Urban Drainage and Flood Control District

E-19 Survey

Cherry Creek below Bayou Gulch
Alert Station ID: 2850

Prepared for:
Urban Drainage and Flood Control District
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1.0 CERTIFICATION

I, Markus Ritsch, state that the information presented in this report entitled, "E-19 Survey: Cherry Creek below Bayou Gulch: ALERT Station ID 2850 in Douglas County, Colorado" prepared for the Urban Drainage and Flood Control District, Colorado was prepared by me or by persons under my supervision and is correct to the best of my knowledge and information.

Markus Ritsch, P.E.
Registration No. 31738

2.0 INTRODUCTION

Under contract to the Urban Drainage and Flood Control District, Water and Earth Technologies, Inc. (WET) surveyed and developed National Weather Service E-19 data for the Cherry Creek below Bayou Gulch ALERT station (Station ID 2850) in Douglas County, Colorado.

On September 4, 2008, WET surveyed the gage site to develop cross-section data in order to develop a hydraulic model to establish a stage-discharge rating relationship for the site. WET also obtained elevation data in order to develop an E19 report. This report describes the site and sources of information relevant to the gage and the monitored stream reach. It also describes the results of research into past flooding and past hydraulic analyses of the stream reach, and information describing the relationship between stage measured by the Cherry Creek below Bayou Gulch ALERT station and likely consequences of associated flooding near the gage.

3.0 SITE LOCATION AND IDENTIFICATION

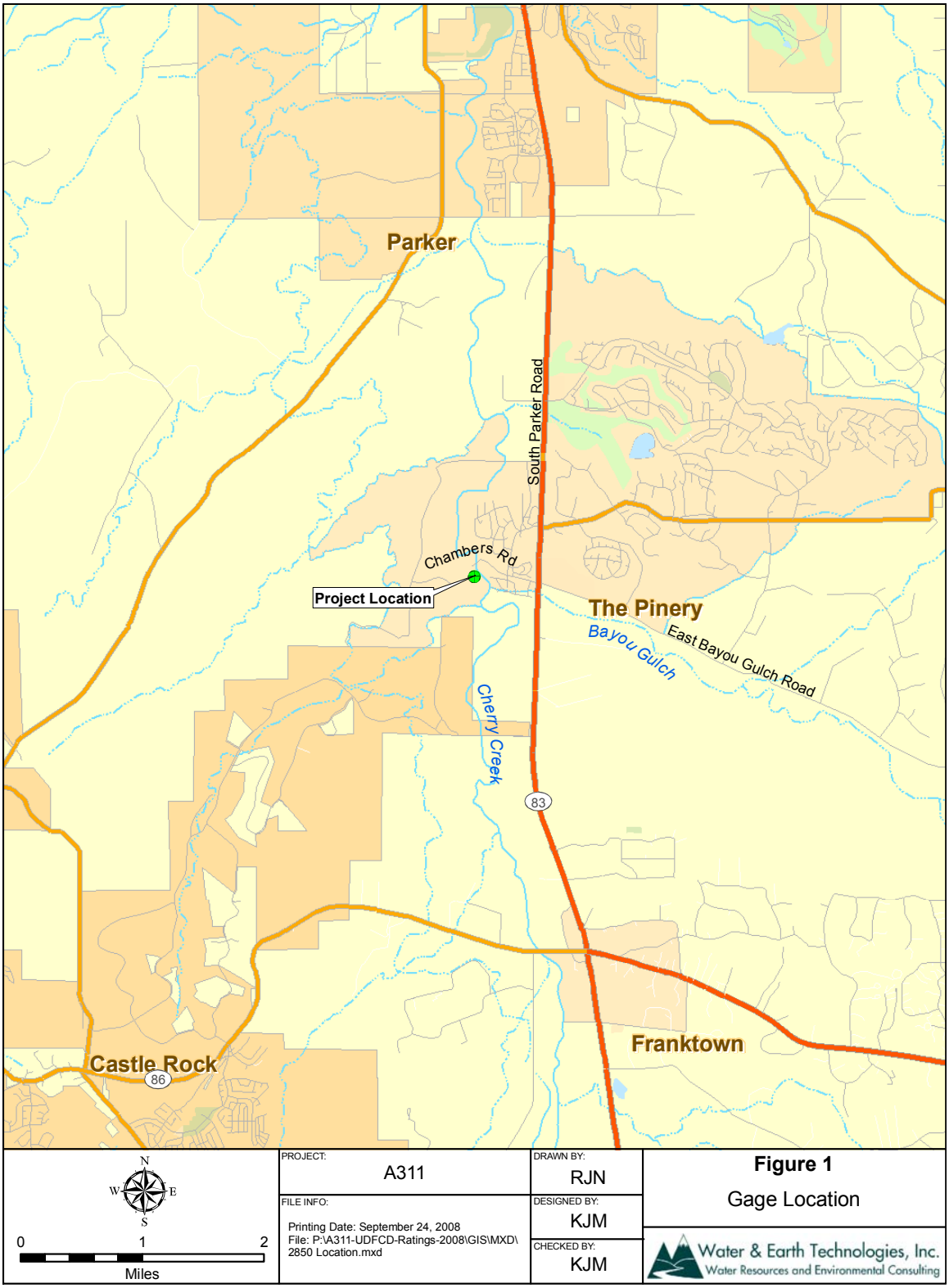
The gage is located on Cherry Creek in Parker, Colorado, near the intersection of South Parker Road (Colorado Highway 83) and East Bayou Gulch Road (formerly Chambers Road), in Section 15 in Township 7 South and Range 66 West. Specifically, the gage is located west of the bridge that carries East Bayou Gulch Road over Cherry Creek (hereafter referred to as the East Bayou Gulch Bridge). Figure 1 shows the general project location.

