# Assessing Costs and Benefits on County Drainage Projects

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Assessing costs and benefits on drainage projects can often lead to controversial viewpoints. However, such points of controversy should not necessarily be blamed on the new drainage law. It doesn't matter what we think about this law, we've got it, and we're going to have to learn to live with it.

Before discussing any particular method of making assessments, one point is emphasized. *There is not one formula or any one method of making assessments that will apply in every county in the State of Indiana.* The differences in the rolling, inexpensive ground in the southern part of the state and the flat, hard-to-drain, expensive ground in the northern part of the state are bound to make differences in any method of assessing. It is going to have to be done more on an individual county basis.

What is a sound approach to assessing? Consider some of the methods that have been used in the past. One of these might be called the "Pete Smith Method." The assessor may think as follows:

> "Yeh, let's see—there's that Pete Smith. Now let's see—he's my wife's brother and he hasn't paid me back that $300 he borrowed two years ago. Oh well, I never did think much of my wife's relatives anyway. And boy, he's got a lot of benefits on that ditch—about $700 worth! Now, let's see—the next one down the line is that widow Brown. Say, she's a cute little blonde. Boy, she was kind of of friendly at that last church supper, too. She hasn't got much benefit—about $50. The next one down the line—now that's John Jones, that son-of-a-gun! Boy, he was out campaigning against our party and everything he said was a big lie! Boy, he's got a lot of benefits—about $800!"

Perhaps that's just a little bit overdrawn. The next method might be called the "Hat Method." All the names are put into one hat and all the figures into another hat and then the two sets are matched.

Here are three soul searching questions pertaining to assessments:

(1) Are the property owners in your county really satisfied with the assessments that they've been getting?

(2) Are you satisfied in your own mind that you have been giving these people honest and fair assessments?

(3) Are you willing to spend the time, the effort and the money to set up a good assessment method that in the long run, will not only be fair, but will save you time, effort and money?

If the answer is no to the first two questions, then try to develop a better assessment method.

To have a successful formula or method for making assesments, first consider a number of factors or physical properties—they may be called parameters. What they are called doesn't matter, but measurements must be made that can be directly related to the benefits for the particular property. In addition, it must be something that can be measured economically.

After investigating, it was found, surprisingly, that there are almost a dozen of these factors that can be used and put into a formula; they are obtained economically and they are directly related to the assessments or benefits of a property.

## WATERSHED DETERMINATION

In making assessments, *area* is probably the most important factor. When examining the methods of determining watershed, it was found that there are four principal classes of determinations, Classes 1, 2, 3 and 4. This is important, so a brief discussion on how these measurements are actually made is given below.

The fourth class is office research only. The compiled data can only be as accurate as the accuracy of records, most of which are old. The normal sources of information are the: U.S. Geological, 7½ minute quadrangle maps; old records of the watershed; old records of contiguous watersheds; soil conservation service records of tiles that have been installed; or any other records on tiles that might be pertinent.

The third class is normally a little higher in accuracy. This entails walking over all of the ground involved, or at least walking over a part of the ground involved, and examining the rest of it from an automobile on the road. Area determination of this type is all done by pure judgment; the accuracy in this case would depend entirely upon the observer and how well he could estimate areas.

The second class determination of watershed area is really a low-order survey. To do this four things are required: a range finder, a slope indicator, a planimeter, and aerial photographs. In this particular instance, the observer actually walks the exact line (or drainage divide) of the watershed, determines his location with a range finder from

identifiable points on the aerial photograph, and actually draws the watershed line on the aerial photograph in the field while walking the drainage divide. The slope indicator is used to determine the location of slope breaks. Back in the office the area is determined with the planimeter. This method is extremely high in accuracy and it is not too expensive. The materials that are required for this method, run between $350 and $450. Normally, this is a very reasonable expense for this type of an operation.

The first class method would be a high-order survey using a transit and level and actually constructing a good topographic map. Now this is something that in most cases is not practical. In some cases, where the property values are extremely high, it might be used, but in many cases some of this information is available from previous work that has been done. Every effort should be made to incorporate existing work into new surveys.

