APPENDIX E-1

SUPPORTING DOCUMENTATION FOR DEVELOPMENTAL ANALYSIS, PREFERRED PLAN AND ALTERNATIVES PROPOSED BY OTHERS

ATTACHMENT A

PRELIMINARY GRAVEL AUGMENTATION DESIGNS FOR DON PEDRO HYDROELECTRIC PROJECT

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TECHNICAL MEMORANDUM

DATE: September 1, 2017

TO: Turlock Irrigation District and Modesto Irrigation District

FROM: Noah Hume, PE, PhD and Chris Lyle

SUBJECT: Preliminary Gravel Augmentation Designs for Don Pedro Hydroelectric Project

Based upon reductions of coarse sediment supplies documented by the Coarse Sediment Management Plan (CSMP) (McBain & Trush 2004) as well as more recent comparisons of gravel availability described in the Spawning Gravel Study (TID/MID 2013), a program of gravel augmentation to benefit salmonid spawning has been included as a potential measure to be undertaken following Relicensing of the Don Pedro Project. Building upon augmentation site recommendations by McBain & Trush (2004), Stillwater Sciences was asked to provide preliminary designs to maximize spawning gravel area resulting from an initial gravel augmentation of 75,000 tons downstream of La Grange Diversion Dam (RM 52).

1 GRAVEL VOLUMES

Based upon estimates from the Spawning Gravel Study, coarse sediment bulk density as assumes to average 1.3 tons yd^{-3}, average coarse-to-total sediment ratio of 0.10 (Reid and Dunne 1996). From this, coarse sediment volumes corresponding to 75,000 tons would be on the order of 55,600 yds^3.

2 SITE SELECTION

Initial gravel augmentation site selection was based on the CSMP recommended conceptual layout/designs of gravel augmentation sites to utilize approximately 75,000 tons of gravel downstream of Don Pedro Dam in the Lower Tuolumne River. Consistent with the priority spawning reaches identified in the CSMP and TID/MID (2013), coarse sediment augmentation within the 12.4 miles of Tuolumne River channel below La Grange Diversion Dam was recommended, with the highest priority being upstream of Old La Grange Bridge. Taking biological needs, geomorphic needs, and sensitive habitat into consideration the recommended short-term coarse sediment augmentation sites selected in order of priority were: 1) Riffle A3/4, 2) Riffle A5/6; and 3) Basso Pool, with augmentation sites from the CSMP (Figure 1) potentially to be considered in the future.