OneRain Inc. installed the station on June 16, 2008. Instantaneous readings of stage are available on a 12-hour timed basis and on an event basis during higher flows. Because the station is new, a continuous historical record of water level is not available. A peak stage reading of 2.94 feet was recorded at the station on August 16, 2008.

Table 1. Cherry Creek at Bayou Gulch Station Information

ALERT Station ID Number	2850
ALERT Water Level Sensor ID Number	2853
Stream	Cherry Creek below Bayou Gulch
Basin and System	South Platte River
Latitude	39.436 N
Longitude	104.770 W
Elevation	1828.8 meters (6000 feet)
Name of the WFO with HSA responsibility for this gage	Denver/Boulder, 325 Broadway Boulder, CO 80305 Tel: 303-494-4221
National Weather Service Identifier (SHEF/AFOS/LID)	BYOC2
NWS Index No. assigned by the National Data Climate Center (NCDC) for cooperative stations	Not available
Owner/Operator	Urban Drainage and Flood Control District

Figure 1. General Project Location, Cherry Creek below Bayou Gulch



4.0 HYDROLOGIC SETTING AND CONDITIONS AFFECTING FLOW

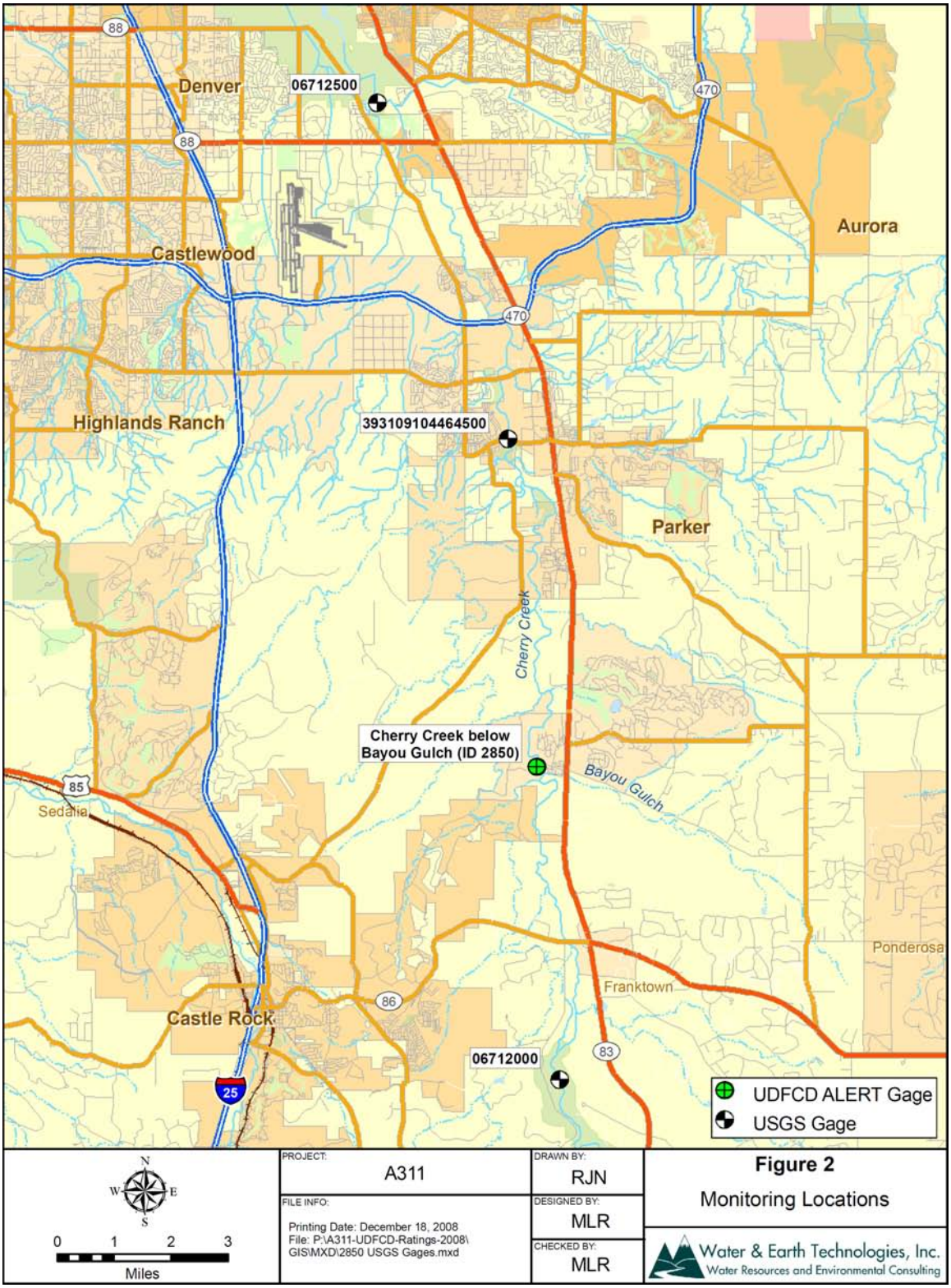
The watershed drained by Cherry Creek upstream of the gage site is over 300 square miles in area. The valley is curved near the gage, with a slope of about 0.8%. The reach of Cherry Creek in the vicinity of the gage is relatively wide and shallow, with a meandering low-flow channel bed composed of natural sand and unlined banks vegetated with coyote willows. The floodway is about 500 feet wide, with large trees growing near the channel transitioning to grasslands vegetation typical of the Colorado high plains at the margins of the floodway.

In addition to the ALERT station, three U.S. Geologic Survey (USGS) gages either have operated in the past or are currently operating on Cherry Creek. Table 2 and Figure 2 summarize the location of these gages.

