Appendix D

Investigation and Analysis Report

Prepared For:

United States Department of Agriculture
Natural Resources Conservation Service

Warner Draw Watershed and Flood Operations Project

Warner Draw Watershed Washington County, Utah

Appendix D

Investigation and Analysis Report

Final

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1.0 Introduction

The purpose of this Investigation and Analysis (I&A) Report is to present information that supports the formulation, evaluation, and conclusions of the Supplemental Watershed Plan No. 8 and Environmental Assessment (Plan-EA) for the Warner Draw Watershed (the project). The report is required and must be included as an appendix to the Plan-EA.

The procedures, techniques, assumptions, scope, and intensity of the investigations for each subject are described in sufficient detail so that a reader not familiar with the project areas or their issues can form an opinion on the adequacy of the Plan-EA. This report supplements information contained in the Plan-EA and is not intended to replace or duplicate information contained therein.

The planning studies presented in this I&A Report are based on standard methods and procedures used and approved for use by the United States Department of Agriculture Natural Resources Conservation Service (NRCS). The following information summarizes the investigation and analysis for the key planning studies conducted in the preparation of the Plan-EA. Additional information relevant to each section provided in this report is available upon request as part of the administrative record for the project. Requests for additional information can be submitted to the following address:

USDA-NRCS
Wallace F. Bennett Federal Building
125 S State St., Room 4010
Salt Lake City, UT 84138-1100

1.1 Project Location

The Warner Draw Watershed (Watershed) includes approximately 298 square miles located within Washington County, Utah, and drains to the Virgin River. This Plan-EA includes five individual project sites for proposed improvement within the Watershed, as noted in Table 1-1 (see Figure 1-1).

Table 1-1. Project List and Location

Feature	Description (Latitude / Longitude [WGS84])	City
Site 1 (Main Street Debris Basins)	37.146280°/ -113.506273°	Washington City
Site 2 (Seegmiller Marsh)	37.093151° / -113.534903°	St. George City
Site 3 (Y-Drain)	37.097142° / -113.521195°	Washington City
Site 4 (Warner Valley Disposal System)	37.163421° / -113.300941°	St. George City
Site 5 (Hurricane Water Efficiency)	37.061653° / -113.518921°	Hurricane City

Detailed descriptions of each project site as well as the procedures, techniques, and assumptions of analysis completed are provided in the following sections.

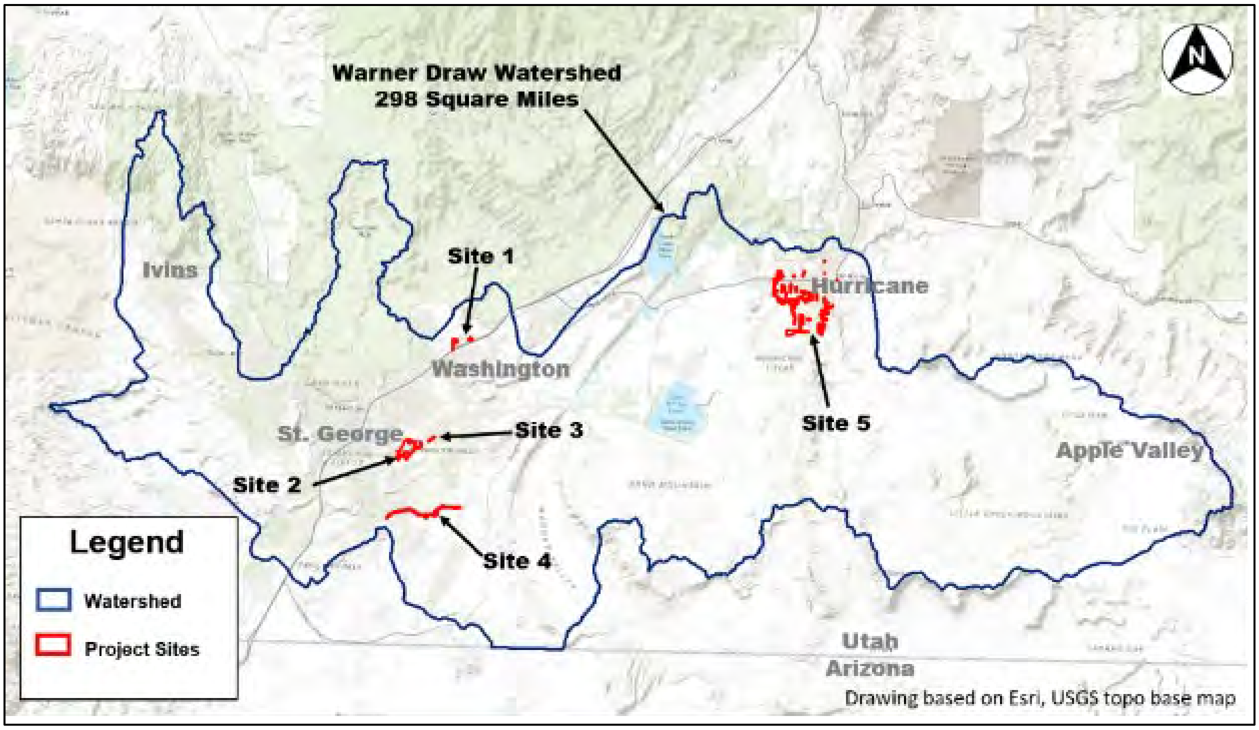

Figure 1-1. Warner Draw Watershed and Project Sites

2.0 Site 1 Main Street Debris Basins

2.1 Project Location and Existing Conditions

Main Street is a minor arterial road that passes under Interstate 15 (I-15) and connects the downtown area of Washington City with the northern part of the city. There is a large tributary drainage area that drains to the Main Street/I-15 overpass, as shown in Figure 2-1.

The Main Street drainage basin is approximately 844 acres (1.3 square miles) in area and contains portions of undeveloped desert landscape, rock outcrops, and residential development. Drainage from this area follows three main flow paths from the foothills north of I-15 (Brio Drainage, Main Street Drainage, and Buena Vista Drainage): south through the Brio Development, south along Main Street, and southwest along Buena Vista Boulevard, where large flood events continue south along Main Street and under I-15 (Figure 2-1). Significant flooding has occurred in Washington City below the Main Street drainage basin, necessitating development of a project to reduce and mitigate damaging flood flows.

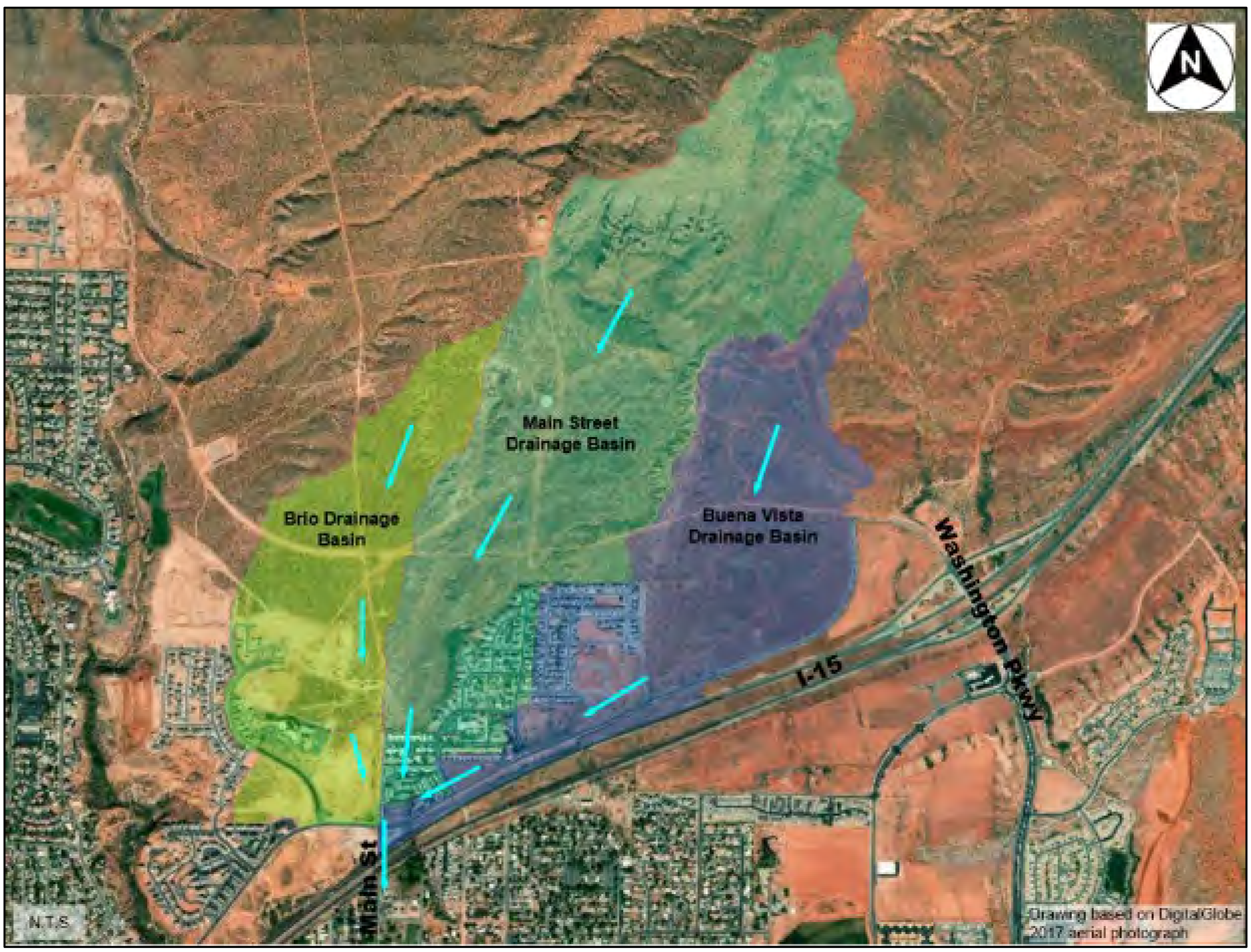

Figure 2-1. Main Street Debris Basin, Three Drainage Paths

A technical analysis was completed for the Main Street Debris Basin site by Bowen Collins & Associates (BC&A) and documented in a Technical Memorandum (TM)-01 (BC&A 2019a). The following paragraphs summarize the findings from TM-01.

2.2 Hydrologic and Hydraulic Analyses

This section summarizes the hydrologic and hydraulic analyses conducted for the Main Street Debris Basin project site.

2.2.1 Hydrologic Analysis

A hydrologic analysis was completed by BC&A. The three major drainage basins were further divided into 13 subbasins (Figure 2-2). The hydrologic parameters are provided in Table 2-1.

Table 2-1. Summary of Subbasin Hydrologic Parameters

Basin ID	Drainage Area		Composite Curve Number	Time of Concentration (Tc) or Lag Time Calculation Method	Time of Conc. (Tc)		Lag Time	
	Acre	Sq. mi.			Hrs	Min	Hrs	Min
Brio D	48	0.075	82.2	TR-55 Method	0.21	12	0.12	7
Brio E	135	0.210	74.8	SCS Lag Method	0.85	51	0.51	30
Center	376	0.587	87.2	SCS Lag Method	0.59	35	0.35	21
East 1A	26	0.040	89.2	SCS Lag Method	0.39	23	0.23	14
East 1B	10	0.016	88.7	SCS Lag Method	0.17	10	0.10	6
East 1C	67	0.104	88.5	SCS Lag Method	0.50	30	0.30	18
East 2	9	0.013	88.6	SCS Lag Method	0.23	14	0.14	8
East 3	100	0.157	90.0	SCS Lag Method	0.42	25	0.25	15
GraceVillas	3	0.005	92.0	TR-55 Method	0.13	8	0.08	5
NewWarmSprings5	27	0.041	92.0	TR-55 Method	0.19	11	0.11	7
NewWarmSprings6	16	0.025	92.0	TR-55 Method	0.15	9	0.09	5
WarmSpringsA	17	0.026	89.6	TR-55 Method	0.19	11	0.11	7
WarmSpringsB	23	0.036	92.0	TR-55 Method	0.16	10	0.10	6

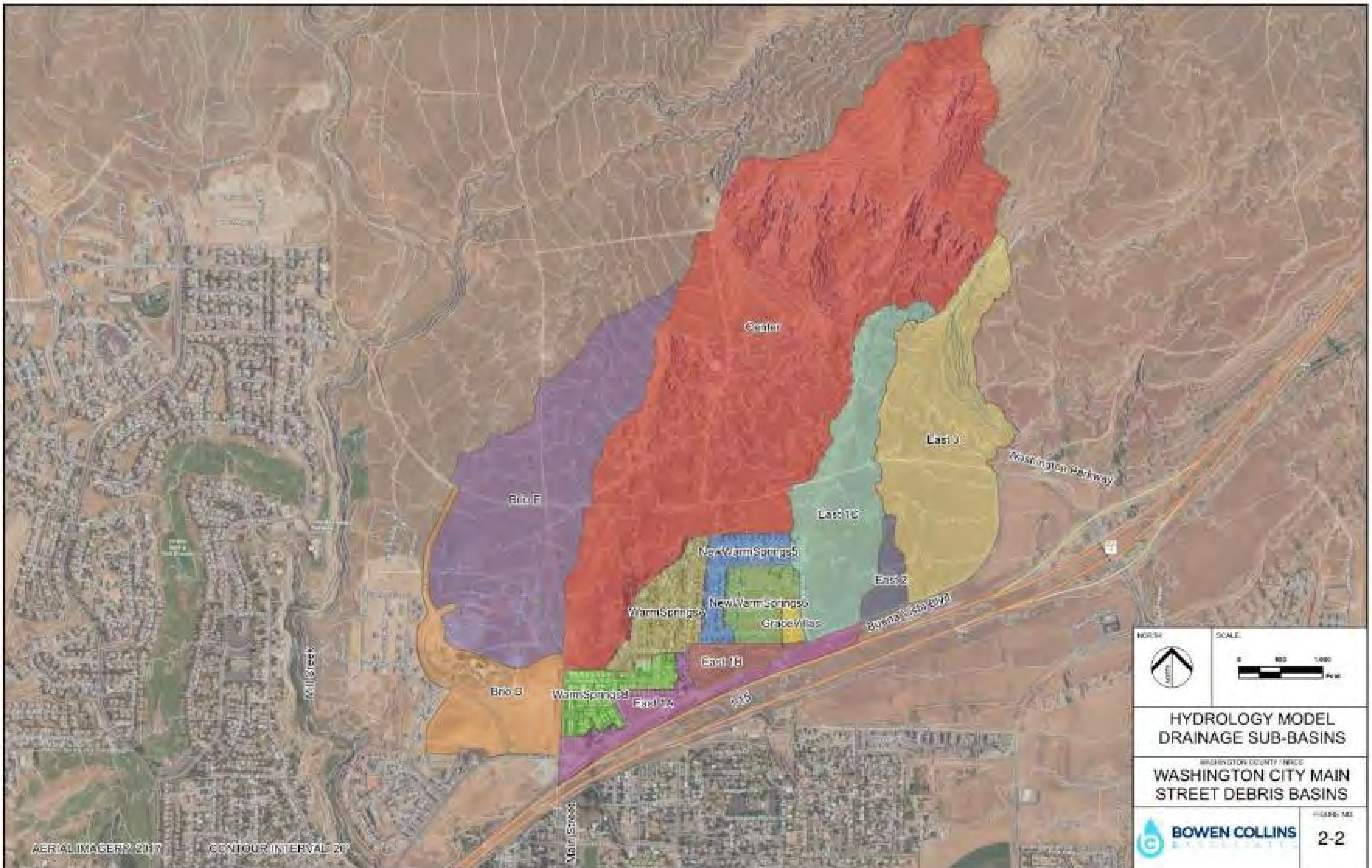

Figure 2-2. Hydrology Model Main Street Subbasins

Three temporal rainfall distributions were considered for the study: the 3-hour Farmer-Fletcher, 24-hour SCS type II, and 24-hour WinTR-20 storms. Among the three distributions, the WinTR-20 distribution typically produced the largest peak runoffs and was therefore selected for use as part of the design. The peak flows for various return periods for each modeled subbasin are summarized in Table 2-2.

Table 2-2. Existing Conditions Model Peak Discharge Summary

Sub-basin ID	Area (Ac)	CN	Lag Time (min)	Peak Discharge (cfs)							
				Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q500
Brio D	48	82.2	7	10	23	35	56	75	98	125	168
Brio E	135	74.8	30	2	9	17	34	50	71	95	135
Center	376	87.2	21	92	164	231	341	440	556	688	891
East 1A	26	89.2	14	10	17	24	34	43	54	66	84
East 1B	10	88.7	6	6	10	13	19	25	31	38	49
East 1C	67	88.5	18	21	36	50	73	93	116	143	184
East 2	8	88.6	8	4	7	10	14	18	23	28	36
East 3	100	90.0	15	42	69	94	133	169	209	256	327
GraceVillas	3	92.0	5	3	4	5	7	9	11	14	17
NewWarmSprings5	27	92.0	7	20	32	42	58	72	88	107	136
NewWarmSprings6	16	92.0	5	14	22	29	40	50	61	74	93
WarmSpringsA	17	89.6	7	10	16	22	32	40	50	61	78
WarmSpringsB	23	92.0	6	19	29	38	53	66	82	99	125

cfs = cubic feet per second

2.2.2 Existing Hydraulic Analysis

Stormwater in this area is collected and conveyed to the west to discharge into Mill Creek, which is a tributary of the Virgin River. The existing storm drain system was designed for a 10-year recurrence event, and during larger events, stormwater overwhelms the storm drain system and generally flows to the south and southwest, as shown on Figure 2-3.

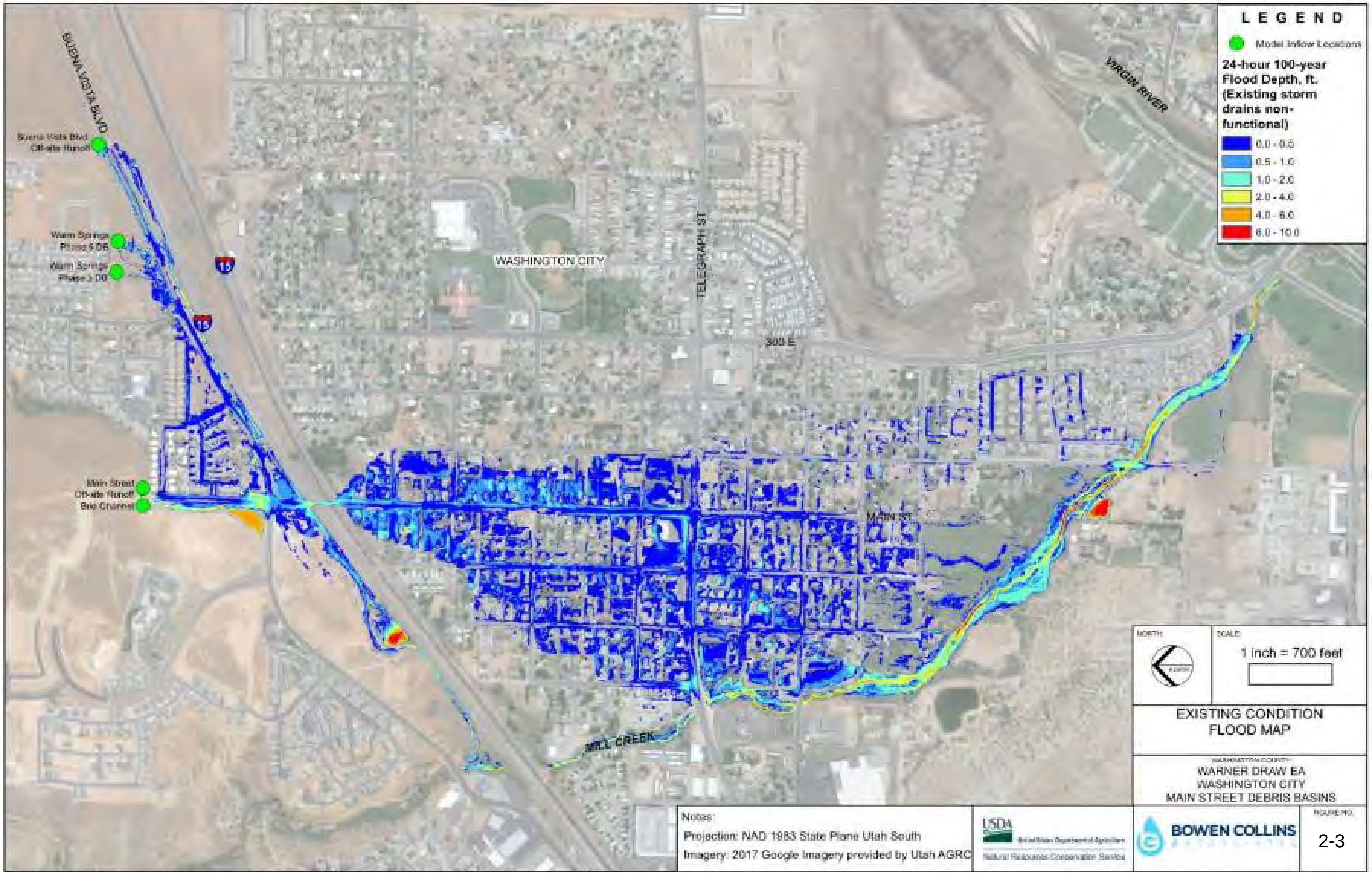

Figure 2-3. Existing Condition Flood Map

2.3 Alternative Evaluation

The process of formulating alternatives for mitigating flooding in the Main Street area followed procedures outlined in the National Watershed Program Manual (NWPM) (NRCS 2015a); National Watershed Program Handbook (NWPH) (NRCS 2014); Economic and Environmental Principles and Guidelines for Water Related Land Resources Implementation Studies (P&G) (U.S. Water Resources Council [USWRC] 1983); and other NRCS watershed planning policy.

The following alternatives were evaluated to help mitigate flooding:

1. Debris Basins Alternative (Alternative 1) – Construct new debris basins adjacent to Main Street and near the intersection of Tortoise Rock Drive and Buena Vista Boulevard to detain expected flood flows to a point where they can be conveyed by the existing storm drain facilities.
2. Mill Creek Flood Channel Alternative (Alternative 2) – Construct a new flood channel that collects all the stormwater runoff from the intersection of Main Street and Buena Vista Boulevard and convey it to the Mill Creek channel.
3. No Action Alternative – Most likely future condition if none of the federally-assisted action alternatives are selected.

The Debris Basins Alternative was chosen as the preferred alternative for the project. Concept Design Drawings for this alternative are included in Attachment 1.

2.3.1 Debris Basins Alternative (Alternative 1)

Alternative 1 includes construction of debris basins on the drainages upstream of Main Street and at the intersection of Buena Vista Boulevard and Tortoise Rock Drive, as shown on Figure 2-4. The purpose of these debris basins is to detain and attenuate expected flood flows and mitigate debris to a point where flows can be conveyed by the existing storm drain facilities, eliminating downstream flooding during the 100-year design event. The inundation area downstream of the proposed debris basins is shown in Figure 2-5.

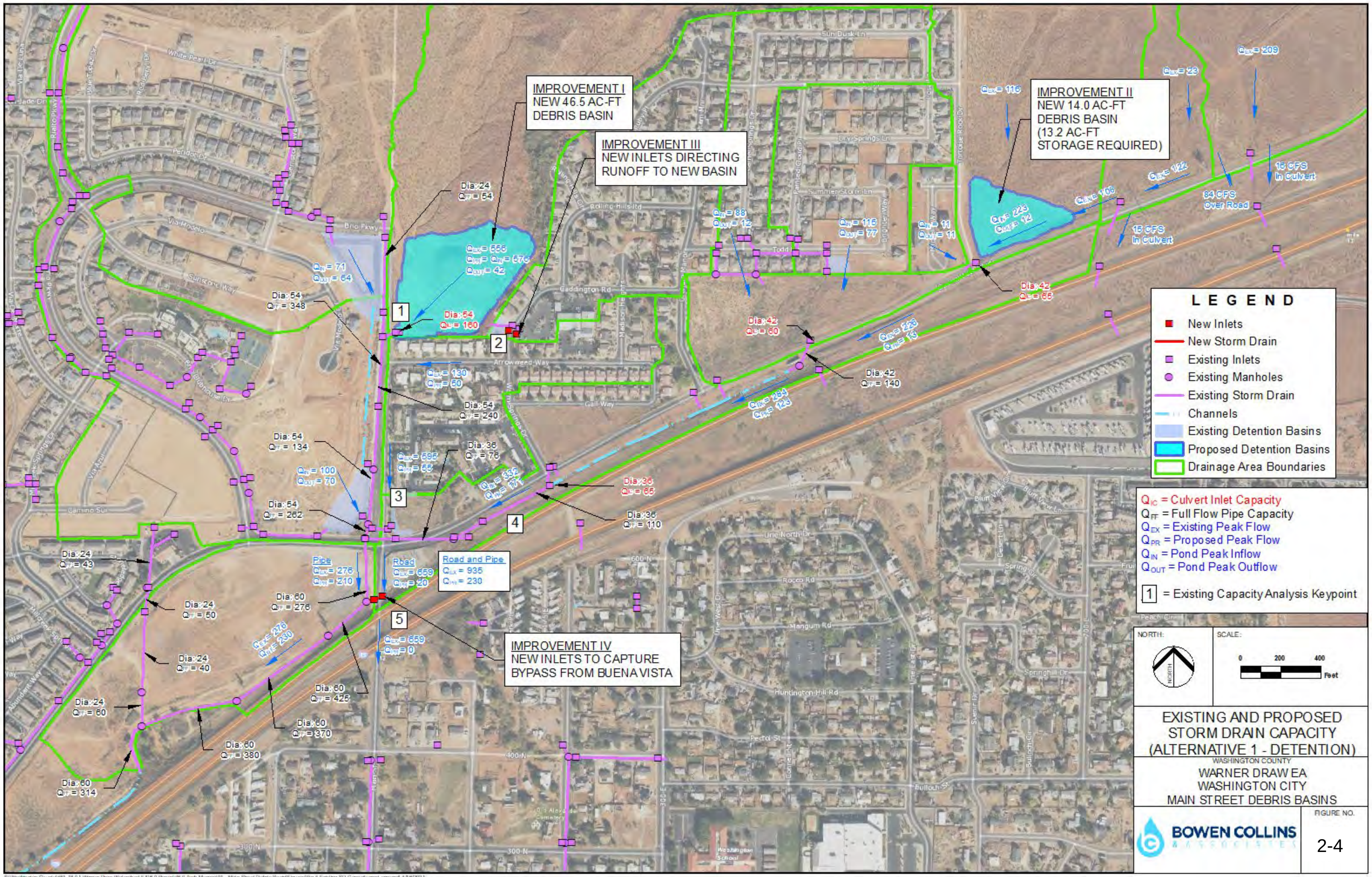

Figure 2-4. Existing and Proposed Storm Drain Capacity (Alternative 1)

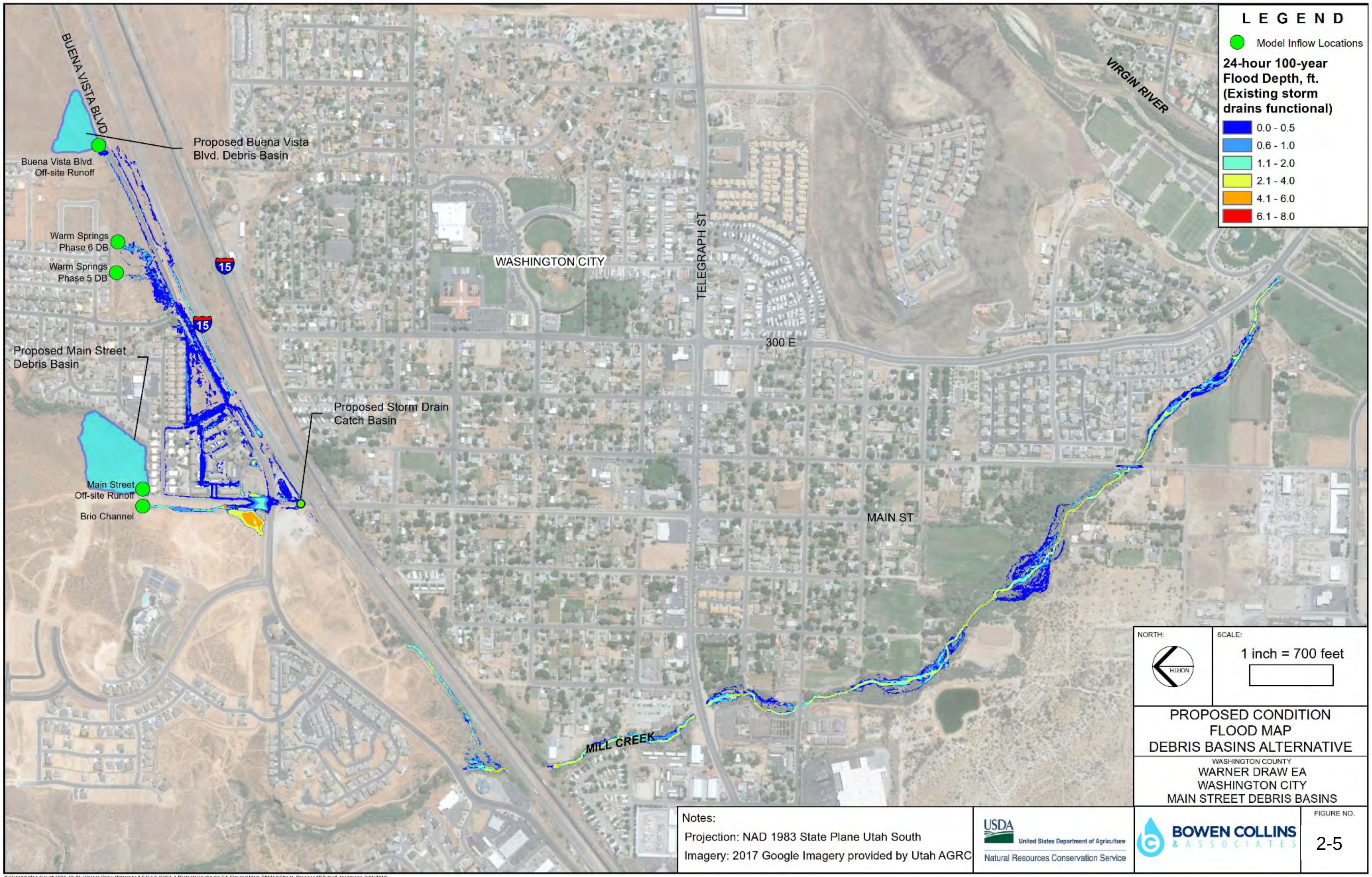

Figure 2-5. Proposed 100-Year Flood Extents (Alternative 1)

The recommended improvements associated with Alternative 1 are summarized in Table 2-3.

Table 2-3. Summary of Proposed Mitigation Measures – Alternative 1

No.	Description of Improvement	Result
I	Construct a 46.5 acre-foot (ac-ft) debris basin (Main Street Debris Basin) upstream of the 54-inch-diameter culvert, immediately east of Main Street and north of the Warm Springs Subdivision.	Reduce the combined “WarmSpringsA” and “Center” subbasin peak runoff from 576 cubic feet per second (cfs) to 42 cfs.
II	Construct a new 14.0 ac-ft debris basin (Buena Vista Debris Basin) at the intersection of Buena Vista Blvd and Tortoise Rock Drive. Storage capacity of this basin is 14.0 ac-ft, however, 13.2 ac-ft are required for the combined 100-year flood (7.8 ac-ft) and 50-year sediment (5.4 ac-ft) storage volumes.	Reduce the peak runoff from Buena Vista Blvd to Main Street from 332 cfs to 171 cfs.
III	Construct additional street catch basins upstream of the intersection of Arrowweed Way and Caddington Road to capture and direct runoff from the “Warm Springs B” subbasin through the new Main Street Debris Basin.	Reduce peak runoff from Warm Springs to Main Street from 130 cfs to 50 cfs.
IV	Construct a new catch basin on the east side of Main Street and replace the existing blocked catch basin on the west side of Main Street just upstream of the I-15 overpass.	Capture remaining bypass runoff from Buena Vista Blvd before it flows under I-15 to the south.

In addition to the overall reduction of peak runoff and elimination of runoff bypass to Main Street south of I-15, the proposed debris basins provide the following benefits:

- Reduces overall flooding on road surfaces north of I-15.
- Holding and controlling the release of runoff within the basins allows suspended sediment and debris to settle out in the basin.
- Sediment is accumulated in a centralized location, significantly reducing cleanup costs after a flood event.
- Provides the best overall protection to Main Street from flooding originating north of I-15.

2.3.1.1 Debris Basin Design Criteria

Based on the dam breach analysis, the breach inundation area for the Main Street Debris Basin is predominantly limited to the surface streets and estimated breach depths are less than 6-inches. The majority of the active storage is below adjacent native ground elevation. The structure would be classified as a low-hazard potential dam meeting the NRCS pond standard. Per Utah State Code 73-5a-106 and R655-10-5A the structure would be considered low-hazard dam. The Buena Vista Debris Basin would also be classified as a low-hazard potential dam meeting the NRCS pond standard; however, it would not be considered a dam per Utah State Code because the entire storage volume is below the adjacent native ground elevation. The two proposed debris basins are both excavated basins. The Main Street Debris Basin has a small embankment, and the Buena Vista Debris Basin does not have an embankment and will not impound water above the natural ground. A summary of various properties of the proposed basins design is provided in Table 2-4.

Table 2-4. Summary of Debris Basin Design

Parameter	Main Street Debris Basin Value	Buena Vista Debris Basin Value
Active Storage Volume (Ac-ft)[1]	46.5	14
Storage Below Native Ground Elevation	27.2	14
Storage Above Native Ground Elevation	19.3	0
Sediment Storage Volume (Ac-ft)[2]	12.3	5.4
Q_{100} Storage Volume (Ac-ft)[3]	46.5	13.2
Tributary Drainage Area (Ac)	393	134
Grading Area (Ac)	5.3	2.7
Overall Height (ft)[4]	8.2	0
Effective Height (ft)[5]	5.2 *(<35')*	0
Crest Width (ft)	12	NA
Upstream Slope	3H:1V	3H:1V
Effective Height x Storage	241.3 *(<3,000)*	0 *(<3,000)*

Notes:
1. Active Volume is the volume from the auxiliary spillway crest to the invert of the outlet pipe (principal spillway).
2. Sediment storage volume is the capacity for sediment from the bottom of the basin to the invert of outlet #2.
3. Storage volume required to attenuate the 100-year flood event assuming a 50-year sediment volume.
4. Overall Height is the difference in elevation between the top of the dam and the lowest elevation at the downstream toe.
5. Effective Height is the difference in elevation between the lowest open channel auxiliary spillway crest and the lowest point in the original cross-section on the centerline of the dam.
6. Below ground storage is calculated assuming no sediment accumulation. Above ground storage volumes are independent of sediment accumulation.

As shown in Table 2-4, the proposed Buena Vista Debris Basin is below grade and has no overall or effective height. The Main Street Debris Basin has a small embankment, but the effective height is less than 35 feet and the effective height times storage volume is less the 3,000. Based on the NRCS classification criteria referenced above, the two debris basins would be classified as low-hazard potential dams meeting the pond standard and shall be designed in accordance with NRCS Practice Standard 378 – Ponds (Practice Standard 378).

2.3.1.2 Principal Spillway Evaluation

Practice Standard 378 does not provide a specific design capacity requirement for the principal spillway of a pond constructed per the standard. Because these ponds will be utilized for flood detention, the Washington City design standards were used to determine the design event for principal spillway hydrograph routing. Section 13.3.2 of the Washington City Grading Manual (Alliance Consulting 2006) states: "*All detention facilities are to be designed for the 10- and 100-year recurrence interval flood.*" Section 13.4.3 states "The minimum required freeboard for open space detention facilities is 1.0 feet above the computed 100-year water surface elevation." Based on these criteria, the principal spillway outlet structures for both the Main Street and Buena Vista debris basins were sized to route all flood events less than or equal to the 100-year, 24-hour flood event while providing 1.0 foot of freeboard .

Section 3.4.2 of the Washington City Grading Manual specifies that the 100-year, 3-hour rainfall should be used for major system design of residential, commercial, and industrial land use. The 100-year, 3-hour rainfall distribution was considered and analyzed for sizing the principal spillway of both debris basins, however, the 100-yr, 24-hr distribution resulted in higher runoff volumes and more conservative requirements for basin storage and principal spillway design, therefore, the 100-yr, 24-hr distribution was used as the basis for design.

The principal spillway structures will be constructed as upright, concrete riser structures with staged orifice outlets. The first outlet is sized to convey frequent, low intensity storm events. The second outlet is designed to convey less-frequent, higher intensity events. The invert elevation of the second outlet is elevated to the anticipated 50-year sediment pool elevation. Each pond will route the design event through the principal spillway with or without the presence of the anticipated sediment storage volume within the pond. The top of the principal spillway structure will include a grated opening. This opening will be elevated above the design event water surface elevation to act as an anti-vortex measure. Design criteria for the principal spillways are provided in Table 2-5.

Table 2-5. Principal Spillway Design Criteria

Parameter	Main Street Debris Basin	Buena Vista Debris Basin
Design Event	100-year, 24-hr	100-yr, 24-hr
Outlet #1 size	10" Square	6" Square
Outlet #1 elevation	2,891.00	2,984.00
Outlet #2 size	19" Square	15.5" Square
Outlet #2 elevation	2,897.10	2,989.15
Peak Inflow (cfs)	576	223
Peak Discharge, sediment pool empty (cfs)	42	12
Peak Water surface elevation, sediment pool empty	2903.70	2,990.90
Peak Discharge, sediment pool full (cfs)	38	16
Peak Water surface elevation, sediment pool full	2,907.00	2,993.60

2.3.1.3 Auxiliary Spillway Evaluation

Practice Standard 378 requires that *"the minimum capacity of a natural or constructed auxiliary spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 2, less any reduction creditable to conduit discharge and detention storage."* Table 2 of

Practice Standard 378 is provided as Figure 2-6 for reference. Based on the debris basin design criteria listed in Table 2-4, the required design event for the auxiliary spillways is the 25-year, 24-hour storm.

Table 2. Minimum auxiliary spillway capacity

			Minimum design storm[2]	
Drainage area (Ac.)	Effective height of dam[1] (Ft.)	Storage (Ac-Ft)	Frequency (Years)	Minimum duration (Hours)
20 or less	20 or less	< than 50	10	24
20 or less	> than 20	< than 50	25	24
> than 20		< than 50	25	24
All others			50	24

1. As defined under "Conditions where Practice Applies".
2. Select rain distribution based on climatological region.

Figure 2-6. NRCS Practice Standard 378 – Ponds, Table 2

Based on the criteria for auxiliary spillways from Practice Standard 378 – Ponds, *"An auxiliary spillway must be provided for each dam, unless the principal spillway is large enough to pass the peak discharge from the routed design hydrograph and the trash that comes to it without overtopping the dam."*

Both the Main Street and Buena Vista debris basins have been designed so that the 100-year, 24-hour hydrograph is contained within the basin, assuming that the basin has accumulated 50 years of sediment. Though not needed per Practice Standard 378, an auxiliary spillway has been provided at both debris basins to meet the design criteria listed in Table 2-6.

Table 2-6. Auxiliary Spillway Design Criteria

Parameter	Main Street Debris Basin	Buena Vista Debris Basin
25-year, 24-hour Peak Inflow (cfs)	354	98
Spillway Crest Elevation	2907.0	2994.0
Width (ft)	30	30
Depth (ft)	3	3
Side Slope (H:V)	3:1	3:1
Slope (ft/ft)	0.067	0.048
Peak Weir Flow (cfs) [1,4]	488	488
Open Channel Lining	Riprap ('n' = 0.045)	Riprap ('n' = 0.045)
Open Channel Flow Depth (ft)[2]	1.43	1.58
Open Channel Velocity (fps) [3]	10.0	8.92

Parameter	Main Street Debris Basin	Buena Vista Debris Basin
Aux. Spillway Freeboard (ft)	1.57	1.42

Notes:

1. Peak weir flow assumes no freeboard between the design water surface elevation and the pond crest. Also, weir flow was calculated based upon a Cipolletti Weir with 4:1 side slopes. The peak flow was then reduced by 93% to account for the reduced area associated with the actual side slopes of 3:1.
2. Open channel flow depths calculated in the channel based on peak weir flow through the auxiliary spillway.
3. Auxiliary spillway channel will be lined with riprap adequately sized to protect the channel against erosion.
4. The auxiliary spillway for the Buena Visit DB is oversized for the design flood event used, in flood events greater than the 100-yr, 24-hr design event, the auxiliary spillway discharges to the same roadway and drainage system as the existing drainage condition. Therefore, for events larger than the design event, the risk of downstream flooding is not greater in the proposed condition than in the existing condition.

As shown on Table 2-6, the auxiliary spillways for both the Main Street and Buena Vista debris basins have more than adequate capacity to pass the design event, less any reduction creditable to conduit discharge and detention storage, per Practice Standard 378. In addition, the elevation of each auxiliary spillway crest is equal to or above the peak 100-year, 24-hour water surface elevations shown in Table 2-4.

2.3.1.4 Sedimentation

Practice Code 378 does not provide specific criteria for sedimentation design for a pond, but notes that *"The drainage area above the pond must be protected against erosion to the extent that expected sedimentation will not shorten the planned effective life of the structure."* The National Engineering Handbook (NEH) Section 3 Sedimentation notes: *"The design life of a reservoir is the period required for the reservoir to fulfill its intended purpose. Structures designed by the SCS in the watershed protection and flood prevention programs usually are designed for a life of 50 or 100 years. Provision must be made to ensure the full design storage capacity for the planned design life. This may mean cleaning out deposited sediment at predetermined intervals during the design life or, as is generally the situation, providing enough capacity to store all the accumulated sediment for the reservoir's design life without diminishing the design water storage."* The design sedimentation rate to be used for the proposed debris basins was calculated based upon the following assumptions:

- The unit weight of sediment for the debris basin watershed was estimated to be 85 lbs/ft^3 based on Table 8-1 from the NEH Section 3 – Sedimentation manual for aerated or submerged sand mixture.
- Trap efficiency was estimated based on basin and watershed characteristics and according to Figure 8-2 of NEH Section 3 – Sedimentation. The estimated trap efficiency for the Main Street and Buena Vista debris basins is 96% and 93%, respectively.
- Three methods for calculating sedimentation yield rates were evaluated. These include the U.S. Department of Agriculture mapped sedimentation rates for the State of Utah; Rangeland Hydrology and Erosion model Web Tool; and comparison to other previously published estimates. The design sediment yield for the two debris basins was estimated to be 0.44 ac-ft per square-mile per year.

The sediment storage volumes for the 50- and 100-year events were further evaluated based upon the estimated trap efficiencies calculated above (i.e., sediment volume x trap efficiency). The design sedimentation volumes for the Main Street and Buena Vista debris basins are as follows:

Main Street Debris Basin 50-year Volume	12.3 ac-ft
Main Street Debris Basin 100-year Volume	24.7 ac-ft
Buena Vista Debris Basin 50-year Volume	5.4 ac-ft
Buena Vista Debris Basin 100-year Volume	10.9 ac-ft

2.3.1.5 Estimated Construction Cost – Alternative 1

The combined estimated construction cost for Alternative 1 – Debris Basins Alternative is approximately $2,659,000 as shown in Tables 2-7 and 2-8. Operation and maintenance (O&M) would consist of pipeline cleaning performed every 5 years at a cost of $40,000 per cleaning and weed control at a cost of approximately $6,000 annually. O&M cost over the 50-year project life would be approximately $700,000.

Table 2-7. Alternative 1 Estimated Construction Cost – Main Street Debris Basin

No.	Item	Quantity	Units	Unit Cost	Cost
1	Mobilization/Demobilization	1	LS	$123,100	$123,100
2	Traffic Control	1	LS	$12,000	$12,000
3	Survey	1	LS	$20,000	$20,000
4	Stormwater Pollution Prevention Plan (SWPPP)	1	LS	$60,000	$60,000
5	Clear and Grub	7	AC	$600	$4,200
6	Excavation and Haul Off	132,850	CY	$7	$929,950
7	Embankment Construction	1,460	CY	$14	$20,440
8	Emergency Spillway	1	LS	$46,700	$46,700
9	Outlet Structure	1	LS	$45,000	$45,000
10	Inlet Channel Erosion Protection	1	LS	$34,250	$34,250
11	Restoration/Reseeding	7	AC	$950	$6,650
12	42-inch reinforced concrete pipe (RCP) Storm Drain	250	LF	$185	$46,250
13	6-ft Diameter Storm Drain Manhole	1	EA	$5,500	$5,500
14	Double Catch Basin	4	EA	$8,500	$34,000
15	24-inch RCP Storm Drain	210	LF	$165	$34,650
				Subtotal[1]	**$1,423,000**
				Contingency (30%)[1]	**$427,000**
				Total[1]	**$1,850,000**

1 - Costs have been rounded to the nearest thousand dollars.

Table 2-8. Alternative 1 Estimated Construction Cost – Buena Vista Debris Basin

No.	Item	Quantity	Units	Unit Cost	Cost
1	Mobilization/Demobilization	1	LS	$56,500	$56,500
2	Traffic Control	1	LS	$15,000	$15,000
3	Survey	1	LS	$20,000	$20,000
4	SWPPP	1	LS	$45,000	$45,000
5	Clear and Grub	4.00	AC	$600	$2,400
6	Excavation and Haul Off	47,160	CY	$7.00	$330,120
7	Embankment Construction	160	CY	$14.00	$2,240
8	Emergency Spillway	1	LS	$10,375	$10,375
9	Outlet Structure	1	LS	$40,000	$40,000
10	Inlet Channel Erosion Protection	1	LS	$25,950.00	$25,950
11	Restoration/Reseeding	4.00	AC	$950.00	$3,800
12	36-inch RCP Storm Drain	280	LF	$165.00	$46,200
13	Remove and Dispose of 42-inch Storm Drain	150	LF	$50.00	$7,500
14	6-ft Diameter Storm Drain Manhole	3	EA	$5,500.00	$16,500
				Subtotal[1]	**$622,000**
				Contingency (30%)[1]	**$187,000**
				Total[1]	**$809,000**

1 - Costs have been rounded to the nearest thousand dollars.

2.3.2 Mill Creek Flood Channel (Alternative 2)

As shown in the existing condition hydrologic analysis, the intersection of Main Street and Buena Vista Boulevard is the concentration point of the Main Street drainage basin. As water collects at this intersection, it currently flows to the south along Main Street and floods residential properties and businesses. The purpose of the Mill Creek flood channel would be to collect all of the flood water that cannot be conveyed in the existing storm drain system north of I-15 and convey it to where it can be discharged into Mill Creek just north of I-15 as shown on Figure 2-7 and Figure 2-8.

It is recommended that major drainage facilities be designed for the 100-year event. Based on the hydrologic analysis completed previously, the governing or most conservative design event would be the 100-year, 24-hour design event of 935 cfs. It was also assumed that the storm drain facilities in and around Main Street and Buena Vista Boulevard were plugged and non-operational due to upstream debris and sediment flows. To mitigate the expected flooding before it flows down Main Street, the following recommendations would need to be implemented:

1. A new approximately 1,900-foot-long flood channel would need to be constructed from the Main Street and Buena Vista Boulevard intersection to Mill Creek, as shown on Figure 2-6. It should be noted that the new channel connects to an existing channel that continues another approximately 1,200 feet to Mill Creek.
2. The intersection of Main Street and Buena Vista Boulevard would need to be re-graded and lowered to direct runoff to the west before it flows south under I-15.
3. A flood-activated diversion/deflector would need to be permanently installed just south of the intersection or temporary barriers would need to be stored along the road that could quickly be placed in Main Street to divert any flood water in Main Street to the new flood channel.

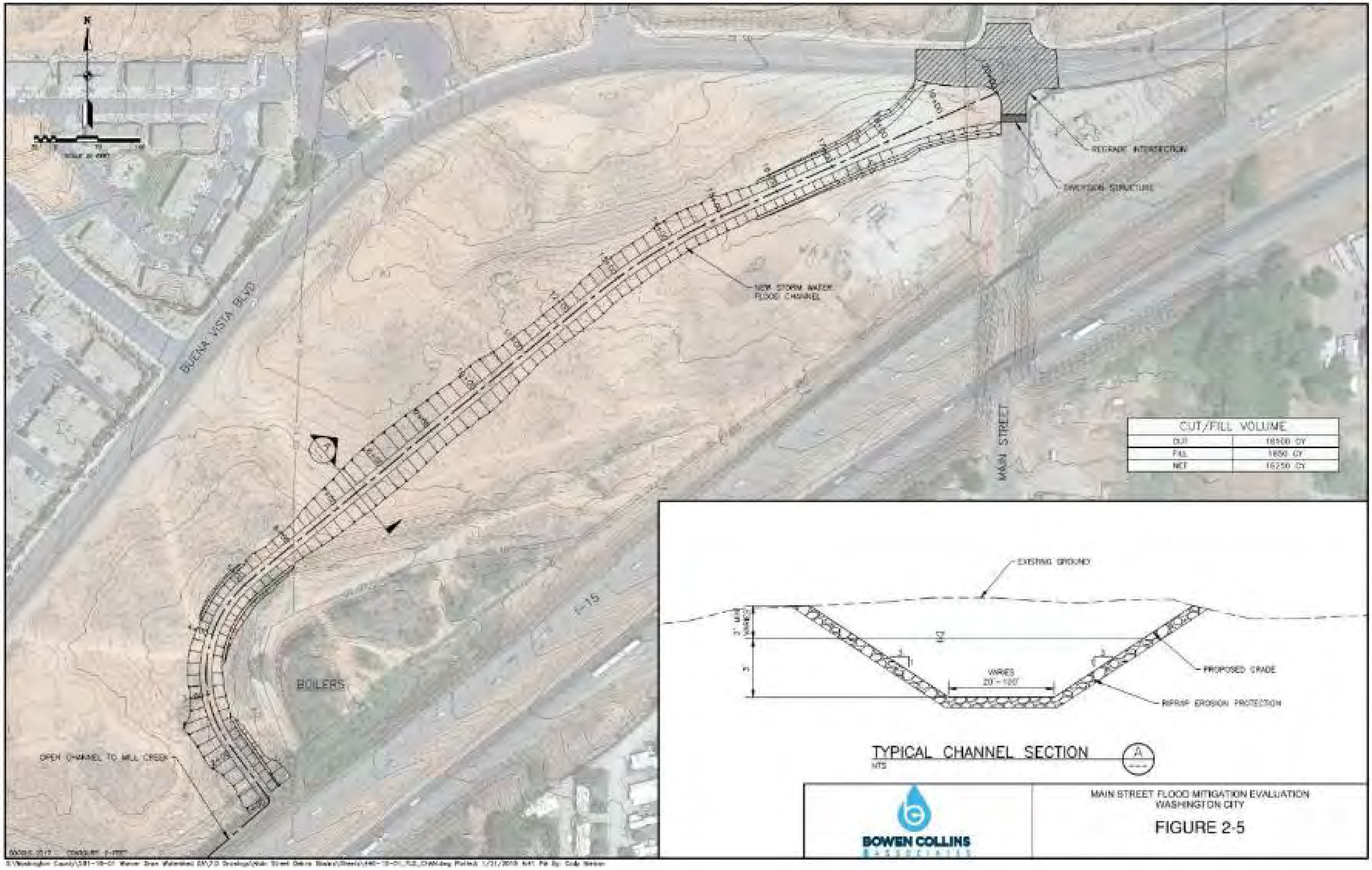

Figure 2-7. Mill Creek Flood Channel (Alternative 2)

Figure 2-8. Alternative 2 Mill Creek Flood Channel Flood Map

2.3.2.1 Mill Creek Flood Channel Advantages and Disadvantages

The advantages of Alternative 2 include the following:

- The project is located entirely on property owned by Washington City, so no easements or property would need to be purchased for the project.
- Floodwaters could be safely routed to the Mill Creek channel, which has capacity to safely convey the flood through the city.

The disadvantages of this Alternative 2 include the following:

- The re-grading of the Main Street and Buena Vista Boulevard intersection could cause additional sags and crests in the road.
- Road re-grading or diversion structure installation will impact existing utilities under Main Street and Buena Vista Boulevard.
- The diversion/deflector or temporary barrier wall could be a safety hazard for drivers in the area when activated or placed in the roadway.
- The diversion/deflector or temporary barrier wall would be a long-term maintenance issue for the City.
- The potential flood flows across Main Street and Buena Vista Boulevard would be a potential hazard to vehicles trying to cross during flooding.
- The flood channel would need to be routed through the middle of the existing City parcel to ensure a proper grade on the channel, decreasing the value of the property.
- Flood flows/volumes are not reduced, they are only routed another direction.

2.3.2.2 Estimated Construction Cost – Alternative 2

The estimated construction cost for Alternative 2 is approximately $3,068,000 (Table 2-9).

Table 2-9. Alternative 2 Estimated Construction Cost – Mill Creek Flood Channel

No.	Item	Quantity	Units	Unit Cost	Cost
1	Mobilization/Demobilization	1	LS	$214,500	$214,500
2	Traffic Control	1	LS	$15,000	$15,000
3	Survey	1	LS	$20,000	$20,000
4	SWPPP	1	LS	$45,000	$45,000
5	Clear and Grub	2.00	AC	$600	$1,200
6	Excavation and Haul Off	18,100	CY	$8.00	$144,800
7	Backfill	2,040	CY	$15.00	$30,600
8	Riprap Erosion Protection	26,190	CY	$50.00	$1,309,500
9	Geotextile Fabric	19,640	SY	$3.00	$58,920
10	Restoration/Reseeding	2	AC	$950.00	$1,900
11	Diversion Structure/Regrading Intersection	1	LS	$250,000.00	$250,000
12	10" Water Utility Relocation	630	LF	$90.00	$56,700
13	16" Water Utility Relocation	680	LF	$120.00	$81,600
14	Power and Gas Utility Relocation	1	LF	$130,000.00	$130,000
				Subtotal[1]	**$2,360,000**
				Contingency (30%)[1]	**$708,000**
				Total[1]	**$3,068,000**

1 - Costs have been rounded to the nearest thousand dollars.

2.3.3 No Action Alternative

The No Action Alternative, also known as the Future-Without-Project Plan, projects the changes in resource concerns from the current condition to the condition that would exist in the future if no NRCS action were taken (NRCS 2015a). The No Action Alternative for this site would take one of the following courses:

- The Sponsoring Local Organization (SLO) decides to construct similar flood control projects without meeting NRCS standards, which may be more or less stringent.
- The SLO chooses to leave the Main Street basin "as-is" with no future improvements.

The Sponsor's most likely course for the No Action Alternative would be to leave the drainage basins "as-is" with no improvements. O&M activities would be required to maintain the existing basins over the 50-year project life. This would consist of storm drain maintenance and removal of sediment from the basins. Storm drain maintenance and cleaning was estimated at a cost of $40,000 every 5 years or $400,000 over the 50-year life of the project. In its current condition, the debris basin only has storage for a 10-year recurrence event, so sediment will need to be removed annually. Approximately 611 cubic yards (cy) of sediment (419 cy from Main Street and 192 cy from Buena Vista) would also need to be removed from the basins annually. Sediment excavation and disposal costs are estimated at $7 per cubic yard. The cost to perform one round of sediment excavation, including 10% mobilization and 30% contingency, would equate to approximately $6,000 annually, and these installation and O&M costs would be paid by the Sponsor.

3.0 Site 2 Seegmiller Marsh

3.1 Project Location and Existing Conditions

Seegmiller Marsh is located in an abandoned river channel meander and includes multiple depressions with wetlands, open water, and upland areas with a mixture of native cottonwood, willow, phragmites, cattail, and dense stands of tamarisk in wet areas, and mesquite, Russian olive, Russian thistle, and rabbitbrush in the drier areas. It provides valuable habitat for a multitude of wildlife species including good nesting habitat for the southwest willow flycatcher (SWFL), and habitat for the Virgin River chub; both are federally listed endangered species. The area appears to have been originally created by the Virgin River but has been modified with the construction of ditches and other low structures to control the flow of water. Seegmiller Marsh is located on the eastern boundary of the City of St. George near the Virgin River and south of the Mall Drive Bridge, as shown on Figure 3-1.

Figure 3-1. Seegmiller Marsh Location Map

The marsh currently receives water from three different open channels: 1) Mall Drive Channel (Washington Fields Drain), 2) Middle Drain, and 3) Seegmiller Drain, and is a unique resource within the city of St. George. Community leaders and natural resource managers with the Virgin River Program and Utah Division of Wildlife Resources (UDWR) have expressed the desire to protect and enhance the Seegmiller Marsh for future generations. A number of factors threaten the function and existence of the marsh area in the short- and long-term that should be addressed to meet these goals:

- The marsh is primarily located on privately-owned property, although the City of St. George owns a small parcel of land within the marsh. Public access to the marsh is limited and difficult. Trash and construction debris are being dumped into the marsh.

- The marsh hydrology is currently dependent on return flows from irrigation on adjacent agricultural fields as well as on precipitation runoff from developed areas and roadways east of the marsh. As the area converts to more urban uses, the quality, quantity, and timing of water inflows will change.
- Invasive non-native tamarisk is the dominant tree in the marsh, causing a lack of biodiversity and structure of native riparian vegetation and impacting wildlife habitat.
- The marsh is located within the Federal Emergency Management Agency (FEMA) Special Flood Hazard Area and the Virgin River Erosion Hazard Zone administered by the City of St. George, and is at risk from flooding and erosion damage during major flood events.
- The marsh is located adjacent to a City of St. George master planned community park and public trails.
- The marsh is home to several endangered species including the SWFL. Existing areas within the marsh include documented breeding habitat for the flycatcher and breeding habitat should be avoided.
- Active restoration of native riparian woodlands in watersheds close to where flycatchers currently nest (primarily in tamarisk) is urgently needed to provide flycatchers with alternate nesting sites.

A technical analysis was completed for the Seegmiller Marsh site by Rosenburg Associates (RA) and is documented in TM-02 (RA 2019a). The following paragraphs summarize the findings from TM-02.

3.2 Water Quality and Quantity Concerns

In 2006, Natural Channel Design and Applied Ecological Services prepared a Concept Plan Report for the Seegmiller Marsh for the Virgin River Program. This document described the following immediate and long-term water quality and quantity concerns related to the marsh:

- *Water Quality* - *Agricultural return flows can contribute sediments and a variety of pollutants to the marsh. The concentration and/or impacts to the marsh from these flows has not been identified or quantified. High salt levels are common in the area and, when concentrated in the soils, reduces the potential diversity of native vegetation. Stormwater pollutants are expected to become an increasing problem. Seegmiller Marsh can play an important role in the treatment process. However, the wetland represents the culmination of a natural treatment process and should not be expected to provide all treatment functions. The direct input of stormwater pollutants will simply degrade the wetland function. An integrated pre-treatment strategy, designed and implemented during development, is recommended.*
- *Water Quantity* - *The marsh and wetland area are dependent on outside sources of water. Existing inflows are contributed by excess agricultural irrigation. The inflows are relatively continuous and occur during the hot, growing season when marsh requirements are greatest. Groundwater inputs may increase in importance as surface flows become more unpredictable. However, urbanization generally results in an increase in impermeable surfaces and a decrease in infiltration, a reduction in the groundwater aquifer, and negatively impacts the marsh. Wetland needs and projected quantities and timing of future stormwater flows and groundwater recharge should be assessed in the project design.*

3.3 Flood Control and Erosion Protection

Seegmiller Marsh is at risk from flooding and erosion damage during major flood events. The marsh is located within the FEMA regulated floodplain and within the City of St. George Erosion Hazard Zone, as shown in Figure 3-2.

The marsh has been impacted by lateral migration of the river historically, and to maintain this unique habitat it may be necessary to stabilize portions of the Virgin River's banks to prevent the river from reclaiming its old channel. In 2006, Washington County, in conjunction with the NRCS, installed rock riprap erosion protection along the west boundary of the marsh as part of the Middle Virgin River Emergency Watershed Protection Project to protect the marsh from future erosion events. The rock riprap erosion protection is intended to keep lateral movement of the river channel away from the marsh while allowing the marsh to be inundated by major flood events in the river.

However, the west bank of the Virgin River has sustained significant damage during the recent floods, including washing out portions of the Virgin River Trail. Lateral erosion during flood events continues to be problematic for the property owners and the City along the west bank of the river, resulting in multiple discussions regarding options to protect property and infrastructure from future erosion damage. However, to-date only minor streambank and trail repair actions have been completed.

Figure 3-2. Seegmiller Marsh Floodplain and Erosion Hazard Boundaries

3.4 Wetland and Wildlife Habitat

Seegmiller Marsh represents a unique functioning wetlands and marsh system along the Virgin River. Typical vegetation includes phragmites stands, tamarisk, cattail and willows in wet areas, and varied upland shrubs and trees including rabbitbrush, cottonwood, Russian olive, and mesquite in the dry areas.

Opinions stated in the 2006 Seegmiller Marsh Concept Plan Report remain relevant, including *"Dense growths of invasive tamarisk are present with sparse but conspicuous scattered cottonwood and occasional willow dominate around the pool areas in the marsh. Good quality wildlife habitat requires structural diversity, large biomass, high biodiversity, connectivity (large patches), and nearness to water. The present vegetation community has few of these characteristics."* In addition, *"The ponded areas and emergent wetlands areas of the marsh can be utilized by waterfowl and shorebirds. However, much of the habitat, particularly the monotypic stands of tamarisk and Phragmites growths are not believed to provide substantial wildlife habitat for foraging, breeding or nesting."* Without protections, it is anticipated that the Seegmiller Marsh wetlands and wildlife habitat will continue to degrade from its current condition.

Seegmiller Marsh is home to several endangered species including the SWFL. Recent monitoring completed by the Utah Division of Wildlife Resources Washington County Field Office indicates existing habitat in the south end of the marsh is being successfully used by nesting SWFL pairs. Biologists recommend that new habitat restoration projects be located as close as possible to existing SWFL populations.

3.5 Nature Park and Pedestrian Trails

The City of St. George Park Planning Department has identified the Seegmiller Marsh as a future nature park. The City is also obtaining property from the adjacent residential development east of the marsh to facilitate construction of a new community park. The City has planned a multi-use asphalt bicycle and pedestrian trail extending the existing Virgin River Trail along the east boundary of the marsh, connecting Springs Park to the Mall Drive Trail. When complete, this trail will provide a loop around the Virgin River from the River Road Bridge to the Mall Drive Bridge on both sides of the river. The City Trail System follows the Virgin River from the Sun River community on the west side of St. George to the Washington City boundary and beyond.

The proposed nature park is intended to provide new education and recreation access to the marsh to promote awareness and appreciation of the Virgin River's ecology and natural history, particularly the riparian environment. Improvements have been proposed to preserve the valuable natural resources by incorporating educational programs to provide an interpretative experience for residents of the community and visitors during their recreation leisure time. Unpaved pedestrian trails and a designated bird viewing station are proposed to allow limited public access within the marsh and wetlands.

3.6 Alternative Evaluation

The process of formulating alternatives for mitigating flooding and providing suitable habitat within the Seegmiller Marsh area followed procedures outlined in the NWPM (NRCS 2015a), NWPH (NRCS 2014), P&G (USWRC 1983), and other NRCS watershed planning policy.

The following alternatives were evaluated.

1. Minimal Habitat Disturbance Alternative (Alternative 1) – Improvements within Seegmiller Marsh but avoiding any disturbance to existing sensitive species and habitat.
2. Landowner Alternative (Alternative 2) – Improvements within Seegmiller Marsh, similar to Alternative 1, but with a series of flood control improvements.
3. No Action Alternative – Most likely future condition if none of the federally-assisted action alternatives are selected.

The Minimal Habitat Disturbance Alternative was chosen as the preferred alternative for the project. Concept Design Drawings for this alternative are included in Attachment 2.

