

# ODOT Greenhill Mitigation Bank

Annual Report 2017



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## 1 Summary

The Oregon Department of Transportation's (ODOT) Greenhill Mitigation Bank is located on 57.55-acres in Lane County, near the City of Eugene. This report summarizes activities to enhance 57.35 acres and restore 0.2 acres of the site to native wetland prairie and includes 2017 management actions and monitoring results. After more than 3 years of site preparation and nonnative species control, the site was seeded and planted in fall 2016. Native vegetation established robustly in late spring and summer of 2017, exceeding the 40% native cover performance criterion. Unfortunately, invasive nonnative species also responded robustly from the soil seedbank and by June, far exceeded the 15% maximum cover allowance provided in the performance criteria. Vernal pools trapped sediments, showed good establishment of characteristic native annual plant species, and held water into early summer, with 26 pools functioning as breeding sites for native amphibians, and no pools holding water throughout the summer. Management activities in 2017 focused on controlling nonnative plant species, fine-tuning erosion control measures, and bolstering the native plant community through a second year of native seeding and planting.

## 2 Introduction and Site Description

### 2.1 Site Location

The Oregon Department of Transportation's (ODOT) Greenhill Mitigation Bank site (the Site) is a 57.55-acre area located in the Long Tom River Watershed, Lane County, near the City of Eugene, Oregon. The Site slopes from an elevation of about 420 ft on its west side down to about 384 ft along its east boundary. The Site is bounded by BLM wet prairie to the north, a railroad on the south, private rural land and residences to the west and Greenhill Road to the east (Fig. 1).

### 2.2 Historic Vegetation and Land Use

Landform, soils, and site location, as well as early land survey maps, suggest the site and surrounding area was historically wetland prairie. Aerial photos indicate that by 1936 (the earliest photo available) the site was already subdivided into multiple agricultural fields and was in crop production or used for pasture or haying for the next 50 years.

A wetland delineation for the site completed in 2011 indicated all but 0.2 acre of the site's pre-project condition was wetland. The natural communities on the site in 2012 were followed agricultural wetlands with scattered trees and shrubs along fencelines (e.g. Oregon ash (*Fraxinus latifolia*), serviceberry (*Amelanchier alternifolia*), California black oak (*Quercus kelloggii*), Oregon white oak (*Quercus garyana*), Suksdorf's hawthorne (*Crataegus gaylussacia*)). Dominant plants were colonial bentgrass (*Agrostis capillaris*), Himalayan blackberry (*Rubus bifrons*), and velvetgrass (*Holcus lanatus*), with a few large dense patches of meadow foxtail (*Alopecurus pratensis*). The northeastern one-quarter of the site was also dominated by colonial bentgrass, large patches of reed canary grass (*Phalaris arundanaceae*), and pennyroyal (*Mentha pulegium*). This was the only area where native tufted hairgrass (*Deschampsia cespitosa*) and a few scattered native forbs and rushes occurred, particularly along the fenceline or boundary with the BLM property to the north.

### 2.3 Public Access, Maintenance Access, and Roads

The site currently has no public access, since it is an active mitigation bank site under construction. Access for maintenance and monitoring by City staff and contractors is via a locked gate and small gravel pad on the west side of Greenhill Road, just north of the railroad tracks or via Goble Lane, a gravel road off Highway 126, at the west end of the site. No roads bisect the site.

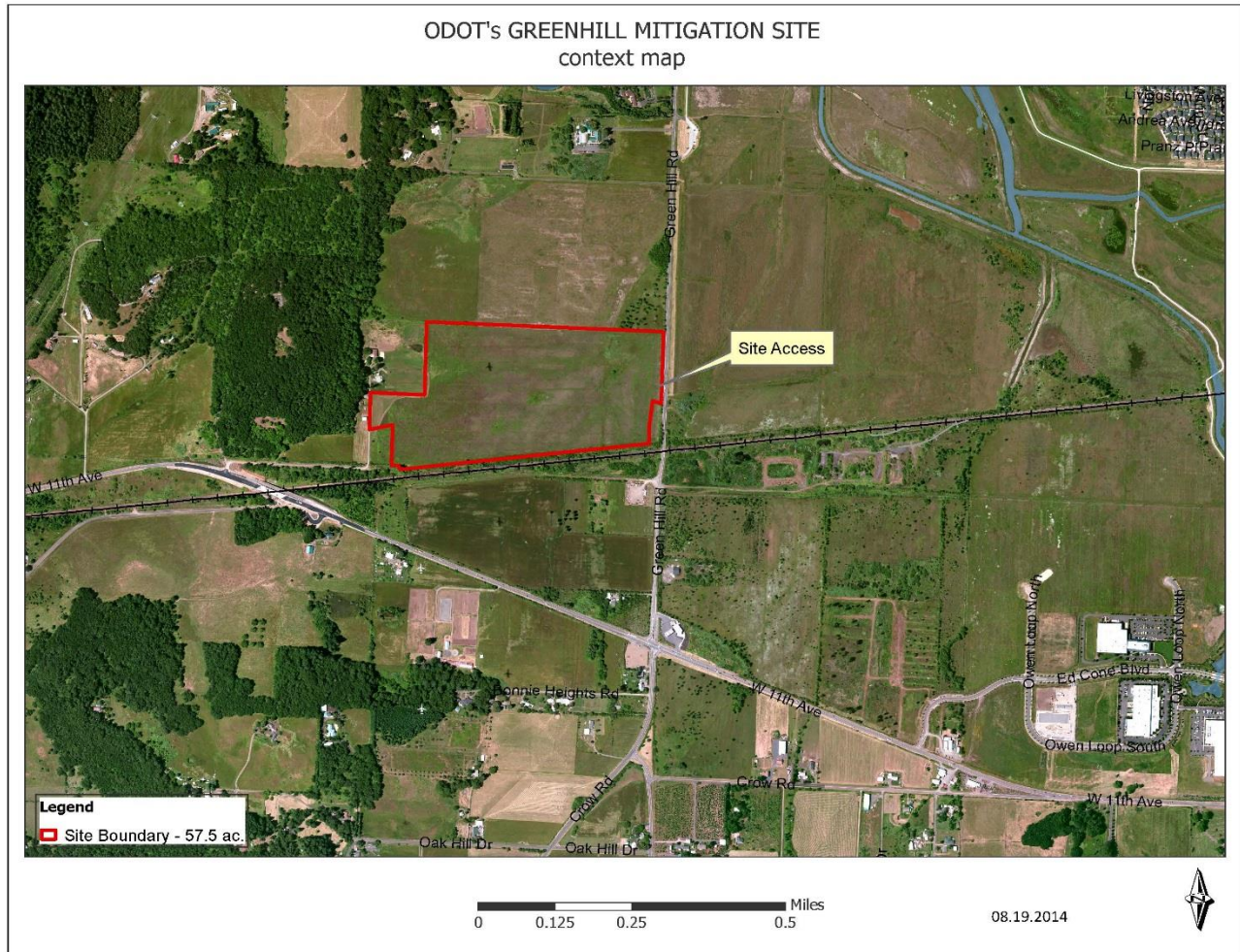


Figure 1. ODOT’s Greenhill Mitigation Bank Site boundary. Lands directly to the north and those east of Greenhill Road are conserved as part of West Eugene Wetlands natural areas. Land to the south is designated for protection in the West Eugene Wetlands Plan.

### 3 Bank Goals

The Mitigation Bank Instrument (MBI) indicates the goals for the Mitigation Bank are to “...enhance/rehabilitate 57.35 acres and restore 0.2 acres, resulting in the establishment of 57.55 acres of Hydrogeomorphic (HGM) class slope/flat native wetland prairie.” In addition to objectives supporting that goal and the long term sustainable management of the Bank, a further objective is to contribute to the recovery of sensitive species.

## 4 Mitigation Bank Administration – Credit Ledger

The Greenhill Mitigation Bank has had total releases of 1.63 credits and withdrawals of 1.14 credits. Table 1 describes transactions to date.

**Table 1. ODOT Greenhill Mitigation Bank Credit Ledger, with transactions from 2017 and prior years.**

Transaction Date	Transaction Type (Withdrawal or Release)	Jurisdiction (State, Federal)	Number of Credits	Credit Unit (ac)	State Permit Number	Federal Permit Number	Credit Type (HGM, Cowardin)	Balance of Released Credits
4/13/15	Release	both	1.22	1.22	RF-52761	NWP-2011-383	Slope-Flats, PEM	1.22
4/16/15	Withdrawal	both	1.14	1.14	57297	NWP 2015-43	Slope-Flats, PEM	0.08
4/14/17	release	both	0.41	0.41				0.49

## 5 2012-2016 Field Enhancement Activity Summary

**Table 2. Key field enhancement activities from 2012 through 2016. Field surveys for invasive species, rare plants, birds, and cultural artifacts are not included in summary.**

Year	Activity
2012 – fall	Controlled reed canary grass ( <i>Phalaris arundinacea</i> ), Himalayan blackberry ( <i>Rubus bifrons</i> ), and Scots broom ( <i>Cytisus scoparius</i> ).
2012 – fall	Mowed entire site.
2013 – spring & summer	Controlled reed canary grass, Himalayan blackberry, and Scot’s broom.
2013 - fall	Salvaged seeds and bulbs of native species with small populations in the site’s east region and along east fenceline.
2013 – summer	Mowed, disked, harrowed, and rolled site prior to earth-moving.
2013 – summer/fall	Earthwork to excavate shallow pools, remove agricultural drainage channels, and install snags and downed wood
2013 – fall	Implemented erosion control measures (jute netting, coir logs, and compost berms).
2014 – winter/spring	Installed additional coir logs.
2014 – spring	Controlled all nonnative species with broadcast herbicide applications
2014 – summer/fall	Manual removal and herbicide applications to control of nonnative species, including Himalayan blackberry, pennyroyal, and ox-eye daisy ( <i>Leucanthemum vulgare</i> ).

Year	Activity
2014 – summer/fall	Earthwork to recontour pool outlet in NE site corner. Installed additional erosion control materials (coir, jute, and river rock) where needed.
2015 – spring/summer	Controlled all nonnative species with broadcast herbicide applications
2015 - summer	Spot herbicide applications to control invasive nonnative species, including Himilayan blackberry, sheep sorrel ( <i>Rumex acetosella</i> ), pennyroyal, and ox-eye daisy.
2016 – spring/summer	Controlled nonnative plants, with focus on bentgrass, false dandelions, ox-eye daisy, and pennyroyal
2016 – fall	Installed 15 monitoring staff gauges to track inundation of vernal pools
2016 - fall (Sept/Oct)	As a first native seeding, distributed 304 lbs of native seed of 60 native plant species in more than 15 seed mixes across the site.
2016 – fall	Planted over 6,000 plants of 10 native species across site.

