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From All Sides

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Gradient boundary explained

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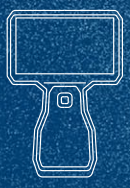

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Our Broad Scope of Services

From the day that Europeans set foot in America the surveyor has been expected to document feature attributes including flora, fauna, soil classifications, bodies of water, type and nature of structures and fences. The great cadastral surveys of the American west were focused on the collection of feature attributes. The forefathers of geospatial info related mountains, streams, and saltlicks with rudimentary precision. Conversely, accurate descriptions and the magnitude of features were the real value of the survey. Nothing has changed with the moon landing. We're just doing the same thing in an artificial frontier.

Modern imagery supplemented with feature data often provides sufficient info for municipal decision makers to arrive at effective solutions. Likewise municipal maintenance doesn't necessarily require a set of engineering drawings. What's important is managing the tasks around the infrastructure. The dependence on knowing who, what, where, when, why, and cost, exceeds the public desire for a certified gnat's ass punch mark on an object you're going to trip over anyway. The surveyor's value to a public agency is ensuring that work was performed with care under the charge of the competent registrant. Cities don't need a Superman flying around the world backwards to reshape the geoid. They need folks that can manage geospatial projects and maintain the built environment. Analytics from this data are what the community leaders use to repave your street, build the trails in your park, and keep your house from burning down.

The current state of the profession most certainly capitalizes on our tools and ability to capture data. Contemporary knowledge, skills, and abilities include database management, scripting, and systems troubleshooting. Connectivity, positioning, and software are also in the tool belt. A surveyor's value in a modern organization is greatly enhanced by database manipulation, connectivity troubleshooting, hardware/software compatibility, and most certainly a minimum competence with ESRI's platform.

I recently watched the Carlson Software team wrap it all up in a user friendly package that hands the keys to the kingdom back over to the surveyor. We're there folks! Every surveyor, no matter how big or small owns a piece of the GIS pie and a seat at the table. The next step is finding fresh talent in our overly ripened demographic. Look for the bright bulbs that are engaged in data connectivity fields. The ambitious kid that helped you at the mobile phone store did the following; Engaged the helpless client (you), collected background information regarding the need or scope of services, troubleshot the symptoms, analyzed the hardware and software, resolved the issue, then documented the incident attributes in a database. The solution driven self-motivated mindset has always prevailed in surveying. Heck, that's what makes a party chief, right?

I can't believe I still hear some ding-a-lings say stuff like "GIS stands for Get It Surveyed". For twenty five years they've belittled the value of GIS and quite frankly I'm done with their poo-pooing. This behavior is nothing more than laziness toward professional development. Fools afraid of tools project their inferiority complex by casting doubt when in fact they are just admitting their own professional and technical ignorance. The contemporary surveyor has the greatest mapping tools in the history of civilization. Lead, follow, or get out of the way, but for God's sake don't decry the opportunity then pull the "sky is falling" routine when someone else embraces it. Ironically, the good news is these naysayers are washing themselves out of our profession. I guess Darwin was right after all. ■

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THE **ONE** THAT STARTED IT ALL

“ THE SX10 IS OPENING UP
A WHOLE NEW RANGE OF POSSIBILITIES.

- Even Sellevoll, Geomatikk Survey

“ WE COULD KEEP OUR FEET ON THE GROUND AND
SAFELY MEASURE REMOTE OBJECTS.

- Joel Cusick, U.S. NPS

“ WE HAVE WITNESSED
BETTER RETURNS THAN ANY OTHER SYSTEM.

- Terry Nygaard, Tx RPLS

“ THE HIGHEST TECH PIECE OF EQUIPMENT
I'VE EVER USED.

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WE'VE HAD IN THE PAST.

- Matt Bryant, NTT DATA

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- Niels Balens, BAM Contractors

“ FASTER IN THE FIELD
AND MUCH MORE ROBUST.

- Steve Sharron, WSP

“ WILL DEFINITELY
REVIVE THE WHOLE INDUSTRY.

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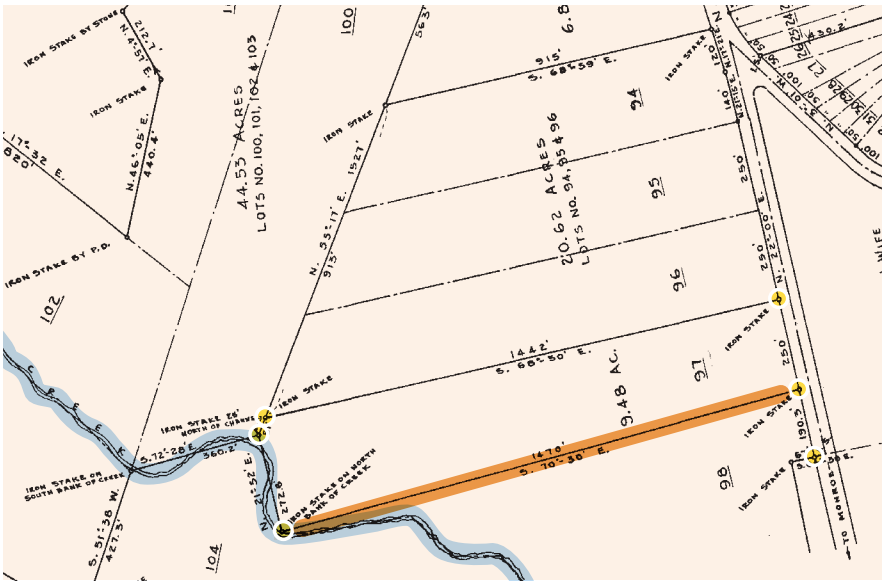
decided guidance: case examinations

Anderson/Griffin Properties v. Wallace Construction & Barrett

Anderson/Griffin Properties v. Wallace Construction & Barrett was debated in North Carolina and settled about a decade ago. It's still just a pup in "court years" and we are looking at the decision of an appellate court. Despite the simplicity of the decision there's whole lot of monkey motion and organ grinding to tally up here. So, let's start with this month's totals.

- 1 plaintiff
- 2 respondents
- 1 trier of fact
- 1 order by the Clerk of the Court per North Carolina General Statutes § 38-3
- 8 Surveyors as follows:
  1.) Guy Fisher
  2.) Jack Ritchie
  2.) ~~Jack Ritchie~~ oops, he wasn't licensed
  3.) Jim Craddock
  3.a) Jim Craddock, again.
  4.) Carol Rushing
  4.a) Carol Rushing, again.
  5.) Greg Flow
  6.) Thomas Harris
  7.) Robert Spidel
  8.) Mel Thompson
- 2 axles.
- An undisclosed number of timber hacks.
- 9 years of litigation.
- 54 findings of fact.
- 6 conclusions of law.
- 15 challenges to those findings of fact.
- 3 witness surveyors in agreement.
- 1 witness surveyor running it by the numbers.
- 11 specific citations of standards for the court to follow.



The original plat shows original monuments. The creek (blue) and subject line (orange) have been colored for this article.

- 1 general citation of monuments controlling the calls.
- 2 statements that the objective of the survey is recovering corners not re-establishing them.
- 1 application of the terms "accretion" and "erosion".
- 1 railroad.
- 1 U.S. Highway.
- 1 SDR (Stop, Drop, n Roll)
- 1 P.O.T.U.S. quote- that's a rare treat in Decided Guidance.
- 2 citations of "What a boundary (is)...is a matter of law, where it is located...is a matter of fact".
- 4 references to "walking in the shoes of the original surveyor".

Boy howdy, that's quite a list! I'm surprised that the petitioner's consul didn't object to the presumption that every surveyor can afford shoes to walk in. Buh-duh-dunt, "I'll be at the comedy club all week, tip your waitresses well". Okay, back to the day job, this case is Survey 101 stuff. Monuments control, mistakes are isolated as mistakes, and for gawd's sake don't expect the most ridiculous interpretation of a broken plat to serve as evidence of anybody's intent.

So, let's "go all NTSB" on this case and reconstruct the scene if the accident. "*The hierarchy of evidence that surveyors typically use to draw a survey map gives artificial or man-made monuments precedence over courses and distances. However, Spidel used the courses and distances methodology to determine the corners of the property and the boundary between lots 97 and 98 because* ***he thought*** *this methodology was more reliable in this case.*" The brake pads started

The tax map layer shows the structures and road in harmony with the property lines. The argument plotted one owner (Anderson) against two(Wallace & Barrett).

An aerial compiled with a parcel layer shows the lay of the land within the accuracy of the fuzz called out in a typical GIS disclaimer.

to fade right here. The standard of care was disregarded and replaced with a personal preference. I get uneasy when my colleagues express results through some sort of clairvoyant decision-making process. They're not necessarily wrong, but my rebuttal is "What evidence do you have to support that decision?" Evidence leads to fact, and fact leads to conclusions. We don't have the authority to decide where a corner belongs, but rather the obligation to recover evidence of where the corner landed. This is best summarized by the honorable Chief Justice Thomas Cooley. *"When a man has had a training in one of the exact sciences, where every problem within its purview is supposed to be susceptible of accurate solution, he is likely to be not a little impatient when he is told that, under some circumstances, he must recognize inaccuracies, and* ***govern his action by facts*** *which lead him away from the results which theoretically he ought to reach. Observation warrants us in saying that this remark may frequently be made of surveyors."*

Smoke really started rolling off the petitioner's brakes with this observation by the court. *"...Rushing "****built this line****" by starting at a point to the north of Hwy 601 and proceeding with the distances of the other lots until* ***he "established"*** *the front common corner of lots 97 and 98."* The terminology emphasized here is synonymous with the tasks performed during a land partition rather than a retracement. I'm sure Rushing knew what he was talking about but I'm not sure the court interpreted his words the same. Remember when President Obama said, "You didn't build that"? Well, in this case he'd be right, and this is a constructive place for a surveyor to stick that sound byte for future looping. The court then observed *"...Furthermore, Rushing also testified that he was hired to "****reestablish****" the line between lots 97 and 98. The trial court found that Rushing "****tried to restore footage*** *to petitioner's lot 97," rather than honor the original axle irons that marked the boundary of lots 97 and 98. That is, Rushing did not attempt to locate the original boundary line; he simply tried to restore the shortage that arose due to the floating error by establishing a new line."* The court concluded that Rushing may have not applied the appropriate standard of care.

We are privy to fifteen of the fifty-four findings of fact in this case. Although not a riparian case, somebody offered a riparian concept to support the position of a monu-

Barbershop Barrister—An Item of Debate

First things first in the Barbershop. North Carolina Barbeque is hands down the best barbeque in the world. Carolina Barbecue is the original American barbeque and is served the way God intended pork to be eaten, with vinegar. *The American Surveyor* Magazine officially honors of the Tarheels' perpetuation of this great American tradition. Okay, now onto my debatable point...

North Carolina General Statutes on Boundaries § 38-3 offers a land owner an opportunity to petition the Clerk of the Court and assert a boundary claim. The Clerk is authorized to adjudicate the location with the aid of the County Surveyor. The process seems like a good idea to quiet title where a defendant is a John Doe or silent. I'm not sure that happens with land except maybe with a gap or some ancient title defect, or maybe with someone deceased??? However, in Anderson it just seems like it prolonged the inevitable trial. It also forced an unnecessary eighth survey and no doubt cost somebody money and time.

From my perch it seems like attempts at legislating common law never really work. Maybe I only see the failed results, but when legal cookbooks fail, they fail big. Here's my take after a few hours of watching C-Span in the 1990's. A legislature tries to package the wisdom of the court in a shipping box. They must cut breathing holes in it, or the law will suffocate and die. After everybody gets their cut, we end up with a useless shell that doesn't really hold anything in it or keep anything out, but it sure as hell makes it to our doorstep, half empty, soaking wet, and crushed. The moral is you just can't automate the equity of a court.

In Anderson the Clerk faithfully followed the letter of the law and was stuck with forcing a non-binding opinion down the throats of anyone dumb enough to accept it or too poor to fight it. I like to think I'm the latter, btw. On the other hand, we've all had our share of crazy "boundary dispute" calls that have ended with the statement "Ma'am, you don't need a Surveyor, you need the number of a good behavioral therapist". So, if the process smokes out the riff raff then it might just serve a good and higher purpose. I suspect I'd take that good with the bad on this one. I also wonder if the attorneys are obligated to exhaust this precursory step or if they can skip it based on the merit of the case. North Carolina has about 390 years of experience at this game. I'll yield to the General Assembly and grab another pulled pork sammich with a side of N.C.G.S. § 38-3:

(a) Petition; Summons; Hearing.—The owner shall file his petition under oath stating therein facts sufficient to constitute the location of such line as claimed by him and making defendants all adjoining owners whose interest may be affected by the location of said line. The clerk shall thereupon issue summons to the defendants as in other cases of special proceedings. If the defendants fail to answer, judgment shall be given establishing the line according to petition. If the answer deny the location set out in the petition, the clerk shall issue an order to the county surveyor or, if cause shown, to any competent surveyor to survey said line or lines according to the contention of both parties, and make report of the same with a map at a time to be fixed by the clerk, not more than 30 days from date of order; to which time the cause shall be continued. The cause shall then be heard by the clerk upon the location of said line or lines and judgment given determining the location thereof.

(b) Appeal to Session.—Either party may within 10 days after such determination by the clerk serve notice of appeal from the ruling of the clerk determining the said location. When notice of appeal is served it shall be the duty of the clerk to transmit the issues raised before him to the next session of the superior court of the county for trial by a jury, when the question shall be heard de novo.

(c) Survey after Judgment.—When final judgment is given in the proceeding the court shall issue an order to the surveyor to run and mark the line or lines as determined in the judgment. The surveyor shall make report including a map of the line as determined, which shall be filed with the judgment roll in the cause and entered with the judgment on the special proceedings docket.

(d) Procedure as in Special Proceedings.—The procedure under this Chapter, the jurisdiction of the court, and the right of appeal shall, in all respects, be the same as in special proceedings except as herein modified.

ment. *"The existing rear axle iron contended by Wallace as the rear common corner of the parties is located on the north side of Muddy Creek. The C.M. Bost Estate map calls for an iron at the corner to be located on the north side of Muddy Creek. The existing axle iron is on the inside bend in the creek making it unlikely that the creek eroded the bank causing the iron to be moved over the years. Water in a creek erodes on the outside of a creek bend where the water flows faster. Accretion, not erosion, usually occurs on the inside of a bend in the creek because the water flow is slower."* This is solid testimony leading to a finding of fact. Sharing an understanding of riparian effects helped the court understand the natural conditions of the land.

