

ODOT Greenhill Mitigation Bank

Annual Report 2019



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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 2019 management actions and monitoring results. The 2019 monitoring results show that the site's wet prairie plant community is establishing well, with 72 percent native plant cover. Invasive non-native species from the site's past continue to be a problem and even with control efforts, cover by non-native invasive species reached 16 percent in summer 2019. The site met all performance criteria in 2019 except for that of invasive species cover, which was exceeded by 1 percent. Vernal pools are functioning as expected, filling rapidly during fall and winter rains, trapping sediment, developing characteristic native vegetation dominated by annual native species, and providing breeding sites for native invertebrates and amphibians, before drying by mid-summer. Management activities in 2019 focused on controlling non-native plant species and enhancing the native plant community through addition of selective native seeding, particularly to compete with non-native invasive species and enhance diversity in vernal pools.

2 Introduction and Site Description

2.1 Site Location

The Greenhill Mitigation Bank site (the site) is 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 (remnant and restored) 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 fallowed 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 garryana*), 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 arundinacea*), 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.

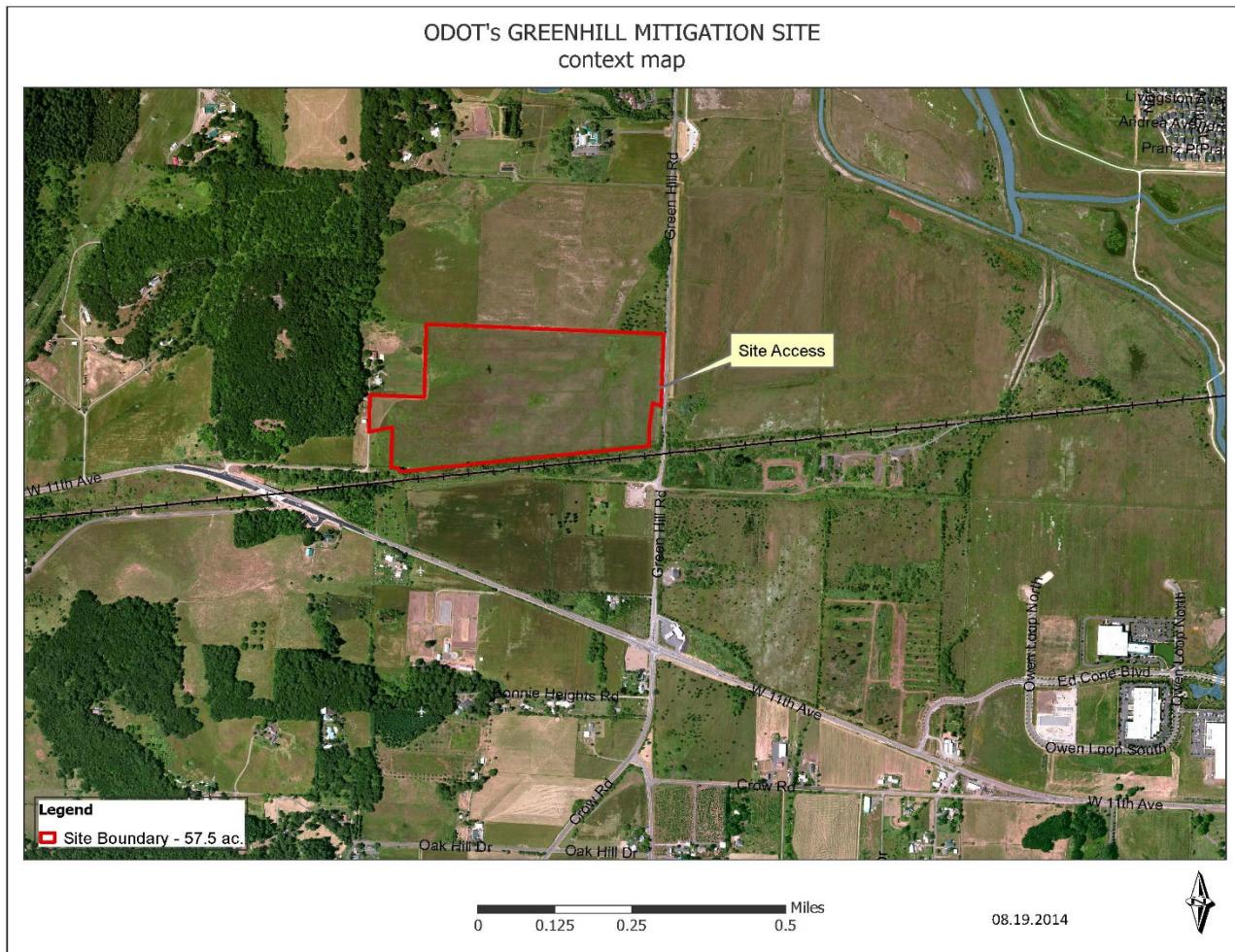


Figure 1. ODOT's Greenhill Mitigation Bank Site boundary. Lands directly to the north and those east of Greenhill Road are conserved as part of West Eugene Wetlands natural areas. Land to the south, on the south side of the railroad tracks, is designated for protection in the West Eugene Wetlands Plan, but is currently in private ownership.

