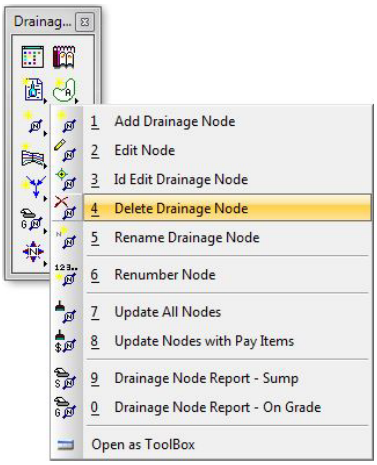
11. System Modification

This exercise shows the user how to modify the storm drainage system design. Specifically we will combine links SS-14 & SS-MH1 by eliminating MH-1, change SS-13 to end at CB-12 instead of at MH-1, reengineering the network connectivity. We will also change our ditch network set up to define a special ditch to handle the drainage along the base of the fill slope in that area.

11.1 Storm Drainage Network Modification

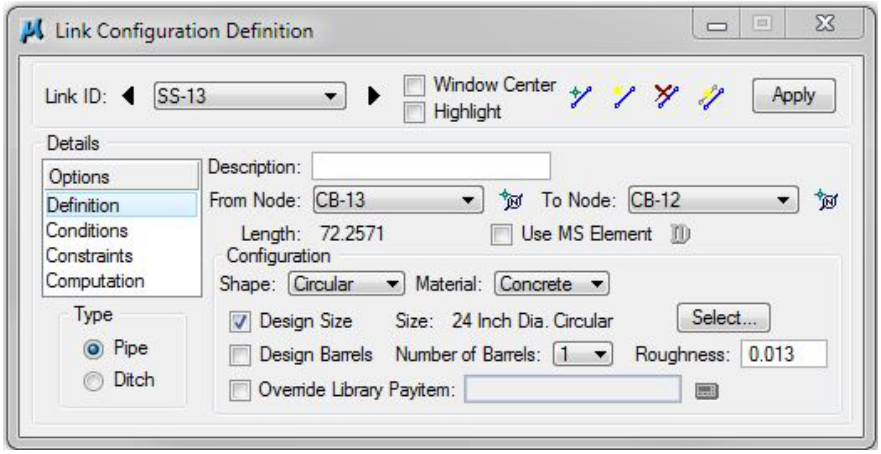
a) Delete **Node MH-1** by using **Drainage Navigator**, selecting **Component > Node > Delete** from the Drainage Menu Bar, or by selecting **Delete Drainage Node** from the Drainage Toolbar.



NOTE: Click **Yes** that you would like to delete the Node, **OK** to delete the Network WEST and NO to *Do you want to delete all the components of the network as well?*

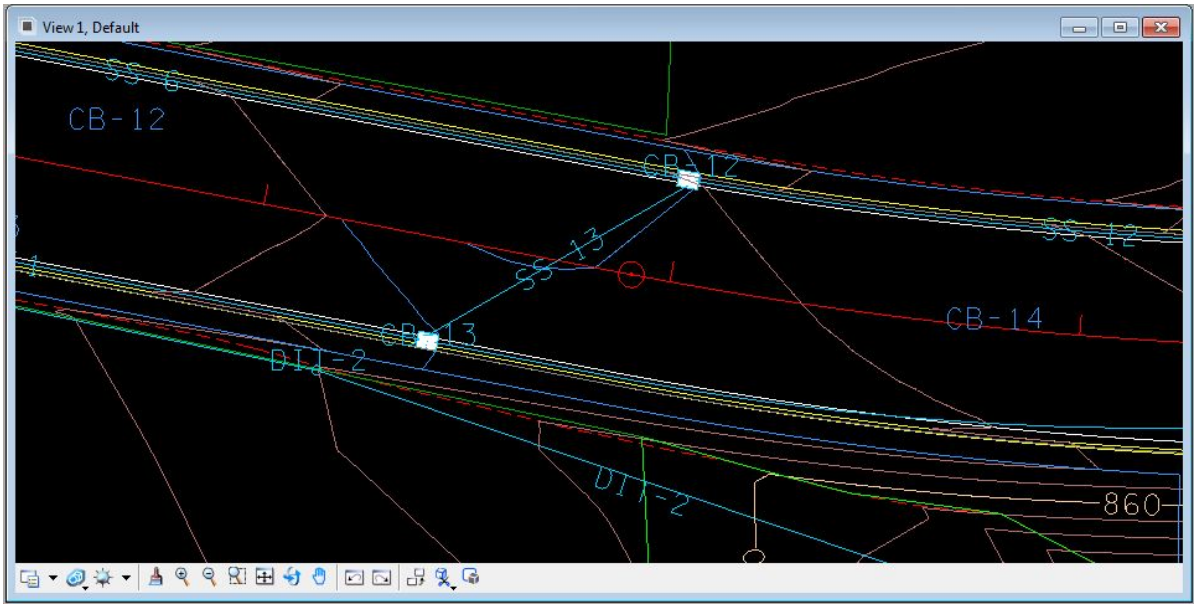
b) Follow the same basic procedures to delete **Link** SS-**MH1**.

c) Edit Link SS-13, to start at the front face of CB-13 towards centerline and end at the front face of Node CB-12 across the road.



d) Go to **edit CB-12 and CB-13** to change the **Library Item to CB#12 4'DIA**.

REMINDER: Use the **ID** button to the right of the node list to identify the front wall connection points at nodes CB-13 and CB-12.

