5053

2020 Rinearson Monitoring Annual Report

Rinearson Natural Area

December 2020

Cardno®

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Acronyms

μS/cm	microsiemens per centimeter
BSS	beach seine sites
Cardno	Cardno, Inc.
DO	dissolved oxygen
˚F	degrees Fahrenheit
GPS	global positioning system
LWD	large woody debris
mg/L	milligrams per liter
NAVD88	North American Vertical Datum of 1988
ODEQ	Oregon Department of Environmental Quality
OHWM	ordinary high water mark
Rinearson HDP	Rinearson Natural Area Habitat Development Plan
RTK	real-time kinematic
TFW	Timber Fish and Wildlife
WQS	water quality station
WSE	water surface elevation

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1 Introduction – Monitoring Overview

Cardno, Inc. (Cardno), was hired by the Columbia Restoration Group on October 25, 2019, to conduct combined Year 1 (2019) and Year 2 (2020) monitoring in the Rinearson Natural Area as part of ongoing restoration monitoring throughout the Rinearson Natural Area. This annual report describes the monitoring of Rinearson Natural Area and documents the efforts conducted to fulfill post-construction monitoring benchmarks defined in the Rinearson Natural Area Habitat Development Plan (Rinearson HDP). The HDP details protocol methods and benchmark metrics to evaluate restoration success over a 10-year monitoring window (Proutt 2017).

1.1 Monitoring Transects and Control Points

Permanent monitoring transects (north to south) and vegetation sampling sub-transects (east to west) were established during baseline monitoring in 2016–2017, as defined in the Rinearson HDP (Proutt 2017; Runyon 2016). However, during Cardno's 2020 monitoring effort no existing transect or subtransect endpoints were found at the site as indicated in the Rinearson HDP. Therefore, Cardno staff georeferenced the established transects and sub-transects shown in Figure 8 of the Rinearson HDP and created shapefiles from the figure to navigate on the site with survey grade real-time kinematic (RTK) global positioning system (GPS) and recreation-grade GPS equipment. Recreation-grade GPS equipment was accurate enough to ensure vegetation sampling and other monitoring efforts occurred along the sub-transects as described in the Rinearson HDP monitoring study design methods. Cardno staff did not establish physical endpoint locations with capped PVC pipes for these transects because navigation was possible without them. Cardno staff did establish physical endpoint locations using capped rebar at the cross-section monitoring locations that are specified in the Rinearson HDP (see Figure 1-1). These endpoint locations were surveyed using RTK GPS and labeled with a cross-section number and bearing (N, S, E and W) (Table 1-1). Cross sections were oriented perpendicular to flow instead of exactly north-south along the baseline transects to ensure the sections accurately captured channel geometry.

Cardno staff established two control points during the channel cross-section survey to ensure cross section endpoints could be found and re-occupied in subsequent sampling years (see Figure 1-1). These control points were established using survey-grade RTK GPS equipment that was post-processed using the National Oceanic and Atmospheric Administration's online positioning user service. Control points were marked with capped rebar, stakes, and flags and positioned in open and easily accessible locations (Table 1-1).

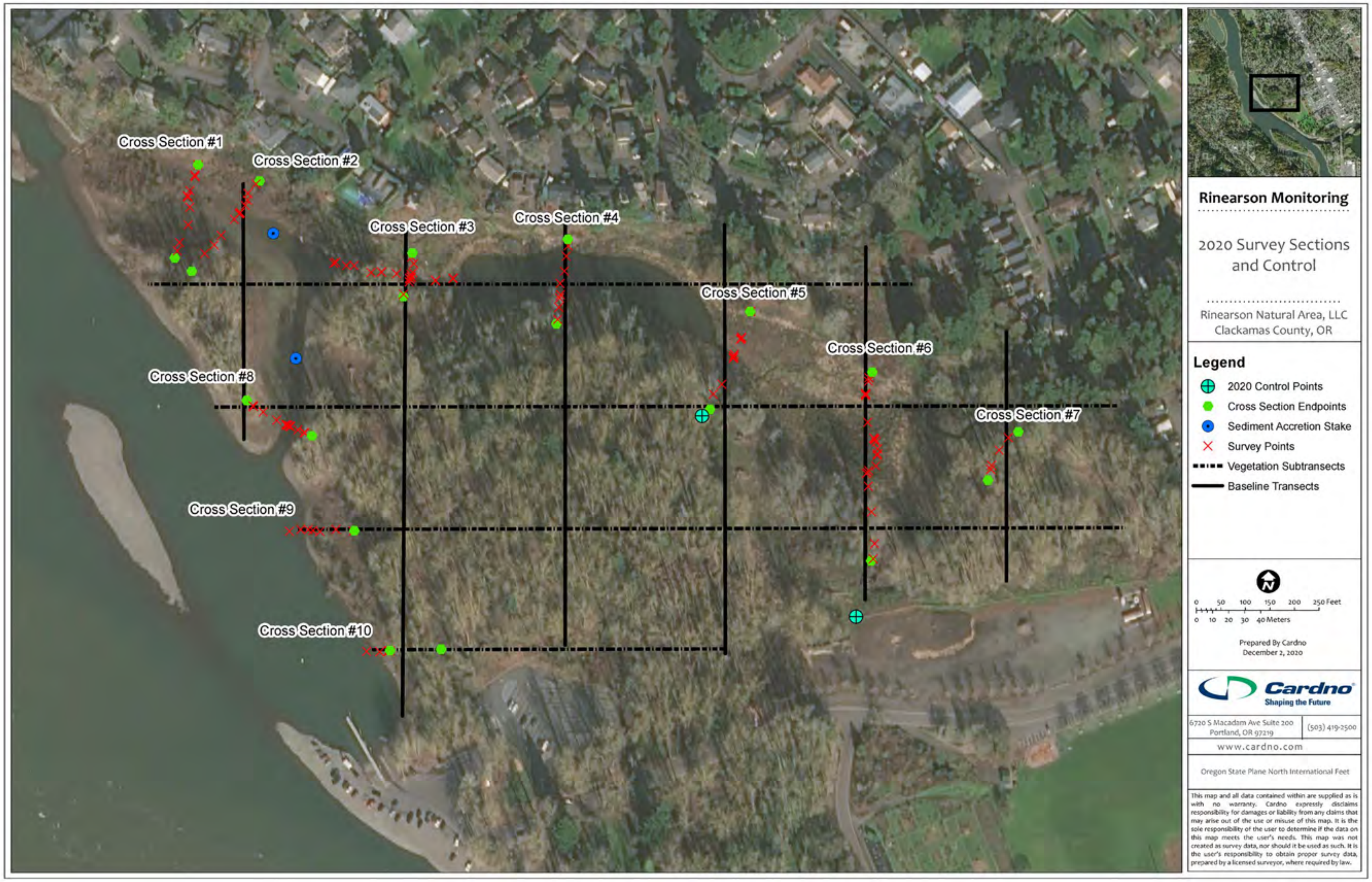

Figure 1-1 Transect and Cross Section Locations, Endpoints, and Survey Points

Table 1-1 Control Points and Cross-Section Endpoints

Point No.	Northing	Easting	Elevation	Description
5000	631027.462	7659297.749	43.05	BASE
5001	631435.633	7658984.136	34.866	CONTROL
34	631467.361	7658056.102	26.187	XS-N_8
62	630958.698	7658348.088	16.862	XS_W_10
48	631395.569	7658188.944	24.756	XS_S_8
143	631305.005	7659566.441	29.634	XS_S_7
118	631140.961	7659328.543	28.204	XS_S_6
103	631449.038	7659000.244	32.635	XS_S_5
88	631622.889	7658687.708	27.337	XS_S_4
78	631678.513	7658375.406	25.209	XS_S_3
33	631730.033	7657943.986	26.857	XS_S_2
3	631757.002	7657909.229	28.879	XS_S_1
148	631403.265	7659628.574	26.667	XS_N_7
142	631524.629	7659331.044	23.608	XS_N_6
117	631647.986	7659081.889	21.755	XS_N_5
97	631794.720	7658710.489	21.285	XS_N_4
87	631767.105	7658393.622	25.144	XS_N_3
19	631913.167	7658082.505	16.175	XS_N_2
18	631946.224	7657957.000	14.341	XS_N_1
56	631202.263	7658275.269	14.96	XS_E_9
61	630961.263	7658452.089	20.224	XS_E_10

Note: Data provided in Oregon State Plane North International Feet; vertical datum is North American Vertical Datum of 1988 (NAVD88).

1.2 Photo Monitoring

The Rinearson HDP required the establishment of permanent photo monitoring locations during the as-built survey using capped PVC pipe. However, like the transect endpoints, it seemed that no physical photo monitoring locations had been established prior to the 2020 field efforts. Consequently, Cardno reoccupied the approximate photo points used during baseline monitoring in 2016 (Runyon 2016) (Figure 1-2). These locations were occupied using recreation-grade GPS equipment, and photos were taken to monitor vegetation community development. Additional photos were taken at each vegetation quadrat sample location (Figure 3-1 below) and of relevant design elements during other field efforts (see Appendix A).

Figure 1-2 Photo Monitoring Locations

2 Geomorphic and Structural Habitat Monitoring

2.1 Habitat Structures and Large Woody Debris

As part of restoration work completed in the project area, habitat structures were designed and installed. Such structures include both wood/debris that were placed in the engineered channel and the floodplain zones and debris wood/rock piles and engineered standing dead trees (snags) that were placed in the upland areas. Long-term monitoring performance measures per the Rinearson HDP include enumeration of engineered wood structures, by type, to verify structural retention and integrity over time.

Cardno refined the Rinearson HDP monitoring protocols for habitat structures and large woody debris (LWD) and modified monitoring protocols to distinguish between the (1) enumeration of wood, both engineered and natural, within the active floodplain and below the ordinary high water mark (OHWM) and (2) the enumeration of engineered debris wood piles and created snags in upland project areas, outside the active floodplain. This approach was favored in consideration of fluvial dynamics that can mobilize wood within the active floodplain zone versus wood located in upland areas that are most likely stationary over time. Cardno conducted the wood/habitat structure surveys on October 29, 2020, and November 23, 2020, noting that surveys were not conducted in August as presented in the Rinearson HDP because of the excessive head-high emergent vegetation present in late summer.

2.1.1 Structures and Large Woody Debris within the Active Channel Margin

The area within the floodplain zone includes stream channel sections at and below the OHWM, which is defined as the high water line where perennial vegetation becomes established. These areas can be periodically exposed to flood waters and water energy can mobilize and relocate woody debris and break down and destroy deposited wood. To evaluate this, Cardno adopted elements of the Timber Fish and Wildlife (TFW) Level 1 survey protocols for LWD (see Schuett-Hames et al. 1999). Cardno's protocol modifications included delineating existing dead wood as either (1) in contact with the water within the active channel, termed *Zone 1*, or (2) wood below the OHWM but not in contact with the water (at time of survey), termed *Zone 2*. Enumerated wood, by the zone criteria, had to be:

- Six feet or greater in length;
- Medium-sized pieces with a diameter of between 8 and 20 inches or large-sized pieces with a diameter of 20 inches or greater; or
- Rootwads, which are LWD pieces less than 6 feet in length and 8 inches or greater diameter with an attached rootwad bulb.

Woodpiles with 10 or more medium and/or large wood pieces were not encountered in the floodplain zone, so no debris jams were identified per the TFW survey criteria (Schuett-Hames et al. 1999). Wood counts, according to the above criteria, were delineated by engineered versus natural wood and general project areas. On-the-ground field surveys were conducted using the restoration site maps that depict types and locations of engineered habitat structures (and when applicable, referenced to as-built record drawing sheets). All engineered wood structures below the OHWM were present and accounted for; meander and floodplain channel log structures were all present, noting that a few structures had deteriorating crib braces.

Field observations noted prevalent beaver activity, foremost around the beaver pond outlet. The dam at the outlet of the beaver pond remains well maintained with active additions of small LWD (less than 8 inches in diameter), vegetation mats, and mud plugs. A second smaller beaver dam, composed of wood pieces less than 8 inches in diameter, had been created in August at the Meldrum Bar Channel inlet.

Beaver cuttings were prevalent throughout the project area floodplain. Wood survey counts are presented in Appendix B.

2.1.2 Upland Structures

Engineered wood structures in upland areas were surveyed for placed wood debris piles and engineered standing dead snag trees. TFW survey criteria detailed above were used to enumerate wood according to size, rootwad, and number of pieces present for a given debris wood pile. Tree snags (n = 8) were more difficult to verify because of the numerous natural snags present and the incursion of dense blackberry patches. Total wood counts for individual engineered debris wood piles are presented in Appendix B.

2.2 Active Channel Margin

Cardno staff took approximate measurements of the OHWM and ordinary low water mark during the 2020 monitoring survey; however, the Rinearson HDP states that the active channel margin area will only be measured in Year 10 of monitoring. Therefore, these measurement were not used to determine the total acreage of the active channel margin. The observations will be used in subsequent years to monitor changes to channel geometry and as a metric to assess habitat development. The 10 permanent monitoring cross sections that Cardno staff surveyed using survey-grade RTK GPS equipment (Figure 1-1) provided a first glance at how the restoration site has evolved since construction in 2018.

Because as-built channel cross sections were not made available, Cardno staff georeferenced the 100 percent design plans and used the contours and appropriate details to estimate proposed as-built design elevations at the surveyed sections. This method only allows for the design geometry to be plotted approximately and is subject to low precision because the georeferencing process was not exact, and the plans are limited to 1-foot design contours that may not reflect construction reality. While this method is not precise, it did allow for a comparison of survey results with baseline as-built conditions, assuming the project was constructed as designed. Cardno's 2020 surveyed cross sections were plotted against the estimated as-built cross sections to allow for easy comparison (see Appendix C). The 2020 survey data varied only slightly from the estimated as-built conditions for all cross sections, except cross section 6. The greatest difference in elevation between the 2020 survey data and the estimated as-built conditions at any station along cross section 6 was approximately 3.3 feet. This difference in elevation could be explained by one of the many beaver or nutria channels encountered during the 2020 survey.

As specified in the Rinearson HDP, sediment accretion stakes were installed in the historical Rinearson Creek and the Meldrum Bar channels (see Figure 1-1). The sediment accretion stakes were marked 2 feet above bed elevation to assist in monitoring future sediment accretion. Cardno staff observed some accretion, mostly fine sediment, in the historical Rinearson Creek channel while surveying cross sections 1 and 2. Approximately 3 inches of sand deposition was observed on river left of Meldrum Bar channel while surveying cross section 8. The roughened channel appeared to have 4 to 6 inches of fine sediment deposited at the connection to the Meldrum Bar channel (see Figure 2-1a), and an insubstantial amount of fine sediment deposition was observed during the survey of cross-section 3.

2.3 Fish Passage

The Rinearson HDP focuses on the remnant pond outlet, slope of the engineered channel, and water availability and depth to determine the measurement criteria for fish passage. The jump height of the remnant pond outlet was measured using a measuring tape from the top of the outlet to the downstream water surface. The measured jump height was approximately 1.6 feet, which greatly exceeds the maximum jump height of 6 inches specified in the Rinearson HDP (see Figure 2-1b). No clear jump pool was available in order for fish to have sufficient depth to make passage possible. The pond drained through a leaky earthen and woody debris dam directly into the roughened channel, and there was little observed flow concentration to a designed outlet or overtopping of the dam, which is the mechanism that would sustain a jump pool deep enough for fish passage.

a. Connection to Meldrum Bar Channel

b. Pond Outlet

c. Impassable Section 1

d. Impassable Section 2

Figure 2-1 Photos of Engineered Channel August 2020

As specified in the Rinearson HDP, survey-grade RTK GPS equipment was used to measure the water surface elevation (WSE) at the upstream and downstream ends of the engineered channel. During the 2020 survey, the engineered channel had an upstream WSE of 16.6 feet North American Vertical Datum of 1988 (NAVD88) and a downstream WSE of 9.3 feet NAVD88 (see Figure 2-2). The distance between these two WSE points was 242.9 feet; therefore, the WSE slope of the engineered channel was measured to be approximately 0.03 or 3 percent. The Rinearson HDP states that water availability would be assessed visually by observing the wetted area in the channel and the discharge over the pond outlet. During the 2020 survey, water discharge over the pond outlet was limited (see Figure 2-1b), and the wetted area within the engineered channel was inadequate for fish passage. Cardno staff observed that fish passage was obstructed by an excessive number of channel roughing boulders, which were stacked on top of one another in multiple sections of the engineered channel (see Figure 2-1c,d). This obstruction created a subsurface flow path for the creek where water went underneath and through the stacked rocks, eliminating the only viable pathway for fish ingress. Cardno staff believes this issue could be resolved if some of the roughening boulders were moved by hand to the outside extents of the channel and were re-configured to create a narrow low-flow thalweg that is not obstructed by stacked rocks.