## 6 2017 Management Actions

1. Staff tracked locations of nonnative plant species and implemented mechanical and chemical control throughout the 2017 growing season. The first control actions for nonnative bentgrass and other nonnative grasses were planned for late May or early June, as soon as site and weather conditions allowed. Due to the suprisingly widespread emergence of invasive nonnative bentgrass (*Agrostis* sp.), staff deteremined that a broadcast application of Clethodim (Select Max) was necessary and this was applied on June 13. Staff and contractors controlled pennyroyal, false dandelion, and hairy hawkbit (*Hypocheris radicata/Leontodon saxatilis*), using spot-herbicide applications across the entire site and ATV broadcast applications to particularly dense areas, beginning on June 22 and continuing as needed through July. Other nonative species, such as sheep sorrel (*Rumex acetosella*), were also controlled during this contract work. On Novembmer 1, 2017, following fall rains and reinvigorated grass growth, a second broadcast of clethodim was applied across the site to further control nonnative bentgrass and *Vulpia* species.
2. The northwest quarter of the site was mowed in June 2017 to expose, and allow chemical control of, the low-growing pennyroyal and nonnative bentgrass that were obscured by a large stand of native, unseeded, willow-herb (*Epilobium ciliatum*). Staff mowed other regions of the site in July, after many of the earlier natives had gone to seed, to stop early flowering pennyroyal and hawksbit that contract herbicide crews had not yet reached or that was not yet controlled by the applications.
3. Throughout chemical control actions, staff checked, flagged, and sometimes covered establishing populations of rare native species, plant diversity circular plots that were not highly invaded, and fall 2016 plantings to reduce the potential for non-target injury.
4. Staff and contractors implemented additional erosion control measures, such as installation of coir logs and jute netting, and shifting of cobble, at several locations in early fall 2017, to reduce the potential for erosion and creation of drainage channels.

5. Staff distributed about 215 pounds of native seed, in about 20 mix combinations, across the site between October 3 and 23. Four main seed mixes were distributed with the ATV broadcaster covering most of the 58 acres, with hand-seeding used to disperse seed into vernal pools, drainage regions, and areas where nonnative species had been particularly problematic. Figure 2 maps the 2017 seeding.
6. Staff and contractors implemented a small planting on November 29, of 709 plants of 8 species in the west third of the site where the pennyroyal had been less abundant. The planting locations and species list are shown in Figure 3 and Table A2 (appendix).

## 7 Vernal Pool Monitoring

**Methods.** The site currently has 31 vernal pools which were wholly or partially excavated during earthwork activities in 2013 and one pool that formed behind a slight rise in soil elevation. To track pool depths, staff had installed staff gauges in a sample of 15 pools of varying depths and sizes in fall 2016, with an emphasis on including gauges in the deepest pools. Staff or interns tracked water depths in the 15 pools with staff gauges every 3 to 6 weeks from February through early June 2017 and measured or estimated water depth at one location in the deepest part of the pool in all 31 pools that consistently held winter water. The two dates when all 31 pools were sampled were May 10 and June 6. To avoid disturbing pool soils, fauna, and flora, assessments of larval amphibians were typically based on observation from pool edges with minimal dip-netting.

**Water.** Pools began holding water in October 2016 when over 10 inches of rain fell in the Eugene area. Pools were at capacity by January 2017. Pools remained at about maximum water holding capacity through mid-March, with any evaporation made up for by additional inflow. By the May 2 observation, pool water depths had dropped 1 to 2 inches below their maximum and the first of the 15 pools with staff gauges to dry completely did so between May 2 and May 10. For the next month, drying was rapid, with 25 of the 31 tracked pools dry by the June 6 sampling. All pools were dry by July 20. Data is summarized in Table 3

**Table 3. Vernal pool depth, drydown, and amphibian breeding, spring/summer 2017.**

<b>Date (for 15 pools with staff gauges, unless noted)</b>	<b>Water depth range of pools with water (inches)</b>	<b># Dry (of 15 unless noted)</b>	<b># pools with larval amphibians observed (of 15 unless noted)</b>
Feb 17, 2017	5 – 22	0	NA
March 16, 2017	5 – 23	0	NA
May 2, 2017	4 – 22	0	7
May 10, 2017	4 – 20	1	13
May 10, 2017 (of all 31 pools)	2 - 20	3 (of 31)	26 (of 31)
June 6, 2017	3 - 12	10	2
June 6, 2017 (of all 31 pools)	2 - 12	25 (of 31)	2 (of 31)

Although two pools had water depths that exceeded the maximum anticipated depth of 18 inches, even the deepest pools, at 23 inches water depth in winter, had bottoms partially vegetated with the vernal pool annuals Willamette downingia (*Downingia yina*) or elegant downingia (*D. elegans*) as they dried. Other vernal pool species, such as bractless hedge hyssop (*Gratiola ebracteata*) and blunt spikerush (*Eleocharis obtusa*) occurred along pool slopes and margins. Based on the rapid drying of all pools from May - July, and their relatively small size, a winter depth of 23 inches is unlikely to result in any pools maintaining water throughout the summer in any years. In fact, the two pools with greater than anticipated depths may benefit native amphibian larvae by providing more time for growth prior to metamorphosis.

**Amphibians.** All larval amphibians observed were Pacific chorus frog larvae (*Pseudacris regilla*). Adult rough-skinned newts (*Taricha granulosa*) were observed in one pool, along with chorus frog larvae, and were also found in flowing water just beyond the south boundary of the mitigation bank site under tree canopy. Long-toed salamanders (*Ambystoma macrodactylum*) are another amphibian likely to breed in Willamette Valley vernal pools (Pearl, et. al 2005). Staff observed 5 long-toed salamander adults sheltering under the bark of a log adjacent to a pool in early February 2017. Although no larval salamanders were observed in the pools, this was likely due to the minimal invasive dip-netting that occurred, rather than their complete absence.

Prior to enhancement, water pooled only in the east end of this site, primarily where it drained off-site at the ODOT/BLM north boundary, where dense nonnative reed canary grass (*Phalaris arundinacea*) was common. The site now provides many locations for amphibian breeding, with short native emergent vegetation on which to attach egg masses, a developing aquatic and terrestrial insect fauna, and access to adjacent sheltering logs for adults and recent metamorphs.

**Sediment.** Because the site was unvegetated in fall 2016, some sediment movement across the site was anticipated. The many pools would function to remove sediments from the water as it flowed from west to east across the site. To ensure that staff gauges would be accurate in future years, staff raised the gauge 0-mark to the new soil surface in fall 2017, when soils were dry and recorded the depths of sediment that had accumulated at the gauge base. The average sediment increase from the prior year, across all pools, was 1.3 inches. This is a one-time, one-location measurement, and therefore cannot be assumed to result entirely from sediment deposition from inflow, as winter waves or water bird activity could also shift bottom sediments. Sediment movement across the site is expected to decrease as native perennial plant cover increases.

Three new staff gauges were added to small pools in fall 2017 to ensure that small pools were adequately represented in the sampling, based on their presence on the landscape.

## 8 Vegetation Monitoring

**Methods.** Vegetation establishment was tracked by walking the site periodically throughout the year and recording emerging and species, especially those uncommon across the landscape and nonnative invasive species that would require treatment. Staff conducted quantitative vegetation sampling from June 7 – 12, 2017, using the point-intercept method, with a tripod and steel pole with pin point. Point-



intercept sampling involved identifying all species that contact the pin point as it is dropped at locations along the transects. Sampling is systematic with a random start. Sample points were taken along 10 transects that ran from the east to west side of the site, with an additional half-transect placed in the southwest region due to the site's broader west end. Transects are shown on Figure 2 and more detail on the point-intercept method employed at this site is provided in Appendix C. Monitoring staff collected 419 sample points. A list of all species found on the site was developed from site-wide meandering surveys in June and July. Plants encountered were identified to species and sometimes to the subspecific level, and the following nonnative species were considered together, since our response to them would be identical and close inspection (or reproductive parts) was required to distinguish them: *Agrostis capillaris* and *Agrostis stolonifera*, *Vulpia myuros* and *Vulpia bromoides*, *Leontodon saxatilis* and *Hypochaeris radicata*.

**Results.** Native wetland grasses. The buffer of native wetland grasses seeded along the east, west, and south borders of the site established well in the fall and recovered from dislodgement by frost heave that occurred in December and January. Both spike bentgrass (*Agrostis exarata*) and meadow barley (*Hordeum brachyantherum*) flowered in the buffers their first growing year and all sections grew densely to the extent that reseeding was unnecessary.

Site-wide species. Results of the site-wide point-intercept plant cover monitoring for 2017 are presented in Table 4. Overall, native species emergence was robust for the first growing season after seeding, with native cover of 99.5% (absolute) and 15% bare ground or moss (no vascular plants encountered). Native wetland annual plants dominated the site, with three native annual species providing almost 70% of the native plant cover at the site in June. This is typical of a wet prairie enhancement site in the southern Willamette Valley in its first growing year after site preparation. Of the four species providing the greatest cover, only one, scouler's popcornflower (*Plagiobothrys scouleri*\*), was seeded. This pattern of native annuals emerging from the soil seedbank is also typical to West Eugene area wetland prairie enhancements, including from sites that have been in ryegrass production for decades.

During point-intercept monitoring, 28 native species and 19 nonnative species were encountered at sampling points (Table 4). During meandering surveys throughout the summer 72 native species and 45 nonnative species were recorded on the site (Appendix 2). This is similar to the numbers of native species encountered at other local wetland enhancements (e.g. Coyote Prairie Phase 2 and Phase NE) at a similar stage of development, although the number of nonnative species encountered at those sites was about 20% lower, likely due to their decades-long history of farming prior to a return to native wetland prairie.