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, with a balance of 0.49 credit. Table 1 describes transactions to date. No transactions occurred in 2018 or 2019.

Table 1. ODOT Greenhill Mitigation Bank Credit Ledger, with transactions to date.

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 2012-2018 Field Enhancement Activity Summary

Table 2. Key field enhancement activities from 2012 through 2018. Field surveys for invasive species, rare plants, birds, and cultural artifacts are not included in summary, nor is monitoring.

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 – late 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 non-native species with broadcast herbicide applications
2014 – summer/fall	Manual removal and herbicide applications to control non-native plant 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 more erosion control materials (coir, jute, and river rock) where needed.
2015 – spring/summer	Controlled all non-native species with broadcast herbicide applications.
2015 - summer	Spot herbicide applications to control invasive non-native species, including Himalayan blackberry, sheep sorrel (<i>Rumex acetosella</i>), pennyroyal, and ox-eye daisy.
2016 – spring/summer	Controlled invasive non-native 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)	First native seeding distributes 304 lbs of native seed of 60 native forb, rush, and sedge species in more than 15 seed mixes across the site.
2016 – fall	Planted over 6,000 plants of 10 native species across site.
2017 – spring/summer	Controlled invasive non-native plants, with focus on bentgrass, false dandelions, sheep sorrel, and pennyroyal.
2017 - fall	Second native seeding distributes 215 lbs of native seed of forb, rush, grass, and sedge species in 20 mix combinations across the site. Planting of over 700 forbs and 500 bulbs.
2018 – spring/summer	Controlled invasive non-native plants, with focus on bentgrass, false dandelions, sheep sorrel, and pennyroyal.
2018 - fall	Third native seeding distributes 315 lbs of native seed of forb, rush, grass, and sedge species across the site. Planting of 643 forbs and about 1,000 bulbs.

6 2019 Management Actions

1. Staff continued to track locations of non-native invasive plant species and implemented mechanical and chemical control of pennyroyal (*Mentha pulegium*) and false dandelion (*Hypocheris radicata/Leontodon saxatilis*), starting in March 2019 extending through October. Non-native invasive bentgrass (*Agrostis capillaris* and *A. stolonifera*) was targeted with a broadcast of grass-specific herbicide in fall 2019, as it appeared to be increasing again, even with the addition of an earlier competitive native grass seeding. In addition to the pennyroyal and false dandelion, staff and contractors controlled sheep sorrel (*Rumex acetosella*), oxeye daisy, and rattail fescue using spot-herbicide applications across the site in May, June, and July. Contractors again used ATV and spot applications of Milestone herbicide across the site in flagged polygons in summer to control false dandelion and these polygons were mapped (as they were in 2018) using GPS, for later assessment. Hand removal of non-native invasive species was used in some planting locations to reduce non-target effects, where uncommon or slow-growing native species such as racemed goldenweed (*Pyrracoma racemosa*) or narrow-leaf mules ears (*Wyethia angustifolia*) were establishing well. Hand-weeding was also used site-wide for removal of remaining flowering pennyroyal in August, when herbicides would no longer affect them, and for species such as Queen Anne's lace (*Daucus carota*) and curly dock (*Rumex crispus*), that can be successfully hand pulled.

2. In late July, staff again mowed native grasses in parts of the buffer (boundary) areas to keep non-native invasive plants from flowering (particularly pennyroyal on the west boundary and invasive bentgrass on the south boundary) and later implemented manual control and spot herbicide control for some regions where non-native species regrew.
3. Staff distributed 58 pounds of native forb, rush, and sedge seed across the site, by hand, in October 2019. Native sloughgrass (salvaged from the site in 2013) was also seeded, but no other native grasses were seeded this year, since non-native invasive *Agrostis capilaris/stolonifera* is being further controlled. This year's forb seeding focused on vernal pool species and on wet prairie species that had not already established well across the site, including *Carex* species, *Symphyotrichum hallii*, and *Wyethia angustifolia*. Table A1 shows species seeded October 2019.

7 Vernal Pool Monitoring

Methods. Vernal pool hydroperiods were tracked in prior years, so this was not repeated in 2019. It was noted that 3 pools still had standing water by the June 7 start to monitoring and that these pools dried within the next 2 weeks. This year, monitoring of pools involved a summer assessment to determine dominant plant species, plant species richness, and potential for further native seeding to increase diversity and ensure species were well-represented in pools across the site.

Results. Greenhill Mitigation Bank site's vernal pools currently have excellent populations of native vernal pool annuals such as *Navarretia willamettensis*, *Lasthenia glaberrima*, *Downingia elegans* and *D. yina*, *Gratiola ebracteata*, as well as perennial *Eryngium petiolatum* (Table 3). *Navarretia willamettensis* is a sensitive species known only from the Willamette Valley. *Navarretia willamettensis* and *N. intertexta* were both seeded into pools here and *N. willamettensis* appears to be the dominant species in numerous pools. *Lasthenia glaberrima* is considered endangered in Canada, threatened in Washington, and is somewhat more common in Oregon and California vernal pools. Several of the species in Table 3 are members of 'at-risk' wetland plant associations that occur in ephemeral pools, tracked by the Oregon Biodiversity Information Center.

