Graham Oaks Nature Park Oak Habitat Conservation Plan

10/4/2022

Report for Metro, Agreement #937826

Report prepared by Sara Alaica, Tyler Roberts, and Andrew Esterson

Institute for Applied Ecology

PREFACE

IAE is a non-profit organization whose mission is the conservation of native ecosystems through restoration, research, and education. IAE provides services to public and private agencies and individuals through development and communication of information on ecosystems, species, and effective management strategies. Restoration of habitats, with a concentration on rare and invasive species, is a primary focus. IAE conducts its work through partnerships with a diverse group of agencies, organizations, and the private sector. IAE aims to link its community with native habitats through education and outreach.

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We appreciate Andrea Berkley for her support and guidance in drafting this plan and providing historic information about Graham Oaks. We are also grateful to Ash Creek Forest Management for their ongoing habitat restoration actions at Graham Oaks.

Cover photographs: Large-leaved lupine at Graham Oaks. Photo by Sara Alaica.

SUGGESTED CITATION

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Graham Oaks Nature Park Oak Habitat Conservation Plan

1. INTRODUCTION

Graham Oaks Nature Park (Graham Oaks) is a 245-acre property located in Wilsonville, OR. The property was purchased by Metro in 2008 with the goal of preserving land in the Tonquin Geologic Area. This landscape was formed in the aftermath of Ice Age floods, carving out unique glacial features that are shared in nearby natural areas. Graham Oaks sits within a corridor of protected areas, with Champoeg State Heritage Area to the west, Corral Creek Natural Area to the south, and Coffee Lake Creek Natural Area and Tonquin Scablands to the north (Figure 1). Portions of these parks are already connected through the Ice Age Tonquin Trail, with more connections planned (Metro 2012).

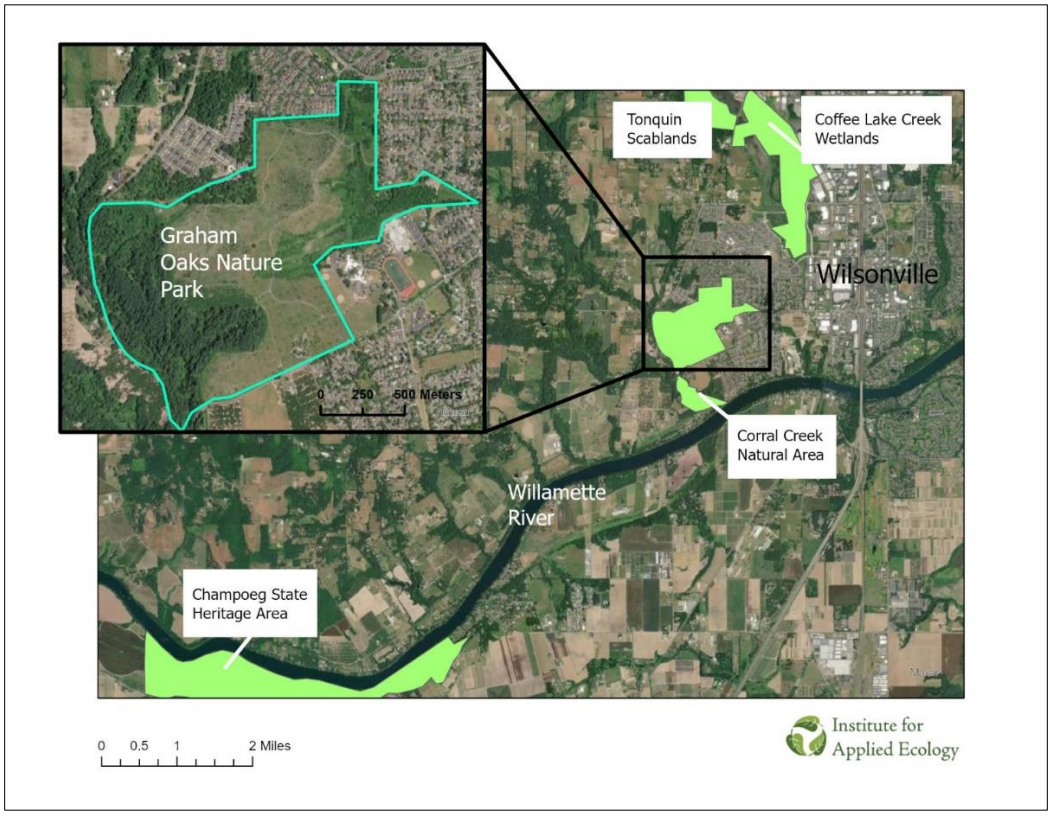

Figure 1. Location of Graham Oaks Nature Park, Wilsonville, OR. Green denotes the property boundary.

Historically, Graham Oaks is thought to have been used as summer travel grounds for the Kalapuya Indians. Early land surveys describe it as a mix of savanna and mixed forest, where strawberries, raspberries, camas bulbs, and acorns were harvested by indigenous peoples (Metro 2019). Cultural

management practices such as burning and coppicing were stopped by the arrival of European colonists, who settled the area around Graham Oaks.

Graham Oaks was used as agricultural land until 2008. Hazelnuts, hops, corn, potatoes, and grass seed were all grown on site. Farmers installed drainage tiles to dry fields for planting and filled in the headwaters of four creeks. Mill Creek flows along the western edge of the property, and at one time would have flooded Graham Oaks and kept the fields seasonally inundated. The soils at Graham Oaks still show signs of this historical hydrology (Appendix A: Graham Oaks Soil Survey).

While Graham Oaks has a range of habitats, including fish-bearing streams, riparian areas, emergent wetlands, forested wetlands, and upland forest, this report will focus only on the two Oregon white oak (*Quercus garryana*) habitats present at Graham Oaks: oak savanna and oak woodland (Figure 2).

