Shine & Associates
REGISTERED SURVEYORS TEXAS AND LOUISIANA
D. D. SHINE, RPS, LSLS, RLS
T. M. JUMPER, RPS

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HUTCHINSON COUNTY, TEXAS
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February 1, 1991

Mr. Ben Thomson
Texas General Land Office
Stephen F. Austin Building
1700 N. Congress
Austin, Texas 78701

Dear Mr. Thomson:

I am enclosing herewith my surveyor's report on the Canadian River gradient boundary survey conducted through portions of Hutchinson and Roberts Counties, Texas.

Sincerely,

[signature]

D. D. Shine

DDS:nf
Enclosure

File No. Sketch File 45
Hutchinson County
Canadian River Gradient Boundary
Filed Feb. 4 1991
GARRY MAURO, Com'r
By Douglas Howard

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JACKIE M. JACKSON
County Clerk, Roberts County, Texas
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[signature] Deputy
VOL 9 PAGE 457

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Shine & Associates
REGISTERED SURVEYORS TEXAS AND LOUISIANA
D. D. SHINE, RPS, LSLS, RLS
T. M. JUMPER, RPS

January 31, 1991

Honorable Garry Mauro
Commissioner of Texas General Land Office
Stephen F. Austin Building
1700 N. Congress
Austin, Texas 78701

RE: SURVEYOR'S REPORT, CANADIAN RIVER GRADIENT BOUNDARY SURVEY, THROUGH PORTIONS OF HUTCHINSON AND ROBERTS COUNTIES, TEXAS

Dear Commissioner Mauro:

Pursuant to our contract of January 13, 1986, the gradient boundary survey performed by General Land Office personnel under my supervision and direction has been accomplished. This survey was performed on both the north and south banks of the Canadian River between Section 15, H.& T.C. Block 47 in Hutchinson County and Section 3, H.& G.N. Block A in Roberts County, covering approximately forty miles of river and approximately eighty miles of gradient boundary.

The procedures of this survey were compatible with those used in my previous 1980-81 gradient boundary survey of an approximate eight mile portion of the Canadian River between Sanford Dam and the Borger/Stinnett Highway crossing. My report, plat, and field notes for this survey are on file in your office.

The gradient boundary as set out by the Supreme Court of the United States in the case of Oklahoma v. Texas on the boundary of the Red River [260 U. S. 606 (1923)] and described in detail in the article entitled "Gradient Boundary" published in the Texas Law Review, January, 1952, Volume 30, Number 3, is the "Stiles Method" because it was principally originated by Colonel Arthur A. Stiles. I mention this because it is the "Stiles Method" used in the "Texas-Oklahoma Red River Case" and the "Stiles Method" adopted by the Texas Courts.

Mr. Irving Webb, through his employment with City Service Oil Company and private surveying, relied upon Colonel Stiles as a consultant many times on gradient boundary surveys across the state. Mr. Ray Wisdom, Chief Surveyor of the General Land Office of Texas for more than forty years, had occasion to work with Colonel Stiles on many gradient boundary surveys. These two gentlemen painstakingly passed this theory to me through many rivers and years.

Surveyors Stiles, Wisdom, and Webb have all passed away, but through their dedicated efforts, the gradient boundary theory as adopted by the U. S. Supreme Court in Oklahoma vs. Texas lives on. I believe this to be the most definite and exact method of stream bank determination of those used today.

In conducting two gradient boundary seminars assisted by Mr. Webb and serving as a survey consultant on gradient boundary surveys throughout the state of Texas, I have had the opportunity to demonstrate to more than seventy-five Texas surveyors the Stiles' gradient boundary theory.

Without exception all of these surveyors had a misconception of the gradient boundary, even after hearing the lecture and seeing slides, until they saw the survey performed on the stream bank. I wholeheartedly agree with Mr. Webb when he states, "I am firmly convinced that no surveyor can locate the gradient boundary properly unless he has had personal contact with Colonel Stiles or someone who has been a student of his."[1]

The report of the Boundary Commissioners adopted by the U. S. Supreme Court in Oklahoma v. Texas states in part:

> The boundary is a gradient of the flowing water in the stream. It is located midway between the lower level of the flowing water that just reaches the cut bank and the higher level of it that just does not overtop the cut bank. The physical top of the cut bank being very uneven in profile, cannot be a datum for locating the boundary line; but a gradient along the bank must be used for that purpose. The highest point on this gradient must not be higher than the lowest acceptable point on the bank in that vicinity.

