Technical Training and Certification Program

USDA — United States Department of Agriculture — Natural Resources Conservation Service

MASWCD — Minnesota Association of Soil and Water Conservation Districts

BWSR
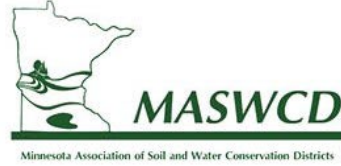
EFT-
Waterway Design Tool
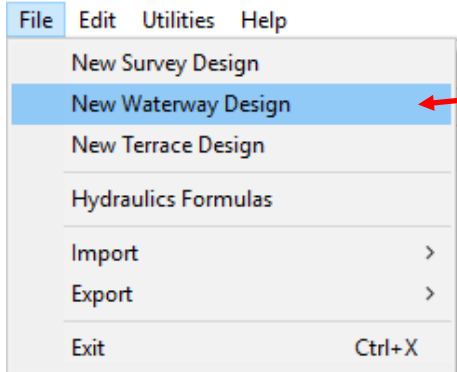

50 cfs

66 cfs

36 cfs

Workflow

2021 Workflow
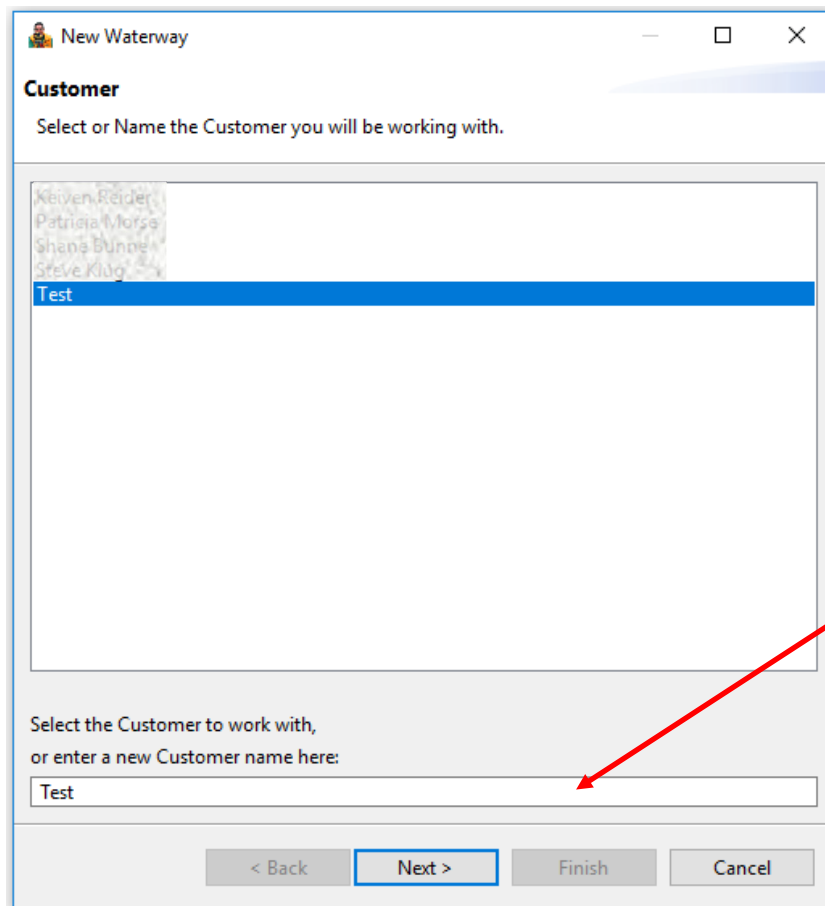
2025 GIS Edits (separate file)

This reference guide covers the design of a waterway and tile using the Engineering Field Tools program as provided by the Natural Resources Conservation Service.

Creating a New Design

File > New Waterway Design

Create a new customer or select an existing customer. E.g. Landowner

New Waterway

Project

Select or Name the Project you will be working with.

BasinTraining
Test 410

Select the Project to work with,
or enter a new Project name here:

Waterway

< Back | Next > | Finish | Cancel

Select a project from the list to work with.
If you have an existing customer or create a new project. E.g. Location (Township and Section number)

New Waterway

WaterwayDesign

Enter a new name for the Design you will be working with.

Enter a new WaterwayDesign name below.
The above list entries already exist, and cannot be used.

Example

< Back | Next > | Finish | Cancel

Enter the name of the design.
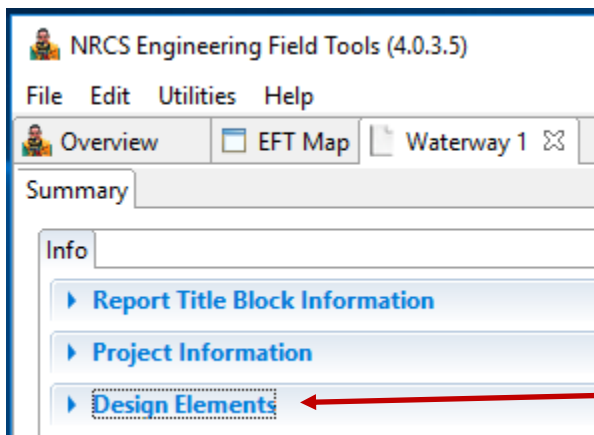E.g. Waterway 3

Finish
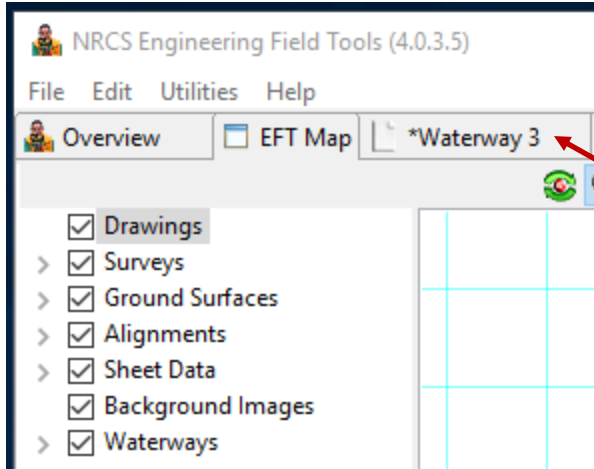
You will now have three tabs located near the top of the page.
- Overview
- EFT Map
- Project name (Waterway 3)

Click on the project name tab to begin the design.

Report Title Block Information – Project name, designed, drawn, checked, approved, applicable dates, location of project

Project Information – Description of the project, benchmark description, and elevation

Design Elements – Surveys, Alignments, Waterway, Forms

Most of the work will be done in "Design Elements."

If you complete the Report Title Block as follows:

This is how the output will look on your reports.

Waterway Cut Sheet

Larry Van Gundy

Grassed Wate
Money Creek 5, Hou

Project Name: Larry VanGundy
Project Description: Waterway 3
Designed by: E. Oolman **Date:** 2/20

Location: Money Creek 5, Houston County
Practice: Grassed Waterway
Checked by: _____ **Date:** ___

Importing a survey

Under the Survey window, select

New

Give the survey a name that you would like to import.

Choose "XYZ" for type of survey to create.

