print... Delete Add MB OK

| Sub Basin ID | Land Use Code | Area (acres) | 2-Year Custom C | 50-Year Custom C | 100-Year Custom C |
|--------------|---------------|--------------|-----------------|------------------|-------------------|
| 0105 | 600 | 0.47 | 0.91 | | |
| 0106 | 600 | 0.86 | 0.91 | | |
| 0107 | 600 | 0.47 | 0.91 | | |
| 0108 | 600 | 0.67 | 0.91 | | |
| 0111 | 200 | 50.00 | 0.85 | .90 | .90 |

After individual Land Use data are entered into the form, click **'Save'** to save the data and click **'Add'** to enter the next Land Use record. When all the Land use data have been entered, click **'OK'** to close and exit the **LAND USE** form.

7.0 UPDATE THE SUB BASIN DATA

To evaluate the parameters of individual Sub Basin with consideration of the Rainfall and the Land Use data developed in the previous Sections 4 and 6, open the **SUB BASINS** form (*Hydrology → Sub Basins*). On the **Details** tab of the form, click the **'Update'** button.

Sub Basins - MB: 01

List | **Details**

Sub Basin

Major Basin: 01

Sub Basin: 0105

Sort: 2

Sub Basin Parameters

Area (acres): 0.47

Length (ft): 390

USGE (ft): 100.0

DSGE (ft): 97.0

Slope (ft/mi): 40.6

Value | Default | Custom

Kb: [] [] []

Sub Basin Hydrology Summary

| | 2 yr | 5 yr | 10 yr | 25 yr | 50 yr | 100 yr |
|-----------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Q (cfs) | | | | | | |
| CA (ac) | | | | | | |
| Custom Tc | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Tc (min) | | | | | | |
| i (in/hr) | | | | | | |

Comments

[]

Info | ReSort | Print... | Delete | Add | MB | Update | OK

For **Sub Basin 0111**, check the **Custom Tc** checkbox for the 2-yr storm event. The rationale for this customized Tc of *14.1 min* is to come close to matching the data in Design Example 4.6.

Sub Basins - MB: 01

List | **Details**

Sub Basin

Major Basin: 01

Sub Basin: 0111

Sort: 50

Sub Basin Parameters

Area (acres): 50.00

Length (ft): 1350

USGE (ft): 100.0

DSGE (ft): 90.0

Slope (ft/mi): 39.1

Value | Default | Custom

Kb: 0.029 | 0.029 | []

Sub Basin Hydrology Summary

| | 2 yr | 5 yr | 10 yr | 25 yr | 50 yr | 100 yr |
|-----------|-------------------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Q (cfs) | 102.0 | 159.8 | 193.8 | 232.1 | 278.1 | 313.2 |
| CA (ac) | 42.50 | 42.50 | 42.50 | 42.50 | 45.00 | 45.00 |
| Custom Tc | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Tc (min) | 14.1 | 10.6 | 10.0 | 10.0 | 10.0 | 10.0 |
| i (in/hr) | 2.40 | 3.76 | 4.56 | 5.46 | 6.18 | 6.96 |

Comments

A Custom Tc for the 2-yr storm event of 14.1 minutes was used to match Q2 from Design example 4.6 in the Hydraulics Manual.

Info | ReSort | Print... | Delete | Add | MB | Update | OK

Click '**OK**' to close and exit the **SUB BASINS** form.

8.0 DEVELOP THE CONVEYANCE FACILITIES DATA

The Storm Drain Layout in Section 1.0 shows one (1) Main Line, one (1) Lateral Line that feeds into the Main Line, and 4 Connector Pipes that feed into the Lateral Line. For this tutorial project, the StormPro backwater model is used to develop the hydraulic grade line (HGL) of the storm drain system. It is, therefore, necessary to sort the Conveyance Facilities in the correct order and establish the Line ID for each Conveyance Facility. With respect to the System Layout, Conveyance Facilities 010035 and 010040 will be **Line ID 10** which outfalls into a Retention Basin. All remaining conveyance facilities (Lateral Line and Connector Pipes) will be designated as **Line ID 20**. **Line ID 20** outfalls into Conveyance Facilities 010040.