The "cut bank" is that portion of the bank that during the course of the year is ordinarily washed free of vegetation. Note: This definition and various others seem to have originated in Oklahoma v. Texas, 260 U.S. 606, 261 U.S. 340 (1923). Colonel Stiles made the following statements in his article in **Texas Law Review** concerning cut banks, "The expression 'cut bank' was used in the opinion and the decree of the Court and in the report of the Boundary Commissioners as a designation and not in any sense as a restrictive qualification of the bank intended as the boundary bank. The 'cut bank' appears to have been a bank in name only, and by tacit agreement it was intentionally all but meaningless topographically. To suppose that the boundary bank

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[1]Webb, Irving, Texas Surveyors Association 29th Annual Short Course, "The Gradient Boundary."

is one and continuous in character and that it is capable of being recognized and followed by means of the designation, 'cut bank,' is a fundamental misconception. There is no such bank. Presuming that the unidentified 'cut bank' is a bank that has been 'cut' or eroded by the natural processes of the river, the well understood expression, 'eroded bank,' will be used hereinafter in lieu of the apparently very misleading designation, 'cut bank.'" [2]

When the surface of the flowing water in the stream and the elevation of the boundary coincide, the boundary is on the ground at the feather edge of the water, and stakes driven there will mark the perfect gradient and the perfect boundary - hence the name "gradient boundary."

The gradient boundary theory is divided into two parts, i. e., (1) the QUALIFIED BANK and (2) the GRADIENT OF THE FLOWING WATER.

THE QUALIFIED BANK

On any stream you will find several different kinds of banks. There are cut or erosion banks, transverse slope banks, and accretion or alluvial banks. On a single cross section of a stream, you could encounter several of these banks. For example the cross section could begin on a high bluff and drop almost vertically to the bed of the stream (a cut or eroded bank). Crossing the stream bed, you could encounter an island in the stream and continuing across the stream bed to the beginning of a long transverse slope whose terminus or top is far removed from the bed of the river. Instead of the transverse slope you could encounter a low accretion or alluvial bank, and a few feet further encounter a second alluvial bank (higher than the first), and a few feet further another bank higher than the second.

It is the lowest accretion or alluvial bank or the first bank that contains the river which will qualify as the correct bank where the mid-height point is set and the gradient boundary begins. This bank is always an accretion bank. Upstream and downstream from the accepted bank are the transverse slopes and cut or eroded banks.

The boundary is never established from the transverse slopes nor from bluffs, eroding banks, or from islands in the bed of the stream.

The accretion bank is built from material conveyed and deposited by the water in the stream. The bank is smooth in profile and reflects the height of the water at the time the bank was formed. The accretion bank is fundamentally consistent because the material composing it cannot be deposited above the

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[2] Texas Law Review, Vol. 30, p.312.

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level of the water conveying it. The accretion bank has these features: between the top of the bank and the rising ground beyond, there is a slight depression somewhat paralleling the stream but not a part of the stream and in no sense a "bypass" or "slough." Near the head of this depression is a minute "divide" frequently discoverable only with a level. This divide is the exact top of the bank. The rising water in the river, on reaching the top of the bank, barely overflows it. Thence, the water flows down the depression and returns to the stream in a different place. This topographic form marks the typical accretion bank and sets it apart from the erosion bank and the transverse slope against which the water rises to an uncertain height and then recedes over the same ground.

To be a qualified bank, it must be well defined. It must bear evidence that it is an "upland bank" with upland vegetation growing thereon. It must be stable and not eroding. This type bank is generally found along the straight sections of the river. Many times they are found immediately downstream from the end of the bar at a bend in the river. When more than one bank is found, the lowest bank is the most acceptable.

Colonel Stiles stated, "Finding the one correct bank in the vicinity that locates the gradient boundary on the ground is no casual undertaking. If this bank is wrong, the whole boundary is wrong on both sides of the river. Once established, the gradient boundary permits no subsequent corrections or adjustments in the line. The boundary is either right or it is wrong in the first instance depending upon the correctness of this one lowest bank which is the basis of the gradient boundary." This statement gave me considerable trouble until Irv Webb stated that Stiles told him he was talking about the mistaken use of the "second or higher bank" and not a series of the same type banks that qualify as "key banks."

The bottom of the bank or toe of slope may require investigation up and down stream from the keypoint selected on the lowest qualified bank. To a more or less approximate extent, the bottom of the bank is indicated by the vertical consistency of the edge of the stream bed and the bottom of the adjacent bank; by the washing of the stream against the bank at prevailing low stages; by the edge of the bare sand, gravel, small stones worn smooth, rock or mud composing the bed of the stream contrasting with the more conglomerate material composing the bank; and by the aquatic vegetation on the stream side of the bank which is soon dead out of the water compared with the upland vegetation on the land side of the bank which is soon dead in the water.