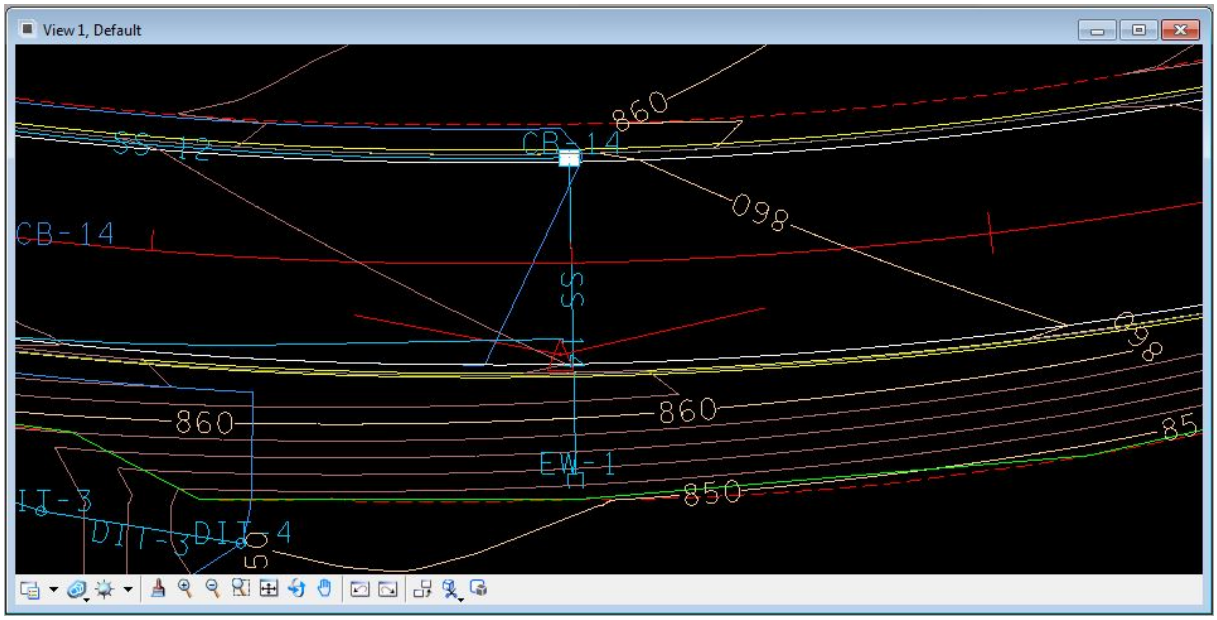


NOTE: In an actual design, the skew angles would now need to be checked to ensure the pipe would fit in the catch basin wall.

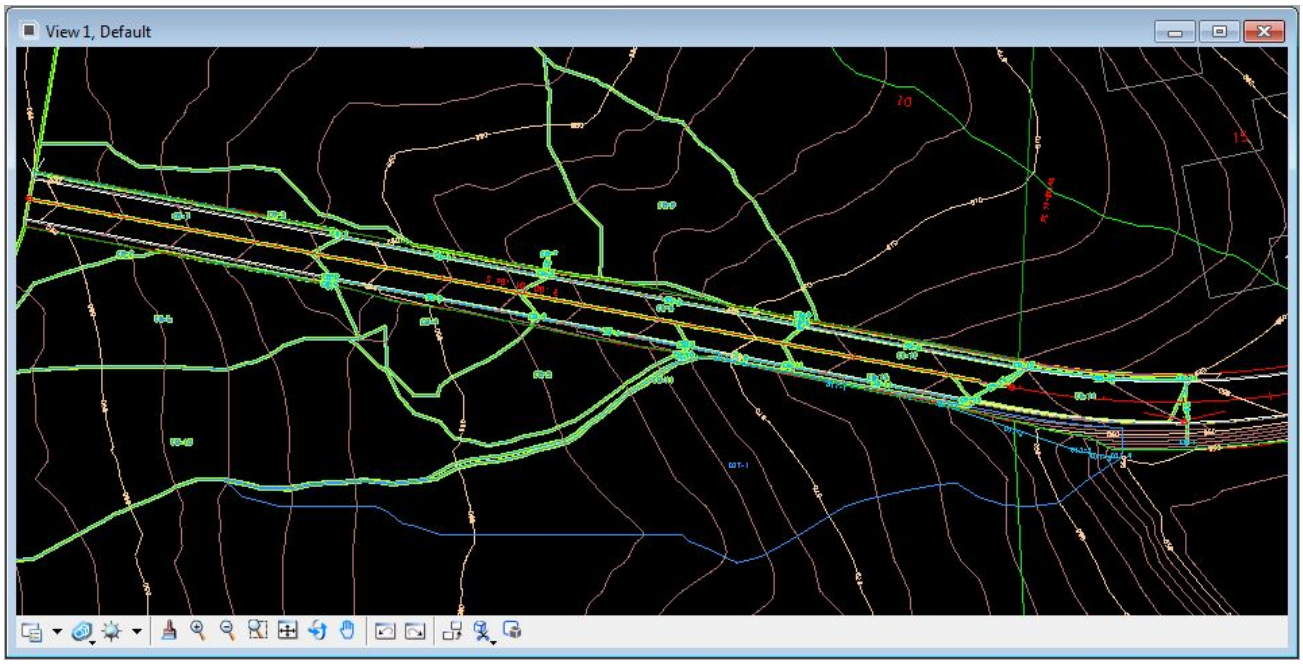
e) Edit Link SS-14, to go to Node **EW-1**.

f) Since pipe at EW-1(link SS-14) is now a 24” pipe (from previous exercise) and the side slope at that location is 2:1, **move the location of the outlet from an offset of 56’ to 52’** to account for the length of the end wall and properly locate the outlet.

g) Reset EW-1’s Max Depth to 2.0 (designed pipe size at outlet).



h) **Add a New Network** named **WEST** with the Outlet Node set to **EW-1** (this is necessary since the network WEST was deleted in **Step 1**). Highlight the Network to ensure all components are connected, and then Design the Network.



i) Update Profile **WestRT** to End at CB-12 and redraw other profiles as required based on these modifications.

Optional:

Depending on the drainage areas developed in the previous exercises you may still have errors in your network. If your hydraulic gradeline exceeds the minimum freeboard, try increasing pipe sizes to lower the water surface. If the velocity in Link SS-14 is over the maximum limit try hard coding SS-14's invert elevation at Node CB-14 to lower the slope of that Link.

11.2 Ditch Network Modification

Initially, we set up a ditch network along a fill line using the Cross Section Based ditch type to analyze the drainage there. Now we will relocate our ditch nodes and set up our links as fixed geometry to design a special ditch along that slope to handle the drainage.

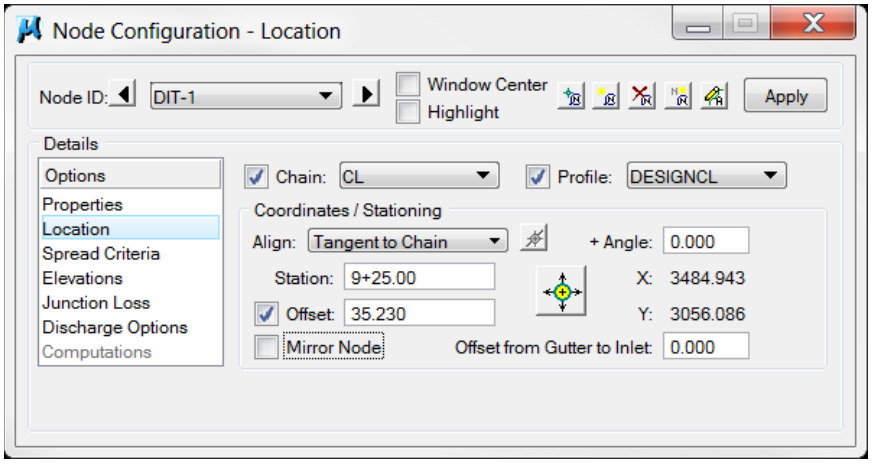
Relocate Ditch Nodes and their Drainage Areas

a) Delete previous drainage areas for ditch nodes.

b) Go to **Component > Node > Edit** and select Node DIT-1.

