McLaughlin Whitewater design group
A DIVISION OF MERRICK & COMPANY

MEMORANDUM
October 25, 2013

TO: Marlene Crosby, P.E. – Gunnison County Public Works

FROM: Ben Nielsen, P.E., Rick McLaughlin, P.E. – McLaughlin Whitewater Design Group

RE: Gunnison Whitewater Park Site Evaluation

PURPOSE

In the spring 2013, Local boaters and Gunnison County staff identified several potential structural issues with two existing whitewater features (play waves) at the Gunnison Whitewater Park. McLaughlin Whitewater Design Group was retained to:

- Evaluate the existing whitewater features
- Identify structural damage (if any)
- Provide recommendations to repair structures

BACKGROUND

The Gunnison Whitewater Park is located in Gunnison Colorado, south of Highway 50, west of the Gunnison-Crested Butte Regional Airport. It is approximately a ¼ mile in length (1350 feet). The park was designed by Recreation Engineering and Planning (REP). It was built in two phases – Phase 1 in 2002 and Phase 2 in 2010/2011. Phase 1 consisted primarily of two "U" dam type whitewater features (Feature #2 & #3) and four "deflectors" built with boulders and grout (grouted boulders in inverts of whitewater features). Phase 2 was a single whitewater feature (Feature #1) at an active irrigation diversion. A fish passage was designed river left of the boat chute. Phase 2 was built using loose boulders at the sides of the boat chute and grouted boulders in the chute. See Drawing 1 for overall site plan of Whitewater Park.

According to the County, the park has experienced structural, sediment transport and hydraulic performance problems. Since 2005, the County has completed several maintenance projects to address various issues. In general these activities have included replacing boulders and removing boulders/sediment. In 2008 a major repair of Feature #3 was completed that replaced boulders to address structural and hydraulic performance issues. Large boulders and concrete debris was placed on the river left bank downstream of Feature #3 to stabilize the bank. Most recently, two separate revisions where made at Feature #1 to correct insufficient diversion function[1].

Utilities and infrastructure exists near and in the Whitewater Park. Upstream of Feature #1 there is an infiltration gallery on river right, a Gunnison County waterline and Highway 50 bridge. A major irrigation diversion (75 Ditch) at Feature #1 is the most senior water right in Gunnison County. A power line to the airport runs under the river between Feature #1 and #2 (exact location not known). Rio Vista County Road runs along the east bank of the river. Gravel parking areas, trails, changing screens, and a restroom exists on the west bank.

The park is used by a variety of users with kayaking being the primary use. There is also significant use by float fisherman in rafts. It was reported by the County that there have been incidents with float fisherman at Feature #1 due to a powerful retentive hydraulic that forms at medium to high flows. The County added a "sneak route" for rafts to bypass on the river left shoulder. During the summer swimmers and tubers are common. The park is a popular hangout by Western State College of Colorado students. Bank and wading fisherman are also common in the park.

EVALUATION

MWDG conducted a site visit on October 3, 2013 to gather information and perform an evaluation of the Whitewater Park. Construction, maintenance and other documents related to the park design, construction, maintenance and performance where requested from the County. The following is a summary of the evaluation tasks completed:

- Interviewed Gunnison County Staff – A meeting with Marlene Crosby, Josh Skupta and Blaine Mazzuca was conducted to gather information on usage, maintenance history, reported incidences with recreational users, identified problems, existing infrastructure, etc.
- Site Evaluation (Dry) – Inspected park features from the bank and feature shoulders, survey of hydraulic drop across features using a level and rod.
- Site Evaluation (Wet) – Snorkeled in pools downstream of Feature #2 and #3 to inspect submerged portions of structure and pools
- Reviewed Available Documents – Review of design drawings, reports, and other available documents.

The evaluation generally focused on three areas:

- Safety – Recreational use of rivers and water have inherent and unavoidable risks. Safety was evaluated based on criteria in the Colorado Water Conservation Board Floodplain and Stormwater Criteria Manual. This document provides guidance on design and construction of in river recreational structures.

  "Structures be designed and constructed so that they are predictable and without hidden or unobvious hazards to responsible users" – CWCB Manual

The following "safety considerations" are presented in the CWCB Manual:

- Overly retentive submerged hydraulic jump ("keeper")
- Impacts, blunt trauma and abrasion
- Foot or extremity entrapment
- Pinning or entrapment against an obstruction
- Lack of egress out of the channel
- Entrapment or entrainment into structures, grates, screens, etc.

- Structural – Existing structural movement/failure, scour/bed movement, and potential future instability.
- Whitewater performance – Recreational hydraulics, wave/hole formation, retentiveness, eddy service, and depth.

