

# Certified Federal Surveyors Certification Program



## Course 5 Introduction to Water Boundaries

Version 3.0  
January 2010

## Course 5: Introduction to Water Boundaries Study Guide

**COURSE DESCRIPTION:**

This course consists of an interactive course on the basics of water boundaries. It is not intended to make one an expert, but rather, to raise awareness of riparian issues. It is followed by a short field video where a State Cadastral Chief offers advice and help from the BLM whenever you face riparian issues that may involve federal interests.

**COURSE OBJECTIVES:**

Upon completion of this course, students will be able to:

- Learn basic riparian boundary survey terms
- Identify boundary issues which arise when working on or near bodies of water
- Demonstrate a basic understanding of simple riparian problems









**COURSE INSTRUCTOR(S):**

Ron Scherler, Bureau of Land Management  
 Randy Zanon, Bureau of Land Management

**VIDEO LECTURE TITLE:**

Water Boundaries – Web-Based Course

ICON LEGEND

 WEB COURSE	 EXERCISE	 DIAGRAM	 READING ASSIGNMENT	 PROBLEM	 HANDOUT	 2009 BLM MANUAL	 QUIZ
---	---	--	---	---	--	---	---

## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---



2009

**BLM MANUAL** Before you begin this course, read Chapter 7 and 8 of the 2009 BLM Manual.

### Introduction

Welcome to the Introduction to Water Boundary Surveys course. This course was created by the Bureau of Land Management (BLM), National Training Center (NTC), Cadastral Survey, for use by entry-level land surveyors.

Identifying boundaries in and near bodies of water is an important task for the cadastral surveyor. Law, geology, and engineering are among the areas of knowledge that will help you make accurate decisions.

This course introduces you to legal issues, water dynamics and natural forces that can change the environment, geological features of bodies of water, and important information about how to meander water bodies. We hope that you enjoy this learning experience and provide feedback as requested at the end. Have fun and good luck!

This course is a production of the Bureau of Land Management, an agency of the Department of the Interior. It was produced specifically for use in the Cadastral Survey Training Program.

We recommend that you have a copy of the current Manual of Surveying Instructions on hand while taking this course. This course is best viewed with the following software and settings:

- Internet Explorer Version 6.0 and higher or Netscape 7.0 and higher.
- A screen resolution setting of 1024 by 768 to maximize non-scrollable content.
- Adobe Acrobat Reader version 5.0 or above.
  - [Click here to download the latest version:](#)

## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

<http://www.adobe.com/products/acrobat/readstep2.html>

- Macromedia Flash Player plug-in version 6.0 or above. This plug-in must be installed in order to view some key course elements correctly. To test which version of the Flash Player is installed on a system, click here:

[http://www.adobe.com/support/flash/ts/documents/test\\_version.htm](http://www.adobe.com/support/flash/ts/documents/test_version.htm).

To download the latest version of the Flash Player, click here:

<http://www.adobe.com/go/getflashplayer> .

- Javascript (for best performance, your browser should be Java enabled). If the calculator opens correctly upon selecting it in the navigation bar, then you have Javascript enabled in your browser. If it doesn't display correctly, please contact your IT department.

In this course you will explore various court cases that have defined navigable and non-navigable waters and the importance of these designations to the cadastral surveyor.

You will also learn about other legal doctrines and how to apply those doctrines. The course provides an overview of the process of meandering, as well as the various kinds of evidence that will help you in that task. In addition, you will learn about the forces of nature that shape the edges of bodies of water.

### Objectives

Upon successful completion of this course, you will be able to accomplish the following objectives:

- Explain the role of the cadastral surveyor in water boundary surveying.
- Name and explain the court cases that affect whether a body of water is navigable.
- Define the doctrines of accretion, reliction, and avulsion.
- Identify the surveyor's role in surveying omitted, accreted, relicted, and avulsed lands; islands; coastal areas; and swamp and overflow lands.
- Demonstrate knowledge of how to meander a body of water.

## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

- Describe the various geological and hydrologic influences that can alter the edges of bodies of water.

### Role of the Surveyor

Welcome to The Role of the Surveyor. In this lesson, you will accomplish the following objectives:

- Describe the general history and law of water boundary surveying.
- Identify the role of the cadastral surveyor in determining ownership of land abutting water.
- Ownership questions concerning property boundaries of land abutting water have caused problems since the days of the Egyptian dynasties.

Ownership questions concerning property boundaries of land abutting water have caused problems since the days of the Egyptian dynasties.

Current water boundary law evolved from early Roman laws through English common law to statute law, which, in turn, has been modified and interpreted by state and federal courts. The first U.S. public land surveys created fractional sections wherever the edges of water were surveyed and the land areas were platted.

Land acreages were figured on the basis of a body of water's sinuosity, so the land could be patented and the remaining public land administered. But, water can cause significant and rapid changes in land areas, and the intricacies of riparian area surveys have evolved from the complexity of these changes.

For the land surveyor, the delineation and resurvey of boundary lines related to bodies of water presents a complex set of conditions. You must protect all landowners' bona fide rights by determining if the land was lost or if it was added to by rapid or slow action. You need to have knowledge of law, geology, engineering, and other sciences in advanced surveying.

## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

In This lesson, you have accomplished the following objectives:

- Described the general history and law of water boundary surveying. Identified the role of the cadastral surveyor in determining ownership of land abutting water.

### Riparian Rights

Welcome to Riparian Rights. In this lesson you will accomplish the following objectives:

- Define riparian rights.
- Describe the three U.S. Supreme Court cases that most affected the definitions of navigable and non-navigable waters.
- List the three reasons the date that a state was admitted into the Union is important in determining riparian rights.
- Explain the doctrines of accretion, reliction, and avulsion.
- Identify the various land and water events that can affect rights.

For the cadastral surveyor, riparian rights refers to the rights of the land adjacent to and in a waterway. The following issues should be considered:

- Is the water navigable or non-navigable?
- Has accretion or avulsion taken place?
- Does the state or federal government have sovereignty over the beds?
- What affect do artificial structures, such as dams, have on rights?
- How are reemerged lands, swamps, islands, and tidewaters treated?
- How are lands that were omitted in the original survey treated?

The first question you need to answer concerning a body of water is whether the water is navigable or non-navigable. The issue of navigable waters has been the subject of much discussion, confusion, and legal interpretation.

At best, you can only make a working decision. The ultimate authority is the U.S. court system. See also *Oklahoma v. Texas*, 258 U.S. 574 (1922). Slide the gavel to see the three most important Supreme Court cases affecting the definition of navigability.

## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

The most important fact about navigable waters is that states acquired sovereignty over the beds on the date they were admitted into the union. Thus, riparian owner's rights below the **ordinary high-water mark** of navigable water bodies are governed by the state law, not federal law.

Note, too, that ownership of the land riparian to a navigable waterway moves as the water shifts its location, but the ownership of the bed does not change

Determining if a water course is **navigable** is not easy. Sometimes navigability is common knowledge, as in the cases of Lake Superior and the Columbia River in Oregon.

Landowners along the waterway also may have a good idea of their rights. In addition, you can ask local residents.

Several facts to keep in mind about **non-navigable** waters are shown below:

- Ownership is to the center of the bed.
- When opposite banks belong to more than one person, the water and the bed are common to both.
- Courts have found that non-navigable waterways cannot be made navigable by artificial means to the detriment of parties holding rights to the waterway bed. The stream's natural condition is the test.
- Beds of non-navigable waters are included when lands are transferred to patentees from the federal government.
- The basis for recognizing some waters as navigable is whether they exist as common highways of commerce.

Once a court has declared a waterway navigable or non-navigable for commercial purposes, a complex question arises if the navigability changes through natural processes.

Research shows varied treatment of riparian property rights in such cases. As a surveyor, you are mainly concerned with the issue of navigability at the time of statehood. The following list shows the factors you need to take into consideration.

Accreted, relicted, and avulsed lands are the focus of legal

## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

doctrines based on common law principles. This section looks at the doctrine of accretion first (and, where appropriate, reliction), then explores the doctrine of avulsion

**Accretion** is the slow, imperceptible addition of soil to the uplands. The upland riparian boundary moves as land and water move. However, the bed remains in the ownership of the title holder.

The doctrine of accretion is the common law principle that the owner of riparian land is entitled to any additions caused by the process of accretion.

The doctrine is grounded in two rationales:

- An adjacent landowner's access to water is a proprietary right that should not end because of the slow addition of intervening land.
- Since the riparian landowner can lose land through erosion, the owner should also gain land through accretion.

A special case of accretion occurs when an artificial structure, such as a breakwater or a wing dam, causes the land addition.

The federal rule is to treat an artificial accretion the same as if it were a natural accretion, to the benefit of the adjacent riparian owner, provided that the intent in placing the artificial structure was not to create accretion.

In cases of accretion and reliction, the federal government may survey and plat any lands added to the federal property, whether the adjoining water is navigable or non-navigable. The federal guideline is that the riparian owner is entitled to the area in front of the basic holding.

In certain cases, a meander line can become a boundary line. One such instance is when an accretion or reliction occurs after the survey of a land parcel but before that parcel has been patented by the federal government.

In applying this principle, the accreted land area must be significant (typically more than 50 percent) in absolute and



## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

relative size when compared to the attached parcel. Extension surveys projecting the regular, rectangular survey lines across the accreted area to form new lots or aliquot parts are used to delineate this new area. The original meander line then becomes a fixed boundary for upland lots adjoining the accreted area.

As a BLM surveyor, you will commonly be involved in the division of accreted or relicited land between adjacent property owners.

The key concept is ownership to the middle of the bed in front of the basic holding.

**Avulsion** is a river's sudden change in flow alignment out from its previous left and right banks to a new channel, leaving an identifiable upland area between the abandoned channel and the new channel.

In the doctrine of avulsion, also rooted in common law, a sudden and perceptible change in a water course from one bed to a new bed does not change boundaries.

The rationale for this doctrine rests on the idea that it is better for a landowner to lose a riparian right than it is for an opposite, upland owner to suddenly lose land that might contain improvements, such as a house or a barn.

The following sequence illustrates the physical process of avulsion in action. This view of the U.S.G.S. quadrangle map shows that the Kuskokwim River is constrained by the local geology to the west. The flood plain east and south of the mountains shows evidence of past river migration and avulsion. Note the numerous oxbow lakes and curved marsh areas typical of an active river as it migrates back and forth across the flood plain. Also note the tightly formed meanders of the South Fork. The red box shows the area of focus for the following sequence.

The following items are considered guidelines and not rules for when the federally interpreted doctrines of accretion or avulsion may apply to certain classifications of land bordering navigable waters:

## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

- First, when the United States had original title to these lands.
- Second, if the federal government has obtained title to public domain riparian lands through reconveyance or acquisition.
- Third, if federal lands were patented to a private owner before statehood, the doctrines may apply.

Expert opinion should be obtained before applying any of these three guidelines to federally involved riparian lands.

When the United States acquires lands not originally public domain lands, the question of whether federal or state interpretation applies to accretion or avulsion is a matter for intensive professional research. If state laws subscribe to the federal doctrine, then the question is easily answered.

A **thalweg** is the line that traces the center of the main channel of navigation in a stream. Absent a main navigable channel, the thalweg follows the deepest channel of a water course. The BLM uses the thalweg to delineate boundary lines in some streambeds. The term is commonplace in boundary disputes between riparian states.

Thalweg division evolved in the late 1800s through international law and subsequent cooperation by the United States Supreme Court. More specifically, the thalweg doctrine developed because the basis of recognizing certain waters as navigable is their availability as common highways of commerce.

Consider the case of two states on opposite banks of a navigable river with a navigable channel on one side of the midstream.

Unless otherwise provided for by convention or law, the navigational jurisdiction of one state could be affected in favor of the other state if boundaries were held strictly to a median line.

In some instances, the entire bed of a boundary river is under the sovereign control of only one state, rather than jointly held between two states or more states. This circumstance is predicated on the original act of cession to the United States in most cases.

## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

Just as accretion and avulsion can raise questions of ownership, so, too, can such things as:

- Non-navigable, non-meandered bodies of water.
- Islands that were not part of an original survey.
- Reemerging land.
- Lands that were omitted by mistake from original surveys.
- Swamp and overflow lands.
- Tidelands.

Wherever a rectangular survey exists, the land titles follow the subdivision lines however they happen to cross a non-meandered, non-navigable body.

In the patent of such subdivisions, the land, the streambeds, islands, and anything else not reserved in a conveyance is transferred to the patentee.

The position of the Department of the Interior is that unsurveyed islands that existed at the time of statehood belong to the federal government.

Islands formed in non-navigable waters after the date of statehood belong to the adjacent upland title holder(s).

Islands formed in navigable waters after the date of statehood belong to the owner of the bed.