3.6.1 Minimal Habitat Disturbance (Alternative 1)

Alternative 1 includes construction of a series of enhancement improvements within the Seegmiller Marsh study area, avoiding any disturbance to existing sensitive SWFL nesting sites and habitat identified by the Utah Division of Wildlife Resources and Virgin River Program. The project components are described as follows:

- Remove sediment from the upland adjoining the Virgin River, within the 100-year flood extents to improve flood capacities and reduce lateral erosion risk to the adjacent streambanks and public infrastructure. Recontour the streambank and vegetate the disturbed area with native cottonwood and willow species.
- Construct rock riprap erosion protection on the west bank of the Virgin River floodplain to protect adjacent properties from lateral bank erosion and allow the acquisition of 60 acres of Virgin River floodplain channel and wetlands within the Seegmiller Marsh.
- Remove flood sediment from and recontour the higher elevation areas of the Seegmiller Marsh to allow for expansion of emergent marsh and open water wetland areas, and restore native vegetation, providing a phased conversion from the tamarisk monoculture to native trees and shrub species with limited tamarisk (30%) to enhance fish and wildlife habitat.
- Construct water conveyance pipelines and diversions to convey water from the Mall Drive Channel to the expanded areas within the Seegmiller Marsh, including limited pretreatment of irrigation return flows and stormwater runoff from the agricultural areas and urban runoff within the watershed.
- Construct a new public improved trail to expand the St. George Trail System and provide new recreation opportunities from Springs Park, south of the Seegmiller Marsh to the existing trails near Mall Drive, including a pedestrian bridge across the Mall Drive Channel.
- Construct a new unimproved loop trail and pedestrian bridge through a portion of the Seegmiller Marsh interior, creating a recreational nature trail with bird viewing stations and unique educational opportunities for residents and visitors to the community with direct access to improved public trails and a planned neighborhood park.
- Construct fencing and gates to limit public / utility vehicle (UTV) / all-terrain vehicle (ATV) access to sensitive areas of the marsh, but allow Utah Division of Wildlife Resources and other regulatory personnel access to monitor endangered species recovery efforts and complete vegetation maintenance activities.

This alternative requires the Sponsor to obtain permanent easements or property rights from eight different private property owners, covering approximately 80 acres within the Seegmiller Marsh or Virgin River floodplain at a cost of approximately $830,000. The construction cost for this alternative is approximately $4,899,000. O&M would consist of removal of sediment from the sediment trap at $180,000 every 10 years, pipeline cleaning at $20,000 every 5 years, weed control at $30,000 for the first 5 years, and trail maintenance at $14,040 annually. The total O&M cost over the 50-year project life would be approximately $1,952,000.

3.6.1.1 Estimated Construction Cost – Alternative 1

The estimated construction cost for Alternative 1 is provided in Table 3-1.

Table 3-1. Alternative 1 Estimated Construction Cost – Minimal Habitat Disturbance

Item No.	Classification of Unit Price Work	Quantity	Unit	Unit Price	Amount
1	Mobilization/Demobilization	1	LS	$279,000	$279,000
2	Field Survey and Staking	1	LS	$25,000	$25,000
3	Traffic Control	1	LS	$10,000	$10,000
4	QAQC (Onsite Observation)	1	LS	$30,240	$30,240
5	Clear & Grub	35	AC	$1,000	$35,000
6	Rock Riprap (d50 = 24")	22,310	CY	$40	$892,400
7	Sediment Removal (Excavate & Haul Offsite)	157,883	CY	$9	$1,420,947
8	Marsh Finished Grading	60,000	CY	$3	$180,000
9	Debris Removal (Excavate & Haul Offsite)	7,600	CY	$12	$91,200
10	Asphalt - 2 & 1/2" Depth (w/ Base) - Trail	40,000	SF	$3	$120,000
11	3/4" Roadbase - 6" Depth (Access Road)	49,200	SF	$1.50	$73,800
12	3/4" Roadbase - 6" Depth (Unpaved Trail)	24,000	SF	$1.50	$36,000
13	Earthwork - Onsite Materials (Paved and Unpaved Trail Construction, Access Roads)	13,500	CY	$4.50	$60,750
14	Bridge Viewing Station (w Benches and Signs)	3	LS	$3,000	$9,000
15	Pedestrian Bridges (70' Span, Includes Abutments)	2	LS	$80,000	$160,000
16	16' Steel Livestock Gate	3	EACH	$1,000	$3,000
17	Beam & Cable Barrier	600	LF	$30	$18,000
18	Concrete Flow Control Boxes w/ Gates	3	LS	$10,000	$30,000
19	Concrete Fish Barrier Structure	1	LS	$5,000	$5,000
20	Concrete Sediment Trap Structure	1	LS	$12,000	$12,000
21	1/4" Steel Trash Rack	1	LS	$7,500	$7,500
22	Rock Riprap Outfall Structures	2	LS	$2,000	$4,000
23	18" Poly Storm Drain	1,050	LF	$50	$52,500
24	Trail Culvert Crossings	2	LS	$10,000	$20,000
25	Restore Native Riparian Vegetation	30	AC	$5,000	$150,000
26	Weed Control	30	AC	$1,000	$30,000
27	Supplemental Irrigation	4	AC	$3,000	$12,000
				Subtotal[1]	**$3,768,000**
				Contingency (30%)[1]	**$1,131,000**
				Total[1]	**$4,899,000**

1 - Costs have been rounded to the nearest thousand dollars.

3.6.2 Landowner Options (Alternative 2)

Alternative 2 includes construction of a similar series of enhancement improvements within the Seegmiller Marsh study area, which are preferred by the majority landowners impacted by the project. The project components are the same as described in Alternative 1 with the following distinct differences:

- The rock riprap erosion protection proposed on the west bank of the Virgin River floodplain to protect adjacent properties from lateral bank erosion would be constructed along the existing trail and streambank where possible, thus minimizing the disturbance to the existing cultivated areas west of the river and reducing the land acquisition needs.
- A portion of the existing rock riprap erosion protection on the east side of the river would be relocated away from the river into the adjacent higher elevation areas of the marsh to remove the existing constriction and maintain a Virgin River central channel width as recommended by the Virgin River Master Plan (WCWCD 2007), thus improving flood capacity and reducing erosion risks to the adjacent properties.
- Sediment removal areas would be modified to remove more sediment from the central channel of the Virgin River between the erosion protection, and less sediment from the marsh areas, reducing the expansion of emergent marsh and open water wetland areas. Native vegetation would still be restored, providing a phased conversion from the tamarisk monoculture to native trees and shrub species with limited tamarisk (30%) to enhance fish and wildlife habitat, but on a slightly smaller scale.
- The other components of Alternative 1 would still be constructed including the trails, recreation and educational opportunities, water conveyance improvements, access gates, and fencing.
- This alternative requires the Sponsor to obtain permanent easements or property rights from eight different private property owners covering approximately 74 acres within the Seegmiller Marsh or Virgin River floodplain. This option has the most impact to areas recently used as breeding habitat by the SWFL and presents additional challenges to work through.

3.6.2.1 Estimated Construction Cost – Alternative 2

The estimated construction cost for Alternative 2 is provided in Table 3-2.

Table 3-2. Alternative 2 Estimated Construction Cost – Landowner Option

Item No.	Classification of Unit Price Work	Quantity	Unit	Unit Price	Amount
1	Mobilization/Demobilization	1	LS	$351,000	$351,000
2	Field Survey and Staking	1	LS	$40,000	$40,000
3	Traffic Control	1	LS	$15,000	$15,000
4	QAQC (Onsite Observation)	1	LS	$45,000	$45,000
5	Clear & Grub	40	AC	$1,000	$40,000
6	Rock Riprap (d50 = 24")	22,220	CY	$40	$888,800
7	Remove and Relocate Rock Riprap (d50 = 24")	22,310	CY	$30	$669,300
8	Clay Liner for Relocated Rock Wall	2,000	CY	$15	$30,000
9	Sediment Removal (Excavate & Haul Offsite)	182,000	CY	$9	$1,638,000
10	Marsh Finished Grading	33,000	CY	$3	$99,000
11	Debris Removal (Excavate & Haul Offsite)	7,600	CY	$12	$91,200
12	Asphalt - 2 & 1/2" Depth (w/ Base) - Trail	40,000	SF	$3	$120,000
13	3/4" Roadbase - 6" Depth (Access Road)	49,200	SF	$1.50	$73,800
14	3/4" Roadbase - 6" Depth (Unpaved Trail)	24,000	SF	$1.50	$36,000
15	Earthwork - Onsite Materials (Paved and Unpaved Trail Construction, Access Roads)	13,500	CY	$4.50	$60,750
16	Bridge Viewing Station (w Benches and Signs)	3	LS	$3,000	$9,000
17	Pedestrian Bridges (70' Span, Includes Abutments)	2	LS	$80,000	$160,000
18	16' Steel Livestock Gate	3	EACH	$1,000	$3,000
19	Beam & Cable Barrier	600	LF	$30	$18,000
20	Concrete Flow Control Boxes w/ Gates	3	LS	$10,000	$30,000
21	Concrete Fish Barrier Structure	1	LS	$5,000	$5,000
22	Concrete Sediment Trap Structure	1	LS	$12,000	$12,000
23	1/4" Steel Trash Rack	1	LS	$7,500	$7,500
24	Rock Riprap Outfall Structures	2	LS	$2,000	$4,000
25	18" Poly Storm Drain	1,050	LF	$50	$52,500
26	Trail Culvert Crossings	2	LS	$10,000	$20,000
27	Restore Native Riparian Vegetation	35	AC	$5,000	$175,000
28	Weed Control	30	AC	$1,000	$30,000
29	Supplemental Irrigation	4	AC	$3,000	$12,000
				Subtotal[1]	**$4,736,000**
				Contingency (30%)[1]	**$1421,000**
				Total[1]	**$6,157,000**

1 - Costs have been rounded to the nearest thousand dollars.

3.6.3 No Action Alternative

The No Action Alternative, also known as the Future-Without-Project Plan, projects the changes in resource concerns from the current condition to the condition that would exist in the future if no NRCS action were taken (NRCS 2015a). The No Action Alternative for this site would take one of the following courses:

- The SLO decides to construct similar enhancement and flood control projects without meeting NRCS standards, which may be more or less stringent.
- The SLO chooses to leave the Main Street drainage basin “as-is” with no future improvements.

Based on coordination with the Sponsor and the project stakeholders, the most likely course of action for the No Action Alternative would be to construct a new public trail as described for Alternative 1. The Sponsor would also purchase approximately 80 acres of land at approximately $$830,000 to protect and conserve the existing floodplain. The total construction cost was estimated at $621,000 (Table 3-3).

Table 3-3. No Action Alternative Costs

Item No.	Classification of Unit Price Work	Quantity	Unit	Unit Price	Amount
	Construction Cost				
1	Mobilization/Demobilization	1	LS	$43,455	$43,455
2	Asphalt - 2 & 1/2" Depth (w/ Base) - Trail	40,000	SF	$3	$120,000
3	3/4" Roadbase – 6” Depth (Access Road)	49,200	SF	$1.50	$73,800
4	Earthwork - Onsite Materials (Paved and Unpaved Trail Construction)	13,500	CY	$4.50	$60,750
5	Pedestrian Bridges (70' Span, Includes Abutments)	2	LS	$80,000	$160,000
6	Trail Culvert Crossings	2	LS	$10,000	$20,000
				Subtotal[1]	**$478,000**
				Contingency (30%)[1]	**$143,000**
				Construction Total[1]	**$621,000**
Floodplain Land Acquisition		80	Acre	$10,375	**$830,000**
				Total Cost	**$1,451,000**

1 - Costs have been rounded to the nearest thousand dollars.

Estimated O&M costs for the trail would be $70,200 every 5 years with an estimated annual cost of $14,040. Installation and O&M costs would be paid by the Sponsor.

4.0 Site 3 Y-Drain

4.1 Project Location and Existing Conditions

The Y-Drain is located in Washington City near the St. George city limits, north and east of the intersection of Sandia Drive and Mall Drive, as shown in Figure 4-1.

Figure 4-1. Y-Drain Location Map

Historically, the Y-Drain ditch has conveyed irrigation and rainfall runoff from agricultural lands in the Washington Fields area via open ditches and canals to the Seegmiller Marsh and eventually to the Virgin River. As residential development has occurred in the Washington Fields in recent years, irrigation runoff has been reduced and rainfall runoff discharges to the ditches and canals have increased. Many of the irrigation ditches have been replaced over time with underground storm drains. Portions of the Y-Drain ditch upstream and downstream of this project area have been replaced with underground storm drains. The existing Y-Drain ditch is an open, unlined earthen ditch with dense vegetation on the north bank and limited vegetation on the south bank. Storm drains from adjacent streets and developed areas enter the ditch.

The Y-Drain ditch is considered a public safety hazard because of its location between a residential neighborhood and an elementary school. The ditch is easily accessible to small children crossing between the neighborhood and the school. Also, an existing pedestrian/bicycle trail ends at the upstream end of the Y-Drain ditch. Washington City would like to connect a new pedestrian/bicycle trail to the pedestrian sidewalk on Sandia Road at the downstream end of the Y-Drain ditch. The proposed trail would also provide the opportunity to connect the existing trails within the Riverside Elementary School to the new trail and reduce pedestrian traffic on Merrill Road and Sandia Road.

It was also determined that flows from the Y-Drain are critical to maintain the emergent wetlands and endangered bird and fish habitat in and near the Seegmiller Marsh, which is approximately 2,200 linear feet downstream of the end of the Y-Drain ditch. Water efficiency (flow) to and water quality in Seegmiller Marsh could be improved by reducing erosion, sedimentation, and vegetation issues in the existing Y-Drain ditch.

A technical analysis was completed for the Seegmiller Marsh site by RA and documented in TM-03 (RA 2019b). The following paragraphs summarize the findings from TM-03.

4.2 Hydrologic and Hydraulic Analyses

This section summarizes the hydrologic and hydraulic analyses conducted for the Y-Drain project site.

4.2.1 Hydrologic Analysis

Multiple hydrologic studies have been performed on the Y-Drain drainage area. The hydrology for this project site references a study performed by BC&A for St. George City, dated August 2013. The BC&A study examined the Y-Drain as part of a larger master plan hydrologic analysis covering the Washington Fields watershed area that impacts both Washington City and St. George City. The 100-year design storm peak discharge from the study was 137 cfs.

4.2.2 Hydraulic Analysis

A hydraulic model was developed using the U.S. Army Corps of Engineer (USACE) HEC-RAS modeling software to calculate water surface profiles within the Y-Drain based on the existing conditions. The results indicate that a 100-year recurrence event is expected to cause shallow flood damage to nine residential homes and properties along the ditch, as shown in Figure 4-2.

The higher water surface elevations are due primarily to the pipe inlet and capacity deficiencies at the Sandia Road culvert. The backwater is projected to cause the existing Y-Drain ditch to back-up and overflow into the residential area north of the ditch and overtop Sandia Road, continuing south and west along Mall Drive toward the Virgin River.

Figure 4-2. Shallow Flood along the Y-Drain

4.3 Alternative Evaluation

The process of formulating alternatives to mitigate flooding and erosion along the Y-Drain area followed procedures outlined in the NWPM (NRCS 2015a), NWPH (NRCS 2014), P&G (USWRC 1983), and other NRCS watershed planning policy.

The following alternatives were evaluated to help mitigate flooding:

1. Pipe Y-Drain Alternative (Alternative 1) – Remove an existing 36-inch culvert which restricts flow at 3000 East and replace with a new 54-inch-diameter reinforced concrete pipe (RCP) storm drain and manholes to replace the existing pipe crossing Sandia Road, and enclose the existing open ditch section of the Y-Drain, including connections to the existing storm drains adjacent to the new pipeline. This recommendation could also include construction of a new 10-foot-wide asphalt pedestrian/bicycle trail parallel to the pipeline to connect the existing trail to Sandia Road.
2. Line Y-Drain Alternative (Alternative 2) – Construct the same new 54-inch-diameter RCP storm drain and manholes to replace the existing pipe crossing Sandia Road and the new 10-foot-wide asphalt paved pedestrian/bicycle trail as described in Alternative 1, but construct a new concrete-lined trapezoidal channel to replace the existing open ditch section of the Y-Drain. This alternative would also require a new 6-foot-high chain link fence between the trail and the open channel and a pedestrian bridge to cross the channel and connect the trail system.
3. No Action Alternative – Most likely future condition if none of the federally-assisted action alternatives are selected.

The Pipe Y-Drain Alternative (Alternative 1) was chosen as the preferred alternative for the project. Concept Design Drawings for this alternative are included in Attachment 3.

4.3.1 Pipe Y-Drain Alternative (Alternative 1)

Alternative 1 includes constructing a new storm drain to connect the existing storm drain above the Y-Drain with the existing storm drains downstream of Sandia Road to convey the 100-year design storm, and extending a new public trail from the existing trail near the east end of the Y-Drain to Sandia Road. The new storm drain and trail would reduce the flooding risk, eliminate the public safety hazard that the open ditch presents, provide additional recreation opportunities and pedestrian access along the trail, eliminate transpiration losses to problematic vegetation, and provide a conduit for groundwater flows downstream, improving water efficiency. The proposed hydraulic design criteria for this alternative are provided as follows:

Model Software	Bentley FlowMaster
Pipe Inside Diameter	54-inch
Manning's 'n' roughness coefficient	0.013 for concrete pipe
Channel Slope	0.43-percent
Design Flow	110 cfs

Based on this analysis, the full-flow capacity for the 54-inch-diameter pipe is 129 cfs, which exceeds the required 100-year design flow of 110 cfs.

It is proposed that the trail be constructed on an alignment parallel to the new storm drain and consist of a 10-foot-wide asphalt paved surface with 2.5-foot-wide gravel shoulders on each side. The trail will also provide a maintenance access for the new storm drain.

4.3.1.1 Estimated Construction Cost – Alternative 1

The estimated construction cost for Alternative 1 is $1,137,000 (Table 4-1).

Table 4-1. Alternative 1 Estimated Construction Cost – Pipe Y-Drain

Item No.	Classification of Unit Price Work	Quantity	Unit	Unit Price	Amount
1	Mobilization/Demobilization	1	LS	$65,000	$65,000
2	Field Survey and Staking	1	LS	$15,000	$15,000
3	Traffic Control	1	LS	$15,000	$15,000
4	QAQC (Onsite Observation)	1	LS	$15,000	$15,000
5	Clear & Grub	1	LS	$3,500.	$3,500
6	Remove & Replace Sandia Rd Asphalt & Base Course	7,000	SF	$3.75	$26,250
7	Remove and Replace Sandia Rd Curb & Gutter	300	LF	$27	$8,100
8	Remove and Replace Sandia Rd Sidewalk	1,500	SF	$6	$9,000
9	Remove Existing 60" Storm Drain Manhole	1	LS	$2,500	$2,500
10	Remove Existing 54" Storm Drain	1	LS	$1,500	$1,500
11	Remove & Replace to Grade 18" CMP Storm Drain	25	LF	$105	$2,625
12	Remove & Replace to Grade 12" PVC Storm Drain	25	LF	$95	$2,375
13	Remove & Replace Curb Inlet Catch Basin & Curb - Riverside Elementary	1	LS	$7,200	$7,200
14	Replace Curb Inlet Catch Basin & Connect 12 " Poly Storm Drain to Manhole - Sandia Rd	1	LS	$5,000	$5,000
15	Modify 20" Waterline in Sandia Rd to Accommodate 60" RCP Storm Drain	1	LS	$50,000	$50,000
16	Modify/Relocate Gas, Fiberoptic, and Other Utilities in Sandia Rd	1	LS	$25,000	$25,000
17	54" Reinforced Concrete Pipe w/ Bedding & Underdrain	1,250	LF	$275	$343,750
18	96" Storm Drain Manhole	5	EA	$10,000	$50,000
19	Asphalt - 2 & 1/2" Depth (w/ Base) - Trail	12,200	SF	$3	$36,600
20	Earthwork - Onsite Materials	12,000	CY	$4.50	$54,000
21	Earthwork - Import Fill	10,000	CY	$8.50	$85,000
22	6' Chain-link Fencing w/ Gates	1,100	LF	$15	$16,500
23	Remove Existing Fence & Encroachments	1	Lump	$25,000	$25,000
24	Landscaping	10,000	SF	$1	$10,000
				Subtotal[1]	**$874,000**
				Contingency (30%)[1]	**$263,000**
				Total[1]	**$1,137,000**

1 - Costs have been rounded to the nearest thousand dollars.

O&M costs would consist of pipeline cleaning at $20,000 every 5 years and trail maintenance at $6,500 annually. Total O&M costs over the 50-year project life would be approximately $525,000.

4.3.2 Line Y-Drain Alternative (Alternative 2)

Alternative 2 includes constructing a new concrete-lined open trapezoidal channel in lieu of the 54-inch-diameter pipe. Alternative 2 would require the same 54-inch-diameter pipe and manhole improvements to cross Sandia Road, then transition to an open concrete-lined channel from Sandia Road to the existing storm drain above the Y-Drain, and would also extend a new public trail from the existing trail near the east end of the Y-Drain to Sandia Road. The new channel and trail would reduce the flooding risk, provide additional recreation opportunities and pedestrian access along the trail, eliminate problematic vegetation, and provide a conduit for flows to continue downstream, improving water efficiency. The proposed hydraulic design criteria for this alternative are provided as follows:

Model Software	Bentley FlowMaster
Channel Bottom Width	2-feet
Side Slopes	1.5H:1V
Flow Depth	4-feet
Manning’s ‘n’ roughness coefficient	0.013 for concrete
Channel Slope	0.43-percent
Design Flow	110 cfs

Based on this analysis, the full-flow capacity for the concrete lined ditch is 374 cfs, which exceeds the required 100-year design flow of 110 cfs.

It is proposed to construct the trail on an alignment parallel to the new concrete channel, which would have the same dimensions as discussed for Alternative 1. A new security fence for safety would need to be installed between the trail and the open ditch.

4.3.2.1 Estimated Construction Cost – Alternative 2

The estimated construction cost for Alternative 1 is approximately $1,326,000, as shown in Table 4-2.

Table 4-2. Alternative 2 Estimated Construction Cost – Lining the Y-Drain

Item No.	Classification of Unit Price Work	Quantity	Unit	Unit Price	Amount
1	Mobilization/Demobilization	1	LS	$76,000	$76,000
2	Field Survey and Staking	1	LS	$15,000	$15,000
3	Traffic Control	1	LS	$15,000	$15,000
4	QAQC (Onsite Observation)	1	LS	$15,000	$15,000
5	Clear & Grub	1	LS	$3,500	$3,500
6	Remove & Replace Sandia Rd Asphalt & Base Course	7,000	SF	$3.75	$26,250
7	Remove and Replace Sandia Rd Curb & Gutter	300	LF	$27	$8,100
8	Remove and Replace Sandia Rd Sidewalk	1,500	SF	$6	$9,000
9	Remove Existing 60" Storm Drain Manhole	1	LS	$2,500	$2,500
10	Remove Existing 54" Storm Drain	1	LS	$1,500	$1,500
11	Remove & Replace to Grade 18" CMP Storm Drain	25	LF	$105	$2,625
12	Remove & Replace to Grade 12" PVC Storm Drain	25	LF	$95	$2,375
13	Remove & Replace Curb Inlet Catch Basin & Curb - Riverside Elementary	1	LS	$7,200	$7,200
14	Replace Curb Inlet Catch Basin & Connect 12 " Poly Storm Drain to Manhole - Sandia Rd	1	LS	$5,000	$5,000
15	Modify 20" Waterline in Sandia Rd to Accommodate 60" RCP Storm Drain	1	LS	$50,000	$50,000
16	Modify/Relocate Gas, Fiberoptic, and Other Utilities in Sandia Rd	1	LS	$25,000	$25,000
17	54" Reinforced Concrete Pipe w/ Bedding & Underdrain	100	LF	$275	$27,500
18	96" Storm Drain Manhole	2	EA	$10,000	$20,000
19	5" Reinforced Concrete Flatwork w/ Base Course (Hand Formed)	18,300	SF	$15	$274,500
20	Concrete Headwall	1	EA	$18,500	$18,500
21	4" Stabilization Rock 2' Depth w/ Underdrain	700	CY	$30	$21,000
22	Pedestrian Bridge w/ Concrete Abutments	1	EA	$50,000	$50,000
23	Asphalt - 2 & 1/2" Depth (w/ Base) - Trail	12,200	SF	$3	$36,600
24	Earthwork - Onsite Materials	12,000	CY	$4.50	$54,000
25	Earthwork - Import Fill	5,000	CY	$8.50	$42,500
26	Gabion Basket Slope Reinforcement	1,000	CY	$150	$150,000
27	6' Chain-link Fencing w/ Gates	2,200	LF	$15	$33,000
28	Remove Existing Fence & Encroachments	1	Lump	$25,000	$25,000
29	Landscaping	3,000	SF	$1.00	$3,000
				Subtotal[1]	**$1,020,000**
				Contingency (30%)[1]	**$306,000**
				Total[1]	**$1,326,000**

1 - Costs have been rounded to the nearest thousand dollars.

4.3.3 No Action Alternative

The No Action Alternative, also known as the Future-Without-Project Plan, projects the changes in resource concerns from the current condition to the condition that would exist in the future if no NRCS action were taken (NRCS 2015a). The No Action Alternative for this site would take one of the following courses:

- The SLO decides to construct similar flood control projects without meeting NRCS standards, which may be more or less stringent.
- The SLO chooses to leave the Y-Drain “as-is” with no future improvements.

Based on coordination with the Sponsor and Washington City, the most likely course of action for the No Action Alternative would be to fence the open ditch at a construction cost of $21,500. This includes installation of approximately 1,100 linear feet of fence at $15/foot and also includes a contingency of 30%. O&M would consist of sediment removal at $60,000 every 10 years and weed control and fence maintenance at $6,500 annually. The O&M costs over the 50-year project life would be approximately $625,000.

5.0 Site 4 Warner Valley Disposal System

5.1 Project Location and Existing Conditions

The Warner Valley Disposal System (Disposal System) consists of over 3.4 miles of open channel ditch and concrete storm drain (from 42 inches to 72 inches in diameter) starting near River Road and the Fort Pierce Wash confluence and ending near Washington Fields Road. The Disposal System collects and conveys runoff discharge from three existing NRCS-constructed debris basins (Washington Fields Debris Basins) in the Washington Fields area of Washington County. These three basins include the Gypsum Debris Basin, the Warner Draw Debris Basin, and the Stucki Debris Basin. NRCS is currently funding design and construction projects that will bring these three debris basins up to current design standards and replace the section of the Disposal System between approximately 3870 East and approximately Washington Fields Road (NRCS 2016, 2017a, & 2017b). Prior to construction of the Disposal System, stormwater released from the three Washington Fields debris basins was discharged into the Washington Fields Canal. The canal conveyed the runoff westward to a point where it discharged into the Fort Pearce Wash. In 2007, the Washington County Water Conservancy District (WCWCD) constructed a project to convert the Washington Fields Canal into a pressurized pipeline. As part of that project, the WCWCD worked with the City of St. George to construct the Disposal System, which includes 66- and 72-inch-diameter reinforced concrete pipe between 3870 East and 2110 East, an open channel between 2110 East and River Road, and a combination of 66-inch-diameter RCP and 7’x3’ reinforced concrete box (RCB) from River Road to the discharge point into Fort Pearce Wash. The location of the Warner Valley Disposal System, including the three NRCS debris basins and the Disposal System, is shown in Figure 5-1.

The City of St. George is experiencing significant development throughout the City, particularly in the southeast region, the Washington Fields area near the Disposal System. Stormwater runoff from this part of the city currently discharges into the Disposal System. Storm Drain Master Plans from the City of St. George also identify plans to utilize the Disposal System as a major storm drain outfall that will receive runoff from future development in this area.

This project documents the existing hydrology design flows expected in the Disposal System, summarizes the hydraulic analyses used to estimate the existing conveyance capacity, identifies capacity deficiencies along the disposal pipeline, and identifies alternatives and recommendations to mitigate those deficiencies. The project also identifies and recommends potential recreational opportunities including a proposed multi-use and equestrian trail along the Disposal Pipeline alignment.

A technical analysis was completed for the Warner Valley Disposal System site by BC&A and documented in TM-04 (BC&A 2019b). The following paragraphs summarize the findings from TM-04.

Figure 5-1. Warner Valley Disposal System Location Map

5.2 Hydrologic and Hydraulic Analyses

This section summarizes the existing hydrologic and hydraulic analyses conducted for the Warner Valley Disposal System site.

5.2.1 Hydrology Analysis

The USACE Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS) software was used to develop a model using the Soil Conservation Service (SCS) Curve Number (CN) methodology to estimate runoff for each of the subbasins that drain to the Disposal System. This analysis requires a transform method, CN values, percent impervious, and area for each subbasin as hydrologic input parameters. The hydrologic parameters for the subbasins upstream of the three NRCS debris basins (Gypsum Wash, Warner Draw, and Stucki) were provided by NRCS.

A description of the methodology used to develop the hydrologic parameters downstream of the NRCS debris basins is included below.

- Sixteen subbasin boundaries were delineated based on existing topography, aerial photography, and existing storm drain infrastructure as shown in Figure 5-2.
- The SCS Unit Hydrograph method was used to convert rainfall to runoff. Time of Concentration (T_c) was calculated based on Worksheet 3 in TR-55 manual (USDA SCS 1986). Lag time was assumed to be (0.6)x(T_c).
- Curve numbers were estimated for each subbasin based on soil type and vegetation cover. Soil types were obtained from the NRCS Soil Survey Geographic (SSURGO) dataset.
- The amount of directly-connected impervious area for existing development conditions was estimated for each subbasin using recent aerial photography.
- Two design storms were analyzed for this study and include the Farmer-Fletcher storm and the SCS Type II storm.
- Precipitation depths for the synthetic design storms were derived from the NOAA Atlas 14 manual (NOAA 2006). These two events.
- Hydrologic calculations were provided for both the 100-year and 10-year recurrence events.

Table 5-1 summarizes the HEC-HMS hydrologic model parameters for each subbasin. Table 5-2 provides the results of the hydrologic analysis for existing development conditions.

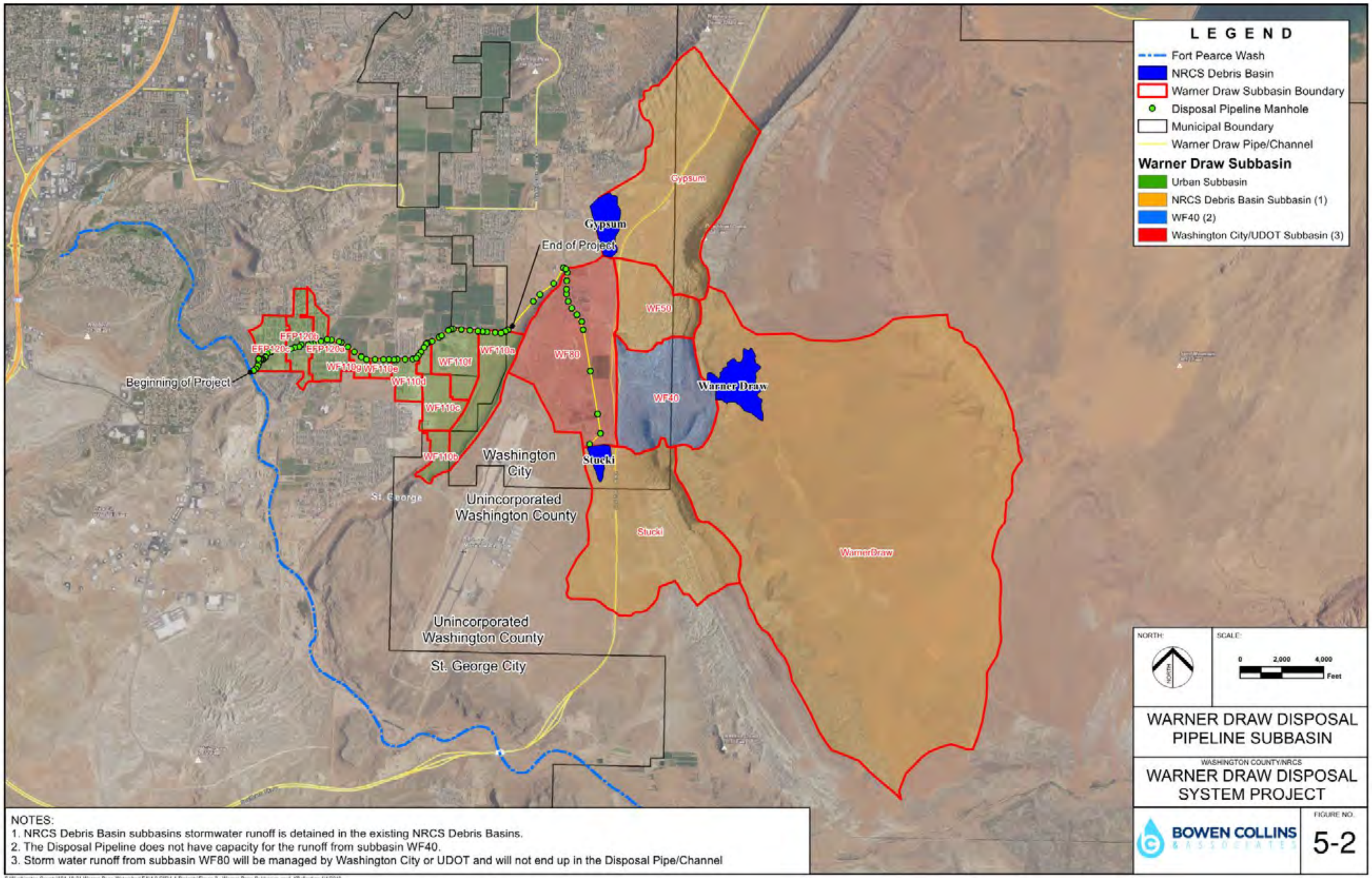

Figure 5-2. Disposal System Subbasins

Table 5-1. Hydrologic Design Data

Subbasin ID	Area (Ac)	Curve Number	Lag Time (min)	Percent Directly-Connected Impervious
Warner Draw[1]	5,888	81.5	68	0
Stucki[1]	1,344	77.7	29	0
Gypsum[1]	1,472	81.5	43	0
WF40	501	80	27	0
WF110a	205	82	22	0
WF110b	59	86	14	10
WF110c	120	71	23	20
WF110d	61	74	19	20
WF110e	22	86	9	0
WF110f	137	85	23	0
WF110g	21	86	9	0
EFP120a	110	67	13	20
EFP120b	98	69	21	20
EFP120c	88	68	21	20

Table 5-2. Summary of Existing Conditions Peak Design Storm Discharges

Subbasin ID	Design Storm Recurrence Interval Associated with the Design of Existing Downstream Facilities	SCS Type II Storm Estimated Runoff (cfs)	Farmer-Fletcher Estimated Runoff (cfs)
Warner Draw[1]	100-year	1,616	1,286
Stucki[1]	100-year	479	363
Gypsum[1]	100-year	557	452
WF40	10-year	228	179
WF110a	10-year	48	18
WF110b[1]	100-year	58	61
WF110c[1]	100-year	52	59
WF110d[1]	100-year	33	36
WF110e	10-year	11	5
WF110f	10-year	44	20
WF110g	10-year	10	5
EFP120a	10-year	25	36
EFP120b	10-year	20	25
EFP120c	10-year	18	23

5.2.2 Hydraulic Analysis

The existing Disposal System conveys stormwater discharged from the three Washington Fields Debris Basins in Washington City and the County, and stormwater generated from urban development within the city of St. George in the Washington Fields area. The section of the existing Disposal System included in this study is approximately 2.6 miles long, extending from 3870 E Street to Fort Pierce Wash (Figure 5-1), and includes approximately:

- 2,122 linear feet of 72-inch-diameter Reinforced Concrete Pipe (RCP)
- 395 linear feet of 7’x3’ Reinforced Concrete Box (RCB)
- 9,594 linear feet of 66-inch-diameter RCP
- 1,443 linear feet of open channel

A hydraulic computer model was developed using the Innovyze InfoSWMM modeling software to evaluate the capacity of the existing Disposal System components. This modeling software uses the Storm Water Management Model (SWMM) modeling engine with a Geographic Information System (GIS) interface and has the ability to model both closed conduit and open channel flows. For the purposes of developing the computer model, a Manning’s ‘n’ hydraulic roughness of 0.013 was selected for the RCP/RCB sections and 0.035 for the open channel. Minor loss coefficients associated with bends and changes in grade were assigned to manholes based on the U.S. Department of Transportation Federal Highway Administration (US DOT FHA) HEC-22 Urban Drainage Design Manual (US DOT FHA 2009).

Through the existing field survey completed with the analysis and the hydraulic modeling, the following deficiencies were identified along the Disposal Pipeline:

- The section of the Disposal Pipeline near the Fort Pearce Wash outfall was partially full of sediment due to backwater and surcharging of the pipeline during high flood stages of the Fort Pearce Wash.
- A section of the Disposal Pipeline just downstream of the connection to the existing 42-inch-diameter section of the pipeline was installed at an adverse grade.
- The 66-inch-diameter Disposal Pipeline has a minimum capacity of approximately 130 cfs and there would be flooding at four locations along the pipeline alignment during the design event.

5.3 Alternative Evaluation

The process of formulating alternatives to mitigate flooding along the Warner Disposal System area followed procedures outlined in the NWPM (NRCS 2015a), NWPH (NRCS 2014), P&G (USWRC 1983), and other NRCS watershed planning policy.

The following alternatives were evaluated to help mitigate flooding:

1. Additional Detention Alternative (Alternative 1) – Provide additional detention in the urban areas of the city of St. George to attenuate peak runoff values before the flows are discharged into the Disposal Pipeline.

2. Parallel Pipeline Alternative (Alternative 2) – Construct a new storm drain pipeline, parallel to the existing Disposal Pipeline, at the location where water exits surcharged manholes, and enclose the open channel section of the Disposal Pipeline system.
3. No Action Alternative – Most likely future condition if none of the federally-assisted action alternatives are selected.

The Additional Detention Alternative (Alternative 1) was chosen as the preferred alternative for the project. Concept Design Drawings for this alternative are included in Attachment 4.

5.3.1 Additional Detention (Alternative 1)

Alternative 1 includes constructing additional detention within the urban drainage areas of the city of St. George to attenuate peak flows before discharging into the Disposal System. The majority of the stormwater collected and conveyed by the Disposal System is from the urban/developed subbasins within the city of St. George. The upstream collection facilities were designed to collect and convey runoff from the 100-year recurrence event. To evaluate this alternative, a proposed-conditions hydrologic model was developed for the purpose of analyzing potential detention improvements that would mitigate the capacity deficiencies of the Disposal System. The proposed-conditions model was developed by copying the existing conditions model and making the following modifications:

- **Increase the directly connected impervious area** – The directly connected impervious area percentage was increased to 20% in subbasins that have potential for development. The City of St. George City general plan indicates that those areas will develop as Low Density Residential.
- **Additional Detention Basins** – Potential detention basins were added to the urban subbasins to attenuate the peak discharges prior to discharging into the Disposal System.

Two protentional detention basins within existing developed area were identified, as shown on Figure 5-3.

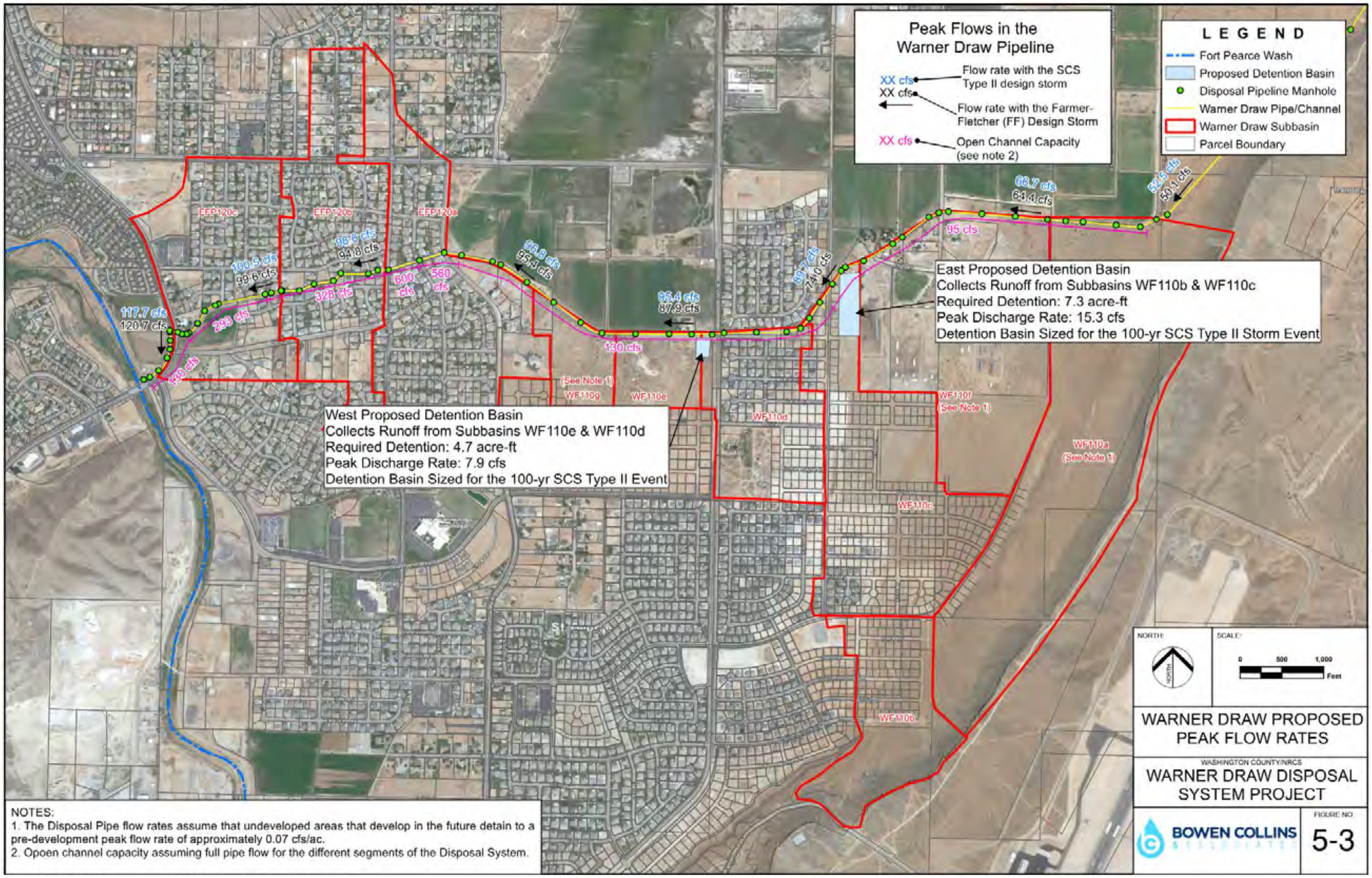

Figure 5-3. Proposed Detention Basins

These two detention basins can be excavated below grade and will not impound water above the natural ground. The preliminary design characteristics for the two detention basins are summarized in Table 5-3.

Table 5-3. Summary of Proposed Warner Draw Disposal System Detention Basins

Parameter	DB-1	DB-2
Active Storage (Ac-ft)[1]	4.7	7.3
Grading Area (Ac)[2]	1.6	2.7
Overall Height (ft)[3]	0 *(0'<35')*	0 *(0'<35')*
Effective Height (ft)[4]	0	0
Crest Width (ft)	NA	NA
Upstream Slope	3H:1V	3H:1V
Effective Height x Storage	0 *(0<3,000)*	0 *(0<3,000)*
Peak Discharge Rate (cfs)	7.9 cfs	15.3 cfs
Basin Design Event	100-year; 24-hour SCS Type II	100-year; 24-hour SCS Type II

Notes:
1. Active Volume is the volume from the auxiliary spillway crest to the invert of the outlet pipe (principal spillway).
2. Area disturbed by grading.
3. Overall Height is the difference in elevation between the top of the dam and the lowest elevation at the downstream toe.
4. Effective Height is the difference in elevation between the lowest open channel auxiliary spillway crest and the lowest point in the original cross section on the centerline of the dam.

The St. George City Drainage manual requires the 100-year, 3-hour or 24-hour rainfall distribution be used for the design of detention facilities. The Washington City Grading manual specifies that the 100-year, 3-hour rainfall should be used for major system design of residential, commercial, and industrial land use. The 100-year, 3-hour rainfall distribution was considered and analyzed for sizing both detention basins. However, the 100-yr, 24-hr distribution resulted in higher runoff volumes and more conservative requirements for basin storage and principal spillway design, therefore, the 100-yr, 24-hr distribution was used as the basis for design.

As shown in Table 5-3, the proposed detention basins are below grade and have no overall or effective height. Based on the NRCS classification criteria, the two detention basins would be classified as low-hazard potential dams meeting the pond standard and will be designed in accordance with NRCS Code 378 and local ordinance.

5.3.1.1 Additional Measures and Recommendations

Along with the previously discussed flood control detention basins, a number of other repairs and improvements are recommended to mitigate potential flooding, provide reduced maintenance, and provide recreational facilities along the Disposal System alignment. A summary of the recommendations is provided in Table 5-4 and shown on Figure 5-3.

Table 5-4. Warner Draw Disposal System Summary of Recommendations

ID	Recommendations
DP-01	Install new headwall on 66-inch RCP with flap gate or Tideflex valve
DP-02	Install new flap gate or Tideflex valve on outlet pipe from storm drain inlet to prevent backwater from flooding roadway sag
DP-03	Remove sediment from pipeline between River Road Crossing and Fort Pearce Wash
DP-04	Enclose existing open channel using 72-inch RCP
DP-05	Construct proposed 4.7 Acre-ft detention basin (West DB)
DP-06	Construct proposed 7.3 Acre-ft detention basin (East DB)
DP-07	Require future developments to detain to pre-development conditions
DP-08	Remove existing 66-inch RCP constructed to create a belly in the pipeline and install new 66-inch RCP with constant downstream slope
DP-09	Install new multi-use asphalt and equestrian trail from River Road to 2350 East
DP-10	Install new multi-use asphalt and equestrian trail from Little Valley Road to 3000 East
DP-11	Install new multi-use asphalt and equestrian trail from 3210 East to 3870 East

ID	Recommendations
DP-01	Install new headwall on 66-inch RCP with flap gate valve or Tideflex valve
DP-02	Install new flap gate or Tideflex valve on existing manhole at catch basin
DP-03	Remove sediment from pipeline between River Road Crossing and Fort Pearce Wash
DP-04	Enclose existing open channel using 72-inch RCP
DP-05	Construct proposed 4.7 Acre-ft detention basin (West DB)
DP-06	Construct proposed 7.3 Acre-ft detention basin (East DB)
DP-07	Require future developments to detain to pre-development conditions
DP-08	Remove existing 66-inch RCP constructed to create a belly in the pipeline and install new 66-inch RCP with constant downstream slope
DP-09	Install new multi-use asphalt and equestrian trail from River Road to 2350 East
DP-10	Install new multi-use asphalt and equestrian trail from Little Valley Road to 3000 East
DP-11	Install new multi-use asphalt and equestrian trail from 3210 East to 3870 East

Figure 5-3. Warner Valley Disposal System Recommendations

5.3.1.2 Estimated Construction Cost – Alternative 1

The estimated construction cost for two detention basins and the other improvements in Alternative 1 is $5,341,000 (Table 5-5). O&M would consist of pipeline cleaning at $79,000 every 5 years, landscape maintenance at $31,160 annually, and trail maintenance at 20,560 annually. The total O&M cost over the 50-year project life is approximately $3,376,000.

Table 5-5. Estimated Construction Cost – Alternative 1

Item No.	Classification of Unit Price Work	Quantity	Unit	Unit Price	Amount
1	Mobilization/Demobilization	1	LS	$304,300	$304,300
2	Field Survey and Staking	1	LS	$24,000	$24,000
3	Traffic Control	1	LS	$30,000	$30,000
4	QAQC	1	LS	$20,000	$20,000
5	Provide and Install 72-inch RCP	1,344	LF	$330.00	$443,520
6	Remove Existing 66-inch RCP	1,112	LF	$30	$33,360
7	Provide and Install 66-inch RCP	1,112	LF	$280	$311,360
8	Provide and Install 48-inch RCP	440	LF	$200	$88,000
9	Provide and Install 24-inch RCP	145	LF	$165	$23,925
10	Provide and Install 18-inch RCP	270	LF	$70	$18,900
11	96-inch Diameter Manholes	9	EA	$10,000	$90,000
12	84-inch Diameter Manholes	7	EA	$9,500	$66,500
13	60-inch Diameter Manholes	2	EA	$5,500	$11,000
14	Raise Existing Manholes	6	EA	$4,000	$24,000
15	Single Catch Basins	4	EA	$4,500	$18,000
16	Double Catch Basin	4	EA	$8,500	$34,000
17	2-Winged Inlet Assembly with 6-foot Diameter Manhole	4	EA	$13,000	$52,000
18	Concrete Headwall with Flap Gate	1	LS	$34,800	$34,800
19	Flap Gate at Manhole/Catch Basin	1	LS	$4,200	$4,200
20	Detention Basin - West	1	LS	$ 493,000	$493,000
21	Detention Basin - East	1	LS	$ 567,000	$567,000
22	Pedestrian and Equestrian Trail Surface	11,800	LF	$35	$413,000
23	Trail Excavation	7,485	CY	$7	$52,395
24	Trail Fill	50,963	CY	$15	$764,445
25	Landscaping	53,100	SF	$3.50	$185,850
				Subtotal[1]	**$4,108,000**
				Contingency (30%)[1]	**$1,233,000**
				Total[1]	**$5,341,000**

1. Costs have been rounded to the nearest thousand dollars.

5.3.2 Parallel Pipeline (Alternative 2)

As shown in the existing conditions hydrologic and hydraulic analyses, the Disposal System does not have capacity to convey the expected hydrologic flows in two pipe segments—between 3870 East and east of Little Valley Road and between approximately 2110 East and Fort Pearce Wash. For Alternative 2, the potential construction of parallel pipelines in these two areas that have capacity issues was evaluated as well as piping the existing open channel ditch, as shown on Figure 5-4.

Figure 5-4. Parallel Pipeline Alternative

To mitigate any flooding along the Disposal System, the following segments of parallel pipeline will be required as well as enclosing of existing open channels:

- Approximately 900 linear feet of 48-inch-diameter pipeline to parallel the existing 66-inch-diameter pipeline and 7’x3’ box culvert from the Fort Pearce Wash outfall to the River Road crossing.
- Approximately 1,445 linear feet of 84-inch-diameter pipeline to enclose the open channel between the River Road crossing and 2110 East.
- Approximately 6,900 linear feet of 42-inch-diameter pipeline to parallel the existing 66-inch-diameter pipeline from the approximately Little Valley Road to 3870 East.

It is noted that construction of this potential parallel pipelines would more than likely require relocation and/or reconstruction of existing irrigation ditch that runs along the east side of the irrigated fields and/or relocations of existing street lights, traffic lights, and underground power conduits that provide lighting for River Road. The new parallel pipeline would also require additional maintenance. This maintenance would include cleaning sediment from a second pipeline—the sediment could be deposited during high flood events in the Fort Pearce Wash. Construction would also take place in narrow rights-of-way near large existing utilities.

5.3.2.1 Additional Measures and Recommendations

Along with the measures for the parallel pipeline discussed in Section 5.3.1.1, the following measures will be required for Alternative 2:

- DP-01 Install new headwall on 66-inch RCP with flap gate or Tideflex valve
- DP-02 Install new flap gate or Tideflex valve on outlet pipe from storm drain inlet
- DP-08 Remove existing 66-inch RCP constructed to create a belly in the pipeline and install new 66-inch RCP with constant downstream slope
- DP-09 Install new multi-use asphalt and equestrian trail from River Road to 2350 East
- DP-10 Install new multi-use asphalt and equestrian trail from Little Valley Road to 3000 East
- DP-11 Install new multi-use asphalt and equestrian trail from 3210 East to 3870 East

5.3.2.2 Estimated Construction Cost – Alternative 2

The estimated construction cost for the Alternative 2 parallel pipelines and additional measures and recommendations is approximately $5,809,000 (Table 5-6).

Table 5-6. Alternative 2 Estimated Construction Cost – Parallel Pipelines

Item	Quantity	Unit	Unit Price	Amount
Mobilization/Demobilization	1	LS	$337,100	$337,100
Field Survey and Staking	1	LS	$24,000	$24,000
Traffic Control	1	LS	$30,000	$30,000
QAQC	1	LS	$20,000	$20,000
Provide and Install 84-inch RCP	1,445	LF	$450	$650,250
Remove Existing 66-inch RCP	1,112	LF	$30.00	$33,360
Provide and Install 66-inch RCP	1,112	LF	$280.00	$311,360
Provide and Install 48-inch RCP	900	LF	$200.00	$180,000
Provide and Install 42-inch RCP	6,900	LF	$185.00	$1,276,500
96-inch Diameter Manholes	4	EA	$10,000.00	$40,000
72-inch Diameter Manholes	3	EA	$9,500.00	$28,500
60-inch Diameter Manholes	16	EA	$5,500.00	$88,000
Concrete Headwall with Flap Gate	1	LS	$34,800.00	$34,800
Flap Gate at Manhole/Catch Basin	1	LS	$4,200.00	$4,200
Pedestrian and Equestrian Trail Surface	11,800	LF	$35.00	$413,000
Trail Excavation	7,485	CY	$7.00	$52,395
Trail Fill	50,963	CY	$15.00	$764,445
Landscaping	53,100	SF	$3.50	$185,850
			Subtotal[1]	**$4,468,000**
			Contingency (30%)[1]	**$1,341,000**
			Total[1]	**$5,809,000**

1 - Costs have been rounded to the nearest thousand dollars.

5.3.3 No Action Alternative

The No Action Alternative, also known as the Future-Without-Project Plan, projects the changes in resource concerns from the current condition to the condition that would exist in the future if no NRCS action were taken (NRCS 2015a). The No Action Alternative for this site would take one of the following courses:

- The SLO decides to construct similar flood control projects without meeting NRCS standards, which may be more or less stringent.
- The SLO chooses to leave the Warner Draw Disposal System "as-is" with no future improvements.

Based on coordination with the Sponsors, the most likely course of action would be to construct a trail along the Disposal System alignment. The cost to construct this mixed-use trail is $1,976,000. Land acquisition of 10.35 acres would also be required for construction of the trail at a cost of $1,242,000. Table 5-7 includes the construction and land acquisition costs for this alternative.

Table 5-7. No Action Alternative Costs

Item No.	Classification of Unit Price Work	Quantity	Unit	Unit Price	Amount
Construction Cost					
1	Mobilization/Demobilization	1	LS	$104,400	$104,400
2	Pedestrian and Equestrian Trail Surface	11,800	SF	$35.00	$413,000
3	Trail Excavation	7,485	SF	$7.00	$52,395
4	Trail Fill	50,963	CY	$15.00	$764,445
5	Landscaping	53,100	LS	$3.50	$185,850
				Subtotal[1]	**$1,520,000**
				Contingency (30%)[1]	**$456,000**
				Construction Total[1]	**$1,976,000**
Residential Land Acquisition		10.35	LS	$120,000	**$1,242,000**
				Total Cost	**$3,218,000**

1 - Costs have been rounded to the nearest thousand dollars.

O&M would consist of annual trail maintenance ($20,560) and landscape maintenance ($31,160). Pipeline cleaning would also be performed at $79,000 every 5 years and sediment removal would take place every 10 years at $100,000 per removal. The adverse sloped disposal pipe would eventually need to be replaced at a cost of approximately $494,000. O&M cost over the 50-year project life is estimated at $4,370,000.

6.0 Site 5 Hurricane Irrigation Efficiency

6.1 Project Location and Existing Conditions

Hurricane City currently has a pressurized irrigation system on the north side of the city from approximately Gould Wash north. The Hurricane Canal Company operates the irrigation system south of Gould Wash to about 3000 South as shown on Figure 6-1. The company would like to convert the system to pressurized irrigation and turn it over to the City.

The purpose of pressurizing the Hurricane Canal Company system and merging it with the City irrigation system is to increase irrigation efficiency. The proposed project would convert approximately 710 acres of flood-irrigated land to pressurized, sprinkler-irrigated land. Water losses associated with flood irrigation—such as excess runoff, infiltration, canal leakage, and evapotranspiration—would be reduced by converting to a pressurized, sprinklered system. The goal and purpose of the project would be to increase irrigation efficiency so that the limited water resources available are used to the maximum extent possible by Hurricane City residents.

A technical analysis was completed for the Hurricane Irrigation Efficiency site by BC&A and documented in TM-05 (BC&A 2019c). The following paragraphs summarize the findings from TM-05.

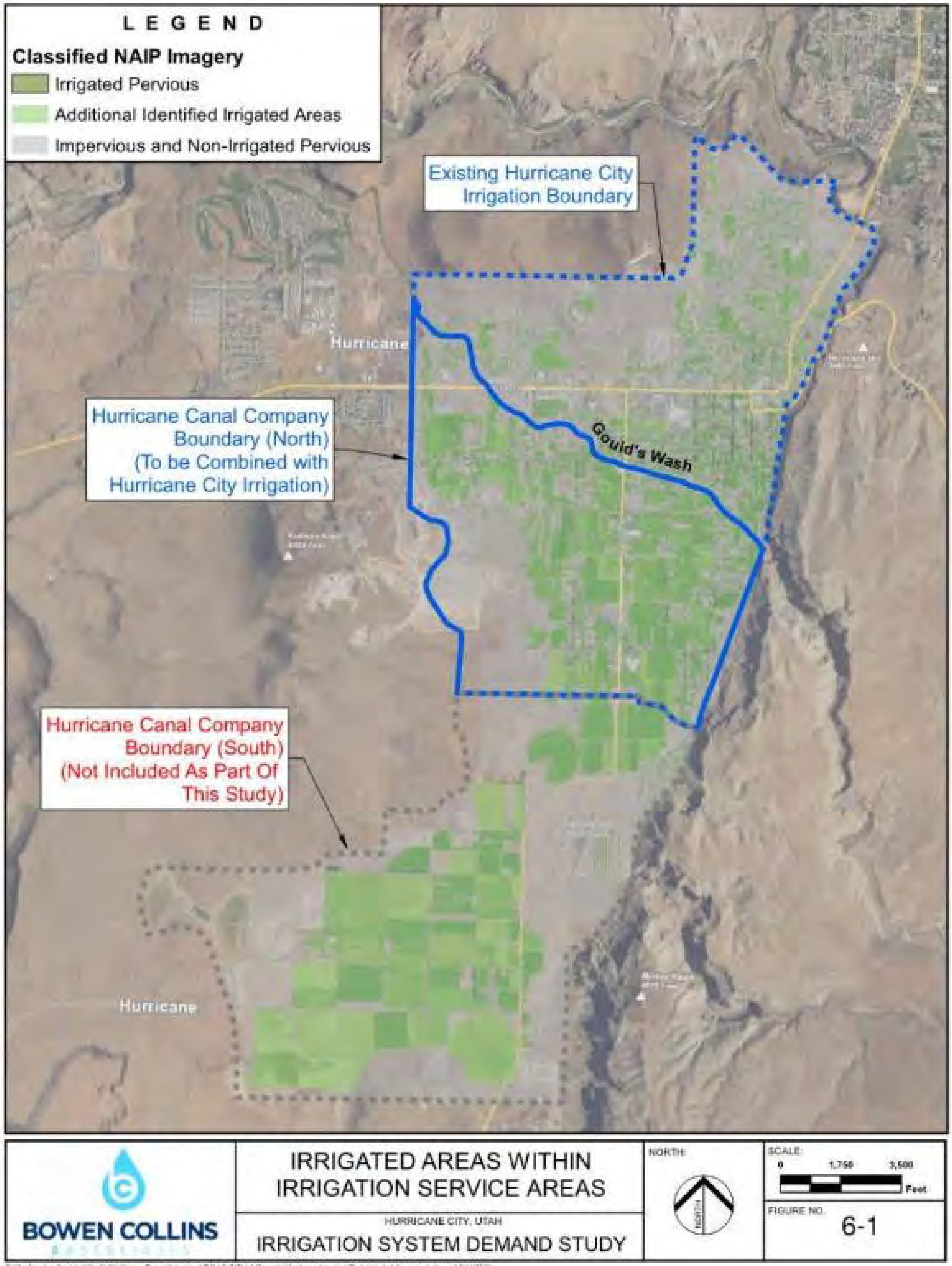

Figure 6-1. Project Location and Irrigated Acreage

6.2 System Water Supply

Currently, both the City and Hurricane Canal Company receive irrigation water from the Washington County Water Conservancy District (WCWCD). The volume and flow rate of water available are defined by an Agreement between the Hurricane Canal Company and WCWCD. The Agreement defines the availability, volume, and flow rate of water as follows:

> *…the District agrees to deliver Hurricane its water as follows:*
>
> *(a) 15,000 acre feet annually at a rate not to exceed 45 cubic feet per second (cfs) of water any year when the flow of the Virgin River is average or above average, provided that during the months of July and August of each year, Hurricane must coordinate the delivery of water in excess of 32 cfs with the District in order to avoid any adverse impacts on power generation from the District's hydrogenating facilities;*
>
> *(b) 12,000 acre feet annually at a rate not to exceed 45 cfs of water during any year when the flow of the Virgin River is below average, provided that during the months of July and August of each year, Hurricane must coordinate the delivery of water in excess of 32 cfs with District in order to avoid any adverse impacts on power generation from the District's hydrogenating facilities;*
>
> *(c) The determination of the percent of average flow of the Virgin River to serve as the basis upon which to make the deliveries provided for above shall be made each year and shall be determined as of May 1 each year by reference to the water supply forecast for the Virgin River near Hurricane as determined by the United States Soil Conservation Service (SCS) or other National Weather Service – whichever service or successor provides the current water supply forecast for the Virgin River;*

6.3 Existing Annual Irrigation Demands

The historical irrigation usage data was utilized to determine an average annual demand for a given acreage. The average annual demands in the system were combined with GIS data to distribute the demands throughout the irrigation service area.

6.3.1 Total Existing Annual Demand

To determine the existing annual demand, historical monthly water usage records were obtained from the distribution pipeline meters that feed the respective systems. A summary of recent annual water usage for the two irrigation systems is found in Table 6-1.

Table 6-1. Annual Irrigation System Water Usage Summary

Year	Annual Water Usage (ac-ft/yr)		
	Hurricane City Irrigation	Hurricane Canal Company	Total
2013	1,287.0	8,411.0	9,698.0
2014	1,362.4	8,808.0	10,170.4
2015	1,364.0	9,856.3	11,220.3
2016	1,405.7	9,701.0	11,106.7
2017	1,403.0	9,997.8	11,400.8
Average	**1,364.4**	**9,354.8**	**10,719.2**

NOTE: DATA OBTAINED FROM WCWCD

Table 6-1 indicates that annual usage from both irrigation systems increased slightly over the period from 2013 to 2017. The average annual water usage for both irrigation systems is approximately 10,719 acre-feet.

6.3.2 Irrigation Application Rate per Irrigated Acre

GIS data and tools were used to determine the total existing irrigated area within the service area. Irrigated areas were developed separately as either residential or agricultural to quantify demands using the specific irrigation application rate. Based on this analysis, the total irrigated area within the City and Company service areas in 2016 was approximately 1,735 acres. Using the 2016 irrigation area and the 2016 irrigation system water usage rate, the irrigation application rate per irrigated acre was calculated for both the City and Company service areas. These 2016 irrigation application rates are considered the baseline demands for this study and are provided in Table 6-2.

Table 6-2. 2016 Annual Existing irrigation System water Usage/Rate Summary

Service Area	Annual Water Usage (ac-ft)	Irrigated Area (acres)	Annual Average Irrigation Rate (ac-ft/yr/irrigated acre)
Hurricane City Irrigation	1,405.7	340.2	4.1
Hurricane Canal Company	9701.0	1,394.8	7.0
Total	11,106.7	1,735.0	-

6.4 Peak System Demand Estimates

6.4.1 Existing Peak Day Demand

Peak day demand (PDD) refers to the volume of water consumed during the highest usage day over the course of the year. In order to estimate the existing PDD for irrigation water use, historical flow data was evaluated. Table 6-3 provides the historical monthly water usage in 2016. Also shown in the table is the ratio of peak month flow to average month flow known as the Peak Month Factor.