The following documents were provided to MWDG from Gunnison County and were included in the evaluation. Documents are grouped by Phase:

<u>Phase 1 (Feature #2 & #3 and deflectors)</u>

- Design drawing by REP dated October 1998
- Design drawing by REP dated March 3, 1999
- Site survey drawing by Furey Land Surveying, Inc. dated May 1, 2003
- Feature #2 & #3 Pool depth measurement sketch (presumably by Gunnison County staff) no date
- Structure maintenance sketch of Feature #2 & #3 by Jeff Crane dated November 27, 2005
- Gunnison Whitewater Park Master Plan Update Chapter IV (abbreviated) no author or date provided.
- Miscellaneous photos of Feature #2 & #3 during high river flows (spring runoff)

<u>Phase 2 (Feature #1)</u>

- Design drawing titled "Ditch Diversion" by Crane Associates dated January 2004
- Design drawing titled "75 Ditch Diversion Reconstruction" by Crane Associates dated June 2004
- Report title "Concept Plan and Cost Estimate Gunnison River Whitewater Park "75" Diversion Improvements" by Recreation Engineering & Planning dated November 2009
- Design Drawings (sealed – 3 sheets total) titled "75 Ditch Improvements Gunnison River, Gunnison, Colorado" by Recreation Engineering & Planning dated November 5, 2010
- Report (no title) summarizing a site evaluation of Feature #1 by Recreation Engineering & Planning dated October 26, 2011
- Photo of Feature #1 during high river flows (spring runoff)

FINDINGS

Findings and conclusions from the site evaluation and review of whitewater park documents are presented in this section. See Drawing 2 for an exhibit showing location and type of deficiency identified.

Table 1 *– Conditions during Site Evaluation*

Date	October 3, 2013
Weather	Sunny, 65°F
Water Clarity	Good (6 – 8 feet)
River Flow	400 cubic feet per second (cfs)*
Water Temperature	45° – 50°F

*USGS gage #09114500

Table 2 *– Hydraulic Drop across Whitewater Features (surveyed)*

Feature	Flow (cfs)	Hydraulic Drop (ft)
1	400	3.4
	-	-
2	400	1.5
	1,460	1.5**
3	400	2.1
	1,460	2.2**

**Measured during previous field study by MWDG June 2003

Table 3 *– Gunnison River Average Monthly Flow*

Month	Flow (cfs)
January	211
February	204
March	252
April	606
May	1,790
June	2,410
July	1,240
August	718
September	522
October	392
November	292
December	236

Source: USGS gage #09114500 historical statistical data

Feature #1

- Apparent structural damage was not observed (inspection from bank only - low flow and location of eddy line made wet inspection difficult). Design drawings show a sloped grouted boulder toe. Vertical faces at the downstream edge of the chute and river right shoulder (eddy line) were observed which may indicate scour and toe instability.
- Safety: No apparent safety issues were observed at the boat chute.
- Review of design drawings (dated November 5, 2011):
    - It does not appear that an adequate cutoff at the crest of the structures is included in the design – Cutoff is shown as one boulder below crest with no dimension or elevation indicated (Sheet 2).
    - Design elevations for the depth of toe protection do not appear to be included on the design drawings. A note stating "1.5' Min. Keyed into Bedrock or Below Scour Depth" – Scour depth or bedrock elevation not indicated (Sheet 2)
    - Constructed boat chute differs from design details. Design drawings note "grout held back 6 to 8-inches" for the grouted boulder chute invert. It appears the chute is grouted to the top or above the boulders. The lip (downstream portion) of the chute appears horizontal where it is shown as sloped in the design drawings.
- Whitewater Performance: Green wave not retentive enough for surfing and very shallow (>1') at river flow observed (low flow) – low recreational value. Josh Skupta indicated that feature is shallow at all typical river flow levels including spring runoff. Hydraulic is powerful and retentive at medium to high flows suitable for advanced paddlers. There have been reported issues with rafts being stuck in hydraulic at higher flows.

Feature #2 – Drawing 2

- Structural damage/instability was observed:
    - Damage Moderate – multiple locations/types of structural damage; low to medium probability of partial or complete structure failure (inability to capture and control water) in the near future. Should Feature #3 suffer significant failure, there would be a high probability of rapid failure of Feature #2 due to increase hydraulic drop and lowered bed elevation.
    - Large boulders along the downstream edge of the feature shoulders (at sides) and boat chute invert have separated from the structure.
    - Undercuts exist in several locations along the downstream edge of the shoulders. It is likely undercutting is also present in the boat chute (boat chute was not inspected due to high water velocities and aeration).
    - Significant grout cracks and separation from surrounding boulders exists in the river left and right shoulders. It is possible similar cracking is occurring in the boat chute (unable to inspect).
    - Water could be heard flowing under boulders on the river right shoulder.