The physical data (pipe size, pipe length, pipe invert elevations, etc.) of all the conduits / pipes in the system are tabulated below.

To enter the Conveyance Facilities data, open the **CONVEYANCE FACILITIES** form (**Hydraulics → Conveyance Facilities**). Click the '**Add**' button to start the data entry for the first record.

| ID | | | Model Options | | | | | Elevations | | | | Section | | |
|-------------|---------|------|---------------|------------|------------|---------|------------|------------|---------|---------|---------|---------|-----|---------------|
| Facility ID | Line ID | Sort | Custom Q | Model Road | First Pipe | Outfall | DS Pipe ID | USGE | DSGE | USIE | DSIE | Length | Dia | Road ID |
| 010040 | 10 | 10 | 105.2 | X | | X | | 1273.55 | 1270.50 | 1266.80 | 1265.50 | 80.00 | 48 | PH-MJC-XSE-80 |
| 010035 | 10 | 20 | 102.0 | X | X | | | 1274.22 | 1273.55 | 1268.30 | 1266.80 | 300.00 | 48 | PH-MJC-XSE-80 |
| 010030 | 20 | 30 | 5.8 | X | | X | 010040 | 1274.36 | 1273.55 | 1269.30 | 1268.80 | 200.00 | 24 | PH-MJC-XSE-80 |
| 010025 | 20 | 40 | 5.8 | X | | | | 1274.77 | 1274.36 | 1270.05 | 1269.80 | 100.00 | 18 | PH-MJC-XSE-80 |
| 010020 | 20 | 50 | 5.8 | | | | | 1274.59 | 1274.77 | 1270.24 | 1270.05 | 75.00 | 18 | |
| 010015 | 20 | 60 | 5.8 | | | | | 1274.44 | 1274.59 | 1270.29 | 1270.24 | 20.00 | 18 | |
| 010010 | 20 | 70 | 4.7 | | | | | 1274.44 | 1274.44 | 1270.31 | 1270.29 | 10.00 | 18 | |
| 010005 | 20 | 80 | 3.4 | X | X | | | 1274.96 | 1274.44 | 1270.79 | 1270.31 | 190.00 | 18 | PH-MJC-XSE-80 |

For the first Conveyance Facilities data, enter the following:

ID:

- **Facility ID** 010040
- **Line ID** 10
- **Sort** 10

Model Options:

- **RP (yrs)** 2
- **Custom** checkbox Check
- **Q (cfs)** 105.2
- **Model Road** checkbox Check
- **First Pipe** checkbox Uncheck

- **Outfall** checkbox *Check18*
- **D/S Pipe ID** *Blank*

Elevations:

- **U/S Ground Elevation (ft)** *1273.55*
- **D/S Ground Elevation (ft)** *1270.50*
- **U/S Invert Elevation (ft)** *1266.80*
- **D/S Invert Elevation (ft)** *1265.50*

Section Type:

- **Section** *Pipe*
- **Length (ft)** *80.00*
- **Manning's n** *0.013*
- **Diameter (in)** *48*
- **No. of Barrels** *1*
- **Road ID** *PH-MJC-XSE-80*
- **No. of Manholes** *0*

After entering all the data for the first record (**Facility ID 010040**), press '**Save**'.

Click '**Add**' to enter the next record. Enter the following data for **Facility ID 010035**.

ID:

- Facility ID 010035
- Line ID 10
- Sort 20

Model Options:

- RP (yrs) 2
- Custom checkbox Check
- Q (cfs) 102.0
- Model Road checkbox Check
- First Pipe checkbox Check
- Outfall checkbox Uncheck

Elevations:

- U/S Ground Elevation (ft) 1274.22
- D/S Ground Elevation (ft) 1273.55
- U/S Invert Elevation (ft) 1268.30
- D/S Invert Elevation (ft) 1266.80

Section Type:

- Section Pipe
- Length (ft) 300.00
- Manning's n 0.013
- Diameter (in) 48
- No. of Barrels 1
- Road ID PH-MJC-XSE-80
- No. of Manholes 0

After entering all the data for the second record (**Facility ID 010035**), press '**Save**'.

