MEMORANDUM

ANDERSON CONSULTING ENGINEERS, INC.
Civil • Water Resources • Environmental

DATE: January 8, 2024 **ACE PROJECT NO.: COMMM04**

TO: Julie Mikulas, Regional Land Manager/West Division – Martin Marietta Materials

FROM: Brian Smith, P.E.: Principal Engineer/Project Manager – Anderson Consulting Engineers

SUBJECT: Flood Evaluation of Taft Hill Site Near Fort Collins, Colorado

BACKGROUND INFORMATION:

In September 2023, Anderson Consulting Engineers, Inc. (ACE) was contracted by Martin Marietta Materials, Inc. (MMM) to conduct a hydraulic evaluation of the Cache la Poudre River along MMM's Taft Hill site near Fort Collins, Colorado. The purpose of this hydraulic evaluation is twofold: 1) to determine how the 100-year flood is currently conveyed through the site, particularly south of the river and west of Taft Hill Road, and 2) address comments from the Colorado Division of Reclamation, Mining, and Safety (DRMS) about how the 100-year flood will safely be conveyed through two planned unlined gravel pits in this area as currently permitted. The gravel pits will ultimately be reclaimed as water storage reservoirs by the property owners (City of Greeley, Fort Collins-Loveland Water District, North Weld County Water District and East Larimer County Water District) once mining is complete. The property owners will be re-permitting the unlined gravel pits similar to what they did for others pits that have been released from the current M-1977-439 permit, approved as M-2011-049 and M-2018-039. A vicinity map illustrating the location of the gravel pits relative to the river and Taft Hill road is provided as Figure 1 in Attachment A to this memo. As shown on Figure 1, these gravel pits are referred to as Pit "E-I" and Pit "E-II".

The effective FEMA flood hazard information for the study area was obtained from FEMA's map service center website and pertinent information related to this study is provided in Attachment B. Hydrology for the effective study along the Cache la Poudre River was developed by the United States Army Corps of Engineers in 1988. The 1988 hydrologic results were utilized in the development of the original hydraulic model for the Cache la Poudre River that became effective in the early 1990s. As part of FEMA's Map Modernization Program to provide flood hazard information in a digital format, Larimer County retained Ayres Associates to conduct an update to the original 1990s hydraulic model. This study, which was completed in 2005, was adopted by FEMA and became effective in 2006 as part of the County's first Digital Flood Insurance Rate Map (DFIRM). The 2005 Ayres study was conducted along approximately 5.5 miles of river, extending from Wood Street (located 1,600 feet downstream of Shields Street) upstream to Watson Lake.

The DFIRM update provides the most recent hydraulic model and flood hazard mapping that has been adopted by FEMA for the current study reach west of Taft Hill Road. It is noted that the effective Flood Insurance Study (FIS) information documented in Attachment B does not report hydrology for the Cache la Poudre River west of the confluence with Dry Creek. This confluence occurs near Timberline Road in Fort Collins, which is approximately 6 river miles downstream of Taft Hill Road. The original hydraulic model, and the 2005 restudy, utilized more detailed discharge profiles than the values reported in the effective FIS. The 100-year peak discharge upstream of Taft Hill Road that was included in the original and 2005 hydraulic models, and utilized for this study, is 14,100 cfs.

In 2014, MMM commissioned ACE to update the 2005 effective hydraulic model to better reflect existing conditions at that time with respect to the gravel mining operations and to evaluate potential improvements to their batch plant operations at their yard located directly east of Taft Hill Road on the south side of the river. This study extended from the Larimer and Weld Diversion Dam (located approximately 2,300 feet east of Taft Hill Road) to the western extents of MMM's mining operation (located approximately 2,800 feet west of Taft Hill Road). The 2014 study incorporated 2013 LiDAR data to update the geometry of the hydraulic model cross sections and to delineate flood hazards more accurately. The 2014 study also collected in-channel ground survey along the cross sections within the study reach to document river geometry changes as a result of the 2013 flood. This in-channel survey was incorporated in the 2014 hydraulic model.

Hydrology for the 2014 study matched the hydrology from the 2005 effective study, with 14,100 cfs utilized as the peak flow for the 100-year event throughout the study reach. Results from the 2014 updated hydraulic model were utilized to remap flood hazard delineations through the study area. A comparison of the updated flood hazard boundaries from the 2014 study to those developed from the effective 2005 study are presented as Figure 2 in Attachment C. As illustrated on Figure 2, the 2014 study predicted minor spilling into the northeast and southeast corners of Pit E-I during the 100-year event. It is noted that 2014 study was not submitted to FEMA for formal adoption to update the effective flood hazard information along this reach of the Cache la Poudre River. However, the 2014 study represents the best available and most-up-to date model of this reach of the Cache la Poudre River.

The updated one-dimensional (1D) model from the 2014 study was originally going to be utilized to assess the flood evaluation as part of this study for the area where gravel pits E-I and E-II will be located. However, the upstream study limits of the 2014 study stopped east of the area where gravel pit E-II will be located, which would have required further updates to the 2014 model. In 2019, ACE developed a preliminary two-dimensional (2D) HEC-RAS model of the river between Shields Street and Overland Trail to help assess the complex hydraulic interactions between the river and the gravel pits in the overbanks. This study was mostly focused on the results in the vicinity of the Larimer and Weld Diversion Dam, but also includes the area that is being evaluated as part of this study. Since the 2014 1D model would have required further updates to properly assess the flood conditions needed for this study, and the 2019 preliminary 2D model already covers the current study area and will provide a better representation of the complex hydraulic interactions between the river and the gravel pits in the overbanks, it was decided that the 2D model would be updated and utilized for this study. As subsequently discussed, information from the 2014 1D model was utilized in the development of the 2D model.

2D MODEL DEVELOPMENT:

The development of the 2D model included the following: 1) defining the domain extents; 2) developing and incorporating topographic surface data for the domain area; 3) defining breaklines to inform the creation of mesh boundaries along critical topographic features; 4) defining the Manning's roughness coefficients for the domain area, and 5) creating the 2D mesh. The domain for the 2D model was generally set to be outside of the 100-year floodplain boundaries delineated on the effective FIRM panel provided in Attachment B. Figure 3 in Attachment D illustrates the extent of the 2D modeling domain for this study. For the initial 2D modeling assessment, and to compare results from the 2D model with those from the 2014 study, the 2013 LiDAR data was utilized as the base topographic surface for the 2D model. Since LiDAR cannot penetrate through water, the in-channel ground survey collected as part of the 2014 study was incorporated into the 2013 LiDAR surface and utilized to develop an in-channel surface between cross sections for the 2D model. Breaklines were defined throughout the modeling domain and set along important topographic features such as the top of the river bank, berms surrounding the gravel pits, and at the crown, top and toe of road embankments. Defined breaklines for the 2D model are also shown on Figure 3.

Manning's roughness coverages for the 2D modeling domain were defined based on the coefficients utilized in the 2014 1D model. In general, roughness coefficients for the river corridor were set between 0.040 to 0.048. Roughness coefficients for the overbanks, outside of the gravel pits, were set between 0.040 and 0.045. Roughness coefficients for areas where flood waters will travel over existing water in the gravel pits were set at 0.020, and a roughness value of 0.025 was used for roadways. Figure 4 in Attachment D shows the Manning's roughness coverage for the 2D modeling domain.

The goal of developing the 2D modeling mesh was to optimize the number of cells, and corresponding model run time, by providing adequate mesh definition in areas of interest to the study, while reducing mesh definition in other areas. In general, the initial mesh cell size was defined with a 25-foot by 25-foot grid spacing over the entire 2D domain. The defined breaklines were then utilized to refine the mesh to decrease cell size and increase hydraulic resolution in areas of interest or areas with rapidly changing topography. Along the breaklines, the mesh generator aligns the faces of the adjacent 2D cells to the prominent features of the terrain. Cell sizes adjacent to the breaklines range in size from 10 to 25 feet. Examples of the various cell sizing as part of the mesh development are provided on Figure 5 in Attachment D. The final mesh included approximately 120,000 cells with an average cell size of approximately 20-feet by 20-feet.

The HEC-RAS 2D modeling software also has the capability to model hydraulic structures within the 2D domain. This provides the flexibility to account for bridge and culvert hydraulics as part of a typical 2D surface flow model. In HEC-RAS 2D, the hydraulic structure locations are connected to the 2D mesh with the use of a special breakline that allows the model to compute the hydraulics through the structure with the use of standard 1D culvert and bridge computation equations that are then correlated back to the 2D surface mesh at the upstream and downstream breakline locations. This enables the hydraulic structure equations to appropriately account for tailwater conditions from the 2D mesh on the downstream side of the structure and then the headwater computed from the 1D structure equations is used to inform the water surface elevation on the 2D mesh at the upstream side of the structure. For the current study, the Taft Hill Road Bridge and Taft Hill Road relief culvert, which is located north of the bridge, were incorporated into the 2D model mesh. Geometric data for these structures were obtained as part of the 2014 in-channel survey efforts. The location of these structures is shown on Figure 5 in Attachment D.

For the 2D modeling boundary conditions, the downstream model boundary condition was set to match normal depth computations with a slope of 0.01 ft/ft. The upstream boundary condition was set to match the 100-year flow hydrograph. This hydrograph was obtained from the hydrologic study that was conducted for the Cache la Poudre River watershed by ACE in 2014. This hydrologic study was conducted as part of FEMA's RiskMAP update and has been reviewed and approved for use by FEMA. Figure 6 in Attachment D provides a plot of the hydrograph utilized as inflow for the 2D model. It is noted that the 100-year flood hydrograph has peak discharge of 14,100 cfs, which matches the hydrology utilized in the 1D hydraulic models. HEC-RAS Version 6.3 was utilized to conduct the 2D evaluation for this study. The model simulations were evaluated using the shallow water equation with Eulerian-Lagrangian computation approach, with adjustable timesteps based on the Courant Number, to provide greater accuracy in shallow water locations. With this computation approach, the model takes approximately three hours to run. At the conclusion of the 2D simulation, a computation log file is written. This file contains the volume accounting check for the entire model run. Volume accounting is a useful metric to gage the overall “health” of the model and is expressed in terms of a percent error. Best practices for 2D modeling suggest that the percent error should be less than 1%, but 2%-3% can be acceptable depending on the modeling objectives. All 2D model simulations for this study have errors of less than 0.02%.

