YAKIMA RIVER BASIN
ECOSYSTEM RESTORATION
YAKIMA COUNTY, WASHINGTON

APPENDIX B

Ecosystem Outputs

June 2018

Integrated Feasibility Report and Environmental Assessment

US Army Corps
of Engineers®
Seattle District

YAKIMA RIVER GAP TO GAP

ECOSYSTEM RESTORATION PROJECT

HABITAT BENEFITS MODEL

November 2017

US Army Corps of Engineers®
Seattle District

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HABITAT EVALUATION PROCEDURE (HEP) METHODS AND RESULTS

1.0 INTRODUCTION

In order to evaluate measures and formulate alternatives for this project the Habitat Evaluation Procedure (HEP) model was used to assess habitat benefits. Details about the model are provided below. This model was used as a method for comparing existing and future without-project habitat conditions to those conditions that would result from proposed restoration alternatives (with-project conditions).

A HEP is a tool for comparing existing and proposed future habitat conditions for a species or assemblage of species in a particular geographic area. A HEP is comprised of one or more Habitat Suitability Indices (HSI), which are models for calculating the habitat suitability of an area for a single species or assemblage of species. A set of variables that represent the life requisites for the species (e.g. percent cover, water depth, tree height) is combined into a mathematical model. The variables are then measured in the field and their corresponding index values are inserted into the model to produce a score that describes existing habitat suitability. The value is an index score between 0 and 1. The mathematical models used for this HEP are derived from existing models, developed by the USFWS.

Selection of species to include in the HEP model is based on several criteria. First and foremost, the species geographic range must include the project vicinity. The species selected must also utilize the habitat type or types that are currently present, or are proposed for restoration. Species with existing HSI models are preferred because the existing models have been extensively peer reviewed. Suitable HSI models must include habitat variables for which data collection is possible, given the availability of time and resources. Finally, variables must also show a change in score between the existing and proposed condition. If the project does not affect the suitability index score for a species, it will not be possible to quantify an effect.

The HEP for this project is directed at the riparian, floodplain, and aquatic species and habitats. Although only a few species have been selected out of the many that could be present in the project area, the selected species are representative of guilds that currently do or could utilize habitats in the project area, or are representative of species of concern in the project area.

The individual HSIs for various habitat parameters for each species are combined to yield an overall index score for the species. Scores for each species can be used individually or combined to yield an overall index score for a site for multiple species or species assemblages.

2.0 EXISTING HABITATS AND SELECTED MODEL SPECIES

The HEP model used for this project is a community-based model with multiple species selected to represent other species that function similarly in riverine systems. The three species selected for

the model are expected to be indicators of habitat conditions for a wide variety of additional species. Table 1 provides a summary of species selected for the model, as well as references.

Table 1 Selected representative species and references for model development.

Habitat	Common Name	Scientific Name	Model Source
Riparian (shrub) Habitat Riparian (forested) Habitat Aquatic Habitat	Yellow Warbler Beaver Steelhead Trout	*Dendroica petechia* *Castor Canadensis* *Oncorhynchus mykiss*	Schroeder 1982 Allen 1982 Raleigh et. al. 1984

Three species were chosen to represent the riparian and aquatic communities for the HEP analysis, including yellow warbler (*Dendroica petechia*), beaver (*Castor canadensis*), and steelhead trout (*Oncorhynchus mykiss*). These species were chosen as there are existing models developed for each of them. In addition, each of these species represents a particular niche or guild of species that utilize these habitats in the project area. The yellow warbler represents migratory neotropical birds that utilize riparian scrub-shrub habitat for nesting. Beaver is a mammal species dependent on riparian structure for food and habitat. Steelhead trout is an anadromous salmonid species that inhabits a wide range of aquatic habitats in the Yakima basin.

