

**TECHNICAL MEMORANDUM**

August 21, 2019

To:	Mr. Doug Beyerlein Clear Creek Solutions, Inc.
From:	Anne Cline, PLA, Raedeke Associates, Inc. Chris Wright, BS, Raedeke Associates, Inc.
RE:	Olympia Bioretention Hydrologic Performance Study Vegetation Results Summary (RAI-2017-114)

A portion of the Olympia Bioretention Hydrologic Performance Study is to measure and describe the vegetation communities within each of the monitored bioretention cells. The purpose of describing the vegetation community composition and percent basal cover is to determine if specific vegetation types have an influence on the ability of the bioretention cell to perform hydrologic control functions.

The following memorandum describes the vegetation conditions observed at each of the monitored cells. Attached are individual tables for each monitored cell listing the vegetation species observed, their percent cover within the monitored area, and the number of individual stems of woody plants growing within the cells.

**METHODS**

Bioretention facility plant composition and density was measured for selected monitoring sites in one of three possible approaches depending on site conditions. Only the bottom (area subject to inundation) of the bioretention cell was sampled for vegetation.

1. For bioretention units that had only woody vegetation (shrubs and trees), the number of stems were counted within the unit (density). A woody plant is considered and inventoried as a single individual, regardless of the number and size of stems emerging from a common root system. A woody sapling/tree with a single stem is also considered and inventoried as a single individual. However, a woody sapling/tree with multiple stems may be considered and inventoried as multiple individuals if the stems split less than 50 centimeters above ground level (along the stem). In addition to a count of the number of stems within the facility,

an estimation of the percent cover of the woody vegetation within the study area was made. Cover is the proportion of the ground obscured by a species's aboveground leaves and stems. The genus and species of the woody plants was recorded, as well as the wetland indicator status (WIS) of the species observed. WIS assignment to plant species is described below.

2. For bioretention units with only herbaceous plant species, a quadrat along pre-determined points along a transect line(s) was used to estimate percent basal vegetation cover. Basal cover is the proportion of the plant that extends into the soil. A 25 cm x 25 cm quadrat was used to record the percentage of herbaceous vegetation at ground level versus the percentage of bare ground that covers each quadrat. Species were identified to genus and species and note made of the wetland indicator status of the observed species. A minimum 25% of the unit was sampled.
3. For bioretention units with woody and herbaceous species, both sampling methods were used. Stem density was counted for the woody species and quadrats were used to estimate coverage of herbaceous vegetation.

### **Wetland Indicator status (WIS)**

#### ***Native Plants***

Wetland Indicator Status (WIS) is a status (Reed 1998) used to designate a plant species' preference for occurrence in a wetland or in upland based on qualitative descriptions. The WIS for a given species will vary based upon region. Western Washington is in the Western Mountains, Valleys and Coast region. The WIS of plants within our region can be found on the USDA, Natural Conservation Service, Plants Database (USDA 2019a). Below are the categories and definitions for characterizing a plants preference for growing conditions:

OBL	Obligate Wetland	Hydrophyte	Almost always occur in wetlands
FACW	Facultative Wetland	Hydrophyte	Usually occur in wetlands, but may occur in non-wetlands
FAC	Facultative	Hydrophyte	Occur in wetlands and non-wetlands
FACU	Facultative Upland	Nonhydrophyte	Usually occur in non-wetlands, but may occur in wetlands
UPL	Obligate Upland	Nonhydrophyte	Almost never occur in wetlands

### ***Ornamental Plants***

The USDA assigns WIS to native plants and nonnative plants that occur frequently in the natural environment, such as Himalayan blackberry. In the bioretention cells, we found ornamental plant species, as well as native plants, had been installed. Since ornamental plants frequently do not have a WIS, we looked for an equivalent native plant, so we could assign the plant with a WIS where possible. For example, multiple varieties of red-twig dogwood (*Cornus alba*, previously known as *sericea*) were recorded in bioretention cells, varieties such as Kelsey's, or the variegated dogwood. Since these varieties do not have a WIS, we assigned the varieties the same WIS as the native red-twig dogwood (FACW).

### **RESULTS**

#### **Corner of Utter & Washington, Cell #5, Bellingham (Site BUW)**

Vegetative cover was measured on May 16, 2019 at Bellingham Cell #5 located at the northwest corner of Utter Street and Washington Street in Bellingham. According to our field measurements, the bottom of this cell is approximately 88 square feet (sf). The cell was constructed in July of 2017. The cell contains both woody and herbaceous vegetation; therefore, both sampling methods were used to collect vegetation data. Cell #5 contains 33 woody plants and approximately 945 woody stems. Woody cover was estimated at 60%. Percent cover of herbaceous vegetation was estimated in 31 quadrats in the cell. Herbaceous species in the sampled area averaged 19% basal cover.



Woody vegetation within the cell was composed of 25 shiny-leaf spirea (*Spiraea betuifolia* var. *lucida*) and 8 Kelsey's dwarf red-twig dogwood (*Cornus sericea* 'Kelseyi;'). The planting plan specified 81 spirea and 29 dwarf red-twig dogwoods. However, installing the specified quantity of shrubs would put the shrubs at less than one foot on center. Plant spacing was not listed in the plant schedule. We assume the cell was smaller than originally planned. The stem count for the dogwood was estimated at 320 and the stem count for the spirea was estimated at 625. Spirea has a tentative WIS of FAC (Native Plants PNW 2019). The dwarf red-twig dog was assigned the same WIS as the native red-twig dogwood of

FACW.

Per the approved plan, this cell was planted with thick-headed sedge (*Carex pachystachya*) (FAC), tufted hair grass (*Deschampsia caespitosa*) (FACW), golden and blue-eyed grass (*Sisyrinchium californicum*, *S. idahoense*) (FACW) Oregon iris (*Iris*

*tenax*) (UPL), and common rush (*Juncus effusus*)(FACW). We recorded all the specified herbaceous species growing in the bottom of the cell. Hairy cat's ear (*Hypochaeris radicata*) (FACU) was the one species recorded in the quadrats that was not per plan, and most likely volunteered in the cell.

Common rush was the dominant herbaceous vegetation and occurred in 45.2% of the quadrats. Plants rated FACW occurred in 80.6% of the quadrats, and included common rush, golden and blue-eyed grass, and tufted hairgrass. Plants rated FAC occurred in 22.6% of the quadrats, and 16.1% of the quadrats contained plants that have a WIS rating of UPL.

This Bellingham cell is located on a native outwash soil. Natural Resource Conservation Service (USDA NRCS 2019b) mapped soils in the area as Urban Land. The native soil is considered well-draining, and the cell has an underdrain. An infiltration test was conducted by the geologists. The bioretention soil infiltrated at approximately 310 inches/hour. The subgrade infiltration was low, but most of the water is interpreted to leave through the underdrain. See the Geotechnical Soils Assessment prepared by AESI (2019) for more information on the soils and the infiltration tests.

#### **Corner of Kentucky St. and Cornwall Ave., Site 2, Bellingham (Site BCK)**



Vegetative cover was measured on May 16, 2019 at Site 2, located at the southeast corner of Kentucky Street and Cornwall Avenue in Bellingham. According to our measurements, the bottom or footprint of the cell totaled approximately 34 square feet, an additional 9 square feet of the cell is unvegetated where the inlet is located. This cell was constructed in August 2016. This cell contains only herbaceous vegetation in the bottom of the cell. Percent cover of herbaceous vegetation was estimated in 17 quadrats.

Per the approved plan, this cell was planted with slough sedge (*Carex obnupta*) (OBL) and blue elk spreading rush (*Juncus patens* 'Blue Elk') (FACW). We recorded both the specified plants in addition to a few volunteers, such as oxeye daisy (*Leucanthemum vulgare*) (FACU) and similar weedy species.

Slough sedge is the only obligate plant growing in the cell and was recorded in 47% of the quadrats. The blue elk spreading rush occurred in 17.6% of the quadrats. Six of the quadrats contained plants that are FACU. All the FACU plants were volunteers within the cell, such as oxeye daisy and English plantain (*Plantago lanceolata*) (FACU). An upland plant, garden vetch (*Vicia sativa*) (UPL), also a volunteer, was found in two quadrats. Herbaceous species in the sampled area averaged 27% basal cover.

The Kentucky/ Cornwall cell is located on glaciomarine drift. The Natural Resource Conservation Service (USDA NRCS 2019b) maps the soils in the area of the cell as Urban Land. The cell has an underdrain surrounded by 16 inches of drain rock. The cell was designed to primarily discharge through the underdrain. An infiltration test was conducted by the geologists. The bioretention soil infiltrated at approximately 6.6 inches/hour. See the Geotechnical Soils Assessment prepared by AESI (2019) for more information on the soils and the infiltration tests.

### 3<sup>rd</sup> & Quinn, Marysville (Site M3Q)

Vegetative cover was measured on May 16, 2019 at the northeast corner of Quinn Avenue and 3<sup>rd</sup> Street in Marysville. This cell was constructed in the spring of 2018. According to our field measurements the cell bottom totaled approximately 162 square feet. The cell contains both woody and herbaceous vegetation; therefore, both sampling methods were used to collect vegetation data. This cell contains 7 woody plants and approximately 62 woody stems. Woody cover was estimated at 30%. Herbaceous vegetation was measured in 47 quadrats.



