APPENDIX L: RAPID GEOMORPHIC ASSESSMENTS (RGA) CONDUCTED FOR THE PROPOSED LOWER BOIS D'ARC CREEK RESERVOIR SITE IN 2008 AND 2016

L-1: RAPID GEOMORPHIC ASSESSMENT OF BOIS D'ARC CREEK AND ITS TRIBUTARIES FOR THE LOWER BOIS D'ARC CREEK RESERVOIR PROJECT (2008)

L-2: SUPPLEMENTAL RAPID GEOMORPHIC ASSESSMENT DATA COLLECTION AT THE PROPOSED LOWER BOIS D'ARC CREEK RESERVOIR SITE (2016)

MEMORANDUM

FREESE AND NICHOLS

Innovative approaches
Practical results
Outstanding service

4055 International Plaza, Suite 200 • Fort Worth, Texas 76109 • 817-735-7300 • fax 817-735-7492 www.freese.com

TO: Robert McCarthy, NTMWD

CC: Simone Kiel, P.E.; Michael Votaw, P.W.S; Steve Watters, P.W.S, Stephanie Coffman, P.G.

FROM: David Coffman, P.G., C.F.M.; Velita Cardenas

SUBJECT: Supplemental Rapid Geomorphic Assessment (RGA) Data Collection at the Proposed Lower Bois d'Arc Creek Reservoir Site

DATE: March 1, 2016

PROJECT: NTD06128

1.0 INTRODUCTION

The North Texas Municipal Water District (NTMWD) is proposing to construct the Lower Bois d'Arc Creek Reservoir (LBCR) in Fannin County, TX. A rapid geomorphic assessment (RGA) of Bois d'Arc Creek and its four major tributaries within the footprint of the proposed LBCR was performed in 2008 to provide an estimate of baseline stream conditions (Freese and Nichols, 2008). At the time of this stream assessment, no functional or conditional stream assessment methods had been proposed, adopted, endorsed, or required by the U.S. Army Corps of Engineers (USACE) or other resource agencies having jurisdiction within the state of Texas. Applicants were encouraged to use best scientific judgement in employing tools to assess the function or condition of streams to be affected by the applicant's proposed project, LBCR. In March 2011 a draft methodology for stream (and wetland) condition assessment, Texas Rapid Assessment Method, Version 1.0 (TXRAM), was first published for use, testing, and public comment (USACE, 2011). The final TXRAM guidebook, Version 2.0, was issued by public notice published in October 2015 (USACE, 2015), seven years after fieldwork at the LBCR site was completed.

The data collection method and subsequent analysis used to assess the proposed LBCR site was also used to assess the streams on the proposed mitigation site, Riverby Ranch, in June 2014. A technical memorandum titled, *Proposed Mitigation for Stream Impacts of the Proposed Lower Bois d'Arc Creek Reservoir – Rapid Geomorphic Assessment* was submitted to NTMWD on November 12, 2014 ("the 2014 RGA memo"; see Attachment A). It described how RGA scores were calculated to characterize baseline condition of streams at both the LBCR site and at Riverby Ranch. The memo also outlined how the proposed stream mitigation would compensate for the stream impacts caused by the proposed LBCR (Freese and Nichols, 2014).

NTMWD submitted the 2014 RGA memo to the USACE, who subsequently distributed it to the Cooperating Agencies working with the USACE on the Clean Water Act, Section 404 permit for the proposed LBCR. These agencies include the U.S. Environmental Protection Agency (EPA), U.S. Fish and Wildlife Service (USFWS), the Texas Commission on Environmental Quality (TCEQ), and Texas Parks and Wildlife Department (TPWD). A workshop was held on October 13, 2015 to discuss the RGA method and its

application at the proposed reservoir site and the proposed mitigation site. The workshop was attended by representatives from USACE, EPA, USFWS, TCEQ, TPWD, NTMWD, and Freese and Nichols (See Attachment B).

During the workshop, the USACE and Cooperating Agencies requested additional RGA data be collected at the proposed reservoir site to supplement the 2008 data collection effort and assessment. In 2008, the RGA data collected on the main stem of Bois d'Arc Creek and four tributaries (Honey Grove Creek, Bullard Creek, Ward Creek, and Sandy Creek) were extrapolated to characterize all of the stream reaches in the proposed reservoir site. At the request of the resource agencies, the requested additional RGA data would be used to confirm the methodology used to characterize streams that were not directly measured in 2008.

The USACE worked with the Cooperating Agencies and NTMWD to identify 10 additional tributaries within the footprint of the proposed reservoir for additional RGA data collection. These tributaries included Allen's Creek, Burns Branch, Fox Creek, Onstott Creek, Pettigrew Branch, Sandy Branch, Stillhouse Branch, Timber Creek, Thomas Branch, and Yoakum Creek, with additional points on Honey Grove Creek, Sandy Creek, and Ward Creek. USACE approved the final locations of the additional RGA data collection sites via email to NTMWD and the Cooperating Agencies on December 7, 2015 (see Exhibit A and Attachment C).

The fieldwork to collect the supplemental RGA data took place during the week of January 11, 2016. Cooperating Agency members were invited to participate in the field data collection effort. In attendance during field work were Ed Parisotto and Robert Hoffman from USACE, Ryan McGillicuddy from TPWD, Robert McCarthy from NTMWD and Freese and Nichols staff.

The supplemental RGA data were collected using the same RGA methods as the previous investigations at the proposed reservoir site (2008) and the proposed mitigation site (2014) as described in the 2014 RGA memo (see Attachment A).

2.0 RESULTS

RGA scores from the supplemental data collected in January 2016 were converted to Stream Quality Factor (SQF) values and used to revise the total number of stream quality units (SQUs) that are present (i.e., that would be impacted) at the proposed reservoir site. Table 1 shows the length of stream within the proposed LBCR footprint by SQF and the corresponding SQUs after incorporating the January 2016 RGA data in the analysis.

Table 1. Summary of Proposed Reservoir Site SQUs Incorporating 2016 RGA Field Data

Stream Quality Factor (SQF)	Existing Length (ft)	Stream Quality Unit (SQU)
0 - .09	39,597	2,729
.1 - .19	116,842	15,512
.2 - .29	164,786	37,535
.3 - .39	125,191	40,463
.4 - .49	145,736	64,159
.5 - .59	58,872	31,519
.6 - .69	0	0
.7 - .79	0	0
.8 - .89	0	0
.9 - .99	0	0
1.0	0	0
Total	651,024	191,917

3.0 DISCUSSION OF RESULTS

Table 2 shows a comparison of the proposed reservoir site SQUs that were presented in the 2014 RGA memo (Attachment A) and the results incorporating the 2016 supplemental data. The total number of SQUs reported in the 2014 RGA memo were developed from an extrapolation of RGA data collected in 2008 from the main stem of Bois d'Arc Creek and its four major tributaries. The 2016 supplemental data collection effort expanded the observed and recorded stream conditions to include 10 additional tributaries of Bois d'Arc Creek and thereby improves on the extrapolation used in the 2014 RGA memo. In total, data were collected along the main stem of Bois d'Arc Creek and 14 tributaries within the footprint of the reservoir.

Table 2. Comparison of Proposed Reservoir Site SQUs with and without 2016 RGA Data

Stream Quality Factor (SQF)	Existing Length (ft)		Stream Quality Unit (SQU)	
	2014	2016	2014	2016
0 - .09	25,171	39,597	2,098	2,729
.1 - .19	91,337	116,842	11,592	15,512
.2 - .29	128,395	164,786	28,902	37,535
.3 - .39	73,580	125,191	23,013	40,463
.4 - .49	184,011	145,736	80,757	64,159
.5 - .59	141,422	58,872	77,835	31,519
.6 - .69	7,107	0	4,857	0
.7 - .79	0	0	0	0
.8 - .89	0	0	0	0
.9 - .99	0	0	0	0
1.0	0	0	0	0
Total	651,023	651,024	229,054	191,917

4.0 COMPENSATORY MITIGATION SUMMARY AND PROPOSED MITIGATION PLAN COMPONENTS

Based upon the supplemental data collection effort described in this memorandum, the total number of SQUs of Bois d'Arc Creek and its tributaries within the proposed reservoir pool, and therefore the total number of SQUs that would be impacted, is 191,917. As described in Attachment A, NTMWD has proposed four mitigation components to compensate for the impact of the proposed reservoir on streams.