2013 TOPOGRAPHIC CONDITION RESULTS:

As previously mentioned, the initial model run was conducted with the 2013 LiDAR data that was supplemented with in-channel ground survey data at the 1D model cross section locations to refine the in-channel surface for the 2D model. The 100-year inundation areas resulting from the 2D modeling of the 2013 Topographic Condition are presented in Figure 7 in Attachment E. The 2D inundation limits shown on Figure 7 provide good correlation to the updated flood hazard delineations developed from the 2014 1D model update as shown on Figure 2 in Attachment C. The 2D model results indicate that the area where Pit E-II is located will not be inundated during a 100-year flood event. The 2D model results also indicate that a minor spill is predicted to occur into the northeast corner of Pit E-I during a 100-year event. This minor spill prediction is similar to the 2014 1D model results.

2023 TOPOGRAPHIC CONDITION RESULTS:

On November 3, 2023, ACE staff conducted a site visit of the area where Pits E-I and E-II are located to determine how the ground elevations have changed in this area compared to 2013 conditions that are represented in the 2013 LiDAR. Based on this site visit it was determined that a buffer zone has been maintained between the river and the proposed gravel pit locations. Ground elevations within this buffer zone appear to not have been modified since 2013 and are assumed to match the 2013 LiDAR data. Ground elevations outside of this buffer zone have changed due to the on-going gravel mining and stockpiling operations, which is evident when a time lapse of aerial imagery for this site is reviewed using Goggle Earth. As part of their material management program, MMM conducts periodic drone flights of the area to capture real time aerial imagery and LiDAR data to help track their mining and stockpile operations. In order to assess if any of the ground elevation modifications that have occurred in this area since 2013 have changed the predicted 100-year inundation boundary, MMM provided ACE with imagery and LiDAR data collected from a drone flight conducted on October 30, 2023. A copy of the done imagery provided by MMM from the October 30th flight is provided as Figure 8 in Attachment F. The buffer zones where ground elevations appear to not have changed since 2013 are also identified on Figure 8.

The drone LiDAR provided by MMM was reviewed by ACE and determined to be vertically and horizontally referenced to the same datums (NAVD88 and Colorado State Plane) as the 2013 LiDAR data and was deemed to be appropriate for use with this study to represent changes in ground elevations within the study area since 2013. The 2023 LiDAR data was incorporated into the 2013 LiDAR to develop a new composite surface that reflects 2023 data where ground elevations have changed and 2013 data outside of this area. The 100-year inundation areas resulting from the 2D modeling of the 2023 Topographic Condition are presented on Figure 9 in Attachment F. The 2D inundation limits shown on Figure 9 are similar to the results from the 2D 2013 Topographic Condition run and the 2014 1D model. As shown on Figure 9, the 2D model results with the 2023 LiDAR incorporated still indicate that the area where Pit E-II is located will not be inundated during a 100-year flood event. The 2D model results with the 2023 LiDAR incorporated also still indicate that a minor spill is predicted to occur into the northeast corner of Pit E-I during a 100-year event, similar to the results from the 2013 Topographic Condition run and the 2014 1D model results.

The results of the 2023 Topographic Condition simulation were utilized to further evaluate the minor spill that is being predicted to occur during the 100-year flood in the northeast corner of Pit E-I. A profile line was defined in the 2D modeling domain to plot the existing ground surface in the location where the spill is predicted to occur and to determine the magnitude of the spill. As shown on Figures 10 and 11 in Attachment F, the spill is occurring over two low areas where flow depths are predicted to be less than 1-foot. The peak magnitude of the flow spill was estimated to be less than 1 cfs.

CONCLUSIONS AND RECOMMENDATIONS:

Three separate hydraulic analyses were documented and conducted as part of this study to determine the 100-year flood inundation areas along the Cache la Poudre River, upstream of Taft Hill Road, where MMM is proposing to excavate two gravel pits that are referred to as Pit E-I and Pit E-II as illustrated on Figure 1 in Attachment A. Based on the results of the hydraulic analyses documented and conducted as part of this study, ACE provides the following conclusions:

- Results of all three analyses (2014 1D model, 2013 Topographic Condition 2D model, and 2023 Topographic Condition 2D model) indicate that the 100-year flood will not inundate the area where Pit E-II is being proposed.
- Results of all three analyses indicate that a minor spill will likely occur into the northeast corner of Pit E-I during the 100-year flood. Results of the 2D modeling indicate that the magnitude of this spill will be less than 1 cfs and that the flow depth of the spill will be less than 1-foot. Based on the 2D model results, this spill is anticipated to occur for a short duration of time, less than 4 hours, during the peak of the 100-year hydrograph.

It is ACE's opinion that the minor spill predicted to occur into the northeast corner of Pit E-I will not result in catastrophic failure of nearby infrastructure or the potential capture of the river by the gravel pit. It is likely that some erosion along the pit embankment would occur if this spill does become activated during a 100-year event. However, this erosion would likely result in localized rills and gullies along the embankment that could be repaired after the flood event. If this erosion potential is a concern to the DRMS, the predicted spill could be temporarily eliminated by adding a small amount of fill in the low areas along the edge of the pit, as shown on Figure 11. For flood events that exceed the 100-year, it is likely that flow will enter Pit E-II from the west and cascade into Pit E-I. Therefore, it is further recommended that the installation of permanent spillways be considered as part of the infrastructure improvements when these gravel pits are converted into formal water storage facilities by the property owners with the re-permitting for water storage. It is ACE's understanding that the owners of the future water storage facilities have already identified the need for these spillways to protect their facilities from potential flooding risk. The 2D models developed as part of this study could be utilized to further evaluate and design these spillways, if needed. Electronic copies of the hydraulic models prepared as part of this study have been digitally provided.

I hereby certify that the hydraulic analysis and documentation associated with study were prepared by me or under my direct supervision for Martin Marietta Materials, Inc.

Responsible Engineer:
Anderson Consulting Engineers, Inc.

Brian A. Smith, P.E. Colorado Registration #41276

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BRIAN ALAN SMITH
41276
1/8/24
PROFESSIONAL ENGINEER

Attachment A. Vicinity Map

Attachment B. Effective Study Documentation

Attachment C. 2014 Study Documentation

Attachment D. 2D Model Development Information

Attachment E. 2013 Condition Results

Attachment F. 2023 Condition Results

ATTACHMENT A. VICINITY MAP

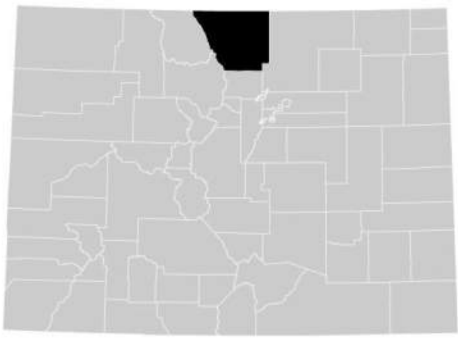
Figure 1: Vicinity Map

ATTACHMENT B. EFFECTIVE STUDY DOCUMENTATION

FLOOD INSURANCE STUDY

FEDERAL EMERGENCY MANAGEMENT AGENCY

VOLUME 1 OF 6



LARIMER COUNTY, COLORADO

AND INCORPORATED AREAS

COMMUNITY NAME	COMMUNITY NUMBER
BERTHOUD, TOWN OF	**080296**
ESTES PARK, TOWN OF	**080193**
FORT COLLINS, CITY OF	**080102**
JOHNSTOWN, TOWN OF	**080250**
LARIMER COUNTY, UNINCORPORATED AREAS	**080101**
LOVELAND, CITY OF	**080103**
TIMNATH, TOWN OF	**080005**
WELLINGTON, TOWN OF	**080104**

REVISED:

JANUARY 15, 2021

FLOOD INSURANCE STUDY NUMBER
08069CV001E

Version Number 2.5.3.6

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Cache La Poudre River	Fort Collins, City of; Timnath, Town of; Larimer County Unincorporated Areas	Larimer-Weld County Line Road	NP	10190006	19.9	Y	AE	2005
Cache La Poudre LEMAYDS	Larimer County Unincorporated Areas	NP	NP	10190006	-	N	A	2005
Cache La Poudre LINC	Larimer County Unincorporated Areas	NP	NP	10190006	-	N	A	2005
Cache La Poudre Lowflow Channel	Fort Collins, City of	Confluence with Cache La Poudre River	1.9 miles upstream of confluence with Cache La Poudre River	10190007	1.9	N	AE	2005
Cache La Poudre L PATH	Larimer County Unincorporated Areas	Confluence with Cache La Poudre River	0.8 miles upstream of confluence with Cache La Poudre River	10190007	0.8	N	AE	2005
Cache La Poudre River-Interstate Highway 25 Divided Flow	Larimer County Unincorporated Areas	At Larimer-Weld County Line Road	0.1 miles upstream of Larimer-Weld County Line Road	10190007	0.1	Y	AE	2005
Cache La Poudre River Split LPATH	Larimer County Unincorporated Areas	Confluence with Cache La Poudre River Split RPATH	Confluence with Boxelder Creek Overflow Channel	10190007	0.9	Y	AE	2005
Cache La Poudre Split RPATH	Larimer County Unincorporated Areas	At Gravel Pit Access Road	Confluence with Boxelder Creek Overflow Channel	10190007	0.2	Y	AE	2005
Cedar Creek	Larimer County Unincorporated Areas	Confluence with Big Thompson River	0.1 miles upstream of Cedar Cove Road	10190006	0.1	Y	AE	1985
Coal Creek	Wellington, Town of; Larimer County Unincorporated Areas	Confluence with Boxelder Creek	2.4 miles upstream of confluence with Boxelder Creek	10190007	2.4	N	AE	2005
Cooper Slough	Larimer County Unincorporated Areas	Confluence with Lake Canal	A East Poudre Trail	10190007	2.9	Y	AE	2005

Table 9: Summary of Discharges (continued)