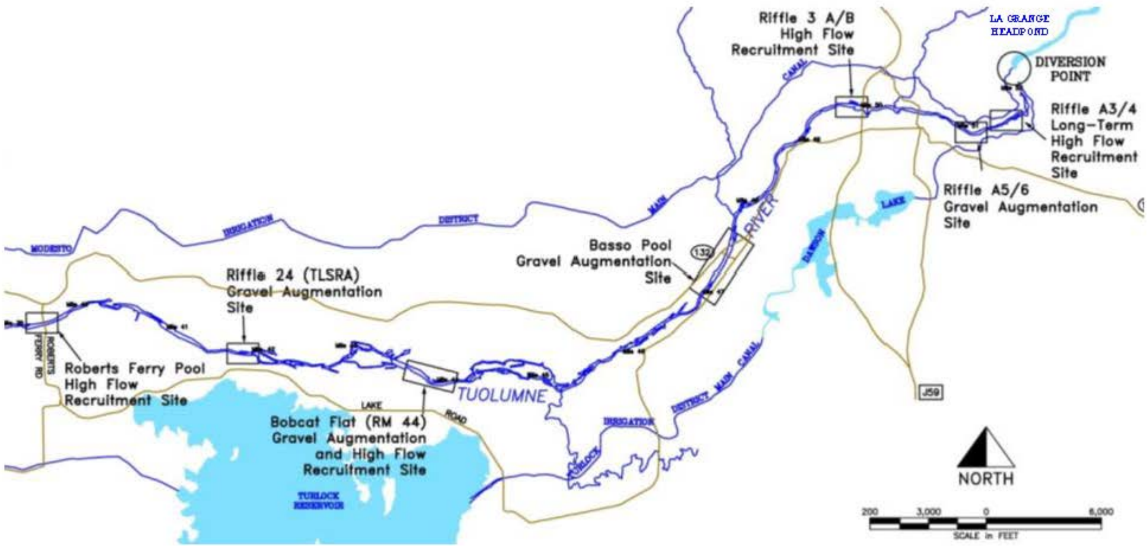

Figure 1. Short-term coarse sediment augmentation sites and long-term high flow recruitment sites.

3 DESIGN METHODS

Preliminary gravel designs were based upon a 2012 topographic and bathymetric surface digital terrain model (DTM) of the channel bed from La Grange Diversion Dam (RM 52) downstream to approximately Peaslee Creek (RM 45.5) (TID/MID 2013). Using the latest version of the lower Tuolumne River HEC-RAS model, “ModelABC_HECRAS_005” received on June 30th 2017, steady state water surface profiles at 320 cfs were used to establish a riffle crest depth of 2 ft or less at the augmentation sites.

To model gravel augmentation volumes, a channel profile was created in AutoCAD Civil 3D 2016 using established channel thalweg alignment, the channel bed DTM and initial water surface profile. The sites previously identified; Basso Pool, A6, A5, A3 & A2, where then assigned proposed profile design elevations and assemblies were constructed with various sub-assembly configurations to achieve the desired grading section geometry. Next, corridor models of each site using the alignment, profile, assembly and base target surface were created to generate a gravel surface at each site. Finally, a volume surface was generated for each individual site using “tuol_2012_krig3_1ft” as the base surface and the corresponding proposed gravel augmentation surface as the comparison.

4 PRELIMINARY DESIGNS

Preliminary Designs are provided as Attachment A to this memorandum with estimated gravel volumes and spawning gravel areas in Table 1 below. In order to maximize spawning gravel areas, the designs combine Riffle-and pool tail coarse sediment augmentation methods with Rehabilitation of alternating riffle-pool and bar habitat in long pool/run sites. The Riffle and pool tail augmentation, primarily applied to Riffle A2/3 places coarse sediment over existing riffle units to reduce coarse sediment size, increase spawning riffle width, and decrease channel slope to be more suitable for salmonid spawning. The primary advantage of this method is that small volumes of coarse sediment may greatly increase the quality and quantity of riffle habitat that can be used by salmonids (McBain & Trush 2004).

The second method combines point/medial bar and riffle-pool tail construction to rehabilitate long pools/runs, relicts of gold era dredging and gravel mining pools, to more contemporary post-dam channel geometry (McBain & Trush 2004). Although large volumes of coarse sediment are typically required to rehabilitate these sites, because establishment of more habitat complexity in upstream habitats may provide additional over summering benefits for rearing *O. mykiss*, construction of alternative riffle pool morphology was included for the Riffle A5/6 and Basso Pool sites.

Table 1. Preliminary Gravel Augmentation Volumes and Spawning Gravel Areas at 320 cfs downstream of La Grange Diversion Dam (RM 52) in the Tuolumne River

Riffle Location	RM	Tons	Volume (cu. yds.)	Wetted Area (sq. ft.)
A2	51.7	519	700	6,446
A3	51.5	3,707	5,000	43,797
A5	51.2	9,637	13,000	120,971
A6	41.0	14,456	19,500	99,542
BASSO UPPER	47.3	25,205	34,000	309,005
BASSO LOWER	47.0	2,076	2,800	73,409
	Totals:	55,600	75,000	653,170

5 REFERENCES

McBain & Trush, Inc. 2004. Coarse Sediment Management Plan for the Lower Tuolumne River (Revised Final), prepared for the Tuolumne River Technical Advisory Committee.