As shown in Table 3, only the SQU uplift for Bois d'Arc Creek downstream of the proposed dam (generated by the proposed environmental flow regime, which would compensate for LBCR dam impacts as well as historical impacts due to channelization over the past century) are included in the total proposed mitigation. Based on re-assessment of impacts by incorporating the 2016 supplemental RGA data requested by the USACE and Cooperating Agencies, the total number of SQUs generated by the four proposed mitigation components would compensate for the stream losses in the proposed reservoir pool with a surplus of 1,417 SQUs.

Table 3. Baseline and mitigated SQUs for proposed stream mitigation components

Mitigation Component	Baseline SQU	Mitigated SQU
Riverby Ranch Stream Restoration and Enhancement	64,140	134,259
Riverby Ranch Stream Creation	0	23,806
Bois d'Arc Creek Downstream of Proposed Dam	N/A	5,974*
On-Site Tributaries to Littoral Zone Wetlands	21,840	29,295
Total Proposed Mitigation*	85,980	193,334**
Total Stream Impacts	191,917	
Total Stream SQU Surplus		1,417

*Uplift generated by improvement to Bois d'Arc creek downstream of proposed dam

**Uplift generated by WRP streams (4,797 SQUs) is not included in the total

5.0 REFERENCES

Freese and Nichols, 2008, Rapid Geomorphic Assessment of Bois d'Arc Creek and its Tributaries for the Lower Bois d'Arc Creek Reservoir Project: Prepared for North Texas Municipal Water District

Freese and Nichols, 2014, Proposed Mitigation for Stream Impacts of the Proposed Lower Bois d'Arc Creek Reservoir – Rapid Geomorphic Assessment: Prepared for North Texas Municipal Water District

U.S. Army Corps of Engineers. 2011. Joint Public Notice CESWF-11-TXRAM announcing release of the *Draft Texas Rapid Assessment Method (TXRAM), Wetland and Streams Modules, Version 1.0. Final Draft.* March 24, 2011.

U.S. Army Corps of Engineers. 2015. Joint Public Notice CESWF-11-TXRAM announcing release of the *Final Texas Rapid Assessment Method (TXRAM), Wetland and Streams Modules, Version 2.0.* October 13, 2015.

EXHIBITS

2015 RGA Data Collection Points

Proposed Lower Bois d'Arc Reservoir Project

North Texas Municipal Water District

FN PROJECT NO.	NTD06128
DATE	December 4, 2015
DATUM & COORDINATE SYSTEM	NAD83 State Plane TX Central
FILE	RGA_2015.mxd
PREPARED BY	VMC

N

EXHIBIT

A

Freese and Nichols
4055 International Plaza
Ste. 200
Fort Worth, TX 76109
Phone: (817) 735-7300
Fax: (817) 735-7491

Road
Stream
Proposed Dam
Proposed Reservoir
2015 Proposed RGA Refinement
2007 Rapid Assessment Reach Field Data Points
USACE Requested 2015 RGA Refinement

0 1 2 4 Miles

Document Path: H:\ENVIRONMENTAL\LBD_RGA_2015\RGA_2015.mxd Austin Network

Attachment A

Proposed Mitigation for Stream Impacts of the Proposed Lower Bois d'Arc Creek Reservoir – Rapid Geomorphic Assessment (Freese and Nichols, 2014)

TECHNICAL MEMORANDUM

FREESE AND NICHOLS
Innovative approaches
Practical results
Outstanding service

4055 International Plaza, Suite 200 • Fort Worth, Texas 76109 • 817-735-7300 • fax 817-735-7492 www.freese.com

TO: Robert McCarthy, NTMWD

CC: Simone Kiel, Randall Howard, Michael Votaw, Steve Watters

FROM: David Coffman, Stephanie Coffman, Velita Cardenas

SUBJECT: Proposed Mitigation for Stream Impacts of the Proposed Lower Bois d'Arc Creek Reservoir – Rapid Geomorphic Assessment

DATE: November 12, 2014; Corrected December 17, 2014

PROJECT: NTD06128

1.0 INTRODUCTION

The North Texas Municipal Water District (NTMWD) is proposing to perform mitigation for impacts to waters of the U.S. that would be caused by the proposed Lower Bois d'Arc Creek Reservoir project on the approximately 15,000 acre Riverby Ranch in northeast Fannin County, TX. Riverby Ranch is located approximately 25 miles northwest of Paris, Texas. The primary objectives of this study was to perform a rapid geomorphic assessment (RGA) of the creeks within Riverby Ranch (Exhibit 1), identify the mitigation potential of the ranch streams, and compare the mitigated condition of the ranch streams to the condition of the impacted streams within the proposed reservoir footprint. The RGA method is an analytical tool used to assess environmental impacts and project planning. The method is designed to describe stream quality at baseline and future conditions to allow for comparisons of the relative values of different areas at the same point in time or of the same area at different points in time.

A rapid geomorphic assessment (RGA) of Lower Bois d'Arc Creek and its four major tributaries within the footprint of the proposed Lower Bois d'Arc Creek Reservoir was performed in 2008 to provide an estimate of baseline stream conditions (Freese and Nichols, 2008). The data collection method and subsequent analysis used to assess the proposed Lower Bois d'Arc Creek Reservoir site was also used to assess the streams on Riverby Ranch. The field investigation component of the Riverby Ranch mitigation assessment took place on June 1-3, 2014. This report describes how RGA scores were calculated for both the proposed impacted and mitigation streams, and it outlines how the proposed stream mitigation would compensate for the stream impacts caused by the proposed reservoir.

Specifically, this memorandum covers the following topics:

- The RGA method and the calculation of Stream Quality Factor and Stream Quality Units
- RGA evaluation of the impacted streams at the proposed reservoir site
- Baseline condition assessment of five stream mitigation opportunities in the Bois d'Arc Creek watershed.
- The potential for ecological uplift in the mitigation streams generated through restoration and enhancement
- Proposed stream mitigation components to compensate for the impacts of the proposed reservoir

2.0 APPROACH AND METHODOLOGY

The following sub-sections provide descriptions of the RGA approach and how the RGA scores were used to derive Stream Quality Factor (SQF) and Stream Quality Unit (SQU) values for the proposed impact streams and mitigation streams. The rapid assessments were based on both anthropogenic and natural factors observed in the field and through comparison of the existing and historic channel pattern and geometry. The major factors evaluated were channel stability, vegetation/armoring, and potential in-stream habitat features. A description of the components used to develop the rapid stream assessments is presented below.

2.1 Rapid Geomorphic Assessment (RGA) Approach

The RGA approach integrates data from field and desktop sources into a quantitative and qualitative description of the features that affect stream stability and the potential for developing aquatic habitat features (Freese and Nichols, 2008). The RGA method is based on a rapid field assessment of stream properties and characteristics at representative field sites along the stream reaches being evaluated. Three forms are used to record data at each field point. The Data Collection sheet includes general stream information related to channel size and location. The Bank Stability form is used to record general bank geometry, information regarding riparian vegetation and rooting depths, and general bank armoring. The Channel Stability form is used to collect a variety of information related to the condition of the upper slopes, lower slopes, and channel bed. For each field point, data collected in the field forms are consolidated into a Channel Stability Rating System form. Examples of the four data forms are included in Appendix A. The following six categories are scored and summed to calculate a final RGA score for each field point out of a maximum possible 60 points, with higher values indicating more optimal stream conditions:

- Evidence of Bank Erosion
- Bank Root Zone
- Vegetative Bank Cover
- Bank Angle
- Sediment Transport
- Channel Alteration

2.2 Channel Stability Variables

Qualitative analysis of channel stability was the primary focus of the Rapid Geomorphic Assessment. The adverse consequences of stream channel instability are increased sediment supply, land loss, habitat deterioration, changes in long-term and short-term channel evolution, and loss of both physical and biological function of the stream.

Channel stability was inferred from field inspections, measurements of stream channel characteristics, and by comparing existing stream conditions to historic maps and aerial photography. Specific categories and variables included in the assessment were streambank erosion and angle, riparian and streambank vegetation, overall channel stability, sediment transport, and manmade channel alteration.

Streambank Erosion and Angle

The Bank Stability parameters included several related to the riparian vegetation and the bank angle. Although the Bank Erosion Hazard Index (BEHI) scoring system was not used, the method was referenced for help in determining the key parameters to be evaluated in relation to the channel erosion potential (Rosgen, 2006). Riparian vegetation plays a key role in bank stabilization. Banks with dense, deep rooting zones and in-channel vegetative cover in alluvium generally have stable banks while shallow, sparse roots and no in-stream vegetation result in unstable banks that are subject to mass wasting. Erosion potential related to bank angle(slope steepness) generally ranges from very low for flat slopes to extreme for steep slopes; however, there is a correction factor associated with bank angle to take into consideration the bank material (i.e. bedrock can be very stable at steep angles while sand and clay are not).

