Post-Construction Project Report of the Larimer County Road 43 River Restoration

North Fork of the Big Thompson River

Prepared for:

U.S. Department of Transportation
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EXECUTIVE SUMMARY

In September 2013, the Colorado Front Range experienced a large flood event that ravaged rivers, communities, and infrastructure, damaging and destroying large sections of highways, local roads, and public, residential, and commercial properties. Large portions of Larimer County Road 43 (CR 43), which follows the North Fork of the Big Thompson River for approximately 8 miles near downstream of the hamlet of Glen Haven, was heavily damaged as a result of flooding and erosion. In conjunction with the road reconstruction led by the Central Federal Lands (CFL) division of the Federal Highway Administration (FHWA), river restoration activities were conducted along most of the North Fork of the Big Thompson River where the river runs adjacent to the roadway. This memorandum provides the technical details and resources used as a basis of design for the stream restoration project.

This report describes channel reconstruction activities; demonstrates the cost-effectiveness of collaboration between entities; lists lessons learned from this project; and identifies next steps for the CR 43 stream corridor. The CR 43 river restoration project was a success because materials, equipment, manpower, and expertise were leveraged from the highway reconstruction efforts in order to restore the river channel for the benefit of both the river and roadway. This coordinated effort helped to identify cost-effective opportunities and best practices for stream rehabilitation within the roadway corridor.

The primary intent of this stream rehabilitation project was to reconstruct a channel capable of efficient sediment transport, effective water conveyance at a range of high and low flows, and the establishment of relative lateral and vertical stability for the benefit of long-term protection of CR 43. These goals were accomplished through the creation of a multi-stage channel and increased in-channel habitat complexity via the strategic placement of boulders, rock structures, and large wood. In order to develop a comprehensive and holistic approach to the rehabilitation of the channel and its floodplain, adjacent riverfront landowners were approached and asked for permission to incorporate restoration treatments on their sections of the river. The nearly 100 percent acceptance rate eliminated a patchwork of management actions and facilitated a coherent, consistent restoration project.

This river restoration project was designed and built around restoring river processes, not just river form. The features that were built are intended to encourage long-term system stability by providing a framework within which natural sediment movement and ecosystem processes can dominate. The river, and low-flow channel in particular, is expected to move and adjust; the river system is expected to recruit woody vegetation and woody debris; and the bankfull channel is expected to scour and form new deposits as it adjusts to varying flow and sediment loading cycles in the coming years and decades. Evidence of these adjustments and observations of change will deem this project a success, not a failure. A monitoring program to record and measure these changes is recommended. In order to maintain and capitalize on improvements made through this river restoration effort, important future activities to be conducted at the CR 43 project sites include this long-term monitoring as well as active riparian revegetation.

The ability to utilize materials from on site and equipment from the road construction project is crucial to developing a cost-effective and holistic project. Budget data from the CR 43 project was not available for analysis so only generalizations can be made but cost savings have been shown to be substantial in previous projects. As a rough comparison, the US 36 project restored 10,750 linear feet of channel while the CR 43 project restored 17,500 linear feet of channel – a 61% increase. The cost savings between the US 36 project and the CR 43 project are likely not linear but if they were the savings would be $1.77 million.

The CR 43 river restoration project had several constraints that influenced the recommended design, particularly the encroachment of the roadway embankment on the river channel corridor. Implementation of the river restoration project was influenced by an accelerated timeline, availability of construction equipment, and transport of needed construction materials. However, useful lessons were learned throughout the process that can benefit future flood recovery efforts and other restoration projects that involve a shared roadway/river corridor.

1.0 BACKGROUND

The North Fork Big Thompson River is approximately 7.5 miles long with tributary creeks originating in the northeast corner of Rocky Mountain National Park and flowing in a southeast direction through the hamlet of Glen Haven to its confluence with the Big Thompson River at Drake. The tributary area of the North Fork at Drake is approximately 86 square miles, and the North Fork carries approximately 25 percent of the flows of the Big Thompson River main stem.

In September 2013, significant rainfall along the Front Range of the Colorado Rocky Mountains resulted in the worst flooding seen in these areas in more than 30 years. These floods caused significant damage to the roadway system that links the western regions of Boulder and Larimer counties to the populated plains cities, and many of these mountain communities were isolated for more than a week. Larimer County Road 43—a major thoroughfare between the Glen Haven and Drake—was one of these impacted corridors (Figure 1).

Figure 1. Example of road damage as a result of the 2013 flood

County Road 43 travels along the North Fork of the Big Thompson River as it winds from the town of Estes Park east through Glen Haven toward the Town of Drake at the confluence with the main stem of the Big Thompson River. There was severe damage to the roadway and some residents had to hike out or be rescued by helicopter.

The North Fork of the Big Thompson River originates in the Roosevelt National Forest at the confluence of West Creek and Fox Creek at the Town of Glen Haven and flows in a easterly direction along CR 43 for approximately 8 miles until it joins the mainstem of the Big Thompson River at Drake.

Following the flood, a temporary road was rebuilt quickly with the help of the Larimer County Public Works Department, and permanent road reconstruction was designed and engineered by Central Federal Lands (CFL), a Division of the Federal Highway Administration (FHWA), and administered by Larimer County to improve resiliency and reduce the likelihood of future flood damage. Relocating the road onto inside bend bedrock benches, elevating of the road bed, flipping the location of the road and the river to keep the river shear stress up against the outside bends of the valley bedrock, replacing culvert crossings with bridges and armoring of the road embankment with large mortared boulders were major design goals. Within the road design and reconstruction process, a unique opportunity was presented for the CR 43 reconstruction project to partner with stream restoration experts to restore the stream channel in conjunction with and with benefit to the road work. CFL and Larimer County sought out Crane Associates (referred to collectively as the Stream Recovery Team) to help guide the river restoration efforts. Jeff Crane, Katie Jagt and Michael Blazewicz made up the Stream Team.

The partnership afforded an opportunity to utilize road reconstruction resources to design and construct stream channel enhancements adjacent to roadway repairs. The Stream Recovery Team leveraged materials, equipment, manpower, and expertise on-site to reconstruct North Fork of the Big Thompson River in the vicinity of the road repair sites (Figure 2). As a result of outreach by Larimer County, nearly all riverfront landowners adjacent to these sites agreed to provide access and participate in this comprehensive public/private partnership to eliminate a patchwork of treatments and implement a consistent design for the stream rehabilitation. Major components of the stream corridor reconstruction included: a low-flow channel, gravel bars and benches, large wood structures, habitat boulders and boulder clusters, grade control structures, side channel habitats, and riffle and pool enhancement. The Stream Recovery Team also worked with Wildland Restoration Volunteers and the US Forest Service to revegetate the riparian corridor.

This coordinated effort helped to identify opportunities and best practices for stream rehabilitation within a highway corridor. The purpose of this report is to outline the process by which the channel reconstruction work was conducted; demonstrate the cost effectiveness of this type of collaboration so that it can be replicated in the future; describe lessons learned from this project; and identify next steps for the CR 43 stream corridor.

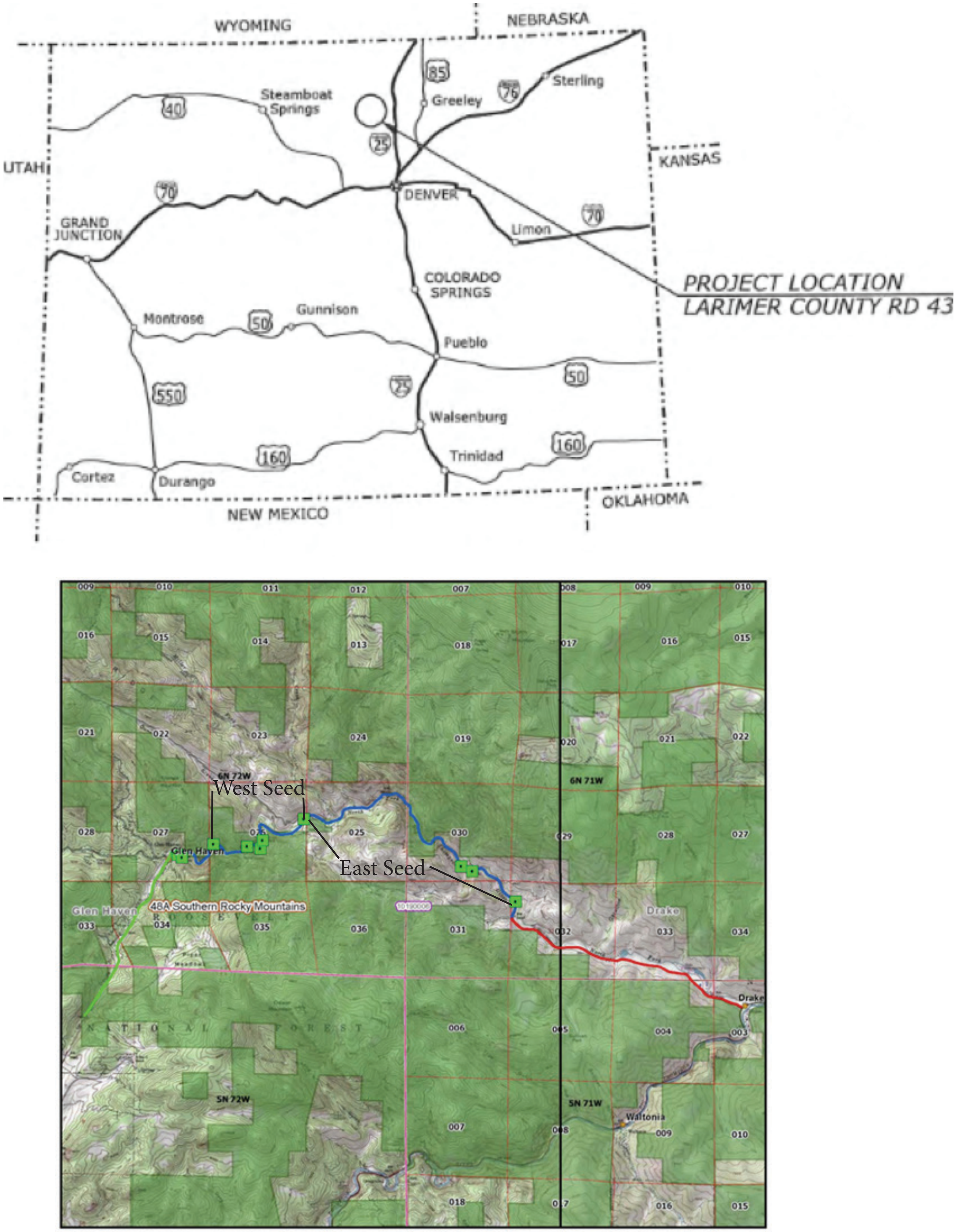


Figure 2. Project location map.

2.0 POST-FLOOD CONDITIONS

The North Fork of the Big Thompson River channel, squeezed by natural canyon walls and encroached on by CR 43, underwent significant bed scour and lateral erosion during the September flood. A National Guard and Larimer County damage assessment team was deployed immediately after the rains stopped. Between the Towns of Glen Haven and Drake, the team identified dozens of sites where CR 43 had been significantly damaged or completely destroyed. At each of these locations, the stream had reclaimed its historic corridor by undermining and overtaking the roadway embankment and washing out culvert crossings. The washouts caused large sections of roadway, including asphalt, road base, guardrail, and signing, to collapse into the river. The road material amassed in the river channel, along with uprooted trees, cars, river rock, and a collection of debris from flooded houses. These and other flood-mobilized materials were deposited in the channel and on the floodplain, leaving debris fields and scour zones.

The resulting post-flood streams were eventually re-channelized into their pre-flood alignment by Larimer County and private contractors hired to provide temporary emergency access. Newly scoured bends and areas of lateral migration were filled during this process and the stream beds were left in a raw and unstable condition. Following the bridge construction and preliminary road alignments (beginning in November 2015), the Stream Recovery Team was provided with materials and equipment to implement stream channel restoration (Fig. 3).

Figure 3. Channelized creek following CR 43 reconstruction and prior to stream restoration.

3.0 DESIGN GOALS

The primary intent of the river restoration project design was to relocate the creek, wherever possible, to keep outside bends of the meanders up against the bedrock of the valley walls; develop a compound, morphologically complex channel capable of transporting future water and sediment inputs while maintaining relative stability within the confining boundaries of the reconstructed roadway embankment; and replacing culvert crossings with free spanning bridges capable of passing the 50-year event. Additional goals included enhanced aquatic habitat along the repaired reach, recreational access in selected areas of the National Forest, and construction of features friendly to fish passage. Major themes introduced included the creation of a low-flow channel, a multi-stage seasonal flow channel created by establishing floodplain benches, and increased in-channel habitat complexity through the strategic placement of boulders and large wood. Due to the emergency nature of the roadway reconstruction and budget constraints, the deployment of a rapid assessment, design, and project build timeline became a necessary goal.

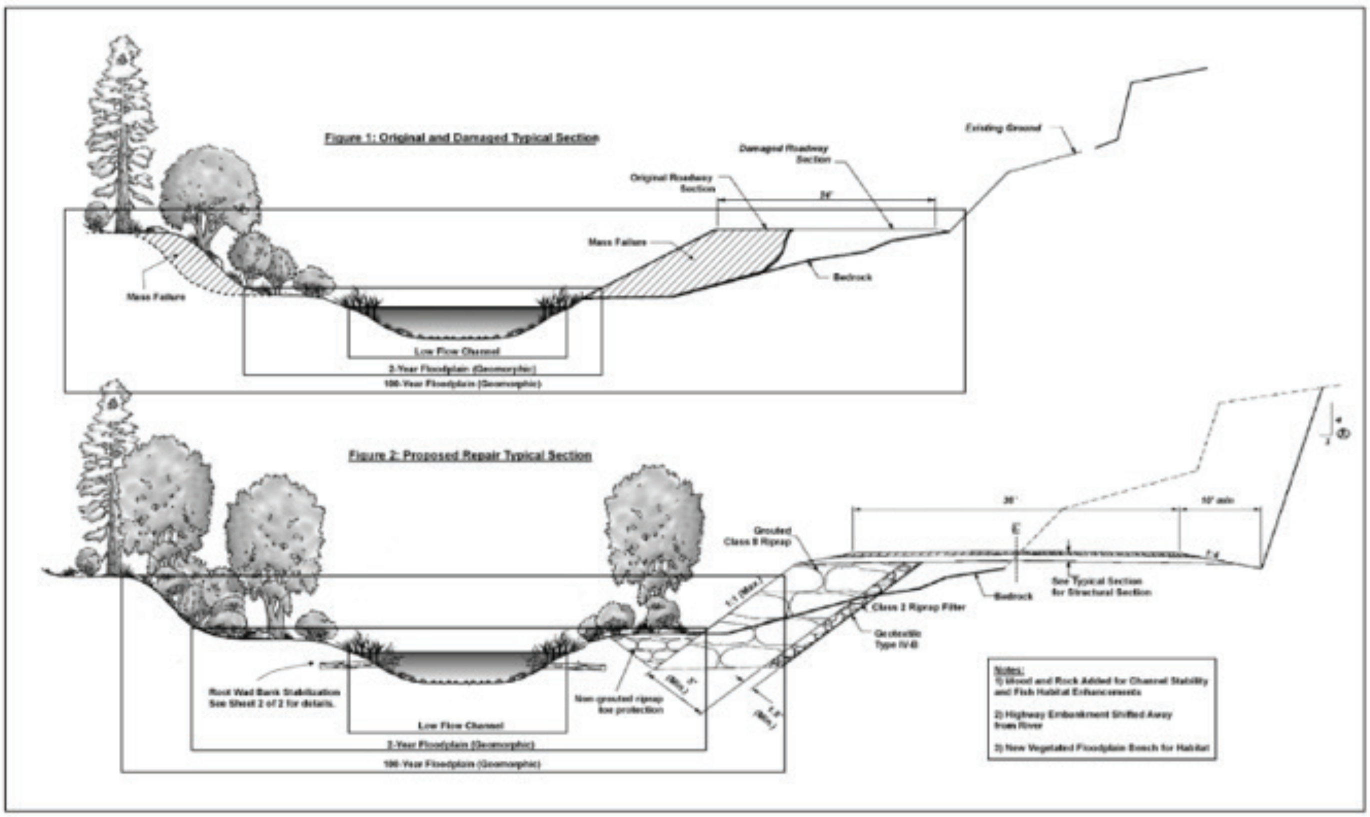
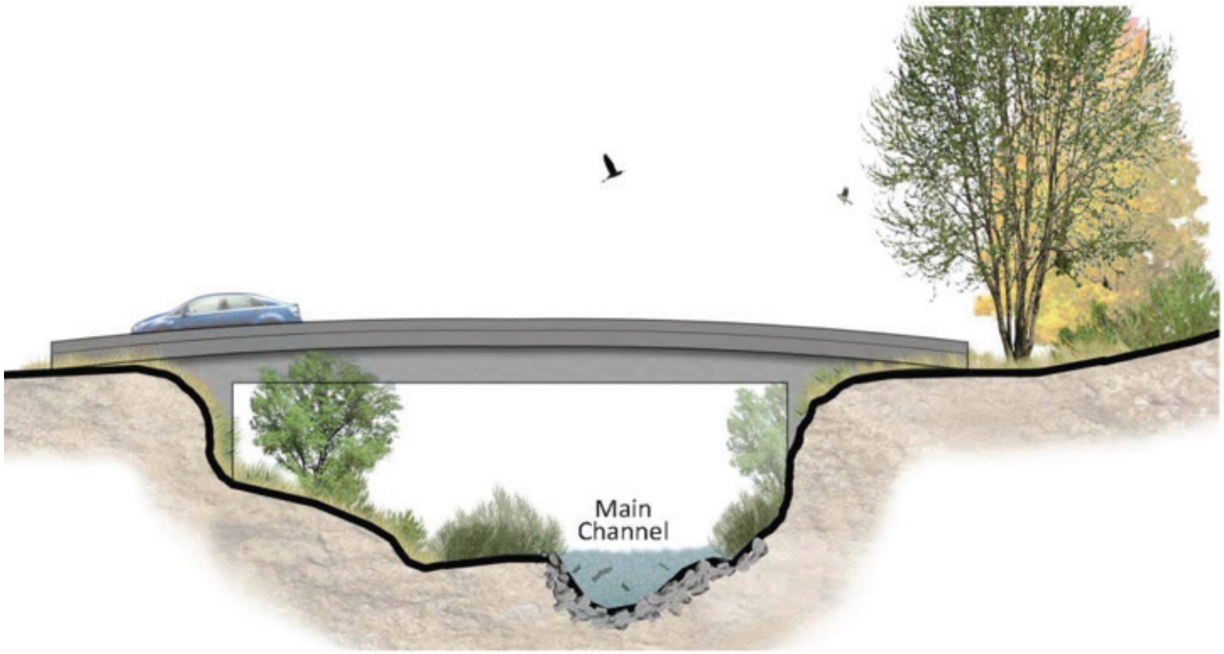


Figure 4. Nested channel concept schematic diagram (Source: CFL and Crane Associates, 2014).

Figure 4 shows a schematic of the nested channel concept with a defined low-flow channel sized for the minimum flows though the driest parts of the year. The 2-year flow channel is intended to overtop in approximately half of all years during spring flows and inundates a low, flat, vegetated floodplain. The cross-section also has capacity to convey the higher, more infrequent flood events.

Pre-flood stream crossing were primarily culverts. This project replaced those culverts with free spanning bridges designed to pass the 50-year flood event. The typical trapezoidal channel associated with most bridge installations were replaced with the same compound channel design used for the river restoration to improve aquatic habitat and morphological integrity through the bridge.



Bridge - Increased Opening Size

4.0 DESIGN BASIS, RECOMMENDED FEATURES, AND FIELD FIT ASSUMPTIONS

This river restoration project was designed and built around restoring river processes. The features that were built are intended to encourage overall system stability and resiliency by providing a framework within which natural processes can dominate. The river is expected to move, adjust, recruit woody vegetation and woody debris, scour, and form new deposits as it adjusts to accommodate fluctuating sediment and water inputs. Evidence of these adjustments and observations of change will deem this project a success, not a failure.

An abbreviated approach to analysis was employed in order to meet the requirement of fall 2015 construction and budget constraints. The budget constraint did not allow for detailed hydraulic modeling and geomorphic and sediment transport analyses, which are typically completed in support of channel restoration projects of this magnitude.

The following rapid approach was undertaken:

- US Geological Survey (USGS) StreamStats were run to determine design flows. These were compared with preliminary reports from the Natural Resources Conservation Service (NRCS) and CWCB/CDOT.

- Approximate channel dimensions were identified for riffle and pool reaches based on 2-year (Q2) and 50-year (Q50) events; approximate bench heights were derived for floodplain bench construction from the 2-year flow water surface elevations. The 50-year water surface elevations were calculated by Central Federal Lands (CFL), a Division of the Federal Highway Administration (FHWA), for roadway elevations.
- A preliminary design was proposed based on post-flood channel morphology, as well as knowledge and anecdotal information regarding pre-flood conditions, access, and design goals. The alignment of the roadway and the river were flipped in 11 locations during the preliminary design stage to protect the road in future events.
- Rock, log, and fill quantities were determined by quantifying the number of structures to be built, the ballast required for the installed rootwads, and the floodplain areas to be constructed.
- Preliminary designs were field fit based on professional experience and abbreviated hydraulic modeling done in conjunction with installation.

Several key design features were recommended for use throughout the project area. The main purpose of these features was to enhance stream structure and function by encouraging the natural processes that reinforce river form and stability. They were sited based on the features of the river in the post-flood and post-road construction condition. The features listed below were incorporated in order to dissipate energy, stabilize the raw and unconsolidated banks, and increase floodplain capacity in anticipation of future high-flow events while integrating aquatic habitat complexity.

Figure 5. A constructed low-flow channel, point bar, installed habitat wood, and increased channel sinuosity downstream of bridge 3

Low-flow channels were integrated to ensure connectivity of aquatic habitat during base-flow conditions. The low-flow channel is permitted and expected to migrate laterally within the existing high-flow channel (Figure 5).

Point bars and alternating bars were constructed at most sites to reduce the width-to-depth ratio of the low-flow channel and to encourage natural sediment transport processes though the reach. These features increase floodplain capacity while adding channel complexity and were constructed mainly using native cobbles, large buried rocks, and large woody debris. Point bars are features on the inside of sweeping bends (Figure 5), and alternating bars are present on both sides of the river, alternating between left bank and right bank, providing low-flow channel sinuosity when the overall river valley is straight.

Figure 6. Floodplain benches and alternating bars

Floodplain benches were incorporated to maintain a bankfull channel while allowing water during higher flow conditions to access the floodplain and dissipate river energy. These benches exist within the bankfull width of the channel, at an intermediate elevation between the channel bottom and the topographic floodplain or terraces (Figure 6).

Figure 7-Wood debris jam

Figure 8-Boulders for habitat and energy dissipation

Figure 9-Fish friendly irrigation diversion

Figure 10-Riffle/pool sequencing

Large woody debris was utilized in several areas for a variety of purposes, including floodplain roughness, bank stabilization, energy dissipation, and habitat complexity. Root wads were installed facing upstream on the outside of meander bends to dissipate energy and create micro-habitats. Large wood was placed strategically at an upstream, downstream, or perpendicular angle to check the direction and speed of the creek's flow. These features were anchored utilizing large blast rock as ballast.

Boulder clusters and habitat boulders were placed throughout the channel to create habitat for fish and other aquatic species. Secondary benefits include increased channel roughness to slow water velocities and reduce sheer stress on the channel bed and banks (including the roadway embankment). These boulders may also create recreational features.

Grade control and drop structures were built to set the elevation of the streambed to reduce the likelihood of severe scour, as well as to aid in the maintenance of riffle and pool bed features. The pools created by these structures provide cover for fish and other aquatic organisms. Water quality at drop structures is enhanced through aeration, and stream bank erosion is typically reduced as energy is dissipated in the vertical instead of horizontal direction. Low head boulder structures can also be used for fish friendly irrigation diversions (Figure 9).

Riffle-pool sequences were constructed throughout the project reach to provide a heterogeneous physical environment that can be used by a diversity of organisms (Figure 10). They provide a refuge from high velocity waters and extreme temperatures, and promote habitat complexity by offering diverse areas of cover, food, as well as spawning and rearing areas.

Figure 11. Floodplain benching, riffle-pool sequencing, boulder clusters and habitat wood in the beginning of a backwater pool (river left top).

Backwater pools were created to increase aquatic and riparian habitat diversity and provide an area of shallow, slower-moving water for aquatic species, particularly fry and juvenile trout (Figure 11).

Field visits, in conjunction with in-office team design activities, yielded a preliminary design set for the CR 43 project. GIS-based aerial photographs were annotated with text and symbols to identify major areas of work. These design sets were compiled into CAD. Technical drawings of typical features were added to the design set to aid in permitting and construction.

At the outset of construction, the Stream Recovery Team worked quickly to field fit the design given the available materials and equipment. Equipment operators were trained in the field and tasked on a daily, and sometimes hourly, basis.

4.1 Hydrology

In contrast to the main stem of the Big Thompson River, where the hydrology is heavily regulated by dams and diversions (e.g., irrigation diversions and removals for the Colorado-Big Thompson Project) from the Olympus Dam in Estes Park through its confluence with the South Platte River, flows on the North Fork are completely unregulated and not altered by dams or diversions (BTRRC 2015). Several sources of hydrologic information were used in the preliminary design of channel dimensions for the North Fork stream restoration project.

The USGS StreamStats program was accessed and run to determine design flows, including the base/low-flow, 2-year flow (Q2), 25-year flow (Q25), and 100-year flow (Q100). StreamStats uses several regression equations to estimate the recurrence interval flows, depending on the geography and location of the river. The North Fork of the Big Thompson River has estimates based on both mountain and plains region statistics, and a weighted average was used to determine the combined statistics for the CR 43 stream segments. Results are provided in Table 1 and Table 2 for the upper North Fork near Dunraven (Glen Haven) and the lower North Fork near Streamside (Drake), respectively.

A summary of hydrology information from the most current source to support North Fork Big Thompson River restoration activities, Hydrologic Evaluation of the Big Thompson Watershed: Post September 2013 Flood Event (August 2014), is included here. This report provides a general site description, a catalog of historical flood events, peak flow estimates for the 2013 flood event, a flood-frequency analysis, a rainfall-runoff model, and HEC-HMS hydrologic model results. The hydrologic model for the North Fork Big Thompson yielded a range of flows for the recurrence intervals identified in Table 1 (CWCB/CDOT at Glen Haven) and Table 2 (CWCB/CDOT at Miller Fork).

The Federal Emergency Management Agency (FEMA) published the effective Larimer County Flood Insurance Study (FIS) in February 2013. The pre-flood information included in the FIS was up-to-date at the time of publication, and no known relevant studies have been conducted between the FIS effective date and the September 2013 flood event. Summaries of FIS peak discharges for the upper and lower portions of the North Fork Big Thompson are provided in Table 1 (FIS at Glen Haven) and Table 2 (FIS at Drake), respectively.

The USGS Streamstats 2-year flow was used to define bankfull stage, and the 5-year flow was used to assess the transition into upland areas. The 50-year FIS was used in the existing conditions model to ensure that proposed improvements do not increase the pre-flood water surface elevation (WSL).

Table 1. Peak Flows from Several Sources, Upper North Fork Big Thompson River

	Streamstats at Dunraven						CWCB/CDOT at Glen Haven	FIS at Glen Haven
	Maximum/Peak Flows (cfs)					Low Flows (cfs)	Modeled Flows (cfs)	Regulatory (cfs)
	Area-Averaged	Mountain Region	Plains Region	Peak & Duration		Min & Duration	Peak	Peak
Drainage Area (mi^2)	53.7	53.7	53.7	53.7	53.7		51	51
2-year	300	302	214					
5-year	439	437	528					
10-year	538	531	822				971	1450
25-year	648	630	1390				1764	2600
50-year	787	760	1900				2640	3400
100-year	894	852	2610				3767	4400
200-year	1020	933	4750					
500-year	1170	1090	4580				7464	11500
7D2Y					207	2.67		
7D10Y					364	1.25		
7D50Y					513	1.64		
D10				95.9				
D25				29.3				
D50				11.9				
D90				4.47				
Sept 2013 Peak (estimated)								

Shaded cells indicate values used in models.

Table 2. Peak Flows from Several Sources, Lower North Fork Big Thompson River

	Streamstats at Streamside						**CWCB/CDOT at Miller Fork**	**FIS at Drake**
	Maximum/Peak Flows (cfs)					Low Flows (cfs)	Modeled Flows (cfs)	Regulatory (cfs)
	Area-Averaged	Mountain Region	Plains Region	Peak & Duration		Min & Duration	Peak	Peak
Drainage Area (mi^2)	68.5	68.5	68.5	68.5	68.5	68.5	69	83
2-year	349	353	242					
5-year	514	511	607					
10-year	633	622	949				1108	1500
25-year	767	737	1610				2083	3000
50-year	935	890	2200				3184	4100
100-year	1070	1000	3050				4625	6100
200-year	1250	1100	5540					
500-year	1420	1280	5350				9460	14100
7D2Y					243	3.21		
7D10Y					434	1.47		
7D50Y					613	2.02		
D10				114				
D25				35.7				
D50				14.6				
D90				5.67				
Sept 2013 Peak (estimated)								18400

Shaded cells indicate values used in models.

Chart 1 presents a peak discharge profile for the North Fork Big Thompson River (as published in CDOT 2014). In the upper North Fork Big Thompson near Glen Haven, the predictive peak discharges are approximately 15 to 30 percent lower than the effective FIS discharge results for all design storms. For the 10-year storm, this may be the result of combined rain/snowmelt events. In the lower North Fork Big Thompson, the predictive peak discharges are approximately equal to the effective FIS discharges at Drake for the 10-year, 50-year, and 100-year storms. For the 500-year storm, the predictive model result is approximately 11 percent lower than the effective FIS discharge at Drake (CDOT 2014).

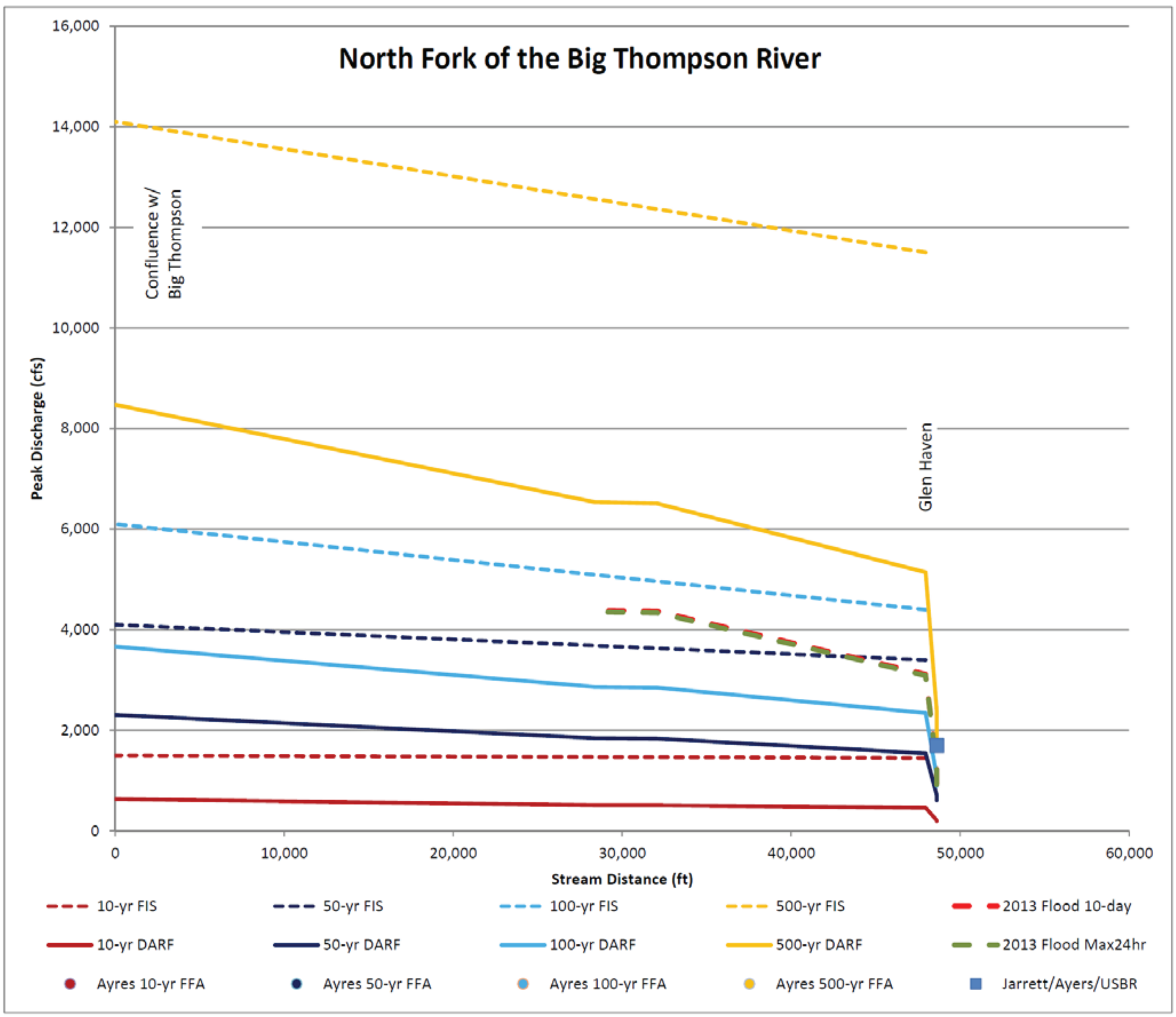


Chart 1. Peak Discharge Profile, North Fork Big Thompson River

In 2015, spring runoff peaked during the second week of June, with flows at about 285 cfs, approximating a 1.5- to 2-year recurrence interval (Chart 2). This data was measured using a velocity meter at a stable cross section upstream of the Dunraven bridge.

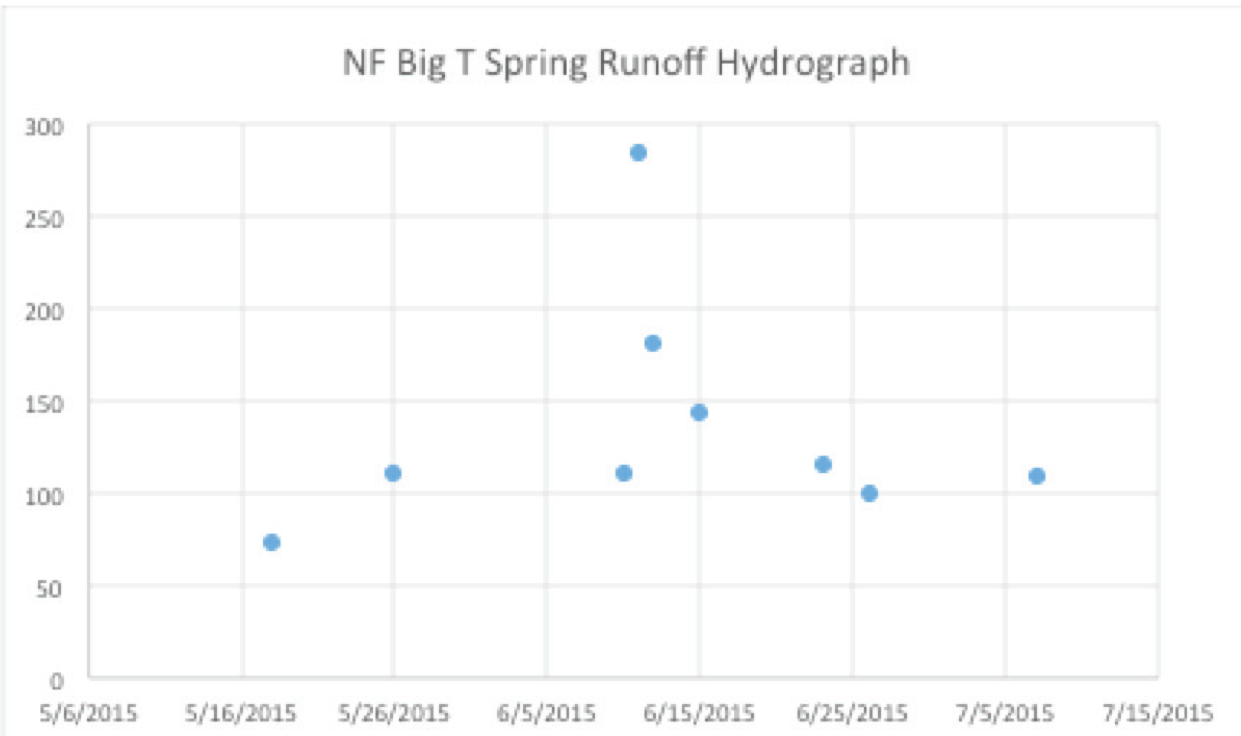


Chart 2. Spring 2015 Hydrograph, North Fork Big Thompson River

The average channel width through this reach is 25 feet, and the channel slope averages 132 feet per mile. Two of the larger tributaries to the North Fork Big Thompson River, West Creek and Devil's Gulch, join near Glen Haven. West Creek and Devil's Gulch have average channel widths of 25 feet, and their slopes are 90 feet per mile and 400 feet per mile, respectively (CDOT 2014).

4.2 Hydraulics

Open channel hydraulic calculations were completed using the CDOT hydrology data to develop a basic low-flow and bankfull channel cross-sections. Channel dimensions were based on pre-flood conditions including available cross-sections, photographs, and landowner reports. These were confirmed with simple Manning's equations and HEC-RAS modeling. Chart 3 provides typical riffle and pool cross-sections for the North Fork Big Thompson River. Ultimately, these dimensions were field fit, recognizing that a natural channel has a high degree of variability and that future runoff events will both erode and deposit sediments as the streams regain and establish relative stability.

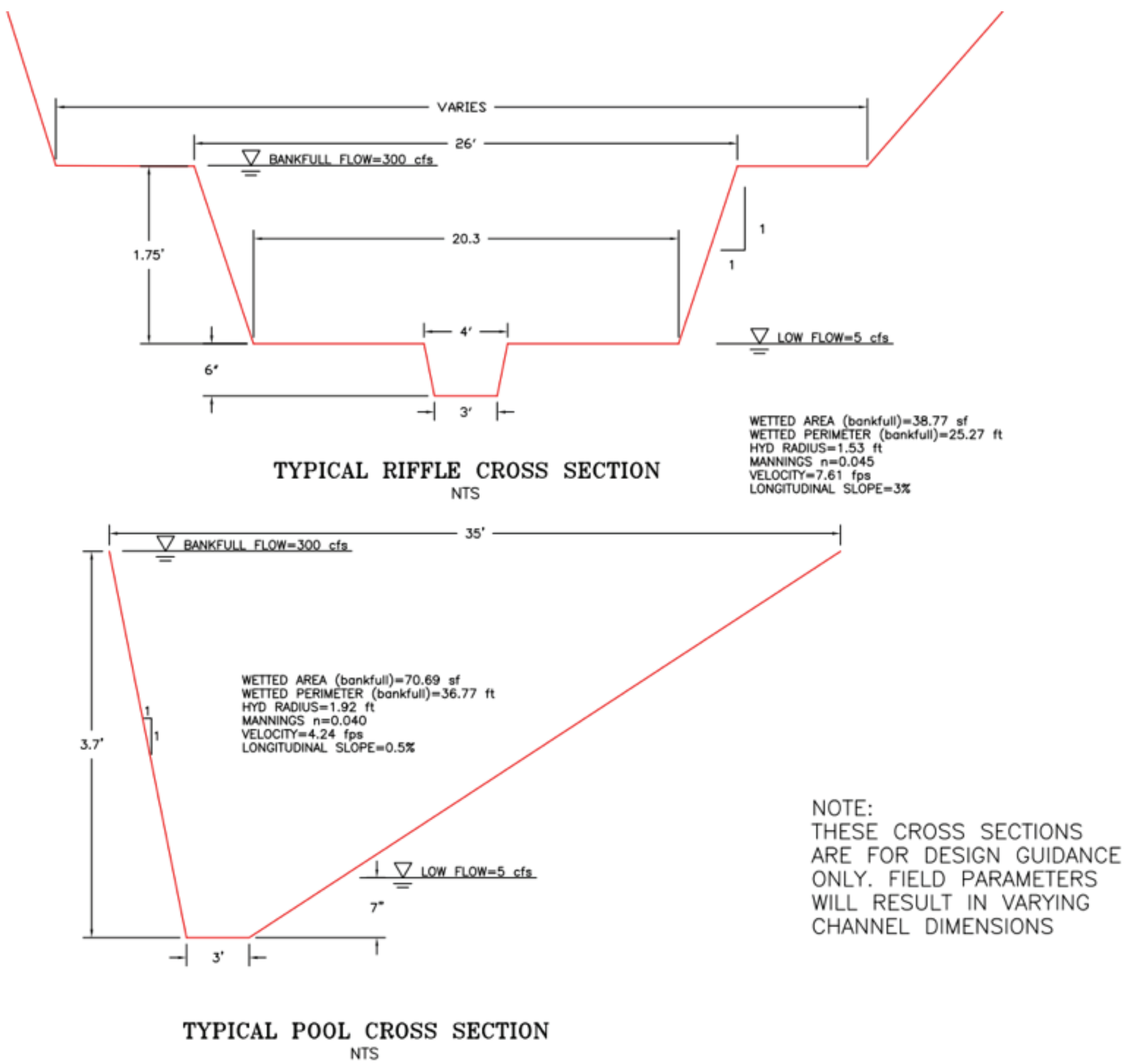


Chart 3. Typical Design Cross Sections

A HEC-RAS hydraulic model was developed by CFL engineers for both the existing and proposed conditions. Road and bridge designs were developed to contain the 50-year event. The objective of the Stream Team was to maximize floodplain capacity while developing a meandering compound low flow channel within the floodplain.

Follow-up analysis was completed during construction to determine the locations where floodplain benches—to be set at the approximate 2-year flow elevations—would not impact 50-year water surface elevations. Basic HEC-RAS modeling showed that adequate river corridor width to include these features without adverse impacts on the 50-year flood surface elevations was absent at many sites. Lower, mobile, alternating bars and point bars were built at all the sites.

Restoration Project Review

This section presents a site-by-site description of work completed for the CR 43 river restoration project. A map of the project area and key site locations is provided as Figure 12. The project was divided into 2 parts; West Seed and East Seed. The West Seed project started downstream of the Town of Glen Haven at the boundary between private property and the US Forest Service and extended downstream to just below the Dunraven bridge. Most of the West Seed project was in the Roosevelt National Forest. The Stream Team worked closely with Dan Cenderelli and Matt Fairchild of the US Forest Service. The Forest Service Team provided post-flood cross sections and longitudinal profiles that were valuable and served as the existing conditions data needed for the proposed design.

The East Seed project was a patchwork of stream rehabilitation sites on both private and public lands. The restoration effort funded by the FHWA project could only be implemented where the roadway was adjacent to the stream. The East Seed project extended from the Section 25/Section 26 line to the Chenoweth Ranch. The red line in Figure 12 does not include any stream restoration efforts performed under the CR 43 project but does include a separate project funded by the Colorado Water Conservation Board.

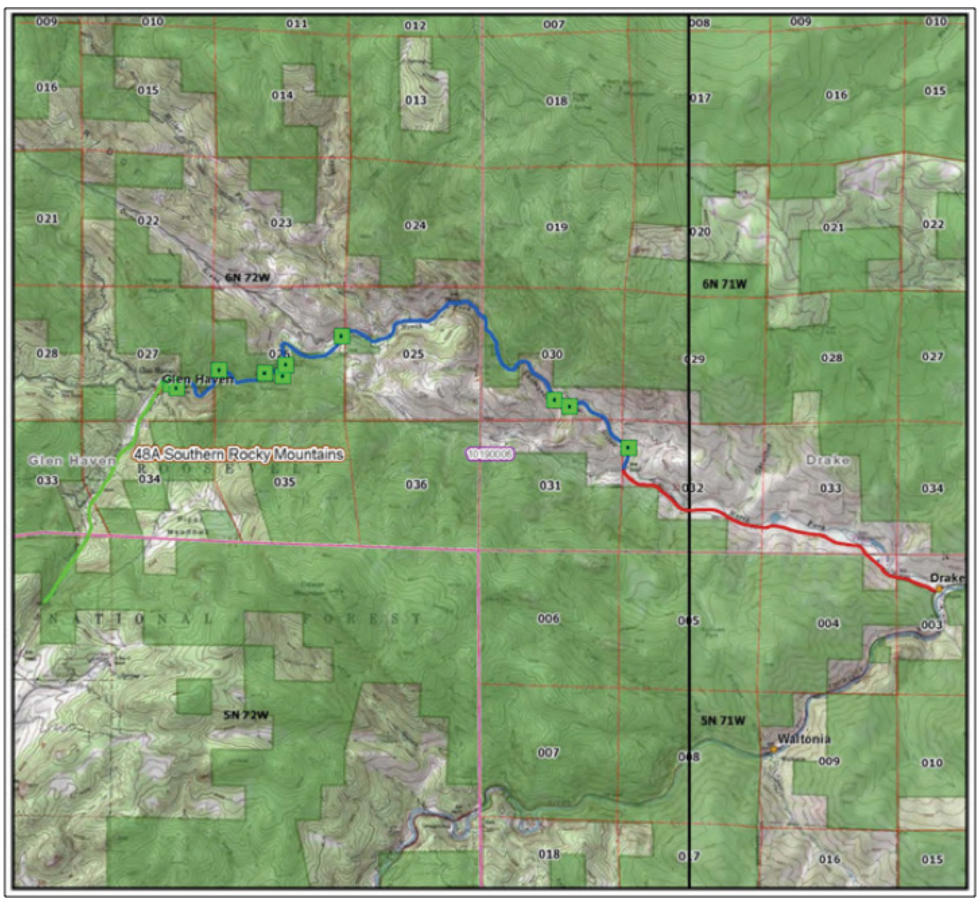


Figure 12. US 36 project area and site location map.

4.3 West Seed

The West Seed reach is almost exclusively on US Forest Service land and as a result the Forest Service Team was very influential and helpful in the design of the project. They worked closely with CFL staff to maximize floodplain potential. The West Seed project was broken up into reaches based upon stream crossings. There were 6 new bridges constructed in this reach beginning with bridge 3 and continuing downstream to bridge 8. The Dunraven bridge is also included in this reach but is on private property. The total length of the West Seed reach is approximately 1.8 miles. West Seed plans are found in Appendix A. Due to budget constraints river as-builts were never completed.

4.3.1 Bridge 3

The bridge 3 reach begins approximately 700 feet upstream of the bridge and extends approximately 600 feet downstream to a bedrock outcropping that formed a steep cascade. The pre-flood alignment had the river on the inside bend of the valley and the roadway on the outside bend. The flood destroyed the road in this location. Bridge 3 was constructed to move the shear stress from high water events to the bedrock walls along the outside of the valley. A significant amount of blasting was required to move the road inward and the river was completely rebuilt in the location where the road was prior to the flood. Minor horizontal and vertical alignment adjustments were made in the field due to bedrock outcrops. A significant amount of excavation was removed to develop bankfull benches and terraces. Additional rock and large woody debris was installed to enhance the aquatic habitat.

Figure 13-Pre-flood alignment

Figure 14-Post construction upstream of Bridge 3 on left and downstream on right

4.3.2 Bridge 4

Bridge 4 was also constructed to flip the alignment of the road and the river to increase resiliency in future flood events. It is located approximately 1,220 feet downstream of Bridge 3. Additional field fits were required throughout this reach to account for the varying elevation of bedrock along the south valley wall. Dozens of exploratory holes were drilled upstream of the bridge to determine bedrock elevations and design an appropriate channel approach to the bridge. At the upstream end of this reach channel excavation uncovered a steep cascade that acted as a fish passage impediment. The Stream Team designed and constructed a series of step-pools to improve fish passage in this location. Additional boulders and large woody debris was incorporated for enhanced aquatic habitat. Floodplain benches were maximized throughout this reach by steepening the side slope of the road and stabilizing the toe of the slope with large boulders.

Figure 15-constructed step-pools on left and root wad revetment with habitat wood on right upstream of bridge

Figure 16-Riffle-pool sequencing and expanded floodplain bench above bridge on left and downstream of bridge on right

4.3.3 Bridge 5

The Bridge 5 reach, running halfway between Bridge 4 & 5 to halfway between Bridge 5 & 6, included a significantly expanded floodplain, low-flow meandering with a riffle-pool complex, large woody debris anchored on both the floodplain and in the channel, and a constructed log jam downstream of the bridge to enhance aquatic habitat and trap floating debris. The stream was constructed along the alignment of the pre-flood road and the new road was relocated towards the inside bend. Again, a significant amount of blasting was required to move the road inward. Downstream of the bridge and the log jam the channel was pinched straight due to valley constraints. The Stream Team constructed a low flow meandering channel with a riffle pool longitudinal sequence and utilized large woody debris and boulders and enhance channel complexity.

Figure 17-Expanded floodplain capacity upstream and downstream of Bridge 5

Figure 18-Constructed log jam and enhanced aquatic habitat downstream of Bridge 5

Figure 19-Long confined reach downstream of Bridge 5 before and after construction

4.3.4 Bridge 6

Bridge 6 was also constructed to move the road away from the outside valley walls to increase resiliency. Upstream of the bridge was the site of a previous Forest Service campground. An old chimney still stands at this site. A small tributary enters the creek on river right just above the chimney site. A significant amount of excavation occurred upstream of the bridge to increase floodplain capacity. The channel takes a hard left turn just above the bridge and utilizes the bedrock wall there to direct the flow. A series of deep pools were constructed along this wall for fish holding. A similar scenario exists downstream of the bridge when the river turns hard right again. Large woody debris was utilized extensively through this reach and another log jam was constructed upstream of the bridge.

Figure 20-Pool habitat upstream of tributary & root wad revetments downstream

Figure 21-Expanded floodplain benches up and downstream of Bridge 6

4.3.5 Bridge 7

Both upstream and downstream of Bridge 7 there has been significant floodplain excavation with large amounts of woody material anchored both on the benches and in the channel. This is another location where the road and the river alignments have been flipped to increase resiliency.

Figure 22-Expanded floodplains, boulder clusters, constructed large woody debris up and downstream of Bridge 7

4.3.6 Bridge 8

Bridge 8 is the last crossing on Forest Service land before crossing over onto private property. This reach extends down to the horseshoe bend above the Dunraven bridge. Numerous anchored root wads were installed at the top of the bend. The roadway was moved back into the hillside here and an overflow swale was constructed to allow high flow events to cut off the horseshoe bend, as it did in the flood, and safely divert back to the stream downstream. This will help protect private residences in the area and act somewhat as a pressure relief valve. Revetment has been buried in the top of the bank to allow water to recede back into its primary channel instead of creating a new one.

Figure 23-Root wad revetment at horseshoe bend & channel downstream of Bridge 8

4.3.7 Dunraven Bridge

Dunraven bridge is a Larimer County bridge that survived the flood. The County repaired scouring along the abutment walls and the compound channel constructed both above and below the bridge continued through it. This reach of the West Seed project was completed first in the Fall of 2015 and allowed Wildland Restoration Volunteers (WRV) to come in and do riparian plantings and seeding. This was all paid for by private grants obtained by WRV. Treatments in this reach included root wad revetment, boulder clusters, riffle-pool sequencing, floodplain benching and expanded capacity.

Figure 24-Riparian regeneration after one season of growth near the Dunraven Bridge

4.4 East Seed

Time and budget constraints put a considerable amount of pressure on the East Seed reach. Design plans were never completed due to the constraints yet there was a substantial amount of restoration work to complete. Hydrology calculations, channel dimensions and treatment details were all complete from the West Seed reach and were used appropriately downstream. The Stream Team was given an excavator and an operator and told to complete the project as quickly as possible. The experience from the West Seed reach was invaluable in developing appropriate natural channel morphology. Unlike the West Seed project, the East Seed reach was broken up by landowners instead of bridges. The existing conditions plans for the East Seed reach can be found in Appendix B.

4.4.1 Ballard site

The Ballard site begins just past the Crosier mountain trailhead, downstream of the Dunraven bridge, to what was known as Bridge 11. The river was pinched between the roadway and a private driveway that serviced several properties. Considerable excavation was required to create a floodplain and develop a meandering channel through approximately 900 feet of stream. Bridge 11 was built to keep the road on the inside bend of the valley and a culvert was eliminated upstream of that to maintain resiliency and sustainable channel morphology. A small amount of wood was installed but primarily strategically placed boulders were used to create channel complexity and improve aquatic habitat.


Figure 25-Meandering riffle-pool complex using primarily boulders at Ballard site

4.4.2 Bridge 11 to Wilder

The site downstream of Bridge 11 was used by the contractor for staging. The channel in that area had been ditched and straightened. The downstream landowner, Wilder, had requested that it be put back into the pre-flood alignment that took it further away from his residence. Treatments at this reach included Boulder and root wad revetments, channel realignment and riffle-pool sequencing throughout the 800-foot reach.

Figure 26-Channel meandering, root wad revetment and boulder clusters downstream of Bridge 11

4.4.3 Whiteside

The stream leaves the roadway for a short stretch and re-emerges alongside the road at the Whiteside property across from Streamside Drive. The Whiteside property owns approximately 1,800 feet of stream but only spot treatments were requested at this reach. Minor channel alignments were constructed through this reach and several boulders were placed to enhance aquatic habitat.

Figure 27-Floodplain grading and boulder placement at Whiteside

4.4.4 US Forest Service

From Whiteside down to the Forest Service property there is an approximate 1 mile gap where no treatments were done. Some of that didn't need anything and in other locations there was no access. At the Forest Service property the floodplain opened up and a significant amount of excavation was removed from there. A meandering channel with riffle-pool sequencing was constructed, deep pools were built alongside the bedrock walls, a log jam was constructed and large woody material and boulders were installed for aquatic habitat along this 1,800 foot reach.

Figure 28-Strategic rock placement for riffle-pool morphology & log jam on expanded floodplain

Figure 29-Deep constructed pools alongside bedrock with log enhancement & expanded floodplain

4.4.5 Shukle-Shea

Two bridges were eliminated at this site, approximately 1,700 feet downstream of the US Forest Service property, by negotiating with landowners to flip the alignment of the road and the river and putting the river along the outside bend of the valley. This reach was approximately 2,100 feet long and included 1,200 feet of channel realignment. Treatments included floodplain grading, low flow meandering channel with riffle-pool sequencing, large woody material installation and boulder placements.

Figure 30-Expanded floodplain benches, root wad installation, meandering channel, riffle-pool sequencing

4.4.6 Rainbow Bridge

A new bridge at the Rainbow Bridge site replaced a previous box culvert that had plugged and washed out. This was the last site of the East Seed reach. The 600-foot reach runs from the bridge to a bedrock wall on river left where it turns south and is transitioned into another river restoration project funded by the Colorado Water Conservation Board on the Chenoweth Ranch. The site was used for staging by the contractor and a significant amount of excavation was removed to develop floodplain benches. Additional boulders and large woody material was installed for enhanced aquatic habitat.

5.0 ESTIMATED MATERIALS AND CONSTRUCTION COSTS

The ability to utilize materials from on site and equipment from the road construction project is crucial to developing a cost-effective and holistic project. Budget data from the CR 43 project was not available for analysis so only generalizations can be made but cost savings have been shown to be substantial in previous projects.

For example, two cost estimates were generated for the river restoration work throughout the US 36 corridor in 2014. The first was an approximation of actual expenditures of the project, including the construction, construction oversight, design, coordination, and permitting. The second was an engineer's opinion of probable cost for a stand-alone river restoration project that would have produced the same on-the-ground product. That estimate was meant to illustrate what the river restoration cost to an outside agency, a watershed coalition, CDOT or private landowners would have been had there been no collaboration with the permanent road rebuild.

5.1 Actual Costs

The total executed cost of the US 36 river restoration project was approximately $191,750. The project restored 8,375 linear feet (LF) of river on North St. Vrain Creek and 2,380 linear feet on the Little Thompson River, for a total of 10,755 linear feet stabilized and enhanced. The average cost of this complete restoration was $18 per linear foot. This cost, however, excludes revegetation activities, as those did not occur as a part of this project.

The estimated actual cost of the conceptual design, coordination, permitting, survey, and construction oversight for river restoration work on both North St. Vrain Creek and the Little Thompson River was approximately $90,000. This number is weighed heavily by the initial coordination time in establishing the agency and private landowner collaboration. The construction oversight services for the work is likely a bit higher than would be expected on a "standard" river restoration project. The compressed timeline of the design process meant that construction began when only a conceptual plan for the work was completed; all construction actions necessitated engineering oversight and extensive field fitting was required throughout the entire project reach.

The estimated actual construction cost was approximately $101,750. 250 hours of equipment operation were used in Phase 1 of the construction process, completing stabilization and channel shaping work before spring runoff in April and May 2014. 300 hours of equipment time were used during Phase 2 of the project during August and September 2014.

5.2 Probable Costs for Identical Work

The costs in this section are an engineer's opinion of probable costs for identical work, but completed as a stand-alone project and executed by a local government agency, watershed coalition, or private landowner(s).

These estimates include design, permitting, landowner coordination, construction mobilization, construction costs, administration, and survey work, as well as similar erosion control, health and safety, and traffic management plans. Because no revegetation was completed, no revegetation costs were included in this estimate.

The total estimated cost for the North St. Vrain Creek river restoration project is $894,141 (Table 3), and the total estimated cost for the Little Thompson river restoration project is $403,844 (Table 4), for a total of $1,297,985.

The estimated total North St. Vrain Creek and Little Thompson River construction costs would have been about $107/LF.

Table 3. Probable Cost for Identical Work, North St. Vrain Creek

Construction Cost Estimate - Highway 36 River Restoration North Saint Vrain Creek Sites 3-11				
Item	**Quantity**	**Units**	**Unit Price**	**Cost***
Pre-Construction Requirements				
Bond, Insurance, Permits, Traffic Control, Mobilization, etc.	1	EA	$ 110,988	$ 110,988
Site Preparation				
Survey--Layout & Boundary	5	DAYS	$ 2,400	$ 12,000
Temporary Erosion and Sediment Controls	1	EA	$ 30,092	$ 30,092
Earthwork/Grading				
Excavation & Regrade--Floodplain Regrading, Channel Realignment, Bank Work	24,081	CY	$ 14.40	$ 346,768
Instream and Bank Stabilization Structures				
Boulders for Grade Control Structures--delivery & installation	359	TON	$ 120	$ 43,080
Habitat Boulder--delivery & installation	192	TON	$ 70	$ 13,440
Riffle Roughening	135	TON	$ 70	$ 9,450
Habitat Log on Floodplain--delivery & installation	16	EA	$ 330	$ 5,280
Engineered Rootwad--delivery & installation	42	EA	$ 1,200	$ 50,400
Engineered log vanes--delivery & installation	4	EA	$ 1,200	$ 4,800
Trash and Debris Removal				
Trash and Debris Removal	4.4	DAYS	$ 1,000	$ 4,400
Closure Actions				
Demobilization and Reclaim	1	EA	$ 9,960	$ 9,960
Final Survey	5	DAYS	$ 2,400	$ 12,000
Construction Subtotal				**$ 652,658**
Support Services				
Construction Design & Engineering	12	%	$ 652,658	$ 78,319
Construction Support Services	10	%	$ 652,658	$ 65,266
Administration	5	%	$ 652,658	$ 32,633
Stakeholder Outreach & Education	10	%	$ 652,658	$ 65,266
Design and Support Services Subtotal				**$ 241,483**
Project Total				**$ 894,141**

Table 4. Probable Cost for Identical Work, Little Thompson River

Construction Cost Estimate - Highway 36 River Restoration Little Thompson River Sites 13-16				
Item	**Quantity**	**Units**	**Unit Price**	**Cost***
Pre-Construction Requirements				
Bond, Insurance, Permits, Traffic Control, Mobilization, etc.	1	EA	$ 102,888	$ 102,888
Site Preparation				
Survey--Layout & Boundary	3	DAYS	$ 2,400	$ 7,200
Temporary Erosion and Sediment Controls	1	EA	$ 23,432	$ 23,432
Earthwork/Grading				
Excavation & Regrade--Floodplain regrading, Channel Realignment, Bank Work	3,667	CY	$ 14.40	$ 52,805
Instream and Bank Stabilization Structures				
Boulders for Grade Control Structures--delivery & installation	174	TON	$ 120	$ 20,880
Habitat Boulder--delivery & installation	49	TON	$ 70	$ 3,430
Plug--material delivery & installation	89	CY	$ 14	$ 1,281.60
Habitat Log on Floodplain--delivery & installation	20	EA	$ 330	$ 6,600
Culvert Installation	6	EA	$ 1,200	$ 7,200
Engineered Rootwad--delivery & installation	42	EA	$ 1,200	$ 50,400
Trash and Debris Removal				
Trash and Debris Removal	1.5	DAYS	$ 1,000	$ 1,500
Closure Actions				
Demobilization and Reclaim	1	EA	$ 9,960	$ 9,960
Final Survey	3	DAYS	$ 2,400	$ 7,200
Construction Subtotal				**$ 294,776**
Support Services				
Construction Design & Engineering	12	%	$ 294,776	$ 35,373
Construction Support Services	10	%	$ 294,776	$ 29,478
Administration	5	%	$ 294,776	$ 14,739
Stakeholder Outreach & Education	10	%	$ 294,776	$ 29,478
Design and Support Services Subtotal				**$ 109,067**
Project Total				**$ 403,844**

Estimated costs are $42/LF on North St. Vrain Creek and $22/LF on the Little Thompson River for the earthwork involved in creating low-flow, bankfull, and high-flow channels. North St. Vrain Creek should have a marginally higher per linear foot cost because there is more width and depth that require working for each segment of stream.

The Little Thompson and Saint Vrain master plans have expected costs for this type of work in these reaches and estimate that on the Little Thompson it would have cost $48/LF for low flow channel and floodplain capacity earthwork, which is quite similar to the costs presented here. The Saint Vrain master plan, however, has $250/LF for the same task, which seems unreasonably high for these canyon reaches, but may be reasonable for the plains portions of the river east of Longmont.

5.3 Cost Comparison

The collaboration between the state, federal, and local agencies for this project resulted in an 85 percent cost savings for the river restoration work on North St. Vrain Creek and the Little Thompson River. The actual cost of the project was $191,750, while the estimated cost of stand-alone projects on both rivers is $1,297,985, resulting in a cost savings of more than $1.1 million.

As a rough comparison, the US 36 project restored 10,750 linear feet of channel while the CR 43 project restored 17,500 linear feet of channel – a 61% increase. The cost savings between the US 36 project and the CR 43 project are likely not linear but if they were the savings would be approximately $1.77 million.

6.0 PROJECT CONSTRAINTS

The CR 43 project site was constrained by several factors, listed below, which affected the recommended design.

Roadway Embankment Constraints: The maximum extent of the toe of the slope of the CR 43 embankment was determined by the emergency repair work and the subsequent roadway work while keeping the road open for local residential traffic. This required the river to be channelized in a very narrow corridor with immense amounts of fill in the floodplain. The grade of temporary culvert crossings (shoo fly) sometimes were set too high which contributed to the fill by depositing sediment at the inlet. This resulted in large quantities of material to be removed and transported off site before restoration work could be done. The tight valley physical constraints of this particular project limited alternatives for stockpiling fill material but on other projects if river restoration experts are consulted earlier in the design process other alternatives may be developed that might reduce the amount of material to be moved.

Budget Constraints: Despite the fact that there was no budget for stream restoration, the FHWA project manager took advantage of necessary right-of-way work in and adjacent to the stream to implement river restoration treatments. Even a small budget for stream restoration design and implementation work could be leveraged by the roadwork budget to construct a more holistic project.

Timing Constraints: The project had a very rapid timeline between roadway subgrade construction and paving. Most of the stream restoration needed to completed in between those two phases. If equipment was dedicated to the river earlier that constraint would have been reduced.

Agency Competition Constraints: Differing priorities by competing federal agencies made timelines somewhat difficult. What one agency thought was important another did not and, therefore, time went into plans that could not be built in the field.

Material Availability, Delivery, and Equipment Constraints: The construction of CR 43 was the priority for the County, CFL and construction crews. Construction materials were made available to the Stream Recovery Team intermittently depending on blasting schedules and availability of equipment to load and haul. On occasion, some sites were left under-constructed due to a lack of available materials and/or equipment. In-channel equipment and/or their operators were occasionally made unavailable to attend to priority needs of the roadway construction. Mechanical issues shut down equipment for repairs frequently during construction and the lost hours contributed to the timing constraint.

Revegetation Constraints: In most cases, streamside vegetation was preserved only to the extent that it did not interfere with construction of the roadway.

7.0 LESSONS LEARNED AND OPPORTUNITIES FOR FUTURE SUCCESSES

The CR 43 river restoration project was a success, due in large part to the support and encouragement of CFL leadership, the County and survey data provided by the Forest Service team, and despite the accelerated time frame, restricted equipment and material availability. As the project served as an excellent project for testing process and partnerships, lessons learned throughout the process will be beneficial to future flood recovery efforts and to other restoration projects that involve a shared roadway/river corridor. This section details recommendations developed as a result of this project.

1) Design the Road and River as a Single System

In areas involving a shared roadway/river corridor, river planning and road planning should be approached and evaluated as a singular system, as opposed to being treated as two disparate planning projects. A sustainable road/river relationship goes beyond predicting water surface elevations and sizing rip-rap for roadway embankments. It starts with evaluating the locations of both the road and river to minimize the length of embankments that are subject to high shear stresses and sizes crossing structures that take into account sediment loads as well as flow capacity. The singular system design can also make great strides in reducing erosive energy in locations where the roadway is vulnerable, as well as providing the grading and seeding to encourage vegetation that will serve ecologic functions as well as provide cohesive structure to the roadway embankments.

2) Begin Collaboration in the Planning Stages of the Project

Clear, early, and frequent communication between river restoration and roadway reconstruction specialists is paramount. This project began with a tour of the road and river alignments and resulted in the river and road being flipped in 11 locations to improve resiliency in future flood events. Additional consultation during the roadway design may have resulted in cost saving with respect to material movement and construction techniques. For example, there were several instances where the river restoration team needed to make channel and floodplain improvements due to previous construction. Had a river restoration specialist been on site with the authority to direct operators, some work would not have had to been repeated.

3) Encourage Private Landowner Cooperation

River processes do not start or stop on political boundaries and easement lines. Often, the most effective way to change or eliminate a vulnerability in a river corridor is to do work upstream, downstream, or on the opposite bank. Coordination with private landowners is critical to implementing a comprehensive and holistic project without the typical patchwork that frequently results from individual landowners working on their own. The CR 43 project's cooperation with private landowners to conduct system-wide river improvements on both banks and upstream and downstream of property boundaries was absolutely necessary for this type of project and was executed extremely well by Larimer County staff and the CFL project manager. Nearly all of the landowners were cooperative and allowed the restoration to take place almost seamlessly across ownership boundaries.

4) Engage in a Concurrent Design and Construction Process

This project underscored the cost-effectiveness of a collaborative design and construction project (rather than stand-alone separate projects). As stated in the previous section, executing the construction of the stream restoration work as a portion of the roadway rebuild, rather than as a separate contract, likely saved the agencies millions of dollars. The project was able to capitalize on and utilize material generated elsewhere within the project corridor, drastically reducing construction costs. In addition, working within the structure of the concurrent road project meant that mobilization and other project start-up and shut-down costs were minimized.

5) Enlist Equipment Operators with River Construction Experience

While the Stream Recovery Team worked closely and well with the several equipment operators provided by the contractor, equipment operators who have previous experience working in rivers and particularly on river restoration projects could benefit future projects. Efficiencies could be attained if equipment operators are versed in the language of river restoration design, necessitating fewer construction oversight hours by the design engineers. Furthermore, operators who have a background in environmental restoration are more likely to construct river-appropriate structures and those with the experience of building within the channel corridor are likely to have better focus on completing the critical design components (Figure 32).

Figure 32. Experienced equipment operators reduce the time needed to build complicated features.

6) Preserve Fallen Trees and Large Wood

CFL, Forest Service and contractor staff did a remarkable job stockpiling large fallen trees for use in the river restoration. Most of those trees came from Forest Service lands and were required to be used on the Forest. However, if the US Forest Service could be allowed to use its tress throughout the watershed we may have had an even more holistic restoration.

Fallen trees with intact root balls, commonly referred to as large woody debris (LWD) or large wood, are a key component of stream stability and stream ecosystems. Decades of research has shown the removal of large wood, and debris jams created during flood events, have a destabilizing effect as the channel loses a significant amount of its ability to dissipate energy though non-destructive means. For a roadway embankment, the presence and use of large wood may actually deflect and dissipate scouring flows providing an additional buffer to the roadway. Furthermore, the complex flow structures, cover, and nutrient loading that in-channel large wood provides have profound benefits to the entire riparian ecosystem, from macroinvertebrates to adult fishes to birds of prey and terrestrial mammals. Wherever and whenever possible, large wood should be stockpiled or left onsite for reuse in channel projects. It should not be burned or removed from the watershed. Chipping some wood debris into mulch for erosion control may be a worthwhile pursuit.

7) Finish the Project with Intensive Revegetation

Figure 33. Floods are regenerative and vegetation will slowly establish; however, jump-starting the process with native plantings and seeding will help suppress weeds and invasive species while encouraging soil and sediment cohesiveness immediately after construction.

Revegetation should be conducted or planned in conjunction with channel work (Figure 33). Native vegetation can have specific topographic and final grade requirements that are necessary for the plants to root and thrive. These considerations are best addressed in the design phase of the project. Immediate coordination with native vegetation experts such as the US Forest Service, CWCB-supported Native Riparian Plant Propagation Program and/or volunteer groups such as Wildlands Restoration Volunteers and the Conservation Corps to improve native revegetation and reduce the need for post-construction weed control is recommended. Additionally, cooperation with these organizations could lead to cost-sharing or other creative financing agreements for revegetation efforts.

8) Stockpile and Redistribute Topsoil

In conjunction with revegetation, the preservation and perhaps even import of topsoil should be considered at the outset of a restoration project. Topsoil is critical to vegetation establishment, soil and sediment cohesion, and a self-sustaining restoration project. Especially on projects such as this one, where significant excavation into areas with layers of topsoil occurred, this limited resource should be stockpiled and graded into floodplain benches and bare channel banks to the extent possible throughout the project area.

9) Prioritize Trash Removal

Trash removal should be considered a priority from the beginning of a flood recovery project. During the CR 43 project, a significant amount of trash that was not transferred off-site early ended up in danger of re-mobilizing during spring runoff and had to be removed immediately.

10) Create Opportunities for Public Access

The CR 43 project had, and took advantage of, the capacity to extend safe access to stream bank areas within the road right-of-way to the general public for fishing and other recreational activities on US Forest Service land. Exploration of the opportunity to partner with Colorado Parks and Wildlife for this additional public benefit is recommended.

11) Improve Roadway Embankments to Benefit the River

The existing embankments built by CFL to protect the road were enhanced in many cases to dissipate river energy and slow water velocities. Adding complexity to the stream bank can be accomplished by placing boulders in a more random pattern at the toe of the roadway embankment to slow flows along the outside bend of the stream, benefiting the river channel without compromising roadway protection. Naturalizing the embankments with the addition of vegetation, such as willows, would also provide benefits to the stream ecosystem.

12) Highlight the Benefits to the Public and Public Perception

A significant benefit to linking road and river work is the reduced inconvenience to nearby residents and drivers as they will experience only one set of traffic delays and road closures. Similarly, nearby residents are only subjected to the annoyances (dust, noise, etc) of a single construction timeline which may reduce the despair and "aren't they ever done?!" sentiment that would certainly arise as multiple projects are done in a single area. Additionally, designing and constructing the project as one indicates to the public that the government agencies are acting collaboratively and with the environment in mind and that there is a drive to effectively complete the entire project and quickly move to the next area in need.

13) Coordinated Permitting and Public Outreach

Preparing permits for both the road projects and stream restoration work simultaneously (and when possible combined) resulted in significant cost and time savings. Treating the project and its impacts, environmental reviews, and strategies for mitigation as one project reduced the burden on both parties for both application and review.

8.0 NEXT STEPS

In order to maintain and capitalize on improvements and roadway stability gained through river restoration activities and to plan for possible future enhancements, long-term monitoring and revegetation of the CR 43 sites are an important next step. Each of these components is described in more detail below.

8.1.1 Long-term River Monitoring

A formal monitoring plan with the goal of generating sound scientific data over a specified period of time should be developed in conjunction with the Forest Service and CFL. The monitoring plan should be constructed with the goals of the project in mind, the data needs of the decision makers, and a means to turn data into information.

Specific methods, sites, timing, and quality assurance procedures could be outlined in the monitoring plan. Quantity and location of sample sites could be determined based on assessed project goals. While professional judgment on the selection of sample site(s) could be supplemented with advice from project stakeholders and guidance from sampling protocols, an overarching goal could be the selection of sites with enough diversity, spacing, and number to obtain a dataset that adequately represents the overall CR 43 flood recovery effort. Parameters and methods could be selected to measure change specific to the project. Sampling timing and frequency, collection of historic/pre-project data, utilization of reference sites, and/or expected condition could also influence selection of monitoring parameters. Example monitoring parameters are listed in Table 5.

Table 5. CR 43 Example Monitoring Parameters

Project Type	Core Parameters	Additional Parameters
Geomorphic enhancements including compound channels, rock structures, large woody debris, and bar/riffle development aimed at maintaining stability	Cross-sections, photo points	Macroinvertebrates and fish, temperature, sediment, thalweg, structures surveys, topographic/ profile survey, hydraulic analysis (HEC-RAS)
Riparian enhancement	Temperature, canopy cover, discharge, nutrients, vegetation survey, macroinvertebrates	Thalweg, cross-sections, photo points, fish

8.1.2 Revegetation

In partnership with the adjacent landowners throughout the CR 43 corridor, an aggressive weed management and revegetation plan should be developed and implemented for the bare earth areas throughout the project site. The denuded landscape causes problems from a structural and safety perspective within the river corridor, and also degrades riparian habitat—a critical ecological habitat for a majority of Colorado's wildlife.

Senate Bill 14-179 provided the CWCB with funding to address this habitat loss throughout the flood-affected corridors. Wildland Restoration Volunteers, one of many grant recipients, is working with private consultants to develop locally-adapted native shrubs, trees, and grasses necessary to restore flood-impacted areas. Working with the newly-formed Southern Rockies Seed Network, a long-term impact of this program will be to build a network of collectors, growers, and distributors that provide native shrubs and trees originating from the Southern Rockies Ecoregion.

9.0 CONCLUSIONS

The September 2013 flood event significantly damaged large portions of Larimer CR 43 along North Fork of the Big Thompson River. Emergency roadway reconstruction activities were underway immediately following the flood, and a unique partnership quickly formed between federal and county highway agencies and state and private stream restoration experts that allowed river rehabilitation to occur concurrently as part of the permanent road reconstruction effort through the CR 43 corridor. This collaborative process proved to be a cost-effective and efficient way to protect the road from future river instability by rehabilitating the river utilizing roadway reconstruction resources to design and construct stream channel enhancements. Similar partnerships where mutual benefit can occur are recommended and should be sought out. Not only did the partnership save millions of dollars in stream restoration costs throughout this corridor, but both the stream restoration project and the roadway reconstruction project came away with lasting benefits. The collaborative process and joint projects resulted in a river/roadway corridor that is much improved and more resilient, from the standpoints of public safety, infrastructure protection, environmental and ecological health, and recreational opportunity.

It should be noted the project management and design staff from Central Federal Lands worked pro-actively with US Forest Service staff, Larimer County Engineering and private landowners to make this project the success it was. Without their forward-thinking approach to consolidate resources and develop resiliency of the design and construction, this project may have simply been another rebuilding of the existing roadway alignment and thus losing an opportunity to build better.

Appendix A: West Seed Plans

NOTES:

1) THE PURPOSE OF THIS BASE MAP IS TO PROVIDE GENERIC BASE MAPPING. DATA SHOWN SHALL BE USED FOR INFORMATIONAL PURPOSES ONLY.

2) CONTOURS SHOWN HEREON WERE PROVIDED BY FEDERAL HIGHWAY ADMINISTRATION (FHWA) ON JANUARY 15, 2015 AND FEBRUARY 13, 2015. CONTOURS SHOWN HERE ON BLEND THE EXISTING CONDITIONS (LIDAR DATA) AND THE DESIGN CONTOURS (ALONG THE ROAD).

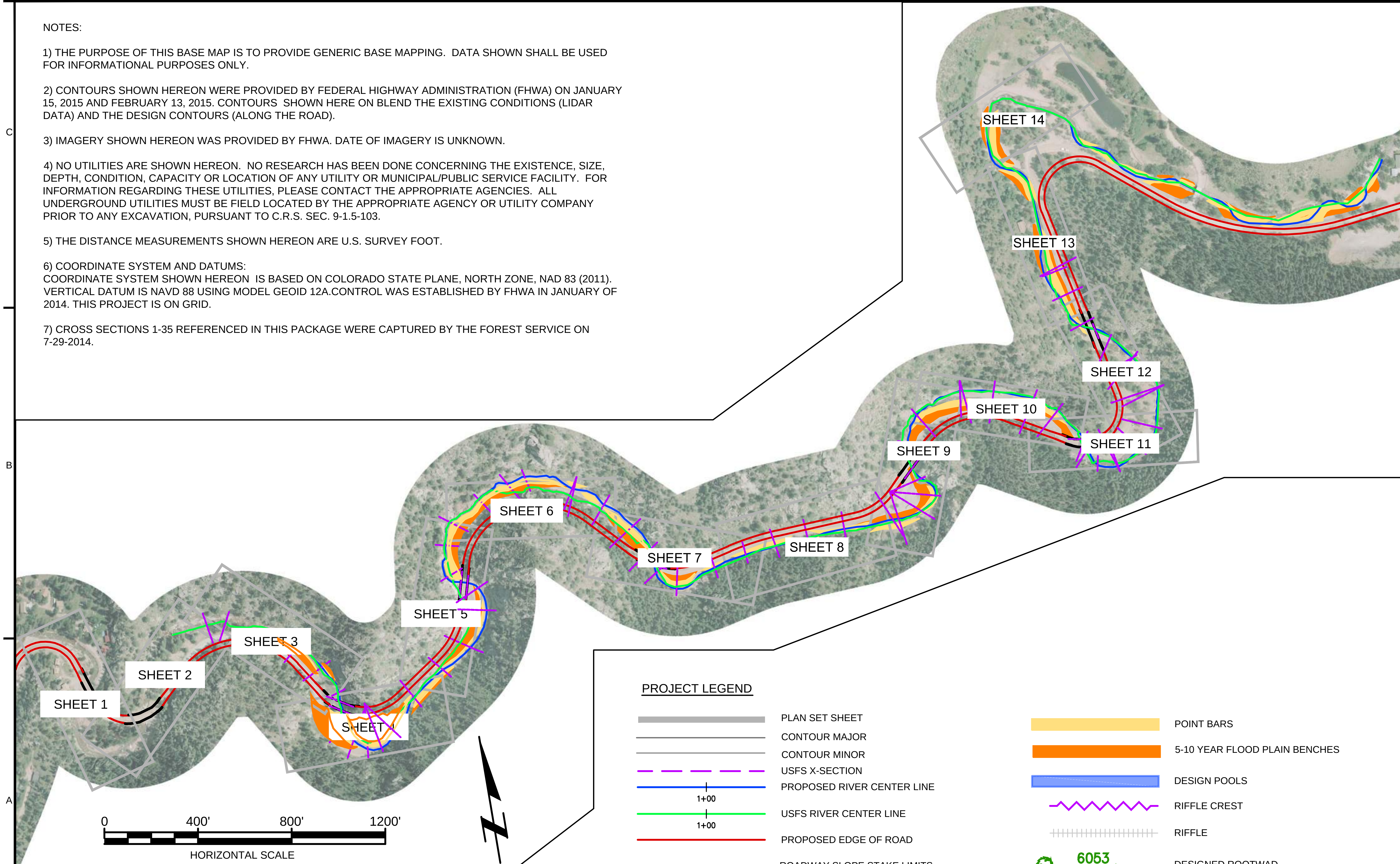
3) IMAGERY SHOWN HEREON WAS PROVIDED BY FHWA. DATE OF IMAGERY IS UNKNOWN.

4) NO UTILITIES ARE SHOWN HEREON. NO RESEARCH HAS BEEN DONE CONCERNING THE EXISTENCE, SIZE, DEPTH, CONDITION, CAPACITY OR LOCATION OF ANY UTILITY OR MUNICIPAL/PUBLIC SERVICE FACILITY. FOR INFORMATION REGARDING THESE UTILITIES, PLEASE CONTACT THE APPROPRIATE AGENCIES. ALL UNDERGROUND UTILITIES MUST BE FIELD LOCATED BY THE APPROPRIATE AGENCY OR UTILITY COMPANY PRIOR TO ANY EXCAVATION, PURSUANT TO C.R.S. SEC. 9-1.5-103.

5) THE DISTANCE MEASUREMENTS SHOWN HEREON ARE U.S. SURVEY FOOT.

6) COORDINATE SYSTEM AND DATUMS:
COORDINATE SYSTEM SHOWN HEREON IS BASED ON COLORADO STATE PLANE, NORTH ZONE, NAD 83 (2011). VERTICAL DATUM IS NAVD 88 USING MODEL GEOID 12A.CONTROL WAS ESTABLISHED BY FHWA IN JANUARY OF 2014. THIS PROJECT IS ON GRID.

7) CROSS SECTIONS 1-35 REFERENCED IN THIS PACKAGE WERE CAPTURED BY THE FOREST SERVICE ON 7-29-2014.



PROJECT LEGEND

PLAN SET SHEET
CONTOUR MAJOR
CONTOUR MINOR
USFS X-SECTION
1+00 PROPOSED RIVER CENTER LINE
1+00 USFS RIVER CENTER LINE
PROPOSED EDGE OF ROAD
ROADWAY SLOPE STAKE LIMITS
POINT BARS
5-10 YEAR FLOOD PLAIN BENCHES
DESIGN POOLS
RIFFLE CREST
RIFFLE
6053 ROOTWAD DESIGNED ROOTWAD

Symbol	Description	Date	Approved

CRANE ASSOCIATES
140 Ash Lane
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Phone (970) 261-5043
jeff@craneassociates.net

Designed by: JEFF CRANE
Dwn by:
Ckd by:
Reviewed by: JPC
Submitted by:
Date: MAR 1, 2016
Rev.
Design file no:
Drawing Code:
File name:
Plot date:
Plot scale:

NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

PLAN SHEET INDEX

SHEET REFERENCE NUMBER:
INDEX

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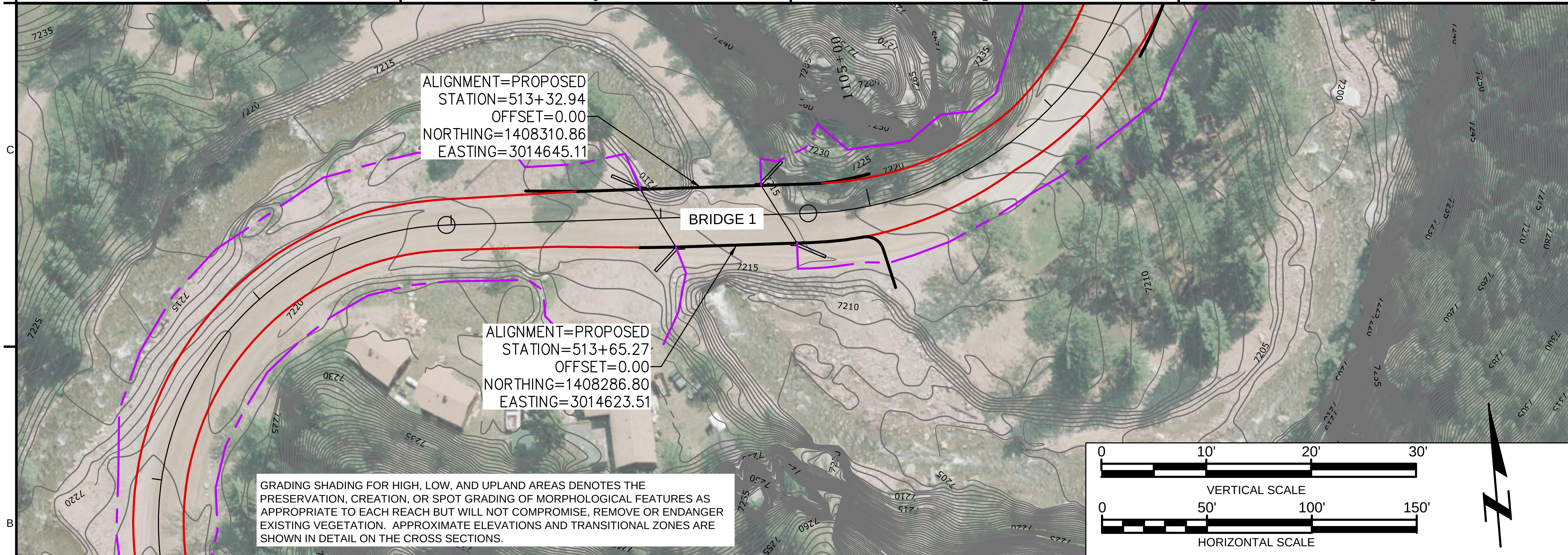

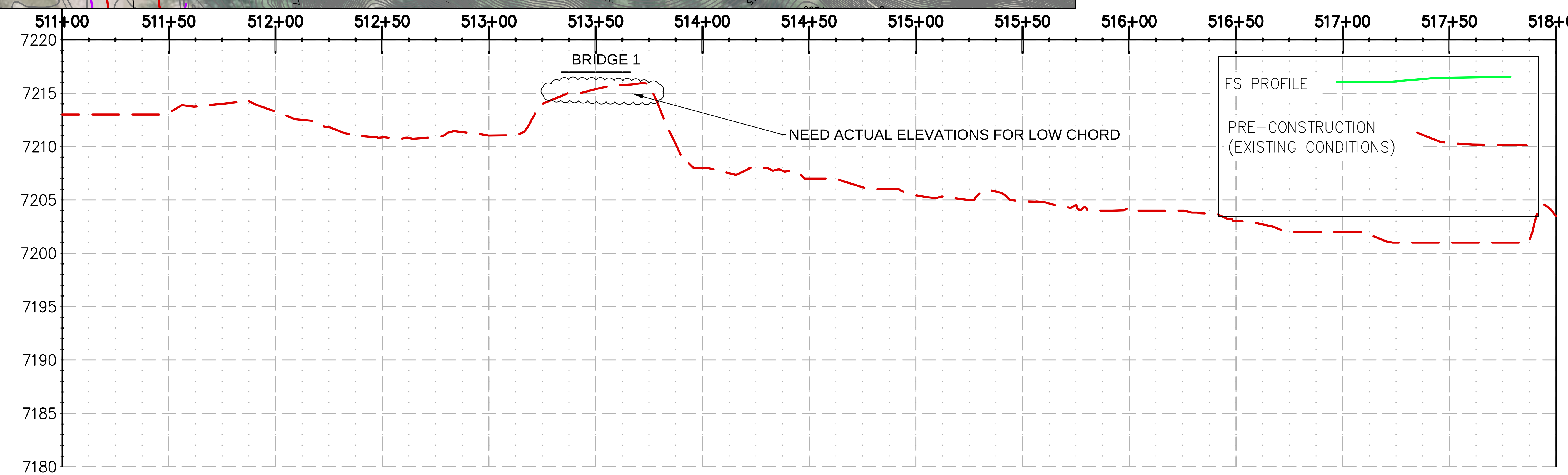

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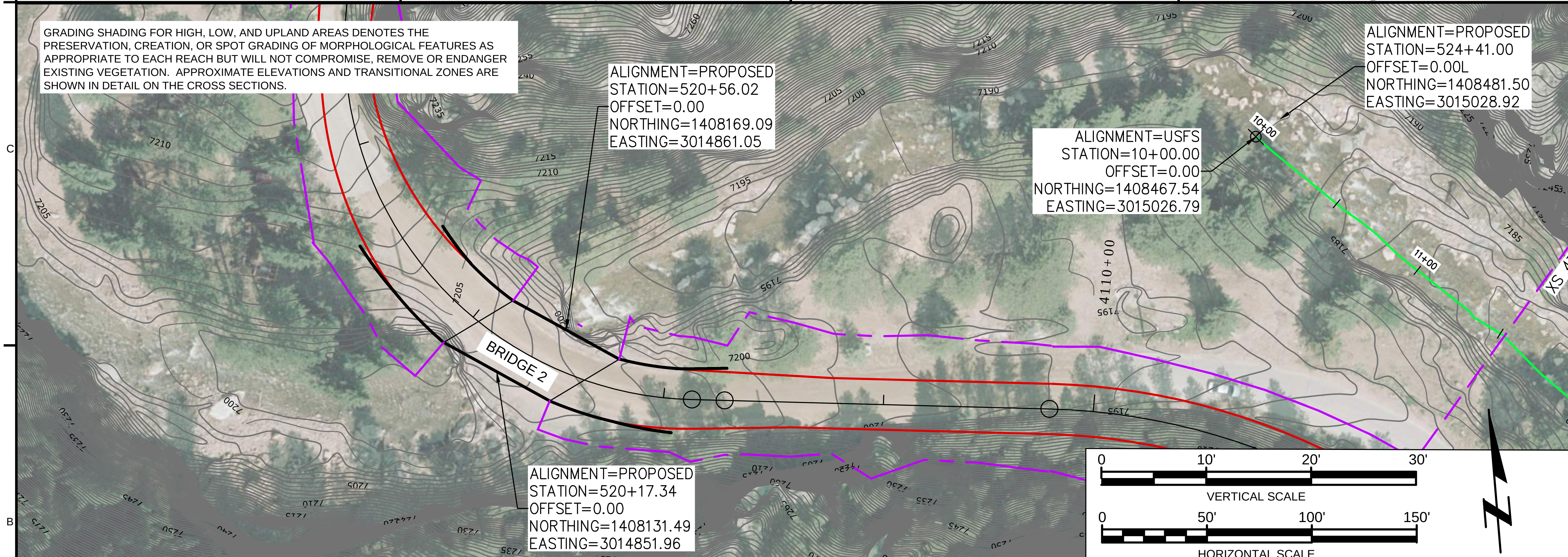
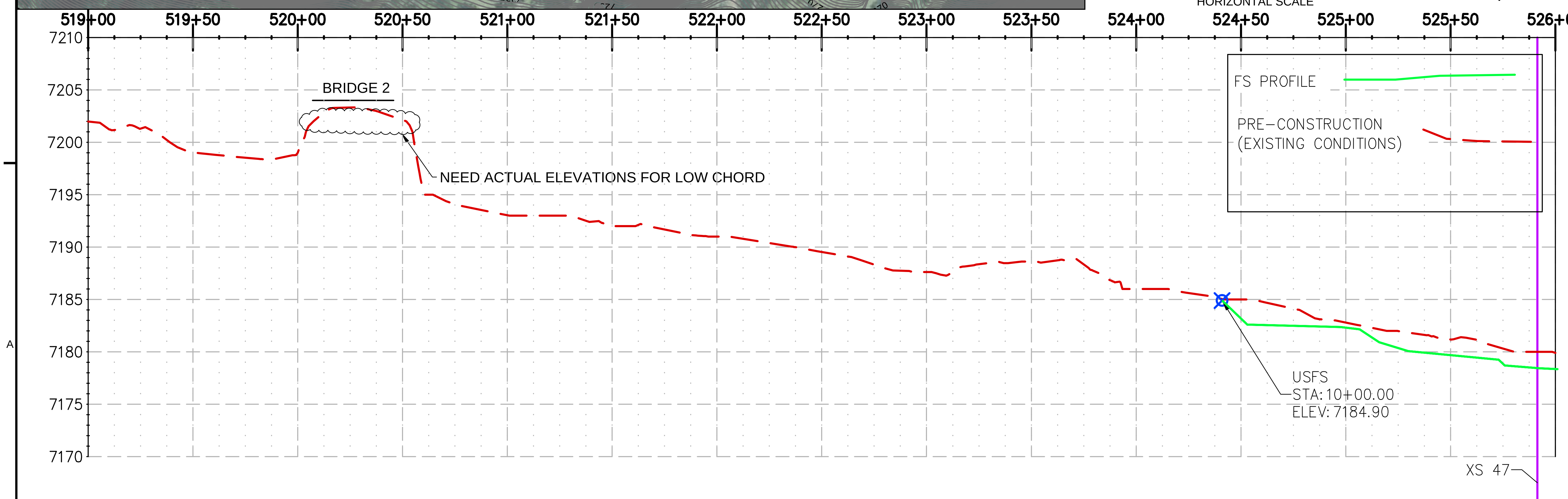
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

PLAN VIEW

SHEET REFERENCE NUMBER:
I

UPDATE





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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

PLAN VIEW

SHEET REFERENCE NUMBER:
2

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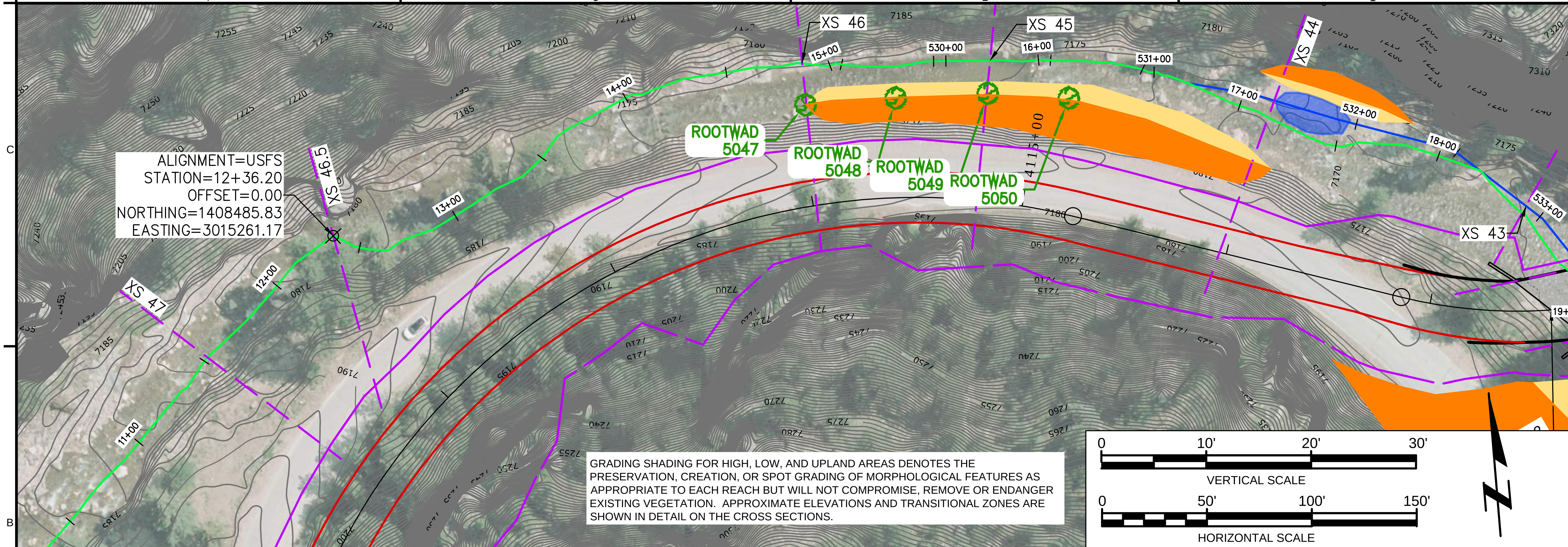

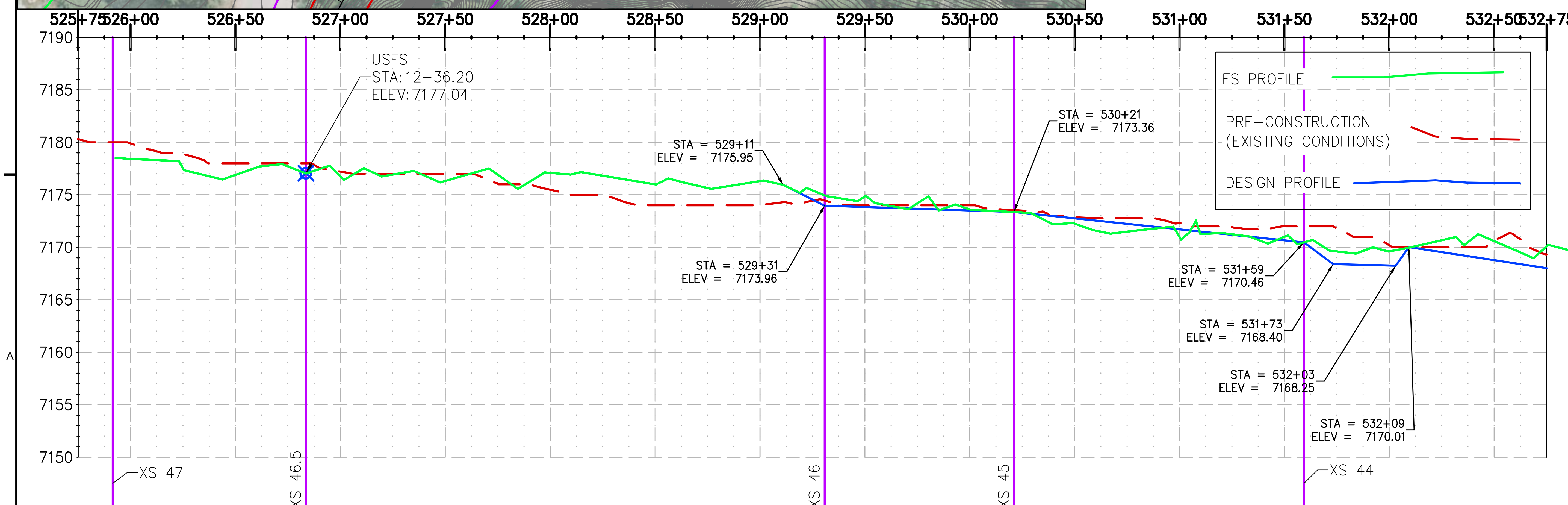

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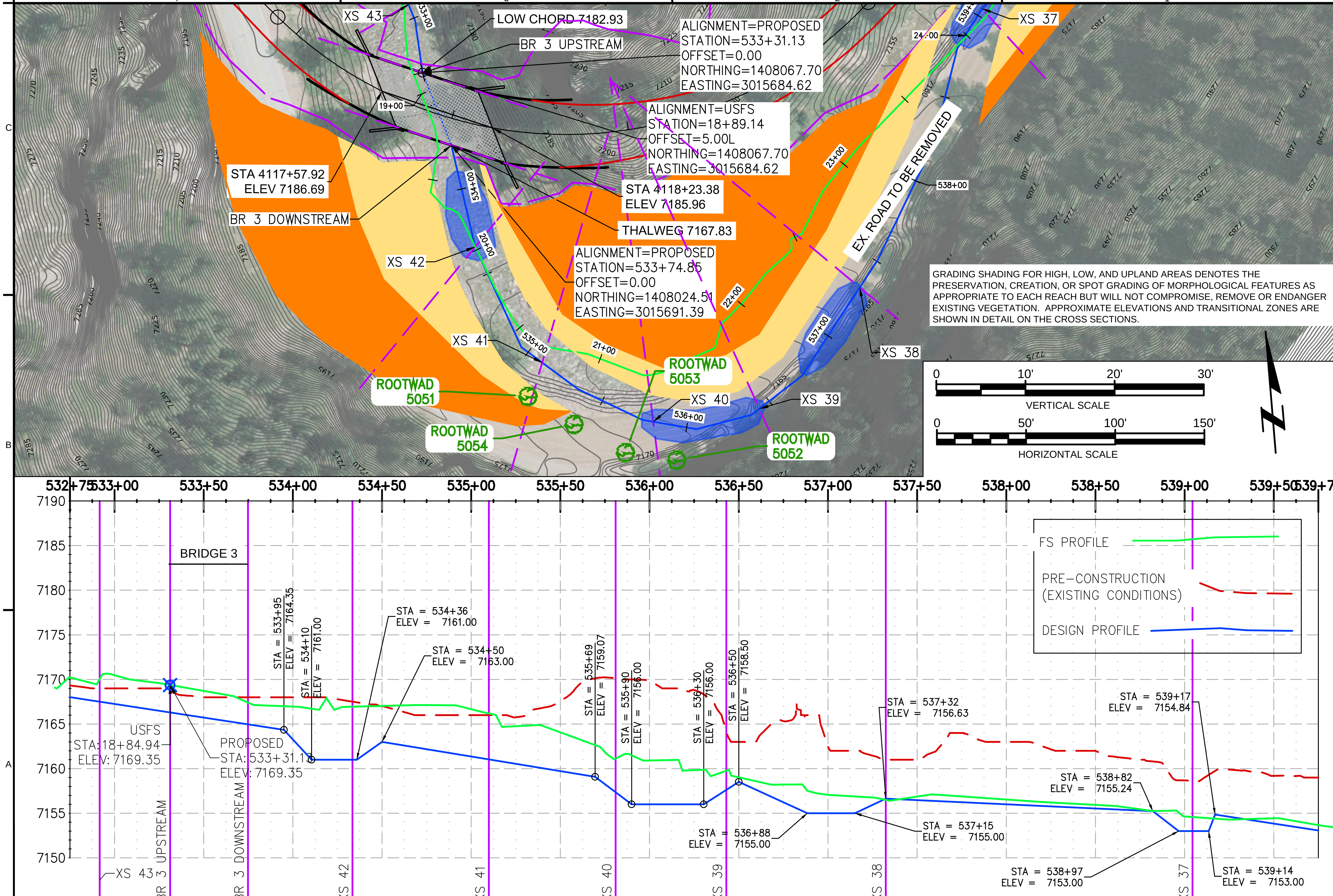
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

PLAN VIEW

SHEET REFERENCE NUMBER:
3

UPDATE



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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

PLAN VIEW

SHEET REFERENCE NUMBER: 4

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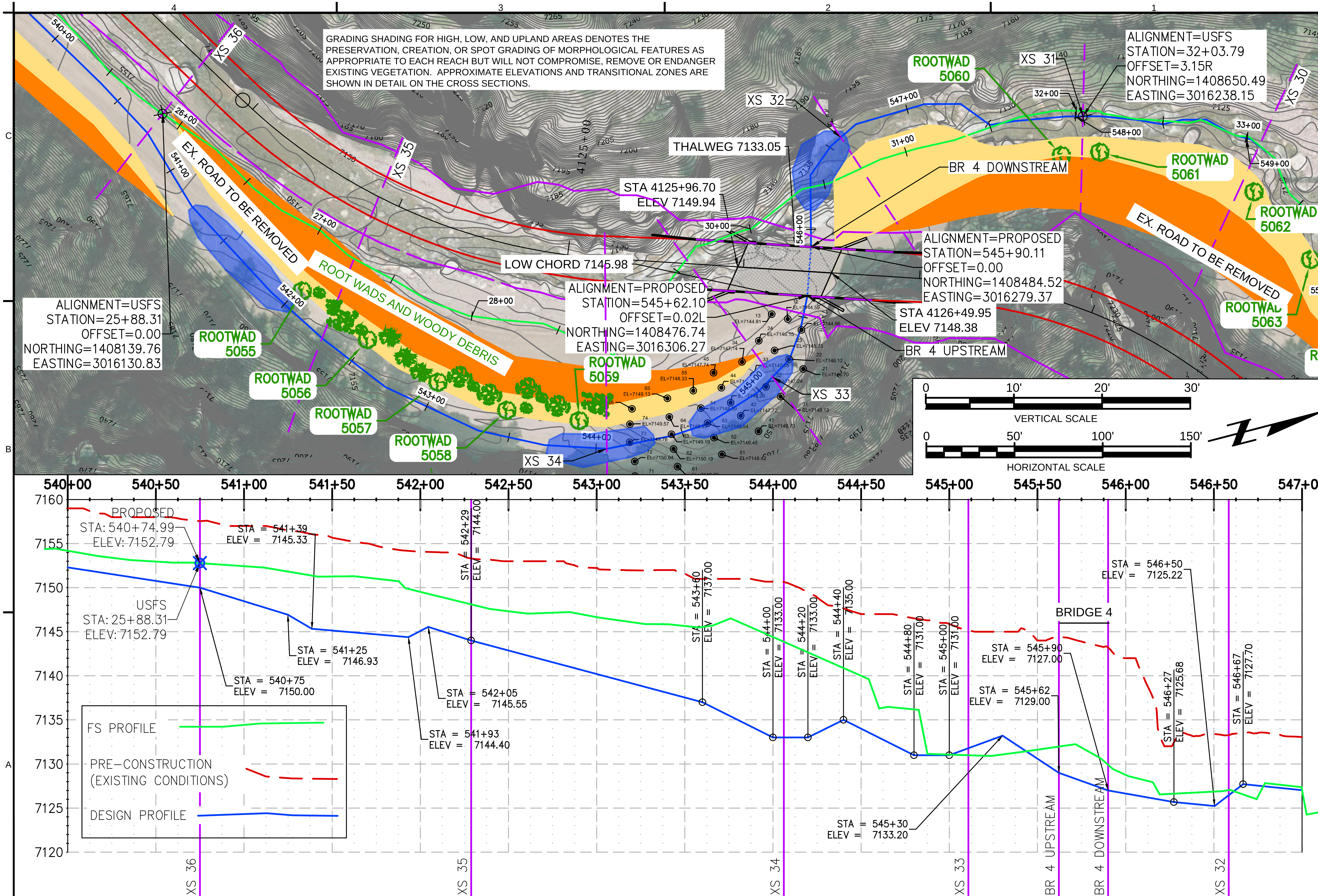

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Reviewed by: JPC

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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

PLAN VIEW

SHEET REFERENCE NUMBER:
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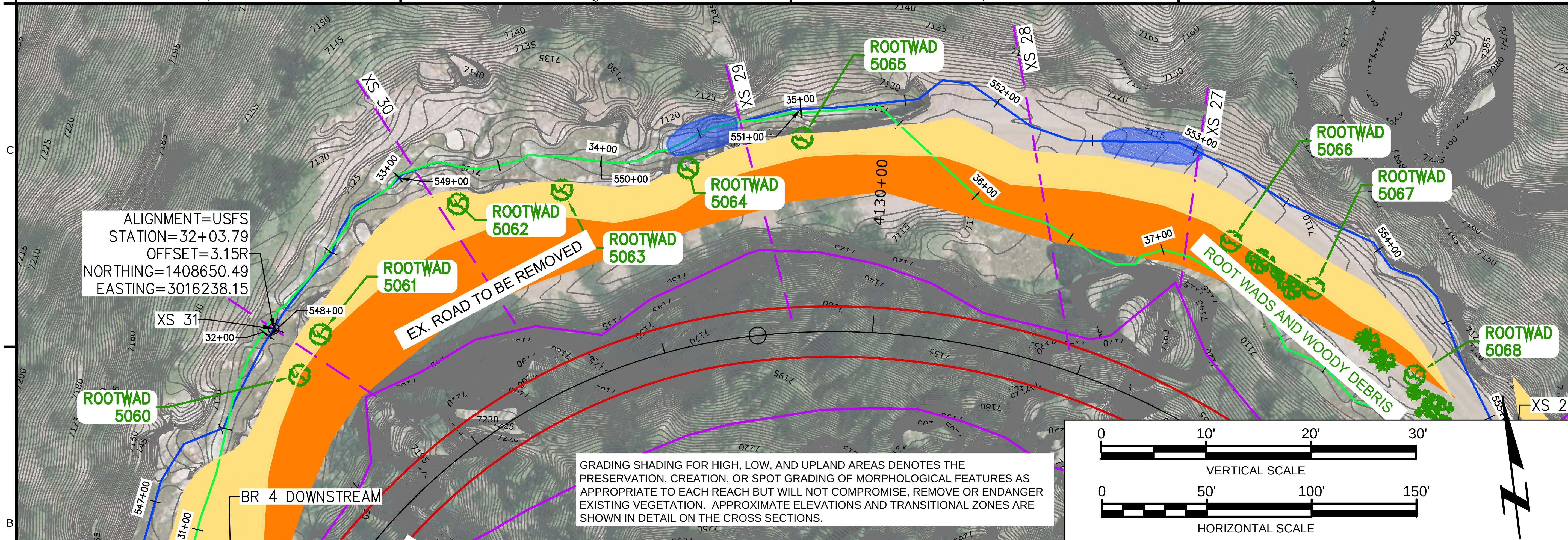

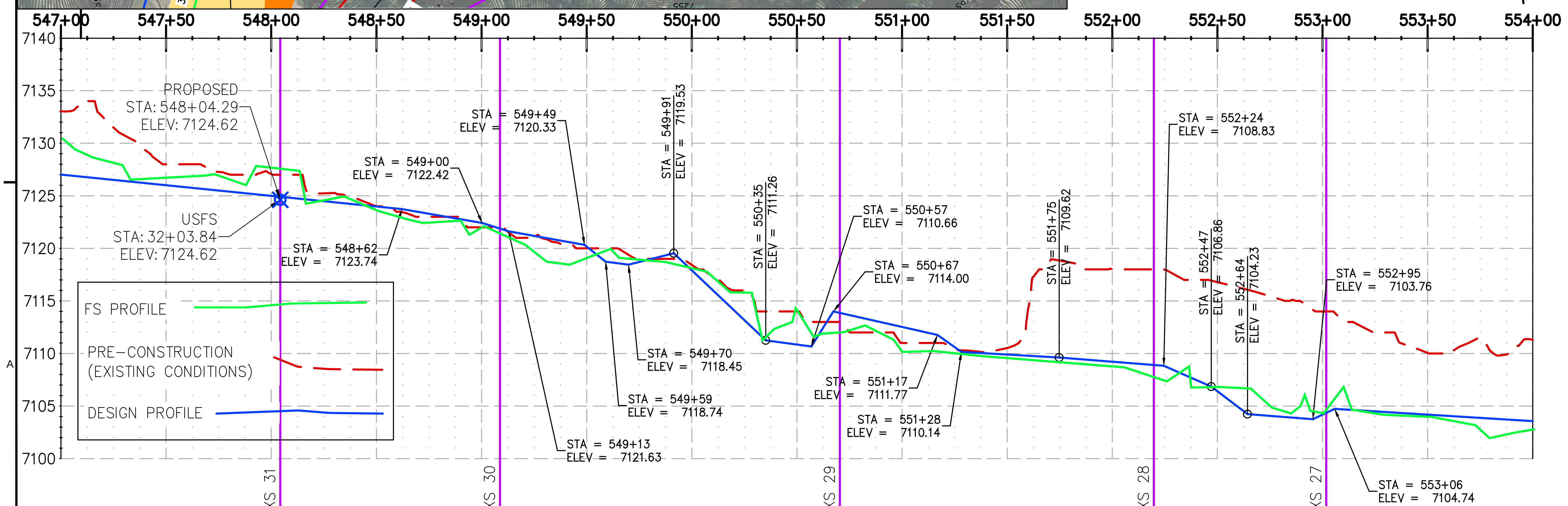

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CRANE ASSOCIATES

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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
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LARIMER COUNTY, COLORADO

PLAN VIEW

SHEET REFERENCE NUMBER:
6

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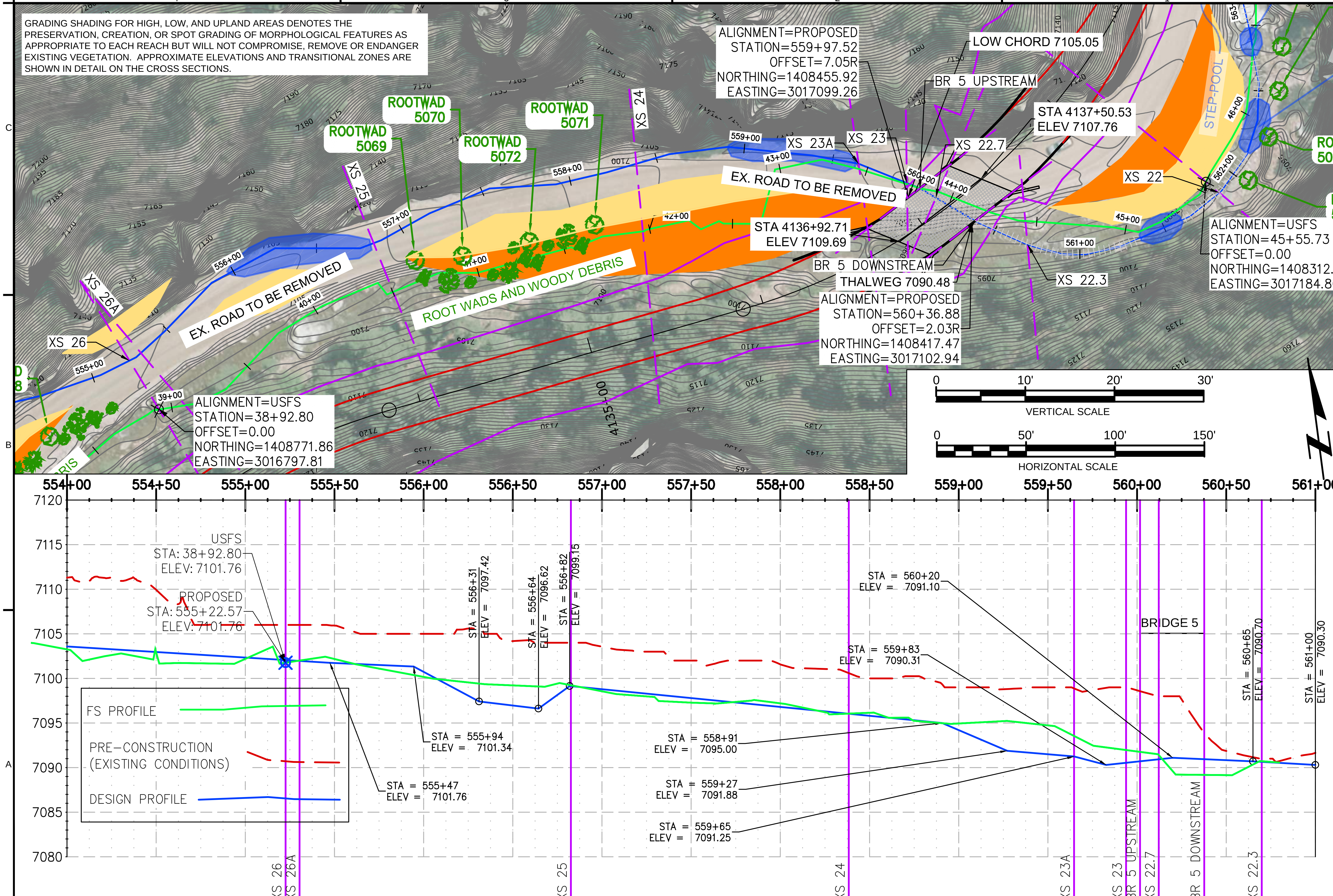

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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

PLAN VIEW

SHEET REFERENCE NUMBER:
7

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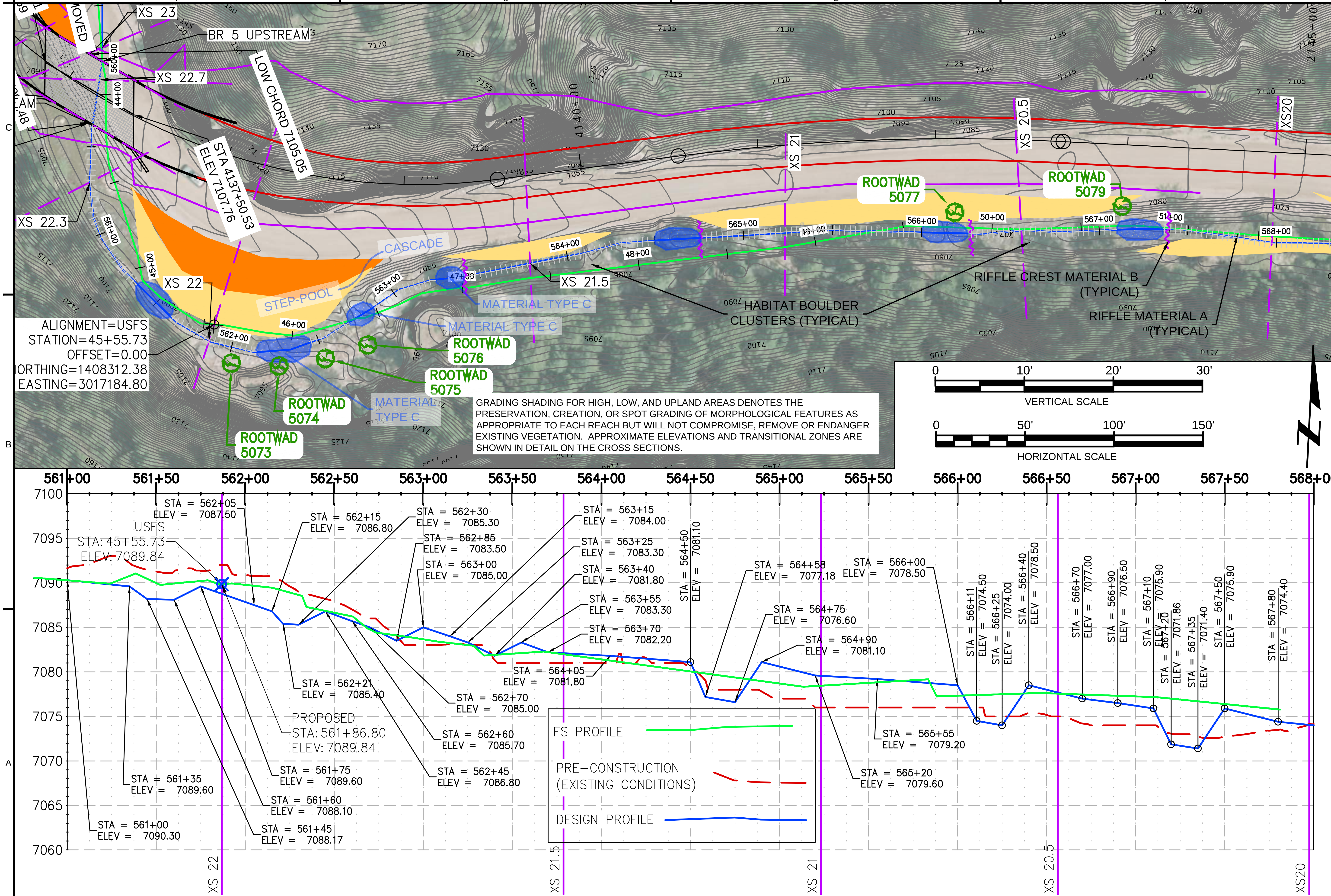

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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

PLAN VIEW

SHEET REFERENCE NUMBER:
8

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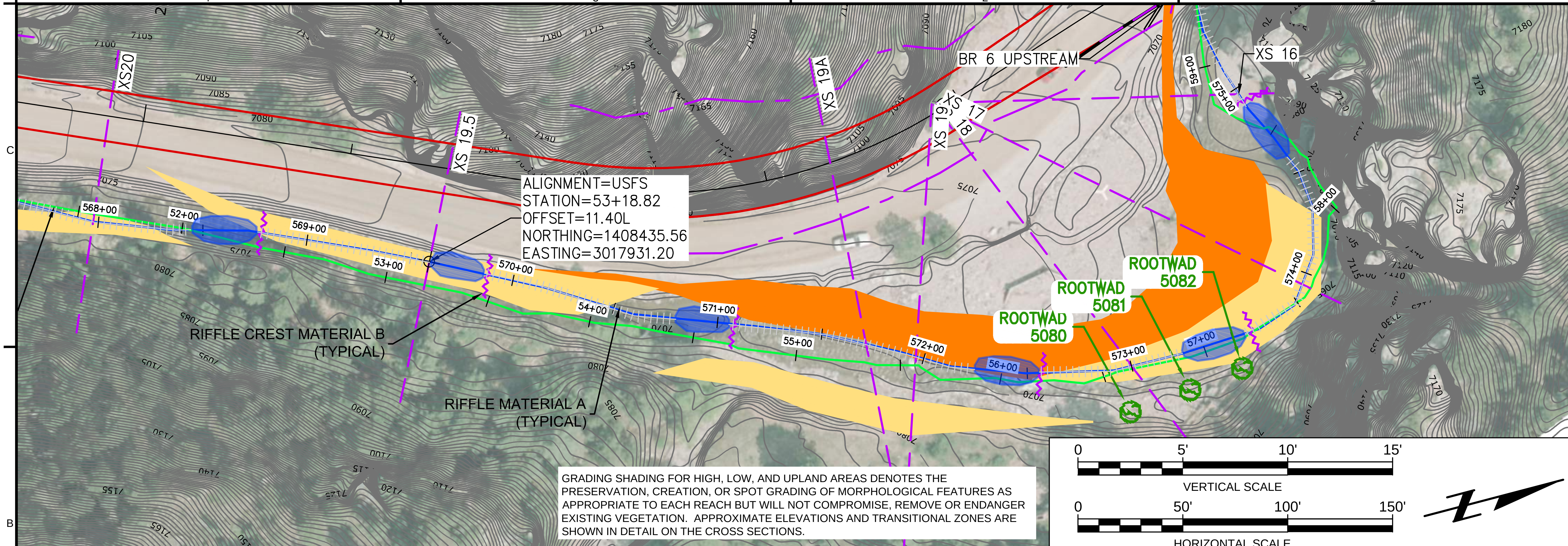

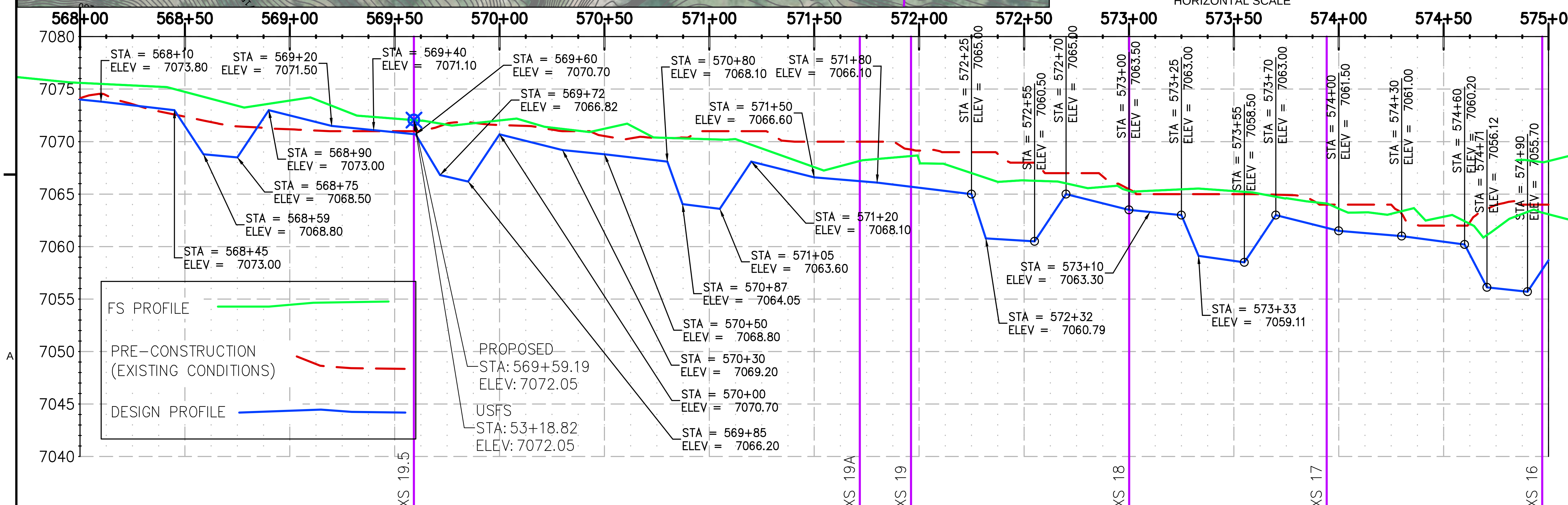

Rev. | Date: MAR 1, 2016 | Design file no: | Drawing Code: | File name: | Plot date: | Plot scale:

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Symbol | Description | Date | Approved

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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

PLAN VIEW

SHEET REFERENCE NUMBER:
9

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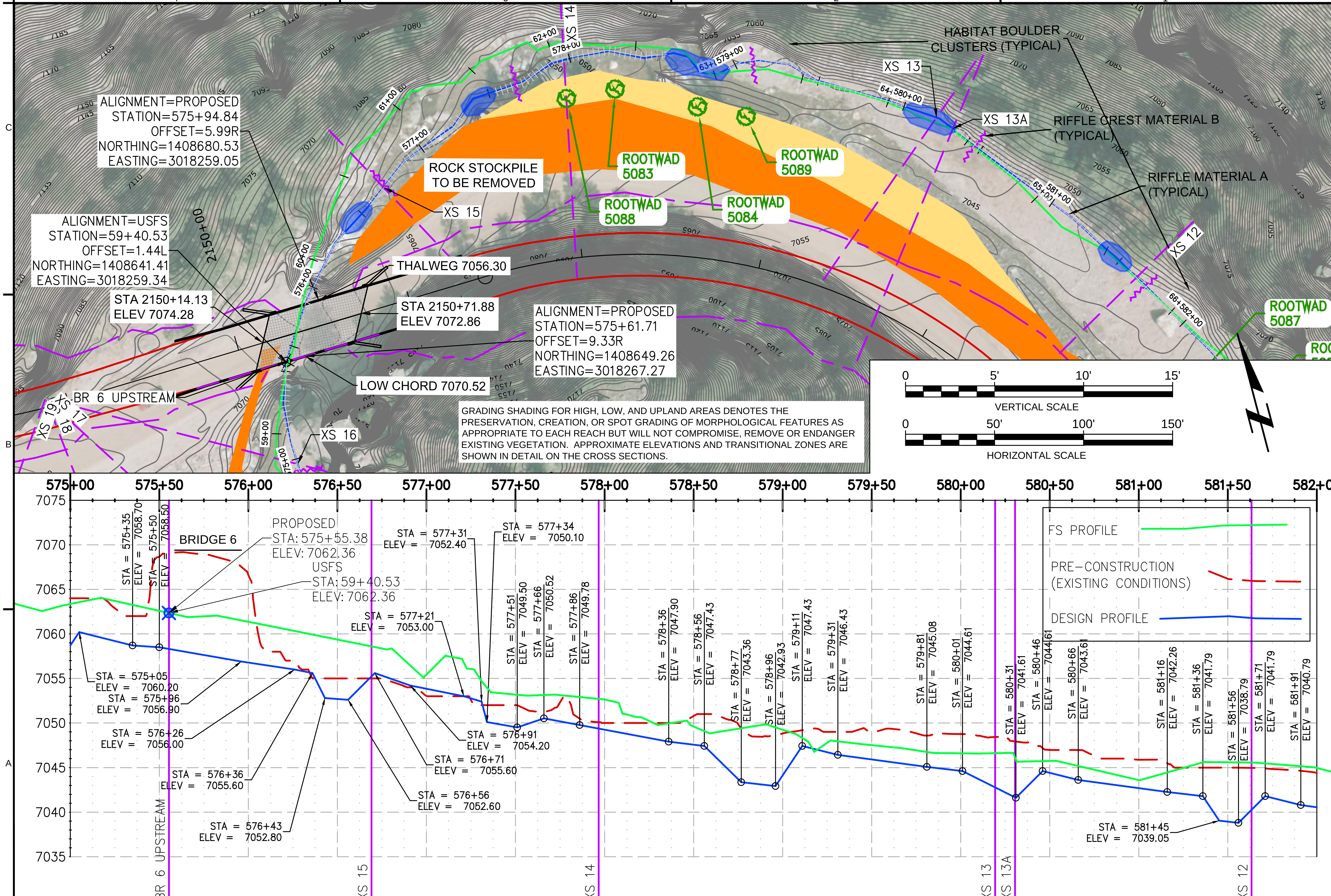

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LARIMER COUNTY, COLORADO

PLAN VIEW

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SHEET REFERENCE NUMBER:
10

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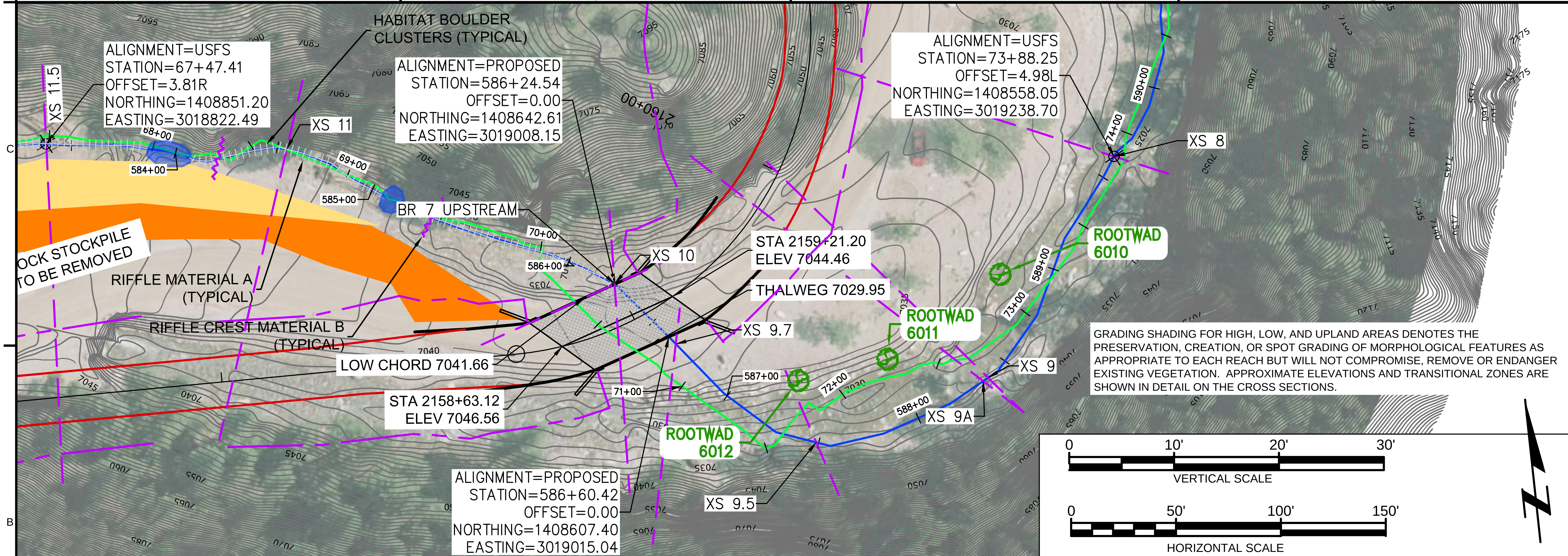

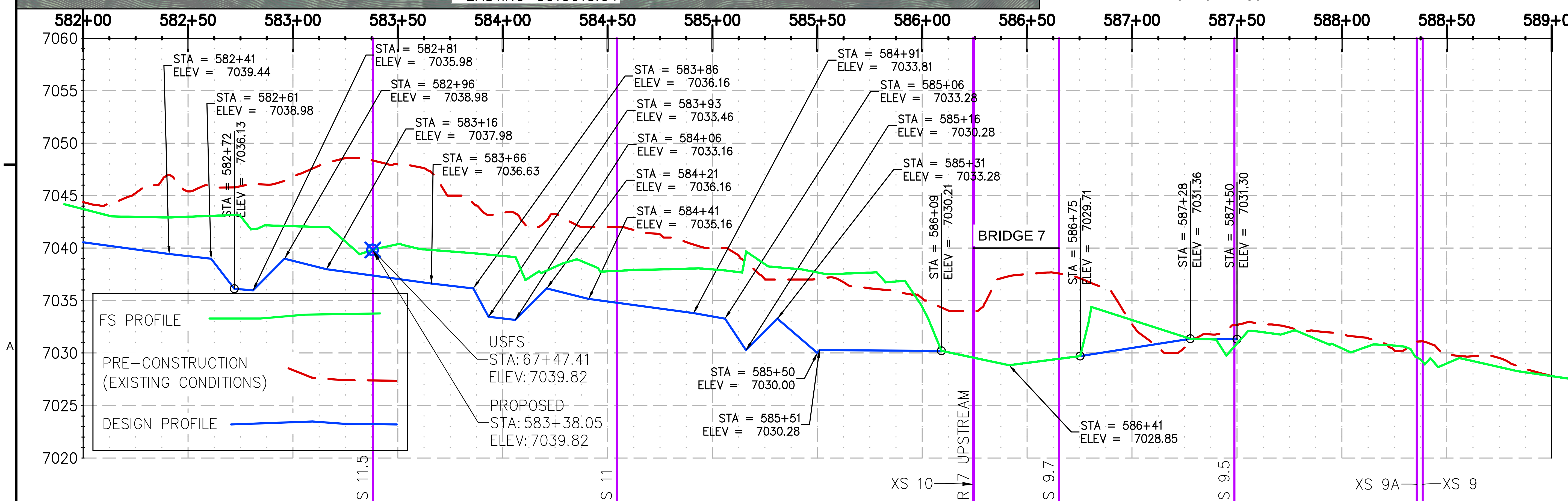

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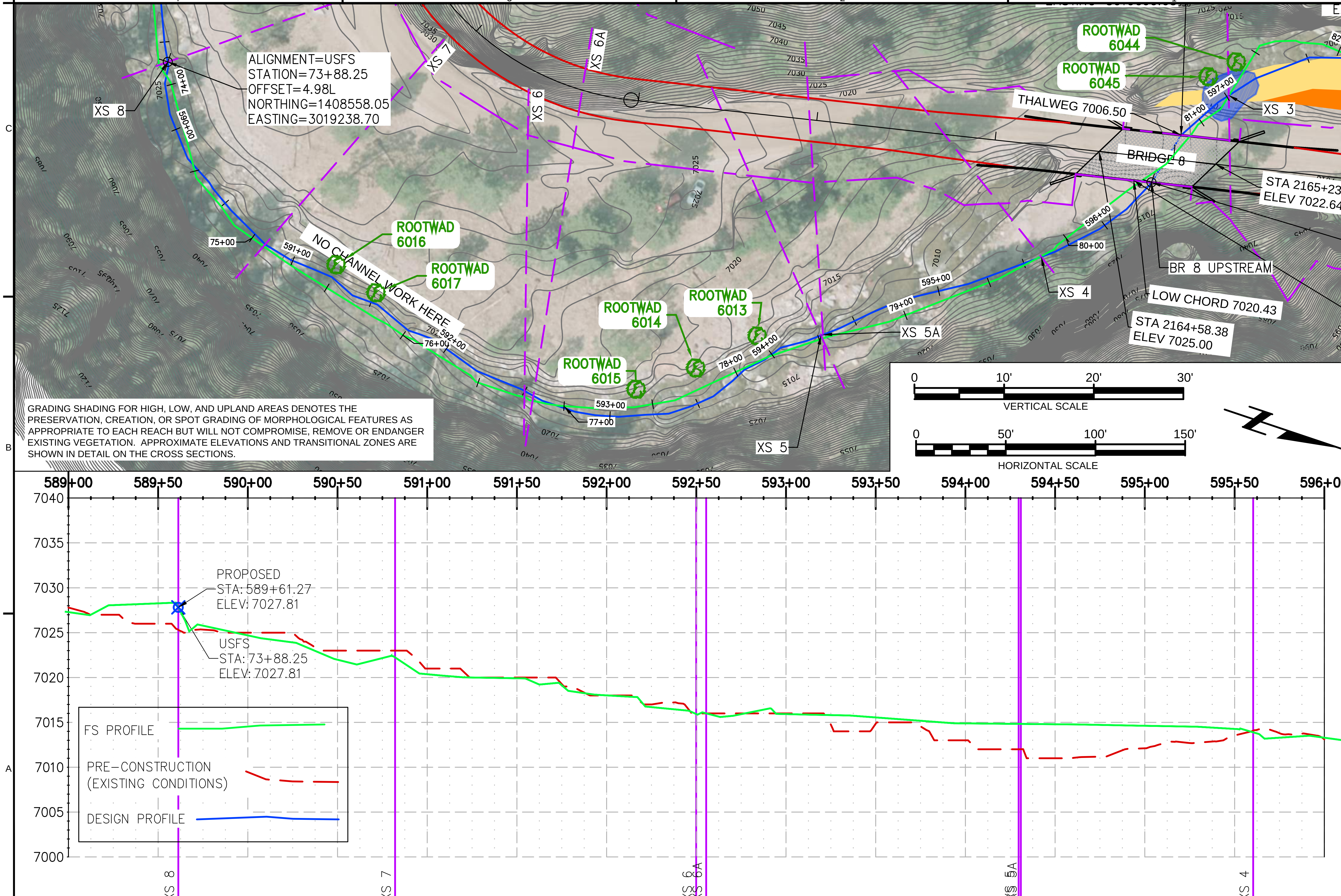
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

PLAN VIEW

SHEET REFERENCE NUMBER:
11

UPDATE



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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

PLAN VIEW

SHEET REFERENCE NUMBER:
12

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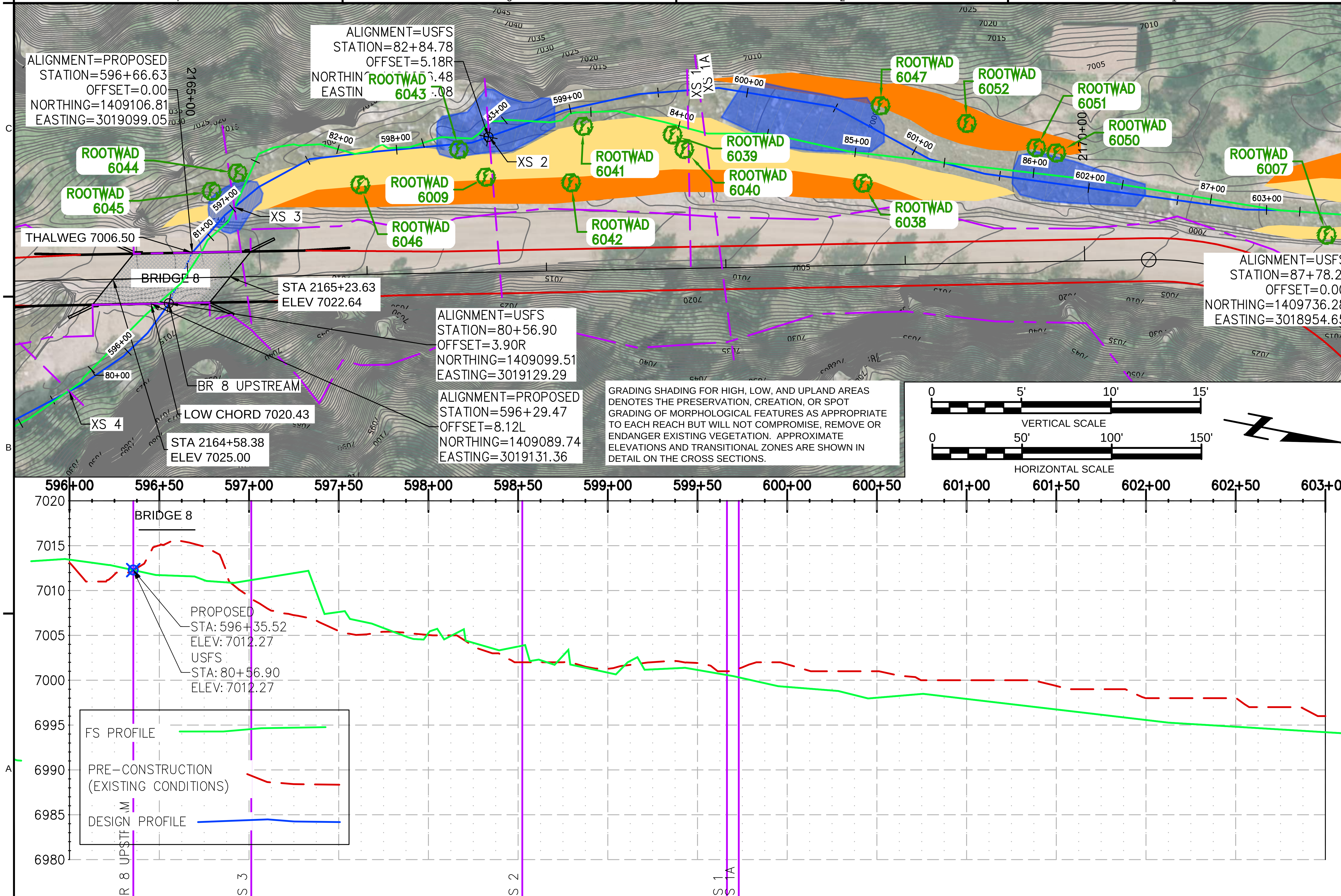

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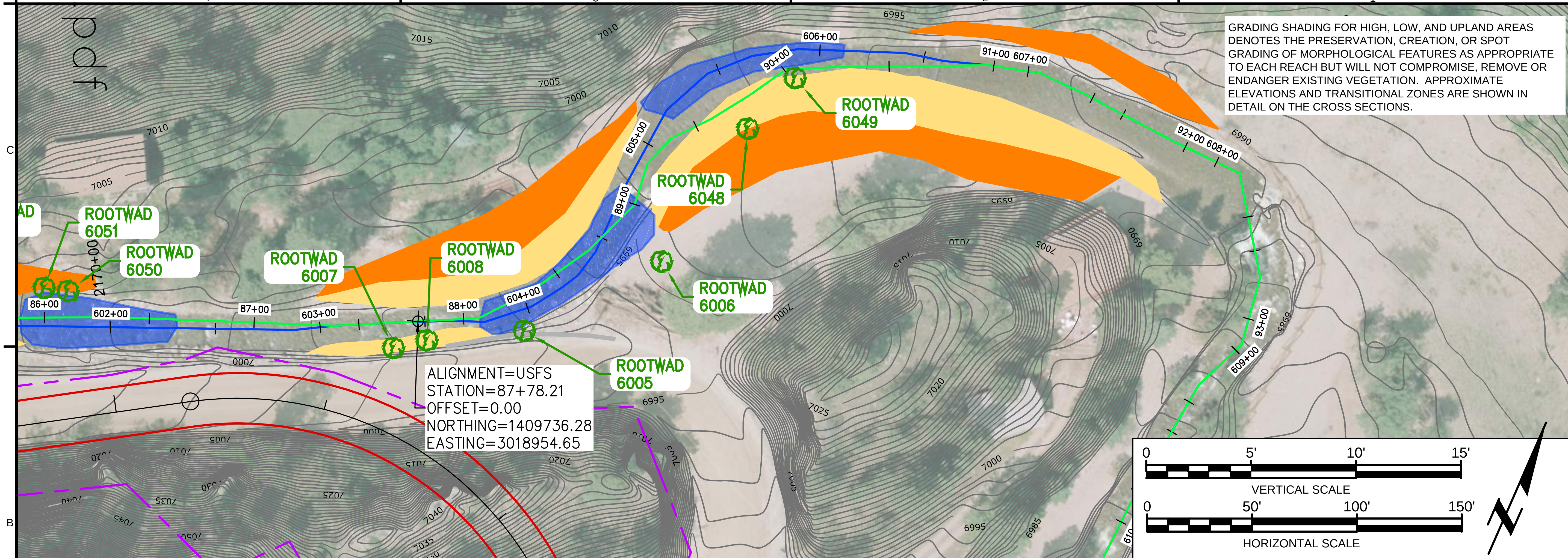
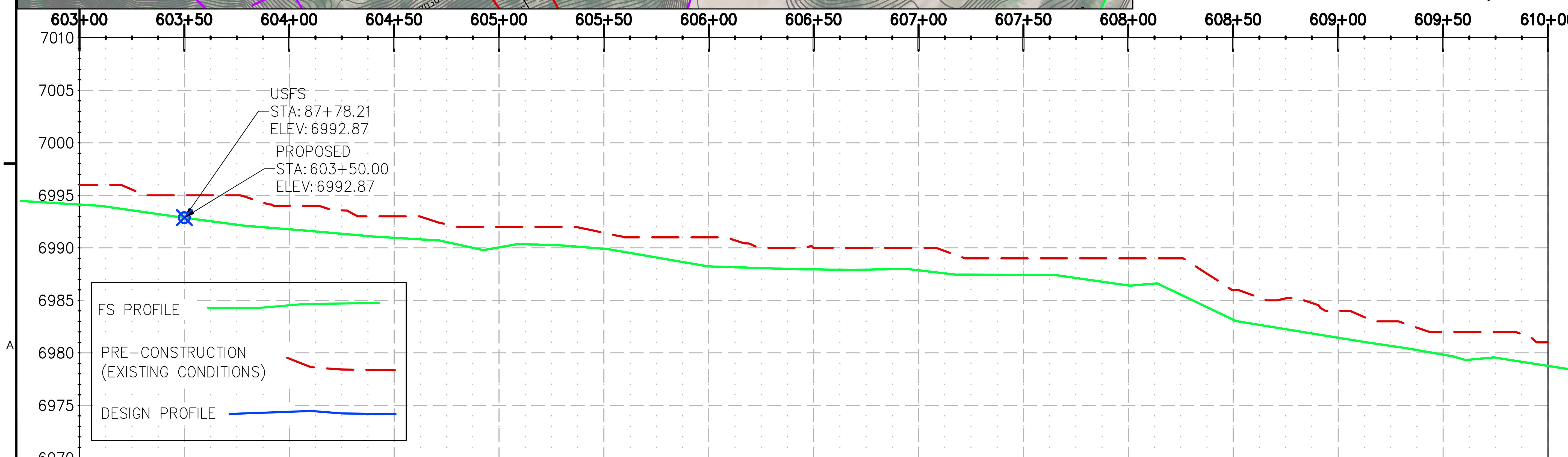
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

