MATHEMATICAL COMPUTATIONS

OF

ACCRETION SURVEYS

FOR

THE GREAT STATE OF

NEBRASKA

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ACCRETION SURVEYS

The solution of accretion lands is essentially the allotment of lands which form by the slow and imperceptible process of accretion. For the purpose of this discussion we will assume that we have already determined that the land in question was formed by accretion or reliction and therefore must be allotted on this basis. We will also assume that some method exists for the exact determination of the previous bank line. This line may have been determined by the original survey meanders, meanders of subsequent surveys, traverse of existing evidence of the bank, or any other type of evidence which would provide information on the previous bank.

In the case of original surveys or subsequent surveys you must locate the correct position for the original meander corners and/or the location where the section lines intersect the meanders of the bank. If the bank has been meandered by a subsequent survey it is almost certain that the previous surveyor will have monumented the intersection of the section lines and his meanders. In the case of the original surveys this point was monumented with meander corners.

ORIGINAL GOVERNMENT

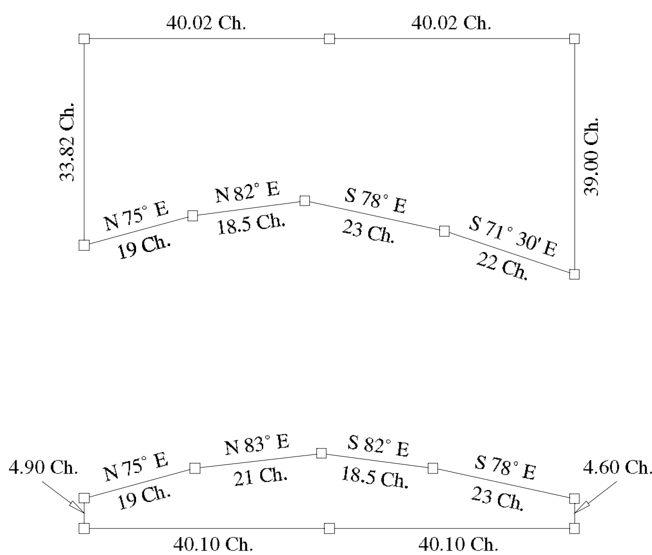


FIGURE 1

If you are able to locate the original or perpetuated monument of the meander corners then you are ready to proceed. If these corners must be reestablished then you must use the methods of retracement surveying to determine the correct position. A word of caution is appropriate to remind you that in Nebraska the meander corners of the original government surveys are original government corners and therefore if they are lost or obliterated they must be restored by the County Surveyor of jurisdiction.

Once the meander corners have been located and their relative position has been determined, by a carefully executed traverse, meanders of the previous survey must be balanced to your relative position. In the case of original government meanders this balance may be considerable because the original calls were only made to the nearest one half of a degree and the nearest one half of a chain.

An example of government meanders is shown above in *Figure 1*.

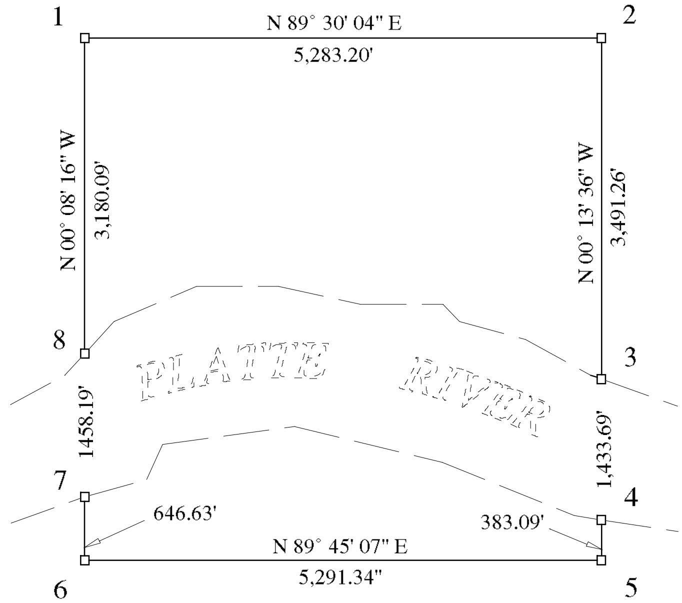


FIGURE 2

Figure 2 suggests probable measurements from your resurvey of the original section lines. A coordinate geometry program has been employed to develop coordinate values for all of the points. By assuming a coordinate value of N. 20000.0000 and E. 20000.0000 for the northwest corner of the section I have arrived at the values shown in *Table 1*.

For your convenience the *"Point Reference Diagram"* is presented on page 4. This figure shows the relationship of all of the points, either existing or to be developed, referenced in the text and necessary for the solution of the geographic centerline and the lines of riparian ownership.

TABLE 1

POINT	NORTHING	EASTING	DESCRIPTION
1	20000.0000	20000.0000	NW Corner
2	20046.0016	25282.9997	NE Corner
3	16554.7689	25296.8114	Present North Bank, East Line
4	15121.0901	25302.4832	Present South Bank, East Line
5	14738.0031	25303.9987	SE Corner
6	14715.1053	20012.7085	SW Corner
7	15361.7334	20011.1535	Present South Bank, West Line
8	16819.9192	20007.6471	Present North Bank, West Line

RESTORATION OF MEANDER CORNERS

Because the original meander corners were not recovered on the resurvey they must now be reestablished. It is assumed that no evidence or testimony exists which would assist us in the reestablishment of these corners and therefore we must rely upon the methods of proportionate measurement. In this case proportionate is a misnomer because the lines of the original survey did not cross the river and therefore no method of proportion exists. In this case we must use record distance and direction to reestablish the meander corners. There exists two distinct possibilities on the placement of these corners.