2.1.1 Yellow Warbler

The yellow warbler was selected to represent neotropical migratory birds that may use the riparian scrub-shrub habitat of the Yakima River. Yellow warblers are a breeding bird throughout the U.S. The existing model and habitat requirements are described in Schroeder (1982). The yellow warbler prefers riparian habitats composed of abundant, moderately tall, deciduous shrubs ranging in height from 1.5 to 4 meters. Shrub densities between 60 and 80% are considered optimal and coniferous areas are avoided. Greater than 90% of prey are insects and foraging takes place primarily on small limbs in deciduous foliage. Nests are generally located 0.9 to 2.4 meters above the ground in willows, alders, and other hydrophytic shrubs and trees, including box elders and cottonwoods. Male yellow warblers have greater mating success in shrubs less than 3 meters tall.

2.1.2 Beaver

Beaver were selected to represent species that may use the riparian forested habitat of the Yakima River. Beaver are herbivorous aquatic mammals found throughout North America wherever suitable riparian and wetland habitats occur. Beaver were once so numerous (60 million) that most aquatic habitats in North America were shaped by beaver activity. The existing model is described in Allen (1982) and winter food habitat requirements are summarized below. Beaver are generalized herbivores, but have strong preferences for specific plant species and size classes. Aspen, willow, cottonwood, and alder are the preferred species. Woody stems less than 10 centimeters in diameter near water are preferred, and herbaceous vegetation and leaves are consumed during the summer. Aquatic vegetation is also utilized.

2.1.3 Steelhead Trout

Adult and juvenile anadromous steelhead trout models were selected to represent salmonid habitat of the Yakima River and its associated side and back channels. The existing model and habitat requirements are described in Raleigh et al. (1984). Optimal steelhead trout riverine habitat is characterized by clear, cold water; a silt-free rocky substrate in riffle-run areas; an approximately 1:1 pool-to-riffle ratio with areas of slow, deep water; well-vegetated stream banks; abundant instream cover; and relatively stable water flow, temperature regimes, and stream banks (Raleigh and Duff 1980).

3.0 MODEL PARAMETERS

3.1.1 Yellow Warbler

The HSI for yellow warbler includes the following variables:

V_1 = % deciduous shrub cover *(Schroeder 1982)*

Percent Cover	SI
0	0
25	0.4
50	0.75
60	1.0
80	1.0
90	0.8
100	0.6

V_2 = Average height of deciduous shrub canopy height *(Schroeder 1982)*

Canopy Height (meters)	SI
0	0
1	0.5
2+	1.0

V_3 = % canopy comprised of hydrophytic shrubs *(Schroeder 1982)*

Percent Hydrophytic Shrubs	SI
0	0.1
25	0.3
50	0.55
75	0.8
100	1.0

3.1.2 Beaver

The HSI model for beaver includes the following winter food variables:

V_1 = Percent tree canopy closure (the percent of the ground surface shaded by a vertical projection of the canopies of woody vegetation ≥5.0 m (16.5 ft) in height) *(Allen 1982)*

Percent Canopy Closure	SI
0	0
25	0.5
50	1.0
75	0.8
100	0.6

V_2 = Percent of trees in 2.5 to 15.2 cm (1 to 6 inches) dbh size class *(Allen 1982)*

Percent of Trees	SI
0	0.2
25	0.4
50	0.6
75	0.8
100	1.0

V_3 = Percent shrub crown cover (the percent of the ground surface shaded by a vertical projection of the canopies of woody vegetation < 5 m (16.5 ft) in height) *(Allen 1982)*

Percent Cover	SI
0	0
25	0.6
50	1.0
75	0.9
100	0.8

V_4 = Average height of shrub canopy *(Allen 1982)*

Average Height (meters)	SI
0	0
1	0.3
2	1.0
3	1.0
4	1.0

V_5 = Species composition of woody vegetation (trees and/or shrubs) *(Allen 1982)*