Table 2. USGS Stream Gages on Cherry Creek

ID	Name	Period of Record	Drainage Area	Latitude	Longitude
06712000	Near Franktown	1939-11-21 to present	169 sq. mi.	39° 21' 21"	104° 45' 46"
393109104464500	Near Parker	1991-10-01 to present	287 sq. mi.	39° 31' 09"	104° 46' 45"
06712500	Near Melvin	1939-10-01 to 1984-09-24	360 sq. mi.	39° 36' 18"	104° 49' 19"

Figure 2. Monitoring Locations



Cherry Creek has an extensive history of flooding. The highest estimated peak flow for the reach of Cherry Creek in the vicinity of the ALERT gage is associated with the 1933 flood, which was caused in part by the failure of Castlewood Dam, located approximately 8.5 miles upstream of the gage site, after heavy rains caused it to overtop.

Damage due to flooding in the area has historically been attributed to erosion and sediment deposition. Stream characteristics, including the presence of fine to medium-grained sand in the creek bed and banks, the channel slope and resulting flood flow velocities, contribute to high sediment transport rates during floods. Flooding over an extended period occurred during the June 1965 flood, with short periods of high intensity rainfall. Damage to rangeland and farmland in the relevant portion of the Cherry Creek watershed was reported as a result of heavy erosion and sediment deposition. Structural damages were limited to road crossings and embankments but the 1965 flood predates most of the construction that exists presently in the gage vicinity.

Table 3. Flooding History on Cherry Creek

Date	Peak Flow in Vicinity of Gage	Description
May 19-20, 1864	Not available	Heavy rain fell over the upper basin of Cherry Creek causing 19 deaths.
July 14, 1912	25,000 cfs in Denver	More than 2 inches of rain fell between 3 pm and 5 pm. Flood damages in the reach between Franktown and Cherry Creek Dam totaled $554,000.
July 28, 1922	8,700 cfs from Bayou Gulch 17,000 cfs on Cherry Creek	A heavy storm over the Bayou Gulch dumped up to 3 inches of rain in about 2 hours.
August 2 and 3, 1933	34,000 cfs	Three to nine inches of rain in nine hours caused Castlewood Dam on Cherry Creek to fail. Seven people died in Denver. Damage was estimated at 1 million dollars.
August 5, 1945	10,700 cfs	Cherry Creek near Melvin, CO
August 5, 1945	9,170	Cherry Creek near Franktown, CO
June 16, 1965	39,900 cfs	Cherry Creek near Melvin, CO