Conveyance Facilities - MB: 01

List Details

ID

MB ID 01

Facility ID 010035

Line ID 10

Sort 20

Section Type

Section Pipe

Length (ft) 300.00

Manning's n 0.013

Diameter (in) 48

No. of Barrels 1

Road ID PH-MJC-XSE-80

No. of Manholes 0

Model Options

RP (yrs) 2

Q (cfs) 102.0

Model Road ☒

First Pipe ☒ Outfall ☐

Elevations

| | U/S (ft) | D/S (ft) |
|--------|----------|----------|
| Ground | 1274.22 | 1273.55 |
| Invert | 1268.30 | 1266.80 |

Calculations

Capacity (cfs)

Slope (ft/ft) 0.0050

Velocity (fps)

| | Q (cfs) | Road Depth (ft) | Upstream HGL (ft) |
|--------|---------|-----------------|-------------------|
| 2 Yr | | | |
| 5 Yr | | | |
| 10 Yr | | | |
| 25 Yr | | | |
| 50 Yr | | | |
| 100 Yr | | | |

Comments

Info ReSort Print... Delete Add Graph MB Update OK

Click '**Add**' to enter the next record. Enter the following data for **Facility ID 010030**.

ID:

- Facility ID 010030
- Line ID 20
- Sort 30

Model Options:

- RP (yrs) 2
- Custom checkbox Check
- Q (cfs) 5.8
- Model Road checkbox Check
- First Pipe checkbox Uncheck
- Outfall checkbox Check
- D/S Pipe ID 010040

Elevations:

- U/S Ground Elevation (ft) 1274.36
- D/S Ground Elevation (ft) 1273.55
- U/S Invert Elevation (ft) 1269.30
- D/S Invert Elevation (ft) 1268.80

Section Type:

- **Section** *Pipe*
- **Length (ft)** *200.00*
- **Manning's n** *0.013*
- **Diameter (in)** *24*
- **No. of Barrels** *1*
- **Road ID** *PH-MJC-XSE-80*
- **No. of Manholes** *0*

After entering all the data for the third record (**Facility ID 010030**), press '**Save**'.

Click '**Add**' to enter the next record. Enter the following data for **Facility ID 010025**.

ID:

- **Facility ID** *010025*
- **Line ID** *20*
- **Sort** *40*

Model Options:

- **RP (yrs)** *2*
- **Custom** checkbox *Check*
- **Q (cfs)** *5.8*
- **Model Road** checkbox *Check*
- **First Pipe** checkbox *Uncheck*
- **Outfall** checkbox *Uncheck*

Elevations:

- U/S Ground Elevation (ft) 1274.77
- D/S Ground Elevation (ft) 1274.36
- U/S Invert Elevation (ft) 1270.05
- D/S Invert Elevation (ft) 1269.80

Section Type:

- Section *Pipe*
- Length (ft) 100.00
- Manning's n 0.013
- Diameter (in) 18
- No. of Barrels 1
- Road ID *PH-MJC-XSE-80*
- No. of Manholes 0

After entering all the data for the fourth record (**Facility ID 010025**), press '**Save**'.

Click '**Add**' to enter the next record. Enter the following data for **Facility ID 010020**.

ID:

- Facility ID 010020
- Line ID 20
- Sort 50

Model Options:

- RP (yrs) 2
- Custom checkbox *Check*

- **Q (cfs)** 5.8
- **Model Road** checkbox *Uncheck*
- **First Pipe** checkbox *Uncheck*
- **Outfall** checkbox *Uncheck*

Elevations:

- **U/S Ground Elevation (ft)** 1274.59
- **D/S Ground Elevation (ft)** 1274.77
- **U/S Invert Elevation (ft)** 1270.24
- **D/S Invert Elevation (ft)** 1270.05

Section Type:

- **Section** *Pipe*
- **Length (ft)** 75.00
- **Manning's n** 0.013
- **Diameter (in)** 18
- **No. of Barrels** 1
- **No. of Manholes** 0

After entering all the data for the fifth record (**Facility ID 010020**), press '**Save**'.