OK

Import Data

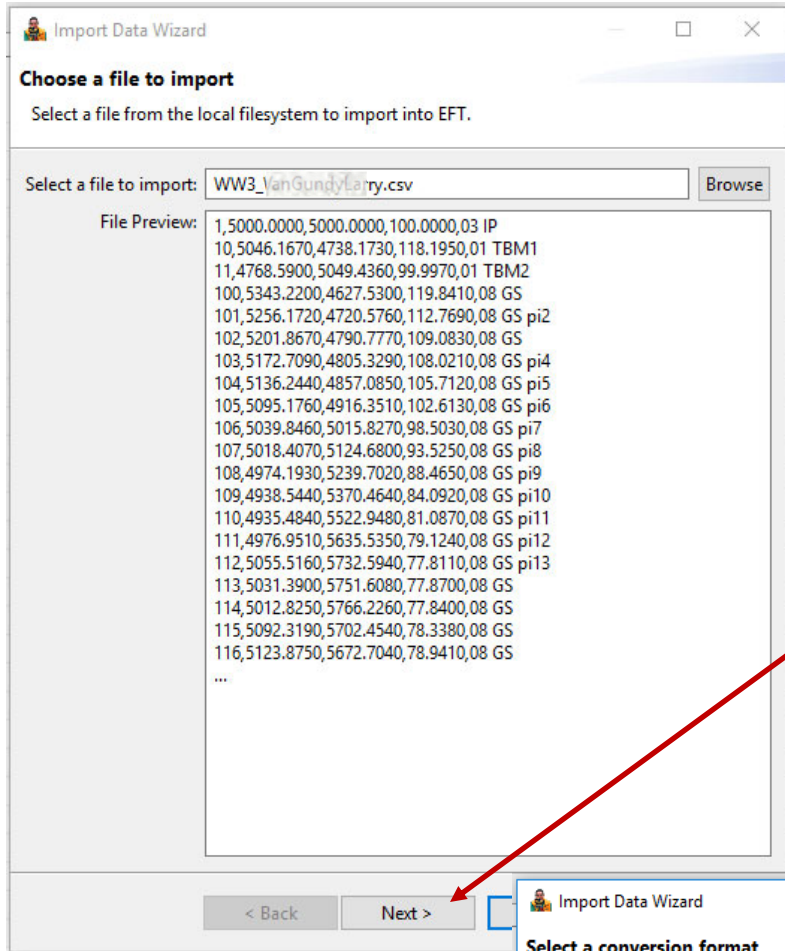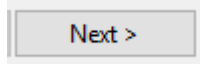Browse to locate *.csv file from desired folder.
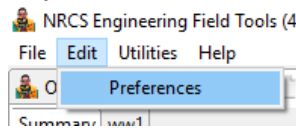
Make sure that the file type is set to *.csv.

Open

NOTE:
The file preview will show show an *EXAMPLE* of the points that you are importing not *ALL* the points you are importing.

Import Data Wizard

Choose a file to import
Select a file from the local filesystem to import into EFT.

Select a file to import: WW3_VanGundyLarry.csv   Browse

File Preview:
```
1,5000.0000,5000.0000,100.0000,03 IP
10,5046.1670,4738.1730,118.1950,01 TBM1
11,4768.5900,5049.4360,99.9970,01 TBM2
100,5343.2200,4627.5300,119.8410,08 GS
101,5256.1720,4720.5760,112.7690,08 GS pi2
102,5201.8670,4790.7770,109.0830,08 GS
103,5172.7090,4805.3290,108.0210,08 GS pi4
104,5136.2440,4857.0850,105.7120,08 GS pi5
105,5095.1760,4916.3510,102.6130,08 GS pi6
106,5039.8460,5015.8270,98.5030,08 GS pi7
107,5018.4070,5124.6800,93.5250,08 GS pi8
108,4974.1930,5239.7020,88.4650,08 GS pi9
109,4938.5440,5370.4640,84.0920,08 GS pi10
110,4935.4840,5522.9480,81.0870,08 GS pi11
111,4976.9510,5635.5350,79.1240,08 GS pi12
112,5055.5160,5732.5940,77.8110,08 GS pi13
113,5031.3900,5751.6080,77.8700,08 GS
114,5012.8250,5766.2260,77.8400,08 GS
115,5092.3190,5702.4540,78.3380,08 GS
116,5123.8750,5672.7040,78.9410,08 GS
...
```
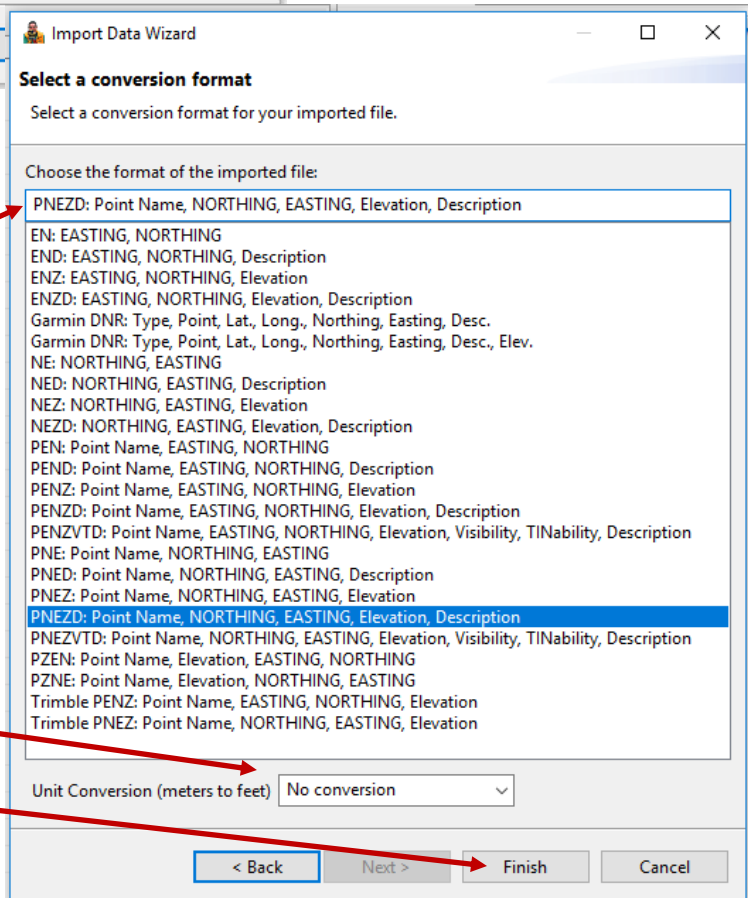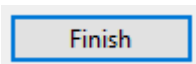
< Back   Next >

Next >

Select a conversion format.

Most electronic survey equipment uses a standard of "PNEZD."

This can be preset in the Preferences.

NRCS Engineering Field Tools (4

File   Edit   Utilities   Help

O   Preferences

Summary ww1

No conversion

Finish

Import Data Wizard

Select a conversion format
Select a conversion format for your imported file.

Choose the format of the imported file:

PNEZD: Point Name, NORTHING, EASTING, Elevation, Description

EN: EASTING, NORTHING
END: EASTING, NORTHING, Description
ENZ: EASTING, NORTHING, Elevation
ENZD: EASTING, NORTHING, Elevation, Description
Garmin DNR: Type, Point, Lat., Long., Northing, Easting, Desc.
Garmin DNR: Type, Point, Lat., Long., Northing, Easting, Desc., Elev.
NE: NORTHING, EASTING
NED: NORTHING, EASTING, Description
NEZ: NORTHING, EASTING, Elevation
NEZD: NORTHING, EASTING, Elevation, Description
PEN: Point Name, EASTING, NORTHING
PEND: Point Name, EASTING, NORTHING, Description
PENZ: Point Name, EASTING, NORTHING, Elevation
PENZD: Point Name, EASTING, NORTHING, Elevation, Description
PENZVTD: Point Name, EASTING, NORTHING, Elevation, Visibility, TINability, Description
PNE: Point Name, NORTHING, EASTING
PNED: Point Name, NORTHING, EASTING, Description
PNEZ: Point Name, NORTHING, EASTING, Elevation
PNEZD: Point Name, NORTHING, EASTING, Elevation, Description
PNEZVTD: Point Name, NORTHING, EASTING, Elevation, Visibility, TINability, Description
PZEN: Point Name, Elevation, EASTING, NORTHING
PZNE: Point Name, Elevation, NORTHING, EASTING
Trimble PENZ: Point Name, EASTING, NORTHING, Elevation
Trimble PNEZ: Point Name, NORTHING, EASTING, Elevation