Table 3. The number of vernal pools at the Greenhill Mitigation Bank site that had well-established populations of pool-adapted native plant species in 2019.

Species	Number of pools in which the species appeared well-established in August 2019 (of 31 total pools)
<i>Eryngium petiolatum</i>	12
<i>Downingia yina</i> and <i>D. elegans</i> (pool # not distinguished by species)	18
<i>Gratiola ebracteata</i>	27
<i>Lasthenia glaberrima</i>	12
<i>Navarretia willamettensis</i> and <i>N. intertexta</i>	29

8 Vegetation Monitoring

Methods. Vegetation establishment was tracked by walking the site periodically throughout the year and recording emerging plant species (especially those that hadn't yet been encountered) and invasive species that would need control. Staff conducted quantitative vegetation sampling from June 7 – 10, 2019, 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 2 partial transects parallel to the others and on the southwest region, to encompass the broader west end of the site. 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 449 sample points in 2019. A list of all species found on the site was developed from site-wide meandering surveys from March through September (Appendix B). Plants encountered were identified to species and sometimes to the subspecific level. The following non-native species were considered together, since our response to them would be identical and close inspection of reproductive parts or leaf hairs is required to distinguish them: *Agrostis capillaris* and *A. stolonifera*; *Vulpia myuros* and *V. bromoides*; *Leontodon saxatilis* and *Hypochaeris radicata*.

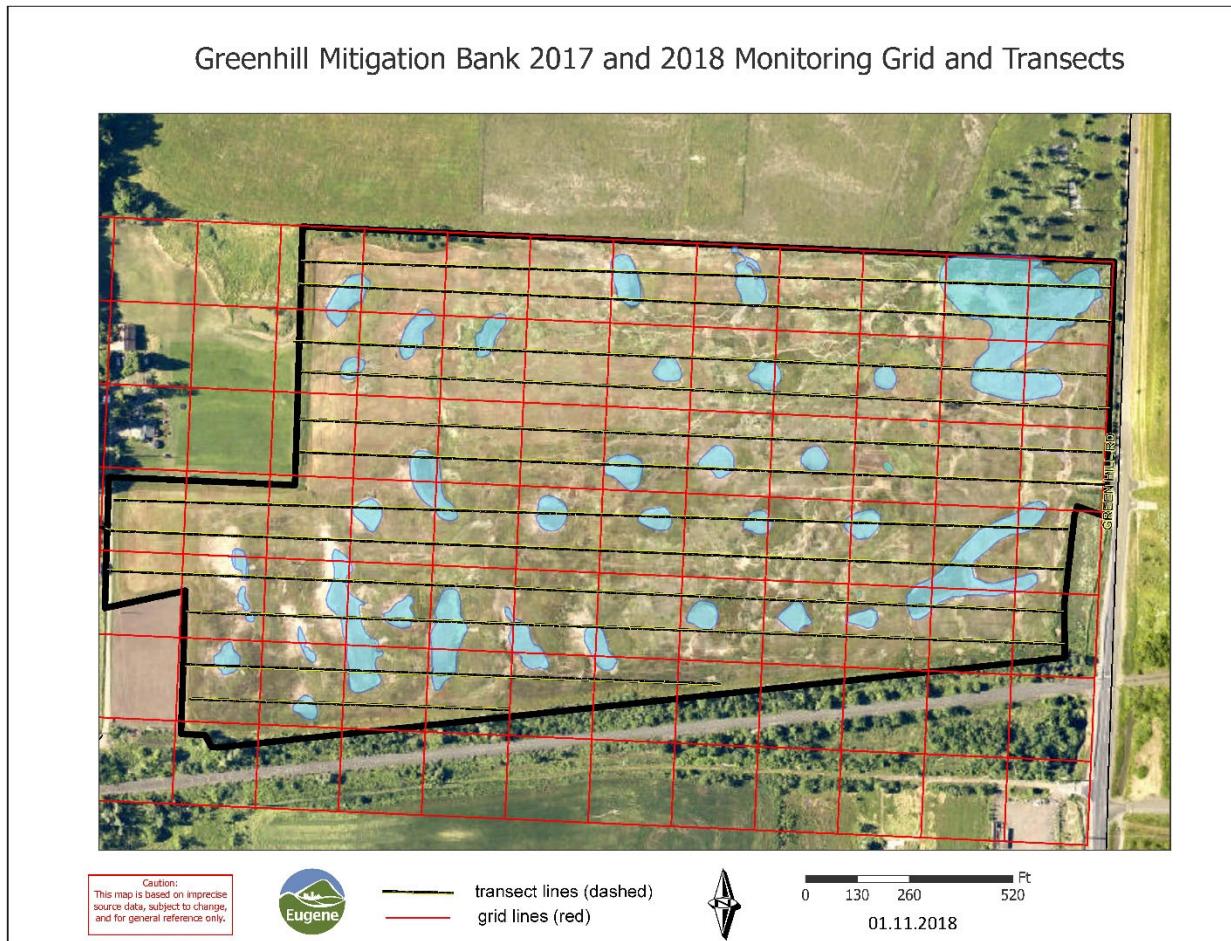


Figure 2. Monitoring grid and transect locations for point-intercept plant cover monitoring, 2017-2019.