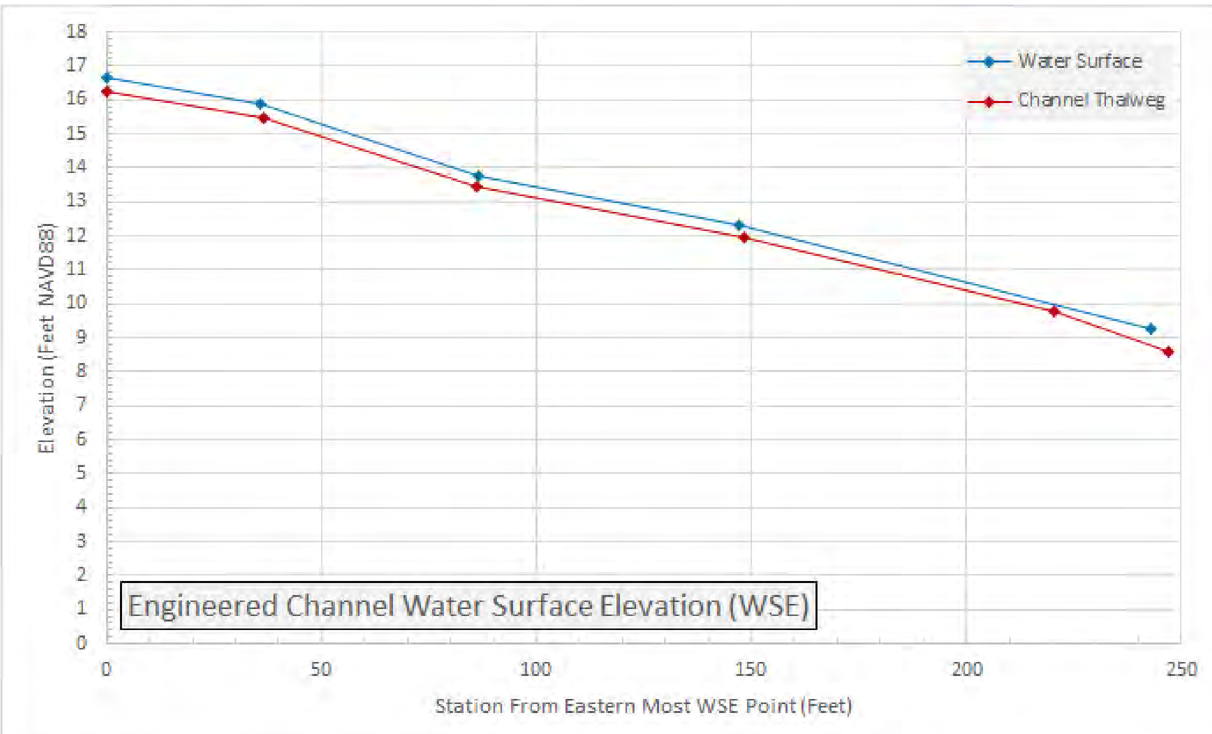

Figure 2-2 Engineered Channel Water Surface Elevation and Channel Thalweg from 2020 Survey

Cardno staff determined that the engineered channel was impassable for fish in August 2020 because (1) the fish jump height exceeded the limit by approximately 13 inches, (2) there was no clear jump pool at the pond outlet, and (3) the roughened channel had low water availability and was blocked by boulders in multiple locations. Cardno recommends adaptive management actions to address these fish passage limitations if and only if passage in late summer were deemed essential. High summer pond temperatures may be a factor, refer to subsequent water quality section.

During the 2020 survey, Cardno staff surveyed a cross section of the pond with survey-grade RTK GPS equipment (see Appendix C). However, analysis of remnant pond hydrology was not completed because of the lack of WSE data for the pond.

3 Vegetation Monitoring

All vegetation sampling sites were chosen using recreation-grade GPS equipment to ensure that sampling occurred along the established vegetation sub-transects (see Figure 3-1). Cardno staff made an effort to select random locations along each sub-transect by choosing an arbitrary number of steps to walk between each sampling location. Wherever that number of steps took Cardno surveyors along the transect is where the next vegetation quadrat was established. All sampling quadrats were established using a measuring tape, rope, and stakes to ensure consistent dimensions. The Rinearson HDP states that species richness and diversity needed to be determined for each sample. Species richness for each sample was determined by counting the number of species present at each sampling site. The method required to represent diversity was not specified in the Rinearson HDP, so Cardno staff determined that the Shannon Diversity Index would be an appropriate metric to represent diversity in this sampling effort (Morris et al. 2014). Cardno's full dataset of species count, percent cover, and locations are available in Appendix D.

3.1 Emergent Marsh

During the 2020 survey, Cardno staff sampled 7 quadrats in the emergent marsh habitat, fewer than the 10 quadrats specified in the Rinearson HDP, but it was the maximum number that could be completed during the allocated survey time. Recreation-grade GPS equipment was used to ensure that sampling occurred along the vegetation sub-transects (see Figure 3-1). Once a location was chosen a 1-square meter (m^2) quadrat was marked with stakes and rope. Once the quadrat was in place, Cardno staff determined the community composition and percent cover of each species through visual cover estimates (see Appendix D). The emergent marsh sampling resulted in a mean species richness of 3.57, mean diversity index of 0.81, mean invasive percent cover of 61.43 percent, and a mean number of invasive species of 2.43 (Table 3-1). Invasive species identified in the emergent marsh included field morning-glory (*Convolvulus arvensis*), Himalayan blackberry (*Rubus armeniacus*), reed canary grass (*Phalaris arundinacea*), Canada thistle (*Cirsium arvense*), birds foot trefoil (*Lotus corniculatus*), spotted jewelweed (*Impatiens capensis*), and yellow flag iris (*Iris pseudacorus*). Spotted jewelweed was the dominant species throughout the emergent marsh area and formed a tall and dense monoculture in much of the meander channel and off channel wetlands.

Figure 3-1 Vegetation Monitoring Quadrat Locations

Table 3-1 Emergent Marsh Vegetation Sampling Summary

Quadrat No.	Species Richness	Diversity (Shannon Diversity Index)	Invasive Percent Cover (%)	Number of Invasive Species
1	3	0.80	20	1
2	2	0.33	10	1
3	6	1.29	40	4
4	4	0.97	100	4
5	6	1.28	60	3
6	1	0.00	100	1
7	3	1.03	100	3
Sample Mean	3.57	0.81	61.43	2.43
Sample Standard Deviation	1.90	0.49	39.34	1.40
80% Confidence Interval for Population Mean	--	--	**61.43 ± 21.41**	--

3.2 Riparian Forest Restoration Area

Vegetation monitoring in the riparian forest restoration area involved establishing 2 different quadrats at each sampling location. The sampling sites were chosen using recreation-grade GPS equipment to sample along the vegetation sub-transects. At each site, a 2-meter × 10-meter quadrat was set up using a measuring tape, rope, and stakes. All living woody native and non-native stems were counted and identified within the large quadrat. A smaller 1-m^2 quadrat was set up within the first large quadrat at each site. The percent cover of herbaceous non-native and invasive species was determined through visual cover estimates within the small quadrat. The total stem count for each species within each large quadrat was divided by the total area sampled to calculate density (see Appendix D). Woody native species were observed in all locations where this vegetation zone was sampled, and shrub planting appeared to have a relatively high success rate in most locations. Dense stands or willow and redosier dogwood (*Cornus sericea*) were observed in many of the planting locations.

Only 6 forest restoration quadrats were sampled during the 2020 survey, less than the minimum of 15 quadrats stated in the Rinearson HDP for Year 2 (see Figure 3-1). The sampling of the herbaceous 1-m^2 quadrats in the forest restoration area resulted in a mean species richness of 2.17, mean diversity index of 0.48, mean invasive percent cover of 59 percent, and a mean number of invasive species of 1.5 (Table 3-2). The invasive species that were identified in the forest restoration area included pennyroyal (*Mentha pulegium*), spotted jewelweed, reed canary grass, and red clover (*Trifolium pretense*). The sampling of the woody 2-meter ×10-meter quadrats resulted in a mean species richness of 3.17, mean diversity index of 0.82, mean stem count of 35.5, and a mean density of 1.78 stems per square meter (Table 3-3). The native woody stem species that were identified while surveying this area included redosier dogwood, Columbia river willow (*Salix exigua* var. *Columbiana*), rigid willow (*Salix rigida* var. *macrogemma*), Sitka willow (*Salix sitchensis*), Pacific willow (*Salix lucida* ssp. *Lasiandra*), red alder (*Alnus rubra*), Douglas spirea (*Spiraea douglasii*), and black twinberry (*Lonicera involucrate*).

Table 3-2 Riparian Forest Restoration Area Herbaceous Vegetation Sampling Summary

Quadrat No.	Species Richness	Diversity (Shannon Diversity Index)	Invasive Percent Cover (%)	Number of Invasive Species
1	1	0.18	80	1
2	3	0.47	10	1
3	1	0.23	10	1
4	3	1.05	100	3
5	1	0.00	100	1
6	4	0.96	55	2
Sample Mean	2.17	0.48	59.17	1.50
Sample Standard Deviation	1.33	0.43	41.52	0.84
80% Confidence Interval for Population Mean	--	--	**59.17 ± 25.02**	--

Table 3-3 Riparian Forest Restoration Area Woody Vegetation Sampling Summary

Quadrat No.	Species Richness	Diversity (Shannon Diversity Index)	Total Stem Count	Total Density (stems/m²)
1	3.00	0.63	48.00	2.40
2	3.00	0.76	58.00	2.90
3	3.00	0.76	61.00	3.05
4	3.00	0.95	5.00	0.25
5	2.00	0.49	21.00	1.05
6	5.00	1.33	20.00	1.00
Sample Mean	3.17	0.82	35.50	1.78
Sample Standard Deviation	0.98	0.29	23.21	1.16
80% Confidence Interval for Population Mean	--	--	--	**1.78 ± 0.70**

3.3 Riparian Forest Enhancement Area

Cardno staff monitored the riparian forest enhancement area for invasive species using the same quadrat methodology as the emergent marsh. Eight forest enhancement quadrats were sampled during the survey, less than the minimum of 15 quadrats stated in the Rinearson HDP for Year 2. The forest enhancement area monitoring revealed a mean species richness of 3.63, mean diversity index of 0.74, mean invasive percent cover of 59 percent, and a mean number of invasive species of 2.38 (Table 3-4). The invasive species identified in this area included reed canary grass, pennyroyal, red clover, Himalayan blackberry, common mullein *(Verbascum thapsus*), bitter dock (*Rumex obtusifolius*), English ivy (*Hedera helix*), oxeye daisy (*Leucanthemum vulgare*), climbing bindweed (*Polygonum convolvulus*), teasel (*Dipsacus fullonum*), and Canada thistle (*Cirsium arvense*).

Table 3-4 Riparian Forest Enhancement Area Vegetation Sampling Summary

Quadrat No.	Species Richness	Diversity (Shannon Diversity Index)	Invasive percent cover (%)	Number of invasive species
1	10.00	2.14	75	6.00
2	5.00	1.29	45	3.00
3	1.00	0.09	0	0.00
4	2.00	0.33	100	2.00
5	4.00	0.75	10	2.00
6	4.00	0.98	40	3.00
7	2.00	0.33	100	2.00
8	1.00	0.00	100	1.00
Sample Mean	3.63	0.74	58.75	2.38
Sample Standard Deviation	2.97	0.72	40.95	1.77
80% Confidence Interval for Population Mean	--	--	**58.75 ± 20.49**	--

3.4 Upland / Riparian Forest Invasive Management Area

Table 6 in the Rinearson HDP states that 1-m^2 quadrats will be used for the riparian forest invasive management area, but Section 6.5.4 in the Rinearson HDP states that the line intercept method should be used. Because the Rinearson HDP has conflicting methods, Cardno staff chose to use 1-m^2 quadrat methodology for the 2020 survey for consistency across vegetation types. Eight quadrats were sampled in the riparian forest invasive management area during the 2020 survey, and a minimum number of quadrats was not specified within the Rinearson HDP for Year 2. Surveying the forest invasive area resulted in a mean species richness of 1.88, mean diversity index of 0.41, mean invasive percent cover of 20 percent, and a mean number of invasive species of 1.63 (Table 3-5). The invasive species that were identified while surveying this area included English ivy, herb-Robert (*Geranium robertianum*), Himalayan blackberry, false brome (*Brachypodium sylvaticum*), reed canary grass, and English holly (*Ilex aquifolium*).

Table 3-5 Riparian Forest Invasive Area Vegetation Sampling Summary

Quadrat No.	Species Richness	Diversity (Shannon Diversity Index)	Invasive percent cover (%)	Number of invasive species
1	2	0.55	30	2
2	2	0.30	10	2
3	1	0.23	10	1
4	1	0.18	0	0
5	3	0.66	25	2
6	2	0.47	25	2
7	2	0.60	50	2
8	2	0.30	10	2
Sample Mean	1.88	0.41	20.00	1.63
Sample Standard Deviation	0.64	0.18	15.81	0.74
80% Confidence Interval for Population Mean	--	--	**20.00 ± 7.91**	--

3.5 Statistical Analyses

Random sampling was accomplished during the 2020 survey by placing sampling plots systematically along the transects starting at a random point. As stated in the Rinearson HDP, 80 percent confidence intervals were calculated for the mean invasive percent cover for each herbaceous quadrat. These confidence intervals resulted in half widths ranging from 25.0 to 7.9 percent (see Tables 3-1, 3-2, 3-4, and 3-5). An 80 percent confidence interval with a half width of 0.70 was also calculated for total stem density (stems/m^2) in the forest restoration area (see Table 3-3). These confidence intervals were calculated using the confidence interval for a population mean procedure outlined in Appendix 8 of *Measuring & Monitoring Plant Populations* referenced in the Rinearson HDP (Elzinga et al. 1998).

$$n = \frac{(Z_{\alpha})^2 (p)(q)}{d^2}$$

Equation 1 Uncorrected Sample Size Equation from Final HDP

Cardno staff completed a statistical assessment to determine the ideal future sampling size. Cardno staff used the equation for uncorrected sample size in the statistical analysis section of the Rinearson HDP to calculate the number of quadrats necessary to achieve a confidence interval half width of 5 percent, 10 percent, and 15 percent for each vegetation area (Equation 1). In the Rinearson HDP, the variable $Z\alpha$ is defined as the standard normal coefficient and the value 1.28 for an 80 percent confidence interval was given. The variable p is defined as the value of the proportion as a decimal percent, the proportion in this case being mean invasive percent cover for each vegetation zone. The variable q is defined as $1-p$, which was calculated using the values determined for p. The variable d is defined as the precision level or confidence interval half width. The values 0.05, 0.1, and 0.15 were used for d to calculate the sample size necessary for confidence interval half widths of 5 percent, 10 percent, and 15 percent, respectively (Equation 1). The Rinearson HDP specifies that the sample size should be chosen in subsequent years so that the reported mean falls within a confidence interval width of 10 percent (d=0.05). Using this methodology, the results suggest that a sample size of greater than 100 quadrats for each vegetation type would be needed to achieve this precision (Table 3-6). Achieving this precision would be costly, time consuming, and not necessarily more insightful than a sampling protocol with a slightly higher margin of error. Therefore, Cardno staff suggest that the confidence interval width be revised to a half width of 15 percent (*d*=0.15) because this margin of error produces a sample size requirement that is reasonable for future monitoring survey efforts.

Table 3-6 Sample Size Estimations for Different Interval Half Widths

80% Confidence Interval Half Width (%)	Emergent Marsh Sample Size Estimate	Forest Restoration Sample Size Estimate	Forest Enhancement Sample Size Estimate	Forest Invasive Sample Size Estimate
5	155	158	159	105
10	39	40	40	26
15	**17**	**18**	**18**	**12**

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4 Fish and Wildlife Monitoring

4.1 Fish Beach Seining

The restoration monitoring protocol involves bi-weekly (twice a month) sampling for fish presence and abundances beginning in February through May. As presented in the Rinearson HDP, fish sampling is to be conducted using beach seine methods and, if applicable, direct observation snorkel methods. Suitable seining sites were initially identified in February and include seven established sites for repeat sampling (Figure 4-1). Beach seine sites (BSS) were distributed throughout the project area to represent four general habitat strata: Willamette River (BSS 1 and BSS 2), lower Rinearson Creek confluence pool (BSS 3), beaver pond (BSS 4 through BSS 6), and the upper marsh channel complex (BSS 7) (see Figure 4-1).

4.1.1 Beach Seine Sampling

Seine sampling was conducted using a 50-foot-long × 6-foot-deep beach seine net with 0.25-inch mesh netting. On a given day, a seine site was sampled once. The seine area was coarsely approximated for each beach seine sample haul. Captured fish were recorded according to species, total abundance, and a sub-set of fish sampled for fish lengths. This annual report does not provide analyses on fish densities. On a given sample day, not all seven sites were beach seine sampled either because of unfavorable conditions, such as changes in water depth, or monitoring protocols that require the cessation of seine sampling if fish listed under the Endangered Species Act (ESA) were captured. Seine sites were not sampled in the second of March and first half of April because of COVID-19 pandemic restrictions.

Over six sample-day events between February and May, a total of 27 beach seine hauls were conducted throughout the seven established seine sites (Table 4-1) (see Figure 4-1). In total, 14 different species of fish were captured, of which 10 fish species were native to the region and the remaining 4 fish species introduced, non-native species (Table 4-2). Besides fish species, signal crayfish and one non-native American bull frog were also identified in seine haul captures. A grand total of 366 fish were captured using beach seine methods with approximately half of all fish captured composed of juvenile Chinook salmon, an ESA-listed species (Table 4-3). Juvenile Chinook salmon were captured in the Meldrum Bar Channel (BSS 2) and in the beaver pond near the pond outlet (BSS 4) with approximately 95 percent of all Chinook captured during March and April sample days. Considering the additional ESA-listed species caught, 1 juvenile coho salmon was captured during February sampling in the beaver pond (BSS 4). In order of total abundance caught, following Chinook salmon, threespine stickleback, juvenile bluegill (non-native) and juvenile northern pikeminnow were the most abundant in total fish caught (Table 4-3). Summary statistics for size of fish captured are presented in Table 4-4 with common carp (non-native species) being the largest fish captured in all beach seine samples. While further examination of fish life history traits is warranted, captured species, such as salmonids, bluegill and northern pikeminnow, were all juveniles, whereas sculpin, speckled dace and threespine stickleback were likely a combination of both juveniles and adults.