## DISTANCE TO MOUTH OF DITCH

The next factor to consider is the distance to the mouth of the ditch. In the particular case, shown in Figure 1, Tract A and Tract B are used as comparisons. The upper end of Tract A is approximately one mile from the mouth of the clean-out; the upper end of Tract B is approximately three miles from the mouth of the clean-out. In a situation such

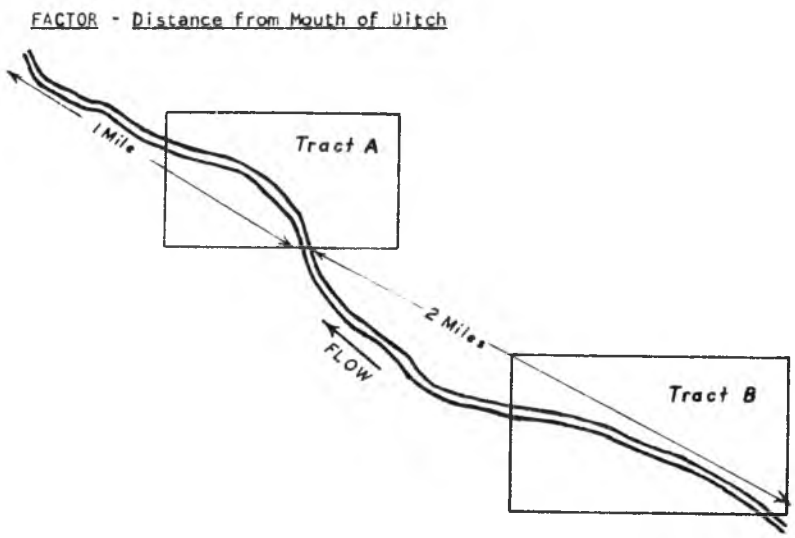


**Fig. 1. Tract A is benefited by 1 mile of clean-out, while Tract B is benefited by 3 miles of clean-out. Therefore, this factor will tend to raise the assessment rate for Tract B.**

as this, obviously Tract A is going to benefit from one mile of the clean-out. However, Tract B is going to benefit not only from that one mile, but from an additional two miles. Therefore, in this particular situation raise the assessment on this part of it, for Tract B, because he is getting more benefit than Tract A.

## AVERAGE AMOUNT OF DIRT REMOVED

Figure 2 shows two cross sections. They are supposedly representative of the average cross section at two different locations in a ditch to be cleaned out. As illustrated in Case 1, the amount of dirt removed below Tract A is low, but Tract B (Case 2) the average cut of the cross section is considerably greater. This certainly is a very direct method of measuring benefit because the more the channel is enlarged—the more the benefits; so therefore, in Case 2 (Tract B) the assessment would be higher than it would be in Case 1 (Tract A).

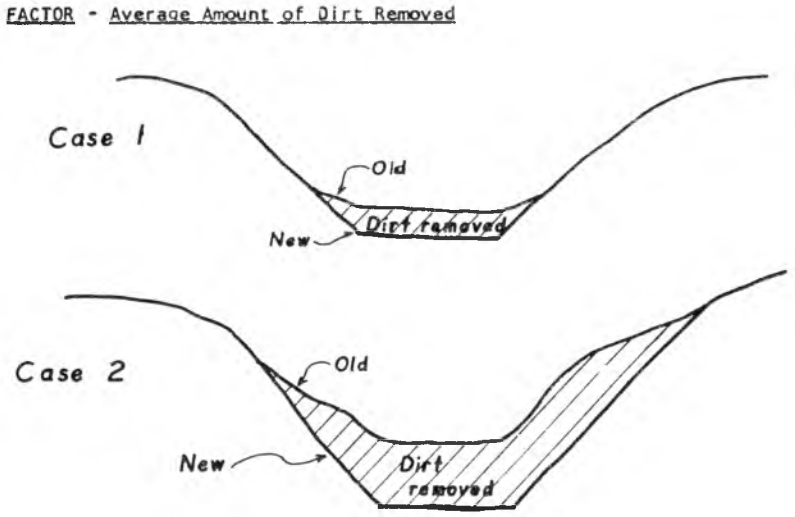


**Fig. 2. The average amount of dirt removed below the location of the Case 2 property owner is greater than for Case 1. Therefore, this factor will tend to raise the assessment rate for Case 2.**

## AVERAGE GRADE OF DITCH

The grade of the ditch in relation to benefits is a little bit more complicated. In Figure 3, there are again two cases—Case 1, a flat grade and Case 2, a steep grade. Ignoring the black triangle, which is representative of an obstruction, observe that the surface water line is parallel to the bottom of the ditch in both instances. However, when an