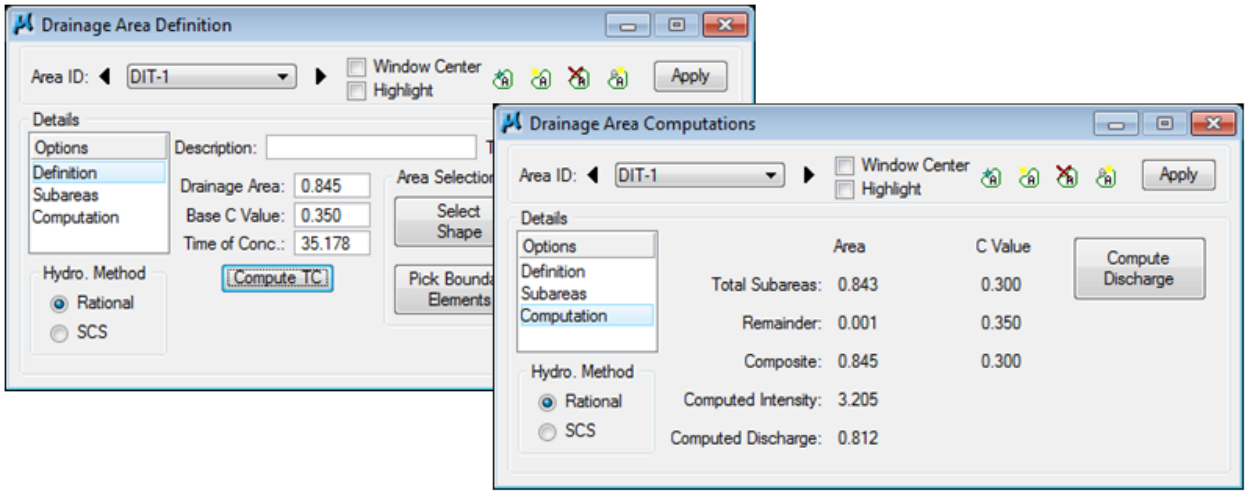
Under **Location**, change the station to **9+25** and the offset to **35.23**.

This is the beginning of the desired special ditch at the base of the fill slope. We will define the ditch link later as a "V" ditch with 2:1 side slopes although it will be at the existing ground elevation here at the beginning.



Click **Apply**.

c) Reference in the new DIT-1 file and use methods described previously to **rebuild the DIT-1 drainage area** for the new location, establish a time of concentration, apply land use areas and compute discharge.

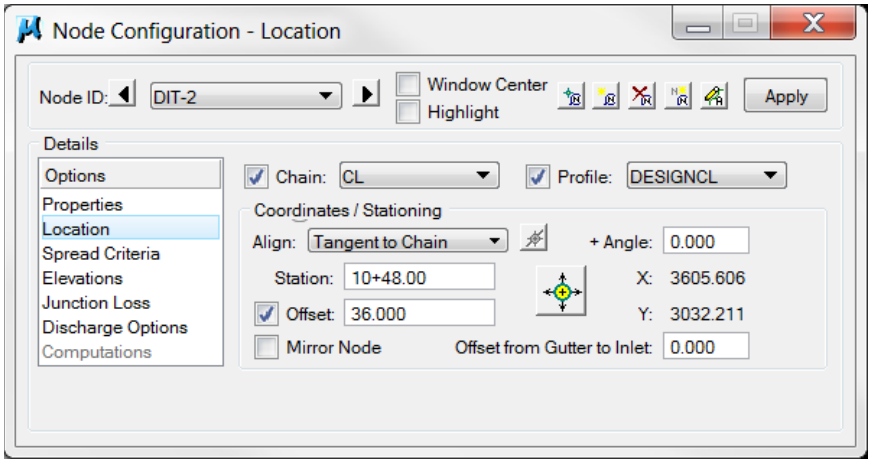


Click **Apply** to save the changes.

d) Go to **Component > Node > Edit** and select Node DIT-2.

Under **Location**, change the station to **10+48** and the offset to **36.00**.

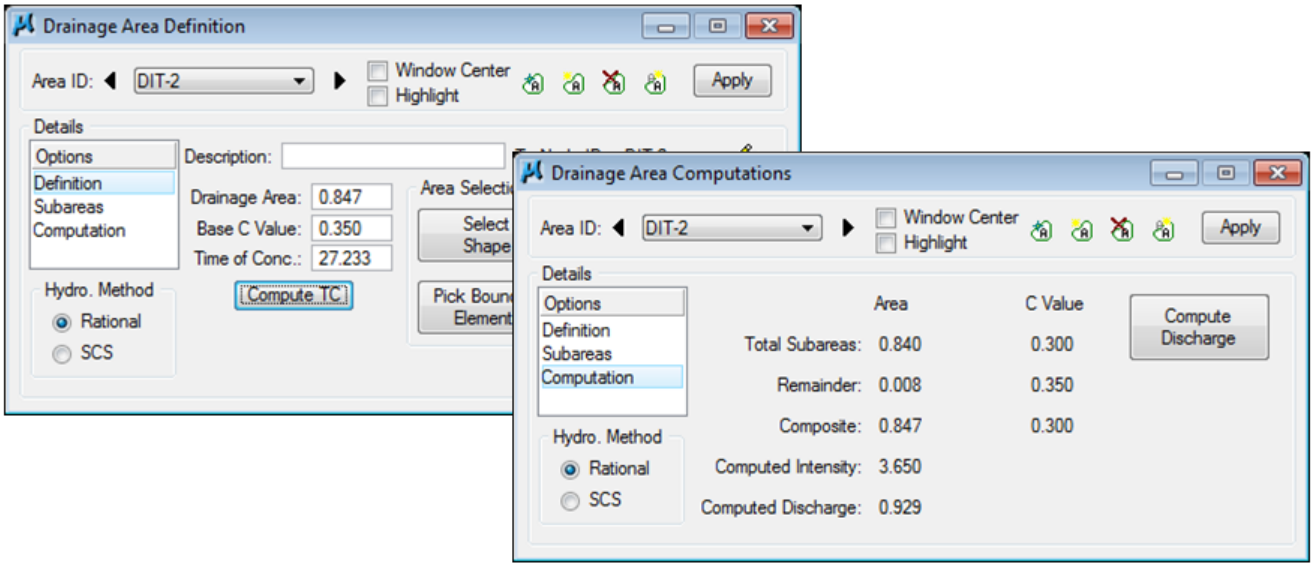
This is the point where we will achieve the 1 foot depth in our special ditch. By modifying the links at this location the ditch link will be a “V” ditch with 2:1 side slopes and is offset from the fill slope tie by 2 feet.