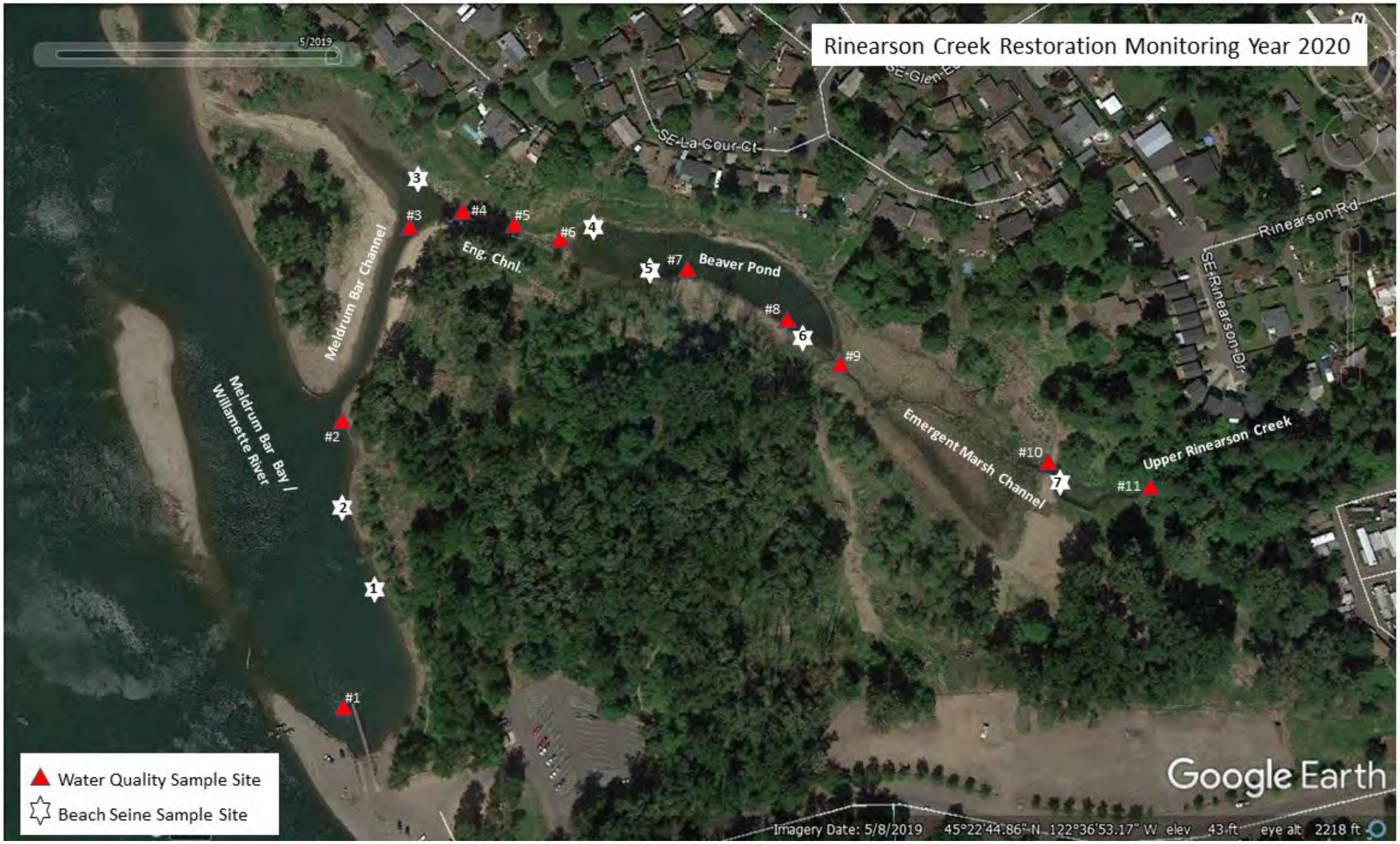

Figure 4-1 Approximate Sample Site Locations for Water Quality Monitoring and Fish Beach Seine Sampling for the Rinearson Creek Restoration Monitoring Plan, Year 2020

Table 4-1 Locations by Survey Date for Beach Seine Sampling throughout the Rinearson Creek Restoration Project Site.

Sample Date	Beach Seine Site (BSS)						
	BSS 1	BSS 2	BSS 3	BSS 4	BSS 5	BSS 6	BSS 7
February 10	X	X	X	X	X	X	X
February 24	X	X	X	X	X	X	
March 13	X	X					
April 24	X	X	X	X			
May 8		X		X	X	X	
May 26	X	X	X	X			

Note: Beach seine sites are numbered sequentially moving upstream; refer to Figure 1-1 for seine site locations.

Table 4-2 Fish and other Aquatic Species Caught using Beach Seine Methods throughout the Rinearson Creek Restoration Project Site in February and May 2020

Common Name	Scientific Name
American Bullfrog*	*Lithobates catesbeianus*
Banded Killifish	*Fundulus diaphanus*
Bluegill*	*Lepomis macrochirus*
Chinook Salmon	*Oncorhynchus tschawytscha*
Chiselmouth	*Acrocheilus alutaceus*
Coho Salmon	*Oncorhynchus kisutch*
Common Carp*	*Cyprinus carpio*
Largescale Sucker	*Catostomus macrocheilus*
Northern Pikeminnow	*Ptychocheilus oregonensis*
Oriental Weatherfish*	*Misgurnus anguillicaudatus*
Prickly Sculpin	*Cottus asper*
Reticulate Sculpin	*Cottus perplexus*
Signal Crayfish	*Pacifastacus leniusculus*
Speckled Dace	*Rhinichthys osculus*
Tadpole	--
Threespine Stickleback	*Gasterosteus aculeatus*

* Introduced non-native species

Table 4-3 Summary Catch Statistics for Number of Fish (and Other Aquatic Species) Captured using Beach Seine Methods

Fish Species	Beach Seine Site (BSS)							Grand Total
	BSS 1	BSS 2	BSS 3	BSS 4	BSS 5	BSS 6	BSS 7	
Banded Killifish	--	1	4	--	--	--	--	**5**
American Bullfrog*	--	--	--	1	--	--	--	**1**
Bluegill*	--	--	4	16	28	1	--	**49**
Chinook Salmon	--	156	--	35	--	--	--	**191**
Chiselmouth	--	2	--	1	--	--	--	**3**
Coho Salmon	--	--	--	1	--	--	--	**1**
Common Carp*	--	--	1	--	--	--	1	**2**
Largescale Sucker	--	1	--	--	--	--	--	**1**
Northern Pikeminnow	--	16	--	--	3	--	1	**20**
Oriental weatherfish*	--	--	--	--	--	1	--	**1**
Prickly Sculpin	1	--	--	--	1	1	2	**5**
Reticulate Sculpin	--	--	--	--	1	--	4	**5**
Signal Crayfish	--	1	--	--	--	1	--	**2**
Speckled Dace	--	1	--	1	--	--	--	**2**
Tadpole	--	--	--	2	1	--	--	**3**
Threespine Stickleback	5	--	--	22	15	9	30	**81**
Grand Total	**6**	**178**	**9**	**79**	**49**	**13**	**38**	**372**

Note: Values reflect total catch over six days of sampling between February and May of 2020 (see Table 4-1 for sample locations by sample day). Beach seine sites are numbered sequentially moving upstream, refer to Figure 1-1 for seine site locations.

* Introduced non-native species

Table 4-4 Summary Statistics for Size of Fish Captured using Beach Seine Methods

Fish Species	Fish Fork Length			
	Average (mm)	Minimum (mm)	Maximum (mm)	Standard Deviation (mm)
Bluegill*	25	15	42	5
Chinook Salmon	52	35	105	13
Chiselmouth	38	35	42	--
Coho	98	--	--	--
Common Carp*	226	146	305	--
Largescale Sucker	55	--	--	--
Northern Pikeminnow	42	28	132	22
Oriental weatherfish*	105	--	--	--
Reticulate Sculpin	51	40	62	9
Speckled Dace	40	32	48	--
Threespine Stickleback	30	13	58	10

Note: -- indicates only one individual fish was caught.

* Introduced non-native species

4.1.2 Direct Observation Snorkel Diver Fish Counts

Monitoring protocols also require direct observation fish counts using snorkel diver methods above the remnant (beaver) pond, given suitable conditions. The project area above the beaver pond can be generically characterized, moving upstream, as (1) narrow, braided wetland marsh channels, turning in to (2) a more defined creek channel with two larger pool areas. Throughout the upper reach, channel substrate is predominantly porous mud-silt. Trial snorkel diver fish counts were conducted in late January and early February during which it was determined that poor underwater visibility would prevent effective snorkel fish count surveys. Poor underwater visibility throughout the fish sampling period prevented snorkel surveys. Based on the field experiences, Cardno staff question the effective application of snorkel diver counts for determining fish presence and abundance.

4.2 Breeding Birds

The Avian Use Survey used the point count protocol that was used in the *Rinearson Natural Area Baseline Monitoring Report* (Runyon 2016). Fifteen point count stations were used—eight in riparian habitat and seven in upland forest habitat. The surveys were performed on May 31, 2020, in order to capture peak breeding season. Each point count station was monitored for 5 minutes and bird species that were visually and audibly observed were recorded. Direction of flight or position were recorded. Birds that were beyond 50 meters were not recorded in order to minimize the risk of recounting birds.

The results for the avian use survey are summarized in Table 1 below for all point count stations. The Table illustrates the number of each species seen at each point count station as well as the location seen. Points 1, 2, 8, 9, 13, 14, and 15 are all upland points. Points 3, 4, 5, 6, 7 10, 11, and 12 are all riparian points. A breeding bird nest was observed at point 2 in an upland area. Field data notes are presented in Appendix E.

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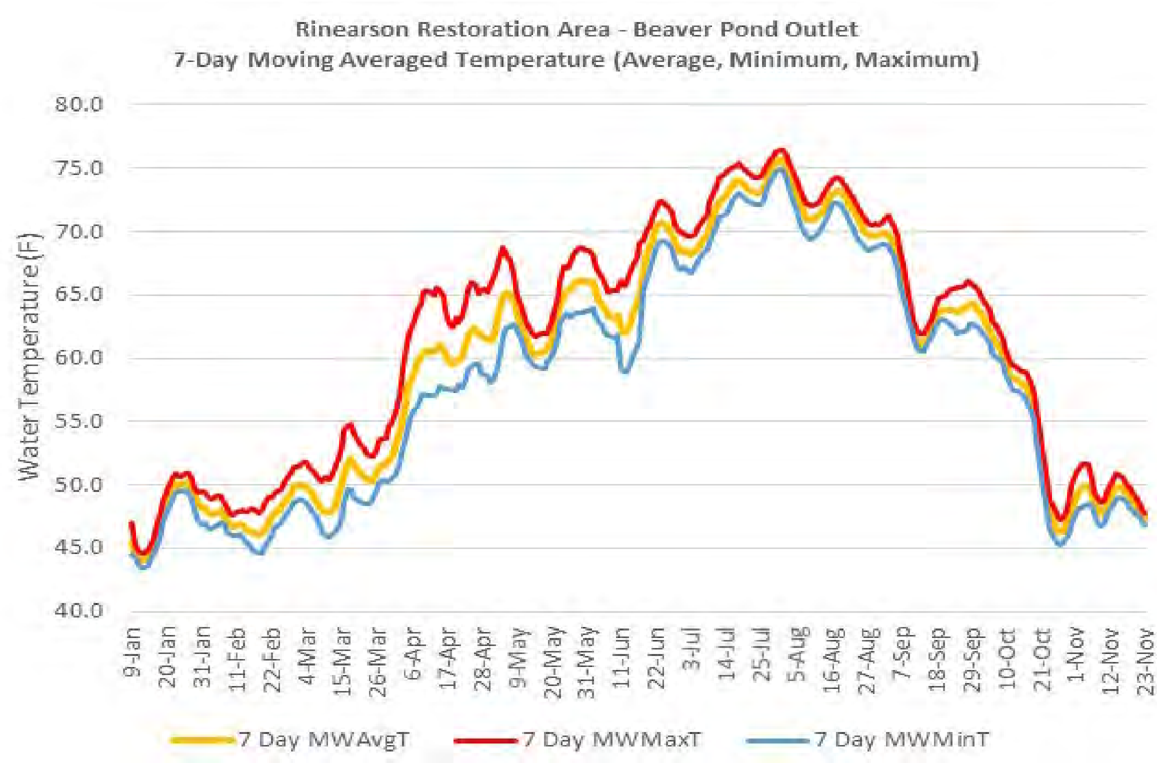
5 Water Quality Monitoring

5.1 Continuous Water Temperature Monitoring

Project monitoring protocols require continuous water temperature monitoring within the site beaver pond (near the outlet) and collecting monthly samples at a suite of representative sites throughout the project area. Long-term temperatures at the beaver pond outlet were determined using redundant temperature data loggers. Data loggers were programmed to collect water temperature at 15-minute intervals and were established just above the beaver pond outlet, approximately 1.5 feet above the pond bottom and roughly 2 to 3 feet below the pond surface, depending upon seasonal fluctuation.

Analysis of continuous long-term water temperatures within the beaver pond involved calculating the 7-day moving (weekly) temperature values. Using this approach, derived metrics reflect daily values over a running 7-day consecutive period; in other words, for a given day, it is the highest single value of the 7-day moving temperature (e.g., average, minimum, or maximum temperatures). Using this approach, Cardno staff evaluated overall averaged daily water temperatures in relation to observed minimum and maximum water temperatures (Figure 5-1). Observed temperatures exhibited seasonal trends and variability with the coldest temperatures (~45 degrees Fahrenheit [˚F]) observed in January and the warmest temperatures in July/August (~75 ˚F). Water temperature data show a steep increase in April with a corresponding steep decrease in October. Overall, there were relatively small differences between calculated daily minimum and maximum water temperatures, with such differences being most pronounced in April through mid-May. Minimum and maximum trend data closely reflect trend lines for overall averaged daily water temperature.



Note: Trend lines show calculated 7-day moving temperatures for averaged minimum, maximum and daily average

Figure 5-1 Recorded Continuous Water Temperature (using 15-minute intervals) in the Rinearson Beaver Pond near the Outlet, Year 2020

5.2 Monthly Water Quality Surveys

Project monitoring protocols require once a month sampling of water quality parameters that include temperature, dissolved oxygen (DO), pH, and conductivity. Water quality characteristic were determined using a handheld field multi-parameter meter. A total of 11 sites were established throughout the project area for repeated sampling and long-term monitoring (Figure 1-1). No sampling occurred in March because of the safety precautions due to the COVID-19 pandemic. All water quality field sampling was conducted between the hours of 9:00 a.m. to 2:00 p.m. Each sample day, water quality monitoring began at the Meldrum Bar boat ramp and proceeded upstream into Rinearson Creek. Using the site naming convention, water quality station (WQS) 1 is located in the Meldrum Bar channel as part of the Willamette River, WQS 2 is the outlet confluence of Rinearson Creek, WQS 3 through WQS 5 are located in the lower restoration segment of Rinearson Creek, WQS 6 through WQS 8 are within the beaver pond and WQS 9 through WQS 11 are above the beaver pond in the marsh meadow wetland complex of the restoration project area (see Figure 1-1). Thus, water quality results can be generically interpreted as follows:

- Willamette River,
- Lower Rinearson Creek (restoration) channel,
- Beaver pond, and
- Upper wetland channel complex.

5.2.1 Monthly Water Temperature

Stream temperatures, by month, throughout the project area exhibited typical seasonal variability with the warmest temperatures (~75˚F) occurring from July through August, and the coolest temperatures from November through February (Figures 5-2). Considering variability between sampling sites throughout the project area, recorded temperatures were consistently higher in the engineered channel and beaver pond during some months, although this trend was inconsistent across months. Temperature trends were variable and somewhat inconsistent between months and between sample locations.

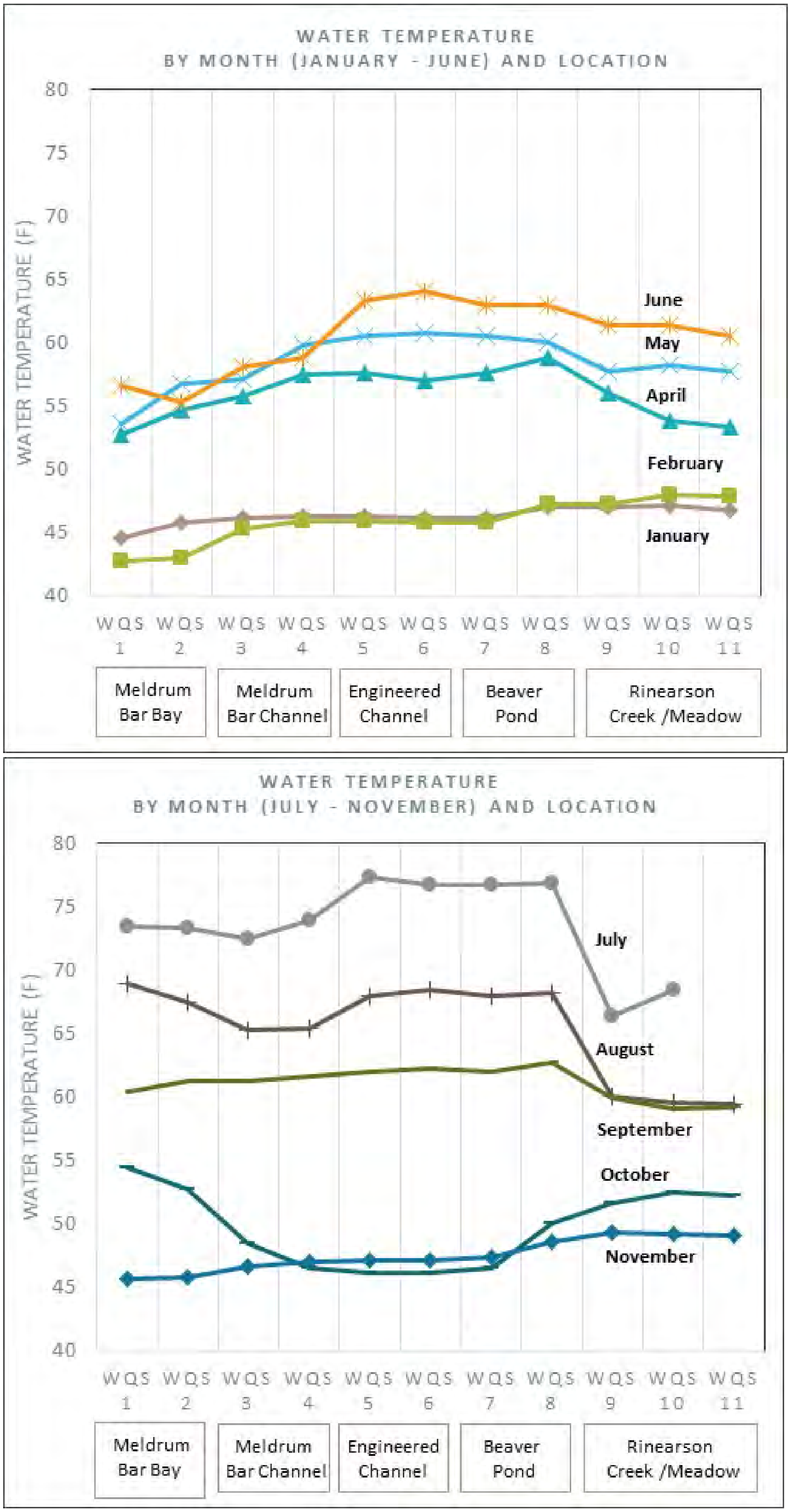


Figure 5-2 Field Meter Recordings for Water Temperature Respective of Month and Water Quality Station, Year 2020

5.2.2 Monthly Water Dissolved Oxygen

Monthly field readings for dissolved oxygen (DO milligrams per liter [mg/L]) show considerable variability between both months and sample sites (Figure 5-3). In general and overall, typical DO values ranged from 8 to 12 mg/L, although peak DO values were observed as high as ~17 mg/L in June and as low as 4 mg/L in July. General trends in low DO readings (typically less than 8 DO mg/L) occurred from July through October, whereas DO readings often exceeded 12 mg/L occurred in April and June. Collectively, DO readings across the year showed less variability (between sites) in the meadow wetland portion of the study area (WQS 9 through WQS 11).