**Reemerging land** is land that existed at one time but has disappeared through erosion and has since reappeared in its original location and on the original side of the river through accretion. The question arises, who now owns the land?

Current federal guidance is that the original riparian ownership is lost forever and the reemerged land is in the ownership of the owners of the once-remote parcel.

The new riparian owner assumes all the benefits and hazards of riparian ownership. This doctrine of “once riparian, always riparian” was formed in *Ralph E. Rosenbaum, et al*, 66 IBLA 374 (1982) and overturns the long held principles of *Towl v. Kelley* and *Blankenship*, 54 I.D. 455 (1934). State law varies on the treatment of re-emerged lands.

## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

The following sequence illustrates the current federal position on reemerged lands. Reemerged lands are those lands which were originally surveyed, lost by erosion, and then reformed by accretion in the same geographic location.

In this illustration, the aliquot part is patented land and lot 5 is a government lot. As the river moves easterly by erosion, Lot 5 gets smaller and smaller until all traces are lost by erosion. The riparian frontage now attaches to the aliquot part.

At some point in time, the river movement changes from erosion to accretion. As the river migrates back to the west, accretions form along the east bank.

Once sufficient accretions have developed in the same geographic location of Original Lot 5 the question of title to the “reemerged” parcel needs to be addressed. Does the government retain title to the new land or does it accrue to the aliquot part?

Until the 1982 Rosenbaum decision, the Federal government claimed the “reemerged” land under the guidelines of the previous decision of the Interior Department (*Towl v. Kelley and Blankenship* 54 I.D. 455 [1934])

Under the Rosenbaum decision, the parcel that was originally land locked becomes riparian and suffers and gains according to the principles of erosion and accretion.

This gives rise to the statement “once riparian always riparian.” The Rosenbaum decision is the current Federal guidance on “reemerged” lands. The obvious question is what becomes of land that forms in the same geographic position as the original Lot 5 but on the opposite or west bank?

The original riparian owner of the land along the west bank would have continually had land added to the original parcel by accretion. The gain by accretion under riparian law overrides any apparent claim to the reemerged land by the original title holder of Lot 5.

## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

**Erroneously omitted lands** are lands proven to have been in place at the time of original survey but were not surveyed. Land may have been erroneously omitted in the following circumstances:

- It was meandered swamplands.
- Several lakes were surveyed as one lake.
- A nonexistent body of water was surveyed.
- There are two general cases when lands omitted from an original survey may remain in federal ownership:
  - The areas were omitted erroneously.
  - Small areas of land were in place and on the water side of original meander lines at the time of survey.
- Swamps or overflow lands are, by definition, unfit for cultivation:
  - Swamps are unfit because they do not drain.
  - Overflow lands are unfit because of the frequency, duration and extent of inundation. Barriers such as levees or embankments are required to keep out the water and render the lands suitable for cultivation.
- Coastal marshes that are not subject to the daily ebb and flow of the tide are swamp and overflowed lands within the meaning of the swamp and overflowed lands grants and are subject to survey.
- Coastal “salt marshes” covered by daily tides are “tidelands” and are not subject to survey.

The intent of the Swamp and Overflowed Land Act of 1850 was for marginal riparian areas subject to periodic flooding to be granted to designated states according to certain guidelines and rules.

The lands were not intended to be segregated by meandering along their margins. Erroneous meandering of this type has resulted in large areas of land falling into the category of omitted land.

The 2009 Manual of Surveying Instructions and *Public Lands Surveying, A Case Book* are good references for swamp and overflowed land cases. There are four key points to remember from the 2009 Manual.

## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

### Surveying Concepts

Welcome to Surveying Concepts. In this lesson, you will accomplish the following objectives:

- Define the ordinary high-water mark and list two types of evidence for finding the ordinary high-water mark.
- Define meandering and describe the circumstances under which you would meander a body of water.
- Describe the various pieces of evidence you should consider when looking for evidence of hydrologic movement.
- Describe the circumstances under which you would survey various land types: islands, seacoasts, and omitted lands.

A key concept in water boundary surveying is **ordinary high-water mark**, which is the edge of the area occupied by the water for the greater portion of each average year. It is the border of land which the water occupies sufficiently long and continuously to wrest it from vegetation and destroy its value for agricultural purposes.

You can find evidence of an ordinary high-water mark by observing:

- Change of vegetation.
- Escarpment or physical markings in the soil.
- Agricultural usage
- Soil types

The area occupied by water for the greater portion of the average year is often well marked by vegetation zones, such as the native trees and shrubs that occupy the uplands.

The zones commonly change from upland type to aquatic type. Absence of vegetation along the upper limits of a shore is an additional criterion.

When using vegetation as a criteria, you will have to research the area to learn what florae are indigenous. If there are periodic overflow areas, you will need to research mixtures that thrive in that environment as well.

## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

Soil escarpments, an indicator of the ordinary high-water mark for some bodies of water, can be located by visual examination.

In coastal areas, driftwood or other beach debris can indicate an ordinary mean high-water mark suitable for meandering.

For complicated but important situations, you can locate the approximate ordinary high-water mark by running elevations around small inland lakes or by establishing gradient elevations along stream peripheries.

Gradient identification might help you avoid meandering low-water escarpments or flood escarpments if you cannot obviously differentiate them from the ordinary high-water level.

Infrequently, the surveyor in the lower 48 states will need to segregate waters in original surveys by meandering. However, familiarity with the proper procedures for meandering is particularly important for original surveys and dependent resurveys of riparian boundaries in Alaska and for understanding the basis of riparian-related surveys in all states.

A **meander line** is the traverse of the margin of a permanent body of water. BLM guidelines provide for the following types of bodies of water to be meandered:

- All navigable rivers and lakes
- Non-navigable lakes with surface area of at least 50 acres
- Non-navigable streams with an average right angle width of 3 chains or greater
- Tidewater streams as far as navigable even when less than 3 chains wide

However, there are exceptions to nearly every guideline. Water bodies that should not be meandered include:

- Non-navigable tidewater inlets or bayous even when greater than 3 chains in width.
- Shallow or intermittent streams without well-defined channels or banks.
- Artificial lakes and reservoirs, seasonal lakes and tundra ponds, playas, dry lake beds, swamp and overflowed lands. Cadastral survey plats should show the position and extent of these features.

To establish original meander lines, you traverse the margin of a

## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

water body using the ordinary high-water mark as a guide. When the average right-angle width of the water course is under the 3-chain limit, meandering is discontinued. The 3-chain guideline also applies to tidewater inlets and small tributaries.

