Manual for DITCH (Copyright (c) Hunter Software, LLC)

This program is produced and manufactured by:

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GENERAL INFORMATION

The program is designed with relatively small windows, and to remain "on top" of other applications. This format will facilitate the identification of ditches, drainage areas, etc., in an underlying CAD display. The window may be minimized.

The modules in the program share information, so that any data on-screen in one module will be visible in the others.

MAIN MENU:

Notice that options for three types of operations - computing flow data, filing, and printing - are gathered in graphic frames on the screen. Pressing "OK" within the frame will begin the selected operation, and "Cancel" will unselect an operation. The "Exit Ditch" button at the bottom of the window closes the program.

File Operations:

The "Save" option saves the current list to a user-specified file. Any file extension, or none, may be used. Standard software will retrieve the data, but only this program will format the data.

The "Open" option opens a file. The opened list is displayed on-screen. If a file is opened when a list is present in the running program, the data in the current list will be lost.

File size is limited to ninety-eight ditches.

Printing:

Selecting the "Print" option will generate a request for optional user input that will be printed as a page header. The header is limited to 85 characters. The current list will be printed.

Compute Ditch Data:

This program computes solutions for uniform and critical flow of water in open channels by solution of Manning's formula Q = 1.486/nAr^2/3s^1/2, in which Q is the rate of flow in CFS; 1.486, the conversion factor from SI units; n, Manning's roughness coefficient; A, the cross sectional area of flow; r, the area divided by the wetted perimeter, and s, the channel slope, in ft./ft. Critical depth is determined to be the depth of flow for which the expression (Q^2T)/(gA^3) is equal to one. In this expression, Q is the flow in CFS; T, the top width of flow; g, the acceleration of gravity (32.17 ft./ft.), and A, the cross sectional area of flow. Shear stress is found by multiplying the weight of water per cubic foot (62.41 lb.) by the normal depth and the channel slope in ft./ft.

With the exception of the Optimum Section and Velocity-Controlled Section the program will solve for a missing variable, except for side slopes.

In cases in which a direct solution for the missing variable is not possible, the bisection method is used, with the upper limit set at 200. For the parabolic section, the upper limit for depth is taken as 200 times the known width, and, for width, 200 times the known depth. For all ditch types, the displayed depth is normal depth.

COMMON OPERATIONS IN COMPUTING DITCH DATA:

The "Compute" button will execute calculations and display the results, along with the critical depth and shear stress.

The "Clear Input" button will clear the input and computed values.

The "Add Ditch to List" button will open a window that will request a ditch ID and lining type. The ditch ID can be any alphanumeric type. Enter the information; press "OK", and the ditch will be entered into a list that will be displayed on-screen, and may be saved and printed from the Main Menu. The program sorts the list in ascending order, using the ditch ID as an index.

The "Remove Pipe from List" button works as the "Add" button does. Enter the ditch ID and press "OK" to remove a ditch from the list.

The "Add Temporary Lining" button calls up a request for the Ditch ID and temporary lining information -- for instance, a manufacturer's product number. A temporary lining can only be added to a ditch that has been assigned a Ditch ID by adding it to the displayed list. Once entered, the temporary lining will be added to the displayed list. The temporary lining can be changed by repeating the Add Temporary Lining process.

The "Exit to Main Menu" button returns the user to the main menu.

TRAPEZOIDAL CHANNELS:
VEE, TRAPEZOIDAL, RECTANGULAR, MOST EFFECIENT SECTION, AND

VELOCITY-CONTROLLED SECTION

Vee and rectangular sections are considered special case of the trapezoidal section, with the bottom dimension set to 0 for the vee, and side slopes set to 0:1 for the rectangular.

For these sections, the area A = D(Bot + ((AD + BD)/2)); the wetted perimeter = (Bot + (AD^2 + D^2)^.5) + (BD^2 + D^2)^.5), and the top width equals ((A * D) + Bot + (B * D)) In these expressions, D is the depth of flow; Bot, the bottom width, and A and B are values for the side slopes, as A:1, and B:1.