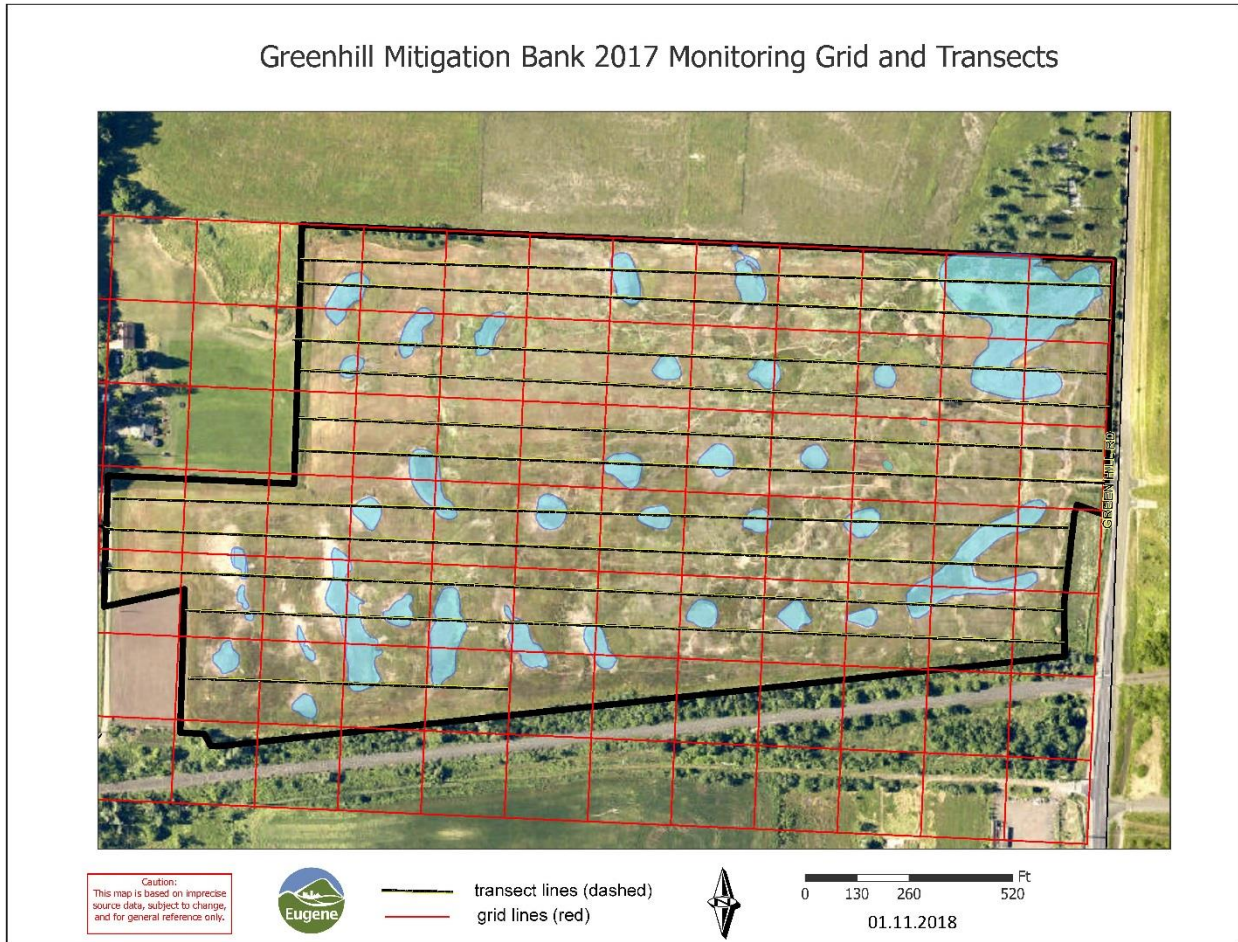


Figure 2. Approximate locations of monitoring grid and transects for point-intercept plant cover monitoring.

The high emergence of perennial nonnative plant species from the soil seedbank in late spring was the most unexpected result of the 2017 growing year, especially given the 3 full years of careful and complete nonnative species control that City staff undertook after earth-moving was completed in fall 2013. The emergence of three species (or species groups), *Mentha pulegium*, *Agrostis capillaris*/*A. stolonifera*, and *Leontodon saxatilis*/*Hypochaeris radicata* was also surprising given their relatively low abundance in the final year of site preparation, from fall 2015 to fall 2016.

Nonnative species cover on the site was 54.9% (absolute) in the second week of June, with the majority of the cover provided by the 3 species (or species groups) indicated above. Cover monitoring was done prior to site and weather conditions being sufficiently dry and calm for herbicide applications, so all of the spring/summer nonnative plant species control took place after the monitoring, starting on June 13 and continuing through July. Initially, staff considered a second monitoring, after nonnative species control actions, but decided that mowing was needed as part of nonnative species control, making further monitoring unfeasible.

\*Seed originally purchased and reported (in mix lists) as *Plagiobothrys figuratus* was determined to include a large component of *Plagiobothrys scouleri* seed in it, based on emergence at this site and discussions with the seed producer. In this year's seed mixes (Appendix 1) this is reported as a species mix.

This report identifies invasive nonnative species as those explicitly identified in the Mitigation Bank Instrument (*Mentha pulegium*, *Anthoxanthum odoratum*), those on the Oregon Noxious Weed list (*Hypericum perforatum*), and *Agrostis capillaris*, due to its abundance on the site pre-enhancement, its current abundance after 3 years of site preparation, and its competitive behavior in wet prairies elsewhere in the West Eugene area. In addition to these, next year two species or species groups should be evaluated for invasiveness on this site, *Leontodon saxatilis* / *Hypochaeris radicata* and *Vulpia myuros* / *V. bromoides*. Invasive nonnative species cover on the site as measured during point-intercept monitoring was 31.3%.

Other notable native species seeded in fall 2016 and recorded establishing in summer 2017 (and not encountered during point-intercept monitoring) include clustered goldenweed (*Pyrrcoma racemosa*), Willamette navarretia (*Navarettia willametensis*), and narrow-leaf mules ear (*Wyethia angustifolia*).

Table 4. Greenhill Mitigation Bank Site Point-intercept Monitoring Results, 2017.  
Percent cover results are shown (with 80% binomial confidence intervals (CI)) for several guild types as well as each species intercepted during monitoring.

		<b>Area Sampled</b>	<b>57.6 acres</b>		
		<b>Sample Size</b>	<b>419</b>		
		<b>Plant Community</b>	<b>Wet Prairie with vernal pools</b>		
<b>Origin<sup>1</sup></b>	<b>Species or Guild (all herbaceous)</b>	<b>% Cover</b>	<b>CI Low</b>	<b>CI High</b>	
	<b>Native (absolute cover)</b>	<b>99.5</b>			
	<b>Invasive Nonnative (absolute cover)</b>	<b>31.3</b>			
	<b>Nonnative, excluding invasives (absolute cover)</b>	<b>23.6</b>			
	<b>Total Plant Cover (absolute cover)</b>	<b>154.4</b>			
	<b>Bare ground (no vascular plants, moss may occur)</b>	<b>15.0</b>			
	<b>Native<sup>2</sup> (a relative cover value)</b>	<b>72.4</b>	69.3	75.2	
	<b>All Nonnative<sup>2</sup> (a relative cover value)</b>	<b>43.9</b>	40.7	47.2	
Native	<i>Plagiobothrys scouleri</i>	30.5	27.6	33.6	
Native	<i>Juncus bufonius</i>	29.8	26.9	32.9	
Native	<i>Epilobium ciliatum</i>	11.9	9.9	14.2	
Native	<i>Gnaphalium palustre</i>	7.9	6.2	9.8	
Native	<i>Prunella vulgaris var. lanceolata</i>	3.8	2.7	5.3	
Native	<i>Downingia yina</i>	2.6	1.7	3.9	
Native	<i>Gratiola ebracteata</i>	2.4	1.5	3.7	

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<b>Origin<sup>1</sup></b>	<b>Species or Guild (all herbaceous)</b>	<b>% Cover</b>	<b>CI Low</b>	<b>CI High</b>
Native	<i>Plagiobothrys figuratus</i>	2.1	1.3	3.4
Native	<i>Agrostis exarata</i>	0.7	0.3	1.6
Native	<i>Eleocharis obtusa</i>	0.7	0.3	1.6
Native	<i>Grindelia integrifolia x nana</i>	0.7	0.3	1.6
Native	<i>Myosotis laxa</i>	0.7	0.3	1.6
Native	<i>Navarretia intertexta</i>	0.7	0.3	1.6
Native	<i>Veronica peregrina xalapensis</i>	0.7	0.3	1.6
Native	<i>Deschampsia cespitosa</i>	0.5	0.1	1.3
Native	<i>Lotus unifoliolatus</i>	0.5	0.1	1.3
Native	<i>Rumex salicifolius</i>	0.5	0.1	1.3
Native	<i>Downingia elegans</i>	0.2	0.0	0.9
Native	<i>Downingia sp.</i>	0.2	0.0	0.9
Native	<i>Epilobium brachycarpum</i>	0.2	0.0	0.9
Native	<i>Hordeum brachyantherum</i>	0.2	0.0	0.9
Native	<i>Lasthenia glaberrima</i>	0.2	0.0	0.9
Native	<i>Madia glomerata</i>	0.2	0.0	0.9
Native	<i>Microseris laciniata</i>	0.2	0.0	0.9
Native	<i>Microsteris gracilis</i>	0.2	0.0	0.9
Native	<i>Nuttallanthus texanus</i>	0.2	0.0	0.9
Native	<i>Panicum capillare</i>	0.2	0.0	0.9
Native	<i>Ranunculus orthorhyncus</i>	0.2	0.0	0.9
Invasive	<i>Agrostis capillaris/stolonifera</i>	23.2	20.5	26.0
Invasive	<i>Mentha pulegium</i>	7.6	6.0	9.6
Invasive	<i>Anthoxanthum oderatum</i>	0.2	0.0	0.9
Invasive	<i>Hypericum perforatum</i>	0.2	0.0	0.9
Nonnative	<i>Leontodon saxatilis / Hypochaeris radicata</i>	5.5	4.1	7.2
Nonnative	<i>Myosotis discolor</i>	4.5	3.3	6.1
Nonnative	<i>Briza minor</i>	4.1	2.9	5.6
Nonnative	<i>Poa annua</i>	3.1	2.1	4.5
Nonnative	<i>Cerastium glomeratum</i>	2.4	1.5	3.7

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<b>Origin<sup>1</sup></b>	<b>Species or Guild (all herbaceous)</b>	<b>% Cover</b>	<b>CI Low</b>	<b>CI High</b>
Nonnative	<i>Parentucellia viscosum</i>	1.2	0.6	2.2
Nonnative	<i>Galium divaricatum</i>	0.7	0.3	1.6
Nonnative	<i>Anagalis arvensis</i>	0.2	0.0	0.9
Nonnative	<i>Limnanthes alba</i>	0.2	0.0	0.9
Nonnative	<i>Lolium multiflorum</i>	0.2	0.0	0.9
Nonnative	<i>Lythrum hyssopifolium</i>	0.2	0.0	0.9
Nonnative	<i>Lythrum portula</i>	0.2	0.0	0.9
Nonnative	<i>Spergularia rubra</i>	0.2	0.0	0.9
Nonnative	<i>Trifolium subterraneum</i>	0.2	0.0	0.9
Nonnative	<i>Vulpia myuros / V. bromoides</i>	0.5	0.1	1.3

1 In Origin column, invasive is as defined in the Mitigation Bank Instrument for this site.

2 Native and nonnative cover data are provided here transformed to allow calculation of binomial confidence intervals appropriate for point guild data. In the transformed data, each of the two guilds (native and nonnative) can only be recorded once at each point (e.g. each point is either native, nonnative, both, or neither). Total native and nonnative cover could therefore each equal 100%.