Riparian and Streambank Vegetation

Riparian vegetation performs several functions in a stream system including bank stabilization water quality protection, fish and wildlife habitat, and thermal cover for the stream. Bank stabilization and water quality are improved with good riparian buffers because the roots of trees and shrubs help hold stream banks in place, preventing erosion. Riparian vegetation also traps sediment and pollutants in land runoff before it reached the stream channel. The field data collected included information on the general type and condition of the riparian vegetation including an estimate of the percentage of the riparian vegetation that was trees, shrubs, and grasses. Rooting depth, root density and the percentage of the bank protected by vegetation are specific measurements that were taken at each data point. This information was used in both the preliminary bank stability and channel stability classifications.

Channel Stability

The channel stability rating system utilized for this assessment is based on the measurement of up to 15 variables that are specific to the channel bottom, the lower banks within the channel, and the upper banks of the channel. Although the Rosgen-Pfankuch rating system was not used, the method was referenced for help in determining the key parameters to be evaluated in relation to channel stability (Rosgen, 2006). The channel stability rating process evaluates the upper banks, lower banks, and streambed for evidence of excessive erosion or deposition, which are indicative of disequilibrium and can be used to identify potential aquatic habitat within a stream. The system quantitatively evaluates the potential for mass wasting of the channel banks, the detachability of bank and bed materials, channel capacity, and evidence of either excessive erosion or deposition. The process provides a means for estimating general channel stability.

Sediment Transport

The description of depositional features utilized for this study is from Mollard (1973) and Galay et al. (1973) as modified by Rosgen (2006). Depositional features, or lack thereof, can be an indicator of channel aggradation or degradation and signal that the channel is experiencing instabilities. Field observations and interpretations of the depositional patterns were used in estimating the sediment transport competency of the channel. Depositional patterns in altered or degraded channel reaches aided in estimating the long-term stability of the channel reach under existing flow conditions.

Photographs

In addition to the data discussed above, GPS-tagged photographs were taken at each data collection point to record visual observations. Photographs looking upstream and downstream were taken at each data point and, at some locations, photographs of the right and left banks were also taken.

Historical Aerial Photography

Current and historical aerial photographs of Riverby Ranch were used to evaluate changes in stream patterns, land use practices, and riparian vegetation over time. The impacts of these changes on the channel pattern and profile were evaluated and documented.

2.3 Channel Stability Rating System

All of the variables discussed in Section 2.2 were assessed for each data point and consolidated into a Channel Stability Rating System form (Appendix A). The data were then used to determine a general RGA score (ranging from zero (0) to 60) for that portion of the creek. These classification sheets were then used in conjunction with field notes, aerial photographs, one-foot LIDAR generated topography and two-foot aerial topography to relate the measured and observed sections of the study reaches to other sections of the creeks to determine their RGA score. The stability rating system was developed by Freese and Nichols to provide an objective means for assigning values to the six major parameters identified on the Channel Stability Rating System form. In order to provide a quantitative measurement of the six evaluation factors, the system relies on the physical parameters measured and recorded on the data collection sheet, bank stability form, and channel stability form. Data are first recorded in the field on those forms and select photographs are attached for future reference. Finally, the information on those three forms is used to complete the Channel Stability Rating System form and subsequently calculate the RGA score. The weighting and scoring system was developed to provide an objective means for interpreting the data and classifying the stream reaches.

2.4 Stream Quality Factor

The RGA score (a number between zero (0) and 60) for a particular study site is normalized into a Stream Quality Factor (SQF) value by dividing the calculated RGA score by the maximum possible score of 60 points. SQF values are a quality weighting factor that are used to quantify the comparison between baseline stream characteristics of the study site to the stream conditions that are ecologically optimal. This SQF value is used to place a value on the impacted streams and to evaluate the success of the proposed stream mitigation. As with the RGA score, the higher the SQF, the higher the stream quality as based on geomorphic stream equilibrium.

2.5 Stream Quality Unit

The calculated SQF score for a study reach is multiplied by the length of the respective study reach to calculate the number of Stream Quality Units (SQUs) provided by the reach. SQUs quantify the relationship between stream characteristics and the length of stream with those particular characteristics. SQUs allow for an unbiased comparison of the condition of one reach of stream to another, regardless of the length of stream being compared.

3.0 EVALUATION OF PROPOSED STREAM IMPACTS FOR LOWER BOIS D'ARC RESERVOIR

Freese and Nichols (2008) provided RGA scores for Bois d'Arc Creek and its larger tributaries (Honey Grove Creek, Ward Creek, Sandy Creek and Bullard Creek) within the proposed reservoir pool. The RGA scores for these assessed streams were converted to SQF values, and subsequently, the number of SQUs were calculated using the SQF value and the associated reach length. SQF values from the assessed streams were extrapolated to the tributaries upstream of the assessed reaches based on the location of the tributary confluence. For example, if a study reach of Honey Grove Creek had an SQF value calculated to be 0.25, then a stream tributary to that study reach was assumed to also have an SQF value of 0.25. The total SQUs of Bois d'Arc Creek and its tributaries within the proposed reservoir pool, designated by the summed product of the SQU scores for all proposed impact streams and the respective lengths of proposed impacted stream, is 229,054. Table 1 shows the length of stream within the Lower Bois d'Arc Creek footprint by SQF and the corresponding calculated SQUs.

Table 1. Summary of Proposed Project Stream Impacts

Stream Quality Factor (SQF)	Existing Length (ft)	Stream Quality Unit (SQU)
0 - .09	25,171	2,098
.1 - .19	91,337	11,592
.2 - .29	128,395	28,902
.3 - .39	73,580	23,013
.4 - .49	184,011	80,757
.5 - .59	141,422	77,835
.6 - .69	7,107	4,857
.7 - .79	0	0
.8 - .89	0	0
.9 - .99	0	0
1.0	0	0
Total	~~651,023~~ 651,024	229,054

4.0 DESCRIPTIONS OF POTENTIAL STREAM MITIGATION OPPORTUNITIES

A number of opportunities have been identified that would provide compensatory stream mitigation for the impacts to streams caused by the construction of the proposed Lower Bois d'Arc Creek Reservoir. The five identified potential opportunities are as follows:

- Riverby Ranch existing stream restoration and enhancement
- Riverby Ranch stream creation by restoring meanders on straightened/channelized streams
- Bois d'Arc Creek downstream of the proposed dam
- On-site tributaries to littoral zone wetlands
- Riverby Ranch Wetlands Reserve Program (WRP) area stream enhancement

The following subsections briefly describe the five stream mitigation opportunities and how they were individually assessed using the RGA methodology.

4.1 Riverby Ranch Existing Stream Restoration and Enhancement

Riverby Ranch (excluding areas enrolled in the Wetlands Reserve Program (WRP)) contains 179,353 linear feet of ephemeral and intermittent streams that have been degraded over time by agricultural practices. During the RGA study of Riverby Ranch, 36 field points were evaluated to quantify characteristics of the existing streams on the ranch outside the WRP area. The streams were each given a unique identifier/name and were divided into reaches based on morphological characteristics, cover types, stream order, tributary confluences, and field point RGA score.

4.2 Riverby Ranch Stream Creation

As stated in the January 2014 Proposed Lower Bois d'Arc Creek Reservoir Mitigation Plan (Freese and Nichols, 2014), the North Texas Municipal Water District is proposing to restore meanders to several first and second-order streams located on the ranch that have been historically straightened/channelized. Field observations and evaluation of current and historical aerial photographs were used to select existing streams on the ranch that would be suitable for meander creation and to calculate an appropriate sinuosity ratio for the created meanders. It was determined that a sinuosity ratio of 1.3 would be a reasonable ratio for the restored channels. Application of the 1.3 sinuosity ratio to streams suitable for meander creation results in 30,084 additional linear feet of meandering stream on the ranch. The additional linear feet are only considered during the future conditions analysis because there are no baseline conditions present prior to the construction of the created meanders.