PLAN VIEW

SHEET REFERENCE NUMBER: 13

UPDATE





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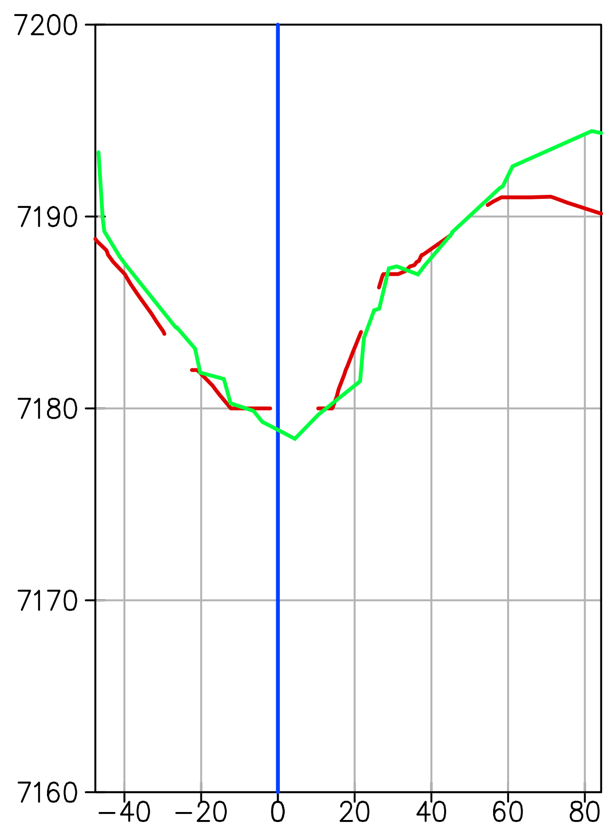
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

PLAN VIEW

SHEET REFERENCE NUMBER:
14

UPDATE

XS 47



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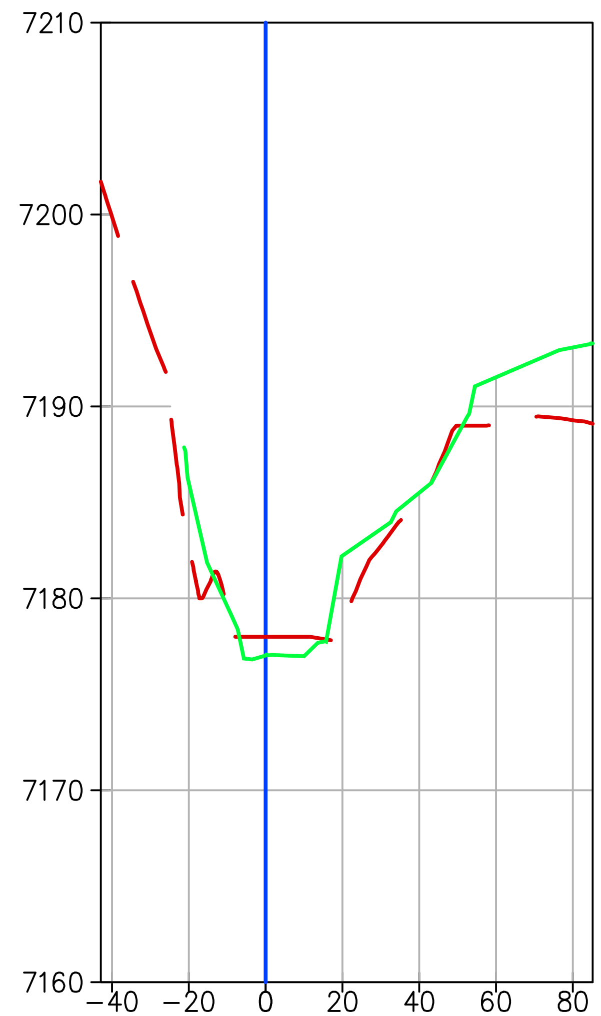

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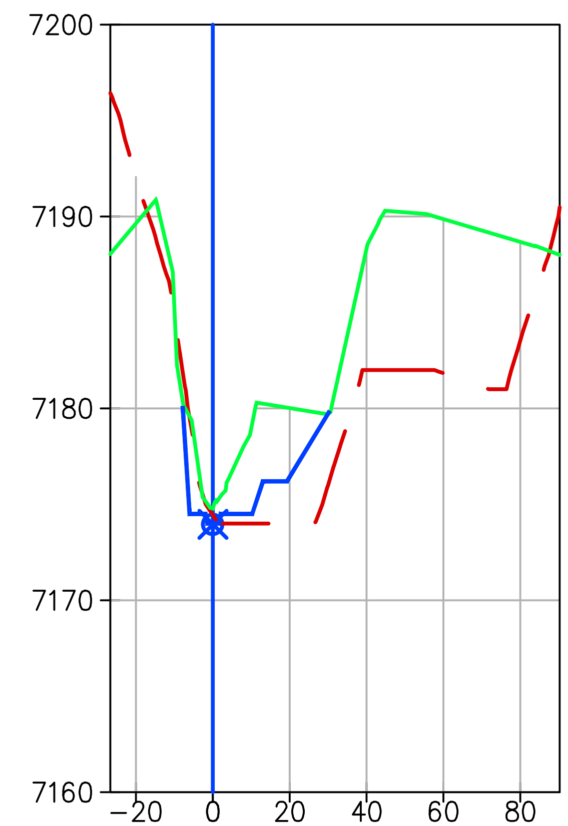

FS PROFILE

PRE−CONSTRUCTION
(EXISTING CONDITIONS)

DESIGN PROFILE

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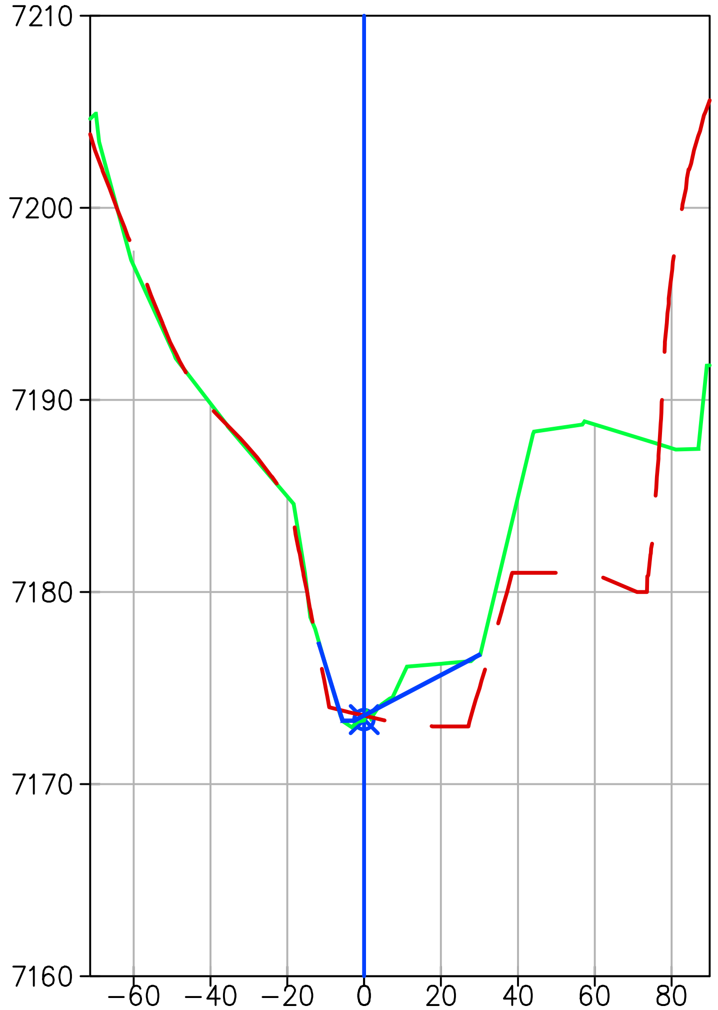
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

SHEET REFERENCE NUMBER:
15

UPDATE

XS 45



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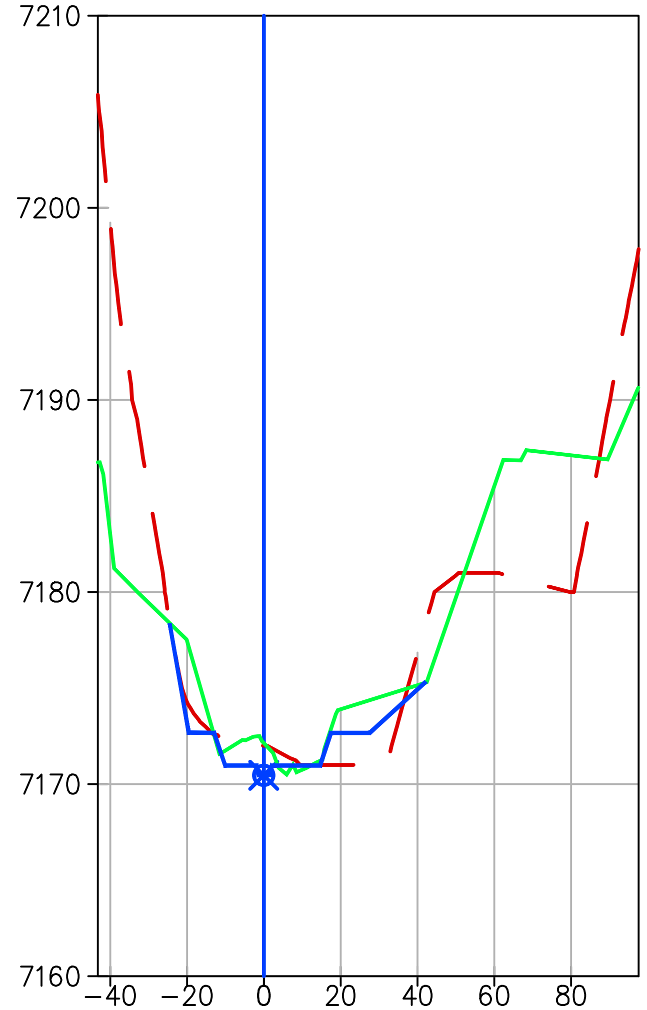

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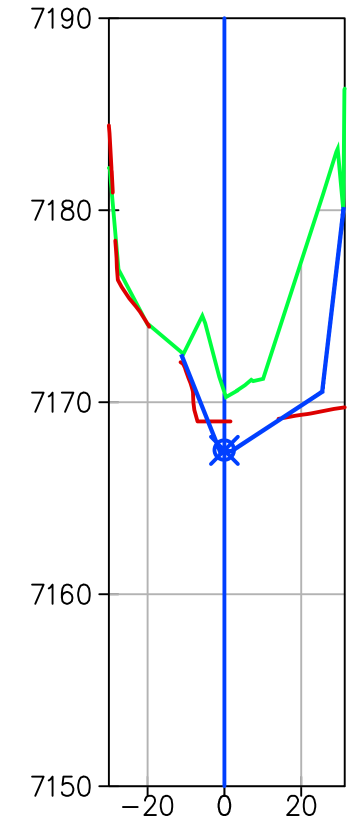

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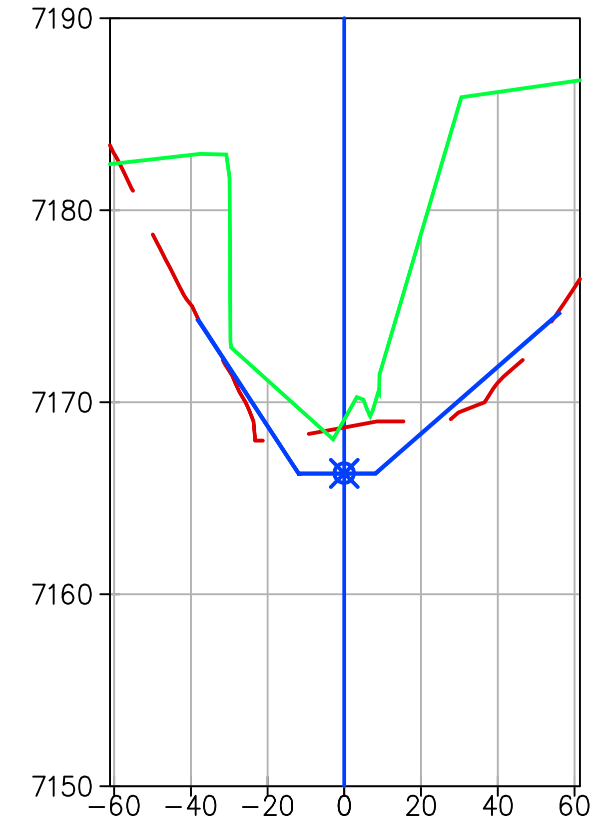

FS PROFILE

PRE−CONSTRUCTION (EXISTING CONDITIONS)

DESIGN PROFILE

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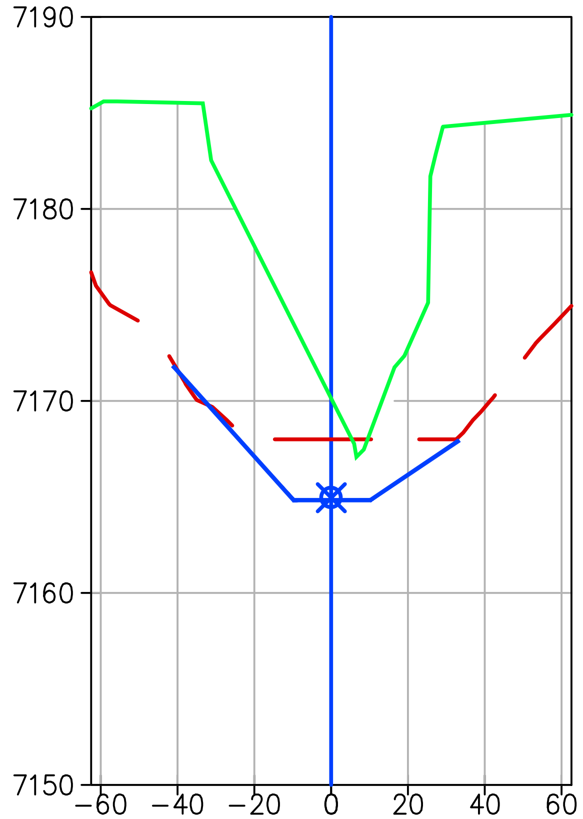
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

SHEET REFERENCE NUMBER:
16

UPDATE

BR 3 DOWNSTREAM



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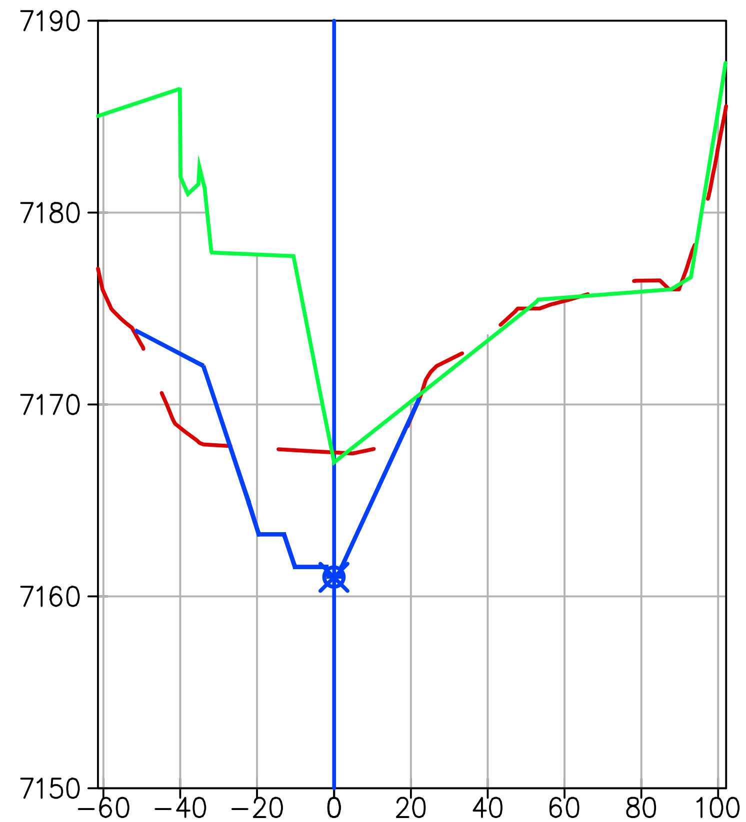

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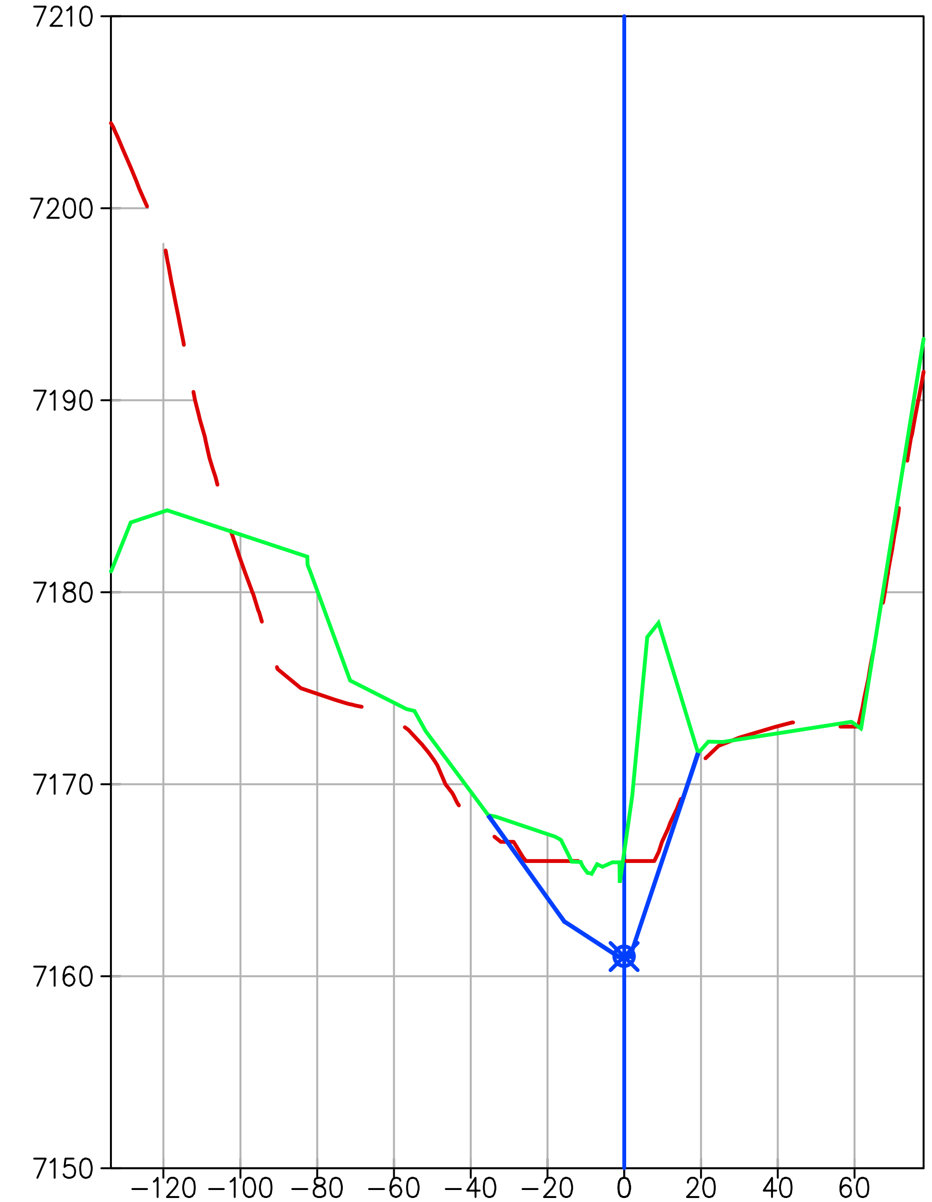

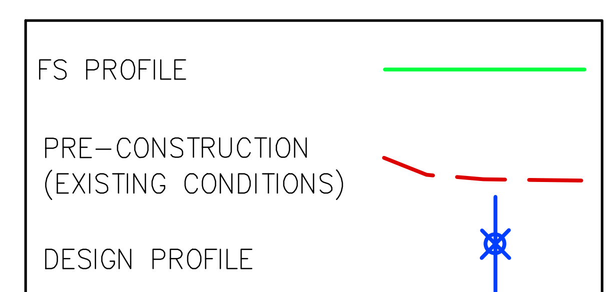

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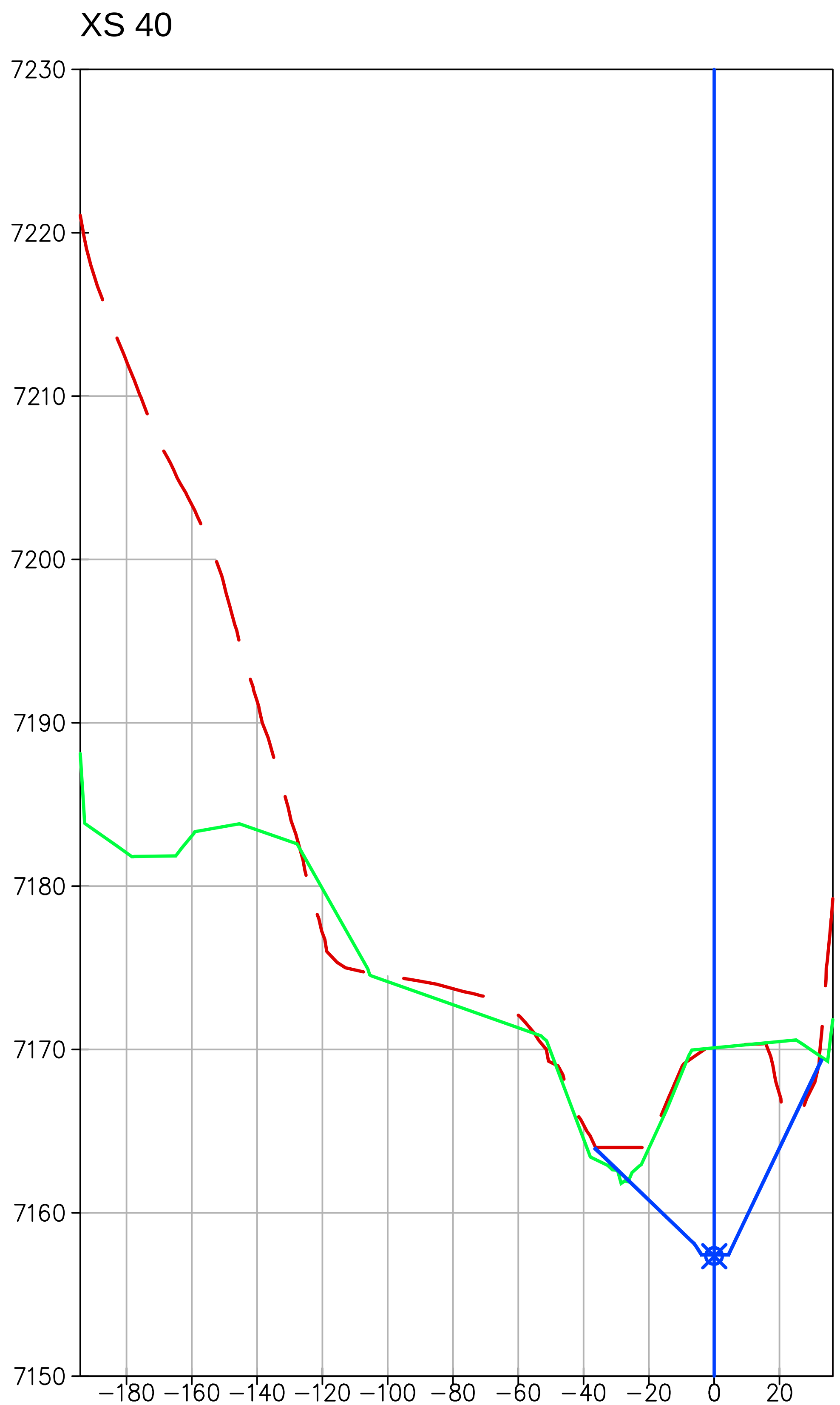
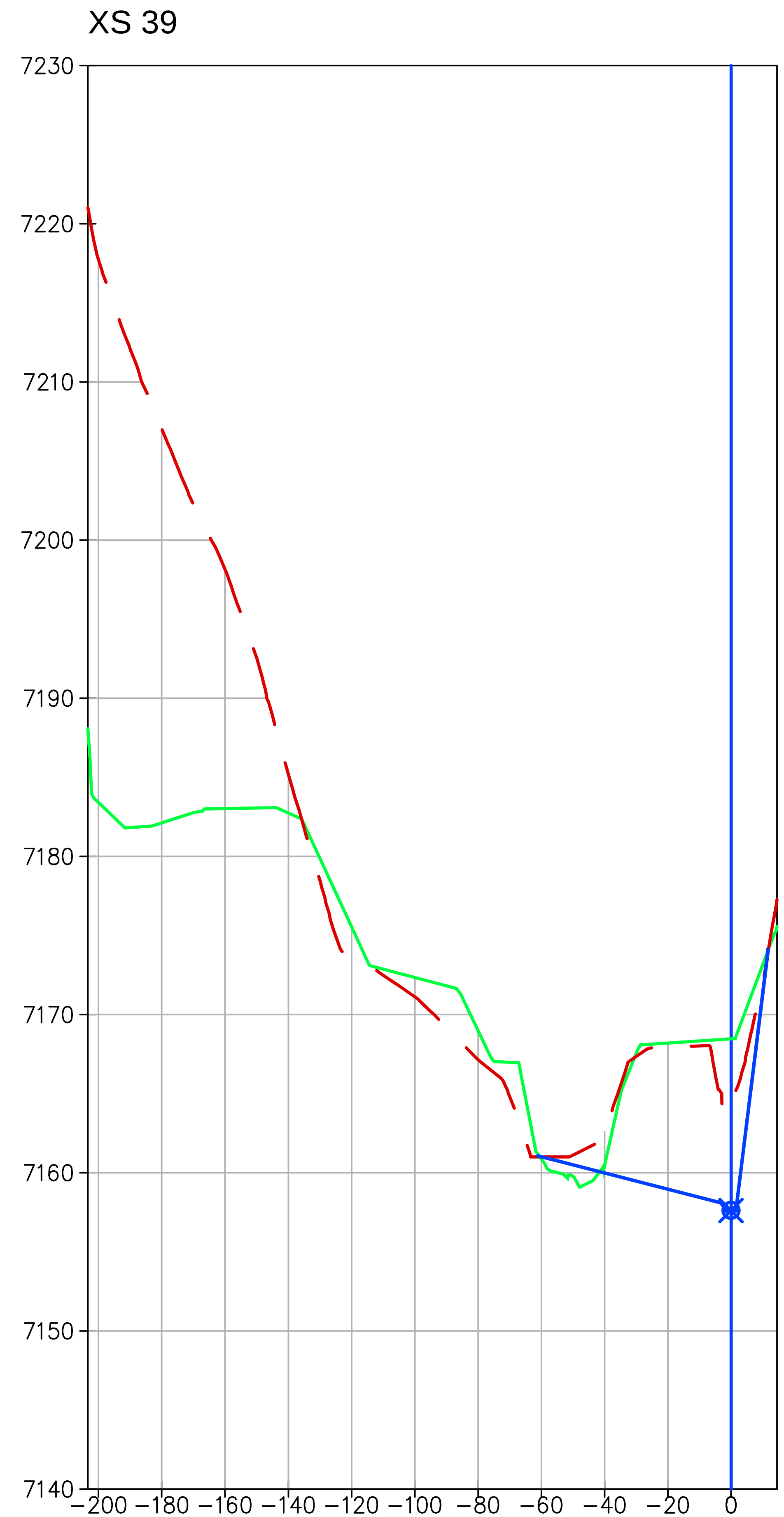
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

SHEET REFERENCE NUMBER:
17

UPDATE





FS PROFILE

PRE−CONSTRUCTION (EXISTING CONDITIONS)

DESIGN PROFILE

NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

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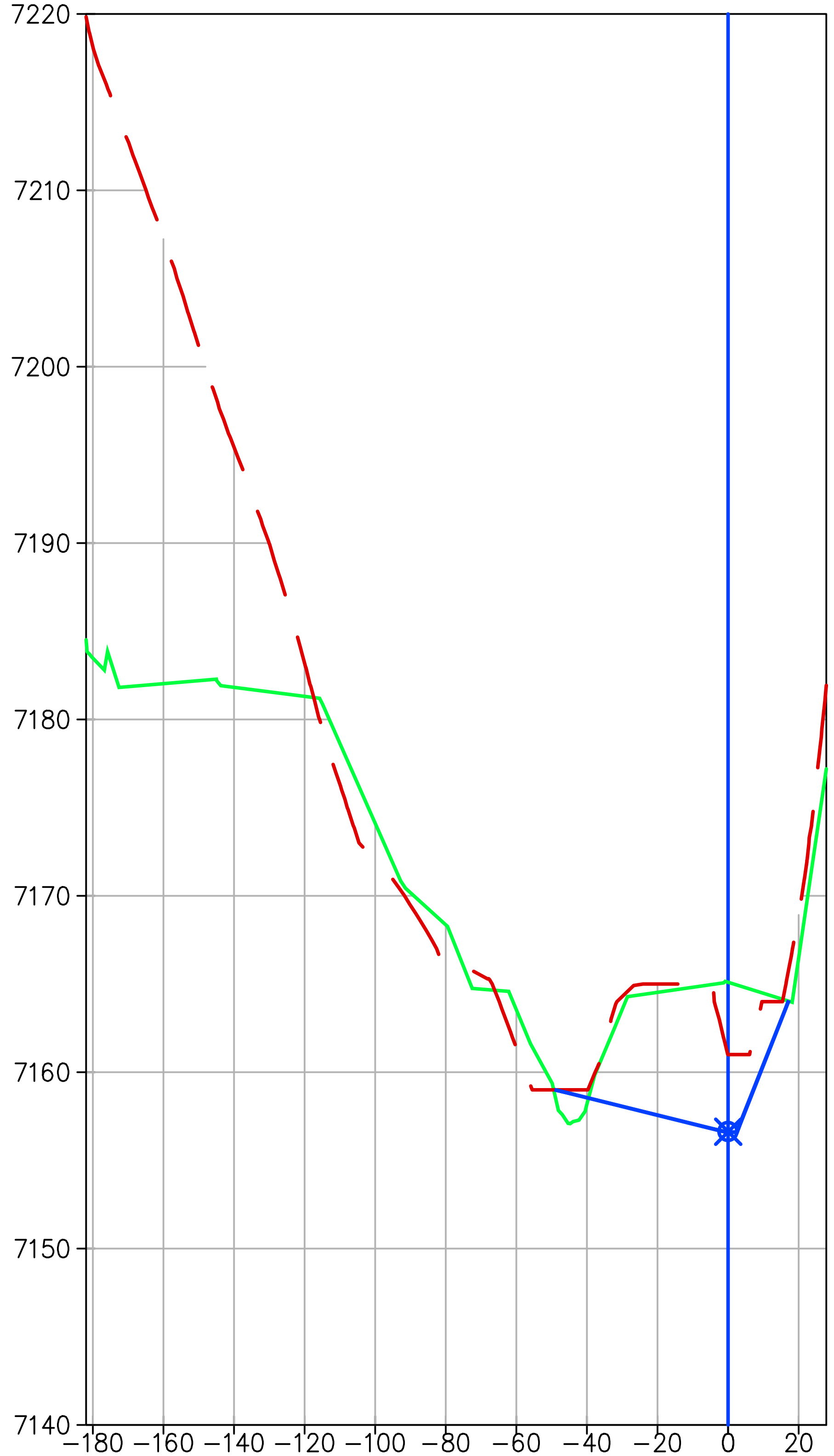
18

UPDATE

XS 38

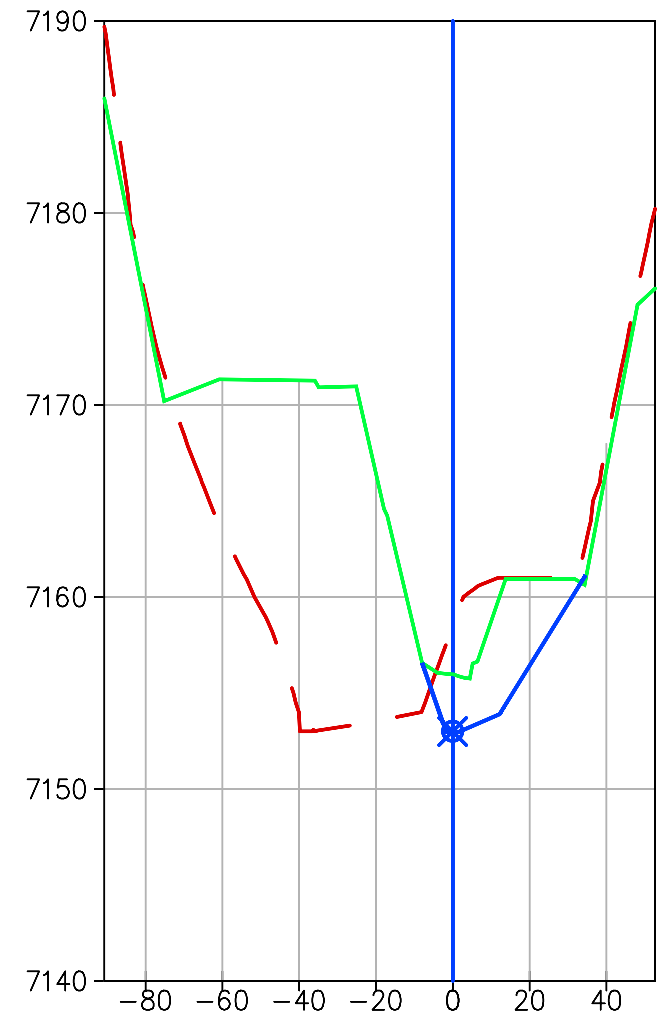


FS PROFILE

PRE−CONSTRUCTION
(EXISTING CONDITIONS)

DESIGN PROFILE

XS 37



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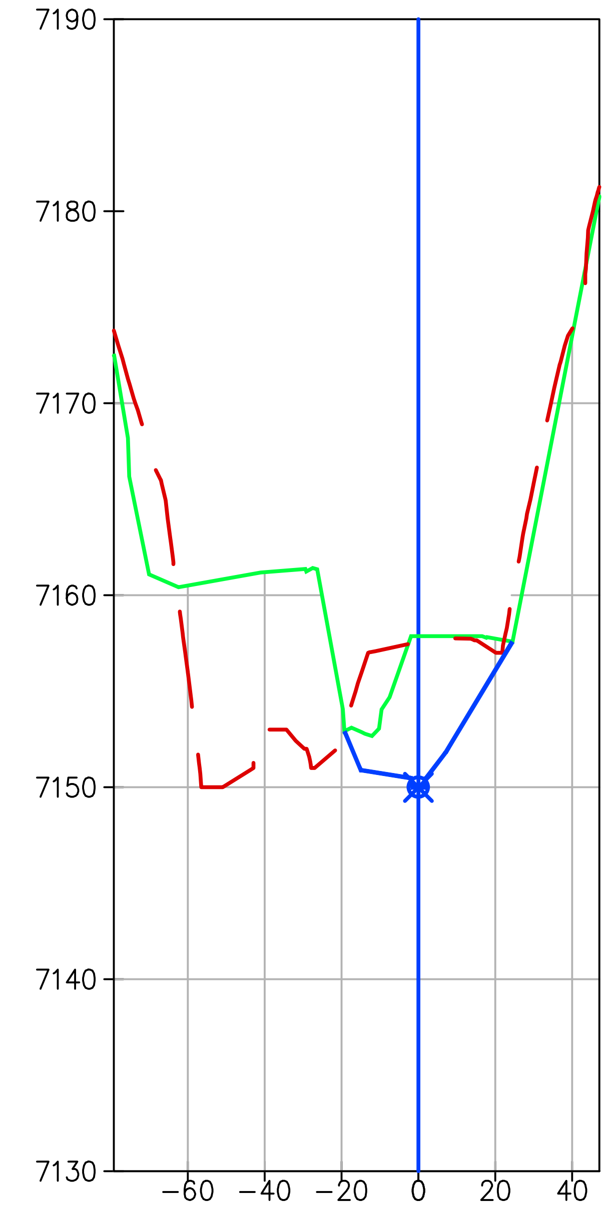

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NORTH FORK BIG THOMPSON RIVER
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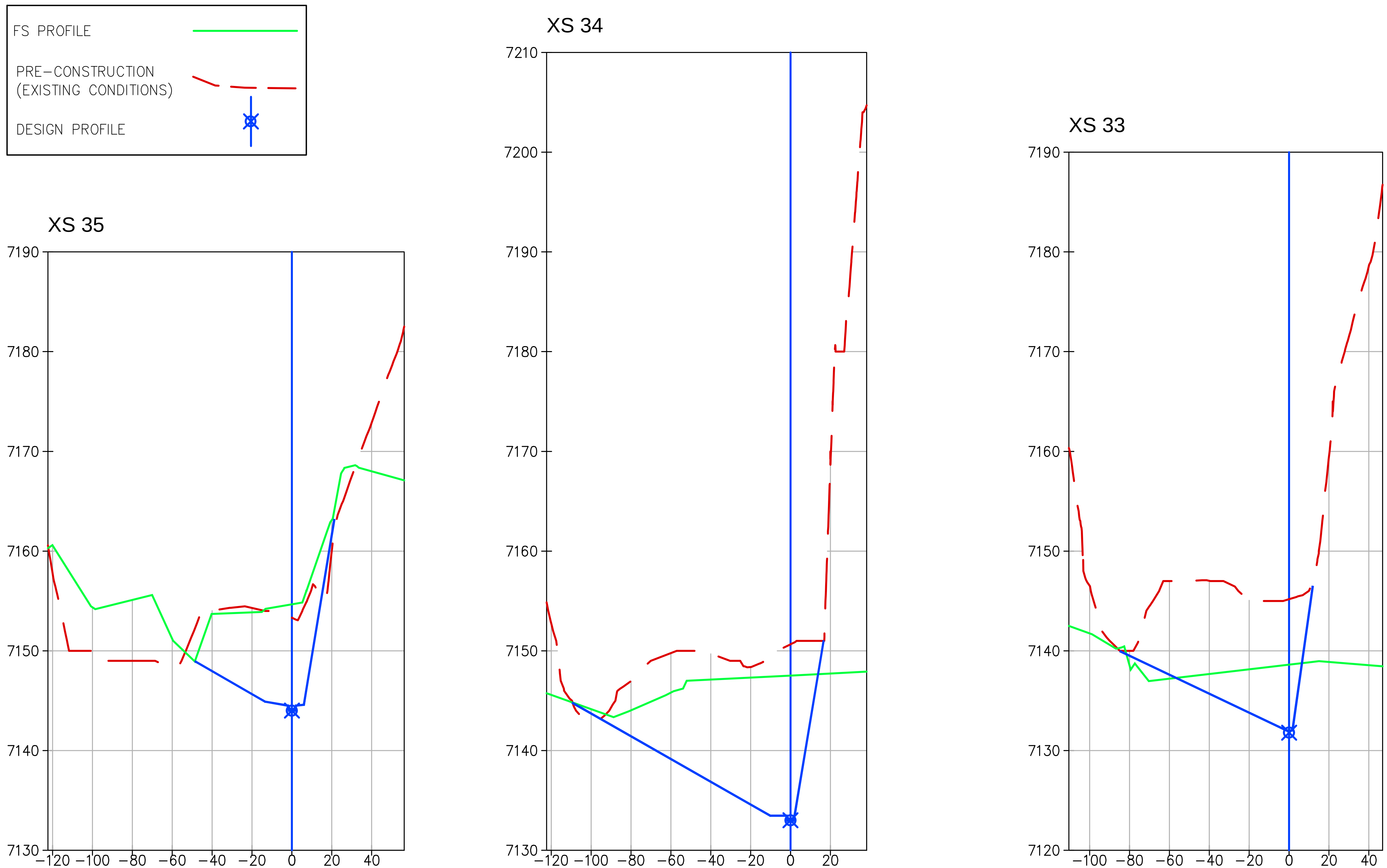
LARIMER COUNTY, COLORADO

CROSS SECTIONS

SHEET REFERENCE NUMBER:
19

UPDATE



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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
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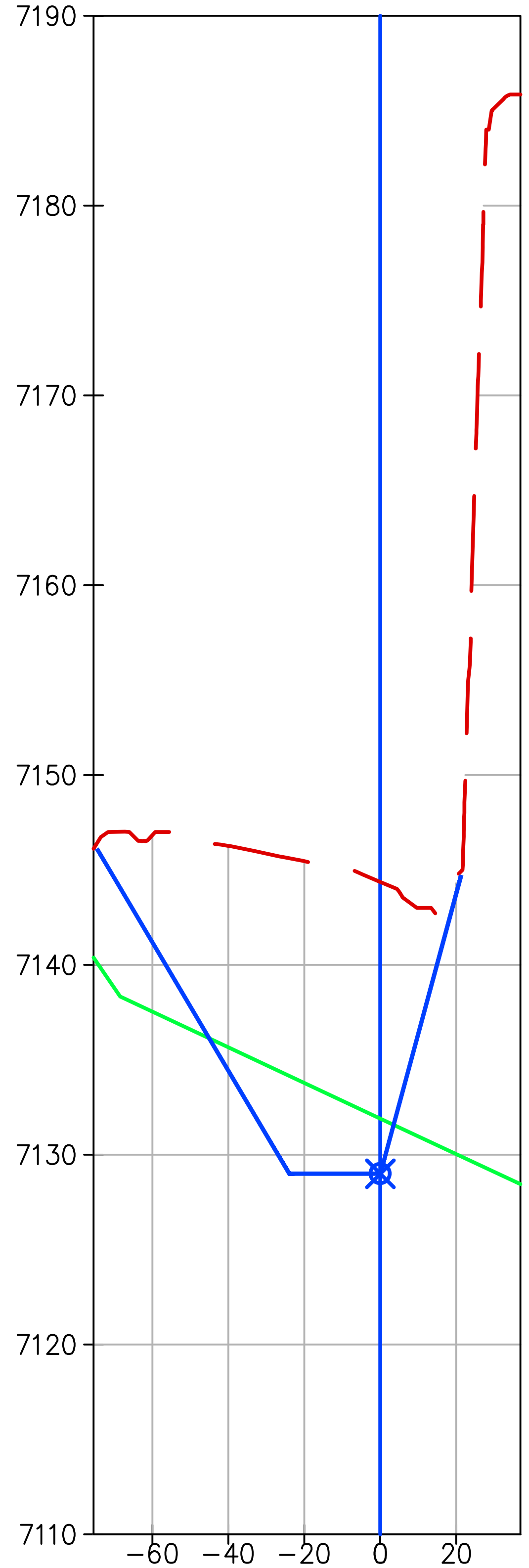
CROSS SECTIONS

SHEET REFERENCE NUMBER: 20

UPDATE

BR 4 UPSTREAM



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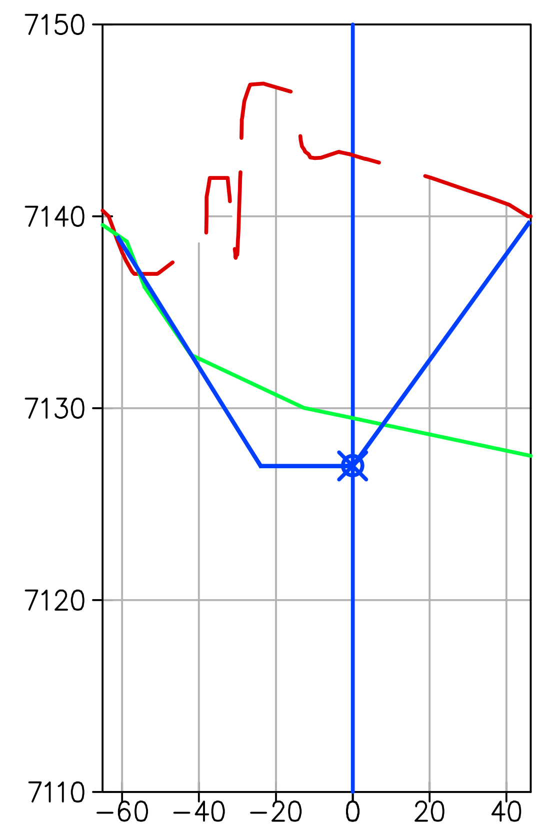

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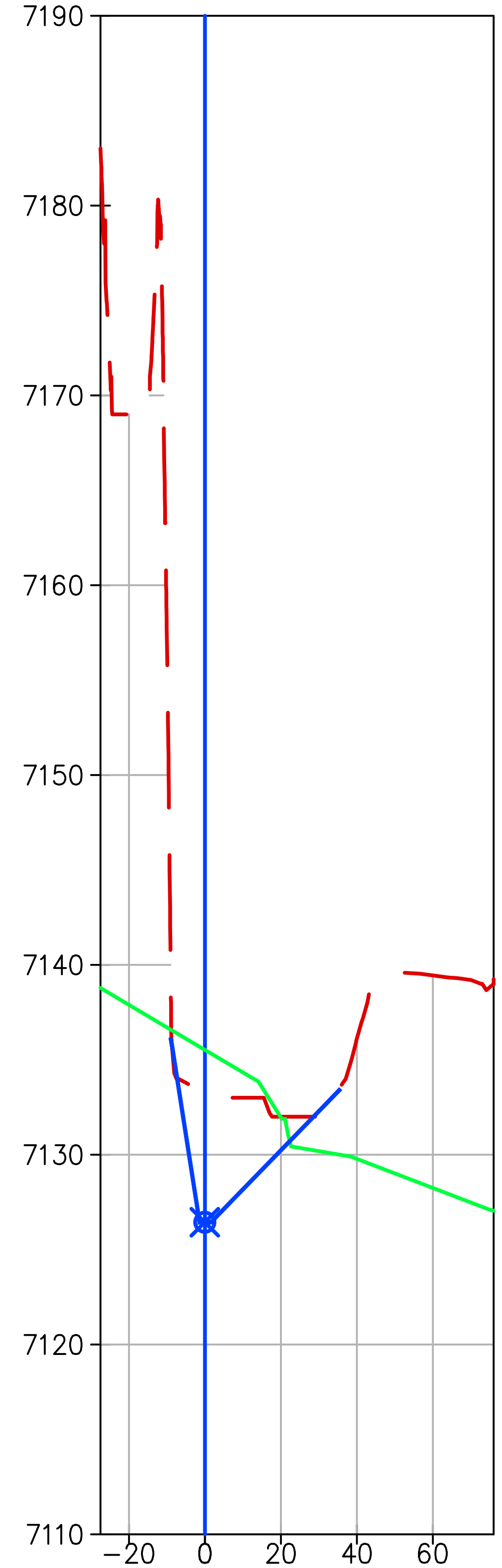
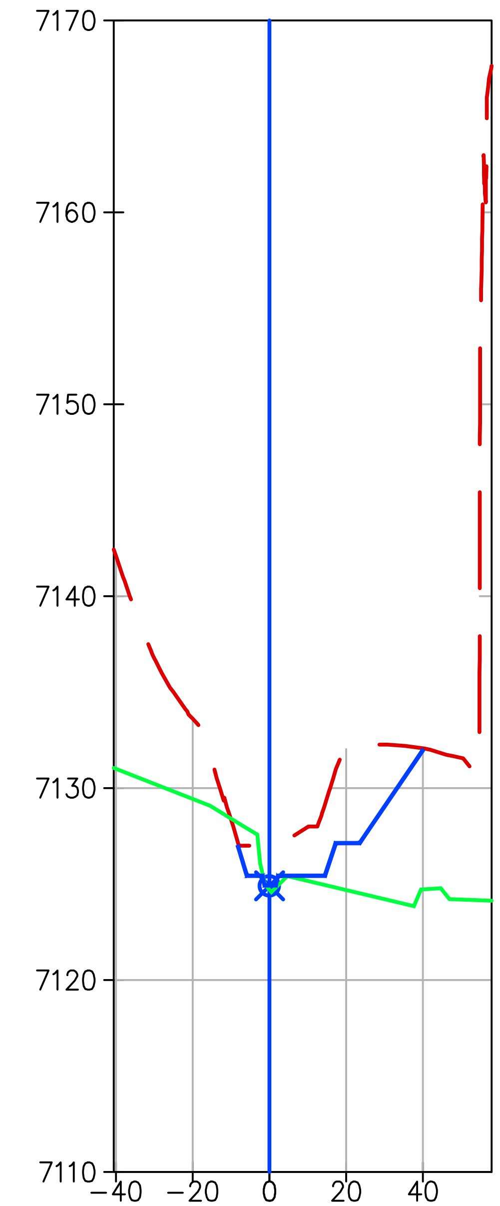


FS PROFILE

PRE−CONSTRUCTION (EXISTING CONDITIONS)

DESIGN PROFILE

XS 31



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Dwn by:

Ckd by:

Reviewed by: JPC

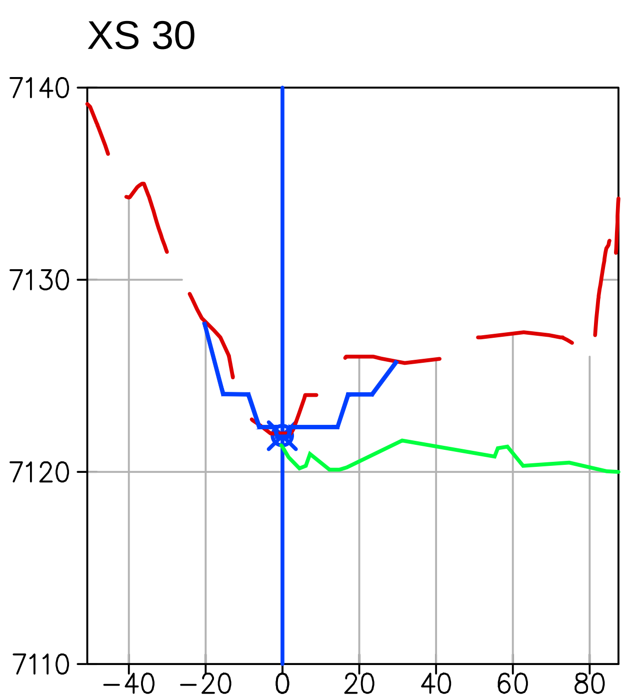
Submitted by:

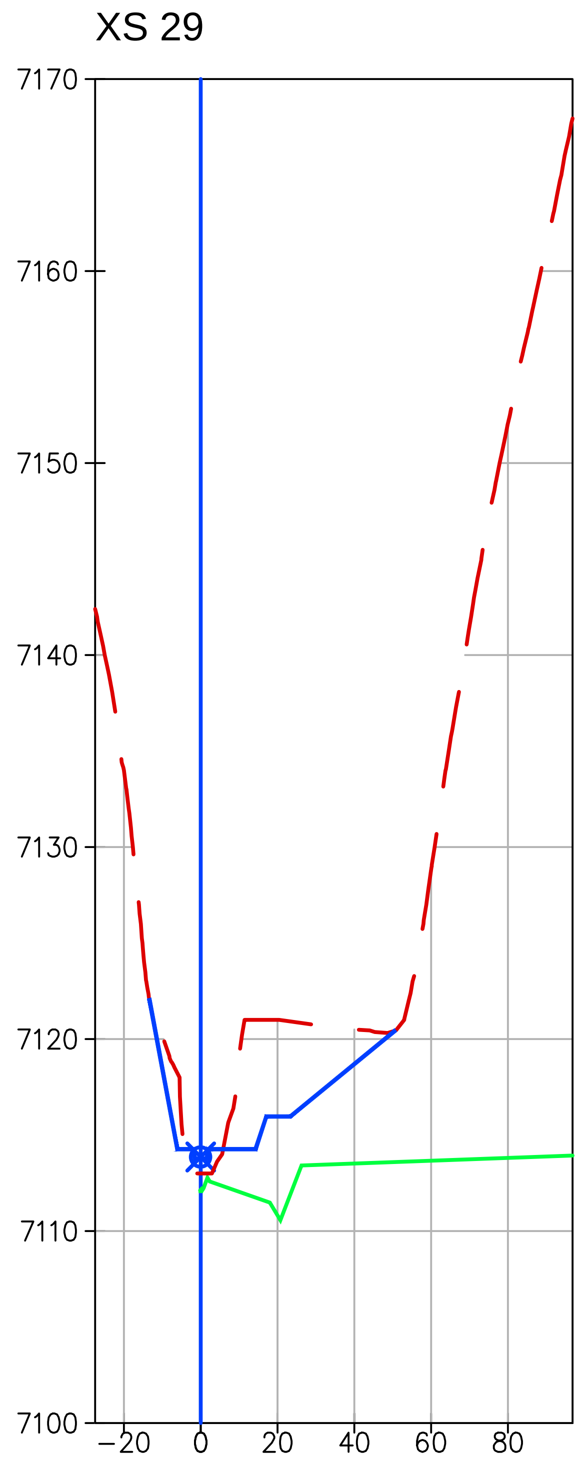
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

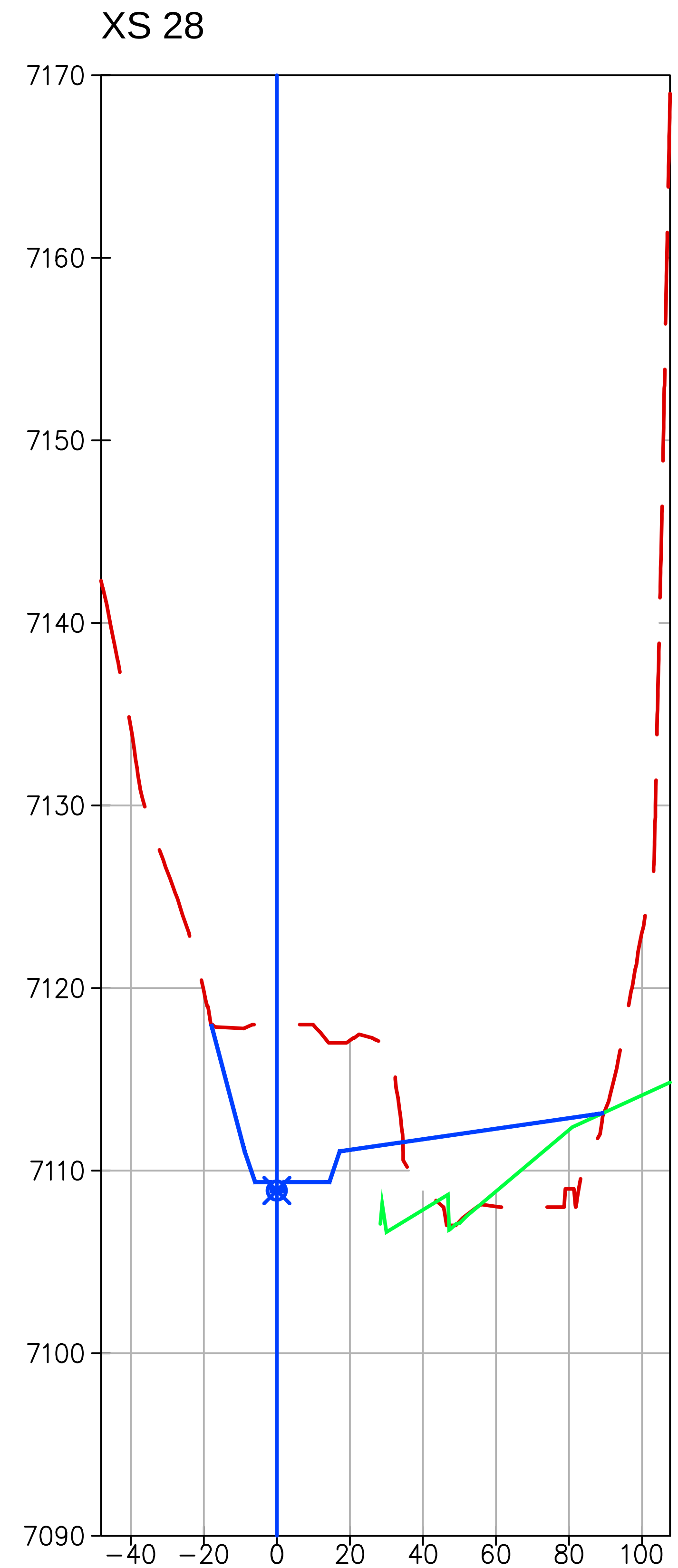
CROSS SECTIONS

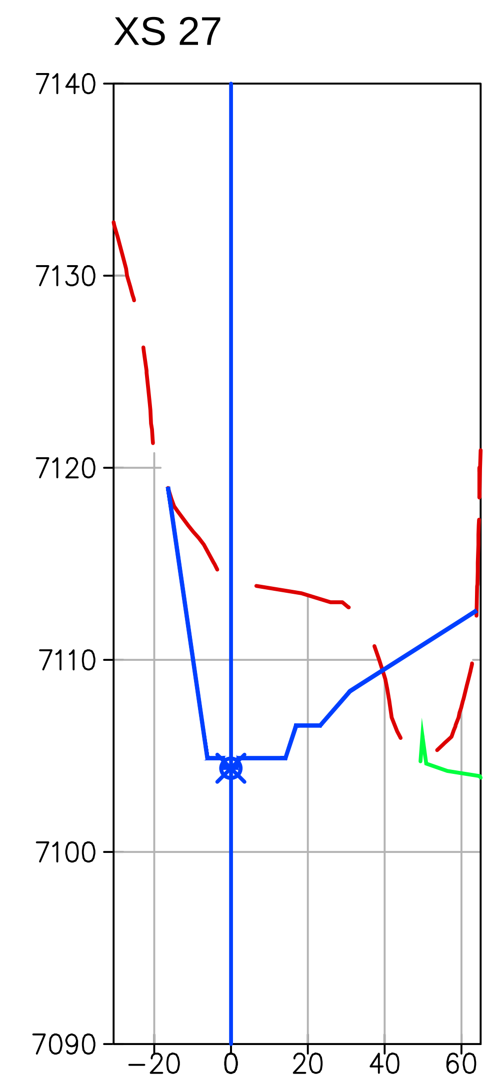
SHEET REFERENCE NUMBER: 21

UPDATE









FS PROFILE

PRE−CONSTRUCTION (EXISTING CONDITIONS)

DESIGN PROFILE

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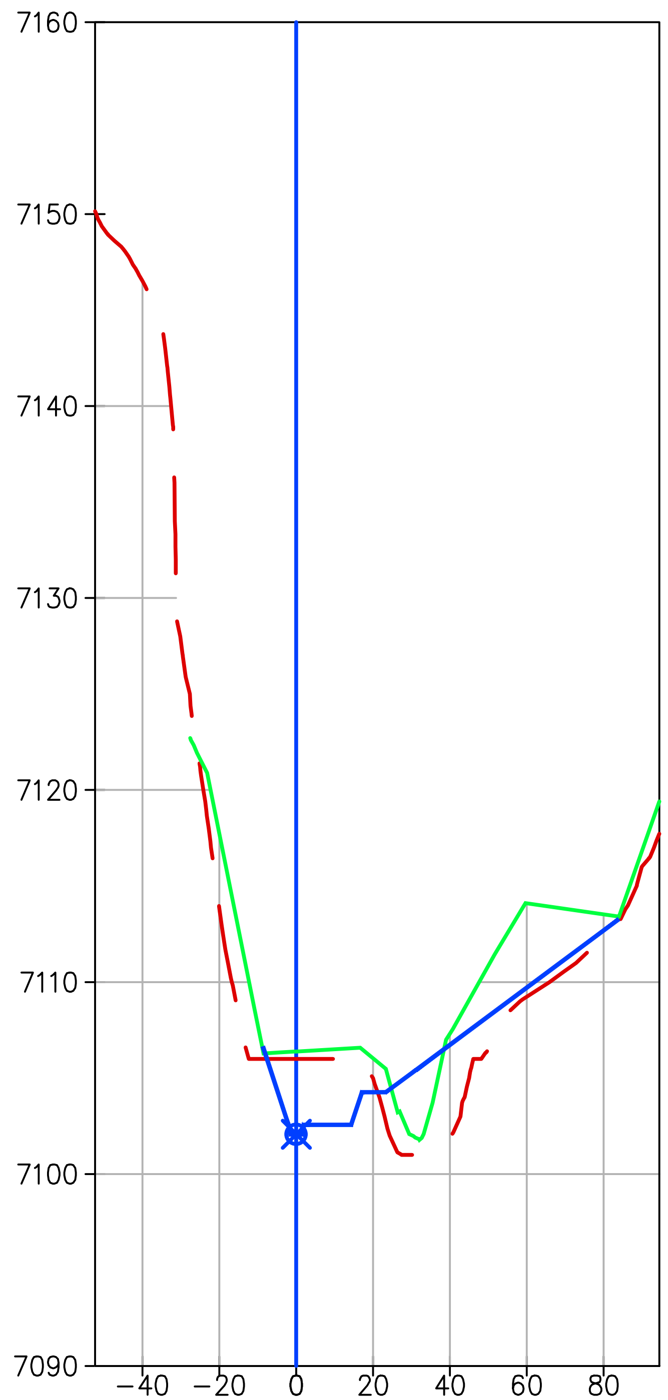
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

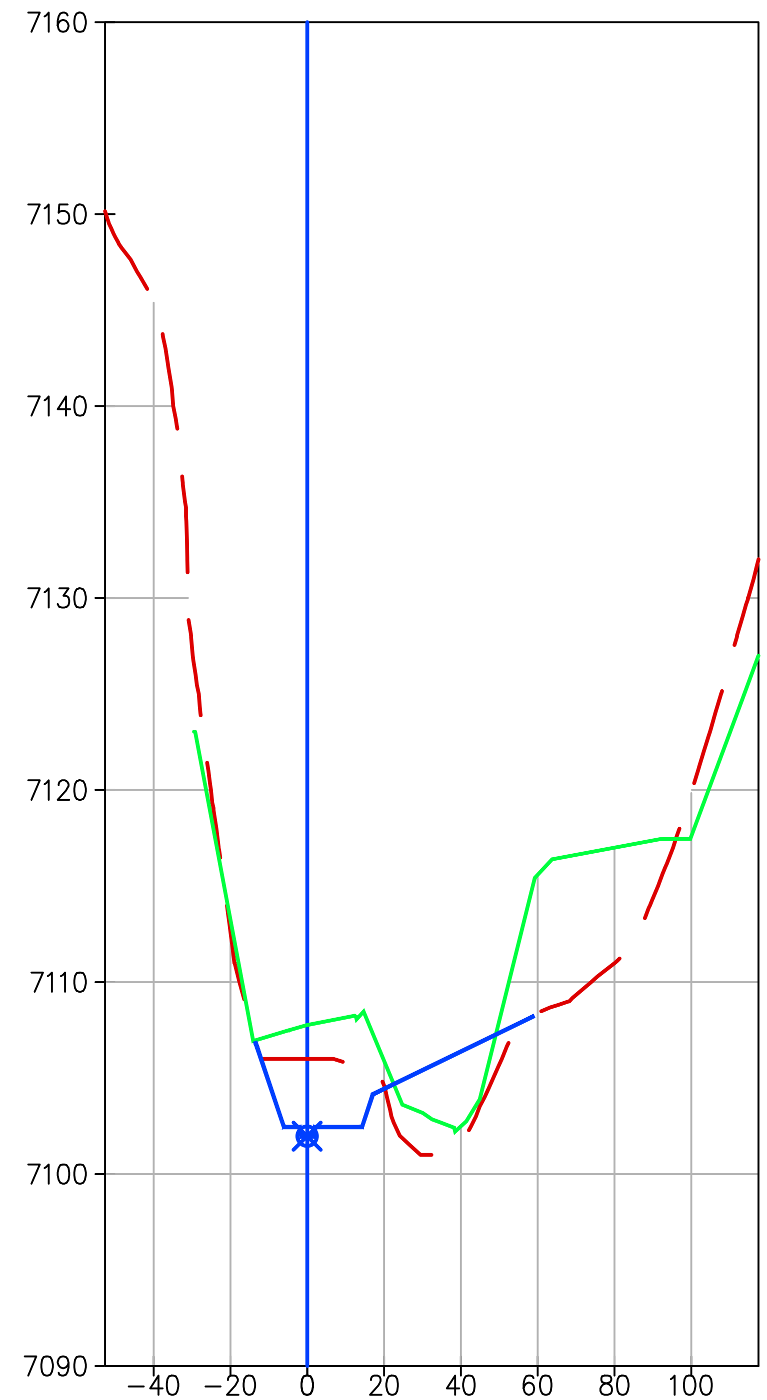
SHEET REFERENCE NUMBER:
22

UPDATE

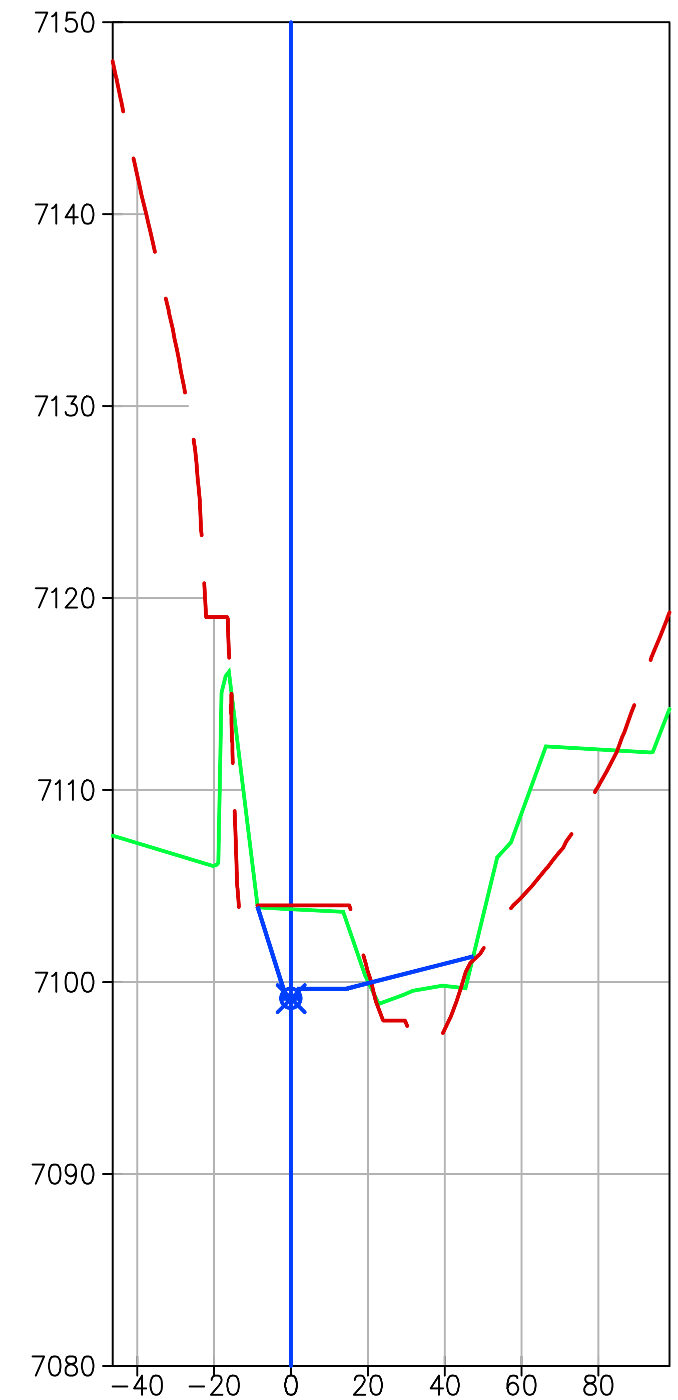
XS 26



XS 26A



XS 25



FS PROFILE

PRE−CONSTRUCTION (EXISTING CONDITIONS)

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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
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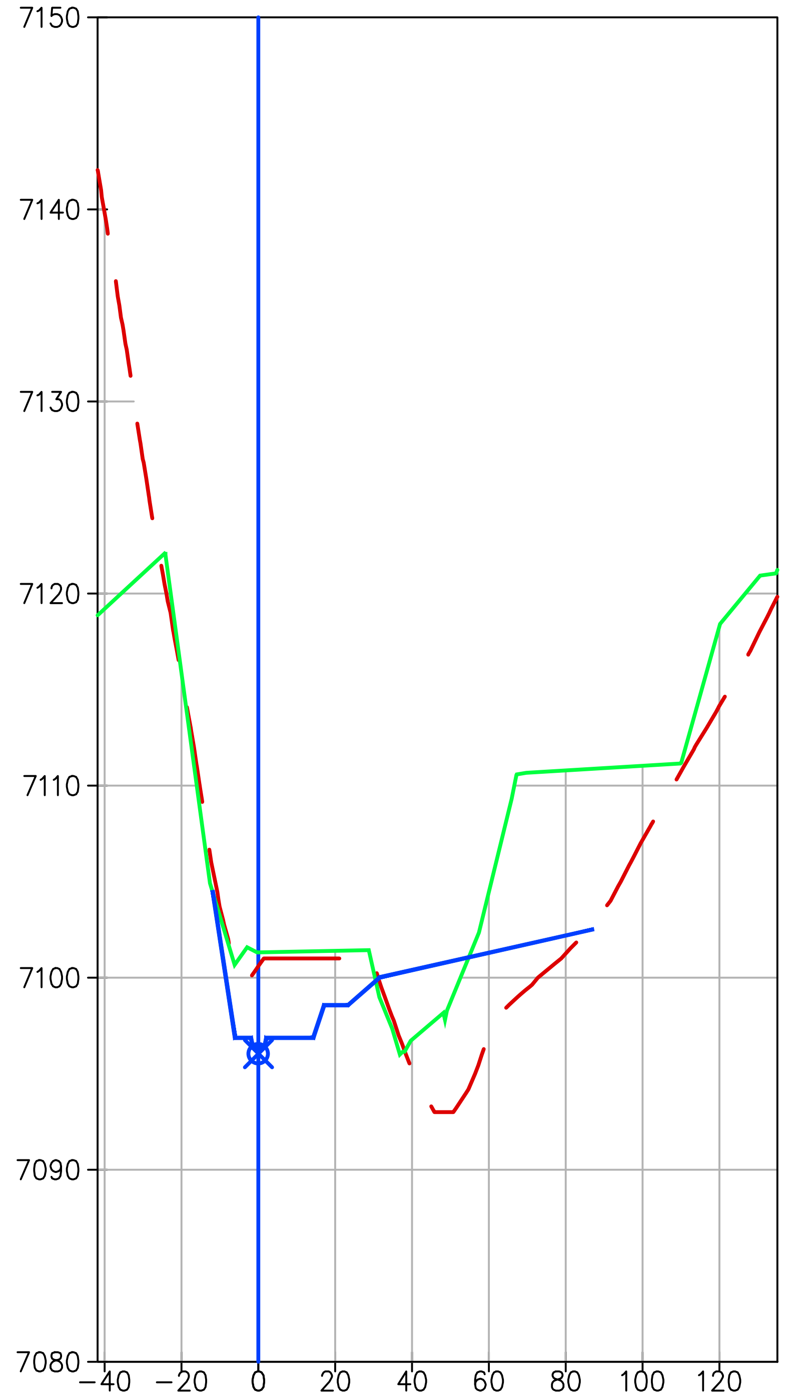
LARIMER COUNTY, COLORADO

CROSS SECTIONS

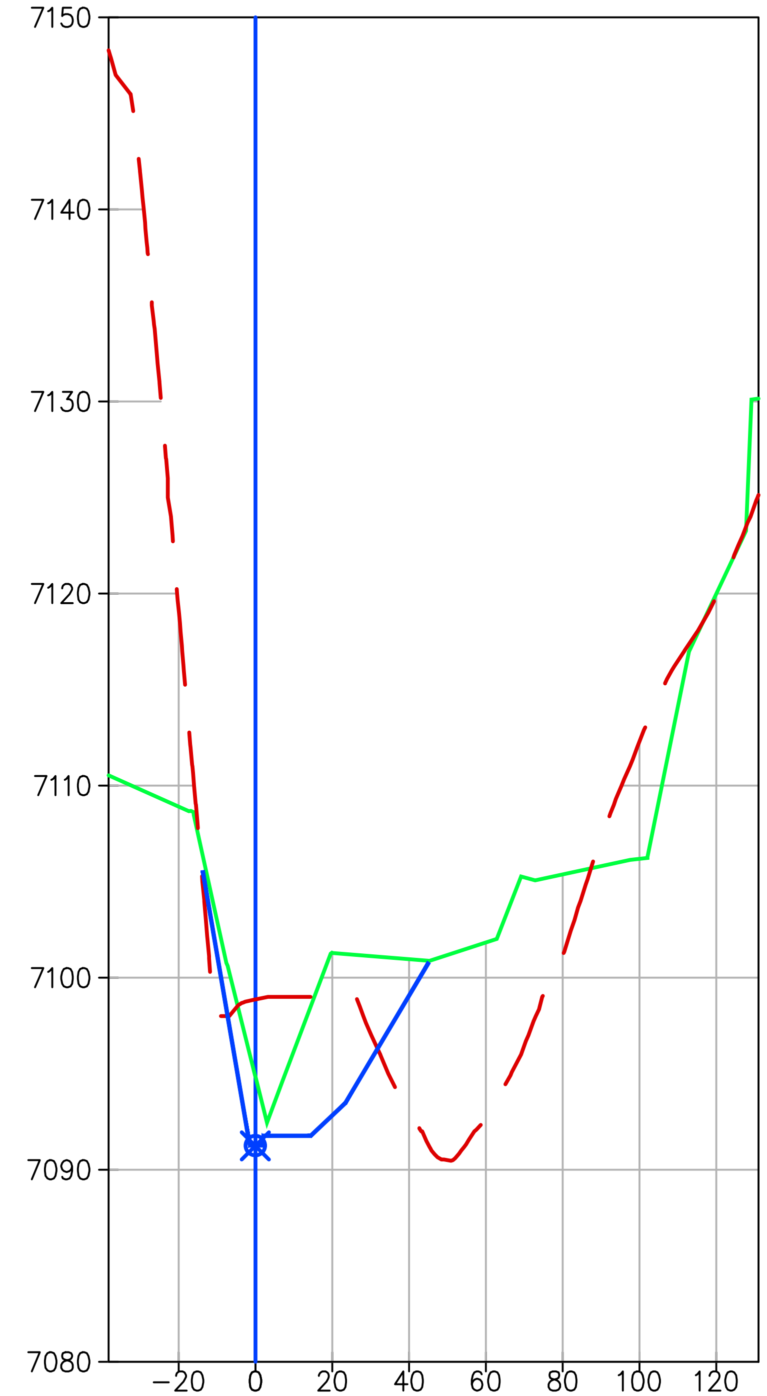
SHEET REFERENCE NUMBER:
23

UPDATE

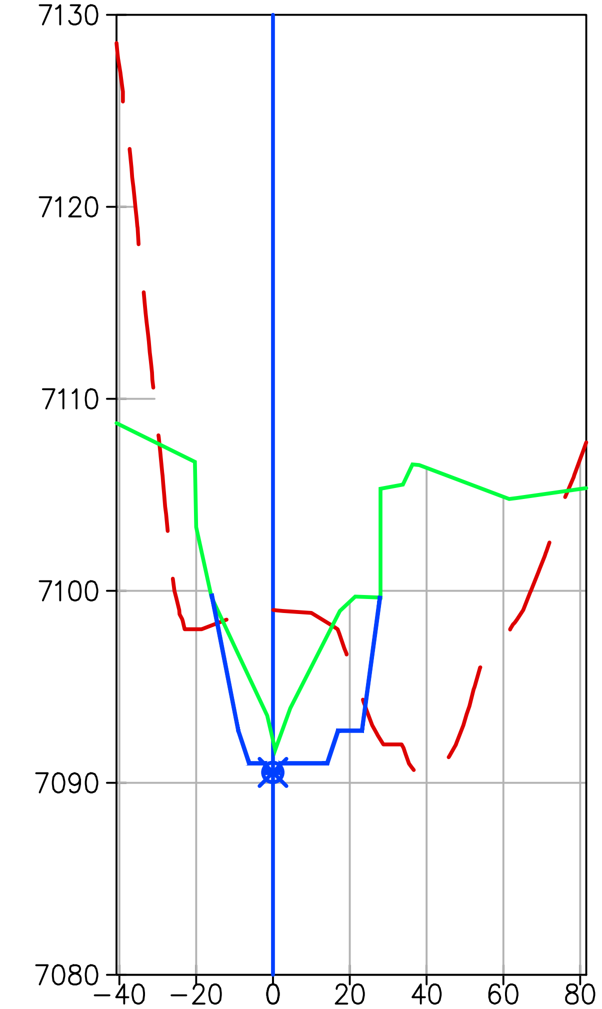
XS 24



XS 23A



XS 23



FS PROFILE

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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
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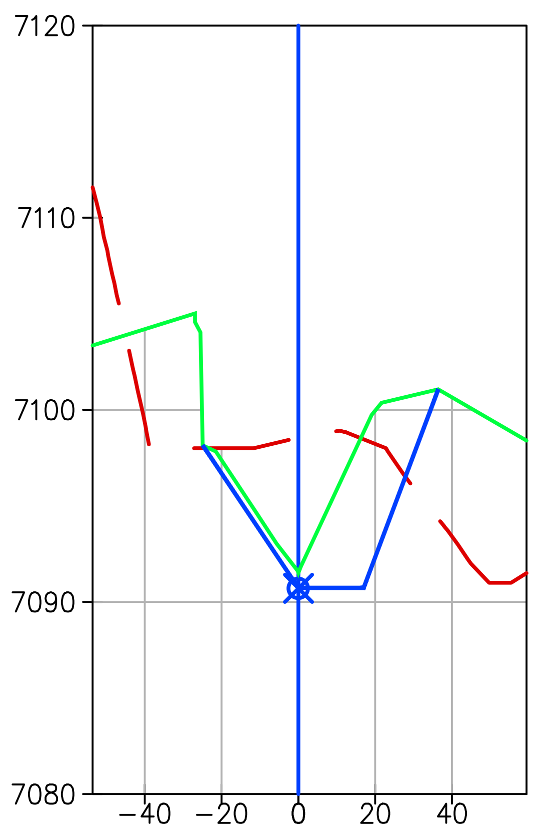
CROSS SECTIONS

SHEET REFERENCE NUMBER:
24

UPDATE

BR 5 UPSTREAM



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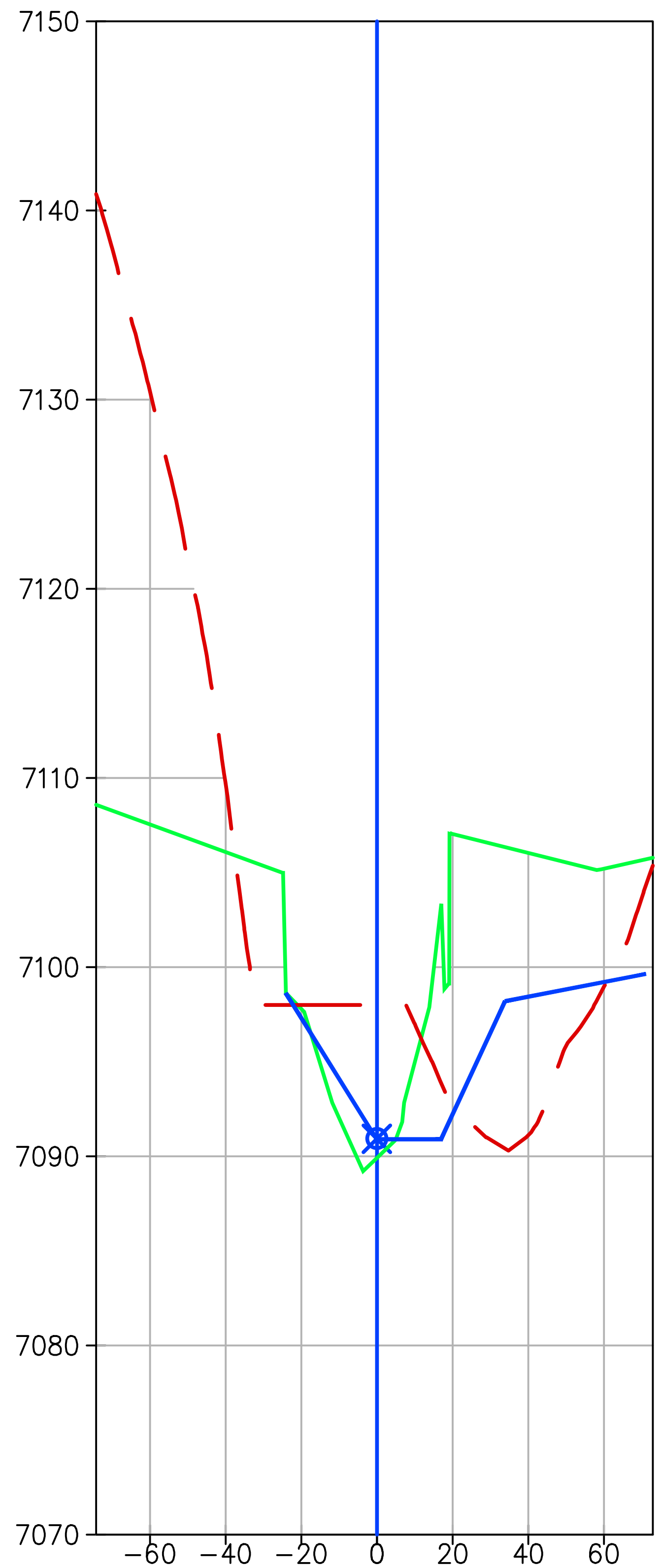

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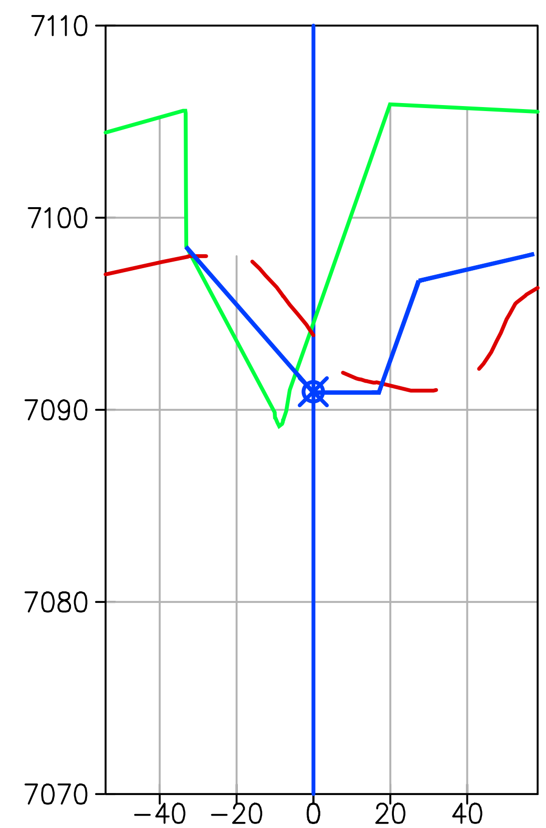

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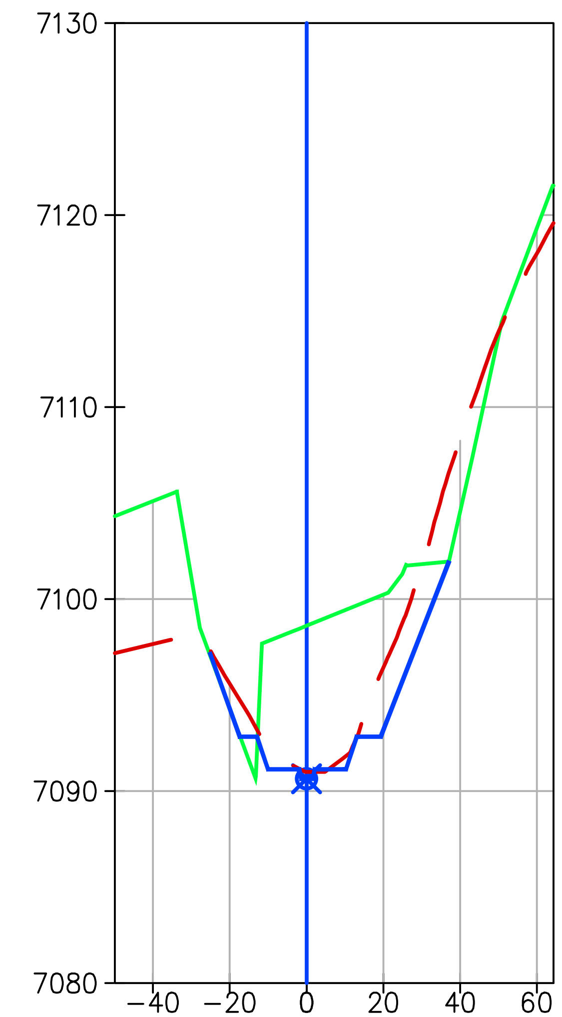

FS PROFILE

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COUNTY ROAD 43
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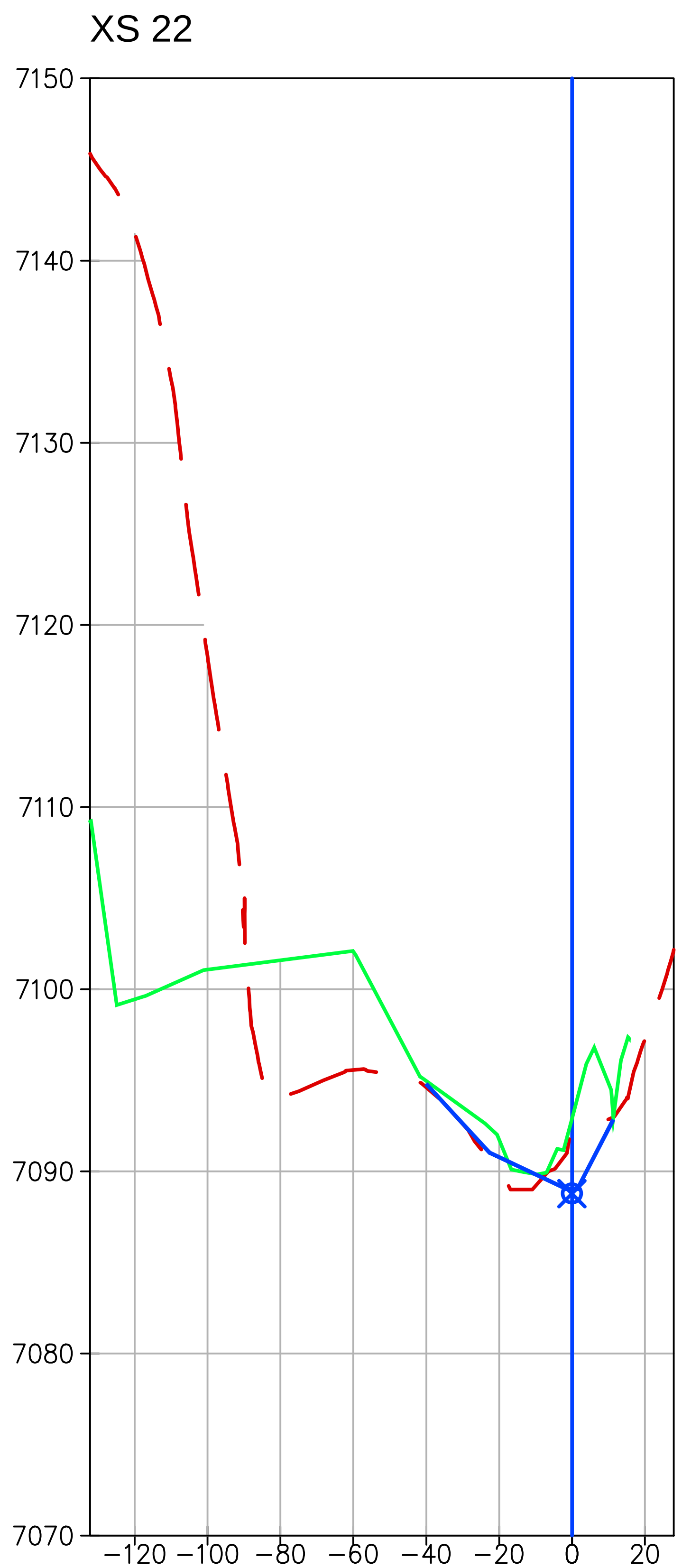
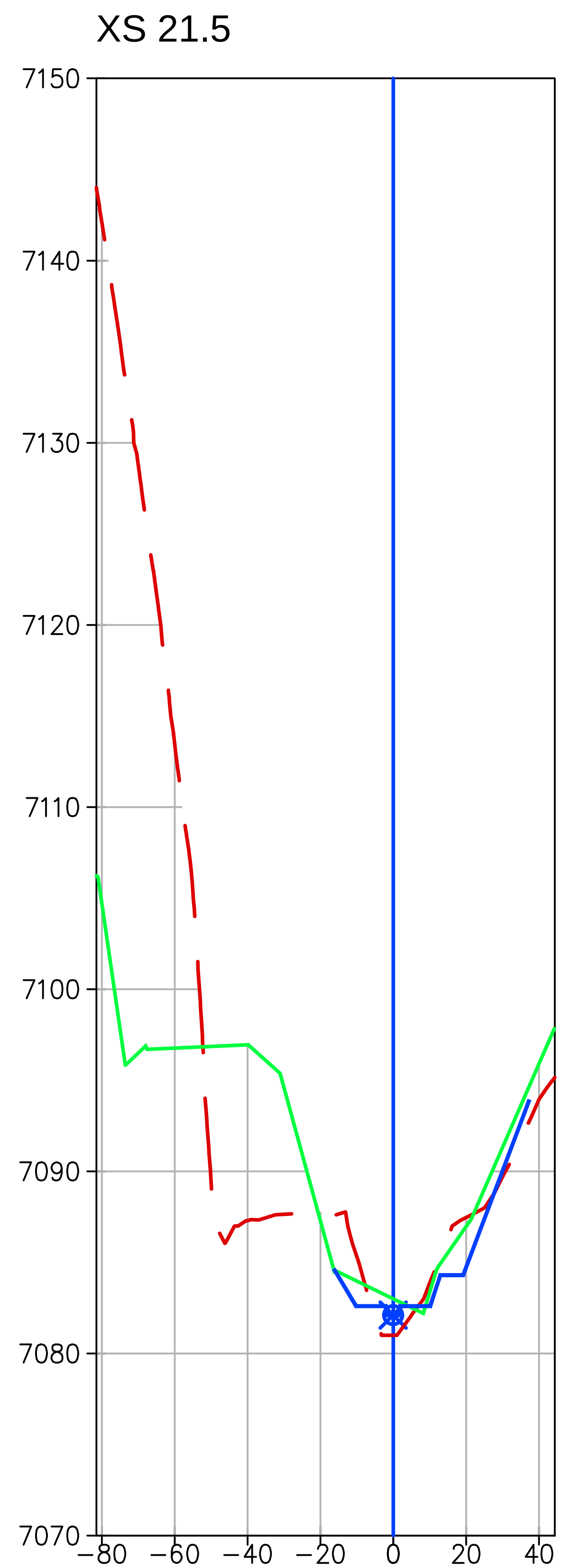
CROSS SECTIONS

SHEET REFERENCE NUMBER:
25

UPDATE





FS PROFILE

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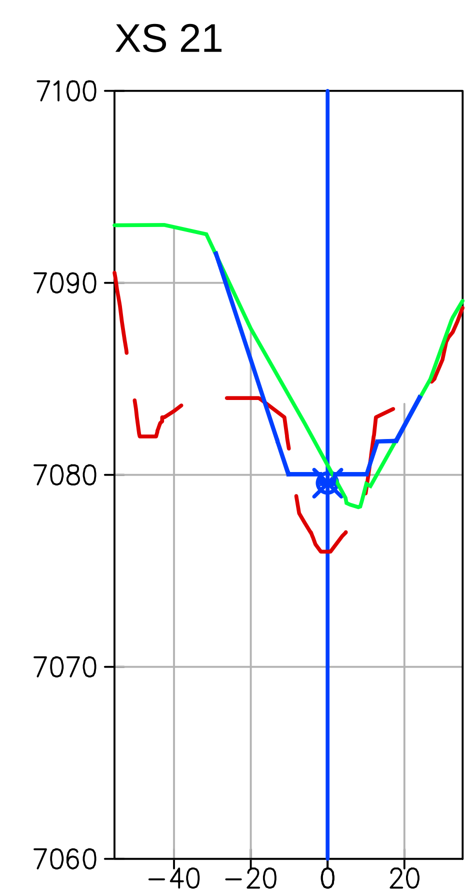

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COUNTY ROAD 43
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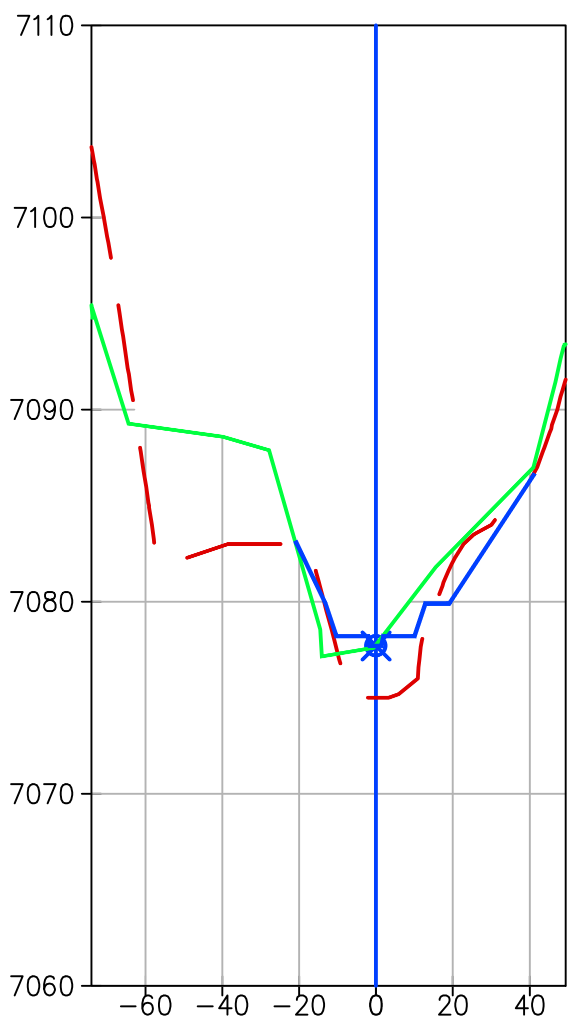
CROSS SECTIONS

SHEET REFERENCE NUMBER:
26

UPDATE

XS 20.5



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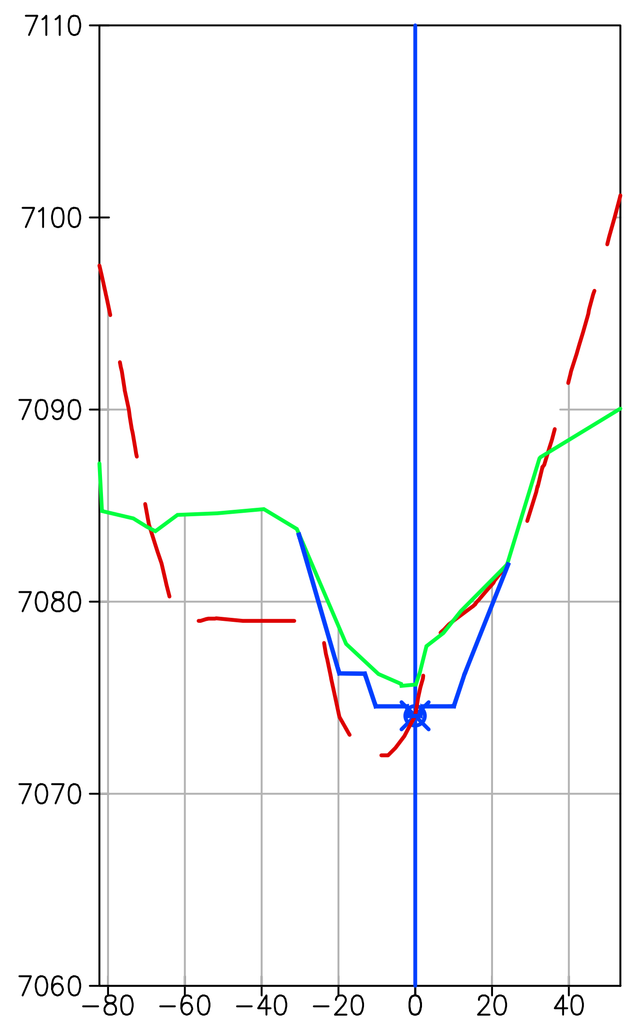

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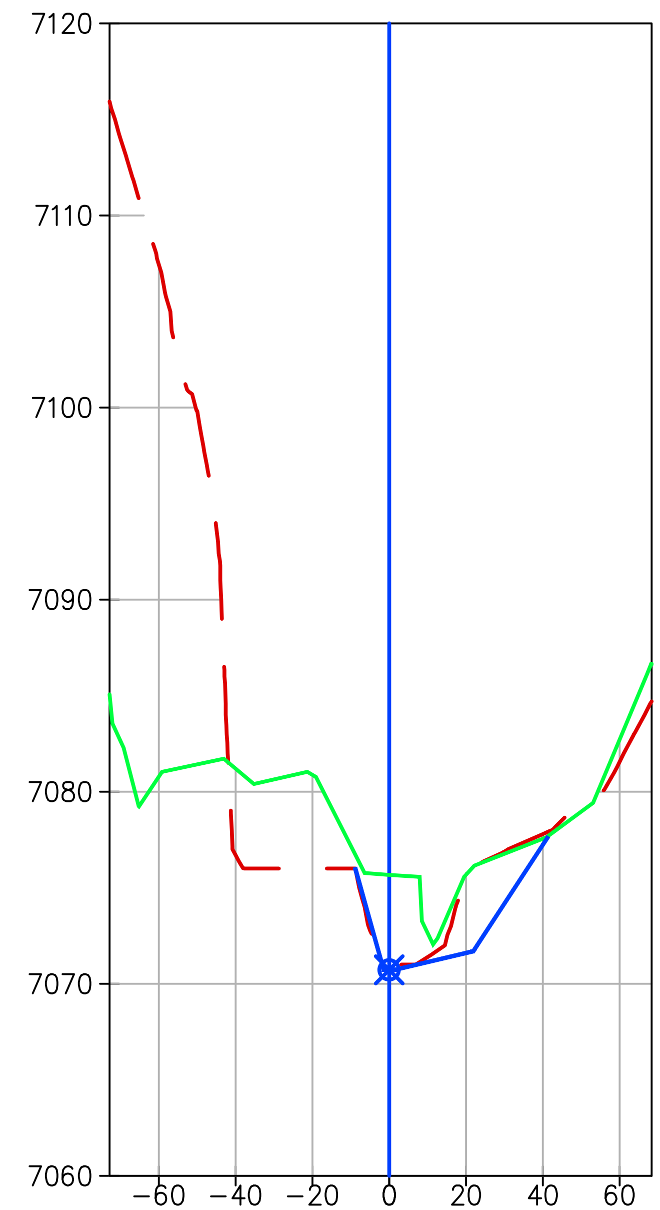

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PRE−CONSTRUCTION (EXISTING CONDITIONS)

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Rev.

Date: MAR 1, 2016

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Reviewed by: JPC

Submitted by:

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CROSS SECTIONS

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27

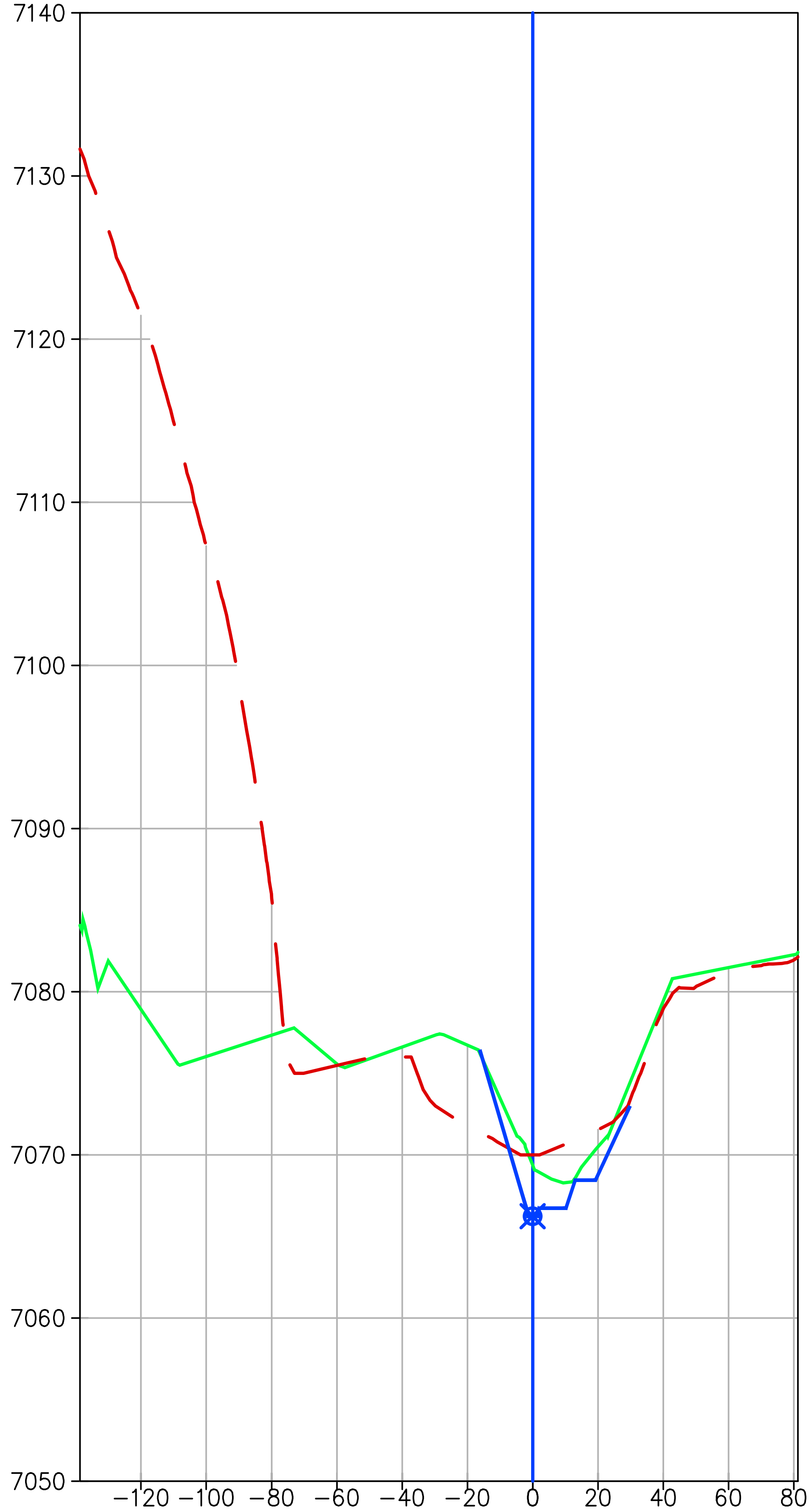
UPDATE

FS PROFILE

PRE–CONSTRUCTION (EXISTING CONDITIONS)

DESIGN PROFILE

XS 19A



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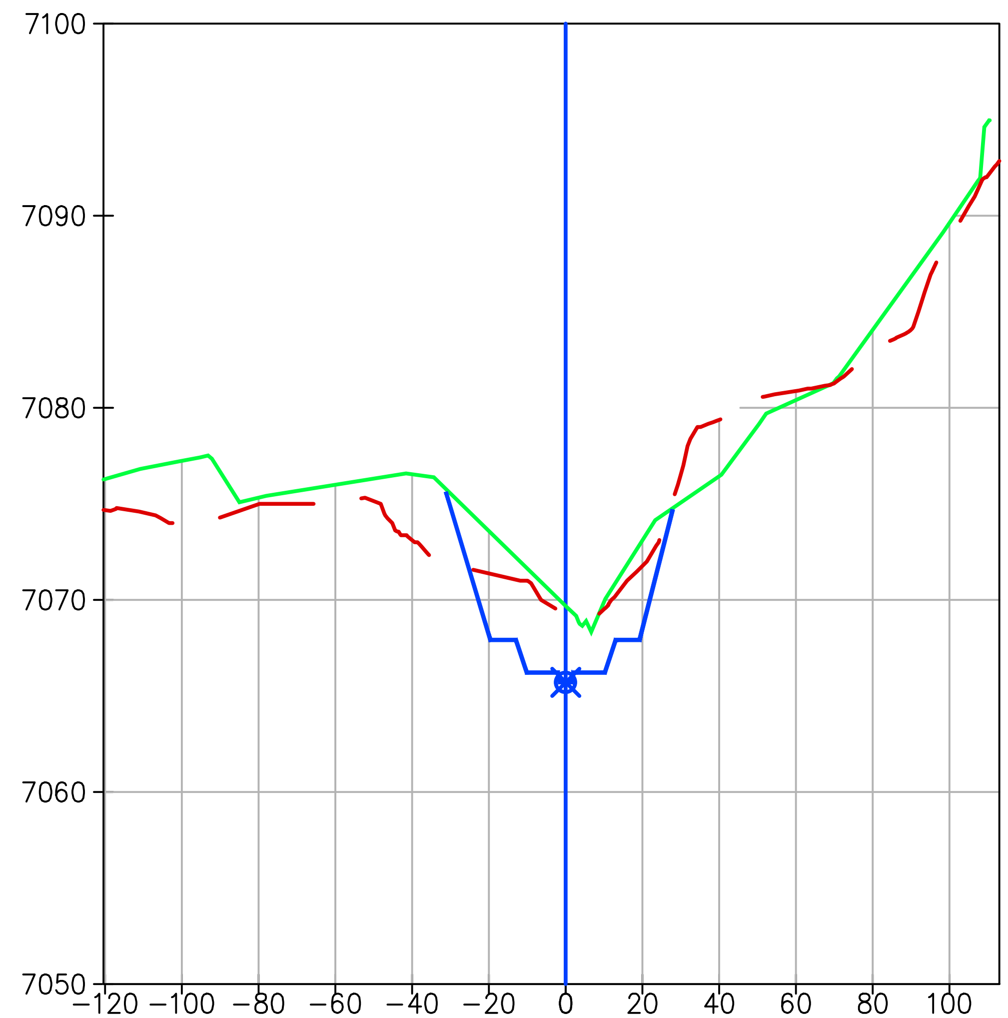

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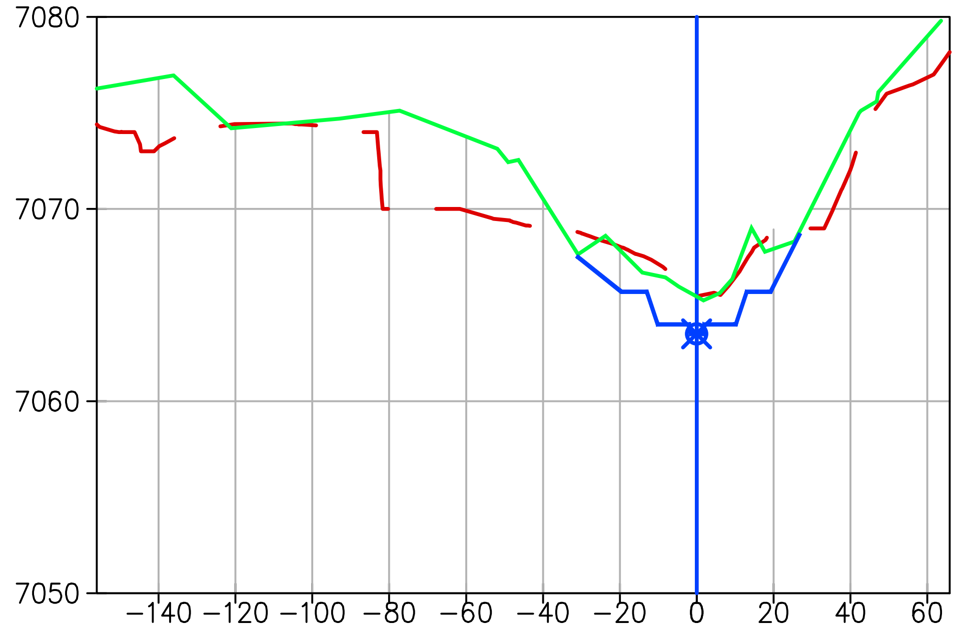
CROSS SECTIONS

SHEET REFERENCE NUMBER:
28

UPDATE

XS 18



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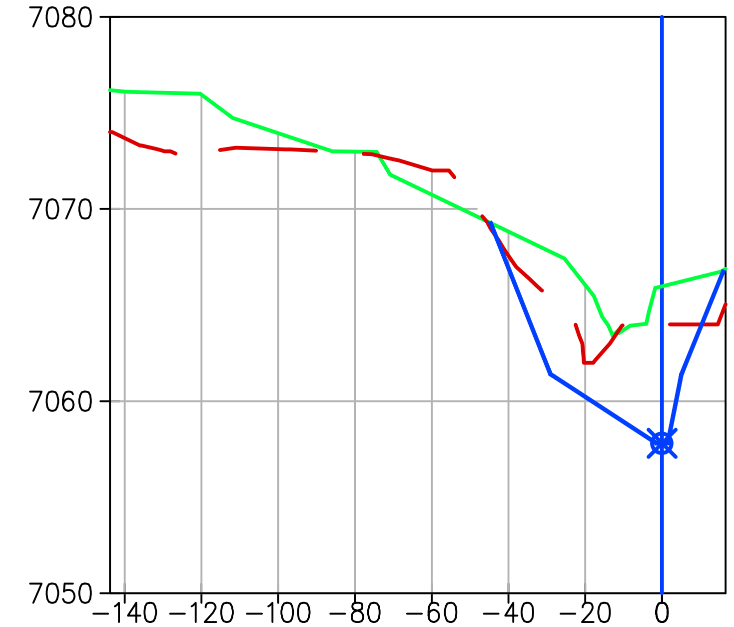
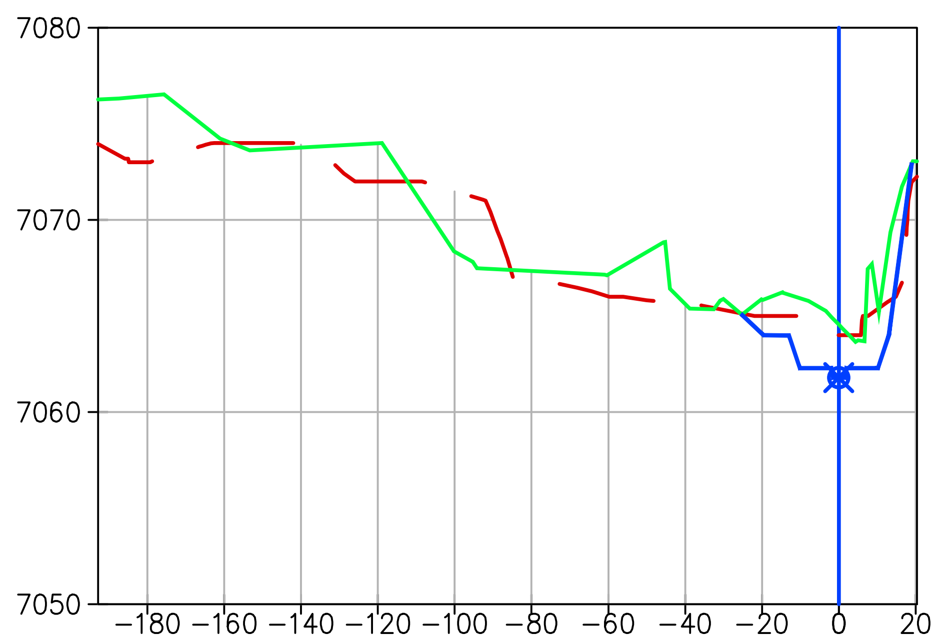


XS 17



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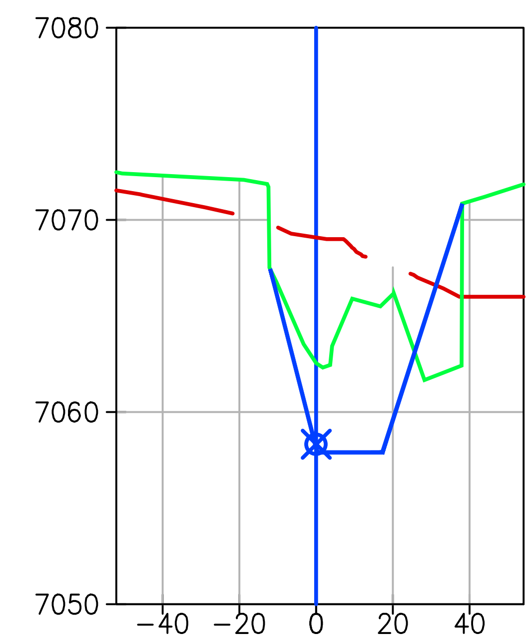

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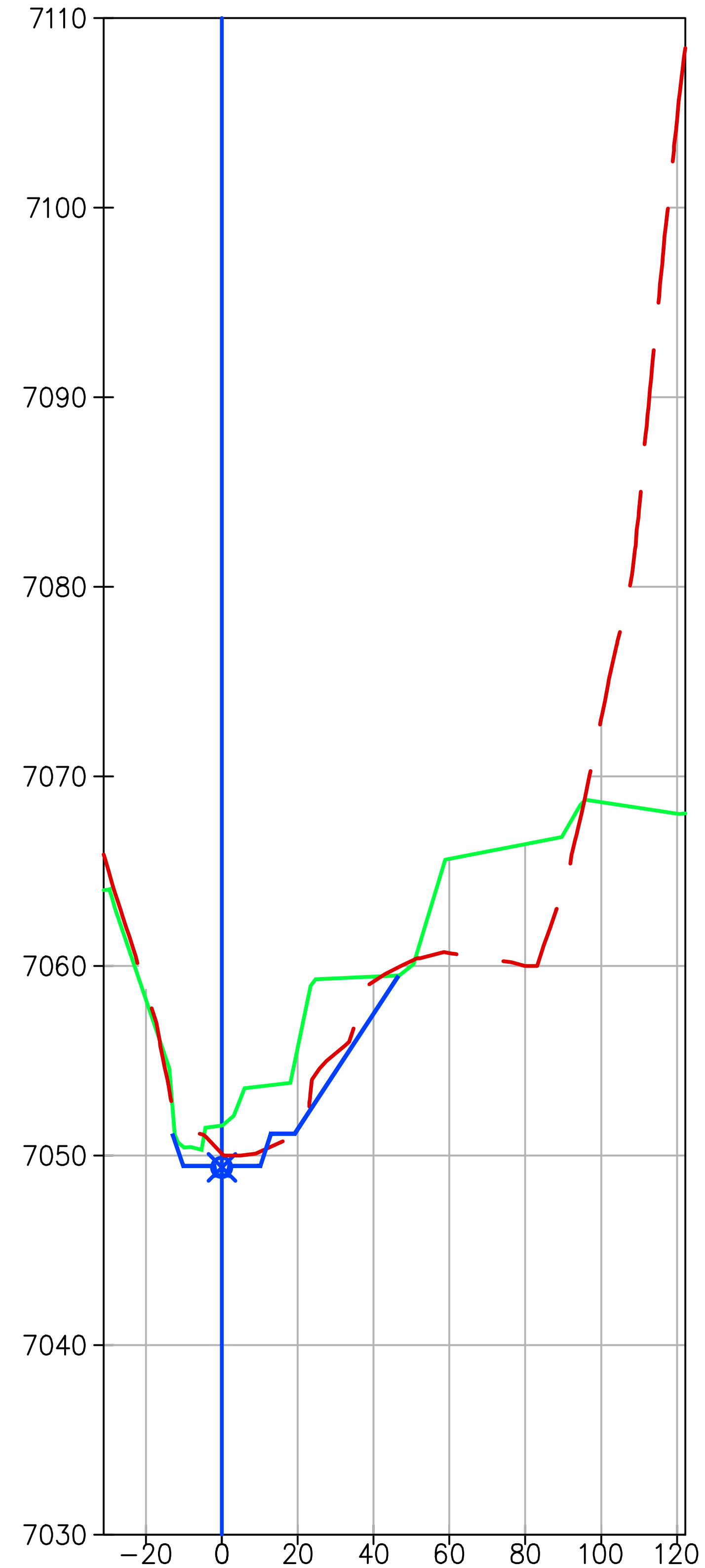
LARIMER COUNTY, COLORADO

CROSS SECTIONS

SHEET REFERENCE NUMBER: 29

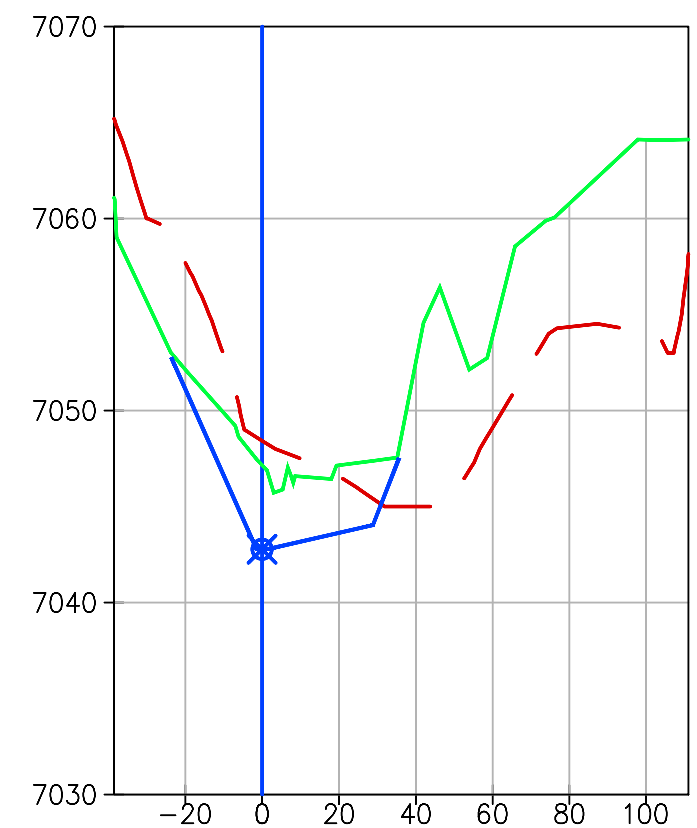
FS PROFILE
PRE–CONSTRUCTION (EXISTING CONDITIONS)
DESIGN PROFILE

XS 14



XS 15

XS 13



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NORTH FORK BIG THOMPSON RIVER
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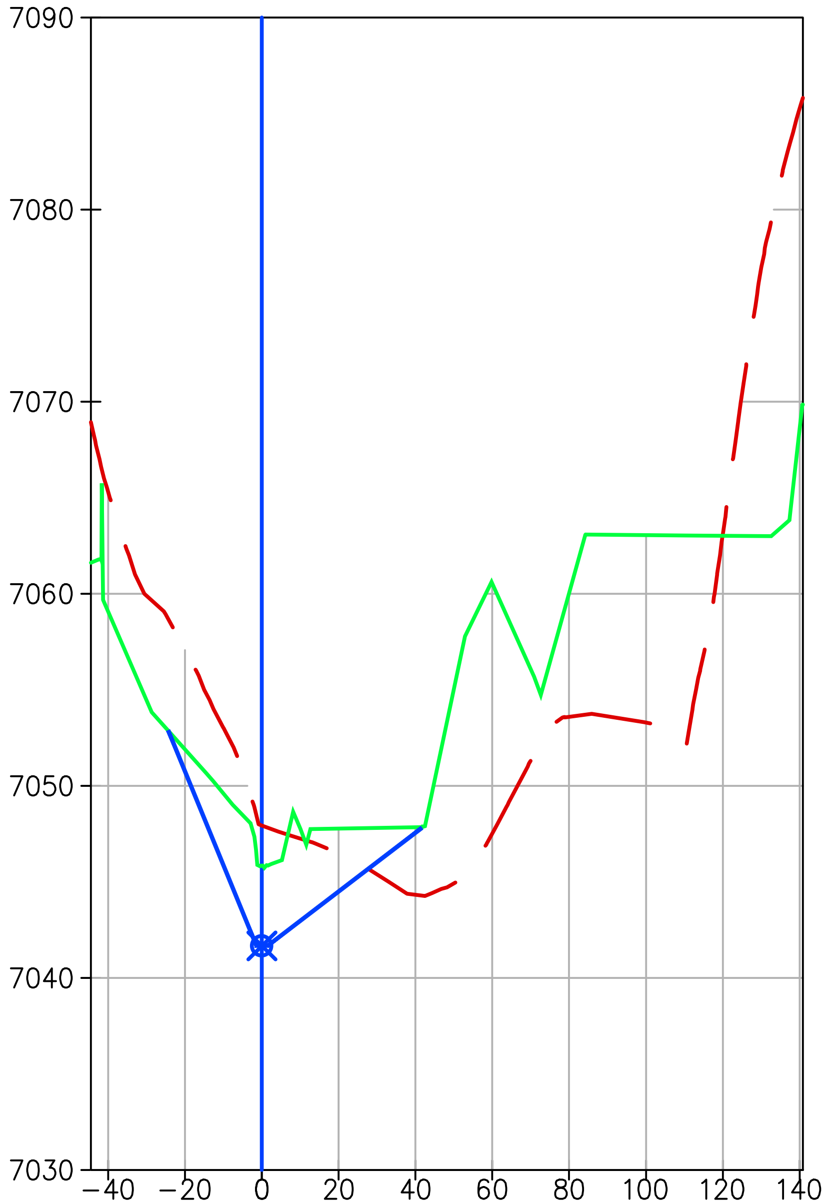
LARIMER COUNTY, COLORADO

CROSS SECTIONS

SHEET REFERENCE NUMBER:
30

XS 13A



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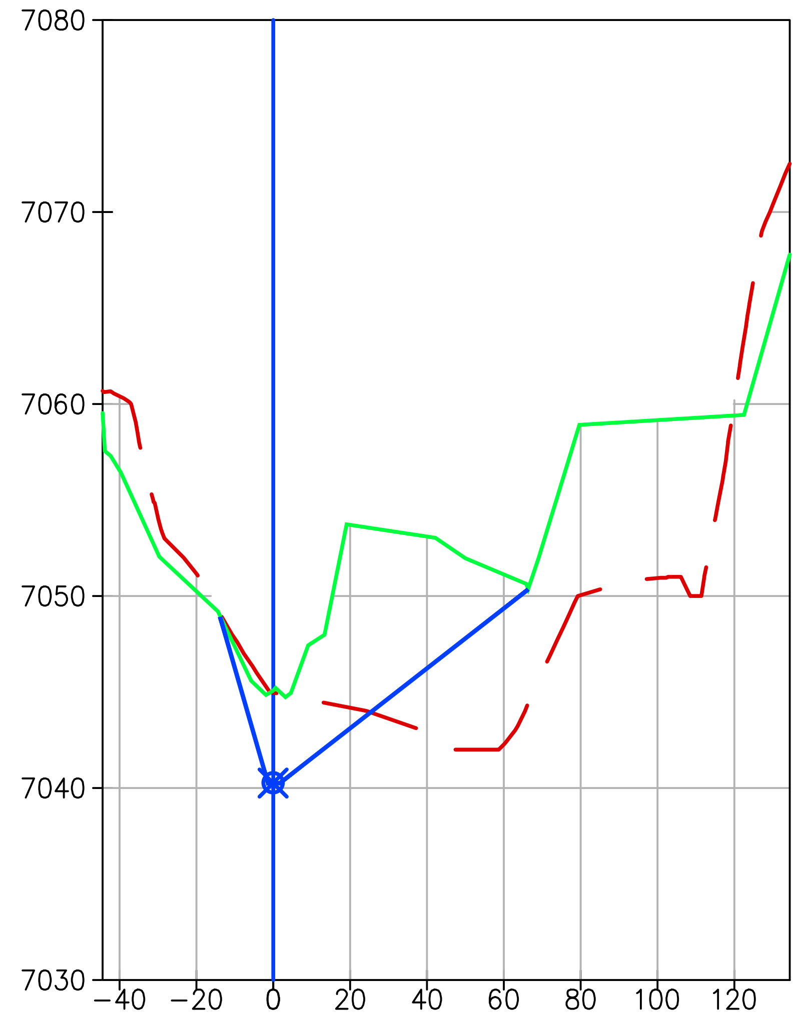
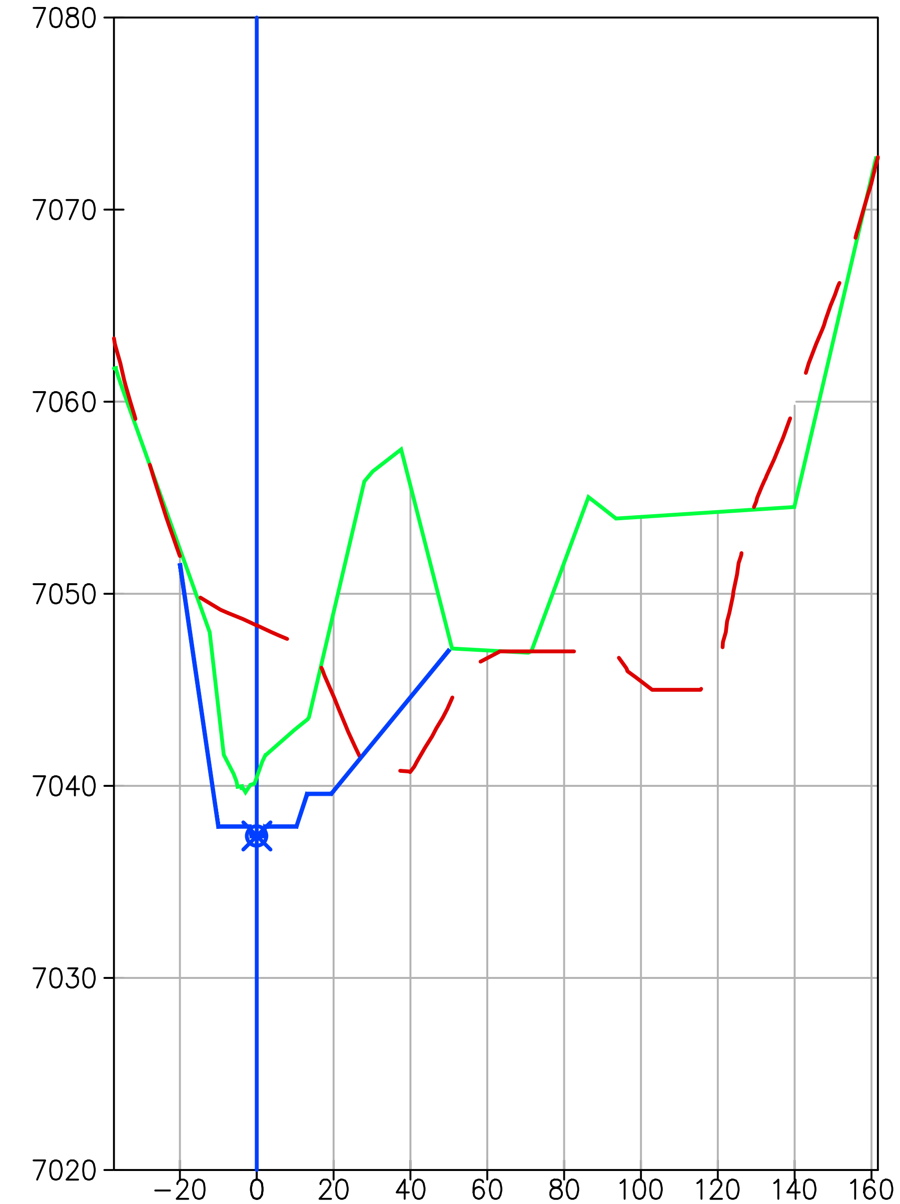


XS 11.5



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Date: MAR 1, 2016

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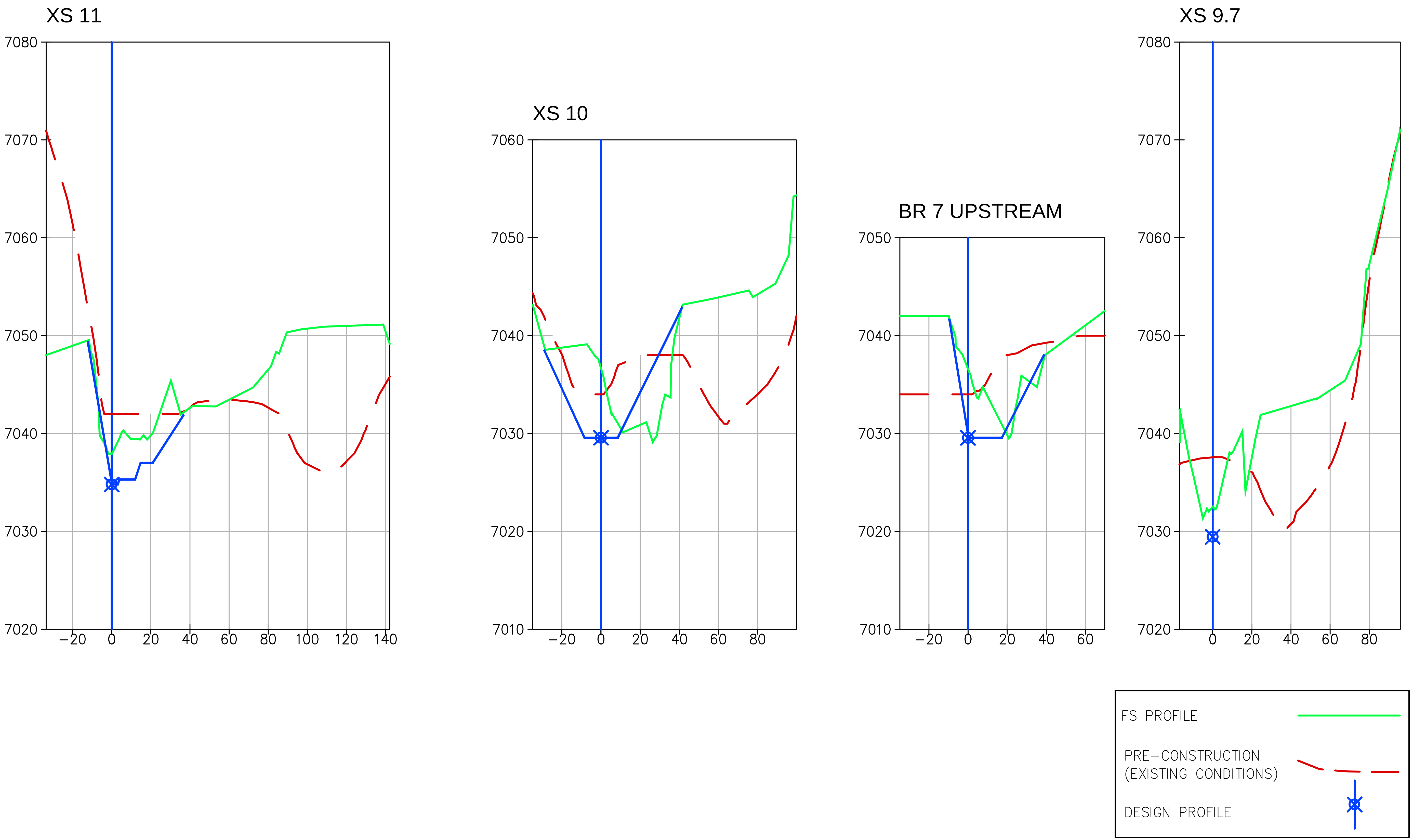
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

SHEET REFERENCE NUMBER:
31

UPDATE



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CROSS SECTIONS

SHEET REFERENCE NUMBER:
32

UPDATE

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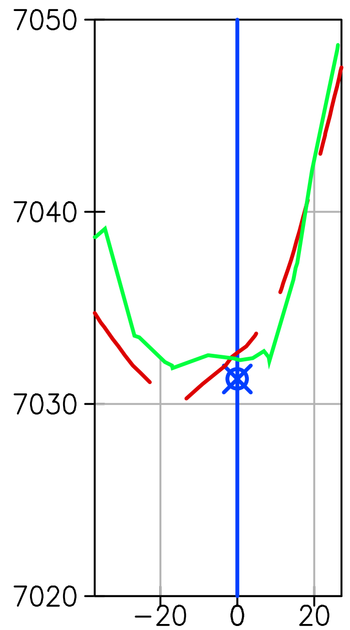

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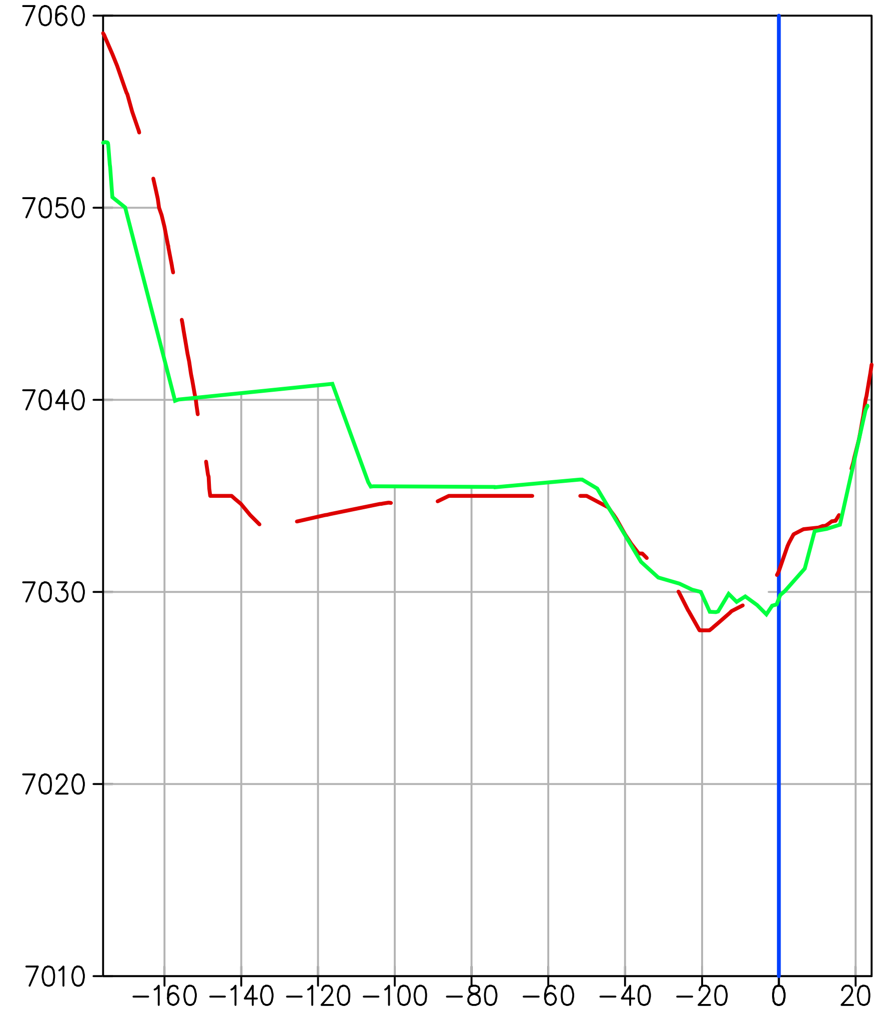

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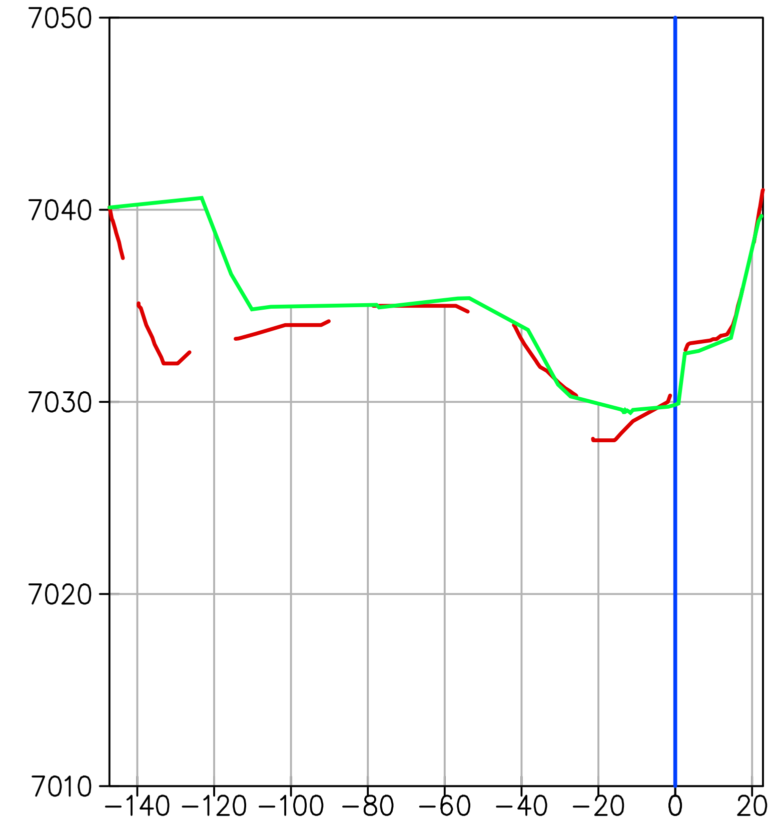

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Reviewed by: JPC		Drawing Code:	
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COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

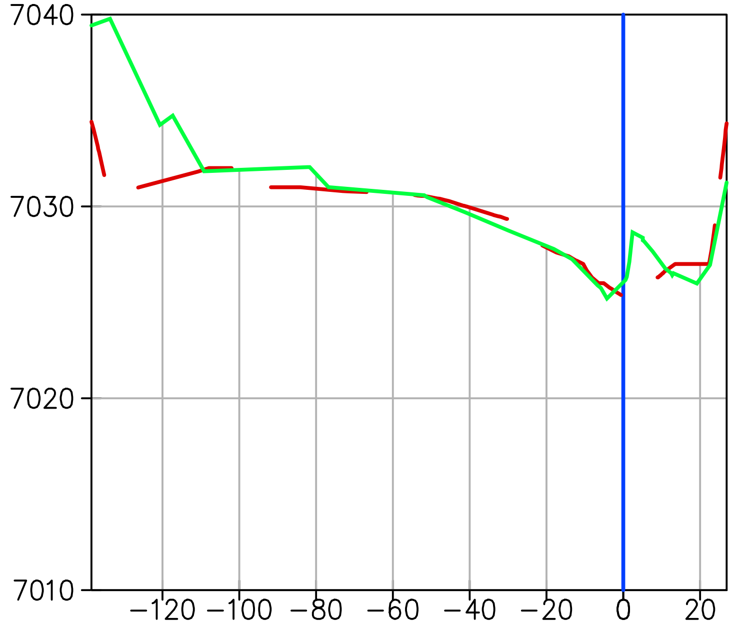
SHEET REFERENCE NUMBER:
33

UPDATE

4 3 2 1

C

XS 8



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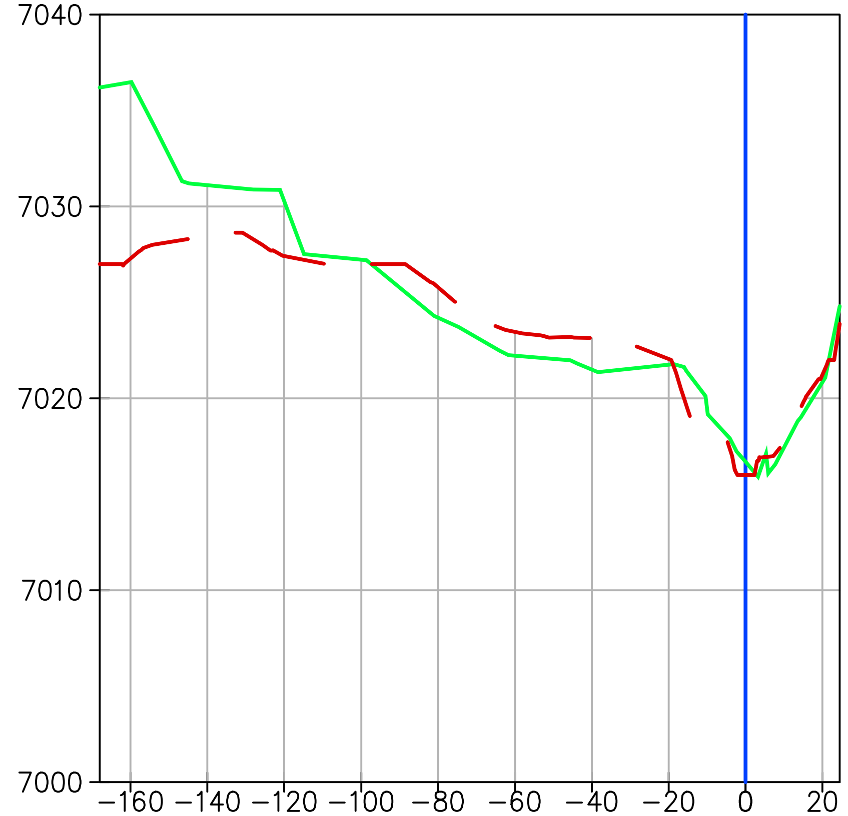

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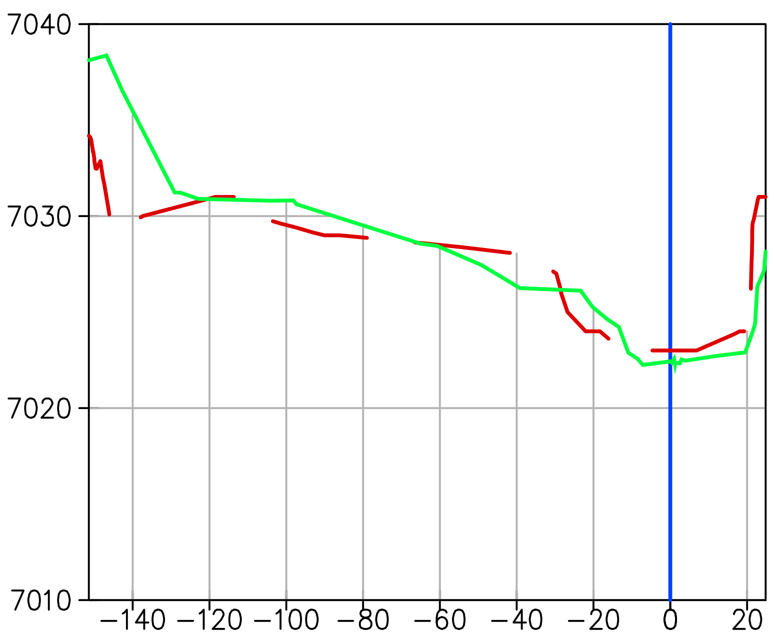

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FS PROFILE

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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
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CROSS SECTIONS