Click '**Add**' to enter the next record. Enter the following data for **Facility ID 010015**.

ID:

- Facility ID 010015
- Line ID 20
- Sort 60

Model Options:

- RP (yrs) 2
- Custom checkbox Check
- Q (cfs) 5.8
- Model Road checkbox Uncheck
- First Pipe checkbox Uncheck
- Outfall checkbox Uncheck

Elevations:

- U/S Ground Elevation (ft) 1274.44
- D/S Ground Elevation (ft) 1274.59
- U/S Invert Elevation (ft) 1270.29
- D/S Invert Elevation (ft) 1270.24

Section Type:

- Section Pipe
- Length (ft) 20.00
- Manning's n 0.013
- Diameter (in) 18
- No. of Barrels 1
- No. of Manholes 0

After entering all the data for the sixth record (**Facility ID 010015**), press '**Save**'.

Conveyance Facilities - MB: 01

List **Details**

ID

MB ID: 01

Facility ID: 010015

Line ID: 20

Sort: 60

Model Options

RP (yrs): 2

Q (cfs): 5.8 ☒ Custom

Model Road ☐

First Pipe ☐ Outfall ☐

Elevations

| | U/S (ft) | D/S (ft) |
|--------|----------|----------|
| Ground | 1274.44 | 1274.59 |
| Invert | 1270.29 | 1270.24 |

Section Type

Section: Pipe

Length (ft): 20.00

Manning's n: 0.013

Diameter (in): 18

No. of Barrels: 1

No. of Manholes: 0

Calculations

Capacity (cfs):

Slope (ft/ft): 0.0025

Velocity (fps):

Q (cfs)

2 Yr:

5 Yr:

10 Yr:

25 Yr:

50 Yr:

100 Yr:

Upstream HGL (ft)

2 Yr:

5 Yr:

10 Yr:

25 Yr:

50 Yr:

100 Yr:

Comments:

Click '**Add**' to enter the next record. Enter the following data for **Facility ID 010010**.

ID:

- **Facility ID** 010010
- **Line ID** 20
- **Sort** 70

Model Options:

- **RP (yrs)** 2
- **Custom** checkbox *Check*
- **Q (cfs)** 4.7
- **Model Road** checkbox *Uncheck*
- **First Pipe** checkbox *Uncheck*
- **Outfall** checkbox *Uncheck*

Elevations:

- **U/S Ground Elevation (ft)** 1274.44
- **D/S Ground Elevation (ft)** 1274.44
- **U/S Invert Elevation (ft)** 1270.31
- **D/S Invert Elevation (ft)** 1270.29

Section Type:

- **Section** *Pipe*

- Length (ft) 10.00
- Manning's n 0.013
- Diameter (in) 18
- No. of Barrels 1
- No. of Manholes 0

After entering all the data for the seventh record (**Facility ID 010010**), press **'Save'**.

Click **'Add'** to enter the next and last record. Enter the following data for **Facility ID 010005**.

ID:

- Facility ID 010005
- Line ID 20
- Sort 80

Model Options:

- RP (yrs) 2
- Custom checkbox Check
- Q (cfs) 3.4
- Model Road checkbox Check
- First Pipe checkbox Check
- Outfall checkbox Uncheck

Elevations:

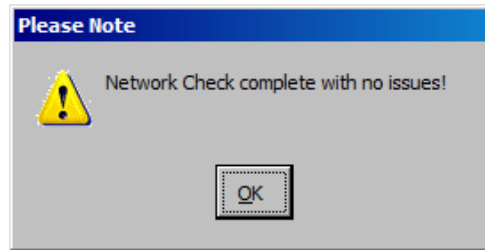
9.0 BUILD THE MODEL NETWORK

Prior to running the Storm Drain system created from the Section 8.0, it is essential to build the model network to define the interconnectivity of the piping / conduit system. To build the model network, open the **RATIONAL METHOD NETWORK** form (*Hydrology → Rational Method → Network*). To start, press the **'Add'** button. Build the model network as shown below. The procedure for building a model network for Rational Method is presented in another tutorial document called, *"Developing a New Project Using Rational Method"*.