Table 6-3. 2016 Estimated Peak Day Demand Multiplier for the Irrigation System

Month	Monthly Measured Water Usage (ac-ft)*	
	Hurricane City Irrigation	Hurricane Canal Company
January	12.5	3.0
February	19.5	64.0
March	104.5	804.0
April	93.6	853.0
May	145.5	1224.0
June	236.4	1403.0
July	228.4	1523.0
August	188.6	1234.0
September	147.6	1125.0
October	141.4	1241.0
November	64.1	221.0
December	23.6	6.0
Average Monthly Outdoor Demand	117.1	808.4
Peak Month Demand Factor	2.02	1.88
Peak Day Demand Factor (1.15 x Peak Month Factor)	**2.32**	**2.16**

* Data obtained from WCWCD

PDD factor was estimated by multiplying the Peak Month Demand Factor by 1.15 as shown in Table 6-3. The PDD per irrigated acre was estimated by converting the average annual application rate per irrigated acre from acre-feet/year to gallons per minute (gpm) and multiplying the value by the PDD factor. The estimated PDD per irrigated acre for Hurricane City and the Canal Company was calculated to be 5.90 gpm and 9.36 gpm, respectably.

In addition to the peak day demands estimated above for the project service area, the passthrough flow to the Bench Lake area must also be included in the total peak day demand evaluation. The Bench Lake area is located south of the project area and is identified as the Hurricane Canal Company Boundary (South) on Figure 6-1. The Hurricane Canal Company delivers up to 20 cfs through a 36” pipeline for use in the Bench Lake area.

6.4.2 Future Peak Day Demand

The future residential irrigation rate is assumed to be equal to the existing residential irrigation rate as residential areas are already utilizing pressurized sprinkler irrigation. However, one goal of the Hurricane Irrigation System Efficiency Project is to convert the existing flood irrigation system for agriculture areas with pressurized, sprinkler irrigation. To determine the future irrigation rate and PDD for agricultural areas, the water requirement for a representative crop (alfalfa) was calculated. Two methods were used to estimate the PDD for a sprinkler irrigation system: the Blaney-Criddle Formula and the method outlined in the NRCS Irrigation Guide, which are provided as follows:

Blaney-Criddle Formula = 8.50 gpm/acre

NRCS Irrigation Guide = 8.48 gpm/acre

As shown, both methods provide similar estimates for calculating the PDD for agricultural areas, so a PDD of 8.50 gpm/acre was utilized in the hydraulic evaluation.

6.4.3 Irrigation Efficiency

Flood irrigation systems are typically less efficient than sprinkler systems because of losses at the point of application, evaporation, and operational losses. Typical application efficiencies for furrow surface irrigation systems are reported as 35-60%, while a sprinkler irrigation system is reported to have 60-75% efficiency (for a stationary lateral system) (Neibling, 1997). The proposed project will convert these flood irrigated areas to sprinkler irrigated areas.

Based on typical average system efficiencies referenced above, pressurized sprinkler irrigation is up to 40% more efficient than flood irrigation. The Hurricane Canal Company irrigation system currently utilizes some pressurized pipelines to convey water through its system. These pipelines do not have the evaporation or leakage losses that are associated with a typical ditch conveyance system. For this reason, the existing Company system is likely slightly more efficient than the average flood irrigation system. Therefore, it is assumed that the proposed pressurized sprinkler irrigation system is approximately 20% to 30% more efficient than the existing Company flood irrigation system. The agricultural lands within the combined service area use approximately 4,000 ac-ft of water per year, based on recent measured water usage. Applying the estimated efficiency savings to this value equates to approximately 800 to 1,200 ac-ft per year of water savings, and up to 1,050 to 1,600 ac-ft per year in a wet year, if the proposed combined system completely converts to sprinkler irrigation.

6.4.4 Peaking Factors

As noted in Section 6.4.1, PDD refers to the average daily flow during the day in which total demand is the highest of the year. In practice, irrigation demand does not occur at a constant rate throughout the day, but at concentrated peak times, typically in the mornings or evenings. These peak hour times result in flow rates higher than the peak day demand. These peak flows can be accounted for in the hydraulic modeling by applying peaking factors.

To account for the higher flows during peak hour times, it was assumed that residential areas were irrigated for 12 hours per day (only watering at low evaporation times of the day as required by local ordinances). This assumption equates to a peaking factor of 2.0, which is typical for residential irrigation applications.

For agricultural areas, irrigation demands can typically occur throughout the day and night. The amount of water required for a field within a given time period is based on the type of crop being cultivated. For alfalfa, NRCS-Utah has determined that the peak daily water requirement is 0.29 inches per day for the Southern Utah region. For this study, it was assumed that irrigation occurs for 22 hours per day to allow an hour per day for operation and maintenance of the irrigation system. This assumption is reflected in the NRCS-Utah net irrigation required table. The PDD for agriculture areas accounts for crop net irrigation required, system efficiency, and application time. A peaking factor of 10% was then applied to the calculated PDD to account for system operational inefficiencies, which is typical for agricultural irrigation applications. A summary of the peak day and peak hour demands for residential and agricultural irrigation is found in Table 6-4.

Table 6-4. Peak Day and Peak Hour Demand Summary

Land Use Type	Acreage[2]	Peak Day Demand		Peak Hour Demand	
		gpm/acre	gpm[1]	gpm/acre	gpm[1]
Residential/Commercial	465	5.90	2,744	11.80	5,487
Agricultural	584	8.50	4,964	9.27	5,414
SUBTOTAL	1,049	-	7,708	-	10,901
Bench Lake Area Passthrough Flow	N/A	-	8,975	-	8,975
TOTAL DEMANDS		-	16,683	-	20,681

1. Based on the total residential or agricultural irrigated acreage times the demand/area
2. Acreage includes the combined Hurricane City service area (irrigated area north of 1500 South), but does not include irrigated area in Bench Lake area

The relatively small difference between the peak day and the peak hour demands for agricultural areas is due to scheduling water use on a turn-based system. A turn-based system delivers consistent irrigation flows by controlling when and where irrigation occurs. An on-demand system for agricultural irrigation would require a 2.0 peaking factor, similar to residential areas, and would require higher capacity infrastructure to accommodate. It is anticipated that agricultural irrigation will continue to be delivered on a turn basis.

6.5 Estimating Storage and Pump Station Size

Irrigation system storage ponds and pump stations are sized based on the peak day and peak hour demands for a given service area. The following sections discuss pond and pump station sizing.

6.5.1 Storage Pond Sizing

Irrigation system storage ponds are sized to provide the necessary water to supply the system for periods when peak hour demand exceeds the peak day supply. This type of storage is commonly referred to as equalization storage. Typical recommended equalization storage is 50% of the PDD for residential irrigation, and 12.5% of the PDD for agriculture irrigation. This includes sufficient storage to provide for expected fluctuations in storage during system operation, as well as additional storage for unexpected fluctuations in demand, emergencies, variable supply, and for general operational flexibility. It is important to remember that equalization storage is used daily during the summer; therefore, the equalization storage needs to have a water supply that can at least meet the total PDD.

As the service area develops and agriculture land is converted to residential and/or commercial land, the demand for storage will increase. The overall PDD will decrease over time as land use changes from agricultural to residential, but the recommended equalization storage as a percentage of that PDD will increase. A comparison of the storage requirements for the existing conditions scenario and a future buildout scenario is provided in Table 6-5. To estimate future buildout, it was assumed that residential areas would develop throughout the entire combined service area at a similar density to the residential areas in the current Hurricane City Irrigation service area. The ratio of irrigated area to total service area was determined for the City system and then applied to the total combined service area to determine the total future residential/commercial irrigated area at buildout.

Table 6-5. Existing and Future Buildout Storage Sizing Requirements

Land Use	Irrigated Area (acres)		Required Storage (MG)	
	Existing*	Buildout	Existing	Buildout
Residential/Commercial	465	1195	1.98	5.08
Agricultural	1653	0	2.53	0.00
Total	465	1195	4.50	**5.08**

* Existing acreage for the entire potential service area, including the Bench Lake area

A detailed growth projection analysis was not performed as part of this irrigation efficiency study. The future buildout scenario was evaluated to compare required storage of existing use (which consists of both residential and agriculture irrigation), and future buildout (assuming all agriculture land use is converted to residential/commercial, as described above). Table 6-5 indicates that the future storage required is 5.08 MG, or approximately 13% higher than the storage required assuming existing land use.

For the purposes of this evaluation, 6 million gallons (MGs) of additional storage is recommended to meet the existing storage demands and to provide operational flexibility, sediment storage, and equalization storage. This storage volume is also sufficient to meet future buildout storage demands.

6.5.2 Pump Station Sizing

The size of a proposed irrigation pump station is estimated based on the peak day demands, peak hour demands, and pond storage volume of the irrigation system. The proposed alternatives evaluated in this study each include a pump station. Depending on the alternative, the proposed pump station must be able to deliver the total PDD volume if pumping to the storage ponds, or the maximum peak hour flow rate if pumping directly into the delivery system. The operations of the proposed pump stations for each of the alternatives are as follows:

- Expanding Existing Irrigation Facilities (Alternative 1): Additional capacity at existing pump station to deliver higher flows to the expanded storage pond. Includes an additional pump station sized to deliver the peak hour demand (pumped into the distribution system on the south end of the service area).
- Higher Reservoir and New Pump Station (Alternative 2): Includes a pump station to deliver the PDD to a pond at a higher elevation. The pond is located farther away (compared to the pond location for Alternative 3) at a higher elevation point and requires additional piping to connect the pump station to the storage pond. The gravity outflow from the pond can deliver peak hour demand directly to the distribution system.
- Lower Reservoir and New Pump Station (Alternative 3): Includes a storage pond at a lower elevation (compared to the pond location for Alternative 2). The pump station is sized to deliver the full peak hour demand (pumped out of the pond into the distribution system), but requires less piping.

The pump station flow rates and horsepower were calculated using the irrigation system hydraulic model with PDD and peak hour demands as inputs. A summary of the sizing of the pump stations is provided in Table 6-6.

Table 6-6. Summary of Pump Station Sizing

Scenarios	Nominal Flowrate (gpm)	Head (ft)	Calculated Horsepower (hp)	Additional Piping
Alternative #1 (Expand Existing)	6,100	120	385	900 LF of 20” pipe
Alternative #1 (New Southern PS)	7,100	130	486	None
Alternative #2	5,300	120	335	6,000 LF of 30” pipe
Alternative #3	7,100	130	486	None

6.6 Hydraulic Modeling

Hydraulic models were developed to evaluate the hydraulic performance of the existing irrigation system and the proposed irrigation system alternatives. The Hurricane City Water Department provided pipeline size and location data throughout the City and Company service areas. Demands were distributed throughout the service area in the model using GIS software and data, based on the results of the irrigation demand study described in Section 6.4.

The hydraulic model was used to determine if each of the proposed alternatives is hydraulically capable of meeting the irrigation system demands, while complying with the requirements outlined in the NRCS Conservation Practice Standard for Irrigation Pipelines (NRCS 1997). The model was also utilized to verify the capacity and horsepower of the pump stations for each alternative.

6.6.1 Data Source and Model Development

Data and assumptions used to develop the hydraulic model are listed below:

- Existing pipeline locations and size — Hurricane City GIS
- Surface elevation data — 2017 1-meter LiDAR from Utah AGRC
- Residential area application rate — 5.60 gpm per irrigated area
- Agricultural area application rate — 8.50 gpm per irrigated area
- Hazen Williams Roughness Coefficient — 110

The purpose of the hydraulic evaluation is to determine whether the proposed alternative improvements to the City irrigation system are hydraulically capable of meeting irrigation demands within the design criteria established. As stated in the NRCS Irrigation Pipeline Standards, the working pressure within each pipe should not exceed 72% of the pipe rating and maximum velocities through the irrigation system are not to exceed 5 feet per second (fps).

6.7 Alternative Evaluation

The process of formulating alternatives to provide irrigation water within Hurricane City area followed procedures outlined in the NWPM (NRCS 2015a), NWPH (NRCS 2014), P&G (USWRC 1983), and other NRCS watershed planning policy.

The following alternatives were evaluated for the proposed irrigation system.

1. Expanding Existing Irrigation Facilities (Alternative 1): Additional 6 MG of storage is added adjacent to the existing 3 MG storage pond at elevation 3,480 feet. The existing booster pump station to the pond would be enlarged from approximately 4,500 gpm to 10,600 gpm. An additional 7,100 gpm booster pump station is required at the south end of the service area to provide sufficient pressure south of Gould Wash.
2. Higher Reservoir and New Pump Station (Alternative 2): Additional storage is provided through the new 6 MG of active storage on the south end of the irrigation system at elevation 3,435 feet. This alternative requires a 5,300-gpm pump station to pump water from the irrigation system to the new storage pond.
3. Lower Reservoir and New Pump Station (Alternative 3): Similar to Alternative 2, however the additional 6 MG of active storage is lower in elevation than that of the current pond, at 3,330 feet. This alternative requires a 7,100-gpm pump station to pump water back into the irrigation system from the storage pond.
4. No Action Alternative – Most likely future condition if none of the federally-assisted action alternatives are selected.

The Lower Reservoir and New Pump Station Alternative (Alternative 3) was chosen as the preferred alternative for the project. Concept Design Drawings for this alternative are included in Attachment 5.

6.7.1 Expanding Existing Irrigation Facilities (Alternative 1)

This alternative consists of expanding storage by providing additional storage ponds near the existing 3-MG storage ponds at the north end of the service area. The existing pump station feeding the storage pond is expanded to deliver higher flows to the enlarged storage facilities. The Company and City irrigation systems are combined, as discussed previously, and the flood irrigation infrastructure is converted to pressurized sprinkler irrigation.

The cost and non-cost factors associated with this alternative are as follows:

- Anticipated highest capital and operation cost of the proposed alternatives due to higher pump station and additional pipeline costs when compared to the other alternatives.
- Operational flexibility is improved due to additional storage volume.
- Less dependent on river flow rate fluctuations due to additional storage volume.
- More efficient system due to conversion from flood irrigation to pressurized sprinkler irrigation.
- Proposed additional storage ponds are located within current tortoise habitat, which will require a significant permitting effort, potentially raising costs and significantly delaying the project schedule.

- High potential environmental impact due to construction activity in sensitive habitats.

6.7.1.1 Estimated Construction Cost – Alternative 1

The estimated construction cost for Alternative 1 is 12,891,000 (Table 6-7).

Table 6-7. Alternative 1 Estimated Construction Cost – Expanding Existing Irrigation Facilities

Item No.	Classification of Unit Price Work	Quantity	Unit	Unit Price	Amount
1	Mobilization	1	LS	$472,210	$472,210
2	6" C-900 PVC Pipe	36,500	LF	$35	$1,277,500
3	8" C-900 PVC Pipe	1,800	LF	$40	$72,000
4	12" C-900 PVC Pipe	3,900	LF	$50	$195,000
5	Replace Concrete Pipe w/ 15" C-900 PVC Pipe	6,600	LF	$66	$435,600
6	16" C-900 PVC Pipe	100	LF	$70	$7,000
7	20" C-900 PVC Pip	900	LF	$85	$76,500
8	24" C-900 PVC Pipe	1,400	LF	$99	$138,600
9	30" C-900 PVC Pipe	6,800	LF	$115	$782,000
10	Concrete Turnout removal and 15" PVC Pipe repair	7	EA	$5,000	$35,000
11	Additional Interconnections	2	EA	$15,000	$30,000
12	Service Connection	700	EA	$1,300	$910,000
13	3.0 MG Settling Pond	2	EA	$750,000	$1,500,000
14	1.3 MG Sludge Pond	1	EA	$350,000	$350,000
15	7,100 gpm Pump Station	1	LS	$1,215,000	$1,215,000
16	6,100 gpm Pump Station (Expand existing)	1	LS	$920,000	920,000
17	Flow Control Valve	1	LS	$100,000	$100,000
18	Asphalt Replacement (3" Asphalt over 6" Roadbase)	350,000	SF	$4	$1,400,000
				Subtotal[1]	**$9,916,000**
				Contingency (30%)[1]	**$2,975,000**
				Total[1]	**$12,891,000**

1 - Costs have been rounded to the nearest thousand dollars.

6.7.2 Higher Reservoir and New Pump Station (Alternative 2)

Alternative 2 consists of expanding storage by providing additional storage ponds near the southwest end of the service area. The proposed ponds are located at 3,435 feet elevation, enough to provide pressure to the south service area. A pump station is required to boost water from the irrigation system to the proposed new storage ponds. The Company and City irrigation systems are combined and the flood irrigation infrastructure is converted to pressurized sprinkler irrigation.

The cost and non-cost factors associated with this alternative are as follows:

- Operational flexibility is improved due to additional storage volume and by having storage facilities at each end of the service area.
- Less dependent on river flow rate fluctuations due to additional storage volume.
- More efficient due to conversion to pressurized sprinkler irrigation.
- High capital cost due to the additional pipeline length required to locate the proposed storage ponds at a higher elevation.
- Larger potential environmental impact during construction (compared to Alternative 3) due to longer pipeline to the storage ponds, but no tortoise habitat encroachment.
- New pump station would pump water prior to de-silting, resulting in considerable pump maintenance.
- Operational benefit: Water delivery from storage pond to distribution system is based on gravity flow, and not dependent on powered pumps.

6.7.2.1 Estimated Construction Cost – Alternative 2

The estimated construction cost for Alternative 2 is $11,961,000 (Table 6-8).

Table 6-8. Alternative 2 Estimated Construction Cost – Higher Reservoir and New Pump Station

Item No.	Classification of Unit Price Work	Quantity	Unit	Unit Price	Amount
1	Mobilization	1	LS	$438,135	$438,135
2	6" C-900 PVC Pipe	36,500	LF	$35	$1,277,500
3	8" C-900 PVC Pipe	1,800	LF	$40	$72,000
4	12" C-900 PVC Pipe	3,900	LF	$50	$195,000
5	Replace Concrete Pipe w/ 15" C-900 PVC Pipe	6,600	LF	$66	$435,600
6	16" C-900 PVC Pipe	100	LF	$70	$7,000
7	24" C-900 PVC Pipe	1,400	LF	$99	$138,600
8	30" C-900 PVC Pipe	12,800	LF	$115	$1,472,000
9	Concrete Turnout removal and 15" PVC Pipe repair	7	EA	$5,000	$35,000
10	Additional Interconnections	2	EA	$15,000	$30,000
11	Service Connection	700	EA	$1,300	$910,000
12	3.0 MG Settling Pond	2	EA	$750,000	$1,500,000
13	1.3 MG Sludge Pond	1	EA	$350,000	$350,000
14	5,300 gpm Pump Station	1	LS	$840,000	$840,000
15	Flow Control Valve	1	LS	$100,000	$100,000
16	Asphalt Replacement (3" Asphalt over 6" Roadbase)	350,000	SF	$4	$1,400,000
				Subtotal[1]	**$9,201,000**
				Contingency (30%)[1]	**$2,760,000**
				Total[1]	**$11,961,000**

1 - Costs have been rounded to the nearest thousand dollars.

6.7.3 Lower Reservoir and New Pump Station (Alternative 3)

Alternative 3 consists of expanding storage by providing additional storage ponds near the south end of the service area. The proposed ponds are located at a lower elevation (3,435 feet) than the existing 3-MG storage pond. A pump station is required to boost water from the proposed storage ponds back to the irrigation system to provide pressure. The Company and City irrigation systems are combined and the flood irrigation infrastructure is converted to pressurized sprinkler irrigation.

The cost and non-cost factors associated with this alternative are as follows:

- Operational flexibility is improved due to additional storage volume and by having storage facilities at each end of the service area.

- Less dependent on river flow rate fluctuations due to additional storage volume.
- More efficient due to conversion to pressurized sprinkler irrigation.
- Lowest capital cost of the alternatives considered. This alternative has $1.22 million in pump station cost with no additional pipeline cost (to storage), compared with Alternative 2.
- Lowest environmental impact of the three proposed alternatives.
- Water delivery from storage ponds is pumped, increasing operation costs, and is more susceptible to power outage or mechanical failures than Alternative 2.

6.7.3.1 Estimated Construction Cost – Alternative 3

The estimated construction cost for Alternative 3 is $11,531,000 (Table 6-9). O&M for this alternative would consist of irrigation system repairs and maintenance at $26,000 annually, or $1,300,000 over the 50-year project life.

Table 6-9. Alternative 3 Estimated Construction Cost – Lower Reservoir and New Pump Station

Item No.	Classification of Unit Price Work	Quantity	Unit	Unit Price	Amount
1	Mobilization	1	LS	$422,385	$422,385
2	6" C-900 PVC Pipe	36,500	LF	$35	$1,277,500
3	8" C-900 PVC Pipe	1,800	LF	$40	$72,000
4	12" C-900 PVC Pipe	3,900	LF	$50	$195,000
5	Replace Concrete Pipe w/ 15" C-900 PVC Pipe	6,600	LF	$66	$435,600
6	16" C-900 PVC Pipe	100	LF	$70	$7,000
7	24" C-900 PVC Pipe	1,400	LF	$99	$138,600
8	30" C-900 PVC Pipe	6,800	LF	$115	$782,000
9	Concrete Turnout removal and 15" PVC Pipe repair	7	EA	$5,000	$35,000
10	Additional Interconnections	2	EA	$15,000	$30,000
11	Service Connection	700	EA	$1,300	$910,000
12	3.0 MG Settling Pond	2	EA	$750,000	$1,500,000
13	1.3 MG Sludge Pond	1	EA	$350,000	$350,000
14	7,100 gpm Pump Station	1	LS	$1,215,000	$1,215,000
15	Flow Control Valve	1	LS	$100,000	$100,000
16	Asphalt Replacement (3" Asphalt over 6" Roadbase)	350,000	SF	$4	$1,400,000
				Subtotal[1]	**$8,870,000**
				Contingency (30%)[1]	**$2,661,000**
				Total[1]	**$11,531,000**

1 - Costs have been rounded to the nearest thousand dollars.

6.7.4 No Action Alternative

The No Action Alternative, also known as the Future-Without-Project Plan, projects the changes in resource concerns from the current condition to the condition that would exist in the future if no federal action were taken (NRCS 2015a). The No Action Alternative for this site would take one of the following courses:

- The SLO decides to construct similar irrigation projects without meeting NRCS standards, which may be more or less stringent.
- The SLO chooses to leave the irrigation system "as-is" with no future improvements.

Based on coordination with the Sponsors, the most likely course of action would be to leave the irrigation system "as-is" with no future improvements.

The O&M cost of the No Action Alternative has been provided by the City based on its current operation of the existing flood irrigation system. This includes an annual cost of $26,000, which includes repairs to the existing system, maintenance of the pipelines and structures (i.e., diversions and turnout), and operational personnel time. The Sponsors would be responsible for O&M costs associated with operation of the existing irrigation system. The cost to operate the system over the 50-year life of the project is $1,300,000.

7.0 Economic Evaluation

The NWPM (NRCS 2015a) was used as a reference for the economic analysis along with the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) (U.S. Water Resources Council 1983). P&G was developed to define a consistent set of project formulation and evaluation instructions for federal agencies that carry out water and related land resource implementation studies. The basic objective of P&G is to determine whether benefits from proposed actions exceed project costs for federally funded projects. P&G also requires that the "National Economic Development" or NED Alternative, which maximizes monetary net benefits, be selected for implementation unless there is an overriding reason for selecting another alternative based on federal, state, local, or international concerns related to the social and environmental accounts.

7.1 Benefits

Damage reduction benefits were calculated for flooding and watershed protection. Benefits were assessed based on the equivalent annual damage reduction expected through implementation of the With Project Alternative (Action Alternative) as compared with the Without Project Alternative (No Action Alternative) baseline. Assumptions and calculation of flood and watershed protection damage reduction benefits are provided below.

7.1.1 Flood Damage Reduction Benefits

The Without Project Alternative does not include flood protection measures, although it does incur installation and O&M costs. The With Project Alternative includes modifications at three sites to reduce flood damages as described below.

- Site 1 (Main Street Debris Basins) – Constructs two debris basins capable of attenuating flood flows from the upstream drainage areas for floods up to and including a 100-year flood. Modifications result in no flooding to lands, buildings, or transportation infrastructure because all flows are attenuated and conveyed through underground stormwater systems.
- Site 3 (Y-Drain) – Pipes and open channel section of the drain eliminating flooding for up to and including a 100-year flood.
- Site 4 (Warner Valley Disposal System) – Adds additional detention to help attenuate flood flows and pipes and open channel section to eliminate flooding for up to and including a 100-year flood.

The period of analysis for all alternatives is 52 years, accounting for a 50-year project life, and a 2-year installation period. All costs and benefits were discounted to a net present value, then annualized over the 50-year period of analysis using the FY2020 Federal Water Resources Discount Rate of 2.75%.

Average annual flood damages were calculated using the cumulative probability method as specified in the URB1 manual (SCS 1990). The 2-, 5-, 10-, 25-, 50-, 100-, and 500-year storm events, where applicable, for each alternative were modeled using HEC-RAS. Mapping of the flood extents, and inundation to structures, transportation infrastructure, and lands were calculated through GIS analysis.

Inundated structures and roads were classified into one of three categories: inundated less than 1 foot, inundated 1 to 3 feet, or inundated greater than 3 feet, for each storm event. Depth-damage functions were collected from the U.S. Army Corps of Engineers (USACE 1985 and 1992) to use for each type of structure. These types included mobile homes, permanent homes, commercial buildings, and other (which in this case included a church). Most of the structures damaged were homes.

Most of the homes in the damage area are one-story with no basement, so this damage function was used as a proxy for all permanent homes inundated. For the mobile homes, a separate damage function was used, as for the commercial buildings, and the other category. Commercial properties included offices, service stations, and restaurants. A composite depth-damage function was used for these.

Median replacement values for structures were calculated from data collected from realtor data, property tax records, or if not available, by estimating the construction cost based on the square footage (Table 7-4).

Table 7-1. Structure Value Estimates

Type	Estimated Replacement Value	Source of Estimate
Mobile Homes	$86,800	80% of market value from realtor data
Homes	$156,600	tax records
Commercial	$389,200	tax records
Other (church)	$885,000	square footage cost estimate

The values in Table 7-1 were applied to the numbers of each type of structure from Table 7-2 and Table 7-3 below. Contents value was assumed 50 percent of property (replacement) value for mobile homes, homes, and the church. Contents value for commercial properties was assumed 100 percent.

Tables 7-2 and 7-3 provide the count of each type of building flooded, an approximate depth, and the estimated value of the damage.

Table 7-2. Existing Condition Flooding

Storm	Mobile Homes	Homes		Commercial	Other	Property and Contents Damage	Average Annual Damage
	<1 ft	<1 ft	1-3 ft	<1 ft	<1 ft		
2-YR	-	1	-	-	-	$17,618	$13,213
5-YR	-	4	-	-	-	$70,470	$13,213
10-YR	-	11	-	-	-	$193,793	$64,055
25-YR	-	87	-	5	-	$1,941,383	$49,894
50-YR	-	130	-	9	1	$3,047,988	$39,162
100-YR	2	182	4	16	1	$4,784,482	$25,983
200-YR	4	206	5	20	1	$5,608,664	$17,986
500-YR	5	227	9	22	1	$6,382,110	$12,764
Total							**$236,271**

Table 7-3. Preferred Alternative Flooding

Storm	Mobile Homes	Homes		Commercial	Other	Property and Contents Damage	Average Annual Damage
	<1 ft	<1 ft	1-3 ft	<1 ft	<1 ft		
2-YR	-	1	-	-	-	$17,618	$m7,928
5-YR	-	2	-	-	-	$35,235	$5,285
10-YR	-	4	-	-	-	$70,470	$5,285
25-YR	-	6	-	-	-	$105,705	$2,114
50-YR	-	6	-	-	-	$105,705	$1,145
100-YR	-	7	-	-	-	$123,323	$7,337
200-YR	1	122	-	8	-	$2,811,437	$9,311
500-YR	1	140	-	11	1	$3,395,873	$6,792
Total							**$45,197**

The project measures as modeled reduce average annual flood damage from $236,271 to $45,197, a $191,074 reduction. It should be noted that there is minor flood control from the Y-drain and Warner disposal sites, amounting to almost $10,000 annually, protecting twelve structures from the 100-year event. The control for all measures will start in year three after installation is complete, so the benefits were discounted to an NPV, then amortized over the evaluation period of 50 years.

Table 7-4 provides floodwater damage reduction benefits calculated for the With Project and Without Project Alternatives, and the resulting damage reduction.

Table 7-4. Floodwater Damage Reduction Benefits

Item	Estimated Average Annual Damage Reduction Benefits[1]		
	With Project	Without Project	Damage Reduction
Residential	$185,000	$37,300	$147,700
Commercial	$47,400	$5,300	$42,100
Other	$600	$100	$500
Total	**$233,000**	**$42,700**	**$190,300**

1-Price base 2019. Calculated using FY 2020 Water Resources Discount Rate (2.75%), annualized over 50-year evaluation period, and 52-year period of analysis.

7.1.2 Water Efficiency Benefits

The Hurricane City Water Efficiency site (Site 5) Preferred Alternative decreases water loss from infiltration, leakage, and evapotranspiration along ditch systems. It also provides more efficient irrigation water delivery that saves approximately 800 to 1,200 ac-ft of water per year, or 1,050 to 1,600 ac-ft of water per year in a wet year.

According to P&G (U.S. Water Resources Council 1983):

(b) Goods and services: General measurement standard. The general measurement standard of the value of goods and services is defined as the willingness of users to pay for each increment of output from a plan. Such a value would be obtained if the "seller" of the output were able to apply a variable unit price and charge each user an individual price to capture the full value of the output to the user. Since it is not possible in most instances for the planner to measure the actual demand situation, four alternative techniques can be used to obtain an estimate of the total value of the output of a plan: Willingness to pay based on actual or simulated market price; change in net income; cost of the most likely alternative; and administratively established values.

Since it is not possible to measure the actual demand situation in this case, and assuming the sponsors of the project are willing to contribute toward the completion of the project and maintain it, with public support, the following from P&G was used (U.S. Water Resources Council 1983):

(1) Actual or simulated market price. If the additional output from a plan is too small to have a significant effect on price, actual or simulated market price will closely approximate the total value of the output and may be used to estimate willingness to pay. If the additional output is expected to have a significant effect on market price and if the price cannot be estimated for each increment of the change in output, a price midway between the price expected with and without the plan may be used to estimate the total value.

For purposes of analysis, the low estimate of 800 ac-ft per year savings was assumed. The price to purchase water rights in the area ranges between $2,500 and $6,000 per acre-foot (confirmed with local sources). For this project, it is assumed an average cost of water rights is $2,500 per acre-foot. The price of water rights was used as a proxy for estimating the actual market price of the saved water. Table 7-5 displays the estimates of saved water and value of the water saved.

Table 7-5. Estimated Value of Water Savings Using Actual Market Prices

Water Savings Estimates	Water Savings Ac-ft /yr	Estimated Value of Savings $/yr (@$4,000/ac-ft)	Estimated Value of Savings $/yr (@$2,500/ac-ft)
normal year low estimate	800	$3,200,000	$2,000,000
normal year high estimate	1,200	$4,800,000	$3,000,000
wet year low estimate	1,050	$4,200,000	$2,625,000
wet year high estimate	1,600	$6,400,000	$4,000,000
average all	1,163	$4,650,000	$2,906,250
average normal	1,000	$4,000,000	$2,500,000

For this project, it is assumed an average cost of water rights is $2,500 per acre-foot. This amounts to $2,000,000 per year in water efficiency savings due to reduction in leakage, infiltration, and evapotranspiration. After discounting and annualizing over 50 years with a 52-year period of analysis this equates to approximately $1,894,400 annually.

7.1.3 Recreation Benefits

Total average annual recreation benefits were estimated at $914,500. Assumptions and methods for calculation of recreation benefits are described below.

7.1.3.1 Seegmiller Marsh (Site 2)

There are anticipated economic benefits due to increased recreation use from measures to be installed at Seegmiller Marsh (Site 2). The Preferred Alternative constructs 4,000 LF of paved public trail to connect to the existing trail system. It will also construct 2,000 LF of gravel pedestrian trail, with 3 wildlife viewing stations and educational signage. An annual recreation benefit of $369,700 was estimated for Site 2 based on the assumptions below, and after discounting and annualizing over 50 years with a 52-year period of analysis.

On-site data on current recreation usage was collected for weekday and weekend usage by city employees. The survey included walkers, runners, and bikers. Over a two-day period including Friday and Saturday, nearly 4,400 visitors were observed. Accounting for weekday and weekend day usage, and accounting for droppage in the winter months, an estimate of 500,000 visitors per year was made. Once this current visitation was estimated for existing facilities to create a baseline, an increased usage due to project measures was estimated at 2 percent. The estimates may be conservative because the count was performed during the onset of the COVID-19 outbreak, and during the month of April, when usage may still be lighter.

The U.S. Fish and Wildlife Service (USFWS 2016) estimated the economic value of wildlife watching to state residents in Utah at $33 per day in 2011 dollars. This was converted to 2020 dollars ($39) and multiplied with the 2 percent increase (10,000) estimated. It should be noted there are annual local bird watching events that were not considered that would likely increase estimates. A degree of uncertainty arises from how much these measures will simply shift birdwatching to the project site from existing sites, but due to the connectivity of the trail system and the viewing stations as well as educational signage, there is expected to be new additional users.

Aside from recreation, there will be a reduction of sediment into the Virgin River. Approximately 900 cubic yards of sediment would be collected in a sediment trap system annually and would not reach the Virgin River. A dredging cost of $10 per cubic yard was used to estimate this benefit, which results in $9,000 per year, or $8,500 after discounted and annualized over 50 years with a 52-year period of analysis. The total combined annual recreation and sediment reduction benefit for Site 2 was calculated at approximately $378,200.

7.1.3.2 Y-Drain (Site 3)

The Y-Drain measures include an asphalt multipurpose trail that provides connection to the Seegmiller Trail system. The length is approximately 1,150 feet, and adjacent to a community of approximately 20 homes. A 2002 survey of home buyers (National Association of Realtors and National Association of Home Builders 2002) revealed that out of 18 local amenities, trails ranked second. Research has found that homes in the vicinity of walking or biking trails tend to sell up to 9% higher than homes of similar type and sell faster (Rails to Trails Conservancy 2003).

In this particular case a more conservative estimate of 3% was chosen because the Seegmiller Marsh is in the vicinity, and to account for uncertainty. Using the property value data collected for flooding analysis, the median property value for the area ($156,600) was multiplied by 3%, then by 20, to arrive at an annual benefit of $93,960. This amount was discounted and annualized over 50 years with a 52-year period of analysis for an annual benefit value of approximately $89,000. Trail usage was not estimated and therefore not valued.

7.1.3.3 Warner Valley Disposal System (Site 4)

The Warner Disposal measures include an asphalt multipurpose trail and a rock chat equestrian trail side-by-side. The length is approximately 11,800 feet, and is adjacent to a community of approximately 100 homes as well as farmland, primarily pasture. Using the approach for the Y-Drain site, 3% was multiplied by the median home value of $156,600 and then by 100 to arrive at an annual benefit of $469,800, or $447,300 after discounted and annualized over 50 years with a 52-year period of analysis.. Trail usage was not estimated and therefore not valued.

7.1.4 Total Project Benefits

The total benefits calculated from flood, water efficiency, and recreation for the Preferred Alternative are included in Table 7-6.

Table 7-6. Summary of Total Annual Project Benefits

Site	Estimated Average Annual Benefits[1]			
	Flood	Water Efficiency	Recreation	Total
Site 1 Main Street	$181,000	-	-	$181,000
Site 2 Seegmiller Marsh	-	-	$378,200	$378,200
Site 3 Y-Drain	$6,900	-	$89,000*	$95,900
Site 4 Warner Valley Disposal System	$2,300	-	$447,300	$449,600
Site 5 Hurricane Water Efficiency	-	$1,894,400	-	$1,894,400
Total	**$190,200**	**$1,894,400**	**$914,500**	**$2,999,100**

1 – Price base 2019. Calculated using FY 2020 Water Resources Discount Rate (2.75%), annualized over 50 years, and 52-year period of analysis.

* – Includes $369,700 for recreation benefit and $8,500 for sediment reduction benefit.

7.2 Benefits Cost Ratio

The annual project costs were calculated and compared to the annual project benefits (shown in Section 7.1.4) in order to calculate a benefit cost ratio. Table 7-7 includes the calculated benefit cost ratio and net annual economic benefits for the project.

Table 7-7. Alternative Benefit Cost Ratios[1]

Site	Total Annual Benefits	Total Annual Costs[2]	Benefit Cost Ratio	Net Annual Economic Benefit
Site 1 – Main Street	$181,000	$123,100	1.5	$57,900
Site 2 – Seegmiller Marsh	$378,200	$268,000	1.4	$110,200
Site 3 – Y-Drain	$95,900	$56,800	1.7	$39,100
Site 4 – Warner Valley Disposal System	$449,600	$326,800	1.4	$122,800
Site 5 – Hurricane Water Efficiency	$1,894,400	$680,400	2.8	$1,214,000
Total	**$2,999,100**	**$1,455,100**	**2.1**	**$1,544,000**

1 – Price base 2019. Calculated using FY 2020 Water Resources Discount Rate (2.75%), annualized over 50 years with a 52-year period of analysis.

8.0 Environmental Evaluation

The Environmental Evaluation (EE) is an NRCS planning process as described in the NRCS National Planning Procedures Handbook (NRCS 2015b). The EE identifies and analyzes the economic, environmental, and social concerns for a project. This planning process is then summarized on the CPA-52 Environmental Evaluation form for Conservation Planning. This EE planning process started with the identification of problems and opportunities and continues through the application and evaluation of the project. A CPA-52 Environmental Evaluation is provided in Attachment 6.

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Attachment 1

Main Street Debris Basin

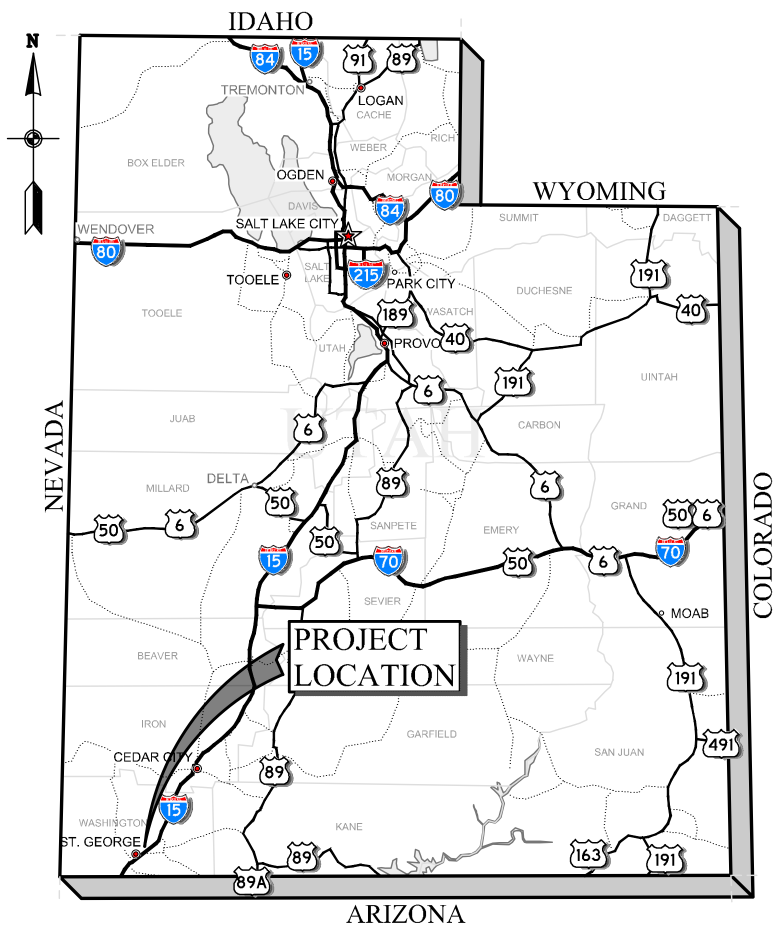
Preferred Alternative Concept Design Drawings

DRAWINGS FOR CONSTRUCTION OF THE

MAIN STREET DEBRIS BASINS PROJECT

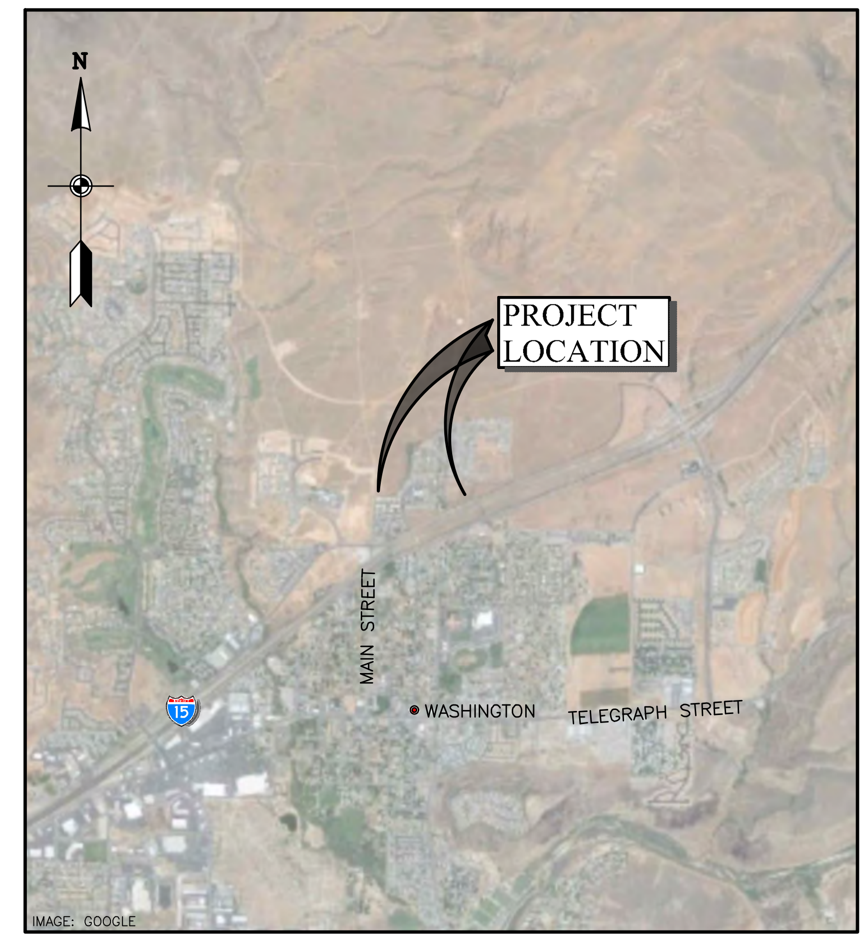
WASHINGTON COUNTY

USDA
United States Department of Agriculture
Natural Resources Conservation Service



PROJECT LOCATION MAP

INDEX OF DRAWINGS		
SHT NO.	DWG NO.	DESCRIPTION
		GENERAL
1	G–01	GENERAL
2	G–02	ABBREVIATIONS
3	G–03	SYMBOLS & NOTES
4	G–04	KEY SHEET
		CIVIL
5	C–01	MAIN STREET DEBRIS BASIN
6	C–02	MAIN STREET DEBRIS BASIN CROSS SECTIONS – 1
7	C–03	MAIN STREET DEBRIS BASIN CROSS SECTIONS – 2
8	C–04	BUENA VISTA BLVD DEBRIS BASIN
9	C–05	BUENA VISTA BLVD DEBRIS BASIN CROSS SECTIONS
		STRUCTURAL
10	S–01	PRINCIPAL SPILLWAY OUTLET STRUCTURE



PROJECT VICINITY MAP

BOWEN COLLINS & ASSOCIATES

30% REVIEW

REVISIONS

NO.	DATE	REV. BY	DESCRIPTION

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY
MAIN STREET DEBRIS BASINS
WASHINGTON, UTAH

REVIEW
CHECKED T. OLSEN
APPROVED C. MERRELL

DESIGN
DESIGN C. MERRELL
DRAWN C. NIELSON

GENERAL
INDEX OF DRAWINGS PROJECT LOCATION AND VICINITY MAPS

PROJECT NUMBER 581–18–01

DATE: FEB 2019

DRAWING NO.
G–01

SHEET 1 OF 10

S:\washington county\581–18–01 warner draw watershed ea\7.0 drawings\main street debris basins\Sheets\G–01.dwg Feb11,2019 – 8:30am

@	AT
AASHTO	AMERICAN ASSOCIATION OF STATE HIGHWAY TRANSPORTATION OFFICIALS
AB	ANCHOR BOLT
ABBR	ABBREVIATION
ABS	ACRYLONITRILE-BUTADIENE-STYRENE
AC	ASPHALTIC CONCRETE OR ALTERNATING CURRENT OR ACTIVATED CARBON
ACI	AMERICAN CONCRETE INSTITUTE
ACP	ASPHALTIC CONCRETE PAVEMENT
ADDL	ADDITIONAL
ADJ	ADJACENT OR ADJUSTABLE
AER	AERATION
AFF	ABOVE FINISH FLOOR
AGGR	AGGREGATE
AH	AIR HANDLER
AIR CONT	AIR CONDITIONING
AISC	AMERICAN INSTITUTE OF STEEL CONSTRUCTION
AL	ALUMINUM, ALUM
ALTN	ALTERNATIVE, ALTERNATE
ANOD	ANODIZED
ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE
APPROX	APPROXIMATE
APVD	APPROVED
ARCH	ARCHITECTURAL
ARV	AIR RELEASE VALVE
ASME	AMERICAN SOCIETY OF MECHANICAL ENGINEERS
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIAL
ASSY	ASSEMBLY
AUTO	AUTOMATIC
AUX	AUXILIARY
AVAR	AIR VACUUM AND AIR RELEASE VALVE
AWS	AMERICAN WELDING SOCIETY
AWWA	AMERICAN WATER WORKS ASSOCIATION
B & S	BELL & SPIGOT
BC	BEGIN CURVE, BOLT CIRCLE
BF	BLIND FLANGE, BUTTERFLY VALVE
BFG	BELOW FINISH GRADE
BFP	BACK FLOW PREVENTER
BFV	BUTTERFLY VALVE
BHD	BULKHEAD
BHP	BRAKE HORSEPOWER
BLDG	BUILDING
BLK	BLACK OR BLOCK
BLKG	BLOCKING
BLT	BOLT
BM	BEAM, BENCH MARK
BO	BLOW-OFF ASSEMBLY, BLOW-OFF
BOT	BOTTOM
BPS	BOOSTER PUMPING STATION
BPV	BACK PRESSURE VALVE
BRK	BRICK
BTU	BRITISH THERMAL UNIT
BTWN	BETWEEN
BUR	BUILT-UP ROOFING
BVC	BEGIN VERTICAL CURVE
BVCE	BEGIN VERTICAL CURVE ELEVATION
BVCS	BEGIN VERTICAL CURVE STATION
BW	BACK WASH, FILTER BACKWASH
C	CENTIGRADE OR CELSIUS
CAB	CABINET
CAP	CAPACITY
CARV	COMBINATION AIR RELEASE VALVE
CB	CATCH BASIN
CC	CENTER TO CENTER
CCP	CONCRETE CYLINDER PIPE
CD	CEILING DIFFUSER CHEMICAL DRAIN AND VENT
CER	CERAMIC
CFH	CUBIC FEET PER HOUR
CFM	CUBIC FEET PER MINUTE
CFR	CODE OF FEDERAL REGULATIONS
CFS	CUBIC FEET PER SECOND
CG	CHLORINE GAS
CGB	CORD GRIP BUSHING
CHBD	CHALKBOARD
CHEM	CHEMICAL
CHG	CHANGE
CHKD PL	CHECKERED PLATE
CI	CAST IRON
CIP	CAST IRON PIPE
CISP	CAST IRON SOIL PIPE
CJ	CONSTRUCTION JOINT
CJP	COMPLETE JOINT PENETRATION
CL	CHLORINATOR, CHAIN LINK, CENTERLINE OR CHLORINE
CLR	CLEAR, CLEARANCE
CLST	CEMENT LINED STEEL PIPE
CLSM	CONTROLLED LOW STRENGTH MATERIAL
CM	CENTIMETER
CML & C	CEMENT MORTAR LINED AND COATED
CMP	CORRUGATED METAL PIPE
CMU	CONCRETE MASONRY UNIT
CO	CLEANOUT
COL	COLUMN
COMM	COMMUNICATION
COMB	COMBINED
CONC	CONCRETE, CONCENTRIC
COND	CONDENSER, CONDENSATE
CONN	CONNECTION
CONST	CONSTRUCTION, CONSTRUCT
CONT	CONTINUED, CONTINUOUS, CONTINUATION
COORD	COORDINATE
COP	COPPER
COTG	CLEAN-OUT TO GRADE
CPLG	COUPLING
CPS	CULINARY PUMP STATION
CPVC	CHLORINATED POLYVINYL CHLORIDE
CS	CAST STEEL OR CAUSTIC SODA
CTRD	CENTERED
CTR	CENTER
CTSK	COUNTERSUNK
CU FT	CUBIC FOOT
CU IN	CUBIC INCH
CU YD	CUBIC YARD
CULV	CULVERT
CV	CHECK VALVE
CW	COLD WATER
CWO	CHAIN WHEEL OPERATOR
CYL	CYLINDER
d	PENNY
DBA	DEFORMED ANCHOR
DBL	DOUBLE
DC	DIRECT CURRENT
DEG	DEGREE
DEMO	DEMOLITION, DEMOLISH
DEQ	DEPARTMENT OF ENVIRONMENTAL QUALITY
DET	DETAIL
DI	DUCTILE IRON, DROP INLET
DIA	DIAMETER
DIAG	DIAGONAL
DIAPH	DIAPHRAGM
DIFF	DIFFUSER
DIM	DIMENSION
DIP	DUCTILE IRON PIPE
DIR	DIRECTION
DISCH	DISCHARGE
DIST	DISTANCE
DIV	DIVISION
D-LOAD	LOADING CONDITION FOR RCP
DMPR	DAMPER
DN	DOWN, DECANT
DOT	DEPARTMENT OF TRANSPORTATION
DP	DAMP PROOFING
DR	DOOR, DRAIN
DS	DRENCH SHOWER & EYE WASH, DOWNSPOUT
DWG	DRAWING
DWL	DOWEL
E(UG)	ELECTRICAL (UNDERGROUND)
E(OH)	ELECTRICAL (OVERHEAD POWER)
E	EAST
EA	EACH
EB	EXPANSION BOLT
EC	END CURVE
ECC	ECCENTRIC
EF	EACH FACE, EXHAUST FAN
EFF	EFFLUENT
EG	EXISTING GRADE
EL	ELEVATION
ELB	ELBOW
ELEV	ELEVATION
ELEC	ELECTRICAL, ELECTRONIC
EMB	EMBEDMENT
EMER	EMERGENCY
ENCL	ENCLOSURE
ENG	ENGINE
ENGR	ENGINEER
EP	EDGE OF PAVEMENT
EPDM	ETHYL PROPYLENE DIENE MONOMER
EPS	EXPANDED POLYSTYRENE
EQ	EQUAL
EQL SP	EQUALLY SPACED
EQUIP	EQUIPMENT
ETC	ETCETERA
EVAP	EVAPORATOR
EVC	END VERTICAL CURVE
EVCE	END VERTICAL CURVE ELEVATION
EVCS	END VERTICAL CURVE STATION
EW	EACH WAY, EYE WASH
EXH	EXHAUST
EXIST	EXISTING
EXP ANR	EXPANSION BOLT, ANCHOR
EXP JT	EXPANSION JOINT
EXT	EXTERIOR, EXTENSION, EXTERNAL
F	FAHRENHEIT, FACE
F TO F	FACE TO FACE
FAB	FABRICATION, FABRICATE, OR FABRICATED
FB	FLAT BAR
FC	FLEXIBLE COUPLING
FCA	FLANGE COUPLING ADAPTER
FCO	FLOOR CLEANOUT
FD	FLOOR DRAIN
FDN	FOUNDATION
FDR	FEEDER
FEXT	FIRE EXTINGUISHER
FF	FLAT FACE, FAR FACE, FINISH FLOOR
FG	FINISH GRADE, FLOW GLASS
FH	FIRE HYDRANT
FLR	FLOOR
FL	FLOW LINE
FLEX	FLEXIBLE
FLG	FLANGE
FM	FORCE MAIN (SANITARY SEWER)
FND	FOUND
FNSH	FINISH
FO	FIBER OPTIC
FRP	FIBERGLASS REINFORCED PLASTIC
FW	FINISH WATER
FWR	FINISH WATER RESERVOIR
G	GAS
GA	GAGE, GAUGE
GAL	GALLON
GALV	GALVANIZED
GEN	GENERATOR
GFI	GROUND FAULT INTERRUPTER
GI	GALVANIZED IRON
GIS	GEOGRAPHIC INFORMATION SYSTEM
GL	GLASS
GLAZ	GLAZING
GLV	GLOBE VALVE
GND	GROUND
GPD	GALLONS PER DAY
GPH	GALLONS PER HOUR
GPM	GALLONS PER MINUTE
GR	GRADE
GR BRK	GRADE BREAK, GRADE CHANGE
GRTG	GRATING
GRV	GROOVED
GSP	GALVANIZED STEEL PIPE
GV	GATE VALVE
GYP	GYPSUM BOARD
H	HEIGHT
HAS	HEADED ANCHOR STUD
HB	HOSE BIBB
HD	HUB DRAIN
HDPE	HIGH DENSITY POLYETHYLENE
HDR	HEADER
HDW	HARDWARE
HEX	HEXAGONAL
HGR	HANGER
HM	HOLLOW METAL
HORIZ	HORIZONTAL
HP	HORSEPOWER, HIGH PRESSURE,HEAT PUMP, HIGH POINT
HR	HEATING RETURN, HOUR, HOSE RACK
HS	HIGH STRENGTH
HSS	HOLLOW STRUCTURAL SECTION
HTG	HEATING
HTR	HEATER
HV	HOSE VALVE
HVAC	HEATING, VENTILATING AND AIR CONDITIONING
HWL	HIGH WATER LEVEL
HWO	HANDWHEEL OPERATED
HYD	HYDRANT, HYDRAULIC
ICFM	INLET CUBIC FEET PER MINUTE
ID	INSIDE DIAMETER
IE	INVERT ELEVATION
IF	INSIDE FACE
IN	INCH
IN LB	INCH-POUND
INFL	INFLUENT
INSUL	INSULATING
INVT	INVERT
IOB	INLET OUTLET BYPASS
IPS	IRON PIPE SIZE
IRR	IRRIGATION
JA	JORDAN AQUEDUCT
JT	JOINT
JTS	JOINTS
JVWTP	JORDAN VALLEY WATER TREATMENT PLANT
K	KELVIN, KILO OR THOUSAND POUNDS
KG	KILOGRAM
KV	KILOVOLT
KW	KILOWATT
KWH	KILOWATT HOUR
L	LEFT OR LITER
LAB	LABORATORY
LAV	LAVATORY
LB	POUND
LC	LENGTH OF CURVE
LF	LINEAR FEET
LG	LENGTH OR LONG
LH	LEFT HAND
LIP	LIP OF GUTTER
LL	LIVE LOAD
LLV	LONG LEG VERTICAL
LOL	LENGTH OF LINE
LP	LOW POINT
LR	LONG RADIUS
LT	LIGHT, LEFT
LVL	LEVEL
LWL	LOW WATER LEVEL
LWR	LOWER
M	METER, MALE (PIPE THREAD)
MACH	MACHINE
MAN	MAGNETIC, MANUAL
MATL	MATERIAL
MAX	MAXIMUM
MB	MACHINE BOLT
MCC	MOTOR CONTROL CENTER
MECH	MECHANICAL, MECHANISM
MEMB	MEMBRANE
MET	METAL
MFR	MANUFACTURER
MG	MILLION GALLONS
MGD	MILLION GALLONS PER DAY
MH	MANHOLE, MONORAIL HOIST
MI	MALLEABLE IRON
MID	MIDDLE
MIL	1/1,000 INCH
MIN	MINIMUM OR MINUTE
MISC	MISCELLANEOUS
MJ	MECHANICAL JOINT
MO	MASONRY OPENING
MPH	MILES PER HOUR
MTG	MOUNTING
MTL	METAL OR MATERIAL
MTR	MOTOR
MWS	MAXIMUM WATER SURFACE
N	NORTH
NAVD	NORTH AMERICAN VERTICAL DATUM
NBS	NATIONAL BUREAU OF STANDARDS
NC	NORMALLY CLOSED
NE	NORTHEAST
NEC	NATIONAL ELECTRIC CODE
NEMA	NATIONAL ELECTRICAL MANUFACTURES ASSOCIATION
NF	NEAR FACE
NFPA	NATIONAL FIRE PROTECTION ASSOCIATION
NIC	NOT IN CONTRACT
NO	NUMBER OR NORMALLY OPEN
NOM	NOMINAL
NPT	NATIONAL PIPE THREAD
NS	NEAR SIDE
NSF	NATIONAL SCIENCE FOUNDATION
NTS	NOT TO SCALE
NW	NORTHWEST
O TO O	OUT TO OUT
OC	ON CENTER, OVER-CROSSING
OD	OUTSIDE DIAMETER, OVERALL DIMENSION
OF	OUTSIDE FACE, OVERFLOW
OFS	OVERFLOW STRUCTURE
OH	OVERHEAD
OPER	OPERATOR, OPERATING
OPNG	OPENING
OPP	OPPOSITE
ORIG	ORIGINAL
OVHD	OVERHEAD
OZ	OUNCE
PC	PORTLAND CEMENT, POINT OF CURVE OR PRIMARY CLARIFIER
PCC	PORTLAND CEMENT CONCRETE
PCF	POUNDS PER CUBIC FOOT
PE	PLAIN END, POLYELECTROLYTE POLYMER, POLYETHYLENE
PG	PRESSURE GAUGE
pH	HYDROGEN ION CONCENTRATION
PI	PLANT INFLUENT, POINT OF INTERSECTION
PJF	PREMOLDED JOINT FILLER
PL	PLATE, PROPERTY LINE, PLACE
PLYWD	PLYWOOD
PM	PUMP, PROPELLER METER
POB	POINT OF BEGINNING
PP	POTASSIUM PERMANGANATE
PPD	POUNDS PER DAY
PPH	POUNDS PER HOUR
PPM	PARTS PER MILLION
PR	PAIR
PRC	POINT OF REVERSE CURVE
PREFAB	PREFABRICATED
PRI	PRIMARY
PRV	PRESSURE REGULATING/REDUCING VALVE
PS	PRESSURE SWITCH, PUMP STATION
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PSIG	POUNDS PER SQUARE INCH GAUGE
PT	POINT OF TANGENT, PRESSURE TREATED
PTDF	PRESSURE TREATED DOUGLAS FIR
PV	PAVEMENT
PVC	POLYVINYL CHLORIDE
PVI	POINT OF VERTICAL INTERSECTION
PW	POTABLE WATER
RAD	RADIUS
RC	REINFORCED CONCRETE
RCP	REINFORCED CONCRETE PIPE
RD	ROOF DRAIN OR ROAD
RDCR	REDUCER, REDUCING
RECIRC	RECIRCULATION
RED	REDUCING
REF	REFERENCE, REFER
REG	REGULATING, REGISTER
REINF	REINFORCE, REINFORCED
REQD	REQUIRED
REV	REVISION
RF	ROOF, RAISED FACE
RND	ROUND
RPM	REVOLUTIONS PER MINUTE
RP	RADIUS POINT
RS	RAW SEWAGE
RST	REINFORCING STEEL, RESET
RT	REGULATING TANK, RADIOGRAPHIC, RIGHT
RV	ROOF VENT
R/W	RIGHT OF WAY
RW	RAW WATER
S	SOUTH, SECOND
SA	SAMPLE, SAMPLE LINE
SCFM	STANDARD CUBIC FEET PER MINUTE
SCH	SCHEDULE
SD	STORM DRAIN
SECT	SECTION
SHT	SHEET
SIM	SIMILAR
SLP	SLOPE
SP	SPACING, STATIC PRESSURE
SPA	SPACED
SPEC	SPECIFIED, SPECIFICATION
SPECS	SPECIFICATIONS
SPG	SPACING
SPKR	SPEAKER
SPLY	SUPPLY
SPRT	SUPPORT
SQ	SQUARE
SQ FT	SQUARE FOOT
SR	SUPPLY REGISTER
SS	SANITARY SEWER, SERVICE SINK
SST	STAINLESS STEEL
STA	STATION
STD	STANDARD
STIFF	STIFFENER
STL	STEEL
STRL	STRUCTURAL
SUC	STRUCTURAL UNDERDRAIN COLLECTOR
SWA	SOUTHWEST AQUEDUCT
SYM	SYMBOL
SYMM	SYMMETRICAL
SYS	SYSTEM
T	THICKNESS, TOP, TOILET
T&B	TOP AND BOTTOM
T&G	TONGUE AND GROOVE
TAN	TANGENT
TBC	TOP BACK OF CURB
TBM	TEMPORARY BENCH MARK
TDH	TOTAL DYNAMIC HEAD
TECH	TECHNICAL
TEL	TELEPHONE
TEMP	TEMPERATURE, TEMPORARY
THK	THICK
THR'D	THREADED
TK	TANK
TO	TOP OF
TOC	TOP OF CONCRETE
TOG	TOP OF GRADE
TP	TELEPHONE POLE, TURNING POINT
TW	TOP OF WALL
TYP	TYPICAL
UBC	UNIFORM BUILDING CODE
UD	UNDERDRAIN
UG	UNDERGROUND
UH	UNIT HEATER
UL	UNDERWRITERS LABORATORIES
UNO	UNLESS OTHERWISE NOTED
USBR	U.S. BUREAU OF RECLAMATION
V	VALVE, VENT, VOLT, VACUUM
VAR	VARIES, OR VARIABLE
VC	VERTICAL CURVE
VCP	VITRIFIED CLAY PIPE
VERT	VERTICAL
VIC	VICTAULIC COUPLING
VOL	VOLUME
VPI	VERTICAL POINT OF INFLECTION
VSS	VOLATILE SUSPENDED SOLIDS
VTC	VENT THROUGH CEILING
VTR	VENT THROUGH ROOF
W	WEST, WASTE, WIDE FLANGE (BEAM)
W/	WITH
W/O	WITHOUT
WC	WATER COLUMN OR WATER CLOSET
WCO	WALL CLEANOUT
WD	WOOD
WH	WATER HEATER
WS	WATER STOP, WATER SURFACE
WSP	WELDED STEEL PIPE
WSTP	WATER STOP
WT	WEIGHT
WWM	WELDED WIRE MESH
XMFR	TRANSFORMER
XMTR	TRANSMITTER
XS	EXTRA STRONG
YD	YARD
YP	YARD PIPING
YR	YEAR

BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY
MAIN STREET DEBRIS BASINS
WASHINGTON, UTAH

DESIGN: DESIGN STANDARDS, DRAWN STANDARDS
REVIEW: CHECKED STANDARDS, APPROVED STANDARDS

GENERAL
ABBREVIATIONS

PROJECT NUMBER 581-18-01
DATE: FEB 2019

DRAWING NO.
G-02
SHEET 2 OF 10

S:\washington county\581-18-01 warner draw watershed ea\7.0 drawings\main street debris basins\Sheets\G-02.dwg Feb11,2019 - 8:31am

SECTION IDENTIFICATION

(1) SECTION CUT SHOWN ON DRAWING AS:

SECTION LETTER — A / C-10

DRAWING NUMBER WHERE THE SECTION IS SHOWN (SEE NOTE A)

(2) THIS SECTION IS IDENTIFIED AS: — SECTION LETTER

SECTION — A / M-01
SCALE: AS DESIGNATED

DRAWING NUMBER WHERE THE SECTION CUT IS SHOWN (SEE NOTE A)

DETAIL IDENTIFICATION

(1) DETAIL IDENTIFICATION SHOWN ON DRAWING AS:

DETAIL NUMBER — 3 / C-10 — THE DETAIL NAME IS OPTIONAL AND LOCATED HERE, FOLLOWING DETAIL CALLOUT

DRAWING NUMBER WHERE THE DETAIL IS SHOWN

(2) THIS DETAIL IS IDENTIFIED AS: — DETAIL NUMBER

DETAIL — 3 / M-01
SCALE: AS DESIGNATED
(SEE NOTE A)

DRAWING NUMBER WHERE THE DETAIL IS SHOWN

TYPICAL DETAIL IDENTIFICATION

DETAIL NAME — C / 2000
NOT TO SCALE

TYPICAL DETAIL NUMBER, SEE INDEX OF DRAWINGS FOR LOCATION OF GENERAL DRAWINGS

DRAWING IDENTIFICATION SYSTEM

LETTER	DISCIPLINE
G	GENERAL
C	CIVIL
GC	GENERAL CIVIL
A	ARCHITECTURAL
GA	GENERAL ARCHITECTURAL
S	STRUCTURAL
GS	GENERAL STRUCTURAL
M	MECHANICAL
GM	GENERAL MECHANICAL
H	HVAC
E	ELECTRICAL
GE	GENERAL ELECTRICAL DETAILS
I	INSTRUMENTATION

S-2 — INDIVIDUAL DRAWING NUMBER — DISCIPLINE

NOTES:

A. IF PLAN AND SECTION (OR DETAIL CALL-OUT AND DETAIL) ARE SHOWN ON SAME DRAWING, DRAWING NUMBER IS REPLACED BY A HORIZONTAL LINE.