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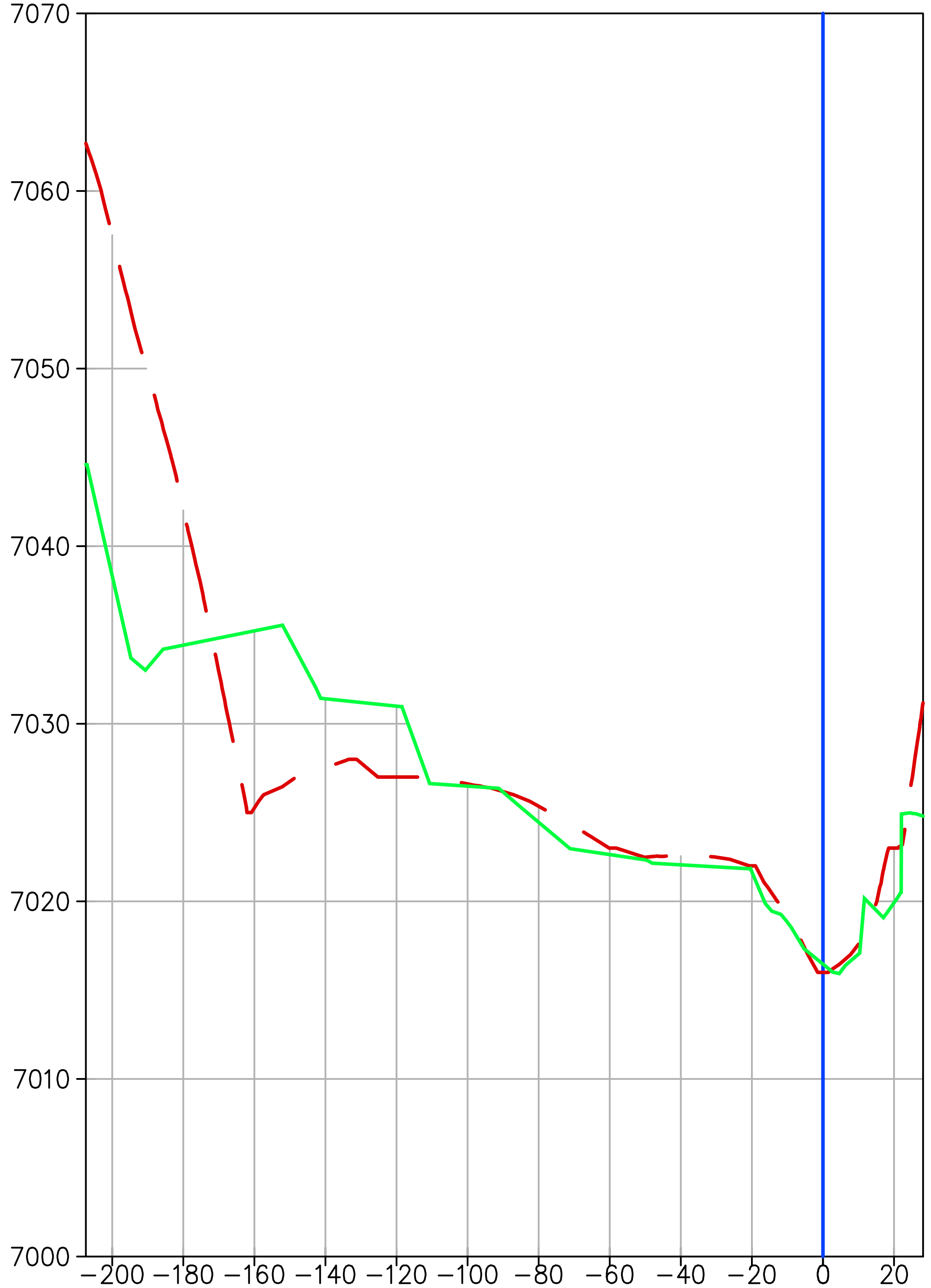
34

UPDATE

XS 6A



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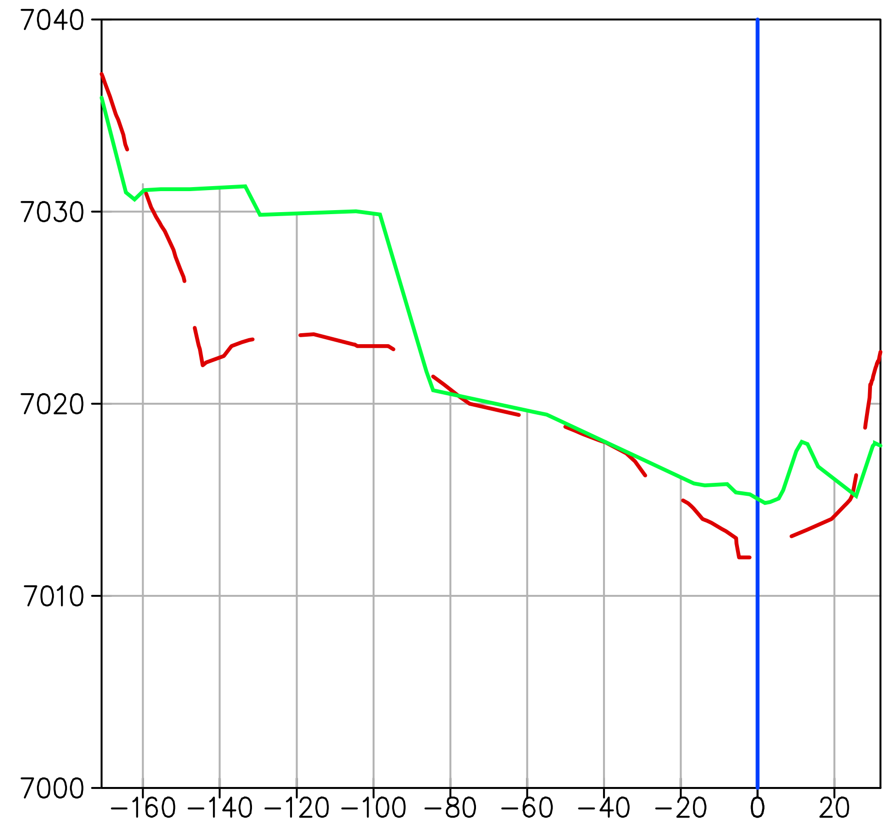

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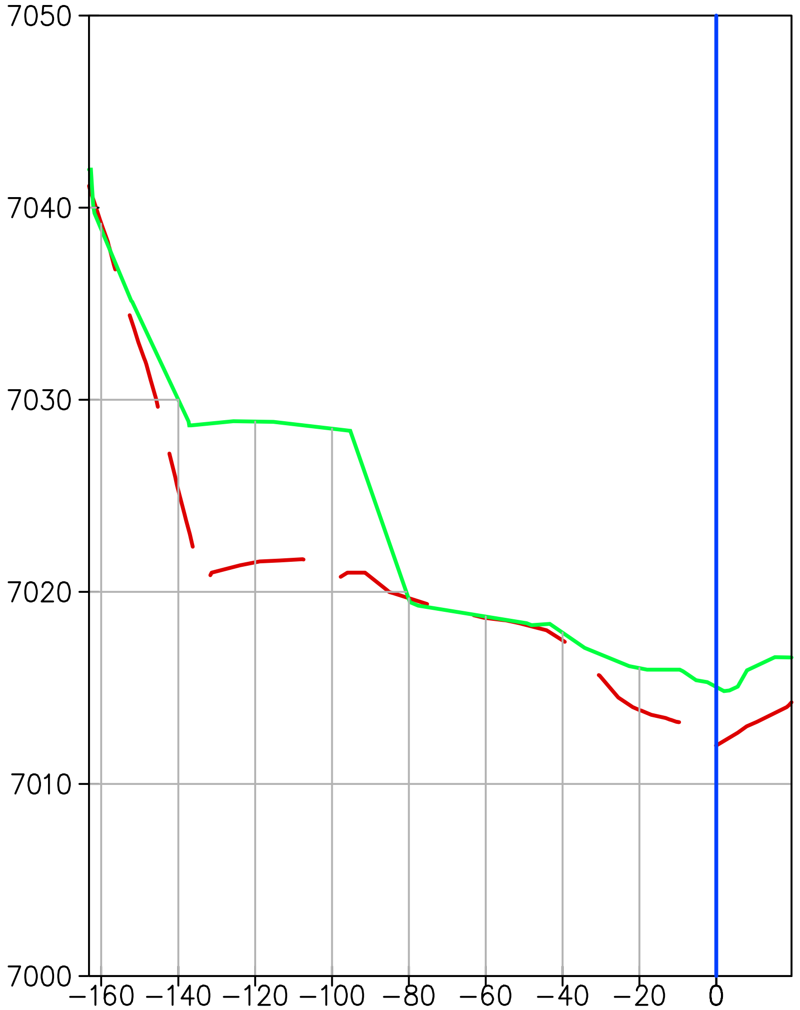
35

UPDATE

XS 5A



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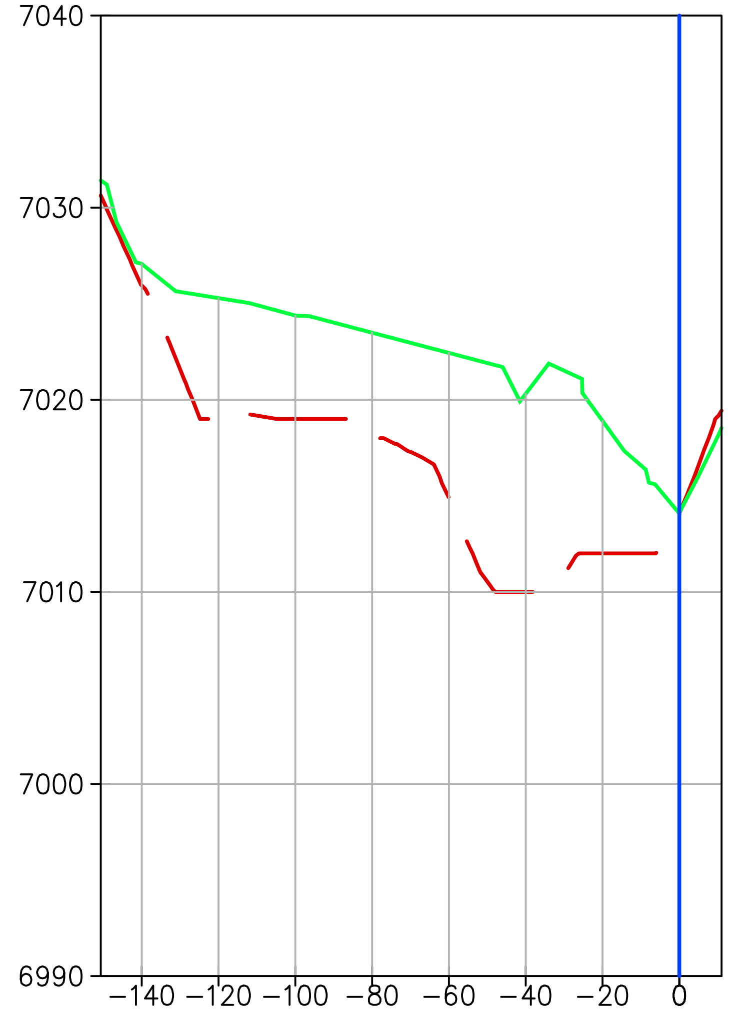

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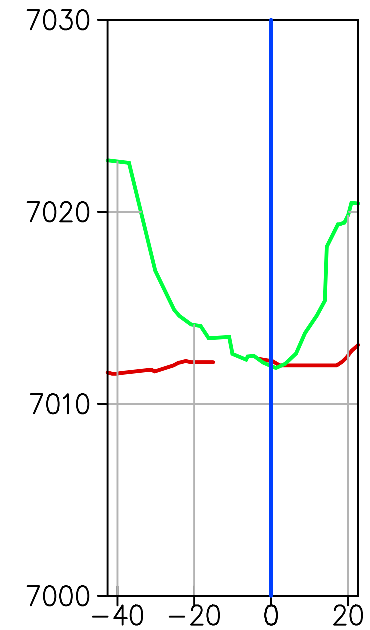

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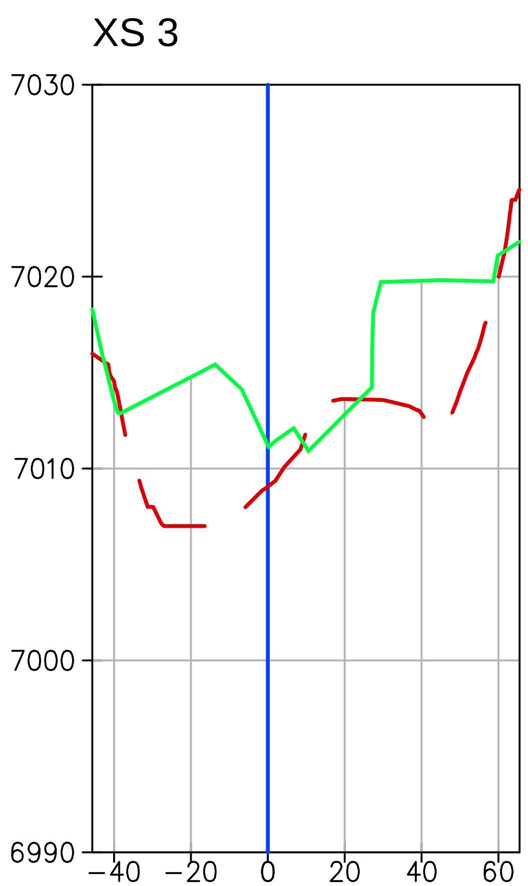
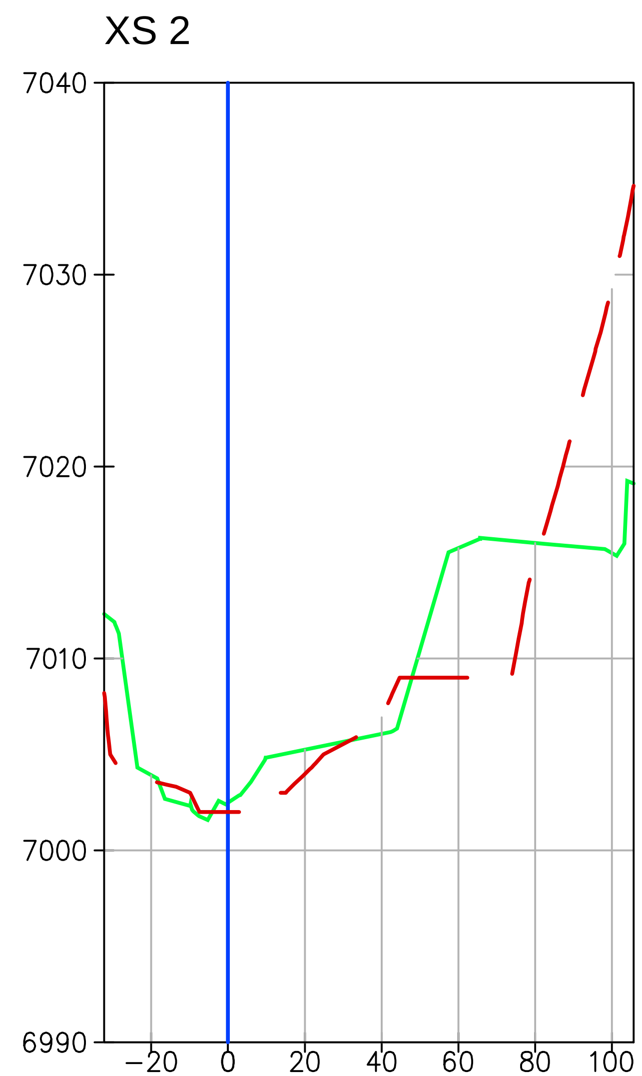
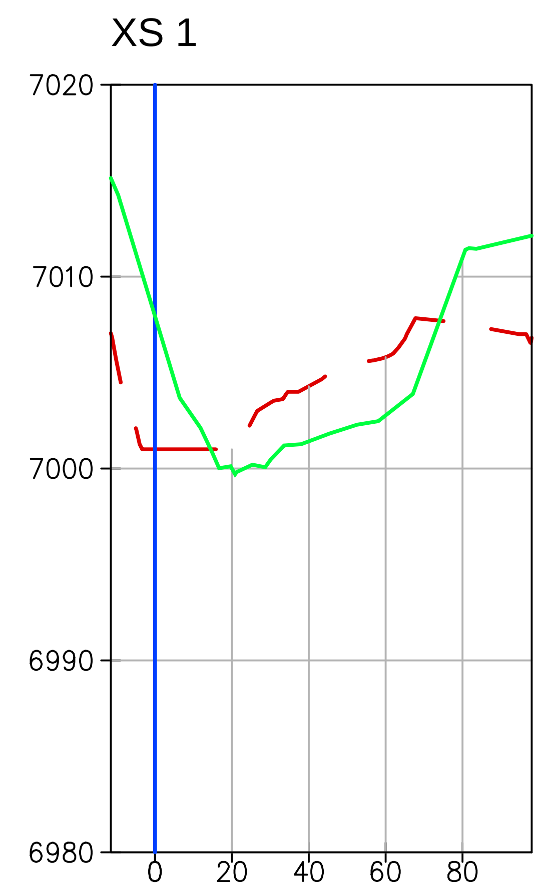
36

UPDATE







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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
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LARIMER COUNTY, COLORADO

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SHEET REFERENCE NUMBER:
37

UPDATE

Bore Hole #	Bore Hole Log	Ground Elevations (ft)	Water Table Elevation (ft)	Bedrock Elevation (ft)	Boulder Top (ft)	Boulder Bottom (ft)
11	Water @ 10' Rock 13'-16'	7144.56	7134.56	7131.56	N/A	N/A
12	Boulder @ 5'-7' Rock 13'-16' Water @ 10	7144.59	7134.59	7131.59	7139.59	7137.59
13	Shot Rock @ 6'-16' Water @10'	7144.81	7134.81	Not Known	N/A	N/A
21	Rock @5-16', Water @10'	7146.7	7136.7	7141.7	N/A	N/A
22	Soft Through 16'	7146.12	Not Noted	N/A	N/A	N/A
23	Boulder @ 7'-10' Water@10' Soft 10'-16'	7145.73	7135.73	N/A	7138.73	7135.73
24	Water @10' Rest Soft	7146.15	7136.15	N/A	N/A	N/A
31	Rock @ 5-16' Water @10'	7148.13	7138.13	N/A	N/A	N/A
32	Water @5' Boulder @12'-14' Rest Soft	7147.24	7142.24	N/A	7135.24	7133.24
33	Water @5' All Soft	7147.05	7142.05	N/A	N/A	N/A
34	Boulder @3'-6' Water @6' Rest Soft	7147.14	7141.14	N/A	7144.14	7141.14
41	Rock @5-16', Water @10'	7148.73	7138.73	7143.73	N/A	N/A
42	Boulder @5'-7' Water @7' Rock 11'-16'	7147.72	7140.72	N/A	7142.72	7140.72
43	Water @5' All Soft	7148.26	7143.26	N/A	N/A	N/A
44	Water @10' All Soft	7147.69	7137.69	N/A	N/A	N/A
45	Boulder @ 6'-9' Water @ 9' Rest Soft	7147.74	7138.74	N/A	7141.74	7138.74
51	Rock/Water @ 5'-14', 14'-16' Soft	7148.42	7143.42	N/A	7138.42	7134.42
52	Water @ 5', Rock 12'-16'	7149.45	7144.45	7137.45	N/A	N/A
53	Water @ 5', Rest Soft	7148.54	7143.54	N/A	N/A	N/A
54	Water @ 6' Rest Soft	7148.39	7142.39	N/A	N/A	N/A
55	Water @ 6' Rest Soft	7148.33	7142.33	N/A	N/A	N/A
61	Water @ 5' Rock @ 6'-16'	7149.72	7144.72	7143.72	N/A	N/A
62	Water @ 5', Rest Soft	7150.19	7145.19	N/A	N/A	N/A
63	Water @5', Rest Soft	7149.19	7144.19	N/A	N/A	N/A
64	Water @5', Rest Soft	7148.93	7143.93	N/A	N/A	N/A
65	Water @5', Rest Soft	7149.13	7144.13	N/A	N/A	N/A
71	Water @7', Rock @ 7'-16'	7150.9	7143.9	7143.9	N/A	N/A
72	Water @6', Rock @12'-16'	7150.94	7144.94	7138.94	N/A	N/A
73	Water @5', Rest Soft	7149.76	7144.76	N/A	N/A	N/A
74	Water @5', Rest Soft	7149.57	7144.57	N/A	N/A	N/A
75	Water @5', Rest Soft	7149.46	7144.46	N/A	N/A	N/A

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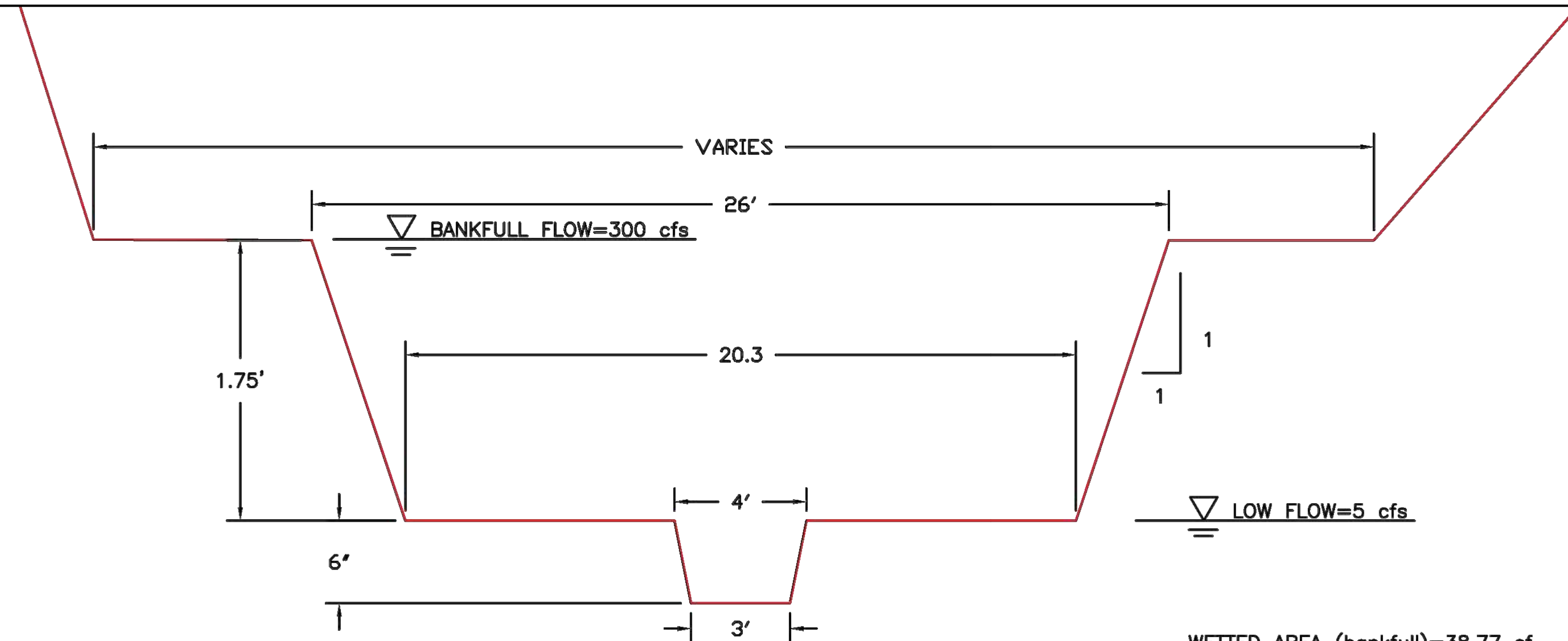
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

BORE HOLE LOGS

SHEET REFERENCE NUMBER: 38

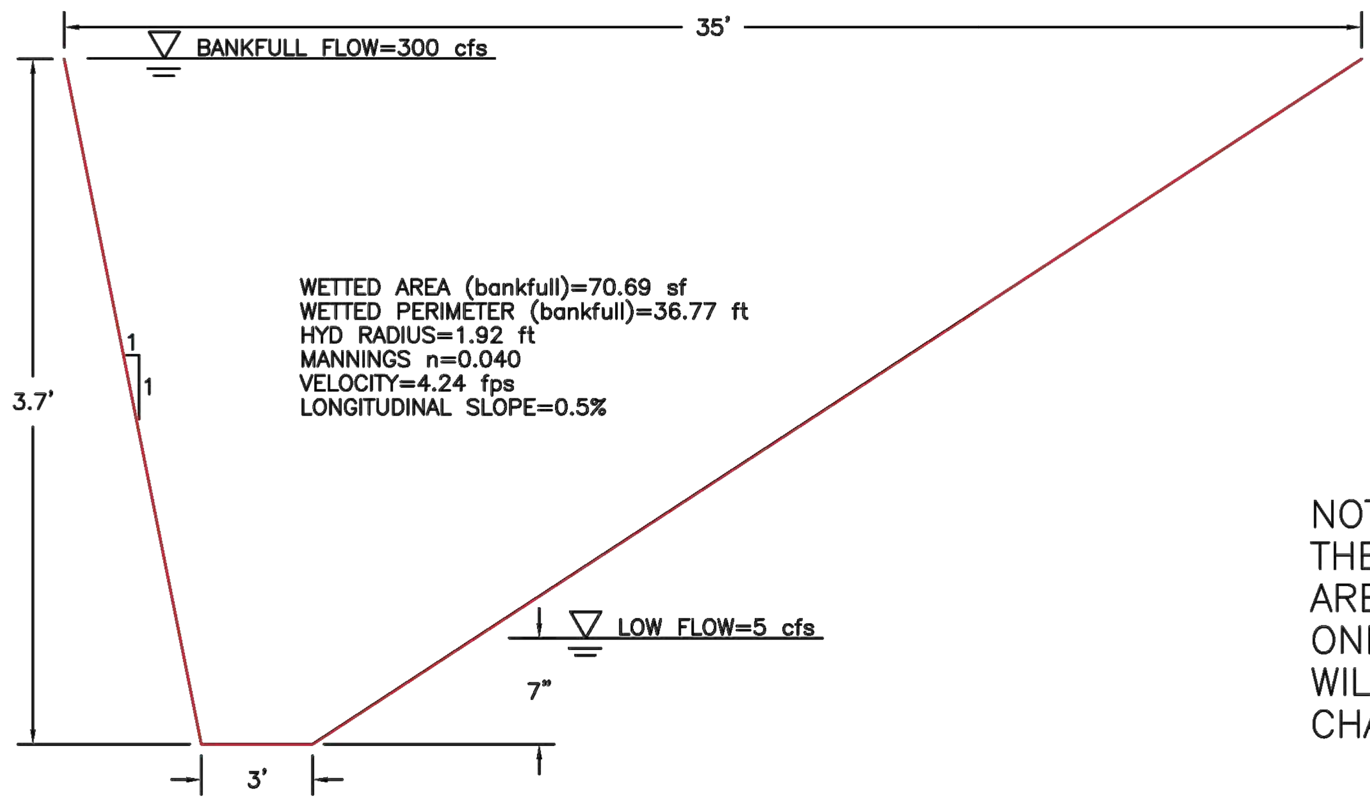
UPDATE



WETTED AREA (bankfull)=38.77 sf
WETTED PERIMETER (bankfull)=25.27 ft
HYD RADIUS=1.53 ft
MANNINGS n=0.045
VELOCITY=7.61 fps
LONGITUDINAL SLOPE=3%

TYPICAL RIFFLE CROSS SECTION

NTS



WETTED AREA (bankfull)=70.69 sf
WETTED PERIMETER (bankfull)=36.77 ft
HYD RADIUS=1.92 ft
MANNINGS n=0.040
VELOCITY=4.24 fps
LONGITUDINAL SLOPE=0.5%

NOTE:
THESE CROSS SECTIONS ARE FOR DESIGN GUIDANCE ONLY. FIELD PARAMETERS WILL RESULT IN VARYING CHANNEL DIMENSIONS

TYPICAL POOL CROSS SECTION

NTS

Symbol	Description	Date	Approved

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Reviewed by: JPC		Drawing Code:
Submitted by:		File name: Plot date: Plot scale:

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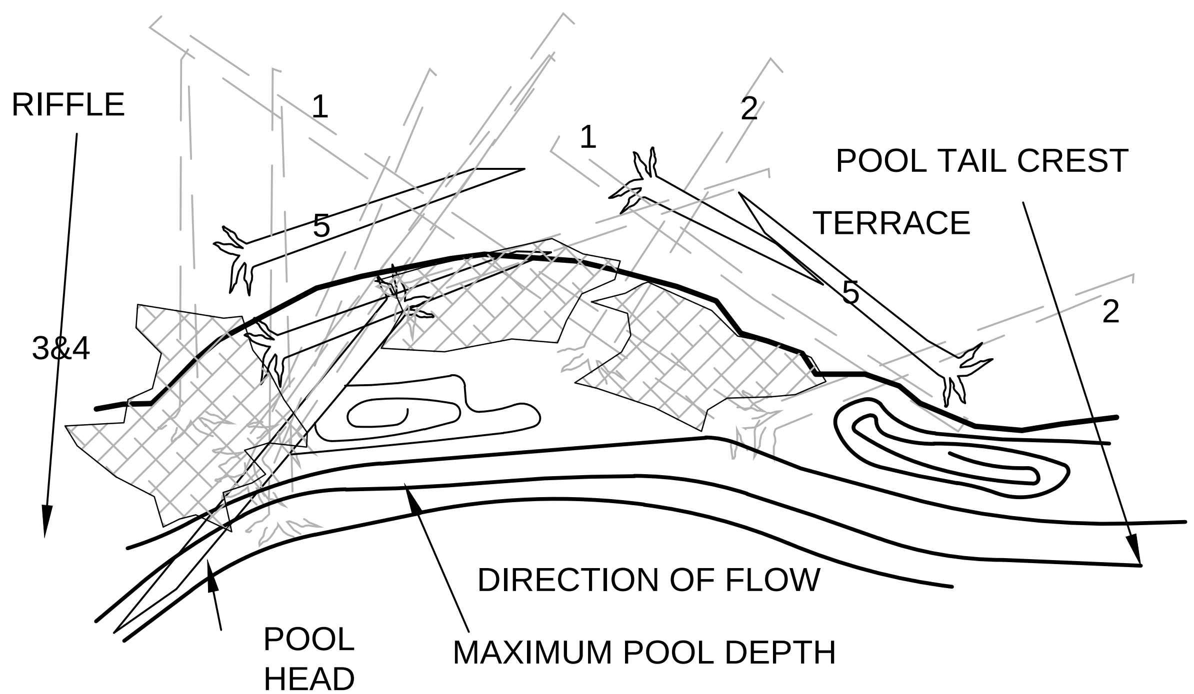
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

DETAILS SHEET 1

SHEET REFERENCE NUMBER:
39

UPDATE

FMF FORMIDABLE MULTI-FACTED LOG COMPLEX



1) EXCAVATE TOE LOG TRENCHES PERPENDICULAR TO PARALLEL WITH CHANNEL BEND BASED ON FIRECTION OF FLOOD FLOW. EXCAVATE INTO BANKAND BELOW CHANNEL BED SURFACE TO MAXIMUM SCOUR DEPTH.
2) EXCAVATE TORSION LOG TRENCHES 15&45 DEGREES (DEPENDENT ON LOCATION IN THE BEND) TO FLOOD FLOW AND TO BED SURFACE ELEVATION SO THE ROOF FAN FACES INTO FLOOD FLOW. TORSION LOGS MAY NEED TO BE LAYERED (LOWER AND UPPER) DEPENDING ON BANK HEIGHT. HIGH BANK (5 FEET OR MORE) WILL REQUIRE 2 LAYERS OF TORSION LOGS TO PIN DOWN THE FACE LOGS.
3) PLACE WEAVE ADDITIONAL TREES, LOGS, LARGE BOULDERS, SLASH OR ROOT WADS IN APEX OF STRUCTURE.
4) PLACE AMPLE SLASH AND SMALL WOODY DEBRIS ON THE UP-STREAM BANK INTERFACE OF THE STRUCTURE.
5) ADD BALLAST LOGS AS REQUIRED TO PREVENT BUOYANCY AT DESIGN FLOW.

Reach 9 Riffle Characteristics

Component	Description	Value	Unit
Riffle height above channel bed	design	1	feet
Reach upstream bed elevation	defined by bridge invert	7006.5	feet
Reach downstram bed elevation	defined by bridge invert	6995.5	feet
Reach length	measured	575	feet
Average width of flow	model output/measured	30	feet
Reach channel slope	calculated	0.02	ft/ft
Slope of upstream riffle face	design	0.3	ft/ft
Slope of downstream riffle face	design	0.05	ft/ft
Distance of heel to crest	calculated	3	feet
Distance of crest to toe	calculated	30	feet
Height of bed at the crest above toe	calculated	0.75	feet
Total drop	calculated	1.5	feet
Pool length	calculated	45	feet
Interval between crests	calculated	80	feet

Material Type A

Riffle and Low Bar Material shall have, at minimum, the following compisition:		
D16	20	mm
D50	45	mm
D84	100	mm
D90	145	mm

Material Type B

Riffle Crest Material shall have, at minimum, the following compisition:		
D16	30	mm
D50	64	mm
D84	150	mm
D90	220	mm

Material Type C

Step Pool Material shall have, at minimum, the following compisition:		
D16	30	mm
D50	128	mm
D84	220	mm
D90	256+	mm

Symbol Description Date Approved

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Ckd by:
Reviewed by: JPC
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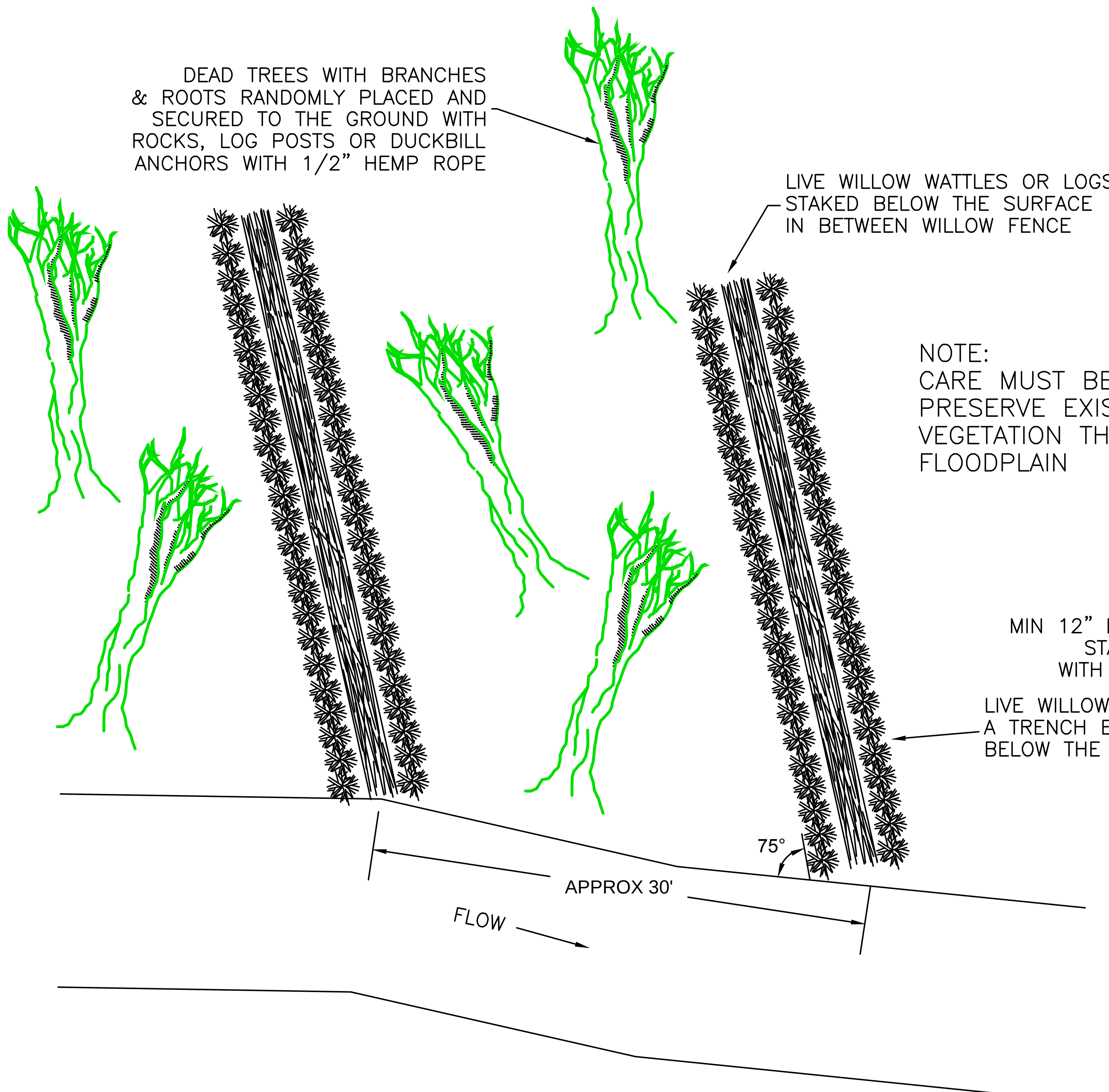
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

DETAILS SHEET 1

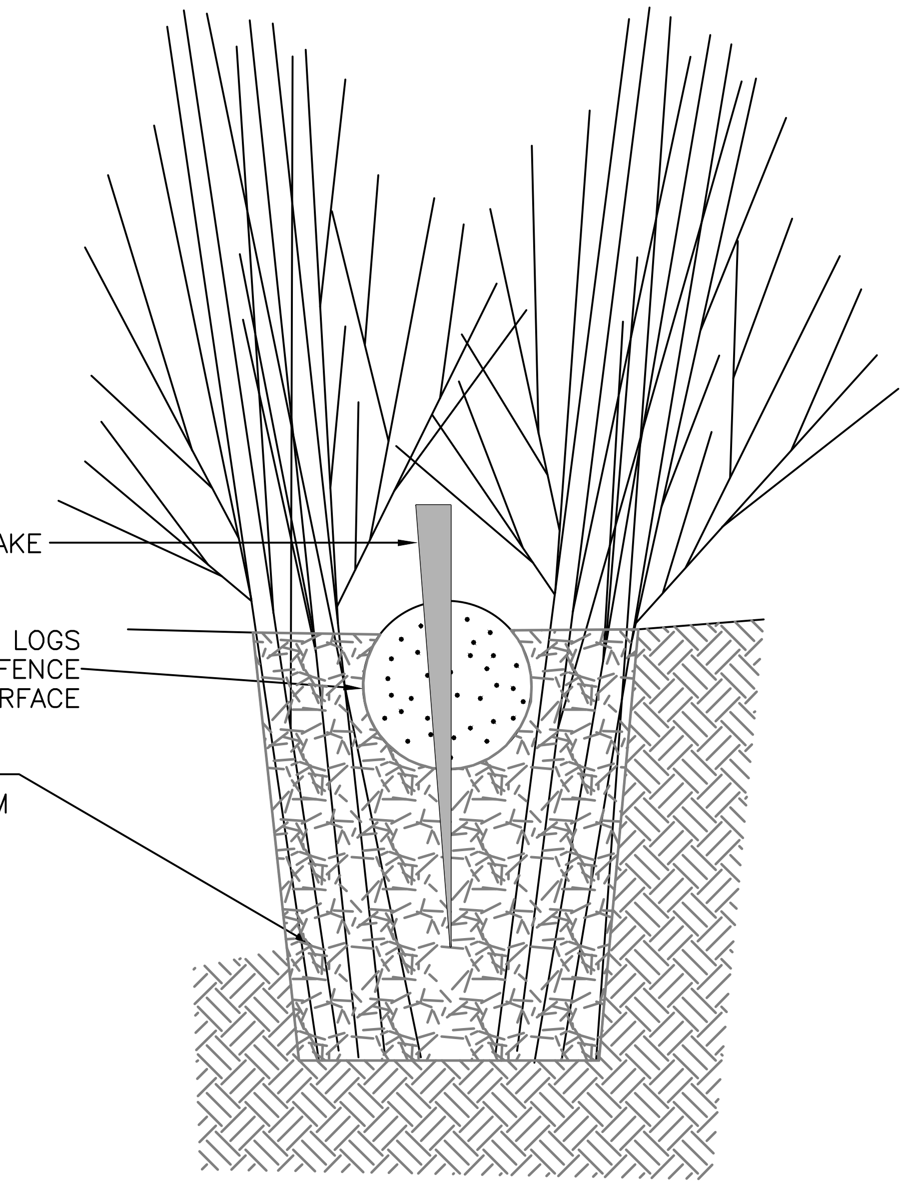
SHEET REFERENCE NUMBER:
40

UPDATE



PLAN VIEW

NOTE:
CARE MUST BE TAKEN TO PRESERVE EXISTING VEGETATION THROUGHOUT FLOODPLAIN



CROSS SECTION

SURFACE TREATMENT FOR EXCAVATED FLOODPLAIN

NTS

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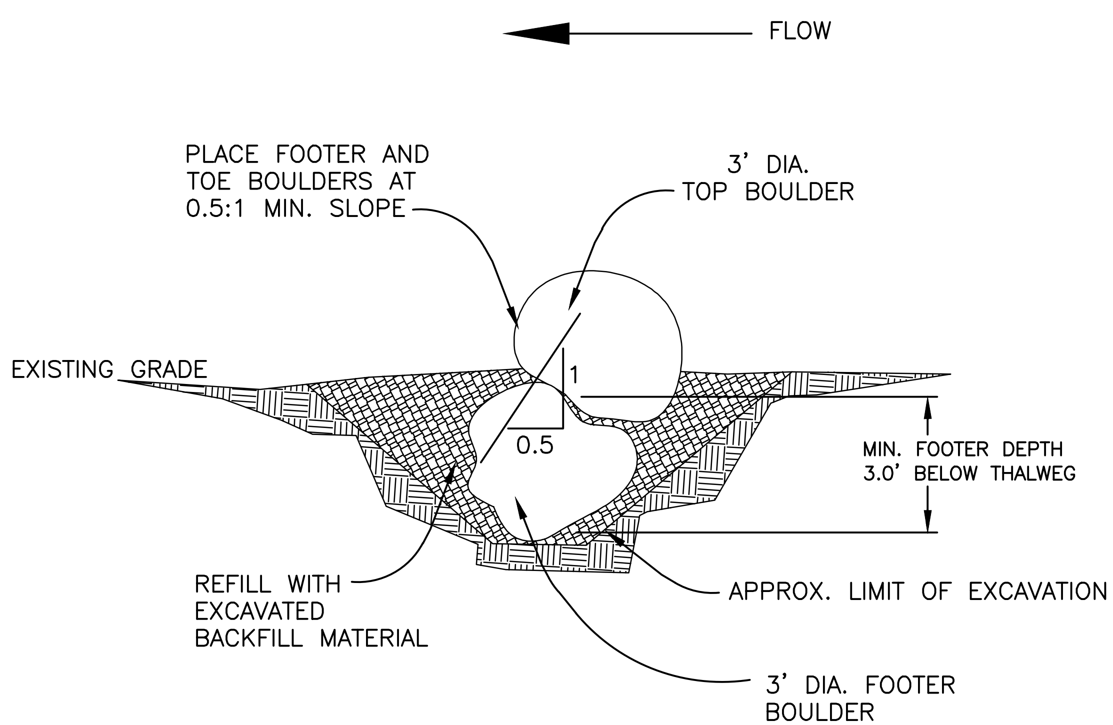
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

DETAILS SHEET 2

SHEET REFERENCE NUMBER:
41

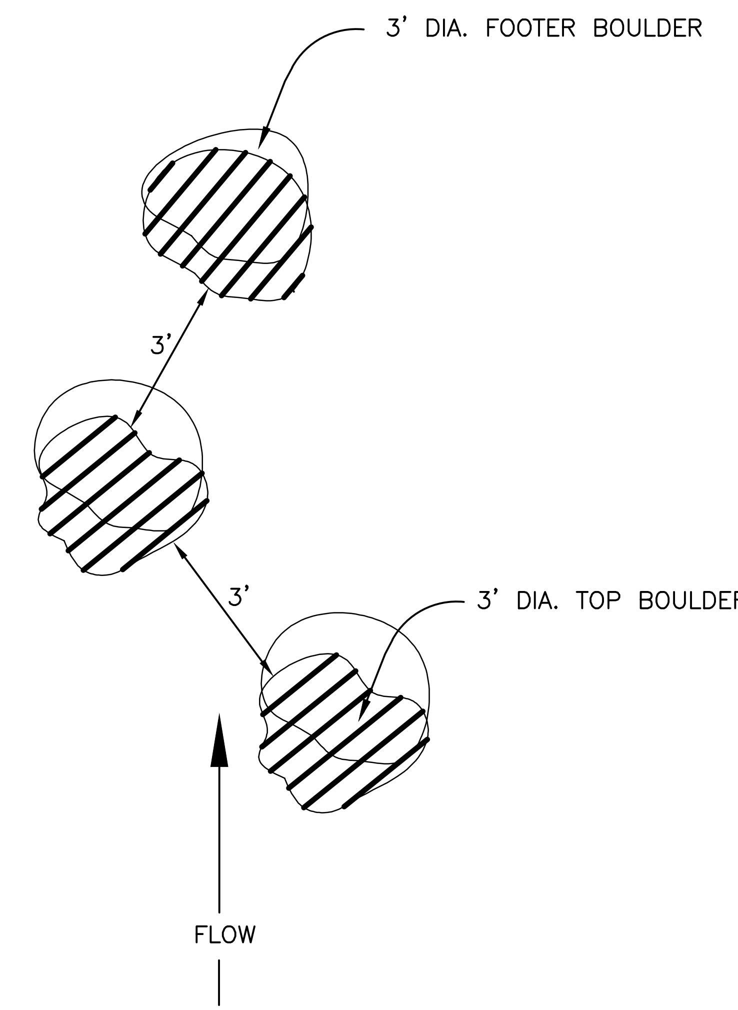
UPDATE



NOTE: OFFSET FOOTER BOULDER IN THE DOWNSTREAM DIRECTION, PERPENDICULAR TO FLOW

BOULDER CLUSTER DETAIL

NTS



NOTE: SPACE BOULDERS A MIN. OF 1 BOULDER WIDTH IN DIAMOND OR TRIANGLE PATTERN.

NOTE: OFFSET BOULDERS FROM FLOW LINE.

BOULDER CLUSTER PLAN VIEW DETAIL

NTS

TYPICAL BOULDER CLUSTER

NTS

Symbol	Description	Date	Approved

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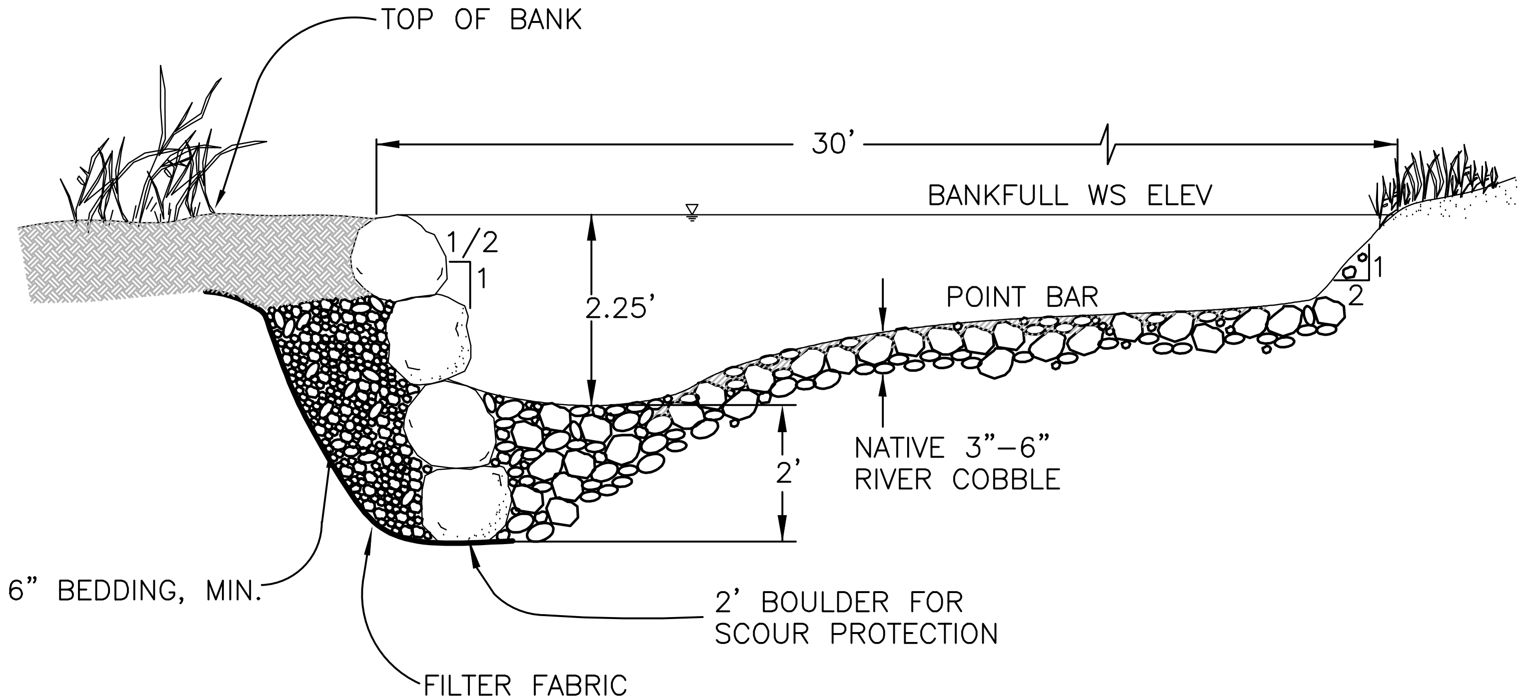
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

DETAILS SHEET 3

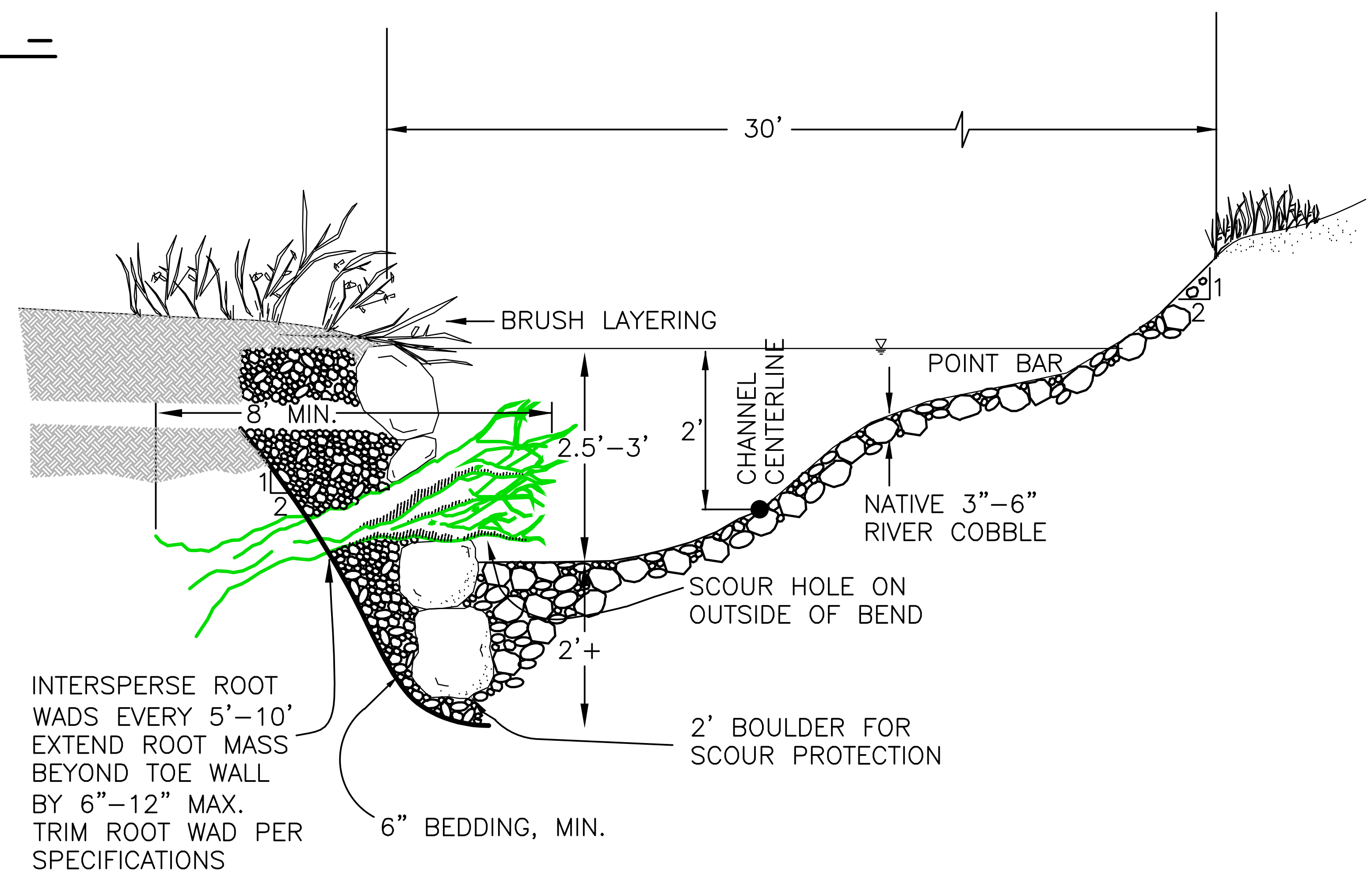
SHEET REFERENCE NUMBER:
42

UPDATE



TYPICAL BANKFULL CHANNEL GEOMETRY –
POOL & BEND SECTIONS

NTS



POOL SCOUR HOLE AND BANK PROTECTION DETAIL

NTS

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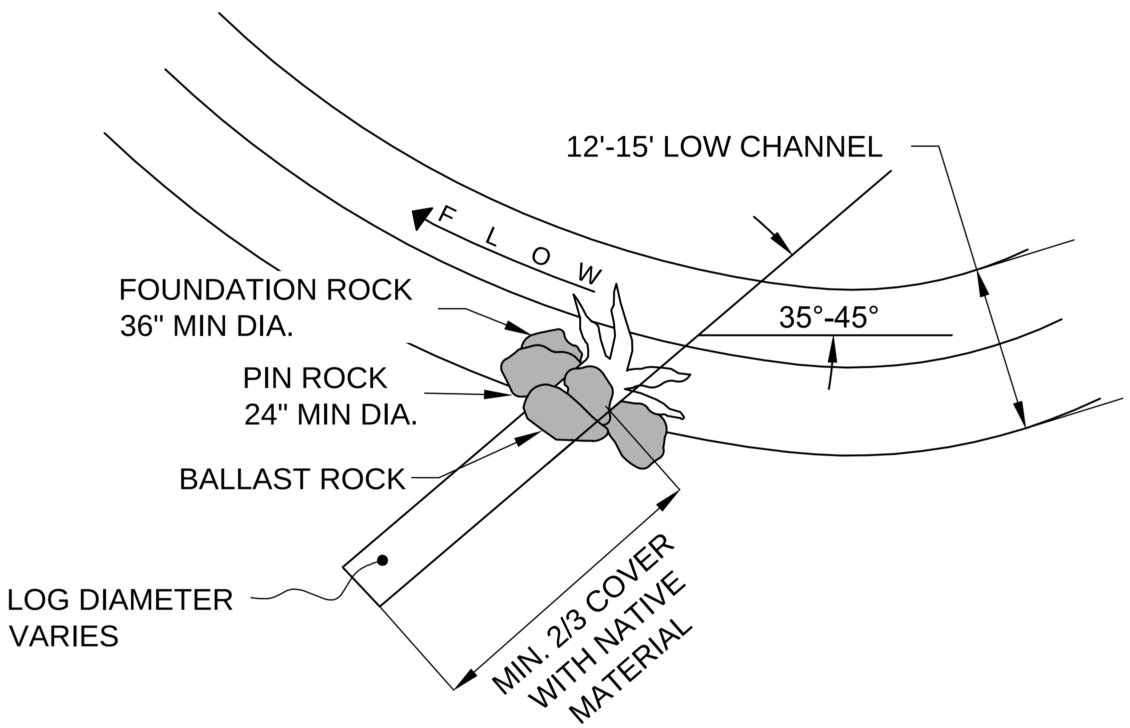
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

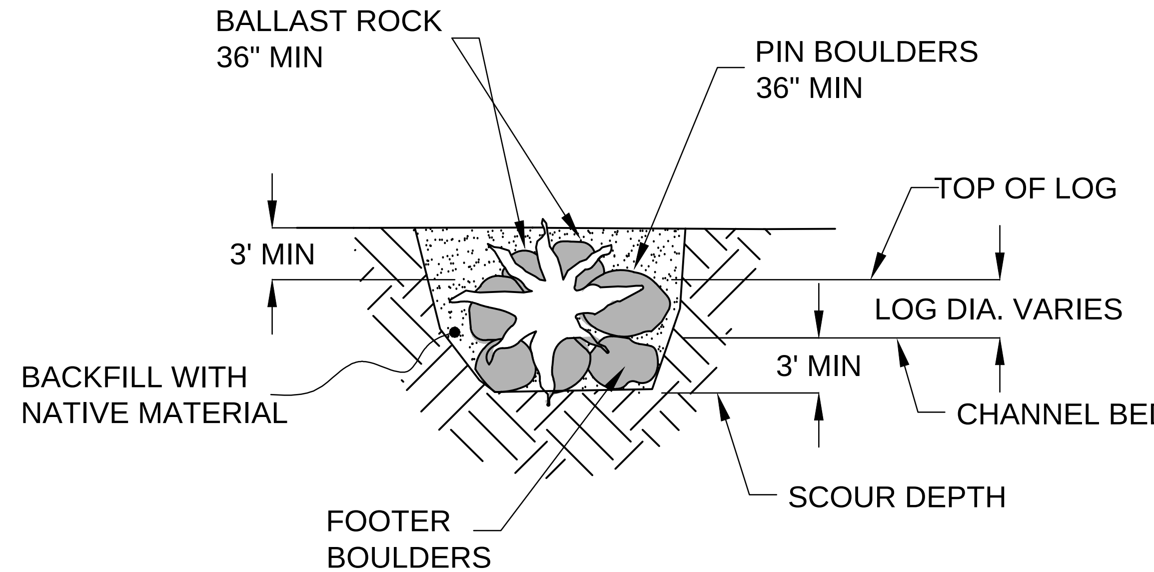
DETAILS SHEET 4

SHEET REFERENCE NUMBER:
43

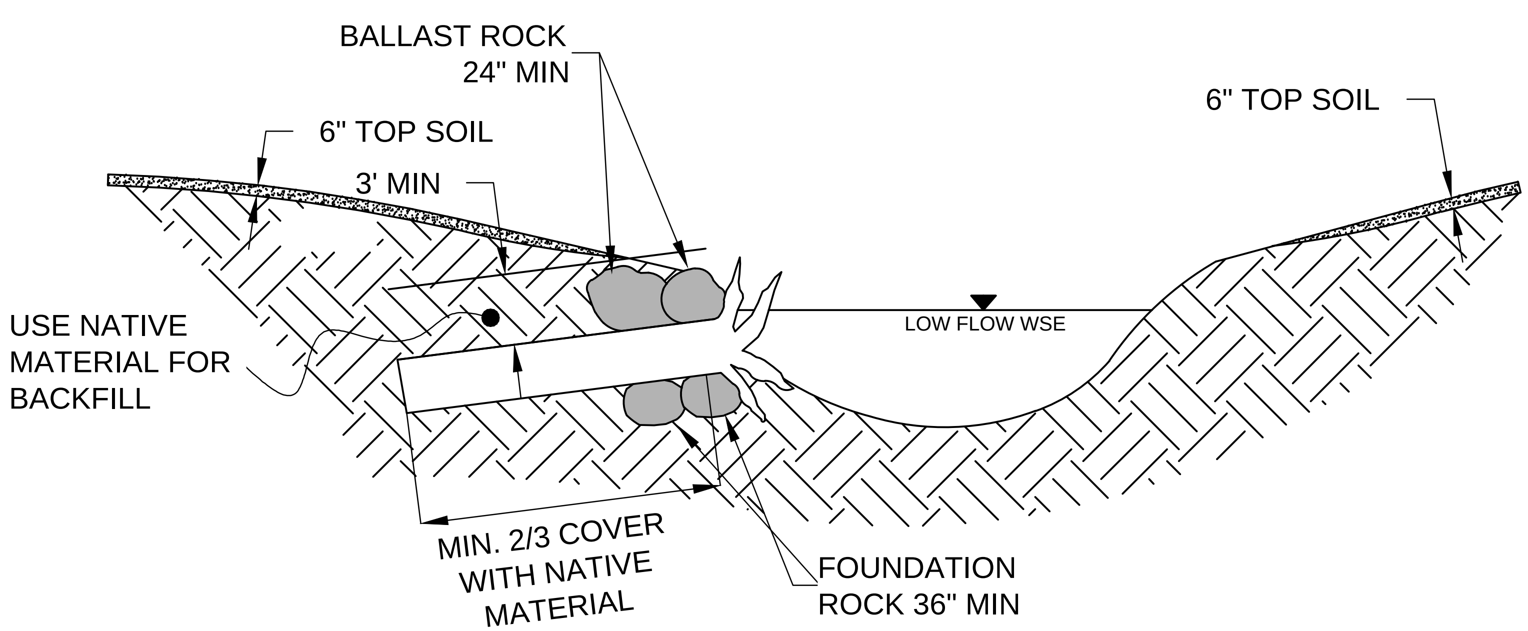
UPDATE



TYPICAL ROOTWAD PLAN VIEW



TYPICAL ROOTWAD PROFILE



TYPICAL ROOTWAD CROSS-SECTION VIEW

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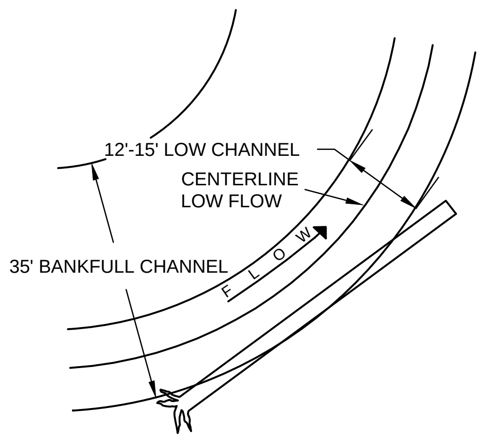
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

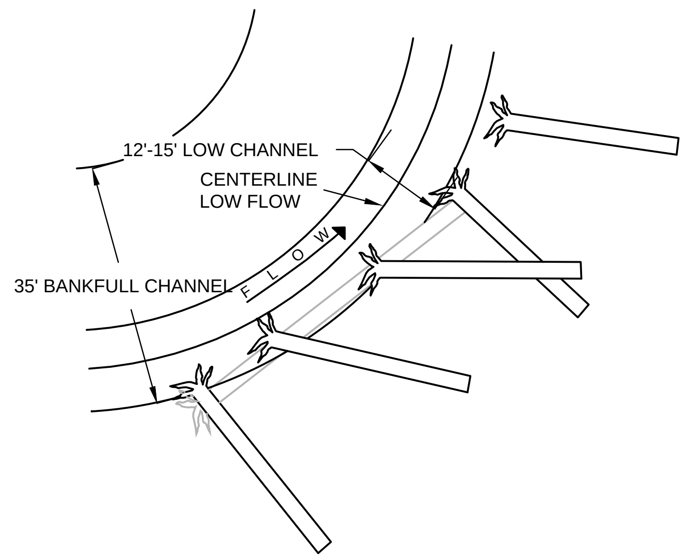
DETAILS SHEET 5

SHEET REFERENCE NUMBER:
44

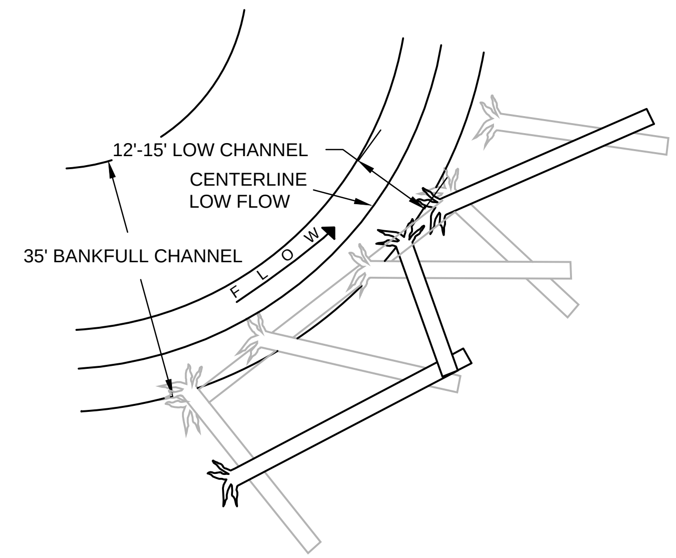
UPDATE



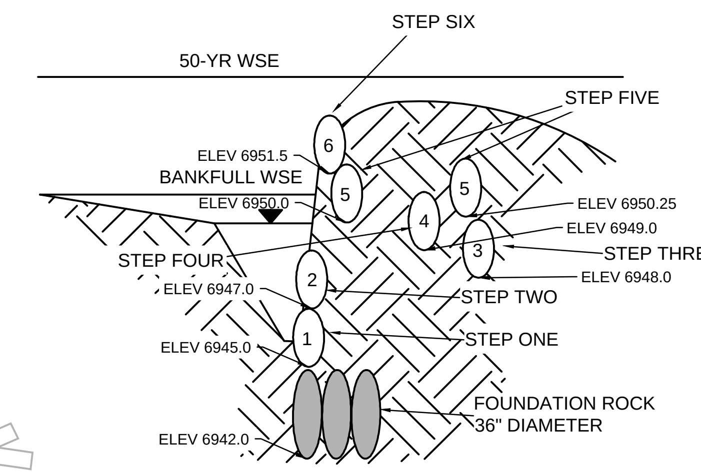
ENGINEERED LOG JAM
PLAN VIEW - STEP 1



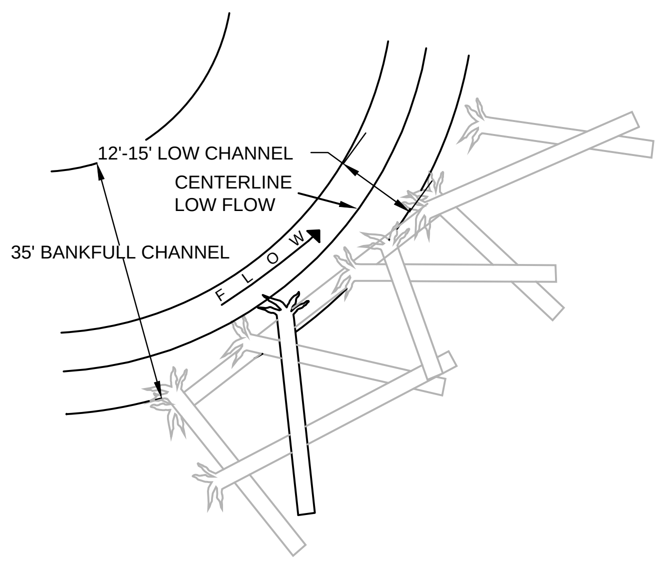
ENGINEERED LOG JAM
PLAN VIEW - STEP 2



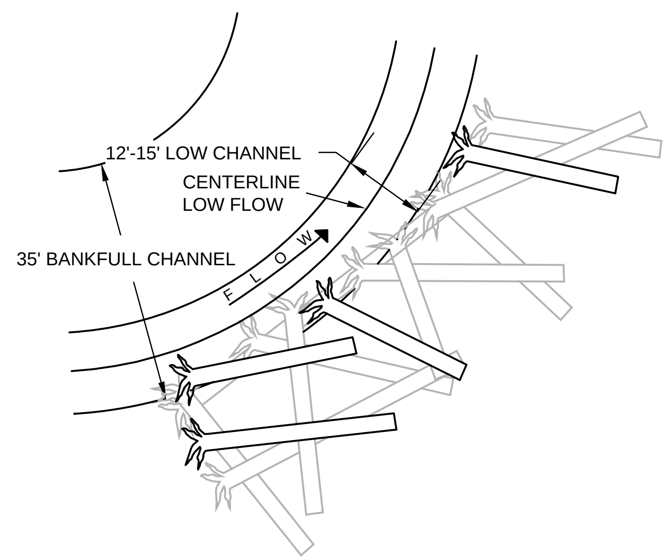
ENGINEERED LOG JAM
PLAN VIEW - STEP 3



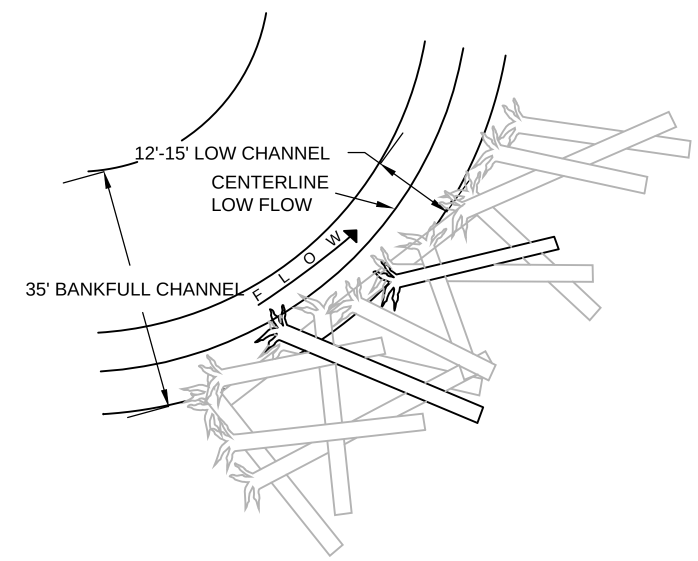
ENGINEERED LOG JAM
CROSS-SECTION VIEW



ENGINEERED LOG JAM
PLAN VIEW - STEP 4



ENGINEERED LOG JAM
PLAN VIEW - STEP 5



ENGINEERED LOG JAM
PLAN VIEW - FINAL STEP

Symbol	Description	Date	Approved

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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

DETAILS SHEET 6

SHEET
REFERENCE
NUMBER:
45

UPDATE

4 3 2 1

Model River Sta (ft)	Cross Section (ft)	Flow Profile	Flow (cfs)	Channel Invert (ft)	Water Surface Elevation (ft)	EstimatedMax. Depth (ft)
7673.817	USFS XS 29	Low Flow 30 cfs	30	7111.5	7113.2	1.6
7673.817	USFS XS 29	StreamStats 2yr	300	7111.5	7115.4	3.9
7462.438	USFS XS 27	Low Flow 30 cfs	30	7101.7	7102.4	0.7
7462.438	USFS XS 27	StreamStats 2yr	300	7101.7	7105.3	3.6
7262.389	USFS XS26	Low Flow 30 cfs	30	7099.0	7101.7	2.7
7262.389	USFS XS26	StreamStats 2yr	300	7099.0	7104.2	5.2
7115.395	USFS XS25	Low Flow 30 cfs	30	7095.5	7097.4	1.9
7115.395	USFS XS25	StreamStats 2yr	300	7095.5	7099.7	4.2
6968.628	USFS XS 24	Low Flow 30 cfs	30	7091.5	7092.4	0.9
6968.628	USFS XS 24	StreamStats 2yr	300	7091.5	7094.5	3.0
6861.255	USFS XS 23	Low Flow 30 cfs	30	7087.8	7090.2	2.4
6861.255	USFS XS 23	StreamStats 2yr	300	7087.8	7093.2	5.4
6643.565	USFS XS 22	Low Flow 30 cfs	30	7088.0	7089.1	1.1
6643.565	USFS XS 22	StreamStats 2yr	300	7088.0	7090.9	2.9
6314.975	USFS XS 21	Low Flow 30 cfs	30	7076.0	7077.6	1.6
6314.975	USFS XS 21	StreamStats 2yr	300	7076.0	7079.8	3.8
5945.151	USFS XS20	Low Flow 30 cfs	30	7071.0	7072.7	1.7
5945.151	USFS XS20	StreamStats 2yr	300	7071.0	7075.2	4.2
5660.946	USFS XS19	Low Flow 30 cfs	30	7068.0	7069.0	1.0
5660.946	USFS XS19	StreamStats 2yr	300	7068.0	7070.4	2.4
5533.594	USFS XS18	Low Flow 30 cfs	30	7064.5	7066.0	1.5
5533.594	USFS XS18	StreamStats 2yr	300	7064.5	7068.0	3.5
5305.82	USFS XS 16	Low Flow 30 cfs	30	7060.3	7061.4	1.1
5305.82	USFS XS 16	StreamStats 2yr	300	7060.3	7063.3	3.0

Model River Sta (ft)	Cross Section (ft)	Flow Profile	Flow (cfs)	Channel Invert (ft)	Water Surface Elevation (ft)	EstimatedMax. Depth (ft)
5141.93	USFS XS 15	Low Flow 30 cfs	30	7055.0	7055.6	0.6
5141.93	USFS XS 15	StreamStats 2yr	300	7055.0	7057.2	2.2
4669.685	USFS XS12	Low Flow 30 cfs	30	7041.5	7043.0	1.5
4669.685	USFS XS12	StreamStats 2yr	300	7041.5	7045.2	3.7
4420.553	USFS XS11	Low Flow 30 cfs	30	7040.0	7042.2	2.2
4420.553	USFS XS11	StreamStats 2yr	300	7040.0	7043.1	3.1
4063.026	USFS XS 9	Low Flow 30 cfs	30	7028.0	7029.2	1.2
4063.026	USFS XS 9	StreamStats 2yr	300	7028.0	7031.0	3.0
3938.423	USFS XS8	Low Flow 30 cfs	30	7026.0	7026.9	0.9
3938.423	USFS XS8	StreamStats 2yr	300	7026.0	7028.1	2.1
3819.788	USFS XS7	Low Flow 30 cfs	30	7023.0	7023.4	0.4
3819.788	USFS XS7	StreamStats 2yr	300	7023.0	7024.6	1.6
3649.238	USFS XS6	Low Flow 30 cfs	30	7016.0	7017.3	1.3
3649.238	USFS XS6	StreamStats 2yr	300	7016.0	7019.6	3.6
3469.493	USFS XS5	Low Flow 30 cfs	30	7011.0	7012.4	1.4
3469.493	USFS XS5	StreamStats 2yr	300	7011.0	7014.1	3.1
3425.121	2163+50	Low Flow 30 cfs	30	7011.3	7012.1	0.8
3425.121	2163+50	StreamStats 2yr	300	7011.3	7013.5	2.2
3344.161	USFS XS4	Low Flow 30 cfs	30	7007.8	7008.6	0.8
3344.161	USFS XS4	StreamStats 2yr	300	7007.8	7010.3	2.5
3184.341	USFS XS3	Low Flow 30 cfs	30	7003.0	7004.3	1.3
3184.341	USFS XS3	StreamStats 2yr	300	7003.0	7006.4	3.4
3038.005	USFS XS2	Low Flow 30 cfs	30	7000.0	7001.2	1.2
3038.005	USFS XS2	StreamStats 2yr	300	7000.0	7003.2	3.1

Model River Sta (ft)	Cross Section (ft)	Flow Profile	Flow (cfs)	Channel Invert (ft)	Water Surface Elevation (ft)	EstimatedMax. Depth (ft)
3007.753	2167+00	Low Flow 30 cfs	30	6999.5	7000.8	1.3
3007.753	2167+00	StreamStats 2yr	300	6999.5	7002.6	3.0
2928.346	USFS XS1	Low Flow 30 cfs	30	6998.0	6999.0	1.0
2928.346	USFS XS1	StreamStats 2yr	300	6998.0	7001.5	3.5
2856.611	XS 2168+50	Low Flow 30 cfs	30	6995.3	6997.5	2.1
2856.611	XS 2168+50	StreamStats 2yr	300	6995.3	7000.7	5.4
2583.848	XS 2171+00	Low Flow 30 cfs	30	6993.0	6994.4	1.3
2583.848	XS 2171+00	StreamStats 2yr	300	6993.0	6995.9	2.9
2356.821	XS 2171+50	Low Flow 30 cfs	30	6988.0	6988.9	0.9
2356.821	XS 2171+50	StreamStats 2yr	300	6988.0	6990.8	2.8
1513.956	2174+50	Low Flow 30 cfs	30	6969.3	6970.1	0.7
1513.956	2174+50	StreamStats 2yr	300	6969.3	6971.5	2.1
1227.34	2177+50	Low Flow 30 cfs	30	6961.0	6962.2	1.2
1227.34	2177+50	StreamStats 2yr	300	6961.0	6963.9	2.9
950.0442	XS 2180+50	Low Flow 30 cfs	30	6957.3	6958.0	0.7
950.0442	XS 2180+50	StreamStats 2yr	300	6957.3	6959.5	2.2
666.6795	XS 2183+50	Low Flow 30 cfs	30	6951.3	6952.9	1.6
666.6795	XS 2183+50	StreamStats 2yr	300	6951.3	6954.9	3.6
369.5939	XS 2186+50	Low Flow 30 cfs	30	6948.5	6949.5	1.0
369.5939	XS 2186+50	StreamStats 2yr	300	6948.5	6950.8	2.3

Site 5 Riffle Characteristics (3.0%)

Component	Description	Value	Unit
Riffle height above channel bed	design	2	feet
Reach upstream bed elevation	defined by bridge invert	7133.05	feet
Reach downstream bed elevation	defined by bridge invert	7090.62	feet
Reach length	measured	1300	feet
Average width of flow	model output/measured	30	feet
Reach channel slope	calculated	0.03	ft/ft
Slope of upstream riffle face	design	0.3	ft/ft
Slope of downstream riffle face	design	0.05	ft/ft
Distance of heel to crest	calculated	6	feet
Distance of crest to toe	calculated	115	feet
Height of bed at the crest above toe	calculated	3.5	feet
Total drop	calculated	5.5	feet
Pool length	calculated	60	feet
Interval between crests	calculated	113	feet

Site 6 Riffle Characteristics (2.0%)

Component	Description	Value	Unit
Riffle height above channel bed	design	1.5	feet
Reach upstream bed elevation	defined by bridge invert	7090.48	feet
Reach downstream bed elevation	defined by bridge invert	7056.3	feet
Reach length	measured	1700	feet
Average width of flow	model output/measured	25	feet
Reach channel slope	calculated	0.02	ft/ft
Slope of upstream riffle face	design	0.3	ft/ft
Slope of downstream riffle face	design	0.05	ft/ft
Distance of heel to crest	calculated	5	feet
Distance of crest to toe	calculated	54	feet
Height of bed at the crest above toe	calculated	1	feet
Total drop	calculated	2.5	feet
Pool length	calculated	80	feet
Interval between crests	calculated	133	feet

Site 8 Riffle Characteristics (2.5%)

Component	Description	Value	Unit
Riffle height above channel bed	design	1.5	feet
Reach upstream bed elevation	defined by bridge invert	7006.4	feet
Reach downstream bed elevation	defined by bridge invert	7029.95	feet
Reach length	measured	1000	feet
Average width of flow	model output/measured	32	feet
Reach channel slope	calculated	0.025	ft/ft
Slope of upstream riffle face	design	0.3	ft/ft
Slope of downstream riffle face	design	0.05	ft/ft
Distance of heel to crest	calculated	4.5	feet
Distance of crest to toe	calculated	55	feet
Height of bed at the crest above toe	calculated	1.25	feet
Total drop	calculated	2.75	feet
Pool length	calculated	60	feet
Interval between crests	calculated	70	feet

Symbol	Description	Date	Approved

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Rev.
Date: MAR 1, 2016
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Designed by: JEFF CRANE
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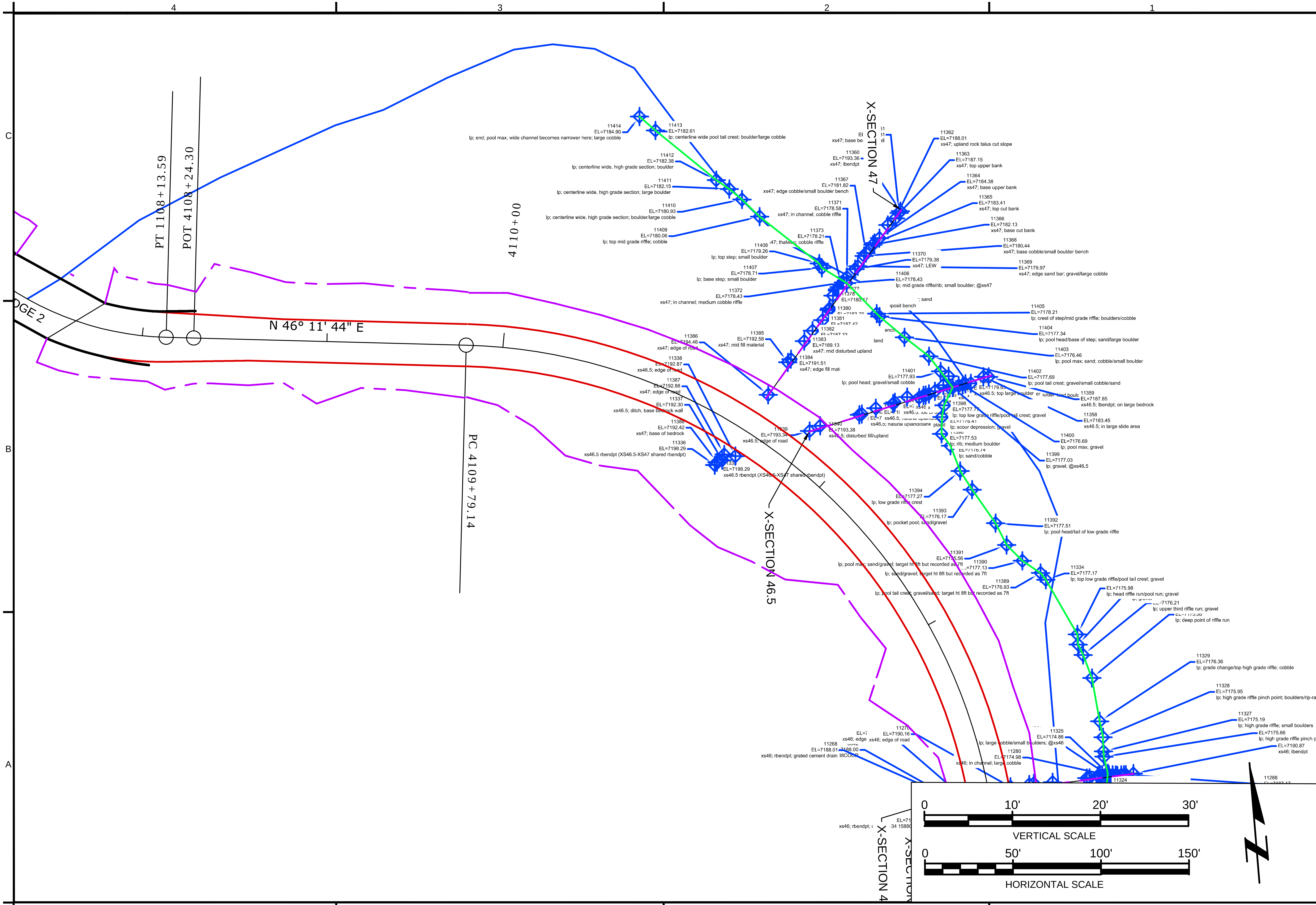
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTION TABLE

SHEET REFERENCE NUMBER: 46

UPDATE



Symbol	Description	Date	Approved

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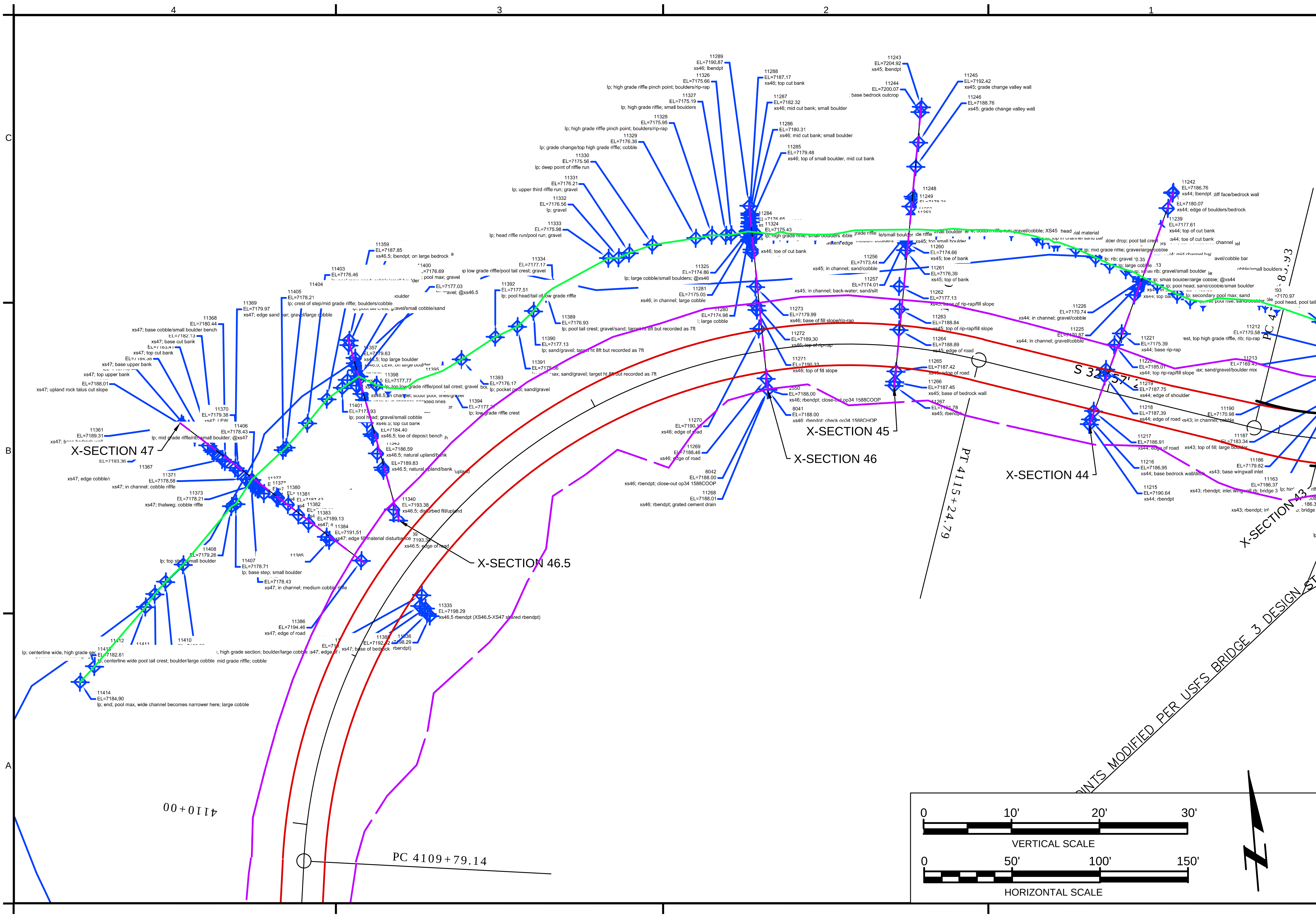
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

USFS SURVEYED POINTS

SHEET REFERENCE NUMBER:
47

UPDATE



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Date: MAR 1, 2016

Design file no:

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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

USFS SURVEYED POINTS

SHEET REFERENCE NUMBER:
48

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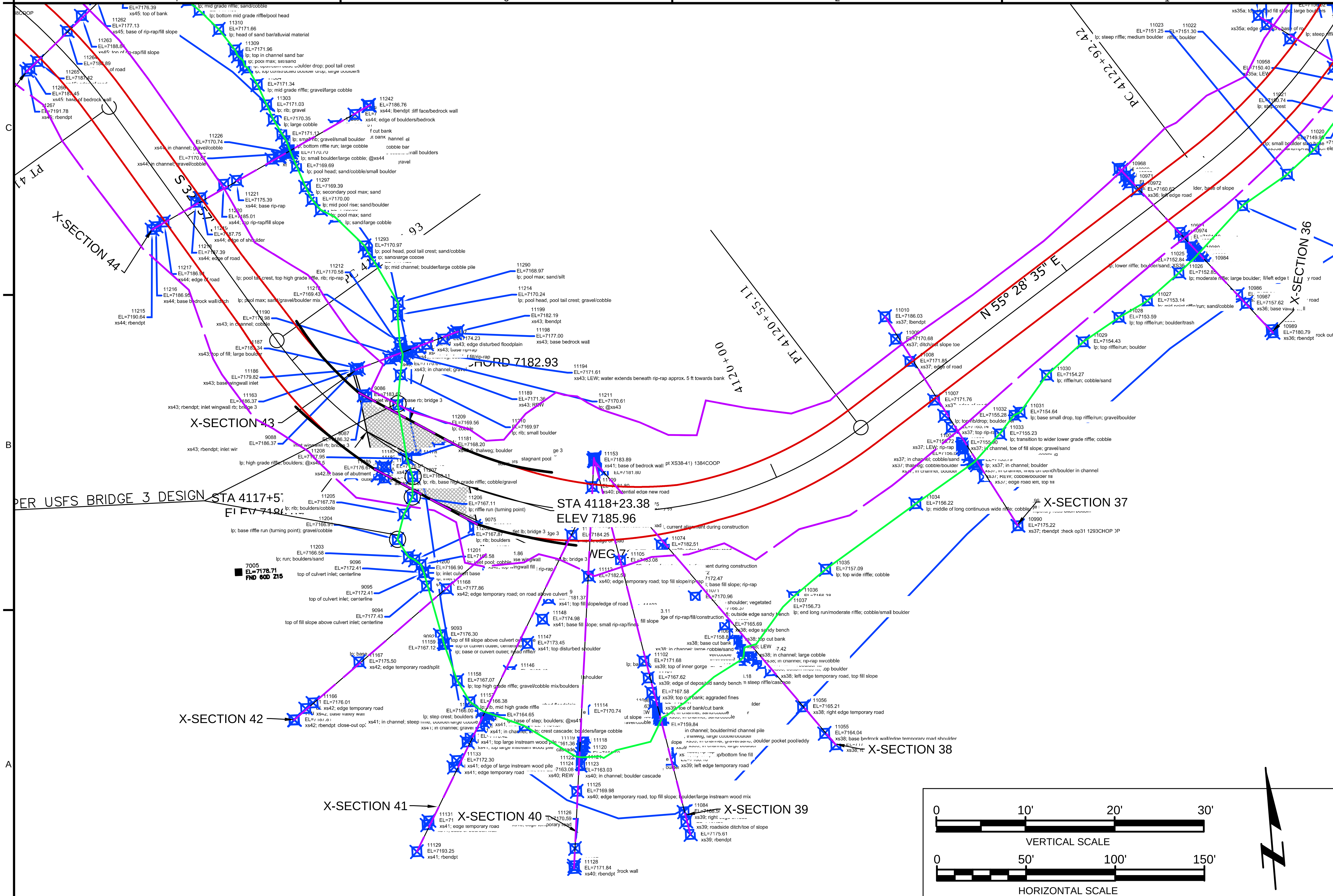

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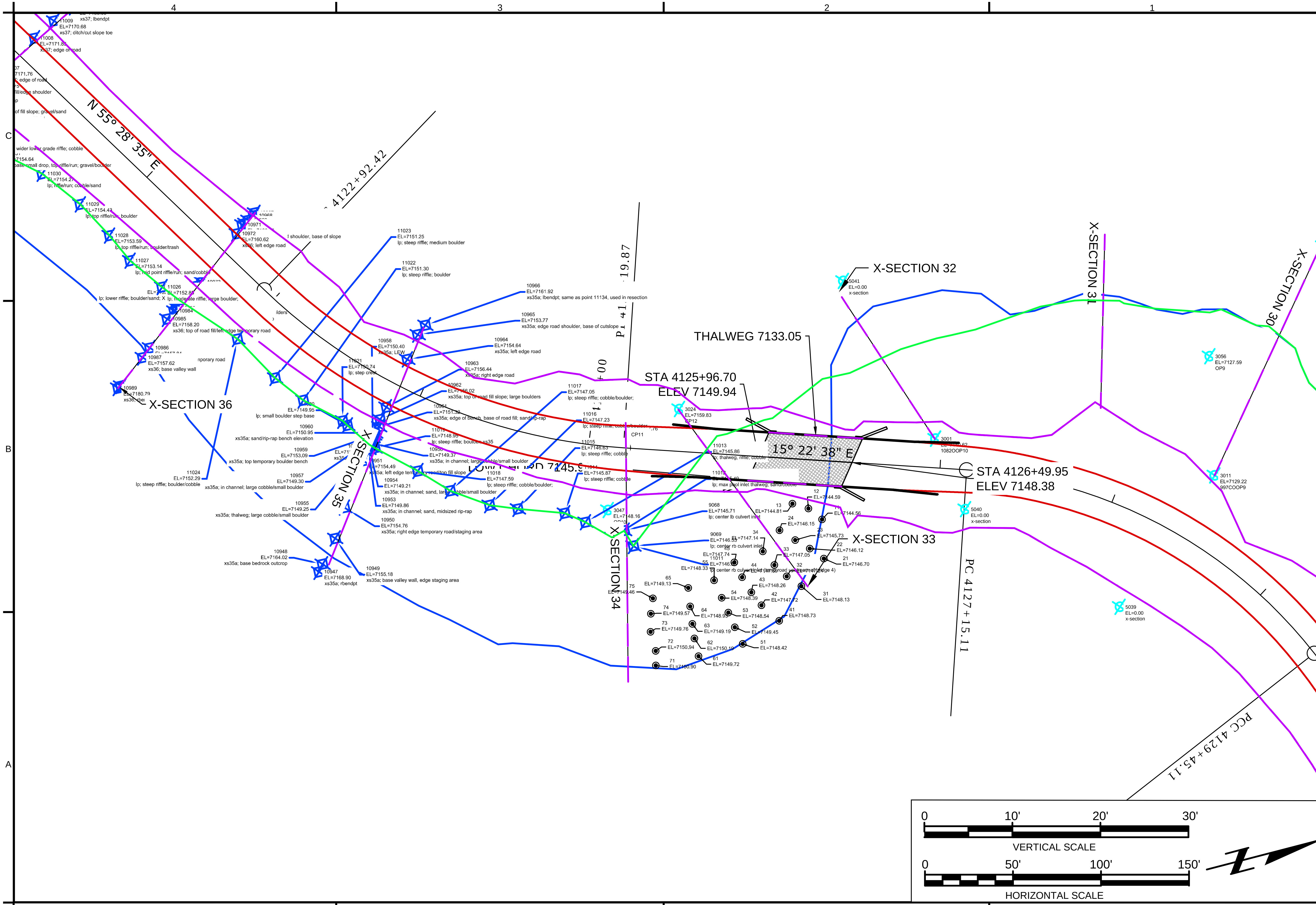
SHEET REFERENCE NUMBER:
49

UPDATE



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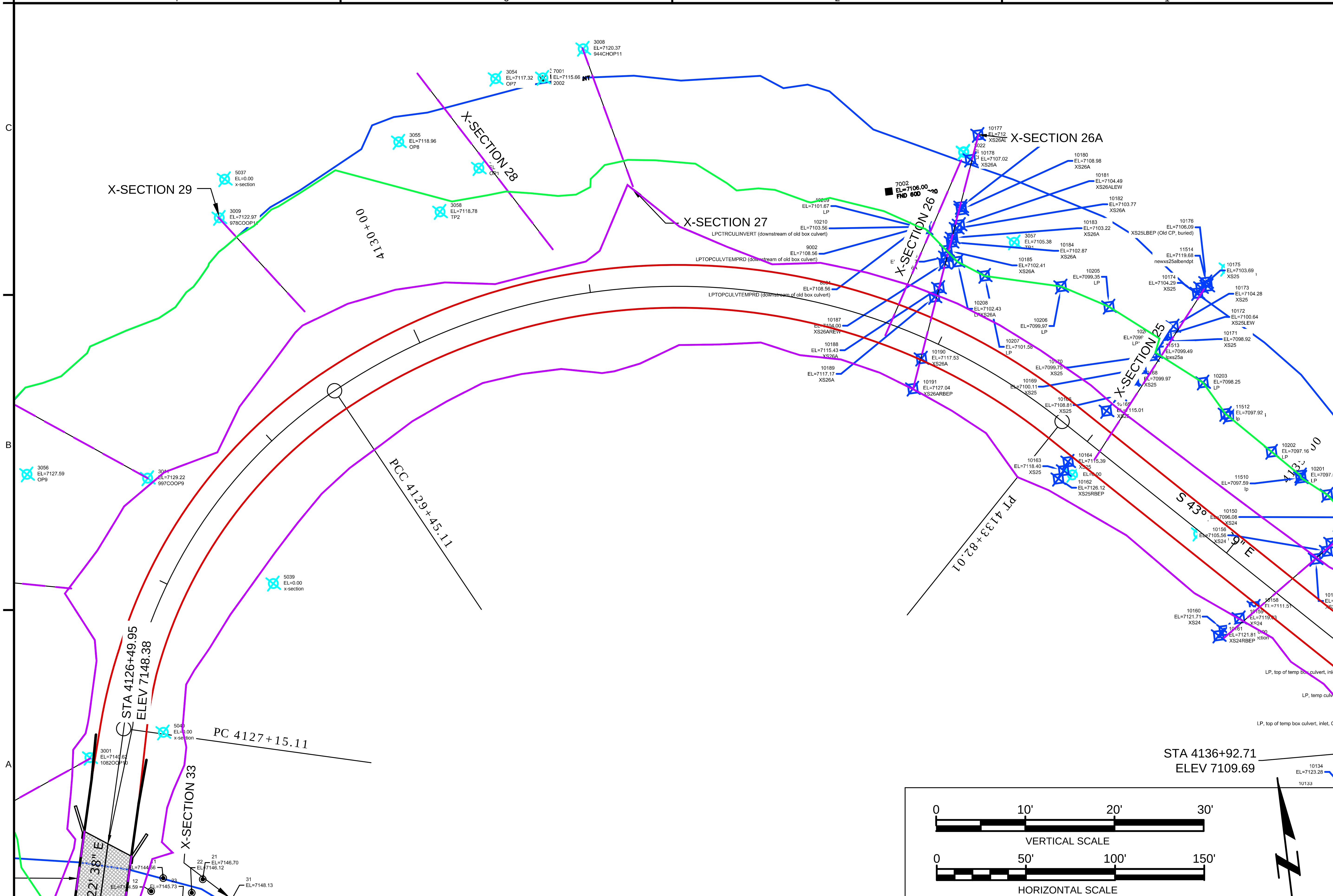
LARIMER COUNTY, COLORADO

USFS SURVEYED POINTS

SHEET REFERENCE NUMBER:
50

UPDATE



Symbol	Description	Date	Approved

Rev.
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COUNTY ROAD 43
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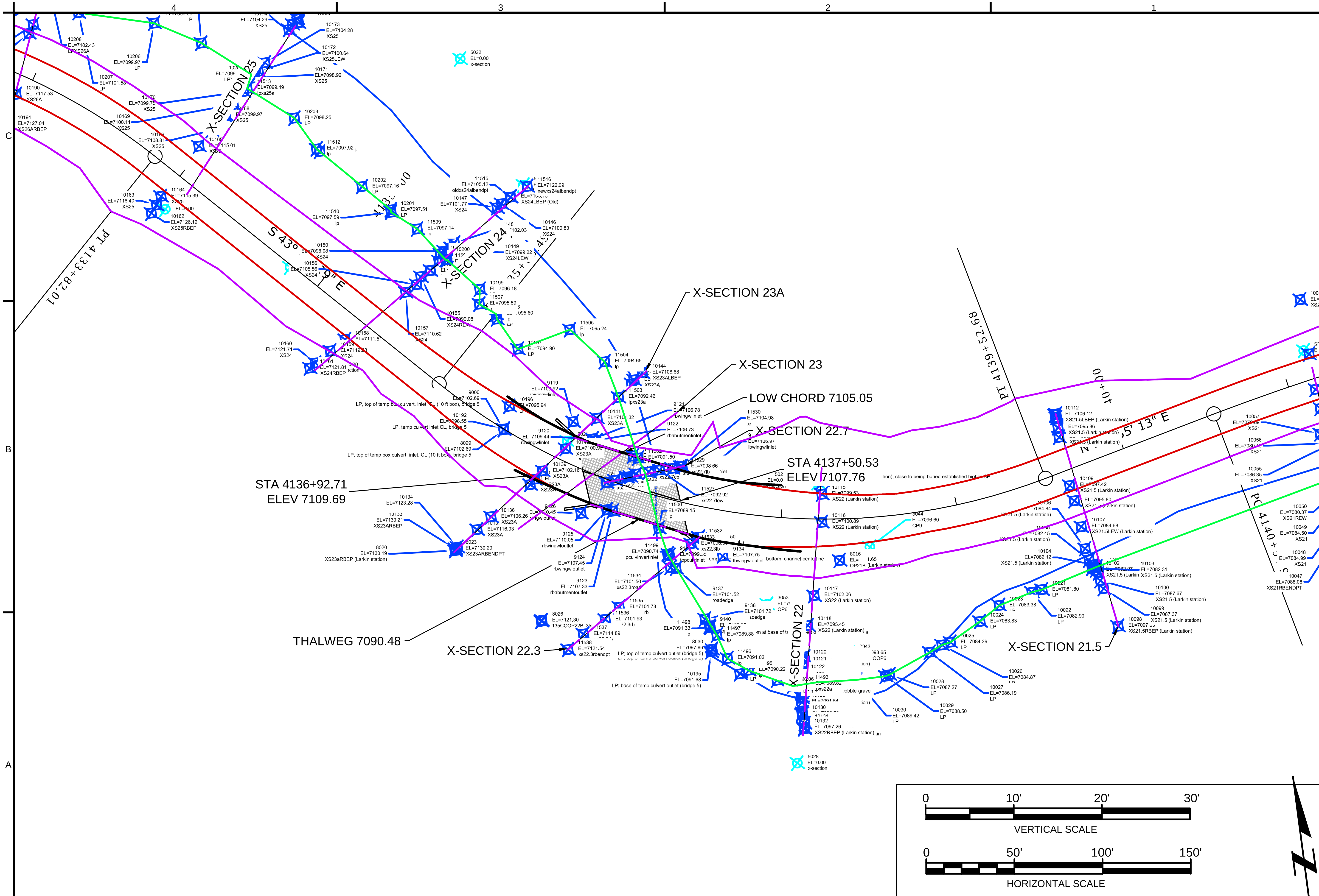
USFS SURVEYED POINTS

SHEET REFERENCE NUMBER:
51

UPDATE



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NORTH FORK BIG THOMPSON RIVER
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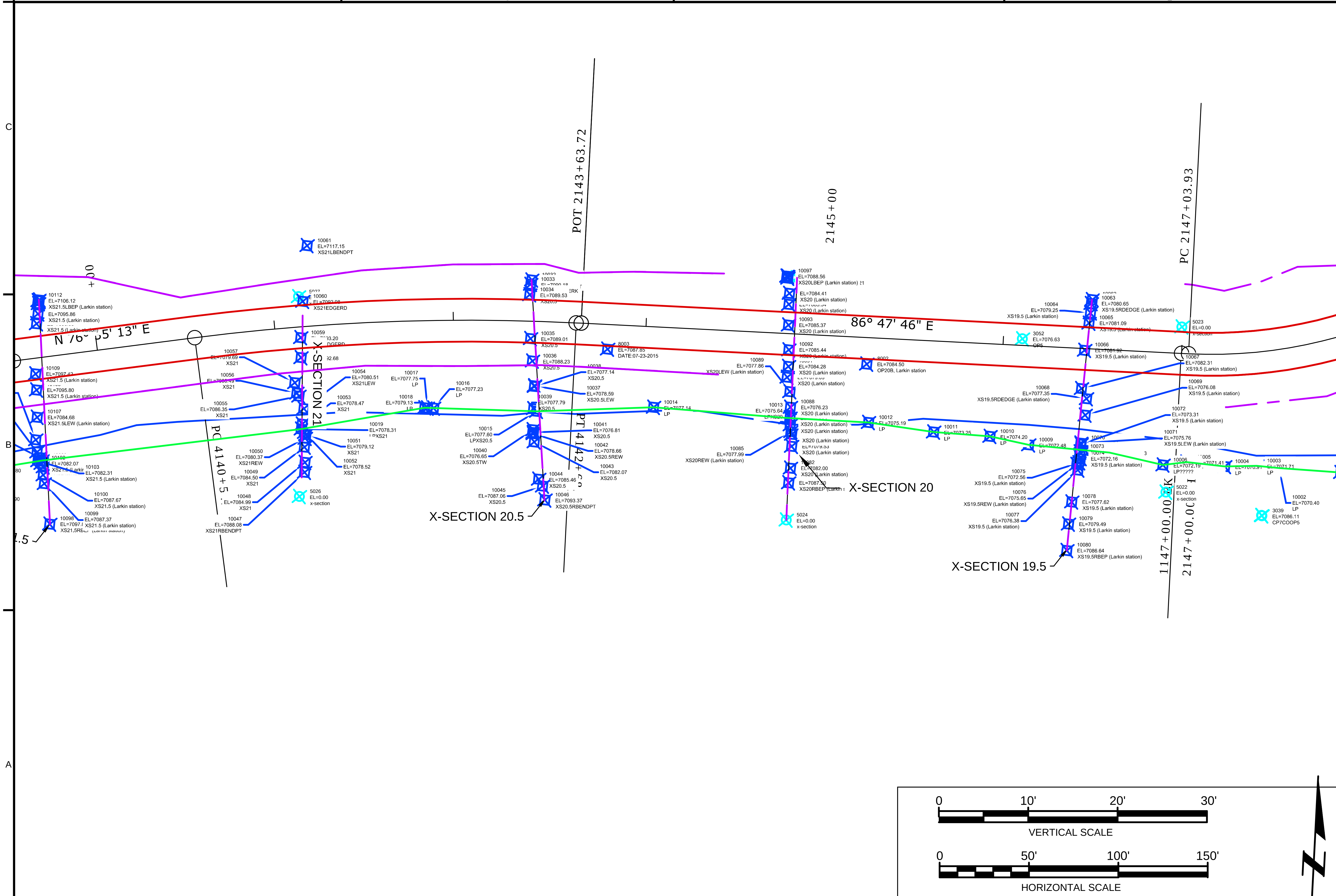
LARIMER COUNTY, COLORADO

USFS SURVEYED POINTS

SHEET REFERENCE NUMBER:
52

UPDATE



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USFS SURVEYED POINTS

SHEET REFERENCE NUMBER:
53

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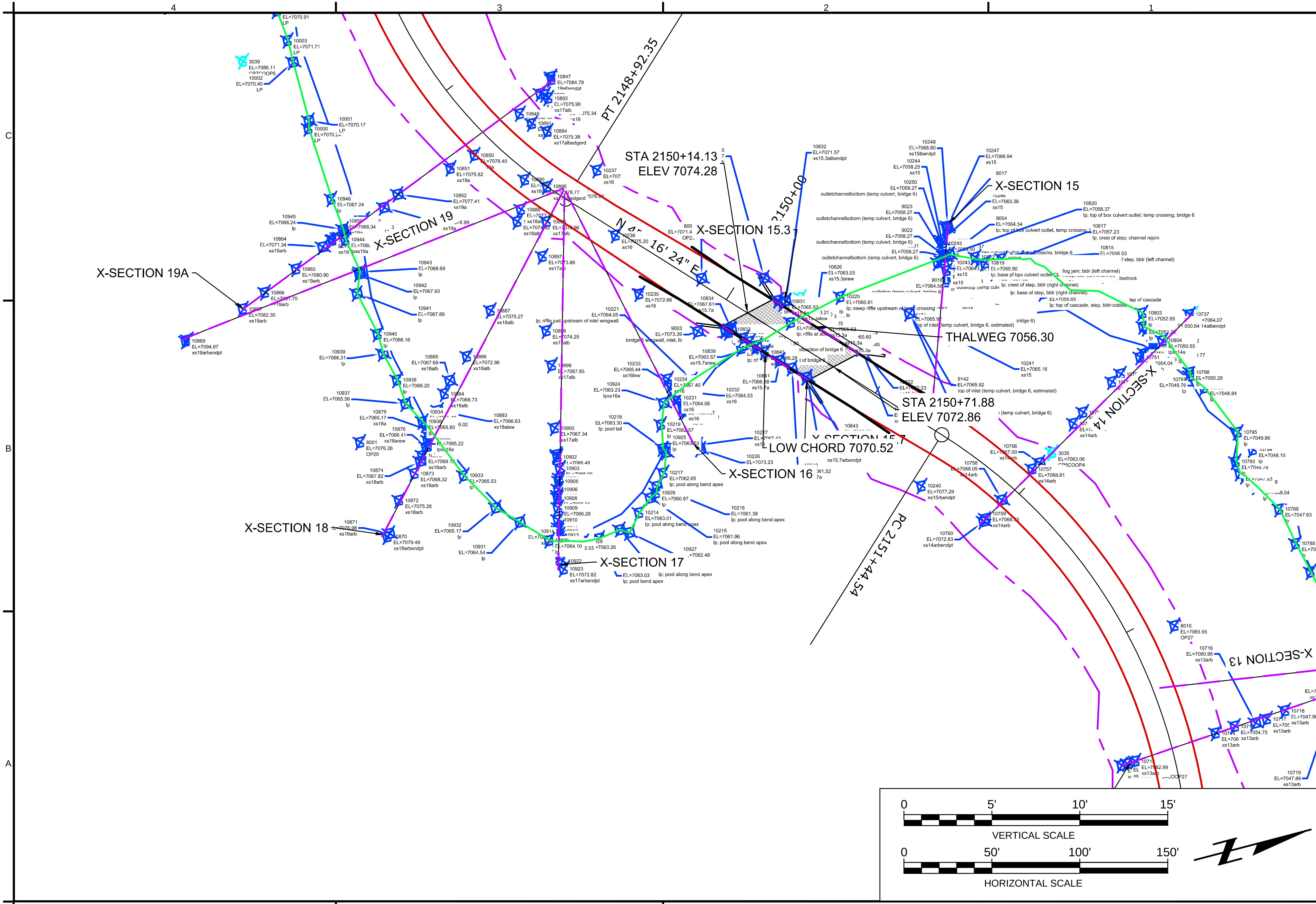

Symbol	Description	Date	Approved

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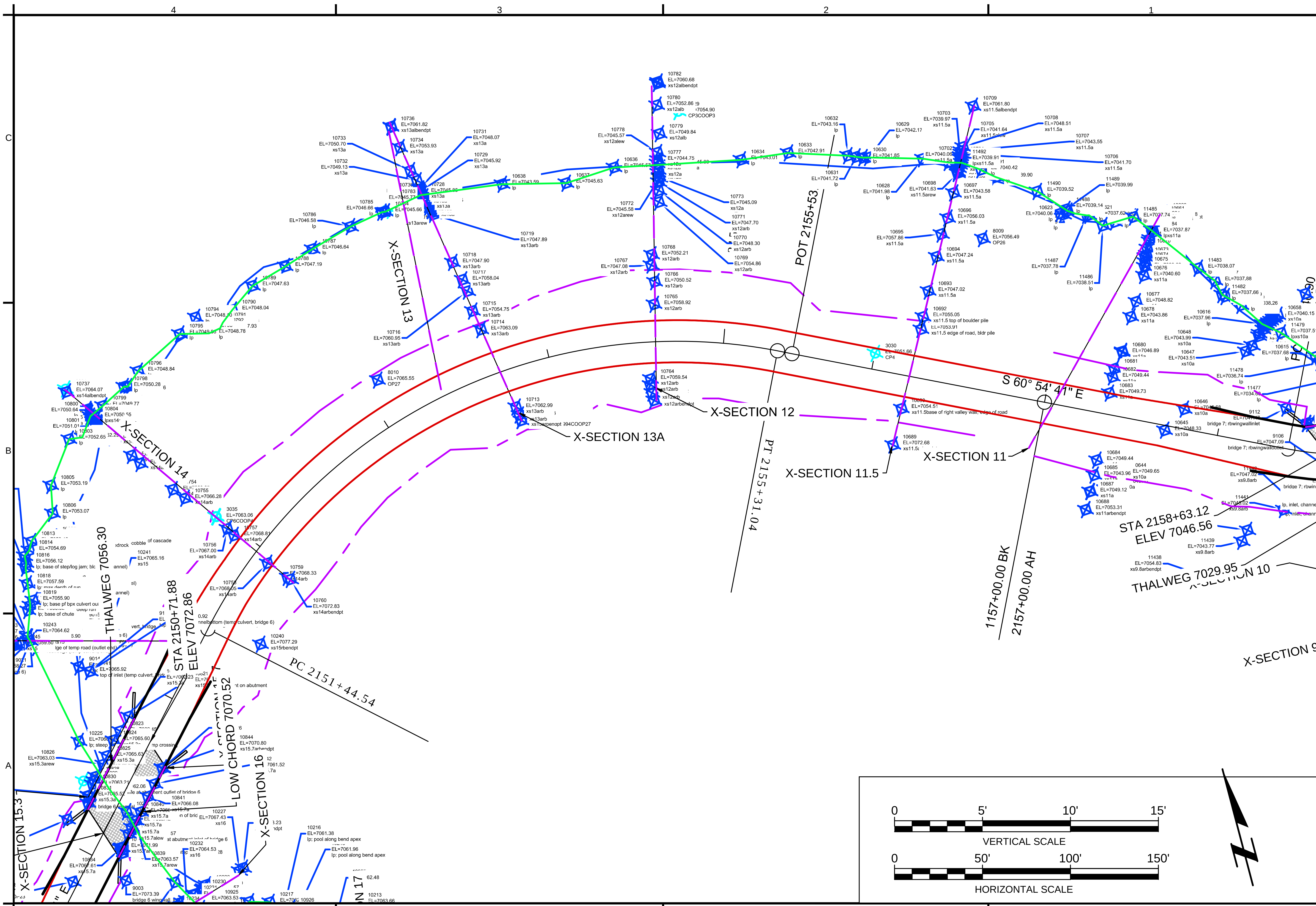
SHEET REFERENCE NUMBER:
54

UPDATE



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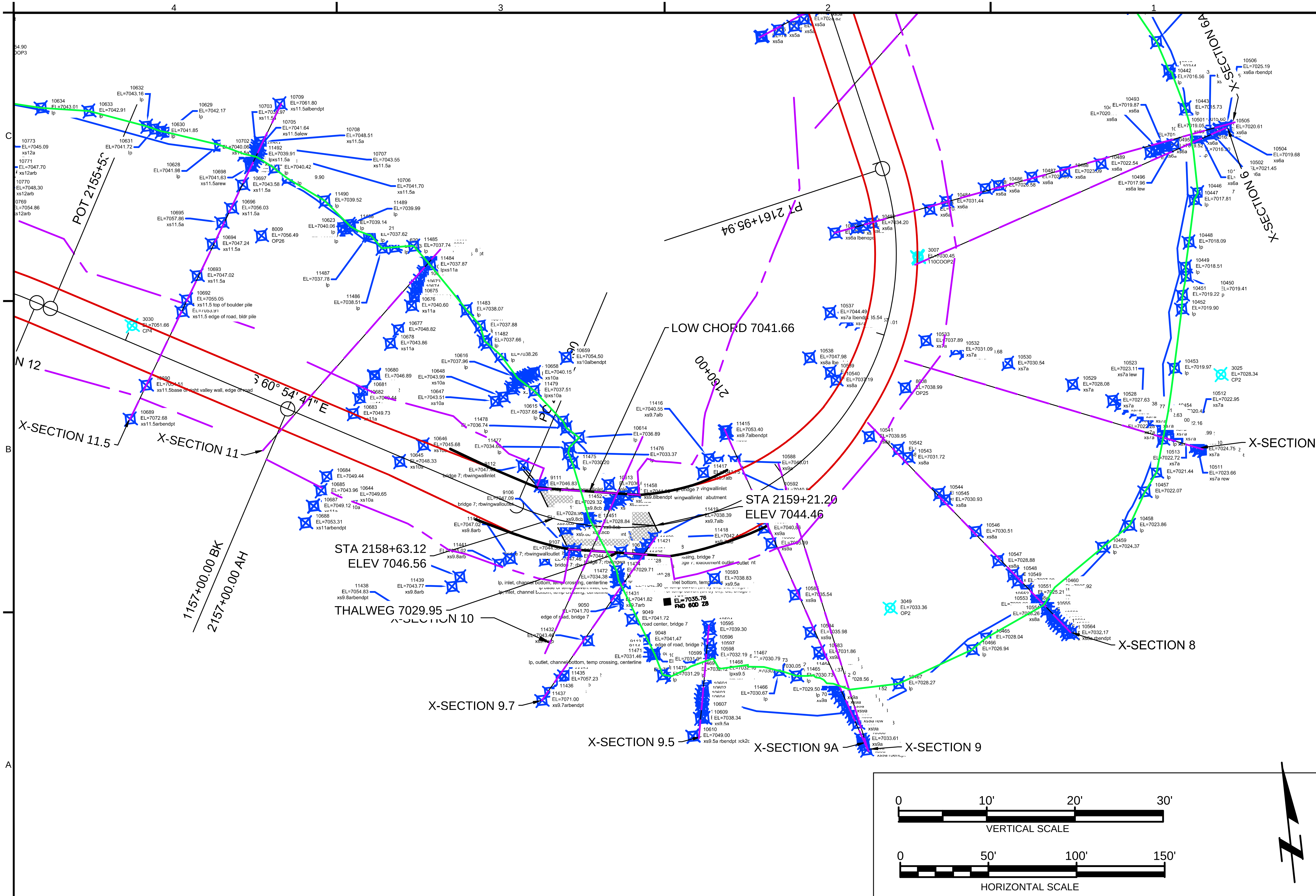
55

UPDATE



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USFS SURVEYED POINTS

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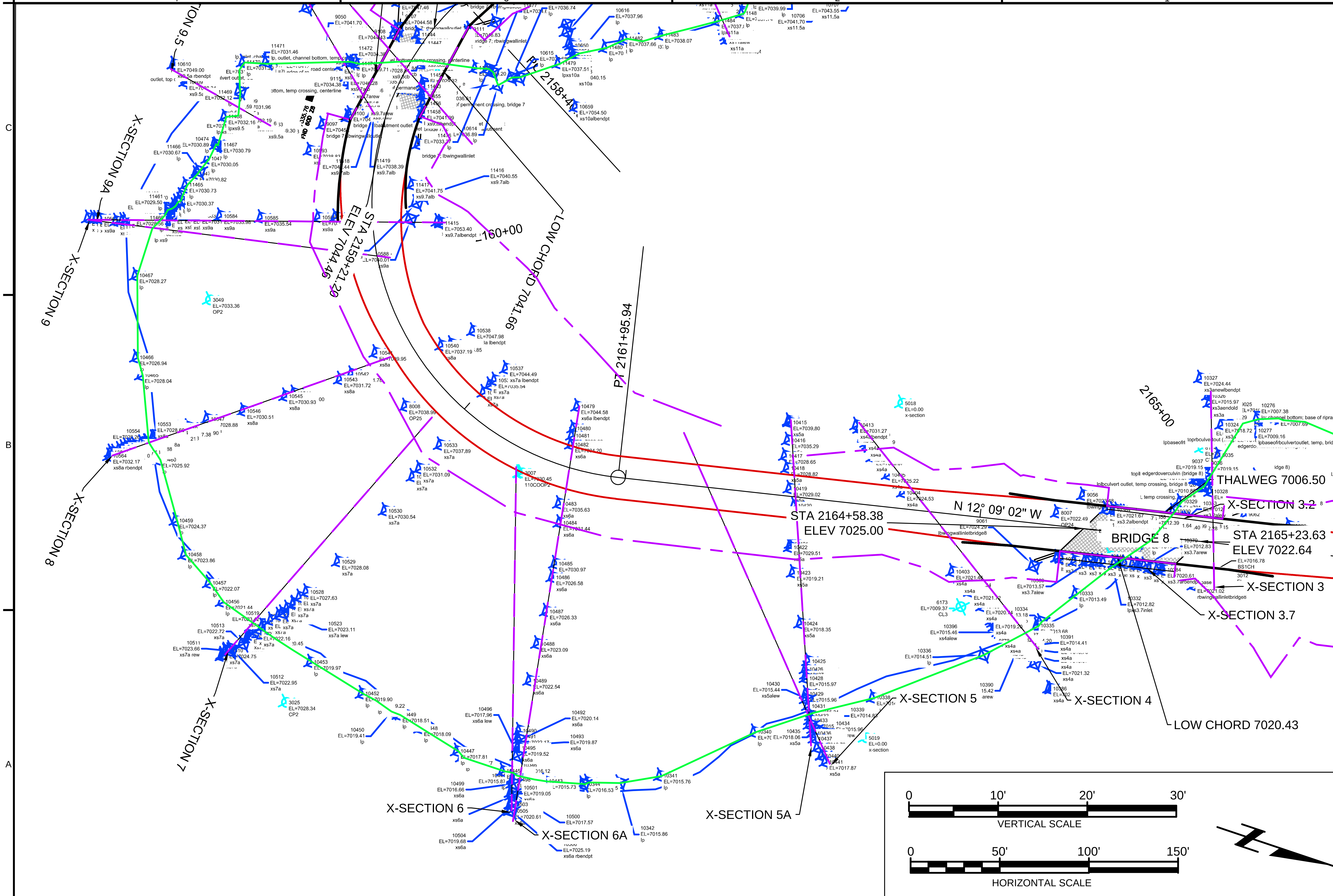
56

UPDATE



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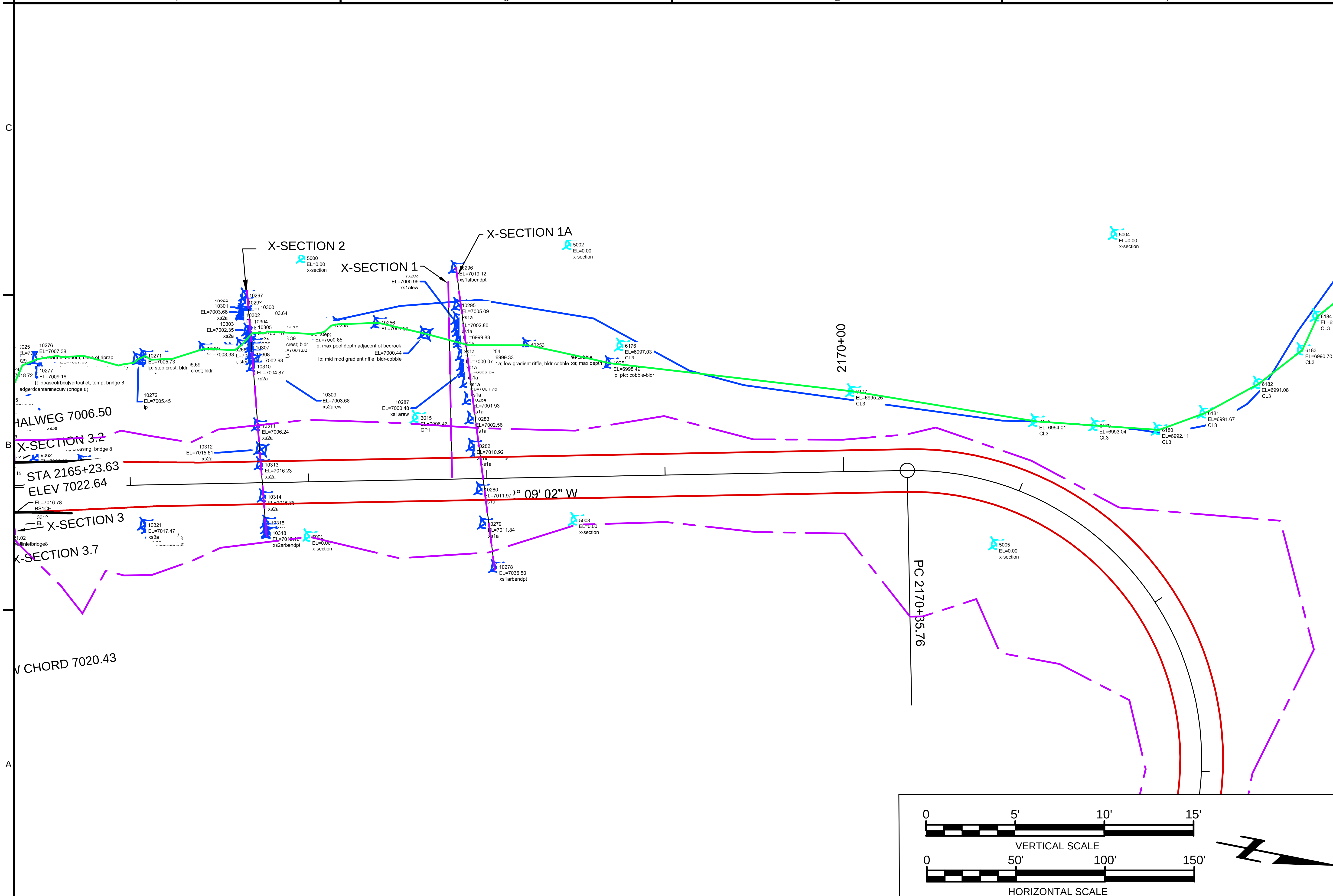
57

UPDATE



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NORTH FORK BIG THOMPSON RIVER

COUNTY ROAD 43

WEST SEED SECTION

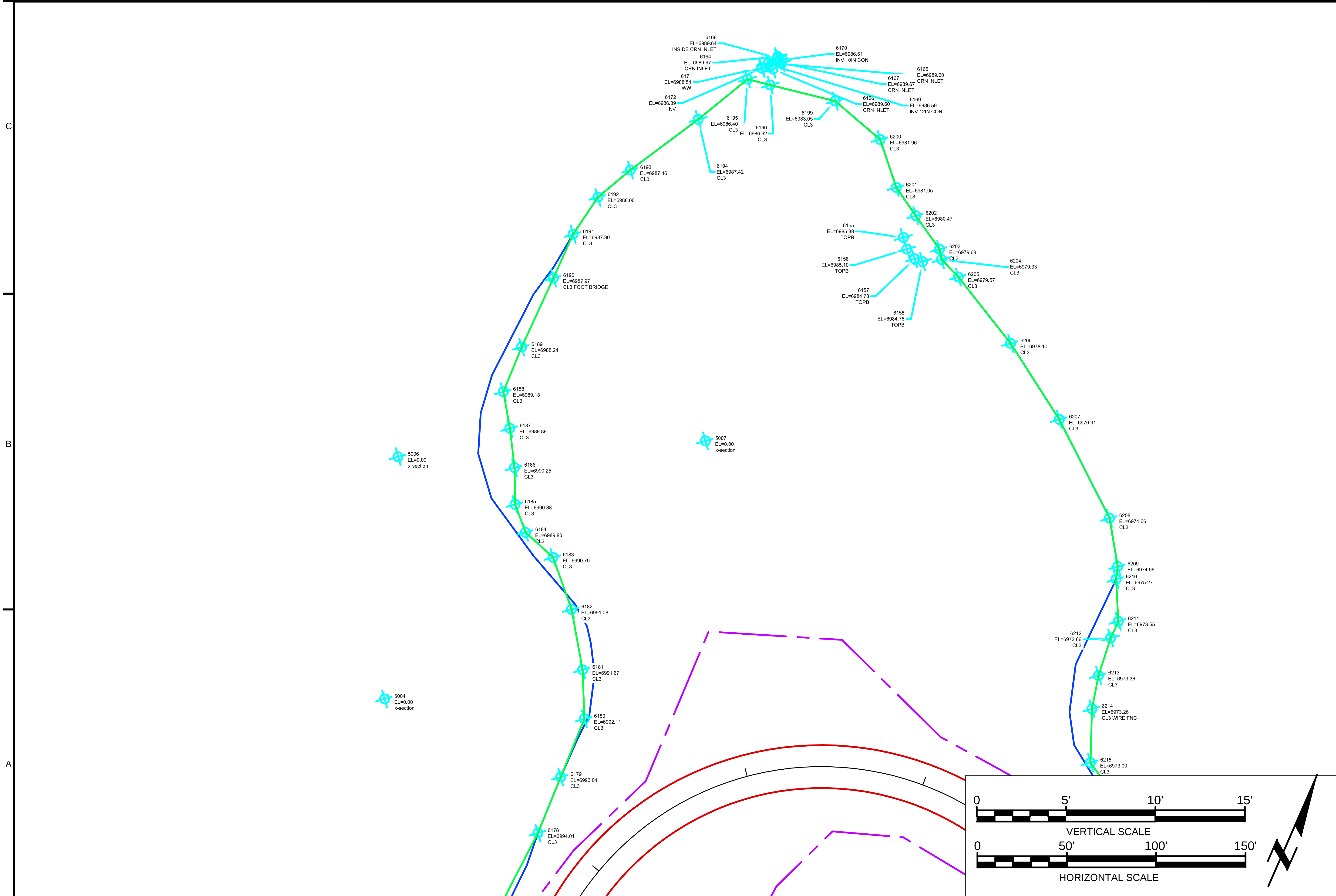
LARIMER COUNTY, COLORADO

USFS SURVEYED POINTS

SHEET REFERENCE NUMBER:

58

UPDATE



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WEST SEED SECTION
LARIMER COUNTY, COLORADO

USFS SURVEYED POINTS

SHEET REFERENCE NUMBER:
59

UPDATE

Point Table			
Point #	Raw Description	Northing	Easting
7029	XS 36	1408093.2174	3016170.2878
7053	XS 26	1408718.3217	3016765.7107
7077	XS 21	1408362.5853	3017501.6488
7027	XS 37	1407988.1471	3016024.4877
7051	XS 27	1408819.6823	3016636.2445
7028	XS 36	1408189.5596	3016088.6065
7052	XS 26	1408844.5037	3016840.7491
7030	XS 35	1408270.0578	3016171.9350
7031	XS 35	1408172.9649	3016321.8607
7095	BR6 US	1408679.4860	3018297.7959
7037	BR4 US	1408512.2805	3016316.0727
7101	XS 13	1408824.3231	3018503.6575
7038	BR4 DS	1408421.7510	3016262.1094
7102	XS 13A	1408977.6380	3018523.3457
7039	BR4 DS	1408529.2097	3016291.7088
7103	XS 13A	1408793.1863	3018541.7286
7040	XS 32	1408503.3583	3016196.4944
7104	XS 12	1408950.6693	3018671.3105
7041	XS 32	1408541.5836	3016292.6820
7105	XS 12	1408780.0545	3018618.0472

Point Table			
Point #	Raw Description	Northing	Easting
7047	XS 29	1408741.2377	3016467.7290
7048	XS 28	1408908.2697	3016518.5922
7049	XS 28	1408773.6056	3016596.9274
7050	XS 27	1408913.0091	3016615.5154
7024	XS 38	1408040.5603	3015786.2775
7025	XS 38	1407874.3997	3015914.2759
7026	XS 37	1408112.7600	3015953.5369
7032	XS 34	1408371.5213	3016248.0842
7096	XS 15	1408767.3934	3018219.2379
7033	XS 34	1408340.3339	3016405.4750
7097	XS 15	1408734.8953	3018317.7418
7034	XS 33	1408402.3071	3016246.7141
7098	XS 14	1408891.0375	3018300.5975
7035	XS 33	1408467.1323	3016390.0509
7099	XS 14	1408760.3352	3018380.9002
7036	BR4 US	1408403.9533	3016286.2259
7100	XS 13	1408972.8138	3018521.2840
7042	XS 31	1408659.6881	3016198.5853
7043	XS 31	1408637.3641	3016294.5790
7044	XS 30	1408775.2030	3016233.9973

Point Table			
Point #	Raw Description	Northing	Easting
7045	XS 30	1408692.9662	3016345.1816
7046	XS 29	1408843.2026	3016396.6365
7054	XS 26A	1408844.5096	3016840.8280
7055	XS 26A	1408686.6483	3016777.1736
7056	XS 25	1408744.3855	3016966.4550
7057	XS 25	1408633.8601	3016872.7827
7058	XS 24	1408622.5100	3017079.5375
7059	XS 24	1408525.3429	3016931.7858
7060	XS 23A	1408511.6141	3017133.8186
7061	XS 23A	1408412.6956	3016996.4677
7062	XS 23	1408478.3153	3017138.7334
7063	XS 23	1408421.0758	3017034.3393
7064	BR4 US	1408430.3997	3017155.4811
7065	BR4 US	1408477.1298	3017052.6249
7066	XS 22.7	1408447.7714	3017180.2348
7067	XS 22.7	1408436.4256	3017033.5087
7068	BR5 DS	1408394.2279	3017154.1050
7069	BR5 DS	1408440.7121	3017051.7890
7070	XS 22.3	1408411.6638	3017148.8899
7071	XS 22.3	1408349.3211	3017053.0230

Symbol | Description | Date | Approved

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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTION POINTS

SHEET REFERENCE NUMBER:
60

UPDATE

Point Table

Point #	Raw Description	Northing	Easting
7072	XS 22	1408432.6768	3017209.3435
7073	XS 22	1408275.6871	3017177.1523
7074	XS 21.5	1408445.8757	3017344.9005
7075	XS 21.5	1408321.5751	3017364.4155
7076	XS 21	1408452.7376	3017492.5738
7106	XS 11.5	1408882.8588	3018842.0458
7107	XS 11.5	1408713.6876	3018737.5567
7108	XS 11	1408806.8386	3018940.2141
7109	XS 11	1408688.3488	3018810.7306
7110	XS 10	1408673.0188	3019025.7297
7111	XS 10	1408556.8072	3018957.6158
7112	BR7 US	1408636.5729	3019042.4272
7113	BR7 US	1408654.7839	3018939.3712
7114	XS 9.7	1408615.5096	3019026.9988
7115	XS 9.7	1408530.4138	3018952.9033
7116	XS 9.5	1408562.5096	3019051.6986
7117	XS 9.5	1408499.5621	3019039.2267
7118	XS 9A	1408672.5612	3019072.3118
7119	XS 9A	1408482.0881	3019134.0569
7120	XS 9	1408649.4795	3019100.7157

Point Table

Point #	Raw Description	Northing	Easting
7121	XS 9	1408482.7572	3019133.9161
7122	XS 8	1408667.2861	3019153.6066
7123	XS 8	1408536.8536	3019255.2202
7124	XS 7	1408700.1053	3019178.3075
7125	XS 7	1408632.1170	3019340.9070
7127	XS 6	1408812.0549	3019373.2787
7128	XS 6A	1408776.5216	3019146.2691
7129	XS 6A	1408814.6988	3019378.7195
7130	XS 5	1408836.8866	3019141.8829
7131	XS 5	1408973.0785	3019292.0830
7132	XS 5A	1408891.4990	3019116.2251
7133	XS 5A	1408959.8718	3019285.7629
7134	XS 4	1408928.3117	3019105.5229
7135	XS 4	1409063.5443	3019194.1068
7136	XS 3	1409109.8230	3019026.6193
7137	XS 3	1409146.7915	3019131.4370
7000	XS 47	1408535.9739	3015169.0468
7001	XS 47	1408405.9798	3015191.0292
7002	XS 46.5	1408523.8948	3015281.0241
7003	XS 46.5	1408410.3046	3015221.7739

Point Table

Point #	Raw Description	Northing	Easting
7004	XS 46	1408413.9488	3015496.5284
7005	XS 46	1408321.0603	3015425.5818
7006	XS 45	1408379.5255	3015600.1170
7007	XS 45	1408273.0502	3015478.9987
7008	XS 44	1408245.3479	3015670.7882
7009	XS 44	1408181.4879	3015545.2457
7010	XS 43	1408116.1161	3015713.9364
7011	XS 43	1408097.4283	3015655.4707
7012	BR3 US	1408036.1706	3015736.9501
7013	BR3 US	1408099.3828	3015632.0422
7014	BR3 DS	1407992.2609	3015744.9119
7015	BR3 DS	1408056.8089	3015637.7891
7016	XS 42	1408003.8694	3015740.3487
7017	XS 42	1407903.0376	3015611.4723
7018	XS 41	1408011.6041	3015778.6685
7019	XS 41	1407825.9895	3015676.7628
7020	XS 40	1408041.7027	3015786.5485
7021	XS 40	1407812.2711	3015764.2663
7022	XS 39	1408041.6614	3015786.5656
7023	XS 39	1407828.2307	3015830.3184

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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTION POINTS

SHEET REFERENCE NUMBER: 61

UPDATE

Point Table			
Point #	Raw Description	Northing	Easting
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7079	XS 20.5	1408364.2676	3017638.0630
7080	XS 20	1408503.0608	3017765.3960
7081	XS 20	1408367.6328	3017773.7564
7082	XS 19.5	1408508.3612	3017930.7745
7083	XS 19.5	1408367.2772	3017931.6045
7084	XS 19A	1408567.8474	3018088.3715
7085	XS 19A	1408365.6753	3018175.1487
7086	XS 19	1408558.7723	3018149.8671
7087	XS 19	1408327.8948	3018184.0207
7088	XS 18	1408558.6761	3018151.0250
7089	XS 18	1408413.4049	3018318.8538
7090	XS 17	1408558.6269	3018153.4527
7091	XS 17	1408506.5356	3018360.1971
7092	XS 16	1408559.8942	3018152.3066
7093	XS 16	1408597.7982	3018308.1532
7094	BR6 US	1408604.8059	3018222.2850
7126	XS 6	1408753.6773	3019189.7774
7138	XS 2	1409248.2236	3018972.7793
7139	XS 2	1409285.3297	3019105.6501

Point Table			
Point #	Raw Description	Northing	Easting
7140	XS 1	1409357.9384	3018946.1042
7141	XS 1	1409380.9914	3019053.0867
7142	XS 1A	1409360.6431	3018937.3564
7143	XS 1A	1409414.5063	3019099.5683

Symbol	Description	Date	Approved

Date: MAR 1, 2016
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Reviewed by: JPC

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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
WEST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTION POINTS

SHEET REFERENCE NUMBER: 62

UPDATE

Appendix B: East Seed Plans

NOTES:

1) THE PURPOSE OF THIS BASE MAP IS TO PROVIDE GENERIC BASE MAPPING. DATA SHOWN SHALL BE USED FOR INFORMATIONAL PURPOSES ONLY.

2) CONTOURS SHOWN HEREON WERE PROVIDED BY FEDERAL HIGHWAY ADMINISTRATION (FHWA) ON JANUARY 15, 2015 AND FEBRUARY 13, 2015. CONTOURS SHOWN HERE ON BLEND THE EXISTING CONDITIONS (LIDAR DATA) AND THE DESIGN CONTOURS (ALONG THE ROAD).

3) IMAGERY SHOWN HEREON WAS PROVIDED BY FHWA. DATE OF IMAGERY IS UNKNOWN.

4) NO UTILITIES ARE SHOWN HEREON. NO RESEARCH HAS BEEN DONE CONCERNING THE EXISTENCE, SIZE, DEPTH, CONDITION, CAPACITY OR LOCATION OF ANY UTILITY OR MUNICIPAL/PUBLIC SERVICE FACILITY. FOR INFORMATION REGARDING THESE UTILITIES, PLEASE CONTACT THE APPROPRIATE AGENCIES. ALL UNDERGROUND UTILITIES MUST BE FIELD LOCATED BY THE APPROPRIATE AGENCY OR UTILITY COMPANY PRIOR TO ANY EXCAVATION, PURSUANT TO C.R.S. SEC. 9-1.5-103.

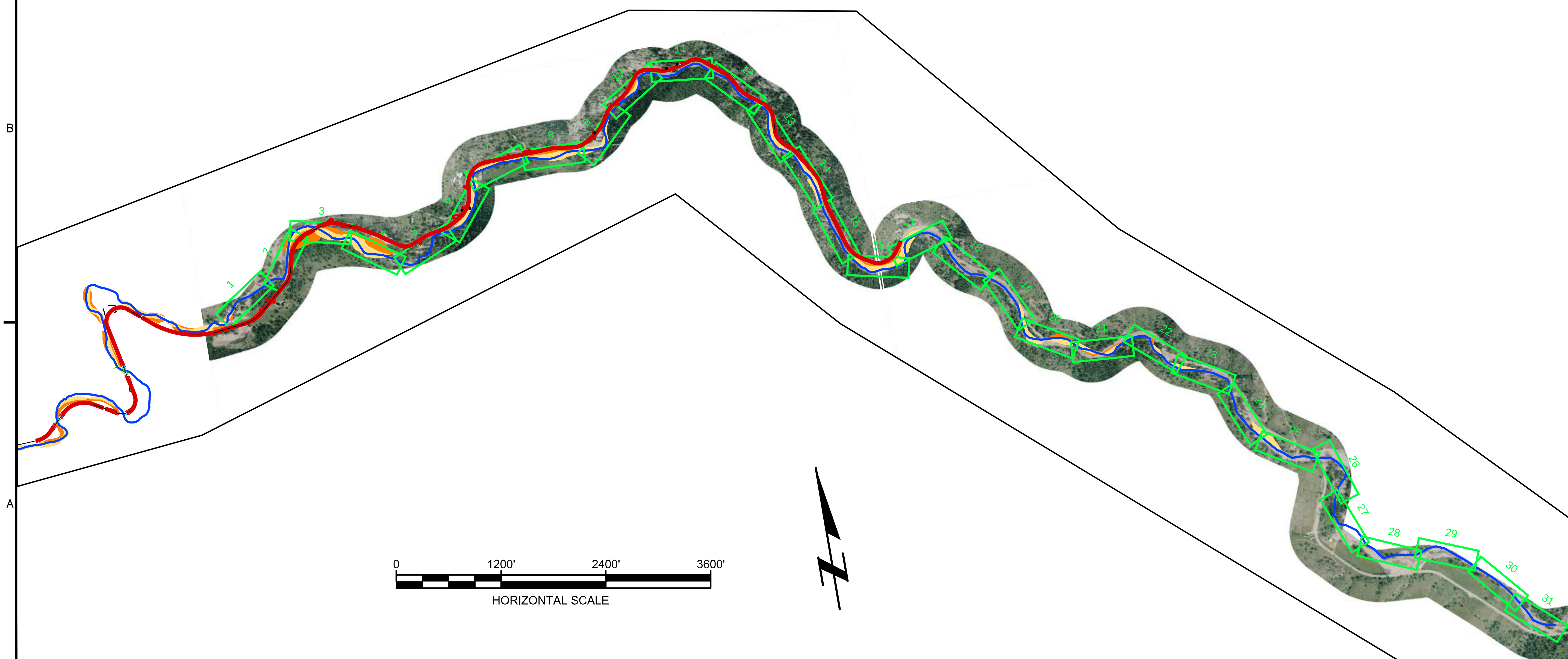
5) THE DISTANCE MEASUREMENTS SHOWN HEREON ARE U.S. SURVEY FOOT.

6) COORDINATE SYSTEM AND DATUMS:
COORDINATE SYSTEM SHOWN HEREON IS BASED ON COLORADO STATE PLANE, NORTH ZONE, NAD 83 (2011). VERTICAL DATUM IS NAVD 88 USING MODEL GEOID 12A.CONTROL WAS ESTABLISHED BY FHWA IN JANUARY OF 2014. THIS PROJECT IS ON GRID.

7) CROSS SECTIONS 1-35 REFERENCED IN THIS PACKAGE WERE CAPTURED BY THE FOREST SERVICE ON 7-29-2014.

