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Technical Memorandum
Yule Creek Monitoring Plan

Date: March 22, 2021

To: U.S. Army Corps of Engineers
Grand Junction Regulatory Office (Sacramento District)

From: Ecological Resource Consultants, Inc.

Project: **Yule Creek Monitoring Plan, Yule Creek Mitigation, Marble, Gunnison County, CO (U.S. Army Corps of Engineers Project Number: SPK-2019-00889)**

On behalf of Greg Lewicki and Associates and Colorado Stone Quarries, Inc. (applicant), Ecological Resource Consultants, Inc. (ERC) has prepared this Monitoring Plan for the Yule Creek Mitigation Plan (ERC 3-22-21, Mitigation Plan). The Mitigation Plan was developed to provide compensatory mitigation and ecological functional uplift for impacts to the eastern channel of Yule Creek subject of SPK-2019-00889. This Monitoring Plan was developed to ensure ecological functional uplift of the Mitigation Plan is achieved as determined by the Yule Creek Functional Assessment technical memorandum (ERC 3-22-21, Functional Assessment).

This Monitoring Plan is based on field data summarized in the Functional Assessment and required as part of the Colorado Stream Quantification Tool (CSQT, Version 1.0, July 7, 2020). Per letter request dated February 18, 2021 (Request for Additional Information or RAI), the U.S. Army Corps of Engineers (Corps) is requiring a plan to monitor the eastern channel of Yule Creek to ensure that the reach is providing the proposed functions as designed (Item #3 of the RAI). During a project conference call on March 9, 2021, the Corps approved the use of the CSQT and/or modified CSQT to define existing baseline conditions of the impact area, assist in development of a mitigation plan, and to determine functional uplift success criteria for the implemented Mitigation Plan. This Monitoring Plan also includes an adaptive management approach to address any design or maintenance issues that may arise.

I. MONITORING OVERVIEW

The intent of the Monitoring Plan is to establish a process for evaluating whether the Mitigation Plan is successfully achieving stream functional uplift as determined per the Functional Assessment. The Monitoring Plan will help ensure that the compensatory mitigation is objectively evaluated to determine if it is developing into the desired stream type and providing the expected functions per the Functional Assessment (e.g., CSQT). The applicant (Colorado Stone Quarries, Inc.) will be responsible for monitoring the mitigation development. Annual field data collection, evaluation, and reporting will be submitted to the Corps for a period of five years (or as specified in the permit or until determined successful) in order to assess the status and success of the Mitigation Plan as well as provide information that can be used for corrective measures and/or adaptive management (as necessary). If the Mitigation Plan meets its success criteria in less than five years, the monitoring period length can be reduced, if there are at least two consecutive monitoring reports that demonstrate that success.

II. SUMMARY OF MONITORING PROTOCOL

Success of the Mitigation Plan shall be determined upon demonstrated benefit (i.e., uplift) in stream function compared to the pre-impacted condition based on assessment of input attributes to the CSQT. The specific monitoring parameters selected herein directly correlate to the CSQT to determine overall functional uplift of the Mitigation Plan.

Functional Categories to be monitored include:

1) **Reach Hydrology and Hydraulics**
2) **Geomorphology**

Table 1 provides a summary of the function based field parameters and monitoring methods. Field forms that will be used for monitoring data collection are provided in **Attachment A**.

Table 1. Summary of Measurement Methods for Annual Monitoring.

Function Based Field Parameter	Relevance to Restoration Objectives and Functions	Monitoring Method Field Form Used to Collect Data (Attachment A)
Reach Hydrology and Hydraulics		
Concentrated Flow Points	Concentrated flow points are defined as storm drains, outfalls or erosional features, such as swales, gullies or other channels that are created by anthropogenic impacts.	Project Reach Form
Average Depth	Average depth (ft) is the area wetted at the baseflow discharge divided by the wetted width of the cross-section. The average depth is calculated from three surveyed cross-sections. This metric uses cross-section geometry to determine the average cross-section depth (d) at riffles within the reach for the baseflow discharge.	Hydrology and Hydraulics
Bank Height Ratio	The bank height ratio (BHR) is a measure of channel incision and an indicator of whether flood flows can access and inundate the floodplain (Rosgen 2014). BHR is measured at riffles/cascades and calculated as the low bank height (LBH) divided by the bankfull riffle maximum depth (also referred to bankfull maximum depth; dmax). The low bank height is defined as the left or right streambank that has a lower elevation, indicating the minimum water depth necessary to inundate the floodplain.	Hydrology and Hydraulics
Entrenchment Ratio	An entrenchment ratio characterizes the vertical containment of the river by evaluating the ratio of the flood-prone width to the bankfull channel width measured at a riffle cross-section (Rosgen 1996). This metric is described in detail by Rosgen (2014). The floodprone width is the cross-section width at a riffle feature perpendicular to the valley at an elevation of two times the bankfull riffle maximum depth.	Hydrology and Hydraulics
Geomorphology		
Large Woody Debris	The Large Woody Debris (LWD) piece count metric is a count of the number of LWD pieces within a 328-foot (100 meters) section of stream.	Geomorphology