## 9 Anticipated Actions for 2018

In 2018, staff will:

1. continue to focus on control of nonnative invasive plant species across the site, particularly the pennyroyal, nonnative grasses, hawksbit/false dandelion, and sheep sorrel.
2. monitor vegetation using quantitative and qualitative methods.
3. disperse native seed for a third year. The composition of the mixes will include native grasses only if invasive nonnative grasses are adequately controlled. It's likely that native grasses beyond the buffer areas will not be introduced to the site until fall 2019.
4. continue to track erosion control measures and the dry down of vernal pools, but systematic vernal pool monitoring for amphibian breeding will not be conducted (or will be much reduced from 2017 levels).
5. continue to coordinate with neighboring landowners, including the BLM; remove site trash (very minimal so far); and monitor for site trespass, illegal camping, or new threats.

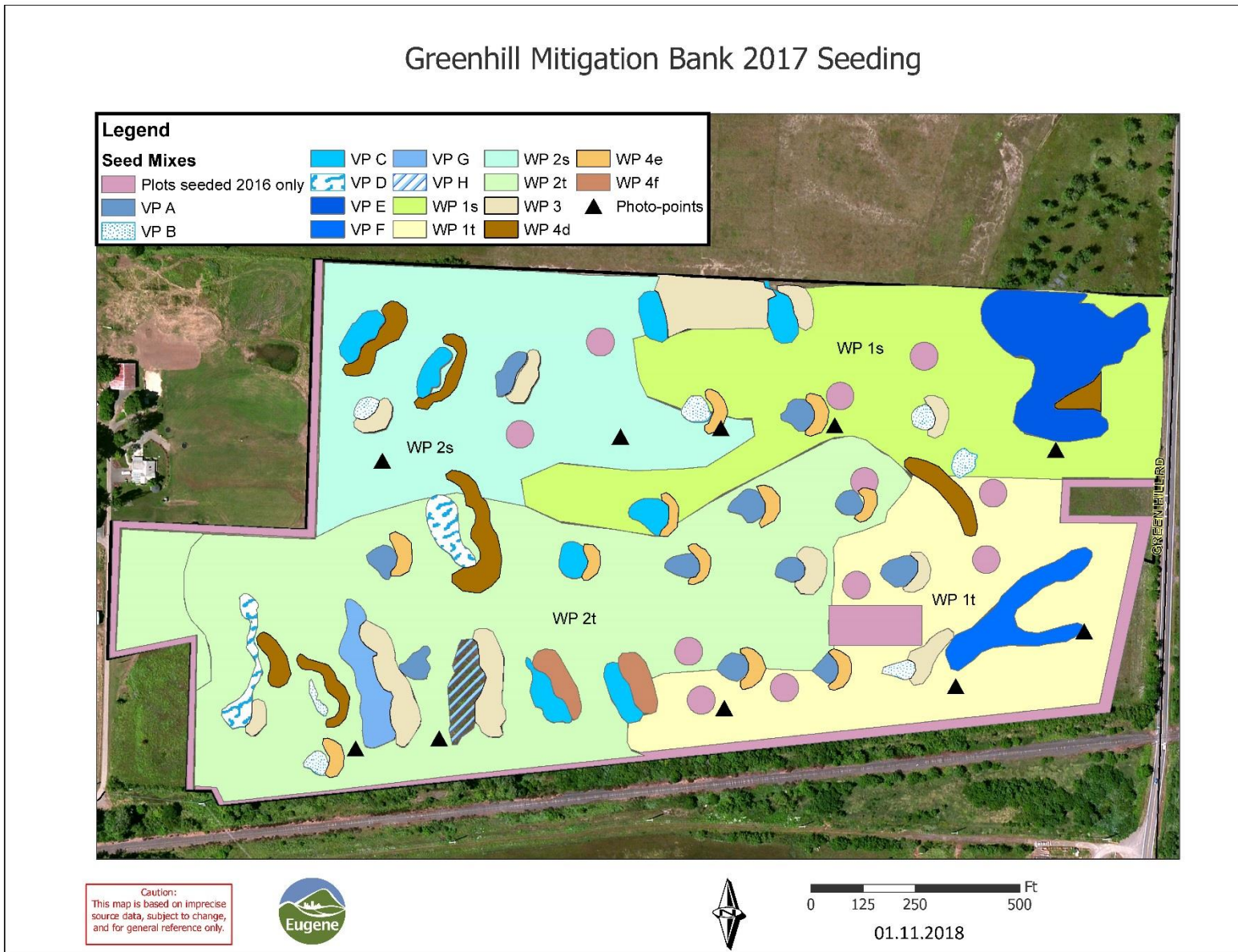


Figure 3. Map of seed mixes distributed October 2017. Detail on the seed mixes is in Appendix A, Table A1.

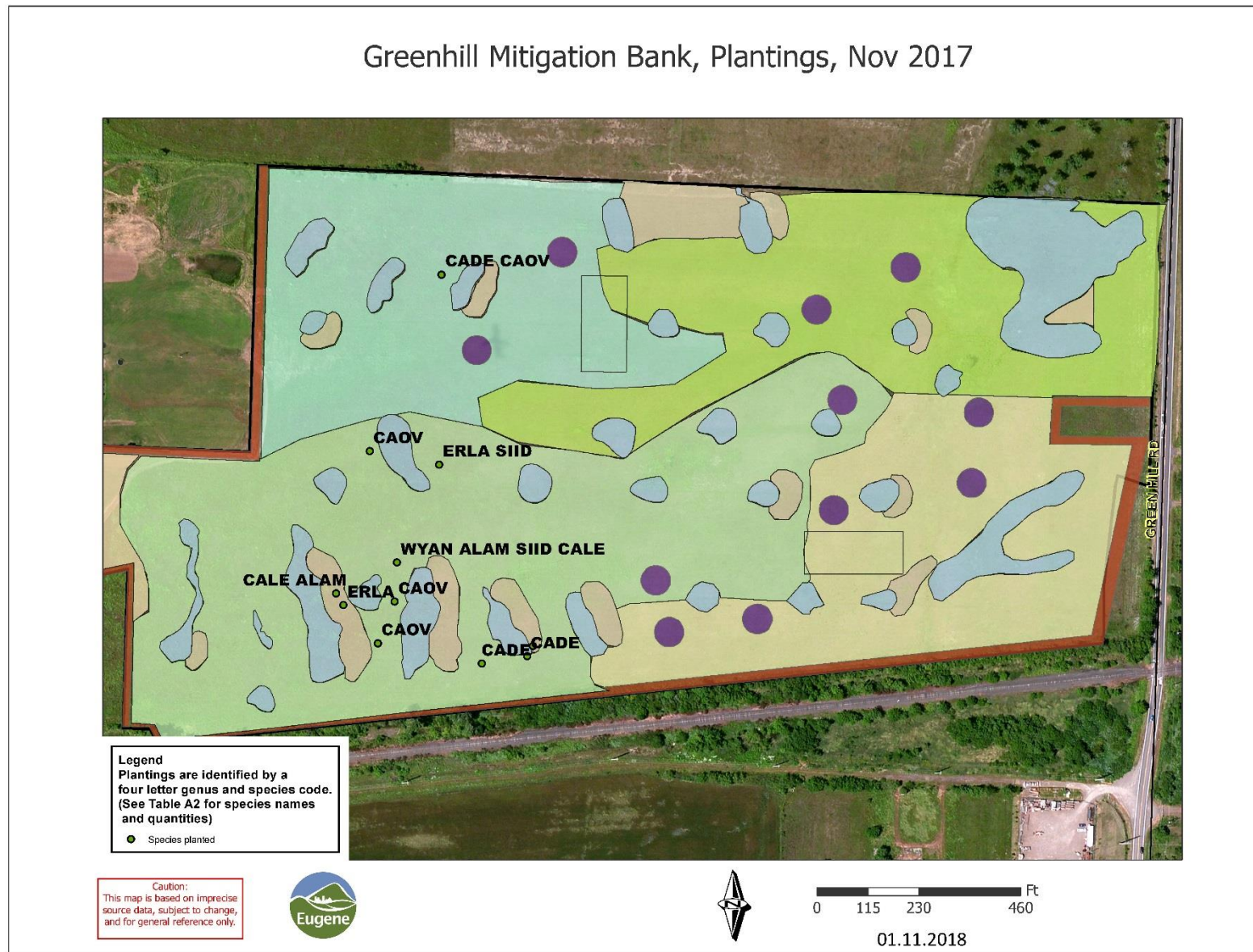


Figure 4. Map of plants installed November 2017. Detail on plantings is in Appendix A, Table A2.

## 10 Progress Toward Meeting Performance Standards

Monitoring and assessment to verify progress toward meeting performance standards in the Greenhill Bank, as described in the MBI, is summarized annually as shown in Table 5.

<b>Monitoring Year</b>	<b>Performance Standard</b>	<b>Monitoring method</b>	<b>Data (Calendar Yr Collected)</b>	<b>Goal Met?</b>
1	Native vascular plant cover > 40%	Point Intercept	99.5% (this report)	Y
1	Nonnative <i>invasive</i> vascular plant cover ≤15%	Point Intercept	31.3% (this report)	N
1 - 5	The depth range for vernal pool inundation is 3 to 18 inches	Staff gauges (sample)	2 pools exceed identified depth range, however intent is met (this report)	Intent
1 - 5	No standing water persists permanently in vernal pools	Staff gauges (sample) and observation	No standing water persists beyond July 20 (this report)	Y
2	Native vascular plant cover > 50%	Point Intercept		
2	Nonnative <i>invasive</i> vascular plant cover ≤15%	Point Intercept		
3	Native vascular plant cover > 60%	Point Intercept		
3	Nonnative <i>invasive</i> vascular plant cover ≤15%	Point Intercept		
3	25 native plant species are present, of which 6 have > 5% cover in at least 10% of area sampled	Point Intercept and Species List		
4	Native vascular plant cover > 60%	Point Intercept		
4	Nonnative <i>invasive</i> vascular plant cover ≤15%	Point Intercept		
5	Native vascular plant cover > 60%	Point Intercept		
5	Nonnative <i>invasive</i> vascular plant cover ≤15%	Point Intercept		
5	50 native plant species are present, of which 6 have > 5% cover in at least 10% of the area sampled	Point Intercept		
5	Bare substrate is < 20%	Point Intercept		



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References cited:

Pearl, C.A., M.J. Adams, N. Leuthold, and R.B. Bury. 2005. Amphibian occurrence and aquatic invaders in a changing landscape: implications for wetland mitigation in the Willamette Valley, Oregon.