PROJECT LEGEND

- PLAN SET SHEET
- CONTOUR MAJOR
- CONTOUR MINOR
- USFS X-SECTION
- PROPOSED RIVER CENTER LINE (1+00)
- USFS RIVER CENTER LINE (1+00)
- PROPOSED EDGE OF ROAD
- ROADWAY SLOPE STAKE LIMITS
- POINT BARS
- 5-10 YEAR FLOOD PLAIN BENCHES
- DESIGN POOLS
- RIFFLE CREST
- RIFFLE
- 1542 ROOTWAD — DESIGNED ROOTWAD



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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

PLAN SHEET INDEX

SHEET REFERENCE NUMBER:
INDEX

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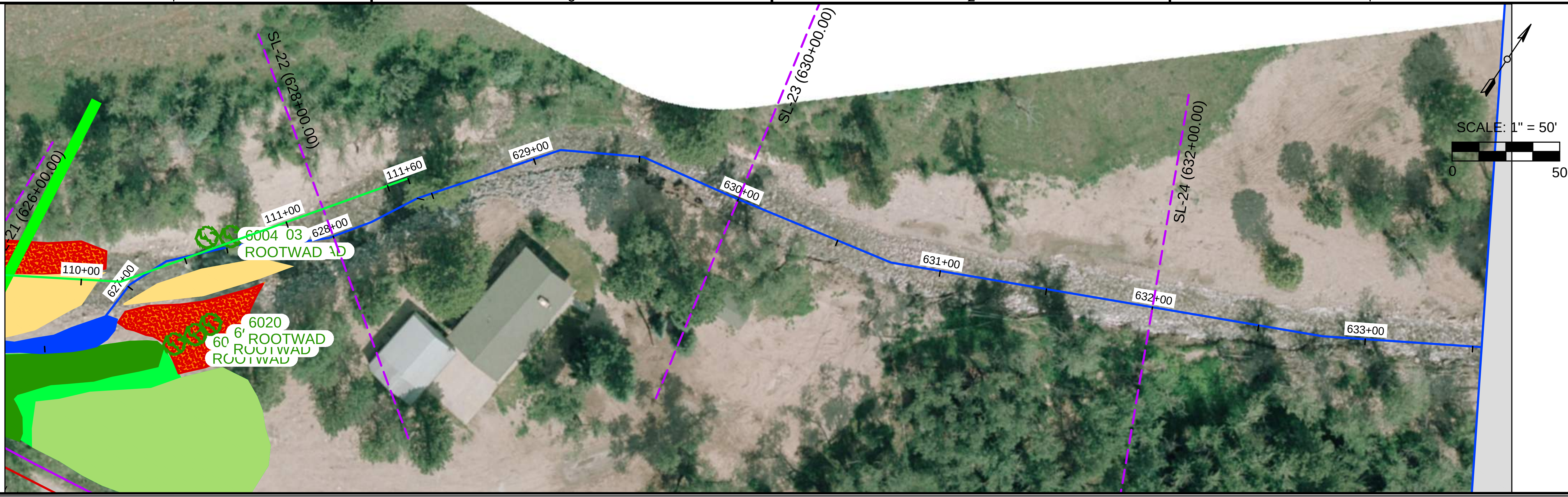

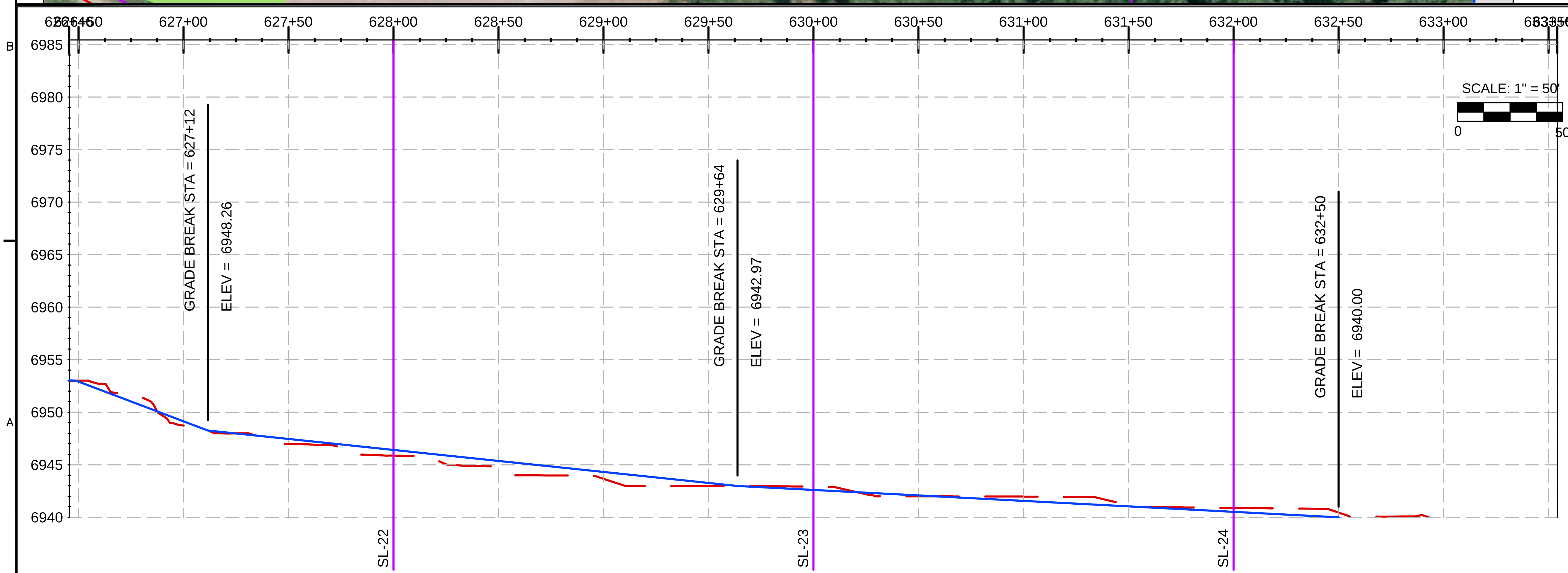

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NORTH FORK BIG THOMPSON RIVER
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LARIMER COUNTY, COLORADO

PLAN AND PROFILE

Sheet reference number:
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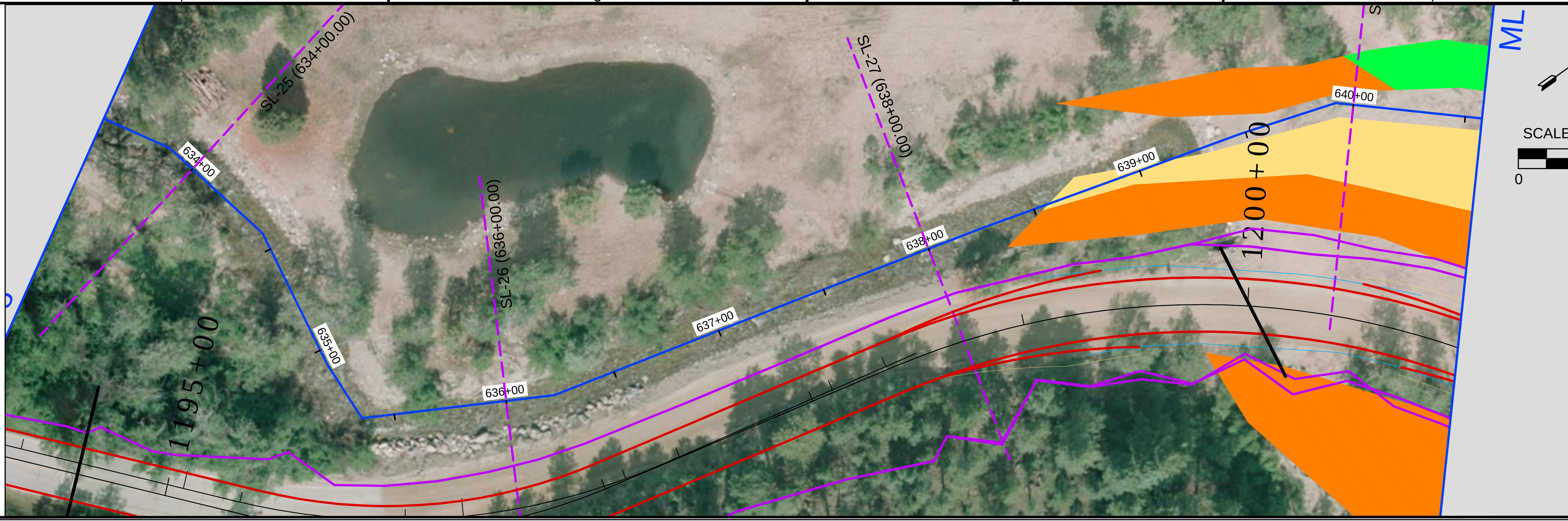

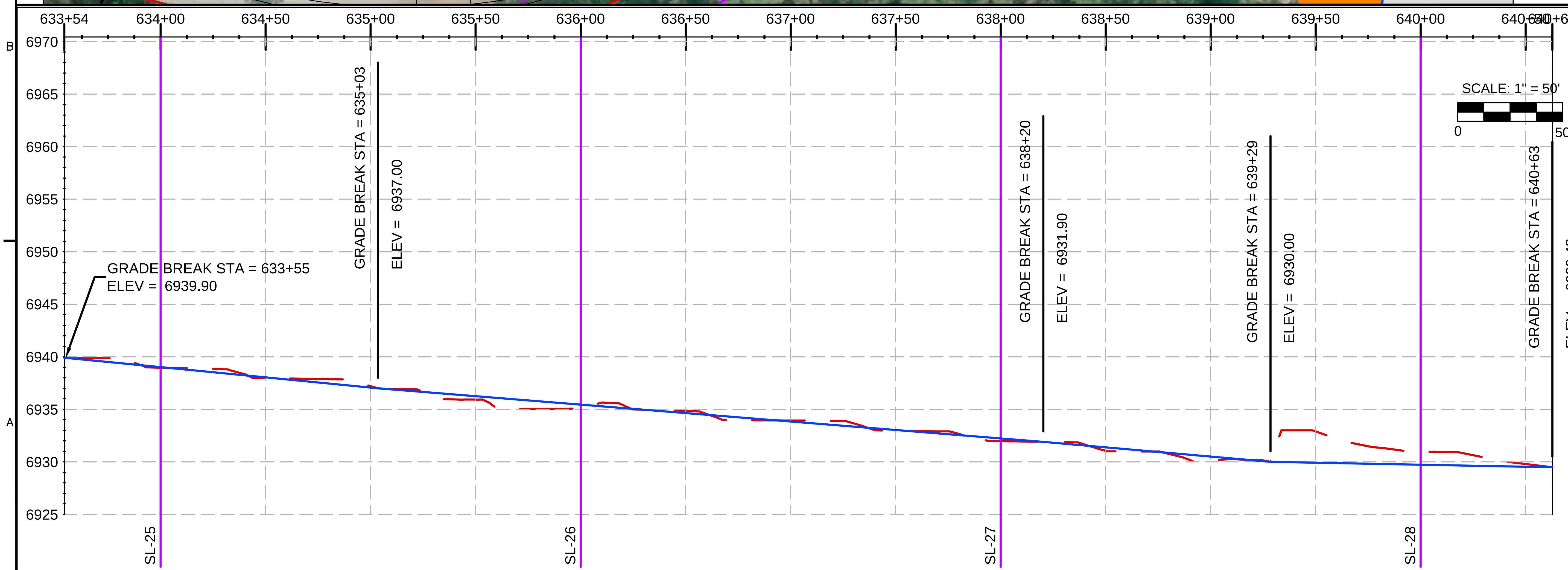

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PLAN AND PROFILE

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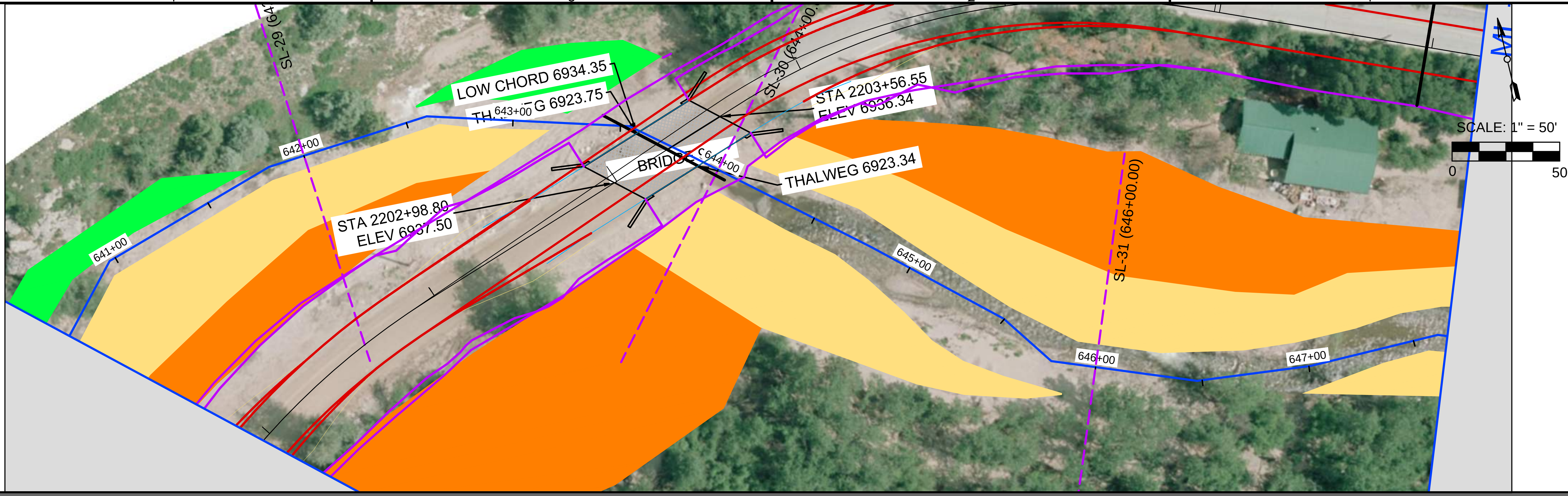

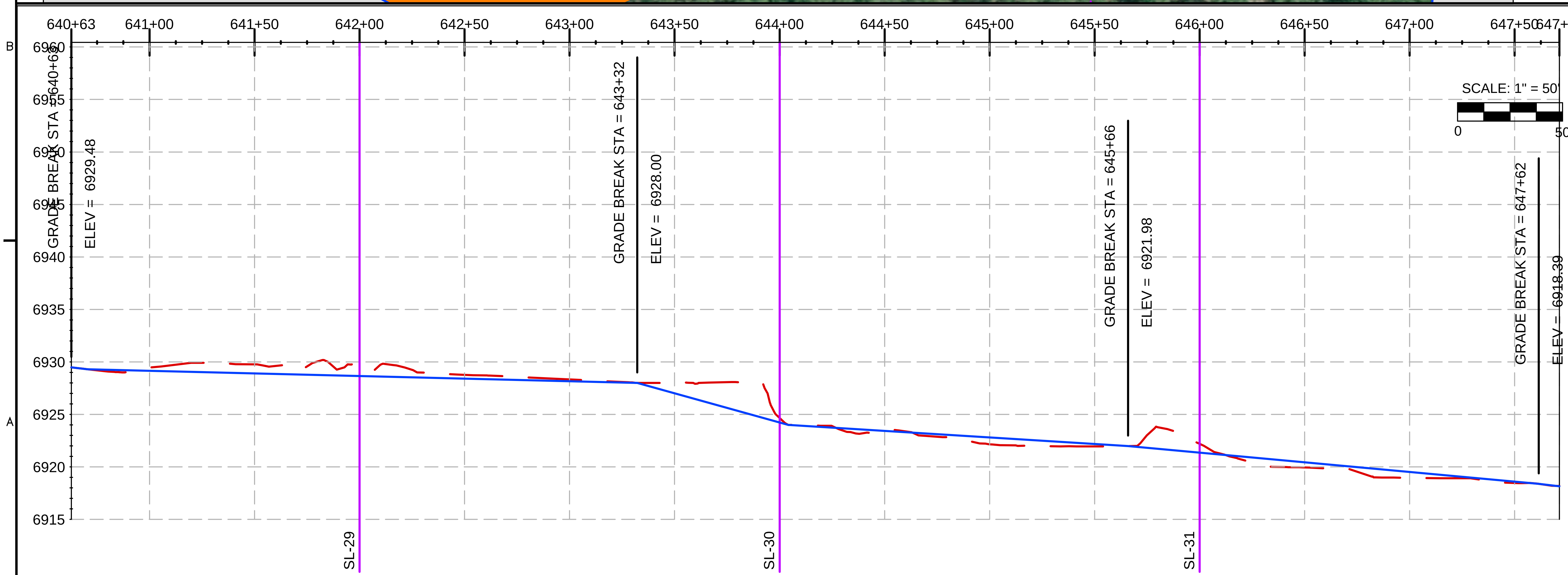

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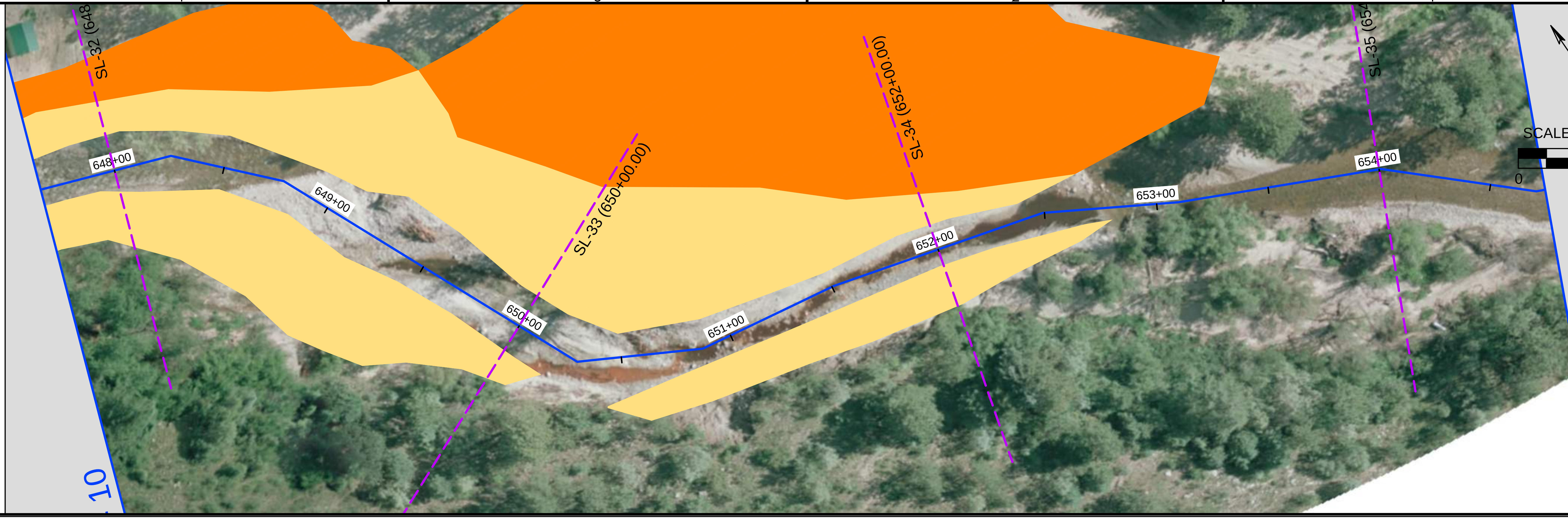

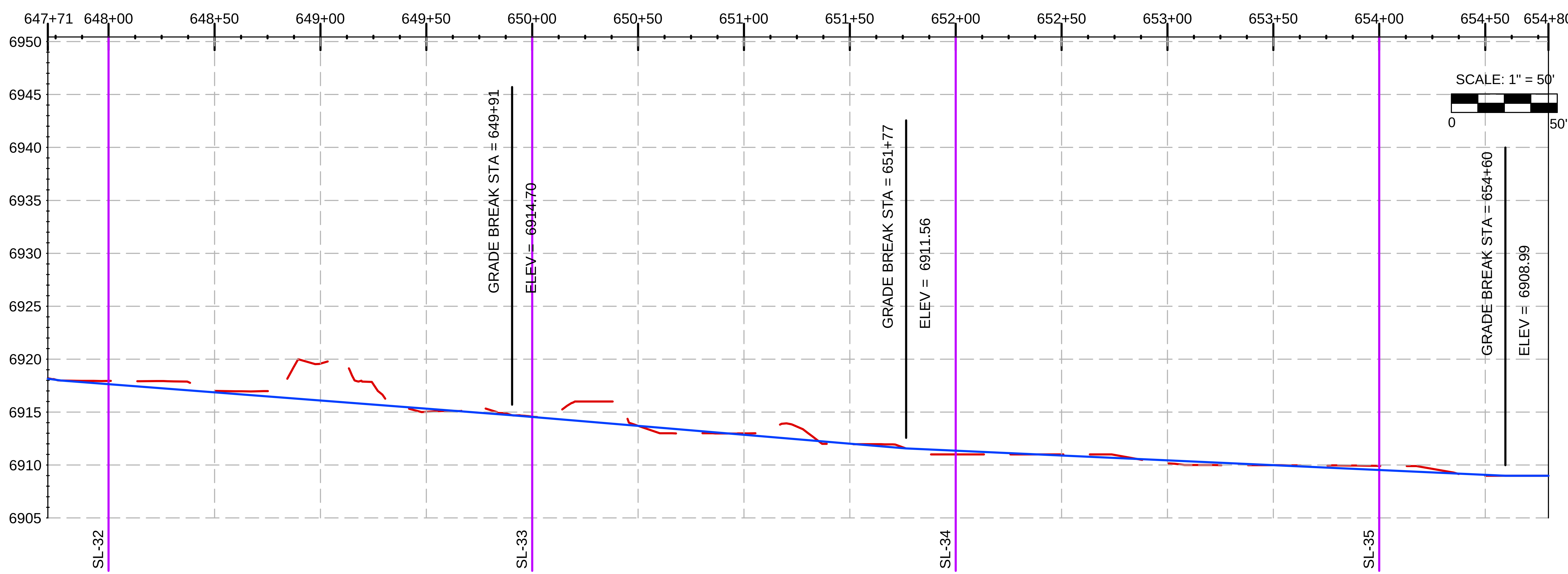

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NORTH FORK BIG THOMPSON RIVER
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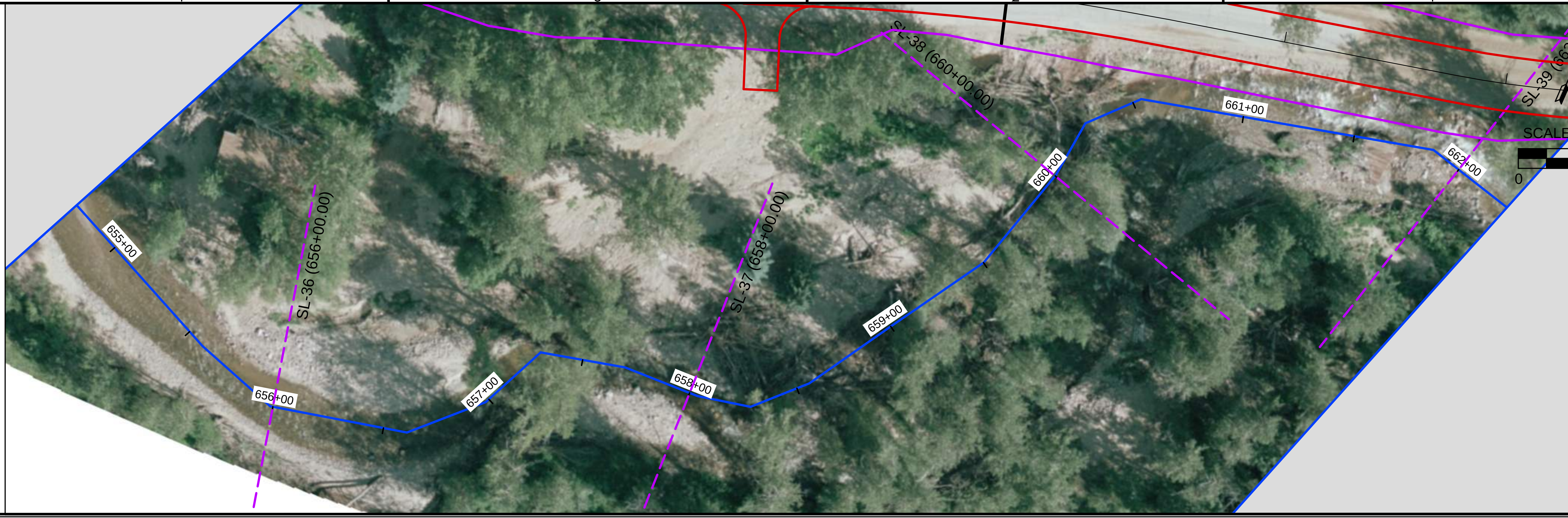

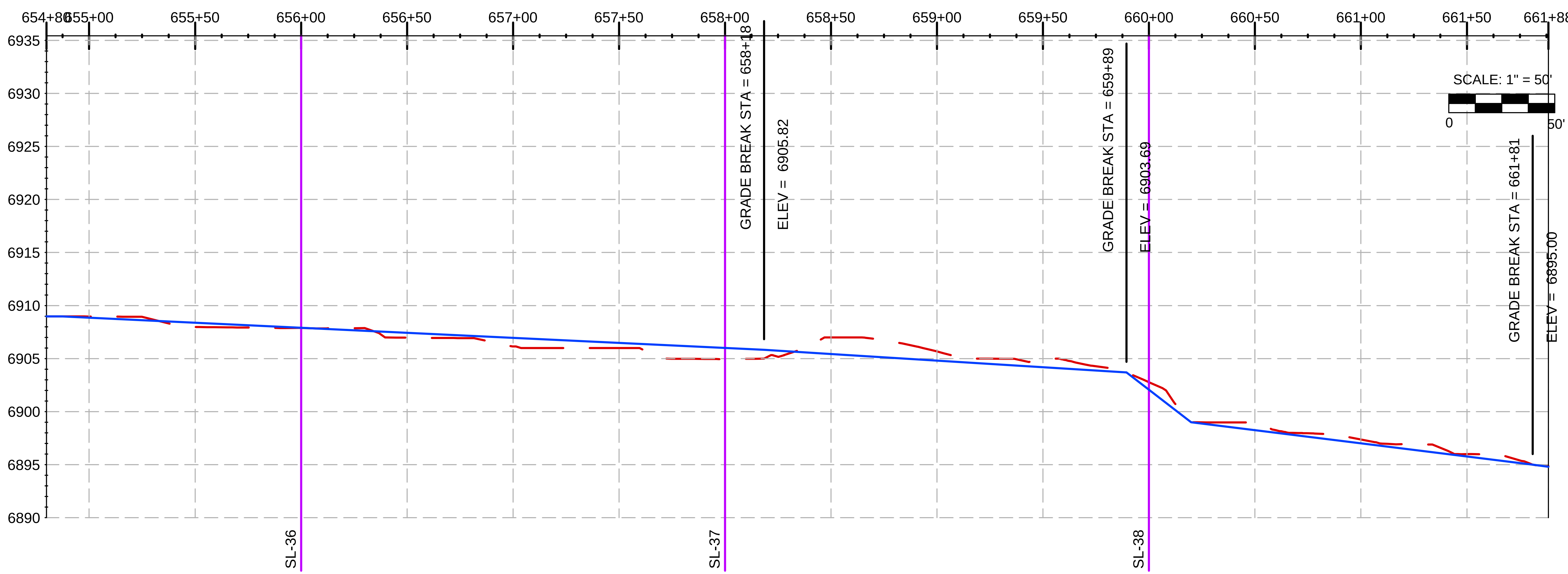

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COUNTY ROAD 43
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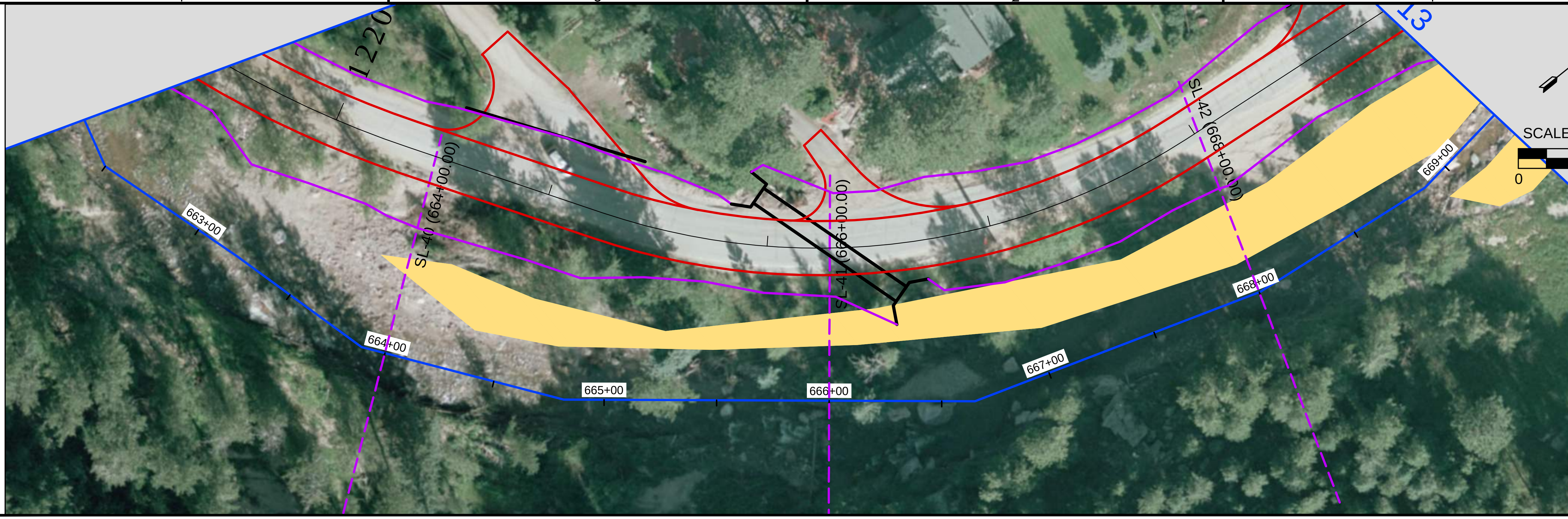

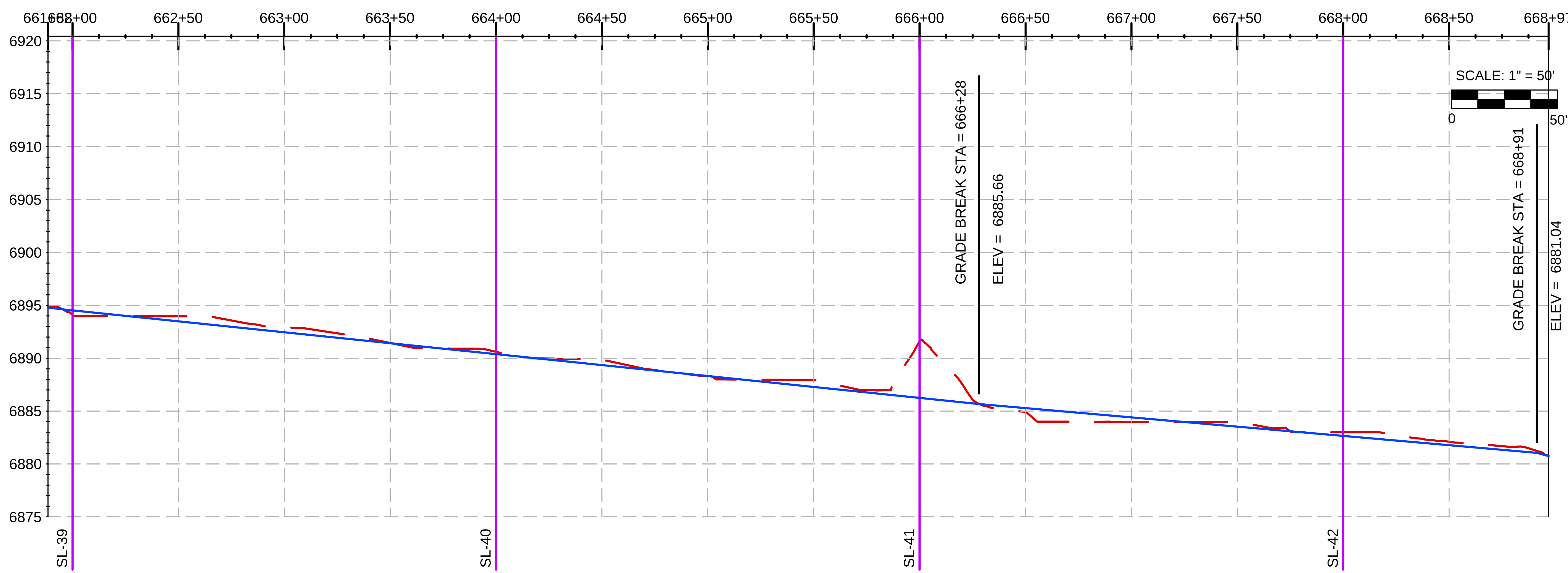

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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
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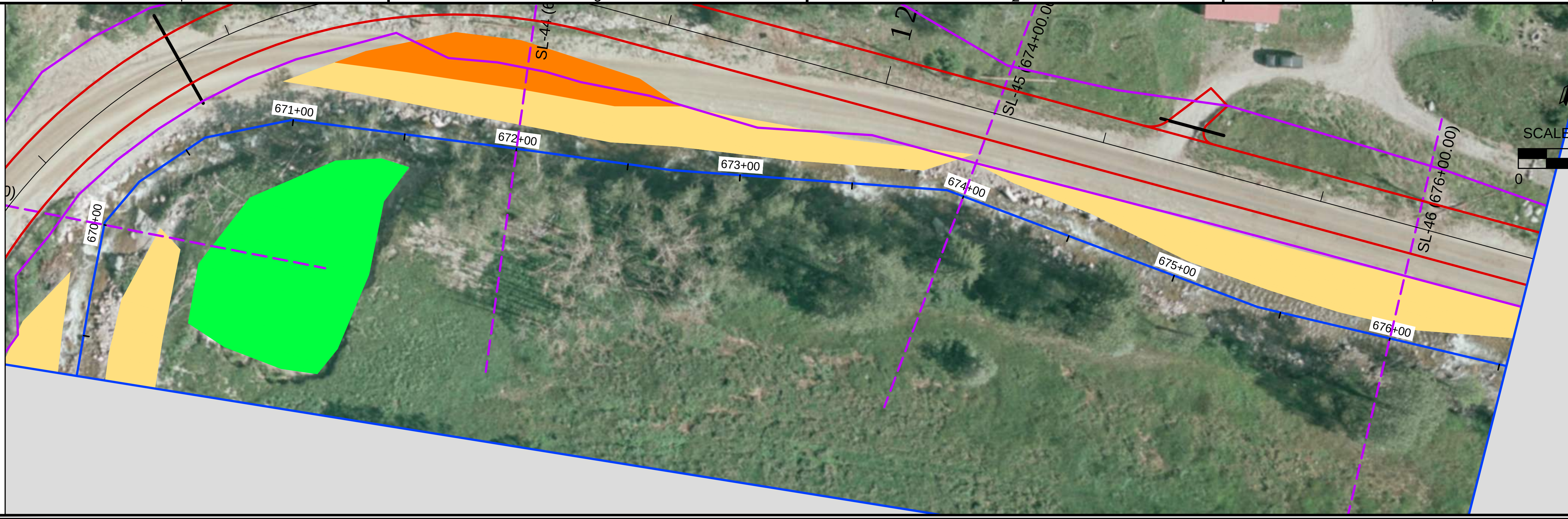

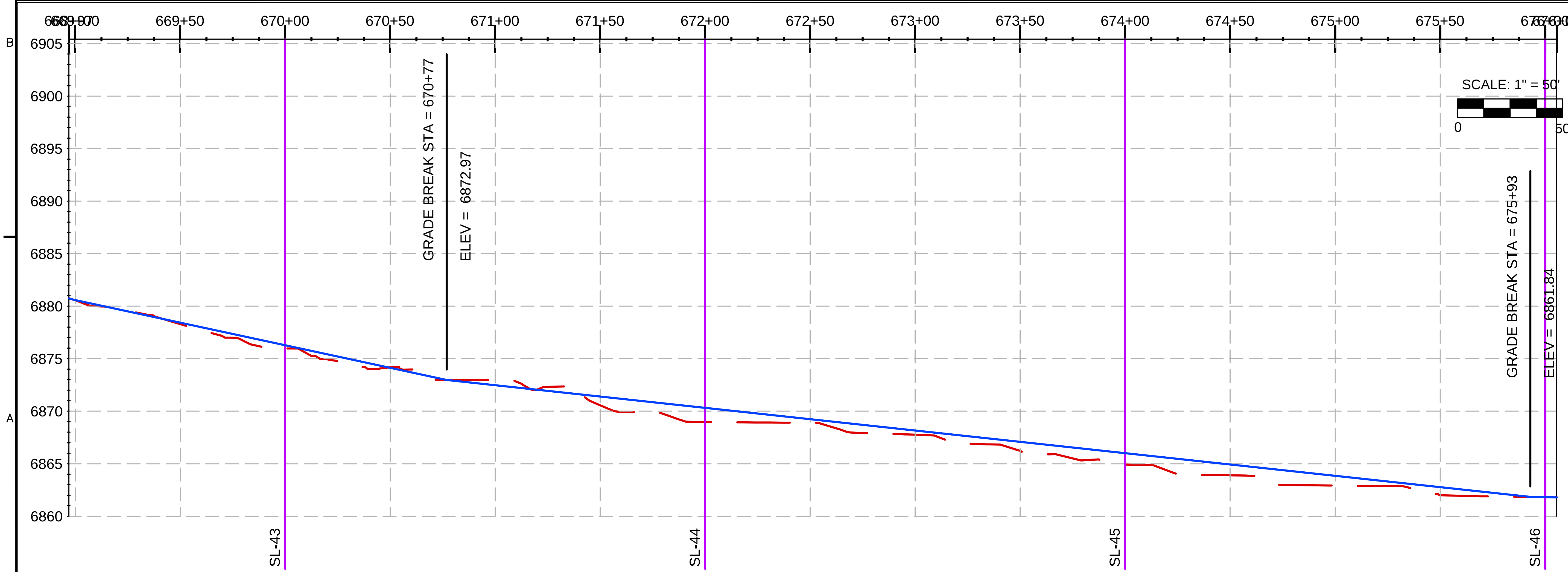

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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
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LARIMER COUNTY, COLORADO

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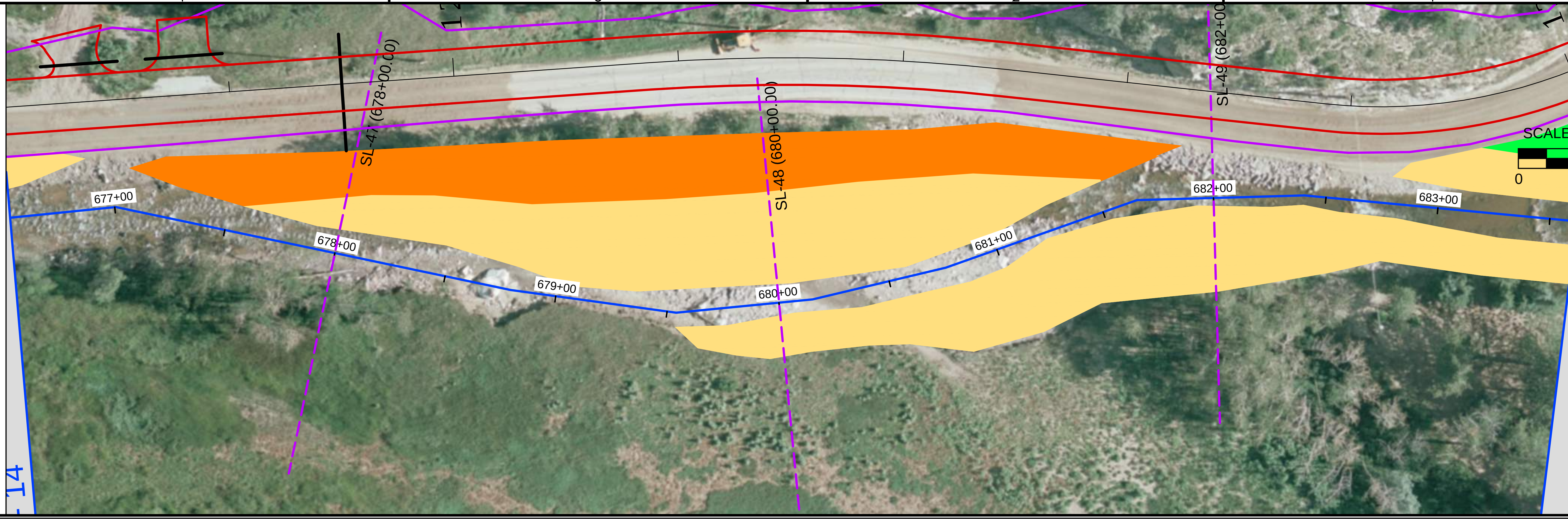

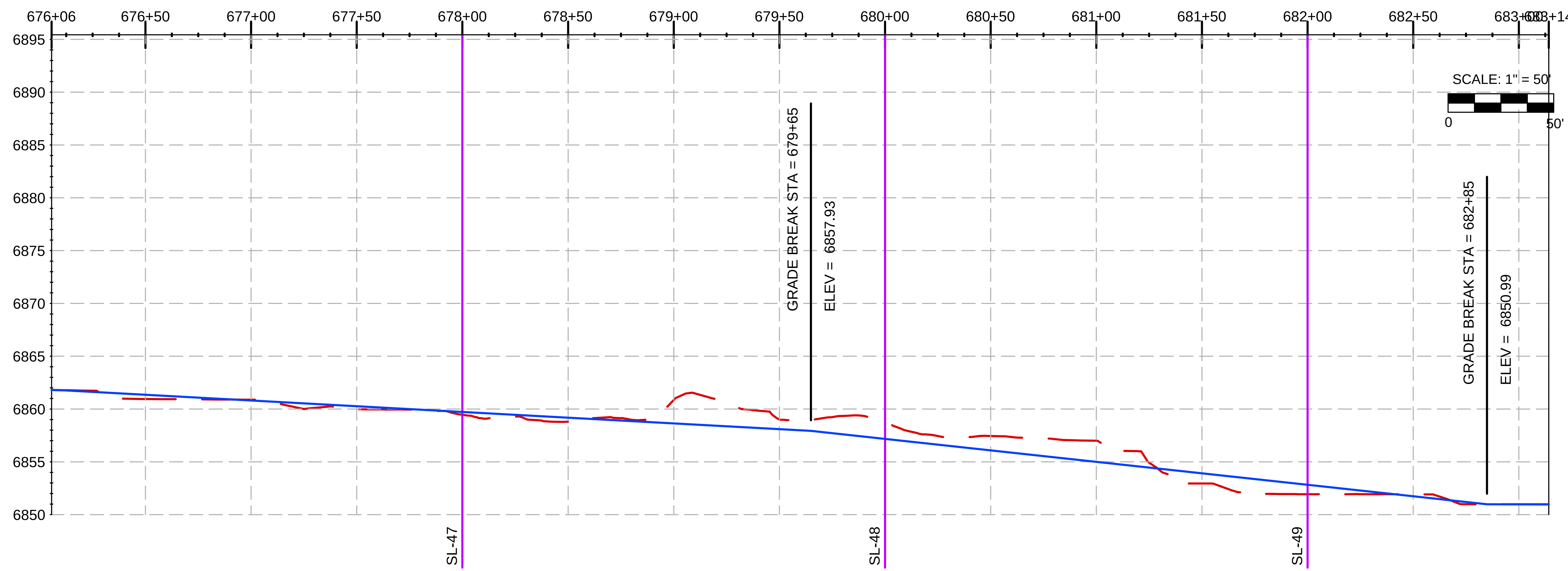

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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

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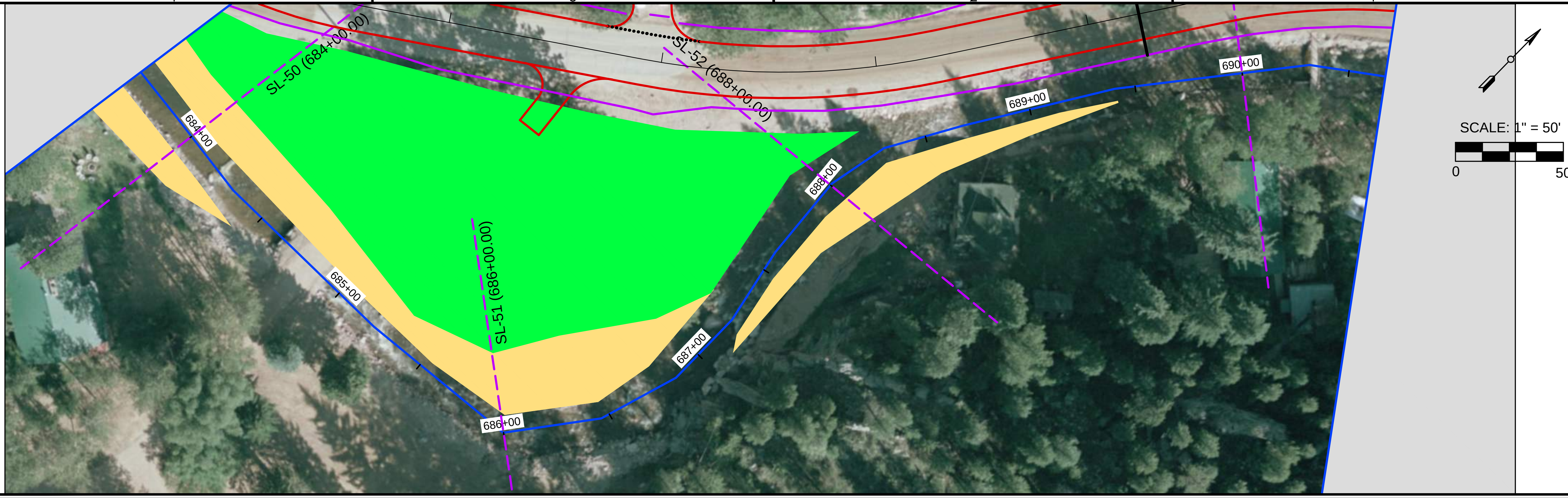

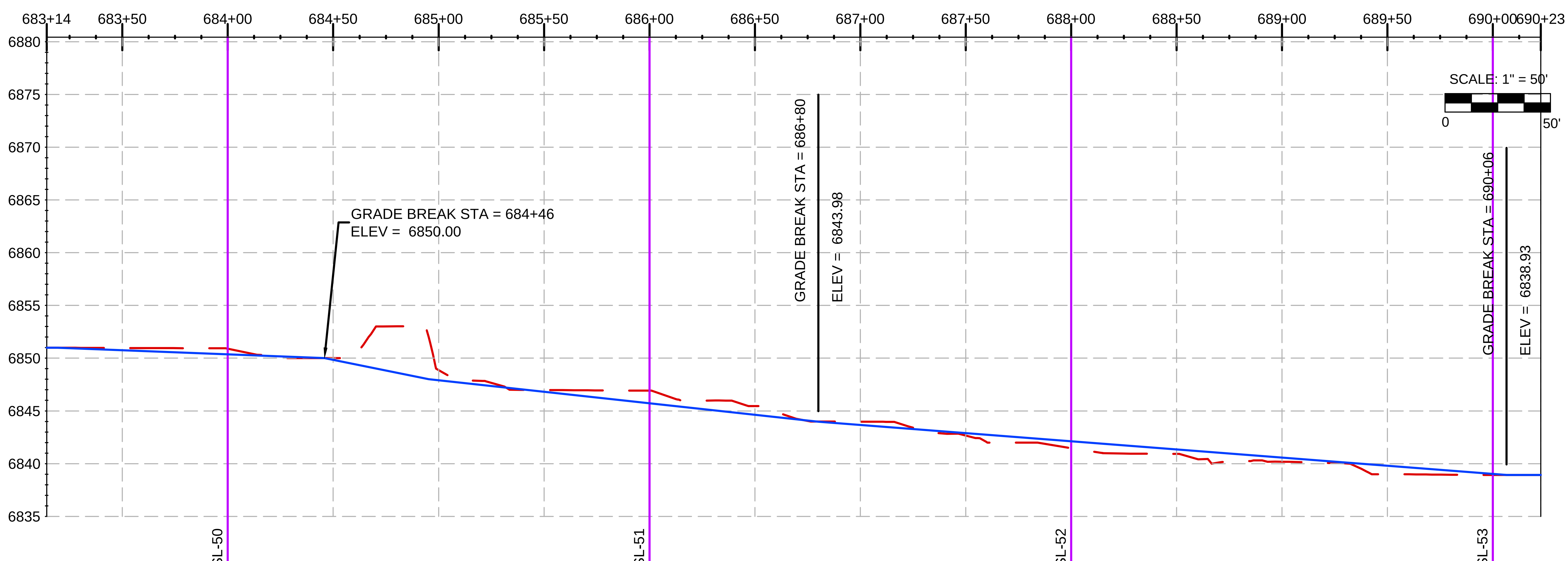

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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

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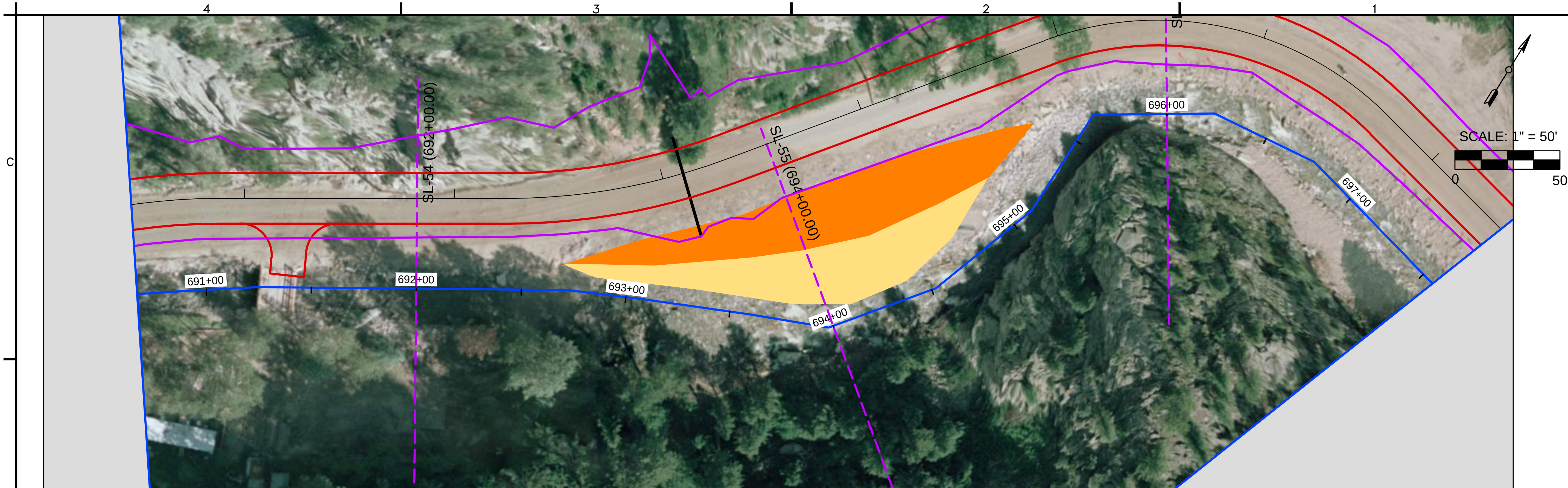

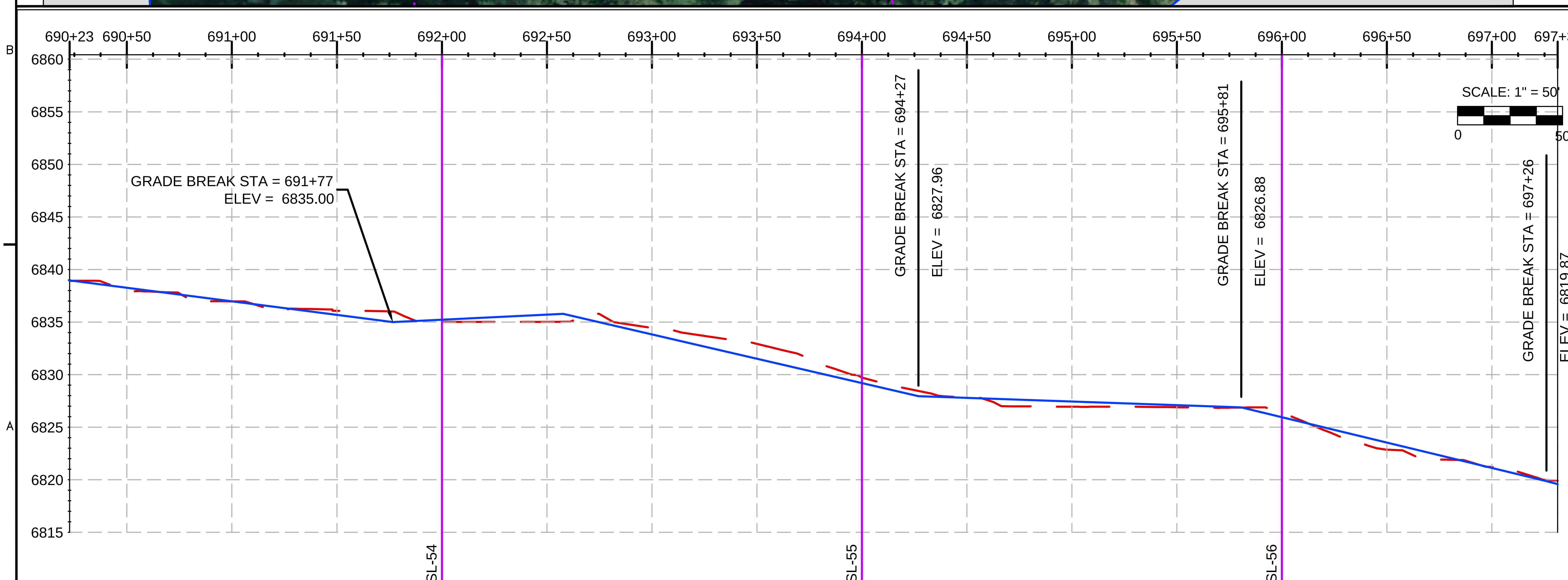

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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

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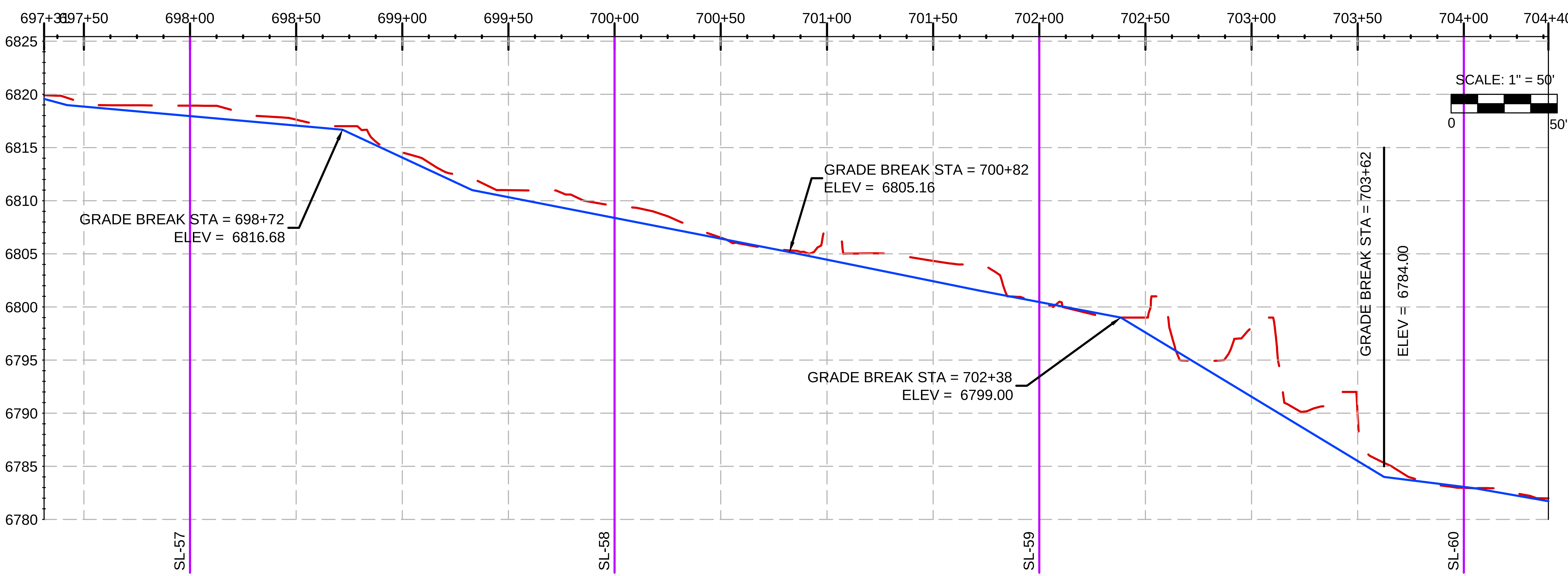

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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
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LARIMER COUNTY, COLORADO

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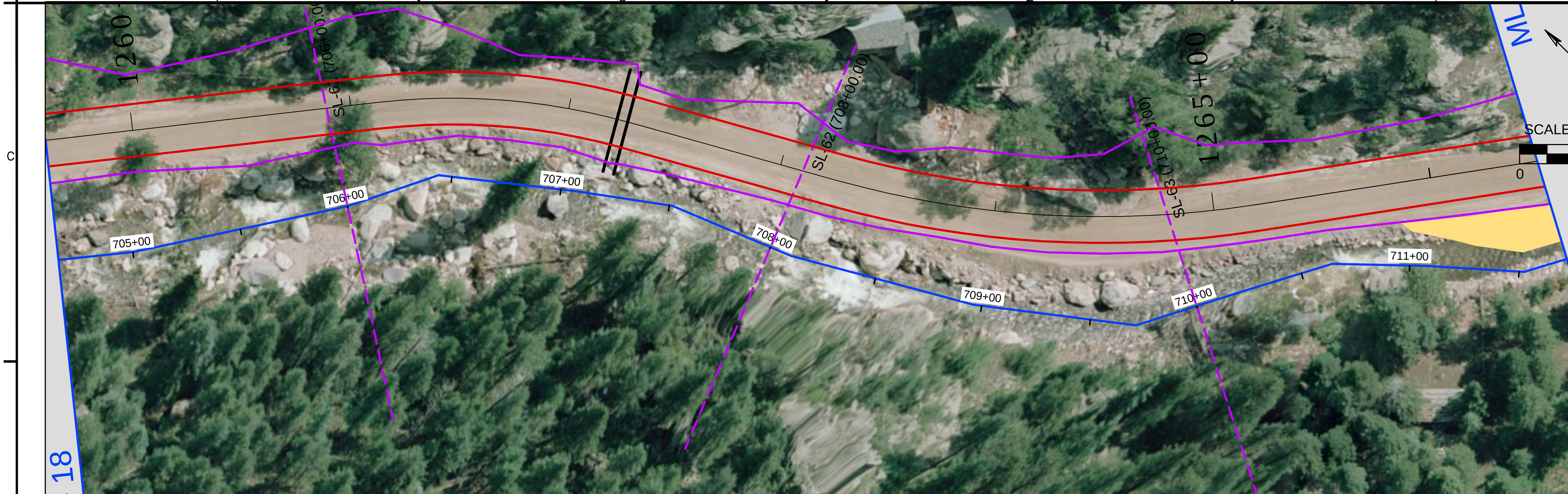

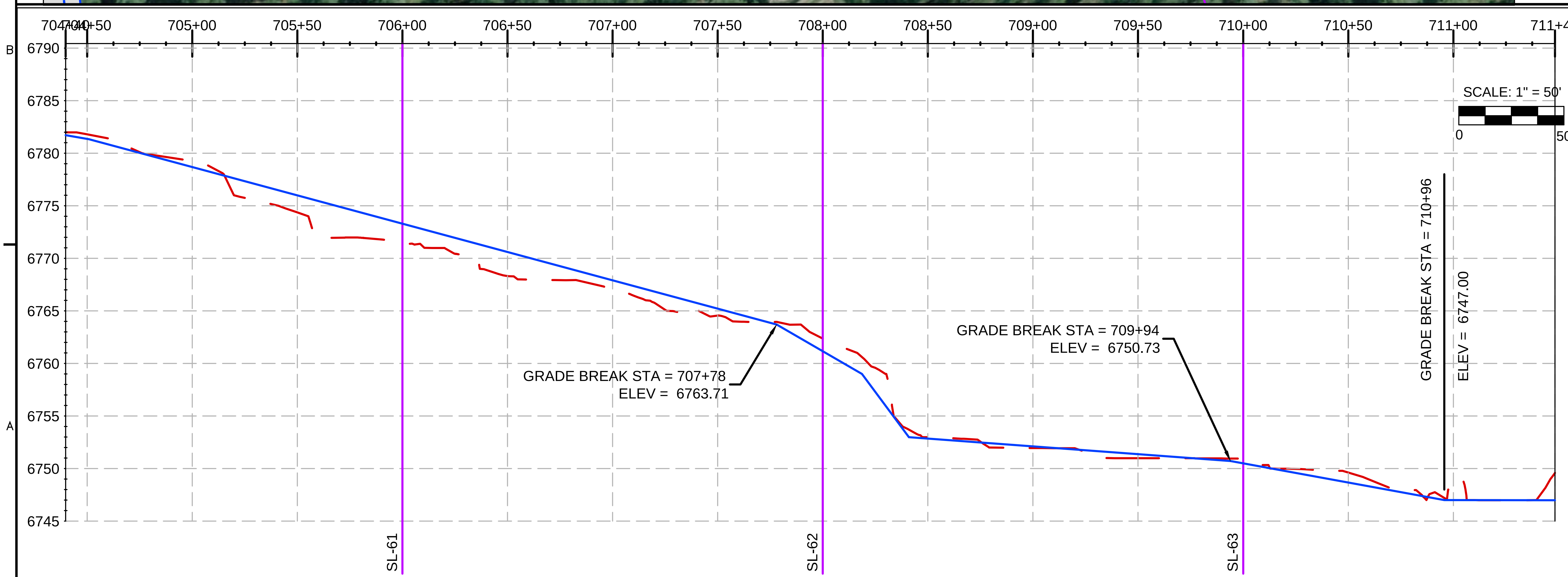

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NORTH FORK BIG THOMPSON RIVER
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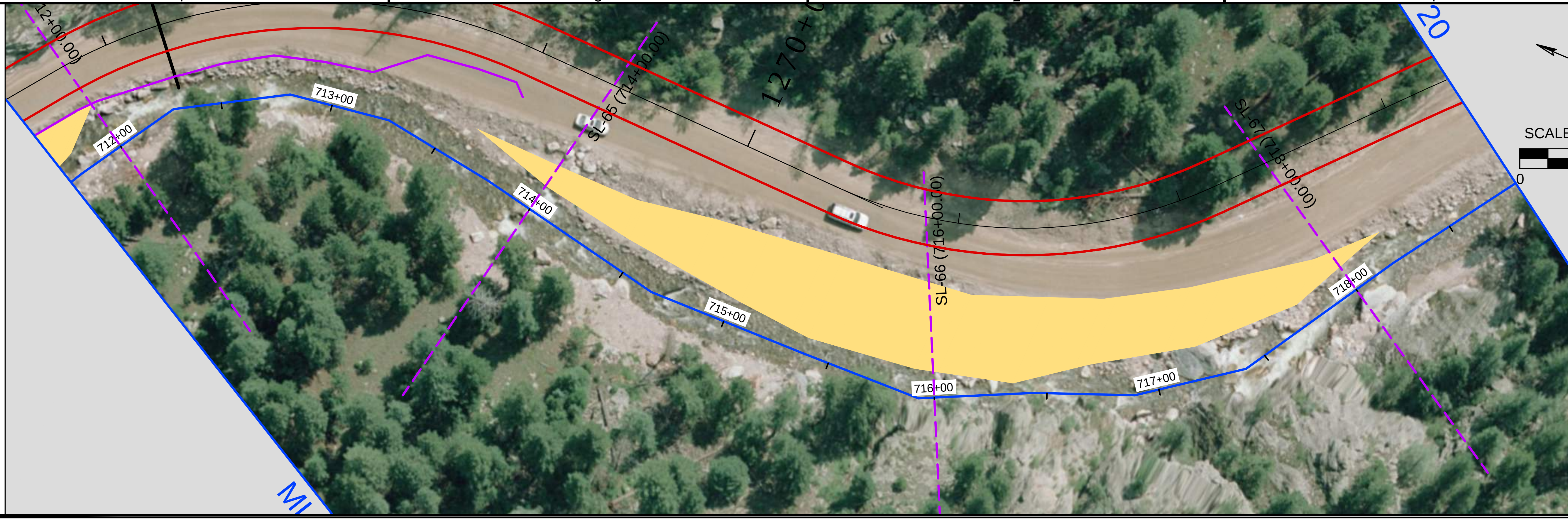

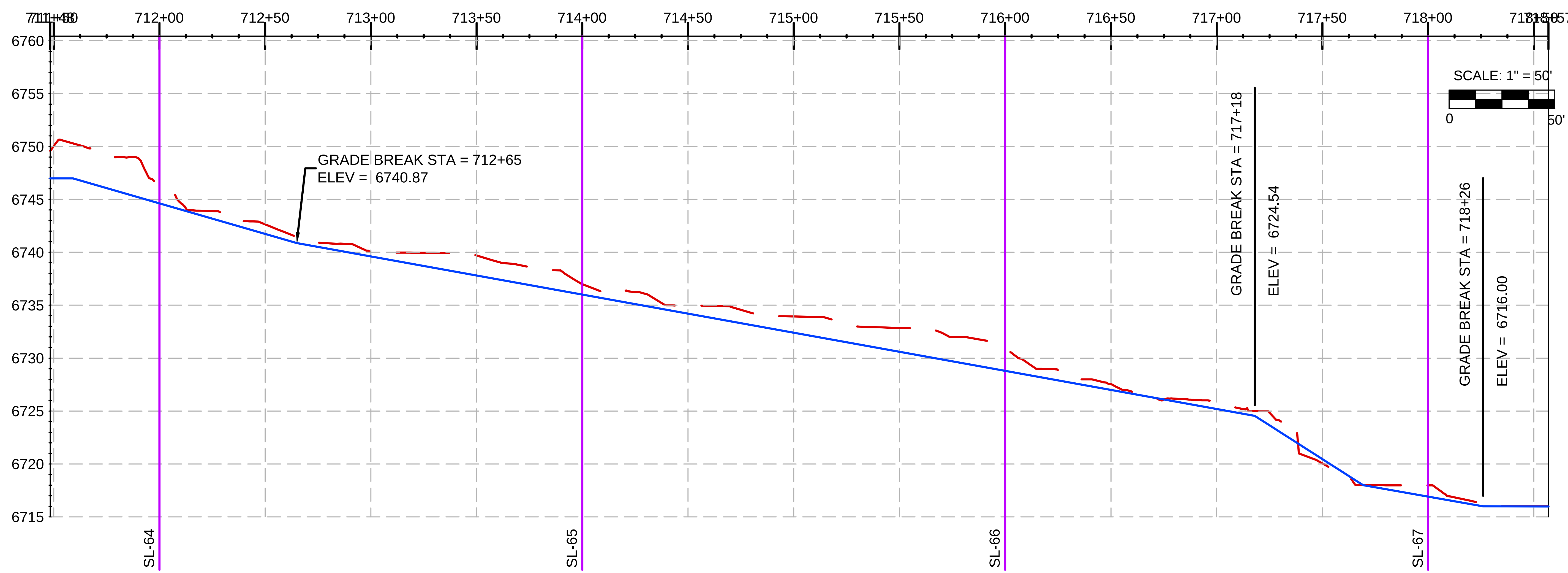

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NORTH FORK BIG THOMPSON RIVER
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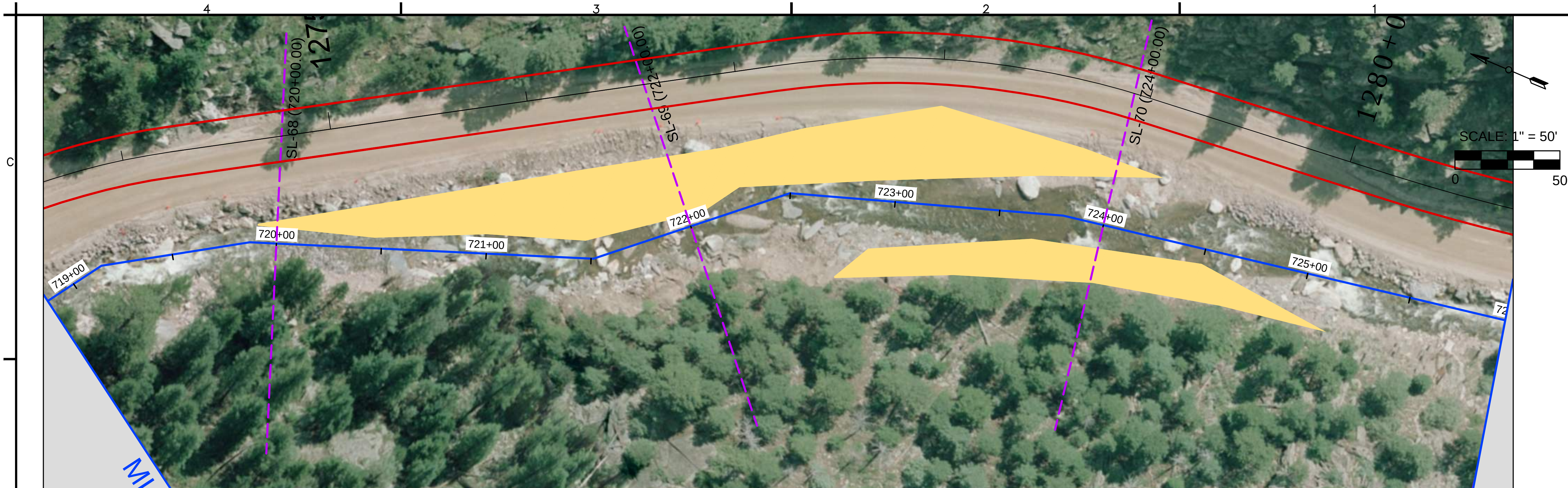

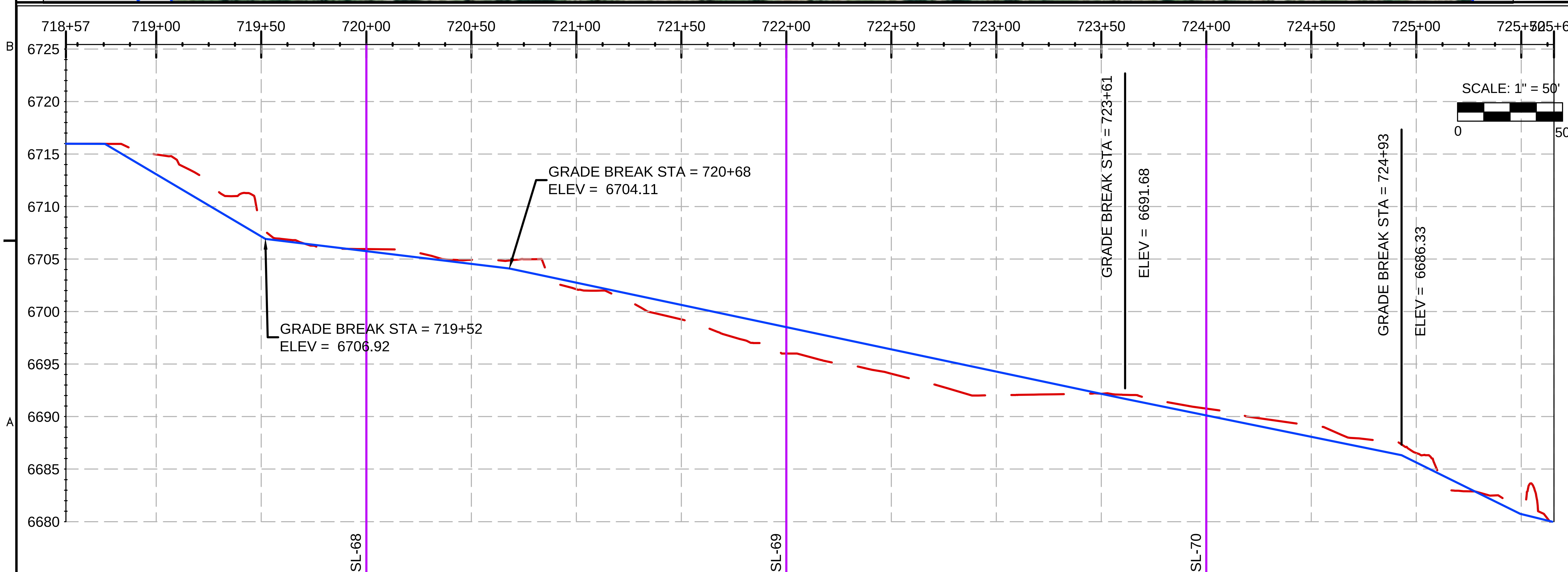

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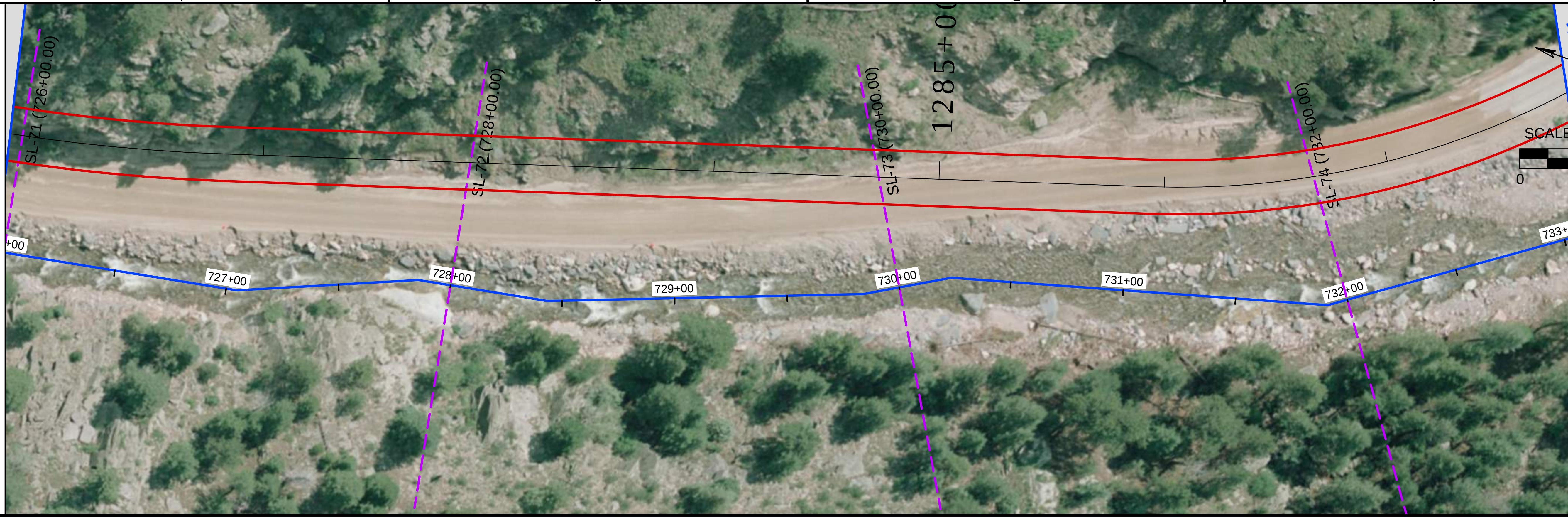

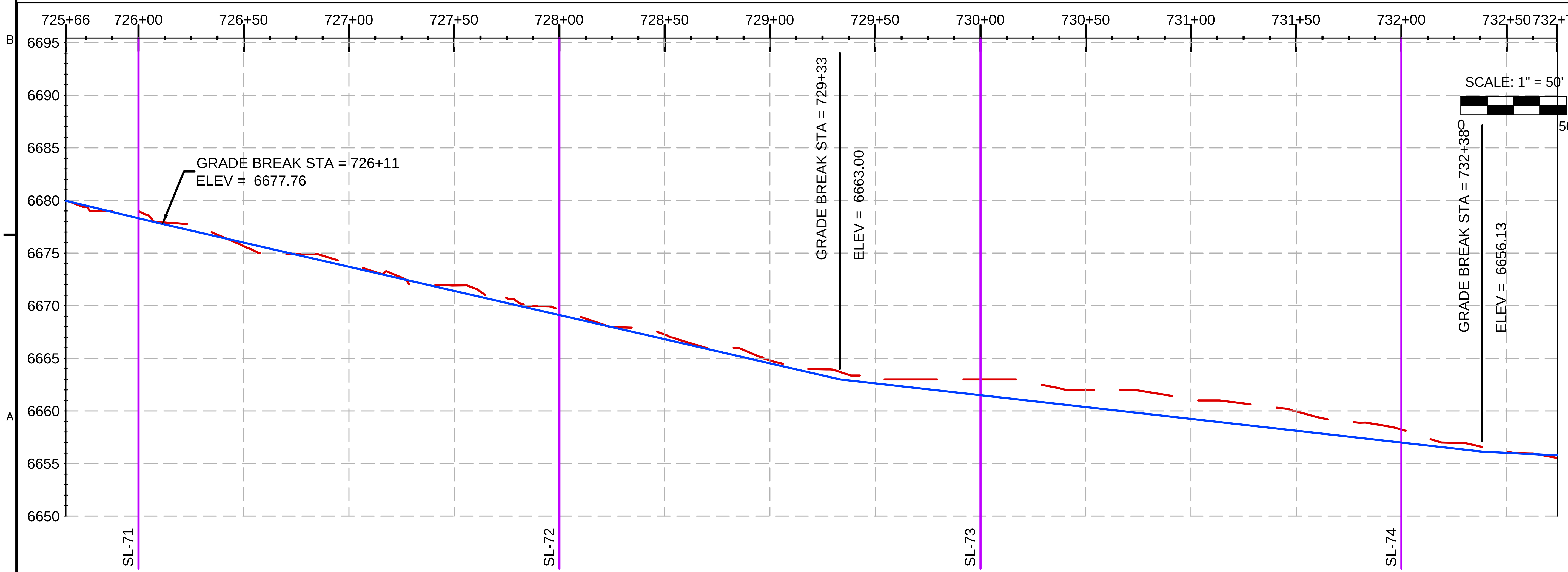

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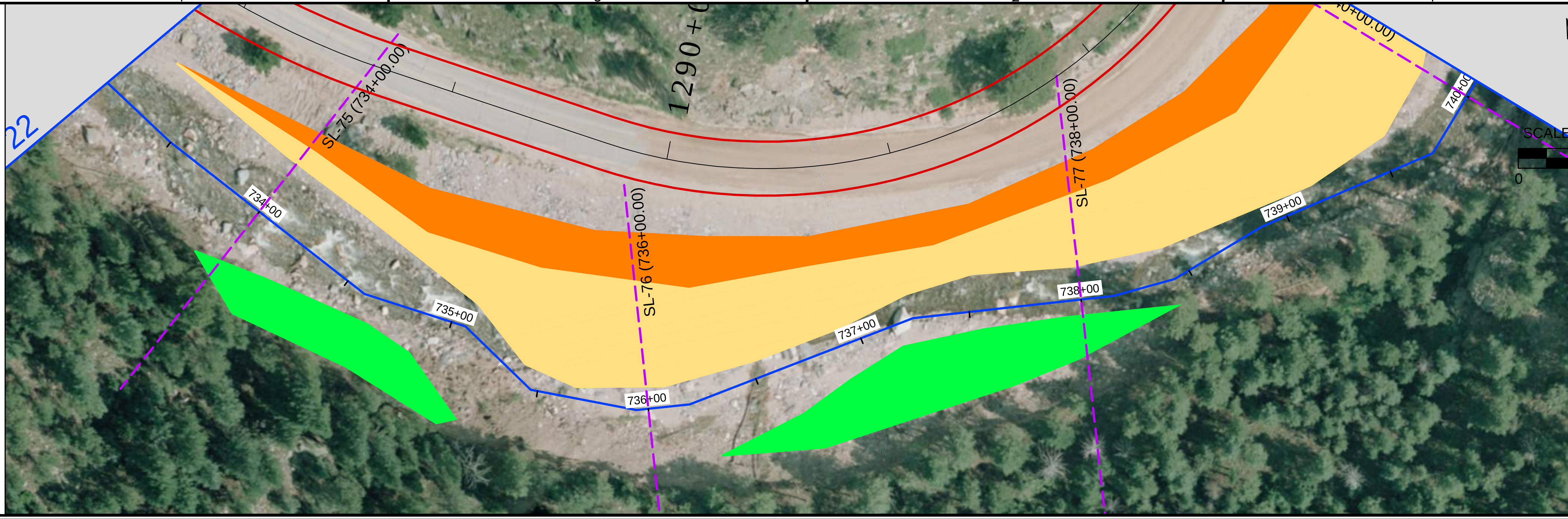

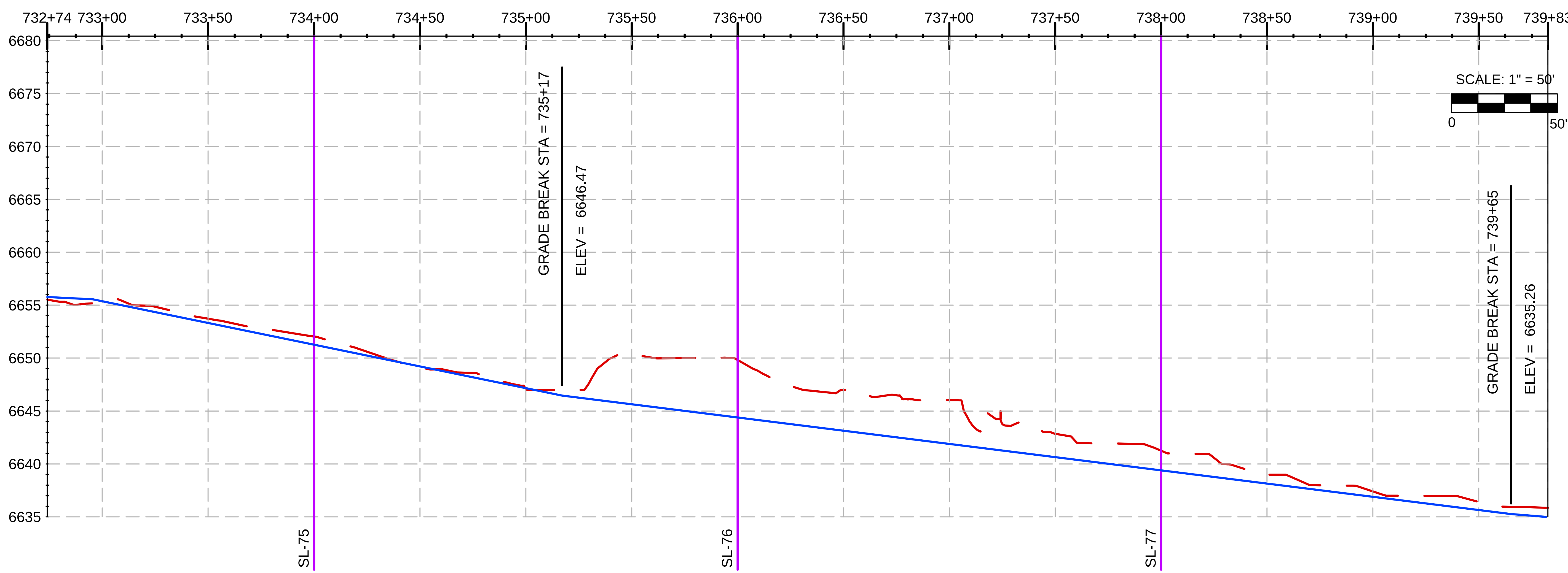

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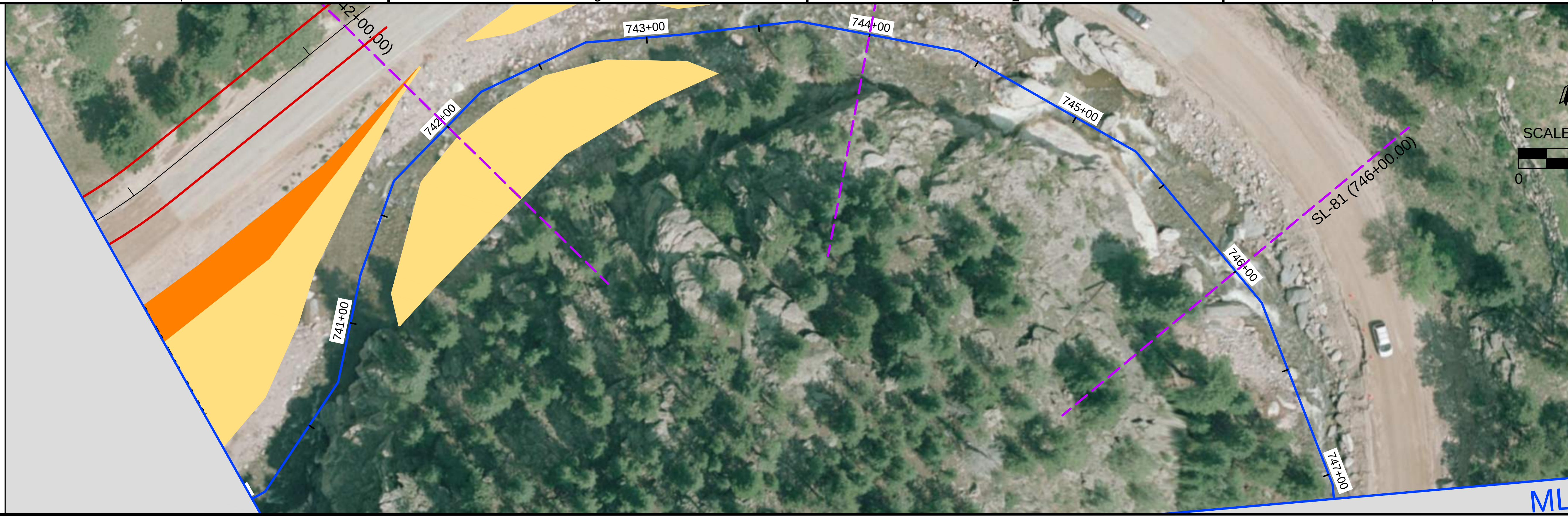

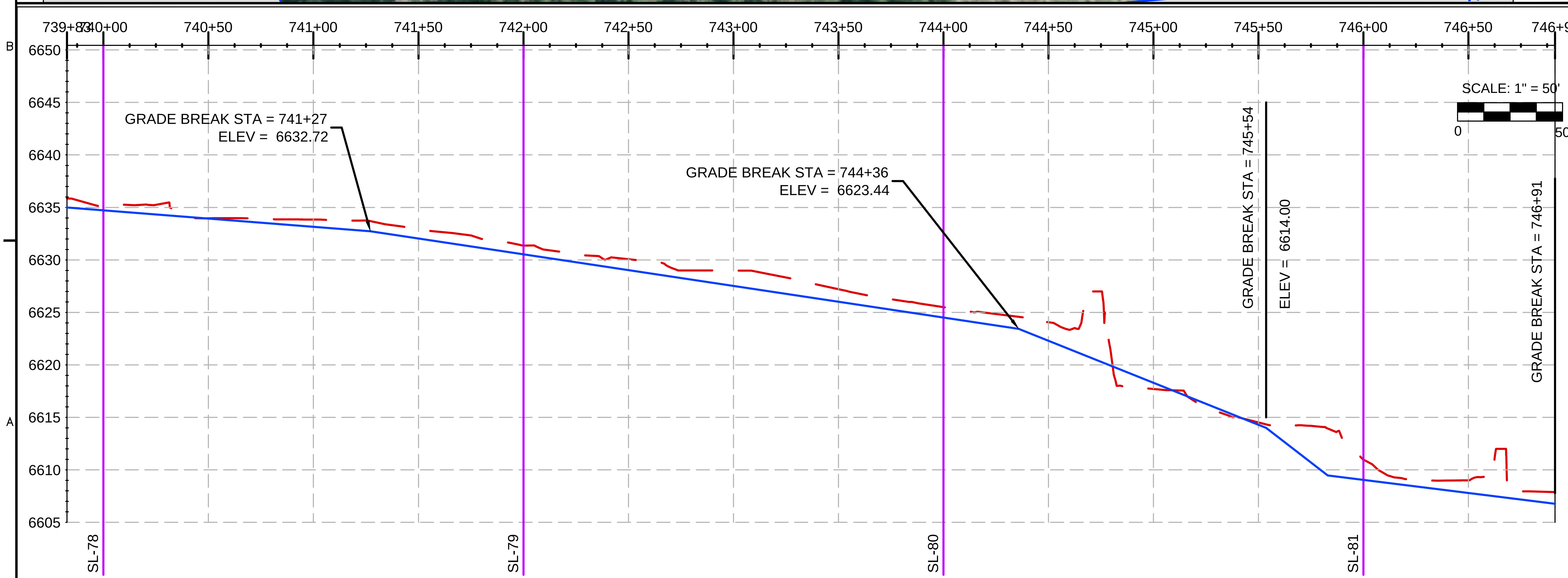

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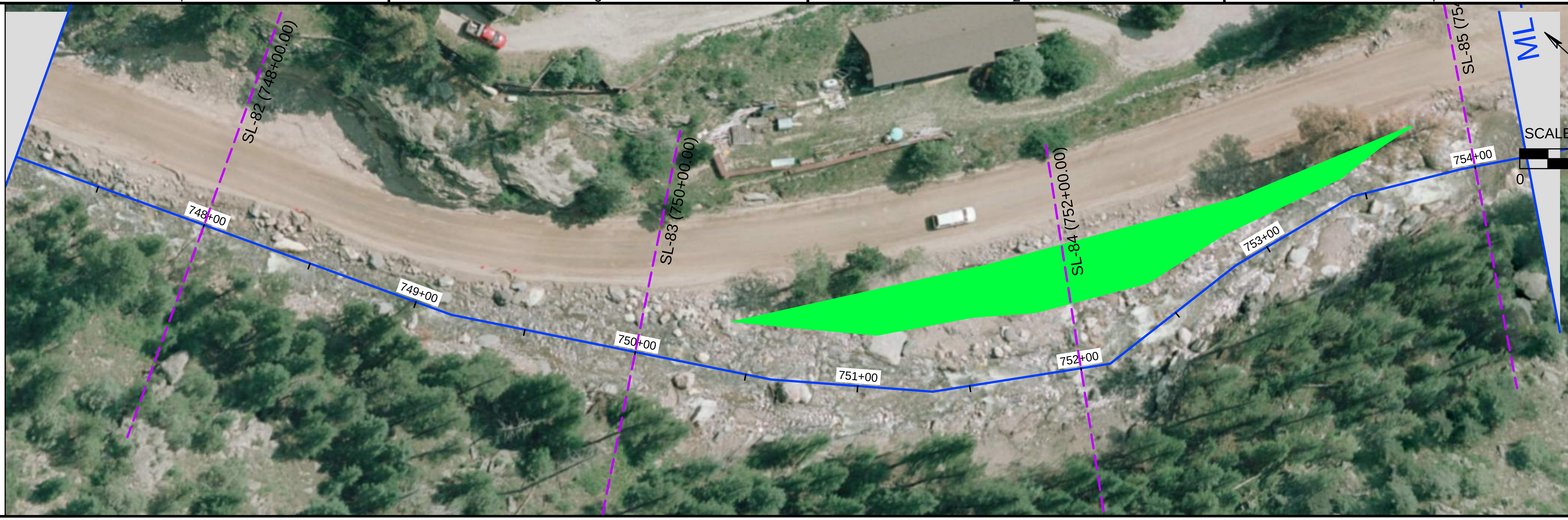

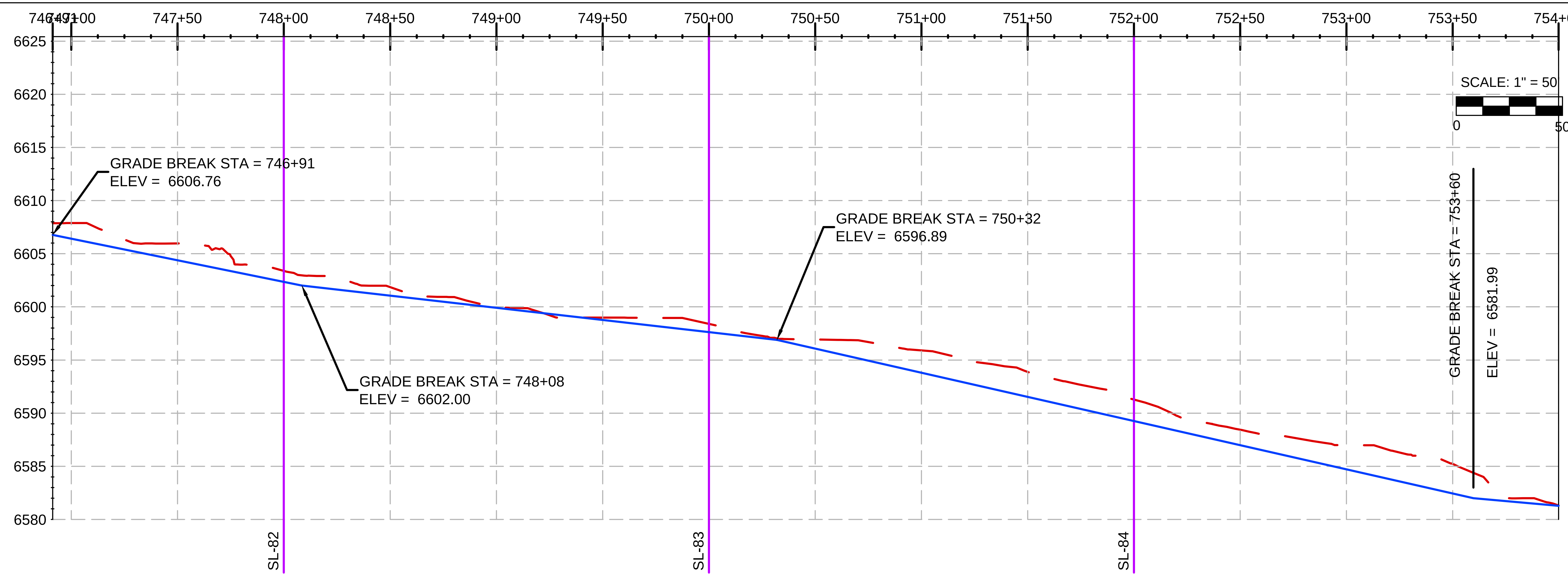

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Reviewed by: JPC		Drawing Code:
Submitted by:		File name: Plot date: Plot scale:

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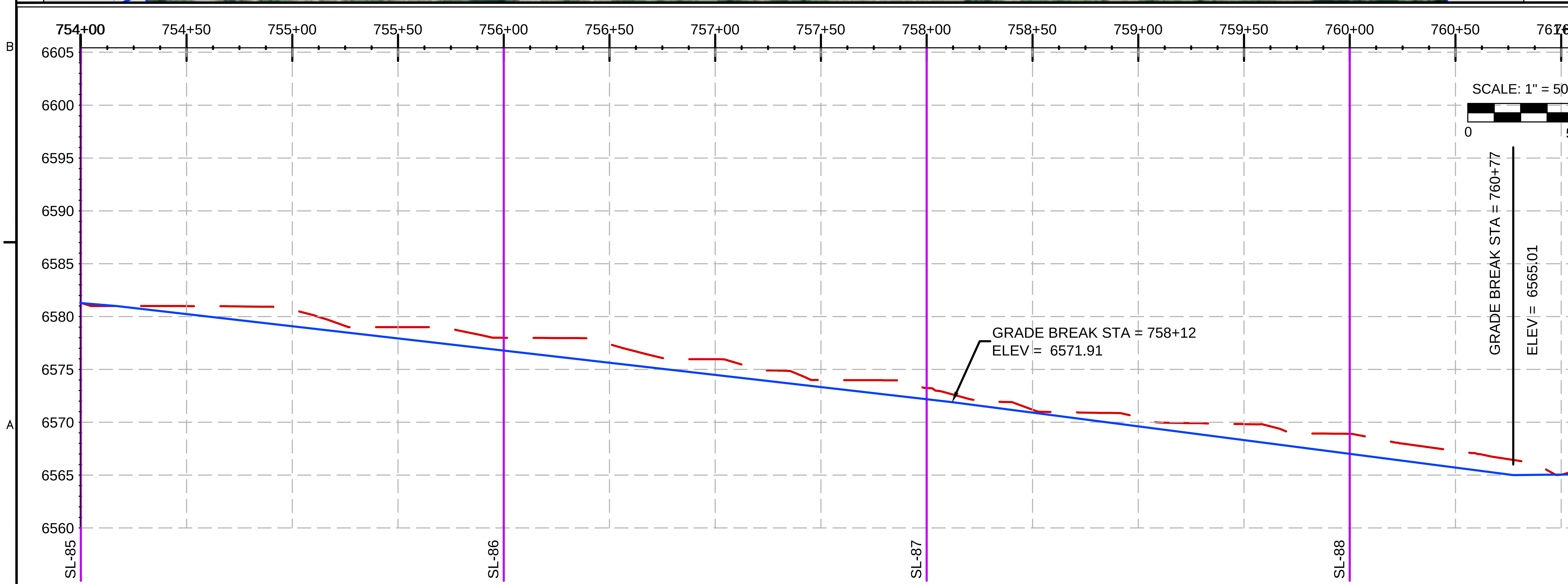
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

PLAN AND PROFILE

Sheet reference number:
18

UPDATE



Designed by: JEFF CRANE	Date: 3/16/2016	Rev.
Dwn by:	Ckd by:	Design file no:
Reviewed by: JPC		Drawing Code:
Submitted by:		File name: / Plot date: / Plot scale:

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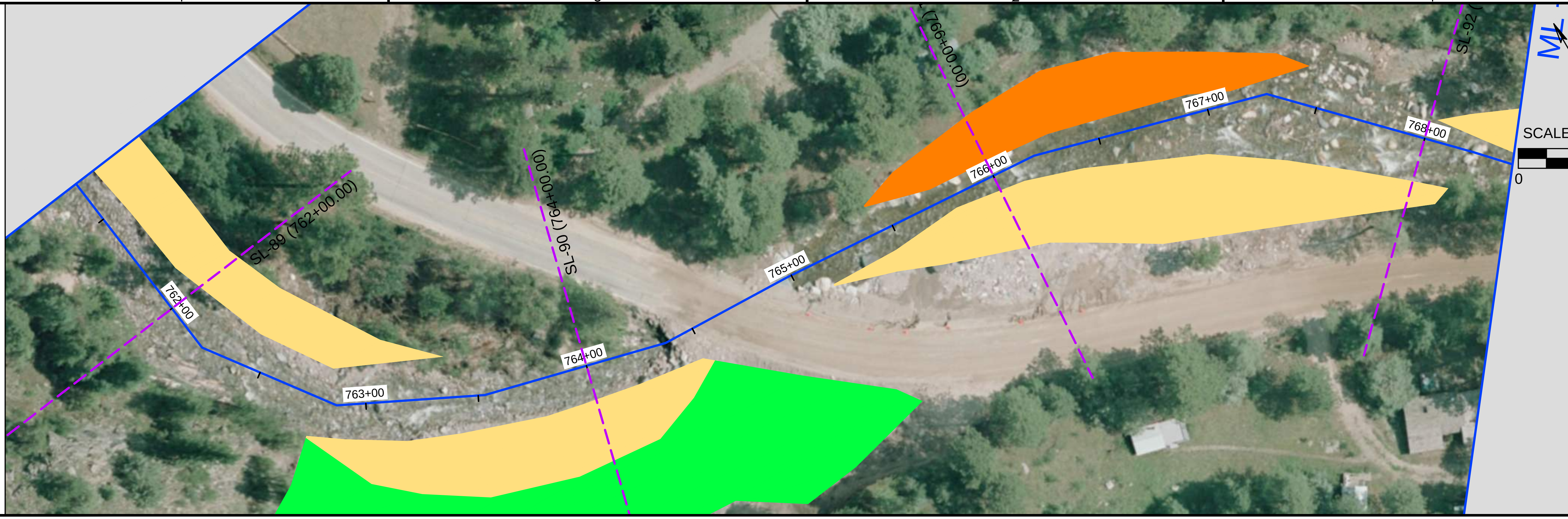
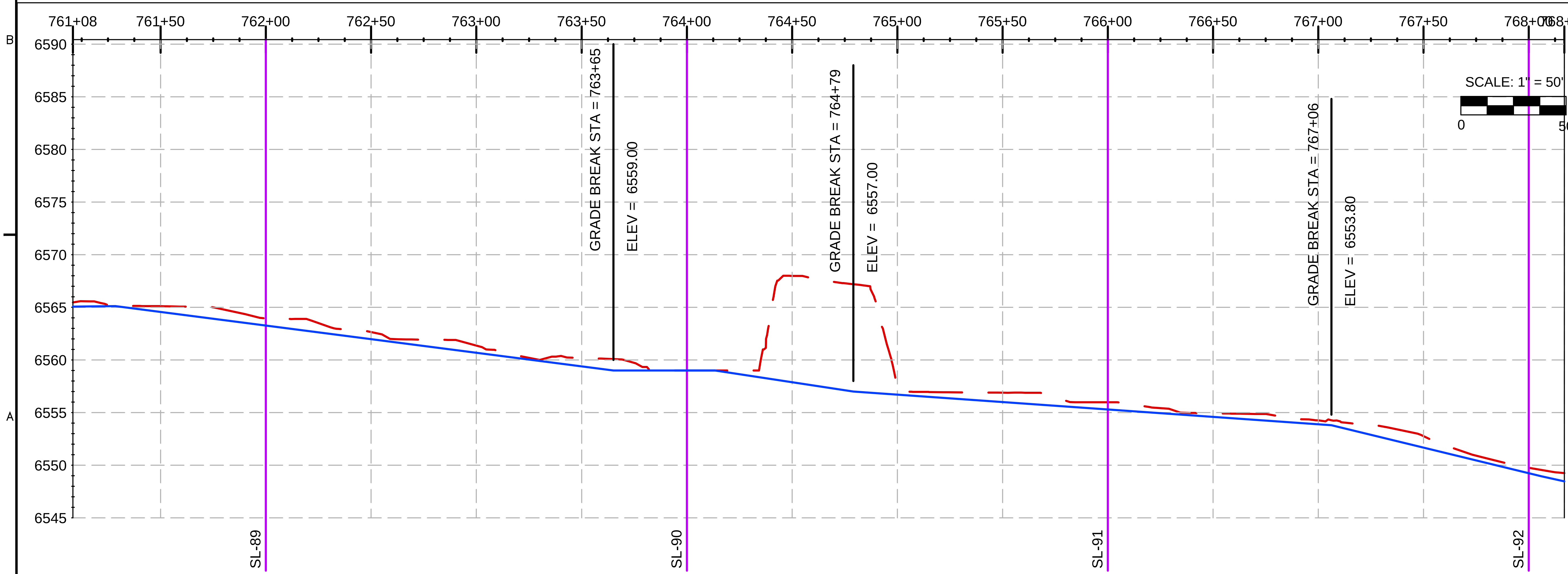
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

PLAN AND PROFILE

Sheet reference number:
19

UPDATE





Symbol	Description	Date	Approved

CRANE ASSOCIATES

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Date: 3/16/2016	Designed by: JEFF CRANE	
Design file no:	Dwn by:	Ckd by:
Drawing Code:	Reviewed by: JPC	
File name: Plot date: Plot scale:	Submitted by:	

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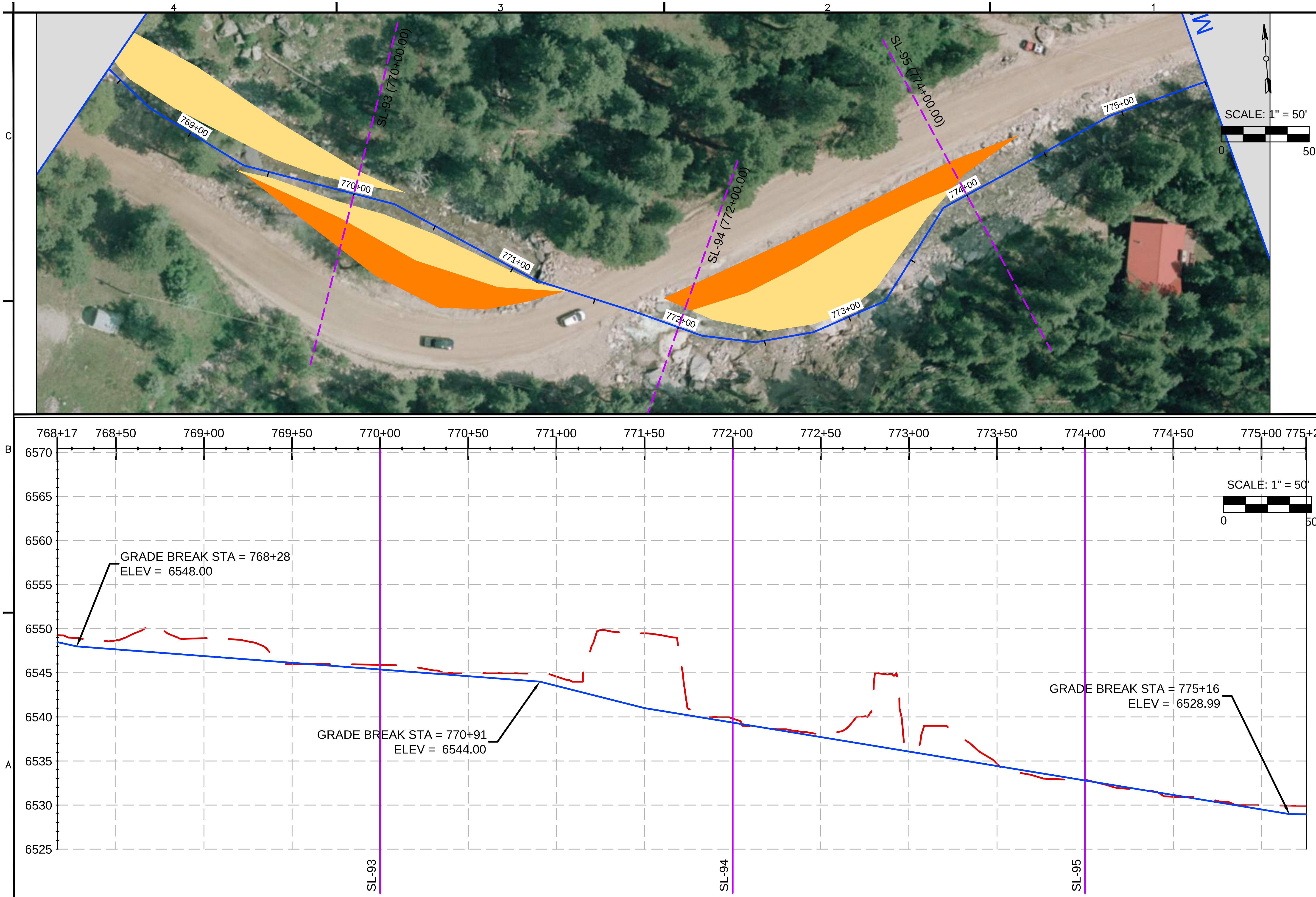
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

PLAN AND PROFILE

Sheet reference number:
20

UPDATE



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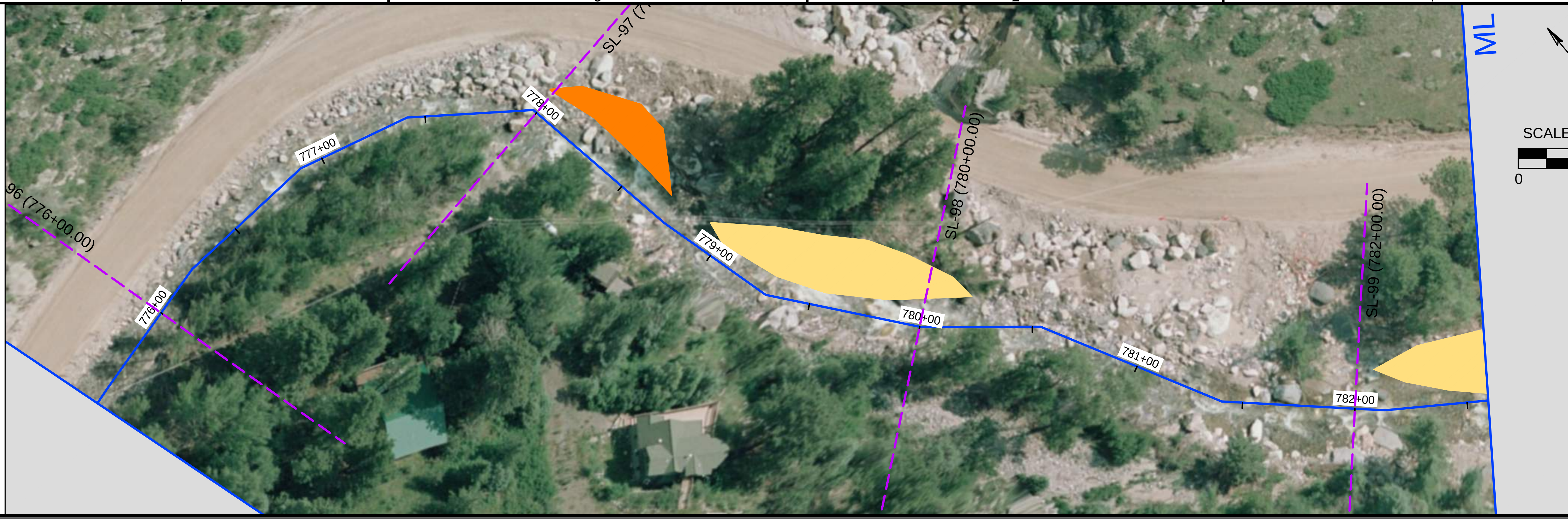
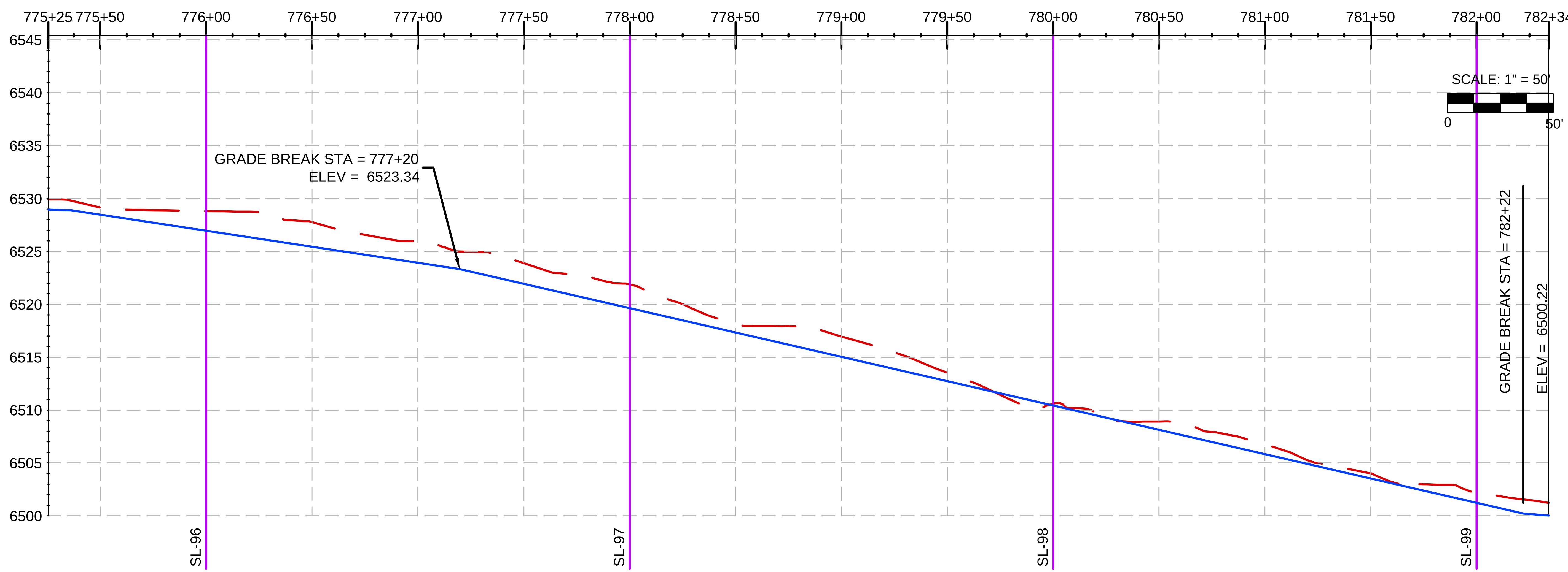
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

PLAN AND PROFILE

Sheet reference number:
21

UPDATE





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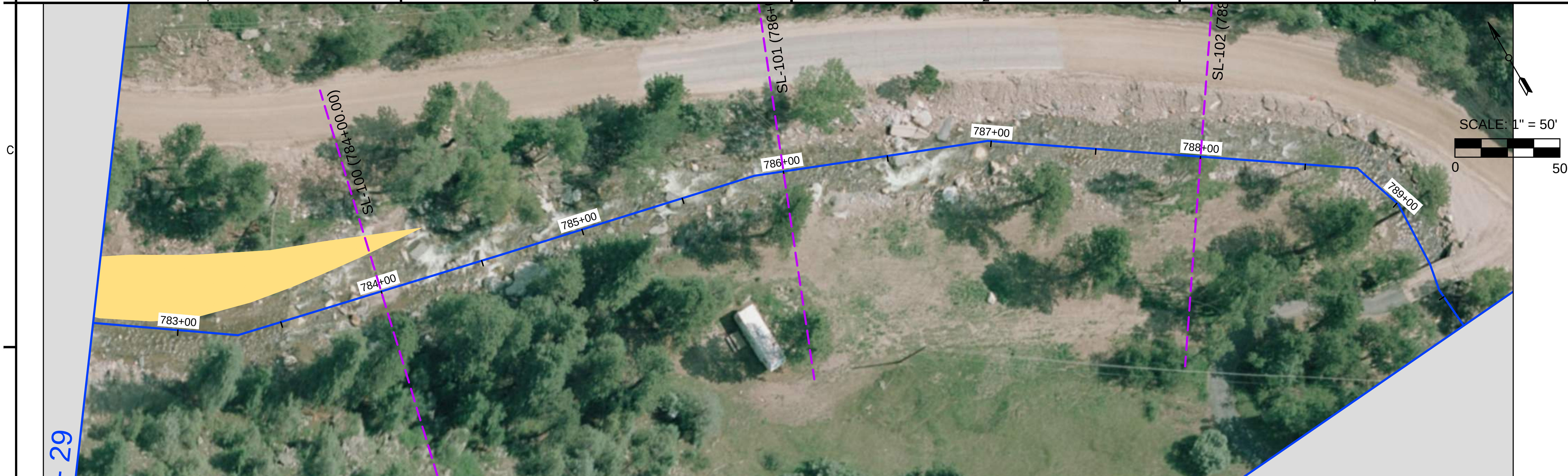
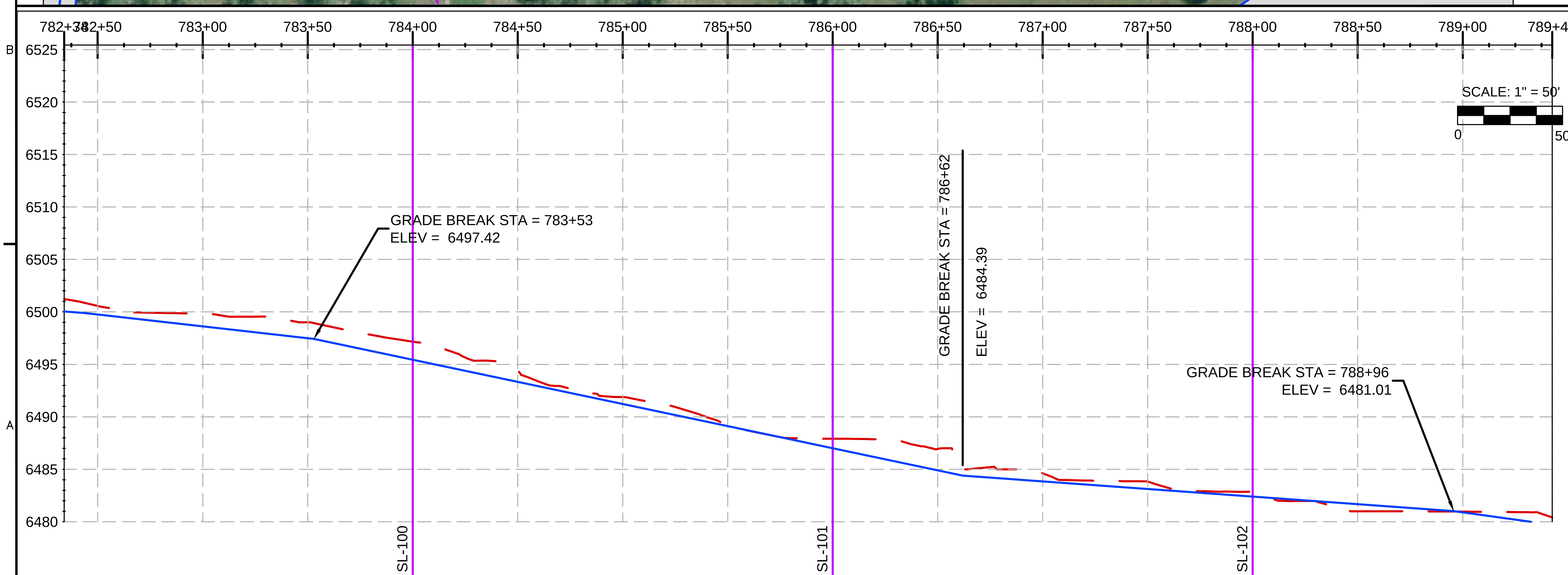
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

PLAN AND PROFILE

Sheet reference number:
22

UPDATE





Symbol	Description	Date	Approved

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Date: 3/16/2016

Design file no:

Drawing Code:

File name:
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Plot scale:

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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
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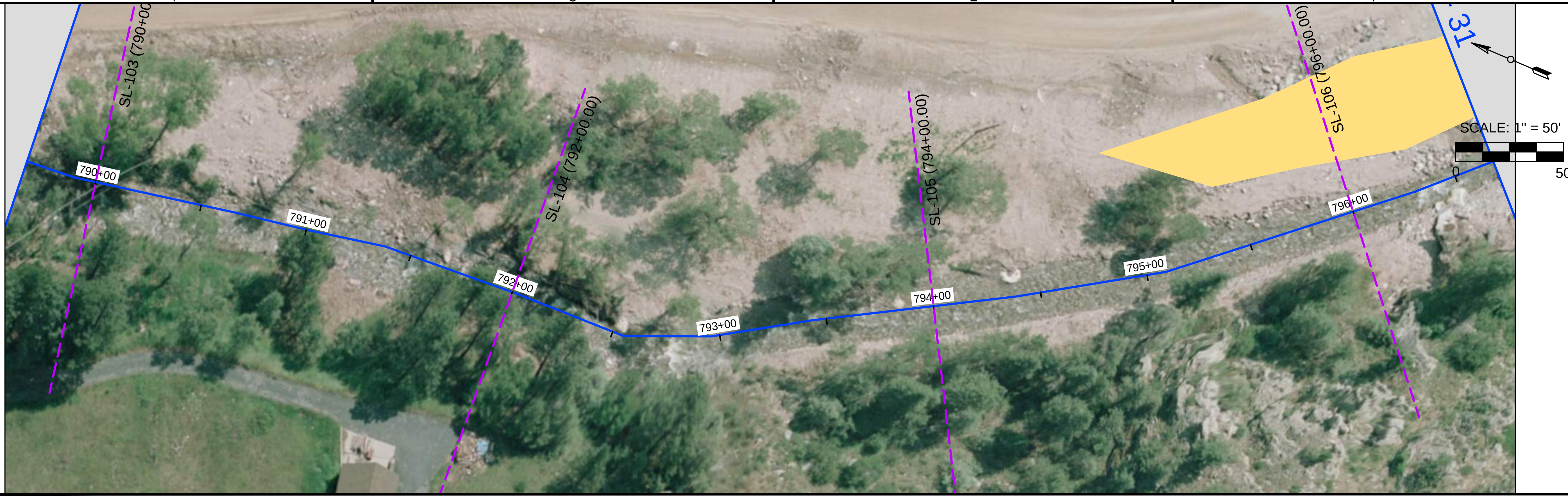
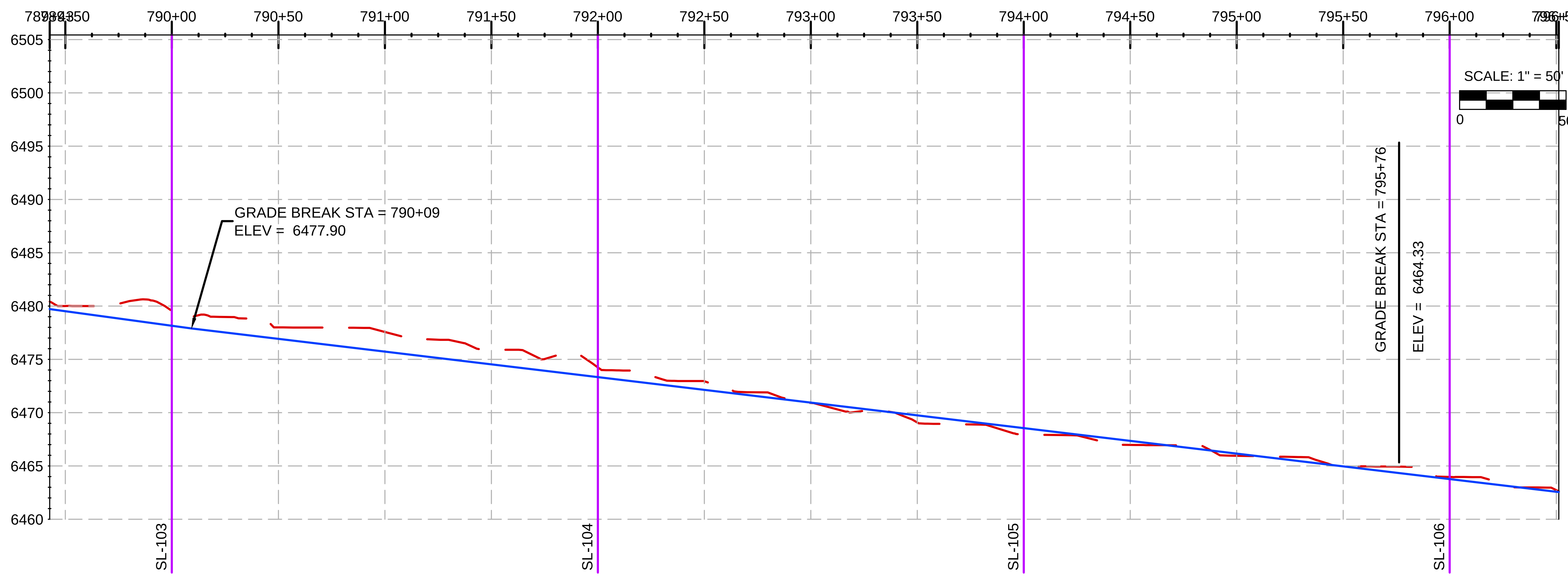
LARIMER COUNTY, COLORADO

PLAN AND PROFILE

Sheet reference number:
23

UPDATE





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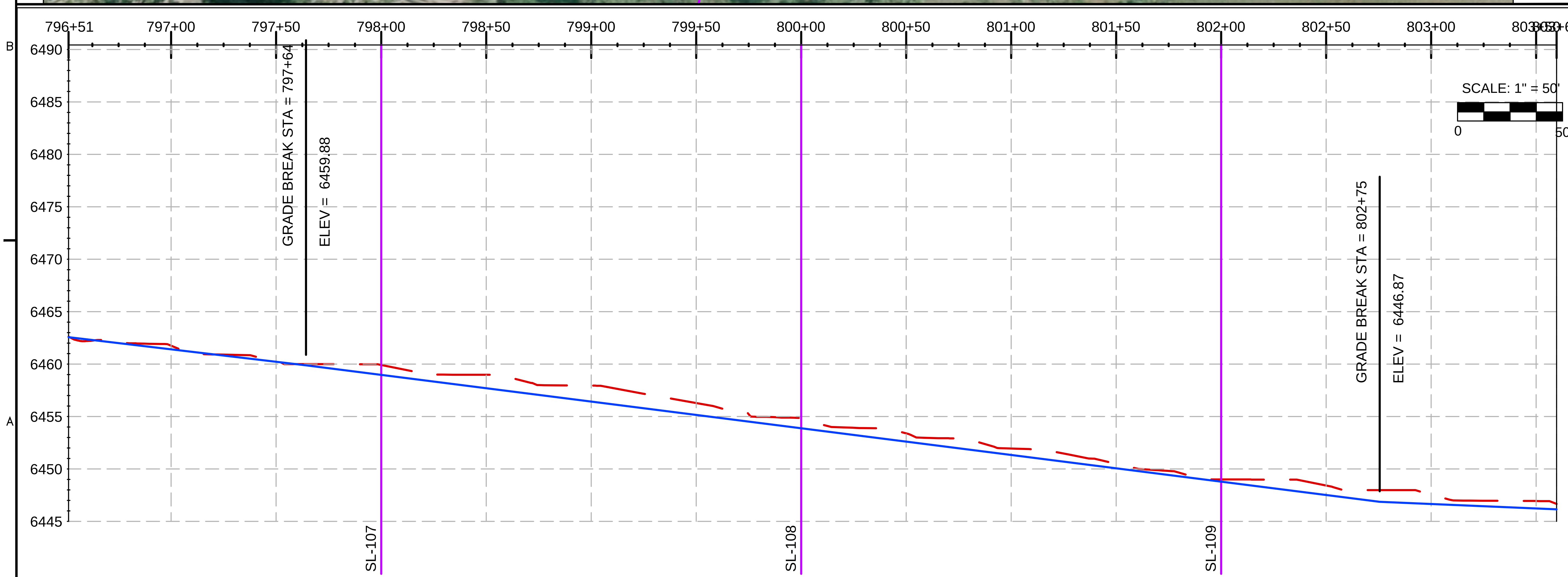
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

PLAN AND PROFILE

Sheet reference number:
24

UPDATE



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File name:

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Plot scale:

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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
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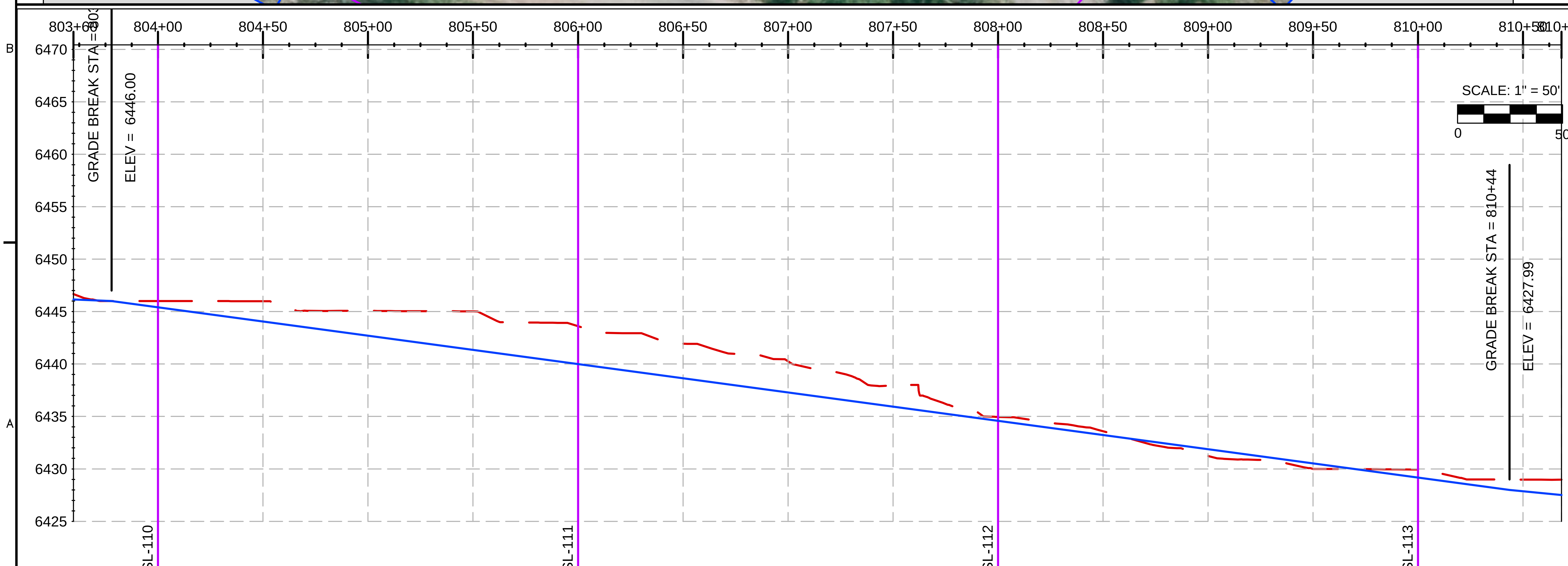
LARIMER COUNTY, COLORADO

PLAN AND PROFILE

Sheet reference number:
25

UPDATE



Symbol	Description	Date	Approved

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Date: 3/16/2016

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Designed by: JEFF CRANE

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Plot date:

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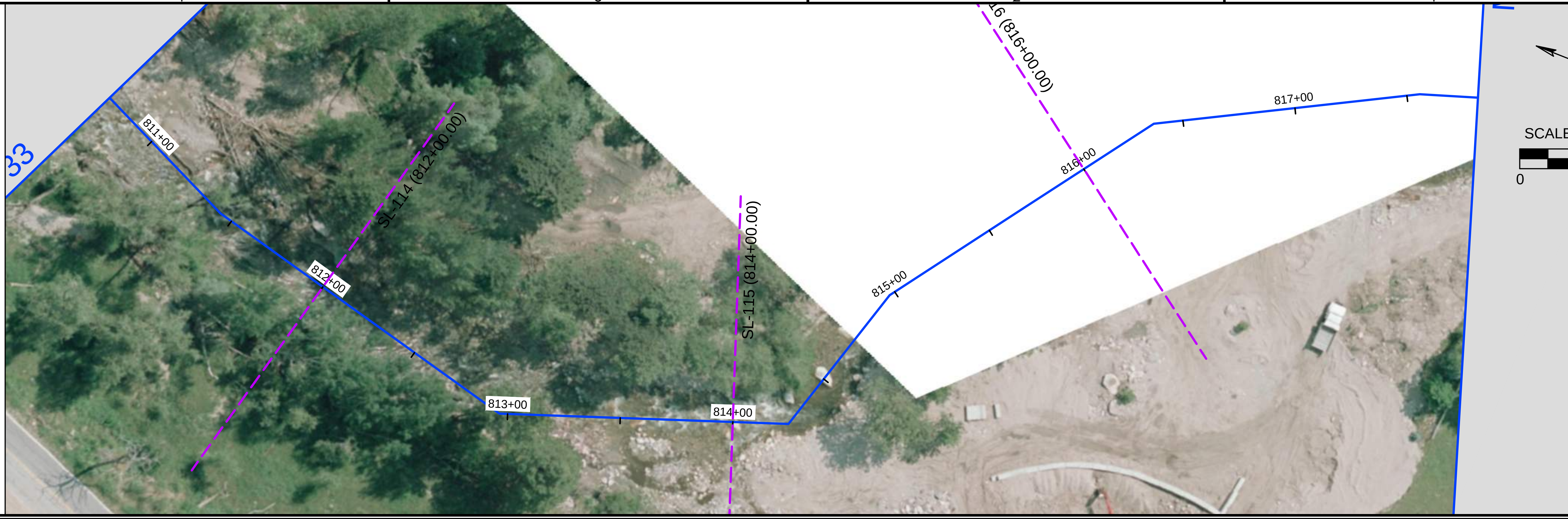
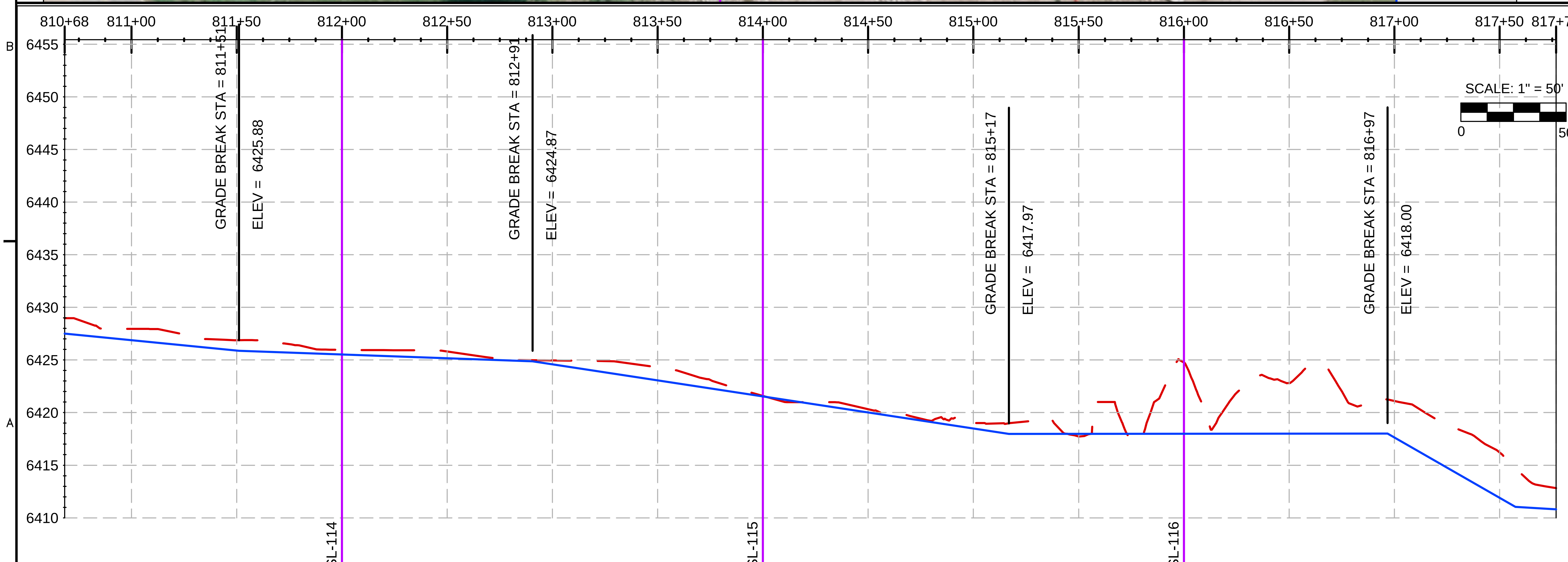
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

PLAN AND PROFILE

Sheet reference number:
26

UPDATE





Symbol	Description	Date	Approved

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Design file no:
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File name:
Plot date:
Plot scale:

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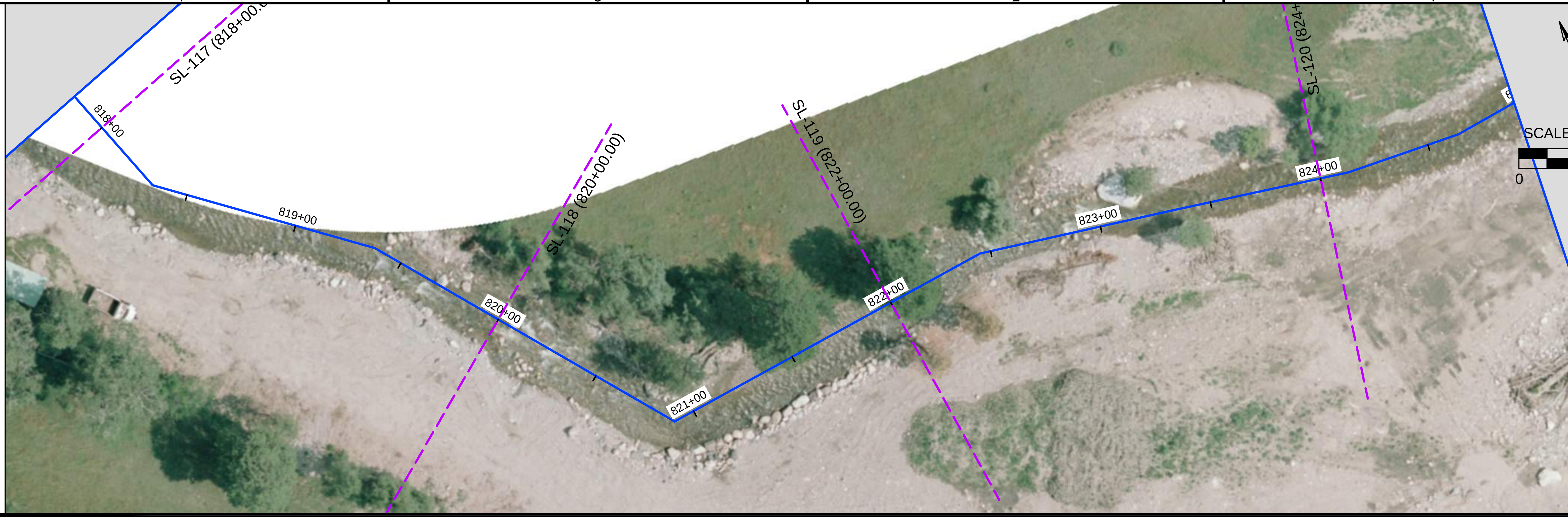
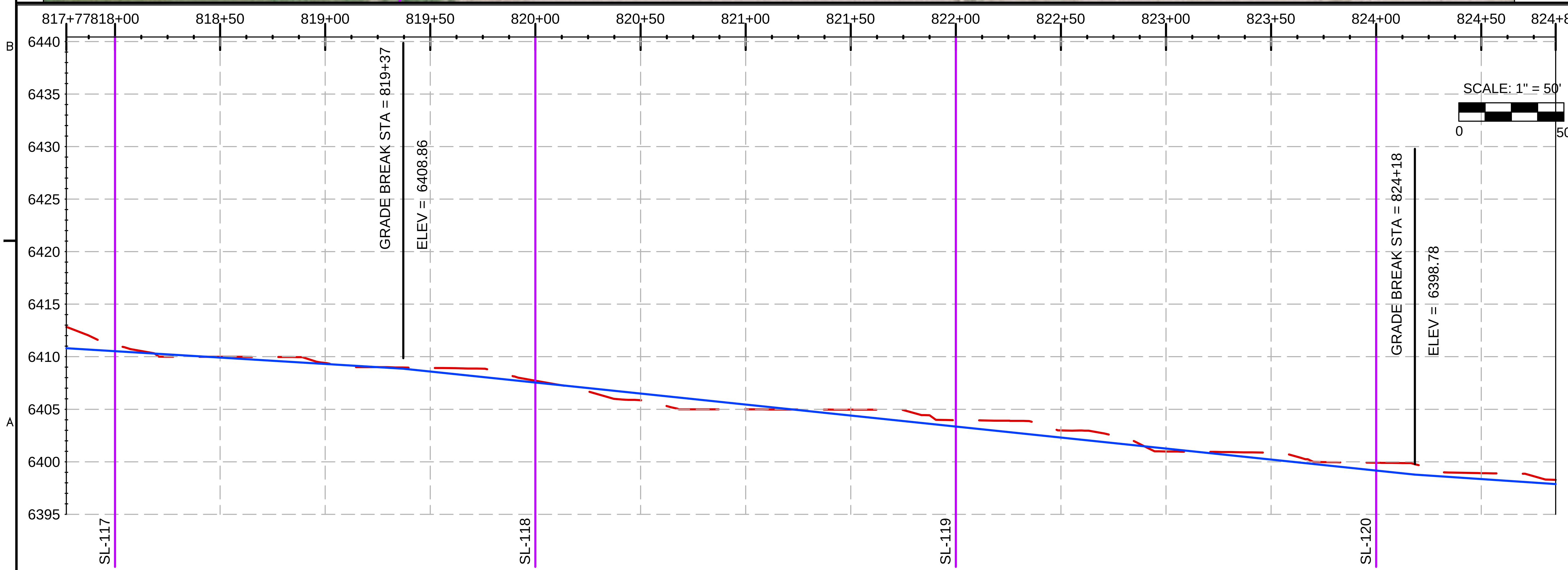
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

PLAN AND PROFILE

Sheet reference number:
27

UPDATE





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Date: 3/16/2016
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Plot scale:
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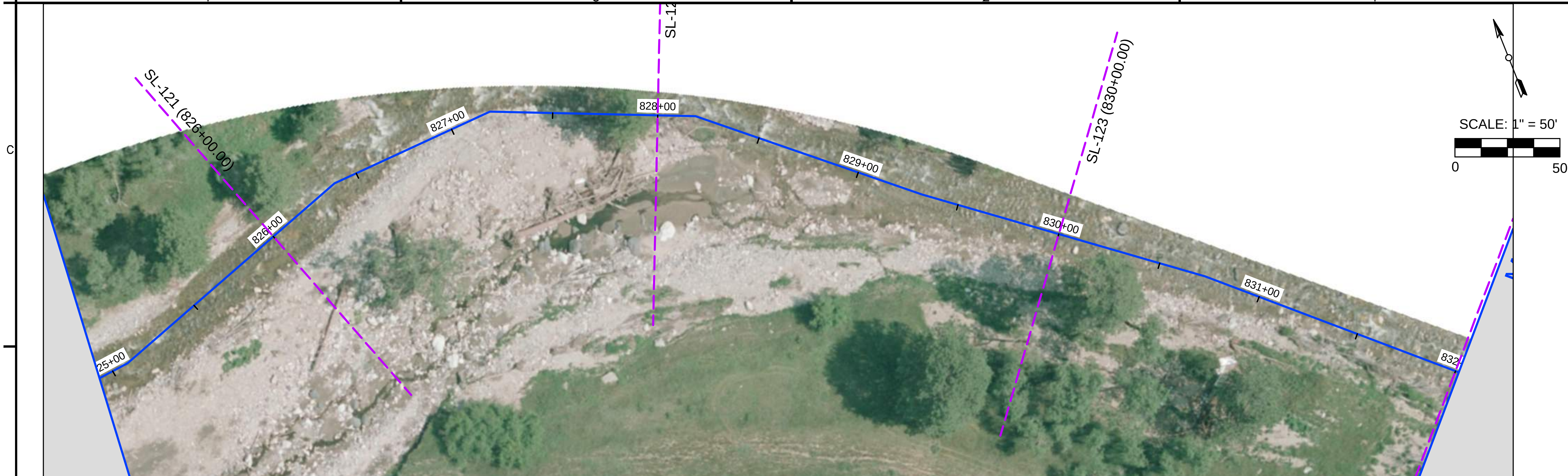
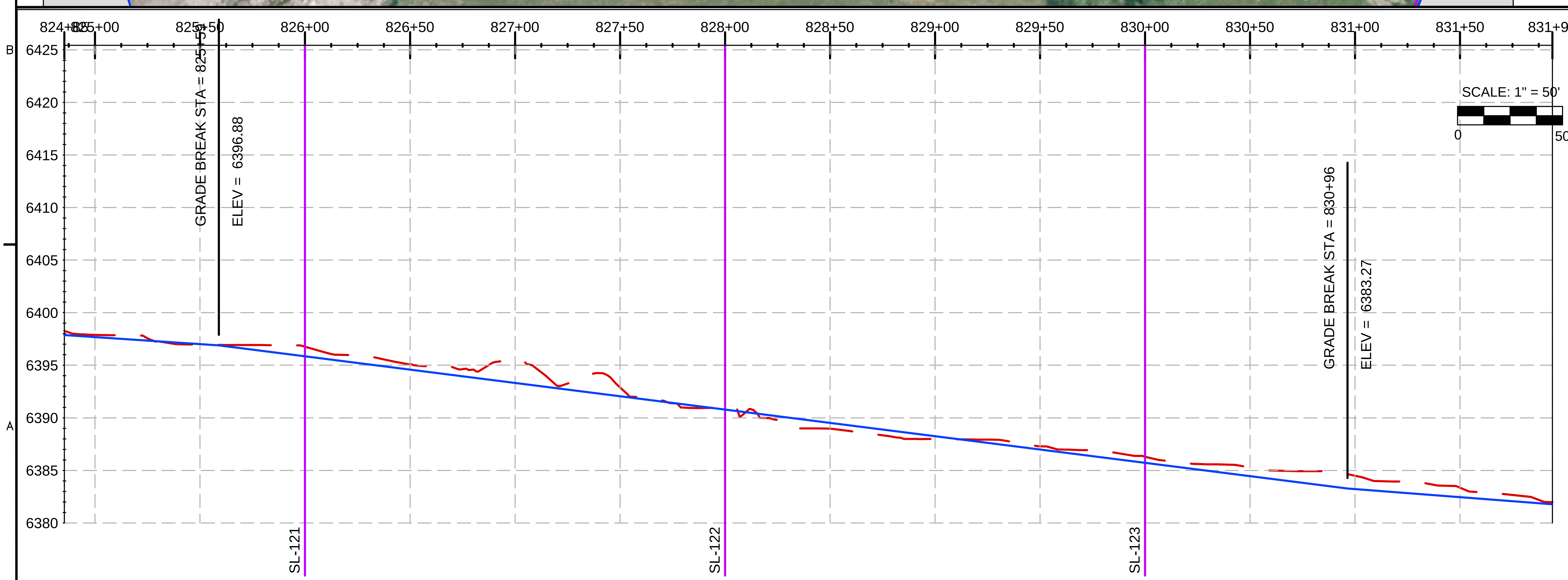
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

PLAN AND PROFILE

Sheet reference number:
28

UPDATE





Symbol	Description	Date	Approved

CRANE ASSOCIATES

Rev.