The screenshot shows the 'Rational Method Network - MB: 01' window. At the top left, there is a 'Look for' field and a 'First Pipe' button. Below this is a table with columns: Sort, ID, Type, and Combine. The table lists various network components. To the right of the table is a 'Network' panel with fields for 'Major Basin ID' (01), 'Sort' (140), 'Type' (Hold), and 'ID' (010030). Below these fields are buttons for 'Sub Basin', 'Combine', 'Convey', 'Diver', 'Hold', 'Receive', 'Retrieve Diversion', and 'Storage'. At the bottom right of the panel is a 'Check Network' button. At the bottom of the window is a toolbar with buttons: Info, ReSort, Print..., Delete, Add, MB, and OK.

| Sort | ID | Type | Combine |
|------|--------|-----------|---------|
| 10 | 0105 | Sub Basin | |
| 20 | 0106 | Sub Basin | |
| 30 | 0106 | Combine | 2 |
| 40 | 010005 | Convey | |
| 50 | 0108 | Sub Basin | |
| 60 | 0108 | Combine | 2 |
| 70 | 010010 | Convey | |
| 80 | 0107 | Sub Basin | |
| 90 | 0107 | Combine | 2 |
| 100 | 010015 | Convey | |
| 110 | 010020 | Convey | |
| 120 | 010025 | Convey | |
| 130 | 010030 | Convey | |
| 140 | 010030 | Hold | |
| 150 | 0111 | Sub Basin | |
| 160 | 010035 | Convey | |
| 172 | 010030 | Receive | |
| 174 | 0111 | Combine | 2 |
| 180 | 010040 | Convey | |

Once the model network is built (like the one shown above), click the **'Check Network'** button for the program to verify if the model network that was built is complete or has issues.

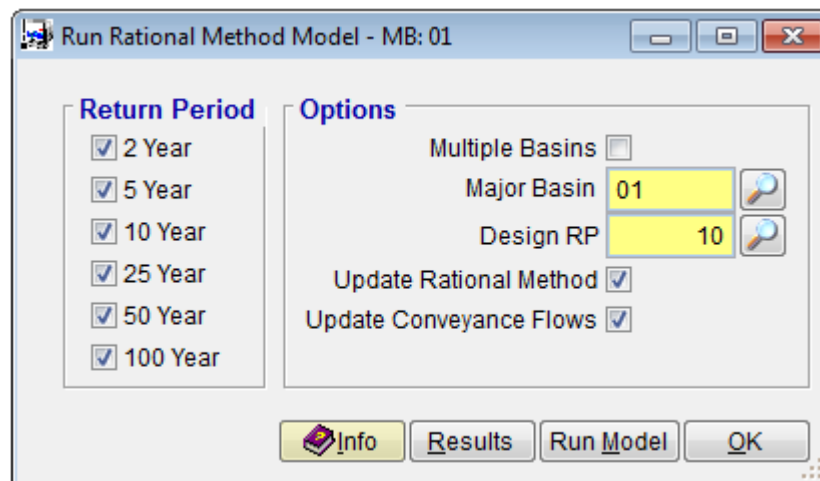


10.0 RUN THE MODEL

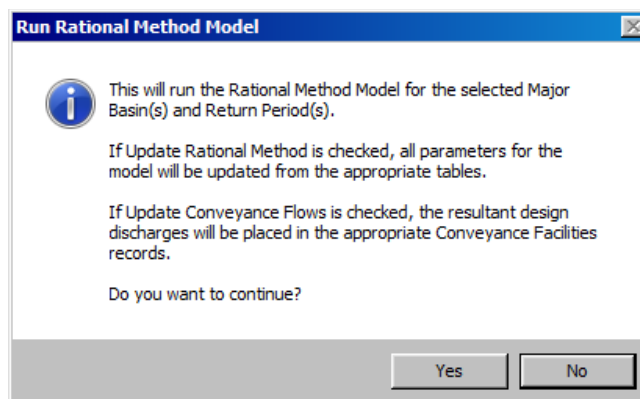
To run the model, open the **RUN RATIONAL METHOD MODEL** form and make the following changes on the form:

- (a) Check all the **Return Periods** (i.e., **2 Year**, **5 Year**, **10 Year**, **25 Year**, **50 Year**, and **100 Year**);
- (b) Check the **'Update Rational Method'** checkbox.
- (c) Check the **'Update Conveyance Flows'** checkbox.