Unit Conversion (meters to feet)   No conversion

< Back   Next >   Finish   Cancel

Name	X (Easting)	Y (Northing)	Z (Elevation)	Visible	Tinable	Description
1	1659707.140	16039648.530	1237.957	☑	☑	01 TBM-01
2	1659989.552	16036225.800	1260.519	☑	☑	01 TBM-02
100	1659642.969	16036329.000	1254.483	☑	☑	32 CLDIT...
101	1659609.289	16036349.910	1255.620	☑	☑	08 GS
102	1659642.811	16036326.780	1254.988	☑	☑	35 BNKL
103	1659645.917	16036325.380	1254.484	☑	☑	33 EBL
104	1659655.140	16036319.960	1254.880	☑	☑	34 EBR
105	1659658.263	16036317.480	1255.184	☑	☑	36 BNKR
106	1659660.662	16036315.890	1255.062	☑	☑	28 EFLD

Points will be added to the list in the survey. There are options to make each point visible and tinable. All points that would be included in a surface should be tinable. Benchmarks, IPs, top of pipes, or other structures that do not represent the landscape should **not be** tinable.

Accept Edit ←

Cancel Edit

Accept Edit

This will close the window.

Illegal Point: 1378

TINable point outside border: Name: 1378, ID: 225

OK
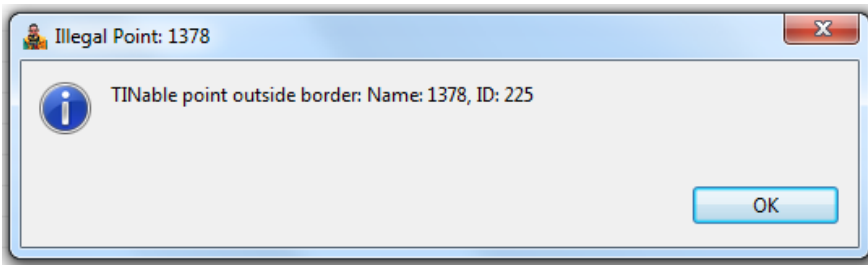
Potential error:
Click OK and go back into the survey and find the name of the point and uncheck the "Tinable" box for that point. At times there has been more than one point to be modified.

NRCS Engineering Field Tools (4.0.3.5)

File   Edit   Utilities   Help

EFT Map   *Waterway 3

Summary
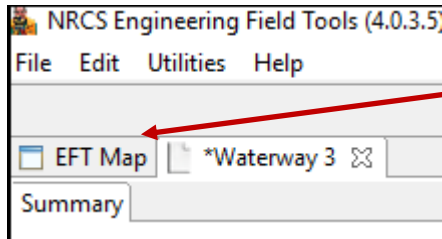
Click on   EFT Map

To see survey, click on   Full Extent

The display of contours and surfaces can be manipulated through the Table of Contents.
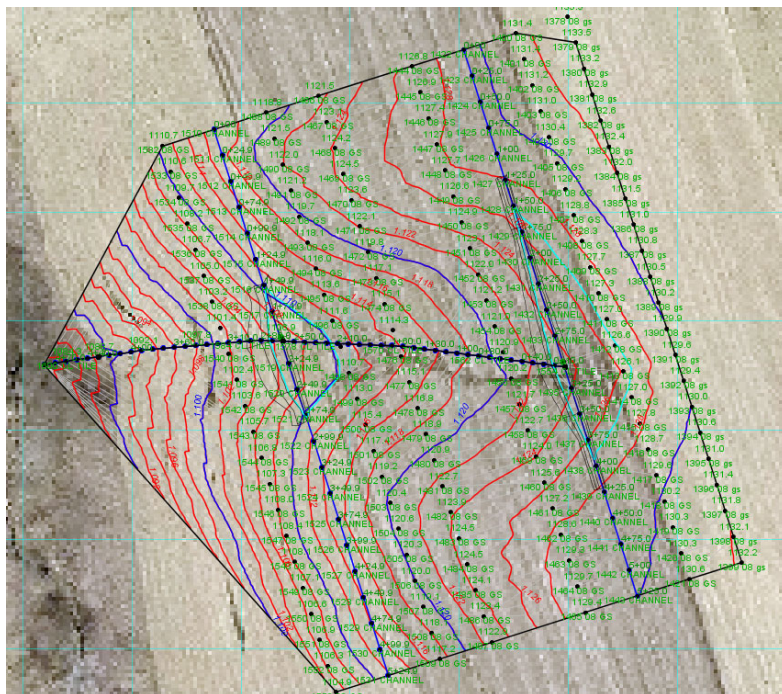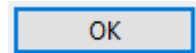Right click on these items to view the options available.

- ☑ Drawings
- ☑ Surveys
  - ☑ ww1
    - ☑ Points
    - ☑ Labels
    - ☑ Elevations
- ☑ Ground Surfaces
  - ☑ TIN Surface
    - ☑ Triangles
    - ☑ Breaklines
    - ☑ Contour Labels
    - ☑ Minor Contours
    - ☑ Major Contours
    - ☑ Border
    - ☑ Ground Points
- ☑ Alignments
- ☑ Sheet Data
  - ☑ Grid
- ☑ Background Images
- ☑ Waterways

Adding an Image to the Map

To create an image file, reference the section Create Background Image

☑ Background Images
◢ ☑ Terraces   Add Background Image
    ◢ ☑ Basin 1

Right Click on Background Images.

Add Background Image

Layer Title   Olmsted

Image File   C:_Projects\Training\Quincy 13 Project\Olr   Select   Link ▾

Transparent ——————————————————— Opaque

Note: In order to include the image in the zipfile produced with 'Export Customer to Zipfile', you need to choose one of the 'Copy' or 'Move' methods of import. The image will then be copied/moved to the Customer directory, and can be shared among design files.

OK   Cancel

Browse to image file. May need to change file type to view needed file.

Use "Link" or "Copy" to share with others.

OK

Adding Breaklines

Filter Ground Surface Points

Name	X	Y	Z	Description
1	5000.0	5000.0	100.0	03 IP
10	4738.2	5046.2	118.2	01 TBM1
11	5049.4	4768.6	100.0	01 TBM2
100	4627.5	5343.2	119.8	08 GS
101	4720.6	5256.2	112.8	08 GS pi2
102	4790.8	5201.9	109.1	08 GS
103	4805.3	5172.7	108.0	08 GS pi4
104	4857.1	5136.2	105.7	08 GS pi5
105	4916.4	5095.2	102.6	08 GS pi6
106	5015.8	5039.8	98.5	08 GS pi7
107	5124.7	5018.4	93.5	08 GS pi8
108	5239.7	4974.2	88.5	08 GS pi9
109	5370.5	4938.5	84.1	08 GS pi10

Isolate Points

Name _____ Set

Description 34 CLD _____ Set

Apply   OK   Cancel

Recommendation:

Filter Ground Surface Points
Name the points you want to keep
Set
Apply
Ok
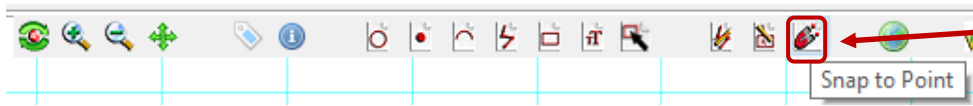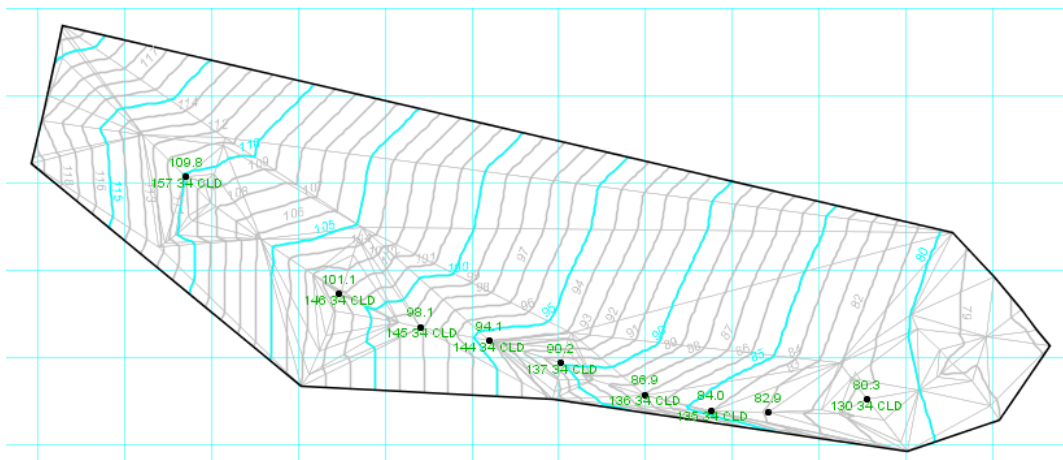
Snap to Point

Snap to Point

Add a breakline
To end the breakline, click on the "Add Breakline" to end.

Delete a breakline
If you want to delete a breakline, you need to click on each segment to delete it.

Adding an Alignment

Go back to Waterway Design tab [☐ EFT Map | *Waterway 3 ✕]

Alignments

New

Open

Under the Alignment window, select

[New]

Create New Alignment ✕

ⓘ Select a Name for your Alignment:

Waterway CL Align

Name your alignment

[OK]

OK   Cancel

Recommend using the word align or alignment in name.

Map Edit Operations

[✏ Sketch Alignment]   [⊙ Insert Station]   [🖑 Move Points]   [✔ Apply Curves]

Sketch Alignment in the middle of the screen

Replace Alignment Content? ✕

❓ Sketch operation will delete all existing stations on this alignment. OK to proceed?

OK   Cancel

A window appears reminding user that this operation will overwrite any existing alignment.

[OK]

[☐ EFT Map | *Waterway 3 ✕]

Click on [☐ EFT Map] .

Recommend Filter Ground Surface Points to waterway's PIs and Snap to Point if you have waterway PIs.

Sketch the alignment. Double click to end.

Enter the "Beginning Station"

Adding a Waterway Profile (design)

Under the Waterways

window, select New

Give the waterway a
name.

OK

Create New Waterway ✕

Select a Name for your Waterway:

Waterway 3 CL

OK   Cancel
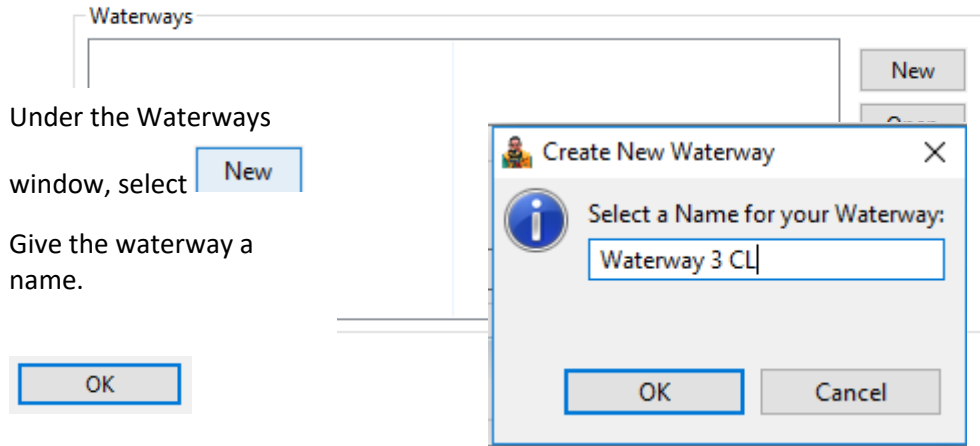
Info | Hydrology | Channel | Profile | Design   ← The design will open multiple tabs.

Info tab

Waterway Name	Waterway 3 CL
Alignment	Waterway CL Align
Seeding Width (ft)	32.0

The information tab requires us to choose an alignment from the menu.

Construction Benchmark

☐ Set Waterway Benchmark

Elevation

Description

Check "Set Waterway Benchmark" to be able to fill out an "Elevation" and "Description".

Hydrology tab

Do **not** use the hydrology.

Check on "Over-ride model output". Enter the "Peak Flow Q (cfs)".

Info	Hydrology	Channel	Profile	Design

Storm Runoff

Runoff Model:	EFH2 Hydrology
Precipitation (in)	
Storm Type	MSE3
Curve Number	80
Watershed Length (ft)	
Watershed Slope (%)	0.1000
Drained Area (ac)	0.00

Model Outputs

Total Runoff (ac-in): 0.00
Runoff Q (in): 2.45
Qu (cfs/ac-in): 0.950
Peak Flow Q (cfs): 0.00

Simulate

Runoff Allocation Options

Peak Flow Q (cfs)	79.00
Initial Q fraction (%)	100.0

☑ Over-ride model output

April 2021

Channel tab

This tab is where the planned waterway cross section will be determined. Follow the steps below to draft a final gradeline for the waterway bottom.

Channel Controls

Channel shape – triangular, trapezoidal, parabolic (EFH Chapter 7 page 4 Figure 7-1)

Left Slope (ft/ft) –

Right Slope (ft/ft) -

Min Bed Width (ft) – Bottom width of the waterway

Bottom Dip – No_Dip, V-dip, parabolic-dip (MN EFH Chapter 7 page 7-4.1 and 7-4.15)

Fills Controls – If extra depth is needed (that is, if the channel bottom plus the required depth exceeds the ground elevation), the channel code will compute the location of the corner of the channel, then design a side fill at a slight side slope to a ground intercept. If no ground intercept is found within a reasonable distance,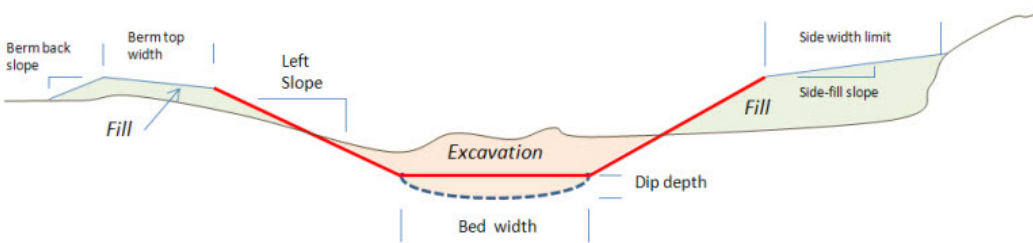 the channel design code will instead design a side-fill berm, ending the side fill at the user-defined berm top width and then sloping back down to ground

Channel Ends – The values used here will tell EFT to bring the channel up to the original ground over the distance used. This is commonly referred to as a blend reach. It is mostly meant to help generate additional yardage, but helps "finish" up the ends graphically to ensure a waterway will fit where you want it, too. It does not find original ground "on grade" from the last station to original ground. It is not included in a stakeout or checkout report/file either.