Function Based Field Parameter	Relevance to Restoration Objectives and Functions	Monitoring Method Field Form Used to Collect Data (Attachment A)
Percent Streambank Erosion	The percent streambank erosion is measured as the length of streambank that is actively eroding divided by the total length of bank (left and right) in the representative subreach.	Geomorphology
Pool Depth Ratio	The pool depth ratio is a measure of pool quality, where deeper pools score higher than shallow pools. Pool depth ratio is calculated as the bankfull pool maximum depth divided by the bankfull mean depth. Pool depth represents the difference in elevation between the deepest point of each pool and the bankfull elevation.	Geomorphology
Percent Riffle (Cascades)	The percent riffle (Cascade) is the proportion of the representative sub-reach containing riffle and run features, as distinct from pool features. Riffle generally refers to the plan form crossover section in between lateral scour pools in meandering channels and the cascade section of a mountain stream.	Geomorphology
Riparian Extent	The riparian extent metric describes the portion of the expected riparian area that currently contains riparian vegetation and is free from utility-related, urban, or otherwise soil disturbing land uses, fill, and development.	Riparian Extent Form, Greenline bank measurements
Woody Vegetation Cover	The woody vegetation cover field value for the CSQT is the sum of absolute percent woody plant cover from shrub and tree species, averaged across all plots within the representative sub-reach.	Riparian Veg Form
Percent Native Cover	Percent native cover metric is the relative cover of native species averaged across all plots within the representative sub-reach. Relative cover is the absolute cover of a species, or group of species, divided by the total coverage of all species, expressed as a percent.	Riparian Veg Form
General	Observations, permanent photo documentation and assessment for Adaptive Management that may not be captured in other Field Parameters.	General observations, notes and photos

III. ADAPTIVE MANAGEMENT

The implementation of an adaptive management plan is essential for evaluating whether the Mitigation Plan is developing properly during the critical establishment period (1-5 years after creation). The project may be vulnerable to inadequate geomorphology, bank erosion, and/or poor riparian vegetation establishment which could lead to the incorrect development of desired functioning per the CSQT. An adaptive management plan as part of the Monitoring Plan is to be used as a more general tool to predict potential downward trends of project components in order to determine necessary corrective measures prior to failure during the early stages of establishment to ensure the desired goals are met.

Once the Mitigation Plan is implemented, the Monitoring Plan, including adaptive management, will be initiated. As part of the adaptive management site-specific evaluation (typically completed as part of routine visual observations), potential concerns/problems will be assessed, and appropriate remediation measures will be implemented. The applicant will commit to the annual Monitoring Plan and implementation of adaptive management, as required. Typical problems or concerns that could arise as part of the Mitigation Plan may include channel instability/cascade failure, pool filling (deposition), bank erosion, lack of woody plant establishment, wildlife herbivory, weed establishment and upland slope failures into the flood prone area. Remedial actions that may need to be considered and implemented include heavy equipment operations to repair cascades/instability, in-channel (pool) sediment removal, replanting of vegetation, wildlife herbivory prevention, weed management, and slope stabilization.

IV. PERFORMANCE STANDARDS AND DETERMINATION OF PROJECT SUCCESS

The success of this Monitoring Plan will be determined based on an observable and measurable increase of functional change. Function based parameters defined in CSQT must show an increase in functional value from the Existing Condition Scores (ECS) versus the Proposed Condition Scores (PCS) as part of the Mitigation Plan and at a minimum provide a positive Total Proposed Functional Feet of 92.5 (per the Functional Assessment). Each functional category is assessed by the CSQT by inputting metrics to calculate scores. The scores are then weighted and summed to calculate overall scores.