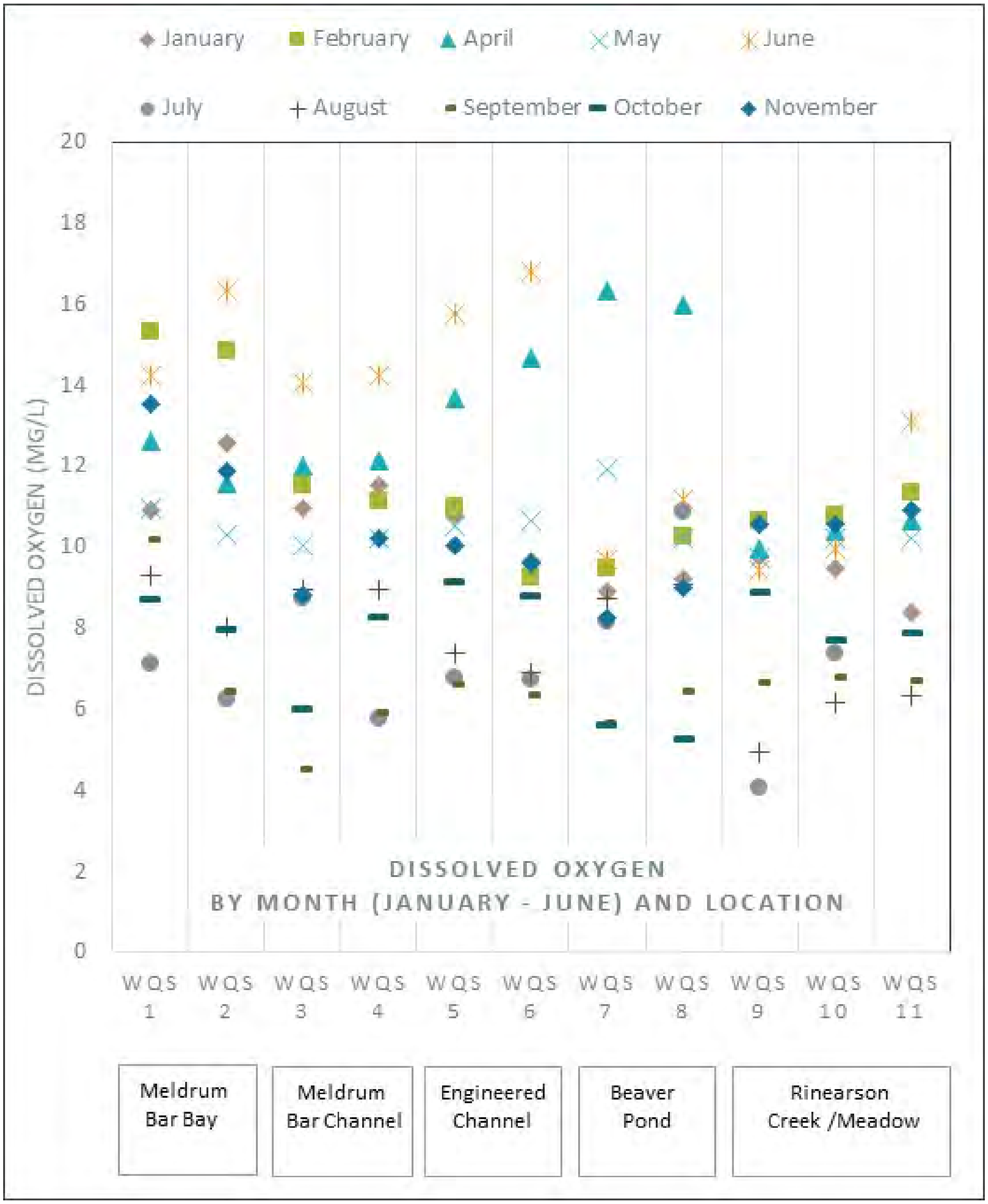


Figure 5-3 Field Meter Recordings for Water Dissolved Oxygen (DO mg/L) by Month and Water Quality Station, Year 2020

5.2.3 Monthly Water pH

Monthly field readings for water pH were relatively consistent between months and sample site. The majority of recorded water pH readings ranged between a pH of 6 to 8 (Figure 5-4) with the highest water pH of 10 and lowest pH of 3 both observed at WQS 1, the Meldrum Bar boat launch (i.e., Willamette River).. Water pH recordings at this site may be influenced by human waste and hydrocarbons associated with motorized watercraft use.

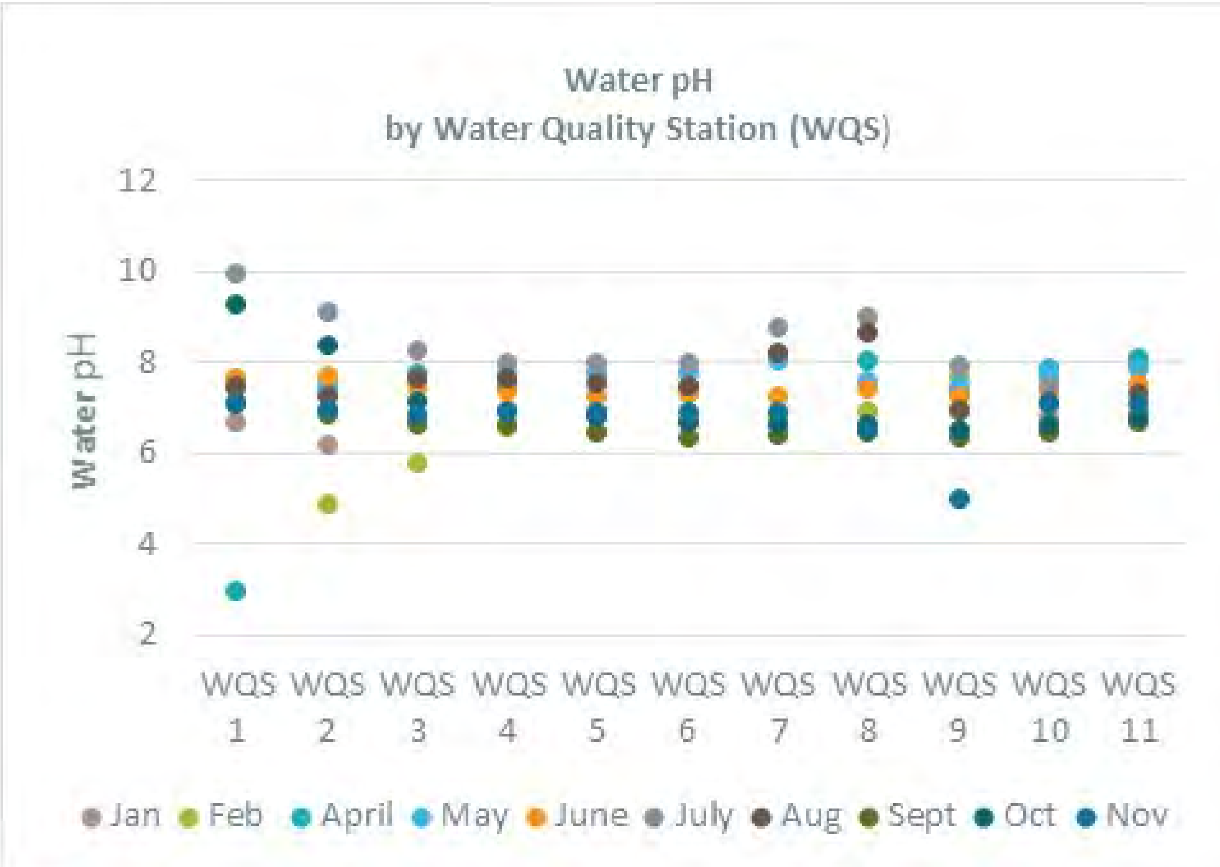
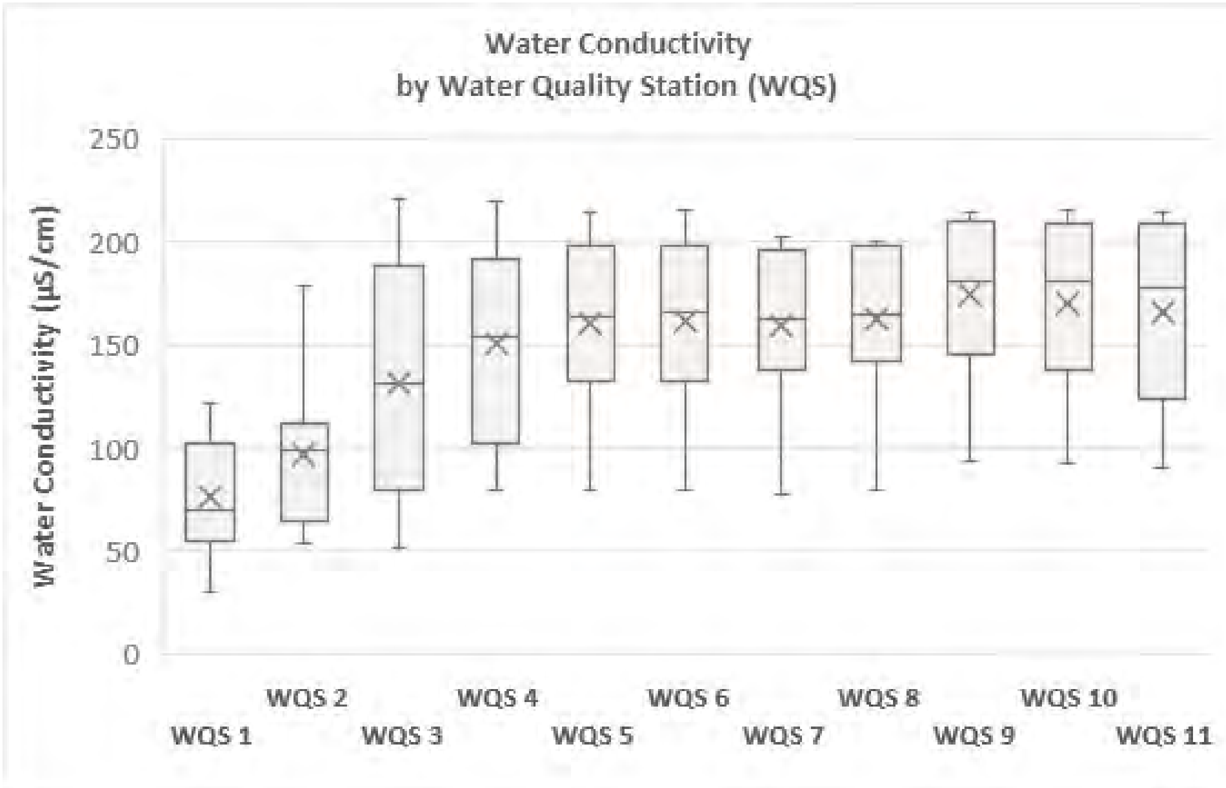


Figure 5-4 Field Meter Recordings for Water pH Respective of Month and Water Quality Station, Year 2020

5.3 Monthly Water Conductivity

Water conductivity, evaluated as microsiemens per centimeter (μS/cm), is a measure of the ability of water to pass an electrical current. Conductivity in water is affected by the presence of inorganic dissolved solids such as chloride, nitrate, sulfate and phosphate. Overall, conductivity is useful as a general measure of stream water quality. Monthly field sampling for water conductivity throughout the project area show consistent values ranging between 100 and 200 μS/cm. Readings rarely exceeded 200 μS/cm with a general conductivity average around 150 μS/cm (Figure 5-5). The lowest conductivity readings (less than 100 μS/cm) were consistently observed at the Meldrum Bar sample sites (WQS 1 and WQS 2). Studies generally indicate that freshwater streams that support healthy populations of freshwater fish have conductivities in the range of 150 to 500 μS/cm.



Note: Average is indicated by “X”; median value is indicated by horizontal line inside the shaded box area, the ends of the box are the upper and lower quartile, and the whiskers are the two lines outside the box that extend to the highest and lowest observations.

Figure 5-5 Field Meter Recordings for Water Conductivity (µS/cm) Respective of Month and Water Quality Station, Year 2020

6 Benthos Monitoring

Monitoring methods for the benthic macroinvertebrate community at the project site were developed with guidance from a sub-group of the Portland Harbor Restoration Committee, Oregon Department of Environmental Quality's (ODEQ's) *Water Monitoring and Assessment Mode of Operations Manual* (ODEQ 2009), the *Water Quality Monitoring Technical Guide Book* (Oregon Watershed Enhancement Board [OWEB] 1999), and The Xerces Society in Portland, Oregon. In accordance with Trustee guidance, a Level 3 protocol was used at the site to provide the best measure of stream condition using macroinvertebrates as the indicator.

Sampling locations for benthic macroinvertebrates were selected according to habitat strata type (sample reaches). Four strata were identified for purposes of benthos samples:

- the constructed engineered (riffle) channel downstream of the beaver pond,
- along the beaver pond edges,
- in the emergent marsh area upstream of the beaver pond, and
- furthermost upstream of the project area in an intact section of Rinearson Creek (to be treated as the reference reach) (see Figure 4-1).

The Rinearson HDP calls for benthos sample locations to be geo-referenced according to prior established transect and sub-transect cross-point locations. At the time of survey Cardno could not locate nor verify where or if the transects had been established (see Section 1.1 of this report). Given this, Cardno biologists selected sample areas most representative of unique sample reaches in accordance with methods detailed in the Rinearson HDP and additional resources clarifying field methods (Adams 2005; Hayslip 2007; ODEQ 2009; OWEB 1999).

We sampled for benthic macroinvertebrates, on May 19 of 2020, according to monitoring protocols detailed in the Rinearson HDP. Composite samples for each reach-strata were collected according to differing field protocols for 1) stream tributary reaches being reaches below the beaver pond and the uppermost reference reach of Rinearson Creek, versus 2) emergent marsh wetland and pond fringe reach-strata type. Samples collected by Cardno were properly preserved and delivered to Aquatic Biology Associates (Corvallis, Oregon) in June of 2020 for further analysis and reporting.

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7 Adaptive Management

7.1 2020 Adaptive Management

Appendix F contains a list of adaptive management activities that were implemented in 2020 (Year 2). Invasive species management continues, and Appendix F presents a detailed list of managed species and removal counts. Additionally, during the week of November 9, 2020, contractors sprayed and hand pulled weeds.

The Columbia Restoration Group will continue to use a combination of herbicide, manual, and mechanical treatment, depending upon the target species and location, and will evaluate whether vegetative growth on the beaver dam at the pond outlet is native or non-native. If non-native, the Columbia Restoration Group will manually remove non-native species. The Columbia Restoration Group has not and will not access northern areas of the site to avoid unnecessarily disturbing plantings and aquatic habitat.

The Columbia Restoration Group has agreed with the Trustees Council that the beaver dams will not be disturbed in any way and the site will be observed for any changes to beaver dam locations by private landowners or others. The Columbia Restoration Group continues to remove and dispose of any remaining erosion control netting as it is encountered on the site.

7.2 2021 Adaptive Management

The Columbia Restoration Group, in conversation with the Trustee Council and Susan Barnes with the Oregon Department of Fish and Wildlife, has developed the following adaptive management plan for the turtle habitat located within the boundary of the Rinearson Natural Area.

In 2021, the Columbia Restoration Group will clear the historical nesting areas (shown on Figure 7-1) of all brush and native plantings to the dirt and will continue to ensure they remain clear from future growth. This clearing will occur prior to the turtle nesting season.

In addition to clearing and maintaining the nesting areas, while onsite for other management activities, the Columbia Restoration Group or contractors will place woody structures (i.e., fallen limbs) on the north bank of the pond for basking structures for the turtles. This is not a permanent fix because these structures will likely float away during any flooding event. The Columbia Restoration Group will enlist assistance from the neighboring home owners association and others who frequent the site to assist in ensuring that woody structures are in place for turtles.