The planting plan for the cell at the corner of 3<sup>rd</sup> St. and Quinn Ave. is reflective of the woody plants that were present at the time of our survey. We recorded mid-winter fire red-twig dogwood (*Cornus sanguinea* 'Midwinter fire')(FACW), yellow twig dogwood (*Cornus sericea* 'Flaviramea') (FACW), evergreen huckleberry (*Vaccinium ovatum*) (FACU), and a sweet bay magnolia (*Magnolia Virginiana*). Sweet bay magnolia is native to the east coast (FACW) and great plains (OBL). We counted 62 stems for seven woody plants.

The herbaceous vegetation recorded in the cell differed in quantities from the approved plan but most of the plant species specified on the planting plan were installed within the cell. Per the approved plan we observed slough sedge, Western swordfern (*Polystichum munitum*) (UPL), Japanese silver grass (*Miscanthus sinensis* 'Morning light') (FAC), tufted hairgrass (*Deschampsia cespitosa*) (FACW), and sneezeweed (*Helenium* 'Sahin's early flowerer') (FACW). Common sneezeweed (*Helenium autumnale*) (FACW) is native to all but three states and tends to grow in wet areas. The plan specified approximately 100 golden variegated sweet flag (*Acorus granimeus*) (FACW) were to be installed in the footprint of the cell. We observed a few sweet flag plants and only one quadrat contained a sweet flag. Since this cell was installed recently, it is not likely that the sweet flag perished due to conditions, so we assume that it was not planted. We did not observe the seven cinnamon fern (*Osmundastrum cinnamomeum*) (FACW) or the crimson flag (*Hesperantha coccinea*) (FAC) specified on the plans. Oregon iris (UPL) was noted in the cell and is not on the plan.

Slough sedge, the only OBL plant within the cell occurred in 34% of the quadrats. Plants rated as FACW occurred in 23% of the quadrats, FAC plants occurred in 10% of the quadrats and 15% contained upland (UPL) plants. Herbaceous species in the sampled area averaged 21% basal cover.

The 3<sup>rd</sup> and Quinn cell is located on an outwash soil. The Natural Resource Conservation Service (USDA NRCS 2019b) maps the soils in the area of the cell as Ragnar fine sandy loam. The soil is considered well-draining. The cell does not have an underdrain and relies on 100% infiltration. An infiltration test was conducted by the geologists. The subgrade infiltrates at approximately 15 inches/ hour and the bioretention soil mix infiltrates more rapidly than 15 inches/ hour. (AESI 2019).

### **Marysville 1<sup>st</sup> Street LID, Cell S-1 (Site M1C)**



Vegetative cover was measured on May 16, 2019 on 1<sup>st</sup> Street in Cell S-1 located in Marysville. This cell is the third cell from the west. It was installed in the spring of 2018.

According to our field measurements, the bottom of this cell totals approximately 133 square feet. The cell contains both woody and herbaceous vegetation; therefore, both sampling methods were used to collect vegetation data. Cell S1 contains ten Kelsey's red-twig dogwood, and an estimated 300 stems (approximately 30 stems per shrub). Woody cover was estimated at 30%. Herbaceous vegetation in the cell was recorded within 33 quadrats.

The shrubs were installed per plan.

Per plan, the cell was planted with evercolor everillo sedge (*Carex oshimensis* Everillo) (FAC), Jakob Cline's bee balm (*Monarda didyma* 'Jakob Cline') (FAC), and Japanese iris (*Iris ensata*) (FAC). Ornamental sedges, such as evercolor everillo, prefer moist, well drained soils. The Japanese Iris was also assigned a WIS of FAC. According to the Missouri Botanical Garden website, the plants will grow in standing water and require constant moist soils, however, are intolerant of standing water in the winter, which may cause the rhizomes to rot.

Plants with a WIS of FAC occurred in 100% of the quadrats. One quadrat contained a willow herb (*Epilobium ciliatum*) (FACW). Herbaceous species in the sampled area averaged 24% basal cover.

The 1<sup>st</sup> Street cell is located on a native outwash soil. Natural Resource Conservation Service (USDA NRCS 2019b) mapped soils in the area as Ragnar fine sandy loam. The soil is considered well-draining. The cell does not have an underdrain and relies only on

infiltration. An infiltration test was conducted by the geologists. The subgrade infiltrates at approximately 17 inches/ hour and the bioretention soil mix infiltrates more quickly rapidly than 17 inches/ hour. (AESI 2019).

### **Salem Woods Middle School, Cell 2, Monroe (Site SSW)**

Vegetative cover was measured on May 16, 2019 at Salem Woods Middle School Cell #2. According to our field measurements, the bottom of Cell 2 totaled approximately 1,638 square feet. This cell was constructed in November 2018. The cell contains primarily herbaceous vegetation, except eight Kelsey's red-twig dogwoods installed around the inlets. Both sampling methods were used to collect vegetation data. Cell 2 contains eight woody plants and approximately 240 woody stems. Woody cover was estimated at 2.0%. Herbaceous vegetation in the cell was recorded within 192 quadrats.

Per plan, Kelsey's red-twig dogwood were installed around inlets of the bioretention cell. The cell was designed to have 11 salmonberry (*Rubus spectabilis*) (FAC) shrubs installed in the footprint. We did not observe salmonberry shrubs growing within the cell.



Herbaceous vegetation in Cell 2 consisted of slough sedge, small fruited bulrush (*Scirpus microcarpus*) (OBL), tapered bulrush (*Juncus acuminatus*) (OBL), iris tenax (UPL), and common spike rush (*Eleocharis palustris*) (OBL). The plan also includes hardstem bulrush (*Scirpus acutus*) (OBL), but we did not observe any growing in the bottom of the cell. Per the plan, slough sedge was to comprise 40% of the installed plants, while the five other herbaceous plants made up the remaining 60% of the plants. Slough sedge was only recorded in 12 quadrats and the other plants were recorded in greater quantities, so the plants do not appear to be installed in the specified quantities.

Within this bioretention cell 97.3% of the sampled area contained OBL plants, and 12.6% contained upland plants. Oregon iris and garden vetch comprised the upland plants. Herbaceous species in the sampled area averaged 6.0% basal cover.

The Salem Woods cell is located on a native outwash soil. USDA NRCS (2019b) mapped soils in the area as Tokul and Tokul Wiston gravelly loams. The native soil is considered well-draining. The cell does not have an underdrain and relies only on infiltration. An infiltration test was conducted by the geologists. Water accumulated on the underlying subgrade. The bioretention soil mix infiltrated at a field rate of 16 inches per hour (AESI 2019).

This cell is irrigated and mulched with a large shredded wood mulch.

### **Park Place Middle School, Monroe (Site MPP)**

Vegetative cover was measured on May 16, 2019 in Cell #6 adjacent to the football field at Park Place Middle School. According to our field measurements, the bottom of this cell totaled approximately 336 square feet. This cell was constructed in the summer of 2017. The cell contains both woody and herbaceous vegetation; therefore, both sampling methods were used to collect vegetation data. The cell contains 14 woody plants and 14 woody stems. Overall woody cover was estimated at 5%. Herbaceous vegetation in the cell was recorded within 80 quadrats.



The plan specifies twenty salmonberry for installation in the bottom of the cell near the inlet. We counted twelve salmonberry and two red alder (*Alnus rubra*) (FAC) saplings within the bottom of the cell.

The planting plan and plant densities for herbaceous species at Park Place is the same as the Salem Woods School described above. This cell is approximately a year older than the Salem Woods cell. We did not record bulrush, iris tenax, or common spike rush growing in the bottom of the cell. Several plant species had volunteered in the cell including willow herb, hairy cats' ear, and garden vetch.

We recorded OBL plants in 69% of the quadrats. All OBL plants were installed in the cell. Based on the results for Salem Woods where 97% of the quadrats contained installed plant material, approximately 25% of the installed plants have died within this cell, if it was installed per plan. The “weedy” plants comprised the other wetland indicator statuses. Plants rated as FACW (willow herb) were observed in 13.8% of the cells, plants rated as FACU occurred in 3.8% of the quadrats, and UPL species were counted in 8.8% of the cells. Herbaceous species in the sampled area averaged 9.2% basal cover.

The Park Place cell is located on a native alluvium soil. Natural Resource Conservation Service (USDA NRCS 2019b) mapped soils in the area as Sultan silt loam. The native soil is considered well-draining. The cell does not have an underdrain and relies only on infiltration. An infiltration test was conducted by the geologists. The subgrade infiltrates at approximately 3 inches/ hour and the bioretention soil mix infiltrates more quickly rapidly than 3 inches/ hour. (AESI 2019).

This cell is irrigated and is mulched with a large shredded wood mulch.

### **Wilson High School, Tacoma (Site TWH)**

Vegetative cover was measured on May 30, 2019 at Wilson High School in a large bioretention cell located between a storm water pond and a parking lot in the vicinity of the sports fields. According to our field measurements, the bottom of this cell totaled

approximately 1,260 square feet. This cell was constructed sometime between June 2016 and May 2017. The cell contains only herbaceous vegetation. Herbaceous vegetation in the cell was recorded with 222 quadrats.