B. ELECTRICAL SYMBOLS SHOWN ON ELECTRICAL DRAWINGS. FOR WELDING SYMBOLS USE AMERICAN WELDING SOCIETY STANDARD SYMBOLS. SEE AMERICAN INSTITUTE OF STEEL CONSTRUCTION MANUAL.

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1 — COORDINATE IDENTIFICATION
ELEVATION INDICATOR
SECTION CORNER
BENCH MARK
MONUMENT INDICATOR
POTHOLE
TEST HOLE
BORING HOLE
SECTION LINE
PROPERTY LINE
EASEMENT
PARCEL
R/W — RIGHT-OF-WAY
NEW ASPHALT
EXISTING ASPHALT
CENTERLINE
4500 — CONTOUR LINE, FINISHED GRADE
4500 — CONTOUR LINE, EXISTING GRADE
4500.20 — FINISHED ELEVATION
(4500.20) — EXISTING ELEVATION
TOP / TOE — CUT OR FILL SLOPE TO BE CONSTRUCTED
SILT FENCE
X — FENCE
RAILING
DITCH
CULVERT
RIPRAP
TREE LINE/VEGETATION
EXISTING STRUCTURE OR FACILITY
NEW STRUCTURE OR FACILITY
FUTURE STRUCTURE OR FACILITY
NEW PIPELINE (CIVIL SHEETS)
NEW PIPELINE 10" DIA AND SMALLER (CIVIL SHEETS)
EXISTING UTILTY PIPELINE
ATMS — ATMS
CTV — CABLE
C(ug) — COMMUNICATION BURIED
COMM — COMMUNICATION OVERHEAD
P(ug) — ELECTRICAL BURIED
OHP — ELECTRICAL OVERHEAD
FO — FIBER OPTICS
GAS — GAS
IRR — IRRIGATION
PETRO — PETROLEUM LINE
SS — SANITARY SEWER
SD — STORM DRAIN
T(ug) — TELEPHONE BURIED
TEL — TELEPHONE OVERHEAD
W — WATERLINE
TV — CABLE BOX
CATCH BASIN
EB — ELECTRICAL BOX
HYDRANT
G — GAS MANHOLE
S — SEWER MANHOLE
D — STORM DRAIN MANHOLE
T — TELEPHONE MANHOLE
W — WATER MANHOLE
WM — WATER METER

POWER POLE
TB — TELEPHONE BOX
LIGHT POLE ONE LUMINAIRE
LIGHT POLE TWO LUMINAIRS
LIGHT POLE
STREET LIGHT WITH BRACKET
MASONRY
STEEL
INSULATION
GRAVEL
CONCRETE
EARTH
SAND
ALUMINUM OR METAL DECKING
CHECKERED PLATE
SPAN — GRATING
PLASTIC, RUBBER OR NEOPRENE
WOOD (ROUGH FRAMING) OR, OPENING OR DEPRESSION IN SLAB OR WALL
FHC — FIRE HOSE CABINET
FE — FIRE EXTINGUISHER
UNIT HEATER
PCOTG — PRESSURE CLEANOUT TO GRADE
WCO — WALL CLEANOUT
FCO — FLOOR CLEANOUT
COTG — CLEANOUT TO GRADE
BLOW OFF ASSEMBLY
HUB DRAIN
FLOOR DRAIN
FLOOR SINK
DRAIN TRAP
CHANGE IN PIPING MATERIAL
24" RCP-RW — PIPE SIZE AND TYPE/FLUID ABBREVIATION (USE FOR EXISTING PIPE CALLOUT)
2" UW (2) — PIPE CALLOUT (SEE PIPING SCHEDULE)
ME-2 — EQUIPMENT NUMBER (SEE EQUIPMENT SCHEDULE)
STOP GATE
SLIDE GATE
SLUICE GATE
GATE VALVE
HOSE BIBB (H/B)
REDUCER OR INCREASER
LIQUID SURFACE EL

REVISION WORK
1 — COLUMN LINE GRID
A — WINDOW TYPE
05 — DOOR NUMBER
05 — ROOM NUMBER

GENERAL NOTES:

30% REVIEW

REVISIONS

NO.	DATE	REV. BY	DESCRIPTION

WASHINGTON COUNTY
MAIN STREET DEBRIS BASINS
WASHINGTON, UTAH

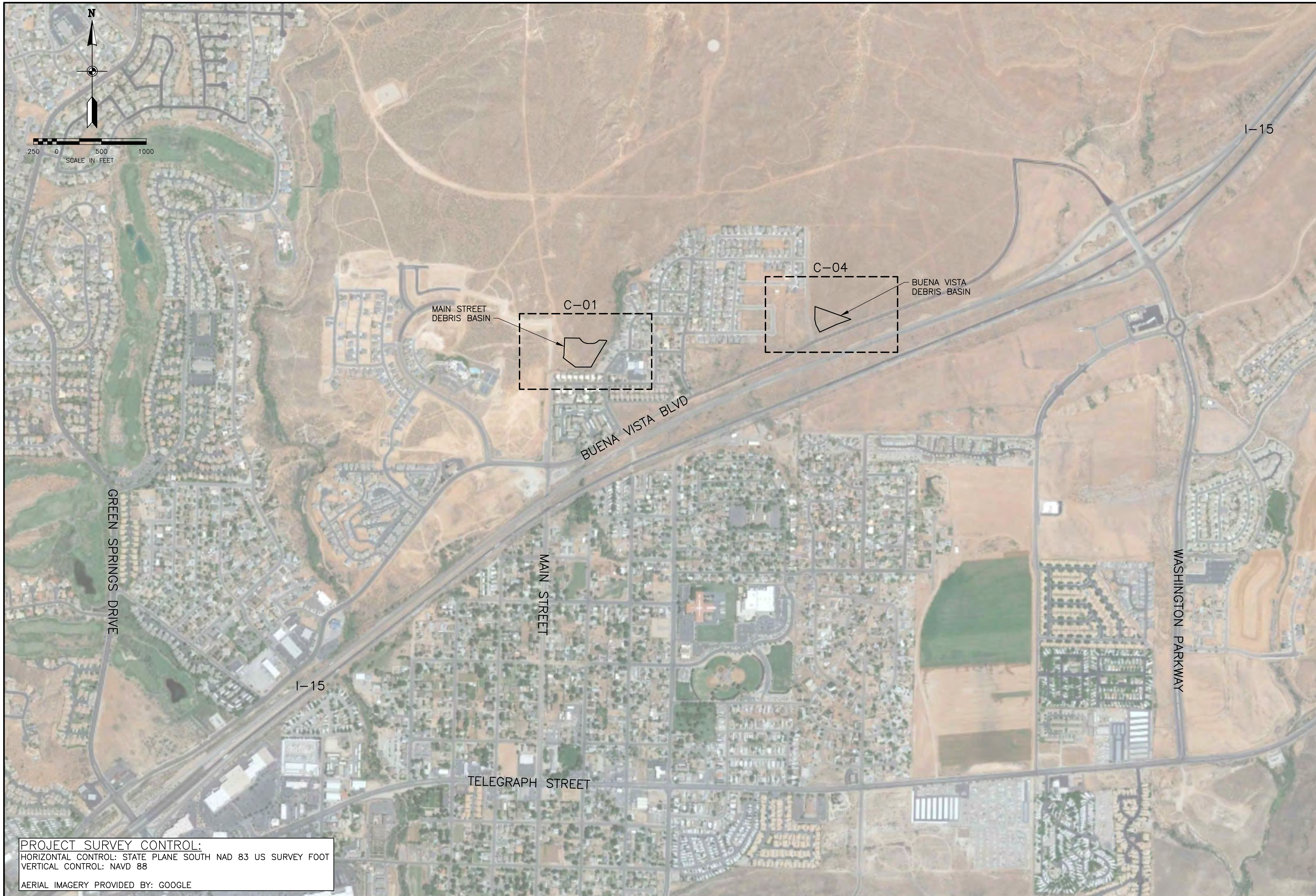
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

DESIGN — DESIGN STANDARDS — DRAWN STANDARDS
REVIEW — CHECKED STANDARDS — APPROVED STANDARDS

GENERAL
SYMBOLS & NOTES

PROJECT NUMBER 581-18-01
DATE: FEB 2019

DRAWING NO.
G-03
SHEET 3 OF 10



PROJECT SURVEY CONTROL:
HORIZONTAL CONTROL: STATE PLANE SOUTH NAD 83 US SURVEY FOOT
VERTICAL CONTROL: NAVD 88

AERIAL IMAGERY PROVIDED BY: GOOGLE

BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY
MAIN STREET DEBRIS BASINS
WASHINGTON, UTAH

DESIGN
DESIGN C. MERRELL
DRAWN C. NIELSON

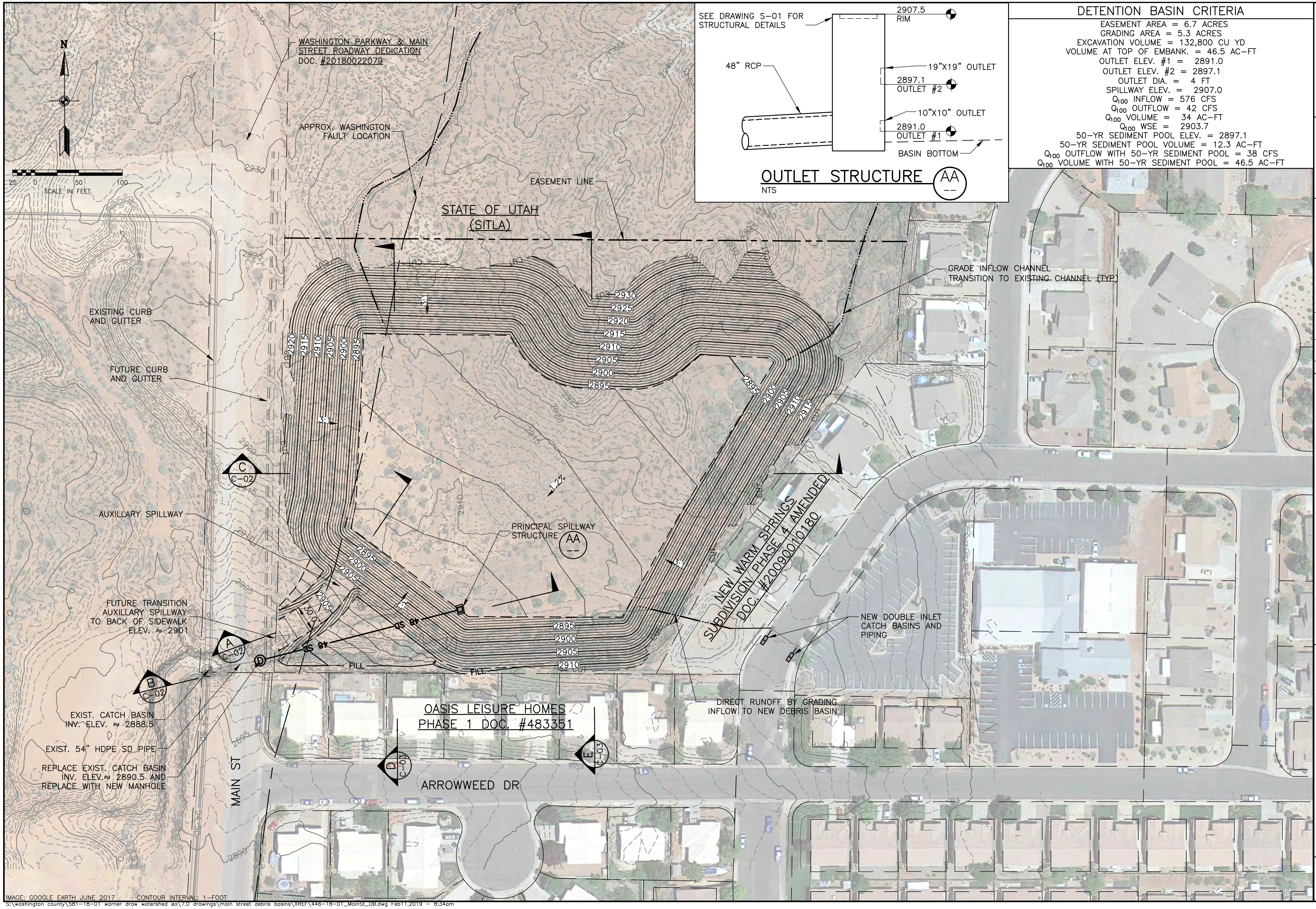
REVIEW
CHECKED T. OLSEN
APPROVED C. MERRELL

GENERAL
KEY SHEET

PROJECT NUMBER 581-18-01
DATE: FEB 2019

DRAWING NO.
G-04
SHEET 4 OF 10

S:\washington county\581-18-01 warner draw watershed ea\7.0 drawings\main street debris basins\Sheets\G-04.dwg Feb11,2019 - 8:31am



DETENTION BASIN CRITERIA

EASEMENT AREA = 6.7 ACRES
GRADING AREA = 5.3 ACRES
EXCAVATION VOLUME = 132,800 CU YD
VOLUME AT TOP OF EMBANK. = 46.5 AC-FT
OUTLET ELEV. #1 = 2891.0
OUTLET ELEV. #2 = 2897.1
OUTLET DIA. = 4 FT
SPILLWAY ELEV. = 2907.0
Q_{100} INFLOW = 576 CFS
Q_{100} OUTFLOW = 42 CFS
Q_{100} VOLUME = 34 AC-FT
Q_{100} WSE = 2903.7
50-YR SEDIMENT POOL ELEV. = 2897.1
50-YR SEDIMENT POOL VOLUME = 12.3 AC-FT
Q_{100} OUTFLOW WITH 50-YR SEDIMENT POOL = 38 CFS
Q_{100} VOLUME WITH 50-YR SEDIMENT POOL = 46.5 AC-FT

S:\washington county\581-18-01 warner draw watershed ea\7.0 drawings\main street debris basins\XREF\446-18-01_MainSt_DB.dwg Feb11,2019 – 8:34am

BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY
MAIN STREET DEBRIS BASINS
WASHINGTON, UTAH

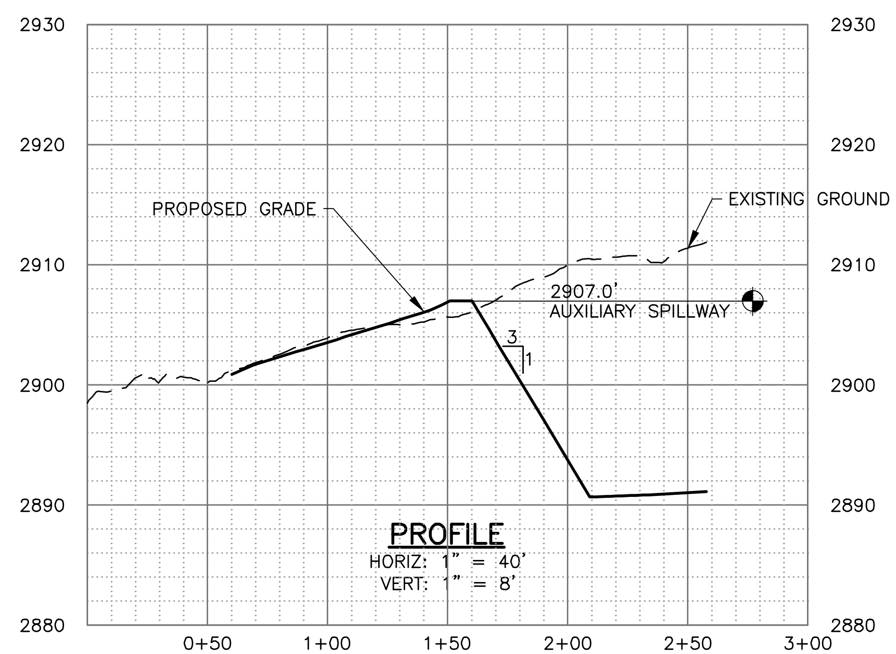
REVIEW
CHECKED T.OLSEN
APPROVED C.MERRELL

DESIGN
DESIGN C.MERRELL
DRAWN C.MERRELL

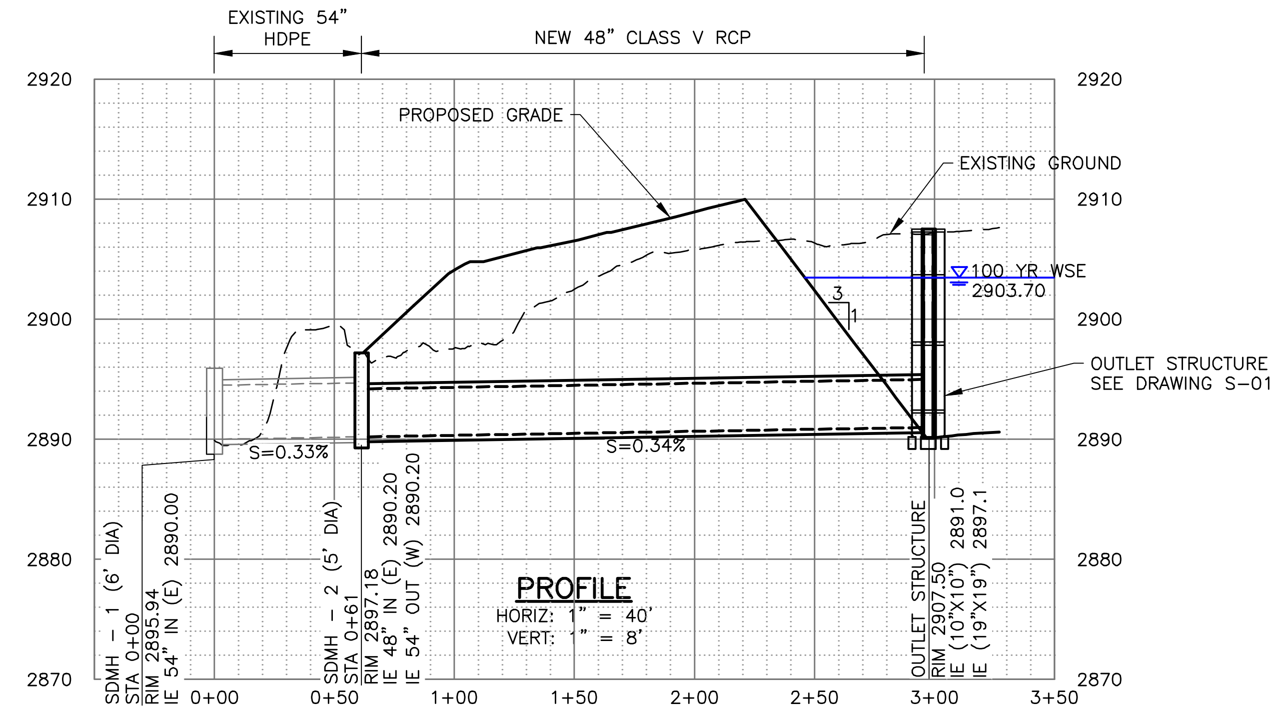
CIVIL
MAIN STREET DEBRIS BASIN

PROJECT NUMBER 581-18-01
DATE: FEB 2019

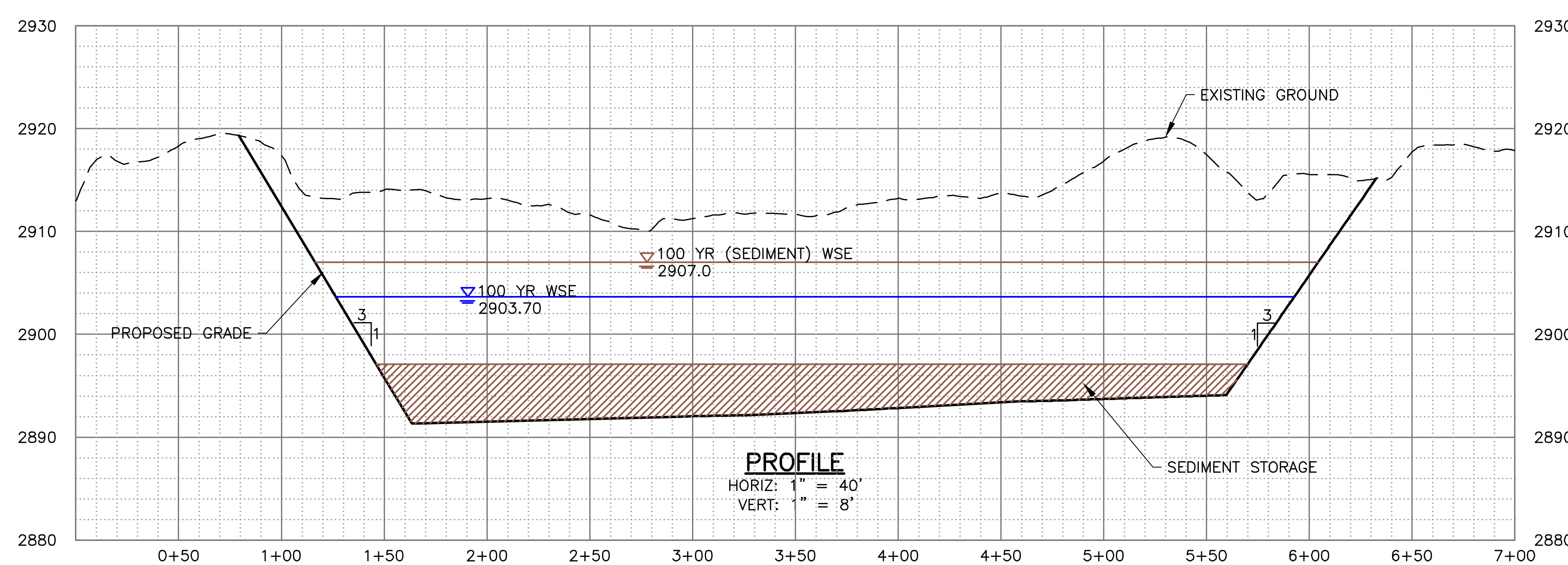
DRAWING NO.
C-01
SHEET 5 OF 10



CROSS SECTION A (C-01)



CROSS SECTION B (C-01)



CROSS SECTION C (C-01)

BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY
MAIN STREET DEBRIS BASINS
WASHINGTON, UTAH

REVIEW
CHECKED T. OLSEN
APPROVED C. MERRELL

DESIGN
DESIGN C. MERRELL
DRAWN C. NIELSON

CIVIL
MAIN STREET DEBRIS BASIN
CROSS SECTIONS – 1

PROJECT NUMBER 581-18-01

DATE: FEB 2019

DRAWING NO.
C-02

SHEET 6 OF 10

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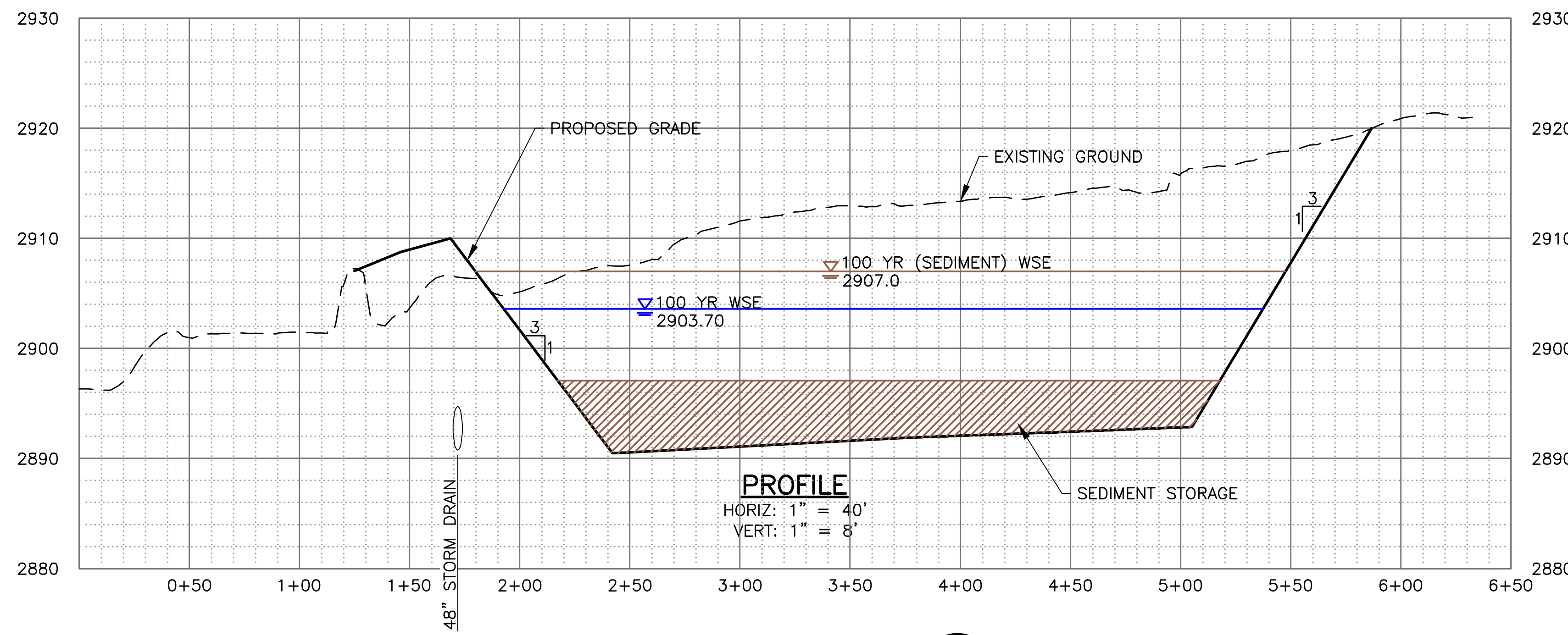
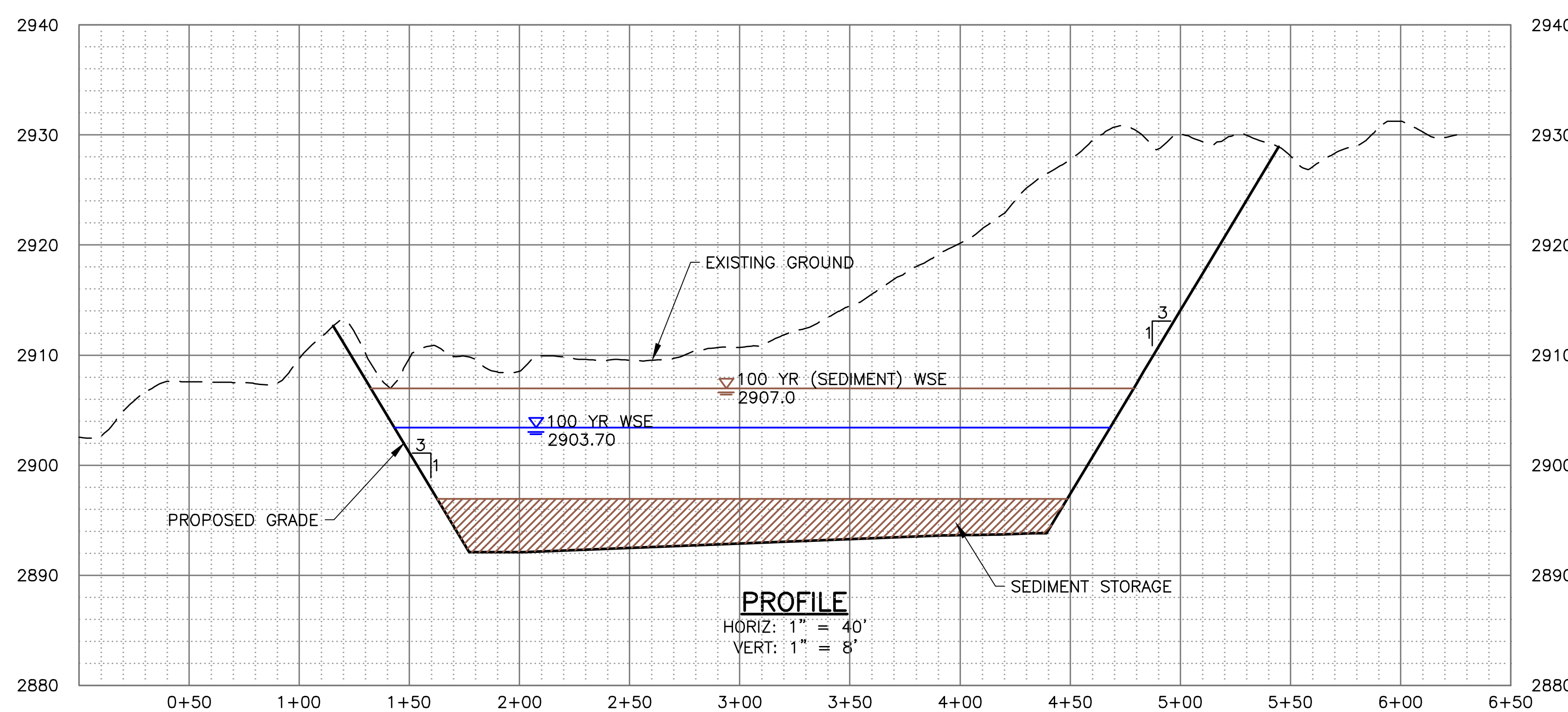


CROSS SECTION D C-01



CROSS SECTION E C-01

BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY
MAIN STREET DEBRIS BASINS
WASHINGTON, UTAH

REVIEW
CHECKED T. OLSEM
APPROVED C. MERRELL

DESIGN
DESIGN C. MERRELL
DRAWN C. NIELSON

CIVIL
MAIN STREET DEBRIS BASIN
CROSS SECTIONS – 2

PROJECT NUMBER 581-18-01
DATE: FEB 2019

DRAWING NO.
C-03
SHEET 7 OF 10

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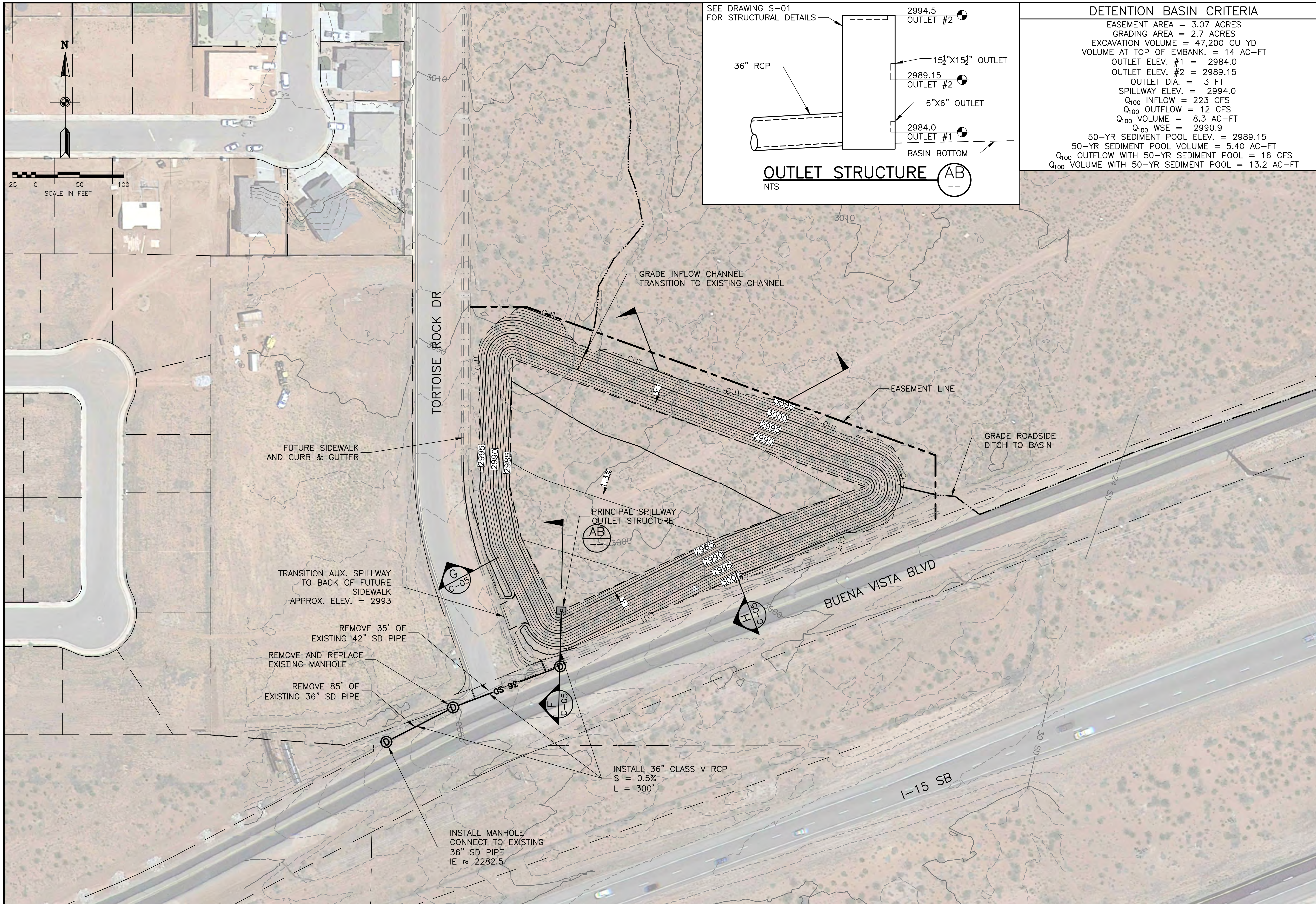

OUTLET STRUCTURE
NTS

DETENTION BASIN CRITERIA

EASEMENT AREA = 3.07 ACRES
GRADING AREA = 2.7 ACRES
EXCAVATION VOLUME = 47,200 CU YD
VOLUME AT TOP OF EMBANK. = 14 AC-FT
OUTLET ELEV. #1 = 2984.0
OUTLET ELEV. #2 = 2989.15
OUTLET DIA. = 3 FT
SPILLWAY ELEV. = 2994.0
Q_{100} INFLOW = 223 CFS
Q_{100} OUTFLOW = 12 CFS
Q_{100} VOLUME = 8.3 AC-FT
Q_{100} WSE = 2990.9
50-YR SEDIMENT POOL ELEV. = 2989.15
50-YR SEDIMENT POOL VOLUME = 5.40 AC-FT
Q_{100} OUTFLOW WITH 50-YR SEDIMENT POOL = 16 CFS
Q_{100} VOLUME WITH 50-YR SEDIMENT POOL = 13.2 AC-FT

BOWEN COLLINS & ASSOCIATES

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NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

WASHINGTON COUNTY
MAIN STREET DEBRIS BASINS
WASHINGTON, UTAH

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BAR IS ONE INCH ON ORIGINAL DRAWING

DESIGN
DESIGN C. MERRELL
DRAWN C. MERRELL

REVIEW
CHECKED T. OLSEN
APPROVED C. MERRELL

CIVIL
BUENA VISTA BLVD DEBRIS BASIN

PROJECT NUMBER 581-18-01
DATE: FEB 2019

DRAWING NO.
C-04
SHEET 8 OF 10

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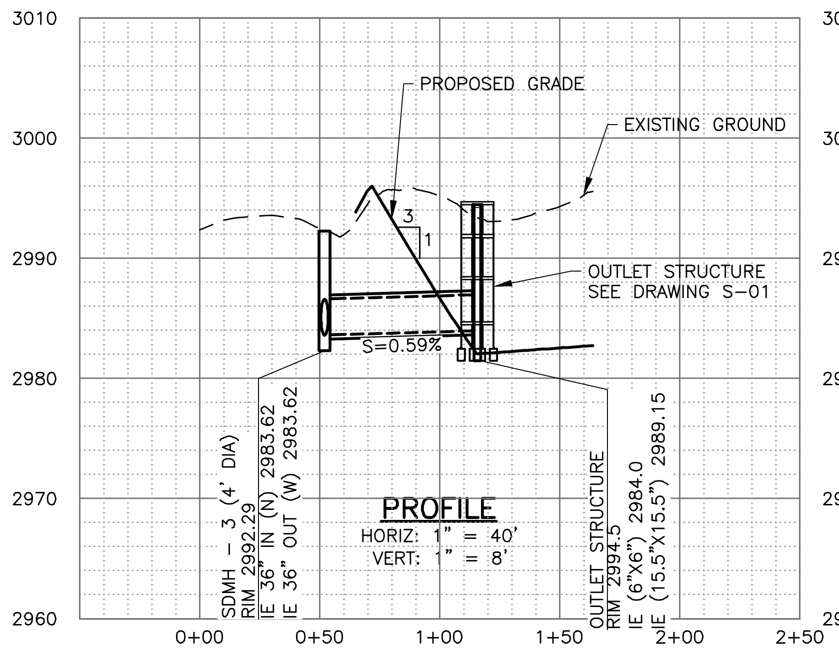

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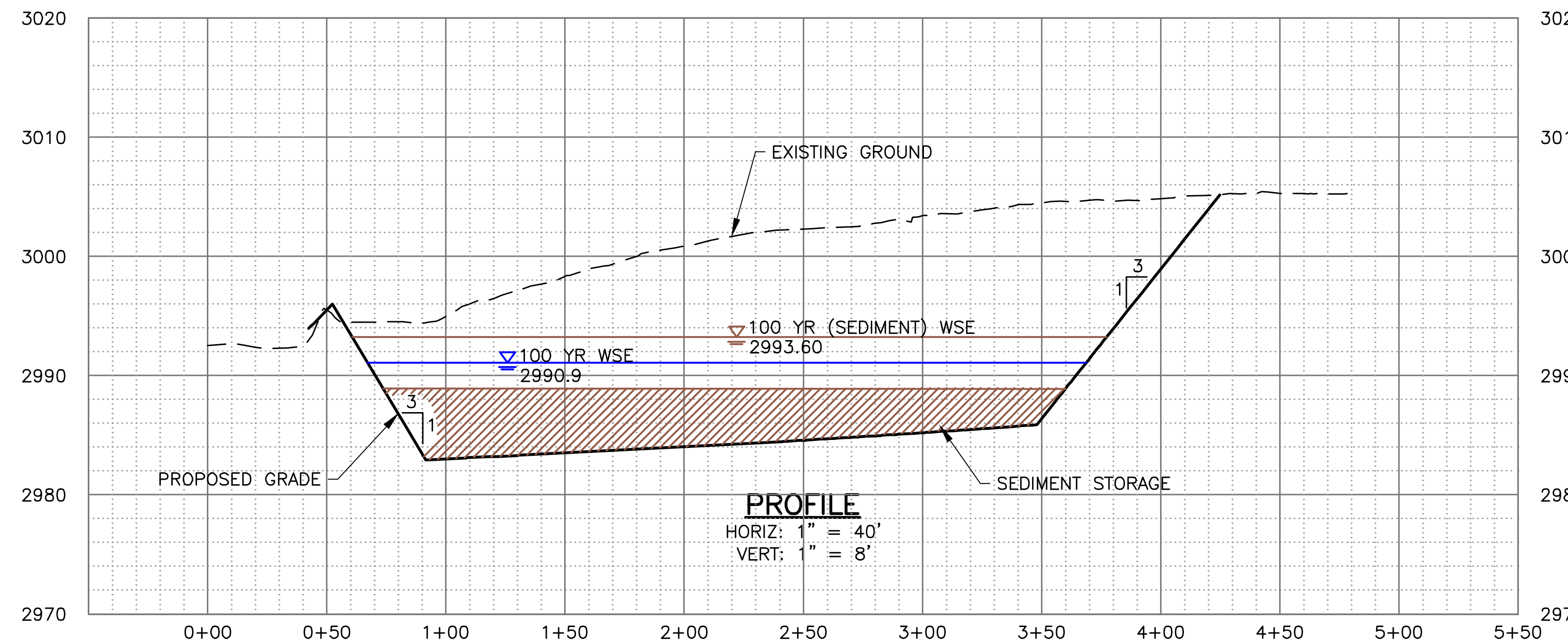

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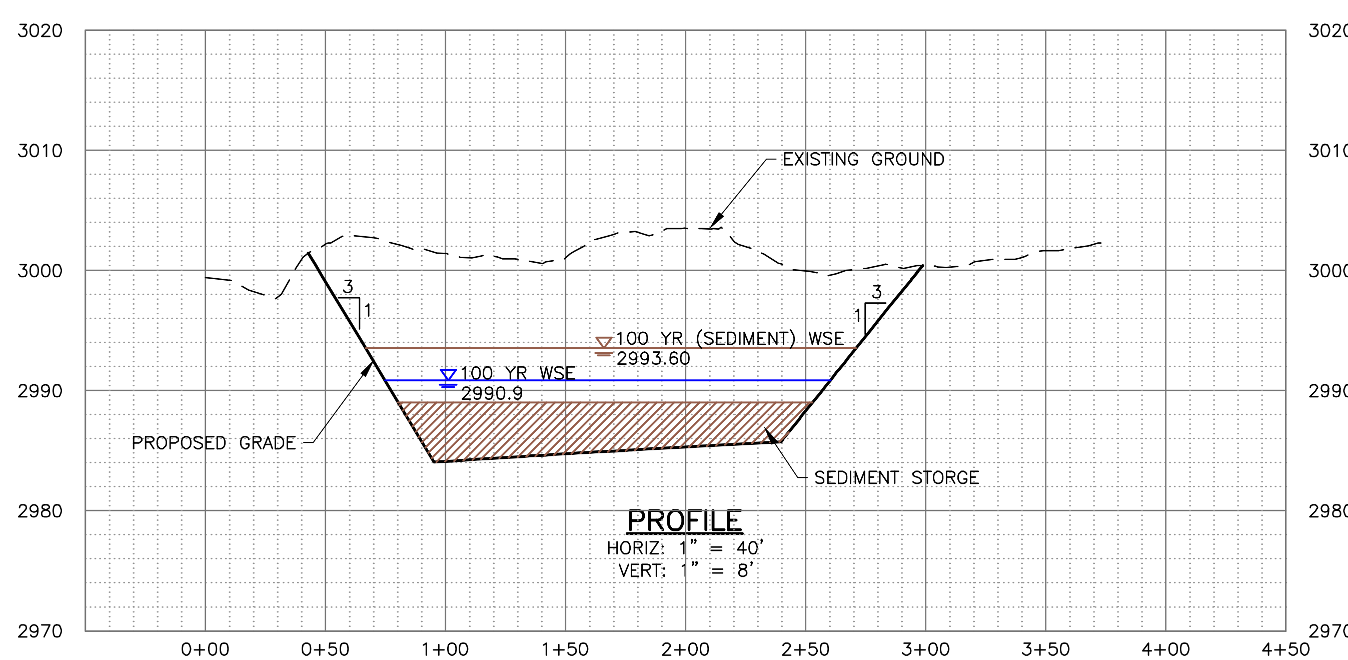


CROSS SECTION H C-04

BOWEN COLLINS & ASSOCIATES

30% REVIEW

REVISIONS
NO. | DATE | REV. BY | DESCRIPTION

WASHINGTON COUNTY
MAIN STREET DEBRIS BASINS
WASHINGTON, UTAH

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

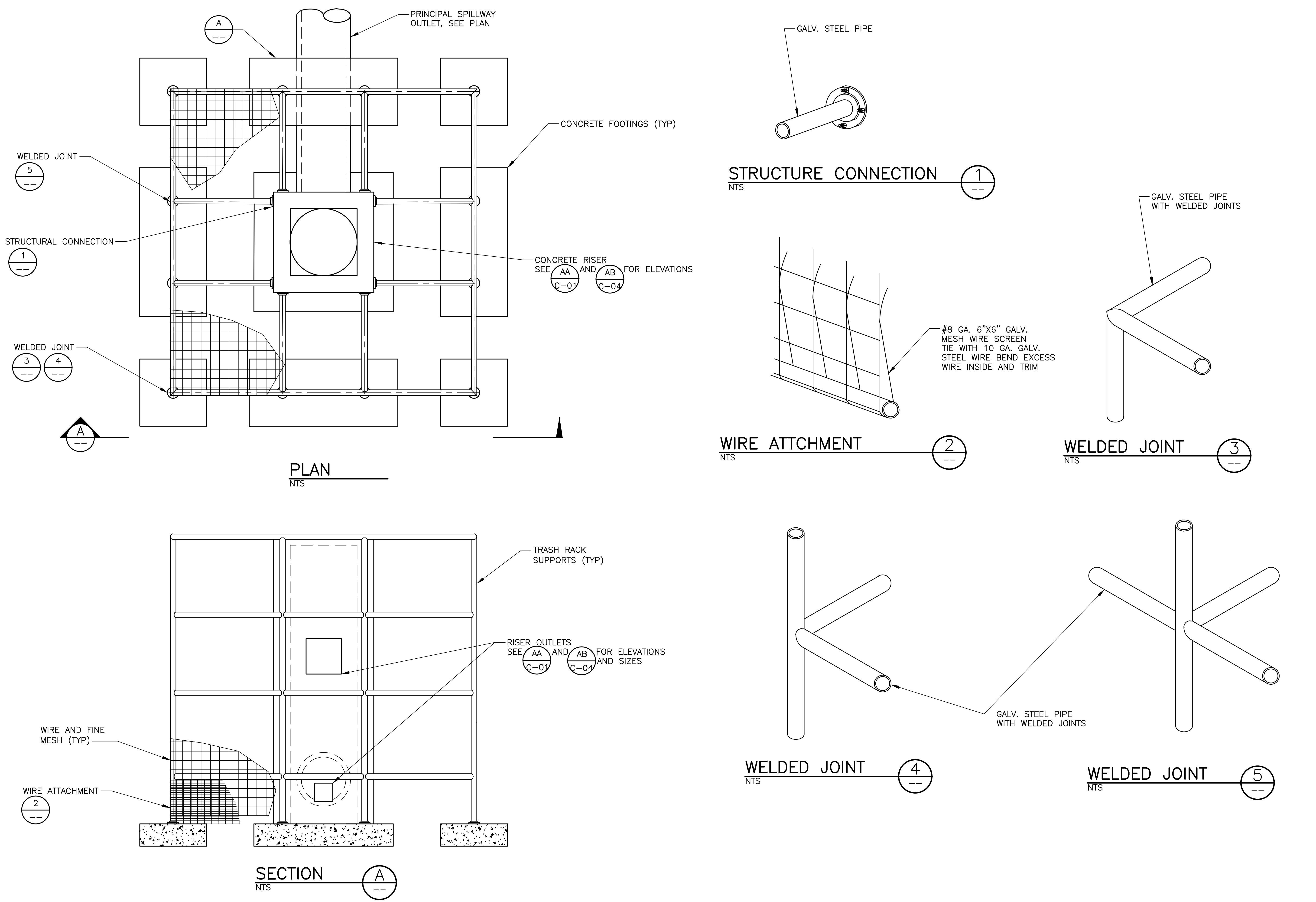
REVIEW
CHECKED T. OLSEN
APPROVED C. MERRELL

DESIGN
DESIGN C. MERRELL
DRAWN C. NIELSON

CIVIL
BUENA VISTA BLVD
DEBRIS BASIN
CROSS SECTIONS

PROJECT NUMBER 581-18-01
DATE: FEB 2019

DRAWING NO.
C-05
SHEET 9 OF 10



BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY

MAIN STREET DEBRIS BASINS

WASHINGTON, UTAH

REVIEW

CHECKED T. OLSEN

APPROVED C. MERRELL

DESIGN

DESIGN C. MERRELL

DRAWN C. NIELSON

PRINCIPAL SPILLWAY OUTLET STRUCTURE

PROJECT NUMBER 581-18-01

DATE: FEB 2019

DRAWING NO.

S-01

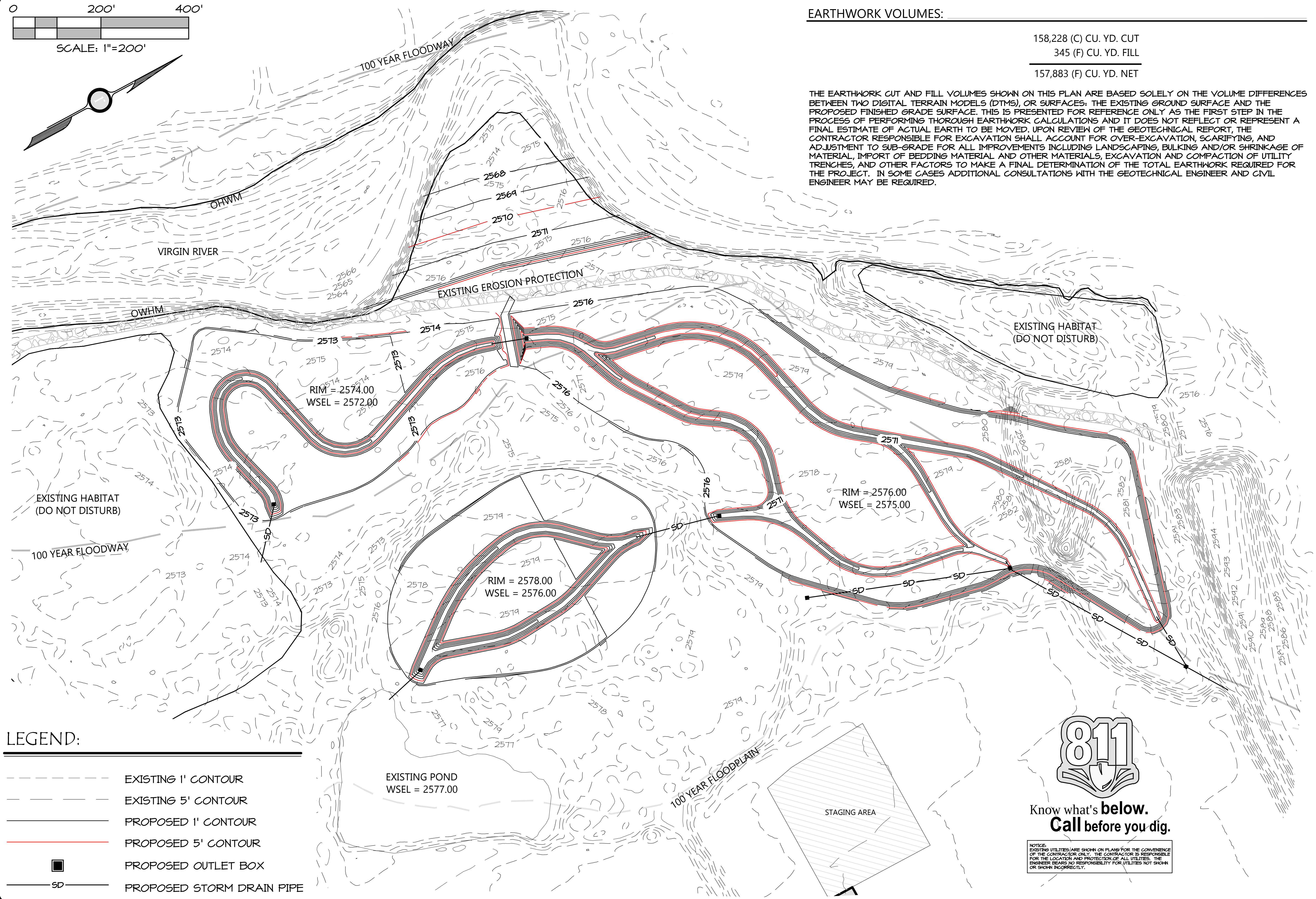
SHEET 10 OF 10

S:\washington county\581-18-01 warner draw watershed ea\7.0 drawings\main street debris basins\Sheets\S-01.dwg Feb11,2019 - 8:32am

Attachment 2

Seegmiller Marsh

Preferred Alternative Concept Design Drawings



EARTHWORK VOLUMES:

158,228 (C) CU. YD. CUT
345 (F) CU. YD. FILL
157,883 (F) CU. YD. NET

THE EARTHWORK CUT AND FILL VOLUMES SHOWN ON THIS PLAN ARE BASED SOLELY ON THE VOLUME DIFFERENCES BETWEEN TWO DIGITAL TERRAIN MODELS (DTMS), OR SURFACES: THE EXISTING GROUND SURFACE AND THE PROPOSED FINISHED GRADE SURFACE. THIS IS PRESENTED FOR REFERENCE ONLY AS THE FIRST STEP IN THE PROCESS OF PERFORMING THOROUGH EARTHWORK CALCULATIONS AND IT DOES NOT REFLECT OR REPRESENT A FINAL ESTIMATE OF ACTUAL EARTH TO BE MOVED. UPON REVIEW OF THE GEOTECHNICAL REPORT, THE CONTRACTOR RESPONSIBLE FOR EXCAVATION SHALL ACCOUNT FOR OVER-EXCAVATION, SCARIFYING, AND ADJUSTMENT TO SUB-GRADE FOR ALL IMPROVEMENTS INCLUDING LANDSCAPING, BULKING AND/OR SHRINKAGE OF MATERIAL, IMPORT OF BEDDING MATERIAL AND OTHER MATERIALS, EXCAVATION AND COMPACTION OF UTILITY TRENCHES, AND OTHER FACTORS TO MAKE A FINAL DETERMINATION OF THE TOTAL EARTHWORK REQUIRED FOR THE PROJECT. IN SOME CASES ADDITIONAL CONSULTATIONS WITH THE GEOTECHNICAL ENGINEER AND CIVIL ENGINEER MAY BE REQUIRED.

LEGEND:

- - - -	EXISTING 1' CONTOUR
— — —	EXISTING 5' CONTOUR
———	PROPOSED 1' CONTOUR
——— (red)	PROPOSED 5' CONTOUR
■	PROPOSED OUTLET BOX
—SD—	PROPOSED STORM DRAIN PIPE

Know what's **below.**
Call before you dig.

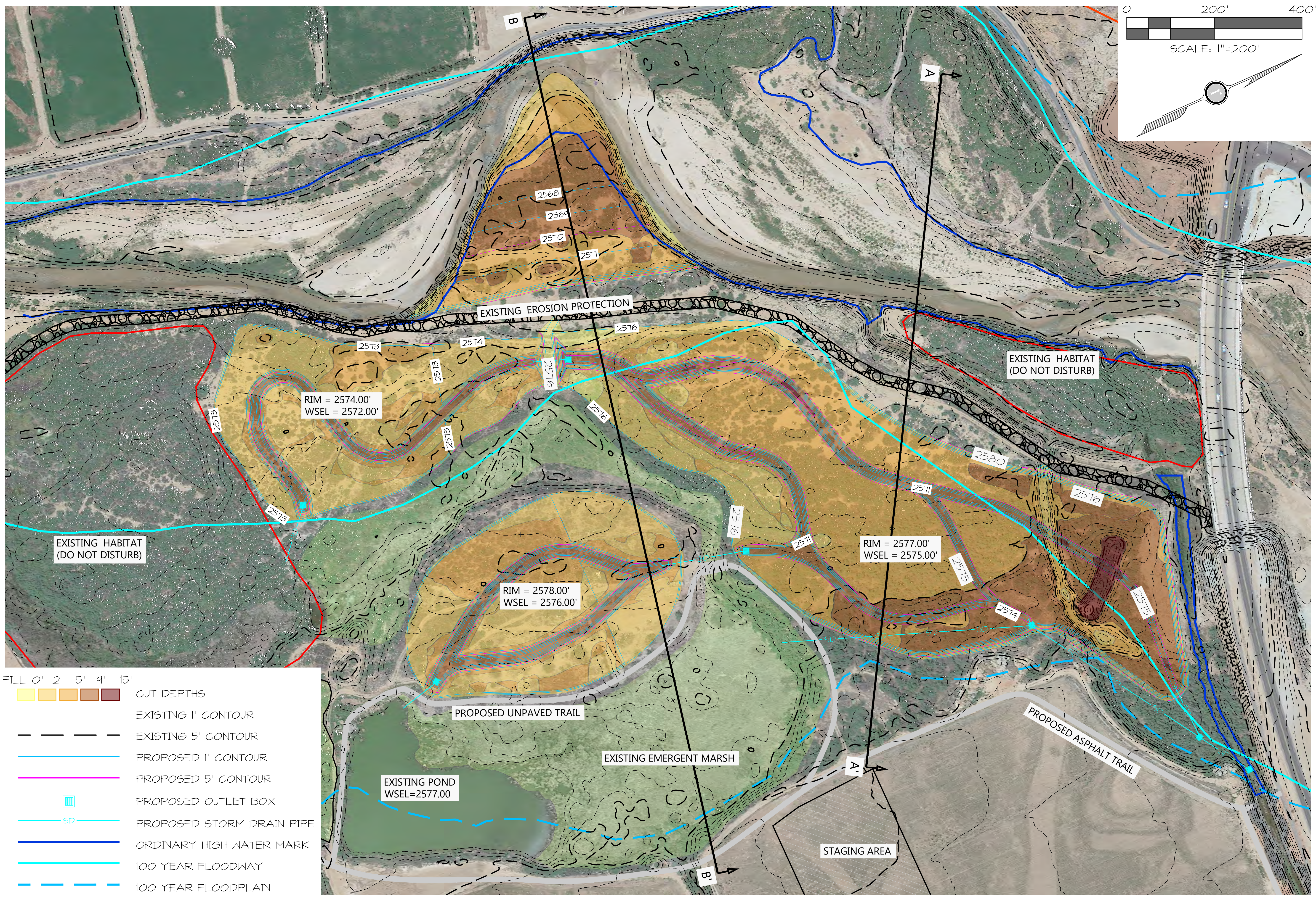
NOTICE:
EXISTING UTILITIES ARE SHOWN ON PLANS FOR THE CONVENIENCE OF THE CONTRACTOR ONLY. THE CONTRACTOR IS RESPONSIBLE FOR THE LOCATION AND PROTECTION OF ALL UTILITIES. THE ENGINEER BEARS NO RESPONSIBILITY FOR UTILITIES NOT SHOWN OR SHOWN INCORRECTLY.

