1. Getting Started

This exercise introduces the GEOPAK Drainage workflow to complete the setup required for a new project. The user will review the project information and set the preferences.

GEOPAK Drainage gives you the best design and analysis based on the input that you enter. Engineering judgment must be used to evaluate the output that the program produces. Refer to the TDOT Roadway Design Division Drainage Manual for additional guidance.

1.1 Project Workflow

The GEOPAK Drainage workflow mirrors a conventional design process beginning with the design of the surface collection system (inlets, drainage areas) followed by the design of the conveyance system (subsurface pipes, channels).

Roadway alignments, vertical profiles, and digital terrain models (DTM) may be used throughout GEOPAK Drainage to provide pertinent information to the drainage design. All drainage components feature interactive *graphical placement tools* for easy definition of the drainage system.

Each of these components (inlets, areas, and pipes) is composed of two basic types of information:

- Spatial information describing its location, shape and connectivity.
- Hydraulic and Hydrologic information describing its properties, conventions and other associated attributes.

1.2 Drainage Components

GEOPAK Drainage organizes the components of a drainage system according to their spatial characteristics. Spatial information is stored as **Nodes**, **Links** and **Networks**. This information is stored in a *.gdf file – GEOPAK Drainage File.

Nodes: A node (inlets, manholes, etc.) is a point with a user-defined location. The location may be in Cartesian coordinates (x,y) or in curvilinear coordinates (station, offset).

Links: A Link represents a linear feature depicting a path connecting two nodes, traversing upstream to downstream. The path may be straight line or curvilinear (along a graphic element).

Networks: A network is a system of interconnected nodes and links that form a system through which water can flow to a single outlet node. A drainage project accommodates any number of Networks.

Other associated components in GEOPAK Drainage include:

Areas: A drainage area can be represented by a closed boundary or simply keyedin (acres or hectares). All flows from a single drainage area are tributary to a single Node. There is a <u>one to one</u> correspondence between a node and an area. Therefore areas and nodes share the same name (ID). A drainage area may contain multiple subareas representing homogeneous features such as soil types and land uses ("C" values), thereby allowing composite "C" value calculations.

Profiles: A profile represents a linear feature depicting a path connecting two nodes, it is different than a link in that a path may span multiple links and traverse upstream, downstream, or any combinations. The primary purpose of a profile is to allow visualization of a profile view between any two nodes in a drainage network.

1.3 Directory Information

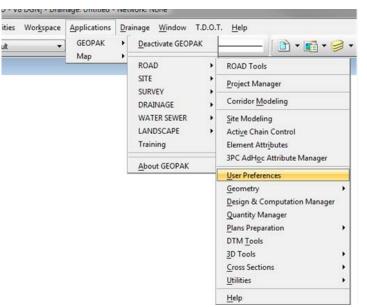
Class files are located in the directory c:\Projects\Drainage*.*

1.4 GEOPAK User Preferences

a) Copy the Geopak Drainage project template file, <u>DrainageProject.gdf</u> from standard directory: <u>C:\Users\Public\Geopak Standards</u> to class project directory: C:\Projects\Drainage\

NOTE: For your project, the 'copy to' location would be your project folder.

- b) Utilizing MicroStation, open DVSR1proposed.dgn using the tdot interface.
- c) Activate GEOPAK by going to Applications > GEOPAK > Activate GEOPAK. The GEOPAK User Preferences control the output format of data produced using GEOPAK. Access the User Preferences by selecting Applications > GEOPAK> Road > User Preferences.



d) Set the Units to English, Stationing to 12+34, and Working Directory to C:\Projects\Drainage\ and click OK.

📕 User Preferences	- • -
Unit System: English Coordinates: NE Direction: Bearing Station: 12+34	Output Accuracy Distance: 99.12 Station: 9+99(9).12 Angle Seconds: 9^9'9''
Working Directory: C:\Projects	Drainage Q
Eeature Preferences COGO Preferences	Show this dialog at startup
<u>о</u> к	Cancel

NOTE: For your project, this would be your working directory.