The first possibility, and perhaps the best in most instances, is to actually determine true bearings and place the corners on a cardinal bearing from the section corners in question. For example the north bank meander corner on the west line would be placed exactly 33.82 chains from the Northwest corner of the section on a bearing of S. 00° 00' 00" E. This method is only appropriate where no lines were run across the river.

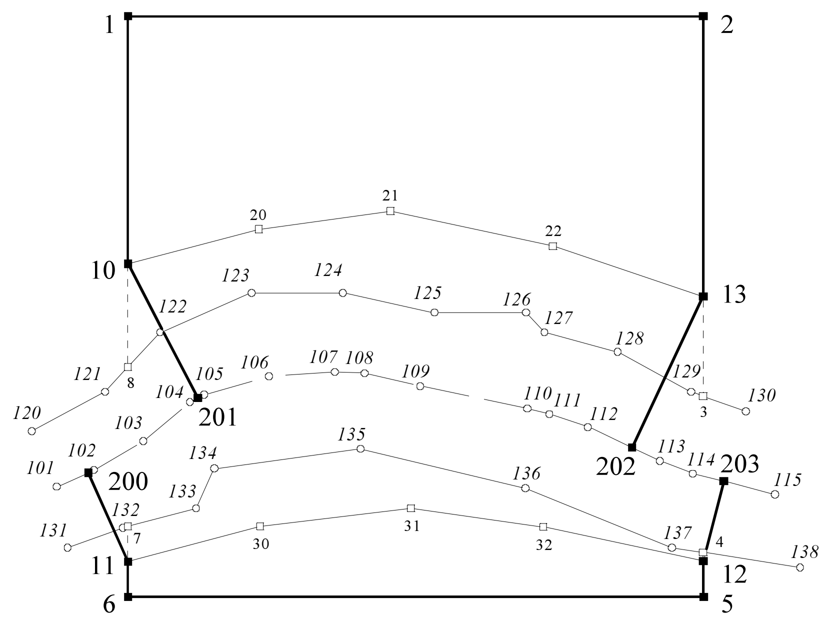
The other possibility is the use of adjacent section lines both upstream and downstream to determine the bearing of the line in question. This method assumes that all of the terminal lines run to the river by the original government survey were cardinal and the best representation of cardinal direction is an average of the lines on each side of the ones in question. Again in this case record distance must be used. I believe this method gives the best results but it relies upon knowing the bearing of other lines in the area. In most cases the bearings of these lines will not be known and it is unreasonable to locate or reestablish numerous other lines only to determine the average bearing.

A third possibility exists and that is the use of collateral evidence to place the meander corners. Collateral evidence might be in the form of testimony, fences, old banklines or any other evidence which would place the original meander corner. Collateral evidence may, in this case, be used to provide information only to the bearing of the line, only to the distance along the line or to both bearing and distance. Fences and testimony often give evidence only to the bearing of the original line. Old visible banklines often give evidence only to the distance and not the bearing. As in all surveying problems collateral evidence must be carefully evaluated and must be duly supported by relationship to other known corners.

For the purpose of this example I have used the method of record bearing as cardinal and record distance from the respective section corners. This computes to the following *Table 2* which gives the coordinate values for the meander corners which we will need.

TABLE 2

FROM	DIRECTION	DISTANCE	TO	NORTHING	EASTING
#2 - NE Cor.	South	2574.00	#13 - Orig. Meander Cor.	17472.0016	25282.9997
			❖ ❖ ❖		
#5 - SE Cor.	North	303.60	#12 - Orig. Meander Cor.	15041.6031	25303.9987
			❖ ❖ ❖		
#6 - SW Cor.	North	323.40	#11 - Orig. Meander Cor.	15038.5053	20012.7085
			❖ ❖ ❖		



POINT REFERENCE DIAGRAM

BALANCED ORIGINAL MEANDER LINES

From these coordinates values for the meander corners we can now balance the original meander calls to our current survey. For this purpose you can use any good balancing program. I recommend the compass rule for this balance because the error is very likely proportional to the length of the line. The following *Table 3* gives the balanced calls for the original meanders.

TABLE 3

BALANCED ORIGINAL NORTH BANK MEANDER LINE

POINT	BEARING	DISTANCE	NORTHING	EASTING	DESCRIPTION
10			17767.8800	20000.0000	Meander Corner
	N 75° 08' 42" E	1253.35			
20			18089.2076	21211.4592	
	N 82° 08' 51" E	1220.75			
21			18255.9915	22420.7599	
	S 77° 51' 27" E	1519.04			
22			17936.4697	23905.8158	
	S 71° 21' 46" E	1453.40			
13			17472.0016	25282.9997	Meander Corner

BALANCED ORIGINAL SOUTH BANK MEANDER LINE

POINT	BEARING	DISTANCE	NORTHING	EASTING	DESCRIPTION
11			15038.5053	20012.7085	Meander Corner
	N 75° 04' 42" E	1256.05			
30			15361.9379	21226.4051	
	N 83° 03' 52" E	1388.51			
31			15529.6038	22604.7551	
	S 81° 57' 52" E	1223.49			
32			15358.5767	23816.2343	
	S 77° 58' 22" E	1521.16			
12			15041.6031	25303.9987	Meander Corner

PRESENT BANKS

In the field we will have traversed the present bank lines of both the north and south bank. The present bank lines are the mean high water mark. This is normally where vegetation no longer grows due to the presence of the flowing water. You must disregard aquatic vegetation using only those plants which grow on firm ground. We will have begun our traverse well outside of the confines of the section and continuously traversed along the mean high water mark until we have exited the section. Generally we will have disregarded all small irregularities in the bank focusing only on the general courses. *Table 4* shows the traverses of the north and south banks of the present channel. Please observe that points 3, 4, 7 and 8 which are the intersection of a straight line between section corners and the bank were also given in *Table 1*.