This month's S.D.R. lies within this observation. *"Rushing performed a survey of the disputed boundary line in 2000 before this litigation began, and Rushing re-did that survey in 2002 based on additional discoveries toward the southern portion of the lot."* I have no polite way to say this. You can't un-shit your pants. I don't mean to discredit Rushing because things do come up after we assemble our evidence packages. Furthermore, both of Rushing's opinions straddled the proceedings which may have diminished the stability of his amended opinion. I'm merely speculating. However, for the cause I will urge everybody to exhaustively search for evidence and document every effort whether successful or failed. Our degree of diligence is paramount in supporting a conclusion of law. Good old Fred Boreman always said "If we can't find it Jase, let's dig deeper than anyone else to make sure they can't find it either." He applied that logic to both shoveling and research. The thought being that our conclusion would actually be conclusive and stable.

Beyond the obvious "monuments control" lesson here, we see the importance of diligence and perhaps the diminished force of an incomplete opinion. It seems like a "clerk appointed" survey holds no more water than any other survey. In this case, as observed by other courts throughout history, adding another surveyor doesn't fix the problem. I can't help but to speculate that the honor of serving the clerk of court might muddy the definitions of "ropes" and "robes" in the duty of a civic minded surveyor. The Appellate Court was quick to remind us that our function is retracement. ■

Jason Foose is the County Surveyor of Mohave County Arizona. He originally hails from the Connecticut Western Reserve Township 3, range XIV West of Ellicott's Line Surveyed in 1785 but now resides in Township 21 North, Range 17 West of the Gila & Salt River Base Line and Meridian.

From All Sides

Det. Gunderson operates the WSP's Matrice 200 UAV.

No one would dispute that courage is at the core of any police officer. It takes a certain braveness to dress for a job in which every day is a mystery—people could go missing, be hurt, be fatally wounded—and one's own life could be at risk of injury or worse.

For detective Eric Gunderson of the Washington State Patrol (WSP), that fearlessness extends to his department's adoption and use of technology, where they regularly move beyond spec sheets to discover new and innovative ways to make technology work for them. For example, they once hung a Trimble TX5 laser scanner upside down through a sun roof to scan the inside of a car. (It worked).

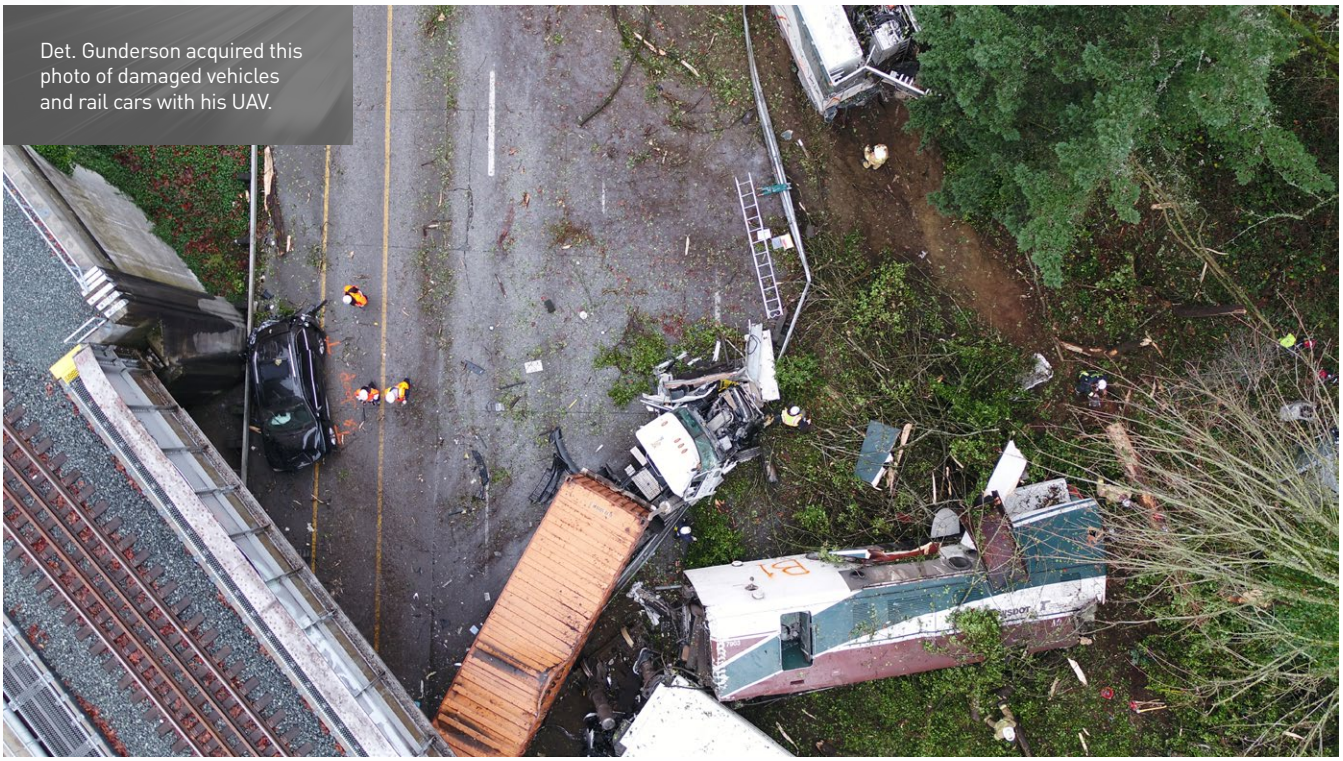
This level of comfort with advanced technological tools has come from years of asking "What if," and a willingness—from the

Wreckage from the Dupont train derailment captured by a Trimble TX5 laser scanner. In total, four teams collected 82 scans and more than one billion data points in five hours.

Gunderson integrated scanning data and UAV photos into Trimble's RealWorks software to create a 3D point cloud of the incident scene. In this view, orange markers indicate the location of each of the 82 set ups taken with the Trimble TX5.

Integrating laser scanning and UAV data gives investigators a new 3D view

» MARY JO WAGNER



Det. Gunderson acquired this photo of damaged vehicles and rail cars with his UAV.

chief down—to embrace technology that can benefit both the WSP and the people it serves.

Laser scanners are now as common as radios for each of the WSP's 15 detective units across the state—the scanners have been in the field for the past four years. And in 2017, they began adding Unmanned Aerial Vehicles (UAV) to their arsenal of technology.

"Whenever we acquire new equipment, my captain always says, 'This technology is another tool in your toolbox,'" says Gunderson, the WSP's technology liaison based in Tacoma. "So, if you need a Phillips [screwdriver], you've got one. If you need a flat head, you've got one. No one tool will solve all your needs. It's important to get comfortable with many different tools both in the field and back in the office."

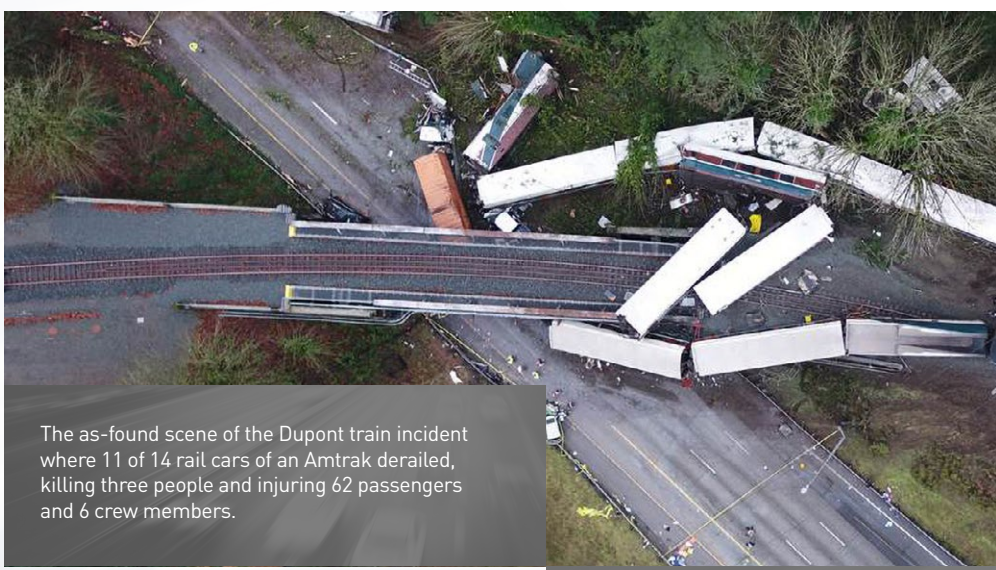
Indeed, Gunderson's penchant for experimentation has been key to becoming at ease with technology. Case in point: soon after acquiring their first UAV, Gunderson used Trimble RealWorks Forensics software to test the possibility of merging scan and UAV data of the same scene into one, integrated point cloud. It was not only a success; the integrated forensics view has become a formidable tool for accident reconstruction cases, which make up 65 percent of their responses.

"Individually, both laser scanning and UAV have their strengths and benefits in the field," says Gunderson. "But the ability to seamlessly combine the two different data sources into one point cloud gives us a complete 3D view from all sides of a crime scene. That is an additional and powerful forensics tool. The technological versatility we have makes us confident that we'll be able to respond to any incident and investigate it thoroughly."

And it's a good thing, too. Because it was that same level of comfort with technology that gave WSP responders the confidence to answer the call to the 2017 DuPont train derailment outside Tacoma, Wash.—an accident so unpredictable and so massive that no training drill could have adequately prepared them. It not only put the WSP to the test, it provided the opportunity for Gunderson to push the limits of the integrated scanning/UAV point cloud approach and display it on a national scale.

Responding from all sides

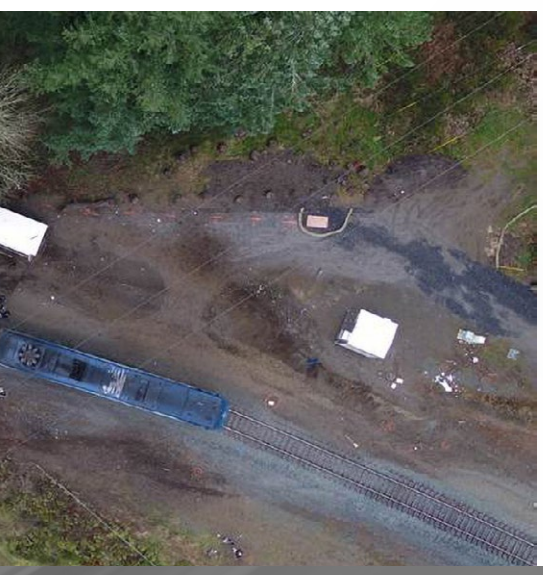
On the crisp early morning of Dec. 18, 2017, an Amtrak passenger train was making its inaugural run between Tacoma and Portland, Oregon. As it neared a curve



The as-found scene of the Dupont train incident where 11 of 14 rail cars of an Amtrak derailed, killing three people and injuring 62 passengers and 6 crew members.

While the teams were scanning the tracks and roadway, Gunderson flew the scene with the UAV and collected 682 photos with the unit's 20MP camera.

> "At the accident scene, you only get one shot to get what you need. You can't put the trains back where they used to be, so you need to be right the first time."



leading to an Interstate-5 overpass near DuPont, the train was traveling at 78 mph—50 mph over the speed limit—and the lead locomotive, along with 11 of its 14 rail cars, derailed. It was 7:33 a.m. and I-5 was already teeming with commuters. The lead locomotive and three rail cars landed on I-5, causing a 14-vehicle pile-up. Three of the 77 passengers onboard the train were killed and 62 passengers and 6 crew members were injured. The initial damage was estimated to be $40 million.

"Where this happened couldn't have been a worse spot as far as impact to the region," says Gunderson. "I-5 is the major artery between Tacoma, Olympia, Portland and Seattle. With Puget Sound to the west, the Nisqually River to the south and a military base to the east, your only driving option is I-5."

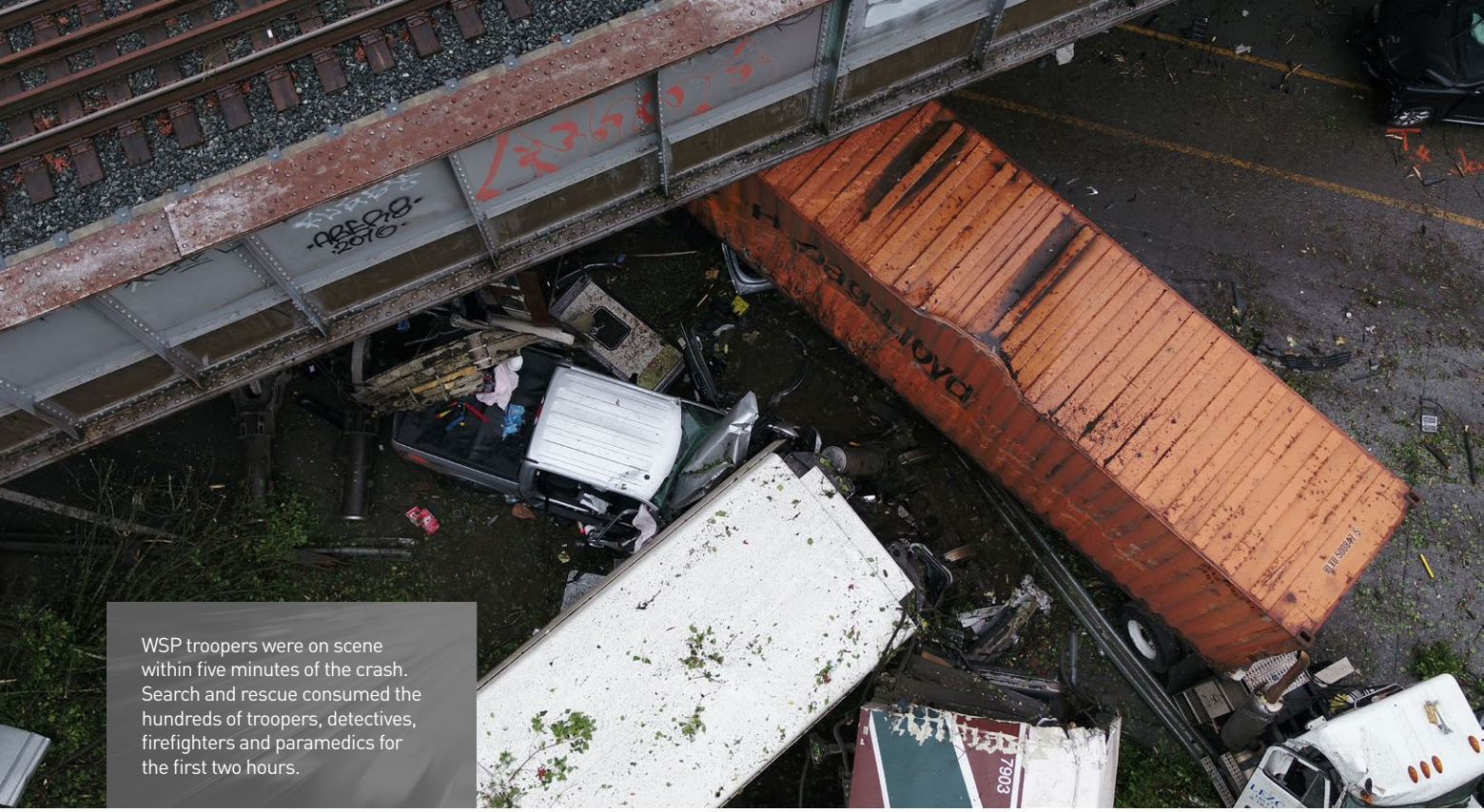
WSP troopers were on scene within five minutes of the crash. By 8:30 a.m. the scene was swarming with hundreds of troopers, detectives, firefighters and paramedics, all of whom had one thing on their mind: rescue.