Channel End Shape
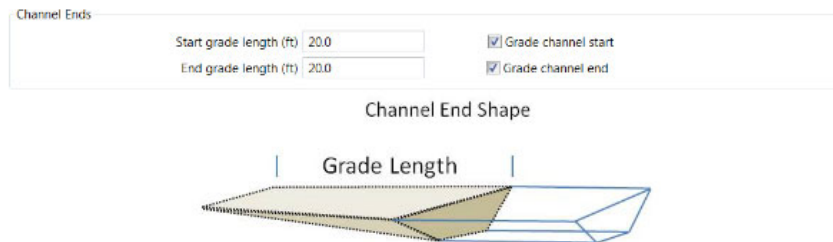
WDT calculates a cut and a fill volume spanning the entire length of the waterway. At the start and end station of the waterway, WDT can calculate cut fill as either the channel blocked off at that point or as graded to natural ground. If **Grade channel start or end** box is checked, WDT extends the channel bottom at the start or end station by the value entered as the **Start grade length** or **End grade length** and sets the bottom of channel elevation at natural ground at that distance.

Figure 7–1   Typical waterway cross sections
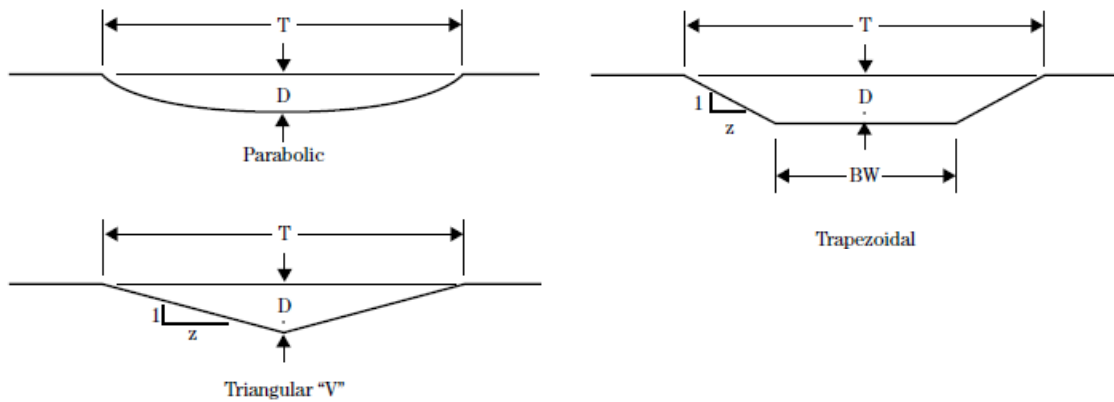
MN EFH Chapter 7 p. 7-4.1 Modified Trapezoidal Sections & p. 7-4.15 Grassed Waterway Shapes for MN
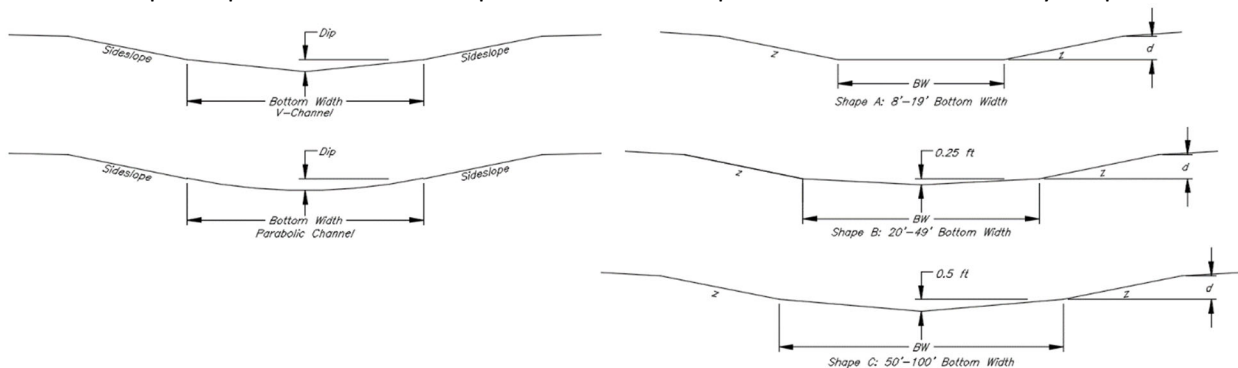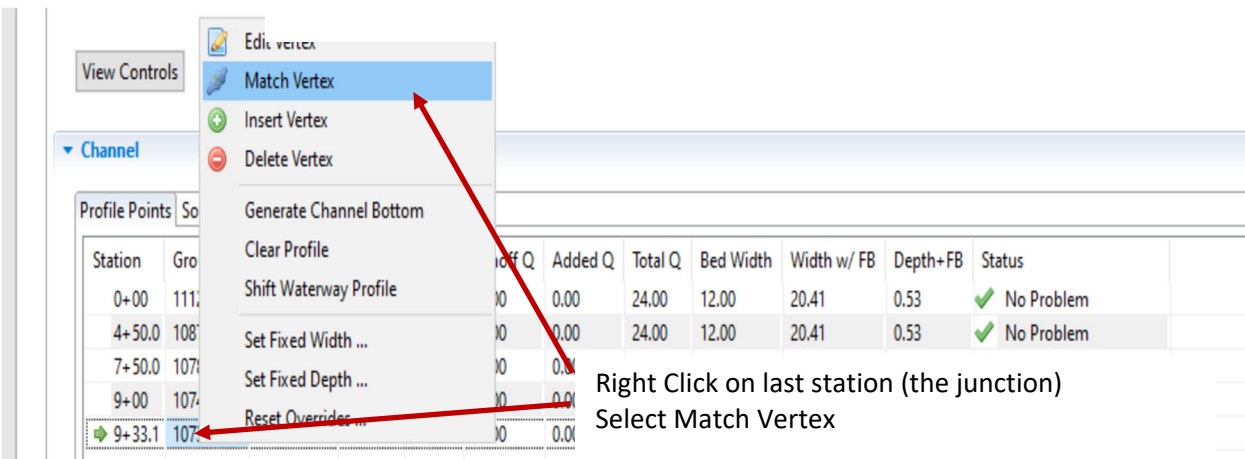
Profile tab

This tab is where the planned waterway bottom grade will be determined. Follow the steps below to draft a final gradeline for the waterway bottom. <u>Tip: When hovering on the profile view the station and elevation can be displayed by turning this option on from the "View Controls" button.</u>


Draw in waterway bottom grade by clicking on the profile view.
Double click to end.

Recommendation: Use even stations and elevations to the tenths (0.1')
Click on the station or elevation you would like to change and enter the value.

If you would like to change any Soil/Vegetal factor for the entire project or reach, click on the Soil/Vegetal tab.

To look at or develop Cross Sections
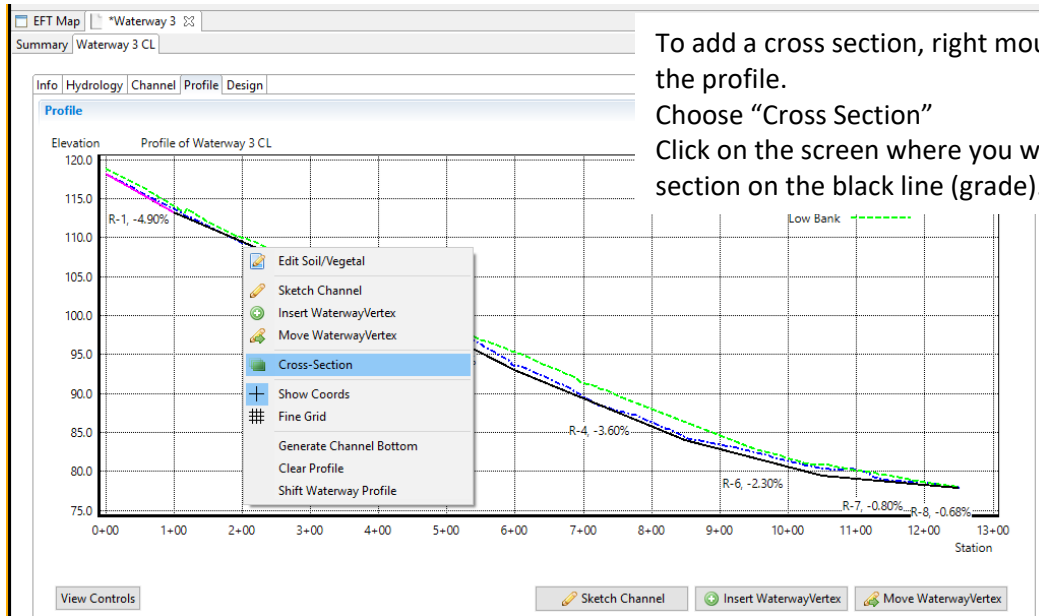
To add a cross section, right mouse click on the profile.
Choose "Cross Section"
Click on the screen where you want a cross section on the black line (grade).

