Ecological Resource Consultants, Inc.
35715 US Hwy. 40, Suite D204 ~ Evergreen, CO ~ 80439 ~ (303) 679-4820

Technical Memorandum

Date: June 12, 2017

To: Scott Edgar, FRICO

cc: Ryan Schoolmeesters, Dam Safety Branch, Office of the State Engineer

From: Troy Thompson/Ryan Hummel, ERC

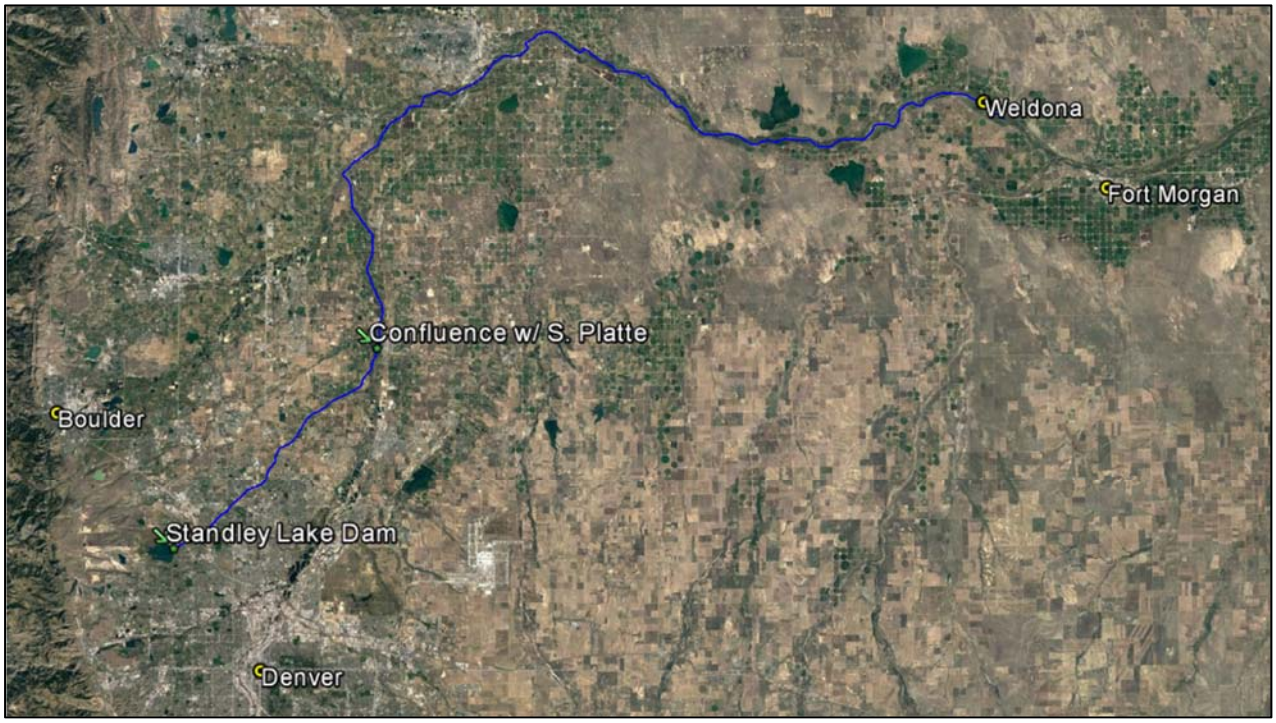
Re: Standley Lake Dam Breach Analysis

Introduction

Ecological Resource Consultants, Inc. (ERC) completed a dam breach analysis of Standley Lake Dam on behalf of the Farmer's Reservoir and Irrigation Company (FRICO). Standley Lake Dam is located in Westminster, CO. The purpose of this study was to understand the characteristics of a breach and then calculate the extent and timing of impacts on areas downstream of the dam. Information derived from this study will be utilized to update the Emergency Action Plan (EAP) for Standley Lake and inform emergency managers in the event of a potential dam breach.

ERC followed the methodology outlined by the Colorado Division of Water Resources' (DWR) Office of the State Engineer Dam Safety Branch to conduct this evaluation. The Standley Lake Dam is classified by the DWR as a large, high hazard dam due to the storage capacity of the dam and the potential for loss of human life should the dam fail (DWR 2007). The dam breach model extends from Big Dry Creek immediately downstream of the dam downstream past Big Dry Creek's confluence with the S. Platte River along the South Platte River to near Weldona, CO. At Weldona, the dam breach flood effects are no longer greater than the effects of the 100-year flood event. The extents of the analysis are shown in **Figure 1**. The Corps of Engineers' river analysis system HEC-RAS (v.5.0.3) was utilized to calculate the peak discharge of the dam breach and route the ensuing flood downstream of the dam. The methodology, input data, and results are described below.

Figure 1 – Standley Lake Dam Breach Study Extents (Breach Flow Path shown in **Blue**)



Methodology

To quantify the peak flow due to a dam breach, ERC followed the methodology outlined in the "Guidelines for Dam Breach Analysis" (Guidelines) published by the Colorado Division of Water Resources' Office of the State Engineer Dam Safety Branch (February 2010). Per the Guidelines, there are four components to a dam breach analysis: breach parameter estimation, breach hydrograph estimation, breach hydrograph routing, and hydraulics at critical sections. ERC completed the parameter estimation for this dam using the methods outlined in the Colorado Dam Safety Branch's "State of Colorado's Dam Breach Toolbox" from 2014 FEMA Technical Seminar No. 21 published by Jeremy Franz and Jason Ward in February 2014, along with recommendations from the SEO for modeling large dams.

After determining the breach parameters, ERC estimated the breach hydrograph using HEC-RAS. Based on the Guidelines, ERC modeled the dam breach for "sunny day" conditions with the reservoir full up to the elevation of the emergency spillway. ERC assumed the breach would occur as a piping failure within the dam.

The breach hydrograph routing and hydraulics at critical sections were conducted in HEC-RAS' two-dimensional (2D) modeling program. Terrain data was obtained from the USGS with 10-meter spatial resolution. Land cover data for determining Manning's roughness coefficients throughout the study area was downloaded from the Multi-Resolution Land Characteristics Consortium's National Land Cover Database 2011 (NLCD) (MRLC 2011) and input into the model. Manning's roughness values for each land cover type were applied based on work done by the Institution of Engineers Australia (2012) and Jung et

al (2013). A 2D flow area of the area downstream of the dam was then created in HEC-RAS and the peak dam break hydrograph was created using the program's storage area-2D area connection breach analysis.

Dam Breach Input Data

Parameter values input into the dam breach model are shown in **Tables 1-3**. These values form the basis for characterizing flows from the dam in the event of a breach. **Table 1** below shows the geometry input to the model.

Table 1 – Geometry Input Data

Parameter	Value	Source
Dam Crest Elevation	5,516.5 feet	Standley Dam Renovation Plans (2001)
Dam Upstream Invert Elevation	5,420.2 feet	Hydro-Triad Feasibility Report (1982)
Water Surface Elevation (Spillway Elevation)	5,506.2 feet	Standley Dam Renovation Plans (2001)
Elevation – Storage Relationship Curve	See **Table 3**	Standley Lake Dam Emergency Action Plan (2013)
Crest Width	15 feet	Standley Lake Dam Stability Analysis Summary (2009)
Upstream Side Slope	2H:1V	Standley Lake Dam Stability Analysis Summary (2009)
Downstream Side Slope	Varies (2H:1V used in model)	Standley Lake Dam Stability Analysis Summary (2009)

Based on the Guidelines, two empirical methods are recommended for estimating breach parameters of the dam breach: the Froehlich method (2008) and the MacDonald & Langridge-Monopolis method (1984) with failure times estimated using the Washington State method (2007) (abbreviated as the MLM-WA method). Criteria provided in the Guidelines suggests that the linear erosion rate (average breach width divided by breach development time) divided by the height of water stored behind the dam should range between 1.6 and 21, while the average breach width divided by the total height of the breach should be greater than 0.60. If the parameter calculations resulting from one of the empirical methods produces values outside of these ranges, it is suggested that the method may be suspect for that dam.

ERC evaluated the dam parameters using each method and determined a linear erosion rate divided by height of water of 0.465 and an average breach width divided by the height of breach of 2.0 for the MLM-WA method. The linear erosion rate divided by the height of water for this method falls outside of the recommended range. Using the Froehlich method, ERC estimated a linear erosion rate divided by height of water of 1.64. The average breach width divided by the height of breach of 2.0. Both of these parameters are within the recommended range and ERC feels the Froehlich method is most appropriate for this analysis. It was therefore used for the evaluation.

Breach parameters calculated using the pond and dam geometry based on the Froehlich method are shown in **Table 2,** while the elevation-storage curve for the reservoir is provided in **Table 3**.

Table 2 – Breach Parameter Input Data

Parameter	Value	Source
Height of Breach, H_b	96.3 feet	Dam Crest Elevation – Upstream Invert Elevation
Volume of Water, V_w	41,470 Acre-ft	Standley Lake Dam Emergency Action Plan (2003)
Failure Mode Factor, K_0	1.0	State of Colorado's Dam Breach Toolbox (2014)
Breach Bottom Width, B_{bottom}	145 feet	1.5*H_b (SEO recommendation for large dams, May 2017)
Breach Left Side Slope	0.5H:1V	SEO recommendation for large dams (May 2017)
Breach Right Side Slope	0.5H:1V	SEO recommendation for large dams (May 2017)
Average Breach Width, B_{avg}	193 feet	B_{bottom} + H_b/2*Right Side Slope + H_b/2*Left Side Slope
Piping Elevation	5,463.2 feet	Assumed halfway between upstream invert and max. WSEL
Coefficient of Piping Orifice	0.74	Table 5 of SEO Dam Safety Branch's Guidelines for Dam Breach Analysis (2010)
Breach Development Time, T_f	1.37 hours	$T_f = 3.664*\sqrt{(V_w/(g*H_b^2))}$, (State of Colorado's Dam Breach Toolbox, 2014)
Breach Start Time	Simulation time 00:00	-

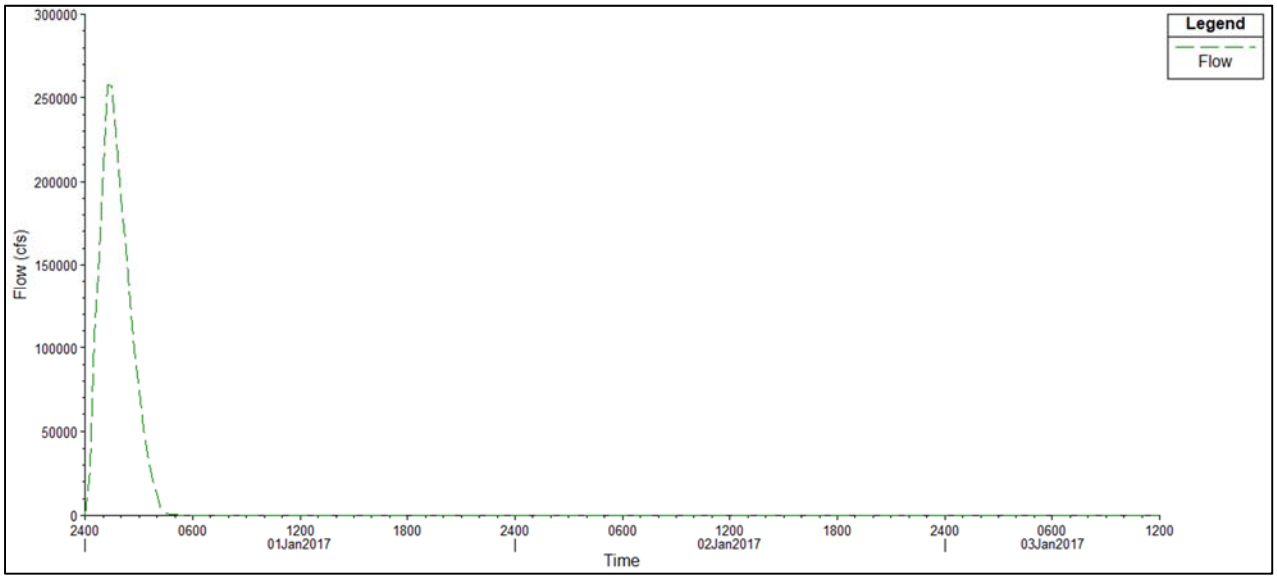
Table 3 – Standley Lake Elevation – Storage Relationship Curve

USGS Elevation (ft)	Reservoir Volume (ac-ft)
5,420.2	0
5,430.2	217
5,440.2	1,134
5,450.2	2,860
5,460.2	5,531
5,470.2	9,427
5,480.2	15,523
5,490.2	24,121
5,500.2	34,446
5,506.2	41,470

Dam Breach Results

The resulting breach hydrograph produced by HEC-RAS is shown in **Figure 2** for the piping breach. The peak discharge from the breach was calculated to be about 257,730 cfs and occurred 1 hour 15 minutes after the simulation began.