"For that kind of incident, the last thing you're thinking of is preserving evidence," says Gunderson. "If I need to move a train or car to get someone out, that's what's going to happen. So our first hour was consumed by all lifesaving first. But once we cleared the scene, everything began to slow down and we could start investigating. Then we owned the scene."

Working in collaboration with the National Transportation Safety Board (NTSB), the lead investigating organization, Gunderson led the accident reconstruction phase, bringing in four Trimble TX5 scanners and one DJI Matrice 200 UAV. Although he had been successfully using Trimble RealWorks Forensics to merge scan and UAV data into point clouds, he had never applied the approach to an incident of this magnitude.

Teams of WSP collision investigation detectives first walked through the debris-riddled scene, taking photographs, painting the footprints of important objects such as cars and tire marks, and documenting them. In parallel, he dispatched two teams per each of the four TX5 scanners and split them into two groups, one to work on the overpass section and one to manage the roadway section.

Setting up on each end of the tracks, the railway teams methodically moved towards each other, scanning all four sides of the



WSP troopers were on scene within five minutes of the crash. Search and rescue consumed the hundreds of troopers, detectives, firefighters and paramedics for the first two hours.

individual rail cars and any strewn debris, and recording each object as it was found. The ground crew followed the same process. Starting at each end of the I-5 scene, the teams collected data points of the rail cars, vehicles, roadway, tire marks, paint marks, and anything that lay within the boundaries of the accident. In total, the four teams collected 82 scans and more than one billion data points in five hours.

"What's awesome about scanning is that it ensures you don't miss anything," says Gunderson. "At the accident scene, you only get one shot to get what you need. You can't put the trains back where they used to be, so you need to be right the first time. Scanning captures everything incredibly quickly and often captures something you didn't know you'd need."

While the teams were scanning the tracks and roadway, Gunderson flew the 920-ft-long by 340-ft-wide scene with the UAV. After a 10-minute set-up, he flew an overall pass at 200 feet at roughly 70 percent front lap and 50 percent side lap to establish a base. He flew a second pass at 100 feet and a final flight at altitudes between 15 feet and 50 feet to acquire some oblique photos. In 89 minutes, Gunderson collected 682 photos with the unit's 20MP camera.

"I could've handled the accident with just one technology, but given its scale, I wanted to have data redundancy," says Gunderson. "The drone would provide different view angles since the scanner can't get the top of the train. In addition, with the volumes of data I'd collect, it would be a great opportunity to test how well I could merge the two massive datasets together."

By 2:00 that afternoon, Gunderson was able to pack up the gear and head back to the office to process the data.

Creating a complete 3D picture

For efficiency, Gunderson loaded the UAV photos into their photogrammetry software for batch processing overnight, so when he returned to the office the next morning, the data would be ready.

Preparing the 3D point cloud began by importing the 82 scans into the RealWorks software, which allows investigators to quickly register, segment and classify 3D laser scan data for analysis and reconstruction. As there was data from four different scanners, Gunderson had to first group and register, or stitch together, all scans from each scanner to produce four scan-data groups. Then he merged each of the four groups to create one overall point cloud.

Since teams were collecting data during the active accident investigation, the scanners also captured the hundreds of responders working the scene, which resulted in superfluous or "parasite" points. RealWorks provides automated clean-up tools to help clear unneeded points. With the automatic classification feature, he moved irrelevant objects into designated layers and removed the parasite measurements from the finished point cloud.

"RealWorks' ground extraction tool is excellent," says Gunderson. "I can separate the ground from another layer, and then cut out the parasite points like the police cars, fire trucks, and people walking around so I can produce the clearest model possible. Being able to almost freeze the scene gives us more confidence when investigating after the fact."

With the laser scan point cloud complete, Gunderson focused on importing the processed UAV point cloud into the RealWorks point cloud. Once imported, he used the automated extraction tool to clean up and remove any superfluous points and then combined the dataset with the master point cloud to produce the final 3D model of the train derailment. The two came together perfectly, he says.

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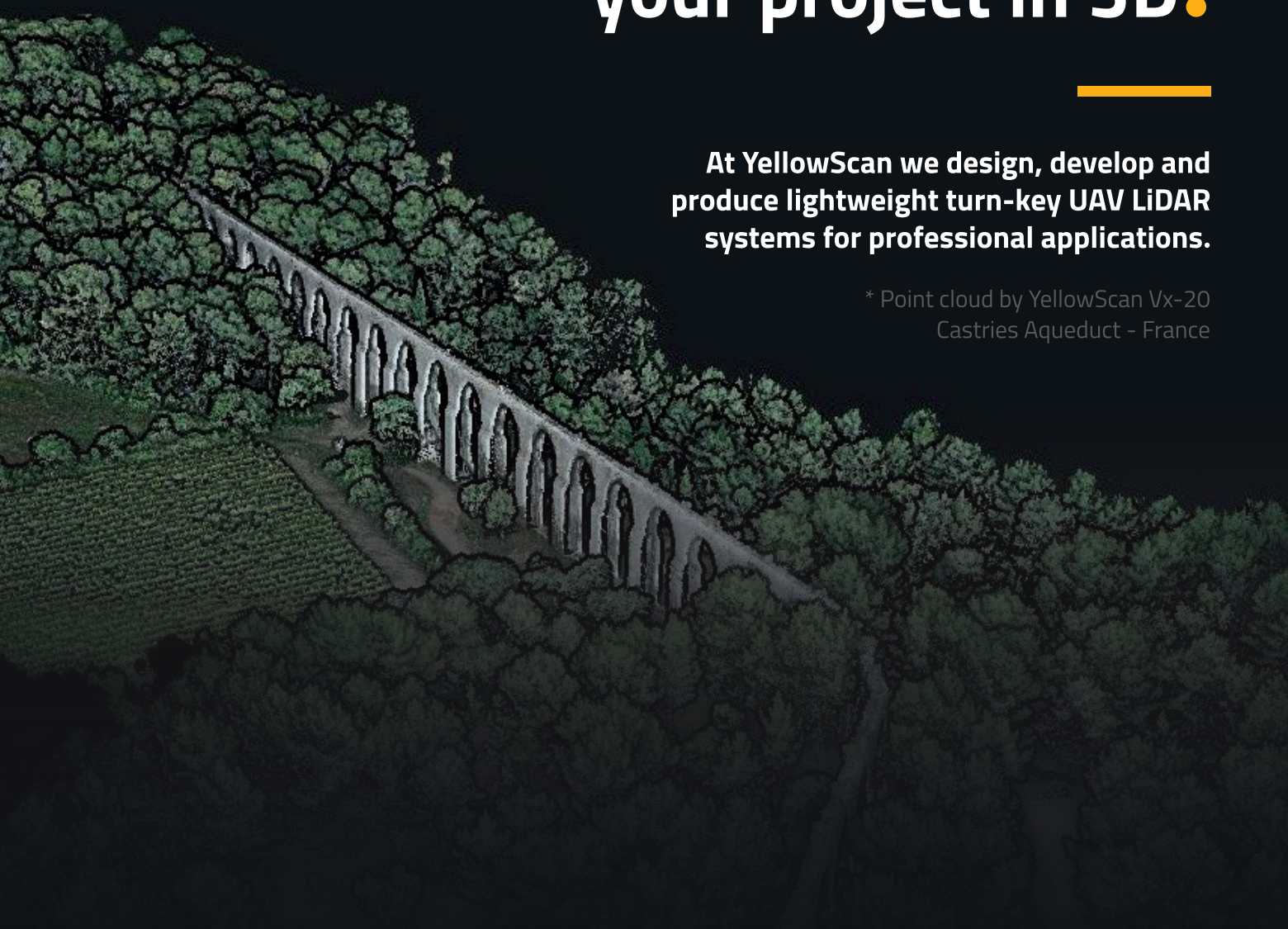

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"Integrating UAV data into RealWorks is nearly seamless because the software views the data as a .las (laser scan) file," says Gunderson. "Pairing the tops of the train cars from the UAV data with the scanning data of the cars gives us a complete view of the incident scene, and one we wouldn't have if we had just used one technology. You can spin the model, rotate it, move along any axis, measure anything and zoom in. It's just like being there."

In total, it took Gunderson about nine hours to create the finished incident model. In less than 36 hours after the initial derailment, he was able to provide a 3D view of the entire accident scene and any object in it.

That afternoon he presented the NTSB with the 3D data and "walked" the officials through the point cloud, demonstrating its visual content and its capabilities.

"They were wowed by the model," says Gunderson. "I don't think they'd ever seen something like this before and as I moved through the scene, they could immediately see the benefits of the detail, accuracy and interaction the point cloud provides for their investigation. They can now revisit the scene from their desktops anytime they need to find evidence or verify details, and they may even find something new to aid the analysis."

The NTSB is expected to issue its final report on the accident in 2019.

"The benefits of the laser scanner and the UAV are unparalleled, both individually and together. Having these choices allows us to tackle any scene."

A TX5 stands protected by the elements as it scans the mangled rail car in front of it.

Value for money

The final point cloud result of the DuPont train derailment not only demonstrated the success of Gunderson's multi-pronged approach on a large scale, it helped cement these technologies as core data sources for the WSP.

"The benefits of the laser scanner and the UAV are unparalleled, both individually and together," says Gunderson. "I can't fly the UAV in a house, but I can definitely scan it. But if I have a mile-long accident scene, I can fly that in five minutes, and I can supplement with the scanner. I can capture great scanning data at each end of the scene and then connect the two in RealWorks. Having these choices allows us to tackle any scene."

Last summer, the department upgraded their scanners and acquired three Trimble TX6 laser scanners. The new units give them 500,000 points per second, better intensity detail, which makes objects stand out more clearly, faster scanning and the ability to scan in the rain—an important feature for the Pacific Northwest.

They also launched a UAV pilot program last July and outfitted 15 collision technology specialists across the state with smaller UAV units. The aim was to assess whether the technology could help them map straightforward accident scenes more efficiently and accurately. Soon after the pilot began, a team responded to a one-car pedestrian accident on I-5. Prior to the UAV, they would have worked the scene for a few hours with traditional baseline methods. Using the UAV, they cleared the scene in 18 minutes.

"Someone from the state DOT (Department of Transportation) once told `me that any time the I-5 is shutdown, the cost to the region is about $350-$400 a minute," says Gunderson. "That adds up to a big number really quickly."

Based on the success of the pilot, the WSP is adding 75 more smaller UAVs to its force this summer and more than 50 WSP detectives have been issued the smaller UAVs—each criminal investigation division has a Matrice UAV.

It's clear the WSP's commitment to asking "What if" and investing in technological choices is not abating. In a job that demands that officers and investigators are ready for any possible scenario at any time, enabling technology is a welcome tool.

"Pushing the envelope with our technology is having a huge impact," says Gunderson. "It's almost unmeasurable to account for what we capture and the impact that data has on the people we serve. We could never have trained for an incident like the derailment. But when it happened, we didn't hesitate to respond because we knew we had the technology and tools we needed. You're going to have victims who want answers and investigators who have to give those answers. Our ability to provide information that will help people find the answers feels really good. And that's real value for money." ■

Mary Jo Wagner is a freelance writer who's covered the geospatial industry for 25 years. Email: *mj_wagner@shaw.ca*.

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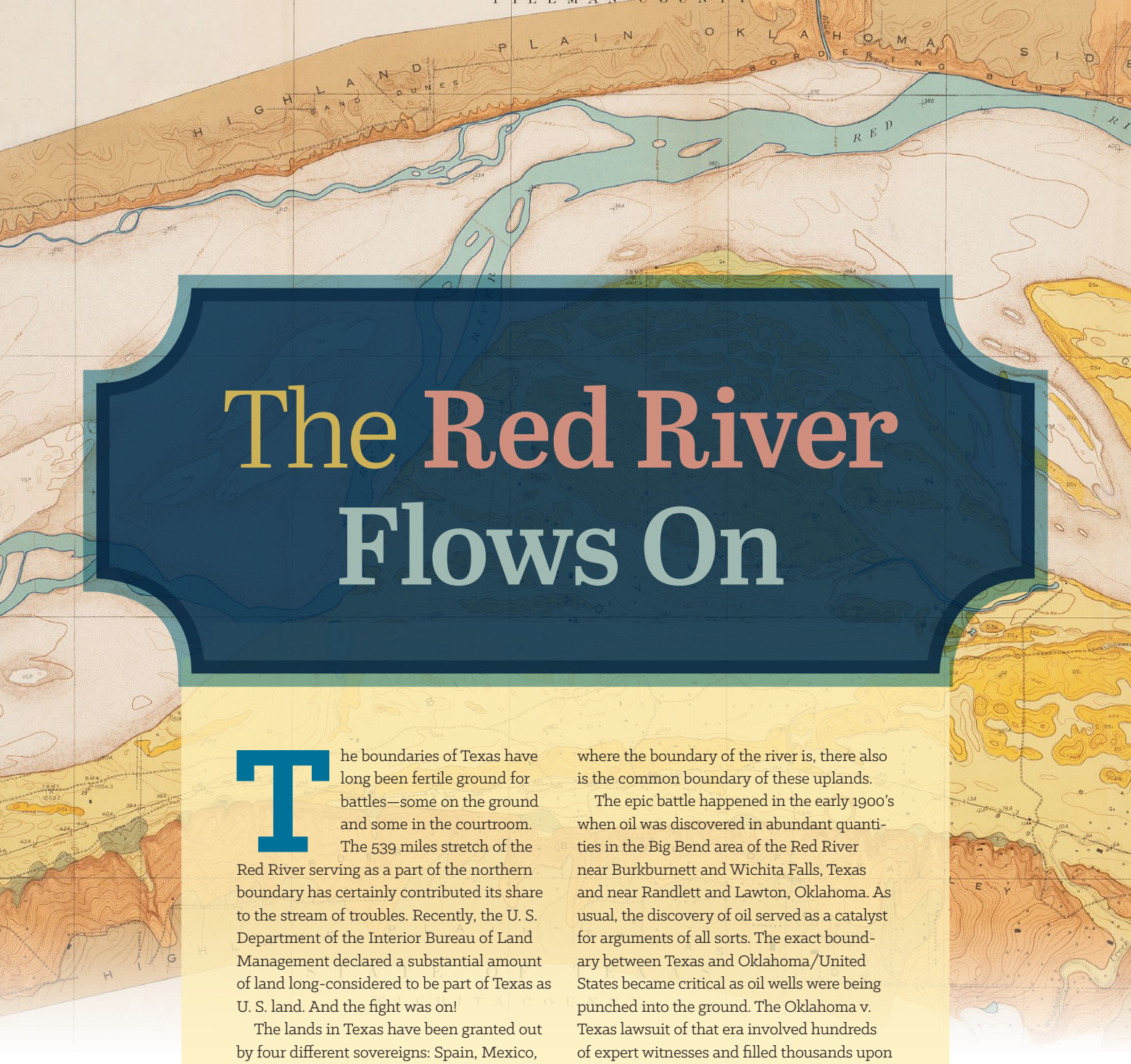

The Red River Flows On

The boundaries of Texas have long been fertile ground for battles—some on the ground and some in the courtroom. The 539 miles stretch of the Red River serving as a part of the northern boundary has certainly contributed its share to the stream of troubles. Recently, the U. S. Department of the Interior Bureau of Land Management declared a substantial amount of land long-considered to be part of Texas as U. S. land. And the fight was on!