Results. Site-wide species. Results of the site-wide point-intercept plant cover monitoring for 2019 are presented in Table 4. Overall, native species establishment remains robust, with absolute cover of native species at 72%. Native cover is continuing a slow shift from primarily annual-dominated to increasing perennial cover, although the site still provides relatively high cover for native annuals, with *Plagiobothrys scouleri* and *Juncus bufonius* being the second and third most abundant native plant species present in 2019. Bareground (ground with no vascular plant cover; mosses are possible) was 24% in 2019 and total plant cover was 100.9% (absolute). Plant cover and bareground at this site are not yet showing a consistent trend, likely due to the need for ongoing control of non-native invasive species. In addition, one area of the site is still being managed for a higher abundance of small native species (e.g. *Gnaphalium* sp., *Plagiobothrys* sp., *Juncus bufonius*) and bareground to support breeding streaked horned larks. Although no lark nests were located in 2019, streaked horned larks were noted at this site in 2018 and earlier.

Site vegetation met the performance criteria requiring that at least 6 native species be present with at least 5% cover in at least 10% of the area (MBI). Over an entire site, this criterion is often hard to meet, as species achieve higher abundances in different microsites. The 2019 data reflect this, with only 3 native species exceeding 5% cover on a site-wide basis. However, using data from 2 transects (about 17% of the site, in this case) showed greater evenness with 6 species (2 perennials, 4 annuals; only 1 grass) reaching or exceeding 5% cover (starred in Table 4).

Non-native invasive plant species abundance was lower in 2019 than it was in 2017, but higher than 2018. In 2019, non-native invasive plant species cover was 16 percent (absolute cover) and non-native (non-invasive) species cover also increased to 13 percent (absolute). Non-native plant species are identified as invasive based on the definition in the mitigation bank instrument. Invasive plant species include those that are identified specifically in the MBI for this site (e.g. *Mentha pulegium*), those on the Oregon Noxious Weed list (one species, *Senecio jacobaea*, encountered in 2019 monitoring), and *Agrostis capillaris/stolonifera* and *Leontodon saxatilis / Hypochaeris radicata* which met the cover criteria in 2017 (for *Agrostis*) and 2018 (*Leontodon/Hypochaeris*) and therefore remain on the list of invasive species for the site. In addition to these, staff evaluated the cover of all non-native species from 2019 monitoring data, to determine if they met the criteria for invasive in the MBI: that they both increased from last year and they exceeded previously identified abundance levels (15% cover in 10% of the site). At this site, 10 non-native species in 2019 exceeded their 2018 cover estimates. All had less than 2.5% cover across the site, except for *Briza minor* at 2.7% cover, and 7 of the 10 species had less than 1% cover. Further evaluation of the location of encountered *Briza minor*, *Lythrum portula* and the *Vulpia* species determined that none of the species met the definition of having 15% cover in 10% of the site area and therefore were not considered invasive at this site for monitoring purposes (Table 4). Of these species, we consistently control the *Vulpia* species by spot herbicide applications or through manual cutting during flowering, because it has the potential to become abundant in wetlands.

During point-intercept monitoring, 27 native species and 17 non-native species were encountered at sampling points (Table 4). During meandering surveys throughout the spring and summer 73 native species and 43 non-native species were recorded on the site (Appendix B), similar to last year. The number of native species far exceeds the performance criterion for 3rd year monitoring which is the presence of 25 native plant species.

Notable plant species that the site continues to support and were not seeded, include *Montia howellii* (candidate for Oregon state listing), found in at least two patches near vernal pools, and *Nuttallanthus texanus* (no State or Federal status but on local chapter Native Plant Society of Oregon rare list). Staff introduced two other sensitive species, *Navarretia willametensis* and *Pyrracantha racemosa* over the past two years and will evaluate their establishment on the site in the 5th or final monitoring year in which performance criteria are evaluated.

Table 4. Greenhill Mitigation Bank Site Point-intercept Monitoring Results, 2019.

Percent cover results are shown (with 80% binomial confidence intervals (CI)) for several guild types as well as each species intercepted during monitoring.