- Scour: Pool scour depth estimated at 10 feet below water surface. It is likely that deeper scour occurs during larger flow events. Design drawings provided do not indicate a design pool scour depth.
- Safety: structure undercuts, structure debris in pool and cracks in grout may pose some existing safety issues related to impact injuries, foot or extremity entrapment, and entrainment/entrapment. However, these concerns are not nearly as significant as those identified below. Further structural failure could however result in more substantial safety problems.
- Review of Design Drawings: Drawings are schematic in nature that lack detail necessary for review of structure design. Drawings are plan view only without sections, profiles, or construction details for structures. Invert elevations and dimensions of boat chutes are shown.
- Whitewater Performance: the green wave in the center of the feature is not retentive enough for surfing, wave, or hole tricks. A hole at river left is playable for intermediate to advanced boaters at the river flow observed (low flow) – limited recreational value. Josh Skupta indicated that the feature performs well at medium to high flows typical in spring and early summer. He indicated that it is good for intermediate to advanced boaters at these flow levels.

<u>Feature #3 – Drawing 2</u>

- Substantial structural damage/instability was observed:
    - Damage Significant – Widespread and extensive damage to structure; high probability of complete or partial structure failure (inability to capture and control water) in the near future.
    - Large boulders along the downstream edge of the feature shoulders (at sides) and boat chute invert have separated from the structure.
    - Large undercuts exist in several locations along the downstream edge of the shoulders. It is likely undercutting is also present in the boat chute (boat chute was not wet inspected due to high water velocities and aeration). A void (12-inches wide x 24" long) in the grouted boulder boat chute was observed indicating likely undercutting.
    - Significant grout cracks and separation from surrounding boulders exists in the river left and right shoulders. It is probable that similar cracking is occurring in the boat chute (unable to inspect).
    - Piping under structure – Water could be heard flowing under boulders on the river right shoulder and a "sink hole" of cobble material between large boulders was observed at the river left shoulder.
- Scour: Pool scour depth observed estimated at 15 feet below water surface. It is likely that deeper scour occurs during larger flow events. Design drawings provided do not indicate a design pool scour depth.
- Tailwater Degradation: It is likely that the river bed downstream has lowered (degradation). A photo from 2003 (Figure 1) shows a boulder structure downstream of the pool that was not apparent during the site evaluation. In addition the hydraulic jump appears to "drop off" the lip of the structure. Typically the jump is design to

occurs at the lip, possibly indicating a lower tailwater condition than designed (or the structure length is shorter due to toe failure). Without design water levels in the pool over a range of flows or topographic/bathymetric survey data of the pool and river downstream it is difficult to determine the extent of the degradation in the tailwater elevation.

Figure 1 *– Compare River Downstream Feature #3 (2003) w/ Current Condition*

- Safety: large structure undercuts, piping under structure (voids with flow water), debris in pool and large cracks in grout pose safety problems – impact injuries, foot or extremity entrapment. Pinning or entrapment against an obstruction and entrainment/entrapment into structure are of concern. This is greater concern for an under-equipped/inexperienced user during lower flows. A complete or partial failure of this feature would likely pose a significant safety risk to users due to debris and undercuts in high velocity areas and/or formation of overly retentive hydraulics at Feature #3 or Feature #2 upstream. A failure of a similarly designed and constructed whitewater feature in Green River Wyoming resulted in a fatality when a user was entrapped in the structure debris.
- Review of Design Drawings: Drawings are schematic in nature that lack detail necessary for review of structure design. Drawings are plan view only without sections, profiles, or construction details for structures. Invert elevations and dimensions of boat chutes are shown.
- Whitewater Performance: Green wave in center difficult to surf, variable hydraulic conditions were observed at the wave shoulders. Unusual hydraulic was occurring on river left of boat chute- likely a result of movement of boulders. Josh Skupta indicated that feature performance is generally poor at low river levels and satisfactory at moderate to high flows that are typical in the spring and early summer. Improved wave performance is desired. At higher river levels the hydraulic at the boat chute was reported to become more powerful and can be “trashy”. The feature is suited for intermediate to advanced boaters.
- Review of Design Drawings: Drawings are schematic in nature that lack detail necessary for review of structure design. Drawings are plan view only without sections, profiles, or

construction details for structures. Invert elevations and dimensions of boat chutes are shown.

RECOMMENDATIONS

General Whitewater Park Recommendations

- Frequent inspection of all the structures at the Park and at varying flow rates. Look for:
  - Overly retentive, unusual, or different hydraulic conditions.
  - New or changes in the boulders or rocks in the pools downstream of each structure.
  - Debris such as logs accumulating at structures.
  - Bank instability such as rocks moving on the banks or new steep drops in the grade.
  - Lowering of the water surface downstream of each structure. This can result in overly retentive hydraulic conditions and increase scour.
  - Lowering of the water surface upstream of each structure. This would be an indication of the failure of the crest of the structure and possible flow paths below structure.
- Once problems are identified:
  - Remove hazardous debris at or in the vicinity of the structures.
  - Repair or otherwise mitigate problems with failed or destabilized banks and structures as allowed by current river flows.
  - If significant hazards are created, consider closing this reach to in-river recreation until repairs can be made. At a minimum, potential hazards should be posted to notify the public. Note that repairs are particularly difficult if not impossible to be made during spring runoff.