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs) 10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	1% Annual Chance Plus	0.2% Annual Chance
Buckhorn Creek	At Masonville Below Redstone Creek	122.50	6,321	*	13,593	18,059	*	32,000
Buckhorn Creek	At Masonville Above Redstone Creek	92.00	4,674	*	10,321	13,862	*	24,000
Cache La Poudre Lowflow Channel	Upstream of Convergence with Cache La Poudre River	*	*	*	*	1,309	*	*
Cache La Poudre Lowflow Channel	At Fossil Creek Ditch Diversion Dam	*	*	*	*	12,071	*	*
Cache La Poudre LPATH	Upstream of Convergence with Cache La Poudre River	*	*	*	1,142	3,983	*	16,015
Cache La Poudre River	Downstream of Confluence with Boxelder Creek	1,537	6,750	*	13,200	17,400	*	32,400
Cache La Poudre River	Upstream of Confluence with Boxelder Creek	1,537	5,820	*	11,400	15,000	*	27,900
Cache La Poudre River	Downstream of Confluence with Dry Creek	*	6,700	*	12,700	16,600	*	30,100
Cache La Poudre River	Upstream of Confluence with Dry Creek	*	5,370	*	10,200	13,300	*	24,100
Cedar Creek	At Confluence with Big Thompson River	19.75	2,460	*	6,530	9,400	*	20,000
Coal Creek	At Town of Wellington	10.6	230	*	600	830	*	1,300

This location is near Timberline Road in Eastern Fort Collins

FLOOD INSURANCE STUDY

FEDERAL EMERGENCY MANAGEMENT AGENCY

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LARIMER COUNTY, COLORADO

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FORT COLLINS, CITY OF	080102
JOHNSTOWN, TOWN OF	080250
LARIMER COUNTY, UNINCORPORATED AREAS	080101
LOVELAND, CITY OF	080103
TIMNATH, TOWN OF	080005
WELLINGTON, TOWN OF	080104

FEMA

REVISED:

JANUARY 15, 2021

FLOOD INSURANCE STUDY NUMBER
08069CV002E

Version Number 2.5.3.6

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD88)			
CROSS SECTION	DISTANCE[1]	WIDTH (**FEET**)	SECTION AREA (**SQ. FEET**)	MEAN VELOCITY (**FEET/ SEC**)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
CK	237,158	192	1,461	9.5	4,988.4	4,988.4	4,988.6	0.2
CL	237,485	550	1,637	8.5	4,989.8	4,989.8	4,990.1	0.3
CM	238,183	1,363	7,148	1.9	4,994.7	4,994.7	4,994.8	0.1
CN	238,974	736	3,039	4.6	4,994.7	4,994.6	4,994.9	0.3
CO	240,553	292	2,387	5.9	5,002.7	5,002.7	5,002.7	0.0
CP	241,276	108	1,263	7.7	5,004.8[2] 5,004.8[3]	5,004.8	5,004.8	0.0
CQ	242,255	1,153	4,349	3.2	5,007.9[2] 5,010.1[3]	5,007.9	5,007.9	0.0
CR	242,685	609	2,616	5.4	5,008.5[2] 5,014.9[3]	5,008.5	5,008.5	0.0
CS	243,225	286	1,388	10.2	5,009.1[2] 5,016.6[3]	5,009.1	5,009.1	0.0
CT	244,123	845	4,582	3.1	5,017.7[2] 5,017.0[3]	5,017.7	5,017.7	0.0
CU	244,143	745	4,276	3.3	5,017.7[2] 5,020.7[3]	5,017.7	5,017.7	0.0
CV	244,551	713	2,736	5.2	5,020.1[2] 5,021.6[3]	5,020.1	5,020.5	0.4
CW	246,128	1,065	5,962	2.4	5,022.7[2] 5,023.2[3]	5,022.7	5,023.0	0.3

[1]Feet above mouth
[2]Levees Failed
[3]Levees Intact

TABLE 23

FEDERAL EMERGENCY MANAGEMENT AGENCY

LARIMER COUNTY, CO

AND INCORPORATED AREAS

FLOODWAY DATA

FLOODING SOURCE: CACHE LA POUDRE RIVER

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
CX	247,787	242	1,240	11.5	5,027.1[2] 5,027.2[3]	5,027.1	5,027.3	0.2
CY	248,897	185	1,265	11.3	5,033.2	5,033.2	5,033.2	0.0
CZ	249,797	174	1,308	10.9	5,038.4	5,038.4	5,038.4	0.0
DA	251,777	258	1,717	8.4	5,047.7	5,047.7	5,047.7	0.0
DB	252,327	212	1,235	11.9	5,050.5	5,050.5	5,050.5	0.0
DC	253,541	124	1,042	13.8	5,057.6	5,057.6	5,057.6	0.0
DD	254,560	277	1,581	9.1	5,062.4	5,062.4	5,062.4	0.0
DE	255,598	270	1,767	8.2	5,069.1	5,069.1	5,069.3	0.2
DF	256,927	809	2,923	4.9	5,074.3	5,074.3	5,074.5	0.2
DG	257,969	161	2,028	14.2	5,080.4	5,080.4	5,080.4	0.0
DH	259,082	570	4,303	4.6	5,088.6	5,088.6	5,088.6	0.0
DI	260,703	1,687	4,796	3.1	5,093.0	5,093.0	5,093.5	0.5
DJ	261,610	985	3,595	3.7	5,098.0	5,098.0	5,098.4	0.4
DK	262,380	1,150	3,752	3.9	5,100.6	5,100.6	5,101.0	0.4
DL	263,459	351	1,506	10.4	5,104.7	5,104.7	5,104.7	0.0
DM	263,564	386	3,633	4.8	5,110.4	5,110.4	5,110.4	0.0
DN	263,971	328	1,881	7.8	5,110.9	5,110.9	5,111.0	0.1
DO	265,046	332	2,197	6.7	5,118.0	5,118.0	5,118.1	0.1
DP	265,297	259	1,719	8.6	5,118.9	5,118.9	5,119.0	0.1

[1]Feet above mouth
[2]Levees Failed
[3]Levees Intact

TABLE 23

FEDERAL EMERGENCY MANAGEMENT AGENCY

LARIMER COUNTY, CO

AND INCORPORATED AREAS

FLOODWAY DATA

FLOODING SOURCE: CACHE LA POUDRE RIVER

FLOOD INSURANCE STUDY

FEDERAL EMERGENCY MANAGEMENT AGENCY

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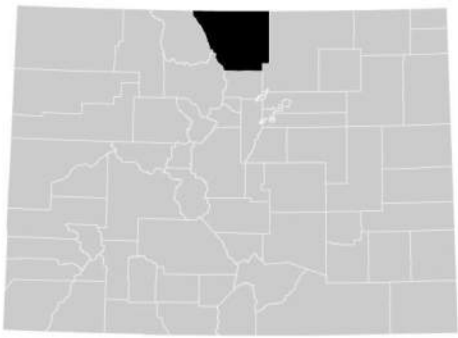

LARIMER COUNTY, COLORADO

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FEMA

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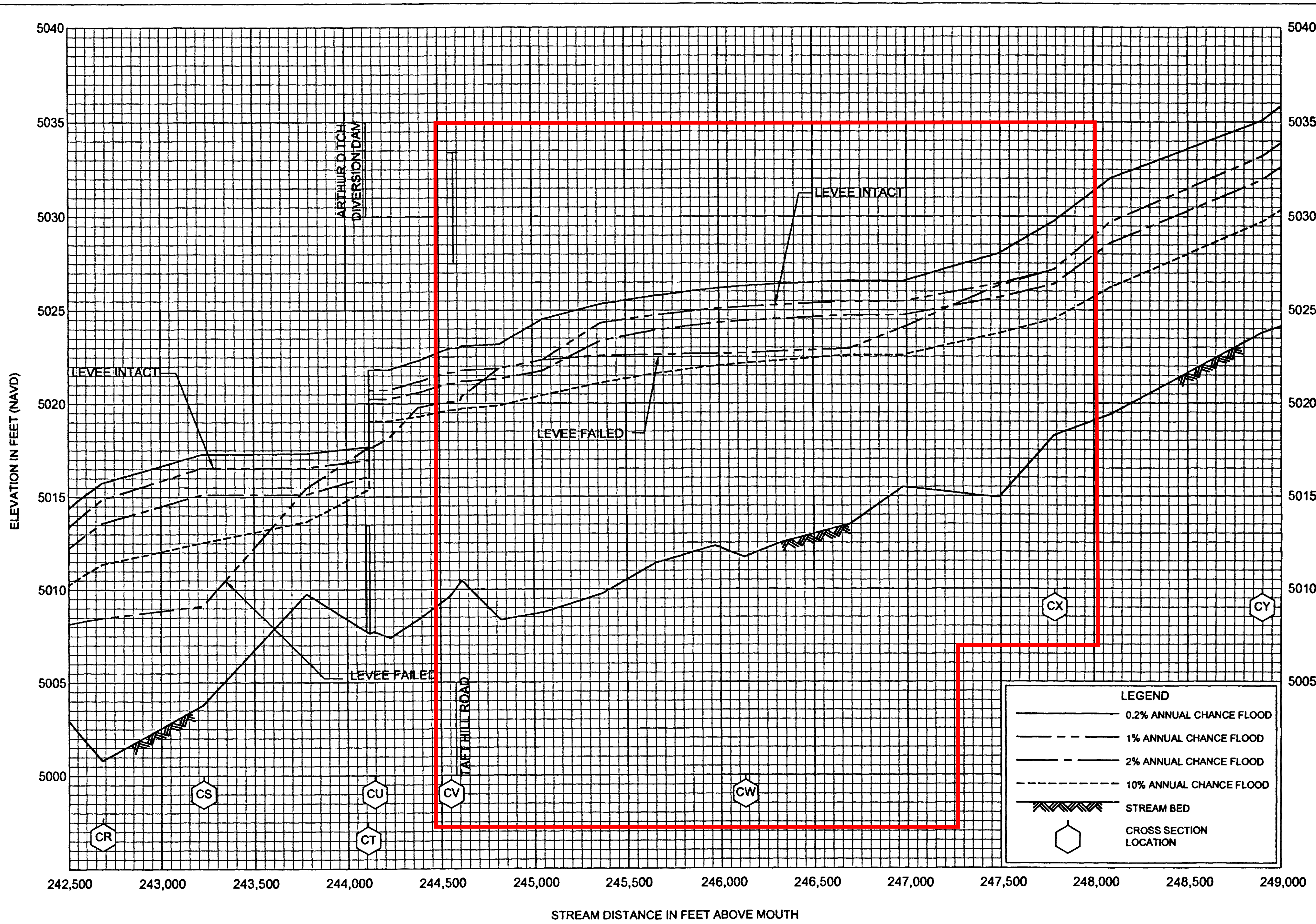
JANUARY 15, 2021

FLOOD INSURANCE STUDY NUMBER
08069CV005E

Version Number 2.5.3.6



FLOOD PROFILES

CACHE LA POUDRE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

LARIMER COUNTY, CO

AND INCORPORATED AREAS

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) Report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS Report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Floodway Data table shown on this FIRM.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study Report for information on flood control structures for this jurisdiction.