Vegetation Class	Description	SI
A	Woody vegetation dominated (>50%) by one or more of the following species: aspen, willow, cottonwood, alder	1.0
B	Woody vegetation dominated by other deciduous species	0.6
C	Woody vegetation dominated by coniferous species	0.2

3.1.3 Steelhead Trout

The HSI model for adult and juvenile trout includes the following variables:

- Juvenile: V6, V10, V15
- Adult: V4, V6, V10, V15
- All life stages: V1, V3, V9, V13, V14, V16

V_1 = Average maximum temperature during warmest period (during upstream migration) *(Raleigh et al. 1984)*

Temp (°C)	Suitability Index
<5 or >18	0
6 or 17.5	0.2
7 or 17	0.4
8 or 16.5	0.6
9 or 16	0.8
11 - 14	1.0

V_3 = Average minimum dissolved oxygen (mg/l) during the late growing season low water period and during embryo development (adult, juvenile, fry, and embryo) *(Raleigh et al. 1984)*

mg/l	Suitability Index
3	0
3.5	0.2
4	0.4
4.5	0.6
5.5	0.8
6.5	1.0

V_4 = Average thalweg depth (cm) during the late growing season low water period (adult) *(Raleigh et al. 1984)*

cm	Suitability Index
10	0
15	0.1
20	0.2
22	0.3
24	0.4
26	0.5
28	0.6
32	0.7
35	0.8
38	0.9
45	1.0

V_6 = Percent in-stream cover during late season low water period *(Raleigh et al. 1984)*

Percent	Suitability Index
0	0
0	0.1
0	0.2
2	0.3
4	0.4
6	0.5
8	0.6
10	0.7
13	0.8
17	0.9
22	1.0

V_9 = Predominant substrate type in riffle-run areas for food production *(Raleigh et al. 1984)*

Substrate Type	Description	SI
A	Rubble or small boulders (or aquatic vegetation in spring areas) predominant; limited amounts of gravel, large boulders, or bedrock	1.0
B	Rubble, gravel, boulders, and fines occur in approximately equal amounts, or gravel is predominant. Aquatic vegetation may or may not be present.	0.6
C	Fines, bedrock, or large boulders are predominant. Rubble and gravel are insignificant (≤ 25%)	0.2

V_{10} = Percent pools during the late season low water period *(Raleigh et al. 1984)*

Percent	Suitability Index
0	0 - 0.3
5	0.4
8 or 100	0.5
12 or 95	0.6
16 or 90	0.7
20 or 82	0.8
26 or 75	0.9
36 to 65	1.0

V_{13} = Annual maximal or minimal pH *(Raleigh et al. 1984)*

pH	Suitability Index
5.5 or 9	0
5.6 or 8.9	0.2
5.8 or 8.7	0.4
6 or 8.5	0.6
6.2 or 8.3	0.8
6.5 or 8	1.0

V_{14} = Average annual base flow regime during low flow period *(Raleigh et al. 1984)*

Percent	Suitability Index
0	0
5	0.1
10	0.2
15	0.3
20	0.4
25	0.5
30	0.6
35	0.7
40	0.8
45	0.9
50	1.0

V_{15} = Pool class rating during late growing season low flow period *(Raleigh et al. 1984)*

Pool Class	Description	SI
A	≥ 30% of the area is comprised of 1st-class pools	1.0
B	≥ 10% but < 30% of the area is 1st –class pools or ≥ 50% is 2nd-class pools	0.6
C	< 10% of the area is 1st-class pools and < 50% is 2nd-class pools	0.2

V_{16} = Percent riffle-fines during average summer low flows *(Raleigh et al. 1984)*

Percent	Suitability Index
1	0
50	0.1
30	0.2
24	0.3
22	0.4
20	0.5
18	0.6
16	0.7
13	0.8
11	0.9
5	1.0

4.0 COMBINED MODEL

The HEP model is a function of the results of the individual species HSIs. Table 2 provides the mathematical equation for calculating the HSIs for each species.