Feature #1 Recommendations:

From the review of available documents, it appears that Feature #1 was designed and constructed similarly to downstream structures. Although structural problems were not observed during the site evaluation, it is likely that problems will develop in the future based on performance of downstream structures. In addition, piping and uplift forces on this structure are greater due to the much larger hydraulic drop than downstream structures. Ultimately it is likely that the following modifications may be necessary:

- Install a subsurface cutoff along the upstream end of the crest.
- Install toe protection along downstream edge – replace boulders that have moved and extend boulders sufficiently below scour depth in pool
- Armor pool with well-graded riprap. This will reduce the required depth of toe protection by limiting pool scour.
- Modification to improve recreational performance – particularly at the downstream end of the structure.

Modifications to this feature are considered low priority relative to repairs recommended at other structures. Therefore, MWDG has excluded these from further budgeting and design consideration in the memorandum but could be added if requested by the County.

Recommendations for Features #2 and #3 (See Drawing 6):

- Install a subsurface cutoff along the upstream end of the crest.
- Remove & replace the boat chute and portions of both shoulders – re-grade and compact subgrade material, reset boulders and re-grout. (Alternatively, injection grouting or other technique may be less costly.)
- Install toe protection along downstream edge of structure – replace boulders that have moved and extend boulders sufficiently below scour or armored depth in pool.
- Armor pool with well-graded riprap – will reduce the required depth of toe protection by limiting pool scour depth
- Install a loose boulder counter weir downstream of Feature #3.

Recommended approach to park repairs (numbered by perceived priority):

1. Repair Feature #3 and construct counter weir as soon as practicable. Temporary measures to shore up structure may be prudent. Immediate execution of an expedited design would be required if repairs are to be made this winter.
2. If funding is available, repair Feature #2 at the same time or alternatively, after Feature #3 is repaired.
3. Continue to observe Feature #1 for signs of failure and movement of boulders. Alternatively some or all of the recommended improvements could be made to avoid potential structural failures and/or improve recreational performance.

BUDGET PLANNING

Table 4 below summarizes opinion of probable costs for budget planning purposes based on MWDG's proposed recommendations and a typical design-bid-build contract. A more detailed opinion of cost would be prepared during preliminary design (30%) that would further refine project costs.

***Table 4** – Gunnison Whitewater Park Budget Summary*

	Budget Range*	Improvement Summary
Feature #2	$200k - $330k	Dewatering, cutoff, toe protection/armor pool, structure modifications, improve whitewater performance
Feature #3	$240k - $400k	Dewatering, cutoff, toe protection/armor pool, structure modifications, improve whitewater performance
Counter weir	$40k - $60k	Dewatering, riprap counter weir structure downstream of Feature #3 to control tailwater

*Budget prepared based on design-bid-build contract. Budget includes design fees (15% of construction value). Unit prices based on pricing for recent MWDG project. Local costs will vary. It was assumed that the County has boulders available for construction. Use of county staff and equipment would likely reduce budget significantly.

Table 5 summarizes the opinion of probable costs for materials only. This may be useful for budget planning if the County chooses to utilize staff and equipment to build the repairs.

Table 5 *– Gunnison Whitewater Park Budget Summary* *Material Costs Only*

	Budget Range*	Improvement Summary
Feature #2	$55k - $90k	Dewatering, cutoff, toe protection/armor pool, structure modifications, improve whitewater performance – Materials Only
Feature #3	$75k - $125k	Dewatering, cutoff, toe protection/armor pool, structure modifications, improve whitewater performance – Materials Only
Counter weir	$12k - $20k	Dewatering, riprap counter weir structure downstream of Feature #3 to control tailwater – Materials Only

*Budget prepared for material costs only. Imported boulders material costs included loading and hauling to site from a County source (boulders not purchased).

NEXT STEPS

- Temporary Repair of Feature #3 – The County may want to consider temporary repairs to shore up the feature. Currently Feature #3 is in poor condition and will continue to degrade over time.
- Funding – Identify potential grant opportunity and other funding sources.
- Design – Should the County choose to move forward with some or all of the recommended modifications, design of the improvements will be necessary.
    - Gather site information – Survey, measurement of water surface elevations at varying river flows, soils evaluation
    - Preliminary Design – 30% level to define improvements and estimate project costs
    - Final Design/Construction Documents
- Permitting – make contact with USACE to determine if a Nationwide CWA 404 or Individual CWA 404 is required, Colorado State Department of Public Health & Environmental (construction discharge permit & CWA 401), local permits (grading, floodplain, building, etc.). MWDG can facilitate this effort if requested.