4.3 Bois d'Arc Creek Downstream of Proposed Dam

The RGA method was used to evaluate the baseline condition and potential future condition of the channel of Bois d'Arc Creek downstream of the proposed dam. It is anticipated that the existing condition of Bois d'Arc Creek downstream of the proposed dam will improve as a result of the hydrologic stability inherent in the proposed environmental flow regime. Two RGA field points on Bois d'Arc Creek were located to coincide with the stream reaches studied during the Inter-Agency Team Instream Flow Study conducted in 2010. One RGA field point was located upstream of the FM 409 bridge crossing, and a second field point

was on USFS property upstream of Riverby Ranch, (Exhibit 1). Bois d'Arc Creek was divided into reaches between the proposed dam and the Red River as follows:

- Proposed dam to FM 100
- FM 100 to the southern boundary of Riverby Ranch
- Three (3) reaches within the WRP area within Riverby Ranch
- Northern boundary of Riverby Ranch to the Red River

4.4 On-site Tributaries to Littoral Zone Wetlands

The RGA method was used to evaluate the baseline condition and potential future conditions of the tributary streams of the littoral zone wetlands that will form between elevations 534 and 541 ft. msl as a result of the proposed impoundment of Bois d'Arc Creek. The baseline RGA scores of the littoral zone tributary streams were extrapolated from the downstream stream reaches within the conservation pool of the proposed reservoir.

4.5 Riverby Ranch WRP

There are approximately 67,496 linear feet of stream channel within the WRP area on Riverby Ranch, excluding the channel of Bois d'Arc Creek. During the RGA study of Riverby Ranch, eight (8) field points were evaluated to quantify characteristics of the existing streams in the WRP area. The study area within the WRP was divided into reaches based on morphological characteristics, cover types, stream order, tributary confluences, and field point RGA score.

5.0 BASELINE CONDITIONS OF PROPOSED MITIGATION STREAMS

The following section discusses the calculations and results for baseline conditions of the potential mitigation opportunities. Table 2 presents a summary of the baseline conditions for the potential stream mitigation opportunities.

5.1 Riverby Ranch Existing Stream Restoration and Enhancement

RGA scores were applied to reaches based on the score of the most representative nearby field data point. The RGA score for reaches with two field data points was calculated as the average of the two field data points. The RGA scores for stream reaches that did not contain field data points were extrapolated from reaches with similar characteristics. Exhibit 2 illustrates the locations of the field data points and stream reaches on Riverby Ranch. The RGA score for each reach was converted to an SQF value, which was then multiplied by the length of the respective reach to calculate the SQU. The total baseline SQU value for Riverby Ranch, defined as the sum of the SQUs for each reach, was calculated to be 64,140. This total does not include streams within the WRP area.

5.2 Riverby Ranch Stream Creation

The restoration of meanders for historically straightened/channelized streams will create additional stream length that does not currently exist. For mitigation accounting purposes, the additional created stream length was designated a baseline RGA score and SQF of zero. Total number of baseline SQUs for this component was assumed to be zero due to the absence of preexisting stream length and the RGA score and SQF value of zero.

5.3 Bois d'Arc Creek Downstream of Proposed Dam

The RGA scores for the reaches containing the FM 409 and USFS field points were designated based on their respective field point RGA score. For the segment of Bois d'Arc Creek within the WRP area, reach RGA scores were designated based on their respective field points within the WRP. The RGA score for the reach of Bois d'Arc Creek north of the Riverby Ranch boundary was extrapolated from a representative field point on Bois d'Arc Creek within the WRP area. The reach RGA scores were converted into SQF values, which were then multiplied by the lengths of the respective stream reaches to calculate the SQUs for the reaches. The total number of baseline SQUs for Bois d'Arc Creek downstream of the proposed dam, defined as the sum of the SQUs for each reach of Bois d'Arc Creek downstream of the proposed dam, was calculated to be 45,673.

5.4 On-site Tributaries to Littoral Zone Wetlands

RGA scores for stream reaches within the pool of the proposed reservoir were extrapolated to the streams tributaries to the littoral zone wetlands between elevations 534 and 541 ft. msl. The RGA scores for the tributaries of the littoral zone wetlands were converted into SQF values, then multiplied by the stream length to calculate the total number of SQUs for each reach. The total baseline SQU value for the on-site littoral zone wetlands tributary streams was calculated to be 21,840.

5.5 Riverby Ranch WRP

The RGA scores for the tributary streams in the WRP area were calculated the same way as the reaches throughout Riverby Ranch. The RGA scores were converted into SQF values, which were then multiplied by the lengths of the respective reaches to calculate the SQUs for each reach within the WRP area. The total number of baseline SQUs for tributary reaches within the WRP area, defined as the sum of the SQUs for each reach within the WRP area, was calculated to be ~~17,117~~ 28,561.

Table 2. Summary of the Baseline Conditions for the Potential Mitigation Opportunities

SQF	Riverby Ranch, Excluding WRP		Bois d'Arc Creek Downstream of Proposed Dam		Tributaries of Littoral Zone		Tributaries within the WRP Area	
	Existing Length (ft)	SQU	Existing Length (ft)	SQU	Existing Length (ft)	SQU	Existing Length (ft)	SQU
0 - .09	8,507	457	0	0	37,717	3,143	7,649	382
.1 - .19	26,966	4,253	0	0	6,973	813	888	163
.2 - .29	47,790	10,764	0	0	14,550	3,079	0	0
.3 - .39	14,086	4,991	40,184	14,734	4,363	1,309	16,026	5,342
.4 - .49	37,838	17,395	65,893	30,939	10,175	4,455	19,621	9,075
.5 - .59	29,393	15,818	0	0	13,555	7,583	23,313	13,599
.6 - .69	10,905	7,239	0	0	2,131	1,456	0	0
.7 - .79	0	0	0	0	0	0	0	0
.8 - .89	3,868	3,223	0	0	0	0	0	0
.9 - .99	0	0	0	0	0	0	0	0
1.0	0	0	0	0	0	0	0	0
Total	179,353	64,140	106,077	45,673	89,465	21,840	67,496	28,561

1. Stream Creation is not shown because the baseline conditions are "0".

6.0 EVALUATION OF POTENTIAL MITIGATION STREAM IMPROVEMENTS

The following section discusses the calculations and results for the potential future conditions of the identified mitigation opportunities. Stream quality improvement potential was estimated assuming appropriate application of potential stream improvement practices. Measures to attain the intended ecological uplift vary from site to site and may include one or more of the following practices:

- Laying back stream banks to reduce erosion and allow for vegetation establishment
- Removal of cattle and other negative anthropogenic influences
- Plugging or diverting drainage ditches
- Restoring meanders to stream channels which were previously straightened
- Establishing a balanced sediment supply

The potential improvement practices directly correspond with the variables on the Channel Stability Rating System form, shown in Appendix A. For example, Table 3 shows that the calculated baseline RGA score for Bois d'Arc Tributary 2, Reach 1 (Figure 1) on Riverby Ranch was determined to be 3 out of 60 possible points, and the improved RGA score due to the application of improvement practices was 47 out of 60 possible points. The stream improvement practices and their expected results that provide the anticipated ecological uplift for this reach are shown in Table 4. Table 5 presents a summary of the mitigated conditions for the potential stream mitigation opportunities.

Table 3. Calculated baseline and potential improved RGA scores for Bois d'Arc Creek Tributary 2, Reach 1

Evaluation Category	Baseline RGA Score	Mitigated RGA Score
Evidence of Bank Erosion	0	8
Bank Root Zone	1	8
Vegetative Cover	2	9
Bank Angle	0	10
Sediment Transport	0	2
Channel Alteration	0	10
Total	3	47

Figure 1. Photograph looking upstream at reach of Bois d'Arc Creek Tributary 2, Reach 1

Table 4. Stream improvement practices and anticipated results for Bois d'Arc Creek Tributary 2, Reach 1

Improvement Practice	Post-Restoration Condition
Decrease streambank angle	Reduces the steepness of the streambank, allows for streambank vegetation to become established, reduces sediment supply from eroding streambanks, and increases floodplain connectivity
Reshaping the channel	Reduces sediment supply from eroding streambanks, increase floodplain connectivity, improves groundwater/surface water exchange, establishes vertical and lateral stability, improves sediment transport capacity, improves bed form diversity, generates habitat, and improves water quality
Establish streambank vegetation and plant riparian buffer	Provides streambank stability, improves vegetated bank cover and bank root zone, provides shade and generates wood debris storage/habitat, reduces bank erosion, and improves water quality
Channelized stream converted to meandering systems	Provides adequate flow duration, increases floodplain connectivity, improves groundwater/surface water exchange, reduces sediment supply from eroding streambanks, establishes vertical and lateral stability, improves sediment transport capacity, improves bed form diversity, generates habitat and biodiversity, and improves water quality
Remove livestock	Improves vegetated bank cover and bank root zone, provides shade and generates wood debris storage, habitat and biodiversity, reduces bank erosion, reduces sediment supply from eroding streambanks and improves bed form diversity, and improves water quality
Terminate agricultural practices	Improves vegetated bank cover and bank root zone, provides shade and generates wood debris storage, habitat and biodiversity, reduces bank erosion, reduces sediment supply from eroding streambanks and improves bed form diversity and improves water quality

6.1 Riverby Ranch Existing Stream Restoration and Enhancement

Mitigated SQUs for the reaches were calculated by estimating the uplift potential for each reach on the ranch and designating an uplift RGA score and SQF for the reach. Uplift potential was estimated assuming appropriate application of potential stream improvement practices. The mitigated SQUs for the reaches were calculated as a product of reach length and reach mitigated SQF. Reach mitigated SQUs were summed to calculate the total number of mitigated SQUs for the Riverby Ranch Property of 134,259, excluding streams in the WRP area.