Table 2 HEP model.

Yellow Warbler: Breeding/Nesting Habitat	V_1 = Percent deciduous shrub crown cover V_2 = Average height of deciduous shrub canopy V_3 = Percent of shrub canopy comprised of hydrophytic shrubs (willow, etc.) $HSI_{Yellow\ Warbler} = (V_1 + V_2 + V_3)/3$

Beaver: Winter Food	V_1 = Percent tree canopy closure V_2 = Percent of trees in 2.5 to 15.2 cm dbh size class V_3 = Percent shrub crown cover V_4 = Average height of shrub canopy V_5 = Species composition of woody vegetation $HSI_{Beaver} = (V_1 + V_2 + V_3 + V_4 + V_5) /5$
Steelhead: Adult and Juvenile	V_1 = Max temperature during warmest period V_3 = Avg. minimum DO during late growing season low water V_4 = Avg. thalweg depth during late growing season low water period V_6 = Percent in-stream cover during late season low water period V_9 = Predominant substrate type in riffle-run areas for food production V_{10} = Percent pools during the late season low water period V_{13} = Annual maximal or minimal pH V_{14} = Average annual base flow regime during low flow period V_{15} = Pool class rating during late growing season low flow period V_{16} = Percent riffle-fines during average summer low flows $HSI_{Steelhead} = (V_1 + V_3 + V_4 + V_6 + V_9 + V_{10} + V_{13} + V_{14} + V_{15} + V_{16}) /10$

To assess existing conditions, input data for the model was collected at the proposed measure sites and by the use of existing reports, modeling, aerial photographs, GIS analysis, and best professional judgement. The input data required varies substantially from one HSI to another. Measured variables were then assigned an SI value (unitless number from 0 to 1) based on the suitability curve or discreet suitability values or thresholds developed in the model.

Typically, input variables were documented at multiple locations at each measure site and then averaged to yield an overall percent canopy cover or similar value. If the measure site was comprised of several distinctly different vegetation communities, then variables were measured specifically for each community to yield multiple scores for the overall site.

Acreages for the model were developed by mapping the areas where measures were both implementable and would have an effect on habitat quality. The acreage for with- and without project conditions is the same to ensure an objective comparison of habitat values before and after implementation of restoration measures.

Assumptions for scoring the no-action alternative were based on the projection of the site if no restoration measures were implemented. Under this scenario, the DID #1 levee would still separate the river from its floodplain. Sportsman Park Island would still have limited water in the existing channels and the weirs would direct the water to the levee near Buchanon Lake. The right bank

of the river would show little improvement in function and habitat quality, with invasive species spreading over time. Both tree and shrub cover and height would show little improvement. The amount of off-channel habitat would remain the same.

Assumptions for scoring the HEP model under with-project conditions were based on the restoration of riparian and aquatic habitat resulting from implementation of the proposed measures. Proposed measures include levee removals, spur dike removals, floodplain topographic restoration, side channel construction, hydrologic enhancement of a disconnected floodplain channel, replacement of barrier culverts, and wetland reconnection.

5.0 HABITAT UNITS

The HSIs are multiplied by the area of forested, shrub, or aquatic habitat, respectively that may be affected by a measure. This final score is called a Habitat Unit (HU). HUs for each habitat type were summed to identify the total amount of HUs for each measure footprint. The future with- and without-project HUs are compared to determine the net difference (either positive or negative) between measures. Depending on the management measures implemented, benefits may or may not be realized immediately. To account for these differing accumulations of benefits over the 50 year planning period, the benefits were scored in the following increments: 0-5, 6-20, and 21-50. Years 0-5 represent the initial response to project implementation including side channel formation and sprouting of vegetation in disturbed areas that are reconnected to the floodplain. It is expected that side channels will stabilize and shrubs and trees will continue to mature in years 6-20, followed by normative river and side channel flows and mature vegetation in years 21-50. These values are averaged creating an output of average annual HUs. Table 3 summarizes the average annual habitat units assigned to each measure. It should be noted that the average annual HUs listed represent the net increase in output above and beyond the without-project condition (i.e., the no-action alternative). The net values were compared to costs via cost effectiveness/incremental cost analysis (CE/ICA) for evaluation and alternatives formulation.