A body of water that should have been meandered in an original survey, but was not, should not be meandered during a resurvey.

If the water body is totally surrounded by vacant public-domain land, however, a new, original survey may be authorized. The most important phase in determining the appropriateness of a riparian survey and in selecting the necessary partitioning methods is evidence of hydrologic movements. You can find evidence by examining:

- Historical aerial photographs.
- Witnesses. (Use discretion.)
- Reliable historical documents and original field notes.
- Upland tree species, soil samples, topography, vegetation, and escarpments.

Modern aerial photography was first used in the 1920's in California and elsewhere beginning in the mid-1930's. If aerial photography from the period in question is available, you can sometimes look directly at an area to check for stream shifting or reliction.

If sequential photography is available (for example, at 10-year intervals) you or a photogrammetrist might be able to see if changes in the location of the ordinary high-water mark were the result of erosion, accretion, or reliction, or the result of an avulsive event. Tree growth and species are conclusive types of evidence pertaining to land in place on a given date.

Living upland tree species, such as oak, hickory, and maple, can be dated by ring count and provide evidence of the highest order. In some cases, remains of dead trees can also be used to provide accurate time frames.

Similarities in soil, topography, and vegetation may present good evidence that a land area was contiguous to adjoining surveyed lands. Sometimes BLM may use a specialist to take a soil sample and prepare a report.



## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

Escarpments are obvious indicators of former stream locations. Use caution, however, when determining whether an actual former stream bank exists or if the escarpment is the edge of a high- or low-water flood plain or a low-water erosion mark.

Flood plain escarpments should not be confused with ancient stream banks. Walking out on an old stream channel will usually indicate an attachment to a present channel as opposed to flood-plane escarpment, which approximately parallels the present channel for an extensive length.

Escarpment lines of relicted bodies are easily identified features of former water levels. As shown by the rocky area, a contour line or line of levels around this body can also substantiate a former lake level. And don't forget the evidence left by preceding surveys in finding former water heights.

Past conditions of a stream shift can be obvious. This scene is the swampy remnant of a former channel. Note the tree stump near the middle of the present channel.

Ownership of the abandoned bed of an avulsed, non-navigable water course can depend on the wording of the original conveyance. Ownership of the bed prior to the avulsion must be determined prior to division of any avulsed beds.

The division of ownership of an avulsed bed of a non-navigable stream will use the outer banks to control a medial line solution if ownership on opposite banks is with multiple owners.

Who owns the new bed of a river body in its new location? Generally, federal law and almost all state laws recognize the owner of the original land that the new channel occupies as being the owner of the bed of the new channel.

However, in the case of navigable rivers, both federal and state courts consider bed ownership in avulsion cases on a case-by-case basis. And, there are exceptions to the general rule.

In cases of accretion and reliction, the federal government may survey and plat any lands added to the federal property, whether

## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

the adjoining water is navigable or non-navigable. The federal guideline is that the riparian owner is entitled to the area in front of the basic holding.

A survey of these lands is usually made when one or more of the riparian subdivisions has been disposed of and the boundaries of the remaining public lands need to be marked.

In certain cases, a meander line can become a boundary line. One such instance is when an accretion or reliction occurs after the survey of a land parcel but before that parcel has been patented by the federal government.

In applying this principle, the accreted land area must be significant (more than 50 percent) in absolute and relative size when compared to the attached parcel. Extension surveys projecting the regular rectangular survey lines across the accreted area to form new lots or aliquot parts are used to delineate this new area. The original meander line then becomes the boundary for the lot adjoining the accreted area.

As a BLM surveyor, you will commonly be involved in the division of accreted or relicted land between adjacent property owners.

The key concept is ownership to the middle of the bed in front of the basic holding.

Purely mathematical establishment of a theoretical median line is not always mandatory or advisable. Past-approved surveys have established partition lines at approximate right angles to the thread of stream by inspection, rather than strictly mathematical construction of a median line.

If a body of water is meandered, islands within that body are required to be surveyed and meandered, depending on whether they existed before or after the state was admitted to the union:

- An island formed in a navigable body of water after the state's admission to the union does not need to be surveyed and meandered by the federal government.
- An island that existed before the state was admitted but was left out of the original survey is subject to federal survey and

## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

ownership. This rule applies to both navigable and non-navigable water.

Original meandering along seacoasts can be difficult, because the ordinary high-water mark is not always as obvious as it is along some rivers and small lakes. But since a meander line is not a boundary line, you can follow approximate lines of driftwood arrangement or vegetation perimeters.

Small land areas inadvertently omitted from an original survey are subject to federal survey if they remain in front of government-owned subdivisions. This omitted land condition is not an accretion situation.

The land rights accruing for the federal government are the same as for any adjoining proprietor.

Once the Bureau of Land Management has decided to survey an erroneously omitted area, one of the following two types of surveys is done:

1. If all subdivisions in a section have remained federal, new lottings and areas between original and new meander lines are established if administratively required.

**Or**

2. If federal and private lands are intermingled in the section, partition lines are run from the original to the new meander lines to protect bona fide rights of the private title holders.

The method for surveying erroneously omitted lands consists of three distinct steps:

- Step 1. Re-establish the original meander line with permanently monumented angle points. Adjust original lines to existent control using the non-riparian meander line, broken-boundary adjustment (Manual 7-53).
- Step 2. Extend the original survey lines across the omitted area if the size of the area warrants it.
- Step 3. Run new meander lines if the omitted tract adjoins or encompasses a meanderable body of water.

## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

### Surveying Methods

Welcome to Surveying Methods. In this section you will accomplish the following objectives:

- Describe how to conduct a meander line survey.
- List the two basic concepts for deciding how to apportion land.
- Name the three methods for apportioning beds of water bodies.
- Describe how to use the colonial, pie, and long-lake methods for figuring perpendicular apportionment.
- List the three reasons you might use longitudinal apportionment.

Meander line surveys begin and end at a meander corner, a special meander corner, or an auxiliary meander corner.

Meander corners are established during a rectangular survey at every point where a standard, township, or section line intersects the bank of a meanderable water body.

Since regular meander corner monuments are especially susceptible to destruction by the elements, consider placing witness meander corner monuments a reasonable distance from water edges.