## 11 Photos

Photos below show representative areas of the site from 2016/2017. Ten photo points are mapped on Figure 3 and marked in the field for future photo documentation.



Figure a. Shallow inundation across site (from site center looking NE, Nov. 21, 2016).



Figure b. Slightly higher elevation adjacent to pool (from NE looking W, Feb. 2, 2017).



Figure c. Even pools that exceeded 20" water depth in winter were relatively well-vegetated with native annuals their first year (June 19, 2017).



Figure d. Annual flora was well-developed over large regions of the site by the early June 2017 monitoring (June 7, 2017)

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## Appendix A. 2017 Seed Mixes and Plantings

<b>Table A1. Greenhill Mitigation Bank, Primary Native Seed Mixes Distributed Fall 2017.</b>				
57.55 acres were seeded with native forbs and grasses. This table includes the species seeded, total grams, and grams per acre used in each mix.				
<b>Seed Mix Name</b>	<b>Acres</b>	<b>Scientific Name</b>	<b>Total Gms</b>	<b>Grams/Acre</b>
<b>Mix WP 1s</b>	<b>9.5</b>	<i>Camassia quamash var. maxima</i>	475	50
<i>Purpose/Location: Very wet northeast region, where low-statured plants may encourage streaked horned lark use.</i>		<i>Downingia yina</i>	285	30
		<i>Epilobium densiflorum</i>	95	10
		<i>Galium trifidum</i>	285	30
		<i>Grindelia integrifolia</i>	285	30
		<i>Microseris laciniata</i>	236	25
		<i>Microseris laciniata</i>	665	70
		<i>Montia linearis</i>	95	10
		<i>Phlox gracilis</i>	131	14
		<i>Plagiobothrys figuratus &amp; P. scouleri</i>	2,375	250
		<i>Rorippa curvisiliqua</i>	28	3
		<i>Rorippa curvisiliqua</i>	285	30
		<i>Sisyrinchium idahoense var. idahoense</i>	1,140	120
		<i>Veronica peregrina var. xalapensis</i>	285	30
		Total:	6,665	702
<b>Mix WP 1t</b>	<b>9.00</b>	<i>Carex ovalis</i>	48	5
<i>Purpose/Location: Very wet southeast region, all plant statures represented .</i>		<i>Epilobium densiflorum</i>	180	20
		<i>Grindelia integrifolia</i>	540	60
		<i>Lomatium nudicaule</i>	409	45
		<i>Perideridia oregana</i>	1,595	177
		<i>Phlox gracilis</i>	180	20
		<i>Plagiobothrys figuratus &amp; P. scouleri</i>	1,800	200
		<i>Rorippa curvisiliqua</i>	180	20
		<i>Rumex salicifolius var. salicifolius</i>	1,890	210
		<i>Sidalcea cusickii</i>	900	100
		<i>Sisyrinchium idahoense var. idahoense</i>	1,980	220
		<i>Veronica peregrina var. xalapensis</i>	270	30
		Total:	9,972	1,108

**Table A1.** Greenhill Mitigation Bank, Primary Native Seed Mixes Distributed Fall 2017. 57.55 acres were seeded with native forbs and grasses. This table includes the species seeded, total grams, and grams per acre used in each mix.

Seed Mix Name	Acres	Scientific Name	Total Gms	Grams/Acre
<b>Mix WP 2s</b>	<b>9.50</b>	<i>Camassia leichtlinii</i> var. <i>suksdorfii</i>	285	30
<i>Purpose/Location: central-northwest region where low-statured plants may encourage streaked horned lark use.</i>		<i>Eriophyllum lanatum</i> var. <i>lanatum</i>	907	95
		<i>Lomatium nudicaule</i>	5,211	549
		<i>Madia glomerata</i>	28	3
		<i>Microseris laciniata</i>	1,805	190
		<i>Plagiobothrys figuratus</i> & <i>P. scouleri</i>	2,375	250
		<i>Potentilla gracilis</i> var. <i>gracilis</i>	380	40
		<i>Prunella vulgaris</i> var. <i>lanceolata</i>	1,520	160
		<i>Ranunculus occidentalis</i> var. <i>occidentalis</i>	1,900	200
		<i>Saxifraga oregana</i>	143	15
		<i>Sisyrinchium idahoense</i> var. <i>idahoense</i>	2,660	280
		<i>Triteleia hyacinthina</i>	837	88
		<i>Veronica peregrina</i> var. <i>xalapensis</i>	190	20
		<i>Wyethia angustifolia</i>	2,052	216
		Total:	20,293	2,136
<b>Mix WP 2t</b>	<b>18.0</b>	<i>Camassia leichtlinii</i> var. <i>suksdorfii</i>	3,121	186
<i>Purpose/Location: central-southwest region, all plant statures represented.</i>		<i>Carex tumulicola</i>	512	30
		<i>Eriophyllum lanatum</i> var. <i>lanatum</i>	1,571	94
		<i>Galium trifidum</i>	181	11
		<i>Grindelia integrifolia</i>	504	30
		<i>Lomatium nudicaule</i>	4,853	289
		<i>Lotus unifoliolatus</i> var. <i>unifoliolatus</i>	168	10
		<i>Perideridia oregana</i>	2,619	156
		<i>Plagiobothrys figuratus</i> & <i>P. scouleri</i>	1,344	80
		<i>Potentilla gracilis</i> var. <i>gracilis</i>	672	40
		<i>Prunella vulgaris</i> var. <i>lanceolata</i>	1,680	100
		<i>Ranunculus occidentalis</i> var. <i>occidentalis</i>	244	15
		<i>Rumex salicifolius</i> var. <i>salicifolius</i>	2,390	142
		<i>Sidalcea cusickii</i>	1,039	62
		<i>Wyethia angustifolia</i>	3,024	180

**Table A1.** Greenhill Mitigation Bank, Primary Native Seed Mixes Distributed Fall 2017. 57.55 acres were seeded with native forbs and grasses. This table includes the species seeded, total grams, and grams per acre used in each mix.

Seed Mix Name	Acres	Scientific Name	Total Gms	Grams/Acre
		Total:	23,922	1,424
<b>Mix WP 3</b>	<b>1.5</b>	<i>Achillea millefolium</i>	332	221
<i>Purpose/Location: Less inundated areas near vernal pools, some with invasive species issues.</i>		<i>Grindelia integrifolia</i>	2400	1,600
		<i>Juncus occidentalis</i>	52	35
		<i>Lotus unifoliolatus</i> var. <i>unifoliolatus</i>	1856	1,237
		<i>Lupinus rivularis</i>	60	40
		<i>Potentilla gracilis</i> var. <i>gracilis</i>	720	480
		<i>Prunella vulgaris</i> var. <i>lanceolata</i>	360	240
		Total:	5780	3,853
<b>Mix WP 4a (0.1 x 5)</b>	<b>0.5</b>	<i>Achillea millefolium</i>	100	200
<i>Purpose/Location: Less inundated areas near vernal pools, some with invasive species issues.</i>		<i>Grindelia integrifolia</i>	800	1,600
		<i>Juncus occidentalis</i>	18	36
		<i>Lotus unifoliolatus</i> var. <i>unifoliolatus</i>	620	1,240
		<i>Lupinus rivularis</i>	20	40
		<i>Potentilla gracilis</i> var. <i>gracilis</i>	240	480
		<i>Prunella vulgaris</i> var. <i>lanceolata</i>	120	240
		Total:	1,918	3,836
<b>Mix WP 4b (0.2 x 4)</b>	<b>0.8</b>	<i>Juncus occidentalis</i>	160	200
<i>Purpose/Location: Less inundated areas near vernal pools, some with invasive species issues.</i>		<i>Lotus unifoliolatus</i> var. <i>unifoliolatus</i>	960	1,200
		<i>Microseris laciniata</i>	960	1,200
		<i>Potentilla gracilis</i> var. <i>gracilis</i>	960	1,200
		<i>Prunella vulgaris</i> var. <i>lanceolata</i>	960	1,200
		Total:	4,000	5,000
<b>Mix WP 4c (0.3 x 1)</b>	<b>0.3</b>	<i>Achillea millefolium</i>	66	220
<i>Purpose/Location: Less inundated areas near vernal pools, some with invasive species issues.</i>		<i>Grindelia integrifolia</i>	480	1,600

**Table A1.** Greenhill Mitigation Bank, Primary Native Seed Mixes Distributed Fall 2017. 57.55 acres were seeded with native forbs and grasses. This table includes the species seeded, total grams, and grams per acre used in each mix.

Seed Mix Name	Acres	Scientific Name	Total Gms	Grams/Acre
		<i>Juncus occidentalis</i>	10	33
		<i>Lotus unifoliolatus</i> var. <i>unifoliolatus</i>	372	1,240
		<i>Lupinus rivularis</i>	12	40
		<i>Potentilla gracilis</i> var. <i>gracilis</i>	144	480
		<i>Prunella vulgaris</i> var. <i>lanceolata</i>	72	240
		Total:	1,156	3,853
<b>Mix WP 4d (0.4 x 1)</b>	<b>0.8</b>	<i>Achillea millefolium</i>	88	220
<i>Purpose/Location: Less inundated areas near vernal pools, some with invasive species issues.</i>		<i>Grindelia integrifolia</i>	640	1,600
		<i>Juncus occidentalis</i>	14	35
		<i>Lotus unifoliolatus</i> var. <i>unifoliolatus</i>	496	1,240
		<i>Lupinus rivularis</i>	16	40
		<i>Potentilla gracilis</i> var. <i>gracilis</i>	192	480
		<i>Prunella vulgaris</i> var. <i>lanceolata</i>	96	240
		Total:	1,542	3,855
<b>Mix WP 4e (0.1 x 11)</b>	<b>1.10</b>	<i>Achillea millefolium</i>	132	120
<i>Purpose/Location: Less inundated areas near vernal pools, some with invasive species issues.</i>		<i>Carex tumulicola</i>	2,200	2,000
		<i>Grindelia integrifolia</i>	1,760	1,600
		<i>Juncus occidentalis</i>	110	100
		<i>Luzula comosa</i>	88	80
		<i>Plagiobothrys figuratus</i> & <i>P. scouleri</i>	88	80
		<i>Potentilla gracilis</i> var. <i>gracilis</i>	990	900
		<i>Prunella vulgaris</i> var. <i>lanceolata</i>	308	280
		Total:	5,676	5,160
<b>Mix WP 4f-JUOC (0.2 x 2)</b>	<b>0.4</b>	<i>Achillea millefolium</i>	48	120
<i>Purpose/Location: Less inundated areas near vernal pools, some with invasive species issues.</i>		<i>Grindelia integrifolia</i>	640	1,600
		<i>Juncus occidentalis</i>	40	100
		<i>Lotus unifoliolatus</i> var. <i>unifoliolatus</i>	270	675
		<i>Lupinus rivularis</i>	16	40
		<i>Potentilla gracilis</i> var. <i>gracilis</i>	192	480

**Table A1.** Greenhill Mitigation Bank, Primary Native Seed Mixes Distributed Fall 2017. 57.55 acres were seeded with native forbs and grasses. This table includes the species seeded, total grams, and grams per acre used in each mix.