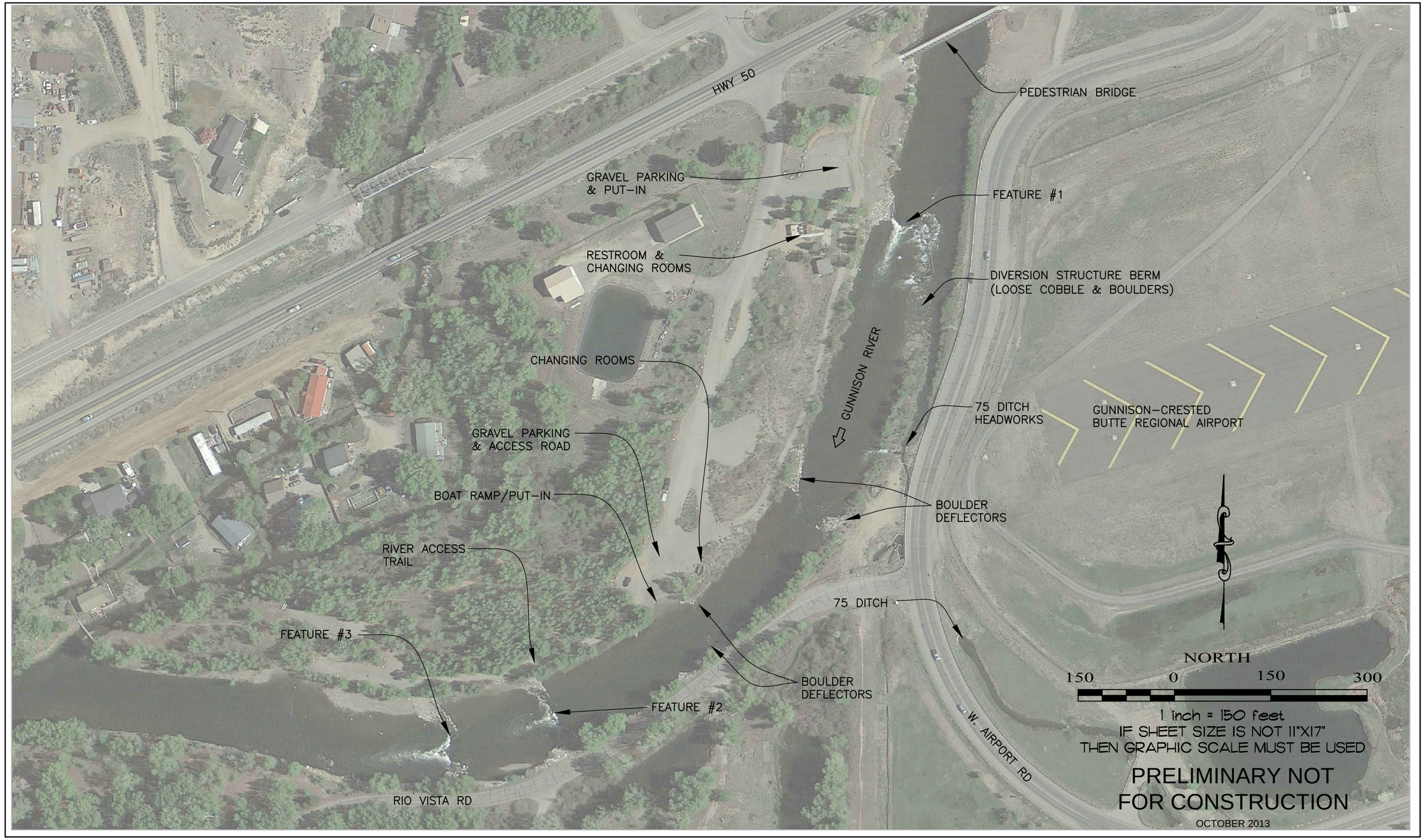
Additional documents would be useful during design. MWDG requests the following documents from the County:

- Construction inspection reports/photos

- Available mapping – Aerial photos, aerial/LiDAR surveys
- Soils information – upstream bridge
- Current planning documents - Master Plans for Gunnison Whitewater Park (most recent document), river corridor, city, trails, other
- Existing FEMA workmaps and hydraulic models – if available

REFERENCES

1. Interview Gunnison County Staff Marlene Crosby, Josh Stupka, Blaine Mazzuca, October 3, 2013.



GUNNISON WHITEWATER PARK GUNNISON COLORADO	OVERALL EXISTING SITE EXHIBIT	McLaughlin Whitewater design group A DIVISION OF MERRICK & COMPANY 2420 Alcott St Denver, CO 80211 T303.964.3333 F303.964.3355	1