Measure #	Measure	Habitat	Existing Cond. Acres	Existing Cond. HIS	Existing Cond. Habitat Units	w/o Project ACRES	w/o Project 0-5 HSI	w/o Project 0-5 Habitat Units	w/o Project 6-20 HSI	w/o Project 6-20 Habitat Units	w/o Project 21-50 HSI	w/o Project 21-50 Habitat Units	w/ Project ACRES	w/ Project 0-5 HSI	w/ Project 0-5 Habitat Units	w/ Project 6-20 HSI	w /Project 6-20 Habitat Units	w/ Project 21-50 HSI	w/ Project 21-50 Habitat Units	Average w/	Average w/o	Net
1	All DID1 Measures	commercial/residential	3.71	0	0.00	3.71	0.00	0.00	0.00	0.00	0.00	0.00	1.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		forest	47.23	0.85	40.15	47.23	0.85	40.15	0.85	40.15	0.84	39.67	36.38	0.63	22.92	0.82	29.83	0.82	29.83	29.14	39.86	-10.72
		gravel/bare ground	42.48	0	0.00	42.48	0.00	0.00	0.00	0.00	0.00	0.00	28.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		herbaceous	64.50	0	0.00	64.50	0.00	0.00	0.00	0.00	0.00	0.00	51.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		shrub	44.27	0.98	43.38	44.27	0.98	43.38	0.97	42.94	0.97	42.94	23.18	0.63	14.60	0.90	20.86	0.90	20.86	20.24	42.99	-22.75
		water connected	19.06	0.68	12.96	19.06	0.68	12.96	0.62	11.82	0.60	11.44	122.50	0.76	93.10	0.78	95.55	0.72	88.20	90.90	11.70	79.19
		water Unconnected	54.22	0	0.00	54.22	0.00	0.00	0.00	0.00	0.00	0.00	12.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Total Measure 1	**275.47**		**96.49**	**275.47**		**96.49**		**94.90**		**94.05**	**275.25**		**130.62**		**146.24**		**138.89**	**140.27**	**94.55**	**45.72**
2	Sportsman Channels	Blue_Slough	12.31	0	0.00	12.31	0.00	0.00	0.00	0.00	0.00	0.00	12.31	0.47	5.79	0.51	6.28	0.49	6.03	6.03	0.00	6.03
		forest	139.68	0.72	100.57	139.68	0.73	101.97	0.80	111.75	0.80	111.75	137.12	0.65	89.13	0.77	105.58	0.78	106.95	104.76	110.77	-6.01
		gravel/bare ground	14.72	0	0.00	14.72	0.00	0.00	0.00	0.00	0.00	0.00	15.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		herbaceous	4.49	0	0.00	4.49	0.00	0.00	0.00	0.00	0.00	0.00	3.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		shrub	11.48	0.83	9.53	11.48	0.83	9.53	0.87	9.99	0.93	10.67	9.48	0.78	7.40	0.93	8.82	0.87	8.25	8.33	10.35	-2.02