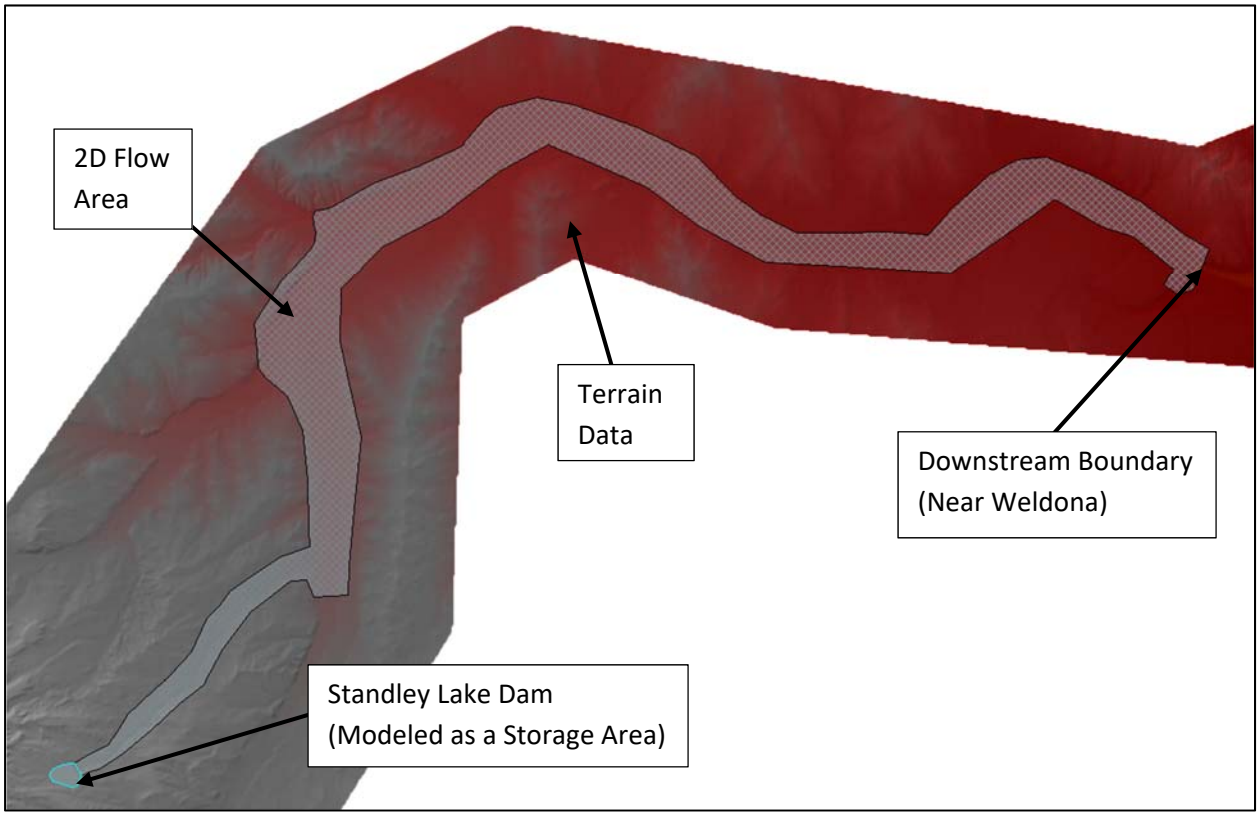
Figure 2 – Piping Breach Hydrograph from HEC-RAS



Flood Routing Input Data

ERC uploaded the terrain data into the HEC-RAS model and created a 2D flow area downstream of the dam following Big Dry Creek and the South Platte River corridors. The extents of the 2D flow area overlaying the input terrain data are shown in **Figure 3**. The upstream boundary of the flow area is the Standley Lake Dam. Here the dam breach hydrograph is input to the model via a storage area represented by the reservoir stage/storage curve with an initial water surface elevation equal to the spillway elevation. The downstream boundary is where the flood would reach a flow rate lower than the 100-year flow rate which occurs near Weldona, CO. Normal depth calculations are applied by the model to quantify the flow leaving the system across this boundary. The 2D flow area consists of a grid of user-defined spaced cells where flow velocities and depths are computed across the cell boundaries within the grid. ERC selected a cell spacing of 250 feet by 250 feet for this analysis.

Figure 3 – 2D Flow Area and Terrain Data



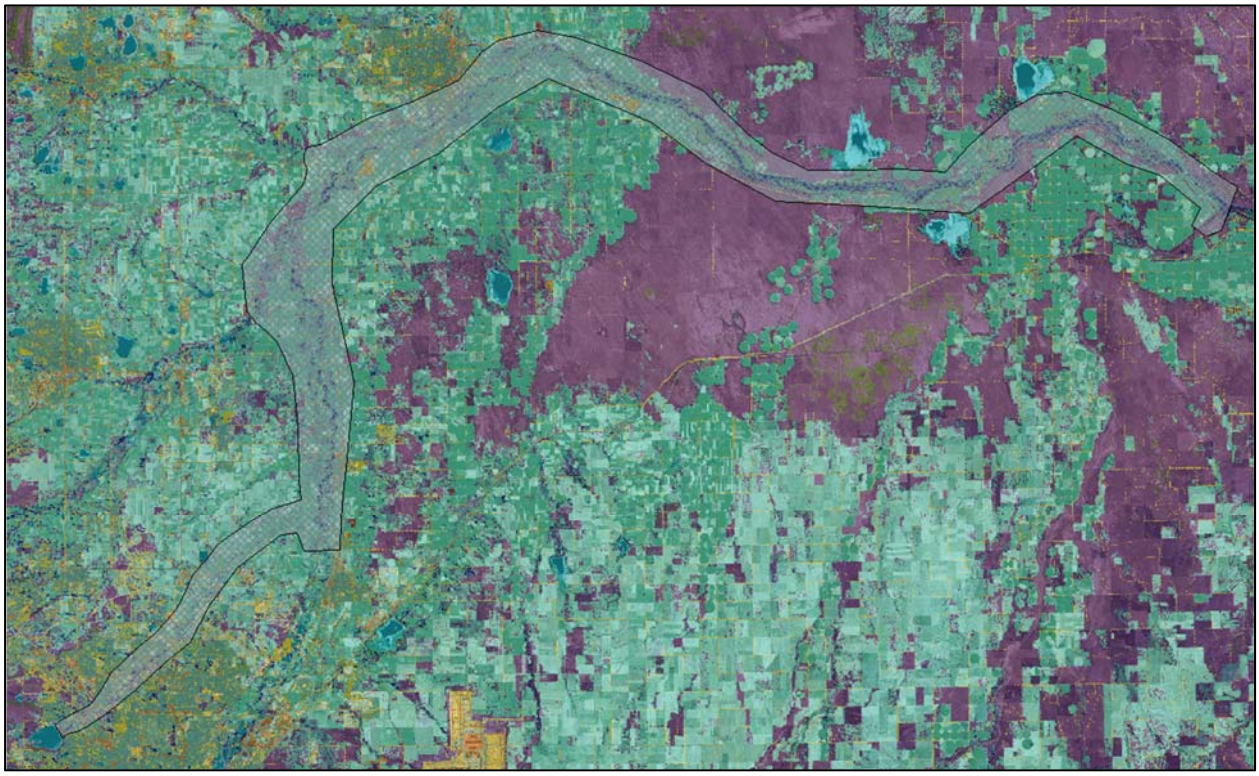
The NLCD land cover data obtained from MRLC was uploaded to the model in order to associate Manning's roughness data to the geometry. ERC approximated the Manning's roughness coefficients for most of the land cover types using values provided by the Institute of Engineers Australia (2012) developed for non-shallow two-dimensional flow. For the land cover types that are not covered in the Institute of Engineers Australia report, ERC supplemented the Manning's roughness inputs with values published by Jung et al. in *Water* (2013) using the NLCD database with one-dimensional flow. The combined average Manning's roughness coefficient data developed from the two sources used in the model is presented in **Table 4**. The NLCD land types overlaid by the 2D flow area used in this analysis are shown in **Figure 4**. The colors representing each land type in this figure are defined in **Table 4**. Much of the upstream flood area is classified as developed land of varying intensity, while farther downstream the predominate land types are grasslands, cultivated crops, and pastures.

Table 4 – Manning Roughness Coefficient (n) Value Applied to Land Cover Input Data

Land Cover Type	Average n	Figure 4 Map Color
Open water	0.18[1]	
Developed, Open space	0.09[2]	
Developed, Low intensity	0.15[1]	
Developed, Medium intensity	0.20[1]	
Developed, High intensity	0.35[1]	
Barren land	0.04[1]	
Deciduous forest	0.10[1]	
Evergreen forest	0.10[1]	
Mixed forest	0.10[1]	
Scrub/shrub	0.06[1]	
Grassland/herbaceous	0.04[1]	
Pasture/hay	0.04[1]	
Cultivated crops	0.04[2]	
Woody wetlands	0.07[1]	
Emergent herbaceous wetland	0.07[1]	

[1]From Institute of Engineers Australia (2012)
[2]From Jung et al (2013)

Figure 4 – NLCD Land Cover Data Overlaid Above the Terrain Data (Land Type Colors Defined in Table 4)