The lands in Texas have been granted out by four different sovereigns: Spain, Mexico, the Republic of Texas, and the State of Texas. Unlike other states of the Union, Texas retained its public domain when it became a part of the United States in 1845. Most of the Texas tracts fronting on the Red River were granted by the State of Texas in the 1870's. The north boundary of these grants generally called to be on the Red River. That means where the boundary of the river is, there also is the common boundary of these uplands.

The epic battle happened in the early 1900's when oil was discovered in abundant quantities in the Big Bend area of the Red River near Burkburnett and Wichita Falls, Texas and near Randlett and Lawton, Oklahoma. As usual, the discovery of oil served as a catalyst for arguments of all sorts. The exact boundary between Texas and Oklahoma/United States became critical as oil wells were being punched into the ground. The Oklahoma v. Texas lawsuit of that era involved hundreds of expert witnesses and filled thousands upon thousands of pages of evidence.

For an in-depth discussion of events leading up to and including the Supreme Court case of *Oklahoma v. Texas*, 260 U. S. 606 (1923), see Part 1 of these two articles which was written by Dr. Richard Elgin of Rolla, Missouri, and was published in the April 2019 issue of this magazine. The outcome of this lawsuit 'settled'

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All GNSS civilian signals

TRIUMPH 3

Based on the TRIUMPH 3 chip with 864 channels

• Spread Spectrum • Bluetooth • UHF • 4G/LTE Cellular • Wi-Fi • Integrated GNSS antenna

see back page >

After adding the high precision built-in inclinometer, now we added

motorized auto focus for the J-Mate high precision camera

J-Mate Overview

6 pages inside >

JAVAD

J-Mate Quick Overview and Update to Videos

First let's set the record straight: J-Mate is not a total-station. J-Mate and TRIUMPH-LS **together** are a **"Total Solution"** which is a combination of GNSS, encoder and laser range measurements that **together** does a lot more than a total station. At long distances you use GNSS and at short distances (maximum of 100 meters) you use the J-Mate along with the TRIUMPH-LS. Together they provide RTK level accuracy (few centimeters) in ranges **from zero to infinity**.

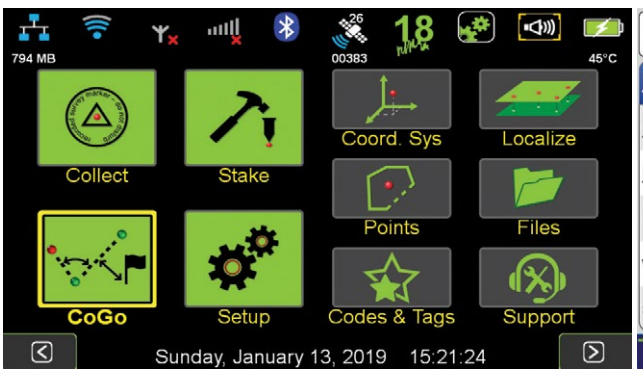
One major improvement that we did recently is to add motorized control of the camera focus feature.

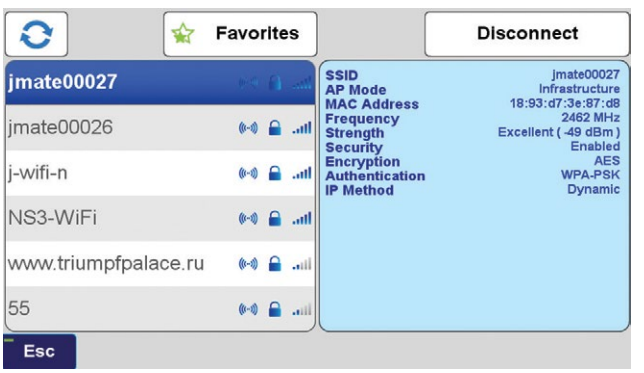
As with the TRIUMPH-LS, with the J-Mate we also provide software improvement updates regularly and free of charge. Download the J-Mate update in your TRIUMPH-LS and then inject it to the J-Mate. When you connect the TRIUMPH-LS to the J-Mate, the injection will be done automatically; but with your consent.

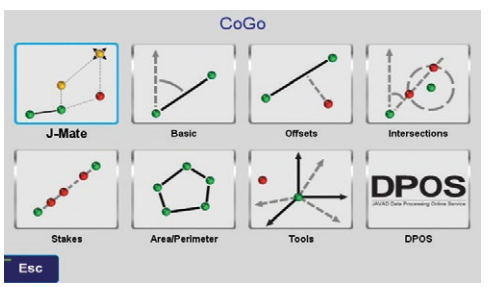
There are many new features in the J-Mate. We try to explain them in a few steps. Please also view the J-Mate videos in our website.

Connecting J-Mate to TRIUMPH-LS:

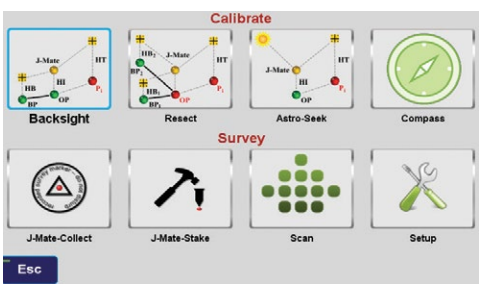
TRIUMPH-LS communicates with the J-Mate through Wi-Fi. Turn on both the TRIUMPH-LS and the J-Mate. Click the Wi-Fi icon of the TRIUMPH-LS Home screen to connect to the J-Mate, much the same way as you connect TRIUMPH-LS to your Wi-Fi access point. J-Mate has ID of the form JMatexxx.

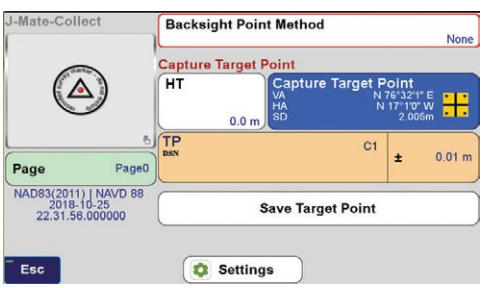






After connection, try to get acquainted with the **Main Navigation Screen**: On the TRIUMPH-LS Home screen, click CoGo/J-Mate/J-Mate Collect/Capture Target points.





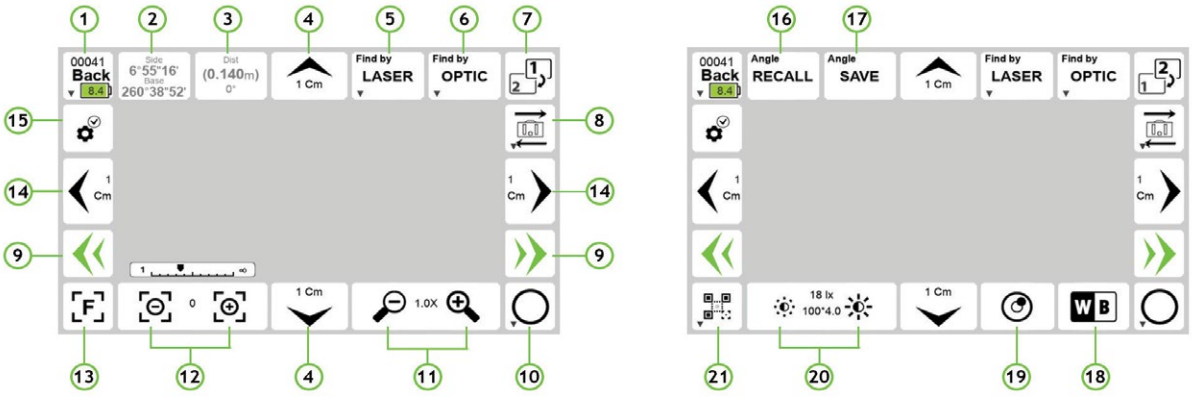


Figure 1

This is the **Main Navigation Screen.**

Clicking the button **"7"** in Figure 1 will switch some controls as shown above.

Aiming at Targets:

You can find targets manually or automatically.

There are five ways that you can manually rotate the J-Mate towards your target:

1. There are Left/Right/Up/Down buttons around the screen (**"4"** and **"14"**). Each click moves the J-Mate according to the value that you assign to them in the set-up screen (**"15"**), as shown in Figure 2.

Figure 2

2. While holding these buttons down, J-Mate rotates about 5 degrees per second.

3. Buttons **"9"** are "Fast Motion" buttons. While you hold them the J-Mate rotates about 30 degrees per second.

4. You can point J-Mate towards points by touching points on the screen and by gestures.

5. You can also rotate the J-Mate manually while it is not moving automatically, but limit that to the small rotations, not to apply backpressure to motor.

Motor manufacturer does not prohibit manual motion, but we think it is better to avoid it as much as possible.

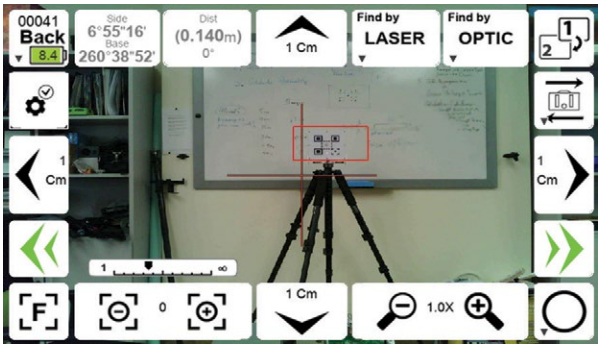
Finding the target automatically:

There are three ways to search and find the target automatically:

1) One is by laser to scan and snap to a point when range changes by the specific amount. This is particularly valuable to snap to cables, poles and edges of buildings.

2) Second is search by laser for the object of the specific flat size and focus on its center, including the J-Target that we supply.

3) Third is with the camera to search for the J-Target. We will discuss these later.



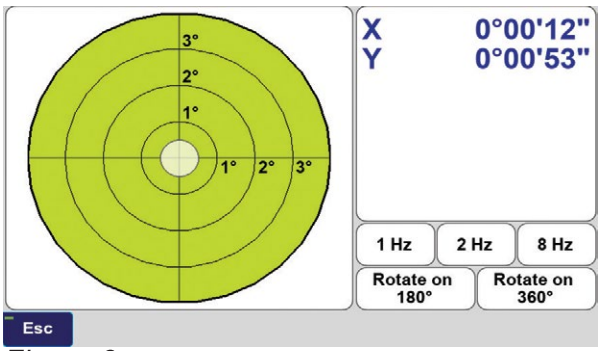


Figure 3

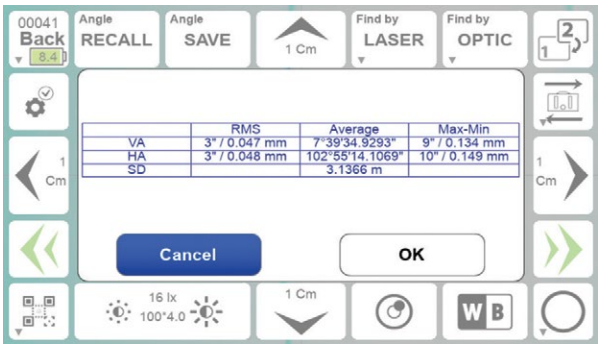


Figure 4

Figure 5

Switching between the two cameras:

You can view the scenes by the wide-angle (about 60 degrees) camera of TRIUMPH-LS, while sitting on top of J-Mate; or by the narrow angle (about 5 degrees) precise camera of the J-Mate. Click Button **"8"** of Figure 1 to switch between the two. A rectangle on the wide angle camera of the TRIUMPH-LS shows the viewing area of the J-Mate camera which helps in aiming to targets.

Viewing the embedded Inclinometer:

Hold button **"8"** or click button **"19"** of Figure 1 to see the embedded 0.001-degree electronic inclinometer of the J-Mate as shown in Figure 3. It updates 10 times per second.

Taking a point:

When you focus on your target manually or automatically, you can click the "Take" button (**"10"** in Figure 1). The Encoders will be measured 10 times, the average, RMS and spread will be shown and you can decide to accept or reject (Figure 4). The accepted points will be treated like RTK points but labelled as "JM" points.

You can also automatically take measurements around that point. Hold Button **"10"** to set up the area around the target.