The Monitoring Plan is designed to consider key elements related to the specific function parameters as part of the Mitigation Plan and CSQT PCS. It is intended to be used to evaluate the stability and natural evolution of the stream as it adjusts to flows and natural development. Upon completion of the project, routine monitoring will document each of the function parameters and physical habitat development per the methods outlined above. The routine monitoring results will then be compared to the baseline data collected in 2021. **Table 2** below lists the metrics evaluated and the target values used to development the Mitigation Plan for each parameter.

Table 2. CSQT Field Values for Success.

Function Based Field Parameter	Target CSQT Field Values* of the Mitigation Plan	Baseline CSQT Field Values (Impacted Western Alignment)
Reach Hydrology and Hydraulics		
Concentrated Flow Points	1.8	5.7
Average Depth	2	2
Bank Height Ratio	2	2
Entrenchment Ratio	1.5	1.3
Geomorphology		
Large Woody Debris	50	30
Percent Streambank Erosion	0	0
Pool Depth Ratio	2	1.5
Percent Riffle (Cascades)	73	78
Riparian Extent	75%	25
Woody Vegetation Cover	75%	40
Percent Native Cover	100%	100

Note: Target field values represent modeled conditions per the Mitigation Plan to achieve 92.5 functional feet (FF) uplift per CSQT.

V. ANNUAL MONITORING REPORT FORMAT.

A Monitoring Report will be prepared after each annual monitoring event. Each report will summarize the resulting data collected and present conclusions and trends for each CSQT parameter and calculated Functional Feet. The report will include graphs and maps for visual comparisons, and permanent photo points to evaluate site development over the monitoring period.

An annual monitoring report which follows the *USACE Minimum Monitoring Requirements for Compensatory Mitigation Projects Involving the Restoration, Establishment, and/or Enhancement of Aquatic Resources* will be submitted to the USACE prior to December 31 of the monitoring year. Per the USACE Minimum Monitoring Requirements, the monitoring report narrative (which does not include supporting data) will be less than 10 pages and include the following information:

i Project Overview (1 page)
ii. Requirements (1 page)
iii. Summary Data (maximum of 4 pages)
iv. Maps and Plans (maximum of 3 pages)
v. Conclusions (1 page)
- Completion of Compensatory Mitigation Requirements
- Special Conditions

vi. Appendix with supporting data

Data to be summarized as part annual monitoring reports shall contain, at a minimum, the following:

- Monitoring methods,

- Performance standards,
- Annual monitoring data,
- Quantitative comparison of current year results with past years' results,
- Assessment of observed trends or trajectory of measured parameters,
- Site photos,
- A discussion of the success or failure of achieving performance standards for the individual parameters and the mitigation as a whole,
- Recommendations for adaptive management remedial actions, as necessary; and
- Monitoring Map depicting data locations, features, conditions, comments, and photo points.

ATTACHMENT A
FIELD FORMS

Project Name:
Reach ID:

Colorado Stream Quantification Tool
Parameter Selection Checklist

	Function-Based Parameter	Metric(s)	Applicability
☑	Reach Runoff*	☑ Land Use Coefficient (D) **AND** Concentrated Flow Points (F)	All streams and flow types.
☑	Baseflow Dynamics	☑ ***Optional:*** Velocity **AND** Average Depth (D/F)	Use where hydraulic conditions during summer/fall baseflow periods may not support trout assemblages under existing or proposed conditions due to flow or channel alteration.
☑	Floodplain Connectivity*	☑ Bank Height Ratio **AND** Entrenchment Ratio (F)	Omit ER in multi-thread channels.
		☐ ***Optional:*** Percent Side Channels (F)	Metric can be used in alluvial valleys with single-thread channels that support side-channels.
☑	Large Woody Debris (LWD)	☐ ***Optional:*** LWD Index (F)	Use in systems with forested catchments, riparian gallery forests, or that otherwise naturally have a supply of LWD.
		or	
		☑ ***Optional:*** No. of LWD Pieces/ 100 meters (F)	
☑	Lateral Migration*	☑ Dominant BEHI/NBS **AND** Percent Streambank Erosion (F)	Use in single-thread channels.
		or	
		☐ Greenline Stability Rating (F)	Likely more applicable in streams naturally in disequilibrium.
		☐ Percent Armoring (F)	Use in addition to the other metric(s) when man-made armoring is present or proposed in the project reach.
☑	Bed Form Diversity *in perennial and intermittent single-thread channels	☑ Pool Spacing Ratio **AND** Pool Depth Ratio **AND** Percent Riffle* (F)	Omit pool spacing ratio in bedrock dominated systems.
		☐ ***Optional:*** Aggradation Ratio (F)	Use in meandering single-thread stream types in transport settings where the riffles are exhibiting signs of aggradation.
☑	Riparian Vegetation*	☑ Riparian Extent (D/F) **AND** Woody Vegetation Cover (F) **AND** Percent Native Cover (F)	Where absolute woody vegetation cover is/should be >20%.
		☐ Riparian Extent (D/F) **AND** Herbaceous Vegetation Cover (F) **AND** Percent Native Cover (F)	Where absolute woody vegetation cover is/should be <20%.
☐	Temperature	☐ ***Optional:*** Daily Maximum Temperature (F) **AND** Maximum Weekly Average Temperature (F)	Use these parameters and metrics for projects with goals related to water quality improvements.
☐	Dissolved Oxygen	☐ ***Optional:*** Dissolved Oxygen Concentration (F)	
☐	Nutrients	☐ ***Optional:*** Chlorophyll α (F)	
☐	Macroinvertebrates	☐ ***Optional:*** Colorado Multi-Metric Index (F)	Use for projects with goals related to biological improvements or where project may impact conservation areas or other valuable fish habitats.
☐	Fish	☐ ***Optional:*** Native Fish Species Richness **AND** SGCN Absent (F)	
		☐ ***Optional:*** Wild Trout Biomass (F)	

* Include in all assessments
(D) indicates metrics are calculated using desktop methods
(F) indicates metrics are calculated or verified using field methods

Date:
Investigators:

Colorado Stream Quantification Tool
Project Reach Form

I. Site Information

Project Name:	
Reach ID:	
Drainage Area (sq. mi.):	
Flow Permanence:	
River Basin:	
Valley Type:	
Stream Reach length (ft):	
Latitude:	
Longitude:	

Shading Key
Desktop Value
Field Value
Calculation

II. Reach Walk

A.

Difference between bankfull (BKF) stage and water surface (WS) (ft)							
Difference between BKF stage and WS (ft) *Average or consensus value from reach walk.*							

B.

Number Concentrated Flow Points	
Concentrated Flow Points/ 1,000 L.F.	

C.

Length of Armoring on banks (ft)							
Total (ft)							
Percent Armoring (%)							

D.

Length of Side Channels (ft)							
Total (ft)							
Percent Side Channels (%)							

E.

Valley length (ft)	
Stream Length (ft)	
Sinuosity	

III. Identification of Representative Sub-Reach

Representative Sub-Reach Length At least 20 x the Bankfull Width		20*Bankfull Width	
Latitude of downstream extent:			
Longitude of downstream extent:			

Sub-Reach Survey Method

□ Rapid Survey
□ Detailed (Laser Level, Standard Level, Total Station, Survey-grade GPS, Other)

Date:
Investigators:

Colorado Stream Quantification Tool
Project Reach Form

Representative Sub-Reach Sketch

Notes

Date:
Investigators:

Colorado Stream Quantification Tool
Riparian Extent Form

Project Reach Name:
Project Reach Length:

Aerial imagery mapped extent:	Expected (area):		Observed (area):	
Check Aerial Imagery indicators used to define Expected Area:			Riparian Area %:	
	Valley Edge		Slope break/Terrace	Notes:
	Change in Sediment		Meander Width Ratio	
	Evidence of Flooding		Other:	
	Change in Vegetation			

If Meander Width Ratio approach was used, enter the following information:

Valley Type:		Meander Width Ratio Used:		Additional width (ft):	
Valley Length (ft):		Bankfull width (ft):		Expected Area (ft^2):	

FIELD VERIFICATION				
Date of Field visit:				
Field measured extent:	Expected (area):		Observed (area):	
Check indicators observed in the field at Expected Riparian Area extent:			Riparian Area %:	
	Valley Edge		Slope break/Terrace	Notes:
	Change in Sediment		Other:	
	Evidence of Flooding			
	Change in Vegetation			

Insert Aerial Photo of Project Reach with Observed and Expected Riparian Area extents:

Shading Key
Desktop Value
Field Value
Calculation

Date:
Investigators:

Colorado Stream Quantification Tool
Riparian Vegetation Form

Sub-Reach Name:
Sub-Reach Length: #Plots/side: Random Start #(1-20):