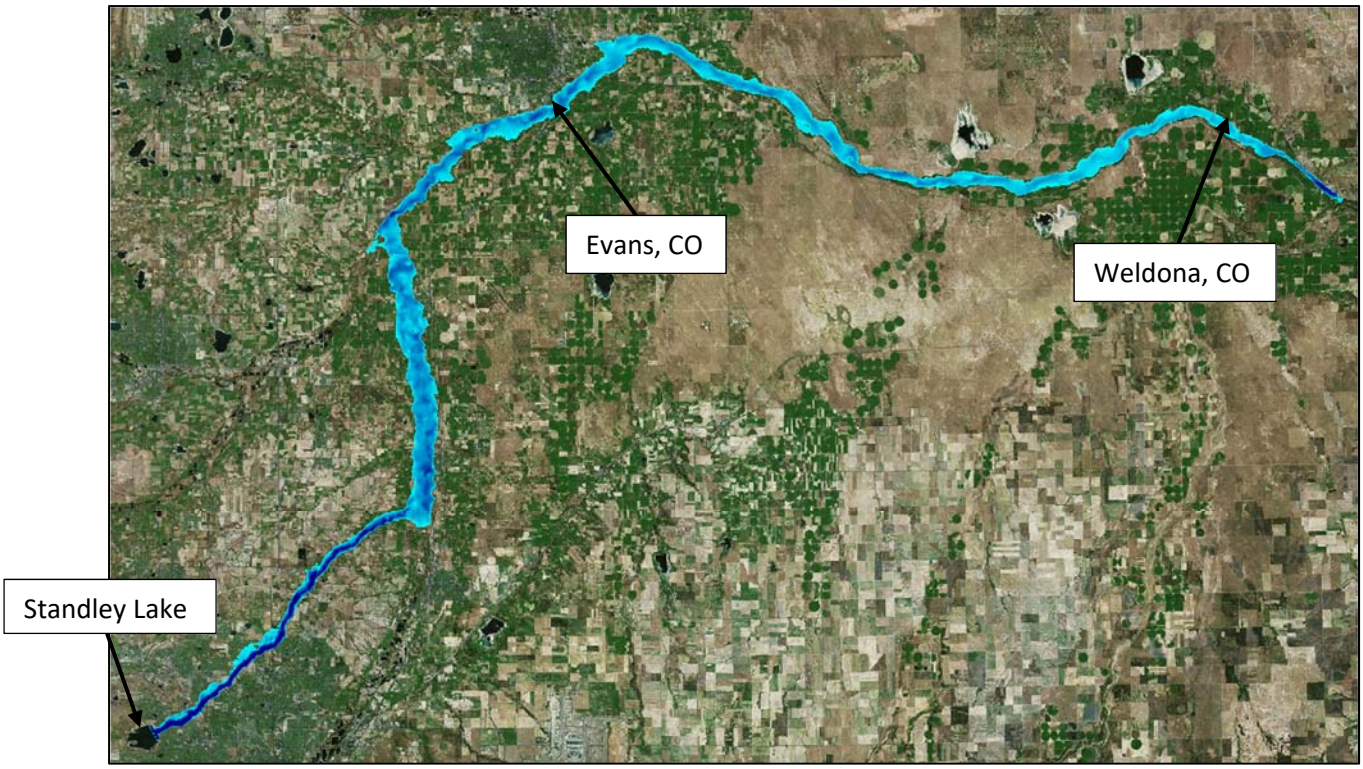
Flood Routing Results

The HEC-RAS model was run for a simulation time of 60 hours with a computational interval of 3 seconds. The model did not produce any convergence errors or warnings under these conditions. As discussed previously, the peak discharge from the Standley Lake dam was estimated at 257,730 cfs at a time of 1 hour 15 minutes after the breach begins. The flood created by the breach follows Big Dry Creek down to its confluence with the South Platte River approximately 25 miles downstream of the dam. The flood continues along the South Platte River to the north before bending to the east a few miles upstream of Evans, CO, which is approximately 55 miles downstream of the dam. The peak flow rate of the dam breach flood is calculated to be approximately 50,750 cfs at US-85 near Evans. This peak at Evans occurs 15.75 hours after the breach begins. The flow from the dam break is calculated to be greater than the 100-year flood discharge of 32,500 cfs published in the FEMA Flood Insurance Study (FIS) for Weld County, Colorado and Incorporated Areas (2016). As the flow from the break exceeds the 100-year flood flow, the model was extended further downstream.

Farther downstream near Weldona, CO (approximately 103 miles downstream from the dam), the breach flood is calculated to have attenuated to a peak flow rate of approximately 16,300 cfs. This is less than the 100-year flood discharge of 27,570 cfs published by FEMA for the South Platte River in its FIS report

for Morgan County, Colorado and Incorporated Areas (2016). ERC therefore ended the analysis at this location. **Figure 5** shows the full extent of the dam breach flood as produced by HEC-RAS, where the blue shading represents the inundated area and darker shading representing deeper flood depths. More detailed views of the flood inundation extents resulting from the dam breach are provided in **Appendix A**.

Figure 5 – Dam Breach Inundation Results



Hydraulics at Critical Sections

There are several road crossings between Standley Lake Dam and the point where the breach flow is predicted to be below the 100-year flood discharge. ERC selected 10 of the most critical road crossings and analyzed the breach flood hydraulics at each of these points. The 10 crossings are listed in **Table 5**, along with the peak flow rates, flood depths, and velocities calculated at each of these locations. This table demonstrates how the breach flood attenuates as it moves downstream away from the dam. The initial and peak flood wave times in this table are presented in total hours after the dam breach begins. The critical road crossings are also shown on the flood inundation maps in **Appendix A**.

Table 5 – Hydraulics at Critical Locations

Location	Distance Downstream from Dam (mi)	Peak Discharge Rate (cfs)	Initial Flood Wave Time (hr)	Peak Flood Wave Time (hr)	Peak Flood Depth (ft)	Peak Wave Velocity (fps)
Wadsworth Parkway	1.0	265,372	0.50	1.50	34.0	8.8
US-36	2.7	253,157	0.75	1.75	36.7	8.9
I-25	8.8	209,697	2.25	3.00	23.2	7.5
Northwest Parkway	12.0	207,575	2.75	3.50	24.5	7.7
1st Street near Fort Lupton	24.9	163,298	5.25	5.75	13.9	5.0
Justin Ave near Platteville	35.6	116,526	8.25	8.75	6.5	5.3
Highway 85 near Evans	54.5	50,753	15.75	17.00	15.7	3.4
County Road 53 north of Kersey	63.9	35,412	21.25	23.00	7.4	3.3
Highway 144 near Orchard	93.1	19,622	41.75	43.25	5.1	2.3
County Road 9 near Weldona	103.2	16,300	49.00	50.75	5.8	2.1

Conclusions

ERC conducted a dam breach analysis of the Standley Lake Dam. The lake was assumed to be at its full capacity up to its spillway elevation when the breach begins and the breach was assumed to be a sunny day, piping failure. The Froehlich method was used to estimate break parameters. ERC calculated the peak discharge from the dam to be approximately 257,730 cfs using HEC-RAS with the peak flow rate occurring approximately 1 hour and 15 minutes after the onset of the breach. The flood resulting from the breach was simulated using HEC-RAS's two-dimensional model throughout a 103-mile stretch along Big Dry Creek and the South Platte River until the effects of the dam breach flood were predicted to be less than those of the 100-year flood event. ERC created inundation maps of the entire 103-mile floodway (**Appendix A**) and provided hydraulic results for locations where the flood is expected to overtop critical roadways (**Table 5**, **Appendix A**).

References

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Appendices

Appendix A – Flood Inundation Maps

Appendix A

Flood Inundation Maps

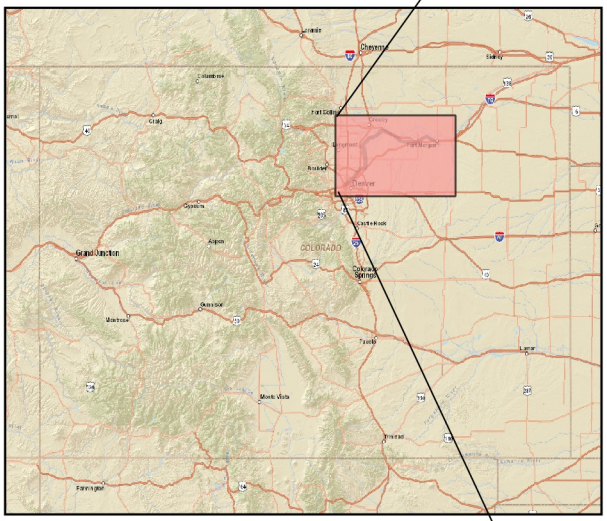
Prepared By:

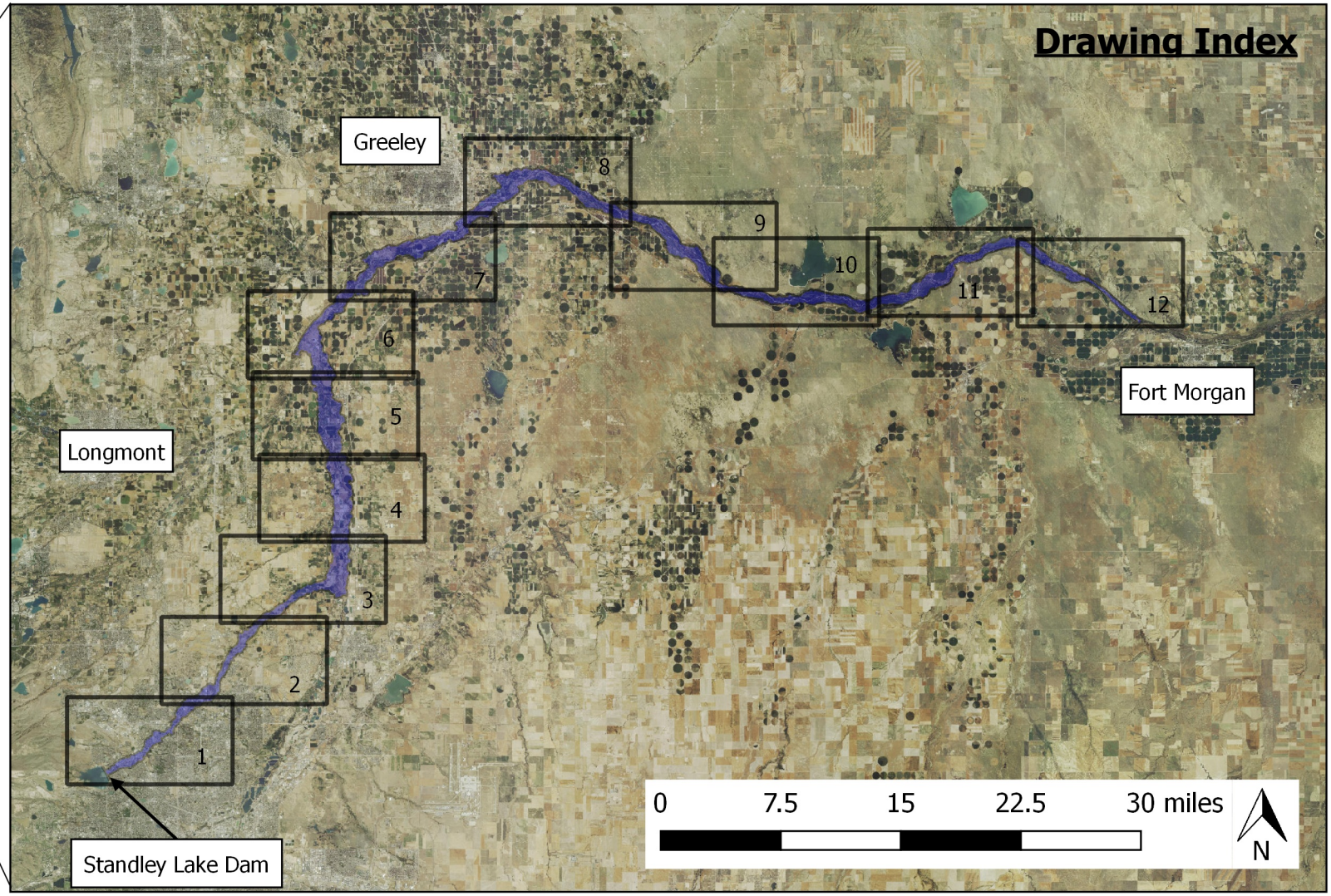
Ecological Resource Consultants, Inc.
35715 US Hwy 40, Suite D204
Evergreen CO 80439
(303) 679-4820