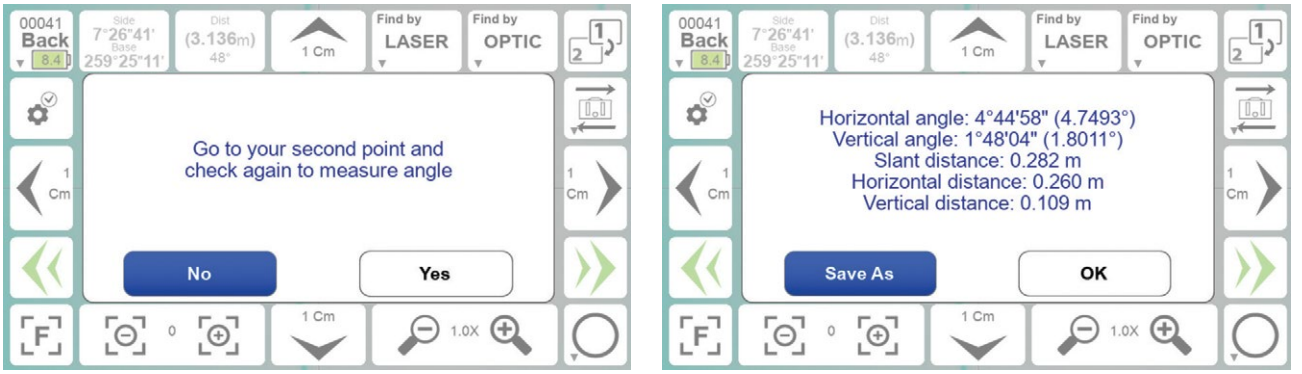
You can access and treat them like any other points in the TRIUMPH-LS.

Viewing the measured points:

Clicking button **"7"** in Figure 1 will change some control buttons. Hold it long and you will see live view of the points taken by J-Mate (Figure 5).

Measuring angles quickly:

Aim at the first point and click button **“2”** of Figure 1. Then Aim to the second point and click this button again. You will see the horizontal angles between the two points. You can save the measured angles in clip boards and use it elsewhere when you need.



Saving and Recalling Orientations:

Aim at a point and click button **“17”** of the Figure 1 to save the horizontal, vertical, or both of that orientation (Figure 6). Click button **“16”** to rotate to that saved orientation.

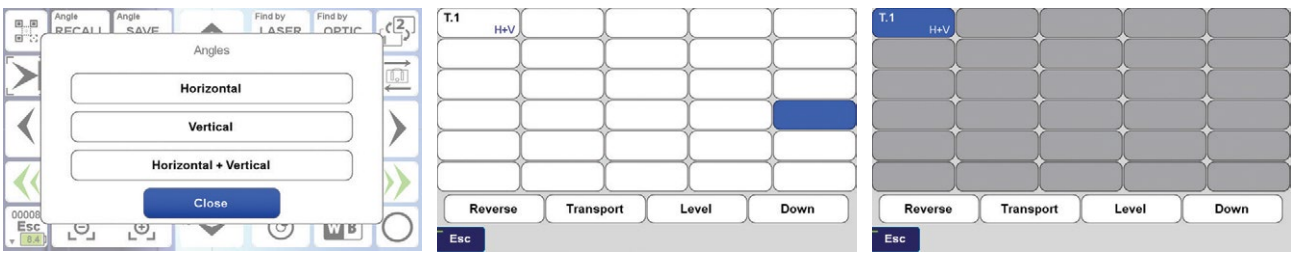


Figure 6

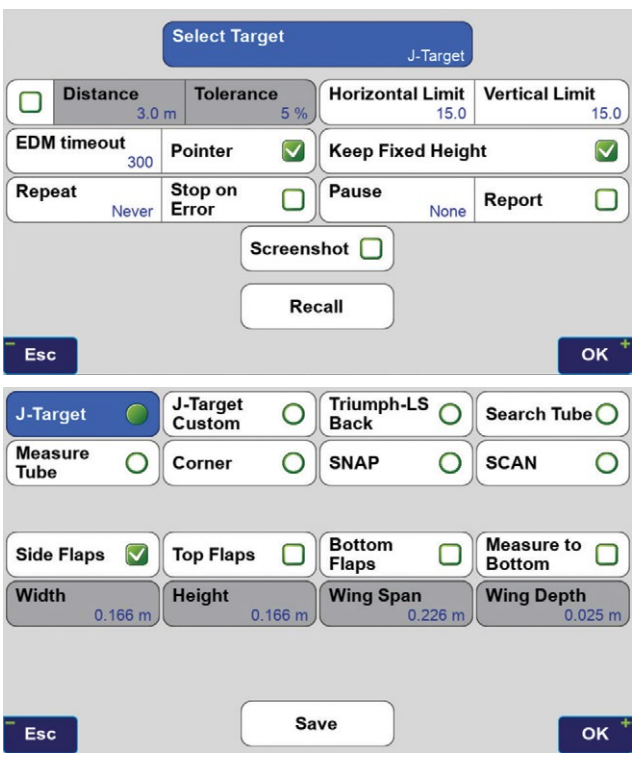
Scanning, snapping and finding targets:

Hold button **“5”** of Figure 1 and see the screen on the right in which you can select some parameters. Then click the “Select Target” button which takes you the below screen. In this screen you can select the type of objects that you want to detect and measure automatically.

You can search for J-Targets, Tubes, and Corners. Corner is when the linear surfaces change direction.

You can select and set the parameters of each target.

You can view the 3D image of the scanned file in the “File” icon of the Home screen of the TRIUMPH-LS as shown at the end of this article.



Connecting and Re-connecting J-Mate to TRIUMPH-LS

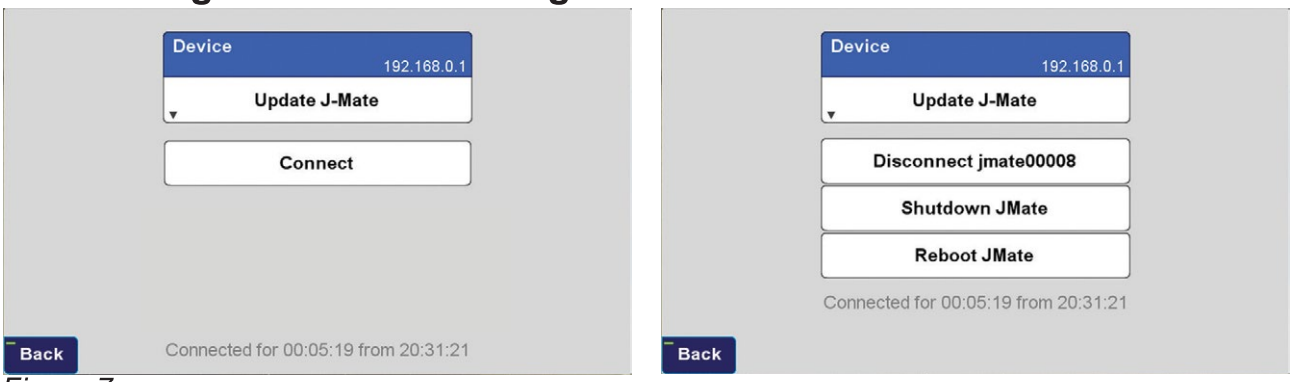


Figure 7

Holding the button **"1"** in Figure 1 which will take you to the set up screen and then to Figure 7 which lets you disconnect J-Mate, Reboot, or turn off. Like all Wi-Fi connections, you may lose connection and need to use this screen to disconnect, re-connect, or re-boot J-Mate and in some occasions reboot TRIUMPH-LS too, especially when connection between the camera of the J-Mate and TRIUMPH-LS is lost.

View range and angular measurements

Boxes **"2"** and **"3"** of the Figure 1 show the range and angular measurements. It reads up to 20 times per second. Click box **"3"** to enter the measured offsets between the two cameras.

Automatic finding of the Target:

Click the J-Target icon (**"21"** of the Figure 1). You will be guided through the following steps to aim at your target point:

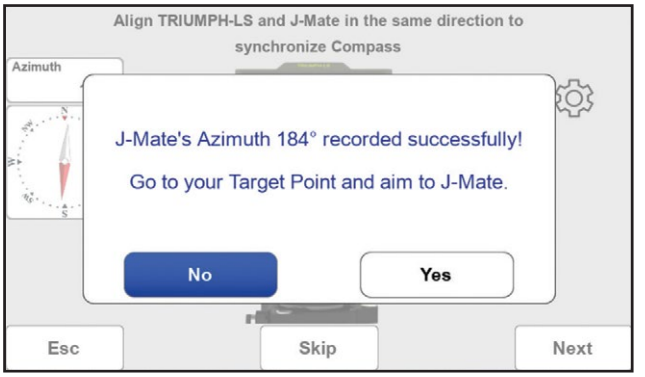
1. Put the TRIUMPH-LS on top of J-Mate (or slightly above it, but at the same orientation as the J-Mate, to be far from the motor magnets of the J-Mate) and click Next.

This step will transfer the compass reading of the TRIUMPH-LS to the J-Mate encoders.

You can skip this and the next step if you are in an area that the compass readings are not valid or you can aim manually in the next steps.

2. Go to your target, Put the J-Target on top of the TRIUMPH-LS and aim the TRIUMPH-LS towards the J-Mate (with the help of the TRIUMPH-LS camera) and click Next.

This will help the J-Mate to know the general direction to the target and limit its search range. You can go back to previous step to fine tune view of the J-Mate. Or you can skip these two steps.



3. You will see the J-Mate camera view on the TRIUMPH-LS screen. You can fine tune the J-Mate view by the navigation buttons to make recognition faster. You can skip these steps if you don't want to make the search faster.

In here you can also manually aim at the center of the J-Target panel and take your shot.

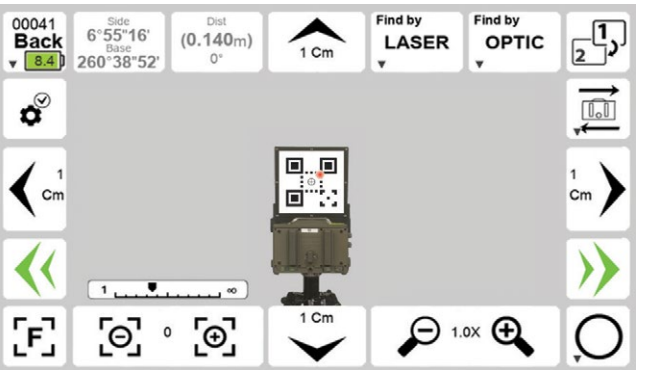
4. Click "Optic" if you want the J-Target panel to be scanned and centered automatically.

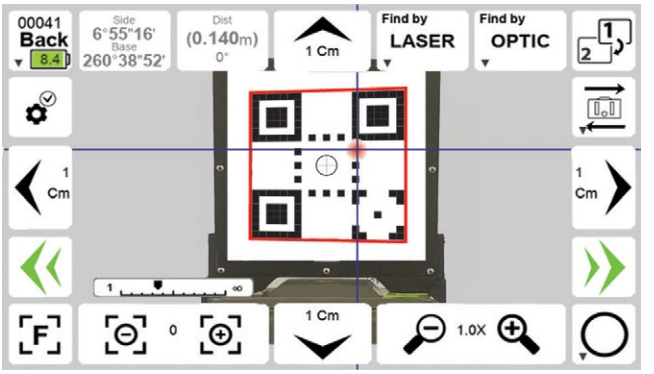
When J-Mate focuses on the center of the J-Target, you can click the "Take" button. You will be asked if you want to record the point.

5. If you also want to find the center of the J-Target by Laser scanning, you can click the "Laser". If Laser scan is successful, you can click the "Take" button to replace the previous measurement with the current measurement done by laser scanning.

The center of the J-Target is vertically collocated with the GNSS antenna and you don't need to be exactly perpendicular to the J-Mate path.

If light condition is such that camera cannot find the J-Target, chances are better that laser scanner can find it.



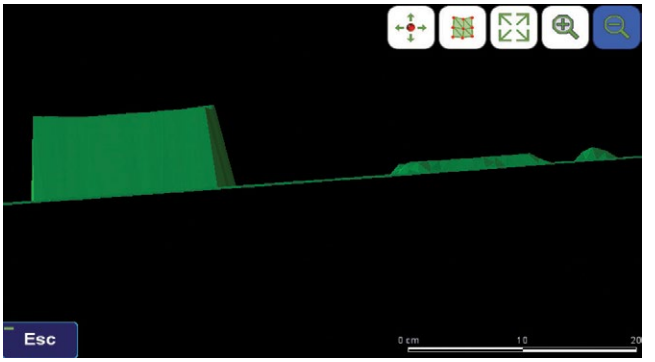


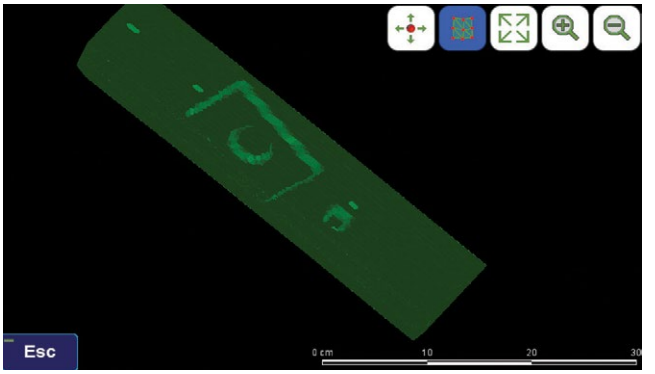
View scanned Images:

You see the 2 views of the 3D scanning

The first scan image is scan of a 1 cm thick and a 6 cm thick objects. 1 cm step resolution.

The last one is scan of a 12.5 x 8 cm object of 1 cm thickness.





This overview as also an update to videos at www.javad.com.

TRIUMPH-3

The new TRIUMPH-3 receiver inherits and builds on the best features of our famous TRIUMPH-1M.

Based on our new third generation a TRIUMPH chip enclosed in a rugged magnesium alloy housing.

The TRIUMPH-3 receiver can operate as a portable base station for Real-time Kinematic (RTK) applications or as a receiver for post-processing, and as a scientific station collecting information for individual studies, such as ionosphere monitoring and the like.

It includes options for all of the software and hardware features required to perform a wide variety of tasks.

- UHF/Spread Spectrum Radio
- 4G/LTE module
- Wi-Fi 5 GHz and 2.4 GHz (802.11 a, b, g, n, d, e, i)
- Dual-mode Bluetooth and Bluetooth LE
- Full-duplex 10BASE-T/100Base-TX Ethernet port
- High Speed USB 2.0 Host (480 Mbps)
- High Speed USB 2.0 Device (480 Mbps)
- High Capacity microSD Card (microSDHC) up to 128GB Class 10;
- “Lift & Tilt”
- J-Mobile interface

Ideal as a base station

Alvin Lassiter standing in Texas—pondering life on the Red River.

On property of Patrick Canan, BLM Monument on south bank showing Texas on one side and Oklahoma and U. S. sections on other side.

This is my marked copy which I used daily on the river prior to writing our First Report, April 25, 1924.
Arthur A. Stiles, Comm.

SUPREME COURT OF THE UNITED STATES.