Click **Apply**.

e) Use methods described previously to rebuild the **DIT-2** drainage area for the new location, establish a time of concentration, apply land use areas and compute discharge.

Remember …ditch node drainage areas should include the area for the current node as well as any others previously defined that contribute to the ditch drainage network.

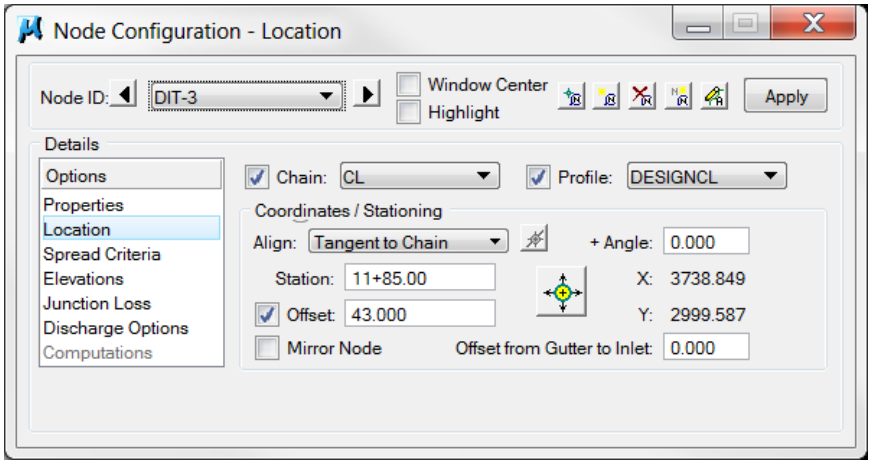


Click **Apply** to save the changes.

f) Go to **Component > Node > Edit** and select Node DIT-3.

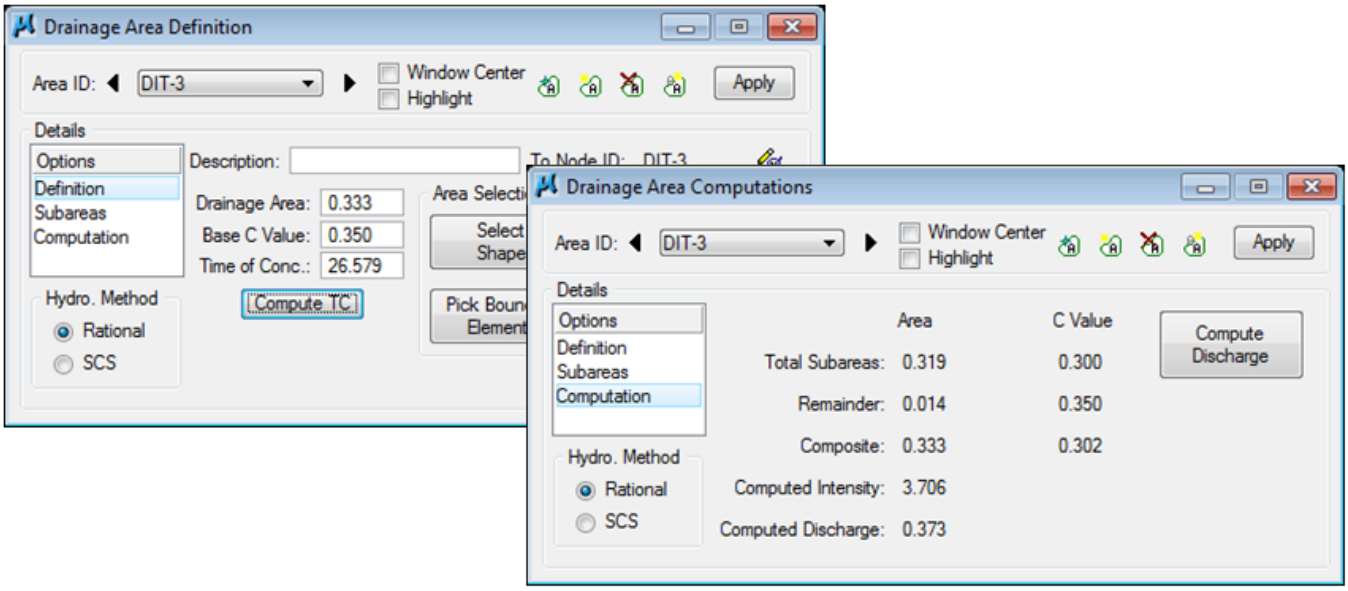
Under **Location**, change the station to **11+85** and the offset to **43.00**.

This is the beginning of the final ditch slope and to mitigate the steeper slope and resulting increase in velocity we will change the ditch link section to a 2 foot wide trapezoidal shape, 1 foot deep with 2:1 side slopes and is offset from the fill slope tie by 3 feet.



Click **Apply**.

g) Use methods described previously to rebuild the **DIT-3** drainage area for the new location, establish a time of concentration, apply land use areas and compute discharge.

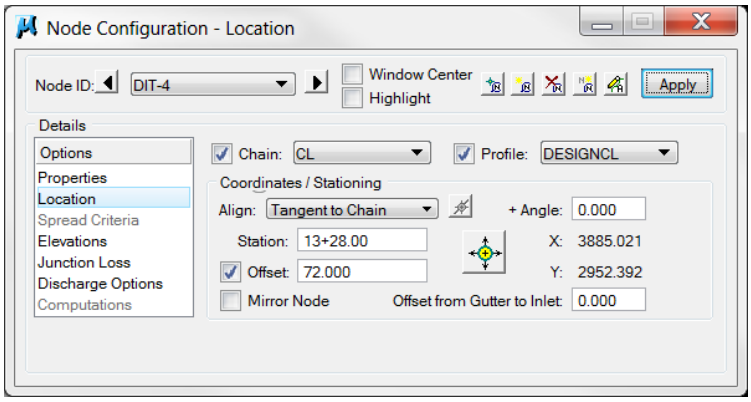


Click **Apply** to save the changes.

h) Go to **Component > Node > Edit** and select Node DIT-4.

