North
Carolina
Department
Of
Transportation

Hydraulics Unit

Instruction Manual For Geopak Drainage

3/12/09

Open Project

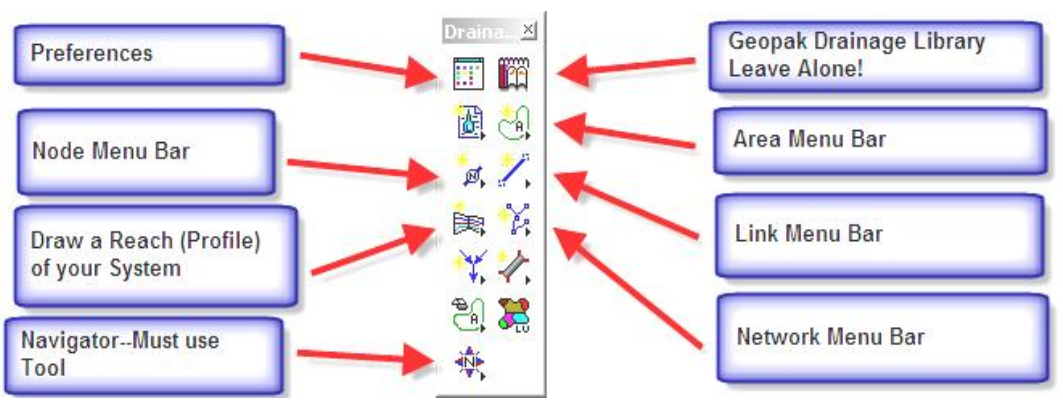
1. Open the Microstation design file
   Path

2. Activate the **GEOPAK Drainage** tools within the Microstation file
   Path: Applications > GEOPAK Drainage > Drainage

3. Open the **GEOPAK DRAINAGE FILE** (GDF) from within the Microstation file.
   Path: Drainage > Project > Open >

Note: You must remember to open your drainage project every time. If you don't you will lose that information.

Open the Drainage Toolbar

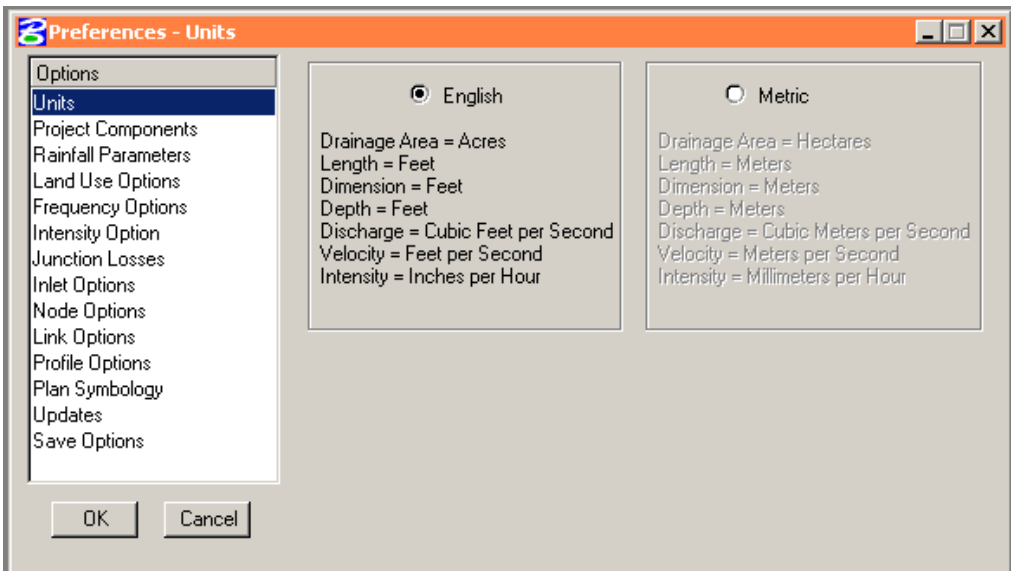


Set Preferences

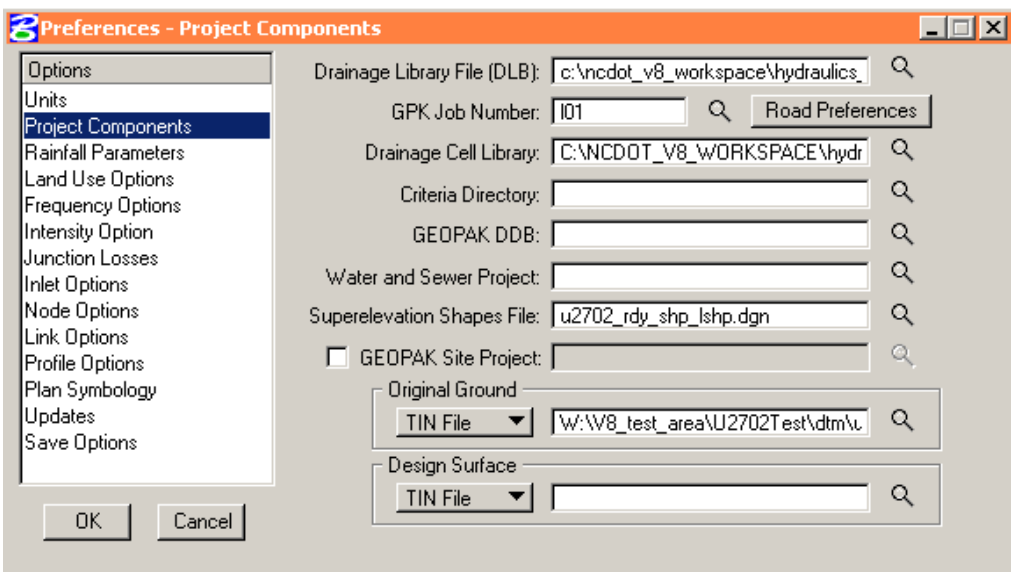
When you start a new Geopak Drainage project, the first thing you have to do is set your **Preferences**. Preferences can be found on the main Drainage toolbox (upper left box) or under **Drainage> Project> Preferences**.

Once you have opened the Preferences, you need to:

Select your units:



Fill in your project components:



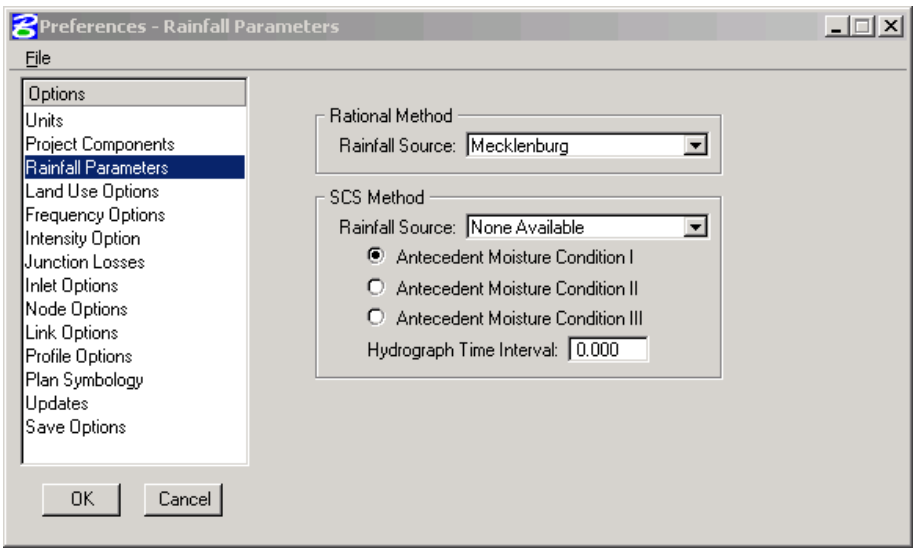
The path to the Drainage Library file is:
C:\NCDOT_V8_WORKSPACE\hydraulics_STDS\English \gepak\dlb\englib.dlb

The path to the correct cell library is:
C:\NCDOT_V8_WORKSPACE\hydraulics_STDS\Standards\cell \Hydraulics.cel

Make sure you pick the RDY gpk file.

You can pick the shape file, but roadway tends to make multiple shape files, one for each chain. Also, I haven't had much luck with shape files anyway.

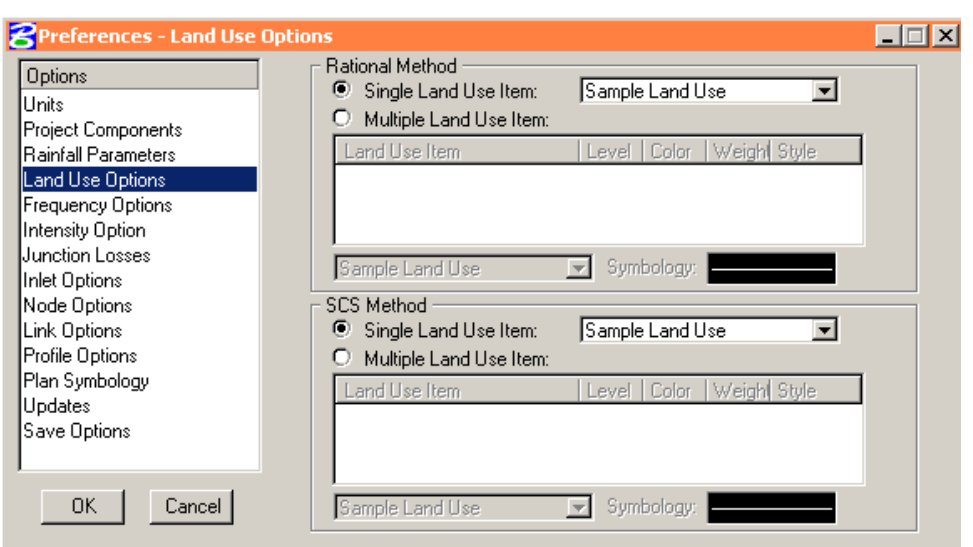
Rainfall Parameters:



Rational Method:
We created an IDF curve data for each of county using data from the NOAA website.