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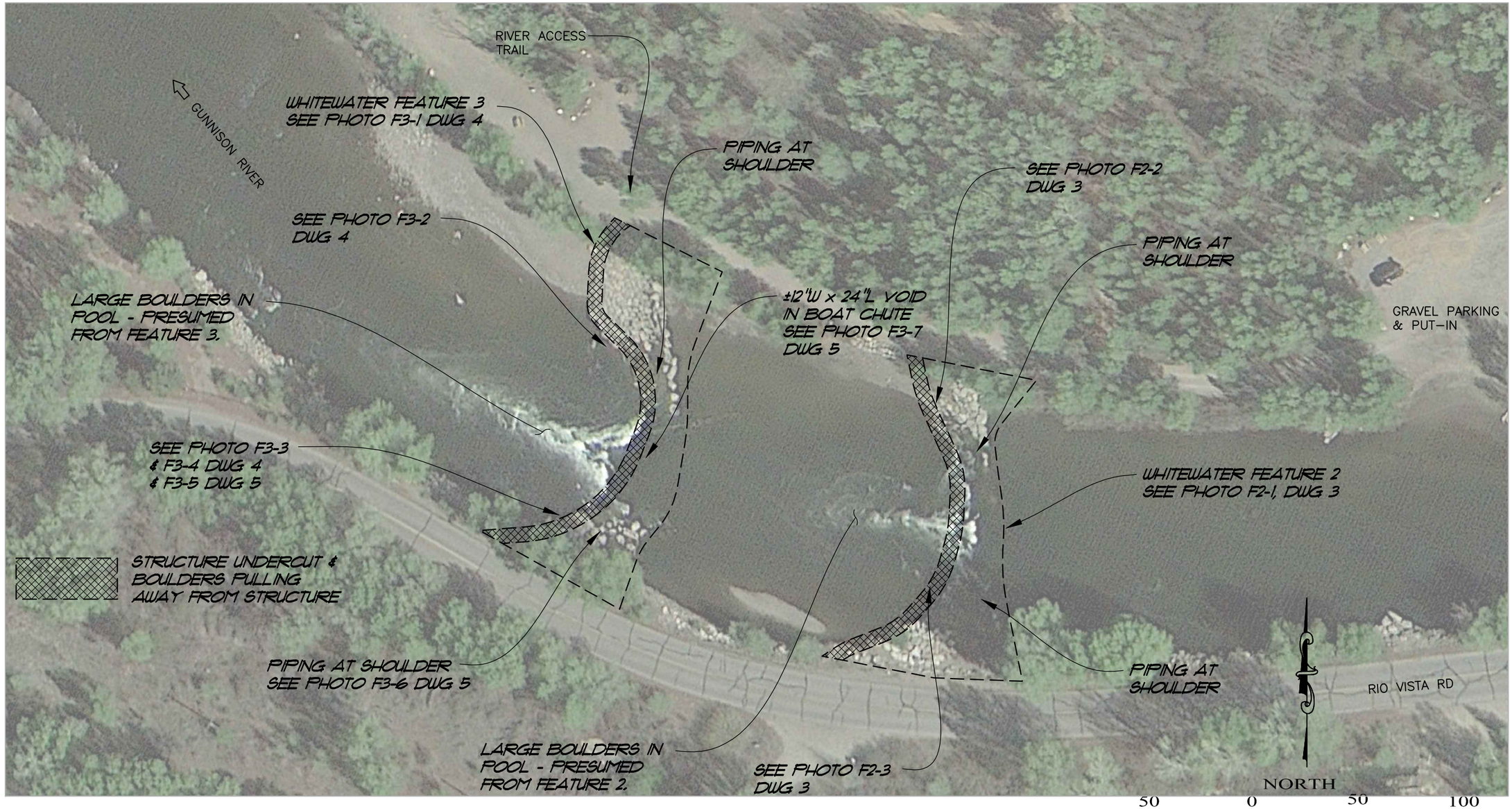

1 inch = 50 feet
IF SHEET SIZE IS NOT 11"X17"
THEN GRAPHIC SCALE MUST BE USED

PRELIMINARY NOT
FOR CONSTRUCTION

OCTOBER 2013

GUNNISON WHITEWATER PARK GUNNISON COLORADO	FEATURE 2 & 3 EVALUATION EXHIBIT	McLaughlin Whitewater design group A DIVISION OF MERRICK & COMPANY 2420 Alcott St Denver, CO 80211 T303.964.3333 F303.964.3355	2