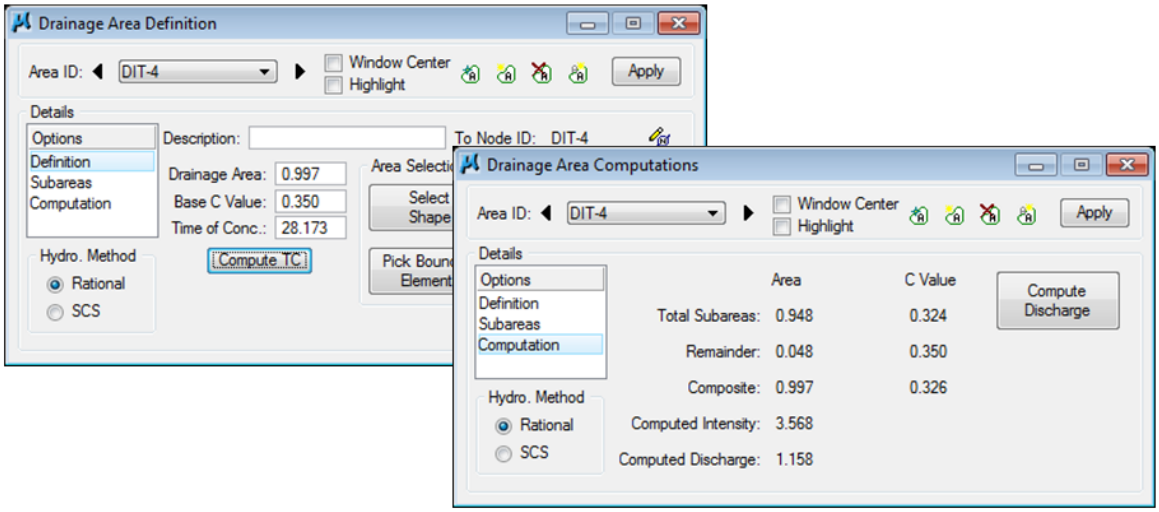
Under **Location**, change the station to **13+28** and the offset to **72.00**.

This is the outlet for the special ditch and is shifted away from the fill slope tie to lead into the current existing drainage path.



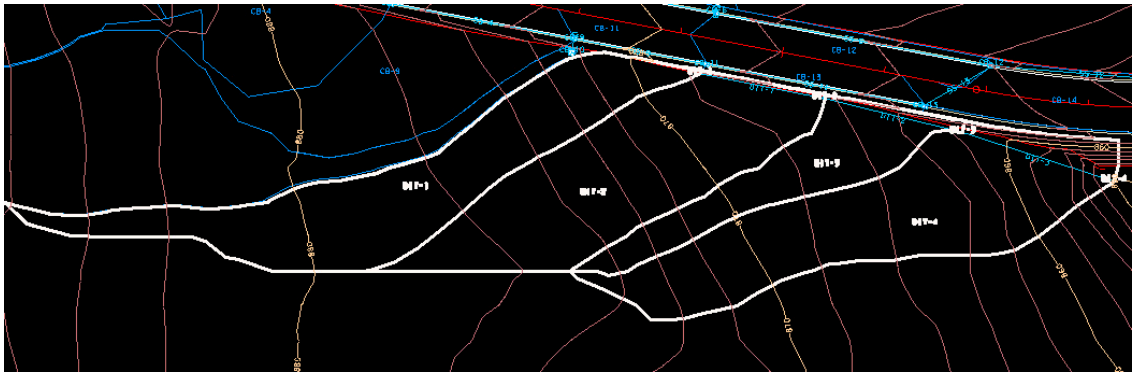
Click **Apply**.

i) Use methods described previously to rebuild the **DIT-4** drainage area for the new location, establish a time of concentration, apply land use areas and compute discharge.



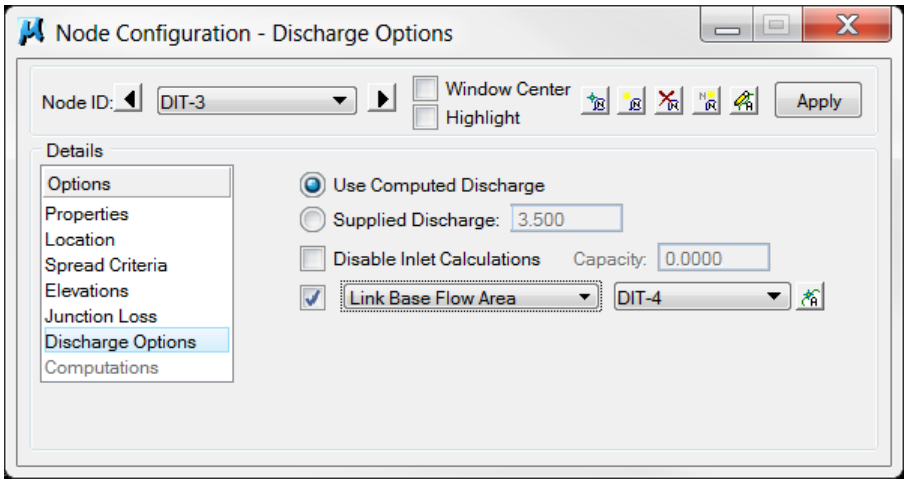
Click **Apply** to save the changes.

Final layout of revised ditch nodes and drainage areas.



j) Since Node DIT-4 is an outlet type, it will not consider the drainage area developed for it. In order to ensure the final ditch link, DIT-3, will be adequate for the capacity at the end we will need to link the DIT-4 drainage area to it.

Go to **Component> Node> Edit** and select node DIT-3. Under Discharge Options click on the option to **Link Base Flow Area** and set to include the DIT-4 drainage area.



11.3 Ditch Link Modification

Redefine Ditch Links with Fixed Geometry & Invert Elevations

a) Go to **Component > Link > Edit** and select Link DIT-1.

Under **Definition**, make the following changes:

Ditch Type: Fixed Geometry

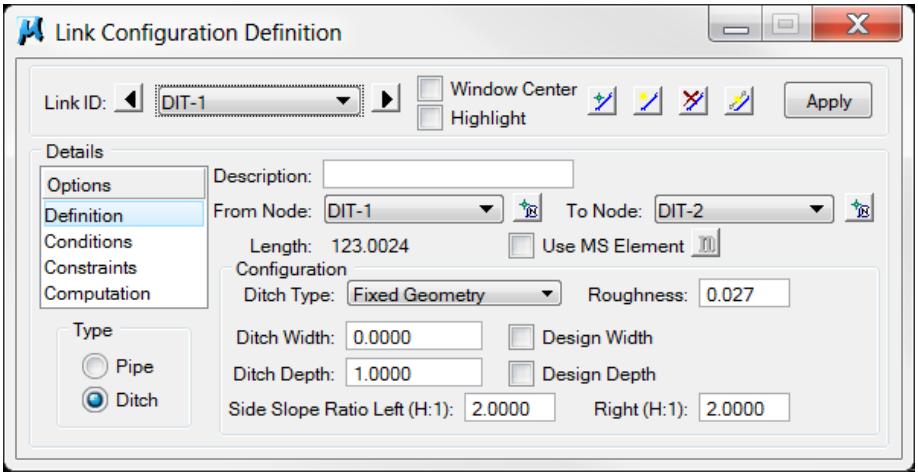
Ditch Width: 0 (Toggle OFF Design Width) - for V-ditch

Ditch Depth: 1 (Toggle OFF Design Depth)

Side Slope Ratio Left (H:1): 2.00

Side Slope Ratio Right (H:1): 2.00

These settings define a “V” ditch at a 1’ depth with 2:1 side slopes.