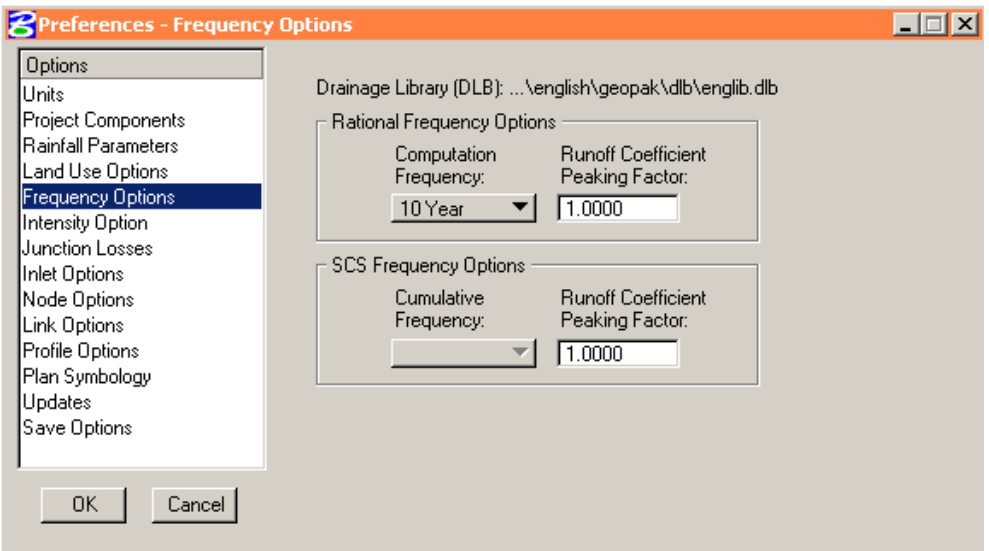
SCS Method:

Land Use Options:



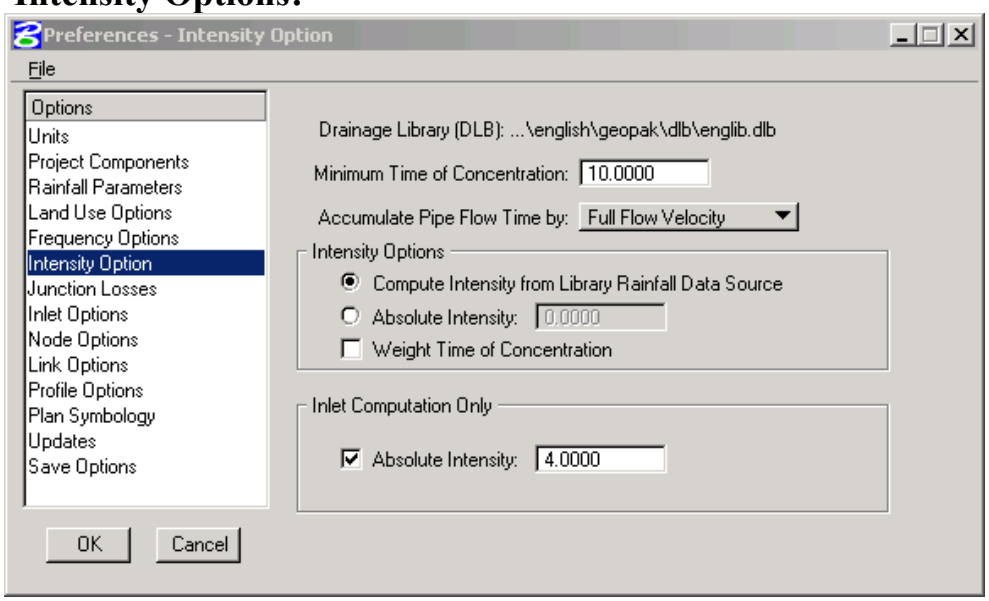
I have added a NCDOT landuse option. Mike has put landuse levels on the toolbar with the other drainage areas. **You have to draw your main drainage area**, then if you choose use the landuse shapes to create your composite C value.

Frequency Options:



Most times you will select the 10 year for the **Computational Frequency**. You will design the network or system with the 10 year. If you want to check for a different frequency storm, but don't want to change the pipe size, you can do that.

Intensity Options:

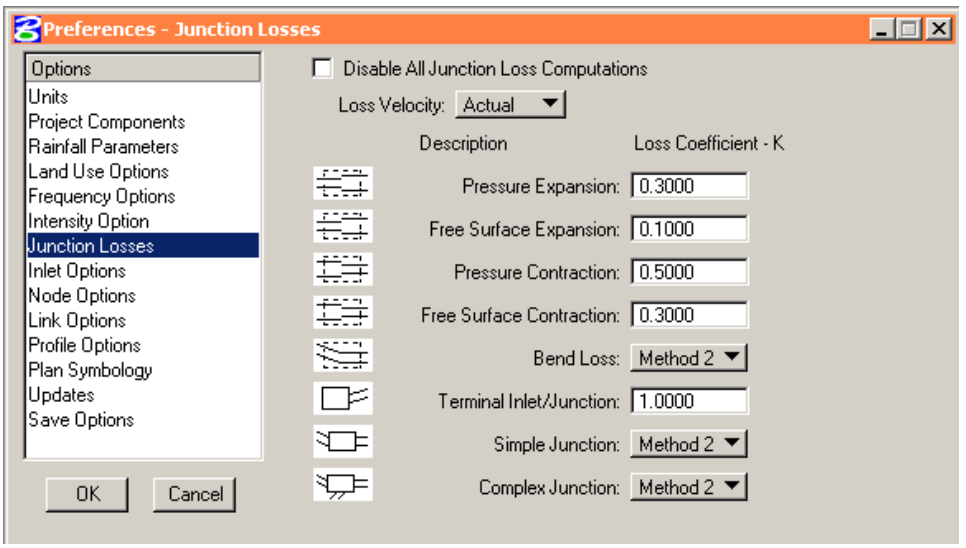


- Per our **Guidelines**, you will use a minimum time of concentration of **10 minutes**.

- You should get your pipe time by: **Full Flow Velocity**.
- Use the **Compute Intensity from Library Rainfall Data Source** for the Intensity Option.
- Inlet computation should be checked on and use 4 in/hr.

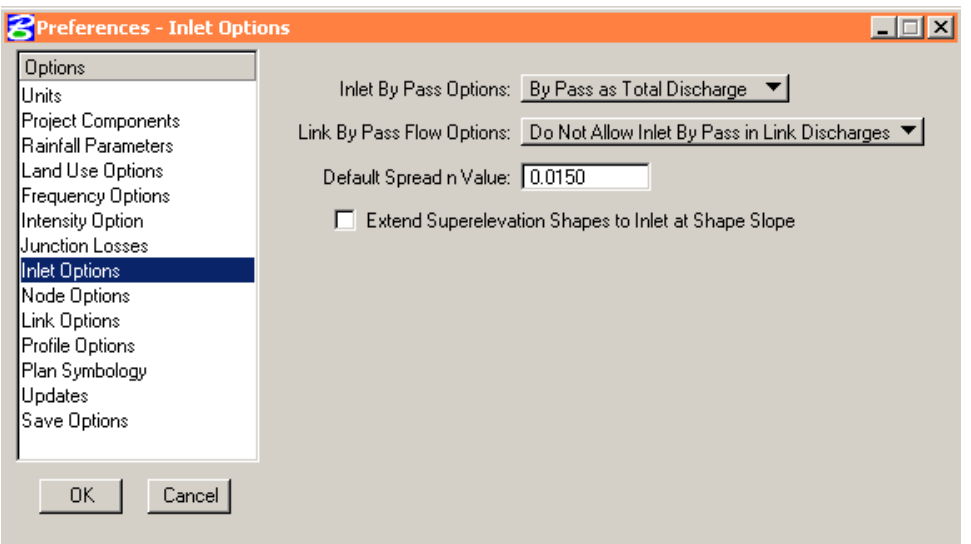
Junction Losses:

Use **Method 2** for your Junction Loss computations. (Bend, Simple & Complex)



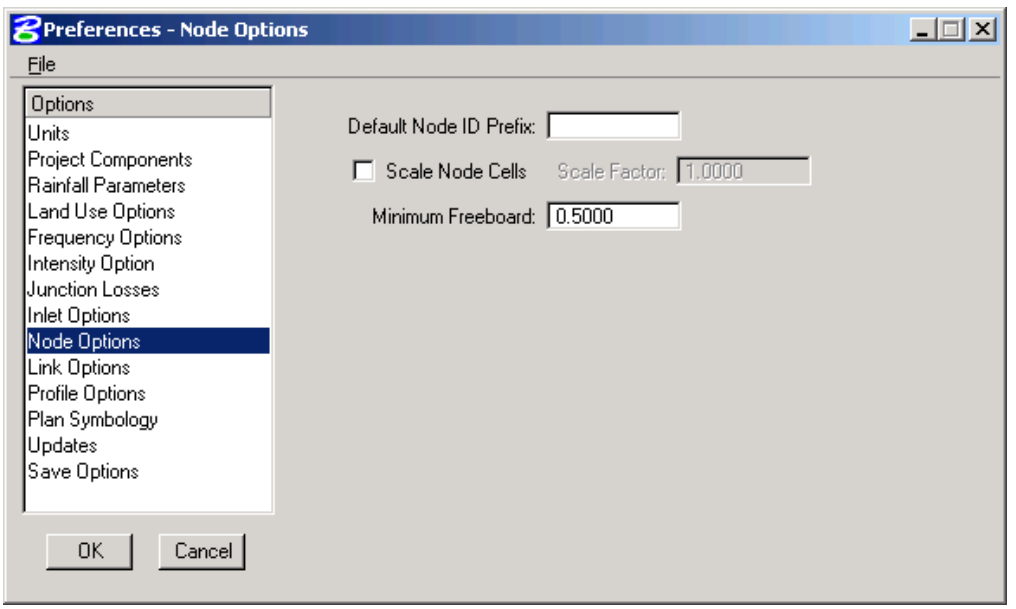
- Method 1 is Modern Sewer Design
- Method 2 is AASHTO