No. 18, Original.—October Term, 1922.

The State of Oklahoma, Complainant,
vs.
The State of Texas, Defendant, United States, Intervener.

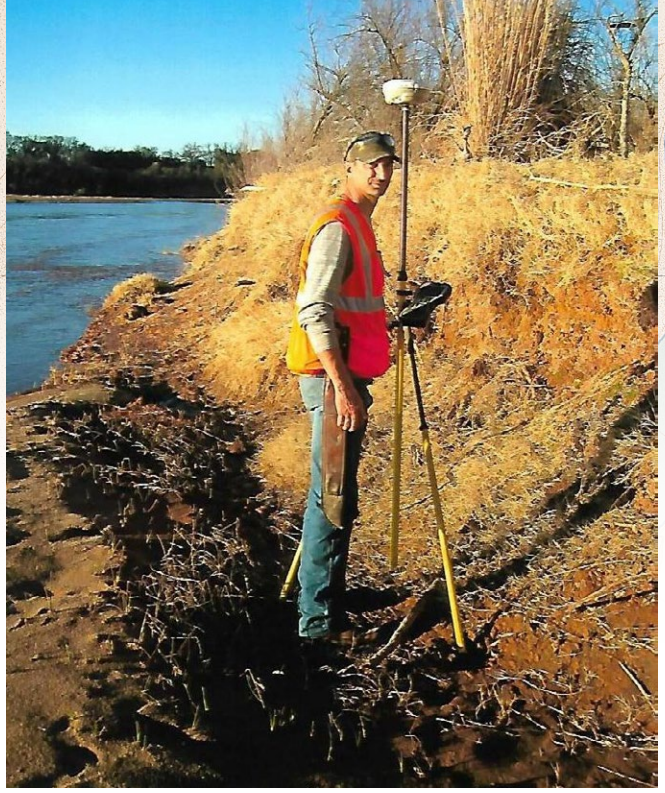
[January 15, 1923.]

Mr. Justice Van Devanter delivered the opinion of the Court.

A principal object of this suit, originally brought in this Court, is to settle a controversy over that part of the boundary between the States of Texas and Oklahoma which follows the course of the Red River from the 100th degree of west longitude to the easterly limit of Oklahoma. This boundary is part of an old one between the territory of the United States and the Spanish possessions to the southest which was agreed on and defined in the third article of the ty of 1819. 8 Stat. 252. As to the line in question that tion is still controlling; it has been reaffirmed on several ns, but never changed. The controversy arises chiefly out of g views of what the definition means and how it is to be The full treaty provision reads as follows:

e 3. The boundary line between the two countries, west ississippi, shall begin on the Gulph of Mexico, at the mouth r Sabine, in the sea, continuing north, along the western t river, to the 32d degree of latitude; thence, by a line to the degree of latitude where it strikes the Rio Roxo oches, or Red River; then following the course of the westward, to the degree of longitude 100 west from nd 23 from Washington; then, crossing the said Red running thence, by a line due north, to the river Arthence, following the course of the southern bank of the s, to its source, in latitude 42 north; and thence, by that of latitude, to the South Sea. The whole being as laid n Melish's map of the United States, published at Phila-a, improved to the first of January, 1818. But, if the source e Arkansas river shall be found to fall north or south of lati-

Copy of portion of Mr. Stiles' field copy of Court's Instructions



John Tucker of Shine & Associates on the gradient boundary of the south bank of Red River. On Kevin Hunter's property, the south bank of the river as determined by BLM is more than 6500 feet south of boundary determined by Foster Townsend.

the common boundary of Texas and Oklahoma/United States on the South bank of the Red River at the gradient boundary.

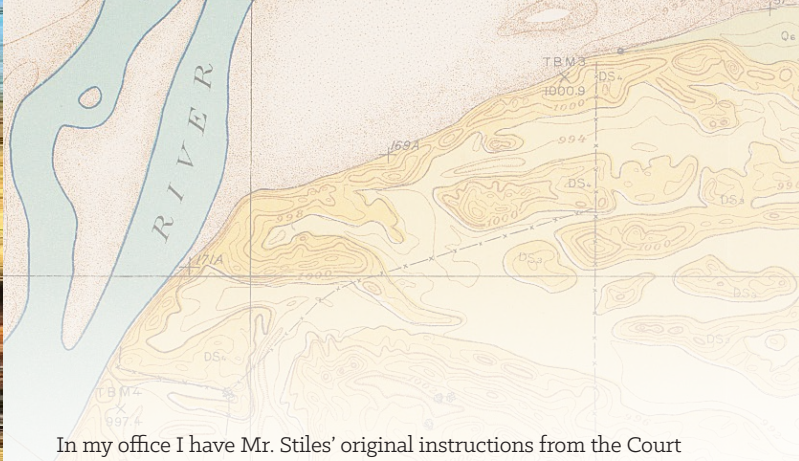
But somehow it has not remained 'settled.' As Dr. Elgin pointed out, like Shakespeare's Banquo's ghost from *Macbeth*, "It will not down."

From 2000-2009 the Bureau of Land Management, under the U. S. Department of the Interior, undertook a resurvey of portions of the Red River. In the course of this work, they requested permission to enter on the lands of some Texas landowners. Corners were monumented on these lands—much to the consternation of those landowners once the corners had been discovered. Through the course of meetings and conferences, it came to light that the Bureau of Land Management was claiming some 90,000 acres lying south of the Red River, west of the 98th Meridian (near Stanfield, TX.) and extending westward to the mouth of the North Fork of the Red River (approximately 34°19'58"N 99°12'33"W in Wilbarger County, TX).

Stiles/Kidder Survey

In the Oklahoma v. Texas lawsuit of the 1920's (addressed at length in Dr. Elgin's Part I of this series), two preeminent surveyors, Colonel Arthur A. Stiles and Arthur D. Kidder, were appointed by the Supreme Court[1] to determine how to go about fixing this boundary line on the ground. They were given instructions by the Court.

1 Quoting from State of Oklahoma v. State of Texas, No. 15 (June 9, 1924), Originally there was a purpose to select three commissioners—one each to represent the interests of U. S., Oklahoma, or Texas. "The Court deemed it better and in the interest of economy to commit the work on the portions of the boundary.... to two commissioners instead of three. The two were selected by the Court as *its* representatives, not as representatives of any of the parties. The Commissioners so understood."



In my office I have Mr. Stiles' original instructions from the Court which he carried to the field daily as they went about their task. He hand stitched the Court's printed instructions into a booklet with a brown craft paper cover. This treasure looks like any information that has gone to the field with a surveyor for extended periods. Folded over and a bit worn in places. It has Mr. Stiles' remarks and observations penciled in the margins as he and Mr. Kidder carried out their assigned work. They spent about three years in fulfilling the project given to them by the Court.

Surveyors today tasked with performing a survey on any river will benefit from reading the instructions and observations of the Court that guided these two surveyors.[2] The Court pointed out that practical judgment must be exercised in making this boundary determination. Indeed! Several times the Court pointed out that 'reasonable and practical' judgments must be made. As is true in almost every survey endeavor undertaken.

Bureau of Land Management

The Bureau of Land Management is tasked with management of more than 245 million acres of public land as well as about 700 million acres of sub-surface minerals throughout the nation. As a part of this process, they develop and from time to time update Resource Management Plans. In the midst of updating part of

2 From the 1923 case (260 U.S. 606, 43 Sup. Ct. 376):

> Paragraph 5. "The south bank of the river is the water-washed and relatively permanent elevation or acclivity, commonly called a cut-bank, along the southerly side of the river which separates its bed from the adjacent upland, whether valley or hill, and usually serves to confine the waters within the bed and to preserve the course of the river.
>
> Paragraph 6. The boundary between the two states is on and along that bank at the mean level attained by the waters of the river when they reach and wash the bank without overflowing it.
>
> Paragraph 7. At exceptional places where there is no well defined cut bank, but only a gradual incline from the sand bed of the river to the upland, the boundary is a line over such incline conforming to the mean level of the waters when at other places in that vicinity they reach and wash the cut bank without overflowing it.
>
> "The foregoing specifications applied in the light of the opinion, admit of, and require the exercise of **practical judgment** in determining the line intended; but certain fundamentals, such as the following obviously must form the final basis for the exact location of the line. 'The boundary line is a gradient of the flowing water in the river. 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 boundary line has been determined accordingly.'"

The Red River at sunset winding its way along between Oklahoma and Texas.

their 'management' along the Red River, it was determined that Oklahoma sections should be retraced, some added, and mapped.

In 1970 Cadastral Surveyor Lane J. Bouman wrote, "Report on the Investigation of the Red River in Townships 4 and 5 South, Range 14 West, Indian Meridian, Oklahoma." Mr. Bouman's objective was to determine if a boundary established (in 1970) in accordance with paragraphs 5, 6, and 7 of the January 15, 1923 opinion of the Supreme Court (see footnote 2 for Court instructions) would coincide with the 1923 gradient boundary established by Surveyors Stiles and Kidder. Mr. Bouman concluded that the boundaries had not changed 'appreciably.' However, he did note that Surveyors Stiles and Kidder were using banks of one to three in height. Mr. Bouman reported that he was relying on banks one to **ten** feet in height in reaching his conclusion. Mr. Bouman did not report performing an actual gradient boundary survey, but simply relied on field observations and comparisons to the work of Stiles and Kidder. Mr. Bouman did note that in areas the 'beds' might remain untouched by scouring rains and "in about thirty years' time, assume an upland appearance." In actuality, this is a good description of accretion—the ground had risen in elevation by some seven feet and was gaining upland vegetation which would cause the banks to stabilize.

In 1994, the BLM published an Oklahoma Resource Management Plan that addressed the Red River Management. It was acknowledged in this report that the lands along the river could not be defined until the U. S. Congress established the 'permanent' state boundary between Oklahoma and Texas. In 2000, this jurisdictional boundary was established through the Red River Boundary Compact to be on the continuous vegetation line on the south bank. Following shortly after that, the BLM once more began updating their Resource Management Plan to address the issue of public domain along the Red River.

2000 Texas Oklahoma Boundary Compact

In 1996, Texas and Oklahoma agreed to create the Red River Boundary Commission to solve the border dispute between the two states once and for all. The goal of this Commission was to establish an identifiable political boundary between Texas and Oklahoma along the Red River without interfering with or otherwise affecting private property rights or title to property. The catalyst for the decision to undertake this effort was uncertainty in taxation and law enforcement issues. The game wardens and other peace officers wanted a better defined jurisdictional line from which to operate. When a body was dumped in the river, there could be uncertainty as to which sheriff was in charge of the investigation. This effort towards certainty of boundary once more involved much ink, many hours and words, and ultimately produced the Red River Compact. This resulted in the vegetation line along the south bank being declared as the political boundary for jurisdictional purposes alone.[3]

3 In 2000 the U. S. Congress adopted what the Commission had hammered out. (114 STAT. 919, PUBLIC LAW 106-288, OCT 10, 2000) According to the federal legislation, "(b) The permanent political boundary line between the states of Texas and Oklahoma along the Red River is the vegetation line along the south bank of the Red River except for the Texoma area, where the boundary does not change. For purposes of this compact: (1) the Texoma area extends from the east bank of Shawnee Creek (which flows into the Red River from the south approximately one-half mile below the Denison Dam) at its mouth to the upper end of the normal pool elevation of Lake Texoma (which is 617 feet); and (2) the upper end of the normal pool elevation of Lake Texoma is along the latitude of 33 degrees 54 minutes as it crosses the watercourse at the approximate location of longitude 96 degrees 59 minutes.

(c) The party states agree that the existing boundary within the Texoma area begins at the intersection of the vegetation line on the south bank of the Red River with the east bank of Shawnee Creek. From this point, the boundary extends west along the south bank of the Red River as the bank existed immediately before the commencement of the construction of Lake Texoma. From Shawnee Creek to Denison Dam, the boundary line is within the current channel of the Red River. Within Lake Texoma, this boundary line follows the south bank of the Red River as the bank was located and marked by the United States Army Corps of Engineers before the commencement of the construction of Lake Texoma." It was also set out that the compact would not alter any of the present or future rights of the Kiowa, Comanche, and Apache Tribes, the Chickasaw Nation, and the Choctaw Nation of Oklahoma.

Photo of BLM Medial Monument on Canan property. GPS on same monument with Alvin Lassiter and John Tucker of Shine & Associates. Note the terrain in what BLM considers to be the middle of the river.

Qualified bank with one lathe at toe and higher one on gradient boundary.

The gradient boundary of the river would remain the correct boundary for real property interests or title to property. So, it's conceivable and likely that in places the property boundary and the political boundary will be in different locations. This does not yield certainty of boundary.

The good news is that the vegetation line may be near the gradient boundary—except for when it isn't. On and along inclines (transverse slopes) the vegetation line may be hundreds of feet away. Article II (g) of the compact set out that if there is a change in the watercourse, the party states would recognize the rules of accretion, erosion, and avulsion. The states agreed that accretion or erosion may cause a change in the boundary between the states if it causes a change in the vegetation line. With regard to avulsion, the states agreed that a change in the course of the Red River caused by an immediately perceivable natural event that changed the vegetation line will change the location of the boundary between the states. It's doubtful that this Compact worked as the 'silver bullet' in solving jurisdictional questions. It seems to have simply muddied the waters further in an already murky boundary situation.

2008-09 BLM Survey

In the initial set of public hearings for the updated Resource Management Plan, the BLM stated that their "update" would impact up to 116 miles of the Red River and could include up to 90,000 acres of public domain along the Red River in Clay, Wichita, and Wilbarger Counties, Texas. Much of these 90,000 acres would have been on lands currently claimed by Texans. This did not set well with the Texans. The BLM subsequently lowered their estimate of public domain to 30,000 acres. But it is said, "If an acre of land is worth owning, it's worth fighting for." And Texans were definitely mad enough to fight!

The monuments set by the BLM surveyors on the lands in contention were dated 2008 and 2009. The field notes set out the methodology and which surveys were being retraced from the original 1875 and onward. I have had occasion to work with BLM surveyors through my career and have consistently found them to be people of highest integrity and very careful surveyors. The only explanation I have for this current work is that it was begun from a wrong premise. Quoting from BLM field notes associated with some of the land in contention, "….it is clearly evident that during the course of this resurvey the portion of the gradient boundary monumented and described within has not been changed since it was established and declared to be the true boundary by the Supreme Court on June 9, 1924." This current BLM work begins from the premise that the boundary was fixed in place in 1924 and that little or no change had occurred in the seventy-five years intervening. However, this is the Red River—notorious for changing course! Some of that 'practical judgment' that the Supreme Court valued would have been well-placed in this retracement endeavor.