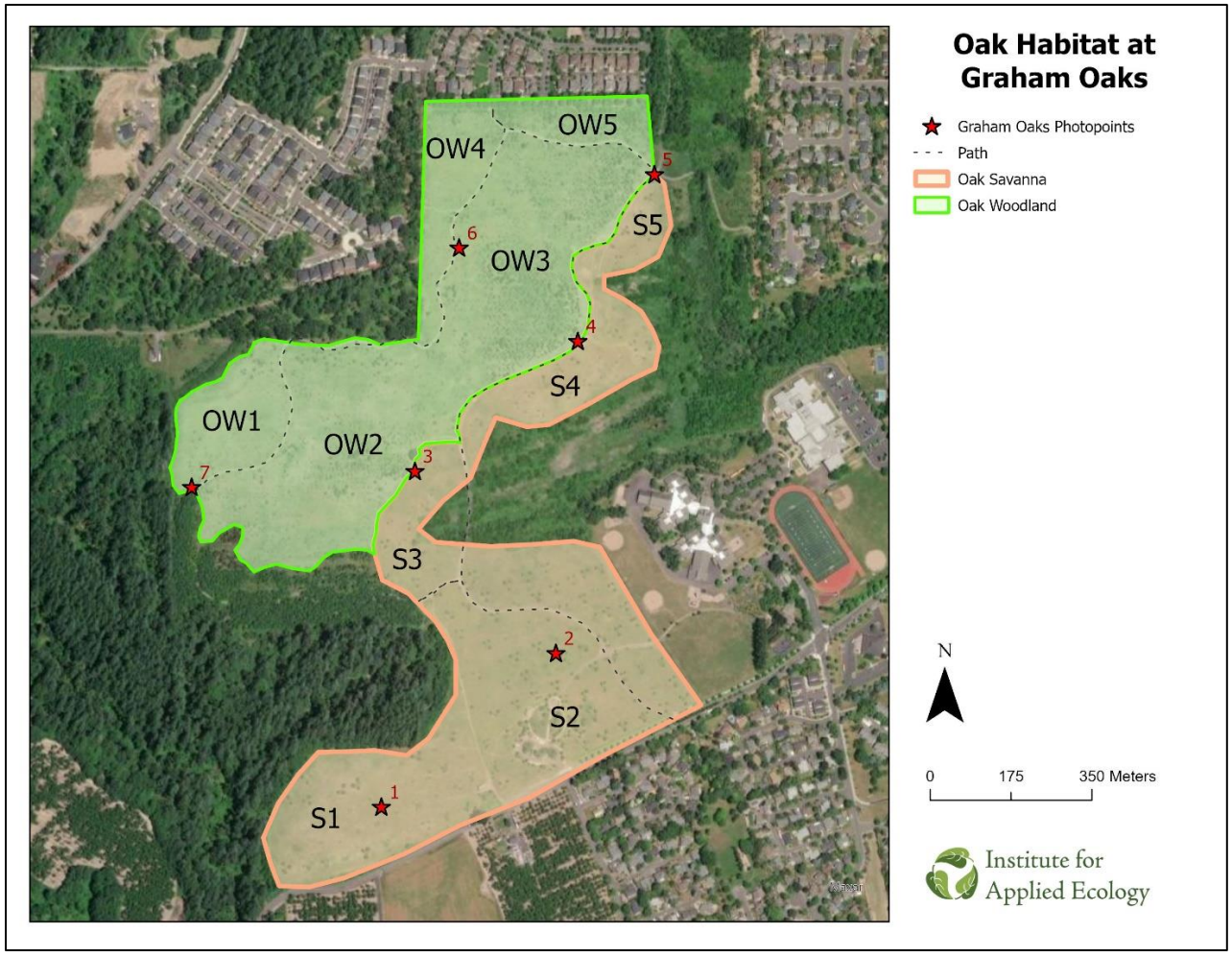

Figure 2. Oak savanna and oak woodland habitats at Graham Oaks, Wilsonville, OR.

Since acquiring the property in 2008, Metro has conducted extensive restoration in the oak savanna and oak woodland (Metro 2019, Table 1). Metro has contracted habitat restoration crews to reduce the abundance of non-native species through mowing, herbicide spray, and woody plant removal. Selective

herbicides including triclopyr, clopyralid, and clethodim have been used to target invasive broadleaf plants, asters, peas, and grasses. Glyphosate, a broad-spectrum herbicide, has been used to reduce vegetation in preparation for seeding and planting.

The oak savanna was planted with Oregon white oak and Willamette Valley ponderosa pine (*Pinus ponderosa var. willamettensis*), and shrubs consisting of snowberry (*Symphoricarpos albus*), Oregon grape (*Mahonia aquifolium*), thimbleberry (*Rubus parviflorus*), serviceberry (*Amelanchier alnifolia*), osoberry (*Oemleria cerasiformis*), and oceanspray (*Holodiscus discolor*) (Metro 2019). The understory was seeded in 2011 with a mix of clopyralid-resistant plants to minimize the negative effects from initial clopyralid herbicide treatments. More diverse mixes were seeded in following years. Species included in mixes were pearly everlasting (*Anaphalis margaritacea*), yarrow (*Achillea millefolium*), selfheal (*Prunella vulgaris*) cinquefoil (*Potentilla sp.*), big-leaved lupine (*Lupinus polyphyllus*), Oregon sunshine (*Eriophyllum lanatum*), gumweed (*Grindelia integrifolia*), and checkermallow (*Sidalcea campestris*). Metro also seeded grasses, including meadow barley (*Hordeum brachyantherum*), slender hairgrass (*Deschampsia elongata*), blue wildrye (*Elymus glaucus*), California brome (*Bromus carinatus*), California oatgrass (*Danthonia californica*), and Junegrass (*Koeleria macrantha*) (Metro 2019).

Table 1. Timeline of restoration activities at Graham Oaks.

Year	Species of concern	Treatment	Seed & Plant Materials
2008	Hawthorn (*Crataegus monogyna*)	Skid steer Herbicide (not specified)	None
2010	Canada thistle (*Cirsium arvense*) Tansy ragwort (*Jacobaea vulgaris*) Queen Anne's lace (*Daucus carota*) Bindweed (*Convolvulus arvensis*) Prickly lettuce (*Lactuca serriola*) Hawkbit (*Leontodon taraxacoides*)	Boom (triclopyr) Spot spray (clopyralid)	None
2011	Canada thistle (*Cirsium arvense*) Queen Anne's lace (*Daucus carota*) Bindweed (Convolvulus arvensis) Prickly lettuce (*Lactuca serriola*) Hawkbit (*Leontodon taraxacoides*)	Boom (triclopyr) Spot spray (clopyralid) Grass-selective (clethodim)	Seed: Roemer's fescue (*Festuca roemeri*) * California oatgrass (*Danthonia californica*) * Camas (*Camassia spp.*) * Checkermallow (*Sidalcea sp.*) * Cinquefoil (*Potentilla sp.*) * Selfheal (*Prunella vulgaris*) *
2012	Rattail fescue (*Vulpia myuros*) Velvet grass (*Holcus lanatus*) Canada thistle (*Cirsium arvense*) Tansy ragwort (*Jacobaea vulgaris*) Queen Anne's lace (*Daucus carota*) Bindweed (Convolvulus arvensis) Prickly lettuce (*Lactuca serriola*) Hawkbit (*Leontodon taraxacoides*)	Hayed Boom & spot spray (clopyralid) Row Spray (glyphosate)	Seed: Roemer's fescue (*Festuca roemeri*) California oatgrass (*Danthonia californica*) Lupine (*Lupinus spp.*) Checkermallow (*Sidalcea sp.*) Yarrow (*Achillea millefolium*) Oregon sunshine (*Eriophyllum lanatum*) other natives (not specified)
2013	Rattail fescue (*Vulpia myuros*)	Hayed	Seed:

Year	Species of concern	Treatment	Seed & Plant Materials
	Velvet grass (*Holcus lanatus*) Tansy ragwort (*Jacobaea vulgaris*) Queen Anne's lace *(Daucus carota)* Bindweed (Convolvulus arvensis) Prickly lettuce *(Lactuca serriola)* Hawkbit *(Leontodon taraxacoides*)	Boom & spot spray (clopyralid) Grass selective spray (clethodim) Row Spray (glyphosate)	Roemer's fescue (*Festuca roemeri)* * California oatgrass (*Danthonia californica*) * Camas (*Camassia spp.*) * Checkermallow (*Sidalcea sp.*) * Cinquefoil (P*otentilla sp.*) * Selfheal *(Prunella vulgaris)* *
2014	Rattail fescue *(Vulpia myuros)* Velvet grass (*Holcus lanatus*) Canada thistle *(Cirsium arvense)* Queen Anne's lace *(Daucus carota)* Hawkbit *(Leontodon taraxacoides)*	Hayed Spot spray (clopyralid) Mowed	Seed: Roemer's fescue (*Festuca roemeri)* * California oatgrass (*Danthonia californica*) * Camas (*Camassia spp.*) * Checkermallow (*Sidalcea sp.*) * Cinquefoil (P*otentilla sp.*) * Selfheal *(Prunella vulgaris)* *
2015	Velvet grass *(Holcus lanatus)* Rattail fescue *(Vulpia myuros)* Canada thistle *(Cirsium arvense)* Queen Anne's lace *(Daucus carota)* Hawkbit *(Leontodon taraxacoides)*	Mowed Spot spray (clopyralid)	Seed: Native pea (not specified) Native aster (not specified)
2016	Rattail fescue *(Vulpia myuros)* Velvet grass *(Holcus lanatus)*	None	None
2017		None	None
2018			Bulb and bare root: Large camas (*Camassia leichtlinii*) Small camas (*Camassia quamash*) Ookow (*Dichelostemma congestum*) Tough-leaved iris (*Iris tenax*) Columbia saxifrage (*Micranthes integrifolia*) Idaho blue-eyed grass (*Sisyrinchium idahoense*) White brodiaea (*Triteleia hyacinthina*)
2019		None	None
2020		Mowed Boom spray (mixed incorrectly) planned mix: 1% clethodim, 1% sethoxydim, 2% clopyralid, 2% Competitor, 2% buffering agent)	Seed: Roemer's fescue (*Festuca roemeri*) Slender hairgrass (*Deschampsia elongata*)
2021		Mowed savanna (fall/winter)	Bulb: Large camas (*Camassia leichtlinii*)
2022	Canada thistle *(Cirsium arvense)* Tansy ragwort *(Jacobaea vulgaris)*	Broadcast Spray (clethodim) Spot Spray (clopyralid)	Planned seed mixes:

Year	Species of concern	Treatment	Seed & Plant Materials
	Queen Anne's lace *(Daucus carota)* Velvet grass *(Holcus lanatus)* Vetch (*Vicia spp.*) Reed canarygrass (*Phalaris arundinacea*)	Seedhead removal Hand removal of vetch (*Vicia spp.*) Mowed	"Tough and Tenacious" and "Urban Meadow' mixes from Heritage Seed Inc

*Clopyralid-resistant seed

2. RESTORATION METHODS

Throughout the restoration process an adaptive management approach following integrated pest management (IPM) principles will achieve restoration goals while minimizing risk to people and the environment. Adaptive management is a structured method of decision making used to maximize efficacy and response time of restoration actions under changing conditions. It allows land managers and restoration practitioners to incorporate new information in their practices as it becomes available. All treatments described in the restoration plan should be assessed for efficacy. Those results will then be integrated into the adaptive management process. Herbicide treatments typically need a minimum of 2 weeks after application for efficacy to be assessed, while mechanical control actions may receive quicker assessment. There should be no less than one site assessment per month to maintain the adaptive management process. The schedule and techniques presented in this plan may be modified through the adaptive management process. Monitoring and assessment results will be reviewed as monitoring is completed and used to modify upcoming management processes.

The tools of IPM include biological control (natural enemies and competition), cultural control (signage and education), mechanical control (mowing, burning, etc.), and chemical control (herbicides). Proper application of IPM requires continued monitoring of the system and consistent assessment of pest management treatments to adapt to changing conditions. In sections 3 and 4 we detail the first suggested steps of an IPM program for the oak savannah and oak woodland sections of Graham Oaks. This schedule is subject to change in accordance with further IPM assessments and the adaptive management process.

3. CURRENT CONDITIONS

3.1. Oak Savanna

There is approximately 50 acres of oak savanna at Graham Oaks. Oregon white oak and Willamette Valley ponderosa pine have established in both S1 and S2 sections of the property (Figure 2). Although these species were planted at similar densities in sections S3-S5, fewer trees have survived there.

The S1-S2 sections of the property has the highest native forb component. Selfheal and checkermallow are the most abundant, but camas (*Camassia sp.*), large-leaved lupine, pearly everlasting, gumweed, and the endangered golden paintbrush (*Castilleja levisecta*) were observed in 2022 (Cover page photo; Figure 3).

In May 2022, the Institute for Applied Ecology (IAE) mapped the most abundant weeds in the oak savanna (Figure 4). The three primary weeds are Canada thistle *(Cirsium arvense)*, tansy ragwort (*Jacobaea vulgaris*), and vetch (*Vicia spp.*). Other invasive species of management concern observed in 2022 include Himalayan blackberry (*Rubus armeniacus*), oxeye daisy (*Leucanthemum vulgare*), queen Anne's lace *(Daucus carota)*, rattail fescue *(Vulpia myuros)*, and velvet grass *(Holcus lanatus)*.

Figure 3. (L-R) Camas (*Camassia* sp.) and golden paintbrush (*Castilleja levisecta*) on May 18, 2022; Pearly everlasting (*Anaphalis margaritacea*) on Sept 7, 2022.