		water connected	75.20	0.56	42.11	75.20	0.56	42.11	0.56	42.11	0.54	40.61	83.27	0.76	63.29	0.78	64.95	0.72	59.96	61.79	41.21	20.58
		water Unconnected	4.81	0	0.00	4.81	0.00	0.00	0.00	0.00	0.00	0.00	1.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Total Measure 2	**262.68**		**152.21**	**262.68**		**153.61**		**163.84**		**163.03**	**262.01**		**165.60**		**185.63**		**181.19**	**180.96**	**162.33**	**18.64**
3	Nob Hill Floodplain Restoration	forest	9.44	0.77	7.27	9.44	0.71	6.70	0.72	6.80	0.74	6.99	9.47	0.73	6.91	0.75	7.10	0.78	7.39	7.25	6.90	0.35
		gravel/bare ground	1.19	0	0.00	1.19	0.00	0.00	0.00	0.00	0.00	0.00	1.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		herbaceous	4.57	0	0.00	4.57	0.00	0.00	0.00	0.00	0.00	0.00	1.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		shrub	4.30	0.75	3.22	4.30	0.75	3.22	0.73	3.14	0.73	3.14	4.26	0.73	3.11	0.75	3.19	0.83	3.53	3.39	3.15	0.24
		water connected	16.62	0.64	10.64	16.62	0.64	10.64	0.60	9.97	0.57	9.47	19.74	0.76	15.00	0.78	15.40	0.72	14.21	14.65	9.74	4.90
		water Unconnected	0.22	0	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Total Measure 3	**36.35**		**21.13**	**36.35**		**20.57**		**19.91**		**19.60**	**36.35**		**25.02**		**25.69**		**25.13**	**25.29**	**19.79**	**5.50**
4	Blue Slough Automated Headgate	Blue_Slough	12.00	0	0.00	12.31	0.00	0.00	0.00	0.00	0.00	0.00	12.31	0.59	7.27	0.59	7.27	0.57	7.02	7.12	0.00	7.12
		Total Measure 4	**12.00**		**0.00**	**12.31**		**0.00**		**0.00**		**0.00**	**12.31**		**7.27**		**7.27**		**7.02**	**7.12**	**0.00**	**7.12**
4.1	Blue Slough Culverts	Blue_Slough	12.00	0	0.00	12.31	0.00	0.00	0.00	0.00	0.00	0.00	12.31	0.77	9.48	0.77	9.48	0.71	8.74	9.04	0.00	9.04
		Total Measure 4.1	**12.00**		**0.00**	**12.31**		**0.00**		**0.00**		**0.00**	**12.31**		**9.48**		**9.48**		**8.74**	**9.04**	**0.00**	**9.04**
		Net (Measure 4.1 – 4.0)																				**1.92**