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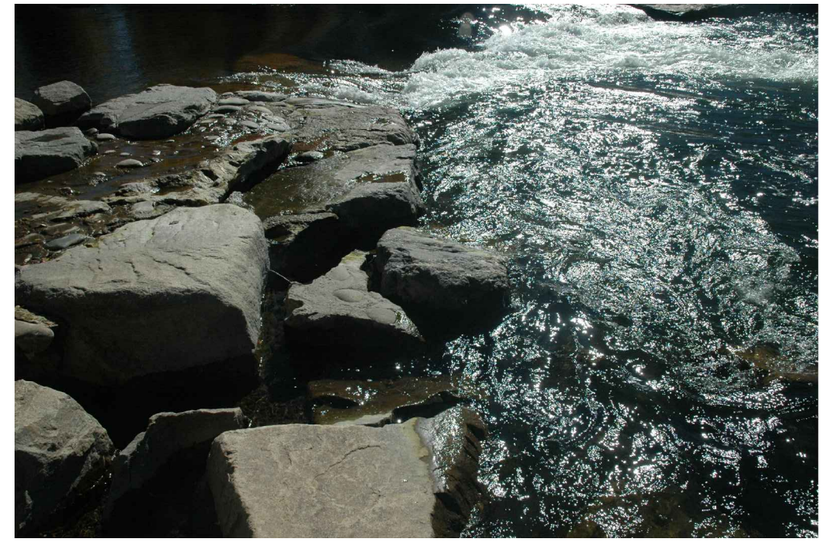
WHITEWATER FEATURE 2

PHOTO F2-1

NO SCALE



BOULDERS SEPARATED FROM STRUCTURE - RIVER RIGHT SHOULDER

PHOTO F2-2

NO SCALE

BOULDERS SEPARATED FROM STRUCTURE - RIVER LEFT SHOULDER

PHOTO F2-3

NO SCALE

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OCTOBER 2013

GUNNISON WHITEWATER PARK GUNNISON COLORADO	FEATURE 2 SITE PHOTOS	McLaughlin Whitewater design group A DIVISION OF MERRICK & COMPANY 2420 Alcott St Denver, CO 80211 T303.964.3333 F303.964.3355	3

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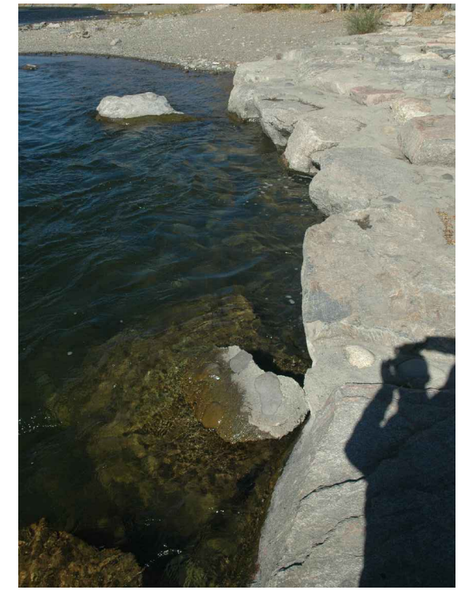
WHITEWATER FEATURE 3

PHOTO F3-1

NO SCALE



BOULDERS SEPARATED FROM STRUCTURE - RIVER RIGHT SHOULDER

PHOTO F3-2

NO SCALE

BOULDERS SEPARATED FROM STRUCTURE & UNDERCUTTING - RIVER LEFT SHOULDER

PHOTO F3-3

NO SCALE

BOULDERS SEPARATED FROM STRUCTURE & UNDERCUTTING - RIVER LEFT SHOULDER

PHOTO F3-4

NO SCALE

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GUNNISON WHITEWATER PARK GUNNISON COLORADO	FEATURE 3 SITE PHOTOS	McLaughlin Whitewater design group A DIVISION OF MERRICK & COMPANY 2420 Alcott St Denver, CO 80211 T303.964.3333 F303.964.3355	4

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BOULDERS SEPARATED FROM STRUCTURE & UNDERCUTTING - RIVER LEFT SHOULDER