Date: 3/16/2016

Design file no:

Drawing Code:

File name:

Plot date:

Plot scale:

Designed by: JEFF CRANE

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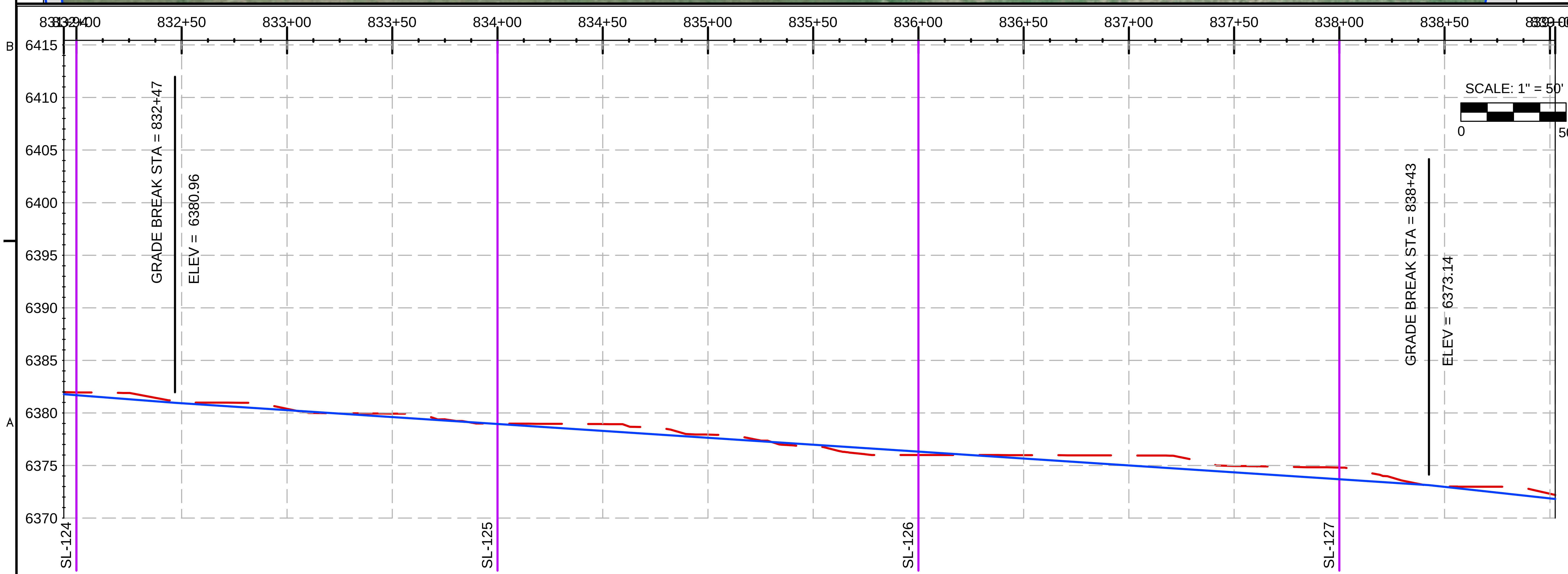
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

PLAN AND PROFILE

Sheet reference number:
29

UPDATE



Designed by: JEFF CRANE	Date: 3/16/2016
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Reviewed by: JPC	Design file no:
	Drawing Code:
Submitted by:	File name: Plot date: Plot scale:
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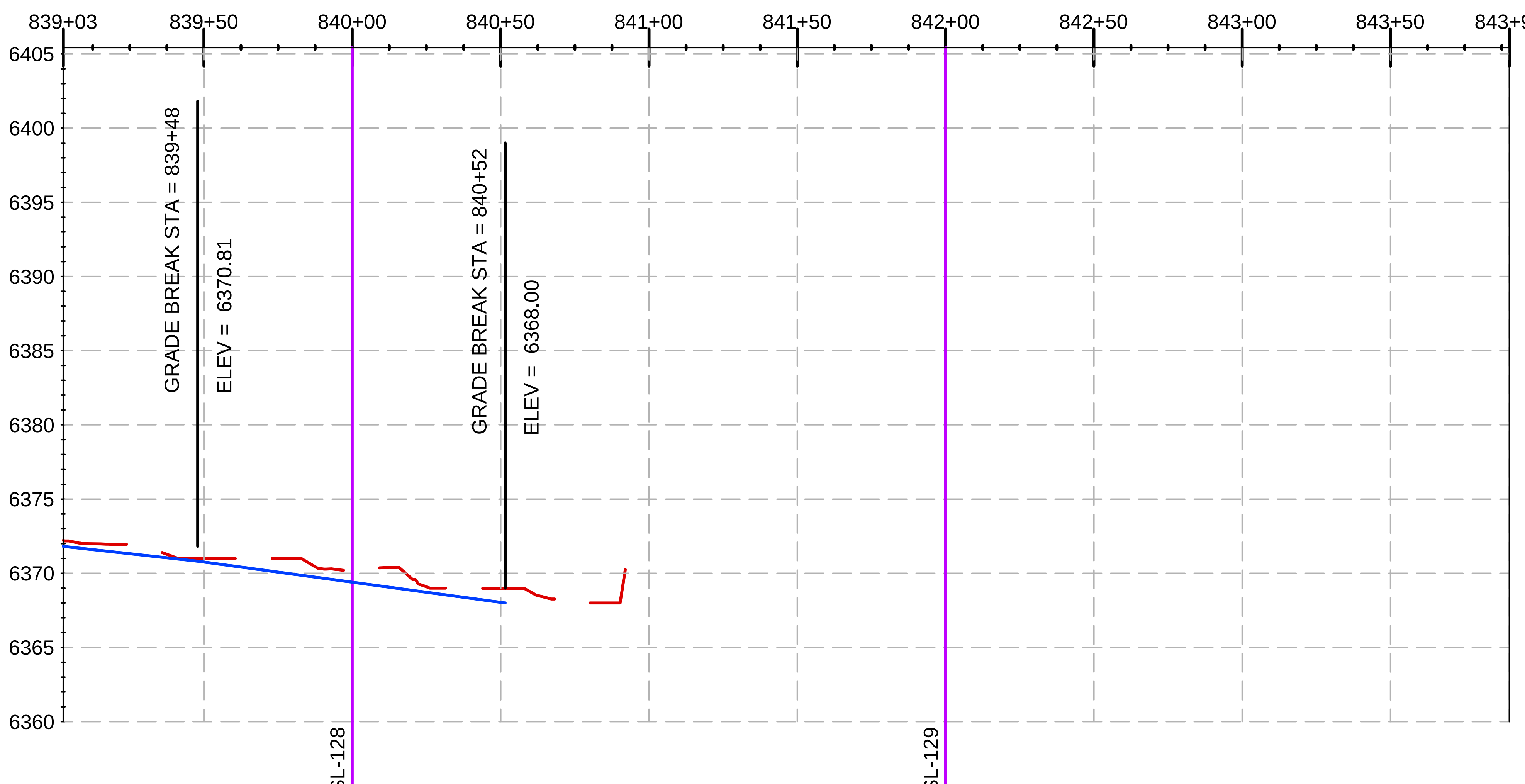
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

PLAN AND PROFILE

Sheet reference number:
30

UPDATE



Symbol | Description | Date | Approved

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Rev.
Date: 3/16/2016
Design file no:
Drawing Code:
File name:
Plot date:
Plot scale:
Designed by: JEFF CRANE
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Submitted by:

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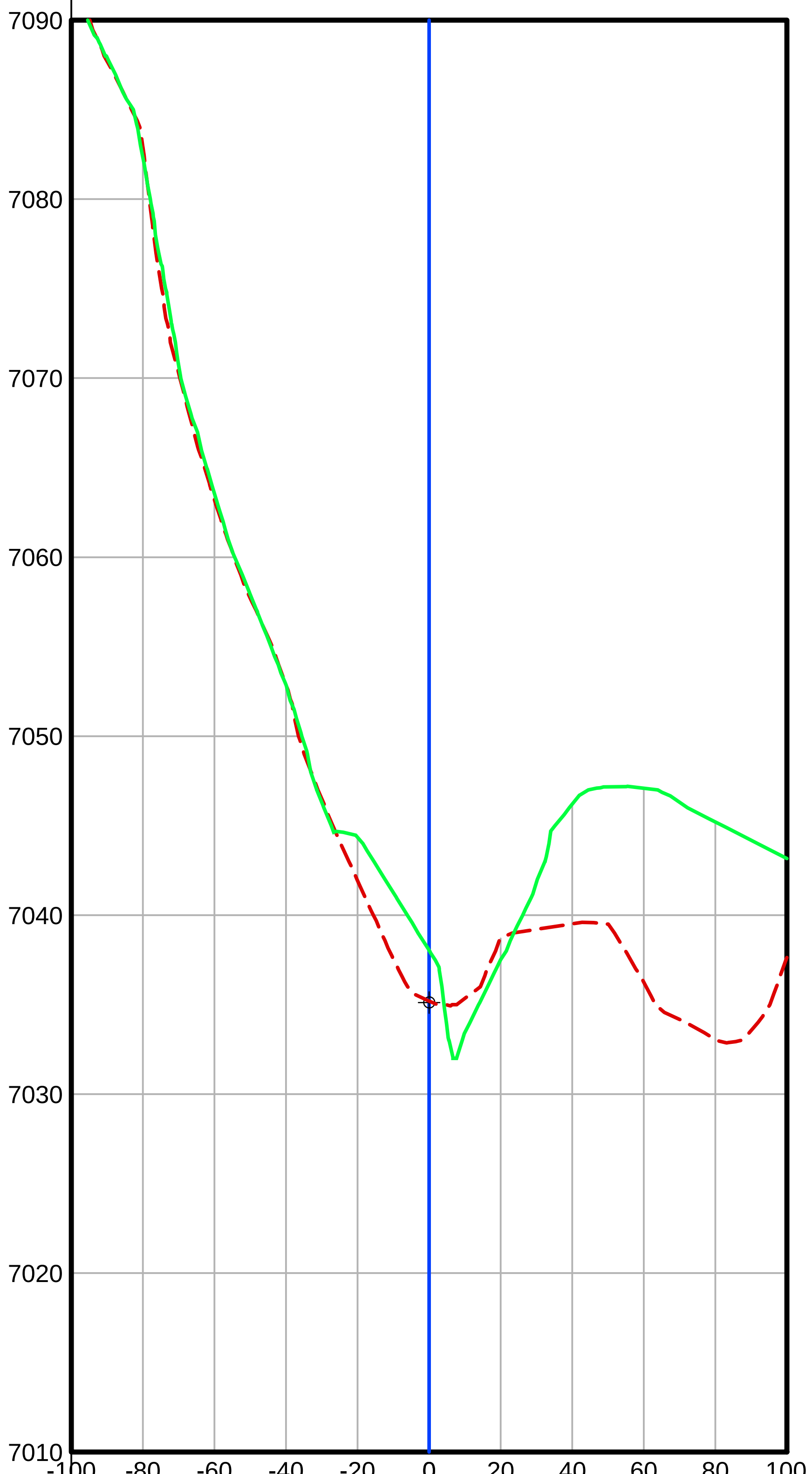
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

PLAN AND PROFILE

Sheet reference number:
31

UPDATE

SL-1 (586+00.00)



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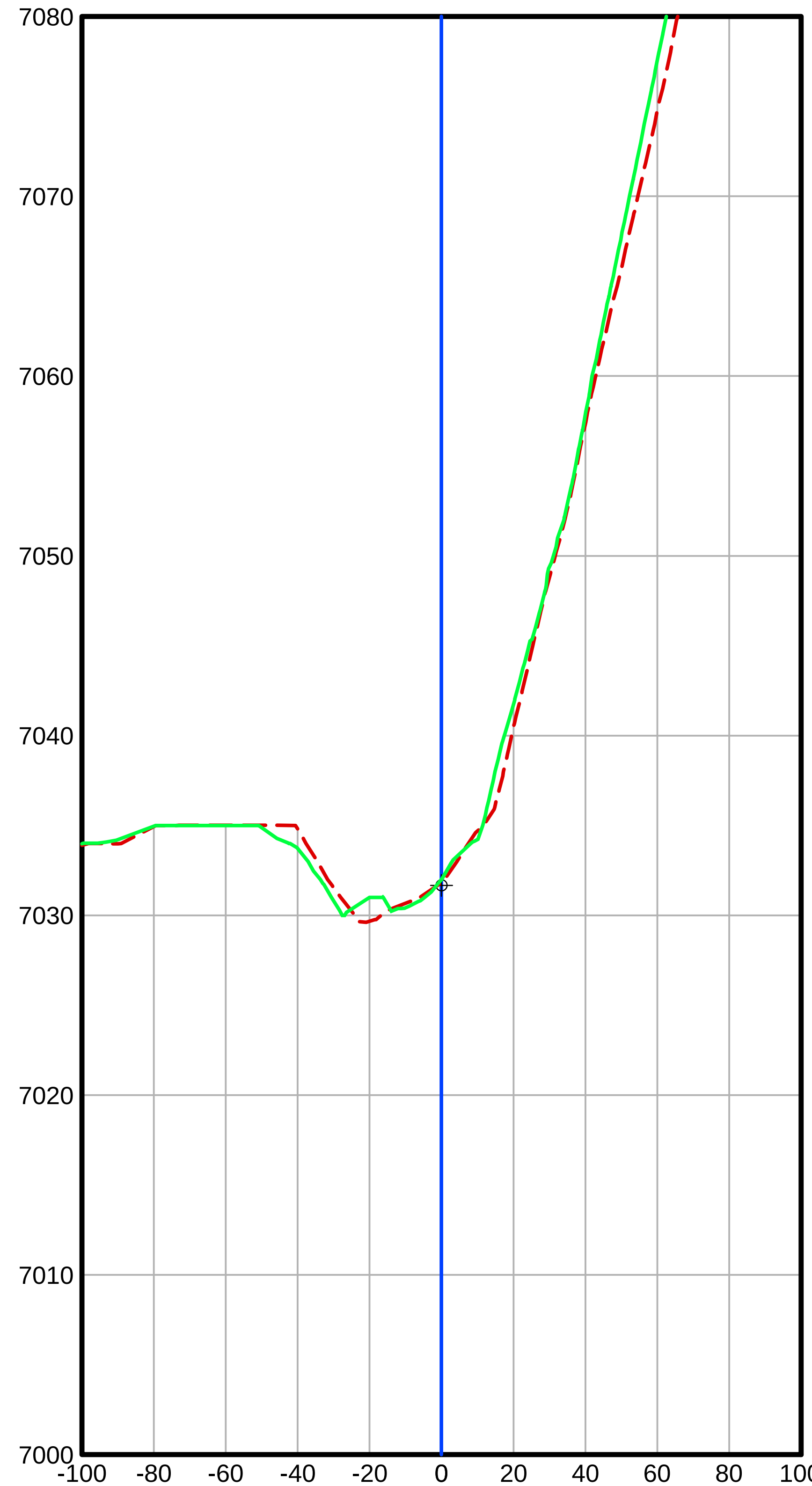

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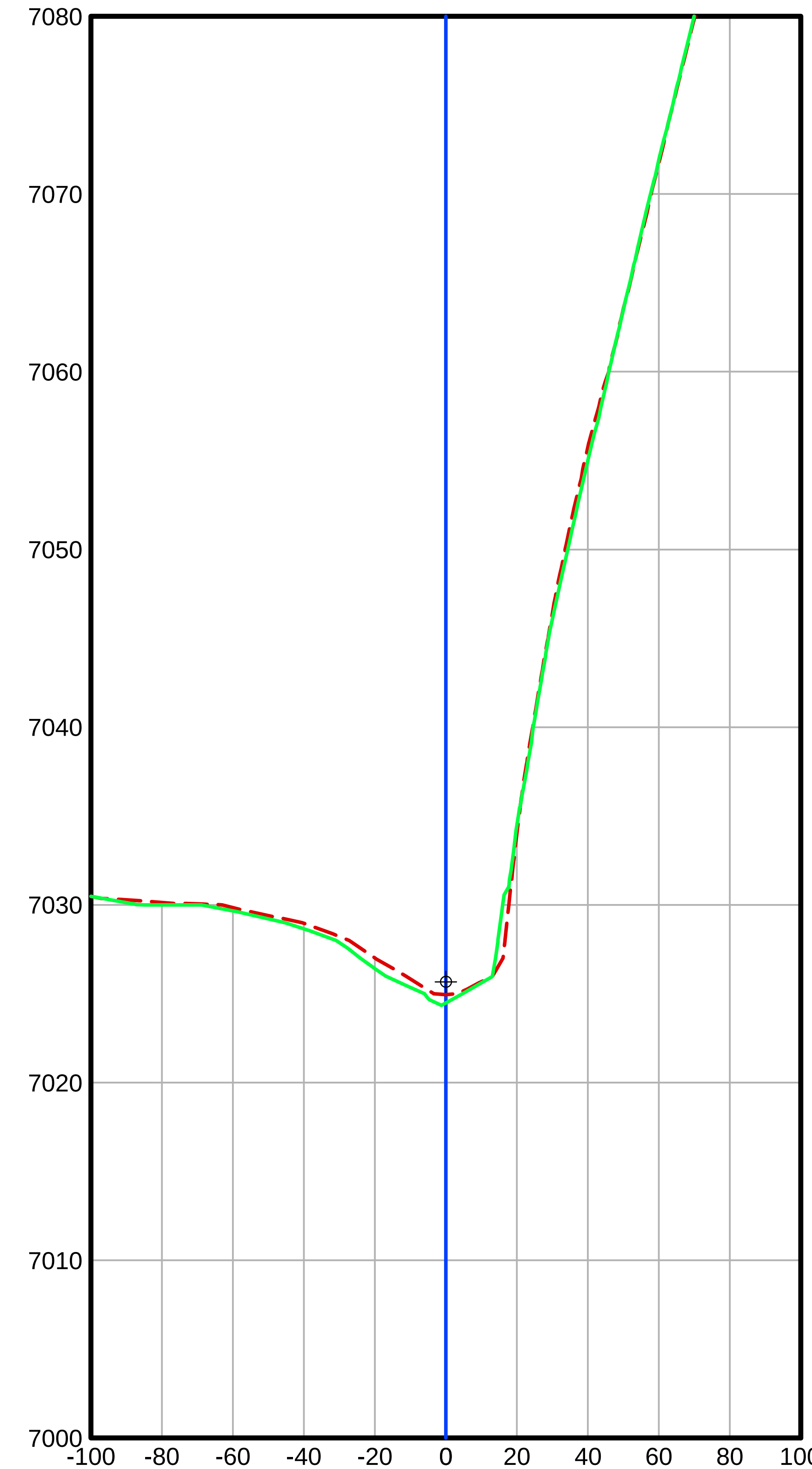

LEGEND — EXISTING — ROAD GRADES — PROPOSED

SCALE: 1" = 50'

0 50'

Symbol	Description	Date	Approved

CRANE ASSOCIATES

Designed by: JEFF CRANE	Date: 2/25/2016	Rev.
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Reviewed by: JPC	Drawing Code:	
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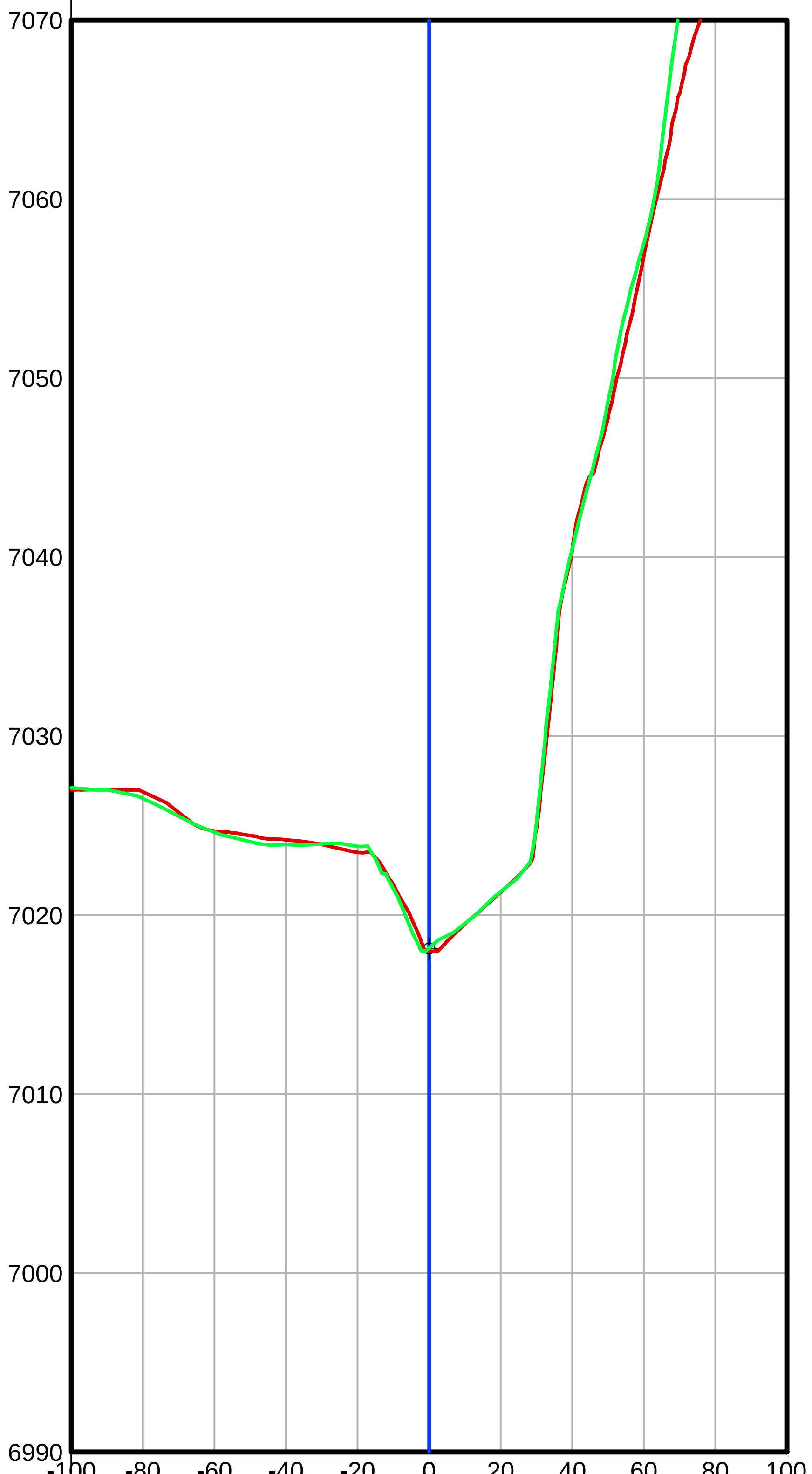
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

Sheet reference number: 32

UPDATE

SL-4 (592+00.00)



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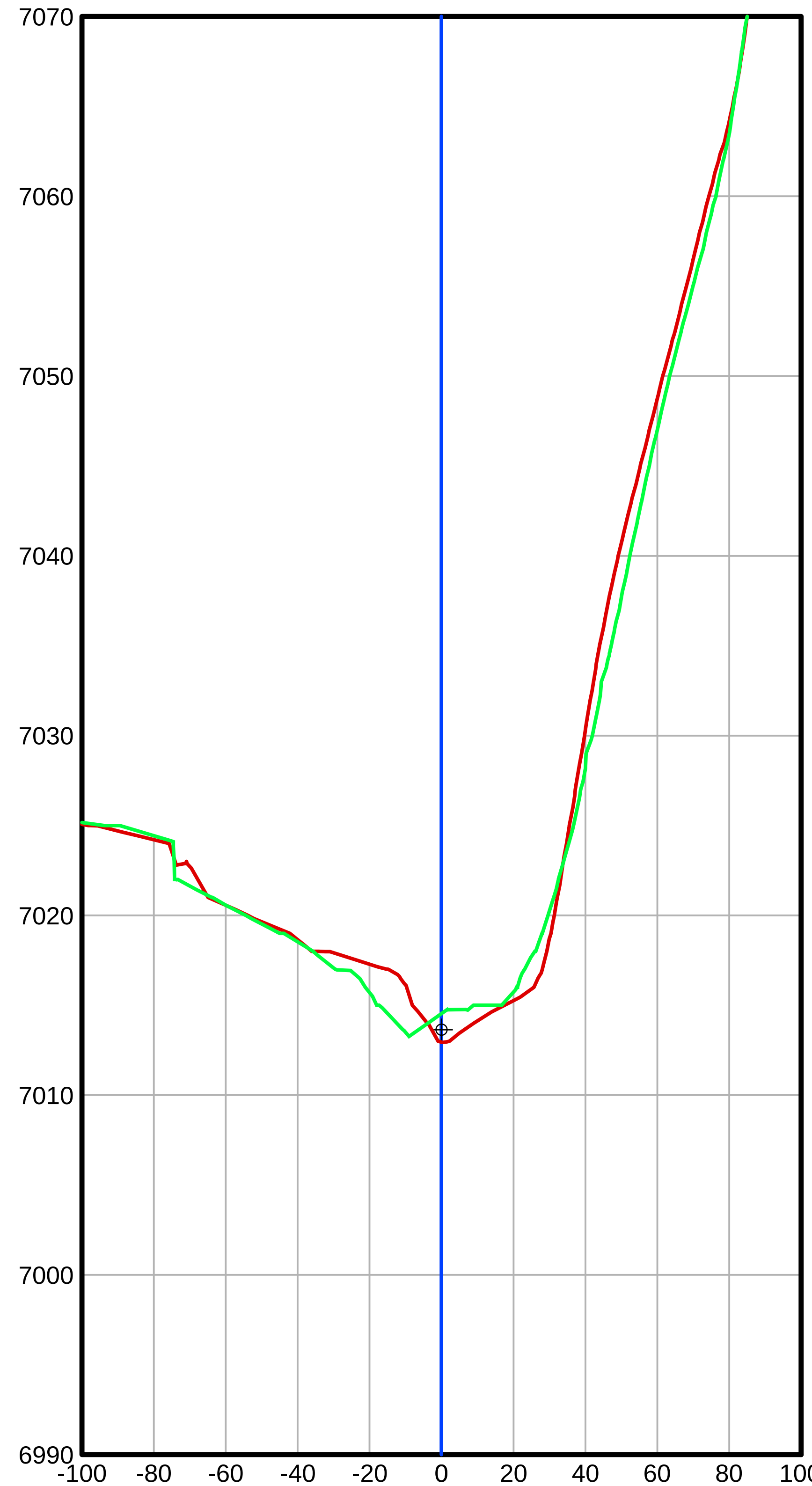
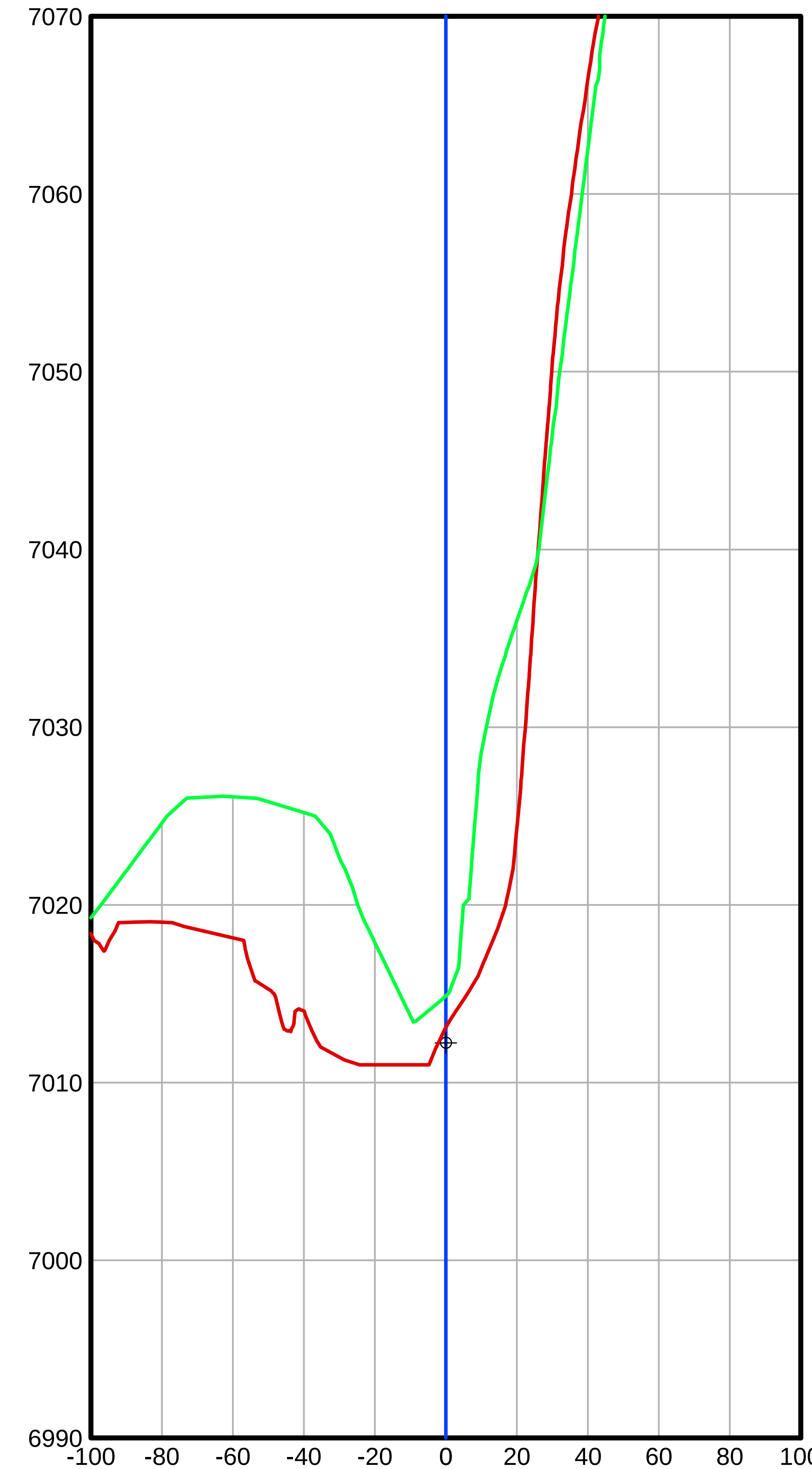


SL-6 (596+00.00)



LEGEND — EXISTING — ROAD GRADES — PROPOSED

SCALE: 1" = 50'

0 50'

CRANE ASSOCIATES

Rev.

Date: 2/25/2016

Design file no:

Drawing Code:

File name:
Plot date:
Plot scale:

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Ckd by:

Reviewed by: JPC

Submitted by:

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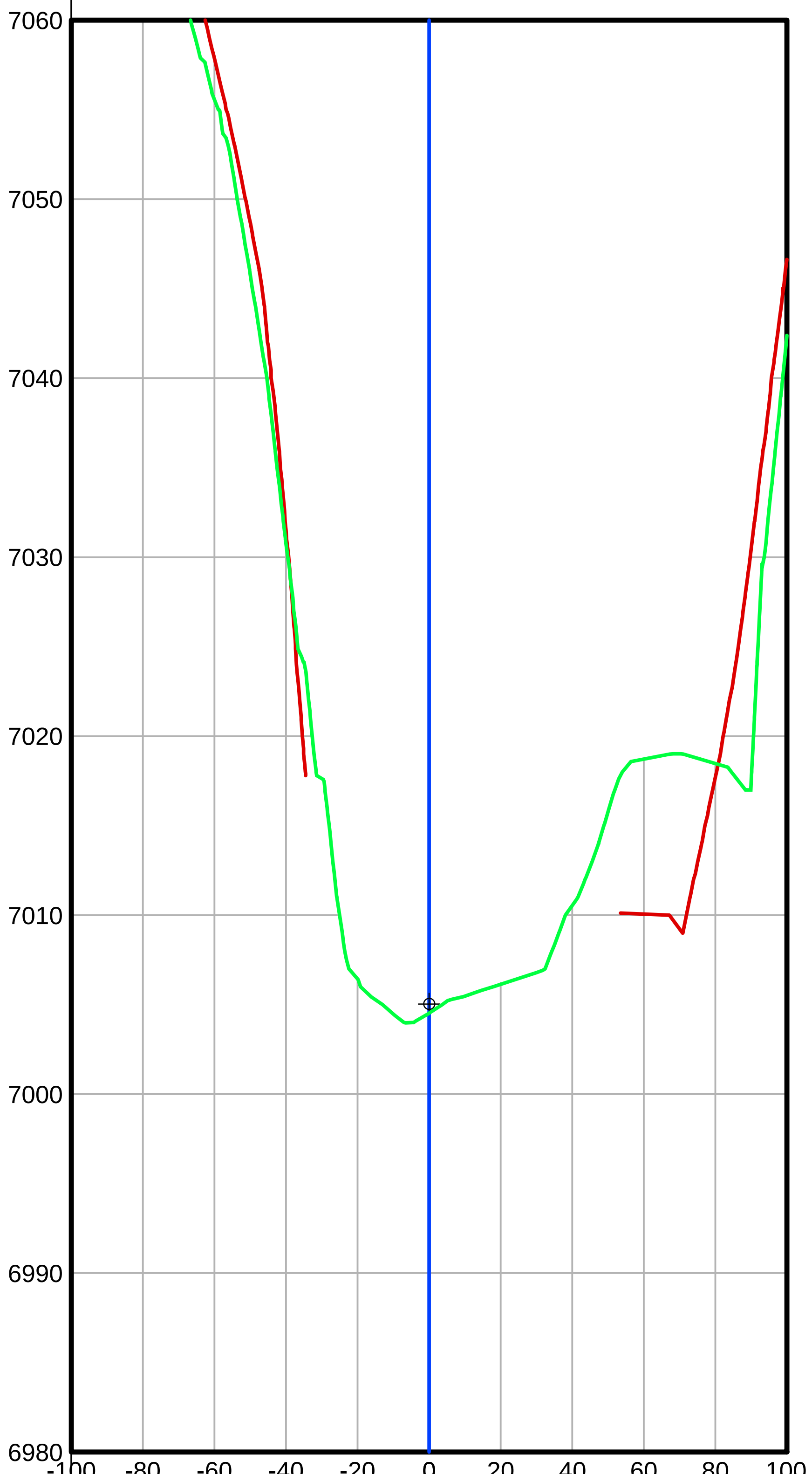
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

Sheet reference number: 33

UPDATE

SL-7 (598+00.00)



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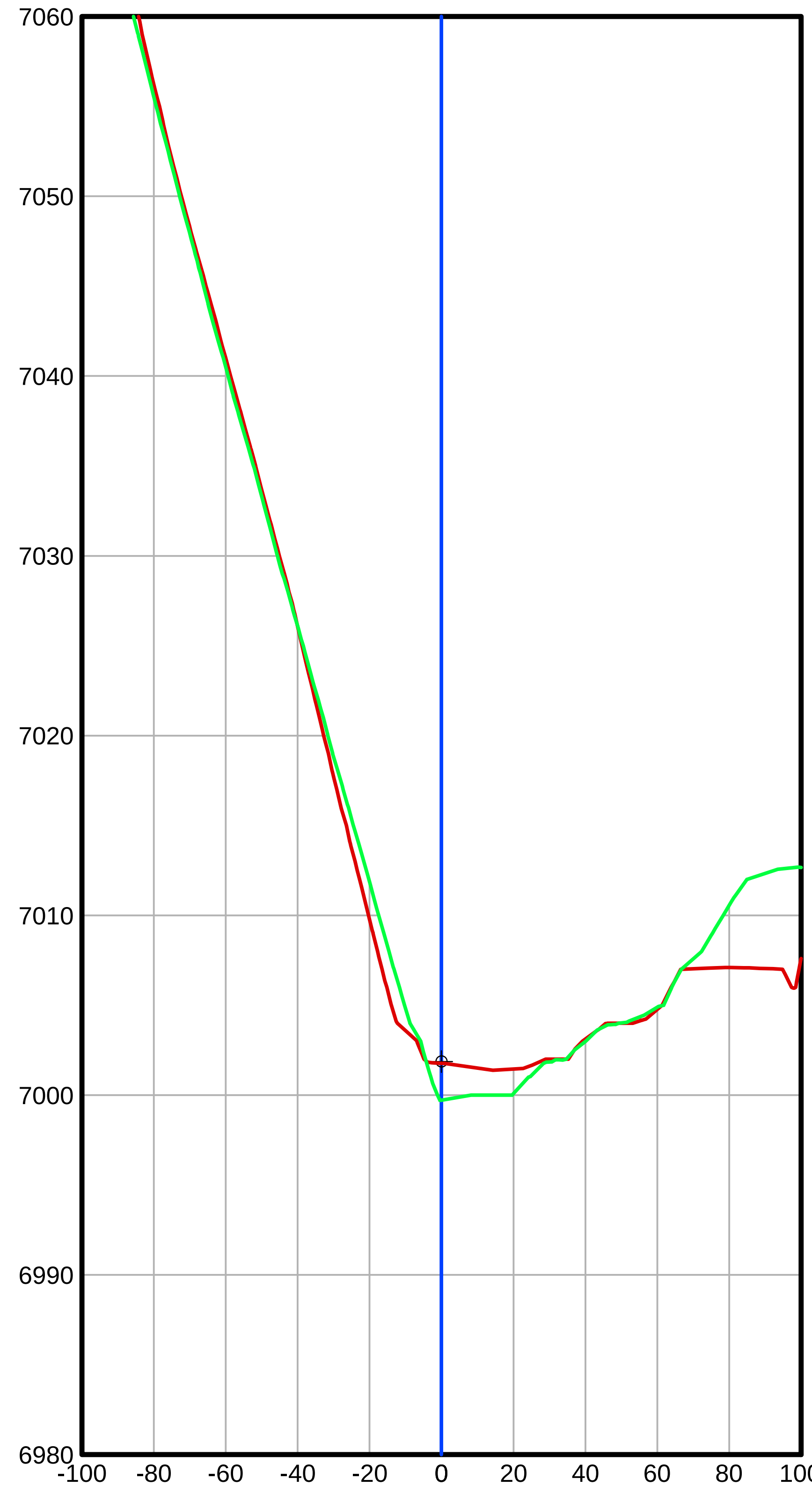

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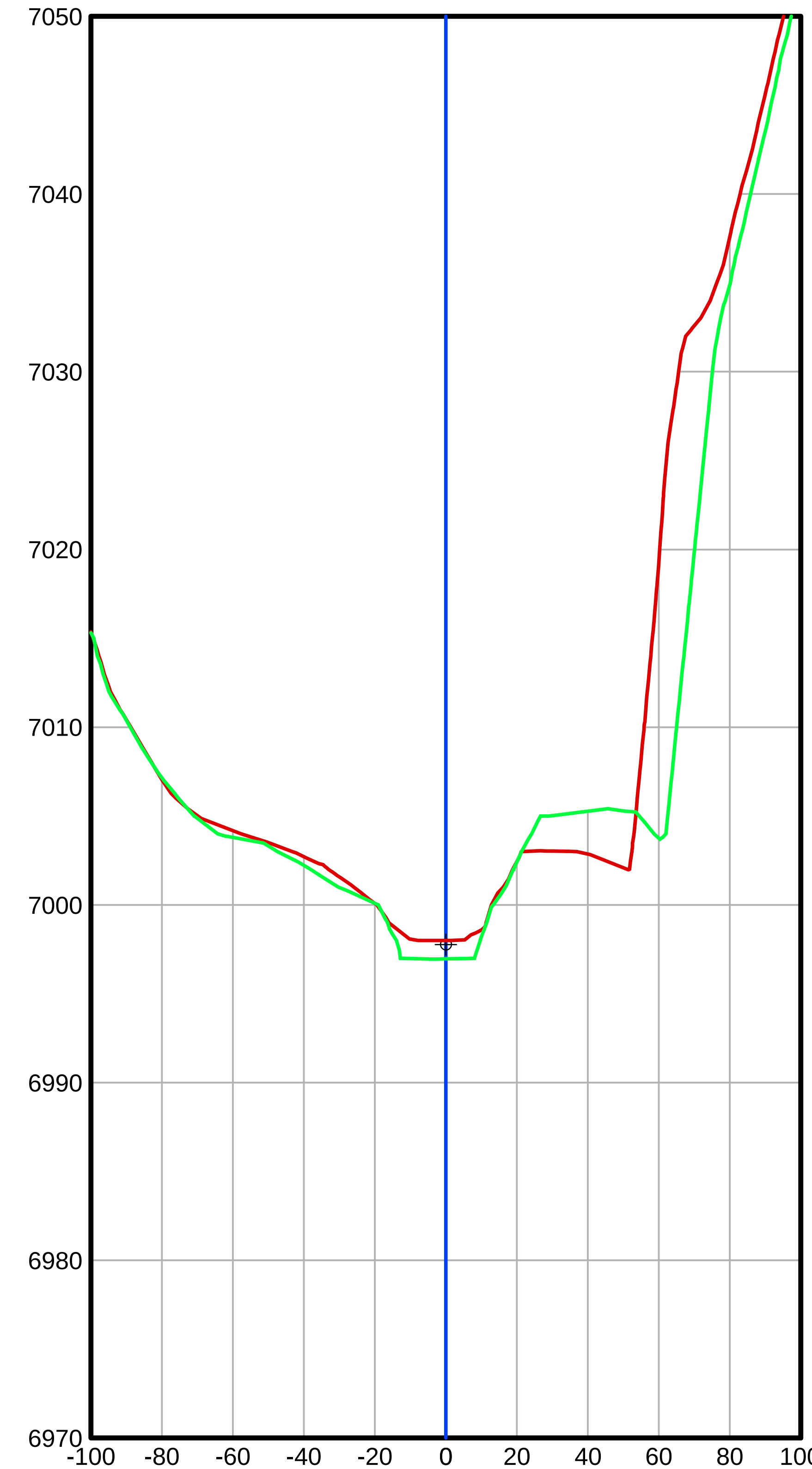

LEGEND — EXISTING — ROAD GRADES — PROPOSED

SCALE: 1" = 50'

0 50'

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Submitted by:
Date: 2/25/2016
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File name:
Plot date:
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Symbol | Description | Date | Approved

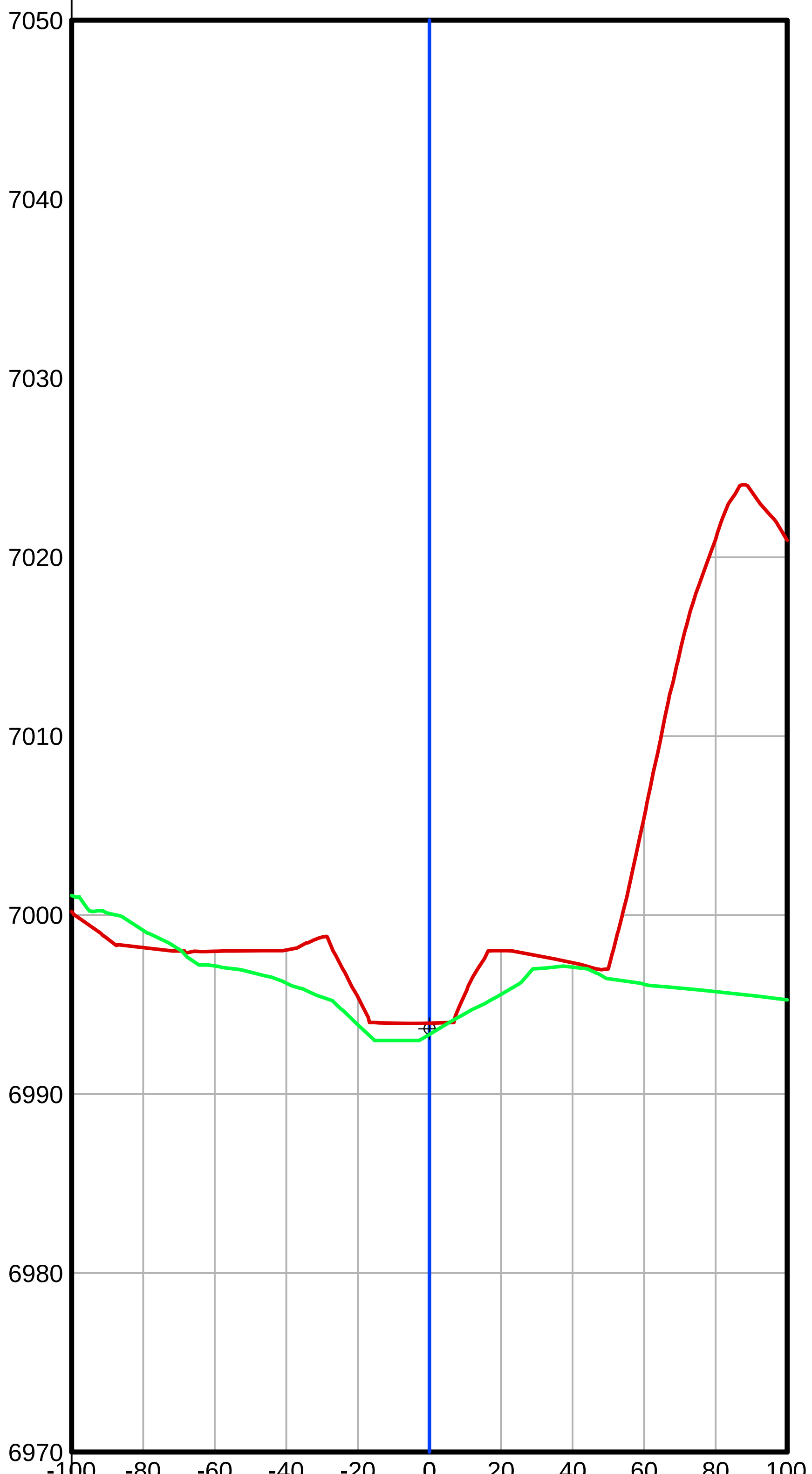
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

Sheet reference number:
34

UPDATE

SL-10 (604+00.00)



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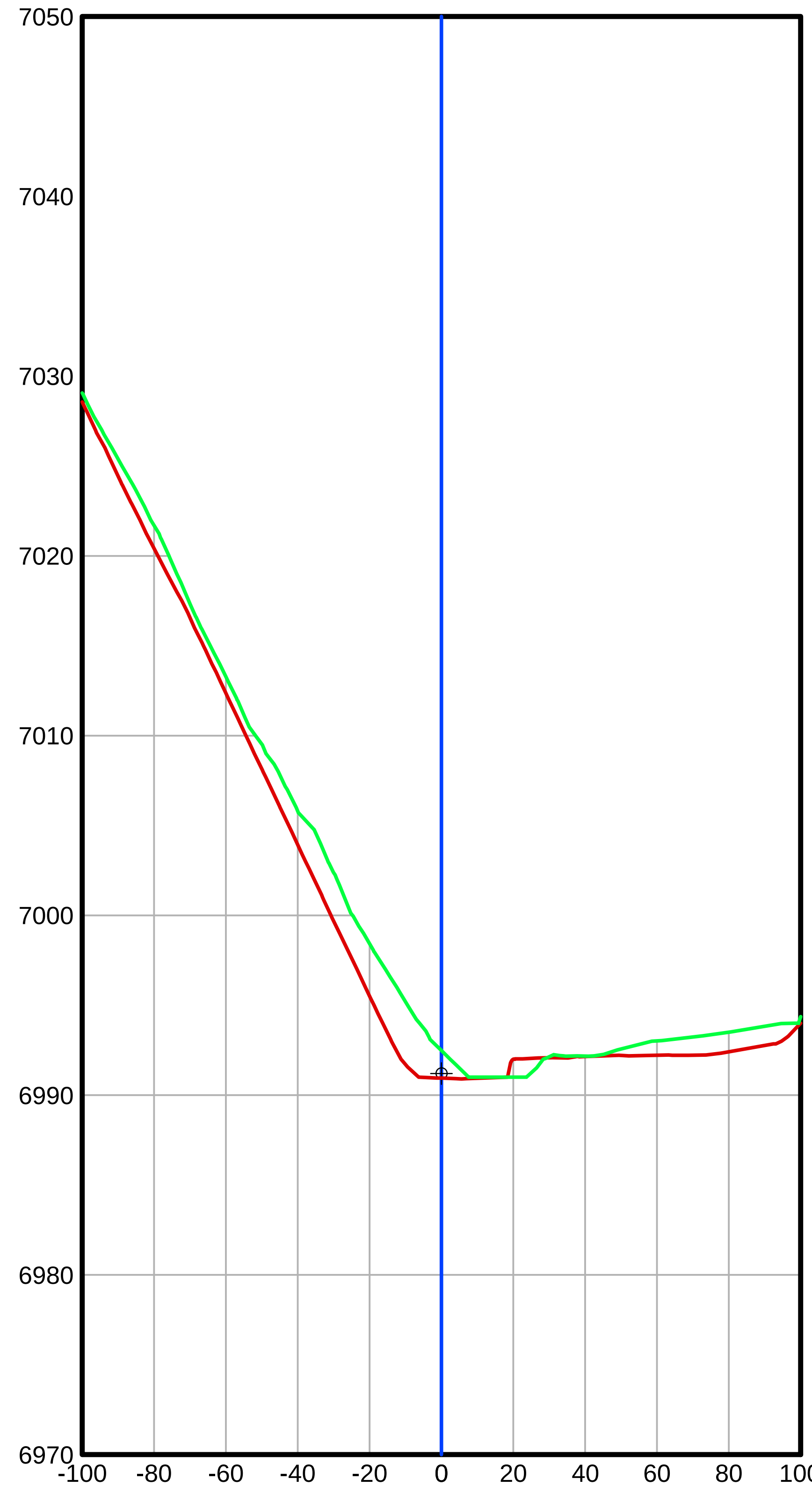

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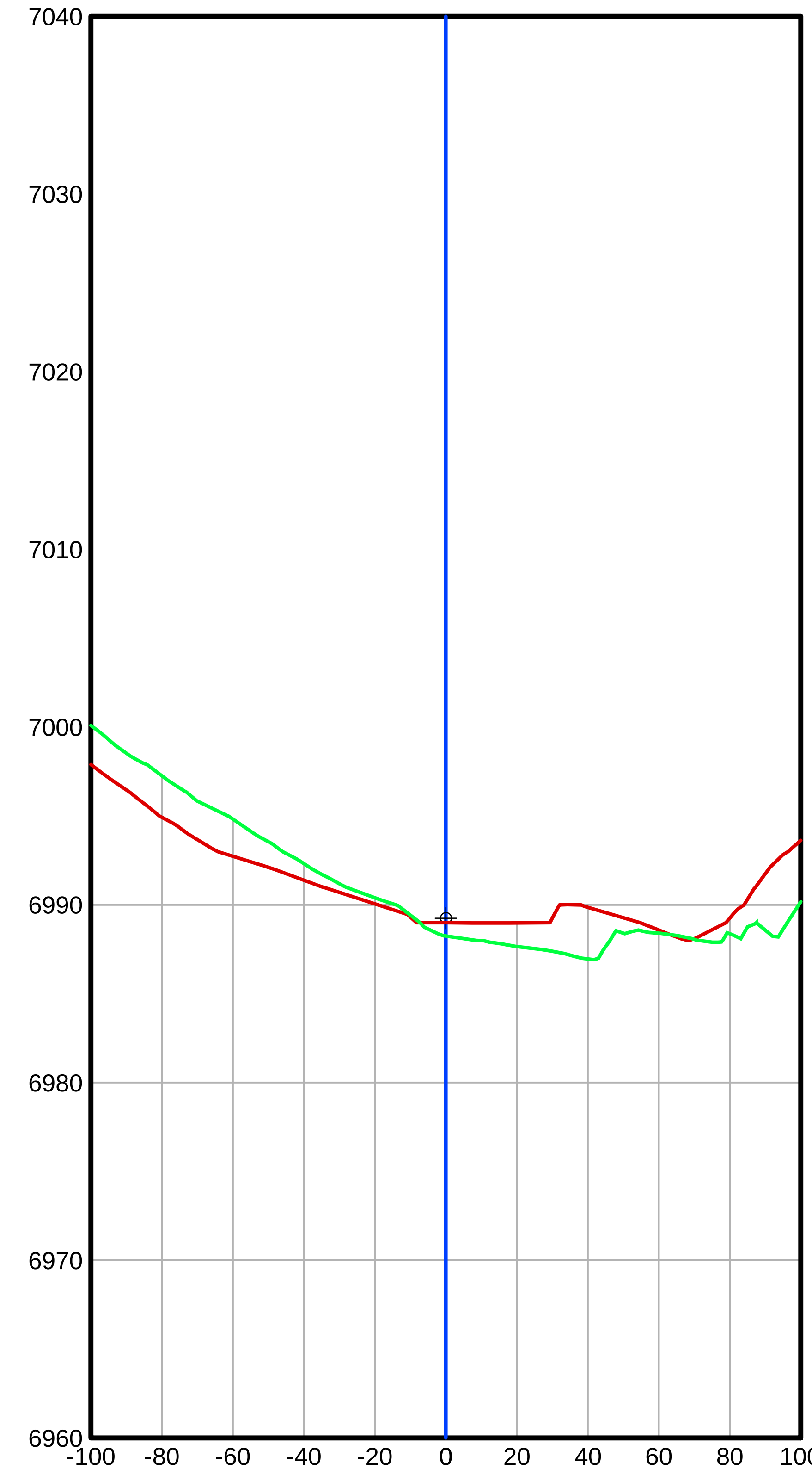

LEGEND EXISTING ROAD GRADES PROPOSED

SCALE: 1" = 50'

0 50'

Symbol | Description | Date | Approved

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Date: 2/25/2016
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File name:
Plot date:
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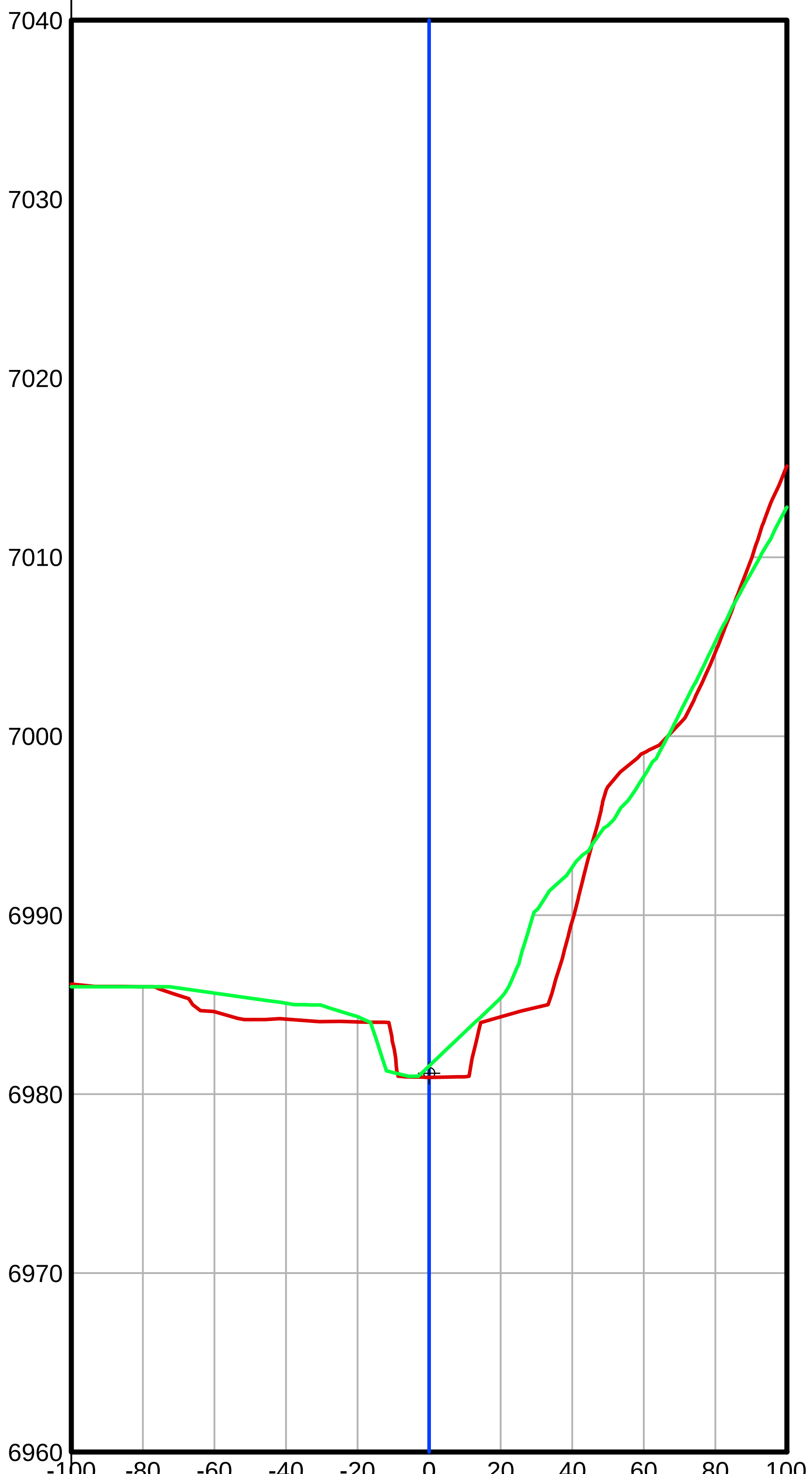
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

Sheet reference number:
35

UPDATE

SL-13 (610+00.00)



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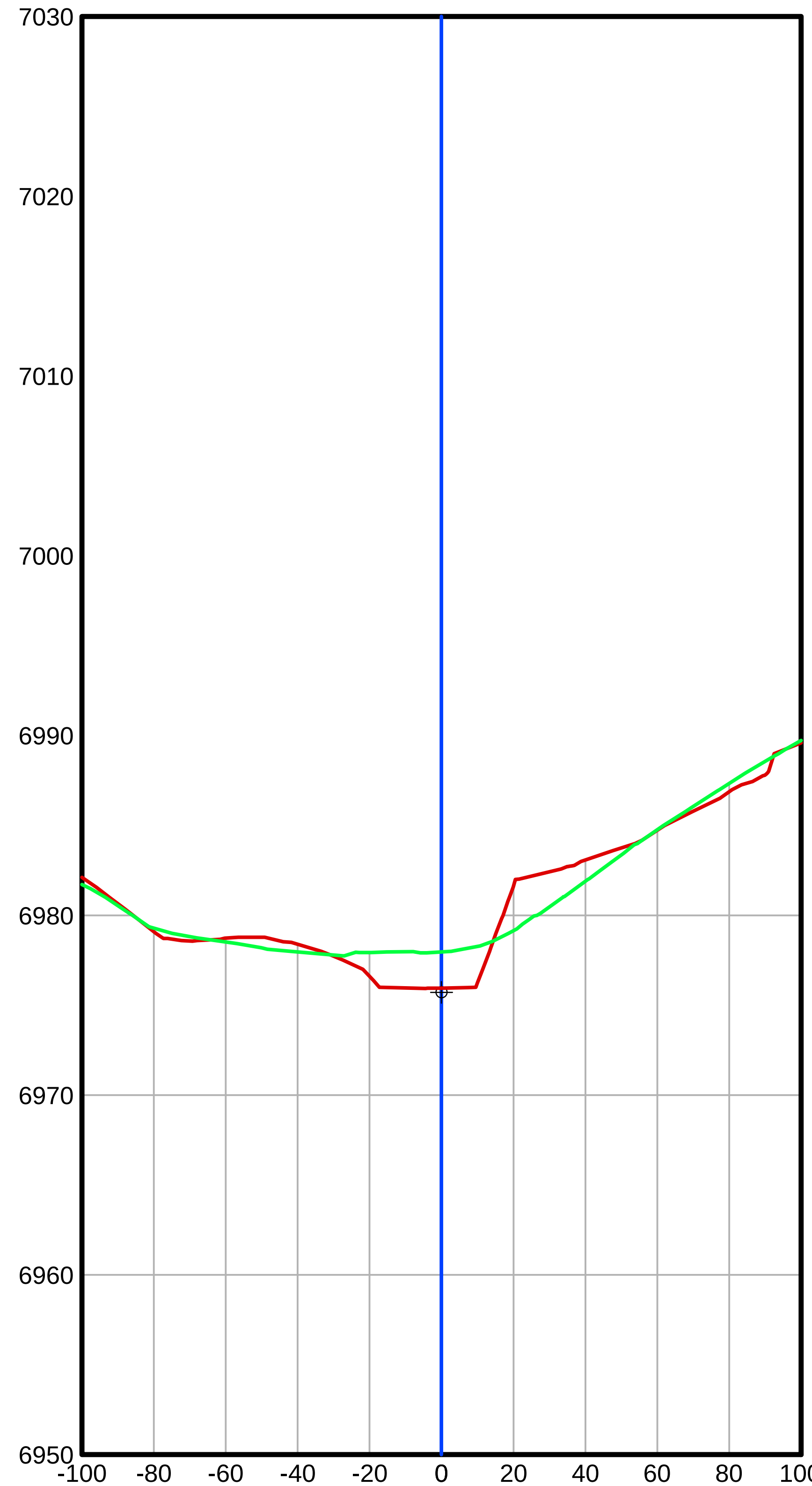
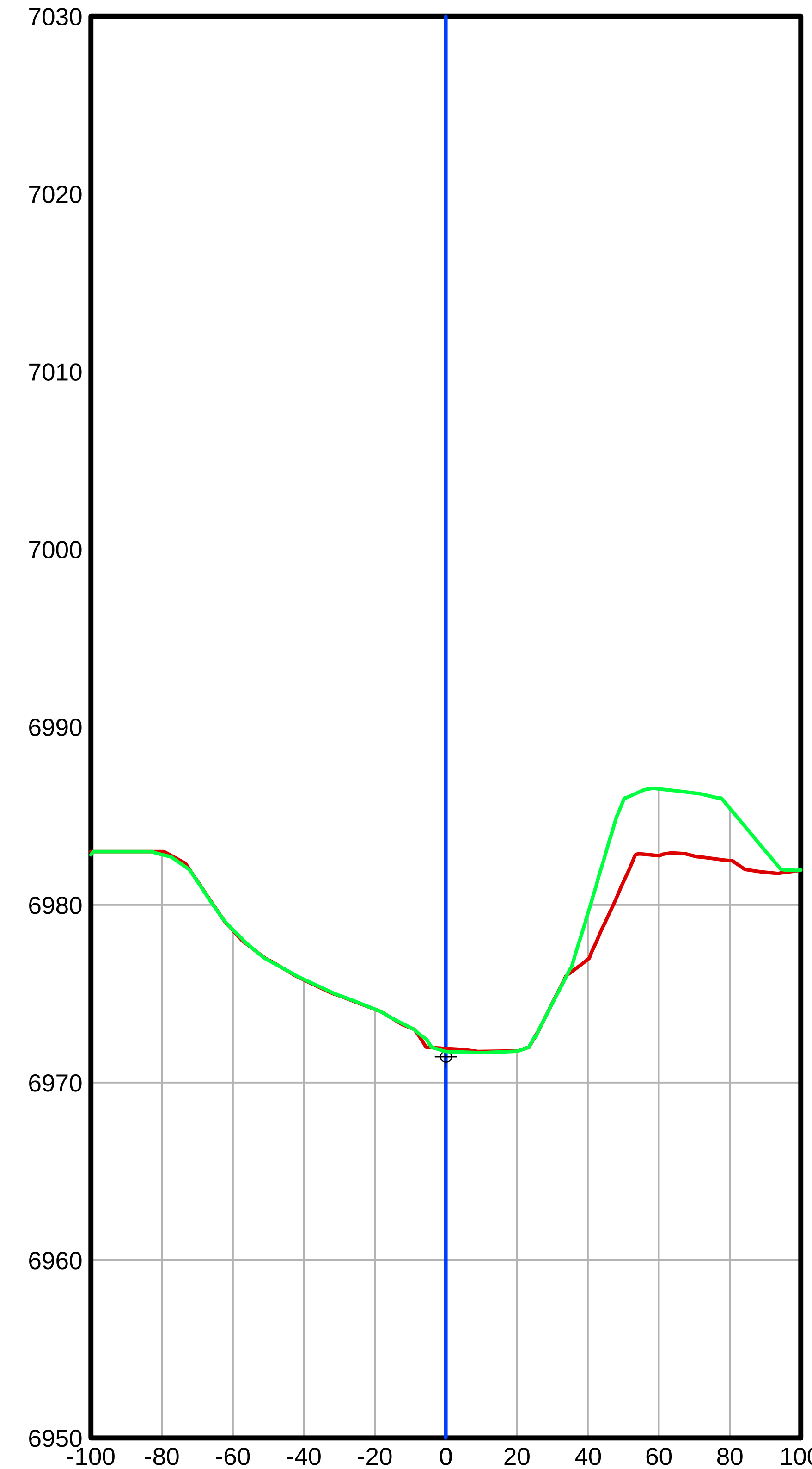


SL-15 (614+00.00)



LEGEND — EXISTING — ROAD GRADES — PROPOSED

SCALE: 1" = 50'

0 50'

Symbol | Description | Date | Approved

CRANE ASSOCIATES

Rev. | Date: 2/25/2016 | Design file no: | Drawing Code: | File name: | Plot date: | Plot scale:

Designed by: JEFF CRANE | Dwn by: | Ckd by: | Reviewed by: JPC | Submitted by:

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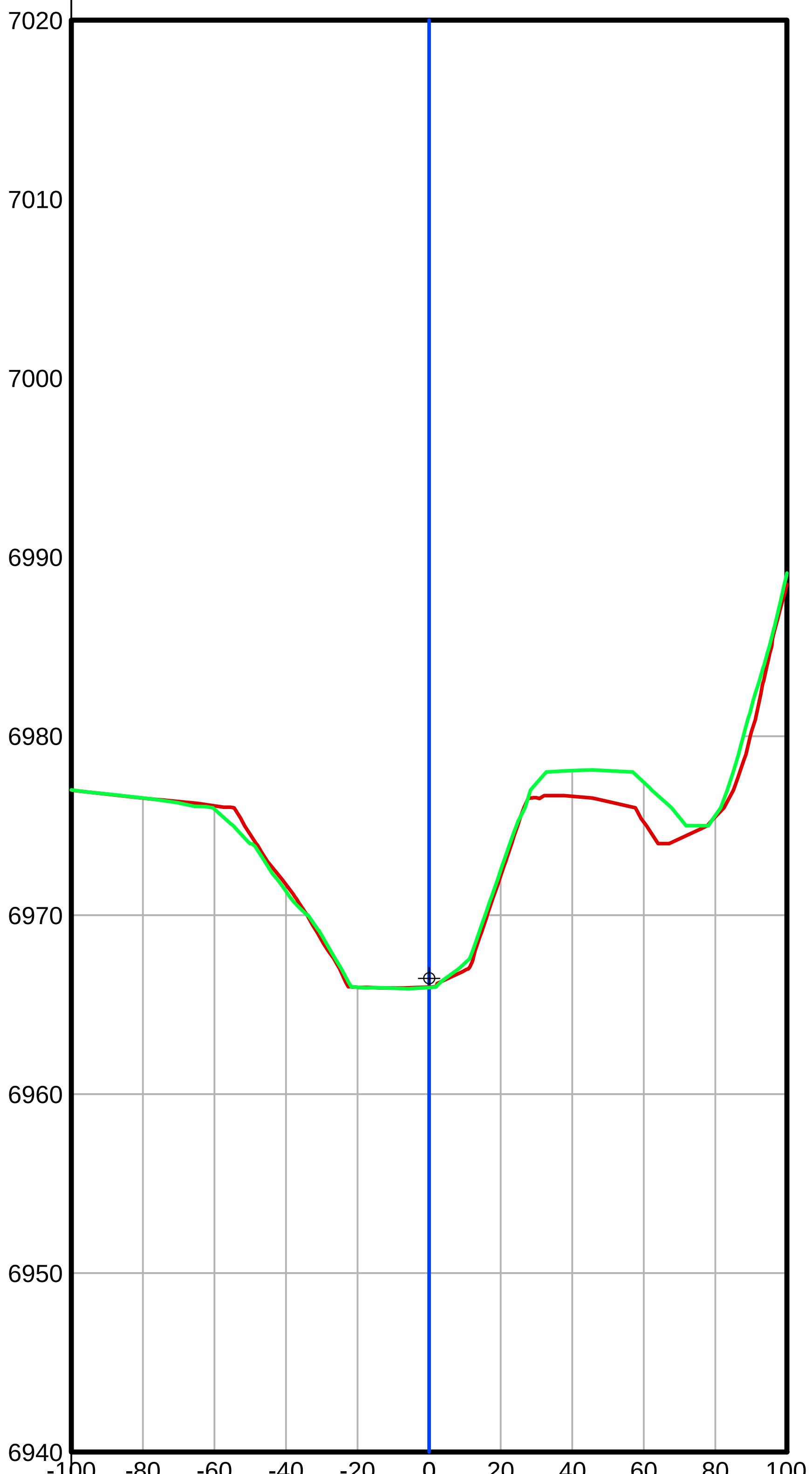
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

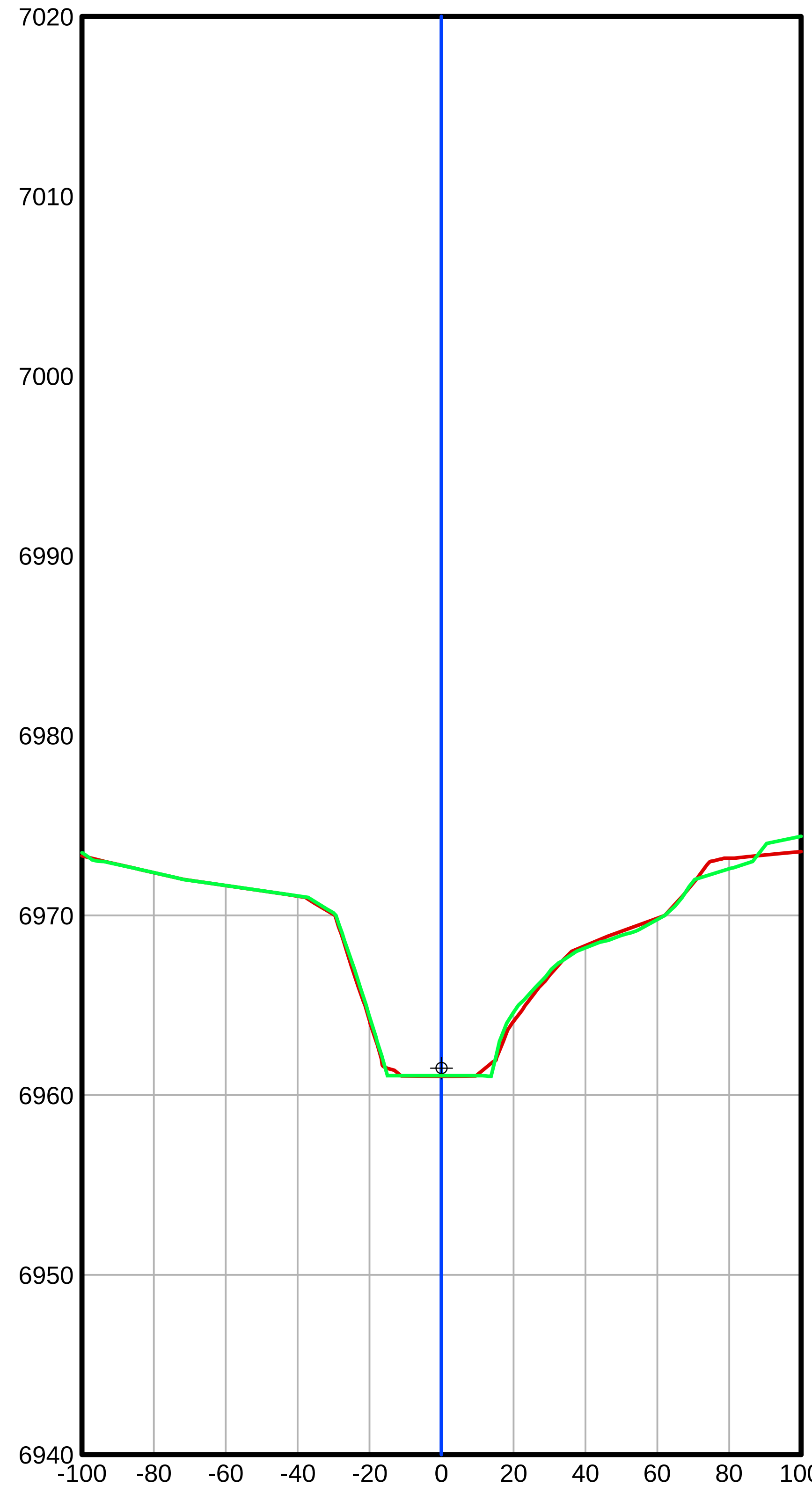
Sheet reference number:
36

UPDATE

SL-16 (616+00.00)



SL-17 (618+00.00)



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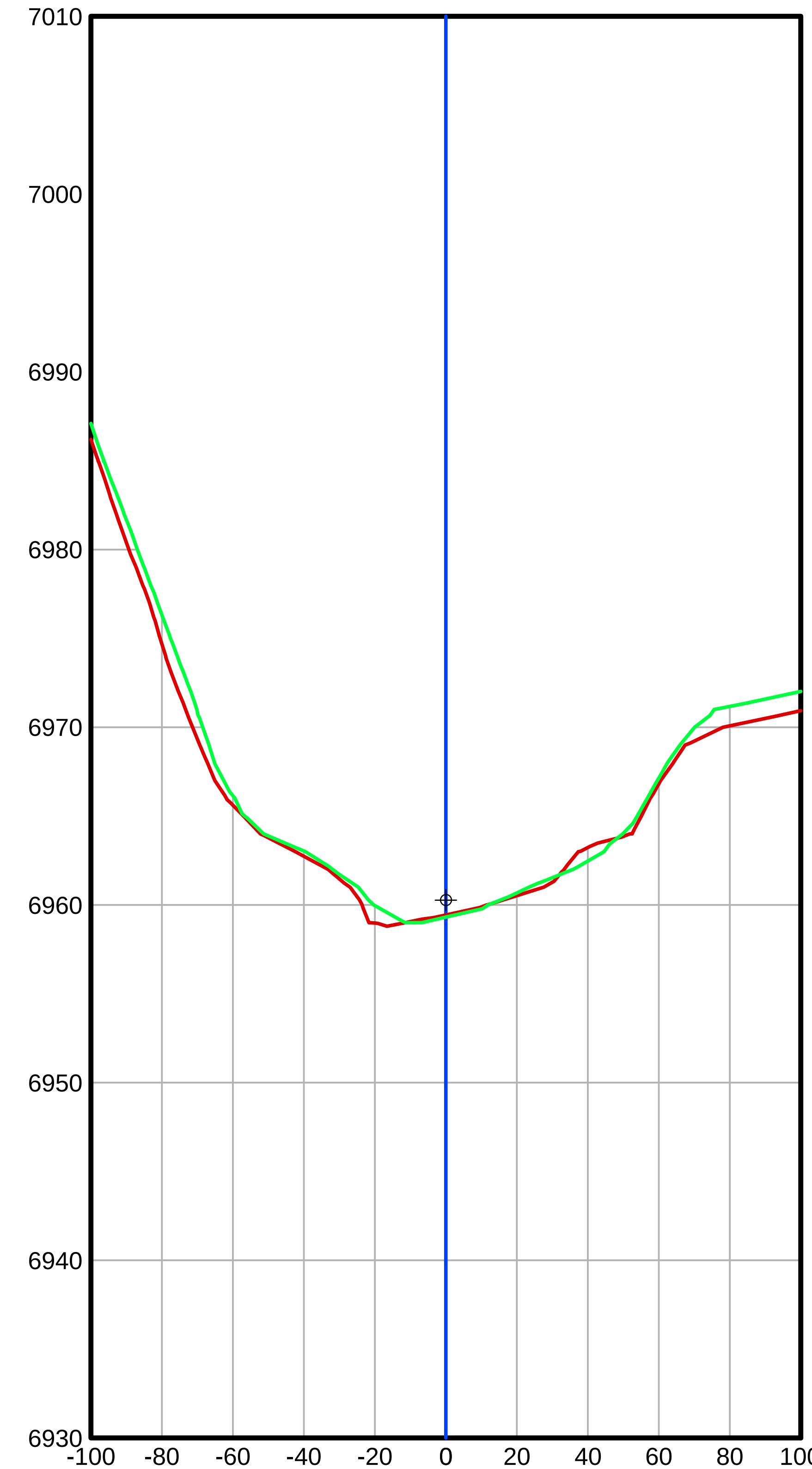

LEGEND — EXISTING (red) — ROAD GRADES (green) — PROPOSED (blue)

SCALE: 1" = 50'

0 50'

Symbol | Description | Date | Approved

Designed by: JEFF CRANE
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Date: 2/25/2016
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Plot scale:
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NORTH FORK BIG THOMPSON RIVER
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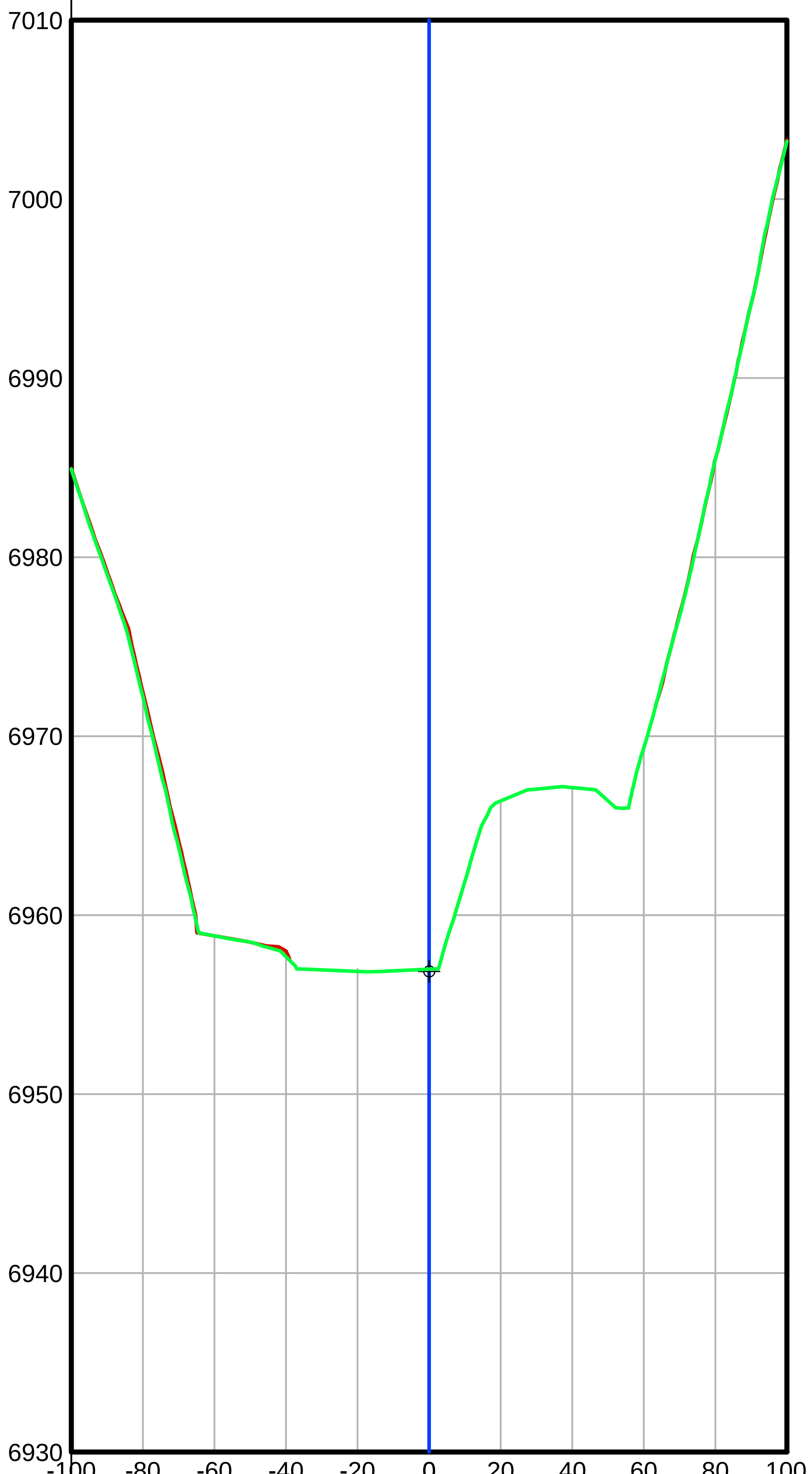
CROSS SECTIONS

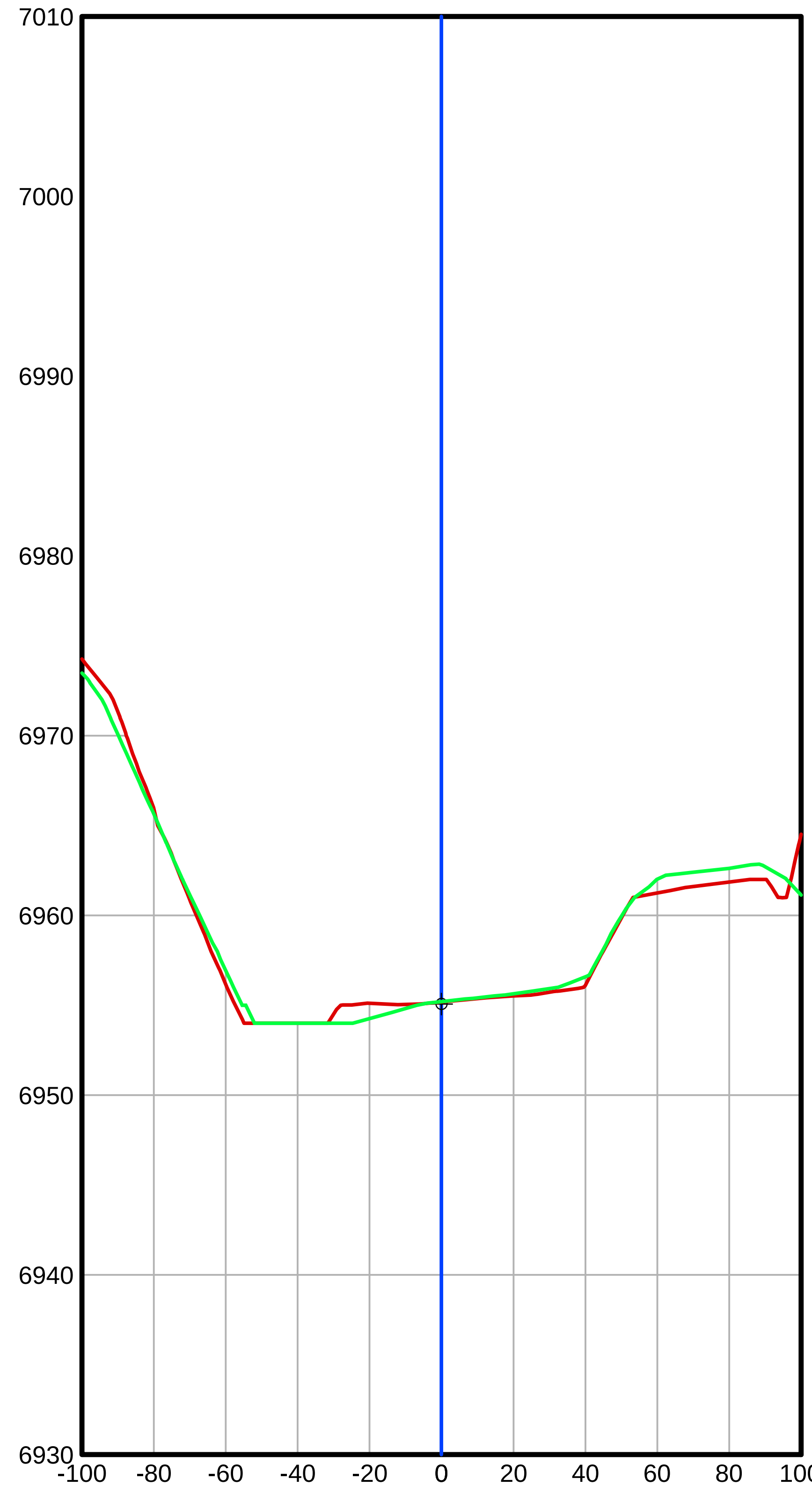
Sheet reference number: 37

UPDATE

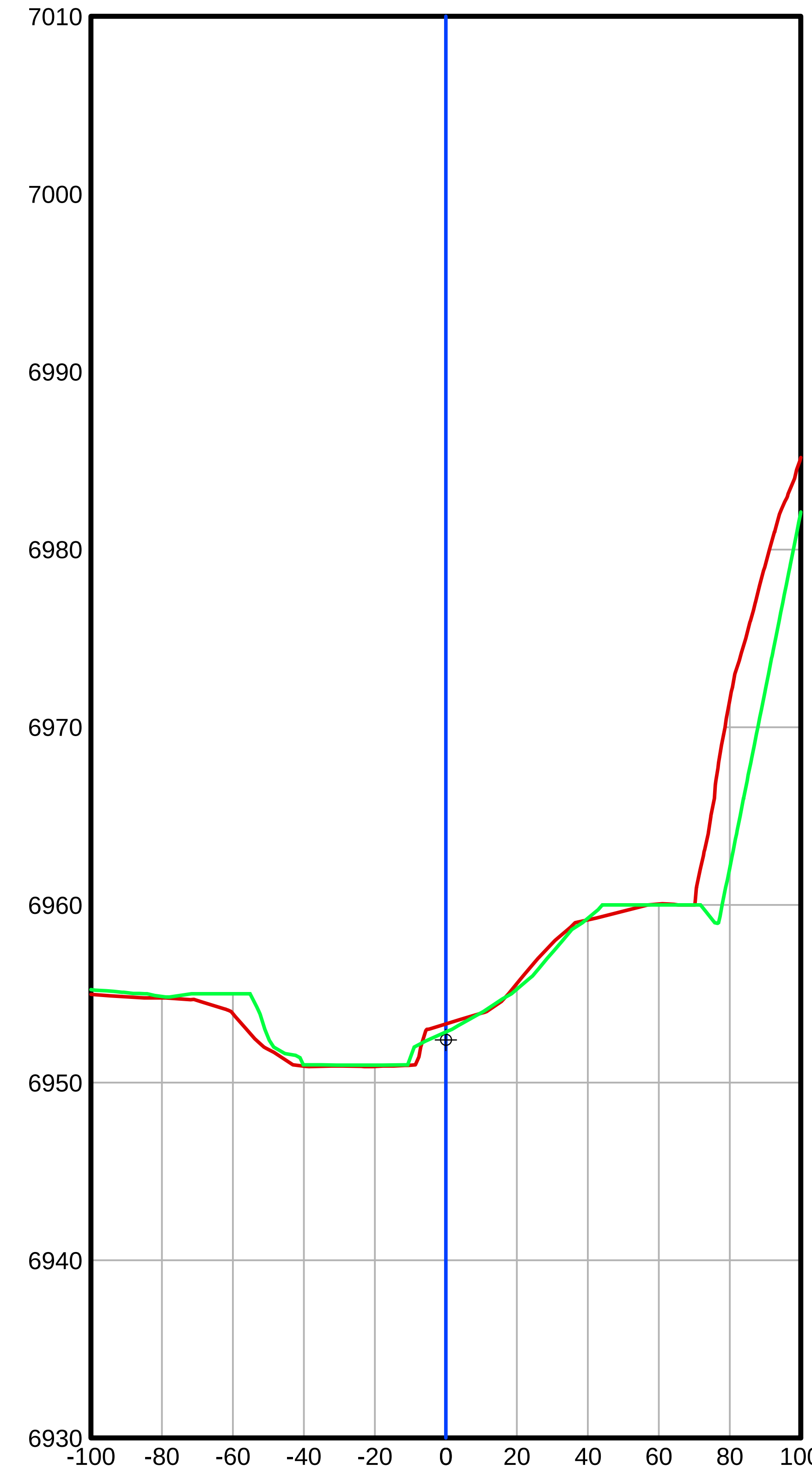
SL-19 (622+00.00)



SL-20 (624+00.00)



SL-21 (626+00.00)



LEGEND — EXISTING — ROAD GRADES — PROPOSED

SCALE: 1" = 50'

0 50'

Symbol	Description	Date	Approved

CRANE ASSOCIATES

Designed by: JEFF CRANE
Dwn by:
Ckd by:
Reviewed by: JPC
Submitted by:
Date: 2/25/2016
Design file no:
Drawing Code:
File name:
Plot date:
Plot scale:
Rev.

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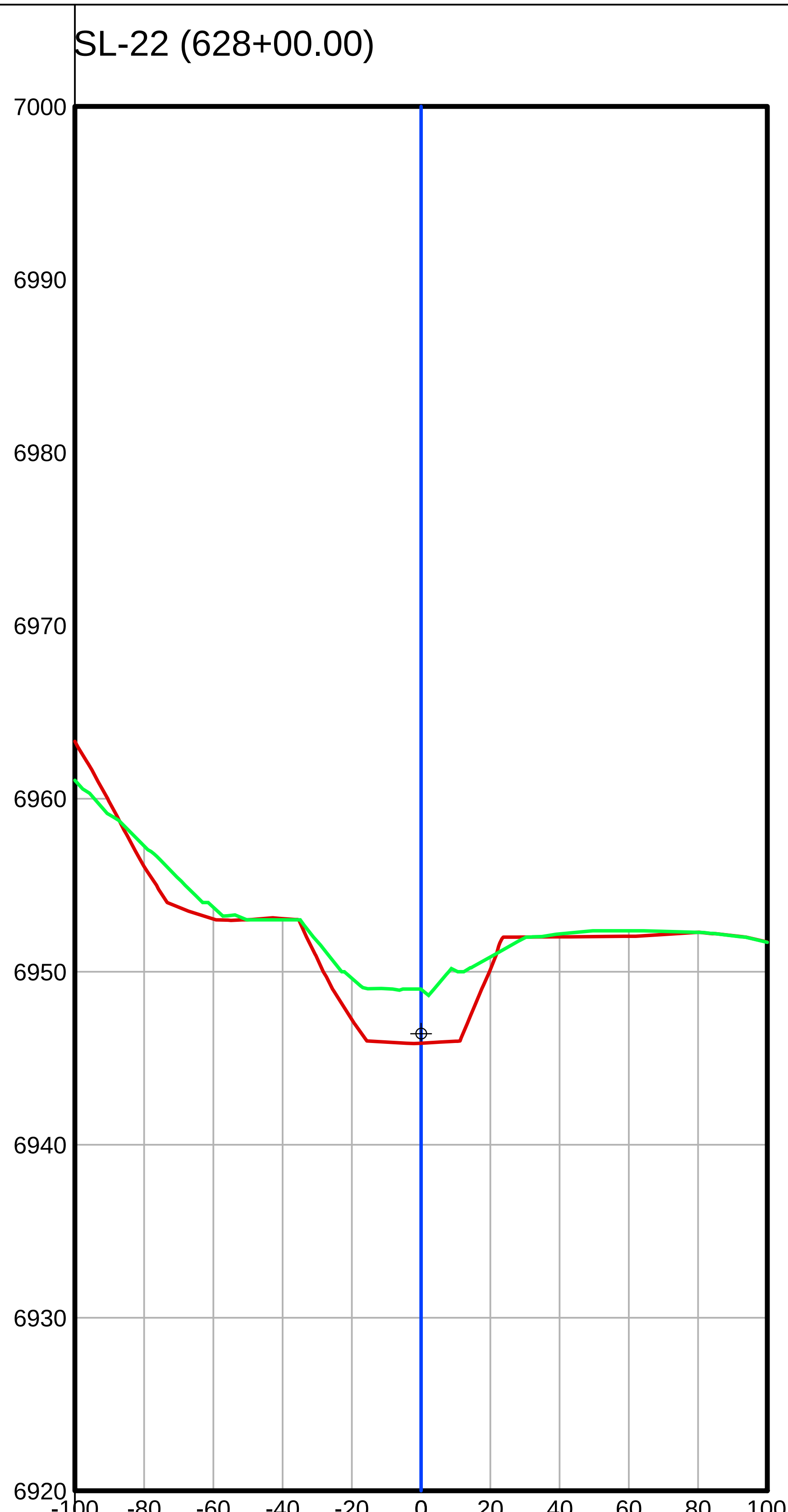
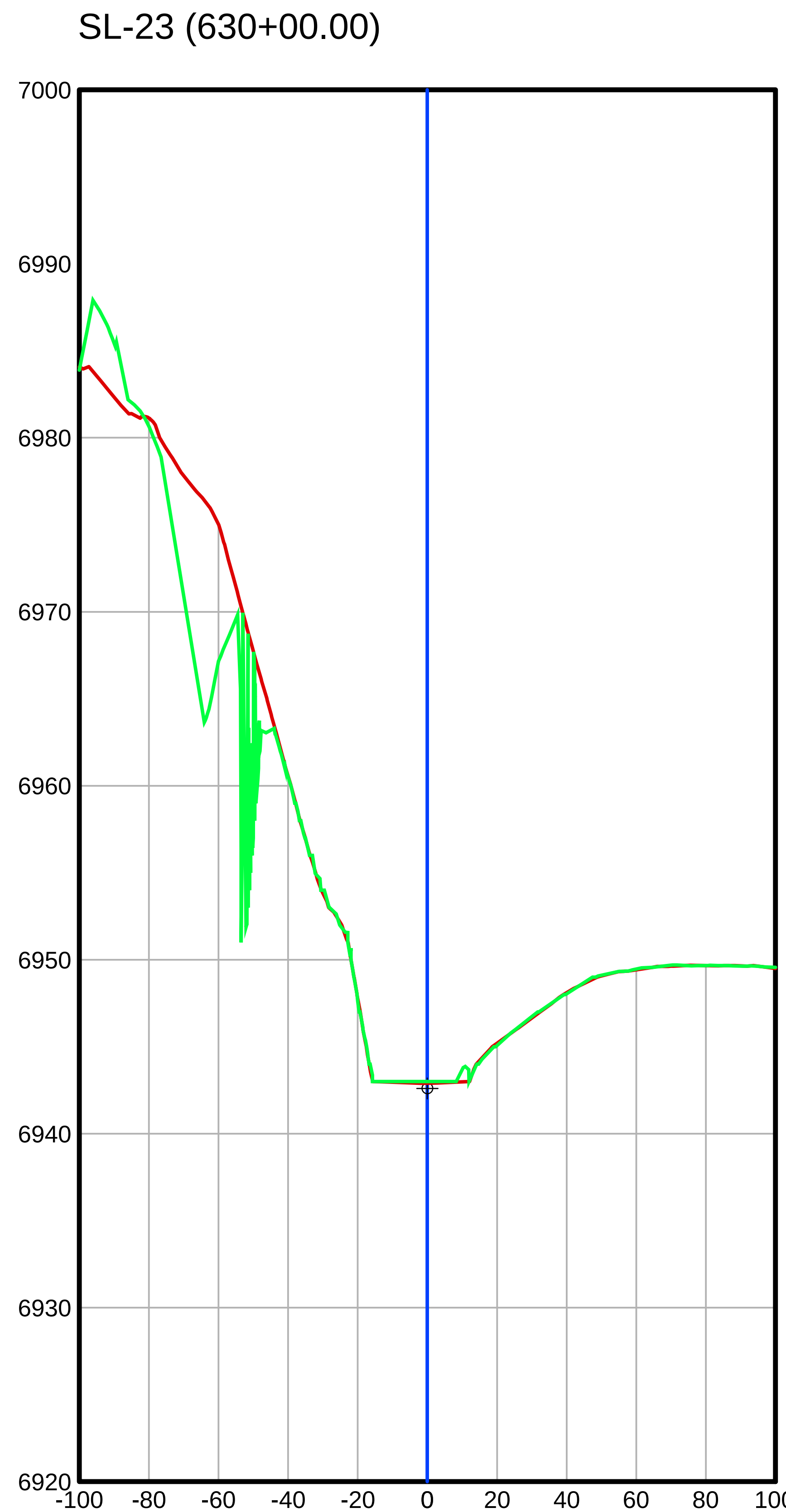
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

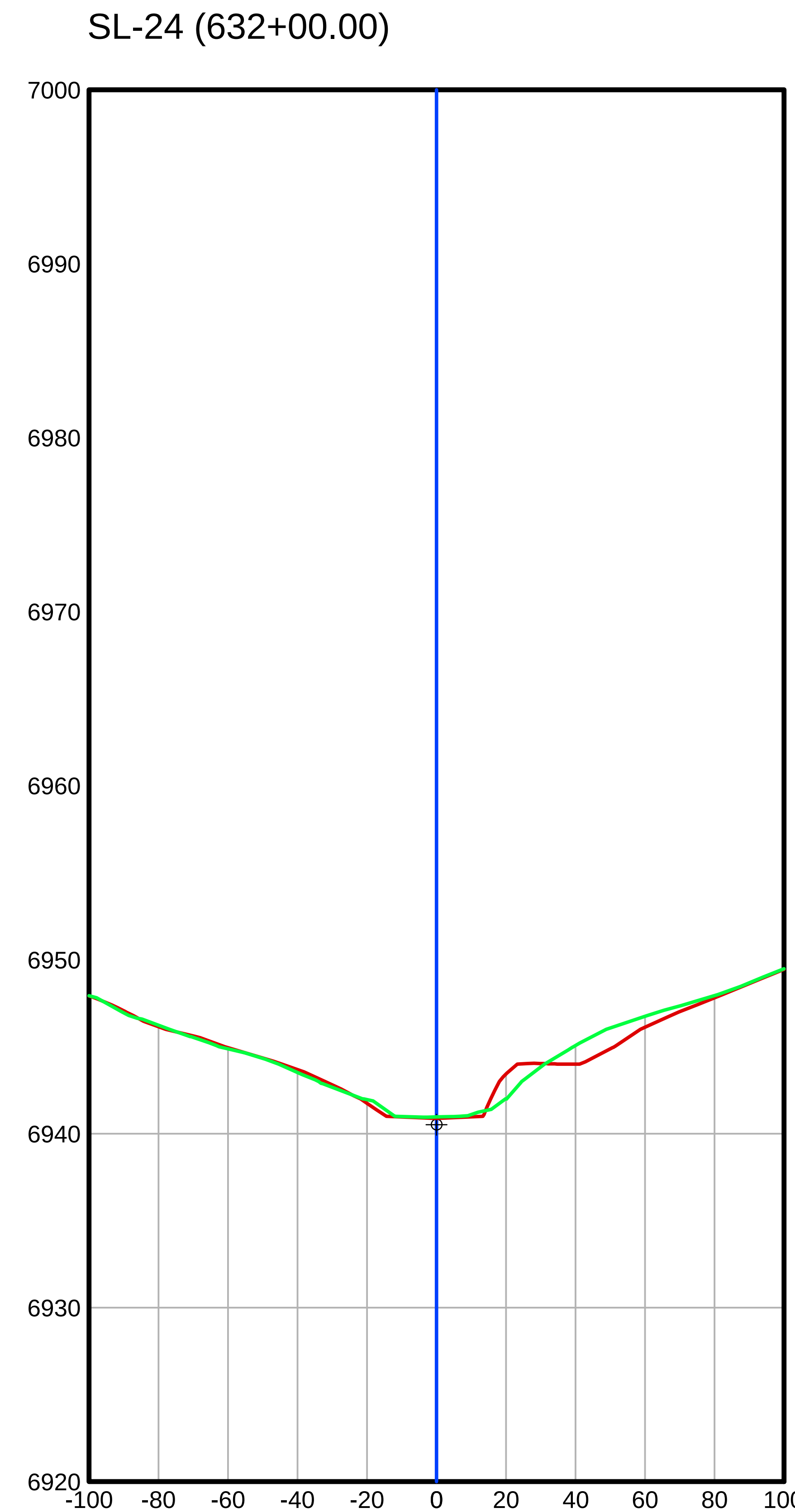
CROSS SECTIONS

Sheet reference number:
38

UPDATE







LEGEND EXISTING ROAD GRADES PROPOSED

SCALE: 1" = 50'

0 50'

Symbol	Description	Date / Approved

CRANE ASSOCIATES

Designed by: JEFF CRANE	Date: 2/25/2016	Rev.
Dwn by: / Ckd by:	Design file no:	
Reviewed by: JPC	Drawing Code:	
Submitted by:	File name: / Plot date: / Plot scale:	

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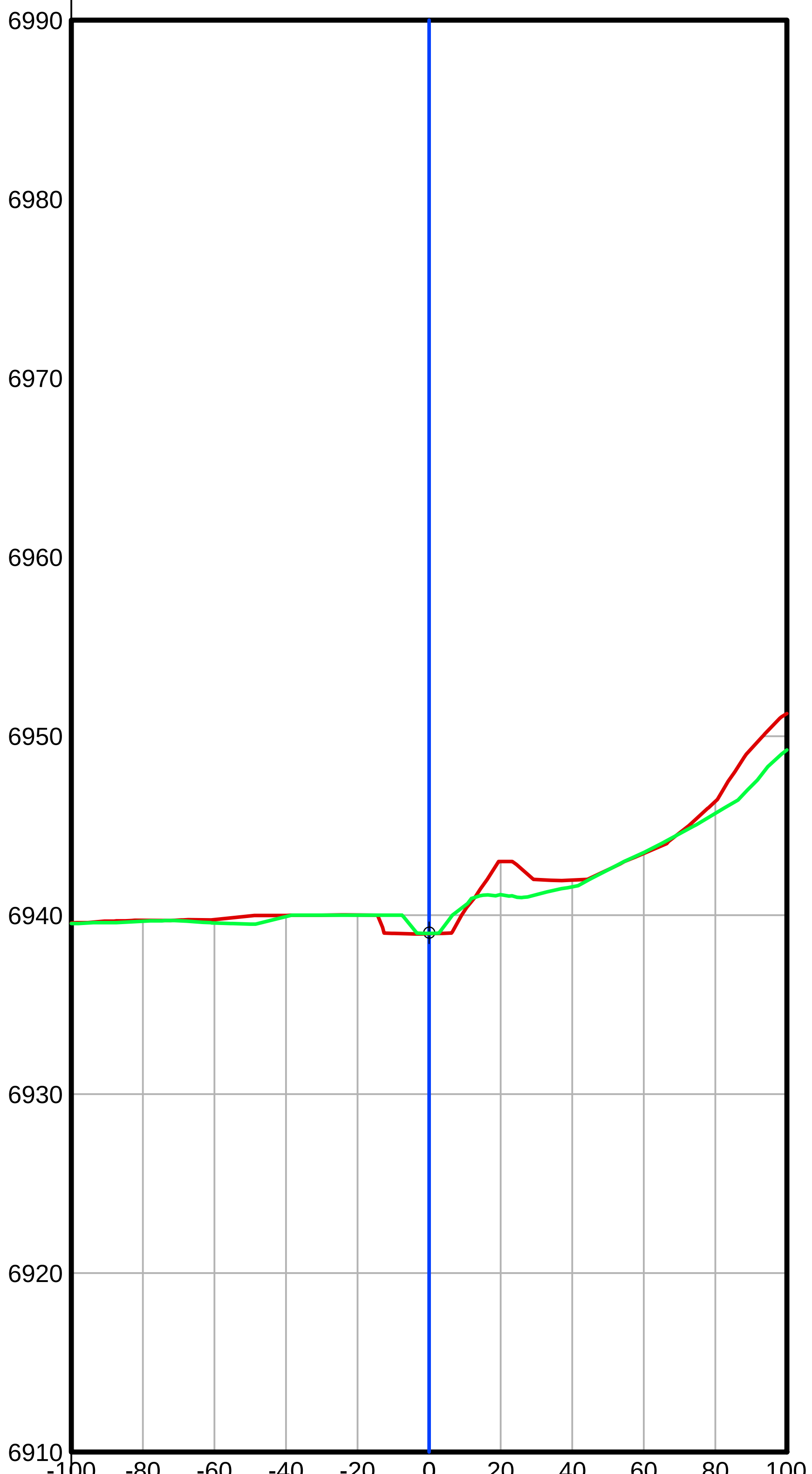
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

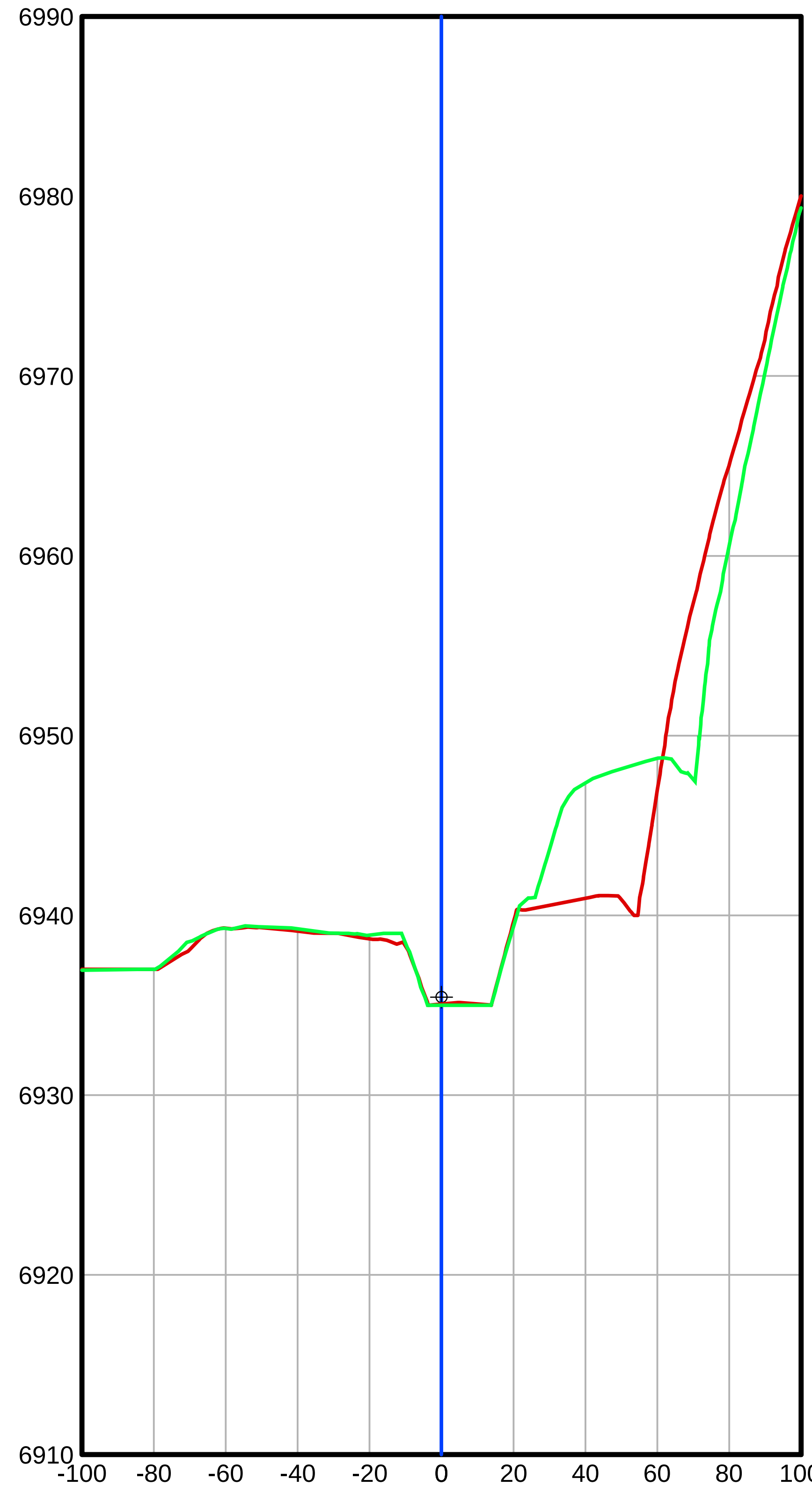
Sheet reference number:
39

UPDATE

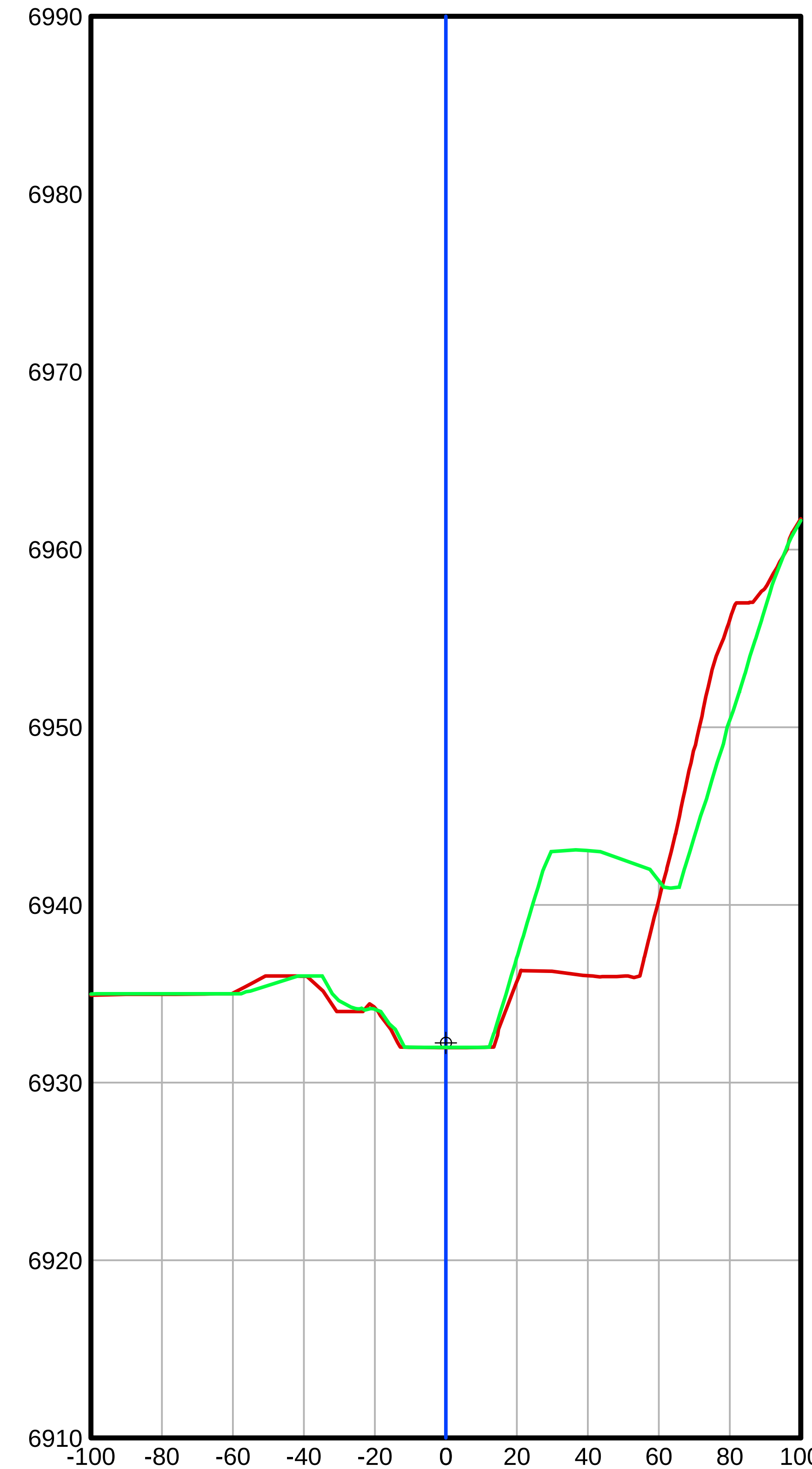
SL-25 (634+00.00)



SL-26 (636+00.00)



SL-27 (638+00.00)



LEGEND — EXISTING (red) — ROAD GRADES (green) — PROPOSED (blue)

SCALE: 1" = 50'

0 50'

Symbol | Description | Date | Approved

Date: 2/25/2016 | Design file no: | Drawing Code: | Rev.

Designed by: JEFF CRANE | Drn by: | Ckd by: | Reviewed by: JPC | Submitted by: | File name: | Plot date: | Plot scale:

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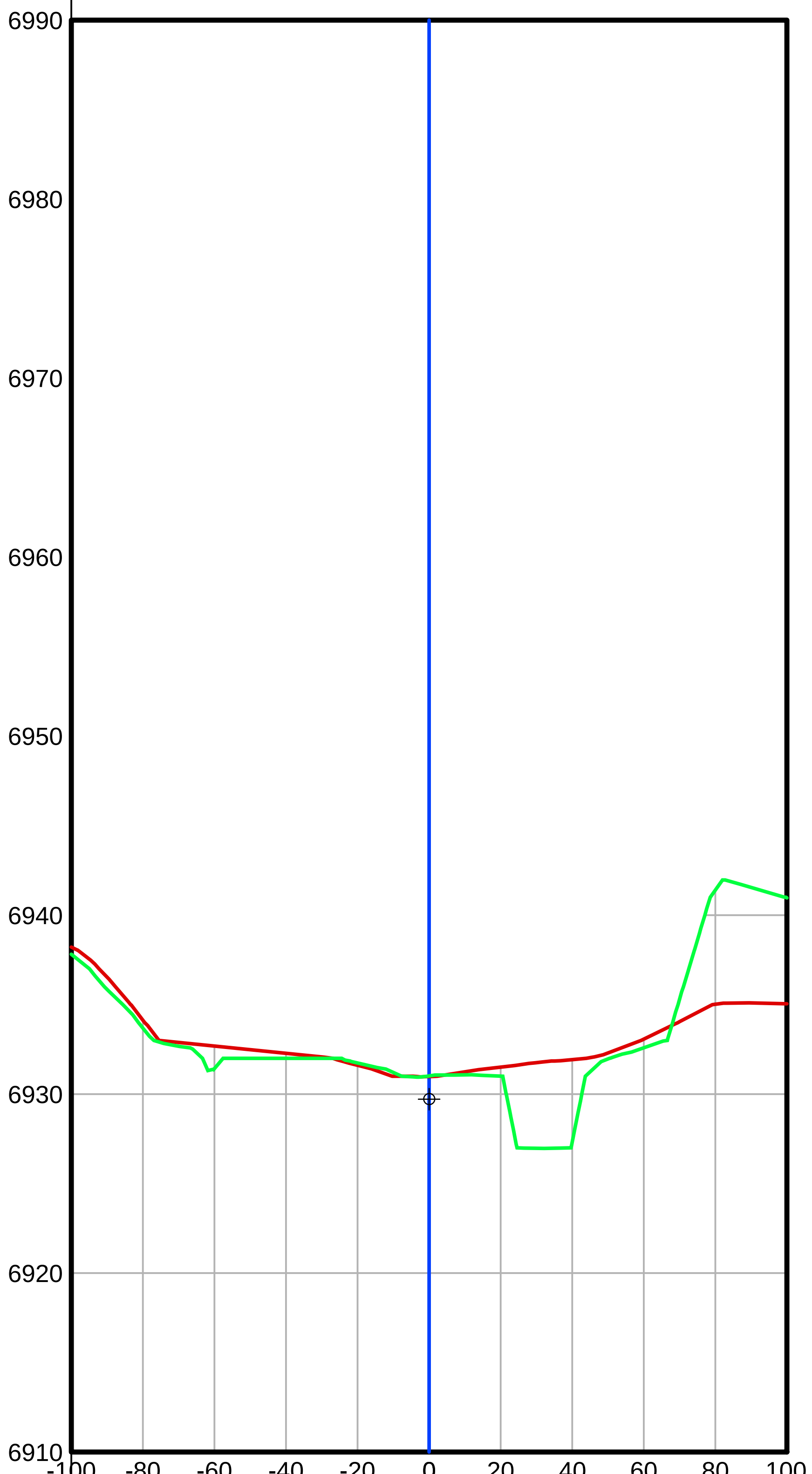
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

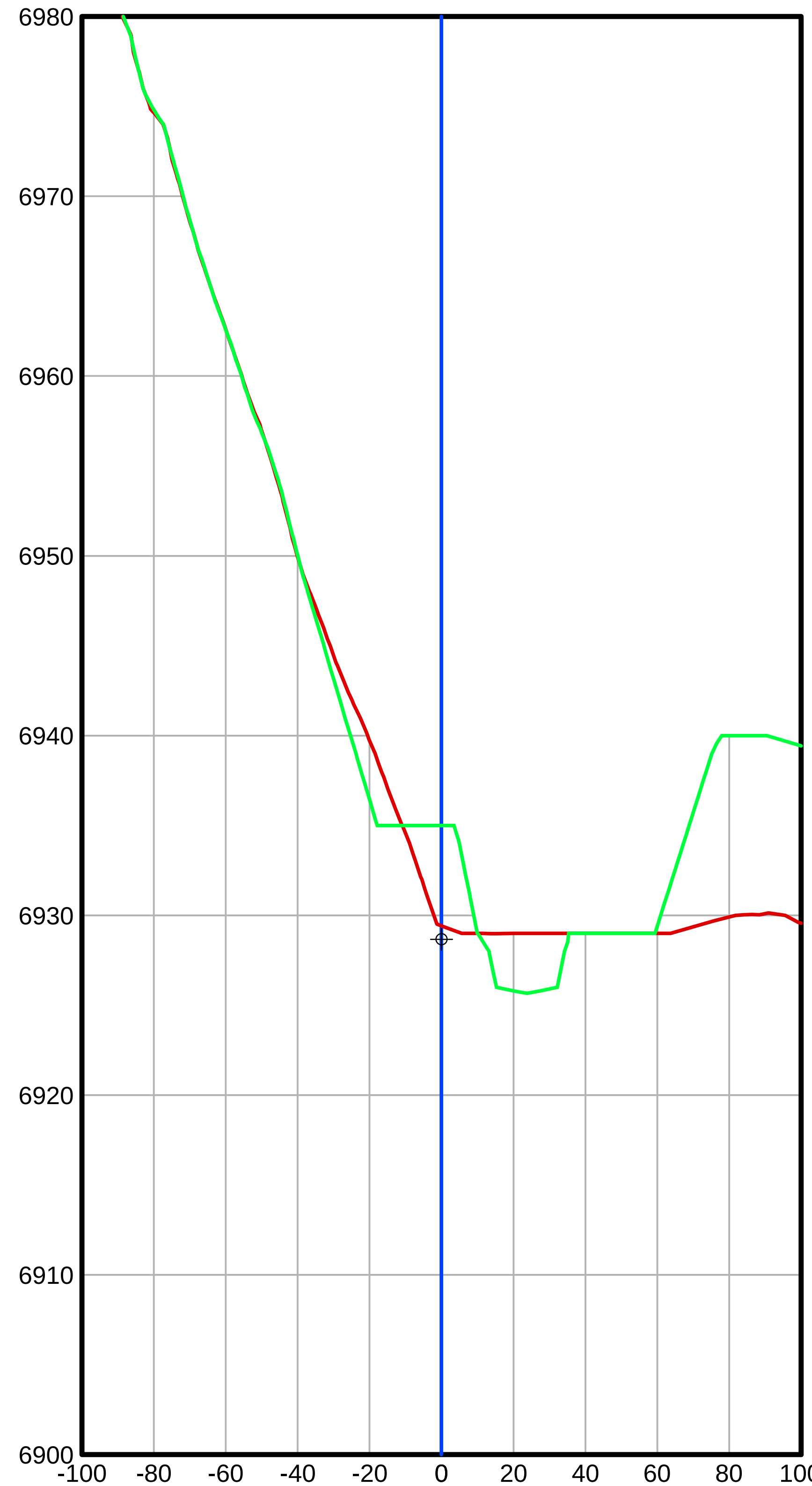
Sheet reference number:
40

UPDATE

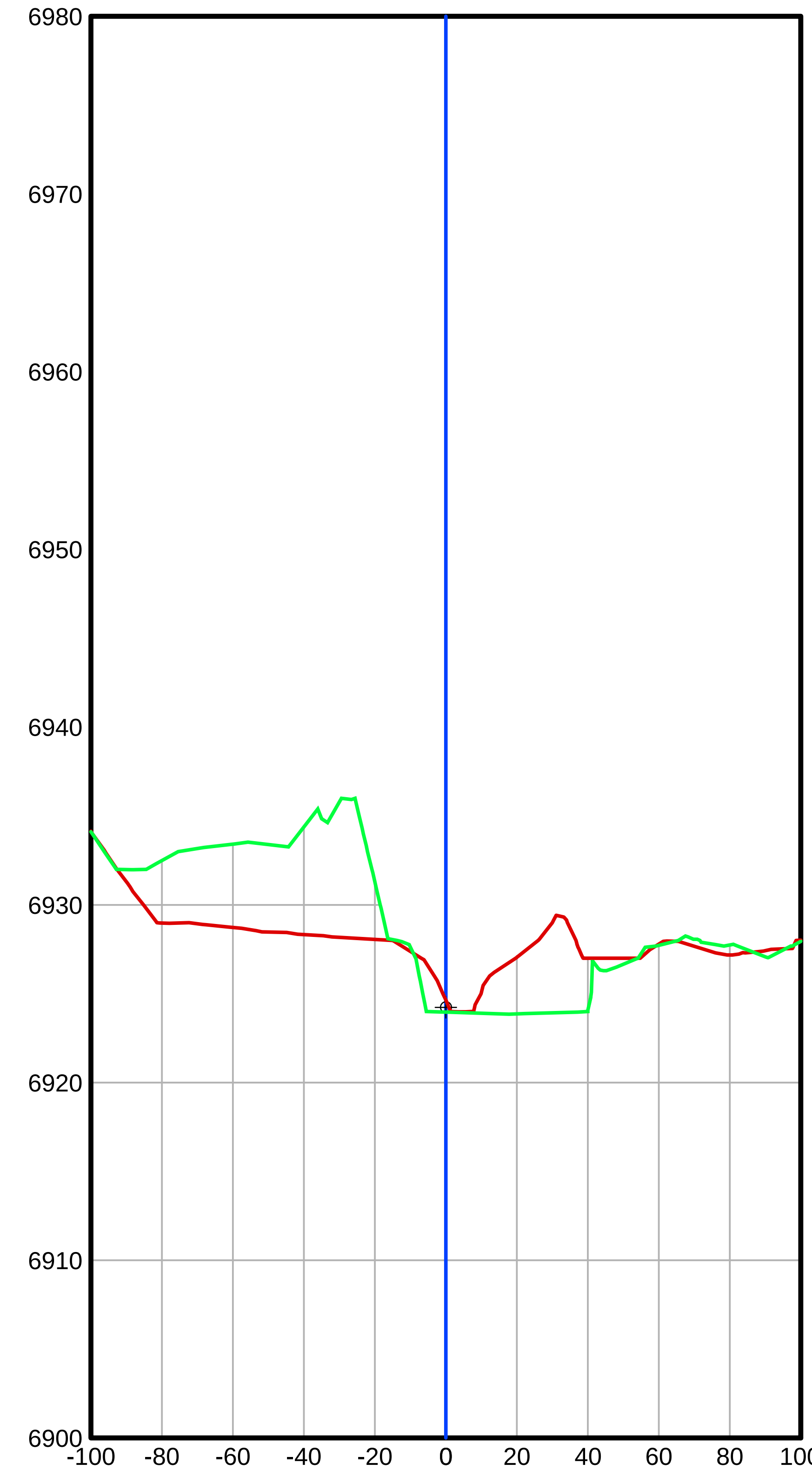
SL-28 (640+00.00)



SL-29 (642+00.00)



SL-30 (644+00.00)



LEGEND — EXISTING — ROAD GRADES — PROPOSED

SCALE: 1" = 50'

0 50'

Symbol | Description | Date | Approved

Rev.

Date: 2/25/2016

Design file no:

Drawing Code:

File name: | Plot date: | Plot scale:

Designed by: JEFF CRANE

Cad by:

Dwn by:

Reviewed by: JPC

Submitted by:

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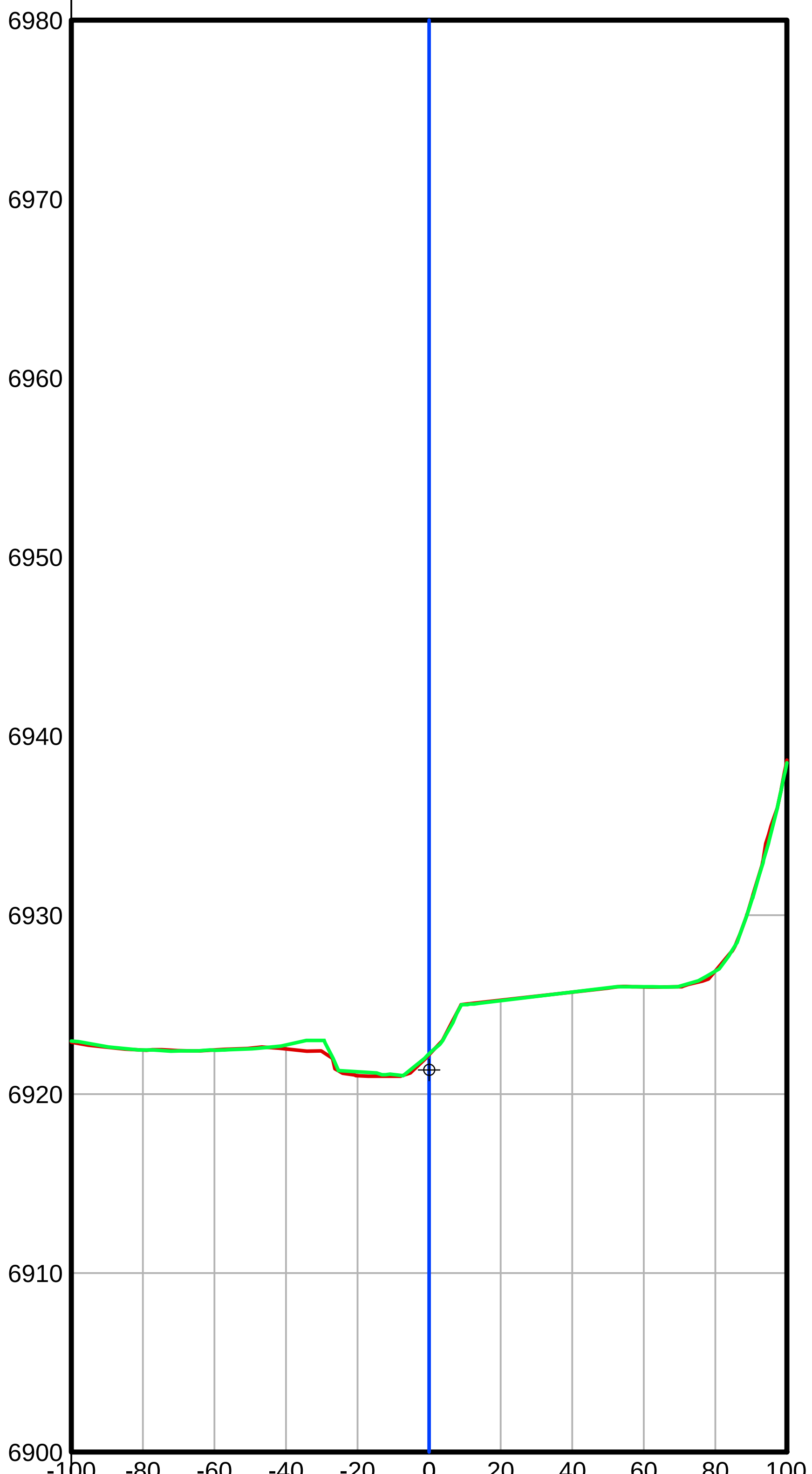
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

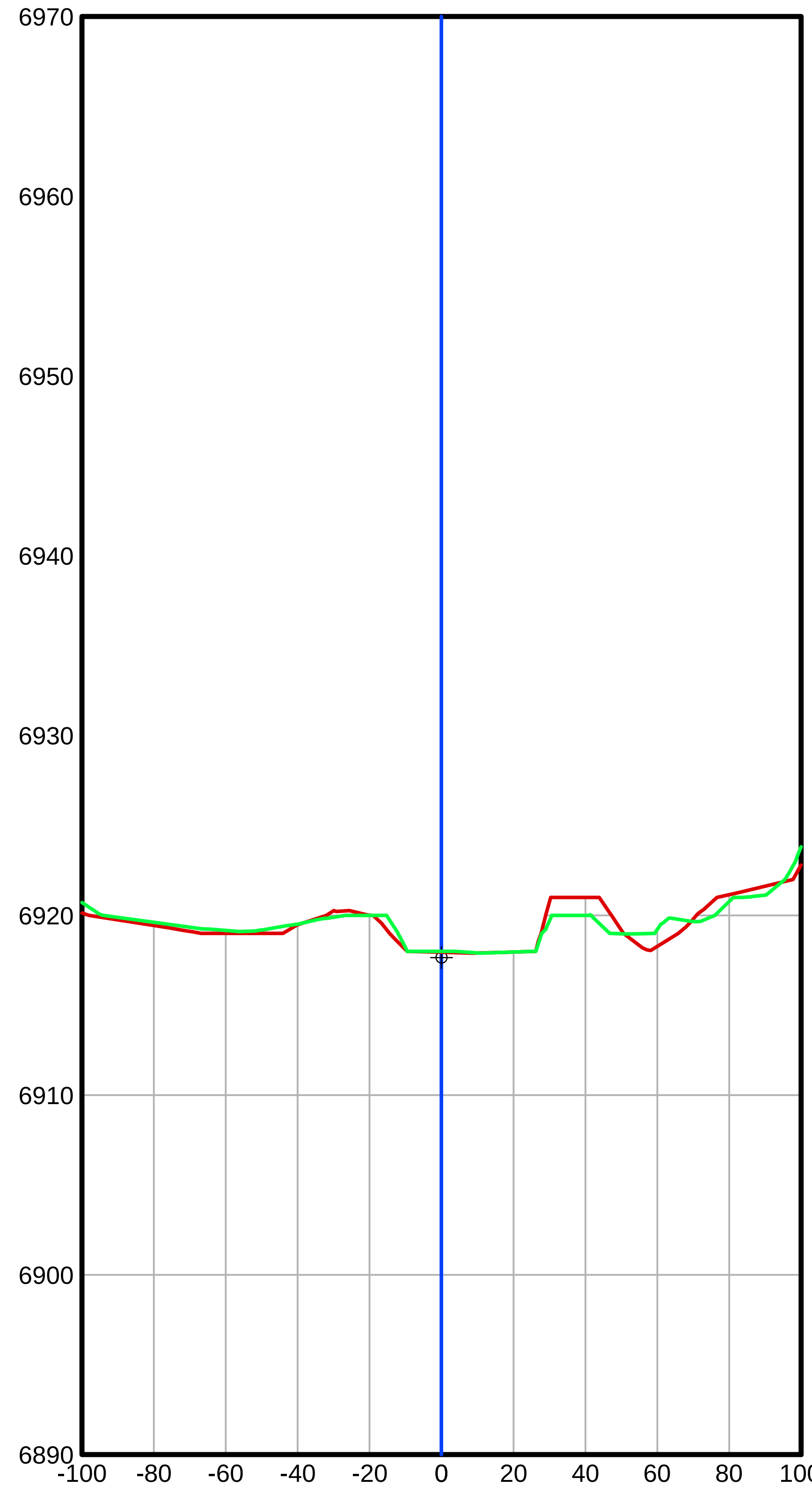
Sheet reference number:
41

UPDATE

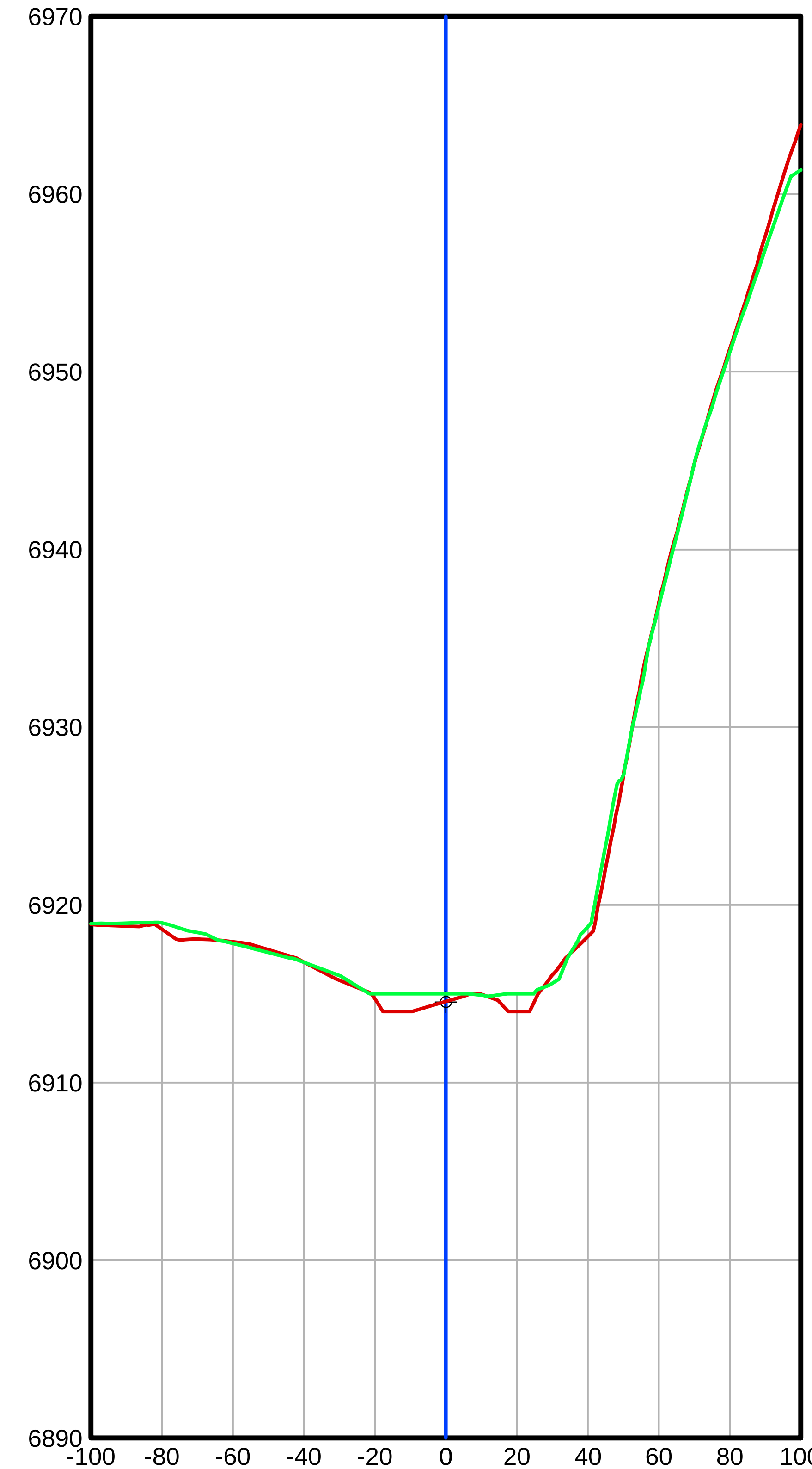
SL-31 (646+00.00)



SL-32 (648+00.00)



SL-33 (650+00.00)



LEGEND EXISTING ROAD GRADES PROPOSED

SCALE: 1" = 50'

0 50'

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Reviewed by: JPC
Date: 2/25/2016

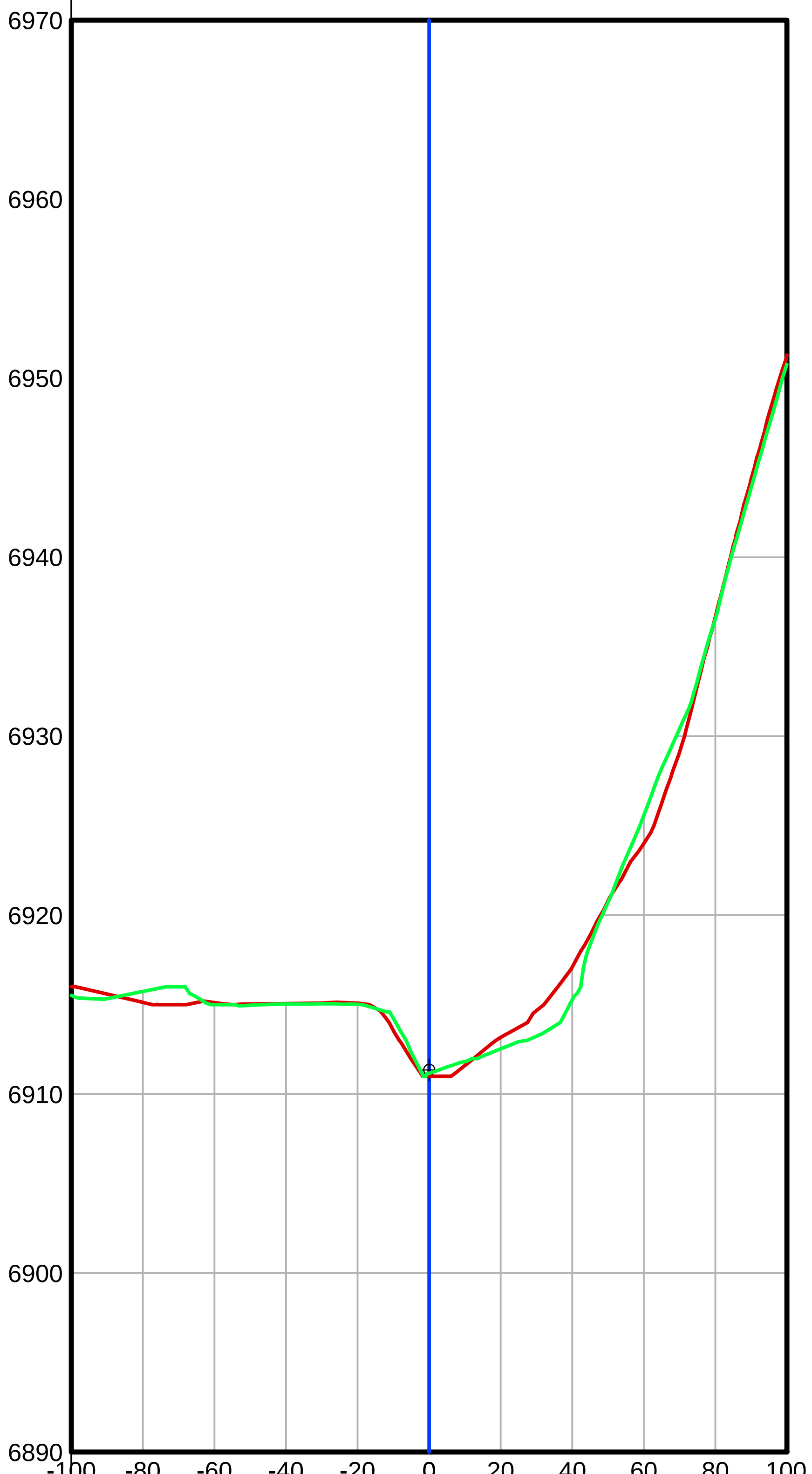
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

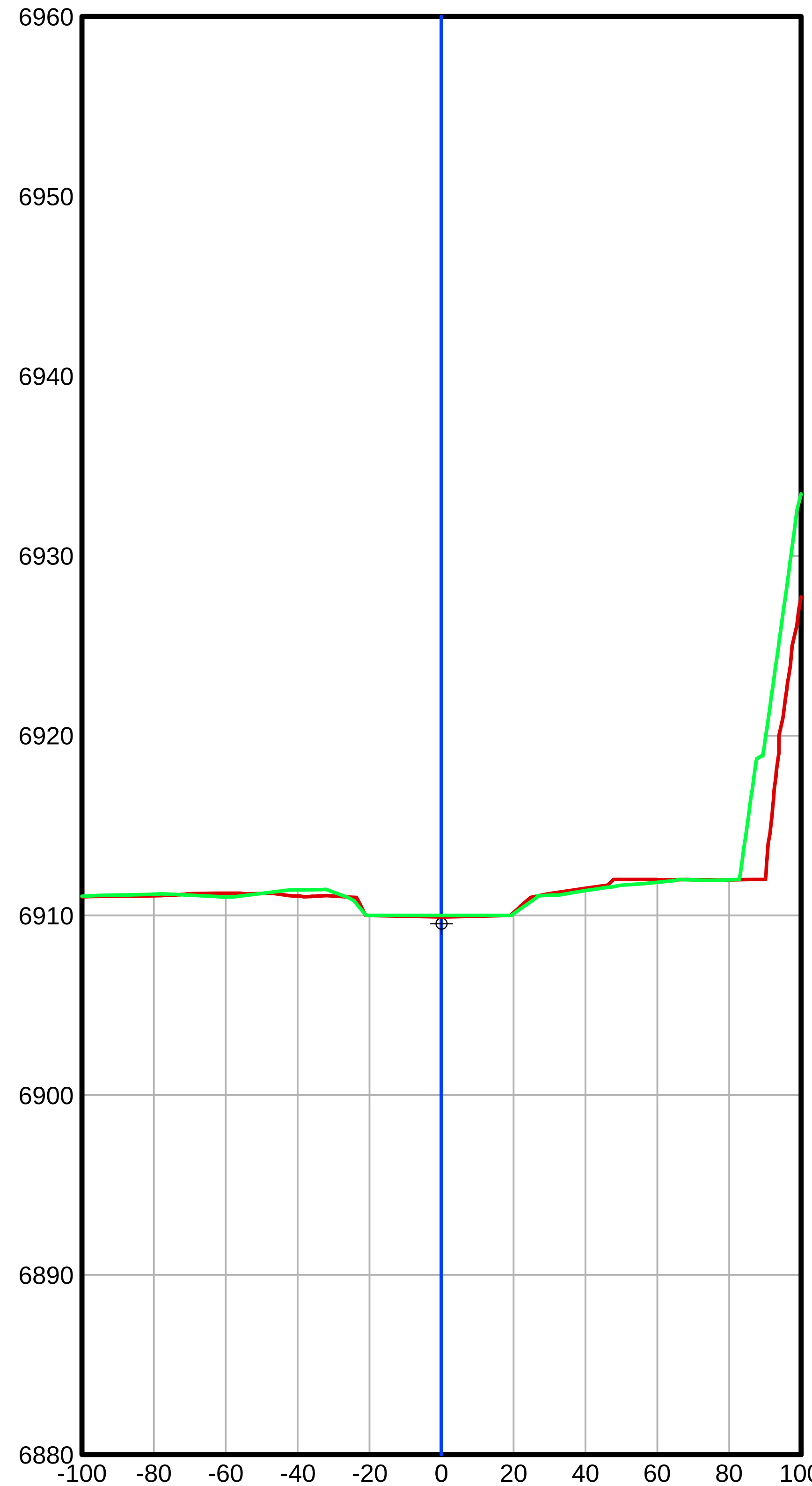
Sheet reference number: 42

UPDATE

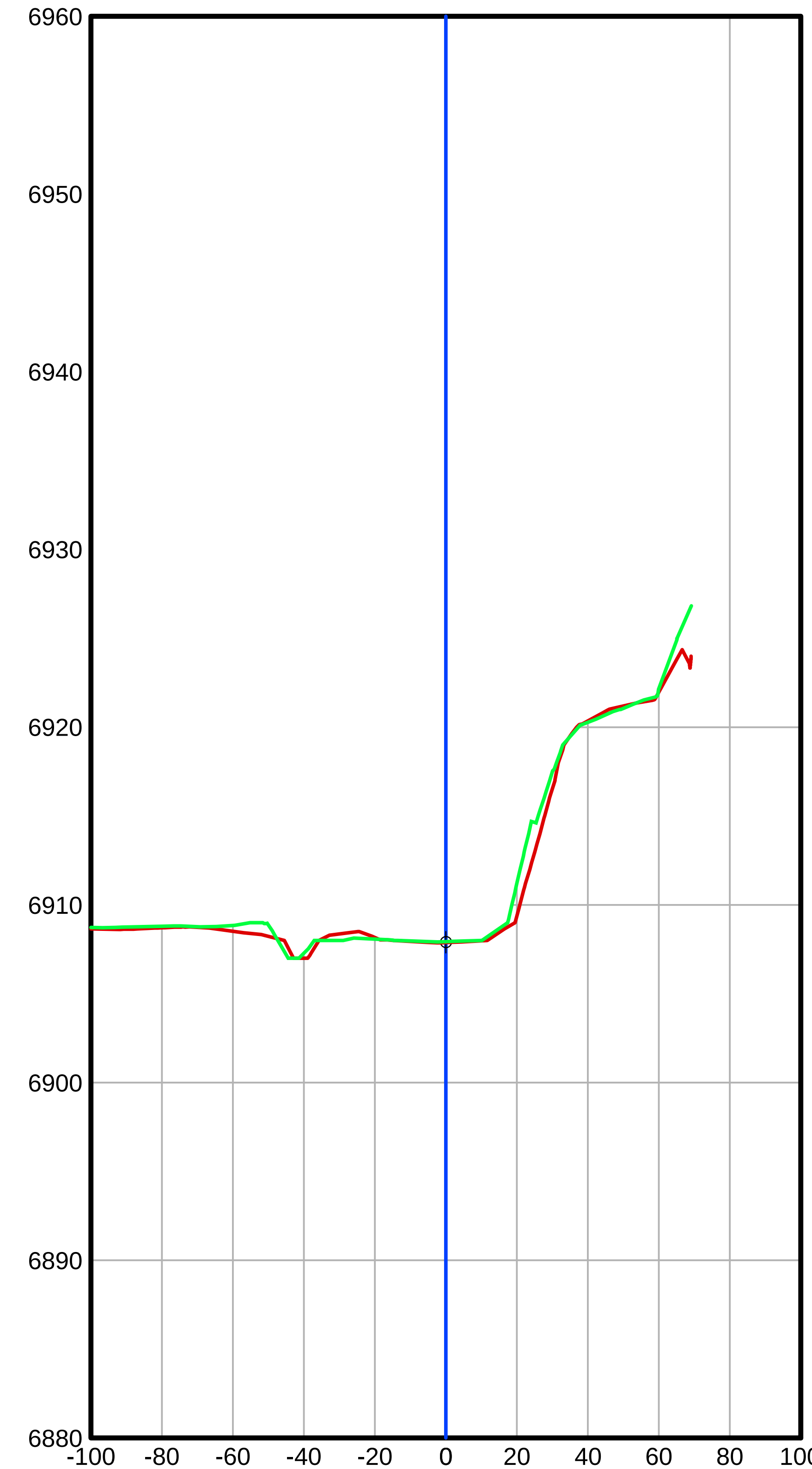
SL-34 (652+00.00)



SL-35 (654+00.00)



SL-36 (656+00.00)



LEGEND — EXISTING — ROAD GRADES — PROPOSED

SCALE: 1" = 50'

0 50'

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Reviewed by: JPC			Design file no:
			Drawing Code:
Submitted by:			File name: Plot date: Plot scale:
Rev.			