We were unable to obtain a planting plan for this cell. Based on our observation of what was present in the cell, we assume the cell was planted with slough sedge (OBL), common rush (FACW), and tapered rush (*Juncus acuminatus*) (OBL). We observed many dead and drought-stressed slough sedge at the south end of the cell. Much of the herbaceous vegetation was comprised of plants that would be considered weeds, such as prickly sow thistle (*Sonchus asper*) (FACU), perennial ryegrass (*Lolium perenne*) (FAC), hairy cat's ear (FACU), and several other weedy plant species. Plants with a status of OBL occurred in 43% of the quadrats. The most common within the OBL plants was the slough sedge. The installed common rush, volunteer willow herb, reed canarygrass (*Phalaris arundinacea*), and field mint (*Mentha arvensis*), all FACW plants, occurred in 9.0% of the cells. The remaining plants, which we assume are volunteers, have a WIS of FAC or drier. Plants with a WIS of FAC occurred in 55% of the quadrats. Plants with a WIS of FACU occurred in 32% of the quadrats, and upland plants occurred in 6.0% of the quadrats. Herbaceous species in the sampled area averaged 17% basal cover. The installed herbaceous plants averaged 19% basal cover, while the volunteer plants only average 6.8% cover. The installed plants provide greater basal cover, and probably root mass, than the volunteer plants.

This cell is located on a Vashon Lodgment till. The Natural Resource Conservation Service (USDA NRCS 2019b) does not have data for soil in this area. This cell has three underdrains. When doing the infiltration test, the geologists were unable to get the entire footprint of the cell wetted. The cell drains through the underdrains prior to the cell filling with water, and the bioretention soil mix infiltrates at 11 to 25 inches/ hour (AESI 2019). The hydrology in the cell explains why much of the assumed installed vegetation is dead, and weedy plants that prefer growing in uplands are growing in the bottom of the cell.

This cell is not irrigated. This cell is probably not maintained since it is not located in an area that is highly visible.

### **Bush Middle School, Tumwater (Site TBM)**

Vegetative cover was measured on May 30, 2019 at Bush Middle School in a cell located in the back of the building adjacent to a small parking area. This cell was constructed in the summer of 2016 based on a review of aerial photography (Google Earth 2019). According to our field measurements, the bottom of this cell totaled approximately 110 square feet. The cell contains both woody and herbaceous vegetation; therefore, both

sampling methods were used to collect vegetation data. The cell contains 9 woody plants and stems. Overall woody cover was estimated at 15%. Herbaceous vegetation was recorded in 64 quadrats.

We counted four dwarf arctic willow (*Salix purpurea* 'nana') (FACW), and five dogwood shrubs. Per the as-built plans, four willows, thirteen red-twig dogwoods, and 13 yellow-twig dogwoods (*Cornus sericea* 'flavireamea') (FACW) were installed. The dogwoods were very small, and it appears the shrubs are browsed heavily by deer. We did not observe any deer on site, but deer are known to eat dogwood shrubs.

According to the planting plan, seven slender rush (*Juncus tenuis*) were supposed to be installed in the cell. However, we identified the rush as common rush. Much of the herbaceous vegetation was comprised of plants that would be considered weeds, such as



mare's tale (*Coryza canadensis*) (UPL), spiny sowthistle (FACU), Kentucky bluegrass (*Poa pratensis*) (FAC), along with other common garden weeds. Plants rated as FACW occurred in 37.5% of the quadrats, this accounts for the installed rush and volunteer willow herb. Plants rated as FAC, primarily Kentucky bluegrass, occurred in 25% of the quadrats. Plants rated as FACU occurred in 100% of the quadrats, and UPL plants, primarily mare's tale, occurred in 33% of the quadrats. No plants rated as OBL were recorded in this cell. Herbaceous species in the sampled area averaged 14.5% basal cover. The installed herbaceous plants averaged 24% basal cover, and the volunteer plants averaged 10.2% cover.

Volunteer plants have a greater density overall in the cell, but on a plant by plant basis provide less basal cover than the installed species.

The Bush Middle School cell is located on a native outwash soil. Natural Resource Conservation Service (USDA NRCS 2019b) mapped soils in the area as Cagey loamy sand. The native soil is considered well-draining. The cell does not have an underdrain and relies only on infiltration. An infiltration test was conducted by the geologists. The subgrade infiltrates at approximately 8 inches/ hour and the bioretention soil mix infiltrates more quickly rapidly than 8 inches/ hour. (AESI 2019).

Due to the quantity of weeds growing in the cell, we assume it is not maintained, at least not regularly. The cell did not appear to be irrigated.

### **Wainwright Intermediate School, Fircrest (Site FWI)**

Vegetative cover was measured on June 5, 2019 in Cell #4, located in the middle of the parking lot, at Wainwright Intermediate School. According to our field measurements, the bottom of Cell #4 totaled approximately 170 square feet. The plan specified only

herbaceous vegetation for installation. However, two river birch (*Betula nigra*) (FACW) have volunteered within the cell. The birch saplings provide 5% woody cover.



Herbaceous vegetation was measured with 44 quadrats in the bottom of the cell. Per plan, twenty-seven small-fruited bulrush and eighteen brown sedge (*Carex testacea*) (FAC) were installed in the cell; however, we did not observe either of those plants within the bottom of the cell. It appears slough sedge was installed at the bottom of the cell instead of the two specified plants. Similar to the cell at Bush Middle School, most of the plants growing within the cell would be considered weeds. The most prevalent weed growing was bull thistle (*Cirsium vulgare*) (FACU). Plants rated as FACU, primarily bull thistle, occurred in 100% of the quadrats. Kentucky bluegrass (FAC) was the most dominant plant with that rating, and FAC plants occurred in 70% of the quadrats. Plants with a WIS of FACW occurred in 38% of the quadrats, and the installed slough sedge occurred in 34% of the quadrats. The slough sedge was more robust at the north end of the cell; most likely the water pools at that end of the cell. Herbaceous species in the sampled area averaged 5.5% basal cover.

This cell is located on a native outwash soil. The Natural Resource Conservation Service (USDA NRCS 2019b) mapped the soil in this location as Alderwood gravelly sandy loam. The native soil is considered well-draining. This cell has an underdrain. An infiltration test was conducted by the geologists. The bioretention soil mix infiltrates at about 66 inches/ hour. (AESI 2019).

### **Harrington Avenue NE, Renton (Site RSH)**

Vegetative cover was measured on June 5, 2019 in Cell E2 located at the northwest corner of NE 8<sup>th</sup> St. and Harrington Ave. NE. According to our field measurements, the bottom of this cell totaled approximately 60 square feet. The cell contained only herbaceous vegetation, which was recorded in 21 quadrats.



The plants observed growing in the cell are per plan. The plan lists a variety of native and non-native rush species including elk blue rush, common rush, and slender rush. Both native rushes have a WIS of FACW, therefore the non-native elk blue rush was assigned a WIS of FACW. Pacific coast iris (*Iris douglasiana*) (UPL) was also listed on the plan, which was recorded in one quadrat. Four quadrats contained no plants. We recorded a rush species or multiple rush species in 100%

of the cells, therefore the dominant vegetation in the cell has a WIS of FACW. Herbaceous species in the sampled area averaged 25.5% basal cover.

The Harrington cell is located on an outwash soil. The Natural Resource Conservation Service (USDA NRCS 2019b) mapped the soil in this location as Ragnar-Indianola Association soils. This cell has a rock trench under the bioretention mix and an underdrain. An infiltration test was conducted by the geologists. The bioretention soil mix infiltrates at than 2 inches/ hour, which is a relatively low infiltration rate. However, do to flaws in the design or execution the geologist believe the cell will experience more frequent bypass overflows. Essentially, the cell will dump water as opposed to filling and infiltrating the water (AESI 2019).

## CONCLUSIONS

Many of these cells have only been planted in the past year or two. Drawing conclusions on the overall health and survival of the plants is difficult since the plants have not had much time to establish and adjust to the hydrologic conditions in the cells. Also, many of the cells we looked at only contained herbaceous plant material, which makes it difficult to draw conclusions about woody material. However, it appears that the use of the dwarf red-twig dogwood is becoming more common in the bioretention cells. We do not know yet whether the dwarf versions will be as successful as the native and full-size dogwoods which grow well in seasonal standing water and are somewhat drought tolerant.

The herbaceous plants specified in the planting plans tend toward plants with a WIS of OBL and FACW. However, most of the cells are very well draining, and plants that need a consistent hydrologic regime either do not survive or struggle to survive. The cells with underdrains infiltrated most rapidly (AESI 2019). The cells with underdrains probably drain better than most residential gardens. We found that most of the volunteer (weedy) plants in the cells have a WIS of FACU, and these plants are growing well in the cells. If the cell has underdrains, drought tolerant plants installed further from the inlet may be a better option than installing wetland-like plants throughout the bottom of the cell. In cells located on well-draining soil without underdrains, plants with a rating of FAC would be a better option than obligate plants. From the previous study, we found the exception is slough sedge (OBL), which seems to tolerate well-draining soils if irrigation is present.

Weedy plants have readily volunteered in the cells where the installed plant material had died. Weedy plants provide tilth and root mass; however, they provide less basal cover than many of the installed plants. The basal cover provided by plants may play a long-term role in creating space for water to infiltrate as sediments accumulate.

In the long run, we expect shrubs will provide more tilth and therefore help keep the water draining more effectively as the cells begin to age and sediments accumulate.

Shrubs also seem to adapt to a variety of hydrologic regimes better than many herbaceous species, and they help minimize the weeds in the cell by providing shade and competition. Shrubs can be problematic due to their large size if site lines are needed; however, it appears that many designers are using smaller shrubs in the cells, like the Kelsey red-twig dogwood, and shiny spirea. Although herbaceous vegetation is more difficult to establish in bioretention cells, herbaceous vegetation plays an important role in maintaining the tilth of the soil with the roots and adding organic matter as the plants senesce. The herbaceous plants also add visual interest to bioretention cells.