The Most Efficient Section is the section that minimizes the requirements for excavation and ditch lining. The computed section will move the given discharge at the maximum velocity for the given conditions. Depth of flow is determined by this equation: y = ((Qn (k + 2((1+M^2)^.5)^(2/3))) / (1.486 s^.5 (k+M)^(5/3)))^(3/8), in which y is the depth of flow; Q, the discharge; n, Manning's roughness coefficient; k, a constant described below; and M, the horizontal component of the side slopes, as in M:1. The constant k is equal to 2((1+M^2)^.5 - M). The bottom dimension is equal to ky. Determination of the Most Efficient Section requires that all the requested information (equal side slopes, discharge, channel slope and roughness coeffecient) be entered.

The Velocity Controlled Section is a procedure to calculate a cross section that will provide a given velocity for a given discharge. First, the necessary area of flow Ax for the given discharge Q is determined by dividing the discharge by the required velocity Vmax. Then two working constants, W' and W" are calculated: W' = M- 2(1+M^2)^.5, and W" = Ax/ [Vmax n / 1.486 s^.5]. In these calculations, M is the horizontal component of the side slopes, as M:1, and s is the ditch slope in ft./ft. Utilizing the constants, the normal depth y is then equal to (-W" + (W"^2+4W'Ax)^.5)/2W', and the bottom width is equal to (Ax/y)-My. Determination of the Most Efficient Section requires that all the requested information (permissible velocity, equal side slopes, discharge, channel slope and roughness coefficient) be entered.

PARABOLIC CHANNELS

A parabola is the set of all points that are equally distant from a fixed point and a fixed line. A parabolic section is described by the formula y = x^2 / 4a. In this formula, y is the depth, and x, the top width; a is a constant equal to the distance referenced above (to a fixed point and a fixed line). To determine a section for a given discharge either the depth or width must be known. The program then determines the missing element that satisfies both the requirements of a parabolic section and the requirements of Manning's equation for the given discharge. The area of flow = (2/3)yx. The wetted perimeter = (x/2) ((1+(4y/x)^2))^.5 + (x/4y) ln(4y/x + (1+(4y/x)^2))^.5)).

In addition to the flow characteristics of the channel, the program calculates the slope of the tangent at the top of the ditch as a ratio of horizontal to vertical. Designating x' as 1/2 the top width and y' as the depth, the formula for finding the value of y for x shifted 1 unit in the positive direction is: y = ((2y' (x-x')) / x') + y'. The inverse of this value gives the value for horizontal : 1 vertical. This information is important in determining whether or not a parabolic section can actually be built.

Upon calculation of a section an option will display which offers an opportunity to calculate lesser flows in the same section; the "OK" button in the box will compute data for the new flows, and the "Clear" button will clear the input flow and computed data. This option is important if lower flows need to be documented; for instance, a ditch may be required to handle discharges from both ten and two year storms, or freeboard may be required. Data for lower flows will be shown in blue to emphasize that the displayed data is for a subset of the major parabolic section. The buttons "Add Ditch to List" and "Add Temporary Lining" will act normally for these flows.

The "Compute Staking Data" button calls up a screen, which displays data for the major parabolic section, and requests input for a Ditch Length, a Station Interval, an Invert Elevation at Station 0+00, and an Offset Increment. The program produces a list of cross sectional elevations, right and left of the centerline, at stations determined by the input station interval. The cross sectional elevations are at the (accumulating) input offset intervals and continue to the ditch limit. The list proceeds downstream, with the centerline elevation at each station set by the Beginning Elevation less the (cumulative) Interval multiplied by the ditch slope. The offset elevations are calculated by the equation ((offset^2/K) + centerline elevation), in which offset is the input value; K, a constant ((Ditch Width/2)^2/Ditch Depth). Click on the "Compute" button to display the Staking Data. Click on the "Print Staking Data" button to print it. The information is useful for drafting and construction purposes.

CIRCULAR CHANNELS:

The program will only compute depths to half the channel diameter. If a greater depth is found, a message will appear asking the user to decrease the flow or increase the channel diameter. The area of flow is equal to the expression (D-R)(2RD-D^2)^.5 + ^ 2(PI / 2 +(-Atan(X/((-X X+1) ^ 0.5)))), in which D is the diameter; R, the radius; and X, the absolute value of (D-R)/R. The wetted perimeter is equal to the expression 2 R *(PI/2+(Atan(X/(-X X + 1)^.5))), in which X = (D-R)/R. The top width is equal to the expression 2(R^2-(D-R)^2)^.5