Inlet Options



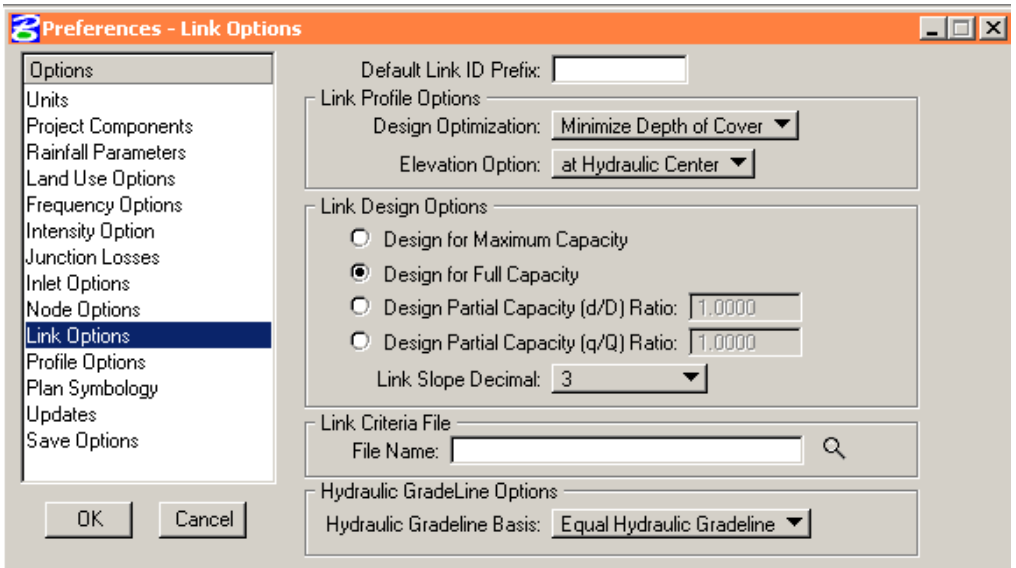
- Per our **Guidelines**, Inlet By Pass should be treated as the **"Total Discharge"**.
- The Link By Pass Flow should be set as **"Do Not Allow Inlet By Pass in Link Discharges"**

Node Options:



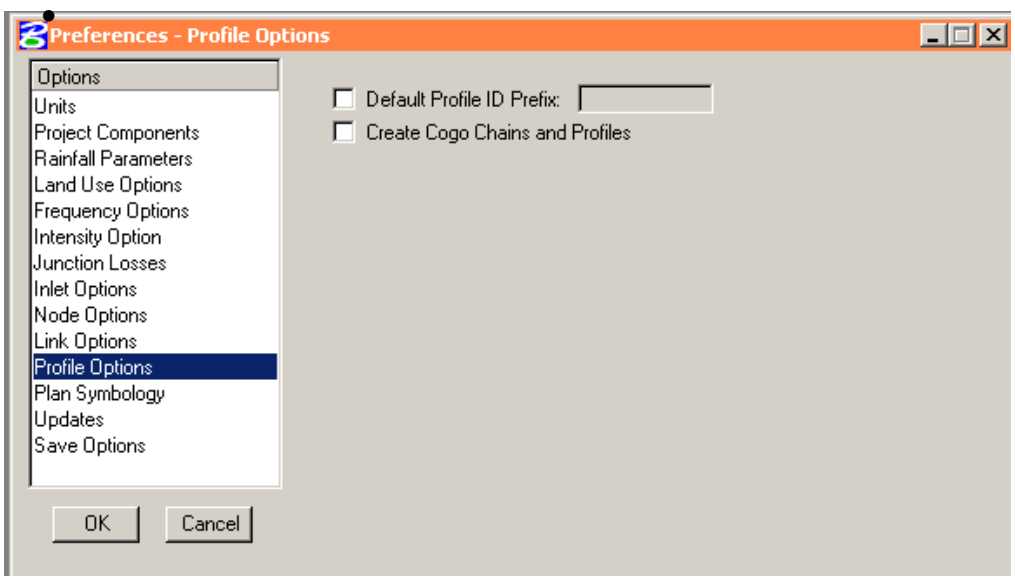
Set you **Minimum Freeboard** to 0.5 per our Guidelines.

Link Options:



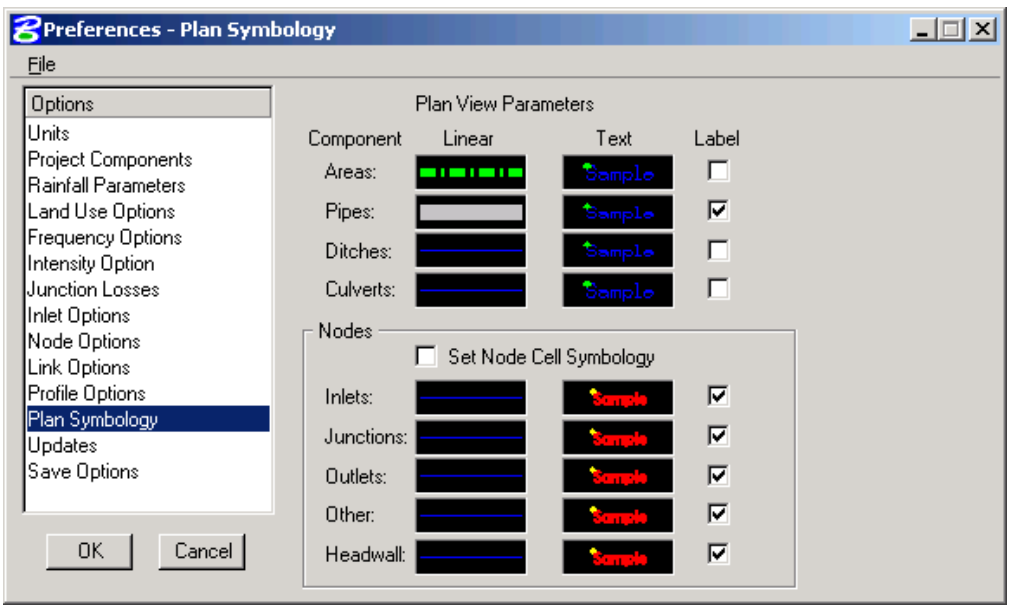
- We want to design pipe by using the **"Minimize Depth of Cover"** option
- Set the Elevation Option to **"at Hydraulic Center"**
- Choose the Link Design Option of **"Design for Full Capacity"**
- This option agrees with the design criteria in our Guidelines

Profile Options:



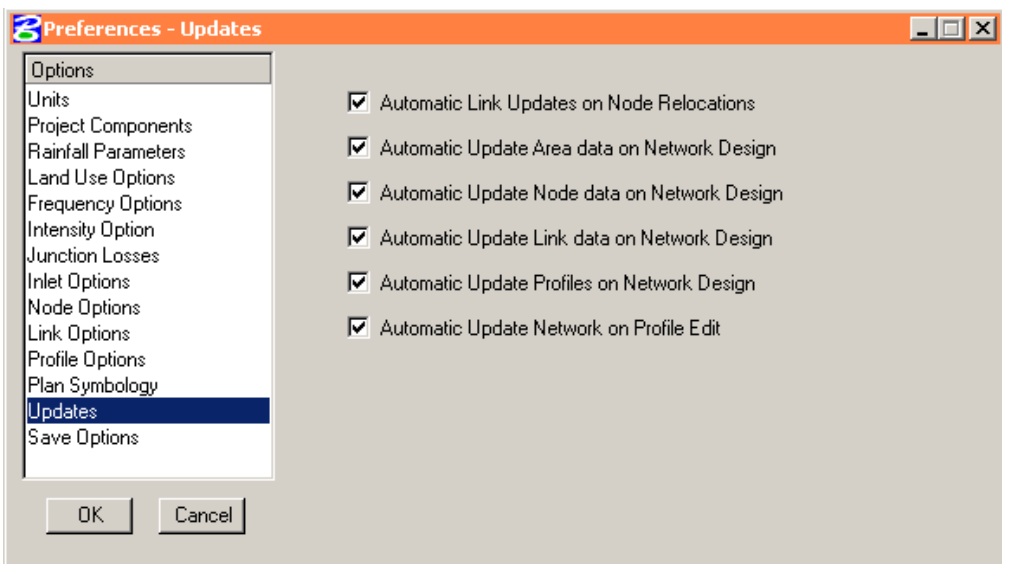
- Leave boxes unchecked

Plan Symbology:



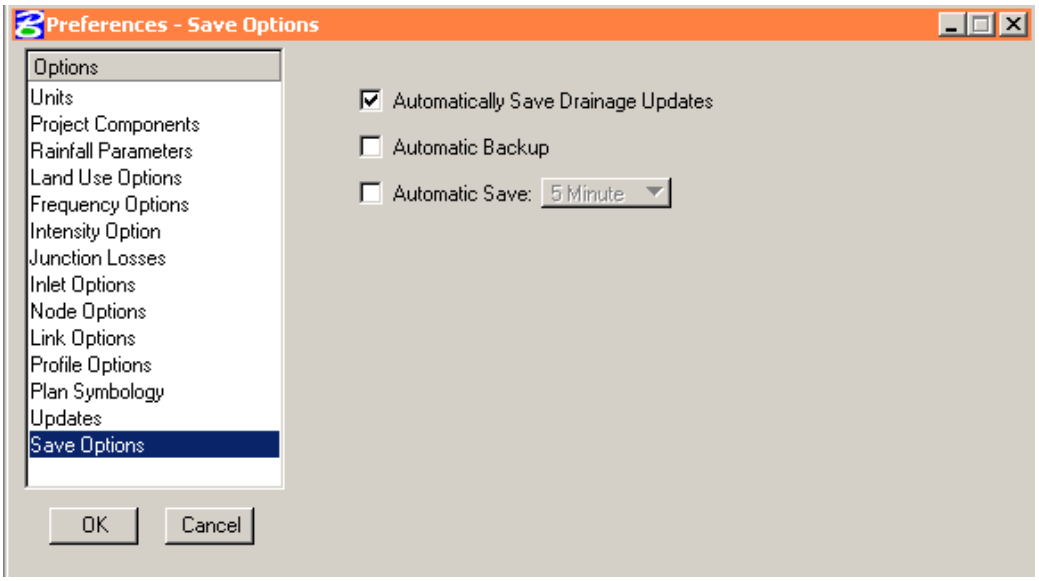
- Set the pipes to the default level, color 9, line style 0, and you can choose the line weight.