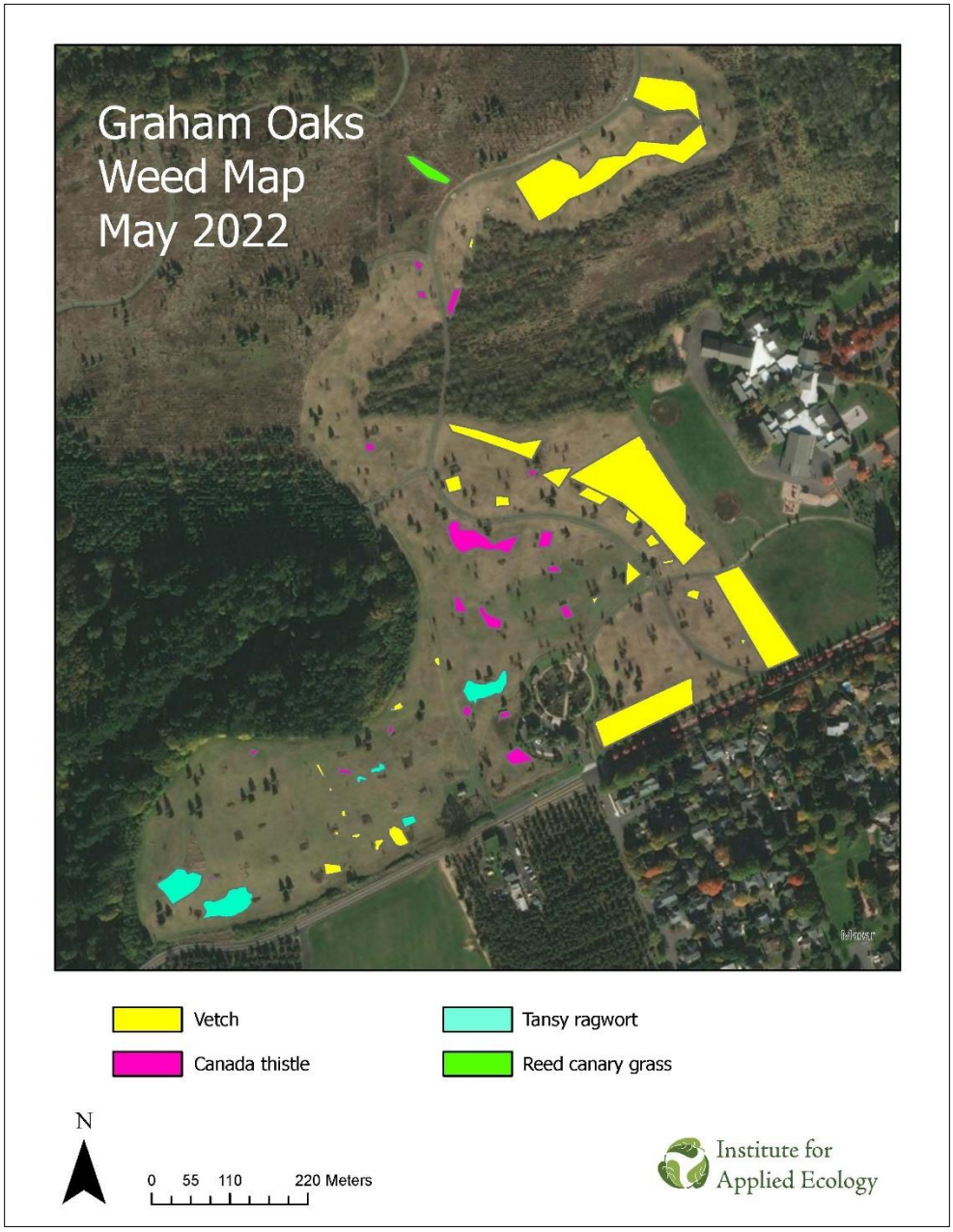

Figure 4. Most common weeds in the oak savanna habitat, Graham Oaks.

3.2. Oak Woodland

There is 58 acres of restored oak woodland at Graham Oaks. The overstory is a mix of Oregon white oak and Willamette Valley ponderosa pine. Establishment varies across the site: trees in OW3 and OW5 average 4.5 m tall, while others planted at the same time but growing in OW1 and OW2 are a meter shorter. In areas where the trees are shorter soil conditions indicate a history of inundation supported by

observations of wet-prairie non-native species (Appendix A: Graham Oaks Soil Survey). In 2022, the shrubs observed in the oak woodland included Oregon grape, snowberry, and oceanspray.

Vetch is encroaching heavily into the woodland (Figure 5). In 2022, vetch was observed growing over shrubs and at times strangling small Oregon white oak that are not yet established. Velvet grass is also growing as a monoculture in the understory, interspersed with pockets of reed canarygrass *(Phalaris arundinacea)* in seeps. (Figure 5).

Figure 5. (L-R) Vetch (*Vicia spp.*) growing over shrubs in oak woodland of Graham Oaks, May 18, 2022; Velvet grass *(Holcus lanatus)* monoculture, Sept 7, 2022.

4. RESTORATION PLAN

IPM principles and the adaptive management approach described in the Restoration Methods section were considered when creating the restoration plans for Graham Oaks. The plans are written to include the month each treatment is expected to occur, however there are additional details in the 'timing' column to account for variability in conditions that may affect the treatment application timing. These details are meant to be used as guides for timing the application of specific actions but do not preclude the need for the adaptive management process and continuing assessments. A minimum of one site visit per month may be needed to monitor and respond to changing conditions. This visit can be coupled with efficacy checks whenever possible.

Herbicide

Herbicide treatments are described as broadcast, spot, or ring sprays.

- **Broadcast sprays** are applied with full coverage for weed control. A fall broadcast spray of grass-selective herbicide is suggested where invasive grasses are competing with a mostly native forb community. This will reduce competition and allow native forb seed to establish during the fall green-up period.

- **Spot sprays** are used to selectively target problematic species. Herbicides suggested to use in the restoration plan for spot spraying include clopyralid, triclopyr, and clethodim or fluazifop-p-butyl.
- **Ring sprays** are when a ring of herbicide is applied to the vegetation directly surrounding a desired species. This method can encourage the expansion of lupine patches in the S1-S3 areas. A ring spray around existing patches can release them from resource competition and help improve establishment.

In some cases, a higher concentration of surfactant, within label limits, is suggested for better application to velvet grass. This allows the herbicide to better penetrate through the protective hairs on velvet grass.

Seeding

Seeding methods include drilling and broadcast by hand or belly bag.

- **Drilling** is appropriate for large areas of bare ground without much thatch. This method ensures the best seed contact with soil.
- A **belly bag** may be used to broadcast seed over an area that cannot be drilled. This is useful on difficult terrain, or to bare soil patches that are not large enough to warrant the use of a drill.
- **Broadcasting by hand** is preferable for targeted seeding of smaller exposed soil patches.

Restoration actions at Graham Oaks are likely to result in an increase of bare soil patches. Hand broadcast or belly bag seeding are suggested for these patches. When seeding areas that do not have exposed soil, reduce thatch through burning or mowing before broadcasting seed.

Heritage Seedlings Inc. has developed seed mixes for specific habitats comprised of native Willamette Valley species. Whenever possible seed should be sourced from local habitats to preserve genetic diversity and locally-adapted populations. The "Tough and Tenacious" seed mix is made up of reliable native species that are quick to establish and support ecosystem function. The "Wet Prairie Mix" is made up of species that do well in wet or seasonally-inundated soils. The "Wet Prairie Mix" should be used in areas that show signs of seasonal wetness as outlined in the soil survey (Appendix A: Graham Oaks Soil Survey).