6.2 Riverby Ranch Stream Creation

Mitigated RGA scores for the additional created stream length were extrapolated from the mitigated RGA scores of the associated stream. For example, if a straightened stream channel was estimated to receive a mitigated RGA score of 40, the additional stream length associated with that stream (calculated using a sinuosity ratio of 1.3) was also given a RGA score of 40. The RGA scores of the additional created stream length were converted to SQF values. The SQUs of the created stream length for each reach were calculated as the product of the mitigated SQF values and the anticipated additional created stream length for each reach. The total number of SQUs for created stream length on Riverby Ranch was calculated as the sum of the SQUs of the created stream length for each reach in which meanders were developed. The total number of SQUs for the created stream length resulting from the restoration of meanders was calculated to be 23,806. Stream reaches in the WRP were not considered suitable for meander creation.

6.3 Bois d'Arc Creek Downstream of Proposed Dam

Changes in the hydrologic regime of Bois d'Arc Creek downstream of the proposed dam are expected to provide sufficient flows to benefit and maintain habitat and not cause erosion and channel degradation. Based on this assumption, RGA scores are expected to improve for the reaches of Bois d'Arc Creek downstream of the proposed dam. Mitigated RGA scores were converted to SQF values, which were used to calculate the mitigated SQUs for the reaches, defined as the product of reach length and reach SQF. Reach mitigated SQUs were summed to calculate a total number of mitigated SQUs for Bois d'Arc Creek downstream of the proposed dam. The total number of mitigated SQUs for Bois d'Arc Creek downstream of the proposed dam was calculated to be 51,646.

6.4 On-site Tributaries to Littoral Zone Wetlands

The proposed mitigation plan intends to offer protection from future development and other non-compatible uses by establishing a conservation easement up to elevation 541 ft. msl. at the proposed reservoir site. The cessation of farming practices such as the application of fertilizers and pesticides, removing cattle and other negative anthropogenic influences will benefit the littoral zone tributary streams and provide ecological uplift. The uplift due to the establishment of a conservation easement and the removal of human influences is expected to be at least five (5) RGA points. Five RGA points were added to the baseline RGA score for each tributary stream to establish the mitigated RGA scores within the littoral zone wetlands. The mitigated RGA scores were converted to SQF values, which were used to calculate the SQUs, defined as the product of the SQF and the length of littoral zone tributary streams. The total number of mitigated SQUs for tributaries of the littoral zone wetlands, defined as the sum of all mitigated SQUs for the littoral zone tributary streams, was calculated to be 29,295.

6.5 Riverby Ranch WRP

Fluvial geomorphic principles support the hypothesis that as upstream reaches of streams are improved and become stabilized, the downstream reaches of channel can experience indirect ecological uplift as a result of the upstream improvements, even with no direct channel work performed in the downstream reaches. For example, removing cattle and other agricultural practices, restoring meanders, modifying channel geometry to stable dimensions, and re-connecting the upstream channel to a floodplain would promote stability and provide uplift to the downstream reach by reducing the volume and velocity of incoming stream flow (thereby reducing channel erosion and bank failures), reducing incoming sediment and nutrient loads (that promote channel infilling and eutrophication), and providing a seed source for channel vegetation.

Mitigated RGA scores for the streams in the WRP that were directly connected to upstream tributaries outside the WRP area were assigned based on the existing condition of the WRP streams and the anticipated future condition that would result from indirect uplift caused by upstream channel restoration efforts. Mitigated RGA scores were converted to mitigated SQF values, and the mitigated SQUs for the WRP stream reaches were calculated as the product of length of the stream reach within the WRP area and the reach mitigated SQUs. Reach mitigated SQUs were summed to calculate the total number of mitigated SQUs for the streams in the WRP area on Riverby Ranch of ~~20,067~~ 33,358.

Table 5. Summary of the Mitigated Conditions for the Potential Mitigation Opportunities

SQF	Riverby Ranch, Excluding WRP		Riverby Ranch Stream Creation		Bois d'Arc Creek Downstream of Proposed Dam		Tributaries of Littoral Zone		Tributaries within the WRP Area	
	Mitigated Length (ft)	SQU	Mitigated Length (ft)	SQU	Mitigated Length (ft)	SQU	Mitigated Length (ft)	SQU	Mitigated Length (ft)	SQU
0 - .09	0	0	0	0	0	0	0	0	0	0
.1 - .19	0	0	0	0	0	0	37,717	6,286	4,502	825
.2 - .29	7,562	2,017	0	0	0	0	11,372	2,641	3,045	791
.3 - .39	0	0	0	0	0	0	14,515	4,718	0	0
.4 - .49	1,012	472	0	0	40,184	17,413	4,397	2,125	23,048	9,638
.5 - .59	0	0	0	0	65,893	34,233	5,779	3,178	13,588	7,240
.6 - .69	29,423	19,378	510	323	0	0	13,555	8,713	23,313	14,864
.7 - .79	96,195	74,879	20,867	16,345	0	0	2,131	1,634	0	0
.8 - .89	45,160	37,513	8,708	7,138	0	0	0	0	0	0
.9 - .99	0	0	0	0	0	0	0	0	0	0
1.0	0	0	0	0	0	0	0	0	0	0
Total	179,353	134,259	30,084	23,806	106,077	51,646	89,465	29,295	67,496	33,358

7.0 COMPENSATORY MITIGATION SUMMARY AND PROPOSED MITIGATION PLAN COMPONENTS

The total number of SQUs of Bois d'Arc Creek and its tributaries within the proposed reservoir pool is 229,054. Of the five (5) potential stream mitigation opportunities discussed above, only four (4) will be included in the proposed mitigation plan to compensate for the impact of the proposed reservoir. Mitigation for the impacted streams would be achieved through the four (4) mitigation components listed in Table 5.

As shown in Table 6, only the SQU uplift for Bois d'Arc Creek downstream of the proposed dam (generated by the stabilized flow regime) are included in the total proposed mitigation. Additionally, the streams located within the WRP area are currently protected in perpetuity under the WRP instrument, and the NRCS has instructed the NTMWD that no earthwork is to be done to streams within the WRP area. The total number of SQUs generated by the four preferred mitigation components compensate for the stream losses in the proposed reservoir pool with a deficit of ~~36,345~~ 35,720 SQUs. Table 5 summarizes the total number of baseline and mitigated condition SQUs for the four proposed mitigation components.

Table 6 Baseline and mitigated SQUs for proposed stream mitigation components

Mitigation Component	Baseline SQU	Mitigated SQU
Riverby Ranch Restoration and Enhancement	~~63,632~~ 64,140	~~133,634~~ 134,259
Riverby Ranch Creation	0	23,806
Bois d'Arc Creek Downstream of Proposed Dam	N/A	5,974*
On-Site Tributaries to Littoral Zone Wetlands	21,840	29,295
Total Proposed Mitigation*	~~85,472~~ 85,980	~~192,709**~~ 193,334**
Total Stream Impacts	229,054	
Total Stream SQU Deficit		~~36,345~~ 35,720