The engineering of the bio-retention cells takes a team of people. It is important to understand the soils under the cells and the models for the cells and their drainage patterns prior to choosing a plant pallet.

## LITERATURE CITED

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2017-114 Olympia Bioretention Study  
 Spring 2019

**BELLINGHAM - CORNER OF UTTER AND WASHINGTON**

Plot Size: 39.25 x 2.75

**Woody Cover:**

60%

**Woody Shrub**

<u>Species</u>	<u>Plant Count</u>	<u>Stems</u>
SPBE	25	625
COSE-KE	8	320
	<b>33</b>	<b>945</b>

**Herb Quadrats**

**Plant List**

<u>Quad. #</u>	<u>Species</u>	<u>% Cover</u>	<u>WIS</u>	<u>Code</u>	<u>Name</u>
1	0	0	0	JUEF	<i>Juncus effusus</i>
2	JUEF	10	FACW	CAPA	<i>Carex pachystachya</i>
3	CAPA	25	FAC	SPBE	<i>Spiraea betulifolia</i>
3	JUEF	10	FACW	COSE	<i>Cornus sericea</i>
4	JUEF	20	FACW	IRTE	<i>Iris tenax</i>
5	CAPA	50	FAC	DECE	<i>Deschampsia caespitosa</i>
7	JUEF	40	FACW	HYRA	<i>Hypochaeris radicata</i>
7	CAPA	25	FAC		
9	JUEF	25	FACW		
10	SPBE	25			
10	CAPA	1	FAC		
11	JUEF	20	FACW		
14	IRTE	15	UPL		
15	IRTE	30	UPL		
15	JUEF	10	FACW		
16	IRTE	25	UPL		
16	DECE	25	FACW		
17	JUEF	50	FACW		
18	SISP	15	FACW		
19	JUEF	30	FACW		
19	SISP	10	FACW		
20	SISP	5	FACW		
21	JUEF	35	FACW		
21	SISP	7	FACW		
22	SISP	7	FACW		
23	JUEF	15	FACW		
23	SISP	7	FACW		
24	SISP	1	FACW		
25	JUEF	10	FACW		
25	SISP	4	FACW		
25	Grass sp	3	FAC		
27	SISP	50	FACW		

27	JUEF	3	FACW
28	HYRA	1	FACU
29	IRTE	50	UPL
30	CAPA	20	FAC
30	IRTE	15	UPL
30	SISP	3	FACW
31	CAPA	50	FAC
31	JUEF	10	FACW

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**BELLINGHAM CORNER OF CORNWALL & KENTUCKY**

Plot Size: 17 x 2

**Woody Cover:**

0%

**Woody Shrub**

<u>Species</u>	<u>Plant Count</u>	<u>Stem Count</u>
SPDO		
COSE-FL		

**Herb Quadrats**

**Plant List**

<u>Quad. #</u>	<u>Species</u>	<u>% Cover</u>	<u>WIS</u>	<u>Code</u>	<u>Name</u>
1	LASE	2	FACU	JUPA	<i>Juncus patens</i> -BLUE ELK
1	LEVU	2	FACU	CAPA	<i>Carex pachystachya</i>
2	Vetch	2	UPL	SPBE	<i>Spiraea betulifolia</i>
2	LEVU	1	FACU	COSE	<i>Cornus sericea</i>
2	0			IRTE	<i>Iris tenax</i>
2	TAOF	1	FACU	DECE	<i>Deschampsia caespitosa</i>
3	0			SI SP	<i>Sisyrinchium species</i>
4	PLLA	1	FACU	HYRA	<i>Hypochaeris radicata</i>
4	Vetch	1	UPL	LEVU	<i>Leucanthemum vulgare</i>
5	0			PLLA	<i>Plantago lanceolata</i>
6	JUPA	80	FACW	CAOB	<i>Carex obnupta</i>
7	JUEF	25	FACW	LASE	<i>Lactuca serriola</i>
8	CAOB	50	OBL	Vetch	<i>Vichia sativa</i>
9	CAOB	30	OBL		
10	JUEF	50	FACW		
10	TAOF	2	FACU		
11	CAOB	50	OBL		
12	0				
13	CAOB	60	OBL		
14	CAOB	40	OBL		
15	CAOB	25	OBL		
16	CAOB	75	OBL		
17	CAOB	15	OBL		

**MARYSVILLE 3RD & QUINN**

**Woody Cover:**

30%

**Woody Shrub**

<u>Species</u>	<u>Plant Count</u>	<u>Stem Count</u>
COSE	2	17
COEL	2	16
VAOV	2	16
Magnolia Tree	1	13

**Herb Quadrats**

<u>Quad. #</u>	<u>Species</u>	<u>% Cover</u>	<u>WIS</u>
1	CAOB	50	OBL
2	CAOB	20	OBL
3	CAOB	50	OBL
4	CAOB	7	OBL
5	COSE	100	
6	POMU	15	UPL
6	VAOV	5	
7	0		
8	0		
9	Woody		
10	CAOB	1	OBL
11	ACGR	15	FACW
11	MISI	5	FAC
12	CAOB	20	OBL
13	CAOB	10	OBL
13	TAOF	1	FACU
14	CAOB	5	OBL
15	CAOB	1	OBL
16	HESA	10	FACW
16	MISI	7	FAC
17	COSE	0	
18	MISI	50	FAC
19	0		
20	0		
21	Woody		
22	0		
23	0		
24	0		
25	MISI	75	FAC
26	HESA	80	FACW
27	HESA	50	FACW
27	POMU	25	UPL
28	CAOB	10	OBL
29	POMU	30	UPL
30	CAOB	10	OBL
31	IRTE	3	UPL

**Plant List**

<u>Code</u>	<u>Name</u>
JUEF	<i>Juncus effusus</i>
CAPA	<i>Carex pachystachya</i>
SPBE	<i>Spiraea betulifolia</i>
COSE	<i>Cornus sericea</i>
IRTE	<i>Iris tenax</i>
DECE	<i>Deschampsia caespitosa</i>
SI SP	<i>Sisyrinchium species</i>
	<i>CALIFORNICUM OR IDAHOENSIS</i>
HYRA	<i>Hypochaeris radicata</i>
LEVU	<i>Leucanthemum vulgare</i>
PLLA	<i>Plantago lanceolata</i>
CAOB	<i>Carex obnupta</i>
Rud	<i>Rudbeckia</i>
VAOV	<i>Vaccinium ovatum</i>
ACGR	<i>Acorus gramineus</i>
MISI	<i>Miscanthus sinensis</i>
EQAR	<i>Equisetum arvense</i>
POMU	<i>Polystichum munitum</i>
HESA	<i>Helenium 'Sahin's early flowerer'</i>

32	IRTE	30	UPL
33	IRTE	25	UPL
33	HESA	10	FACW
34	HESA	10	FACW
34	CAOB	8	OBL
35	HESA	15	FACW
35	CAOB	1	OBL
36	COSE		
36	EQAR	3	FAC
37	Woody		
38	0		
39	0		
40	POMU	25	UPL
41	Woody		
42	CAOB	10	OBL
43	HESA	50	FACW
44	HESA	25	FACW
44	CAOB	5	OBL
45	HESA	15	FACW
46	DECE	10	FACW
47	CAOB	15	OBL

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**MARYSVILLE 1ST & STATE**

Plot Size: 33.2 x 4

**Woody Cover:**

20%

**Woody Shrub**

<u>Species</u>	<u>Plant Count</u>	<u>Stem Count</u>
COKE	10	30



**Herb Quadrats**

**Plant List**

<u>Quad. #</u>	<u>Species</u>	<u>% Cover</u>	<u>WIS</u>
1	MODI	25	FAC
2	MODI	18	FAC
3	IRSE	75	FAC
4	IRSE	15	FAC
4	MODI	6	FAC
5	MODI	10	FAC
6	Woody		
6	MODI	16	FAC
7	Woody		
7	MODI	10	FAC
8	CAOS	50	FAC
9	COSE	75	
9	CAOS	15	FAC
10	Woody		
11	Woody		
12	Woody		
12	EPAN	1	FACW
13	IRSE	25	FAC
14	IRSE	50	FAC
15	MODI	20	FAC
15	IRSE	15	FAC
16	IRSE	30	FAC
16	MODI	6	FAC
17	IRSE	40	FAC
17	MODI	4	FAC
18	Woody		
18	MODI	4	FAC
19	CAOS	15	FAC
20	CAOS	30	FAC
21	CAOS	15	FAC
22	CAOS	30	FAC
23	CAOS	30	FAC
24	CAOS	50	FAC
25	COSE	0	
26	CAOS	30	FAC
27	CAOS	10	FAC
28	CAOS	20	FAC
28	Woody		FAC
29	0		
30	CAOS	25	FAC

<u>Code</u>	<u>Name</u>
CAOS	<i>Carex oshimensis</i>
COSE	<i>Cornus sericea</i>
MODI	<i>Monarda didyma 'Jakob Cline'</i>
IRSE	<i>Iris ensata</i>
EPAN	<i>EPILOBIUM ANGUSTI (CHAMERION)</i>