Symbol	Description	Date	Approved

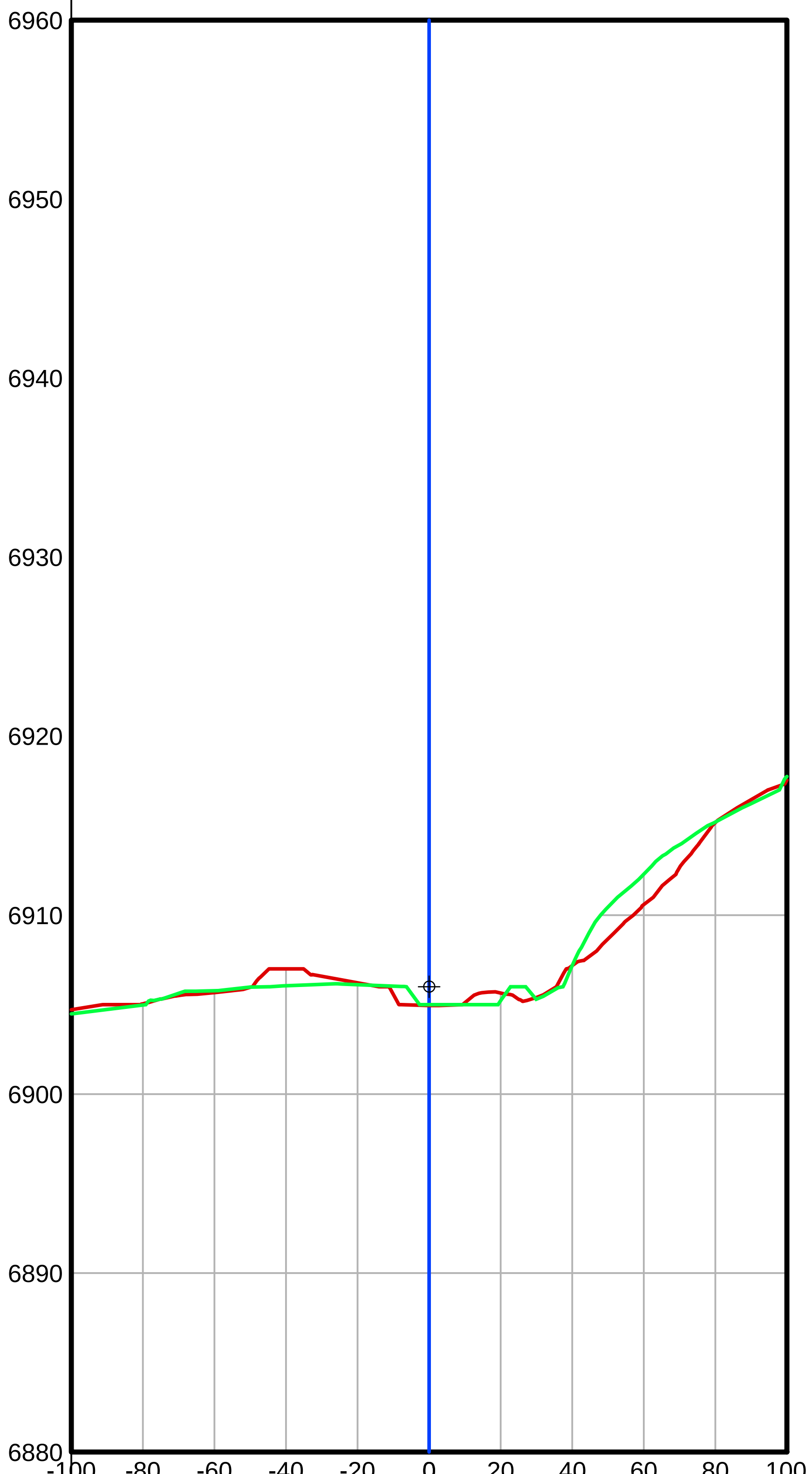
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

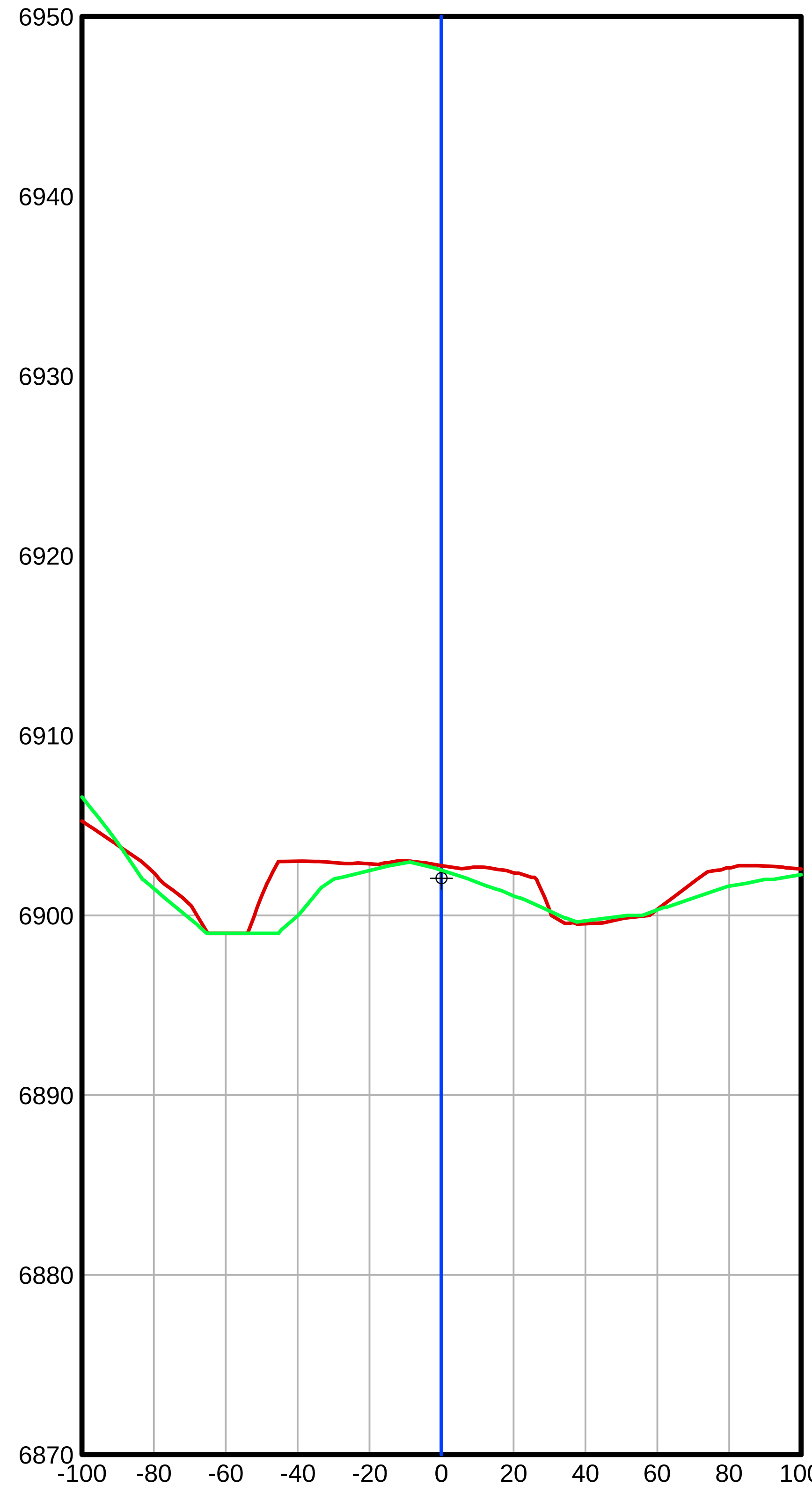
Sheet reference number: 43

UPDATE

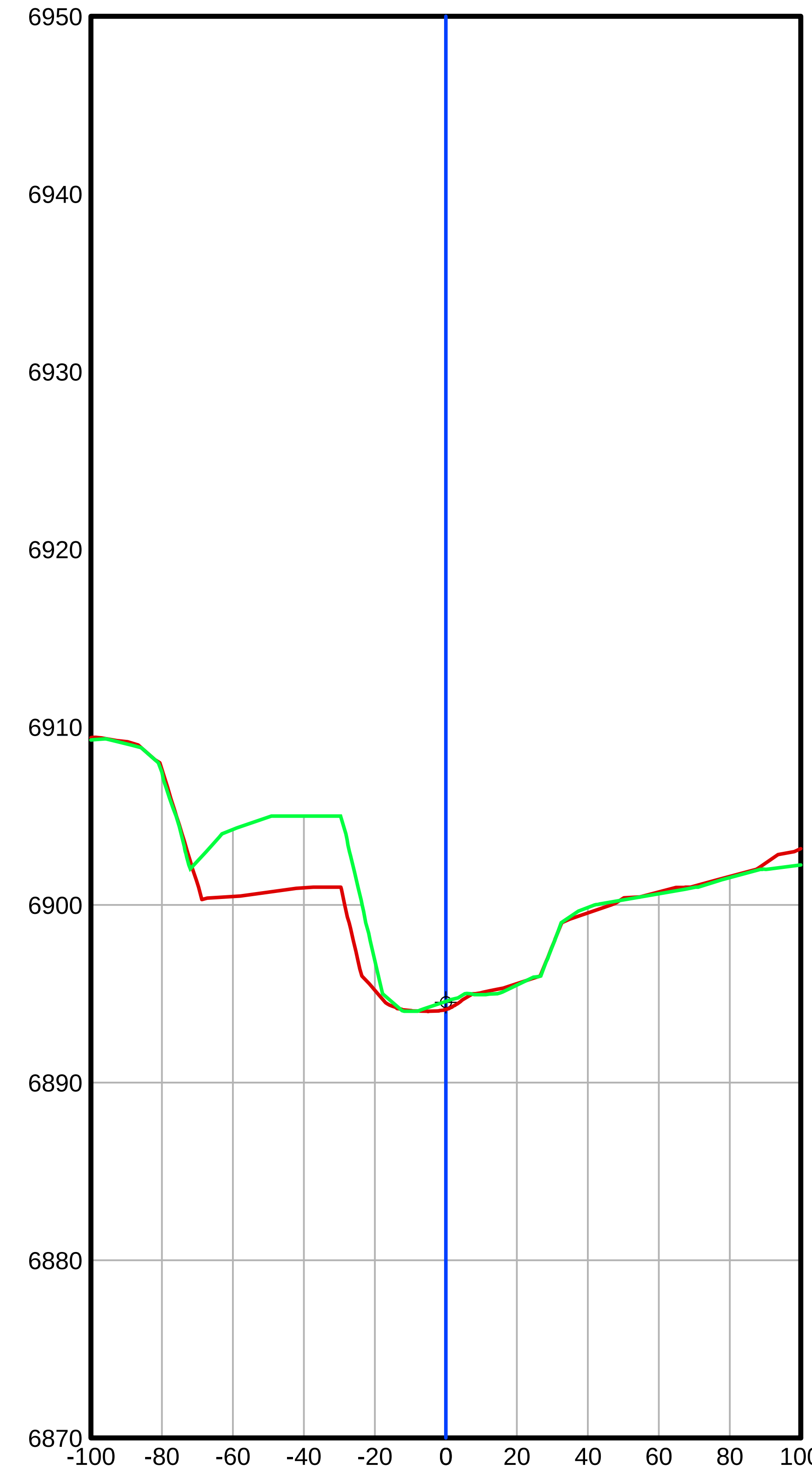
SL-37 (658+00.00)



SL-38 (660+00.00)



SL-39 (662+00.00)



LEGEND EXISTING ROAD GRADES PROPOSED

SCALE: 1" = 50'

0 50'

Symbol | Description | Date | Approved

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Rev.

Date: 2/25/2016

Design file no:

Drawing Code:

Designed by: JEFF CRANE

Dwn by:

Ckd by:

Reviewed by: JPC

Submitted by:

File name:
Plot date:
Plot scale:

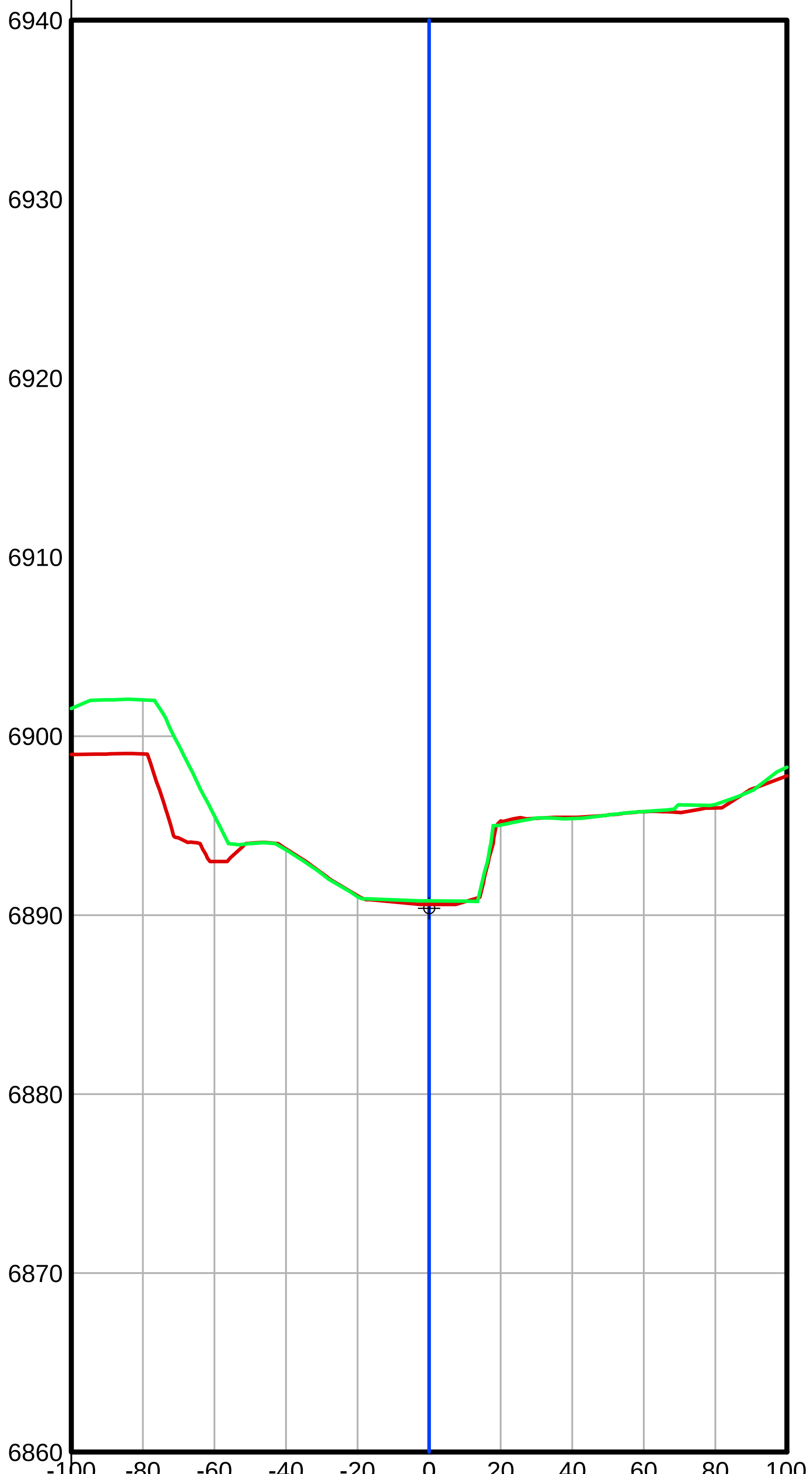
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

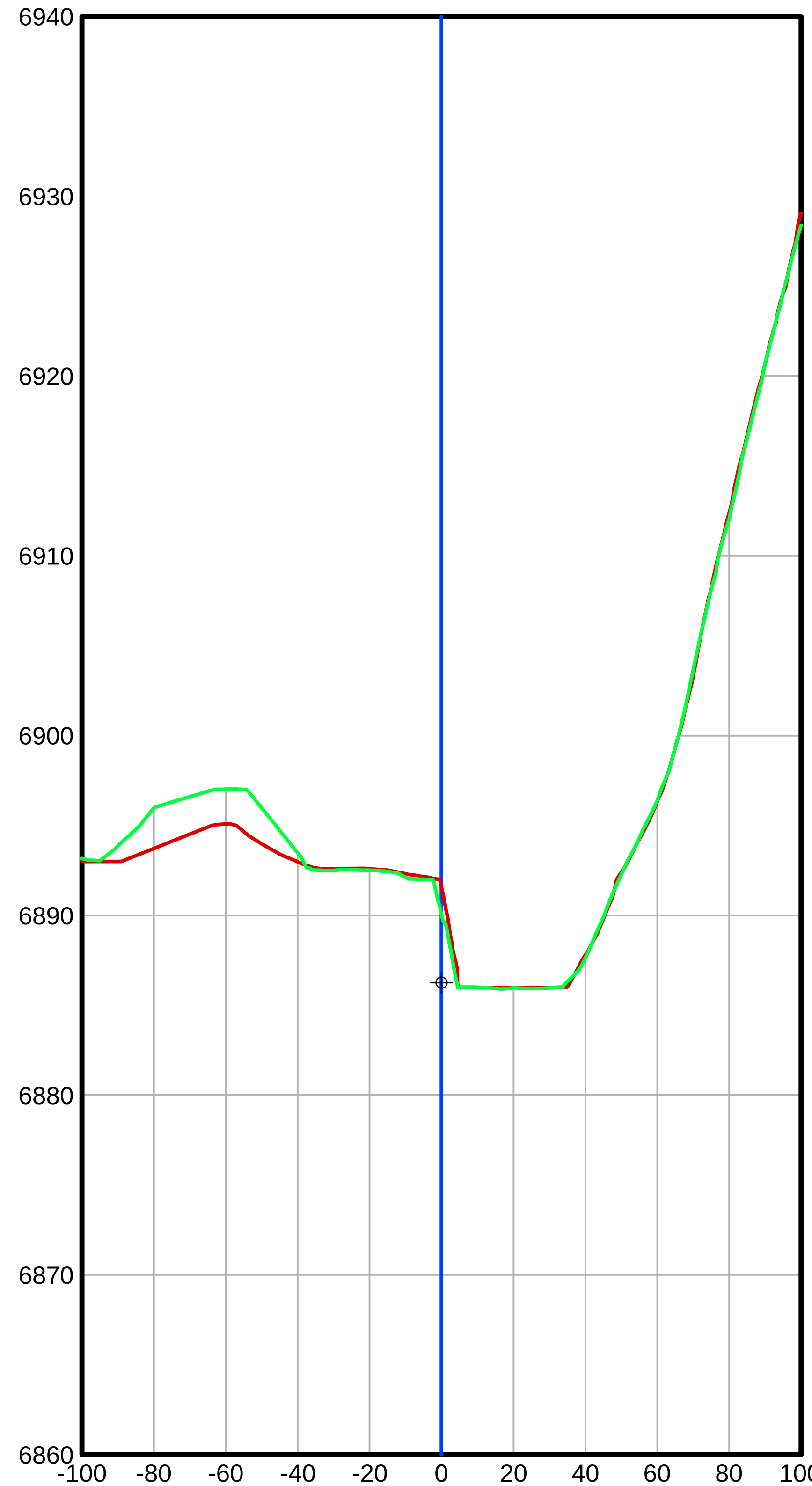
Sheet reference number:
44

UPDATE

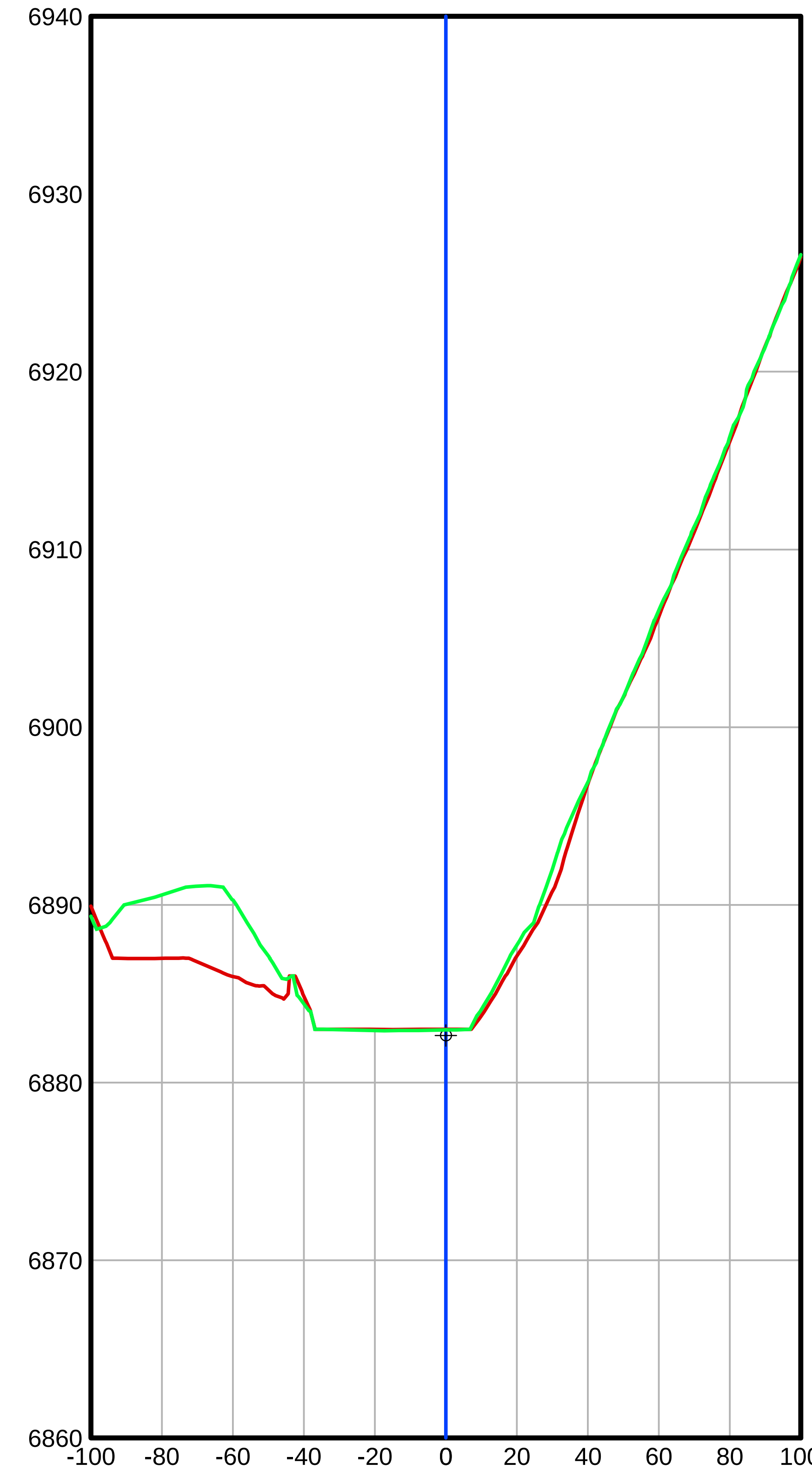
SL-40 (664+00.00)



SL-41 (666+00.00)



SL-42 (668+00.00)



LEGEND — EXISTING (red line) — ROAD GRADES (green line) — PROPOSED (blue line)

SCALE: 1" = 50'

0 50'

Symbol | Description | Date | Approved

CRANE ASSOCIATES

Rev.
Date: 2/25/2016
Design file no:
Drawing Code:
File name:
Plot date:
Plot scale:
Designed by: JEFF CRANE
Dwn by:
Ckd by:
Reviewed by: JPC
Submitted by:

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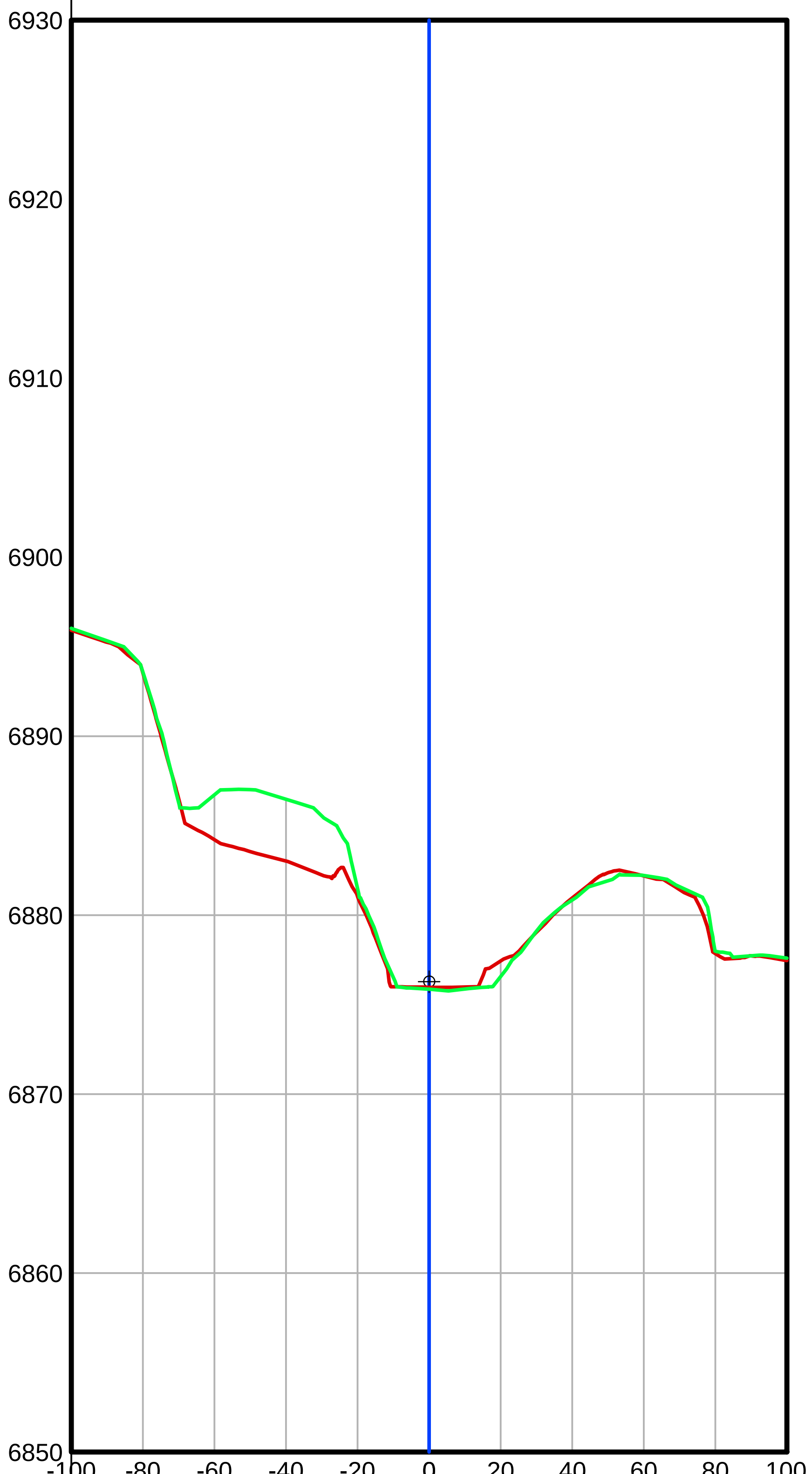
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

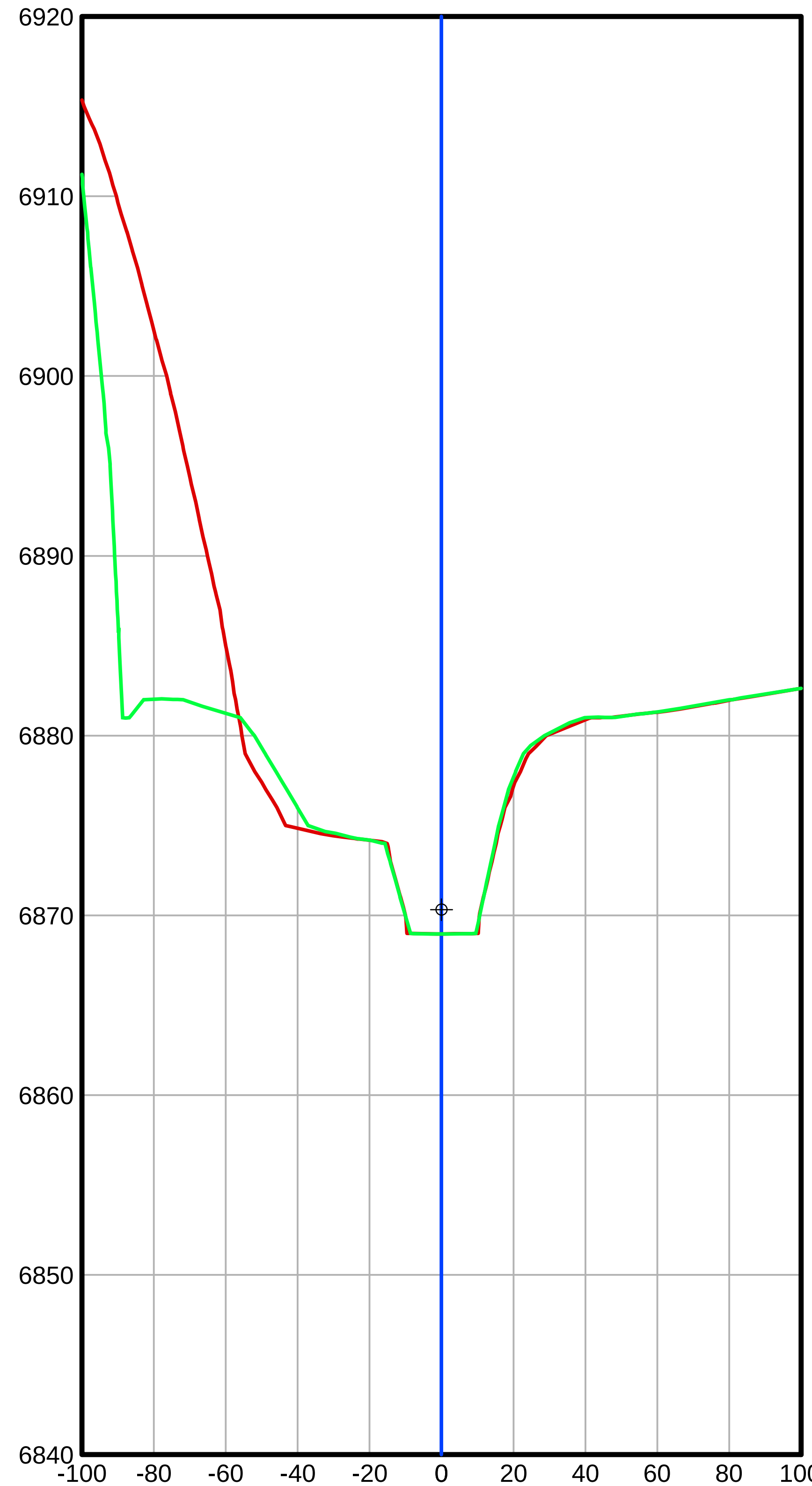
Sheet reference number:
45

UPDATE

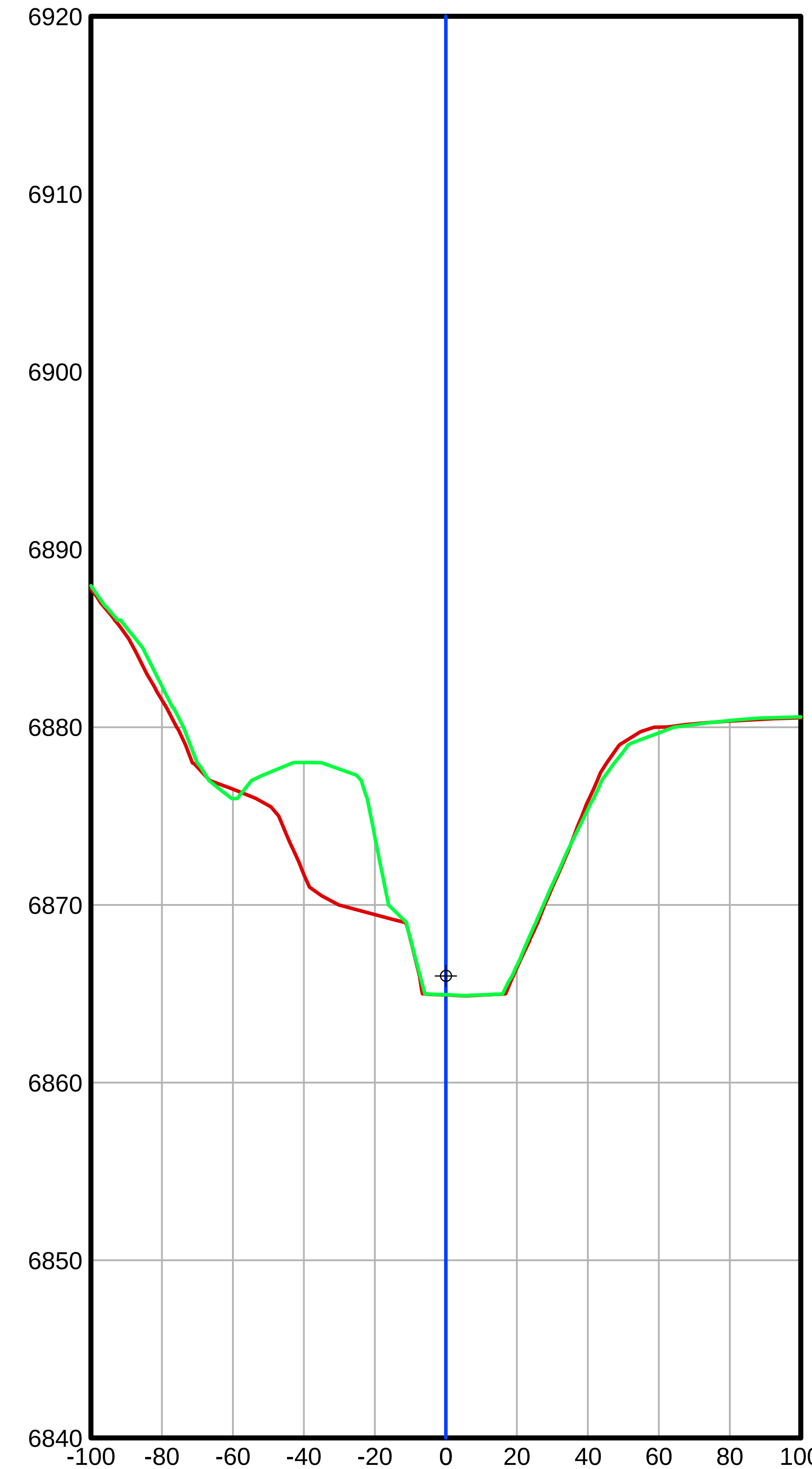
SL-43 (670+00.00)



SL-44 (672+00.00)



SL-45 (674+00.00)



LEGEND EXISTING ROAD GRADES PROPOSED

SCALE: 1" = 50'

0 50'

Symbol	Description	Date	Approved

CRANE ASSOCIATES

Designed by: JEFF CRANE	Date: 2/25/2016	Rev.
Dwn by:	Ckd by:	Design file no:
Reviewed by: JPC	Drawing Code:	
Submitted by:	File name: Plot date: Plot scale:	

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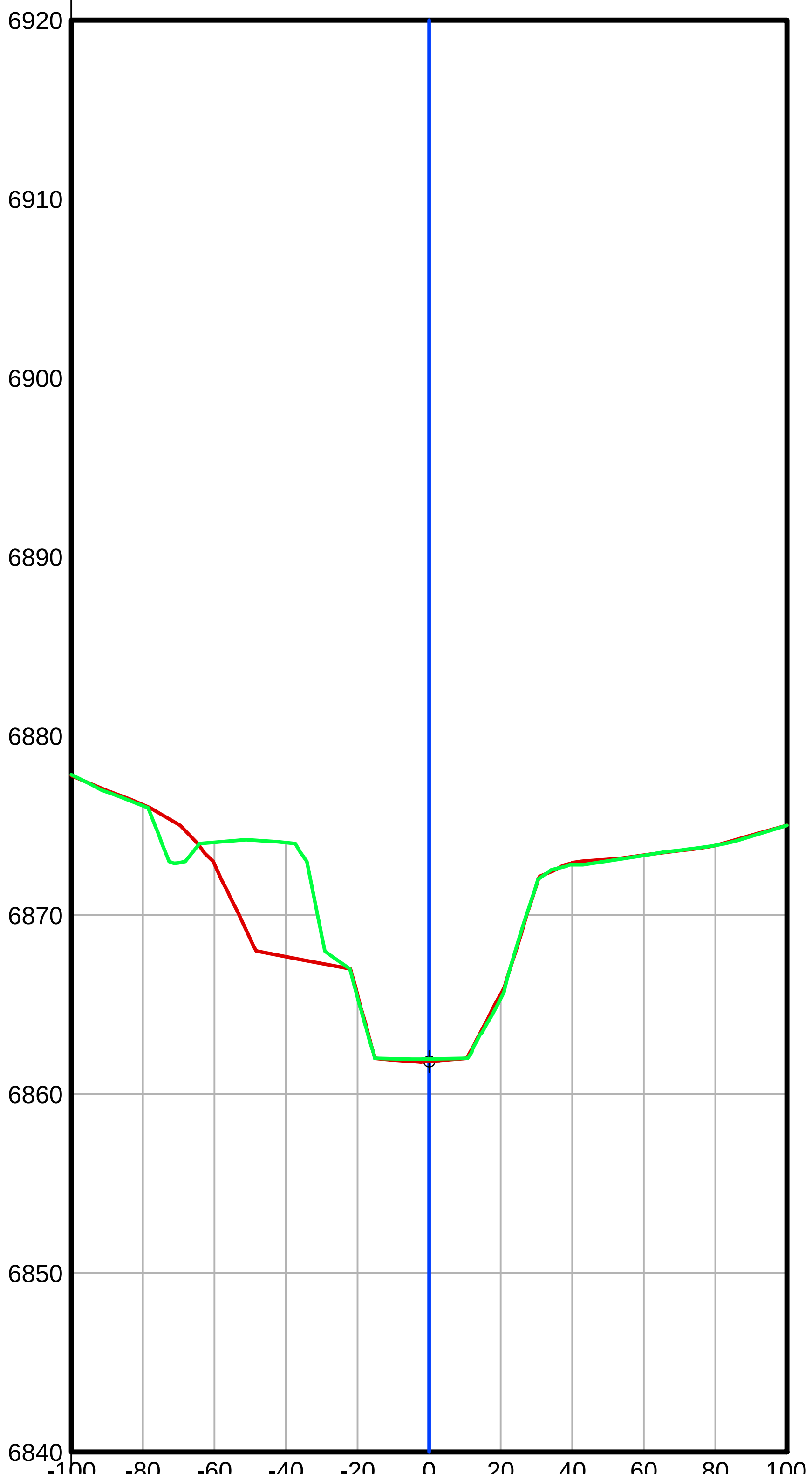
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

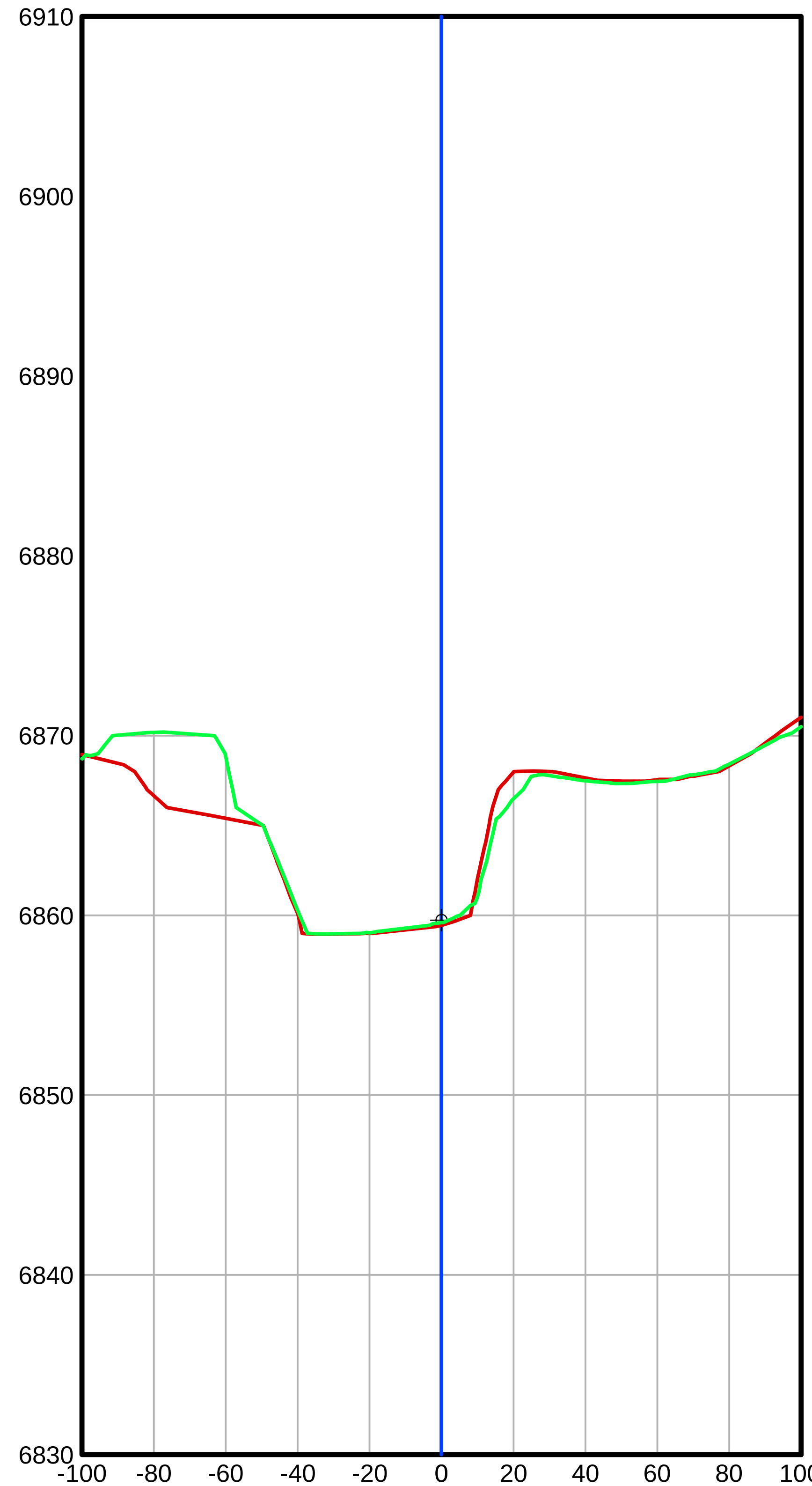
Sheet reference number: 46

UPDATE

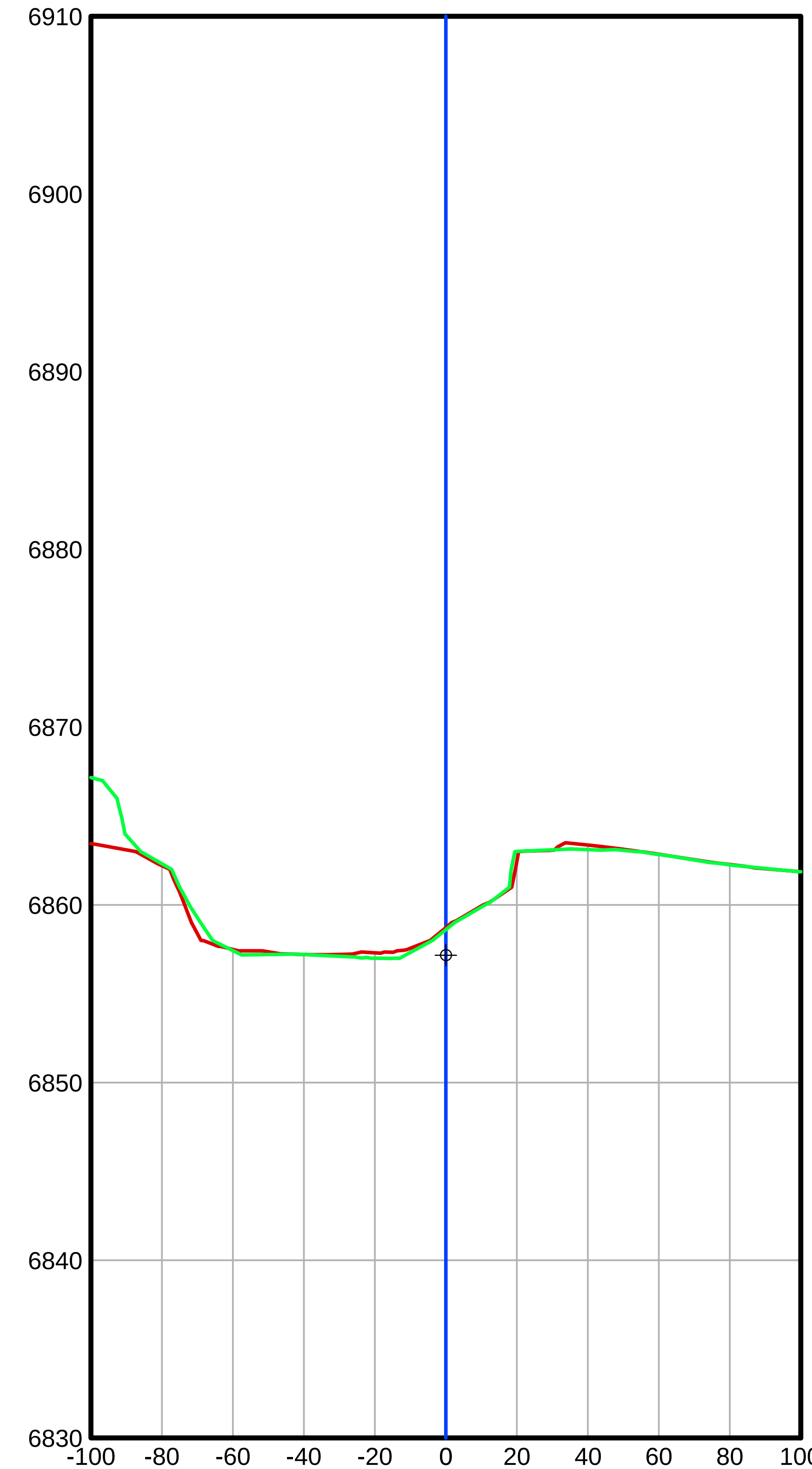
SL-46 (676+00.00)



SL-47 (678+00.00)



SL-48 (680+00.00)



LEGEND EXISTING ROAD GRADES PROPOSED

SCALE: 1" = 50'

0 50'

Symbol | Description | Date | Approved

Rev.

Date: 2/25/2016

Design file no:

Drawing Code:

File name:
Plot date:
Plot scale:

Designed by: JEFF CRANE

Dwn by:

Ckd by:

Reviewed by: JPC

Submitted by:

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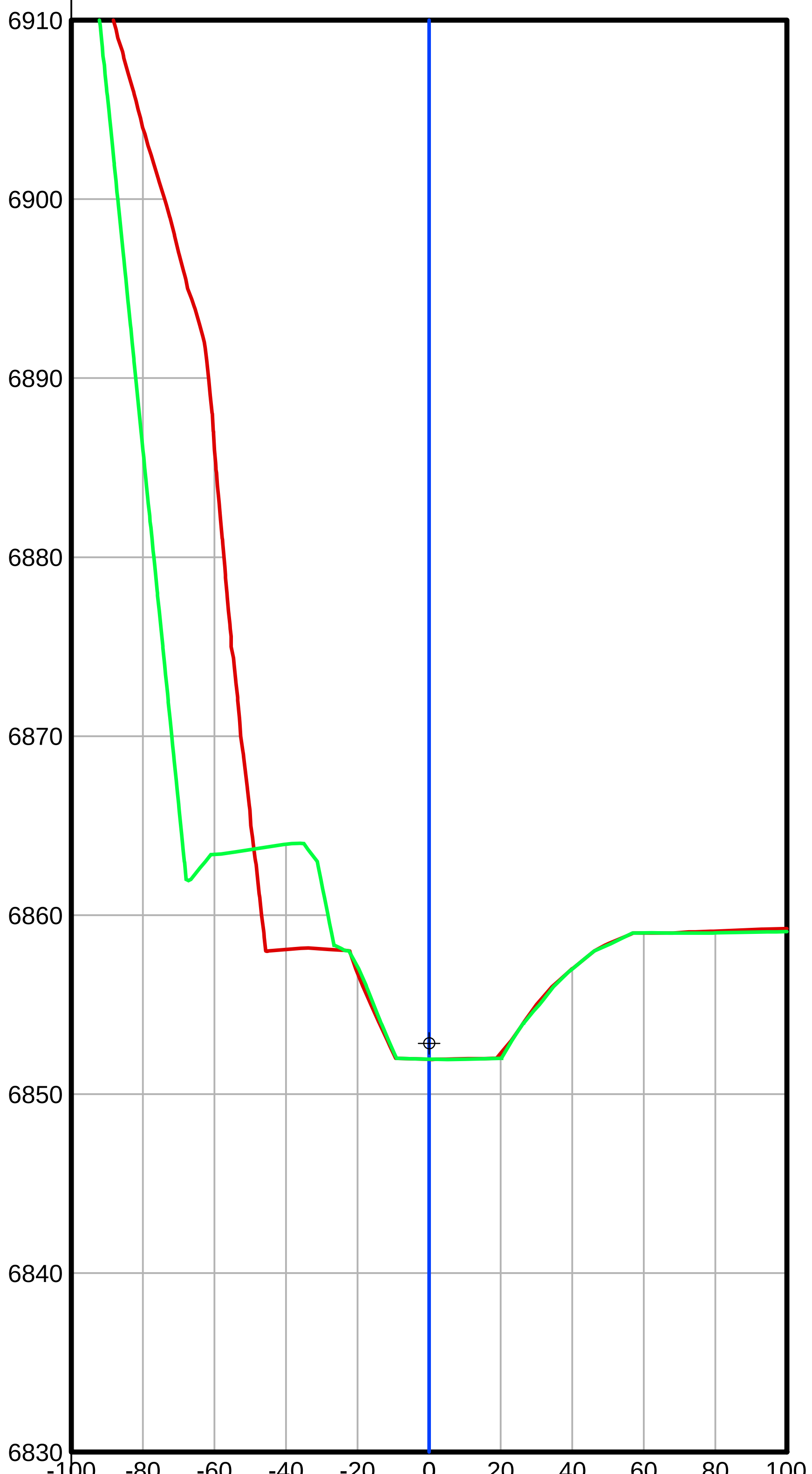
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

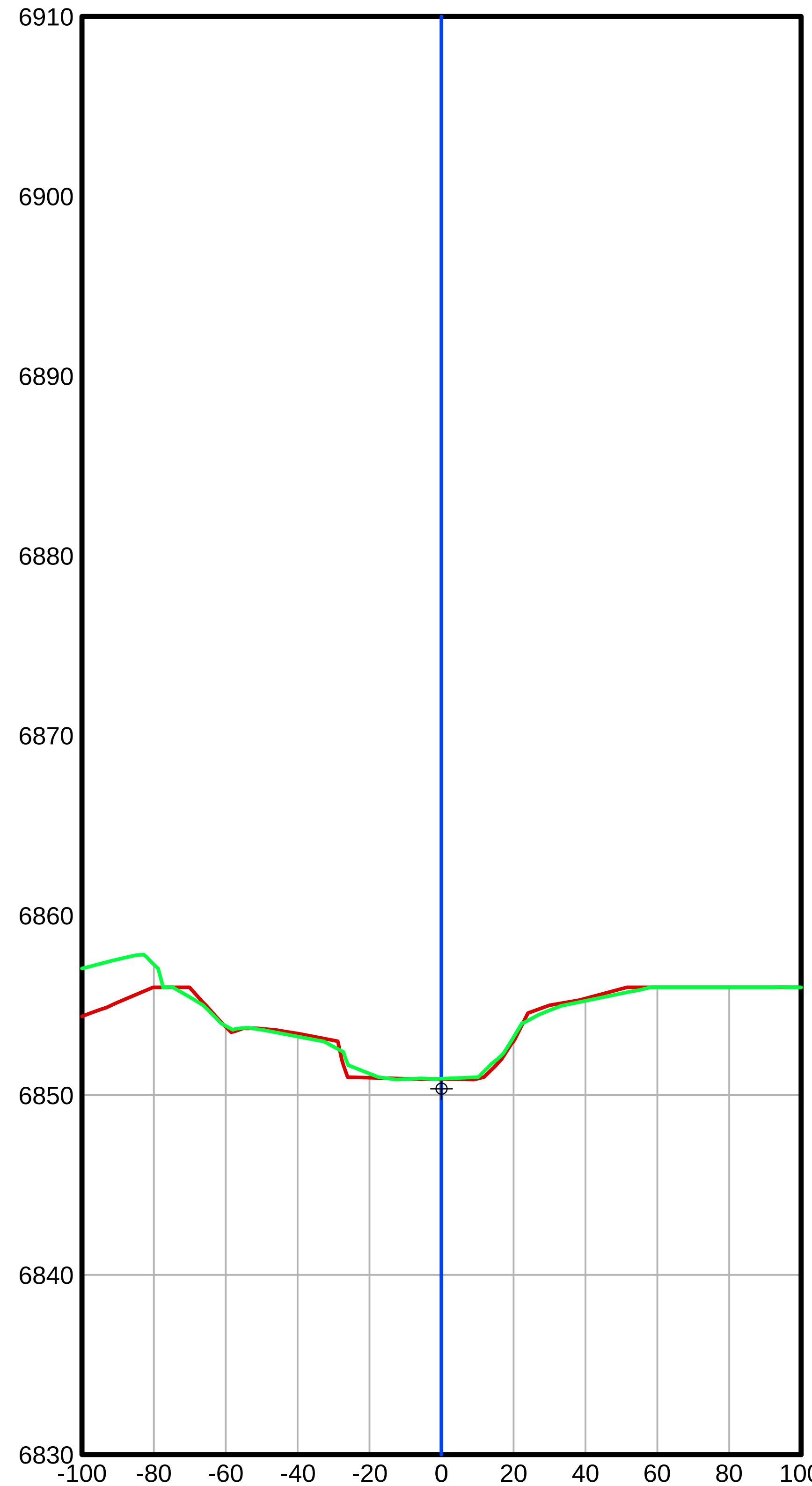
Sheet reference number:
47

UPDATE

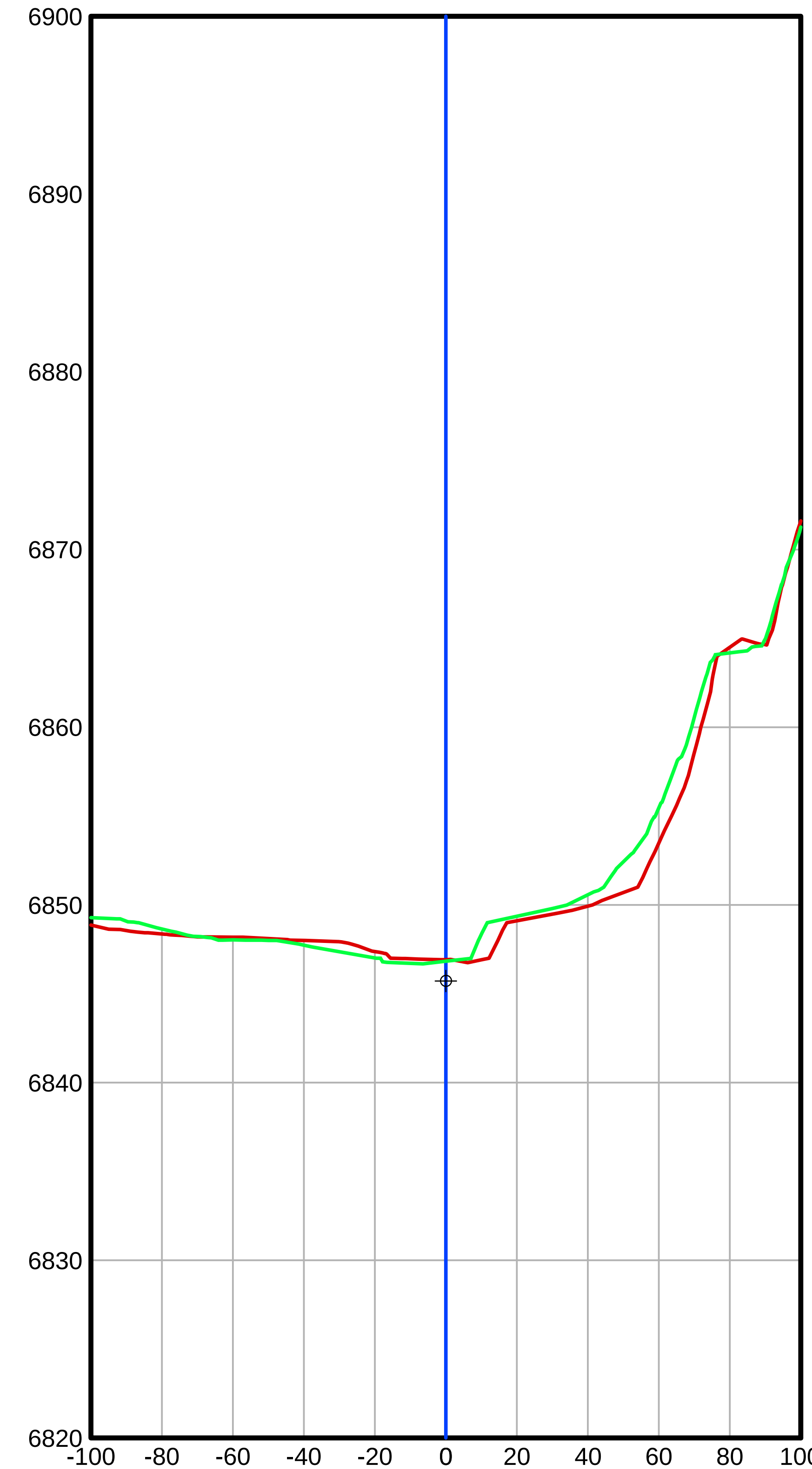
SL-49 (682+00.00)



SL-50 (684+00.00)



SL-51 (686+00.00)



LEGEND — EXISTING (red) — ROAD GRADES (green) — PROPOSED (blue)

SCALE: 1" = 50'

0 50'

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Designed by: JEFF CRANE
Dwn by:
Ckd by:
Reviewed by: JPC
Submitted by:
Date: 2/25/2016
Design file no:
Drawing Code:
File name:
Plot date:
Plot scale:
Rev.

Symbol | Description | Date | Approved

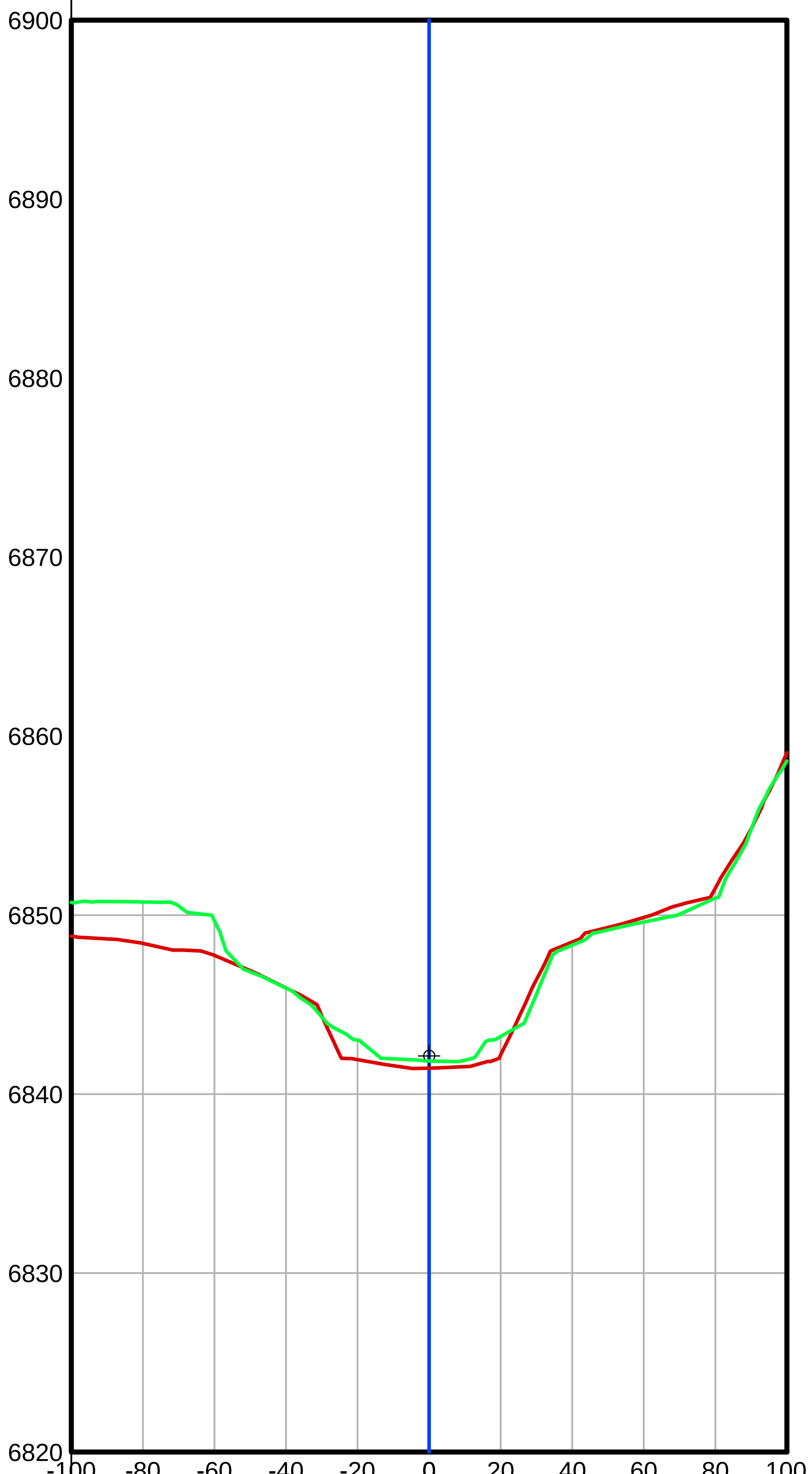
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

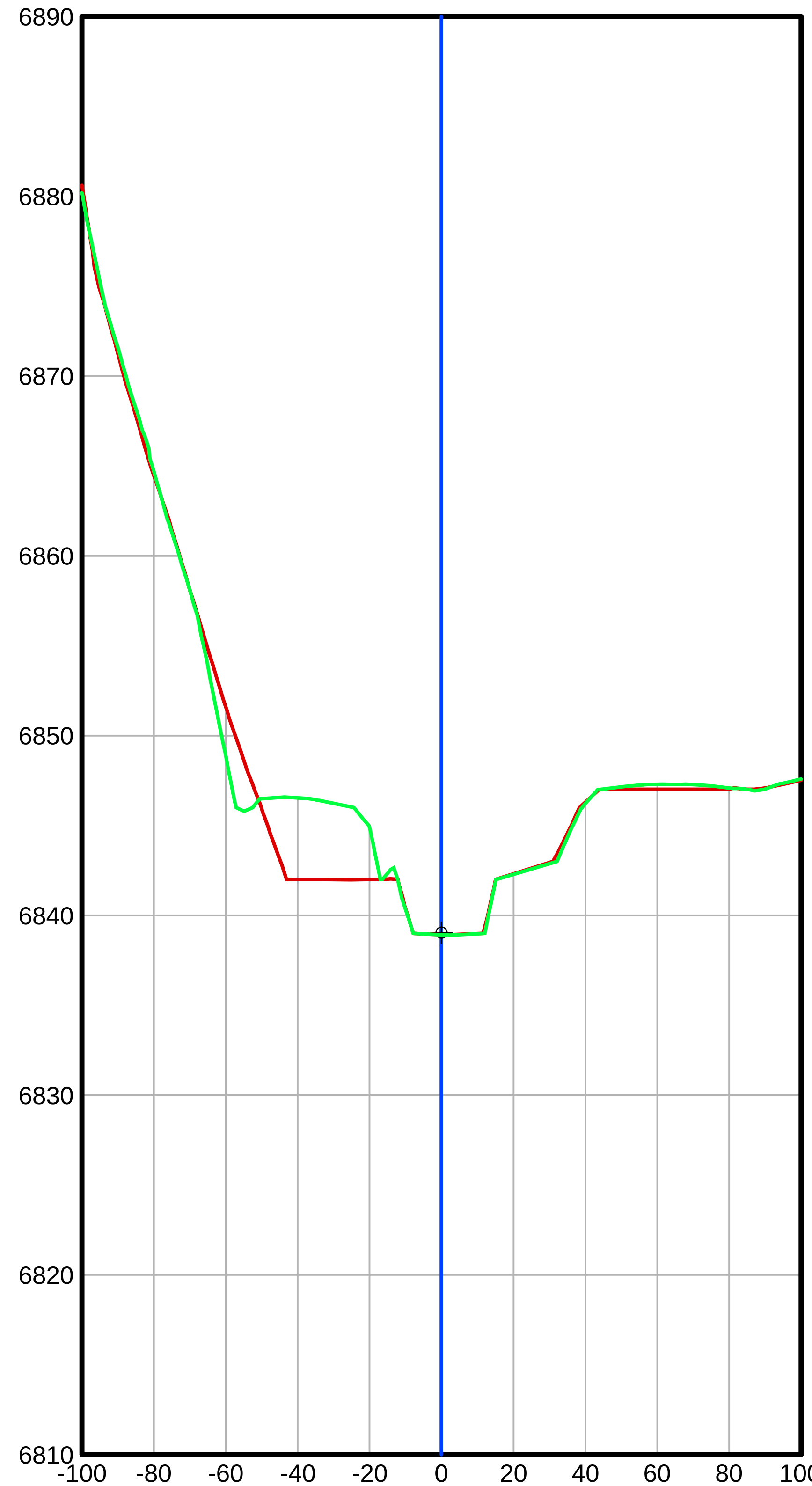
Sheet reference number: 48

UPDATE

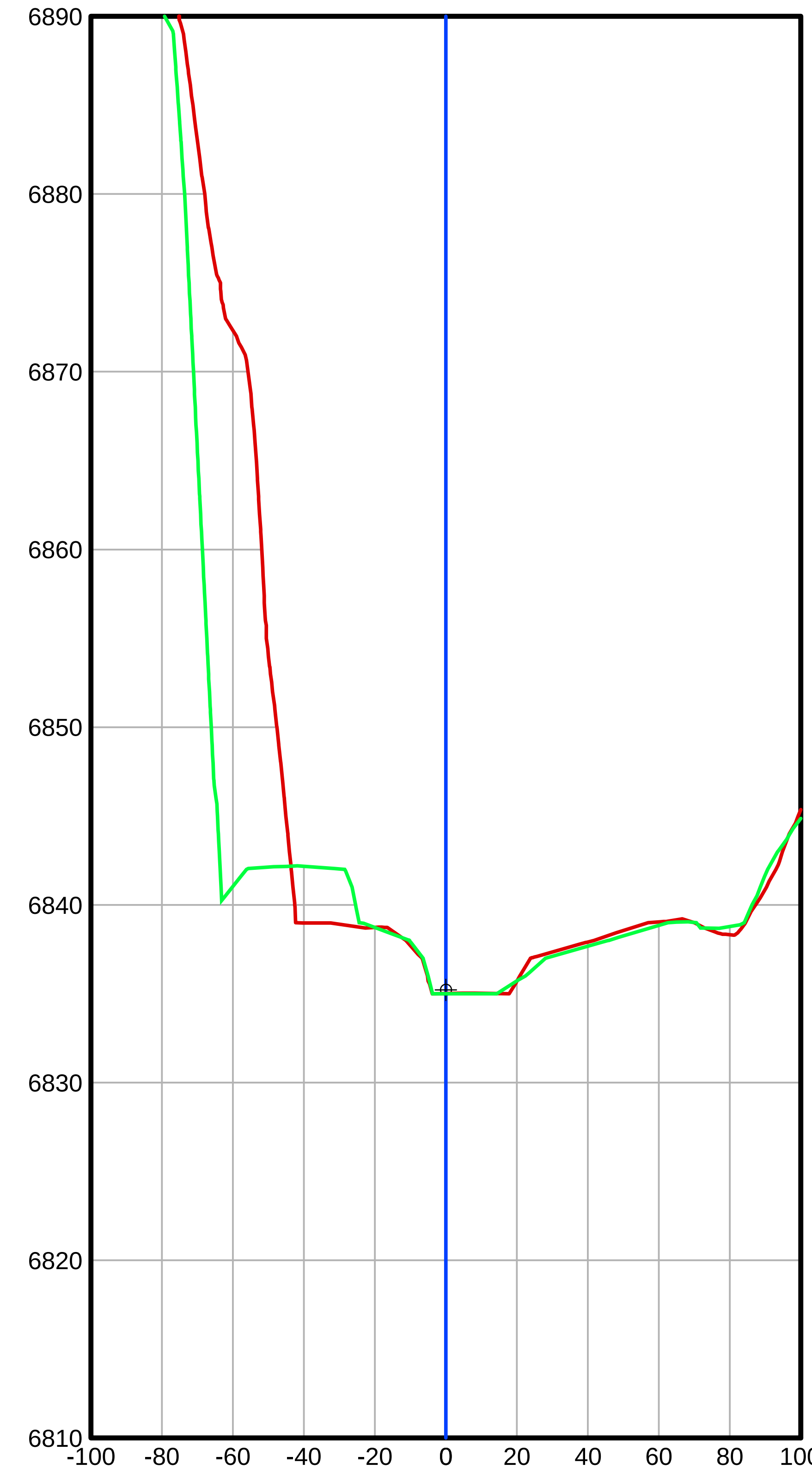
SL-52 (688+00.00)



SL-53 (690+00.00)



SL-54 (692+00.00)



LEGEND — EXISTING — ROAD GRADES — PROPOSED

SCALE: 1" = 50'

0 50'

CRANE ASSOCIATES
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Designed by: JEFF CRANE
Date: 2/25/2016
Reviewed by: JPC

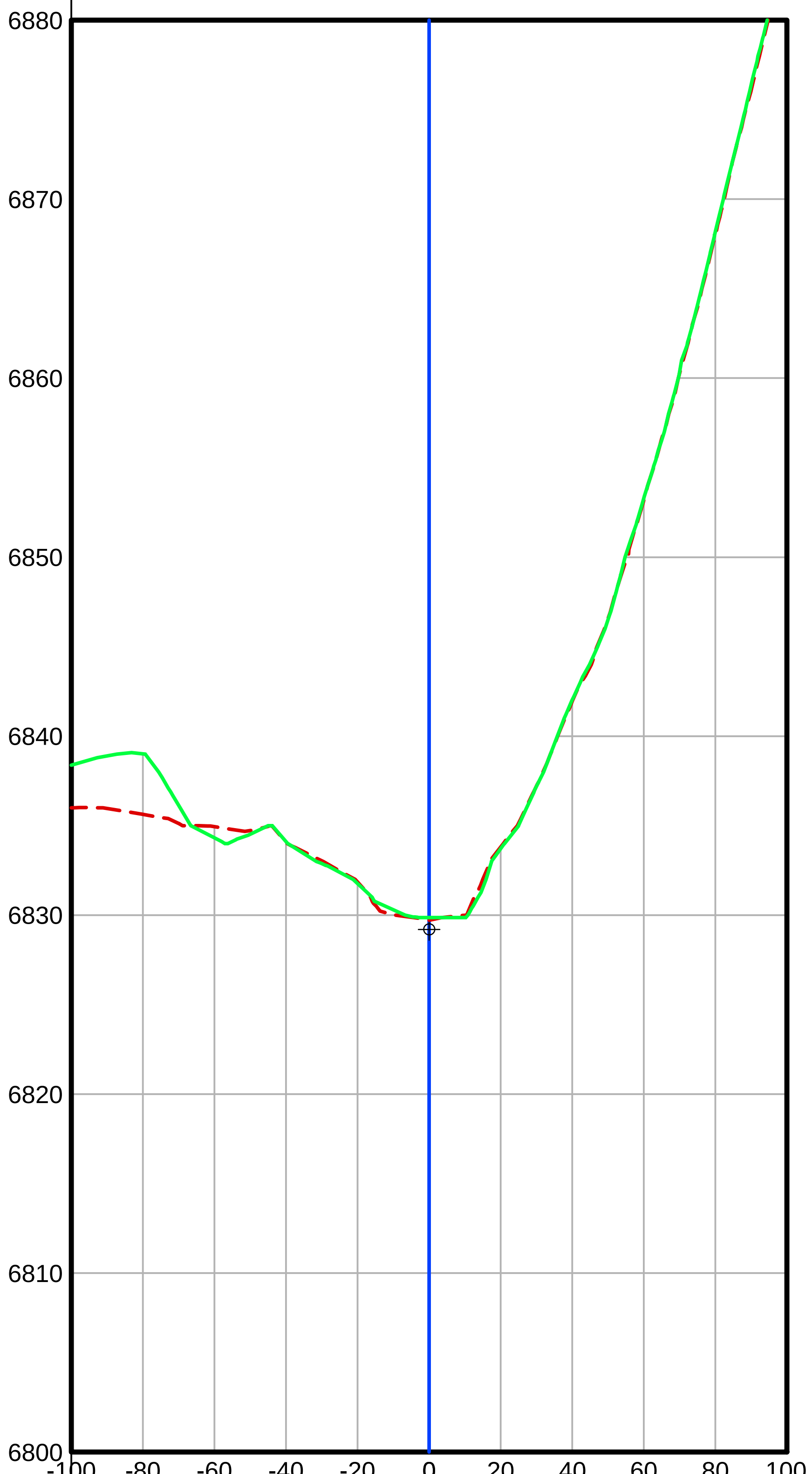
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

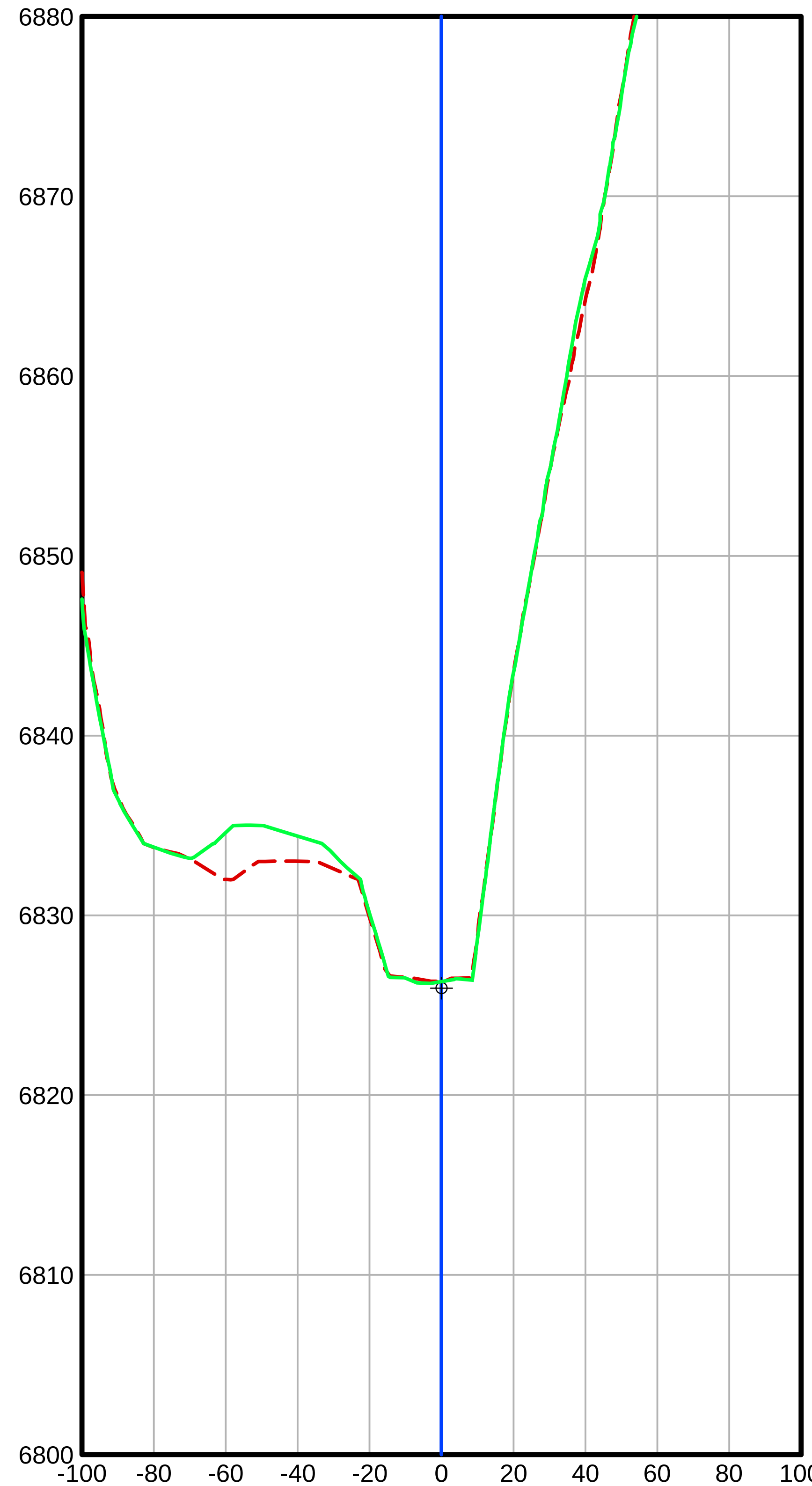
Sheet reference number: 49

UPDATE

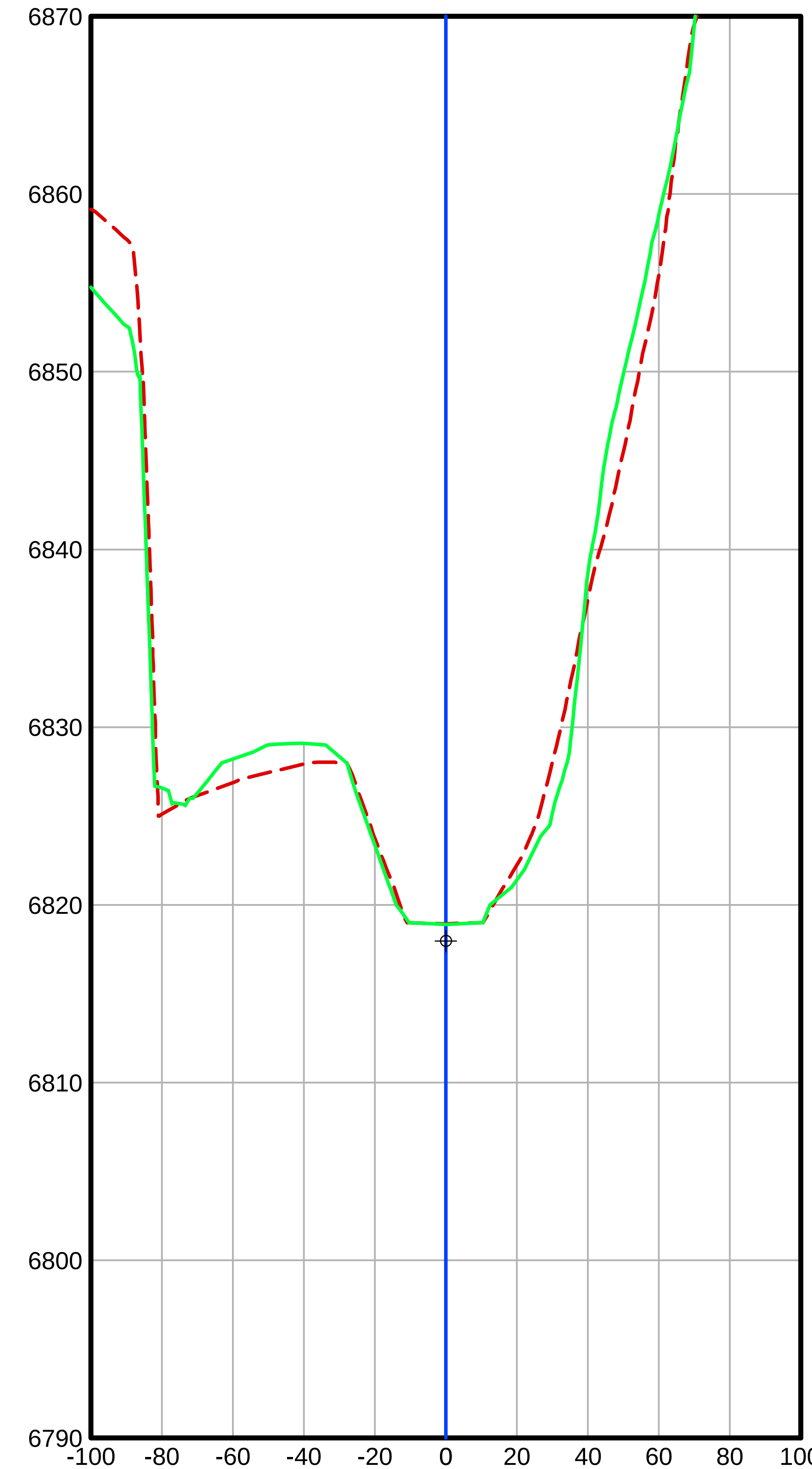
SL-55 (694+00.00)



SL-56 (696+00.00)



SL-57 (698+00.00)



LEGEND EXISTING ROAD GRADES PROPOSED

SCALE: 1" = 50'

0 50'

Symbol	Description	Date	Approved

CRANE ASSOCIATES

Designed by: JEFF CRANE	Date: 2/25/2016	Rev.
Dwn by: / Ckd by:	Design file no:	
Reviewed by: JPC	Drawing Code:	
Submitted by:	File name: Plot date: Plot scale:	

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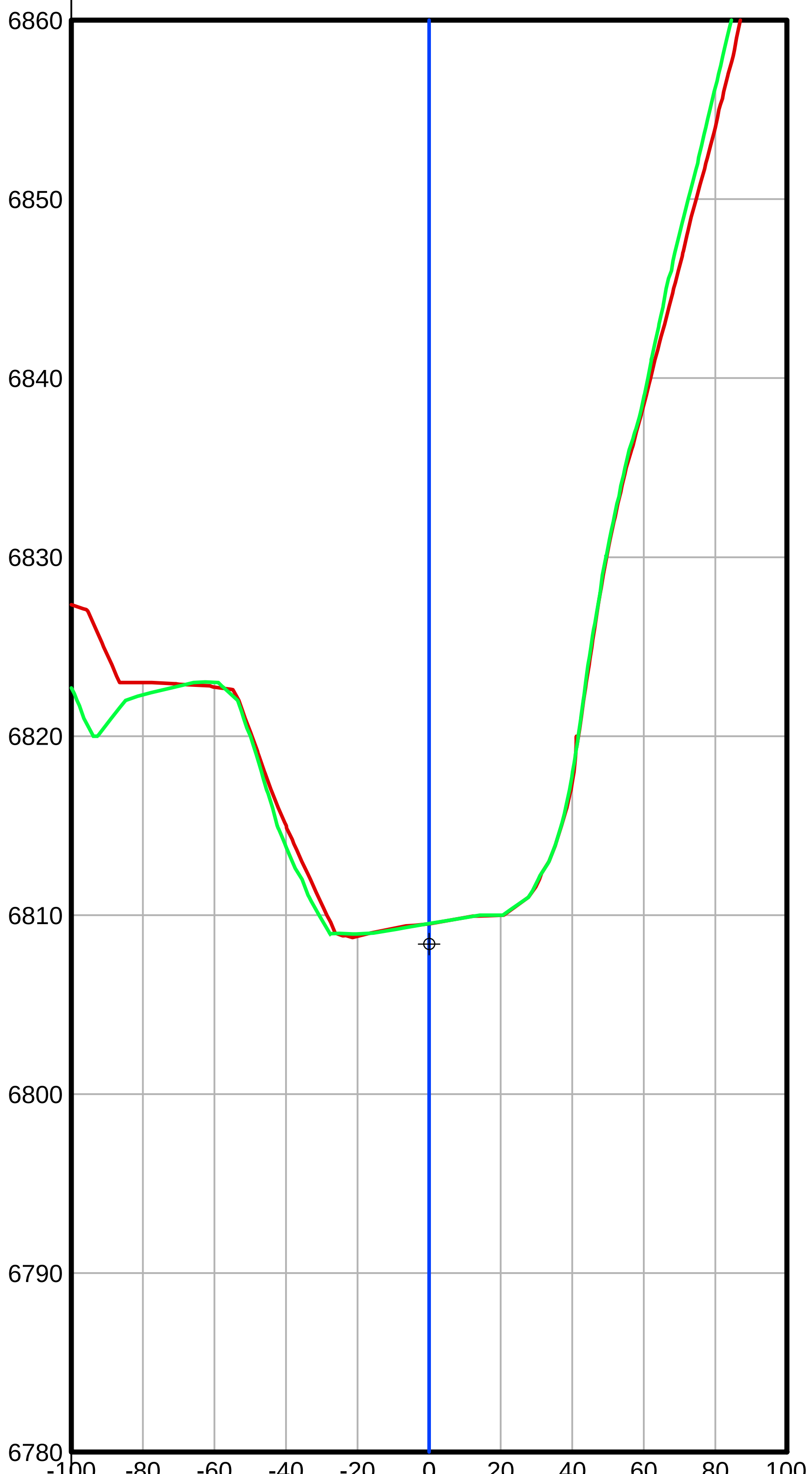
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

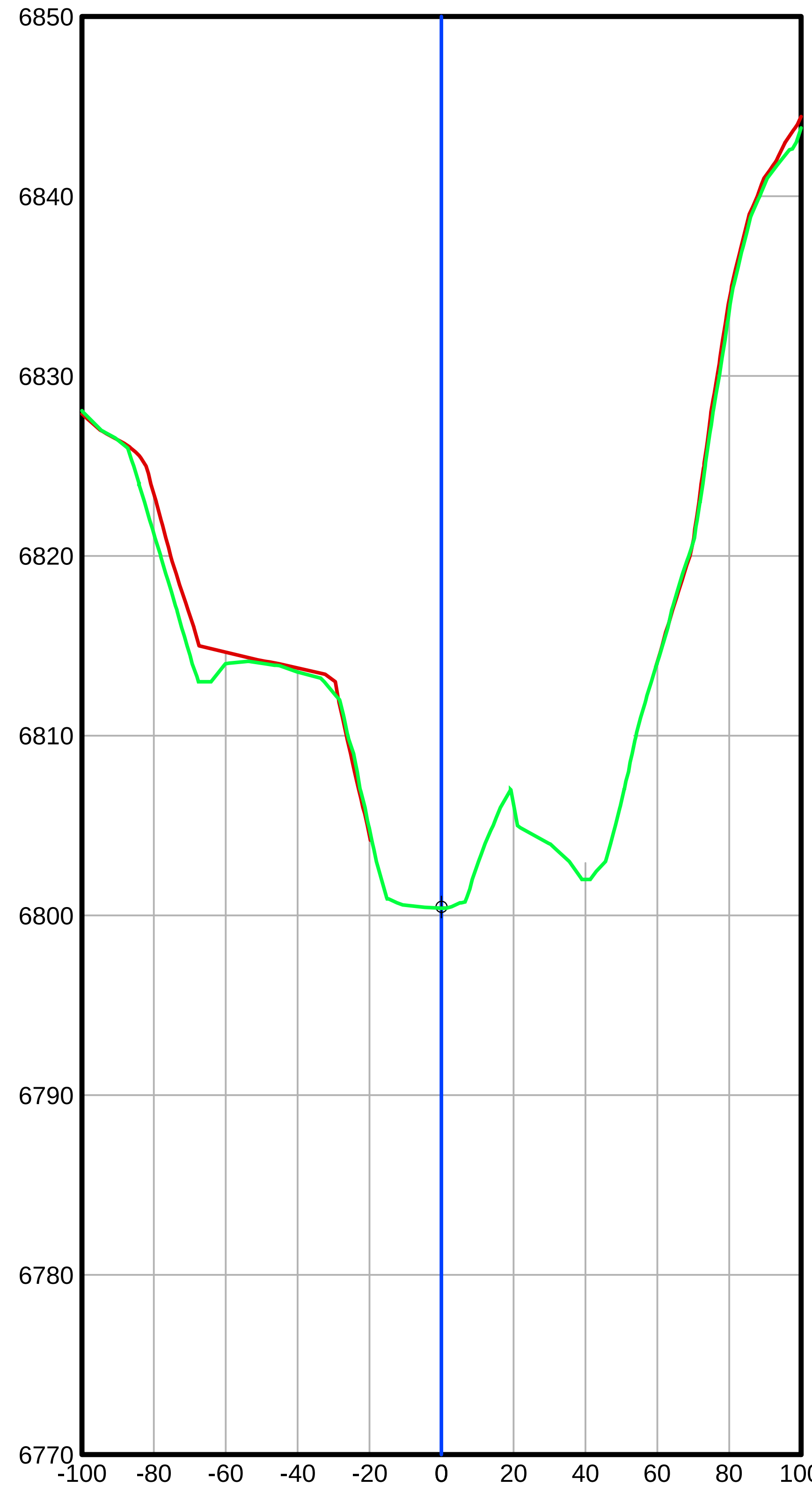
Sheet reference number:
50

UPDATE

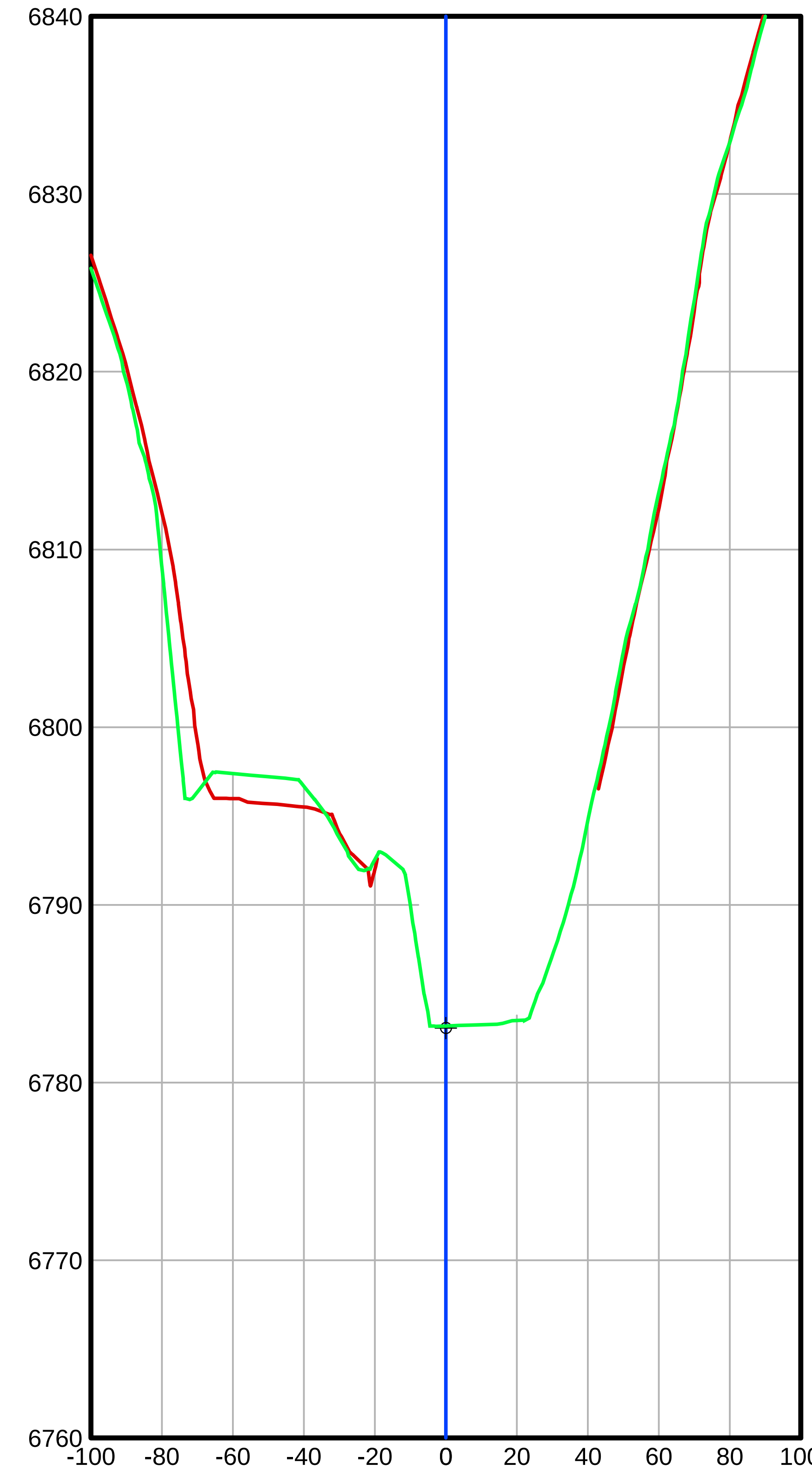
SL-58 (700+00.00)



SL-59 (702+00.00)



SL-60 (704+00.00)



LEGEND EXISTING ROAD GRADES PROPOSED

SCALE: 1" = 50'

0 50'

Symbol | Description | Date | Approved

CRANE ASSOCIATES

Designed by: JEFF CRANE
Dwn by:
Ckd by:
Reviewed by: JPC
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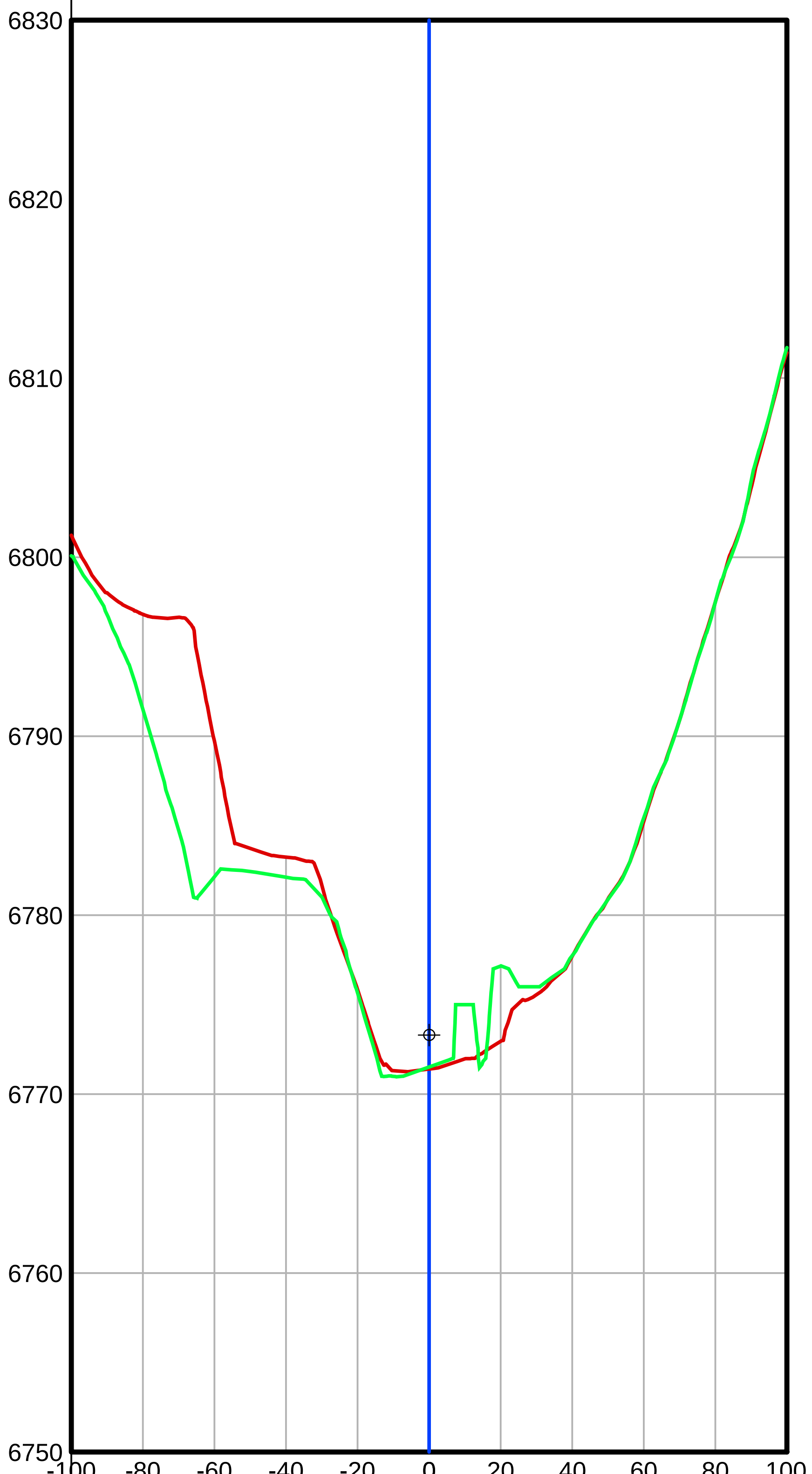
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

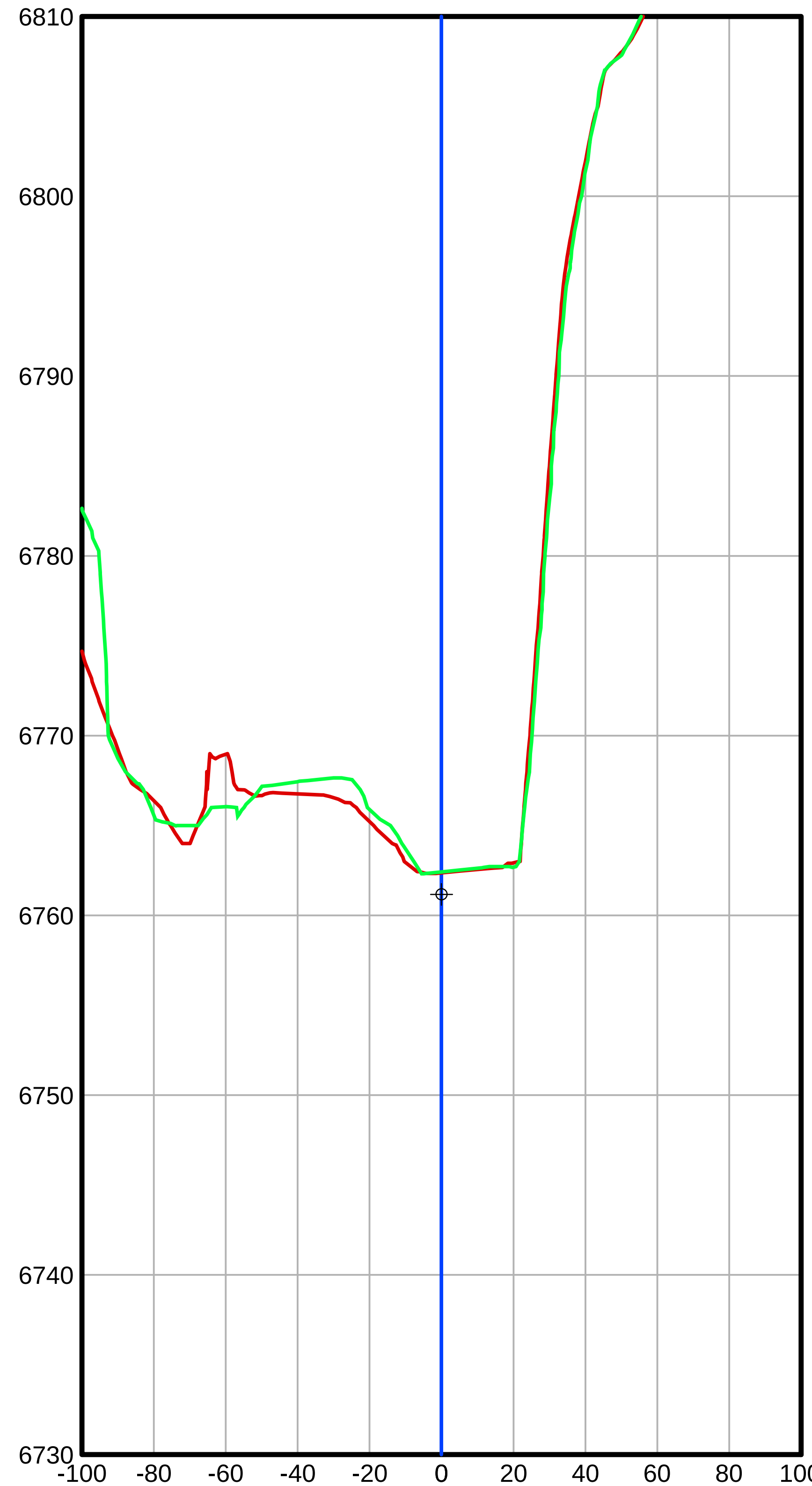
Sheet reference number:
51

UPDATE

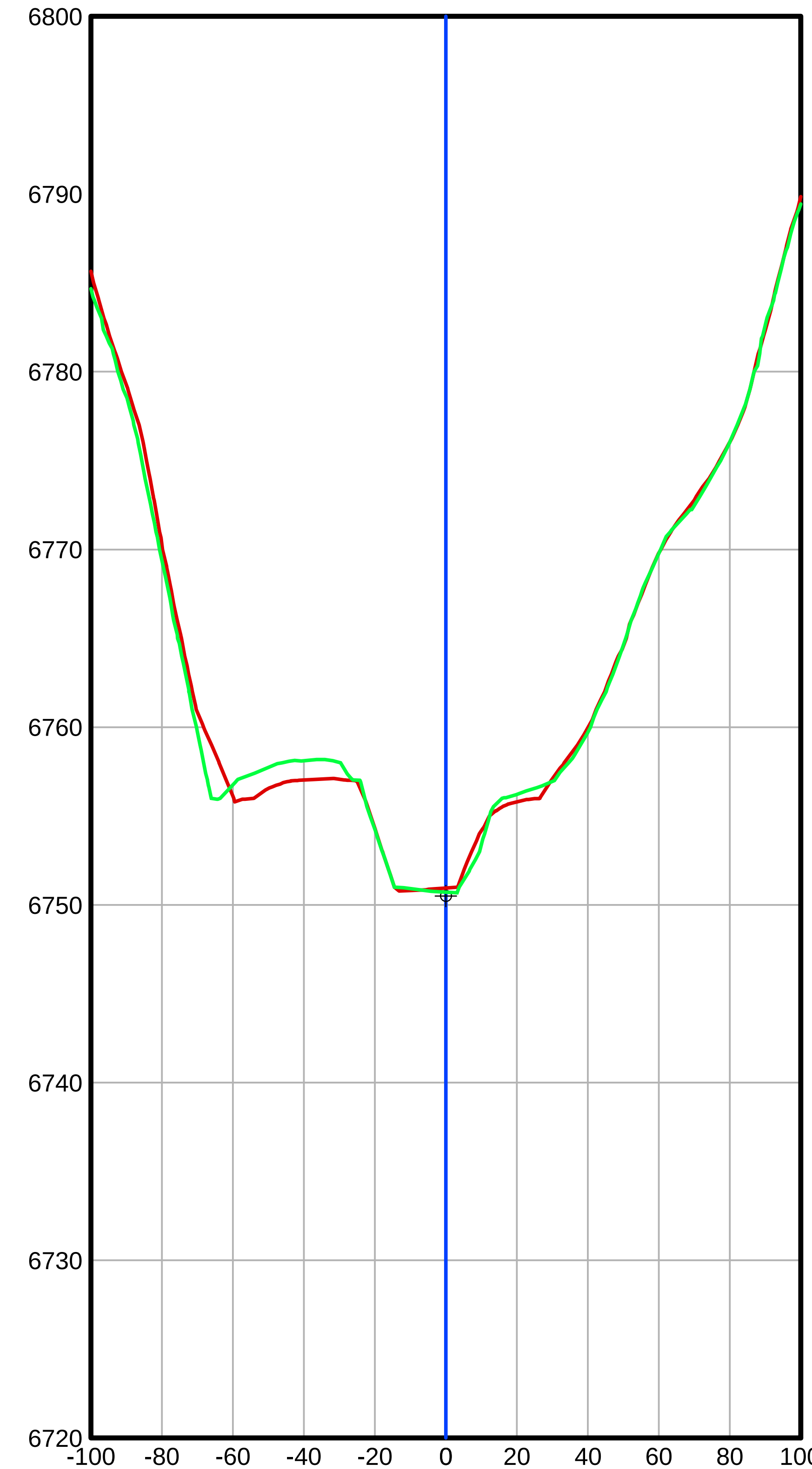
SL-61 (706+00.00)



SL-62 (708+00.00)



SL-63 (710+00.00)



LEGEND EXISTING ROAD GRADES PROPOSED

SCALE: 1" = 50'

0 50'

Symbol Description Date Approved

CRANE ASSOCIATES

Rev. Date: 2/25/2016 Design file no: Drawing Code: File name: Plot date: Plot scale:

Designed by: JEFF CRANE Dwn by: Ckd by: Reviewed by: JPC Submitted by:

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140 Ash Lane
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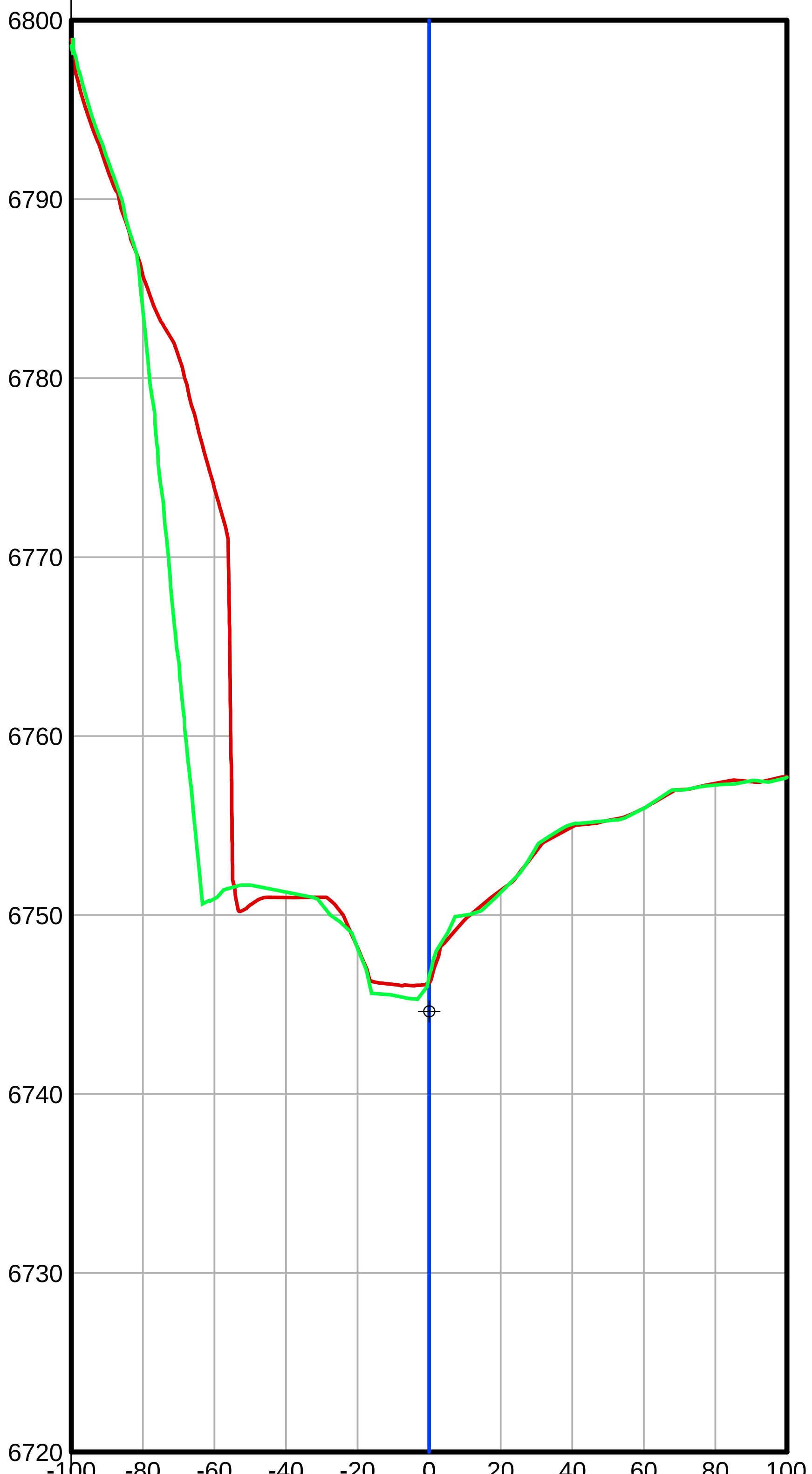
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

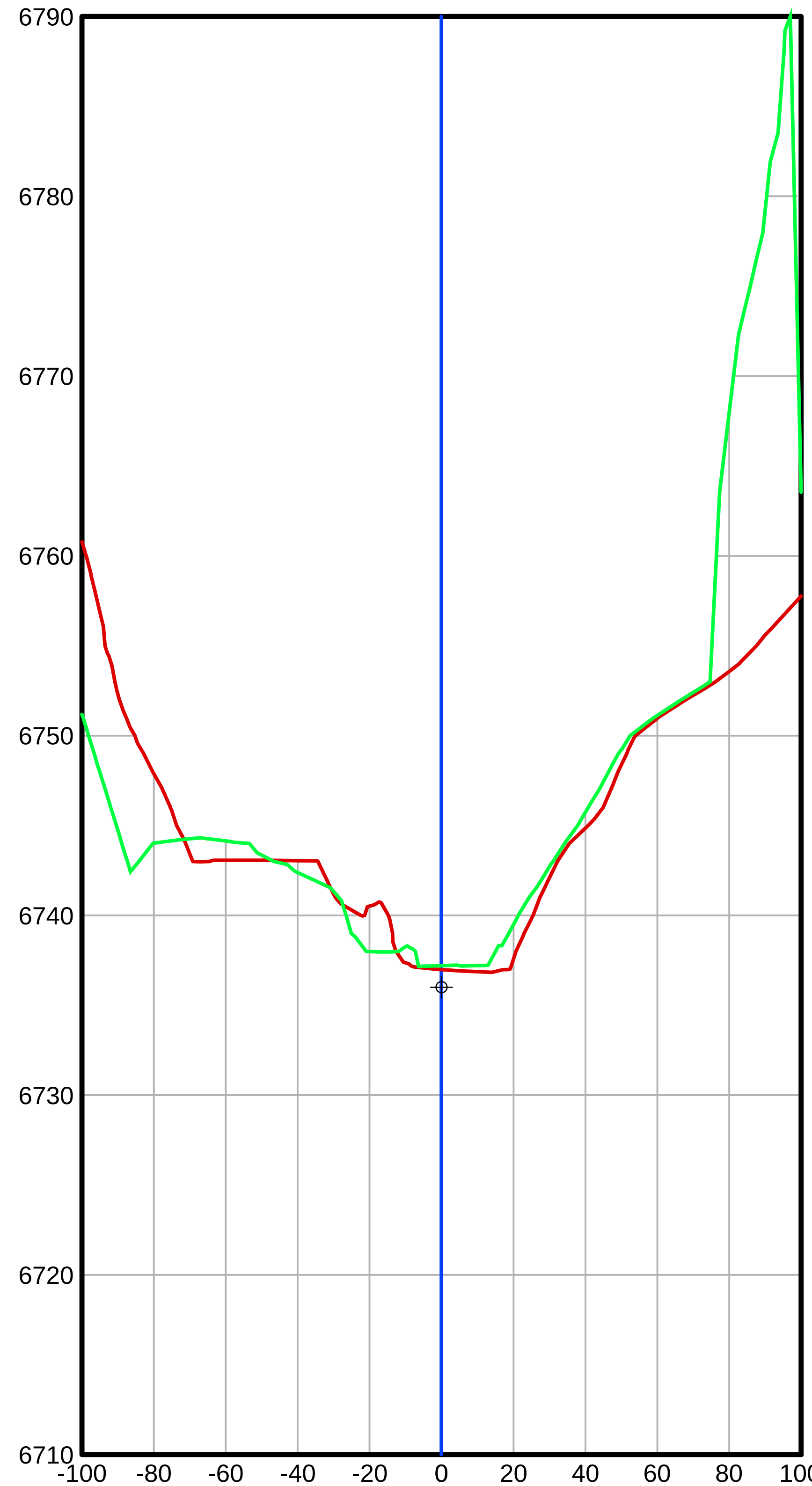
Sheet reference number: 52

UPDATE

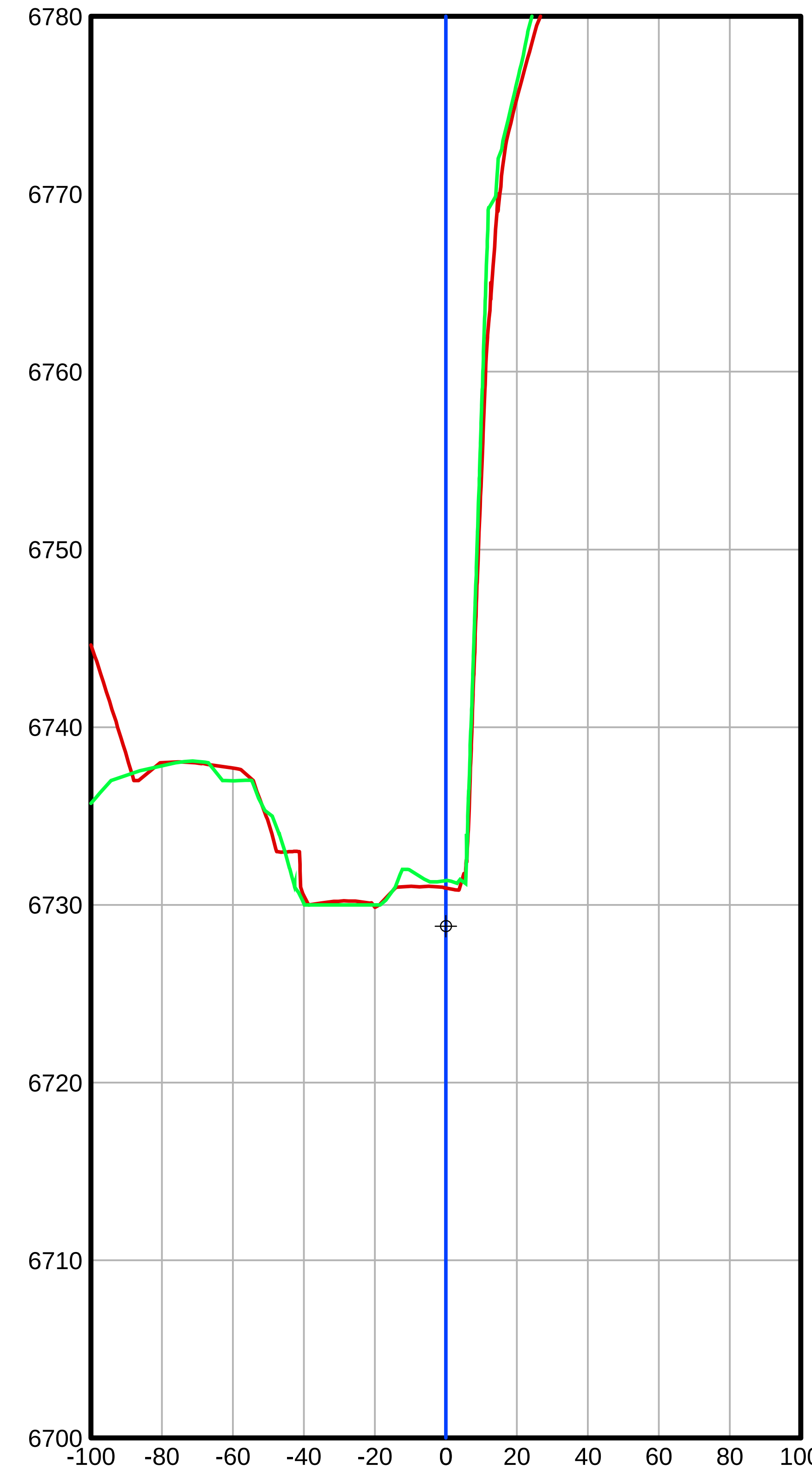
SL-64 (712+00.00)



SL-65 (714+00.00)



SL-66 (716+00.00)



LEGEND EXISTING ROAD GRADES PROPOSED

SCALE: 1" = 50'

0 50'

Symbol	Description	Date	Approved

Designed by: JEFF CRANE
Dwn by:
Ckd by:
Reviewed by: JPC
Submitted by:
Date: 2/25/2016
Design file no:
Drawing Code:
File name:
Plot date:
Plot scale:
Rev.

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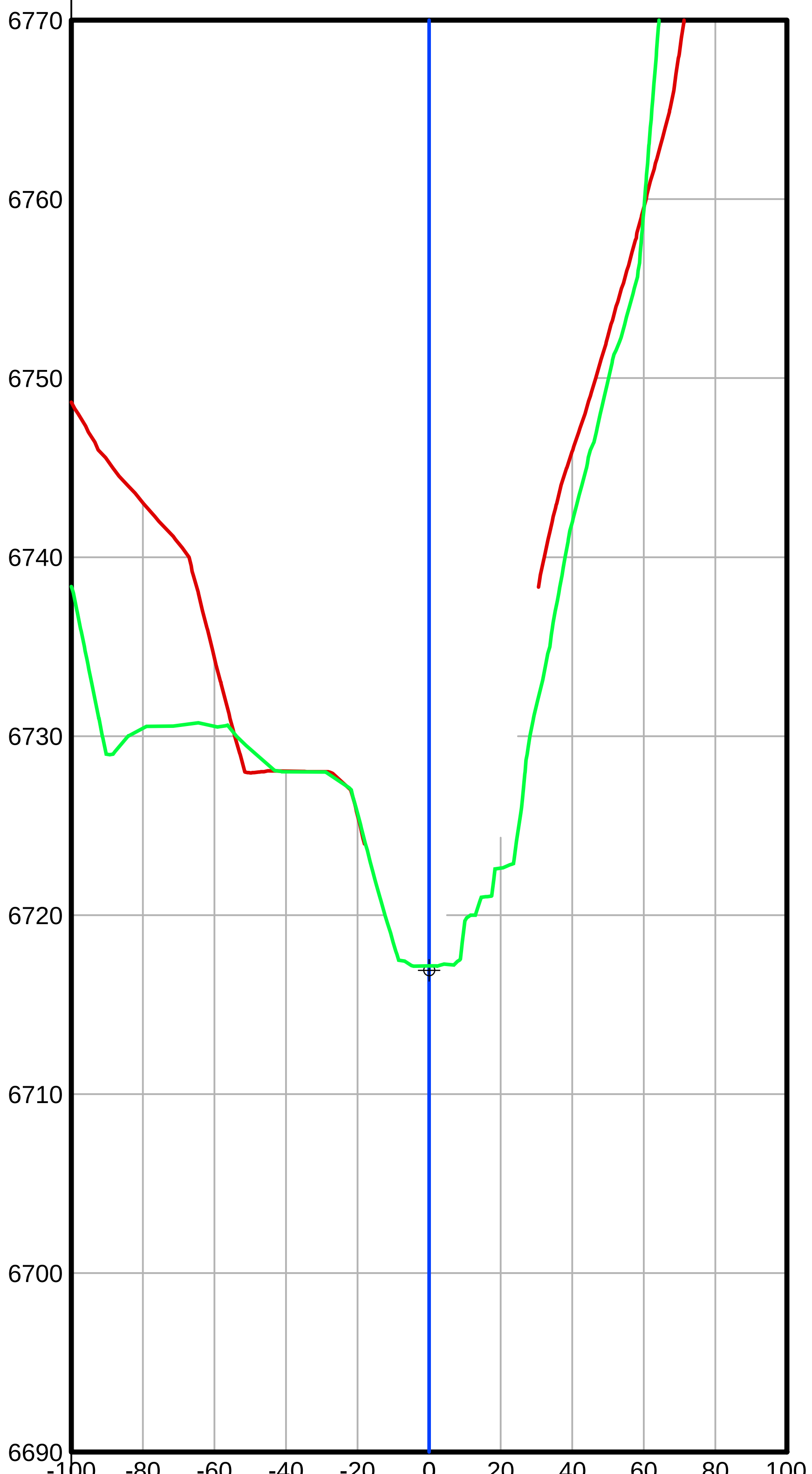
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

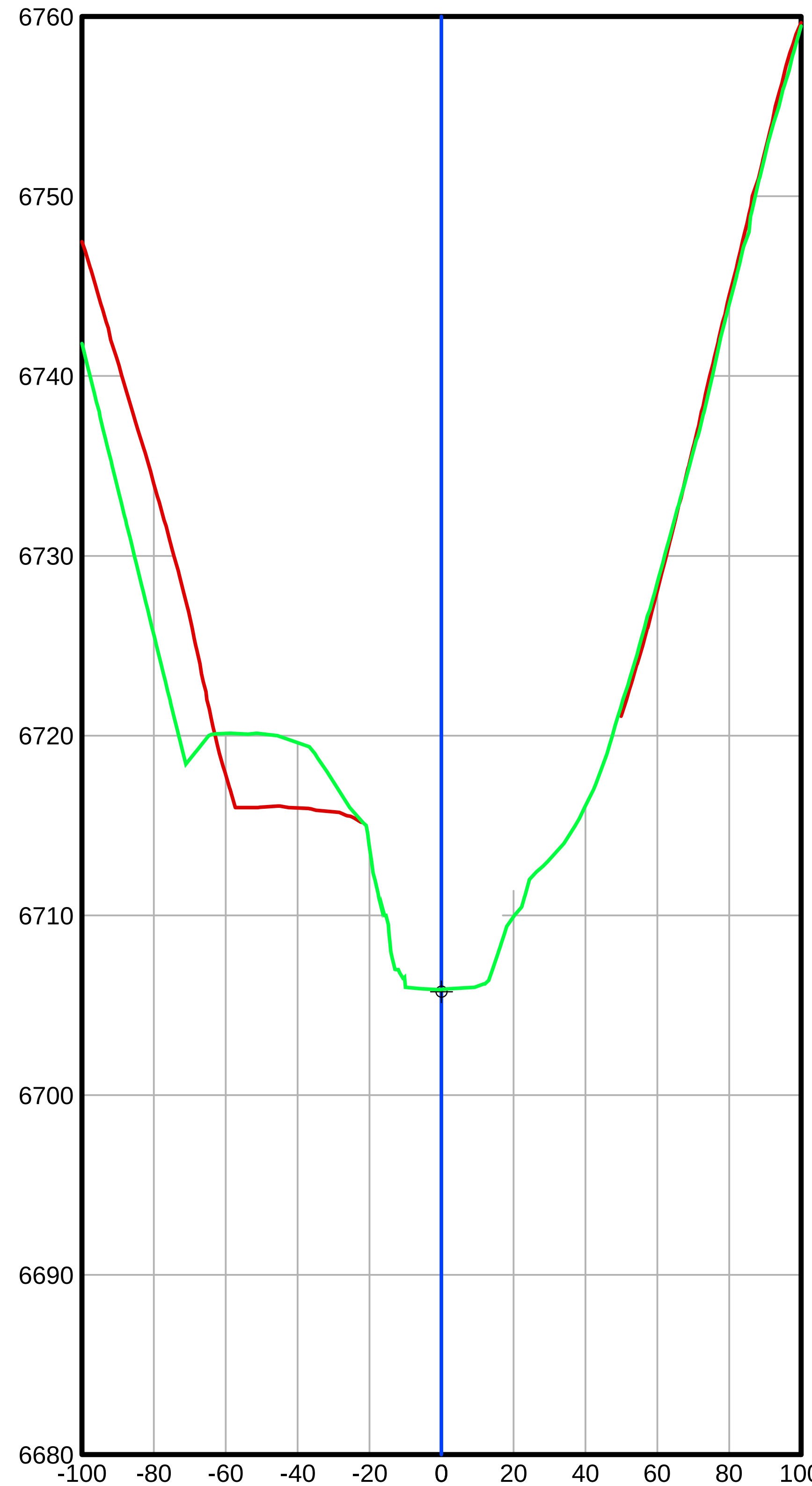
Sheet reference number:
53

UPDATE

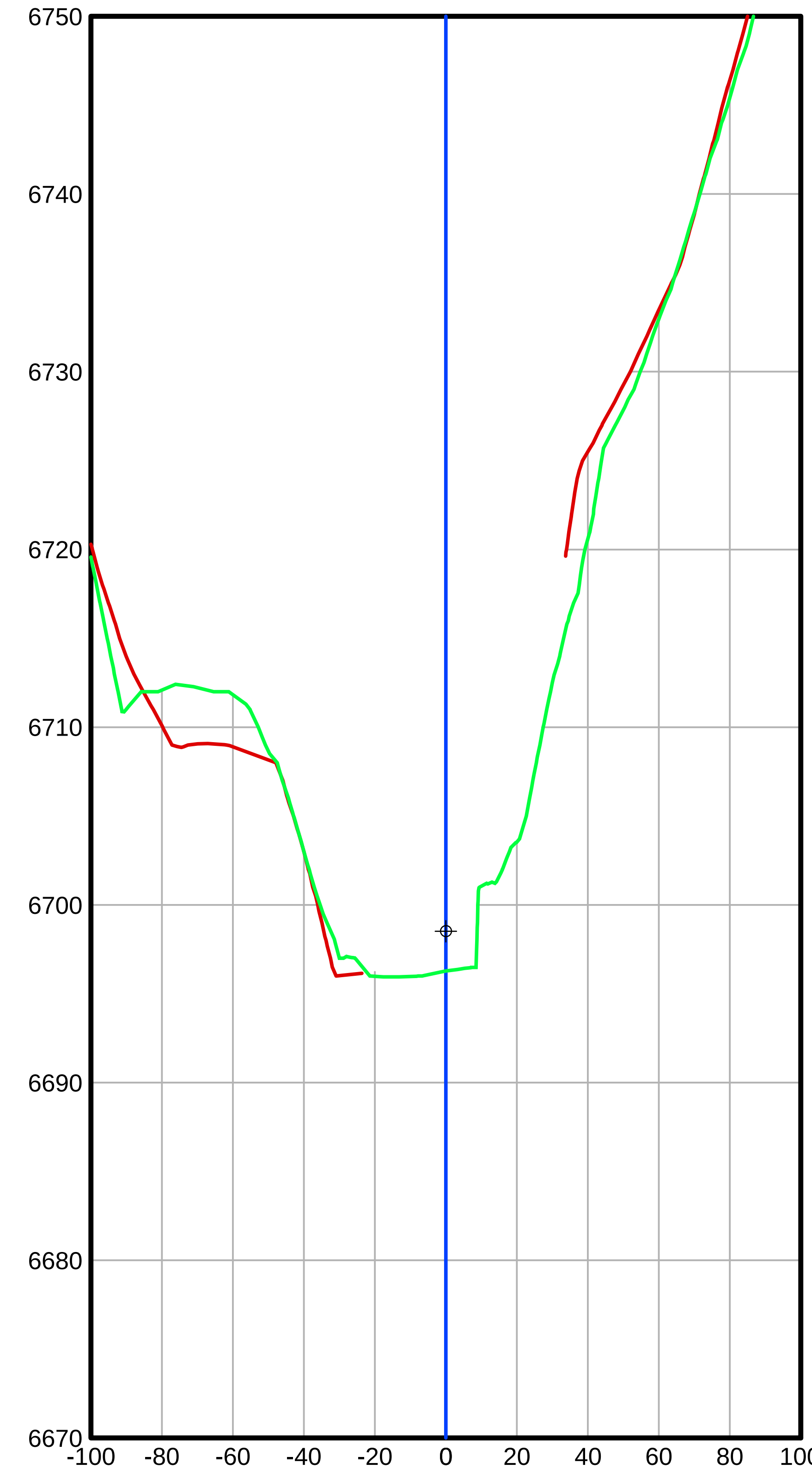
SL-67 (718+00.00)



SL-68 (720+00.00)



SL-69 (722+00.00)



LEGEND — EXISTING — ROAD GRADES — PROPOSED

SCALE: 1" = 50'

0 50'

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Designed by: JEFF CRANE
Date: 2/25/2016
Reviewed by: JPC

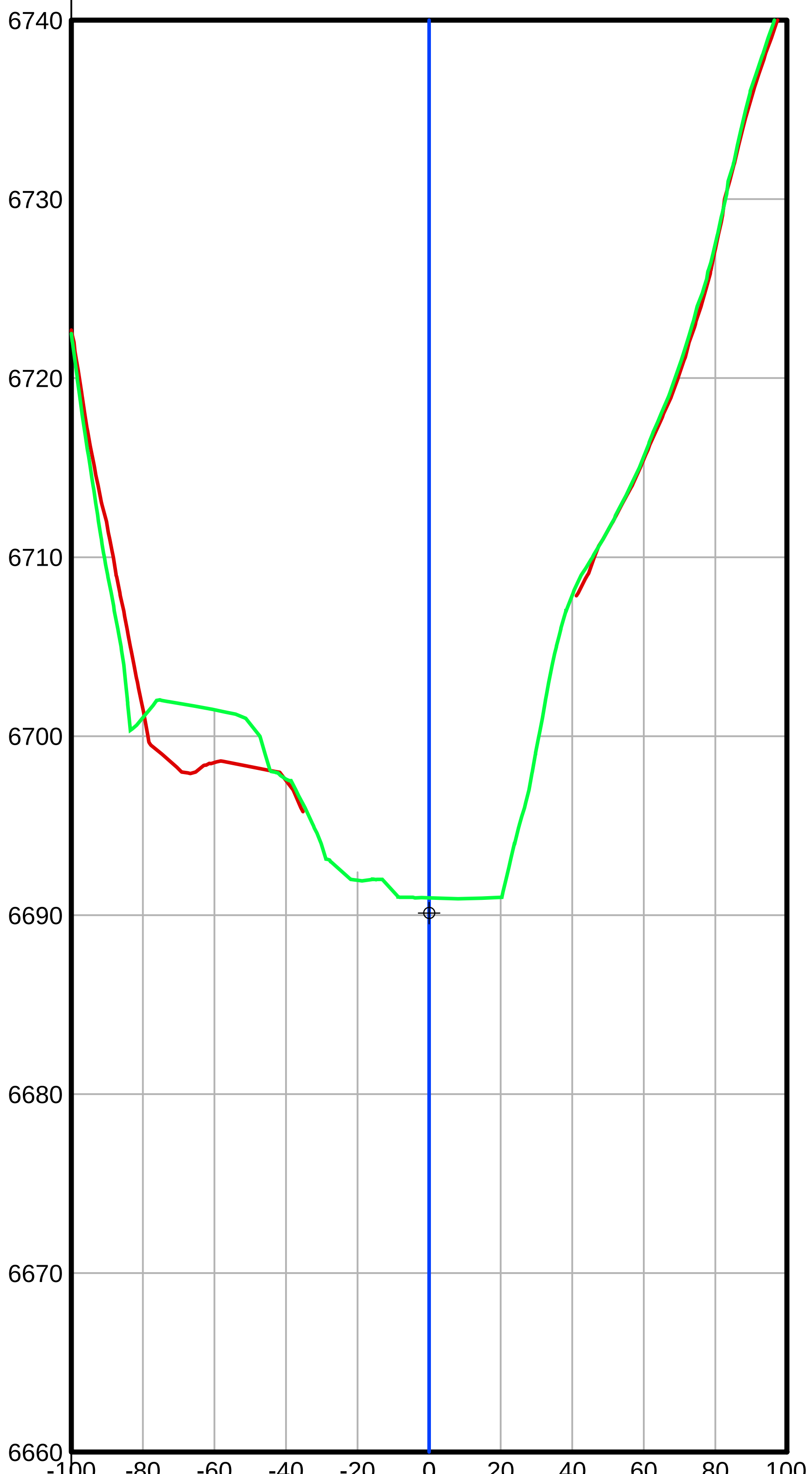
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

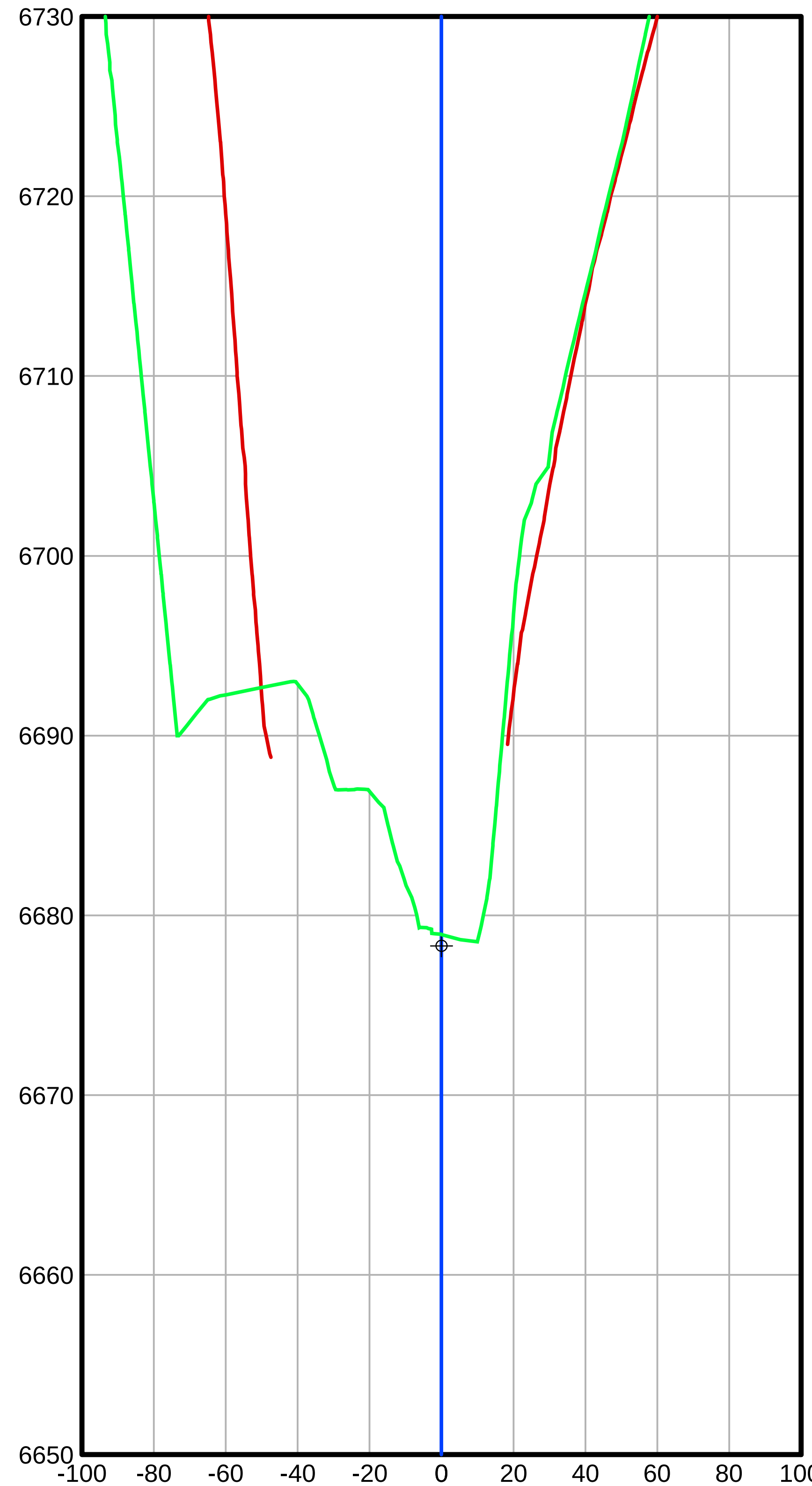
Sheet reference number: 54

UPDATE

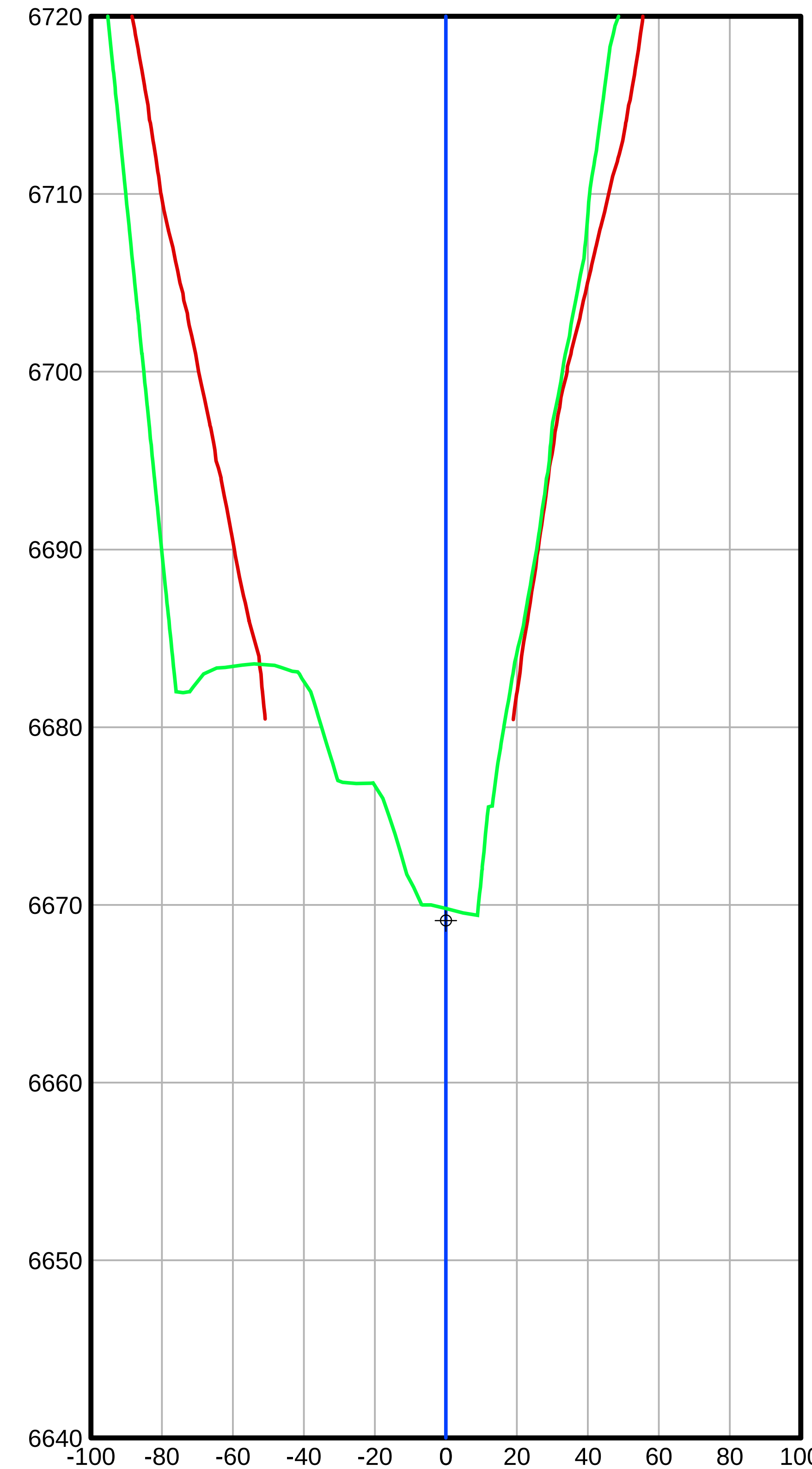
SL-70 (724+00.00)



SL-71 (726+00.00)



SL-72 (728+00.00)



LEGEND EXISTING ROAD GRADES PROPOSED

SCALE: 1" = 50'

0 50'

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Date: 2/25/2016

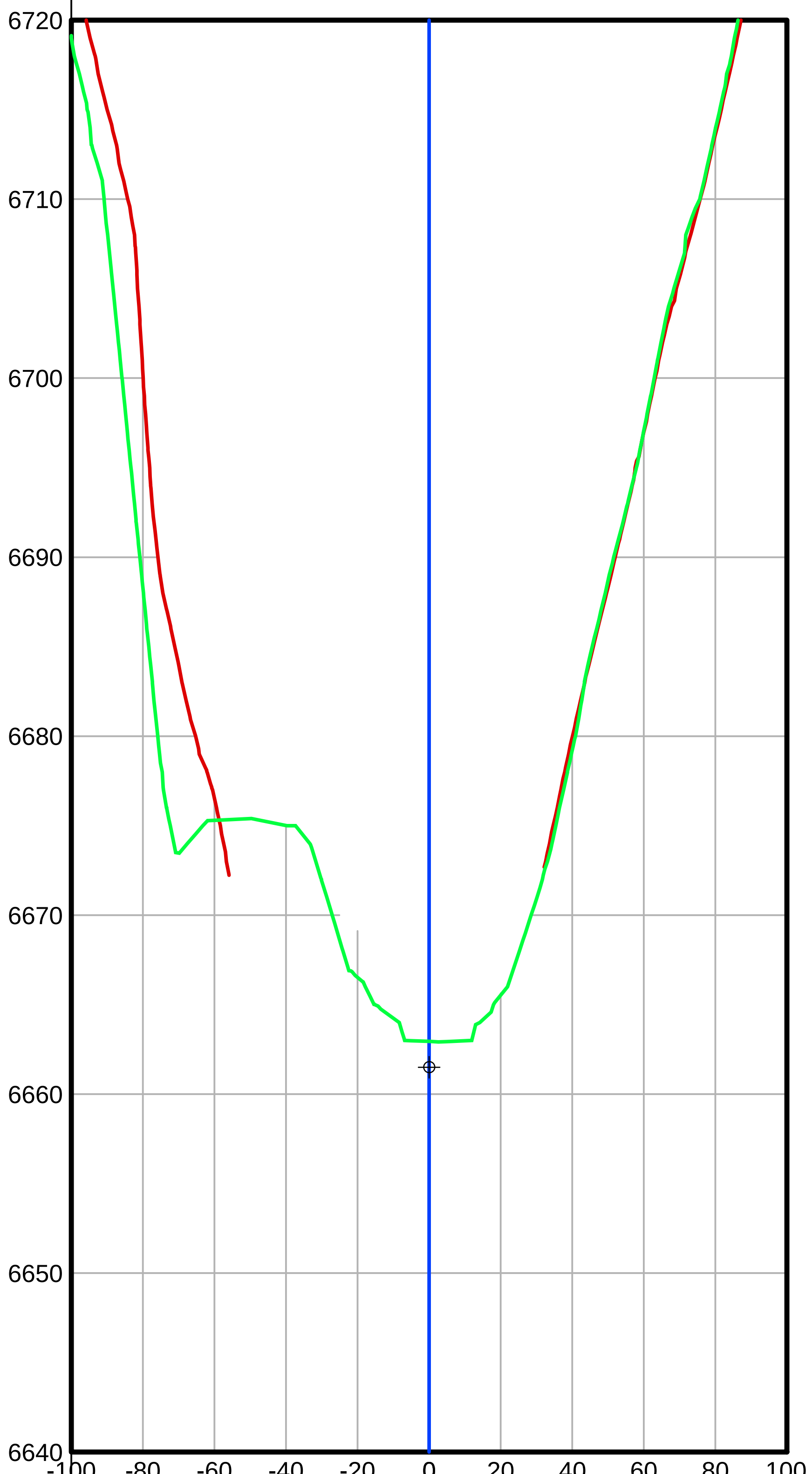
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

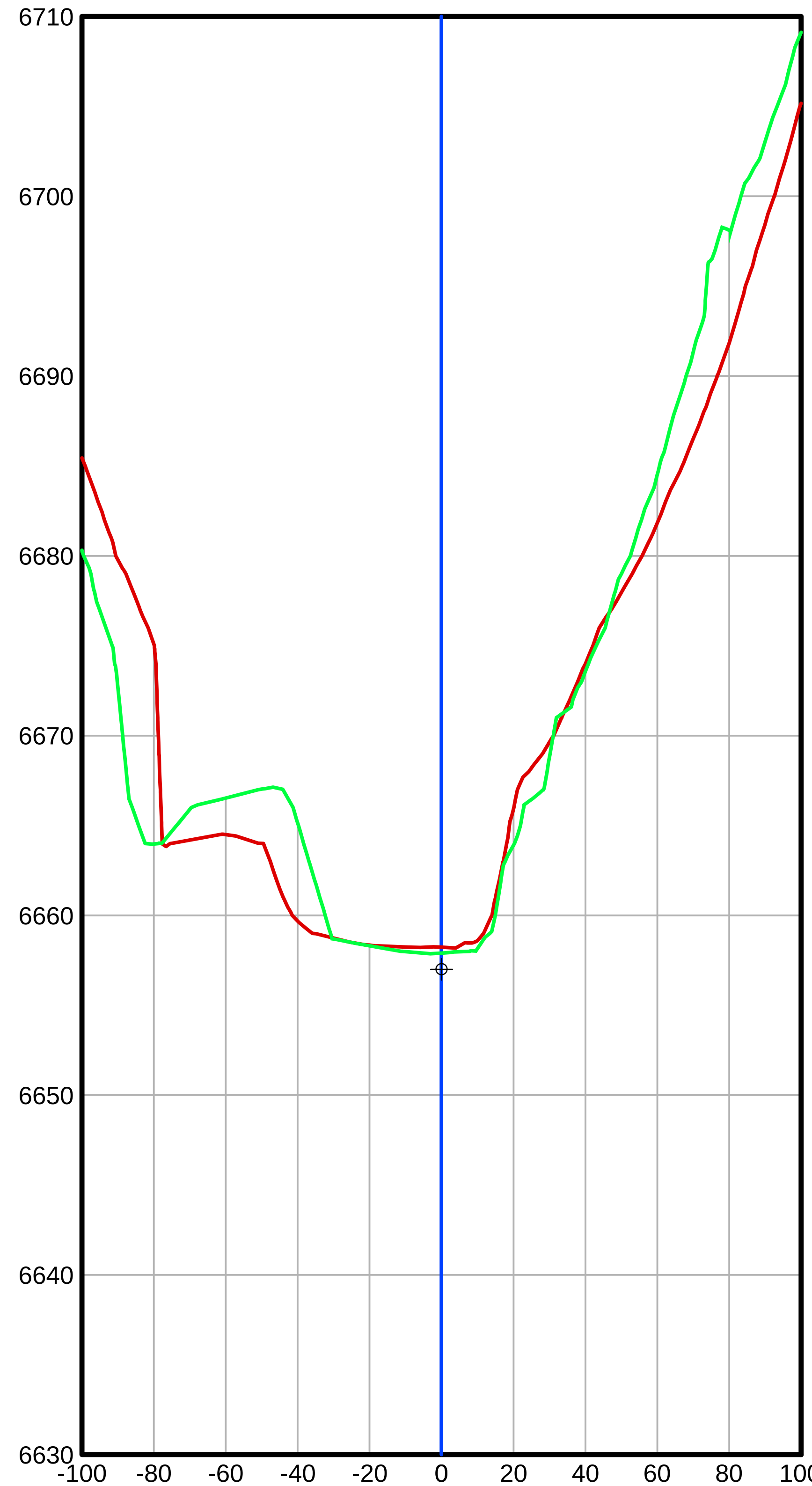
Sheet reference number: 55

UPDATE

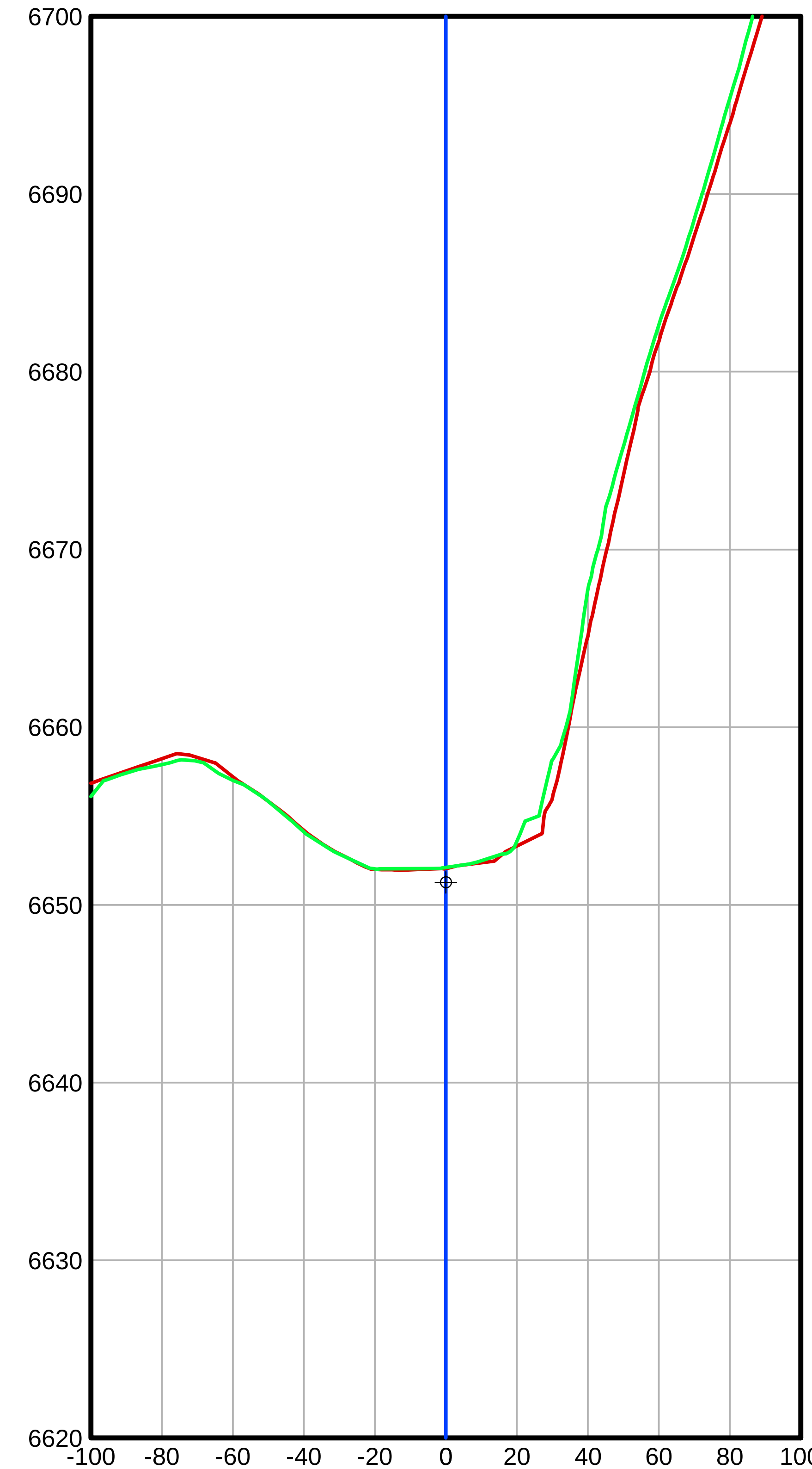
SL-73 (730+00.00)



SL-74 (732+00.00)



SL-75 (734+00.00)



LEGEND EXISTING ROAD GRADES PROPOSED

SCALE: 1" = 50'

0 50'

CRANE ASSOCIATES

Designed by: JEFF CRANE | Dwn by: | Ckd by: | Reviewed by: JPC | Submitted by:

Date: 2/25/2016 | Design file no: | Drawing Code: | File name: | Plot date: | Plot scale: | Rev.