Reid, L.M. and T. Dunne. 1996. Rapid evaluation of sediment budgets. Catena Verlag, GMBH, Reiskirchen, Germany.

Turlock Irrigation District and Modesto Irrigation District (TID/MID). 2013. Spawning Gravel in the Lower Tuolumne River Study Report (W&AR-04). Prepared by Stillwater Sciences. December 2013.

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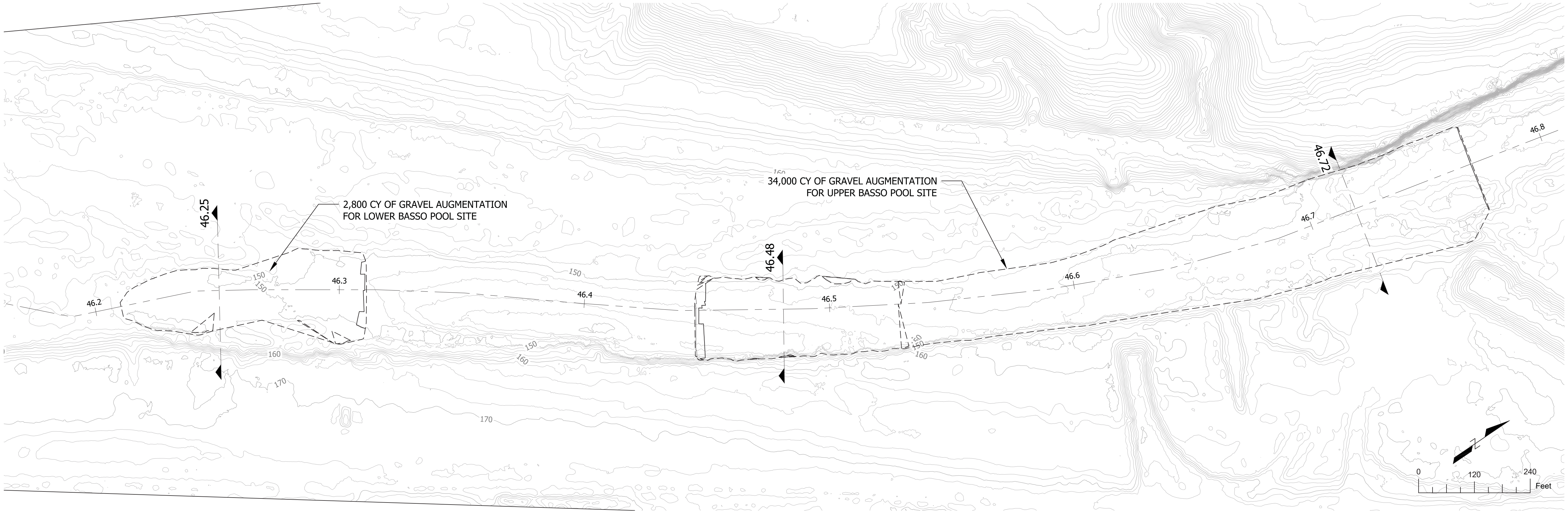
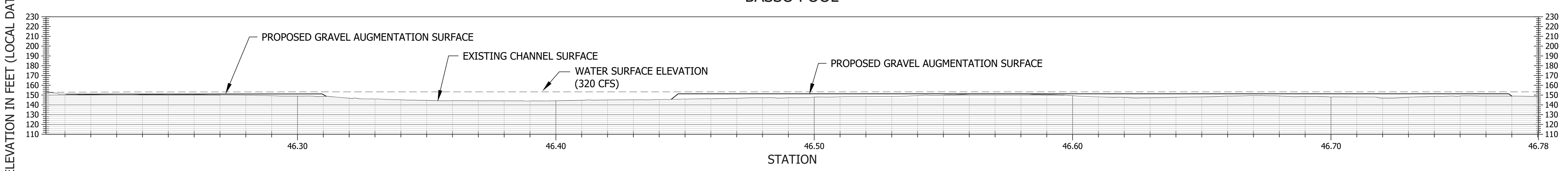