Included in the BLM retracement work was that performed by the original surveyor, subsequent perpetuating surveyors, and Stiles and Kidder. Some of the Stiles/Kidder permanent monuments set back away from the river as well as some of the wood posts near the

river were recovered. The BLM surveyor reproduced this 1923 survey work and in the field notes declared the south bank monuments set in 2008 to be "along the Gradient Boundary, identical with the Boundary Line between the States of Texas and Oklahoma." Many of these were far removed—a mile or more—from the river.

Monuments of the 2008 era were also set marking the 'medial' line of the river—which should be in the middle of the river bed. These also were well inland—in some instances with substantial trees nearby. Even some of the BLM monuments marking the **north** bank were well south of the current south bank of the Red River, placed on the upland on lands claimed by Texans for generations.

Foster Survey Work

In 2016-17 I performed survey work on lands of eight different individuals and a ninth tract in which the State of Texas had interest. These were located in Wichita and Wilbarger Counties. They were all parties to the lawsuit which was filed by them against the U. S. Bureau of Land Management. I was privileged to learn gradient boundary methodology from my mentor, Darrell D. Shine, who learned from Irving Webb, a direct student of Arthur Stiles.

The beginning point of any gradient boundary survey as set out by Arthur Stiles and Arthur Kidder is the location of qualified or key banks. In the Court's writings the boundary bank was often referred to as a 'cut bank.' The qualified bank that contains the river will be an accretion bank that has been built by the deposit of alluvion as the river rises, deposits its load of soil, and recedes. In various survey projects along the Red River from 2001 through 2017, I have located twelve qualified banks on which I've relied to perform gradient boundary projects. The total bank height of these ranged from a low of 2.00 feet to a high of 3.43 feet. These were located in Cooke, Clay, Wichita, Wilbarger, and Hardeman Counties. The total bank height is measured from the toe (the break between river bed and bank) to top (the point where the water reaches but does not overtop the bank). This consistency was one of the objectives of the Supreme Court when they were instructing Stiles and Kidder on what they wanted—a repeatable, consistent method of determining a boundary on a river bank. The bank heights found by me are consistent with those of Stiles and Kidder who worked with banks from 1.0 to 3.0 feet in total height. Our work is separated by some ninety-five years and yet the Red River continues to flow along and form the same types of banks.

Nedra Foster Townsend at Stiles/ Kidder Reference Monument 25 set back from river as a permanent monument.

Nedra Foster Townsend at Witness Post 17 set by Stiles and Kidder in 1923 near to the river. From these posts, bearings and distances were taken to points on the gradient boundary.

I performed a survey on the property of Jimmy Smith in Wichita County. A qualified bank was located on the Oklahoma side of the river, and a gradient boundary survey was carried out in accordance with the principles set out by Stiles and Kidder and adopted by the Supreme Court. I also located ten BLM monuments on or near to the Smith property as well as recovering some of the Stiles/Kidder monuments. The two 'medial' line monuments I recovered on this property were from 900 to 1,000 feet south of the south bank of the gradient boundary of the river as determined in my survey. These were on upland with substantial vegetation in the area. These were

far removed from what 'practical judgment' would determine as the middle of a riverbed.

This particular tract had both gained substantial acreage through accretion and lost a small amount of land through erosion compared to the description under which Mr. Smith purchased this property in 2006. Tract 2 called to be 131.948 acres and my resurvey found 534.14 acres. This increase in acreage was due to the large amounts of accretion along the northerly portions of the tract. On my surveying of this and the other tracts, I found substantial accretion that had taken place, but I also noted that in places the riverbed was in the process of being eroded back. It's the nature of the Red River to move about, and it is certainly doing so.

On the tracts belonging to six other individuals, I did limited surveying but performed a gradient boundary survey on the portion of the tracts fronting on the river. I located ten additional BLM monuments that had been placed on these tracts.

I also performed a survey on a tract in Wilbarger County in which the State of Texas has an interest. This tract also had gained acreage through accretion—268.8 acres worth . A qualified bank was located downstream of the subject property on the south bank of the river, and the gradient boundary portion of this work was performed from measurements of the qualified bank.

Addressing Erosion and Accretion

In the 2000's era controversy, the Bureau of Land Management witnesses continually pointed out their opinion that the loose sand banks at the edge of the water could not possibly be what the Court intended because they would shift from time to time. They claimed that such an 'impermanent' boundary would be inconsistent with what the Supreme Court intended. I agree that some of the banks are composed of loose sand. Survey corners that I located miles away from the river were also in loose sand. It was an easy task to dig out corners in this

John Tucker standing in Texas.

Medial Monument—Property of Kevin and Barbara Patton. This 'middle of the river' monument is 2360 feet south of the gradient boundary determined by Foster Townsend on the south bank.

area. Much of the soil in this part of Texas is loose sand, so naturally the banks of the river are also sandy.

The 1920's era Oklahoma v. Texas controversy extended over several years with some specific issues considered separately. One of these[4] addressed avulsions, accretions, and erosions that occurred during the years that this lawsuit was grinding along. In the No. 15 portion of the 1924 Court proceedings, the Court considered an area that had been surveyed in 1920. In the intervening four years the river washed away a large section of the opposite bank on the north and shifted its principal channel to that side. There was gradual accretion added to the south bank. The north bank was cut away as much as 1400 feet from where it had been located in 1920 while the south bank gained from 60 to 80 feet of accretion which had reached the same elevation as the former bank, had similar vegetation on it, and appeared to be stable land. The Court determined that Stiles and Kidder had made the correct decision when they included this accretion in the upland and ran the boundary on the outer line (river side) of this accretion.

This interim decision strongly reiterated the Court's stance that the boundary would be subject to the normal accretions and erosions that affect rivers. "The boundary between the two states is not an unswerving line, but a river bank, and where through the natural and gradual processes of erosion and accretion the bank is changed, the boundary follows the change. We so said in the opinion and decree which were to guide the commissioners."

The Outcome

On March 29, 2017, the Chief Cadastral Surveyor of the BLM New Mexico Office issued a statement suspending the surveys of T5S R15W; T5S R13W; and T5 and 6 R12W of the Indian Meridian, Oklahoma. Quoting from this document, "BLM has recently obtained new information that brings into questions whether the doctrines of erosion, accretion, and avulsion were appropriately considered, as directed by the Supreme Court's direction in Ok v. TX.... Having reviewed this deposition testimony and other new information, the BLM believes the survey methodology used was in error, and may have caused errors in identifying the location of the Gradient Boundary."

A Joint Settlement Agreement was reached on December 19, 2017, and so ordered by the judge on January 3, 2018, in which the Settlement Agreement offered by the Plaintiffs, Kenneth Aderholt et al, was incorporated in its entirety to be part of the Joint Settlement Agreement. The stated purpose for the Agreement was to settle litigation. It was set out that the field notes for Group Number 81 and 126 OK Surveys would be corrected to clarify that any references to the location of the Texas/Oklahoma border do not reflect Defendants' position as to the present-day political boundary between the States of Texas and Oklahoma. Within 120 days after this Agreement, Defendants were supposed to remove from the monuments any references to the States of Texas or Oklahoma (that is, if the Texas landowners would allow them access to their property.) [The monument shown on the opening spread is one that should have references to OK and TX removed—if Mr. Canan would allow **anyone** from BLM on his property.]

From time immemorial people have been drawn to the water—want to live beside the water. This is all well and good, but folks must not lose sight of the fact that their waterfront will be subject to all the vicissitudes of nature. I try to warn clients who own property fronting on water that there is an inherent risk in that ownership—now, the Texas landowners' whose rights were being threatened can rest much easier. Here's to peace on the Red River! ■

4 Quoting from *State of Oklahoma v. State of Texas*, 44 Sup.Ct. 571, No. 15 (June 9, 1924).

Nedra Foster Townsend is President of Shine & Associates in Silsbee, Texas, and is the only woman to be a Licensed State Land Surveyor in Texas. She served nine years on the Texas Board of Professional Land Surveying, two of those as Chairman. She teaches various continuing education classes for surveyors in addition to keeping up with seven grandchildren.

With both the existing and the emerging structures in the background, CPM's Taylor Light-Surek gathers data using their new GNSS solution, a Sokkia GCX3 receiver and SCH500 field controller.

NEITHER RAIN NOR SNOW...

Maine contractor gets impressive, all-weather GNSS performance in bridge replacement project.

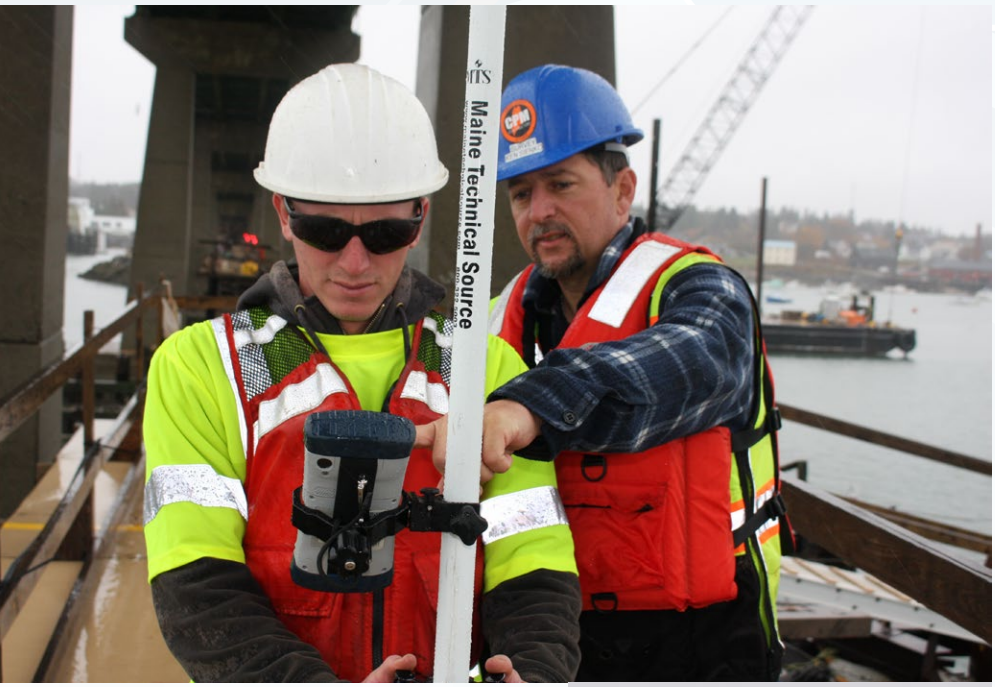
Home to just over 500 Maine residents, the town of Beals is located on a small (5 square mile) island across from moderately-larger Jonesport. To access either town by car from the mainland, residents and visitors alike must cross the Jonesport-Beals Bridge, a half-mile span built in 1958. After more than six decades of service and constant exposure to the salt air of the Atlantic, the structure's pier piles were recently identified as being deteriorating, prompting the bridge to be classified as "structurally deficient" and slated for replacement. Heading up construction of the new $22 million span, CPM Constructors had for years relied heavily upon their existing robotic total station and GNSS technology. Facing this project in an area traditionally hindered by foggy coastal weather, however, it chose to replace those older instruments with newer state-of-the-art technology. Doing so, has not only eliminated long periods spent waiting to gain a satellite fix, it has improved overall performance of the company's survey-based operation.

Excellent Bridge Work

CPM Constructors is a general contractor which performs everything from marine construction to power station work to roadbuilding and more. However, the Freeport, Maine-based company has established itself as one of the state's go-to sources for excellence in bridge construction, according to Ken Sienko, CPM's survey manager.

"We probably have anywhere from seven to ten bridges going on at any given time," he said. "That can include structures designed to carry vehicles, railroads, pedestrians, you name it. So we were definitely in our element when we got to Jonesport. Here, we are replacing an existing structure that has succumbed to the elements, with an updated design which will serve area residents and visitors for the next 60-70 years or so. When we secured the bid for the Jonesport project, we felt the time was right to upgrade our survey equipment and spoke to Stuart MacDonald at Maine Technical Source (MTS), the area Sokkia dealer. Because our two companies have worked together for quite a while, we trusted their expertise in these matters."

» LARRY TROJAK



In situations such as working directly beneath the existing bridge, the new system's ability to get—and hold—a fix on satellites impressed both Light-Surek and Ken Sienko, CPM survey manager (shown here at right).

The upshot to that discussion with MacDonald at MTS's Yarmouth, Me., location was the purchase of a GCX3 GNSS receiver and an iX503 robotic total station—both from Sokkia. Sienko said that, while they set out to simply bring their capabilities more current, they quickly discovered the benefits went far beyond that.

Making a Connection

Work on the Jonesport-Beals Bridge began in September, 2017. In addition to the structural construction itself, CPM was also responsible for all the earthwork at the approaches, the abutments and all adjacent roadwork. Structural work started with driving of piles which, according to Taylor Light-Surek, CPM's field engineer, immediately drew upon the strengths of their new GNSS solution.

"We used GPS heavily to help with setting the piles," he said. "Working alongside Case Foundation, we first located the centerline of bearing for two H-piles welded to the deck of a barge and pushed the barge into location to set a temporary frame to drive the pile," he said. "We then set a larger driving frame to hold the caissons onto the header of that initial driving frame. Then, while standing on the deck of the barge, I shot center line of bearing and center line of construction and used those points to guide the upper driving frame into place where it was welded and braced off."

Even in inclement weather—one stretch included 20 out of 30 days with rain and heavy fog—CPM was able to keep the Jonesport Bridge project on track, largely due to the performance of the GCX3.

Simple as the procedure described above might seem, things were complicated by the weather which threatened to wreak havoc with their schedule.

"The weather here is very erratic—there was one month in which we had 20 separate days of dense fog with visibilities less than 1/8 mile," he said. "Because most of the shots I've been taking out here are between 700 and 1500 feet, we obviously couldn't use a robot in those conditions, so we turned to the GNSS solution and were pretty amazed at what it did for us. To be able to functionally use a base and rover in those conditions and have tight accuracies is pretty amazing, but that's exactly what we got. In fact, I shot a number of points with the base and rover and then checked them the next day using the robot and it was within hundredths. That really convinced us that we hit on something good with the Sokkia gear."

Though they have not had occasion to use it to date, CPM's new system also offers Sokkia Fusion technology, which provides an ability to bring a true hybrid solution to the jobsite. Doing so has been shown to dramatically speed up field work; get rapid prism acquisition, even in dense areas; and easily jump between optical and GNSS measurements.

Lighten the Load

While Sienko might focus on the accuracies they are now able to achieve—and maybe even how well the newly-added solutions fit into their budget—Light-Surek recognized another benefit neither of them foresaw: the comfort factor.