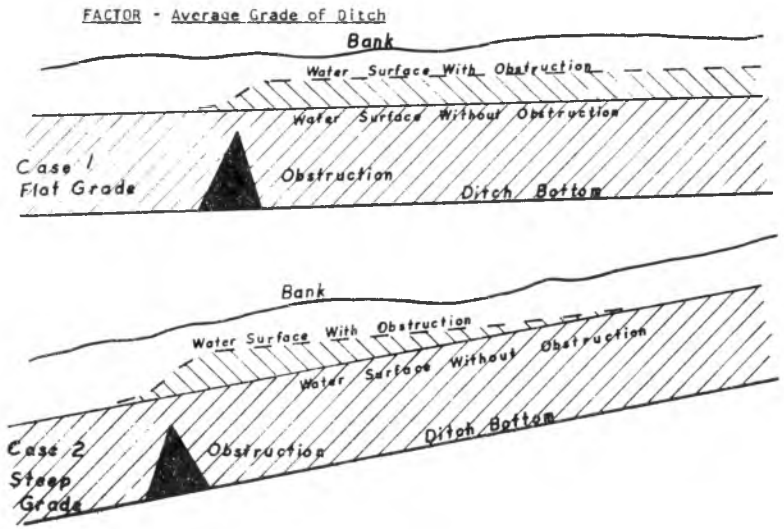


**Fig. 3. The effect of an obstruction does not extend nearly as far upstream on a steep grade ditch as it does on a flat grade ditch. Since clean-out is basically removal of a number of small obstructions, therefore, this factor will tend to raise the assessment rate for Case 1.**

obstruction is put into a flat ditch, and one into a steep ditch, the water surface line will jump up. In the case of a flat ditch, the surface will go back almost parallel to the previous water surface line; however, in the case of the steep ditch, the jump of the water line at the obstruction is going to be about the same but it is going to taper off much quicker. This is a demonstration of the effect of an obstruction on various slopes. Actually, the clean-out is removing a number of small obstructions, so therefore we can say that when we remove these small obstructions, or clean out on a steep-grade ditch, the effect is not going to carry nearly as high as it does on a flat-grade ditch. Therefore in Figure 3, Case 1 will have the higher assessment because this benefit will be carried further upstream.

## SLOPE TOWARD DITCH

The next factor to examine is the slope of the ground to the ditch. Illustrated in Figure 4, are two cases showing a cross-section of an entire watershed with the open ditch being located in the center. Case 1, shows a flat watershed and has numerous pockets; Case 2 is a steep watershed and has no pockets. Obviously, in Case 1 there will be less water running into the ditch and it not only will be less, but it will also run in much slower. Now in channel hydraulics, when sizing the open ditch,

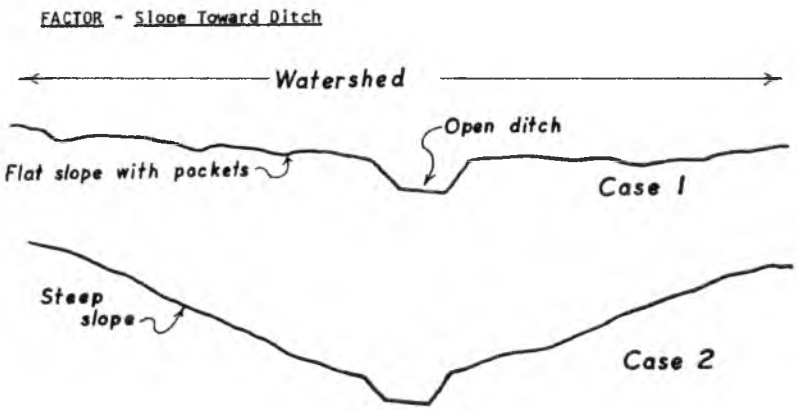


**Fig. 4. Case 1 shows a situation where both total run-off and rate of run-off are lower than in Case 2. The size of ditch required is determined by rate of run-off. Therefore, this factor will tend to increase the assessment rate for Case 2 compared to Case 1.**

it is necessary to take into account not only the quantity of water, but the rate of accumulation. In Case 2, there will be a much higher rate of accumulation, there will be a greater quantity; therefore, there must be a bigger ditch in Case 2. The assessment would have to be higher on this particular type of ground, than it would be on the flat, pocketed ground because much more water is entering the ditch and a larger ditch is required.