Seed Mix Name	Acres	Scientific Name	Total Gms	Grams/Acre
		<i>Prunella vulgaris var. lanceolata</i>	96	240
		Total:	1,302	3,255
<b>Mix WP 4e (0.1 x 11)</b>	<b>1.10</b>	<i>Achillea millefolium</i>	132	120
<i>Purpose/Location: Less inundated areas near vernal pools, some with invasive species issues.</i>		<i>Carex tumulicola</i>	2,200	2,000
		<i>Grindelia integrifolia</i>	1,760	1,600
		<i>Juncus occidentalis</i>	110	100
		<i>Luzula comosa</i>	88	80
		<i>Plagiobothrys figuratus &amp; P. scouleri</i>	88	80
		<i>Potentilla gracilis var. gracilis</i>	990	900
		<i>Prunella vulgaris var. lanceolata</i>	308	280
		Total:	5,676	5,160
<b>VP A 0.1 2017 (0.1 x 11)</b>	<b>1.10</b>	<i>Downingia elegans</i>	30	300
<i>11 pools, each 0.1 (± 0.03) acre in size, received this base mix.</i>		<i>Lasthenia glaberrima</i>	33	335
		<i>Navarretia intertexta ssp. intertexta</i>	30	305
		<i>Ranunculus orthorhynchus</i>	33	300
		<i>Rorippa curvisiliqua</i>	20	200
		Total:	146	1,441
<b>VP B 0.08 2017</b>	<b>0.6</b>	<i>Alisma triviale</i>	12	80
<i>7 pools, each about 0.08 (± 0.02) acre in size, received this base mix.</i>		<i>Downingia elegans</i>	21	149
		<i>Navarretia intertexta ssp. intertexta</i>	17	120
		<i>Veronica peregrina var. xalapensis</i>	13	91
		Total:	63	440
<b>VP C 0.17 2017</b>	<b>1.3</b>	<i>Downingia elegans</i>	70	555
<i>8 pools, each about 0.16 (± 0.02) acre in size, received these species, except the Eryngium, which went into only 4 pools.</i>		<i>Eryngium petiolatum</i>	60	240
		<i>Lasthenia glaberrima</i>	90	719
		<i>Navarretia intertexta ssp. intertexta</i>	30	240
		Total:	250	1,754

**Table A1.** Greenhill Mitigation Bank, Primary Native Seed Mixes Distributed Fall 2017. 57.55 acres were seeded with native forbs and grasses. This table includes the species seeded, total grams, and grams per acre used in each mix.

Seed Mix Name	Acres	Scientific Name	Total Gms	Grams/Acre
<b>VP D 0.25 2017</b>	0.5	<i>Downingia elegans</i>	352	704
<i>2 pools, each about 0.25 acre in size, received this base mix.</i>		<i>Gratiola ebracteata</i>	78	156
		<i>Lasthenia glaberrima</i>	99	197
		Total:	529	1,057
<b>VP Individ F 1.9 2017</b>	1.90	<i>Alisma triviale</i>	38	20
<i>Purpose/Location: Pool F on map.</i>		<i>Carex densa</i>	57	30
		<i>Carex feta</i>	95	50
		<i>Carex obnupta</i>	76	40
		<i>Gratiola ebracteata</i>	4	2
		<i>Juncus ensifolius/bolanderi mix</i>	8	4
		<i>Juncus oxymersis</i>	8	4
		<i>Navarretia willamettensis</i>	49	26
		Total:	335	176
<b>VP Individ E 0.7 2017</b>	0.70	<i>Downingia elegans</i>	42	60
<i>Purpose/Location: Pool E on map.</i>		<i>Gratiola ebracteata</i>	19	27
		<i>Myosotis laxa</i>	37	53
		Total:	98	140
<b>VP Individ G 0.5 2016</b>	0.50	<i>Dichantherium acuminatum var. fasciculatum</i>	70	140
<i>Purpose/Location: Pool G on map.</i>		<i>Downingia yina</i>	118	236
		<i>Gratiola ebracteata</i>	19	38
		<i>Myosotis laxa</i>	30	60
		<i>Navarretia intertexta ssp. intertexta</i>	160	320
		Total:	397	794
<b>VP Individ H 0.4 2017</b>	0.40	<i>Downingia yina</i>	36	90
<i>Purpose/Location: Pool H on map.</i>		<i>Eryngium petiolatum</i>	68	170
		<i>Eryngium petiolatum</i>	44	110
		<i>Navarretia intertexta ssp. intertexta</i>	44	110
		Total:	192	480
<b>Single sp – by hand. Not locational mix</b>	N/A	<i>Asclepias speciosa</i>	152	N/A

**Table A1. Greenhill Mitigation Bank, Primary Native Seed Mixes Distributed Fall 2017.**  
57.55 acres were seeded with native forbs and grasses. This table includes the species seeded, total grams, and grams per acre used in each mix.

Seed Mix Name	Acres	Scientific Name	Total Gms	Grams/Acre
<i>Purpose/Location: targeted hand seeding to improve establishment, reduce erosion potential, and distribute some seed bag remainders.</i>		<i>Camassia leichtlinii var. suksdorfii</i>	167	
		<i>Camassia quamash var. maxima</i>	2,000	
		<i>Carex unilateralis</i>	191	
		<i>Eriophyllum lanatum var. lanatum</i>	1	
		<i>Gentiana sceptrum</i>	102	
		<i>Juncus patens</i>	104	
		<i>Linanthus bicolor</i>	300	
		<i>Lotus formosissimus</i>	155	
		<i>Lupinus polyphyllus</i>	696	
		<i>Madia glomerata</i>	617	
		<i>Madia sativa</i>	220	
		<i>Orthocarpus bracteosus</i>	27	
		<i>Phlox gracilis</i>	16	
		<i>Thalictrum polycarpum</i>	9	
		Total:	4,757	
<b>Single sp – by hand. Not locational mix</b>		<i>Gratiola ebracteata</i>	10	10
<i>Purpose/Location: by hand in 1s/1t area</i>		<i>Mimulus guttatus</i>	10	10
		<i>Ranunculus alismaefolius var. alismifolius</i>	289	289
		<i>Ranunculus orthorhynchus</i>	2,997	2,997
		Total:	3,306	3,306

**Table A2. Plants Installed at Site November 2017.**  
Plant code is used on map to identify planting location.

Species	Map Code	Size	Quantity
<i>Allium amplexans</i>	ALAM	Flats of bulbs	6
<i>Camassia leichtlinii</i>	CALE	Flats of bulbs	4
<i>Carex densa</i>	CADE	plugs	184
<i>Carex ovalis</i>	CAOV	plugs	175
<i>Eriophyllum lanatum</i>	ERLA	Band pots	190
<i>Sisyrinchium idahoense</i>	SIID	Band pots	100



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**Table A2. Plants Installed at Site November 2017.**  
Plant code is used on map to identify planting location.

<i>Triteleia hyacinthina</i>	TRHY	Loose bulbs	500
<i>Wyethia angustifolia</i>	WYAN	Band pots	50
		total	709

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## Appendix B. Species List

Those species recorded at the Greenhill Mitigation Bank site in 2017 during meandering spring and summer surveys, as well as those encountered during point-intercept monitoring, are marked with an X.

Scientific Name	Common Name	Origin	Present
<i>Achillea millefolium</i>	yarrow	N	X
<i>Acmispon americanus</i> (Syn: <i>Lotus unifoliolatus</i> )	Spanish-clover	N	X
<i>Agrostis exarata</i>	spike bentgrass	N	X
<i>Agrostis stolonifera/capillaris</i>	fiorin (bentgrass)	I	X
<i>Aira caryophyllaea</i>	silver hairgrass	I	
<i>Alisma lanceolatum</i>	narrowleaf waterplantain	I	
<i>Alisma trivale</i>	northern waterplantain	N	
<i>Allium amplexans</i>	Slim leaf onion	N	
<i>Alopecurus geniculatus</i>	water foxtail	N	
<i>Alopecurus pratensis</i>	meadow foxtail	I	X
<i>Amelanchier alnifolia</i> var. <i>semiintegrifolia</i>	western serviceberry	N	
<i>Anagallis arvensis</i>	scarlet pimpernel	I	X
<i>Anaphalis margaritacea</i>	pearly everlasting	N	
<i>Anthemis cotula</i>	mayweed chamomile	I	
<i>Anthoxanthum odoratum</i>	sweet vernalgrass	I	X
<i>Anthriscus caucalis</i>	bur chervil	I	
<i>Asclepias speciosa</i>	showy milkweed	N	X
<i>Beckmannia syzigachne</i>	American sloughgrass	N	X
<i>Bidens frondosa</i>	leafy beggars-tick	N	X
<i>Bidens</i> sp.			
<i>Briza minor</i>	little quaking-grass	I	X
<i>Brodiaea coronaria</i>	harvest brodiaea	N	
<i>Brodiaea elegans</i>	harvest brodiaea	N	X
<i>Bromus carinatus</i>	California brome	N	
<i>Bromus hordeaceus</i>	soft brome	I	
<i>Calandrinia ciliata</i>	red maids	N	
<i>Camassia leichtlinii</i> ssp. <i>suksdorfii</i>	tall camas	N	X
<i>Camassia quamash</i> ssp. <i>maxima</i>	common camas	N	
<i>Cardamine hirsuta</i>	hairy bittercress	I	X
<i>Cardamine penduliflora</i>	Willamette V. bittercress	N	X
<i>Carex densa</i>	dense sedge	N	X
<i>Carex feta</i>	green-sheath sedge	N	