4.1. Oak Savanna Restoration Plan

The restoration focus for the oak savanna is on maintaining and enhancing native forbs and grasses while reducing invasive species. This will be accomplished through selective and well-timed mowing, herbicide application, and seeding. Further specificity in timing and priority areas for treatment actions can be determined during routine assessments.

Table 2. Restoration plan for oak savanna in Graham Oaks

Year	Month	Area	Action	Desired Outcome	Timing
2022	Oct	S1, S2	Mow savanna	Reduce thatch and allow for more seed-soil contact	Post-lupine seed set

Year	Month	Area	Action	Desired Outcome	Timing
2022	Oct	S1, S2	Triclopyr spot spray	Manage Himalayan blackberry (*Rubus armeniacus*) while it is sending energy reserves into root system	Fruiting stage
2022	Oct	S3-S5	Mow vetch (*Vicia spp.*)	Reduce vetch (*Vicia spp.*) biomass	Vetch (*Vicia spp.*) ~ 12"
2022	Nov	S1, S2	Clethodim or fluazifop-p-butyl (Fusilade) broadcast spray	Manage grasses during annual green-up in November	Fall green-up
2022	Nov	S1-S5	Sow "Tough & Tenacious" seed mix with a belly bag or by hand	Fill bare patches exposed through herbicide treatments with native forbs and grasses	After first fall rain
2023	Mar-Apr	S1, S2	Broadcast clethodim or fluazifop-p-butyl with high concentration of surfactant (within label limits)	Manage Velvet grass *(Holcus lanatus)* before it grows flowering spikes.	Velvet grass *(Holcus lanatus)* <6"
2023	May	All	Assessment	Assess weeds and repeat treatments as necessary. Recommended at regular intervals and 2-3 weeks following each herbicide application to maintain IPM practices.	Spring green-up
2023	May	S1-S5	Clopyralid spot spray	Manage oxeye daisy *(Leucanthemum vulgare)*, tansy ragwort (*Jacobaea vulgaris*), false-dandelion, and thistles (caution near lupine)	Rosette stage
2023	May	S3-S5	Mow vetch (*Vicia spp.*)	Mow early in the season to prevent flowering	Vetch (*Vicia spp.*)~ 12"
2023	May	S1, S2	Mow blackberry (*Rubus armeniacus*)	Remove canes and release native shrubs	Leaves present
2023	Jun	S3, S5	Map lupine	Map lupine patches for baseline data to later assess expansion of patches	Bud stage
2023	Jun	S3-S5	Glyphosate ring spray	Reduce competition around lupine patches allowing expansion via seed and/or rhizome	Bud stage
2023	Jul	S1, S2	Selective mow	Manage Queen Anne's lace *(Daucus carota)* before its sets seed	In flower
2023	Jul	S1-S5	Clopyralid spot spray	Manage oxeye daisy *(Leucanthemum vulgare)*, tansy ragwort (*Jacobaea vulgaris*), false-dandelion, and thistle (caution near lupine)	Rosette stage
2023	Aug	S3-S5	Mow vetch (*Vicia spp.*)	Mow late in the season to prevent seeding	Vetch (*Vicia spp.*)~ 12"

Year	Month	Area	Action	Desired Outcome	Timing
2023	Sep	S1, S2	Triclopyr spot spray	Manage Himalayan blackberry (*Rubus armeniacus*) while it is sending energy reserves into root system	Fruiting stage
2023	Sep	S1-S5	Clopyralid spot spray	Manage oxeye daisy *(Leucanthemum vulgare)*, tansy ragwort (*Jacobaea vulgaris*), false-dandelion, and thistle (caution near lupine)	Rosette stage
2023	Nov	S1, S2	Sow "Tough & Tenacious" seed mix with a belly bag or by hand	Fill bare patches exposed through herbicide treatments with native forbs and grasses	After first fall rain
2024	May	All	Assessment	Assess weeds and repeat treatments as necessary. Recommended at regular intervals and 2-3 weeks following each herbicide application to maintain IPM practices.	Spring green-up
2024	Jun	S3-S5	Mow grasses	Prevent seed set of annual grasses	Bud stage
2024	Nov	S1-S5	Plantings	Plant plugs to increase native diversity	After first fall rain

4.2. Oak Woodland Restoration Plan

Controlling invasive grasses and forbs in the entirety of the oak woodland and preserving the oak trees is a multi-phased process. Phase one will preserve the previously planted trees and shrubs while maximizing restoration efforts in the understory and phase two will target invasive grasses and forbs. This report only provides recommendations for phase one which will be primarily achieved through well-timed mowing and competition-reducing spot and ring spray herbicide treatments.

Mowing will be used to keep vetch and velvet grass from producing seed and to reduce competition on native shrubs and trees. Repetitive mowing of the spaces between planting rows will keep the invasive grass and forb resource competition to a minimum and allow easier access to the woodland for herbicide treatments and continuing assessments (Figure 6).

In addition, establishing dense, high quality 'habitat patches' will help to increase diversity and minimize competition between invasive plants and the newly establishing native species. Habitat patches are small focus areas that are treated to exterminate weed species and establish a dense pocket of native forbs and grasses. This method focuses time and effort on producing patches of high-quality habitat that can be readily maintained rather than spending resources over a large area with comparatively little progress. Habitat patches can then be expanded as a future management option.

Table 3. Restoration plan for oak woodland in Graham Oaks.

Year	Month	Area	Action	Desired Outcome	Timing
2022	Oct	OW3-OW5	Clethodim spot spray	Manage reed canarygrass *(Phalaris arundinacea)* patches	Grass ~ 6"