Updates :



- All the updates should be turned on

Save Options:

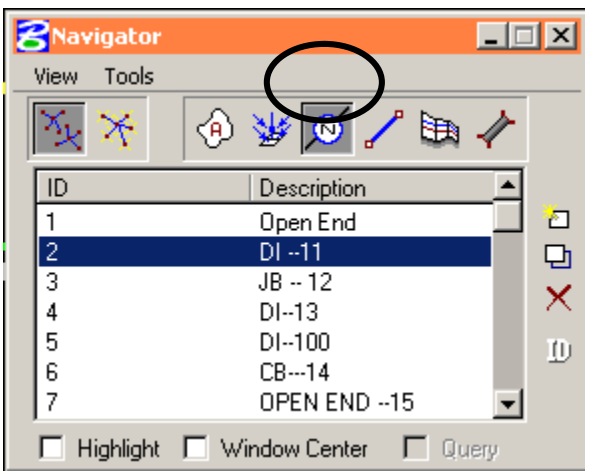


Turn on the “Automatically Save Drainage Updates” option.

NODES

Placing Nodes:

1. Open the **Navigator** tool (Drainage: Utilities > Navigator) ---- You can also reach most tools from the Main Drainage Toolbar



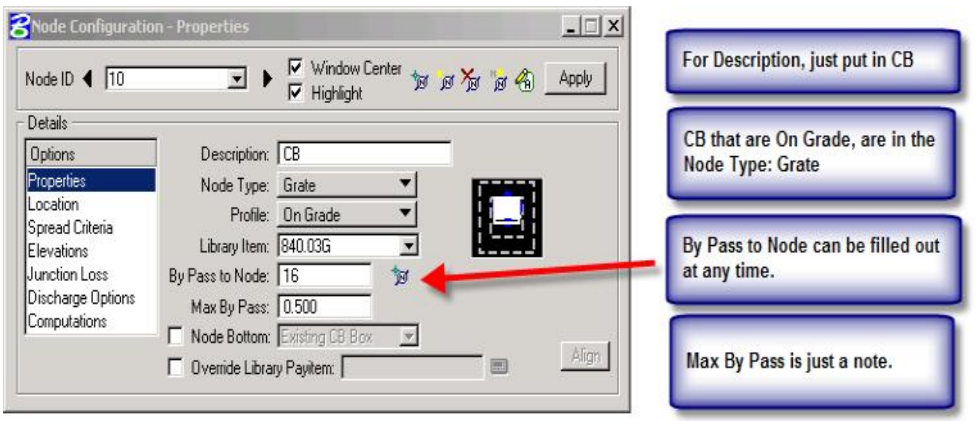
2. Click on the Node button from short-cut tools at the top of the Navigator.

3. Click Add Item (right side of the list box)

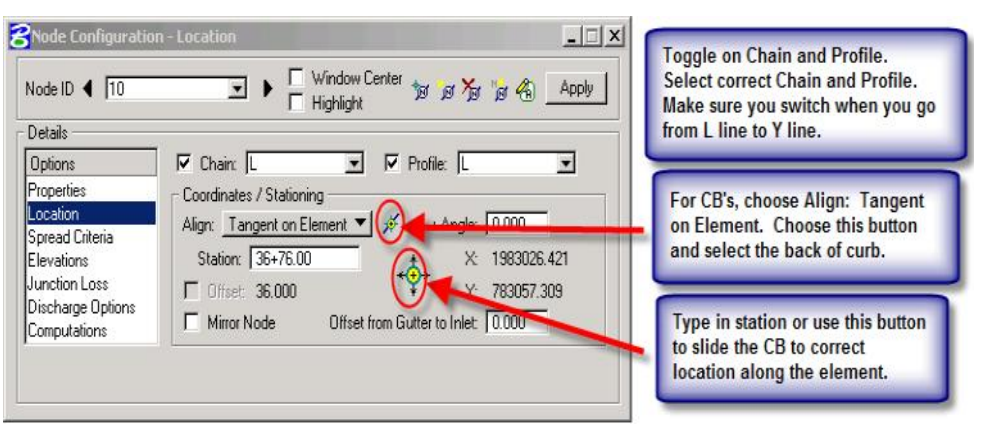
4. Enter the Properties Information

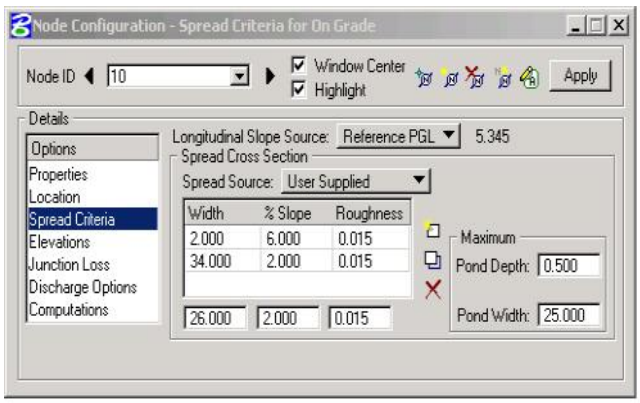
For a Catch Basin.

Catch Basins on Grade



After you get several nodes placed you can start filling in the "By Pass to Node" box. Select or input the box that this box (in this case Box 10) will bypass to. If the CB happens to be the last one in line then there will not be a box for it to bypass to. This will give you a warning message when you run your system. It is not an error, it is just a message.

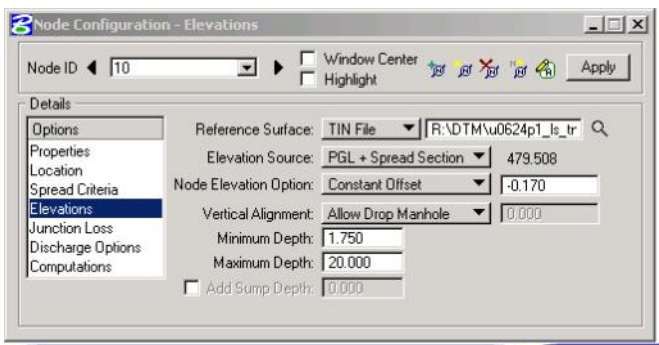




In most cases, Reference PGL is the best choice. Make sure you have the right Profile

Spread Source: You can use the library I built to get started. Then go back to User Supplied to modify the widths. You build from curb face to the Center line.

Pond Depth and Pond width are used as checks. They do not control the design.



Elevation Source: For CB's I use PGL + Spread Section. You can use User Supplied.

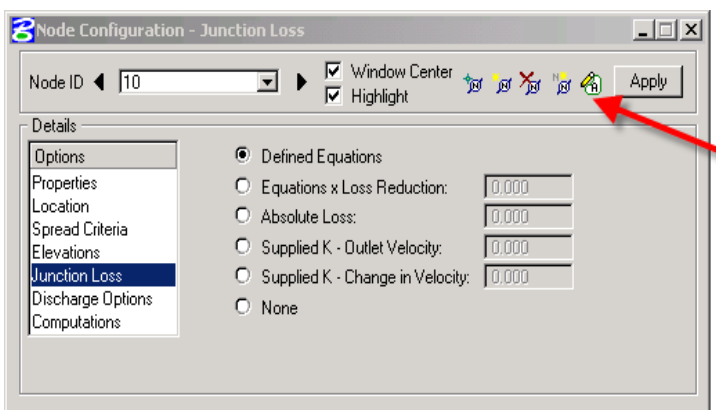
Node Elevation Option: For CB's show 0.17'. This will accomdate the 2" drop in the curb.

Vertical Alignment: Use Allow Drop Manhole. Match soffits (crown) can cause issues.

For Minimum Depth, see the Box Depth Chart from 10/21/2001. Minimum cover is listed for each box type

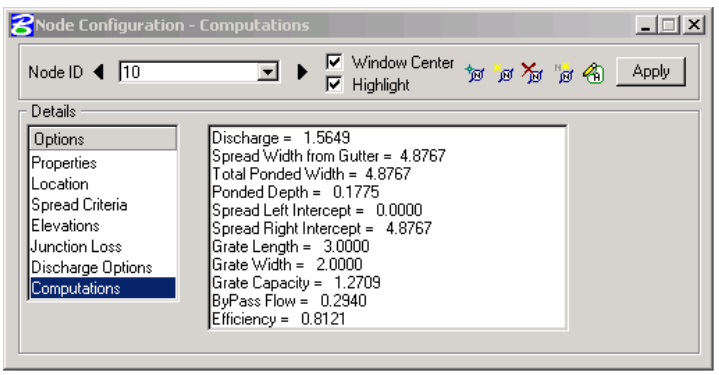
Maximum Depth: I usually put in 20 feet to create a large envelope

Before going to Computation "page", add your drainage area.