Click the **'Run Model'** button.

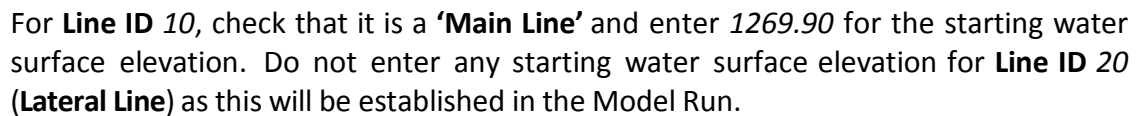


Click **'OK'** to continue.



11.0 ESTABLISH DATA FOR THE STORMPRO LINES

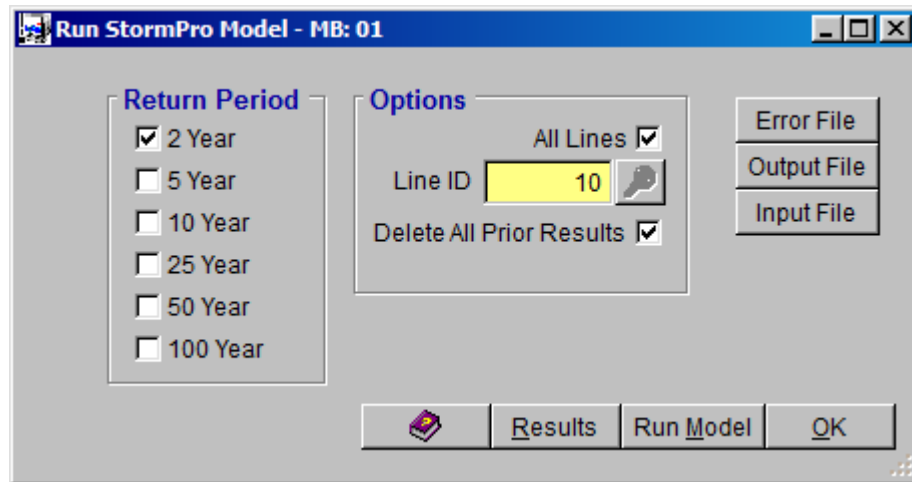
On the **STORMPRO LINES** form, press the **'Update'** button to start. On the **UPDATE STORMPRO LINES** form, click **'Yes'** to continue.



Click '**OK**' to close the form.

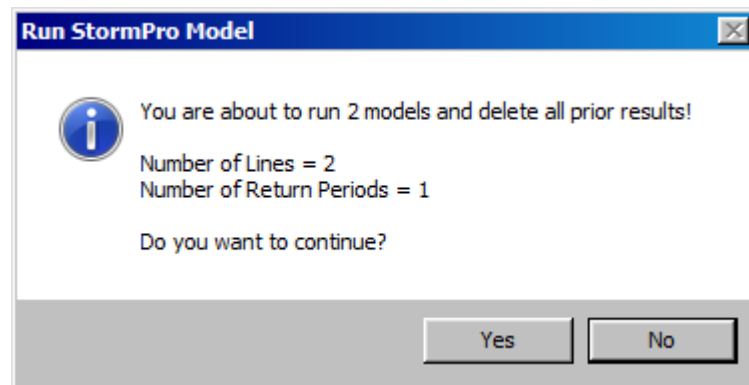
12.0 RUN STORMPRO

To run the model, open the **RUN STORMPRO MODEL** form (*Hydraulics → StormPro Backwater → Model*). Select the **2 Year** Return Period, check **All Lines** and **Delete All Prior Results** checkboxes. Click '**Save**' to save the data entered and press '**Run Model**'.