BASSO POOL



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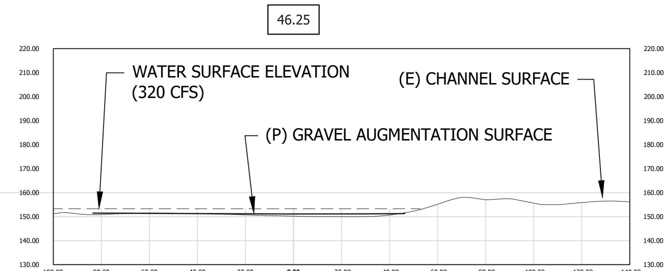

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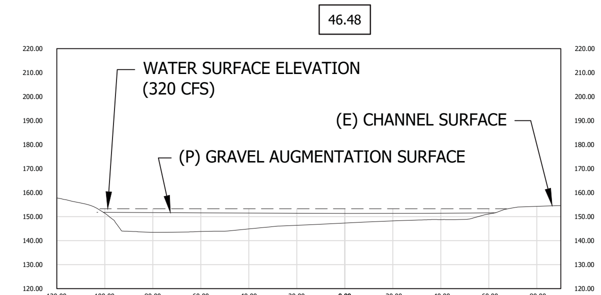

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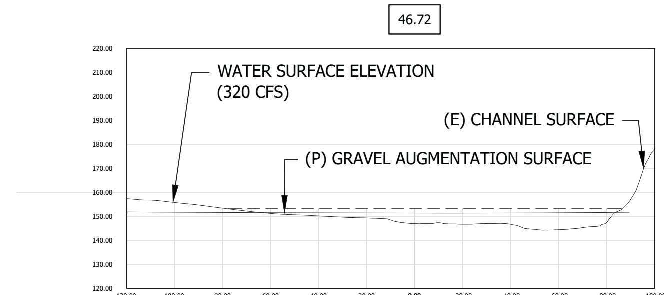

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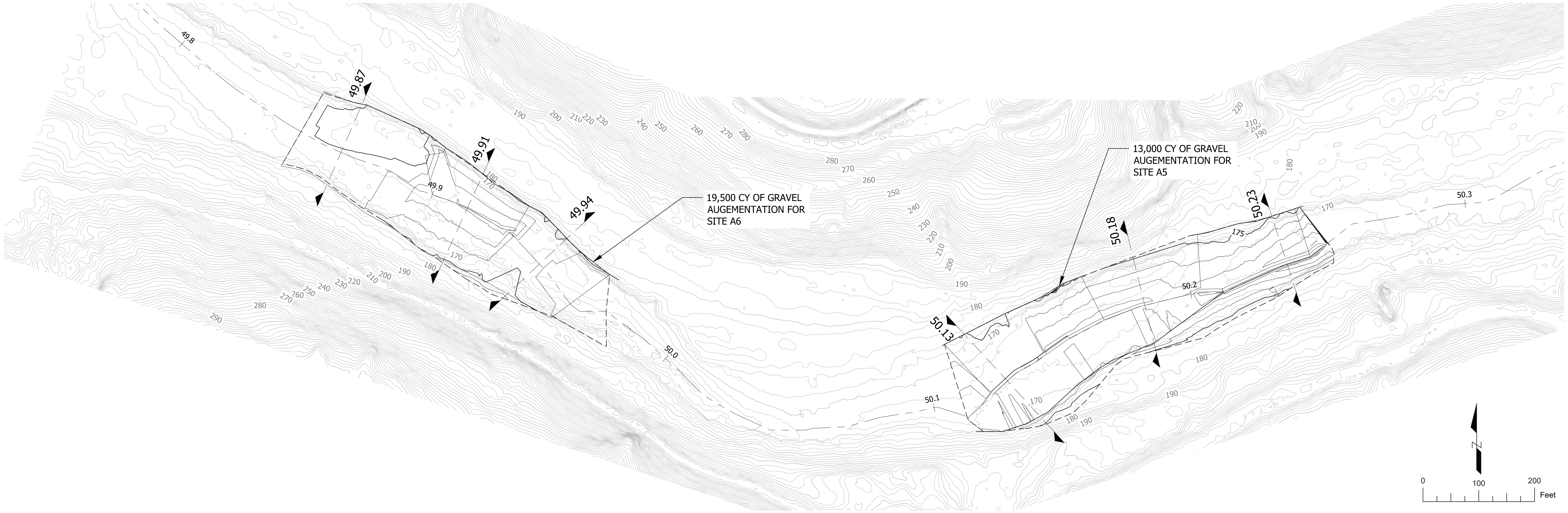
BASSO POOL