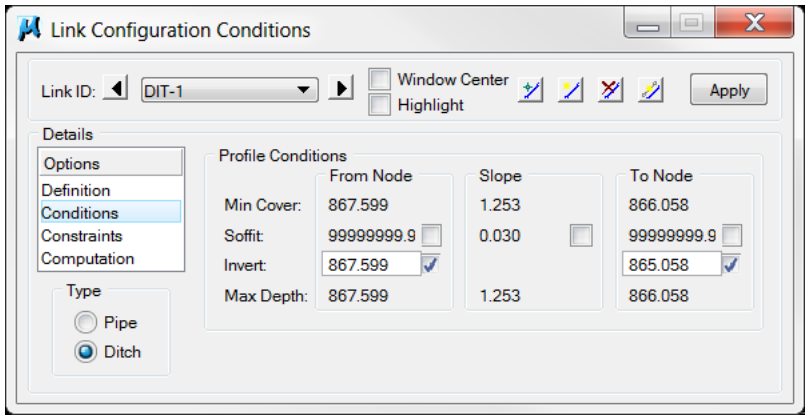


NOTE: You can use the **Design Width** or **Design Depth** options individually but it is **not** recommended to use both at the same time. The software will always use the Minimum Rise value under **Constraints** for the depth and only adjusts the width if needed from that point.

b) Under **Conditions**, make the following changes:

From Node Invert: 867.599 (existing ground elevation)

To Node Invert: 865.058 (1 foot below existing ground elevation)

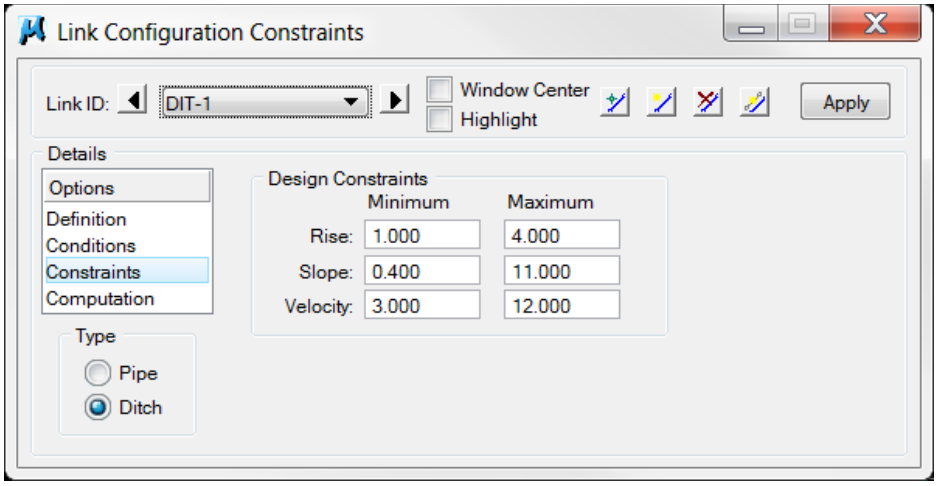


These settings provide the transition from existing ground to the 1' depth.

NOTE: The large numbers you may see specified for **Soffit** elevations can be ignored. These values are a result of the previous application of the Cross Section Based ditch type where these values are not applicable. When the ditch network is redesigned, the Soffit elevations will be recalculated.

c) Under **Constraints**, make the following change:

Minimum Rise: 1.000 (to allow for defined 1 foot depth)



d) Click **Apply** to save the changes to link DIT-1.

e) In the **Link Configuration Definition** dialog go to Link DIT-2.

Under **Definition**, make the following changes:

Ditch Type: Fixed Geometry

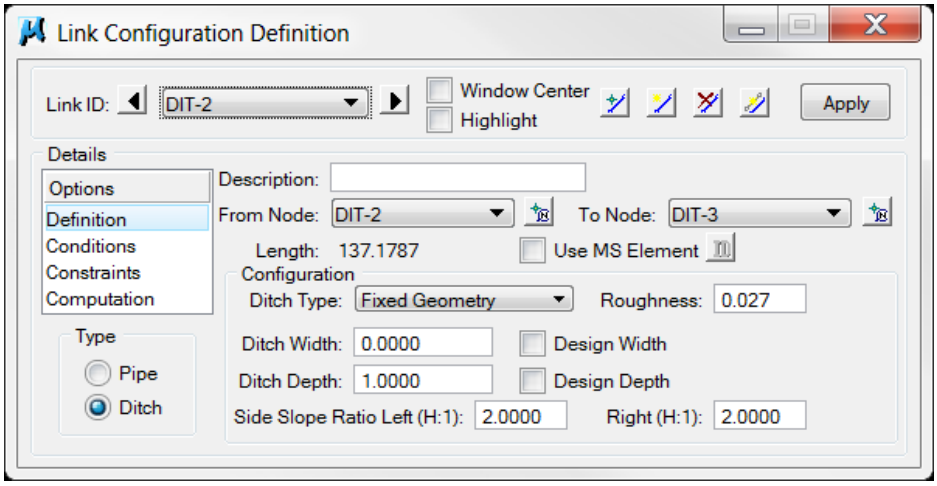
Ditch Width: 0 (Toggle OFF Design Width) – for V-ditch

Ditch Depth: 1 (Toggle OFF Design Depth)

Side Slope Ratio Left (H:1): 2.00

Side Slope Ratio Right (H:1): 2.00

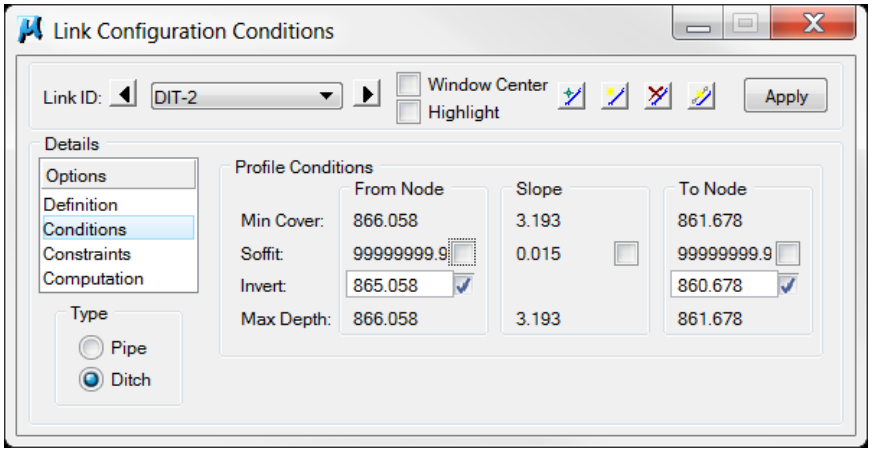
These settings define a "V" ditch at a 1' depth with 2:1 side slopes.