	Area Sampled	57.6 acres		
	Sample Size	449		
	Plant Community	Wet Prairie with vernal pools		
Origin¹	Species or Guild (all herbaceous)	% Cover	CI Low	CI High
	Native (absolute cover)	71.70		
	Invasive Non-native (absolute cover)	16.04		
	Non-native, excluding invasives (absolute cover)	13.14		
	Total Plant Cover (absolute cover)	100.88		
	Bare ground (no vascular plants, moss may occur)	23.6		
	Native² (a relative cover value)	62.4	59.3	65.4
	All Non-native² (a relative cover value)	25.6	22.9	28.4
Native	<i>Prunella vulgaris</i> var. <i>lanceolata</i> *	20.3	17.8	22.9
Native	<i>Plagiobothrys scouleri</i> *	14.0	11.9	16.4
Native	<i>Juncus bufonius</i> *	10.5	8.6	12.6
Native	<i>Grindelia integrifolia</i>	3.3	2.3	4.7
Native	<i>Juncus occidentalis</i> *	3.1	2.1	4.5
Native	<i>Deschampsia cespitosa</i> *	2.9	1.9	4.2
Native	<i>Gratiola ebracteata</i>	2.4	1.6	3.7
Native	<i>Veronica peregrina</i> <i>xalapensis</i>	2.2	1.4	3.4
Native	<i>Plagiobothrys figuratus</i> *	2.0	1.2	3.1
Native	<i>Lasthenia glaberrima</i>	1.6	0.9	2.6
Native	<i>Gnaphalium palustre</i>	1.3	0.7	2.3
Native	<i>Navarretia willamettensis</i>	1.3	0.7	2.3
Native	<i>Agrostis exerata</i>	1.1	0.5	2.1
Native	<i>Danthonia californica</i>	0.7	0.2	1.5
Native	<i>Eleocharis obtusa</i>	0.7	0.2	1.5
Native	<i>Eleocharis palustris</i>	0.7	0.2	1.5
Native	<i>Microseris laciniata</i>	0.7	0.2	1.5
Native	<i>Bidens frondosa</i>	0.4	0.1	1.2
Native	<i>Epilobium ciliatum</i>	0.4	0.1	1.2
Native	<i>Hordeum brachycarpum</i>	0.4	0.1	1.2
Native	<i>Acmisspon americanus</i>	0.2	0.0	0.9

Table 4. Greenhill Mitigation Bank Site Point-intercept Monitoring Results, 2019.

Percent cover results are shown (with 80% binomial confidence intervals (CI)) for several guild types as well as each species intercepted during monitoring.

	Area Sampled	57.6 acres		
	Sample Size	449		
	Plant Community	Wet Prairie with vernal pools		
Origin ¹	Species or Guild (all herbaceous)	% Cover	CI Low	CI High
Native	<i>Downingia yina</i>	0.2	0.0	0.9
Native	<i>Eryngium petiolatum</i>	0.2	0.0	0.9
Native	<i>Madia glomerata</i>	0.2	0.0	0.9
Native	<i>Myosotis laxa</i>	0.2	0.0	0.9
Native	<i>Ranunculus occidentalis</i>	0.2	0.0	0.9
Native	<i>Sisyrinchium sp. (no flowers)</i>	0.2	0.0	0.9
Invasive	<i>Leontodon saxatilis/Hypochaeris radicata</i>	12.5	10.5	14.7
Invasive	<i>Agrostis capillaris/stolonifera</i>	2.4	1.6	3.7
Invasive	<i>Mentha pulegium</i>	0.9	0.4	1.8
Invasive	<i>Senecio jacobaea</i>	0.2	0.0	0.9
Non-native	<i>Briza minor</i>	2.7	1.7	3.9
Non-native	<i>Lythrum portula</i>	2.2	1.4	3.4
Non-native	<i>Vulpia myuros and V. bromoides</i>	2.0	1.2	3.1
Non-native	<i>Poa annua</i>	1.1	0.5	2.1
Non-native	<i>Lythrum hyssopifolium</i>	0.9	0.4	1.8
Non-native	<i>Moenchia erecta</i>	0.9	0.4	1.8
Non-native	<i>Parentucellia viscosa</i>	0.9	0.4	1.8
Non-native	<i>Rumex acetosella</i>	0.7	0.2	1.5
Non-native	<i>Anagallis arvensis</i>	0.4	0.1	1.2
Non-native	<i>Cerastium glomeratum</i>	0.4	0.1	1.2
Non-native	<i>Galium divaricatum</i>	0.4	0.1	1.2
Non-native	<i>Geranium dissectum</i>	0.2	0.0	0.9
Non-native	<i>Kickxia elatine</i>	0.2	0.0	0.9

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

2 Native and non-native 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 non-native) can only be recorded once at each point (e.g. each point is either native, non-native, both, or neither). Total native and non-native cover could therefore each equal 100%.

9 Anticipated Actions for 2020

In 2020, staff will:

1. continue to focus on control of non-native invasive plant species across the site, particularly the pennyroyal, non-native grasses, hawksbit/false dandelion, and sheep sorrel, since these have been problematic at other sites.
2. monitor vegetation using quantitative and qualitative methods. Tracking native grass establishment will continue at the site to determine the need for further native grass seeding.
3. disperse native seed in areas that may need it due to invasive species control activites.
4. continue to track the effectiveness of erosion control measures.
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.

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 (Table 5). See Monitor Year 3 for this year's data.

Table 5. Summarized performance standards for the ODOT Greenhill Mitigation Bank site, by year.