FEMA recommends that a Flood Insurance Policy be purchased for structures in areas where **levees** are shown as providing protection from the 1% annual chance flood. Flooding is not covered by standard property/fire/dwelling insurance policies nor is it covered by Homeowners Insurance, Renters Insurance, Condominium Owners Insurance, or Commercial Property Insurance. Contact your insurance agent and local floodplain administrator for further information.

Visit http://www.fema.gov/pdf/fhm/frm_gsah.pdf for information on levees and the risk of flooding in areas shown as being protected by levees.

The **projection** used in the preparation of this map was State Plane Colorado North (feet). The **horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

Spatial Reference System Division
National Geodetic Survey, NOAA
Silver Spring Metro Center
1315 East-West Highway
Silver Spring, Maryland 20910
(301) 713-3191

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713- 3242**, or visit its website at http://www.ngs.noaa.gov.

Base map information shown on this FIRM was provided by the Larimer County GIS and Mapping Department. Additional input was provided by the City of Fort Collins Geographic Information Service Division. These data are current as of 2005.

The **profile baselines** depicted on this map represent the hydraulic modeling baselines that match the flood profiles in the Flood Insurance Study report. As a result of improved topographic data, the profile baseline, in some cases, may deviate significantly from the channel centerline or appear outside the Special Flood Hazard Area.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov.

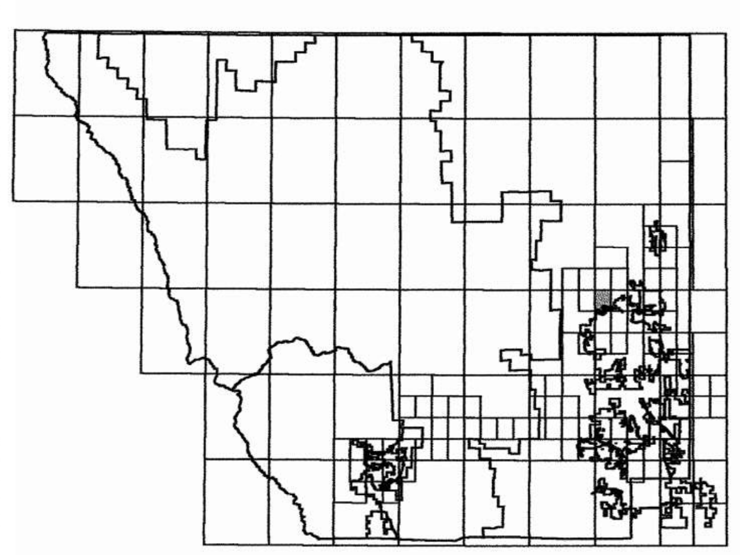
If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1- 877- FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov.

Larimer County Vertical Datum Offset Table

Flooding Source	Vertical Datum Offset (ft)	Flooding Source	Vertical Datum Offset (ft)
Cache La Poudre River	3.0		

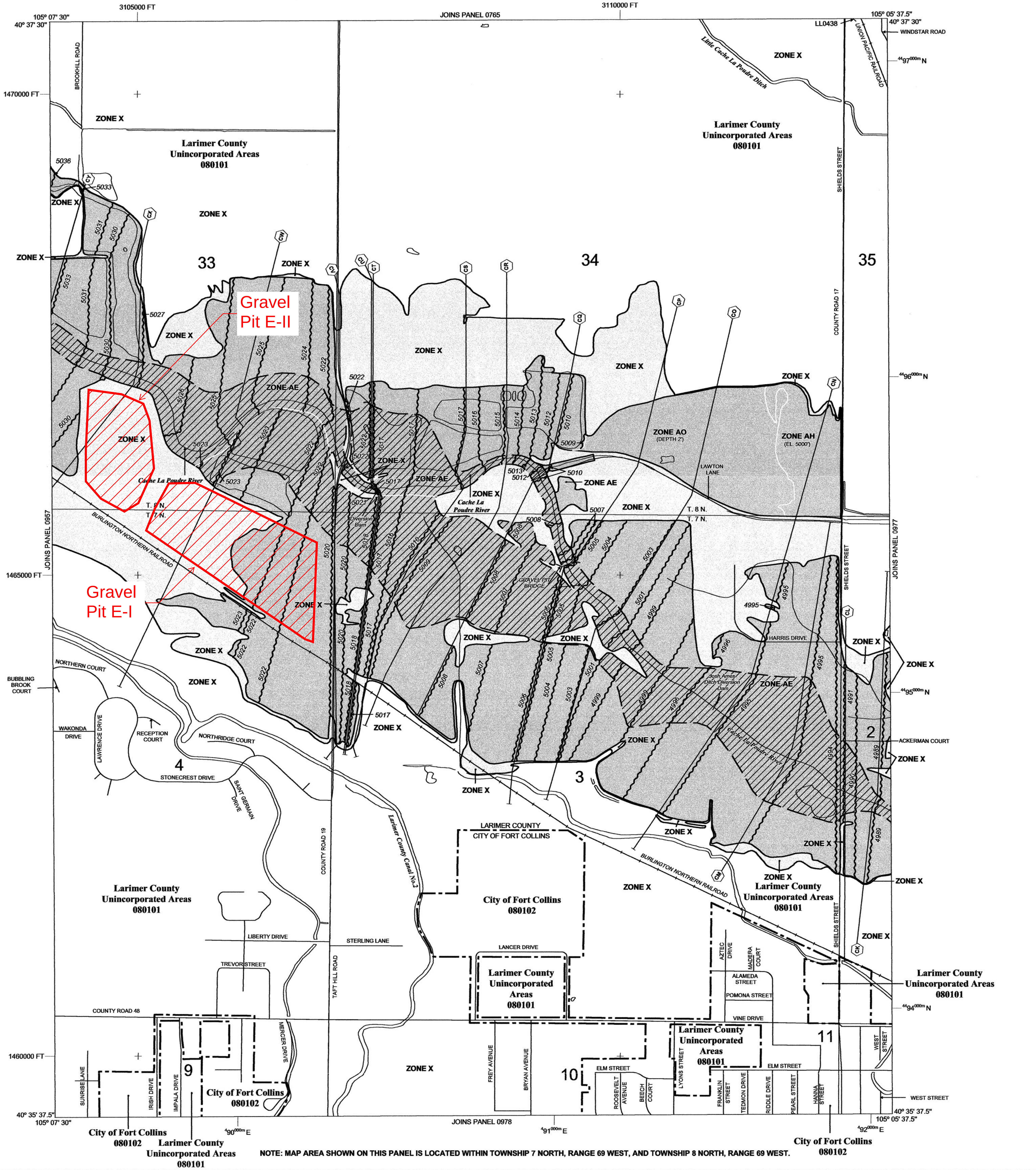
Example: To convert Cache La Poudre River elevations to NAVD 88, 3.0 feet were added to the NGVD 29 elevations.

Panel Location Map



This Digital Flood Insurance Rate Map (DFIRM) was produced through a Cooperating Technical Partner (CTP) agreement between the State of Colorado Water Conservation Board and the Federal Emergency Management Agency (FEMA).

Additional Flood Hazard Information and resources are available from local communities and the Colorado Water Conservation Board.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

Floodplain boundary
Floodway boundary
Zone D boundary

Boundary dividing Special Flood Hazard Area zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

513 — Base Flood Elevation line and value; elevation in feet*

(EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

A — A Cross section line

104° 50' 37.5" , 39° 30' 00" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere

3180000 FT — 5000-foot ticks: Colorado State Plane coordinate system, North zone, Lambert Conformal Conic projection

$^{42}76^{000m}$N — 1000-meter Universal Transverse Mercator grid ticks, zone 13

KK6400 × — National Geodetic Survey bench mark (see explanation in Notes to Users section of this FIRM panel)

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
DECEMBER 19, 2006

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET
150 0 150 300 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0976F

FIRM

FLOOD INSURANCE RATE MAP

LARIMER COUNTY, COLORADO

AND INCORPORATED AREAS

PANEL 976 OF 1420

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
FORT COLLINS, CITY OF	080102	0976	F
LARIMER COUNTY	080101	0976	F