## LATERAL DISTANCE FROM DITCH

In Figure 5 are two ditches, before a clean-out and after clean-out. The dotted lines, in the after clean-out situation, indicate the cross-section before the clean-out was made. This diagram also shows a tile line and two ponds, A and B. Before the clean-out, Pond A was five feet above the surface of the water, Pond B was ten feet above the surface of the water. A is 2000 feet away, B is 4000 feet away. Converting these into grades, observe that A has a grade of 0.25 percent going into the ditch and B also has 0.25 percent going into the ditch. Lowering the surface of the water in the ditch brings it down to the top of the tile where it should be. Observe that Pond A is now ten feet above the surface of the water and Pond B is 15 feet above the water surface. Converting these into grades, it is found that there is a grade of 0.50 percent from Pond A and a grade of 0.33 percent from Pond B. This is a good demonstration to show that as the distance from the ditch increases the effect of clean-out decreases. So, ground that is in the vicinity

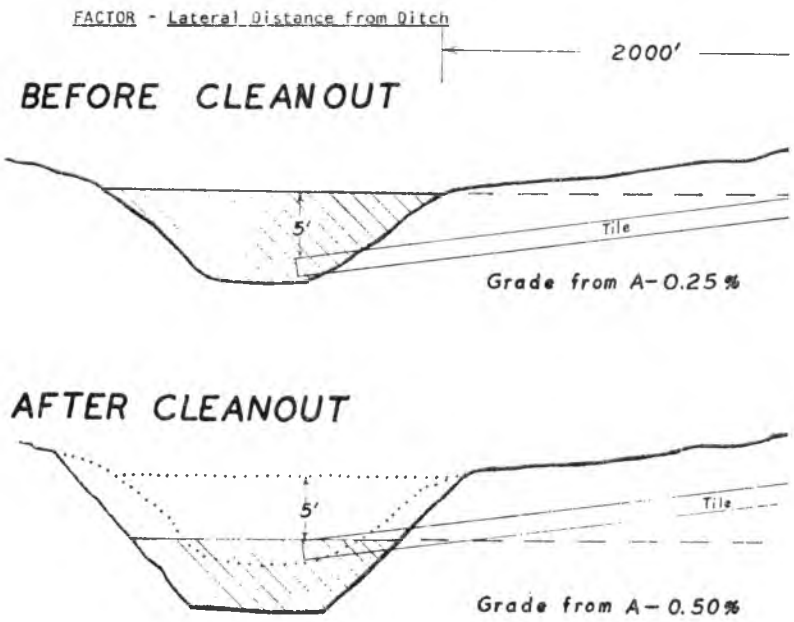


**Fig. 5. The effective grade of the tile is increased more from Pond A to the ditch than from Pond B to the ditch. Therefore, this factor will tend to increase the assessment rate for Pond A (or land located in the position of Pond A) over Pond B.**

of Pond B is not going to have as high an assessment rate as the ground up next to the ditch; this can be easily proven mathematically.

There is another good example of something that doesn't bear directly on assessment, but is a problem that will be encountered. When Pete Smith says, "Now look, I've got some tile running into that ditch—yes! But I'm way up here on a bank and while all of my water is running in, when you clean this ditch out, it isn't going to benefit me any. My water isn't going to get away any faster." In this case it will be necessary to show Pete Smith these drawings and to prove to him that the effective grade has been changed. Though the *actual* grade of the tile has not been changed the *effective* grade of the tile has been changed. When the effective grade of the tile is changed, the amount of flow is increased and this actually increases the effective size of the tile.

So Pete Smith does get a benefit from that clean-out because his tiles are going to be carrying more water than they carried before. Again, it can be proven mathematically that he is benefited. Many times it will be necessary to convince people that they really are being benefited. Some people will say, "I'm not benefited, I don't want to pay; I don't have

any tile going in there." The same reasoning applies, because if an individual puts tile in, the effective size of the tile would be greater after the clean-out than it was before. Do not lose sight of the true purpose of a clean-out. A clean-out is not supposed to satisfy all the drainage problems of every property owner in a watershed. A clean-out is to provide an outlet and each indivdual property owner must get his drainage into that outlet. It's the same with county roads. The county provides an outlet and each individual property owner must get his driveway into it. In drainage, the drainage board provides the outlet and the property owner provides a drainage way into the outlet—thus the owner is receiving a benefit.