TABLE 4

NORTH BANK LINE

POINT	BEARING	DISTANCE	NORTHING	EASTING	DESCRIPTION
120			16237.1229	19133.2380	Beg. Point
	N 61° 36’ 03" E	762.72			
121			16599.8812	19804.1689	
	N 42° 45’ 39" E	299.70			
8			16819.9192	20007.6471	West Line
	N 42° 45’ 39" E	441.46			
122			17144.0365	20307.3717	
	N 66° 36’ 31" E	913.76			
123			17506.8084	21146.0337	
	East	838.66			
124			17506.8084	21984.6937	
	S 77° 47’ 48" E	858.06			
125			17325.4302	22823.3647	
	East	838.66			
126			17325.4302	23662.0247	
	S 42° 45’ 34" E	247.05			
127			17144.0435	23829.7523	
	S 74° 52’ 20" E	695.01			
128			16962.6649	24500.6776	
	S 61° 36’ 00" E	762.72			
129			16599.8969	25171.6031	
	S 70° 10’ 47" E	133.09			
3			16554.7689	25296.8114	East Line
	S 70° 10’ 47" E	401.80			
130			16418.5307	25674.8065	End Point

SOUTH BANK LINE

POINT	BEARING	DISTANCE	NORTHING	EASTING	DESCRIPTION
131			15168.1311	19462.7483	Beg. Point
	N 70° 10’ 41" E	534.89			
132			15349.5114	19965.9466	
	N 74° 52’ 17" E	46.83			
7			15361.7334	20011.1535	West Line
	N 74° 52’ 17" E	648.19			
133			15530.9023	20636.8789	
	N 24° 48’ 52" E	399.66			
134			15893.6624	20804.6085	
	N 82° 18’ 06" E	1354.06			
135			16075.0487	22146.4645	
	S 76° 29’ 15" E	1552.57			
136			15712.2791	23656.0578	
	S 67° 55’ 35" E	1447.99			
137			15168.1281	24997.9127	
	S 81° 13’ 14" E	308.18			
4			15121.0901	25302.4832	East Line
	S 81° 13’ 14" E	879.87			
138			14986.7951	26172.0427	End Point

The drawing below (*Figure 3*) illustrates the relationship between the present bank lines and the original meander corners. Notice that the present banks are well within the confines of the original meanders. This is not an unusual situation when dealing with the Platte River in Nebraska. This really more correctly represents a case of reliction than classical accretion but the mathematical solution is identical in either case. In this case both the riparian owners on the north and south bank will claim lands lying within the old bed of the stream.

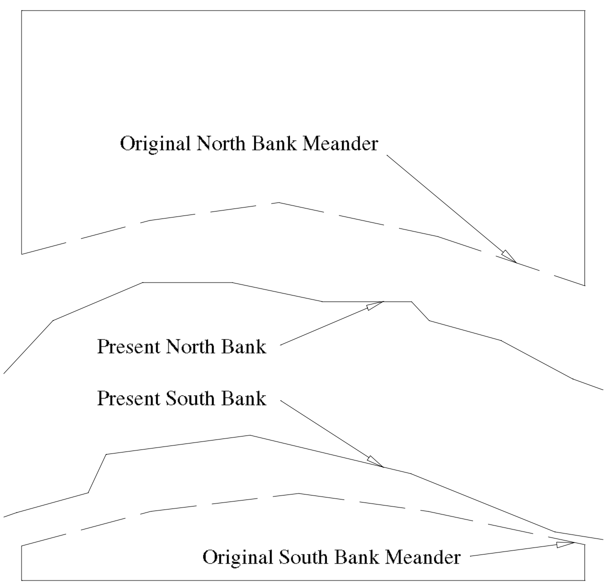


FIGURE 3

The next step of the solution is to look at the traverse of the present banks to be sure that they correctly represent the general course of the river. In observing the courses of our traverses it appears that they are a gentle curve to the right. There are two areas which do not fit into this gentle curve. The point on the left bank numbered 126 and the point on the right bank numbered 133 do not seem to fit the general curve of the river. This is usually caused by poor selection of the traverse points in the field and is not unusual even if you carefully select your points.

In order to more correctly fit the general bank lines of the river these points are often eliminated from the traverses. The next drawing (*Figure 4*) shows the bank lines with the dashed line showing the curve with these points removed. You can clearly see that the general course of the river is much better with these two points removed. From this point on we will deal with the bank traverses with points 126 and 134 removed and courses computed between the adjacent points.

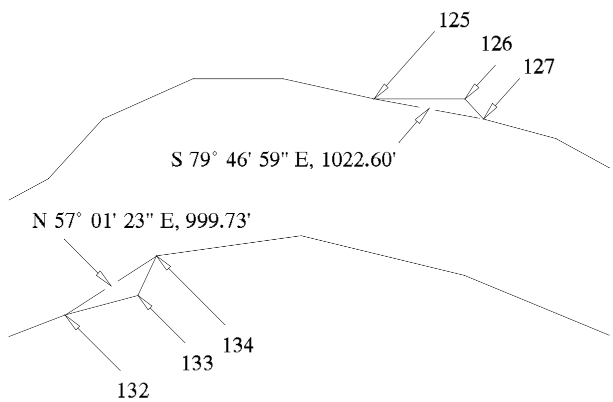


FIGURE 4

CENTERLINE OF THE STREAM

We have now determined the location of the section lines, the original meander lines and the current bank at mean high water. For the next portion of the problem we must project the property lines to the current centerline or thread of the stream.