Standley Lake Dam Breach Inundation Mapping
Dam ID: 020326

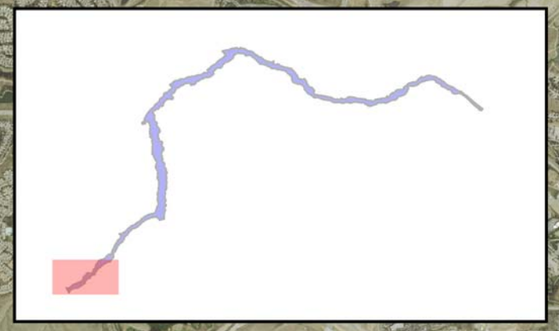
Prepared for the Farmers Reservoir and Irrigation Company (FRICO)

June 2017





Inundation limits are based on a seepage-induced failure of Standley Lake Dam under "Sunny Day" conditions (absent precipitation)



Matchline - Drawing 2

Matchline - Drawing 1

US-36

Wadsworth Parkway

Location	Distance DS from Dam (mi)	Peak Discharge Rate (cfs)	Initial Flood Wave Time (hr)	Peak Flood Wave Time (hr)	Peak Flood Depth (ft)	Peak Wave Velocity (fps)
Wadsworth Parkway	1.0	265,372	0.50	1.50	34.0	8.8
US-36	2.7	253,157	0.75	1.75	36.7	8.9

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Evergreen, CO 80439
(303)679-4820

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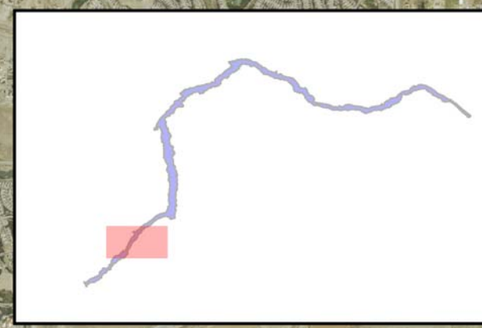
N

0 0.5 1 1.5 2 miles

Inundated Area

Date: June 5, 2017

Drawing: 1 of 12



Matchline - Drawing 3

Matchline - Drawing 2

Northwest Parkway

I-25

Matchline - Drawing 2

Matchline - Drawing 1

Location	Distance DS from Dam (mi)	Peak Discharge Rate (cfs)	Initial Flood Wave Time (hr)	Peak Flood Wave Time (hr)	Peak Flood Depth (ft)	Peak Wave Velocity (fps)
I-25	8.8	209,697	2.25	3.00	23.2	7.5
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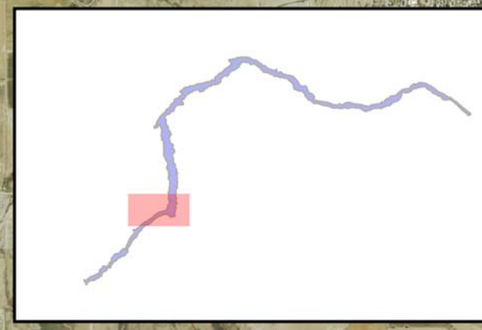
Date: June 5, 2017

Drawing: 2 of 12



Matchline - Drawing 4

Matchline - Drawing 3

1st Street

Matchline - Drawing 3

Matchline - Drawing 2

Location	Distance DS from Dam (mi)	Peak Discharge Rate (cfs)	Initial Flood Wave Time (hr)	Peak Flood Wave Time (hr)	Peak Flood Depth (ft)	Peak Wave Velocity (fps)
1st Street near Fort Lupton	24.9	163,298	5.25	5.75	13.9	5.0

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Inundated Area

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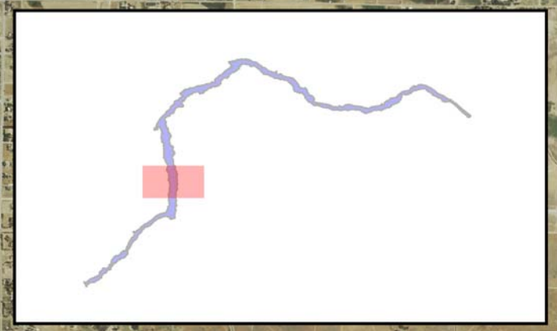
Drawing: 3 of 12



Matchline - Drawing 5

Matchline - Drawing 4

Matchline - Drawing 4

Matchline - Drawing 3

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Inundated Area

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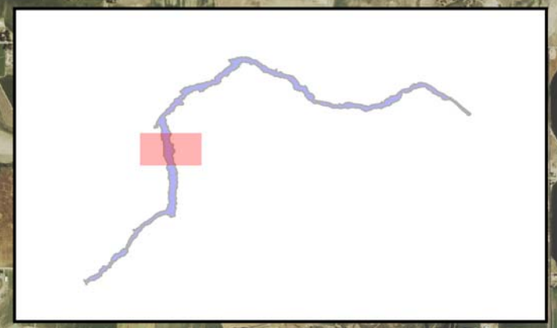

Matchline - Drawing 6

Matchline - Drawing 5

Justin Ave

Matchline - Drawing 5

Matchline - Drawing 4

Location	Distance DS from Dam (mi)	Peak Discharge Rate (cfs)	Initial Flood Wave Time (hr)	Peak Flood Wave Time (hr)	Peak Flood Depth (ft)	Peak Wave Velocity (fps)
Justin Avenue near Platteville	35.6	116,526	8.25	8.75	6.5	5.3

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Evergreen, CO 80439
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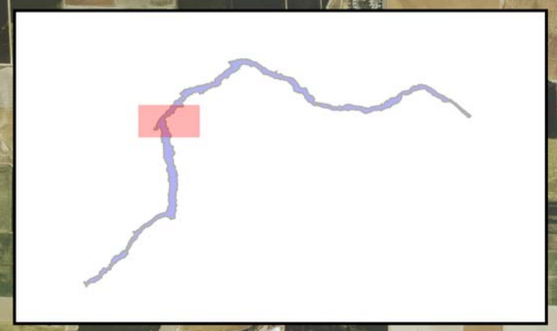
0 0.5 1 1.5 2 miles

Inundated Area

Date: June 5, 2017

Drawing: 5 of 12



Matchline - Drawing 7

Matchline - Drawing 6

Matchline - Drawing 6

Matchline - Drawing 5

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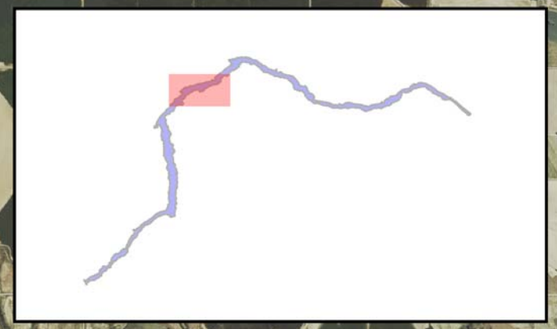

Matchline - Drawing 8

Matchline - Drawing 7

Highway 85

Matchline - Drawing 7

Matchline - Drawing 6

Location	Distance DS from Dam (mi)	Peak Discharge Rate (cfs)	Initial Flood Wave Time (hr)	Peak Flood Wave Time (hr)	Peak Flood Depth (ft)	Peak Wave Velocity (fps)
Highway 85 near Evans	54.5	50,753	15.75	17.00	15.7	3.4

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Date: June 5, 2017

Drawing: 7 of 12

Location	Distance DS from Dam (mi)	Peak Discharge Rate (cfs)	Initial Flood Wave Time (hr)	Peak Flood Wave Time (hr)	Peak Flood Depth (ft)	Peak Wave Velocity (fps)
County Road 53 north of Kersey	63.9	35,412	21.25	23.00	7.4	3.3

County Road 53

Matchline - Drawing 7

Matchline - Drawing 8

Matchline - Drawing 8

Matchline - Drawing 9

Prepared By:

35715 US Hwy 40, Suite D204
Evergreen, CO 80439
(303)679-4820

Standley Lake Dam Breach Inundation Mapping
DAM ID: 020326

Prepared for the Farmers Reservoir and Irrigation Company (FRICO)

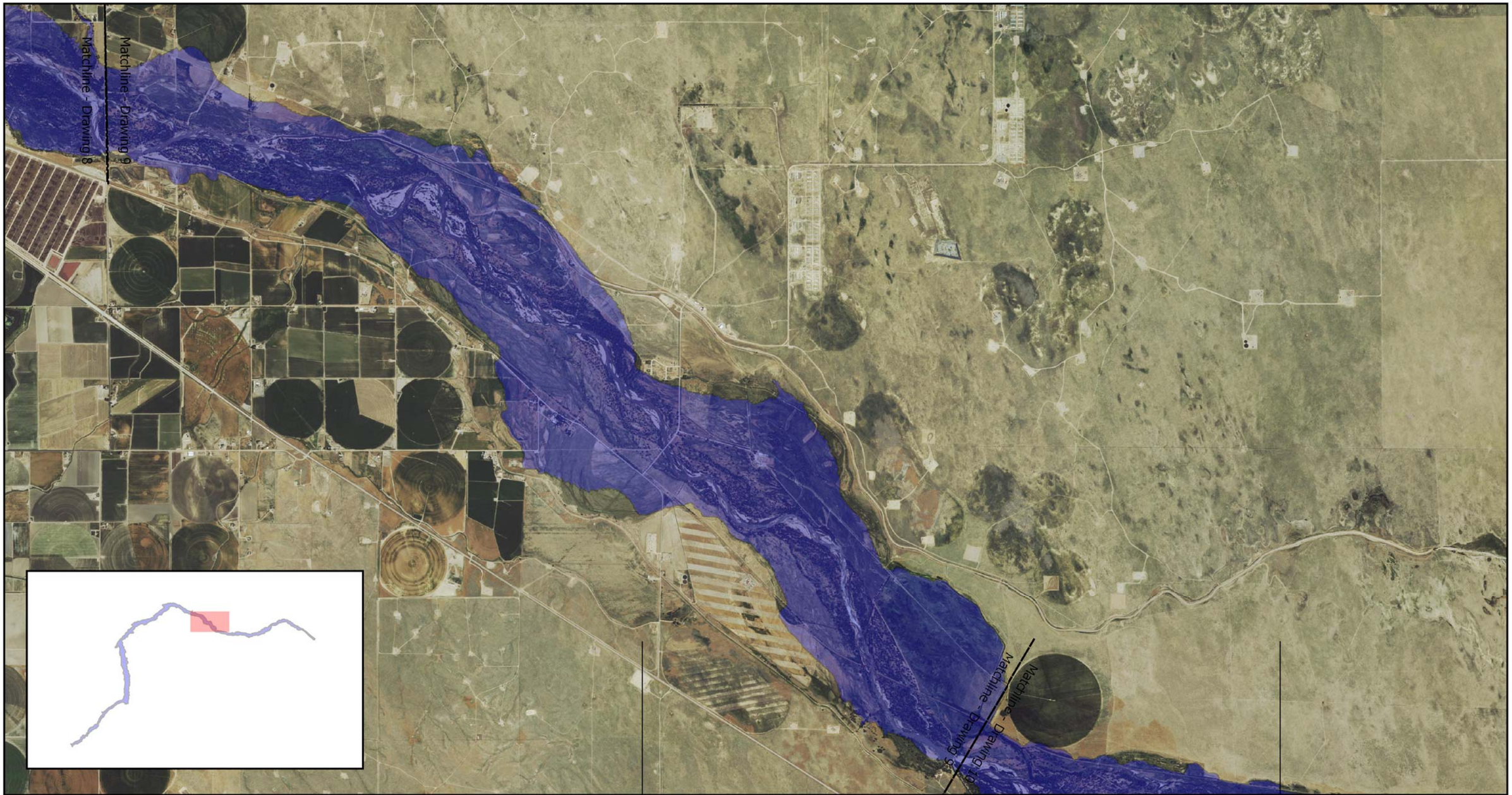
N

0 0.5 1 1.5 2 miles

Inundated Area

Date: June 5, 2017

Drawing: 8 of 12



Prepared By:

35715 US Hwy 40, Suite D204
Evergreen, CO 80439
(303)679-4820

Standley Lake Dam Breach Inundation Mapping
DAM ID: 020326

Prepared for the Farmers Reservoir and Irrigation Company (FRICO)

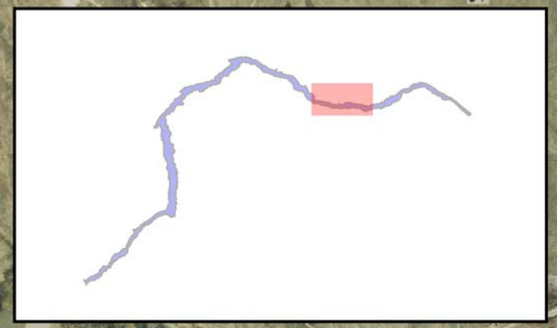
N

0 0.5 1 1.5 2 miles

Inundated Area

Date: June 5, 2017

Drawing: 9 of 12



Matchline - Drawing 9

Matchline - Drawing 10

Matchline - Drawing 11

Prepared By:

35715 US Hwy 40, Suite D204
Evergreen, CO 80439
(303)679-4820

Standley Lake Dam Breach Inundation Mapping
DAM ID: 020326

Prepared for the Farmers Reservoir and Irrigation Company (FRICO)

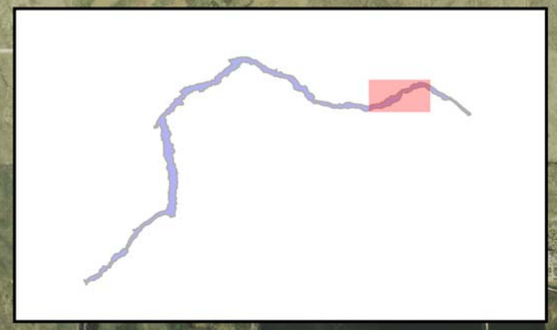
N

0 0.5 1 1.5 2 miles

Inundated Area

Date: June 5, 2017

Drawing: 10 of 12



Highway 144

Matchline - Drawing 10

Matchline - Drawing 11

Matchline - Drawing 12

Location	Distance DS from Dam (mi)	Peak Discharge Rate (cfs)	Initial Flood Wave Time (hr)	Peak Flood Wave Time (hr)	Peak Flood Depth (ft)	Peak Wave Velocity (fps)
Highway 144 near Orchard	93.1	19,622	41.75	43.25	5.1	2.3

Prepared By:

35715 US Hwy 40, Suite D204
Evergreen, CO 80439
(303)679-4820

Standley Lake Dam Breach Inundation Mapping
DAM ID: 020326

Prepared for the Farmers Reservoir and Irrigation Company (FRICO)

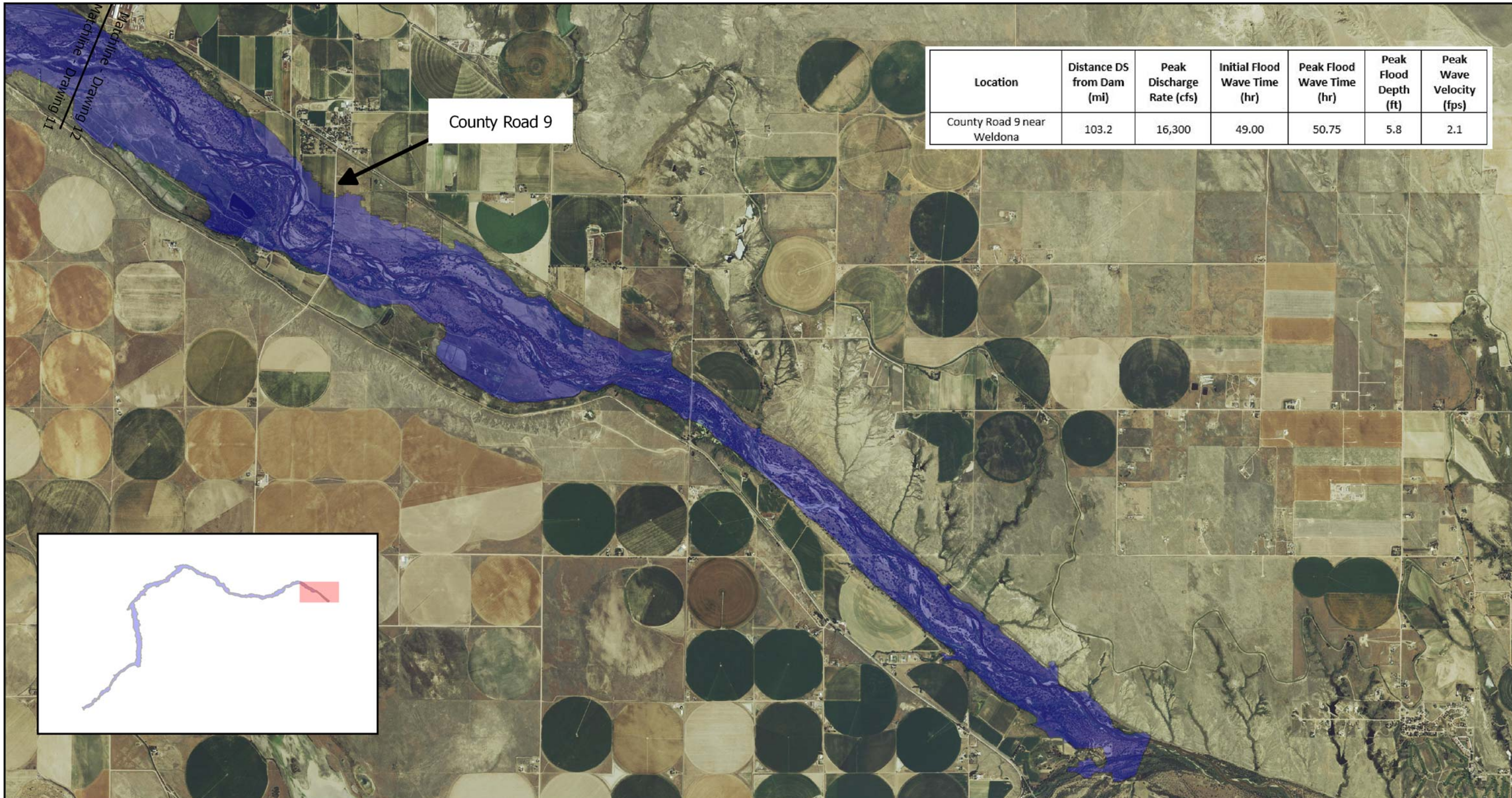
N

0 0.5 1 1.5 2 miles

Inundated Area

Date: June 5, 2017

Drawing: 11 of 12



Location	Distance DS from Dam (mi)	Peak Discharge Rate (cfs)	Initial Flood Wave Time (hr)	Peak Flood Wave Time (hr)	Peak Flood Depth (ft)	Peak Wave Velocity (fps)
County Road 9 near Weldona	103.2	16,300	49.00	50.75	5.8	2.1

Prepared By:

35715 US Hwy 40, Suite D204
Evergreen, CO 80439
(303)679-4820

Standley Lake Dam Breach Inundation Mapping
DAM ID: 020326

Prepared for the Farmers Reservoir and Irrigation Company (FRICO)

N

0 0.5 1 1.5 2 miles

Inundated Area

Date: June 5, 2017

Drawing: 12 of 12

THE FARMERS RESERVOIR AND IRRIGATION COMPANY
80 South 27th Ave. • Brighton, CO 80601
Telephone: 303-659-7373 • FAX 303-659-6077

June 14, 2017

Colorado Water Conservation Board
1313 Sherman Street, Room 718
Denver, CO 80203
Attn: Jonathan Hernandez, PE
Jonathan.hernandez@state.co.us

Re: Payment of Purchase Order #POGG1 PDAA 201700000762

Dear Mr. Hernandez:

The Farmers Reservoir and Irrigation Company has been invoiced in the amount of $27,965.00 by Ecological Resource Consultants (ERC) for the inundation mapping of the Standley Lake Dam. The work was performed in accordance with the Scope of Work referenced in Purchase Order# POGG1 PDAA 201700000762.

Please remit payment of $10,800.00 as agreed upon in the Purchase Order.

Sincerely,

Scott Edgar
General Manager
Farmers Reservoir & Irrigation Company

COLORADO DIVISION OF WATER RESOURCES - DAM SAFETY BRANCH
STANDLEY LAKE DAM - EAP INUNDATION MAPPING GRANT - PO# 201700000762

6/13/2017 Invoice

Ecological Resource Consultants, Inc. (ERC)	Inv#7206 (03/02/17)	$9,328.00
Ecological Resource Consultants, Inc. (ERC)	Inv#7272 (04/05/17)	$4,617.00
Ecological Resource Consultants, Inc. (ERC)	Inv#7361 (05/04/17)	$171.00
Ecological Resource Consultants, Inc. (ERC)	Inv#7401 (06/05/17)	$13,222.00
Ecological Resource Consultants, Inc. (ERC)	Inv#7430 (06/12/17)	$627.00
	TOTAL	$27,965.00

Ecological Resource Consultants, Inc.
35715 US Hwy. 40, Suite D204
Evergreen, CO 80439

Date	Invoice #
3/2/2017	7206

Bill To:

Farmers Reservoir & Irrigation Co.
80 South 27th Avenue
Brighton, CO 80601

127-SLOC
(DH)

Project

340 1615 Standley Dam Breach Analysis

Item	Description	Qty	Rate	Amount
Engineer	Dam break modeling	55	114.00	6,270.00
Project Manager	Raster Input for HEC Ras Model, LIDAR GIS import	3	145.00	435.00
Project Ecologist	GIS mapping	19.5	114.00	2,223.00
Sr Project Mgr/Technical S...	Standley dam break analysis	2.5	160.00	400.00

Please remit payment to:
Ecological Resource Consultants, Inc.
35715 US Hwy. 40, Suite D204
Evergreen, CO 80439

If you have any questions or concerns, please contact us at (303) 679-4820.

Total $9,328.00

Thank you for your business!

Balance Due $9,328.00

Ecological Resource Consultants, Inc.

35715 US Hwy. 40, Suite D204
Evergreen, CO 80439

Date	Invoice #
4/5/2017	7272

Bill To:

Farmers Reservoir & Irrigation Co.
80 South 27th Avenue
Brighton, CO 80601

BILL BACK
127-00 $4,617.00
SLCC (DH)

Project

340-1615 Standley Dam Breach Analysis

Item	Description	Qty	Rate	Amount
Engineer	03-14 Revise dam break model	1	114.00	114.00
Engineer	03-16 Standley dam break modeling	2.5	114.00	285.00
Engineer	03-17 Standley dam break modeling	5	114.00	570.00
Engineer	03-20 Standley dam break modeling	7.5	114.00	855.00
Engineer	03-21 Standley dam break modeling	3	114.00	342.00
Engineer	03-22 Standley dam break modeling	4.5	114.00	513.00
Engineer	03-23 Standley dam break modeling	4	114.00	456.00
Engineer	03-24 Standley dam break modeling	2	114.00	228.00
Engineer	03-27 Dam break analysis/call with SEO	3	114.00	342.00
Engineer	03-28 Dam break modeling	4.5	114.00	513.00
Engineer	03-29 Dam break modeling	1.5	114.00	171.00
Engineer	03-30 Dam break modeling	1	114.00	114.00
Engineer	03-31 Dam break modeling	1	114.00	114.00

Please remit payment to:
Ecological Resource Consultants, Inc.
35715 US Hwy. 40, Suite D204
Evergreen, CO 80439

Total $4,617.00

If you have any questions or concerns, please contact us at (303) 679-4820.