1.5 GEOPAK Drainage Menu

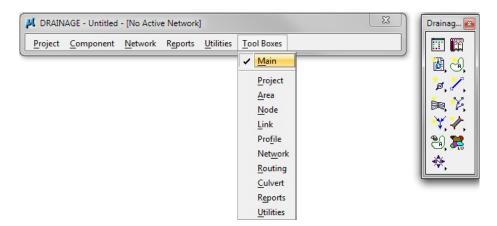
a) Access GEOPAK Drainage from MicroStation's Applications menu:

<u>T</u> ools <u>U</u> tilities Wor <u>k</u> space	Applications	Dra	iinage <u>W</u> indow T	.D.O.1	f. <u>H</u> elp
? Default -	GEOPAK Map	•	Deactivate GEOPA	ĸ	
			ROAD SITE SURVEY	+ +	
			DRAINAGE	•	Drainage
			WATER SEWER LANDSCAPE Training	•	<u>H</u> elp
			About GEOPAK	_	

All items in Drainage can be accessed through this main GEOPAK DRAINAGE Menu Bar:



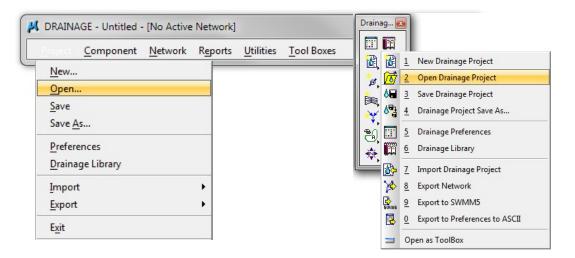
Or by invoking the GEOPAK Drainage Main Tool Box from Tool Boxes>Main:



Or they can be accessed through the Drainage Menu which has been added to the main menu bar once you load GEOPAK Drainage.

osed.dgn [2D - V8 DGN] - Drainage: Untitled -	Network: None
Tools Utilities Workspace Applications	Drainage Window T.D.O.T. Help
? Default - 0 -	Project
	Component
t	Network
	Reports +
	Utilities •
	Tool Boxes
	Exit

b) Open GEOPAK Drainage project file <u>DrainageProject.gdf</u> that was copied into the project directory: C:\Projects\Drainage\.

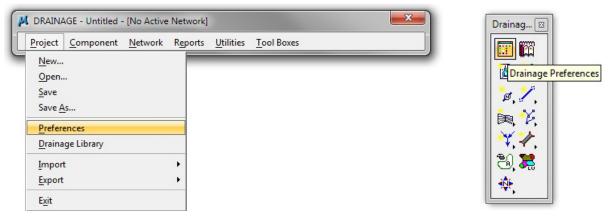


NOTE: Every time that you open GEOPAK Drainage, an untitled project will open. Therefore, you must go to **Project>Open** and select your project .gdf file every time you want to edit or continue working on a project.

1.6 Project Preferences

The Project Preferences control the *graphic and computational* options of the drainage system. The Project Preferences may be changed at any time and the system can then be redesigned or analyzed utilizing the new preferences.

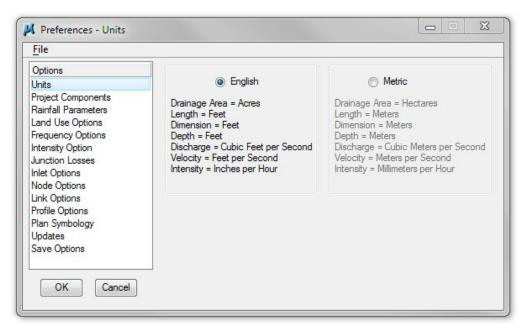
a) Select Project > Preferences.