Figure 3. Peak Streamflow Record, Cherry Creek near Melvin

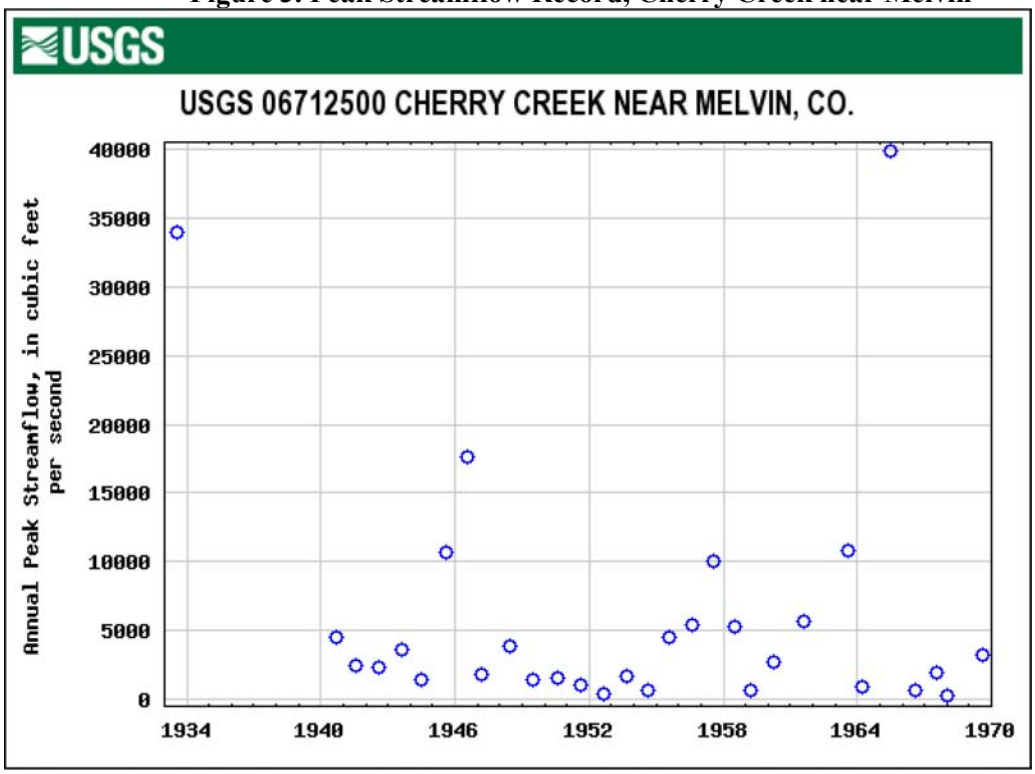


Figure 4. Peak Streamflow Record, Cherry Creek near Franktown

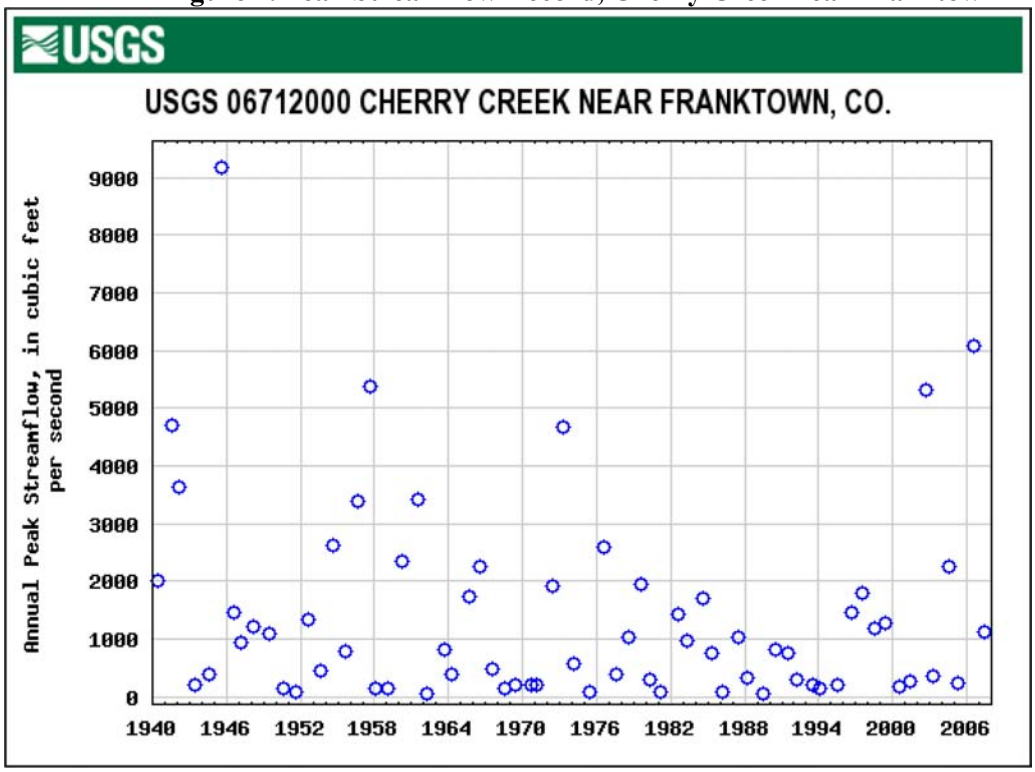
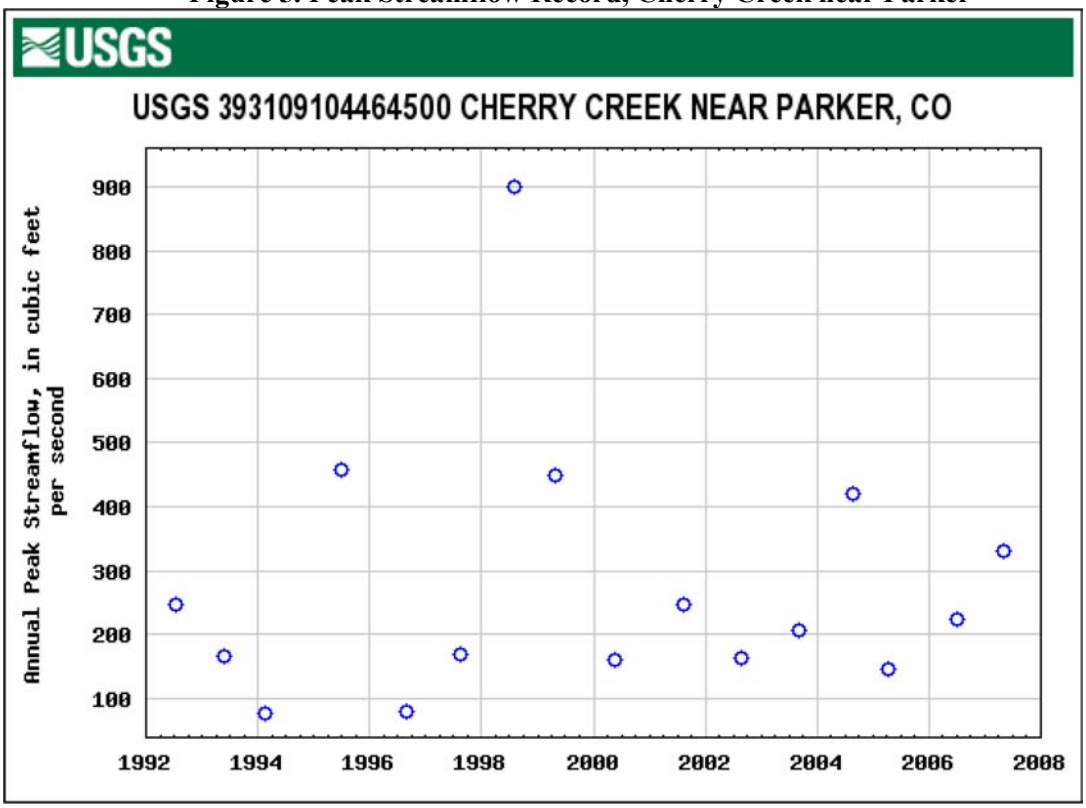


Figure 5. Peak Streamflow Record, Cherry Creek near Parker



4.1 East Bayou Gulch Road Bridge

The ALERT monitoring station is located several hundred feet upstream of the East Bayou Gulch Road Bridge. The bridge, built in 2002, can safely pass the 100-year discharge with one foot of freeboard. The hydraulic design information associated with the bridge is shown (Table 4) along with a schematic profile drawing of the bridge (Figure 6). Photos showing the bridge and stream taken during the fieldwork to complete the cross section survey are shown in the following pages.

Table 4. Hydraulic Information for East Bayou Gulch Road Bridge

Recurrence Interval (years)	Discharge (cfs)	Water Surface Elevation (ft AMSL)
10	5,447	5,995.46
50	15,955	5,998.73
100	24,861	5,999.62
500	89,680	6,007.12

During periods of high flow, flow in Cherry Creek in the vicinity of the gage will be profoundly affected by changes to the hydraulic regime associated with the East Bayou Gulch Road bridge. The bridge will pass the 100-year flow of 24,861 cfs. The bridge begins pressure flow and weir flow between 45,000 cfs and 50,000 cfs (about twice the 100-year flow).