Special meander corners (SMCs) are used to monument points:

- Where a quarter section line intersects a lake entirely within one section.
- When an island subject to subdivision—that is, 50 acres or larger—is entirely within a section.
- Use auxiliary meander corners (AMCs) to monument points not on a surveyed subdivision of a section line.
- When a meanderable lake is located entirely within a quarter section, then an AMC is established at a suitable place on the lake's margin and a tie is made to a regular corner of the section boundary.

You would also establish an AMC when an island entirely in one section is too small to be subdivided. You can establish an AMC at any suitable place on the island and make a tie to any regular corner on the mainland.

## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

Special meander corners are sometimes used when the starting point of a partition line is monumented. An example is where the subdivision of section line intersects a restored meander line; the partition line is then run across an accretion.

You can also use AMCs if you want to monument the ends of partition lines. In your field notes, you should record in-flowing streams, springs, bayous, rapids, falls, bank elevation, bars, and artificial structures encountered during the meandering.

The broken-boundary method (also known as the compass rule adjustment) is used for restoring angle points of meander lines. The broken-boundary method is outlined in the 2009 Manual (7-53).

Before applying the broken-boundary adjustment, you must locate appropriate original meander corners or restore them if they are lost.

There are several methods for restoring lost meander corners. One easily applied method is a single proportionate measurement. However, the particular conditions on the ground may override this method in favor of another.

You might best determine the latitudinal or longitudinal position of a meander corner by a natural shoreline feature if there is an apparent harmony with the original field notes and if you can verify the proper alignment of an original section line.

The evidence may outweigh the record. For example, a meander corner can be treated as a terminal meander corner, even though the record indicates that lines were extended across the water body.

Another rarely used method is to compare bearings and distances of original meander lines to present shore and bank configurations.

You must first determine that there has been extensive obliteration of possible controlling corners and that the pertinent land area has not been appreciably affected by accretions, erosions, or other water actions.

## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

Another convenient and acceptable method for meandering water bodies is photogrammetry.

If aerial photography is available, an expert photogrammetrist can sometimes define the various sinuosity's with a stereo plotting instrument.

After the meander corners are established or recovered, the needed meander lines are photogram metrically surveyed.

Following cadastral survey directions, the photogrammetrist selects angle points at ordinary high-water lines and at a frequency rate that defines the water body's sinuosity's.

With the photo, the photogrammetrist can often recognize the line of vegetation change or escarpment.

The photogrammetrist then photogram metrically generates coordinate values for both the meander corners and the selected angle point. The course and distances of the meander lines are inversed from the coordinate values.

The apportionment methods covered in this section, which concern both navigable and non-navigable bodies of water, are:

- Proportionate shoreline.
- Perpendicular.
- Prolongation of property line.
- Proportionate acreage.

You should be particularly aware of the proportionate shoreline method, since the 1923 land decision (50 LD 216) and the Johnston v. Jones decision of 1861 accepted this method for federal use. (Manual, § 8-154)

In a proportionate shoreline solution, the new frontage along the water boundary of an accreted area is apportioned in the same ratio as the frontage of the ancient bank.

The following pages illustrate the general principles involved. The principles will be reinforced with a basic proportioning exercise.

Certain modifications may be required under particular circumstances where bays or peninsulas would make strict

## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

apportionment inequitable. The area in brown was determined to have accreted after the original survey. How is the accretion divided?

The first step is to determine the zero accretion point (ZAP) and then restore and adjust the record meanders. A ZAP may not always be located within reasonable proximity to the survey. A line drawn normal to the new meander line may be created as a substitute for a ZAP at a point where the banks are nearly parallel.

The next step is to establish a meander line traverse of the present meander line.

Sum the new meander courses between the ZAP and substitute ZAP (courses 9 -13). Also, sum the adjusted original frontage of the area involved, in this case courses 1 through 7.

These sums will provide the values required to compute a ratio of original frontage to new frontage. This ratio will then be used to calculate the apportioned frontages for each lot along the new meanders.

Compute the ratio of the new frontage to the adjusted record meanders:

$$\frac{\text{New Frontage}}{\text{Adj. Frontage}} = \text{Ratio}$$

Calculate the allotted frontage for each lot. For instance: the northern lot would receive new frontage based on the formula:

$$\text{New Frontage} = \text{Ratio} (C2+C3)$$

Assignment starts from either end of the new shoreline traverse. Calculating each of the apportioned traverse distances results in the accretion partitioning shown. Partition lines are established only between public and private lands, and between any two public land lots.

It is necessary, however, to survey along the frontages of the private holdings. While the proportionate shoreline method lends itself well to apportionment of curving shorelines, it does not work

## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

for “S” or multiple curves.

The following exercise demonstrates the proportionate shoreline method.

Use the data provided in the following pages to calculate the proportioning ratio and the lengths of the new meander courses for each lot.

The illustration shows the adjusted record meanders. Here are the new meander courses along the accreted river bank.

Note that the substitute ZAP was created normal to the new river bank from an existing meander corner. It could have been constructed farther down original course number 8 considering the old and new banks are nearly parallel.

Take a few minutes to compute your answer, then move to the next series of slides to review the solution.

The given data is repeated here for your convenience  
 Compute the ratio of the new frontage to the adjusted record meanders:

$$\frac{143.00}{126.35} = 1.1318$$

Calculate and perform a check sum for new courses.

**ex. New Frontage 2a = 1.1318 (adj. course 2 + adj. course 3)**

The final step is calculating each individual meander course for each lot. Once this is complete, partition lines can be computed and the plat constructed.

The following slide lists the formulas required to compute the individual meander courses. If you had trouble computing the appropriate meander courses, review the past few slides or print them out for additional study.



## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

Formulas for final meander  
line proportioning :

$$R = 1.1318$$

$$C14 = R (C1)$$

$$C15 = C9 - C14$$

$$C16 = C10$$

$$C17 = \{R (C2+C3)\} - C15 - C16$$

$$C18 = C11 - C17$$

$$C19 = \{R (C4 + C5)\} - C18$$

$$C20 = C12 - C19$$

$$C21 = \{R (C6 + C7)\} - C20$$

The perpendicular apportionment method is actually a set of methods involving perpendicular lines. It uses a median or medial line.

Whenever divisional lines are established perpendicular to or from a common reference, the perpendicular term applies.

A purely perpendicular method usually works well with straight shorelines and ownership division of streambeds.

Other perpendicular methods include the following:

- Colonial method
- Pie method
- Long-lake method

The **colonial method** may provide the best equity for a given configuration. With this method, you project a line from meander corner to meander corner. Next, perpendiculars to each projected line are created. The bisector of the angle between adjoining perpendiculars is the resultant partition line.