<i>Carex leporina</i>	oval broom sedge	N	X
<i>Carex obnupta</i>	slough sedge	N	X
<i>Carex stipata</i> var. <i>stipata</i>	awl-fruit sedge	N	
<i>Carex tumulicola</i>	foothill sedge	N	
<i>Carex unilateralis</i>	one-sided sedge	N	
<i>Carex vesicaria</i>	inflated sedge	N	
<i>Castilleja tenuis</i>	hairy owl-clover	N	
<i>Centaurium erythraeae</i>	common centaury	I	X
<i>Centunculus minimus</i>	chaffweed	N	
<i>Cerastium glomeratum</i>	sticky chickweed	I	X
<i>Chamerion angustifolium</i> var. <i>canescens</i>	perennial fireweed	N	X
<i>Cicendia quadrangularis</i>	Timwort	N	
<i>Cirsium arvense</i>	Canada thistle	I	
<i>Cirsium vulgare</i>	bull thistle	I	
<i>Clarkia amoena</i> ssp. <i>lindleyi</i>	farewell-to-spring	N	X
<i>Clarkia purpurea</i> ssp. ssp. <i>quadrivulnera</i>	winecup clarkia	N	
<i>Collomia grandiflora</i>	grand collomia	N	
<i>Convolvulus arvensis</i>	bindweed	I	
<i>Coryza canadensis</i>	Canadian horseweed	I	
<i>Crassula aquatica</i>	water pygmy weed	N	X
<i>Crataegus monogyna</i>	English hawthorn	I	
<i>Crataegus suksdorfii</i>	black hawthorn	N	
<i>Crataegus suksdorfii</i> X <i>monogyna</i>	hybrid hawthorn	I	
<i>Crepis capillaries</i>	smooth hawksbeard	I	
<i>Crepis setosa</i>	bristly hawksbeard	I	X
<i>Cynosurus echinatus</i>	hedgehog dogtail	I	
<i>Cyperus eragrostis</i>	tall flatsedge	I	
<i>Cyperus</i> sp. (likely <i>C. erythrorhizos</i> )	(red-rooted flat sedge)	(N)	X
<i>Danthonia californica</i>	California oatgrass	N	
<i>Daucus carota</i>	Queen Anne's lace	I	X
<i>Deschampsia cespitosa</i>	tufted hairgrass	N	X
<i>Deschampsia danthonioides</i>	annual hairgrass	N	
<i>Dianthus armeria</i>	Deptford pink	I	
<i>Dichanthelium acuminatum</i> var. <i>fasciculatum</i>	western witchgrass	N	X
<i>Dichelostemma congestum</i>	ookow	N	
<i>Dipsacus fullonum</i>	teasel	I	
<i>Downingia elegans</i>	showy downingia	N	X

<i>Downingia yina</i>	Willamette downingia	N	X
<i>Echinochloa crus-galli</i>	large barnyard-grass	I	
<i>Eleocharis acicularis</i>	needle spike-rush	N	
<i>Eleocharis obtusa</i>	common spike-rush	N	X
<i>Eleocharis palustris</i>	common spikerush	N	X
<i>Elymus glaucus</i> ssp.ssp. <i>glaucus</i>	western ryegrass	N	
<i>Epilobium brachycarpum</i>	autumn willowherb	N	X
<i>Epilobium campestre</i>	smooth willowherb	N	
<i>Epilobium ciliatum</i>	hairy willowherb	N	X
<i>Epilobium densiflorum</i>	dense spike-primrose	N	X
<i>Equisetum</i> sp.	horsetail	N	
<i>Eriophyllum lanatum</i> var. <i>lanatum</i>	wooly sunflower	N	X
<i>Eryngium petiolatum</i>	coyote thistle	N	X
<i>Festuca roemerii</i>	Roemer's fescue	N	
<i>Fragaria virginiana</i> ssp.ssp. <i>platypetala</i>	mountain strawberry	N	
<i>Fraxinus latifolia</i>	Oregon ash	N	
<i>Galium aparine</i>	catchweed	N	
<i>Galium divaricatum</i>	wall bedstraw	I	X
<i>Galium</i> sp.	bedstraw sp.	N/I	
<i>Galium trifidum</i>	small bedstraw	N	X
<i>Galium triflorum</i>	fragrant bedstraw	N	
<i>Gentiana sceptrum</i>	king's gentian	N	
<i>Geranium dissectum</i>	cut-leaved geranium	I	X
<i>Geranium lucidum</i>	shining geranium	I	
<i>Geum macrophyllum</i>	large-leaf avens	N	
<i>Gilia capitata</i> ssp. <i>capitata</i>	bluehead gilia	N	
<i>Glyceria occidentalis</i>	western mannagrass	N	
<i>Gnaphalium palustre</i>	lowland cudweed	N	X
<i>Gnaphalium purpureum</i>	purple cudweed	N	X
<i>Gnaphalium stramineum</i>	cotton batting plant	N	
<i>Gnaphalium uliginosum</i>	marsh cudweed	I	
<i>Gratiola ebracteata</i>	bractless hedge-hyssop	N	X
<i>Grindelia integrifolia</i> x <i>Grindelia nana</i> var. <i>nana</i>	Willamette V. gumweed	N	X
<i>Heracleum maximum</i>	cow parsnip	N	
<i>Holcus lanatus</i>	velvet grass	I	X
<i>Hordeum brachyantherum</i>	meadow barley	N	X
<i>Hordeum marinum</i>	Mediterranean barley	I	
<i>Hypericum perforatum</i>	St. John's-wort	I	X

<i>Hypochaeris radicata</i>	false dandelion	I	X
<i>Isoetes</i> sp.	quillwort	N	
<i>Juncus acuminatus</i>	tapered rush	N	
<i>Juncus articulatus</i>	jointed rush	N	
<i>Juncus bolanderi</i>	Bolander's rush	N	
<i>Juncus bufonius</i>	toad rush	N	X
<i>Juncus effusus</i> var. var. <i>effuses</i>	common rush	I	
<i>Juncus effusus</i> var. var. <i>pacificus</i>	soft rush	N	X
<i>Juncus ensifolius</i>	Swordleaf rush	N	X
<i>Juncus marginatus</i>	grass-leaf rush	I	
<i>Juncus nevadensis</i>	Nevada rush	N	X
<i>Juncus occidentalis</i>	slender rush	N	X
<i>Juncus oxymeris</i>	pointed rush	N	X
<i>Juncus patens</i>	Spreading rush	N	X
<i>Kickxia elatine</i>	cancerwort	I	
<i>Lactuca saligna</i>	willow lettuce	I	X
<i>Lactuca serriola</i>	prickly lettuce	I	
<i>Lasthenia glaberrima</i>	smooth lasthenia	N	X
<i>Lathyrus aphaca</i>	yellow vetch	I	
<i>Lathyrus hirsutus</i>	rough pea	I	
<i>Lathyrus sphaericus</i>	grass pea	I	
<i>Leontodon saxatilis</i> (Syn: <i>Leontodon taraxacoides</i> )	hairy hawkbit	I	X
<i>Leucanthemum vulgare</i>	oxeye daisy	I	X
<i>Limnanthes alba</i> (agriculture escape)	white meadowfoam	I	X
<i>Linum bienne</i>	pale flax	I	X
<i>Lolium multiflorum</i>	Italian ryegrass	I	X
<i>Lomatium bradshawii</i>	Bradshaw's desert parsley	N	
<i>Lomatium nudicaule</i>	barestem desert-parsley	N	X
<i>Lotus corniculatus</i>	bird'sfoot trefoil	I	X
<i>Lotus formosissimus</i>	seaside lotus	N	
<i>Lotus micranthus</i>	small-flowered deervetch	N	
<i>Ludwigia palustris</i>	marsh speedbox		
<i>Lupinus affinis</i>	fleshy lupine	N	
<i>Lupinus bicolor</i>	field lupine	N	
<i>Lupinus oreganus</i>	Kincaid's lupine	N	
<i>Lupinus polyphyllus</i> var. var. <i>polyphyllus</i>	bigleaf lupine	N	X
<i>Lupinus rivularis</i>	stream lupine	N	
<i>Luzula comosa</i> var. <i>comosa</i>	field woodrush	N	

<i>Lythrum hyssopifolium</i>	hyssop loosestrife	I	X
<i>Lythrum portula</i>	water-purslane	I	X
<i>Madia elegans</i>	showy tarweed	N	X
<i>Madia glomerata</i>	cluster tarweed	N	X
<i>Madia sativa</i>	coast tarweed	N	X
<i>Malus fusca</i>	western crab-apple	N	
<i>Matricaria discoidea</i>	pineapple weed	N	
<i>Melilotus alba</i>	white sweetclover	I	
<i>Mentha pulegium</i>	pennyroyal	I	X
<i>Micranthes integrifolia</i>	swamp saxifrage	N	
<i>Micranthes oregana</i>	bog saxifrage	N	
<i>Microseris laciniata</i> ssp. <i>laciniata</i>	cut-leaved microseris	N	X
<i>Microsteris gracilis</i>	pink microsteris	N	X
<i>Mimulus guttatus</i> var. <i>depauperatus</i>	depauperate monkeyflower	N	X
<i>Moenchia erecta</i> ssp. <i>erecta</i>	moenchia	I	
<i>Montia linearis</i>	narrow-leaved montia	N	X
<i>Myosotis discolor</i>	yellow & blue forget me not	I	X
<i>Myosotis laxa</i>	small-flowered forget me not	N	X
<i>Navarretia intertexta</i> ssp. <i>intertexta</i>	needle-leaved navarretia	N	X
<i>Navarretia squarrosa</i>	skunkweed	N	
<i>Navarretia willamettensis</i>	Willamette navarretia	N	X
<i>Nemophila menziesii</i>	baby blue eyes	N	
<i>Nuttallanthus texanus</i>	Large flowered blue toadflax	N	X
<i>Orobanche californica</i> ssp. <i>californica</i>	California broomrape	N	
<i>Orthocarpus bracteosus</i>	rosy owl-clover	N	
<i>Panicum capillare</i> ssp. <i>capillare</i>	common witchgrass	N	X
<i>Parentucellia viscosa</i>	yellow parentucellia	I	X
<i>Perideridia montana</i>	Gairdner's yampah	N	
<i>Perideridia oregana</i>	Oregon yampah	N	
<i>Persicaria hydropiperoides</i>	marshpepper smartweed	N	
<i>Persicaria maculosa</i>	heartweed	I	
<i>Phalaris aquatica</i>	Harding grass	I	
<i>Phalaris arundinacea</i>	reed canarygrass	I	X
<i>Phleum pratense</i>	Timothy	I	
<i>Plagiobothrys figuratus</i> var. <i>figuratus</i>	fragrant popcorn-flower	N	X
<i>Plagiobothrys scouleri</i>	Scouler's popcorn-flower	N	X
<i>Plantago lanceolata</i>	English plantain	I	X
<i>Plectritis congesta</i>	rosy plectritis	N	
<i>Poa annua</i>	annual bluegrass	I	X