DATE:	2/4/2019
JOB NO.:	10514
DESIGNED BY:	AMH
CHECKED BY:	RTR
DWG:	

DATE
REVISIONS

ROSENBERG ASSOCIATES
CIVIL ENGINEERS • LAND SURVEYORS
352 East Riverside Drive, Suite A-2
St. George, Utah 84790
Ph (435) 673-8586 Fx (435) 673-8397
www.racivil.com

CONCEPTUAL GRADING PLAN
FOR
SEEGMILLER MARSH RESTORATION
ST. GEORGE
UTAH



DATE:	2/7/2019
JOB NO.:	10514-17
DESIGNED BY:	GRF
CHECKED BY:	RTR
DWG:	

DATE

REVISIONS

ROSENBERG
ASSOCIATES
CIVIL ENGINEERS • LAND SURVEYORS

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St. George, Utah 84790
Ph (435) 673-8586 Fx (435) 673-8397
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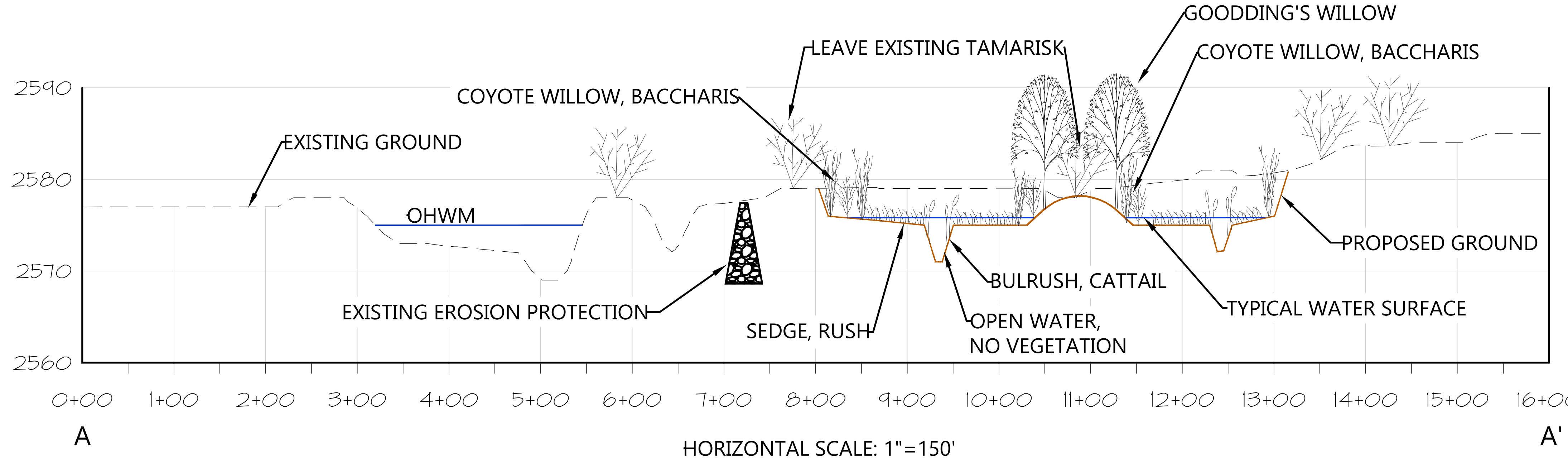
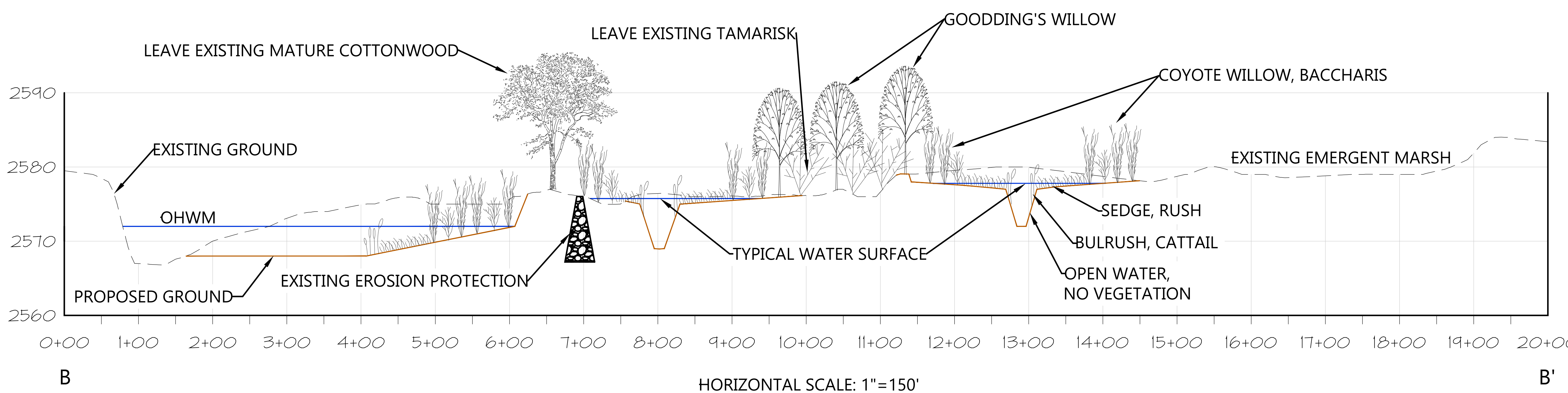
CONCEPTUAL CUT/FILL PLAN
FOR
SEEGMILLER MARSH RESTORATION
ST. GEORGE
UTAH



HORIZONTAL SCALE: 1"=150'
VERTICAL SCALE: 1'=15'



HORIZONTAL SCALE: 1"=150'
VERTICAL SCALE: 1'=15'

DATE:	2/7/2019
JOB NO.:	10514-17
DESIGNED BY:	GRF
CHECKED BY:	RTR
DWG:	

DATE

REVISIONS

ROSENBERG
ASSOCIATES
CIVIL ENGINEERS • LAND SURVEYORS

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St. George, Utah 84790
Ph (435) 673-8586 Fx (435) 673-8397
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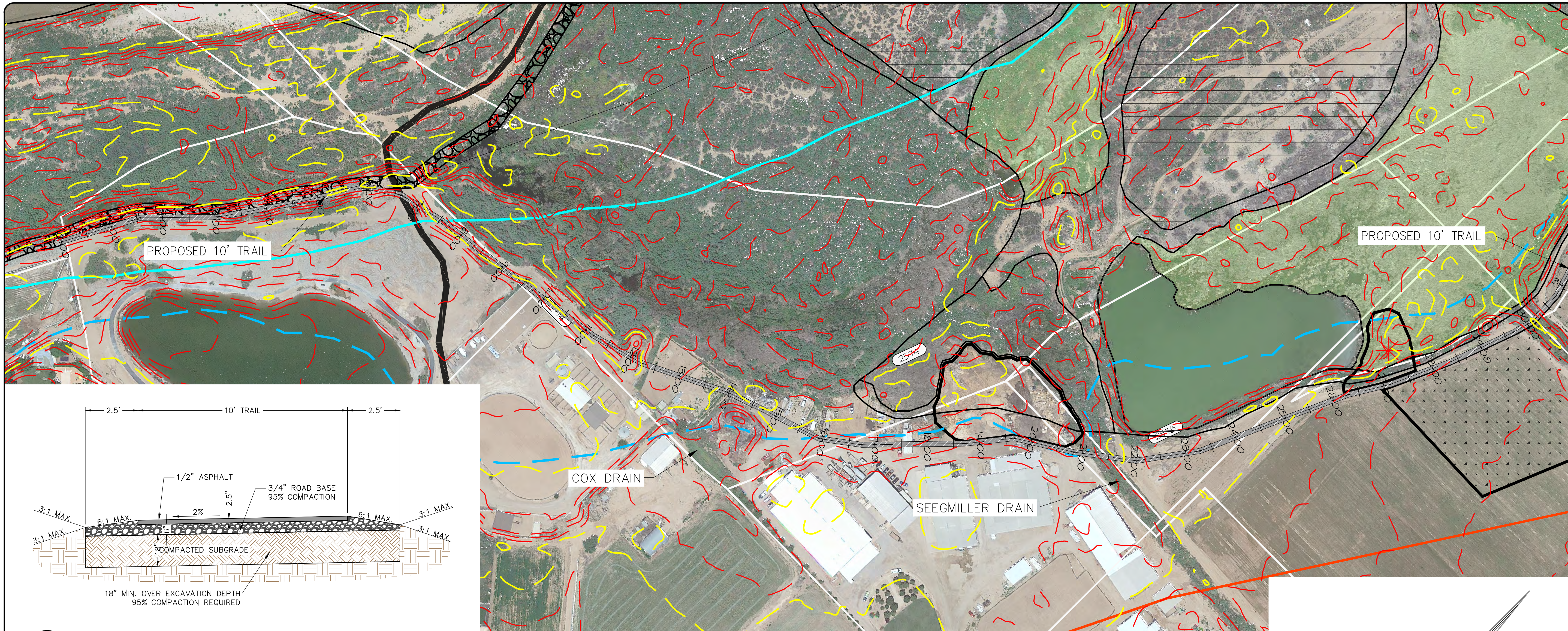
GRADING AND RESTORATION CROSS SECTIONS
FOR
SEEGMILLER MARSH RESTORATION
ST. GEORGE
UTAH

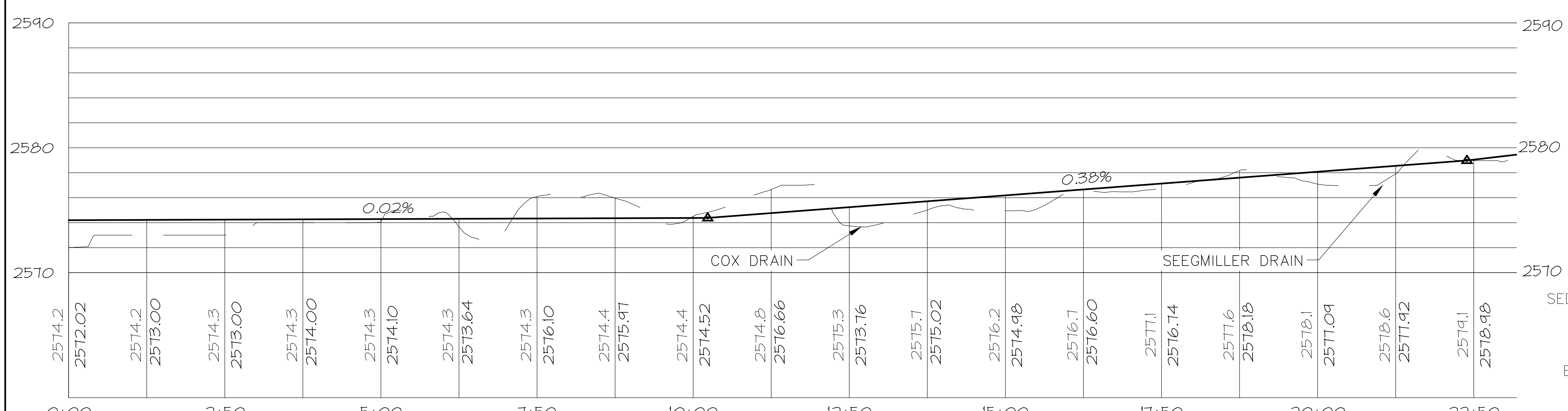
SHEET
3
3 OF 3 SHEETS



PROPOSED TRAIL CROSS SECTION

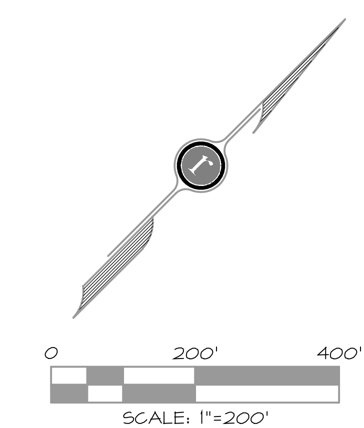
A / –

SCALE: NTS



PROPOSED TRAIL – STA: 0+00 TO 22+50 (PROFILE VIEW)

HORIZONTAL SCALE: 1"=200'
VERTICAL SCALE: 1"=5'



ORDINARY HIGH WATER MARK
EMERGENT MARSH (WETLANDS)
SEDIMENT REMOVAL AREA
POST–PROJECT FLOW PATTERN
EROSION HAZARD ZONE
100 YEAR FLOODPLAIN
FLOODWAY

DATE: 02/04/2019
JOB NO.: 10514-17
DESIGNED BY: TKH
CHECKED BY: JWB
DWG: BASE MAP

DATE
REVISIONS

ROSENBERG
ASSOCIATES
CIVIL ENGINEERS • LAND SURVEYORS

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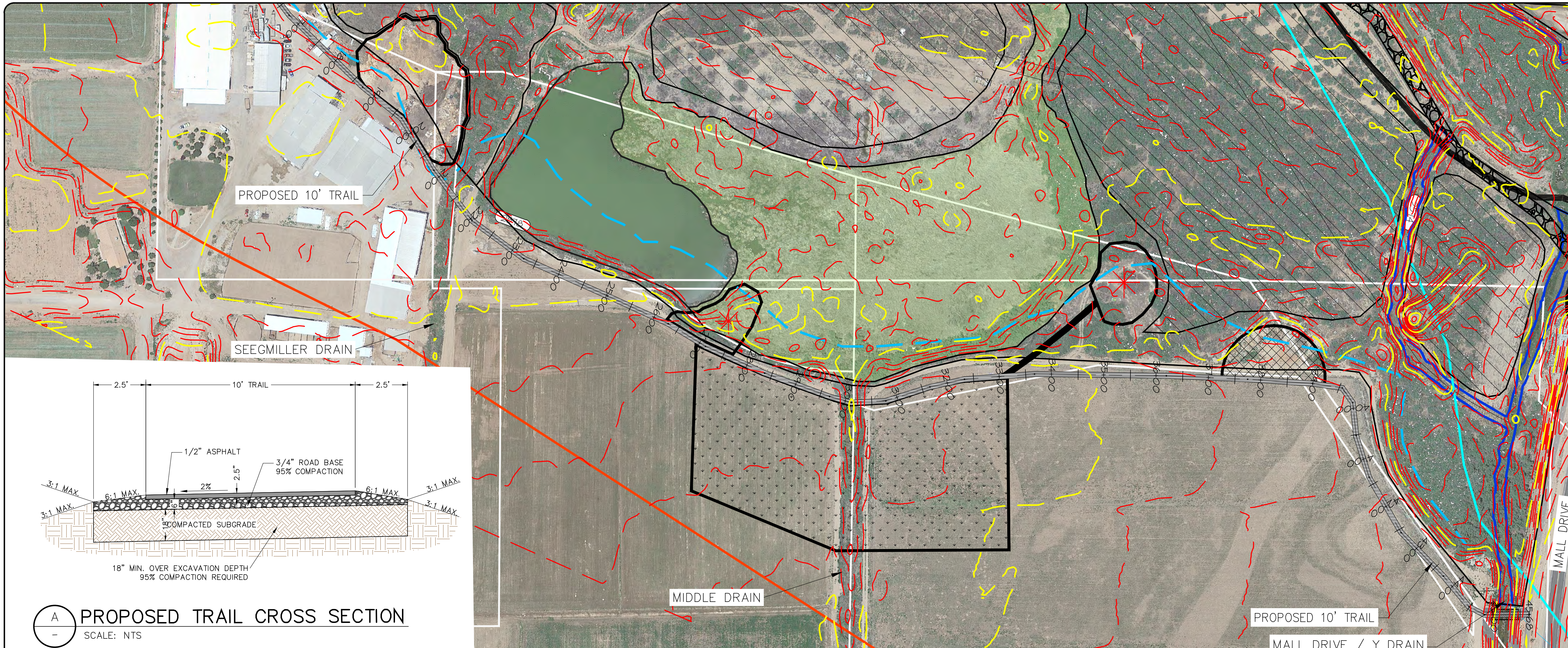
St. George, Utah 84790
Ph (435) 673-8586 Fx (435) 673-8397
www.racivil.com

PROPOSED TRAIL PLAN & PROFILE STA: 0+00 - 22+50
FOR
SEEGMILLER MARSH RESTORATION
ST. GEORGE
UTAH

SHEET
1
1 OF 2 SHEETS



0 200' 400'

SCALE: 1"=200'

ORDINARY HIGH WATER MARK

EMERGENT MARSH (WETLANDS)

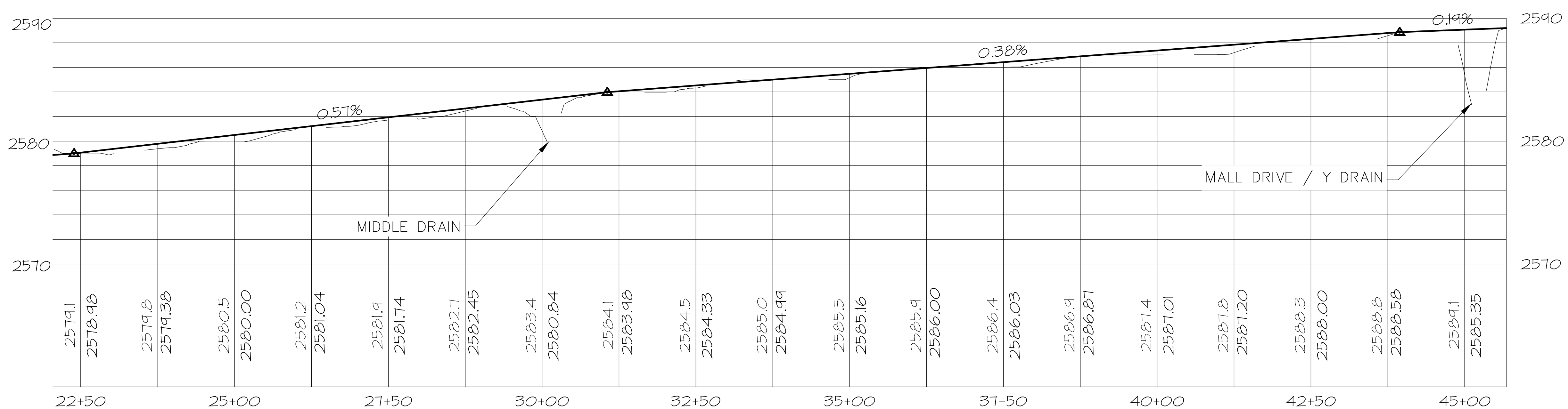
SEDIMENT REMOVAL AREA

POST-PROJECT FLOW PATTERN

EROSION HAZARD ZONE

100 YEAR FLOODPLAIN

FLOODWAY



PROPOSED TRAIL – STA: 22+50 TO 45+67 (PROFILE VIEW)

HORIZONTAL SCALE: 1"=200'
VERTICAL SCALE: 1"=5'

DATE:	02/04/2019
JOB NO.:	10514-17
DESIGNED BY:	TKH
CHECKED BY:	JWB
DWG:	BASE MAP

DATE

REVISIONS

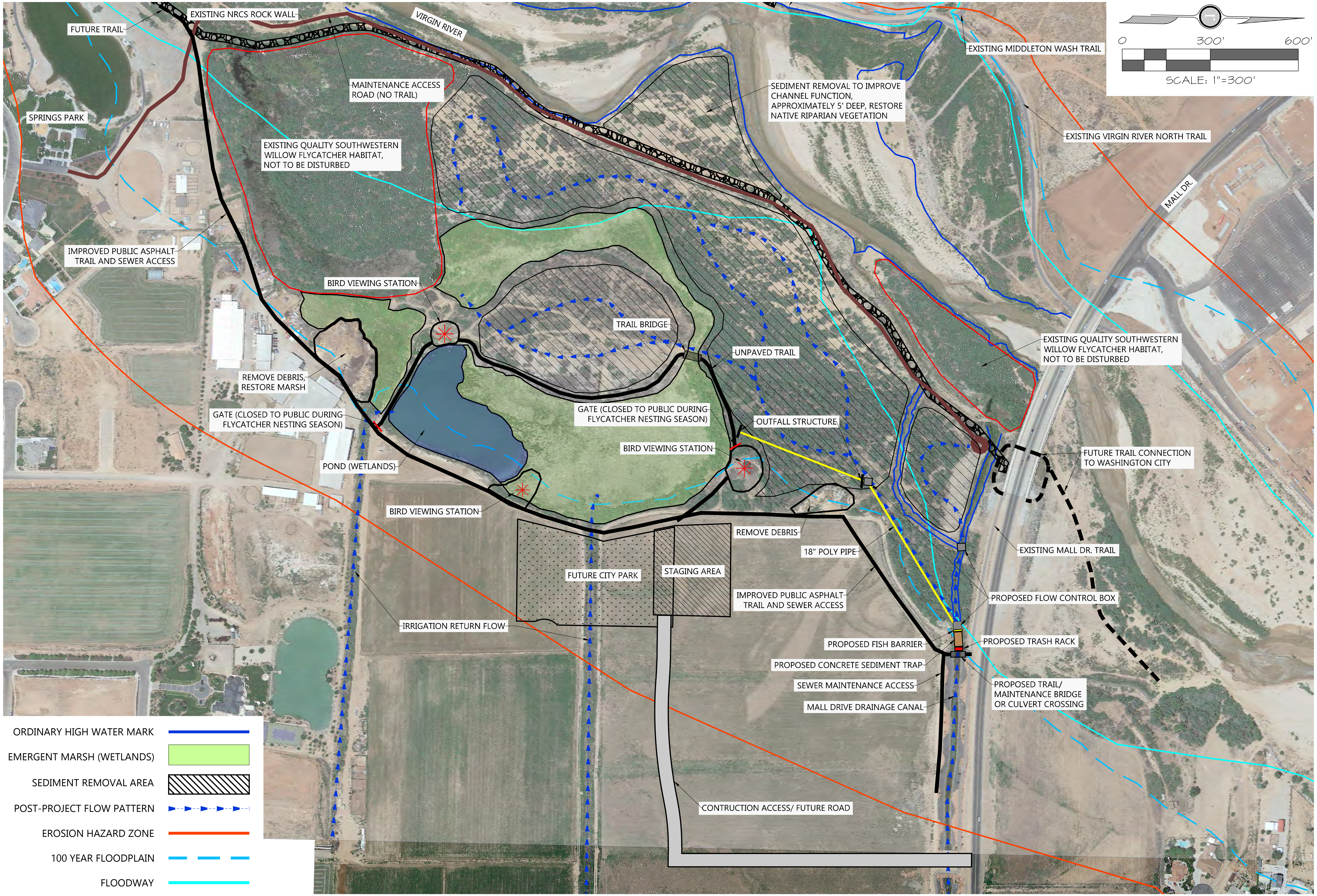
ROSENBERG
ASSOCIATES
CIVIL ENGINEERS • LAND SURVEYORS
352 East Riverside Drive, Suite A-2
St. George, Utah 84790
Ph (435) 673-8586 Fx (435) 673-8397
www.racivil.com

PROPOSED TRAIL PLAN & PROFILE STA: 22+50 - 45+67

FOR

SEEGMILLER MARSH RESTORATION

ST. GEORGE
UTAH



DATE: 11/14/2018
JOB NO: 10514-17
DESIGNED BY: GRF
CHECKED BY: JAB
DWG: BASE MAP

DATE
REVISIONS

ROSENBERG
ASSOCIATES
CIVIL ENGINEERS • LAND SURVEYORS

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Ph (435) 673-8586 Fx (435) 673-8397
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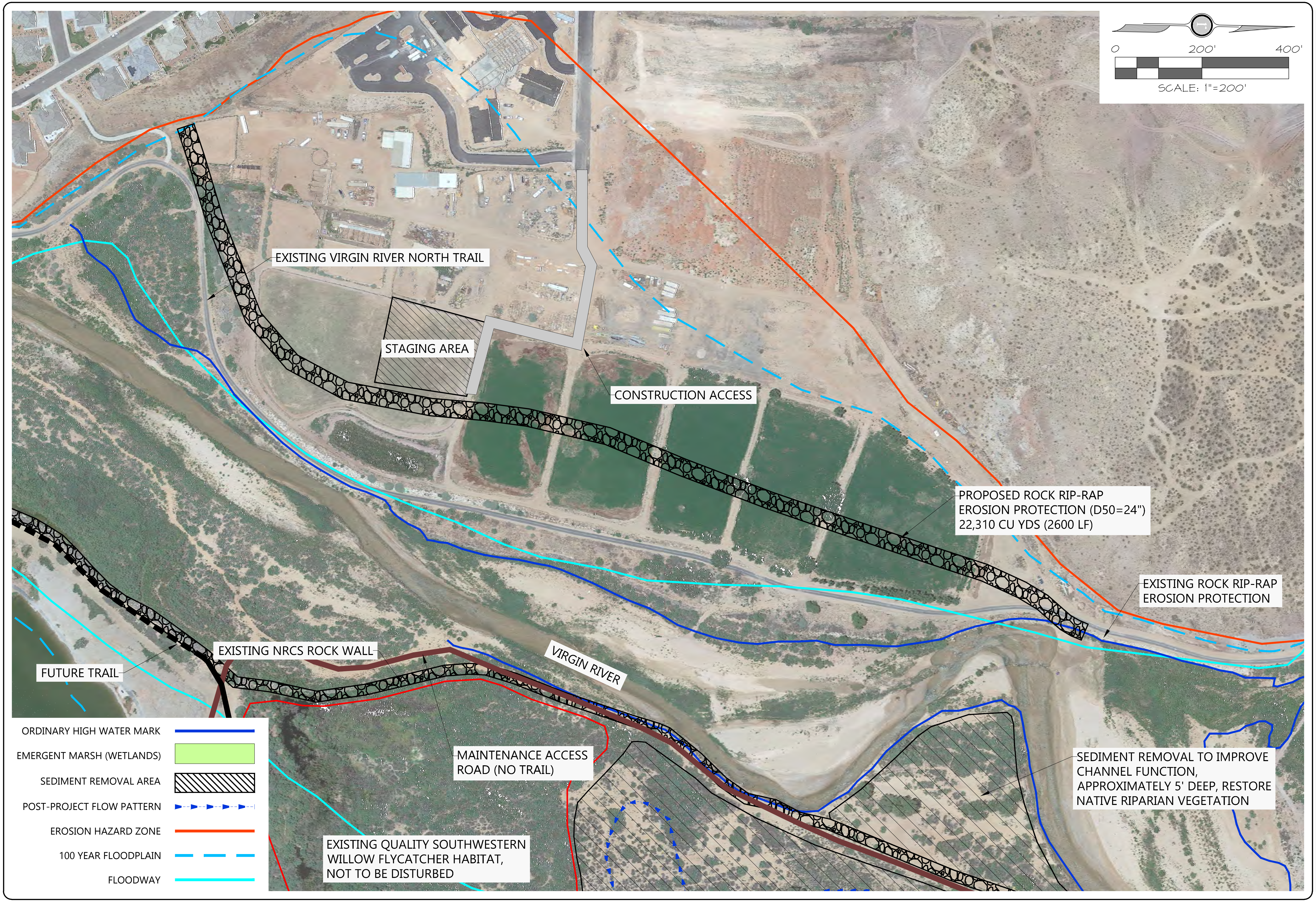
ALTERNATIVE 1 CONCEPT PLAN
FOR
SEEGMILLER MARSH RESTORATION
ST. GEORGE
UTAH

SHEET
1
1 OF 4 SHEETS



DATE:	11/14/2018
JOB NO.:	10514-17
DESIGNED BY:	GRF
CHECKED BY:	JWB
DWG:	BASE MAP

DATE

REVISIONS

ROSENBERG ASSOCIATES
CIVIL ENGINEERS • LAND SURVEYORS

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St. George, Utah 84790
Ph (435) 673-8586 Fx (435) 673-8397
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ALTERNATIVE 1 EROSION PROTECTION
FOR
SEEGMILLER MARSH RESTORATION
ST. GEORGE
UTAH

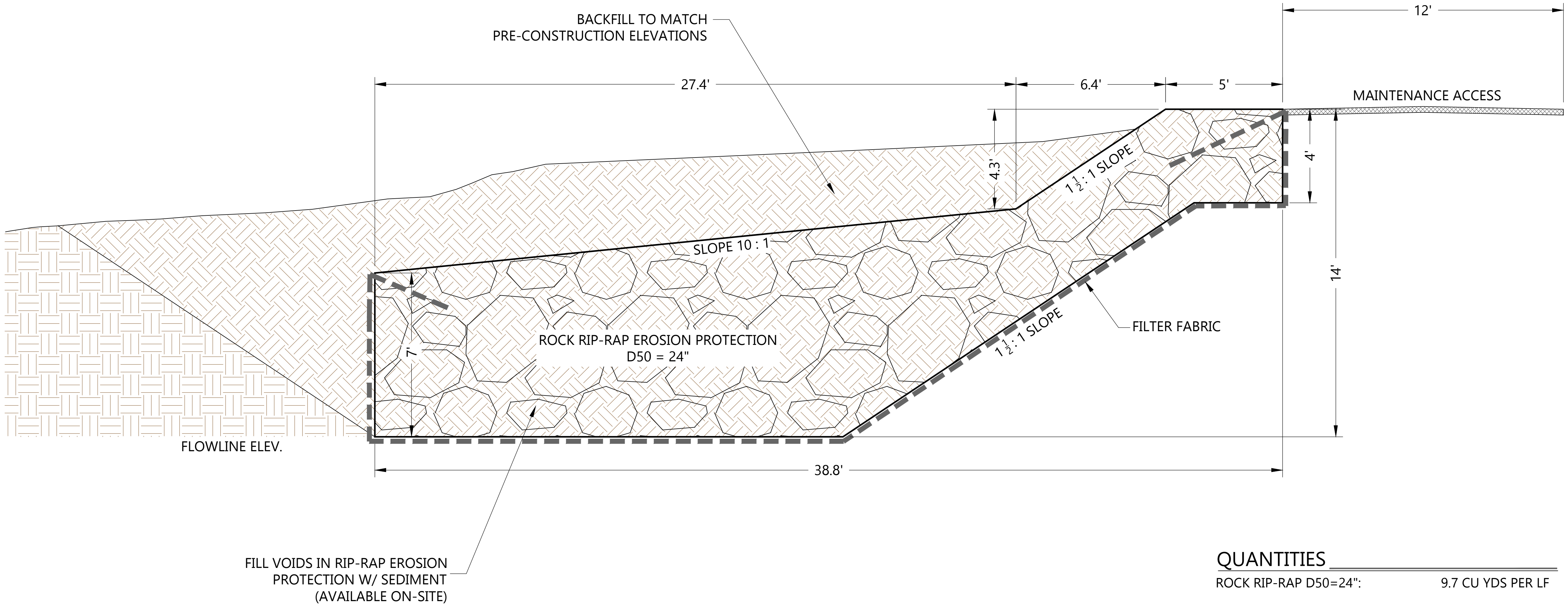
SHEET
2

RIP-RAP CONSTRUCTION NOTES

1. AVERAGE ROCK SIZE, D50=24". USE ANGULAR-SHAPED ROCK FREE FROM CRACKS, OVERBURDEN, SHALE; WITH A MINIMUM DENSITY OF 156 LB. PER CUBIC FT. (SPECIFIC GRAVITY = 2.50), WITH THE BREADTH OR THICKNESS OF A SINGLE STONE NOT LESS THAN ONE THIRD ITS LENGTH. FURNISH ROCK GRADED AS INDICATED IN THE TABLE. ALL ROCK RIP-RAP SHALL BE INSPECTED BY THE ENGINEER PRIOR TO INSTALLATION AND BACKFILL.
2. FILTER FABRIC SHALL BE MIRIFI 180 N 8 OZ. NON WOVEN GEO-TEXTILE OR APPROVED EQUAL. FABRIC SHALL BE PLACED AS SHOWN HEREON AND INSTALLED ACCORDING TO MANUFACTURE'S INSTRUCTIONS. CARE SHALL BE TAKEN TO PREVENT FABRIC FROM TEARING DURING ROCK PLACEMENT.
3. CONTRACTOR SHALL FILL VOIDS IN RIP-RAP EROSION PROTECTION WITH SEDIMENT USING WATER JETTING OR OTHER APPROVED METHODS. ALL ROCK RIP-RAP SHALL BE INSPECTED BY THE ENGINEER PRIOR TO SEDIMENT PLACEMENT.
4. ALL UNSUITABLE VEGETATION AND WOODY DEBRIS MATERIAL SHALL BE REMOVED FROM THE WORK AREA AND DISPOSED OF PROPERLY OFFSITE.
5. ALL WORK SHALL COMPLY WITH THE ARMY CORPS OF ENGINEERS AND STATE OF UTAH PERMIT REQUIREMENT & CONDITIONS.
6. RIP-RAP EROSION PROTECTION REPAIR TERMINATION LOCATIONS TO BE VERIFIED BY ENGINEER BASED ON FIELD CONDITIONS.

ROCK GRADATION

D100	42"
D75	36"
D50	24"
D25	18"
MIN SIZE	9"



QUANTITIES

ROCK RIP-RAP D50=24":	9.7 CU YDS PER LF
FILTER FABRIC:	6.9 SQ YDS PER LF

A
–
EROSION PROTECTION - JOHNSON FARM
SCALE: 1"=5'

DATE:	2/1/2016
JOB NO.:	10514-17
DESIGNED BY:	JWB
CHECKED BY:	JWB

DATE
REVISIONS

ROSENBERG
ASSOCIATES
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St. George, Utah 84790
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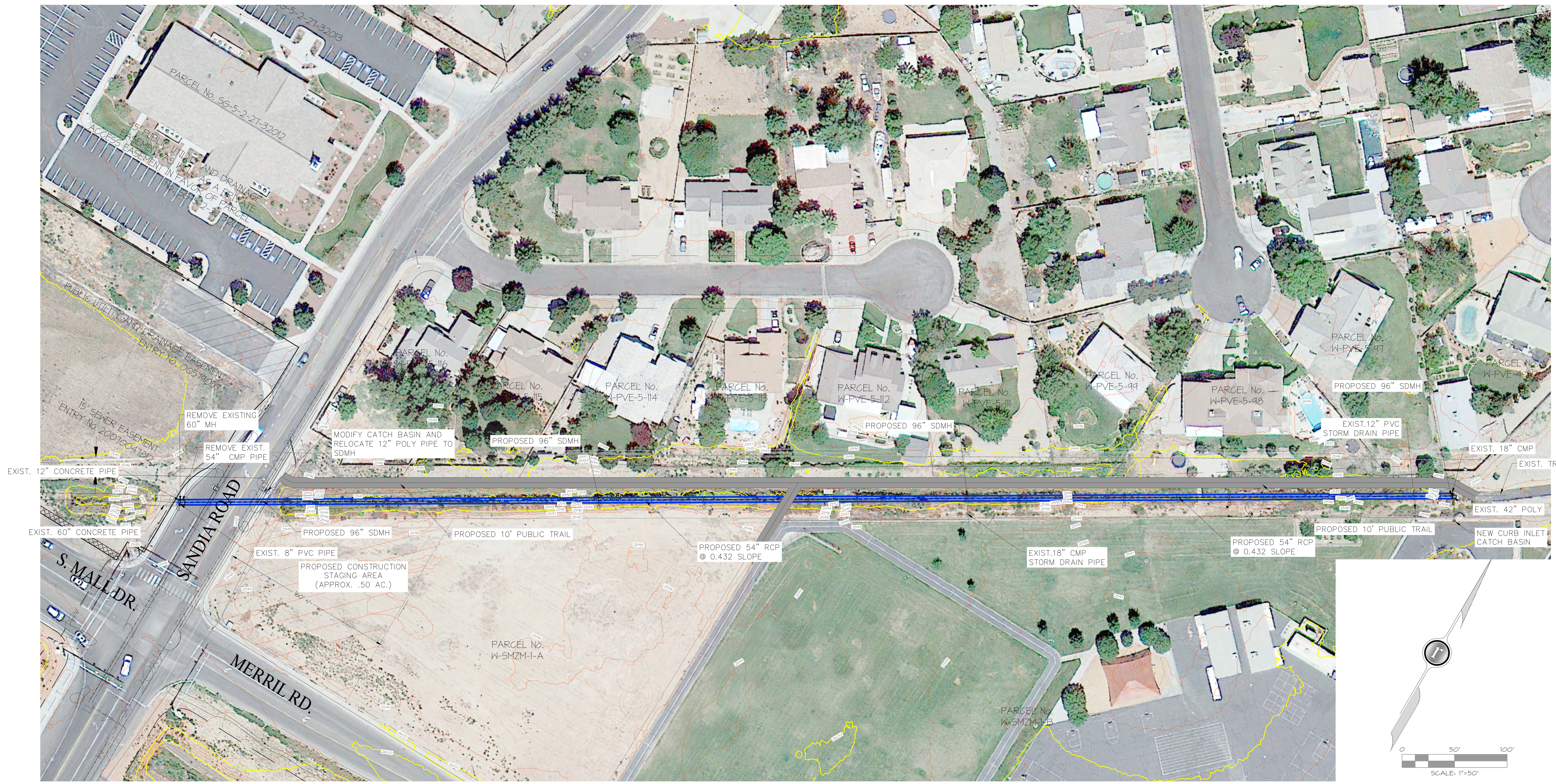
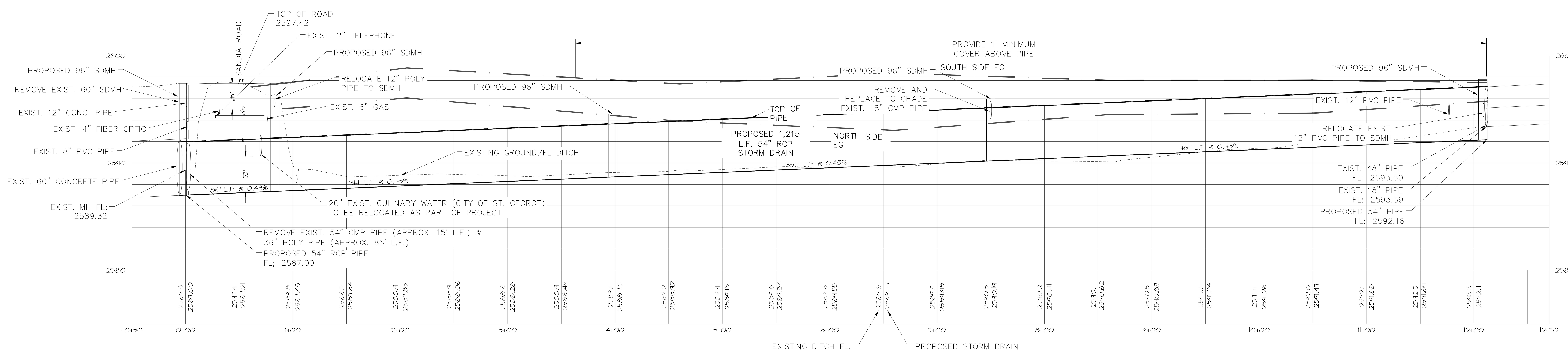
EROSION PROTECTION - TYPICAL CROSS-SECTION
FOR
SEEGMILLER MARSH RESTORATION
ST. GEORGE
UTAH

Attachment 3

Y-Drain

Preferred Alternative Concept Design Drawings





DATE: 01/25/14
JOB NO.: 10514-11
DESIGNED BY: RP
CHECKED BY: JKB
DWG: Y-DRAIN

DATE

REVISIONS

ROSENBERG
ASSOCIATES
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PROPOSED Y-DRAIN IMPROVEMENTS -30% DESIGN

PLAN/PROFILE

NRCS WARNER DRAW WATERSHED PROJECT

WASHINGTON COUNTY, UTAH

SHEET

1

1 OF 1 SHEETS

Attachment 4

Warner Valley Disposal System

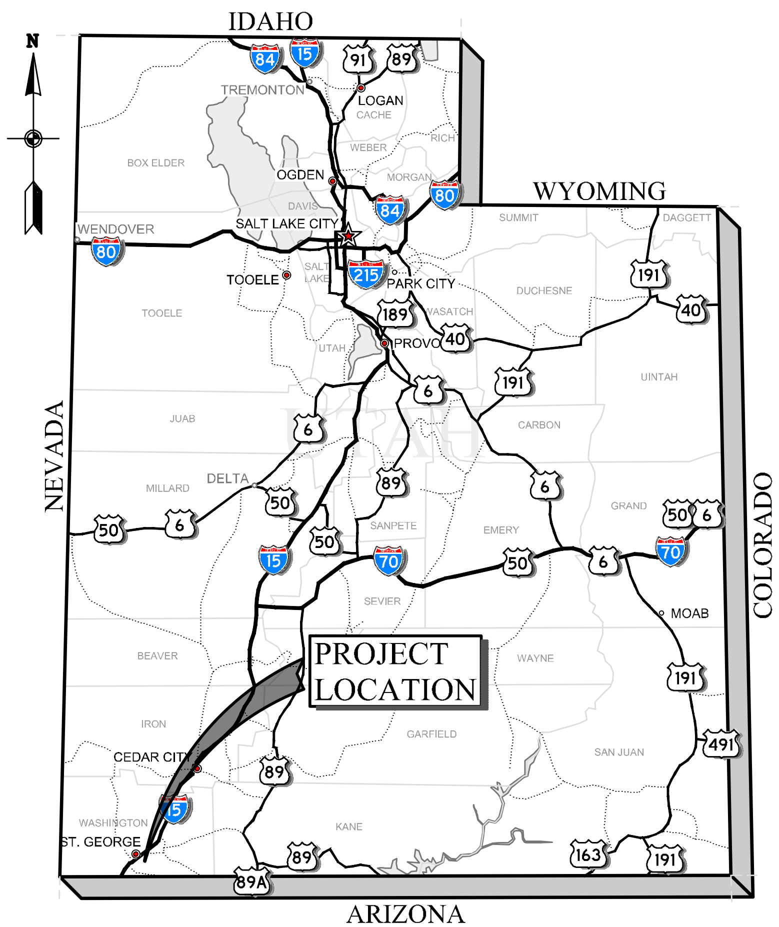
Preferred Alternative Concept Design Drawings

DRAWINGS FOR CONSTRUCTION OF THE

WARNER DRAW DISPOSAL SYSTEM PROJECT

WASHINGTON COUNTY

USDA United States Department of Agriculture
Natural Resources Conservation Service



PROJECT LOCATION MAP

INDEX OF DRAWINGS		
SHT NO.	DWG NO.	DESCRIPTION
GENERAL		
1	G-01	INDEX OF DRAWINGS, PROJECT LOCATION AND VICINITY MAPS
2	G-02	ABBREVIATIONS
3	G-03	SYMBOLS AND NOTES
4	G-04	KEY SHEET
CIVIL		
5	C-01	PLAN & PROFILE STA 1+00 TO 14+00
6	C-02	PLAN & PROFILE STA 14+00 TO 27+50
7	C-03	PLAN & PROFILE STA 27+50 TO 41+50
8	C-04	PLAN & PROFILE STA 41+50 TO 55+00
9	C-05	PLAN & PROFILE STA 55+50 TO 69+00
10	C-06	PLAN & PROFILE STA 69+00 TO 82+50
11	C-07	PLAN & PROFILE STA 82+50 TO 95+00
12	C-08	PLAN & PROFILE STA 95+00 TO 108+00
13	C-09	PLAN & PROFILE STA 108+00 TO 118+00
14	C-10	PLAN & PROFILE STA 118+00 TO 128+00
15	C-11	PALN & PROFILE STA 128+00 TO 138+00
16	C-12	BASIN SITE – 1
17	C-13	BASIN SITE – 2
18	C-14	DETENTION BASIN CROSS SECTIONS
19	C-15	TRAIL PLAN STA 200+00 TO 223+50
20	C-16	TRAIL PLAN STA 223+50 TO 234+00
21	C-17	TRAIL PLAN STA 234+00 TO 256+50
22	C-18	TRAIL PLAN STA 256+50 TO 282+00
23	C-19	TRAIL PLAN STA 282+00 TO 307+00
24	C-20	TRAIL PLAN STA 307+00 TO 312+87
25	C-21	TYPICAL TRAIL CROSS SECTION
STRUCTURAL		
26	S-01	CATCH BASIN FLOODING REPAIRS
27	S-02	WARNER DISPOSAL PIPELINE OUTFALL HEADWALL
28	S-03	OUTLET STRUCTURE

PROJECT VICINITY MAP

BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

WASHINGTON COUNTY
WARNER DRAW DISPOSAL SYSTEM
WASHINGTON COUNTY

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

DESIGN
DESIGN C. NIELSON
DRAWN C. NIELSON

REVIEW
CHECKED T. OLSEN
APPROVED T. OLSEN

GENERAL
INDEX OF DRAWINGS PROJECT LOCATION AND VICINITY MAPS

PROJECT NUMBER 581-18-01
DATE: DEC 2018

DRAWING NO.
G-01
SHEET 1 OF 28

@	AT
AASHTO	AMERICAN ASSOCIATION OF STATE HIGHWAY TRANSPORTATION OFFICIALS
AB	ANCHOR BOLT
ABBR	ABBREVIATION
ABS	ACRYLONITRILE-BUTADIENE-STYRENE
AC	ASPHALTIC CONCRETE OR ALTERNATING CURRENT OR ACTIVATED CARBON
ACI	AMERICAN CONCRETE INSTITUTE
ACP	ASPHALTIC CONCRETE PAVEMENT
ADDL	ADDITIONAL
ADJ	ADJACENT OR ADJUSTABLE
AER	AERATION
AFF	ABOVE FINISH FLOOR
AGGR	AGGREGATE
AH	AIR HANDLER
AIR CONT	AIR CONDITIONING
AISC	AMERICAN INSTITUTE OF STEEL CONSTRUCTION
AL	ALUMINUM, ALUM
ALTN	ALTERNATIVE, ALTERNATE
ANOD	ANODIZED
ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE
APPROX	APPROXIMATE
APVD	APPROVED
ARCH	ARCHITECTURAL
ARV	AIR RELEASE VALVE
ASME	AMERICAN SOCIETY OF MECHANICAL ENGINEERS
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIAL
ASSY	ASSEMBLY
AUTO	AUTOMATIC
AUX	AUXILIARY
AVAR	AIR VACUUM AND AIR RELEASE VALVE
AWS	AMERICAN WELDING SOCIETY
AWWA	AMERICAN WATER WORKS ASSOCIATION
B & S	BELL & SPIGOT
BC	BEGIN CURVE, BOLT CIRCLE
BF	BLIND FLANGE, BUTTERFLY VALVE
BFG	BELOW FINISH GRADE
BFP	BACK FLOW PREVENTER
BFV	BUTTERFLY VALVE
BHD	BULKHEAD
BHP	BRAKE HORSEPOWER
BLDG	BUILDING
BLK	BLACK OR BLOCK
BLKG	BLOCKING
BLT	BOLT
BM	BEAM, BENCH MARK
BO	BLOW-OFF ASSEMBLY, BLOW-OFF
BOT	BOTTOM
BPS	BOOSTER PUMPING STATION
BPV	BACK PRESSURE VALVE
BRK	BRICK
BTU	BRITISH THERMAL UNIT
BTWN	BETWEEN
BUR	BUILT-UP ROOFING
BVC	BEGIN VERTICAL CURVE
BVCE	BEGIN VERTICAL CURVE ELEVATION
BVCS	BEGIN VERTICAL CURVE STATION
BW	BACK WASH, FILTER BACKWASH
C	CENTIGRADE OR CELSIUS
CAB	CABINET
CAP	CAPACITY
CARV	COMBINATION AIR RELEASE VALVE
CB	CATCH BASIN
CC	CENTER TO CENTER
CCP	CONCRETE CYLINDER PIPE
CD	CEILING DIFFUSER CHEMICAL DRAIN AND VENT
CER	CERAMIC
CFH	CUBIC FEET PER HOUR
CFM	CUBIC FEET PER MINUTE
CFR	CODE OF FEDERAL REGULATIONS
CFS	CUBIC FEET PER SECOND
CG	CHLORINE GAS
CGB	CORD GRIP BUSHING
CHBD	CHALKBOARD
CHEM	CHEMICAL
CHG	CHANGE
CHKD PL	CHECKERED PLATE
CI	CAST IRON
CIP	CAST IRON PIPE
CISP	CAST IRON SOIL PIPE
CJ	CONSTRUCTION JOINT
CJP	COMPLETE JOINT PENETRATION
CL	CHLORINATOR, CHAIN LINK, CENTERLINE OR CHLORINE
CLR	CLEAR, CLEARANCE
CLST	CEMENT LINED STEEL PIPE
CLSM	CONTROLLED LOW STRENGTH MATERIAL
CM	CENTIMETER
CML & C	CEMENT MORTAR LINED AND COATED
CMP	CORRUGATED METAL PIPE
CMU	CONCRETE MASONRY UNIT
CO	CLEANOUT
COL	COLUMN
COMM	COMMUNICATION
COMB	COMBINED
CONC	CONCRETE, CONCENTRIC
COND	CONDENSER, CONDENSATE
CONN	CONNECTION
CONST	CONSTRUCTION, CONSTRUCT
CONT	CONTINUED, CONTINUOUS, CONTINUATION
COORD	COORDINATE
COP	COPPER
COTG	CLEAN-OUT TO GRADE
CPLG	COUPLING
CPS	CULINARY PUMP STATION
CPVC	CHLORINATED POLYVINYL CHLORIDE
CS	CAST STEEL OR CAUSTIC SODA
CTRD	CENTERED
CTR	CENTER
CTSK	COUNTERSUNK
CU FT	CUBIC FOOT
CU IN	CUBIC INCH
CU YD	CUBIC YARD
CULV	CULVERT
CV	CHECK VALVE
CW	COLD WATER
CWO	CHAIN WHEEL OPERATOR
CYL	CYLINDER
d	PENNY
DBA	DEFORMED ANCHOR
DBL	DOUBLE
DC	DIRECT CURRENT
DEG	DEGREE
DEMO	DEMOLITION, DEMOLISH
DEQ	DEPARTMENT OF ENVIRONMENTAL QUALITY
DET	DETAIL
DI	DUCTILE IRON, DROP INLET
DIA	DIAMETER
DIAG	DIAGONAL
DIAPH	DIAPHRAGM
DIFF	DIFFUSER
DIM	DIMENSION
DIP	DUCTILE IRON PIPE
DIR	DIRECTION
DISCH	DISCHARGE
DIST	DISTANCE
DIV	DIVISION
D-LOAD	LOADING CONDITION FOR RCP
DMPR	DAMPER
DN	DOWN, DECANT
DOT	DEPARTMENT OF TRANSPORTATION
DP	DAMP PROOFING
DR	DOOR, DRAIN
DS	DRENCH SHOWER & EYE WASH, DOWNSPOUT
DWG	DRAWING
DWL	DOWEL
E(UG)	ELECTRICAL (UNDERGROUND)
E(OH)	ELECTRICAL (OVERHEAD POWER)
E	EAST
EA	EACH
EB	EXPANSION BOLT
EC	END CURVE
ECC	ECCENTRIC
EF	EACH FACE, EXHAUST FAN
EFF	EFFLUENT
EG	EXISTING GRADE
EL	ELEVATION
ELB	ELBOW
ELEV	ELEVATION
ELEC	ELECTRICAL, ELECTRONIC
EMB	EMBEDMENT
EMER	EMERGENCY
ENCL	ENCLOSURE
ENG	ENGINE
ENGR	ENGINEER
EP	EDGE OF PAVEMENT
EPDM	ETHYL PROPYLENE DIENE MONOMER
EPS	EXPANDED POLYSTYRENE
EQ	EQUAL
EQL SP	EQUALLY SPACED
EQUIP	EQUIPMENT
ETC	ETCETERA
EVAP	EVAPORATOR
EVC	END VERTICAL CURVE
EVCE	END VERTICAL CURVE ELEVATION
EVCS	END VERTICAL CURVE STATION
EW	EACH WAY, EYE WASH
EXH	EXHAUST
EXIST	EXISTING
EXP ANR	EXPANSION BOLT, ANCHOR
EXP JT	EXPANSION JOINT
EXT	EXTERIOR, EXTENSION, EXTERNAL
F	FAHRENHEIT, FACE
F TO F	FACE TO FACE
FAB	FABRICATION, FABRICATE, OR FABRICATED
FB	FLAT BAR
FC	FLEXIBLE COUPLING
FCA	FLANGE COUPLING ADAPTER
FCO	FLOOR CLEANOUT
FD	FLOOR DRAIN
FDN	FOUNDATION
FDR	FEEDER
FEXT	FIRE EXTINGUISHER
FF	FLAT FACE, FAR FACE, FINISH FLOOR
FG	FINISH GRADE, FLOW GLASS
FH	FIRE HYDRANT
FLR	FLOOR
FL	FLOW LINE
FLEX	FLEXIBLE
FLG	FLANGE
FM	FORCE MAIN (SANITARY SEWER)
FND	FOUND
FNSH	FINISH
FO	FIBER OPTIC
FRP	FIBERGLASS REINFORCED PLASTIC
FW	FINISH WATER
FWR	FINISH WATER RESERVOIR
G	GAS
GA	GAGE, GAUGE
GAL	GALLON
GALV	GALVANIZED
GEN	GENERATOR
GFI	GROUND FAULT INTERRUPTER
GI	GALVANIZED IRON
GIS	GEOGRAPHIC INFORMATION SYSTEM
GL	GLASS
GLAZ	GLAZING
GLV	GLOBE VALVE
GND	GROUND
GPD	GALLONS PER DAY
GPH	GALLONS PER HOUR
GPM	GALLONS PER MINUTE
GR	GRADE
GR BRK	GRADE BREAK, GRADE CHANGE
GRTG	GRATING
GRV	GROOVED
GSP	GALVANIZED STEEL PIPE
GV	GATE VALVE
GYP	GYPSUM BOARD
H	HEIGHT
HAS	HEADED ANCHOR STUD
HB	HOSE BIBB
HD	HUB DRAIN
HDPE	HIGH DENSITY POLYETHYLENE
HDR	HEADER
HDW	HARDWARE
HEX	HEXAGONAL
HGR	HANGER
HM	HOLLOW METAL
HORIZ	HORIZONTAL
HP	HORSEPOWER, HIGH PRESSURE,HEAT PUMP, HIGH POINT
HR	HEATING RETURN, HOUR, HOSE RACK
HS	HIGH STRENGTH
HSS	HOLLOW STRUCTURAL SECTION
HTG	HEATING
HTR	HEATER
HV	HOSE VALVE
HVAC	HEATING, VENTILATING AND AIR CONDITIONING
HWL	HIGH WATER LEVEL
HWO	HANDWHEEL OPERATED
HYD	HYDRANT, HYDRAULIC
ICFM	INLET CUBIC FEET PER MINUTE
ID	INSIDE DIAMETER
IE	INVERT ELEVATION
IF	INSIDE FACE
IN	INCH
IN LB	INCH-POUND
INFL	INFLUENT
INSUL	INSULATING
INVT	INVERT
IOB	INLET OUTLET BYPASS
IPS	IRON PIPE SIZE
IRR	IRRIGATION
JA	JORDAN AQUEDUCT
JT	JOINT
JTS	JOINTS
JVWTP	JORDAN VALLEY WATER TREATMENT PLANT
K	KELVIN, KILO OR THOUSAND POUNDS
KG	KILOGRAM
KV	KILOVOLT
KW	KILOWATT
KWH	KILOWATT HOUR
L	LEFT OR LITER
LAB	LABORATORY
LAV	LAVATORY
LB	POUND
LC	LENGTH OF CURVE
LF	LINEAR FEET
LG	LENGTH OR LONG
LH	LEFT HAND
LIP	LIP OF GUTTER
LL	LIVE LOAD
LLV	LONG LEG VERTICAL
LOL	LENGTH OF LINE
LP	LOW POINT
LR	LONG RADIUS
LT	LIGHT, LEFT
LVL	LEVEL
LWL	LOW WATER LEVEL
LWR	LOWER
M	METER, MALE (PIPE THREAD)
MACH	MACHINE
MAN	MAGNETIC, MANUAL
MATL	MATERIAL
MAX	MAXIMUM
MB	MACHINE BOLT
MCC	MOTOR CONTROL CENTER
MECH	MECHANICAL, MECHANISM
MEMB	MEMBRANE
MET	METAL
MFR	MANUFACTURER
MG	MILLION GALLONS
MGD	MILLION GALLONS PER DAY
MH	MANHOLE, MONORAIL HOIST
MI	MALLEABLE IRON
MID	MIDDLE
MIL	1/1,000 INCH
MIN	MINIMUM OR MINUTE
MISC	MISCELLANEOUS
MJ	MECHANICAL JOINT
MO	MASONRY OPENING
MPH	MILES PER HOUR
MTG	MOUNTING
MTL	METAL OR MATERIAL
MTR	MOTOR
MWS	MAXIMUM WATER SURFACE
N	NORTH
NAVD	NORTH AMERICAN VERTICAL DATUM
NBS	NATIONAL BUREAU OF STANDARDS
NC	NORMALLY CLOSED
NE	NORTHEAST
NEC	NATIONAL ELECTRIC CODE
NEMA	NATIONAL ELECTRICAL MANUFACTURES ASSOCIATION
NF	NEAR FACE
NFPA	NATIONAL FIRE PROTECTION ASSOCIATION
NIC	NOT IN CONTRACT
NO	NUMBER OR NORMALLY OPEN
NOM	NOMINAL
NPT	NATIONAL PIPE THREAD
NS	NEAR SIDE
NSF	NATIONAL SCIENCE FOUNDATION
NTS	NOT TO SCALE
NW	NORTHWEST
O TO O	OUT TO OUT
OC	ON CENTER, OVER-CROSSING
OD	OUTSIDE DIAMETER, OVERALL DIMENSION
OF	OUTSIDE FACE, OVERFLOW
OFS	OVERFLOW STRUCTURE
OH	OVERHEAD
OPER	OPERATOR, OPERATING
OPNG	OPENING
OPP	OPPOSITE
ORIG	ORIGINAL
OVHD	OVERHEAD
OZ	OUNCE
PC	PORTLAND CEMENT, POINT OF CURVE OR PRIMARY CLARIFIER
PCC	PORTLAND CEMENT CONCRETE
PCF	POUNDS PER CUBIC FOOT
PE	PLAIN END, POLYELECTROLYTE POLYMER, POLYETHYLENE
PG	PRESSURE GAUGE
pH	HYDROGEN ION CONCENTRATION
PI	PLANT INFLUENT, POINT OF INTERSECTION
PJF	PREMOLDED JOINT FILLER
PL	PLATE, PROPERTY LINE, PLACE
PLYWD	PLYWOOD
PM	PUMP, PROPELLER METER
POB	POINT OF BEGINNING
PP	POTASSIUM PERMANGANATE
PPD	POUNDS PER DAY
PPH	POUNDS PER HOUR
PPM	PARTS PER MILLION
PR	PAIR
PRC	POINT OF REVERSE CURVE
PREFAB	PREFABRICATED
PRI	PRIMARY
PRV	PRESSURE REGULATING/REDUCING VALVE
PS	PRESSURE SWITCH, PUMP STATION
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PSIG	POUNDS PER SQUARE INCH GAUGE
PT	POINT OF TANGENT, PRESSURE TREATED
PTDF	PRESSURE TREATED DOUGLAS FIR
PV	PAVEMENT
PVC	POLYVINYL CHLORIDE
PVI	POINT OF VERTICAL INTERSECTION
PW	POTABLE WATER
RAD	RADIUS
RC	REINFORCED CONCRETE
RCP	REINFORCED CONCRETE PIPE
RD	ROOF DRAIN OR ROAD
RDCR	REDUCER, REDUCING
RECIRC	RECIRCULATION
RED	REDUCING
REF	REFERENCE, REFER
REG	REGULATING, REGISTER
REINF	REINFORCE, REINFORCED
REQD	REQUIRED
REV	REVISION
RF	ROOF, RAISED FACE
RND	ROUND
RPM	REVOLUTIONS PER MINUTE
RP	RADIUS POINT
RS	RAW SEWAGE
RST	REINFORCING STEEL, RESET
RT	REGULATING TANK, RADIOGRAPHIC, RIGHT
RV	ROOF VENT
R/W	RIGHT OF WAY
RW	RAW WATER
S	SOUTH, SECOND
SA	SAMPLE, SAMPLE LINE
SCFM	STANDARD CUBIC FEET PER MINUTE
SCH	SCHEDULE
SD	STORM DRAIN
SECT	SECTION
SHT	SHEET
SIM	SIMILAR
SLP	SLOPE
SP	SPACING, STATIC PRESSURE
SPA	SPACED
SPEC	SPECIFIED, SPECIFICATION
SPECS	SPECIFICATIONS
SPG	SPACING
SPKR	SPEAKER
SPLY	SUPPLY
SPRT	SUPPORT
SQ	SQUARE
SQ FT	SQUARE FOOT
SR	SUPPLY REGISTER
SS	SANITARY SEWER, SERVICE SINK
SST	STAINLESS STEEL
STA	STATION
STD	STANDARD
STIFF	STIFFENER
STL	STEEL
STRL	STRUCTURAL
SUC	STRUCTURAL UNDERDRAIN COLLECTOR
SWA	SOUTHWEST AQUEDUCT
SYM	SYMBOL
SYMM	SYMMETRICAL
SYS	SYSTEM
T	THICKNESS, TOP, TOILET
T&B	TOP AND BOTTOM
T&G	TONGUE AND GROOVE
TAN	TANGENT
TBC	TOP BACK OF CURB
TBM	TEMPORARY BENCH MARK
TDH	TOTAL DYNAMIC HEAD
TECH	TECHNICAL
TEL	TELEPHONE
TEMP	TEMPERATURE, TEMPORARY
THK	THICK
THR'D	THREADED
TK	TANK
TO	TOP OF
TOC	TOP OF CONCRETE
TOG	TOP OF GRADE
TP	TELEPHONE POLE, TURNING POINT
TW	TOP OF WALL
TYP	TYPICAL
UBC	UNIFORM BUILDING CODE
UD	UNDERDRAIN
UG	UNDERGROUND
UH	UNIT HEATER
UL	UNDERWRITERS LABORATORIES
UNO	UNLESS OTHERWISE NOTED
USBR	U.S. BUREAU OF RECLAMATION
V	VALVE, VENT, VOLT, VACUUM
VAR	VARIES, OR VARIABLE
VC	VERTICAL CURVE
VCP	VITRIFIED CLAY PIPE
VERT	VERTICAL
VIC	VICTAULIC COUPLING
VOL	VOLUME
VPI	VERTICAL POINT OF INFLECTION
VSS	VOLATILE SUSPENDED SOLIDS
VTC	VENT THROUGH CEILING
VTR	VENT THROUGH ROOF
W	WEST, WASTE, WIDE FLANGE (BEAM)
W/	WITH
W/O	WITHOUT
WC	WATER COLUMN OR WATER CLOSET
WCO	WALL CLEANOUT
WD	WOOD
WH	WATER HEATER
WS	WATER STOP, WATER SURFACE
WSP	WELDED STEEL PIPE
WSTP	WATER STOP
WT	WEIGHT
WWM	WELDED WIRE MESH
XMFR	TRANSFORMER
XMTR	TRANSMITTER
XS	EXTRA STRONG
YD	YARD
YP	YARD PIPING
YR	YEAR

BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY

WARNER DRAW DISPOSAL SYSTEM

WASHINGTON COUNTY

DESIGN: STANDARDS | DRAWN: STANDARDS

REVIEW: CHECKED: STANDARDS | APPROVED: STANDARDS

GENERAL

ABBREVIATIONS

PROJECT NUMBER 581-18-01

DATE: DEC 2018

DRAWING NO. G-02

SHEET 2 OF 28

S:\washington county\581-18-01 warner draw watershed ea\7.0 drawings\disposal_pipeline\SHT\5811801_G-02.dwg Plotted: 1/10/2019 4:51 PM By: Cody Nielson

SECTION IDENTIFICATION

(1) SECTION CUT SHOWN ON DRAWING AS:

SECTION LETTER — A

C-10 — DRAWING NUMBER WHERE THE SECTION IS SHOWN (SEE NOTE A)

(2) THIS SECTION IS IDENTIFIED AS:

SECTION — A — SECTION LETTER

SCALE: AS DESIGNATED

M-01 — DRAWING NUMBER WHERE THE SECTION CUT IS SHOWN (SEE NOTE A)

DETAIL IDENTIFICATION

(1) DETAIL IDENTIFICATION SHOWN ON DRAWING AS:

DETAIL NUMBER — 3

C-10 — DRAWING NUMBER WHERE THE DETAIL IS SHOWN

THE DETAIL NAME IS OPTIONAL AND LOCATED HERE, FOLLOWING DETAIL CALLOUT

(2) THIS DETAIL IS IDENTIFIED AS:

DETAIL — 3 — DETAIL NUMBER

SCALE: AS DESIGNATED (SEE NOTE A)

M-01 — DRAWING NUMBER WHERE THE DETAIL IS SHOWN

TYPICAL DETAIL IDENTIFICATION

DETAIL NAME — C

NOT TO SCALE

2000 — TYPICAL DETAIL NUMBER, SEE INDEX OF DRAWINGS FOR LOCATION OF GENERAL DRAWINGS

DRAWING IDENTIFICATION SYSTEM

LETTER	DISCIPLINE
G	GENERAL
C	CIVIL
GC	GENERAL CIVIL
A	ARCHITECTURAL
GA	GENERAL ARCHITECTURAL
S	STRUCTURAL
GS	GENERAL STRUCTURAL
M	MECHANICAL
GM	GENERAL MECHANICAL
H	HVAC
E	ELECTRICAL
GE	GENERAL ELECTRICAL DETAILS
I	INSTRUMENTATION

S-2 — INDIVIDUAL DRAWING NUMBER — DISCIPLINE

NOTES:

A. IF PLAN AND SECTION (OR DETAIL CALL-OUT AND DETAIL) ARE SHOWN ON SAME DRAWING, DRAWING NUMBER IS REPLACED BY A HORIZONTAL LINE.

B. ELECTRICAL SYMBOLS SHOWN ON ELECTRICAL DRAWINGS. FOR WELDING SYMBOLS USE AMERICAN WELDING SOCIETY STANDARD SYMBOLS. SEE AMERICAN INSTITUTE OF STEEL CONSTRUCTION MANUAL.