Thank you for your business!

Balance Due $4,617.00

Ecological Resource Consultants, Inc.
35715 US Hwy. 40, Suite D204
Evergreen, CO 80439

Date	Invoice #
5/4/2017	7361

Bill To:

Farmers Reservoir & Irrigation Co.
80 South 27th Avenue
Brighton, CO 80601

BILL BACK
12 for track

Project

345-1615 Standley Dam Breach Analysis

Item	Description	Qty	Rate	Amount
Engineer	04-03 Standley dam break modeling	1.5	114.00	171.00

Please remit payment to:
Ecological Resource Consultants, Inc.
35715 US Hwy. 40, Suite D204
Evergreen, CO 80439

If you have any questions or concerns, please contact us at (303) 679-4820.

Total $171.00

Thank you for your business!

Balance Due **$171.00**

Ecological Resource Consultants, Inc.
35715 US Hwy. 40, Suite D204
Evergreen, CO 80439

Date	Invoice #
6/5/2017	7401

Bill To:

Farmers Reservoir & Irrigation Co.
80 South 27th Avenue
Brighton, CO 80601

True

BILL BACK
12-7-00 #13,222.00

Project

345-1615 Standley Dam Breach Analysis

Item	Description	Qty	Rate	Amount
Sr Project Mgr/Technical S...	05-01 review	0.5	160.00	80.00
Engineer	05-03 Standley dam break modeling	7.5	114.00	855.00
Sr Project Mgr/Technical S...	05-04 review	0.5	160.00	80.00
Engineer	05-04 Standley dam break modeling	3	114.00	342.00
Engineer	05-08 Dam break modeling	0.5	114.00	57.00
Engineer	05-10 Dam break analysis	2	114.00	228.00
Sr Project Mgr/Technical S...	05-11 coordination	1	160.00	160.00
Engineer	05-11 Dam break analysis	8.5	114.00	969.00
Engineer	05-12 Dam break modeling	7.5	114.00	855.00
Engineer	05-15 Dam breach modeling	8	114.00	912.00
Sr Project Mgr/Technical S...	05-17 review	1	160.00	160.00
Engineer	05-16 Dam breach modeling	6	114.00	684.00
Engineer	05-17 Dam breach modeling	2	114.00	228.00
Engineer	05-18 Dam breach modeling	3	114.00	342.00
Engineer	05-19 Dam break modeling	9.5	114.00	1,083.00
Project Manager	05-19 - Help Ryan with Terrain Model	1	145.00	145.00
Sr Project Mgr/Technical S...	05-22 review	0.5	160.00	80.00
Project Manager	05-22 - Terrian Model Analysis	4	145.00	580.00
Engineer	05-22 Dam break modeling	9	114.00	1,026.00
Engineer	05-23 Dam break modeling	7.5	114.00	855.00
Engineer	05-24 Dam break modeling	9	114.00	1,026.00
Engineer	05-25 Dam break modeling	9	114.00	1,026.00
Sr Project Mgr/Technical S...	05-26 review	1	160.00	160.00
Sr Project Mgr/Technical S...	05-26 Report review	1.5	160.00	240.00
Engineer	05-26 Dam break modeling	8.5	114.00	969.00

Total

Thank you for your business!

Balance Due

Ecological Resource Consultants, Inc.

35715 US Hwy. 40, Suite D204
Evergreen, CO 80439

Date	Invoice #
6/5/2017	7401

Bill To:

Farmers Reservoir & Irrigation Co.
80 South 27th Avenue
Brighton, CO 80601

Project

345-1615 Standley Dam Breach Analysis

Item	Description	Qty	Rate	Amount
Sr Project Mgr/Technical S...	05-30 review	0.5	160.00	80.00

Please remit payment to:
Ecological Resource Consultants, Inc.
35715 US Hwy. 40, Suite D204
Evergreen, CO 80439

If you have any questions or concerns, please contact us at (303) 679-4820.

Total $13,222.00

Thank you for your business!

Balance Due **$13,222.00**

Ecological Resource Consultants, Inc.
35715 US Hwy. 40, Suite D204
Evergreen, CO 80439

Date	Invoice #
6/12/2017	7430

Bill To:

Farmers Reservoir & Irrigation Co.
80 South 27th Avenue
Brighton, CO 80601

Project

345-1615 Standley Dam Breach Analysis

Item	Description	Qty	Rate	Amount
Engineer	06-05 Inundation mapping	5.5	114.00	627.00

Please remit payment to:
Ecological Resource Consultants, Inc.
35715 US Hwy. 40, Suite D204
Evergreen, CO 80439

If you have any questions or concerns, please contact us at (303) 679-4820.

Total $627.00

Thank you for your business!

Balance Due **$627.00**

COLORADO
Division of Water Resources
Department of Natural Resources

Dam Safety Branch

June 12, 2017

Mr. Troy Thompson, P.E.
Ecological Resource Consultants, Inc.
35715 US Hwy. 40, Suite D204
Evergreen, CO 80439
Troy@erccolorado.net

Via EMAIL

When replying, please refer to:
STANDLEY LAKE DAM, DAMID 020326
Water Division 1, Water District 2

SUBJECT: Dam Breach Inundation Mapping Acceptance

Dear Mr. Thompson,

We received your response to our review comments and revised inundation maps prepared for the Farmer's Reservoir and Irrigation Company (FRICO), dated June 2017. We have reviewed the documents and agree that our review comments have been satisfactorily addressed. Therefore, it is our opinion that the inundation maps are acceptable for inclusion in the dam EAP and are ready for distribution to the EAP record holders.

Please assemble and distribute a final copy of the report, inundation mapping, and GIS shapefiles to the FRICO and this office. The transmittal to this office should be in digital format only. Please coordinate with the FRICO to fulfill any further outstanding requirements in accordance with your contract and submit the final invoice to them as soon as possible so they can submit their request for reimbursement in accordance with their inundation map grant.

Thank you again for helping the FRICO with this important project. If you have any further questions or comments, please feel free to give me a call at (303) 866-3581 ext.8284.

Sincerely,

Ryan Schoolmeesters
Dam Safety Engineer

ec: Bill McCormick, Chief of Dam Safety
John Batka, Dam Safety Engineer
Jorge Vidal, WD 2 Water Commissioner
Scott Edgar, FRICO, scott@farmersres.com
Ashley Henderson, FRICO, ashley@farmersres.com
Jonathan Hernandez, CWCB, jonathan.hernandez@state.co.us

COLORADO
Division of Water Resources
Department of Natural Resources

Dam Safety Branch

June 12, 2017

Mr. Troy Thompson, P.E.
Ecological Resource Consultants, Inc.
35715 US Hwy. 40, Suite D204
Evergreen, CO 80439
Troy@erccolorado.net

Via EMAIL

When replying, please refer to:
STANDLEY LAKE DAM, DAMID 020326
Water Division 1, Water District 2

SUBJECT: Dam Breach Inundation Mapping Acceptance

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Thank you again for helping the FRICO with this important project. If you have any further questions or comments, please feel free to give me a call at (303) 866-3581 ext.8284.

Sincerely,

Ryan Schoolmeesters
Dam Safety Engineer

ec: Bill McCormick, Chief of Dam Safety
John Batka, Dam Safety Engineer
Jorge Vidal, WD 2 Water Commissioner
Scott Edgar, FRICO, scott@farmersres.com
Ashley Henderson, FRICO, ashley@farmersres.com
Jonathan Hernandez, CWCB, jonathan.hernandez@state.co.us

Ecological Resource Consultants, Inc.
35715 US Hwy. 40, Suite D204 ~ Evergreen, CO ~ 80439 ~ (303) 679-4820

March 1, 2016

Scott Edgar, General Manager
Farmers Reservoir and Irrigation Company
80 South 27th Street
Brighton, CO 80601

RE: ERC Proposal for Dam Break and Flood Inundation Mapping
Standley Lake (DAMID 020326)
Marshall Lake (DAMID 060203)

Dear Scott,

Ecological Resource Consultants, Inc. (ERC) is pleased to provide this proposal to perform dam breach modeling, flood routing and inundation mapping for Standley Lake and Marshall Lake Dams. Standley Lake Dam is located in Westminster, CO and Marshall Lake Dam is located west of Superior in Boulder County, CO. Both dams are high hazard dams. The purpose of these studies are to update current estimates inundation mapping and provide Farmers Reservoir and Irrigation Company (FRICO) and the State Engineer's Office (SEO) for better tools to manage dam safety risks. ERC is actively involved in past evaluations of both dams and will build upon our existing knowledge base for the successful completion of these studies.

Details regarding our anticipated work scope and associated costs are presented below.

Scope of Work

Task 1 – Breach Modeling

The dam breach for each site will be evaluated using a combination of HEC-RAS modeling and the Division of Water Resource's empirical equations for dam breach. The breach evaluation will be performed in accordance with the simplified techniques in the latest version of the SEO's "Guidelines for Dam Breach Analysis". For modeling purposes, it will be assumed that the failure would occur due to overtopping and piping failure mechanisms. HEC-RAS will be used to generate a flood wave at the dam.

Task 2 – Flood Routing and Inundation Mapping

We anticipated that the hydraulic model FLO-2D will be used to route the flood waves downstream. We believe a 2D model is appropriate for both studies as it should represent conditions through developed areas more accurately than a 1D model. For our modeling, the best available topographic mapping

including recent LiDAR will be used. It is expected that the Standley Lake model will extend to Fort Morgan while the Marshall Lake model will extend through Kersey.

Alternative breach locations will be evaluated for each dam and each respective flow path will be modeled. The flow path of the spillway of each dam will also be evaluated and may be included in inundation results. Spillway flows may be modeled using HEC-RAS or FLO-2D.

Inundation limits of the flood will be depicted in ESRI shapefile format in UTM coordinates and overlain on color aerial imagery. The inundation maps and associated results tables will include cross-sections at critical locations showing lateral and vertical flood extents, flood wave velocity, flood wave depth and estimated flood wave arrival time after the breach. Critical infrastructure within the inundation area and roads expected to be overtopped will be illustrated in the project mapping files.

Task 3 – Deliverables

Preliminary and final mapping reports will be prepared. The preliminary report will be submitted to FRICO and the SEO for review. Reporting will provide the basis of our analysis, assumptions, calculations and ultimate results. Hydraulic models and mapping will also be provided in digital format. It is expected that ERC will work with the SEO on the review process; revisions based on SEO input are anticipated after the draft report is submitted.

A final report will be prepared after any FRICO and SEO revisions have been incorporated into the analysis. All reporting and final mapping will be provided in digital format.

Task 4 – Coordination with the SEO

Throughout the course of the project, ERC will coordinate with the SEO. We believe that communications early in the process will be helpful to ensure ERC's modeling approach and model assumptions are consistent with the expectations of the State. This communication will likely include a sit down meeting at the beginning of the project, update calls throughout the course of the work and a sit down meeting to present the draft results.

Cost Estimate

ERC's estimated costs for the individual tasks are summarized in the table below. Work will be performed on a time and materials basis. Work hours and costs will be tracked separately for each of the two studies and separate involves will be generated for Standley Lake and Marshall Lake work. All work will be billed according to ERC's 2016 standard rate sheets. Total costs for the two studies combined is estimated to be $47,000. Our costs assume some efficiencies can be achieved by completing both studies at the same time.

Ecological Resource Consultants, Inc.
35715 US Hwy. 40, Suite D204 ~ Evergreen, CO ~ 80439 ~ (303) 679-4820

Task	Standley Lake Dam	Marshall Lake Dam
Task 1 – Dam Breach Modeling	$3,000	$2,500
Task 2 – Flood Routing and Inundation Mapping	$15,000	$9,000
Task 3 – Project Deliverables	$9,000	$5,500
Task 4 – SEO Coordination	$1,500	$1,500
Total	$28,500	$18,500

If you should require any further information at this time or have any questions regarding this proposal, please do not hesitate to contact me.