<i>Poa compressa</i>	Canada bluegrass	I	
<i>Poa pratensis</i>	Kentucky blugrass	I	X
<i>Poa sp.</i>	bluegrass sp	I	
<i>Polygonum aviculare</i> ssp. <i>aviculare</i>	doorweed	I	
<i>Polygonum douglasii</i>	douglas knotweed	N	
<i>Populus trichocarpa</i>	black cottonwood	N	X
<i>Portulaca oleracea</i>	little hogweed	I	X
<i>Potentilla gracilis</i> var. <i>gracilis</i>	slender cinquefoil	N	X
<i>Prunella vulgaris</i> var. <i>lanceolata</i>	self-heal	N	X
<i>Prunus sp.</i>	plum	I	
<i>Psilocarphus spp.</i>	wooly heads	N	
<i>Pyrrocoma racemosa</i> var. <i>racemosa</i>	racemed goldenweed	N	X
<i>Pyrus communis</i>	pear	I	
<i>Pyrus malus</i>	apple	I	
<i>Quercus garryana</i> var. <i>garryana</i>	Oregon white oak	N	X
<i>Quercus kelloggii</i>	California black oak	N	X
<i>Ranunculus alismifolius</i>	water-plantain buttercup	N	
<i>Ranunculus aquatilis</i>	white water buttercup	N	
<i>Ranunculus flammula</i>	creeping buttercup	N	
<i>Ranunculus occidentalis</i>	western buttercup	N	X
<i>Ranunculus orthorhynchus</i>	straight beaked buttercup	N	X
<i>Ranunculus sceleratus</i>	celery-leaf butter-cup	N	
<i>Rhamnus purshiana</i>	cascara	N	
<i>Rorippa curvisiliqua</i>	western yellowcress	N	X
<i>Rorippa palustris</i>			
<i>Rosa multiflora</i>	many flowered rose	I	
<i>Rosa nutkana</i>	Nootka rose	N	
<i>Rosa pisocarpa</i>	peafruit rose	I	
<i>Rosa sp.</i>	rose sp.	N/I	
<i>Rubus bifrons</i>	Himalayan blackberry	I	X
<i>Rubus laciniatus</i>	evergreen blackberry	I	
<i>Rumex acetocella</i>	sheep sorrel	I	X
<i>Rumex conglomeratus</i>	clustered dock	I	
<i>Rumex crispus</i>	curly dock	I	X
<i>Rumex salicifolius</i> var. <i>salicifolius</i>	willow dock	N	X
<i>Saxifraga oregana</i> (see <i>Micranthes oregana</i> )			
<i>Salix sp.</i>	willow	N	X
<i>Schedonorus arundinaceus</i>	tall fescue	I	X
<i>Schoenoplectus tabernaemontani</i>	softstem bulrush	N	

<i>Senecio jacobea</i>	tansy ragwort	I	X
<i>Senecio sylvaticus</i>	wood groundsel	I	
<i>Senecio vulgaris</i>	old-man-in-the-spring	I	X
<i>Sericocarpus rigidus</i>	rigid white topped aster	N	
<i>Sherardia arvensis</i>	blue field-madder	I	
<i>Sidalcea cusickii</i>	Cusick's checker-mallow	N	X
<i>Sidalcea malviflora</i> ssp. <i>virgata</i>	dwarf checker-mallow	N	
<i>Sisyrinchium bellum</i>	Western blue-eyed grass	N	
<i>Sisyrinchium hitchcockii</i>	Hitchcock's blue-eyed grass	N	
<i>Sisyrinchium idahoense</i>	Idaho blue-eyed grass	N	X
<i>Solanum dulcamara</i>	bitter nightshade	I	
<i>Solanum nigrum</i>	black nightshade	I	
<i>Sonchus asper</i>	prickly sow-thistle	I	X
<i>Sparganium emersum</i>	simplestem bur-reed	N	
<i>Spergula arvensis</i>	stickwort	I	
<i>Spergularia rubra</i>	red sandspurry	I	X
<i>Spiraea douglasii</i>	Douglas spirea	N	X
<i>Spiranthes romanzoffiana</i>	hooded ladies tresses	N	
<i>Stellaria media</i>	chickweed	I	
<i>Symphoricarpos albus</i> var. <i>laevigatus</i>	snowberry	N	
<i>Symphyotrichum hallii</i>	Hall's aster	N	X
<i>Tanacetum vulgare</i>	common tansy	I	
<i>Taraxicum officinale</i>	dandelion	I	X
<i>Thalictrum polycarpum</i>	Meadow rue	N	X
<i>Toxicodendron diversiloba</i>	poison oak	N	
<i>Toxicoscordion venenosum</i>	meadow death camas	N	
<i>Trifolium arvense</i>	rabbitfoot clover	I	
<i>Trifolium dubium</i>	least hop clover	I	
<i>Trifolium pratense</i>	red clover	I	
<i>Trifolium repens</i>	white clover	I	X
<i>Trifolium subterraneum</i>	subterranean clover	I	X
<i>Trifolium vesiculosum</i>	arrowleaf clover	I	
<i>Triphysaria versicolor</i> ssp. <i>versicolor</i>	johnnytuck	N	
<i>Triteleia hyacinthina</i>	hyacinth brodiaea	N	X
<i>Typha latifolia</i>	cat-tail	N	
<i>Verbascum blattaria</i>	moth mullein	I	
<i>Verbascum thapsus</i>	common mullein	I	
<i>Veronica americana</i>	American speedwell	N	
<i>Veronica anagallis-aquatica</i>	water speedwell	I	X



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<i>Veronica peregrine</i> var. <i>xalapensis</i>	purslane speedwell	N	X
<i>Veronica scutellata</i>	marsh speedwell	N	X
<i>Vicia cracca</i>	bird vetch	I	
<i>Vicia hirsuta</i>	hairy vetch	I	X
<i>Vicia sativa</i>	common vetch	I	
<i>Vicia tetrasperma</i>	slender vetch	I	X
<i>Vulpia bromoides</i>	barren fescue	I	X
<i>Vulpia myuros</i>	rat-tail fescue	I	X
<i>Wyethia angustifolia</i>	narrow-leaf mule's ears	N	X
<i>Zeltnera muehlenbergii</i>	monterey centaury	N	

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## Appendix C. Monitoring Methods

Monitoring is based on the protocol included in the Compensatory Mitigation Plan of the Mitigation Bank Instrument for the Greenhill Mitigation Bank. Sections of that protocol are included below and updated to reflect the .

### Vegetation

The point-intercept method (Elzinga et al. 1998) is used to quantitatively monitor vegetation at the Greenhill Mitigation Bank site. This method is currently being used at several wetland sites managed and monitored by the City of Eugene. The point-intercept method is typically considered the most objective measure for plant cover, particularly when monitoring staff may vary from year to year. This monitoring method allows for both repeatability and reliability among monitoring staff and facilitates cross-referencing of monitoring results.

Point-intercept sampling typically occurs in June, sometimes running into early July depending on spring weather patterns. A 1-acre monitoring grid was established over the entire 58 acres and grid intersections were flagged in the field using a GPS with sub-foot accuracy. At the Greenhill Mitigation Bank Site, transects were established starting at the edge of the grass buffer in the east end of the site, running west upslope. Because neither the east nor west end of the sites has a straight line boundary the lengths of the transects vary from south to north. Transect starts were systematically placed 21.5 meters from the acre boundary markers from south to north to achieve good interspersed sampling points across the entire site. The sampling unit is the point, not the transect. Starting points along the transects are chosen randomly from a random number table to be between 1 and 5 meters. After the random start, three more sampling points are taken, approximately 13 meters apart using pacing. Measuring tapes were used initially in training to adjust staff's paces to meters. In summary, the first point is a random start between 1 and 5 meters, and the next three points along the transect, within each acre, were taken every 13 meters. The random start is then applied again at the beginning of each acre, after staff realign themselves along the flagged acre boundary, to ensure that site conditions that may alter pace length (e.g. presence of pools with standing water) doesn't shift sample placement. This design of systematic sampling with a random start achieved about 8 sampling points per acre, although the partial acres at the site's boundary means that a total of 419 points were sampled in 57.6 acres (7.3 points per acre on average). This relatively high number of samples was taken to ensure an adequate sample size this first year of vegetation monitoring. In 2017, point-intercept monitoring, including establishing the transects, took approximately 48 person hours. In future years, reestablishing the transects will be more rapid, but time required to record the point data will likely increase as the vegetation density increases bare ground diminishes.

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At each sampling point, a tripod with level (ensuring perpendicular dropping of the rod) and steel rod are used to determine species cover. For each point, every individual plant that intercepts the very tip of the rod is recorded, as well as the substrate (rock, bare ground, litter, or moss). Percent absolute cover of each species is calculated and an 80% confidence interval is provided for all individual species estimates. Although point-intercept sampling provides a high level of accuracy, it occasionally discounts the presence of species with low cover values. Therefore, walking surveys will be conducted to provide measurements of species richness by species census. Walking surveys will occur at least twice during the growing season. The surveyor will create a comprehensive list of all plant species observed during the walk-through. Special attention will be paid to recording and mapping the presence of invasive plant species and uncommon native, wetland plant species.

## Hydrology / Vernal Pools

In addition to winter walking surveys to observe water flow across the site and look for formation of erosion channels, a set of 15 representative pools were sampled for depth (via staff gauge placement and recording) from January through June 2017. This intensive level of monitoring will not be necessary annually, since initial depths and dry down have been observed across a season. However, in 2018 pool depths will again be tracked (in 18 pools with staff gauges) once in winter for depth maximums and again to confirm dry down in a second year. A late summer walking survey of the wettest areas will map any persistent standing water.

Approximately 8-10 photo points will be established along sampling transects after site construction. Photographs will be routinely taken from the designated points and included in monitoring reports. Photo points should appropriately capture important areas of hydrology and representative areas of vegetation.

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