f) Under **Conditions**, make the following changes:

From Node Invert: 865.058 (1 foot below existing ground elevation)

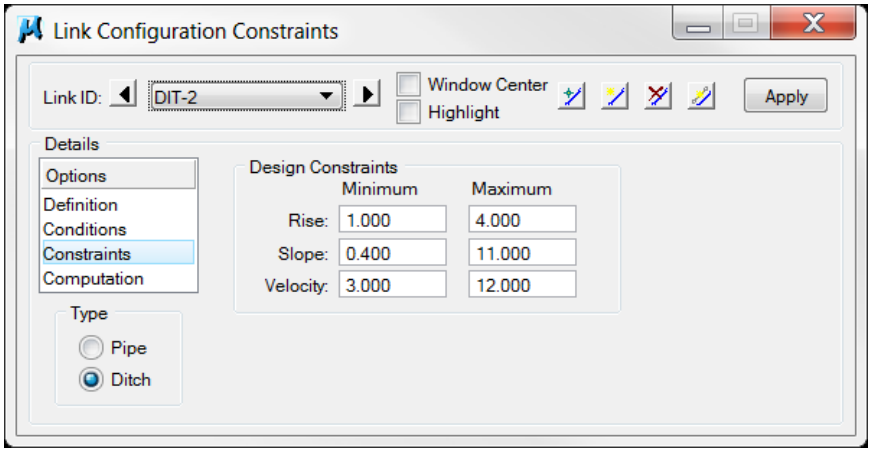
To Node Invert: 860.678 (1 foot below existing ground elevation)



These settings maintain the 1' depth below the existing ground.

g) Under **Constraints**, make the following change:

Minimum Rise: 1.000 (to allow for defined 1 foot depth)



Click **Apply** to save the changes to link DIT-2.

h) In the **Link Configuration Definition** dialog go to Link DIT-3.

Under **Definition**, make the following changes:

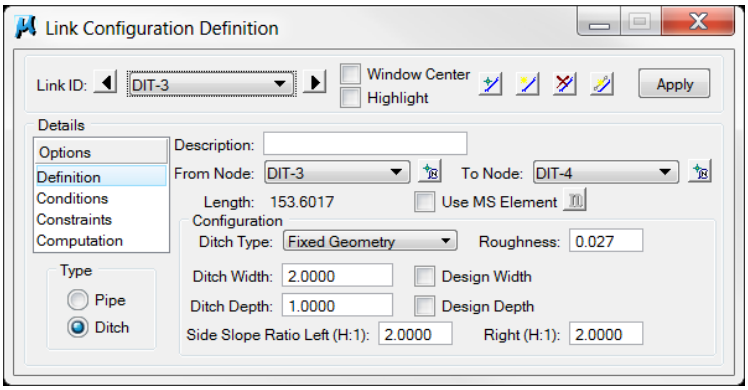
Ditch Type: Fixed Geometry

Ditch Width: 2 (Toggle OFF Design Width)

Ditch Depth: 1 (Toggle OFF Design Depth)

Side Slope Ratio Left (H:1): 2.00

Side Slope Ratio Right (H:1): 2.00



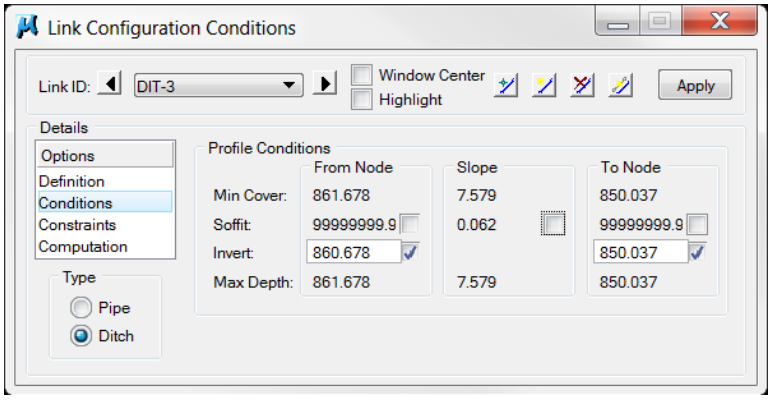
These settings define a 2' wide trapezoidal (flat bottom) ditch at a 1' depth with 2:1 side slopes.

Note: See Appendix E for Roughness Values for Open Channel Hydraulics.

i) Under **Conditions**, make the following changes:

From Node Invert: 860.678 (1 foot below existing ground elevation)

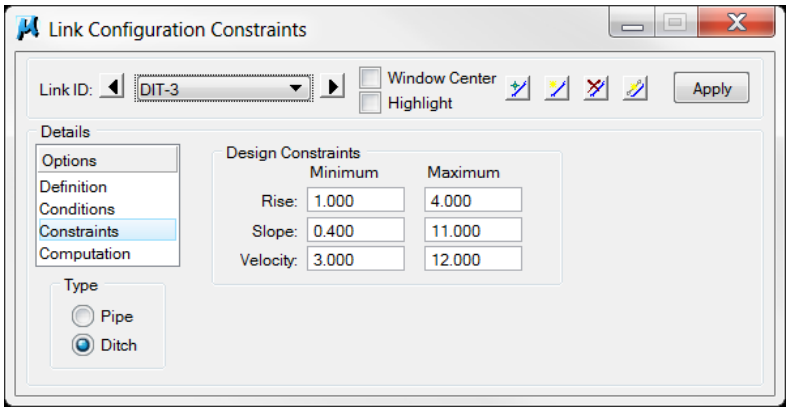
To Node Invert: 850.037 (existing ground elevation)



These settings provide the transition from the 1' depth back to the existing ground elevation at the end of the ditch.

j) Under **Constraints**, make the following change:

Minimum Rise: 1.000 (to allow for defined 1 foot depth)



k) Click **Apply** to save the changes to link DIT-3.