Analyses conducted in support of the design of the East Bayou Gulch Road Bridge, immediately downstream of the gage site, confirm the creek's vulnerability to scour. To meet Colorado Department of Transportation scour protection guidelines, the bridge supports were designed for scour associated with the 500-year flood of 89,680 cfs. Pier and abutment scour calculations predicted an average of 30 feet of scour and 25 feet, respectively, associated with the 500-year storm. Structural improvements to the bridge were preferred over a massive riprap installation to mitigate the expected scour. Bridge abutments and piers were drilled into bedrock using reinforced concrete caissons, and were designed assuming the loss of support and additional hydraulic loads. The west roadway approach to the bridge is lower than the bridge deck and is expected to overtop during floods exceeding the 100-year recurrence interval.

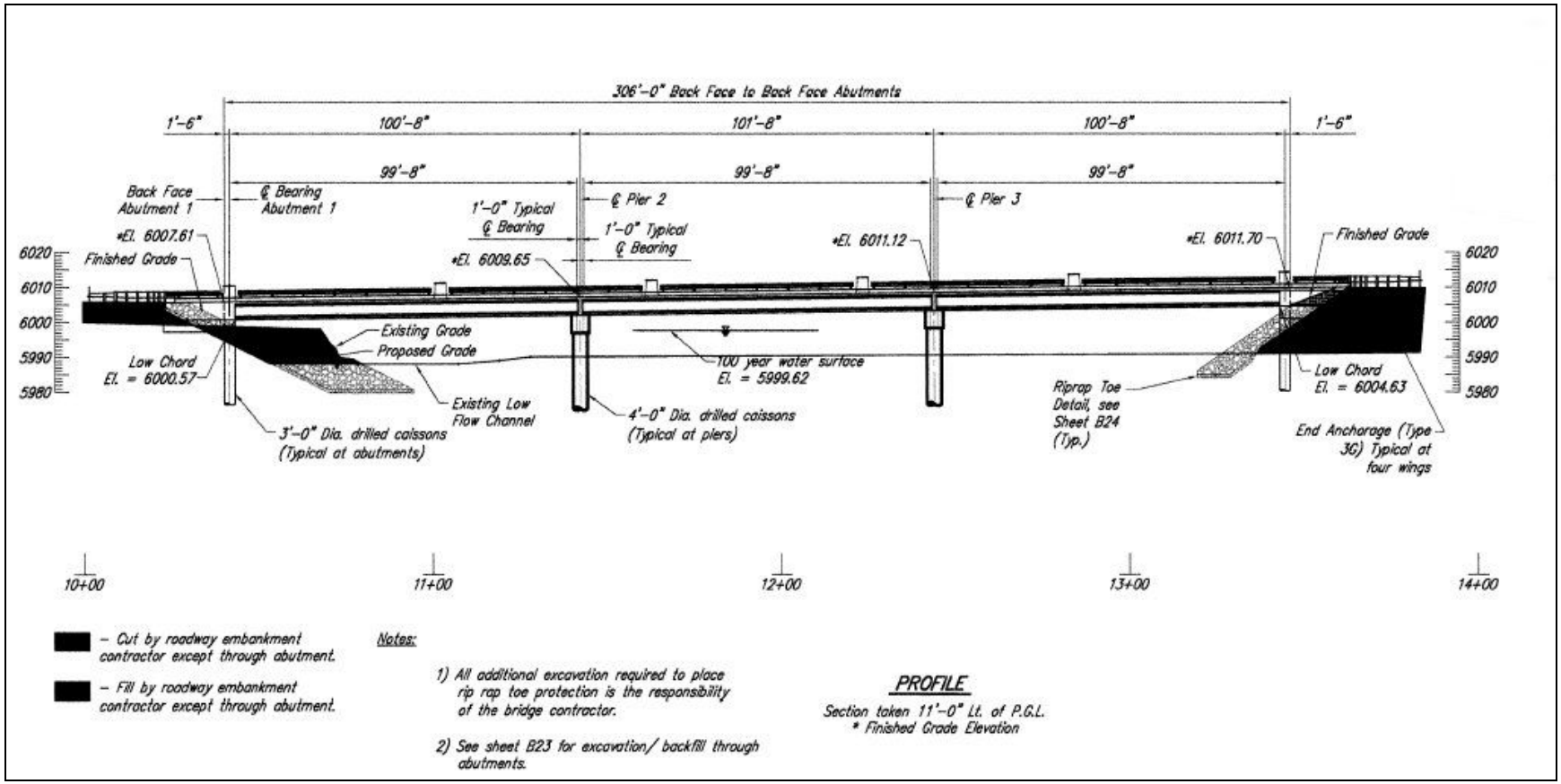


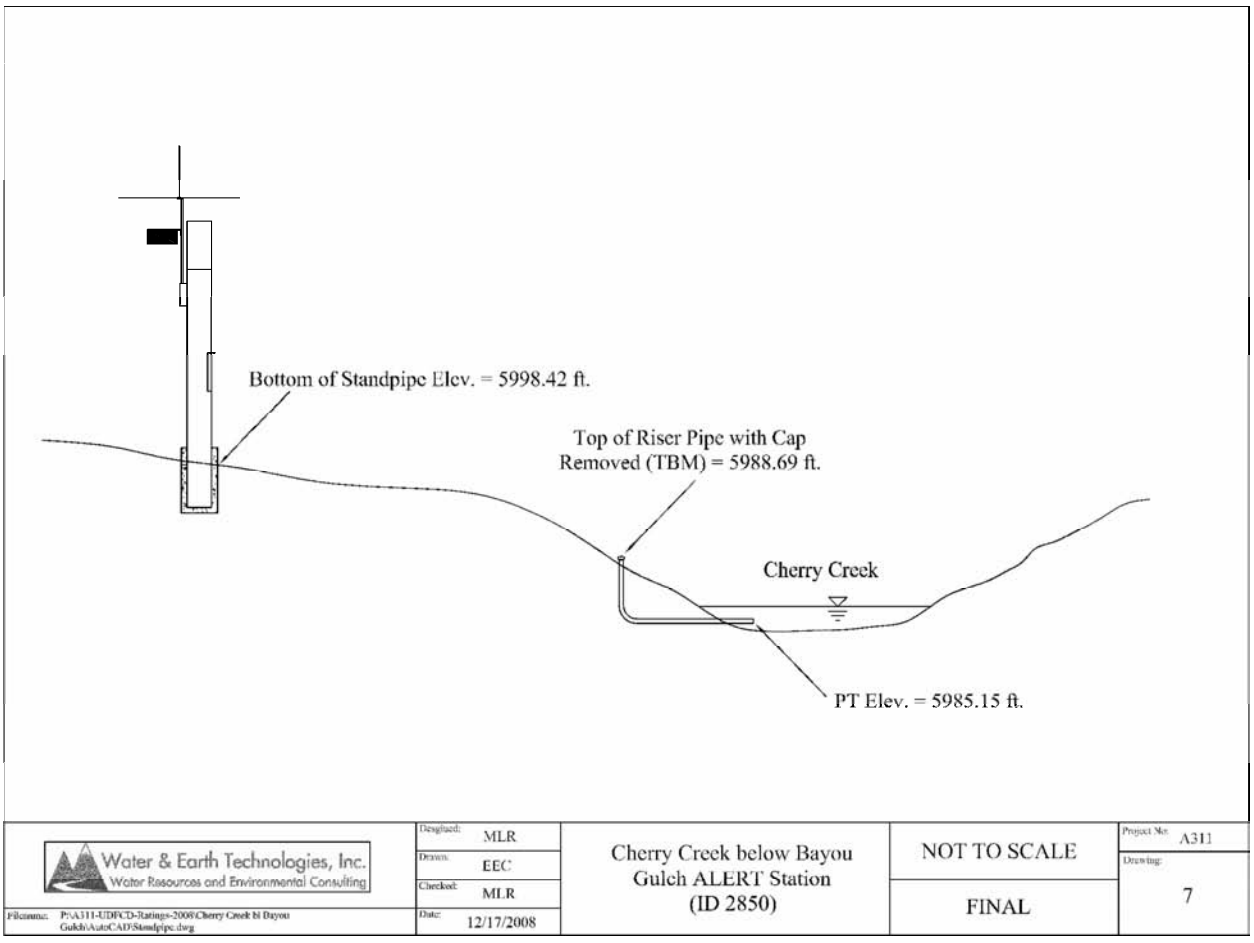
Figure 6. East Bayou Gulch Road Bridge (formerly Chambers Parkway Bridge) over Cherry Creek: Schematic excerpted from Record Drawing Sheet B3-b; Douglas County Department of Public Works, Engineering Division