Symbol | Description | Date | Approved

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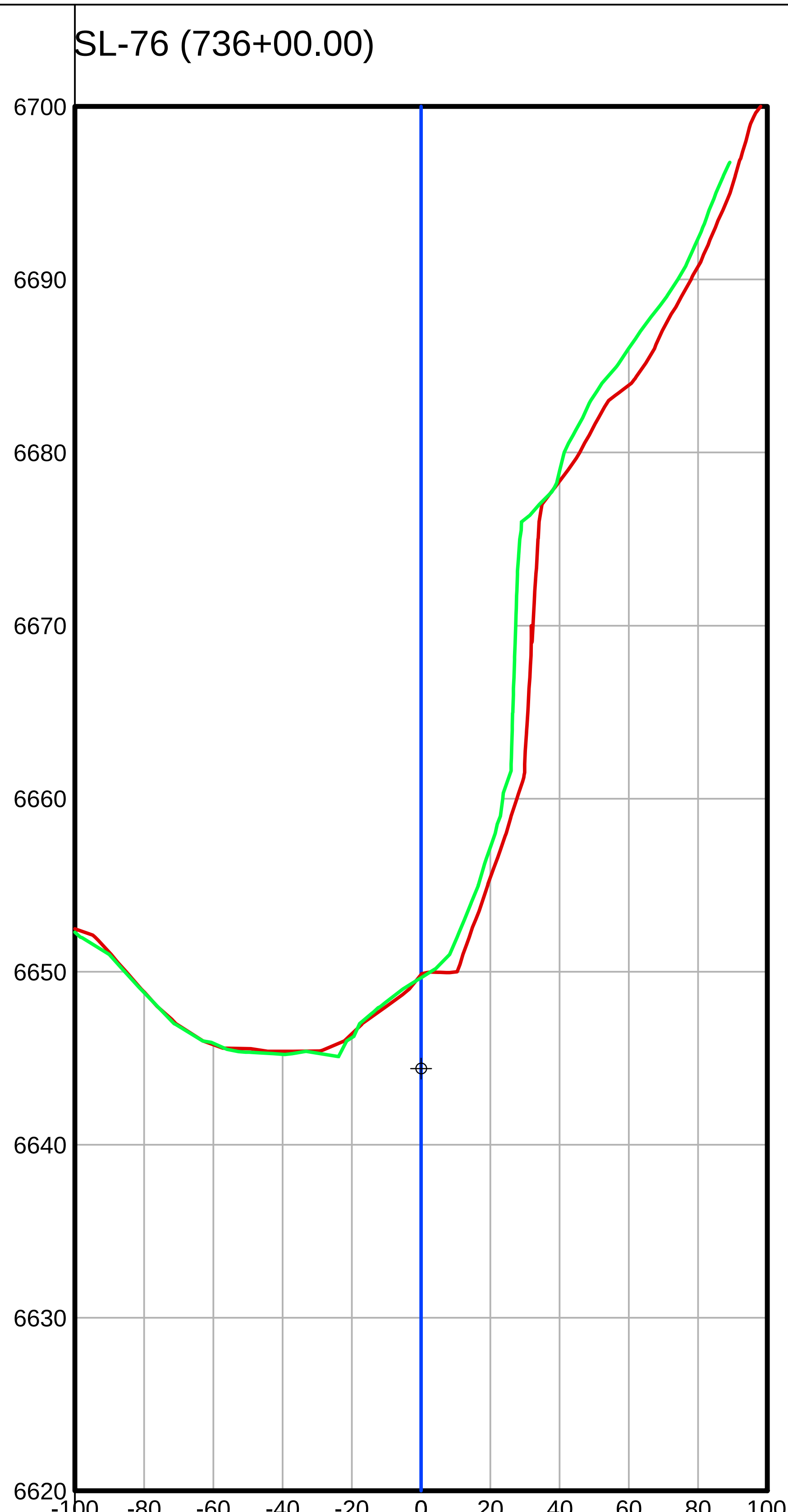
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

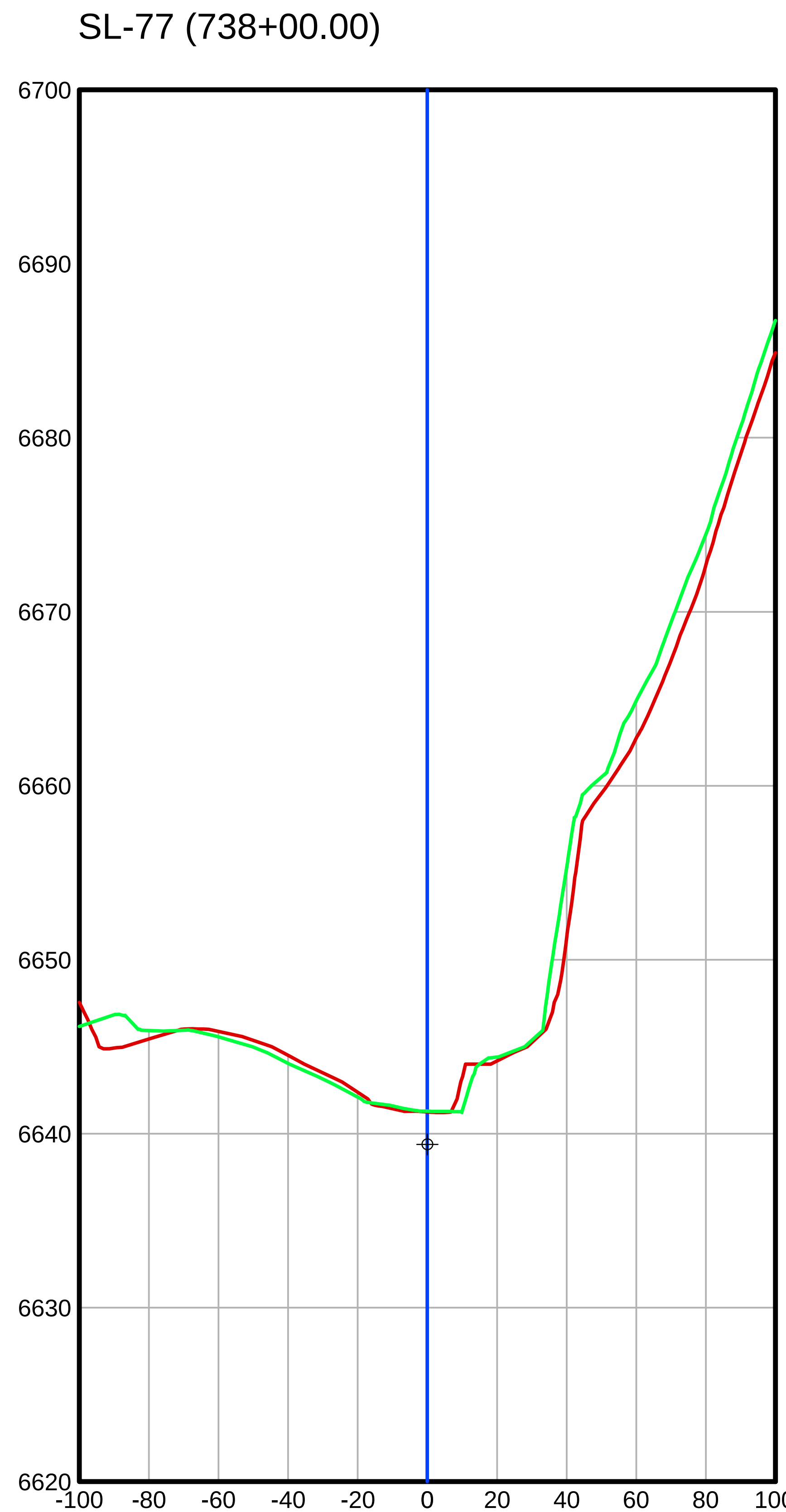
CROSS SECTIONS

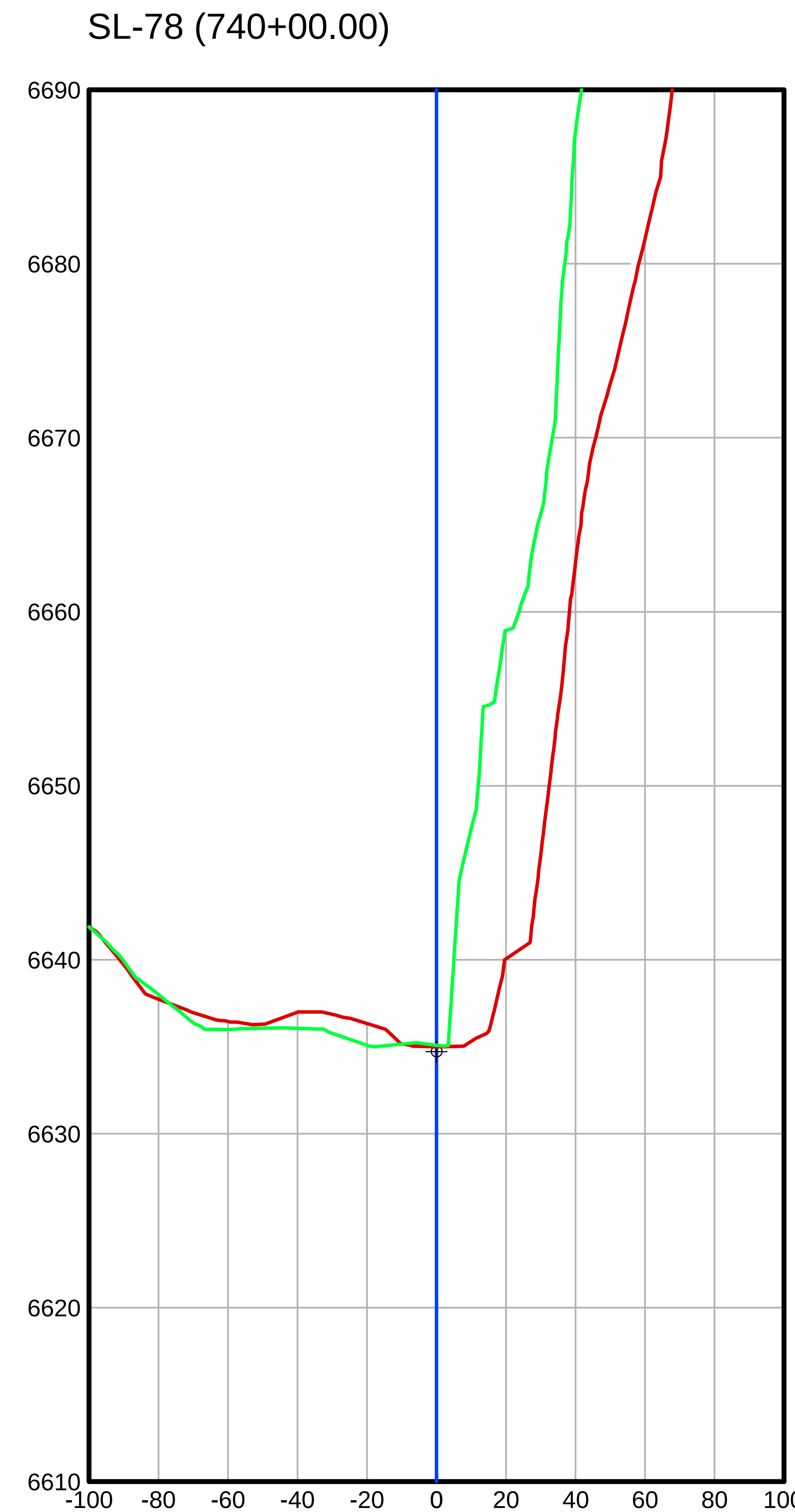
Sheet reference number:

56

UPDATE







LEGEND EXISTING ROAD GRADES PROPOSED

SCALE: 1" = 50'

0 50'

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Designed by: JEFF CRANE
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Reviewed by: JPC
Submitted by:
Date: 2/25/2016
Design file no:
Drawing Code:
File name:
Plot date:
Plot scale:
Rev.

Symbol Description Date Approved

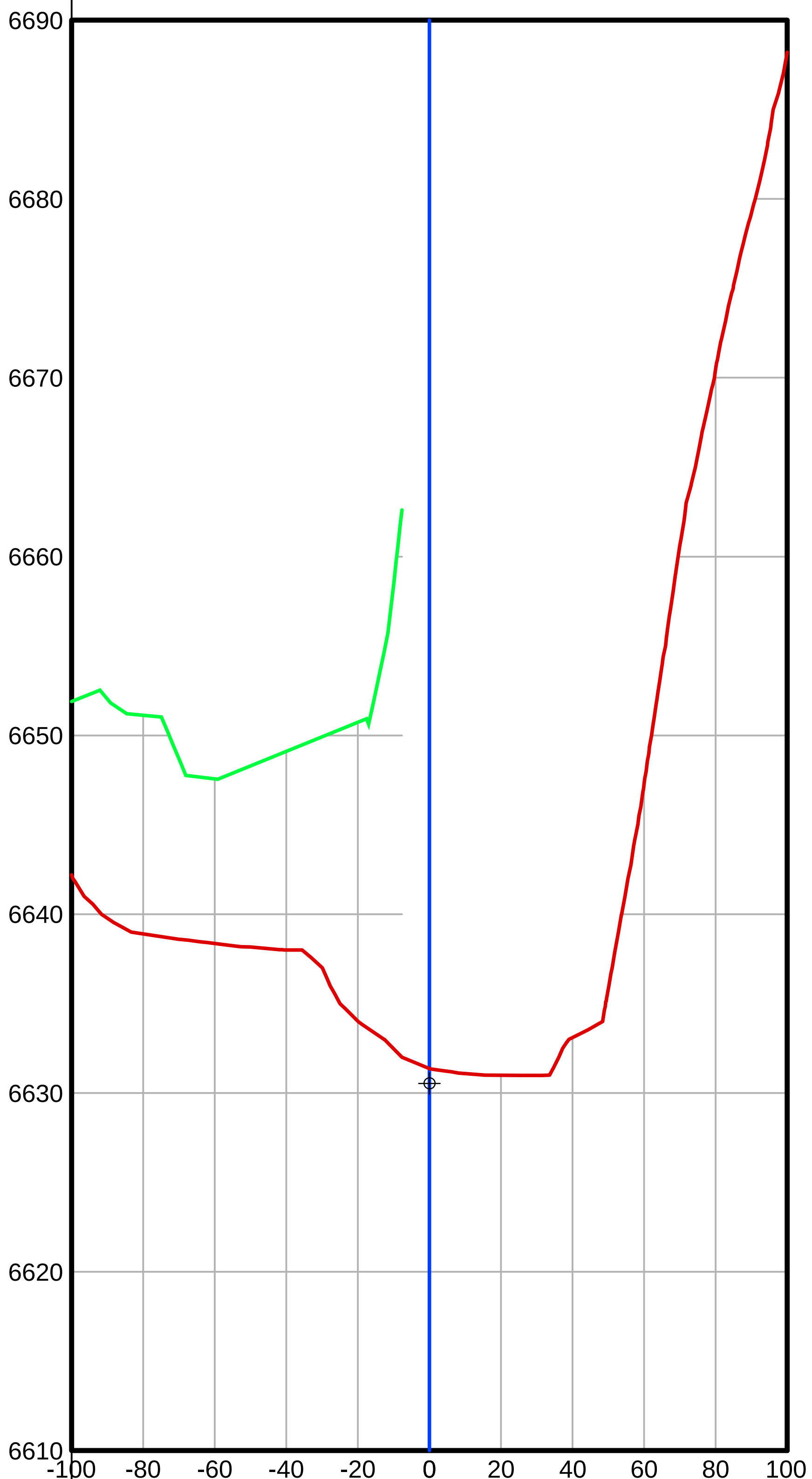
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

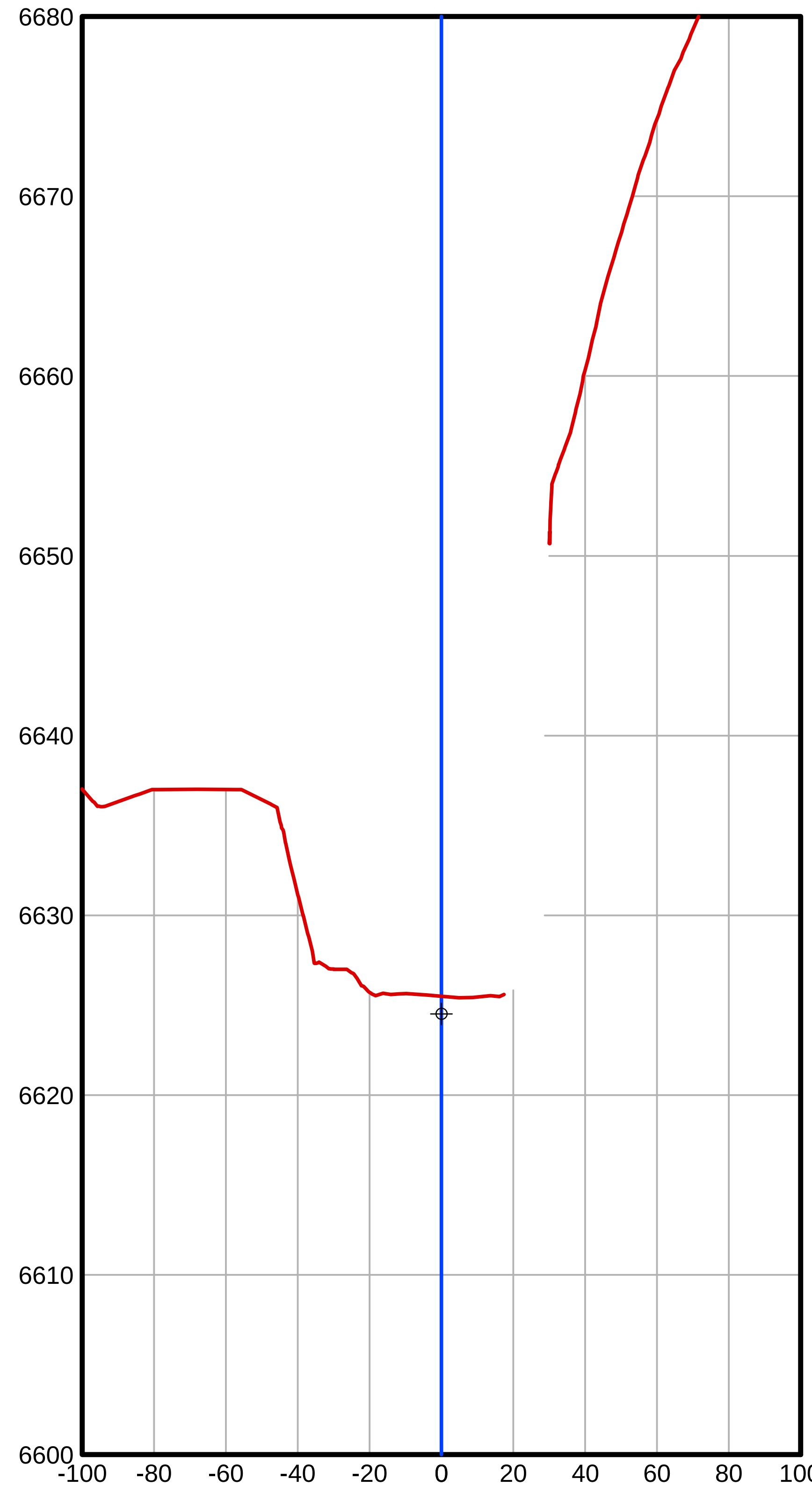
Sheet reference number:
57

UPDATE

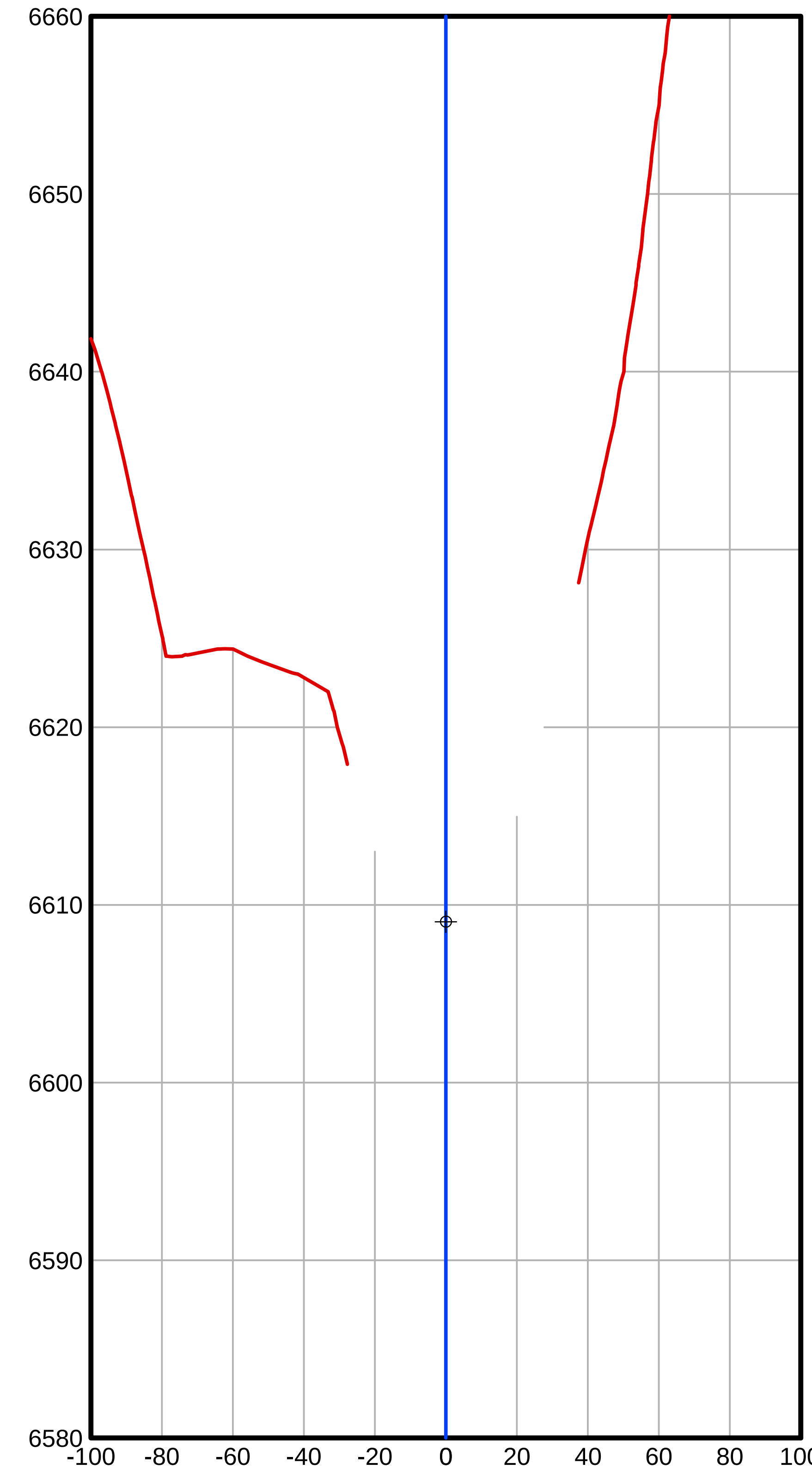
SL-79 (742+00.00)



SL-80 (744+00.00)



SL-81 (746+00.00)



LEGEND — EXISTING — ROAD GRADES — PROPOSED

SCALE: 1" = 50'

0 50'

Designed by: JEFF CRANE
Dwn by:
Ckd by:
Reviewed by: JPC
Submitted by:
Date: 2/25/2016
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Plot date:
Plot scale:
Rev.

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Symbol | Description | Date | Approved

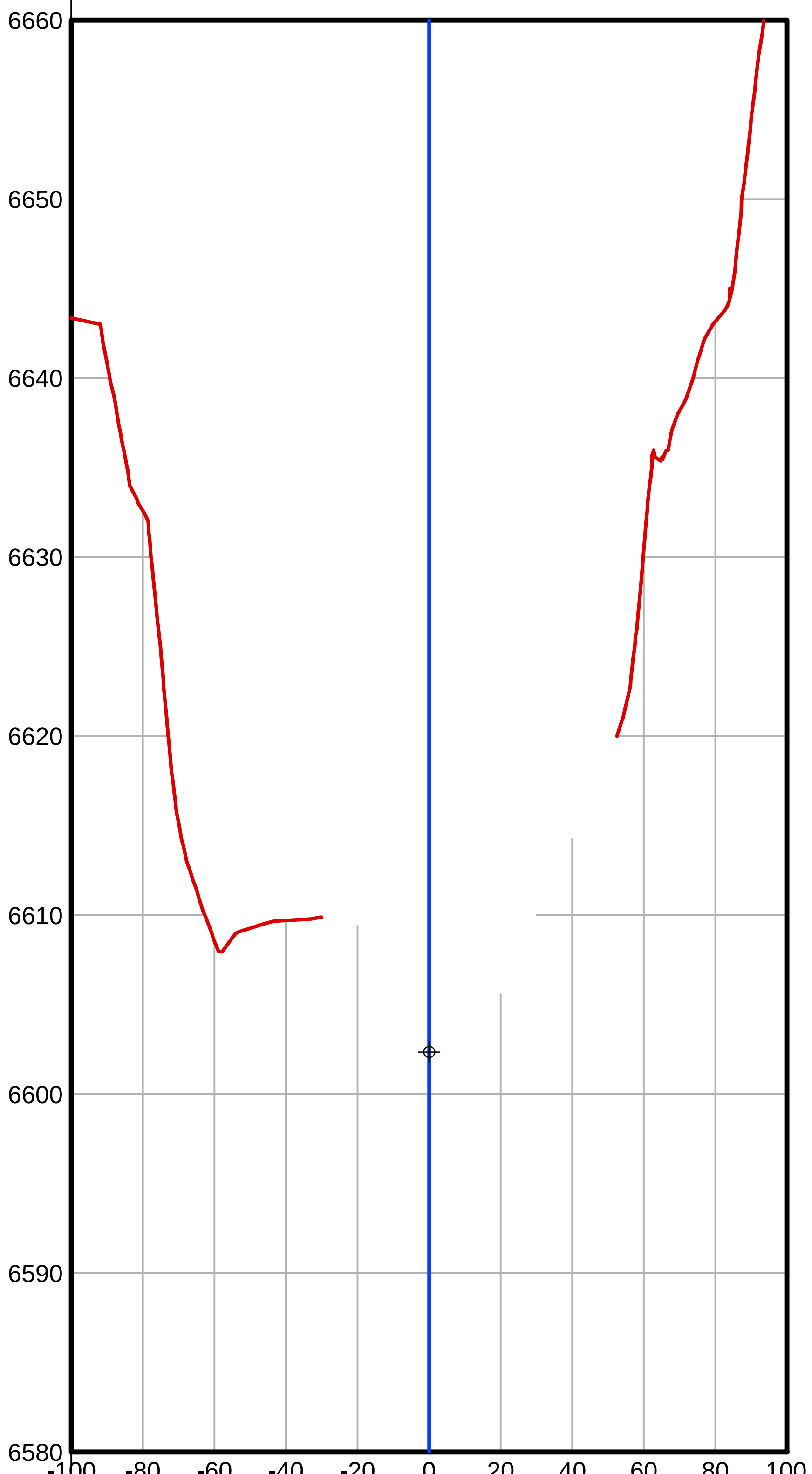
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

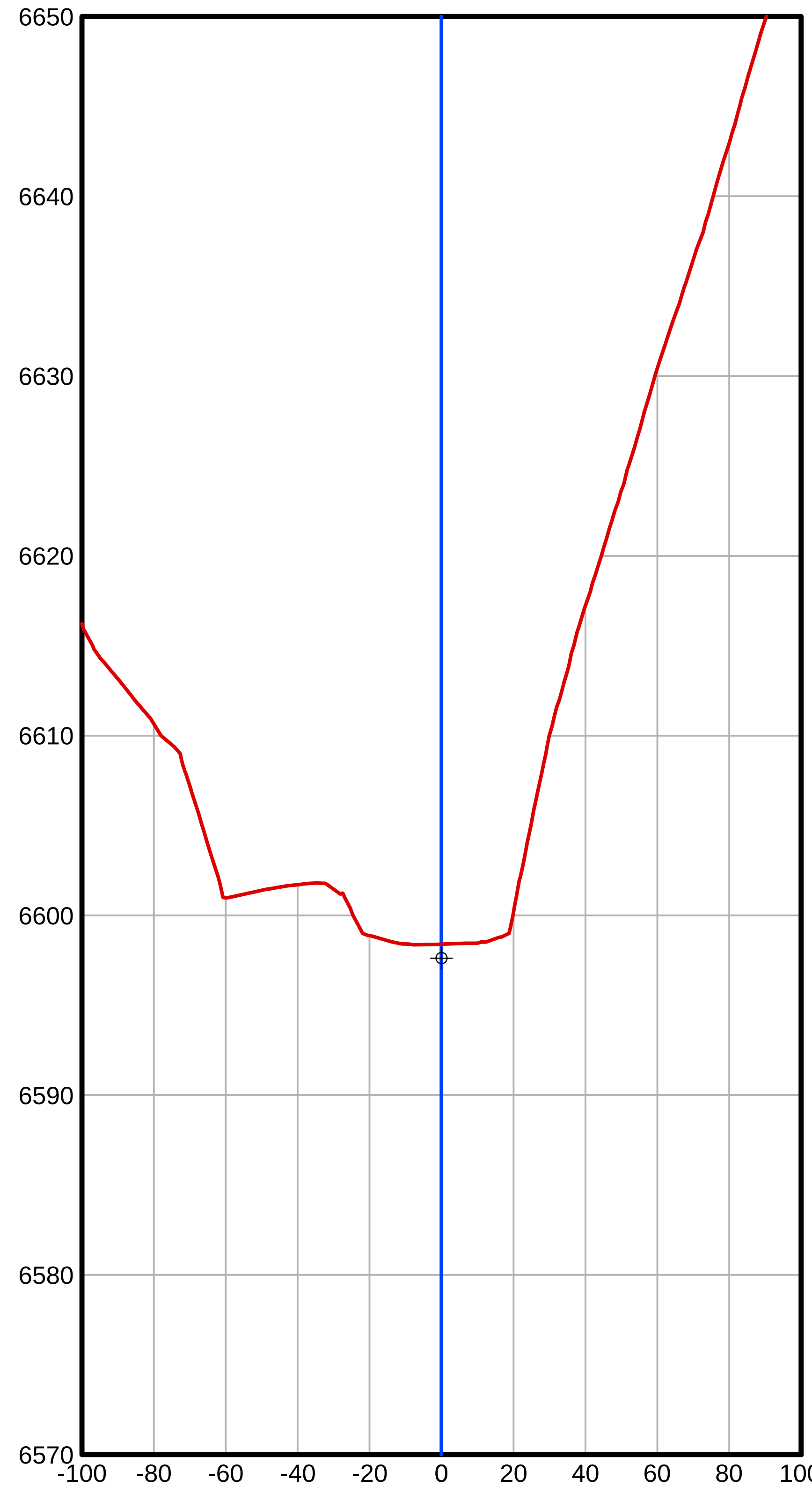
Sheet reference number:
58

UPDATE

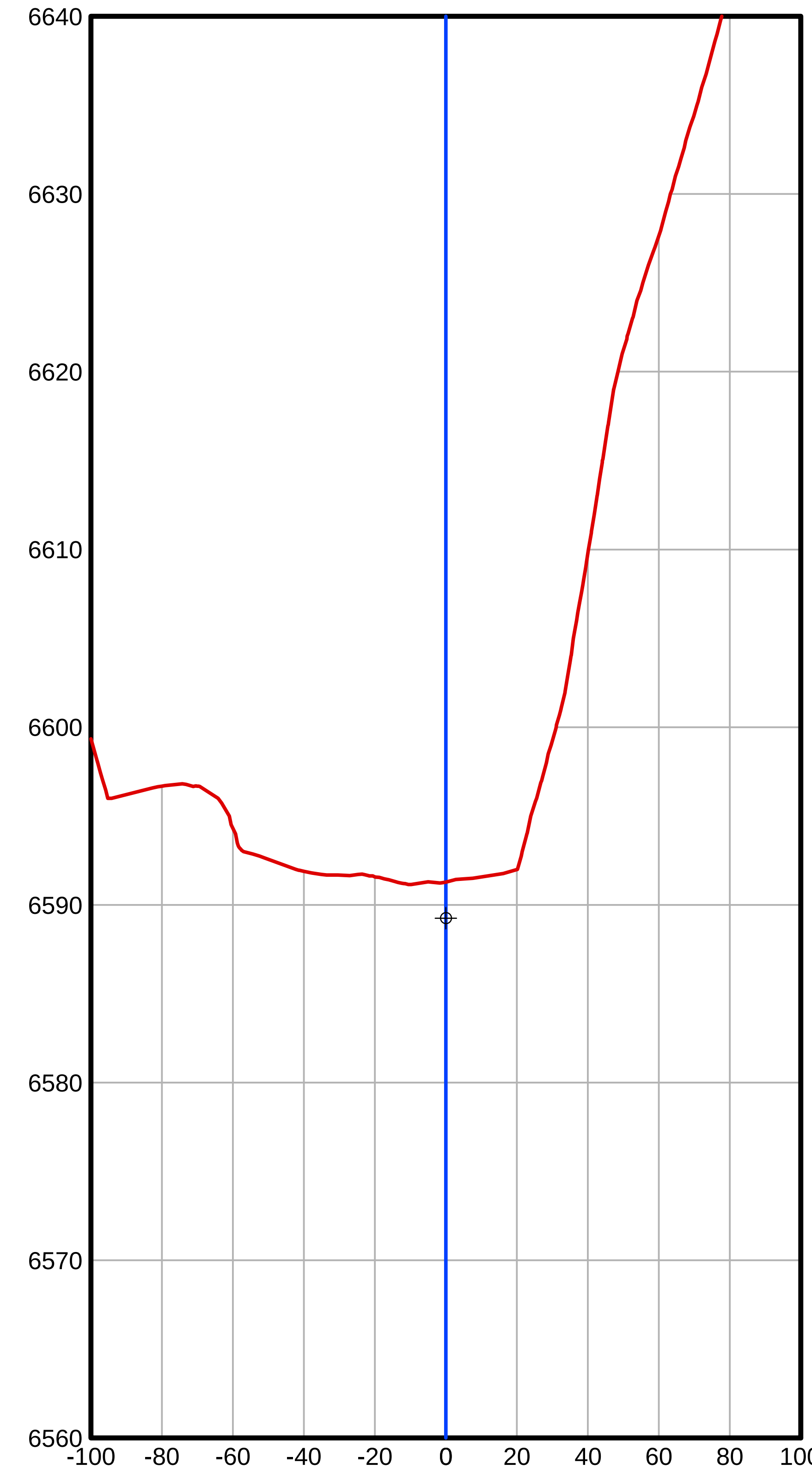
SL-82 (748+00.00)



SL-83 (750+00.00)



SL-84 (752+00.00)



LEGEND EXISTING ROAD GRADES PROPOSED

SCALE: 1" = 50'

0 50'

Symbol Description Date Approved

CRANE ASSOCIATES

Rev. Date: 2/25/2016 Design file no: Drawing Code: File name: Plot date: Plot scale:

Designed by: JEFF CRANE Dwn by: Ckd by: Reviewed by: JPC Submitted by:

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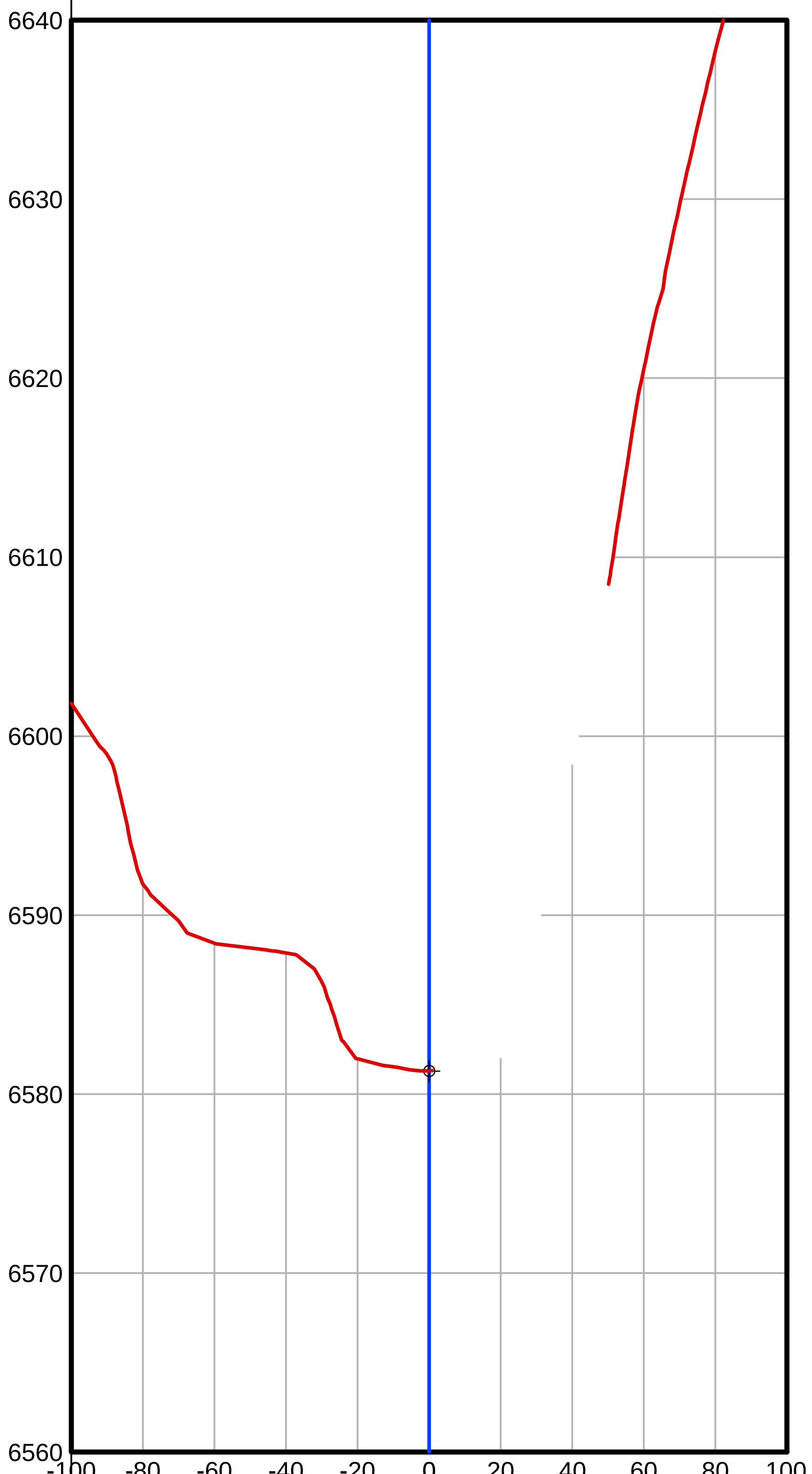
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

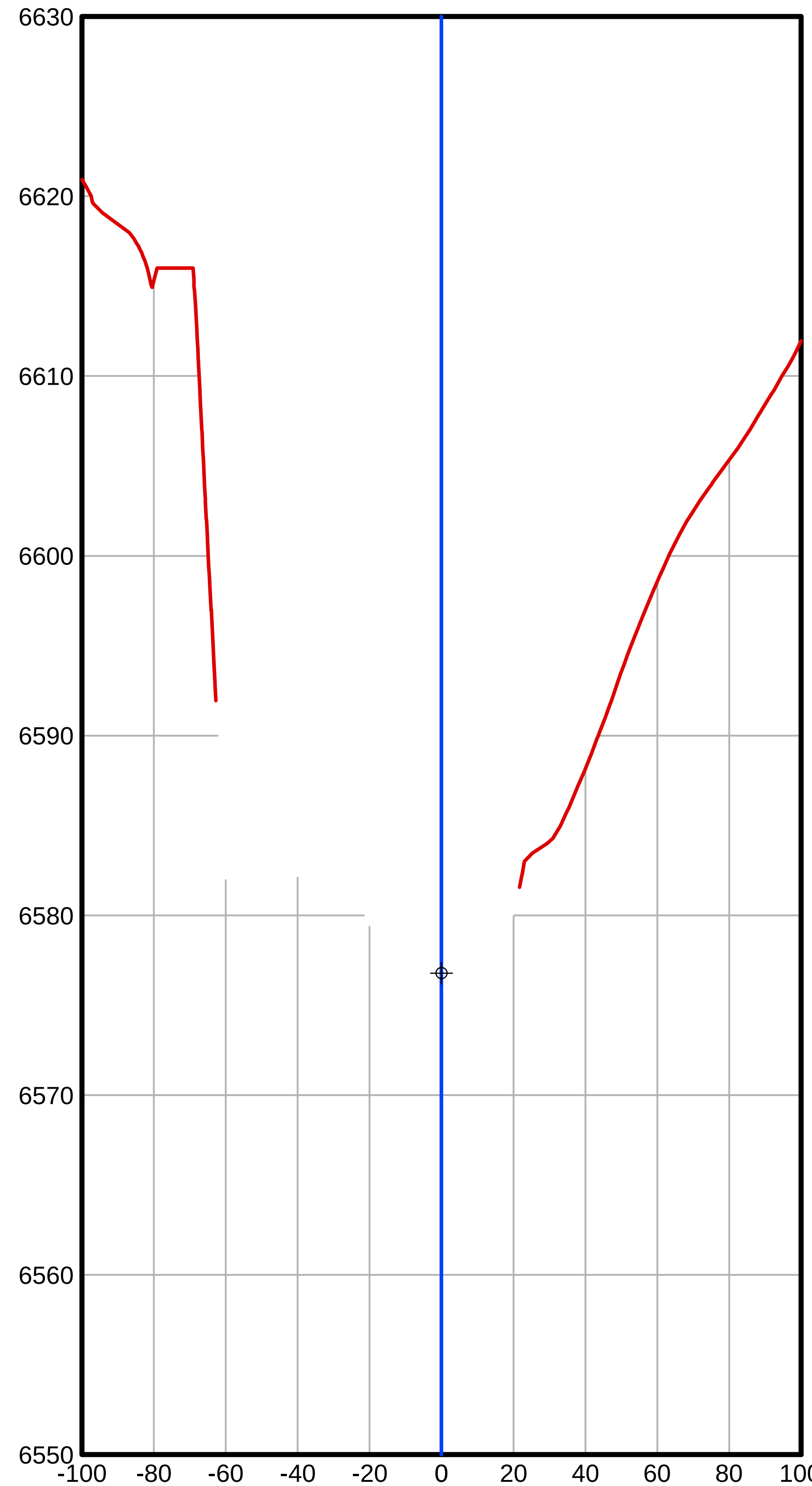
Sheet reference number:
59

UPDATE

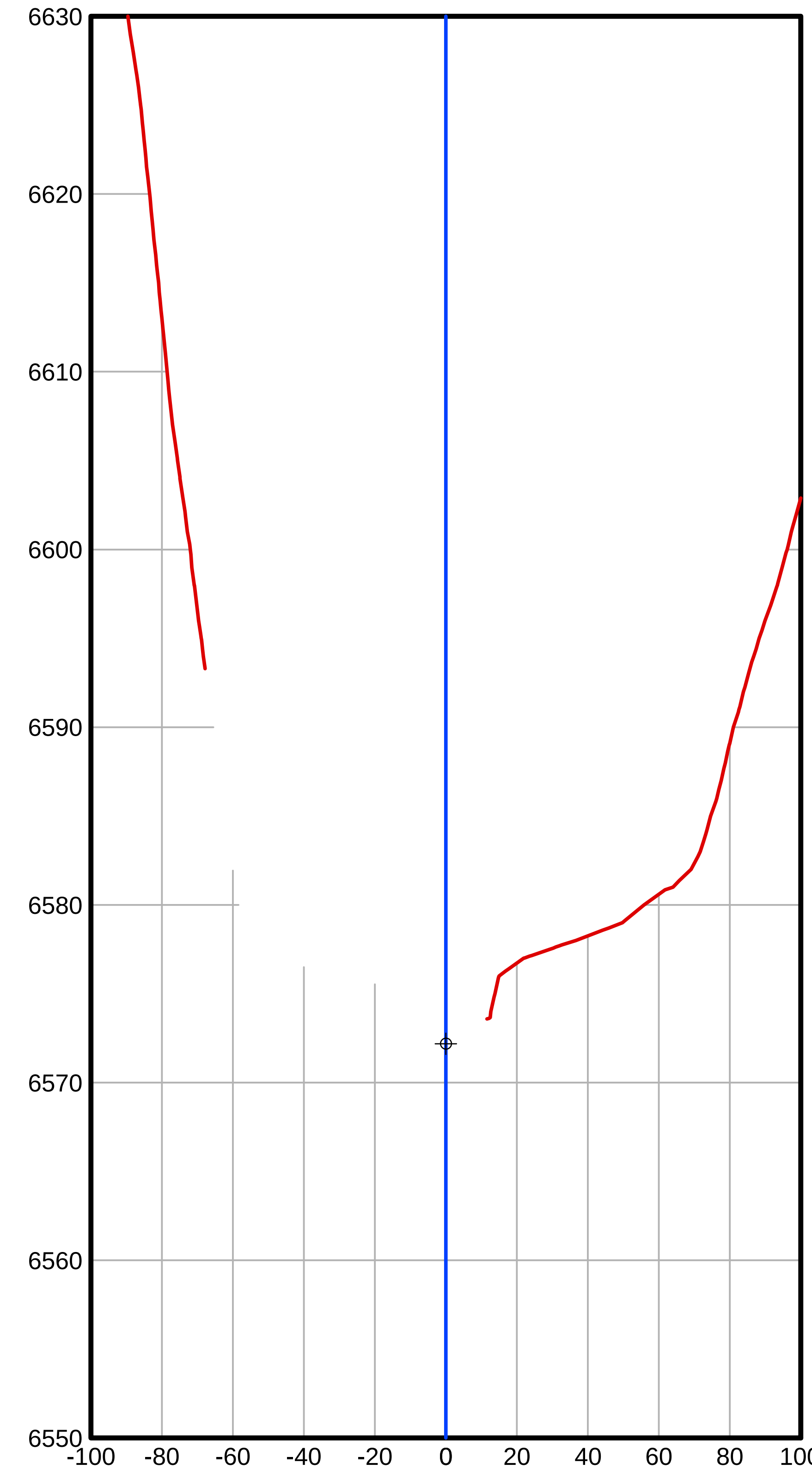
SL-85 (754+00.00)



SL-86 (756+00.00)



SL-87 (758+00.00)



LEGEND EXISTING ROAD GRADES PROPOSED

SCALE: 1" = 50'

0 50'

Symbol	Description	Date	Approved

CRANE ASSOCIATES
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Rev.
Date: 2/25/2016
Design file no:
Drawing Code:
File name:
Plot date:
Plot scale:
Designed by: JEFF CRANE
Dwn by:
Ckd by:
Reviewed by: JPC
Submitted by:

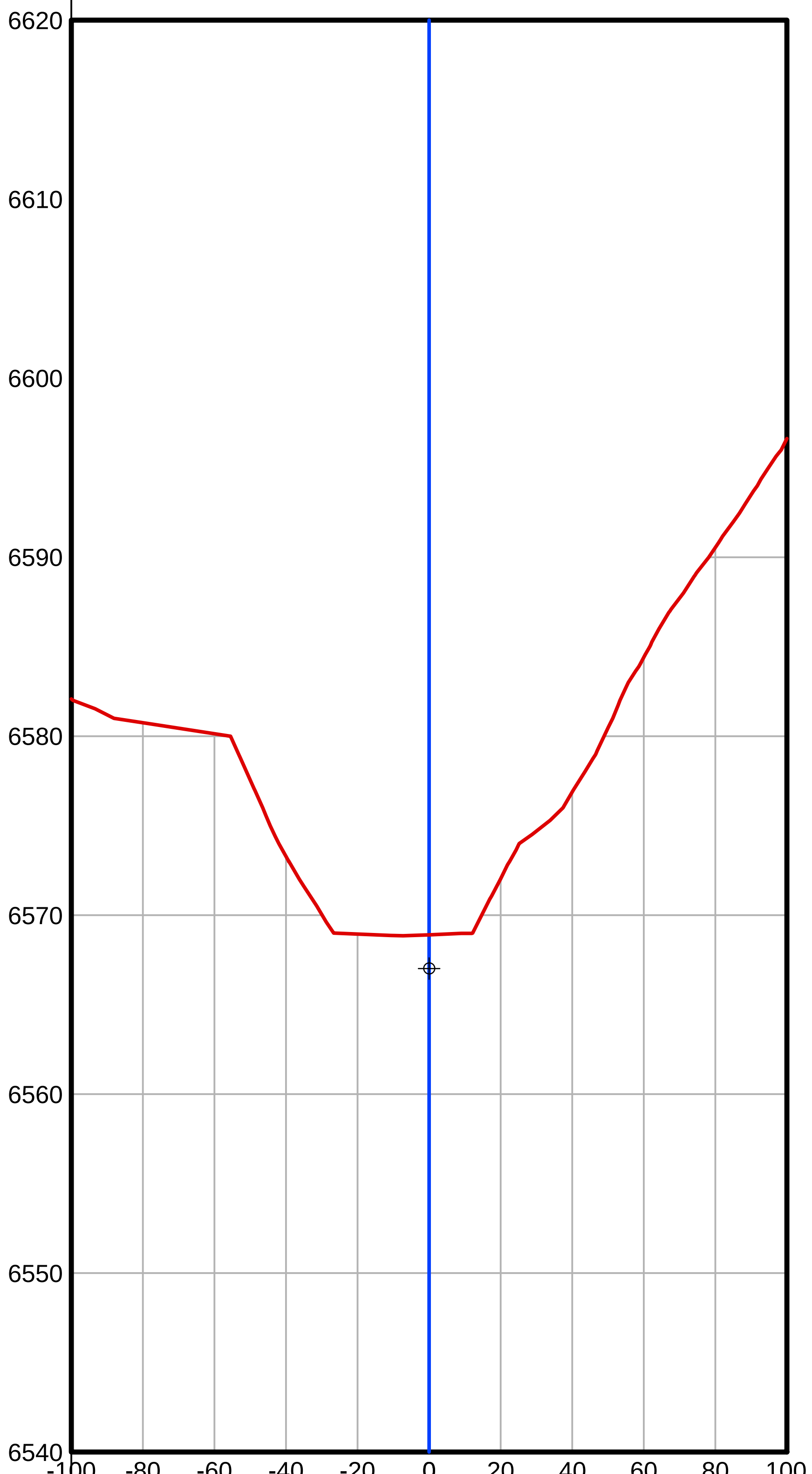
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

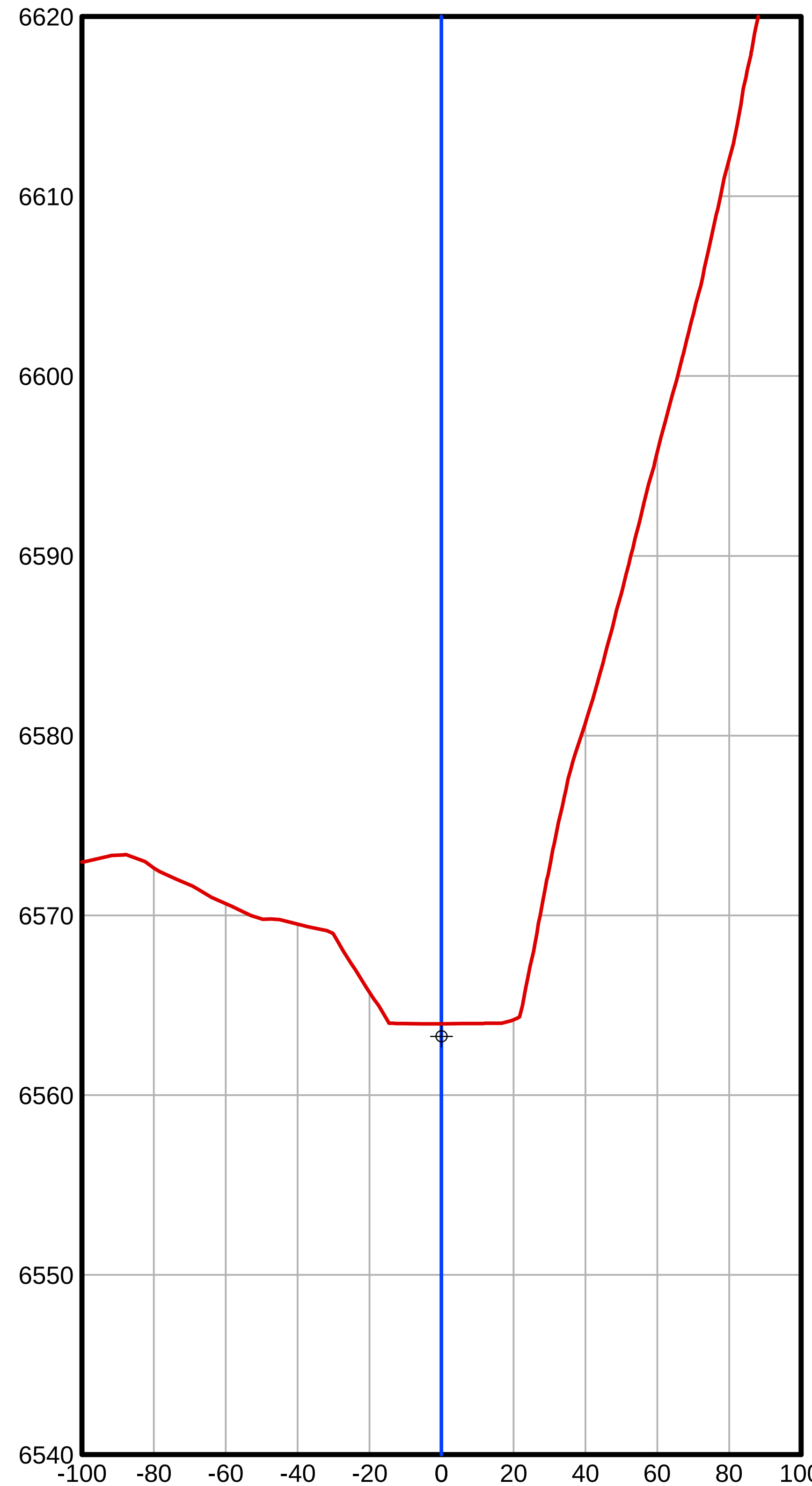
Sheet reference number:
60

UPDATE

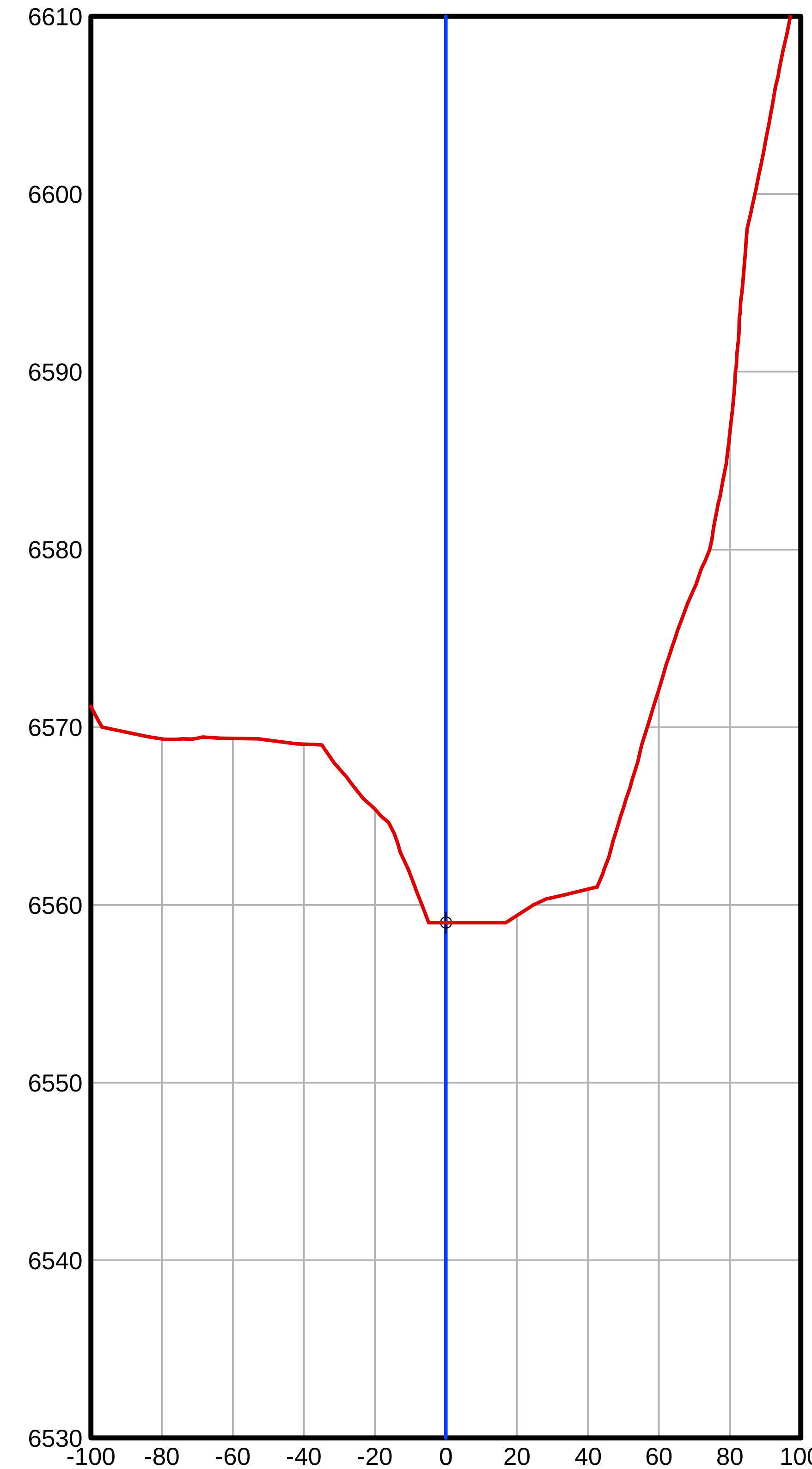
SL-88 (760+00.00)



SL-89 (762+00.00)



SL-90 (764+00.00)



LEGEND EXISTING ROAD GRADES PROPOSED

SCALE: 1" = 50'

0 50'

Rev. | Symbol | Description | Date | Approved

Designed by: JEFF CRANE
Dwn by:
Ckd by:
Reviewed by: JPC
Submitted by:
Date: 2/25/2016
Design file no:
Drawing Code:
File name:
Plot date:
Plot scale:

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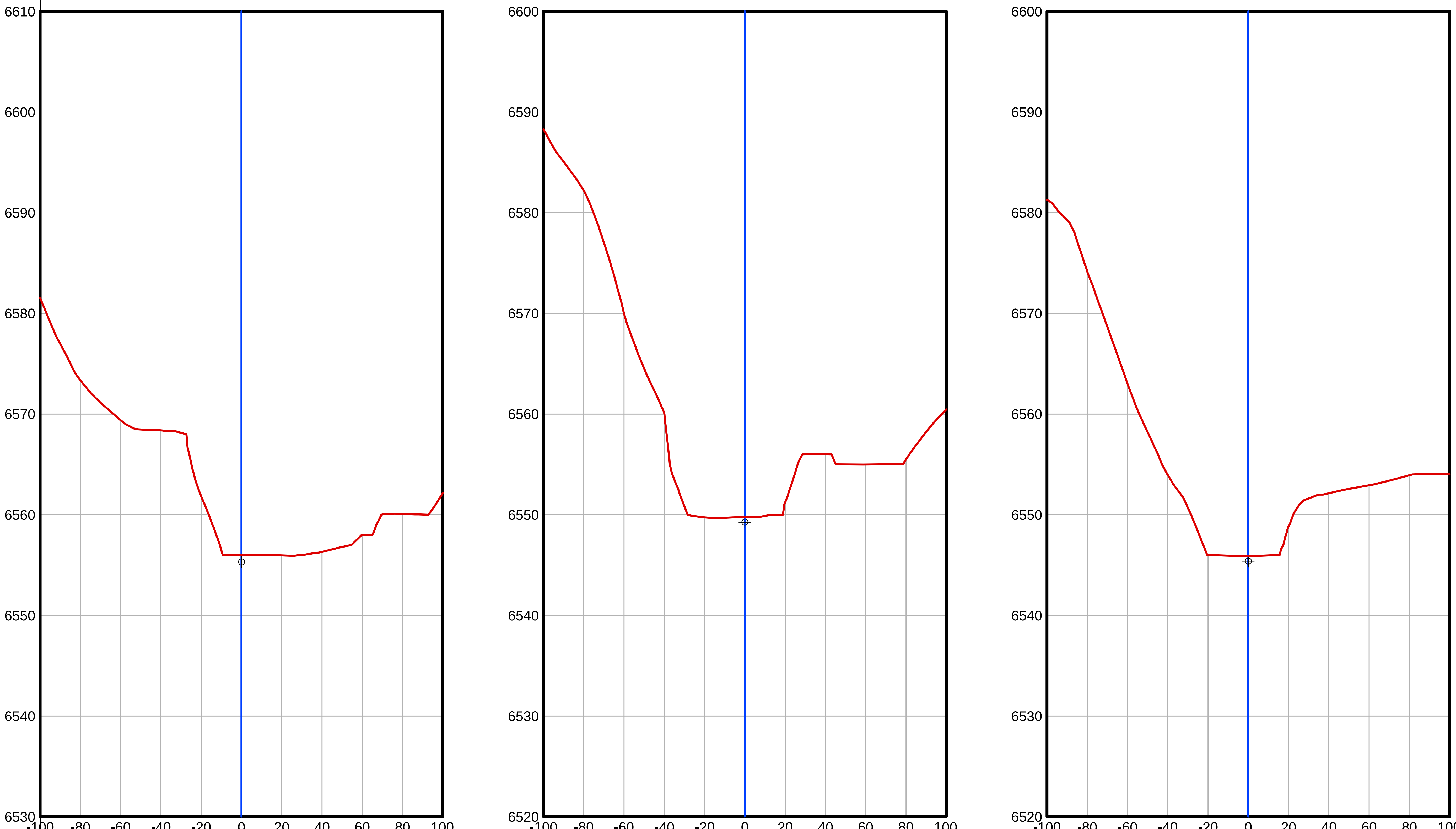
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

Sheet reference number: 61

UPDATE

SL-91 (766+00.00)　SL-92 (768+00.00)　SL-93 (770+00.00)



LEGEND　EXISTING　ROAD GRADES　PROPOSED

SCALE: 1" = 50'
0　50'

NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

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Designed by: JEFF CRANE　Dwn by:　Ckd by:　Reviewed by: JPC　Submitted by:

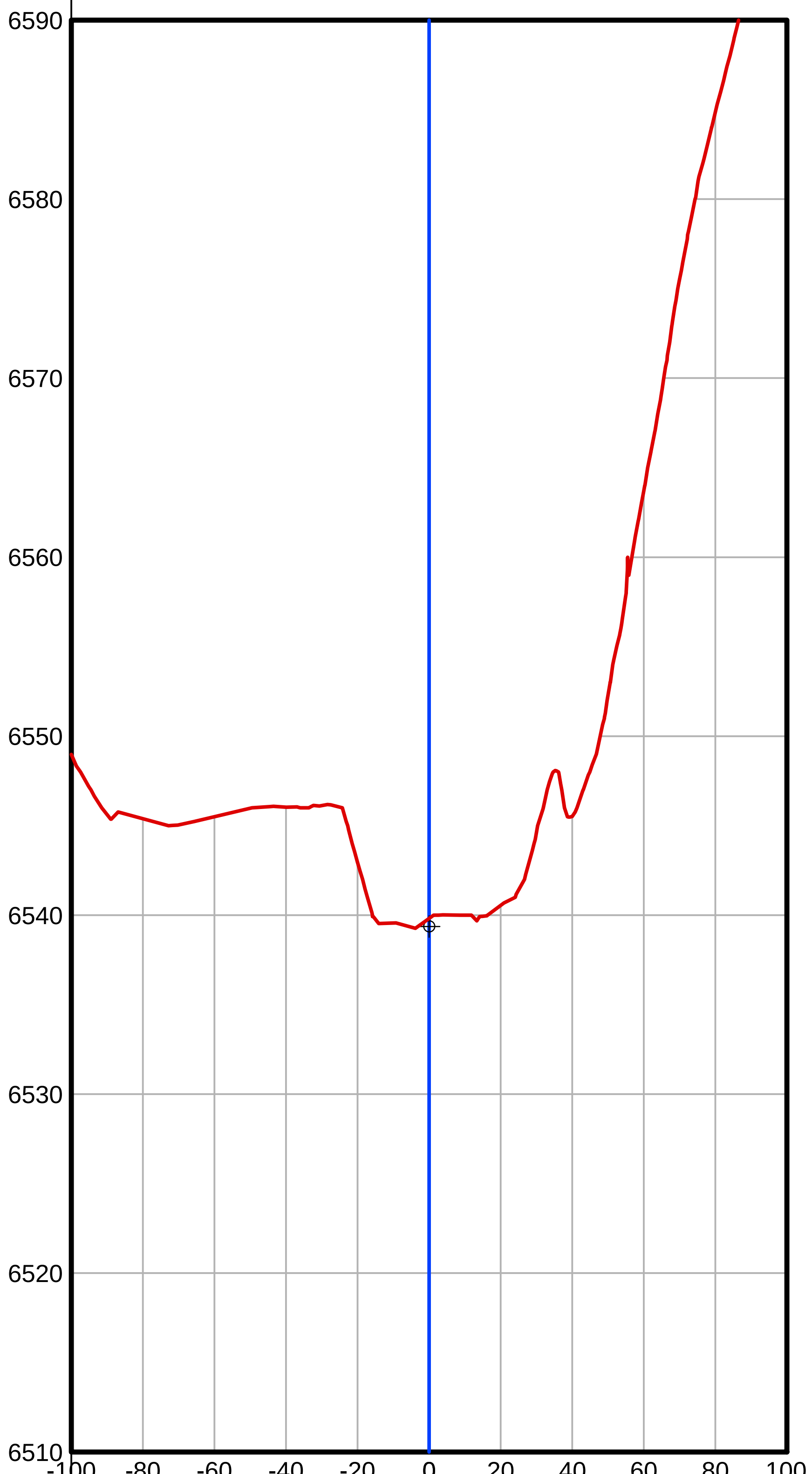
Date: 2/25/2016　Design file no:　Drawing Code:　File name:　Plot date:　Plot scale:　Rev.

Symbol　Description　Date　Approved

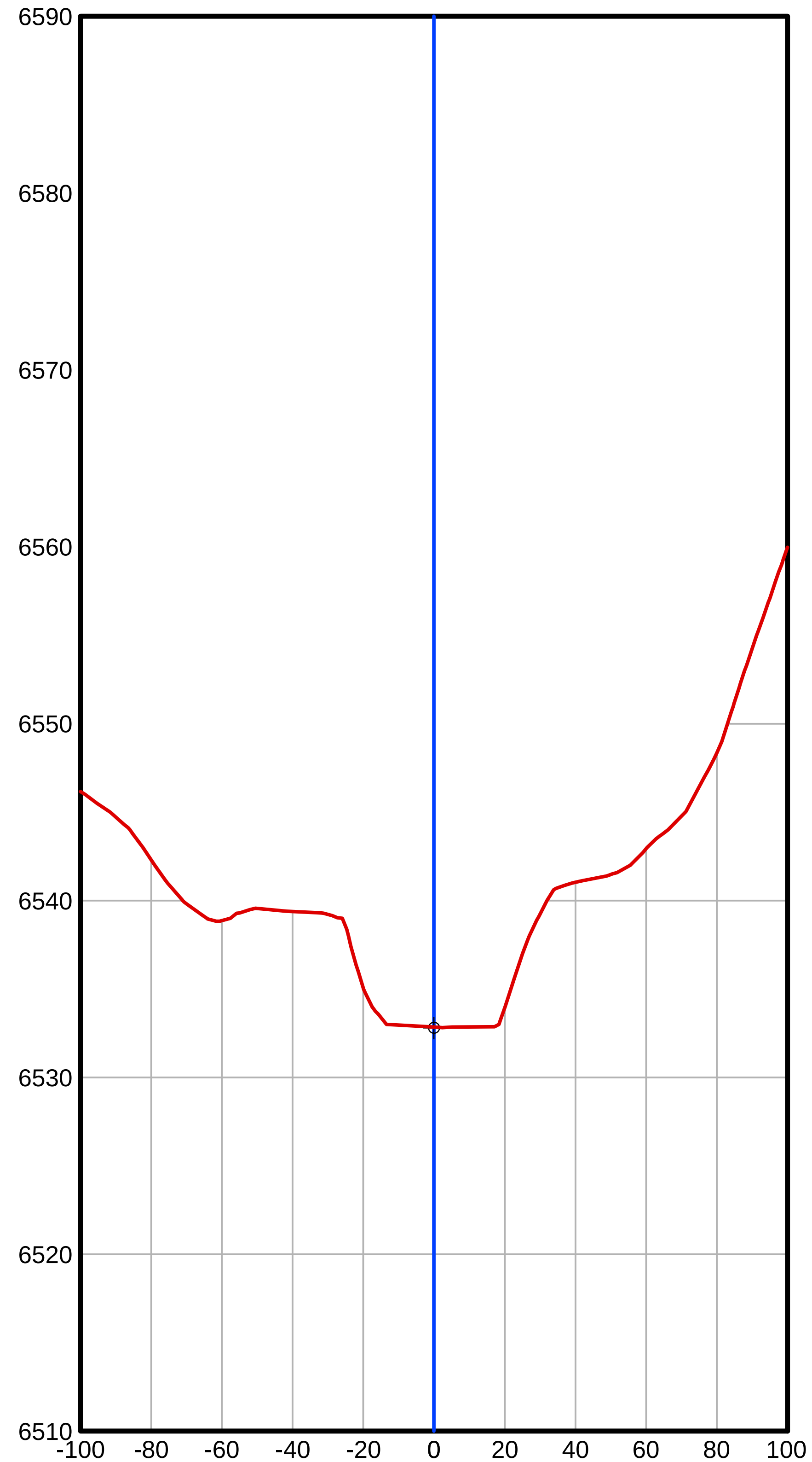
Sheet reference number:
62

UPDATE

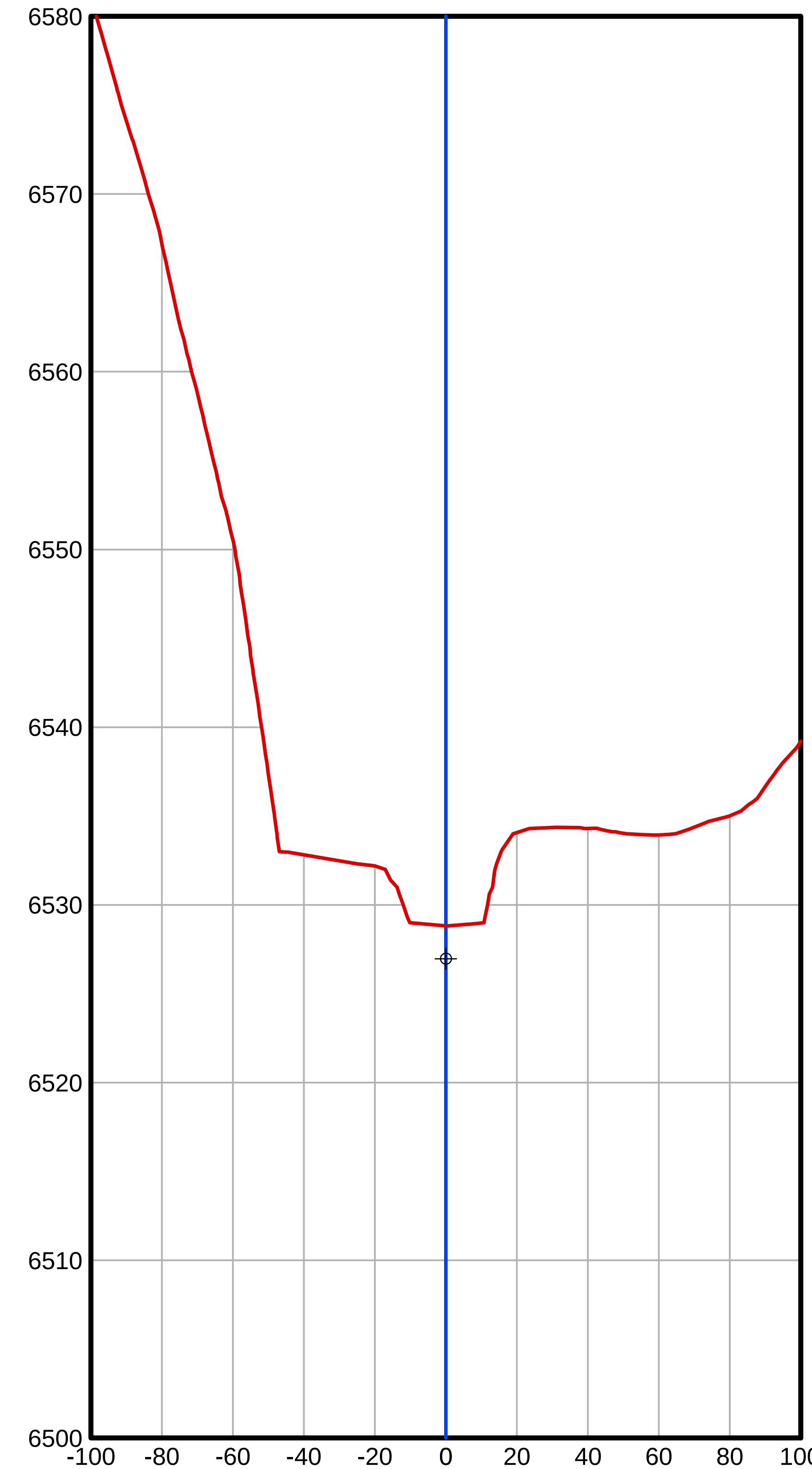
SL-94 (772+00.00)



SL-95 (774+00.00)



SL-96 (776+00.00)



LEGEND — EXISTING (red) — ROAD GRADES (green) — PROPOSED (blue)

SCALE: 1" = 50'
0 50'

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Designed by: JEFF CRANE
Dwn by:
Ckd by:
Reviewed by: JPC
Submitted by:
Date: 2/25/2016
Design file no:
Drawing Code:
File name:
Plot date:
Plot scale:
Rev.

Symbol | Description | Date | Approved

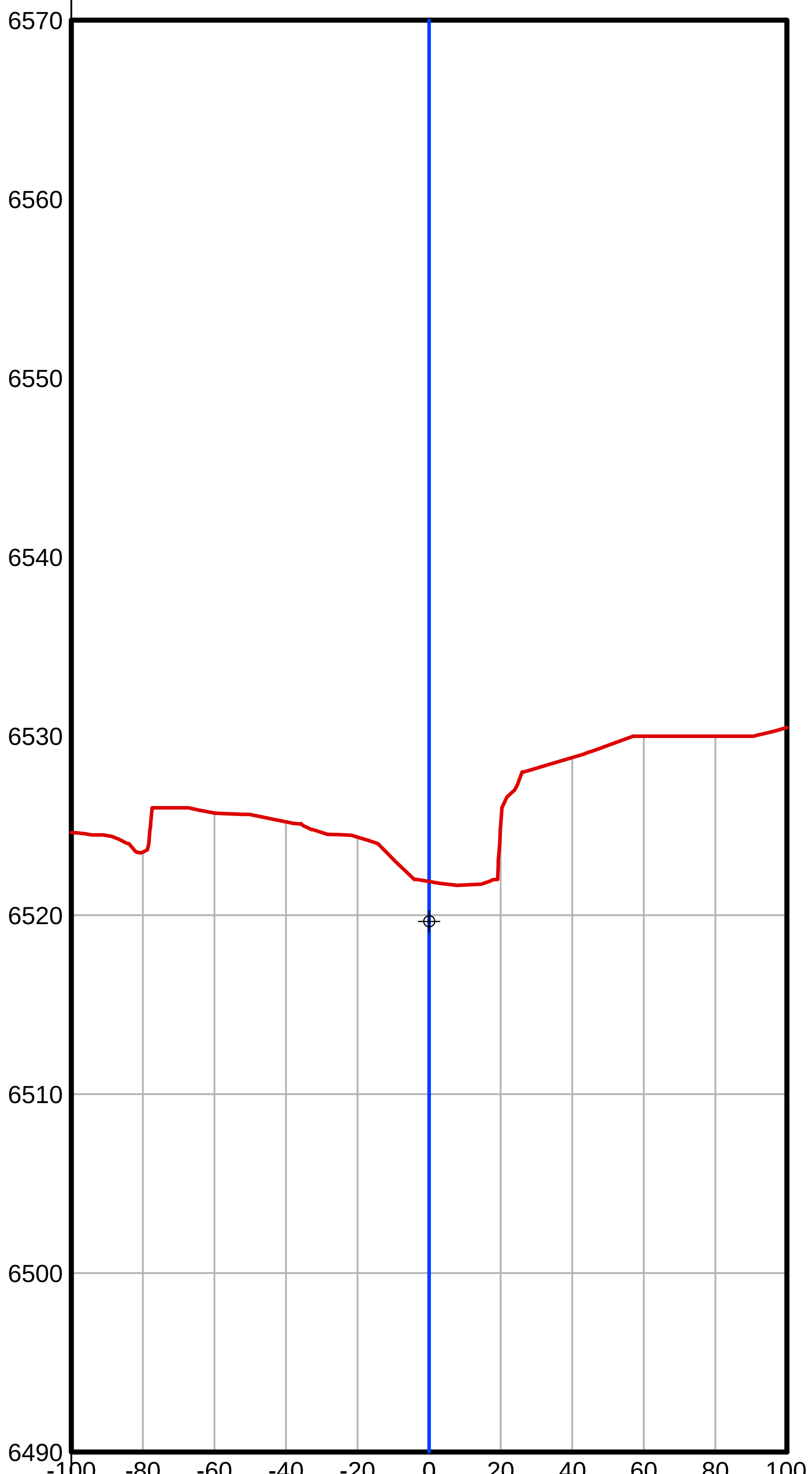
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

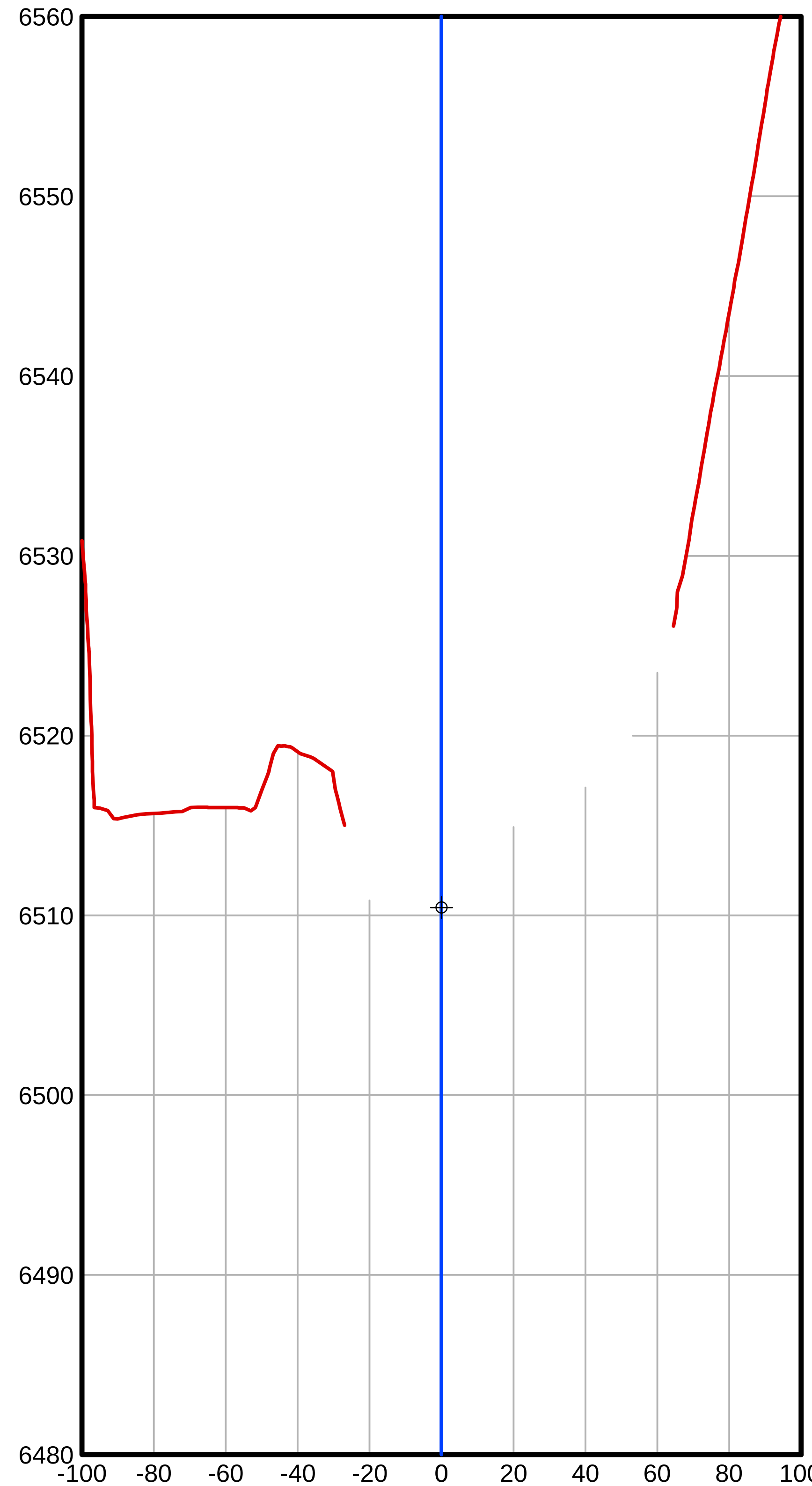
Sheet reference number:
63

UPDATE

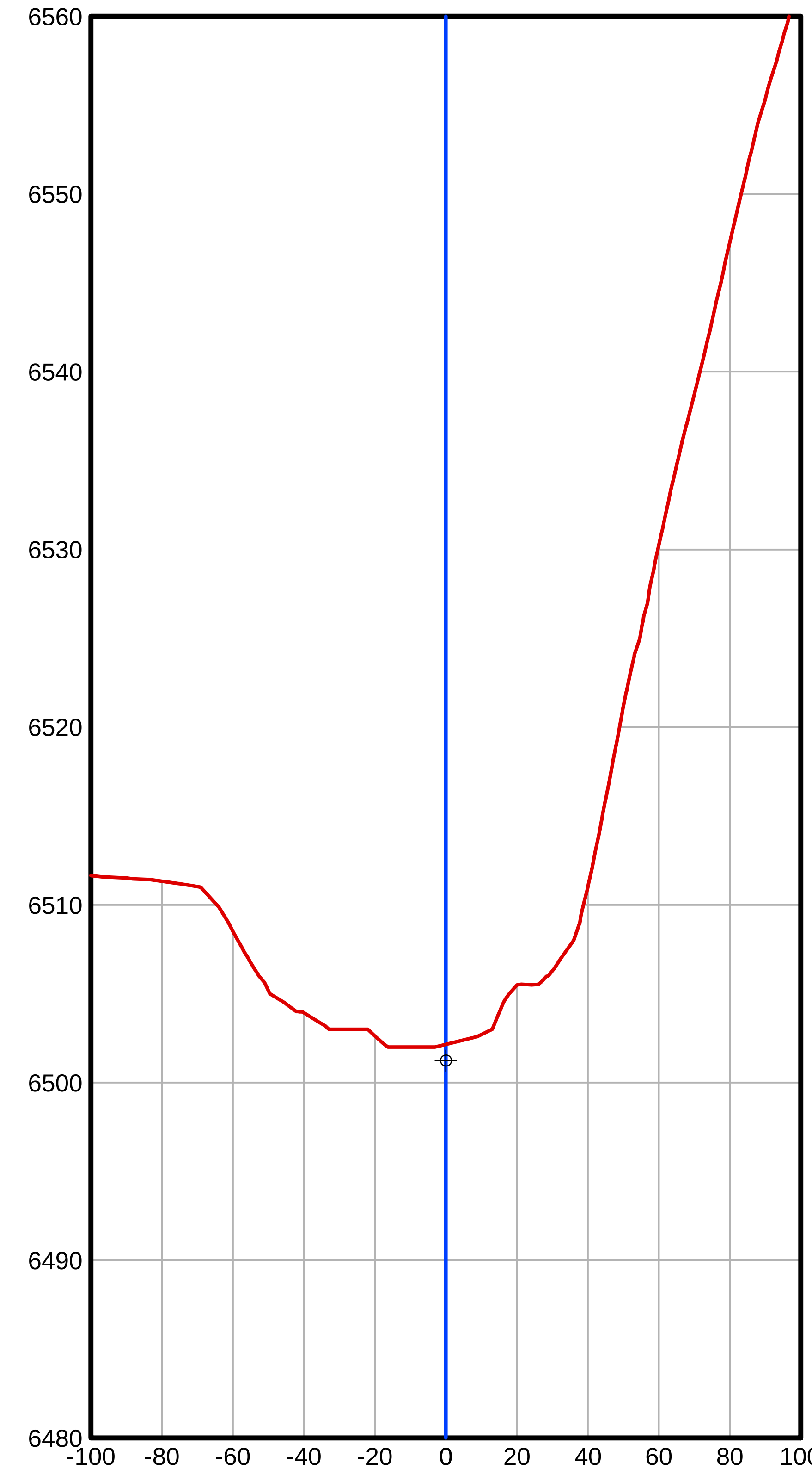
SL-97 (778+00.00)



SL-98 (780+00.00)



SL-99 (782+00.00)



LEGEND — EXISTING — ROAD GRADES — PROPOSED

SCALE: 1" = 50'

0 50'

Symbol | Description | Date | Approved

Designed by: JEFF CRANE
Dwn by:
Ckd by:
Reviewed by: JPC
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Date: 2/25/2016
Design file no:
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Rev.

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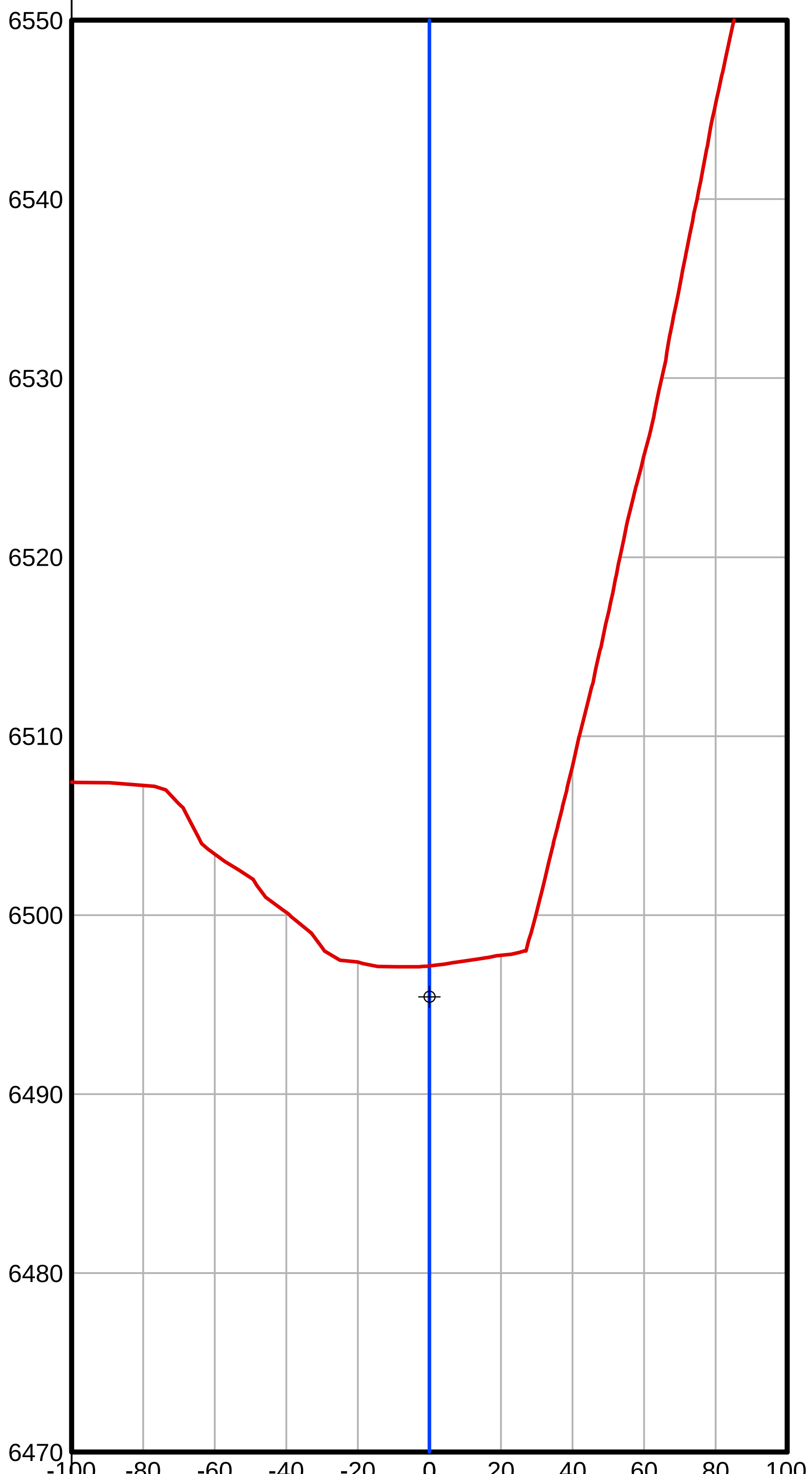
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

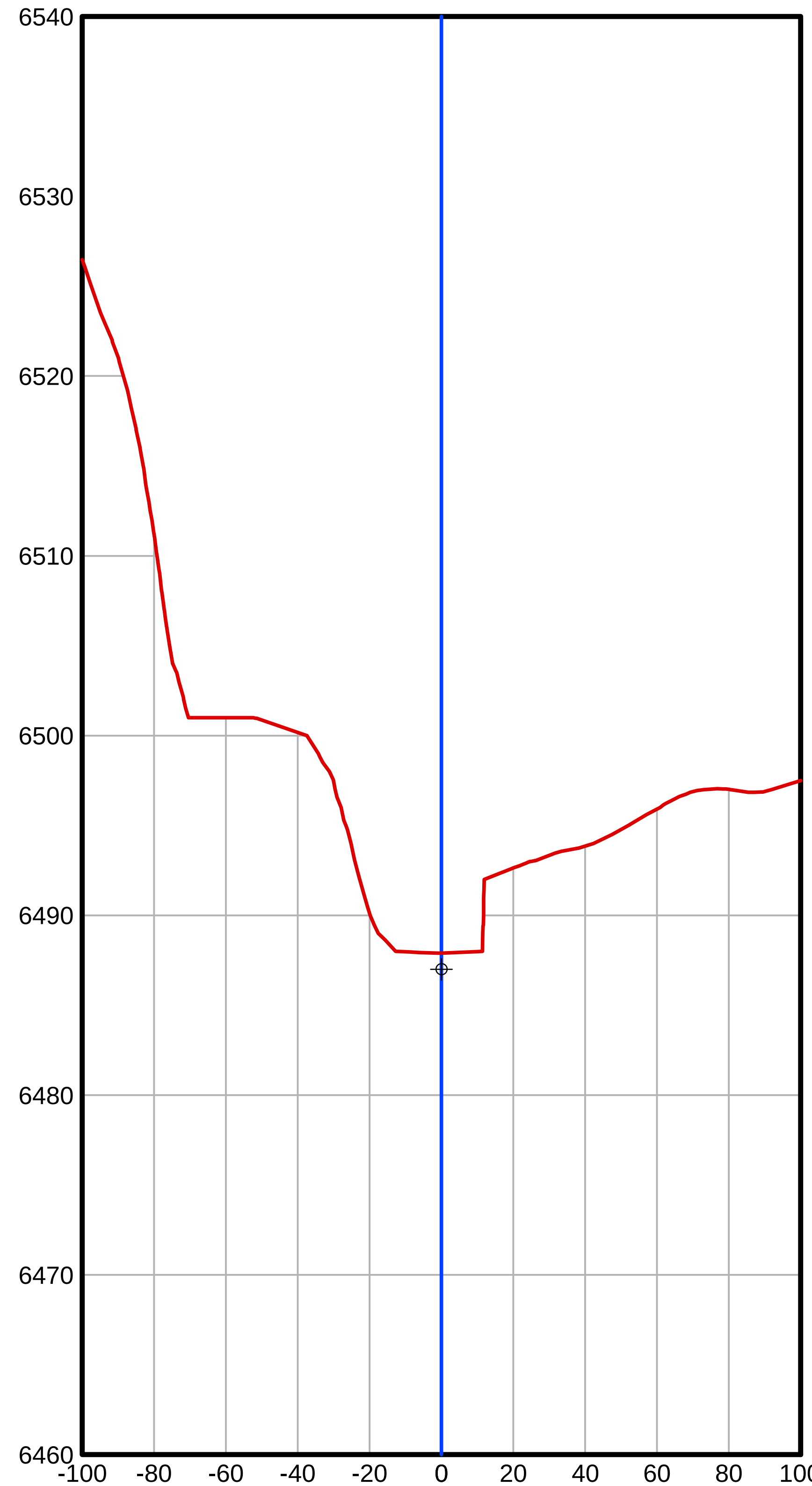
Sheet reference number:
64

UPDATE

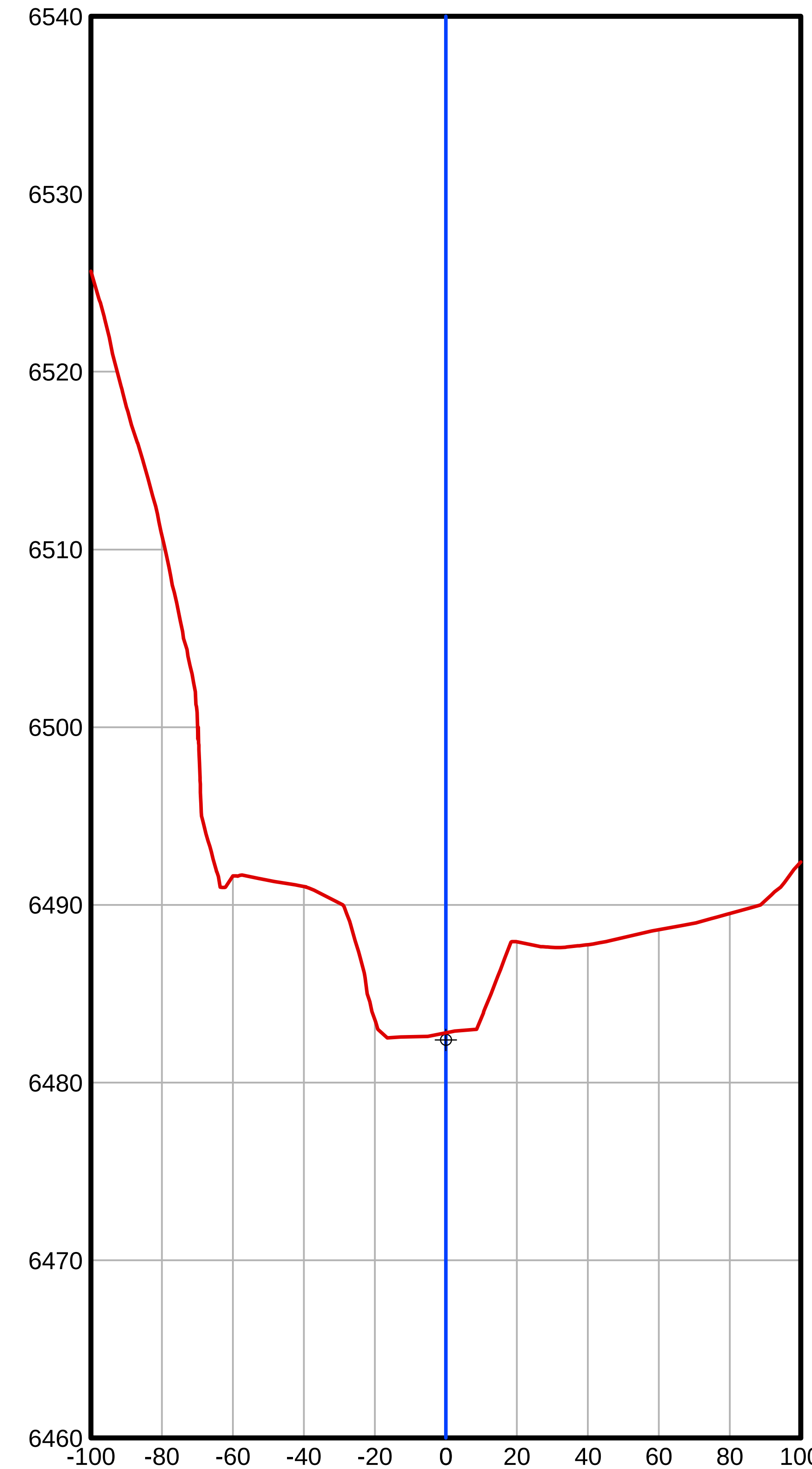
SL-100 (784+00.00)



SL-101 (786+00.00)



SL-102 (788+00.00)



LEGEND — EXISTING — ROAD GRADES — PROPOSED

SCALE: 1" = 50'

0 50'

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Plot date:
Plot scale:
Rev.

Symbol | Description | Date | Approved

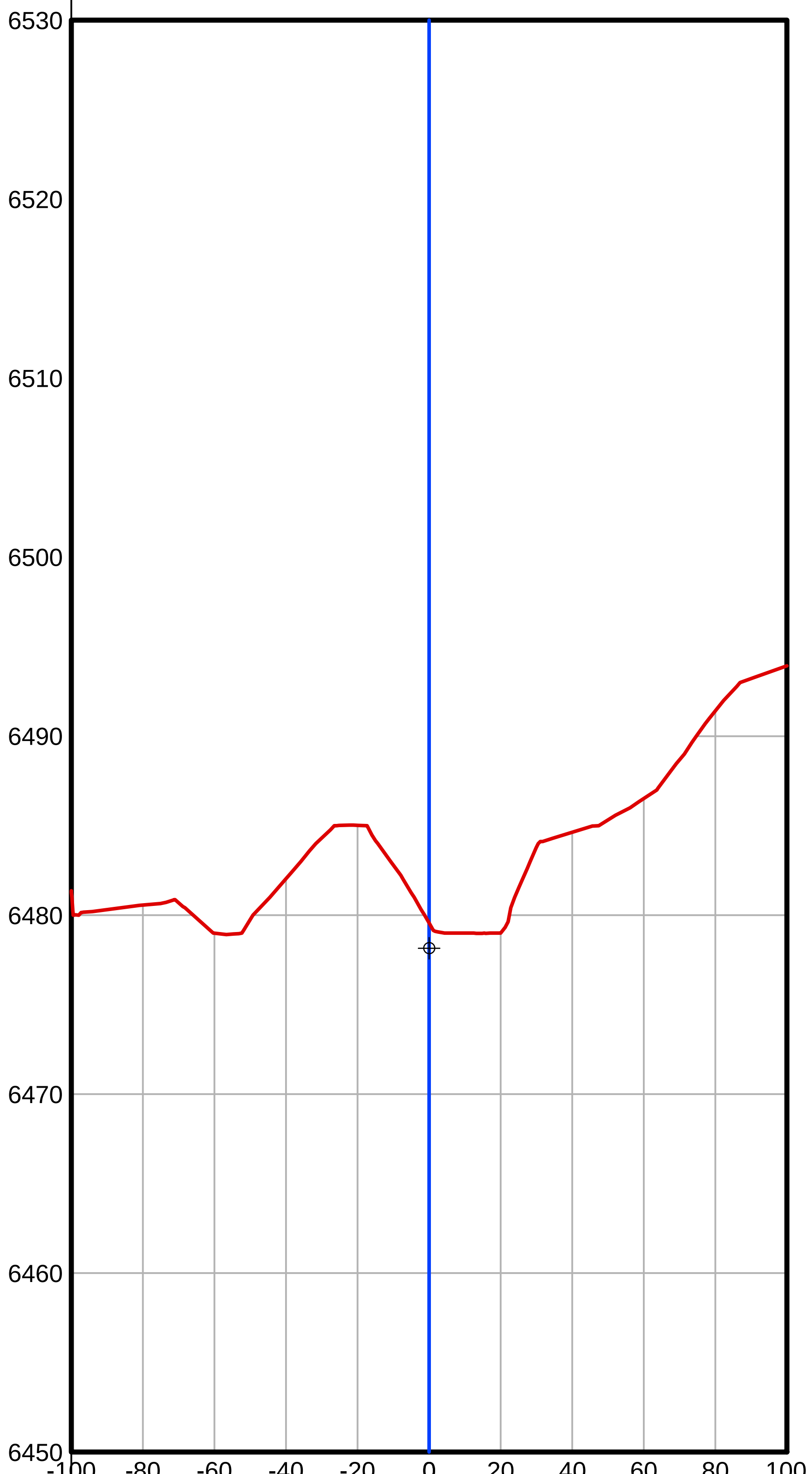
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

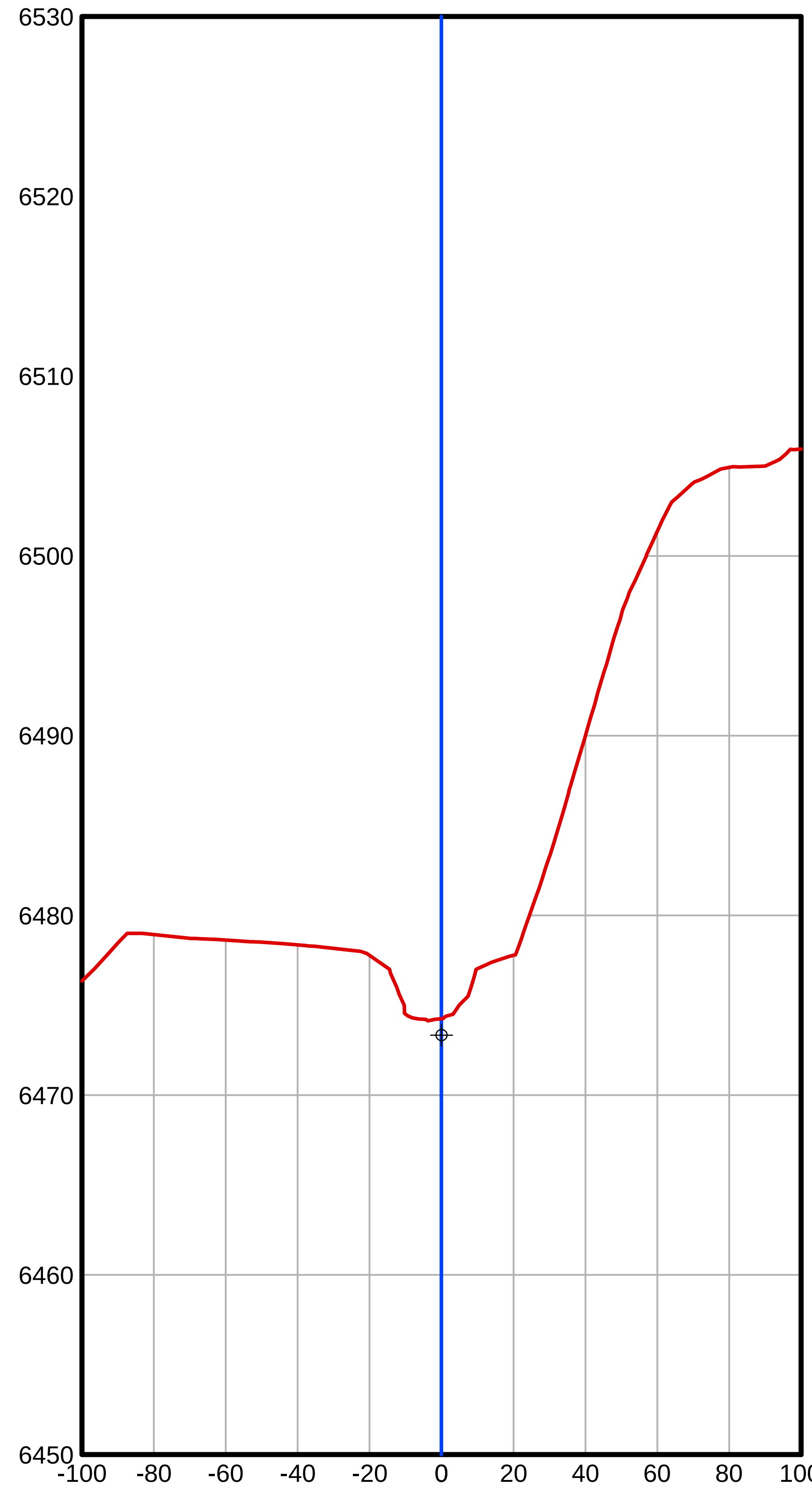
Sheet reference number:
65

UPDATE

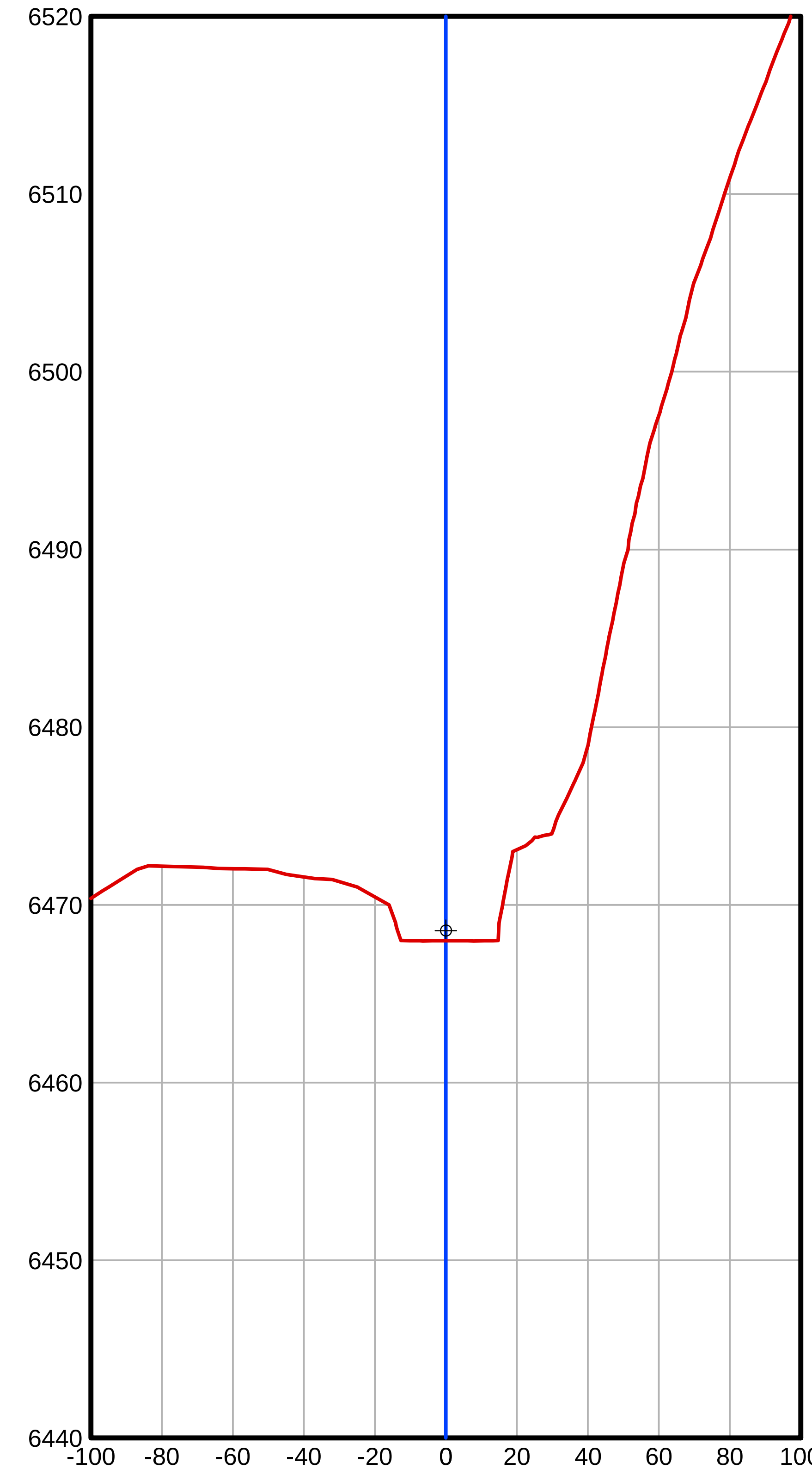
SL-103 (790+00.00)



SL-104 (792+00.00)



SL-105 (794+00.00)



LEGEND — EXISTING — ROAD GRADES — PROPOSED

SCALE: 1" = 50'

0 50'

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Designed by: JEFF CRANE
Date: 2/25/2016
Reviewed by: JPC

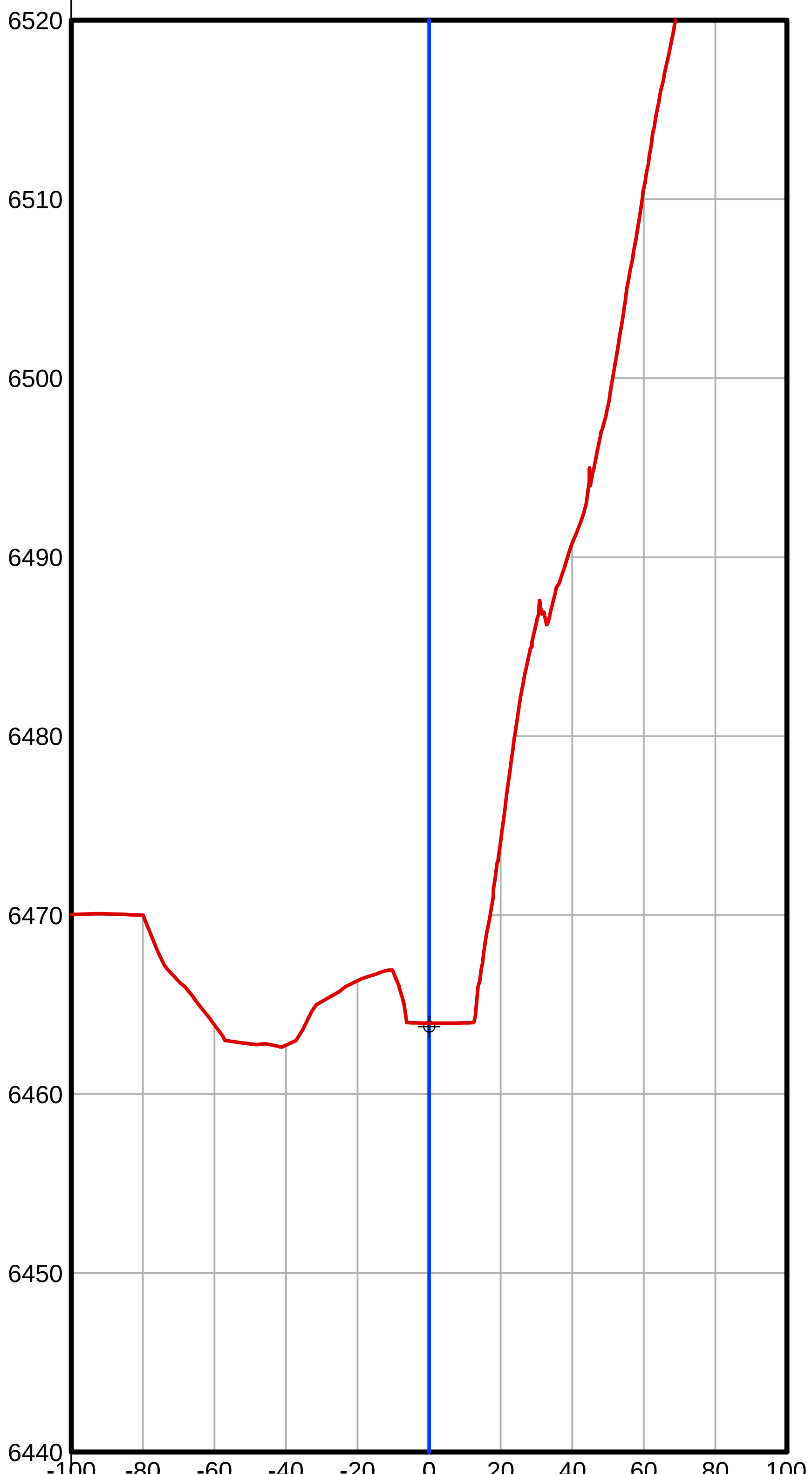
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

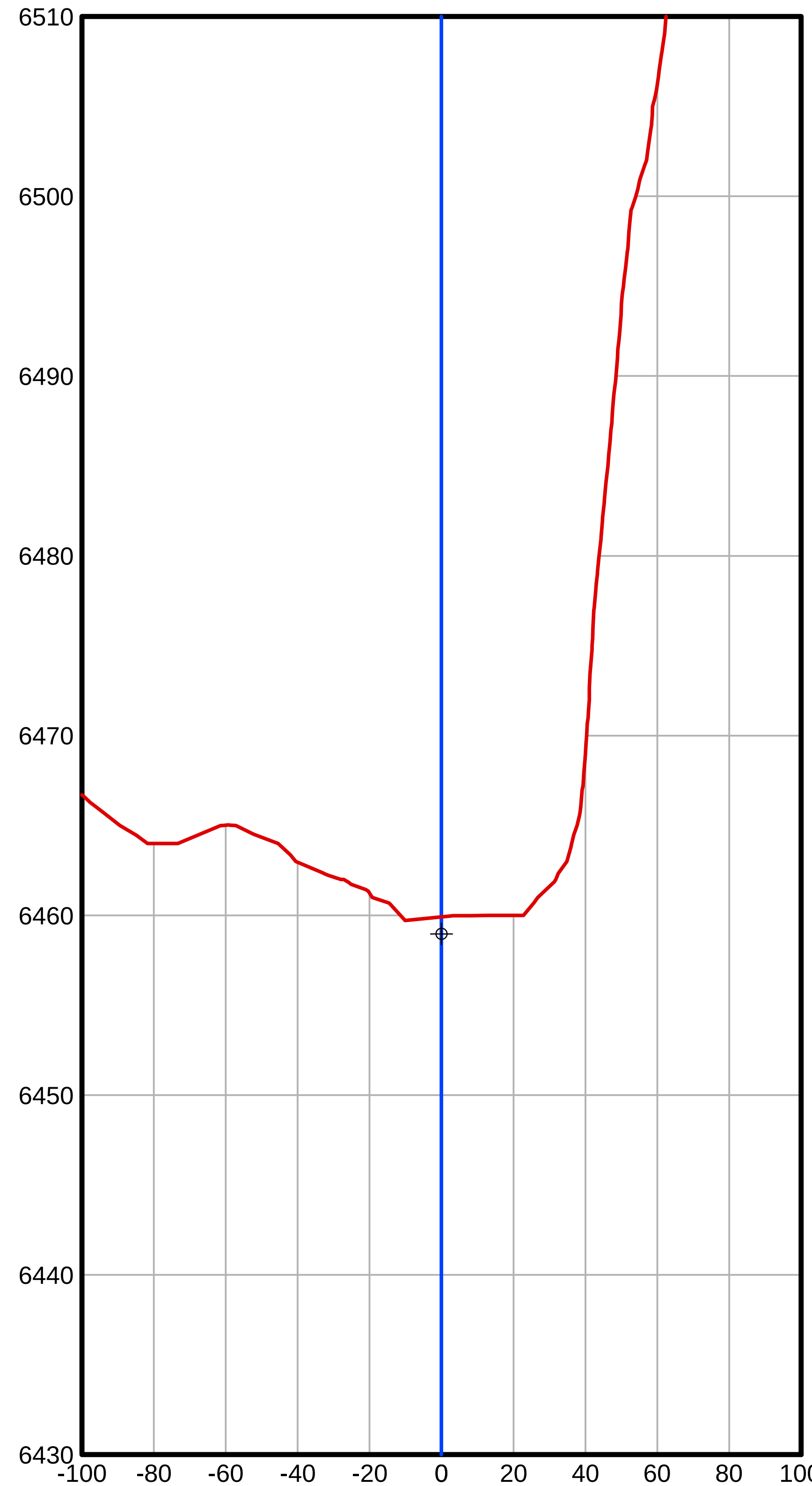
Sheet reference number: 66

UPDATE

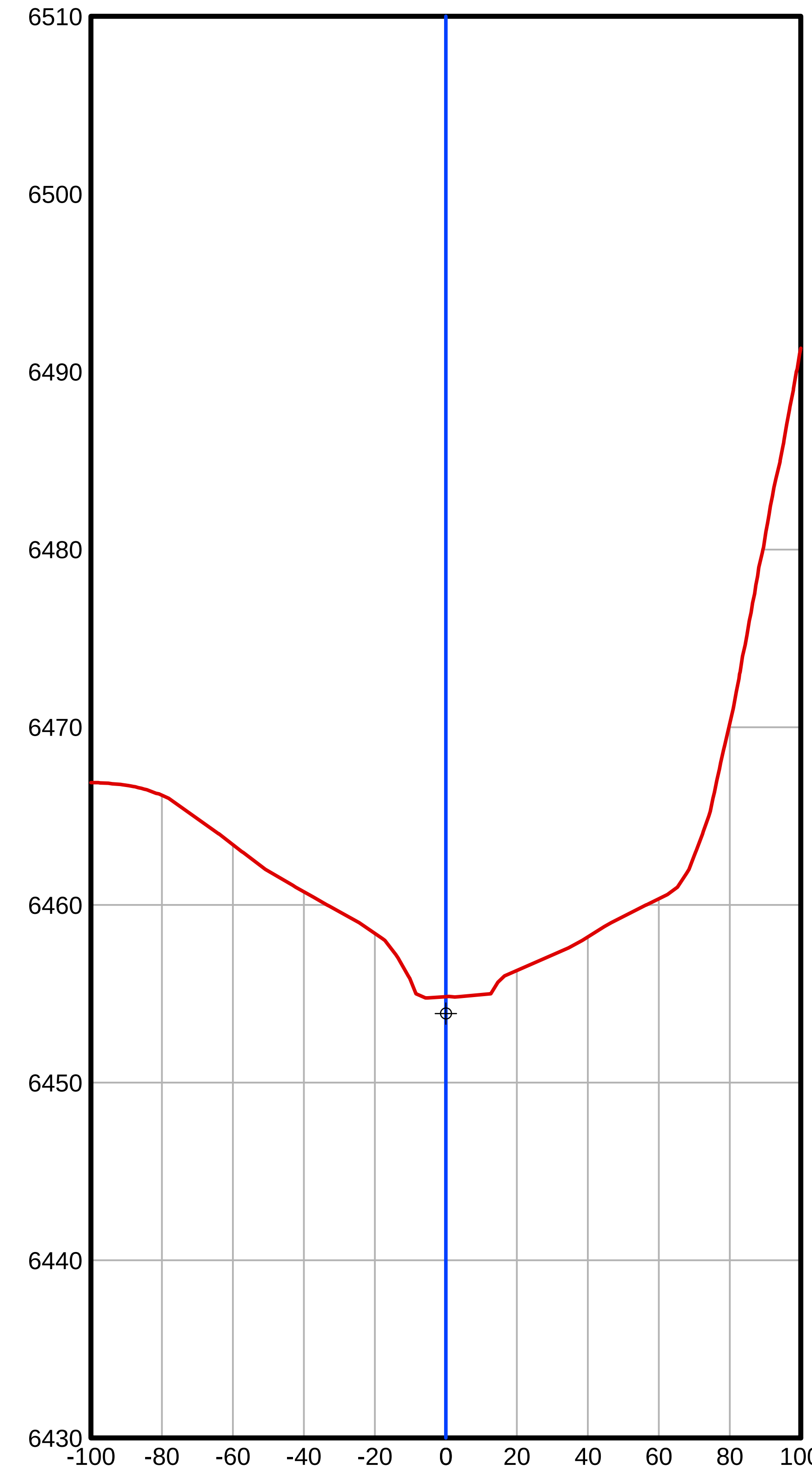
SL-106 (796+00.00)



SL-107 (798+00.00)



SL-108 (800+00.00)



LEGEND — EXISTING — ROAD GRADES — PROPOSED

SCALE: 1" = 50'

0 50'

Designed by: JEFF CRANE | Dwn by: | Ckd by: | Reviewed by: JPC | Submitted by:

Date: 2/25/2016 | Rev. | Design file no: | Drawing Code: | File name: | Plot date: | Plot scale:

Symbol | Description | Date | Approved

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jeff@craneassociates.net

NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

Sheet reference number: 67

UPDATE

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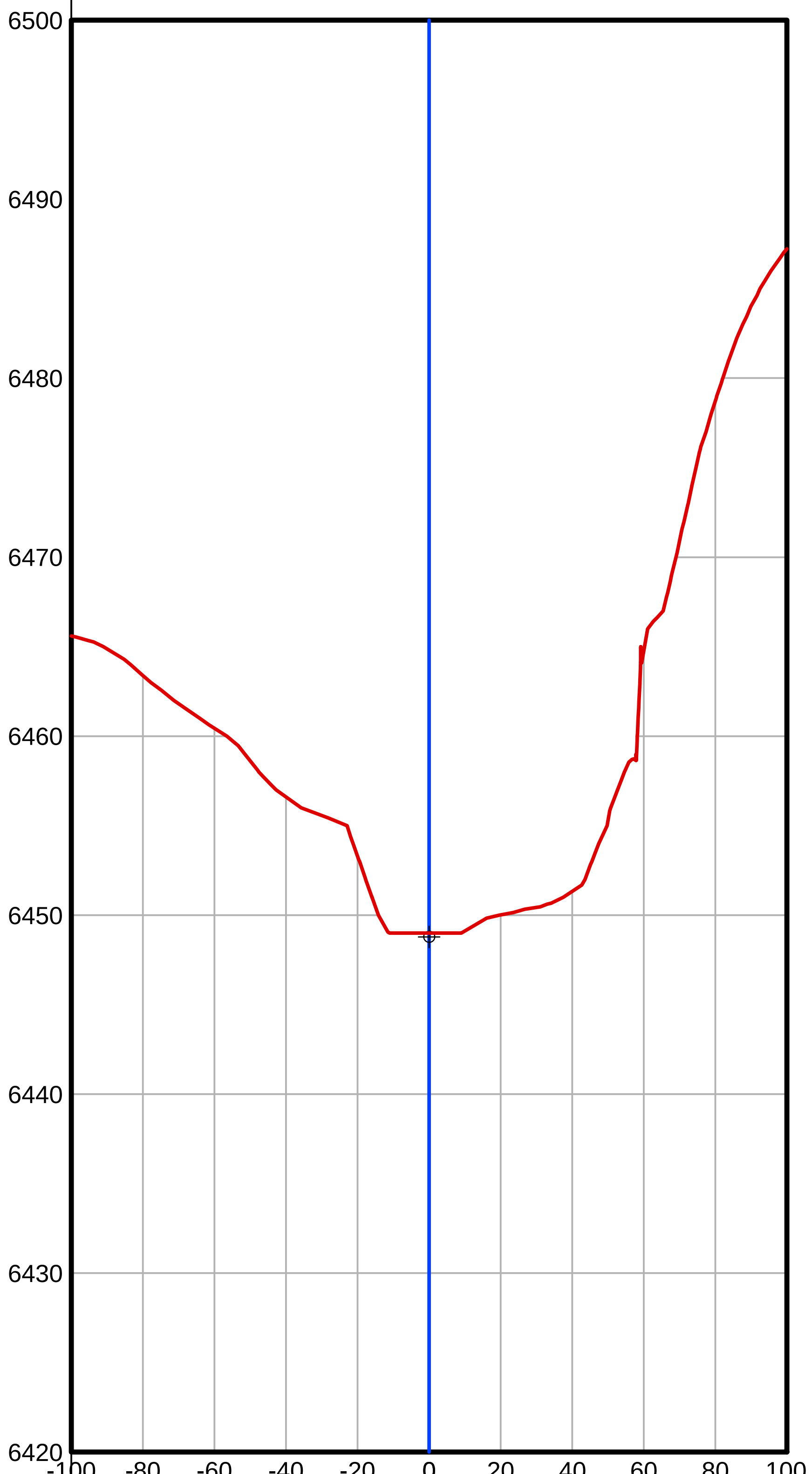

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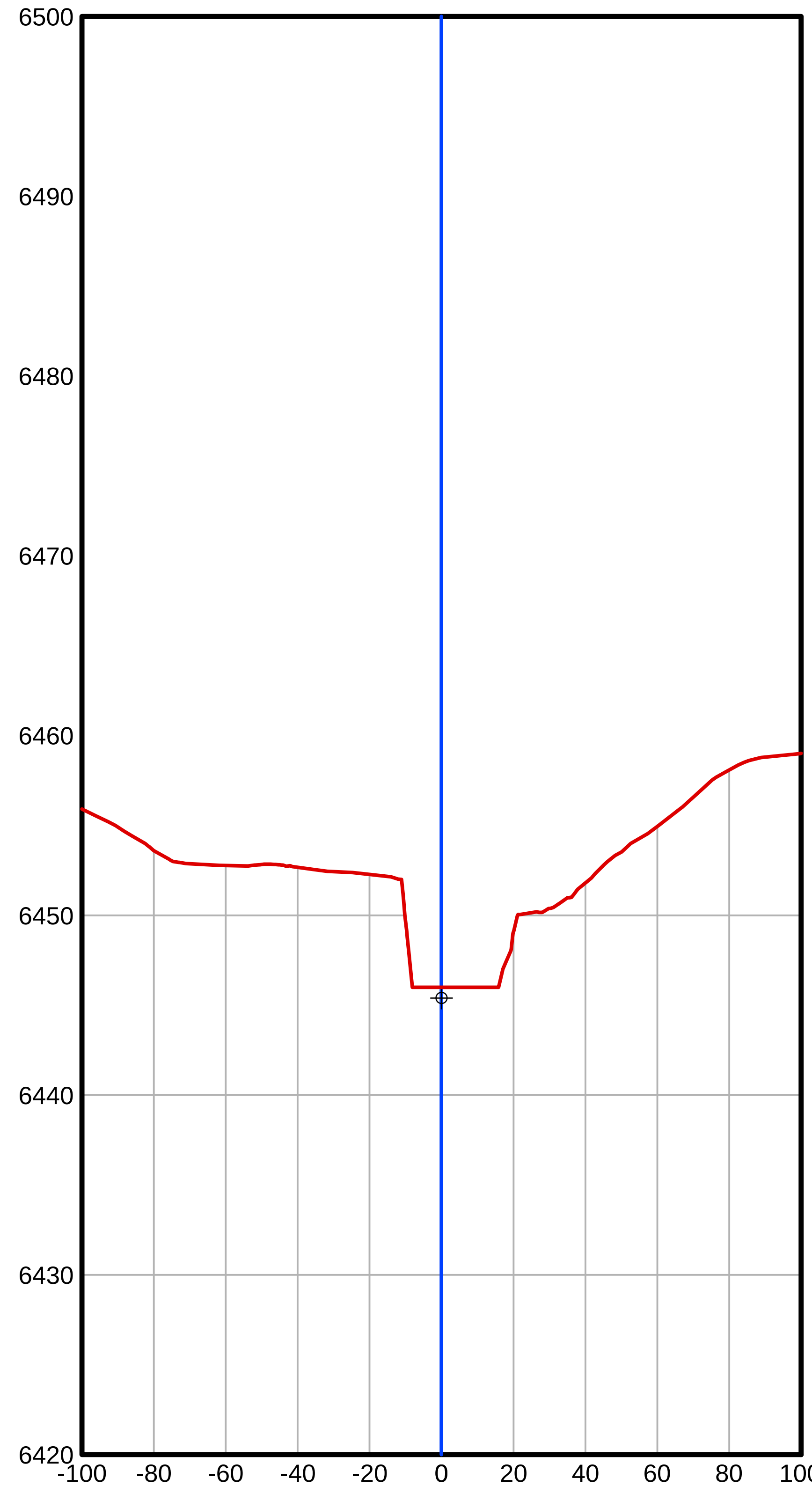

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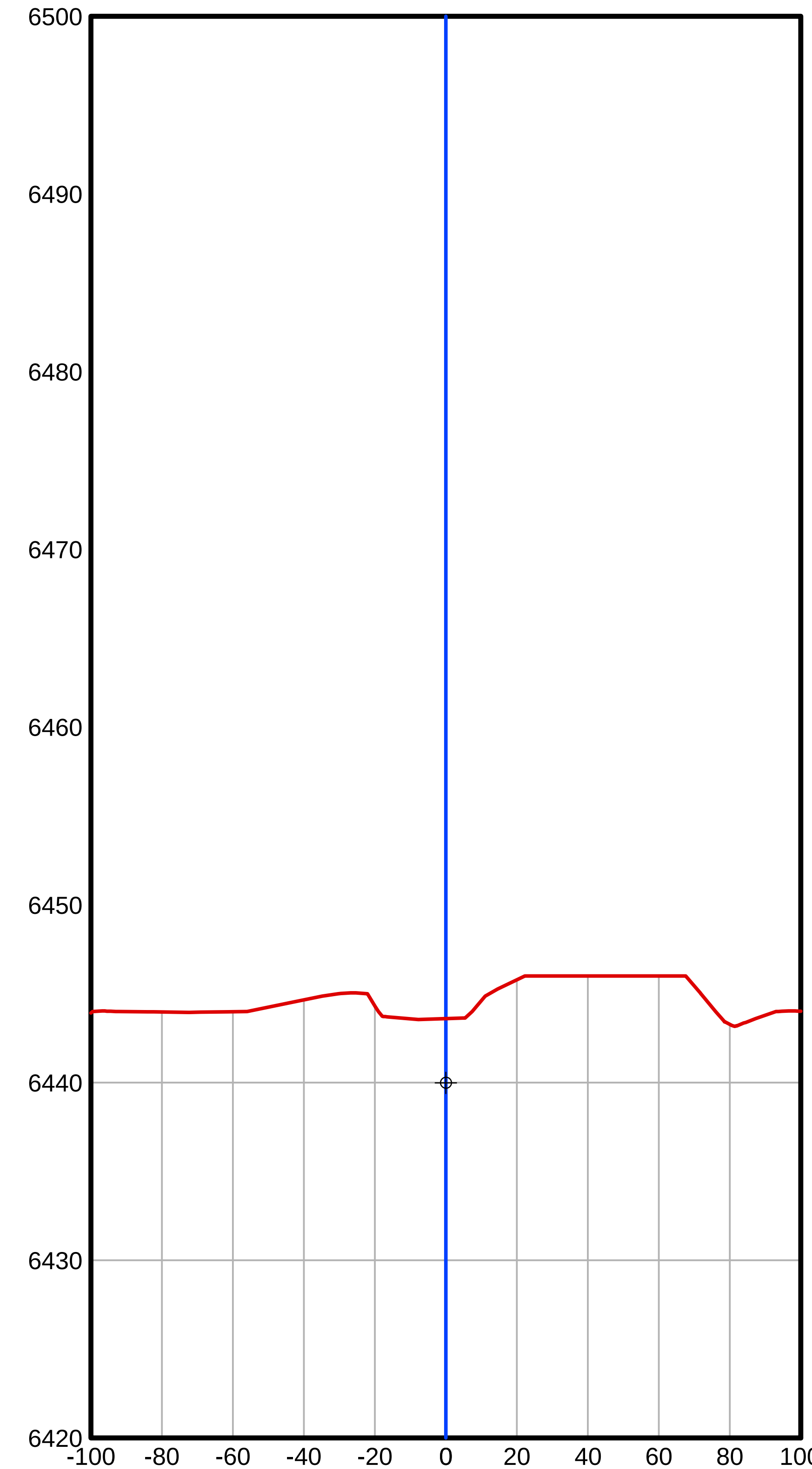

LEGEND — EXISTING — ROAD GRADES — PROPOSED

SCALE: 1" = 50'

0 50'

Symbol | Description | Date | Approved

CRANE ASSOCIATES

Rev.