*Uplift generated by improvement to Bois d'Arc creek downstream of proposed dam

**Uplift generated by WRP streams (~~2,951~~ 4,797 SQUs) is not included in the total

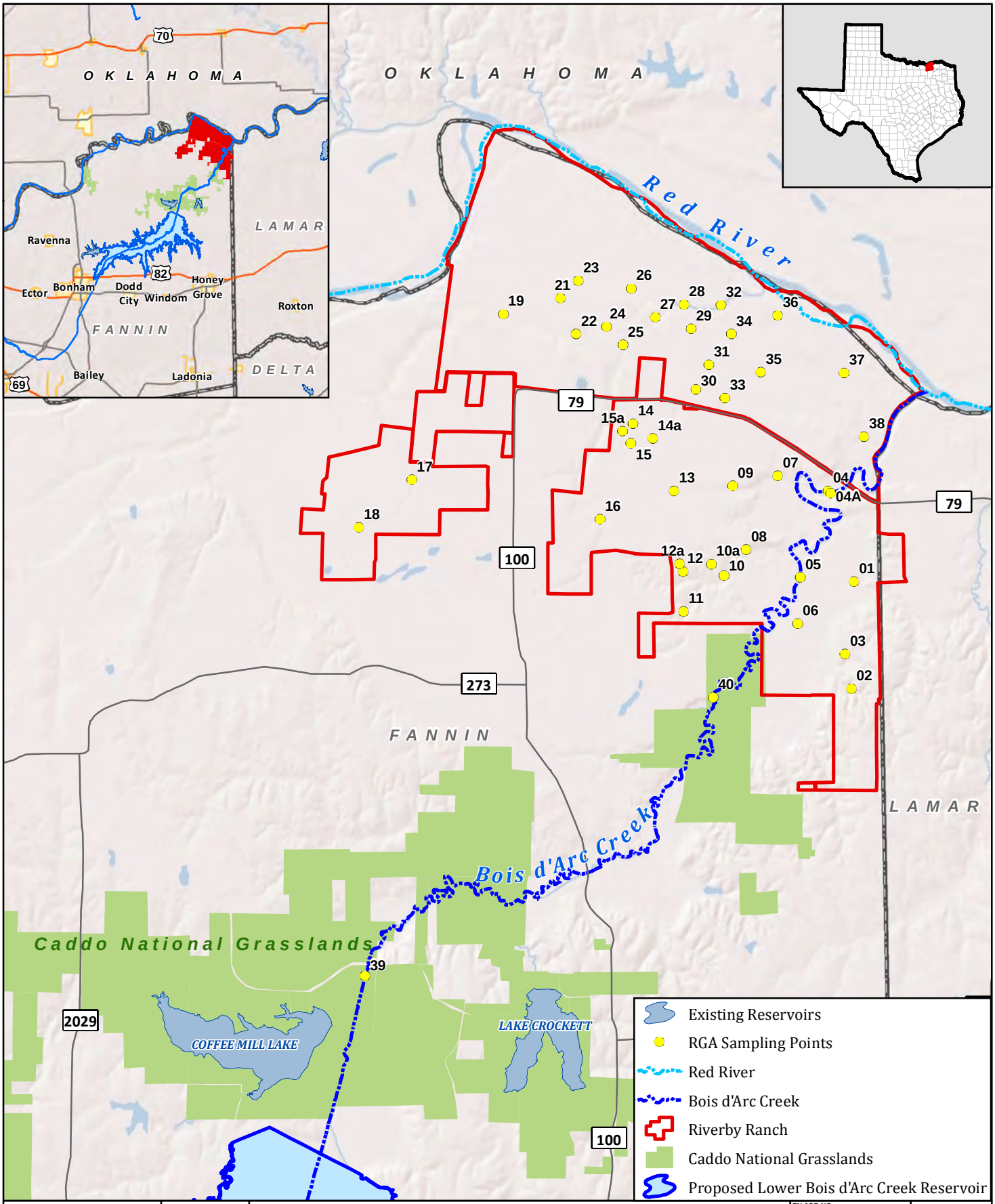
8.0 REFERENCES

FNI, 2008, Rapid Geomorphic Assessment of Bois d'Arc Creek and its Tributaries for the Lower Bois d'Arc Creek Reservoir Project: Prepared for North Texas Municipal Water District

FNI, 2014, Mitigation Plan for the Proposed Lower Bois d'Arc Creek Reservoir, January 2014: Prepared for North Texas Municipal Water District

Rosgen, David, 2006, Watershed Assessment of River Stability and Sediment Supply: Wildland Hydrology, Fort Collins, CO.

Exhibits



FREESE AND NICHOLS
Freese and Nichols, Inc.
4055 International Plaza Suite 200
Fort Worth, Texas 76109-4895
817-735-7300

Attachment A

N W E S

NORTH TEXAS MUNICPAL WATER DISTRICT

Riverby Ranch

Location Map

0 2 4 Miles

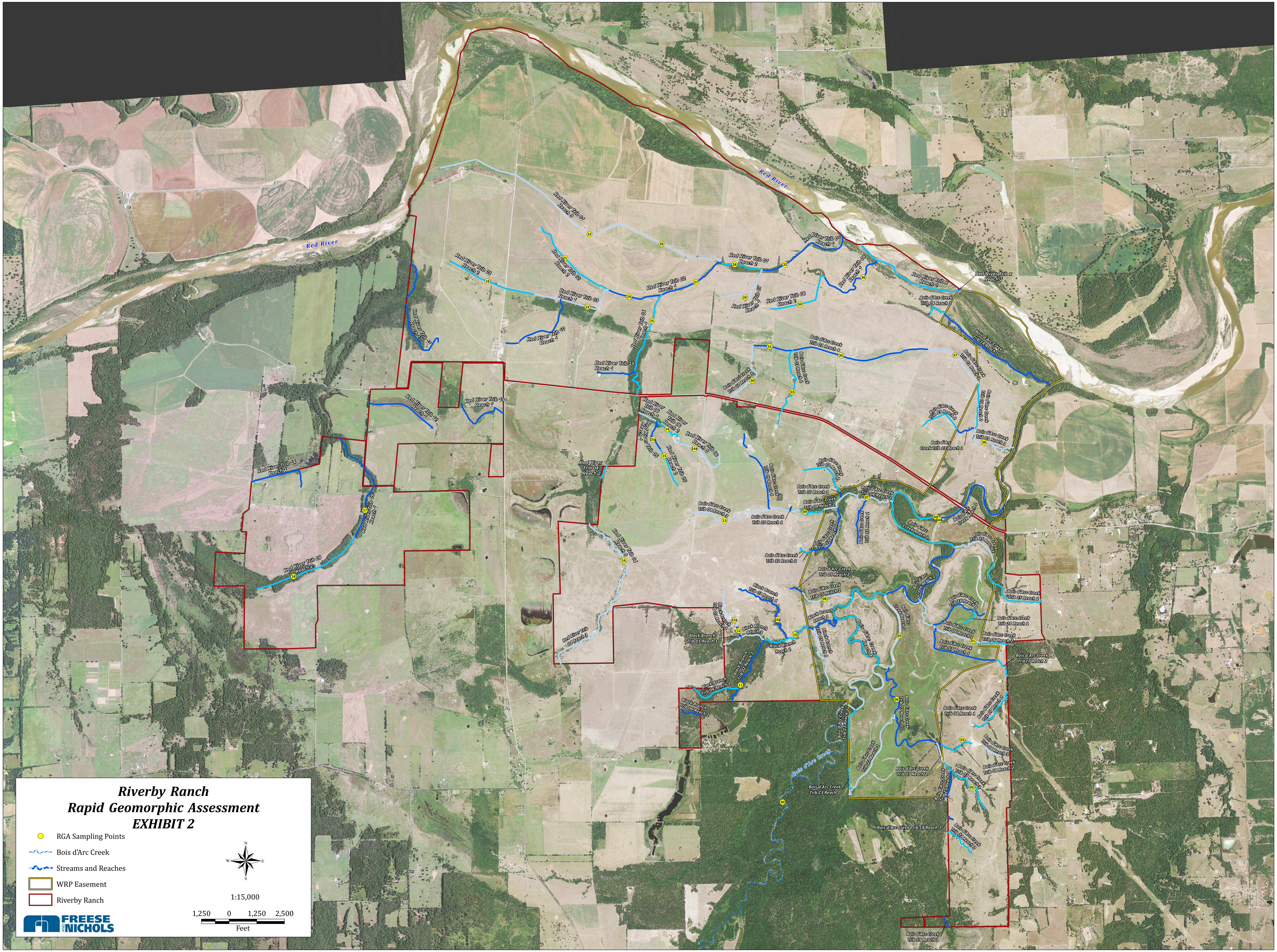
FN JOB NO	NTD06128
FILE NAME	Location.mxd
DATE	8/5/2014
SCALE	1:96,411
DESIGNED	SSJ
DRAFTED	ssj

1

EXHIBIT

Path: H:\ENVIRONMENTAL\FINAL_EXHIBITS\RGA_Stream_Reaches\Location.mxd

NAD 1983 StatePlane Texas North Central FIPS 4202 Feet



Attachment A

Appendix A

Example RGA Field Forms and Channel Stability Rating System Form

Data Collection Sheet

Sheet No.