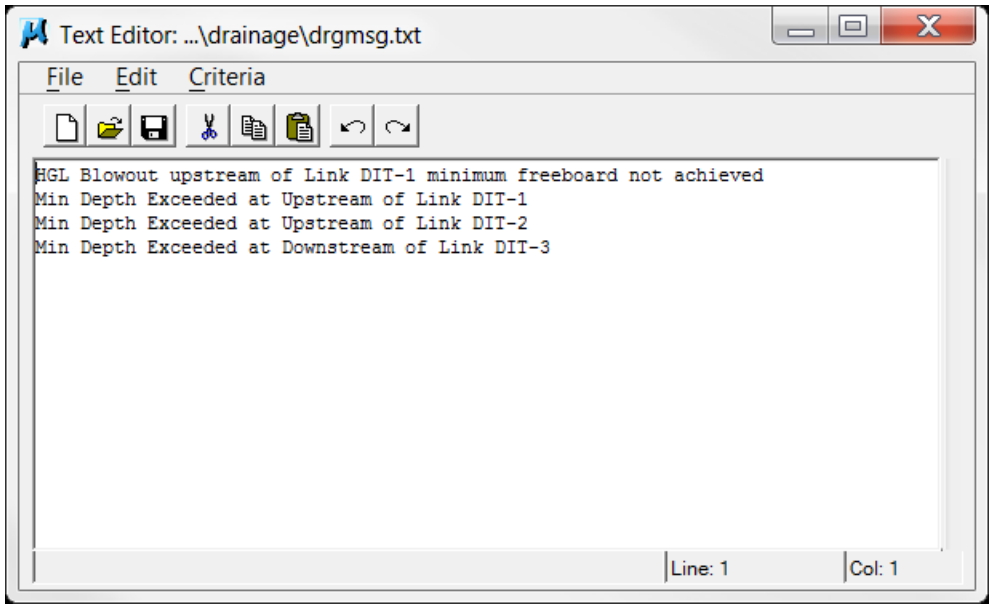
NOTE: You can select the entire ditch of one profile, copy beside itself, select all and Edit > Group so that you will still have the ditch profile from before modifications and you can compare.

11.4 Redesign Ditch Network & Review

a) Go to **Network > Active Network** and select WEST DIT.

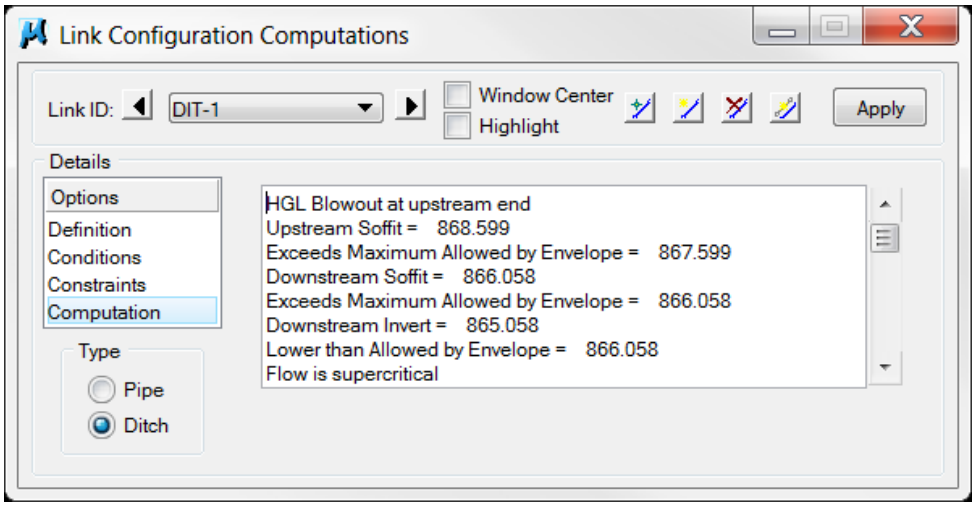
b) Go to **Network > Design** to run the network.

c) Review any errors that are generated by the redesign of the network and close the text editor. (See **Appendix C** for common errors and fixes)

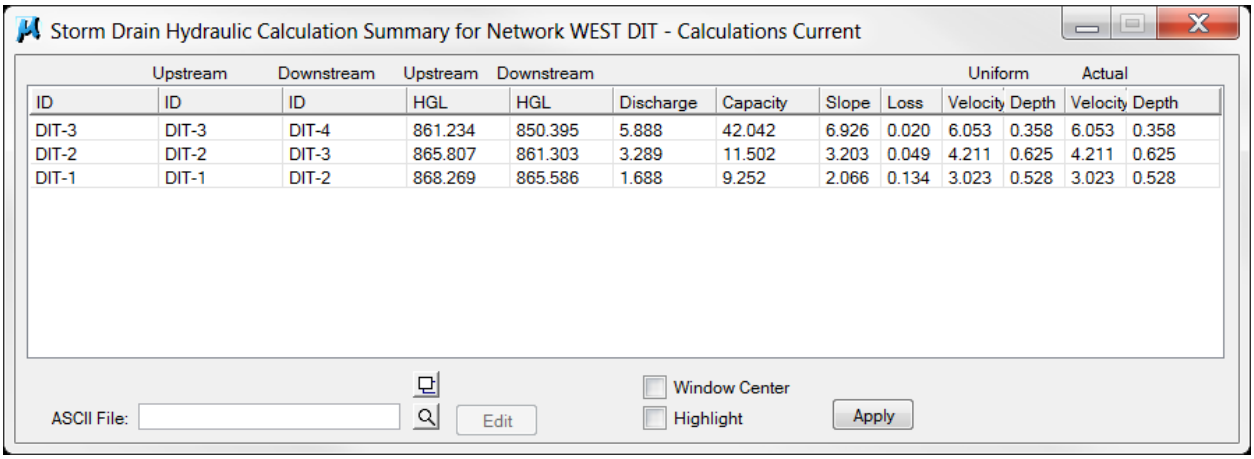


d) Review computation results.

Go to **Component > Link > Edit** and review the link computations for links DIT-1, DIT-2 & DIT-3.



Go to **Reports> Storm Drains\Links> Link Hydraulic Computations**.



	Upstream	Downstream	Upstream	Downstream					Uniform		Actual	
ID	ID	ID	HGL	HGL	Discharge	Capacity	Slope	Loss	Velocity	Depth	Velocity	Depth
DIT-3	DIT-3	DIT-4	861.234	850.395	5.888	42.042	6.926	0.020	6.053	0.358	6.053	0.358
DIT-2	DIT-2	DIT-3	865.807	861.303	3.289	11.502	3.203	0.049	4.211	0.625	4.211	0.625
DIT-1	DIT-1	DIT-2	868.269	865.586	1.688	9.252	2.066	0.134	3.023	0.528	3.023	0.528

e) Zoom in on the ditch profile graphics.

The profile has been automatically updated and reflects our new proposed ditch definitions.