Date: 2/25/2016

Design file no:

Drawing Code:

File name:

Plot date:

Plot scale:

Designed by: JEFF CRANE

Dwn by:

Ckd by:

Reviewed by: JPC

Submitted by:

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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

Sheet reference number:

68

UPDATE

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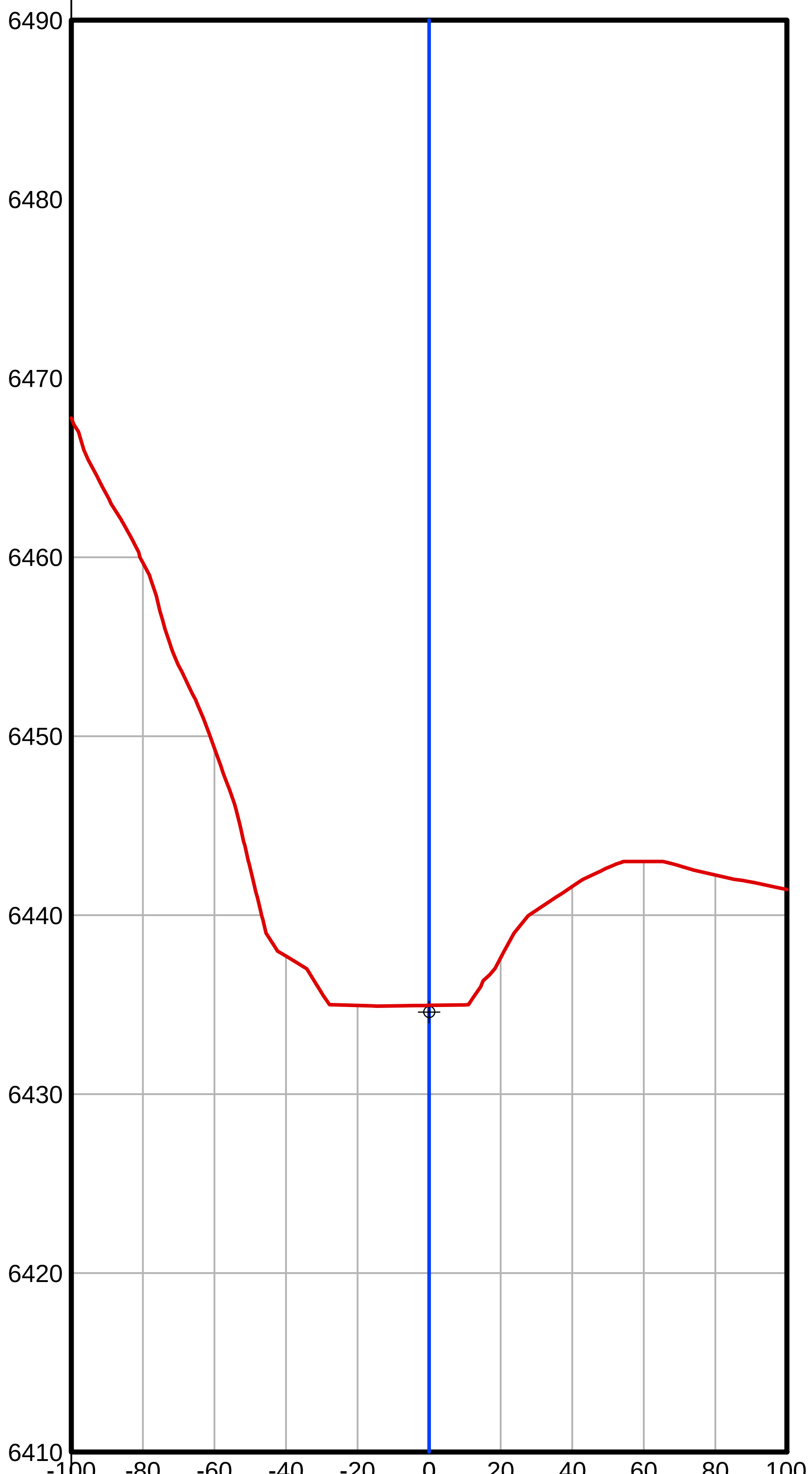

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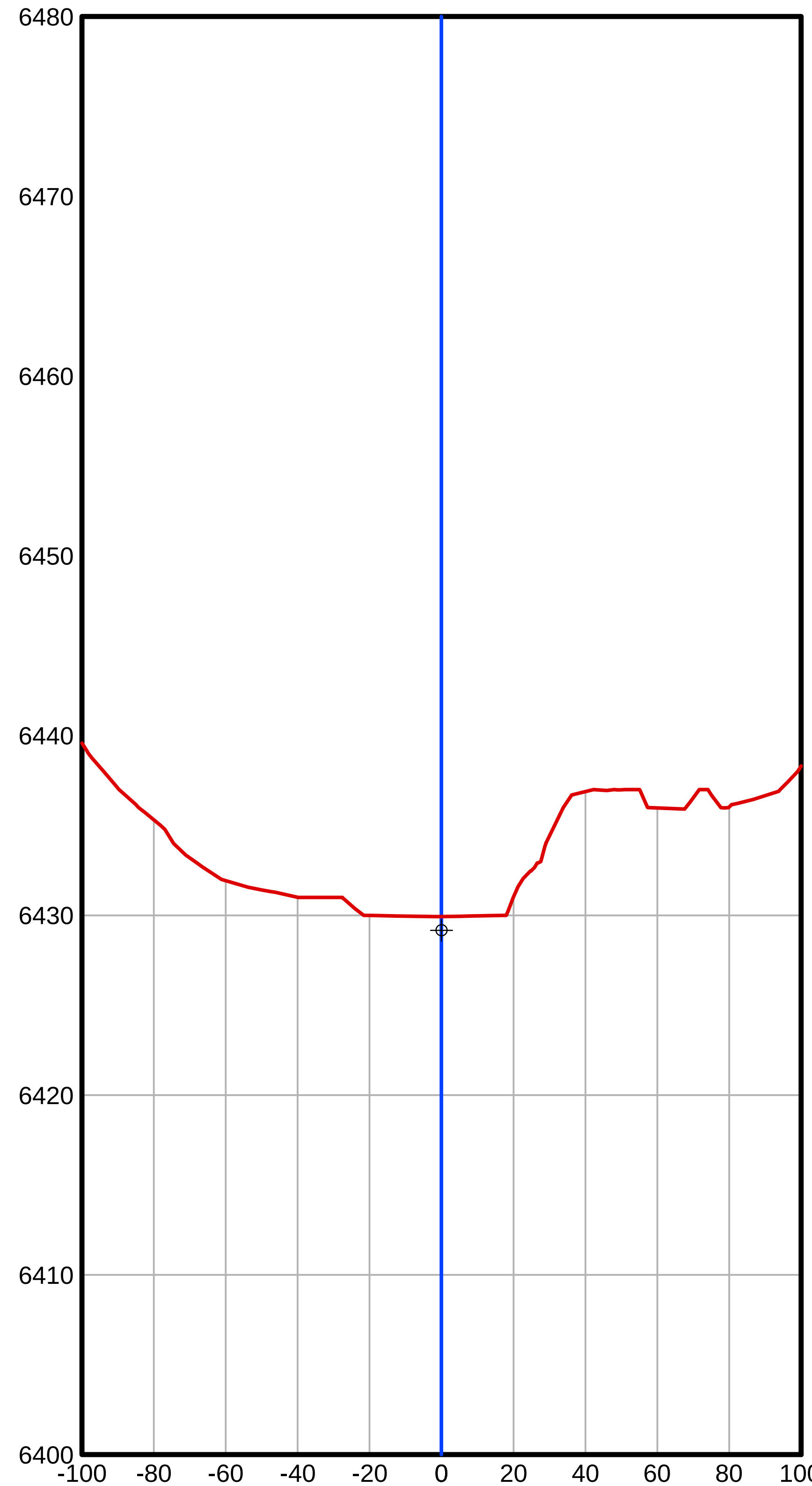

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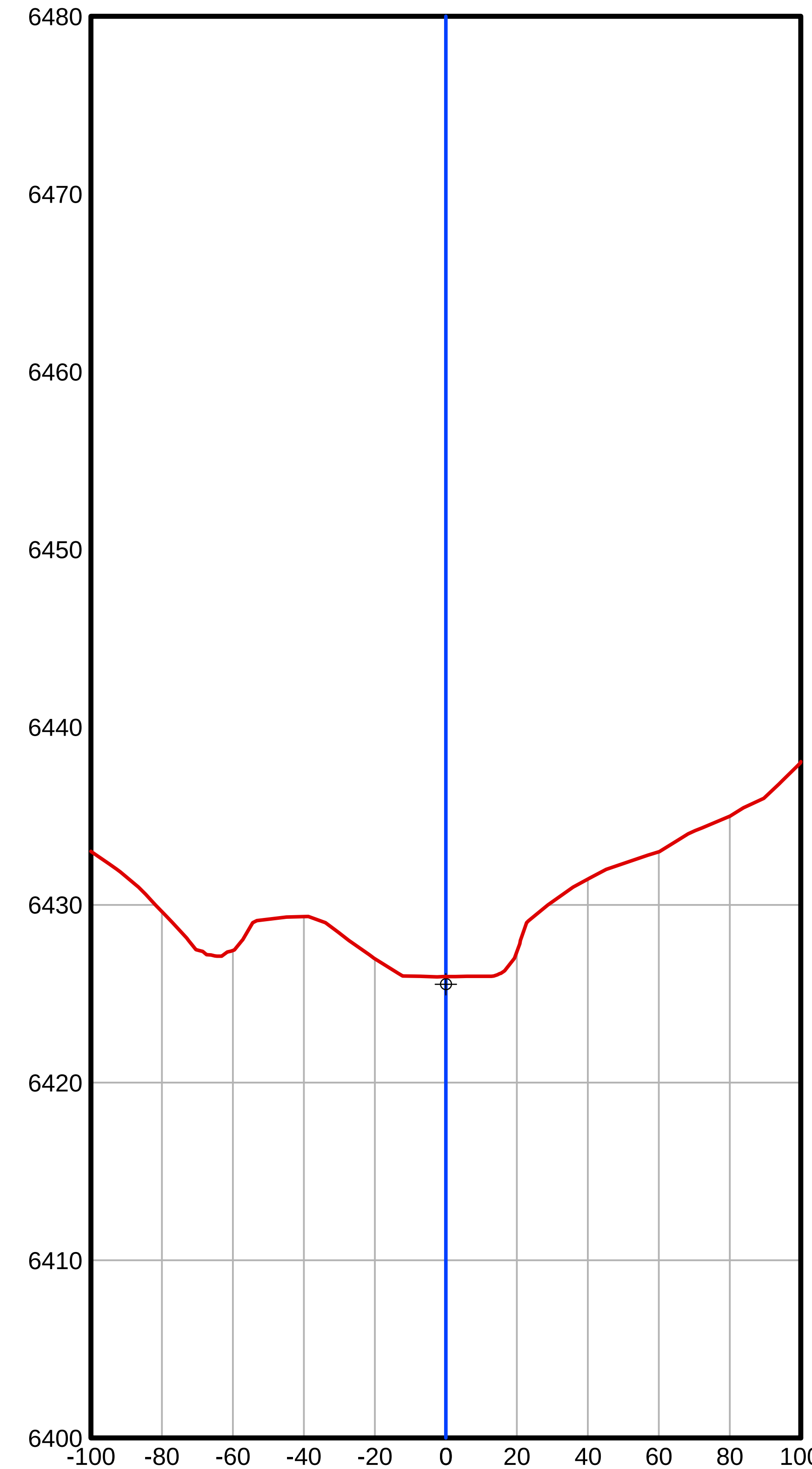

LEGEND — EXISTING — ROAD GRADES — PROPOSED

SCALE: 1" = 50'

0 50'

Symbol | Description | Date | Approved

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Designed by: JEFF CRANE
Dwn by:
Ckd by:
Reviewed by: JPC
Submitted by:
Date: 2/25/2016
Design file no:
Drawing Code:
File name:
Plot date:
Plot scale:
Rev.

NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

Sheet reference number:
69

UPDATE

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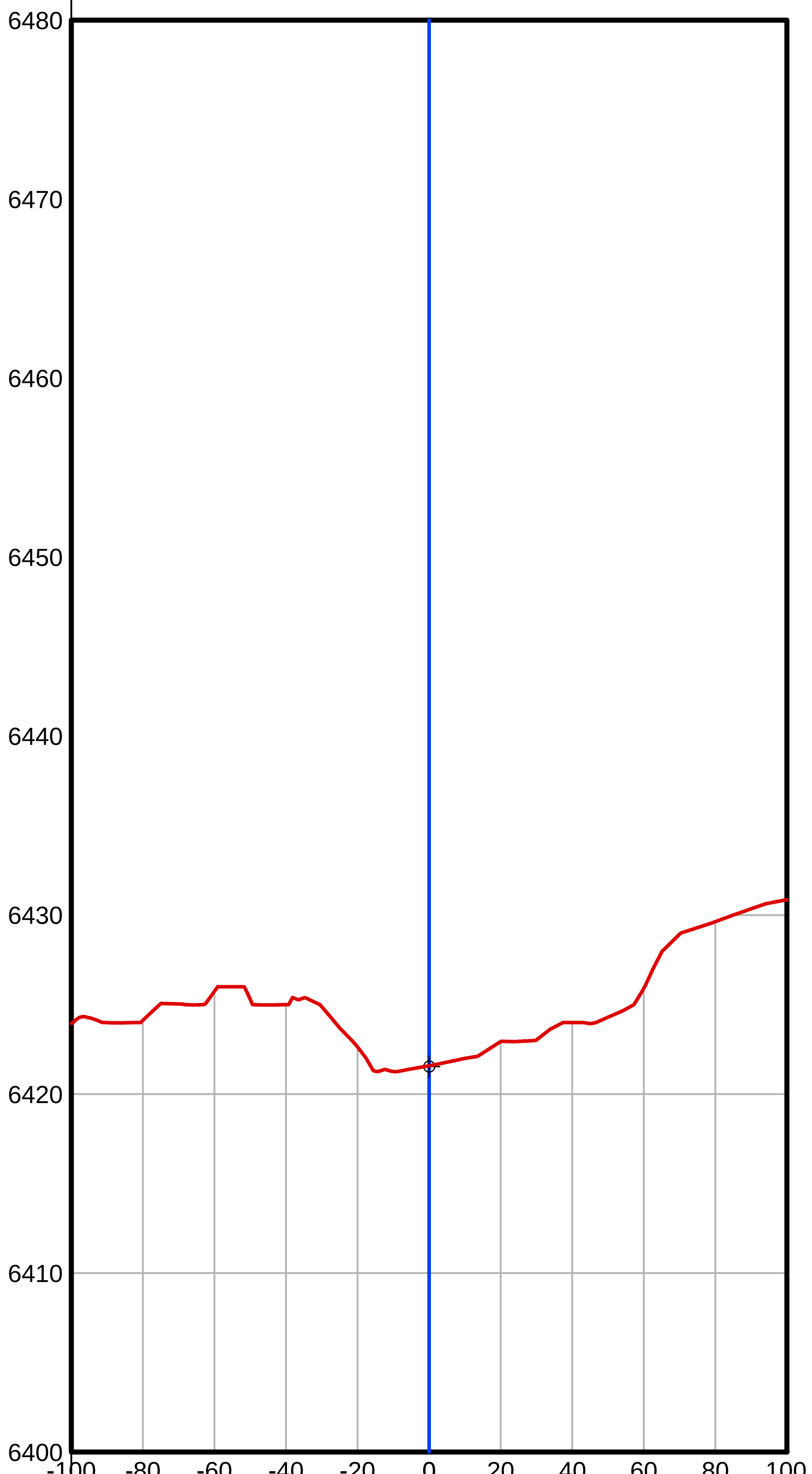

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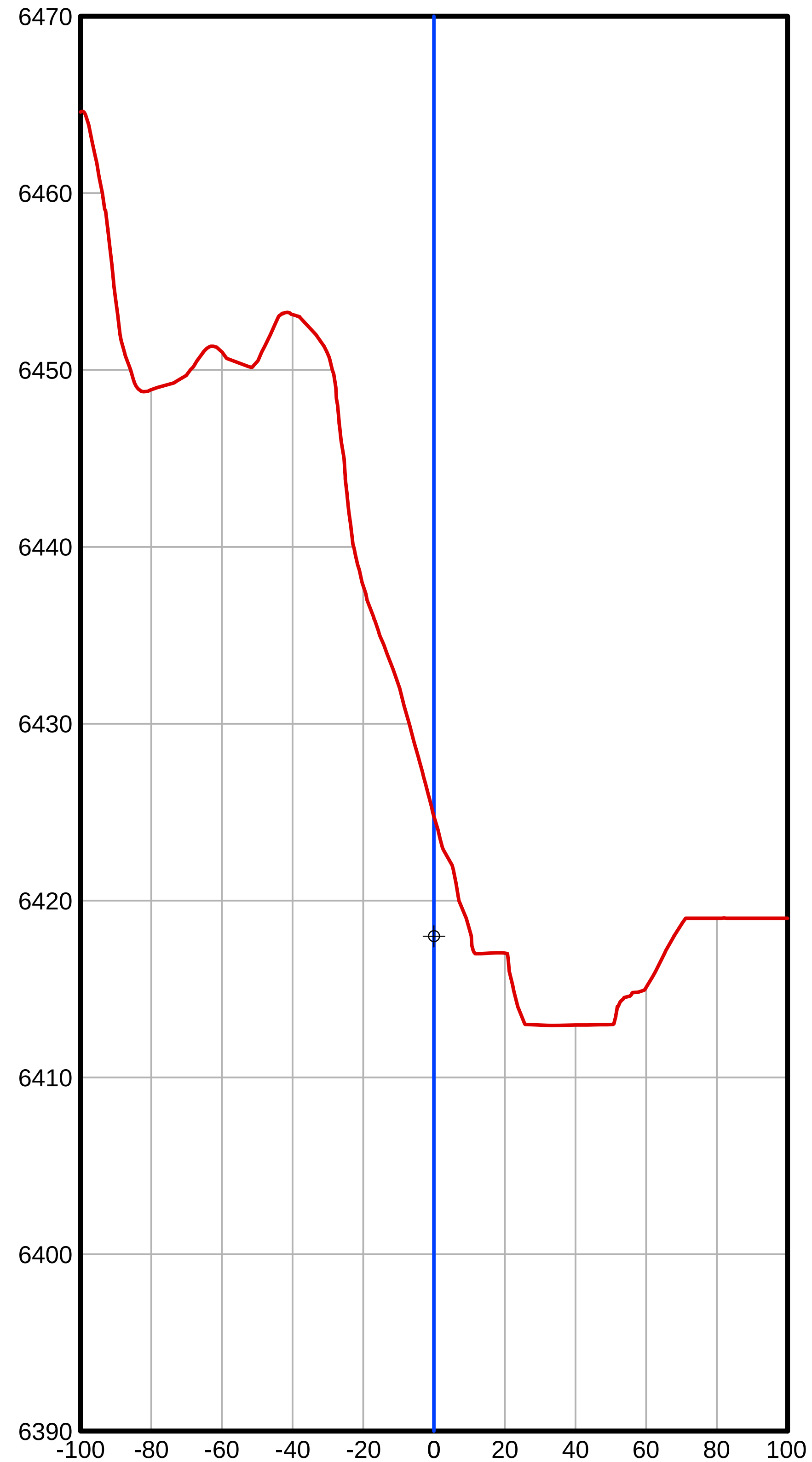

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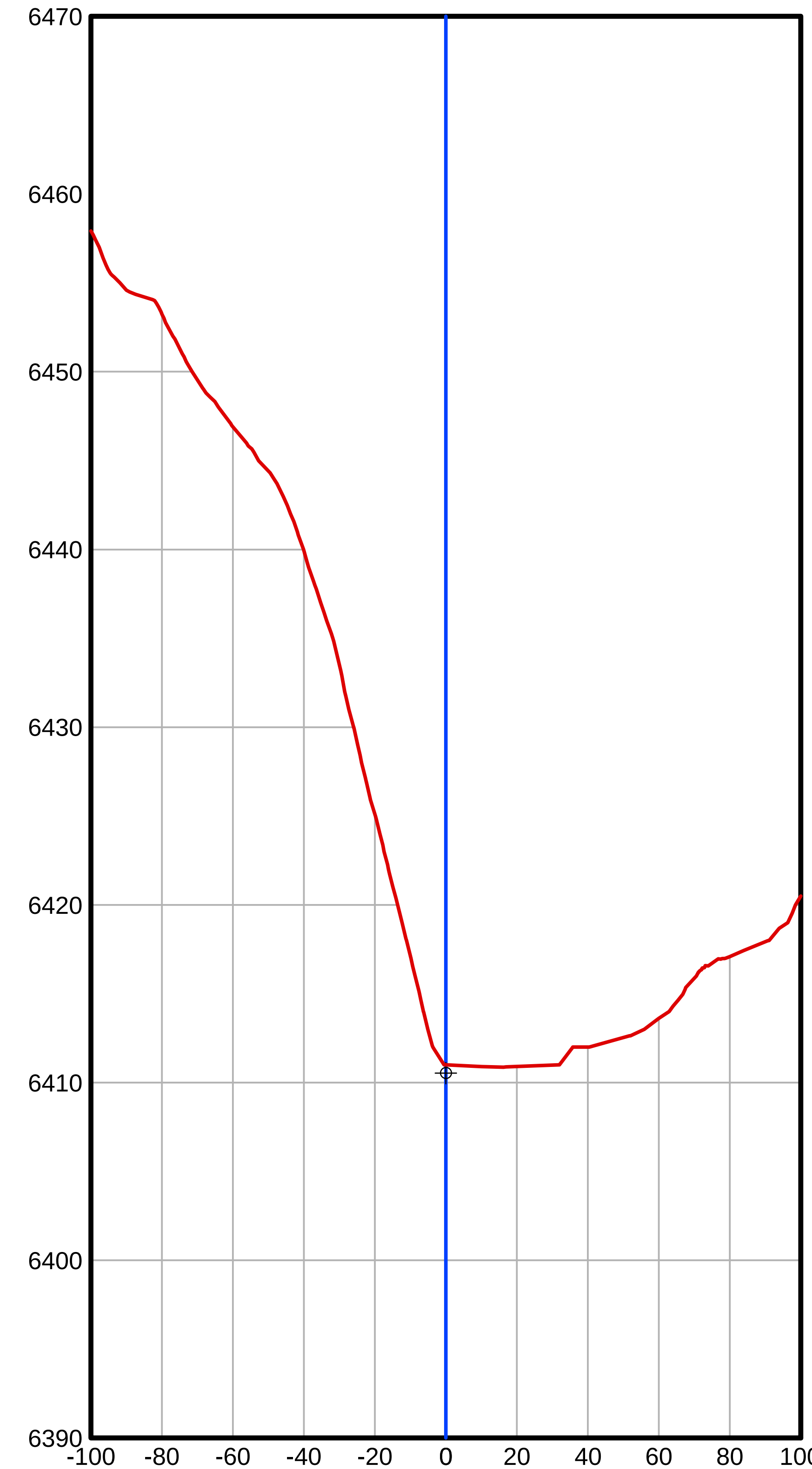

LEGEND — EXISTING — ROAD GRADES — PROPOSED

SCALE: 1" = 50'

0 50'

Symbol | Description | Date | Approved

CRANE ASSOCIATES

Rev.

Date: 2/25/2016

Design file no:

Drawing Code:

File name:
Plot date:
Plot scale:

Designed by: JEFF CRANE

Dwn by:

Ckd by:

Reviewed by: JPC

Submitted by:

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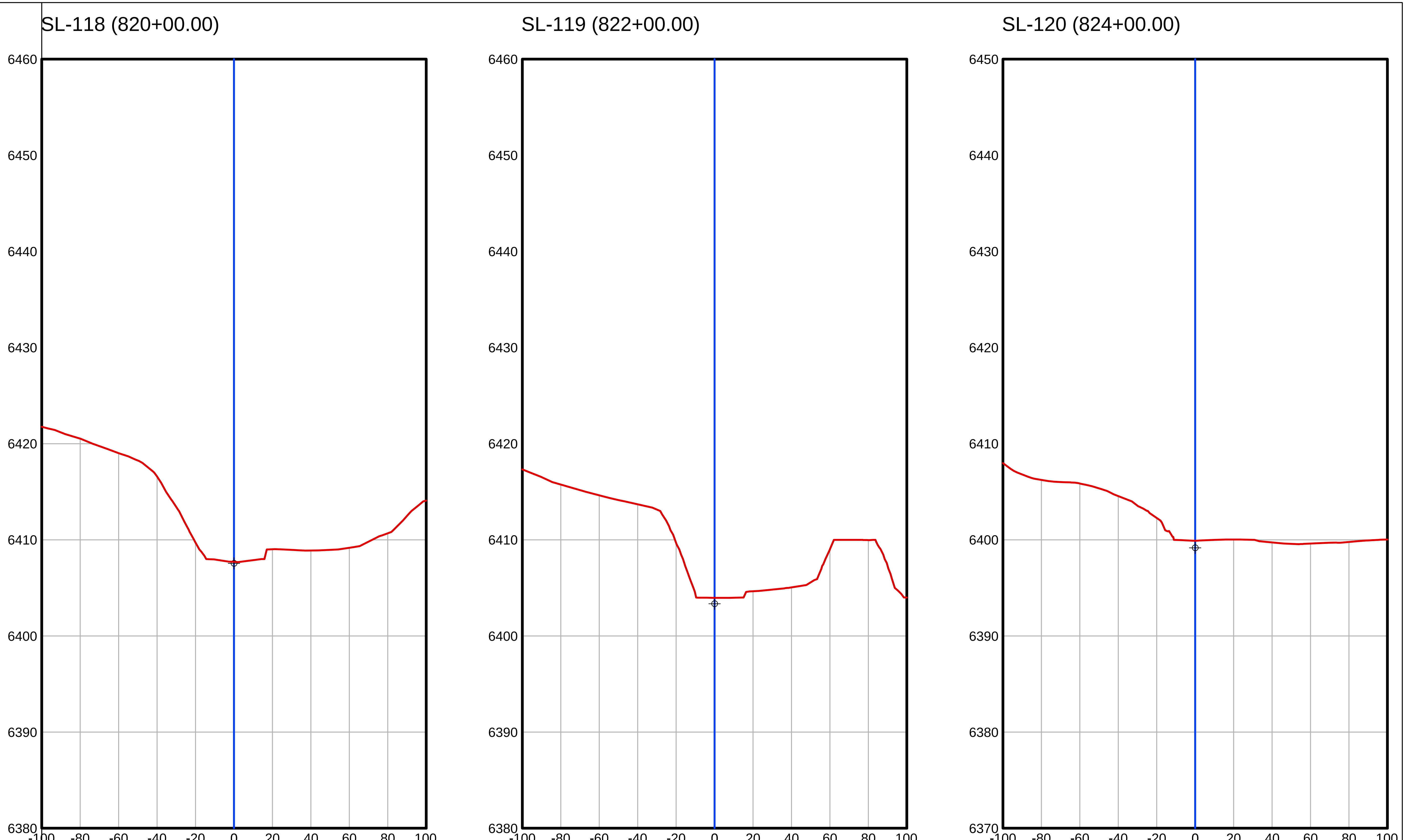
NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

Sheet reference number: 70

UPDATE



LEGEND — EXISTING — ROAD GRADES — PROPOSED

SCALE: 1" = 50'

0 50'

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Designed by: JEFF CRANE
Reviewed by: JPC
Date: 2/25/2016

NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

Sheet reference number:
71

UPDATE

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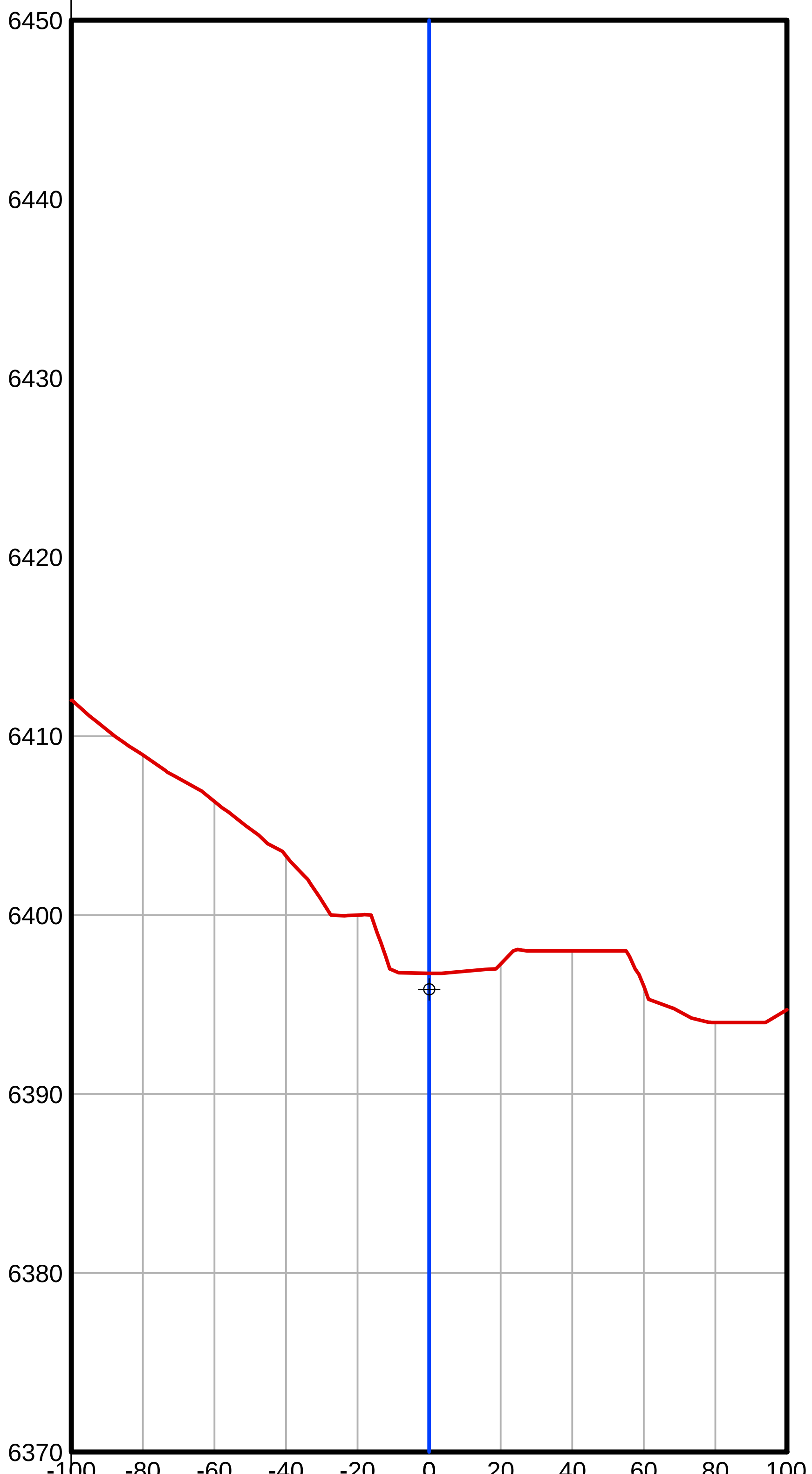

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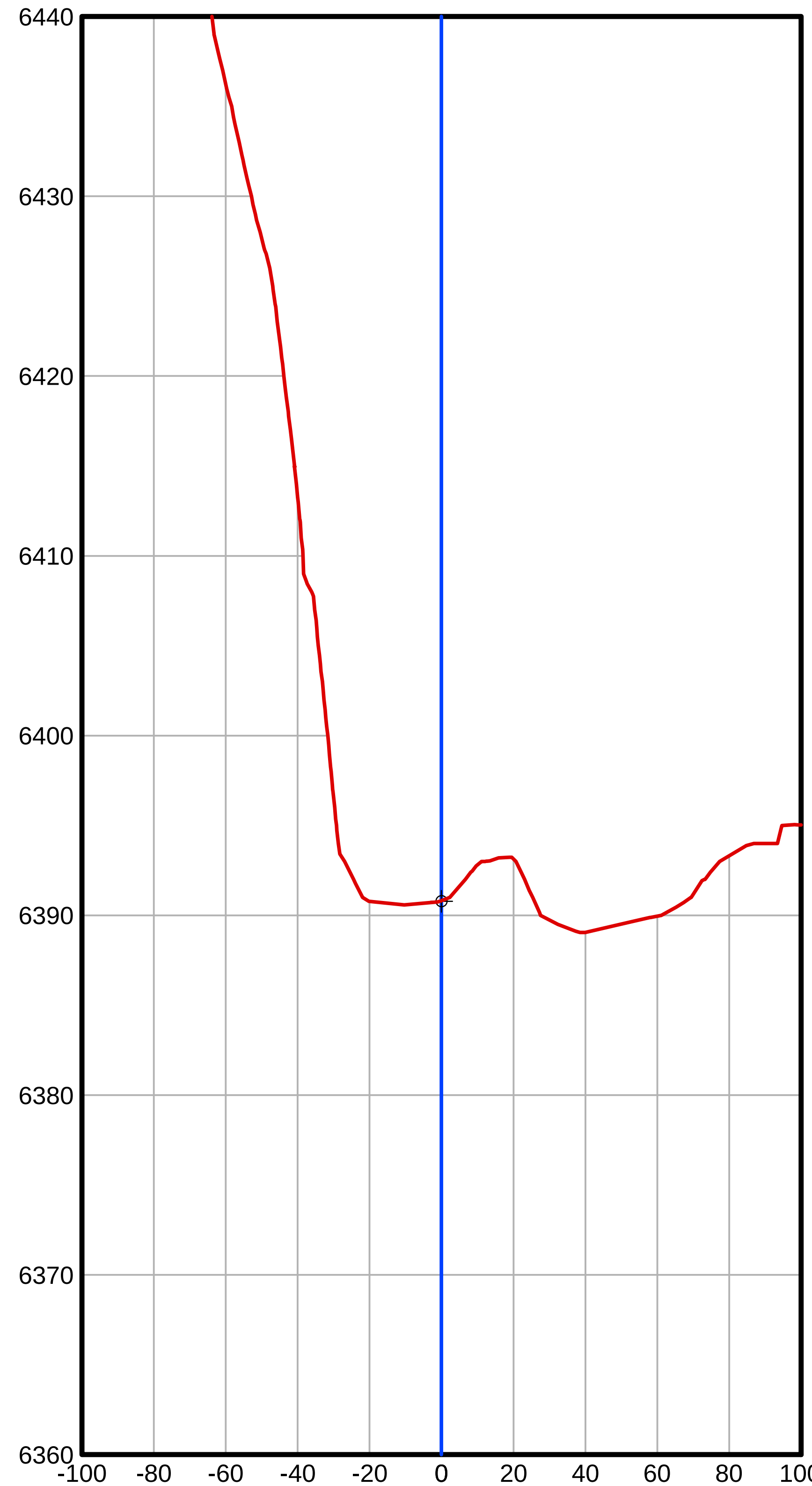

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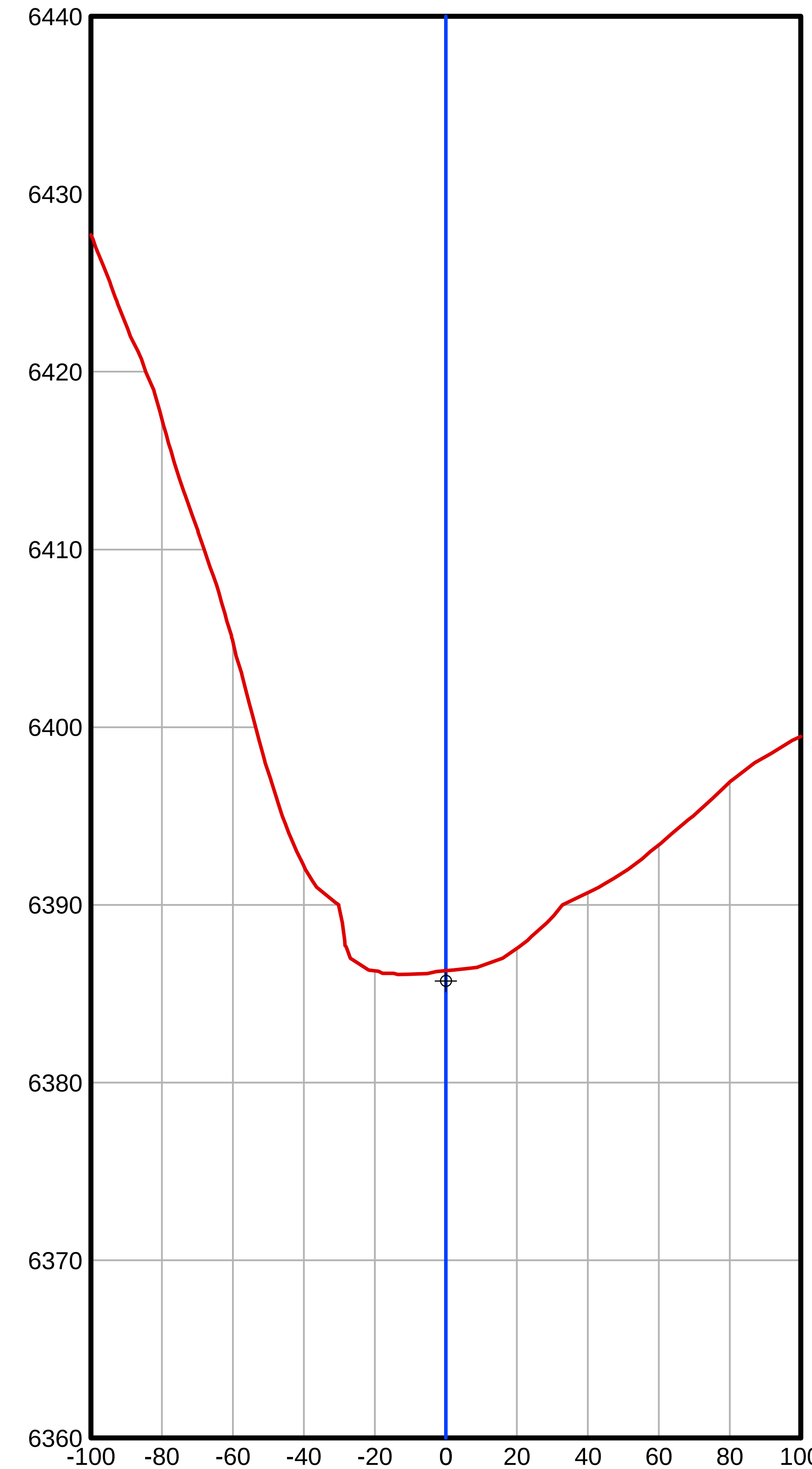

LEGEND EXISTING ROAD GRADES PROPOSED

SCALE: 1" = 50'

0 50'

Symbol Description Date Approved

Date: 2/25/2016

Designed by: JEFF CRANE

Reviewed by: JPC

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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

Sheet reference number: 72

UPDATE

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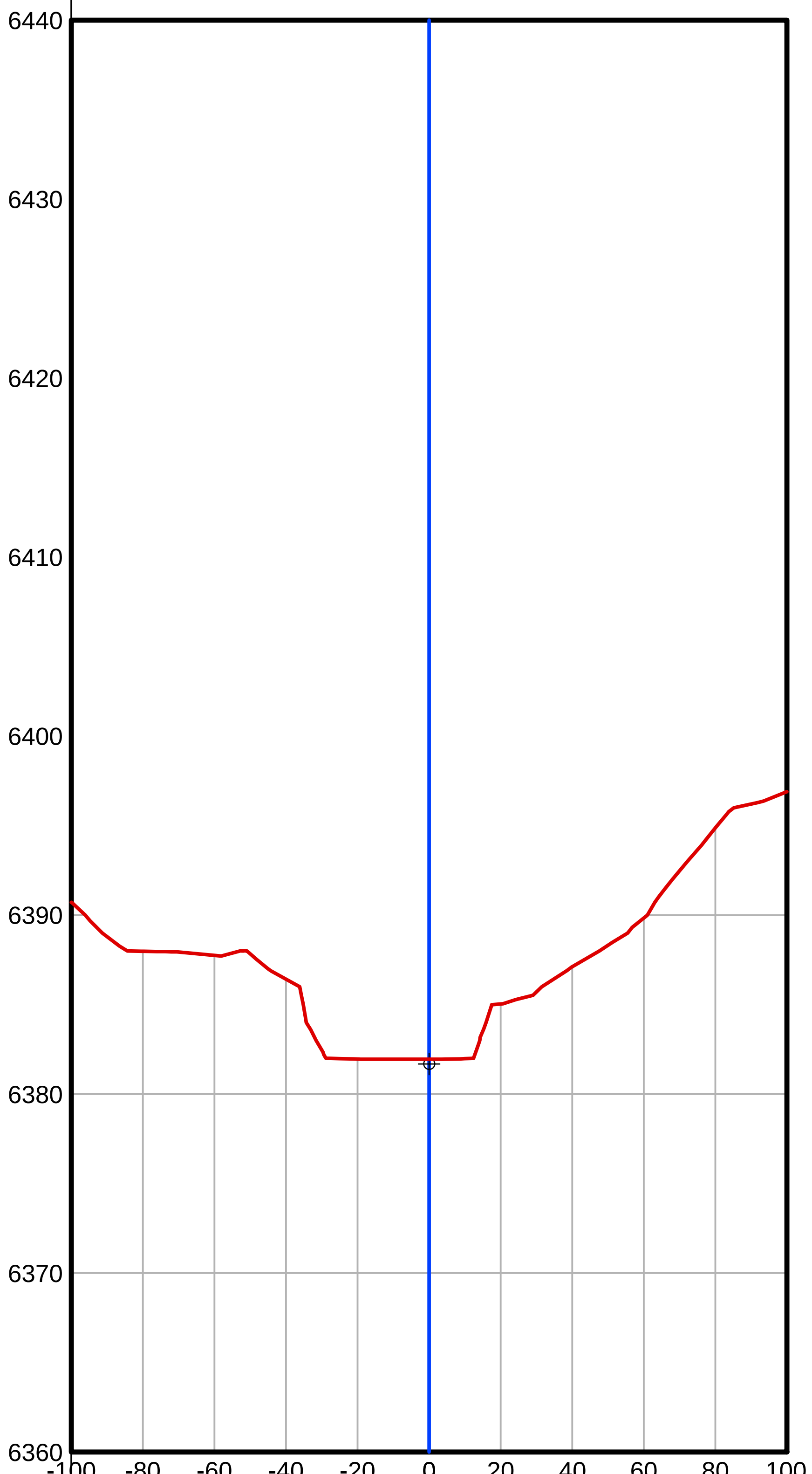

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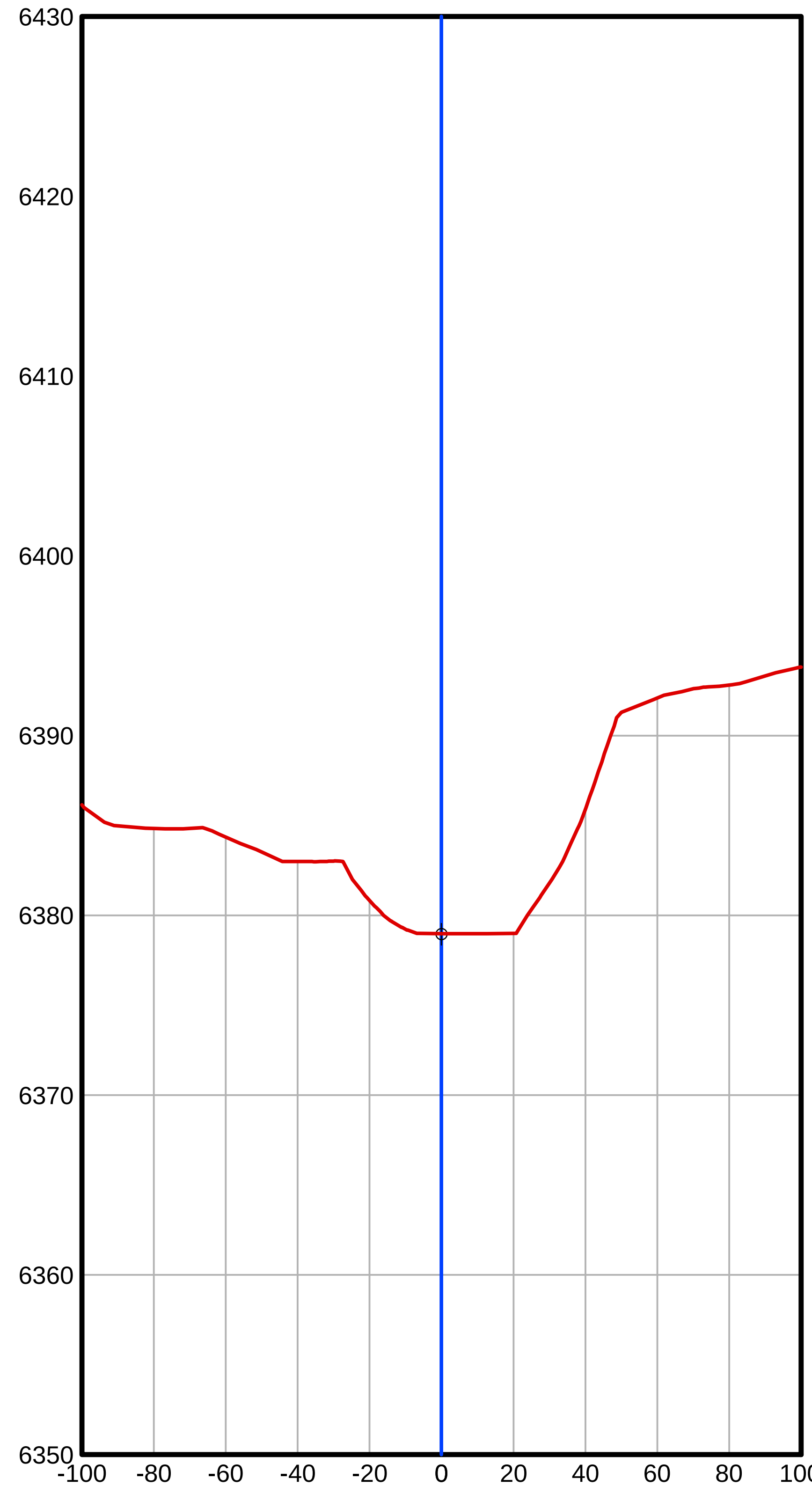

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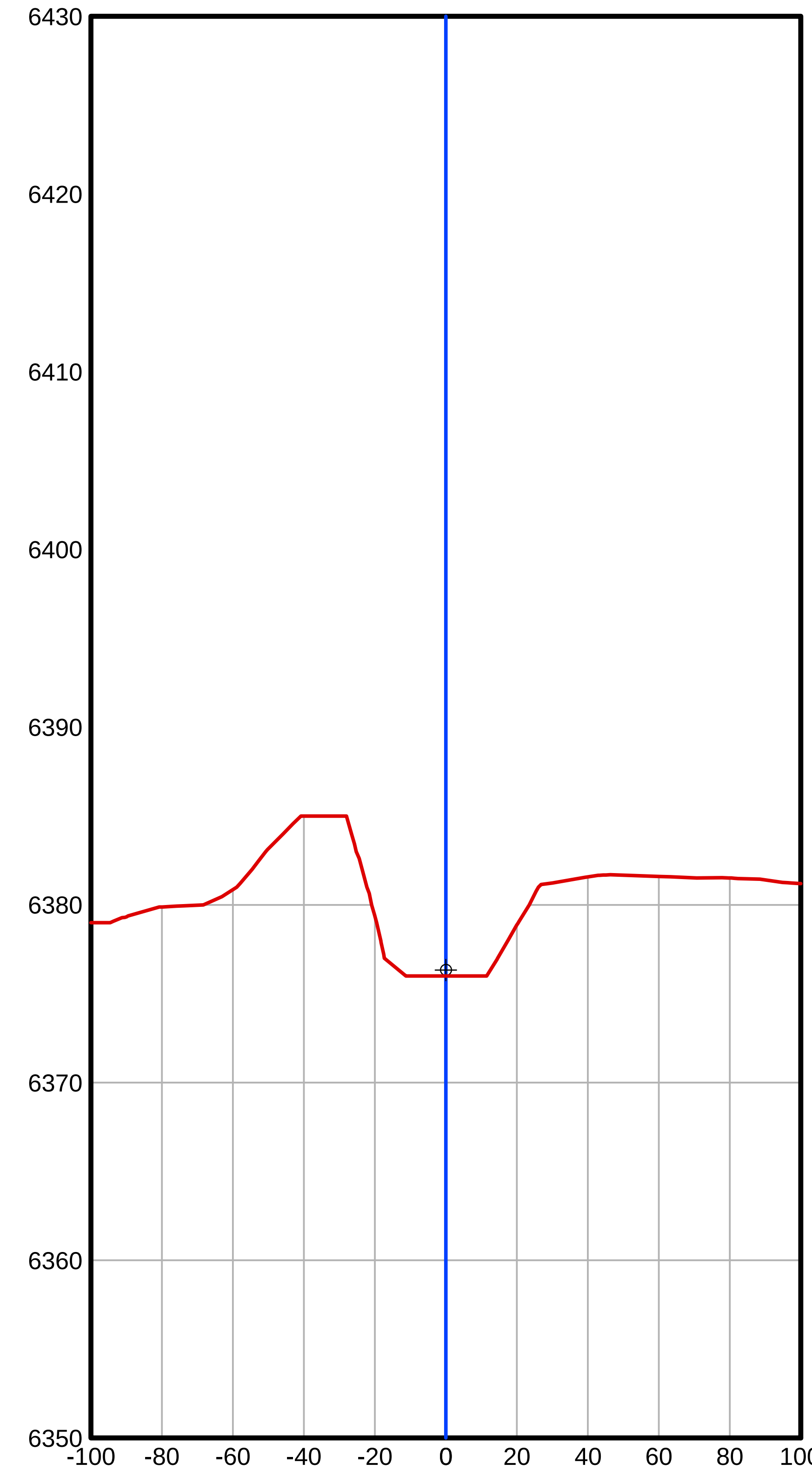

LEGEND EXISTING ROAD GRADES PROPOSED

SCALE: 1" = 50'

0 50'

Date: 2/25/2016

Designed by: JEFF CRANE

Reviewed by: JPC

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NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO

CROSS SECTIONS

Sheet reference number: 73

UPDATE

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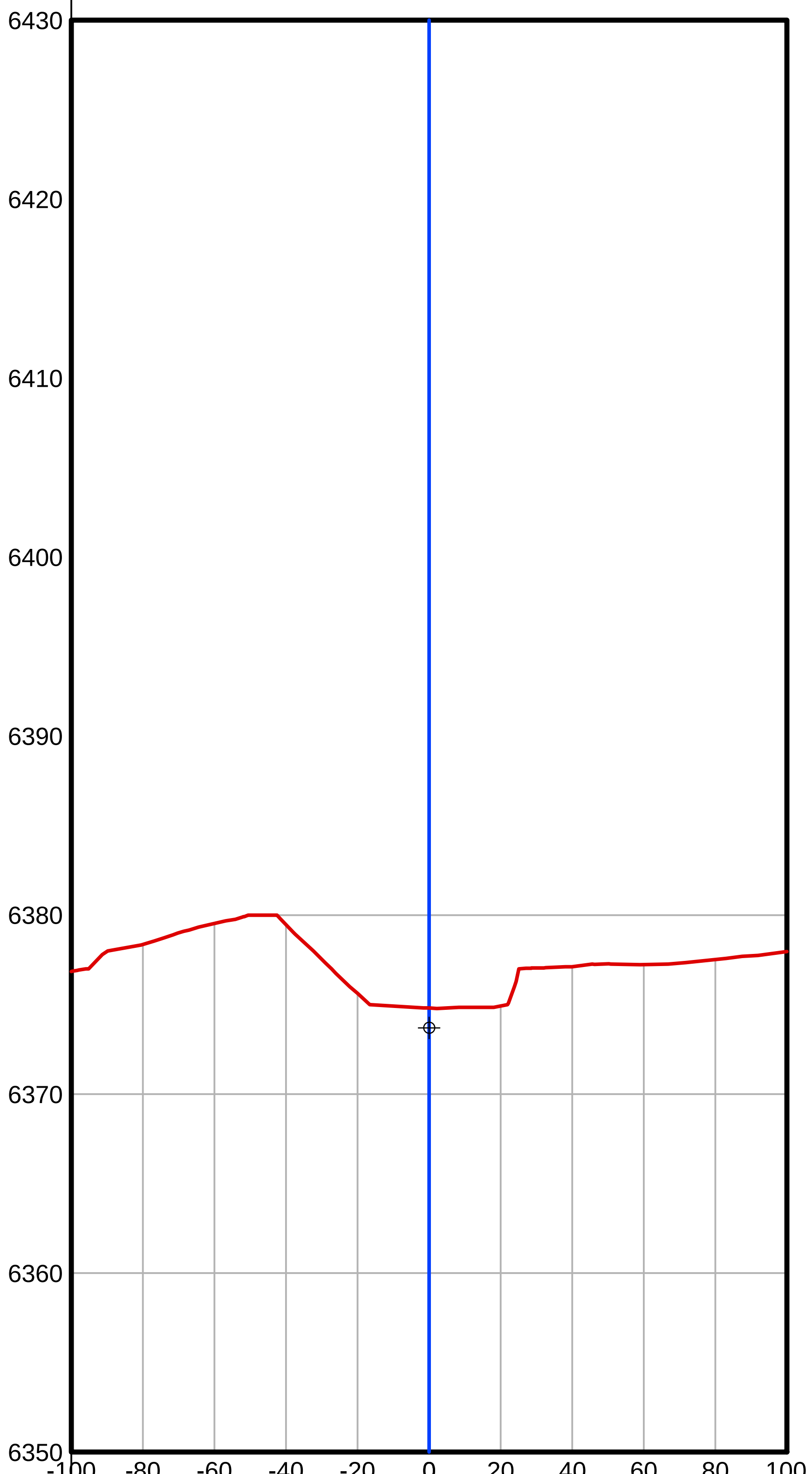

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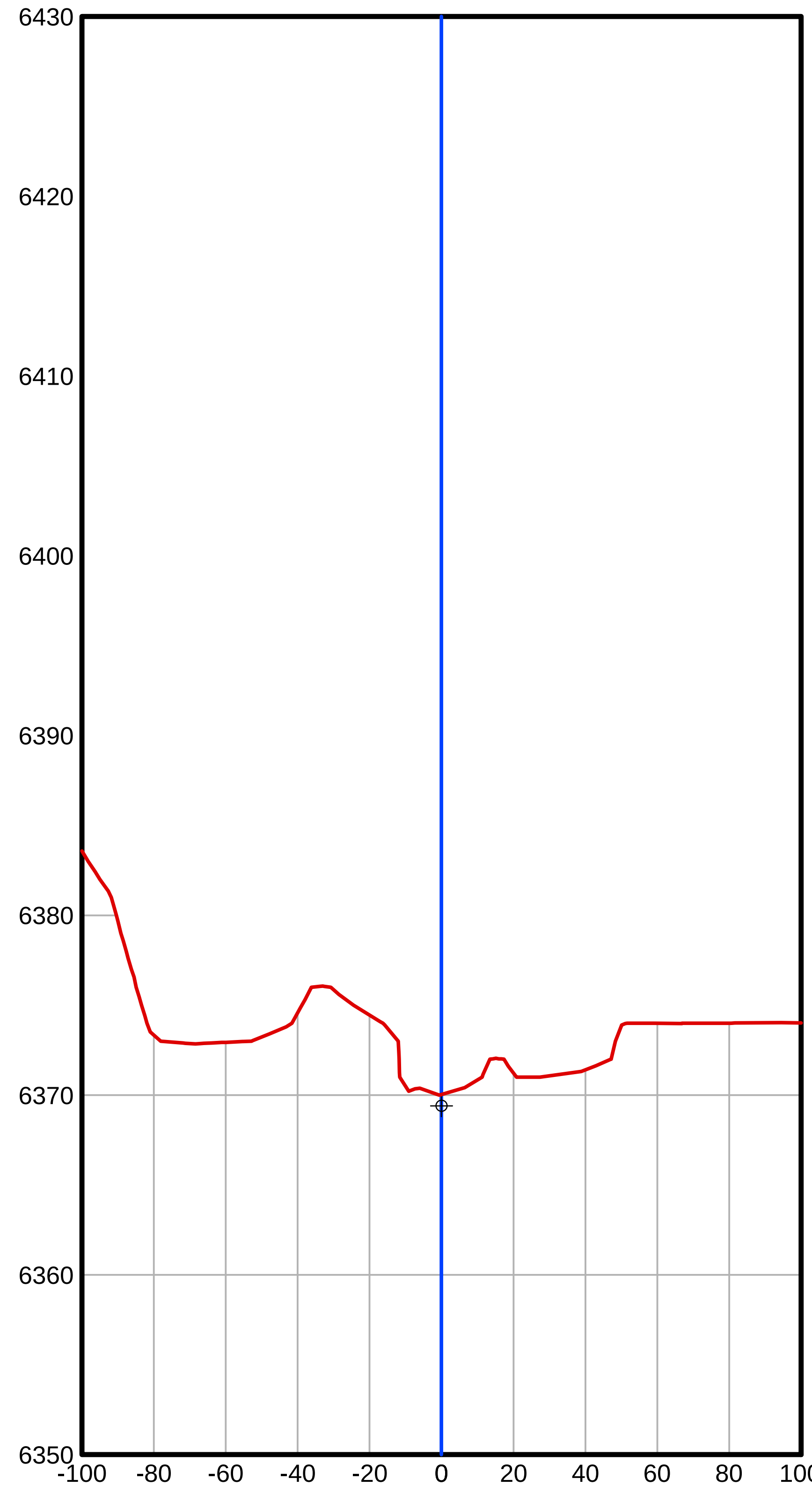

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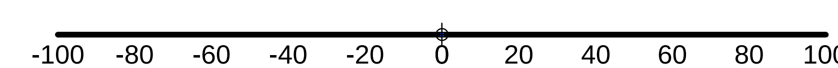

LEGEND EXISTING ROAD GRADES PROPOSED

SCALE: 1" = 50'

0 50'

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Designed by: JEFF CRANE
Date: 2/25/2016
Reviewed by: JPC

NORTH FORK BIG THOMPSON RIVER
COUNTY ROAD 43
EAST SEED SECTION
LARIMER COUNTY, COLORADO
CROSS SECTIONS

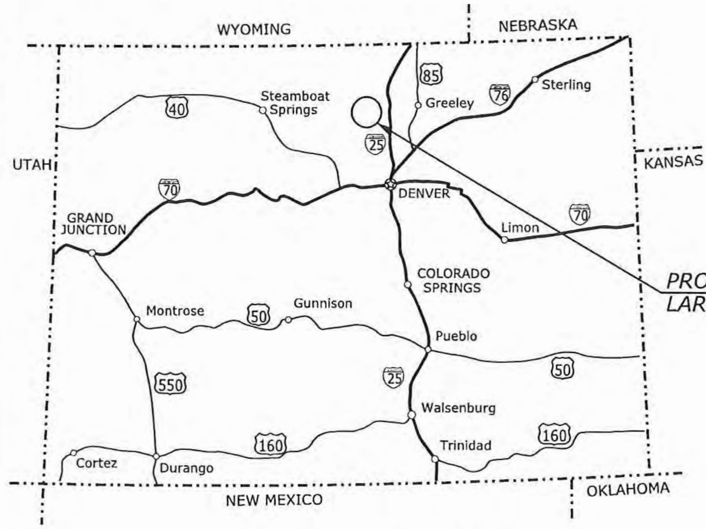
Sheet reference number: 74

UPDATE

Appendix C: Central Federal Lands Road Construction Plans

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
IMR	CO	ER 43(1) Larimer County CR43 Glen Haven Rd Reconstruction	A1	A7

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION



KEY MAP OF COLORADO

PLANS FOR PROPOSED

CO ER 43(1)
LARIMER COUNTY CR43
GLEN HAVEN ROAD RECONSTRUCTION

ROOSEVELT NATIONAL FOREST
LARIMER COUNTY

Schedule A LENGTH 2.02 miles
Option X CM Services
Option Y See Site Map
Anticipated Project LENGTH 9.46 miles

INDEX TO SHEETS

SHEET	DESCRIPTION
A1	TITLE SHEET
A2-A3	CONVENTIONAL PLAN SYMBOLS & ABBREVIATIONS
A4	SURVEY CONTROL
A5	SITE MAP
A6-A7	TYPICAL SECTIONS - MAINLINE
B1-B4	SUMMARY OF QUANTITIES
B5	TABULATION OF QUANTITIES
C1-C9	PLAN AND PROFILE - MAINLINE
E1-E2	EROSION CONTROL DETAILS
F1	EMBANKMENT BENCHING
G1-G3	ROCKERY
G4	ROCK BOLTS
S1-S3	GRS DETAILS
T1-T7	CULVERT STANDARDS
T8-T10	GUARDRAIL STANDARDS
T11-T18	TEMPORARY TRAFFIC CONTROL STANDARDS
X1-X58	CROSS SECTIONS - MAINLINE

TYPE OF CONSTRUCTION:
Schedule A: Road reconstruction, grading, drainage and aggregate surfacing
Option X: CM Services
Option Y: Drainage Structures

DESIGN DESIGNATIONS:
ADT (2014) ------------------- 1400
ADT (2034) ------------------- 1680
T ------------------------------- <1%
V -- 1000+50 to 1366+53 -- 30
V -- 1366+53 to 1500+20 -- 35
e(max) ---------------------- 6%

U.S. CUSTOMARY DIMENSIONS:
Slopes are expressed as RISE:RUN

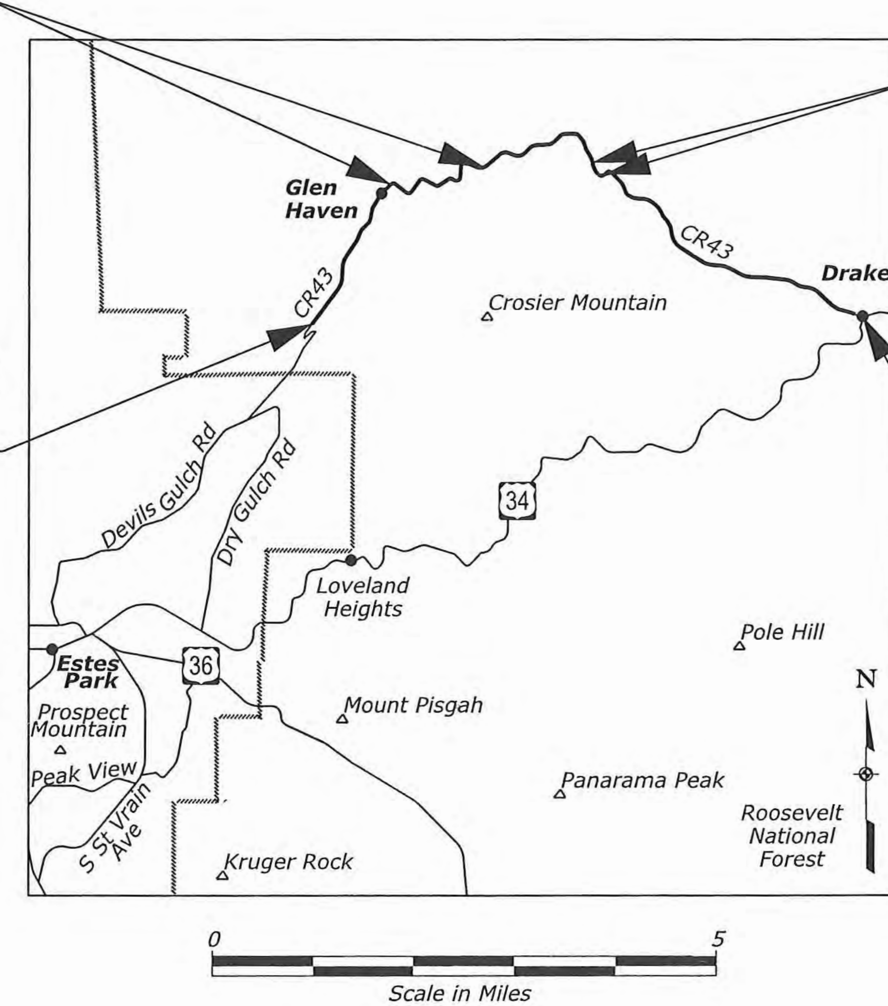
SPECIFICATIONS:
"STANDARD SPECIFICATIONS FOR CONSTRUCTION OF ROADS AND BRIDGES ON FEDERAL HIGHWAY PROJECTS, FP-03, U.S. CUSTOMARY UNITS"

Begin Schedule A
Larimer County Rd 43
Station 1109+80.00
Suspend Schedule A
Station 1191+25.00

Resume Schedule A
Larimer County Rd 43
Station 1269+00.00
End Schedule A
Station 1294+00.00

Begin Anticipated Project
Larimer County Rd 43
Station 1000+50.00

End Anticipated Project
Larimer County Rd 43
Station 1500+20.00



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COMMITMENT TO EXCELLENCE

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PLANS PREPARED BY

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION
DENVER, COLORADO

APPROVED: Michael Davis

DIRECTOR, PROJECT DELIVERY
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

DATE: 7/21/2014

PROJECT MANAGER	LEAD DESIGNER
M. Leadford	S. Diccicco

7/21/2014 11:13:22 AM N:\CO\er043(1)\Roadway\CADD_Sheets\A-Gen_sht\TTL_CR43.dgn
User: Stacy.Diccicco

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
IMR	CO	ER 43(1) Larimer County CR43 Glen Haven Rd Reconstruction	A2	A7

ABBREVIATIONS

	℄	centerline
	Δ	curve delta
A	abut.	abutment
	ADT	average daily traffic
	aggr.	aggregate
	AH	ahead
	alt.	alternate
	appr.	approach
	asph.	asphalt
B	b.f.	both faces
	beg.	beginning,begin
	BK	back
	BM	bench mark
	BP	balance point
	br.	bridge
	brg.	bearing
C	CBC	concrete box culvert
	c-c	center to center
	clr.	clear
	CMP	corrugated metal pipe
	Co.	county
	col.	column
	conc.	concrete
	constr.	construction
	constr. jt.	construction joint
	cont.	continuous
	corr.	corrugated
	cr.	creek
	CS	point of curve to spiral
	ctrs.	centers
	CTSM	contingent sum
	culv.	culvert
D	decr.	decrement
	DHV	design hour volume
	DI	drop inlet
	dia. or D	diameter
	diag.	diagonal
	diaph.	diaphragm
	dist.	distance
	Dist.	district
	DLC	donation land claim
	dwg(s).	drawing(s)
E	E	east
	e	superelevation rate
	El. 94.066	elevation with number
	elev.	elevation
	emb.	embankment
	engr(s).	Engineer(s)
	EOP	edge of pavement
	EQ or eq.	equation
	ER	edge of road
	et al	and others
	et ux	and wife
	EW	edge of water
	exc.	excavation
	exp. jt.	expansion joint
	ext.	exterior
F	f.f.	fill face
	Fed.	federal
	FES	flared end section
	fin.	finish
	ftg.	footing
G	ga.	gage (gauge)
	galv.	galvanized
	gdr.	girder
H	hdwl.	headwall
	HES	homestead entry survey
	hex.	hexagon
	horiz.	horizontal
	HW	high water
	hwy.	highway
I	ID	inside diameter
	incl.	inclusive,including
	incr.	increment
	int.	interior
J	jt.	joint

L	L	length of curve
	lam.	lamination
	lat.	latitude
	long.	longitudinal
	LPSM	lump sum
	Lt. or LT	left
	LW	low water
M	mag.	magnetic
	maint.	maintenance
	matl.	material
	max.	maximum
	min.	minimum
	mon.	monument
	mtn(s).	mountain(s)
N	N	north
	NC	normal crown
	neg.	negative
	no. or #	number
O	o.c.	on centers
	o.f.	other face
	OD	outside diameter
P	PC	point of curve
	PCC	point of compound curve
	perf.	perforate
	PI	point of intersection
	pl.	plate
	POC	point on curve
	POS	point on spiral
	POT	point on tangent
	proj.	project
	psi	pounds per square inch
	PT	point of tangent
	pvmt.	pavement
Q	quant., Qty	quantities
R	R	radius
	R.	range
	R/W	right-of-way
	rd.	road
	rdwy.	roadway
	reconst.	reconstruction
	reinf.	reinforcement
	reqd.	required
	res.	reservoir
	Res.	Reservation
	ret. wall	retaining wall
	RH	reference hub
	Rt. or RT	right
	rte.	route
S	S	south
	SADT	seasonal average daily traffic
	SC	point of spiral to curve
	sec.	section
	shldr.	shoulder
	spa.	spacing, Spaces or Spaced
	spec.	specification
	st.	street
	ST	point of spiral to tangent
	sta.	station
	std.	standard
	stiff.	stiffener
	str.	straight
	struc.	structural
	sym.	symmetrical
T	T	tangent length
	T.	township
	tan.	tangent
	TBM	temporary bench mark
	TCE	temporary construction easement
	transv.	transverse
	TS	point of tangent to spiral
	typ.	typical
V	V	design speed
	vert.	vertical
	vph	vehicles per hour
	VPI	vertical point of intersection
W	W	west

DRAINAGE SYMBOLS

Ditch (Existing, Proposed)

Flow Arrow

Drainage or Small Creek

Lake, Pond or Reservoir

Large Creek

Wetland

River

Spring

Bridge (Existing, Proposed)

Box Culvert (Existing, Proposed)

Pipe Culvert (Existing, Proposed)

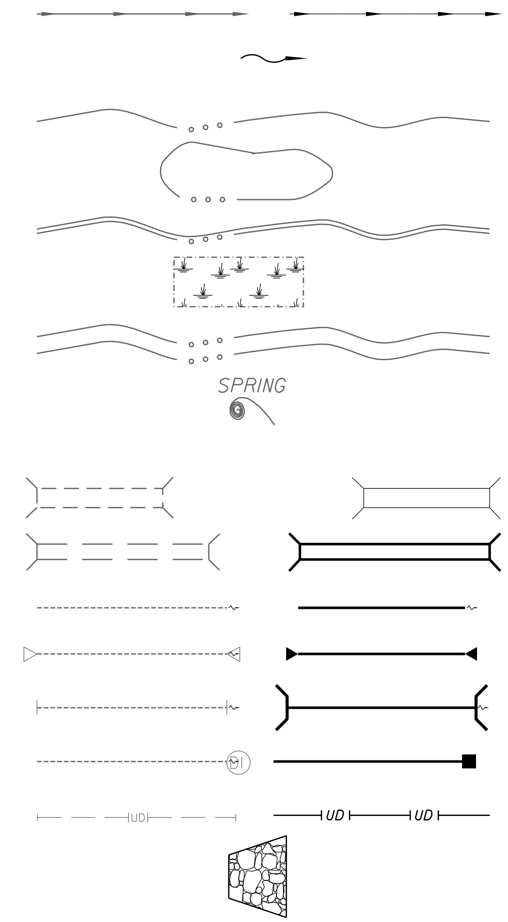
With End Sections (Existing, Proposed)

With Headwalls (Existing, Proposed)

With Drop Inlet (Existing, Proposed)

Underdrain (Existing, Proposed)

Riprap Apron (Proposed)



EROSION & SEDIMENT CONTROL SYMBOLS

Bonded Fiber Matrix Mulching

Check Dam

Diversion Berm

Erosion Control Mat

Riprap

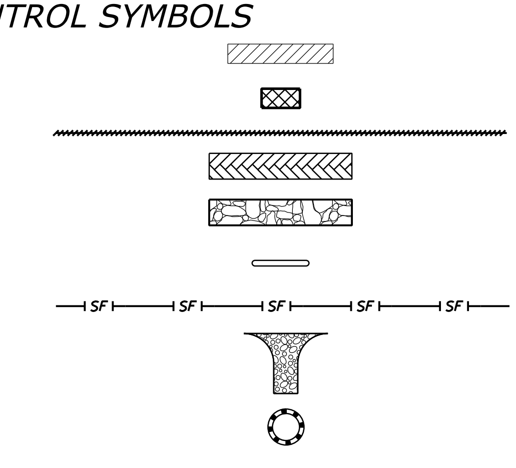
Sediment Log

Silt Fence

Stabilized Construction Entrance

Temporary Inlet Protection

Wattle

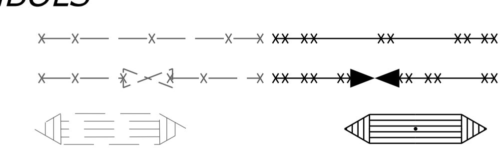


FENCE & CATTLEGUARD SYMBOLS

Fence (Existing, Proposed)

Fence w/ Gate (Existing, Proposed)

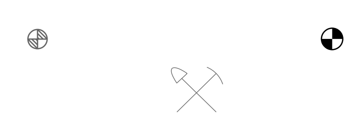
Cattleguard (Existing, Proposed)



GEOLOGIC SYMBOLS

Boring Location (Existing, Proposed)

Material Source



U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

U.S. CUSTOMARY

CONVENTIONAL PLAN SYMBOLS AND ABBREVIATIONS

Sheet 1 of 2

User: Stacy.Diciccco N:\CO\erfo43(1)\Roadway\CADD_Sheets\A-Gen_sht\SYM_CR43.dgn 1:11:15 PM 7/15/2014

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
IMR	CO	ER 43(1) Larimer County CR43 Glen Haven Rd Reconstruction	A3	A7

LANDSCAPING & VEGETATION SYMBOLS

Tree

Treeline

MAPPING SYMBOLS

Building (Existing, Proposed)

Coordinate Grid Tick

North Arrow

Railroad
- *Single Track*
- *Double Track*

Spot Elevation — 999.9

Trail

Survey Control Point

RIGHT-OF-WAY SYMBOLS

Boundaries
- *National*
- *State*
- *County*
- *City*
- *Township or Range Line*
- *Section*
- *¼ Section*
- *1/16 Section*
- *Bureau of Indian Affairs*
- *Bureau of Land Management*
- *National Forest*
- *National Park*
- *National Wildlife Refuge*

Easements
- *Permanent (Existing)* — P/E
- *Permanent (Proposed)* — P/E
- *Temporary (Proposed)* — TCE

Monument (As described)

Parcel Number — 400

Property Line — P/L

Right-of-Way Line (Existing) — r/w

Right-of-Way Line (Proposed) — R/W

Section Corner (Found, Projected) — 36 31 1 6

¼ Section Corner (Found, Projected) — 15 22

1/16 Section Corner (Found) — 1/16

GUARDRAIL, BARRIER & WALL SYMBOLS

Guardrail (Existing, Proposed)

Guardwall (Existing, Proposed)

Median & Side Barrier (Existing, Proposed)

Retaining Wall (Existing, Proposed)

ROADWAY SYMBOLS

Clearing/Construction Limits

Slope Stake Limits
- *Top of Cut*
- *Transition*
- *Toe of Fill*

Edge of Roadway
- *Existing*
- *Proposed*

Roadway Centerline (With Station ticks)

Roadway Obliteration

SIGN SYMBOLS

Signs
- *Commercial (Existing, Proposed)*
- *Delineator (Existing, Proposed)*
- *Portable (Proposed)*
- *Post Mounted (Existing, Proposed)*

UTILITY SYMBOLS

Irrigation Ditch
- *Underground (Existing, Proposed)* — IRR
- *Surface (Existing, Proposed)* — IRR

Support Pole (Existing, Proposed)

Support Pole Anchor (Existing, Proposed)

Street Light (Existing, Proposed)

Telephone Booth (Existing, Proposed) — TB

Telephone Pedestal (Existing, Proposed) — TP

Underground Utility (Existing, Proposed)
- *CATV* — TV
- *Fiber Optic* — FO
- *Gas* — G
- *Oil* — O
- *Power* — P
- *Sanitary Sewer* — SS
- *Telephone* — T
- *Water* — W

Overhead Utility Line (Existing, Proposed)
- *CATV* — TV
- *Fiber Optic* — FO
- *Power* — P
- *Telephone* — T

MISCELLANEOUS SYMBOLS

See Note 4 — 4

PROJECT SPECIFIC SYMBOLS

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

U.S. CUSTOMARY

CONVENTIONAL PLAN SYMBOLS AND ABBREVIATIONS

Sheet 2 of 2

User: Stacy.Diciccio

N:\CO\erfo43(1)\Roadway\CADD_Sheets\A-Gen_sht\SYM_CR43.dgn

1:11:50 PM

7/15/2014

PROJECT : CO ER 43(1) LARIMER COUNTY ROAD 43

Review FP03, Section 152.02

DATE OF FIELD WORK : JANUARY 2014
DATE OF FINAL ADJUSTMENT : JANUARY 2014

PROJECT UNITS : US SURVEY FOOT
COORDINATE SYSTEM : LAMBERT NAD83; CO NORTH 0501
EPOCH DATE : NAD_83(2011)(EPOCH:2010.0000)
VERTICAL DATUM : NAVD88 MODELED USING GEOID12A

GPK FILE DATED:

	STATE PLANE COORDINATES			GEO COORDINATES							
POINT NUMBER	NORTH	EAST	ELEVATION	LATITUDE	LONGITUDE	ELLIPSOID HEIGHT	MAPPING ANGLE	COMBINED FACTOR	JOB???.GPK STATION	??? OFFSET	DESCRIPTION
2001	1408377.72	3014571.99	7222.95	40°27'15.79208"N	105°26'51.49249"W	7180.77	0°02'02"	0.99961994			FHWA ALUMINUM CAP
2002	1408886.54	3016594.12	7115.66	40°27'20.80766"N	105°26'25.32928"W	7073.30	0°02'19"	0.99962516			FHWA ALUMINUM CAP
2003	1408544.97	3018203.60	7074.28	40°27'17.42103"N	105°26'04.51137"W	7031.75	0°02'32"	0.99962708			FHWA ALUMINUM CAP
2004	1409350.45	3019020.47	7006.35	40°27'25.37465"N	105°25'53.93607"W	6963.77	0°02'39"	0.99963047			FHWA ALUMINUM CAP
2005	1410355.94	3021544.53	6928.44	40°27'35.29029"N	105°25'21.27143"W	6885.62	0°03'00"	0.99963438			FHWA ALUMINUM CAP
2006	1405901.28	3032451.47	6452.25	40°26'51.15182"N	105°23'00.24066"W	6408.13	0°04'31"	0.99965644			FHWA ALUMINUM CAP

PROJECT AVERAGES = 0.99963224

NOTE: TO PRECISELY CHECK DISTANCES BETWEEN POINTS AS MEASURED ON THE GROUND :
INVERSE THE STATE PLANE COORDINATES AND DIVIDE THE COMPUTED DISTANCE
BY A MEAN COMBINED FACTOR OF THE TWO POINTS.

TO COMPUTE GEODETIC AZIMUTHS USE THE FOLLOWING FORMULA :
GEODETIC AZIMUTH = GRID AZIMUTH + MAPPING ANGLE

NO.	DESCRIPTION REVISIONS (OR CHANGE NOTICES)	DATE	INIT.
6			
5			
4			
3			
2			
1	*Created*	*2/3/14*	*klw*

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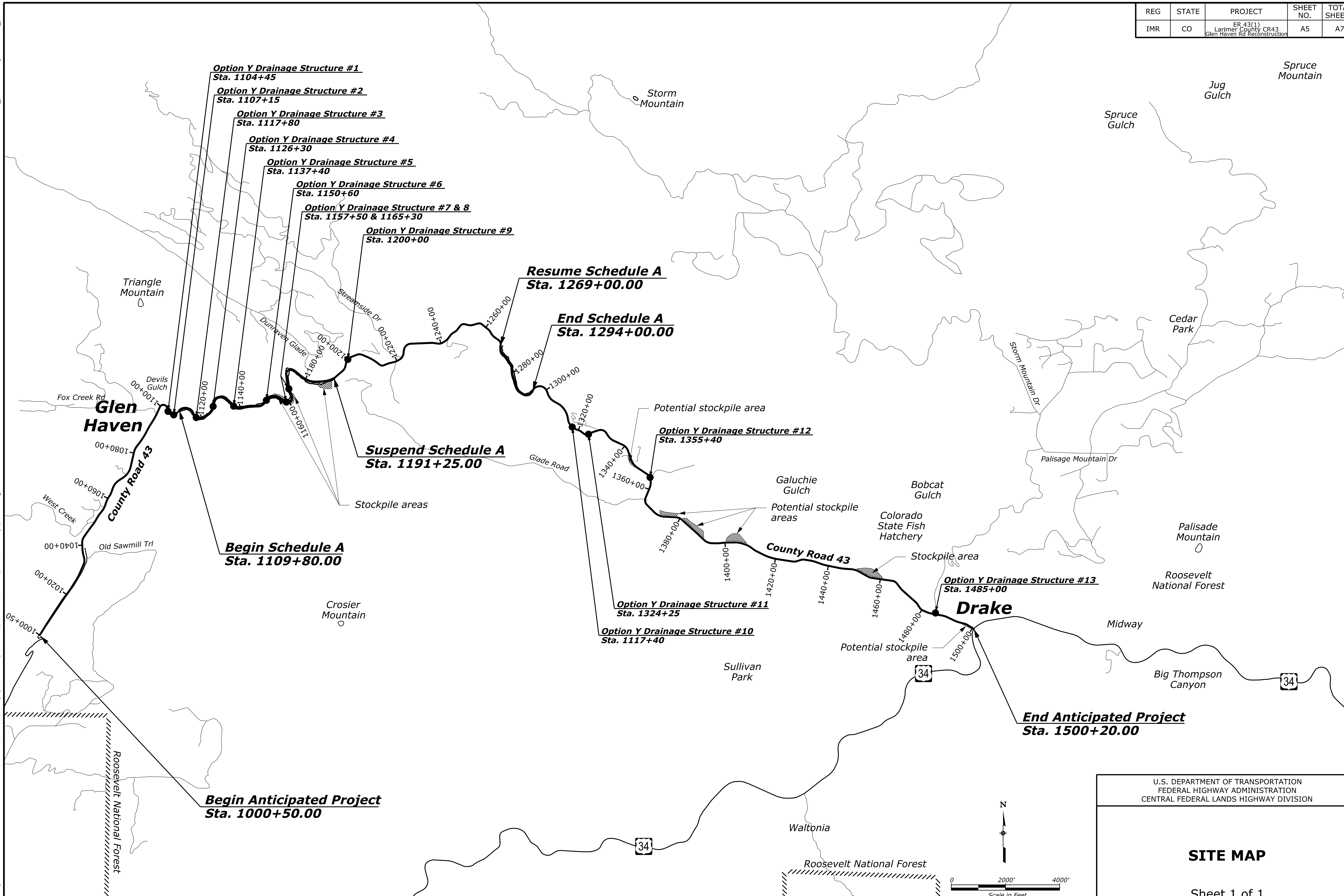
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

SURVEY CONTROL

Sheet 1 of 1

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
IMR	CO	ER 43(1) Larimer County CR43 Glen Haven Rd Reconstruction	A5	A7



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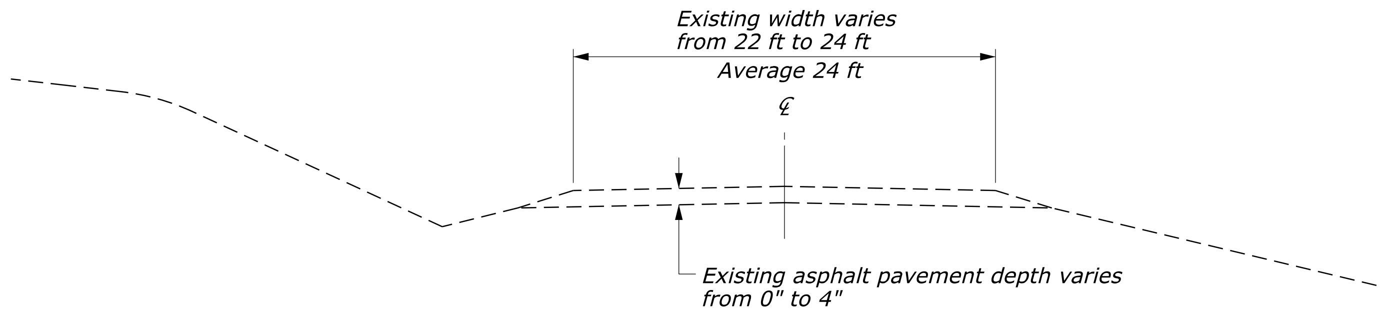
7/15/2014

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

SITE MAP

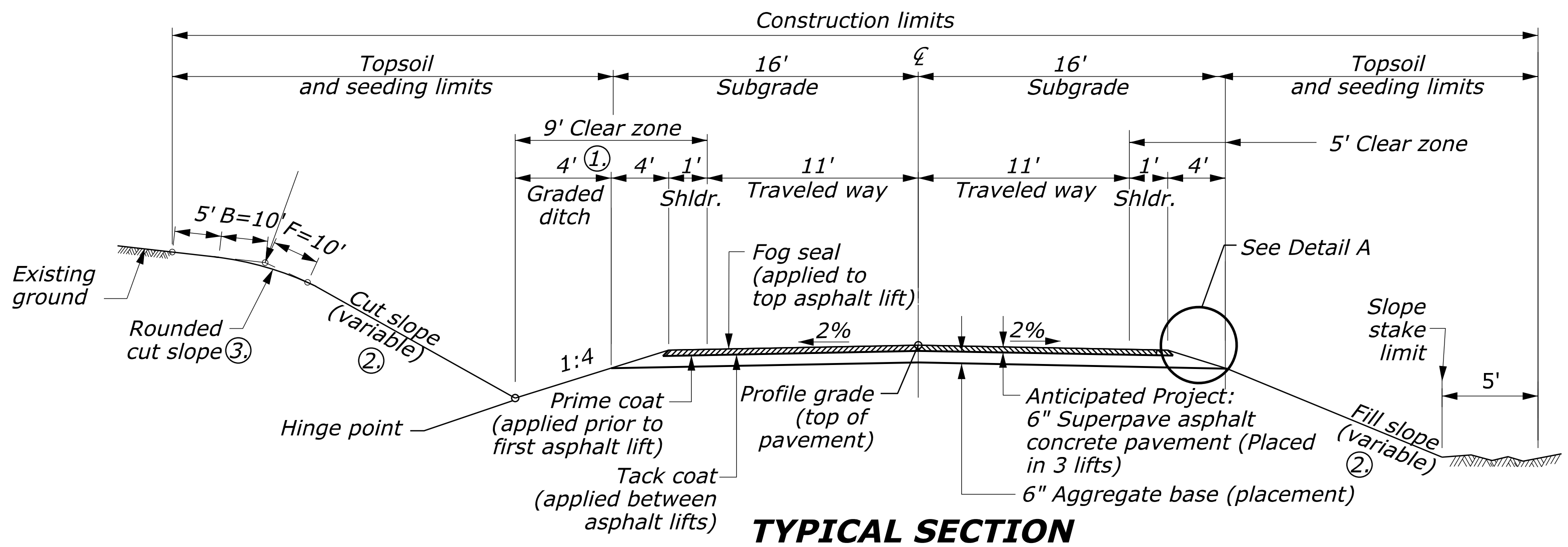
Sheet 1 of 1



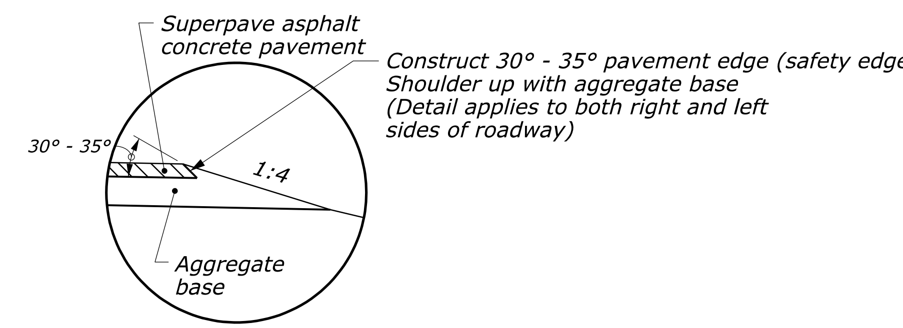
EXISTING TYPICAL SECTION
1000+50 to 1500+20

NOTE:

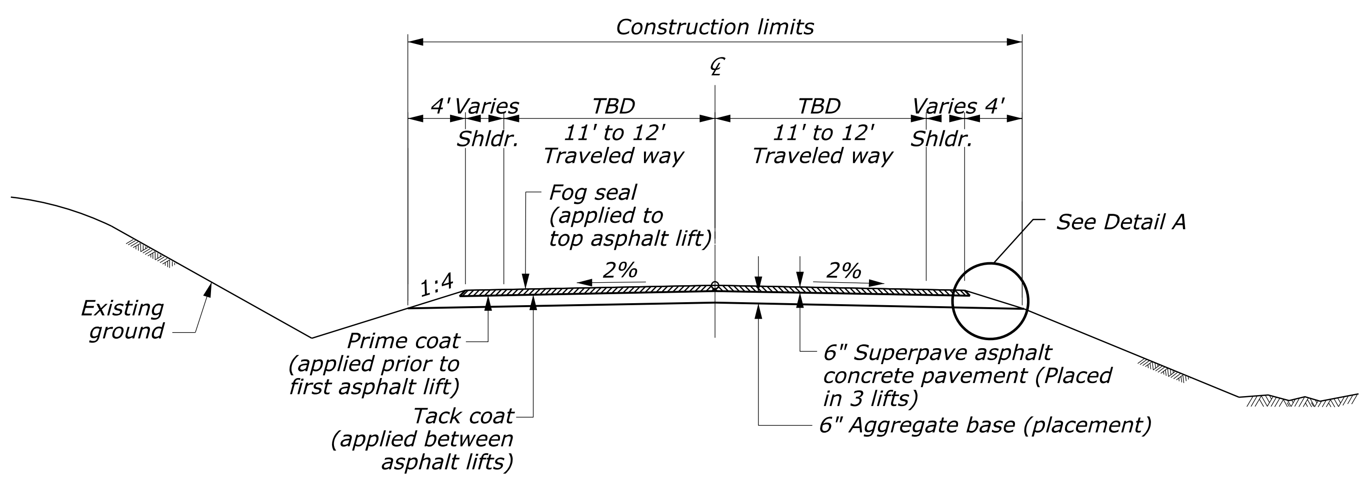
1. The gradient and width of roadway ditches and the excavation and embankment slope ratios may be adjusted by the CO to assure adequate drainage and stability.
2. See the cross sections for cut and fill slope ratios.
3. Round all earth slopes and all rippable rock slopes. For cut heights less than B, reduce the B and F dimensions to the actual cut height.



TYPICAL SECTION
Schedule A: 1109+80-1191+25 & 1269+00 to 1291+00
Anticipated: 1099+00-1109+80, 1191+25-1269+00, & 1291+00-1367+00

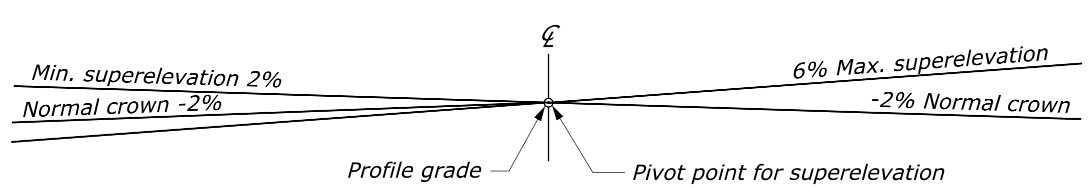


DETAIL A



ANTICIPATED PROJECT TYPICAL SECTION
1000+50 to 1099+00
1367+00 to 1500+20

LENGTH OF PROJECT		
Station to Station	Schedule A (ft)	Anticipated Project (ft)
1000+50 to 1109+80		10930
1109+80 to 1191+25	8145	8145
1191+25 to 1269+00		7775
1269+00 to 1294+00	2500	2500
1294+00 to 1500+20		20620
TOTALS (ft)	10645	49970
TOTAL (mi)	2.02	9.46



METHOD OF SUPERELEVATION ON CURVES
See plans for locations of curves and superelevations

NO SCALE

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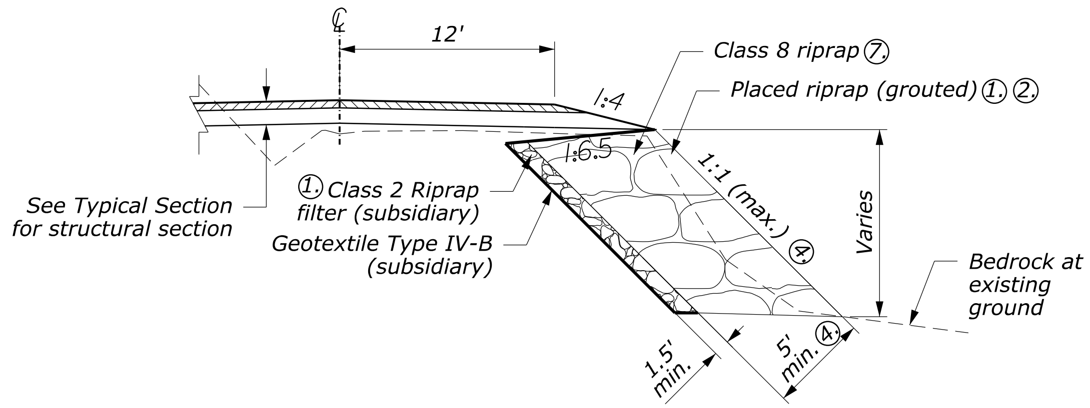
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

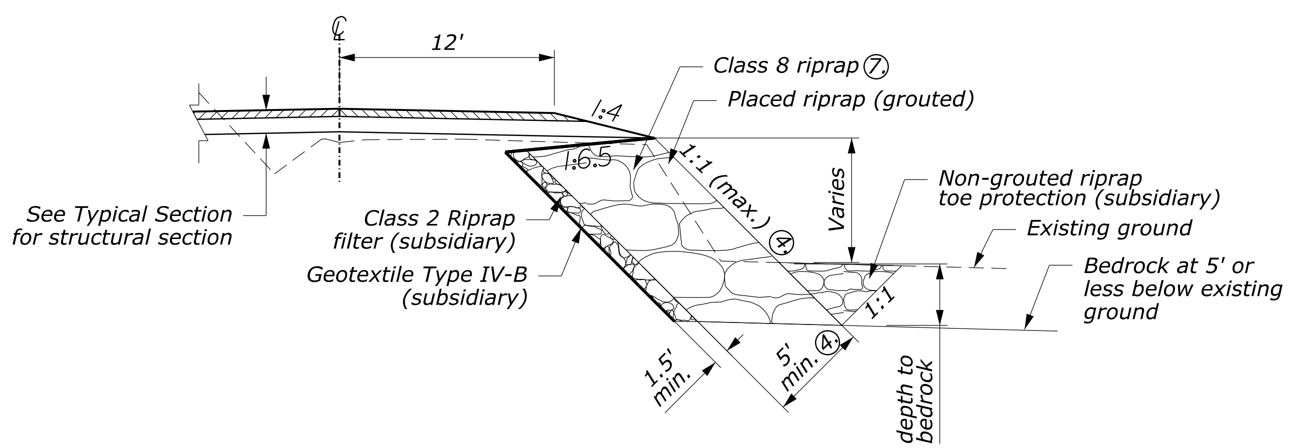
TYPICAL SECTIONS MAINLINE

Sheet 1 of 2

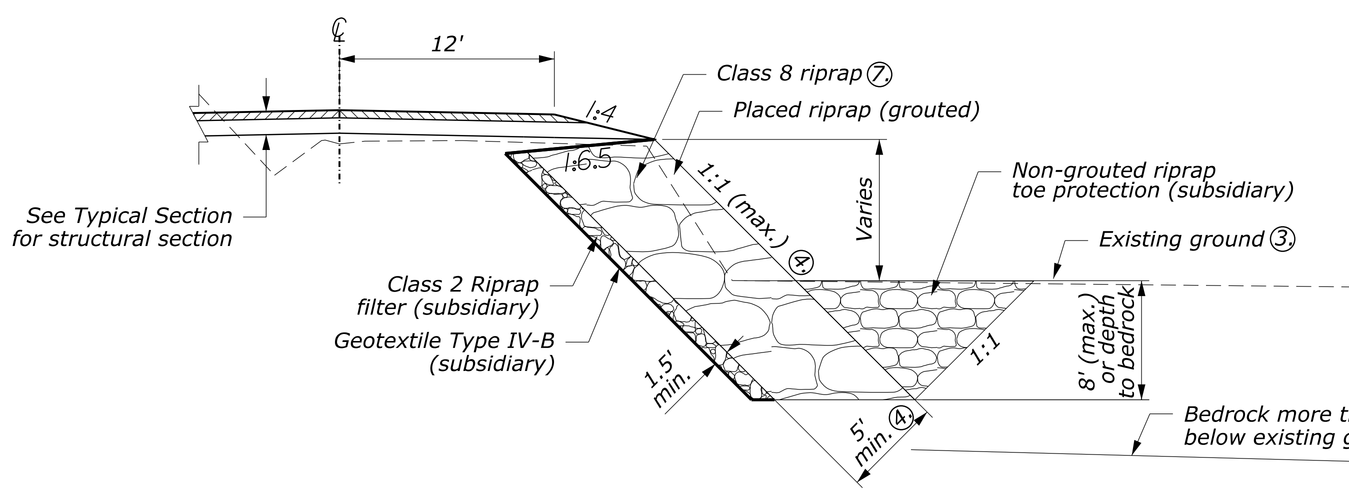
REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
IMR	CO	ER 43(1) Larimer County CR43 Glen Haven Rd Reconstruction	A7	A7



TYPICAL EMBANKMENT ARMORING SECTION
BEDROCK AT EXISTING GROUND



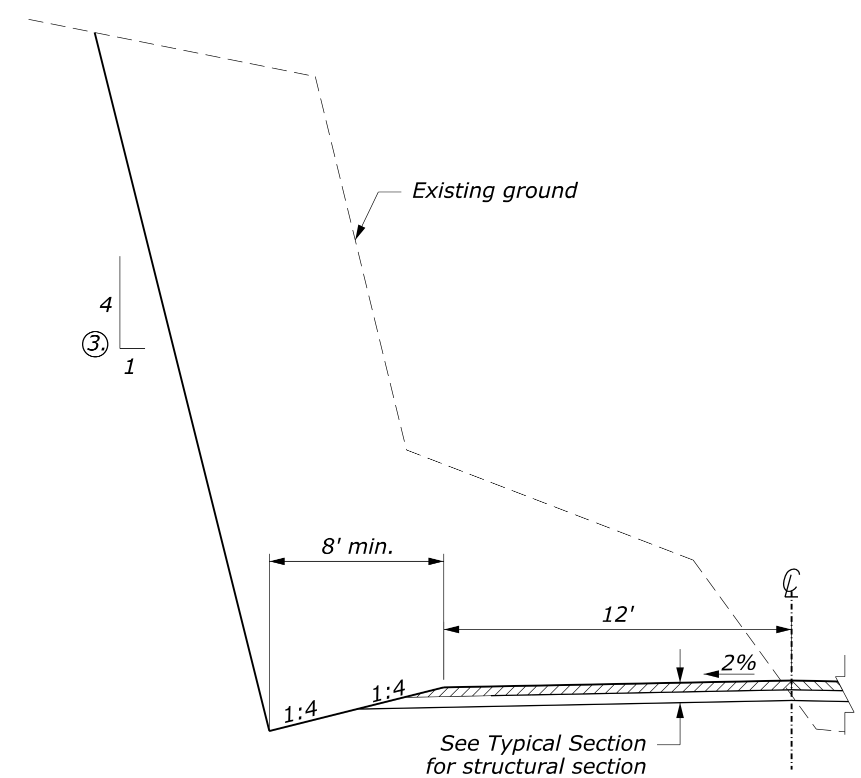
TYPICAL EMBANKMENT ARMORING SECTION
BEDROCK 5' OR LESS BELOW EXISTING GROUND



TYPICAL EMBANKMENT ARMORING SECTION
BEDROCK MORE THAN 5' BELOW EXISTING GROUND

NOTE:

1. In Embankment Armoring areas where the existing riprap is on bedrock and determined by the CO to be hydraulically stable, grout the existing riprap. Riprap filter will not be installed.
2. In Embankment Armoring areas where the existing riprap is on bedrock and hydraulically unstable, provide one of two repairs as determined by the CO:
   - Excavate existing riprap to a minimum thickness of 6.5 feet and replace with riprap filter and hydraulically stable grouted armor riprap.
   - Leave existing riprap in-place and grout existing riprap to a thickness of five feet.
3. Existing ground elevation will be the lowest point in channel cross section, not the embankment material placed during emergency access repairs. Field verify existing ground as directed by the CO.
4. Grouted armor riprap slope may be steepened to a 3(V):1(H) maximum slope by the CO. When steepened slope is used, base riprap width will be increased to seven feet minimum.
5. Provide grout according to Section 601 of the FP-03, (3000 psi concrete). For estimating purposes, assume 15% grout by volume of riprap.
6. Classification of all riprap will be determined by the CO to fit conditions.
7. A larger class of riprap may be required in select locations, as determined by the CO.



TYPICAL ROCK FALL DITCH SECTION

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CENTRAL FEDERAL LANDS HIGHWAY DIVISION

NO SCALE

TYPICAL SECTIONS
MAINLINE

Sheet 2 of 2

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
IMR	CO	ER 43(1) Larimer County CR43	B1	B5

SUMMARY OF QUANTITIES - Schedule A

AMEND	Line Item No.	Pay Item Number	Pay Item Description	Unit	Sheet and Description													Estimated Quantities	Remarks and/or Determination of Estimated Quantity
					B5														
					Tabulation of Quantities	Allowance												Bid Schedule	
	A0100	15101-0000	MOBILIZATION	LPSM														ALL	
	A0150	15206-0000	SLOPE, REFERENCE, AND CLEARING AND GRUBBING STAKE	STA														106.450	
	A0200	15216-2000	SURVEY AND STAKING, GRADE FINISHING STAKES	STA														106.450	
	A0250	15301-0000	CONTRACTOR QUALITY CONTROL	LPSM														ALL	
	A0300	15401-0000	CONTRACTOR TESTING	LPSM														ALL	
	A0350	15501-0000	CONSTRUCTION SCHEDULE	LPSM														ALL	
	A0400	15705-0100	SOIL EROSION CONTROL, SILT FENCE	LNFT														20,000	
	A0450	15705-1500	SOIL EROSION CONTROL, SEDIMENT WATTLE	LNFT														10,000	
	A0500	20101-0000	CLEARING AND GRUBBING	ACRE														20.4	
	A0550	20401-0000	ROADWAY EXCAVATION	CUYD	116,106	5,894												122,000	
	A0600	25101-0000	PLACED RIPRAP (PRODUCTION ONLY)	CUYD	36,825	1,875												38,700	
	A0650	25101-0000	PLACED RIPRAP (GROUTED)	CUYD	15,010	740												15,750	
	A0700	25210-0000	ROCKERY	SQYD														2,000	
	A0750	26001-0000	ROCK BOLT	LNFT														1,000	
	A0800	30103-0000	AGGREGATE BASE (PRODUCTION ONLY)	CUYD	29,347	1,453												30,800	
	A0850	30103-0000	AGGREGATE BASE (PLACEMENT)	CUYD	6,084	316												6,400	
	A0900	30306-2000	PULVERIZING, 4-INCH DEPTH	SQYD	5,842	258												6,100	
	A0950	30606-0000	MAGNESIUM CHLORIDE	TON														500	
	A1000	41103-0000	PRIME COAT	SQYD	29,489	1,476												30,965	
	A1050	60201-0800	24-INCH PIPE CULVERT	LNFT														5,770	
	A1100	60201-0900	30-INCH PIPE CULVERT	LNFT														1,180	
	A1150	60201-1000	36-INCH PIPE CULVERT	LNFT														360	
	A1200	60210-0800	END SECTION FOR 24-INCH PIPE CULVERT	EACH														80	
	A1250	60210-0900	END SECTION FOR 30-INCH PIPE CULVERT	EACH														19	
	A1300	60210-1000	END SECTION FOR 36-INCH PIPE CULVERT	EACH														6	
	A1350	60404-1000	CATCH BASIN, TYPE 1	EACH														20	
	A1400	60409-0100	INLET TOP, METAL FRAME AND GRATE TYPE A	EACH														20	
	A1450	62201-0250	DUMP TRUCK, 10 CUBIC YARD MINIMUM CAPACITY	HOUR														250	

MileStone: 100% PS&E
Date Completed: 07/21/14
Report Date: 07/21/14

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
IMR	CO	ER 43(1) Larimer County CR43	B2	B5

SUMMARY OF QUANTITIES - Schedule A

AMEND	Line Item No.	Pay Item Number	Pay Item Description	Unit	Sheet and Description: B5 Tabulation of Quantities	Allowance												Estimated Quantities Bid Schedule	Remarks and/or Determination of Estimated Quantity
	A1500	62201-0550	BACKHOE LOADER, 6 CUBIC FOOT MINIMUM RATED CAPACITY BUCKET, 24-INCH WIDTH	HOUR														250	
	A1550	62201-1000	WHEEL LOADER, 4 CUBIC YARD MINIMUM RATED CAPACITY	HOUR														250	
	A1600	62201-1450	BULLDOZER, 350HP MINIMUM FLYWHEEL POWER	HOUR														250	
	A1650	62201-2850	MOTOR GRADER, 12 FOOT MINIMUM BLADE	HOUR														250	
	A1700	62201-3000	HYDRAULIC EXCAVATOR	HOUR														250	
	A1750	62301-0000	GENERAL LABOR	HOUR														300	
	A1800	62302-0100	SPECIAL LABOR, SLOPE SCALING	HOUR														300	
	A1850	62302-1000	SPECIAL LABOR, HIRED TECHNICAL SERVICES	HOUR														500	
	A1900	62302-1100	SPECIAL LABOR, HIRED SURVEY SERVICES	HOUR														250	
	A1950	63501-1000	TEMPORARY TRAFFIC CONTROL, TRAFFIC AND SAFETY SUPERVISOR	LPSM														ALL	
	A2000	63502-0700	TEMPORARY TRAFFIC CONTROL, CONE	EACH														750	
	A2050	63502-1300	TEMPORARY TRAFFIC CONTROL, DRUM	EACH														100	
	A2100	63502-2000	TEMPORARY TRAFFIC CONTROL, PORTABLE CHANGEABLE MESSAGE SIGN	EACH														8	
	A2150	63502-3100	TEMPORARY TRAFFIC CONTROL, TRAFFIC SIGNAL SYSTEM	EACH														2	
	A2200	63503-0300	TEMPORARY TRAFFIC CONTROL, BARRICADE TYPE 3	LNFT														200	
	A2250	63503-0400	TEMPORARY TRAFFIC CONTROL, CONCRETE BARRIER	LNFT														1,000	
	A2300	63503-0500	TEMPORARY TRAFFIC CONTROL, MOVING CONCRETE BARRIER	LNFT														3,000	
	A2350	63504-1000	TEMPORARY TRAFFIC CONTROL, CONSTRUCTION SIGN	SQFT														1,000	
	A2400	63506-0500	TEMPORARY TRAFFIC CONTROL, FLAGGER	HOUR														10,000	
	A2450	63506-0600	TEMPORARY TRAFFIC CONTROL, PILOT CAR	HOUR														7,000	

MileStone: 100% PS&E
Date Completed: 07/21/14
Report Date: 07/21/14

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REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
IMR	CO	ER 43(1) Larimer County CR43	B3	B5

SUMMARY OF QUANTITIES - Option X

AMEND	Line Item No.	Pay Item Number	Pay Item Description	Unit	Sheet and Description													Estimated Quantities	Remarks and/or Determination of Estimated Quantity
					B5														
					Tabulation of Quantities	Allowance												Bid Schedule	
	X0100	62302-1000	SPECIAL LABOR, HIRED TECHNICAL SERVICES	HOUR														200	

MileStone: 100% PS&E
Date Completed: 07/21/14
Report Date: 07/21/14

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SUMMARY OF QUANTITIES - Option Y

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
IMR	CO	ER 43(1) Larimer County CR43	B4	B5

AMEND	Line Item No.	Pay Item Number	Pay Item Description	Unit	Sheet and Description													Estimated Quantities	Remarks and/or Determination of Estimated Quantity
					B5														
					Tabulation of Quantities	Allowance												Bid Schedule	
	Y0100	15101-0000	MOBILIZATION	LPSM														ALL	
	Y0150	15215-2000	SURVEY AND STAKING, BRIDGE	EACH														13	
	Y0200	15301-0000	CONTRACTOR QUALITY CONTROL	LPSM														ALL	
	Y0250	15401-0000	CONTRACTOR TESTING	LPSM														ALL	
	Y0300	20301-1900	REMOVAL OF PIPE CULVERT	EACH														13	
	Y0350	20435-2500	BACKFILL, PERMEABLE	CUYD														8,450	
	Y0400	20801-0000	STRUCTURE EXCAVATION	CUYD														5,330	
	Y0450	25101-0000	PLACED RIPRAP (CLASS 8 GROUTED)	CUYD														5,850	
	Y0500	25904-0000	GEOSYNTHETIC REINFORCEMENT	SQYD														43,056	
	Y0550	55302-0500	PRECAST, PRESTRESSED CONCRETE SLABS, 48" VOIDED	LNFT														5,005	
	Y0600	55601-0900	BRIDGE RAILING, STEEL	LNFT														1,430	
	Y0650	55901-1000	MEMBRANE WATERPROOFING, TYPE 1	SQYD														2,224	
	Y0700	61701-1350	GUARDRAIL SYSTEM G4, TYPE 2, CLASS B STEEL POSTS	LNFT														1,690	
	Y0750	61702-0800	TERMINAL SECTION TYPE TANGENT	EACH														52	
	Y0800	61707-0000	STRUCTURE TRANSITION RAILING	LNFT														975	
	Y0850	62006-0000	CONCRETE MASONRY UNITS	SQYD														585	

MileStone: 100% PS&E
Date Completed: 07/21/14
Report Date: 07/21/14

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
IMR	CO	ER 43(1) Larimer County CR43 Glen Haven Rd Reconstruction	B5	B5

SCHEDULE A GRADING SUMMARY

	Roadway Excavation		Pay Item 20401-0000	Additional Excavation	Embankment For info only		For info only	For info only
Station to Station	Roadway Prism	Approach Roads	ROADWAY EXCAVATION	(-) Unavailable Material (see note 1)	Roadway Prism	Approach Roads	(+) Various Backfill Material Generated Onsite (see note 2)	Waste (see note 3)
	BCY	BCY	CUYD	BCY	CCY	CCY	CCY	CUYD
1109+80 - 1191+25	86,391	0	86,391	240	45,328	0	490	
1269+00 - 1294+00	29,715	0	29,715	0	6,582	0	0	
Emergency Access Embankment (6)					-30,000			
Aggregate Base (production only)							29,347	
Placed Riprap (production only)							36,825	
Class 2 riprap filter (subsidiary)							11,050	
TOTALS	**116,106**	**0**	**116,106**	**240**	**21,910**	**0**	**77,712**	**39,403**

NOTE:

1. Unavailable material includes pavement removal in cuts. Assumed 4 inch depth in undamaged areas, 0 inch depth in damaged areas.
2. Various backfill material generated onsite includes pavement removal under fill, aggregate base (production), placed riprap (production) and class 2 riprap filter (subsidiary). Additional uses for material generated onsite are anticipated (potentially rockery rocks, rock backdrain and GRS backfill).
3. Waste or Unclassified borrow quantity calculated using volumes adjusted for an estimated 1.2 swell.
4. The quantities shown herein are approximations. Payment will be made for the actual quantities of work performed.
5. BCY = Bank cubic yard - one cubic yard of material as it lies in the natural state.
   CCY = Compacted cubic yard - one cubic yard of material after it has been compacted to specification density.
6. Earthwork quantities are based on contour data obtained prior to Emergency Access repairs. Embankment quantity adjusted to approximately account for embankment placed during Emergency Access repair work.

SCHEDULE A SURFACING SUMMARY

Item Number	30103-0000	30103-0000	30306-2000	30606-0000	41103-0000
Station to Station	AGGREGATE BASE (PRODUCTION ONLY)	AGGREGATE BASE (PLACEMENT)	PULVERIZING, 4 INCH DEPTH	MAGNESIUM CHLORIDE	PRIME COAT
	CUYD	CUYD	SQYD	TON	SQYD
1109+80 - 1191+25.	4640	4640	5842		22521
1269+00. - 1294+00.	1445	1445	0		6968
Project Wide	23263			500	
TOTALS	**29,347**	**6,084**	**5,842**	**500**	**29,489**

Values used for estimating purposes:

Aggregate base 139 lb/ft3
Magnesium chloride . . . . 0.20 gal/sqyd, 8.3 lb/gal

SCHEDULE A PLACED RIPRAP SUMMARY

Item Number ->	25101-0000	25101-0000	for info only	
Station to Station	PLACED RIPRAP (PRODUCTION ONLY)	PLACED RIPRAP (GROUTED)	grout	NOTES
	CUYD	CUYD	CUYD	
1109+80. - 1191+25.	10640	10640	1596	Assume grout 15% by volume
1269+00. - 1294+00.	4370	4370	656	Assume grout 15% by volume
Project Wide	21815			
TOTALS	**36825**	**15010**	**2252**	

FOR INFORMATION ONLY: ANTICIPATED PROJECT SURFACING SUMMARY

Item Number	for info only	for info only	for info only	for info only	for info only	for info only	for info only	for info only
Station to Station	AGGREGATE BASE (PLACEMENT)	PULVERIZING, 4 INCH DEPTH	MAGNESIUM CHLORIDE	SUPERPAVE PAVEMENT, 1-INCH NOMINAL MAXIMUM SIZE AGGREGATE, EQUAL OR >30 MILLION ESAL	ANTISTRIP ADDITIVE, TYPE 3	FOG SEAL, EMULSIFIED ASPHALT GRADE CSS-1 OR CSS-1H, SS-1 OR SS-1H	PRIME COAT	TACK COAT
	CUYD	SQYD	TON	TON	TON	TON	SQYD	TON
1000+50 - 1109+80.	6272	25471		9946.9	99.5	19.6	45670	19.6
1109+80 - 1191+25.				7467.8	74.7	14.7	34287	14.7
1191+25. - 1269+00.	4510	13916		7024.8	70.2	13.8	32253	13.8
1269+00. - 1294+00.				2365.4	23.7	4.7	10860	4.7
1294+00. - 1500+20.	12480	54853		19819.1	198.2	39.1	90997	39.1
Project wide			1500					
TOTALS	**23,263**	**94,240**	**1,500**	**46624.0**	**466.3**	**91.9**	**214067**	**91.9**

Values used for estimating purposes:

Aggregate base 139 lb/ft3
Hot asphalt concrete pavement 145.2 lb/ft3
Antistrip . . . . 1 % of weight of mix
Fog seal . . . . 0.1 gal/yd2 (240.7 gal/ton)
Prime coat . . . . 0.33 gal/yd2 (251 gal/ton)
Tack coat . . . . 0.1 gal/yd2 (233 gal/ton)
Magnesium Chloride . . . . 0.2 gal/yd2 (8.3 lb/gal)

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

TABULATION OF QUANTITIES

Sheet 1 of 1

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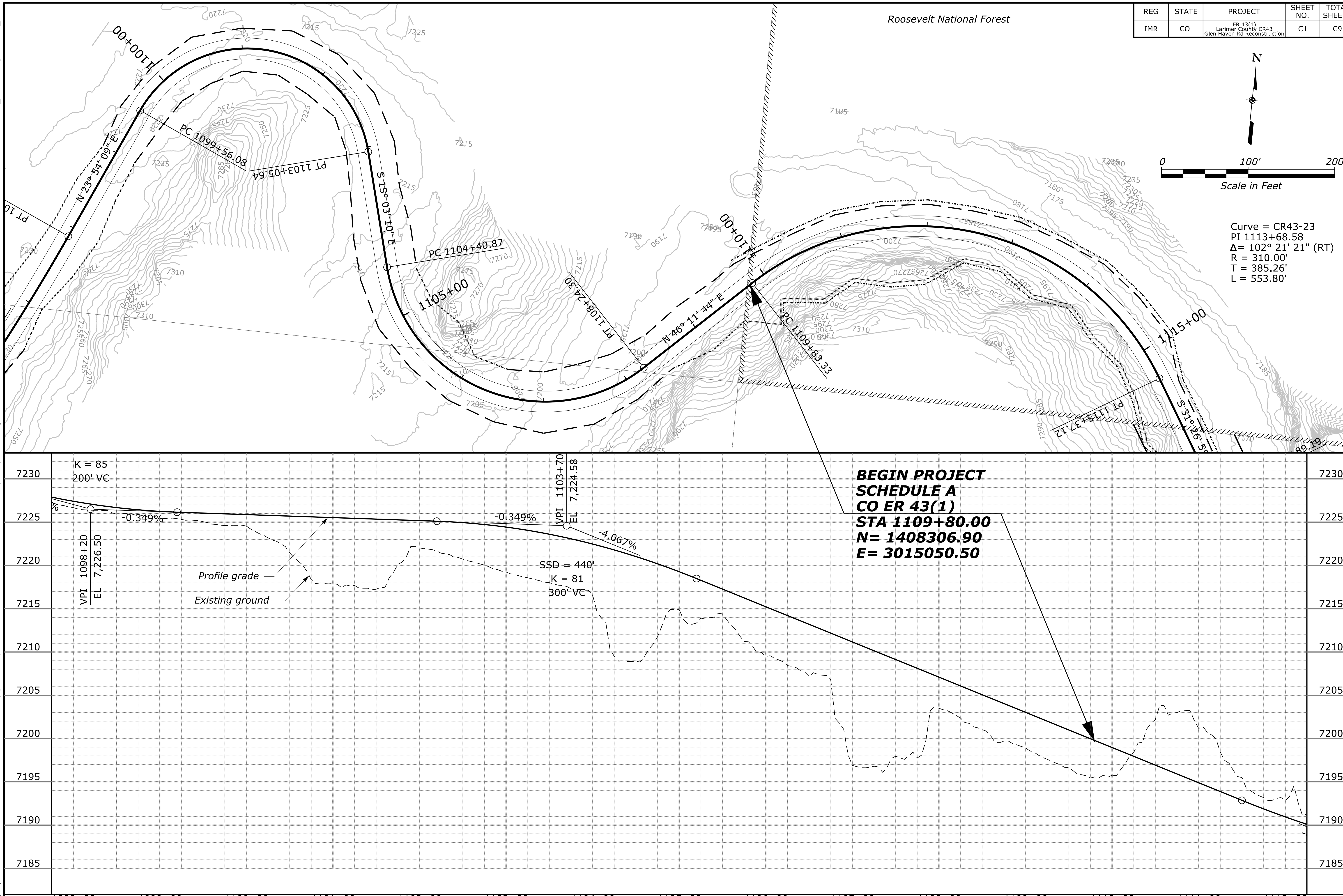
REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
IMR	CO	ER 43(1) Larimer County CR43 Glen Haven Rd Reconstruction	C1	C9



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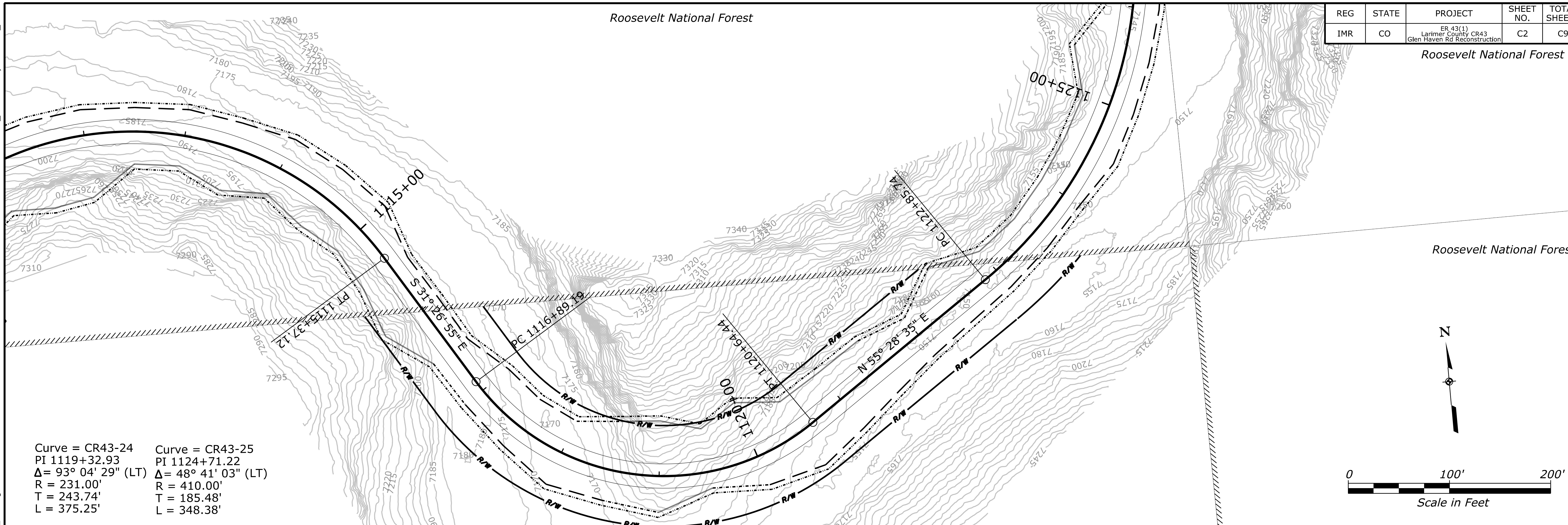
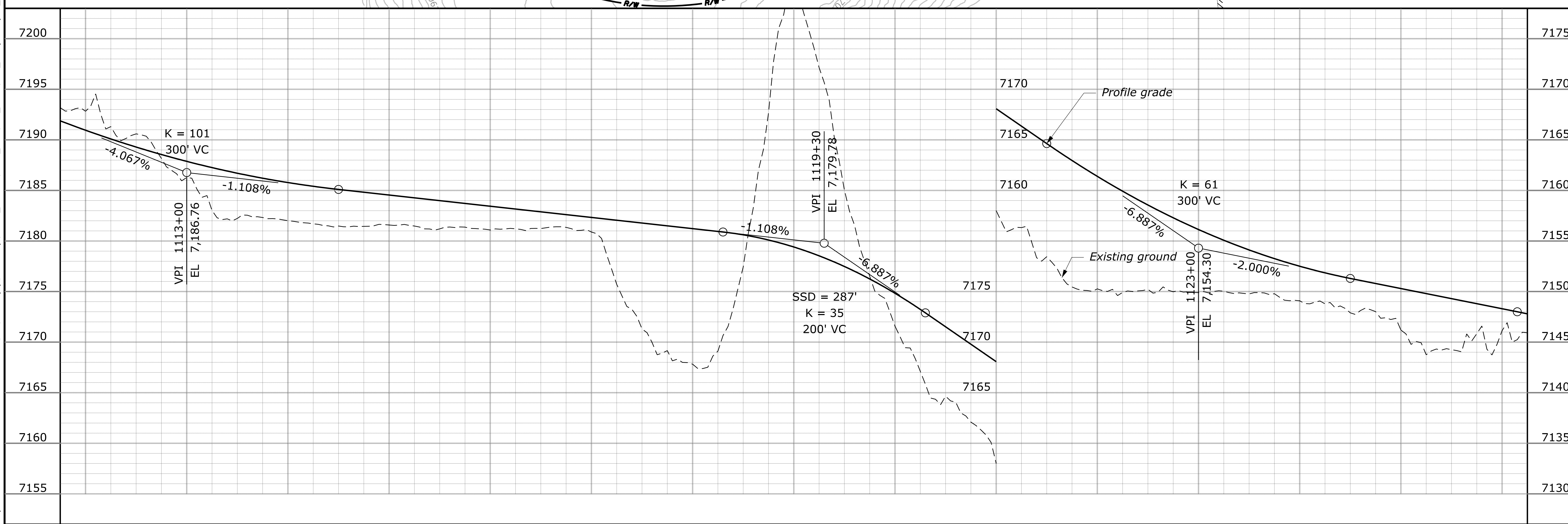
REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
IMR	CO	ER 43(1) Larimer County CR43 Glen Haven Rd Reconstruction	C2	C9





User: Stacy.Diciccco

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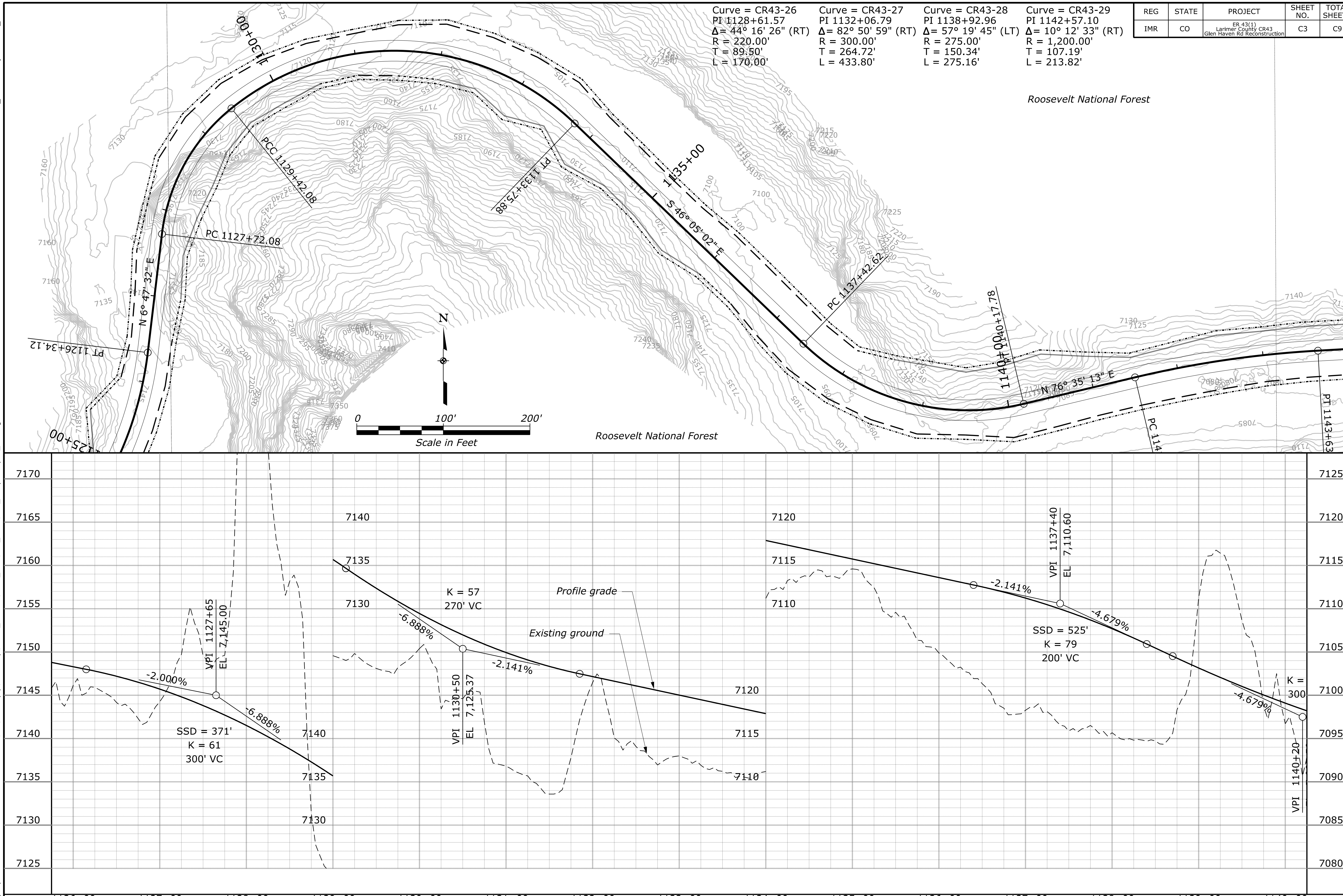
2:14:45 PM

7/15/2014

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
IMR	CO	ER 43(1) Larimer County CR43 Glen Haven Rd Reconstruction	C3	C9



User: Stacy.Diciccco
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3:47:07 PM
7/15/2014

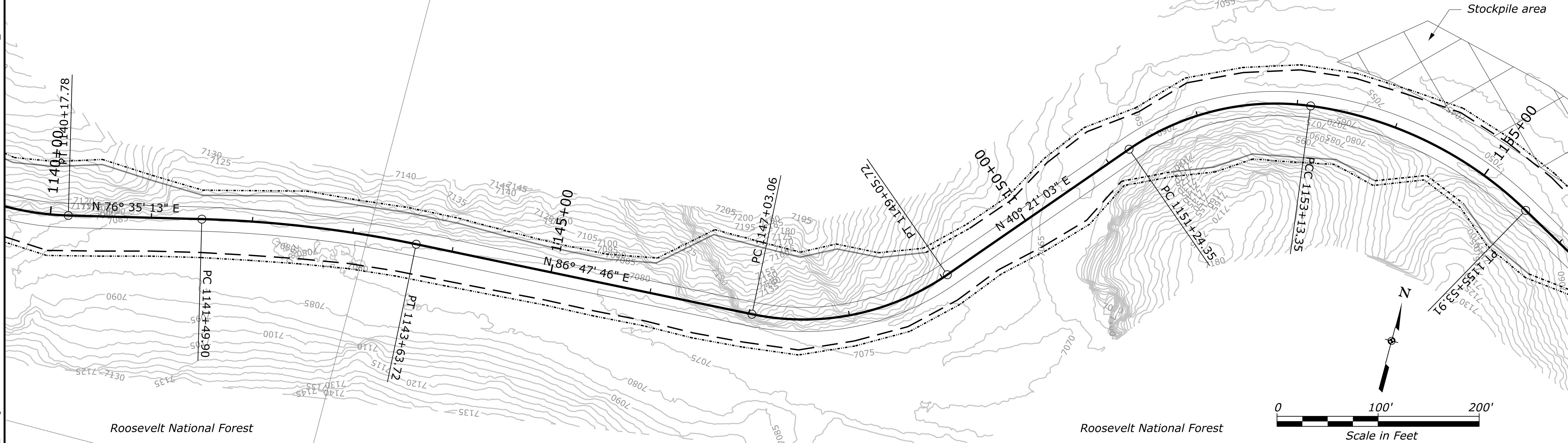
REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
IMR	CO	ER 43(1) Larimer County CR43 Glen Haven Rd Reconstruction	C4	C9

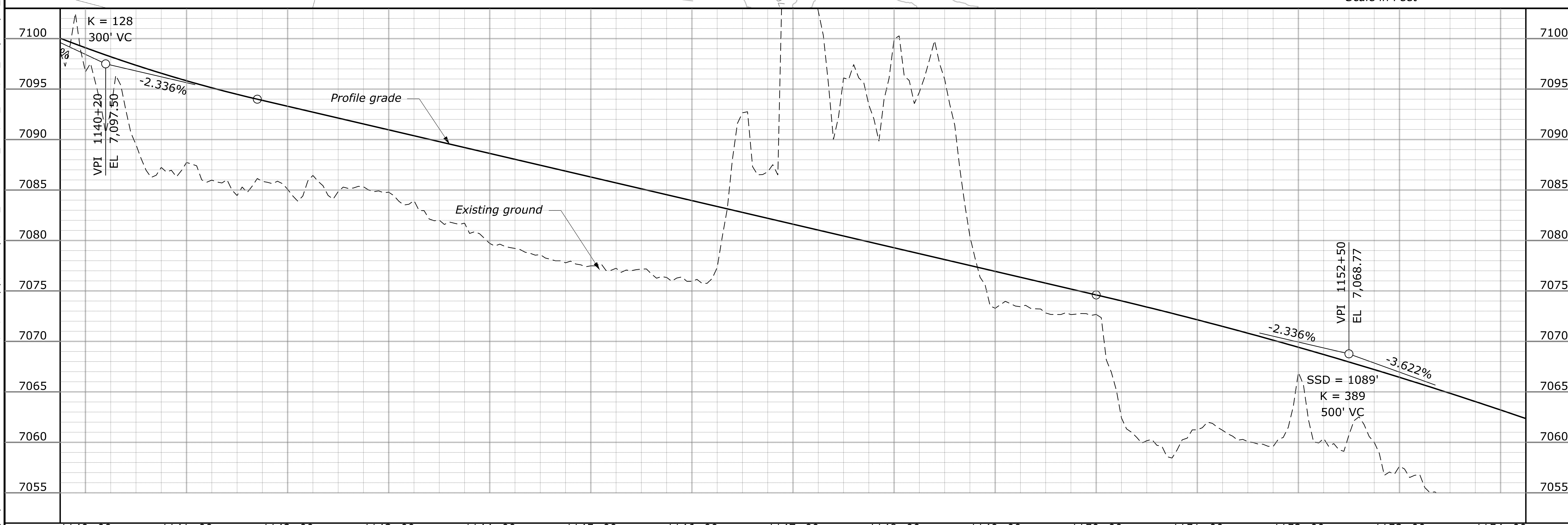
Curve = CR43-29
PI 1142+57.10
Δ= 10° 12' 33" (RT)
R = 1,200.00'
T = 107.19'
L = 213.82'

Curve = CR43-30
PI 1148+10.33
Δ= 46° 26' 43" (LT)
R = 250.00'
T = 107.27'
L = 202.66'

Curve = CR43-31
PI 1152+23.43
Δ= 42° 27' 59" (RT)
R = 255.00'
T = 99.08'
L = 189.00'

Curve = CR43-32
PI 1154+37.82
Δ= 36° 16' 17" (RT)
R = 380.00'
T = 124.47'
L = 240.56'





User: Stacy.Diccicco
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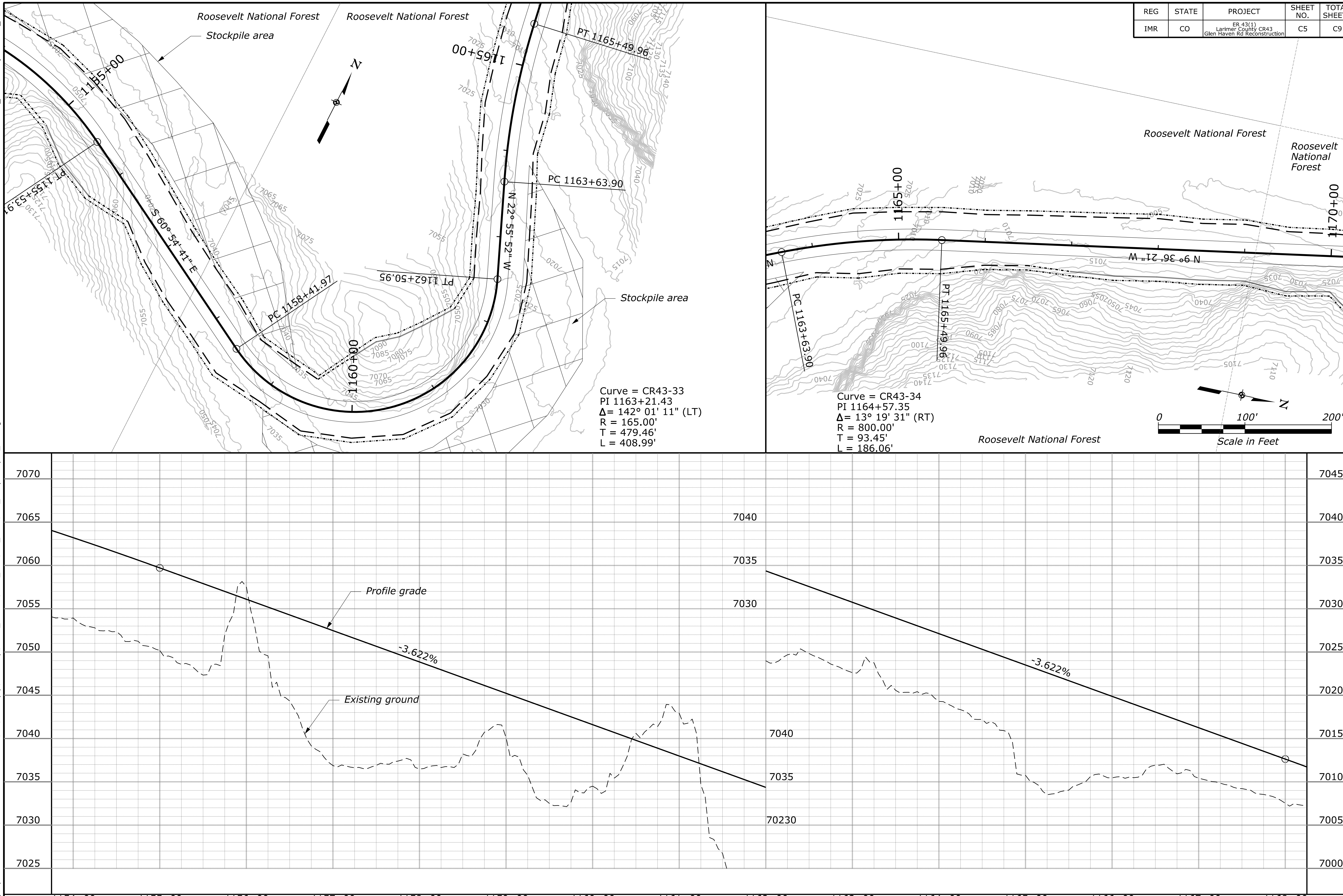
3:48:02 PM
7/15/2014

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
IMR	CO	ER 43(1) Larimer County CR43 Glen Haven Rd Reconstruction	C5	C9



User: Stacy.Diccicco_
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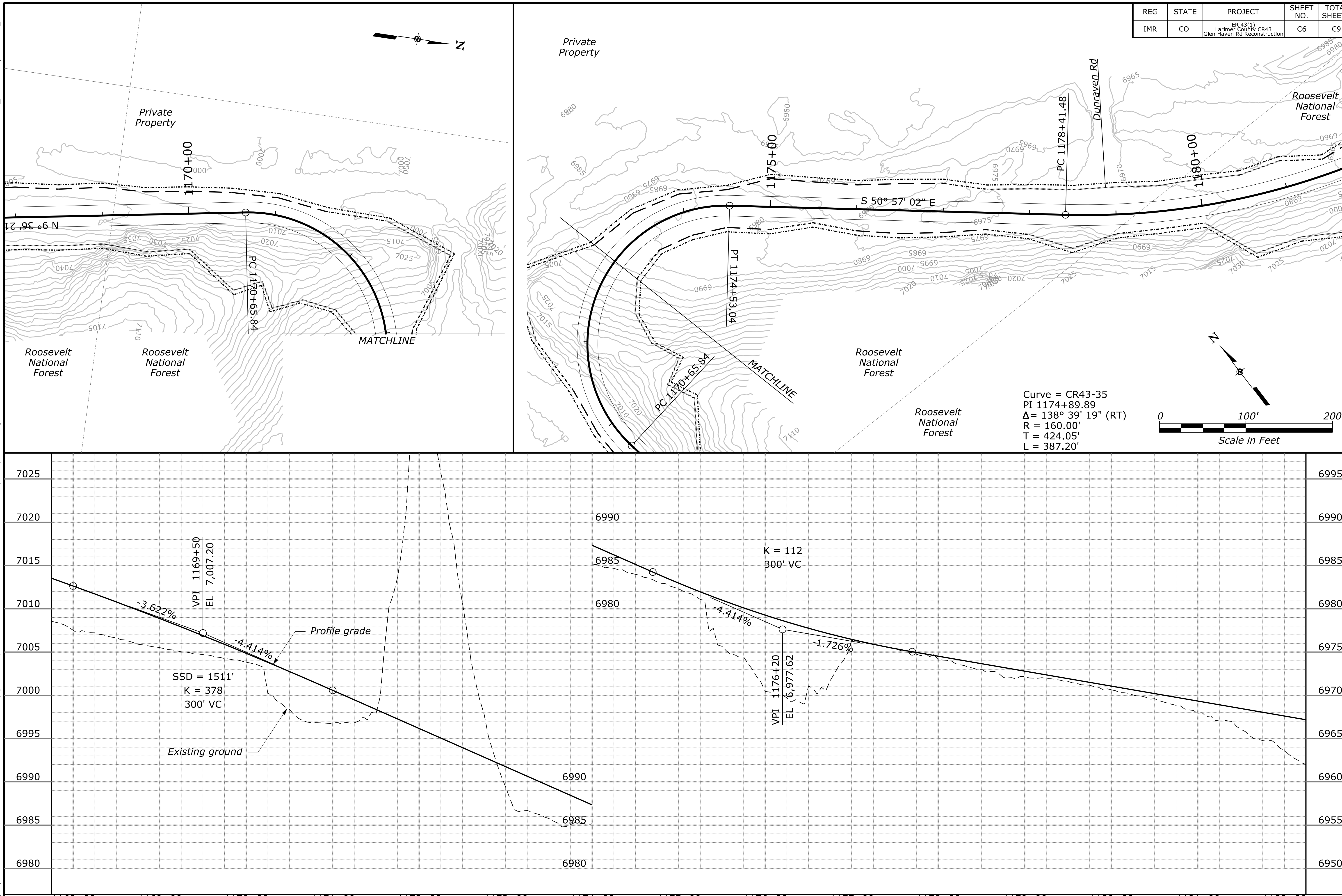
3:52:39 PM
7/15/2014

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
IMR	CO	ER 43(1) Larimer County CR43 Glen Haven Rd Reconstruction	C6	C9



User: Stacy.Diccicco

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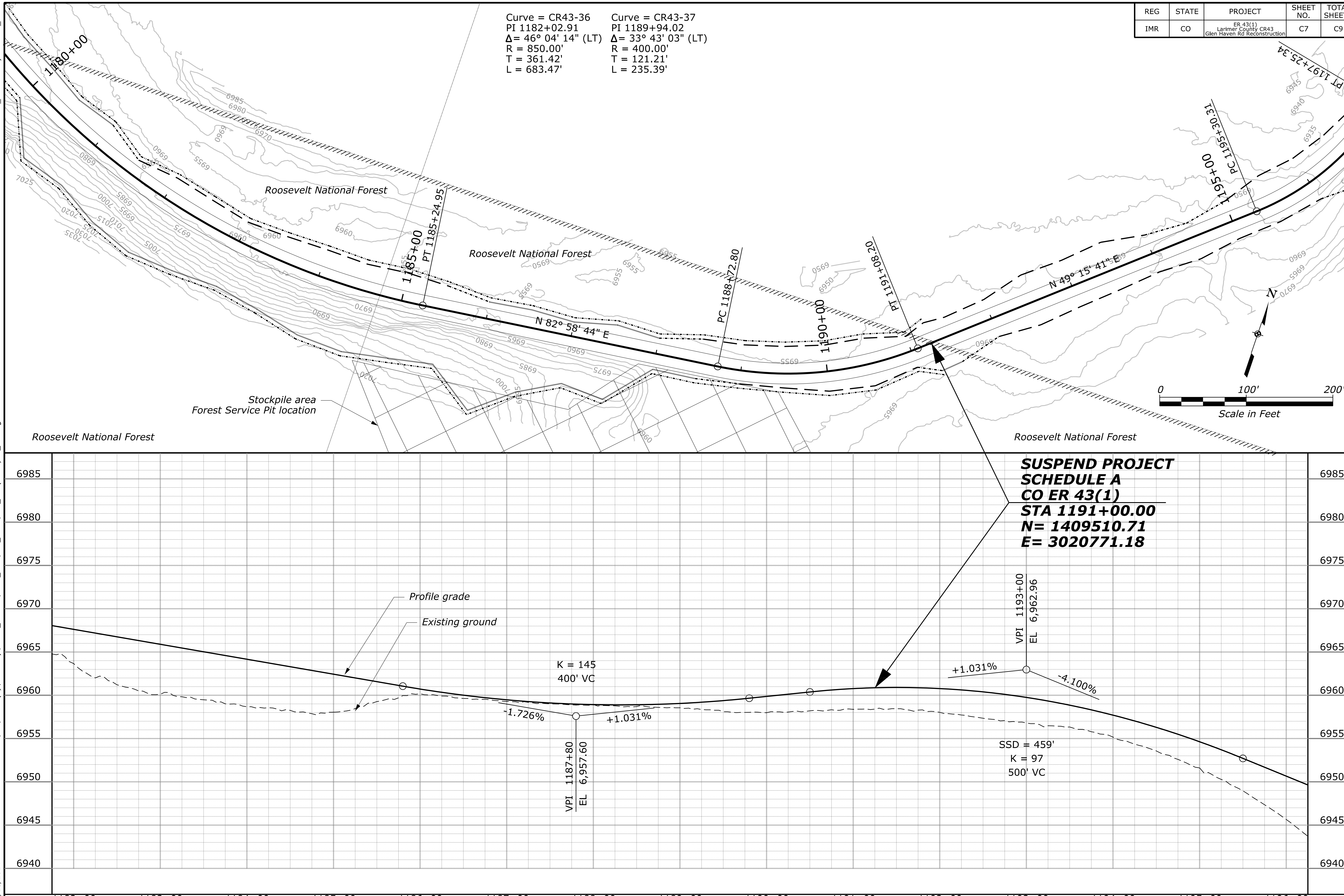
7/15/2014

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
IMR	CO	ER 43(1) Larimer County CR43 Glen Haven Rd Reconstruction	C7	C9



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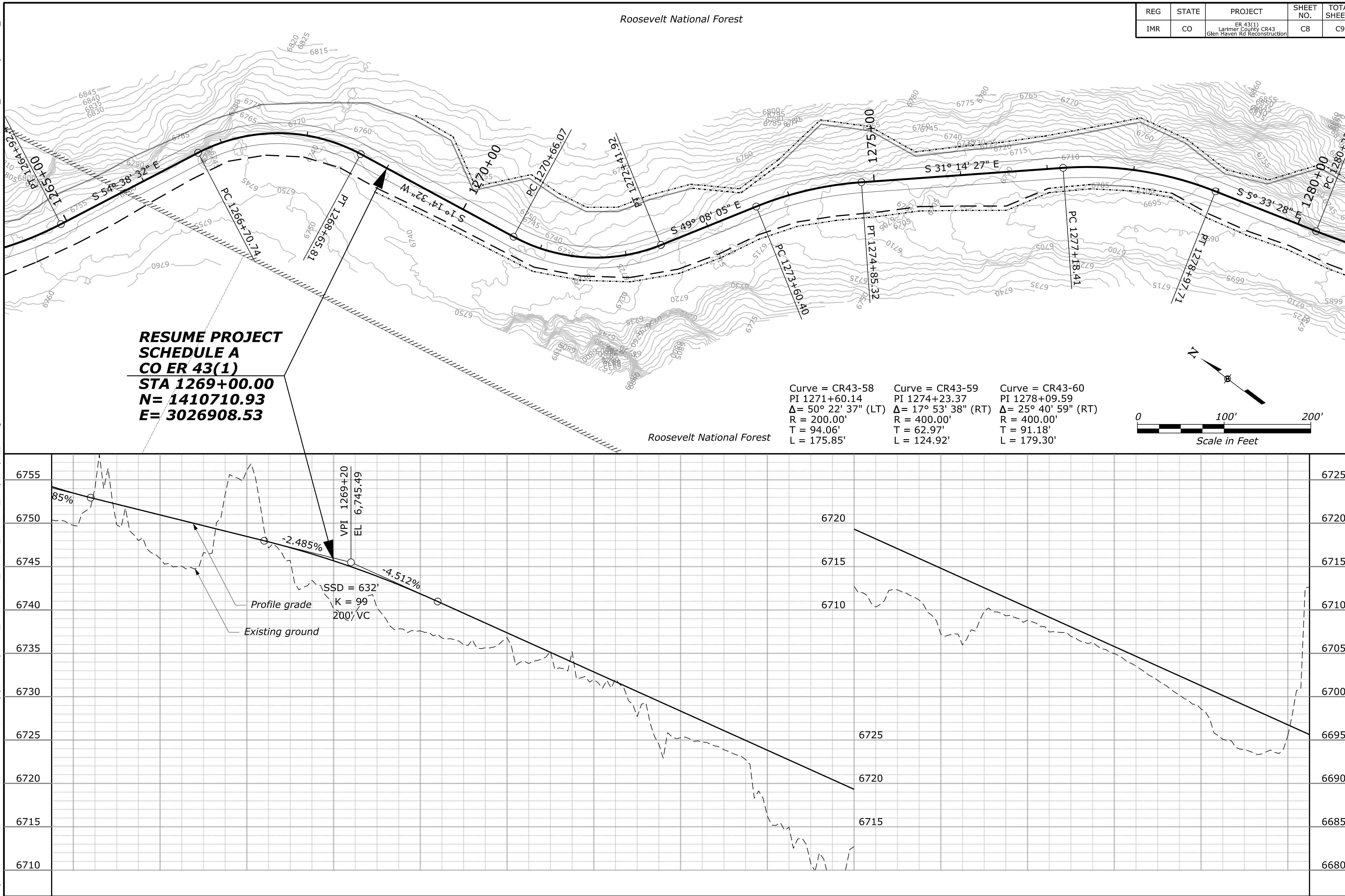
REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
IMR	CO	ER 43(1) Larimer County CR43 Glen Haven Rd Reconstruction	C8	C9



User: Stacy.Diciccco

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User: Stacy.Diccicco

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7/15/2014 3:59:42 PM