Normally, the bottom of the bank will be well defined at or near the qualified bank. The gradient boundary is then set at the mid-point between the top and the bottom of the bank.

THE GRADIENT OF THE FLOWING WATER

The surface of the steadily flowing water in the stream fixes the gradient boundary upon the ground. If there is no flowing water and no reliable markings of it on the ground, the gradient boundary cannot be located until the flowing water comes again. On the unmarked ground there is no equivalent of the gradient of the flowing water, and none can be established except by the stream itself. The only datum to be considered is the surface of the flowing water in the stream.

A stream is ever changing grade along its onward course by reason of the topographic changes over which it flows. For example, in one place the water may be flowing placidly where its surface is barely falling; in another place the water flows down a "rapids"; and in still another place it encounters a "fault" and falls almost vertically, and so on. But the stream makes these changes in the grade and the gradient boundary must conform to them; otherwise, the boundary is not a gradient of the flowing water in the stream.

A water mark line is indisputably a perfect gradient of the flowing water in a stream. At the peak of a rise in a stream the water will continue to flow steadily for a period of time and then recede, leaving a water mark line consisting of silt and fine drift deposited continuously on both banks of the stream.

This water mark line is a true datum for locating the gradient boundary on the ground. Being fixed in place, this stream-made gradient nullifies the fluctuating of the water surface when used as datum and does away with all stream gauges and simplifies the work in many respects.

The boundary bank is ever subject to changes by erosion and accretion, and the gradient boundary follows the change. Where the bank is, there is the boundary also.

Lieutenant A. W. Whipple in his Railroad Reconnaissance survey across the Panhandle of Texas in 1853 stated, "The bed of the Canadian River, we found about six hundred yards wide, with streams a foot deep coursing through it in a network of channels....The valley of the Canadian possesses alluvial bottoms, covered with loamy soil and occasional patches of grass....." [3]

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[3] Reports of Explorations and Surveys, to Ascertain the Most Practicable and Economical Route for a Railroad from the Mississippi River to the Pacific Ocean. Made under the direction of the Secretary of War in 1853-54, According to Acts of Congress of March 3, 1853, May 31, 1854, and August 5, 1854. Washington: Beverley Tucker Printer, 1856, Volume III, Page 10.

A glance at the current U. S. Geological Survey quadrangle maps of the Canadian River reveals the conditions very much the same as those described by Lieutenant Whipple. In nearly every section of the river shown on the quadrangle map, there are from six to twelve channels coursing through the stream bed.

After reviewing the records and photographs and conducting personal interviews with persons who had lived on or seen the Canadian River prior to the construction of Sanford Dam, and also from my personal inspection of the river miles upstream from Lake Meredith, I found that before Sanford Dam the Canadian River was a clean sand bed, free from vegetation with shallow channels coursing through the river bed with a relatively uniform and steady gradient over great lengths of the river.

An inspection of the river bed today, twenty five years after construction of Sanford Dam, reveals the river bed to be covered with a growth of cane, cattails, and salt cedar, apparently due to the diminished flow of water through the gates at Sanford Dam. This vegetation growth within the river bed has obscured to a casual glance the existence of this "network" of channels.

In addition to this natural network of channels, industry in the Borger area has discharged effluent which has created a new channel. This substantial effluent enters the Canadian River seven to twelve miles downstream from Sanford Dam. It appears this new channel, which has become the prominent one among the network of natural channels, is fed by a constant, continuous release of effluent.

The United States Department of the Interior, Bureau of Reclamation, surveyed degradation range lines across the Canadian River at intervals through our area of interest. We secured copies of the original field books of this survey which are housed in the Bureau of Reclamation Archives in Denver, Colorado. This survey revealed that in November and December of 1960, detailed cross sections were made across the river bed at each of these degradation lines. These cross sections noted the beginning and ending of the apparent river banks as well as the elevations of the water surfaces of the multiple channels found at the particular cross section.

In our survey we recovered all benchmarks set at the beginning and end of all degradation lines. We also duplicated the Department of Interior's survey on several of these cross sections. Our current survey found no significant changes in the river bed from the 1960 survey. The channels described in 1960 were found in the same place and the elevation of the water surface was within approximately 0.10 (one-tenth) foot of the 1960 water surface elevation. The only change found between our survey and the 1960 survey was the newly created channel. This channel was simply not there in 1960. Also the bottom and the water surface of this new channel were approximately two feet lower than the bottom and water surfaces of the natural channels. The apparent constant, continuous discharge of water has worn down a channel, within the river bed, deeper than any of the natural channels.