The screenshot shows a window titled "Run StormPro Model - MB: 01". It contains two main sections: "Return Period" and "Options". In the "Return Period" section, the "2 Year" checkbox is checked, while "5 Year", "10 Year", "25 Year", "50 Year", and "100 Year" are unchecked. In the "Options" section, the "All Lines" checkbox is checked, the "Line ID" is set to "10", and the "Delete All Prior Results" checkbox is checked. To the right of these sections are three buttons: "Error File", "Output File", and "Input File". At the bottom of the window are four buttons: a folder icon, "Results", "Run Model", and "OK".

Click '**Yes**' to continue.



The screenshot shows a confirmation dialog box titled "Run StormPro Model". It features an information icon (i) and the following text: "You are about to run 2 models and delete all prior results!", "Number of Lines = 2", "Number of Return Periods = 1", and "Do you want to continue?". At the bottom of the dialog are two buttons: "Yes" and "No".

Once the model run is complete, model results viewed by clicking the '**Results**' button and can be graphed by clicking the '**Graph**' on the **STORMPRO RESULTS** form.

Model View

View Option

Line ID

Return Period

File Type

Graph EGL ☐

| Flood Control District of Maricopa County | | | | | | | | | | | | | | | |
|---|--------|---------|------|---------|-------|-------|---------|---------|----------|------|------|--------|------|------|-------|
| File: 01-00010-002.SPI | | | | | | | | | | | | | | | |
| Major Basin: 01 - Line ID: 10 - RP: 2 | | | | | | | | | | | | | | | |
| 0 STATION | INVERT | DEPTH | W.S. | Q | VEL | VEL | ENERGY | SUPER | CRITICAL | | HGT/ | BASE/ | ZL | NO | AUBPR |
| 0 L/ELEM | ELEV | OF FLOW | ELEV | | | HEAD | GRD.EL. | ELEV | DEPTH | | DIA | ID NO. | ZR | PIER | |
| ***** | | | | | | | | | | | | | | | |
| 0 | 0.00 | 1265.50 | 4.40 | 1269.90 | 106.3 | 8.46 | 1.11 | 1271.01 | 0.00 | 3.12 | | | | | |
| 0 | 37.13 | 0.01625 | | | | | 0.00544 | 0.20 | | | | | | | |
| 0 | 37.13 | 1266.10 | 4.00 | 1270.10 | 106.3 | 8.46 | 1.11 | 1271.22 | 0.00 | 3.12 | 2.19 | 4.00 | 0.00 | 0 | 0.00 |
| 0 | 23.19 | 0.01625 | | | | | 0.00510 | 0.12 | | | | | | | |
| 0 | 60.32 | 1266.48 | 3.63 | 1270.11 | 106.3 | 8.87 | 1.22 | 1271.33 | 0.00 | 3.12 | 2.19 | 4.00 | 0.00 | 0 | 0.00 |
| 0 | 1.59 | 0.01625 | | | | | 0.00481 | 0.01 | | | | | | | |
| 0 | 61.91 | 1266.51 | 3.59 | 1270.10 | 106.3 | 8.93 | 1.24 | 1271.34 | 0.00 | 3.12 | 2.19 | 4.00 | 0.00 | 0 | 0.00 |
| OHYDRAULIC JUMP | | | | | | | | | | | | | | | |
| 0 | 61.91 | 1266.51 | 2.69 | 1269.20 | 106.3 | 11.81 | 2.17 | 1271.37 | 0.00 | 3.12 | | | | | |
| 0 | 3.20 | 0.01625 | | | | | 0.00854 | 0.03 | | | | | | | |
| 0 | 65.11 | 1266.56 | 2.72 | 1269.28 | 106.3 | 11.67 | 2.11 | 1271.40 | 0.00 | 3.12 | 2.19 | 4.00 | 0.00 | 0 | 0.00 |
| 0 | 8.59 | 0.01625 | | | | | 0.00796 | 0.07 | | | | | | | |
| 0 | 73.70 | 1266.70 | 2.84 | 1269.54 | 106.3 | 11.12 | 1.92 | 1271.46 | 0.00 | 3.12 | 2.19 | 4.00 | 0.00 | 0 | 0.00 |
| 0 | 4.79 | 0.01625 | | | | | 0.00711 | 0.03 | | | | | | | |
| 0 | 78.48 | 1266.78 | 2.98 | 1269.75 | 106.3 | 10.60 | 1.75 | 1271.50 | 0.00 | 3.12 | 2.19 | 4.00 | 0.00 | 0 | 0.00 |
| 0 | 1.52 | 0.01625 | | | | | 0.00637 | 0.01 | | | | | | | |
| 0 | 80.00 | 1266.80 | 3.12 | 1269.92 | 106.3 | 10.11 | 1.59 | 1271.51 | 0.00 | 3.12 | 2.19 | 4.00 | 0.00 | 0 | 0.00 |
| OJUNCT STR | | | | | | | | | | | | | | | |
| 0 | 85.00 | 1266.80 | 3.81 | 1270.61 | 101.3 | 8.20 | 1.05 | 1271.66 | 0.00 | 3.05 | | | | | |
| 0 | 228.92 | 0.00508 | | | | | 0.00438 | 1.00 | | | | | | | |
| 0 | 313.92 | 1267.96 | 3.55 | 1271.51 | 101.3 | 8.60 | 1.15 | 1272.66 | 0.00 | 3.05 | 3.24 | 4.00 | 0.00 | 0 | 0.00 |
| 0 | 66.08 | 0.00508 | | | | | 0.00450 | 0.30 | | | | | | | |
| 1 | | | | | | | | | | | | | | | |
| WATER SURFACE PROFILE LISTING | | | | | | | | | | | | | | | |
| Flood Control District of Maricopa County | | | | | | | | | | | | | | | |
| File: 01-00010-002.SPI | | | | | | | | | | | | | | | |
| Major Basin: 01 - Line ID: 10 - RP: 2 | | | | | | | | | | | | | | | |
| 0 STATION | INVERT | DEPTH | W.S. | Q | VEL | VEL | ENERGY | SUPER | CRITICAL | | HGT/ | BASE/ | ZL | NO | AUBPR |
| 0 L/ELEM | ELEV | OF FLOW | ELEV | | | HEAD | GRD.EL. | ELEV | DEPTH | | DIA | ID NO. | ZR | PIER | |
| ***** | | | | | | | | | | | | | | | |
| 0 | 380.00 | 1268.30 | 3.46 | 1271.76 | 101.3 | 8.76 | 1.19 | 1272.96 | 0.00 | 3.05 | 4.00 | 0.00 | 0.00 | 0 | 0.00 |