The **pie method** is probably the best method in apportioning beds of relicted round lakes.

Using your best judgment, establish a center point in the bed, then connect partition lines to the center point from the restored meander corners.

The **long-lake method** is a combination of methods for the apportionment of a lake bed that is long compared to its width.

## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

A medial line is determined first. The relict bed at each end of the lake is divided using the pie method. The radius points for the circles used at the end of the lake are located on the medial line. Divide the remainder of the bed by constructing partition lines from the original meander corners normal to the medial line. The illustrations show a case where the proportionate shoreline method would have caused serious apportionment problems. Division by lines constructed normal to the medial line was applied instead.

These examples also illustrate the principle that accretions should be apportioned “in front of” the basic holding.

The difficulty with extension of property lines is that natural configurations of shoreline ownership preclude straight-out projections with equalization of riparian rights across accretion or reliction. The method is mentioned mainly so you will be aware of all apportionment methods.

Use the **proportionate acreage method** with caution and only after consulting the affected property owners, since erratic deflections of divisional lines are possible.

With this method, you must determine the area of the accretion and then work a simple proportion against the length of the original, individually owned shoreline.

Longitudinal divisions are sometimes necessary for the following circumstances:

**Avulsed waters** - Some administratively determined cases when an exact median reference line is needed instead of an approximate thread of the stream. An island has become attached to the mainland on one side and an ownership division through the attachment is needed.

Remember that the BLM uses thalwegs to delineate boundary lines in some streambeds. Thalweg evidence may be used if a conveyance is to the middle of the main channel or to the middle of the channel. Thalweg evidence used in past cases has included witness testimony, aerial photographs, low points in the bed, and even cross-sections.

## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

In contrast to physically determined thalwegs, median lines are analytically determined.

Median lines are everywhere equidistant from the nearest point on opposite shorelines. These lines mathematically and physically define the center of a water body and usually delineate the middle of a non-navigable and some navigable waters.

A meander-line-dependent median line is intended to define the center of a water body as it is presently constituted. You must determine whether record meander lines fit the banks of the body well enough to accommodate a well-located median line.

New meanders may have to be established or record meanders may have to be restored with the broken-boundary method.

Monumentation and field note descriptions of median lines constitute a particular problem. The special instructions issued before you start the job will indicate the administrative necessities for the median line, which will make it easier for you to make on-the-ground decisions.

You can identify actual monumentation points from the computer printout coordinates. If you need intermediate monuments on straight line segments between angle points, you can use witness point monuments.

In a situation where there are numerous angle points and tightly formed curves, you would probably want to monument only key points, depending on the administrative needs of the survey. The field notes would then call for an unmonumented point, if appropriate.

In writing the field notes for the survey of a median line, you can take as an example the standard working for highway curves using the parameter's information from the computer printout. And of course, the bearings and distances for chords can always be inversed from any two sets of coordinates.

There are cases of water bodies that, for one reason or another, have not been or are not required to be meandered that still require a median-line survey.

## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

The most frequent examples are in Alaska where ground surveys have not been required along meanderable water bodies and there is no field note record of the meanders used to calculate acreages. To delineate the median line between meander lines, you will use a somewhat simpler construction method: the **salient point method**.

As the name implies, a salient point is a point that is prominent by virtue of projecting noticeably outward from the average configuration of a shoreline. A smooth shoreline contains an infinite number of salient points.

Before you compute the coordinates of a salient-point, median-line angle point, an approximate sketch using accurate maps or aerial photographs will help identify the geometric conditions affecting the lines' locations.

All of the lines constructed will be straight lines, all points of which are equidistant from opposite salient points. Angle points occur only at points equidistant from three or more salient points. At least one of the three salient points must be on the shoreline opposite the other two.

By definition, the median line segments will bisect the line connecting opposite salient points at its mid-point and at a right angle.

A simple method of graphing the median line is to find the midpoints between all opposite pairs of salient points and then plot the angle points at the intersections of extended straight lines. The results will be the same as in the previous example.

The most practical graphing combines these two construction methods

- Mathematical computation of median-line angle points assumes that accurate coordinates have been generated for the salient points. The most accurate method of obtaining the needed coordinates is an on-the-ground control survey.
- Once the salient point coordinates are determined, computing the median line coordinates is easy. For midpoint positions between pairs of salient points, add the two X coordinates and

## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

the two Y coordinates and then divide by 2.

For computing median-line angle point coordinates, a series of plug-in formulas are in the 2009 Manual Section 8-69 footnote #1. Computer programs are also available to quickly compute these positions.

### Geology and Water Dynamics

Welcome to Geology and Water Dynamics. In this lesson, you will accomplish the following objectives:

- Describe how water moves in a stream.
- Describe how sediment is deposited.
- Describe the affects of erosion on lakes and other bodies of water.
- List and define the life stages of a river.
- Explain how the movement of water affects the edges of rivers, lakes, seas, and other bodies of water.

When planning for a riparian survey job, it is helpful if you know about the following:

- Geology.
- Geology of the region you will be working in.
- The forces working to create or destroy land forms.
- Land form classifications.
- Running water is by far the most influential agent of erosion. The sediment carried by rivers is the source of accretion.

The transportation of sediment depends on the following two factors:

- Rivers sort sediment by size as a function of velocity of the water column.
- As flow decreases – sediment size decreases.
- The velocity at the bottom of the stream channel is relatively slight, but it increases as you move up the water column. The greatest water velocity is in the middle of the channel.

In mathematical terms, the carrying ability of a stream is proportional to the square of its velocity.

The downstream portions of rivers handle progressively greater

## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

discharges of water, resulting in an increase in width, depth, and velocity, even though channel gradients usually decrease.

The sediment in a water column generally moves downstream. However, turbulence occurs in which particles move backwards and laterally. This particle movement causes erratic erosive actions and sediment movements.

The term **flood plain** refers to an area of sediment deposition when a river overflows its banks during floods. The term also describes a total valley area where a laterally migrating stream has deposited sediment over a long period of time.

Once a river overflows its banks, its greater width causes a drop in water velocity, and sedimentation is more likely.

Geological meanders tend to migrate downstream because of erosion on the outside and accretion on the inside of the bends. Accretions occur when sediment settles as the water's velocity decreases on the inside turn.

Meanders also tend to cut themselves off, resulting in oxbow lakes.

In addition to oxbow lakes, the following features are associated with meanders:

- Cut-offs.
- Meander scars.
- Natural levees.
- Of these, the natural levee is the only one likely to cause a surveyor a problem with ordinary high-water identification.