Photos taken during cross section survey and direct flow measurement in August 2008.

5.0 ALERT MONITORING STATION DETAILS

The monitoring station utilizes a pressure transducer housed inside a vertical 2-inch galvanized rigid conduit installed in the west bank of Cherry Creek upstream of the bridge. Some point elevations from the field survey conducted on September 4, 2008 and are provided (Figure 7).

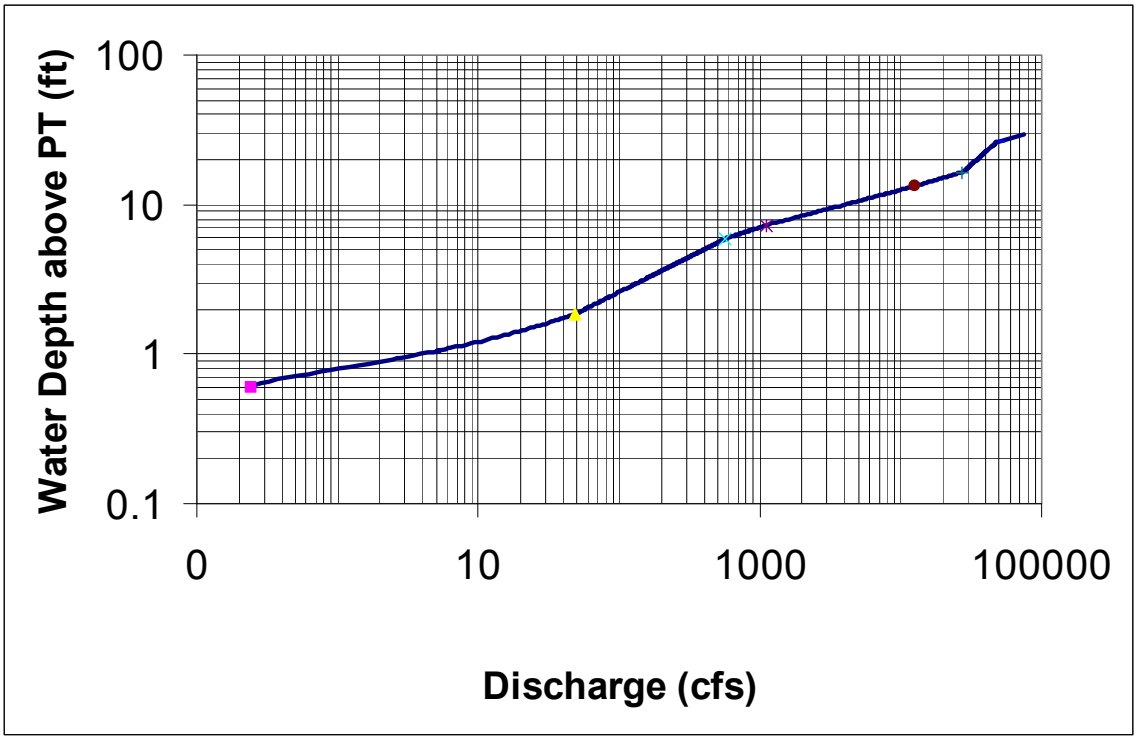
Figure 7. Cherry Creek below Bayou Gulch ALERT Station (ID 2850)



6.0 STAGE-DISCHARGE RATING

A theoretical stage-discharge rating was developed using a step-backwater technique with the U.S. Army Corps of Engineers Hydrologic Engineering Center-River Analysis System (HEC-RAS) computer model (USACOE 2002). The report entitled "Development of a Stage-Discharge Rating for the Cherry Creek below Bayou Gulch ALERT Station (ID 2850) in Douglas County, Colorado, January 2008" contains the details regarding the development of the rating. The final discharge rating for the cross section at the ALERT sensor is provided (Figure 8).