PAGE 2

Note that there is a Hydraulic Jump at Station 61.91 and also that the depth of flow after the Hydraulic Jump is significantly lower than the Normal depth resulting in extremely high velocities.

13.0 COMPARISON OF RESULTS

The differences in HGL and EGL between the Manual method and the StormPro Model are tabulated below.

| ID | Q | HGL | | EGL | | Comments |
|--------|--------|---------|----------|---------|----------|---------------------|
| | | Manual | StormPro | Manual | StormPro | |
| 010040 | 105.20 | 1271.52 | 1268.91 | 1272.61 | 1272.63 | Hydraulic Jump |
| 010035 | 102.00 | 1273.07 | 1269.30 | 1274.09 | 1296.30 | Super Critical Flow |
| 010030 | 5.80 | 1271.69 | 1270.31 | 1271.74 | 1270.64 | |
| 010025 | 5.80 | 1272.10 | 1270.98 | 1272.27 | 1271.37 | |
| 010020 | 5.80 | 1272.36 | 1271.43 | 1272.53 | 1271.66 | |
| 010015 | 5.80 | 1272.47 | 1271.50 | 1272.64 | 1271.72 | |
| 010010 | 4.70 | 1272.55 | 1271.70 | 1272.66 | 1271.82 | |
| 010005 | 3.40 | 1272.74 | 1271.17 | 1272.80 | 1272.62 | |