30	MODI	4	FAC
31	IRSE	50	FAC
32	MODI	25	FAC
33	IRSE	30	FAC

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**SALEM WOODS**

Plot Size: 43 x 29

**Woody Cover:**

2%

**Woody Shrub**

<u>Species</u>	<u>Plant Count</u>	<u>Stem Count</u>
COKE	8	

**Herb Quadrats**

**Plant List**

<u>Quad. #</u>	<u>Species</u>	<u>% Cover</u>	<u>WIS</u>
1	SCMI	2	OBL
2	SCMI	2	OBL
2	JUAC	1	OBL
3	JUAC	2	OBL
4	JUAC	2	OBL
5	JUAC	2	OBL
6	ViSA	1	UPL
6	JUAC	1	OBL
7	JUAC	6	OBL
8	SCMI	5	OBL
8	ELPA	2	OBL
9	ELPA	3	OBL
9	SCMI	2	OBL
10	ELPA	2	OBL
11	IRTE	3	UNK.
12	IRTE	2	UNK.
12	ELPA	1	OBL
13	IRTE	3	UNK.
14	IRTE	1	UNK.
15	ELPA	3	OBL
16	ELPA	6	OBL
17	SCMI	4	OBL
18	SCMI	2	OBL
19	SCMI	10	OBL
20	SCMI	10	OBL
20	IRTE	2	UNK.
21	SCMI	10	OBL
21	ELPA	2	OBL
22	SCMI	5	OBL
22	ELPA	2	OBL
23	ELPA	6	OBL
24	ELPA	4	OBL

<u>Code</u>	<u>Name</u>
CAOS	<i>Carex oshimensis</i>
COSE	<i>Cornus sericea</i>
MODI	<i>Monarda</i>
IRTE	<i>Iris tenax</i>
ELPA	<i>Eleocharis palustris</i>
SCMI	<i>Scirpus microcarpos</i>
JUAC	<i>Juncus acuminatus</i>
VISA	<i>Vichia sativa</i>

25	ELPA	8	OBL
26	IRTE	6	UNK.
27	IRTE	10	UNK.
28	IRTE	10	UNK.
29	IRTE	6	UNK.
29	ELPA	4	OBL
30	SCMI	4	OBL
31	SCMI	10	OBL
32	IRTE	3	UNK.
33	SCMI	10	OBL
34	IRTE	2	UNK.
35	SCMI	5	OBL
36	ELPA	5	OBL
37	ELPA	5	OBL
38	ELPA	1	OBL
39	ELPA	1	OBL
40	ELPA	1	OBL
41	SCMI	5	OBL
42	SCMI	10	OBL
43	SCMI	10	OBL
44	SCMI	12	OBL
45	SCMI	12	OBL
46	ELPA	10	OBL
47	SCMI	5	OBL
47	ELPA	2	OBL
48	SCMI	10	OBL
49	SCMI	15	OBL
50	SCMI	7	OBL
51	SCMI	7	OBL
52	SCMI	10	OBL
53	SCMI	7	OBL
54	ELPA	5	OBL
54	SCMI	5	OBL
55	ELPA	6	OBL
56	ELPA	7	OBL
57	ELPA	8	OBL
58	ELPA	5	OBL
59	SCMI	7	OBL
60	SCMI	5	OBL
61	SCMI	15	OBL
62	0		
63	ELPA	1	OBL
64	ELPA	1	OBL
65	SCMI	7	OBL
66	SCMI	8	OBL
67	SCMI	5	OBL
68	SCMI	12	OBL

69	ELPA	3	OBL
70	SCMI	12	OBL
71	ELPA	3	OBL
72	ELPA	7	OBL
73	ELPA	3	OBL
74	ELPA	3	OBL
75	ELPA	2	OBL
76	0		
77	ELPA	2	OBL
78	ELPA	3	OBL
79	SCMI	10	OBL
79	ELPA	2	OBL
80	ELPA	4	OBL
80	IRTE	1	UNK.
81	ELPA	3	OBL
82	ELPA	5	OBL
83	ELPA	5	OBL
84	SCMI	12	OBL
85	SCMI	15	OBL
86	SCMI	10	OBL
87	SCMI	7	OBL
88	SCMI	7	OBL
88	ELPA	2	OBL
89	ELPA	6	OBL
90	SCMI	10	OBL
91	SCMI	12	OBL
92	ELPA	10	OBL
93	ELPA	3	OBL
94	ELPA	10	OBL
95	ELPA	6	OBL
95	IRTE	2	UNK.
96	SCMI	8	OBL
97	SCMI	8	OBL
98	ELPA	9	OBL
99	ELPA	9	OBL
100	ELPA	3	OBL
101	ELPA	6	OBL
102	ELPA	3	OBL
103	ELPA	6	OBL
104	ELPA	2	OBL
105	SCMI	10	OBL
106	SCMI	20	OBL
107	SCMI	10	OBL
108	ELPA	6	OBL
108	SCMI	5	OBL
109	SCMI	5	OBL
109	IRTE	2	UNK.

110	SCMI	7	OBL
111	SCMI	3	OBL
112	SCMI	5	OBL
113	SCMI	6	OBL
114	SCMI	4	OBL
115	ELPA	6	OBL
115	SCMI	4	OBL
116	SCMI	15	OBL
116	VISA	1	UPL
117	SCMI	7	OBL
117	ELPA	5	OBL
118	ELPA	5	OBL
119	JUAC	5	OBL
120	JUAC	10	OBL
121	JUAC	3	OBL
122	0		
123	0		
124	JUAC	10	OBL
125	IRTE	2	UNK.
126	CAOB	7	OBL
126	IRTE	2	UNK.
127	IRTE	4	UNK.
128	CAOB	12	OBL
129	CAOB	10	OBL
130	CAOB	25	OBL
131	CAOB	10	OBL
132	CAOB	10	OBL
133	SCMI	7	OBL
134	SCMI	10	OBL
135	SCMI	7	OBL
136	ELPA	3	OBL
136	VISA	1	UPL
137	ELPA	9	OBL
138	ELPA	7	OBL
139	ELPA	9	OBL
140	ELPA	3	OBL
141	SCMI	5	OBL
142	0		
143	0		
144	SCMI	5	OBL
145	IRTE	3	UNK.
146	IRTE	5	UNK.
147	IRTE	2	UNK.
148	SCMI	5	OBL
149	SCMI	10	OBL
150	SCMI	12	OBL
151	SCMI	9	OBL

152	SCMI	7	OBL
153	SCMI	8	OBL
154	SCMI	7	OBL
155	SCMI	10	OBL
156	SCMI	1	OBL
157	SCMI	7	OBL
158	SCMI	10	OBL
159	SCMI	4	OBL
160	SCMI	7	OBL
161	IRTE	2	UNK.
162	SCMI	6	OBL
163	SCMI	10	OBL
164	SCMI	10	OBL
165	SCMI	3	OBL
166	0		
167	JUAC	1	OBL
168	JUAC	1	OBL
169	SCMI	5	OBL
170	SCMI	7	OBL
171	SCMI	10	OBL
172	JUAC	3	OBL
172	ELPA	2	OBL
173	JUAC	5	OBL
174	JUAC	5	OBL
174	vetch	1	UPL
175	JUAC	7	OBL
175	ELPA	3	OBL
176	SCMI	10	OBL
177	SCMI	5	OBL
178	SCMI	5	OBL
179	SCMI	12	OBL
180	SCMI	5	OBL
181	IRTE	3	UNK.
182	IRTE	3	UNK.
182	SCMI	3	OBL
183	IRTE	3	UNK.
184	CAOB	5	OBL
185	CAOB	12	OBL
186	CAOB	10	OBL
187	CAOB	12	OBL
188	CAOB	10	OBL
189	CAOB	8	OBL
190	CAOB	9	OBL

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**PARK PLACE MIDDLE SCHOOL**

Plots Size: 32 x 10.5, 52 x 22

**Woody Cover:**

**Woody Shrub**

<u>Species</u>	<u>Plant Count</u>	<u>Stem Count</u>
RUSP	12	
ALRU	2	

**Herb Quadrats**

**Plant List**

<u>Quad. #</u>	<u>Species</u>	<u>% Cover</u>		<u>Code</u>	<u>Name</u>
1	EPCI	1	FACW	CAOS	<i>Carex oshimensis</i>
1	vetch	1	UPL	COSE	<i>Cornus sericea</i>
2	EPCI	25	FACW	MODI	<i>Monarda</i>
3	HYRA	5	FACU	IRTE	<i>Iris tenax</i>
4	TAOF	5	FACU	ELPA	<i>Eleocharis palustris</i>
4	EPCI	1	FACW	SCMI	<i>Scirpus microcarpos</i>
4	VISA	1	UPL	JUAC	<i>Juncus acuminatus</i>
5	VISA	1	UPL	EPCI	<i>Epilobium ciliatum</i>
6	EPCI	5	FACW	HYRA	<i>Hypochaeris radicata</i>
7	VISA	1	UPL	TAOF	<i>Taraxacum officinale</i>
8	SCMI	4	OBL	JUEF	<i>Juncus effusus</i>
8	vetch	1	UPL	RUAR	<i>Rubus armeniacus</i>
10	0			RARE	<i>Ranunculus repens</i>
11	SCMI	5	OBL	HODI	<i>Holodiscus discolor</i>
11	vetch	1	UPL	VISA	<i>Vichia sativa</i>
12	SCMI	1	OBL		
13	SCMI	5	OBL		
14	SCMI	6	OBL		
14	HYRA	5	FACU		
14	EPCI	2	FACW		
15	SCMI	5	OBL		
16	SCMI	6	OBL		
17	SCMI	15	OBL		
18	SCMI	5	OBL		
19	SCMI	10	OBL		
19	vetch	1	UPL		
20	SCMI	5	OBL		
21	SCMI	9	OBL		
22	SCMI	6	OBL		
22	HOLA	1	FAC		
23	JUAC	7	OBL		