Date:		Stream Name:	
Project Name:	Lower Bois d'Arc Creek Reservoir Phase II	Coordinates:	
Project Number:	NTD06128	Field Crew:	

Channel Characteristics:				**Stream Size: Category (Bankfull Width, ft)**					
Average Bank Width:		OHWM Width:		S-1 (<1)	❑	S-6 (50-75)	❑	S-11 (350-500)	❑
Average Bank Depth:		Circle: Perennial, Intermittent, or Ephemeral		S-2 (1-5)	❑	S-7 (75-100)	❑	S-12 (500-1000)	❑
Average Stream Bed Depth:				S-3 (5-15)	❑	S-8 (100-150)	❑	S-13 (>1000)	❑
Average Water Width:		Circle: Clear or Turbid		S-4 (15-30)	❑	S-9 (150-250)	❑		
Average Water Depth:		Water Color:		S-5 (30-50)	❑	S-10 (250-350)	❑		
Maximum Water Depth:									

Substrate:				**Debris/Blockages:**				*B.D.= Beaver Dams	
Silt/Clay	❑	Boulder (>10")	❑	D1: None	❑	D5: Extensive	❑	D9: B.D. - Abandoned	❑
Sand	❑	Bedrock	❑	D2: Infrequent	❑	D6: Dominating	❑		
Gravel (.25"-2.5")	❑	Concrete	❑	D3: Moderate	❑	D7: B.D. - Few	❑	D10 - Human Influences	❑
Cobble (2.5"-10")	❑	Organic	❑	D4: Numerous	❑	D8: B.D. - Frequent	❑		

Instream Cover:				**Riparian Zone:**			
Undercut Banks	❑	Deep Pools	❑	Forest	❑	Scrub/Shrub	❑
Shallows	❑	Overhanging Vegetation	❑	Pasture	❑	Row-Crop	❑
Boulders	❑	Emergent/Submergent Vegetation	❑	Paved	❑	Residential	❑
Oxbows	❑	Logs/Brush	❑	Old-Field/ROW	❑	Width of Riparian Zone	

Riparian Vegetation:

Category	Percent Aerial Cover	Percent Site Coverage	Species Composition	Percent of Total
Canopy Layer				
Shrub Layer				
Herbaceous				
Leaf or Needle Litter				
Bare Ground				

Photos:

Attachment A

Additional Notes:

BEHI Variable Worksheet

Stream:	Reach:	Cross Section:	
Observers:			Date:

						BEHI Score
Bank Height/Max Depth Bankfull (C)						
Study Bank Height (ft)	(A)	Bankfull Height (ft)	(B)	(A)/(B) =	(C)	
Root Depth/Bank Height (E)						
Root Depth (ft)	(D)	Study Bank Height (ft)	(A)	(D)/(A) =	(E)	
Weighted Root Density (F)						
Root Density (%)	(F)					
Bank Angle (G)						
Bank Angle (Degrees)	(G)					
Surface Protection (H)						
Surface Protection (%)	(H)					

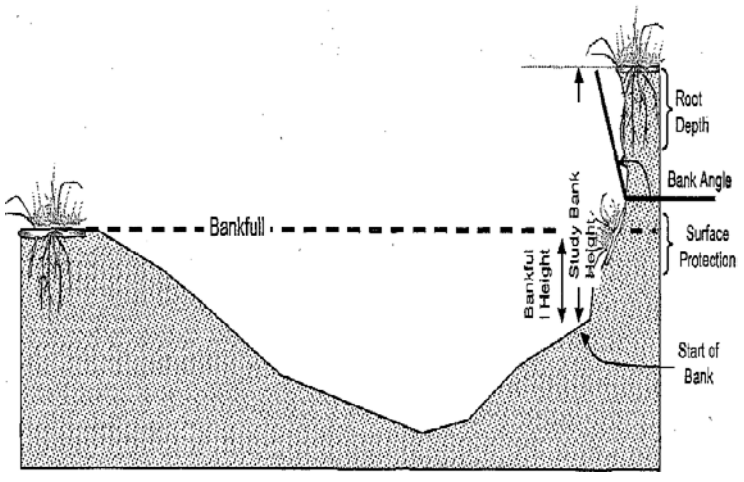
Bank Material Adjustment		
Bedrock (Overall Very Low BEHI) Boulders (Overall Low BEHI) Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust Gravel (Add 5-10 points depending percentage of bank material that is composed of sand) Sand (Add 10 points) Silt Clay (no adjustment)	⇨ **Bank Materials Adjustment**	
	Stratification Adjustment Add 5-10 points, depending on position of unstable layers in relation to bankfull stage	

VERY LOW	LOW	MODERATE	HIGH	VERY HIGH	EXTREME		
						⇨ **ADJECTIVE RATING** and **TOTAL SCORE**	
5 - 9.5	**10 - 19.5**	**20 - 29.5**	**30 - 39.5**	**40 - 45**	**46 - 50**		

Bank Sketch

Vertical Distance (ft)

Horizontal Distance (ft)



Pfankuch Channel Stability Form

Stream: _____ Reach: _____ Date: _____ Observers: _____ Comments: _____

Location	Key	Category	Excellent		Good		Fair		Poor	
			Description	Rating	Description	Rating	Description	Rating	Description	Rating
Upper Banks	1	Landform Slope	Bank slope gradient <30%.	2	Bank slope gradient 30-40%.	4	Bank slope gradient 40-60%.	6	Bank slope gradient 60%+.	8
	2	Mass Wasting	No evidence of past or future mass wasting.	3	Infrequent. Mostly healed over. Low future potential.	6	Frequent or large, causing sediment nearly year long.	9	Frequent or large, causing sediment nearly yearlong OR imminent danger of same.	12
	3	Debris Jam Potential	Essentially absent from immediate channel area.	2	Present, but mostly small twigs and limbs.	4	Moderate to heavy amounts, mostly larger sizes.	6	Moderate to heavy amounts, predominantly larger sizes.	8
	4	Vegetative Bank Protection	90%+ plant density. Vigor and variety suggest a deep, dense soil binding root mass.	3	70-90% density. Fewer species or less vigor suggest less dense or deep root mass.	6	50-70% density. Lower vigor and fewer species from a shallow, discontinuous root mass.	9	<50% density plus fewer species & less vigor indicating poor, discontinuous, and shallow root mass.	12
Lower Banks	5	Channel Capacity	Ample for present plus some increases. Peak flows contained. (W/D)/(W/Dref) < 1.1, BHR = 1.0 - 1.1	1	Adequate. Bank overflows are rare. (W/D)/(W/Dref) = 1.1 - 1.2, BHR = 1.1 - 1.3	2	Barely contains present peaks. Occasional overbank floods. (W/D)/(W/Dref) = 1.2 - 1.6, BHR = 1.3 - 1.5	3	Inadequate. Overbank flows common. (W/D)/(W/Dref) > 1.6, BHR > 1.5	4
	6	Bank Rock Content	65%+ w/ large angular boulders. 12"+ common.	2	40-65%. Mostly boulders and small cobbles 6-12".	4	20-40%. With most in the 3-6" diameter class.	6	<20% rock fragments of gravel sizes, 1-3" or less.	8
	7	Obstructions to Flow	Rocks and logs firmly embedded. Flow pattern w/o cutting or deposition. Stable bed.	2	Some present causing erosive cross currents and minor pool filling. Obstructions fewer and less firm.	4	Moderately frequent, unstable obstructions move with high flows causing bank cutting and pool filling.	6	Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full, channel migration occurring.	8
	8	Cutting	Little or none. Infrequent raw banks <6".	4	Some, intermittently at outcurves and constrictions. Raw banks may be up to 12".	6	Significant. Cuts 12-24" high. Root mat overhangs and sloughing evident.	12	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	16
	9	Deposition	Little or no enlargement of channel or point bars.	4	Some new bar increase, mostly from coarse gravel.	8	Moderate deposition of new gravel and coarse sand on old and some new bars.	12	Extensive deposit of predominantly fine particles. Accelerated bar development.	16
Bottom	10	Rock Angularity	Sharp edges and corners. Plane surfaces rough.	1	Rounded corners and edges, surfaces smooth, flat.	2	Corners and edges well rounded in 2 dimensions.	3	Well rounded in all dimensions, surfaces smooth.	4
	11	Brightness	Surfaces dull, dark or stained. Generally not bright.	1	Mostly dull, but may have <35% bright surfaces.	2	Mixture dull and bright, i.e. 35-65% mixture range.	3	Predominantly bright, 65%+, exposed or scoured surfaces.	4
	12	Consolidation of Particles	Assorted sizes tightly packed or overlapping.	2	Moderately packed with some overlapping.	4	Mostly loose assortment with no apparent overlap.	6	No packing evident. Loose assortment, easily moved.	8
	13	Bottom Size Distribution	No size change evident. Stable material 80-100%.	4	Distribution shift light. Stable material 50-80%.	8	Moderate change in sizes. Stable materials 20-50%.	12	Marked distribution change. Stable materials 0-20%.	16
	14	Scouring and Deposition	<5% of bottom affected by scour or deposition.	6	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	12	30-50% affected. Deposits and scour at obstructions, constrictions and bends. Some filling of pools.	18	More than 50% of the bottom in a state of flux or change nearly yearlong.	24
	15	Aquatic Vegetation	Abundant growth moss-like, dark green perennial. In swift water, too.	1	Common. Algae forms in low velocity and pool areas. Moss here, too.	2	Present but spotty, mostly in backwater. Seasonal algae growth makes rocks slick.	3	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	4
			Excellent Total =		**Good Total =**		**Fair Total =**		**Poor Total =**	