Monitor Year	Performance Standard	Monitoring method	Data (Calendar Yr Collected)	Goal Met?
1	Native vascular plant cover > 40%	Point Intercept	99.5% (2017 report)	Y
1	Non-native <i>invasive</i> vascular plant cover $\leq 15\%$	Point Intercept	31.3% (2017 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 (2017 report)	Intent Y
1 - 5	No standing water persists permanently in vernal pools	Staff gauges (sample) and observation	No standing water persists beyond July 20 (2017 report)	Y
2	Native vascular plant cover > 50%	Point Intercept	64.6% (2018 report)	Y
2	Non-native <i>invasive</i> vascular plant cover $\leq 15\%$	Point Intercept	8.6.% (2018 report)	Y
3	Native vascular plant cover > 60%	Point Intercept	71.7% (this report)	Y
3	Non-native <i>invasive</i> vascular plant cover $\leq 15\%$	Point Intercept	16.0% (this report)	N
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	73 native sp. present; 6 have 5% cover in at least 10% area (this report)	Y
4	Native vascular plant cover > 60%	Point Intercept		
4	Non-native <i>invasive</i> vascular plant cover $\leq 15\%$	Point Intercept		
5	Native vascular plant cover > 60%	Point Intercept		
5	Non-native <i>invasive</i> vascular plant cover $\leq 15\%$	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		

Table 5. Summarized performance standards for the ODOT Greenhill Mitigation Bank site, by year.

Monitor Year	Performance Standard	Monitoring method	Data (Calendar Yr Collected)	Goal Met?
5	Bare substrate is < 20%	Point Intercept		

11 Photos

Photos below show representative areas of the site from 2018 and 2019. Ten photo points are mapped and marked in the field for future photo documentation.



Figure a. Winter conditions (Photo pt 3N, Jan. 2018).



Figure b. Summer conditions (Photo pt 3N, June 2019)



Figure c. Winter conditions (Photo pt 2E, Jan. 2018)



Figure d. Summer conditions (Photo pt 2E, June 2019)

Appendix A. 2019 Seed Mixes

Table A1. Greenhill Mitigation Bank, Native Seed Mixes Distributed Fall 2019.

58 pounds of native seed was distributed by hand across the site, focusing on increasing the diversity in 10 (of 31) vernal pools and seeding perennials, such as members of the genus Carex, that have not established broadly to date. This table includes the species and total grams distributed across the site.

Seed Mix Name	Scientific Name	Total Gms
Mix GHMB VP3 IncrDiv 2019	<i>Alisma triviale</i>	30
	<i>Carex unilateralis</i>	30
	<i>Eleocharis obtusa</i>	18
	<i>Juncus oxymeris</i>	4
	Total:	82
Mix GHMB VP9A IncrDiv 2019	<i>Alisma triviale</i>	30
	<i>Carex unilateralis</i>	30
	<i>Eleocharis obtusa</i>	20
	<i>Veronica scutellata</i>	6
	Total:	86
Mix GHMB VP 10s IncrDiv 2019	<i>Alisma triviale</i>	20
	<i>Beckmannia syzigachne</i>	60
	<i>Lasthenia glaberrima</i>	40
	<i>Veronica scutellata</i>	6
	Total:	126
Mix GHMB VP12 IncrDiv 2019	<i>Alisma triviale</i>	20
	<i>Beckmannia syzigachne</i>	70
	<i>Carex densa</i>	20
	<i>Carex unilateralis</i>	40
	<i>Juncus acuminatus</i>	8
	<i>Juncus bolanderi</i>	8
	Total:	166
Mix GHMB VP13 IncrDiv 2019	<i>Alisma triviale</i>	40
	<i>Veronica scutellata</i>	9
	Total:	49
Mix GHMB V21 IncrDiv 2019	<i>Alisma triviale</i>	20
	<i>Juncus bolanderi</i>	7
	<i>Veronica scutellata</i>	3
	Total:	30

Table A1. Greenhill Mitigation Bank, Native Seed Mixes Distributed Fall 2019.

58 pounds of native seed was distributed by hand across the site, focusing on increasing the diversity in 10 (of 31) vernal pools and seeding perennials, such as members of the genus Carex, that have not established broadly to date. This table includes the species and total grams distributed across the site.

Seed Mix Name	Scientific Name	Total Gms
Mix GHMB VP22 IncrDiv 2019	<i>Alisma triviale</i>	30
	<i>Carex unilateralis</i>	20
	<i>Eleocharis obtusa</i>	14
	<i>Juncus acuminatus</i>	5
	<i>Juncus bolanderi</i>	6
	<i>Veronica scutellata</i>	2
	Total:	77
Mix GHMB VP26 IncrDiv 2019	<i>Alisma triviale</i>	30
	<i>Carex unilateralis</i>	53
	<i>Juncus acuminatus</i>	10
	<i>Juncus oxymeris</i>	8
	<i>Juncus patens</i>	17
	<i>Veronica scutellata</i>	8
	Total:	126
Mix GHMB VP27 IncrDiv 2019	<i>Alisma triviale</i>	10
	<i>Juncus bolanderi</i>	8
	<i>Juncus oxymeris</i>	8
	<i>Veronica scutellata</i>	5
	Total:	31
Mix GHMB VP29A IncreDiv 2019	<i>Carex obnupta</i>	210
	<i>Carex unilateralis</i>	98
	Total:	308
Single sp – by hand	<i>Beckmannia syzigachne</i>	851
Purpose/Location: targeted hand seeding to improve establishment for specific species.	<i>Beckmannia syzigachne</i>	24
	<i>Carex densa</i>	980
	<i>Carex feta</i>	220
	<i>Carex leporina</i>	175
	<i>Carex tumulicola</i>	2724
	<i>Carex unilateralis</i>	212
	<i>Chamerion angustifolium</i>	178
	<i>Eriophyllum lanatum var. lanatum</i>	908
	<i>Juncus occidentalis</i>	49
	<i>Juncus oxymeris</i>	18
	<i>Acmispon americanus</i>	114

Table A1. Greenhill Mitigation Bank, Native Seed Mixes Distributed Fall 2019.