These levees—alluvial materials deposited near the banks during flood times—consist of low ridges that parallel the water course.

Rivers go through three stages of development.

Stream braiding occurs when overloaded waters lose velocity, choke up otherwise clear channels, and start spreading laterally. The interwoven channels are constantly shifting through islands of alluvium and sand. This feature can make placing the proper meander line difficult.

## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

Although there is no absolute answer for properly placing meander lines, the only practical treatment in the case of stream braiding is to meander along the outer edge of the obviously unstable conditions.

Deltas are accumulations of sediment where streams empty into lakes or oceans. Depending on local geological conditions, their shapes and sizes vary greatly. You can base survey meandering of small delta areas on the ordinary high-water rule.

River terraces are ancient floodplains. These terraces are not part of the present floodplain and are usually far enough away from the stream's present course so that you will not confuse them with stream banks.

The development of shoreline features along some small lakes tends to be indistinct. Some lakes are short lived due to geological influences. Their lives can be affected by the deposit of sediment at the inlet and by erosion cutting down their outlets and, thus, lowering the lake's level.

Some lakes with a floor below the water table are fed by underground springs either with outlets at the surface or with subsurface passages. In such cases, long-term fluctuations in the lake's level could be marked by escarpment lines.

In arid areas where long periods of evaporation exceed periods of water supply, lakes become saltier when the water level drops below the natural lake outlet.

Tracing various stages of the natural relictions can involve a complex array of considerations. In this case, you will need expert assistance.

When trying to determine the ground conditions that existed at an earlier date, it is important to understand how swamps, bogs, and marshes form.

The form of coastlines is influenced by the rock structure, current, tides, waves, climate, and fluctuating sea levels. The topography of some coastal areas can change rapidly.

Many coasts have definite nicks or scarps caused by attacking waves. Typically, ordinary high tide is seaward or immediately

## WATER BOUNDARY SURVEYS WEB-BASED COURSE

---

adjacent to the scarp, which are also known as sea cliffs. Sea cliffs vary greatly in appearance and structure, depending on the area's geology.

A wave-cut bench commonly extends seaward from the sea cliff. When a bench is covered with impermanent deposits of sand or gravel, it is a beach. Usually, you will have difficulty in determining an ordinary high-tide level in a beach area for two reasons:

- High tides usually occur twice a day.
- Winter storm waves sometimes sculpt the land inward.

Storm waves can cause a high-water platform to form above a sea cliff. Do not confuse this erosional feature with the features that normally occur with high-tide waves.

Tsunamis are high, single waves that can completely remove beaches and shove beach material long distances inland.

Conversely, beach accretions are much more likely during periods of quiet water. Two other coastal features are bars and spits.

Bars are embankments of sand or gravel constructed on a sea floor by waves and currents. They emerge only at low tide and, thus, are not part of an upland survey.

Spits are sediments deposited by long-shore currents. They are attached to land at one end and, although they can assume a number of curved forms, are commonly parallel to the coastline. If the main land connection of the spit is above ordinary high water, it could be considered as part of the upland.

Spit configuration is strongly influenced by storm waves, and portions of the spit may lie above ordinary high-water level.

### Summary

Congratulations! You have completed the Introduction to Water Boundary Survey course. We hope that you have found this to be an interesting and rewarding learning experience.



## **WATER BOUNDARY SURVEYS WEB-BASED COURSE**

---

This program has introduced landmark legal cases, legal principles, survey concepts and possible solutions to situations you will likely encounter during your Cadastral survey career.

This introduction is by no means all inclusive. We have examined the very basic concepts and elementary examples of riparian boundary problems. The important lessons to remember are that meander lines are not boundaries and that there are few situations that call for simple solutions.

The study of riparian boundary law and the surveying and dependent resurvey of riparian boundaries are complex undertakings. Proper survey solutions are found only after extensive investigation, application of the principles presented here and your knowledge and experience. Continued study and increased exposure to riparian boundary situations will provide you with rewarding and fulfilling experiences and promote your standing as a professional land surveyor.

## Course 5: Introduction to Water Boundaries Study Guide

**COURSE DESCRIPTION:**

This course consists of an interactive course on the basics of water boundaries. It is not intended to make one an expert, but rather, to raise awareness of riparian issues. It is followed by a short field video where a State Cadastral Chief offers advice and help from the BLM whenever you face riparian issues that may involve federal interests.

**COURSE OBJECTIVES:**

Upon completion of this course, students will be able to:

- Learn basic riparian boundary survey terms
- Identify boundary issues which arise when working on or near bodies of water
- Demonstrate a basic understanding of simple riparian problems









**COURSE INSTRUCTOR(S):**

Ron Scherler, Bureau of Land Management  
Randy Zanon, Bureau of Land Management

**VIDEO LECTURE TITLE:**

Water Boundaries (12 minutes)

ICON LEGEND

 WEB COURSE	 EXERCISE	 DIAGRAM	 READING ASSIGNMENT	 PROBLEM	 HANDOUT	 2009 BLM MANUAL	 QUIZ
---	---	--	---	--	--	---	---

## WATER BOUNDARIES

---

Hi. We are here on the banks of the Verde River in central Arizona. I'm here with Randy Zanon the Cadastral Chief from the Colorado state office. And the CFedS candidates you have just finished the Introduction to Water Boundary courses.

Randy, what kinds of advice can you give these students about a project that may involve some kind of right riparian issues.

Well Ron, I think I would advise these CFedS candidates to contact their state cadastral survey office to get advice on any kind of riparian issue. Especially before they develop the cost estimates because a riparian consideration could easily be a greater cost than the survey themselves. To contact their state office to get advice and record and stuff like that with the legal implications and things that they might run into it would be advisable for them to contact their state office as soon as possible.

So even BLM, when their involved in surveys that involve riparian issues are concerned about all the issues that can come up. The legal ramifications, the cost of survey that sort of things. Absolutely. Absolutely. They're probably one of the toughest types of surveys that we deal with. We have all the records there and everything and even some of the surveys that we do are sometimes overturned in court.

So Randy, have you had any in Colorado you can think of that ended up being much more difficult and had issues that you hadn't really anticipated in the beginning. That's correct. We did. On the Colorado River in western Colorado, we did a survey about 10-15 years ago on nine islands in the river. We thought we had everything right, we'd done our research, we'd hired outside sources - dendrochronologist, geomorphologist. And IBLA overturned our case. And I can't imagine a CFedS walking into that type of situation and having to resolve those types of problems.