The basis for the apportionment of accretions in Nebraska is the proportional bank line method. The Nebraska supreme court in *Conkey v. Knudsen*, 143 Neb. 5, 8 N.W. 2d 538 (1943) approved the following language:

> The rule is 1. To measure the whole extent of the ancient bank or line of the river and compute how many rods, yards, or feet each riparian proprietor owned on the river line. 2. The next step is supposing the former line, for instance, to amount to 200 rods, to divide the newly formed bank or river line into 200 equal parts, and appropriate to each proprietor as many portions of this new river line as he owned rods on the old. Then to complete the division, lines are to

> be drawn from the points at which the proprietors respectively bounded on the old, to the points thus determined as the points of division on the newly formed shore. The new lines thus formed, it is obvious will be either parallel, or divergent, or convergent, according as the new shore line of the river equal, or exceeds or falls short of the old.

It can be easily seen that this method of apportionment is impossible in our example. We are faced with a dilemma. We may return to the project and continue to traverse the new bank until it intersects the government meanders in both directions or we must use a different method. If we return to the Platte River and attempt to traverse present banks until they intersect government meanders we are faced with an extremely large task. The Platte River, during the course of Nebraska history, has had continually diminished flows. Numerous dams and diversions have been placed in the river and other projects are presently proposed which have or will reduce the flow of the river. In most cases the present banks of the river are well within the government meanders.

In *Conkey v. Knudsen*, supra, the Court went on to say that if the rule as set out is substantially complied with, the court will approve a division even though it does not achieve an exact "proper apportionment of the accretive **AREA**" (emphasis added). In the final analysis, the goals are to divide the accretions fairly and give each owner an equitable portion of the new boundary line of the shore.

In this case the proportionate bank line method will not work and we must search for another method. Here we must realize that what we are dealing with is generally the receding of the water or reliction. In this case as with the case of a lake drying up the lines must be run so that each owner has full use and access to the water. In the case of reliction there are few Nebraska cases to follow but there are numerous cases in federal jurisdiction or in other states. The most common method and the one that will most nearly approximate the proportionate method is to project lines at right angles to the centerline or thread of the stream. It can be quickly seen that we are usually dealing with a curve and that the proportionate share of different sized circular curves always lies on the radial line of the curve or at right angles to the curve. Although we are not dealing specifically with circular curves this method appears to give the best results and is the most clearly supported by other courts. In the case of *In re Central Nebraska Public Power and Irrigation District*, 138 Neb. 742, 295 N.W. 386 there seems to be support for the right angle method. The court said:

> The boundary line between riparian owners on the same side of the stream runs from the end of the shore line to, and along a line at right angles with, the center line of the stream. Clark Surveying and Boundaries (2d ed.) 301-385; *Clark v. Campau*, 19 Mich. 325; *Bay City Gas-Light Co. v. Industrial Works*, 28 Mich. 182.

I believe that the preferred method of apportioning accretions is the proportional bank line method. If this method is impossible or impractical, which is often the case when the water has receded rather than moved, then the method of right angles to the centerline of the stream is the logical alternative.

We have now determined that we are going to run lines from the ancient banks to the current banks at right angles to the centerline of the stream. There is only one problem with this approach, we must now define "centerline of the stream". The courts have alternatively used the terms "centerline of the stream", "thread of the stream", "center of the channel" and "thalweg" almost interchangeable. The term "thalweg" and "thread of the stream" are indeed quite clearly defined as the line of water at its lowest flow or the deepest channel (See *Figure 5*). The terms "centerline of the stream" and "center of the channel" are not nearly as easily defined. In some cases the courts use these terms to mean thread of the stream and in other cases it has not been so clear.

When we are speaking of the rights of riparian owners to the use of the water it becomes eminently clear that the access to the water is the most important consideration. For this reason the use of the geographical centerline of the river at high stage to determine the termination of the riparian owners claims under the water may fail when the stage reduces to minimum flow and he or she no longer has access to the water. This point is made in *Higgins v. Adelson*, 31 Neb. 820, 270 N.W. 502 as well as other cases almost too numerous to mention.

As a surveyor we must concern ourselves with practical solutions to this problem. If we were using the proportional bank line method to apportion accretion lands we would not need to concern ourselves with the location of the thread of the stream as it lies between the banks. The angle of the property lines extending to the bank would not change as the thread of the stream moved about within the confines of the banks. If we are using right angles to the centerline of the stream to determine the angle of these lines it is not logical or practical to assume that they would change as the thread of the stream moves within the confines of the banks. As the banks control the angle of these lines in the preferred method of proportional bank line it is logical to believe that the banks would also control in the alternate method of right angles to the center line of the stream. To allow the thread of the stream or thalweg to control the angle of these lines would cause the lines to move when the banks have remained stable and the only change has been the location of the thalweg as it moves about within the confines of the banks. For these reasons I believe that the term centerline of the stream, when used to determine the angle the property line makes with the river, should be interpreted to be geographic center line of the opposing present banks.