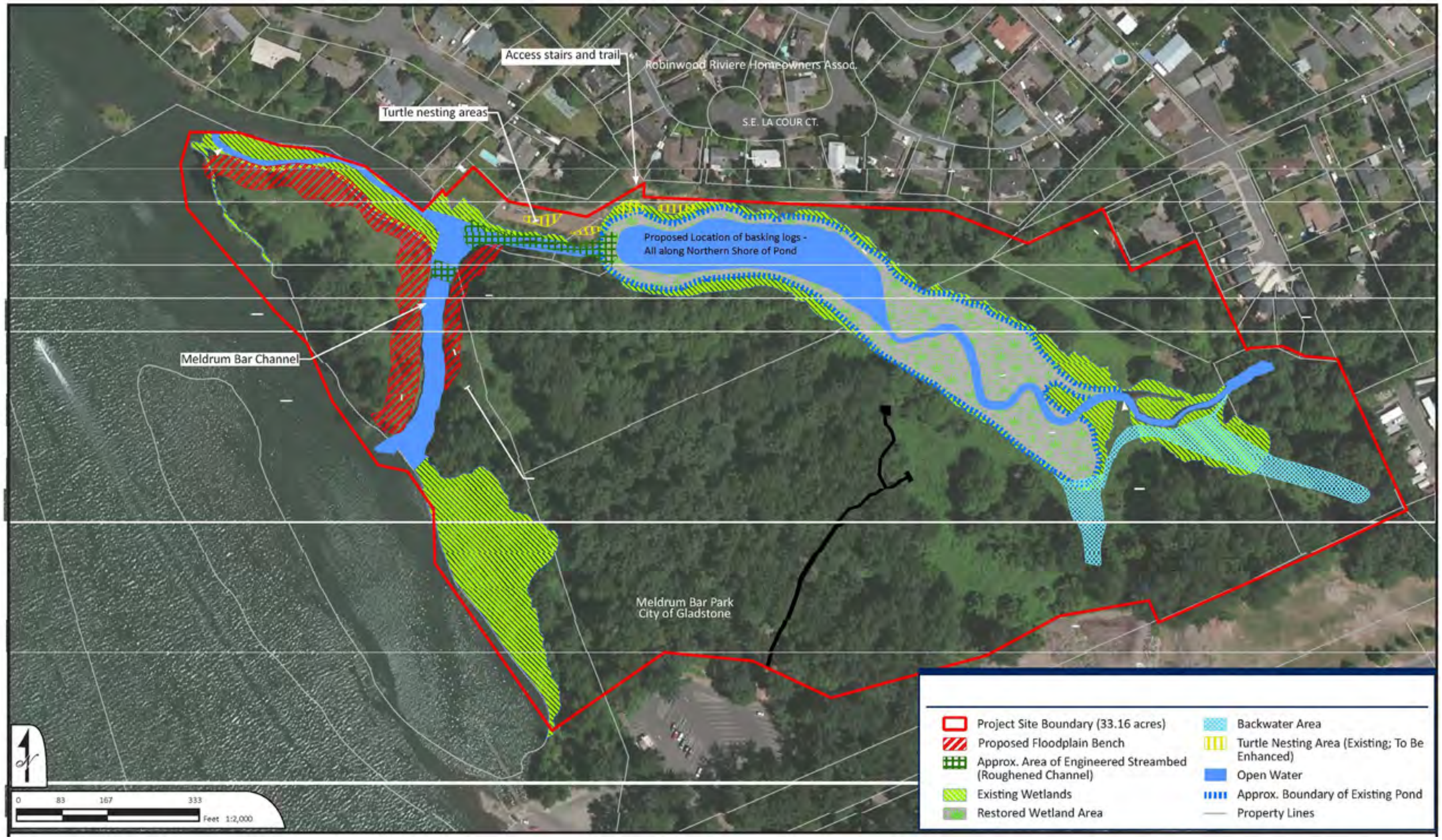

Figure 7-1 Adaptive Management Turtle Habitat for Rinearson Natural Area, 2021

8 Literature Cited

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APPENDIX A

PHOTO MONITORING

Rinearson Natural Area Monitoring

APPENDIX

A

FIELD PHOTOS

Long-Term Monitoring Photo Points

Photo Point #2

Photo Point #3

Photo Point #4 West

Photo Point #4 East

Photo Point #5

Photo Point #6

Photo Point #7

Photo Point #8

Photo Point #9

Photo Point #10

Photo Point #11

Photo Point #13

Photo Point #14

Photo Point #15

Photo Point #16

Vegetation Sampling Quadrats

Photo 1. Emergent Marsh Quadrat #1

Photo 2. Emergent Marsh Quadrat #2

Photo 3. Emergent Marsh Quadrat #3

Photo 4. Emergent Marsh Quadrat #4

Photo 5. Emergent Marsh Quadrat #5

Photo 6. Emergent Marsh Quadrat #6

Photo 7. Emergent Marsh Quadrat #7

Photo 8. Forest Restoration Quadrat #1

Photo 8A. Forest Restoration Quadrat #1 Herbaceous

Photo 9. Forest Restoration Quadrat #2

Photo 9A. Forest Restoration Quadrat #2 Herbaceous

Photo 10. Forest Restoration Quadrat #3

Photo 10A. Forest Restoration Quadrat #3 Herbaceous

Photo 11. Forest Restoration Quadrat #4 West

Photo 11A. Forest Restoration Quadrat #4 East

Photo 11B. Forest Restoration Quadrat #4 Herbaceous

Photo 12. Forest Restoration Quadrat #5

Photo 12A. Forest Restoration Quadrat #5 Herbaceous

Photo 13. Forest Restoration Quadrat #6

Photo 13A. Forest Restoration Quadrat #6 Herbaceous

Photo 14. Forest Enhancement Quadrat #1

Photo 15. Forest Enhancement Quadrat #2

Photo 16. Forest Enhancement Quadrat #3

Photo 17. Forest Enhancement Quadrat #4

Photo 18. Forest Enhancement Quadrat #5

Photo 19. Forest Enhancement Quadrat #6

Photo 20. Forest Enhancement Quadrat #7

Photo 21. Forest Enhancement Quadrat #8

Photo 22. Forest Invasive Quadrat #1

Photo 23. Forest Invasive Quadrat #2

Photo 24. Forest Invasive Quadrat #3

Photo 25. Forest Invasive Quadrat #4

Photo 26. Forest Invasive Quadrat #5

Photo 27. Forest Invasive Quadrat #6

Photo 28. Forest Invasive Quadrat #7

Photo 29. Forest Invasive Quadrat #8

Miscellaneous Field Photos

Photo 1. Base control point #5000

Photo 2. Control point #5001

APPENDIX B

HABITAT STRUCTURES AND LARGE WOODY DEBRIS MONITORING DATA

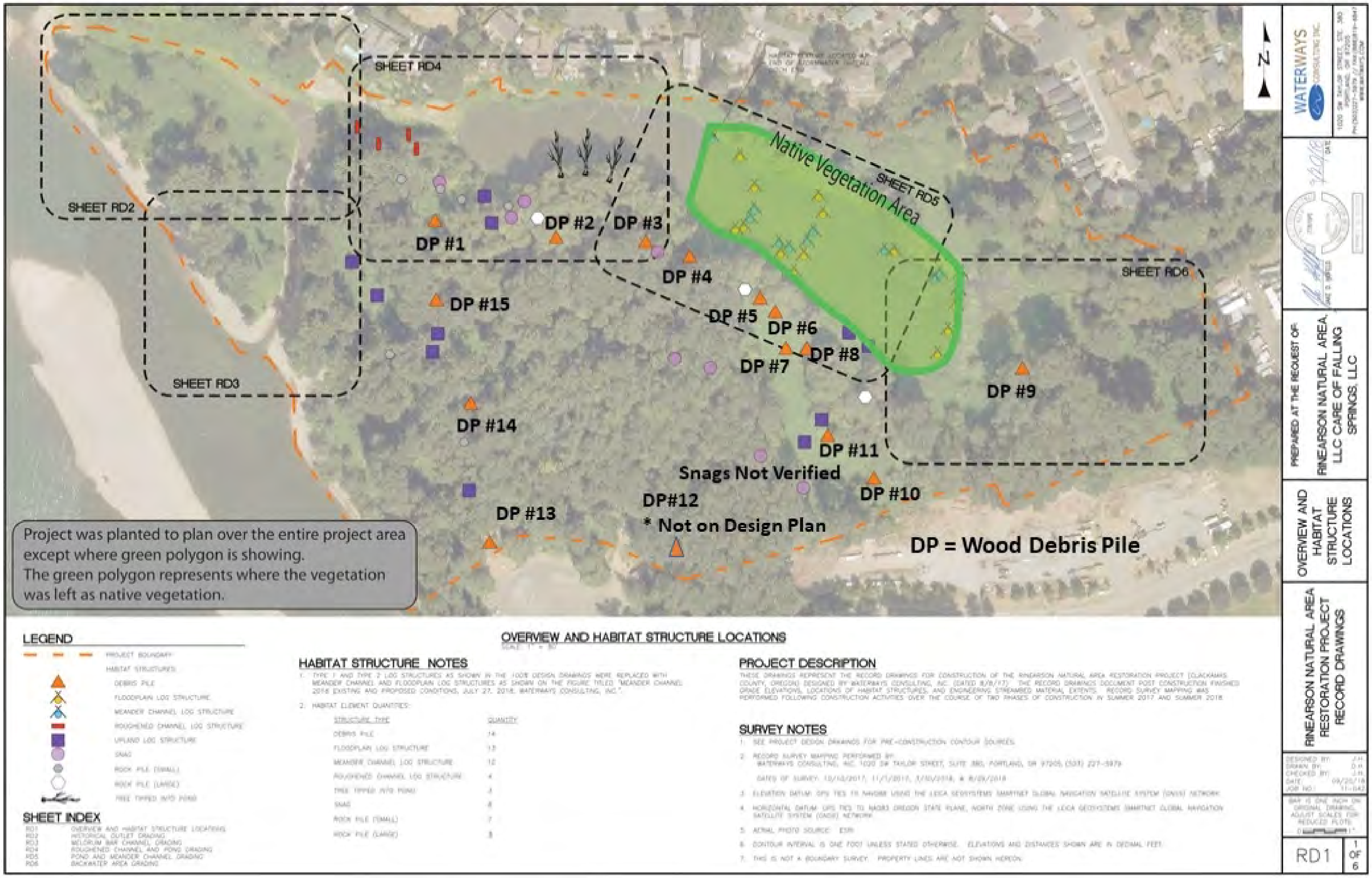


Figure B-1 Overview of Habitat Structure Locations

Table B-1 Large Woody Debris Survey Counts Associated with Engineered Wood Upland Debris Piles, Year 2020

Upland DP No.	RD Sheet	Medium LWD	Large LWD	Rootwad	Total LWD	No. of Snags Verified	Comments / Notes
1	4	16	8	1	25	1	
2	4	20	6			2	
3	4/5	25	7	1	33		Could not verify snag adjacent to DP #3 and 4, placed closer to beaver pond than RD map?
4	5	28	11	1	40		
5	5	19	3	1	23		
6	5	29	5	3	37		
7	5	24			24		
8	5	15	5	1	21		
9	6	20	1	1	22		
10	N/A	32	13		45		Outside RD quadrants. Snag west of DP #11 not verified.
11	N/A	36	5		41		Outside RD quadrants. Snag west of DP #10 not verified.
12	N/A	22	9		31		Outside RD quadrants.
13	N/A	16	8		24		Outside RD quadrants.
14	N/A	13	5		18		Outside RD quadrants.
15	N/A	23	6		29		Outside RD quadrants.
Grand Total		**338**	**92**	**9**	**413**		

Note: See Figure B-1.
DP – debris pile
LWD – large woody debris
RD – record drawings

Table B-2 Large Woody Debris Survey Counts Associated with Engineered Upland Wood Structures, Year 2020

No. of Upland Wood Structures Verified	Count Medium LWD	Count Large LWD	Comment
10	1	11	Could not locate upland wood structures on far west side of project area.

Note: See Figure B-1.
LWD – large woody debris

Table B-3 Large Woody Debris Survey Counts in Riparian Areas below the Ordinary High Water Mark for Survey Year 2020

Reach	Zone	Medium LWD	Large LWD	Rootwad	General Notes
Emergent marsh	1	3	12		All LWD part of meander channel log structures.
Emergent marsh	2	6	4		Two upland log structures—1 large LWD each.
Meldrum Bar bay and channel	1	4		6	RD Sheets 2 and 3. All rootwads engineered wood (roughened channel log structure). Two medium LWD part of Meldrum Bar channel small beaver pond.
Meldrum Bar Bay And Channel	2	2			
Beaver pond	1	11	3		Three medium pieces are engineered LWD; 3 large pieces are engineered LWD fallen into beaver pond; 3 medium LWD are part of beaver pond dam.
Beaver pond	2	3			

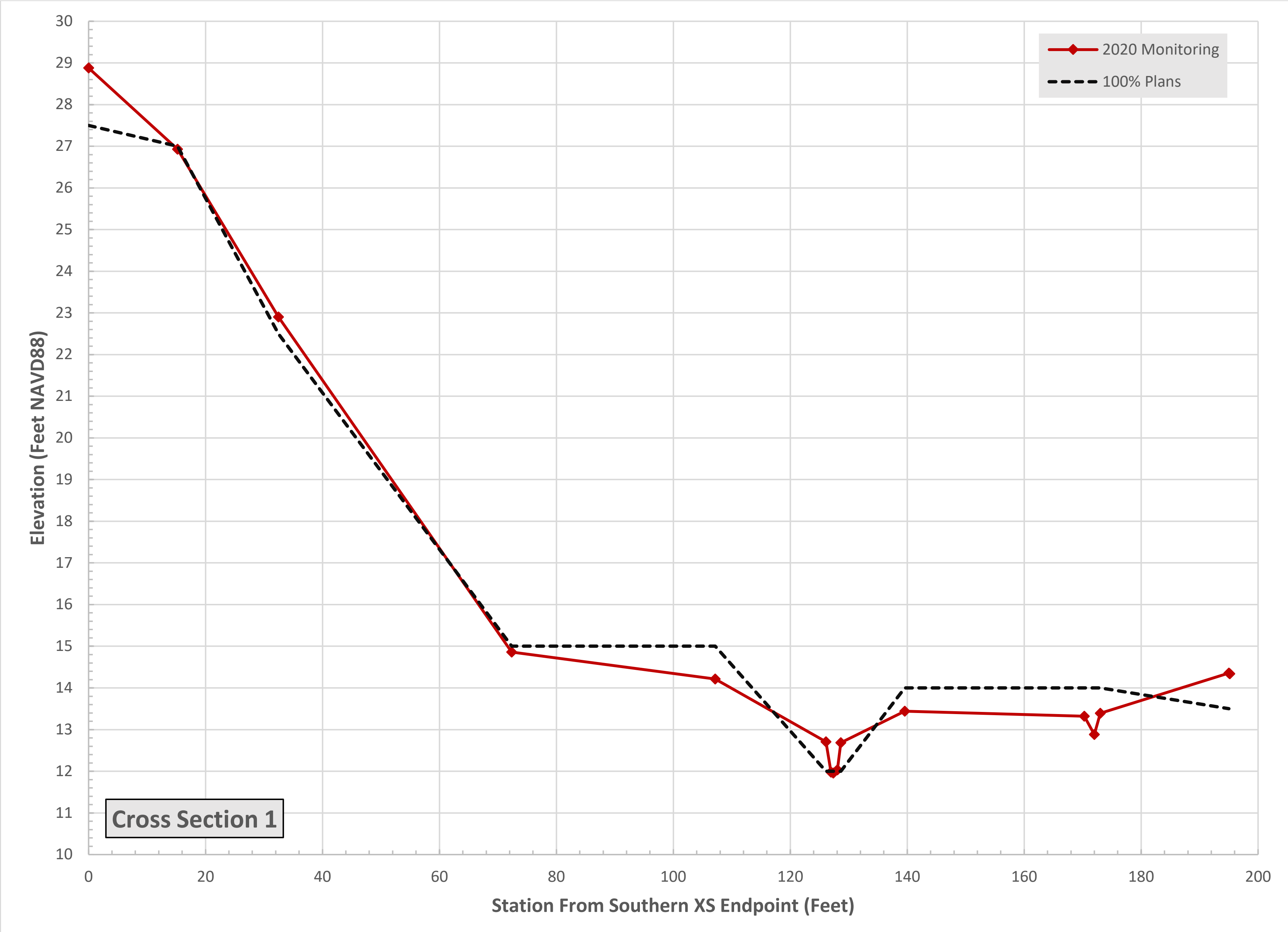
Notes: Zone 1 is wood at least touching water, whereas Zone 2 is wood in the waterway but outside existing water.
See Figure B-1
LWD – large woody debris
RD – record drawings

Photos taken October 1, 2020.