NOTE: Each Drainage Project should begin by copying the file in Step 1 of 1.4 into the project folder. This step automatically imports all needed preferences. If this step is missed, TDOT Standard Preferences may be loaded **after opening** the Preferences window and going to **File > Open** and navigating to the following file: **C:\Users\Public\Geopak Standards\TDOTdrainageprefs.dpf**

Review the Preferences by selecting each option in the column and reviewing the various options.

b) Units:



c) Project Components:

<u>F</u> ile			
Options	Drainage Library File (DLB):	C:\Users\Public\Geopak Standards`	9
Units	GPK Job Number:	Q User Preferen	ces
Project Components Rainfall Parameters	Drainage Cell Library:	C:\Users\Public\MicroStation Stand;	Q
Land Use Options		C:\Users\Public\Geopak Standards`	Q
Frequency Options Intensity Option	DDB:	•	à
Junction Losses		C: \Users \rubiic \Geopak Standards	
Inlet Options	Water and Sewer Project:		Q
Node Options Link Options	Superelevation Shapes File:	DVSR1SEShapes.dgn	Q
Profile Options	Site Project:		9
Plan Symbology	Original Ground		
Updates Saus Options	TIN File 💌		Q
Save Options	Design Surface		
	TIN File	final.tin	Q

The following items are set to the defaults and NO CHANGES need to be made:

Drainage Library File (DLB) – C:\Users\Public\Geopak Standards\TDOTEnglish.dlb

User Preferences – These settings are already set for you for this exercise.

Drainage Cell Library - C:\Users\Public\MicroStation Standards\cell\STDS.CEL

Criteria Directory - C:\Users\Public\Geopak Standards\Criteria

GEOPAK DDB: C:\Users\Public\Geopak Standards\tdot.ddb

For each Library and Directory file location, select the explorer button and go to the following file locations:

GPK Job Number – Pick the GPK file and it will automatically set the correct number (this only happens if it goes to the correct User Preferences)

Superelevation Shapes File – Choose DVSR1SEShapes.dgn from the project directory

Design Surface – Choose final.tin from the project directory. This final tin is a combination of the proposed tin and existing tin. The final tin includes the proposed areas inside the slopes and the existing area outside the slopes. The tin file has been created for your use in class. Refer to the <u>Geopak Road Course Guide</u> Chapter 22 for instruction on how to create a final tin file for your project.

Exercise 1

d) Rainfall Parameters:

File	
Options Units Project Components Rainfall Parameters Land Use Options	Rational Method Rainfall Source: Lebanon
Earl Ose Options Frequency Options Intensity Option Junction Losses Inlet Options Node Options Link Options Profile Options Plan Symbology Updates Save Options	SCS Method Rainfall Source: None Available Antecedent Moisture Condition I Antecedent Moisture Condition III Antecedent Moisture Condition III Hydrograph Time Interval: 0.000

Select the appropriate rainfall source for the city closest to the project site.

See the <u>TDOT Drainage Manual</u>, Chapter 4, Figure 4A-1 or Appendix I.

NOTE: The Tennessee Department of Transportation Roadway Design Division uses the Rational Method for drainage design.

e) Land Use Options:

File				
Options	Rational Method			
Units	Single Land Use Item:	Rural Steep 💌		
Project Components	Multiple Land Use Item:			
Rainfall Parameters	Land Use Item	Level Color Weight Style		
Land Use Options				
Frequency Options Intensity Option Junction Losses Inlet Options Node Options Link Options Profile Options Plan Symbology	Urban SCS Method	Symbology:		
Jpdates	Land Use Item	Level Color Weight Style		
OK Cancel	Urban	Symbology:		

Set the Land Use Option to **Single Land Use Item: Rural Steep** for this class. The Roadway Design Division **does not** use the option for Multiple Land Use Items. All definitions for land use must come from a specific category.

f) Frequency Options:

File			
Options Units Project Components Rainfall Parameters Land Use Options	Drainage Library (DLB):\G Rational Frequency Option Computation	Runoff Coefficient	English.dlb
Frequency Options Intensity Option Junction Losses Inlet Options Node Options Link Options Profile Options	Frequency: 50 Year SCS Frequency Options Cumulative Frequency:	Peaking Factor: 1.0000 Runoff Coefficient Peaking Factor: 1.0000	
Plan Symbology Updates Save Options OK Cancel			

g) Intensity Options:

File	
Options Units Project Components Rainfall Parameters Land Use Options Frequency Options Intensity Option Junction Losses Inlet Options Node Options Link Options	Drainage Library (DLB):\Geopak Standards\TDOTEnglish.dlb Minimum Time of Concentration: 5.0000 Accumulate Pipe Flow Time by: Uniform Flow Velocity Intensity Options © Compute Intensity from Library Rainfall Data Source © Absolute Intensity: 0.0000 © Weight Time of Concentration
Profile Options Plan Symbology Updates Save Options	Inlet Computation Only Absolute Intensity: 0.0000

h) Junction Losses Options:

ile			
ptions	📄 📄 Disable	e All Junction Loss Computatio	ns
nits oject Components	Loss Ve	elo <mark>c</mark> ity: Actual 💌	
ainfall Parameters		Description	Loss Coefficient - K
and Use Options equency Options	###	Pressure Expansion:	0.3000
ensity Option	÷::	Free Surface Expansion:	0.1000
iction Losses et Options	t∋	Pressure Contraction:	0.5000
ode Options nk Options	式当	Free Surface Contraction:	0.3000
ofile Options	5	Bend Loss:	Method 1 💌
an Symbology odates		Terminal Inlet/Junction:	1.0000
ave Options	₹ T F	Simple Junction:	Method 1 -
OK Cancel		Complex Junction:	

i) Inlet Options:

<u>F</u> ile	
Options Units Project Components Rainfall Parameters Land Use Options Frequency Options Intensity Option Junction Losses Inlet Options Node Options Profile Options Profile Options Plan Symbology Updates Save Options OK Cancel	Inlet By Pass Options: By Pass as Total Discharge Link By Pass Flow Options: Do Not Allow Inlet By Pass in Link Discharges Default Spread n Value: 0.0160 Extend Superelevation Shapes to Inlet at Shape Slope

j) Node Options:

File				
Options Units Project Components Rainfall Parameters Land Use Options Frequency Options Intensity Option Junction Losses Inlet Options Ink Options Profile Options Plan Symbology Updates Save Options OK Cancel	Default Node ID Prefix:	Scale Factor:]	

k) Link Options:

<u>File</u>	
Options Units Project Components Rainfall Parameters Land Use Options	Default Link ID Prefix: SS- Link Profile Options Design Optimization: Minimize Depth of Cover Elevation Option: at Actual Link End
Frequency Options Intensity Option Junction Losses Inlet Options Node Options	Link Design Options O Design for Maximum Capacity Design for Full Capacity Design Partial Capacity (d/D) Ratio: 1.0000
Link Options Profile Options Plan Symbology Updates Save Options	 Design Partial Capacity (q/Q) Ratio: 1.0000 Link Slope Decimal: No Rounding
	Link Criteria File File Name:
OK Cancel	Hydraulic GradeLine Options Hydraulic Gradeline Basis: Equal Hydraulic Gradeline 💌

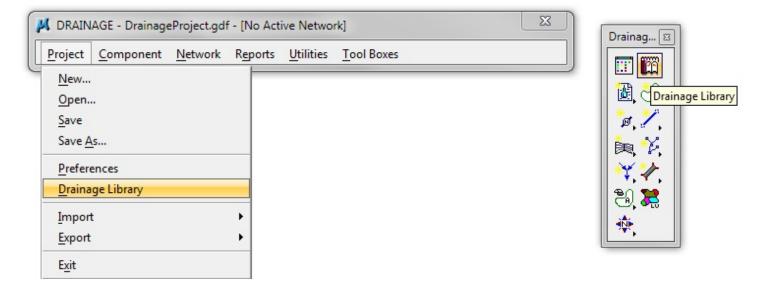
NOTE: Do **not** set the **Link Slope Decimal** to rounding. This setting is for control of Pipe Design not annotation. If set it will be impossible to design for minimum depth drainage structures.