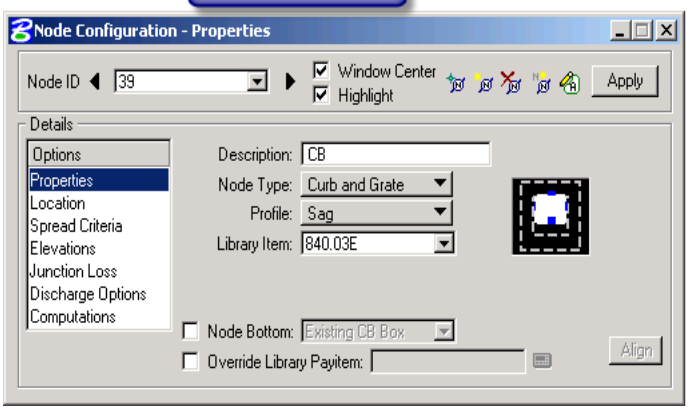
Add your Drainage area to your CB Node before going to compuations.

No input is typically required for the Juction Loss "page" or Discharge Option "page"



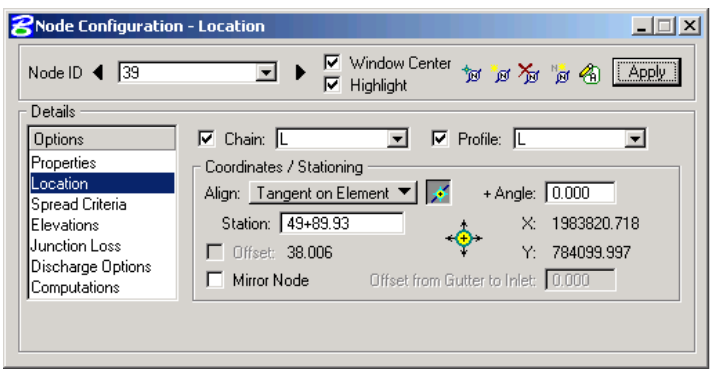
Discharge is based on 4"/hr + Bypass

Catch Basins in a SAG

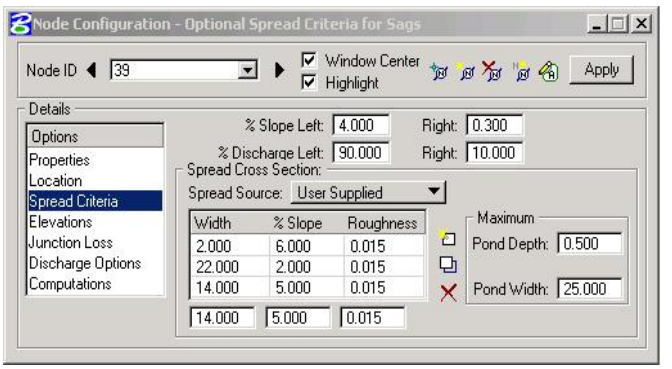


CB Type E are found in the Curb and Grate Node Type.

Make sure to change Profile to SAG



Follow the previous steps to place the CB

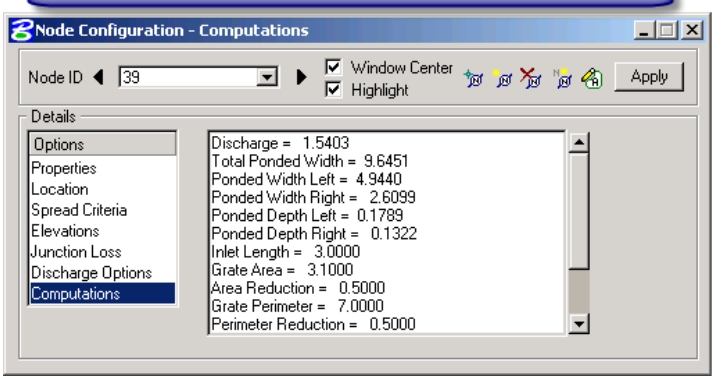


Set the % Slope Left and Right. Generally we will use 0.3%

Estimate the % Discharge Left and Right

Remember to build your spread from the Curb face out

Elevation page handled the same way before. No input required for the Junction Loss and Discharge Options pages.



DI's and 2GI's

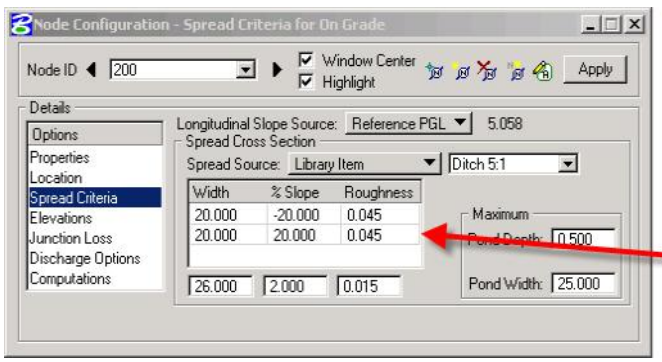
DI's and 2GI's are handled just like CB's. DI's and 2GI's that are against curbs or island will have similar spread criteria as a CB. The DI's and 2GI's will also have bypass if on a grade.

If the DI's and 2GI's are in a yard, I usually say that the box is in a sag. This way I don't have to worry about bypass. I build a ditch here with a steep front slope and a flat back slope. This is for a rough estimate only. These ideas are up for discussion.

Remember to add your drainage areas.

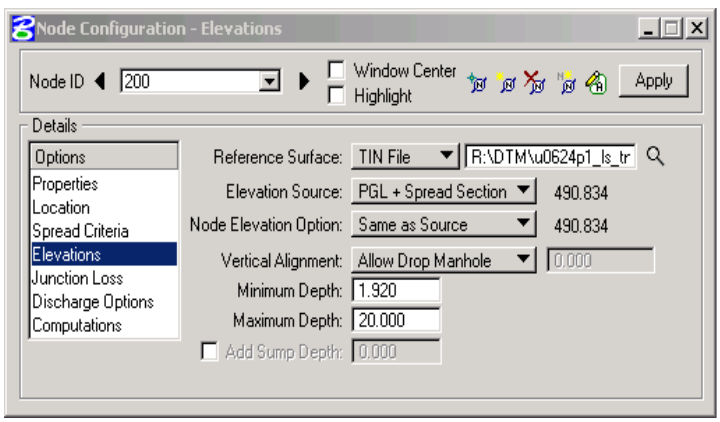
For DI's and 2GI's in a ditch

If the ditch has a false sump in it, then choose the Profile: Sag option. If you are going to use false sumps then you will want to enter the By Pass to Node data.



Used the Library Item as the spread source and chose the 5:1 ditch option. If you need to modify the ditch dimensions, toggle it back to User Supplied.

Notice how the ditch has both a positive and negative slopes to create the ditch.



Elevation Source: Choose the User Supplied option for the top of box elevation.

Minimum cover is different for each type of 2GI and for both types of DI's.

SAGS INLETS in GEOPAK DRAINAGE

Geopak Drainage handles inlets in a sag a little different than Flowmaster.

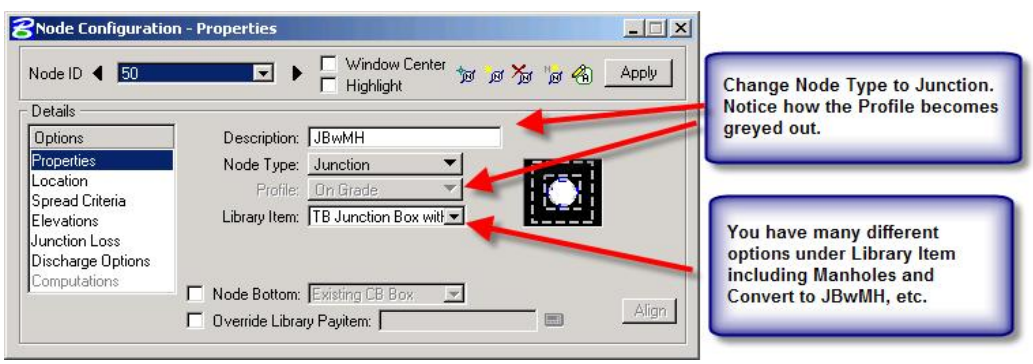
Flowmaster asks for a % clogged. We usually use 50%.

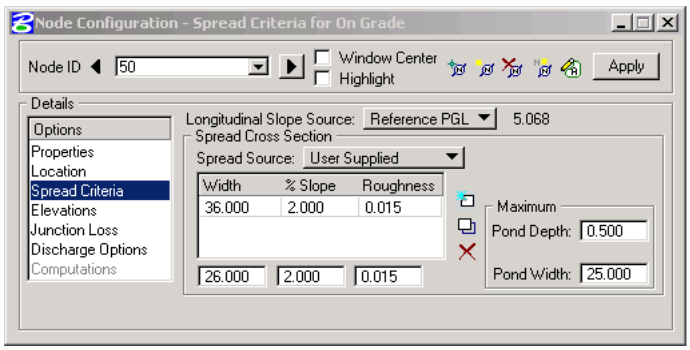
Geopak Drainage asks for an area reduction and a perimeter reduction. This was tested against Flowmaster. The area and perimeter reductions were adjusted to match the results found in Flowmaster.