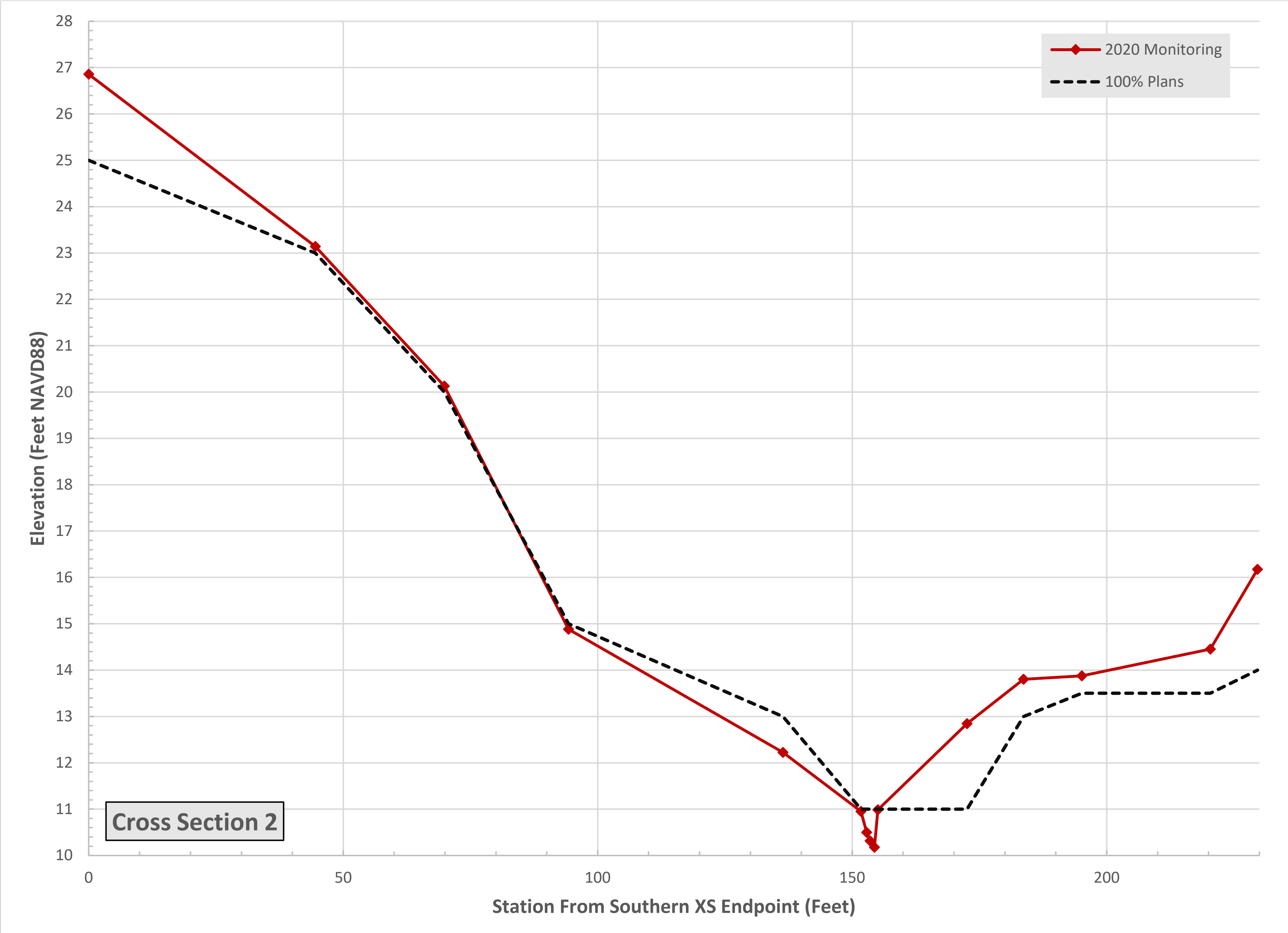
Beaver Dam at Top of Meldrum Bar Channel and Beaver Dam as Part of the Large Pond Complex in Rinearson Natural Area

APPENDIX C

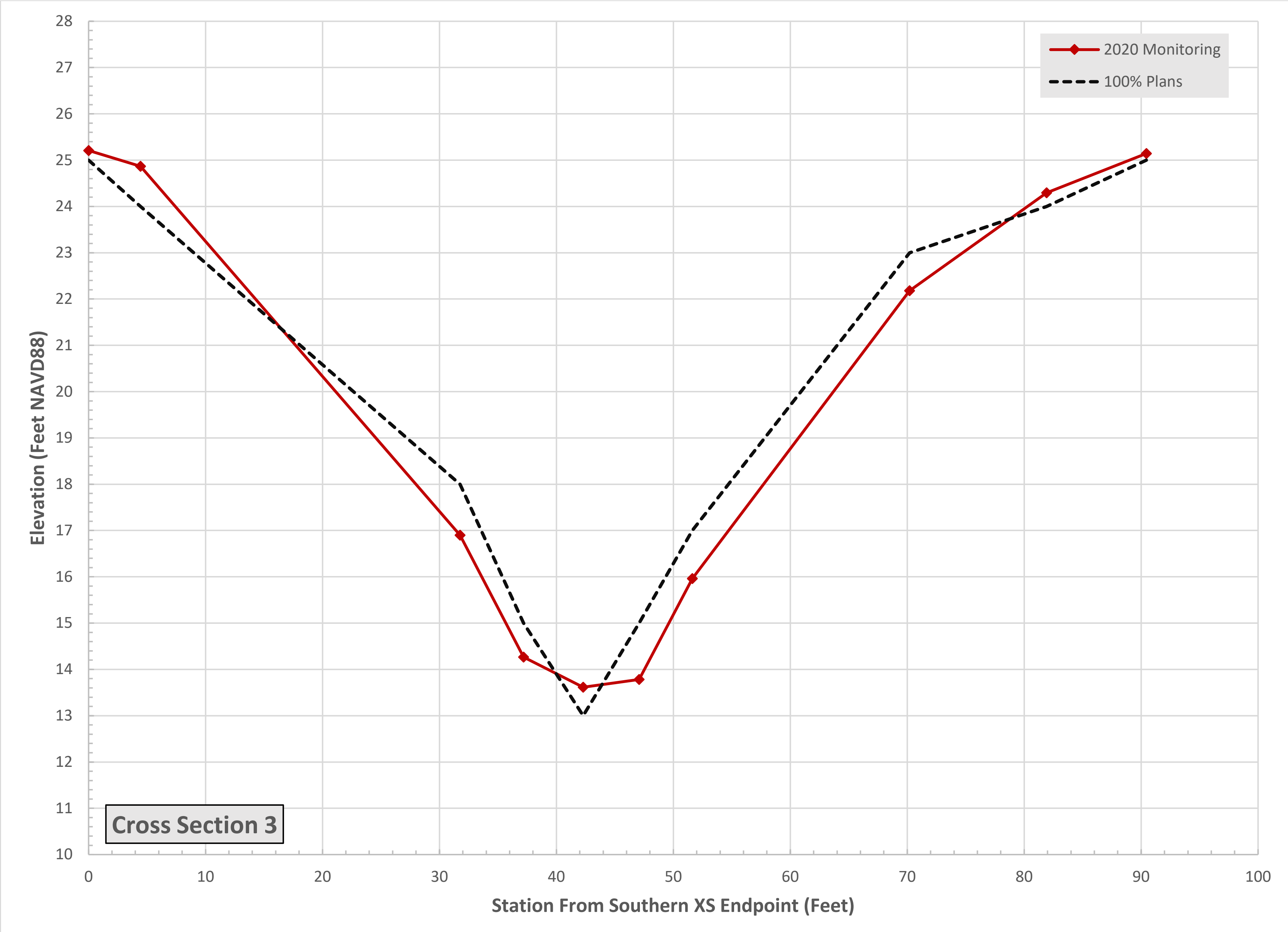
SURVEY CROSS SECTIONS



2020 Monitoring
100% Plans
Cross Section 1
Elevation (Feet NAVD88)
Station From Southern XS Endpoint (Feet)
30
29
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
0
20
40
60
80
100
120
140
160
180
200



28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
Elevation (Feet NAVD88)
0
50
100
150
200
Station From Southern XS Endpoint (Feet)
2020 Monitoring
100% Plans
Cross Section 2



2020 Monitoring
100% Plans
Elevation (Feet NAVD88)
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
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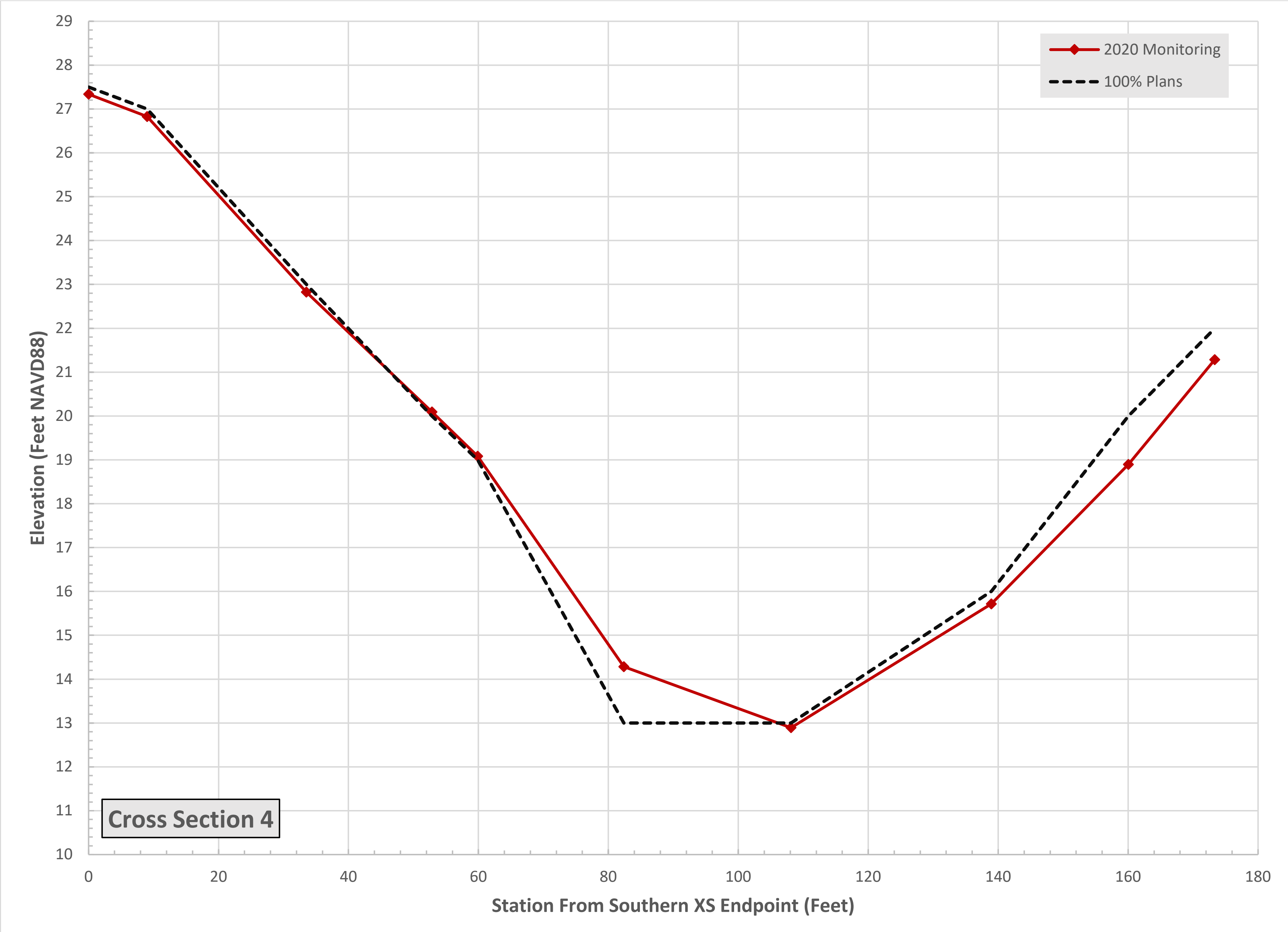
10
Cross Section 3
0
10
20
30
40
50
60
70
80
90
100
Station From Southern XS Endpoint (Feet)



2020 Monitoring
100% Plans
Cross Section 4
Elevation (Feet NAVD88)
Station From Southern XS Endpoint (Feet)
29
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14
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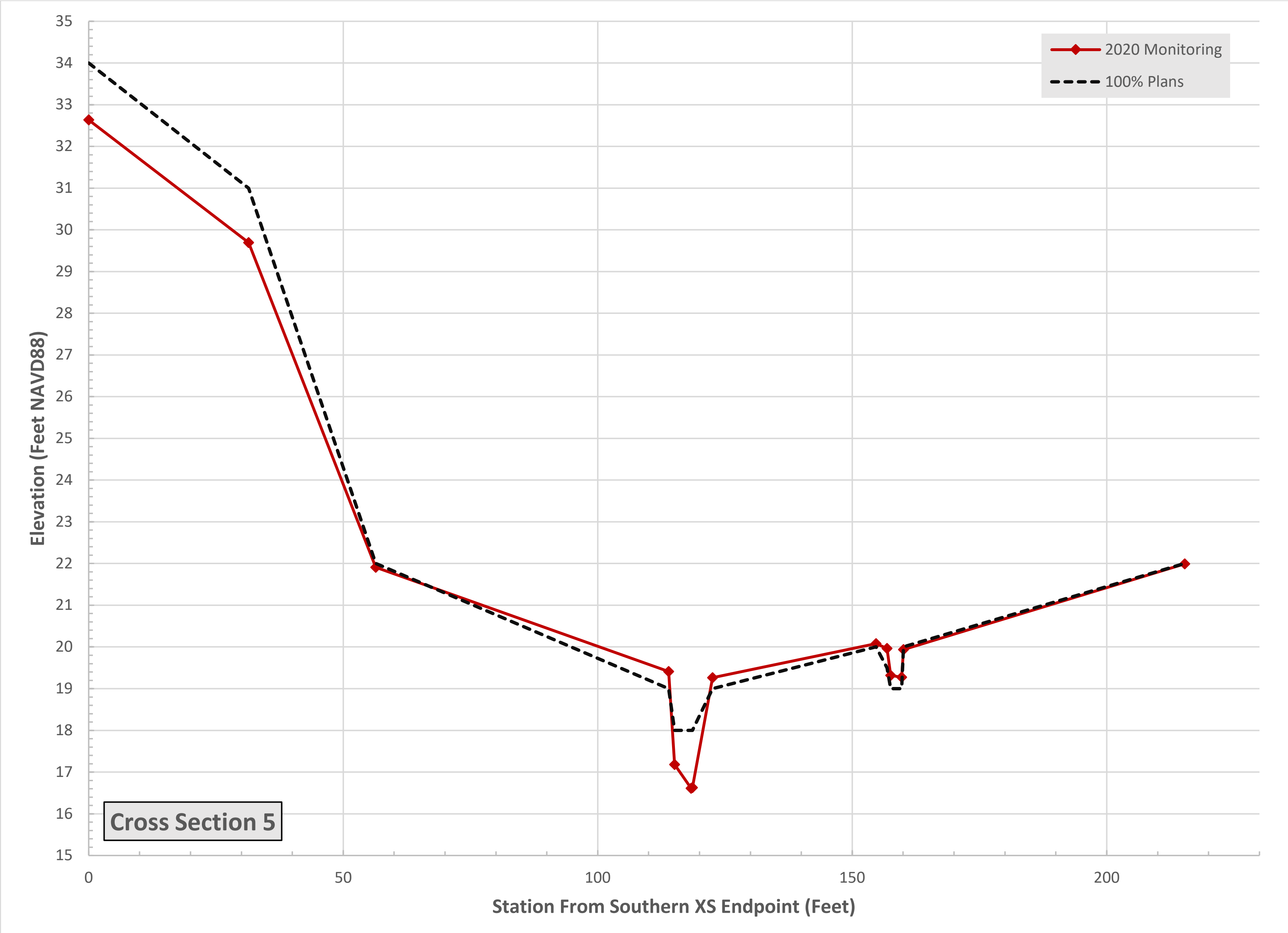
40
60
80
100
120
140
160
180



Cross Section 5
2020 Monitoring
100% Plans
Elevation (Feet NAVD88)
Station From Southern XS Endpoint (Feet)
35
34
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32
31
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19
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0
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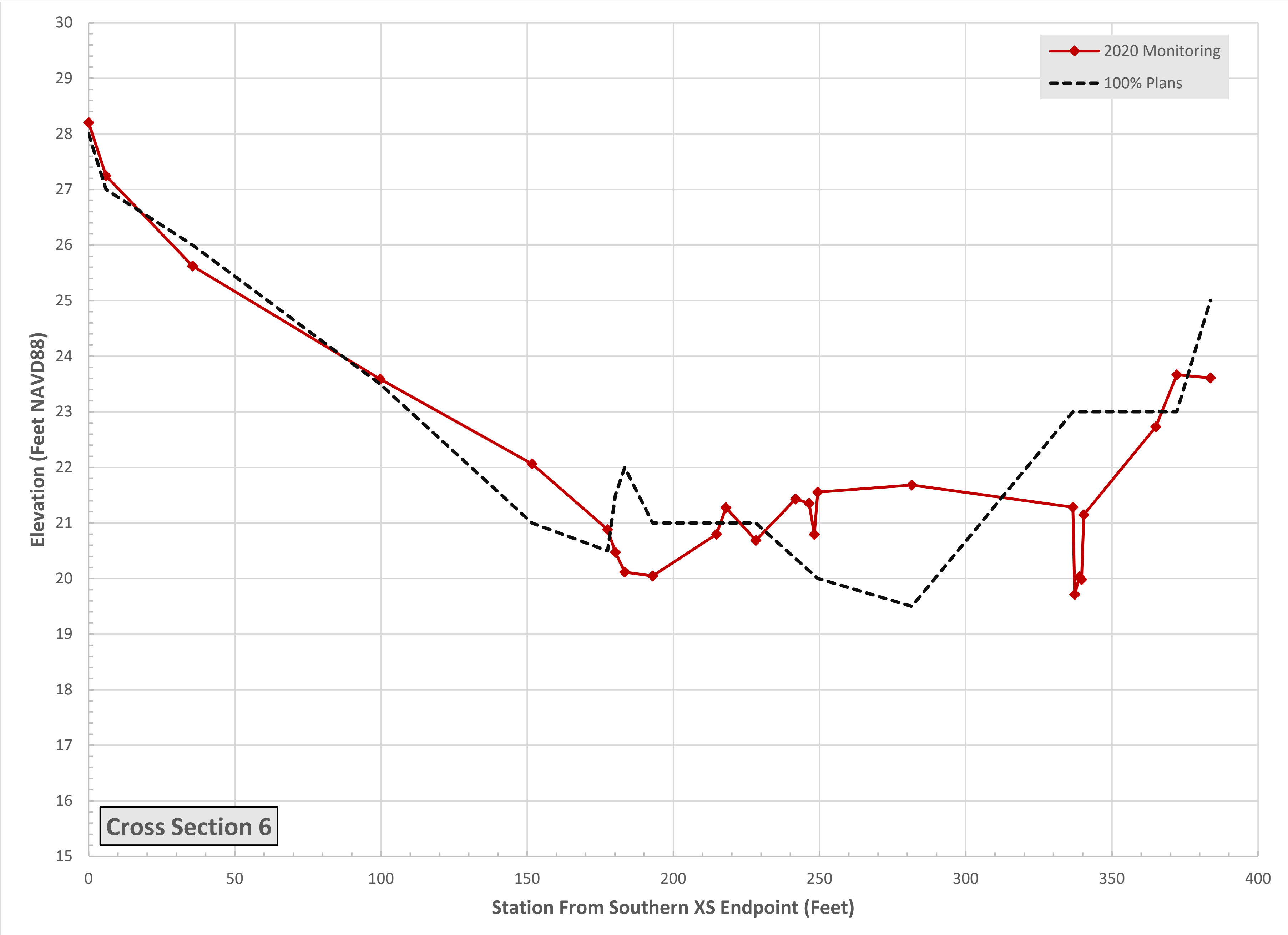
150
200