Figure 8. Stage-Discharge Rating, Cherry Creek below Bayou Gulch (ID 2853)



7.0 E19 INFORMATION

A number of critical features exist in the floodplain near the ALERT monitoring station. These features include the East Bayou Gulch Road Bridge, a bike path that runs along the creek and passes under the bridge, the west roadway approach to the bridge and the Pinery residential development.

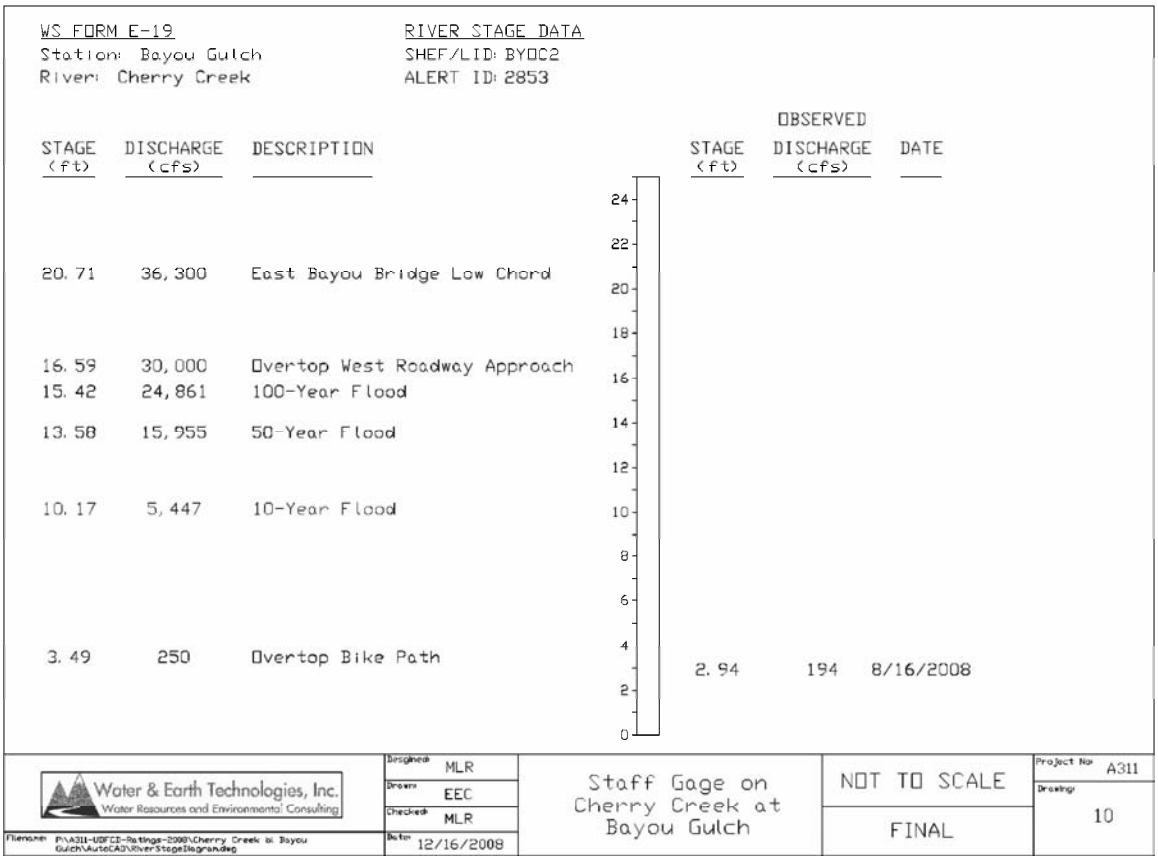
Scour is a concern during high flows due to the geomorphology of the region. The Bayou Gulch Road Bridge can pass the 100-year discharge and the bridge has been designed to withstand the scour associated the 500-year flood.

Flooding associated with lower flows in the 50-year to 100-year level are of concern to the bike path that runs along the creek. In addition, the west roadway approach to the bridge is lower than the bridge deck and is expected to overtop during floods exceeding the 100-year event. Critical elevations at the bridge have been correlated to the water surface elevation and stage measured at the ALERT station using the HEC-RAS model developed for Cherry Creek (Table 5).

Table 5. E19-Critical Features and Pressure Transducer Readings

Critical Feature at East Bayou Gulch Bridge	Discharge (cfs)	W.S.E.L at PT (ft)	Stage at PT (ft)
Bike Path Overtops (lowest elevation near bridge)	250	5,988.64	3.49
10-year Discharge	5,447	5,995.32	10.17
50-year Discharge	15,955	5,998.73	13.58
100-year Discharge	24,861	6,000.57	15.42
West Roadway Approach Overtops	30,000	6,001.74	16.59
East Bayou Gulch Bridge Low Chord (pressure flow)	36,300	6,005.86	20.71
500-year Discharge	89,680	6,013.75	28.6