SHEET 1 OF 3



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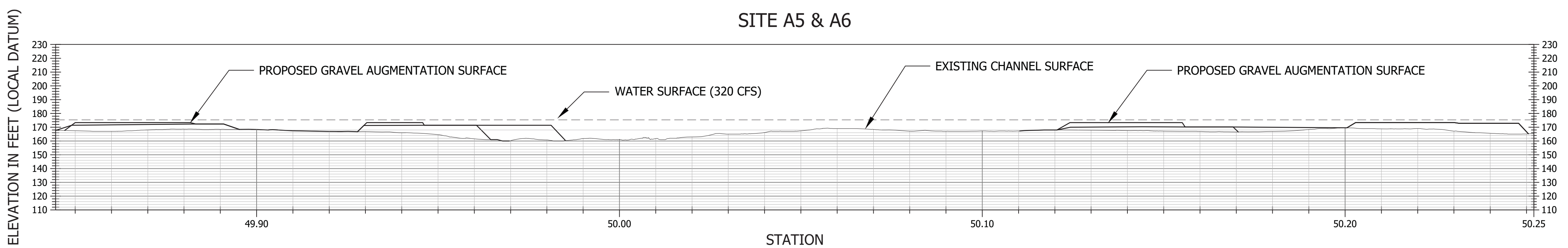

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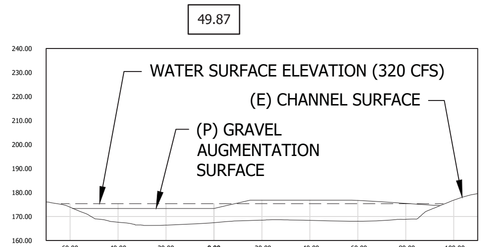

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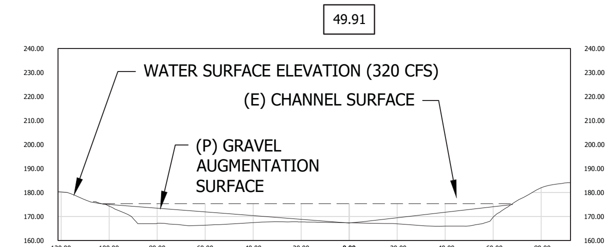

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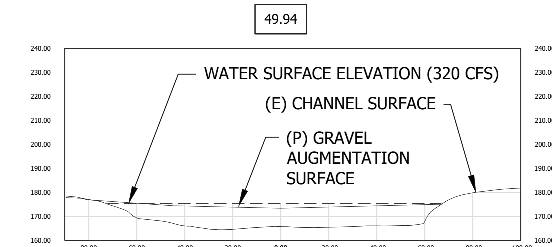

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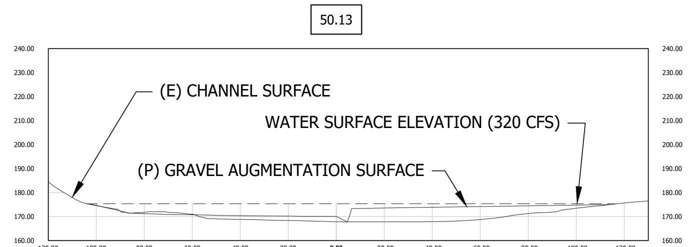