Sincerely,

Ecological Resource Consultants, Inc.

Troy Thompson, President

Scott Edgar, FRICO General Manager

Ecological Resource Consultants, Inc.
35715 US Hwy. 40, Suite D204 ~ Evergreen, CO ~ 80439 ~ (303) 679-4820

Ecological Resource Consultants, Inc.
2016 Rate Sheet

Professional Services

Senior Project Manager/Technical Specialist……$155 per hour

Project Manager……$140 per hour

Senior Engineer……$130 per hour

Project Engineer……$120 per hour

Engineer……$110 per hour

Senior Ecologist……$120 per hour

Project Ecologist……$110 per hour

Ecologist……$90 per hour

Clerical Services……$60 per hour

Expenses

GPS rental……$250 per day

Mileage……IRS Rate

Subconsultant……Cost + 10%

Plots (B&W or Color, 24”x36”). ……$10 per sheet

*Additional direct project expenses billed at cost

Trial and trial preparation time billed at 125% of regular hourly rates

Rates listed on this sheet are valid from January 1, 2016 through December 31, 2016. ERC reserves the right to increase rates effective January 1, 2017.

CERTIFICATE OF LIABILITY INSURANCE

DATE (MM/DD/YYYY): 2/8/2017

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER F&W Insurance Assoc 3005 Center Green Drive Suite 120 Boulder CO 80301	**CONTACT NAME:** Lauren Hix **PHONE (A/C, No, Ext):** 303-444-4666 **FAX (A/C, No):** 303-444-8481 **E-MAIL ADDRESS:** Lauren_Hix@ajg.com
	INSURER(S) AFFORDING COVERAGE / **NAIC #** **INSURER A :** American Alternative Insurance Corp / 19720
INSURED FARMRES-02 The Farmers Reservoir & Irrigation Company 80 South 27th Ave Brighton CO 80601	**INSURER B :** **INSURER C :** **INSURER D :** **INSURER E :** **INSURER F :**

COVERAGES **CERTIFICATE NUMBER:** 523013376 **REVISION NUMBER:**

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

INSR LTR	TYPE OF INSURANCE	ADDL INSD	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS	
A	X **COMMERCIAL GENERAL LIABILITY** CLAIMS-MADE [X] OCCUR GEN'L AGGREGATE LIMIT APPLIES PER: [X] POLICY [ ] PRO-JECT [ ] LOC [ ] OTHER:	Y		GPPAPF605179905	8/1/2016	8/1/2017	EACH OCCURRENCE DAMAGE TO RENTED PREMISES (Ea occurrence) MED EXP (Any one person) PERSONAL & ADV INJURY GENERAL AGGREGATE PRODUCTS - COMP/OP AGG	$1,000,000 $1,000,000 $10,000 $1,000,000 $3,000,000 $3,000,000
	AUTOMOBILE LIABILITY ANY AUTO ALL OWNED AUTOS SCHEDULED AUTOS HIRED AUTOS NON-OWNED AUTOS						COMBINED SINGLE LIMIT (Ea accident) BODILY INJURY (Per person) BODILY INJURY (Per accident) PROPERTY DAMAGE (Per accident)	$ $ $ $
	UMBRELLA LIAB OCCUR **EXCESS LIAB** CLAIMS-MADE DED RETENTION $						EACH OCCURRENCE AGGREGATE	$ $
	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY ANY PROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED? **(Mandatory in NH)** Y / N [ ] If yes, describe under DESCRIPTION OF OPERATIONS below	N / A					PER STATUTE [ ] OTH-ER E.L. EACH ACCIDENT E.L. DISEASE - EA EMPLOYEE E.L. DISEASE - POLICY LIMIT	 $ $ $

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (ACORD 101, Additional Remarks Schedule, may be attached if more space is required)

Colorado Department of Natural Resources is an Additional Insured as respects to the General Liability policy, pursuant to and subject to the policy's terms, definitions, conditions and exclusions.

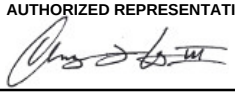
CERTIFICATE HOLDER

Colorado Department of Natural Resources
1313 Sherman Street, #718
Denver CO 80203

CANCELLATION

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.

AUTHORIZED REPRESENTATIVE



d. An organization other than a partnership, joint venture or limited liability company, you are an insured. Your "executive officers" and directors are insureds, but only with respect to their duties as your officers or directors. Your stockholders are also insureds, but only with respect to their liability as stockholders.

e. A public entity, you are an insured. Your operating authorities, boards, commissions, districts or any other governmental units are insureds, provided that you operate, control, and fund the authority, board, commission, district, or other governmental unit. Coverage does not extend to an authority, board, commission, district, or other governmental unit that operates, controls, or funds a school, hospital or medical clinic, nursing home, airport, port, public housing, gas or electric generation facility.

f. A trust, you are an insured. Your trustees are also insureds, but only with respect to their duties as trustees.

2. Each of the following is also an insured:

a. **Elected or appointed officials.** Your elected and appointed officials, including elected and appointed officials of your operating authorities, boards, commissions, districts, or other governmental units but only for acts within the course and scope of their duties for the insured public entity or its operating authorities, boards, commissions, districts or other governmental units.

b. **Employees and Volunteer Workers.** "Employees" and "volunteer workers" but only for acts within the course and scope of their employment or volunteer activities for you.

c. **Real Estate Managers.** Any person (other than your "employee" or "volunteer worker"), or any organization while acting as your real estate manager.

d. **Temporary Custodians.** Any person or organization having proper temporary custody of your property if you die, but only:

(1) With respect to liability arising out of the maintenance or use of that property; and

(2) Until your legal representative has been appointed.

e. **Legal Representatives.** Your legal representative if you die, but only with respect to duties as such. That representative will have all your rights and duties under this Coverage Part.

f. **Medical Directors.** Physicians who are your medical directors, but only for acts within the course and scope of their medical director duties on behalf of your "emergency service activity".

g. **Mutual Aid Agreements.** Any persons or organizations providing service to you under any mutual aid or similar agreement, but only for acts within the scope of that mutual aid or similar agreement.

h. **Good Samaritans.** "Employees" and "volunteer workers" while acting as a Good Samaritan independently of his or her activities on your behalf, but only when he or she encounters the scene of an emergency requiring sudden action. In no event will such person who responds to the scene of an emergency with or for any other emergency service organization be an insured.

i. **Owners of Commandeered Equipment.** The owner of commandeered equipment other than an "auto" is an insured while the equipment is in your temporary care, custody or control and is being used as part of an "emergency service activity".

J. **Blanket Additional Insureds.** Any person or organization required to be an additional insured under an "insured contract", if agreed to by you prior to the "bodily injury", "property damage", or "personal and advertising injury", caused in whole or in part, by your acts or omissions or the acts or omissions of those acting on your behalf:

(1) In the performance of your operations; or

(2) In connection with your premises owned or rented by you.

3. Any organization you newly acquire or form, other than a partnership, joint venture or limited liability company, and over which you maintain ownership or majority interest, will qualify as a Named Insured if there is no other similar insurance available to that organization. However:
   a. Coverage under this provision is afforded only until the 90th day after you acquire or form the organization or the end of the policy period, whichever is earlier;
   b. **COVERAGE A** does not apply to "bodily injury" or "property damage" that occurred before you acquired or formed the organization; and
   c. **COVERAGE B** does not apply to "personal and advertising injury" arising out of an offense committed before you acquired or formed the organization.

No person or organization is an insured with respect to the conduct of any current or past partnership, joint venture or limited liability company that is not shown as a Named Insured in the Declarations.

SECTION III. LIMITS OF INSURANCE

1. The Limits of Insurance shown in the Declarations and the rules below fix the most we will pay regardless of the number of:
   a. Insureds;
   b. Claims made or "suits" brought; or
   c. Persons or organizations making claims or bringing "suits".

2. The General Aggregate Limit is the most we will pay for the sum of:
   a. Medical expenses under **COVERAGE C**;
   b. Damages under **COVERAGE A**, except damages because of "bodily injury" or "property damage" included in the "products-completed operations hazard"; and
   c. Damages under **COVERAGE B.**

3. The Products - Completed Operations Aggregate Limit is the most we will pay under **COVERAGE A** for damages because of "bodily injury" and "property damage" included in the "products-completed operations hazard".

4. Subject to Paragraph 2. above, the Personal and Advertising Injury Limit is the most we will pay under **COVERAGE B** for the sum of all damages because of all "personal and advertising injury" sustained by any one person or organization.

5. Subject to Paragraph 2. or 3. above, whichever applies, the Each Occurrence Limit is the most we will pay for the sum of:
   a. Damages under **COVERAGES A** and
   b. Medical expenses under **COVERAGE C**;

   because of all damages arising out of the same or related "occurrence" .

6. Subject to Paragraph 5. above, the Each Occurrence Limit is the most we will pay under **COVERAGE A** for damages because of "property damage" to any one premises, while rented to you, or in the case of damage by fire, while rented to you or temporarily occupied by you with permission of the owner.

7. Subject to Paragraph 5. above, the Medical Expense Limit is the most we will pay under **COVERAGE C** for all medical expenses because of "bodily injury" sustained by any one person.

The Limits of Insurance of this coverage part apply separately to each consecutive annual period and to any remaining period of less than 12 months, starting with the beginning of the policy period shown in the Declarations, unless the policy period is extended after issuance for an additional period of less than 12 months. In that case, the additional period will be deemed part of the last preceding period for purposes of determining the Limits of Insurance.

SECTION IV. CONDITIONS

The following conditions apply in addition to the Common Policy Conditions.

1. **Bankruptcy**

   Bankruptcy or insolvency of the insured or of the insured's estate will not relieve us of our obligations under this coverage part.

2. **Duties in the Event of an Occurrence, Offense, Claim or Suit**

   a. You must see to it that we are notified as soon as practicable of an "occurrence", or an offense which may result in a claim or "suit". To the extent possible, notice should include:

      (1) How, when and where the "occurrence" or offense took place;

      (2) The names and addresses of any injured persons and witnesses; and

      (3) The nature and location of any injury or damage arising out of the "occurrence" or offense.

   b. If a claim is made or "suit" is brought against any insured, you must:

      (1) Immediately record the specifics of the claim or "suit" and the date received; and

      (2) Notify us as soon as practicable.

      You must see to it that we receive written notice of the claim or "suit" as soon as practicable.

   c. You and any other involved insured must:

      (1) Immediately send us copies of any demands, notices, summonses or legal papers received in connection with the claim or "suit";

      (2) Authorize us to obtain records and other information;

      (3) Cooperate with us in the investigation or settlement of the claim or defense against the "suit"; and

      (4) Assist us, upon our request, in the enforcement of any right against any person or organization which may be liable to the insured because of injury or damage to which this insurance may also apply.

   d. No insured will, except at that insured's own cost, voluntarily make a payment, assume any obligation, or incur any expense, other than for first aid, without our consent.

   e. If you report an "occurrence" or offense, to an insurer providing other than General Liability insurance, which later develops into a General Liability claim covered under this coverage part, failure to report such "occurrence" or offense to us at the time of the "occurrence" or offense shall not be deemed in violation of these conditions. However, you shall give notification to us, as soon as is reasonably possible, that the "occurrence" or offense is a General Liability claim.

   f. Knowledge of an "occurrence" or offense by any of your agents, "volunteer workers" or "employees" shall not constitute knowledge by you unless one of your officers or anyone responsible for administering your insurance program has received a notification from the agent, "volunteer worker" or "employee".