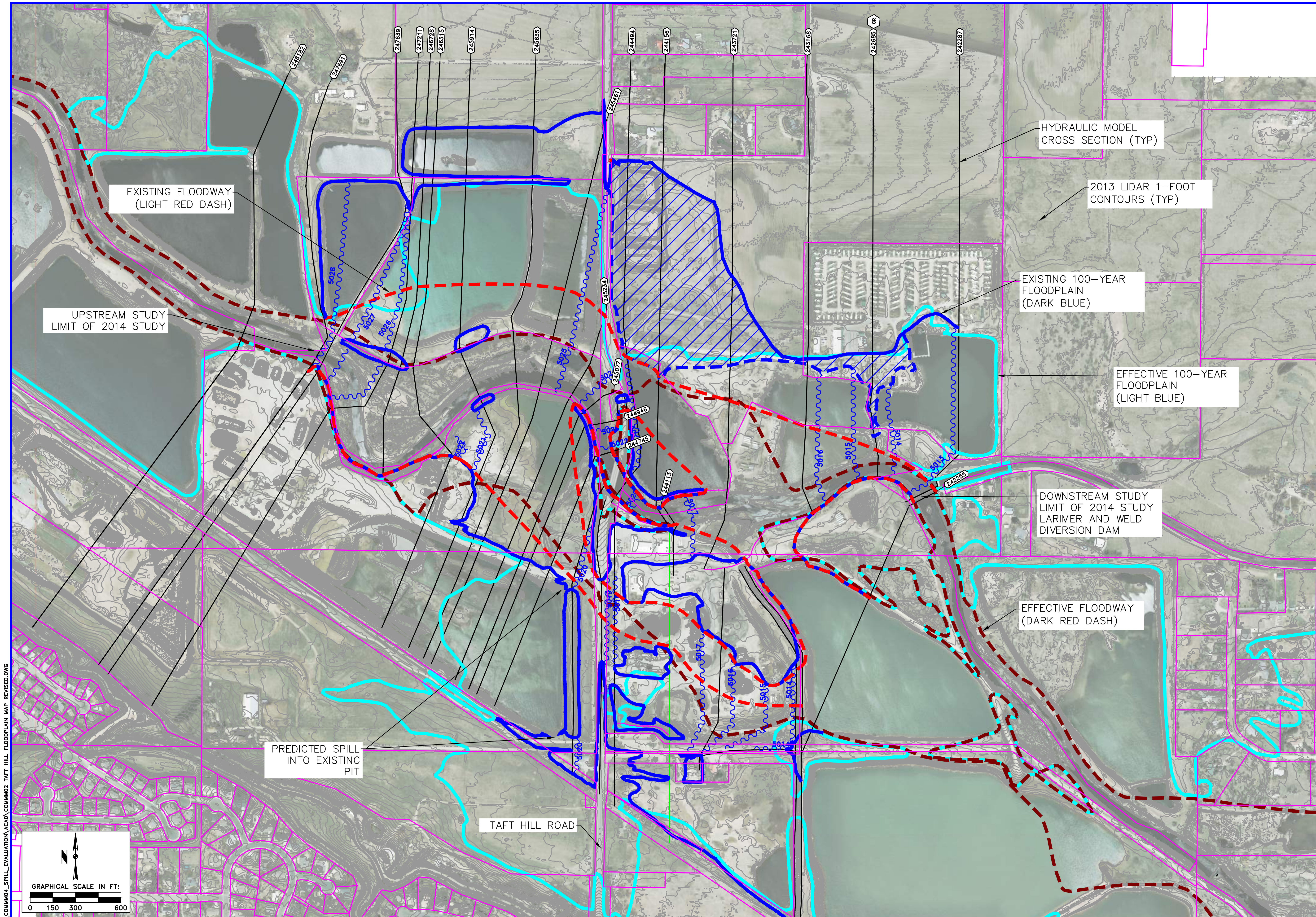
Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
08069C0976F

EFFECTIVE DATE
DECEMBER 19, 2006

Federal Emergency Management Agency

ATTACHMENT C. 2014 STUDY DOCUMENTATION



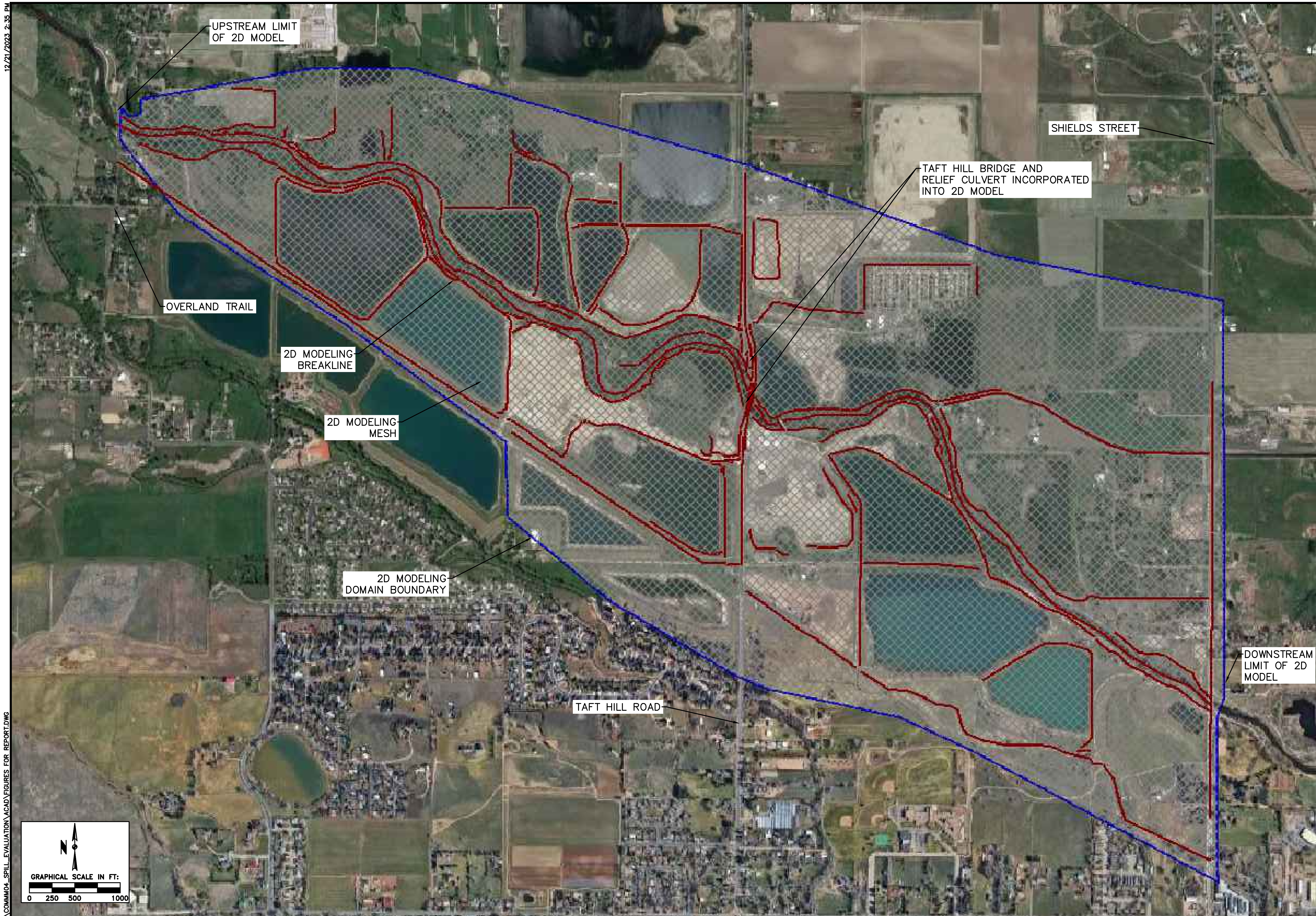
Anderson Consulting Engineers, Inc
Civil • Water Resources • Environmental
375 East Horsetooth Road, Building 5, Fort Collins, CO 80525
Phone (970) 226-0120 / Fax (970) 226-0121
www.acewater.com

EXISTING CONDITION FLOODPLAIN AND FLOODWAY WORKMAP

MARTIN MARIETTA MATERIALS TAFT HILL SITE

DRAWN BY:	BAS
DESIGNED BY:	BAS
CHECKED BY:	CJP
PROJECT NUMBER:	COMM02
DATE:	01/22/2015
FIGURE:	2

ATTACHMENT D. 2D MODEL DEVELOPMENT INFORMATION



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Phone (970) 226-0120 / Fax (970) 226-0121
www.acewater.com