24	JUAC	25	OBL
25	JUAC	9	OBL
26	JUAC	5	OBL
26	SCMI	1	OBL
27	JUAC	20	OBL
28	JUAC	1	OBL
28	SCMI	1	OBL
29	CAOB	6	OBL
29	SCMI	5	OBL
30	CAOB	50	OBL
31	CAOB	5	OBL
31	SCMI	5	OBL
32	CAOB	20	OBL
33	CAOB	10	OBL
34	CAOB	25	OBL
35	CAOB	20	OBL
35	JUEF	5	OBL
36	0		
37	CAOB	25	OBL
38	CAOB	1	OBL
39	CAOB	20	OBL
40	CAOB	30	OBL
41	0		
42	CAOB	30	OBL
43	SCMI	2	OBL
44	SCMI	3	OBL
45	SCMI	15	OBL
46	CAOB	25	OBL
47	CAOB	40	OBL
48	CAOB	40	OBL
49	CAOB	25	OBL
50	CAOB	5	OBL
51	CAOB	10	OBL
51	JUAC	2	OBL
52	0		
53	CAOB	5	OBL
54	SCMI	2	OBL
55	CAOB	30	OBL
56	0		
57	CAOB	25	OBL
58	0		
59	0		
60	0		
61	SCMI	1	OBL
62	0		
63	0		
64	EPCI	7	FACW

65	EPCI	5	FACW
65	TAOF	1	FACU
65	RUAR	1	FAC
66	EPCI	1	FACW
67	RARE	10	FAC
68	EPCI	10	FACW
69	EPCI	5	FACW
70	HOLA	1	FAC
70	EPCI	1	FACW
71	0		
72	SCMI	1	OBL
73	0		
74	0		
75	0		
76	0		
77	CAOB	2	OBL
78	JUAC	3	OBL
79	JUAC	2	OBL
80	0		

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**WILSON HIGH SCHOOL TACOMA**

Plot Size: 84 x 15

**Woody Cover:**

No shrubs

**Woody Shrub**

<u>Species</u>	<u>Plant Count</u>	<u>Stem Count</u>
	No shrubs	

**Herb Quadrats**

**Plant List**

<u>Quad. #</u>	<u>Species</u>	<u>% Cover</u>	<u>WIS</u>	<u>Code</u>	<u>Name</u>
1	HOLA	15	FAC	HOLA	<i>Holcus lanatus</i>
2	HYRA	5	FACU	HYRA	<i>Hypochaeris radicata</i>
3	HOLA	10	FAC	LOPE	<i>Lolium perenne</i>
3	CHJU	10	UPL	FERU	<i>Festuca rubra</i>
4	HOLA	15	FAC	FEAR	<i>Festuca arundinacea</i>
4	CHJU	15	UPL	SOAS	<i>Sonchus asper</i>
5	CHJU	25	UPL	CAEX	<i>Castilleja exserta</i>
6	HOLA	3	FAC	SIAL	<i>Sisymbrium altissimum</i>
6	MYMU	3	UPL	MYMU	<i>Mycelis muralis</i>
7	PHAR	25	FACW	PHAR	<i>Phalaris arundinacea</i>
8	PHAR	25	FACW	PLLA	<i>Plantago lanceolata</i>
8	LOPE	15	FAC	CAOB	<i>Carex obnupta</i>
9	PHAR	25	FACW	TAOF	<i>Taraxacum officinale</i>
9	LOPE	5	FAC	VIAM	<i>Vicia americana</i>
10	LOPE	50	FAC	EPCI	<i>Epilobium ciliatum</i>
11	PLLA	20	FACU	LEVU	<i>Leucanthemum vulgare</i>
11	HYRA	15	FACU	TAVU	<i>Tanacetum vulgare</i>
11	LOPE	10	FAC	CEGL	<i>Cerastium glomeratum</i>
11	MEAR	1	FACW	JUAC	<i>Juncus acuminatus</i>
12	LOPE	50	FAC	CIHO	<i>Cirsium horridulum</i>
12	CAOB	5	OBL	JUEF	<i>Juncus effesus</i>
12	PLLA	5	FACU	CHJU	<i>Chondrilla juncea</i>
13	FERU	15	FAC	CAEX	<i>Castilleja exserta</i>
13	LOPE	15	FAC	TRRE	<i>Trifolium repens</i>
13	PLLA	5	FACU	TRPR	<i>Trifolium pratense</i>
14	LOPE	50	FAC	VISA	<i>Vicia sativa</i>
14	PLLA	3	FACU		
15	SOAS	3	FACU		
16	LOPE	15	FAC		
16	PLLA	7	FACU		
17	LOPE	10	FAC		
18	LOPE	10	FAC		

18	PLLA	5	FACU
18	SOAS	3	FACU
19	PLLA	15	FACU
20	LOPE	1	FAC
21	LOPE	50	FAC
22	LOPE	50	FAC
22	FERU	3	FAC
23	LOPE	30	FAC
23	SOAS	3	FACU
24	PLLA	10	FACU
25	LOPE	10	FAC
25	SOAS	2	FACU
26	LOPE	50	FAC
27	LOPE	10	FAC
27	TRPR	3	FACU
27	SOAS	3	FACU
27	VISA	1	UPL
28	LOPE	50	FAC
29	FERU	50	FAC
30	FERU	25	FAC
31	LOPE	10	FAC
31	PLLA	3	FACU
31	SOAS	3	FACU
32	FERU	75	FAC
33	PLLA	15	FACU
34	FERU	60	FAC
35	FERU	50	FAC
36	FERU	10	FAC
36	VISA	5	UPL
36	CAOB	5	OBL
37	HYRA	15	FACU
38	HYRA	25	FACU
38	CAOB	15	OBL
39	HYRA	25	FACU
39	CAOB	10	OBL
40	HYRA	10	FACU
40	FEAR	2	FAC
40	TAOF	2	FACU
41	CAOB	15	OBL
41	LOPE	5	FAC
42	HYRA	15	FACU
42	CAOB	5	OBL
43	HYRA	15	FACU
44	PLLA	20	FACU
45	CAOB	20	OBL
46	CAOB	10	OBL
46	HYRA	3	FACU

47	TAOF	5	FACU
47	LOPE	3	FAC
48	CAOB	25	OBL
48	VISA	5	UPL
49	CAOB	5	OBL
49	FEAR	3	FAC
50	CAOB	25	OBL
50	VISA	2	UPL
51	CAOB	5	OBL
52	CAOB	25	OBL
53	CAOB	25	OBL
54	CAOB	25	OBL
55	CAOB	50	OBL
56	CAOB	20	OBL
57	0		
58	CAOB	25	OBL
59	CAOB	10	OBL
59	JUEF	5	FACW
59	EPCI	1	FACW
60	CAOB	25	OBL
61	CAOB	10	OBL
62	JUEF	15	FACW
62	CAOB	5	OBL
63	JUEF	50	FACW
64	JUEF	50	FACW
65	JUEF	50	FACW
66	CAOB	10	OBL
66	CAEX	10	UPL
66	JUEF	5	FACW
67	CAEX	10	UPL
67	CAOB	3	UPL
68	CAEX	40	UPL
68	LOPE	40	FAC
69	ROCK		
70	CAEX	40	UPL
71	CAEX	60	UPL
72	CAEX	50	UPL
72	CAOB	3	OBL
73	CAEX	60	UPL
73	JUEF	3	FACW
74	JUEF	80	FACW
74	EPCI	1	FACW
75	CAOB	50	OBL
76	CAOB	50	OBL
77	CAOB	20	OBL
78	CAOB	25	OBL
79	VISA	3	UPL

80	CAOB	25	OBL
81	CAOB	50	OBL
82	CAOB	20	OBL
83	LOPE	50	FAC
84	PLLA	10	FACU
84	LOPE	10	FAC
84	CAOB	3	OBL
85	LOPE	25	FAC
85	PLLA	3	FACU
86	LOPE	10	FAC
86	PLLA	5	FACU
87	LOPE	3	FAC
88	LOPE	20	FAC
89	LOPE	10	FAC
90	LOPE	20	FAC
91	PLLA	5	FACU
92	LOPE	40	FAC
93	LOPE	60	FAC
94	LOPE	10	FAC
94	PLLA	7	FACU
94	HYRA	1	FACU
95	CAOB	10	OBL
95	PLLA	10	FACU
95	LOPE	5	FAC
96	PLLA	5	FACU
96	CAOB	5	OBL
97	LOPE	50	FAC
97	PLLA	7	FACU
98	FERU	10	FAC
98	CAOB	5	OBL
99	HYRA	10	FACU
99	FERU	10	FAC
100	CAOB	25	OBL
100	LOPE	5	FAC
101	FERU	25	FAC
101	TAOF	3	FACU
102	LOPE	25	FAC
102	LEVU	7	FACU
103	LOPE	20	FAC
103	LEVU	7	FACU
104	CAOB	25	OBL
104	LEVU	5	FACU
105	LEVU	10	FACU
105	VISA	3	FACU
106	CAOB	20	OBL
106	HYRA	3	FACU
107	HYRA	25	FACU