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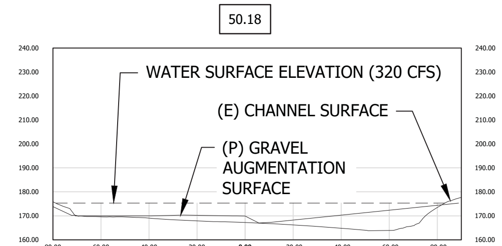

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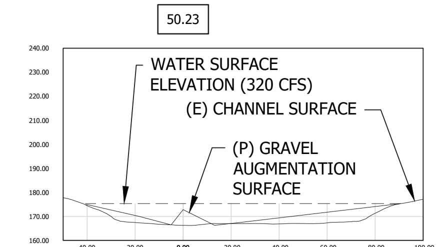

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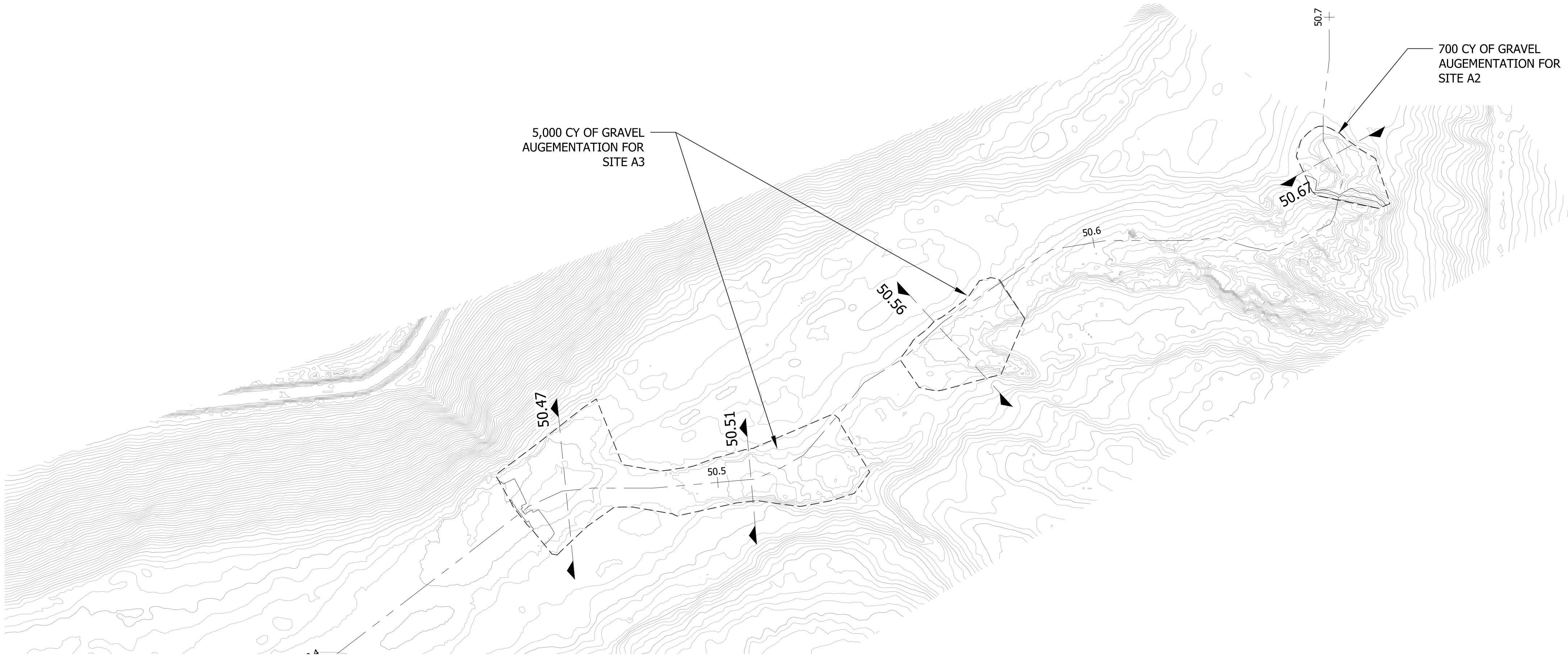