2D MODELING DOMAIN

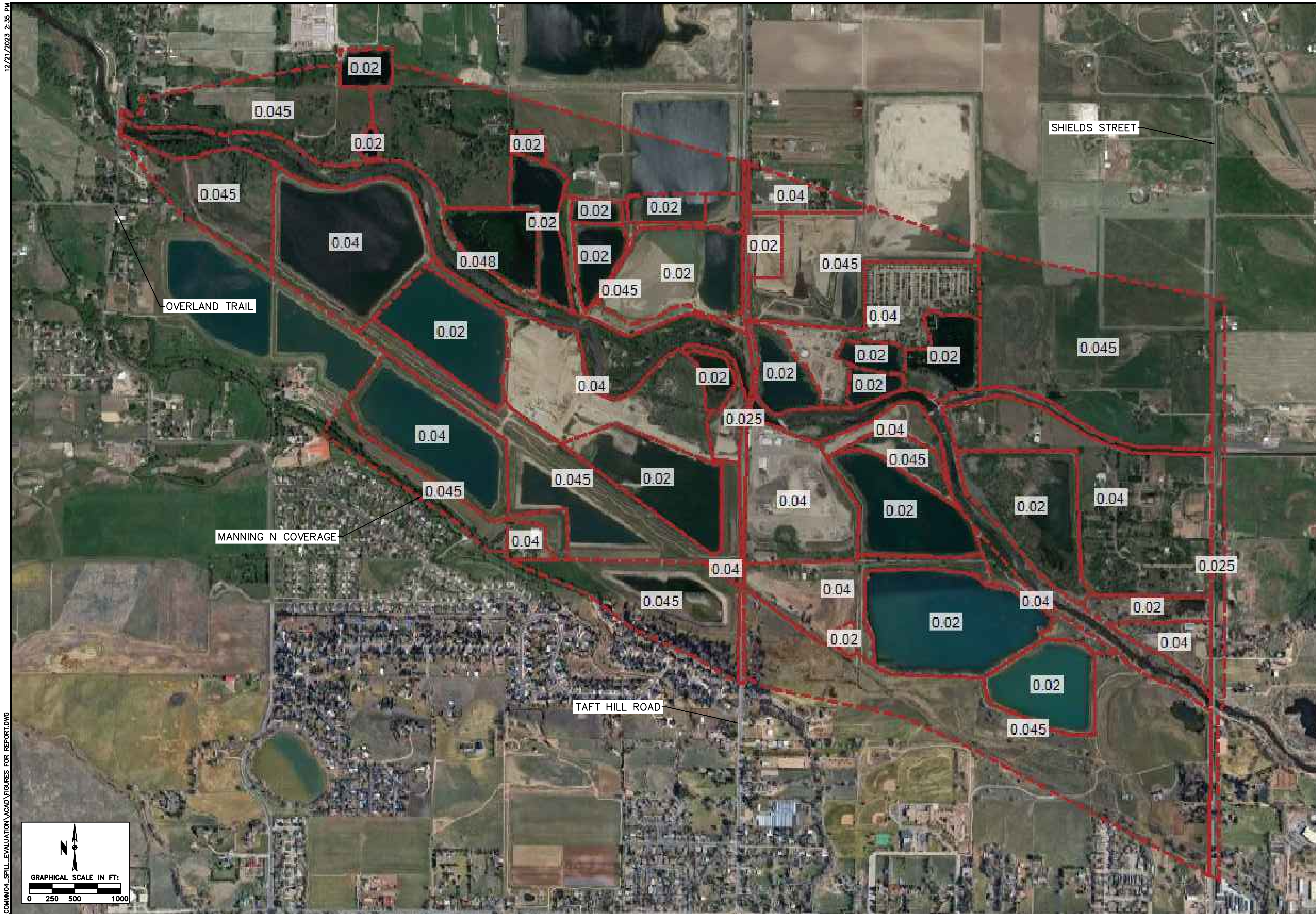
**MARTIN MARIETTA MATERIALS, INC.
FLOOD EVALUATION OF
TAFT HILL SITE**

DRAWN BY:	BAS
DESIGNED BY:	BAS
CHECKED BY:	BAS

PROJECT NUMBER: COMM04
DATE: 12/21/2023
FIGURE: 3

12/21/2023 2:35 PM
P:\COMM04_SPILL_EVALUATION\ACAD\FIGURES FOR REPORT.DWG

12/21/2023 2:35 PM



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Phone (970) 226-0120 / Fax (970) 226-0121
www.acewater.com

MANNING ROUGHNESS COVERAGE MAP

MARTIN MARIETTA MATERIALS, INC. FLOOD EVALUATION OF TAFT HILL SITE

DRAWN BY:	BAS
DESIGNED BY:	BAS
CHECKED BY:	BAS

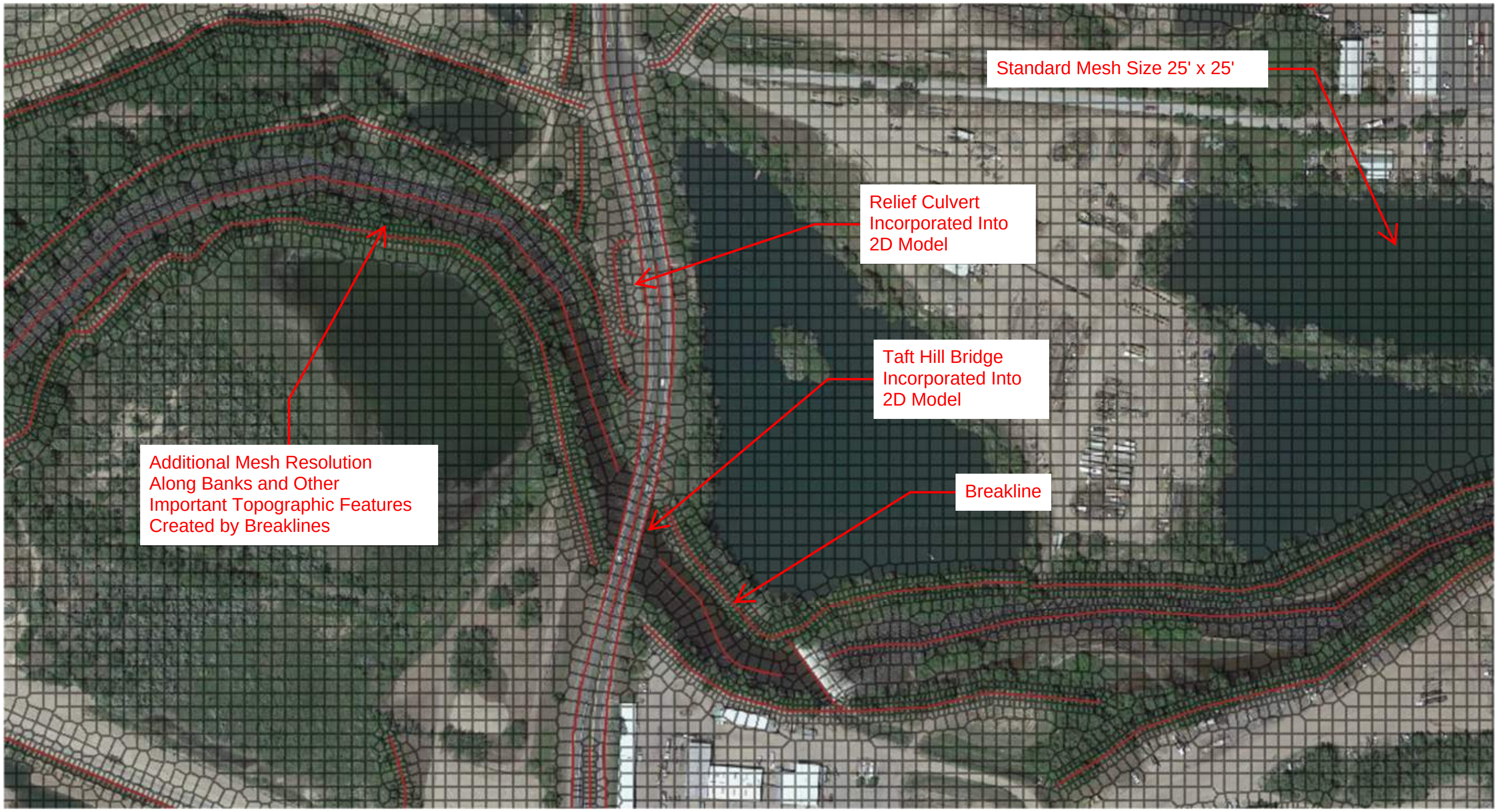
PROJECT NUMBER: COMM04

DATE: 12/21/2023

FIGURE: 4

P:\COMM04_SPILL_EVALUATION\ACAD\FIGURES FOR REPORT.DWG

Figure 5: Mesh Development



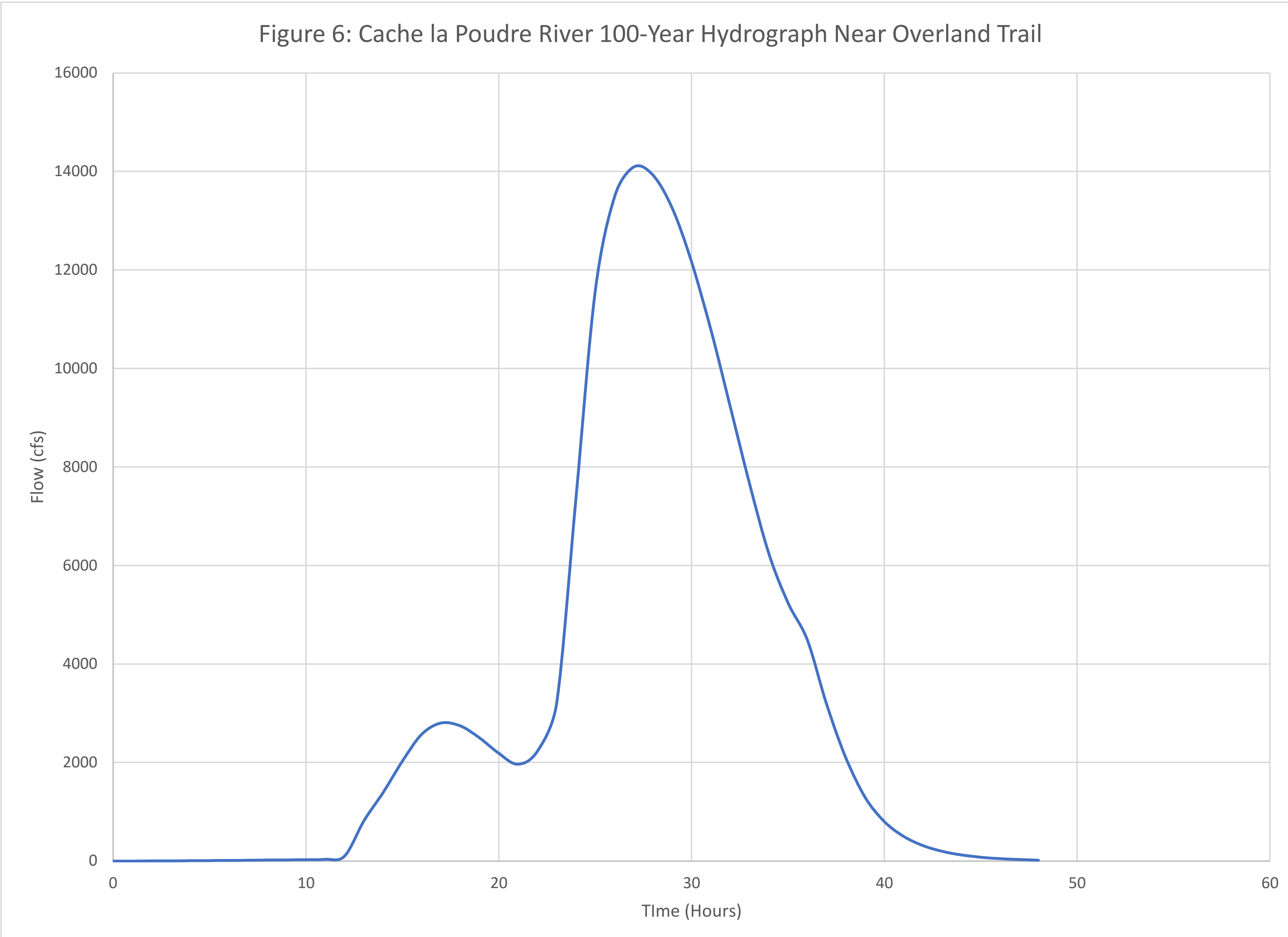
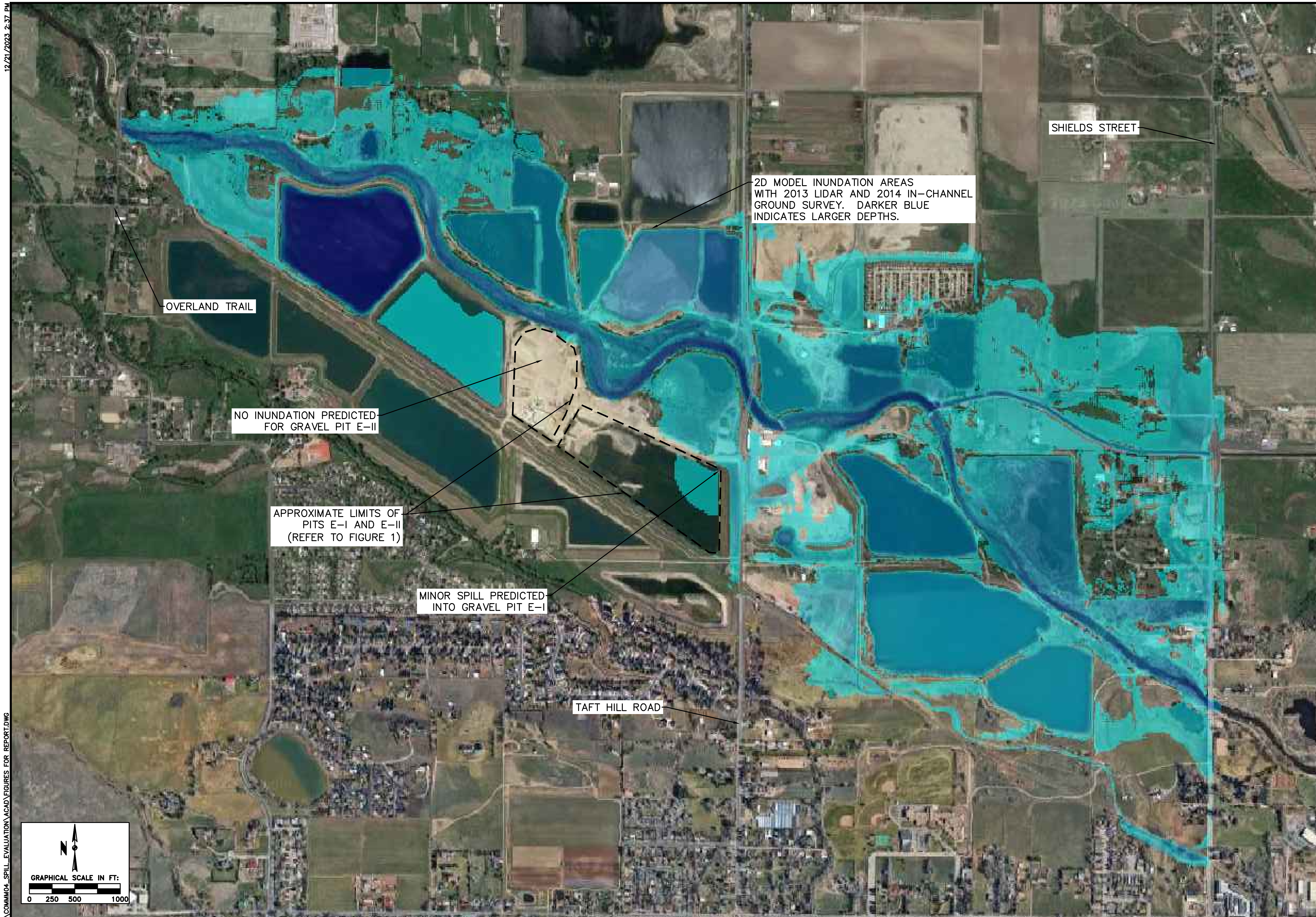