107	CAOB	3	OBL
107	VISA	3	FACU
108	HYRA	15	FACU
108	CAOB	5	OBL
108	JUEF	5	FACW
109	LEVU	20	FACU
109	JUEF	15	FACW
109	SOAS	2	FACU
110	CAOB	15	OBL
110	LEVU	10	FACU
111	LEVU	25	FACU
111	VIAM	10	FACU
112	CAOB	30	OBL
113	LEVU	10	FACU
113	CAOB	10	OBL
114	CAOB	25	OBL
115	LOPE	10	FAC
116	CAOB	25	OBL
116	HYRA	7	FACU
117	CAOB	50	OBL
118	CAOB	10	OBL
119	CAOB	20	OBL
119	LOPE	15	FAC
120	CAOB	10	OBL
121	CAOB	15	OBL
122	CAOB	25	OBL
123	CAOB	15	OBL
123	LEVU	3	FACU
124	CAOB	10	OBL
125	CAOB	25	OBL
125	HYRA	5	FACU
126	CAOB	15	OBL
127	CAOB	30	OBL
128	CAOB	25	OBL
129	CAOB	10	OBL
130	FERU	15	FAC
130	CAOB	10	OBL
131	CAOB	25	OBL
132	CAOB	30	OBL
132	SOAS	8	FACU
133	CAOB	20	OBL
134	CAOB	15	OBL
135	CAOB	5	OBL
136	CAOB	30	OBL
137	CAOB	15	OBL
138	CAOB	20	OBL
138	EPCI	1	FACW

139	CAOB	25	OBL
139	SOAS	3	FACU
140	CAOB	15	OBL
140	EPCI	1	FACW
141	CAOB	10	OBL
142	CAOB	25	OBL
143	CAOB	25	OBL
144	CAOB	30	OBL
144	EPCI	2	FACW
145	CAOB	5	OBL
146	CAOB	50	OBL
147	CAOB	25	OBL
148	CAOB	25	OBL
149	0		
150	CAOB	50	OBL
151	RARE	10	FAC
151	CAOB	5	OBL
152	CAOB	10	OBL
153	CAOB	10	OBL
153	RARE	3	FAC
154	LOPE	5	FAC
155	PLLA	10	FACU
155	LOPE	5	FAC
156	PLLA	25	FACU
156	LOPE	5	FAC
157	PLLA	50	FACU
157	LOPE	3	FAC
158	LOPE	60	FAC
159	LOPE	25	FAC
159	PLLA	10	FAC
160	LOPE	50	FAC
160	PLLA	10	FACU
161	LOPE	30	FAC
161	PLLA	5	FACU
162	LOPE	15	FAC
162	PLLA	5	FACU
163	FERU	10	FAC
163	PLLA	5	FACU
163	SOAS	2	FACU
164	FERU	20	FAC
165	FERU	25	FAC
166	LOPE	25	FAC
167	LOPE	5	FAC
167	VISA	3	UPL
167	SOAS	3	FACU
168	LOPE	20	FAC
168	PLLA	5	FACU

169	FERU	20	FAC
169	PLLA	5	FACU
170	FERU	25	FAC
170	PLLA	5	FACU
172	HYRA	10	FACU
172	FERU	5	FAC
173	PLLA	15	FACU
173	SOAS	3	FACU
174	FERU	50	FAC
175	PLLA	10	FACU
175	FERU	5	FAC
176	FERU	20	FAC
176	PLLA	10	FACU
177	LOPE	30	FAC
178	LOPE	25	FAC
179	TAOF	5	FACU
179	TAVU	3	FACU
179	HOLA	3	FAC
181	HOLA	20	FAC
181	VISA	1	UPL
182	HOLA	5	FAC
182	SOAS	6	FACU
183	HOLA	15	FAC
183	TAOF	5	FACU
183	LOPE	5	FAC
184	HYRA	5	FACU
184	FERU	5	FAC
185	HOLA	15	FAC
185	FERU	15	FAC
186	LOPE	50	FAC
187	JUEF	15	FACW
187	TAOF	5	FACU
189	LOPE	40	FAC
189	HOLA	5	FAC
190	HOLA	13	FAC
190	TAOF	5	FACU
191	LOPE	30	FAC
191	HOLA	3	FAC
192	LOPE	50	FAC
193	LOPE	50	FAC
194	LOPE	50	FAC
195	LOPE	50	FAC
196	LOPE	50	FAC
197	LOPE	50	FAC
198	LOPE	10	FAC
198	TAOF	5	FACU
198	VISA	3	UPL

199	LOPE	50	FAC
200	LOPE	20	FAC
200	HYRA	3	FACU
200	VISA	1	UPL
201	CEGL	20	FACU
201	VISA	10	UPL
201	LOPE	5	FAC
202	CEGL	20	FACU
202	LOPE	5	FAC
203	CEGL	20	FACU
203	LOPE	5	FAC
204	CEGL	20	FACU
204	LOPE	5	FAC
205	CEGL	20	FACU
205	LOPE	5	FAC
206	HOLA	10	FAC
206	TAOF	5	FACU
206	VISA	5	UPL
207	HYRA	15	FACU
208	TRPR	15	FAC
208	HYRA	3	FACU
209	SOAS	10	FACU
209	TRPR	10	FACU
209	EPCI	3	FACW
210	SOAS	14	FACU
210	JUAC	5	OBL
210	HOLA	1	FAC
211	FERU	10	FACU
211	TRRE	10	FAC
211	JUAC	3	OBL
212	LOPE	50	FAC
212	TRPA	3	FACU
212	HYRA	3	FACU
213	LOPE	10	FAC
213	SOAS	5	FACU
213	TRRE	3	FAC
214	TRRE	5	FAC
214	SOAS	1	FACU
215	SOAS	20	FACU
216	FEAR	50	FAC
217	SOAS	20	FACU
218	FEAR	50	FAC
219	FEAR	50	FAC
220	FEAR	50	FAC
221	CAOB	25	OBL
222	CAOB	25	OBL

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**BUSH MIDDLE SCHOOL**

Plot Size: 8.7 x 12.6, 24.6 x 5.6

**Woody Cover:**

15%

**Woody Shrub**

<u>Species</u>	<u>Plant Count</u>	<u>Stem Count</u>
SAPU	4	
COSE	5	

**Herb Quadrats**

**Plant List**

<u>Quad. #</u>	<u>Species</u>	<u>% Cover</u>	<u>WIS</u>	<u>Code</u>	<u>Name</u>
1	COCA	3	UPL	HOLA	<i>Holcus lanatus</i>
1	POPR	1	FAC	HYRA	<i>Hypochaeris radicata</i>
1	LASE	1	FACU	LOPE	<i>Lolium perenne</i>
2	Woody			FERU	<i>Festuca rubra</i>
2	COCA	1	UPL	FEAR	<i>Festuca arundinacea</i>
3	Woody			SOAS	<i>Sonchus asper</i>
3	LASE	4	FACU	CAEX	<i>Castilleja exserta</i>
3	SOAS	1	FACU	SIAL	<i>Sisymbrium altissimum</i>
4	LASE	3	FACU	MYMU	<i>Mycelis muralis</i>
4	COCA	1	UPL	PHAR	<i>Phalaris arundinacea</i>
4	EPCI	1	FACW	PLLA	<i>Plantago lanceolata</i>
5	COCA	3	UPL	CAOB	<i>Carex obnupta</i>
6	COCA	6	UPL	TAOF	<i>Taraxacum officinale</i>
6	SOAS	5	FACU	VIAM	<i>Vicia americana</i>
6	UNK.	2		EPCI	<i>Epilobium ciliatum</i>
7	Woody			LEVU	<i>Leucanthemum vulgare</i>
7	EPCI	2	FACW	TAVU	<i>Tanacetum vulgare</i>
8	EPCI	6	FACW	CEGL	<i>Cerastium glomeratum</i>
8	COCA	3	UPL	JUAC	<i>Juncus acuminatus</i>
8	TAOF	2	FACU	POPR	<i>Poa pratensis</i>
9	LASE	15	FACU	COCA	<i>Conyza canadensis</i>
10	LASE	6	FACU	LASE	<i>Lactuca serriola</i>
10	COCA	1	FACU	MATA	<i>Mare's Tail</i>
10	EPCI	1	FACW		
11	COCA	15	FACU		
11	LASE	5	FACU		
12	COCA	5	FACU		
12	SOAS	2	FACU		
13	COCA	10	FACU		
13	LASE	5	FACU		
13	SOAS	1	UPL		

14	LASE	10	FACU
14	COCA	10	FACU
15	EPCI	8	FACW
15	COCA	6	FACU
15	LASE	3	FACU
16	JUEF	40	FACW
17	POPR	40	FAC
17	JUEF	10	FACW
17	COCA	10	FACU
18	POPR	30	FAC
18	EPCI	20	FACW
18	JUEF	10	FACW
19	POPR	50	FAC
19	HYRA	10	FACU
19	MATA	10	FACU
20	JUEF	40	FACW
20	POPR	20	FAC
21	POPR	50	FAC
21	HYRA	20	FACU
21	COCA	1	FACU
22	JUEF	25	FACW
22	EPCI	2	FACW
23	JUEF	25	FACW
24	POPR	15	FAC
24	EPCI	1	FACW
25	JUEF	25	FACW
25	EPCI	10	FACW
25	HYRA	1	FACU
26	POPR	15	FAC
26	HYRA	9	FACU
27	Woody		
28	HYRA	80	FACU
29	POPR	10	FAC
29	TRRE	5	FAC
29	HYRA	5	FACU
30	HYRA	25	FACU
30	unkn.	16	
30	SOAS	1	UPL
31	POPR	30	FAC
31	SOAS	10	UPL
31	RUCR	3	FAC
32	Woody		
33	FERU	10	UPL
33	LASE	2	FACU
33	COCA	1	FACU
34	CEFO	10	FACU
34	UNK.	6	