Year	Month	Area	Action	Desired Outcome	Timing
2022	Oct	OW3-OW5	Mow rows	Remove vetch (*Vicia spp.*) and Velvet grass *(Holcus lanatus)* biomass to prepare for spraying	Vetch (*Vicia spp.*)~ 12"
2022	Oct	OW1, OW2	Glyphosate broadcast habitat patches of 5m^2	Reduce vegetation in concentrated patched for later seeding.	Leaf stage
2022	Oct	OW3-OW5	Triclopyr spot spray	Manage Himalayan blackberry (*Rubus armeniacus*) while it is sending energy reserves into root system	Fruiting stage
2023	Mar-Apr	OW3-OW5	Broadcast clethodim or fluazifop-p-butyl with high concentration of surfactant (within label limits)	Manage Velvet grass *(Holcus lanatus)* and reed canarygrass *(Phalaris arundinacea)* before they grow flowering spikes	Velvet grass *(Holcus lanatus)* <6"
2023	Apr-May	OW3-OW5	Glyphosate ring spray	Release shrubs from competition	Spring green-up
2023	Apr-May	OW3-OW5	Mow rows	Prevent vetch (*Vicia spp.*) from seeding	Vetch (*Vicia spp.*)~ 12"
2023	May	OW1-OW3	Mow blackberry (*Rubus armeniacus*)	Remove canes and free native shrubs. Mow native shrubs as needed to cut back blackberry (*Rubus armeniacus*).	Leaf stage
2023	May	OW1-OW5	Assessment	Assess weeds and repeat treatments as necessary	Spring green-up
2023	May	OW3-OW5	Map shrubs	Produce GPS map for mowing operator to do ongoing maintenance	Leaf stage
2023	May	OW3-OW5	Clopyralid spot spray	Manage oxeye daisy *(Leucanthemum vulgare)*, tansy, and thistle (caution near lupine)	Rosette stage
2023	May	OW1, OW2	Prep habitat patches with glyphosate spray	Reduce thatch and prepare for fall seeding	Spring green-up
2023	Jul	OW3-OW5	Mow rows	Prevent vetch (*Vicia spp.*) from seeding.	Vetch (*Vicia spp.*)~ 12"
2023	Sep	OW3-OW5	Triclopyr spot spray	Manage Himalayan blackberry (*Rubus armeniacus*) while it is sending energy reserves into root system	Fruiting stage
2023	Nov	OW1, OW2	Seed "Wet Prairie" seed mix by belly bag or hand	Improve species diversity without managing Velvet grass *(Holcus lanatus)* on a large scale	After first fall rain
2023	Nov	OW1, OW2	Plant	Introduce wet-tolerant species to site to increase species diversity	After first fall rain
2024	Apr-May	OW1-OW5	Assessment	Assess weeds and repeat treatments as necessary	Spring green-up

Figure 6. Mowing in between planting rows reduces competition with invasive grasses and forbs in the Graham Oaks woodland.

5. REFERENCES

Metro (2012) Ice Age Tonquin Trail Master Plan: Connecting the cities of Wilsonville, Tualatin, and Sherwood in Oregon. Portland, Oregon.

Metro (2019) Draft Graham Oaks Nature Park Site Conservation Plan. Portland, Oregon.

APPENDIX A: GRAHAM OAKS SOIL SURVEY

Soil Compaction and Oregon White Oak Stunting at Graham Oaks Nature Park

6/23/2022

Report prepared for Metro

Report prepared by Sara Alaica and Tyler Roberts

Institute for Applied Ecology

PREFACE

IAE is a non-profit organization whose mission is the conservation of native ecosystems through restoration, research, and education. IAE provides services to public and private agencies and individuals through development and communication of information on ecosystems, species, and effective management strategies. Restoration of habitats, with a concentration on rare and invasive species, is a primary focus. IAE conducts its work through partnerships with a diverse group of agencies, organizations, and the private sector. IAE aims to link its community with native habitats through education and outreach.

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Cover photographs: Planted Oregon white oak woodland. Photo by Sara Alaica.

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Soil Compaction and Oregon White Oak Stunting at Graham Oaks Nature Park

1. EXECUTIVE SUMMARY

The Graham Oaks Nature Park planted woodland has experienced uneven growth and stunting of Oregon white oak (*Quercus garryana*). This project investigated compaction as a limiting factor for Oregon white oak establishment by digging four soil pits and evaluating soil horizons. We found no evidence of compaction on the site. Soil textures across soil pits were uniform, roots were present throughout, and we easily penetrated the soil with probes. The soil pits revealed the presence of anaerobic conditions and varying levels of inundation which may be influencing oak establishment. We recommend managing these areas as wet meadow rather than oak woodland.

2. INTRODUCTION

Graham Oaks Nature Park is located in Wilsonville, OR, approximately 20 miles south of Portland. Once an oak savannah, the site that is now Graham Oaks Nature Park was cleared for agriculture and was most recently farmed for rye grass seed production. In 2008, 58 acres of the agricultural field were planted with Oregon white oak (*Quercus garryana*), ponderosa pine (*Pinus ponderosa*) and a mix of shrubs to restore an oak woodland on the property. Oregon white oak establishment has been uneven, with some trees reaching 4.5 m tall, while others are stunted and experience high mortality.

The goal of this project is to investigate possible reasons for Oregon white oak stunting in the planted oak woodland.

This project has two primary objectives:

1) Determine whether there is evidence of compaction; and

2) Provide restoration recommendations

3. METHODS

We selected four areas in the planted oak woodland of Graham Oaks Nature Park to dig soil pits: two where Oregon white oaks were establishing well, and two where growth was stunted (Figure 1).

Soil pit 1 is on the eastern edge of the planted oak woodland and was highlighted by Metro staff as a successful planting area. Oregon white oaks in this area average 4.5 m tall (Figure 2). Soil pit 2 is directly east of Alta Ct. In a spring 2022 field visit, this area had water pooling at the surface. Oregon white oaks in this area average 3 m tall and have high mortality (Figure 3). Soil pit 3 is in the remnant oak woodland triangle at the edge of the park. Mature, well-established oaks in this area average 9 m

tall (Figure 4). Soil pit 4 is in the western part of the planted oak woodland and was identified by Metro staff as an area where Oregon white oaks struggle to establish. Oregon white oaks in this area average 3 m tall, have high mortality, and have poor canopy cover (Figure 5).

At each location, we chose a site equidistant from an Oregon white oak and dug a soil pit 40 cm deep. We retrieved an additional 20 cm soil sample using a soil probe.

FIGURE 1. LOCATION OF SOIL PITS AT GRAHAM OAKS NATURE PARK, WILSONVILLE, OR

4. RESULTS

The horizon of soil pit 1 was uniform throughout (Figure 6). Soil pit 2 had redoximorphic soils beginning at 30 cm (Figure 7), with the same features starting at 35 cm in soil pit 3 (Figure 8) and at 40 cm in soil pit 4 (Figure 9). The soils in pit 3 were redder than at the other sites (Figure 8). The lowest 40-60 cm of soil sampled by probe in pit 4 were grey (Figure 13).