Where the effluent enters the river approximately seven miles downstream from the dam and begins this new channel, it is less than ten feet wide. This being the deepest channel within the river bed, higher incoming channels naturally seek to join the lower channel, making it about forty feet wide at the end of our project approximately forty miles downstream .

Colonel Stiles states, "It is obvious that a simple rate of fall in the river throughout its length does not represent the many changes in grade made by a stream. Consequently, the gradient boundary can be correctly located on the ground in only one way, as follows: every point on the gradient boundary is independent of every other point; hence, for every individual point to be located on the boundary, the level must be used to measure the required vertical distance from the surface of the flowing water to the gradient boundary on the bank. There is no substitute for this procedure. It is only the vertical distance that pertains to the gradient boundary. The horizontal distance has nothing whatever to do with the subject and may remain unmeasured and unknown. Every point set on the gradient boundary represents a separate operation in surveying. Every gradient boundary point is independent of every other point."

The greatest benefit derived from the 1960 survey by the Department of the Interior was the determination of the gradient of the flowing water in its natural state. The frequency of the cross sections across the river bed made it possible to determine the gradient of the flowing water in the segments between the degradation range lines. The gradient fixed by the 1960 survey coincided almost identically to the gradient of the flowing water in the new channel. (1960 overall gradient: 0.0013628 - New channel overall gradient: 0.0013657) The rate of fall of the 1960 gradient is 13.628 feet per ten thousand feet of river length; the rate of fall of the new channel today is 13.657 feet per ten thousand feet of river length. The difference in the gradient between the 1960 and the new channel is only 3/8 of an inch in two miles of river. This difference would be insignificant in any gradient boundary determination.

While there were only minor differences in the gradient of each segment from the overall gradient, we used the segment gradient between the range lines in order to follow the natural gradient as nearly as possible.

The Canadian River presented many logistical problems in the literal sense of establishing each gradient boundary point in relation to the surface of the flowing water in the channels within the river beds. As mentioned above most of the river bed is now covered with a dense growth of vegetation preventing a "line of sight" between the water surface in the channel and the river bank. In many instances the channel is on the opposite bank of the river, sometimes nearly a mile removed from the bank being surveyed. Being able to recreate the water surface from the 1960 survey simplified our task greatly in this respect.

The survey was performed in the following manner: A random traverse was run in the close proximity of the gradient boundary along the north and south banks of the river. Using the bench marks as set in connection with the 1960 survey, an elevation was established on each of the random traverse points along both banks of the river. This data was platted and the degradation cross section lines reconstructed on the plat.

With the gradient datum thus established, I examined the entire north and south banks of the river (approximately 80 miles). This examination revealed fourteen banks that would possibly qualify under the Stiles' Theory of gradient boundary. These banks were all similar in character and height. I selected the three lowest banks, one near the beginning, one near the end, and one in between (refer to Exhibit 1 for comparison of these banks). The gradient boundary was determined to be at the mid-height point of each of these three banks. These mid-height points were referenced to the gradient datum determined from the 1960 survey. The gradient boundary on these three banks was found to be 1.67, 1.56, and 1.50 feet respectively above the gradient of the water surface in 1960.

With the gradient boundary thus established, a gradient boundary elevation was calculated for each of the random traverse points on the north and south banks. Applying the difference between the elevation of the actual random traverse point and the calculated gradient boundary elevation, a point on the gradient boundary was staked opposite the random traverse point. With the exception of rare instances, these gradient boundary points fell along an existing bank. The gradient boundary as staked was supported by 1964 aerial photographs which showed the river banks and the wide expanse of bare sand bed as it existed immediately prior to the closing of the gates of Sanford Dam.

At the gradient boundary opposite each random traverse point, an iron stake was driven with an aluminum cap stamped "Texas General Land Office Gradient Boundary" with the appropriate number. A State Plane Coordinate value was established on each of these meander points. These points, with the appropriate numbers, are shown on the map now on file in your office. There is also on file a complete coordinate listing accompanying said map. With the map and coordinate listings, bearings and distances can be calculated for each meander line connecting the gradient boundary points.

Our survey also included the location of corners of the sections lying on both sides of the river. Although many original corners were recovered, this survey did not attempt to resurvey each section. We merely located the corners apparently used and recognized by the land owners, whether they be right or wrong, in order to calculate the acreages between these corners and our gradient boundary survey on each of the sections fronting on the river. There is an identifying number shown on the map at each of the section corners. These numbers are also included in the coordinate listing.