35	FERU	70	UPL
36	FERU	50	UPL
36	CEFO	30	FACU
37	Woody		
38	COCA	15	UPL
38	SEJA	2	FACU
38	HYRA	1	FACU
39	COCA	10	UPL
39	LASE	10	FACU
39	SOAS	8	FACU
40	LASE	20	FACU
40	COCA	10	UPL
40	SOAS	2	FACU
41	HYRA	50	FACU
41	TRRE	5	FACU
42	HYRA	10	FACU
42	POPR	10	FAC
42	EPCI	1	FACW
43	POPR	25	FAC
43	HYRA	10	FACU
44	JUEF	25	FACW
45	POPR	25	FAC
45	SOAS	3	FACU
45	EPCI	2	FACW
46	HYRA	25	FACU
47	JUEF	25	FACW
47	HYRA	3	FACU
47	LASE	3	FACU
48	SOAS	8	FACU
49	JUEF	15	FACW
49	SOAS	10	FACU
50	SOAS	15	FACU
50	LASE	7	FACU
51	SOAS	10	FACU
51	LASE	5	FACU
52	SOAS	15	FACU
52	unkn.	12	
53	COCA	6	UPL
53	LASE	6	FACU
53	SOAS	1	FACU
54	COCA	20	UPL
54	LASE	6	FACU
54	EPCI	1	FACW
55	COCA	25	UPL
55	LASE	4	FACU
55	LASE	2	FACU
56	COCA	12	UPL

56	LASE	10	FACU
57	Woody		
58	COCA	10	UPL
58	HYRA	6	FACU
58	LASE	3	FACU
59	EPCI	10	FACW
59	COCA	5	UPL
59	HYRA	1	FACU
60	TAOF	4	FACU
60	COCA	4	UPL
61	POPR	15	FAC
61	COCA	6	UPL
62	HYRA	25	FACU
63	Woody		
63	EPCI	3	FACW
63	COCA	2	UPL
64	HYRA	25	FACU

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**WAINWRIGHT INTERMEDIATE SCHOOL**

Plot Size: 24' x 7'

**Woody Cover:**

5% Betula

**Woody Shrub**

<u>Species</u>	<u>Plant Count</u>	<u>Stem Count</u>
Betula	2	

**Herb Quadrats**

**Plant List**

<u>Quad. #</u>	<u>Species</u>	<u>% Cover</u>	<u>WIS</u>	<u>Code</u>	<u>Name</u>
1	LASE	15	FACU	CAOB	<i>Carex obnupta</i>
1	SOTH	6	FACU	CIVU	<i>Cirsium vulgare</i>
1	EPCI	3	FACW	EPCI	<i>Epilobium ciliatum</i>
2	CAOB	3	OBL	GER	<i>Geranium</i>
2	SOTH	2	FACU	HYRA	<i>Hypochaeris radicata</i>
2	VIAM	2	FAC	LASE	<i>Lactuca serriola</i>
3	CIVU	10	FACU	POPR	<i>Poa pratensis</i>
3	EPCI	3	FACW	SOTH	<i>Sow Thistle</i>
3	HYRA	2	FACU	VIAM	<i>Vicia americana</i>
3	POPR	2	FAC	COCA	<i>Conyza canadensis</i>
4	SOTH	12	FACU	HOLA	<i>Holcus lanatus</i>
4	EPCI	7	FACW	MATA	<i>Mare's Tail</i>
5	POPR	15	FAC	LOPE	<i>Lolium perenne</i>
5	CIVU	6	FACU	FERU	<i>Festuca rubra</i>
5	HYRA	2	FACU	FEAR	<i>Festuca arundinacea</i>
5	CIVU	1	FACU	SOAS	<i>Sonchus asper</i>
6	POPR	10	FAC	CAEX	<i>Castilleja exserta</i>
6	CIVU	10	FACU	SIAM	<i>Sisymbrium altissimum</i>
7	CIVU	10	FACU	MYMU	<i>Mycelis muralis</i>
7	POPR	5	FAC	PHAR	<i>Phalaris arundinacea</i>
7	SOTH	1	FACU	PLLA	<i>Plantago lanceolata</i>
7	VIAM	1	UPL	OXAL	<i>Oxalis</i>
8	CIVU	16	FACU	TAOF	<i>Taraxacum officinale</i>
8	POPR	3	FAC	GAAP	<i>Galium aparine</i>
8	GER	1	UPL	LEVU	<i>Leucanthemum vulgare</i>
9	CIVU	20	FACU	TAVU	<i>Tanacetum vulgare</i>
9	POPR	2	FAC	CEGL	<i>Cerastium glomeratum</i>
10	CIVU	25	FACU	JUAC	<i>Juncus acuminatus</i>
10	POPR	3	FAC		
10	GER	1	UPL		
11	CIVU	25	FACU		

11	POPR	1	FAC
12	CIVU	25	FACU
12	POPR	5	FAC
13	CIVU	6	FACU
13	POPR	2	FAC
13	HOLA	1	FAC
14	CIVU	10	FACU
14	POPR	3	FAC
15	CIVU	6	FACU
15	POPR	5	FAC
15	HYRA	3	FACU
16	CIVU	10	FACU
16	POPR	5	FAC
17	VIAM	2	UPL
17	POPR	2	FAC
17	CAOB	1	OBL
17	OXAL	1	FACU
18	CIVU	10	FACU
18	HYRA	6	FACU
19	CAOB	15	OBL
19	HYRA	3	FACU
20	CAOB	5	OBL
20	HYRA	4	FACU
20	CIVU	2	FACU
21	SOTH	6	FACU
21	CAOB	2	OBL
22	EPCI	10	FACW
22	SOTH	2	FACU
22	TAOF	1	FACU
23	EPCI	15	FACW
23	HYRA	1	FACU
24	EPCI	20	FACW
24	CAOB	4	OBL
24	SOTH	2	FACU
25	EPCI	3	FACW
25	CIVU	2	FACU
25	POPR	2	FAC
25	HOLA	1	FACU
26	SOMI	6	
26	POPR	3	FAC
26	CAOB	2	OBL
26	TAOF	2	FACU
26	VIAM	1	UPL
27	EPCI	5	FACW
27	HYRA	2	FACU
27	CAOB	2	OBL
27	CIVU	2	facu

27	PLMA	2	FAC
27	TANSY	2	UPL
27	SOTH	1	facu
28	Grass	5	FAC
28	EPCI	3	FACW
28	CAOB	2	OBL
28	CIVU	2	facu
29	JUEF	15	FACW
29	CAOB	5	OBL
29	HYRA	2	FACU
29	EPCI	2	FACW
31	POPR	12	FAC
31	CIVU	2	facu
31	CAOB	2	OBL
32	CAOB	10	OBL
32	EPCI	10	FACW
32	HYRA	4	FACU
32	GAAP	3	FACW
33	SOTH	5	facu
33	HYRA	5	FACU
33	Grass	5	FAC
33	EPCI	3	FACW
33	VIAM	2	UPL
34	EPCI	25	FACW
34	CIVU	12	facu
34	PLMA	2	FAC
35	CIVU	4	facu
35	HYRA	2	FACU
35	EPCI	2	FACW
35	CAOB	1	OBL
36	POPR	5	FAC
36	Grass	3	FAC
36	HYRA	3	FACU
36	CAOB	3	OBL
37	CIVU	10	facu
37	POPR	3	FAC
38	CIVU	10	FACU
38	POPR	3	FAC
39	CIVU	8	facu
39	HYRA	3	FACU
39	POPR	3	FAC
40	POPR	10	FAC
40	HYRA	8	FACU
40	EPCI	2	FACW
41	CIVU	12	facu
41	TAOF	2	FACU
41	EPCI	1	FACW

41	POPR	1	FAC
42	CIVU	20	facu
42	TAOF	4	FACU
43	SOTH	8	facu
43	CIVU	6	facu
43	CAOB	2	OBL
43	HYRA	2	FACU
43	POPR	1	FAC
44	EPCI	8	FACW
44	SOTH	4	facu
44	CIVU	4	facu
44	POPR	3	FAC

2017-114 Olympia Bioretention Study  
 Spring 2019

**HARRINGTON AVENUE RENTON**

Plot Size: 20' x 3'

**Woody Cover:**

Zero

**Woody Shrub**

<u>Species</u>	<u>Plant Count</u>	<u>Stem Count</u>
	Zero	

**Herb Quadrats**

**Plant List**

<u>Quad. #</u>	<u>Species</u>	<u>% Cover</u>	<u>WIS</u>
1	0		
2	0		
3	0		
4	JUEF	30	FACW
5	JUEF	20	FACW
6	JUSP	20	FACW
7	JUEF	35	FACW
8	JUEF	25	FACW
9	JUEF	25	FACW
10	JUEF	30	FACW
11	JUEF	30	FACW
11	JUSP	10	FACW
12	JUEF	40	FACW
13	JUEF	5	FACW
13	JUSP	5	FACW
14	JUEF	40	FACW
15	JUEF	40	FACW
16	JUEF	50	FACW
16	JUSP	10	FACW
17	JUEF	25	FACW
18	JUEF	30	FACW
19	IRDO	25	UPL
19	JUEF	15	FACW
19	JUSP	10	FACW
20	JUEF	40	FACW
21	0		

<u>Code</u>	<u>Name</u>
JUEF	<i>Juncus effusus</i>
JUSP	<i>Juncus species</i>
IRTE	<i>Iris tenax</i>