FIGURE 2. AVERAGE TREE SIZE AT SOIL PIT 1, GRAHAM OAKS NATURE PARK, WILSONVILLE, OR

FIGURE 3. AVERAGE TREE SIZE AT SOIL PIT 2, GRAHAM OAKS NATURE PARK, WILSONVILLE, OR

FIGURE 4. AVERAGE TREE SIZE AT SOIL PIT 3, GRAHAM OAKS NATURE PARK, WILSONVILLE, OR

FIGURE 5. AVERAGE TREE SIZE AT SOIL PIT 4, GRAHAM OAKS NATURE PARK, WILSONVILLE, OR

FIGURE 6. UNIFORM SOIL HORIZON, PIT 1, GRAHAM OAKS NATURE PARK, WILSONVILLE, OR

FIGURE 7. REDOXIMORPHIC HORIZON, PIT 2, GRAHAM OAKS NATURE PARK, WILSONVILLE, OR

FIGURE 8. REDOXIMOPRHIC HORIZON AND RED SOIL, PIT 3, GRAHAM OAKS NATURE PARK, WILSONVILLE, OR

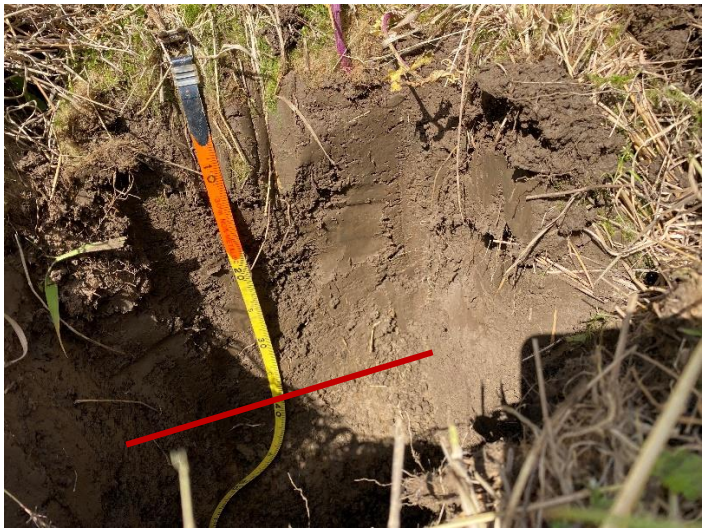


FIGURE 9. REDOXIMOROPHIC HORIZON, PIT 4, GRAHAM OAKS NATURE PARK, WILSONVILLE, OR

FIGURE 10. SOIL HORIZON, 40-60 CM, PIT 1, GRAHAM OAKS NATURE PARK, WILSONVILLE, OR

FIGURE 11. SOIL HORIZON 40-60 CM, PIT 2, GRAHAM OAKS NATURE PARK, WILSONVILLE, OR

FIGURE 12. SOIL HORIZON, 40-60 CM, PIT 3, GRAHAM OAKS NATURE PARK, WILSONVILLE, OR

FIGURE 13. SOIL HORIZON, 40-60 CM, PIT 4, GRAHAM OAKS NATURE PARK, WILSONVILLE, OR

5. DISCUSSION

We did not find evidence of compaction. We were able to insert the probe to the same depth at each location, with equally low amounts of pressure. In all soil pits, the texture was vertically uniform, with roots growing evenly throughout the soil profile.

Soil pits 2, 3, and 4 all showed varying degrees of inundation. Soils contain large amounts of iron, which appear red, orange, and yellow when dry. When soils are flooded, anaerobic conditions cause iron reduction, which makes soil appear gray. If soils are seasonally inundated and dry out periodically, the iron reoxidizes when it comes into contact with oxygen and becomes mottled in appearance (Figure 14). The presence of grey or mottled soil is an indicator of flooding and saturation (Craft 2016).

FIGURE 14. REDOXIMORPHIC SOIL FEATURES, PIT 2, GRAHAM OAKS NATURE PARK, WILSONVILLE, OR

Pit 2 had the shallowest horizon, indicating that the soil is seasonally saturated as close as 30 cm to the surface. Pit 4 was the wettest site: it was the only place where we found gray soil, indicating longer-term inundation and standing water. When the probe was extracted, we heard and felt water suction, suggesting that the water table is close to the surface. Pennyroyal (*Mentha pulegium*) was also growing at this location, a species common in wetlands.

Oregon white oak is adapted to flooding but grows slower and experiences higher mortality on wet soils that are seasonally inundated (Devine and Harrington 2010). It is possible that the stunted growth at soil pits 2 and 4 is due to the high-water table, which explains why the Oregon white oaks growing at pit 1, where flooding is not occurring had better establishment.

However, this does not explain why the mature Oregon white oaks growing in the oak triangle under similar conditions reached 9 m. It could be that these trees are also stunted and are much older than their height suggests. Metro may want to core these trees to test this hypothesis. It is more likely that since the oak triangle was not farmed, the soils differ in nutrient composition. This difference in organic content between the mature Oregon white oak stand and the planted woodland can be seen in the varying soil color between pit 3 and the other sites. Metro may want to have soil samples tested for N, P, K, Ca, and Mg levels. If deficiencies are found, soil amendments can be applied to the sites to improve growth.

6. MANAGEMENT RECOMMENDATIONS

- Reclassify the compacted site (Figure 1, green) and western woodland (Figure 1, yellow) from oak woodland to wet meadow
- Plant and/or seed the sites with wet meadow species such as sedges *(Carex spp.*), rushes (*Juncus spp.*), popcorn flower (*Plagiobothrys figuratus)* and gumweed (*Grindelia integrifolia)*

- Manage pennyroyal to prevent spreading into remainder of wet meadow
- Core a sample of Oregon white oaks in the oak triangle to determine age
- Collect soil samples from the oak triangle and adjacent land and test for N, P, K, Ca, and Mg