2020 Monitoring
100% Plans
Cross Section 6
Elevation (Feet NAVD88)
Station From Southern XS Endpoint (Feet)
30
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17
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15
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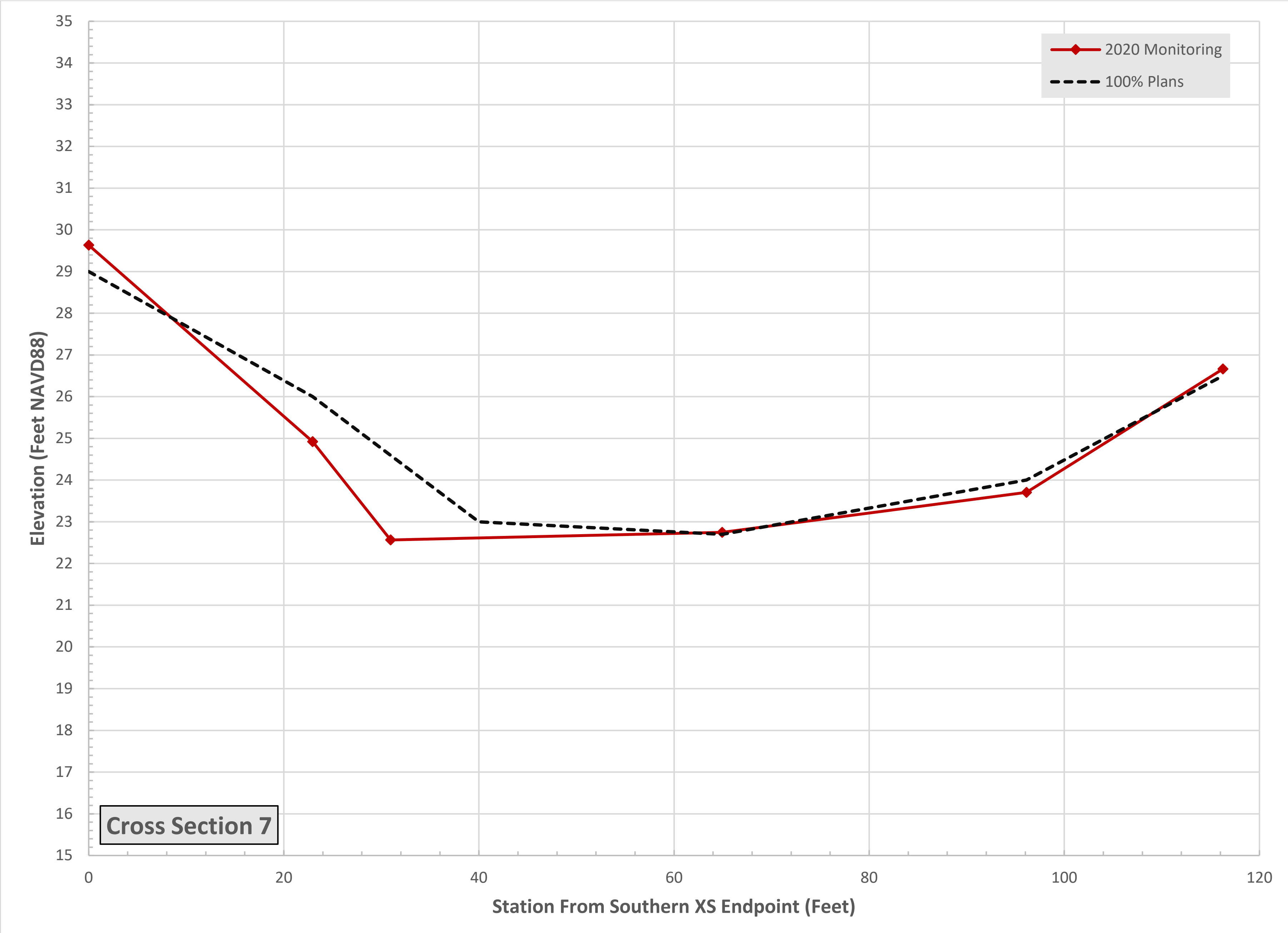
50
100
150
200
250
300
350
400



2020 Monitoring
100% Plans
Cross Section 7
Elevation (Feet NAVD88)
Station From Southern XS Endpoint (Feet)
35
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15
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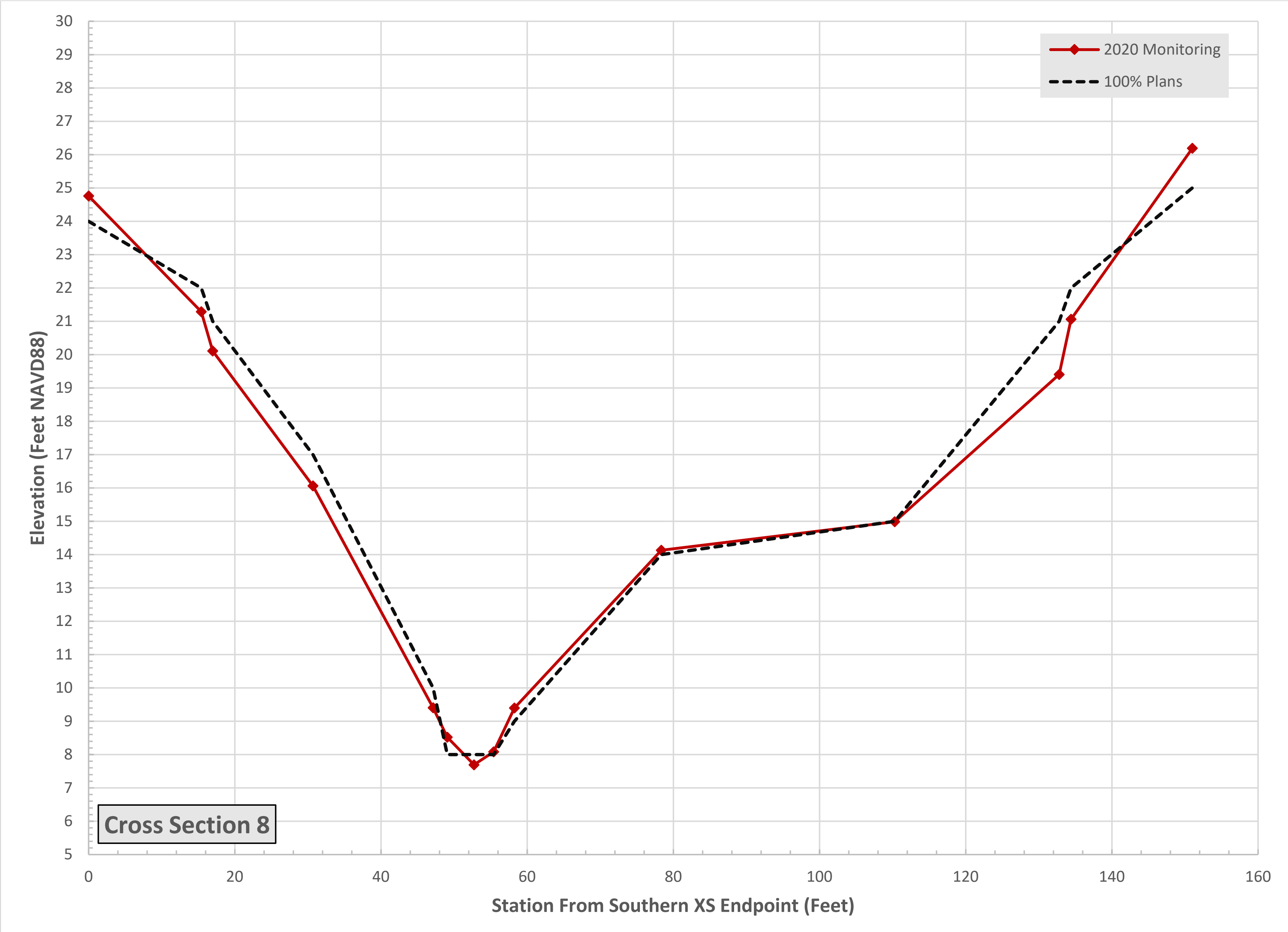

2020 Monitoring
100% Plans
Cross Section 8
Elevation (Feet NAVD88)
Station From Southern XS Endpoint (Feet)
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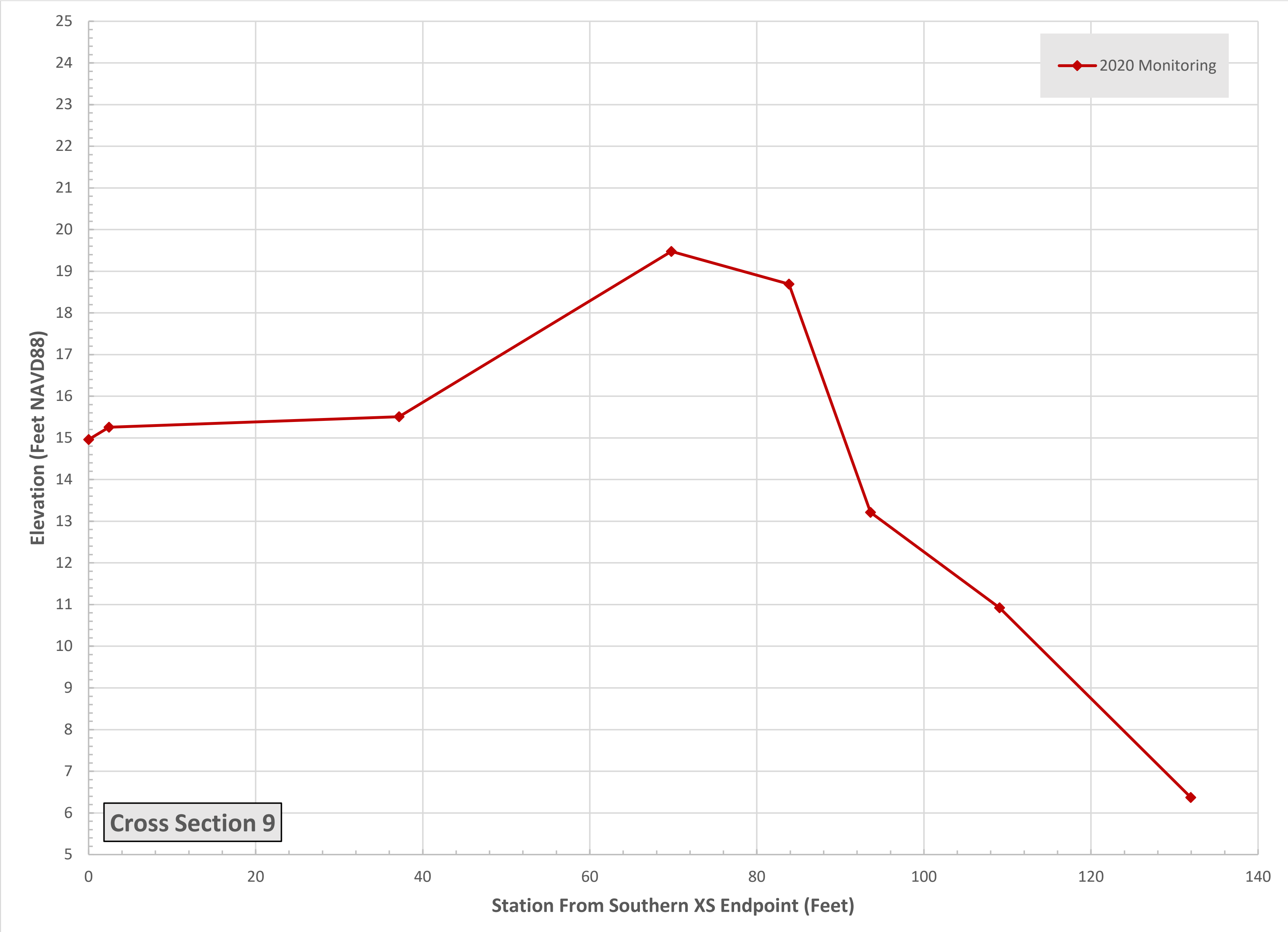
2020 Monitoring
Cross Section 9
Elevation (Feet NAVD88)
Station From Southern XS Endpoint (Feet)
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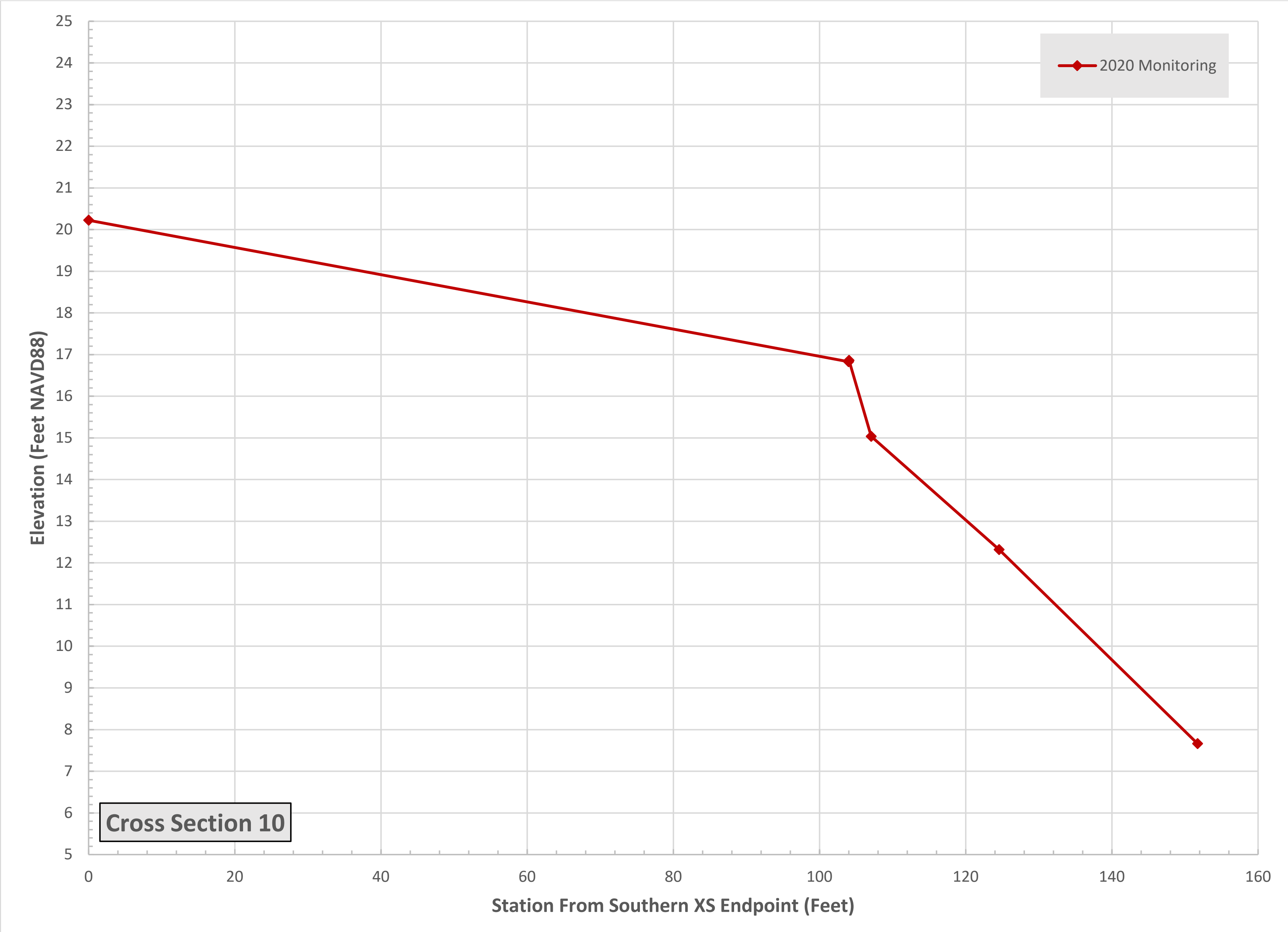
140



2020 Monitoring
Cross Section 10
Elevation (Feet NAVD88)
Station From Southern XS Endpoint (Feet)
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20
40
60
80
100
120
140
160