Stream Type	A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6	C1	C2	C3	C4	C5	C6	D3	D4	D5	D6
Good (Stable)	38-43	38-43	54-90	60-95	60-95	50-80	38-45	38-45	40-60	40-64	48-68	40-60	38-50	38-50	60-85	70-90	70-90	60-85	85-107	85-107	85-107	67-98
Fair (Mod. Unstable)	44-47	44-47	91-129	96-132	96-142	81-110	46-58	46-58	61-78	65-84	69-88	61-78	51-61	51-61	86-105	91-110	91-110	86-105	108-132	108-132	108-132	99-125
Poor (Unstable)	48+	48+	130+	133+	143+	111+	59+	59+	79+	85+	89+	79+	62+	62+	106+	111+	111+	106+	133+	133+	133+	126+

Stream Type	DA3	DA4	DA5	DA6	E3	E4	E5	E6	F1	F2	F3	F4	F5	F6	G1	G2	G3	G4	G5	G6
Good (Stable)	40-63	40-63	40-63	40-63	40-63	50-75	50-75	40-63	60-85	60-85	85-110	85-110	90-115	80-95	40-60	40-60	85-107	85-107	90-112	85-107
Fair (Mod. Unstable)	64-86	64-86	64-86	64-86	64-86	76-96	76-96	64-86	86-105	86-105	111-125	111-125	116-130	96-110	61-78	61-78	108-120	108-120	113-125	108-120
Poor (Unstable)	87+	87+	87+	87+	87+	97+	97+	87+	106+	106+	126+	126+	131+	111+	79+	79+	121+	121+	126+	121+

Grand Total =	
Existing Stream Type =	
Potential Stream Type* =	
Modified Channel Stability Rating =	

* Rating should be adjusted to Potential Stream Type, not existing.

Attachment A

Riverby Ranch Streams
Channel Stability Rating System

Reach: _____

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	○ Fair	◉ Poor

Field Data Point	Station	
	To	From

Extrapolated Stations		
To	From	Reasoning

Classification Basis								
Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)		High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.		Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)		Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.		Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	
Total		0		0		0		0

Description:

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	0

Attachment A

Attachment B

October 2015 RGA Workshop Attendees

RGA Workshop Attendees List – October 13, 2015

1. USACE
    a. Andy Comer
    b. Ed Parisotto

2. USEPA
    a. Maria Martinez
    b. Keith Hayden
    c. Alison Kitto

3. USFWS
    a. Sid Putter

4. TPWD
    a. Tom Heger
    b. Ryan McGillicuddy

5. TCEQ
    a. Peter Schaffer

6. Solv
    a. Leon Kolankiewicz

7. NTMWD
    a. Robert McCarthy
    b. Ashley Burt

8. FNI
    a. Simone Kiel
    b. Steve Watters
    c. David Coffman
    d. Stephanie Coffman
    e. Velita Cardenas
    f. Michael Votaw
    g. Randall Howard

9. Lloyd Gosselink
    a. Sara Thornton

10. Baylor University
    a. Dr. Peter Allen

Attachment C

Email: LBRC RGA “ground truthing” of data

From:	Robert McCarthy
To:	Mike Rickman; Billy George; Sara Thornton; Steve Watters; Michael Votaw; Randall Howard; Simone Kiel
Subject:	Fwd: LBCR RGA "ground truthing" of data
Date:	Monday, December 07, 2015 10:42:07 AM
Attachments:	RGA_2015.pdf RGA_2015_DataPoints_20151204.zip FW LBCR RGA ground truthing of data (UNCLASSIFIED).msg

---

Fyi

RM:
Sent via the Samsung GALAXY S5

-------- Original message --------
From: "Parisotto, Edward SWT" <Edward.Parisotto@usace.army.mil>
Date: 12/7/2015 9:00 AM (GMT-06:00)
To: "Crawford, Dorothy" <Crawford.Dorothy@epa.gov>, "Kitto, Alison" <Kitto.Alison@epa.gov>, "Hayden, Keith" <Hayden.Keith@epa.gov>, "'sidney_puder@fws.gov'" <sidney_puder@fws.gov>, 'Ryan McGillicuddy' <Ryan.McGillicuddy@tpwd.texas.gov>, 'Tom Heger' <Tom.Heger@tpwd.texas.gov>, 'Peter Schaefer' <peter.schaefer@tceq.texas.gov>, "'robertpotts@fs.fed.us'" <robertpotts@fs.fed.us>, 'H M Williams' <hwilliams@sfasu.edu>, "Commer, Andrew SWT" <Andrew.Commer@usace.army.mil>, Robert McCarthy <rmccarthy@NTMWD.COM>, 'Leon Kolankiewicz' <Leon.Kolankiewicz@solvllc.com>, "Hoffmann, Robert SWT" <Robert.B.Hoffmann@usace.army.mil>, "Poulos, Lauren" <poulos.lauren@epa.gov>
Subject: FW: LBCR RGA "ground truthing" of data

Team,

Please reference my November 13th email regarding RGA "truthing". The Corps received valuable comments from some of you and appreciate the time you have taken to provide that input. The Corps has finalized the required additional field work with the applicant.

Attached is a map and data points that the applicant is required to assess utilizing the same RGA method used previously for this project. The field work is tentatively scheduled for the week of 11 January 2016. Field contacts numbers are Michael Votaw, 817-676-3610 or Steve Watters, 817-706-5733.

I will still be the POC for coordination if you plan on monitoring the field work OR schedule changes need to be made (due to weather). If for some reason I am not available, feel free to contact Robert McCarthy at 469-626-4635.

I want to thank each of you again for all of you time and assistance with the evaluation of this field work.

Respectfully,
Ed

Ed Parisotto
Supervisory Regulatory Project Manager
Tulsa District U.S. Army Corps of Engineers
(918) 669-7549 / Fax: (918) 669-4306
http://www.swt.usace.army.mil/Missions/Regulatory.aspx
You are invited to complete our Regulatory Service Survey at:

http://corpsmapu.usace.army.mil/cm_apex/f?p=136:4:0

-----Original Message-----
From: Robert McCarthy [mailto:rmccarthy@NTMWD.COM]
Sent: Friday, December 04, 2015 3:42 PM
To: Parisotto, Edward SWT <Edward.Parisotto@usace.army.mil>
Cc: spw@freese.com; Mike Rickman <mrickman@NTMWD.COM>; Billy George <bgeorge@NTMWD.COM>; mpv@freese.com
Subject: [EXTERNAL] LBCR RGA "ground truthing" of data

Ed,

Pease see attached a revised RGA "ground truthing" map (and associated shapefiles) on which we relocated the following stream assessment points in response to EPA's November 20, 2015 comment.

- Relocated site TC01 to Stillhouse Branch and renamed it SB01.
  While reviewing the stream assessment site placement on Timber Creek, it became apparent that the site that had been labeled SB01 (in the November 2, 2015 email) was actually on an inactive, historic channel of Timber Creek. The name of the point was changed to TC01 and the point was moved northeast, out of the USACE proposed 2015 RGA ground truthing site box, onto the active channel of Timber Creek, which is a previously straightened reach.

With regard to schedule, we are tentatively planning to conduct the RGA ground truthing field study during the week of January 11, 2016. This field schedule is dependent on USACE concurrence with our proposed stream assessment locations as well as weather/field conditions. We'll firm up the field logistics as we get closer to January 11.

Please let me know if you have any questions.

Robert McCarthy
Permit Manager
North Texas Municipal Water District
505 E. Brown St.
P.O. Box 2408
Wylie, Texas 75098
Telephone (469) 626-4633
Email: rmccarthy@ntmwd.com