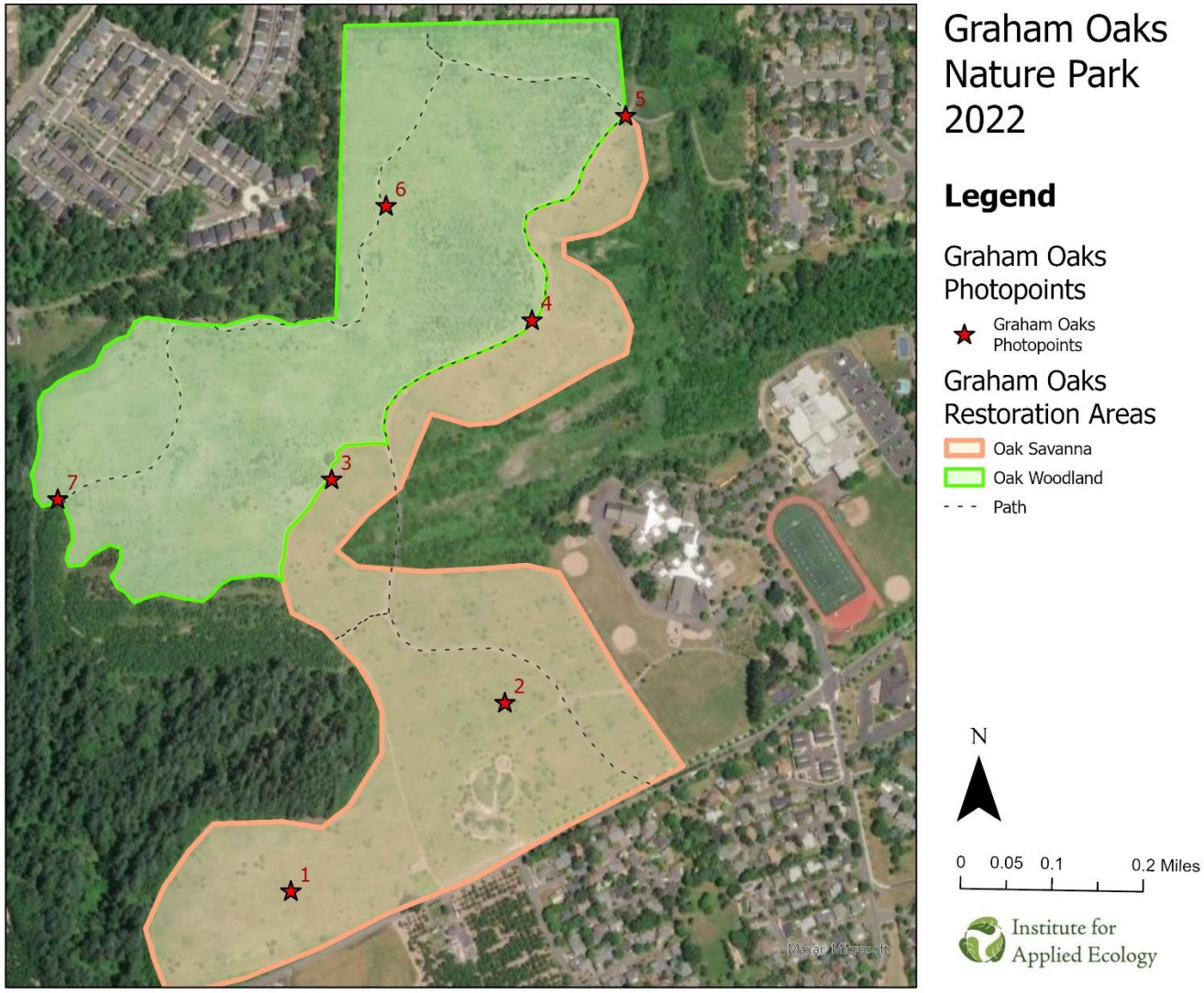
7. REFERENCES

Craft, C. 2016. *Creating and restoring wetlands: from theory to practice*. Elsevier. Boston, MA.

Devine, W, Harrington, C. 2010. Planting native oak in the Pacific Northwest. Portland, OR: US Department of Agriculture, Forest Service, Pacific Northwest Research Station.

APPENDIX B: GRAHAM OAKS PHOTOPOINTS

Graham Oaks Photo Points



Graham Oaks Nature Park 2022

Legend

Graham Oaks Photopoints

Graham Oaks Photopoints

Graham Oaks Restoration Areas

Oak Savanna

Oak Woodland

Path

N

0 0.05 0.1 0.2 Miles

Institute for Applied Ecology

1. South Arm 05/18/2022 (45.2964724°N 122.8013138°W)

North

East

South

West

2. Central Savannah 05/18/2022 (45.2985694°N 122.7979236°W)

North

East

South

West

3. Historic Oak 05/18/2022 (45.3010527°N 122.8006660°W)

North

East

South

West

4. Eastern Savannah 05/18/2022 (45.3028240°N 122.7974947°W)

North

East

South

West

5. Northeast Junction 09/07/2022 (45.305098°N 122.796011°W)

North

East

South

West

6. Central Oak Woodland 09/07/2022 (45.304097°N 122.799804°W)

North

East

Missing

South

West

7. West Oak Woodland Edge 09/07/2022 (45.300832°N 122.805004°W)

North

East

South

West

APPENDIX C: SEED MIX SPECIES LISTS

*Seed mixes based on native Willamette Valley seed mixes from Heritage Seedling, Inc.

Tough and Tenacious Seed Mix*	
Scientific Name	**Common Name**
Achillea millefolium	common yarrow
Amsinckia menziesii var. intermedia	common fiddleneck
Aquilegia formosa	western red columbine
Clarkia amoena	farewell-to-spring
Clarkia purpurea	small-flowered godetia
Clarkia rhomboidea	rhombic-petalled clarkia
Collinsia grandiflora	large-flowered blue-eyed mary
Collomia grandiflora	large-flowered collomia
Eriophyllum lanatum	woolly sunflower
Geum macrophyllum	large-leaves avens
Grindelia integrifolia	Willamette gumweed
Ligusticum apiifolium	celeryleaf-licoriceroot
Lomatium dissectum	fern-leaved lomatium
Lomatium nudicaule	barestem biscuitroot
Lotus purshianus	American bird's-foot trefoil
Madia elegans	showy tarweed
Madia gracilis	common tarweed
Phacelia nemoralis var. oregonensis	Oregon woods phacelia
Potentilla gracilis	slender cinquefoil
Prunella vulgaris var. Lanceolata	common selfheal
Ranunculus occidentalis	western buttercup
Rumex salicifolius	willow dock
Sanguisorba annua	western burnet
Sidalcea campestris	meadow checkermallow
Sidalcea malviflora ssp. *virgata*	dwarf checkermallow
Symphyotrichum hallii	Hall's aster

Wet Prairie Mix*	
Scientific Name	**Common Name**
Carex densa, Carex leporina	dense sedge, eggbract sedge
Carex pachystachya, Carex scoparia	chamisso sedge, pointed broom sedge
Carex stipata, Carex unilateralis	sawbeak sedge, one-sided sedge
Agrostis exarata, Danthonia californica	spike bentgrass, California oatgrass
Deschampsia cespitosa and D. elongata	tufted hairgrass, slender hairgrass
Juncus ensifolius, J. tenuis	dagger-leaved rush, poverty rush
Achillea millefolium	common yarrow
Asclepias speciosa	showy milkweed
Barbarea orthoceras	American yellowrocket
Camassia leichtlinii	great camas
Clarkia amoena	farewell-to-spring
Clarkia purpurea	small-flowered godetia
Downingia elegans	showy downingia
Epilobium densiflorum	dense spike-primrose
Eriophyllum lanatum	woolly sunflower
Grindelia integrifolia	Willamette gumweed
Lupinus rivularis	riverbank lupine
Madia elegans	showy tarweed
Erythranthe guttata	monkeyflower
Perideridia oregana	Oregon yampah
Plagiobothrys figuratus	fragrant popcorn flower
Plectritis congesta	rosy plectritis
Potentilla gracilis	slender cinquefoil
Prunella vulgaris var. lanceolata	common selfheal
Ranunculus orthorhyncus	straightbeak buttercup
Sanguisorba annua	western burnet
Sidalcea campestris	meadow checkermallow
Symphyotrichum hallii	Hall's aster
Thalictrum polycarpum	mountain meadow-rue