## OTHER FACTORS—DAMAGES

In addition to all the physical factors actually measured on the property, there are other factors to be considered. Primarily, these concern the usage of ground. In the formula described there are about three different factors that enter into the usage, but it all boils down to a question of, how much the usage of the ground increases the demand for drainage. A wooded area is not going to demand as much drainage as a tilled area; a tilled area does not demand as much drainage as a residential area; and a residential area does not demand as much drainage as an industrial area. These things are certainly going to have to be considered in the formula.

In addition to benefits measured, some damages will have to be measured because clean-outs frequently produce damages. Perhaps some ground has been taken and its farming potential destroyed. Fences may have been taken. Distribution of spoil material can be a problem. Ditches sever the land and cause access problems to man and cattle. One owner may have some or all of these damages while another owner, who is back away from the cleaned out ditch, has lesser damages or none at all. All these factors must be carefully considered.

## CALCULATING ASSESSMENTS

In addition to determining all of the factors that influence the benefits and assessments, there is also the practical problem of applying these factors and calculating the assessments. This of course, is a rather detailed procedure. The methods used in Boone County, for calculating the assessments, are demonstrated by an example shown in the Appendum to this paper. The example shows the form used for making the calculations along with a portion of an actual assessment made about a year ago. All the figures in the example were actually used in making this

particular assessment. The appended material also includes three pages of written instructions on how the assessing form is used, line by line. Income tax forms are hard to figure and perhaps the appended forms may be found to be as hard. This example is included for information and shows how it is done in Boone County. Though the formula used in Boone County is not going to apply directly to all counties, it may supply some helpful ideas.

## CLOSURE

In conclusion, three points are very strongly emphasized. First, if a county does not have a workable method of calculating assessments, then set up some type of mathematical formula to calculate these in a manner that will be equitable to property owners and that will be approved by the courts. This means that in setting up an assessing procedure, have the attorneys and judge in on the committee and be aware of their ideas. Developing a procedural method that will not get the approval of the courts and judge is a waste of time.

Secondly, when developing the assessing procedure, don't be reluctant to go beyond your county officials to ask for help. Just because your own county officials don't have the ability or don't feel that they have the ability—don't hesitate. Get somebody else to work with. Perhaps a real estate broker who does a lot of assessing, perhaps an appraiser who does nothing but appraise property, maybe a mathematical wizard, a math teacher in a high school or a professor who is interested in this type of thing, or a professional engineer, who isn't connected with your county government may help. Don't hesitate to go outside for help to get the assessing procedure set up properly at the start.

The last and most important point of all—when the formula is developed stay with it. When making an assessment, stay with the formula. When Pete Smith comes in, don't change his assessment because just as soon as Pete gets a 15-cent reduction, the formula is up for change to everybody else in the county. If Pete actually did not get a fair assessment, change the formula, but don't arbitrarily change Pete's assessment. In the long run gain respect by developing a formula and saying: "This is the rule, this is what we're going to abide by, and there will be no arbitrary changes in assessments."

# APPENDUM A

## METHOD OF CALCULATING ASSESSMENTS

The following paragraphs outline the procedure used by the Boone County Surveyor's Office for calculating assessments on drainage improvements.

The benefits to each tract are directly proportional to the amount of water run-off reaching the ditch from each tract; and the distance that the ditch much transport the run-off.

The following explains the computations used to calculate the run-off, and the distance that the ditch transports the run-off. The method of computation used here is a special derivation, as set up by the Boone County Surveyor, using the "Rational Run-off Formula."

The following is a brief summary of the factors taken into consideration:

1. The closer the property is to the mouth of a ditch, the lower the assessment.
2. The less dirt removed below the landowner's location, the lower the assessment.
3. The greater the slope of the ditch bottom below the landowner's location, the lower the assessment.
4. The less ground slope in the landowner's portion, the lower the assessment.
5. The farther away from the ditch the landowner's property is located, the lower the assessment.
6. If the landowner's portion is agriculturally used, compared to urban, the lower the assessment.
7. The more wooded area on the landowner's property, the lower the assessment.
8. The less drainage demanded by the use of the land, the lower the assessment.
9. Damages are allowed each landowner on the ditch bank in proportion to the feet of ditch on property, and amount of fence to be cut, or to be removed and replaced; and are also allowed according to the amount of ground taken permanently by the improvement.

All properties are assessed individually, by comparing each property with all other properties in the project.

*Instructions for Use of Calculation Sheets*

A station is defined as one interval of 100 feet. Whenever constants are calculated, they are shown in the upper left hand corner of Form Assess. A2.