APPENDIX

D

VEGETATION SAMPLING DATA

Common Name	Scientific Name	Percent Cover	Native Status	Stem Count (#)	Density (stems/m2)	Vegetation Treatment Type	Quadrat Sample Number
Field morning-glory	Convolvulus arvensis	20%	Invasive	--	--	Emergent Marsh	1
Columbia River Willow	Salix exigua var. columbiana	70%	Native	--	--	Emergent Marsh	1
Sitka Willow	Salix sitchensis	10%	Native	--	--	Emergent Marsh	1
Field morning-glory	Convolvulus arvensis	10%	Invasive	--	--	Emergent Marsh	2
Dotted Smartweed	Polygonum punctatum	90%	Native	--	--	Emergent Marsh	2
Red Alder	Alnus rubra	2%	Native	--	--	Emergent Marsh	3
Rigid Willow	Salix rigida var. macrogemma	20%	Native	--	--	Emergent Marsh	3
Himalyan Blackberry	Rubus armeniacus	5%	Invasive	--	--	Emergent Marsh	3
Field morning-glory	Convolvulus arvensis	10%	Invasive	--	--	Emergent Marsh	3
Reed Canarygrass	Phalaris arundinacea	15%	Invasive	--	--	Emergent Marsh	3
Soft Rush	Juncus effusus	10%	Native	--	--	Emergent Marsh	3
Reed Canarygrass	Phalaris arundinacea	60%	Invasive	--	--	Emergent Marsh	4
Himalyan Blackberry	Rubus armeniacus	5%	Invasive	--	--	Emergent Marsh	4
Canada Thistle	Cirsium arvense	5%	Invasive	--	--	Emergent Marsh	4
Birds Foot Trefoil	Lotus corniculatus	30%	Invasive	--	--	Emergent Marsh	4
Spotted Jewelweed	Impatiens capensis	10%	Invasive	--	--	Emergent Marsh	5
Reed Canarygrass	Phalaris arundinacea	40%	Invasive	--	--	Emergent Marsh	5
Red Alder	Alnus rubra	5%	Native	--	--	Emergent Marsh	5
Sitka Willow	Salix sitchensis	5%	Native	--	--	Emergent Marsh	5
Soft Rush	Juncus effusus	10%	Native	--	--	Emergent Marsh	5
American Brooklime	Veronica americana	5%	Native	--	--	Emergent Marsh	5
Spotted Jewelweed	Impatiens capensis	100%	Invasive	--	--	Emergent Marsh	6
Spotted Jewelweed	Impatiens capensis	50%	Invasive	--	--	Emergent Marsh	7
Soft Rush	Juncus effusus	30%	Native	--	--	Emergent Marsh	7
Yellow Flag Iris	Iris pseudacorus	20%	Invasive	--	--	Emergent Marsh	7
Pacific Blackberry	Rubus ursinus	5%	Native	--	--	Forest Enhancement	1
Reed Canarygrass	Phalaris arundinacea	10%	Invasive	--	--	Forest Enhancement	1
Pennyroyal	Mentha pulegium	20%	Invasive	--	--	Forest Enhancement	1
Red Clover	Trifolium pratense	15%	Invasive	--	--	Forest Enhancement	1
Great Camas	Camassia leichtlinii	5%	Native	--	--	Forest Enhancement	1
Himalyan Blackberry	Rubus armeniacus	5%	Invasive	--	--	Forest Enhancement	1
Unknown	--	5%	--	--	--	Forest Enhancement	1
Common Mullien	Verbascum thapsus	5%	Invasive	--	--	Forest Enhancement	1
Unknown	--	5%	--	--	--	Forest Enhancement	1
Bitter Dock	Rumex obtusifolius	20%	Invasive	--	--	Forest Enhancement	1
English Ivy	Hedera helix	20%	Invasive	--	--	Forest Enhancement	2
Pennyroyal	Mentha pulegium	20%	Invasive	--	--	Forest Enhancement	2
Oxeye Daisy	Leucanthemum vulgare	5%	Invasive	--	--	Forest Enhancement	2
Leafy Beggars-Tick	Bidens cernua	50%	Native	--	--	Forest Enhancement	2
Unknown	--	5%	--	--	--	Forest Enhancement	2
Pacific Blackberry	Rubus ursinus	90%	Native	--	--	Forest Enhancement	3
Reed Canarygrass	Phalaris arundinacea	90%	Invasive	--	--	Forest Enhancement	4
Climbing Bindweed	Polygonum convolvulus	10%	Invasive	--	--	Forest Enhancement	4
Pacific Blackberry	Rubus ursinus	75%	Native	--	--	Forest Enhancement	5
Unknown	--	10%	--	--	--	Forest Enhancement	5
Pennyroyal	Mentha pulegium	5%	Invasive	--	--	Forest Enhancement	5
Bitter Dock	Rumex obtusifolius	5%	Invasive	--	--	Forest Enhancement	5
Butterfly Bush	Buddleja (Buddleia) davidii	20%	Native	--	--	Forest Enhancement	6
Teasel	Dipsacus fullonum	5%	Invasive	--	--	Forest Enhancement	6
Canada Thistle	Cirsium arvense	30%	Invasive	--	--	Forest Enhancement	6
Reed Canarygrass	Phalaris arundinacea	5%	Invasive	--	--	Forest Enhancement	6
Reed Canarygrass	Phalaris arundinacea	90%	Invasive	--	--	Forest Enhancement	7
Himalyan Blackberry	Rubus armeniacus	10%	Invasive	--	--	Forest Enhancement	7
Reed Canarygrass	Phalaris arundinacea	100%	Invasive	--	--	Forest Enhancement	8
English Ivy	Hedera helix	10%	Invasive	--	--	Forest Invasive	1
Herb-Robert	Geranium robertianum	20%	Invasive	--	--	Forest Invasive	1
English Ivy	Hedera helix	5%	Invasive	--	--	Forest Invasive	2
Himalyan Blackberry	Rubus armeniacus	5%	Invasive	--	--	Forest Invasive	2
English Ivy	Hedera helix	10%	Invasive	--	--	Forest Invasive	3

Pacific Blackberry	Rubus ursinus	80%	Native	--	--	Forest Invasive	4
False Brome	Brachypodium sylvaticum	10%	Invasive	--	--	Forest Invasive	5
Soft Rush	Juncus effusus	15%	Native	--	--	Forest Invasive	5
Horseweed	Conyza canadensis var. glabrata	5%	Native	--	--	Forest Invasive	5
English Ivy	Hedera helix	20%	Invasive	--	--	Forest Invasive	6
Himalyan Blackberry	Rubus armeniacus	5%	Invasive	--	--	Forest Invasive	6
Himalyan Blackberry	Rubus armeniacus	40%	Invasive	--	--	Forest Invasive	7
Reed Canarygrass	Phalaris arundinacea	10%	Invasive	--	--	Forest Invasive	7
English Ivy	Hedera helix	5%	Invasive	--	--	Forest Invasive	8
English Holly	Ilex aquifolium	5%	Invasive	--	--	Forest Invasive	8
Pennyroyal	Mentha pulegium	80%	Invasive	--	--	Forest Restoration	1
Redosier Dogwood	Cornus sericea	--	Native	36	1.8	Forest Restoration	1
Columbia River Willow	Salix exigua var. columbiana	--	Native	11	0.55	Forest Restoration	1
Rigid Willow	Salix rigida var. macrogemma	--	Native	1	0.05	Forest Restoration	1
Pennyroyal	Mentha pulegium	10%	Invasive	--	--	Forest Restoration	2
Unknown	--	5%	--	--	--	Forest Restoration	2
Leafy Beggars-Tick	Bidens cernua	90%	Native	--	--	Forest Restoration	2
Sitka Willow	Salix sitchensis	--	Native	5	0.25	Forest Restoration	2
Pacific Willow	Salix lucida ssp. lasiandra	--	Native	42	2.1	Forest Restoration	2
Rigid WIllow	Salix rigida var. macrogemma	--	Native	11	0.55	Forest Restoration	2
Pennyroyal	Mentha pulegium	10%	Invasive	--	--	Forest Restoration	3
Redosier Dogwood	Cornus sericea	--	Native	20	1	Forest Restoration	3
Pacific Willow	Salix lucida ssp. lasiandra	--	Native	39	1.95	Forest Restoration	3
Sitka Willow	Salix sitchensis	--	Native	2	0.1	Forest Restoration	3
Spotted Jewelweed	Impatiens capensis	40%	Invasive	--	--	Forest Restoration	4
Reed Canarygrass	Phalaris arundinacea	40%	Invasive	--	--	Forest Restoration	4
Soft Rush	Juncus effusus	20%	Native	--	--	Forest Restoration	4
Red Alder	Alnus rubra	--	Native	3	0.15	Forest Restoration	4
Pacific Willow	Salix lucida ssp. lasiandra	--	Native	1	0.05	Forest Restoration	4
Sitka Willow	Salix sitchensis	--	Native	1	0.05	Forest Restoration	4
Spotted Jewelweed	Impatiens capensis	100%	Invasive	--	--	Forest Restoration	5
Sitka Willow	Salix sitchensis	--	Native	17	0.85	Forest Restoration	5
Douglass Spirea	Spiraea douglasii	--	Native	4	0.2	Forest Restoration	5
Reed Canarygrass	Phalaris arundinacea	40%	Invasive	--	--	Forest Restoration	6
Red Clover	Trifolium pratense	15%	Invasive	--	--	Forest Restoration	6
Unknown	--	10%	--	--	--	Forest Restoration	6
Slough Sedge	Carex obnupta	2%	Native	--	--	Forest Restoration	6
Sitka Willow	Salix sitchensis	--	Native	10	0.5	Forest Restoration	6
Pacific Willow	Salix lucida ssp. lasiandra	--	Native	1	0.05	Forest Restoration	6
Rigid Willow	Salix rigida var. macrogemma	--	Native	2	0.1	Forest Restoration	6
Red Alder	Alnus rubra	--	Native	3	0.15	Forest Restoration	6
Black twinberry	Lonicera involucrata	--	Native	4	0.2	Forest Restoration	6

APPENDIX E

BIRD SURVEY FIELD NOTES

Rinearson Natural Area Avian Survey

Point 1:
Downy Woodpecker on tree
Downy Woodpecker on tree
American Crow NE to SW
Brewer's Blackbird on tree
American Robin on tree

Point 2:
Song Sparrow on tree
American Robin N to S
Bushtit on tree
Nest
American Crow

Point 3:
American Robin on tree
Spotted Towhee on tree
Black-headed Grosbeak on tree
American Crow

Point 4:
Mallard on water
Song Sparrow on tree

Point 5:
House Finch on tree
American Crow N to S
Willow Flycatcher on tree

Point 6:
16 American Crow in tree
Seagull on water
Song Sparrow on tree
2 Mallards on water

Point 7:
American Robin on tree
Song Sparrow on tree
Brewer's Blackbird on tree

Point 8:
Bewick's Wren on tree
American Crow on tree
Song Sparrow on tree
American Robin N to S

Point 9:
American Robin N to S
American Robin
American Crow N to S
Willow Flycatcher on tree

Point 10:
14 Mallards on water
2 American Crow flying North
Seagull on water
Great Blue Heron flying North

Point 11:
3 Song Sparrow in tree
6 American Crows in a tree
Red tailed Hawk tree to north
Anna's Hummingbird in a tree

Point 12:
Swainson's Thrush in tree
Black-headed Grosbeak in tree
American Robin S to N
American Crow S to N

Point 13:
American Crow in tree
Brown Creeper in tree
2 Teal S to N
3 Canadian Geese W to E
Song Sparrow in tree

Point 14:
Mourning Dove in tree
2 American Crows in tree
American Robin S to N

Point 15:
American Robin S to N
Song Sparrow N to S

APPENDIX F

ASH CREEK TREATMENT LOG

ASH CREEK WEEKLY STATUS REPORT

Week of: 7/20/20, 7/27/20

1) Date: 7/21/20 Site: Rinearson
   Total Hours: 64
   Crew Members: Nick Lewis, Bryant Young, Chris Conrad, Parker Steele, Logan Insinga, Emma Davis, Holden Jones, David Okert (8)

   Equipment: Hand snips, contractor bags

   Activity Notes (species treated, estimated # of plants treated, methods, etc.):
   Deadhead and bag inflorescences. Grid site focusing on large Loosestrife and Tansy patches

   Estimates:
   Tansy Ragwort 400
   Dune Tansy 50
   Teasel 150
   Canada Thistle 100
   Bull Thistle 200
   Purple Loosestrife 36,000 – 50,000
   Chicory 75
   Common Mullein 50
   Butterfly Bush 15
   English Ivy (trees) 5

Treatment Maps:

Photos:

ASH CREEK WEEKLY STATUS REPORT

ASH CREEK WEEKLY STATUS REPORT

2) Date: 7/22/20 Site: Rinearson
Total Hours: 80
Crew Members: Nick Lewis, Bryant Young, Chris Conrad, Parker Steele, Logan Insinga, Emma Davis, Holden Jones, Zach Vande Slunt, Kyle Sorenson, Daniel Baik (10)

Equipment: Hand snips, contractor bags

Activity Notes (species treated, estimated # of plants treated, methods, etc.):

Deadhead and bag inflorescences.

Estimates (total):

Tansy Ragwort 2000
Dune Tansy 50
Teasel 250
Canada Thistle 350
Bull Thistle 350
Purple Loosestrife 100
Chicory 500
Common Mullein 50
Butterfly Bush 50
English Ivy (trees) 20

ASH CREEK WEEKLY STATUS REPORT

Treatment Maps:

Photos:

ASH CREEK WEEKLY STATUS REPORT

ASH CREEK WEEKLY STATUS REPORT

ASH CREEK WEEKLY STATUS REPORT

3) Date: 7/23/2020 Site: Rinearson

Total Hours: 53

Crew Members: Nick Lewis (5hr), Bryant Young, Chris Conrad, Logan Insinga, Emma Davis, Holden Jones, David Okert

Equipment: Hand Snips, Contractor bags

Activity Notes (species treated, estimated # of plants treated, methods, etc.):

Deadhead and bag inflorescences.

Estimates:
Tansy Ragwort 3000
Dune Tansy 3
Teasel 60
Thistle 3000
Purple Loosestrife 15
Chicory 40
Common Mullein 30
Butterfly Bush 5
English Ivy (trees)0

Treatment Maps:

ASH CREEK WEEKLY STATUS REPORT

Photos:

ASH CREEK WEEKLY STATUS REPORT

ASH CREEK WEEKLY STATUS REPORT

4) Date: 7/24/20 Site: Rinearson

Total Hours: 40.5

ASH CREEK WEEKLY STATUS REPORT

Crew Members: Nick Lewis, Spencer Hansen, Scott Brennan, Justine Brumm, Joe Dahlke, Theodore Peterschmidt, Owen Phinney, Olivia Barnes

Equipment: Hand snips, contractor bags

Activity Notes (species treated, estimated # of plants treated, methods, etc.):
Deadhead and bag inflorescences in large dense Teasel patch.

Estimates:
Teasel 12,768-22,344 (4-7 per ft2)
Chicory 75

Treatment Maps:

Photos:

ASH CREEK WEEKLY STATUS REPORT

ASH CREEK WEEKLY STATUS REPORT

5) Date: 7/27/20 Site: Rinearson
Total Hours: 96 hrs
Crew Members: Heather Tippit (6hr), Justine Brumm (1hr), Kyle Gibbs, Bryant Young, David Okert, Holden Jones, Logan Insigna, Emma Davis, Parker Steele, Owen Phinney, Joe Dahlke, Teddy Peterschmidt, Lauren Swett, Daniel Baik (12)

Equipment: Hand Snips, contractor bags

Activity Notes (species treated, estimated # of plants treated, methods, etc.): Deadhead and bag inflorenscences of Teasel, Tansy, Thistle, Mullein, Butterfly Bush, and Purple Loosestrife

Estimates:
Teasel - 8,200
Thistle - 350
Tansy - 25
Mullein - 100
Butterfly Bush - 20
Purple Loosestrife – 0

Treatment Maps:

ASH CREEK WEEKLY STATUS REPORT

Photos:

ASH CREEK WEEKLY STATUS REPORT

ASH CREEK WEEKLY STATUS REPORT

ASH CREEK WEEKLY STATUS REPORT

6) Date: 7/28/20 Site: Rinearson Total Hours: 97
Crew Members: Logan, Bryant, Emma, Parker, Holden, David, Owen, Theodore, Joseph, Kyle, Daniel, Justine

Equipment: hand snips, contractor bags

Activity Notes (species treated, estimated # of plants treated, methods, etc.):

Thistle –800
Tansy-130
Butterfly bush- 60
Teasel- 4300
Purple loosestrife- 400
Mullen- 300

Treatment Maps:

Photos:

ASH CREEK WEEKLY STATUS REPORT

ASH CREEK WEEKLY STATUS REPORT

ASH CREEK WEEKLY STATUS REPORT

ASH CREEK WEEKLY STATUS REPORT

ASH CREEK WEEKLY STATUS REPORT

ASH CREEK WEEKLY STATUS REPORT

7) Date: 7-29-20 Site: Rinearson

Total Hours: 105

Crew Members: Bryant Young, David Okert, Holden Jones, Logan Insigna, Emma Davis, Parker Steele, Owen Phinney, Joe Dahlke, Teddy Peterschmidt, Daniel Baik, Zach Vandeslunt, Drake Kutkat-Tonkin, Kyle Sorensen, Nick Lewis, Kyle Gibbs

Equipment: handsnips and contractor bags

Activity Notes (species treated, estimated # of plants treated, methods, etc.):

Cut and bag seed heads and inflorescences.

3,000 tansy

10,000 teasel

2000 purple loosestrife

5 butterfly bush

200 Mullen

Treatment Maps:

Photos:

ASH CREEK WEEKLY STATUS REPORT

About Cardno

Cardno is an ASX-200 professional infrastructure and environmental services company, with expertise in the development and improvement of physical and social infrastructure for communities around the world. Cardno's team includes leading professionals who plan, design, manage, and deliver sustainable projects and community programs. Cardno is an international company listed on the Australian Securities Exchange [ASX:CDD].

Cardno Zero Harm

Cardno ZERO HARM EVERY JOB. EVERY DAY.

At Cardno, our primary concern is to develop and maintain safe and healthy conditions for anyone involved at our project worksites. We require full compliance with our Health and Safety Policy Manual and established work procedures and expect the same protocol from our subcontractors. We are committed to achieving our Zero Harm goal by continually improving our safety systems, education, and vigilance at the workplace and in the field. Safety is a Cardno core value and through strong leadership and active employee participation, we seek to implement and reinforce these leading actions on every job, every day.