650.0703 Design process

INTRODUCTION Use of Minnesota Waterway Design Charts

The development of the charts for Minnesota for small waterways bears some similarity to the development of the "quickie" charts in Iowa, developed in spring 2011.

Runoff in Minnesota for the 10-year event was assumed to range from 1.4 inches to 2.5 inches using rainfall values of 3.5 to 4.4 inches with an RCN of 76 for B soils and RCN of 82 for C soils. By using runoff, a chart dividing the state into regions is not needed.

Side slopes used are 6:1, 8:1, and 10:1.

The tables were prepared for all four soil erosion categories – easily erodible, erodible, erosion resistant and very erosion resistant. MN soils were grouped into soil erosion categories using the unified soil classification (USC) and plasticity index (PI) (see separate explanation). Instructions were developed for obtaining USC and PI from soil data viewer in Toolkit. Thus no charts of soils are needed and up-to-date soils information is used.

Following Iowa's method, designs for grassed waterways with drainage areas from 0 to 10 acres were based on B-C retardance values for capacity and stability design respectively. Designs for waterways with drainage areas from 11 to 30 acres were based on B-D retardance values for capacity and stability design respectively.

The minimum waterway depth used was 12 inches or 1 foot. The charts were developed using a Shape A bottom (flat). Thus for wide bottom widths, it would be best to run WDT again using a v-bottom appropriate for the width.

Minimum top widths varied depending on the side slope (z) ratio. For a z value of 6, the minimum top width is 30 feet. For a z value of 8, the minimum top width is 32 feet. For a z value of 10, the minimum top width is 34 feet.

The vegetative factor used was 0.87. This is valid for brome grass and brome grass mixtures.

The actual acreage used in the design is the maximum in each grouping. For 0-7 acres, 7 acres was used to develop the chart values. This smallest category was used to coincide with the CAP waterways described in MN standard 412. For 8-10 acres, 10 acres was used to develop the chart values. For 11-20 acres, 20 acres was used to develop the chart values. For 21-30 acres, 30 acres was used to develop the chart values.

EFH2 was used to determine the peak discharge for each scenario. Since these are basically all under 30 acres, the Folmar & Miller adjustment to Tc was not used.

A shape was used where the watershed length is about 1.5 times the watershed width. The length was used in EFH2 to calculate Tc. Assumptions used:

Range	DA used	Area	Watershed width	Watershed length
0-7 acres	7	304,920 sq ft	451	677
8-10 acres	10	435,600 sq ft	539	808
11-20 acres	20	871,200 sq ft	762	1143
21-30 acres	30	1,306,800 sq ft	933	1400

Many runs of the Engineering Field Tools (EFT) Waterway Design Tool (WDT) software were completed to develop the charts. The software does not allow for a fixed bottom width so the tables are given with depth and top width for each soil erodibility class. The user will need to back calculate to a bottom width if that is desired for design and construction, or WDT can be run looking at options.

Steps to Use the Design Charts

1. Select the site up to 30 acres in drainage area.
2. Determine the dominant soil(s) the waterway will be constructed in. Note the depth of the surface layer to know whether the waterway is likely to be constructed deeper than the surface layer or not.
3. Use the Soil Lookup Instructions to determine which of the four soil classes is to be used for the site.

Decision Tree

If the soil textural class is	**And the reference PI is**	**the erodibility class is**
CL	Any value	Erosion resistant (ER)
CH	Any value	Very erosion resistant (VER)
CL-ML	PI < = 16	Erodible (E)
CL-ML	PI > 16	Erosion resistant (ER)
ML	PI < 5	Easily erodible (EE)
ML	5 <= PI < 19	Erodible (E)
ML	PI >= 19	Erosion resistant (ER)
MH (elastic silts)	PI <= 15	Erodible (E)
MH (elastic silts)	PI > 15	Erosion resistant (ER)
SC, SC-SM, SM	PI < 5	Easily Erodible (EE)
SC, SC-SM, SM	PI > =5	Erodible (E)
SP, SP-SM, PT, organics	Any value (typically PI < 5)	Easily erodible (EE)

4. Determine the drainage area for the project. Measure or estimate the slope of the waterway course.
5. Determine the 10 year, 24 hour rainfall amount and calculate the runoff curve number (RCN) and peak discharge (Q) using EFH2 software. Note the runoff amount calculated in EFH2.
6. Choose a side slope ratio, 6:1, 8:1, or 10:1.
7. Use the charts to determine the required size of the waterway, or execute EFT-WDT to look at options. The charts are the more conservative option.