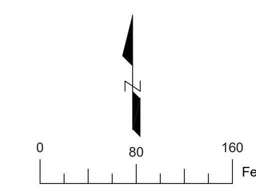

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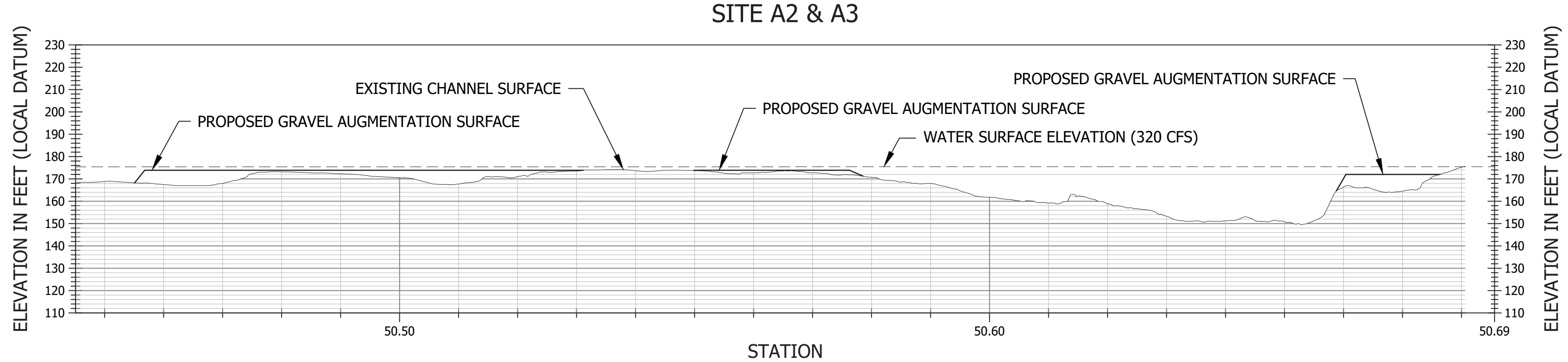

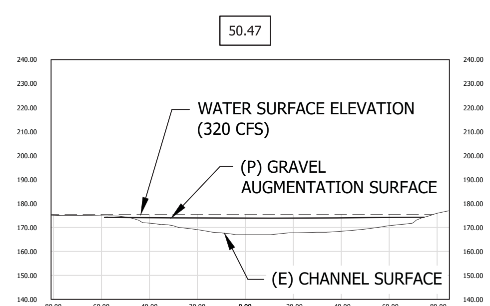

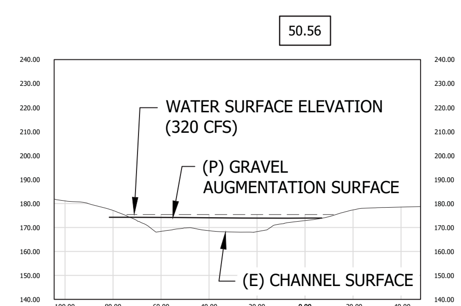

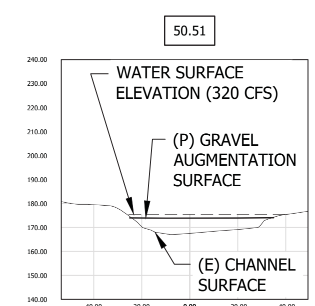

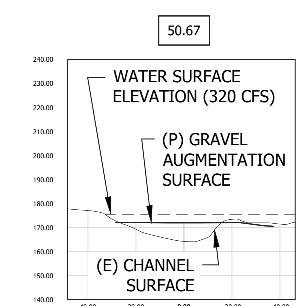

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