- I) Profile Options, Plan Symbology, Updates and Save Options should be kept at the default settings. Do not make any changes.
- m) Click OK to save changes and dismiss the dialog.

1.7 Drainage Library

The Drainage Library is used to store hydraulic, hydrologic, and construction standards, which may be shared by different projects and designers. Each GEOPAK Drainage project accesses items from the *Drainage Library* for use on the specific project.

a) Select **Project > Drainage Library**. The library stored in the Preferences will be opened by default.



The Drainage Library currently contains five (5) tabs as shown below:

File Edit		

- Rainfall Rainfall Data Source
- Land Use Land Uses, their corresponding "C" values and symbology
- Nodes Inlets, Junctions, Manholes, Outlets, etc.
- Links...... Circular Pipes, Elliptical Pipes, Pipe-Arch pipes, Boxes, etc.
- Spread Section Inventory of varying Spread Cross Sections

The **Rainfall** tab stores the rainfall data information to be used on GEOPAK Drainage Projects. GEOPAK Drainage supports rainfall sources in the form of intensity duration frequency (IDF) tables, or as coefficients for intensity-durationequation formats. **b)** Select the **Rainfall** tab, highlight Lebanon, and select **Modify** to review the various options:

Rainfall Land Use Node:	s Links Spread Section	
Element ID	Description	
Shelbyville	IDF Curve Data	
Manchester	IDF Curve Data	2
Lebanon	IDF Curve Data	
Lawrenceburg	IDF Curve Data	
Knoxville	IDF Curve Data	Modify Library
Johnson City	IDF Curve Data	Childrey Elbrary
Jackson	IDF Curve Data	_
Cookeville	IDF Curve Data	
Clarksville	IDF Curve Data	₽
Chattanooga	IDF Curve Data	

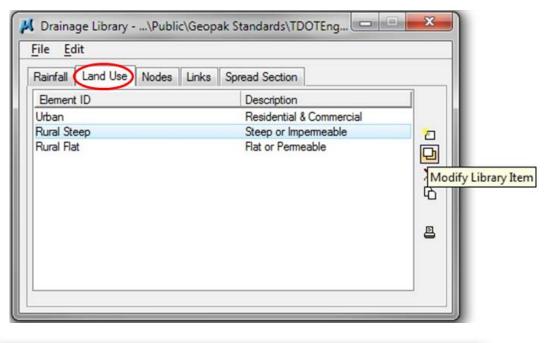
NOTE: See Appendix I for IDF Zone Location Map.

tem ID: Le	banon	Description	n: IDF Cu	rve Data	Data	Type: Ta	able	
	User Defin	ned Frequer	ncies		2.24			
Duration:	2.00	5.00	10.00	25.00	50.00	100.00		
5.0000	5.5100	6.3400	6.9800	7.7600	8.3600	8.9400		2
10.0000	4.4000	5.0700	5.5800	6.1900	6.6700	7.1000		
15.0000	3.6900	4.2800	4.7100	5.2300	5.6200	5.9800		Ð
30.0000	2.5500	3.0400	3.4100	3.8700	4.2400	4.5800		
60.0000	1.6000	1.9500	2.2200	2.5800	2.8700	3.1600	-	×
1440.000	0.150	0.180	0.210	0.250	0.280	0.310	1	
		_	Populate	Table By:			7.	
OK	Cancel		Import A	SCIL	HYDRO-3	5	TP 40.	

The table contains the Duration-Frequency Table for the Lebanon area.