Figure 6: Cache la Poudre River 100-Year Hydrograph Near Overland Trail
16000
14000
12000
10000
8000
6000
4000
2000
0
Flow (cfs)
0
10
20
30
40
50
60
TIme (Hours)

ATTACHMENT E. 2013 CONDITION RESULTS



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www.acewater.com

2013 TOPOGRAPHIC CONDITION RESULTS

MARTIN MARIETTA MATERIALS, INC.
FLOOD EVALUATION OF TAFT HILL SITE

DRAWN BY:	BAS
DESIGNED BY:	BAS
CHECKED BY:	BAS

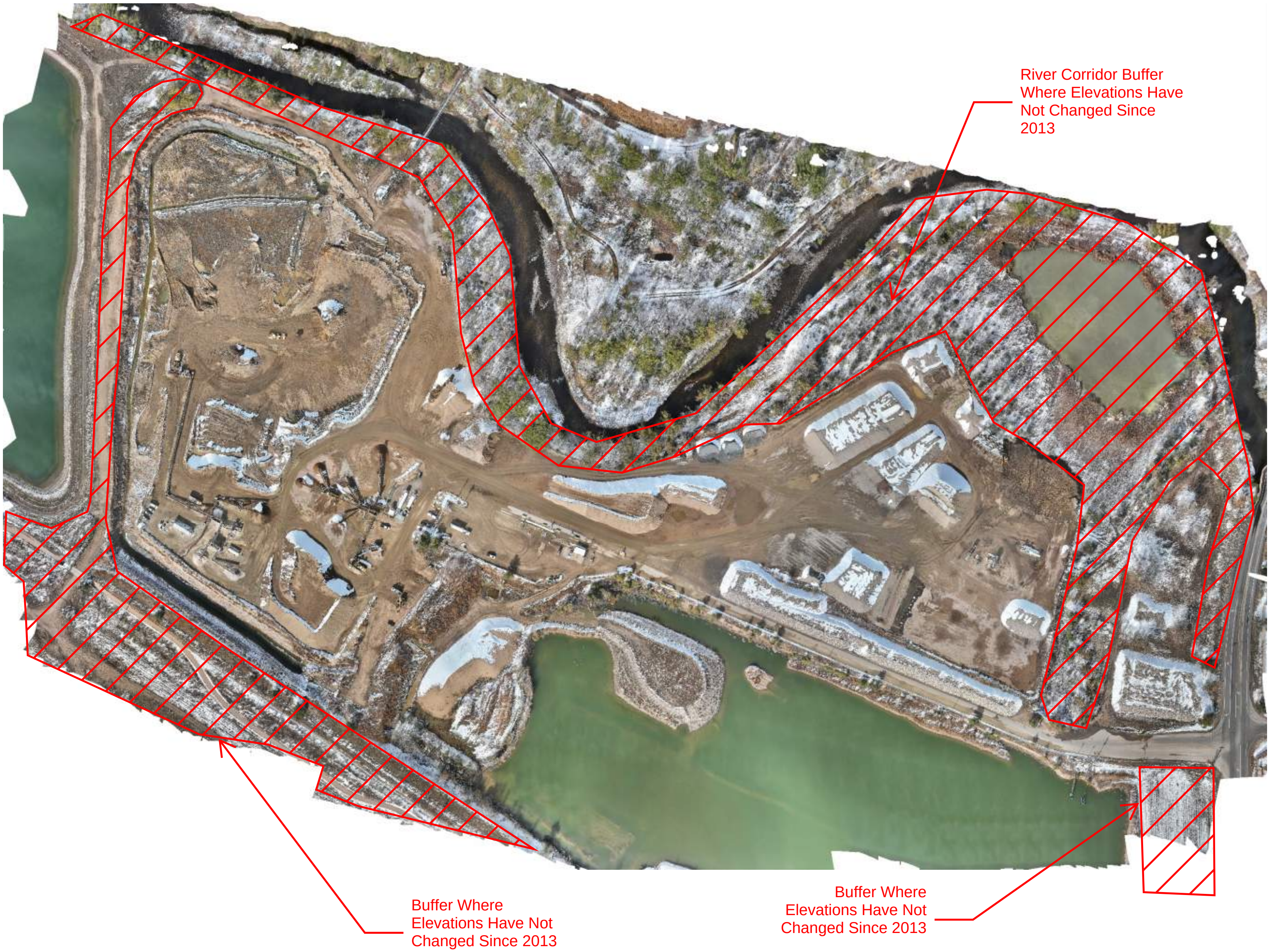
PROJECT NUMBER: COMM04

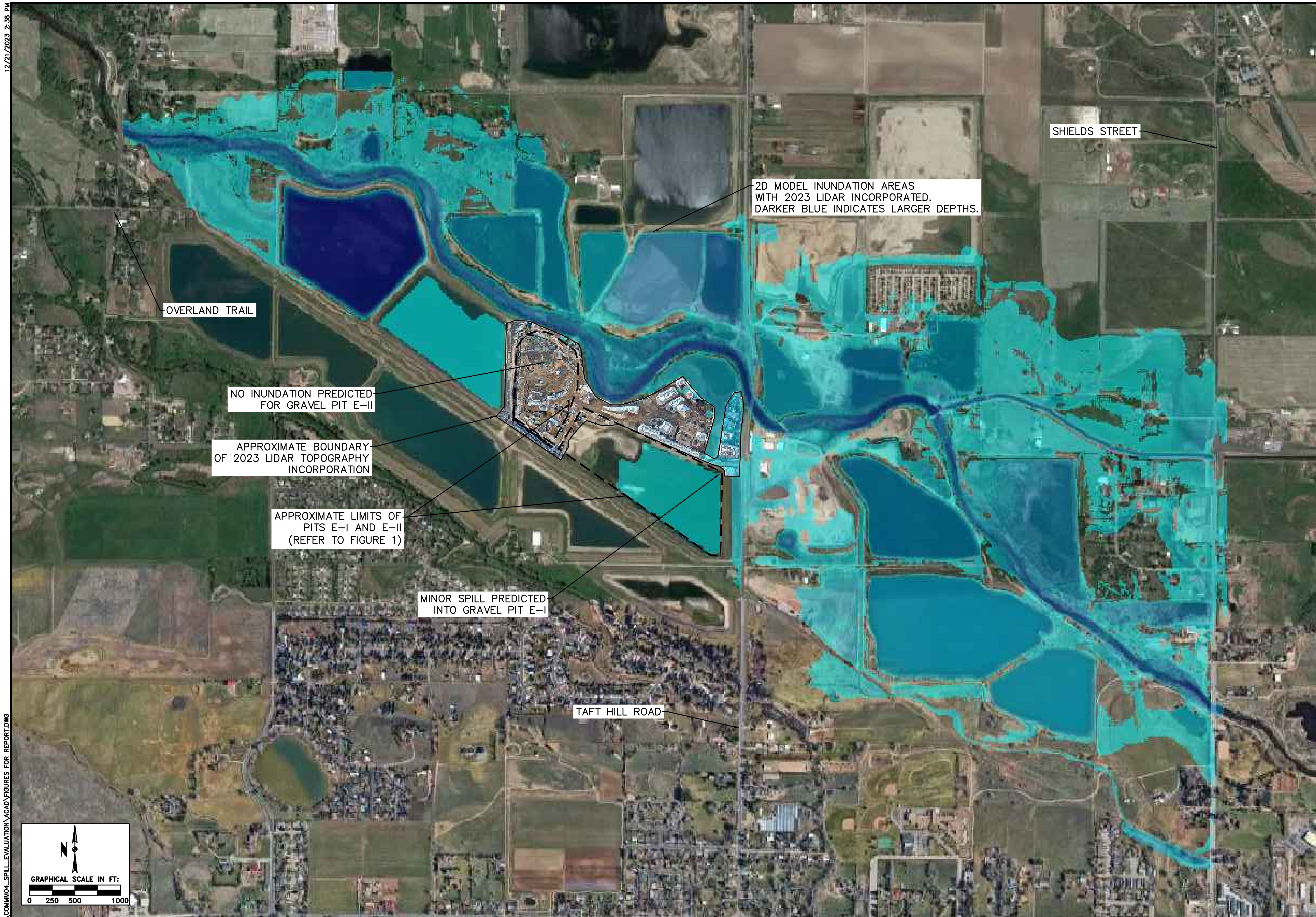
DATE: 12/21/2023

FIGURE: 7

ATTACHMENT F. 2023 CONDITION RESULTS

Figure 8: October 30, 2023 Drone Image