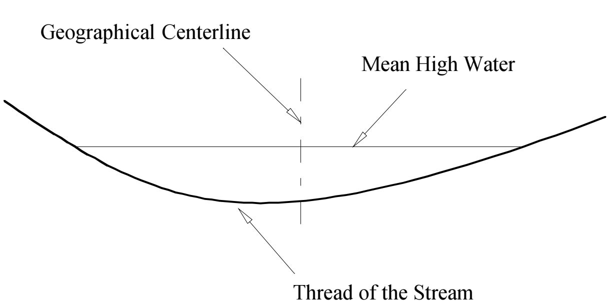


FIGURE 5

CENTERLINE COMPUTATIONS

The next step is the solution of the exact mathematical centerline of the two bank traverses. There have been proposed several approximate solutions to this problem. The one most often seen by the writer is the method of connecting the angle points on opposite banks and using the mid point of the line thus constructed as an angle point on the center line. The best that can be said of this solution is that it is an approximation. If there are nearly an equal number of courses on each bank this approximation works but not too well. If there are a large number of angle points on one bank and a much smaller number on the other bank there is a question of which points to connect. When this occurs there can be numerous solutions depending upon which points the surveyor selects to connect. I much prefer a rigorous solution which gives an exact and repeatable answer to the problem regardless of the number of angle points and their orientation.

The basis of this rigorous solution is that any point on the centerline must be equidistant from both banks when measured at right angles to the bank. The rules of geometry cause several other things to also be true. First the points along the centerline will all fall on a bearing which is the average of the two bank line bearings. Second any point on the centerline will be equidistant from the two banks when measured at right angles to the centerline. From these rules we can begin to use trigonometry to construct the centerline.

Referring to *Figure 6* the first course of the centerline must be the average of the bank courses between points 120 and 121 and between points 131 and 132. The average of these two courses is N 65° 53' 22" E and a right angle to this course is N 24° 06' 38" W. By laying out a triangle with its points at 120, 131 and 132 we can determine that a line from point 120 on a bearing of S 24° 06' 38" E will intersect the line between points 131 and 132 at a distance of 1120.52 feet. The centerline will be at midpoint on this line or 560.26 feet from point 120.

This line on a bearing of N 65° 53' 22" E will continue up the centerline of the stream until it intersects a line which bisects the angle of the banks at point 132.

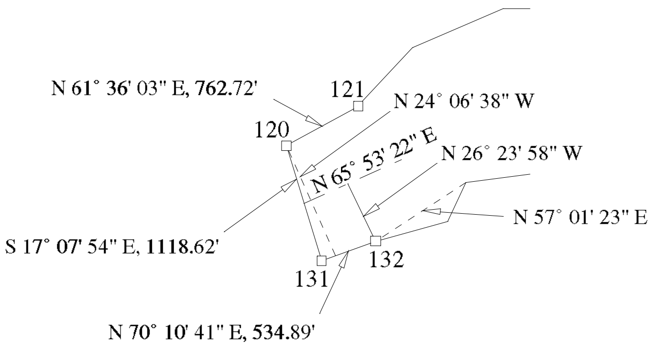


FIGURE 6

We continue to compute the centerline in this manner down the stream until we have exhausted all of the courses on both banks. You might note that an angle point on either bank produces an angle point at the centerline. There should be the same number of courses along the centerline as the total number of courses on both banks.

These computations are tedious and time consuming. I have found that a geometric construction program (any of the popular CADD programs) is extremely useful in computing these centerlines. I am equally sure that shortcuts could be found and that a short program could be written for programmable calculators or computers. It may seem on the surface that these computations are far too time consuming but it must be pointed out that no other solution, of which I am aware, produces an exact centerline. Additionally any surveyor given the same bank lines will produce exactly the same centerline using this method. Any other method such as connection angle points and splitting the distance or curve fitting are arbitrary and the results are not reproducible with different people making the calculations.

I have completed the calculations for the remainder of the center line and the courses and coordinates are given in *Table 5*.

TABLE 5

PRESENT CENTERLINE

POINT	BEARING	DISTANCE	NORTHING	EASTING
101			15697.7205	19299.5056
	N 65° 53' 22" E	442.47		
102			15878.4700	19703.3764
	N 59° 18' 43" E	526.04		
103			16146.9405	20155.7484
	N 49° 53' 31" E	552.98		
104			16503.1864	20578.6843
	N 62° 31' 53" E	150.48		
105			16572.5984	20712.2013
	N 74° 27' 18" E	615.59		
106			16737.5724	21305.2746
	N 86° 09' 03" E	602.88		
107			16778.0434	21906.7898
	S 87° 44' 51" E	275.04		
108			16767.2335	22181.6149
	S 77° 08' 31" E	521.20		
109			16651.2481	22689.7485
	S 78° 08' 07" E	1004.23		
110			16444.7768	23672.5195
	S 75° 40' 47" E	208.55		
111			16393.1953	23874.5850
	S 71° 23' 58" E	370.88		
112			16274.8954	24226.0921
	S 64° 45' 47" E	730.41		
113			15963.4788	24886.7840
	S 69° 03' 11" E	320.18		
114			15849.0150	25185.7993
	S 75° 42' 00" E	777.59		
115			15656.9519	25939.2999

RIPARIAN CLAIM LINES

The next step in the solution is to project lines from the original meander corners to the centerline of the current stream. As we discussed earlier these lines must be constructed at right angles to the geographical centerline of the traverse of the existing bank lines. The geographical centerline of the banks is shown in the previous table. From these coordinates and the coordinates of the meander corners which we computed earlier it is easy to compute these lines. It can be estimated from a sketch of the project that the line from the north meander corner on the west line will intersect the centerline of the stream between points 104 and 105. The line from the south meander corner on the west line will intersect the centerline between points 101 and 102. The line from the north meander corner on the east line will intersect the centerline between points 112 and 113. The line from the south meander corner on the east line will intersect the centerline between points 114 and 115. *Table 6* shows the computed lines from the meander corners to the thread of the stream.