To view an even station, enter the station. Hit enter.
The arrow buttons will change the cross section above or below the current.

If you would like to include the cross section in your report/printout. Check the box next to "Include in Report".

Design tab

Errors will appear under Design Status

 at the bottom of the page.

Adding a Lateral

Add Lateral Alignment (See *Adding Alignment* Section)

The design will open multiple tabs.

Info tab

The information tab requires us to choose an alignment from the menu.

Check "Set Waterway Benchmark" to be able to fill out an "Elevation" and "Description".

Hydrology tab
Do **not** use the hydrology.
Check on "Over-ride model output". Enter the "Peak Flow Q (cfs)".

Channel tab

Profile tab

This tab is where the planned waterway bottom grade will be determined. Follow the steps below to draft a final gradeline for the waterway bottom. <u>Tip: When hovering on the profile view the station and elevation can be displayed by turning this option on from the "View Controls" button.</u>

Draw in waterway bottom grade by clicking on the profile view.
Double click to end.

Recommendation: Use even stations and elevations to the tenths (0.1')
Click on the station or elevation you would like to change and enter the value.

Right Click on last station (the junction)
Select Match Vertex
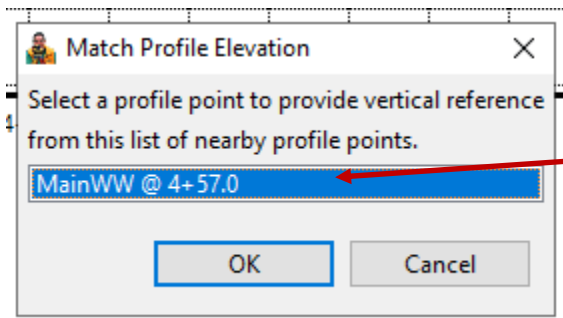
Select Station on Main Waterway (if you do not have a station on the main waterway you will need to add it)
Select Ok

If you would like to change any Soil/Vegetal factor for the entire project or reach, click on the Soil/Vegetal tab.

Design tab

Errors will appear under Design Status

Accept Edit at the bottom of the page.
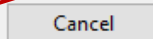
Creating a Plan View
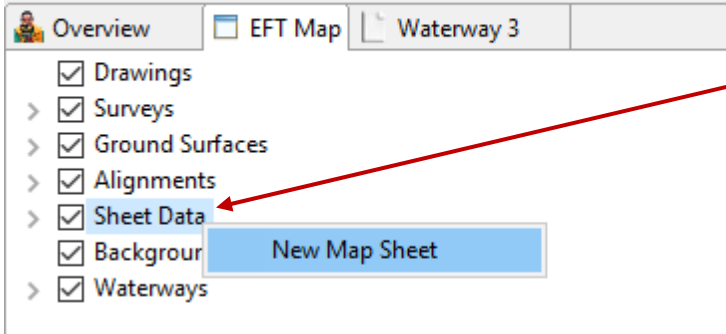
Open the ☐ EFT Map tab.
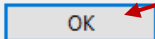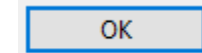
Right click on "Sheet Data"

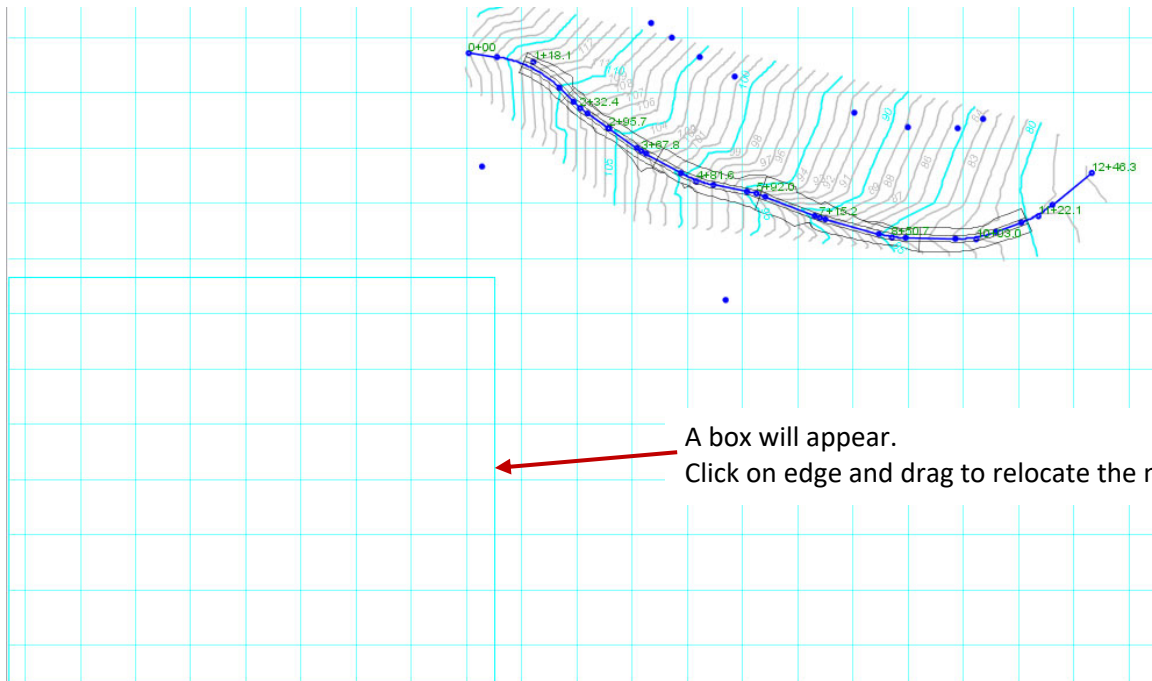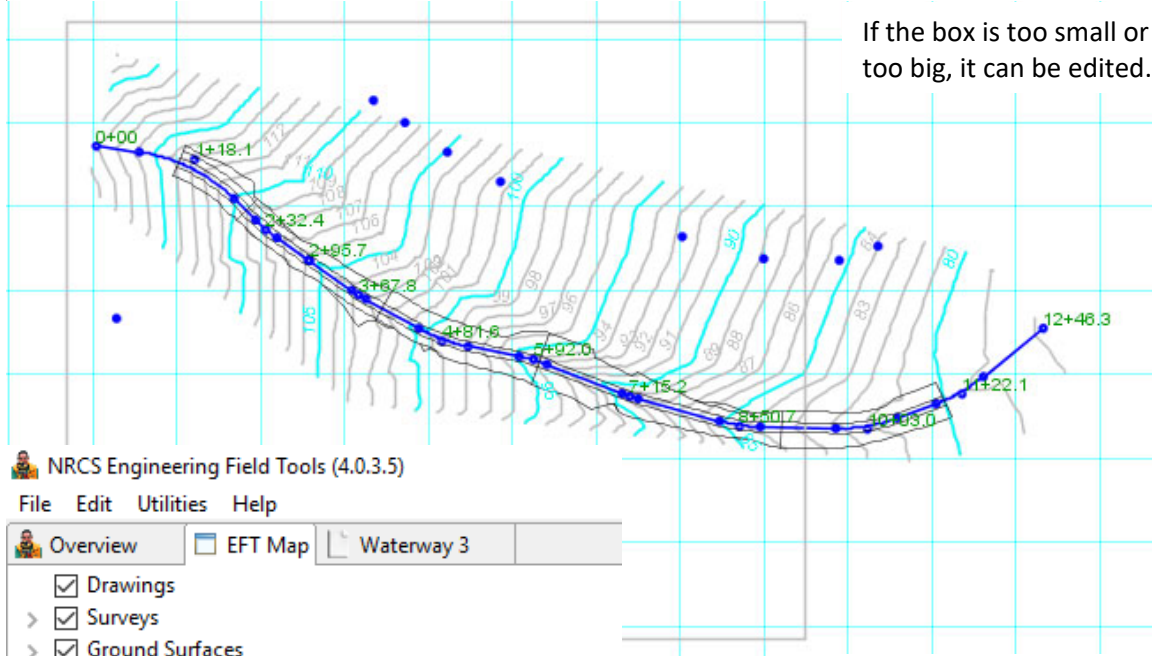New Map Sheet
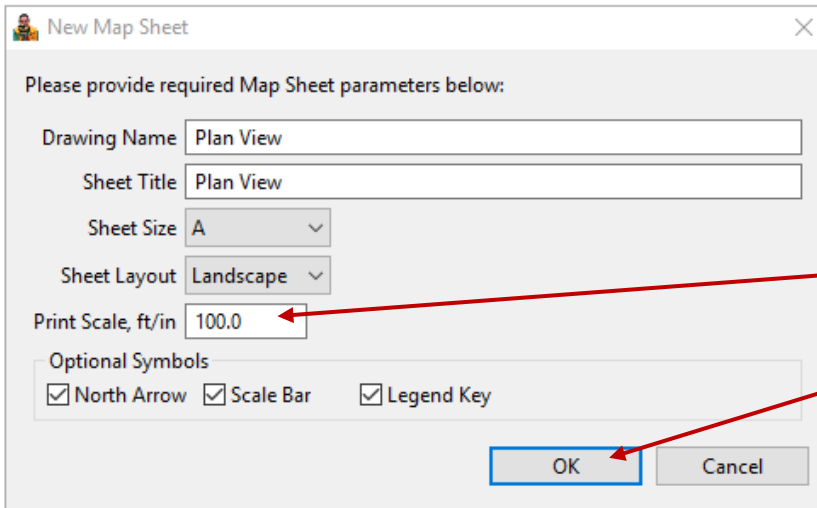
<u>Sheet Size</u>
A – 8.5 x11
B – 11 x 17
D – 22 x 34