Plot Information		Cover Type: Location: Station ID:	Cover Type: Location: Station ID:	Cover Type: Location: Station ID:	Cover Type: Location: Station ID:
Tree Plots	N/I	Left Plot __	Right Plot __	Left Plot __	Right Plot __
Tree Absolute Cover Subtotal		0	0	0	0
Shrub Plots	N/I	Left Plot __	Right Plot __	Left Plot __	Right Plot __
Shrub Absolute Cover Subtotal		0	0	0	0
Absolute Woody Cover (%)		0	0	0	0
Absolute Native Woody Cover (%)		0	0	0	0

N= Native
I = Introduced

Cover Type: H, S, F
Herbaceous, Scrub-shrub, Forested

Location = Geomorphic Location: I, O, S
Inside meander, Outside meander, Straight/riffle

Date:
Investigators:

Colorado Stream Quantification Tool
Riparian Vegetation Form

Herbaceous Plots		Left Plot __		Right Plot __		Left Plot __		Right Plot __	
Species	N/I	Herb Plot 1	Herb Plot 2	Herb Plot 1	Herb Plot 2	Herb Plot 1	Herb Plot 2	Herb Plot 1	Herb Plot 2
Absolute Herb Cover (%)		0	0	0	0	0	0	0	0
Absolute Native Herb Cover (%)		0	0	0	0	0	0	0	0

N= Native
I = Introduced

Cover Type: H, S, F
Herbaceous, Scrub-shrub, Forested

Location = Geomorphic Location: I, O, S
Inside meander, Outside meander, Straight/riffle

Project Name:
Reach ID:

Colorado Stream Quantification Tool
Bankfull Verification Documentation

Bankfull Riffle Values used for CSQT Calculations:

Discharge (CFS):	
Cross-sectional area (SF):	
Width (FT):	
Maximum Depth (FT):	
Mean Depth (FT):	

If field verification was not possible, explain why.

(1) Line of Evidence:

- ☐ Surveyed Profile of WSEL and Bankfull
- ☐ Return Interval Analysis
- ☐ Regional Curves
- ☐ H&H Modeling
- ☐ Other:_____
- ☐ Other:_____

BKF value calculated from this method:

Description:

(2) Line of Evidence:

- ☐ Surveyed Profile of WSEL and Bankfull
- ☐ Return Interval Analysis
- ☐ Regional Curves
- ☐ H&H Modeling
- ☐ Other:_____
- ☐ Other:_____

BKF value calculated from this method:

Description

Project Name:
Reach ID:

Colorado Stream Quantification Tool
Bankfull Verification Documentation

(3) Line of Evidence:

- ☐ Surveyed Profile of WSEL and Bankfull
- ☐ Return Interval Analysis
- ☐ Regional Curves
- ☐ H&H Modeling
- ☐ Other:_____
- ☐ Other:_____

BKF value calculated from this method:

Description

(4) Line of Evidence:

- ☐ Surveyed Profile of WSEL and Bankfull
- ☐ Return Interval Analysis
- ☐ Regional Curves
- ☐ H&H Modeling
- ☐ Other:_____
- ☐ Other:_____

BKF value calculated from this method:

Description

Project Name:
Reach ID:

EXISTING or PROPOSED or Monitoring (Select one)

Colorado Stream Quantification Tool
Field Value Documentation

Item	Value	Value Source/Reference
Reach Hydrology & Hydraulics Reach Runoff Land Use Coefficient		
Lateral Drainage Area (total; Acres)		
Forested or scrub-shrub (Acres)		
Herbaceous (Acres)		
Open Water (Acres)		
Open Space (Acres)		
Impervious Surfaces (Acres)		
Pasture (Acres)		
Cropland (Acres)		
FIELD VALUE - Land Use Coefficient (%)		Calculated
Concentrated Flow Points (#/1000 LF)		
FIELD VALUE - Concentrated Flow Points		Pulls from project reach form.
Baseflow Dynamics		
Gage Sampling Period (start, stop, and sampling interval)		
Gage number (if applicable)		
Q baseflow (cfs)		
Area wetted (sf) - Riffle 1		
Area wetted (sf) - Riffle 2		
Area wetted (sf) - Riffle 3		
Average Velocity (fps)		
Average Velocity (fps) - Riffle 1		
Average Velocity (fps) - Riffle 2		
Average Velocity (fps) - Riffle 3		
FIELD VALUE - Average Velocity (fps)		Calculated
Average Depth (ft)		
Top Width wetted (ft) - Riffle 1		
Average depth (ft) - Riffle 1		
Top Width wetted (ft) - Riffle 2		
Average depth (ft) - Riffle 2		
Top Width wetted (ft) - Riffle 3		
Average depth (ft) - Riffle 3		
FIELD VALUE - Average Depth (ft)		Calculated