- COORDINATE IDENTIFICATION
- ELEVATION INDICATOR
- SECTION CORNER
- BENCH MARK
- MONUMENT INDICATOR
- POTHOLE
- TEST HOLE
- BORING HOLE
- SECTION LINE
- PROPERTY LINE
- EASEMENT
- PARCEL
- R/W — RIGHT-OF-WAY
- NEW ASPHALT
- EXISTING ASPHALT
- CENTERLINE
- 4500 — CONTOUR LINE, FINISHED GRADE
- 4500 — CONTOUR LINE, EXISTING GRADE
- 4500.20 — FINISHED ELEVATION
- (4500. 20) — EXISTING ELEVATION
- TOP / TOE — CUT OR FILL SLOPE TO BE CONSTRUCTED
- SILT FENCE
- X — FENCE
- RAILING
- DITCH
- CULVERT
- RIPRAP
- TREE LINE/VEGETATION
- EXISTING STRUCTURE OR FACILITY
- NEW STRUCTURE OR FACILITY
- FUTURE STRUCTURE OR FACILITY
- NEW PIPELINE (CIVIL SHEETS)
- NEW PIPELINE 10" DIA AND SMALLER (CIVIL SHEETS)
- EXISTING UTILITY PIPELINE
- ATMS — ATMS
- CTV — CABLE
- C(ug) — COMMUNICATION BURIED
- COMM — COMMUNICATION OVERHEAD
- P(ug) — ELECTRICAL BURIED
- OHP — ELECTRICAL OVERHEAD
- FO — FIBER OPTICS
- GAS — GAS
- IRR — IRRIGATION
- PETRO — PETROLEUM LINE
- SS — SANITARY SEWER
- SD — STORM DRAIN
- T(ug) — TELEPHONE BURIED
- TEL — TELEPHONE OVERHEAD
- W — WATERLINE
- TV — CABLE BOX
- CATCH BASIN
- EB — ELECTRICAL BOX
- HYDRANT
- G — GAS MANHOLE
- S — SEWER MANHOLE
- D — STORM DRAIN MANHOLE
- T — TELEPHONE MANHOLE
- W — WATER MANHOLE
- WM — WATER METER

- POWER POLE
- TB — TELEPHONE BOX
- LIGHT POLE ONE LUMINAIRE
- LIGHT POLE TWO LUMINAIRS
- LIGHT POLE
- STREET LIGHT WITH BRACKET
- MASONRY
- STEEL
- INSULATION
- GRAVEL
- CONCRETE
- EARTH
- SAND
- ALUMINUM OR METAL DECKING
- CHECKERED PLATE
- SPAN — GRATING
- PLASTIC, RUBBER OR NEOPRENE
- WOOD (ROUGH FRAMING) OR, OPENING OR DEPRESSION IN SLAB OR WALL
- FHC — FIRE HOSE CABINET
- FE — FIRE EXTINGUISHER
- UNIT HEATER
- PCOTG — PRESSURE CLEANOUT TO GRADE
- WCO — WALL CLEANOUT
- FCO — FLOOR CLEANOUT
- COTG — CLEANOUT TO GRADE
- BLOW OFF ASSEMBLY
- HUB DRAIN
- FLOOR DRAIN
- FLOOR SINK
- DRAIN TRAP
- CHANGE IN PIPING MATERIAL
- 24" RCP-RW — PIPE SIZE AND TYPE/FLUID ABBREVIATION (USE FOR EXISTING PIPE CALLOUT)
- 2" UW (2) — PIPE CALLOUT (SEE PIPING SCHEDULE)
- ME-2 — EQUIPMENT NUMBER (SEE EQUIPMENT SCHEDULE)
- STOP GATE
- SLIDE GATE
- SLUICE GATE
- GATE VALVE
- HOSE BIBB (H/B)
- REDUCER OR INCREASER
- LIQUID SURFACE EL

- REVISION WORK
- 1 — COLUMN LINE GRID
- A — WINDOW TYPE
- 05 — DOOR NUMBER
- 05 — ROOM NUMBER

GENERAL NOTES:

BOWEN COLLINS & ASSOCIATES

30% REVIEW

REVISIONS: NO. | DATE | REV. BY | DESCRIPTION

VERIFY SCALE — BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY
WARNER DRAW DISPOSAL SYSTEM
WASHINGTON COUNTY

REVIEW: CHECKED STANDARDS, APPROVED STANDARDS

DESIGN: DESIGN STANDARDS, DRAWN STANDARDS

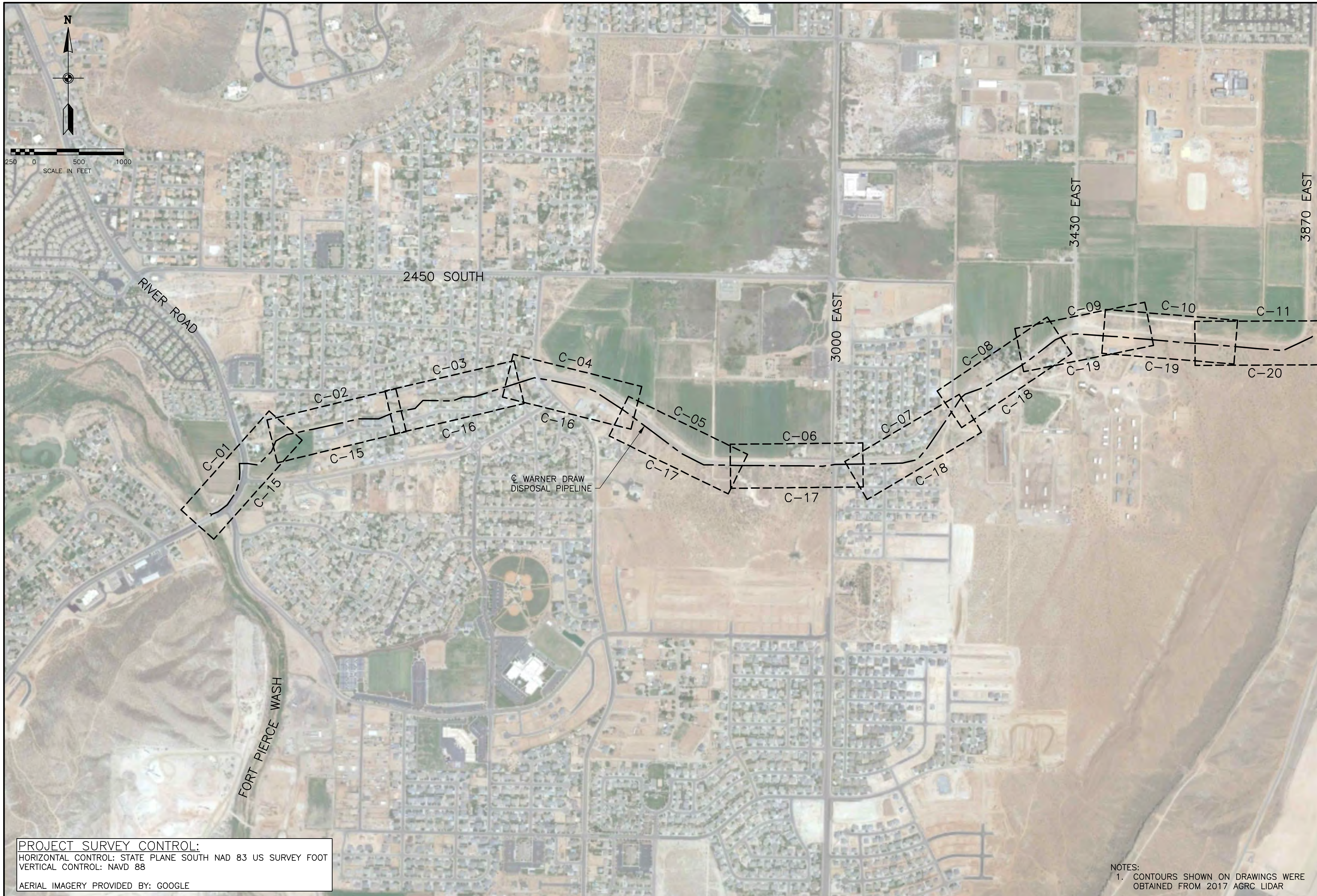
GENERAL
SYMBOLS AND NOTES

PROJECT NUMBER 581-18-01

DATE: DEC 2018

DRAWING NO. G-03

SHEET 3 OF 28



PROJECT SURVEY CONTROL:

HORIZONTAL CONTROL: STATE PLANE SOUTH NAD 83 US SURVEY FOOT
VERTICAL CONTROL: NAVD 88

AERIAL IMAGERY PROVIDED BY: GOOGLE

NOTES:
1. CONTOURS SHOWN ON DRAWINGS WERE OBTAINED FROM 2017 AGRC LIDAR

BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY
WARNER DRAW DISPOSAL SYSTEM
WASHINGTON COUNTY

DESIGN
DESIGN C. NIELSON
DRAWN C. NIELSON

REVIEW
CHECKED T. OLSEN
APPROVED T. OLSEN

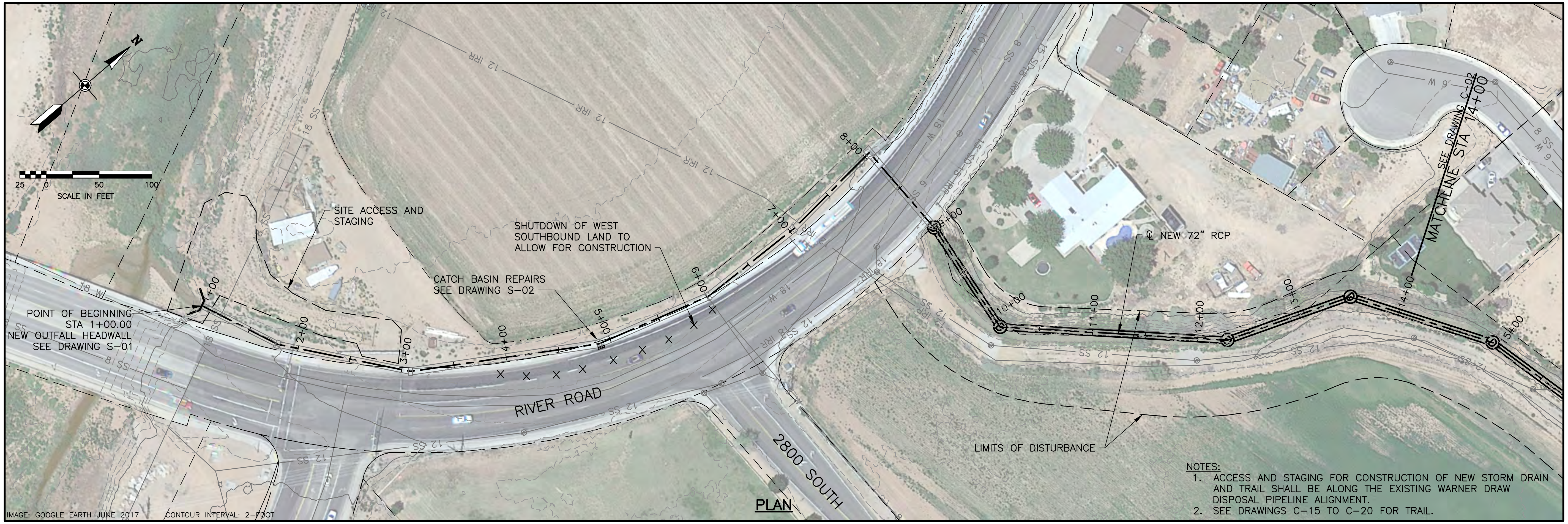
GENERAL
KEY SHEET

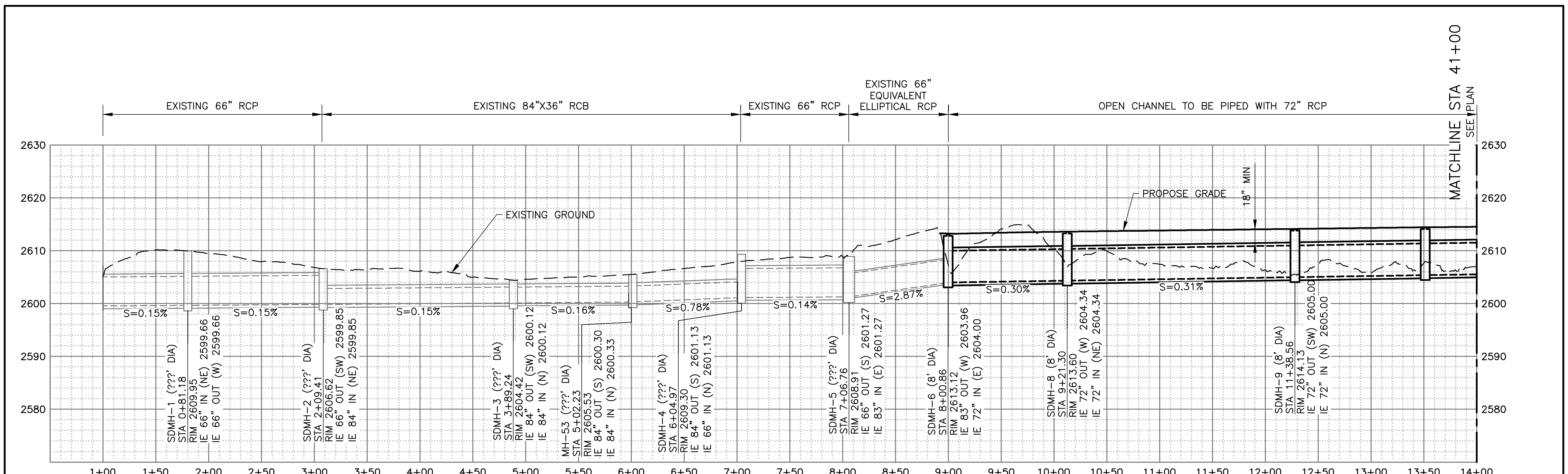
PROJECT NUMBER 581-18-01

DATE: DEC 2018

DRAWING NO.
G-04

SHEET 4 OF 28





PROFILE
HORIZ: 1" = 50'
VERT: 1" = 10'

BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY
WARNER DRAW DISPOSAL SYSTEM
WASHINGTON COUNTY

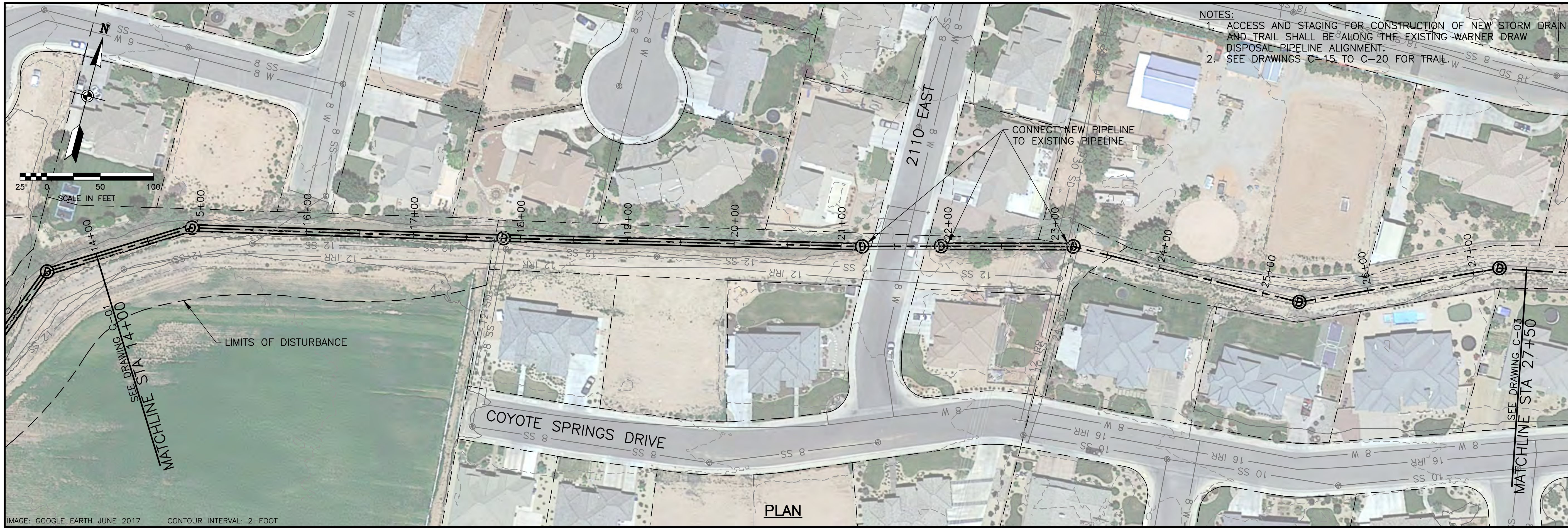
DESIGN: DESIGN C. MERRELL; DRAWN C. NIELSON
REVIEW: CHECKED C. MERRELL; APPROVED T. OLSEN

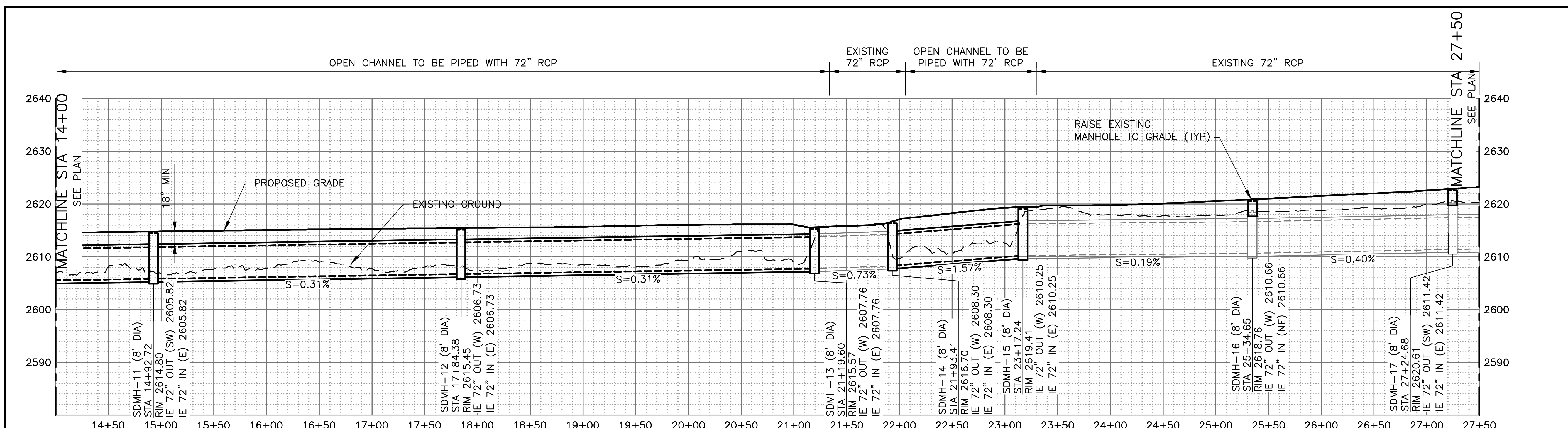
CIVIL
PLAN & PROFILE
STA 1+00 TO 14+00

PROJECT NUMBER 581-18-01
DATE: DEC 2018

DRAWING NO. C-01
SHEET 5 OF 28

S:\Washington County\581-18-01 Warner Draw Watershed EA\7.0 Drawings\Disposal_Pipeline\SHT\5811801_C-01.dwg Plotted: 1/14/2019 9:00 AM By: Cody Nielson





PROFILE
HORIZ: 1" = 50'
VERT: 1" = 10'

BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

WASHINGTON COUNTY
WARNER DRAW DISPOSAL SYSTEM
WASHINGTON COUNTY

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

DESIGN
DESIGN C. NIELSON
DRAWN C. NIELSON

REVIEW
CHECKED T. OLSEN
APPROVED T. OLSEN

CIVIL
PLAN & PROFILE
STA 14+00 TO 27+50

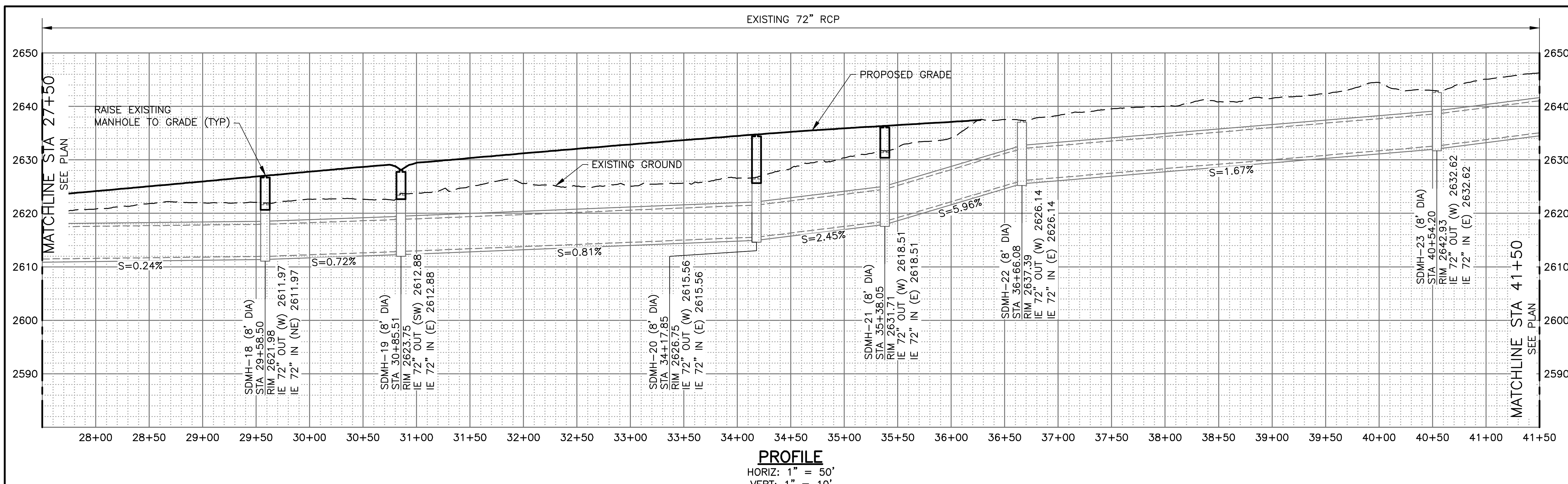
PROJECT NUMBER 581-18-01
DATE: DEC 2018

DRAWING NO.
C-02
SHEET 6 OF 28

S:\washington county\581-18-01 warner draw watershed ea\7.0 drawings\disposal_pipeline\SHT\5811801_C-02.dwg Plotted: 1/14/2019 9:04 AM By: Cody Nielson

NOTES:
1. ACCESS AND STAGING FOR CONSTRUCTION OF NEW STORM DRAIN AND TRAIL SHALL BE ALONG THE EXISTING WARNER DRAW DISPOSAL PIPELINE ALIGNMENT.
2. SEE DRAWINGS C-15 TO C-20 FOR TRAIL.

PLAN



PROFILE

HORIZ: 1" = 50'
VERT: 1" = 10'

BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION
REVISIONS			

WASHINGTON COUNTY
WARNER DRAW DISPOSAL SYSTEM
WASHINGTON COUNTY

DESIGN
DESIGN C. NIELSON
DRAWN C. NIELSON

REVIEW
CHECKED T. OLSEN
APPROVED T. OLSEN

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

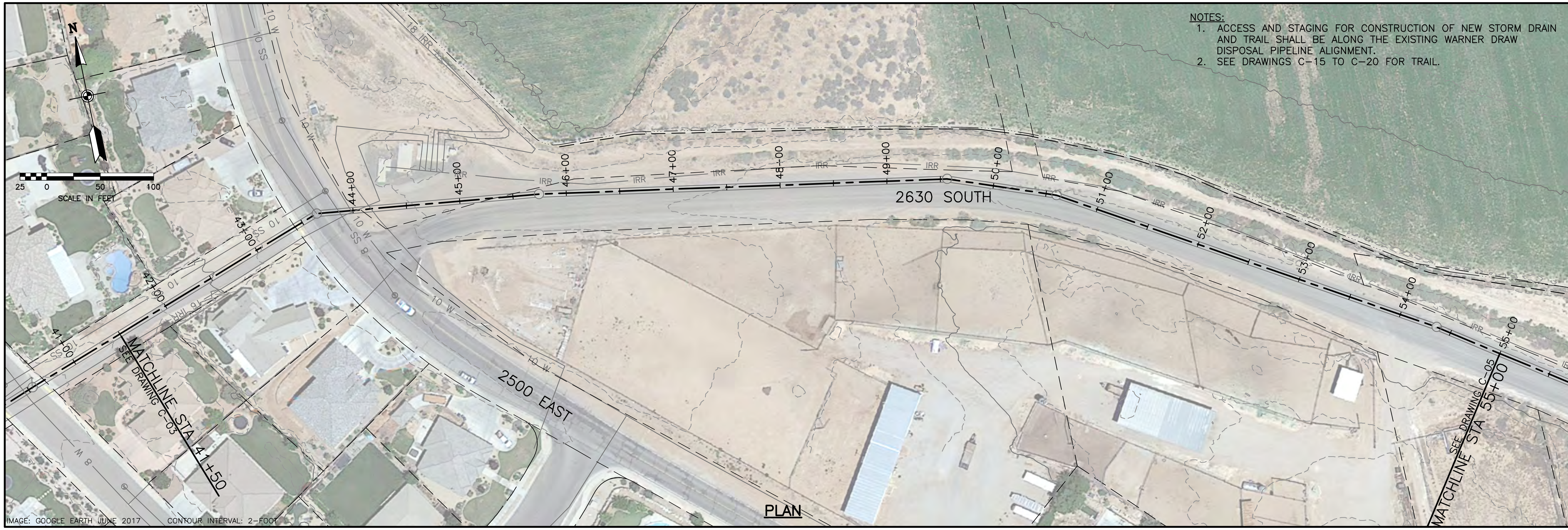
CIVIL
PLAN & PROFILE
STA 27+50 TO 41+50

PROJECT NUMBER 581-18-01
DATE: DEC 2018

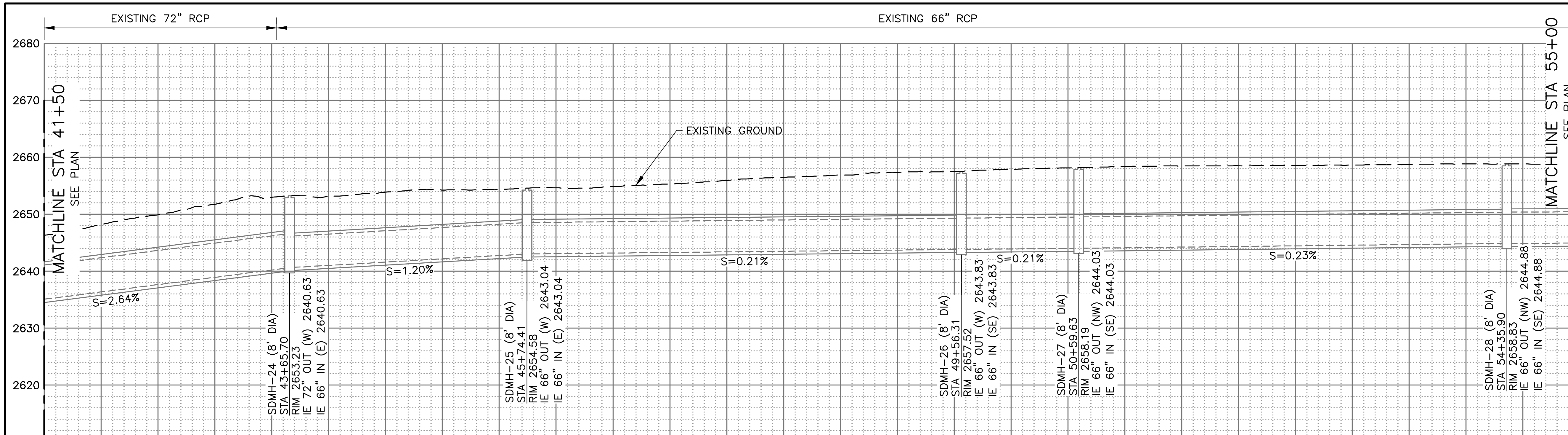
DRAWING NO.
C-03
SHEET 7 OF 28

S:\washington county\581-18-01 warner draw watershed ea\7.0 drawings\disposal_pipeline\SHT\5811801_C-03.dwg Plotted: 1/10/2019 4:57 PM By: Cody Nielson

NOTES:
1. ACCESS AND STAGING FOR CONSTRUCTION OF NEW STORM DRAIN AND TRAIL SHALL BE ALONG THE EXISTING WARNER DRAW DISPOSAL PIPELINE ALIGNMENT.
2. SEE DRAWINGS C-15 TO C-20 FOR TRAIL.



PLAN



PROFILE
HORIZ: 1" = 50'
VERT: 1" = 10'

BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY
WARNER DRAW DISPOSAL SYSTEM
WASHINGTON COUNTY

DESIGN
DESIGN C. NIELSON
DRAWN C. NIELSON

REVIEW
CHECKED T. OLSEN
APPROVED T. OLSEN

CIVIL
PLAN & PROFILE
STA 41+50 TO 55+00

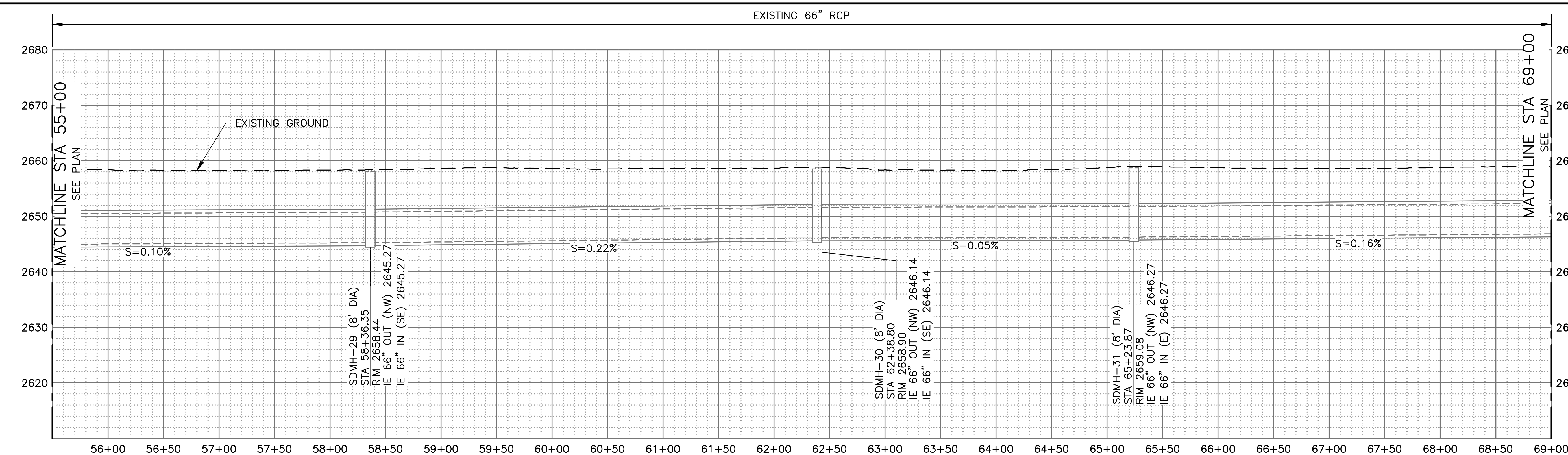
DATE: DEC 2018
PROJECT NUMBER 581-18-01

DRAWING NO.
C-04
SHEET 8 OF 28

S:\washington county\581-18-01 warner draw watershed ea\7.0 drawings\disposal_pipeline\SHT\5811801_C-04.dwg Plotted: 1/10/2019 4:58 PM By: Cody Nielson

NOTES:
1. ACCESS AND STAGING FOR CONSTRUCTION OF NEW STORM DRAIN AND TRAIL SHALL BE ALONG THE EXISTING WARNER DRAW DISPOSAL PIPELINE ALIGNMENT.
2. SEE DRAWINGS C-15 TO C-20 FOR TRAIL.

PLAN



PROFILE
HORIZ: 1" = 50'
VERT: 1" = 10'

BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY
WARNER DRAW DISPOSAL SYSTEM
WASHINGTON COUNTY

DESIGN
DESIGN C. NIELSON
DRAWN C. NIELSON

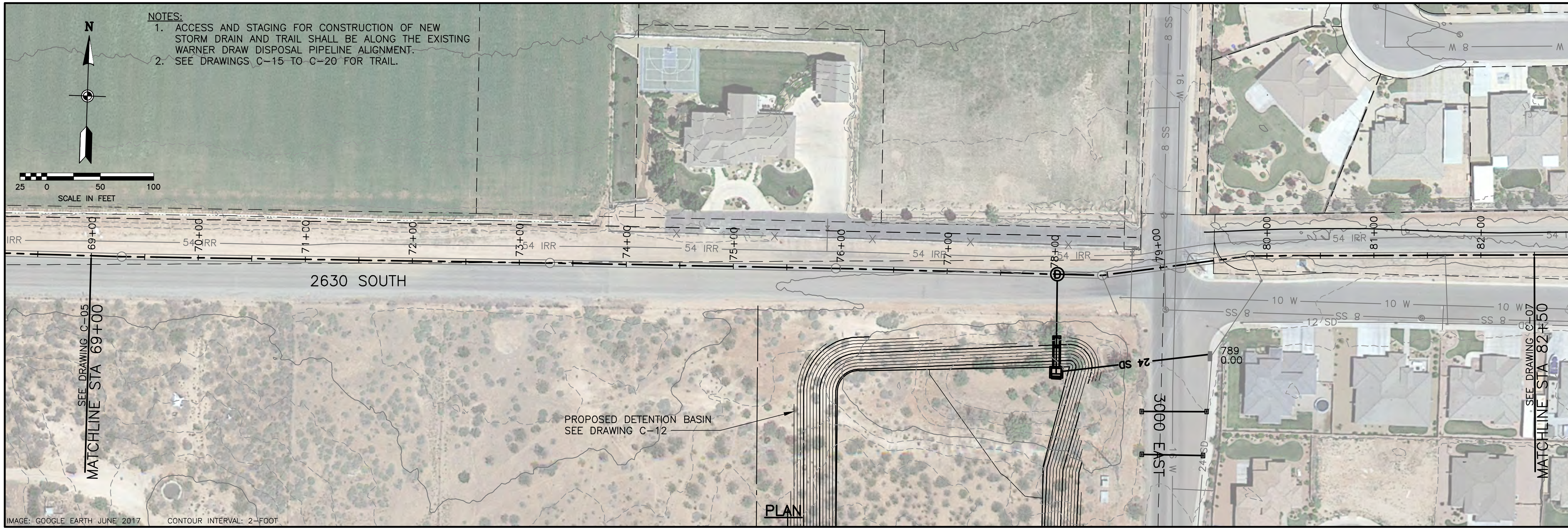
REVIEW
CHECKED T. OLSEN
APPROVED T. OLSEN

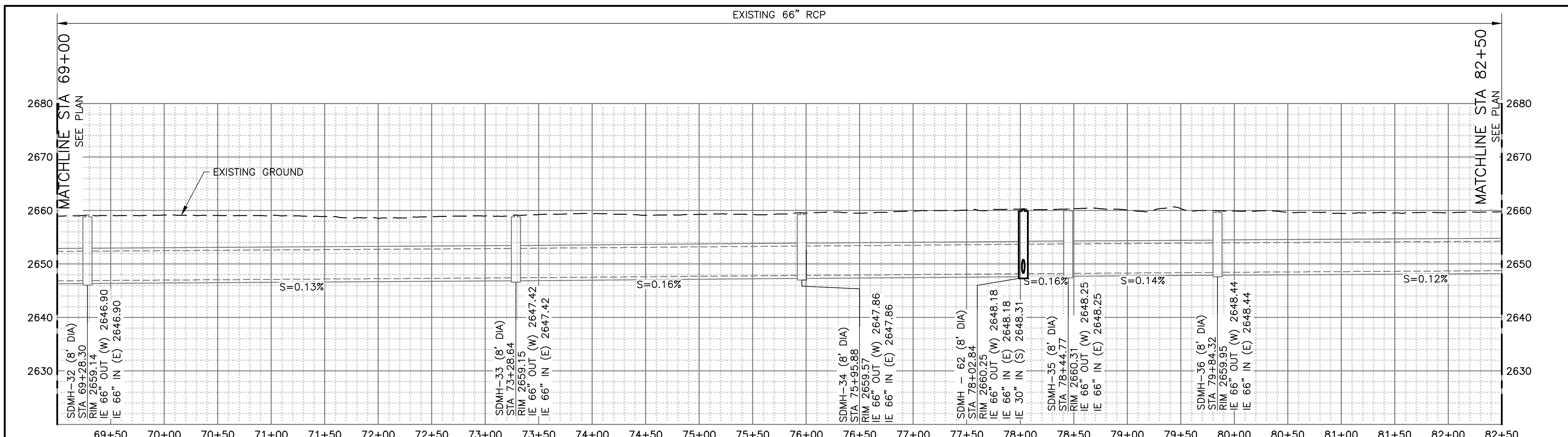
CIVIL
PLAN & PROFILE
STA 55+50 TO 69+00

PROJECT NUMBER 581-18-01
DATE: DEC 2018

DRAWING NO.
C-05
SHEET 9 OF 28

S:\washington county\581-18-01 warner draw watershed ea\7.0 drawings\disposal_pipeline\SHT\5811801_C-05.dwg Plotted: 1/10/2019 5:00 PM By: Cody Nielson





PROFILE
HORIZ: 1" = 50'
VERT: 1" = 10'

BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION
			REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY
WARNER DRAW DISPOSAL SYSTEM
WASHINGTON COUNTY

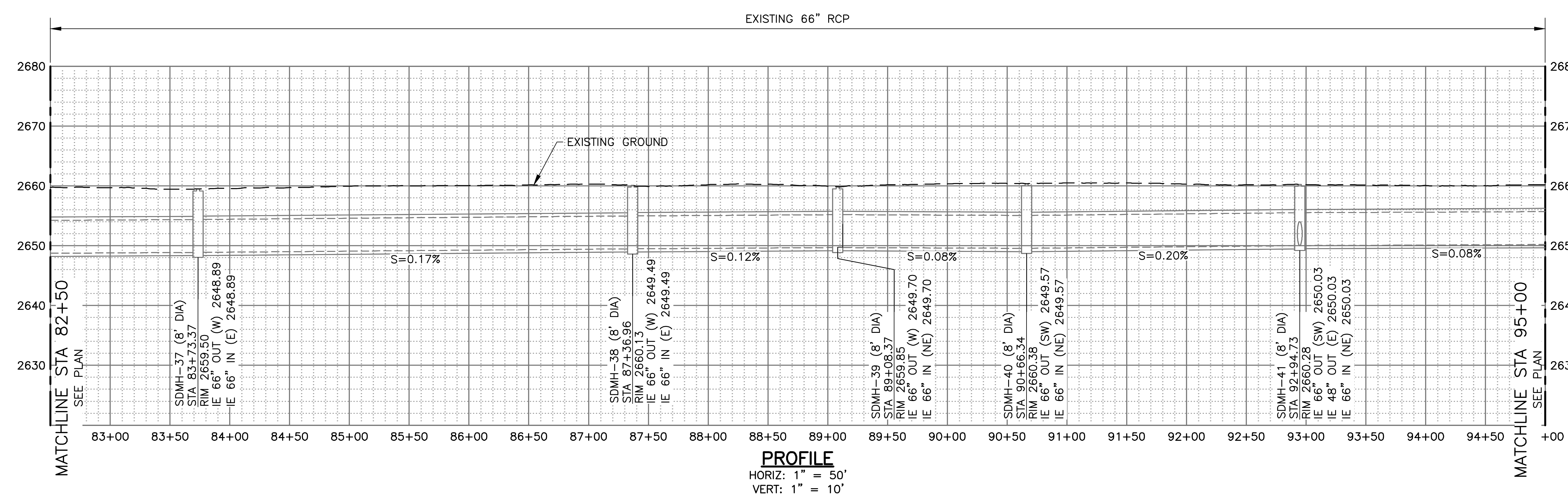
DESIGN: DESIGN C. NIELSON; DRAWN C. NIELSON
REVIEW: CHECKED T. OLSEN; APPROVED T. OLSEN

CIVIL
PLAN & PROFILE
STA 69+00 TO 82+50

PROJECT NUMBER 581-18-01
DATE: DEC 2018

DRAWING NO.
C-06
SHEET 10 OF 28

S:\washington county\581-18-01 warner draw watershed ea\7.0 drawings\disposal_pipeline\SHT\5811801_C-06.dwg Plotted: 1/10/2019 5:02 PM By: Cody Nielson



BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY
WARNER DRAW DISPOSAL SYSTEM
WASHINGTON COUNTY

DESIGN
DESIGN C. NIELSON
DRAWN C. NIELSON

REVIEW
CHECKED T. OLSEN
APPROVED T. OLSEN

CIVIL
PLAN & PROFILE
STA 82+50 TO 95+00

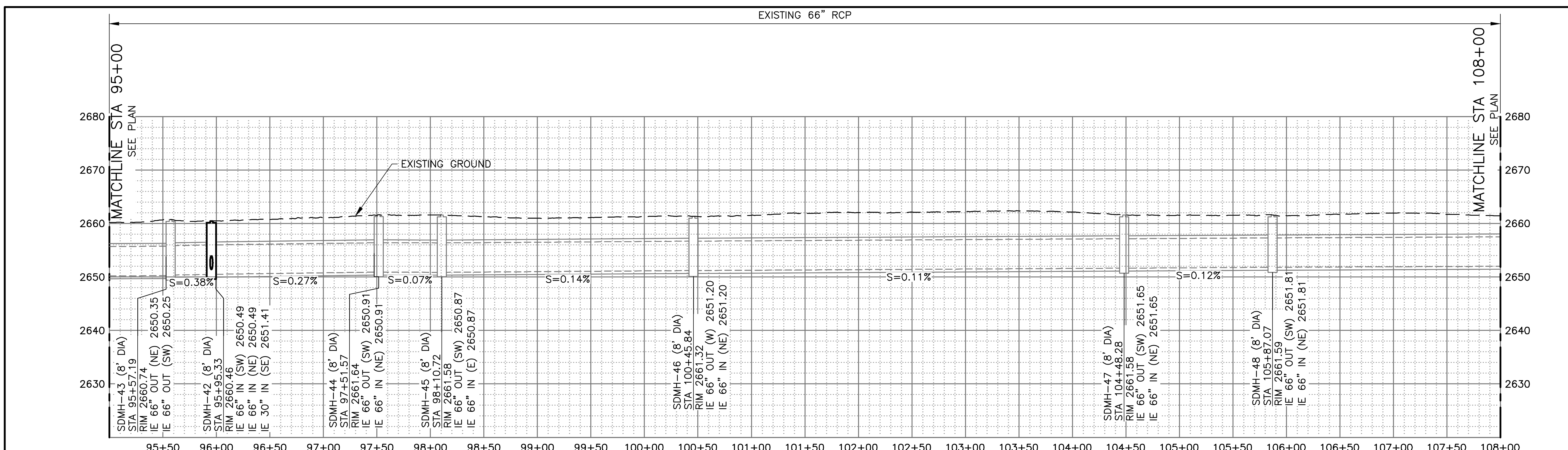
PROJECT NUMBER 581-18-01
DATE: DEC 2018

DRAWING NO.
C-07
SHEET 11 OF 28

S:\washington county\581-18-01 warner draw watershed ea\7.0 drawings\disposal_pipeline\SHT\5811801_C-07.dwg Plotted: 1/10/2019 5:03 PM By: Cody Nielson

NOTES:
1. ACCESS AND STAGING FOR CONSTRUCTION OF NEW STORM DRAIN AND TRAIL SHALL BE ALONG THE EXISTING WARNER DRAW DISPOSAL PIPELINE ALIGNMENT.
2. SEE DRAWINGS C-15 TO C-20 FOR TRAIL.

PLAN



PROFILE
HORIZ: 1" = 50'
VERT: 1" = 10'

BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY
WARNER DRAW DISPOSAL SYSTEM
WASHINGTON COUNTY

DESIGN
DESIGN C. NIELSON
DRAWN C. NIELSON

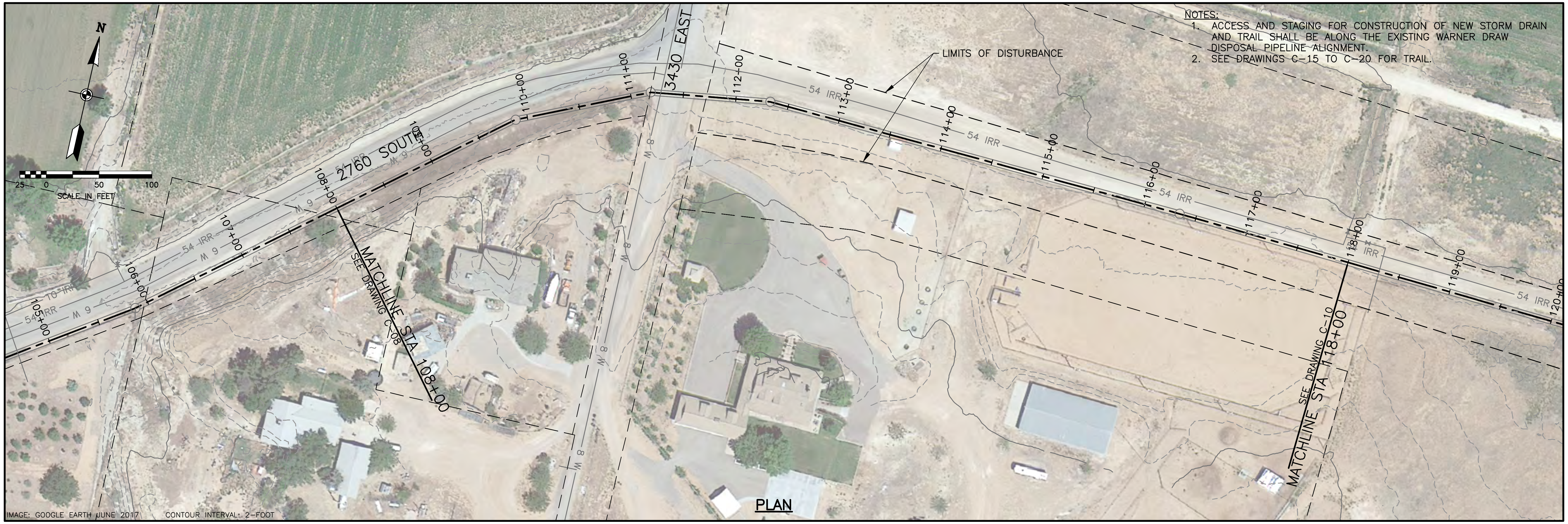
REVIEW
CHECKED T. OLSEN
APPROVED T. OLSEN

CIVIL
PLAN & PROFILE
STA 95+00 TO 108+00

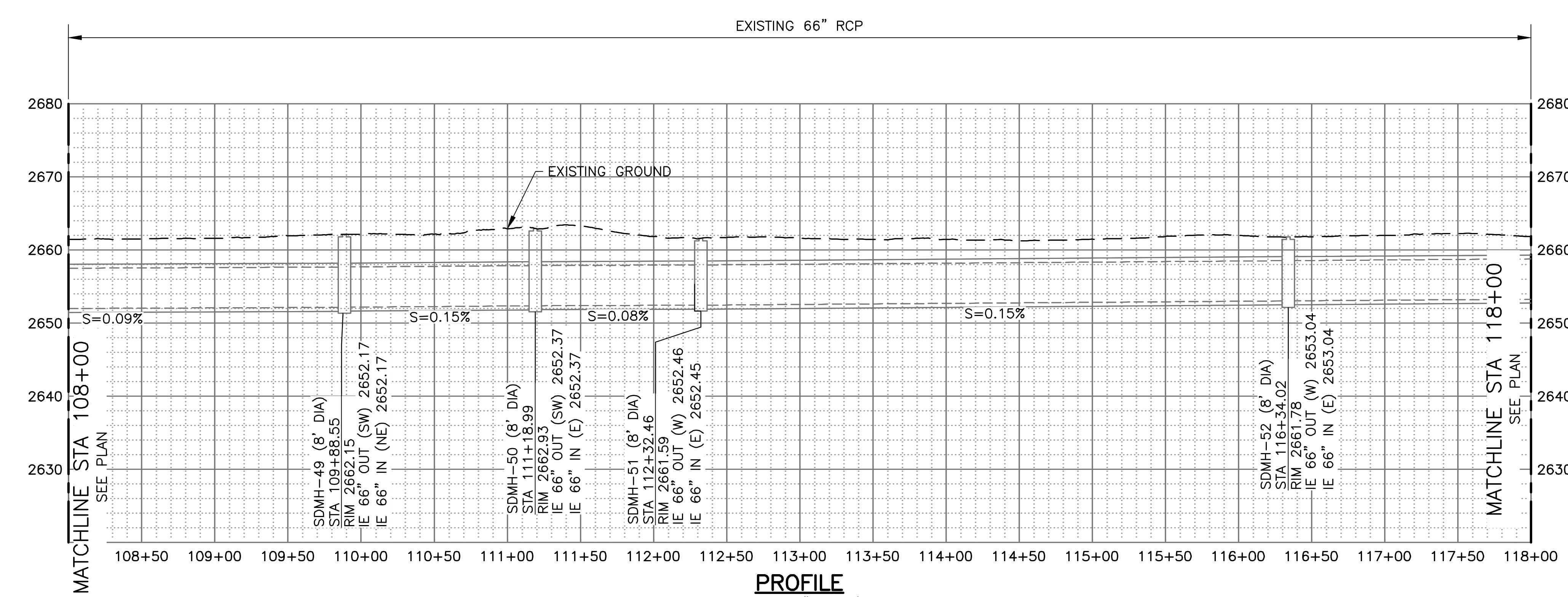
DATE: DEC 2018
PROJECT NUMBER 581-18-01

DRAWING NO.
C-08
SHEET 12 OF 28

S:\washington county\581-18-01 warner draw watershed ea\7.0 drawings\disposal_pipeline\SHT\5811801_C-08.dwg Plotted: 1/10/2019 5:05 PM By: Cody Nielson



PLAN



PROFILE

HORIZ: 1" = 50'

VERT: 1" = 10'

BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY

WARNER DRAW DISPOSAL SYSTEM

WASHINGTON COUNTY

DESIGN: DESIGN C. NIELSON, DRAWN C. NIELSON

REVIEW: CHECKED T. OLSEN, APPROVED T. OLSEN

CIVIL

PLAN & PROFILE STA 108+00 TO 118+00

PROJECT NUMBER 581-18-01

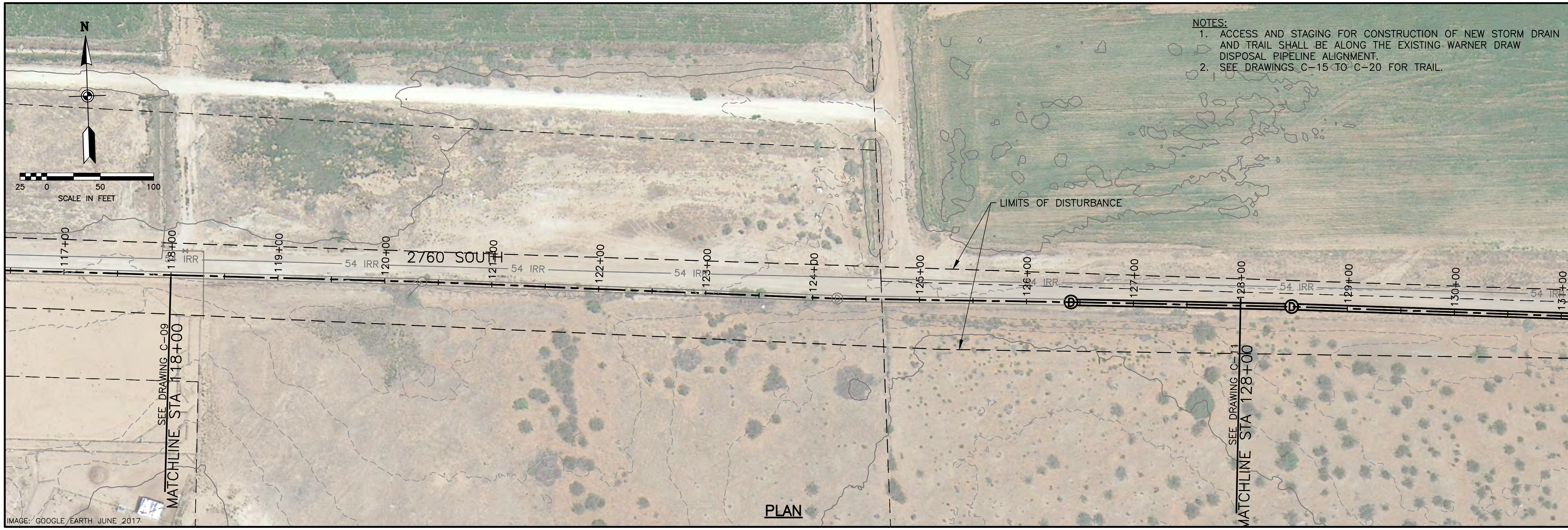
DATE: DEC 2018

DRAWING NO. C-09

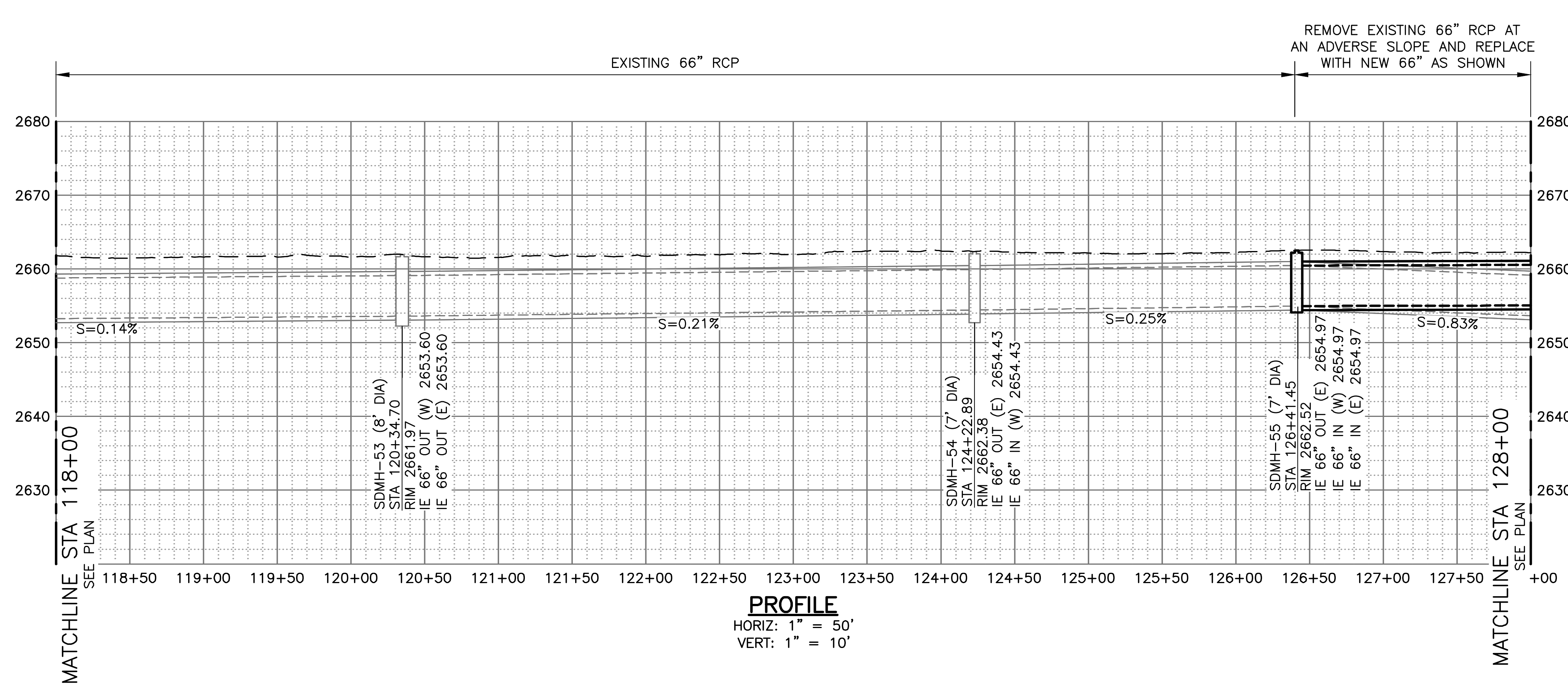
SHEET 13 OF 28

S:\washington county\581-18-01 warner draw watershed ea\7.0 drawings\disposal_pipeline\SHT\5811801_C-09.dwg Plotted: 1/10/2019 5:07 PM By: Cody Nielson

NOTES:
1. ACCESS AND STAGING FOR CONSTRUCTION OF NEW STORM DRAIN AND TRAIL SHALL BE ALONG THE EXISTING WARNER DRAW DISPOSAL PIPELINE ALIGNMENT.
2. SEE DRAWINGS C-15 TO C-20 FOR TRAIL.



PLAN



PROFILE
HORIZ: 1" = 50'
VERT: 1" = 10'

BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY
WARNER DRAW DISPOSAL SYSTEM
WASHINGTON COUNTY

DESIGN
DESIGN C. NIELSON
DRAWN C. NIELSON

REVIEW
CHECKED T. OLSEN
APPROVED T. OLSEN

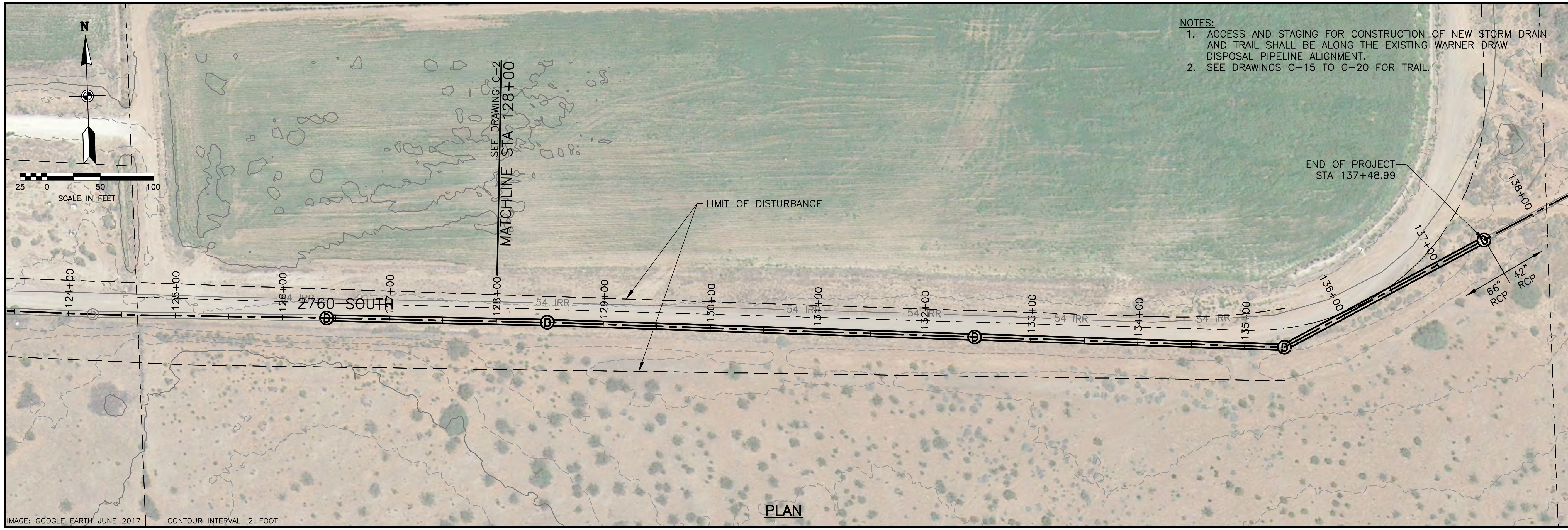
CIVIL
PLAN & PROFILE
STA 118+00 TO 128+00

PROJECT NUMBER 581-18-01
DATE: DEC 2018

DRAWING NO.
C-10

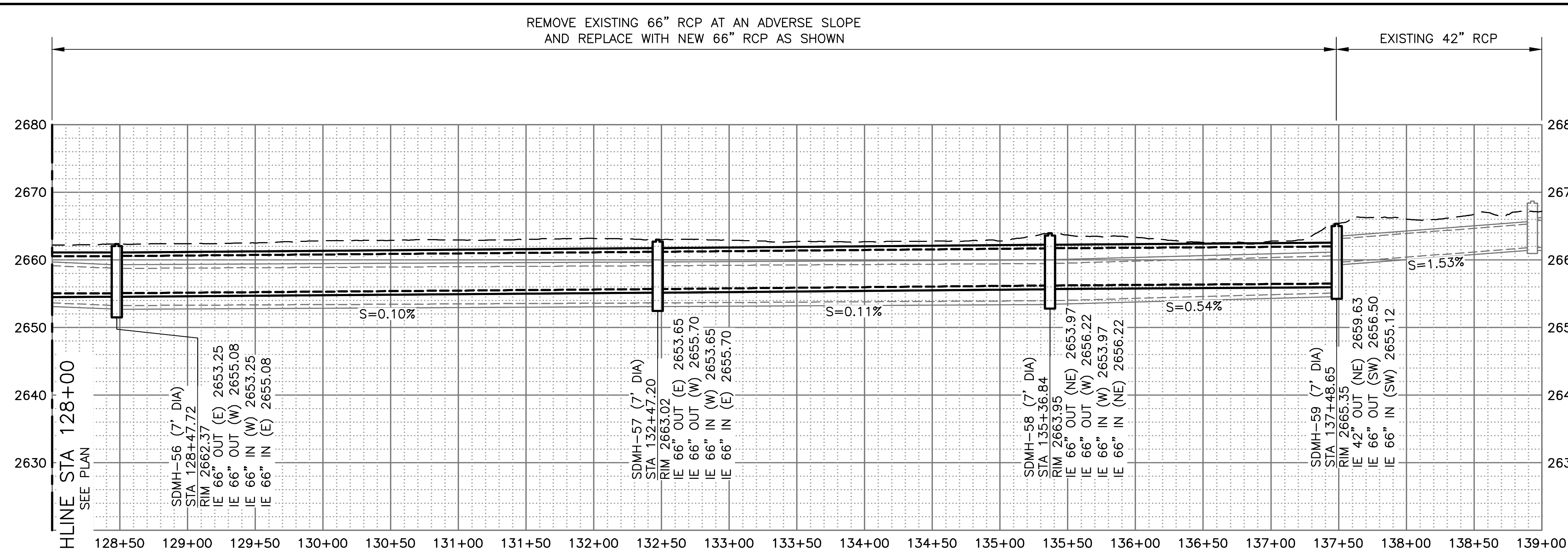
SHEET 14 OF 28

S:\washington county\581-18-01 warner draw watershed ea\7.0 drawings\disposal_pipeline\SHT\5811801_C-10.dwg Plotted: 1/10/2019 5:39 PM By: Cody Nielson



NOTES:
1. ACCESS AND STAGING FOR CONSTRUCTION OF NEW STORM DRAIN AND TRAIL SHALL BE ALONG THE EXISTING WARNER DRAW DISPOSAL PIPELINE ALIGNMENT.
2. SEE DRAWINGS C-15 TO C-20 FOR TRAIL.

PLAN



PROFILE
HORIZ: 1" = 50'
VERT: 1" = 10'

BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

WASHINGTON COUNTY
WARNER DRAW DISPOSAL SYSTEM
WASHINGTON COUNTY

DESIGN: DESIGN C. NIELSON, DRAWN C. NIELSON
REVIEW: CHECKED T. OLSEN, APPROVED T. OLSEN

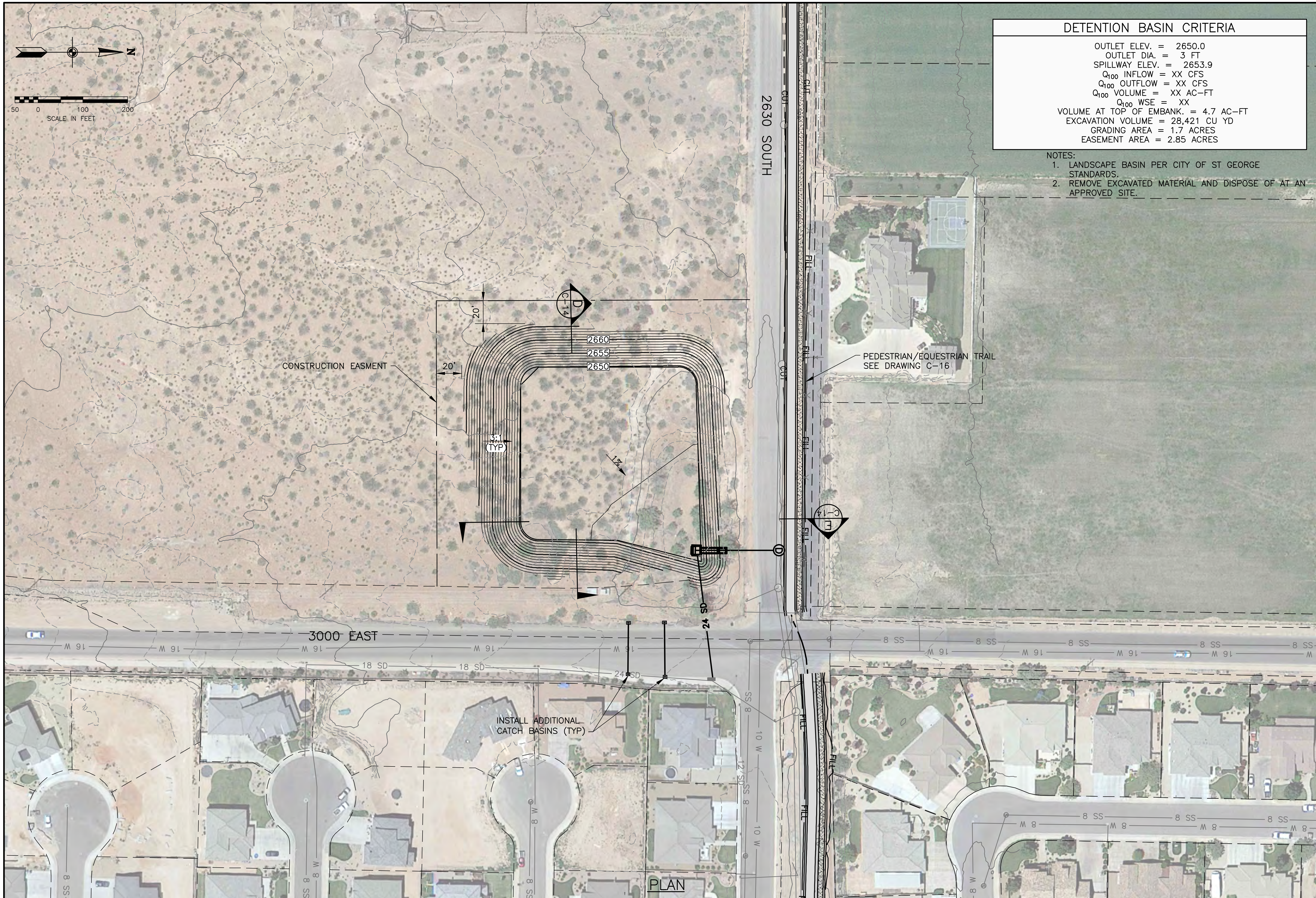
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

CIVIL
PLAN & PROFILE
STA 128+00 TO 138+00

PROJECT NUMBER 581-18-01
DATE: DEC 2018

DRAWING NO.
C-11
SHEET 15 OF 28

S:\washington county\581-18-01 warner draw watershed ea\7.0 drawings\disposal_pipeline\SHT\5811801_C-11.dwg Plotted: 1/14/2019 9:14 AM By: Cody Nielson



DETENTION BASIN CRITERIA

OUTLET ELEV. = 2650.0
OUTLET DIA. = 3 FT
SPILLWAY ELEV. = 2653.9
Q_{100} INFLOW = XX CFS
Q_{100} OUTFLOW = XX CFS
Q_{100} VOLUME = XX AC-FT
Q_{100} WSE = XX
VOLUME AT TOP OF EMBANK. = 4.7 AC-FT
EXCAVATION VOLUME = 28,421 CU YD
GRADING AREA = 1.7 ACRES
EASEMENT AREA = 2.85 ACRES

NOTES:
1. LANDSCAPE BASIN PER CITY OF ST GEORGE STANDARDS.
2. REMOVE EXCAVATED MATERIAL AND DISPOSE OF AT AN APPROVED SITE.

BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY
WARNER DRAW DISPOSAL SYSTEM
WASHINGTON COUNTY

DESIGN: DESIGN C. NIELSON, DRAWN C. NIELSON
REVIEW: CHECKED T. OLSEN, APPROVED T. OLSEN

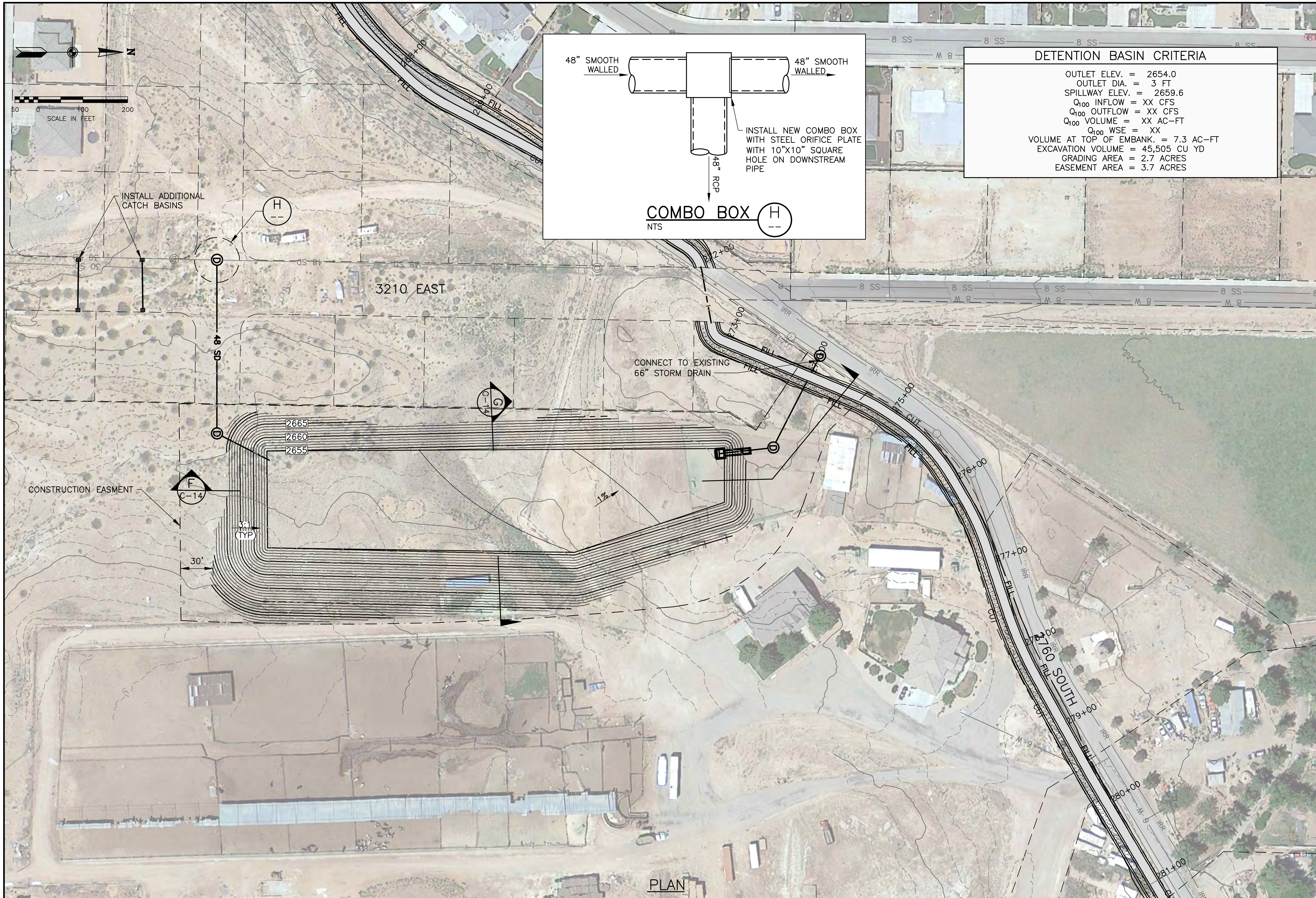
CIVIL
BASIN SITE - 1

PROJECT NUMBER 581-18-01
DATE: DEC 2018

DRAWING NO.
C-12

SHEET 16 OF 28

S:\washington county\581-18-01 warner draw watershed ea\7.0 drawings\disposal_pipeline\SHT\5811801_C-12.dwg Plotted: 1/10/2019 5:12 PM By: Cody Nielson



DETENTION BASIN CRITERIA

OUTLET ELEV. = 2654.0
OUTLET DIA. = 3 FT
SPILLWAY ELEV. = 2659.6
Q_{100} INFLOW = XX CFS
Q_{100} OUTFLOW = XX CFS
Q_{100} VOLUME = XX AC-FT
Q_{100} WSE = XX
VOLUME AT TOP OF EMBANK. = 7.3 AC-FT
EXCAVATION VOLUME = 45,505 CU YD
GRADING AREA = 2.7 ACRES
EASEMENT AREA = 3.7 ACRES

BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY
WARNER DRAW DISPOSAL SYSTEM
WASHINGTON COUNTY

DESIGN
DESIGN C. NIELSON
DRAWN C. NIELSON

REVIEW
CHECKED T. OLSNE
APPROVED T. OLSEN

CIVIL
BASIN SITE – 2

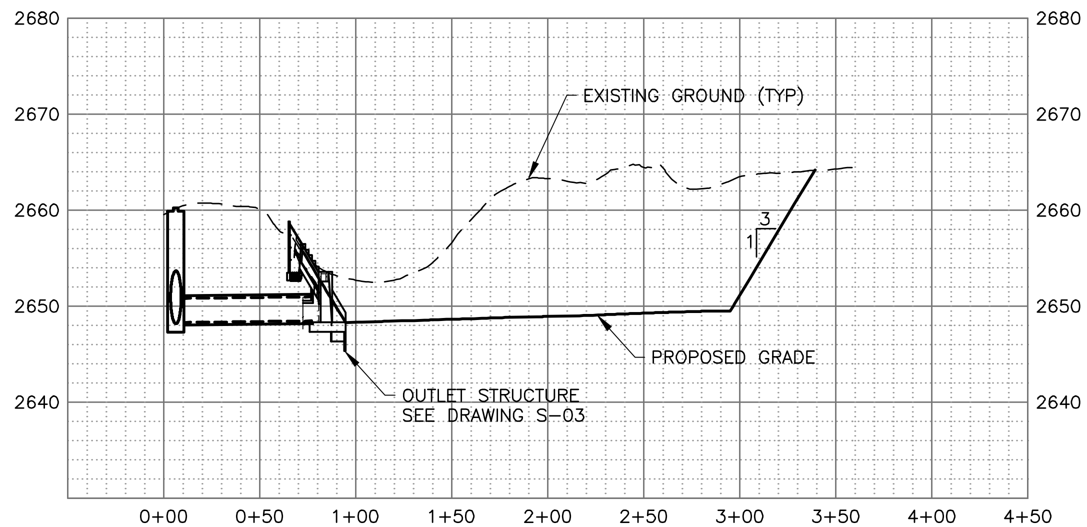
PROJECT NUMBER 581-18-01

DATE: DEC 2018

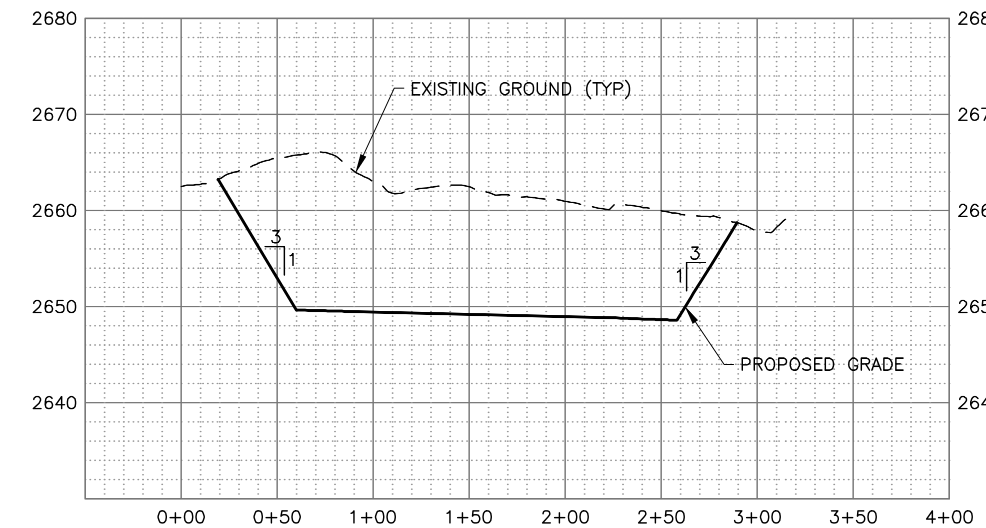
DRAWING NO. C-13

SHEET 17 OF 28

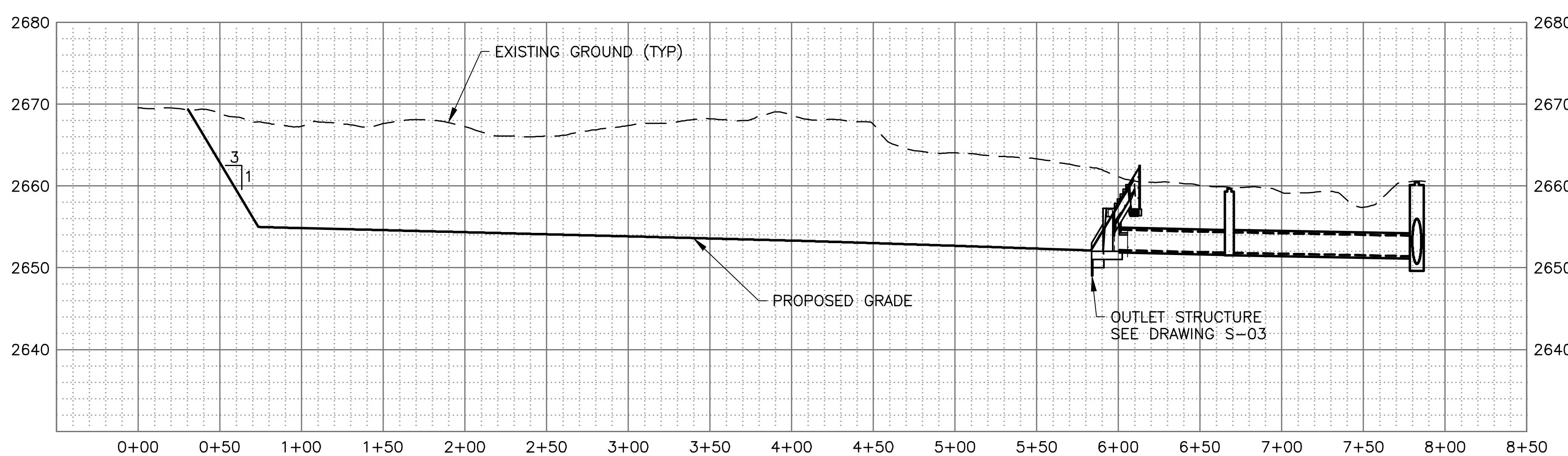
S:\washington county\581-18-01 warner draw watershed ea\7.0 drawings\disposal_pipeline\SHT\5811801_C-13.dwg Plotted: 1/10/2019 5:13 PM By: Cody Nielson



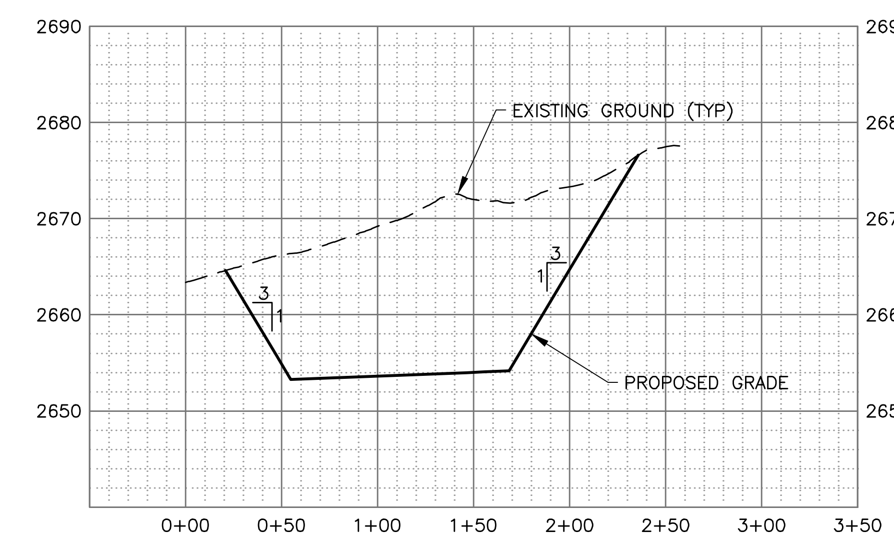
SECTION D C-12
HORIZ: 1" = 50'
VERT: 1" = 10'



SECTION E C-12
HORIZ: 1" = 50'
VERT: 1" = 10'



SECTION F C-13
HORIZ: 1" = 50'
VERT: 1" = 10'



SECTION G C-13
HORIZ: 1" = 50'
VERT: 1" = 10'

IMAGE: GOOGLE EARTH JUNE 2017 CONTOUR INTERVAL: 2-FOOT

BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY
WARNER DRAW DISPOSAL SYSTEM
WASHINGTON COUNTY

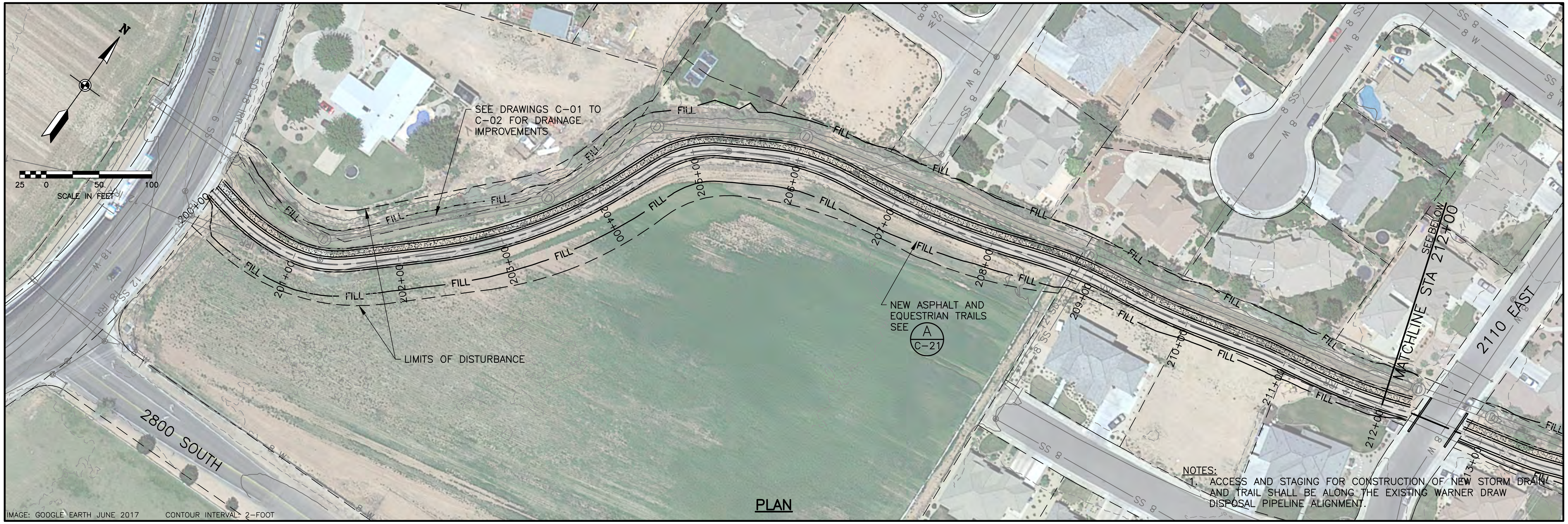
DESIGN
DESIGN C. NIELSON
DRAWN C. NIELSON

REVIEW
CHECKED T. OLSEN
APPROVED T. OLSEN

CIVIL
DETENTION BASIN CROSS SECTIONS

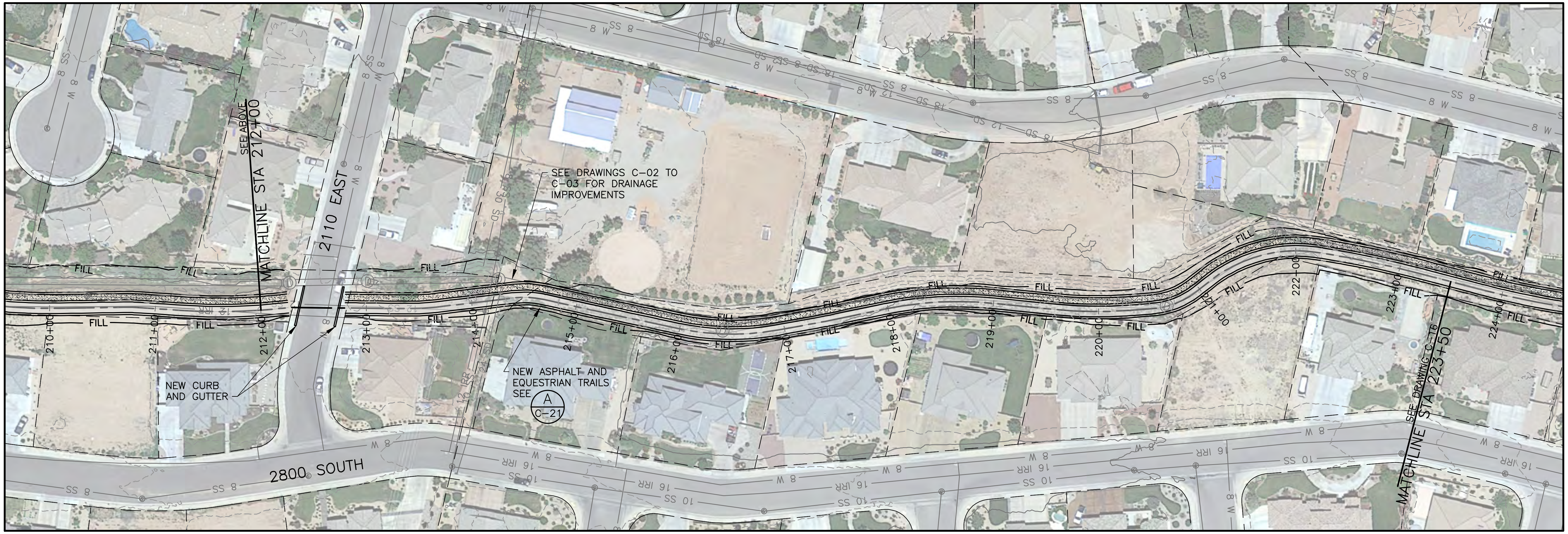
PROJECT NUMBER 581-18-01
DATE: DEC 2018

DRAWING NO.
C-14
SHEET 18 OF 28



NOTES:
1. ACCESS AND STAGING FOR CONSTRUCTION OF NEW STORM DRAIN AND TRAIL SHALL BE ALONG THE EXISTING WARNER DRAW DISPOSAL PIPELINE ALIGNMENT.

PLAN



BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION
REVISIONS			

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY
WARNER DRAW DISPOSAL SYSTEM
WASHINGTON COUNTY

DESIGN
DESIGN C. NIELSON
DRAWN C. NIELSON

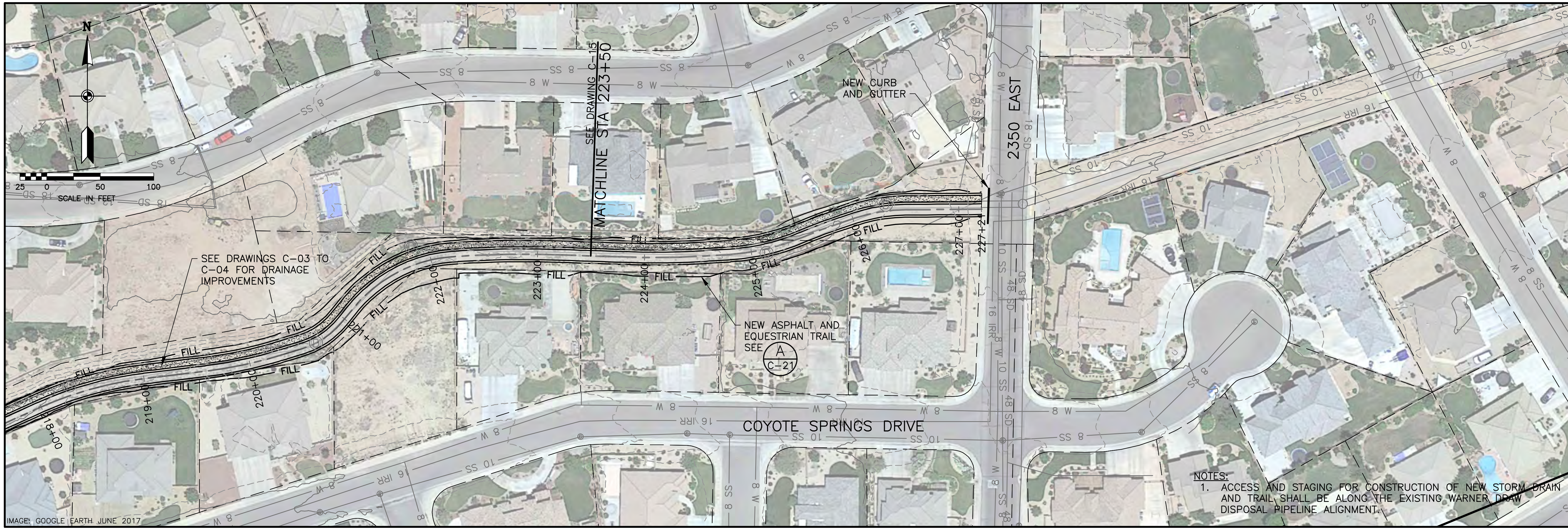
REVIEW
CHECKED T. OLSEN
APPROVED T. OLSEN

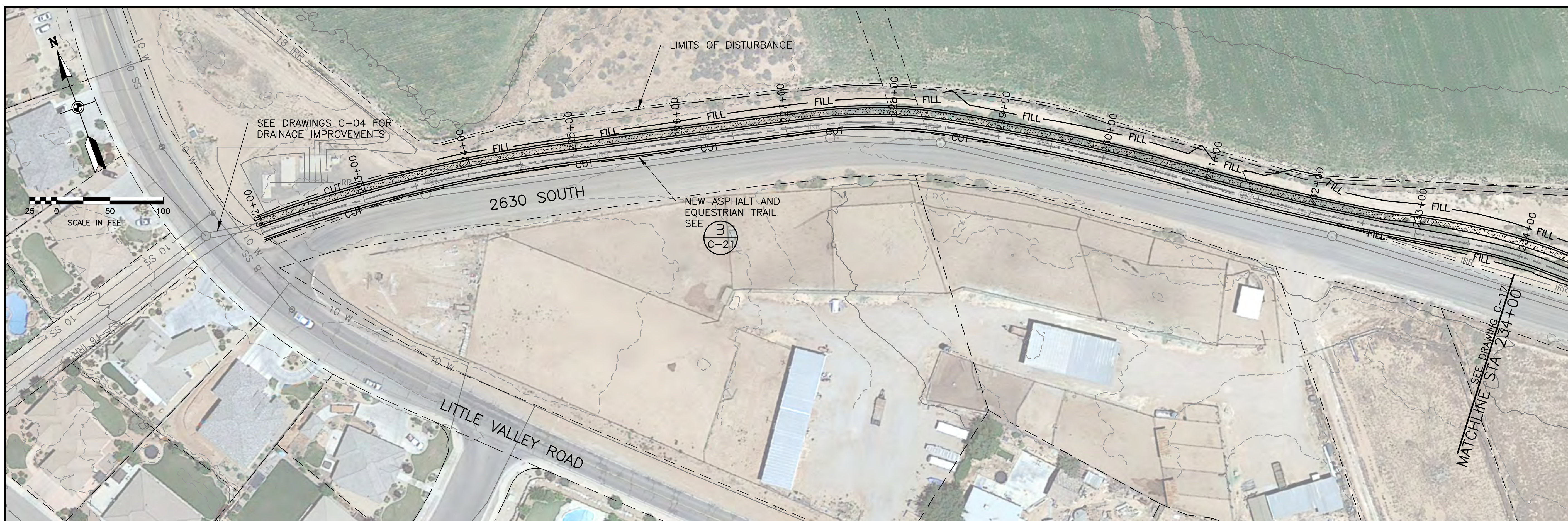
CIVIL
TRAIL PLAN
STA 200+00 TO 223+50

PROJECT NUMBER 581-18-01
DATE: DEC 2018

DRAWING NO.
C-15
SHEET 19 OF 28

S:\washington county\581-18-01 warner draw watershed ea\7.0 drawings\disposal_pipeline\SHT\5811801_C-15.dwg Plotted: 1/14/2019 9:08 AM By: Cody Nielson





BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY
WARNER DRAW DISPOSAL SYSTEM
WASHINGTON COUNTY

DESIGN
DESIGN C. NIELSON
DRAWN C. NIELSON

REVIEW
CHECKED T. OLSEN
APPROVED T. OLSEN

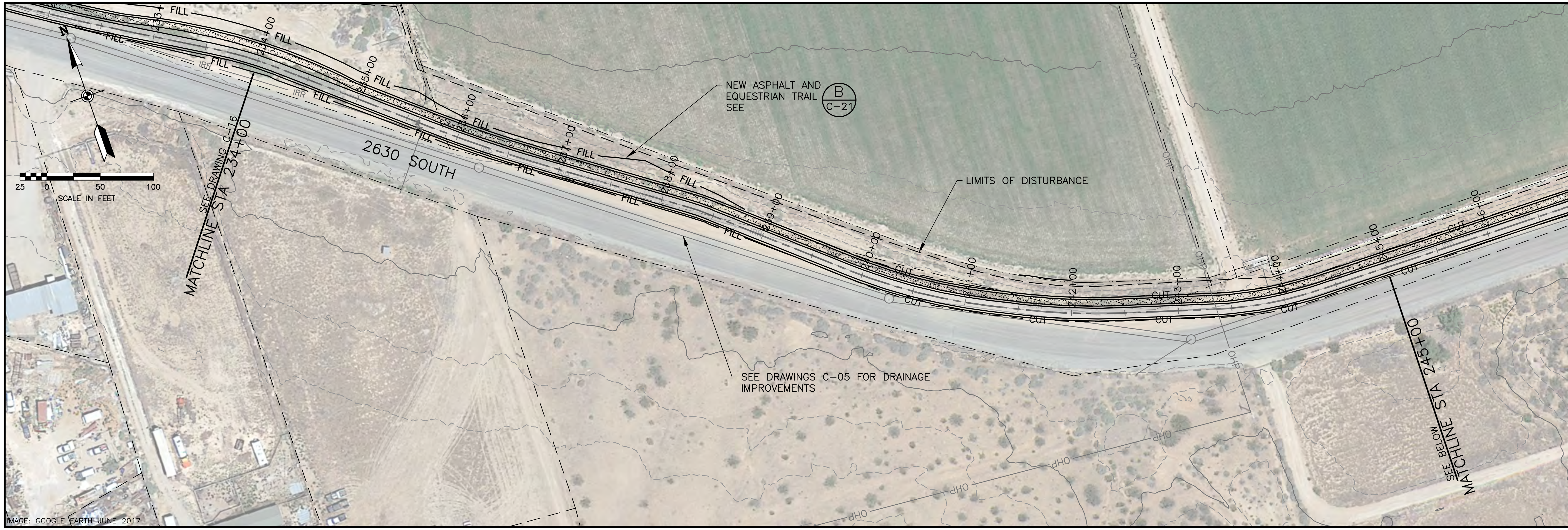
CIVIL
TRAIL PLAN
STA 223+50 TO 234+00

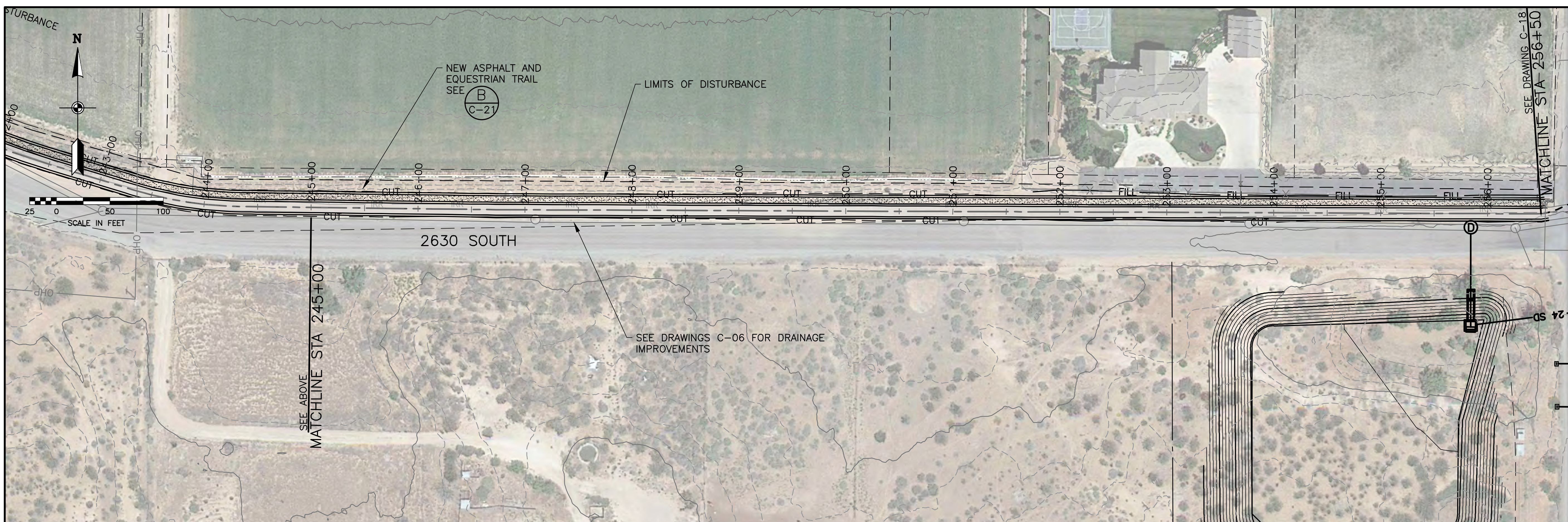
DATE: DEC 2018
PROJECT NUMBER 581-18-01

DRAWING NO.
C-16

SHEET 20 OF 28

S:\washington county\581-18-01 warner draw watershed ea\7.0 drawings\disposal_pipeline\SHT\5811801_C-16.dwg Plotted: 1/10/2019 5:17 PM By: Cody Nielson





BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY
WARNER DRAW DISPOSAL SYSTEM
WASHINGTON COUNTY

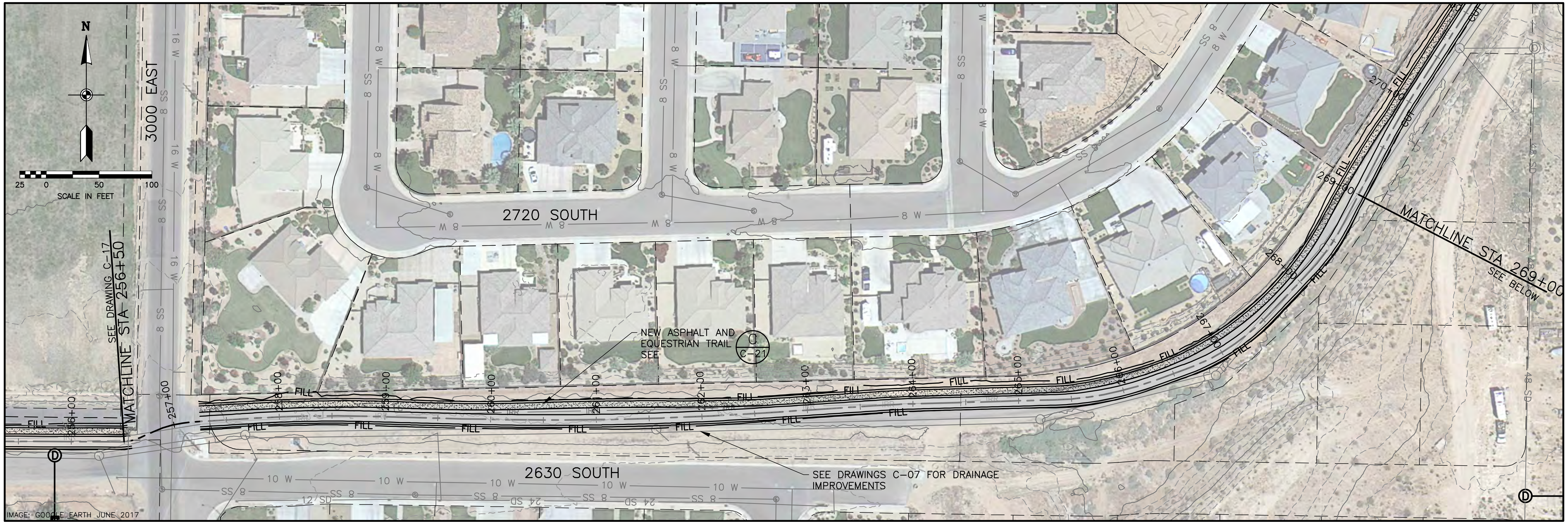
DESIGN C. NIELSON
DRAWN C. NIELSON
REVIEW
CHECKED T. OLSEN
APPROVED T. OLSEN

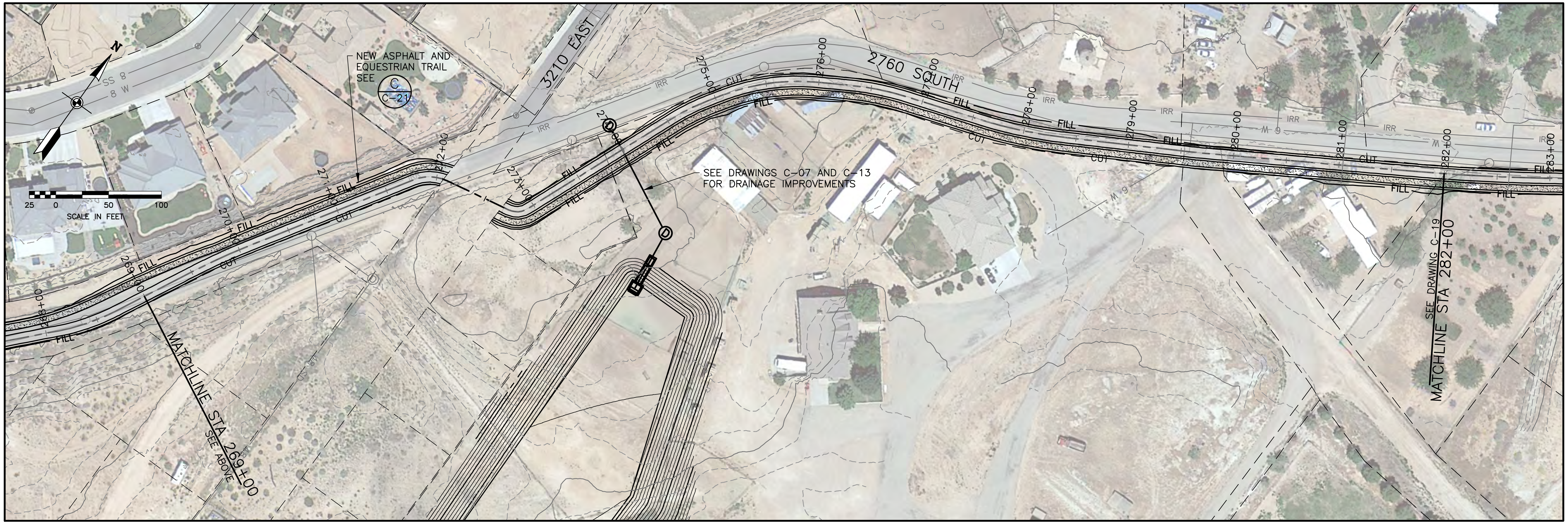
CIVIL
TRAIL PLAN
STA 234+00 TO 256+50

PROJECT NUMBER 581-18-01
DATE: DEC 2018

DRAWING NO.
C-17
SHEET 21 OF 28

S:\washington county\581-18-01 warner draw watershed ea\7.0 drawings\disposal_pipeline\SHT\5811801_C-17.dwg Plotted: 1/10/2019 5:18 PM By: Cody Nielson





BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY

WARNER DRAW DISPOSAL SYSTEM

WASHINGTON COUNTY

DESIGN: DESIGN C. NIELSON; DRAWN C. NIELSON

REVIEW: CHECKED T. OLSEN; APPROVED T. OLSEN

CIVIL

TRAIL PLAN

STA 256+50 TO 282+00

PROJECT NUMBER 581-18-01

DATE: DEC 2018

DRAWING NO.

C-18

SHEET 22 OF 28

BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY
WARNER DRAW DISPOSAL SYSTEM
WASHINGTON COUNTY

DESIGN
DESIGN C. NIELSON
DRAWN C. NIELSON

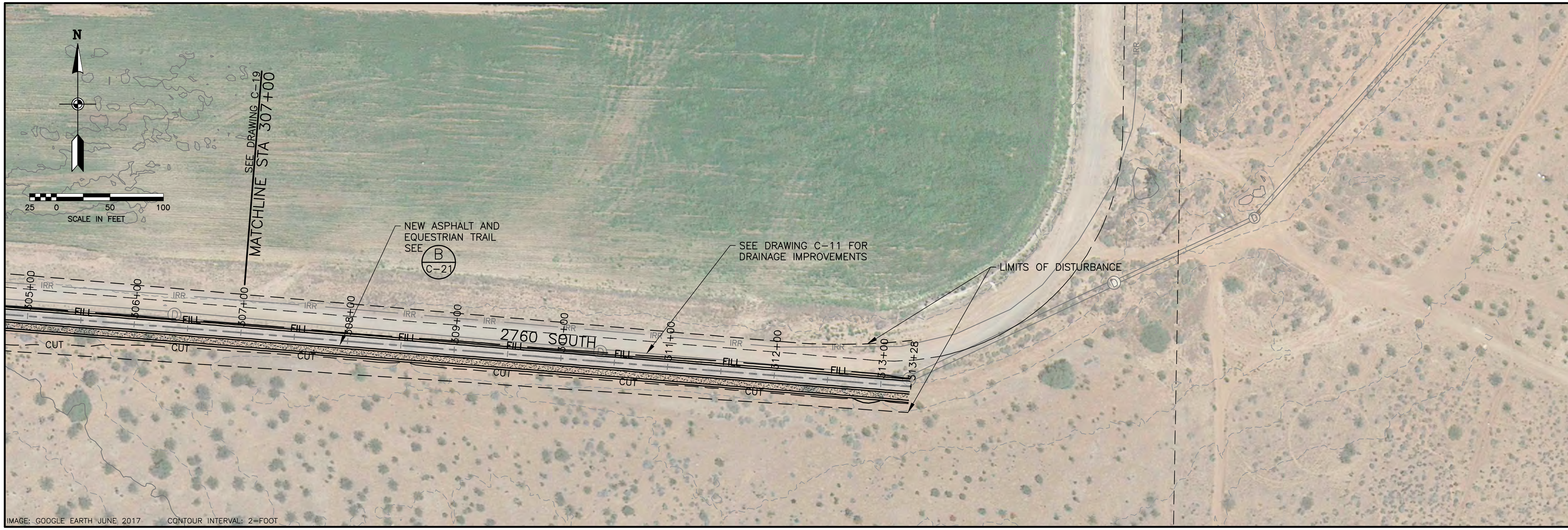
REVIEW
CHECKED T. OLSEN
APPROVED T. OLSEN

CIVIL
TRAIL PLAN
STA 282+00 TO 307+00

DATE: DEC 2018
PROJECT NUMBER 581-18-01

DRAWING NO.
C-19
SHEET 23 OF 28

S:\washington county\581-18-01 warner draw watershed ea\7.0 drawings\disposal_pipeline\SHT\5811801_C-19.dwg Plotted: 1/10/2019 5:44 PM By: Cody Nielson



BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

WASHINGTON COUNTY
WARNER DRAW DISPOSAL SYSTEM
WASHINGTON COUNTY

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

DESIGN
DESIGN C. NIELSON
DRAWN C. NIELSON

REVIEW
CHECKED T. OLSEN
APPROVED T. OLSEN

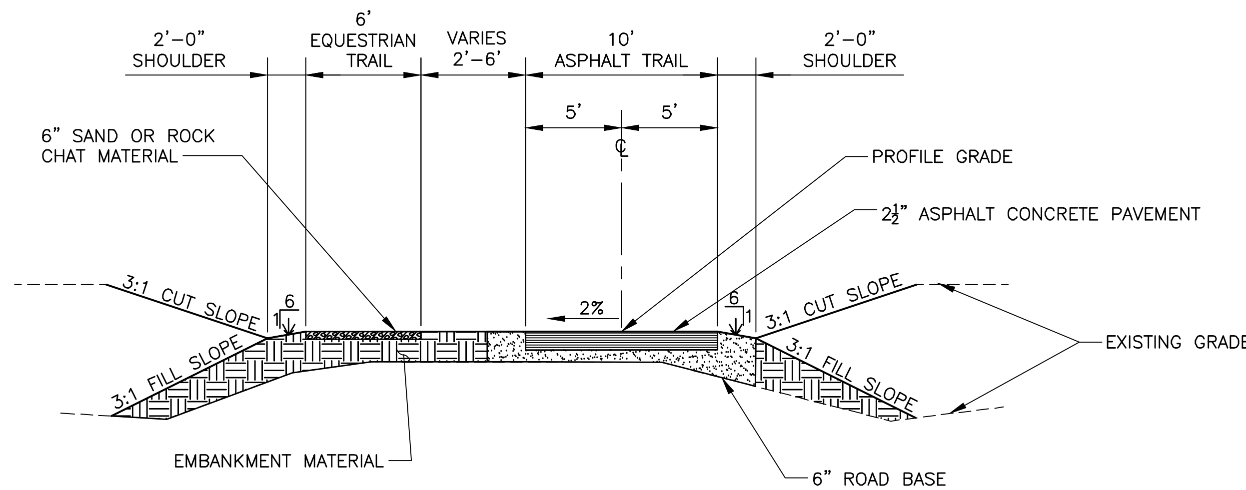
CIVIL
TRAIL PLAN
STA 307+00 TO 312+87

DATE: DEC 2018
PROJECT NUMBER 581-18-01

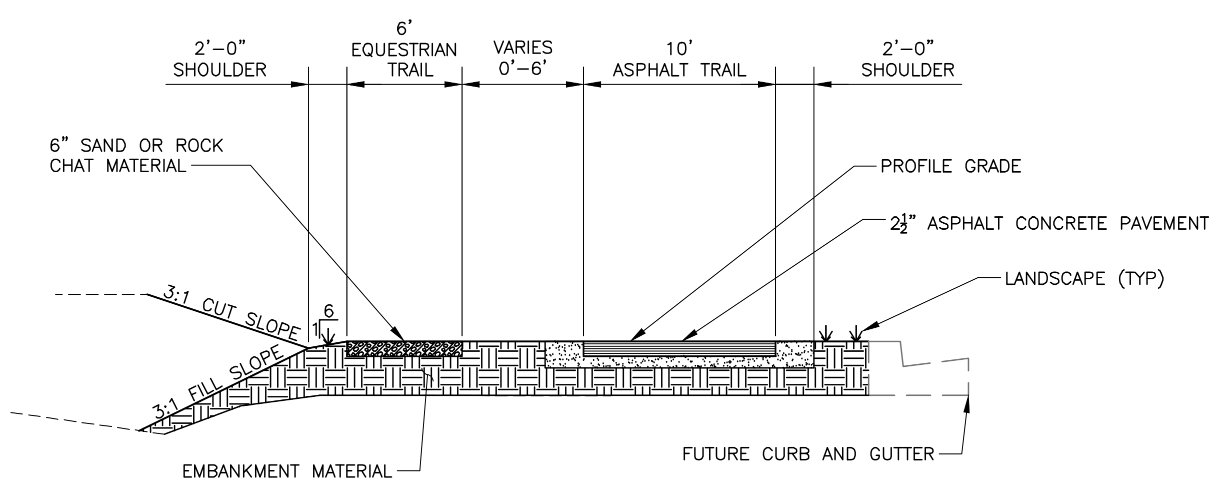
DRAWING NO.
C-20
SHEET 24 OF 28

S:\washington county\581-18-01 warner draw watershed ea\7.0 drawings\disposal_pipeline\SHT\5811801_C-20.dwg Plotted: 1/10/2019 5:45 PM By: Cody Nielson

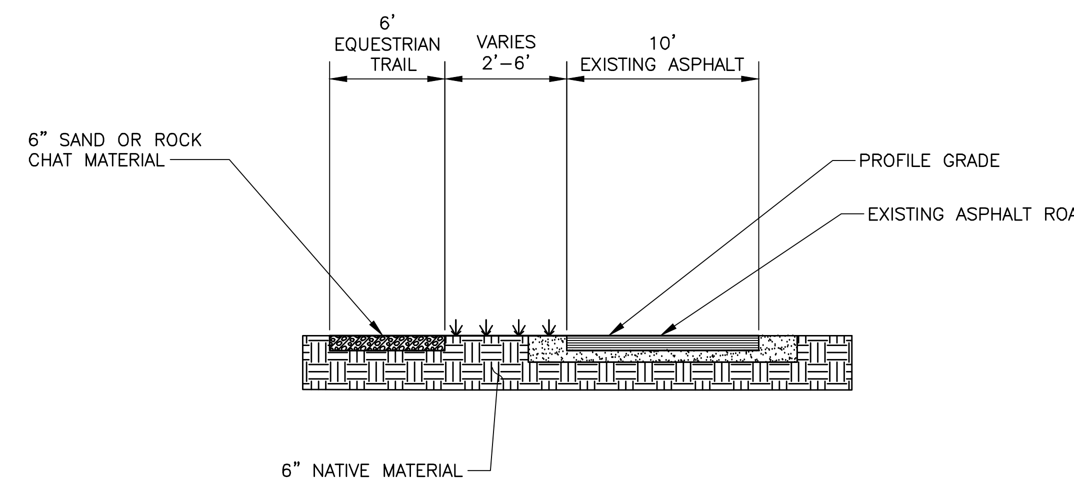
S ← → N



TYPICAL TRAIL CROSS SECTION (A C-15) TO C-20
NTS



TYPICAL TRAIL CROSS SECTION (B C-15) TO C-20
NTS



TYPICAL TRAIL CROSS SECTION (C C-15) TO C-20
NTS

NOTES:
1. REMOVE EXISTING ASPHALT AND INSTALL SAND AND NATIVE MATERIAL AS SHOWN.

BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY
WARNER DRAW DISPOSAL SYSTEM
WASHINGTON COUNTY

REVIEW
CHECKED T. OLSEN
APPROVED T. OLSEN

DESIGN
DESIGN C. NIELSON
DRAWN C. NIELSON

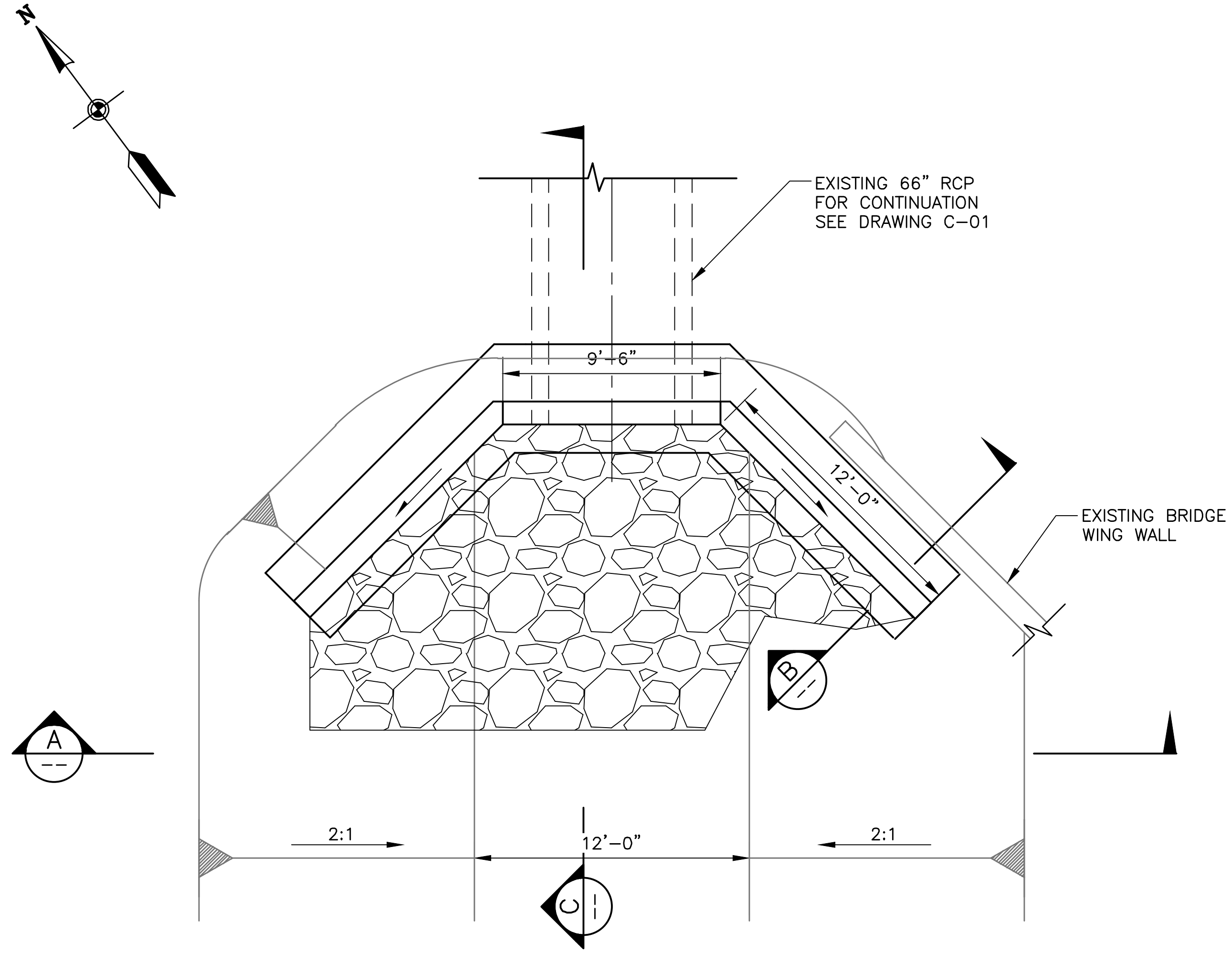
CIVIL
TYPICAL TRAIL CROSS SECTION

PROJECT NUMBER 581-18-01

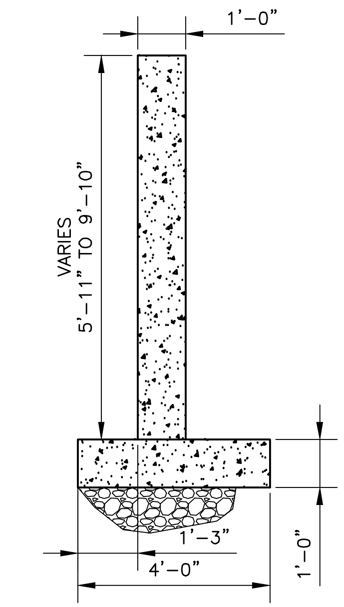
DATE: DEC 2018

DRAWING NO. C-21

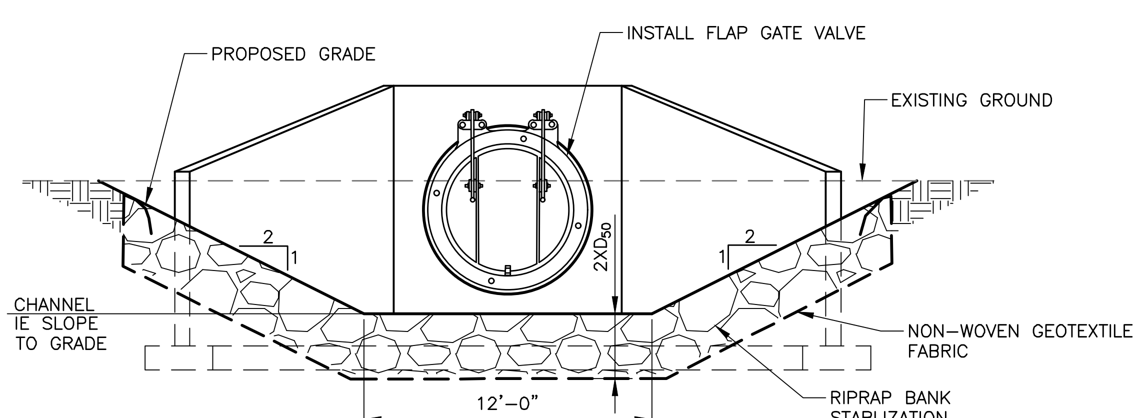
SHEET 25 OF 28



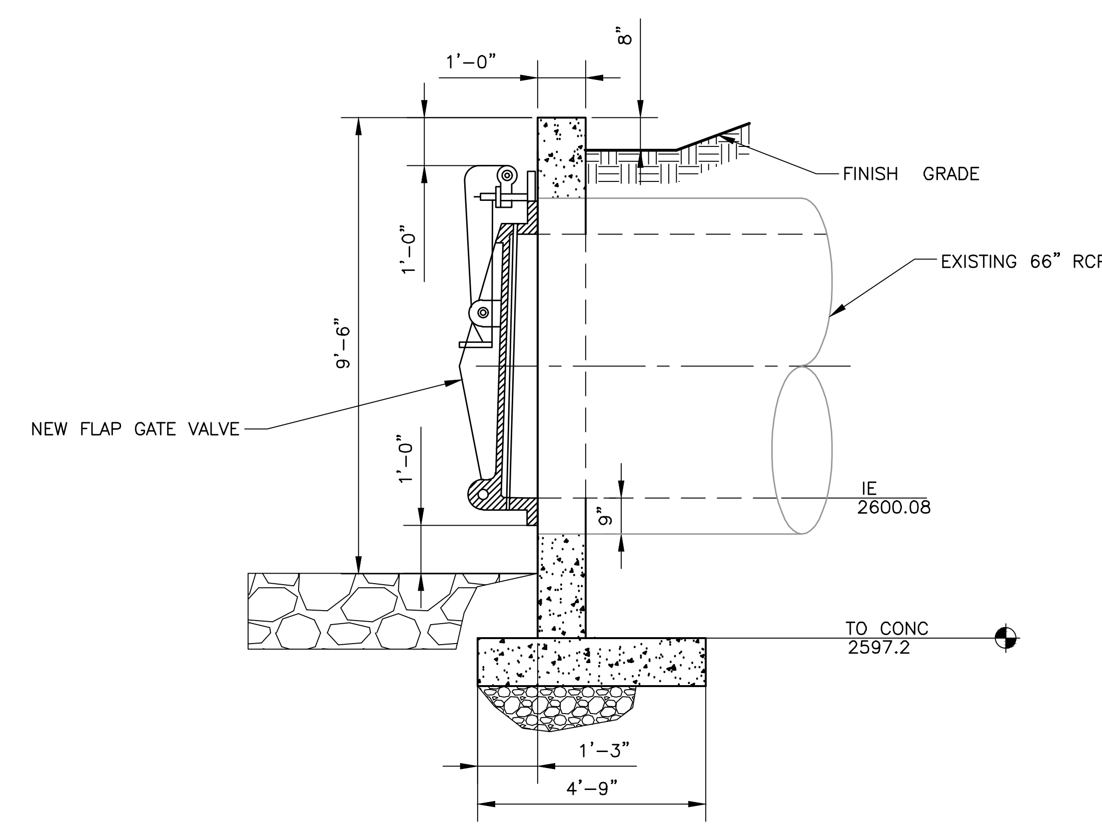
PLAN
SCALE: 1/4" = 1'-0"



SECTION B
SCALE: 1/2" = 1'-0"



SECTION A
SCALE: 1/4" = 1'-0"



SECTION C
SCALE: 1/2" = 1'-0"

BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY
WARNER DRAW DISPOSAL SYSTEM
WASHINGTON COUNTY

REVIEW
CHECKED T.OLSEN
APPROVED T. OLSEN

DESIGN
DESIGN C. NIELSON
DRAWN C. NIELSON

STRUCTURAL
CATCH BASIN
FLOODING REPAIRS

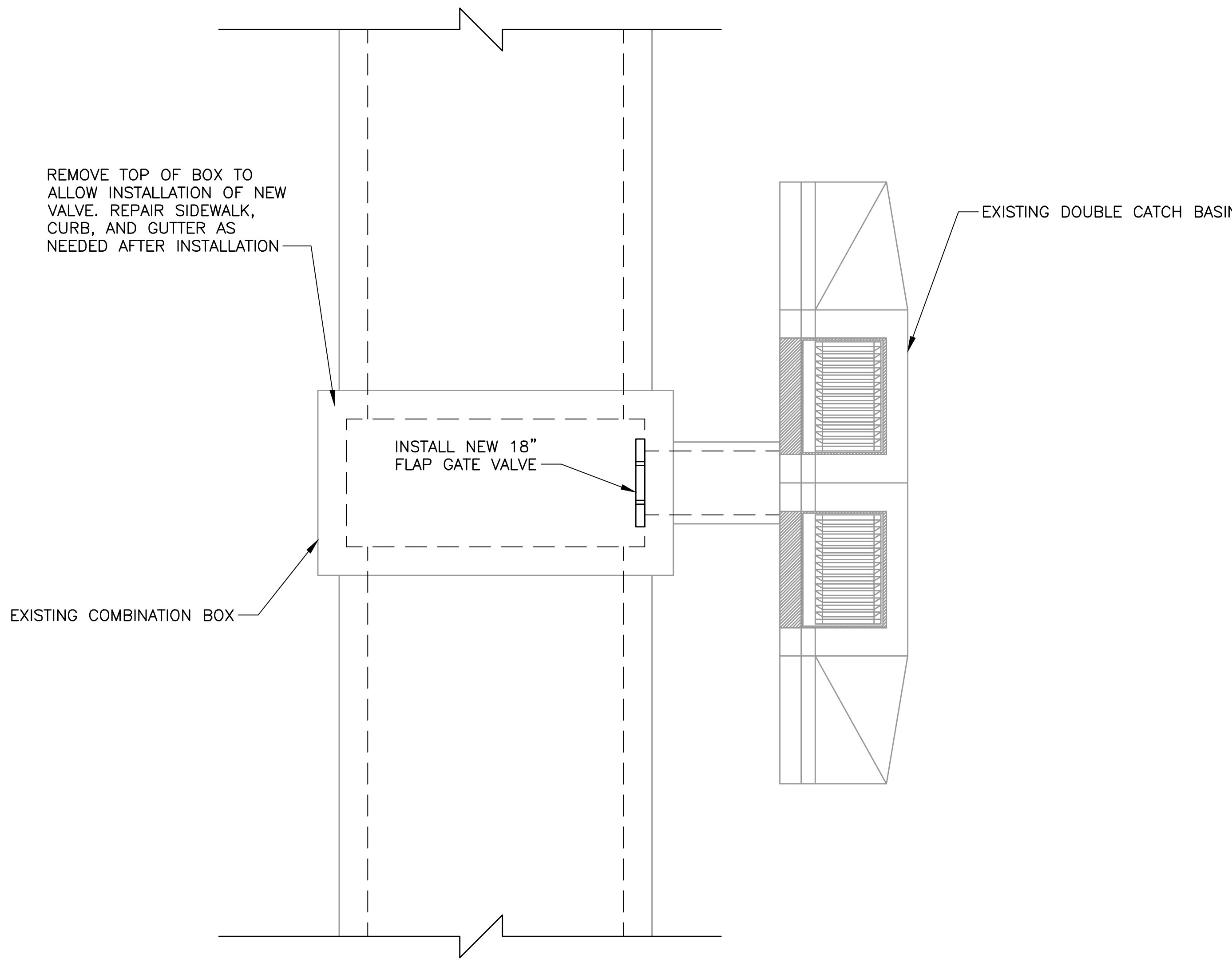
PROJECT NUMBER 581-18-01

DATE: DEC 2018

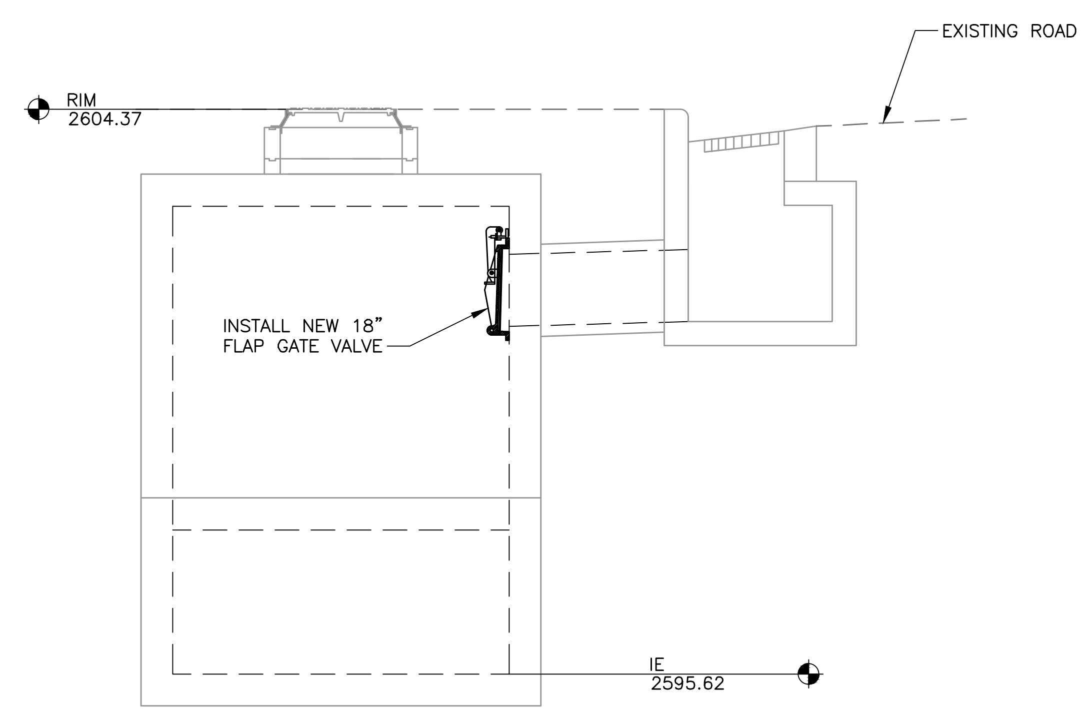
DRAWING NO.
S-01

SHEET 26 OF 28

N



PLAN
1/2" = 1'-0"