Measure #	Measure	Habitat	Existing Cond. Acres	Existing Cond. HIS	Existing Cond. Habitat Units	w/o Project ACRES	w/o Project 0-5 HSI	w/o Project 0-5 Habitat Units	w/o Project 6-20 HSI	w/o Project 6-20 Habitat Units	w/o Project 21-50 HSI	w/o Project 21-50 Habitat Units	w/ Project ACRES	w/ Project 0-5 HSI	w/ Project 0-5 Habitat Units	w/ Project 6-20 HSI	w /Project 6-20 Habitat Units	w/ Project 21-50 HSI	w/ Project 21-50 Habitat Units	Average w/	Average w/o	Net
4.2	Lower Blue Slough Connection	commercial/residential	3.71	0	0.00	3.71	0.00	0.00	0.00	0.00	0.00	0.00	1.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		forest	47.23	0.85	40.15	47.23	0.85	40.15	0.85	40.15	0.84	39.67	36.54	0.63	23.02	0.82	29.96	0.82	29.96	29.27	39.86	-10.59
		gravel/bare ground	42.48	0	0.00	42.48	0.00	0.00	0.00	0.00	0.00	0.00	27.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		herbaceous	64.50	0	0.00	64.50	0.00	0.00	0.00	0.00	0.00	0.00	50.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		shrub	44.27	0.98	43.38	44.27	0.98	43.38	0.97	42.94	0.97	42.94	22.71	0.63	14.31	0.90	20.44	0.90	20.44	19.83	42.99	-23.16
		water connected	19.06	0.68	12.96	19.06	0.68	12.96	0.62	11.82	0.60	11.44	125.50	0.76	95.38	0.78	97.89	0.72	90.36	93.12	11.70	81.42
		water Unconnected	54.22	0	0.00	54.22	0.00	0.00	0.00	0.00	0.00	0.00	11.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Total Measure 4.2	**275.47**		**96.49**	**275.47**		**96.49**		**94.90**		**94.05**	**275.24**		**132.71**		**148.29**		**140.76**	**142.22**	**94.55**	47.66
		Net (Measure 4.2 – 1.0)																		**1.94**	**0.00**	**1.94**
5	WSDOT Pilot Channels	forest	80.39	0.82	65.92	80.39	0.81	65.11	0.81	65.11	0.80	64.31	72.67	0.62	45.06	0.76	55.23	0.78	56.68	55.08	64.63	-9.55
		gravel/bare ground	21.86	0	0.00	21.86	0.00	0.00	0.00	0.00	0.00	0.00	20.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		herbaceous	26.40	0	0.00	26.40	0.00	0.00	0.00	0.00	0.00	0.00	25.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		shrub	35.50	0.9	31.95	35.50	0.90	31.95	0.90	31.95	0.90	31.95	31.47	0.68	21.40	0.87	27.38	0.90	28.33	27.35	31.95	-4.60
		water connected	49.25	0.47	23.15	49.25	0.47	23.15	0.47	23.15	0.46	22.66	65.05	0.76	49.44	0.78	50.74	0.72	46.84	48.27	22.85	25.41
		water Unconnected	15.05	0	0.00	15.05	0.00	0.00	0.00	0.00	0.00	0.00	12.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Total Measure 5	**228.45**		**121.02**	**228.45**		**120.21**		**120.21**		**118.91**	**228.29**		**115.90**		**133.35**		**131.84**	**130.70**	**119.43**	**11.27**
6	Greenway Trail Armor Removal	forest	80.39	0.82	65.92	80.39	0.81	65.11	0.81	65.11	0.80	64.31	80.39	0.62	49.84	0.76	61.10	0.78	62.70	60.93	64.63	-3.70
		gravel/bare ground	21.86	0	0.00	21.86	0.00	0.00	0.00	0.00	0.00	0.00	21.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		herbaceous	26.40	0	0.00	26.40	0.00	0.00	0.00	0.00	0.00	0.00	26.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		shrub	35.50	0.9	31.95	35.50	0.90	31.95	0.90	31.95	0.90	31.95	35.50	0.68	24.14	0.87	30.89	0.90	31.95	30.85	31.95	-1.10
		water connected	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		water Unconnected	64.30	0	0.00	64.30	0.00	0.00	0.00	0.00	0.00	0.00	64.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Total Measure 6	**228.45**		**97.87**	**228.45**		**97.06**		**97.06**		**96.26**	**228.46**		**73.98**		**91.98**		**94.65**	**91.78**	**96.58**	**-4.80**
7	Spring Creek Reconnection	forest	4.45	0.82	3.65	4.45	0.81	3.60	0.81	3.60	0.80	3.56	4.43	0.75	3.32	0.78	3.45	0.78	3.45	3.44	3.58	-0.14
		gravel/bare ground	0.01	0	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		herbaceous	3.93	0	0.00	3.93	0.00	0.00	0.00	0.00	0.00	0.00	3.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		shrub	2.91	0.9	2.62	2.91	0.90	2.62	0.90	2.62	0.90	2.62	2.93	0.90	2.64	0.90	2.64	0.90	2.64	2.64	2.62	0.02
		water connected	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.05	0.60	1.83	0.60	1.83	0.58	1.77	1.79	0.00	1.79
		water Unconnected	2.92	0	0.00	2.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Total Measure 7	**14.22**		**6.27**	**14.22**		**6.22**		**6.22**		**6.18**	**14.34**		**7.79**		**7.92**		**7.86**	**7.87**	**6.19**	**1.67**

6.0 REFERENCES

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