Set the Print Scale

A box will appear.
Click on edge and drag to relocate the map.

If the box is too small or
too big, it can be edited.

NRCS Engineering Field Tools (4.0.3.5)

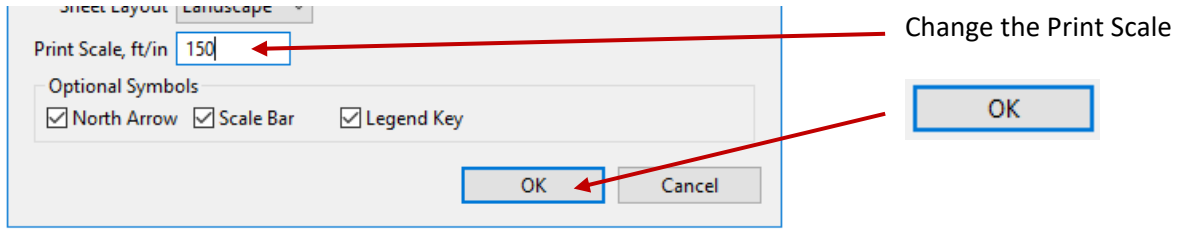File   Edit   Utilities   Help

Overview   EFT Map   Waterway 3

☑ Drawings
> ☑ Surveys
> ☑ Ground Surfaces
> ☑ Alignments
∨ ☑ Sheet Data
    ☑ Plan View
    ☑ Grid   Layer Properties
☑ Background   Preview Sheet
> ☑ Waterways   Edit Params

Editing the Sheet
Right click on the drawing

Edit Params

Change the Print Scale

Sheet Layout Landscape

Print Scale, ft/in 150

Optional Symbols
☑ North Arrow ☑ Scale Bar ☑ Legend Key

OK   Cancel

OK

NRCS Engineering Field Tools (4.0.3.5)

File   Edit   Utilities   Help

Overview   ☐ EFT Map   *Waterway 3

☑ Drawings
> ☑ Surveys
> ☑ Ground Surfaces
> ☑ Alignments
∨ ☑ Sheet Data
  ☑ Grid
  ☑ Plan View
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> ☑ Waterwa

Layer Properties
Preview Sheet
Edit Params
Move Sheet
Delete Sheet
Save Map-Layer Config
Restore Map-Layer Config
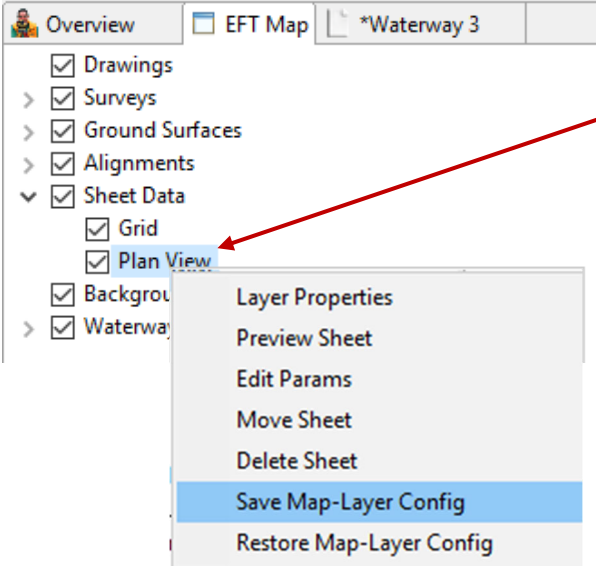
Previewing the Sheet

Right click on the drawing

Save Map-Layer Config

Preview Sheet

Designing Support Tile

Close the current waterway design. From the Overview tab, right click on the same project to reopen it, but choose Open Design As > Terrace Design. You'll have access to your original waterway's alignments and now the UnderGround Outlet design element.
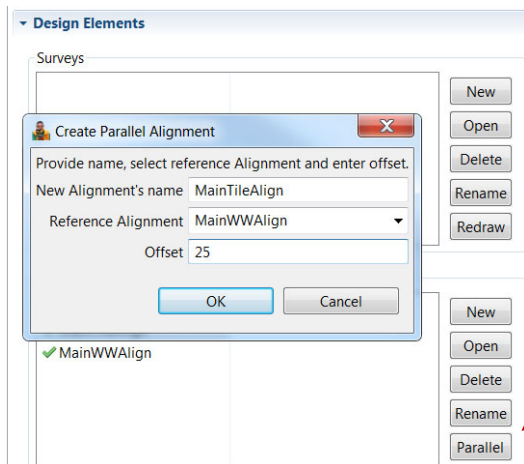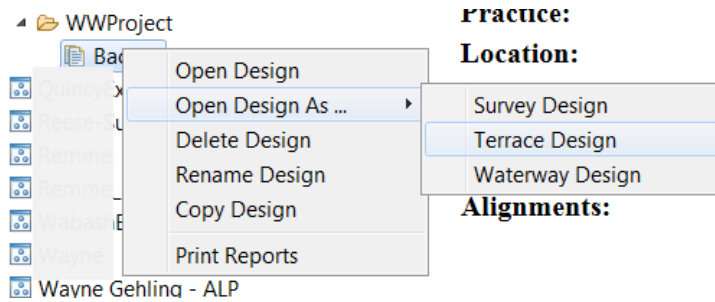
Create your tile alignment, either by the same method as above using New and Sketch Alignment to manually draw it, or offset your existing waterway centerline alignment to parallel the waterway.