Ecological Resource Consultants, Inc.
35715 US Hwy. 40, Suite D204 ~ Evergreen, CO ~ 80439 ~ (303) 679-4820

Task	Standley Lake Dam	Marshall Lake Dam
Task 1 – Dam Breach Modeling	$3,000	$2,500
Task 2 – Flood Routing and Inundation Mapping	$15,000	$9,000
Task 3 – Project Deliverables	$9,000	$5,500
Task 4 – SEO Coordination	$1,500	$1,500
Total	$28,500	$18,500

Ecological Resource Consultants, Inc.
2016 Rate Sheet

Professional Services

Senior Project Manager/Technical Specialist.....$155 per hour

Project Manager.....$140 per hour

Senior Engineer.....$130 per hour

Project Engineer.....$120 per hour

Engineer.....$110 per hour

Senior Ecologist.....$120 per hour

Project Ecologist.....$110 per hour

Ecologist.....$90 per hour

Clerical Services.....$60 per hour

Expenses

GPS rental.....$250 per day

Mileage.....IRS Rate

Subconsultant.....Cost + 10%

Plots (B&W or Color, 24"x36"). .....$10 per sheet

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Mileage.....IRS Rate

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February 9, 2017

Project: Inundation Mapping for the Standley Lake Dam

Vendor: Farmers Reservoir and Irrigation Company
Mr. Scott Edgar
80 South 27th Avenue
Brighton, CO 80601
Phone / email: 303-659-7373 / scott@farmersres.com

Consultant: Ecological Resource Consultants, Inc.
Mr. Troy Thompson, P.E.
35715 U.S. Hwy 40, Suite D204
Evergreen, CO 80439
Phone / email: (303) 679-4820 / Troy@erccolorado.net

CWCB funding source: Severance Tax Trust Fund Operational Account

SCOPE OF WORK

Ecological Resource Consultants, Inc. (Consultant), at the direction of the Farmers Reservoir and Irrigation Company (Vendor), will perform a dam breach modeling study and associated flood inundation mapping for the above structure which they are the owner of. Standley Lake Dam is a High Hazard dam located in Boulder County and is tributary to Big Dry Creek within the South Platte River Basin. A breach analysis of the Standley Lake Dam and inundation mapping of the flood flows will be performed along Big Dry Creek and the South Platte River to a point where impacts to public safety are negligible. This reach is expected to extend down the South Platte River to the City of Fort Morgan, Co

Consultant or Vendor will submit the final report and mapping to the Colorado Division of Water Resources, Dam Safety Branch, for approval. Grant funds will not be disbursed until the project has been approved by the Dam Safety Branch.

PROPOSED METHODOLOGY

The Consultant shall perform a clear dam breach analyses in accordance with the State of Colorado Rules and Regulations for Dam Safety and Dam Construction (1/1/2007), and the Dam Safety Guidelines for Dam Breach Analysis (2/10/2010). Correspondence shall be with Ryan Schoolmeesters, P.E., of the Colorado Division of Water Resources, Dam Safety Branch, to present preliminary dam breach parameters, water surface profile modeling, and inundation mapping and to determine if field measurements are necessary for critical bridges.

Inundation mapping for High Hazard dams shall show the calculated extents of the dam breach flood wave. The mapping will also include cross sections at critical locations showing lateral and vertical flood extents, flood wave velocity, and flood wave arrival time. Inundation mapping shall be extended downstream to a location where no potential for loss of life and/or no significant property damage exist.

Inundation mapping for Significant Hazard dams shall show the route of the dam breach flood wave, the estimated time of arrival of the flood wave at critical sections, and the estimated lateral extent of inundation. The inundation mapping shall be extended downstream to a location where no significant

property damage exists. The inundation mapping requirements for Significant Hazard dams may be modified for good cause, with the approval of the State Engineer.

DELIVERABLES

The Vendor shall provide the CWCB electronic copies of the following: Final Report for the inundation mapping analysis stamped by a licensed Colorado professional engineer, and inundation maps. Additionally the Vendor shall provide a copy of the project's Colorado Division of Water Resources, Dam Safety Branch, approval letter.

SCHEDULE

Work may initiate on the date of the State's Purchase Order. Deliverables are due no later than June 15, 2017.

BUDGET

The Consultant will complete the work described for a not-to-exceed budget of $28,500 based on Consultant's current rate schedule and projection of effort. The estimate is summarized. The Consultant shall invoice Vendor on a Time and Materials basis for services performed below:

Task: Breach Modeling, Flood Routing	Budget
Standley Lake Dam:	$28,500
TOTAL	$28,500

PAYMENT

The State shall pay Vendor 50% of the Project Cost up to $21,600, for a maximum grant of $10,800 for Consultant's project related invoices following receipt of final deliverables. The Vendor is responsible for all expenses in excess of the State's contribution. Any overages or increases in project costs shall be the responsibility of the Vendor.

Estimated Project Cost Sharing:	
Owner Match	$ 17,700
CWCB Grant	$ 10,800
TOTAL	$ 28,500

CWCB shall issue payment following receipt and processing of Vendor's Request for Payment submittal. The Request for Payment must include: a summary of Consultant's labor effort and direct costs in accordance with the attached estimate, copies of corresponding invoices from Consultant, and identification of any major issues with proposed or implemented corrective actions. The Deliverable, including the Dam Safety Branch's approval letter, must be provided to the CWCB as part of project documentation prior to CWCB issue of payment.

Form **W-9**
State of Colorado Substitute

Request for Taxpayer Identification Number and Certification

Give Form to the requester. Do not send to the IRS.

Print or type
See Specific Instructions on page 2.

Name (as shown on your income tax return) FARMERS RESERVOIR & IRRIGATION COMPANY

Business name/disregarded entity name, if different from above

Check appropriate box for federal tax classification:
☐ Individual ☐ Sole Proprietor ☑ Corporation ☐ Partnership ☐ Trust/estate
☐ Limited liability company. Enter the tax classification (C=C corporation, S=S corporation, P=partnership) ▸
☐ Other (see instructions) ▸ ☐ Government

Exemptions (see instructions):
Exempt payee code (if any)
Exemption from FATCA reporting code (if any)

Address (number, street, and apt. or suite no.) 80 S. 27TH AVE.

Purchase Order address if different (optional)

City, state, and ZIP code BRIGHTON, CO 80601

List account number(s) here (optional) Contact name Contact Email

Part I Taxpayer Identification Number (TIN)

Enter your TIN in the appropriate box. The TIN provided must match the name given on the "Name" line to avoid backup withholding. For individuals, this is your social security number (SSN). However, for a resident alien, sole proprietor, or disregarded entity, see the Part I instructions on page 3. For other entities, it is your employer identification number (EIN). If you do not have a number, see *How to get a TIN* on page 3.

Note. If the account is in more than one name, see the chart on page 4 for guidelines on whose number to enter.

Social security number

Employer identification number
84-0200860

Part II Certification

Under penalties of perjury, I certify that:

1. The number shown on this form is my correct taxpayer identification number (or I am waiting for a number to be issued to me), and
2. I am not subject to backup withholding because: (a) I am exempt from backup withholding, or (b) I have not been notified by the Internal Revenue Service (IRS) that I am subject to backup withholding as a result of a failure to report all interest or dividends, or (c) the IRS has notified me that I am no longer subject to backup withholding, and
3. I am a U.S. citizen or other U.S. person (defined below), and
4. The FATCA code(s) entered on this form (if any) indicating that I am exempt from FATCA reporting is correct.

Certification instructions. You must cross out item 2 above if you have been notified by the IRS that you are currently subject to backup withholding because you have failed to report all interest and dividends on your tax return. For real estate transactions, item 2 does not apply. For mortgage interest paid, acquisition or abandonment of secured property, cancellation of debt, contributions to an individual retirement arrangement (IRA), and generally, payments other than interest and dividends, you are not required to sign the certification, but you must provide your correct TIN. See the instructions on page 3.

Sign Here Signature of U.S. person ▸ Yvette Schipman Date ▸ 02/07/2017

Have you ever worked for the State of Colorado? ○ Yes ◉ No

Have you ever worked for a PERA Employer? ○ Yes ◉ No

Business Types (check all that apply):

- ☑ CO Location/HQ in CO
- ☐ CO Location/HQ out of CO
- ☐ No CO Location/HQ in US
- ☐ No CO Location/HQ out of US
- ☐ Has Paid Compensation Tax
- ☐ Has Not Paid Compensation Tax
- ☐ African American
- ☐ Asian Pacific American
- ☐ Subcontinent Asian American
- ☐ Hispanic American
- ☐ Native American
- ☐ CDOT Certified Emerging Small Business
- ☐ CDOT Certified Disadvantaged Small Business
- ☐ Women Owned
- ☐ Woman Business Enterprise
- ☐ Veteran Owned
- ☐ Disabled Vet Business Enterprise
- ☐ Disadvantaged Veteran Enterprise
- ☐ Service Disabled Veteran
- ☐ Vietnam Veteran
- ☐ Veteran Business Enterprise
- ☐ Disadvantaged Business Enterprise
- ☐ Small Disadvantaged Business
- ☐ Disabled Owned
- ☐ 8(A) Designation
- ☐ HUBZone Certified
- ☐ Labor Surplus
- ☐ Historical Black Colleges & Universities
- ☐ Small Business
- ☐ Airport Concession Disadvantaged Business

STATE OF COLORADO
Department of Natural Resources

ORDER
Number: POGG1 PDAA 201700000762
Date: 02/14/17
Description:
PDAA6000 Sev Tax Grant Inundation map Standley Lake Dam
Effective Date: Expiration Date:

BUYER
Buyer:
Email:

VENDOR
FARMERS RESERVOIR & IRRIGATION CO
80 S 27TH AVE
BRIGHTON, CO 80601-2699

Contact: .
Phone: .

**** IMPORTANT ****
The order number and line number must appear on all invoices, packing slips, cartons and correspondence

BILL TO
COLORADO WATER BOARD CONSERVATION
1313 SHERMAN STREET, ROOM 718
DENVER, CO 80203

SHIP TO
COLORADO WATER BOARD CONSERVATION
1313 SHERMAN STREET, ROOM 718
DENVER, CO 80203

SHIPPING INSTRUCTIONS
Delivery/Install Date:
F.O.B:
VENDOR INSTRUCTIONS:

Line Item	Commodity/Item Code	UOM	QTY	Unit Cost	Total Cost	MSDS Req.
1	G1000		0	0.00	$10,800.00	☐

Description: PDAA6000 Sev Tax Grant Inundation map Standley Lake Dam

Service From: 02/15/17 Service To: 06/15/17

TERMS AND CONDITIONS
https://www.colorado.gov/osc/purchase-order-terms-conditions

DOCUMENT TOTAL = $10,800.00

February 9, 2017

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Phone / email: 303-659-7373 / scott@farmersres.com

Consultant: Ecological Resource Consultants, Inc.
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35715 U.S. Hwy 40, Suite D204
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Phone / email: (303) 679-4820 / Troy@erccolorado.net

CWCB funding source: Severance Tax Trust Fund Operational Account

SCOPE OF WORK

Ecological Resource Consultants, Inc. (Consultant), at the direction of the Farmers Reservoir and Irrigation Company (Vendor), will perform a dam breach modeling study and associated flood inundation mapping for the above structure which they are the owner of. Standley Lake Dam is a High Hazard dam located in Boulder County and is tributary to Big Dry Creek within the South Platte River Basin. A breach analysis of the Standley Lake Dam and inundation mapping of the flood flows will be performed along Big Dry Creek and the South Platte River to a point where impacts to public safety are negligible. This reach is expected to extend down the South Platte River to the City of Fort Morgan, Co

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