Project Name:
Reach ID:

EXISTING or PROPOSED or Monitoring (Select one)

Colorado Stream Quantification Tool
Field Value Documentation

Item	Value	Value Source/Reference
Reach Hydrology & Hydraulics Floodplain Connectivity		
Riffle lengths - Riffle 1		
Riffle lengths - Riffle 2		
Riffle lengths - Riffle 3		
Riffle lengths - Riffle 4		
Bank Height Ratio		
BHR - Riffle 1		
BHR - Riffle 2		
BHR - Riffle 3		
BHR - Riffle 4		
FIELD VALUE - Weighted Bank Height Ratio (ft/ft)		Calculated
Entrenchment Ratio		
ER - Riffle 1		
ER - Riffle 2		
ER - Riffle 3		
ER - Riffle 4		
FIELD VALUE - Weighted Entrenchment Ratio (ft/ft)		Calculated
Percent Side Channels (%)		
FIELD VALUE - Percent Side Channels (%)		Pulls from project reach form.

Project Name:
Reach ID:

EXISTING or **PROPOSED** or **Monitoring**
(Select one)

CSQT
Field Value Documentation

Item	Value(s)	Value Source/Reference
Geomorphology Large Woody Debris LWD Index		
FIELD VALUE - LWDI		LWDI spreadsheet output
No. of LWD Pieces/ 100 meters		
FIELD VALUE - No of LWD Pieces / 100 m		Counted in field
Lateral Migration Greenline Stability Rating		
% Composition of Stability Class 1		
% Composition of Stability Class 2		
% Composition of Stability Class 3		
% Composition of Stability Class 4		
% Composition of Stability Class 5		
% Composition of Stability Class 6		
% Composition of Stability Class 7		
% Composition of Stability Class 8		
% Composition of Stability Class 9		
% Composition of Stability Class 10		
FIELD VALUE - Greenline Stability rating		Calculated
Dominant BEHI/NBS		
Total Length of Bank Assessed (ft)		
BEHI/NBS Category 1		
Total Bank Length for Category 1 (ft)		
BEHI/NBS Category 2		
Total Bank Length for Category 2 (ft)		
BEHI/NBS Category 3		
Total Bank Length for Category 3 (ft)		
BEHI/NBS Category 4		
Total Bank Length for Category 4 (ft)		
BEHI/NBS Category 5		
Total Bank Length for Category 5 (ft)		
BEHI/NBS Category 6		
Total Bank Length for Category 6 (ft)		
FIELD VALUE - Dominant BEHI/NBS		
Percent Streambank Erosion (%)		
Length of Eroding Streambanks (sum)		Sum from values above
Representative Sub-reach Length (ft)		Pulls from project reach form.
FIELD VALUE - Percent Streambank Erosion (%)		Calculated
Percent Streambank Armoring (%)		
FIELD VALUE - Percent armoring (%)		Pulls from project reach form.

Project Name:
Reach ID:

EXISTING or **PROPOSED** or **Monitoring**
(Select one)

CSQT
Field Value Documentation

Item	Value(s)	Value Source/Reference
Geomorphology Bed Form Diversity Pool Spacing Ratio		
Median of Pool Spacings		
Number of Geomorphic Pools		
Bankfull Riffle Width (ft)		
FIELD VALUE - Pool Spacing Ratio		Calculated
Pool Depth Ratio		
Average of measured pool depth		
Number of pools measured		
Mean Riffle Depth		
FIELD VALUE - Pool Depth Ratio		Calculated
Percent Riffle (%)		
Reach Length		
Bankfull Riffle Width		
Representative Sub-Reach Length		Pulls from project reach form.
Total Riffle Length in Representative Sub-Reach		
FIELD VALUE - Percent Riffle (%)		Calculated
Aggradation Ratio		
Bankfull width at max riffle (ft)		
Bankfull mean depth (ft)		
Reference width/depth ratio (ft/ft)		
FIELD VALUE - Aggradation Ratio		Calculated
Riparian Vegetation - Field Forms Required, values calculated from those forms. Riparian Extent (%)		
Meander width ratio		
Additional width (ft)		per User Manual
FIELD VALUE - Riparian Extent (%)		Calculated
Woody Vegetation Cover (%)		
FIELD VALUE - Average Woody Cover (%)		Calculated
Herbaceous Vegetation Cover (%)		
FIELD VALUE - Average Herbaceous Vegetation Cover (%)		Calculated
Percent Native Cover (%)		
FIELD VALUE - Native Cover (%)		Calculated