*Length of Ditch*—This is the total length, expressed as stations, from the upper end of the project (where construction work stops) to the lower end of the project (normally where dredging, not brush clearing, begins). Depending on anticipated benefits, the lower point may be shifted under unusual conditions. The maximum figure (Main + any Trib.) is used for the project.

*Line 1—Acreage*—This figure is the acreage, in the watershed, of each individual tract, as it is being considered.

*Line 2—Station of Property*—This is determined by connecting a point on the property to the centerline of the ditch with a line perpendicular to the centerline of the ditch. The station of the property is defined as the station at the centerline of the ditch, as determined from the above described line. In all cases, the highest possible station is used.

*Line3—Corrected Station of Property*—However, if the lower end of the project (as defined in the line above) is not "Sta.0 + 00" then a correction is made by subtracting the station of the lower end of the project. If a tract is located on a tributary, the station is found by measuring up the mainstream to the mouth of the tributary and thence along the tributary.

*Line 4—Rate No. 1*—This is calculated by dividing line 3 by the length of the ditch and expressing the result as a decimal to the nearest hundreth. This is then multiplied by Factor A, which is the square root of the length of the ditch, in stations, divided by 200. If the ditch is shorter than 200 stations, use 1.00 for Factor A.

*Line 5—Distance to Ditch*—This is the shortest measurement from the particular tract to the centerline of the ditch, measured at the *closest* point. If the ditch touches the property, it shall be shown as "zero."

*Line 6—Rate 2*—Rate 2 is calculated as follows: Divide line 5 by the maximum width of the watershed for the project (as measured from the centerline of the ditch to the outside of the watershed line); and subtract this result (expressed as a decimal to nearest one hundreth)

from 1.00. The maximum width of the watershed shall be constant throughout any one project.

*Line 7—Elevation at "Line 2"*—This line shows the elevation of the proposed bottom of the ditch, at the location shown by the station number in line 2.

*Line 8—Grade of Ditch*—This shows the average grade from the station of the tract to the beginning point of the project (as discussed under line 1). It is calculated by subtracting the elevation at the beginning point of the project from line 7 and dividing the result by line 3; and then multiplying by 100. This shows percent of grade; and is shown as a decimal to the nearest one hundreth.

*Line 9—Rate* 3—After line 8 is calculated for the entire project, the maximum figure shown on line 8 is taken as a constant. The rate is calculated by dividing line 8 by the constant (maximum grade). This result, expressed as a decimal to the nearest hundreth, is then subtracted from 1.00.

*Line 10—Percent Avg. Fall of Property*—This figure is the average fall to the ditch, of each piece of property. It is calculated by subtracting the elevation of the ditch bank, at its point of closest location to the property—from the elevation, at the point of average elevation of the property; and thence dividing this result by the distance between the two points. The figure is expressed to the nearest hundreth. After calculating line 10 for the entire project, the maximum figure is taken as a constant for the project.

*Line 11—Rate 4*—Rate 4 is calculated by dividing line 10 by the constant (maximum fall of property, as discussed under line 10) and extracting the square root of the result.

*Line 12—Average Cut to Property*—This figure is arrived at on Form Assess. B1, which is tabulated as follows: Column 1 is already filled out by consecutive numbers. Column 2 shows the station of each cross-section on the plans. Column 3 tabulates the cut as each station shown in column 2. Column 4 is a cumulative total of Column 3. Column 5 is a result of Column 4 divided by Column 1. The station of Form Assess. B1 that comes the closest to the station of property (line 2) is chosen; and the corresponding figure in Column 5 is then transferred to line 12. The maximum figure shown in column 5 is used as a constant for the project.

*Line 13—Rate 5*—Rate five is calculated by dividing line 12 by the constant (average maximum cut as discussed under line 12), and expressing it to the nearest one hundreth.

*Line 14—Acres in Woods*—This line shows the acres of woods or special low-rate ground in each owner's tract.

*Line 15—Rate 6*—This rate is calculated by dividing one half of line 14 by line 1 (showing result to nearest one hundreth); and then subtracting this result from 1.

*Line 16—Use and Permeability Factor*—All ground for agricultural use shall be rated as 1.00 (if all ground is agricultural and has the same permeability, this factor may be eliminated). The use factor shall be determined by the run-off divided by the run-off of average agricultural ground, expressed as a decimal to the nearest tenth.