PROFILE
1/2" = 1'-0"

BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

WASHINGTON COUNTY
WARNER DRAW DISPOSAL SYSTEM
WASHINGTON COUNTY

REVIEW
CHECKED T. OLSEN
APPROVED T. OLSEN

DESIGN
DESIGN C. NIELSON
DRAWN C. NIELSON

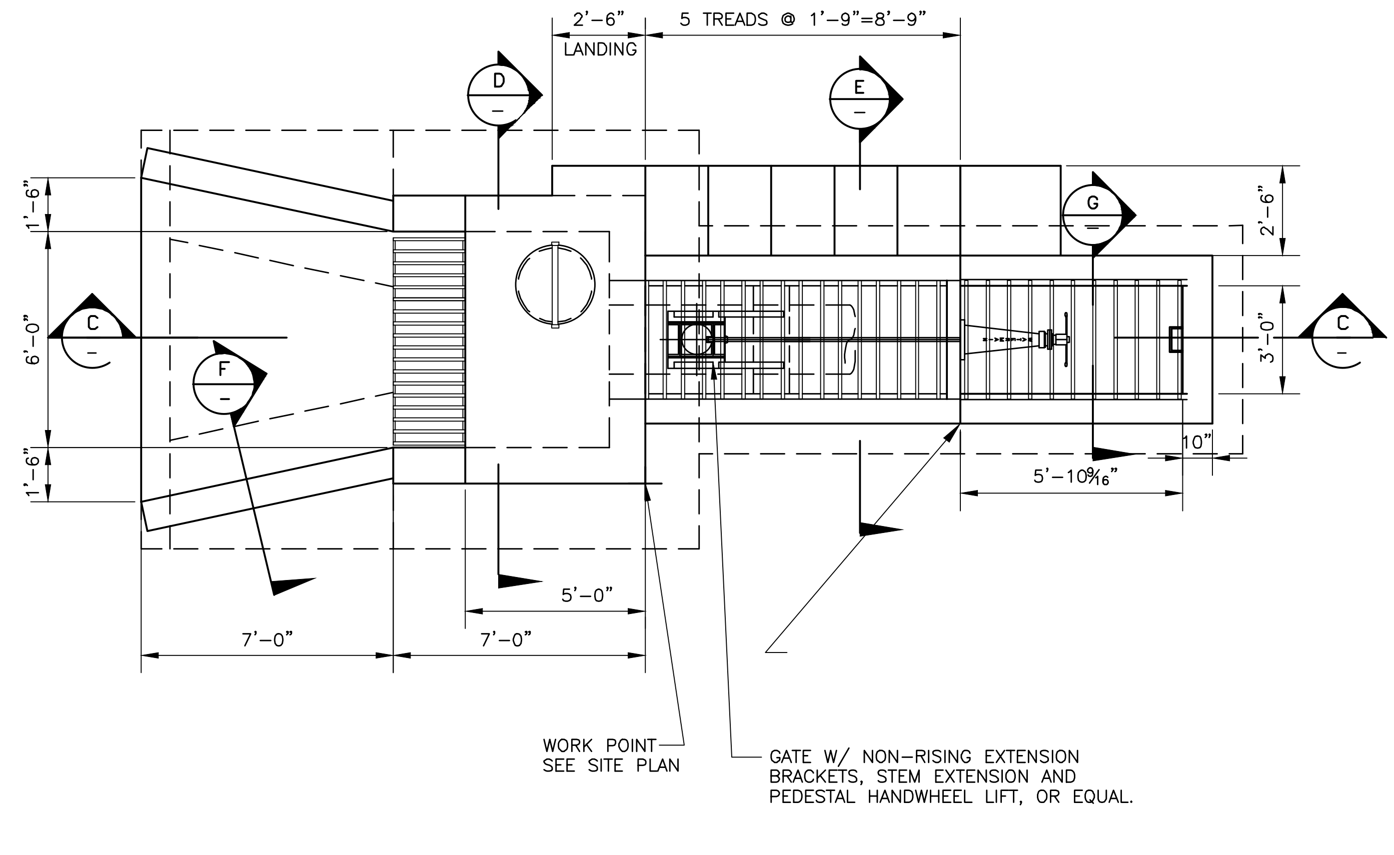
STRUCTURAL
WARNER DISPOSAL PIPELINE OUTFALL HEADWALL

PROJECT NUMBER 581-18-01

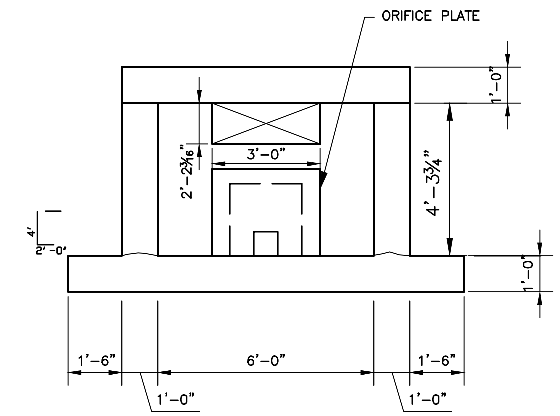
DATE: DEC 2018

DRAWING NO.
S-02
SHEET 27 OF 28

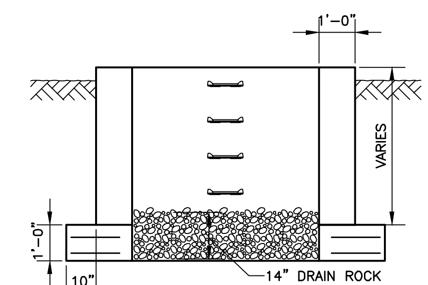
S:\washington county\581-18-01 warner draw watershed ea\7.0 drawings\disposal_pipeline\SHT\5811801_S-02.dwg Plotted: 1/10/2019 5:23 PM By: Cody Nielson



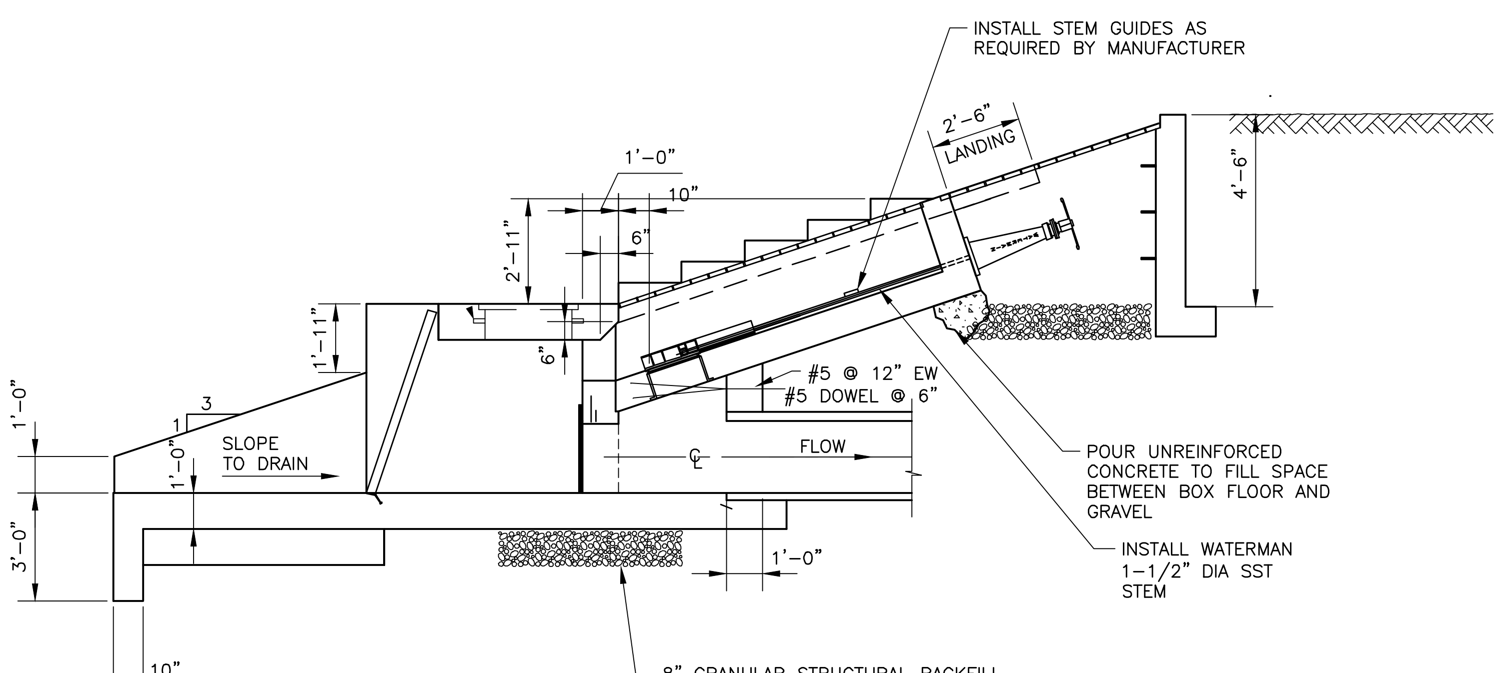
PLAN
3/8"=1'-0"



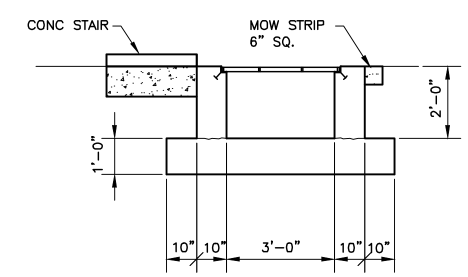
SECTION D
1/2"=1'-0"



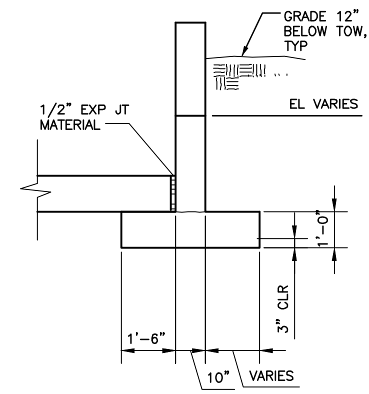
SECTION G
1/2"=1'-0"



SECTION C
3/8"=1'-0"



SECTION E
1/2"=1'-0"



SECTION F
1/2"=1'-0"

BOWEN COLLINS & ASSOCIATES

30% REVIEW

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

WASHINGTON COUNTY
WARNER DRAW DISPOSAL SYSTEM
WASHINGTON COUNTY

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

DESIGN
DESIGN C. NIELSON
DRAWN C. NIELSON

REVIEW
CHECKED T. OLSEN
APPROVED T. OLSEN

STRUCTURAL
OUTLET STRUCTURE

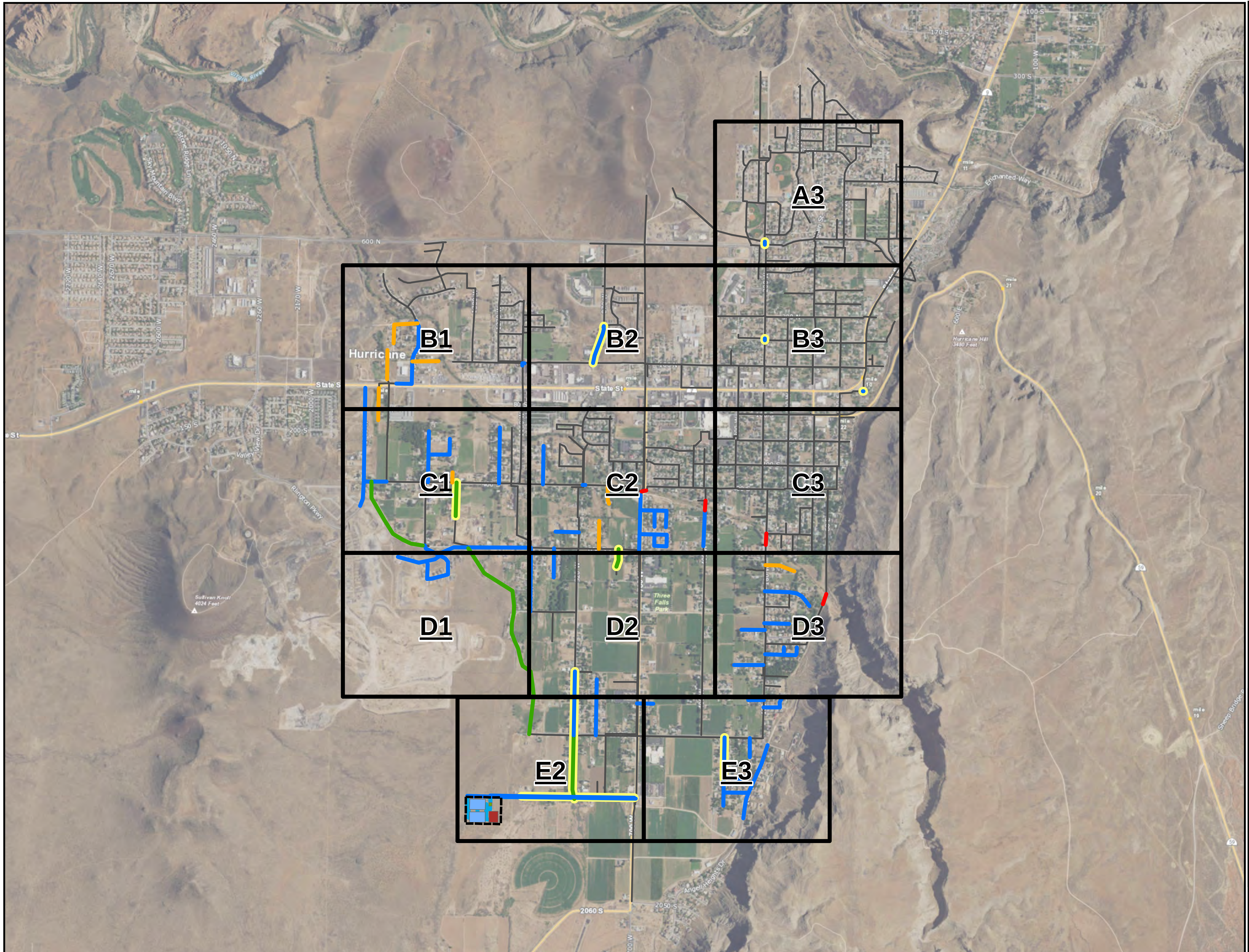
PROJECT NUMBER 581-18-01
DATE: DEC 2018

DRAWING NO.
S-03
SHEET 28 OF 28

Attachment 5

Hurricane Water Efficiency

Preferred Alternative Concept Design Drawings



LEGEND

Proposed New Pipelines

Cover Type

- Asphalt
- Dirt Road
- Gould's Wash
- Open Space
- Upsized Pipes
- Existing Pipelines

Proposed Ponds/Pump Station

- 3MG Storage Pond
- Pump Station
- Sludge Pond
- Pond/Pump Piping

NORTH:

SCALE: 0 1,000 2,000 Feet

PROPOSED IMPROVEMENTS KEY SHEET

WASHINGTON COUNTY

WARNER DRAW WATERSHED EA

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 1

L E G E N D

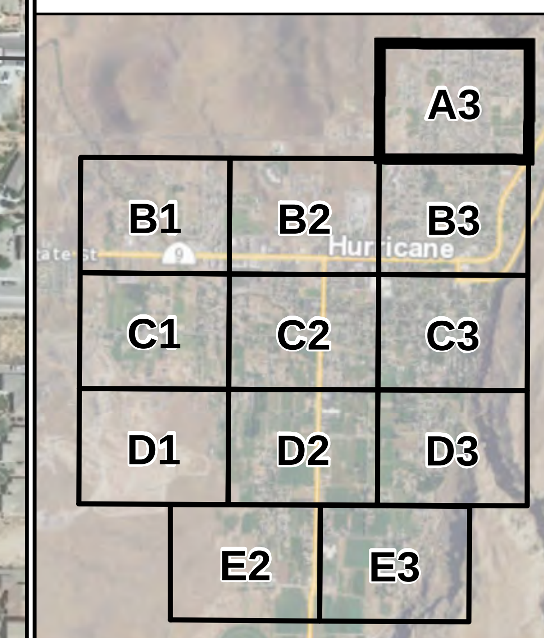
Proposed New Pipelines

Cover Type

- Asphalt
- Dirt Road
- Gould's Wash
- Open Space
- Upsized Pipes
- Existing Pipelines

Proposed Ponds/Pump Station

- 3MG Storage Pond
- Pump Station
- Sludge Pond
- Pond/Pump Piping



NORTH:

SCALE:

0 150 300 Feet

PROPOSED IMPROVEMENTS
A3

WASHINGTON COUNTY
WARNER DRAW
WATERSHED EA

BOWEN COLLINS & ASSOCIATES

FIGURE NO.
2

S:\Washington County\581-18-01 Warner Draw Watershed EA\4.0 GIS\4.1 Projects\Hurricane Irrigation\AppD_Proposed Improvements Plan Views.mxd cmoultrie 5/3/2019

LEGEND

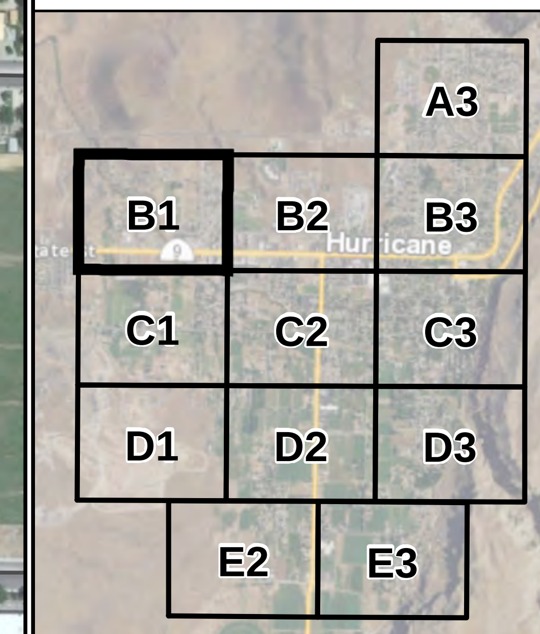
Proposed New Pipelines

Cover Type

- Asphalt
- Dirt Road
- Gould's Wash
- Open Space
- Upsized Pipes
- Existing Pipelines

Proposed Ponds/Pump Station

- 3MG Storage Pond
- Pump Station
- Sludge Pond
- Pond/Pump Piping



NORTH:

SCALE: 0 150 300 Feet

PROPOSED IMPROVEMENTS B1

WASHINGTON COUNTY
WARNER DRAW WATERSHED EA

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 3

S:\Washington County\581-18-01 Warner Draw Watershed EA\4.0 GIS\4.1 Projects\Hurricane Irrigation\AppD_Proposed Improvements Plan Views.mxd cmoultrie 5/3/2019

LEGEND

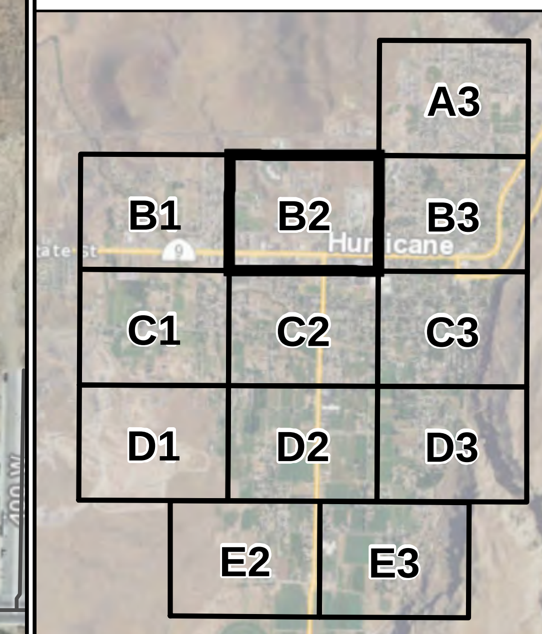
Proposed New Pipelines

Cover Type

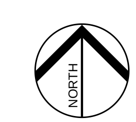
- Asphalt
- Dirt Road
- Gould's Wash
- Open Space
- Upsized Pipes
- Existing Pipelines

Proposed Ponds/Pump Station

- 3MG Storage Pond
- Pump Station
- Sludge Pond
- Pond/Pump Piping



NORTH:



SCALE:

0 150 300 Feet

PROPOSED IMPROVEMENTS
B2

WASHINGTON COUNTY

WARNER DRAW WATERSHED EA

BOWEN COLLINS & ASSOCIATES

FIGURE NO.

4

S:\Washington County\581-18-01 Warner Draw Watershed EA\4.0 GIS\4.1 Projects\Hurricane Irrigation\AppD_Proposed Improvements Plan Views.mxd cmoultrie 5/3/2019

L E G E N D

Proposed New Pipelines

Cover Type

- Asphalt
- Dirt Road
- Gould's Wash
- Open Space
- Upsized Pipes
- Existing Pipelines

Proposed Ponds/Pump Station

- 3MG Storage Pond
- Pump Station
- Sludge Pond
- Pond/Pump Piping

NORTH:

SCALE: 0 150 300 Feet

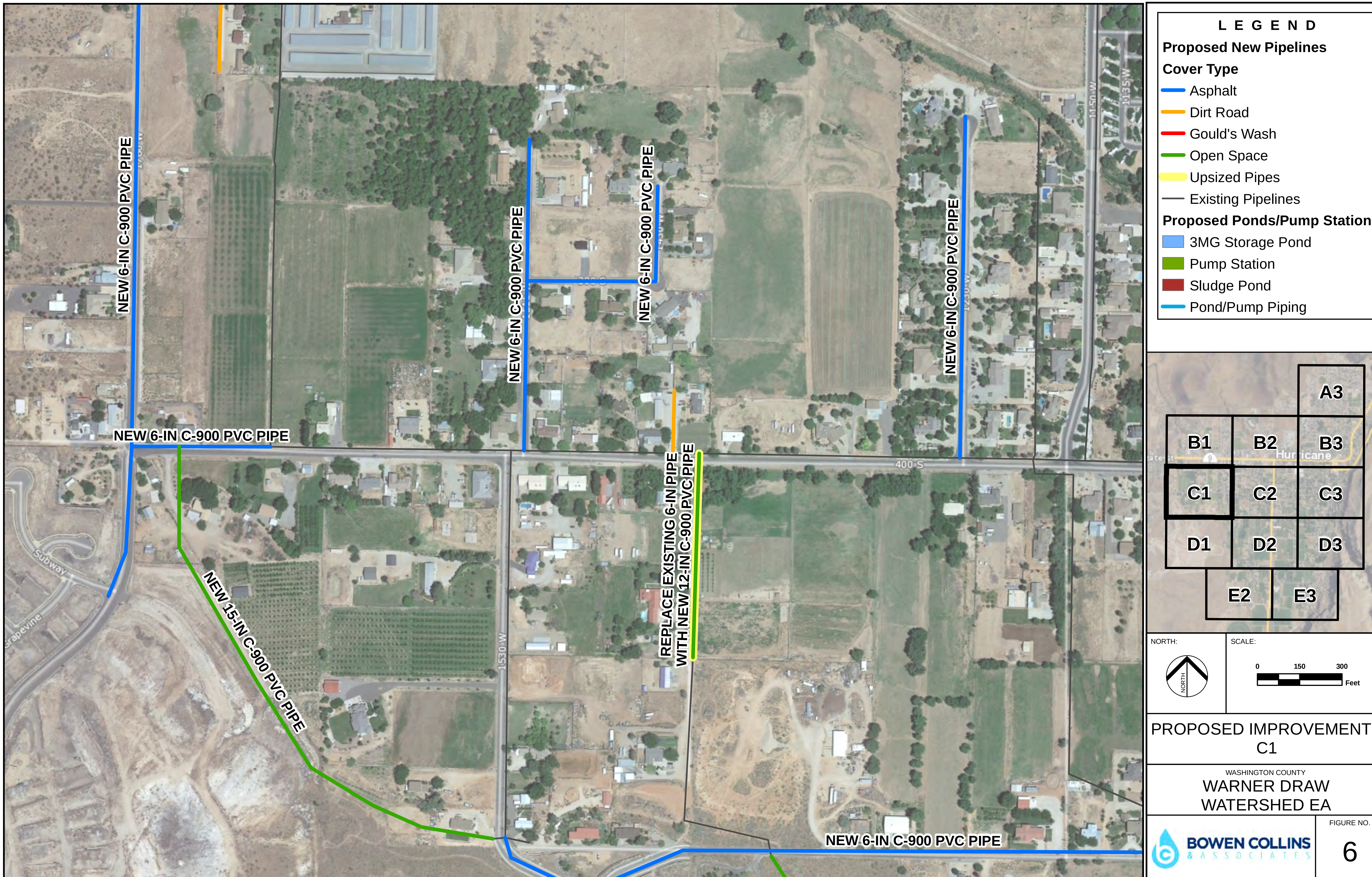
PROPOSED IMPROVEMENTS
B3

WASHINGTON COUNTY
WARNER DRAW WATERSHED EA

BOWEN COLLINS & ASSOCIATES

FIGURE NO.
5

S:\Washington County\581-18-01 Warner Draw Watershed EA\4.0 GIS\4.1 Projects\Hurricane Irrigation\AppD_Proposed Improvements Plan Views.mxd cmoultrie 5/3/2019



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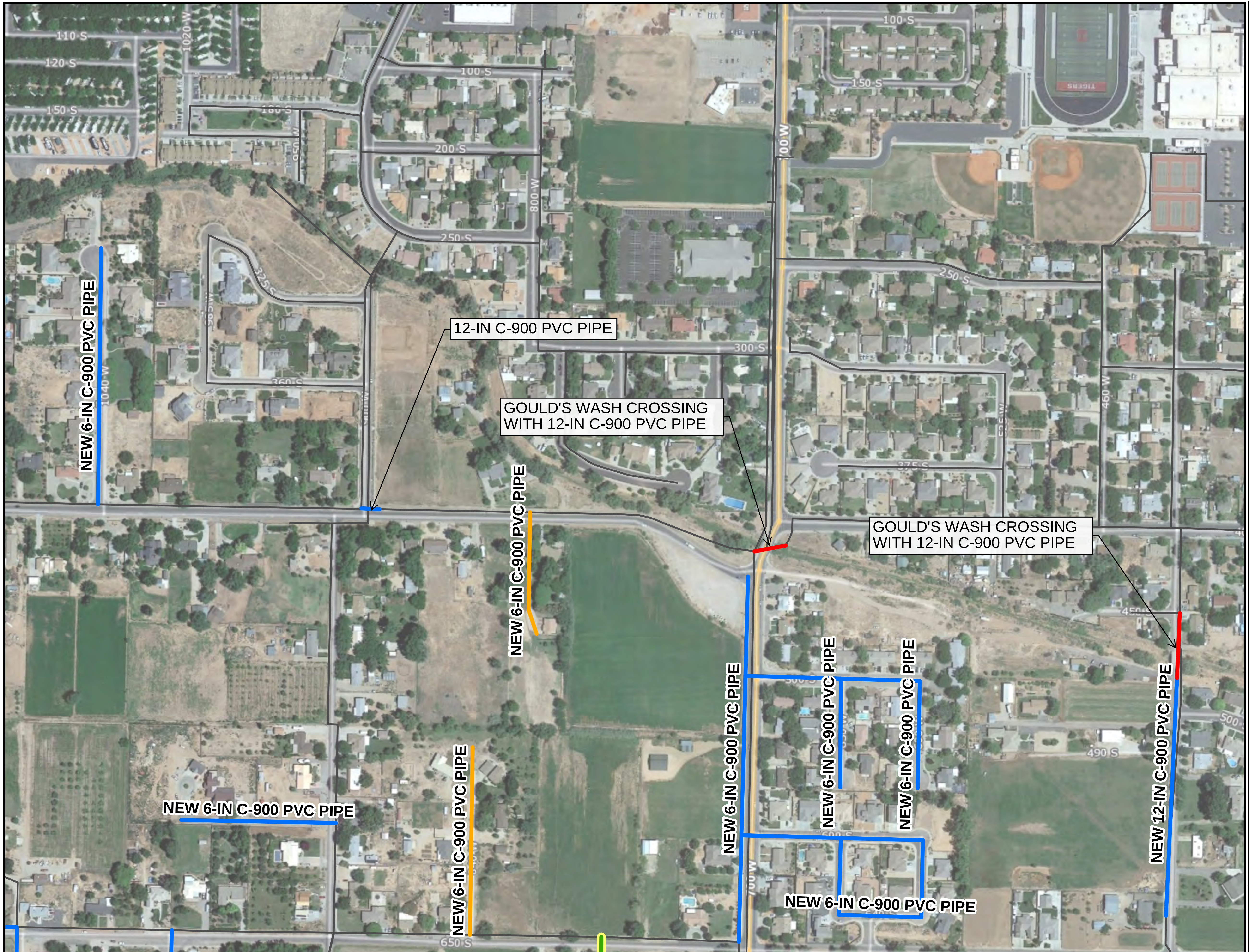


L E G E N D

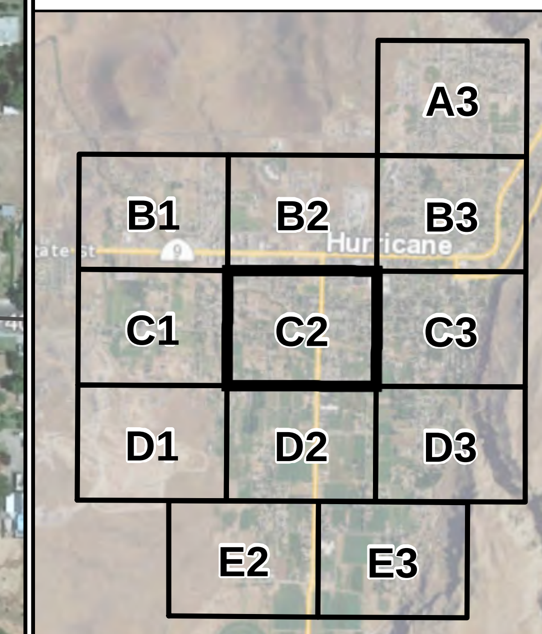
Proposed New Pipelines

Cover Type

- Asphalt
- Dirt Road
- Gould's Wash
- Open Space
- Upsized Pipes
- Existing Pipelines

Proposed Ponds/Pump Station

- 3MG Storage Pond
- Pump Station
- Sludge Pond
- Pond/Pump Piping



NORTH:

SCALE: 0 150 300 Feet

PROPOSED IMPROVEMENTS C2

WASHINGTON COUNTY

WARNER DRAW WATERSHED EA

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 7

S:\Washington County\581-18-01 Warner Draw Watershed EA\4.0 GIS\4.1 Projects\Hurricane Irrigation\AppD_Proposed Improvements Plan Views.mxd cmoultrie 5/3/2019

LEGEND

Proposed New Pipelines

Cover Type

- Asphalt
- Dirt Road
- Gould's Wash
- Open Space
- Upsized Pipes
- Existing Pipelines

Proposed Ponds/Pump Station

- 3MG Storage Pond
- Pump Station
- Sludge Pond
- Pond/Pump Piping

NORTH:

SCALE: 0 150 300 Feet

PROPOSED IMPROVEMENTS C3

WASHINGTON COUNTY

WARNER DRAW WATERSHED EA

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 8

S:\Washington County\581-18-01 Warner Draw Watershed EA\4.0 GIS\4.1 Projects\Hurricane Irrigation\AppD_Proposed Improvements Plan Views.mxd cmoultrie 5/3/2019

L E G E N D

Proposed New Pipelines

Cover Type

- Asphalt
- Dirt Road
- Gould's Wash
- Open Space
- Upsized Pipes
- Existing Pipelines

Proposed Ponds/Pump Station

- 3MG Storage Pond
- Pump Station
- Sludge Pond
- Pond/Pump Piping

NORTH:

SCALE:

0 150 300 Feet

PROPOSED IMPROVEMENTS
D1

WASHINGTON COUNTY
WARNER DRAW
WATERSHED EA

BOWEN COLLINS & ASSOCIATES

FIGURE NO.
9

LEGEND

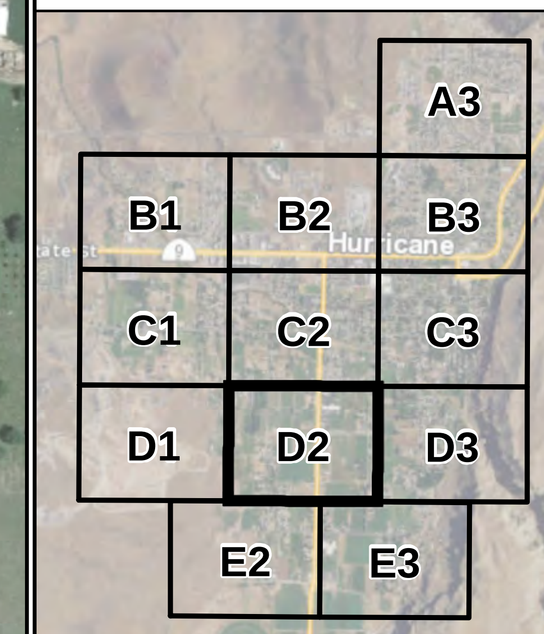
Proposed New Pipelines

Cover Type

- Asphalt
- Dirt Road
- Gould's Wash
- Open Space
- Upsized Pipes
- Existing Pipelines

Proposed Ponds/Pump Station

- 3MG Storage Pond
- Pump Station
- Sludge Pond
- Pond/Pump Piping



NORTH:

SCALE: 0 150 300 Feet

PROPOSED IMPROVEMENTS
D2

WASHINGTON COUNTY
WARNER DRAW
WATERSHED EA

BOWEN COLLINS & ASSOCIATES

FIGURE NO.
10

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L E G E N D

Proposed New Pipelines

Cover Type

- Asphalt
- Dirt Road
- Gould's Wash
- Open Space
- Upsized Pipes
- Existing Pipelines

Proposed Ponds/Pump Station

- 3MG Storage Pond
- Pump Station
- Sludge Pond
- Pond/Pump Piping

NORTH:

SCALE: 0 150 300 Feet

PROPOSED IMPROVEMENTS
D3

WASHINGTON COUNTY
WARNER DRAW
WATERSHED EA

BOWEN COLLINS & ASSOCIATES

FIGURE NO.
11

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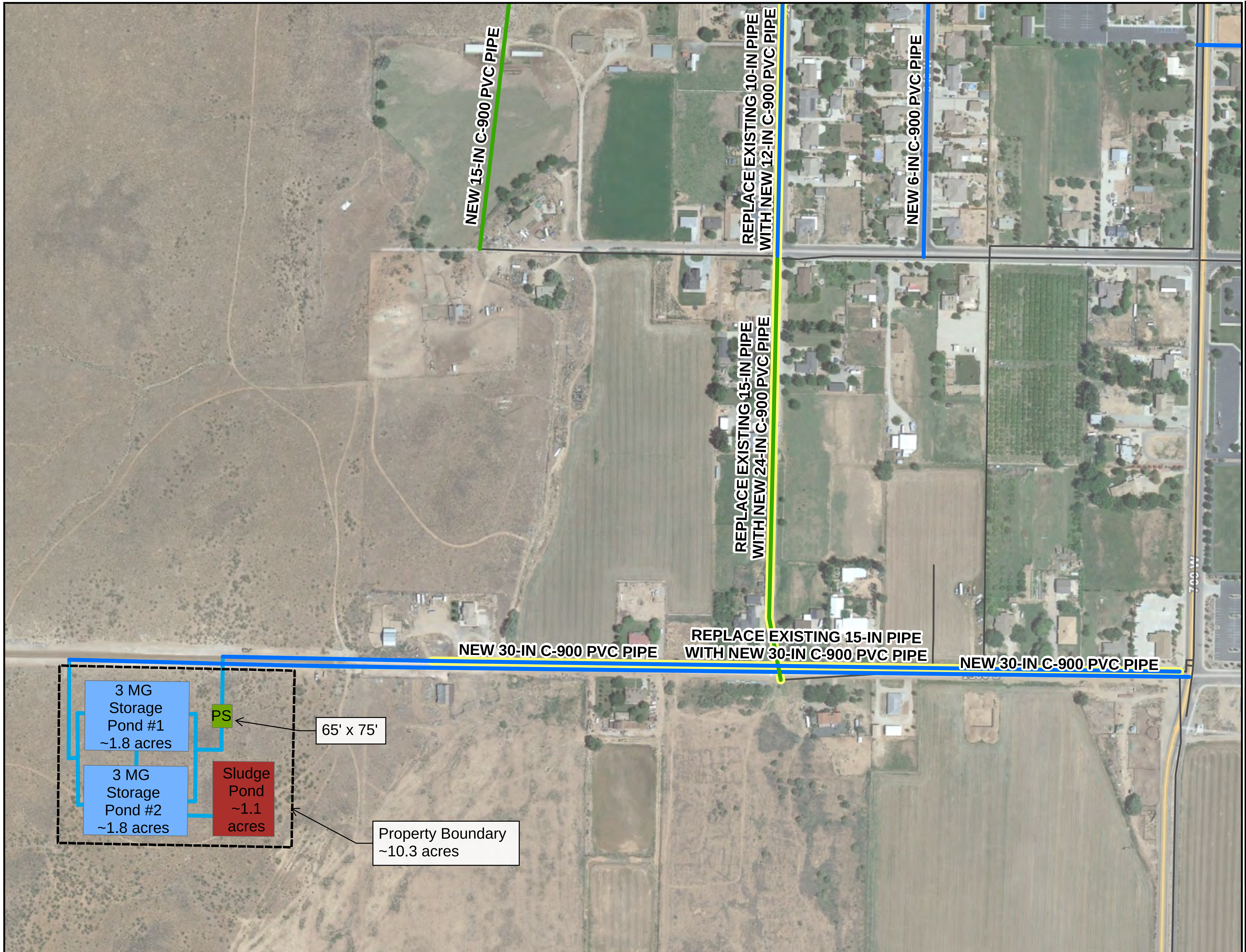


LEGEND

Proposed New Pipelines

Cover Type

- Asphalt
- Dirt Road
- Gould's Wash
- Open Space
- Upsized Pipes
- Existing Pipelines

Proposed Ponds/Pump Station

- 3MG Storage Pond
- Pump Station
- Sludge Pond
- Pond/Pump Piping

NORTH:

SCALE: 0 150 300 Feet

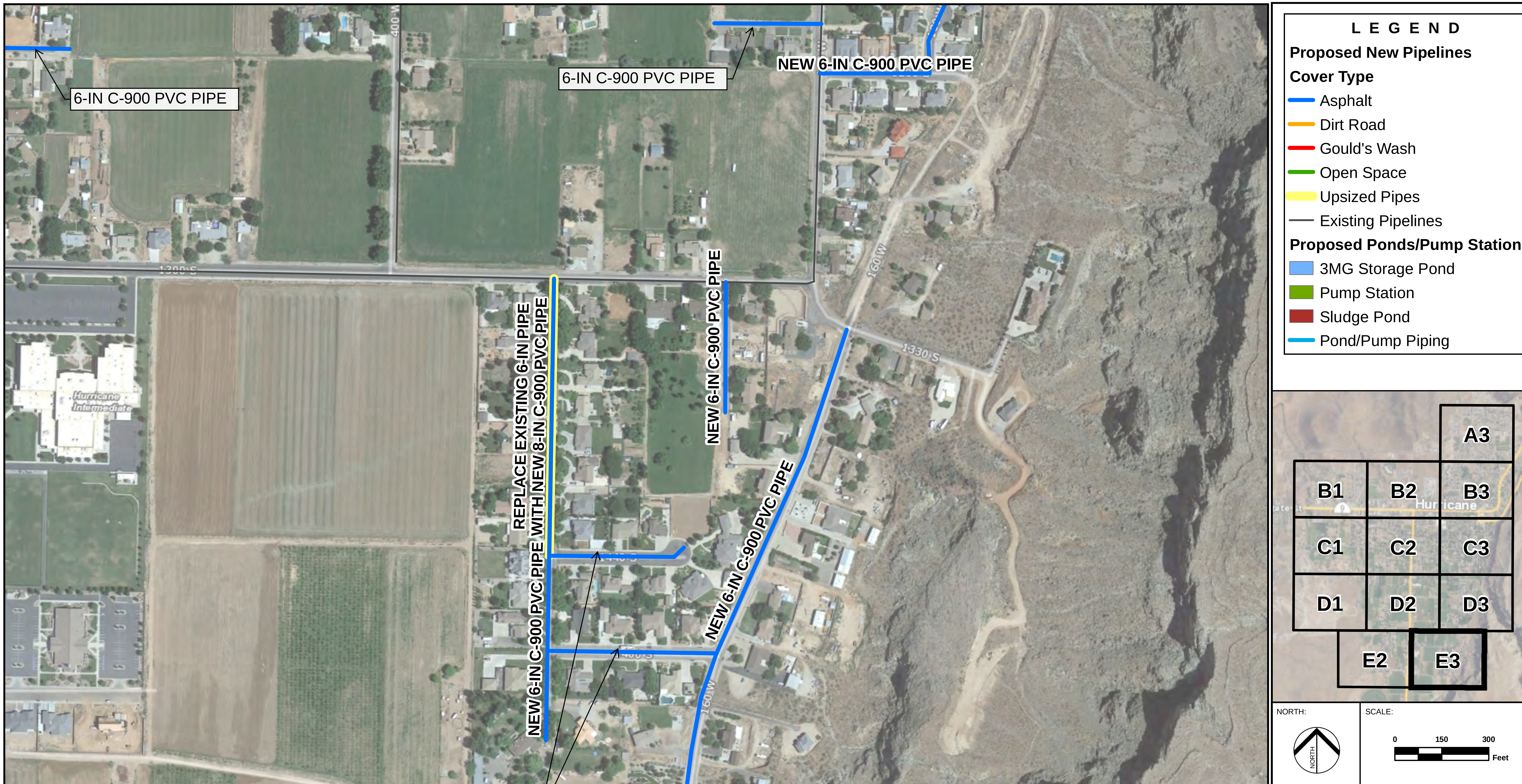
PROPOSED IMPROVEMENTS
E2

WASHINGTON COUNTY
WARNER DRAW
WATERSHED EA

BOWEN COLLINS & ASSOCIATES

FIGURE NO.
12

S:\Washington County\581-18-01 Warner Draw Watershed EA\4.0 GIS\4.1 Projects\Hurricane Irrigation\AppD_Proposed Improvements Plan Views.mxd cmoultrie 5/3/2019



PROPOSED IMPROVEMENTS E3

WASHINGTON COUNTY

WARNER DRAW WATERSHED EA

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 13

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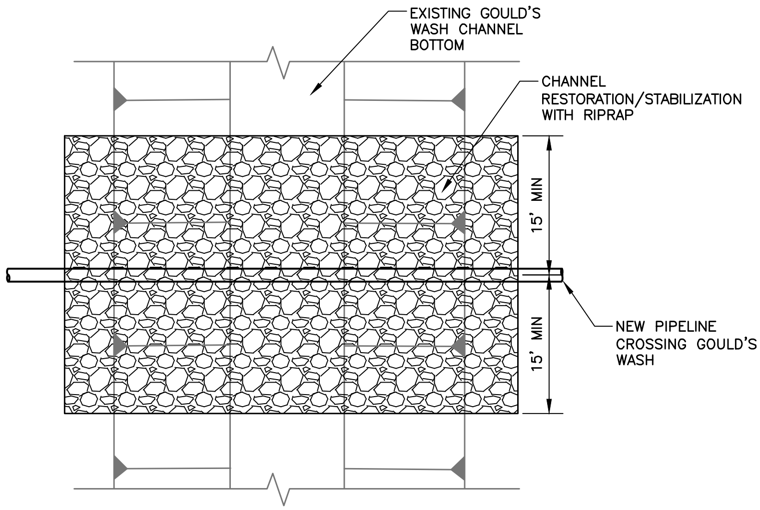
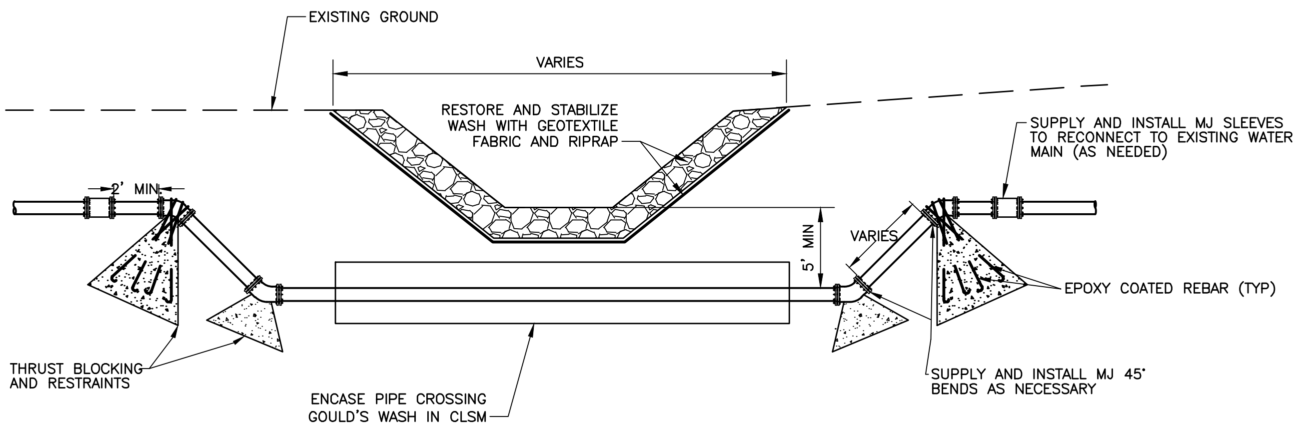


GOULD'S WASH CROSSING PLAN VIEW
SCALE: NTS



GOULD'S WASH CROSSING SECTION VIEW
SCALE: NTS

S:\Washington County\581-18-01 Warner Draw Watershed EA\7.0 Drawings\Hurricane Irrigation\SHT\GouldsWashCrossing.dwg Plotted: 5/2/2019 11:41 PM By: Cody Moultrie

BOWEN COLLINS & ASSOCIATES

WARNER DRAW WATERSHED EA
WASHINGTON COUNTY

FIGURE 14
TYPICAL GOULD'S WASH CROSSING DETAIL

Attachment 6

CPA 52 Environmental Evaluation

U.S. Department of Agriculture Natural Resources Conservation Service NRCS-CPA-52 11/2019 **ENVIRONMENTAL EVALUATION WORKSHEET**	**A. Client Name:** **Washington City, St. George, Hurricane City, WCWCD, Washington County, The Nature Conservancy** **B. Conservation Plan ID #** (as applicable)**:** **Program Authority** (optional)**:**
D. Client's Objective(s) (purpose): The purpose of the project is to improve flood prevention, watershed protection, public recreation, and agricultural water management in the Warner Draw Watershed.	**C. Identification #** (farm, tract, field #, etc. as required)**:** Warner Draw Watershed and Flood Operations Project Washington County, Utah

E. Need for Action:	**H. Alternatives**		
	No Action √ if RMS ☐	***Alternative 1*** √ if RMS ☐	***Alternative 2*** √ if RMS ☐
There is a need to reduce flood damages to developed and agricultural areas of St. George and Washington City; to improve irrigation water delivery efficiency for the existing flood irrigation systems in Hurricane that would also benefit Virgin River water quantities; to expand trail systems for recreation, education, and public safety; and to improve Virgin River ecosystems.	A new public trail would be constructed at Site 2 (Seegmiller Marsh), a fence installed around the Y-Drain at Site 3, and a pedestrian and equestrian trail construted along the Warner Valley Disposal System at Site 4.	**Site 1 (Main Street Debris Basins):** Construct 2 debris basins upstream of Main Street in Washington City to provide flood prevention to the downstream community. **Site 2 (Seegmiller Marsh):** Enhance the upland adjoining the Virgin River near Seegmiller Marsh by regrading to add wetlands and conveyance channels, and replanting with native emergent plants, shrubs, and trees. Extend the Virgin River South trail system by constructing an additional 4,000 ft long public trail with educational signage. Protect the sensitive riparian corridor/marsh ecosystem by purchasing a conservation easement. **Site 3 (Y-Drain):** Pipe the 1,125-foot open channel section of the Y-Drain to improve water conveyance and water quality, provide flood prevention, and reduce safety hazards. Extend the existing trail system along the newly piped section. **Site 4 (Warner Valley Disposal System):** Improve and increase the capacity of the the existing disposal system along an approximately 13,650-foot lenth to provide flood prevention, improve conveyance, and reduce safety hazards. Construct a pedestrian and equestrian trail along the disposal system alignment. **Site 5:** Convert portions of Hurricane City from flood irrigation to pressurized irrigation to improve water supply, conservation, and delivery.	

Special Environmental Concerns: Environmental Laws, Executive Orders, policies, etc.

G. Special Environmental Concerns (Document existing/ benchmark conditions)	**J. Impacts to Special Environmental Concerns**					
	No Action		***Alternative 1***		***Alternative 2***	
	Document all impacts (Attach Guide Sheets as applicable)	√ if needs further action	Document all impacts (Attach Guide Sheets as applicable)	√ if needs further action	Document all impacts (Attach Guide Sheets as applicable)	√ if needs further action
Clean Air Act	No Effect Construction activities are not expected to violate air quality standards, due to the implementation of BMPs and the short duration of construction.	☐	No Effect Construction activities are not expected to violate air quality standards, due to the implementation of BMPs and the short duration of construction.	☐		☐

G. Special Environmental Concerns (Document existing/ benchmark conditions)	J. Impacts to Special Environmental Concerns					
	No Action		***Alternative 1***		***Alternative 2***	
	Document all impacts (Attach Guide Sheets as applicable)	√ if needs further action	Document all impacts (Attach Guide Sheets as applicable)	√ if needs further action	Document all impacts (Attach Guide Sheets as applicable)	√ if needs further action
Clean Water Act / Waters of the U.S.	May Affect BMPs, would be implemented to reduce the quantity of sediment (1) entering drainages, and (2) flowing downstream and violating any federal or state water quality rules and regulations.	☐	May Affect BMPs, would be implemented to reduce the quantity of sediment (1) entering drainages, and (2) flowing downstream and violating any federal or state water quality rules and regulations.	☐		☐
Coastal Zone Management	No Effect Not Applicable	☐	No Effect Not Applicable	☐		☐
Coral Reefs	No Effect Not Applicable	☐	No Effect Not Applicable	☐		☐
Cultural Resources / Historic Properties	No Effect No Adverse Effect determination has been made for project measures and SHPO concurrence has been received.	☐	No Effect No Adverse Effect determination has been made for project measures and SHPO concurrence has been received.	☐		☐
Endangered and Threatened Species	May Affect A BA is not required and there is increased risk to desert tortoise, Virgin River chub, wouldfin, southwestern willow flycatcher, and yellow-billed cuckoo with no avoidance and minimization measures in place.	☐	May Affect May Affect Not Likely to Adversely Affect for desert tortoise and May Affect Likely to Adversely Affect for Virgin River chub, woundfin, Southwestern willow flycatcher, and yellow-billed cuckoo. A BA was submited to USFWS and and BO issued. The project will comply with avoidance and minimization measures identified in the BO.	☐		☐
Environmental Justice	No Effect No disproportionately high or adverse human health or environmental effects on minority or low-income populations are anticipated. Project actions are intended to benefit subject populations.	☐	No Effect No disproportionately high or adverse human health or environmental effects on minority or low-income populations are anticipated. Project actions are intended to benefit subject populations.	☐		☐
Essential Fish Habitat	No Effect Essential fish habitat is not located in or near the project area.	☐	No Effect Essential fish habitat is not located in or near the project area.	☐		☐
Floodplain Management	No Effect There would be no change to flooding from the existing conditions.	☐	May Affect Removes flooding to 162 acres of land containing 200 residences, 16 commercial/office buildings, 36 roads, and one major interstate for up to and including a 100-year flood, which provides a long-term benefit that decreases the risk to life and property.	☐		☐

G. Special Environmental Concerns (Document existing/ benchmark conditions)	J. Impacts to Special Environmental Concerns					
	No Action		***Alternative 1***		***Alternative 2***	
	Document all impacts (Attach Guide Sheets as applicable)	√ if needs further action	Document all impacts (Attach Guide Sheets as applicable)	√ if needs further action	Document all impacts (Attach Guide Sheets as applicable)	√ if needs further action
Invasive Species	May Affect This alternative would put the project area at risk for future invasion of noxious weeds and invasive plants. BMPs would be implemented to minimize the short-term impacts associated with construction activities.	☐	May Affect Similar to the No Action Alternative but a Post Construction Rehabilitation Plan (PCRP) would also be developed. Impacts would be minimal with implementation of BMPs and development of a PCRP. Non-native and N&I plant species would be removed and replaced with native species in sensitive riparian habitat at Seegmiller Marsh.	☐		☐
Migratory Birds/Bald and Golden Eagle Protection Act	May Affect Construction activities have the potential to destroy nests and harm or kill species, if present. Impacts to suitable habitat for migratory birds would be temporary and minor based on duration of construction, restoration of disturbed areas, and abundant suitable habitat in the surrounding area.	☐	May Affect Migratory birds and bald eagles could be present in the project area. Preconstruction surveys would be performed, and spatial buffers would be established as necessary in coordination with USFWS and NRCS. Impacts to migratory birds/bald eagles and associated habitat would be temporary and minor based on the duration of construction, restoration of disturbed areas, abundant suitable habitat in the surrounding area, and avoidance/minimization measures in place.	☐		☐
Natural Areas	No Effect There are no protected natural areas or Areas of Critical Environmental Concern located within the project area.	☐	No Effect There are no protected natural areas or Areas of Critical Environmental Concern located within the project area.	☐		☐
Prime and Unique Farmlands	May Affect Approximately 1.96 acres would be temporarily disturbed and 0.53 acres would be permanently disturbed on irrigated lands with soils designated as “prime farmland if irrigated.”	☐	May Affect Approximately 2.82 acres would be temporarily disturbed and 0.58 acres would be permanently disturbed on irrigated lands with soils designated as “prime farmland if irrigated.”	☐		☐
Riparian Area	May Affect Removal of 0.93 acres of riparian vegetation would have minor long-term impacts.	☐	May Affect Removal of 1.04 acres of riparian vegetation and adding 5.53 acres of new riparian vegetation would take place. Also, 10.35 acres of riparian habitat would be converted to new water and wetland habitat areas. There would be temporary adverse impacts to riparian areas during construction and long-term beneficial impact from the reestablishment of native riparian vegetation and habitat diversity in the riparian corridor.	☐		☐
Scenic Beauty	May Affect Temporary impacts would occur during construction from construction disturbance and construction equipment. Construction of a new trail system would offer a long-term benefit from increased opportunity to view scenic areas of the Virgin River corridor.	☐	May Affect Temporary impacts would occur during construction from construction disturbance and construction equipment. Construction of a new trail system would offer a long-term benefit from increased opportunity to view scenic areas of the Virgin River corridor.	☐		☐

G. Special Environmental Concerns (Document existing/ benchmark conditions)	J. Impacts to Special Environmental Concerns					
	No Action		***Alternative 1***		***Alternative 2***	
	Document all impacts (Attach Guide Sheets as applicable)	√ if needs further action	Document all impacts (Attach Guide Sheets as applicable)	√ if needs further action	Document all impacts (Attach Guide Sheets as applicable)	√ if needs further action
Wetlands	May Affect Removes 0.09 acres of emergent wetland.	☐	May Affect Removes 0.13 acres of emergent wetland and adds 14.23 acres of new wetland.	☐		☐
Wild and Scenic Rivers	No Effect No Wild and Scenic Rivers are present in or near the project area.	☐	No Effect No Wild and Scenic Rivers are present in or near the project area.	☐		☐

K. Other Agencies and Broad Public Concerns	***No Action***	***Alternative 1***	***Alternative 2***
Easements, Permissions, Public Review, or Permits Required and Agencies Consulted.	Easements for trails would be needed at Sites 2 and 4. USACE and UDEQ permits required. Washington City and St. George building/grading permits as necessary.	Easements with no costs on SITLA lands needed at Site 1. Conservation and trail easement needed at Site 2. Trail easement and utility easements needed at Site 4. Easement for pumping facility and purchase of water shares needed at Site 5. USFWS Section 7, Section 106, and tribal consultation completed. USACE 404 permit, FEMA floodplain map updates, UDEQ permits, Utah Division of Water Rights authorization, and county/city permits needed.	
Cumulative Effects Narrative (Describe the cumulative impacts considered, including past, present and known future actions regardless of who performed the actions)	Minor short-term cumulative disturbance to wildlife/special status animal species/migratory birds and habitat if other actions occur at the same time and in the same area as the proposed action. Cumulative increase in recreational facilities would improve recreation opportunities over the long-term.	Minor short-term cumulative disturbance to wildlife/special status animal species/migratory birds and habitat if other actions occur at the same time and in the same area as the proposed action. Cumulative long-term beneficial impact that would decrease sediment and flood damages within developed areas of the Warner Draw Watershed and increase safety to the public. Cumulative increase in recreational facilities would improve recreation opportunities over the long-term. Temporary direct socioeconomic benefits from additional employment requirements that may be necessary during construction of projects.	
L. Mitigation (Record actions to avoid, minimize, and compensate)	None	Measures would be in place for erosion, suface water quality, air quality, noxious weeds, wildlife, special status species, migratory birds/bald eagles, hazardous materials, and visual resources.	
M. Preferred Alternative – √ preferred alternative	☐	☑	☐
M. Preferred Alternative – Supporting reason	Does not meet the pupose and need for the project.	Meets the pupose and need for the project and results in long-term benefits to resources.	

N. Context (Record context of alternatives analysis) | local | local |

The significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected interests, and the locality.

O. To the best of my knowledge, the data shown on this form is accurate and complete:
In the case where a non-NRCS person (e.g. a TSP) assists with planning they are to sign the first signature block and then NRCS is to sign the second block to verify the information's accuracy.

[signature]	**McMillen Jacobs Associates Natural Resources Consultant**	**6/18/2021**
Signature (TSP if applicable)	**Title**	**Date**
Signature (NRCS)	**Title**	**Date**

If preferred alternative is not a federal action where NRCS has control or responsibility and this NRCS-CPA-52 is shared with someone other than the client then indicate to whom this is being provided.

The following sections are to be completed by the Responsible Federal Official (RFO)

NRCS is the RFO if the action is subject to NRCS control and responsibility (e.g., actions financed, funded, assisted, conducted, regulated, or approved by NRCS). These actions do not include situations in which NRCS is only providing technical assistance because NRCS cannot control what the client ultimately does with that assistance and situations where NRCS is making a technical determination (such as Farm Bill HEL or wetland determinations) not associated with the planning process.

P. Determination of Significance or Extraordinary Circumstances

To answer the questions below, consider the severity (intensity) of impacts in the contexts identified above. Impacts may be both beneficial and adverse. A significant effect may exist even if the Federal agency believes that on balance the effect will be beneficial. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts.

If you answer ANY of the below questions "yes" then contact the State Environmental Liaison as there may be extraordinary circumstances and significance issues to consider and a site specific NEPA analysis may be required.

Yes	No	
☐	☑	• Is the preferred alternative expected to cause significant effects on public health or safety?
☐	☑	• Is the preferred alternative expected to significantly affect unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas?
☐	☑	• Are the effects of the preferred alternative on the quality of the human environment likely to be highly controversial?
☐	☑	• Does the preferred alternative have highly uncertain effects or involve unique or unknown risks on the human environment?
☐	☑	• Does the preferred alternative establish a precedent for future actions with significant impacts or represent a decision in principle about a future consideration?
☐	☑	• Is the preferred alternative known or reasonably expected to have potentially significant environment impacts to the quality of the human environment either individually or cumulatively over time?
☐	☑	• Will the preferred alternative likely have a significant adverse effect on ANY of the special environmental concerns? Use the Evaluation Procedure Guide Sheets to assist in this determination. This includes, but is not limited to, concerns such as cultural or historical resources, endangered and threatened species, environmental justice, wetlands, floodplains, coastal zones, coral reefs, essential fish habitat, wild and scenic rivers, clean air, riparian areas, natural areas, and invasive species.
☐	☑	• Will the preferred alternative threaten a violation of Federal, State, or local law or requirements for the protection of the environment?

Q. NEPA Compliance Finding (check one)

The preferred alternative:

		Action required
☐	1) is **not a federal action** where the agency has control or responsibility.	Document in "R.1" below. No additional analysis is required
☐	2) is a federal action **ALL** of which is **categorically excluded** from further environmental analysis **AND** there are **no extraordinary circumstances as identified in Section "P".**	Document in "R.2" below. No additional analysis is required
☐	3) is a federal action that has been **sufficiently analyzed** in an existing Agency state, regional, or national NEPA document **and** there are no predicted significant adverse environmental effects or extraordinary circumstances.	Document in "R.1" below. No additional analysis is required.
☐	4) is a federal action that has been sufficiently analyzed in another Federal agency's NEPA document (EA or EIS) that addresses the proposed NRCS action and its' effects **and has been formally adopted by NRCS**. NRCS is required to prepare and publish its own Finding of No Significant Impact for an EA or Record of Decision for an EIS when adopting another agency's EA or EIS document. (**Note: This box is not applicable to FSA)**	Contact the State Environmental Liaison for list of NEPA documents formally adopted and available for tiering. Document in "R.1" below. No additional analysis is required
☑	5) is a federal action that has **NOT** been sufficiently analyzed or may involve predicted significant adverse environmental effects or extraordinary circumstances and may require an EA or EIS.	Contact the State Environmental Liaison. Further NEPA analysis required.

R. Rationale Supporting the Finding	
R.1 Findings Documentation	A Supplemental Watershed Plan and Environmental Assessment is required for the Warner Draw Watershed and Flood Operations Project.
R.2 Applicable Categorical Exclusion(s) **(more than one may apply)** 7 CFR Part 650 *Compliance With NEPA* , subpart 650.6 *Categorical Exclusions* states prior to determining that a proposed action is categorically excluded under paragraph (d) of this section, the proposed action must meet six sideboard criteria.	None

I have considered the effects of the alternatives on the Resource Concerns, Economic and Social Considerations, Special Environmental Concerns, and Extraordinary Circumstances as defined by Agency regulation and policy and based on that made the finding indicated above

S. Signature of Responsible Federal Official:

Signature	**Title**	**Date**

Additional notes