The **Land Use** tab is used to store runoff coefficients ("C" values) and corresponding graphic symbology for each land use. Land uses can then be delineated automatically using the selected symbology.

c) Select the Land Use tab, highlight the Rural Steep item and select **Modify** to review the various options:



Item ID: Rural Steep		Description: Steep or Impermeable	
Land Use Description	Runoff C	Symbology	
Conc/Asphalt Pvmt	0.90	Lv:DESIGN - SCRATCH - User 1, Co:1, Lc:(
AsphaltMacadem Pvmt	0.80	Lv:DESIGN - SCRATCH - User 1, Co:5, Lc:(
Gravel	0.60	Lv:DESIGN - SCRATCH - User 1, Co:2, Lc:(
Bare Earth	0.90	Lv:DESIGN - SCRATCH - User 1, Co:13, Lc	
Steep Grass (2:1)	0.70	Lv:DESIGN - SCRATCH - User 1, Co:14, Lc	
Turf Meadows	0.40	Lv:DESIGN - SCRATCH - User 1, Co:8, Lc:(
Forested Areas	0.30	Lv:DESIGN - SCRATCH - User 1, Co:28, Lc	
Cultivated Fields	0.40	Lv:DESIGN - SCRATCH - User 1, Co:7, Lc:(

Note the various land uses and their associated symbology. Chapter 2 will discuss how to make a land use file.

The **Nodes** tab contains standard configurations for Grates, Curbs and Slotted drain inlets, as well as Junctions, Outlets and Other nodes. The description, plan view representation and dimensional information are stored for each node.

d) Select the **Nodes** tab, highlight a Grate inlet and select **Modify** to review the various options:

ile <u>E</u> dit		
Rainfall Land Use Nodes	Links Spread Section	
Node Types: Grate	•	
Element ID	Description	A
CB#52 9X9	#52	E
CB#51 9X9	#51	2
CB#51 7X7	#51	
B#51 5'2"X5'2"	#51	
B#46 9X9	#46	Modify Library
B#45 8X4	#45	
B#44 9X9	#44	
B#43 8X5'2"	#43	
:B#43 8X4	#43	₽
B#43 8' DIA	#43	
CB#42 8' DIA	#42	-

Item ID:	CB#51 5'2")	×5'2"	ОК
Description:	#51		
Payltem:	51		Cancel
Criteria File:		٩	Plan View Cell:
Plan View Cell:	CB62X62R	Select	
Node Type:	Grate	•	
Profile Type:	On Grade	•	
Data for On Grad	le		
Grate Type:	Curved Van	• •	
Length:	3.021		
Width:	1.813		
Data for Sag			
	Area:	5.477	
Area Redu	iction Factor:	0.542	
	Perimeter:	6.647	
Perimeter Redu	ction Factor:	0.000	

Note the various geometric values required for the nodes.

Exercise 1

The **Links** tab contains all culverts to be used on drainage projects. Each link type is categorized by three properties: Shape, Material and Type (for some combinations of Shape & Material); and contains information regarding specific culvert geometry, default roughness coefficient and material combination.

e) Select the Links tab, select Circular from the Shape dialog box and Concrete from the Material dialog box. Highlight the first Circular Concrete pipe, and select Modify to review the various options:

Shape: Circula	ar 🔹 Material: (Concrete		
Element ID		Description	<u>^</u>	
102 Inch Dia. C		PROP. 102" RCP		
108 Inch Dia. C		PROP. 108" RCP	_ 🖸	
114 Inch Dia. C		PROP. 114" RCP		
120 Inch Dia. C 126 Inch Dia. C		PROP. 120" RCP PROP. 126" RCP		
132 Inch Dia. C		PROP. 128 RCP	Modify Libra	ry
138 Inch Dia. C		PROP. 138" RCP	40	
15 Inch Dia. Cir	Set of the	PROP. 15" RCP		
18 Inch Dia. Cir	cular	PROP. 18" RCP	8	
24 Inch Dia. Cir		PROP. 24" RCP		
30 Inch Dia. Cir	cular	PROP. 30" RCP	•	
Drainage Library - be Properties Item ID: 15 Inch escription: PROP.	n Dia. Circular			
be Properties Item ID: 15 Incr escription: PROP. Payltem: 607-02 Shape: Circular	1 Dia. Circular 15" RCP .02			
be Properties Item ID: 15 Inch escription: PROP. Payltem: 607-02	1 Dia. Circular 15" RCP .02			
be Properties Item ID: 15 Incr escription: PROP. Payltem: 607-02 Shape: Circular	n Dia. Circular 15" RCP .02 te			
be Properties Item ID: 15 Inchescription: PROP. Payltem: 607-02 Shape: Circular Material: Concre	n Dia. Circular 15" RCP .02 te 0.0130			
Properties Item ID: 15 Inchescription: PROP. Payltem: 607-02 Shape: Circular Material: Concre Roughness: Thickness:	n Dia. Circular 15" RCP .02 te 0.0130			
be Properties Item ID: 15 Incr escription: PROP. Payltem: 607-02 Shape: Circular Material: Concre Roughness: Thickness: Rise:	n Dia. Circular 15" RCP .02 .02 .02 .02 .02 .02 .02 .02			
Properties Item ID: 15 Incr escription: PROP. Payltem: 607-02 Shape: Circular Material: Concre Roughness: Thickness: Rise:	n Dia. Circular 15" RCP .02			
Properties Item ID: 15 Incr escription: PROP. Payltem: 607-02 Shape: Circular Material: Concre Roughness: Thickness: Rise: Span: RadiusA:	n Dia. Circular 15" RCP .02			
be Properties Item ID: 15 Incr escription: PROP. PayItem: 607-02 Shape: Circular Material: Concre Roughness: Thickness: Rise: Span: RadiusA: RadiusB:	n Dia. Circular 15" RCP .02			
be Properties Item ID: 15 Incr escription: PROP. Payltem: 607-02 Shape: Circular Material: Concre Roughness: Thickness: Rise: Span: RadiusA: RadiusB: RadiusC:	n Dia. Circular 15" RCP .02			
be Properties Item ID: 15 Incr escription: PROP, Payltem: 607-02 Shape: Circular Material: Concre Roughness: Thickness: Rise: Span: RadiusA: RadiusA: RadiusE: RadiusD:	n Dia. Circular 15" RCP .02			
be Properties Item ID: 15 Incr escription: PROP. Payltem: 607-02 Shape: Circular Material: Concre Roughness: Thickness: Rise: Span: RadiusA: RadiusB: RadiusB: RadiusD: ench Details	n Dia. Circular 15" RCP .02			
Properties Item ID: 15 Incr escription: PROP, Payltem: 607-02 Shape: Circular Material: Concre Roughness: Thickness: Rise: Span: RadiusA: RadiusA: RadiusB: RadiusC: RadiusD:	n Dia. Circular 15" RCP .02			

Note the various geometric values required for the links.

The **Spread Section** tab stores standard spread cross sections for roadway, shoulders and gutter that can be used on drainage projects.

f) Select the **Spread Section** tab, highlight any section, and select **Modify** to review the various options:

<u>File E</u> dit			
Rainfall Land Use Nodes	Links Spread Section		
Element ID	Description	*	
5Lane12S	5 lane with 12' shld		
5Lane10S	5 lane with 10' shld		2
5Lane	5 lane with no shld		
4Lane8S	4 lane with 8' shld		
4Lane12S	4 lane with 12' shld		Y
4Lane10S	4 lane with 10' shld	=	Modify Libra
4Lane	4 lane with no shld		
3Lane8S	3 lane with 8' shld		
3Lane12S	3 lane with 12' shid		8
3Lane10S	3 lane with 10' shld		
3Lane	3 lane with no shld		
2Lane8S	2 lane with 8' shld	-	

-	3Lane			
Description: 3 lane w	vith no shld	Cancel		
Width % Slope	Roughness			
2.000 8.500	0.016	0		
18.000 2.000	0.016	Ð		
		×		

Note the spread cross section characteristics for the spread item.