*Line 17—Total of Rates*—This line is the sum of Rates 1 thru 6, multiplied by Rate 7.

*Trial Amount*—The trial amount is obtained by multiplying line 1 times Line 17. The trial amounts (of each property owner) are then added to get the total trial amount. The estimated total cost of the project is then divided by the total trial amount to obtain the rate factor which is constant for each project.

*Line 18—Assessment Rate*—The assessment rate for each individual property is obtained by multiplying line 17 by the rate factor.

The assessment on each property is calculated by multiplying Line 1 by Line 18.

## SAMPLE CALCULATIONS

| CALCULATIONS<br>Page No. 1<br>Ditch name—Osborne<br>Lgth. ditch—16711'<br>Max. av. grade—.63<br>Max. av. fall—<br>Mav. av. cut—27.31<br>Wdth. w'shed—2900'<br>Total trial amt.—3,476,578<br>Rate factor—2.83228 | NAME<br>No. 1 ALEXANDER, Earl H. | No. 2 ANDERSON, M. & Henry | No. 3 CLINE, Wm. & Joyce | No. 4 COCHRAN, Elmer | No. 5 FRICHOT, B. C. | No. 6 HECKMAN, Robert & P. | No. 7 KOUNS, Cecil & Laoma |
|---|---|---|---|---|---|---|---|
| 1. Area | 15.00 | 77.00 | 22.35 | 17.55 | 10.00 | 32.00 | 29.50 |
| 2. Actual Sta. of prop. | 143+02 | 162+38 | 122+53 | 101+47 | 153+38 | 54+85 | 137+02 |
| 3. Corr. Sta. of prop. | 121+22 | 140+58 | 100+73 | 79+67 | 131+58 | 33+35 | 115+22 |
| 4. Rate 1 | .73 | .84 | .60 | .48 | .79 | .20 | .69 |
| 5. Distance to ditch | 1520 | 0 | 1220 | 100 | 1420 | 0 | 425 |
| 6. Rate 2 | .48 | 1.00 | .58 | .97 | .51 | 1.00 | .85 |
| 7. Elev. at 2 | 926.58 | 929.49 | 923.51 | 920.35 | 928.14 | 909.83 | 925.68 |
| 8. $\frac{7 - \text{elev.}}{\text{line 3}} \times 100$ | .25 | .25 | .27 | .31 | .24 | .41 | .26 |
| 9. Rate 3 | .60 | .60 | .57 | .51 | .62 | .35 | .59 |
| 10. % avg. fall of prop. | .5 | .5 | .5 | 1.0 | .5 | 1.5 | .5 |
| 11. Rate 4 | .57 | .57 | .57 | .81 | .57 | 1.0 | .57 |
| 12. Avg. cut to prop. | 10.14 | 9.68 | 9.89 | 8.63 | 9.98 | 7.91 | 10.81 |
| 13. Rate 5 | .37 | .35 | .36 | .32 | .37 | .29 | .37 |
| 14. Acres of woods | 0 | 7.50 | 0 | 0 | 0 | 10.00 | 0 |
| 15. Rate 6 | 1.00 | .95 | 1.00 | 1.00 | 1.00 | .84 | 1.00 |
| 16. Use Factor—Rate 7 | | | | | | | |
| 17. Total of Rates | 3.75 | 4.31 | 3.68 | 4.09 | 3.86 | 3.68 | 4.07 |
| 18. Assess. Rate | 10.62 | 12.21 | 10.42 | 11.58 | 10.93 | 10.42 | 11.53 |

FORM: Assess. A2

*Damages* are calculated as follows:

1. Number of feet of ditch on property owners land, multiplied by a predetermined fixed amount—Plus—
2. Number of feet of fence removed and replaced, multiplied by a predetermined fixed amount—Plus—
3. Number of acres of ground taken permanently by the improvement, multiplied by the probable selling price per acre of the ground taken.

The above calculated damages are then subtraced from the assessment.

Minimum Assessment on any tract is established at $20.00. This is done on the basis that many individual services either performed or made available to each property owner require such a minimum to cover the costs of such services and that the costs of said services are less than the benefits of said services.

Incorporated areas are considered as an individual owner until the dollar assessment is determined by the previous method. Then, each property within the corporation is considered individually for two factors only (a. area and b. land use and permeability). The average rate per acre shall be set for the corporation and then each property shall be assigned a rate in comparison to the average, depending on usage of land. The assessment shall then be the area times the rate.