"Our older equipment is so much heavier," he said. "You don't think it's much of a big deal until you are out here for ten hours a day walking around with a rover. Walking back and forth doing centerlines, carrying a 10 to 15 lb. rod definitely wears on a person. By comparison, I can literally put everything I need now in a backpack. For the size and convenience factor alone it's amazing. This system takes me about 10 minutes from the time I get a call that someone needs a shot to the time I'm there and working. In the past, that could have easily been twice as long, so there's a time savings at work here with the new solution as well."

Working with the Eastern Division of Case Foundation, CPM drew upon the benefits of the GNSS solution to help set the piles for the new bridge. The system's ability to function in fog, as shown here, proved huge.

It's important to note that prior to the Jonesport project, Light-Surek's familiarity with GNSS solutions was extremely limited. Though he'd worked a bit with Sienko using GPS on previous projects, the new bridge was, in a sense, a baptism by fire for him.

"It was a little difficult at first, but mostly because Ken also does GPS for all our other projects and couldn't be out here that often," he said. "However, the process came quickly to me and once I got the hang of it, I've pretty much done it all since then. In fact, if I was put in a situation where I had to hand someone else one of the Sokkia controllers, it would be much easier for that person to functionally use this instrument than anything else. If I was sick and someone had to stake something out, I could literally talk them through it—it's very streamlined and intuitive."

Sienko also had a particularly unique opportunity to benefit from the compact nature of the new GNSS solution when working to streamline placement of the structure's pier caps.

"We are having a Virginia-based company called Coastal Precast Systems in Virginia do all the precast caps," he said. "I recently flew down to their plant and, using long range Bluetooth, set up the base in their yard and recorded all the as-builts for the caps right there. By doing so, when we went to place them here in Jonesport, all the rebar coming up out of the columns lined up perfectly with the holes. It worked out really well, but was made even better by the fact that I didn't have to lug several cases of bulky equipment to get those results. That small system packs a lot of power."

Getting Their Fix

Though reduced to one lane with traffic signal metering (the second lane is being used for construction of the abutments, concrete pours, trucking of materials, etc.), the existing Jonesport-Beals Bridge is remaining operational while the new structure takes shape. The presence of the bridge, compounded by the on-again off-again weather issues, has allowed CPM to fully appreciate the strengths their new GNSS and robotic solutions bring to the job site.

"We used both our previous system and the new one out here at different times and there really is no comparison in terms of signal acquisition," said Sienko. "Our older GPS receiver really struggles to keep a connection, particularly when we are close to the existing bridge—unfortunately, that's where most of our work takes place. As a result, when using the older solution, we would have to stay a good 30 feet off from the bridge."

Contrast that, he said, with the ability of the GCX3 to get a fix on the satellites while almost directly under the structure, and the differences become stark."

"We were working at times between several barges and the bridge," he said. "Even though I could probably only see 20-30% of the sky, we were still able to get—and hold—a fix on between 10 and 14 satellites. That was enough for me to keep my residuals within a half-inch and impressed the heck out of me."

The Big Attraction

The Jonesport location, while picturesque, is in a fairly remote area—a good 3 ½ hours from Portland and roughly the same distance to CPM's corporate offices in Freeport. To expedite the transfer of files, implement updates, and so on, Sienko's crew is using Topcon MAGNET (Field and Enterprise) in conjunction with their Sokkia SHC500 and SHC5000 controllers. According to Light-Surek, the software solution has fit into their operation nicely.

"I started out using different software here and as far as functionality and ease of use and being able to switch tasks on the fly, MAGNET is far ahead of what that software had to offer," he said. "There are a number of functions that have impressed me, but I really like the opportunity to create layers. I've probably taken at least a thousand shots on this site and having that many points in a relatively small area can make things look extremely crowded. So it's really nice to be able to go into the new software, layer all those points, then turn individual layers on and off, letting us see only what we need to see."

Sienko added that the MAGNET Enterprise function has also proven key for the transfer of information. "If our office was a 15 minute drive up the road it'd be no big deal—but it's not," he said. "So that function is invaluable for us; if Taylor needs a point, I can calculate it in the office, shoot it to him and it's done. In the same way, at the end of the day, he simply uploads his data and I can review it in real-time in Freeport—it doesn't get any easier than that."

It's About Time

By now it should be obvious that the key savings CPM is realizing—even when considering a unit's superior ability to

With the drilled shaft cage set in place, latent concrete from the shaft pour is removed in preparation for setting of the column cage itself. There were 14 new caissons installed to support the new piers.

acquire a signal or pierce fog and allow work to proceed—are in time. Both Sienko and Light-Surek will attest that time spent waiting for technology to work is time wasted.

"The most obvious savings is in data acquisition," said Sienko. "When we had work near the bridge with the old system, there were times when Taylor was spending very long periods waiting to get a fix. In fact, when I first brought the new GNSS receiver to him to do a side-by-side comparison, he told me he'd have a fix with that older unit in 20 minutes—I already had one. So for us, the time savings is really in how fast it can grab a signal—and that's been substantial."

Light-Surek concurs, adding that the advantages can be even more basic than that. "Our older system had a tendency to freeze up in cold weather and, being Maine, there's no shortage of that," he said. "Waiting for a unit to respond is a huge waste of time. But this past winter, we ran both the new receiver and the new robot in subzero temperatures without seeing any adverse effects on performance. That was great to see. In addition, I often have to do centerlines provided by the office, which can consist of roughly 25 to 30 points. With the Sokkia, I have a fix for each point in about three seconds. In the past, I'd have to wait a minute and a half for each point. While that might not seem like much, when you add it up, you've suddenly lost three quarters of an hour just waiting."

Smoothing Out the Bumps

For CPM, the process of moving into the newer solutions was not without its speed bumps. However, according to Sienko, it was those challenges that helped them realize they'd made the right choice in both an equipment manufacturer and dealer.

"We decided early on that we wanted to boost satellite coverage by adding the Galileo Constellation package," he said. "But we quickly realized that we had an issue getting the unit to see those satellites. So Pat Moran, the Sokkia regional manager, came out here and worked with us until things were resolved and we were getting the coverage we wanted. We are currently averaging about 22 satellites at all times. The new solutions have been key in helping us keep pace on this job and it's great to have that level of support from both the manufacturer and the dealer to back it all up."

The Jonesport-Beals Bridge is slated for a late 2019 opening. ■

Larry Trojak of Minnesota-based Trojak Communications is a freelance marketing content specialist. He writes extensively for the geopositioning, utility, aggregate processing, recycling, construction, and demolition markets.

Lathrop, *continued from page 40*

must allow that signer to certify elevation data. Aside from the obvious legal aspects, I'm not sure how many engineers or architects understand conversions between NGVD 1929 and NAVD 1988 when FIRMs and current surveyed elevations aren't in the same datum.

The next point made by the NFIP Coordinator in this story is significant: understanding the nuances of the Elevation Certificate is a significant factor in correct completion. This translates to prevention of harm to property owners, who rely on the form for pre-construction permitting, for Certificates of Occupancy, and for flood insurance rating. Assuring correct data in the correct location on the form with appropriate comments, explanations, and supporting documentation requires more than copying numbers from a plan to the form.

There is another aspect of this saga that grates my patience, and that is what appears to be arrogance by the engineer (and supporting architect). It's the same reaction I have when someone says I'm "just" a surveyor. Beyond the loose self-serving interpretation of laws, the emails to the public service staff involved had a tone of near-condescension. We all owe each other professional courtesy and acknowledgement of our various knowledge and skill sets.

Finally, I'd like to make a plug for how surveyors can overcome some of this turf war and condescension by showing we have particular qualifications that should earn us the respect and right to complete Elevation Certificates without being stepped on by engineers or architects. If you are in one of the few states with a Certified Floodplain Surveyor program, enroll in the training and take the test to put CFS after your name. If you aren't in one of those lucky places, pursue Certified Floodplain Manager (CFM) credentials from the Association of State Floodplain Managers (*www.floods.org*), which requires a bit more training and experience but shows others your commitment to understanding the NFIP. ■

Wendy Lathrop is licensed as a Professional Land Surveyor in NJ, PA, DE, and MD, and has been involved since 1974 in surveying projects ranging from construction to boundary to environmental land use disputes. She is a Professional Planner in NJ, and a Certified Floodplain Manager through ASFPM.

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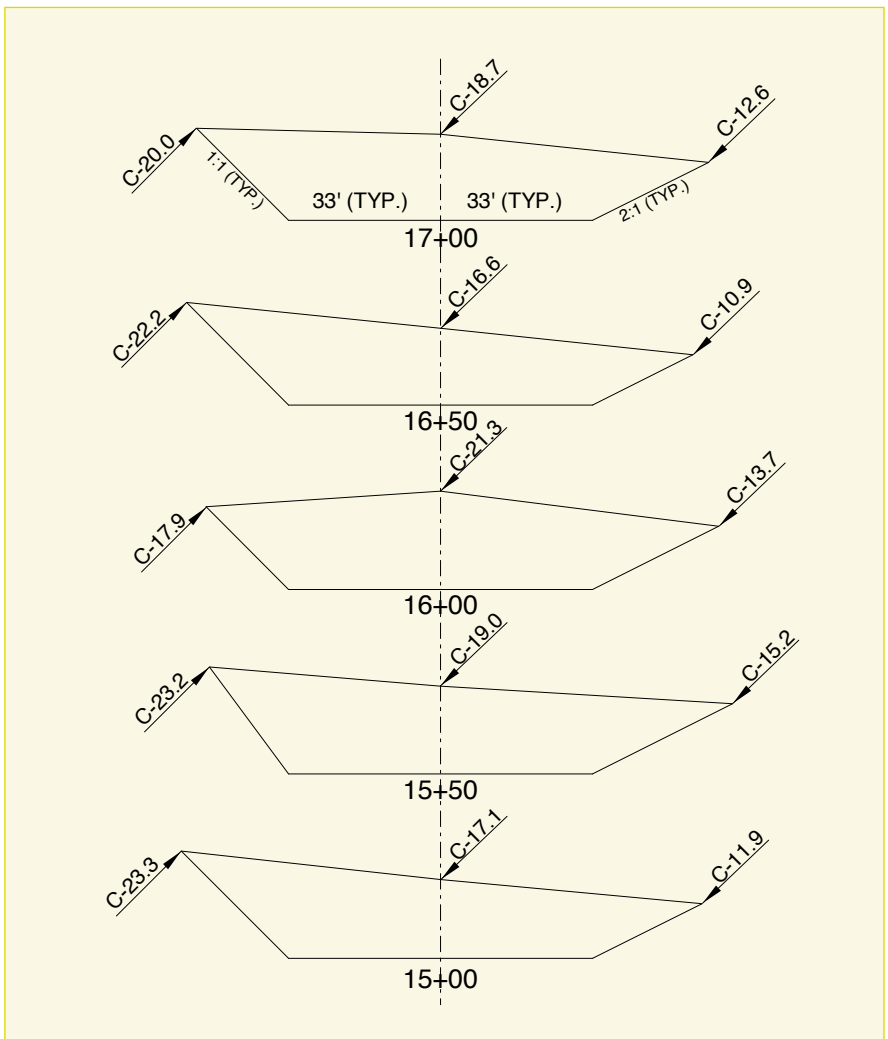
Calculate the volume of cut between station 15+00 and 17+00 by the Average End Area Method and by the Prismoidal Formula. ■

For the solution to this problem (and much more), please visit our website at: *www.amerisurv.com*. Good luck!

Dave Lindell, PS, retired after 36 1/2 years with the City of Los Angeles. He keeps surveying part time to stay busy and keep out of trouble. Dave can be reached at *dllindell@msn.com*.



WENDY LATHROP / PS / CFM

vantage point

Turf Wars, Flood Data, and Professionalism

Sometimes it is hard to pigeon-hole events into a single category to be able to come up with a title that will appropriately reflect the topic. This time I used the buckshot method to try to catch it all. At the request of one of the parties involved, I've left out specifics that would identify that person.

It all started when an engineer in a state to remain unnamed submitted an Elevation Certificate for proposed construction to a municipality in that state. The local Code Enforcement Inspector refused to confront the question of who could complete the form, forwarding it instead to the State's Coordinator for the National Flood Insurance Program (NFIP), who stated that the form was to be signed by a surveyor. This triggered a lengthy argument by the engineer about surveyors only being required for post-construction, based on the scope of engineering including the reading and interpretation of proposed construction drawings, Flood Insurance Rate Maps (FIRMs), and the profiles in the Flood Insurance Study (FIS) reports that accompany FIRMs.

The NFIP Coordinator countered by pointing out to the engineer that the instructions for the Elevation Certificate specify that the form is to be completed by only those professionals who are "authorized by law" (in bold red in the email), and then citing that state's specific statutes defining professional scope of practice.

An architect on the project then provided an interpretation of the State's statutes for professional conduct as allowing architects and engineers to expand their practices based on qualification and experience. This architect then opined that this allowed either professional to read topographic surveys and fill in relevant data on the Elevation Certificate, that any other interpretation would improperly limit these professional practices in the state, and that most surveyors wouldn't fill out the form based on proposed elevations anyway.

> "Thanks to a brave NFIP Coordinator who stuck it out against some pretty aggressive turf war tactics, both the public and the practice of surveying have been protected in that state."

The NFIP Coordinator was concerned that a self-determined voluntary expansion of practice would lead to engineers completing Elevation Certificates without really understanding them, harming the public in the process. The next step was to reach out to the State's licensing board for a legal opinion about who could certify elevations.

The response came a week later, with the messenger noting that there were "several examples at hand": Elevations Certificates are to be prepared by surveyors in that state, as provided in the statutes and as is standard practice. Outside of the Elevation Certificate, practices such as a drainage analysis fall within engineering.

Thanks to a brave NFIP Coordinator who stuck it out against some pretty aggressive turf war tactics, both the public and the practice of surveying have been protected in that state. Perhaps not everyone has such a champion in their state, but let's look at some of the language minimized by the engineer and architect in their arguments. Section D is the part of the form in which the certifying professional supplies comments, signature, and seal. The header for Section D does state "Surveyor, Engineer, or Architect Certification." Surveyors get top billing here, but FEMA can't impose limits on what a state allows the other two professionals to do. The lines directly beneath this indicate that the signer must be authorized by law to certify elevation information. This is reiterated in the instructions for Section D. What it means is that statutes in the individual state in which the property is located AND the signer is licensed (these must be the same)

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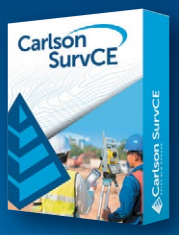

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