TABLE 4

SECTION LINES EXTENDED TO THE GEOGRAPHIC CENTERLINE

POINT	BEARING	DISTANCE	NORTHING	EASTING	DESCRIPTION
11			15038.5053	20012.7085	South M.C. on West S.L.
	N 24° 06' 38" W	893.05			
200			15853.6419	19647.9000	Center line
❖ ❖ ❖					
10			17767.8800	20000.0000	North M.C. on West S.L.
	S 27° 28' 07" E	1389.04			
201			16535.4351	20640.7161	Center line
❖ ❖ ❖					
13			17472.0016	25282.9997	North M.C. on East S.L.
	S 25° 14' 13" W	1533.47			
202			16084.8961	24629.1888	Center line
❖ ❖ ❖					
12			15041.6031	25303.9987	South M.C. on East S.L.
	N 14°17' 59" E	753.20			
203			15771.4666	25490.0367	Center line

Figure 7 shows how the section will appear with the centerline and the riparian property lines added to the original section.

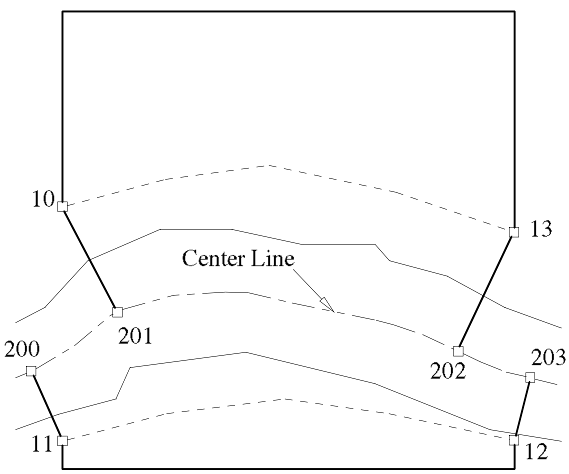


FIGURE 7

Now we have computed the position for the reestablishment of the original government meander corners, the geographical centerline of the present stream and property lines at right angles to the centerline to the meander corners. There can be little question that the riparian owners on both sides of the river own the accretion lands which are bounded by the original meander lines, the mean high water line of the present stream and on the sides by the lines which are at right angles to the centerline of the stream. There can be considerable question whether the riparian owners own to the geographical centerline of the present stream or whether their claim is bordered by some other line which may be the thread of the stream.

In the case of *Hardt v. Orr*, 142 Neb. 460, 6 sp. N.W.2d 589 the court said:

> One of our accepted texts on the law of water rights employs this language: “The law of riparian rights grows out of this exclusion of nonriparian owners because they have no access to the water. The right of access is, in the end, a determinative factor in all systems of water law.” *1 S. Wiel, Water Rights in Western States.* (3d ed.) 759.

In *Horton v. Niagara, Lockport & Ontario Power Co.*, 231 App. Div. (N.Y.) 386, 247 N.Y. Supp. 741. it is stated in part:

“In order to determine just where the center of the channel is, it is necessary to determine what constitutes such center line the filium aquae, as it is so often called in the older decisions. Plaintiffs contend that this line is midway between the banks of the river at the ordinary height of the water, without regard to the contour of the channel. Defendant insists that the thread of the stream is the line to which the water would finally recede, just before it entirely ran out or evaporated. That line would depend upon the location of the low and deep parts of the channel, which many times would be upon one border or the other of the stream, and seldom, if ever, in its exact geographical center.”

“Water always seeks its lowest level. If the deepest part of a channel is well to one side, and the equidistant rule is applied, the riparian owner upon the shallow side would, in times of low flow, be shut off from access to the water which is supposed to flow past his door, without trespassing upon the lands of his neighbor, as the exact middle of the stream would be on dry land. In the very nature of things, the thread or center of a stream must be the line which would give to the owner upon either side access to the water, whatever its stage might be, and particularly at its lowest flow. Upon principle, therefore, it would appear that the thread of a nonnavigable river is the line of the water at its lowest stage. The weight of authority, in this state at least, upholds such contention.”

We have, in effect, adopted the foregoing reasoning of the New York courts and have announced the rule applicable in this state as follows: “The thread or center of a channel, as the term is above employed, must be the line which would give the owners on either side access to the water, whatever its stage might be and particularly at its lowest flow” *Higgins v. Adelson*,131 Neb. 820, 270 N.W. 502.

From these and other cases it becomes eminently clear that we cannot restrict the riparian owner from access to the flow of water, at its lowest stage, by any arbitrary line including the geographical centerline.

Basically the rivers in the State of Nebraska fall within two categories. The first are braided streams of which the Platte is a prime example and the second type is the Missouri River which is controlled within confined bank lines by the Corps of Engineers. In the case of the Missouri River there is a design channel of from 600 to 700 feet in width which the Corps maintains a depth adequate for shipping. In this case the depth can be assumed to be uniform and the thread of the stream can be considered to be the geographical centerline of the design channel. This fact was considered and the method approved in *Nebraska v. Iowa*, 406 U.S. 117. In the case of a braided river such as the Platte we have a very difficult situation. The river flows through many channels which appear from the air as a braided rope and thus the name is derived. Within these braided channels the flow varies from day to day or in some cases instant to instant. Any person who has waded in the Platte River will testify that you can cross one chute in the morning easily only to return at noon and find the depth to be over your boots. Within the banks towheads or small islands will occur with some small growth of vegetation on them. These towheads will change with each occurrence of high water usually in the spring. The surveyor who contours the bed of the Platte River, during normal or high flows, is foolish indeed for the river will have changed before the task can be completed.