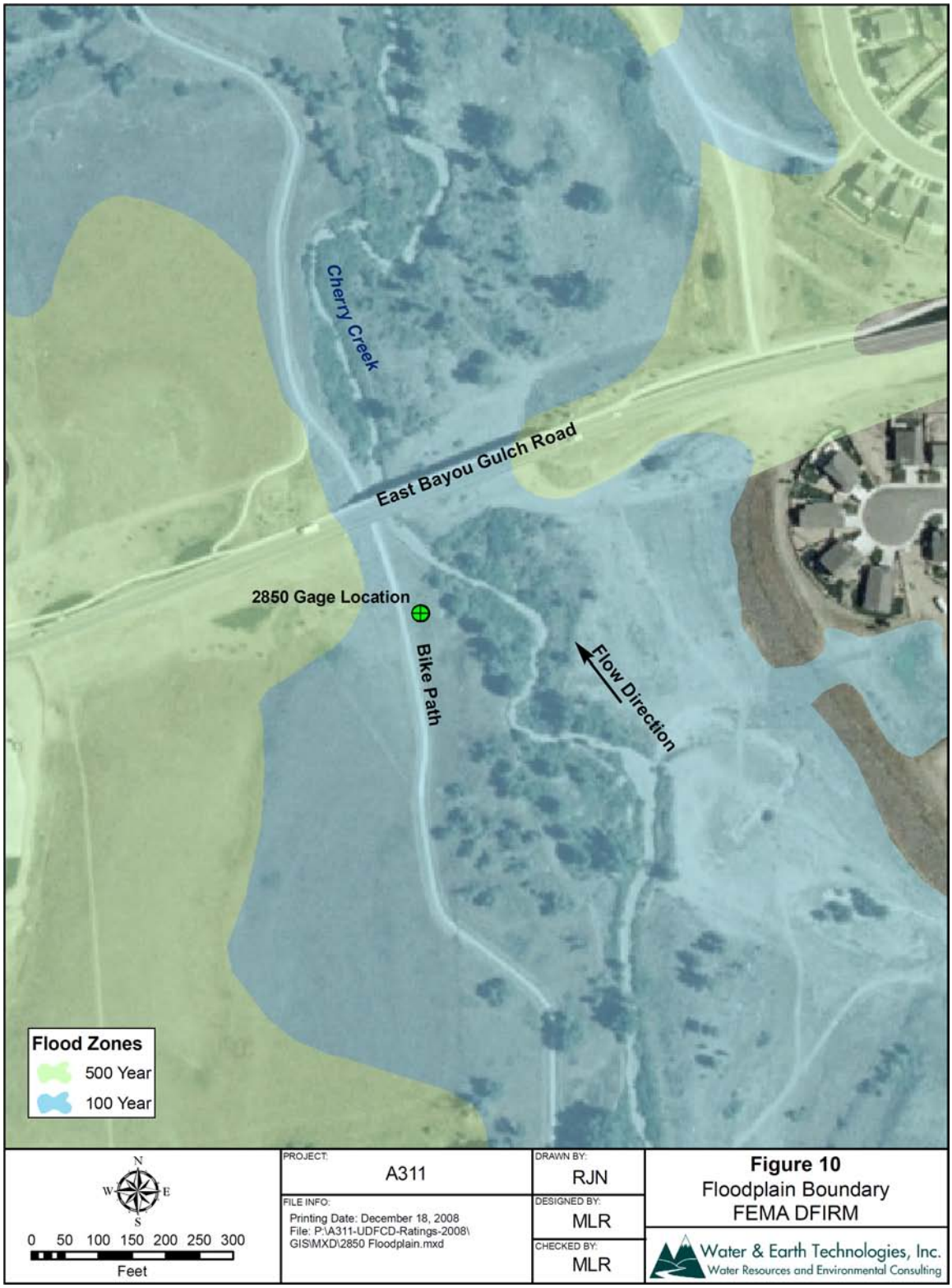
Figure 9. E19 Stage Information for Cherry Creek at East Bayou Gulch Road Bridge



8.0 FLOOD INUNDATION BOUNDARY

The Pinery West and Pinery Southwest residential developments are adjacent to Cherry Creek east and west of the gage location. These developments are generally elevated above the 500-year floodplain for Cherry Creek (Figure 10). In terms of flooding, the primary concern is the bike path and the west roadway approach to East Bayou Gulch Road Bridge.

Figure 10. Floodplain Boundaries near the East Bayou Gulch Road Bridge



9.0 REFERENCES

Pinery West Metropolitan District No. 1: Chamber Parkway Bridge Over Cherry Creek, Douglas County, Colorado, August, 2000. Record drawing set prepared by Bates Engineering and accepted Nov. 2002 by the Douglas County Department of Public Works. Hydraulics/Hydrology prepared by Kiowa Engineering Corporation.

U.S. Geological Survey. Digital Raster Graphics Topographic Mapping via Terraserver.

U.S. Army Corps of Engineers, Hydrologic Engineering Center. (1998). "HEC-2 Water Surface Profiles User's Manual and Computing Water Surface Profiles with HEC-2 on a Personal Computer."

Federal Emergency Management Agency. Flood Insurance Study Data Request through the FEAM Project Library, c/o Michael Baker Jr., Inc. Digital HEC-2 modeling from LOMR 03-08-0096P.

Federal Emergency Management Agency Flood Insurance Rate Map for Douglas County, Colorado, Panel 195 of 500 and associated Floodway Data and Profiles, Revised to Reflect LOMR dated July 30, 2003.

Design Report for the Hydraulics and Scour Protection for the Proposed Chambers Road Bridge over Cherry Creek, Douglas County, Colorado. Prepared by Kiowa Engineering Corporation for Pinery West Metropolitan District No. 1. August, 2000; Revised July 13, 2001.

Request for a letter of Map Revision: Cherry Creek and Bayou Gulch; Jordan Road Bridge at Cherry Creek, Douglas County, Colorado. Prepared by Kiowa Engineering Corporation for Community Development Group, May 14, 1999.

Correspondence between the Federal Emergency Management Agency and various participants in the process to obtain a Letter of Map Revision for Case No.: 99-08-344R; relevant to the construction of the Jordan Road Bridge, including HEC-2 output and the Request for a Conditional Letter of Map Revision: Jordan Road Bridge at Cherry Creek, Douglas County, Colorado. Prepared by Kiowa Engineering Corporaton for Community Community Development Group, September 16, 1999.