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Phone (970) 226-0120 / Fax (970) 226-0121
www.acewater.com

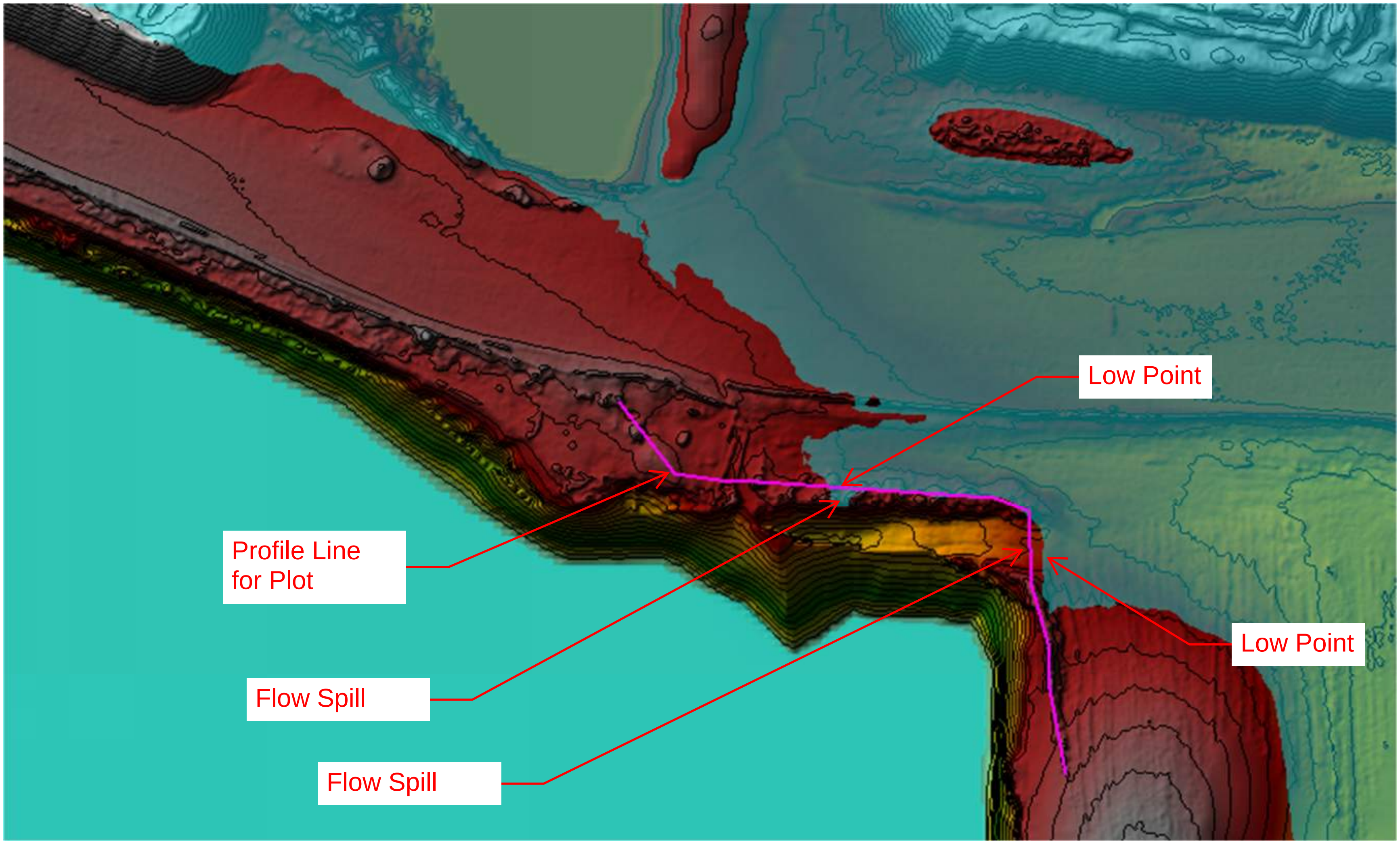
2023 TOPOGRAPHIC CONDITION RESULTS

MARTIN MARIETTA MATERIALS, INC.
FLOOD EVALUATION OF TAFT HILL SITE

COLORADO LICENSED BRIAN ALAN SMITH 41276 PROFESSIONAL ENGINEER

DRAWN BY:	BAS
DESIGNED BY:	BAS
CHECKED BY:	BAS
PROJECT NUMBER:	COMM04
DATE:	12/21/2023
FIGURE:	9

Figure 10: Zoomed in View of Predicted Spill Location



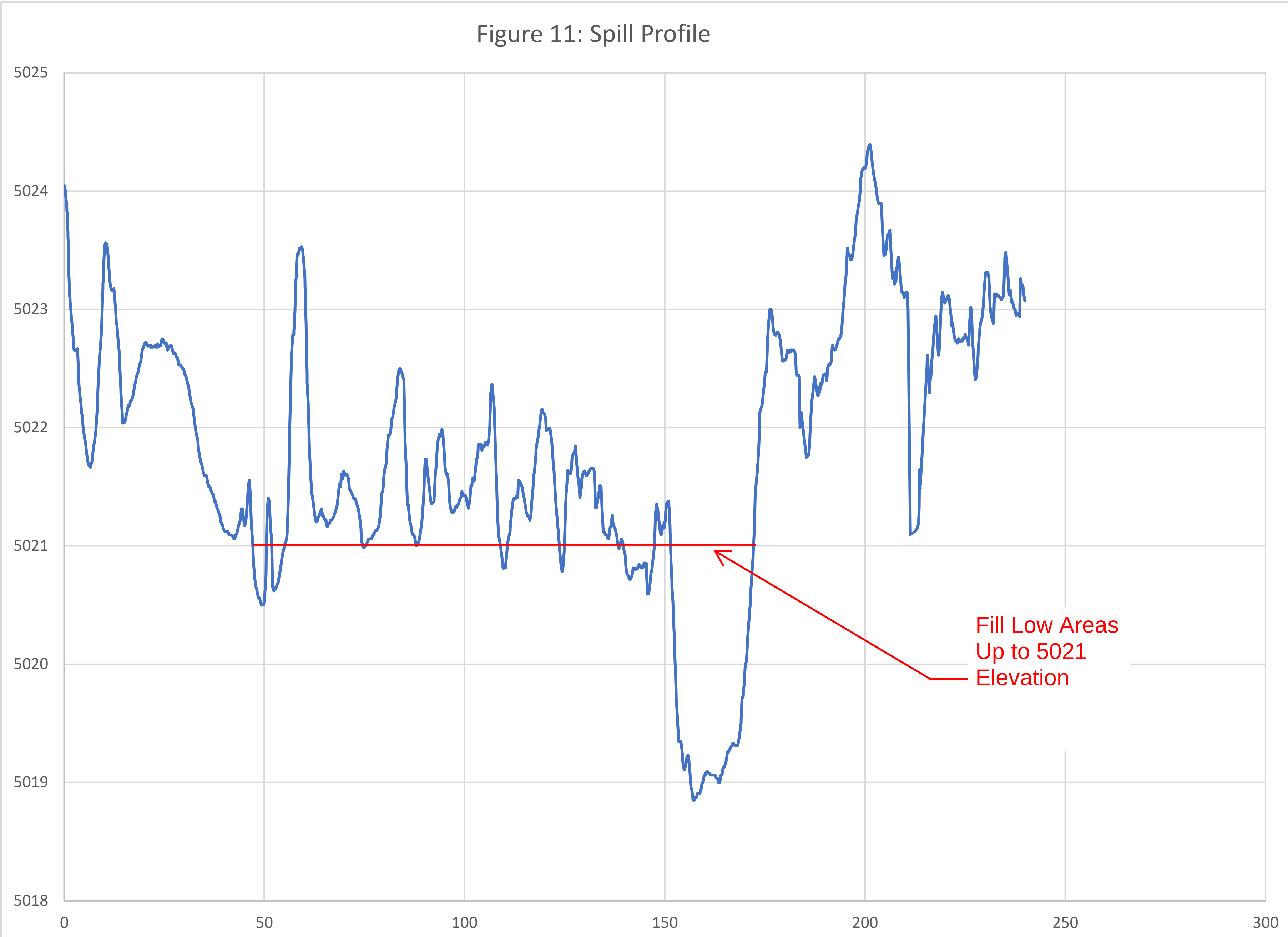


Figure 11: Spill Profile
5025
5024
5023
5022
5021
5020
5019
5018
0
50
100
150
200
250
300
Fill Low Areas
Up to 5021
Elevation