Colorado Stream Quantification Tool
Longitudinal Profile Form

Date:	Rod Team:
Stream Name:	Instrument Team:
Reach I.D.	Notes Team:
Team Number:	

Longitudinal Profile Field Form

Key Codes:

Head of Riffle	R	Bankfull	BKF	Benchmark	TBM
Head of Run	N	Top of Bank	TOB	Turning Point	TP
Head of Pool	P	Edge of Channel	EC	Backsight	BS
Head of Glide	G	Inner Berm	IB	Foresight	FS
Thalweg	TW			Height of Instrument	HI

Survey:			**Thalweg**		**Water Surface**		**Bankfull**		**Top of Low Bank**			
Station	**BS (+)**	**HI**	**FS (-)**	**Elevation**	**FS (-)**	**Elevation**	**FS (-)**	**Elevation**	**FS (-)**	**Elevation**	**FS (-)**	**Elevation**

Colorado Stream Quantification Tool
Longitudinal Profile Form

Survey:			Thalweg		Water Surface		Bankfull		Top of Low Bank			
Station	BS (+)	HI	FS (-)	Elevation	FS (-)	Elevation	FS (-)	Elevation	FS (-)	Elevation	FS (-)	Elevation

Colorado Stream Quantification Tool

Cross Section Form

Date:	Rod Team:
Stream Name:	Instrument Team:
Reach I.D.	Notes Team:
Team Number:	

Key Codes:

Head of Riffle	R	Bankfull	BKF	Benchmark	TBM
Head of Run	N	Top of Bank	TOB	Turning Point	TP
Head of Pool	P	Edge of Channel	EC	Backsight	BS
Head of Glide	G	Inner Berm	IB	Foresight	FS
Thalweg	TW			Height of Instrument	HI

Cross Section Field Form

Station	**BS (+)**	**HI**	**FS (-)**	**Elevation**	**Notes**

Date:
Investigators:

Colorado Stream Quantification Tool
Rapid Survey Form

Reach ID:

I. Riffle Data (Floodplain Connectivity & Bed Form Diversity)

A.	Representative Sub-Reach Length			20*Bankfull Width	

B. Bank Height & Riffle Data: Record for each riffle in the Sub-Reach

	R1	R2	R3	R4	R5	R6	R7	R8
Begin Station								
End Station								
Low Bank Height (ft)								
BKF Max Depth (ft)								
BKF Mean Depth (ft)								
BKF Width (ft)								
Flood Prone Width (ft)								
Riffle Length (ft) *Including Run*								
Bank Height Ratio (BHR) Low Bank H / BKF Max D								
BHR * Riffle Length (ft)								
Entrenchment Ratio (ER)								
ER * Riffle Length (ft)								
WDR BKF Width/BKF Mean Depth								

C.	Total Riffle Length (ft) *Excludes Additional Pool Lengths*	
D.	**Weighted BHR** $\frac{\Sigma(Bank\ Height\ Ratio_i \times \text{Riffle Length}_i)}{\Sigma Riffle\ Length}$	
E.	**Weighted ER**	
F.	**Maximum WDR**	
G.	**Percent Riffle (%)**	

Shading Key
Field Value
Calculation

II. Pool Data (Bed Form Diversity)

A. Pool Data: Record for each pool within the Sub-Reach

	P1	P2	P3	P4	P5	P6	P7	P8
Geomorphic Pool?								
Station								
P-P Spacing (ft)								
Pool Spacing Ratio Pool Spacing/BKF Width								
Pool Depth (ft) Measured from BKF								
Pool Depth Ratio Pool Depth/BKF Mean Depth								

B.	**Average Pool Depth Ratio**		C.	**Median Pool Spacing Ratio**	

III. Slope

	Begin	End	Difference	Slope (ft/ft)
Station along tape (ft)				
Stadia Rod Reading (ft)				

IV. Notes