This leaves us with the circular problem. If we attempt to find the thalweg or deepest channel the constant changing of the river will defeat us. If we use the geographical centerline of the mean high water banks the riparian owner may not have access to water at low flows. There are indeed low flows in the Platte River. In dry summers the flow of the river will often cease completely. It has often been observed that 90% of the flow of the Platte is under ground.

The only practical solution to this problem is a combination of the two methods. The surveyor should observe the portion of the stream in question in an attempt to determine if a consistent main channel exists. The term consistent main channel should be interpreted to be a flowage which is deeper than all of the other channels and its existence is permanent. In order to be considered permanent it should have been in place for more than one season and thus not subject to change by the normal spring high flows. If such a permanent main channel exists then its centerline or deepest point should be used for the limits of the riparian claims. If no permanent main channel exists the surveyor should ignore the minor daily and seasonal changes within the high banks and use the geographical centerline of the high water lines to determine the limits of the riparian claims.

Regardless of the method used to determine the centerline or thread of the stream the surveyor must remember at all times that his or her conclusions are subject to review by the courts of jurisdiction. It is imperative that the surveyor include in the record of survey all observations and conclusions made so the court will have benefit of all of the information possible in the event the line is litigated.

Legal Description

We now have completed the computations necessary for the accretions to the north half and the south half of the section. The next step in the solution is the production of the plat, notes and legal description of the property. I will not attempt to give an example of the plat and notes because they are individual efforts and should represent the surveyors personality. Please remember to include all of the observations and conclusions you reached in progressing with your survey into the notes. These notes are an integral part of your work in any survey and in the case of accretion work they represent important historical information. This will greatly assist both future surveyors who will build upon your work and the courts who may make findings of fact involving the properties.

The legal description of that part of the section lying north of the river might read something like this:

> That part of Section XX, Township XX North, Range XX West of the Sixth Principal Meridian, Hooker County, Nebraska lying north of the Platte River and accretions thereto more particularly described as follows:

> Beginning at the northwest corner of said Section XX thence N 89° 30' 04" E on the section line a distance of 5,283.20 feet to the northeast corner of said section; thence South on the section line a distance of 2,574.00 feet to the north meander corner on the east line of said section; thence S 25° 14' 13" W at right angle to the centerline of the present channel of the Platte River a distance of 821.38 feet to a point on the present left bank; thence along said left bank and upstream, N 61° 36' 00" W a distance of 491.24 feet; N 74° 52' 20" W a distance of 695.01 feet; N 79° 46' 59" W a distance of 1,022.60 feet; N 77° 47' 48" W a distance of 858.06 feet; West a distance of 838.66 feet; S 66° 36' 31" W a distance of 898.68 feet to a point on the bank; thence N 27° 28' 07" W on a line at a right angle to the present centerline to the channel a distance of 696.36 feet to the north meander corner on the east line of said section; thence North along said section line a distance of 2,232.12 feet to the point of beginning containing 333.74 acres more or less.

Please notice that the legal description did not include the bed of the stream. This is normal procedure in most legal descriptions for riparian property. It is possible to include the bed of the stream in the legal description but I believe it should not be included with the description of the riparian lands but should be described as a second tract clearly stated as being the bed of the stream. Remember that the ownership of the bed might be subject to the constant changes of the thread of the stream to allow access for the riparian owners to the use of the water. If we include the bed of the stream into the description a clear statement indicating that it is the bed and the method of selection of the dividing line should also be shown. This statement would indicate if the division was made on geographical centerline, thalweg (thread of the stream) or some other method.

This completes the discussion and mathematical solution of accretion by right angle to the centerline of the stream. I would now like to give a very brief example of the computations involved in the proportional bank line method.

PROPORTIONAL BANK LINE METHOD

For the purpose of this example I will use the same section dimensions that were used previously. The exterior of the section can be found in *Table 2*. The balanced original meanders can be found in *Table 3*. We will concern ourselves only with that portion of the section north of the river. First we will split the section on its meridional centerline. To do this we will reestablish the north quarter corner to the section at a point midway and on line between the northwest and the northeast corner. From this quarter corner we will project a line due south to its intersection with the balanced government meanders. The purpose of this example is to resolve the ownership of accretion property between the riparian owners of the east half and the west half of the section. We will assume that there is no part of the section south of the river and concern ourselves only with the north bank.

I have constructed a new north bank of the present river in a location to allow us to use proportional bank line method. *Table 7* shows this new north bank from its intersection with the west section line to its intersection with the east section line. These bank traverses would be subject to review and smoothing as described on page 6, *Figure 4*.

From the coordinate values for the new bank line in *Table 7* and the balanced original meanders in *Table 3* we can use simple trigonometry to resolve the location of the intersection of the new bank line with the ancient banks. On the west end the intersection point will be at coordinate value of N. 17917.4682 and E. 20563.9729. On the east end the intersection point will be at coordinate value of N. 17630.6785 and E. 24812.5104. From point 300 which is on the west section line we would traverse down the new bank line on a bearing of S 64° 06' 47" E a distance of 626.88 feet to the intersection with the original meander line. From point 305 which is on the east section line we would traverse up the new bank line on a bearing of S 68° 23' 28" W a distance of 506.05 feet to the intersection with the original meander line. *Table 8* shows the courses around the accretions which have

Table 7

Present North Bank

Point	Bearing	Distance	Northing	Easting	Description
1			20000.0000	20000.0000	NW Corner
	South	1808.84			
300			18191.1600	20000.0000	North Bank
	S 64° 06' 47" E	1016.77			
301			17747.2415	20914.7445	
	S 66° 49' 40" E	787.16			
302			17437.4970	21638.4014	
	S 82° 06' 21" E	1187.29			
303			17274.4302	22814.4400	
	N 85° 17' 38" E	1391.63			
304			17388.6062	24201.3783	
	N 68° 23' 28" E	1163.38			
305			17817.0416	25282.9997	Section Line
	North	2228.96			
2			20046.0016	25282.9997	NE Corner

been added to the north half of the section.