So are there any special issues with Indian lands, reservation boundaries, trust boundaries, those kinds of considerations. Absolutely. You know a lot of reservation boundaries or treaty boundaries were established along ago and a lot of them are on

## WATER BOUNDARIES

---

riparian boundaries. They got water boundaries as part of their borders and so you know you get accretions, you get avulsions on top of accretions and over the years and it can become just a real nightmare for a CFedS or private surveyor coming in trying to resolve that without some assistance.

You know Randy; we are here on this stream. It's a small, slow moving stream, fairly insignificant it appears, yet you're saying there could be riparian issues that could be unforeseen and very important issues. What kinds of things might happen? Well absolutely, you know as you said it is tranquil stream now but it is meandered on both sides.

The meander is on the east bank or a chain off to the east and the meanders on the west bank are like three chains away. I guess the point I'm trying to make is that whether a stream meandered or not meandered whenever you have riparian issues involved you know you're going to have, especially with the upland owners, you're going to have issues that are going to come into play with riparian ownership that are different than a standard boundary survey.

Well another thing here, we're looking downstream and behind us it is tranquil it is brush we appear to be out in the middle of nowhere. But as we look in the other direction the highway crosses on the other side of the highway there are subdivisions, what kind of issues does that bring up? Well you know as you said we got the highway crossing right up stream from us, we got the subdivisions and development coming right down to the river. This is a big problem throughout the west not only here in Arizona but Colorado, New Mexico and other states. That rural/urban interface and you get high dollar value homes built and often times they don't get the proper surveys done before they build their developments or their homes. And you see you get all kinds of trespassing and encroachment issues that come up so you its really key for a CFedS candidate to get a hold of their BLM surveyors get a hold of the BILS in your BIA office.

You know we want to work with you; our goal is to make sure that we have a legal and defendable survey and we want to be a part of that. The BLM doesn't work in a vacuum, we want to be a part of that to help you and assist you with getting the survey done so that it's legal and defendable.

## WATER BOUNDARIES

---

So Randy, what kind of legal issues might we be involved in with reservation boundaries? Well you know, the language in reservation boundaries a lot of times is very vague and unsettled and you throw into the mix their riparian boundaries and it just compounds the situations that you might have.

So with reservation boundaries we have problems to begin with because with treaty language and then you put riparian issues in that just compound it, it can be some real problems. Absolutely. Absolutely.

So if I'm a CFedS I'm contacted by a tribe or a reservation the BIA to do a survey involving riparian issues, what should I do? Well my advice would be to have the surveyor contact the BILS surveyor in the regional BIA office where he's working their the subject matter experts in a lot of these cases they have access to volumes of records that we could get and their really your first line of contact and then they can direct you to the state BLM office for additional help with riparian issues that we've probably already dealt with or similar situations that we've probably already dealt with.

So, what's your overall advice? If I'm a CFed Surveyor I'm dealing with a riparian issue, sum it up.

Well my overall advice would be, don't try to do it on your own, come to us. We want to work with you; the BLM doesn't work in a vacuum. We want to work with the BIA with the BILS surveyors and the BIA and that doesn't matter whether you're a CFedS or a contract surveyor, or a private surveyor, our goal is to make sure that the surveys that are done on federal interest lands are defensible and correct. That's the whole goal, so we have the resources, we have the records, come to us for that information and let us help you. Because like I said the BLM doesn't work in a vacuum we want to work with you not against you.

Alright, well thank you Randy and I think this pulls together the introduction to water boundaries course that you've just viewed. And we begin to see that there are a lot of issues out there and they can become very complicated issues and we've really looked at, you have some resources, you have some people to go to for help

## WATER BOUNDARIES

---

and hopefully you'll take advantage of that.

We've moved now a little higher into the mountains we're along a small stream and in fact this stream was not meandered in the original survey but Randy you're telling me that we could have riparian issues here as well. Exactly Ron, a small stream like this for instance just off to our right here is a homestead entry that was patented in the early 1900's and it's been reacquired by the federal government.

The deed calls the boundary to be Oak Creek and we don't know exactly where but we can determine where the center of the stream or the median line you have those issues, those riparian issues that can crop up. As you can see, behind us here the water has been up at higher levels at certain times of the year, flood events so you could have accretion or even evulsions in a heavy flood event and those things could affect the boundary line.

I can just imagine the values along a stream like this, this is a beautiful place the values are probably sky high. Again with that urban/rural interface and more people moving out into the forest and purchasing small lots and building homes they get up against something like this you could have all kinds of riparian issues that could determine the property ownership.

Now lets get back to the reservations a little bit, what kind of legal issues when we're dealing with Indian land, specifically reservation boundaries might we come up against? Well a lot of reservation boundaries are bounded by streams such as this right here small unmeandered streams.

The language is sometimes vague as to exactly where the boundary is, they're open to interpretation and so you could have all kinds of legal ramifications and implications that come into play when you're talking about riparian boundaries of the Indian boundaries. With a small stream like this it's pretty well defined but when the waters up we can see it gets a little bigger. If we get out into flat lands even a small stream like this can move around. Exactly. Exactly. And that's where your accretion comes in and the change in the property lines so to speak. Sure. Sure.

## WATER BOUNDARIES

---

Well, last question. What kind of overall advice are you going to give a CFed Surveyor in dealing with riparian issues? Well my advice to the CFedS would be first of all contact your BILS surveyor in your regional BIA office.

They are the subject matter experts, they have a lot of experience in dealing with these types of riparian issues, they have access to hundreds of old records, old aerial photographs and so work with them. And they would even direct you, if they couldn't help you directly; they could direct you to your BLM cadastral state office where there are even more subject matter experts and more records that they could obtain. I guess the point that I'd like to make is we would like to work with the BLM, with the BILS surveyors. Our goal is to make sure that you have a defensible and accurate survey when it's all said and done and for a CFedS to jump into something like this with riparian boundaries without any help would be really fatal almost. And so we don't work in a vacuum and we want to help you and we're there to help you.

Alright, well thank you Randy. You bet. Well this completes our segment on introduction to water boundaries and I hope you've gained a new insight into some of the issues. I think, as Randy said, the bottom line is take advantage of all those resources out there. Take advantage of the BILS, the cadastral staff and other CFed Surveyors who have experience in these issues.



**QUIZ**

**It's time to take the Course 5 Quiz which you can access from the CFedS website.**