58 pounds of native seed was distributed by hand across the site, focusing on increasing the diversity in 10 (of 31) vernal pools and seeding perennials, such as members of the genus *Carex*, that have not established broadly to date. This table includes the species and total grams distributed across the site.

Seed Mix Name	Scientific Name	Total Gms
	<i>Potentilla gracilis</i> var. <i>gracilis</i>	6810
	<i>Pyrrocoma racemosa</i> var. <i>racemosa</i>	601
	<i>Ranunculus occidentalis</i> var. <i>occidentalis</i>	454
	<i>Rumex salicifolius</i> var. <i>salicifolius</i>	4540
	<i>Sidalcea malviflora</i> ssp. <i>virgata</i>	2724
	<i>Symphyotrichum hallii</i>	2064
	<i>Wyethia angustifolia</i>	1816
	Total:	25462

Appendix B. Species List

Those species recorded at the Greenhill Mitigation Bank site in 2019 during site-wide 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>	Creeping bentgrass	I	X
<i>Aira elegans</i> (syn. <i>A. caryophyllea</i>)	silver hairgrass	I	X
<i>Alisma lanceolatum</i>	narrowleaf waterplantain	I	
<i>Alisma trivale</i>	northern waterplantain	N	X
<i>Allium amplectens</i>	Slim leaf onion	N	X
<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>Barbarea orthoceras</i>	American wintercress	N	X
<i>Beckmannia syzigachne</i>	American sloughgrass	N	X
<i>Bidens frondosa</i>	leafy beggars-ticks	N	X
<i>Bidens cernua</i>	nodding beggar-ticks	N	X
<i>Briza minor</i>	little quaking-grass	I	X
<i>Brodiaea coronaria</i>	harvest brodiaea	N	
<i>Brodiaea elegans</i>	harvest brodiaea	N	
<i>Bromus carinatus</i>	California brome	N	
<i>Bromus commutatus</i>	Meadow brome	I	
<i>Calandrinia ciliata</i>	red maids	N	
<i>Callitriches stagnalis</i>	Pond water-starwort	N	X
<i>Camassia leichtlinii</i> ssp. <i>suksdorfii</i>	tall camas	N	X
<i>Camassia quamash</i> ssp. <i>maxima</i>	common camas	N	X
<i>Cardamine hirsuta</i>	hairy bittercress	I	
<i>Cardamine penduliflora</i>	Willamette V. bittercress	N	

<i>Carex densa</i>	dense sedge	N	X
<i>Carex feta</i>	green-sheath sedge	N	X
<i>Carex leporina</i>	oval broom sedge	N	
<i>Carex obnupta</i>	slough sedge	N	
<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	X
<i>Carex vesicaria</i>	inflated sedge	N	
<i>Castilleja tenuis</i>	hairy owl-clover	N	X
<i>Centaurium erythraeae</i>	common centaury	I	X
<i>Centunculus minimus</i>	chaffweed	N	
<i>Cerastium glomeratum</i>	sticky chickweed	I	X
<i>Chamaenerion angustifolium</i> var. <i>canescens</i>	perennial fireweed	N	
<i>Cicendia quadrangularis</i>	Timwort	N	X
<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	
<i>Clarkia purpurea</i> ssp. <i>quadrivulnera</i>	winecup clarkia	N	X
<i>Collinsia grandiflora</i>	Large flowered blue-eyed Mary	N	
<i>Collomia grandiflora</i>	grand collomia	N	
<i>Convolvulus arvensis</i>	bindweed	I	
<i>Conyza canadensis</i>	Canadian horseweed	I	
<i>Crassula aquatica</i>	water pygmy weed	N	
<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	
<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)	
<i>Danthonia californica</i>	California oatgrass	N	X
<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>Deschampsia elongata</i>	Slender hairgrass	N	
<i>Dianthus armeria</i>	Deptford pink	I	