To offset your centerline alignment, use the Parallel button in the Alignments design element. Use an appropriate offset distance for the tile location. Negative is left of the alignment, positive values are right of the alignment, when looking at ascending alignment stations.


Start your tile design. In the UnderGround Outlets element choose New and name it. On the Info tab, select the corresponding tile alignment. Choose the Backfill USDA soil type in the area of your tile installation. You may need to use the most restrictive if you have several soil types. Reference PS 606, Table M-3. Set PipeLine Defaults as the minimum tile diameter you would like to use.
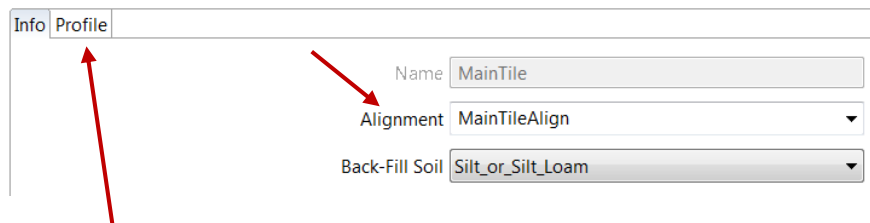
In the Profile tab, draw the tile flowline using Sketch Pipe. *Design Tip: you'll need to maintain tile cover and depth to meet the practice standard. If tile stations and waterway stations are approximately the same, you can use the EFT waterway cut sheet's channel elevations to determine appropriate tile flow line elevations.*

Each "click" along the profile and the tile ends should be identified as certain fixtures.

Right click the red box for the <u>top</u> of your tile and choose Set Fixture and set as a Junction. Type in an ID and adjust the station, elevation, and pipe material and size if needed.
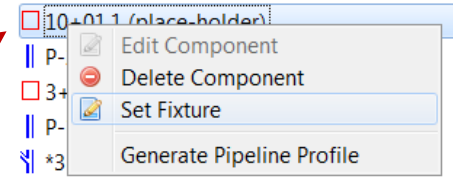
Click the Override Added Q to enter the drainage discharge for the tile. Use drainage calculators or charts (e.g. EFH Fig. 14-33) to determine the Q.
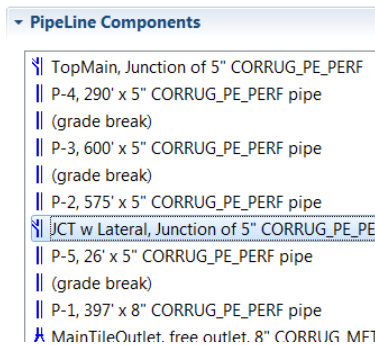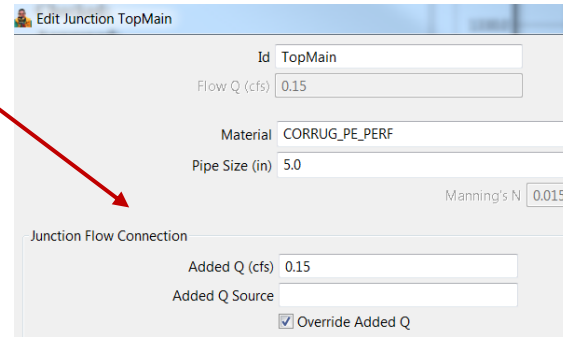
Insert a Junction anywhere you anticipate a lateral tile entering in.

Right click the red box for the bottom <u>end</u> of your tile, choose Set Fixture, and set as a Standard Outlet if your tile ends here. Edit the appropriate details (e.g. corrugated annular pipe, animal guard).

However, if this outlet connects into another tile within EFT, Set Fixture as a Junction (see diagram, next page). Choose the corresponding end/junction of the other tile in the Pipeline and Junction table (if designed, it will appear in the table) to "connect" them. Edit the station to get the two junctions relatively close. Edit the pipe elevation or, if the other tile has been designed, click OK, re-right click on this Junction and choose Match Vertex to match elevations of the two junctions.
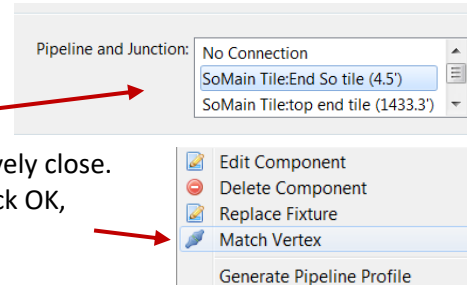
All other red boxes can bet set as Grade Breaks. Once set as a grade break, you can right click again to open the Edit Component window and adjust stations and elevations (normally, round-off values)
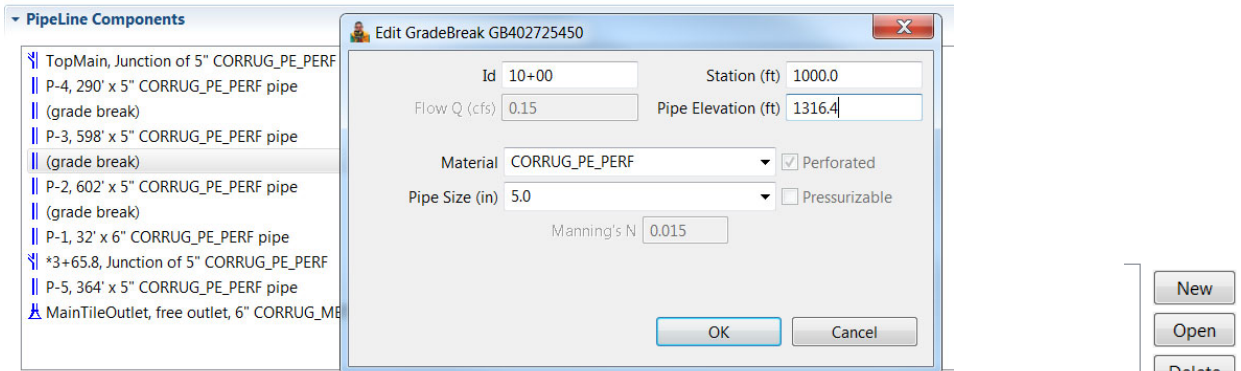
Once all pipeline components are labeled and edited, click Accept Edit at the bottom. To test the tile, from the UnderGround Outlet design element, choose Simulate.

Choose Design Network. Any subsequent errors can be addressed by clicking Edit Pipeline to make changes to the design. The program will show warnings or increase diameters where flow exceeds the default's capacity.

A successful design will show green checks and No Problem in the status column.

Click Accept Edits. Even with a successful design, the UnderGround Outlets element will show a warning that there has been a user entered Q.

Tile Design Concepts

Plan view of EFT profile junctions and ends

Jct.- Designer enters Q

Jct.- Designer enters Q

Lateral Tile

Main Tile

Jct.

Jct.

These two junctions will be "connected" and need identical elevations. They should be drawn or stationed such that they are relatively close to each other.

Standard Outlet – where tile daylights to surface