Geopak Drainage Definitions

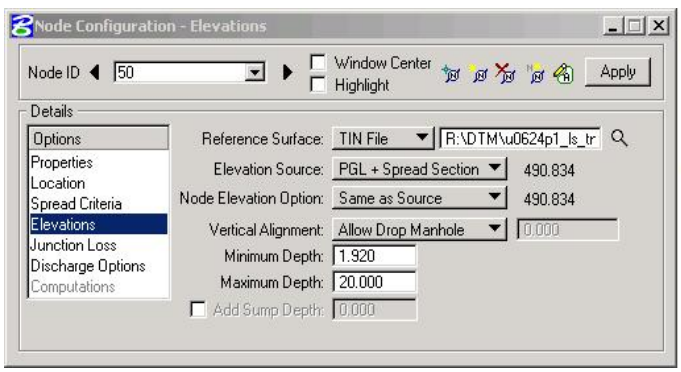
Ponded Width Left:	Spread calculated just before the inlet on the left side
Ponded Width Right:	Spread calculated just before the inlet on the right side
Pnded Depth Left:	Depth calculated just before the inlet on the left side
Ponded Depth Right:	Depth calculated just before the inlet on the right side
Total Ponded Width:	Spread Calculated at the inlet based on the depth. The depth is determined by weir or orfice equation, whichever is greater.

Junction Boxes and Manholes





Making sure you have the Reference PGL selected and filling out the Spread Criteria will help you find you top elevation.



Elevation source can be from the PGL+Spread Section, User Supplied or the TIN file.
If JB is behind the curb, use User Supplied

Minimum Cover varies based on if JB has manhole and is under pavement.

You can put in a drainage area for JB's if you are tying into an existing drainage system. It just won't have computations.

Other Drainage Structure or Nodes

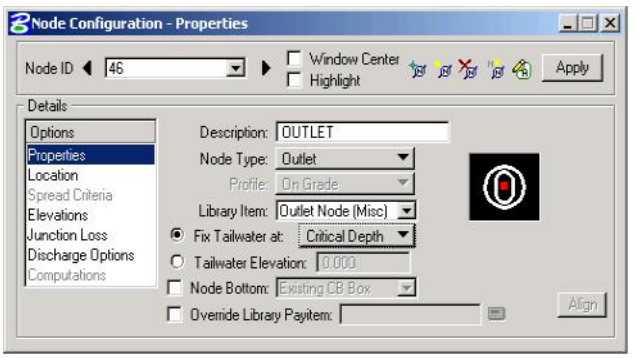
Most other drainage structures have been added to the drainage library and follow a similar pattern.

OTCB are located under the **Curb** Node Type. I set it up for the number of sides you could have open.

Under the **Other** Node Type you have collars, open end pipes, etc. The tops of these nodes should either at least the top of the pipe. You can control the invert in the links for these items.

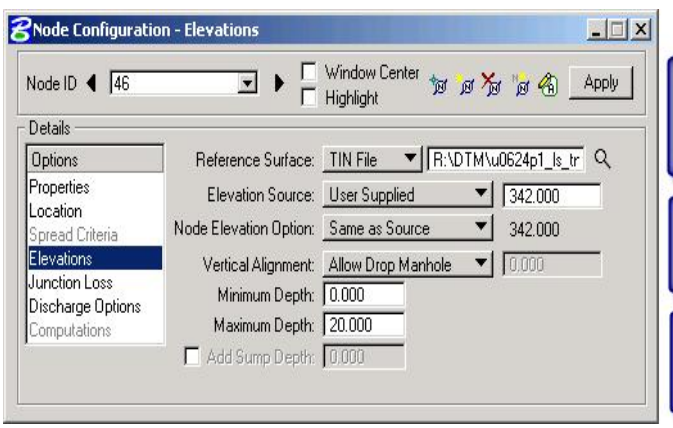
Outlets

The way Geopak handles an outlet is awkward. Because the outlet is a node, you have to put in a top elevation. We would rather put in the invert out elevation. So, you have to estimate the pipe size add at least a couple of inches to it and run it. You can adjust the final elevation in the **Link Conditions**.



Right now we offer 4 outlet nodes. 2 for Rip Rap, a headwall, and a generic that can be used when connecting to an existing system.

I have been using the Fixed Tailwater at: Critical Depth. There are several other options to choose from.

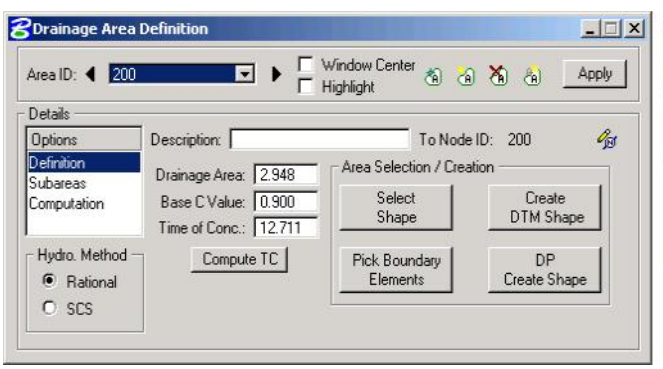


Elevation has to be the top of the pipe or higher.

Vertical Alignment: Allow Drop Manhole

Minimum Depth: Set to 0

AREAS



Draw a Drainage Area

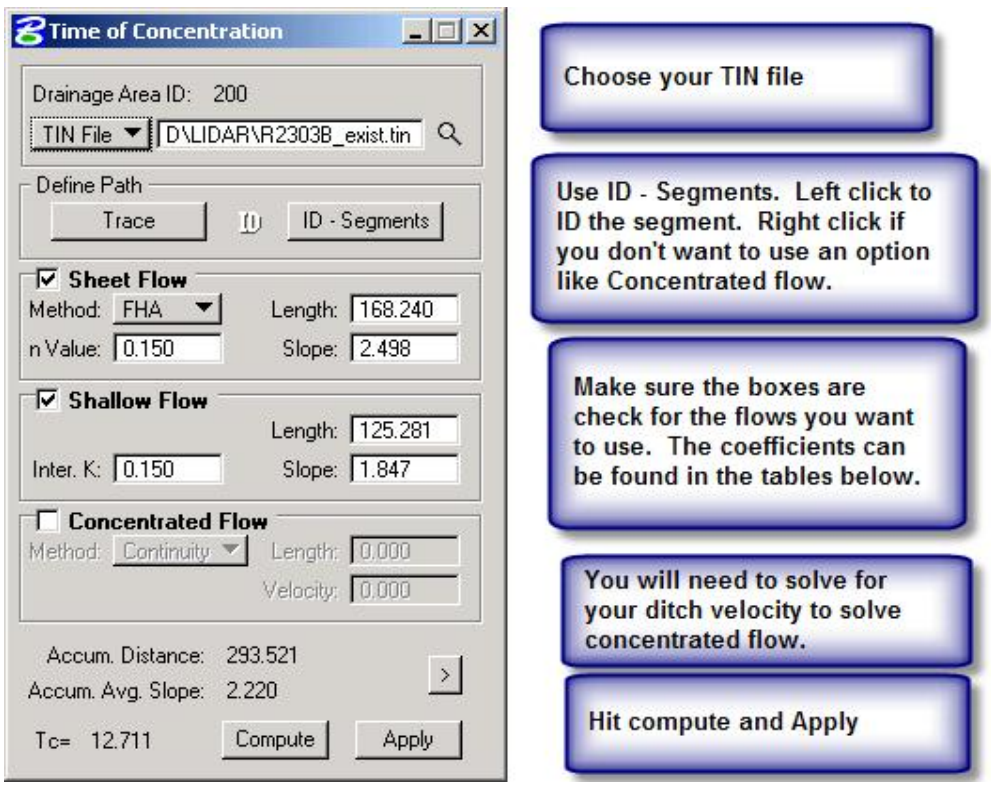
Use Select Shape Option to choose the drainage area

Pick your base C value. I usually use 0.9

Time of C: I usually put in 5 min for a CB. For off site "Compute TC" works good.

COMPUTE TC

Compute TC seems to work pretty well. The better your tin files are the better results you will get. Most of us will not have proposed DTM so this option will not as well for CB as it will for DI's picking offsite drainage. You can also use this tool any time you need a time of concentration as long as you have DTM coverage.



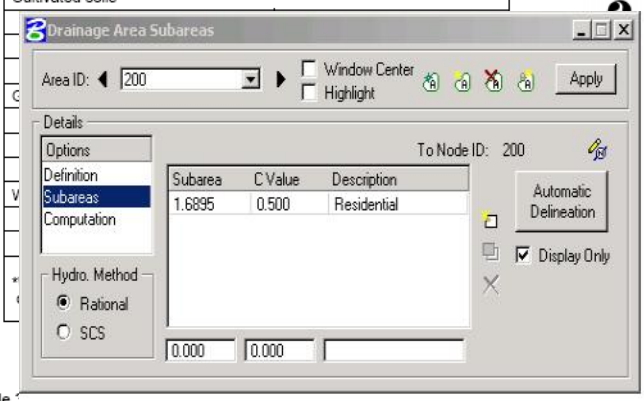
Choose your TIN file.
I like to use the **ID-Segments** option so that I can control things more, but the **TRACE** option may work better for you. Use the tables below for HEC-22 to get your "n values" and "intercept K".
Right now use another program to determine your velocity for concentrated flow.

Hit compute and apply.

Table 3-2. Manning's Roughness Coefficient (n) for Overland Sheet Flow[6].

1. Report No. FHWA-NHI-01-021 HEC-22	2. Governmental Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Urban Drainage Design Manual Hydraulic Engineering Circular 22, Second Edition		5. Report Date July 2001 6. Performing Organization Code

Cast iron	0.015
Corrugated metal pipe	0.024
Cement rubble surface	0.024
Fallow (no residue)	0.05
Cultivated soils	



You got 3 options

1. Make your base C on the Definition page be your composite C

2. Fill this subarea chart in by hand.

3. Use the "Land Use" levels found in the Plan Prep tool bar under Drainage Areas. Draw the shapes and click "Automatic Delineation." You have to draw and choose the entire drainage area on the Definition page.