<i>Dichanthelium acuminatum</i> var. <i>fasciculatum</i>	western witchgrass	N	
<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>Drymocallis glandulosa</i> (syn <i>Potentilla glandulosa</i>)	Sticky drymcoallis	N	
<i>Echinochloa crus-galli</i>	large barnyard-grass	I	X
<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. <i>glaucus</i>	Blue wild rye	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>	woolly sunflower	N	X
<i>Eryngium petiolatum</i>	coyote thistle	N	X
<i>Erythranthe guttata</i> (syn. <i>Mimulus guttatus</i> var. <i>guttatus</i>)	Common monkeyflower	N	
<i>Erythranthe microphylla</i> (syn. <i>Mimulus guttatus</i> var. <i>depauperatus</i>)	depauperate monkeyflower	N	
<i>Festuca roemeri</i>	Roemer's fescue	N	
<i>Fragaria virginiana</i> ssp. <i>platypetala</i>	mountain strawberry	N	
<i>Fraxinus latifolia</i>	Oregon ash	N	X
<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	
<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 managrass	N	
<i>Gnaphalium palustre</i>	lowland cudweed	N	X
<i>Gnaphalium purpureum</i>	purple cudweed	N	
<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> × <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 sp.</i>	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. <i>effusus</i>	common rush	I	
<i>Juncus effusus</i> var. <i>pacificus</i>	soft rush	N	X
<i>Juncus ensifolius</i>	Swordleaf rush	N	X
<i>Juncus marginatus</i>	grass-leaf rush	I	X
<i>Juncus nevadensis</i>	Nevada rush	N	
<i>Juncus occidentalis</i>	slender rush	N	X
<i>Juncus oxymeris</i>	pointed rush	N	X
<i>Juncus patens</i>	Spreading rush	N	
<i>Kickxia elatine</i>	cancerwort	I	X
<i>Lactuca saligna</i>	willow lettuce	I	
<i>Lactuca serriola</i>	prickly lettuce	I	
<i>Lasthenia glaberrima</i>	smooth lasthenia	N	X
<i>Lamium purpureum</i>	purple deadnettle	I	
<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>Leptosiphon bicolor</i> (Syn: <i>Linanthus bicolor</i>)	bicolored linanthus	N	
<i>Leucanthemum vulgare</i>	oxeye daisy	I	X
<i>Limnanthes alba</i> (agriculture escape)	white meadowfoam	I	X
<i>Lindernia dubia</i>	yellowseed false pimpernel	N	
<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	
<i>Lotus formosissimus</i>	seaside lotus	N	
<i>Lotus micranthus</i>	small-flowered deervetch	N	X
<i>Ludwigia palustris</i>	marsh speedbox	N	
<i>Lupinus affinis</i>	fleshy lupine	N	
<i>Lupinus bicolor</i>	field lupine	N	
<i>Lupinus oreganus</i>	Kincaid's lupine	N	
<i>Lupinus polycarpus</i>	small-flowered lupine	N	
<i>Lupinus polyphyllus</i> var. <i>polyphyllus</i>	bigleaf lupine	N	
<i>Lupinus rivularis</i>	stream lupine	N	X
<i>Luzula comosa</i> var. <i>comosa</i>	field woodrush	N	X
<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> (syn: <i>Saxifraga 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>Moenchia erecta</i> ssp. <i>erecta</i>	moenchia	I	X
<i>Montia fontana</i>	spring water chickweed	N	
<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>Panicum dichotomiflorum</i>	Fall panicum	I	
<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	
<i>Plectritis congesta</i>	rosy plectritis	N	X
<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</i> sp.	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	
<i>Potentilla gracilis</i> var. <i>gracilis</i>	slender cinquefoil	N	X
<i>Prunella vulgaris</i> var. <i>lanceolata</i>	Native heal all	N	X
<i>Prunus</i> sp.	plum	I	
<i>Pseudognaphalium stramineum</i>	Cotton batting cudweed	N	
<i>Psilocarphus</i> spp.	woolly 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	
<i>Quercus kelloggii</i>	California black oak	N	
<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 parviflorus</i>	Small-flowered buttercup	I	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>	Smooth marsh yellowcress	N	
<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 acetosella</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	
<i>Schedonorus arundinaceus</i>	tall fescue	I	
<i>Schoenoplectus tabernaemontani</i>	softstem bulrush	N	
<i>Senecio jacobaea</i>	tansy ragwort	I	X
<i>Senecio sylvaticus</i>	wood groundsel	I	
<i>Senecio vulgaris</i>	old-man-in-the-spring	I	
<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	
<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	
<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	
<i>Trifolium subterraneum</i>	subterranean clover	I	
<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	X
<i>Verbascum blattaria</i>	moth mullein	I	
<i>Verbascum thapsus</i>	common mullein	I	
<i>Ventanata dubia</i>		I	
<i>Veronica americana</i>	American speedwell	N	
<i>Veronica anagallis-aquatica</i>	water speedwell	I	X
<i>Veronica peregrina</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	
<i>Vicia sativa</i>	common vetch	I	
<i>Vicia tetrasperma</i>	slender vetch	I	
<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	

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 current monitoring.

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 one-acre monitoring grid was established over the entire 58 acres of the site 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. Transects starts were systematically placed from the acre boundary markers from south to north to achieve good interspersion of 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 440 - 450 points were sampled in 57.6 acres (7.7 points per acre on average). This relatively high number of samples was taken to ensure an adequate sample size in the first year and could be repeated fairly rapidly, so has been maintained.

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 are conducted to provide measurements of species richness by

species census. Walking surveys 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) in 2017. This intensive level of monitoring is not repeated annually, since initial depths and dry down have been observed across a season and in 2018 maximum pool depths at those with staff guages were recorded (18 pools) and dry down was checked in late June and early July to determine when all pools were dry.

Ten photo points were established along transects after site Construction and the first year of seeding. Photographs will be routinely taken from the designated points and included in monitoring reports. Photo points will appropriately capture important areas of hydrology and representative areas of vegetation.