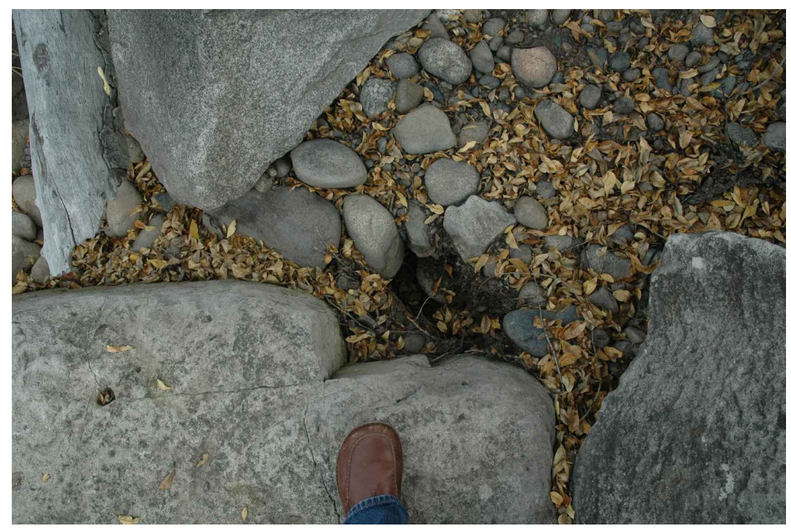
PHOTO F3-5

NO SCALE

VOID IN GROUTED BOULDERS - BOAT CHUTE

PHOTO F3-7

NO SCALE



"SINK HOLE" - RIVER LEFT SHOULDER

PHOTO F3-6

NO SCALE

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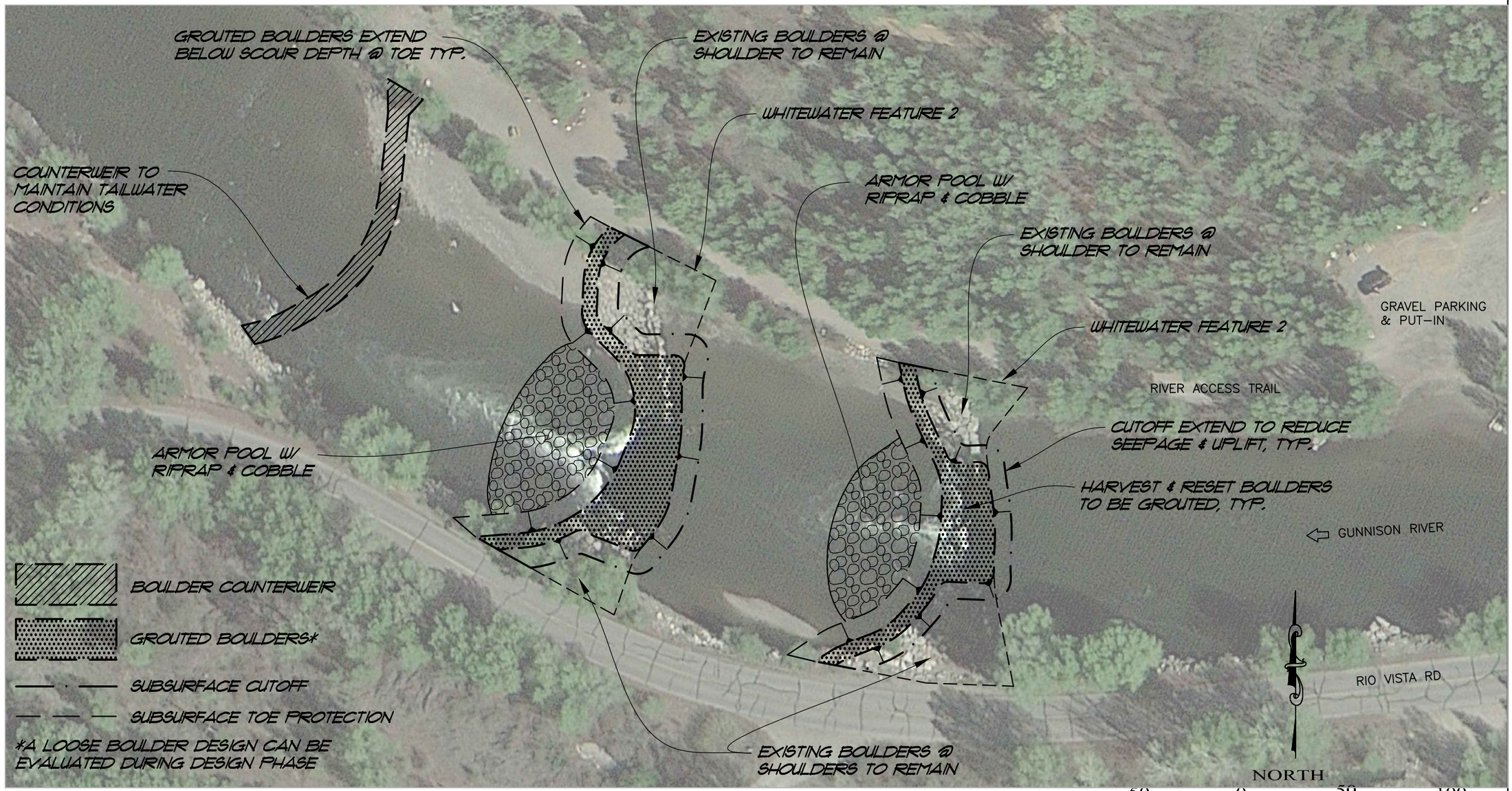

PRELIMINARY NOT FOR CONSTRUCTION

OCTOBER 2013

NOTE: PROPOSED IMPROVEMENTS SHOWN ARE SCHEMATIC AND NOT TO SCALE. SIZES, MATERIAL TYPES, CONSTRUCTION DETAILS AND LAYOUT TO BE DETERMINED DURING DESIGN PHASE.

1 inch = 50 feet
IF SHEET SIZE IS NOT 11"X17"
THEN GRAPHIC SCALE MUST BE USED

GUNNISON WHITEWATER PARK GUNNISON COLORADO	FEATURE 2 & 3 RECOMMENDED REPAIRS EXHIBIT	McLaughlin Whitewater design group A DIVISION OF MERRICK & COMPANY 2420 Alcott St Denver, CO 80211 T303.964.3333 F303.964.3355	6

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