Table

cropped; woodland (overland flow)	
Short grass pasture (overland flow)	0.213
Cultivated straight row (overland flow)	0.274
Nearly bare and untilled (overland flow); alluvial fans in western mountain regions	0.305
Grassed waterway (shallow concentrated flow)	0.457
Unpaved (shallow concentrated flow)	0.491
Paved area (shallow concentrated flow); small upland gullies	0.619

1. Report No. FHWA-NHI-01-021 HEC-22	2. Governmental Accession No.	3. Recipient's Catalog No.
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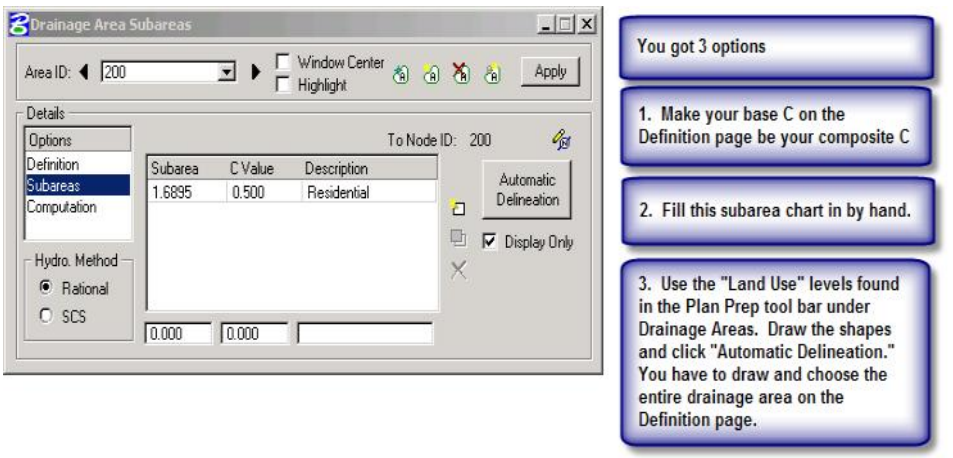
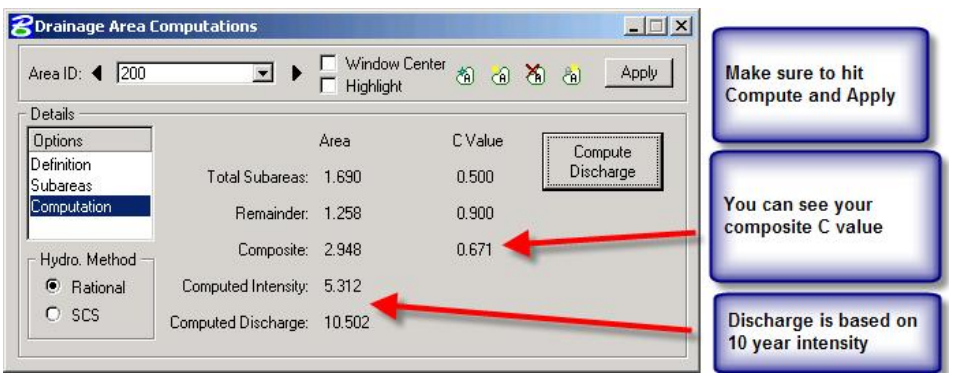


Finally, click on the **Computation** tab. Click on the **Compute Discharge** button and choose **Apply**.



Close the "Drainage Area Computations" box.

Now that the drainage area has been entered, return to the Node dialogue box and click on **Computations**. Go to page ? in the Nodes handout.

LINKS

Links are pipes and ditches. For now we will only design pipes.

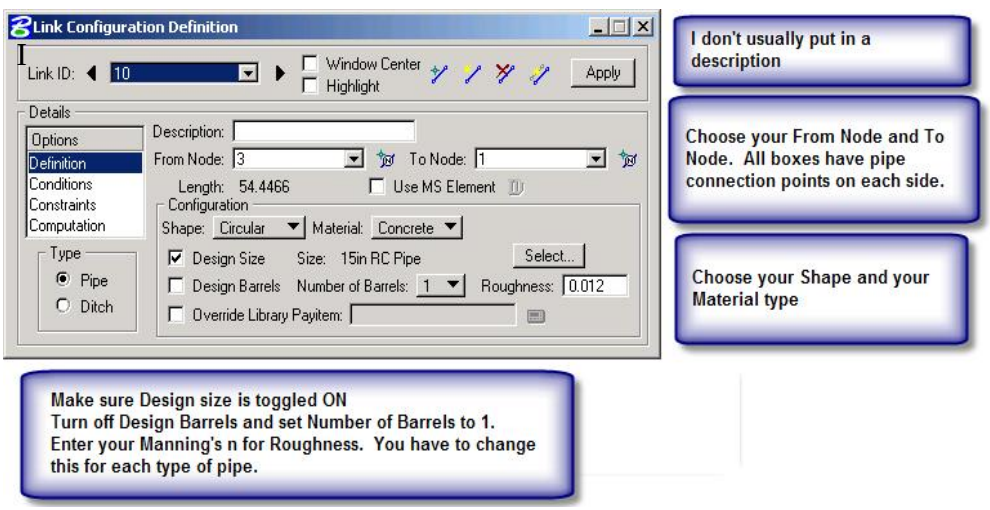
This is where you will create your system, by connecting **nodes** with **links**.

You will not get any computations until you have created a **Network** (next section), but you will create a path for program to follow.

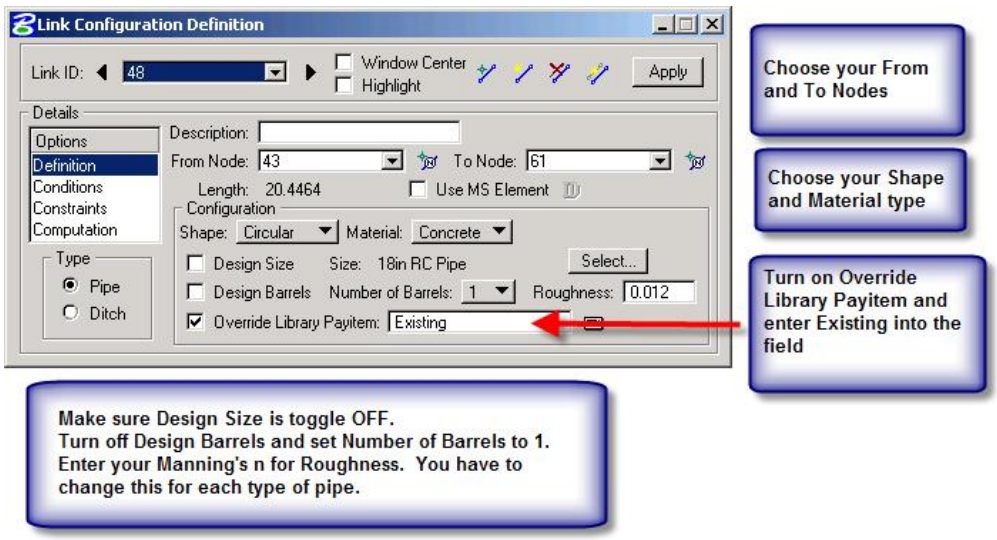
Pipes are designed by slope capacity only. If discharge exceeds the maximum allowable inlet capacity, the <u>pipe size must be changed manually</u>. At this time the program does not check for inlet control of a pipe based on our STORM DRAIN PIPE MAXIMUM CAPACITY TABLE.

!Don't hit Add or Update until you have completed all options!

On your **Navigator**, click the **LINK** button. Then choose the **Add Link** option. (Note that the program defaults to the next available link number.)



If the pipe is an existing pipe, check the "override library payitem" and type in "existing". When you run the Payitem Utility at the end of the project, the application will move existing pipes to a scratch level that will not plot and have a 0 line weight.

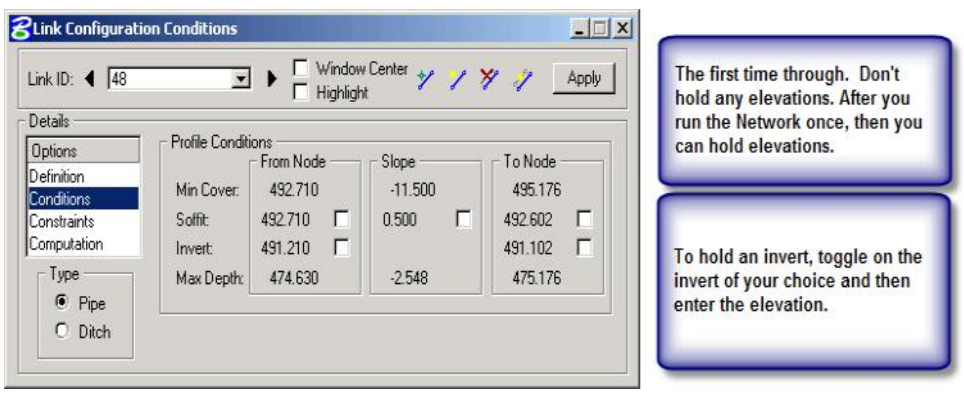


Go to Conditions

Conditions

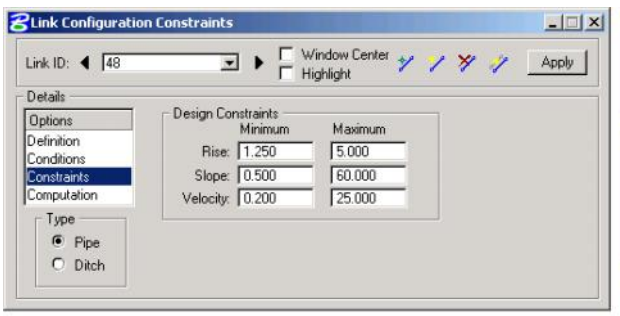
-Unless you want to hold an elevation, no change is required here.
For this workshop, no entries are required.

-Note: If you need to hold an elevation at either end of the Link (pipe) (for example tying to an existing system) check the Invert "from Node" or "To Node" box you want hold and enter the invert elevation.