Respectfully submitted,

D. D. Shine

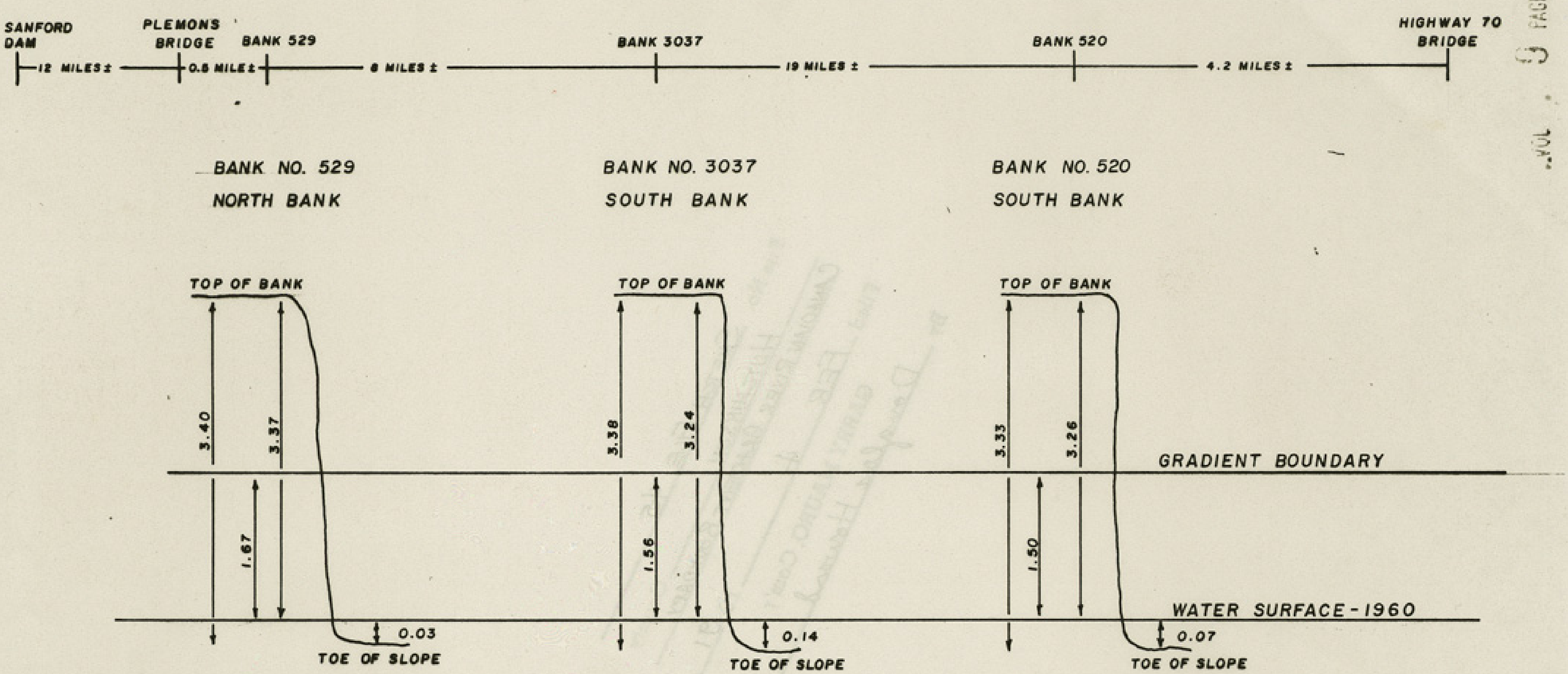
STATE LICENSED LAND SURVEYOR TEXAS

DDS:nf
Attachment

File No. SKETCH FILE 45
HUTCHINSON County
CANADIAN RIVER GRADIENT BOUNDARY
Filed FEB. 4 1991
GARRY MAURO, Com'r
By Douglas Howard

EXHIBIT I

CANADIAN RIVER
HUTCHINSON AND ROBERTS COUNTIES
LOWEST QUALIFIED BANK



QUALIFIED BANK NUMBER	GRADIENT BOUNDARY OR MID POINT ABOVE WATER SURFACE 1960	TOP OF BANK ABOVE WATER SURFACE	TOE OF SLOPE BELOW WATER SURFACE	TOTAL BANK HEIGHT
529	1.67	3.37	0.03	3.40
3037	1.56	3.24	0.14	3.38
520	1.50	3.26	0.07	3.33

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