Using these coordinates we can compute the intersection of a line from the reestablished north quarter corner due south to the original meanders. This line intersects the original meanders between points 21 and 22 a distance of 225.79 feet from point 21. We now simply add up the amount of the old bank which is in each half of the section. The total of the banks is as follows:

404 to 20	669.88
20 to 21	1220.75
21 to 1/4 Sec. line (401)	225.79
Total in W. 1/2	2116.42
1/4 Sec. line (401) to 22	1293.25
23 to 403	956.87
Total in E. 1/2	2250.12
Grand Total Old Bank	4366.54

The following is the total distance along the new bank line from its intersection with the original meanders:

404 to 301	389.89
301 to 302	787.16
302 to 303	1187.29
303 to 304	1391.63
304 to 403	657.33
Grand Total New Bank	4431.30

The proportion of these two distances shows that for each foot of old bank line a riparian owner held they would now have 1.014831 feet. Using this multiplier we find that the owner of the west half would have 2147.81' and the owner of the east half would have 2283.49'. We simply then travel down the new bank from an intersection point these distances and the point so located is the dividing line between the two riparian owners.

TABLE 8

ACCRETIONS

POINT	BEARING	DISTANCE	NORTHING	EASTING	DESCRIPTION
404			17917.4682	20563.9729	West Intersection
	N 75° 08' 42" E	669.88			
20			18089.2076	21211.4592	
	N 82° 08' 51" E	1220.75			
21			18255.9915	22420.7599	
	S 77° 51' 27" E	225.79			
401			18208.4975	22641.4999	Section Line
	S 77° 51' 27" E	1293.25			
22			17936.4697	23905.8158	
	S 71° 21' 46" E	956.87			
403			17630.6785	24812.5104	East Intersection
	S 68° 23' 28" W	657.33			
304			17388.6062	24201.3783	
	S 85° 17' 38" W	1391.63			
303			17274.4302	22814.4400	
	N 82° 06' 21" W	216.53			
402			17304.1692	22599.9619	Section Line
	N 82° 06' 21" W	970.76			
302			17437.4970	21638.4014	
	N 66° 49' 40" W	787.16			
301			17747.2415	20914.7445	
	N 64° 06' 47" W	389.89			
404			17917.4682	20563.9729	West Intersection

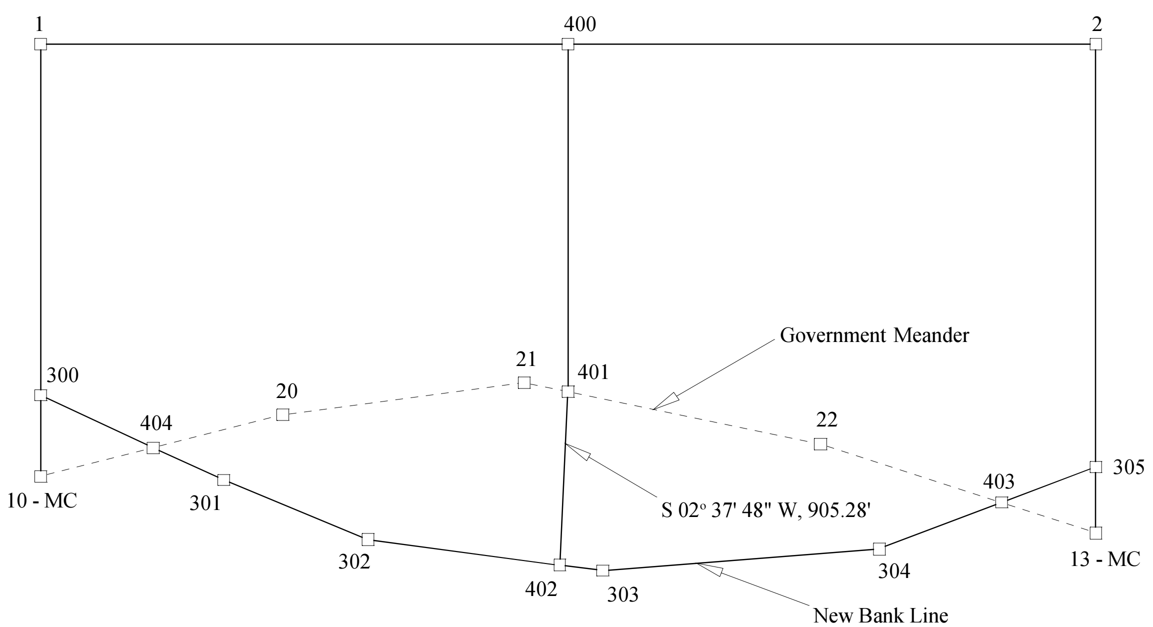


FIGURE 8

This concludes our discussion of accretion surveys. I would like to conclude by stressing that in no other area of surveying is the judgement more critical. For every rule there are numerous exceptions. No project will ever be as simple as the examples shown herein.

If you proceed in accretion or riparian surveying you will often find yourself spending hours reading. You will make numerous calls to other surveyors for advice. You will become very familiar with a legal library in your area. I do not intend to dissuade you from tackling riparian projects. The point is that in riparian work you must question each decision and expect the exception rather than the rule. I hope you will find this type of work as challenging as I have and I hope you don't make as many mistakes as I have.