Constraints

- Note: For this program, "**Rise**" is the diameter of the pipe.



Rise: Put your minimum and maximum pipe sizes. As shown, I usually pick between an 18" and 60".

Slope: Set your minimum and maximum slopes. Remember a 2:1 slope is a 50% slope. You can increase your maximum slope a pipe to decrease the pipe size.

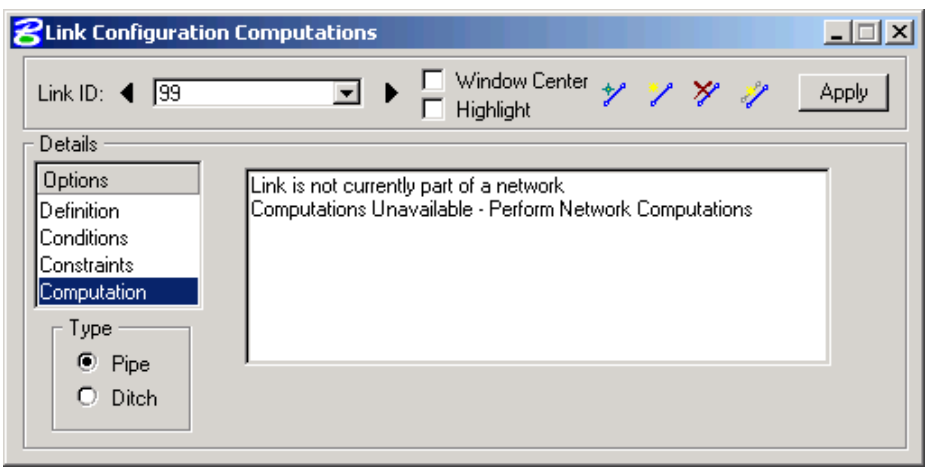
Velocity: Does not affect design. It will give you a message when you run your network if it outside the constraints.

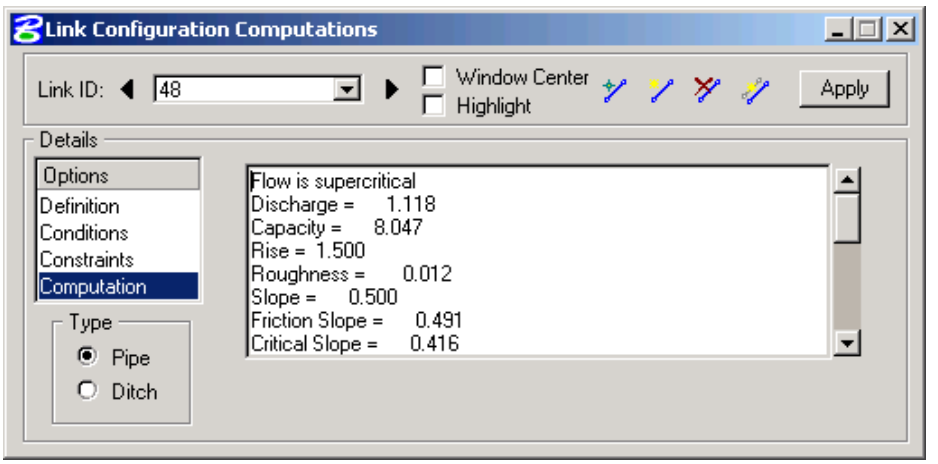
HIT APPLY

COMPUTATIONS

-Will not show up until we have created and run a network.

Before the network is run.





After the Network has been run.

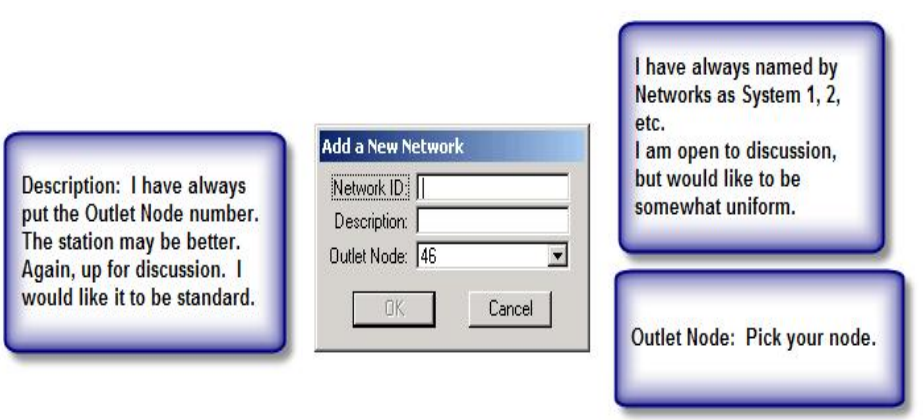
NETWORKS

A NETWORK is your system. A GEOPAK Drainage Network is defined as a series of interconnected Nodes and Links draining to a single outlet. GEOPAK Drainage can maintain multiple Networks in a single project. The Network computations serve as the final calculation process in the design or analysis of a storm drain system. Drainage Areas and Inlets may be computed individually and are not dependent on any type of Network configuration. Pipes and Ditches, however, are dependent on the connectivity and Network characteristic and therefore, require a Network be defined and successfully built, in order to complete the hydraulic computations on these features.

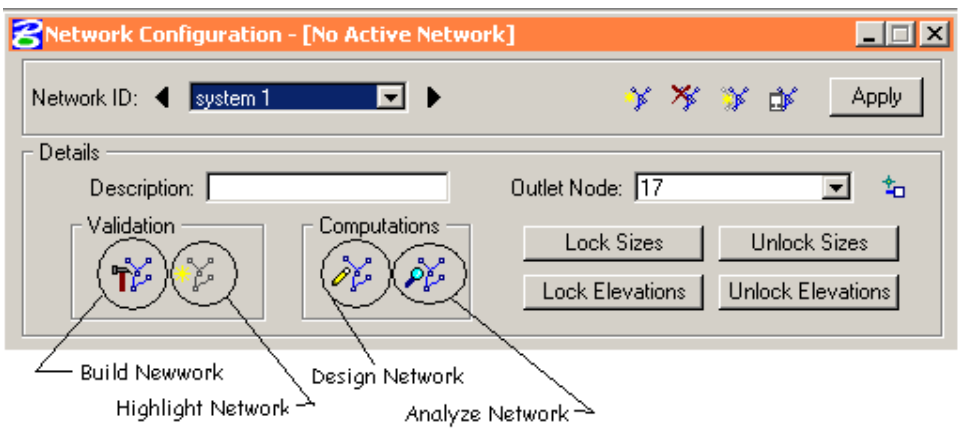
To create or modify a network

Go to the Microstation tool bar, click on “Drainage”, “Network”, “Add”. (Note that Network Utilities are also available from the “Drainage Tool Box”). This will open the NETWORK dialog box.

-Give your Network a name in Network ID



-Pick your **Outlet Node**



-Click **Build Network** in the Validation group box.

This process checks to make sure the network is correctly assembled. It should tell that the network was successfully built.

-Click **OK** on the dialog box

-Click **Apply** to add the network "System 1" to the project.

-Click the **Design Network** in the Computation group box to design the system.

-Click **OK** in the dialog box.
There may (and probably will be) warnings in a dialog box. Not all warnings are errors.

-Close the Network Configuration dialog box.

-We need to make the Network Active.

-Select the **Active Network** tool (Drainage menu: Network > Active)

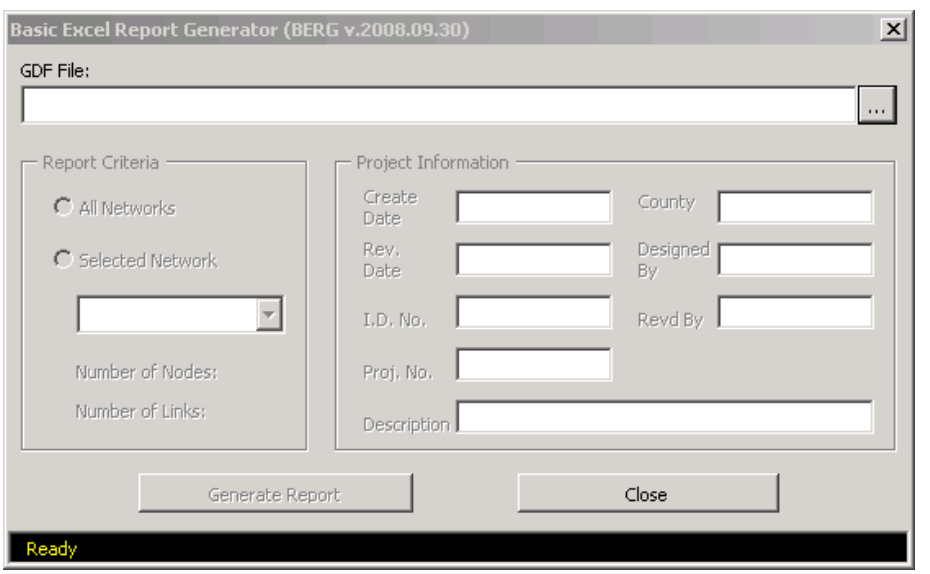
-Highlight **System 1**

-Click **OK**

GENERATING REPORTS-

We have a brand new application to create your Storm Drain comp sheets. We have eliminated the "Hydraulics Gradeline Sheet" by combining it with the "Storm Drain Sheet."

The drn file has to be in the Drainage directory for this application to work.



After opening the report generator, you will path to the GDF. Then fill out the Project Information.

Choose to either run all projects. This will put everything in one document. Or choose the system you want to run.
Then select "Generate Report". Follow the directions and when the application is done, look for the spreadsheet in the Hdyraulics\Documents folder.

See VBA document to run the Pay Item Utility to ad hoc pay items and to get the pipes moved to the correct level